

# **Evaluation of Portable Gas Monitors for the Detection of Low Levels of H<sub>2</sub>S and SO<sub>2</sub> in Petroleum Environments**

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# Introduction

- Many portable gas monitors are used for the detection of low concentrations of H<sub>2</sub>S and SO<sub>2</sub> in the workplace. They provide an alarm at a preset concentration level so that the person can take appropriate action.
- With the reduction of the H<sub>2</sub>S & SO<sub>2</sub> TLV the ability of these devices to selectively measure and respond to these levels is not well documented in petroleum industry environments.
- If the instruments are unable to provide reliable warnings at these lower levels one standard practice of control is compromised.
- In addition, the potential lack of reliable warnings can promote poor safety practices.

# Objectives

- Measure the ability of the monitors to correctly quantify and respond to H<sub>2</sub>S and SO<sub>2</sub> in a simulated petroleum industry environment.
- Identify the effect of any interference on these instruments.
- Determine the reliable lower limit of detection for these sensors in real workplace environments.
- Publish the full results in a peer reviewed journal.

*Note: This is a review of results so far – the full test programme has not yet been completed.*

# Background for Selection

Laboratory selection – UK Health & Safety Laboratory

- <http://www.hsl.gov.uk/>

What tests & limitations?

- practical considerations
- alarm limits (first alarm not TWA)

Which instruments?

- focus on single gas personal monitors, 6 manufacturers selected (H1 – H6, H2S and S1-S6, SO2 monitors)
- all popular current instruments & voluntarily provided

Publish the findings

- full results in a peer reviewed journal

# Test Conditions

- Relative Humidity: 0% and 80%
- Temperature: -5°C and 30°C
- Concentrations: 0.0, 0.1, 1.0 and 5.0 times TLV\* for SO<sub>2</sub> and H<sub>2</sub>S
- Interferents: NO<sub>2</sub>, SO<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>, CO, ethylene, toluene, hexane, acetylene
- Additional verification of H<sub>2</sub>S, SO<sub>2</sub> and other gas concentrations
- Flowrates: 0.1 to 0.5 m/sec

*Approximately 50 tests in per monitor.*

\* ACGIH TLVs:

- H<sub>2</sub>S = 1 ppm TWA, 5 ppm STEL
- SO<sub>2</sub> = 0.25 ppm STEL

# Set Alarm Levels

- All the H<sub>2</sub>S monitors had an alarm set to the TLV level of 1 ppm.
- None of the SO<sub>2</sub> monitors had an alarm set at or below the TLV of 0.25 ppm.
  - monitors S1, S3 and S4 had alarms set to 0.3 ppm
  - monitor S5's had alarms set to 0.4 ppm
  - monitor S2 was set to 2.0 ppm.

## H<sub>2</sub>S Monitor Responses to 51.6 ppm H<sub>2</sub>S

Instrument	Reading after 180 s (ppm)
H1	50
H2	40.0
H3	33.9
H5	44
H6	50

Instrument H6 was not supplied with a calibration mask.

