Installation Report for the Micro-Flare
Leichner Landfill
Clark County, Washington

Clark County Public Health
P.O. Box 9825
Vancouver, WA 98662
564-397-7343

SCS ENGINEERS

04221030.16 | March 2021

2405 140th Avenue NE, Suite 107
Bellevue, WA 98005
425-746-4600

Table of Contents

Tables

Appendices

1.0 INTRODUCTION

SCS Engineers (SCS) has prepared this summary of activities related to the installation, testing, and commissioning of the micro-flare at the Leichner Landfill (Landfill) located in Clark County, Washington, on behalf of Clark County Public Health (County). SCS provided project coordination and permitting, and performed construction quality assurance (CQA) by observing the installation, testing, and commissioning activities.

2.0 BACKGROUND

The Leichner Landfill is a closed municipal solid waste (MSW) landfill that stopped accepting waste in 1991. The landfill gas (LFG) produced by the decaying waste is extracted via a network of gas wells and conveyed through a system of pipes (i.e., gas collection and control system [GCCS]) to an enclosed flare located at the blower flare station (BFS) on the south side of the landfill. Due to the age of the in-place waste, and the continual exponential decline in LFG production, the flow rate to the flare (LFG destruction device) from the GCCS has been steadily declining, approaching the operational limits of the flare. A new smaller flare was required to replace the existing flare to allow for continued operations under a much lower range of flow rates over the remaining life of the GCCS operations.

The purpose of this project was to replace the existing LFG flare with a smaller, lower-capacity, enclosed flare (micro flare). The replaced flare had a capacity of 80 to 300 standard cubic feet per minute (scfm) at 50 percent methane by volume (% by vol.), and was installed as a replacement to the original flare in March 2007 due to declining LFG generation rates. These rates have continued to decline as shown by LFG recovery modeling and the measured average LFG flow rate to the flare. In 2019, the average flow rate was 115.9 scfm at 39.2% by vol. methane (91.1 scfm normalized to 50% by vol. methane). A continued decrease in LFG generation and collection would have soon rendered the existing flare inoperable. A more appropriately sized enclosed micro flare with a capacity of 9 to 90 scfm at 50% by vol. methane was installed to extend the GCCS operating life, increase reliability, and minimize flare downtime.

3.0 EQUIPMENT SPECIFICATIONS

The following summarizes the equipment specifications from the manufacturer for the replacement micro flare:

- Make/Model: Perennial Energy, Inc., 2.7 million British thermal units per hour (MMBtu/hr) Micro Enclosed Flare (micro-flare)
- Rated Capacity: Thermal loading rate of 0.27 – 3 MMBtu/hr, 9 to 90 scfm of LFG with a calorific density between 250 and 550 British thermal units per cubic foot (Btu/ft^3)
- Flare Dimensions: Fully enclosed with a 40-inch diameter, 25-foot tall shell
- Location: Southwest corner of the closed landfill at the blower flare station (location of existing flare)
- Destruction Efficiency: 99% for hydrocarbons, 98% for non-methane organic compounds (NMOCs)
- Turndown ratio: 10:1
- Minimum Methane: Approximately 24.7 percent methane by volume (assuming heating value of methane of 1,011 Btu/ft^3)
- Flare Pilot Light: Propane used for pilot light during startup only.

A copy of the manufacturer's specifications for the flare is included as Appendix A. Copies of the Process Flow Diagram and Equipment Layout can be found in Appendix B.

4.0 AIR PERMITTING SUPPORT

Prior to replacement of the flare, an application to modify the Landfill's Air Discharge Permit (ADP) No. 07-2714 was required to be submitted in the Southwest Clean Air Agency (SWCAA). SCS met with SWCAA on February 8, 2019 to discuss the proposed project and timeline for the permit modification application submittal to the Agency. A complete application to modify the ADP was submitted to SWCAA on August 6, 2020, and included the required permit application forms, site plan, copy of the existing permit, manufacturer's information for the proposed flare, site emissions estimate (with supporting documentation), a Best Available Control Technology (BACT) analysis, and a State Environmental Policy Act (SEPA) determination letter.

The application (No. CL-3138) was received by SWCAA on August 6, 2020, and the final (modified) ADP No. 20-3433 was issued on October 1, 2020. A copy of the permit and technical support document is included as Appendix C.

5.0 KEY PERSONNEL

The following table summarizes the key personnel involved in the project:

Table 1. Key Project Personnel

Role	Affiliation	Key Personnel
Owner	Clark County Public Health	Mike Davis
Consultant	SCS Engineers	Steve Harquail, Louis Caruso, Greg Helland, Ted Massart, Phil Carrillo, Alexa Deep
Manufacturer	Perennial Energy, Inc.	Edward Boys, Colby Bain
Subcontractor – Installation	Ness Campbell	
Subconsultant – Source Testing	Montrose Air Quality Services, Inc.	Sean Donovan, Peter Becker, Kristina Schafer

6.0 OBSERVATIONS DURING INSTALLATION, TESTING, AND COMMISSIONING

Flare installation activities began on the morning of September 28, 2020. The existing flare was de-energized and disconnected from the GCCS. Crane setup consisted of the addition of counterweights, load testing, and man-basket setup before the existing flare was removed. Following setup, SCS and Ness Campbell (Crane subcontractor) led a project kickoff meeting and safety talk.

Removal of the existing flare began at 10:00am. The old flare was loaded onto a truck and placed in a lay down area off the road near the site entrance. Next, the new control panel was lifted from the truck and placed inside the flare compound near the control panel shed. Finally, the new flare was lifted from the transport truck and set on its side to remove the transport brackets, attach the top-lift cords, and install the top metal platform piece. The flare was then lifted vertically and placed within the flare compound on the concrete pad, which had three of four sets of bolt holes pre-drilled.

The primary issue encountered during the flare installation was with the bolt hole alignment. After attempts were made to adjust the bolts in the pad, SCS personnel discussed the problem with Perennial (flare manufacturer) and decided the appropriate course of action was to enlarge select bolt holes on the foot of the flare. The flare was lifted off the flare pad and SCS personnel extended the bolt holes by ¼-in. on one of the flare feet. The flare was then aligned over the bolt holes on the flare pad. Extra-large washers were placed over the enlarged holes.

