



**BASCOM-TURNER
INSTRUMENTS**

GAS-RANGER™ DETECTORS

OPERATION MANUAL

**NATURAL GAS, CARBON MONOXIDE, OXYGEN,
AND HYDROGEN SULFIDE DETECTORS**

Part Number OM-1108

LIMITED WARRANTY

Bascom-Turner Instruments warrants Gas-Ranger Detectors to be free from defects in materials and workmanship for one year following the date of shipment. This limited warranty applies to the original purchaser of the Detector and is not transferable except by Bascom-Turner's authorized Distributors.

The instruments described in this manual are produced with standard commercial parts, any of which may fail under some circumstances. Although the probability of such failure is low, it is not zero. Accordingly, all personnel using such instruments must be trained to recognize instrument malfunctions and to have such instruments repaired promptly. Bascom-Turner offers no warranty that failures will not occur – only that when they occur, they will be promptly cured with the following procedure:

During the limited warranty period, we will repair or replace, at our option, any defective products or parts at no additional charge. A return merchandise authorization (RMA) number must be obtained prior to returning a detector to Bascom-Turner. A detector returned to Bascom-Turner with probe and water-block filter, shipping prepaid, will be repaired, calibrated and returned second day air. Warranty repairs do not include pump cleaning, filter replacement and calibration. All replaced parts and products become the property of Bascom-Turner Instruments.

This limited warranty does NOT extend to any Detectors which have been damaged as a result of accident, abuse, modification, misuse, such as failure to follow the operating instructions provided by Bascom-Turner Instruments, or other contingencies beyond our control. No other warranty is expressed or implied. Bascom-Turner is not liable for consequential damages.

CAUTION

Personnel who operate, calibrate, or repair this instrument must first read and fully understand this manual in its entirety.

For use in Class I, Division 1, Groups A, B, C and D atmospheres.

This product has not been tested for intrinsic safety in oxygen enriched atmospheres.

Change batteries and service detectors only in non-hazardous locations.

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FEATURES

The Gas-Ranger™ portable methane, and combined methane, carbon monoxide, hydrogen sulfide and oxygen detectors are intrinsically safe, microprocessor based instruments designed to test ambient air and flue gas over a wide temperature range.

These detectors have many features for easy and reliable operation:

- **Measurements Over the Full Range of Gas**
The instruments detect methane over the full range of methane concentrations.
- **TRACK GAS Scale**
A sensitive scale with quick response makes it easy to find gas leaks.
- **Automatic Zero**
Automatic zero adjustment without knobs to turn or buttons to press.
- **Automatic Calibration**
Calibration is performed automatically using Bascom-Turner's calibration gas.
- **Automatic Sampling**
An intrinsically safe, high speed pump automatically samples ambient air or flue gas. No need to "purge" on changing operating mode or scale.
- **Automatic Self-Tests**
Automatic checks of battery, sensors, and pump. Tests for blockage and for tight connection of probe to instrument.
- **Bar Holing**
Peak and sustained bar-hole readings automatically displayed after gas is pumped for a precise, fixed time.
- **Audible and Visual Alarms**
Audible and visual alarms on each scale that can be individually set. Background monitoring of natural gas, CO, O₂, and hydrogen sulfide.
- **Easy-to-Use**
One selector switch sets the mode and scale. No complicated or confusing displays.
- **Easy-to-Read, Bright Display**
A bright, efficient LED display readable at twenty feet is easy to use both indoors and outdoors.
- **A Water-block Filter**
A special Teflon® filter keeps water out even if the probe is fully immersed in water.
- **A Tough Package**
Housed in a high impact Xenoy alloy, the instruments weigh only about three pounds.

SPECIFICATIONS ^(1,2)

Gases Detected	Natural Gas (Methane) Carbon Monoxide (CO) Oxygen (O ₂) Hydrogen Sulfide (H ₂ S)
Sensors	Catalytic Combustion (CH ₄) Thermal Conductivity (CH ₄) Electrochemical (CO) Electrochemical (O ₂) Electrochemical (H ₂ S)
Ranges	
% GAS	0 to 100% by volume of methane in steps of 0.05% up to 4.0% and steps of 1% from 4 to 100%.
% LEL	0 to 100% LEL of methane in steps of 1%.
PPM CO	0 to 5000 ppm of carbon monoxide in steps of 1 ppm.
PPM H ₂ S	0 to 1000 ppm of hydrogen sulfide in steps of 1 ppm.
% O ₂	0 to 40% by volume in steps of 0.1%
Accuracy (5° to 45°C)	±2% LEL for % LEL scale ±2% GAS for % GAS scale ±5% of reading, ±10 ppm for PPM CO scale (±10% from 1000 ppm to 5000 ppm) ±5% of reading, ±10 ppm for PPM H ₂ S scale ±5% of reading for % oxygen

Warm-Up Time	30 seconds
Operating Temperature (with fresh batteries)	-30°C to 50°C (-20°F to 120°F)
Maximum Temperature of Sampled Gas	325°C (620°F)
Storage Temperature	-40°C to 60°C (-40°F to 140°F)
Continuous Operating Time per Battery Set	12 hours typical (25°C)
Humidity	0 to 98% RH (non-condensing)
Power Supply	Two D-size Alkaline or Rechargeable
Dimensions	Length 7.80" (19.8 cm) Width 4.25" (10.8 cm) Height 4.00" (10.2 cm)
Weight	3.20 lb. (1.45 kg)

(1) Not all instruments detect all gases. For a list of detectors see page 1.

(2) Specifications are applicable to properly calibrated instruments, see page 2.

PART 1. OPERATION

1. THE GAS-RANGER DETECTORS

This manual describes the operation of the family of Gas-Ranger detectors for natural gas, carbon monoxide and oxygen:

- Model RGI -201 - Detects natural gas and displays it as % LEL or % GAS
- Model RGI -211 - Detects natural gas and displays it as % GAS
- Model RGC-301 - Detects natural gas and carbon monoxide and displays % LEL or % GAS and PPM CO (parts per million of CO)
- Model RGC-311 - Detects natural gas and carbon monoxide and displays % GAS and PPM CO (parts per million of CO)
- Model RGO-321 - Detects natural gas and oxygen and displays % LEL or % GAS and % Oxygen.
- Model RGA-411 - Detects natural gas, CO, and oxygen and displays % GAS, PPM CO and % Oxygen with TRACK GAS in % LEL
- Model RGA-412 - Detects natural gas, CO, and oxygen and displays % GAS, PPM CO and % Oxygen with TRACK GAS in % GAS.
- Model RGA-611 - Detects natural gas, CO, oxygen and H₂S and displays % GAS, PPM CO, % Oxygen and PPM H₂S with TRACK GAS in % LEL
- Model RGA-612 - Detects natural gas, CO, oxygen and H₂S and displays % GAS, PPM CO, % Oxygen and PPM H₂S with TRACK GAS in % GAS.

All models detect natural gas and may be used to test ambient air for natural gas, bar hole, and track gas leaks in pipes and other conduits.

All models which detect carbon monoxide (CO) may be used to test for CO in ambient air and test for CO in flue gas and gases given off by appliances.

All models have a TRACK GAS scale which operates as follows:

- TRACK GAS - Displays the concentration of natural gas in % LEL (Models RGI-201, RGC-301, RGA-411 and RGA-611) or % GAS (Models RGI-211, RGC-311, RGA-412 and RGA-612) and operates a beeper for tracking the source of a leak

All gases detected by a particular instrument are monitored continuously while using any choice of display, including TRACK GAS.

A unit alerts the user visually and audibly (with an alarm) when the concentration of one or more gases exceeds preset limits. Alarm limits can be set by the user. Factory set limits are:

- % GAS = 1.0% equivalent to % LEL = 20%
- PPM CO = 200 ppm
- % OXYGEN = 19.5% for low and 23.0% for high
- PPM H₂S = 10 ppm

In the "TRACK GAS" mode, the frequency of a beeper depends on the natural gas concentration. The beeper is silent below 0.2% LEL (0.04% GAS) and sounds once every 2 seconds at 0.2% LEL of gas, speeds up with rising concentration and is on continuously at 2% LEL (0.1% gas) above ambient.

2. OPERATION

A. Overview of Essential Operating Practice

Gas-Ranger detectors are easy to use. Once the appropriate display is selected, operation is automatic. However, a few general rules must be followed to insure reliability and accuracy.

Pump. Gas-Ranger detectors have a built-in pump and depend on this pump for their operation. If the pump is not functioning normally, the instrument will not function properly. It is therefore essential to check the pump each time the instrument is first turned on.

Pump Test: Connect the probe you plan to use and select any scale. When the display shows a number, normally zero, block the probe tip with your finger until the display shows "*bloc*".

If "*bloc*" does not appear, there may be a leak along the probe. Tighten all connections and repeat the test. If a block condition is still not observed, remove the hose and block directly the inlet to the instrument. If "*bloc*" still does not appear, call the factory or return the instrument to the factory for repair.

