



WatchGas Colorimetric Gas Detection Tubes & Pump

Quick Start Guide

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WARNING

The products described herein will perform as designed only if they are used, maintained, and serviced in accordance with the manufacturer's instructions. Failure to use, maintain, and operate products properly can result in dangerously inaccurate readings.

CAUTION: For safety reasons, the equipment described herein must be operated and serviced by qualified personnel only. Read and understand this instruction manual completely before operating or servicing.

ATTENTION: Pour des raisons de sécurité, ces équipements Doivent être utilisés, entretenus et réparés uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Custom Tubes

For information regarding the availability of custom gas detection tubes not listed in this manual, please contact your authorized WatchGas distributor or local supplier.

Application & Technical Notes

Additional Application Notes and Technical Notes referenced in this manual—as well as many others—are available on the WatchGas website. Visit: www.watchgas.com

WatchGas Tubes App



Download the
WatchGas Tubes App
using the QR code

1. INTRODUCTION

This handbook outlines the use and performance of gas detection tubes and sampling pumps manufactured by WatchGas. WatchGas began producing gas detection tubes in 2018 and continues to add many new tubes to its product line each year. With modern production facilities and techniques, we are able to offer high-quality tubes at a highly competitive price.

Gas detection tubes were first developed at Harvard University in the early 1900s for measuring carbon monoxide. In this method, a gas sample is drawn through a glass tube containing a reagent, and a reaction between the gas and the solid reagent forms a color that correlates with the concentration of the gas. The concept is similar to other colorimetric methods, such as pH paper for measuring acids and bases, or the bleaching of dyes to determine ozone or chlorine levels in water or air. Early tubes were primarily designed for confined space entry, particularly in industries like mining, where CO and H₂S are the main toxic gases. Since then, a wide range of tubes has been developed for detecting a variety of chemicals. With the introduction of OSHA regulations in the workplace in the 1970s, these tubes expanded from mostly inorganic, acutely toxic compounds to include a large number of organic compounds, whose health effects are generally more long-term. Along with this shift, there has been a growing need for increased specificity in the measurements.

Several important factors limited the accuracy of early tube/hand pump systems. First, the tubes lacked precalibrated markings. Some tubes were read using a color comparison chart, which relied on the user's interpretation of the color. Other tubes came with an external scale that the user had to slide into position. This introduced potential errors in the scale's positioning and, more importantly, did not account for variations in the length of the stain produced by different batches of the same tubes. Modern tubes eliminate such errors by performing calibrations on each batch, with the results marked directly on the tubes.

A second source of error was the volume of air sampled. Early pumps were variations of a rubber squeeze bulb, which had poor reproducibility in the amount of compression. Later, fixtures were added to the bulbs to ensure uniform compression and, as a result, a fixed volume. The Draeger and MSA bellows pumps operate in the same way as the squeeze bulbs but are designed to draw in accurate sample volumes.

Air sampling can also be performed using piston pumps, which latch into a precisely defined position to fix the volume. These pumps initially create a strong vacuum, generating a substantially higher flow rate than bellows pumps. Piston pumps produce a high flow at first, followed by an approximately exponential decay, while bellows pumps provide a more steady flow initially, followed by a slow decay. The difference in flow patterns means that the pumps are not interchangeable between types. For instance, piston pumps can sometimes cause smearing of the color stain when used on tubes that were originally developed for bellows pumps. This happens because the higher flow rates do not allow enough contact time to achieve sharp endpoints when a piston pump is used.

For a time, efforts were made to improve accuracy by stabilizing the flow rate using rate-limiting orifices. Some manufacturers provided up to four different orifice sizes to match the specific tube being used. However, swapping limiting orifices proved to be cumbersome and unnecessary, as long as sufficient contact time was allowed to prevent smearing of the stain. As a result, limiting orifices have fallen out of use, and it is now standard practice to incorporate the flow restriction directly into the tube itself. This is achieved by selecting the appropriate particle size of the support material and type of end plug to provide a sampling time that is suitable for the particular chemical reaction of the tube.

As a result of these developments, modern tube/pump systems have evolved into two categories: (1) low-vacuum bellows pumps, which have less flow resistance in the tubes due to being wider (~7 mm o.d.) and containing larger particles, and (2) high-vacuum piston pumps, which have greater resistance in the tubes due to being narrower (~5 mm) and containing smaller particles. The bellows pump/tube systems tend to offer faster sampling but require more pump strokes to complete a measurement, whereas the piston pump systems typically need fewer strokes but longer sampling time per stroke. WatchGas tubes are primarily of the narrow-bore type and are designed for use with a piston sampling pump.

With WatchGas tubes every tube reading can become a permanent digital record.

No more illegible handwriting or lost paper logs — pair any tube in this catalog with the WatchGas Tubes App to capture GPS location, timestamp, and photo evidence automatically, synced live to RTR. See section 3.2.5.

Colorimetric tube chemistry is an industry standard — what isn't standard is what happens to the result afterward. WatchGas is the only tube system built to feed directly into RTR, turning a one-off spot check into a searchable, auditable site record without extra hardware or manual data entry.

2. QUALITY ASSURANCE PROCEDURES FOR GAS DETECTION TUBE MANUFACTURE

All WatchGas gas detection tubes are developed in an ISO 9001 certified facility and manufactured in an ISO 9001 certified factory. All procedures, work instructions, and quality records are thoroughly documented and maintained to ensure the quality of the tubes. The procedures are outlined below.

A. Tube Selection. Glass tubing is chosen to match a standard bore size, ensuring a uniform length of color change.

B. Support Preparation. Silica, alumina, and other support materials are selected from the highest quality available and sieved to achieve a narrow particle size distribution. The supports are then further purified as needed and dried to precise levels based on the requirements of the tube reactions.

C. Reagent Loading. Chemicals are selected based on stringent purity standards and then loaded onto the support materials. The deposition of chemicals onto the support follows a protocol specifically developed for each tube type. The loaded support material is then dried as required for the reaction.

D. Tube Filling and Sealing. End plugs are chosen from materials that do not react with the reagent. The tubes are filled under conditions that minimize exposure to air, water vapor, or other gases that could affect the quality of the tubes. The tubes are then tightly packed using a combination of shaking and physical compression. The ends of the tubes are sealed by melting them closed with an automated flame sealer. Any required inert atmosphere is maintained throughout the tube-sealing process.

E. Calibration. Each batch of tubes is calibrated independently of other batches. A series of standard gases are either purchased or prepared using various methods, including flow dilution of gas primary standards, permeation tubes, diffusion tubes, or static dilution from liquid or gas primary standards. Multiple tubes are used to determine each calibration point, and these are then printed onto each tube in the batch using an automated printing machine.

F. Packaging. The tubes, along with their technical data sheets, are packed into labeled boxes using sturdy protective plastic casing.

G. Quality Control Sampling Plan. A sample from each batch is sent to the WatchGas Quality Assurance Laboratory for independent QA testing. The most commonly used tubes meet the accuracy criterion of $\pm 15\%$ of the length of stain. A separate set of tubes is stored in both the QA laboratory and the manufacturing facility for evaluation at later dates, if needed.

H. Accuracy and Precision. The accuracy is determined by testing a minimum of five tubes and calculating the average deviation from the standard gas value. Precision is calculated as the standard deviation from the average value of the five measurements. All tubes meet the accuracy and precision criteria outlined in Table 1:

Table 1. WatchGas Tube Accuracy and Precision Specifications

Tube Type	Conc. Range	Precision	Accuracy	
			>20-100% Full Scale	$\leq 20\%$ Full Scale
CO, CO ₂ , H ₂ O, H ₂ S, NH ₃ , PH ₃ , SO ₂	>50 ppm	10%	10%	12%
CO, H ₂ O, H ₂ S, NH ₃ , PH ₃ , SO ₂	≤ 50 ppm	12%	15%	20%
CO, Acetone, Benzene, MEK, Toluene, Xylene	All	12%	15%	20%
Cl ₂ , ClO ₂ , HCN, HCl, HF, NO _x , NO ₂ , RSH, RNH ₂ , Butane, Diesel, Ethanol, Formaldehyde, Gasoline, Methyl Bromide, Ozone, Phenol, Trichloroethylene, Vinyl Chloride, Others	All	20%	20%	25%

I. Interim Storage. Only batches that successfully pass all quality assurance procedures are transferred to interim storage. In this storage, they are kept at a temperature range of 3-7°C (37 - 45°F) and stored in darkness until they are ready for shipment.

3. OPERATION OF DETECTION TUBES & PUMPS

CAUTION



Always wear safety glasses and gloves when opening tubes or handling open tubes with sharp edges. Failure to wear protective equipment may result in cuts or other serious injuries to the eyes and hands.



Before using the pump for a series of measurements, always test it for leaks. Neglecting to do so could lead to dangerously inaccurate readings.



In case of accidental breakage, avoid contact with the tube contents. Exposure to these contents can present significant health risks.



Dispose of used tubes according to local regulations. Consult the reaction principle and other information provided in the Gas Detection Tube Data Sheet to identify materials that may require special disposal procedures. (Data Sheets for all currently available WatchGas tubes are included in Chapter 5.)

3.1 Hand Pump Description

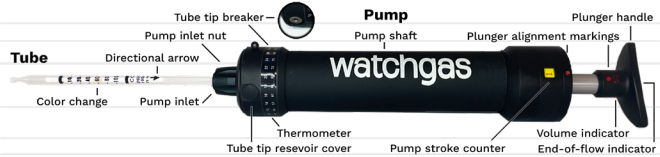


Figure 1. WatchGas Colorimetric Gas Pump with tube inserted.

The WatchGas Colorimetric Gas Pump is a piston-type hand pump that draws a fixed volume of gas, which can be selected at either 50 mL or 100 mL by rotating the handle. A tight vacuum seal is created by a greased plunger gasket. The tapered rubber inlet accommodates a range of tube diameters for different types of tubes. The inlet filter prevents glass particles and dust from entering the shaft. An end-of-flow indicator in the handle turns white when the gas sampling is complete. A pump stroke counter is also included to track the number of strokes completed.

3.2 Tube Measurements

3.2.1 Tube Description & Packaging

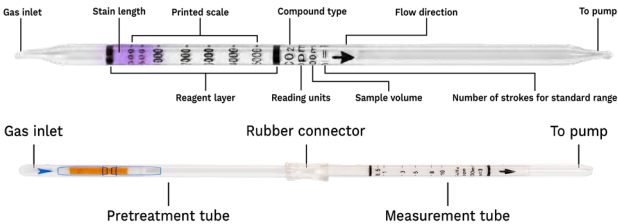


Figure 2. Gas detection tube parts description.

Top: Standard single tube. Bottom: Pretreatment tube connected to measurement tube with rubber connector.

1. Tube and Box. Figure 2 illustrates the key components of a WatchGas gas detection tube. The tubes are typically packaged in boxes of 10. Each box contains quick instructions on the back. Some tubes require preconditioning of the gas and are packaged with 5 pretreatment tubes and 5 measurement tubes, allowing for a total of 5 measurements. The concentration scale is printed directly on the tube, with an arrow indicating the direction in which the gas must enter. The standard volume is 100 mL.

2. Data Sheet. Each box is accompanied by a Data Sheet that provides detailed information on the tube's performance. Figure 3 shows an excerpt from a typical data sheet. Complete data sheets are available in Chapter 5 and are discussed in detail in Chapters 4.2 and 4.3.

3. Part Number. The part number is located on the top left of the data sheet. The first two letters represent the company, WatchGas, the second set of letters and numbers represent the tube's chemical type. The last digits indicate the approximate range of the tube. The higher the number, the higher the range.