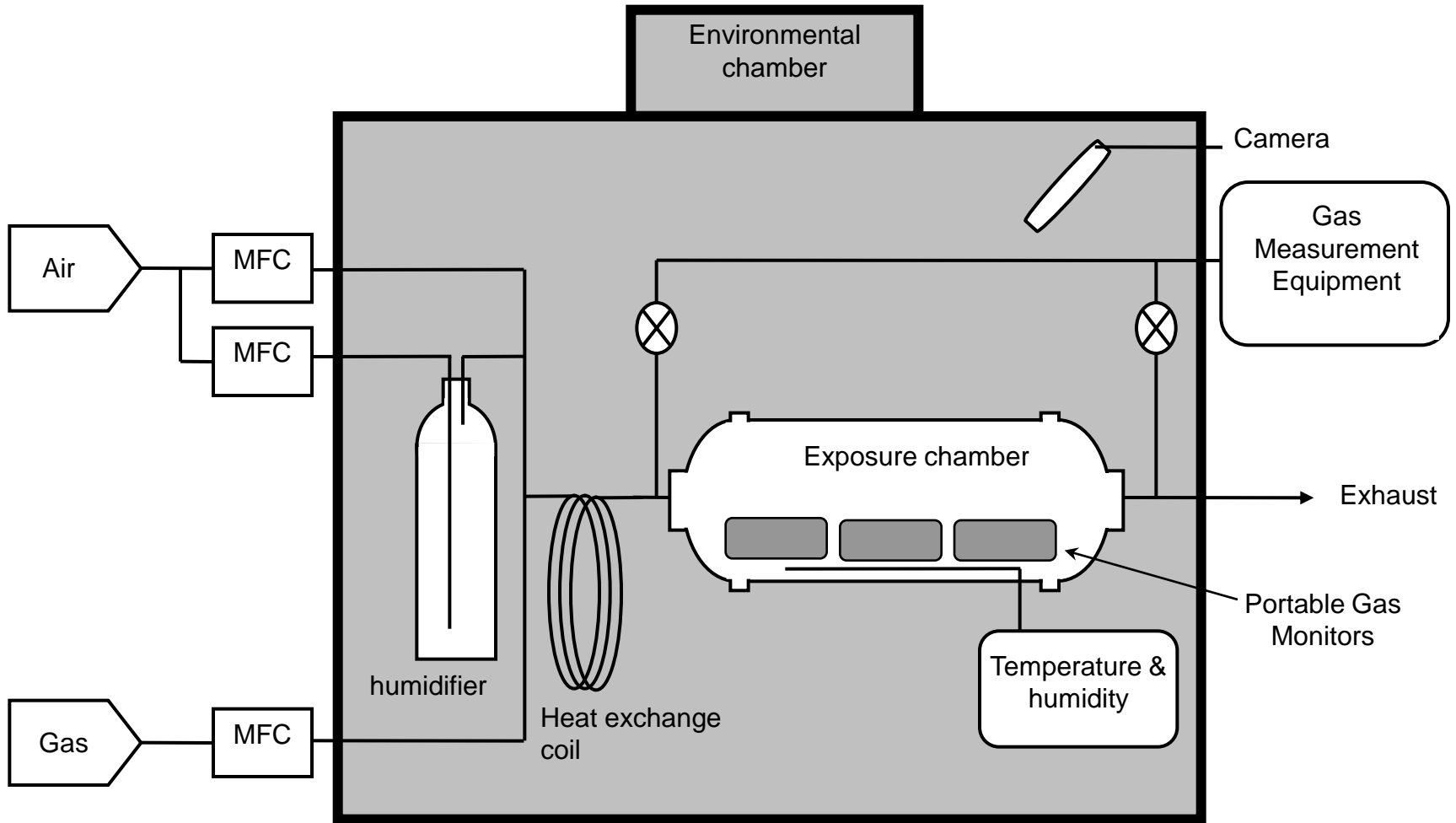
## SO<sub>2</sub> Monitor Responses to 5.3 ppm SO<sub>2</sub>

Instrument	Reading after 180 s (ppm)
S1	4.3
S2	4.4
S3	4.7
S4	3.3
S5	3.8

Instrument S2 was not supplied with a calibration mask.