<p>WARNING: The instrument should never be used when "<i>bloc</i>" fails to appear upon blocking the inlet.</p>

Filters. Dust and water-block filters protect the sensors and the pump from dust and accidental intake of liquid water. Just as a car would not be operated without air and fuel filters, do not operate a Gas-Ranger detector without a filter on the hose. Operation without this filter will eventually degrade the pump. It also voids the limited warranty.

From time to time, examine the water-block filter on the hose. If loose dirt has accumulated, shake it out. Do **not** poke at the filter with a tool or any other implement which may puncture it. If the filter is substantially discolored by dirt, replace it.

Zero Check. All sensors drift to some extent over time. Sensor drift is corrected by using the AUTO ZERO position (see Section 3, Instrument Checks). Zeroing takes about 60 seconds and is normally required no more frequently than once a day. It is important that the zero adjustment be done in clean air, for example, outdoors. If the sampled gas is not clean, a systematic error will be introduced in all subsequent measurements.

<p>WARNING: On a gas call, use the AUTO ZERO adjustment outdoors, never indoors. Zero adjustments must be carried out with clean air.</p>

Test and Calibration. Gas-Ranger detectors must be checked and calibrated periodically with gas of known composition. The catalytic combustion, carbon monoxide, and hydrogen sulfide sensors depend on catalysts which may lose activity or get poisoned during use. When this happens, there will be diminished response.

The necessary frequency of calibration depends on actual use and on the concentration of catalyst poisons in the sampled gas. This concentration is, of course, not generally known.

A detector can be tested with "bump" gas. Such tests verify that the gas sensor(s) are in operating condition. To verify and adjust, if necessary, their sensitivity they must be calibrated.

A detector can be automatically calibrated in approximately one minute using Bascom-Turner's calibration gas (2.5% CH₄ and 100 ppm CO in air). Given the ease and speed of

automatic calibration, it pays to calibrate as frequently as possible, and certainly, no less than monthly.

Accuracy. A properly operating and calibrated detector will respond with the specified accuracy. If combustible gases other than the gas used for calibration are likely or suspected, the instrument **cannot** be relied upon to give a proper indication of their concentration and hence of how close to their combustible limits they may be. For example, the detector responds quite differently to gasoline, to methane, and to propane. Accordingly, readings of % LEL (or its equivalent in percent gas) refer only to the calibration gas and can be relied upon only in this respect in assessing an atmosphere sampled by the detector. Furthermore, concentrations displayed by the detector refer to a local sample at the tip of the instrument probe. Low gas concentrations at one spot do not necessarily mean that the gas concentration is low throughout a wider area.

Note:	All gases detected by a particular instrument are monitored continuously while using any choice of display.
WARNING:	Each detector responds to the gases for which it was designed. Other toxic or dangerous gases may not be detected.

B. Operational Description

To conserve the batteries, the selector switch should be in the "OFF" position when the instrument is not in use.

To Use the % GAS Display. Connect an appropriate probe to the water-block filter attached to the hose and turn selector switch to position marked "% GAS". The display shows "GAS" for about 15 seconds.

- After warm-up, the display shows the concentration of natural gas in air in percent by volume (% GAS). If the air is clean (contains no gas), the display should read zero. If it does not, switch to position marked "AUTO ZERO". After automatic adjustment of zero is complete (display shows "End"), return the switch to the "% GAS" position. The % GAS scale spans the whole range of gas in steps of 0.05% from zero to 4.0% and in steps of 1% from 4 to 100%.

Bar Holing. The detectors may be used to measure gas levels in sampling holes used for locating underground natural gas resulting from seepage or leaks in a conduit. Gas concentrations in a bar hole near a significant leak will exceed several percent. Therefore an alarm for gas is likely, but it has no relevance to the ambient atmosphere above ground. During bar-holing, the alarm for the % GAS scale is automatically turned OFF.

To bar hole, select an appropriate probe (see Section 7), set the front panel switch to % GAS and, after a number appears on the display (typically zero), press the RESET switch on the front panel. The pump is turned off, the display shows "go" and the instrument beeps - it is ready for bar holing. After inserting the probe into the bar hole, press the RESET switch again. The pump is turned on and the instrument samples gas for a fixed time (**factory set time is 15 seconds**). Readings during sampling are shown on the display. At the end of the fixed time for sampling, the instrument beeps, turns off the pump, and displays the peak (left side of display) and the sustained (right side of the display) readings. Both values are in % GAS. The instrument can be returned to the standard display by pressing the RESET switch again.

If a check is to be made for trace amounts of gas in a bar hole or above ground, for example around the foundation of a structure, the % GAS or % LEL display should be used. The bar holing feature using the RESET switch is appropriate for pinpointing underground leaks.

To Use the % LEL Scale. Connect an appropriate probe to the water-block filter attached to the hose and turn selector switch to position marked "% LEL". The display shows "LEL" for about 15 seconds.

- * After warm-up, the concentration of natural gas in air is displayed as percent of the lower flammable limit (LEL). If the air is clean (contains no gas), the display should read zero. If it does not, switch to position marked "AUTO ZERO". After the display shows "End", return the switch to the % LEL position.
- * The % LEL scale ranges from 0 to 100 % in steps of 1%. The following table shows equivalent readings in % LEL and % GAS (percent volume):

EQUIVALENT READINGS IN % LEL AND % GAS		
% LEL		% GAS
0.6	equivalent to	0.03
1		0.05
2		0.1
10		0.5
20		1.0
100		5.0

To Detect Gas and Track Its Source with the TRACK GAS Display. Connect an appropriate probe to the water-block filter attached to the hose and turn selector switch to position marked "TRACK GAS". The display shows "SniF" (sniff) for about 25 seconds.

- * After warm-up, the display shows the concentration of gas in air in % LEL with the RGI-201, RGC-301, RGO-321, RGA-411 and RGA-611 and % GAS with the RGI-211, RGC-311, RGA-412 and RGA-612. If the air is clean (contains no gas), the display should read zero. If it does not, switch to position marked "AUTO ZERO". After automatic adjustment of zero is complete, return the switch to the "TRACK GAS" position.
- Advance a probe along the pipe or other conduit suspected of having a gas leak. The beeper will sound once every 2 seconds at 0.2% LEL (0.04% GAS) concentrations of gas, will speed up with rising concentration, and will beep continuously at 2% LEL (0.1% GAS) above ambient (no beep at or below 0.1% LEL). By listening to the beeper or by reading the display, the source of gas can be located.
- If, during leak tracking, the background concentration of gas rises above zero, the display and beeper can be reset to zero by pressing the RESET switch on the front panel. Resetting or suppression of the zero for background gas can be carried out up to 3% LEL (0.15% GAS); above this level, the instrument will not reset the zero.
- Sometimes it is desirable to silence the beeper during a leak survey. To silence the beeper, first place the selector switch in the % GAS position, then press and hold the RESET switch on the front panel while turning the selector switch from % GAS to

TRACK GAS. The survey can now be done by observing the readings on the display while the beeper is silent.

- Notes:**
- Both background zero suppression and silencing of the beeper are only applicable as long as the selector switch remains in the TRACK GAS position. If the selector switch is moved to some other position and then returned to TRACK GAS, TRACK GAS will operate in the normal way (no background suppression and active beeper).
 - Since gas is lighter than air, track a pipe from above when possible.
 - The TRACK GAS mode uses more power. To conserve the batteries, use the TRACK GAS display only when tracking a gas leak.

To Detect Carbon Monoxide

Carbon Monoxide in Ambient Air

- * Connect an appropriate probe to the water-block filter and turn selector switch to position marked "PPM CO". The display shows "CO" for about 15 seconds.
- * After warm-up, the display shows the concentration of CO in parts per million (ppm). If the air is clean (contains no carbon monoxide), the display should read zero. If it does not, switch to "AUTO ZERO". After automatic adjustment of the zero is complete (display shows "End"), return the switch to the "PPM CO" position.

Carbon Monoxide in Flue Gas

- * Connect the flue gas probe, with an attached flue gas filter, to the water-block filter on the hose and turn selector switch to position marked "PPM CO". The display shows "CO" for about 15 seconds.
- * After warm-up, insert the probe into the flue and read the concentration of CO in parts per million. A flue gas check of CO should take one minute or less. For every minute of flue gas sampling allow the detector a minute of room air sampling to dry the filters.

<p>CAUTION: The filter provided with the flue probe must be used to avoid interference by nitrogen oxides present in combusted gas. A filter is good for about three months of ordinary use. It should be replaced when about 90% of its purple material has changed color to brown, or when it gets clogged or flooded (see "Accessories and Spare Parts", Flue Gas Filter, Part No. FF-005).</p>

Note: The standard flue gas probe and filter are suitable for spot checks lasting a minute or two. For measurements of CO in flue gas over longer periods use an Extended Duty Flue Gas Probe and Filter (Part No. FP-012).

