GASGUARD 2
GAS MONITORING SYSTEM
RECOMMENDED SETPOINTS
USER MANUAL

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Before You Begin

Thank you for purchasing the Ampcontrol GG2 Gas Monitoring System

WARNING!

In the interests of **safety and correct equipment operation**, please take the time to read and understand the content in this manual.

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Table of Contents

1. Scope and General Information

This document sets out the GG2 Detector protocols and the detectors output to aid the end user in selecting alarm and trip setpoints outside of the normal operating range of:

- Analogue 4-20mA.
- iMAC 4000-20000uA
- RS485 0-10000 units

To be able to apply information contained in the document for inclusion in a risk assessment or in a physical application, the reader needs to look at it as a whole document including the reference documents rather than as a discrete set of values.

1.1. Reference Documentation:

- GG2B011 GG2 Detector User Manual
- GG2B023 GG2 Display User Manual
- GG2B032 Communications User Manual
- GG2B033 GG2 Detector Design Installation and Maintenance Guide
- AS/NZS 60079.29.1 Part 29.1: Gas detectors—Performance requirements of detectors for flammable gases
- AS/NZS 4641 Electrical equipment for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods
- AS/NZS **2290.3** Gas detecting and monitoring equipment

1.2. Appendix:

- Appendix A – explores the effects of temperature and pressure on an ideal (healthy) gas detector.
- Appendix B - Boundary Low fault Setpoints – GG2 Catalytic Detector Setpoint 1
- Appendix C – NSW Plant Design Registration
- Appendix D - AS/NZS 60079.29.1 Part 29.1
- Appendix E - AS/NZS 4641
- Appendix F - AS/NZS 2290.3:2018

1.3. Key Terms and Definitions:

- *RTGM* – Real Time Gas Monitoring.
- RTGMS – Real Time Gas Monitoring System.
- GG – Ampcontrol's Gasguard 65-655xxxx series of detectors.
- GG2 – Ampcontrol's Gasguard 2 series of detectors.
- GGL – Ampcontrol's Gasguard Live, is a digital application for the purpose of maintaining, diagnosing, and programming of the RTGMS.
- GGC – Ampcontrol's Gasguard Controller.
- GGS - Gasguard virtual server on existing client hardware.
- iMAC – Ampcontrol's Integrated Monitoring and Control System.
- Fieldbus – iMAC network used for real-time distributed control.
- SLP – iMAC Application software.
- IOM – Installation, operation, and maintenance manual.
- RTGMS Data Consumers – 3rd party users that consume RTGM data i.e. SAFEGAS, Client SCADA system.
- LAN – Local Area Network a computer network that interconnects computers.
- *VLAN* - A virtual LAN is any broadcast domain that is partitioned and isolated in a computer network at the data link layer.

2. Background Information

The GG2 Detectors are designed by Ampcontrol and performance tested by NSW Mine Safety Technology Centre and found to be compliant with the following standards:

- AS/NZS 60079.29.1 Part 29.1: Gas detectors—Performance requirements of detectors for flammable gases
- AS/NZS 4641 Electrical equipment for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods

Note: the accuracy requirements of these two standards are repeated in AS/NZS 2290.3.

The Gasguard 2 smart detector suite is designed to communicate over three different protocols independently or combined as one digital and one analogue. Each protocol has its unique methods of allowing the end user to determine the instrumentations behaviour remotely via a HMI, and allows hardcoding or setting of fault values in ancillary equipment. Table 3.1 to Table 3.9 provides the nominal values for those values outside of the normal operating range of 4-20mA.

GG2 protocols can be enabled as any of the following:

1. Analogue (4-20mA)
2. iMAC
3. Modbus – RS485.
4. iMAC and Analogue
5. Modbus and Analogue

These protocols and mapping of digital registers are detailed in GG2B032 Communications User Manual located at https://ampcontrolgroup.com/technical-resources/

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

3. GG2 Recommended Setpoints and Suppression of Indication Below Zero

When considering alarms or trip under-range values of the GG2 instrumentation the following performance requirements for suppression of indication below zero needs to be considered:

- AS/NZS 60079.29.1 Part 29.1: Gas detectors—Performance requirements of detectors for flammable gases
- AS/NZS 4641 Electrical equipment for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods

For suppression of indication and measured values below zero (0), the GG2 detectors output the measured value up to the limits stated in the relevant performance standards and a fault signal for values greater than the suppression value as stated in the standards (refer to Appendix D and Appendix E).

3.1 GG2 Setpoints.

The GG2 detector has three configurable setpoints available, these are also tied to the healthy range set by the user.

These setpoints are typically used in the following manner for the GG2 iMAC RTGMS.

- The healthy range is set >SP1 and <SP2.
- SP1 – Low Level Trip – this is considered a calibration alarm due to:
  - Incorrect adjustment of the instrument.
  - Degradation of the sensing element.
  - Sensor drift.
- SP2 – Alarm - rising or falling pending sensor type [typically nominated in legislation]
- SP3 – Hi Level Trip [typically nominated in legislation]

Note: setpoints shall determine by the end user with deliberation on:

- The hazardous area classification
- Coal mine regulations
- Information contained in this document
- The site operational risk assessments and
- Principle hazard management plan

The Recommended setpoints in tables 3.1 to table 3.9 are in reference to the GG2 Setpoint 1.
Note: all output values are nominal.

