Model 332
Hydrogen Sulfide Monitor
Operator's Manual

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Envent
Knowledge by Analysis

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For further information, or a copy of our most recent operating manual, please visit us at www.enventengineering.com. Envent Engineering Ltd. reserves the right to change product design and specifications at any time without prior notice

All products carry a one year limited warranty from the date of start-up or 18 months from date of shipment, whichever occurs first, F.O.B. the factory, against defective parts or workmanship.

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A. Figures and Tables

A.1. Figures

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B.Introduction

The model 332 Mini H2S monitor is a low cost alternative to standard H_2S analyzers. Specific applications ideal for the 332 H_2S monitor are, down hole chemical injection, waste water treatment odour abatement and landfill gas quality assurance. For applications requiring high speed analysis, high accuracy or advanced communication and alarm functions, Envent offers the model 330 and 331 H2S analyzers.

This manual contains a comprehensive overview of Envent Engineering's 332 H2S monitor and step-by-step instructions on:

- Installation and Startup
- Operation
- Maintenance
- Troubleshooting

This manual should be read and referenced by the person who will install, operate, or have contact with the 332. Take time to familiarize yourself with the content of this Operator's Manual, reading each section carefully so you can quickly and easily install and operate the monitor.

The manual includes images, tables, and charts that provide a visual understanding of the monitor and its functions. Take note of all the caution symbols and notes, as they will alert you of potential hazards and important information.

B.1. Warnings and Cautions

CAUTION: The monitor should be mounted in an area in which it is not exposed to vibration; and excessive pressure, temperature, and environmental variations.

CAUTION: Ensure that the monitor received is suitable for the installation location electrical classification of the installation site.

- The 332 is designed for Class I Division 2 Groups A,B,C&D hazardous locations

CAUTION: Disassembly of the pressure regulator and solenoids in the field is not advised. Consult the factory if the regulator or solenoid appears contaminated.

CAUTION: Before resuming line pressure be sure that all port connections, sample sweep, and sample conditioning system are securely installed.

CAUTION: All connections must be LEAKTIGHT to insure the effectiveness of the monitor as well as SAFETY. The user, through his own analysis and testing, is solely responsible for the product selection and ensuring all responsibility, safety and warning requirements of the application are met. If the equipment is used in a manner not specified by Envent Engineering Ltd., the protection provided by the equipment may be impaired.

CAUTION: Do not use solvents, brake cleaner, soaps or detergents.

CAUTION: Turn off power before servicing. Ensure breakers are off before connecting or disconnecting supply power.

CAUTION: This unit may require a disconnect device rated 24 VDC and 5A max, must be protected by a circuit breaker rated 24 VDC and 5A max, and is to be installed in accordance with local electrical codes.

B.2. Technical Specifications

Table 1: Technical Specifications

Specifications	
Measurement Method	ASTM D4084 - 07: Standard Test Method for Analysis of Hydrogen Sulfide in Gaseous Fuels (Lead Acetate Reaction Rate Method)
Ambient Temperature	0-50°C (standard) consult factory for other requirements, 0 to 90% humidity (non-condensing)
Power	12-24 VDC @ less than 3W
Electrical	Designed to Class I, Division 2 Groups A,B,C&D
Output Ranges	Standard ranges are between 10 and100 ppm
Response Time	3 minutes
Accuracy	+/- 2.0% of full scale
Display	2 x 16 character LCD Scrolling menu
Outputs	4-20mA output (loop power required)
	2 solid state alarms

C. Principle of Operation

Envent Engineering Ltd. models 332 use ASTM D4084 - 07: Standard Test Method for Analysis of Hydrogen Sulfide in Gaseous Fuels (Lead Acetate Reaction Rate Method). This method uses lead acetate impregnated paper, referred to by Envent Engineering Ltd. as 'H2S sensing tape".

The H2S sensing tape reacts when in contact with hydrogen sulfide by the relationship shown below. This reaction is visibly evident by a brown stain directly on the H2S sensing tape. The electronics built into the Models 332 have been programmed to measure the rate of darkening over time which, in turn, gives the hydrogen sulfide concentration.

$$H_2S + \mathrm{Pb(CH_3COO)_2}\overrightarrow{H_2O}\mathrm{PbS} + 2\mathrm{CH_3COOH}$$

