World Leader In Gas Detection & Sensor Technology

RKI Model GX-2003 Training Program

Prepared for TransCanada Pipeline

GX-2003 Features & Benefits

- Simultaneous Monitoring for
  - Combustible gas
    - LEL & VOL%
  - Oxygen content
  - Hydrogen Sulfide
  - Carbon Monoxide
- Built-in Sample Pump
- Simple to operate
- Audible and visual alarms
- Internal vibrating alarm
- Data logging
- Rechargeable Ni-MH battery pack
- Rugged construction

Flammability Band - Methane

Lower Explosive Limit (LEL)

- Minimum concentration of gas in air to sustain combustion provided there is a source of ignition
  - Potential for Explosion
    - If the LEL is exceeded
  - Potential Toxic Hazard
    - Depending on the gas or vapor present
  - Unsafe for Entry or Work
    - If levels exceed 10% LEL

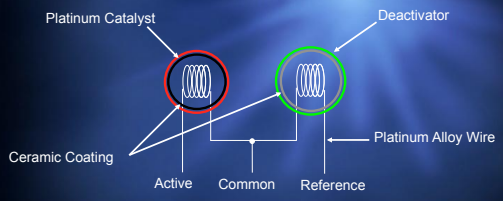
Upper Explosive Limit (UEL)

- Concentration of gas in air which is too rich to sustain combustion
  - Possible asphyxiation hazard
    - Due to displacement of oxygen
  - Potential for explosion with the addition of oxygen
  - May be extremely toxic

Definitions

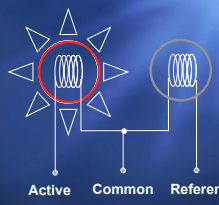
Flash Point	The minimum temperature at which a liquid gives off sufficient vapor to form an ignitable mixture with air near the surface of the liquid
Ignition Temperature	The minimum temperature required to cause self-sustained combustion, independently of the heating or heated element whether solid, liquid, or gas

Combustible Gas Detector

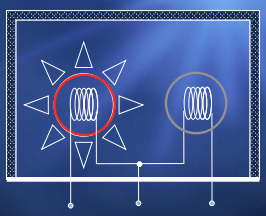


Catalytic Detector

Catalytic Oxidation



Flame Arrestor



Sintered Stainless Steel Beads Prevent Flashback in Gas-in-Air Mixtures

Combustible Sensor Poisons and Inhibitors

Poisons

- Lead containing compounds (especially tetraethyl lead)
- Sulfur containing compounds
- Silicones
- Phosphates and phosphorus containing substances

Inhibitors

- Hydrogen sulfide
- Halogenated hydrocarbons (Freon, trichloroethylene, methylene chloride)

Oxygen Deficiencies

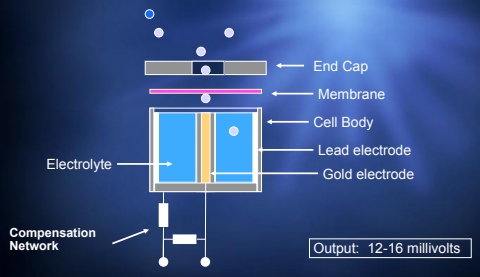
- Deficiencies are caused by:
  - Displacement
  - Oxidation
  - Bacterial Action
  - Absorption
  - Combustion

OSHA has determined that oxygen deficiency is the leading cause of death in confined spaces.

Symptoms of O_2 Deficiency

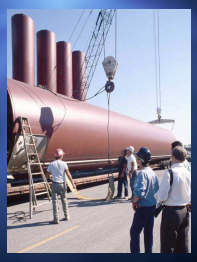
- 20.9%
  - Oxygen content in normal air
- 19.5 - 12%
  - Increased pulse and respiration
- 12 - 10%
  - Disturbed respiration, fatigue, faulty judgment
- 10-6%
  - Nausea, vomiting, inability to move, loss of consciousness and death
- 6 - 0%
  - Convulsions, cardiac arrest and death

Galvanic Oxygen Sensor (O_2)



Hydrogen Sulfide (H_2S)

- Colorless
- Rotten egg odor
- Heavier than air
- Corrosive
- Flammable
- Soluble



Effects of Hydrogen Sulfide

- 0.01 - 10 ppm
  - Rotten egg smell
- 11 - 20 ppm
  - Rotten egg smell, irritation to eyes and throat
- 100 - 200 ppm
  - Loss of sense of smell in 2 - 5 minutes
- 250-400 PPM
  - Eye and throat irritation, loss of consciousness in 5-15 minutes
- 450-600 PPM
  - Eye and throat irritation, respiratory distress, unconscious in 1-15 minutes
- 650-900 PPM
  - Respiratory distress and unconsciousness in 1-3 minutes
- 950-1000 PPM
  - Unconscious with one breath