<p>WARNING: Do not touch the flue probe immediately after a measurement. Wait until it cools. Running the instrument in air helps cool the probe.</p>

To Display Oxygen with the "% Oxygen" Display (Models RGO-321, RGA-411/412, RGA-611/612). Connect an appropriate probe to the dust and water-block filter and set the selector switch to "% Oxygen". After warm-up, the display shows the ambient concentration of oxygen in percent by volume. If ordinary air is being sampled, the display should read 20.9 ± 0.2 . If it does not, switch to "AUTO ZERO", wait until the display shows "End", and return the switch to the "% Oxygen" position.

- The "% Oxygen" display spans the range 0 to 40.0% with a resolution of 0.1%.

"Air-free" CO Flue Measurements

The RGA-411/412 and RGA-611/612 detectors can display measurements of CO on an "air-free" basis if this feature is selected (see Section 10). When this selection is made, the measured CO concentration is referred to air-free flue gas according to:

$$\text{"Air-free" PPM CO} = \frac{20.9}{20.9 - \text{measured \% O}_2} (\text{measured ppm CO})$$

The instrument measures CO and % Oxygen and displays CO concentrations on an air-free basis using the above relation. This calculation is used up to 16.0% Oxygen. If the oxygen concentration is above 16.0%, measured values are displayed without conversion, i.e., the "air-free" formula is **not** used.

Hydrogen Sulfide Detection - Models RGC-301/311 and RGA-411/412

The electrochemical cell used to detect CO also responds quantitatively to hydrogen sulfide (H₂S). The response to 1 ppm H₂S is registered as 4 on the PPM CO display. This ratio holds for all values of H₂S up to about 100 ppm H₂S. Thus, 10 ppm H₂S will register as 40 on the PPM CO display. Since these detectors monitor ambient levels of hydrogen sulfide, as well as CO and they will alarm if the H₂S concentration rises above one quarter of the limit set for the CO alarm.

If an atmosphere contains both CO and H₂S, the response of the detector is additive. If a reading for CO only is needed or desired, the flue gas probe and its attached filter can be used for sampling ambient air. The filter removes H₂S and the reading then corresponds to the CO concentration.

WARNING: A detector will not respond to H₂S when the sampled gas is drawn through the flue gas probe and filter.

Hydrogen Sulfide Detection in Ambient Air - Models RGA-611/612

Connect the standard probe to the dust and water block filter and set the selector switch to "PPM H₂S". After warm-up, the display shows the ambient concentration of H₂S in PPM.

If an atmosphere contains both CO and H₂S the detector will selectively display the concentration of CO on the PPM CO scale and the concentration of H₂S on the PPM H₂S scale. The CO sensor in these detectors has an internal H₂S filter, which results in CO selectively.

WARNING: A detector will not respond to H₂S when the sampled gas is drawn through the flue gas probe and filter.

C. Alarms

A detector alerts the user acoustically, with a sound alarm or beeper, and visually by "flashing" the symbol(s) for the detected gas(es) whose concentration exceeds preset limits. Visual alarms are displayed in-between readings for the particular display in use. For example, if the display is showing readings for natural gas (selector switch at "% GAS") and the concentration of CO rises above its alarm limit, the display will flash "CO", approximately every two seconds, in-between displays of the concentration of natural gas. If the concentration of natural gas also rises above its alarm limit, the display will show a reading, then "GAS", then a reading, then "CO", and so on. Simultaneously, the sound alarm will be on.

Visual alarm symbols are "GAS" for natural gas, "CO" for carbon monoxide. "LoO₂" for low oxygen, "HiO₂" for high oxygen, and "H₂S" for hydrogen sulfide (models 611/612 only).

Factory set alarm limits are 1.0% methane (20% LEL), 200 ppm CO, and 19.5% for low and 23.0% for high oxygen, and 10 ppm for H₂S.

3. INSTRUMENT CHECKS

Automatic Battery Check

If the battery life is less than about 1 hour, the display flashes "Lo" (low) between readings. The batteries should be changed at a convenient time. If the battery life is over, the display stays on "Lo". The batteries must be changed to make the instrument operational.

Automatic Pump Check

If the intake is blocked, the display shows "bloc" (block) and the detector beeps until the problem is cleared. This check is carried out whether or not a probe is being used.

If the intake is blocked during AUTO ZERO (see below), the display shows "bloc" but the detector does not beep.

Check for Tight Connections

To check for tight connections, block the probe inlet to observe "bloc" on the display. If "bloc" fails to appear, there may be a leak (see Section 6, "Troubleshooting").

WARNING: The instrument should not be operated if it fails to display "bloc" when the air intake is blocked.

Automatic Zero

To adjust the zero automatically, advance the selector switch to "AUTO ZERO". Zero adjustment, which takes 60 seconds, is typically required only once a day.

Models CGA-611 and CGA-612 do not have a separate position marked AUTO ZERO. For these models, the AUTO ZERO mode is entered by switching from the % Oxygen position to the PPM H₂S position while holding down the RESET button.

Display	Automatic Operation
Air, O ₂	The oxygen sensor (if present) is adjusted.
GAS 1	The zero of the thermal conductivity sensor is adjusted.
CO	The zero of the CO sensor (if present) is adjusted.
GAS 2	The zero of the combustion sensor is adjusted.
H ₂ S	The zero of the H ₂ S scale (if present) is adjusted.
End	The instrument beeps briefly denoting that it is ready for use.

If automatic adjustment of zero cannot be carried out, for example, because the methane concentration is too high, the display shows "nogo" (no go) and the name of the scale that failed to zero, and does not advance to "End" (see Troubleshooting Section).

CAUTION: Zero adjustment **must** be carried out with clean air. If the air is not clean, a systematic error will be introduced in subsequent measurements. The instrument will auto zero in concentrations of methane below 0.25% (5% LEL) and concentrations of CO below 20 ppm. If higher concentrations of methane or CO are detected, the instrument will not change its zero, and the display will show "nogo" (no go).

Automatic Sensor Check

If a gas sensor fails (opens up), the display shows "FAIL" along with the name of the sensor that failed, e.g. GAS1, GAS2, or O₂ (see Troubleshooting Section). CO or H₂S failures do not produce the "FAIL" message.

4. INTERFERENCE FROM OTHER GASES, LIQUIDS, OR RFI

The methane detectors use two sensors:

- i) A catalytic combustion filament calibrated with methane. It is used up to about the lower flammable limit (5.0% by volume) of methane.
- ii) A thermal conductivity sensor calibrated with methane. It is used from the lower flammable limit (5.0 vol %) to 100 vol % of methane.

Models RGC-301 and RGC-311 use the sensors listed above and:

- iii) A three-electrode, electrochemical cell for carbon monoxide.

Model RGO-321 methane and oxygen detector uses the methane sensors listed above and,

- iv) A two-electrode, electrochemical cell for oxygen.

Models CGA-611/612 use the above sensors and

- v) A three-electrode, electrochemical cell for hydrogen sulfide.

Gases, or liquids with appreciable vapor pressure, which may interfere with the detection of methane include substances which can be combusted on the catalytic combustion filament (examples are ethane, propane, ethylene, propylene, octane, and the like) and substances which differ in thermal conductivity from air (examples are hydrogen, helium, carbon dioxide, other hydrocarbons).

Gases or vapors which may interfere with carbon monoxide detection include substances which can be electrochemically oxidized or reduced on the working electrode of the electrochemical sensor. Examples are hydrogen, hydrogen sulfide, oxides of nitrogen, alcohols, and unsaturated hydrocarbons.

Many of the substances that interfere with CO are removed by the flue gas filter (Part No. FF-005). This filter can be used for both flue gas measurements and for ambient air measurements of CO whenever the ambient concentration of other oxidizable substances is significant. This filter **must not** be used whenever H₂S measurements are desired.

Radio Frequency Interference

The Gas-Ranger detectors have an interior coating on their cases to suppress radio frequency interference (RFI).

WARNING: The methane, CO, and H₂S sensors use catalytically active surfaces which may be poisoned by air contaminants. These sensors should not be exposed to atmospheres that contain silicones, halogens and halides, such as chlorides, and volatile compounds containing lead or antimony. If exposure to atmospheres that adversely affect the sensors is suspected, the detector should be recalibrated promptly.

5. CHANGE OF BATTERIES

Gas-Ranger detectors are powered by two (2) alkaline (**non-rechargeable**) D-size batteries (1.5V, Type AM-3) or by two rechargeable batteries sold by Bascom-Turner. The batteries are good for at least eight, and typically twelve, hours of continuous operation. When the batteries are drained to about one hour of remaining continuous use, the display flashes "Lo" (low) between readings. If the batteries get very low, the display stays on "Lo", and the batteries must be changed to make the instrument operational again.

WARNING: The batteries must be changed in an atmosphere known to be non-hazardous.

To change batteries:

1. Turn selector switch to "OFF".
2. Remove spent batteries.
 - a) Unscrew the battery cap and slide out two D-cells.
 - b) Discard two alkaline D-cells.
3. Insert two, fresh D-size alkaline batteries.
4. Replace the battery cap and give it one quarter turn (battery cap bar vertical).

Note that the batteries are inserted with the flat end (negative) terminal first.

If the instrument does not operate after battery replacement, there is a high probability that a battery has been inserted with the wrong polarity. Re-insert the batteries taking extra care to insert each battery correctly.

