

**SAUDI ARABIAN OIL COMPANY (Saudi Aramco)**  
**GENERAL INSTRUCTION MANUAL**
G. I. NUMBER Approved

2.709

ISSUING ORG. LOSS PREVENTION DEPARTMENT

ISSUE DATE

05/05/2009

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SUBJECT GAS TESTING PROCEDURE

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## CONTENT

\* This General Instruction provides basic information on the proper use of the portable gas monitors (Industrial Scientific Corporation models LTX310 and TMX412) to perform gas tests as required by G.I. 2.100, "Work Permit System." The TMX412 gas monitor is the enhancement to the existing LTX310. The LTX310 and TMX412 equipment are used to determine levels of oxygen, combustible gases, and toxic gases, e.g., hydrogen sulfide. The main body of this G.I. covers the responsibilities of various organizations. Additionally, the G.I. contains supplements which provide information on the operation of the LTX310 and TMX412 gas monitors and their key accessories. This G.I. is organized as follows:

1. References
2. Responsibilities
3. Gas Testing Requirement
4. Limitations

\* Supplement

\* Supplement 2.709-1: Operation of LTX310 and TMX412 Gas Monitors, SP402 Sampling Pump, and Key Accessories

## 1.0 REFERENCES

G.I. 2.100 Work Permit System

G.I. 6.012 Isolation, Lockout and Use of Hold Tags

G.I. 1780.001 Atmosphere-Supplying Respirators

OIM 2.125 Confined Space Entry Procedure -- Abqaiq Plants

ISC Multi-Gas Monitor (LTX310) Instruction Manual

\*\* ISC Multi-Gas Monitor (TMX412) Instruction Manual

ISC Sampling Pump (SP402) Instruction Manual

## 2.0 RESPONSIBILITIES

\*2.1 Department, division and unit heads should ensure that:

2.1.1 The procedures outlined in this G.I. are followed by all users involved in gas testing.

2.1.2 Appropriate gas tests are conducted in accordance with G.I. 2.100, Work Permit System, prior to issuing a work permit, and for all jobs where toxic gas, combustible gas or oxygen deficiency may exist. The work permit issuer must determine when periodic, frequent or continuous gas

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monitoring is required, state the requirement on the work permit, and make arrangements to have a certified gas tester available to perform required tests.

- 2.1.3 LTX310 and TMX412 gas monitors users conduct daily pre-use instrument checks. These checks should include, but are not limited to, a visual inspection of the equipment, a leak test and a function test. Results of the checks should be recorded on a daily log sheet.
- 2.1.4 Every two years, gas testing personnel are trained, tested and certified in the correct use of gas testing equipment. They should carry a valid certificate issued by the Training & Career Development (T&CD) and signed by the gas testers' division head.
- 2.1.5 They enroll for certification only employees who have plant experience, hands-on practices, competent and familiar with the requirements stated in this G.I. and G.I. 2.100.
- 2.1.6 Only personnel having a valid gas testing certificate issued by T&CD and signed by the gas testers' division head perform gas tests in connection with the requirements of G.I. 2.100, Work Permit System, or use the LTX310 or TMX412 as a personal warning device.
- \*\* 2.1.7 They encourage employees before enrollment for certification to complete gas testing information available in e-Learning posted at LP Website to enhance their knowledge before and after certification test.
- 2.1.8 Each instrument is sent for calibration and routine maintenance every three months. Refer to Supplement 2.709-1 for details. Proponent department, division, or unit heads should immediately notify the vendor of any non-functional or faulty gas monitor.
- 2.1.9 Each LTX310 or TMX412 and its key accessories such as the SP402 sampling pump, four-unit charger, etc., are sent to the vendor's service center for needed repairs.
- 2.1.10 The person conducting gas tests in an atmosphere known or suspected of being potentially hazardous should enter the area only after donning adequate personal protective equipment, including but not limited to appropriate respiratory protection equipment, i.e., Scott Air-Pak or approved air line supplied respirator. Refer to G.I. 1780.001 for details.
- 2.1.11 Work is stopped immediately upon a gas monitor alarm condition. Remedial actions are taken to deal with the situation and to correct the conditions causing the alarm. Note: The reason for stopping the work, the time and other relevant information should be written on the work permit.
- \* 2.2 Training & Career Development will:
  - 2.2.1 Conduct gas tester classes and administer a test in each division so that the proponent division head can certify successful candidates as department/division gas testers once every two years.
  - 2.2.2 Maintain a record of current certified gas testers.