# Test Apparatus



# The Environmental Chamber



# H<sub>2</sub>S Monitor Response to H<sub>2</sub>S

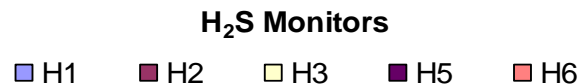
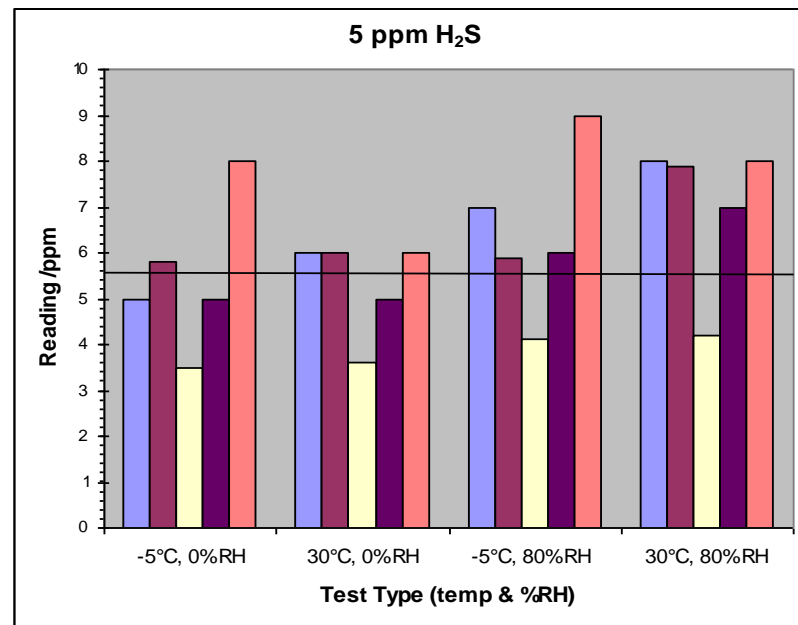
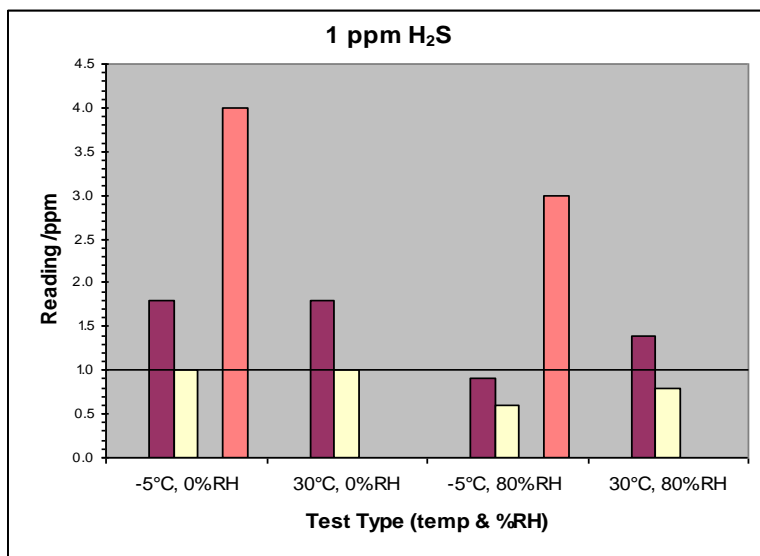
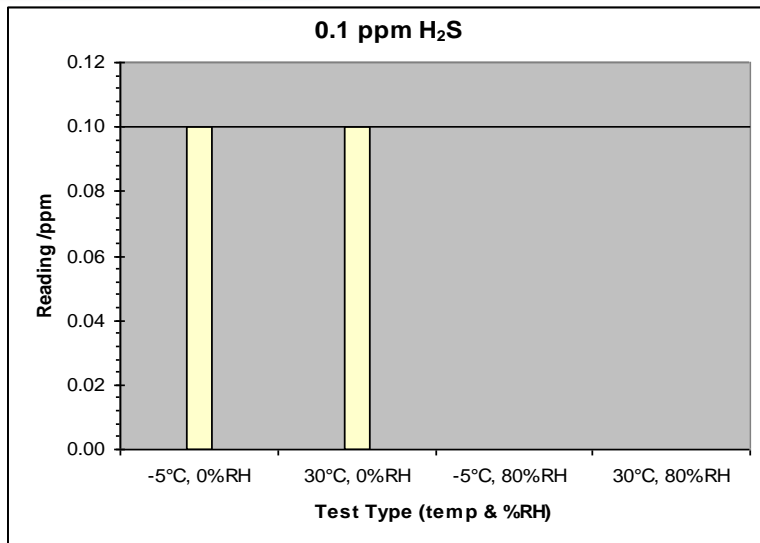
	Temp °C	%RH	H1*	H2	H3	H5	H6*
Set alarm level ppm			1	1.0	1.0	1.0	1
<b>Clean Air</b>	-5	0	0	0.0	0.1	0.0	0
	30	0	0	0.0	0.2	0.0	0
	-5	80	0	0.0	0.0	0.0	0
	30	80	0	0.0	0.0	0.0	0
<b>0.1 ppm H<sub>2</sub>S (0.1 TLV)</b>	-5	0	0	0.0	0.1	-	-
	30	0	0	0.0	0.1	-	-
	-5	80	0	0.0	0.0	-	0
	30	80	0	0.0	0.0	-	-
<b>1 ppm H<sub>2</sub>S (1 TLV)</b>	-5	0	0 A	1.8 A	1.0 A	0.0	4
	30	0	0 A	1.8 A	1.0 A	0.0	0
	-5	80	0 A	0.9 A	0.6	0.0	3
	30	80	0	1.4 A	0.8	0.0	0
<b>5 ppm H<sub>2</sub>S (5 TLV)</b>	-5	0	5 A	5.8 A	3.5 A	5.0 A	8 A
	30	0	6 A	6.0 A	3.6 A	5.0 A	6 A
	-5	80	7 A	5.9 A	4.1 A	6.0 A	9 A
	30	80	8 A	7.9 A	4.2 A	7.0 A	8 A