GG2 CH4 Cat 0-5% Detectors				
Warmup Config	**GG2 Display CH4 Cat 0-5%**	**iMAC uA**	**Analogue mA**	**RS 485 (Permyriad)**
-	0	4000	4.00	0
Low	-0.01	3968	3.96	-20
Low	-0.02	3936	3.93	-40
Low	-0.03	3904	3.90	-60
Low	-0.04	3872	3.87	-80
Low	-0.05	3840	3.84	-100
Low	-0.06	3808	3.80	-120
Low	-0.07	3776	3.77	-140
Low	-0.08	3744	3.74	-160
Low	-0.09	3712	3.71	-180
Low	-0.1	2800	2.80	-750
Low	-0.2	2800	2.80	-750
Low	-0.3	2800	2.80	-750
Low	-0.5	2800	2.80	-750
Low	-1	2800	2.80	-750
Low	-1.5	2800	2.80	-750
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-				
-	4.9	19360	19.36	9600
-	5	20000	20.00	10000
High	5.1	20352	20.35	10200
High	5.2	20640	20.64	10400
High	5.25	21200	21.20	10750
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.1 – GG2 Catalytic CH4 0-5% Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 CH4 NDIR 0-5% Detectors				
Warmup Config	GG2 Display CH4 NDIR 0-5%	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.00	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	-0.20	3700	3.70	-188
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-				
-	4.9	19360	19.36	9600
-	5	20000	20.00	10000
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.2 – GG2 NDIR CH4 0-5% Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 O2 EC 0-25% Detectors				
Warmup Config	GG2 Display O2 EC 0-25%	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.1	3936	3.93	-40
Low	-0.2	3872	3.87	-80
Low	-0.25	3840	3.84	-100
Low	-0.4	3744	3.77	-160
Low	-0.5	2800	2.80	-750
Low	-0.1	2800	2.80	-750
Low	-0.2	2800	2.80	-750
Low	-0.5	2800	2.80	-750
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-	-	-	-	-
-	24	19360	19.36	9600
-	25	20000	20.00	10000
High	25.1	21200	21.20	10750
High	26	21200	21.20	10750
High	26.9	21200	21.20	10750
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.3 – GG2 EC O2 0-25% Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 CO EC 0-50ppm Detectors				
Warmup Config	GG2 Display CO EC 0-50ppm	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.000	0
Low	-1	3680	3.680	-200
Low	-2	3360	3.360	-400
Low	-2.5	3200	3.2	-500
Low	-3	3040	3.040	-600
Low	-4	2720	2.720	-800
Low	-5	2400	2.400	-1000
Low	-6	2080	2.08	-1200
Low	-7	2800	2.800	-750
Low	-8	2800	2.800	-750
Low	-9	2800	2.800	-750
Low	-10	2800	2.800	-750
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-	-	-	-	-
-	49	19680	19.68	9800
-	50	20000	20.00	10000
High	51	20320	20.32	10200
High	52.5	20800	20.80	10500
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.4 – GG2 EC CO 0-50ppm Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 CO EC 0-100ppm Detectors				
Warmup Config	GG2 Display CO EC 0-100ppm	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.000	0
Low	-1	3840	3.840	-100
Low	-2	3680	3.680	-200
Low	-3	3520	3.520	-300
Low	-4	3360	3.360	-400
Low	-5	3200	3.200	-500
Low	-6	3040	3.040	-600
Low	-7	2880	2.88	-700
Low	-8	2720	2.72	-800
Low	-9	2560	2.56	-900
Low	-10	2400	2.40	-1000
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-	-	-	-	-
-	99	19840	19.84	9900
-	100	20000	20.00	10000
High	101	20160	20.16	10100
High	102	20320	20.32	10200
High	103	20480	20.48	10300
High	104	20640	20.64	10400
High	105	20800	20.80	10500
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.5 – GG2 EC CO 0-100ppm Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 CO2 NDIR 0-2% Detectors				
Warmup Config	GG2 Display CO2 NDIR 0-5%	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.00	3700	3.70	-188
Low	-0.01	3700	3.70	-188
Low	-0.02	3700	3.70	-188
Low	-0.03	3700	3.70	-188
Low	-0.04	3700	3.70	-188
Low	-0.05	3700	3.70	-188
Low	-0.06	3700	3.70	-188
Low	-0.07	3700	3.70	-188
Low	-0.08	3700	3.70	-188
Low	-0.09	3700	3.70	-188
Low	-0.1	3700	3.70	-188
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-				
-	1.9	19200	19.20	9500
-	2	20000	20.00	10000
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.6 – GG2 NDIR CO2 0-2% Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 CO2 NDIR 0-5% Detectors				
Warmup Config	GG2 Display CO2 NDIR 0-5%	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.00	3700	3.70	-188
Low	-0.01	3700	3.70	-188
Low	-0.02	3700	3.70	-188
Low	-0.03	3700	3.70	-188
Low	-0.04	3700	3.70	-188
Low	-0.05	3700	3.70	-188
Low	-0.06	3700	3.70	-188
Low	-0.07	3700	3.70	-188
Low	-0.08	3700	3.70	-188
Low	-0.09	3700	3.70	-188
Low	-0.1	3700	3.70	-188
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2800	2.80	-750
Low	Fault	2800	2.80	-750
-				
-	4.9	19360	19.36	9600
-	5	20000	20.00	10000
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.7 – GG2 NDIR CO2 0-5% Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 H2S EC 0-50ppm Detectors				
Warmup Config	GG2 Display H2S EC 0-50ppm	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.5	3840	3.84	-100
Low	-0.6	3808	3.80	-120
Low	-0.7	3776	3.77	-140
Low	-0.8	3744	3.74	-160
Low	-0.9	3712	3.71	-180
Low	-1	3680	3.68	-200
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2797	2.80	-750
Low	Fault	2797	2.80	-750
-	-	-	-	-
-	49	19680	19.68	9800
-	50	20000	20.00	10000
High	51	20320	20.32	10200
High	52.5	20800	20.80	10500
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.8 – GG2 EC H2S 0-50ppm Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 H2S EC 0-100ppm Detectors				
Warmup Config	GG2 Display CO EC 0-50ppm	iMAC uA	Analogue mA	RS 485 (Permyriad)
-	0	4000	4.00	0
Low	-0.1	3984	3.98	-10
Low	-0.2	3968	3.96	-20
Low	-0.3	3952	3.95	-30
Low	-0.4	3936	3.93	-40
Low	-0.5	3920	3.92	-50
Low	-0.6	3904	3.90	-60
Low	-0.7	3888	3.88	-70
Low	-0.8	3872	3.87	-80
Low	-0.9	3856	3.85	-90
Low	-1	3840	3.84	-100
Low	Healthy warmup	3000	3.00	-625
Low	Faulty warmup	2797	2.80	-750
Low	Fault	2797	2.80	-750
-	-	-	-	-
-	99	19840	19.84	9900
-	100	20000	20.00	10000
High	101	20160	20.16	10100
High	102	20320	20.32	10200
High	103	20480	20.48	10300
High	104	20640	20.64	10400
High	105	20800	20.80	10500
High	Healthy warmup	21000	21.00	10628
High	Faulty warmup	21200	21.20	10750
High	Fault	21200	21.20	10750

Table 3.9 – GG2 EC H2S 0-100ppm Suppression Values

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Normal Operating Range	Suppressed Fault Value
Out of Range Analogue Values	Display Reading
Suppression Values	Warmup Values
Recommended Setpoints	Forced Value/Recommended SP

GG2 Under Range Recommended Setpoint Summary

Suppression of Indication Below Zero – Under-range Recommended Setpoints										
Protocol Readings	**GG2 Display Readings**									
Analogue 4-20mA	**CH4 Cat 0-5%**	**CH4 NDIR 0-5%**	**CH4 NDIR 0-100%**	**O2 EC 0-25%**	**CO EC 0-50ppm**	**CO EC 0-100ppm**	**CO2 NDIR 0-2%**	**CO2 NDIR 0-5%**	**H2S EC 0-50ppm**	**H2S EC 0-100ppm**
4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.90	-0.03	-	-	-0.16	-0.31	-0.63	-	-	-0.31	-0.63
3.86	-0.05	-	-	-0.23	-0.45	-0.90	-	-	-0.45	**-0.90**
3.85	-0.05	-	-	-0.23	-0.47	-0.94	-	-	-0.47	-0.94
3.84	-0.05	-	-	**-0.25**	-0.50	-1.00	-	-	-0.50	-1.00
3.74	-0.08	-	-	-0.40	-0.80	-1.60	-	-	-0.80	-1.60
3.71	-0.09	-	-	-0.45	-0.90	-1.80	-	-	**-0.90**	-1.80
3.70	**-0.09**	**-0.09**	**-1.88**	-0.47	-0.94	-1.88	**-0.04**	**-0.09**	-0.94	-1.88
3.68	-0.10	-	-	-0.50	-1.00	-2.00	-	-	-1.00	-2.00
3.60	-0.13	-	-	-0.63	-1.25	-2.50	-	-	-1.25	-2.50
3.36	-0.20	-	-	-1.00	-2.00	-4.00	-	-	-2.00	-4.00
3.20	-0.25	-	-	-1.25	**-2.50**	**-5.00**	-	-	-2.50	-5.00
3.15	-0.27	-	-	-1.33	-2.66	-5.31	-	-	-2.66	-5.31
3.00	-0.31	-0.31	-6.25	-1.56	-3.13	-6.25	-0.13	-0.31	-3.13	-6.25
2.80	-0.38	-0.38	-7.50	-1.88	-3.75	-7.50	-0.15	-0.38	-3.75	-7.50
2.40	-0.50	-0.50	-10.00	-2.50	-5.00	-10.00	-0.20	-0.50	-5.00	-10.00
0.80	-1.00	-1.00	-20.00	-5.00	-10.00	-20.00	-0.40	-1.00	-10.00	-20.00