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\* 2.3 Certified gas testers should ensure that:

- 2.3.1 They have a valid gas testing certificate issued by the T&CD and signed by their division head.
- 2.3.2 They only use an instrument which bears a valid calibration-due-date sticker, has the correct sensors for the gases to be detected, and which passes all the pre-use checks in Section 2.3.4.
- 2.3.3 They only use instruments for which they have been certified.
- 2.3.4 They conduct daily pre-use checks for the LTX310 and TMX412 gas monitors in accordance with the procedure detailed in Supplement 2.709-1, Section 7. Results of the checks should be recorded on a daily log sheet.
- 2.3.5 They conduct the required gas tests for combustible gases, toxic gases (e.g., hydrogen sulfide), and oxygen levels (referenced on the back of the G.I. 2.100 Work Permit System) based upon G.I. 2.100 requirements to determine if safe working conditions exist, before a work permit is issued.
- 2.3.6 They enter the gas test results on the work permit and sign it.
- 2.3.7 Work is stopped immediately upon a monitor alarm condition. Remedial actions are taken to deal with the situation and to correct the conditions causing the alarm. The reason for stopping the work, the time, and other relevant information should be written on the work permit.

### 3.0 GAS TESTING REQUIREMENTS

3.1 Gas testing is required in all locations where injury to personnel or damage to property could occur due to the presence of combustible gases, toxic gases, or oxygen enriched/deficient atmospheres. Some examples/situations where gas testing should be performed are given in Sections 3.1.1 to 3.1.4 below. This is not an all-inclusive list. The Loss Prevention Department should be consulted when any questions arise regarding these requirements.

3.1.1 Oxygen testing should be conducted for:

- a) All confined space entry areas such as bins, boilers, valve boxes, cellars, columns, drums, exhaust ducts, electrical duct manholes, excavation over 1.2 meters (4 feet) deep, pits, roof areas of floating roof tanks, sewers, ship holds, sump pits, tanks, towers, tunnels, underground utility vaults, telecommunication manholes, vats, vessels, pipe lines, and trenches, etc.
- b) All areas not covered under Section 3.1.1 (a) which may have a potential for an oxygen enriched or deficient atmosphere.

3.1.2 Combustible gas testing should be conducted for:

- a) All confined space entries [see Section 3.1.1 (a)].
- b) All hot work in restricted areas, as defined in G.I. 2.100.
- c) All work locations not covered under Section 3.1.2 (a) or (b), where combustible gases are or may be present and monitoring is required.

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3.1.3 Hydrogen sulfide gas testing should be conducted for:

- a) All confined space entry where there is a possibility of hydrogen sulfide presence.
- b) Jobs in areas of sour crude/gas producing, transporting, storage or processing where Operations determine that hydrogen sulfide gas testing is necessary.
- c) All work locations not covered under Section 3.1.3 (a) or (b) where hydrogen sulfide is or may be present and H<sub>2</sub>S monitoring is required for work or operational purposes.

3.1.4 Other toxic gas testing should be conducted for all work locations where other toxic gas(es) or vapor(s) is(are) or may be present. Examples of other toxic gases include carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), chlorine (Cl<sub>2</sub>), ammonia (NH<sub>3</sub>), hydrogen chloride (HCl), and mercury vapor (Hg). The Loss Prevention Department should be consulted when any questions arise regarding other toxic gas testing.

#### 4.0 LIMITATIONS

\* The LTX310 and TMX412 have certain limitations which must be considered to avoid potentially dangerous consequences.

##### 4.1 Poisoning

\* The LTX310 and TMX412 are susceptible to poisoning of the sensors when exposed to vapors containing appreciable concentrations of contaminants such as:

- a) tetra ethyl lead (from leaded gasoline or its sludge)
- b) silicone vapors from greases, etc.

The effect of these poisons is that they reduce sensitivity to respective sensors. Any instrument exposed to such vapors without an appropriate filter in place to remove the contaminants must be function-tested. If it fails the test, the affected instrument must be sent for service before the next use.

The Loss Prevention Department should be consulted on questions regarding sensor poisoning and the proper filters to remove such poisons.

##### 4.2 Oxygen Deficient Atmospheres

To ensure combustible gas testing accuracy, the sampled atmospheres should contain at least 16% oxygen by volume.

##### 4.3 High Temperature

Minimize prolonged exposure to high temperature environments. The instrument should not be exposed to a temperature of 50°C for more than eight hours.

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## 4.4 Warranty

The vendor has agreed to warrant the gas monitoring equipment for two years. Physical abuse such as crushing or drowning the instrument, using unapproved materials, or performing service and repairs by an unauthorized provider will nullify the warranty. Accordingly, intentionally undertaking these activities is forbidden.

