5.0 *Calibration*

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5.1 Introduction

The following procedures are provided to verify the proper operation, calibration and maintenance of the Gas Module.

5.2 Warnings and Guidelines

In the event that the instrument covers are removed, observe these following warnings and general guidelines:

- Do not short component leads together.
- Perform all steps in the exact order given.
- Use extreme care when reaching inside the opened instrument. Do not contact exposed metal parts which may become live.
- Read through each step in the procedure so it is understood prior to beginning the step.

5.3   Test Equipment and Special Tools Required

Description	Specification
Volt Meter	Standard
Calibration Gas 2% DES, 5% CO_2, 55% O_2, 33% N_2O	P/N 0075-00-0028
Calibration Gas Regulator	P/N 0119-00-0166
Sample Line for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry	P/N 0683-00-0451-XX
Sample Line for Gas Module 3	Adult/Ped: P/N 0683-00-0525-XX Neonate: P/N 0683-00-0524-XX
Spirometry Tester	P/N 0138-00-0011

5.4   Power-Up Verification

5.4.1   Passport XG Configuration for Gas Module

The Passport XG must be configured to communicate with the Gas Module. To configure the Passport XG for use with the Gas Module:

1. Turn on the Passport and wait for the "Diagnostics in Progress" message to appear.
2. While the message is displayed press and hold the **FREEZE** key until the User Configuration screen appears.
3. Use the down arrow to choose **Serial Output Type**.
4. Press **SELECT** to activate the sub-menu.
5. Press either arrow until **Gas Module** appears in the highlighted area.
6. Press **SELECT**, then press and hold the **EXIT** key for three (3) seconds to return to normal operation.

NOTE: **Setting the "Serial Output Type" to any other selection activates the Passport XG's on-board CO_2 function and deactivates the Gas Module.**

Electrical Connection and Power On

Verify that the Interface cable is connected between the Passport XG's J1 connector and the Gas Module's rear panel Interface connection. Attach a sample line to the front panel water trap inlet. Turn on the Gas Module by switching its power switch to "1".

Warm Up

The Gas Module begins its warm up by changing the "Disconnected" message to "Warming Up" approximately 15 seconds after turn on. The messages "Warming up", "Agent Warming Up", and "Zero in Progress" alternate in the message area for approximately two (2) minutes. After two (2) minutes the CO_2, N_2O, O_2, and respiration displays become active. The agent display becomes active after approximately five (5) minutes. Automatic zeroing of all Gas channels will take place at 5, 10, 15 and 30 minutes after turn-on and at 60 minute intervals thereafter.

5.4.2   Expert Configuration for Gas Module

The Expert must be configured to communicate with the Gas Module. To configure the Expert to be used with the Gas Module perform the following steps:

1. Under the Service Panel of the Expert, set Dip switch #5 to ON to accept Gas Module II information. Refer to the Expert Operating Instructions, section 2.2 "Main Control Unit" for information on the location of the dip switch.

2. Set the soft switch for the CO_2 Source to "GAS monitor". Refer to section 3.29.15 of the Expert Operating Instructions for more information on the soft switch setting.

3. For more information on the Gas Module Operation with the Expert, refer to section 3.21.2 of the Expert Operating Instructions.

Electrical Connection and Power On

Verify the interface cable is connected between the Expert RS-232C connector and the Gas Module rear panel interface connection. Attach a sample line to the front panel water trap inlet. Turn on the Gas Module by switching it's power switch to "1".

Warm Up

The Gas Module begins its warm up by changing the "Disconnected" message to "Warming Up" approximately 15 seconds after turn on. The messages "Warming Up," "Agent Warming Up" and "Zero in Progress" alternate in the message are for approximately two (2) minutes. After two (2) minutes the CO_2, N2O, O_2 and respiration displays become active. The agent display becomes active after approximately five (5) minutes. Automatic zeroing of all Gas channels will take place at 5, 10, 15 and 30 minutes after turn-on and at 60 minute intervals thereafter.