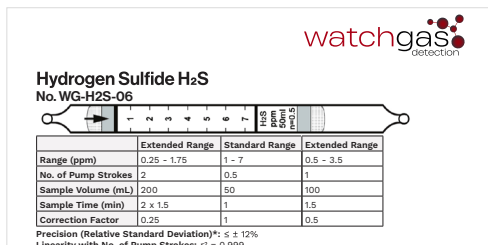


Figure 3. Excerpt of a Tube Data Sheet

4. Sampling Volume and Time. Using the standard number of pump strokes, the gas concentration is read directly from the stain length, which is matched to the printed scale after the specified sampling time has elapsed. However, the range of the tube can be extended by using a smaller or larger sample volume. In such cases, the scale reading must be multiplied by a Correction Factor (CF) to account for the different sample size. For example, the WatchGas 10-103-18 hydrogen sulfide tube has a standard range of 25-250 ppm. When used with the standard one stroke, the readings will directly correspond to the printed scale on the tube. When used with half a stroke, a Correction Factor (CF) of 2 is applied. An observed reading of 50 ppm then corresponds to an actual concentration of:
 $50 \times 2 = 100 \text{ ppm}$

5. Cross-sensitivity. Gas detection tubes are typically quite selective, but certain compounds may interfere with the measurements. The Data Sheet provides a list of potential interfering compounds, although others may also exist. In most cases, these compounds will extend the stain length, but in some instances, they may shorten it. The user must be aware of possible interferences to avoid incorrect readings.

3.2.2 Testing Hand Pump for Leaks

Before conducting a series of measurements, the pump used must be checked for leaks. Follow these steps:

1. Insert an unopened tube securely into the inlet of the aspirating pump.
2. Align the red dot on the plunger with the red dot on the pump shaft.
3. Pull the plunger fully back in one stroke and wait for 2 minutes.

4. Rotate the plunger dot away from the pump shaft alignment mark, allowing the plunger to retract into the pump shaft. Keep your hand on the shaft to prevent it from snapping back too quickly.

If the plunger returns to within 3 mm of its original position, the pump has passed the leak test. If the plunger does not return within 3 mm, a leak is present. Refer to Section 3.3 for maintenance instructions.

3.2.3 Measurement Procedure

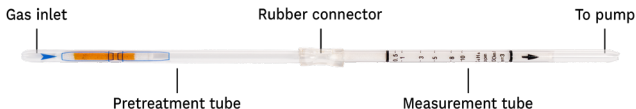
Step 1.

Break both ends of a new detection tube using the tip breaker located on the side of the front of the handpump. Insert the tube until it stops, then back off about 1 mm before breaking off the tip. This procedure allows the tip to fall into the tip reservoir at the end of the pump shaft. The reservoir can be emptied by opening the rubber cover on the opposite side of the pump.



Step 2.

In cases where a pre-tube is provided (e.g., Benzene and NO_x), repeat step 1 for the pre-tube and connect it to the measurement tube using the rubber connector, following the direction indicated on the tube.



Step 3.

At the rubber pump inlet, insert the measurement tube. Point the tube directional arrow towards the pump inlet.



Step 4.

Based on the sample volume specified in the tube datasheet (100 mL, 50 mL, or 25 mL), rotate the plunger dot to the corresponding alignment mark shown below. The visual also illustrates how far the plunger retracts for each sample volume during operation.



Withdraw plunger until it locks in place, the stroke counter will update automatically when sampling 100 mL. At 25 or 50 mL, manually adjust the stroke counter.

Indicated sampling time is completed when the end-of-flow indicator turns white. End-of-flow indicator is dark when sampling (left) and white when the sampling is complete (right).

Step 5.

For additional pump strokes, rotate the handle a quarter turn clockwise or counter-clockwise and push it back fully without removing the tube from the pump



Rotate plunger 90 degrees. Push plunger back into pump shaft without removing tube.



Withdraw plunger for second stroke and repeat strokes as necessary.



Remove and read tube, return plunger and stroke counter to the original position.



Empty the tube tip reservoir as necessary.



Rotate the small pin on the pump to reset the stroke counter to 0.

3.2.4 Reading Tubes

The concentration of the measured compound can be directly determined from the scale marked on the tube.

To take a reading, observe the point along the tube where the color change first becomes noticeable. If the front edge of the color change appears at an angle rather than straight across the tube, use the average between the lowest and highest points. In Figure 4, all three tubes are interpreted as showing a value of 0.9.

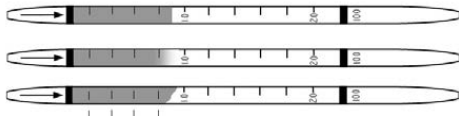


Figure 4. Reading of various types of endpoints after sampling

Read the tube immediately after collecting the gas sample, as the colors may shift, fade, or spread over time.

If the sampling was done using a non-standard number of pump strokes, adjust the reading by applying the Correction Factor found on the tube's Data Sheet.

When the Data Sheets indicate that temperature and humidity adjustments are needed, multiply the measured value by the specified Correction Factor(s) (CF) to determine the accurate concentration. For more explanation and background, see Chapter 4.3, which covers how humidity and temperature can affect results.

Users should also be mindful of substances that may interfere with the tube measurements. These interferences can cause readings to be either higher or lower than the actual value.

CAUTION: Always examine the data sheet and other available information for possible interferences. Failure to consider interferences may lead to dangerously inaccurate readings.

3.2.5 Using the WatchGas Tubes App

Every reading in this manual can be captured digitally instead of on paper — GPS-tagged, timestamped, and photo-verified, with results pushed live to your site's RTR dashboard the moment they're recorded.

- **Located** — GPS coordinates and a named work area, tied to a specific point on site.
- **Verified** — a photo of the read tube and the sampling location attached to every result.
- **Live** — pass/warning status appears on the site's RTR dashboard in real time, not at end of shift.



See the Quick Start Guide WatchGas Tubes App for app setup and step-by-step use.



3.3 Maintenance of the WatchGas Sampling Pump

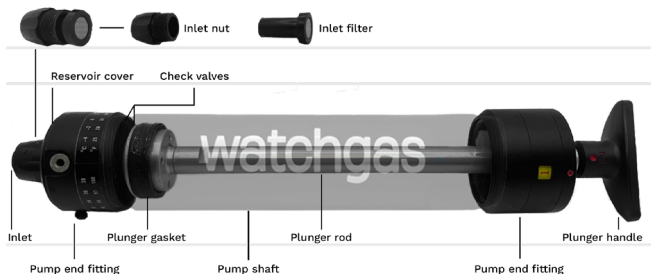


Figure 5. WatchGas Handpump Internal View

1. Tube Tip Reservoir

Remove the cover from the tube tip reservoir whenever necessary to empty the broken glass collected in the pump's end fitting. See page 14 for a clearer view of the reservoir cover and how to empty it.

2. Pump Inlet and Filter

Over time, the rubber pump inlet may wear out, which can lead to leaks. To replace it, unscrew the pump inlet nut and install a new rubber inlet. If replacement is not needed, inspect the inlet filter. Clean or replace it if it appears visibly dirty, or if the end-of-flow indicator on the pump shows longer flow times than specified on the tube packaging.

3. Pump Mechanism

A worn or poorly lubricated plunger gasket can cause leaks. To replace it:

1. Unscrew the end fitting located on the handle side of the pump.
2. Remove the plunger from the shaft.
3. Install a new gasket.
4. Carefully reinsert the plunger into the shaft, using tweezers or a small screwdriver to guide the gasket into place.
5. Apply vacuum grease to the inside of the shaft to ensure proper sealing.

Caution: Avoid overtightening the plunger gasket, as this may cause sudden vacuum failure.

Leaks may also result from a worn or dry inlet check valve. To service it, unscrew the fitting on the inlet side and remove the disk-shaped rubber check valve. If needed, replace it and apply a light layer of grease around the valve hole.

If resistance is felt on the return stroke, the outlet check valve gasket may need

attention. Use a specialized tool or needle-nose pliers to unscrew the plunger tip from the plunger rod. Replace the O-ring and the check valve gasket, then reassemble. Also inspect the gasket ring located in the inlet end fitting, and replace it if damaged before reinstalling the fitting.

3.4 Choosing a Sampling Pump

WatchGas colorimetric tubes are designed for use with the WatchGas hand pump, which is specifically calibrated to deliver the correct sampling volume for accurate results. Using pumps from other manufacturers may lead to significant measurement errors due to variations in flow rate or sampling pattern. For example, bellows-type hand pumps from other suppliers may operate with different flow characteristics, which can affect tube performance and readings.

Caution: To ensure measurement accuracy, always use the designated WatchGas hand pump. Before each use, inspect the pump for possible leaks.

3.5 Remote Sampler – Use and Maintenance

The Remote Sampler for WatchGas Colorimetric Gas Detection Tubes & Pump is designed to work with the WatchGas hand pump and supports both gas-detection and adsorption tubes. It enables sampling from confined spaces, narrow openings, or other hard-to-reach areas.

Note: Remote samplers are not included with the standard kit. Please contact your local supplier to request delivery or check availability.

1. Setup

Refer to Figure 6 for installation guidance and part identification. Begin by removing the standard rubber tube adapter from the pump by unscrewing the adapter nut. Ensure the porous metal filter in the remote sampler is properly in place. Then, attach the remote sampler by screwing the adapter nut into the WatchGas pump. Store the standard adapter and nut in a safe place for future use.

2. Operation

To ensure a secure fit, insert the gas detection tube into the holder and twist it slightly while pressing in. If using a pre-tube, insert it into its designated holder and push it into the standard tube holder. Secure the pre-tube holder using the rubber buckles. Lower the extension hose into the desired sampling location.

Refer to Figure 6 for an example of installing the remote sampling probe into the WatchGas hand pump.

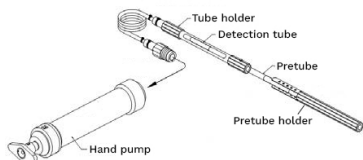


Figure 6. Installation of a remote sampling probe into the WatchGas hand pump

3. Sampling Correction

Caution: When using a longer remote sampler, the additional tubing volume may cause delayed flow and lower readings. These can be found in the documentation of the sampling probe.

4. Routine Maintenance

a. Porous Metal Filter:

Replace the metal frit filter if it becomes visibly dirty or if the end-of-flow indicator on the WatchGas pump shows longer flow time than recommended.

b. Leak Testing:

If you detect a potential leak, remove the remote sampler and test the WatchGas pump on its own. Then inspect all tubing and connections as follows:

WatchGas Hand Pump Leak Test:

1. Insert a sealed tube firmly into the holder.
2. Pull three pump strokes to clear air from the system.
3. Pull a fourth stroke and wait two minutes.
4. Rotate the plunger dot away from the shaft alignment mark to allow slow return.
5. Keep your hand on the shaft to prevent sudden movement.
6. If the plunger returns to within 3 mm of its starting position, the system is properly sealed.

4. TECHNICAL INFORMATION

4.1 Theory of Operation – WatchGas Colorimetric Tubes

WatchGas colorimetric gas detection tubes operate based on chemical reactions between vapor-phase compounds and reactive substances supported on an inert substrate. These reactions cause a visible color change, which is proportional to the amount of target gas present.

The most common reaction types include:

Acid-base reactions

Acidic gases (e.g., HCl, HF) react with basic reagents, and alkaline vapors like ammonia react with acids in the tube. A pH-sensitive dye shifts color based on the gas exposure.

