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<b>CALIBRATION AND USE OF MULTI-GAS MONITORS</b>	<b>Document</b>	<b>TFC-ESHQ-S_IH-D-14, REV A</b>
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<b>FUNCTIONAL AREA MANAGER:</b>		<b>T. J. Anderson</b>
<b>DOCUMENT OWNER:</b>		<b>J. W. Jabara</b>

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**CALIBRATION AND USE OF  
MULTI-GAS MONITORS**

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**1.0 PURPOSE AND SCOPE**

This guidance document provides instructions to industrial hygienists and industrial hygiene technicians for calibrating and using Industrial Scientific multi-gas monitors (models TMX410, TMX412, LTX310, and the MX251). These instruments are used to detect combustible gases/vapors (% lower explosive limit (LEL)), oxygen levels (% v/v), as well as up to two of the following pollutants: carbon monoxide, hydrogen sulfide, chlorine, sulfur dioxide, and nitrogen dioxide. The MX251 only detects combustible gases/vapors and oxygen levels.

These instruments can be used with a motorized sampling pump to enable the operator to monitor adjacent air spaces or perform remote sampling (such as confined spaces and tanks). The monitors take real-time measurements and activate alarms when measurements exceed preset limits. The monitors and their associated pumps are tested and rated intrinsically safe in explosive gas/air mixtures.

**2.0 IMPLEMENTATION**

This guidance document is effective on the date shown in the header.

**3.0 RESPONSIBILITIES**

Responsibilities are contained within Section 4.0.

**4.0 PROCEDURE****4.1 Operation and Calibration of the Industrial Scientific TMX412 Multi-Gas Monitor**

NOTE: To ensure maximum safety, perform a functional (bump) test prior to use each day. This check will be most accurate if the instrument has been in a stable temperature environment for at least one hour before testing.

Industrial Hygienist  
or Industrial Hygiene  
Technician

1. Identify the required sensors for the specific gases/vapors to be monitored. Refer to the appropriate sampling plan to determine the required sensors.
2. Select an appropriately configured multi-gas monitor and an appropriate motorized sampling pump, if needed, (see Section 4.5) and remove them from their charger.

NOTE: A green light on the charger indicates a fully charged battery.

3. Verify the maintenance calibration date on the sticker from the Industrial Hygiene Equipment Laboratory (IHDL) is current for both the monitor and the sampling pump.
  - a. If calibration is past due, return the instrument to the equipment custodian.
  - b. If calibration is current, use the instrument.

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4. Turn on the monitor by pressing and holding the MODE button (found on the bottom of the monitor). The display will read HOLD and the instrument sounds a short beep approximately once every second. Continue holding the MODE switch in until RELEASE is displayed, at which time you release the MODE button.

NOTE 1: After the instrument is turned on, the following start-up screens will be displayed:

- SENSOR CONFIGURATION, which indicates the type of sensors installed in the instrument
- WARM-UP TIMER, which indicates the number of seconds remaining until the instrument begins normal operation.

NOTE 2: After the warm-up sequence is complete, the instrument will enter the normal operating mode and will be continuously monitoring all calibrated sensors.

5. Verify that the correct sensors are installed by observing the display during the start-up cycle.
6. Allow the unit to warm up for several minutes.
7. Perform a battery check by looking at the battery status indicator, which is located above BATT.
  - a. If the battery status indicator shows some segments or all segments, the battery is good; proceed to step 8.
  - b. If the battery status indicator is not displayed, the battery is dead. Turn the instrument off by pressing and holding the MODE button until RELEASE is displayed. Put the instrument on a charger station or replace the battery package.
8. Press the MODE button twice to see ZERO display. Press the E button to start zeroing and span oxygen sensor.

NOTE 1: Zeroing the instrument in clean air is preferred, provided that there is no trace of toxic or combustible gas that would cause the instrument to respond. If the air purity is uncertain, use a cylinder of zero grade air to zero the instrument and span the oxygen sensor.