Carbon Monoxide (CO)

- Formed by the incomplete combustion of carbon
- Found in automobile exhaust
- Colorless
- Odorless
- Poisonous
- Slightly less dense than air

Effects of CO Exposure

- 25 PPM
  - 8 hour time weighted average
- 200 PPM
  - Slight headache, discomfort within 3 hours
- 600 PPM
  - Headache, discomfort within 1 hour
- 1000 - 2000 PPM
  - Confusion, headache, nausea within 2 hours
- 2000 - 2500 PPM
  - Unconsciousness within 30 minutes
- 4000 PPM
  - Fatal in less than one hour

Why use the GX-2003?

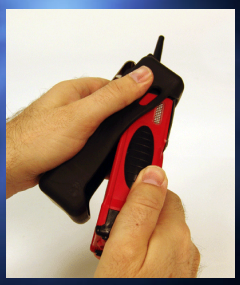
- Protection when entering confined spaces
  - Combustible atmospheres
  - Oxygen deficient atmospheres
  - Toxic Hydrogen Sulfide gas
- Survey work on the pipeline looking for presence H_2S

Let's Get Started!

- Preparing the GX-2003 for use
  - Remove the GX-2003 from its case keeping it close by for storage
  - Store instrument in closed case when not in use
  - Do not store instrument if damp or wet
  - Never store in vehicle overnight or for extended period of time

Removing the Rubber Boot

- Grasp the GX-2003 in your hands pulling the boot down exposing the battery compartment latch
- Pull the GX-2003 towards you to remove boot



Opening Battery Compartment

- Turn GX-2003 over to view latch. Move lever from right to left. The indicator dot will move from close to open

Opening Battery Compartment

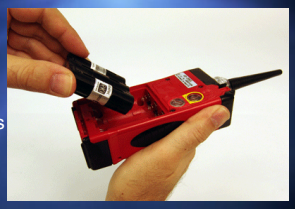
- Lift battery lid straight up to expose battery compartment

Ni-MH Battery Pack

- Orientation of the battery pack is important to ensure proper operation
- Note the polarity and removal tab

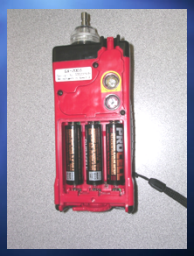
Ni-MH Battery Installation

- Hold Ni-MH battery pack with pull tab facing you. Place top of battery pack into battery compartment, push forward and press down to snap battery pack in place



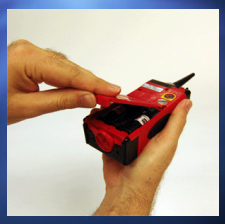
Alkaline Batteries

- As an option, three alkaline AA batteries can be substituted in place of the Ni-MH battery pack.
- Please note the proper orientation for the batteries as indicated in the battery compartment



Closing & Locking

- Slide top of battery compartment lid under retaining tab locking it in place
- Press down closing lid
- Move latch from left to right locking lid in place



Attaching the Probe Tip

- Press the rubber probe tip over inlet of GX-2003

Charging the Battery

- The GX-2003 Ni-MH battery pack will recharge in 90 minutes
- A fully charged Ni-MH battery pack will run the GX-2003 for 10 hours
- Drop GX-2003 into charging stand to recharge
- A red light will illuminate at the beginning of a charge and will turn off after charging is complete

Charge Ni-MH Battery Pack

- You may also charge the battery pack by itself in the charging unit
- Note the orientation by matching polarity and arrows between charger and pack

Attaching Rubber Boot

- Insert top of GX-2003 into rubber boot pressing it tight
- Pull bottom of rubber boot over battery latch securing in place

Remote Sampling – Confined Space

- Drawing samples from remote locations will require the use of a hose and probe
- The GX-2003 comes with a standard 10’ hose and 10” probe with filter.
- Hose lengths of up to 40’ can be provided if needed

Attaching the Sampling Probe

- Screw probe on hose and tighten

Attaching the Hose

- Remove rubber probe tip from inlet fitting if attached
- Slide collar of quick disconnect fitting onto inlet fitting of GX-2003
- You can also use the sample line without the probe and filter

GX-2003 Remote Sampling

- Drawing a sample from a confined space must be performed prior to entry
- It is required to measure gas concentration at multiple levels in the space because of different gas densities
- Allow 1 second per foot for sample time to evaluate the possibility of multiple gases present

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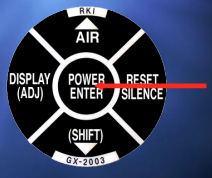
Basic Operation of the GX-2003

Always turn on and prepare the GX-2003 for use in a fresh air area!