Table 3.10 – GG2 Under range Recommended Setpoints

GG2 Over Range Recommended Setpoint Summary

Suppression of Indication Above Full Scale – Over-range Recommended Setpoints										
Protocol Readings	**GG2 Display Readings**									
Analogue 4-20mA	**CH4 Cat 0-5%**	**CH4 NDIR 0-5%**	**CH4 NDIR 0-100%**	**O2 EC 0-25%**	**CO EC 0-50ppm**	**CO EC 0-100ppm**	**CO2 NDIR 0-2%**	**CO2 NDIR 0-5%**	**H2S EC 0-50ppm**	**H2S EC 0-100ppm**
19.20	4.75	4.75	95.00	23.75	47.50	95.00	1.90	4.75	47.50	95.00
19.36	4.80	4.80	96.00	24.00	48.00	96.00	1.92	4.80	48.00	96.00
19.67	4.90	4.90	97.94	24.48	48.97	97.94	1.96	4.90	48.97	97.94
20.00	5.00	**5.00**	**100.00**	**25.00**	50.00	100.00	**2.00**	**5.00**	50.00	100.00
20.32	**5.10**	5.10	102.00	25.50	**51.00**	102.00	2.04	5.10	**51.00**	102.00
20.64	5.20	5.20	104.00	26.00	52.00	**104.00**	2.08	5.20	52.00	**104.00**
20.80	5.25	5.25	105.00	26.25	52.5	105	2.10	5.25	52.5	105
20.90	5.28	5.28	105.63	26.41	52.81	105.63	2.11	5.28	52.81	105.63
21.00	5.31	5.31	106.25	26.56	53.13	106.25	2.13	5.31	53.13	106.25
21.10	5.34	5.34	106.88	26.72	53.44	106.88	2.14	5.34	53.44	106.88
21.20	5.38	5.38	107.50	26.88	53.75	107.50	2.15	5.38	53.75	107.50

Table 3.11 – GG2 Over range Recommended Setpoints

4. GG2 Detector Analogue Output

The GG2 analogue output for out of range (NDIR only), warmup, and fault values are hardcoded to allow the end user the ability to determine the instruments behaviour remotely or via ancillary equipment when operating outside of the normal operating range i.e. 4-20mA.

The nominal values in table 4.1 should be used in alarm only (SCADA) systems to warn the end user of instrumentation behaviour, and in the trip permissives of instruments used for the removal of electrical and mechanical hazards.

State	Nominal	Range
Hard Fault	-	x ≤ 2mA
Low Soft Fault	2.8mA	2.6mA < x ≤ 2.9mA
Low Warmup*	3.0mA	2.9mA < x ≤ 3.2mA
Under-range	Section 3	3.2mA < x ≤ 4.0mA
Under-range NDIR only	3.7mA	≤3.7mA
Operating Range	~4-20mA	4.0mA < x ≤ 20.0mA
Over-range	Section 3	20.0mA < x ≤ 20.8mA
High Warmup**	21mA	20.8mA < x ≤ 21.1mA
High Soft Fault	21.2mA	21.1mA < x ≤ 21.4mA
Hard Fault	-	21.4mA < x

Table 4.1 – GG2 Analogue Output

*applicable only if low warmup is selected in the GG2 configuration.
** applicable only if high warmup is selected in the GG2 configuration.

4.1 Gasguard Controller Recommended Setpoints

Powerup Behaviour

1. Gasguard Controller:
   - The GGC commences start-up sequence and starts counting down from the value set in the start delay setpoint.
   - Once the start-up delay is complete the controller will change relay state based on the analogue input and configuration.

2. Gasguard 2 Detector:
   - Low warmup selected
     - Commences warmup period, output will change from 0mA to 3mA which is the warmup default value
   - High warmup selected
     - Commences warmup period, output will change from 0mA to 21.2mA which is the warmup default value
   - Catalytic detector 60sec warmup
   - NDIR detector 120sec warmup
   - Electrochemical detectors 60sec warmup, with exception of the O2 Sensor which is 30 minutes.
   - At the end of the warmup period the detector will output somewhere between 4-20mA based on the local gas concentration.

Scenario

4.2 When the Gasguard controller and the GG2 detectors are powered simultaneously:

The following recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

- Recommendation:
  - CH4 Catalytic detector 60sec warmup – Set the GGC start delay to 70sec
  - CH4 NDIR detector 120sec warmup – Set the GGC start delay to 130sec
  - Catalytic set the low fault setpoint to 3.7mA
  - Electrochemical set the low fault setpoint to 3.2mA
  - Oxygen set the low fault setpoint to 3.8mA
  - NDIR set the low fault setpoint to 3.7mA
  - Set the high fault setpoint to ≤20.8mA

4.3 Hot detector change-out:

- When the GG2 detector is isolated via the GG2 display or simply removed from the GG2 display it will output 2.8mA
- When the new detector is plugged in it will revert to the high or low warmup value pending configuration of the GG2 detector
- Recommendation:
  - With the above GGC low/high set points set the system will behave as intended and will be in an unhealthy state during warmup
  - If the detector head is not replaced the GG2 will continue to publish 2.8mA on the analogue output.

5. GG2 Detector iMAC Communications

The GG2 iMAC protocol for out of range (NDIR only), warmup, and fault values operating outside the normal operating range can be identified by monitoring the appropriate GG2 Flags register, additionally the analogue values can be monitored via the users HMI to determine the instruments behaviour remotely or via ancillary equipment.

The flags and nominal values in table 5.1 should be used in alarm only (SCADA) systems to warn the end user of instrumentation behaviour, and in the trip permissives of instruments used for the removal of electrical and mechanical hazards.

State	Nominal	GG2 Flags Register Bits
Hard Fault	-	7, 13
Low Soft Fault	2.8mA	7, 13
*Low Warmup	3.0mA	9,10
Under-range	Section 3	***0
Under-range NDIR only	3.7mA	***0
Operating Range	~4-20mA	4.0mA < x ≤ 20.0mA
Over-range	Section 3	****12
**High Warmup	21mA	9,10
High Soft Fault	21.2mA	7, 13
Hard Fault	-	7, 13

Table 5.1 – GG2 Analogue Output

*applicable only if low warmup is selected in the GG2 configuration.

** applicable only if high warmup is selected in the GG2 configuration.

*** pending user configuration.

**** Catalytic detectors. Note: this bit is dual purpose (refer to GG2B032)

The recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Typical RTGMS utilised in QLD coal mines