Reduction-oxidation (Redox) reactions

These involve changes in oxidation state, resulting in a different-colored product. For example:

- Chlorine detection uses oxidative coupling of o-toluidine to form an orange azo dye.
- Carbon monoxide and some organic vapors reduce white di-iodine pentoxide, producing brown iodine.
- Orange chromium (VI) is reduced by organics into brown or green Cr(III) compounds.

Ligand-exchange reactions

These create new, more intensely colored complexes. One example is the conversion of white lead acetate into dark lead sulfide when detecting hydrogen sulfide. For phosphine detection, a reaction with HgCl_2 releases HCl, which triggers a pH-dependent dye color change.

Pre-layers or pre-tubes

These elements condition the sample—removing humidity, interferences, or transforming the target gas into a detectable form. For instance:

- Drying agents are used in ammonia and HCl tubes.
- Charcoal or oxidation pre-layers are used to remove organics in CO tubes.
- NO is oxidized to NO_2 in nitrogen oxide tubes.

All WatchGas tubes are length-of-stain type. In these tubes, the gas reacts rapidly with the reagent as the air sample flows through. This means that most of the gas is fully reacted within the tube, reducing dependency on the exact flow rate. However, excessive flow rates may smear the stain and overestimate the concentration, while very slow rates may shorten the stain and lead to underestimation.

Tubes are calibrated using WatchGas piston hand pumps. A single pump stroke produces a sharp initial flow followed by an exponential decay (see Figure 7). The most accurate readings are obtained when the sampling profile matches this flow behavior.

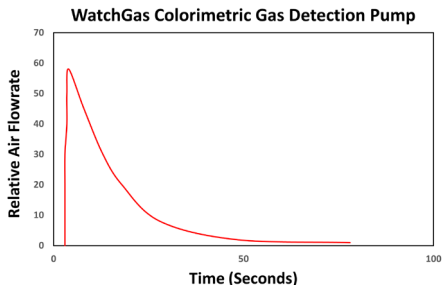


Figure 7: Example piston pump internal pressure profile (data offset by 2 seconds for clarity).

4.2 Understanding the Tube Data Sheets

Each box of WatchGas tubes comes with a Data Sheet providing reference information relevant to all manufacturing batches. These sheets include:

Measurement Ranges & Pump Strokes

Standard and extended concentration ranges, number of strokes, gas volumes, sampling times, and detection limits. The printed calibration scale is based on standard strokes but may be extended by adjusting the number of pump strokes.

Correction Factors (CFs)

CFs account for variations in pump strokes, ambient temperature, humidity, or gas type. Multiply the measured value by the CF to get the corrected concentration.

Precision

Determined by testing a standard gas sample with five randomly selected tubes. Precision is typically $\leq \pm 15\%$ and reported as standard deviation.

Linearity

Tube response is tested at low concentrations with multiple strokes. Tubes with correlation coefficients (r^2) > 0.95 are considered linear.

Humidity Impact

Listed as a function of relative humidity. Any required corrections are provided.

Temperature Impact

Effects are evaluated at typical conditions (0°, 10°, 25°, 40°C). Corrections for temperature are also provided. If humidity affects results, temperature tests are performed at constant relative humidity.

Shelf Life

Storage stability is assessed over time. To maximize shelf life, store tubes in the dark between 3°C and 7°C (37°F–45°F). Do not freeze tubes; sub-zero temperatures may cause damage.

Cross-Sensitivity

Each tube is tested with potential interfering gases. Some chemically similar compounds may cause false positives. Notes on known interferences—especially in mixed environments—are listed under “Interferes in Mixtures.” Be aware of your sampling environment, as interference may change the stain pattern or color.

4.3 Environmental Effects on Tube Performance

1. Humidity

Humidity typically has minimal effect unless the gas is highly water-soluble, such as acids or bases. Some tubes include pre-layers with drying agents. However, reactive gases like HF require specific correction due to their sensitivity to moisture. Corrections are listed on the Data Sheets and should be applied using the relative humidity at the measurement temperature—not absolute humidity.

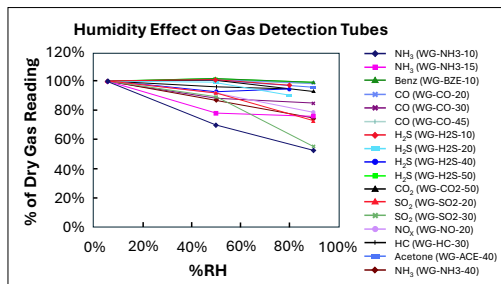


Figure 8: Example of humidity impact on stain length.

2. Temperature

Temperature influences tube readings in several ways:

- **Gas Density:** Higher temperatures reduce gas density, leading to lower readings.
- **Reaction Kinetics:** Reactions often occur faster at higher temperatures, resulting in sharper, shorter stains.
- **Adsorption:** Since many reactions rely on adsorption, higher temperatures can reduce adsorption, potentially elongating the stain.

These effects may counterbalance each other. In some cases, temperature can also affect stain color. For example, the water vapor tube may appear green at room temperature and shift to purple at lower temperatures.

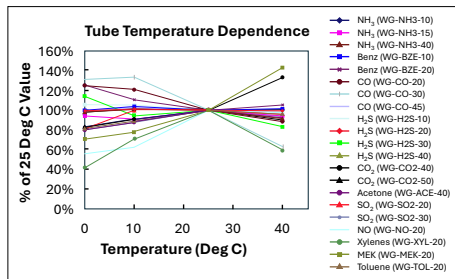


Figure 9: Temperature-related effects on readings.

3. Pressure

Gas detection tubes measure based on the total mass of the compound reacting with the reagent. At higher altitudes (lower pressure), fewer molecules enter the tube per volume, lowering the reading. Tubes are calibrated at 1 atm (760 mm Hg) at sea level.

For tubes reporting absolute concentrations (e.g., mg/m³ or lbs/MMCF), no correction is necessary.

For relative concentrations (e.g., ppmv), apply the following corrections:

- Corrected Reading = (Observed Reading × 760) / Pressure (mm Hg)
- Corrected Reading = (Observed Reading × 101.3 kPa) / Pressure (kPa)
- Corrected Reading = (Observed Reading × 14.7 psia) / Pressure (psia)

Estimated pressure by altitude (under 2 km) can be calculated using:

- $P(\text{mm Hg}) = 760 \exp(-0.1286[\text{altitude}(\text{km})])$ below 2 km

Pressure changes due to weather are typically minor (<10%) but can be considered for high-precision applications.

Example Location	Altitude (km)	Altitude (feet)	Pressure (mm Hg)	CF
San Francisco, CA	0	0	760	1.00
Atlanta, GA	0.3	1000	731	1.04
Spokane, WA	0.6	2000	703	1.08
Rapid City, SD	0.9	3000	676	1.12
Salt Lake City, UT	1.2	4000	650	1.17
Denver, CO	1.5	5000	625	1.22
Colo. Spgs., CO	1.8	6000	601	1.27
Santa Fe, NM	2.1	7000	578	1.32
Alta, UT	2.4	8000	555	1.37
Winter Park, CO	2.7	9000	534	1.42
Keystone, CO	3.0	10000	514	1.48

4.4 Matrix Gas Effects

The surrounding gas (matrix gas) usually has no effect on the measurement, as long as it doesn't chemically react with the target gas or tube reagent. Tubes generally work consistently in air, nitrogen, hydrogen, helium, or CO₂.

Matrix Gas	Viscosity @ 27°C (μPa-s)	Sampling Time Relative to Air	Sampling Time for a 90 second Tube (seconds)
Air	18.6	1.00	90
n-Butane	7.5	0.40	36
Propane	8.3	0.45	40
Hydrogen	9.0	0.48	44
Ethane	9.5	0.51	46
Acetylene	10.4	0.56	50
Methane	11.2	0.60	54
Carbon Dioxide	15.0	0.81	73
Nitrogen	17.9	0.96	87
Helium	20.0	1.08	97
Oxygen	20.8	1.12	101
Argon	22.9	1.23	111
Neon	32.1	1.73	155

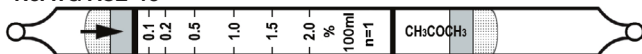
However, gas viscosity impacts sampling time. For example, in low-viscosity gases like hydrogen, sampling time may be significantly shorter than in air. While higher flow rates could extend the stain, the increase in diffusion to the reactive surface often offsets this, leaving the final reading largely unaffected.

List of Tubes

Alphabetical order by part number

Acetone C₃H₆O

No. WG-ACE-20



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.05 - 1%	0.1 - 2%	0.4 - 8%
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: ≤ ± 12%

Linearity with No. of Pump Strokes: r² = 0.992

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.25	1.15	1.0	0.95

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Orange → Black

Reaction Principle: CH₃COCH₃ + Cr(VI) + H₂SO₄ → Cr(III) + Oxidation Prods.

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*	Corr. Factor
Methyl ethyl ketone	0.6%	0.55%	1.1
Methyl propyl ketone	1%	0.65%	1.5
Methyl isobutyl ketone	1%	0.40%	2.5
CO	1.5%	0	-
CO ₂	1.5%	0	-
CH ₄	2.5%	0	-
NH ₃	5%	1.4% brown	3.6
H ₂ S	300	0.5% diffuse [#]	-
Ethyl Acetate	1%	0.85% diffuse [#]	-
Hexane	0.24%	entire tube [#]	-
Isobutylene	0.20%	entire tube [#]	-
Toluene	400	0.3% diffuse [#]	-

* Data based on WatchGas pumps and tubes used in standard range.

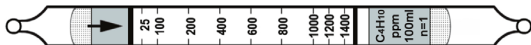
[#] Faint black color over entire stain length. Ketones can be distinguished by their darker stains and sharp endpoints.

Other Possible Interferences: Other hydrocarbons.

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Butane C₄H₁₀

No. WG-BTE-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	12.5 - 700	25 - 1400	50 - 2800
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2.5	2.5	2
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 > 0.999$

Humidity: No effect 5 - 100% RH.

Temperature Range: No effect 0 - 40°C (32 - 104°F).

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow-Orange → Brown (greenish)

Reaction Principle: C₄H₁₀ + K₂Cr₂O₇ + H₂SO₄ → Cr(III) + Oxidation Products

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*	Corr. Factor
CH ₄	25000	0	-
Propane	500	~650 (lbrown) [#]	~0.8
Isobutane	100	20	~5
Isobutylene	1500	~15	~100
n-Pentane	200	80 (green) [#]	2.5
n-Hexane	1500	530 (green) [#]	2.8
CO	500	0	-
H ₂ S	500	90	5.6
Ethanol	1000	~3	>300
Acetone	1000	~9	>100
Methyl Ethyl Ketone	1000	~8	>100

* Data based on WatchGas pumps and tubes used in standard range.

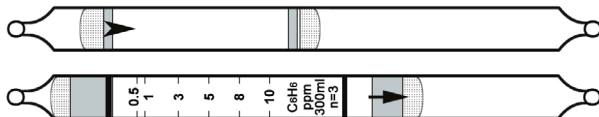
[#] Propane gives light brown reading with very indistinct endpoint, butane gives moderately sharp endpoint, and pentane and hexane give sharp endpoints.