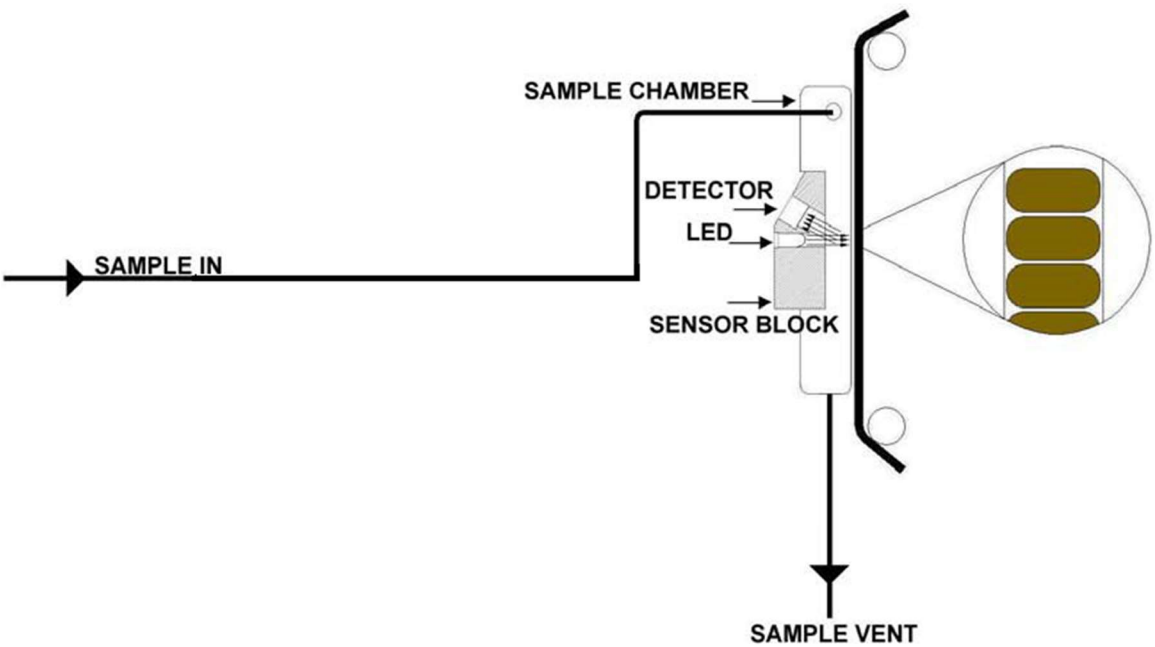


Figure 1: 332 monitor principle of operation diagram

The figure above shows a flow regulated, pressure regulated and filtered process sample gas passing into the sample chamber. (See the following figure) A window in the sample chamber allows the gas to come in contact with the sensing tape creating the brown stain.

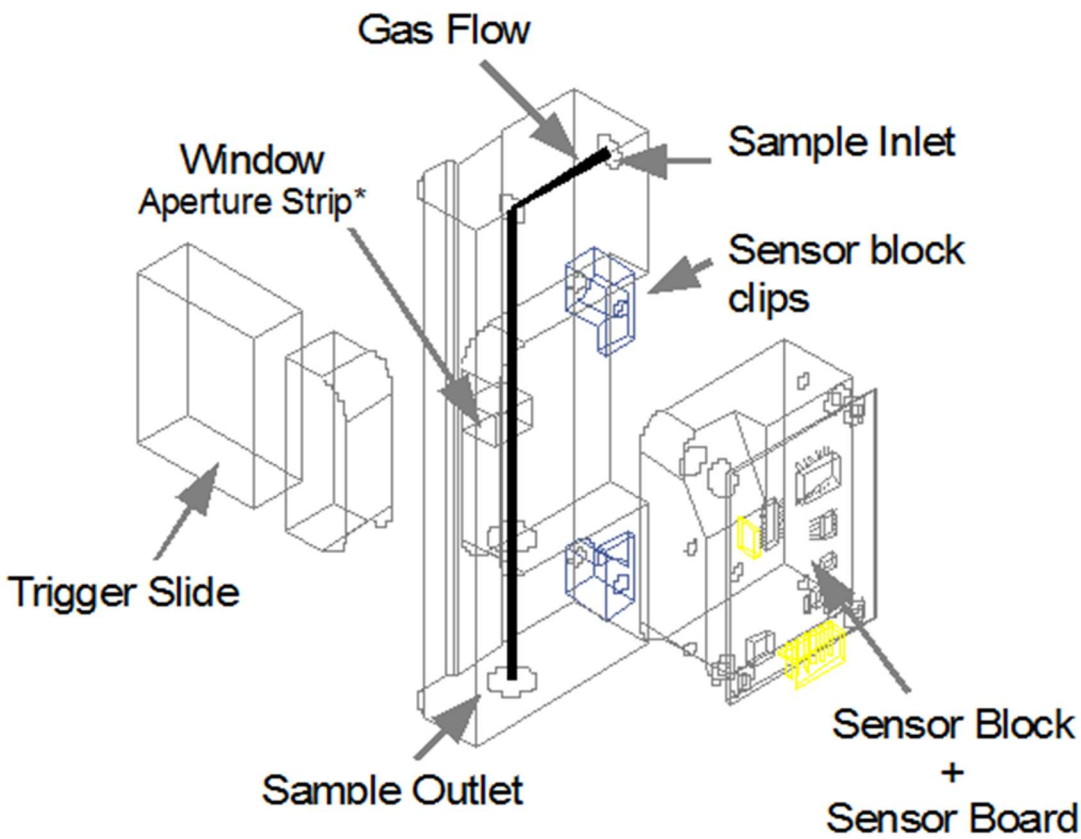


Figure 2: Sample chamber and parts

For concentration applications over 10 ppm there may be a restricting aperture behind the window. Various sizes of apertures match different measurement ranges. See the table below.

Table 2: *Range & Aperture Information

Range	Aperture Size	PN
100 ppb – 10 ppm	None	NA
10 ppm – 20 ppm	1/16"	330103
20 ppm – 50 ppm	1/32"	330102
50 ppm – 100 ppm	1/64"	330101
More than 100 ppm	Consult Factory	

D. Operator Interface

The 332 is configured by using the push-buttons as shown below.

