# 01679 2020 AnnRpt-LF

# REGIONAL DISTRICT
## of Fraser-Fort George

**2020 ANNUAL GREENHOUSE GAS EMISSION REPORT**
**FOOTHILLS BOULEVARD REGIONAL LANDFILL**
**AND COMPOST FACILITY**
**PRINCE GEORGE, BRITISH COLUMBIA**
**(JANUARY 1, 2020 – DECEMBER 31, 2020)**

March 2020

Prepared by:

**THE REGIONAL DISTRICT OF FRASER-FORT GEORGE**
155 George Street
Prince George, British Columbia
V2L 1P8

Darwin Paton
Environmental Technician

Petra Wildauer
General Manager Environmental Services

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## 1.0 *INTRODUCTION*

The Regional District of Fraser-Fort George (RDFFG) is pleased to submit the following report entitled "2020 Annual Greenhouse Gas Emission Report" for the greenhouse gas emission reductions associated with the collection and destruction of landfill gas at the Foothills Boulevard Regional Landfill and Compost Facility.

The 2020 Annual Greenhouse Gas Emission Report presents the emission reductions associated with the capture and destruction of landfill gas at the Site from January 1, 2020 to December 31, 2020.

## 2.0 *OBJECTIVE*

The objective of this report is to present a summary of total landfill gas collected at the Site during the report period in compliance with the British Columbia Landfill Gas Management Regulation. This report presents the following information as prescribed in Section 14 of the aforementioned regulation:

- Quantity and composition of landfill gas collected at the site;
- Quantity and composition of landfill gas flared or used as an alternative to flaring;
- Maintenance and shutdown of landfill gas management facility;
- Landfill gas management facility efficiency; and
- Proposed modifications and alterations to the landfill gas management facility.

# 3.0 *SITE OVERVIEW*

## *3.1* Background

The Site was operated by the City of Prince George from 1976 until 1994. At that time, the RDFFG assumed responsibility for the Site, as recommended in the Regional Solid Waste Management Plan. Since that time, the RDFFG has made several improvements to the operation of the Site, including the addition of an on-site transfer station, a yard waste composting facility, a scale house, and a landfill gas collection system. In 2008 the Regional District of Fraser-Fort George obtained title to the landfill property from the province.

The Site serves a population of approximately 96,000 people and receives approximately 96 percent of the regional solid waste stream. The Site accepts waste from the Prince George municipal and commercial collection services, the general public, local institutions and businesses, and numerous regional transfer stations.

The property boundary for the Site encompasses an area of approximately 86.7 hectares. The landfill, composting, and recycling activities conducted at the Site encompass an area of approximately 25 hectares within the permitted landfill property.

## *3.2* Site Description

The Site is located in the northwest portion of the City of Prince George, British Columbia at 6595 Foothills Boulevard, northwest of the intersection with West Austin Road. The legal description of the Site is Block A of the northwest ¼ of District Lot 4053 and Block A of the northwest ¼ of District Lot 4048, Cariboo District. The location of the Site is shown on Figure 3.1.

The Site property (Figure 3.2) is bounded to the east by Foothills Boulevard and to the south by a gravel pit maintained and operated by the BC Ministry of Transportation and Infrastructure. The Site is bounded to the north and west by naturalized northern coniferous forest. A residential area, referred to as the Hart Highlands area of Prince George, is located approximately 500 metres east of the site, and a sport and recreation facility is located approximately 250 metres east of the site entrance. The Site is located approximately 2.5 kilometres north of the Nechako River.

## 4.0 *PROJECT OVERVIEW*

The following section presents an overview of the existing landfill gas management facility. The facility is comprised of a well field consisting of vertical extraction wells, horizontal collection pipes and control plant as illustrated in Figure 4.1. The original landfill gas collection system was installed and commissioned in 2002 as part of the closure of the eastern portion of Phase 1. During the summer of 2011 an additional eight (8) vertical wells were installed and commissioned to the west of the original sixteen (16) wells. They were completed with the tie-in of a 150 millimetre (mm) sub-header into the main landfill gas header as illustrated in Figure 4.1. Further wellfield expansion will be completed in 2021 to offset the decommissioning of the original 16 wells to implement a landfill remediation project.

### *4.1* Well Field Overview

The original 2002 landfill gas well field was composed of sixteen (16) vertical landfill gas extraction wells, connected to a main header via five (5) lateral lines. The original vertical extraction wells were constructed using CES-Landtec Accu-Flo wellheads, non-telescoping perforated PVC well assemblies, 100 mm diameter high density polyethylene (HDPE) laterals, and a 200 mm diameter HDPE main header.

Eight (8) new temporary extraction wells were constructed during the summer of 2011 using telescopic perforated PVC well assemblies, 50 mm in diameter. The landfill gas is transported through 100 mm diameter HDPE laterals, and a 150 mm diameter HDPE sub-header to the main landfill gas header. Butterfly isolation valves with buno seals, (150 mm and 200 mm respectively) were installed on both the main header and the new sub-header landfill gas lines.

Two (2) separate 150 mm diameter HDPE perforated telescopic horizontals (approximately 150 m in length and 60 m in length) were installed for the future collection of landfill gas.

The original main header pipe conveys landfill gas to the Control Plant over a distance of approximately 926 m. Condensate is managed via two (2) condensate knock-outs located adjacent to the Control Plant (condensate knockout #2) and adjacent to the public transfer station area (condensate knockout #1). The knockouts include electrically powered pumps. Condensate is conveyed from the knockouts via a force main to the leachate recirculation sump, located adjacent to condensate knockout #1. The condensate force main is located in the main header trench, adjacent to the 200 mm header pipe.

In the summer of 2013, an additional 580 metres of 200 mm diameter HDPE main header pipe was constructed off the west end of the existing main header. A 200 mm ball valve for isolation was installed where the main header was joined. Three (3) – 150 mm diameter HDPE sub-headers were then connected to the main header using 200 mm to 150 mm reducing tees and three (3) – 150 mm ball valves. These sub-headers were then flanged to two (2) – 150 mm horizontal collector pipes that were installed in the fall of 2011. A new in-line condensate trap with a pneumatically driven SP4000 condensate pump was also installed in the main header at this time.

In October of 2014, an additional 150 mm diameter HDPE perforated telescopic horizontal (approximately 250 m in length) was installed for the future collection of landfill gas.

In the autumn of 2016, a 350 m landfill gas header extension and perimeter road construction project was initiated in order to connect to the perforated horizontal collector pipe that was installed in 2014. One additional pneumatically driven SP4000 condensate pump was installed at this time. This project was completed in the early summer of 2017. During the summer of 2018 the last connection of the sub-header to the LFG Main Header pipe was completed.

2020 saw three (3) major projects undertaken that will increase the overall collection efficiency of the landfill gas system once completed.

In May of 2020, the final LFG Header Extension Project was completed. This extension completed a perimeter loop of the 200mm HDPE LFG Main Header pipe that was started with the initial LFG Project installed in 2002. The final length of the 200 mm HDPE LFG Main Header pipe is just over 2,000 meters. Its completion will greatly reduce variations of vacuum pressure throughout the collection system.

In the Autumn of 2020, the Remediation of the Phase 1, Stage one commenced with the decommissioning of five (5) of the original 2002 Landfill gas collection wells and two (2) of the Phase 1 leachate recirculation fields. (Collected leachate is, as of May 2020, conveyed via a 150mm force main to the municipal waste water collection system).

This remediation project was undertaken after it was identified that the air space available for solid waste disposal was significant to the landfills projected site life and the long-term increase in the collection of LFG. The remediation project will continue through 2021 and 2022 with the decommissioning of four (4) additional 2002 Landfill gas collection wells in the late spring of 2020.

Concurrently with the aforementioned remediation project a LFG Wellfield Expansion was undertaken in the south west area of the landfill. This well field expansion will see the installation of sixteen (16) new extraction wells using telescopic perforated PVC well assemblies, 50 mm in diameter with 100mm laterals and 150mm sub-headers connected to the now completed 200mm HDPE LFG Main Header perimeter loop. This project will be completed and the new wells brought on line in the spring of 2021.

## *4.2* Control Plant Overview

The landfill gas Control Plant is located at the northern extent of the landfill property. The landfill gas Control Plant is comprised of two primary components: abstraction building, and enclosed flare. The abstraction building includes three (3) main areas: blower room, electrical room, and garage facility. The blower room includes parallel National Turbine multi-stage blowers (2), isolation valve, condensate knock-out pot, landfill gas analyzer, and landfill gas flow meter. The electrical room houses the flare controls, programmable logic controller, blower variable frequency drive controls, and datalogger.

The flaring mechanism is an enclosed flare unit with a reported thermal capacity of 25 million BTU per hour. Hence, at 50 percent methane (volumetric basis), the flare has a maximum flow capacity of approximately 1,360 cubic metres per hour (800 cfm).

## *4.3* Field Instrumentation and Datalogger

Field instrumentation installed in the Control Plant associated with the monitoring of landfill gas include the following:

- Datalogger;
- Landfill Gas Analyzer; and
- Flow meter.

### *4.3.1* Datalogger

Data collected by the Control Plant programmable logic controller (PLC) is stored using Wonderware Historian and Information Server Portal at a rate of one (1) data sample every five (5) seconds. The following fourteen (14) channels are recorded by the PLC/Wonderware Historian software:

1. Air Damper Position Feedback;
2. Flare lower Thermocouple Temperature Feedback;
3. Flare middle Thermocouple Temperature Feedback;
4. Flare upper Thermocouple Temperature Feedback;
5. Blower #1 Speed Setpoint from HMI;
6. Blower #2 Speed Setpoint from HMI;
7. Blower #1 Speed Readback;
8. Blower #2 Speed Readback;
9. Discharge Gas Differential Pressure Readback;
10. Gas Discharge Flow Readback;
11. Gas Discharge Temperature Readback;
12. Gas Analyzer Methane Level Readback;
13. Gas Analyzer Oxygen Level Readback; and
14. Gas Discharge Pressure Readback.

### *4.3.2* Gas Analyzer

The volumetric methane concentration of the landfill gas is measured at the landfill gas Control Plant via a Galvanic Applied Sciences Inc. gas analyzer. The gas analyzer measures the volumetric concentration of methane using infrared absorption, and oxygen using a paramagnetic sensor. The reported accuracy range of the methane sensor is plus or minus 2 percent. A copy of the manufacturer's attestation of the accuracy range of the methane analyzer and gas analyzer calibration documentation for the reporting period is presented in Appendix A.

### *4.3.3* Flow Meter

The landfill gas flow rate is measured at the landfill gas Control Plant by a thermal flow meter (Thermal Instrument Company model 62-9) located in the landfill gas exhaust pipe, downstream of the blowers. The reported accuracy range of the flow meter is plus or minus 1 percent. A copy of the calibration records and manufacturer's attestation of the accuracy range of the flow meter is presented in Appendix B.

# 5.0 *LANDFILL GAS DATA SUMMARY*

The following section presents a summary of landfill gas collected and destroyed by the Site's landfill gas management facility. A summary of formulas and parameters utilized herein to calculate the mass of methane destroyed is presented in Appendix C.

## *5.1* Landfill Gas Collection

A summary of landfill gas collected at the site is summarized in Table 5.1. The raw data from which this summary is derived is presented in Appendix D. The total volume of landfill gas collected during the report period is 3,293,511 cubic metres. The average methane content of the collected landfill gas during the report is 55 percent (volumetric basis).

The landfill gas management facility operated for 7,416 hours 4 minutes during the report period with an 84 percent operational time.

## *5.2* Landfill Gas Destruction

The calculations presented herein are based upon the following parameters:

- Methane density of 0.667 kg per cubic metre at 25 ºC;
- Flare hydrocarbon destruction efficiency of 98 percent; and
- Methane global warming potential of 25 times that of carbon dioxide.

A summary of landfill gas destroyed during the reporting period is presented in Table 5.2. A total of 3,227,641 cubic metres of landfill gas were flared during the report period, resulting in the destruction of 1,148 tonnes of methane. The equivalent mass of carbon dioxide destroyed during the reporting period is 28,703 tonnes.

## *5.3* Landfill Management Facility Collection Efficiency

The landfill gas management facility collection efficiency is estimated based upon the predicted average landfill gas generation rate for the Site (during the reporting period). Based upon the above stated total volume of landfill gas collected during the reporting period 3,293,411 cubic metres) and an estimated total landfill gas production volume of 13,515,853 cubic metres for the reporting period (Landfill Gas Generation Assessment Report, June, 2018) the operational collection efficiency of the landfill management facility is estimated to be 24 percent.

## 6.0 *MAINTENANCE AND SHUTDOWNS*

The following section presents a summary of shutdowns which occurred during the reporting period. In addition, a summary of scheduled modifications and expansion of the landfill gas management facility is presented herein.

### *6.1* Scheduled Maintenance

Scheduled maintenance shutdowns of the landfill gas management facility are summarized in Table 6.1. The facility was shut down for a total of 705 hours 18 minutes during the reporting period for scheduled maintenance.

Routine maintenance was carried out as scheduled in 2020. The semi-annual and annual maintenance were completed in October. Instrument calibrations were performed as scheduled during the 2020 reporting period.

The annual compressor inspection and maintenance was carried out in February.

In May the plant was shut down to facilitate the completion of the 2020 LFG Header Extension.

As part of the continuous maintenance program Blowers 1 and 2 underwent bearing and seal replacement and adjustment in July.

In September, the plant was shut down to accommodate the undertaking of gas well decommissioning in support of the Cell 1 remediation project.

All four Condensate Traps were serviced in October and were found to be in good operational condition.

In October, the Annual Environmental Sensor calibrations were carried out and completed.

The Landfill Gas System Annual Fire Alarm testing and maintenance was carried out in December.

Construction project considerations represent the main reason of decreased system efficiency in relation to scheduled shutdowns over the 2020 landfill gas collection period.