Other Possible Interferences: Other hydrocarbons.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Benzene Specific C₆H₆

No. WG-BZE-01



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.14 - 2.7	0.5 - 10	2 - 40
No. of Pump Strokes	6	3	1
Sample Volume (mL)	600	300	100
Sample Time (min)	6 x 3	3 x 3	3
Correction Factor	0.27	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Humidity: No effect 0 - 95% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	2.7	1.6	1.0	0.6

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Brown

Reaction Principle: $2\text{C}_6\text{H}_6 + \text{CH}_2\text{O} \rightarrow \text{diphenylmethane} + \text{H}_2\text{O}$
 $\text{diphenylmethane} + \text{H}_2\text{S}_2\text{O}_7 \rightarrow p\text{-quinoid products}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Isobutylene	100	0
n-Hexane	500 [#]	0
n-Heptane	100	0
Toluene	100	0
m-Xylene	50	0
m-Xylene	100	5
CH ₄	25000	0
CO	10	0
H ₂ S	25	0

* Data based on WatchGas pumps and tubes used in standard range.

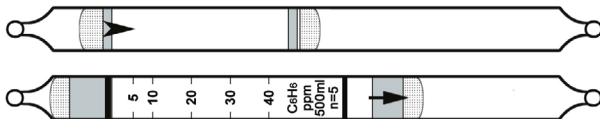
[#] Hexane above 100 ppm will reduce the benzene response.

Other Possible Interferences: Hydrocarbons and similar reducing gases.

CAUTION: Dispose of spent or expired tubes according to local regulations.
 Possibly hazardous materials are given under the section Reaction Principle.

Benzene Specific C₆H₆

No. WG-BZE-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 20	5 - 40	25 - 200
No. of Pump Strokes	10	5	1
Sample Volume (mL)	1000	500	100
Sample Time (min)	10 x 3	5 x 3	3
Correction Factor	0.5	1	5

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r = 0.997$

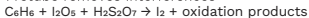
Humidity: No effect 5 - 100% RH

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Brownish Green

Reaction Principle: Pretube removes interferences



Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Isobutylene	100	~2 (faint)
n-Hexane	10	0
n-Octane	100	0
Toluene	35	0 [#]
m-Xylene	50	0 [#]
α-pinene	50	~2 (very faint)
CO	10	7
H ₂ S	25	0

* Data based on WatchGas pumps and tubes used in standard range.

With 10 strokes, toluene and xylene at 50 ppm read ~2 ppm and 100 ppm octane reads ≤2 ppm.

Other Data: Without the pretube the readings are 30% higher.

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Benzene C₆H₆

No. WG-BZE-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	10 - 200
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.992$

Humidity: No effect 5 - 95% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	21/70	40/104
Corr. Factor	0.8	0.9	1.0	1.1

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred

Color Change: White → Light Brown

Reaction Principle: $C_6H_6 + I_2O_5 + H_2S_2O_7 \rightarrow I_2 + \text{Oxidation products}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	50	40
CO ₂	50000	0
H ₂ S	50	20
NO	100	40
NH ₃	100	0
CH ₄	25000	0
SO ₂	10	0
Hexane	50	>100
Isobutylene	100	10
Toluene	100	20
o-Xylene	50	3

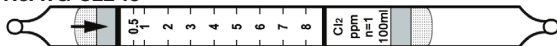
* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Hydrocarbons and similar reducing gases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Chlorine Cl₂

No. WG-CL2-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.25 - 4	0.5 - 8	1 - 16
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2.5	2.5	2
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.99$

Humidity: No data

Temperature Range: 0-40°C (32-104°F)

Temp (°C/°F)	0/32	10/50	18/70	40/104
Corr. Factor	ND	ND	1.0	ND

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Yellow

Reaction Principle: Cl₂ + o-Tolidine → Yellow colored product + HCl

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
ClO ₂	1	2
CO ₂	15000	0
NH ₃	50000	0*
NO ₂	5	7
CH ₄	25000	0
H ₂ S	250	0
Isobutylene	2000	0

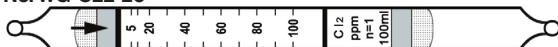
* Data based on WatchGas pumps and tubes used in standard range. #Interferes in mixtures.

Other Possible Interferences: Other oxidizing gases

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Chlorine Cl₂

No. WG-CL2-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	10 - 200
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect between 0-90%RH.

Temperature Range: No effect between 0 - 40°C (32 - 104°F)

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Green

Reaction Principle: Cl₂ + o-Tolidine → Green colored product + HCl

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
ClO ₂	10	9
CO	250	0
CO ₂	50000	0
NO	100	5
NH ₃	100	0
CH ₄	25000	0
H ₂ S	5000	0
SO ₂	10	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

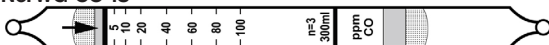
Other Possible Interferences: Other oxidizing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Carbon Monoxide CO

No. WG-CO-18



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	15 - 300
No. of Pump Strokes	6	3	1
Sample Volume (mL)	600	300	100
Sample Time (min)	6 x 4	2 x 2	2 x 4
Correction Factor	0.5	1	3

Precision (Relative Standard Deviation)*: $\leq \pm 15\%$

Linearity with No. of Pump Strokes: $r^2 > 0.999$

Humidity: No effect 5 - 100% RH

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Light Brown

Reaction Principle: $5\text{CO} + \text{I}_2\text{O}_5 + \text{H}_2\text{S}_2\text{O}_7 \rightarrow \text{I}_2 + \text{CO}_2 + \text{sulfur products}$
(Pre-layer removes most interferences)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
H ₂	100%	0
NO	100	0
H ₂ S	50	0
NH ₃	300	0
CH ₄	25000	0
Hexane	100	12
Isobutylene	100	0
Toluene	100	0
Trichloroethylene	25	16**

* Data based on WatchGas pumps and tubes used in standard range.

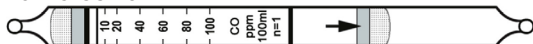
**Very light blue.

Other Possible Interferences: Other hydrocarbons; most organic vapor interferences are eliminated by the pretreatment layer.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Monoxide CO

No. WG-CO-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	10 - 200
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 > 0.99$

Humidity: No effect 5 - 100% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.80	0.83	1.0	1.15

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Light Brown Ring

Reaction Principle: $5\text{CO} + \text{I}_2\text{O}_5 + \text{H}_2\text{S}_2\text{O}_7 \rightarrow \text{I}_2 + \text{CO}_2 + \text{sulfur products}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
NO	200	0
H ₂ S	100	0
NH ₃	300	0
CH ₄	25000	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0
Trichloroethylene	25	20 (v.faint)

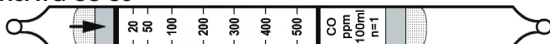
* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Most hydrocarbon interferences are eliminated in the pretreatment layer. Can be used to measure CO in pure hydrogen.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Monoxide CO

No. WG-CO-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	10 - 250	20 - 500	40 - 1000
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 10	10	5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 15\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 95% RH

Temperature Range: No effect 0-40°C (32-104°F)

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Light Brown

Reaction Principle: $5\text{CO} + \text{I}_2\text{O}_5 + \text{H}_2\text{S}_2\text{O}_7 \rightarrow \text{I}_2 + \text{CO}_2 + \text{sulfur products}$
(Pre-layer removes most interferences)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
NO	200	0
H ₂ S	100	0
NH ₃	300	0
CH ₄	25000	0
Hexane	100	0
Hexane	400	18
Isobutylene	100	0
Toluene	100	0
Trichloroethylene	25	15**

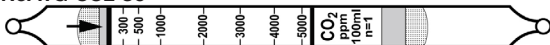
* Data based on WatchGas pumps and tubes used in standard range. **Very light green.

Other Possible Interferences: Hydrocarbons and similar reducing gases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Dioxide CO₂

No. WG-CO2-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	150 - 2500	300 - 5000	1200 - 20000
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.993$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	21/70	40/104
Corr. Factor	0.90	0.95	1.0	0.95

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Purple

Reaction Principle: $\text{CO}_2 + \text{H}_2\text{NNH}_2 \rightarrow \text{H}_2\text{NNHCO}_2\text{H}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
SO ₂	2050	500
SO ₂	200	~50
NO	100	0
NH ₃	50000	0
H ₂ S	2000	0
Hexane	1500	0
Isobutylene	100	0
Toluene	400	0

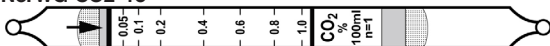
* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Acid gases. Ammonia does not interfere in mixtures.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Dioxide CO₂

No. WG-CO2-40



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.025 - 0.5%	0.05 - 1%	0.2 - 4%
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.994$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	21/70	40/104
Corr. Factor	1.2	1.1	1.0	0.75

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Purple

Reaction Principle: $\text{CO}_2 + \text{H}_2\text{NNH}_2 \rightarrow \text{H}_2\text{NNHCO}_2\text{H}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
SO ₂	10	0.1%
NO	100	0
NH ₃	10%	0
CH ₄	2.5%	0
H ₂ S	0.5%	0.1%
Hexane	1200	0
Isobutylene	100	0
Benzene	100	0
Toluene	400	0

* Data based on WatchGas pumps and tubes used in standard range.

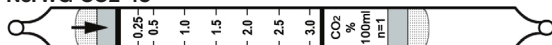
Other Possible Interferences: Acid gases. Ammonia interferes in mixtures.

Note: Tube should be read immediately after exposure.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Dioxide CO₂

No. WG-CO2-45



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.125 - 1.5%	0.25 - 3%	1 - 12%
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	23/73	40/104
Corr. Factor	0.85	0.95	1.0	1.05

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Purple

Reaction Principle: $\text{CO}_2 + \text{H}_2\text{NNH}_2 \rightarrow \text{H}_2\text{NNHCO}_2\text{H}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	1.5%	0
SO ₂	5%	2.5%
SO ₂	200	0
NO	100	0
NH ₃	5%	0
CH ₄	2.5%	0
H ₂ S	2000	0
Hexane	1500	0
Toluene	400	0

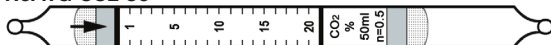
* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Acid gases. Ammonia interferes in mixtures.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Dioxide CO₂

No. WG-CO2-50



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.25 - 5%	1 - 20%	2 - 40%
No. of Pump Strokes	2	0.5	0.25
Sample Volume (mL)	200	50	25
Sample Time (min)	2 x 1.5	1	1
Correction Factor	0.25	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 > 0.999$

Humidity: No effect 5 - 100% RH

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Purple

Reaction Principle: $\text{CO}_2 + \text{H}_2\text{NNH}_2 \rightarrow \text{H}_2\text{NNHCO}_2\text{H}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
SO ₂	200	0
NO	100	0
NH ₃	300	0
CH ₄	25000	0
H ₂ S	100	0
Hexane	1200	0
Isobutylene	100	0
Toluene	100	0

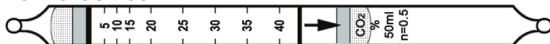
* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Acid gases

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Carbon Dioxide CO₂

No. WG-CO2-60



	Extended Range	Standard Range	Extended Range
Range (Vol%)	1.65 - 13.2%	5 - 40%	9 - 72%
No. of Pump Strokes	2	0.5	0.25
Sample Volume (mL)	200	50	25
Sample Time (min)	2 x 1.5	1	1
Correction Factor	0.33	1	1.8**

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r = 0.997$

Humidity: No effect 5 - 100% RH

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Purple

Reaction Principle: $\text{CO}_2 + \text{H}_2\text{NNH}_2 \rightarrow \text{H}_2\text{NNHCO}_2\text{H}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	40000	0
SO ₂	4000	~0.5
NO	100	0
NH ₃	500	0
CH ₄	25000	0
H ₂ S	10000	0
Hexane	1200	0
Isobutylene	100	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

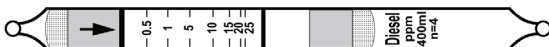
Other Possible Interferences: Acid gases

****Note:** CF varies with concentration: CF = 2.7 @ if readings are 0-10%; CF = 2.4 if readings are 10-20%; and CF = 2.0 if readings are over 20%. For example, if reading is 30% with 0.25 strokes then the true concentration is $30\% \times 2 = 60\%$.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Diesel & Jet Fuel

No. WG-DJF-10



	Extended Range	Standard Range	Extended Range
Range (ppm)		0.5 - 25	2 - 100
No. of Pump Strokes		4	2
Sample Volume (mL)	Do not extend	400	200
Sample Time (min)		4 x 1.5	2 x 1.5
Correction Factor		1	4.2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$ for undecane

Linearity with No. of Pump Strokes: $r = 0.997$

Humidity: 0 - 95%RH.