Following the flare alignment, and once the flare was secured to the flare pad, the burner pot was installed. The crane lifted the burner pot off the truck, and slowly lowered it down into the flare to rest on the burner pot manifold.

On September 29, 2020, the electrical and piping installation work began. These activities included installing the (1) new control panel, (2) gas pipe and fittings to connect the blower discharge pipe to the flare, and (3) electrical conduit to connect power and signal wire from the control panel to the flare:

Additional electrical and piping installation work took place on September 30, 2020. Activities performed included:

- Installing electrical conduit and wiring through conduits.
- Completing gas pipe plumbing from blower discharge pipe to the flare, including installing fittings for mounting a thermocouple and two pressure transmitters.
- Relocating the propane meter.
- Installing piping support braces.
- Constructing a 2-ft by 5-ft concrete pad to install metal supports for instrumentation.

Additional programming, electrical, and instrumentation work took place on October 1, 2020. Activities performed included:

- Checking and testing wire connections from control panel to flare instruments, louver motors, and blowers.
- Installing instrumentation on the gas process pipe including pressure and temperature gauges and thermocouples and pressure transmitters.
- Testing the control panel and programming logic.

On October 2, 2020, the flare startup was initiated after the final flare components were installed. The following issues were noted by on-site SCS personnel performing CQA:

- The two nitrogen tanks were temporarily secured with tie-downs until a base stand for the tanks can be obtained and installed.

- The Rosemount pressure transmitters were temporarily secured to the existing metal brackets, which were eventually replaced.
- New bushings were planned to be installed at the two adjacent tee fittings to connect the sample tubing to the transmitters.
- The transmitter that relays vacuum pressure from the wellfield (at inlet of the blower flare) was not operating correctly and needed to be replaced.

The commissioning of the new flare was completed on October 8, 2020. Drawings for installation of pipe, valves, instrumentation and equipment are included in Appendix D and a photo log of the installation is included in Appendix E. Copies of the commissioning and testing documentation provided by Perennial are included in Appendix F.

7.0 SOURCE TESTING

Source testing requirements are outlined in Appendix A of the ADP and included the following:

- Conducting an initial source test no later than 90 days after commencing regular operation of the flare.
- Submitting a source test plan to SWCAA for review and approval at least 10 business days prior to the scheduled date of testing.
- Notifying SWCAA personnel at least 5 business days prior to the beginning of the test so that they can be present during testing, if available.
- Providing a copy of the source test report to SWCAA within 45 calendar days following completion of the source test.

All of the above requirements were met as discussed below.

With the flare startup on October 2, 2020, the source test was required to be completed by the end of the year (by December 31, 2020). Montrose Air Quality Services, Inc. was subcontracted to complete the source test for the Landfill's new flare. The test was scheduled for December 9th-10th, 2020. As such, a source test plan prepared by Montrose and schedule notification was submitted to SWCAA on November 20, 2020. The plan was approved via email on December 3, 2020. A copy of the source test plan is included in Appendix G.

The Landfill is required to test for compliance with the permitted emission limits for the following parameters: sulfur dioxide (SO_2), nitrous oxides (NO_x), carbon monoxide (CO), and non-methane organic compounds (NMOCs). Source testing of the flare consisted of three test runs lasting 1 hour each for the following test methods and parameters:

- Flare Inlet and Outlet Velocity/Volumetric Flow Rate & Temperature (EPA Methods 1 & 2)
- Flare Inlet Fuel Factor (EPA Methods 3C and 19)
- Flare Inlet & Outlet O_2 & CO_2 (EPA Method 3A)
- Flare Outlet Moisture Content (EPA Method 4)
- Flare Outlet SO_2 Concentration (EPA Method 6C)
- Flare Outlet NOx Concentration (EPA Method 7E)
- Flare Outlet Opacity (EPA Method 9)

- Flare Outlet CO Concentration (EPA Method 10)
- Flare Inlet & Outlet NMOC Concentration (EPA Method 25C)
- Flare Inlet & Outlet Post-Test Thermocouple Calibration Check (EPA Alt. Method 11).

SCS personnel were onsite during the source test to document the testing and assist Montrose with operations of the flare. During the testing, an issue with the flare's data recording system was discovered and is discussed in further detail in Section 9. The issue did not affect the outcome of the source test as SCS personnel were onsite to photographically document the flare operating parameters (flow, temperature, and vacuum) periodically throughout each test run. Montrose confirmed this was acceptable for calculation purposes.

A copy of the source test results is included as Appendix H. These results were provided to SWCAA on January 22 2021, within 45 days of the source test as required by the permit. The results indicate that the new flare meets the permit limits for SO2, NO_x, CO, and NMOC emissions at the minimum and maximum expected operating temperatures. The table below summarizes the results of the source test. Test 1 was conducted at the maximum expected operating temperature (1,475 °F setpoint, 1,475 °F average). Test 2 was conducted at the minimum expected operating temperature (1,300 °F setpoint, 1,303 °F average). Based on the source test results, the flare meets the permitted emission limits over the range of 1,303 °F to 1,475 °F.

Table 2. Summary of Source Test Results

Parameter	Test 1 Average Results (lb/MMBtu)	Test 2 Average Results (lb/MMBtu)	Permit Limit (lb/MMBtu)	Equal to or Below Limit?
SO2	< 0.0024	< 0.0029	0.016	Y
NOx	0.060	0.059	0.060	Y
CO	0.0035	0.0085	0.15	Y
Total NMOC	< 0.0065	< 0.0070	0.050	Y

8.0 ADDITIONAL ISSUES

During the source test, it was discovered that the data recorder at the blower flare station had malfunctioned, and data recording and storage had not occurred since the installation of the new flare. Data for the period of September 28, 2020, through December 10, 2020, including continuously recorded parameters for LFG flow sent to the flare, destruction temperature of the flare, and vacuum of the wellfield, was unavailable for review.