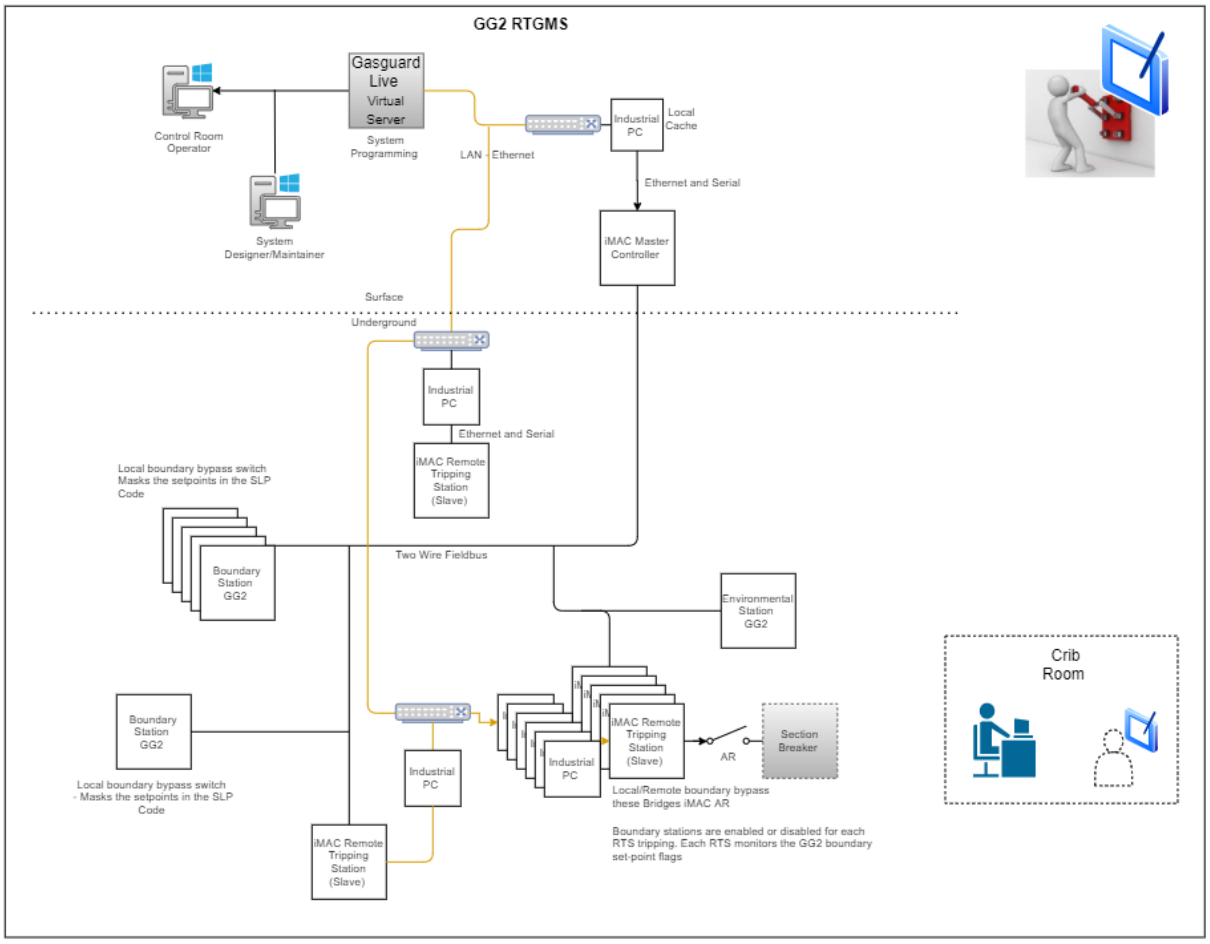

Figure 5.1 - GG2 RTGMS Communications Block Diagram

4.1 Typical SLP Code Trip Permissives

The GG2 RTGMS trip permissives may incorporate the following, each system will need to be risk assessed on its application:

- GG2 Setpoint 1 flag
- GG2 Setpoint 3 flag
- GG2 health status flag
- GG2 warmup flag
- GG2 Gas invalid flag
- GG2 Linearity Test due flag
- GG2 Catalytic latch flag
- GG2 NDIR incomplete adjustment flag
- GG2 Enabled Offline (RTS)
- Analogue High fault 21mA
- Analogue Low Fault 3.2mA
- GG2 Power Supply Trip flag
- Offline
- DI4/PLC Bypass Active

6. GG2 Detector Modbus Communications

The GG2 RS-485 protocol for out of range (NDIR only), warmup, and fault values operating outside the normal operating range can be identified by monitoring the appropriate GG2 register, additionally the permyriad values can be monitored via the users HMI to determine the instruments behaviour remotely or via ancillary equipment.

The flags and nominal values in table 6.1 should be used in alarm only (SCADA) systems to warn the end user of instrumentation behaviour, and in the trip permissives of instruments used for the removal of electrical and mechanical hazards.

State	Nominal	GG2 Modbus Register / Bits
Hard Fault	-	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12
Low Soft Fault	2.8mA	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12
*Low Warmup	3.0mA	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12
Under-range	Section 3	1, 2, 5
Under-range NDIR only	3.7mA	1, 2, 5
Operating Range	~4-20mA	4.0mA < x ≤ 20.0mA
Over-range	Section 3	1,2,5
**High Warmup	21mA	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12
High Soft Fault	21.2mA	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12
Hard Fault	-	1, 2, 3, 4/1, 4/2, 5, 6/11, 6/12

Table 6.1 – GG2 Analogue Output

*applicable only if low warmup is selected in the GG2 configuration.

** applicable only if high warmup is selected in the GG2 configuration.

*** pending user configuration.

The recommended setpoints for the Gasguard hardware are recommendations only, each user shall determine their setpoints based on the Application, hazardous area classification, coal mine regulations, this publication, site operational risk assessments and their principle hazard management plans.