### *6.2* Unscheduled Shutdowns

Unscheduled shutdowns of the landfill gas management facility are summarized in Table 6.2. The facility was shut down for a total of 663 hours 9 minutes during the reporting period for unscheduled maintenance, repairs, and shutdowns due to control plant critical alarm conditions.

In February, March, July, August, October and November, local power supply failures caused the facility to shut down.

Further interruptions were encountered throughout the year when wildlife interrupted the power supply.

In August and October, instrument failure, due to a suspected power surge at the Abstraction Plant, shut down the system requiring repair.

In November, an Oxygen Analyzer failure shut down the system requiring examination and repair.

Power Supply interruptions represent the main reason of decreased system efficiency in relation to unscheduled shutdowns over the 2020 landfill gas collection period.

## *6.3* System Improvements

In May, the final LFG Header Extension Project was completed. This extension completed a perimeter loop of the 200 mm HDPE LFG Main Header pipe that was started with the initial LFG Project installed in 2002.

In the Autumn of 2020 a LFG Well Field Expansion Project was started that will see 16 additional LFG wells online by spring or early summer 2021.

## *6.4* Proposed Facility Modifications and Alterations

In 2021, in addition to the scheduled maintenance, the Regional District will be looking at replacing or upgrading key system components due to aging infrastructure as part of a continuous program to improve system reliability.

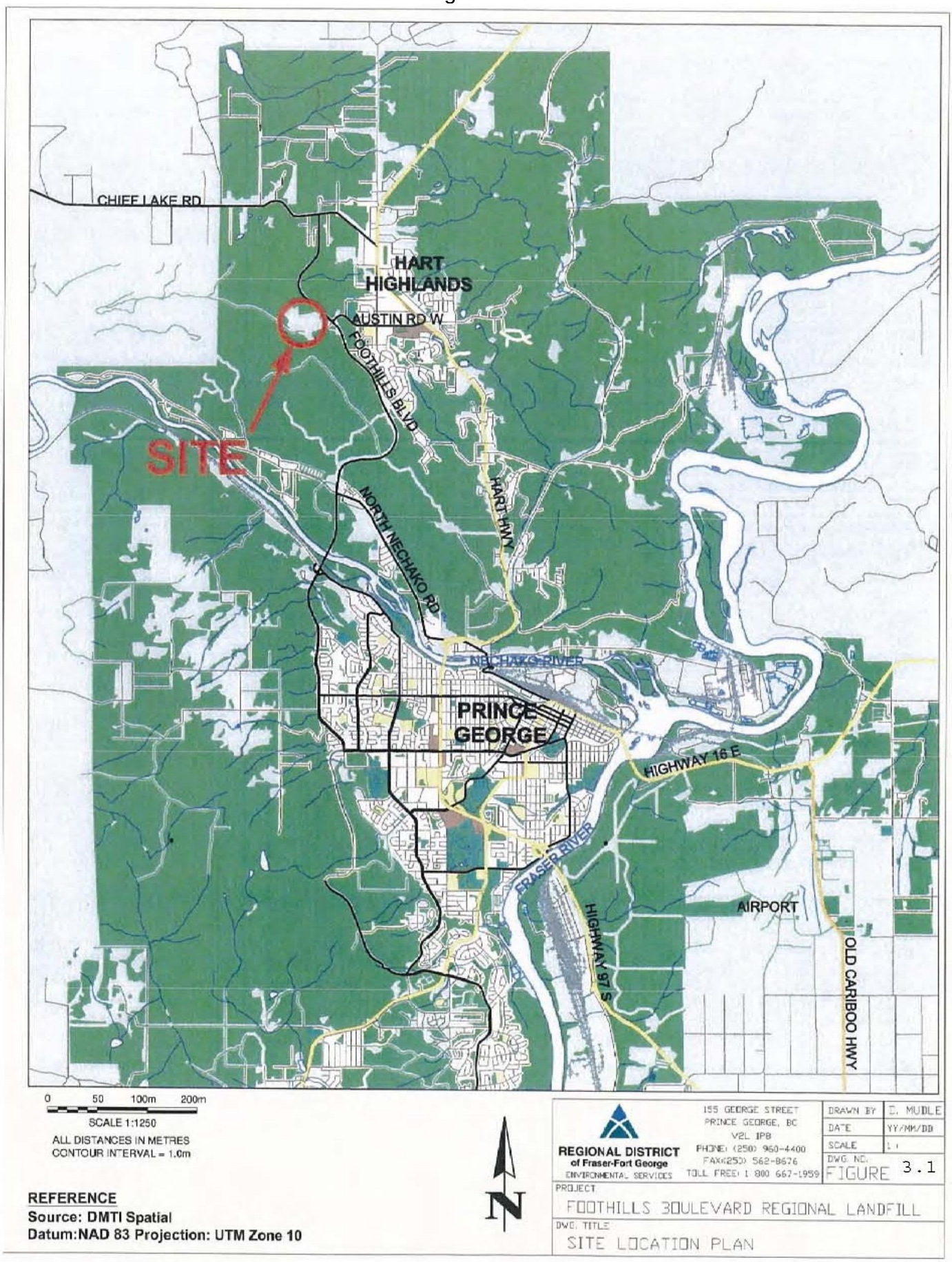
In early 2021 a Hydro realignment project will be undertaken to minimize power lines on site along with the installation of safe roosts and wildlife deterrents on required lines to help reduce power interruption.

Process Instrumentation upgrades will be undertaken and installed in the summer/fall of 2021 to help facilitate any potential alternative end use activities.

The Landfill Gas Well Field Expansion that was started in the fall of 2020 will be completed in the spring of 2021. Further progress on the remediation project that, once complete, will increase the overall efficiency of the current landfill gas collection system.

# *FIGURES*

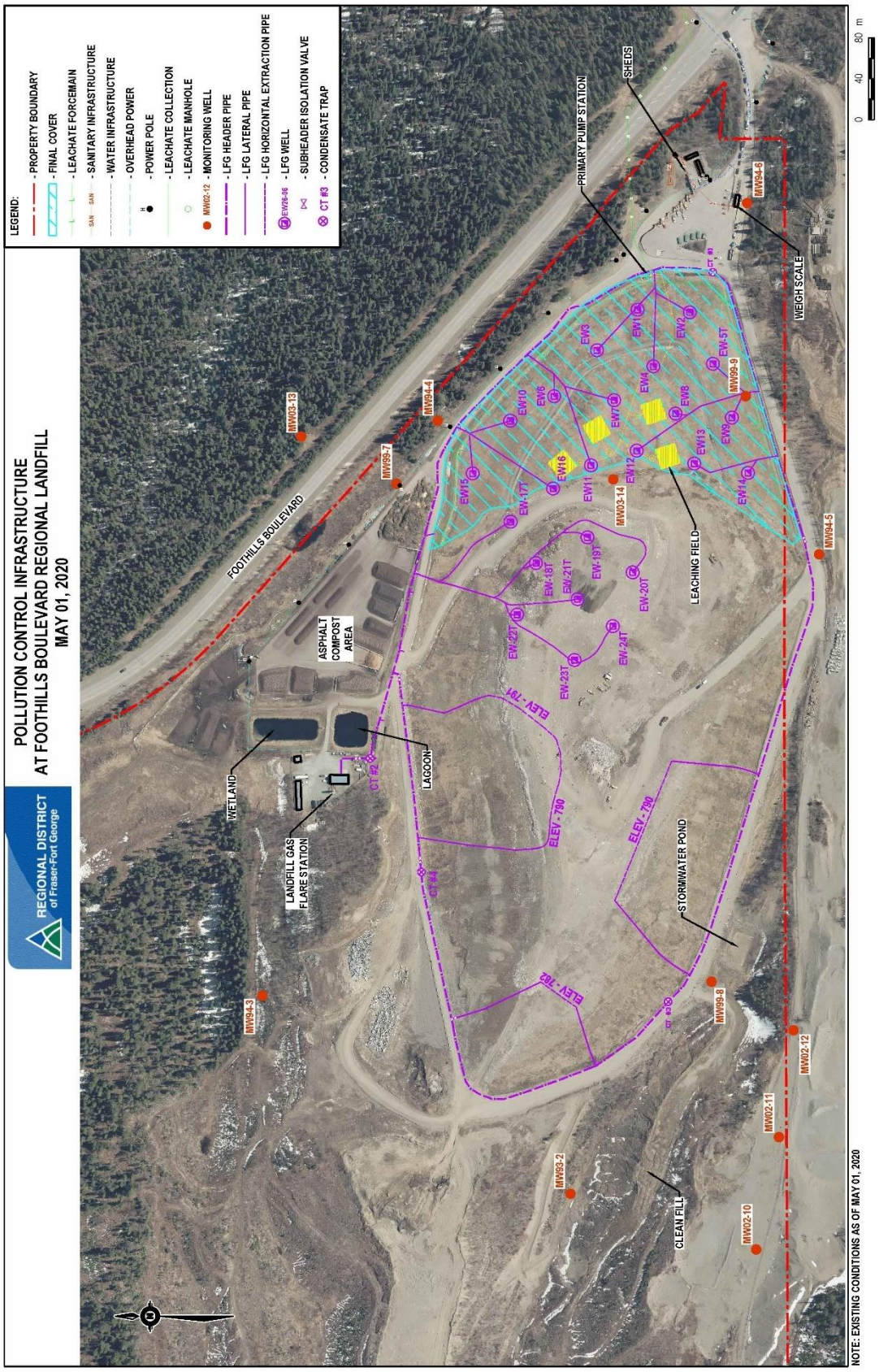
Figure 3.1


CHIEF LAKE RD
HART HIGHLANDS
AUSTIN RD W
FOOTHILLS BLVD
SITE
NORTH NECHAKO RD
HART HWY
NECHAKO RIVER
PRINCE GEORGE
HIGHWAY 16 E
FRASER RIVER
HIGHWAY 97 S
AIRPORT
OLD CARIBOO HWY
0 50 100m 200m
SCALE 1:1250
ALL DISTANCES IN METRES
CONTOUR INTERVAL = 1.0m
N
REFERENCE
Source: DMTI Spatial
Datum:NAD 83 Projection: UTM Zone 10
REGIONAL DISTRICT of Fraser-Fort George
ENVIRONMENTAL SERVICES
155 GEORGE STREET
PRINCE GEORGE, BC
V2L 1P8
PHONE: (250) 960-4400
FAX:(250) 562-8676
TOLL FREE: 1 800 667-1959
DRAWN BY: D. MUDLE
DATE: YY/MM/DD
SCALE: 1:
DWG. NO. FIGURE 3.1
PROJECT
FOOTHILLS BOULEVARD REGIONAL LANDFILL
DWG. TITLE
SITE LOCATION PLAN


HART HIGHLANDS
AREA OF PRINCE GEORGE
LFG FLARE STATION
AND MAINTENANCE
COMPOSTING FACILITY
FOOTHILLS BOULEVARD
SPORT AND
RECREATIONAL FACILITY
SWAP SHED
SCALE H
SITE ENTRANCE
BC MINISTRTY OF TRA
NSPORTATION
GRAVEL PIT
0
150
300 m
17500
LEGEND
PROPERTY BOUNDARY
APPROXIMATE LIMIT OF WASTE
SITE PLAN
LANDFILL GAS MANAGEMENT PLAN
FOOTHILLS BOULEVARD REGIONAL LANDFILL
REGIONAL DISTRICT OF FRASER-FORT GEORGE
XCG
XCG CONSULTANTS LTD.
DATE
JOB NO.
FIGURE NO.
OCT 2008
4-2428-01-02
3.2

Figure 3.2

Figure 4.1


REGIONAL DISTRICT of Fraser-Fort George
POLLUTION CONTROL INFRASTRUCTURE
AT FOOTHILLS BOULEVARD REGIONAL LANDFILL
MAY 01, 2020
LEGEND:
- PROPERTY BOUNDARY
- FINAL COVER
- LEACHATE FORCEMAIN
- SANITARY INFRASTRUCTURE
- WATER INFRASTRUCTURE
- OVERHEAD POWER
- POWER POLE
- LEACHATE COLLECTION
- LEACHATE MANHOLE
- MONITORING WELL
- LFG HEADER PIPE
- LFG LATERAL PIPE
- LFG HORIZONTAL EXTRACTION PIPE
- LFG WELL
- SUBHEADER ISOLATION VALVE
- CONDENSATE TRAP
FOOTHILLS BOULEVARD
PRIMARY PUMP STATION
SHEDS
WEIGH SCALE
LEACHING FIELD
ASPHALT COMPOST AREA
LAGOON
WETLAND
LANDFILL GAS FLARE STATION
STORMWATER POND
CLEAN FILL
ELEV - 791
ELEV - 790
ELEV - 789
ELEV - 788
MW94-3
MW03-13
MW99-7
MW94-4
MW03-14
MW94-5
MW94-6
MW99-8
MW02-12
MW02-11
MW02-10
MW99-2
EW1
EW2
EW3
EW4
EW5T
EW6
EW7
EW8
EW9
EW10
EW11
EW12
EW13
EW14
EW15
EW16
EW17
EW18T
EW19T
EW20T
EW21T
EW22T
EW23T
EW24T
MW99-9
CT #1
CT #2
CT #3
CT #4
0
40
80 m
NOTE: EXISTING CONDITIONS AS OF MAY 01, 2020