% RH	< 5%	30%	50%	80%	95%
Corr. Factor	1.0	0.8	0.7	0.7	0.7

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	20/68	40/104
Corr. Factor	1.9	1.3	1.0	0.8

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Brown Ring

Reaction Principle: $C_nH_m + I_2O_5 + H_2S_2O_7 \rightarrow I_2 + \text{Oxidation Products}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*	Correction Factor
Undecane ($C_{11}H_{24}$)	25	25	1.0 [†]
Diesel, whole (Automotive or Marine)	50	20	2.5
Diesel vapors	10	~20	~0.4
JP-5, whole (kerosene)	25	22	1.1
JP-8, whole (kerosene) [†]	10	11.5	0.87 [†]
Gasoline, whole	25	10	2.5
CO ₂	10000	0	-
CO	10	10	1.0
CH ₄	25000	0	-
H ₂ S	60	0	-
Butane	25	0	-
Propane	100	0	-
Hexane	25	0.5**	~50
Octane	5	10	0.5
Benzene	25	1**	~25
Toluene	25	0.5**	~50
Xylene	25	0.5	~50
Styrene	20	0.4	~50
Ethanol	2000	0	-
Isopropanol	200	0	-
Acetone	50	0	-

* Data based on WatchGas pumps and tubes used in standard range. ** Very faint brown stain. † Can use 1 stroke @ CF = 7.2 or 2 strokes @ CF = 2.5.

Other Possible Interferences: No response to 50 ppm HCl, or 100 ppm SO₂, NH₃, or NO₂.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Version 3: 17.10.2025

Ethanol C_2H_5OH

No. WG-ETN-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	50 - 200 [#]	100 - 2000	Do not extend
No. of Pump Strokes	2	1	
Sample Volume (mL)	200	100	
Sample Time (min)	2 x 3	3	
Correction Factor	0.5 [#]	1	

This CF only applies between 50-200 ppm; for higher concentrations use one stroke.

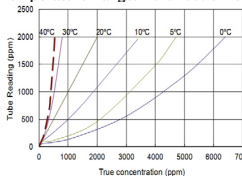
Values above 1200 ppm are indicative as the response is logarithmic.

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.87$

Humidity: No effect 5 - 95% RH

Temperature Range: No effect 0-40°C (32-104°F)



Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Orange-Yellow → Pale Green

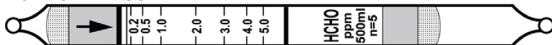
Reaction Principle: $C_2H_5OH + Cr(VI) + H_2SO_4 \rightarrow Cr(III) + \text{Oxidation Products}$.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Formaldehyde HCHO

No. WG-FLH-05



	Extended Range	Standard Range	Extended Range
Range (ppm)		0.1 - 5	0.75 - 37.5
No. of Pump Strokes		5	1
Sample Volume (mL)	Do not extend**	500	100
Sample Time (min)		5 x 2	2
Correction Factor		1	7.5

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 > 0.995$

Humidity: 0 - 95% RH

% RH	< 5%	30%	50%	80%
Corr. Factor	1.0	0.85	0.79	0.75

Temperature Range: 5 - 25°C (40 - 77°F)

Temp (°C/°F)	0/32	10/50	20/68	30/86	40/104
Corr. Factor	1.27	1.10	1.0	0.87	0.79

Storage Life: 2 years in darkness at 3 - 10°C (37 - 50°F). Refrigeration required.

Color Change: Yellow → Reddish brown

Reaction Principle: $3\text{HCHO} + (\text{NH}_2\text{OH})_3 \cdot \text{H}_3\text{PO}_4 \rightarrow \text{H}_3\text{PO}_4 + 3\text{H}_2\text{C}=\text{NOH} + 3\text{H}_2\text{O}$
 $\text{H}_3\text{PO}_4 + \text{Base} \rightarrow \text{Phosphate (dye color change)}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Acetaldehyde	3	3
Propionaldehyde	3	3
Acetone	3	Entire tube*
Methyl ethyl ketone	3	Entire tube*
CH ₄	25000	0
CO	500	0
CO ₂	1000	0
H ₂ S	100	0
SO ₂	100	0
Hexane	2000	0
Toluene	100	0
Isobutylene	100	0.5
Isopropanol	2000	0
Phenol	25	0
Styrene	20	0

* Data based on WatchGas pumps and tubes used in standard range.

Faint brown color over entire stain length. 100 ppm gives stronger color.

**Note: does not allow for more than 5 pump strokes.

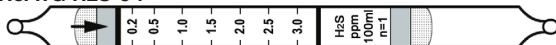
Note: In dry air the background color may change: read only reddish-brown color.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Version 4: 25.09.2025

Hydrogen Sulfide H₂S

No. WG-H2S-04



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.1 - 1.5	0.2 - 3	0.4 - 6
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: Tubes must be used at $<5\%$ RH. Reading drops sharply above 5% RH

Temperature Range: No effect between $0 - 40^\circ\text{C}$ ($32 - 104^\circ\text{F}$)

Storage Life: 1 year in darkness at $5 - 25^\circ\text{C}$ ($40 - 77^\circ\text{F}$)

Color Change: Pale orange $\rightarrow$ Pink

Reaction Principle: $\text{H}_2\text{S} + \text{HgCl}_2 \rightarrow \text{Mercury sulfide product} + \text{HCl}$

$\text{HCl} + \text{Base} \rightarrow \text{Chloride Salt} + \text{H}_2\text{O}$ (dye color change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Methyl mercaptan	2	0.4
Butyl mercaptan	2	0.3
NH ₃	100	0
NO ₂	5	0
SO ₂	100	0
CS ₂	100	0
CO	250	0
Hexane	100	0
Isobutylene	100	0 [^]
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

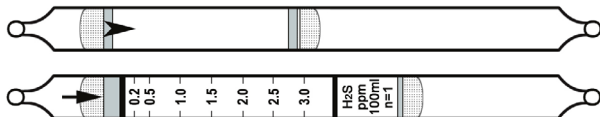
[^] Reduces response when mixed with H₂S.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-05



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.1 - 1.5	0.2 - 3	0.4 - 6
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 90% RH

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Pale Orange → Pink

Reaction Principle: Pretube removes interferences

$\text{H}_2\text{S} + \text{HgCl}_2 \rightarrow \text{Mercury sulfide product} + \text{HCl}$

$\text{HCl} + \text{Base} \rightarrow \text{Chloride Salt} + \text{H}_2\text{O}$ (dye color change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Methyl mercaptan	3	0 [#]
Butyl mercaptan	3	0 [#]
NH ₃	100	0
NO ₂	5	0
SO ₂	100	0
CS ₂	100	0
CO	250	0
Hexane	100	0
Isobutylene	100	0 [^]
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

[#] Interferes at higher concentrations.

[^] Reduces response when mixed with H₂S.

Other Possible Interferences: HCl and other acids.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-06



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.25 - 1.75	1 - 7	0.5 - 3.5
No. of Pump Strokes	2	0.5	1
Sample Volume (mL)	200	50	100
Sample Time (min)	2 x 1.5	1	1.5
Correction Factor	0.25	1	0.5

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: Tubes must be used at $<5\%$ RH. Reading drops sharply above 5% RH

Temperature Range: No effect between $0 - 40^\circ\text{C}$ ($32 - 104^\circ\text{F}$)

Storage Life: 1 year in darkness at $5 - 25^\circ\text{C}$ ($40 - 77^\circ\text{F}$)

Color Change: Pale orange $\rightarrow$ Pink

Reaction Principle: $\text{H}_2\text{S} + \text{HgCl}_2 \rightarrow \text{Mercury sulfide product} + \text{HCl}$

$\text{HCl} + \text{Base} \rightarrow \text{Chloride Salt} + \text{H}_2\text{O}$ (dye color change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Methyl mercaptan	2	0.2
Butyl mercaptan	2	0.15
NH ₃	100	0
NO ₂	5	0
SO ₂	100	0
SO ₂	2000	0 [#]
CS ₂	100	0
CO	250	0
Hexane	100	0
Isobutylene	100	0 [^]
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

Forms orange color over entire tube but pink H₂S reading is unaffected in mixtures.

[^] Reduces response when mixed with H₂S.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	1.25 - 30	2.5 - 60	10 - 240
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.998$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.95	0.95	1.0	1.2

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Light Brown

Reaction Principle: $\text{H}_2\text{S} + \text{Pb}(\text{OAc})_2 \rightarrow \text{PbS} + 2\text{HOAc}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
H ₂	100%	0 [^]
CO	250	0
CH ₄	25000	0
NH ₃	300	0
NO ₂	200	0 [†]
SO ₂	20	0
SO ₂	1800	0 [†]
CS ₂	100	0
Methyl mercaptan	100	0 [#]
Diethyl sulfide	100	0
Hexane	100	0
Isobutylene	100	0 [^]
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

[^] No effect in mixtures.

[‡] Interferes in mixtures; may result in transient light brown H₂S response.

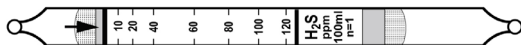
[†] Interferes in mixtures; high SO₂ concentrations suppress H₂S response.

[#] Concentrations in the high % range leave a yellow color over the entire tube.

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-15



	Extended Range	Standard Range	Extended Range
Range (ppm)	5 - 60	10 - 120	44 - 528
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	4.4

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.88	0.96	1.0	1.1

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Brown

Reaction Principle: $\text{H}_2\text{S} + \text{Pb}(\text{OAc})_2 \rightarrow \text{PbS} + 2\text{HOAc}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CH ₄	25000	0
NH ₃	100	0
NO ₂	200	0 [†]
CS ₂	100	0
Methyl mercaptan	1000	0 [#]
Diethyl sulfide	100	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

† Interferes in mixtures; may result in transient light brown H₂S response.

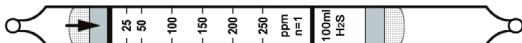
No effect in mixtures. Concentrations in the high % range leave a yellow color over the entire tube.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-18



	Extended Range	Standard Range	Extended Range
Range (ppm)	12.5 - 125	25 - 250	100 - 1000
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 1	1	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	23/73	40/104
Corr. Factor	0.9	0.9	1.0	1.1

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Brown

Reaction Principle: $\text{H}_2\text{S} + \text{Pb}(\text{OAc})_2 \rightarrow \text{PbS} + 2\text{HOAc}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CH ₄	25000	0
NH ₃	100	0
NO ₂	200	0*
CS ₂	100	0
Methyl mercaptan	500	0*
Diethyl sulfide	100	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

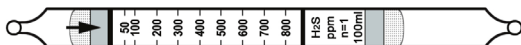
‡ Interferes in mixtures; may result in transient brown H₂S response.