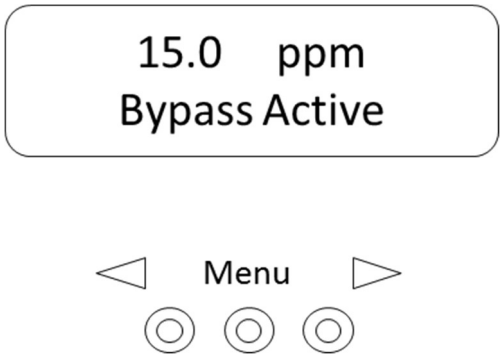


Figure 3: Standard operator interface

Table 3: Monitor display-button functions

Button	Description/Function
Scroll Right [→]	Used to move the cursor to the right. Also used to SAVE configuration adjustments.
Scroll Left [←]	Used to move the cursor to the left. Also used to CANCEL configuration adjustments.
Menu/Set	Used to cycle through the menu options. Also used to increase numerical values when making configuration adjustments

E. Installation and Start-up

Your monitor was configured, functionally tested and calibrated at the factory. All test and calibration data is documented in the factory calibration report. (See the end of this manual)

CAUTION: The monitor should be mounted in an area in which it is not exposed to vibration; and excessive pressure, temperature, and environmental variations.

E.1. Sample Point Selection

The sample to the monitor must be representative of the process stream and should be taken from a point as close as possible to the monitor to avoid lag times and sample degradation in the tubing.

A ¾" weldelet is required for installation. The probe must be installed vertically on a horizontal section of pipe ensuring that the sample is drawn from between the middle and the top third of the pipeline.

An optional Genie GPR probe regulator may be included. The function of this probe is to ensure a clean dry sample to the monitor and to reduce the pressure of the sample. The lower pressure will improve the response time of the monitor. For installation instructions, refer to associated documents. Do not install the Genie probe regulator on a vertical pipe.

E.2. Sample Volume and Flow Rate

The sample should be supplied to the monitor at 10-15 psig. The flow is between 100-200 cc/min controlled by a critical orifice. A bypass sweep is recommended to reduce sample lag time in the sample line if it is at high pressure or it is longer than 15 feet. The standard sample tubing material is 1/4" 316 stainless steel; however, 1/8" stainless steel tubing can be used if the response time is critical. Carbon steel sample line and/or fittings are not acceptable

E.2.1. Sample Lag Time vs. Tubing Size

Table 4: Sample Lag Time vs. Tubing Size

Tube Size (")	Tube Gauge	ID (")	ID (cm)	Flow (SCFH)	Flow Std. (cc/min)	Pressure (PSIA)	Lag Time per 100' (min)	Lag Time per 100' (sec)
3/8	20	0.319	0.810	5	2359	800	36.30	2178
3/8	20	0.319	0.810	5	2359	200	9.07	544
3/8	20	0.319	0.810	5	2359	50	2.27	136
1/4	20	0.181	0.459	5	2359	800	11.69	701
1/4	20	0.181	0.459	5	2359	200	2.92	175
1/4	20	0.181	0.459	5	2359	50	0.73	44
1/8	20	0.081	0.205	5	2359	800	2.34	140
1/8	20	0.081	0.205	5	2359	200	0.59	35
1/8	20	0.081	0.205	5	2359	50	0.15	9

E.3. Sample Conditioning

The function of the optional sample conditioning system is to regulate and filter particulates or free liquids from the sample. Consideration must be taken of upset conditions as well as normal conditions when designing the sample conditioning system. The figure below shows the typical sample conditioning system used for the 332.

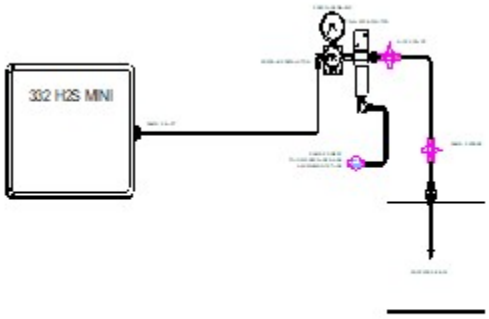


Figure 4: 332 Optional Sample Conditioning System

The optional, coalescing & regulated sample conditioning system consists of a 5000 psig inlet filter and a 3000 psig inlet regulator. The sample sweep valve on the filter is left slightly open to drain any liquids that may collect and to provide a sample sweep to reduce lag time in the sample piping.

E.4. Installation Procedure

Step 1. Unpack the monitor and check for damage

Step 2. Ensure that the monitor power supply and range are suitable for the application

Step 3. Check that the hazardous location rating is suitable for the installation location (designed to Class I, Div 2, Groups ABC&D)

Step 4. Select an installation location that is close to the sample point.

- Ensure that the selected installation site provides adequate room for maintenance and repair

Step 5. Bolt the monitor to the wall with the tape drive at approximately eye level

Step 6. Wire power, analog outputs and discrete outputs to the monitor (See section D)

CAUTION: Turn off power before servicing. Ensure breakers are off before connecting or disconnecting supply power.

Step 7. Tube the sample inlet, sample sweep and sample vent lines to the monitor

- 1/4" 316 stainless steel tubing is recommended for the sample tubing
- 1/8" 316 stainless steel tubing can also be used if the response time of the monitor is of particular concern
- All fittings in the sample and vent lines must be 316 stainless steel

- The vent line should be tubed in 3/8" stainless steel tubing to a maximum of 6'
- 1/2" 316 stainless steel tubing should be used for vent lines exceeding 6'
- The tubing should be installed with a slight downward slope and should be as short as possible
- The sample vent line must be tubed to atmospheric pressure and cannot be connected to a flare line

Note: For recommended venting, see Appendix: Recommended Venting

Step 8. Ensure there is enough H2S sensing tape

Step 9. With the sample pressure turned off (sample inlet valve closed)

a. Apply power to the monitor. The display will illuminate and the sensing tape will advance.

b. Press the menu button until mV is displayed. Check that the mV reading is 1000 mV ± 100 mV

CAUTION: Before resuming line pressure be sure that all port connections, sample sweep, and sample conditioning system are securely installed.