CONCURRED BY: \_\_\_\_\_  
**GENERAL MANAGER**  
 Training & Career Development Department

Date: \_\_\_\_\_

APPROVED BY: \_\_\_\_\_  
**MANAGER**  
 Loss Prevention Department

Date: \_\_\_\_\_

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\*SUPPLEMENT 2.709-1

OPERATION OF ISC LTX310, TMX412 GAS MONITORS, SP402 SAMPLING PUMP, AND ACCESSORIES
**1.0 INTRODUCTION**

The Industrial Scientific Model LTX310 and TMX412 gas monitors and their accessories are used to continuously and simultaneously monitor the presence and concentration of combustible gases or vapors, oxygen deficiency and hydrogen sulfide gas in air. These instruments can be used to detect seven other toxic gases, i.e., CO, SO<sub>2</sub>, NO<sub>2</sub>, Cl<sub>2</sub>, NO, HCN, and NH<sub>3</sub>, provided the correct sensors are installed. Cl<sub>2</sub> and NH<sub>3</sub> (NH<sub>3</sub> for LTX310 only) sensors may be supplied in lieu of the H<sub>2</sub>S sensor by using appropriate SAMS material numbers (see note (\*) below). For ordering these alternative sensors, the Loss Prevention Department should be consulted.

A Standard Gas Monitor Kit (material no. 1000128580) which contains the following items is available from SAMS. Each item can also be ordered individually by using the corresponding SAMS material number.

STANDARD GAS MONITOR KIT CONTENTS - MATERIAL NO. 1000128580

DESCRIPTION	QUANTITY (UNIT)	SAMS MATERIAL NUMBER
TMX412 Gas Monitor with LEL (Lower Explosive Limit), Oxygen, Hydrogen Sulfide* Sensors, NI-CAD	One	1000128517
SP402 Sampling Pump with 10 Ft. of Hose (UL Version)	One	1000502869
Constant Flow Hand Aspirator for LTX310	One	1000502804
Extendable Probe with Teflon Tube Insert (3 Ft.)	One	1000502867
Dust Filters For Sampling Pump	Two	1000502864
Dust Filter/Water Stops (0.45 µm) for Sampling Pump	Two	1000502865
Lithium Battery Pack	One	1000502806
Combination Leather Carrying Case	One	1000502860
Leather Carrying Case Handle	One	1000502866
Shoulder Strap	One	1000502920
Blow-Molded Carrying Case	One	1000502809

Note 1: The LTX310 gas monitor is also configured with a chlorine or ammonia sensor in place of a hydrogen sulfide sensor. The material number of the Standard Gas Monitor Kit with a chlorine sensor in the gas monitor is 1000128571. The material number of the Kit with an ammonia sensor in the gas monitor is 1000128575 (with the LTX310 only).

In addition to the above standard gas monitor kit, a four-unit Charger (material number 1000502863), NI-CAD Rechargeable Battery Pack (material number 1000502807), Function Test Gas Canister (material number 1000502862), a reusable Flow Control Valve (material number 1000502805), and an External

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Alarm (material number 1000502803) with 20 ft. Extension Cable (material number 1000502808) are also available from SAMS.

The LTX310 and TMX412 can be used for personal protection when working in areas that contain or have the potential to contain hazardous gases. The LTX310 and TMX421 can be worn either on a belt or over the shoulder (with the included leather belt case and shoulder strap) as a personal monitor for continuous and simultaneous monitoring of toxic gases, oxygen, and combustible gases. When preset levels are reached, audible and visual alarms will warn the users.

With the addition of the SP402 Sampling Pump or the Constant Flow Hand Aspirator, the LTX310 and TMX412 may also be used as a remote sample-draw monitor. In this configuration, a confined space can be tested to ensure safety before entry. Additionally, with the addition of the 3 ft. Extendable Probe, testing pipeline valves or flanges for leaks can be performed.

## 2.0 LTX310 AND TMX412 GAS MONITORS OPERATION (REFER TO LTX310 AND TMX412 INSTRUCTION MANUALS FOR DETAILS)

### 2.1 Use and charging of the NI-CAD Battery

- 2.1.1 Make sure the LTX310 or TMX412 has a valid calibration due date sticker and has been properly function tested.
- 2.1.2 Fully charge the battery pack before using the nickel-cadmium powered LTX310 or TMX412.
- 2.1.3 Store the instrument in the energized battery charger when not in use. The battery charger is capable of charging the battery in or out of the instrument.
- 2.1.4 Turn off the instrument and place it on the battery charger when charging the battery pack in the instrument.
- 2.1.5 To charge the battery pack out of the instrument, remove the pack from the instrument and place it on the charger.
- 2.1.6 A fully charged battery pack will operate a LTX310 or TMX412 unit for approximately 10 hours.
- 2.1.7 When the battery is fully discharged, the display reads "BATTERY FAIL" and the instrument emits a short beep once a second. Turn off the instrument and recharge the battery when the "BATTERY FAIL" appears.
- 2.1.8 When the battery pack is fully charged, the display shows eight segments on the battery status indicator.
- 2.1.9 All four-unit chargers offer a discharge-before charge feature. On a monthly basis, before placing instruments or battery packs on the chargers, switch chargers to the DISCHARGE position to prevent a memory condition in the battery packs.



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## 2.2 Operating the LTX310 and TMX412

2.2.1 Press and hold the ON/OFF key for the LTX310 or Mode key for the TMX412. The “HOLD” screen appears and the instrument sounds a beep approximately once per second.