NOTE 2: The zeroing process will take about 40 seconds. The unit will beep when finished and the screen will display "GO CAL PRESS (E) TO CAL".

9. Wait a few seconds and the instrument will switch back to normal operating mode.

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10. Obtain a test cup or an appropriate motorized sampling pump (see Section 4.5) and attach tubing from the cup or sampling pump to the appropriate calibration gas cylinder.

NOTE: If using the test cup, the gas cylinder should have a one liter per minute regulator attached to it. If using the motorized sampling pump, the gas cylinder should have a pressure demand valve.

11. Install the test cup over the instrument's sensor ports or attach the sampling pump to the monitor.

NOTE: If using the motorized sampling pump to perform the bump test, refer to Section 4.5 prior to performing the following step.

12. Apply the calibration gas. **Wait two minutes to get an accurate measurement.**

13. Record the results on the Industrial Hygiene Direct Reading Instrument Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: The results should be within 10% of the calibration gas concentrations.

14. Repeat steps 12 and 13 if a second cylinder of calibration gas is used.
15. Press the MODE button four times until PK CLR PRESS (E) TO RESET is displayed, and then press the E key to clear the previous peak readings. The instrument will return to the normal operating mode after a few seconds.

NOTE: The instrument is now ready for field use.

16. Perform monitoring in accordance with [TFC-ESHQ-S\\_IH-D-22](#) and the Industrial Hygiene sampling plan, if applicable.

17. When sampling is completed, turn the TMX412 off by pressing and holding the MODE button until RELEASED is displayed, then release the button. The instrument will turn off.

NOTE: The instrument will emit short beeps while going through the shut-down cycle.

18. Record all sampling data on the Industrial Hygiene Direct Reading Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: If using a motorized sampling pump, the identification number for the pump and its calibration date should be recorded on the survey report.

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19. Provide the completed sampling forms and associated field records to the industrial hygienist in a timely manner.

#### 4.2 Operation and Calibration of the Industrial Scientific TMX410 Multi-Gas Monitor

Industrial Hygienist  
or Industrial Hygiene  
Technician

1. Identify the required sensors for the specific gases/vapors to be monitored. Refer to the appropriate industrial hygiene sampling plan to determine the required sensors.
2. Select an appropriately configured multi-gas monitor and an appropriate motorized sampling pump, if needed (see Section 4.5), and remove them from their charger.

NOTE: A green light on the charger indicates a fully charged battery.

3. Verify the maintenance calibration date on the sticker from the IHEL is current for both the monitor and the sampling pump.
  - a. If calibration is past due, return the instrument to the equipment custodian.
  - b. If calibration is current, use the instrument.
4. Turn on the monitor by loosening the finger nut on the bottom of the instrument and rotate the calibration cover to expose five switches. Rock the ON/OFF switch to the left. The four light-emitting diodes (LEDs) will flash once and the instrument will emit a short beep.

NOTE 1: After the instrument is turned on, the following start-up screens will be displayed:

- DISPLAY TEST, during which all display segments are activated briefly to verify that they are operating properly.
- BATTERY, which indicates the status of the battery. If the battery is not fully charged, the voltage reading will blink.
- SENSOR CONFIGURATION, which indicates the type of sensors installed in the instrument.
- CODE, during which the calibration system can be accessed. Normal start-up continues without any operator response.
- HYGIENE, which will initiate a new data logging session. Normal start-up continues without any operator response.

NOTE 2: After the warm-up sequence is complete, the instrument will enter the normal operating mode and will be continuously monitoring all calibrated sensors.

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5. Verify that the correct sensors are installed by observing the display during the start-up cycle, **or** press and hold the MODE button until the sensors are displayed, then release, and the instrument will return to the normal operating mode.
6. Press and **hold** the MODE button to see the scrolling ZERO display.
  - a. Press the E button to start zeroing and span oxygen sensor. The display will show “ZEROING PRESS (M) TO EXIT.”
  - b. Wait 40 seconds for the instrument to complete the zeroing process. The instrument will then return to the normal operating mode.