Step 10. Turn on sample gas flow (open sample inlet valve).

Step 11. Open the sweep valve slightly and adjust pressure regulator to 15 psig

CAUTION: All connections must be LEAKTIGHT to insure the effectiveness of the monitor as well as SAFETY. The user, through his own analysis and testing, is solely responsible for the product selection and ensuring all responsibility, safety and warning requirements of the application are met. If the equipment is used in a manner not specified by Envent Engineering Ltd., the protection provided by the equipment may be impaired.

Step 12. Allow twenty minutes for the monitor to stabilize. The monitor calibration can be verified if calibration gas is available (refer to the calibration section). If no calibration gas is available, the monitor may be operated using the factory calibration settings until calibration gas is available.

F. Customer Connections

CAUTION: This unit requires a disconnect device rated 24 VDC and 5 A max, must be protected by a circuit breaker rated 24 VDC and 5 A max, and is to be installed in accordance with local electrical codes.

CAUTION: Turn off power before servicing. Ensure breakers are off before connecting or disconnecting supply power.

All customer connections are indicated on the circuit board. For a larger view and detailed information on the controller board, please see Appendix: Controller Board Schematic

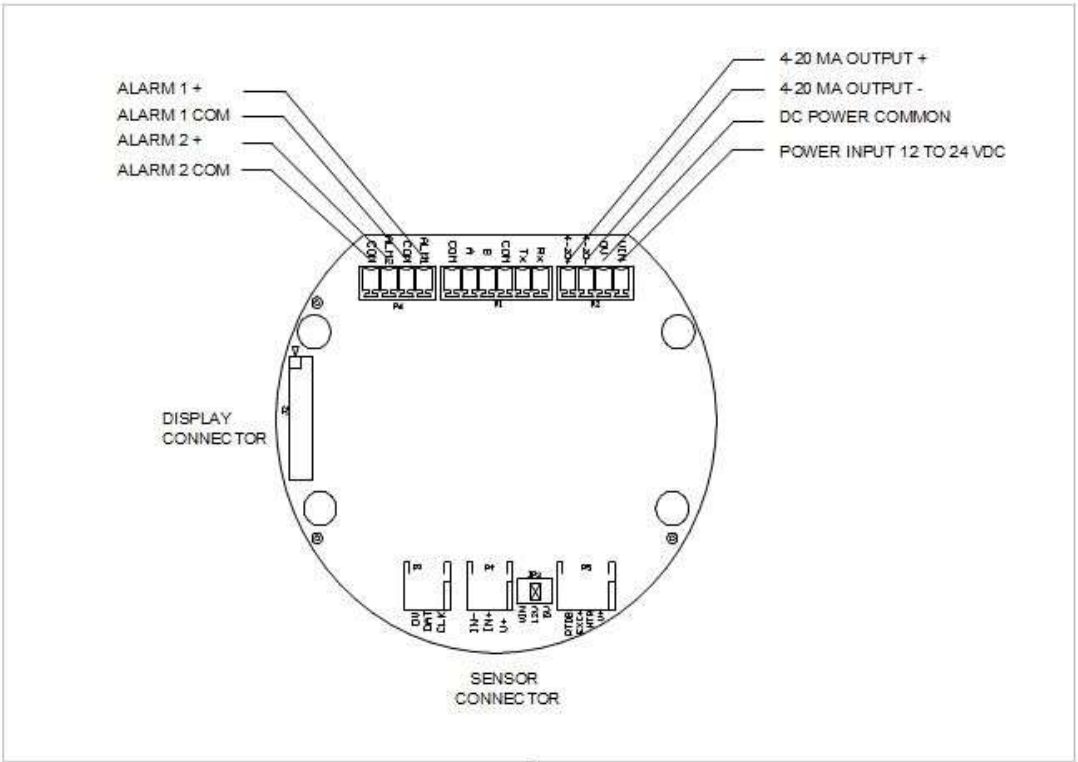


Figure 5: Controller Board Layout & Power Input

F.1. Alarm Outputs

Two solenoid drivers are provided to directly drive solenoids for alarm, shutdown, or pump control. DO NOT supply external power to solenoid drivers.

F.2. Analog Outputs

An isolated analog output is provided. The analog output is normally set to the full scale range of the monitor. Loop power (10 to 32 volts) sourced from the end device (PLC) is required for the analog output.

G. Calibration

G.1. Calibration & Alarms

The H_2S monitor configuration and calibration was set at the factory. The factory gain and alarm settings can be found in the factory calibration sheet, found at the end of this manual. Monitor settings can be read and adjusted using the operator interface.

G.2. Calibration Procedure

Ensure a suitable calibration gas and a clean stainless steel regulator with the correct CGA fitting is available. Check that the regulator is rated for calibration cylinder pressure.

- The recommended calibration gas is hydrogen sulfide in a balance of nitrogen certified and analyzed.
- Calibration gas concentration should be approximately 2/3 of the full scale range of the monitor or at the alarm point of the facility to be monitored
- Check the expiry date on the calibration gas bottle before using

Note that the following instructions apply to monitors with standard sample systems; however, the basic principles still apply.