5.4.3   Passport 2/Spectrum/Spectrum OR Configuration for the
         Gas Module

The Passport 2, Spectrum and Spectrum OR must be configured to communicate with the Gas
Module as follows:

1. Access the Installation Menu by pressing and holding the **DISCHARGE** key
   (**Passport 2/Spectrum**®) or the **TRENDS** key (**Spectrum OR**™) while powering
   ON the monitor.

2. Rotate to the **Set up Serial Port 1** menu choice and press the Navigator knob.

3. Rotate to **GMII** or **Gas Module** and press the Navigator knob to accept the selection.

4. Rotate to the **Save Current** menu choice and press the Navigator knob.

5. Powering **OFF** the monitor. Wait 3 seconds and power **ON** the monitor.

NOTE: **Setting Serial Port 1 to any other selection activates the
             monitor's on board CO_2 function and deactivates the Gas
             Module.**

Electrical Connection and Power On

Verify the Interface cable is connected between the Passport 2/Spectrum/Spectrum OR SP1
connector and the Gas Module's rear panel Interface Connection. Attach a sample line to the
front panel water trap inlet. Turn on the Gas Module by switching its power switch to "1".

Warm Up

Gas Module II, Gas Module SE, and Gas Module SE with Spirometry – The Gas
Module begins its warm up by changing the "Disconnected" message to "Warming Up"
approximately 15 seconds after turn on. The messages "Warming Up", "Agent Warming
Up" and "Zero in Progress" alternate in the message area for approximately two (2) minutes.
Automatic Zeroing of all channels will take place at 2, 4, 10, 15 and 30 minutes after turn
on and at 60 minute intervals thereafter.

Gas Module 3 – "Warming Up" is displayed until ISO accuracy is reached (approximately
45 seconds). During this period, two room air reference measurements are taken. Thereafter
they occur automatically whenever the bench temperature has changed 1°C. When the Gas
Module 3 has reached full accuracy (approximately 10 minutes), reference measurements
are taken every 4 hours.

5.5   Gas Module 3 Pneumatic Leakage Test

This test does not require any extra equipment. It is recommended that this test be performed prior to each use.

1. Start the multigas system and occlude the gas sample inlet of the water trap.
2. Verify that the Gas Module 3 reports occlusion and enters purge mode.
3. Wait 10 seconds for stabilization.
4. Verify that the gas flow reported by the Gas Module 3 is less than 7 ml/min.

NOTE: **At occlusion, gas trapped in the pump may oscillate and make the Gas Module 3 flow meter report a false flow reading, even though the actual flow is 0 ml/min.**

If the pneumatic leakage test fails, the pneumatic system should be carefully checked for leaks and damaged tubing, the water trap should be replaced and the test should then be repeated.

5.6   Gas Module 3 Zero Reference Valve Test

NOTE: **An incorrect zero reference measurement can occur if ambient CO_2 is too high. The limits for ambient CO_2 concentration are: 300 – 800 ppm.**

1. Power up the system and allow it to enter mode (10 minutes).
2. Note the CO_2 level.
3. Run gas through the system.
4. Perform a manual calibration.
5. After the calibration procedure, verify that the CO_2 level is close to the level that was noted in step 2.

5.7   Calibration

5.7.1   Passport XG Gas Calibration

Accuracy verification of the Gas Module is recommended at six (6) month intervals or whenever gas readings appear to be in error. The date of the last successful mixture calibration appears at the bottom of the "Gases" menu. The operator may elect to perform a Zero calibration (lasting approximately 10 seconds) or a Span calibration (lasting approximately 2 minutes) at any time. During the calibration session gas readings and all other gas functions are not available.

Zero calibration is a single action command that compensates all gas channels for the effects of offset drift. Zero calibration may be performed on command and also takes place automatically at preset intervals. To manually perform a Zero cal, choose 'YES' from the Zero calibration gas menu (refer to Gas Monitor Calibration section of the Passport Operating Instructions).