NOTE: Zeroing the instrument in clean air is preferred, provided that there is no trace of toxic or combustible gas that would cause the instrument to respond. If the air purity is uncertain, use a cylinder of zero grade air to zero the instrument and span the oxygen sensor.

7. Allow the instrument to warm up for a several minutes prior to performing the next steps.
8. Obtain a test cup or an appropriate motorized sampling pump (see Section 4.5) and attach tubing from the cup or sampling pump to the appropriate calibration gas cylinder.

NOTE: If using the test cup, the gas cylinder should have a one liter per minute regulator attached to it. If using the motorized sampling pump, the gas cylinder should have a pressure demand valve attached to it.

9. Install the test cup over the instrument’s sensor ports or attach the sampling pump to the monitor.
10. Apply the calibration gas. **Wait two minutes to get an accurate measurement.**
11. Record the results on the Industrial Hygiene Direct Reading Instrument Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: The results should be within 10% of the calibration gas concentrations.

12. Repeat steps 10 and 11 if a second cylinder of calibration gas is used.

13. Press and hold the MODE button until PEAKS PRESS (E) TO RESET is displayed, and then press the E key to clear the previous peak readings.
14. Press the MODE button until the instrument returns to the normal operating mode.
15. Reposition the calibration cover and tighten the finger nut. Do not use tools to tighten the nut and only tighten until finger tight.

NOTE: The instrument is now ready for field use.

16. Perform monitoring in accordance with [TFC-ESHQ-S\\_IH-D-22](#) and the Industrial Hygiene sampling plan, if applicable.
17. When sampling is completed, turn the TMX410 off.
  - a. Turn the knurled screw and rotate the calibration cover plate.
  - b. Rock the ON/OFF switch to the right.
  - c. Replace the cover and tighten the knurled screw.

18. Record all sampling data on the Industrial Hygiene Direct Reading Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: If using a motorized sampling pump, the identification number for the pump and its calibration date should be recorded on the survey report.

19. Provide the completed sampling forms and associated field records to the industrial hygienist in a timely manner.

#### 4.3 Operation and Calibration of the Industrial Scientific LTX310 Multi-Gas Monitor

Industrial Hygienist  
or Industrial Hygiene  
Technician

1. Identify the required sensors for the specific gases/vapors to be monitored. Refer to the appropriate industrial hygiene sampling plan to determine the required sensors.
2. Select an appropriately configured multi-gas monitor and an appropriate motorized sampling pump, if needed (see Section 4.5), and remove them from their charger.

NOTE: A green light on the charger indicates a fully charged battery.

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3. Verify the maintenance calibration date on the sticker from the IHEL is current for both the monitor and the sampling pump.
  - a. If calibration is past due, return the instrument to the equipment custodian.
  - b. If calibration is current, use the instrument.

4. Turn on the monitor by pressing and holding the ON/OFF button. The display will read HOLD and the instrument sounds a short beep approximately once every second. Continue holding the ON/OFF button until RELEASE is displayed, at which time, release the ON/OFF button.

NOTE 1: After the instrument is turned on, the following start-up screens will be displayed:

- DISPLAY TEST, during which all display segments are activated briefly to verify that they are operating properly
- BATTERY, which indicates the status of the battery. The battery condition is displayed as either NORMAL or LOW. If LOW is displayed, the word will flash.
- SENSOR CONFIGURATION, which indicates the type of sensors installed in the instrument.
- WARM-UP TIMER, which indicates the number of seconds remaining until the instrument begins normal operation.

NOTE 2: After the warm-up sequence is complete, the instrument will emit a short beep and enter the normal operating mode, during which it will be continuously monitoring all calibrated sensors.

5. Verify that the correct sensors for the work activity are installed by observing the display during the start-up cycle.
6. Allow the unit to warm up for several minutes.
7. Perform a battery check by looking at the battery status indicator, which is located above BATT.
  - a. If the battery status indicator shows some segments or all segments, the battery is good; proceed to step 8.
  - b. If the battery status indicator is not displayed, the battery is dead. Turn the instrument off by pressing and holding the MODE button until RELEASE is displayed. Put the instrument on a charger station or replace the battery package.