Typical RTGMS utilised in NSW coal mines

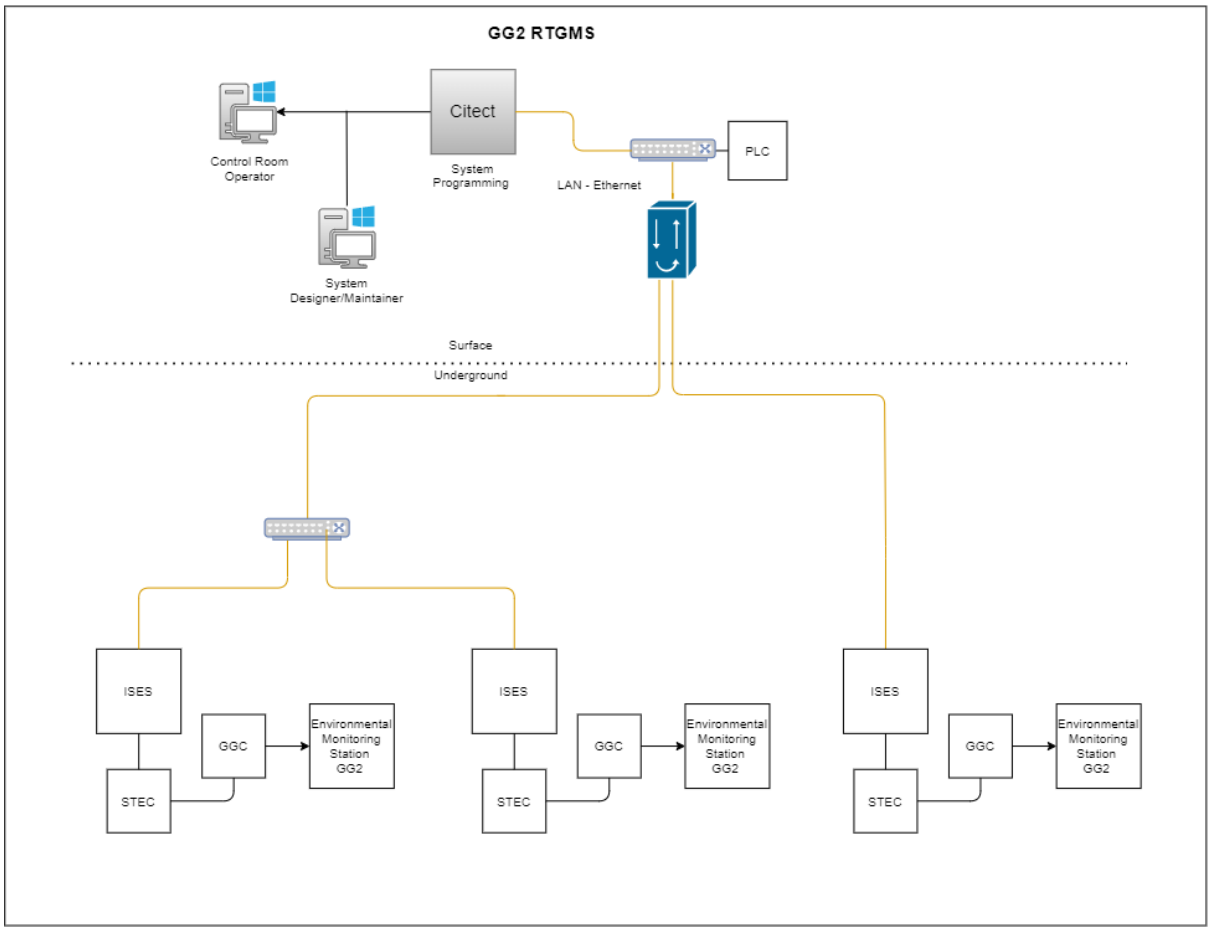

Figure 6.1 - GG2 RTGMS Communications Block Diagram

7. Appendix A – The Ideal Gas Law

An ideal gas can be characterized by three state variables: absolute pressure (P), volume (V), and absolute temperature (T). The relationship between them may be deduced from kinetic theory and is called the Ideal Gas Law.

Pressure Effect Experiment

The ideal gas law is often written as,

$$PV = nRT$$

But can be rewritten as,

$$\frac{n}{V} = \frac{P}{RT}$$

where $\frac{n}{V}$ is the absolute concentration. (number of moles in a given volume) If temperature is held constant, and pressure increased, then the absolute concentration must also increase. Given an atmospheric pressure of 100 kPa, an increase of 1 kPa will cause a 1 % increase in absolute gas concentration.

An experiment was undertaken to observe this behaviour.

Two infrared detectors (different model detectors labelled A and B) were calibrated using the same zero gas and 2.47 %V/V CH4 span gas. Detector A was calibrated at a pressure of 101.6 kPa while detector B was calibrated at an elevated pressure of 104.0 kPa. This represents as 2.4 kPa or 2.36 % increase over the initial pressure of 101.6 kPa.

Both detectors were then placed in an enclosure which was gradually filled with calibration gas while being kept at 101.6 kPa.

The plot below shows the output of both detectors. After 15 minutes the concentration within the enclosure had stabilised at the concentration of the incoming calibration gas before the gas supply was turned off. At this point Detector A (indicated by the black line in Figure 6.1) accurately measured the concentration of the calibration gas while Detector B (indicated by the red line) under-read by 2.3 %.

The results agree closely with the ideal gas law - the detector spanned at a pressure 2.36 % high under-read the gas concentration by 2.3 %.

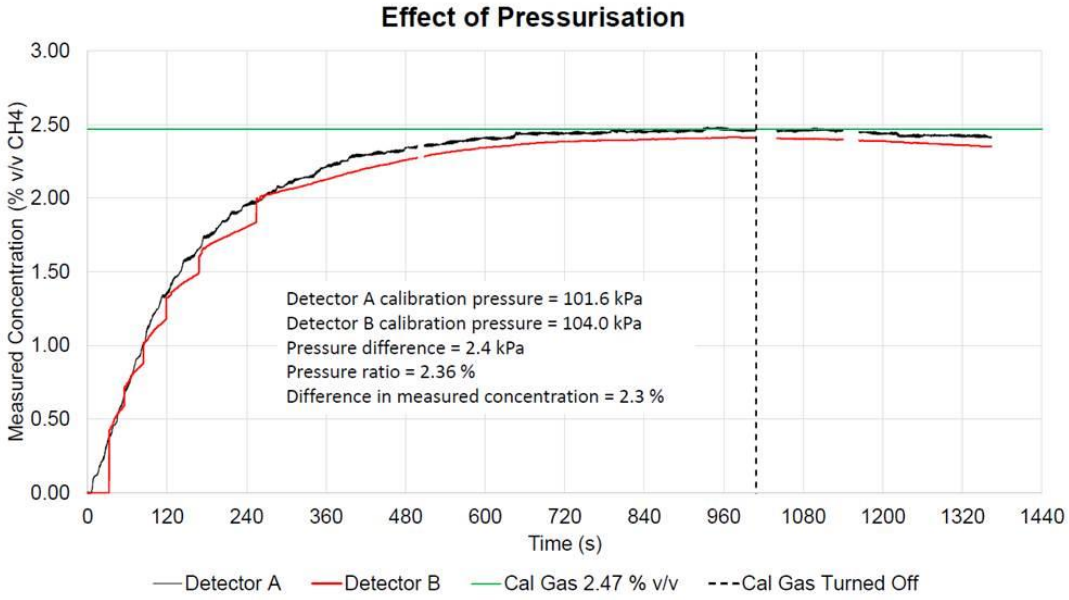

Figure 7.1 – Research conducted by Thomas Steigler (BEng MECH(Hons)/BEng MCHA(Hons))

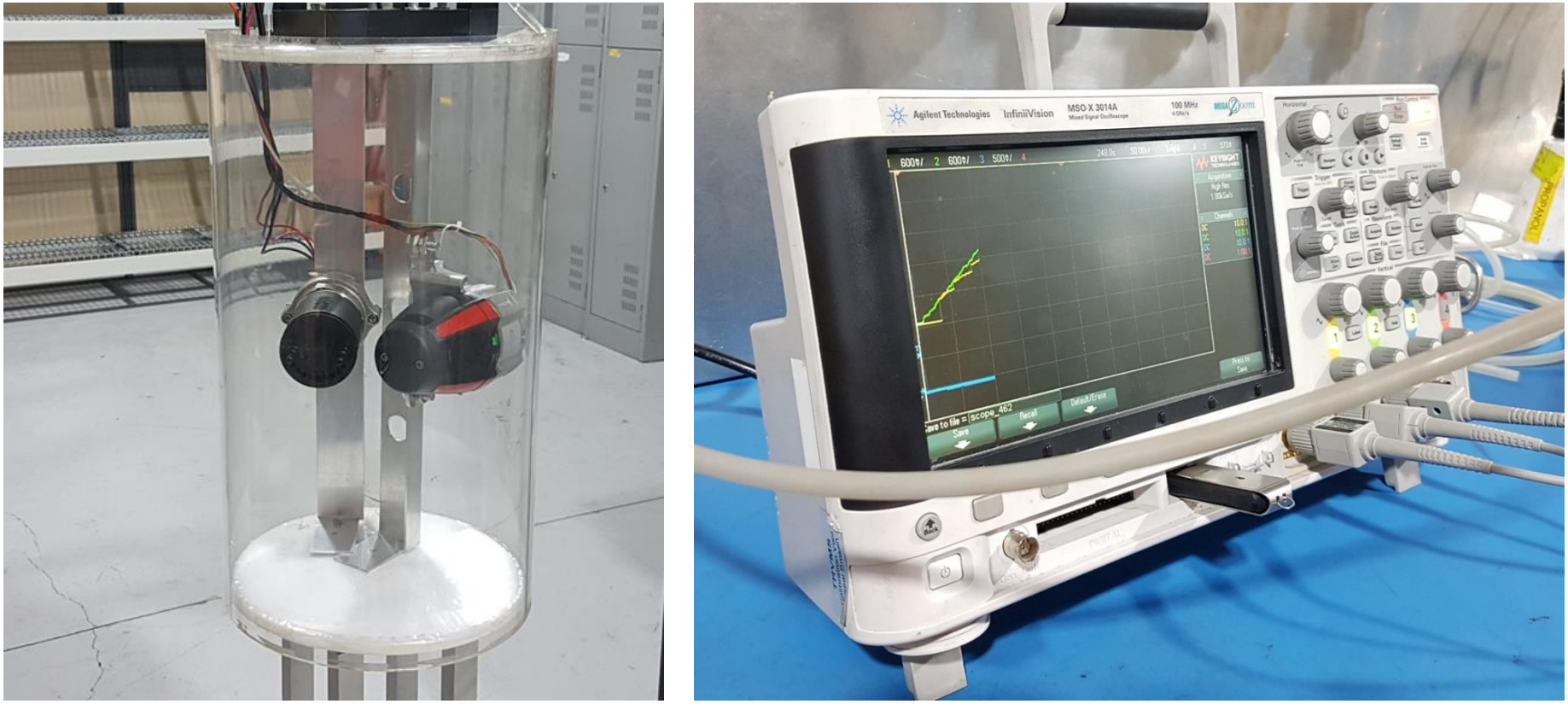

Figure 7.2 – Detectors A and B setup within enclosure [LEFT] Oscilloscope connected to record detector outputs [RIGHT]