Span calibration is a set of prompted commands that enables the operator to align the gas display(s) to specific gas concentration(s) within the Calibration Gas canister. Span calibration can be initiated by the operator any time the gas module's readings are suspected to be inaccurate. Span calibration should be performed if after performing a Zero cal, the gas readings do not display the accurate valves.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: **The Gas Module must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.**

1. Select Start Calibration and "Yes" within the Gas Module Menu (refer to section Gas Monitor Calibration section of the Passport Operating Instructions). The menu shown on the next page will appear:

```
┌──────────────────────────────────────┐
│          CHANGE CAL GAS              │
│──────────────────────────────────────│
│ CalGas Selection:      ▐ Mixture ▌   │
│                                       │
│ Calibrate:      No                   │
│──────────────────────────────────────│
│ Choices:   Mixture,    5%    Co₂,    │
│                                       │
│ 55% O₂,    33% N₂O,      2% DES      │
│──────────────────────────────────────│
│ ↕ = Adjust value        Exit = Quit  │
│   SELECT = Enter/move                │
└──────────────────────────────────────┘
```

FIGURE 5-1 Start Calibration Menu

2. Select the calibration gas type from the choices, and "Yes" to start calibration.

3. If Mixture has been selected, the following window will appear:

CALIBRATION DATA
Co_2
O_2
N_2O
DES:
Zero In Progress
Exit = Cancel Calibration

FIGURE 5-2 Calibration Data

4. At the start of the calibration, the Gas Module will zero the gas channels. After a successful zeroing, the Gas Module will request the calibration gas.

NOTE: **If the Gas Module cannot zero, a "zeroing error" will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, call for service.**

5. The message "Feed Calibration Gas" will appear. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

6. When sampling is complete, a "Continue?" message will appear below the gas monitor's currently measured values. Selecting "Yes" will set these currently measured values to the following specified values; 5.0% CO_2, 55% O_2, 33% N_2O, and 2.0% Desflurane. The operator must take care that the cal gas being applied matches the value that the gas monitor will set them to. If for any reason it is desirable to cancel the calibration, i.e. the cal gas does not contain the correct gas concentrations, press **EXIT** to abandon the calibration attempt. If the values are acceptable, press the **SELECT** key. The entire calibration must be accepted as a whole or not at all.

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure, prior to storage.**

7. The message "Calibration Complete" will appear when all the channel(s) have been successfully calibrated. Any channel that has been adjusted will display "Adj".

CALIBRATION DATA		
Co_2	5.0%	ADJ
O_2	55%	ADJ
N_2O	33%	ADJ
DES:	2.0%	ADJ
Calibration Complete		
Exit = Quit		

FIGURE 5-3 Calibration Completed

NOTE: **If any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear under the "Continue?" message and "ERR" will be displayed next to any channels with a sampling error. Pressing select will calibrate only those channels that do not have a sampling error.**

If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, call for service.

5.7.2   Expert Gas Module Calibration

Accuracy verification of the Gas Module is recommended at six (6) month intervals or whenever gas readings appear to be in error. The date of the last successful mixture calibration appears in the Gas Calibration menu. The operator may elect to perform a Zero calibration (lasts approximately 10 seconds). During the calibration session gas readings and all other gas functions are not available.

Zero calibration is a single action command that compensates all gas channels for the effects of offset drift. Zero calibration may be performed on command and also takes place automatically at preset intervals. To manually perform a Zero calibration, press the gas numeric window, then press the Start zeroing button.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: **The Gas Module must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.**

1. Select System Config. from the main menu. Press the Pre-Set button followed by the Gas Calibration button. The following menu will appear.
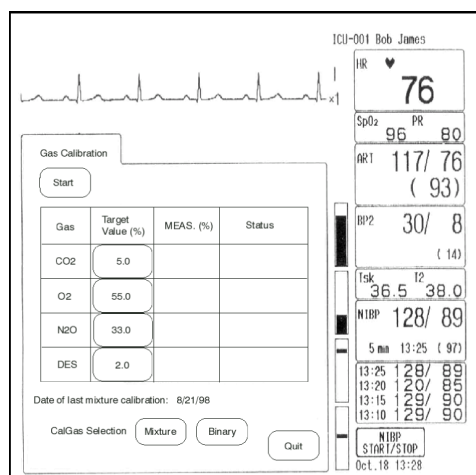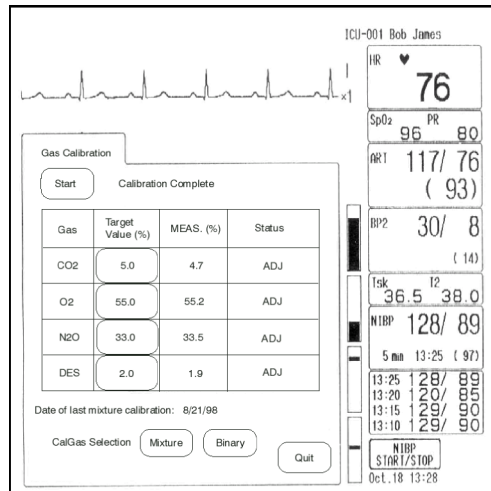