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8. Press the MODE button once to see ZERO display. Press the CLEAR button to start zeroing and span oxygen sensor. “ZEROING” and then the oxygen span value is displayed.

NOTE 1: Zeroing the instrument in clean air is preferred, provided that there is no trace of toxic or combustible gas that would cause the instrument to respond. If the air purity is uncertain, use a cylinder of zero grade air to zero the instrument and span the oxygen sensor.

NOTE 2: The zeroing process will take about one minute. The unit will beep when finished and the screen will display “GO CAL PRESS (CLEAR) TO CAL.”

9. Wait a few seconds and the instrument will switch back to normal operating mode or press the MODE button once to return to the normal operating mode.
10. Obtain a test cup or an appropriate motorized sampling pump (see Section 4.5) and attach tubing from the cup or sampling pump to the appropriate calibration gas cylinder.

NOTE: If using the test cup, the gas cylinder should have a one liter per minute regulator attached to it. If using the motorized sampling pump, the gas cylinder should have a pressure demand valve attached to it.

11. Install the test cup over the instrument’s sensor ports or attach the sampling pump to the monitor.
12. Apply the calibration gas. **Wait two minutes to get an accurate measurement.**
13. Record the results on the Industrial Hygiene Direct Reading Instrument Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: The results should be within 10% of the calibration gas concentrations.

14. Repeat steps 12 and 13 if a second cylinder of calibration gas is used.
15. When functional (bump) tests are complete, turn off the gas cylinder and remove the test cup from the monitor or remove the tubing from the sampling pump.
16. Press the MODE button twice to access the PEAK screen.
  - a. Press CLEAR. The scrolling message “PRESS (CLEAR) TO RESET” is displayed.
  - b. Press the CLEAR key to clear the previous peak readings.

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- c. Press CLEAR a second time. The PEAK screen returns to verify that PEAK readings have been cleared. The instrument will return to the normal operating mode after a few seconds.

NOTE: The instrument is now ready for field use.

17. Perform monitoring in accordance with [TFC-ESHQ-S\\_IH-D-22](#) and the industrial hygiene sampling plan, if applicable.
18. To switch on the back light when needed, press CLEAR and release. The back light will remain on for 15 seconds.
19. When the LTX310 detects combustible gases in excess of 100% of LEL or 5% CH<sub>4</sub> by volume, a high alarm condition is latched and +OR (for OVER-RANGE) is displayed for the combustible gas. To clear the over-range alarm:
  - a. Exit the hazardous area **immediately**.
  - b. Turn the instrument off.
  - c. In clean air, turn the instrument back on.
20. To change the alarm setting:
  - a. Turn the instrument on.
  - b. When the sensor configuration screen appears, simultaneously press the (+) and (-) keys to access the CODE screen.
  - c. When the CODE screen is displayed, press the (+) button to move to the ALARM screen.
  - d. Press the (E) button to access the ALARM menu.
  - e. Press the (+) button to scroll through the ALARM MENU.
  - f. Press (E) to select the sensor for which an adjustment to the alarm setting needs to be made.
  - g. Press (+) or (-) to adjust the alarm setting.
  - h. Press (E) to accept the change to the alarm setting.
  - i. Press (+) to select the next sensor and repeat steps f through h.
  - j. When the alarms are appropriately set, press the MODE button until the ALARM screen is displayed.

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- k. Press the MODE button until the normal operating mode is displayed.
21. When sampling is completed, turn the LTX310 off by pressing and holding the ON/OFF button until “RELEASED” is displayed, then release the button and the instrument will turn off.
22. Record all sampling data on the Industrial Hygiene Direct Reading Survey form ([A-6001-760](#)), or an approved equivalent.  
  
