Title: Standard Operating Procedure for Sabio 2010 and 4010 Dilution Calibrator		
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1. INTRODUCTION AND SCOPE

This procedure is intended to describe the operations of the Sabio model 2010 and 4010 dilution calibrators. These dilution calibrators were designed to provide the highest standard of quality and performance in a light weight durable package. This procedure describes the set up and operational requirements of the Sabio model 2010 and 4010 calibrator to complete a multipoint calibration on an ambient air monitoring analyzer with the additional section describing the gas phase titration portion of the NO_2 calibration.

This method adheres to the requirements of the current Air Monitoring Directive (AMD) drafted by Alberta Environment in 1989. In some cases the limits and specifications exceed the requirements of the current AMD and subsequent amendments. It should be considered that the current and any future amendments or drafts of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

The principle of this method utilizes Mass Flow Controllers (MFC) to regulate the flow of two separate gasses and combining the flows to generate a known concentration of gas. The dilution gas source is typically zero air and is usually provided by a zero air system consisting of a compressor, air dryer and a scrubbing system for removal of all compounds found in ambient air. A cylinder of Zero Air can also be used. The source gas is provided by a cylinder with a certified analyzed amount of the compound of interest with a balance of Nitrogen gas. Each of these flows are controlled separately with individual mass flow controllers. The controlled flows then exit the MFCs and are combined in a mixing chamber to generate a homogonous gas mixture that exits the calibrator to introduce to the analyzer being calibrated.

The Sabio model 2010 and 4010 calibrators are equipped with an Ozone generator to complete both the GPT portion of a NO_2 calibration and an Ozone monitor calibration. The Ozone generator is a mercury lamp that emits UV light to form Ozone. The Ozone generator is regulated by an optical detector that measures the intensity of UV light and correlates that to the last calibrated amount of Ozone. See figure 1 for flow path.

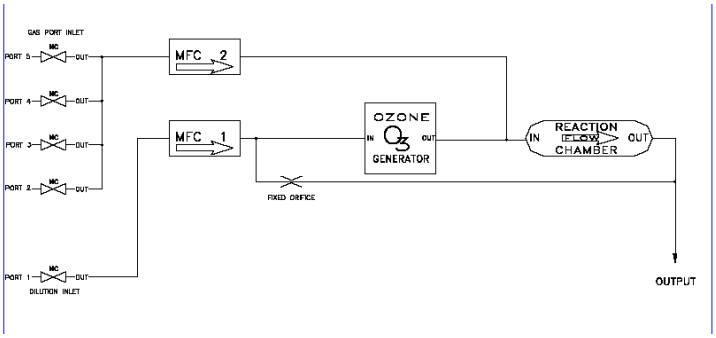

Figure 1 – Typical flow path

Gas Calculations:

To calculate the output concentration utilizing calibration gas and zero air:

OGC = (SGC x SGF) / (DF x 1000 +SGF)

Where:

OGC = output gas concentration

SGC = source gas concentration

DF = dilution (zero) air flow in LPM

SGF = source gas flow in CCM

3. MEASUREMENT RANGE AND SENSITIVITY

The Sabio 2010 and 4010 utilizes two MFCs to control the dilution flows, and the Ozone generator described in section 2. These three components of the calibrator govern the range and sensitivity of the calibrator. The table below indicates the range and sensitivity for all three components.

Component	Range	Sensitivity (accuracy)	Repeatability
MFC 1 - Dilution	0 - 10 SLPM	± 1.0% of full scale	± 0.15%
MFC 2 – Gas	0 – 100 SCCM	± 1.0% of full scale	± 0.15%
O_3 generator	0.05 – 1.0 PPM	±2.0% of set point or ±3 ppb @ 4 SLPM	N/A

4. EQUIPMENT AND APPARATUS

The following are components that are used with this SOP to complete a multipoint calibration on an ambient analyzer. Different available brand names may be used, but essentially provide a similar function.

- Sabio 2010 or 4010 dilution calibrator
- Zero air generator
- EPA protocol calibration gas cylinder
- Teflon tubing with appropriate stainless steel fittings. Note: tubing must be free of kinks, cracks, dirt, moisture or other foreign material or defects
- Stainless Steel two stage regulator and proper cylinder gas adapter (CGA)
- Primary reference flow measuring device (BIOS)

5. INTERFERENCES

Interferences with the operation of the dilution calibrator are typically the two listed below. However, it must be considered that when changing calibration gases, residue of one gas may interfere with the next gas used. A good practice to reduce the possibility of these types of interferences is to flush the calibrator thoroughly with zero air after the completion of each multipoint calibration.

Two common interferences with a dilution calibrator are:

- Moisture can consume source gas molecules if allowed to enter the system. This is prevented by ensuring the zero air generator is functioning properly.
- Ambient temperature swings can affect the OGC of the calibrator.