2.2.2 Continue holding the ON/OFF key for the LTX310 or Mode key for the TMX412 until the “RELEASE” screen appears.

2.2.3 DISPLAY TEST screen will be displayed.

2.2.4 The battery charge condition is displayed as either “NORMAL” (at least eight hours of operation) or “LOW” (insufficient charge to operate the instrument for eight hours).

2.2.5 SENSOR CONFIGURATION screen displays the types of installed sensors, i.e., oxygen, LEL, hydrogen sulfide.

2.2.6 The instrument begins normal operation in the display mode. A confidence beep will sound every 15 seconds to indicate that the instrument is on and operation is normal.

2.2.7 The backlight is automatically switched on when the instrument is in an alarm condition. To switch on the backlight when needed, press the CLEAR key for the LTX310 or the E key for the TMX412 and release. The backlight will remain for 15 seconds.

2.2.8 To change viewing modes, press the MODE switch and then release it when the next screen appears. The modes are accessed in the following sequence:

**READING** This mode continuously displays the instantaneous levels of oxygen (%), LEL (%), and hydrogen sulfide (ppm).

**ZERO** This mode allows the user to zero the instrument and span oxygen (to set oxygen reading to 21.0%). Press MODE to access ZERO the screen. Then press the CLEAR key for the LTX310 or the E key for the TMX412 to start the Zeroing Function. When Zeroing and Oxygen span sequences are completed, the instrument will beep and return to the READING mode.

**PEAK** The instrument continually saves the highest measured values of hydrogen sulfide, LEL, and the lowest measured value of oxygen. These readings are displayed in the PEAK mode. To obtain the PEAK readings, press MODE twice for the LTX310 or three times for the TMX412. The PEAK screen appears. To clear the PEAK readings, press CLEAR key on the LTX310 or the Mode key on the TMX412. The message “PRESS (CLEAR) TO RESET” appears. Then press CLEAR key on the LTX310 again or the E key on the TMX412. The instrument will return to the PEAK display. Check the PEAK screen to verify that PEAK readings have been cleared. The instrument will return to the normal display after 15 seconds. Press MODE to return to the normal display immediately.

2.2.9 When the instrument detects combustible gases in excess of 100% of LEL, an over-range alarm condition is latched and “+OR” (for OVER-RANGE) is displayed for the combustible gas. This feature protects the combustible gas sensor. To clear the combustible gas over-range alarm:

a) Exit the hazardous area immediately.



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b) Turn the instrument off.

c) In clear air, turn the instrument on.

2.2.10 To turn the instrument off, press and continue holding the ON/OFF key or Mode key for the TMX412 until the "RELEASE" screen appears.

### 2.3 Description of Alarm Indicators

2.3.1 HIGH/LOW ALARMS. When a monitored gas reaches the following high/low level alarm settings (set in factory),

HIGH ALARM:	oxygen:	23.5%
	LEL:	5%
LOW ALARM:	hydrogen sulfide:	10 ppm
	oxygen	20.0%

the instrument emits a high-pitched warbling tone, a red indicator LED flashes, and the displayed value of the alarming gas blinks when the normal viewing mode is active. Upon receiving the alarm, all work must be stopped immediately in accordance with G.I. 2.100, Section 5.1. The cause(s) of the alarm must be investigated and corrective measures must be taken immediately.

2.3.2 OVER-RANGE. An over-range condition occurs when a sensor reading exceeds the upper limit of the Measuring Range and is indicated by "+OR" in the appropriate display location.

2.3.3 LOW BATTERY. With approximately 30-90 minutes of run time remaining, the instrument will emit a short double-beep once every 15 seconds.

2.3.4 BATTERY FAILURE. When the battery has insufficient charge to operate the instrument, "BATTERY FAIL" is displayed. The instrument stops monitoring. The words "BATTERY FAIL" will continue to be displayed. To clear the display, momentarily press the ON/OFF key for the LTX310 or Mode key for the TMX412 until the RELEASE screen appears. Then recharge or replace the battery.

### 2.4 Changing the Battery (NI-CAD Battery Pack material number 1000502807 or Lithium Battery Pack material number 1000502806)

NOTE: All battery packs for the LTX310, TMX412 and SP402 are interchangeable.

2.4.1 Changing the battery must be performed in a non-hazardous area, for example, an office, or a control room.

2.4.2 Hold the instrument with the battery cover facing up.

2.4.3 Using the service tool supplied, turn the battery cover latch counter-clockwise until the stop is reached.

2.4.4 Lift the cover at the latch end, rocking it back on the hinged cam at the bottom end until the cover is released.

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2.4.5 Press on the bottom of the battery to disengage. Then lift the battery out from the top.

2.4.6 Insert replacement battery. The instrument will be initialized when the battery is inserted. All display screen segments are on during the initialization cycle.