INDICATED CONCENTRATION [%V/V]																						
		Pressure [hPa]																				
		800	820	840	860	880	900	920	940	960	980	1000	1020	1040	1060	1080	1100	1120	1140	1160	1180	1200
Temperature [°C]	-20	-0.086	-0.088	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116	-0.119	-0.121	-0.123	-0.125	-0.127	-0.129
	-18	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115	-0.118	-0.120	-0.122	-0.124	-0.126	-0.128
	-16	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.115	-0.117	-0.119	-0.121	-0.123	-0.125	-0.127
	-14	-0.084	-0.086	-0.088	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.112	-0.114	-0.116	-0.118	-0.120	-0.122	-0.124	-0.126
	-12	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.107	-0.109	-0.111	-0.113	-0.115	-0.117	-0.119	-0.121	-0.123	-0.125
	-10	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116	-0.118	-0.120	-0.122	-0.124
	-8	-0.082	-0.084	-0.086	-0.088	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115	-0.117	-0.119	-0.121	-0.123
	-6	-0.082	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116	-0.118	-0.121	-0.123
	-4	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.112	-0.114	-0.116	-0.118	-0.120	-0.122
	-2	-0.080	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115	-0.117	-0.119	-0.121
	0	-0.080	-0.082	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116	-0.118	-0.120
	2	-0.079	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115	-0.117	-0.119
	4	-0.079	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116	-0.118
	6	-0.078	-0.080	-0.082	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.109	-0.111	-0.113	-0.115	-0.117
	8	-0.078	-0.080	-0.082	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115	-0.116
	10	-0.077	-0.079	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.093	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112	-0.114	-0.116
	12	-0.077	-0.078	-0.080	-0.082	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.098	-0.100	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.113	-0.115
	14	-0.076	-0.078	-0.080	-0.082	-0.084	-0.086	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.106	-0.108	-0.110	-0.112	-0.114
	16	-0.075	-0.077	-0.079	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.109	-0.111	-0.113
	18	-0.075	-0.077	-0.079	-0.081	-0.082	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.096	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.109	-0.111	-0.112
	20	-0.074	-0.076	-0.078	-0.080	-0.082	-0.084	-0.086	-0.087	-0.089	-0.091	-0.093	-0.095	-0.097	-0.099	-0.101	-0.102	-0.104	-0.106	-0.108	-0.110	-0.112
	22	-0.074	-0.076	-0.078	-0.079	-0.081	-0.083	-0.085	-0.087	-0.089	-0.091	-0.092	-0.094	-0.096	-0.098	-0.100	-0.102	-0.104	-0.105	-0.107	-0.109	-0.111
	24	-0.073	-0.075	-0.077	-0.079	-0.081	-0.083	-0.084	-0.086	-0.088	-0.090	-0.092	-0.094	-0.095	-0.097	-0.099	-0.101	-0.103	-0.105	-0.107	-0.108	-0.110
	26	-0.073	-0.075	-0.077	-0.078	-0.080	-0.082	-0.084	-0.086	-0.088	-0.089	-0.091	-0.093	-0.095	-0.097	-0.098	-0.100	-0.102	-0.104	-0.106	-0.108	-0.109
	28	-0.072	-0.074	-0.076	-0.078	-0.080	-0.082	-0.083	-0.085	-0.087	-0.089	-0.091	-0.092	-0.094	-0.096	-0.098	-0.100	-0.101	-0.103	-0.105	-0.107	-0.109
	30	-0.072	-0.074	-0.076	-0.077	-0.079	-0.081	-0.083	-0.085	-0.086	-0.088	-0.090	-0.092	-0.094	-0.095	-0.097	-0.099	-0.101	-0.103	-0.104	-0.106	-0.108
	32	-0.072	-0.073	-0.075	-0.077	-0.079	-0.080	-0.082	-0.084	-0.086	-0.088	-0.089	-0.091	-0.093	-0.095	-0.097	-0.098	-0.100	-0.102	-0.104	-0.106	-0.107
	34	-0.071	-0.073	-0.075	-0.076	-0.078	-0.080	-0.082	-0.083	-0.085	-0.087	-0.089	-0.091	-0.092	-0.094	-0.096	-0.098	-0.099	-0.101	-0.103	-0.105	-0.107
	36	-0.071	-0.072	-0.074	-0.076	-0.078	-0.079	-0.081	-0.083	-0.085	-0.086	-0.088	-0.090	-0.092	-0.094	-0.095	-0.097	-0.099	-0.101	-0.102	-0.104	-0.106
	38	-0.070	-0.072	-0.074	-0.075	-0.077	-0.079	-0.081	-0.082	-0.084	-0.086	-0.088	-0.089	-0.091	-0.093	-0.095	-0.096	-0.098	-0.100	-0.102	-0.103	-0.105
	40	-0.070	-0.071	-0.073	-0.075	-0.077	-0.078	-0.080	-0.082	-0.084	-0.085	-0.087	-0.089	-0.091	-0.092	-0.094	-0.096	-0.098	-0.099	-0.101	-0.103	-0.105

Table 7.1 - GG2 Catalytic Methane Detector - Low Fault Set Point (SP1)

The highlighted cell in table 7.1 is the recommended setpoint for SP1 of the GG2 Catalytic Methane Detector, as derived from the idea gas law pressure and temperature Change variations from the setpoint and the calibrated pressure and temperature will over-read or under-read. This is a function of physics and does not change which measurement techniques, technologies, or instruments without further compensation.

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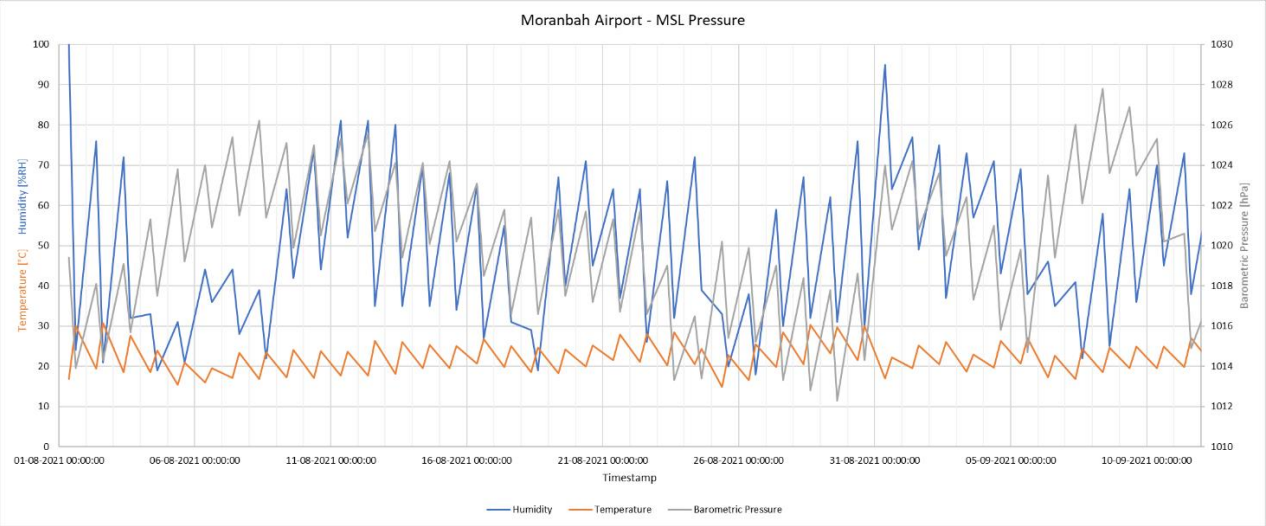