***TABLES***

***Table 5.1 Landfill Gas Collection Summary (2020)***

| Month | Volume LFG ($m^3$) | Average Methane Content (%) | Operational Hours (hours) | Percent Time Operational (%) |
|---|---|---|---|---|
| January | 323,565 | 53 | 744 hrs 0 min | 100 |
| February | 237,616 | 55 | 542 hrs 31 min | 78 |
| March | 314,257 | 54 | 740 hrs 0 min | 99 |
| April | 221,845 | 55 | 510 hrs 23 min | 71 |
| May | 177,800 | 55 | 426 hrs 32 min | 57 |
| June | 337,551 | 55 | 704 hrs 18 min | 98 |
| July | 334,405 | 54 | 691 hrs 14 min | 93 |
| August | 351,000 | 51 | 696 hrs 36 min | 94 |
| September | 164,799 | 57 | 356 hrs 55 min | 50 |
| October | 276,553 | 57 | 636 hrs 23 min | 86 |
| November | 258,024 | 55 | 643 hrs 46 min | 89 |
| December | 296,097 | 55 | 723 hrs 26 min | 97 |
| ***Total*** | **3,293,511** | ***55*** | ***7,416 hrs 4 min*** | ***84*** |

***Table 5.2 Landfill Gas Destruction Summary (2020)***

| Month | Volume LFG Flared ($m^3$) | Mass Methane Destroyed (tonnes GWP 25) | Mass Carbon Dioxide Equivalent Destroyed (tonnes) |
|---|---|---|---|
| January | 317,093 | 109 | 2,732 |
| February | 232,864 | 84 | 2,093 |
| March | 307,972 | 109 | 2,722 |
| April | 217,408 | 78 | 1,958 |
| May | 174,244 | 62 | 1,554 |
| June | 330,800 | 118 | 2,959 |
| July | 327,717 | 116 | 2,894 |
| August | 343,980 | 115 | 2,876 |
| September | 161,503 | 60 | 1,496 |
| October | 271,022 | 101 | 2,521 |
| November | 252,864 | 91 | 2,281 |
| December | 290,175 | 105 | 2,617 |
| ***Total*** | **3,227,641** | **1,148** | **28,703** |

***Table 6.1 Summary of Scheduled Maintenance Shutdowns***

| Date | Duration (hours) | Reason | Comments |
|---|---|---|---|
| February 3, 2020 | 48 min | Monthly Maintenance | |
| February 19, 2020 | 46 min | CH4 and O2 Analyzer Calibration | Lakewood Electric |
| February 26 and 27, 2020 | 9 hrs 35 min | Finish Fire Alarm Testing, Compressor Maintenance | All Points Fire Protection, NW Compressed Air |
| March 18, 2020 | 40 min | Monthly Maintenance, CH4 and O2 analyzer calibration | Lakewood Electric |
| May 20 to May 31, 2020 | 272 hrs 20 min | Decommissioning of LFG System for the LFG Header Extension Construction Project, Monthly Maintenance | |
| June 1, 2020 | 15 hrs 12 min | Recommissioning of the LFG System Upon Completion of the LFG Header Extension Project | |
| June 3, 2020 | 18 min | Training staff on Basic Plant Restart Procedure | |
| June 9, 2020 | 12 min | Monthly Maintenance, Quarterly and Semi Annual Maintenance | |
| July 9 and July 10, 2020 | 23 hrs 6 min | Bater Electric Servicing of Blowers | Bater Electric |
| July 16, 2020 | 53 min | CH4 and O2 Analyzer Calibration | Lakewood Electric |
| August 17, 2020 | 1 hr | Monthly Maintenance | |
| September 3 to September 15, 2020 | 290 hrs 44 min | Decommissioning of LFG System in Support of the Landfill Remediation Project, Monthly Maintenance | |
| September 21, 2020 | 5 min | Switched to Blower 2 | |
| September 22 to September 24, 2020 | 45 hrs, 59 min | System switched off to Complete Tasks Related to the Landfill Remediation Project | |
| October 8, 2020 | 1 hr 5 min | CH4 and O2 Analyzer Calibration | Lakewood Electric |
| October 22, 2020 | 2 hrs 11 min | Monthly Maintenance, Quarterly Maintenance, Start Semi Annual, Annual Maintenance, Change Out Flow Meter, Environmental Sensor Calibration | Lakewood Electric |
| November 5, 2020 | 2 hrs 38 min | Raising of EW24T | |
| November 18 and 19,2020 | 16 hrs 53 min | Finish Annual, Semi Annual Maintenance | |
| December 1, 2020 | 23 min | Annual Fire Alarm Inspection Started | All Points Fire Protection |
| December 3, 2020 | 42 min | Monthly Maintenance | |
| December 21 and 22, 2020 | 19 hrs 29 min | Re calibration of O2 Analyzer, Start Environmental Sensor Replacement | Lakewood Electric |

***Table 6.2 Summary of Unscheduled Shutdowns***

| Date | Duration (hours) | Reason | Comments |
|---|---|---|---|
| February 10 to 13, 2020 | 69 hrs 25 min | Wildlife Flew Into Power Line | |
| February 15 to 18, 2020 | 72 hrs 55 min | Suspected Power Surge | BC Hydro |
| March 17, 2020 | 2 hrs 20 min | Power Surge | BC Hydro |
| April 12 to 16, 2020 | 87 hrs 49 min | Wildlife Flew Into Power Line | |
| April 23 to 28, 2020 | 121 hrs 48 min | Power Surge | BC Hydro |
| May 14 to 16, 2020 | 45 hrs 08 min | Wildlife Flew Into Power Line | |
| July 11, 2020 | 5 hrs 13 min | Wildlife Flew Into Power Line | |
| July 22 and 23, 2020 | 23 hrs 34 min | Power Surge/Outage | BC Hydro |
| August 15 to 17, 2020 | 47 hrs 24 min | Power Surge/Outage | BC Hydro |
| September 29 and 30, 2020 | 26 hrs 17 min | Wildlife Flew Into Power Line | |
| October 5 to 7, 2020 | 40 hrs 31 min | Wildlife Flew Into Power Line | |
| October 16 and 17, 2020 | 31 hrs 12 min | Power Surge | BC Hydro |
| October 26 to 28, 2020 | 32 hrs 38 min | Power Surge/Outage | BC Hydro |
| November 2, 2020 | 5 hrs 12 min | O2 Analyzer | Lakewood Electric |
| November 4, 2020 | 4 hrs 18 min | Wildlife Flew Into Power Line | |
| November 10 to 12, 2020 | 47 hrs 25 min | Power Surge/Outage | BC Hydro |

# *APPENDIX A*

# *METHANE AND OXYGEN ANALYZER CALIBRATION CERTIFICATES*

# Certificate of Calibration

**Report number LE-RDFFG-20200219-0002**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| Galvanic IR | IR Gas Analyser | CH4 | 0249IR011 | 2019-02-19 | 2019-08-19 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In Tolerance **As Left Condition:** In Tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

| Definitions: | | |
|---|---|---|
| | Temperature | Measured temperature of test during data collection. |
| | Reference Reading | True value according to our reference standards. |
| | Gauge Reading | Displayed reading from test unit. |
| | Condition | Pass or Fail. |
| | Difference | Indicated reading minus reference reading. |
| | Relative Difference | (Difference / reference reading) x 100 |
| | Allowable Tolerance | ± according to manufacturer's specifications. |
| | Water column | Referenced at 20° C and 1 atmosphere. |
| | Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 50% Methane |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for CH4

**LE-RDFFG-20200219-0002**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

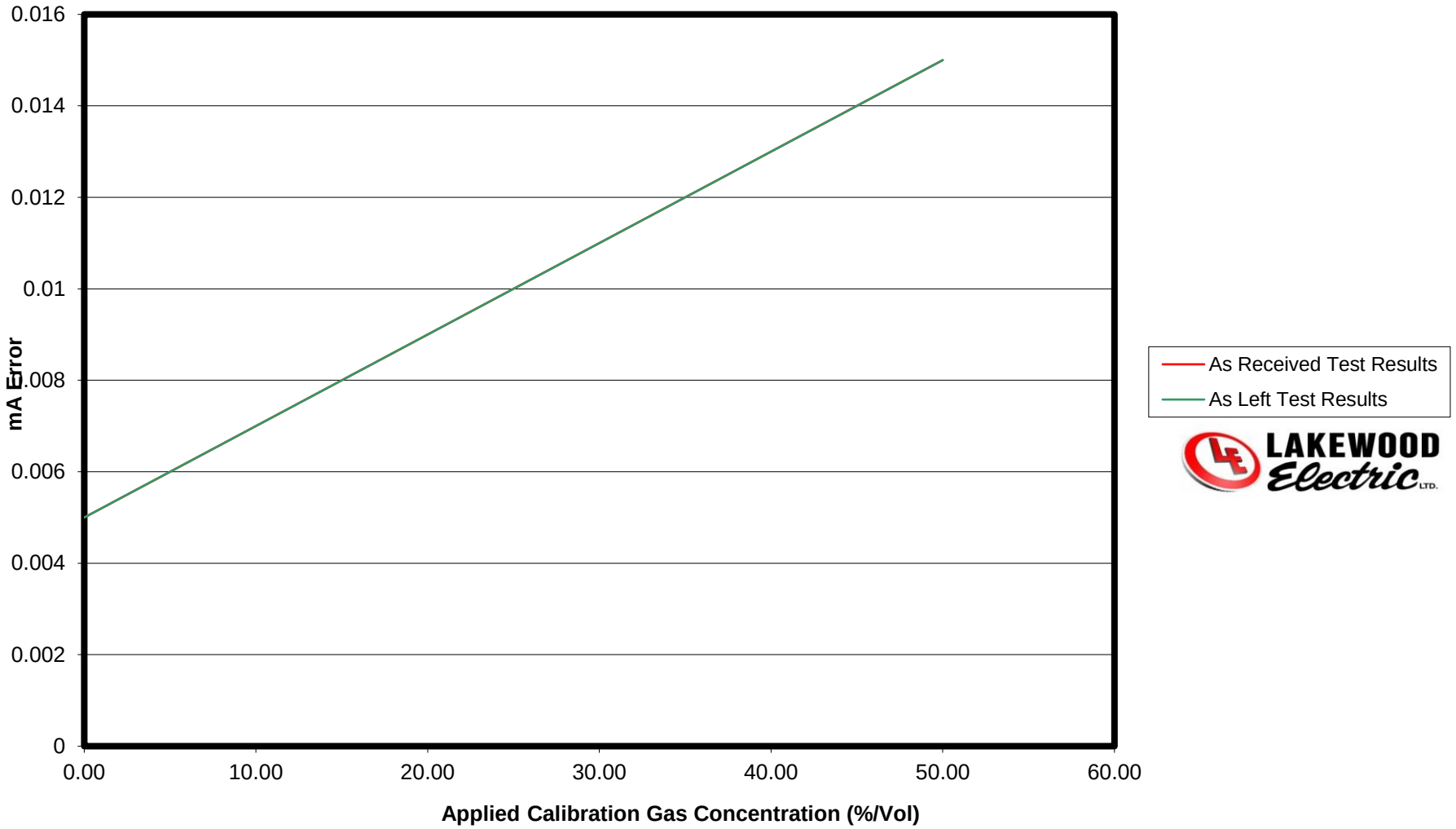
**As Received Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.995 | 0.016 | 0.005 | 0.03% | Pass |
| 50.00 | 12.000 | 12.015 | 0.016 | 0.015 | 0.09% | Pass |

**As Left Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.995 | 0.016 | 0.005 | 0.03% | Pass |
| 50.00 | 12.000 | 12.015 | 0.016 | 0.015 | 0.09% | Pass |

## mA Error Graph for Gauge # CH4, S/N 0249IR011, Report LE-RDFFG-20200219-0002



# Certificate of Calibration

**Report number LE-RDFFG-20200318-0002**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| Galvanic IR | IR Gas Analyser | CH4 | 0249IR011 | 2020-03-18 | 2020-09-18 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In Tolerance **As Left Condition:** In Tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

Definitions:

| | |
|---|---|
| Temperature | Measured temperature of test during data collection. |
| Reference Reading | True value according to our reference standards. |
| Gauge Reading | Displayed reading from test unit. |
| Condition | Pass or Fail. |
| Difference | Indicated reading minus reference reading. |
| Relative Difference | (Difference / reference reading) x 100 |
| Allowable Tolerance | ± according to manufacturer's specifications. |
| Water column | Referenced at 20° C and 1 atmosphere. |
| Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 50% Methane |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for CH4