\* = monitor does not read to one decimal place

- = test not yet carried out

A = monitor alarmed during test.

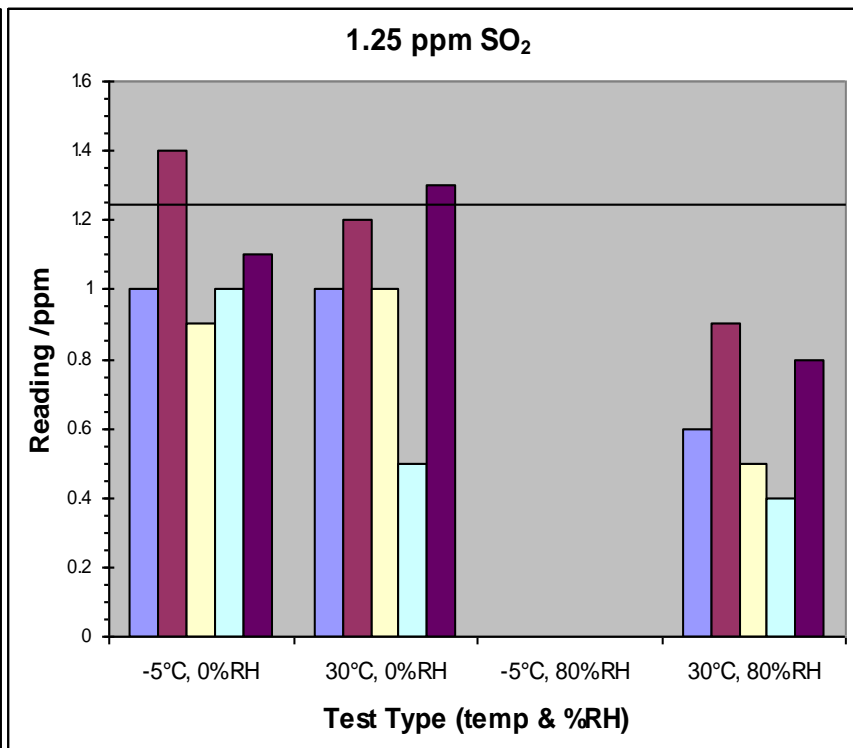
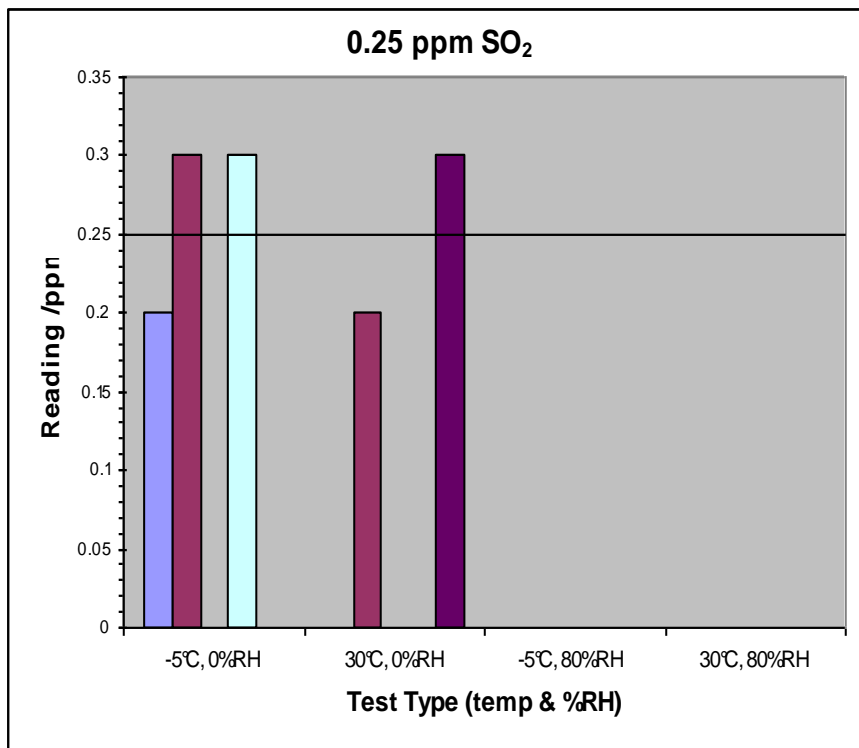
# H<sub>2</sub>S Monitor Response to H<sub>2</sub>S