Step 1. Press the Menu button until Bypass displays on the display. Press the side arrow to toggle the state from "Off" to "On".

Step 2. Turn off gas flow using the sample block valve.

Step 3. Ensure there is enough H2S sensing tape (See E.2.2 if tape requires changing)

Step 4. Ensure there is enough 5% acetic acid, if the monitor has a humidifier

Step 5. Push the "Menu/Set" button until "Mtr Run" is displayed

Step 6. Push the right arrow [→] to move the H2S sensing tape forward

- Ensure there is white tape at the sensor block window

Step 7. Press the "Menu/Set" button until the mV reading is displayed ("### mV")

Step 8. If the mV reading is 1000 ± 100 mV, proceed to the next step, otherwise:

a. Ensure there is no brown stain on the sensing tape at the sensor block window
b. Ensure the sample chamber is clean
c. Re-zero the sensor block (See section E.2.1 {Start at Step 4})
d. Re-check that the mV reading is 1000 ± 100 mV

Step 9. Connect calibration gas bottle to the Sample Inlet

a. If the monitor does NOT use a humidifier, See Appendix: Calibration Gas Humidifier for further instructions

Step 10. Set the calibration gas pressure to 15 psig
Step 11. Allow the monitor reading to stabilize (10 to 15 minutes)
Step 12. Press the "Menu/Set" button until the gain setting is displayed ("### Gain")
Step 13. Adjust the gain setting such that the monitor reads the correct concentration

a. Calculate gain, calculation should be close to the factory calibration sheet (See end of this manual)

$$\left(\frac{\text{CalGasConcentration}}{\text{CurrentReading}}\right) \times (\text{CurrentGain}) = (\text{NewGain})$$

b. Press the right [→] and/or left [←] arrows until the cursor is underneath the number you wish to change
c. Adjust the number using the "Menu/Set" pushbutton (it will increase until '9', then cycle back through to 0')
d. The new gain can be saved by pressing the right arrow [→] until "Saved" appears or discarded by pressing the left [←] arrow until "Cancel" appears

Step 14. Allow the monitor to complete two cycles with the new gain setting
- The reading should match the calibration gas concentration

Step 15. Turn on sample gas flow
Step 16. Set the sample gas pressure to 15 psig
Step 17. Disconnect calibration gas bottle
Step 18. Allow the monitor to return to a no-alarm condition
Step 19. Remove the monitor from bypass
Step 20. Calibration is complete!

G.2.1. Re-Zero Sensor Procedure

Step 1. Press the bypass button and verify that the "Bypass" LED illuminates
Step 2. Turn off sample gas flow using sample inlet valve
Step 3. Press the "Menu/Set" button until "Mtr Run" is displayed
Step 4. Push the right arrow [→] to move the H2S sensing tape forward
- Ensure there is white tape at the sensor block window

Step 5. Remove the sensor cover
Step 6. Press the small pushbutton on the sensor block located on the lower left side next to the wire connector
- The sensor block will implement a "re-zero" procedure, indicated by a lit, red LED
- When the "re-zero" procedure is complete the LED light will turn green

Step 7. Initiate another motor run (Step 3 & 4)
Step 8. Press the "Menu/Set" button until "### mV" is displayed
- Value should be between 900 & 1100 mV Step 8. Put on sensor cover

Step 9. Turn on sample gas flow using sample inlet valve
Step 10. Set the gas pressure to 15 psig
Step 11. Remove the monitor from bypass