Note: Always replace a set of batteries with a new set. Do not mix used and new batteries. When operating in cold weather (below -10°C) use a fresh set of batteries, if possible.

WARNING: Do not attempt to charge the alkaline (non-rechargeable) batteries because they may leak or vent.

WARNING: Use only alkaline batteries or rechargeable batteries sold by Bascom-Turner in a Gas-Ranger.

6. TROUBLESHOOTING

Coarse Zero Procedure: If the display shows *"nogo"* in clean air during auto zero, press and hold the RESET switch on the front panel while turning the selector switch from AUTO ZERO to some other scale and back to AUTO ZERO again. Please note that you **must** carry out this procedure starting with the *"nogo"* display; if the instrument was turned off after *"nogo"* was displayed, select AUTO ZERO again, wait until *"nogo"* is displayed and proceed as described above. For RGA-611 and RGA-612 detectors use the ppm H₂S scale in place of AUTO ZERO in this procedure.

Problem	Probable Cause	Action
1. Display is blank and pump does not operate.	<ul style="list-style-type: none"> Batteries are too low or spent. 	<ul style="list-style-type: none"> Replace batteries (see Section 5 "Change of Batteries").
2. Batteries are replaced but display is blank and pump does not run.	<ul style="list-style-type: none"> One or more batteries were inserted with the wrong polarity. One or more batteries are too low. 	<ul style="list-style-type: none"> Re-insert batteries with proper polarity. Replace batteries with a new set.
3. The Display shows <i>"bloc"</i> .	<ul style="list-style-type: none"> The intake to the instrument is blocked. There is water in the probe. Limit set incorrectly. 	<ul style="list-style-type: none"> Check probe tip and water-block filter, drain probe, and dry probe and filter by shaking. Detach probe from water-block filter, drain probe, and dry probe and filter by shaking. See Section 11-E.
4. The display does not show <i>"bloc"</i> when the probe tip is blocked.	<ul style="list-style-type: none"> There is a leak between the probe tip and the pump. Limit set incorrectly. 	<ul style="list-style-type: none"> Tighten connections of probe. Check hose and probe for cracks. Disconnect hose and block intake. If <i>"bloc"</i> does not appear, clean or replace pump. See Section 11-E.
5. The display shows <i>"nogo"</i> prior to <i>"End"</i> when on AUTO ZERO scale.	<ul style="list-style-type: none"> Ambient concentration of methane or CO is high. Detector will not purge. A sensor zero has drifted too far. 	<ul style="list-style-type: none"> Repeat zero in clean air. Check pump by blocking. If <i>"bloc"</i> appears repeat zero in clean air (see coarse "zero"). See "coarse zero" above.
6. The display shows <i>"FAIL"</i> and a sensor name.	<ul style="list-style-type: none"> The natural gas or oxygen sensor has failed. 	<ul style="list-style-type: none"> Replace indicated sensor.

WARNING: Do not open a sensor under any conditions. Sensors must be replaced only by personnel trained in instrument service.

WARNING: Do not operate an instrument which fails to show *"bloc"* when the intake is blocked. Clean the pump or return the instrument for repair. See the inside of the front cover (limited warranty) on how to return an instrument.

7. PROBES

Standard Probe

The standard probe (Part No. SP-306), a rigid tube, connects to the dust and water-block filter. If extra length is desired, an extension (7", SP-308) is screwed finger-tight onto the end of the probe. A rubber gas collector (Part No. RT-107) is useful for finding leaks under windy conditions.

CAUTION: Do not use this probe for flue gas measurements. The plastic probe may become soft, deform, or decompose.

Flue Gas Probe

The flue gas probe (Part No. FP-110) is a telescoping metal probe screwed finger-tight into the flue gas filter. The other end of the filter attaches to the dust and water-block filter. This probe, together with its filter, may also be used for CO measurements in ambient air.

CAUTION: Never attach the filter cartridge directly to the sample hose - always use a water block filter.

WARNING: Hold the probe without touching the metal while it is in the flue and immediately afterwards. Running the instrument in air after a measurement will help cool the probe quickly and dry the filters.

Bar Hole Probes

There are four optional probes suitable for bar holing:

Bar Hole/Ceiling Probe (Part No. BP-034) 34" long, clear, one hole at end.

Bar Hole Probe (Part No. BP-134) 34" long, clear, side holes.

Bar Hole Probe (Part No. BP-236) 36" long, fiberglass, side holes

Bar Hole Probe (Part No. BP-536) 36" long, steel, side holes.

The bar hole/ceiling probe has a single inlet on the end and comes with a rubber gas collector (Part No. RT-030) useful for finding leaks in overhead pipes. The stainless steel probe has an electrically insulated handle. Bar hole probes are designed to be attached to the water block filter on the hose. A convenient way to release water from a bar hole probe is with a water-stopper (Part No. WS-001) described in Section 8.

WARNING: Hold the steel bar hole probe only by the insulated handle to avoid electrical shock from buried power lines.

8. ROUTINE MAINTENANCE

Dust and Water-block Filter

A filter, housed in a knurled nut, removes particles of dust and dirt and blocks water. The white disk in the filter should be inspected periodically for accumulated dirt which may slow air sampling. A filter can be cleaned by removing the probe and tapping the filter cartridge on a hard surface to remove dry dust and dirt. Do not insert objects into the water block filter while attempting to clean it as they may puncture the filter. Typically, the filter needs to be replaced twice a year. Replacement water-block filters are available as Part No. WF-305 (package of 5 filters).

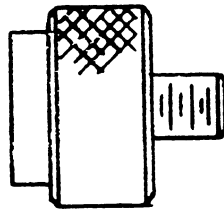


Figure 1. Dust and water-block filter.

CAUTION: Do not use a Gas-Ranger without a dust and water-block filter. Do not use a dust and water-block filter with a puncture.

Inlet Dust Filter

Removal of the intake connector (used to attach the sampling hose) of the detector exposes a metal filter pressfit onto the intake. These filters are not a substitute for dust and water-block filters as they will not block water or remove very fine dust and dirt. If this filter gets blocked, it may be cleaned with compressed air or replaced.

Water-stopper

The water-stopper (Figure 2) provides a quick way to continue bar holing if water is encountered in a bar-hole. The water-stopper is inserted between the dust and water-block filter and the bar hole probe. A float inside the water-stopper is connected to a plunger which blocks flow whenever the float is lifted by water. Water is released and the plunger returned to its normal position by depressing a release push-button.



Figure 2. Water-stopper

Dust-Stopper

The dust-stopper is a filter with a large surface area on which dust can collect without slowing the sampling rate of the Gas-Ranger. The filter element is easily cleaned or replaced by removing the threaded cap and either blowing off the filter element or pulling it off and replacing. Replacement dust filter cartridges are available as Part No. DF-105. The dust-stopper should be used between the dust and water-block filter and the probe or water-stopper.

Flue Gas Filter

This filter is designed to be screwed finger-tight between the telescoping metal probe and the dust and water-block filter. It must be used for CO measurements in flue gas and may also be used for CO measurements in ambient air. The filter cartridge should be replaced when about 90% of the material has changed color from purple to brown or when it becomes blocked by soot or water. Replacement flue gas filters are available as Part No. FF-005 (package of 5 filters).

Heavy Hydrocarbon Filter

A heavy hydrocarbon filter, filled with activated carbon, is designed to be used with the standard probe or the bar hole probe on a one-time-only basis. Activated carbon adsorbs gasoline and other heavy hydrocarbons (for example, propane or butane) which interfere with methane detection. In order to keep the filter material from adsorbing hydrocarbons prior to use, the filter is fitted with plastic endcaps which must be removed just before use. The filter should be either discarded after use or refilled with activated carbon and recapped with the plastic endcaps. This filter is designed to be screwed finger-tight between the probe and the dust and water-block filter. Heavy hydrocarbon filters are available as Part No. HF-005 (package of 5 filters).

The heavy hydrocarbon filter can also remove some alcohols and unsaturated hydrocarbons which can interfere with CO readings. The filter should be discarded or refilled after each use.

Activated carbon for refilling approximately 50 cartridges is available as Part No. HR-050. To refill the filter cartridge, remove threaded top and pour out spent filter material. Retrieve the plastic retainer disk from the spent filter material. Fill cartridge with fresh filter material to bottom of threads and place the plastic retainer disk flat on top of the filter material. Screw in top until finger tight and check seal with block tests.

<p>CAUTION: Do not remove or puncture the white filter in the bottom of the filter cartridge. If this filter becomes damaged, discard the filter cartridge.</p>

PART 2. CALIBRATION AND ALARM LEVEL SELECTION

9. AUTOMATIC CALIBRATION WITH A-CAL™

The A-CAL firmware calibrates instruments automatically using calibration gas available from Bascom-Turner

Calibration Gas. The gas required for automatic calibration of the catalytic combustion and CO sensors is Bascom-Turner's methane and CO calibration gas (Part No. MC-620) containing $2.5 \pm 0.05\%$ methane and $100 \text{ ppm} \pm 2 \text{ ppm}$ CO in air. It is provided in a disposable aluminum tank containing 620 liters of gas, sufficient for at least 300 calibrations.