Turning the GX-2003 ON

- Press and briefly hold the POWER/ ENTER button
- Release button when GX-2003 beeps



Warming up the GX-2003

- If USER ID / STATION ID is turned on, you will see the ID screen briefly then NEXT CAL DATE
- If the instrument is due for calibration, a CAL DATE PAST - CAL IS REQUIRED message will appear
- Do not use instrument, re-calibrate.
- If the above features are activated they will appear at instrument start up

Warming up the GX-2003

- If the GX-2003 is not due for calibration, the NEXT CAL DATE will be displayed and the days remaining during start up
- Next screen will be the Date, Time and Battery power remaining
- Recharge batteries if battery power icon displays one bar or less

Warming up the GX-2003

What if I get a FAIL SENSOR message

- DO NOT use the instrument
- Return the instrument for service, calibration or replacement of unit

Why Perform an AIR Adjustment

- Zeroing instrument to current gas free environment
- Extreme temp change (<-10 C and >30 C) can cause an Oxygen sensor alarm
- When the instrument returns to current environment temperature, perform AIR adjustment

Performing an AIR Adjustment

- Press and HOLD AIR key to set GX-2003 for fresh air values
- Release AIR key when RELEASE AIR KEY is displayed

Always turn on and AIR adjust the GX-2003 in a fresh air area!

Performing an AIR Adjustment

- When completed, the GX-2003 should display:
  - CH_4 0%LEL
  - OXY 20.9VOL%
  - H_2S 0.0ppm (if equipped)
  - CO 0ppm (if equipped)

Flow Integrity Test

- Testing the flow system is necessary to ensure correct gas readings. Leaks in the hose or probe can adversely affect the accuracy of the GX-2003
- Check instrument without hose first and then check again hose/probe assembly if used for confined space entry

Flow Integrity Test

- Place finger over end of rubber nozzle or end of 10" probe

Flow Integrity Test

- The GX-2003 should indicate FAIL LOW FLOW LEVEL
  - Audible, visual and vibratory alarm will activate
  - If no response do not use unit, return for repair or replacement

Flow Integrity Test

- Press RESET SILENCE to clear alarms and restart pump

Performance Checks

- Bump Test – prior to use
- Verification Test – monthly
- Calibration Test – quarterly

See TCPL TOP's for protocol for performance checks

Performing a daily "Bump" Test

- TCPL TOP's requires a "Bump" test prior to each use of the GX-2003
- Expose the GX-2003 to Calibration Gas and confirm sensor response for all sensors found in the unit

Performing a Verification Test

- TCPL TOP's requires a Verification Test monthly
- Performing a verification test on the GX-2003 builds confidence in its operation and tests the following:
  - Pump flow
  - Visual, Audible and Vibratory alarms
  - Sensor response to a known concentration of gas

Performance Test Components

- Required Items
  - Multi-gas blend cylinder (50% LEL CH_4, 12% O_2, 25 ppm H_2S, 50 ppm CO (if equipped)
  - 50%Vol Methane gas cylinder
  - Deman Flow Regulator
  - Tubing

Conducting a Performance Test

- Assemble the test kit
- Cylinder needs to be in the vertical position
- Connect one end of tubing from gas test kit to the inlet fitting of the GX-2003
- Connect the other end of the tubing to the regulator
- Twist gas cylinder onto the regulator

Performing a Verification Test

- Allow gas to flow for 60 seconds or until the readings stabilize
- Readings should be within the following range:
  - 40 to 60% LEL (using 50% LEL CH_4)
  - 9.6% to 14.4Vol % O_2 (using 12% O2)
  - 20 to 30 ppm H2S (using 25 ppm H_2S)
  - 40 to 60 ppm CO (using 50 ppm CO)
  - 40 to 60Vol % CH_4 (using 50%Vol CH_4)
- If readings are outside the above parameters, return instrument for calibration or service

Breath Test

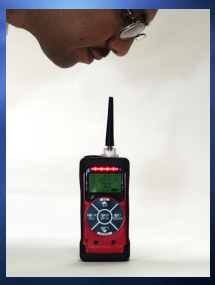
- Most confined space entry deaths are due to oxygen deficient atmospheres!
- A quick and convenient way to test the operation of the oxygen sensor is to perform a "Breath Test"
- This test quickly verifies the operation of the oxygen sensor, pump and alarm circuits
- Breath Test can be done at any time!