G.2.2. Tape Change Procedure

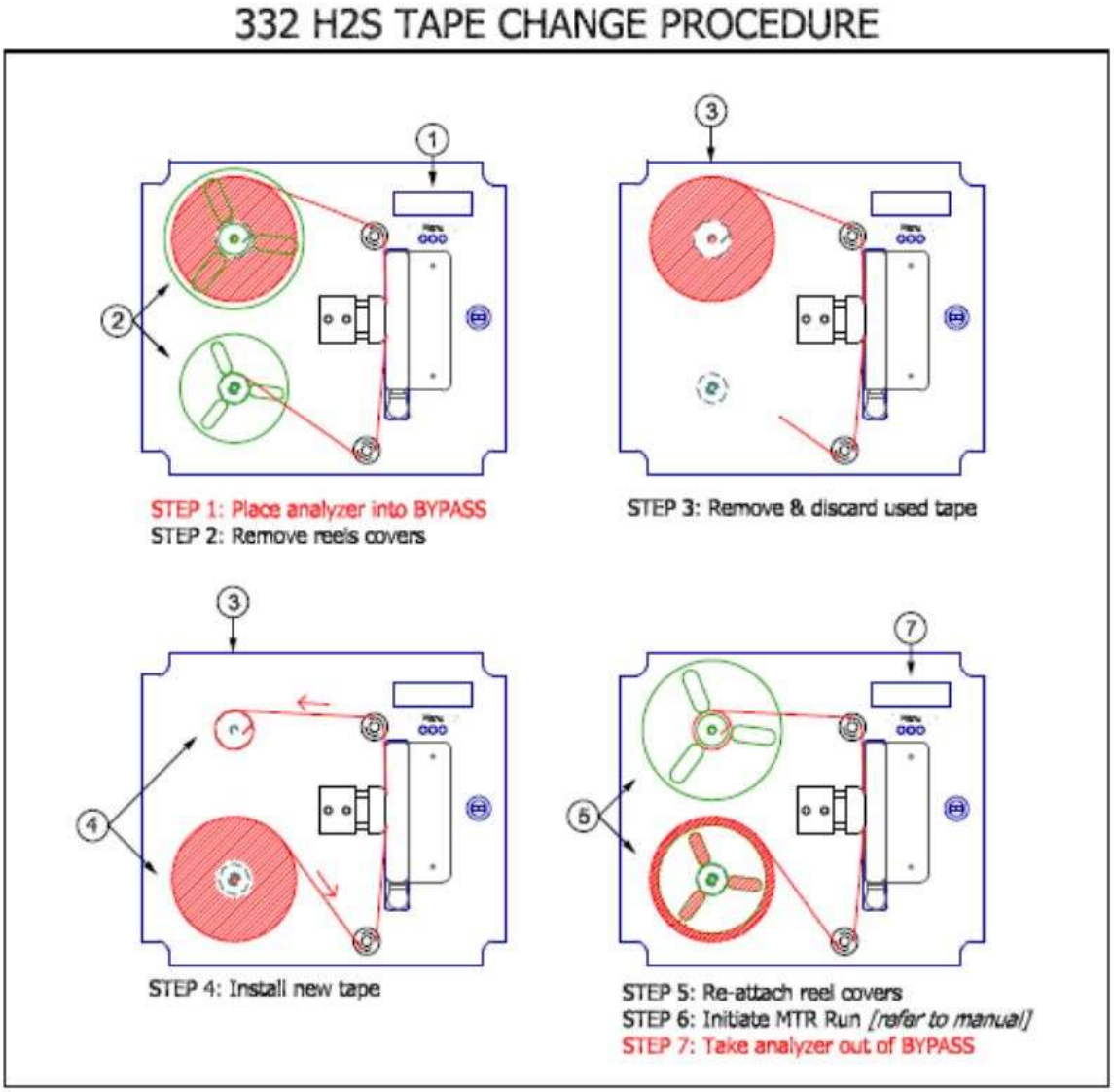


Figure 6: 332 Tape change procedure

H. Maintenance & Troubleshooting

H.1. Monthly Checkup

Your monitor will provide reliable service with very little attention. If the monitor is kept clean there should be no requirement to recalibrate from factory gain settings. However, regular check-up will ensure that the monitor is operating to specifications.

- Ensure that the tape take-up and feed reels are tight
- Ensure that the sample chamber tubing is free of liquid or particulate contamination.
- Check the sample conditioning filters every tape change or when sample conditioning system is saturated with liquid. Replace the inlet filter as required.

H.2. Troubleshooting

For other possible solutions, please visit the 'Frequently Asked Questions' section of our website, at www.enventengineering.com

Table 5: Troubleshooting recommendations

Problem	Possible reasons	Possible Solution
Erratic H_2S Readings	a. Trigger slide not seated properly	Ensure trigger slide is seated in the groove of the sample chamber.
	b. Pressure in building moving up and down from fan, exhaust or wind	Check that all vent tubing and fittings are 316 stainless steel, sized 3/8" or larger.
	c. Sample vent either blocked or frozen	Vent should be 3/8" or larger tubing on a downward slope. Possible heat trace required.
	d. Liquid carry over in sample conditioning system	Sample conditioning system requires cleaning. Refer to cleaning procedures.
	e. Regulator not maintaining 15 psig	Pre-regulation to 50 psig of sample at sample point. Possible regulator requires repair or replacement of Hydrocarbon liquid carried over through the sample regulator. Heated regulator may be required.
	g. Sensor block fault	Re-zero Sensor block. Refer to Sensor Re-zero procedure. check for green status led on sensor block.
	h. Contaminants in sample chamber	Clean sample chamber. Replace aperture and window if required.
		Clear grease from window. Envent no longer uses grease on the chamber window. *Applies to earlier H_2S monitors.*
	i. Contaminants in sample conditioning system	Sample conditioning system requires cleaning. Refer to cleaning procedures.
Tape does not advance	a. No tension on take up reel	Check setscrew in take up reel collars. Check to see if manual advance is possible on tape.

Problem	Possible reasons	Possible Solution
Tape breaking	a. High liquid content in sample gas	Genie sample probe and additional filtration may be required.
	b. Feed wheel not spinning freely	Dust and refuse build up between feed wheel and chassis. Requires removal and cleaning of chassis.
	c. Tape cover wheels pressing against tape.	Tape cover wheel became warped. Needs to be flattened to not contact tape when on feed wheel bolt.
	d. Trigger slide not seated properly	Ensure trigger slide is seated in groove of sample chamber.
Slow Response	a. Aperture in chamber not optimized for range	Removal or change of aperture type required. Contact Envent tech support for ideal setting
	b. Liquid contamination in sample tubing	Sample conditioning system requires cleaning. Refer to cleaning procedures.
	c. Sensor block in fault	Re-zero Sensor block. Refer to Sensor Re-zero procedure.
Higher or Lower than expecting reading	a. Liquid contamination in sample tubing	Sample conditioning system requires cleaning. Refer to cleaning procedures.
	b. Sample vent either blocked or frozen	Vent should be 3/8" or larger 316 stainless steel tubing on a downward slope. Possible heat trace required.
	c. Contaminants in sample chamber	Sample conditioning system requires cleaning. Refer to cleaning procedures.
Fault indicated	a. Sensor Low fault	Re-zero Sensor block. Refer to Sensor Re-zero procedure.
	b. Sensor High fault	Re-zero Sensor block. Refer to sensor re-zero procedure.
Sensor Fault	a. Sensor didn't zero on white tape.	Re-zero Sensor block. Refer to Sensor Re-zero procedure.
	b. Sensor Wire failure	Wire or Sensor requires replacement.