The thermal conductivity sensor can be calibrated with pure methane.

The oxygen sensor is calibrated with ambient air whenever the instrument is autozeroed.

Calibration Gas Dispenser. The calibration gas must be delivered at or near atmospheric pressure to ensure accurate calibration. Bascom-Turner recommends using the Calibration Gas Dispenser (Part No. CGD-001) which regulates and displays the delivery pressure, approximately 6-7 inches of water. The flow or pressure regulator used upstream of the gas dispenser must be capable of delivering at least 2 liters per minute.

A-CAL Operation. In carrying out automatic calibrations with the A-CAL firmware, **always calibrate the catalytic combustion and CO sensors first**, that is, use the Bascom-Turner methane and CO calibration gas first. Then, if necessary, recalibrate the thermal conductivity sensor. This sequence of calibration gases ensures that no errors are introduced from residual gas in the detector.

A-CAL Calibration with the Methane and CO Calibration Gas

1. Place the selector switch in "AUTO ZERO" and zero the instrument in clean air. The usual series of displays will appear on the monitor display, depending on the model.
2. After "*End*" appears on the display and the instrument beeps, insert the tip of the standard probe partially into the outlet port of the gas dispenser. If a manual calibration apparatus (for example, Part No. PCA-302) is used, attach the monitor's water-block filter to the threaded hose barb (TB-512) with the regulator's valve off and wait for "*bloc*".
3. After "*bloc*" appears on the monitor display, push the probe completely into the dispenser port. The "*bloc*" display will be replaced by "*go*" and the instrument will proceed to calibrate the catalytic combustion and CO sensors.
If a manual apparatus is used, open the flow regulator's valve and observe "*go*" on the display.
4. The monitor display will show "*GAS 2*" while the catalytic combustion sensor is being re-calibrated and "*CO*" when the CO sensor is being re-calibrated.

5. After calibration, the monitor will show "CAL" and the instrument will beep briefly. Remove the probe from the gas outlet. The instrument is ready for use.

Note: During calibration, the selector switch remains in the AUTO ZERO position. After calibration is complete and "CAL" is displayed, the selector switch must be placed at some other scale (or the OFF position) to return the monitor to a normal operating mode.

CAUTION: Automatic calibration presupposes and depends on using Bascom-Turner's calibration gas (Part No. MC-620). Do not use a gas of a different composition for automatic calibration.

A-CAL Calibration with the Methane or System Gas

The thermal conductivity sensor is calibrated at the factory with methane. Routine re-calibration of this sensor is not necessary. The thermal conductivity sensor is checked operationally using air as the reference gas every time the AUTO ZERO routine is used. However, should there be need to recalibrate the thermal conductivity sensor, proceed as follows:

1. Place the selector switch on "AUTO ZERO" and zero the instrument in clean air. The usual series of displays will appear on the monitor display. Note that if the instrument had just been calibrated with the methane and CO calibration gas, the selector switch must be moved to some other scale and given 30 seconds to purge residual gas before the AUTO ZERO routine is repeated.
2. After "End" appears on the display and the instrument beeps, block the probe tip manually until "bloc" appears on the display. Now release the block. The display will show "go" and the instrument is ready for calibration.
3. Connect the probe to a source of pure methane or system gas. The gas pressure should not exceed 6" or 7" of water column and gas must be delivered at the rate of at least 2 liters per minute. The display will show "GAS 1" while the thermal conductivity sensor is being calibrated. When calibration is complete, "CAL" will appear on the display and the instrument will beep briefly.
4. Disconnect the probe from the gas and let the instrument run briefly in clean air to purge residual gas. Monitor the purging by placing the selector switch on the GAS scale. When the reading on this scale returns to zero, the instrument is ready for use.

Note that while the probe is being connected to a source of methane or system gas, "bloc" may appear briefly on the display, for example, if some time elapses between connection to the gas outlet and opening of a valve that allows calibration gas to flow. This will not interfere with proper calibration.

Models CGA-611 and 612 have a H₂S sensor that is calibrated at the same time as the thermal conductivity sensor. The proper calibration gas for these models is methane with 25 ppm of H₂S (Part No. MH-620). For these models, the "GAS 1" display will be followed by "H2S", while the H₂S sensor is calibrated, and then by "CAL" when calibration is complete.

Error Codes during Automatic Calibration. The only special error code that may appear during automatic calibration is "*nogo*" (no go). This code, which denotes that automatic calibration cannot proceed, may appear in the following circumstances:

- i) More than 30 seconds elapse between the "*go*" display and the introduction of calibration gas. If this is the case, wait for an additional period up to 60 seconds, with gas flowing through the instrument. The "*nogo*" display will be replaced by "*CAL*" when the sensors are calibrated.
- ii) A sensor is outside the normal range for automatic calibration. If this is the case, typically after replacing a sensor, the "*nogo*" display will alternate with a display indicative of the sensor which cannot be calibrated. Thus, "*nogo*" alternating with "*GAS 2*" indicates that the catalytic combustion sensor is outside the range for automatic calibration. Similarly, "*nogo*" alternating with "*CO*" indicates that the CO sensor is outside the range for automatic calibration. If this result is obtained, the monitor must be calibrated manually.

FYI:

It is possible for a monitor to be manually calibrated and yet not calibrate with A-CAL. This indicates a sensor sensitivity is less than a preset limit in the software and means that the sensor should be replaced.

- iii) A sensor is not sufficiently stable for calibration to proceed normally or the gas composition is varying with time. This last condition may hold if the calibration system has not been purged (e.g., first calibration of the day). If this is the case, wait for an additional period of up to 60 seconds with gas flowing through the instrument. If response is stable, the monitor will be calibrated and "*CAL*" will appear on the display. If the instability persists, the "*nogo*" display will persist. The instrument must then be tested manually and the cause of the malfunction corrected.

<p>CAUTION: Do not use a calibration gas of a different composition than Bascom-Turner's calibration gas (Part No. MC-620 or MH-620), or pure methane or "system gas" for automatic calibration. If some calibration gas other than those stipulated here is to be used, calibration should be carried out manually.</p>

10. ALARM LEVEL SELECTION

To review or change alarm limits, remove the pan head #4-40 black screw (see Figure 3) from the right side of the instrument (as you face it) using a Phillips screwdriver and access a push-button switch with a short rod 3/32" (or less) in diameter. Set the front panel selector switch to AUTO ZERO and after "Air" is displayed, press the push-button switch. The pump will stop running and the instrument will enter a display/set-up mode for alarms and other options.

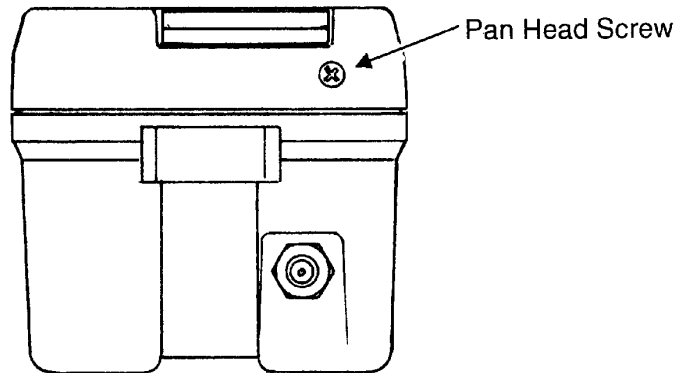


Figure 3. Side view of detector.

To Display Alarm Levels Without Changing Them. Each time the push-button is pressed, the display advances through the sequence shown in Table 1. The display shows whether an alarm or other option is ON or OFF, and if ON, at what level.

To Turn Off or On Alarms or Select Options. Alarm levels for gas and CO can be adjusted within certain limits or turned OFF, the beeper for the TRACK GAS scale may be turned OFF, the CO display may be put on an air-free basis, and the block limit for the pump may be adjusted by using the push-button and the RESET switch on the front panel. The oxygen alarm limits are always ON at the factory set levels.

To turn an alarm OFF or select an option, enter the alarm display mode as described above (set selector switch to AUTO ZERO and press the push-button once), advance to the relevant display by pressing the push-button an appropriate number of times, and then press the RESET switch. Each time RESET is pressed, the display changes from OFF to ON (and the reverse). If the change to be made is to turn off a particular alarm or operating mode, once OFF appears on the display, press the push-button. The display will show a symbol followed by OFF (see Table 1). Exit by turning the selector switch out of the AUTO ZERO position or continue, by pressing the push-button, to a subsequent display of another alarm or option to be changed.

The oxygen alarms and the block level for the pump cannot be turned OFF. If OFF is entered with RESET, when the push-button is pressed, the display will show "LoO2" or "HiO2" or "Pu" followed by a number (19.5 for LoO2, 23.0 for HiO2 and the block limit for the pump).