2.4.7 Replace cover by engaging the hinged cam and rotating the cover into the closed position. Pay close attention to the alignment of the hinged cam. Proper seal will not be maintained if misalignment occurs.

2.4.8 Turn the latch in the clockwise direction until the cover is firmly secured. Do not over-tighten latch.

2.4.9 A NI-CAD rechargeable battery pack will operate a LTX310 unit for approximately 10 hours. A Lithium battery pack will operate an instrument unit for approximately 18 hours.

## 2.5 Maintenance

2.5.1 All routine and non-routine maintenance services are provided by the vendor. Refer to supplement 2.709-1 for maintenance service details.

2.5.2 Each gas testing instrument should be sent to the vendor's service center for calibration and routine service every three months. As a reminder, a notice will be faxed to the site supervisor two weeks prior to the calibration due date listing the serial numbers of the instruments which are due for service.

## 2.6 Warnings and Cautions - The following procedures must be observed to ensure proper performance of the instrument.

2.6.1 Recharge NI-CAD batteries only in a non-hazardous area.

2.6.2 Minimize prolonged exposure to high temperature environment. It is recommended that the instrument not be exposed to a temperature of 50°C for more than eight hours.

2.6.3 To ensure meaningful combustible gas testing, the sampled atmosphere should contain at least 16% oxygen by volume.

2.6.4 Sensor aperture areas and water barriers must be kept clean.

2.6.5 If an instrument has been used in an area where silicone vapors were previously present, e.g., from silicon sealant or grease, this can cause erroneous low readings. The instrument should be sent to the vendor for recalibration before next use to ensure accurate measurements.

2.6.6 Exposure to silicon or tetra ethyl lead (TEL) vapors can reduce sensitivity to sensors. Any instrument exposed to such vapors should be function-tested first by following the procedure in Section 7.3, to determine if the sensors are still responding to the test gas mixture. If not, the affected instrument should be sent to the vendor for service before next use.

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### 3.0 SP402 SAMPLING PUMP OPERATION (REFER TO SP402 INSTRUCTION MANUAL FOR DETAILS)

#### 3.1 Testing the Pump for Proper Operation

- 3.1.1 Turn the pump on. 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. If the pump does not turn on, or if the red fault LED only turns on, or if the red fault LED and audible alarm 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. Refer to Section 3.4.2 for details of a visual inspection of the filter and filter replacement. If the pump still does not function properly, the pump must be repaired before next use.
- 3.1.2 Block the inlet of the SP402 by placing a finger over the inlet of the external filter. The red fault LED and the audible alarm will turn on. Immediately remove the finger from the inlet of the pump and verify that the red fault LED and the audible alarm shut off.
- 3.1.3 Block the outlet port of the SP402 by placing a finger over the outlet in the sensor plenum. The red fault LED and the audible alarm will turn on. Remove the finger from the outlet of the pump and verify that the red fault LED and the audible alarm shut off.
- 3.1.4 If the pump fails any of these tests or fails to recover from the alarm as a result of any of these tests, the pump must be repaired before next use.

#### 3.2 Operating the Sampling Pump SP402

- 3.2.1 Insert the gas monitor instrument into the SP402 first by placing the pump face down (the switch and status indicator area down). Disengage both hook and loop straps and loosen them enough to allow the monitor to fit into the instrument cavity freely. Insert the monitor into the cavity of the SP402, sensor end first, with the monitor sensors facing downward. Lower the monitor onto the sensor seal. Verify that the monitor is fully inserted into the cavity and that it is seated on the sensor seal. Secure the monitor in place by firmly pressing the monitor down onto the sensor seal, tighten the straps nearest the center of the pump, then bring the end of the strap up and back onto itself. The other strap is then secured in the same manner. The straps do not require much tension to hold the monitor firmly in place.
- 3.2.2 Turn on the SP402. Allow 5 seconds for the Low Flow Alarm to reset. After the Low Flow Alarm resets, the pump motor should be heard running, and the green power LED should be lit. When taking a reading, allow two seconds per foot of hose length or probe length for the sampling line to be purged, and then continue the sampling for another 60 to 90 seconds before reading the concentration in the display screen of the gas monitor.
- 3.2.3 If the pump motor is heard to slow or stall and the Low Flow Alarm sounds during use, there may be a blockage in the sampling draw line or sampling probe, or the external filter(s) may be clogged and in need of replacement. If there is a blockage in the sampling line or probe, withdraw the sampling device, clear the blockage and/or replace the filter(s) as necessary. Test the pump as described in Section 3.1 before resuming operation.