Performing a Breath Test

- Turn the GX-2003 **ON**
- Attach rubber probe tip or hose and probe assembly to inlet fitting
- Press and hold the AIR button to perform a Demand Zero in a Fresh Air Atmosphere
- The Breath Test will confirm that the oxygen sensor is functioning

Breath Test

- Exhale over the inlet of the probe
- Verify that the oxygen reading falls below 19.5% and activates the alarm
- Press reset switch if necessary to reset alarm



Accessing the DISPLAY Menu

- Press and release the DISPLAY button to access the following:
  - HC Range
  - User ID/Station ID (Data Logging Versions if activated)
  - PEAK readings are displayed for LEL, O_2 , H_2S, and CO sensors
  - Time in Operation
  - TWA and STEL for H2S
  - Date / Time & Battery capacity
  - Clear Data Logger
  - Log Time in Hours Remaining
  - Normal measuring screen

GX-2003 Alarms

- Flow Alarm
  - Activates in the event of a flow blockage or pump malfunction
    - Fail Low Flow Level is displayed, alarm sounds, unit vibrates intermittently
    - Remove blockage, change filters
    - Press RESET / SILENCE to restart pump
    - If unable to clear, do not use instrument, return for servicing

GX-2003 Alarms - CAUTION

- Failed Sensor Alarm
  - If a sensor should fail a "FAILED SENSOR" message will be displayed
  - The display will indicate the sensor that has failed in brackets. Example: <H_2S>
  - The instrument will alarm and vibrate to indicate failure
  - Press the RESET SILENCE button to silence alarm. Reading for failed sensor will be XXX
  - Do not use instrument with failed sensor. Return instrument for servicing

Gas Alarms Matrix – TCPL Values

Gas Type	Alarm 1	Alarm 2	STEL Alarm	TWA Alarm
Oxygen	19.5% Decreasing	23.5% Increasing	N/A	N/A
% Vol Gas	None	None	N/A	N/A
% LEL Comb	10% LEL	40% LEL	N/A	N/A
Hydrogen Sulfide	10 ppm	15 ppm	15.5 ppm	10.0 ppm
Carbon Monoxide	35 ppm	70 ppm	N/A	25 ppm

Low Battery Alarm

- When battery power is low, the battery icon blinks
- When Ni-MH batteries are dead, display will indicate "Recharge Ni-MH Batteries"
- When Alkaline batteries are dead, the display will indicate "Change the Batteries"
- Alarm LED's will flash and buzzer will sound a rapid pulsing tone with vibration – Continuous Alarm Warning

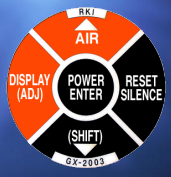
ONLY CHANGE OR CHARGE BATTERIES
IN NON HAZARDOUS AREAS

TWA or STEL Alarm

- TWA (Time Weighted Average) or STEL (Short Term Exposure Limit) alarm will activate if the concentration of H_2S or CO rises above the TWA or STEL alarm point setting.
  - TWA- 8 hour exposure for H_2S is 10 ppm
  - TWA – 8 hour exposure for CO is 25 ppm
  - STEL- 15 minute exposure limit for H_2S is 15 ppm
  - STEL – not available for CO but RKI uses the ceiling value of 200 ppm as established by NIOSH, for this alarm

Warming up the GX-2003

- If Lunch break feature is turned on, press the AIR button to resume data logging or press DISPLAY button to reset measurements
- This applies to the use of the TWA or STEL application



Resetting Alarms

- If GX-2003 is configured for Alarm Latching the alarm condition will not be cleared until user presses the RESET SILENCE button
- Press the RESET SILENCE button to reset alarms once gas conditions have cleared
- When alarm latching is set to off, the unit is self resetting (TCPL does not recommend)

Responding to Alarms

- Determine which gas has been detected
- Follow established TCPL procedure for an increasing gas condition or decreased oxygen condition
- If necessary, reset the alarm using the RESET SILENCE button once the alarm condition has been cleared

Protocol for Pipeline Testing

- CAUTION – if not in VOL% of HC range you will damage catalytic combustible sensor
- Repeated exposure of the catalytic combustible gas sensor to gas concentrations exceeding 100% LEL (5% vol CH_4) may shorten the life of the combustible gas sensor