The issue was found to result from a combination of a programming error and site-wide network problem that prevented data from being stored and uploaded to the Landfill's remote monitoring and control (RMC) system as intended. Upon discovery of the issue on December 10th, SCS personnel immediately began taking steps to troubleshoot and correct the malfunction. SCS RMC personnel rebuilt the system for the programmable logic controller (PLC) and C-More so that data recording and storage resumed on December 10th at 14:04. Further troubleshooting discovered a network connection issue that prevented data from being uploaded to SCS's eTools database, which was also corrected.

Based on the flare temperature set points programmed by Perennial during the startup and initial testing, it is believed that during the missing data period, the flare operated according to the Landfill's ADP, which required that the flare be operated at a minimum of 1,400 °F on a 1-hour average basis prior to the source test. The flare operating temperature set point was programmed at 1,475 °F, and the low and high temperature shut down set points were programmed at 1,400 °F and 1,950 °F, respectively. The low temperature set point prevents the flare from operating below 1,400 °F for more than 3 consecutive minutes without shutting down.

Notification of the issue and missing data was provided to SWCAA on December 17, 2020, after confirming that the issue was fully resolved. A copy of this notification is provided in Appendix I.

Appendix A

Flare Manufacturer’s Equipment Specifications

ENGINEERING SUBMITTAL

for a

2.7 MM BTU/HR
Micro Enclosed Flare

for the

Leichner Landfill
Clark County, WA

RFP# 773

ENGINEER

SCS Engineers
2405 140th Ave NE
Suite 107
Bellevue, WA 98005
Phone: (425 289-5457)

CLIENT

Clark County Washington
1300 Franklin St.
Vancouver, WA 98660
Phone: (564) 397.2323

MANUFACTURER

PERENNIAL ENERGY, LLC.
1375 County Road 8690
West Plains, MO 65775
Phone: 417-256-2002
Fax: 417-256-2801

PEI # 1910
MAY 2020

Leichner Landfill Micro Enclosed Ground Flare
Perennial Energy Project # 1910
Clark County Public Health Solicitation No. 773

Table of Contents

Name	Drawing #	Sheets
Cover	Cover 1910	1 of 1
P&ID	ME-010-0166	1 of 2, 2 of 2
120 VAC, Control	EE-005-0584	1of 1
Interconnection Wiring	EE-018-0255	1 of 1
Top Assembly	PA-001-1037	1 of 1
Spare Parts	SP-001-0192	1 of 1

PEI PERENNIAL ENERGY

17 May 2020

Job # 1910
Leichner Landfill Micro Enclosed Flare

Control Objectives, Scope of Supply Clarifications, Exceptions, Control Objectives

The objective of this project is to provide a micro Enclosed Flare that meets the following requirements (these are identical to those in paragraphs 1.02, 1.07 & 1.08 of Section 43 10 00 of the specifications):

Condition	Value
LFG flow rate, SCFM	9-90
Site Latitude	45.6868 Degrees
Site Elevation, ft-msl	214
Climate	Short hot summers to mild wet winters
Ambient Dry Bulb, Degrees F	21 to 91
Average Rainfall, inches	42
Methane Concentration	25-55%
Carbon Dioxide Concentration	25-45%
Nitrogen Concentration	5-25%
Water Vapor Concentration	1-12%
Oxygen Concentration	0-4%
Argon Concentration	0-1%
Hydrogen Concentration	Less than 1%
Trace Compounds (Listed in detail in specification)	Less than 1%
Gas Supply Pressure to Shutdown Valve	10 " WC
NOX Emissions	Less than 0.06#/MM BTU
CO Emissions	Less than 0.15 #/MM BTU
NMOC Destruction efficiency	98% or less than 0.050 #/MM BTU as Hexane at 3% O2
Visible Emissions - EPA Method 22	None except periods not exceeding 5 minutes in any two consecutive hours
Visible Emissions - EPA Method 9	Not to exceed 0% opacity except for 3 minutes in any 1 hour period

This landfill is a 120 acre site with about 74 acres of fill. It was operated from the late 1930s until it closed completely in 1991. Gas production is declining in both quality & quantity, turn down is critical to project ongoing success.

1375 County Road 8690 West Plains, MO 65775
Phone (417) 256-2002 Fax (417) 256-2801
www.PerennialEnergy.com PEI@PerennialEnergy.com

Scope Of Supply Clarifications

Section 43 10 00 describes a micro Flare and controls. PEI's Scope of Supply only includes the Micro Flare as described in this submittal, the controls & programming are provided by others. PEI is supplying a Honeywell Burner Controller, base, amp card and purge card. Included Spare Parts are delineated on the included PEI Drawing SP-001-0192.

Exceptions to Specifications, Clarifications

The equipment provided by PEI is compliant with the specifications in Section 43 10 00 with the following exceptions:

1.02 A. requires operation throughout the entire range (9-90 SCFM and 25-55% CH4) without extra manipulation of equipment, instruments, and/or components. The flare provided by PEI will turn down from 3 MM BTU/Hr to 0.27 MM BTU/Hr, however, as noted in our March 9 proposal the flare will turn down to 0.45 MM BTU/Hr without manipulation (6:1), below this point the original 12" ceramic burner tip is replaced with a supplied 7" burner tip, a supplied spud sleeve is installed, and one of the two louvers is disabled.

1.02 D. references staged burner nozzles. The supplied flare has a single nozzle based on the proven PEI design that has a demonstrated 30 year performance record.

2.02 A requires a high performance butterfly valve with 316 stainless internal parts and a Viton resilient seat. PEI typically interprets "high performance butterfly valve" to be a valve for higher pressures and it has a hard, thin PTFE or plastic seat. PEI's experience is that in low pressure LFG applications a Viton resilient seat provides better service, therefore the proposed valve has 316 stainless steel internal parts and a Viton resilient seat.

2.03 A requires a UL certification on the Flame arrester, this is not available from Groth, it is provided with ATEX certification.