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### 3.3 Operating Precautions

- 3.3.1 The external dust filter will not filter out mists, vapors or steam.
- 3.3.2 The Water Stop filter (material number 1000502865) must be used to prevent liquid from being drawn into the pump which may damage internal pump parts. The Water Stop should be inserted into the end of the sampling tubing (tapered end into the hose) prior to sampling.
- 3.3.3 If the Water Stop should become filled with liquid, it will restrict the flow of gas and the pump will slow and/or stall, triggering the Low Flow Alarm. If this occurs, withdraw the tubing, turn off the Sampling Pump, disconnect the Water Stop from the tubing and tap or shake the Water Stop to the tubing, and test the unit as described in Section 3.1, Testing the Pump, before resuming operation.
- 3.3.4 If the pump will not operate after attempting to remove the liquid from the Water Stop, remove the Water Stop from the tubing. If the pump resumes normal operation (non-alarm condition), the Water Stop is clogged and requires replacement.
- 3.3.5 Do not operate the SP402 without the Dust Filter (material number 1000502864). Pump damage may result, and the warranty will be voided. The screw-in External Dust Filter on the SP402 is designed to stop very small particles from damaging internal pump parts. In very dusty atmospheres, this filter may clog quickly.
- 3.3.6 Operating the pump with clogged filters or excessive lengths (>20 ft. or 6.1 m.) of sampling tubing will cause increased loading of the pump and reduced running time. This excessive loading could cause the pump to go into Low Battery Fault prematurely. If this happens, turn off the pump, remove the cause of the load and restart the pump. If the pump restarts and then returns to Low Battery Fault, the battery does not have enough charge left to operate the pump effectively with the load. Turn the SP402 off and refer to Section 3.5, Battery Charging, or Section 3.6, Battery Replacement.

### 3.4 Maintenance

- 3.4.1 The SP402 Sampling Pump requires no regular maintenance except for recharging the battery and periodic replacement of filters. Spare filters are included in the Standard Kit (material number 1000128580) or can be ordered separately (material number 1000502864).
- 3.4.2 A visual inspection of the filter can be used to provide a quick check of the condition of the filter. To visually check the filter:
  - a) Unscrew and remove the filter.
  - b) Take the old filter and hold it up to a light source.
  - c) Look through the inlet of the old filter and examine the condition of the filter element. A clean filter will not have any dirt or particulate in it. A filter that has a large amount of dirt and particulate trapped in its filter element should be discarded and replaced.

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3.4.3 The sensor pump seal area should be inspected periodically to ensure that it is free of dirt and debris that may prevent a proper seal around the instrument's sensor area.

3.4.4 The exhaust port in the seal should also be kept open to prevent overpressurization of the sensors, which could cause erroneously higher readings on the instrument.

3.4.5 Any pump repairs should be sent to the vendor's service center.

### 3.5 SP402 Sampling Pump NI-CAD Battery Charging

3.5.1 A four-unit dual rate charger (material number 1000502863) is available for charging the battery of the SP402.

3.5.2 This charger provides a complete discharge feature, eliminating the memory condition that may result from repetitive use patterns. There is no danger of overcharging the battery.

3.5.3 When charging the NI-CAD battery pack while it is in the pump, turn the pump power switch to the off position, plug in a flying lead from the charger and lay the pump beside the charger. To charge the battery pack out of the pump, remove the battery pack from the pump and place the battery pack onto the charger. Refer to Section 3.6, Battery Replacement, for information on removal of the battery.

3.5.4 When fully charged, the battery pack will power the SP402 for approximately 10 hours. Near the end of the battery's charge, the Low Battery Indicator circuit will warn the user that approximately 10 minutes of charge is left by sounding a short (1 second) tone each minute. At this point turn the SP402 off and recharge or replace the battery pack.

3.5.5 A Lithium battery pack will operate a SP402 for approximately 24 hours.

### 3.6 SP402 Sampling Pump Battery Replacement (NI-CAD Battery Pack, or Lithium Battery Pack)

NOTE: All battery packs for the LTX310, TMX412 and SP402 are interchangeable.

3.6.1 To replace the battery pack, disengage the fastener mounted to the battery cover by turning it counterclockwise. Lift off the battery cover and pull the battery pack out of the battery compartment.

3.6.2 Install a new battery by aligning the spring contacts of the battery with the male tabs protruding from the battery compartment of the pump. Push the battery pack fully into place.

3.6.3 Insert the two plastic tabs of the battery cover into the two slots on the pump and close the cover over the battery compartment. Secure the cover by turning the fastener clockwise.

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#### 4.0 CONSTANT FLOW HAND ASPIRATOR OPERATION

The Constant Flow Hand Pump can be used as a back-up sampling system or for spot air sampling readings. It is not recommended for sampling of ammonia (NH<sub>3</sub>), chlorine (Cl<sub>2</sub>), or hydrogen cyanide (HCN) with the Hand Pump due to potential for low response and/or erroneous gas readings.