HC range selection for VOL%

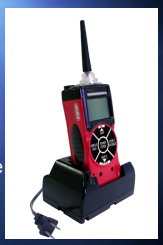
- See TCPL Sampling procedure
- Direct hydrocarbon gas measurement using GX-2003 – non PPE application
- To minimize the possibility of premature sensor failure, select ONLY VOL% from the HC Range menu
- This turns off the LEL sensor protecting it from damage due to over exposure

Selecting the HC Range

- Press the DISPLAY (ADJ) button and release.
  - HC RANGE - to select -YES: AIR, NO: DISPLAY
  - Press the AIR button, AUTO RANGE %LEL/VOL% is displayed
  - Press the AIR button again to select ONLY VOL% (NO ALARM)
  - Press the POWER ENTER button to select ONLY VOL%
    - Press the DISPLAY button repeatedly to scroll to the normal gas measuring screen
    - The normal gas reading will appear with NO ALARM flashing

User Maintenance

- Charging Batteries
  - Turn GX-2003 **OFF**
  - Remove instrument from rubber boot
  - Set GX-2003 into charging stand
  - The red charging LED will illuminate
  - When red LED turns off, batteries are fully charged (90 min)
  - Applies to plug in charger and car charger



Battery Pack Replacement

- Ni-MH batteries can be charged hundreds of times, however, if the battery fails to accept a charge or if the run-time of the instrument does not meet specifications, then replacement of the battery pack is required
  - Complete cycling of the battery will extend life
- *Always replace the battery pack in a non-hazardous location!*

Battery Pack Replacement

- Remove GX-2003 from rubber boot
- Unlatch battery compartment and remove lid
- Lift up on tab on battery pack and remove
- Place new battery pack into GX-2003 battery compartment noting polarity and lock into place
- Attach battery compartment door and close latch
- Recharge GX-2003 as required before use

NOTE: Dispose of old Ni-MH battery pack in an environmentally friendly manner

Alkaline Batteries

- The GX-2003 can operate on Ni-MH's or Alkaline batteries
- In situations when the Ni-MH battery is low and no charger is available, remove discharged Ni-MH pack and install three AA alkaline batteries
- Recommend carrying three alkaline batteries for emergency back-up

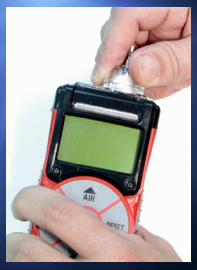
Use only high quality alkaline batteries!

Probe Filter Replacement

- Unscrew probe from hose
- Unscrew clear plastic body from probe
- Remove soiled cotton ball from probe body and discard
- Replace cotton filter using about 1/3 of a cotton ball
- Place cotton loosely into probe
- Screw plastic body back on probe and attach to hose

Instrument Filter Replacement

- The instrument filter consists of a cotton particulate filter and two hydrophobic filters separated by a wire mesh screen
- Change filters when they become discolored or if liquid is sampled into the inlet
- Failure to install the filters will damage the GX-2003!



Instrument Filter Replacement

- Verify the the GX-2003 is OFF
- Locate the clear plastic filter holder at the top of the GX-2003
- Grasp the filter holder and turn it about 1/8 of a turn counterclockwise
- Pull the filter holder away from the case. Inspect the cotton dust filter and replace if dirty

Instrument Filter Replacement

- The hydrophobic disk filters and wire mesh disk are located in the case and are retained by a rubber gasket. Pull out the rubber gasket with needle nose pliers.
- Remove the old hydrophobic filters and wire mesh disk from the gasket. A hydrophobic filter is located on either side of the wire mesh disk.
- Install the new hydrophobic filters and /or wire mesh disk making sure a hydrophobic filter is located on each side of the wire mesh disk.

Instrument Filter Replacement

- Reinstall the filter holder with the cotton dust filter
- Align the two wide tabs on the bottom of the filter holder with the two wide slots in the case where the filter holder fits. Push the filter holder into the case and turn it about 1/8 of a turn clockwise until it snaps into place

Cleaning the GX-2003

- Keeping your GX-2003 clean will help to prolong the useful life of the instrument
- Never use solvents such as acetone to clean the GX-2003 as it will damage the plastic
- Only use warm soapy water or household cleaning products to keep the instrument and accessories clean
- Keep instrument and accessories in case when not in use

Turning GX-2003 OFF

- Press and hold the POWER ENTER button until “Good-Bye” is displayed