6. PRECISION AND ACCURACY

The measurement precision is generally considered to be the "repeatability of the measurement". Precision in the context of the dilution calibrators relates to the repeatability of the mass flow controllers. The factory specifications for repeatability are quoted in section three of this document. It is, however, prudent to confirm this by conducting MFC calibrations on at least a yearly basis. See section 10.0 in this document for information on these procedures.

The accuracy is generally considered to be the "deviation from true". This means how close it is to what it should be. The factory specifications for accuracy are quoted in section three of this document. Accuracy is also confirmed through yearly MFC calibrations, procedures identified in section 10.

7. SITE REQUIREMENTS

The Sabio 2010 or 4010 and all supporting equipment should be set up inside a temperature controlled structure to avoid influence of temperature drift. It is also recommended to not set up calibration equipment out doors due to effects of the weather, i.e. rain, wind, dust, temperature, etc. The calibrator should be set up so that the controls and display are easily accessible as changes need to be made throughout an analyzer calibration.

The source gas cylinder's regulator needs to be purged prior to connecting the Teflon lines to the calibrator.

8. INSTALLATION REQUIREMENTS

The set up of the calibration system is done at the station where the monitoring is taking place. Follow the steps below for proper set up of the calibration system.

8.1 Prior to disconnecting the analyzer's sample line from the sample manifold, the DAS collecting data from that analyzer must be flagged for calibration.

The Sabio 2010 and 4010 calibrators need to be set up in a location where the controls and display are easily accessible. It can be mounted in a standard 19" instrument rack, or placed on a solid workbench. The vents on the bottom near the front need to be exposed to allow air flow through the calibrator during operation. The zero air generator should be set up nearby, but not adjacent to the calibrator.

9. OPERATIONAL REQUIREMENTS

Detailed descriptions of the operation can be found in the Sabio 2010 or 4010 calibrator operations manual. It is strongly recommended that the operating manual be reviewed prior to completing the steps below.

The Sabio 2010 and 4010 calibrator allows three methods of generating gas concentrations; predefined calibration points stepped manually, predefined calibration points stepped by a timer, and manually entering the desired flows. The Sabio 2010 and 4010 are very flexible calibrators in the way calibration concentrations are generated. The predefined calibration steps can be entered in many different ways to accomplish the same result. It is recommended that the operations manual for the Sabio 2010 or 4010 as applicable is studied, particularly section 5, to become well versed in the operation capabilities of the calibrator. Once a decision is made as to the desired method of generating calibration points, follow the steps outlined in Section 8 and 9 of SOP -011 on Dilution Calibrations to complete a multipoint calibration.

The recommended method of generating points would be to enter in the desired flows for each calibration point for each gas that is typically used in the calibrator, and step through the desired calibration points manually recording the measured flows and cylinder gas concentration on the calibration field sheet.

10. CALIBRATION

Calibration of the Sabio 2010 or 4010 calibrator involves measuring and adjusting the MFC's (if required) the flows generated by the mass flow controllers. Calibration of MFC's on dilution calibrators used by AENV does not need to be completed regularly since AENV calibration procedure requires that both gas and dilution flows be measured at each calibration point. Calibration of the MFC's should be completed as required depending on repairs or problems. Multipoint flow calibrations are conducted on the Sabio 2010 and 4010 calibrators to verify precision, accuracy and linearity of the flow controllers.

Flow calibrations on the mass flow controllers of dilution calibrators are completed using a primary flow meter. The DHI MOLBOX primary flow calibrator or BIOS flow meter with a date-current calibration certificate are used for this purpose.

10.1 Flow calibration

Calibration procedures specific to the Sabio 2010 and 4010 calibrator can be found in section 8 of each calibrator's operation manual.

10.2 Calibrator Maintenance

Preventative maintenance tasks should be completed on the calibrator on a periodic basis. These tasks are outlined in the operations manual. A strict regiment of these tasks should be adhered to as they are intended to fix a problem before it happens. Any maintenance must be recorded in the instrument log book and/or a electronic logbook.

11. APPLICABLE DOCUMENTS

- **EM-012a** Sabio 4010 Gas Dilution Calibrator operations manual
- **EM-012b** Sabio Model 4010 Calibrator With Ozone Generator and Photometer Options - Key Information and Operating Procedures - Environment Canada 2007-05-04 Version 1.0
- **EM-012c** Sabio 2010 Gas Dilution Calibrator operations manual

12. LITERATURE REFERENCES

None

13. REVISION HISTORY

Revision 1.0 Added reference to EC Key Information document in Section 11

Revision 1.1 added reference to sabio model 2010 dilution calibrators

Revision 1.2 changed “Team Leader” to “Manager”

14. APPROVAL

Approved by: **Harry Benders** **Date: January 27, 2011**

Title: **Air Monitoring Manager**