FIGURE 5-4

2. Select either Mixture or Binary (individual gases). If Binary is selected, press the appropriate gas to be calibrated.

3. Press Start to begin the gas calibration routine.

4. At the start of the calibration, the Gas Module will zero the gas channels. After a successful zeroing, the Gas Module will request the calibration gas.

NOTE: **If the Gas Module cannot zero, a "zeroing error" will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, call for service.**

5. The message "Feed Calibration Gas" will appear. At this point, attach the calibration gas canister with regulator to the Gas Module trap and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

6. When sampling is complete, a "Continue?" message will appear. If the values are acceptable, press the YES button. If for any reason, it is desired to cancel calibration, press NO to re-install the previous calibration values. The entire calibration must be accepted as a whole or not at all.

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure, prior to storage.**

7. The message "Calibration Complete" will appear when all the channel(s) have been successfully calibrated. Any channel that has been adjusted will display "Adj".

FIGURE 5-5

NOTE: **If any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear and "ERR" will be displayed next to any channels with a sampling error. Pressing YES will calibrate only those channels that do not have a sampling error.**

If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, call for service.

5.7.3 Gas Monitor Calibration - Passport 2/Spectrum/Spectrum OR

Accuracy verification of the Gas Module II, Gas Module SE, and Gas Module SE with Spirometry is recommended at six (6) month intervals or whenever gas readings appear to be in error. Accuracy verification of the Gas Module 3 is recommended at one (1) year intervals or whenever gas readings appear to be in error.

The date of the last successful mixture calibration appears at the bottom of the gas **Calibration Menu**. During the calibration session gas readings and all other gas functions are not available.

Span calibration is a set of prompted commands that enables the operator to align the gas display(s) to specific gas concentration(s) within the Calibration Gas canister. Span calibration can be initiated by the operator any time the gas module's readings are suspected to be inaccurate.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: **The Gas Module II, Gas Module SE, and Gas Module SE with Spirometry must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.**

NOTE: **The Gas Module 3 must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 10 minutes is recommended.**

5.7.3.1 Passport 2/Spectrum

1. Select **Calibrate** from the **Gas Menu**. The **Calibration Menu** opens.
2. Select **Gas Selection** from the **Calibration Menu** and choose the calibration gas type. Choices are: Mixture, 5% CO_2, 55% O_2, 33% N_2O and 2% Des.
3. Select **Start** to begin calibration.
4. At the start of the calibration, the Gas Module will zero the gas channels. After successful zeroing, the Gas Module will request the calibration gas.
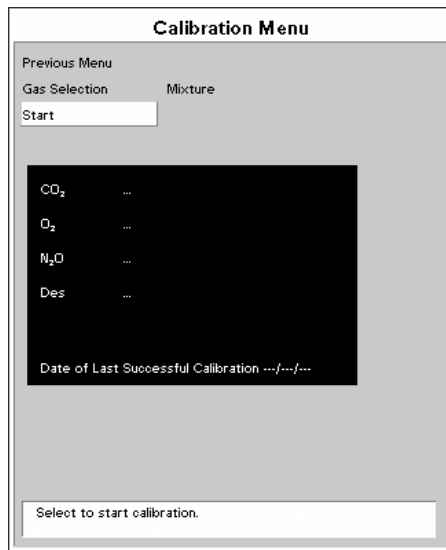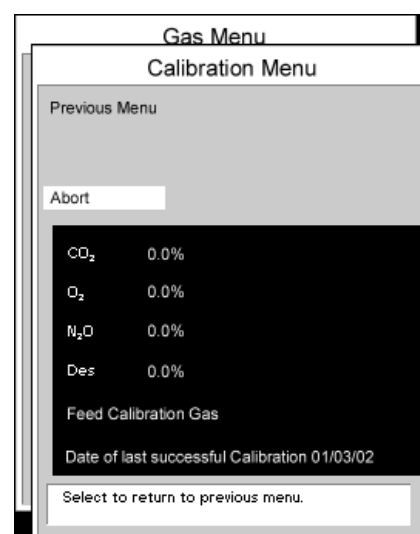
FIGURE 5-6 Calibration Menu