Concentrations in the high % range leave a yellow color over the entire tube.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	25 - 400	50 - 800	200 - 3200
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.989$

Humidity: 80% RH reduces the reading by about 10% compared to dry air

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.0	1.0	1.0	1.2

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Dark Brown

Reaction Principle: $\text{H}_2\text{S} + \text{Pb}(\text{OAc})_2 \rightarrow \text{PbS} + 2\text{HOAc}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CH ₄	25000	0
NH ₃	300	0
NO ₂	200	0†
SO ₂	20	0
CS ₂	100	0
Methyl mercaptan	500	<50
Diethyl sulfide	1000	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

† Interferes in mixtures; may result in transient brown H₂S response.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	50 - 1000	100 - 2000	400 - 8000
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.88	0.93	1.0	1.2

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Black

Reaction Principle: $\text{H}_2\text{S} + \text{Pb}(\text{OAc})_2 \rightarrow \text{PbS} + 2\text{HOAc}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CH ₄	25000	0
NH ₃	300	0
NO ₂	200	0†
SO ₂	20	0
CS ₂	100	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

† Interferes in mixtures; may result in transient brown H₂S response.

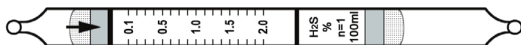
Other Possible Interferences: No response to mercaptans and sulfides.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-40



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.05 - 1%	0.1 - 2%	0.4 - 8%
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.998$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	18/64	25/77	40/104
Corr. Factor	1.2	1.1	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Light Blue → Black

Reaction Principle: $\text{H}_2\text{S} + \text{CuSO}_4 \rightarrow \text{CuS} + \text{H}_2\text{SO}_4$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CH ₄	25000	0
NO	100	0
NO ₂	200	0
NH ₃	300	0
SO ₂	20	0
Methyl mercaptan	0.1%	0.1%#
Diethyl sulfide	1000	0
Isobutylene	100	0
Toluene	100	0
Hexane	1200	0

*Data based on WatchGas pumps and tubes used in standard range.

Concentrations in the high % range leave a yellow color over the entire tube.

Other Possible Interferences: High concentrations of ammonia; NO₂ in mixtures.

No response to CS₂.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Sulfide H₂S

No. WG-H2S-50



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.5 - 10%	2 - 40%	3.4 - 68%
No. of Pump Strokes	2	0.5	0.25
Sample Volume (mL)	200	50	25
Sample Time (min)	2 x 1.5	1.5	1.5
Correction Factor	0.25	1	1.7**

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	18/64	40/104
Corr. Factor	0.75	1.0	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Dark Green

Reaction Principle: $\text{H}_2\text{S} + \text{K}_2\text{Cr}_2\text{O}_7 \rightarrow \text{Cr}_2\text{S}_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CO ₂	5%	0
NO	100	0
NH ₃	10%	3.5% (blue)
CH ₄	2.5%	0
SO ₂	10	0
Isobutylene	100	0
Hexane	100	0
Benzene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

** CF varies with concentration: CF = 2.3 if readings are 0-10%; CF = 2.1 if readings are 10-25%; and CF = 1.8 if readings are over 25%. For example, if reading is 30% with 0.25 strokes then the true concentration is $30\% \times 1.8 = 54\%$.

Other Possible Interferences: Mercaptans. No response to sulfides

Note: Time measurement to exactly 1.5 minutes for best accuracy.

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Chloride HCl

No. WG-HCL-09



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.5 - 10	1 - 20	2 - 40
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1	1	0.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: Must be used @ $<5\%$ RH. Reading drops sharply above 5% RH.

Temperature Range: No effect between $0 - 40^\circ\text{C}$ ($32 - 104^\circ\text{F}$) at $<5\%$ RH.

Storage Life: 2 year in darkness at $5 - 25^\circ\text{C}$ ($40 - 77^\circ\text{F}$). Refrigeration preferred.

Color Change: Yellow $\rightarrow$ Pink

Reaction Principle: $\text{HCl} + \text{NaOH} \rightarrow \text{Chloride Salt} + \text{H}_2\text{O}$ (dye color change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	15000	0
CO ₂	8000	0
H ₂ S	800	0
SO ₂	200	0
NO	100	0
NO ₂	200	20
NH ₃	100	0
HF	25	15
CL ₂	20	0
CH ₄	25000	0
Hexane	2400	0
Toluene	400	0

* Data based on WatchGas pumps and tubes used in standard range.

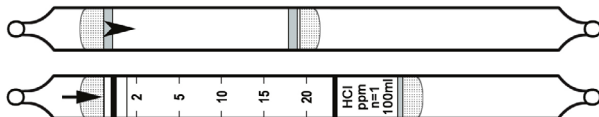
Other Possible Interferences: Other acid vapors; amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Chloride HCl

No. WG-HCL-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.5 - 10	1 - 20	2 - 40
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1	1	0.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: Calibrated at 50% RH and 23 °C (73 °F).

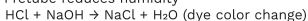
% RH	<5%	30%	50%	70%	90%
Corr. Factor at 10 ppm	0.7	0.8	1.0	1.1	2.7

Temperature Range: No effect between 0 - 40°C (32 - 104°F) at <5% RH.

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Pink

Reaction Principle: Pretube reduces humidity



Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	15000	0
CO ₂	8000	0
H ₂ S	800	0
SO ₂	200	0
NO	100	0
NO ₂	200	20
NH ₃	100	0^
HF	25	15
Cl ₂	10	>20
CH ₄	25000	0
Hexane	2400	0
Toluene	400	0

* Data based on WatchGas pumps and tubes used in standard range.

^Interferes in mixtures

Other Possible Interferences: Other acid vapors; amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Chloride HCl

No. WG-HCL-22



	Extended Range	Standard Range	Extended Range
Range (ppm)	10 - 250	20 - 500	40 - 1000
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 > 0.995$

Humidity: No effect at RH (5-95%)

Temperature Range: No effect at 0 - 40 °C (32 - 104 °F);

at -20 °C, the response is reduced by about 5%.

Storage Life: 2 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Red

Reaction Principle: $\text{HCl} + \text{Base} \rightarrow \text{Chloride (dye color change)}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CH ₄	25000	0
CO	500	0
CO ₂	1000	0
H ₂ S	100	0
SO ₂	1000	0
NO	200	0
NO ₂	100	0
NH ₃	100	0
HF	100	0
CL ₂	200	0
Hexane	2000	0
Toluene	2000	0

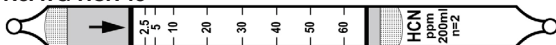
* Data based on WatchGas pumps and tubes used in standard range.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Cyanide HCN

No. WG-HCN-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	1 - 24	2.5 - 60	5 - 120
No. of Pump Strokes	4	2	1
Sample Volume (mL)	400	200	100
Sample Time (min)	4 x 2.5	2 x 2.5	2.5
Correction Factor	0.4	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 > 0.999$

Humidity: 5 - 95% RH.

Humidity (RH)	<5%	10%	50%	95%
Corr. Factor	1.0	1.0	1.2	1.4

Temperature Range: No effect 0 - 40°C (32 - 104°F)

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Red (ignore light orange color formed in clean air)

Reaction Principle: $2\text{HCN} + \text{HgCl}_2 \rightarrow \text{Hg}(\text{CN})_2 + 2\text{HCl}$

$\text{HCl} + \text{Base} \rightarrow \text{Chloride Salt} + \text{H}_2\text{O}$ (dye color change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
H ₂	2000	0
CH ₄	25000	0
CO	300	0
H ₂ S	100	<1 [#]
HCl	100	<1 [#]
SO ₂	20	20 [#]
NH ₃	50	0
CO ₂	5000	0

* Data based on WatchGas pumps and tubes used in standard range.

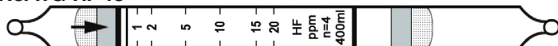
[#] Measured in dry gas; at >20% RH, no response is observed by these gases.

Note: A light orange color may form when drawing in air with no HCN present. This color can be ignored and does not affect true HCN readings, which form a bright pinkish-red color. The color boundary is sharp in ambient, humid air and somewhat diffuse in very dry air.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Hydrogen Fluoride HF

No. WG-HF-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.2 - 8	0.5 - 20	0.8 - 32
No. of Pump Strokes	8	4	2
Sample Volume (mL)	800	400	200
Sample Time (min)	8 x 0.5	4 x 0.5	2 x 0.5
Correction Factor	0.4	1	1.6

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.98$

Humidity: Calibrated at 50% RH and 23°C (73°F).

Humidity (RH)	30%	40%	50%	60%	70%	80%	90%
Corr. Factor	0.3	0.4	1.0	1.3	1.6	2.0	2.6

Temperature Range: No effect 10 - 30°C (50 - 86°F) at constant 41% RH.

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F)

Color Change: Beige → Purple

Reaction Principle: $\text{HF} + \text{NaOH} \rightarrow \text{NaF} + \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	250	0
CO ₂	50000	0
NH ₃	300	0 [^]
NO	100	0
H ₂ S	800	0
SO ₂	200	0
CH ₄	25000	0
HCl	4	entire tube [#]
Cl ₂	15	entire tube [#]

* Data based on WatchGas pumps and tubes used in standard range.

[#] Pink color over entire tube length.

[^] May interfere in mixtures.

Other Possible Interferences: Other acid vapors; amines and other bases.

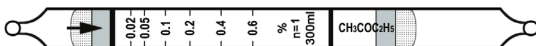
No effect of 100 ppm toluene or 2400 ppm hexane.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Methyl Ethyl Ketone C₄H₈O

No. WG-MEK-20



	Extended Range	Standard Range	Extended Range
Range (vol)	0.01 - 0.3%	0.02 - 0.6%	0.06 - 1.8%
No. of Pump Strokes	6	3	1
Sample Volume (mL)	600	300	100
Sample Time (min)	6 x 2	3 x 2	2
Correction Factor	0.5	5	3

Precision (Relative Standard Deviation)*: ≤ ± 12%

Linearity with No. of Pump Strokes: r² = 0.996

Humidity: 85% RH increases the response by 15% compared to dry gas

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.4	1.3	1.0	0.7

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Orange → Black

Reaction Principle: CH₃COCH₂CH₃ + Cr(VI) + H₂SO₄ → Cr(III) + Oxidation Prods.

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*	Corr. Factor
Acetone	0.4%	0.5%	0.8
Methyl propyl ketone	1.0%	0.7%	1.4
Methyl isobutyl ketone	1.0%	0.49%	2.0
CO	1.5%	0	-
CO ₂	1.5%	0	-
CH ₄	2.5%	0	-
NH ₃	5.0%	>0.3% brown	-
H ₂ S	250	0.2% diffuse#	-
Ethyl Acetate	1.0%	>0.3% diffuse#	-
Hexane	0.24%	entire tube#	-
Isobutylene	0.20%	0.5%	0.4
Toluene	400	0.3% diffuse#	-

*Data based on WatchGas pumps and tubes used in standard range.

#Faint black color. Ketones can be distinguished by their darker stains and sharp endpoints.

Other Possible Interferences: Other hydrocarbons

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Ammonia NH₃

No. WG-NH3-05



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.55 - 16.5	1 - 30	2.4 - 72
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.55	1	2.4

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: The tubes are calibrated at 50% RH.

% RH	< 5%	10%	50%	80%	95%
Corr. Factor	0.8	0.85	1.0	1	1

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	35/95
Corr. Factor	0.9	0.95	1.0	1.1

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Purple → Beige

Reaction Principle: $3\text{NH}_3 + \text{H}_3\text{PO}_4 \rightarrow (\text{NH}_4)_3\text{PO}_4$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Pyridine	10	15
Diethylamine	20	18
Hydrazine	20	2**
Methylhydrazine	20	2.3**
CO	100	0
CO ₂	20000	0 [#]
H ₂ S	200	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

** These hydrazines can be measured using 2 strokes with a CF of 5.

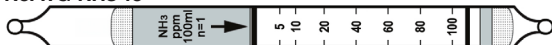
[#] 16000 ppm CO₂ reduces the NH₃ response by 30% in mixtures, 5000 ppm CO₂ reduces NH₃ response by 10% in mixtures, and 1000 ppm CO₂ has no effect.