2.04.C.1.k requires a 6" Main Gas Inlet Nozzle, this is oversized for 90 SCFM, the proposed flare is provided with a 3" Main Gas Inlet with a 150# flange.

2.04.C.2.a describes a burner with five individual burners, please see the comments on 1.02 D above.

2.06 B.13 The supplied UL-certified burner controller is a mass produced device intended for use on power burners. The functionalities are largely fixed and not subject to user adjustment. Power burners use the burner blower to purge the flare, and the air flow switch remains satisfied throughout the entire run cycle. This is an atmospheric burner, the purge blower only runs during purge, and the air flow switch is only satisfied during the purge cycle. Therefore, in order to use the UL-Certified burner controller a bit of external manipulation to the signals entering/leaving the burner controller is required. Please see the manufacturer's literature on the Burner Controller for a complete and thorough description of functionality.

May 15th, 2020

New *PEI* Enclosed Landfill Gas Flare – Guaranteed Performance Specifications

The following is a synopsis of the guaranteed emissions levels and destruction efficiencies of the *PEI* enclosed landfill gas flare proposed for the Leichner Landfill project. The emissions levels and destruction efficiencies stated herein are only guaranteed if the flare is properly adjusted and testing is performed by an approved testing company with documented experience in emissions testing of low velocity landfill gas flare exhaust streams.

The flare is designed to combust from **9 to 90 SCFM** of landfill gas having a calorific density of between **250 Btu/ft^3** and **550 Btu/ft^3**, as long as the thermal loading rate is between **0.27 MMBtu/hr** and **3 MMBtu/hr**.

Operated within the above criteria, the *PEI* flare will emit no more than **0.06 lb/MMBtu NOx** (evaluated as NO_2). Such guarantee is based on CEMS testing performed by a approved testing company using chemiluminescence analytical techniques compliant with EPA method 7E, and when the following equation is used as the basis of the emission calculation;

lb/MMBtu NOx = (ppm NOx / 10^6) x (46 lb/lb-mole / 385.3 dscf/lb-mole) x Ff * x 20.9 / (20.9 - % Stack O_2)

Operated within the above criteria, the flare will emit no more than **0.15 lb/MMBtu CO**. Such guarantee is based on CEMS testing performed by an approved testing company using NDIR/GFC analytical techniques compliant with EPA method 10, and when the following equation is used as the basis of the emission calculation;

lb/MMBtu CO = (ppm CO / 10^6) x (28 lb/lb-mole / 385.3 dscf/lb-mole) x Ff * x 20.9 / (20.9 - % Stack O_2)

*** The Ff (fuel factor) shall be as determined by laboratory analysis or per EPA Method 19, Table 19-1**

Operated within the above criteria, the flare will provide NMOC destruction efficiency compliant with Subpart Cc, 60.33c, (c) (2), i.e. ". . .shall **reduce NMOC by 98 weight percent**, or;" (c) (3) of that same section, i.e. ". . . reduce the outlet NMOC concentration to **0.050#/MM Btu** as hexane by volume, dry basis at 3 percent oxygen, or less." Such guarantee is based on inlet flow rate measurement taken via pitot tube traverses performed in compliance with EPA method 2, and for **exhaust flow rates determined by a carbon balance equation evaluation**. Samples of the inlet and exhaust gases to provide methane and total gaseous non-methane organics constituencies shall be collected in summa canisters, and shall be laboratory evaluated using the TCA/FID analytical technique compliant with EPA method 25C. A GC/FID analyzer shall be employed during source testing for sampling exhaust gas during CEMS testing to provide an "on-line" indication and record of total volatile organic compounds (TVOC's). The calculation to determine the destruction efficiency shall be as follows;

(lb/hr NMOC's IN - lb/hr NMOC's OUT) / lb/hr NMOC's IN . . . where;

lb/hr NMOC's as hexane = (ppm as C_1 NMOC's / 6 / 10^6) x (86 lb/lb-mole / 385.3 dscf/lb-mole) x (dscf / hr)
or;
ppm NMOC's as hexane at 3% Oxygen = (ppm as C_1 NMOC's / 6) x (20.9 - 3) / (20.9 - % Stack O_2)

The system shall be capable of achieving a minimum of **99**% DRE of Total Volatile Organic Compounds (VOC's) (Sum of methane and non-methane organics). Please note that oxidizing combustion systems (such as landfill gas flares) neither generate nor remove sulphur. Any H_2S entering the flare is oxidized to form SOx compounds, but on a molecular basis, sulphur in is equal to sulphur out.

Note also that mineral based particulates, such as wind blown dust or silica, can be entrained into the ambient cooling and quenching air or purge air streams and passed into the combustor. As non-combustible matter, they will be passed into the exhaust stream and will be measured as particulate emissions, but are not generated by the combustion process. PEI makes no guarantees regarding these particulates. Barring individual identification of the particulate matter, it shall be assumed that if the combustor is meeting the above destruction efficiencies, it is evidence that any particulates measured are ambient particles and not generated by the combustion process.

1375 County Road 8690 West Plains, MO 65775
Phone (417) 256-2002 Fax (417) 256-2801
www.PerennialEnergy.com PEI@PerennialEnergy.com

Equipment Data Sheet

3 MMBTU Flare

Spec. #
Sheet # 1 of 1
By: ETB
Date: 15 May 2020

Reference Designator or Item # **FLR-1**

Quantity	1	
Manufacturer or Approved Equal	PEI	
Model #	FL-40-25-E	
Capacity	9-90 SCFM	0.27- 3 MMBtuh
Emissions Compliance Design Criteria	See Emissions Statement	
Temperature/Retention Time	Min 1400 Deg F for 0.6 Seconds	2000 F Max
Thermocouples	Three Type K	
Site Glasses	5	
Anchor feet	4	
Flare Shell Height, O.D., Thickness	25 ft, 40 in, 0.25 in	ASTM A-36
Air Entrance Louvers	2 each – 12" w x 14" h	Motor Operated
Flare floor, feet, manway, lift lug, housing & hooks	ASTM-A-36	
Top Ring & Shield	304L S.S.	
Flare Insulation	**4" Ceramic Fiber**	
Insulation Attachment	Inconel Studs & Retainers	
Insulation Layers	3 ea. - Overlapping	
Insulation Density	**2" 4 lb/ft^3 and 2" 8 lb/ft^3**	
Inlet Nozzle Size	3"	ANSI 150# Flange
Flare Burner Manifold & Associated Parts	304L S.S.	
Flare Burner Ports	Castable Refractory	
External Ladder & Tie Off points	OSHA & ANSI A14.3 Standards	
Head Shield	ASTM-A-36.	
Head Shield Supports	ASTM-A-36	
Pilot Fuel	Propane	
Purge Blower HP, Voltage, phase	1/3 HP, 120 VAC, 1 phase	