H.3. Sample Conditioning System Cleaning Procedure

CAUTION: Do not use solvents, brake cleaner, soaps or detergents.

During startup or plant upset situations, the hydrogen sulfide monitor may become contaminated with amine or hydrogen sulfide scavenger solution. This may cause the monitor to read low (this can be determined at calibration). If the monitor reads low, it will require incremental increases in the gain to maintain calibration. Please refer to factory calibration sheet for factory set gain factor. The scavenger solution is water soluble and therefore is relatively easy to clean.

Material List

Cleaning kit part number: 330900

- Alconox Laboratory cleaner or equivalent residue free cleaning agent
  - **Do not use solvents, detergents or soaps!**
- Fresh water
- 100% Isopropyl Alcohol
  - **Do not use rubbing alcohol!**
  - **Do not use brake cleaner product!**
- Large bucket to mix cleaning solution
- Rinse bottle

Procedure

Step 1. Mix a 1% (2-1/2 tbsp per gallon) of Alconox in warm water

Step 2. Sample line tubing

a. Shut off flow at the sample point prior to sample conditioning system
b. Flush the sample line and components with cleaning solution
c. Rinse with fresh water
d. Flush with isopropyl alcohol
e. Dry with clean, dry instrument air or gas

Step 3. Sample conditioning system

CAUTION: Disassembly of the pressure regulator and solenoids in the field is not advised. Consult the factory if the regulator or solenoid appears contaminated.

a. Remove filter elements from filter housings and discard
b. Remove all sample conditioning system components and soak in cleaning solution
c. Ensure valves are fully open when cleaning
d. Flush sample components with fresh water
e. Rinse with isopropyl alcohol
f. Blow dry with clean compressed air or fuel gas
g. If any of the clear vinyl tubing appears discoloured, replace the tubing

Step 4. Re-assemble Stainless Steel Tubing to monitor according to monitor drawing (refer to back of manual)

Step 5. Once sample conditioning system has been re-assembled, apply calibration gas to the monitor, refer to section E.2.

Step 6. Adjust gain to indicate value from calibration certificate

Step 7. Gains for streams should be ± 2.00 from factory cal sheet or last calibration.

- If the reading is not with in range, then the monitor sample conditioning system may need further cleaning. Please consult factory.

Recommended Spare Parts List

Table 6: Recommended spare parts list for 2 years

Part Number	Qty	Description
330079	1	Rear Window & Gasket
330103	1	Aperture Strip (Associated to measurement range)
330132	12	250' Lead Acetate Tape
330406	1	Box of 10 Micrafilter glass fibre element 12-57-50S
330900	1	Tubing, cleaner, fittings maintenance kit
330130	1	4L 5% Acetic Acid

H2S Concentration Conversion Factors

Table 7: H2S Concentration conversion factors

Original Unit	Multiply By	Final Unit
mg / m^3	0.698	ppm
ppm	0.0626	grain / 100 cf
%	10 000	ppm
Mole / kMole	1000	ppm

Sub Assemblies

#	Description	Part number
1	Trigger Slide	330042
2	Sample Chamber	330075
3	Senosr block clips	330074
4	Sensor block	330230

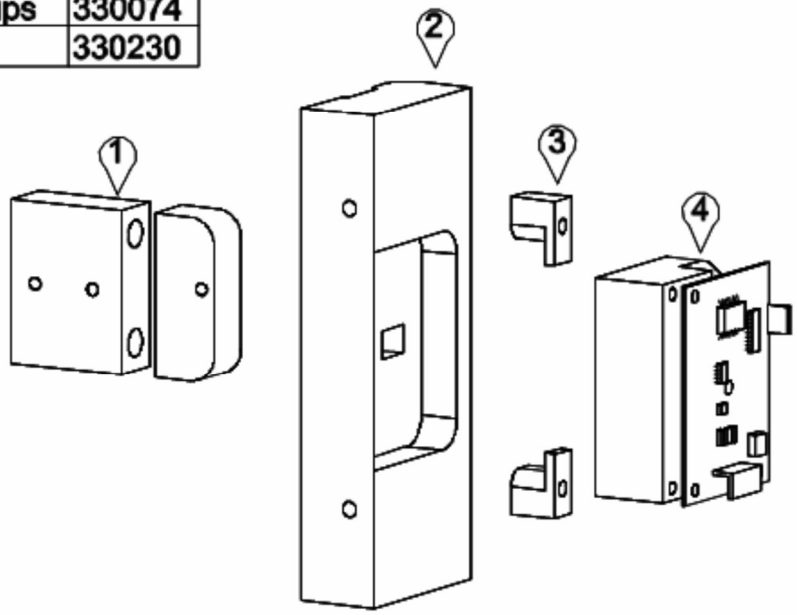
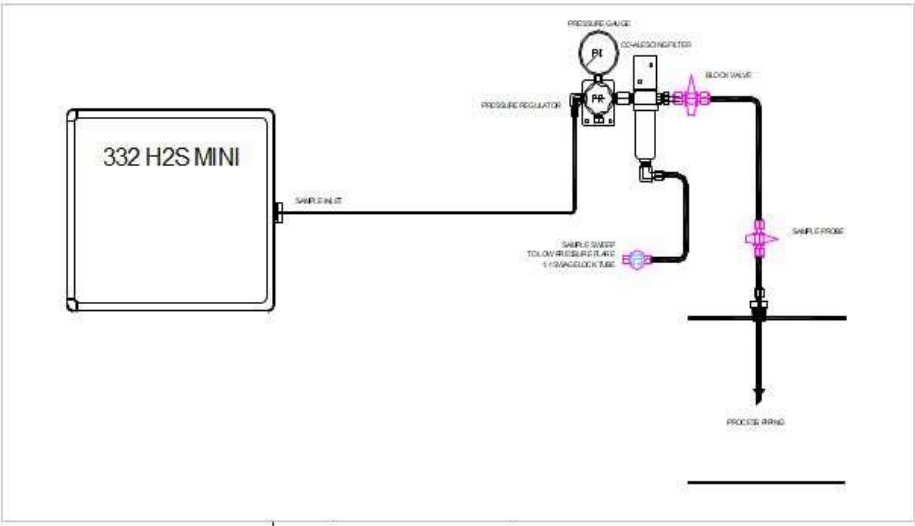