Table 1. Display Sequence

Display	Statement	Use/Comments
bBEEP followed by ON or by OFF	The TRACK GAS beeper is active. The TRACK GAS beeper is silent.	Used only for turning beeper ON or OFF. The alarm limit is set by <i>SniF</i> display (see below).
SniF followed by a number or by OFF	The TRACK GAS alarm is at value shown. The TRACK GAS alarm is OFF.	If ON, displayed number is % LEL (RGI-201, RGC-301, RGA-411, or RGA-611) or % GAS (RGI-211, RGC-311, RGA-412, or RGA-612). Maximum setting is 20% LEL or 1.00% GAS.
GAS followed by a number or by OFF	The % GAS alarm is at value shown. The % GAS alarm is OFF.	If ON, displayed number is % GAS. Maximum setting is 1.00% gas.
AFCO followed by ON or by OFF	The air-free CO option is enabled. The air-free CO option is disabled.	Used only for enabling or disabling air-free CO option.
Cloc followed by a number or by OFF	The timer for bar hole gas sampling is set to seconds as shown. The timer is set OFF.	Used to set sampling time prior to the display of peak and sustained readings on % GAS scale.
LEL followed by a number or by OFF	The % LEL alarm is at value shown. The % LEL alarm is OFF.	If ON, displayed number is % LEL. Maximum setting is 20% LEL.
CO followed by a number or by OFF	The PPM CO alarm is at value shown. The PPM CO alarm is OFF.	If ON, displayed number is PPM CO. Maximum setting is 200 PPM CO.
H2S followed by a number or by OFF	The PPM H ₂ S alarm is at value shown . The PPM H ₂ S alarm is OFF	If ON, displayed number is PPM H ₂ S. Maximum setting is 20 PPM H ₂ S.
LoO2 followed by a number	The lower alarm limit for oxygen is at value shown.	This alarm is always ON and is fixed at 19.5% oxygen.
HiO2 followed by a number	The upper alarm limit for oxygen is at value shown.	This alarm is always ON and is fixed at 23.0% oxygen.
Pu followed by a number	The block limit for the pump is at value shown.	Factory set number is 3500. Can be changed to adjust the pump (see Section 11E).

To Change Alarm Levels. If an alarm level is to be changed, rather than turned OFF, select the relevant display by pressing the push-button an appropriate number of times, then press RESET until ON appears, then press the push-button. The display will show a number (the previous alarm level) with a flashing first digit. If this digit does not need to be changed, press the push-button again. The next digit will now be flashing. To change the digit, press RESET to advance sequentially through 1,2,3,...0. Once the proper digit is reached, press the push-button to advance the flashing digit to the next position. Repeat until all digits are adjusted. At the end, the display will show the relevant symbol followed by the new alarm level.

Examples of Selection or Adjustments

To Disable the Beeper on the TRACK GAS Scale. Set selector switch to AUTO ZERO and press the push-button.

Press	Display	Followed By
	BEEP	ON
RESET	OFF	
Push-button	BEEP	OFF

Exit by placing the front panel switch to a position other than AUTO ZERO. The beeper on the TRACK GAS scale can be activated again by repeating the above procedure.

To Change the Alarm Level for the % GAS Display to 0.5% Gas. Set the front panel selector switch to AUTO ZERO and press push-button three times. The display will advance to GAS followed by a number (the current alarm limit). Continue by

<u>Press</u>	<u>Display</u>	<u>Comment</u>
RESET	ON	
Push-button	<u>0</u> 1.00	Underlined digit is flashing
Push-button	0 <u>1</u> .00	Underlined digit is flashing
RESET		Continue pressing the RESET switch until 0 appears as the second digit
	0 <u>0</u> .00	
Push-button	00 <u>0</u>	
RESET		Continue pressing the RESET switch until 5 appears as the third digit
	00 <u>5</u>	
Push-button	00 <u>5</u>	
Push-button	GAS followed by 0.50	

Exit by placing the front panel switch to a position other than AUTO ZERO.

To Change the Alarm Level for the CO Display to 35 PPM CO. Set the front panel switch to AUTO ZERO and press the push-button seven times. The display will advance to CO followed by a number (the current alarm level). Continue by

<u>Press</u>	<u>Display</u>	<u>Comment</u>
RESET	ON	
Push-button	<u>0</u> 200	Underlined digit is flashing
Push-button	0 <u>2</u> 00	Underlined digit is flashing
RESET		Continue pressing the RESET switch
	00 <u>0</u> 0	until 0 appears at the second digit
Push-button	00 <u>0</u> 0	
RESET		Continue pressing the RESET switch
	00 <u>3</u> 0	until 3 appears as the third digit
Push-button	003 <u>0</u>	
RESET		Continue pressing the RESET switch
	003 <u>5</u>	until 5 appears on the last digit
Push-button	CO followed by 35	

Exit by placing the front panel switch to a position other than AUTO ZERO.

11. MANUAL CALIBRATION, SENSOR REPLACEMENT, PUMP ADJUSTMENT

Manual calibration is required if a sensor has drifted too far to be calibrated automatically and sometimes when a sensor is replaced. Since the procedures described below access basic operating parameters, safeguards have been built to ensure that the set-up mode is not entered accidentally.

To access the set-up mode, remove the pan head #4-40 black screw (see Figure 3) from the right side of the instrument (as you face it) using a Phillips screwdriver and access a push-button switch with a short rod 3/32" (or less) in diameter. Place the instrument on a flat surface with some stop to keep the instrument in place. Set the front panel switch to the position nearest AUTO ZERO and press both the push-button and RESET simultaneously. With both switches depressed, turn the front panel switch to AUTO ZERO and release buttons. The instrument will enter the set-up mode for manual calibration and adjust; the display will show "Pu" (pump).

The parameters that can be accessed in the set-up mode are described in Table 2. Each state is reached sequentially by pressing the push-button and can be adjusted by using RESET and the push-button in the same way as described in detail for setting alarm levels (see Section 10). Ordinarily, only some of the parameters need be adjusted during manual calibration or when installing a new sensor. The main adjustments to an instrument in the field are described separately below.

A. Manual Calibration

If the sensitivity of a sensor has drifted too far to be automatically adjusted, "nogo" will appear during auto calibration. The sensor must then be calibrated manually.

To calibrate, enter the set-up mode (see above) and press the push-button until GAS 2 appears on the display (4 depressions). If clean air is being pumped through the instrument, the display should show 0.00 or -0.00. Introduce calibration gas (2.5% methane) and adjust the display by using the RESET and the push-button, as described in Section 10 and in the example below, until the display reads 2.50.

Example: The display reads 1.45 with calibration gas. To adjust, press RESET. The display will flash the left most digit, a zero. Press the push-button. The display will now flash the second digit, 1. Press RESET to advance to 2; press the push-button. The third digit, 4, will now be flashing. Press the RESET to advance the third digit to 5. Press the push-button; the last digit, 5, will now be flashing. Press RESET until this digit is zero, and then press the push-button. The display will show "GAS 2" followed by a number which ought to be 2.50. If this number is more than 2.52 or less than 2.48, repeat the procedure (beginning with RESET) to adjust again to 2.50.

The procedure for calibrating manually the CO sensor is similar. After entering the set-up mode, the push-button is pressed until "CO" appears on the display followed by a number (7 depressions). The number is adjusted to 100 (assuming the calibration gas contains 100 ppm CO) by using RESET and the push-button as described in Section 10.

Table 2. Display Sequence in Set-Up Mode

Display*	Parameter	Use/Comments
Pu followed by a number	Pump current in arbitrary units	Used to adjust block limit for pump (see Section 11E)
bA followed by a number	Battery voltage	Should be between 2.15 and 3.15 (Do NOT Adjust)
°C 1 followed by a number	Room temperature (°C)	For installing a new sensor (set automatically by SCAL)
°C 2 followed by a number	Filament temperature (°C)	For installing a new sensor (set automatically by SCAL)
GAS 2 followed by a number	<u>In Calibration Gas</u> : % GAS	For manual calibration (Sect. 11A)
GAS 1 followed by a number	<u>In Pure Methane</u> : % GAS	For manual calibration (Sect. 11A)
°C 3 followed by a number	Room temperature (°C) of the on-board temperature sensor	Should read room temperature (°C) (Do NOT Change)
CO followed by a number	<u>In Calibration Gas</u> : PPM CO	For manual calibration (Sect. 11A)
H2S followed by a number	<u>In Calibration Gas</u> : PPM H ₂ S	For manual calibration (Sect. 11A)
O2 followed by 9999	Not used in the field	Do NOT Adjust.
Air	Beginning of AUTO ZERO sequence	Normal operating mode

*After each depression of the push-button.

B. SENSOR REPLACEMENT

Sensor replacement must be followed by new sensor calibration as described in Part C of this Section.

The tools required for sensor replacement and new sensor calibration are a Phillips #1 screwdriver and a small rod (less than 3/32" in dia.) to actuate the push-button under the 4-40 black screw on the right side of the detector (see Figure 3).