**LE-RDFFG-20200318-0002**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

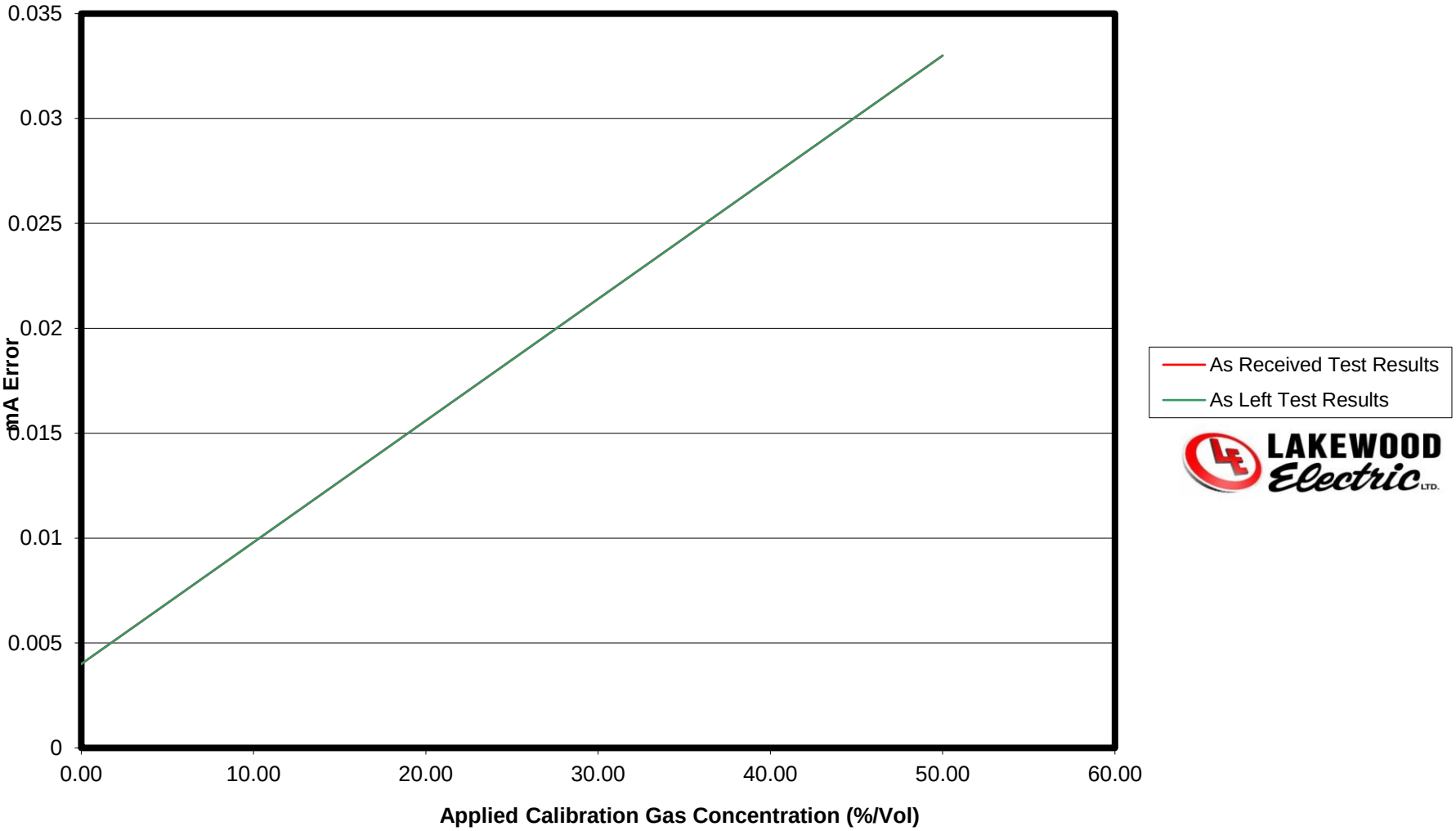
**As Received Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.996 | 0.016 | 0.004 | 0.03% | Pass |
| 50.00 | 12.000 | 11.967 | 0.016 | 0.033 | 0.21% | Pass |

**As Left Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.996 | 0.016 | 0.004 | 0.03% | Pass |
| 50.00 | 12.000 | 11.967 | 0.016 | 0.033 | 0.21% | Pass |

## mA Error Graph for Gauge # CH4, S/N 0249IR011, Report LE-RDFFG-20200318-0002



# Certificate of Calibration

**Report number LE-RDFFG-20200219-0001**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| GE Sensing | XMO2-2H-41 | O2 | 1906 | 2020-02-19 | 2020-08-19 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In tolerance **As Left Condition:** In tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

Definitions:

| | |
|---|---|
| Temperature | Measured temperature of test during data collection. |
| Reference Reading | True value according to our reference standards. |
| Gauge Reading | Displayed reading from test unit. |
| Condition | Pass or Fail. |
| Difference | Indicated reading minus reference reading. |
| Relative Difference | (Difference / reference reading) x 100 |
| Allowable Tolerance | ± according to manufacturer's specifications. |
| Water column | Referenced at 20° C and 1 atmosphere. |
| Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 20.9% Oxygen |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for O2

**LE-RDFFG-20200219-0001**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

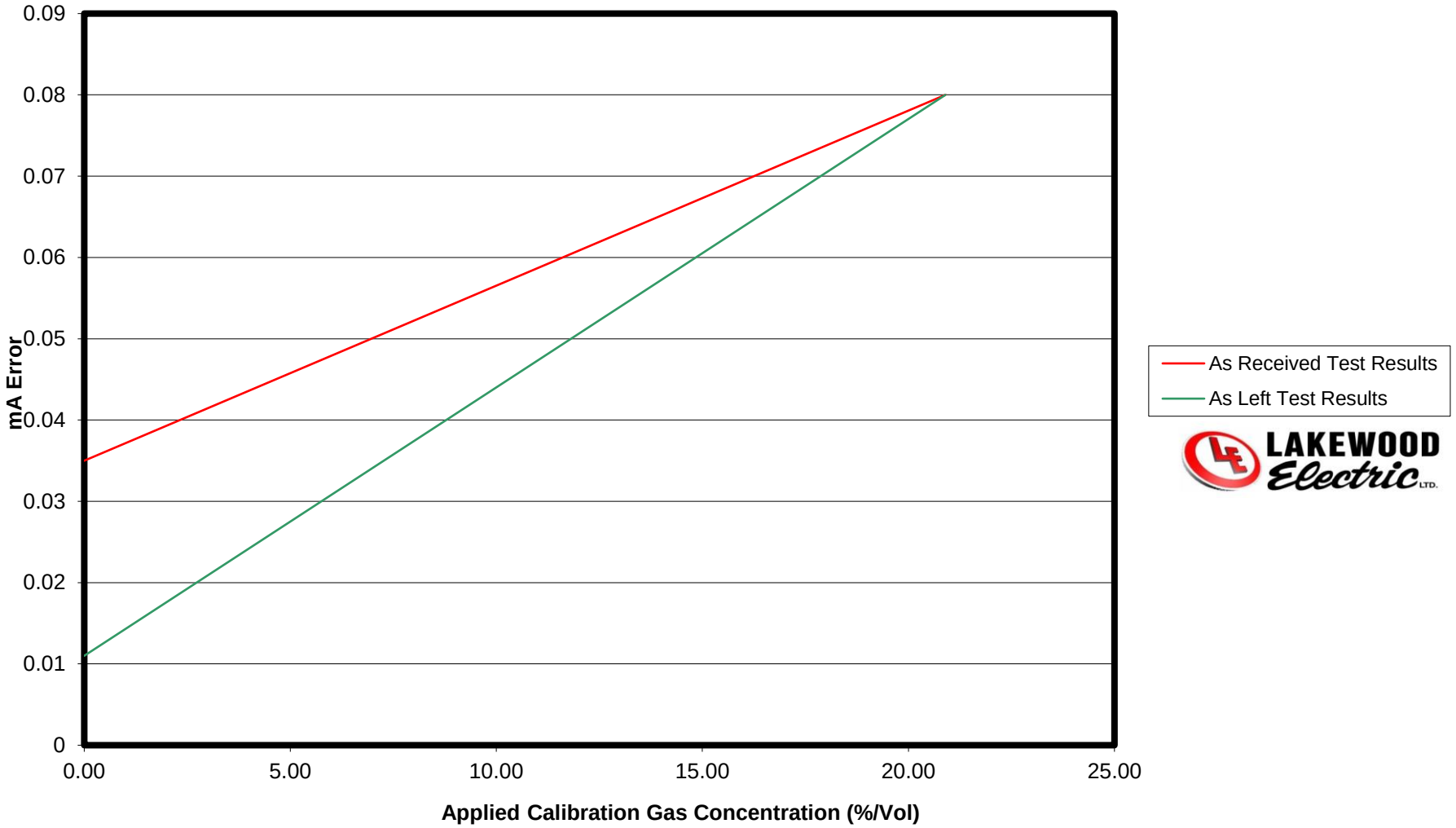
**As Received Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.965 | 0.640 | 0.035 | 0.22% | PASS |
| 20.90 | 17.376 | 17.456 | 0.640 | 0.080 | 0.50% | PASS |

**As Left Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 4.011 | 0.640 | 0.011 | 0.07% | Pass |
| 20.90 | 17.376 | 17.456 | 0.640 | 0.080 | 0.50% | Pass |

## mA Error Graph for Gauge # O2, S/N 1906, Report LE-RDFFG-20200219-0001



# Certificate of Calibration

**Report number LE-RDFFG-20200318-0001**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| GE Sensing | XMO2-2H-41 | O2 | 1906 | 2020-03-18 | 2020-09-18 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In tolerance **As Left Condition:** In tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

Definitions:

| | |
|---|---|
| Temperature | Measured temperature of test during data collection. |
| Reference Reading | True value according to our reference standards. |
| Gauge Reading | Displayed reading from test unit. |
| Condition | Pass or Fail. |
| Difference | Indicated reading minus reference reading. |
| Relative Difference | (Difference / reference reading) x 100 |
| Allowable Tolerance | ± according to manufacturer's specifications. |
| Water column | Referenced at 20° C and 1 atmosphere. |
| Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 20.9% Oxygen |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for O2

**LE-RDFFG-20200318-0001**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

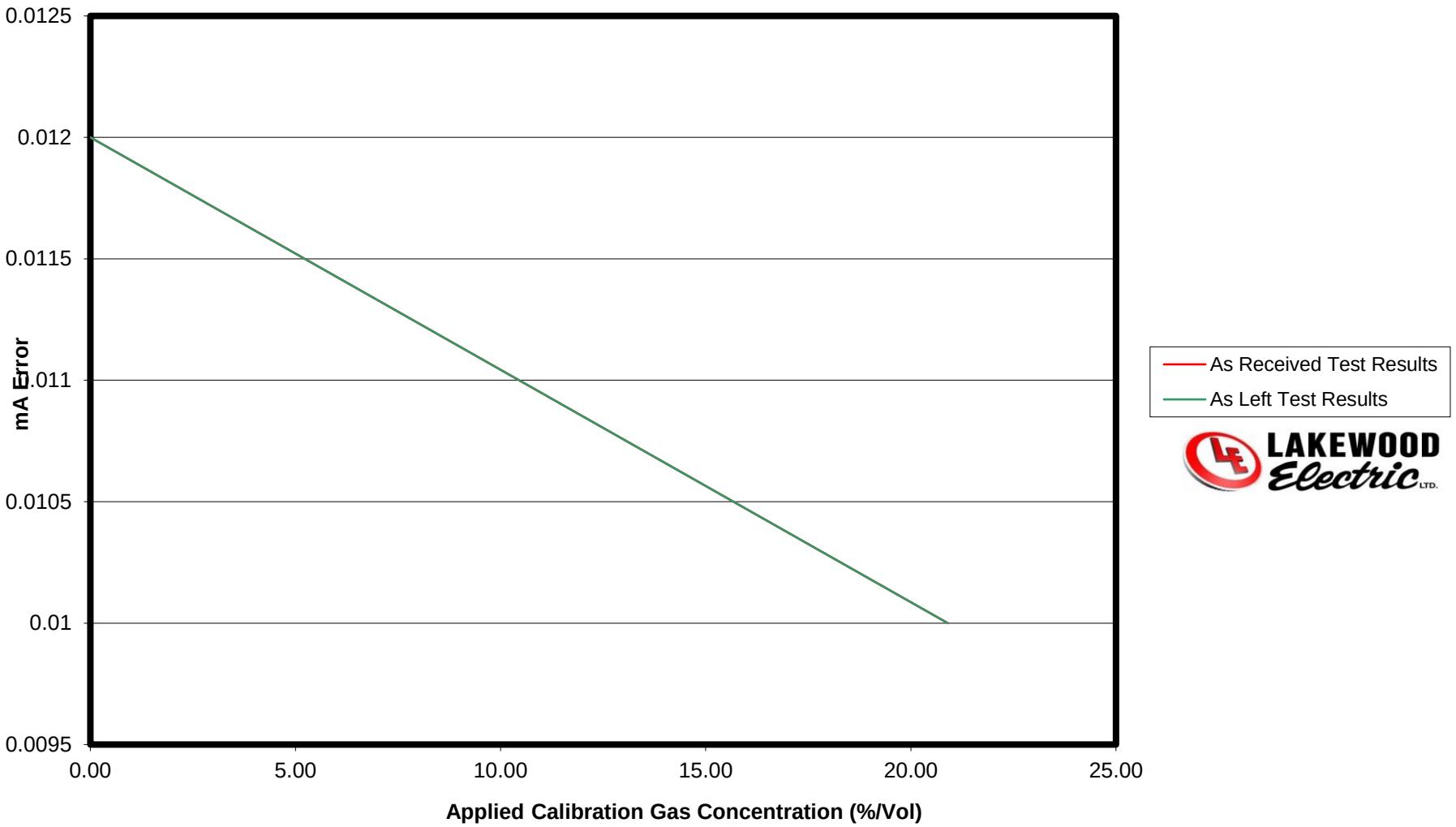
**As Received Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.988 | 0.640 | 0.012 | 0.08% | PASS |
| 20.90 | 17.376 | 17.366 | 0.640 | 0.010 | 0.06% | PASS |

**As Left Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.988 | 0.640 | 0.012 | 0.08% | Pass |
| 20.90 | 17.376 | 17.366 | 0.640 | 0.010 | 0.06% | Pass |

## mA Error Graph for Gauge # O2, S/N 1906, Report LE-RDFFG-20200318-0001



# Certificate of Calibration

**Report number LE-RDFFG-20200318-0002**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| Galvanic IR | IR Gas Analyser | CH4 | 0249IR011 | 2020-07-16 | 2021-01-16 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In Tolerance **As Left Condition:** In Tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

| Definitions: | | |
|---|---|---|
| | Temperature | Measured temperature of test during data collection. |
| | Reference Reading | True value according to our reference standards. |
| | Gauge Reading | Displayed reading from test unit. |
| | Condition | Pass or Fail. |
| | Difference | Indicated reading minus reference reading. |
| | Relative Difference | (Difference / reference reading) x 100 |
| | Allowable Tolerance | ± according to manufacturer's specifications. |
| | Water column | Referenced at 20° C and 1 atmosphere. |
| | Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 50% Methane |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for CH4