##### 4.1 Testing

- 4.1.1 Compress and hold the pump bulb.
- 4.1.2 Plug the filter inlet with a finger.
- 4.1.3 Release the pump bulb and make sure that it does not inflate in less than one (1) minute. If the pump bulb inflates in less than one (1) minute, a leak is present in the pump, filter or sample tubing. All leaks must be found and repaired before the Hand Pump is used.
- 4.1.4 Purge the reservoir bulb by squeezing it completely.
- 4.1.5 Squeeze the pump bulb ten (10) times.
- 4.1.6 Make sure each squeeze inflates the reservoir bulb.
- 4.1.7 Hold the sample cup close to the ear and make sure there is a constant air flow.
- 4.1.8 Visually inspect the pump for the following conditions, which could affect its performance.
  - A split or cracked sample cup.
  - A leaky or damaged reservoir bulb.
  - Tubing that is not the factory original 3/32" Inside Diameter or is longer than 10 ft.
  - A filter which is damaged, missing, or in need of replacement.

##### 4.2 Operation

- 4.2.1 Make sure the LTX310 or TMX412 has a valid calibration due date sticker and has been properly function tested.
- 4.2.2 Squeeze the reservoir bulb until it is completely deflated. Note: The hand pump's reservoir bulb MUST be emptied before drawing each sample. Failure to empty the reservoir will result in dilution of the gas sample. This condition will affect the indicated gas readings.
- 4.2.3 Insert the instrument into the pump's sample cup.
- 4.2.4 Insert the sample line with filter into the area to be monitored.
- 4.2.5 Squeeze the pump bulb fifteen (15) times. Allow the pump bulb to fully expand after each squeeze. The more squeezes that are performed the more accurate the gas readings.
- 4.2.6 Monitor the instrument's display to determine gas readings. The instrument MUST be left in the pump's sample cup while monitoring the display. Reaction times will vary between sensors. When inflating the reservoir bulb without counting the number of pump squeezes, use the

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netting to gauge its maximum capacity. Continuous sampling can be done by maintaining the reservoir inflation. Warning: The reservoir bulb can be damaged by over inflation.

- 4.2.7 Take gas readings from at least three (3) different levels when entering a confined space. Remember to purge the system by squeezing the reservoir bulb completely between levels.

#### 4.3 Maintenance

- 4.3.1 Replace the pump filters (Dust Filter material number 1000502864, Dust Filter/Water Stop (material number 1000502865) periodically to maintain accurate sampling, and protect the pump from dust or water contamination.

- 4.3.2 Replace the pump filters immediately if exposed directly to water, liquids, debris, and/or dust.

### 5.0 INSTALLING AND OPERATING THREE-FOOT EXTENDABLE PROBE

#### 5.1 Three-foot Extendable Probe with Teflon Insert

- 5.1.1 Remove Tygon tubing from SP402 pump inlet filter.
- 5.1.2 Attach the 3 ft. Extendable Probe by fitting the tubing connection over the pump filter.
- 5.1.3 Turn pump ON and test probe for leaks by putting finger over inlet of the probe.
- 5.1.4 Extend probe by grabbing tip and pulling to length. Be careful not to extend probe past the last stop.
- 5.1.5 Use probe for confined space entry or to test around pipe joints, valves, and flanges for possible leaks.

### 6.0 INSTALLING AND OPERATING EXTERNAL ALARM WITH 20 FT. EXTENSION CABLE

#### 6.1 External Alarm Installation

- 6.1.1 Remove and retain the black protective plug from the alarm jack on the right side of the LTX310 or TMX412.
- 6.1.2 Grasp the External Alarm cable connector by the barrel and pull to disconnect it from the jack on the alarm case. The External Alarm will sound a continuous, loud and high pitched tone. If this does not occur, check for a dead or missing battery before use.
- 6.1.3 To replace battery, see Section 6.4, Battery Replacement.
- 6.1.4 Insert the External Alarm connector plug into the alarm jack on the LTX310 or TMX412. When inserted, the External Alarm tone should immediately change to a slightly lower frequency and the red grill should illuminate. This condition will last for about one second. These indications verify proper operation.
- 6.1.5 Insert the protective plug (removed from the LTX310 or TMX412 in STEP 6.1.1) into the jack on the External Alarm.



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## 6.2 External Alarm Operation

- 6.2.1 The External Alarm is designed for use with the LTX310 and TMX412 to provide higher alarm sound levels and bright visual indications when alarms are activated.
- 6.2.2 The External Alarm may be used as a remote signaling device by using the optional extension cable (material number 1000502808), see Section 6.5.
- 6.2.3 The instrument's run-time will not be affected when using the External Alarm since it does not draw power from the instrument.
- 6.2.4 Power is supplied by an internal 9 vdc battery (material number 1000061623, also available in the local market) which will power the alarm for up to 500 hours of continuous operation in the non-alarm mode.
- 6.2.5 The External Alarm will be powered as long as it is connected to the LTX310 or TMX412. To conserve battery life when not in use, the External Alarm should be unplugged from the instrument and the connector plugged into the jack on the External Alarm.
- 6.2.6 When used with the LTX310 or TMX412, the External Alarm will copy the instrument alarm functions, including low battery warning, battery failure, and confidence beep.