> **NOTE:**   **If the Gas Module cannot zero, a zeroing error will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, contact Technical Support.**

5. The message **Feed Calibration Gas** will appear. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.
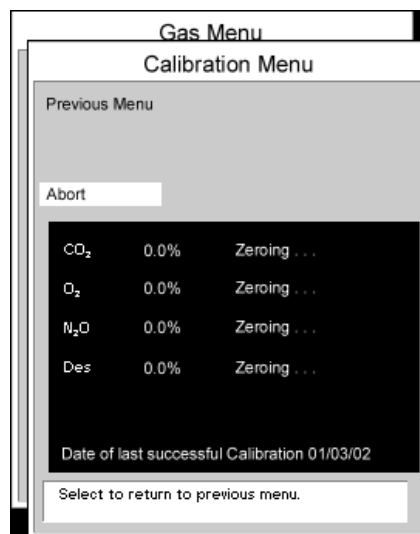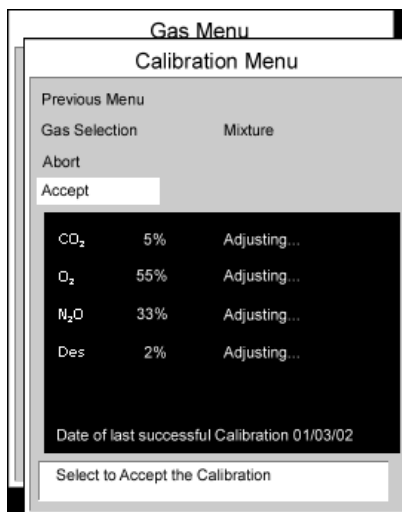

FIGURE 5-7 Gas Calibration Menu

FIGURE 5-8 Gas Calibration Menu

6. When sampling is complete, the **Feed Calibration Gas** message will disappear and **Adjusting** will appear next to each value. An **Accept** menu item will also appear. If the values are acceptable, select **Accept**. To cancel calibration and re-install the previous calibration values, select **Abort**.
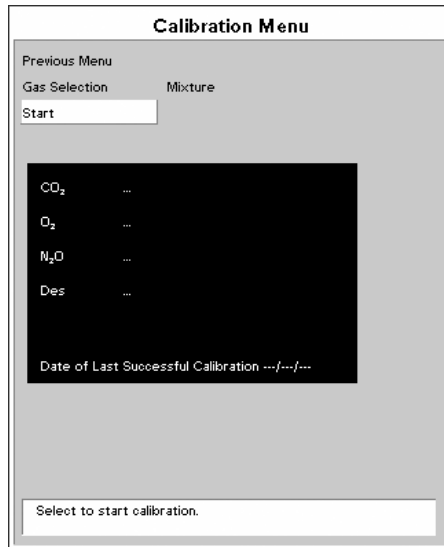

FIGURE 5-9 Gas Calibration Menu

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure.**

NOTE: **For Gas Module II and SE, if any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear. Selecting the "Accept" button will calibrate only those channels that do not have a sampling error. If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, contact Technical Support.**

NOTE: **For Gas Module 3, if any input data is corrupt or if there are other errors, a "Calibration Error" message will appear after the "Accept" button is selected. The Gas Module 3 will not accept span calibration with errors in any channel.**

5.7.3.2   Spectrum OR

1. Select **Calibrate** from the **Gas Menu**. The **Calibration Menu** opens.

FIGURE 5-10 Calibration Menu

2. Select **Gas Selection** from the **Calibration Menu** and choose the calibration gas type. Choices are: Mixture, 5% CO_2, 55% O_2, 33% N_2O and 2% Des.