**RDFFG-20200716-CH4**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

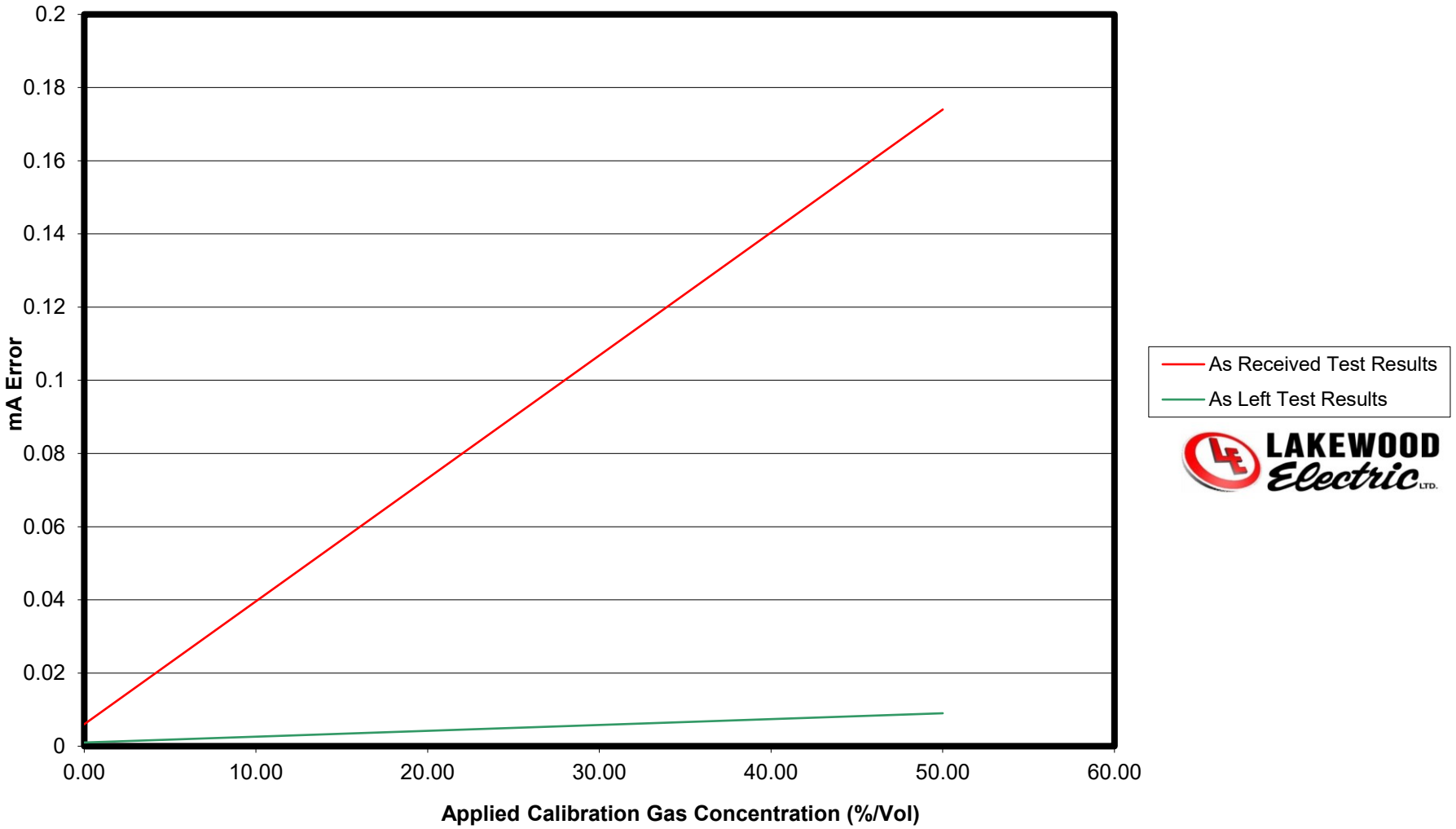
**As Received Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.994 | 0.016 | 0.006 | 0.04% | Pass |
| 50.00 | 12.000 | 11.826 | 0.016 | 0.174 | 1.09% | Fail |

**As Left Test Results** **4-20 mA**

| Reference $CH_4$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.999 | 0.016 | 0.001 | 0.01% | Pass |
| 50.00 | 12.000 | 11.991 | 0.016 | 0.009 | 0.06% | Pass |

## mA Error Graph for Gauge CH4, SN 0249IR011, Report RDFFG-20200716-CH4



# Certificate of Calibration

**Report number LE-RDFFG-20200318-0001**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

| Manufacturer | Model | Gauge Number | Serial Number | Calibration Date | Expiration Date |
|---|---|---|---|---|---|
| GE Sensing | XMO2-2H-41 | O2 | 1906 | 2020-07-16 | 2021-01-16 |

| Model Uncertainty |
|---|
| "+/- 1% Span" |

All instrument calibrations are verified for accuracy before they are shipped. The recommended calibration interval for this instrument is 6 months from the date of verification. Your particular quality assurance requirements may supersede this recommendation.

**As Received Condition:** In tolerance **As Left Condition:** Out of Tolerance

All calibrations are performed in a controlled or operational environment by qualified personnel using instrumentation and methods which guarantee that specifications claimed are reliable. Calibrations conform to ANSI/NCSL Z540-1-1994, MIL-STD 45662A, 10CFR21 and 10CFR50 when specified by customer documentation.

Definitions:

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| Temperature | Measured temperature of test during data collection. |
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| Condition | Pass or Fail. |
| Difference | Indicated reading minus reference reading. |
| Relative Difference | (Difference / reference reading) x 100 |
| Allowable Tolerance | ± according to manufacturer's specifications. |
| Water column | Referenced at 20° C and 1 atmosphere. |
| Test Accuracy Ratio | At least 4:1 unless otherwise stated. |

Media used during this calibration were:

| | |
|---|---|
| Manufature | Praxair |
| Zero | 100% Nitrogen |
| Linearity | 20.9% Oxygen |
| Balance | Nitrogen |

Reference Standards used in this calibration are traceable to the National Institute of Standards and Technology of the United States, through the following report numbers:

| Manufacturer | Model | Serial Number | Report Number | Due Date | Reference Uncertainty |
|---|---|---|---|---|---|
| Crystal Engineering | IS33-36/3000PSI | 2262-432200 | 48487 | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| Crystal Engineering | IS33-36/300PSI | 2535-841542 | 48487-A | Dec. 11, 2020 | +/-(0.05% of Reading + 0.005% of F.S.), vacuum: +/-(0.25% of Reading + 0.004 PSI) |
| | | | | | |



Laboratory Representative
Darren Heggelund

Quality Representative
Darren Heggelund

# mA Test Results for O2

**RDFFG-20200716-O2**

2007 Ogilvie St., Prince George BC V2N 1X2 | Phone: 250-563-4100 Fax: 250-563-1571

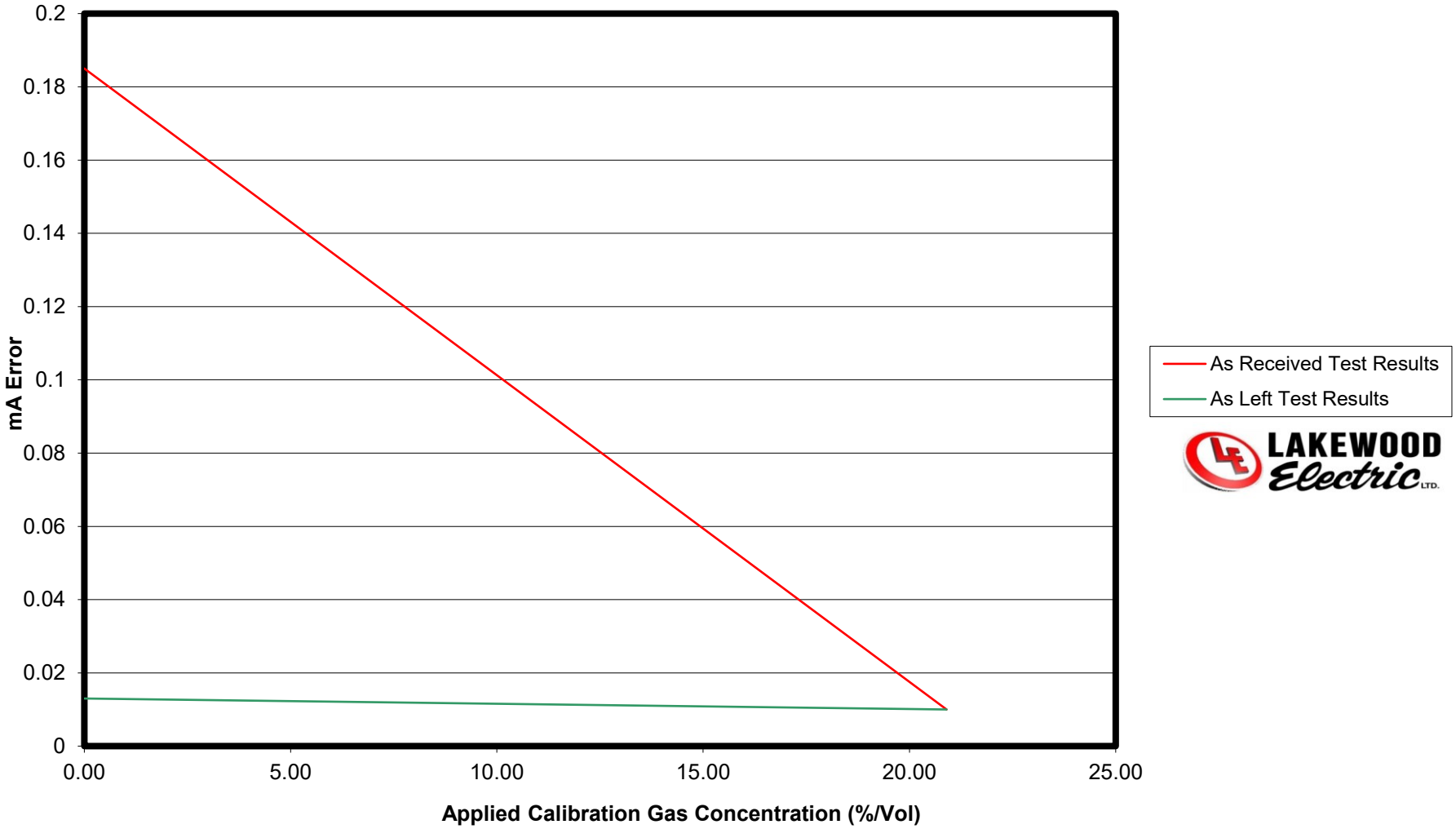
**As Received Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 4.185 | 0.640 | 0.185 | 1.16% | FAIL |
| 20.90 | 17.376 | 17.366 | 0.640 | 0.010 | 0.06% | PASS |

**As Left Test Results** **4-20 mA**

| Reference $O_2$ (%/vol) | Calculated mA | Reference mA | Tolerance mA | Difference mA | Difference (% of Span) | Condition |
|---|---|---|---|---|---|---|
| 0.00 | 4.000 | 3.987 | 0.640 | 0.013 | 0.08% | Pass |
| 20.90 | 17.376 | 17.366 | 0.640 | 0.010 | 0.06% | Pass |

## mA Error Graph for Gauge O2, SN 1906, Report RDFFG-20200716-O2



# INFRA-RED BASED MEASUREMENT TECHNOLOGY

## GALVANIC APPLIED SCIENCES NOW OFFERS $CO_2$, $CH_4$ AND CO MEASUREMENT BASED ON INFRA-RED TECHNOLOGY.

Class 1 Div I *IR*

The sensor is based on true dual wavelength infra-red technology with no moving parts. The result is a low drift, high accuracy with a fast response time and low power consumption.

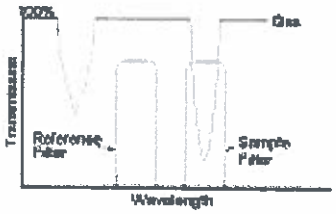
General Purpose

## PRINCIPLE OF OPERATION

Many gases including $CO_2$, CO and $CH_4$ absorb energy in the infra-red spectrum. This absorption is selective, occurring at specific frequencies corresponding to the resonant frequencies of bond vibrations within the molecule. Measuring at a characteristic absorption wavelength enables the detection of the gas, and the strength of the absorption gives a measure of the gas concentration.

The infra-red source emits a broad band of radiation that is guided through the gas in the sample cell. The radiation then passes through either of the two filters. The two filters are selected so that one is coincident with the gas to be measured and the other is independent of any gas likely to be present in the cell. In the absence of gas, the energy reaching the two detectors is equal. As the sample gas concentration increases, the amount of infra-red radiation reaching the two detectors differs due to the absorption at one filter wavelength only.

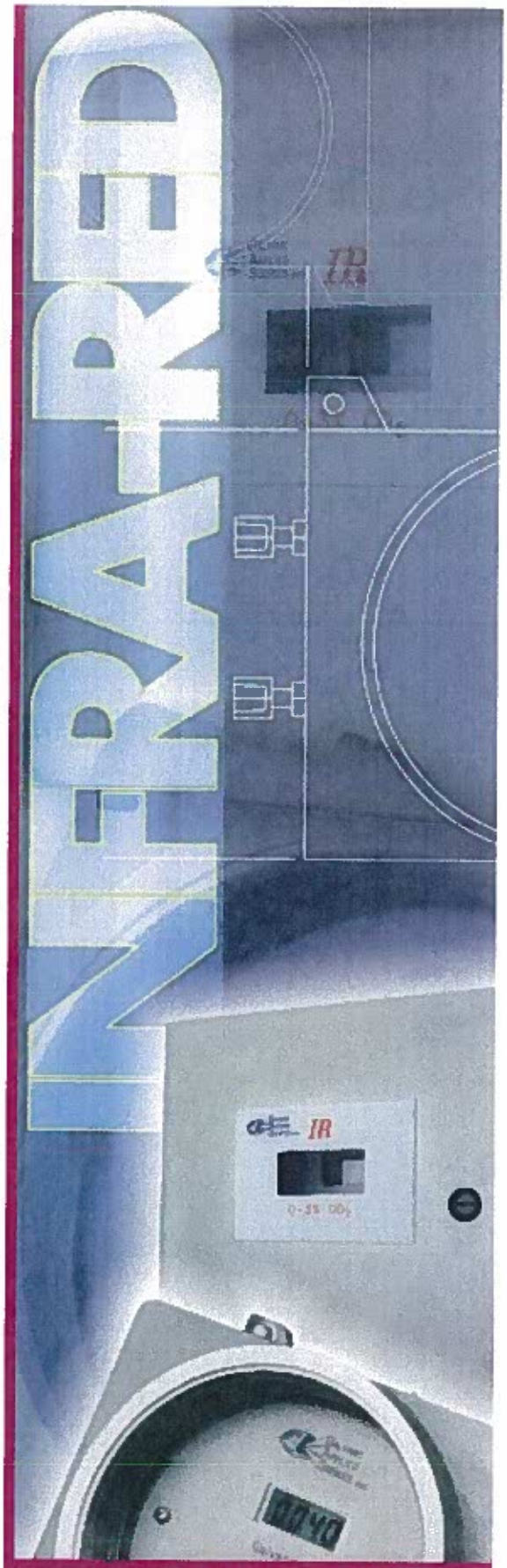

DUAL WAVELENGTH DETECTOR




Electronic signal ratioing using a dedicated on-board microprocessor gives the gas concentration, automatically compensated for source intensity changes or contamination of the optical components

## APPLICATIONS

- $CO_2$ in natural gas
- $CH_4$ in land fill gas
- Food storage and packaging
- Environmental

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GALVANIC APPLIED SCIENCES INC.