NOTE: If using a motorized sampling pump, the identification number for the pump and its calibration date should be recorded on the survey report.
23. Provide the completed sampling forms and associated field records to the industrial hygienist in a timely manner.

**4.4 Operation and Calibration of the Industrial Scientific MX251 Multi-Gas Monitor**

NOTE: The MX251 only contains two sensors: the combustible gas/vapor sensor and the oxygen sensor.

Industrial Hygienist  
or Industrial Hygiene  
Technician

1. Refer to the appropriate sampling plan to determine the required sensors.
2. Select an appropriately configured multi-gas monitor and an appropriate motorized sampling pump, if needed, (see Section 4.5) and remove them from their charger.  
  
NOTE: A green light on the charger indicates a fully charged battery.
3. Verify the maintenance calibration date on the sticker from the IHEL is current.
  - a. If calibration is past due, return the instrument to the equipment custodian.
  - b. If calibration is current, use the instrument.
4. Turn on the monitor.
  - a. Turn the knurled nut that holds the calibration cover in place.
  - b. Rotate the cover so that the metal button is inserted in the oval-shaped hole.
  - c. Tighten the nut until the calibration cover is flush with the case. Do not over tighten.

NOTE: When the knurled nut is loosened, the monitor will alarm briefly. After the instrument is turned on, the oxygen sensor screen

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**CALIBRATION AND USE OF  
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will be displayed and the instrument will be ready to use as soon as the display stabilizes.

5. Once the instrument is stabilized, allow the instrument to warm up for a few minutes in the normal operating mode.
6. Verify the battery status indicator is not displayed. The status of the battery will only be displayed if the battery charge is low. The screen should display either the oxygen levels or % LEL levels if the battery is adequately charged.
7. Perform a functional (bump) test:
  - a. Obtain a test cup or a motorized sampling pump (see Section 4.5) and attach the tubing from the cup or the sampling pump to the appropriate calibration gas cylinder.

NOTE: If using the test cup, the gas cylinder should have a one liter per minute regulator attached to it. If using the motorized sampling pump, the gas cylinder should have a pressure demand valve attached to it.

- b. Install the test cup over the instrument's sensor ports or attach the sampling pump to the monitor.

NOTE : If using the motorized sampling pump to perform the bump test, refer to Section 4.5 prior to performing the following steps.

- c. Apply the calibration gas. **Wait two minutes to get an accurate measurement.**
    - d. Record the results on the Direct Reading Instrument Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: The results should be within 10% of the calibration gas concentrations.

- e. Repeat steps a through d if a second cylinder of calibration gas is used.

NOTE: Instrument is now ready for field use.

8. Perform monitoring in accordance with [TFC-ESHQ-S\\_IH-D-22](#) and the Industrial Hygiene sampling plan, if applicable.

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9. To select which sensor reading is displayed:
  - a. Press the % OX button to detect oxygen levels in an area. An arrow head will point downwards towards the % OX button indicating the oxygen sensor reading is displayed.
  - b. Press the % LEL button to detect % LEL. An arrow head will point towards the % LEL button indicating the % LEL sensor reading is displayed.
10. Record sampling results on the Industrial Hygiene Direct Reading Survey form ([A-6001-760](#)), or an approved equivalent.

NOTE: If using a motorized sampling pump, the identification number for the pump and its calibration date should be recorded on the survey report.
11. Turn off instrument.
  - a. Turn the knurled nut to back off the calibration cover.
  - b. Rotate the cover so that the metal button is inserted in the unmarked round hole.
  - c. Tighten the nut until the calibration cover is flush with the case. Do not over tighten.
  - d. Return the monitor to the battery charger.
12. Provide the completed sampling forms and associated field records to the industrial hygienist in a timely manner.

#### **4.5 Functional Testing and Operating the SP 402 Motorized Sampling Pump**

Industrial Hygienist  
or Industrial Hygiene  
Technician

1. Obtain a motorized sampling pump and verify the maintenance calibration date on the sticker from the IHEL is current.
  - a. If calibration is past due, return the instrument to the equipment custodian.
  - b. If calibration is current, use the instrument.