COMMENTS or NOTES:

Provided with Automatic Shut Off Valve, Flex, Flame Arrester, Flame Arrester Temperature switch, Purge Blower, Purge Blower Pressure Switch, Honeywell Purple Peeper. Controls provided by others.

Unloading & Assembly Instructions

Perennial will coordinate shipment, delivery & startup as the date draws near. We will provide a phone number for the truck driver. An exact weight will be provided for the flare at shipment.

The Enclosed Ground Flare (EGF) will largely assembled, other components ship loose for their protection. Upon arrival at the jobsite, a crane or other lifting device will be required to unload and place the flare. Approximate weights for major equipment:

EGF: ~ 4000 lbs

The EGF is shipped in the horizontal position. Lift the flare to a vertical position using the provide lift lugs on the top of the flare. Anchor after setting in place. While the crane is on site lower the 12" burner tile into the flare – do not install the thermocouples in the flare before installing the burner tile! All connections including sealtite, thermocouple wire, ignition wire and gas run should be properly secured and tightened.

The landfill gas piping and electrical service connections can now be made. In addition, the condensate drain on the flame arrester must be connected to a proper condensate collection system. The Flare must be grounded per instructions provided by the Engineer of Record. Grounding lugs are provided.

Factory Testing, Startup, and Functional Tests

Factory Testing

Factory test forms are included in this section. Testing will be scheduled as the project nears completion, the client is welcome to witness the tests in person or via Skype.

On Site Startup, Functional & Validation Tests

After the equipment is installed the Perennial Startup Tech will conduct tests & inspections & document that the equipment is acceptably installed and performs to specification. The client will be asked to document any deficiencies and sign a startup form. The startup packet will be delivered to the client for review, comment & approval at least 2 weeks prior to scheduled startup.

Pre-Startup Form

A pre-start up form is attached, this ensures that the unit is ready for the PEI Start Up tech upon arrival. This form needs to be completed & returned to PEI before the start up trip is scheduled, we request at least two weeks advance notice.

Test Bay Packet

V1.3

Job #	1910	
Job Name:	Leichner Landfill Mico Flare	

Drawing List Attached:

- P & ID Drawing
- Top Assembly Drawings
- Interconnection Drawing

Reference Documents Attached:	Tab #
Control Objectives, Control Narrative	1
Valve Configuration	2

Forms to be Completed (Attached)	Tab #
All Skids Test Form	3
Enclosed Ground Flare Test Form	4

Save on Server after Completion:

- Completed Test Pkt

Created By:	ETB	Date:	15-May-20
Reviewed & Approved By:			

Standardized Test Packet			
V 1.0			
Project number			1910
Project name			Leichner
Req'd?	Item	Complete	Notes
	1.0 General System Inspection		
	Inspect system for any visible physical mechanical or electrical defects that would be prevent the system from being tested or be harmful to equipment or personnel.		
	1.1 Mechanical Inspection		
	Verify all handles are installed on valves		
	Verify valves are in the proper state (open/closed) per the P&ID		
	Verify devices are present per the P&ID		
	Verify devices are in the proper location per the P&ID		
	Verify all LFG ports are plugged, including condensate lines		
	Verify tubing has been installed on correct port (L or H) of transmitters and gauges		
	Verify all gauges and transmitters are the correct range per the P&ID.		
	Verify all tubing connections are tightened correctly.		
	Verify that all bolts have been torqued & marked		
	Confirm measurements on gas inlets, gas outlets, condensate drains, and electrical connections match prints.		
	1.2 Electrical Inspection		
	Verify all appropriate electrical panel, skid, blower, and earth grounds are properly installed		
	Verify all power wires are landed on proper terminals for breakers, VFD's starters, and motors		
	Verify all connection points for AC circuits are properly landed and required jumpers installed per schematics. Connections tight and secure		
	Verify all connections points for DC circuits are properly landed and required jumpers are installed per schematics. Connections tight and secure.		
	Ohm AC circuits, Verify no shorts on system to ground.		
	Ohm DC Circuits, Verify no shorts on system to ground.		
	Ohm and verify no AC-DC cross over on either circuit.		
	Verify that all interconnecting wires are per Interconnection Drawings		
	Verify Junction boxes, junction blocks are per Interconnection drawing		

Enclosed Ground Flare			
Req'd?	Item	Complete	Notes
	1.0 General System Inspection		
	Verify overall flare height		
	Verify base & Anchor hole dimensions		
	Verify louver linkage & louvers work freely		
	Verify weatherproof kits in Modutrol motors		
	Verify Thermocouples are correct type & length		
	Verify lens is in Purple Peeper		
	Verify upper, middle & lower Thermocouples are on correct terminal blocks.		
	1.1 Electrical Inspection		
	Verify Peeper cable landed in Junction Box		
	Verify thermocouple extension wire is correct type		
	Verify louvers operate, open close as indicated on 4-20 mA signal. 4 mA= open, 20 mA = closed.		
	Verify limit switch on Louver Motor is closed in closed position.		
	1.2 Pilot Test		
	Test fire pilot. Confirm that it lights, extends far enough to light burner, and satisfies flame detector.		
	1.2 Purge Blower Test		
	Confirm purge blower voltage matches interconnection drawing		
	Connect purge blower to utlity through test bay motor starter. Confirm rotation		
	Confirm that flow switch makes when purge blower runs.		