ISO 9002: 1994
Registered QMS

## SPECIFICATIONS

### Measuring Range:

| $CO_2$ | $CH_4$ | CO |
|---|---|---|
| 0-2000 ppm | 0-10% | 0-10% |
| 0-3000 ppm | 0-30% | |
| 0-5000 ppm | 0-100% | |
| 0-1% | | |
| 0-3% | | |
| 0-10% | | |
| 0-100% | | |

### Response Time:
T90=10 seconds

### Operating Temperature:
0-45 C
(temperature compensated)

### Output:
4-20 ma
Lcd digital display
3 relays

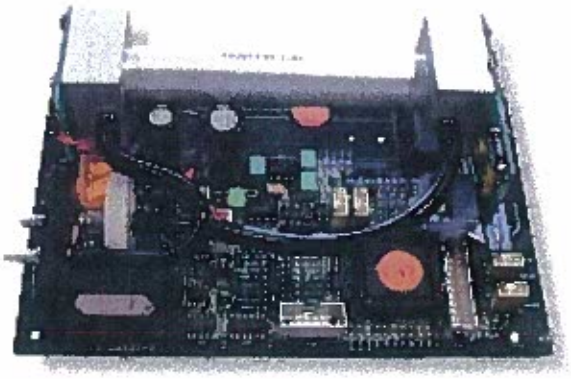
### Accuracy:
+/- 2% of range

### Stability:
+/- 2% of range per year

### Repeatability:
At zero +/- 0.3%
At span +/- 1.5%

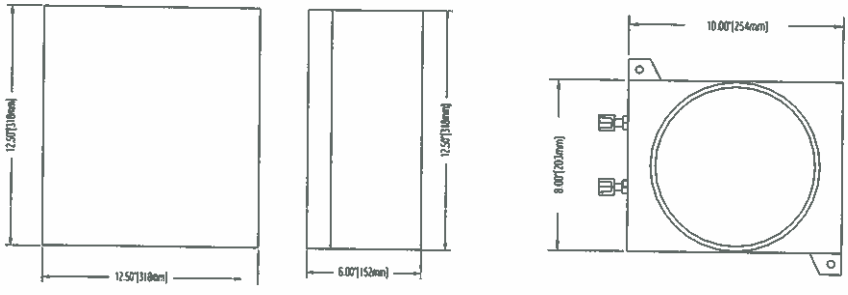
### Power:
24 vdc 6 watts (standard)
120/240 vac (optional)

### Electrical:
General area classification (standard)
Class 1 Div I Grps C, D (optional)



Dual Wavelength
IR Sensor

## DIMENSIONS

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Galvanic Applied Sciences Inc.
Bay 6, 6325-12 Street S.E.
Calgary, Alberta T2H 2K1
Telephone: 403-252-8470
Fax: 403-255-6287

Calgary, Alberta
1200, 715-5th Avenue S.W.
Calgary, Alberta T2P 2X6
Telephone: 403-252-8470
Fax: 403-571-2684

Edmonton, Alberta
Telephone: 780-430-0142
Fax: 780-430-0172

Houston, Texas
Telephone: 281-477-9002
Fax: 281-477-9004

Toll Free 1-866-252-8470 (US & Canada only)

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GE
Sensing

## Applications

An oxygen transmitter for use in:

- Inerting/blanketing liquid storage tanks
- Reactor feed gases
- Centrifuge gases
- Catalyst regeneration
- Solvent recovery
- Landfill gas
- Sewage wastewater digester gas
- Oxygen purity

## Features

- Measurement ranges from 0.01 percent to 100 percent $O_2$ in gases
- Explosion-proof and flameproof enclosure with weatherproof protection allows sensor to be remotely mounted at the measurement point
- Push-button, single or dual gas calibration
- Compact, rugged sensor design with no moving parts provides long term reliability and trouble-free operation
- Dual-bridge measurement circuit compensates for variations in background gas composition
- Unique dual-chamber, temperature-controlled cell design provides resistance to contamination and flow fluctuation
- Computer-enhanced accuracy of 1 percent of span and linearity of better than 0.5 percent of span

# XMO2

## Panametrics Smart Oxygen Analyzer


XMO2 is a Panametrics product.
Panametrics has joined other GE high-technology sensing businesses under a new name–
GE Industrial, Sensing.

GE
Sensing


*XMO2 rack-mount configuration*

## Smart Oxygen Transmitter

The XMO2 thermoparamagnetic oxygen transmitter is the most stable oxygen analyzer available on the market today. It represents the state of the art in oxygen measurement. With the XMO2 transmitter, reliable process oxygen measurement can be as easy as temperature or pressure measurement.

## Top Performance and Ease of Use

The XMO2 combines computer-enhanced, automatic oxygen signal compensation, fast-response software, real-time error detection and automated calibration with a proven thermoparamagnetic oxygen sensor to achieve unequaled performance and ease of use.

The compact, weatherproof, explosion-proof and flameproof XMO2 is specifically designed to be field installed at the process measurement point, thus minimizing sample-conditioning requirements while ensuring the best sample and the fastest possible response. With no moving parts, it is insensitive to mounting position or vibration, and it has excellent long-term reliability. The XMO2's dual-chamber oxygen cell design makes it resistant to contamination and flow variation.

## Automatic Background Gas Compensation

An onboard microprocessor gives the XMO2 the computing power to provide advanced online signal conditioning and digital communications via an RS232 interface and menu-driven software. Integrated signal-processing algorithms provide improved linearity and accuracy, and automatic compensation for background gas variations and/or atmospheric pressure effects. A fast-response software routine provides typical response times of less than 15 seconds. When recalibration does become necessary, it can be accomplished quickly and easily through software, with no potentiometers to adjust.

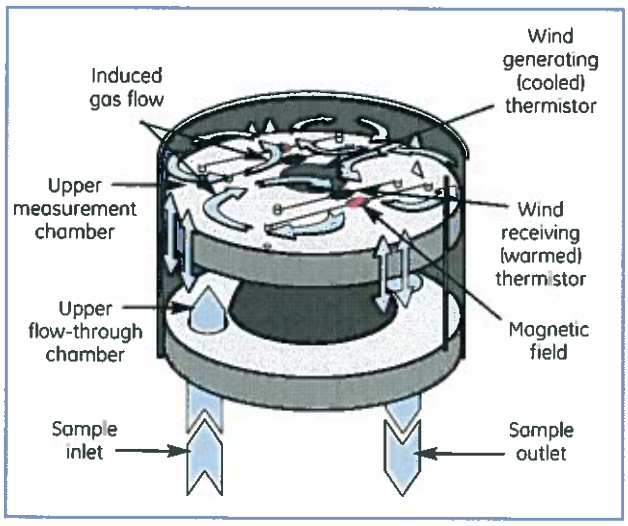
## Choice of Enclosures and Ranges

The XMO2 requires 24 VDC power and provides a 4 to 20 mA output signal with fully programmable zero and span settings. The output is proportional to oxygen concentration and internally compensated for background gas and/or atmospheric pressure variations. The weatherproof, explosion-proof and rack-mount XMO2s are available in a wide variety of measurement ranges.

## XMO2 Accessories

GE provides a complete line of accessories for use with the XMO2. This includes sample systems custom-designed for specific applications, a 24 VDC power supply and a four-wire color-coded cable in lengths up to 4000 ft (1200 m). The XMO2 can also be interfaced with other GE displays and analyzers, such as the TMO2D, XDP and Moisture Series analyzers. The TMO2D and XDP displays provide microprocessor-based oxygen signal compensation for maximum accuracy, software-enhanced response and automatic calibration of the XMO2 transmitter.

**Dual-Chamber Design**




*Flow schematic of the XMO2 thermoparamagnetic oxygen measuring cell. Oxygen's paramagnetic property causes an oxygen-containing gas sample to move within the magnetic field. The gas movement creates a "magnetic wind" that is sensed by the thermistor pairs. Oxygen concentration and background gas compensation are determined by the transmitter's microprocessor.*

GE
Sensing

# XMO2 Specifications

## Performance

### Accuracy
- ±1% of span
- ±2% of span for 0 to 1% range
- ±0.2% $O_2$ for 90 to 100% and 80 to 100% ranges

### Linearity
±0.5% of span

### Repeatability
±0.2% of span

### Measurement Resolution
0.01 mA

### Zero Stability
±1% of span per month (±2% for 0 to 1% range)

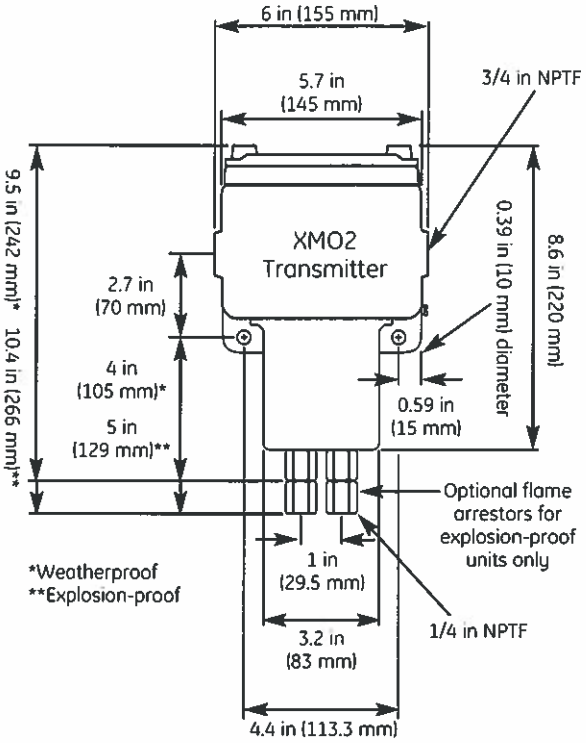
### Span Stability
±0.4% of span per month (±0.8% for 0 to 1% range)

### Measurement Ranges (Typical)
- 0% to 1%
- 0% to 2%
- 0% to 5%
- 0% to 10%
- 0% to 21%
- 0% to 25%
- 0% to 50%*
- 0% to 100%*
- 90% to 100%*
- 80% to 100%*

** Pressure compensation required*

### Transmitter Temperature
- Standard: Controlled to 113°F (45°C)
- Optional: Controlled to 140°F (60°C)


*The XMO2 output may be used as an input to GE Moisture Series analyzers for simultaneous measurement and display of both moisture and oxygen content.*




*XMO2 oxygen transmitter dimensions*

### Pressure Effect
- ±0.2% of reading per mm Hg (without pressure compensation)
- Option available for pressure compensation

### Required Sample Flow Rate
0.1–2.0 SCFH (50–1,000 cc/min),
1.0 SCFH (500 cc/min) nominal

### Sample Flow Rate Effect
Less than 1% of span for flow range of 0.1 to 2.0 SCFH (50 to 1000 cc/min) for weatherproof XMO2 with background gas compensation

### Response Time, 90% Step Change
- Fast 15 seconds
- EN50104 45 seconds
- Standard 70 seconds

### Warm-Up Time
30 minutes

## Functional

### Analog Output
4 to 20 mA, isolated, 800 Ω maximum, field programmable

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### Digital Output
RS232, three-wire

### Power
24 VDC ±4 VDC, 1.2 A maximum

### Cable
- Standard: 10 ft (3 m), four-wire
- Lengths up to 4000 ft (1200 m) available for current output

### Ambient Temperature Range
(Sample Conditions):
- –4°F to 104°F (–20°C to 40°C), standard cell operating temperature of 113°F (45°C)
- 23°F to 131°F (–5°C to 55°C), optional cell operating temperature of 140°F (60°C)

### Maximum Pressure
20 psig (2 bar)

## Physical

### Wetted Sensor Materials
- Standard: 316 stainless steel, glass and Viton® O-rings
- Optional: Hastelloy® C276 and Chemraz® O-rings

### Dimensions
- Weatherproof unit (h x dia): 9.53 in x 5.71 in (242 mm x 145 mm)
- Explosion-proof/weatherproof unit (h x dia): 10.47 in x 5.71 in (266 mm x 145 mm)

### Weight
9.5 lb (4.3 kg)

### Environmental, Transmitter
- Weatherproof: Type 4X/IP66
- Explosion-proof: Class I, Division 1, Groups A,B,C&D, FM/CSA
- Flameproof:
  ⟨Ex⟩ II 2 GD EEx d IIC T6
  ISSeP02ATEX022;
  Ex d II C T6 IP66 Class I, Zone 1
  SAA AUS Ex 3139X

*ATEX compliance with EN50104 requires response-time calibration to EN50104 and constant control of sample-system pressure or pressure compensation of XMO2.*

### Environmental, Rack Mount
Rack-mount configuration is suitable for ordinary locations only. Not suitable for use in hazardous (classified) locations.