NOTE: The SP 402 sampling pump can be used in conjunction with models TMX412, TMX410, and LTX310 multi-gas monitors. The SP200 sampling pump is used in conjunction with model MX251 combustible gas and oxygen monitor.

**CALIBRATION AND USE OF  
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2. Attach the sampling pump to the appropriate monitor.
  - a. If performing remote sampling, attach the appropriate length of tubing to the probe on the sampling pump.
  - b. If sampling in radiological areas, attach an in-line particulate filter to the probe first and then attach the appropriate length of tubing.

3. Turn on the SP 402 pump.

NOTE 1: The green power LED will light and the pump motor will begin to run. The red fault LED and the audible alarm will turn on briefly and then turn off.

NOTE 2: If the pump does not turn on, or if the only the red fault LED turns on, or if the red fault LED and audible alarms do not turn off after five seconds, the battery may need to be charged/changed or the filter may be obstructed and may require replacement. The instrument will need to be returned to the equipment custodian.

4. Test the sampling pump to ensure it is operating properly by placing a finger over the end of the probe/tubing. The red fault LED and the audible alarm will turn on.

NOTE: This leak test must be performed to ensure there is adequate flow rate through the sampling pump prior to use.

5. Remove the obstruction from the inlet of the pump and verify that the red fault LED and the audible alarm shut off.
  - a. If the pump fails this test, return the instrument to the equipment custodian.
  - b. If the pump leak test is acceptable, use the instrument for field use.

**5.0 DEFINITIONS**

No terms or phrases unique to this guidance document are used.

**6.0 RECORDS**

The following records are generated during the performance of this guidance document:

- Industrial Hygiene Direct Reading Instrument Survey form (A-6001-760), or an approved equivalent.

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**CALIBRATION AND USE OF  
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The Industrial Hygiene Programs Records Coordinator is responsible for record retention and retirement in accordance with [TFC-BSM-IRM\\_DC-C-02](#) and HNF-IP-0842, [Volume 9, Section 4.27](#).

**7.0 REFERENCES**

1. HNF-IP-0842, [RPP Administration, Volume 9, Section 4.27](#), “Exposure Monitoring, Reporting, and Records Management.”
2. Industrial Scientific Corporation Model SP200 Sampling Pump Instruction Manual.
3. Industrial Scientific Corporation Model SP402 Sampling Pump Instruction Manual.
4. Industrial Scientific Corporation Model TMX412 Multi-Gas Monitor Instruction Manual.
5. Industrial Scientific Corporation Model TMX410 Multi-Gas Monitor Instruction Manual.
6. Industrial Scientific Corporation Model LTX310 Multi-Gas Monitor Instruction Manual.
7. Industrial Scientific Corporation Model MX251 Combustible Gas and Oxygen Monitor Instruction Manual.
8. [TFC-BSM-IRM\\_DC-C-02](#), “Records Management.”
9. [TFC-ESHQ-S\\_IH-D-22](#), “Using Direct Reading Instruments.”

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**ATTACHMENT A – PRECAUTIONS AND LIMITATIONS FOR INDUSTRIAL SCIENTIFIC CORPORATION MULTI-GAS MONITORS**

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**Certain conditions or failure to heed these precautions and limitations may impair the performance of the instrument.**