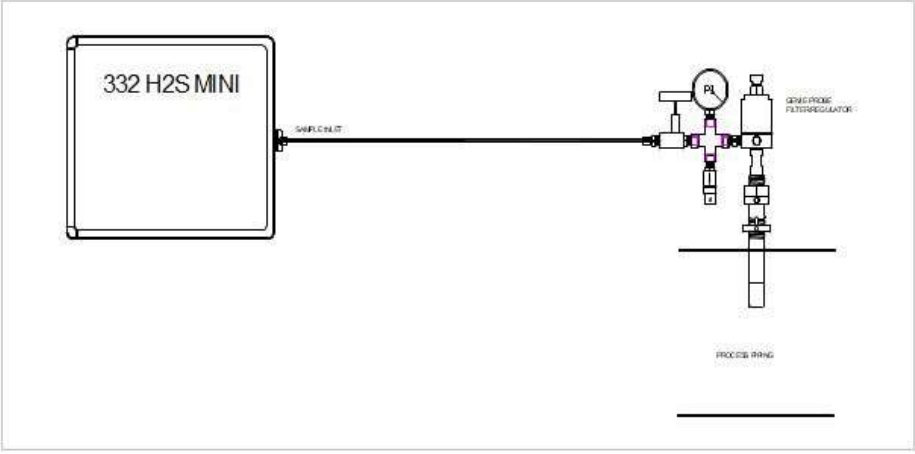
Figure 7: Sample chamber assembly (expanded)

Standard System Drawing

Figure 8: 332 Optional Sample System Drawings



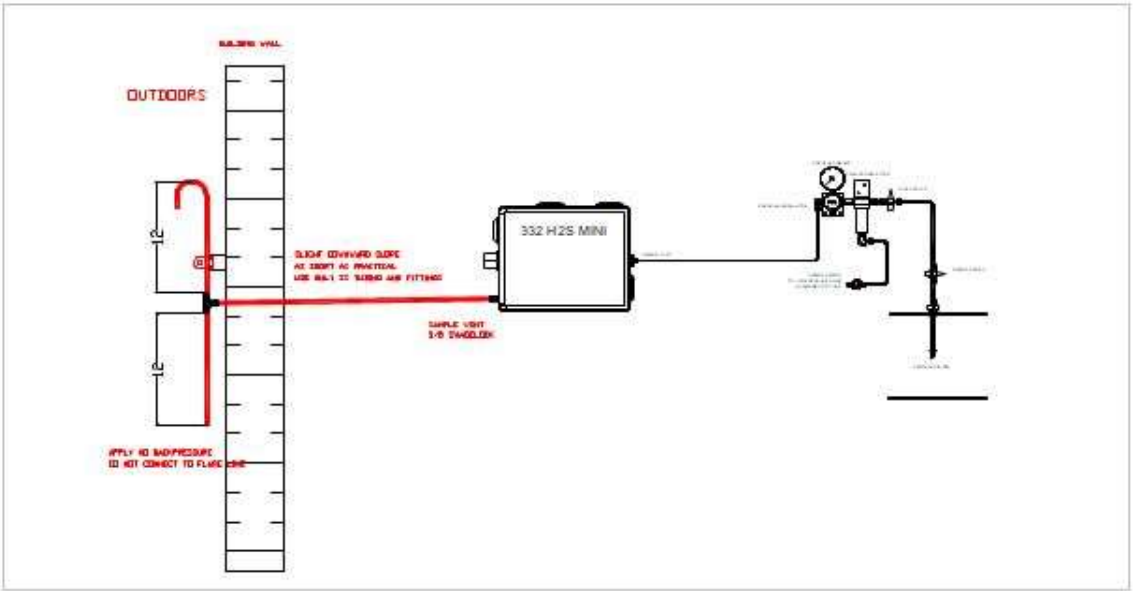
Coalescing Sample System



Genie Membrane Probe Sample System

Recommended Venting

Figure 9: 332 Recommended venting



This document has been continuously improved and revised over time; see the table below for revision (rev) information.

Rev No.	***Rev Date***	***Rev Description***
0	2013-07-12	Initial Release
1	2013-08-23	Manual Update
2	2018 Oct 22	Updated Envent's Address
3	17 Sep 2019	Manual Update
4	08 Jun 22	Updated company's logo

For further information, or a copy of our most recent operating manual, please visit us at www.enventengineering.com. Envent Engineering Ltd. reserves the right to change product design and specifications at any time without prior notice

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