Other Possible Interferences: Amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Ammonia NH₃

No. WG-NH3-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	10 - 200
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1	1	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 1.000$

Humidity: @ 24 °C (75 °F)

% RH	< 5%	20%	50%	70%	90%
Corr. Factor	0.7	0.8	1.0	1.1	1.3

Temperature Range: 0 - 35°C (32 - 95°F)

Temp (°C/°F)	0/32	10/50	24/75	34/93
Corr. Factor	0.8	1.0	1.0	1.0

Storage Life: 2 years in darkness at 3 - 10°C (37 - 50°F). Refrigeration required.

Color Change: Purple → Beige

Reaction Principle: $3\text{NH}_3 + \text{H}_3\text{PO}_4 \rightarrow (\text{NH}_4)_3\text{PO}_4$ (Pre-layer reduces humidity effects)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Butylamine	100#	45
Diethylamine	50#	60
CO	250	0
H ₂ S	100#	0
SO ₂	100#	0
CH ₄	50000	0
CO ₂	50000	0
NO ₂	200	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

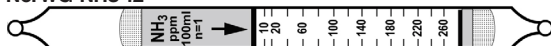
At 50% RH.

Other Possible Interferences: Amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Ammonia NH₃

No. WG-NH3-12



	Extended Range	Standard Range	Extended Range
Range (ppm)	5 - 130	10 - 260	20 - 520
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.99$

Humidity: @ 22 °C (72 °F)

% RH	< 5%	10%	50%	70%	90%
Corr. Factor	0.8	0.9	1.0	1.0	1.0

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	22/72	40/104
Corr. Factor	0.8	1.0	1.0	1.0

Storage Life: 2 years in darkness at 3 - 10°C (37 - 50°F). Refrigeration required.

Color Change: Purple → Beige

Reaction Principle: $3\text{NH}_3 + \text{H}_3\text{PO}_4 \rightarrow (\text{NH}_4)_3\text{PO}_4$ (Pre-layer reduces humidity effects)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Butylamine	200 [#]	200
Diethylamine	200 [#]	260
CO	250	0
H ₂ S	100 [#]	0
SO ₂	100 [#]	0
CH ₄	50000	0
CO ₂	50000	0
NO ₂	200	0
Hexane	100	0
Isobutylene	100	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

[#] At 50% RH.

Other Possible Interferences: Amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Ammonia NH₃

No. WG-NH3-15



	Extended Range	Standard Range	Extended Range
Range (ppm)	14 - 280	25 - 500	50 - 1000
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1	1	1
Correction Factor	0.56	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.998$

Humidity: No effect at 10%-90% RH. At <5% RH multiply the reading by 0.8.

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	24/75	40/104
Corr. Factor	1.3	1.0	1.0	1.2

Storage Life: 2 years in darkness at 3 - 10°C (37 - 50°F). Refrigeration required.

Color Change: Purple → Beige

Reaction Principle: $3\text{NH}_3 + \text{H}_3\text{PO}_4 \rightarrow (\text{NH}_4)_3\text{PO}_4$ (Pre-layer reduces humidity effects)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Butylamine	300 [#]	200
Diethylamine	100 [#]	90
CO	250	0
CO ₂	50000	0
H ₂ S	250	0
SO ₂	500 [#]	0 [†]
NO ₂	200	0
CH ₄	25000	0
Hexane	1500	0
Toluene	200	0
Isobutylene	5000	0

* Data based on WatchGas pumps and tubes used in standard range.

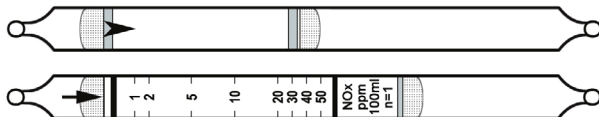
[#] At 50% RH. [†] Reduces reading in mixtures.

Other Possible Interferences: Amines and other bases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Nitrogen Oxides NO_x

No. WG-NO-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.5 - 25	1 - 50	2 - 100
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 3	3	2.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.997$

Humidity: 100% RH reduces the response by about 20% vs. dry air

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.8	1.6	1.0	1.0

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Blue

Reaction Principle: $\text{NO} + \text{CrO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NO}_2$ (Pre-tube)

$\text{NO}_2 + \text{C}_{16}\text{H}_{14}\text{N}_2 + (\text{HCHO})_n \rightarrow \text{Nitrated Blue Product (Meas. tube)}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CO ₂	10%	0
SO ₂	200	0
CH ₄	25000	0
H ₂ S	100	0
Acetone	10000	5

* Data based on WatchGas pumps and tubes used in standard range.

Other Possible Interferences: Reducing gases. No response to 5 ppm benzene. No response to 1200 ppm hexane, 100 ppm isobutylene, or 100 ppm toluene.

Separate Quantification: Sampling without the pre-tube gives NO₂ only. Using the pre-tube gives the sum of NO + NO₂. NO can be obtained by difference.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Nitrogen Dioxide NO₂

No. WG-NO2-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.25 - 15	0.5 - 30	1 - 60
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	3	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: Non-linear, do not extend

Humidity: No effect between 0-90%RH

Temperature Range: No effect between 0 - 40°C (32 - 104°F)

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Blue

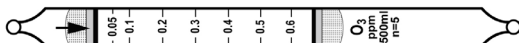
Reaction Principle: $\text{NO}_2 + \text{C}_{16}\text{H}_{14}\text{N}_2 + (\text{HCHO})_n \rightarrow \text{Nitrated Blue product}$

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Ozone O₃

No. WG-03-03



	Extended Range	Standard Range	Extended Range
Range (ppm)	Do not extend	0.05 - 0.6	0.15 - 1.8
No. of Pump Strokes		5	1
Sample Volume (mL)		500	100
Sample Time (min)		5 x 2	2
Correction Factor		1	3

Precision (Relative Standard Deviation)*: ≤ ± 20%

Linearity with No. of Pump Strokes: r² = 0.990

Humidity: Calibration is based on approximately 50% relative humidity

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	20/68	40/104
Corr. Factor	0.74	1.0	1.0	1.1

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → White

Reaction Principle: 2O₃ + C₁₆H₁₀N₂O₂ → 2C₈H₅NO₂ + 2O₂

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
Cl ₂	<10	0
Cl ₂	≥10	~0.1 [#]
ClO ₂	1	entire tube [#]
CO	100	0
CO ₂	10000	0
CH ₄	70000	0
SO ₂	100	0
H ₂ S	120	0
NO	5	0
NO ₂	1	0
Isobutylene	100	0
n-Hexane	100	0

*Data based on WatchGas pumps and tubes used in standard range.

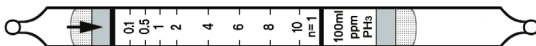
[#] Slight discoloration and unclear demarcation

Other Possible Interferences: Bromine and other oxidants.

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Phosphine PH₃

No. WG-PH3-005



	Extended Range	Standard Range	Extended Range
Range (ppm)	0.05 - 5	0.1 - 10	0.2 - 20
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1 x 1.5	1 x 1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.997$

Humidity: No effect 5 - 90% RH.

Temperature Range: 0 - 40°C (32 - 104°F)

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Pink

Reaction Principle: $\text{PH}_3 + 3\text{HgCl}_2 \rightarrow \text{P}(\text{HgCl})_3 + 3\text{HCl}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
HCL	N/A	Pink
SO2	N/A	No
H2S	N/A	Pink
HCN	N/A	Pink

*Data based on WatchGas pumps and tubes used in standard range.

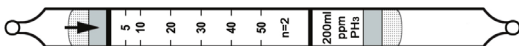
Other Possible Interferences: Strongly reducing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Phosphine PH₃

No. WG-PH3-10



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 25	5 - 50	8.5 - 85
No. of Pump Strokes	4	2	1
Sample Volume (mL)	400	200	100
Sample Time (min)	4 x 1.5	2 x 1.5	1.5
Correction Factor	0.5	1	1.7

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.997$

Humidity: No effect 5 - 90% RH.

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.85	0.9	1.0	1.0

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Black

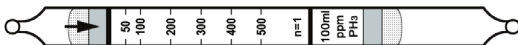
Reaction Principle: PH₃ + AgNO₃ → Ag₃P + others

Other Possible Interferences: Strongly reducing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Phosphine PH₃

No. WG-PH3-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	12.5 - 250	25 - 500	50 - 1000
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.99$

Humidity: No effect 5 - 80% RH.

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	24/75	40/104
Corr. Factor	0.85	0.95	1.0	1.15

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: White → Black

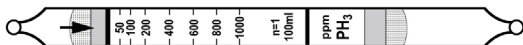
Reaction Principle: $\text{PH}_3 + \text{AgNO}_3 \rightarrow \text{Ag}_3\text{P} + \text{others}$

Other Possible Interferences: Strongly reducing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Phosphine PH₃

No. WG-PH3-25



	Extended Range	Standard Range	Extended Range
Range (ppm)	25 - 500	50 - 1000	100 - 2000
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 1.000$

Humidity: No effect 5 - 80% RH.

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/75	40/104
Corr. Factor	0.8	0.9	1.0	1.05

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → Brown

Reaction Principle: $2\text{PH}_3 + \text{Cu}^{2+} \rightarrow \text{Cu}_3\text{P} + \text{H}^+$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
H ₂ S	200	140‡
SO ₂	3940	0
NO	100	0
NH ₃	100	0
CO	250	0
CO ₂	50000	0
CH ₄	25000	0
Hexane	1500	0
Toluene	100	0

* Data based on WatchGas pumps and tubes used in standard range.

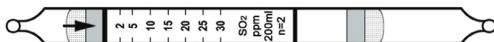
‡ Interferes in mixtures; may result in transient light brown H₂S response.

Other Possible Interferences: Strongly reducing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.
Possibly hazardous materials are given under the section Reaction Principle.

Sulfur Dioxide SO₂

No. WG-SO2-15



	Extended Range	Standard Range	Extended Range
Range (ppm)	1 - 15	2 - 30	4 - 60
No. of Pump Strokes	4	2	1
Sample Volume (mL)	400	200	100
Sample Time (min)	4 x 2	2 x 2	2
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.991$

Humidity: No effect 5 - 90% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	24/75	40/104
Corr. Factor	1.1	1.1	1.0	1.1

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → Yellow

Reaction Principle: $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	15000	0
CO ₂	50000	0
NO	100	0
NH ₃	100	2 (blue)#
H ₂ S	2000	3 (blue)
PH ₃	30	0
HF	50	0.5
CH ₄	25000	0
Hexane	1500	0
Toluene	400	0

*Data based on WatchGas pumps and tubes used in standard range.

Reduces reading in mixture.

Other Possible Interferences: Acid gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Sulfur Dioxide SO₂

No. WG-SO2-20



	Extended Range	Standard Range	Extended Range
Range (ppm)	2.5 - 50	5 - 100	10 - 200
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 50% RH; 100% RH reduces the response by about 25%

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.2	1.0	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → Yellow

Reaction Principle: $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CO ₂	10%	0
NO	100	0
NH ₃	300	0 [#]
CH ₄	25000	0
H ₂ S	100	0
Isobutylene	100	0
Hexane	1200	0
Toluene	100	0
Acetone	10000	0

*Data based on WatchGas pumps and tubes used in standard range.