Figure 7.3 - Moranbah Airport (http://www.bom.gov.au/climate/dwo/IDCJDW4087.latest.shtml)

Figure 7.3 Observations – this data was accessed via the BOM, to align with table 6.1 as a demonstration on how the ideal gas law will impact the instruments readings:

- Grey trace – Barometer
- Black trace – Humidity
- Orange trace temperature
- As temperature rises the barometer and humidity fall
- As temperature falls the barometer and humidity rise

8. Appendix B – Boundary Low fault Setpoints – GG2 Catalytic Detector Setpoint 1

The catalytic boundary detector low fault setpoint deliberations:

GG2 Accuracy Requirements
The GG2 Catalytic methane detectors accuracy requirements in accordance with AS/NZS2290.3 are ±0.1% v/v or ±5% of indication at -0.1% v/v (3.68mA) the detector enters an under-range error forcing the output to the hardware fault value of 2.8mA.

GG2 Catalytic 5% v/v Methane Detector configuration and recommended low fault setpoint:

- Measurement range 0-5% v/v CH4
- Low fault setpoint (GG2 SP1) – negative 0.09% v/v
- AS/NZS 2290.3 accuracy requirements at 0% v/v methane - ±0.1%

Note: the accuracy requirements AS/NZS2290.3 are copied from AS/NZS 60079.29.1.

9. Appendix C – NSW Plant Design Registration

All detector sold for use in the NSW Coal Mining industry must be plant design registered. All registered detectors must be designed and tested to AS/NZS 60079.29.1 Part 29.1 or AS/NZS 4641 The performance tests set out in these standards are undertaken by the NSW Mine Safety Technology Centre. All GG2 detectors with the exception of the 100%V/V Methane Detector have current plant design registration certificates.

10. Appendix D - AS/NZS 60079.29.1 Part 29.1

AS/NZS 60079.29.1 Part 29.1: Gas detectors - Performance criteria of detectors for flammable gases

Clause 3.6.5 Warm-up time
Time interval, with the equipment in a stated atmosphere, between the time when the equipment is switched on and the time when the indication reaches and remains within the stated tolerances.

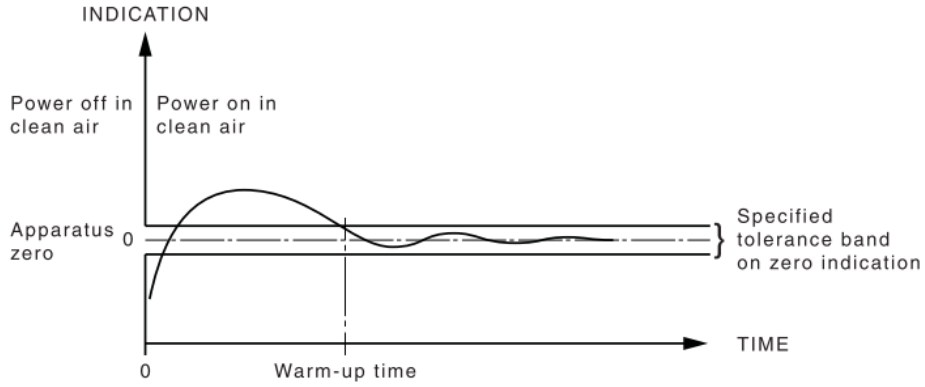

Figure 10.1 Warm-up in clean Air

Clause 4.2.2.5 - Suppression of indication and measured values below zero
It shall be possible to configure the equipment such that in measuring mode any kind of suppression of the measured value is permanently disabled. In calibration mode any kind of suppression of the measured value shall be automatically disabled.

Measured values within the measuring range shall be indicated.

Measured values below 5 % of the measuring range (values below zero included) shall be indicated as:

a) zero,
b) another indication that the measured value is below 5 % of the measuring range or
c) the measured value.

Equipment with a measuring range up to 20 % LFL shall indicate measured values below -10 % of the measuring range or shall provide a fault signal. The equipment shall provide a fault signal at measured values below –20 % of the measuring range at the latest.

All equipment with measuring ranges greater than 20 % LFL shall provide a fault signal at measured values below –10 % of the measuring range at the latest. Portable and transportable equipment shall indicate measured values below –5 % of the measuring range or shall provide a fault signal.

AS/NZS 60079.29.1 Part 29.1 - Test criteria

Pressure

Acceptance criteria are:
Volume fraction up to 5 % methane in air indication, ±0.2 % methane or ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)

Air Velocity

Measurements shall be made under:

- non-forced ventilation conditions
- at (3 ± 0,3) m/s and
- at (6 ± 0,6) m/s.

Acceptance criteria to meet the requirement are:
Volume fraction up to 5 % methane in air indication, ±0.1 % methane or ±5 % of indication

Warm-up Time

Acceptance criteria are:
Volume fraction up to 5 % methane in air indication, Fixed: ±0.1 % methane within 5 min, and no false alarm

11. Appendix E - AS/NZS 4641

AS/NZS 4641 Electrical equipment for detection of oxygen and other gases and vapours at toxic levels - General requirements and test methods

Clause 1.3.7.4 Warm-up time

Time interval, with the equipment in a stated atmosphere, between the time when the equipment is switched on and the time when the indication reaches and remains within the stated tolerances.

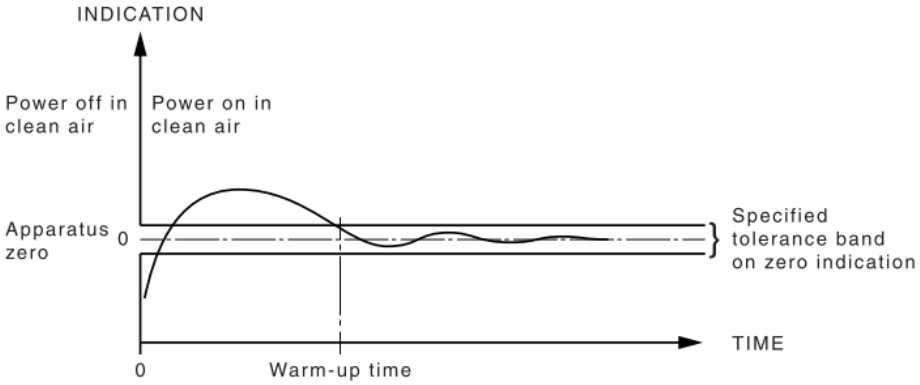

Figure 11.1 Warm-up in Clean Air

Clause 2.2.2.5 Suppression of indication and measured values below zero
It shall be possible to configure the equipment such that when in measuring mode any suppression of the measured value is permanently disabled. When in calibration mode any suppression of the measured value shall be automatically disabled.