### European Compliance
Complies with EMC Directive 89/336/EEC and PED 97/23/EC for DN<25 (CE approval pending for rack mount)

### Lloyd's Registry Approval
Please refer to the XMO2-LR data sheet for details.

### Order Information

**Record selected option in blank indicated at bottom of form.**

**XMO2 Thermomagnetic Oxygen Transmitter**

**Package**
- 1 Weatherproof enclosure
- 2 Explosion-proof/weatherproof enclosure
- 5 Rack-mount configuration
- X Without enclosure (spare)

**Cell Magnetization**
- H High (suitable for 0 to 1%, 0 to 2%, 0 to 5%, 0 to 10%, 0 to 21%, 0 to 25%, 0 to 50%, 90 to 100%, 80 to 100% and 0 to 100% ranges)

**Compensation**
- 3 Background gas only (standard)
- 4 Atmospheric pressure and background gas (optional)

**Material**
- 1 316 stainless steel
- 2 Hastelloy C276

**XMO2 – ___ – ___ Use this number to order product**

**XMO2 Calibration Specifications**

**Range of Oxygen Output**

| | | |
|---|---|---|
| 1 0 to 1% | 5 0 to 21% | A 90 to 100%* |
| 2 0 to 2% | 6 0 to 25% | B 80 to 100%* |
| 3 0 to 5% | 7 0 to 50%* | S Special |
| 4 0 to 10% | 8 0 to 100%* | |

**Compensation Signal**
- 1 Background gas, standard $N_2/CO_2$
- 2 Atmospheric pressure, standard range (700 to 800 mm Hg)

**Response**
- 1 Standard response
- 2 Response to meet EN50104
- 3 Fast response

**XCAL – ___ Use this number to order product**

**Requires pressure compensation option.*


920-032B



N4271 CE

www.gesensing.com

# *APPENDIX B*

## *FLOW METER CALIBRATION CERTIFICATE*

SERIAL NUMBER 2008045 02-27-2020

## COMPONENT VALUES DETERMINED AT CALIBRATION

| PCB 100287 | | PB 100301 | |
|---|---|---|---|
| R3 | 100 | R9 | 49900 |
| R4 | 455 | R10 | 7320 |
| R11 | 5900 | R11 | 49900 |
| R18 | 800 | R13 | 7320 |
| R15 | | DP | 56200 |

FLOW SENSOR - 50 OHMS NI @75 ·F
TEMP SENSOR - 100 OHMS NI @75 ·F

## CALIBRATION POTENTIOMETERS

TA 765 TC 592

| | OPERATING RANGE minimum | maximum | |
|---|---|---|---|
| FLOW | 0 | 750 | SCFM LFG |
| TEMPERATURE | 33 | 200 | ·F |
| PRESSURE | 0 | 15 | PSIG |

COMMENTS: 6.357" LINE ID
ONE PULSE = 500 SCF

## METER OUTPUT SIGNAL CALIBRATION

| mAmps | SCFM LFG | EXC Volts |
|---|---|---|
| 4.00 | 0.00 | 7.895 |
| 5.60 | 75.00 | 8.819 |
| 7.20 | 150.00 | 9.360 |
| 8.80 | 225.00 | 9.740 |
| 10.40 | 300.00 | 10.031 |
| 12.00 | 375.00 | 10.263 |
| 13.60 | 450.00 | 10.456 |
| 15.20 | 525.00 | 10.619 |
| 16.80 | 600.00 | 10.761 |
| 18.40 | 675.00 | 10.887 |
| 20.00 | 750.00 | 10.999 |

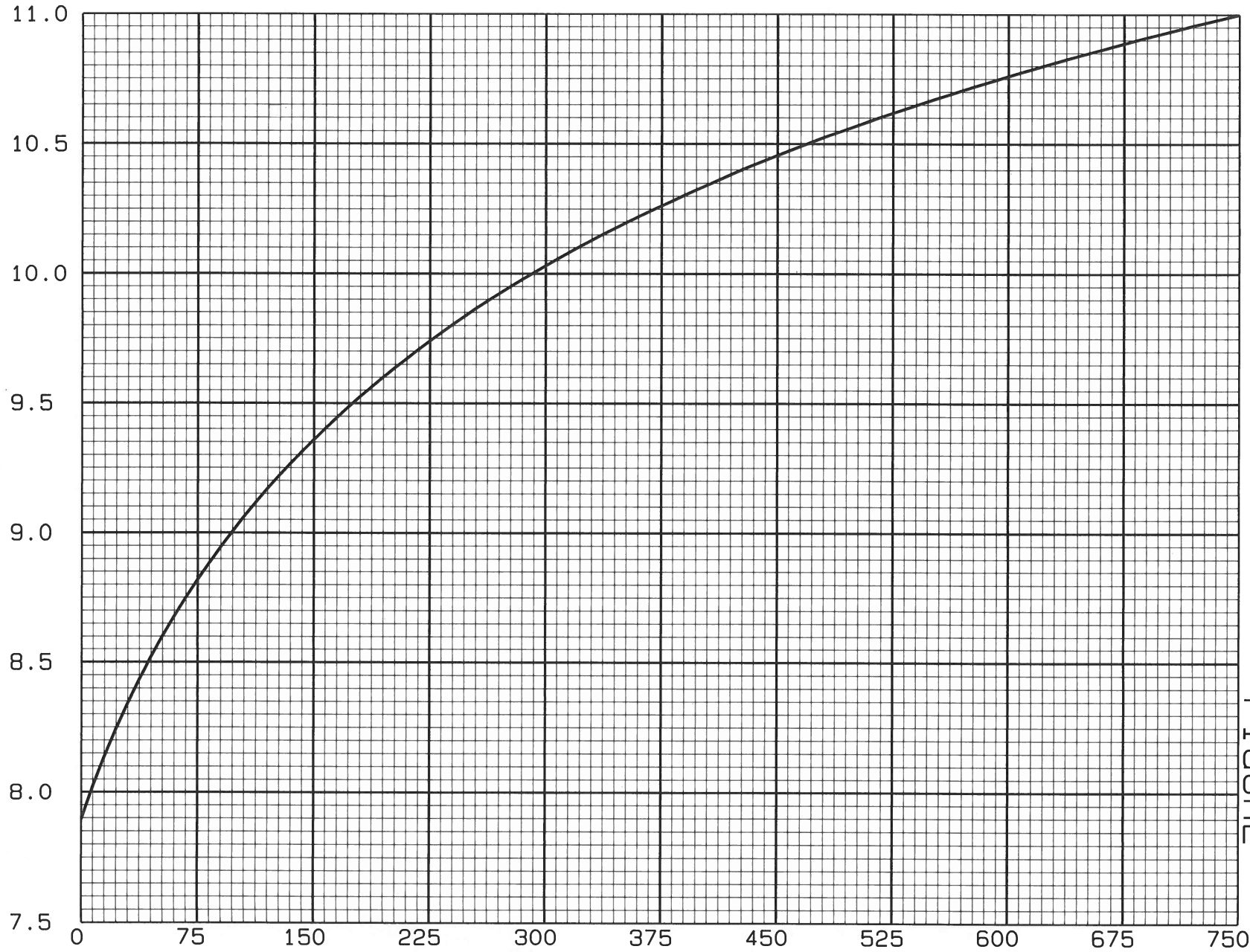


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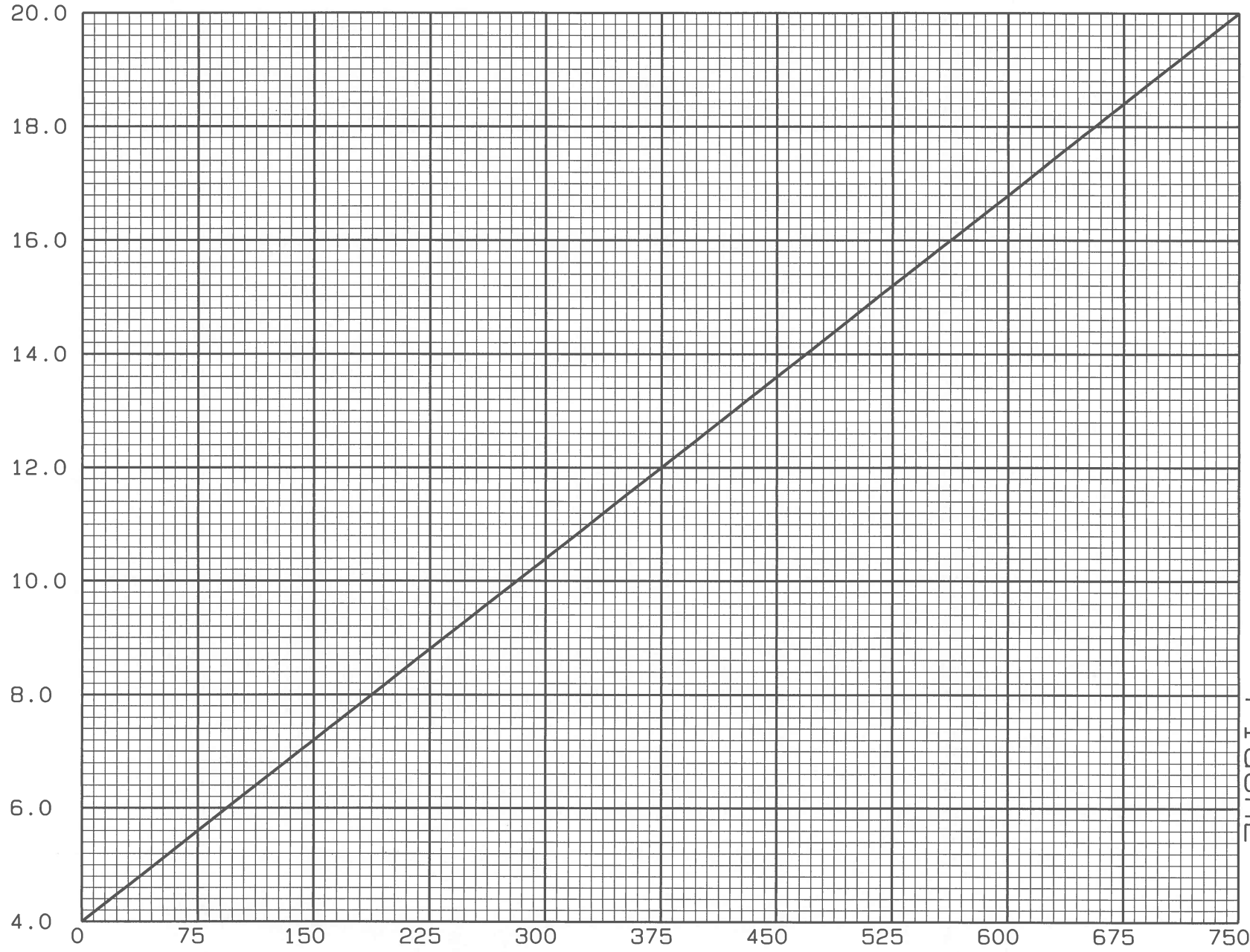
FIGURE

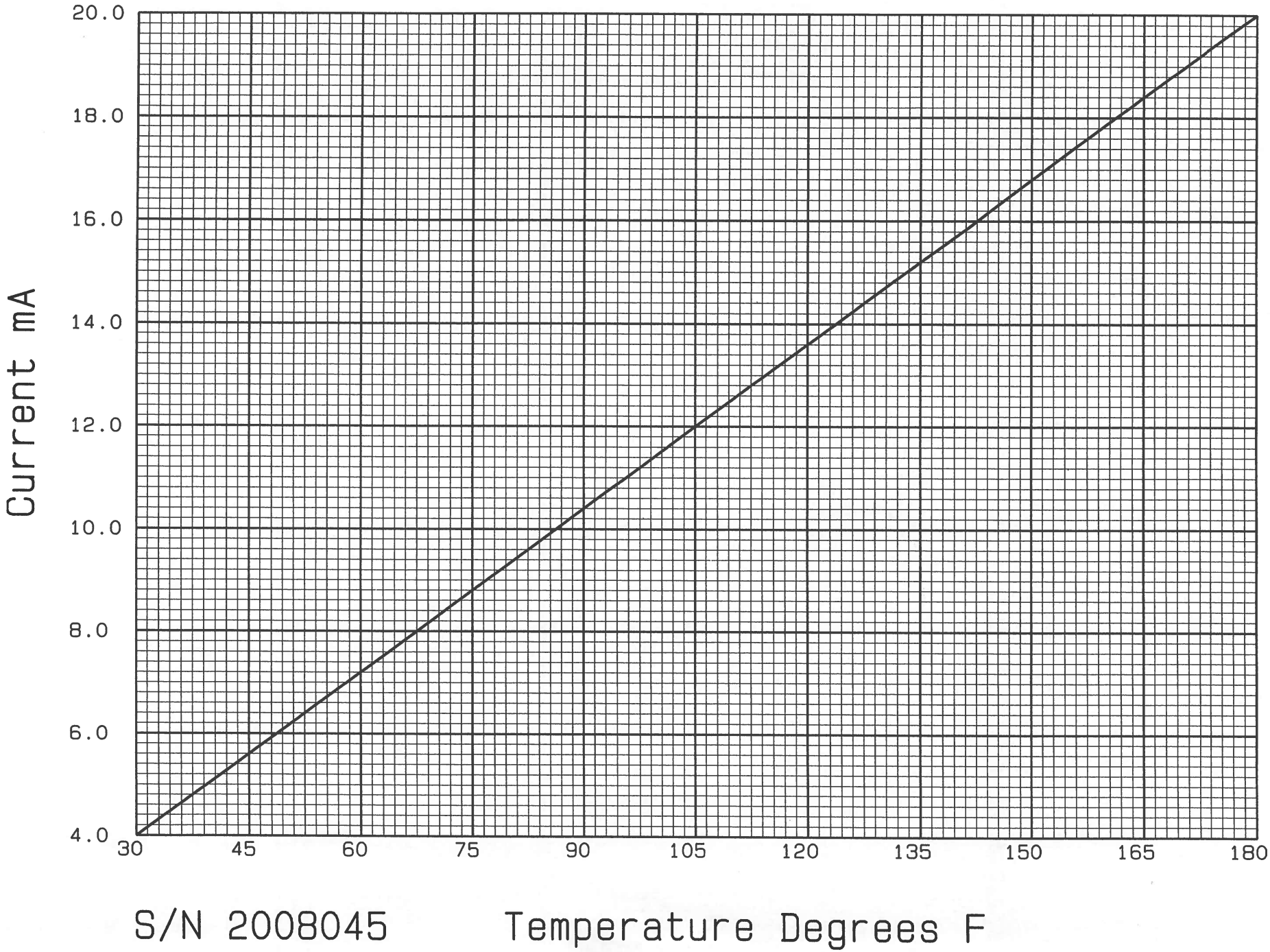
S/N 2008045.0
02-27-2020




FIGURE

PAGE

S/N 2008045.0
02-27-2020


20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
Current mA
30
45
60
75
90
105
120
135
150
165
180
S/N 2008045
Temperature Degrees F