3. Select **Start** to begin calibration. At the start of the calibration, the message **Zeroing...** will be initially displayed for each of the gas labels as the Gas Module zeros the gas channels. After successful zeroing, the Gas Module will request the calibration gas as indicated in the next step.

NOTE: **If the Gas Module cannot zero, a zeroing error will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, contact Technical Support.**

4. The message **Feed calibration gas** will be displayed. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.
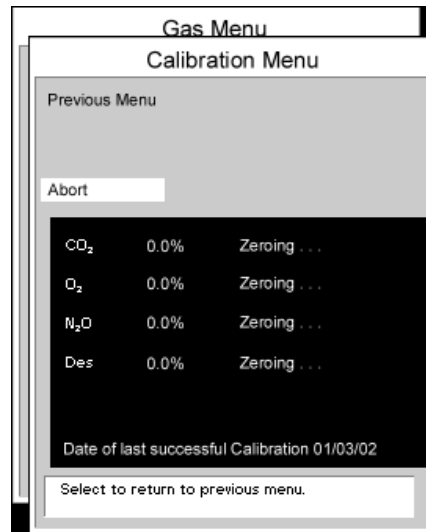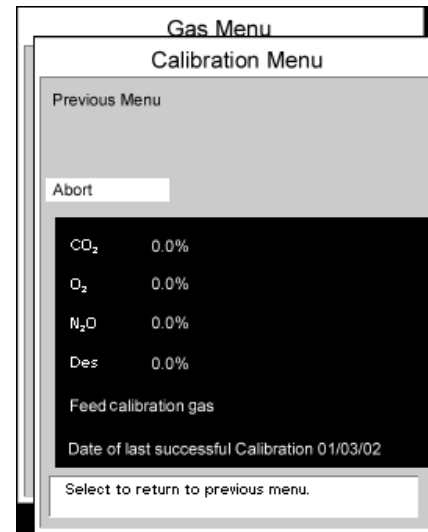

FIGURE 5-11 Gas Calibration Menu

FIGURE 5-12 Gas Calibration Menu

5. When calibration is complete, the **Feed calibration gas** message will be removed from the display and the message **Complete** will be displayed next to each value that was successfully measured. If at least one gas was successfully measured, the **Accept** menu choice will become available. If the values are acceptable, select **Accept**. To cancel calibration and re-install the previous calibration values, select **Abort**.
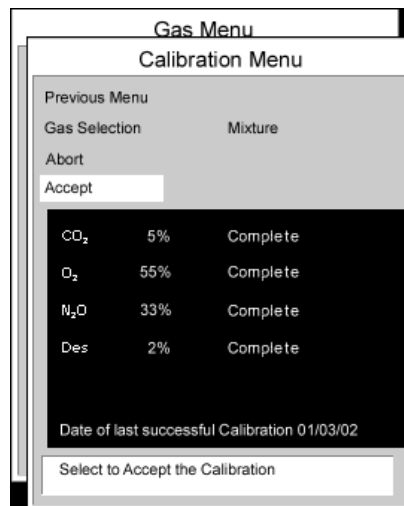

FIGURE 5-13 Gas Calibration Menu

NOTE: **When the "Accept" menu choice is selected, the message "Disconnect calibration gas." will be displayed. To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure.**

NOTE: For Gas Module II, Gas Module SE, and Gas Module SE with Spirometry, if any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will be displayed. Selecting the "Accept" button will calibrate only those channels that do not have a sampling error. If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat the procedure from step 1. If problems persist, contact Technical Support.

NOTE: For Gas Module 3, if any input data is corrupt or if there are other errors, a "Calibration Error" message will appear after the "Accept" button is selected. The Gas Module 3 will not accept span calibration with errors in any channel.