# SO<sub>2</sub> Monitor Response to SO<sub>2</sub>

	Temp °C	%RH	S1	S2	S3	S4	S5
Set alarm level ppm			0.3	2.0	0.3	0.3	0.4
<b>0.025 ppm SO<sub>2</sub></b> <b>(0.1 TLV)</b>	-5	0	-	-	-	-	-
	30	0	-	-	-	-	-
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-
<b>0.25 ppm SO<sub>2</sub></b> <b>(1 TLV)</b>	-5	0	0.2	0.3	0.0	0.3 A	0.0
	30	0	0.0	0.2	0.0	0.0	0.3 A
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-
<b>1.25 ppm SO<sub>2</sub></b> <b>(5 TLV)</b>	-5	0	1.0	1.4	0.9 A	1.0 A	1.1 A
	30	0	1.0 A	1.2	1.0 A	0.5A	1.3 A
	-5	80	-	-	-	-	-
	30	80	0.6 A	0.9	0.5 A	0.4 A	0.8 A

# SO<sub>2</sub> Monitor Response to SO<sub>2</sub>



## SO<sub>2</sub> Monitors

■ S1

■ S2

■ S3

■ S4

■ S5

# H<sub>2</sub>S Monitor Response to Interference Gases

	Temp °C	%RH	H1*	H2	H3	H5	H6*
Set alarm level ppm			1	1.0	1.0	1.0	1
<b>500 ppm Ethylene</b>	-5	0	0	0.0	0.1	0.0	0
	30	0	0	0.0	2.7 A	0.0	0
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-
<b>500 ppm Hydrogen</b>	-5	0	0	0.0	2.3 A	0.0	0/3 <sup>1</sup>
	30	0	0	0.9 A	8.5 A	0.0	0
	-5	80	-	-	-	0.0	0
	30	80	0	1.1 A	8.4 A	0.0	0
<b>2 ppm NO<sub>2</sub></b>	-5	0	0	0.0	0.0	0.0	0
	30	0	0	0.0	0.0	0.0	0
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-
<b>100 ppm Acetylene</b>	-5	0	0	0.0	0.5	-	-
	30	0	0	0.0	3.4 A	0.0	0
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-
<b>200 ppm CO</b>	-5	0	0	0.0	4.6 A	0.0	3
	30	0	0	1.6 A	10.2 A	0.0	3 A
	-5	80	-	-	-	-	-
	30	80	-	-	-	-	-

1 = reading 3 only occasionally.

# Conclusions to-date

## H<sub>2</sub>S Monitors (personal single gas instruments)

- In general monitors cannot reliably indicate < 1 ppm H<sub>2</sub>S.
- Ethylene, acetylene, H<sub>2</sub> and CO produce a positive response with some H<sub>2</sub>S monitors.
- Alarms and display readings can differ.

## SO<sub>2</sub> Monitors (personal single gas instruments)

- In general monitors cannot reliably indicate < 0.25 ppm SO<sub>2</sub>.
- SO<sub>2</sub> monitors cannot be currently set to a first alarm level of 0.25 ppm

*These monitors are primarily designed to alarm and warn people to leave an area as a life safety device. These interim results should not change things.*



# Next Steps & Acknowledgements

## Next steps

- Complete work programme (expected early June 2010)
- Publish results in peer reviewed journal (NB all instruments will be anonymised with no reference made to identify individual manufacturers or instruments).

## Acknowledgements

- API & API IH Task Force members
- UK Health & Safety Laboratory scientists
- Manufacturers for supplying instruments



# Thank you

Any questions & discussion ?

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