Measured values below the lower limit of measurement specified in the instruction manual shall be indicated as one of the following:

a) Zero

b) The measured value

c) An indication that the measured value is below the lower limit of measurement

Measured values below minus twice the lower limit of measurement shall be indicated as one of the following:

i) The measured value

ii) A fault signal

Measured values below minus four times the lower limit of measurement shall be indicated by a fault signal.

Clause 3.5 Standard laboratory conditions

Except where otherwise stated, tests shall be performed under the following conditions:

a) Temperature: Controlled to within □2°C over the range 20ºC □ 25ºC

b) Relative humidity: Controlled to within 10% RH over the range 20% to 80% RH

c) Pressure: Maintained within □1 kPa in the range 86 kPa to 108 kPa

PERFORMANCE CRITERIA FOR TOXIC GAS MONITORS

Pressure Variation

Acceptance criteria are:
Equipment response shall not exceed a volume fraction ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)

Air Velocity

Measurements shall be made under:

- non-forced ventilation conditions
- at (3 ± 0,3) m/s and
- at (6 ± 0,6) m/s.

Acceptance criteria are:

- For test gas concentrations greater than the TWA, response shall not vary by more than ±5% of the stated measuring range, or ±10% of the test gas concentration, whichever is least.
- For test gas concentrations less than the TWA, response shall not vary by more than a volume fraction of ±10% of the TWA.

Warm-up Time

Acceptance criteria are:
The equipment shall warm-up in the standard test gas to give a final indication to within a volume fraction in accordance in a time not exceeding 5 min, or as specified by the manufacturer, and no false alarms shall be generated.

PERFORMANCE CRITERIA FOR OXYGEN DETECTORS

Pressure Variation

Acceptance criteria are:
Equipment response shall remain within ±0.3% v/v of the standard test gas indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)

Air Velocity

Measurements shall be made under:

- non-forced ventilation conditions
- at (3 ± 0,3) m/s and
- at (6 ± 0,6) m/s

Acceptance criteria are:

- ±0.3% v/v over the range 10% to 25% v/v oxygen; or
- ±0.5% v/v over the range 0 to 9.9% v/v oxygen

Warm-up Time

Acceptance criteria are:
The equipment shall warm-up in the standard test gas to give a final indication to within a volume fraction in accordance in a time not exceeding 5 min, or as specified by the manufacturer, and no false alarms shall be generated.

12. Appendix F - AS/NZS 2290.3:2018

AS/NZS 2290.3:2018 Electrical equipment for coal mines— Introduction, inspection and maintenance Part 3: Gas detecting and monitoring equipment

The accuracy requirements AS/NZS2290.3 are copied from and are identical to AS/NZS 60079.29.1 and AS/NZS 4641.

AS/NZS 2290.3:2018 ACCURACY REQUIREMENTS FOR FLAMMABLE GAS DETECTORS
Indicating up to 5% v/v methane
For flammable gas detectors indicating up to 5% v/v methane in air, the apparatus response shall not vary from the test gas concentration by more than:

- ±5% of the manufacturer's stated measuring range, or ±10% of the test gas concentration, whichever is least; or
- a minimum of ±0.1% v/v of methane

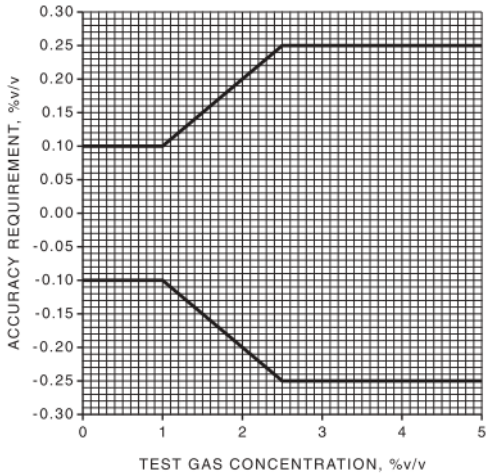

Figure 11.1 ACCURACY REQUIREMENTS FOR FLAMMABLE GAS DETECTORS INDICATING UP TO 5% v/v METHANE

GG2 toxic detector accuracy:

- Oxygen
  - ±0.3% v/v over the range 10% to 25% v/v
  - ±0.5% v/v over the range 0% to 9.9% v/v
- Carbon Monoxide
  - ±3 ppm over the range 0 ppm to 29 ppm
  - ±6 ppm over the range 30 ppm to 100 ppm
- Hydrogen Sulphide
  - ±1 ppm over the range 0 ppm to 9 ppm
  - ±5 ppm over the range 10 ppm to 100 ppm
- Carbon Dioxide
  - ±0.05 v/v over the range 0% to 0.5%
  - 10% of applied test gas over the range 0.5% to 2.5%
  - ±0.25 v/v over the range 2.5% to 5%

SPECIFIED VALUE FOR VARIOUS GASES

Gas	Specified value
Carbon monoxide	30 ppm
Hydrogen sulfide	10 ppm
Sulphur dioxide	2 ppm
Nitric oxide	25 ppm
Nitrogen dioxide	3 ppm
Carbon dioxide	0.5%

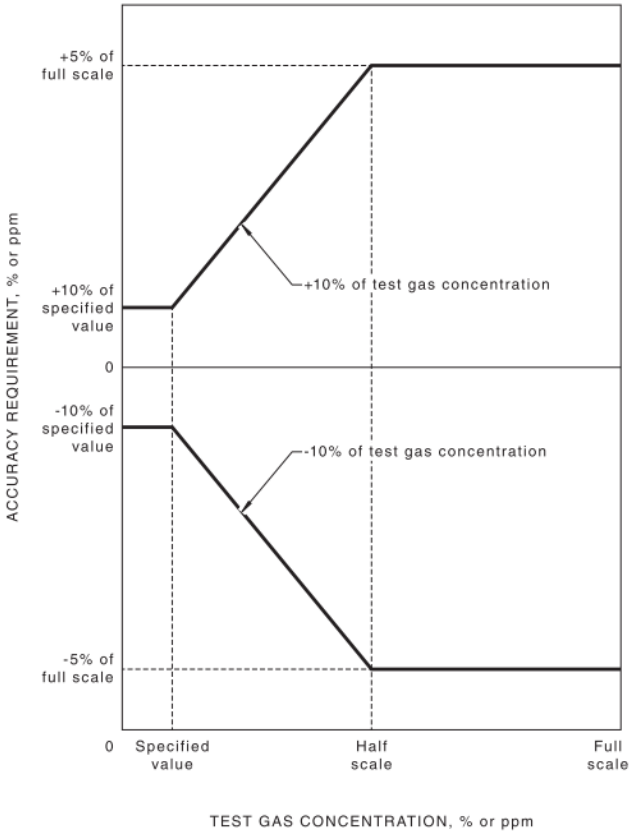

Figure 11.2 ACCURACY REQUIREMENTS FOR TOXIC GAS DETECTORS

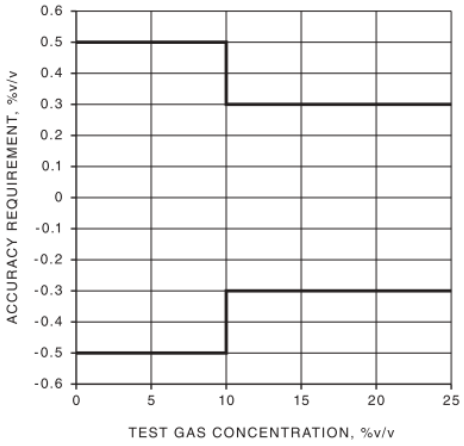

Figure 11.3 ACCURACY REQUIREMENTS FOR OYEGEN DETECTORS

DISCLAIMER

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