Pre-startup Checklist

Before PEI personnel arrive on site the contractor must confirm the following items are complete and the equipment is ready for startup. Delays due to the equipment not being ready will be billed at standard published PEI rates.

- ❑ The Flare must be leveled, anchored, and grounded with an appropriately sized grounding system.
- ❑ Grounds should be Cad-welded to the feet of the flare if possible. Ground flare per documents provided by the Engineer of Record. All applicable code requirements must be met such as NEC, OSHA, etc.
- ❑ All electrical connections must be checked for tightness including sealtights, Myers hubs, and box covers. All conduits installed by the contractor must have Myers hubs and sealoffs where applicable. The electrical system's NEMA enclosure rating can be jeopardized if appropriate gaskets and/or sealing materials are not used.
- ❑ Seal offs provided by the contractor shall be filled by the contractor after inspection & testing. PEI Service techs will fill seal offs provided by PEI after inspection & testing.
- ❑ Pilot fuel must be present at the required pressure. Ensure pilot fuel lines are free from moisture & debris.
- ❑ Install the head shield on the flare prior to standing it upright. Nuts, bolts & washers are provided.
- ❑ All incoming gas lines to the system must be blown down to remove any debris and water that may have accumulated in the line. Gas lines must be sized and regulated to provide flow at the flow rates & pressures shown on the P&ID.
- ❑ Provide dry compressed air or nitrogen as required. Ensure tanks are full and pressures are as shown on the P&ID.
- ❑ Connect drain lines as directed by Engineer of Record. Do not create a short circuit around the flame arrestor.
- ❑ Clearances in front of disconnects must comply with current NEC guidelines for clearances.
- ❑ A wiring interconnection drawing is provided. **Ensure that the installing electrician has the most up to date revision.** Contact Perennial at 417-256-2002 if you and/or the electrician have questions. Incorrect or incomplete wiring is the most common cause of startup delays, we are always happy to answer questions and work to ensure that the onsite electrician is successful on the first attempt.
- ❑ Use the correct type of Thermocouple Extension wire to connect thermocouples. Contact PEI if you need assistance.

- Do not throw any boxes away without checking that they are completely empty. Small items such as spark plugs, bolts, gaskets, etc. are sometimes shipped in a box containing larger items. Make sure that you have accounted for all such items before disposing of boxes.

- Cast aluminum parts are fragile and will not support excess weight. Flame arrestors and check valves are examples. Attachments to these parts should be supported so that the weight is not resting on the flanges. When bolting raised face flanges to cast aluminum flanges care should be taken not to over tighten the bolts.

- Enclosed flares must have the wooden shipping covers and the top shipping stand removed before standing upright. Block up top end of flare and attach chokers to two of the lifting eyes at the top of the flare. Stand the flare up using the bottom shipping stand as a pivot point. Once the flare is vertical, remove the bottom stand. Set the flare into place and lag down.

- Burner pots, pilot tile, spark plugs, and the flame scanner should be installed after the flare is standing up. The flame scanner should be installed with the arrow on the back of the unit pointing *down*. Tighten the nut so that the unit will move with firm hand pressure.

- Coordinate any other vendors or trades to be present as needed. Delays due to waiting on other vendors may result in additional charges.

- The system must be ready for the PEI Service Tech to begin testing and commissioning within 30 minutes of arrival on site.

- If the PEI Service Technician will require Safety Training please provide the relevant information in advance so that, if possible, the Technician arrives at site ready to go to work.

Date: ______________________________

Project Name: ______________________________

Project Location: ______________________________

Signature: ______________________________

Printed Name: ______________________________

ASCE 7-10

WIND LOAD CALCULATIONS FOR "RIGID" -- "OTHER STRUCTURES"

in accordance with IBC 2012, 1609.1.1

Chapter 29 - *"Wind Loads on Other Structures and Building Appurtenances-MWFRS"* . . .
and Chapter 26 - *"Wind Loads: General Requirements"* by reference

PEI Project #: 1910 **PEI Project Name:** Leichner Landfill **Structure Description:** Enclosed Flare

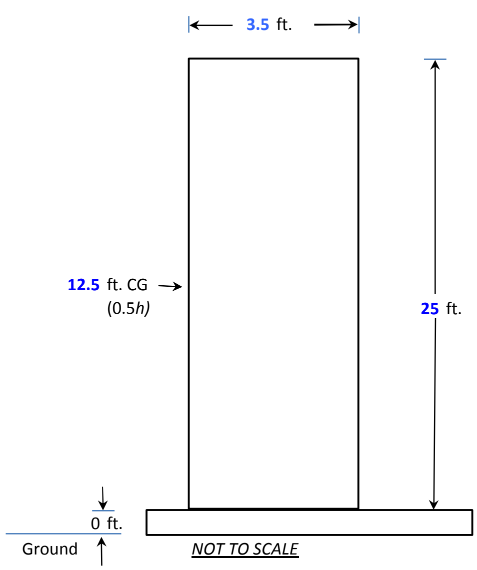
Structure Height (h)	Height above Ground (z)	Structure Dia. or Length (D)		Basic Shape of Structure
(ft.)	*(ft.)*	*(ft.)*		Table 26.6-1
				*(**S** quare, **H** exagonal OR octagonal, or **R** ound)*
25	25	3.5		R

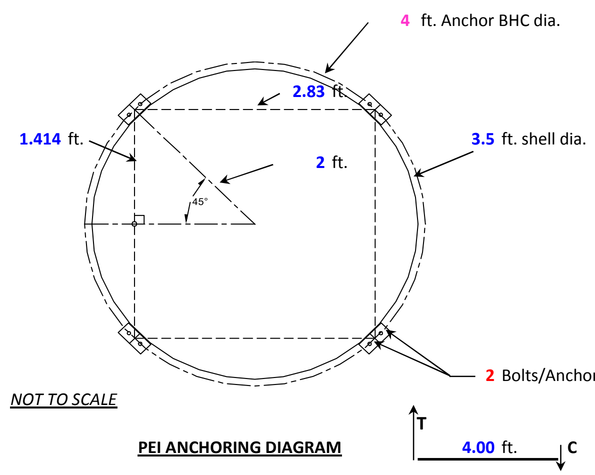
Exposure Category	Risk Category	Basic Wind Speed (V)		Wind Directionality Factor (K_d)
Section 26.7	Table 1.5-1	Fig. 26.5-1,A, B or C		Table 26.6-1
(B, C or D)	*(I, II, or III)*	*(Consult Figures if in Special Zone)*		
C	II	115		0.95