[#] Reduces reading in mixture.

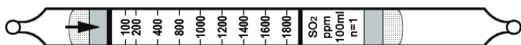
Other Possible Interferences: Acid gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Sulfur Dioxide SO₂

No. WG-SO2-25



	Extended Range	Standard Range	Extended Range
Range (ppm)	50 - 900	100 - 1800	200 - 3600
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 2	2	1.5
Correction Factor	0.5	1	2

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 85% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.1	1.0	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → Yellow

Reaction Principle: $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CO ₂	10%	0
NO	100	0
NH ₃	300	0 [#]
CH ₄	25000	0
H ₂ S	100	0
Hexane	1200	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

Reduces reading in mixture.

Other Possible Interferences: Acid gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Sulfur Dioxide SO₂

No. WG-SO2-30



	Extended Range	Standard Range	Extended Range
Range (ppm)	50 - 1000	200 - 4000	500 - 10000
No. of Pump Strokes	2	0.5	0.25
Sample Volume (mL)	200	50	25
Sample Time (min)	2 x 1	1	1
Correction Factor	0.25	1	2.5

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 50% RH; 100% RH reduces the response by about 40%

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.1	1.0	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Blue → Yellow

Reaction Principle: $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$ (pH indicator change)

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CO ₂	10%	0
NO	100	0
NH ₃	300	0 [#]
CH ₄	25000	0
H ₂ S	100	0
Hexane	1200	0
Isobutylene	100	0
Toluene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

[#] Reduces reading in mixture.

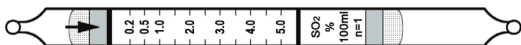
Other Possible Interferences: Acid gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Sulfur Dioxide SO₂

No. WG-SO2-40



	Extended Range	Standard Range	Extended Range
Range (Vol%)	0.1 - 2.5%	0.2 - 5%	0.8 - 20%
No. of Pump Strokes	2	1	0.25
Sample Volume (mL)	200	100	25
Sample Time (min)	2 x 2	2	1
Correction Factor	0.5	1	4

Precision (Relative Standard Deviation)*: $\leq \pm 10\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Humidity: No effect 5 - 90% RH

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.15	1.0	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Green

Reaction Principle: $\text{SO}_2 + \text{Cr(VI)} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + \text{Cr(III)}$

Cross-sensitivity: Substance	Concentration (ppm)	Apparent Reading*
CO	3000	0
CO ₂	5%	0
NH ₃	5%	2.3%#
CH ₄	2.5%	0
H ₂ S	50	0
Hexane	1500	0
Isobutylene	2000	0
Benzene	100	0

*Data based on WatchGas pumps and tubes used in standard range.

Forms a bright yellow color and reduces reading in mixture.

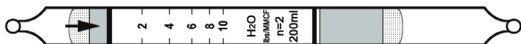
Other Possible Interferences: Reducing gases

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Water Vapor (Pipeline) H₂O

No. WG-WVA-10



	Extended Range	Standard Range	Extended Range
Range (lbs/MMCF)	1 - 5.1	2 - 10	4.44 - 22.2
No. of Pump Strokes	4	2	1
Sample Volume (mL)	400	200	100
Sample Time (min) in air (sec) in natural gas	4 x 1.5 min 4 x 45 sec	2 x 1.5 min 2 x 45 sec	1.5 min 45 sec
Correction Factor	0.51	1	2.22

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.99$

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	23/73	40/104
Corr. Factor	1.1	1.0	1.0	0.9

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Green**

Reaction Principle: $\text{H}_2\text{O} + \text{Mg}(\text{ClO}_4)_2 \rightarrow \text{Mg}(\text{ClO}_4)_2 \cdot \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Reading* (lbs/MMCF)
CH ₄	100%	0
Propane (C ₃ H ₈)	10000	≤ 2
Isobutylene	10000	0
Hexanes	3000	0
CO	200	0
CO ₂	3000	0
SO ₂	1500	0
H ₂ S	2000	~1
NH ₃	100	entire tube
HCl	300	0
Ethylene glycol	saturated	0
Triethylene glycol	saturated	0
Methanol	50	0*
Toluene	400	~1

*Data based on WatchGas pumps and tubes used in standard range.

† Forms light green stain when methanol is above 70 ppm. Water can be measured in a mixture with methanol by reading the dark green stain only, ignoring the light green methanol stain beyond the dark green end point. See Technical Note 179 for pictures.

****Note:** Color tends towards purple as temperature decreases.

Other Possible Interferences: Amines, alcohols. No response to heptanes, octanes as present in "rich" natural gas or commonly called "condensate".

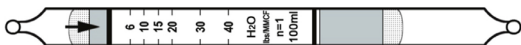
CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Version 3: 25.09.2025

Water Vapor (Pipeline) H₂O

No. WG-WVA-20



	Extended Range	Standard Range	Extended Range
Range (lbs/MMCF)	2.7 - 18	6 - 40	13.9 - 92
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min) in air (sec) in natural gas	2 x 1.5 min 2 x 45 sec	1.5 min 45 sec	1 min 30 sec
Correction Factor	0.45	1	2.3

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 = 0.994$

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	1.33	1.09	1.0	0.74

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Dark Green**

Reaction Principle: $\text{H}_2\text{O} + \text{Mg}(\text{ClO}_4)_2 \rightarrow \text{Mg}(\text{ClO}_4)_2 \cdot \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Reading* (lbs/MMCF)
CH ₄	100%	0
CO	200	0 [#]
CO ₂	10%	0 [#]
SO ₂	1500	0 [#]
H ₂ S	2000	<3 [#]
NH ₃	250	0 [#]
HA	300	0 [#]
Methanol	80	0 ⁺
Gasoline	saturated	0
Heptane	saturated	0
Ethylene glycol	saturated	0
Triethylene glycol	saturated	0
Toluene	saturated	0

*Data based on WatchGas pumps and tubes used in standard range.

No interference in mixtures with water vapor. + No response below 80 ppm. Light green stain when methanol is above 80 ppm, 340 ppm alone reads ~30 bl s/MMCF. Water can be measured in a mixture with methanol by reading the dark green stain only, ignoring the light green methanol stain beyond the purple end point. See Technical Note 179 for pictures.

Other Possible Interferences: Amines, alcohols; no effect of 500 ppm PH₃.

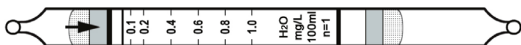
****Note:** Color tends towards purple as temperature decreases.

CAUTION: Dispose of spent or expired tubes according to local regulations.

Possibly hazardous materials are given under the section Reaction Principle.

Water Vapor (Metric) H₂O

No. WG-WVA-30



	Extended Range	Standard Range	Extended Range
Range (mg/L)	0.023 - 0.46	0.05 - 1.0	0.1 - 2.1
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.46	1	2.1

Precision (Relative Standard Deviation)*: $\leq \pm 12\%$

Linearity with No. of Pump Strokes: $r^2 = 0.999$

Temperature Range: 0 - 40°C (32 - 104°F)

Temp (°C/°F)	0/32	10/50	25/77	40/104
Corr. Factor	0.95	0.95	1.0	1.0

Storage Life: 2 years in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow → Dark Green**

Reaction Principle: $\text{H}_2\text{O} + \text{Mg}(\text{ClO}_4)_2 \rightarrow \text{Mg}(\text{ClO}_4)_2 \cdot \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Reading* (mg/L)
CH ₄	100%	0
Propane (C ₃ H ₈)	10000	0
CO	200	0 [#]
CO ₂	10%	0 [#]
SO ₂	1500	0 [#]
H ₂ S	600	0 [#]
NH ₃	250	0.6
PH ₃	500	0
HCl	300	0 [#]
Methanol	100	~0.02‡
Triethylene glycol	saturated	~0.05
Toluene	400	<0.1

*Data based on WatchGas pumps and tubes used in standard range.

No interference in mixtures with water vapor.

‡ No response below 100 ppm. Positive interference when methanol is above 100 ppm. 250 ppm alone reads ~0.5 mg/L.

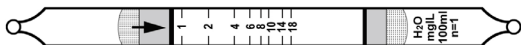
Other Possible Interferences: Amines, alcohols

****Note:** Read tube at end of dark green stain. Color tends towards purple as temperature decreases.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Water Vapor H₂O

No. WG-WVA-40



	Extended Range	Standard Range	Extended Range
Range (mg/L)	0.4 - 7.2	1 - 18	2 - 32
No. of Pump Strokes	2	1	0.5
Sample Volume (mL)	200	100	50
Sample Time (min)	2 x 1.5	1.5	1
Correction Factor	0.4	1	See Fig 2

Precision (Relative Standard Deviation)*: $\leq \pm 20\%$

Linearity with No. of Pump Strokes: $r^2 > 0.95$

Temperature Range: Refer to Figures 1 and 2. Requires accurate temperature measurement.

Storage Life: 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration preferred.

Color Change: Yellow-green → Purple

Reaction Principle: $\text{H}_2\text{O} + \text{Mg}(\text{ClO}_4)_2 \rightarrow \text{Mg}(\text{ClO}_4)_2 \cdot \text{H}_2\text{O}$

Cross-sensitivity: Substance	Concentration (ppm)	Reading* (mg/L)
CH ₄	25000	0
CO ₂	200000	0
CO	500	0
H ₂ S	1000	0
SO ₂	3500	0
HCl	2000	0
NO ₂	460	0
NH ₃	460	1
PH ₃	40	0
Acetone	1000	1 (green)
Ethanol	2000	1.5

*Data based on WatchGas pumps and tubes used in standard range.

CAUTION: Dispose of spent or expired tubes according to local regulations. Possibly hazardous materials are given under the section Reaction Principle.

Water Vapor H₂O (Continued)

No. WG-WVA-40

Fig. 1. Temp. Correction, 1 Pump Stroke

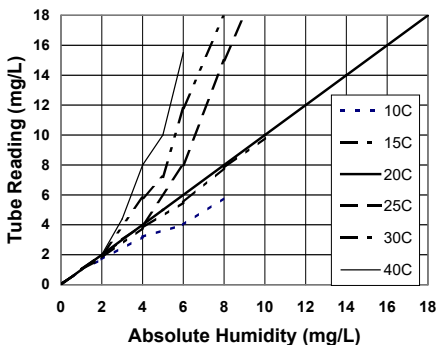
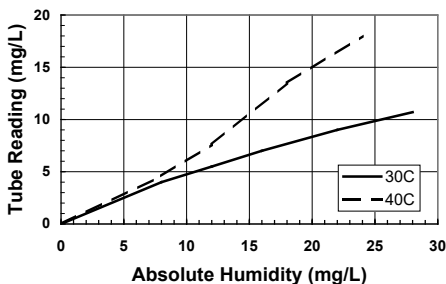


Fig. 2. Temp. Correction, 1/2 Stroke



Headquarters

Europe

Klaverbaan 121, 2908 KD,
Capelle aan den IJssel,
The Netherlands

info@watchgas.com
www.watchgas.com



Other Locations

Americas

313 N. State Hwy 342,
Red Oak, TX 75154,
USA

info@watchgasusa.com
www.watchgasusa.com

ANZ

Unit 5, 11 Brand Drive,
Thomastown, Victoria,
Australia 3074

anz@watchgas.com
www.watchgas.com

APAC

Woods Square Tower 1,
12 Woodlands Square,
#11-71, Singapore 737715

info@watchgas.com
www.watchgas.com

China

3rd floor, Building No. 28, Lane 1818,
Chengbei Road, Jiading district,
Shanghai, PRC

info@watchgas.com
www.watchgas.com