# Thermal Instrument Company

217 Sterner Mill Road, Trevose, PA 19053
Telephone No. (215) 355-8400 Fax No. (215) 355-1789
Email: Office@Thermalinstrument.com Web: www.Thermalinstrument.com

## Calibration Test Data Sheet

| | | |
|---|---|---|
| SN: 2008045 | Master Meter: Venturi S/N 75279 | Fluid: Landfill Gas |
| Flow Range: 0 - 750 SCFM | Temperature Range: 33 - 200 Deg F | Pressure Range: 0 - 15 PSIG |
| Accuracy: +/- 1% FS Failed | Calibrator: BB | Line Size: 6.357" Line ID |
| Date Calibrated: 2/26/2020 | Customer: Regional District of Fraser- Fort George | Approved By: Susan Roxberry |

## As Found

| Master Meter Indication | % Flow Range | Test Meter Exc. (DC V) | Test Meter Output #1 (DC mA) | % MA Range | % Error | Test Meter Output #2 (If Avail) | % Display Range | % Display Error |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 7.895 | 4.148 | 0.9 | 0.9 | 0 | 0 | 0 |
| 90.8 | 12.1 | 8.953 | 6.06 | 12.9 | 0.8 | 0 | 0 | 0 |
| 168.4 | 22.5 | 9.464 | 7.712 | 23.2 | 0.7 | 0 | 0 | 0 |
| 221.3 | 29.5 | 9.724 | 8.846 | 30.3 | 0.8 | 0 | 0 | 0 |
| 327.5 | 43.7 | 10.122 | 11.116 | 44.5 | 0.8 | 0 | 0 | 0 |
| 368.7 | 49.2 | 10.245 | 12 | 50 | 0.8 | 0 | 0 | 0 |
| 466.2 | 62.2 | 10.494 | 14.098 | 63.1 | 1 | 0 | 0 | 0 |
| 549.1 | 73.2 | 10.667 | 15.875 | 74.2 | 1 | 0 | 0 | 0 |
| 615.9 | 82.1 | 10.789 | 17.279 | 83 | 0.9 | 0 | 0 | 0 |
| 662.5 | 88.3 | 10.866 | 18.303 | 89.4 | 1.1 | 0 | 0 | 0 |

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| Accuracy: +/- 1% FS | Calibrator: BB | Line Size: 6.357" Line ID |
| Date Calibrated: 2/27/2020 | Customer: Regional District of Fraser-Fort George | Approved By: Susan Rothery |

## As Left

| Master Meter Indication | % Flow Range | Test Meter Exc. (DC V) | Test Meter Output #1 (DC mA) | % MA Range | % Error | Test Meter Output #2 (If Avail) | % Display Range | % Display Error |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 7.895 | 4.069 | 0.4 | 0.4 | 0 | 0 | 0 |
| 88.1 | 11.7 | 8.931 | 5.873 | 11.7 | 0 | 0 | 0 | 0 |
| 132.6 | 17.7 | 9.253 | 6.802 | 17.5 | -0.2 | 0 | 0 | 0 |
| 248.3 | 33.1 | 9.838 | 9.24 | 32.7 | -0.4 | 0 | 0 | 0 |
| 279.4 | 37.3 | 9.958 | 9.905 | 36.9 | -0.3 | 0 | 0 | 0 |
| 381.7 | 50.9 | 10.282 | 12.084 | 50.5 | -0.4 | 0 | 0 | 0 |
| 466.9 | 62.3 | 10.495 | 13.915 | 62 | -0.3 | 0 | 0 | 0 |
| 501.2 | 66.8 | 10.57 | 14.659 | 66.6 | -0.2 | 0 | 0 | 0 |
| 628.4 | 83.8 | 10.81 | 17.363 | 83.5 | -0.3 | 0 | 0 | 0 |
| 662.5 | 88.3 | 10.866 | 18.135 | 88.3 | 0 | 0 | 0 | 0 |

# CALIBRATION CERTIFICATION

**We certify that the calibration accuracies listed below are obtained on equipment, and with methods, that can be traced directly to the US National Institute of Standards and Technology.**

FLOWRATE READOUT ACCURACY: ± 1% Full Scale

PRESSURE TESTED AT:

METER SERIAL NUMBER: **2008045** MODEL NUMBER: **62-9/926**

*The calibration listed above was performed under the following conditions:*

0 to 750 SCFM LANDFILL GAS
33 to 200 DEG F
0 to 15 PSIG
6.357" LINE ID

Standard Conditions: 60 Deg. F @ 1 ATM

Signature _____ Date **February 27, 2020**

**THERMAL INSTRUMENT COMPANY, INC**

217 Sterner Mill Road, Trevose, PA 19053 Phone: 215-355-8400 Fax: 215-355-1789 Web: www.thermalinstrument.com

Flowmeters by.....
**Thermal Instrument Company, Inc**

**217 Sterner Mill Road, Trevose, PA 19053**
**(215) 355-8400 FAX (215) 355-1789**
**Website: www.thermalinstrument.com**
**e-mail: office@thermalinstrument.com**

## MODEL 62-9/62T-9/9500P INTEGRAL THERMAL MASS PROBE FLOWMETER

**The Thermal Instrument Model 62-9 Mass Probe Flowmeter With Integral 9500P Microprocessor Electronics** brings an element of versatility to Mass Flow Measurement of Liquids and Gases.

A uniquely designed microprocessor controlled electronics provides integral local control and display in an explosion proof housing. Optional Remote Mounting of the electronics up to a distance of 4000 ft. provides additional versatility depending on the application.

Flow signal linearity and temperature effects, determined at calibration, are corrected by the microprocessor using operating parameter data stored in EEPROM memory.

## DESIGN FEATURES

> **Unobstructed Flow Tube with Non-wetted Sensors** mounted on the Inner Surface of the flow tube of the Insertion Probe Design permits measurement of Gases, Liquids and Slurries.

> **Wide Selection of Probe Materials:** 316 SS is standard. Corrosion resistant materials such as Hastelloy C, Monel, Inconel, Carpenter 20 as well as carbide and fluorocarbon coatings are available.

> **Hi Temperature designs to 800 F.**

> **Wide Flow Range on Gases** is greater than 100:1

> **Vent Flow Measurement** at near atmospheric conditions and low flow.

> **Rate and Totalizer** Ultra-bright LED display

> **NIST Traceable Calibration** on user gases and liquids. Calibration in user piping configurations.

## SPECIFICATION MODEL 62-9/9500P

> **Isolated Fluid Temperature Signal** , 4-20MA from an RTD Sensor on the Flow Tube.

> **Multi sensor Design for large ducts and stacks**

> **Electronics suitable for Remote Mount** to 4000 ft.

> **Totalizer Data** is stored in the EEPROM memory on power loss and restored on startup. No batteries required.

## ENGINEERING SPECIFICATIONS

**Accuracy:**
+/- .50% of Full Scale, [or 2.0% of reading whichever is better. Full Scale over the calibrated range.]
[Process fluid temperature span +/- 50 F]

**Repeatability:** +/- .20 % of Rate

**Response Time:**
Gases: 1 to 2 sec. Typical
Liquids: Less than 500ms.

**Pressure Rating:**
0 - 1200 psig (Std)
0 - 10000 psig Dependent on meter size

**Mass Flowrates:**
**Gas:** 40 to 50,000 SFPM
**Liquid:** .02 to 20 FPS
Note: maximum determined by pipe capacity.

**Flow Range:** 100:1 Std. Multiple ranges available.

**Calibrated Temperature Range:**
**Gas:** -40 F to 350 F (-40 to 177 C )STD.
[-20 F to 800 F] ( -28 C to 427 C) Optional).
**Liquid:** -40 F to 350 F (-40 to 177 C ) STD.
[ -40 F to 500 F](-40 to 260 C ) Optional

**Calibration Temperature Capability:**
-200 TO 800 F ( -129 to 427 C )

**Wetted Materials:** 316SS (STD). Consult the factory for other material requirements.

**Mounting:** Flange, Packing Gland, Triclover, Hot Tap

**MICROPROCESSOR SPECIFICATIONS:**

**EEPROM Memory:** 64K

**Displays:** 8 digit Flowrate and Totalizer (Optional)

**Communicator:**
**Interface:** RS-232 via Ribbon Connector
**Baud Rate:** 9600
**Adjustable Variables with RS-232 Communicator:**
**Zero Cutoff; Zero Offset**
Filter Factor
Flow Full Scale
Flow Rate Decimal Point
Flow Totalizer Decimal Point
Flow Totalizer/Flowrate Ratio

**Power:** 120/240 vac, 50/60 Hz.
24VDC, 1 Amp (Factory Set)

**Electrical Connections:** 3/4" FNPT Power & Signal

**Enclosure:** Cast Aluminum, Epoxy Painted

**Environmental Ratings:**
Housing: Explosion Proof, Class 1, Div. 1, Groups, B, C D Weatherproof: Nema 4
Ambient Temperature: -25 to 60 C ( -13 to 140 F )
Storage Temperature: -40 to 70 C ( -40 to 158F )

**Mounting:**
Integral to the Flow Transducer.
Remote to 4000 ft., Wall or Frame mount.

**Signal Cable for Remote Design:** 18 gauge, 2 pair with cable shield. Maximum distance, 4000 ft.

**MODEL NUMBERING SYSTEM:**

**Base Model: = 62-9/9500P**

**Electronics MOUNTING:**
**I** = Integral Mount
**R** = Remote Mount

**Fluid:**
**G** = Gas
**L** = Liquid

**Probe Size:** ½ to 2" (See Sizing Tables for Gas and Liquid).

**Material:**
**316SS** = STD.
**Other** = Consult Factory

**Process Connection:**
**PG** = Packing Gland (Std.)
**FLG-150** =150# RF Flange (Std.Van stone)
**TC** = Triclover
**FLG-Other** = Consult Factory
**Other** = Consult Factory

**Power:**
**24** = 22-26 VDC, 1AMP. 4 WIRE
**120** = 120VAC, 50/60 HZ (STD.)
**240** = 240VAC, 50/'60 HZ

**Output Signals: (Select One**)**
**0/5** = **0-5 VDC****
**0/10** = **0-10 VDC****
**4/20** = **4-20MADC****into 750 ohms, Isolated
**4/20T** = **Optional** Process Fluid Temp. **4-20MA. Self Powered**

**Display: (Optional)**
**D** = Flowrate Display, 5 1/2 Digit
**8T** = Totalizer
**D/8T** = Flowrate and Total Display, 8 digit

**Signal Cable for Remote Design:**
**SC** = 25 FT Supplied with remote configuration

**Thermal Instrument Company, Inc**
**(215) 355-8400 FAX (215) 355-1789**
**Website:www.thermalinstrument.com**
**e-Mail:office@thermalinstrument.com**

# *APPENDIX C*

# *CALCULATION SUMMARY*

FOOTHILLS BOULEVARD LANDFILL
GREENHOUSE GAS EMISSIONS REPORT
CALCULATION SUMMARY

**Total Average Daily Methane Concentration**

$\bar{c}_{daily} = (c_x)/ (\sum x)$

Where,

$\bar{c}_{daily}$ - Daily average methane concentration (volumetric basis).
$c_x$ -Recorded methane concentration (volumetric basis).
$\sum x$ - Total number of data points recorded during the day.

**Total Average Weekly Methane Concentration**

$\bar{c}_{weekly} = (\sum \bar{c}_{daily})/ (\sum x)$

Where,

$\bar{c}_{weekly}$ - Weekly average methane concentration (volumetric basis).
$\bar{c}_{daily}$ - Daily average methane concentration (volumetric basis).
$\sum x$ - Total number of days data points were recorded during the week.

**Methane Destruction**

$M = \rho_m \ (\sum c_x \ V_x) \ (DE)$

Where,

M - Mass methane destroyed.
$\rho_m$ - Density of methane at 25°C (0.6557 tonnes per cubic metre).
$c_x$ - Methane concentration (volumetric basis).
$V_x$ - Volume of landfill gas destroyed (cubic metres).
DE - Destruction efficiency (98 percent.

**Emission Reduction**

$r = (GWP) \ \rho_m \ (\sum c_x \ V_x) \ (DE)$

Where,

r - Unit emission reduction.
(GWP) - global warming potential of 21 for methane.
$\rho_m$ - Density of methane at 25°C (0.0006557 tonnes per cubic metre).
$c_x$ - Methane concentration (volumetric basis).
$V_x$ - Volume of landfill gas destroyed (cubic metres).
DE - Destruction efficiency (98 percent).

# *APPENDIX D*

# *DATA RECORDS*