Topographic Factor (K_{zt})	Gust Effect Factor (G)	Terrain Exposure Constants		Velocity Pressure Exposure Coefficient (K_z)
Section 26.8.2	Section 26.9.1	Table 26.9-1		Table 29.3.1 Formula
Fig. 26.8-1	G	a	z_g	$K_z = 2.01\,(z/z_g)^{2/\alpha}$
1.0	0.85	9.5	900	0.945

Velocity Pressure (q_z)	Force Coefficient Qualifier		Type of Surface	Force Coefficient (C_f)
Eq. 29.3-1	Fig. 29.5-1		Fig. 29.5-1	Fig. 29.5-1
$q_z = 0.00256\,K_z K_{zt} K_d V^2$ (lb/ft2)	$D\sqrt{q_z}$		*(**S** mooth, **R** ough, **V** ery Rough)*	*Table Interpolation*
30.403	19.299	>2.5	V	1.000

Aspect Ratio (h/D)	Area Normal to the Wind (A_f)	Wind Force (F)	Overturn moment (M)
Fig. 29.5-1	Section 29.5	Eq. 29.5-1	@ CG = 0.5h
(IF <1, Use 1)	$A_f = hD$	$F = q_z G C_f A_f$	$M = F\ (0.5h)$
7.14	87.5 ft^2	2,261 lbs	28,265 lb-ft





8 ***Total Anchor bolts*** ***Windward overturn restraint bolts =*** **2**

Shear Force per bolt (F_S) = Wind Force *(F)* / No. of Bolts

Therefore: 2,261 lbs. / 8 bolts = 283 lbs. min. shear strength/bolt

Overturn Restraint Force (Tension)(F_T)= Overturn Moment (M) / Chord Length

Therefore: F_T = 28,265 ft.lbs. / 4.00 ft. = 7,066 lbs

For: 2 bolts in 1 anchors ... 3,533 lbs. minimum tensile strength / bolt

DOMINANT MOMENT IS THE RESULT OF
WIND FORCES **USE . . .** ***THIS SHEET***
FOR ANCHOR BOLT SELECTION CRITERIA !!!

https://seismicmaps.o

ASCE 7-10

Seismic Force Calculations for "Non-Building Structures Not Similar to Buildings"

in accordance with IBC 2012 , Section 13

ASCE 7-10 Chapters 1, 11, 12, 15, 21, and 22

PEI Project #: 1910	**GPS Coordinates:**	**Type of Structure**	**Structure Weight** *(lbs)*	**Structure Height** *(ft)*
PEI Project Name: Leichner Landfill	45.68921 ^{O} N	Table 15.4-2	**W**	***h***
Structure: EGF	-122.573 ^{O} W	Flat bottom, Ground Supported	4,000	25
(EGF, CSF or Skids)		Steel Tank, Mechanically Anchored		

Site Class	**Seismic Design Category**	**Risk Category**	**Importance Factor**	**Response Modification Coefficient**	**Overstrength Factor**
From Site Engineer	***SDC***	From Site Engineer	I_e	**R**	Ω_o
	Table 11.6-1,-2	Table 1.5-1	Table 1.5.2	Table 15.4-2	Table 15.4-2
D	D	*II*	1	3	2

Deflection Amplification Factor	**Site Coefficient Short Period (0.2s)**	**Site Coefficient Long Period (1.0s)**	**Mapped Acceleration Parameters Short Period (0.2s)**	**Mapped Acceleration Parameters Long Period (1.0s)**
C_d	F_a	F_v	S_S	S_1
Table 15.4-2	Table 11.4-1 *(Note 1)*	Table 11.4-2 *(Note 1)*	Fig. 22-1, 22-3 ,22-5 ,22-6 *(Note 1)*	Fig. 22-2, 22-4 ,22-5 ,22-6 *(Note 1)*
2.5	1.146	1.628	1.616 g	0.6 g

Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters / **Design Spectral Response Acceleration Parameters**

Short Period (0.2s)	**Long Period (1.0s)**	**Short Period (0.2s)**	**Long Period (1.0s)**	**Total Base Shear Force**
S_{MS}	S_{M1}	S_{DS}	S_{D1}	***Lateral Force (V)***
$S_{MS} = F_a \times S_s$	$S_{M1} = F_v \times S_1$	$S_{DS} = 2/3 \times S_{MS}$	$S_{D1} = 2/3 \times S_{M1}$	$V = 0.3 \times S_{DS} \times W \times I_e$
Eq. 11.4-1	Eq. 11.4-2	Eq. 11.4-3	Eq. 11.4-4	Eq. 15.4-5
1.852 g	0.977 g	1.235 g	0.651 g	1,481.55 *lbs*

Seismic Response Coefficient	**Peak Ground Acceleration**	**Site Coefficient**	PGA_M	C_{RS}	C_{R1}
$C_S = 0.044 \times S_{DS} \times I_e$ ... if $S_1 < 0.6g$	**PGA**	F_{PGA}	$PGA_M = F_{PGA} \times PGA$		
$C_S = 0.8 \times S_1 / (R/I_e)$ ... if $S_1 \geq 0.6g$	Fig. 22-7 *(Note 1)*	Table 11.8-1 *(Note 1)*	Table. 11.8-1	Section 21.2.1.1 --Method 1 *(Note 1)*	
Eq. 15.4-1; Eq. 15.4-2					
0.16000 *(not to be less than 0.03)*	0.38 g	1.1	0.4256	0.919	0.879