1. Oxygen deficient atmospheres may cause readings of combustible gas lower than actual concentrations.
2. Oxygen enriched atmospheres may cause readings of combustible gas higher than actual concentrations.
3. Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond upper scale limit which may be hazardous.
4. High off-scale readings may indicate an explosive concentration.
5. Verify calibration of the combustible gas sensor after use where the combustible gas content causes the instrument to latch in the OVER-RANGE alarm condition or where the combustible gas content as a percent of the LEL was 100% or greater.
6. Silicone compound vapors may cause desensitization of the combustible gas sensor and may cause readings of combustible gas to be lower than actual gas concentrations. If the instrument has been used in an area where silicone vapors were previously present, always verify the instrument's calibration before next use to ensure accurate measurements.
7. Alarms are non-latching and will automatically reset when ambient air is cleared of alarm condition.
8. Sensor aperture areas and water barriers must be kept clean. Obstruction of the sensor aperture areas and/or contamination of the water barriers may cause readings to be lower than actual gas concentrations.
9. Sudden changes in atmospheric pressure may cause temporary fluctuations in the oxygen reading.
10. Recharge battery only in a non-hazardous location.
11. Use the RS-232 port only in a non-hazardous location.
12. Instrument is tested for intrinsic safety in explosive gas/air (21% oxygen) mixtures only.
13. **CAUTION:** High Over-Range (+OR) combustible gas readings may indicate an explosive concentration of combustible gas.
14. **CAUTION:** If the TMX412 is using the nickel-cadmium battery pack, fully charge the battery pack prior to use. **NOTE:** The TMX412 must be turned off while charging the battery.

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**ATTACHMENT A – PRECAUTIONS AND LIMITATIONS FOR INDUSTRIAL SCIENTIFIC CORPORATION MULTI-GAS MONITORS (cont.)**

15. The TMX412 uses the continuous high alarm tone for both low (depletion) and high (enrichment) oxygen alarm conditions.
16. **WARNING:** When changing lithium battery cells, replace the cells within the lithium battery pack in a non-hazardous location. Replace the lithium cells with three Duracell DL123A or three Panasonic CR123A or three Sanyo CR123A 3.0 volt lithium battery cells only. Use of another battery may present a risk of fire or explosion.
17. **WARNING:** Lithium battery cells may explode if mistreated. Do not recharge, disassemble, or dispose of in fire. Do not charge the replaceable lithium battery pack either while it is installed in or removed from the instrument.
18. **WARNING:** The 1704-9889 replaceable lithium battery pack is not approved for use in applications or areas requiring MSHA approval.
19. High or prolonged concentrations of HCN and NH<sub>3</sub> can cause loss of sensitivity to respective sensors in the LTX310. Calibrate prior to each use.
20. Always use Teflon tubing when calibrating Cl<sub>2</sub>, HCN, NO NO<sub>2</sub>, or NH<sub>3</sub> sensors.

**ATTACHMENT B – PRECAUTIONS AND LIMITATIONS FOR THE SP402 AND SP200  
MOTORIZED SAMPLING PUMPS**

**Certain conditions or failure to heed these precautions and limitations may impair the performance of the instrument.**

1. Substitution of components may impair intrinsic safety of this design.
2. Battery charging and/or replacement should only be performed in a known non-hazardous location.
3. Prior to use, test the sampling pump (see Section 4.5) to ensure that it is operating properly. Failure of internal components may cause inaccurate instrument readings due to the inability of the pump to draw a proper gas sample.
4. Do not use Tygon tubing when sampling for chlorine, nitrogen dioxide, nitric oxide, ammonia, hydrogen cyanide, or aromatic hydrocarbons because the inside surface of the tubing may absorb the gas being measured, providing an inaccurate reading. Teflon sampling tubing is recommended in these applications.
5. Use only the SP402/TMX412, SP402/TMX410, or SP402/LTX310 pump/instrument combinations in Class I hazardous locations.
6. Use the SP200/MX251 pump/instrument combination in Class I hazardous locations.
7. Battery cells may explode if mistreated. Do not recharge, disassemble, or dispose of in fire.
8. Do NOT operate the SP200 without the external dust filter as pump damage may result and the warranty will be voided.
9. Do NOT use sampling tubing longer than 100 feet.
10. External dust filters on the sampling pumps will not stop mists, vapors, or steam. If liquid is drawn into the pump, internal components may be damaged so precautions must be taken to prevent this from occurring.
11. Never allow the battery to become fully discharged. Discharge the battery to different degrees before each charging. Charge the battery when the motor begins to slow down. Turn the pump off and charge the battery for a minimum of fourteen hours.