## 6.3 External Alarm Failure Indications

## 6.3.1 Low Battery

When the battery in the External Alarm nears the end of its life, the Alarm will begin to sound short audible tone bursts. No visual indications will occur.

## 6.3.2 Cable Fault

- 6.3.2.1 If the cable becomes pinched or penetrated by a sharp metal object and cause a short circuit, the Alarm will sound a continuous tone and the grill will illuminate.
- 6.3.2.2 If the cable becomes disconnected or cut and cause an open circuit, the Alarm will sound a continuous audible tone with no visual indications.

## 6.4 External Alarm Battery Replacement

- 6.4.1 Remove the four (4) screws that secure the back cover of the Alarm using the tool supplied with the LTX310 or TMX412.
- 6.4.2 Lift and swing the back cover away to expose the 9 vdc battery.
- 6.4.3 Hold the case front in one hand and remove the battery from the snap type terminals with the other hand.
- 6.4.4 Replace the battery with a 9 vdc battery. Make sure that the insulator is between the battery and circuit board.

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6.4.5 Reassemble the External Alarm by placing the back cover on the Alarm. Make sure that the sides of the internal Radio Frequency (RF) shield top half lay to the inside of the RF shield bottom half.

6.4.6 Insert and tighten the four screws to secure the back cover of the alarm.

## 6.5 Extension Cable

6.5.1 Prepare the External Alarm as specified in Sections 6.1.1 and 6.1.2.

6.5.2 Insert the External Alarm connector plug into the connector on the extension cable.

6.5.3 Insert the extension cable connector plug into the alarm jack on the LTX310 or TMX412. When inserted, the External Alarm tone should immediately change to a slightly lower frequency and the red grill should illuminate. This condition will last for about one second. These indications verify proper operation.

6.5.4 Insert the protective plug (removed from the LTX310 or TMX412 in STEP 6.1.1) into the jack on the External Alarm.

## 7.0 DAILY INSPECTION AND FUNCTION TEST

Conduct an inspection and function test at the beginning of each shift or prior to use and complete the Daily Inspection and Function Test Log.

### 7.1 Visual Inspection

7.1.1 Check sensor ports of LTX310 or TMX412 to make sure that they are free of any obstruction, such as an accumulation of dust or dirt.

7.1.2 Check sensor seal area of SP402 to make sure it is free of dust and debris.

### 7.2 Leak Test

7.2.1 Test the SP402 for the leaks according to the guidelines in Section 3.1.

7.2.2 Attach the sample tubing or probe that will be used.

7.2.3 Block the flow of the pump by placing a finger over the inlet of the tubing or probe. The red fault LED and the audible alarm will turn on. Immediately remove the finger from the tubing or probe inlet and verify that the red fault LED and the audible alarm shut off.

7.2.4 If the pump does not give a fault alarm during test, remove tubing or probe and re-test pump. If pump passes test, install a different section of tubing or a different probe and again re-test.

7.2.5 If the tubing is bad, discard it and order a replacement. If the probe is bad, return it for repair.

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### 7.3 Function Test

Conduct a function test at the beginning of each shift or prior to use on each LTX310 or TMX412 using the following procedures to verify that all three sensors and alarms of the instrument are functioning properly. A Function Test Gas Canister (material number 1000502862, Bumper) and a reusable Flow Control Valve (material number 1000502805) are available from SAMS for performing this test.

NOTE: Canisters are provided for function tests only and are not intended to be used for normal calibration. Additionally, contents in the canisters are under pressure. Do not store or use the canisters near heat or open flame. Exposure to temperatures above 51.7°C (125°F) may cause contents to vent or cause bursting.

7.3.1 Turn the instrument on and allow it to warm-up.

7.3.2 Install the test cup on the instrument.

7.3.3 Insert the canister injector tube into the test cup inlet.

7.3.4 Pull the trigger and allow gas to flow for approximately one second.

7.3.5 Verify that all three sensors respond and alarms function properly.

7.3.6 Remove the canister injector tube and the test cup from the instrument. Allow the instrument to clear.

7.3.7 If any of the sensors fail to respond, consider the following:

7.3.7.1 Verify canister has not emptied.

7.3.7.2 Verify sensor ports are not plugged.

7.3.7.3 If the unit will not respond, return it to the vendor's service center for maintenance.

### 7.4 Canister Disposal

The useful life of function test gas canister is designated by expiration date on canister. Any expired or spent canisters are to be disposed of by sending them to the nearest Storehouse Operations Reclamation facility. Complete a Saudi Aramco form 112 (Reclamation Request/Disposal) to request this service.

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## DAILY INSPECTION AND FUNCTION TEST LOG

Organization \_\_\_\_\_

SP402

Org. Code \_\_\_\_\_

[illegible]

Supervising Operator

P = Pass

**F = Fail**

(Check P or F)