The following stepwise procedure will result in an efficient and trouble-free installation of any sensor in the Gas-Ranger:

1. Remove the four Phillips-head screws from the bottom of the case, lift the top cover off and place it face down in front of the case.
2. Remove the sensor to be replaced from the circuit board by pulling the sensor straight up. Make certain that the rubber gaskets remain in place in the gas manifold.
3. Align the new sensor pins with the receptacles on board. Push directly down to secure the sensor to the board.
4. Place the top cover back on the base, aligning the two brass power connections over their receptacles, and re-attach the cover to the base using the four Phillips-head screws.

C. NEW SENSOR CALIBRATION (SCAL)

The following procedure will calibrate the new sensor after installation

CAUTION: SCAL must be performed after a new sensor is installed before the detector can be used.

1. Remove the black #4-40 screw from the right side of the detector (see Figure 3).
2. While simultaneously pressing both RESET and the push-button on the right of the detector, move the selector switch from OFF to TRACK GAS and wait 2-3 seconds before releasing the buttons. "SCAL" should be displayed for several seconds.

Note: If 1 or 2 dots appear, repeat Step 2.

3. The detector automatically sets up and zeros the new sensors and calibrates the oxygen sensor (if present) on the air sampled by the pump. When finished, "End" is displayed.

CAUTION: The detector must be sampling clean air to ensure accurate set up and zeroing.

4. After "*End*" appears on the display and the instrument beeps, **calibrate without moving the selector switch from the TRACK GAS position.** Insert the tip of the standard probe partially into the outlet port of the gas dispenser or, if a manual calibration apparatus (for example, Part No. PCA-302) is used, attach the detector's water-block filter to the threaded hose barb (TB-512) with the regulator's valve off and wait for "*bloc*".
5. After "*bloc*" appears on the display, push the probe completely into the dispenser port. The "*bloc*" display will be replaced by "*go*" and the instrument will calibrate the catalytic combustion and CO sensors.

If a manual apparatus is used, open the flow regulator's valve and observe "*go*" on the display.

The detector's display will show "*GAS 2*" while the catalytic combustion sensor is being re-calibrated and "*CO*" when the CO sensor is being re-calibrated.

6. After calibration, the detector will show "*CAL*" and the instrument will beep briefly. Remove the probe from the gas outlet. Replace the black #4-40 screw and the instrument is ready for use.

Note: During SCAL calibration, the selector switch remains in the TRACK GAS position. After calibration is complete and "*CAL*" is displayed, the selector switch must be placed at the OFF position to return the monitor to a normal operating mode.

CAUTION: SCAL calibration presupposes and depends on using Bascom-Turner's calibration gas (Part No. MC-620). Do not use a gas of a different composition for automatic calibration. If some other gas is used, calibration should be carried out manually.

Error Codes during SCAL. The only error code that may appear during SCAL calibration is "*nogo*" (no go). This code, which denotes that SCAL calibration cannot proceed, may appear in the following circumstances:

- i) More than 30 seconds elapse between the "*go*" display and the introduction of calibration gas. If this is the case, wait for an additional period up to 60 seconds, with gas flowing through the instrument. The "*nogo*" display will be replaced by "*CAL*" when the sensors are calibrated.
- ii) A sensor is not sufficiently stable for calibration to proceed normally or the gas composition is varying with time. This last condition may hold if the calibration system has not been purged (e.g., first calibration of the day). If this is the case, wait for an additional period of up to 60 seconds with gas flowing through the instrument. If response is stable, the monitor will be calibrated and "*CAL*" will appear on the display. If the instability persists, the "*nogo*" display will persist. The instrument must then be tested manually and the cause of the malfunction corrected.
- iii) The monitor's gain is set too high by a previous manual calibration. The unit must be calibrated manually.

D. BOOSTING SENSOR SENSITIVITY

The sensitivity of a natural gas sensor generally decreases with use because some substances, for example, silicones, tend to poison the catalyst. A catalytic sensor can often be restored to its original sensitivity by periodically cleaning it with Boost Gas available from Bascom-Turner. The sensor does not need to be removed from the detector for boosting. The catalytic combustion sensor's sensitivity can be boosted many times, but if boosting must be performed too frequently on a given detector, its methane sensor is best replaced.

The following stepwise procedure will boost the sensitivity of the catalytic combustion sensor and then calibrate the sensor.

1. Remove the black #4-40 screw from the right side of the detector (see Figure 3).
2. While pressing the push-button with a small rod (3/32" in dia. or less), move the selector switch from OFF to TRACK GAS and wait 2-3 seconds before releasing the button "*bGAS*" should be displayed.

Note: If 1 or 2 dots appear repeat step 2.

3. Connect the boost gas assembly (Part No. BGA-302) to the dust and water-block filter on the hose of the Gas-Ranger and turn on the gas valve. The display should stop flashing "*bGAS*" "*nogo*" and display "*bGAS*" with the pump off for 5 minutes.
4. When the detector beeps and displays "*End*", turn the boost gas tank valve off and disconnect from the dust and water-block filter.
5. Press the RESET button and allow the detector to purge out the boost gas with clean air.
6. Press the RESET button again and the detector will auto zero the sensors. When finished, "*End*" is displayed.
7. A calibration must now be performed without moving the selector switch from the TRACK GAS position. After "*End*" appears on the display and the instrument beeps, insert the tip of the standard probe partially into the outlet port of the gas dispenser. If a manual calibration apparatus (for example, Part No. PCA-302) is used, attach the detector's water-block filter to the threaded hose barb (TB-512) with the regulator's valve off and wait for "*bloc*".

After "*bloc*" appears on the detector's display, push the probe completely into the dispenser port. The "*bloc*" display will be replaced by "*go*" and the instrument will proceed to calibrate the catalytic combustion and CO sensors.

If a manual apparatus is used, open the flow regulator's valve and observe "*go*" on the display.

The detector's display will show "*GAS 2*" while the catalytic combustion sensor is being re-calibrated and "*CO*" when the CO sensor is being re-calibrated.

8. After calibration, the detector will show "CAL" and the instrument will beep briefly. Remove the probe from the gas outlet. Replace the black #4-40 screw and the instrument is ready for use.

Note: During calibration, the selector switch remains in the TRACK GAS position. After calibration is complete and "CAL" is displayed, the selector switch must be placed at the OFF position to return the detector to a normal operation mode.

Note: Error codes during calibration are the same as those during SCAL calibration (see Sect.11C).

CAUTION: Automatic calibration presupposes and depends on using Bascom-Turner's calibration gas (Part No. MC-620). Do not use a gas of a different composition for automatic calibration.

E. Adjustment of the Block Limit of the Pump

If a "bloc" signal is not displayed when the air intake to the instrument is directly blocked, the problem may be corrected by adjusting the block limit used to detect a block.

1. Observe the Pump Current in Normal Operation and When Blocked

To adjust the "bloc" limit, first enter the set up mode, described at the beginning of this Section 11 (press RESET and the push-button simultaneously while switching the front panel switch to AUTO ZERO), and note the reading on the display following "Pu" (see Table 2). It represents in arbitrary units the current to the pump. When the probe is blocked, a reading with a decimal point, for example 350.0, should be displayed.

If a decimal point is not displayed, the block limit may be too high. If required, adjust the block limit, as described below, to some lower value. The block limit should not be set to a value less than one and a half times (1.5x) the value observed when the probe is **not** blocked. Otherwise, a "bloc" signal may appear in normal operation. If this margin to normal operation cannot be maintained, the pump must be re-adjusted mechanically.

2. Adjust the Block Limit

To adjust the block limit to some lower value, for example, 3000 place the front panel switch in a position other than AUTO ZERO and then back to AUTO ZERO and press the push-button. The instrument will be in the alarm setting and option selection mode (Section 10). Press the push-button until "Pu" appears on the display followed by 3500. Press RESET to show "On", then press the push-button to show 3500 with the underlined digit flashing. Press the push-button again to advance the flashing digit to the second position. Now press RESET to advance this digit to 0 and then press the push-button three more times until Pu appears followed by 3000. Exit by placing the front panel switch at some position other than AUTO ZERO.

APPENDIX I

SET UP AND PURGE OF THE CALIBRATION GAS DISPENSER

Calibration Gas. The gas required for automatic calibration of the catalytic combustion and CO sensors is Bascom-Turner's methane calibration gas (Part No. MC-620) containing 2.5 \pm 0.05% methane and 100 ppm \pm 2 ppm CO in air. It is provided in a disposable aluminum tank containing 620 liters of gas, sufficient for at least 300 calibrations.

The thermal conductivity sensor can be calibrated with either pure methane or "pure" system gas provided by the user.

Calibration Gas Dispenser. The calibration gas must be delivered at or near atmospheric pressure to ensure accurate calibration. Bascom-Turner recommends using the Calibration Gas Dispenser (Part No. CGD-001) which regulates and displays the delivery pressure, approximately 5 to 10 inches of water, with a front panel pressure gauge.

Accessories with the calibration gas dispenser shown assembled in Figure 4 include:

Description	Part Number
Calibration gas dispenser	CGD-001
Methane & CO calibration gas	MC-620
Flow regulator	FR-302

SAFETY PRECAUTIONS: For your safety please read these instructions carefully. To operate the flow regulator on a compressed gas cylinder, it is required that you be trained in its proper use or be under competent supervision.

1. Wear safety glasses when installing a gas regulator on a gas cylinder.
2. Never heat or expose a gas cylinder to temperatures above 125°F.
3. Be certain that the gas stream is shut off at the regulator when not in use.
4. Vent all calibration gas to outside air.

INSTALLING CALIBRATION GAS TANK

1. Inspect cylinder's and regulator's Standard Compressed Gas Association (CGA) connections for damage, dirt, dust, oil, or grease. Do not use if either is damaged. Remove all traces of foreign materials with a clean, lint-free cloth.
2. Be sure both the regulator and cylinder have compatible CGA fittings. Do not attempt to use an adapter to connect incompatible CGA fittings.
3. Verify that the regulator's valve is closed.
4. Attach the regulator to the cylinder and tighten the CGA connection nut counter-clockwise.

5. Secure gas cylinder to a wall, bench or stand with a mounting bracket so it will not tip over or fall.
6. Observe the inlet supply pressure gauge, which will verify cylinder pressure.

PURGING THE GAS DISPENSER: Purging air from the gas dispenser should be done each time a new tank of calibration gas is installed and prior to instrument calibration.

1. Open the regulator's valve and observe 5 to 10 inches of water column pressure on the gas dispenser's gauge.
2. Leaving the regulator's valve open insert the tip of the detector's extended standard probe as far as it will go into the outlet on the front panel of the gas dispenser.
3. Switch to the % LEL scale and wait several minutes. The % LEL reading will slowly climb to a maximum and stabilize.
4. When finished purging close the regulator's valve.

CALIBRATING DETECTORS

1. Calibrate gas detectors following the procedure for A-CAL calibration (Part 2, Section 1).
2. When finished calibrating close the regulator's valve.

APPENDIX II

SET UP OF THE MANUAL CALIBRATION APPARATUS

These instructions should be followed when setting up and using the manual calibration apparatus (Part No. PCA-302).

The components of the manual calibration apparatus are shown assembled in Figure 5, they include:

Description	Part Number
Methane & CO calibration gas	MC-620
Flow regulator	FR-302
Tubing and connector	TB-512

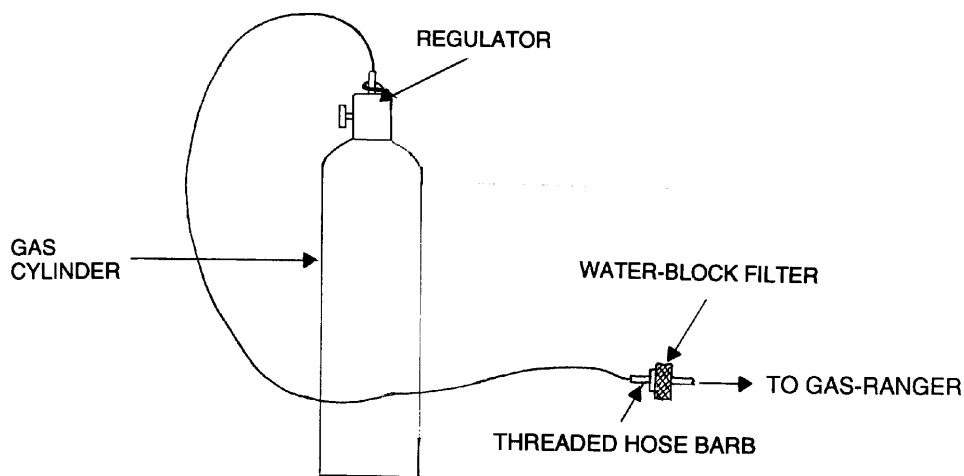


Figure 5. Manual calibration apparatus (Part No. PCA-302).
Above drawing is symbolic.

SAFETY PRECAUTIONS

For your safety please read these instructions carefully. To operate the flow regulator on a compressed gas cylinder, it is required that you be trained in its proper use or be under competent supervision.

1. Wear safety glasses.
2. Never heat or expose a gas cylinder to temperatures above 125°F.
3. Be certain that the gas stream is shut off at the regulator when not in use.
4. Vent all calibration gas directly to outside air.
6. Always use the flow regulator to prevent pump damage.

REGULATOR AND HOSE INSTALLATION

1. Secure gas cylinder to a wall, bench or stand with a mounting bracket so it will not tip over or fall.
2. Be sure both the regulator and cylinder have compatible CGA fittings. Do not attempt to use an adapter to connect incompatible CGA fittings.
3. Inspect cylinder's and regulator's Standard Compressed Gas Association (CGA) connections for damage, dirt, dust, oil, or grease. Do not use if either is damaged. Remove all traces of foreign materials with a clean, lint-free cloth.
4. Attach the regulator to the cylinder and tighten the CGA connection nut counter-clockwise.
5. Verify that the regulator's valve is closed.
6. Observe the inlet supply pressure gauge, which will verify cylinder pressure.
7. Connect the 3/16" ID tubing with a threaded hose barb (Part No. TB-512) to the hose barb on the regulator and secure with a cable clamp.

CALIBRATION

1. Use either the automatic or manual calibration procedure described in Part 2, "Calibration and Alarm Level Selection".
2. When finished close the regulator valve.

<p>CAUTION: Always attach the detector's water-block filter to the threaded hose barb (TB-512) with the regulator off, wait for "<i>bloc</i>", then open regulator's valve. Blocking the flow with the regulator's valve open can result in a pressure surge when the flow is resumed which will damage the detector's pump.</p>

ACCESSORIES AND SPARE PARTS

Description	Part Number
1. Probes and Hoses	
Gas-Ranger Probe & Rubber Tip	SP - 306
Gas-Ranger Probe Extension (7" long)	SP - 308
Ceiling/Bar Hole Probe & Rubber Tip (34 inch long, clear).....	BP - 034
Clear Bar Hole Probe (34 inch long, side holes).....	BP - 134
Fiberglass Bar Hole Probe (36 inch long, side holes)	BP - 236
Metal Bar Hole Probe (36 inch long, side holes)	BP - 536
Standard Flue Gas Probe & Filter (10 inch long)	FP - 110
Extended Duty Flue Gas Probe & Filter	FP - 012
Straight Hose (5 feet long)	QH - 042
Straight Hose (10 feet long)	QH - 120
Surface Vacuum Probe (36 inch long with quick connect).....	VP - 136
Rubber Gas Collecting Tips (for SP-306 or SP-308, 5/pkg).....	RT - 107
Rubber Gas Collecting Tips (for BP-034, 5/pkg).....	RT - 030
2. Filters	
Dust & Water-block Filter (5/pkg)	WF - 305
Water-stopper (with push-button release)	WS - 001
Dust-stopper (with replaceable filters)	DS - 001
Replacement Dust Filters (5/pkg).....	DF - 105
Flue Gas Filter (5/pkg)	FF - 005
Extended Duty Flue Gas Filter (5/pkg).....	FF - 105
Heavy Hydrocarbon Filter (5/pkg).....	HF - 005
Inlet Filter & Quick Connect Air Intake (5/pkg)	IF - 305
3. Sensors	
Methane Sensor (in flame arrestor)	MS - 302
Carbon Monoxide Sensor	CO - 301
Carbon Monoxide Sensor for RGA-611 & RGA-612.....	CO - 302
Hydrogen Sulfide Sensor for RGA-611 & RGA-612.....	HS - 301
Oxygen Sensor	OS - 301
4. Replacement Parts and Manual	
Main Circuit Board (### = Model No.)	RB - ###
Battery Board	BB - 001
Pump Motor	PM - 301
Pump Head (5/pkg)	PH - 305
Pump Head, Diaphragm/Plunger Assembly (5 sets/pkg).....	PD - 305
Intake Manifold with Pump	RM - 301
Xenoy Case (without BC-003, ### = Model No.).....	XC - ###
Battery Compartment Cap.....	BC - 301
Operating Manual.....	OM - 1002
5. Instrument Case	
Instrument Case.....	IC - 301
Shoulder Strap.....	SS - 301
6. Accessories for Calibration & Maintenance	
Two in One Bump Gas (5/pkg)	BG - 005
Calibration Gas Dispenser (without MC-620 & FR-302)	CGD - 001
Manual Calibration Apparatus (with MC-620 & FR-302).....	PCA - 302
Manual Calibration Apparatus (with MH-620 & FR-303).....	MCA - 302
Boost Gas Apparatus (with BG-620 & FR-303)	BGA - 302
Boost Gas (620 L)	BG - 620
Methane & CO Calibration Gas (2.5% CH ₄ & 100 ppm CO)	MC - 620
Methane & H ₂ S Calibration Gas (100% CH ₄ & 25 ppm H ₂ S)	MH - 620
Flow Regulator for MC-620.....	FR - 302
Flow Regulator for MH-620 or BG-620	FR - 303
Threaded Hose Barb & Tubing	TB - 512
Pump Repair Kit (with 1 can of UJ-206).....	PK - 301
7. Filter Material for Refilling Filters	
Activated Carbon & Spare Retaining Disks (50 refills of HF-005).....	HR - 050