T_o (s)	T_S (s)	T_L (s)
$T_o = 0.2 \times SD_1 / SD_S$	$T_S = SD_1 / SD_S$	**Mapped Long-Period Transition Period** (s)
11.4.5	11.4.5	Figs. 22-12 -- 22-16
0.105	0.527	6

Fundamental Period (T) *Eq. 15.4-6*

$$T = 2\pi \sqrt{\frac{\sum_{i=1}^{n} f_i \, \delta_i^{2}}{g \sum_{i=1}^{n} f_i \, \delta_i}} = 0.0531 \text{ s}$$

(<0.06 = "Rigid Structure")

Where: f_i = V and $\delta_i = 0.0023$ *(single story structure)*

NOTE 1: *Values entered are from data provided by the USGS website http://geohazards.usgs/gov/designmaps/us/report. See full report --attached.*

Total Moment (M_s) = 18,519 *lb-ft*
Resulting from the seismic imposition of Lateral Force (V x 1/2h)

8 ***Total Anchor bolts*** ***Overturn restraint bolts =*** 2

(See "EGF Wind Load Calculations" for Diagrams)

Shear Force per bolt (F_S) = Lateral Force *(V)* / No. of Bolts

Therefore: 1,482 lbs. / 8 bolts = 185 lbs. minimum shear strength/bolt

DOMINANT MOMENT IS THE RESULT OF WIND FORCES **USE . . .** ***WIND FORCES FOR ANCHOR BOLT SELECTION CRITERIA !!!***

Seismic Restraint Force (Tension)(F_T)= Total Moment (M_s) / Chord Length

Therefore: F_T = 18,519 ft.lbs. / 4.00 ft. = 4,630 lbs

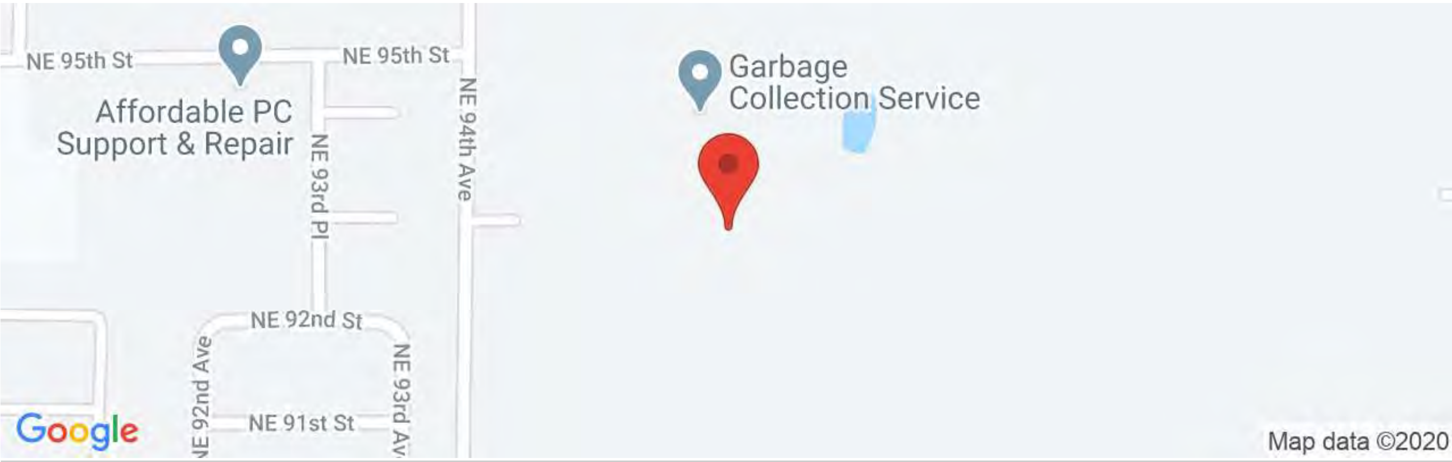
For: 2 bolts in 2 anchors ... 2,315 lbs. minimum tensile strength / bolt

OSHPD

1910-Leichner Landfill

9411 NE 94th Ave, Vancouver, WA 98662, USA

Latitude, Longitude: 45.6892115, -122.5733841



Date	5/15/2020, 12:15:25 PM
Design Code Reference Document	ASCE7-10
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	0.886	MCE_R ground motion. (for 0.2 second period)
S_1	0.386	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.015	Site-modified spectral acceleration value
S_{M1}	0.628	Site-modified spectral acceleration value
S_{DS}	0.677	Numeric seismic design value at 0.2 second SA
S_{D1}	0.419	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1.146	Site amplification factor at 0.2 second
F_v	1.628	Site amplification factor at 1.0 second
PGA	0.38	MCE_G peak ground acceleration
F_{PGA}	1.12	Site amplification factor at PGA
PGA_M	0.426	Site modified peak ground acceleration
T_L	16	Long-period transition period in seconds
SsRT	0.886	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.965	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.616	Factored deterministic acceleration value. (0.2 second)
S1RT	0.386	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.439	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.614	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.919	Mapped value of the risk coefficient at short periods
C_{R1}	0.879	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

While the information presented on this website is believed to be correct, SEAOC /OSHPD and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in this web application should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. SEAOC / OSHPD do not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the seismic data provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the search results of this website.

PAINTING PROCEDURES

for the

CLEANING, TREATING, & FINISHING

of

ENCLOSED LANDFILL GAS FLARES

CANDLESTICK FLARES,

and

GAS HANDLING SYSTEMS

Perennial Energy, Inc.
1375 County Road 8690
West Plains, MO 65775
Phone: (417) 256-2002
Fax: (417) 256-2801
www.PerennialEnergy.com

SURFACE PREPARATION AND PAINT SPECIFICATIONS

All welded structural steel bases for the unitized flare skid will be sandblasted in accordance with SSPC-SP6, then primed and top-coated with an Acrylic Modified Alkyd Enamel, prior to the installation of the equipment and components mounted on these skids.

This coating system, applied with airless spray equipment in accordance with the manufacturer's directions provides superior protection from rust and acids in harsh service conditions.

The mounted equipment, components, structural skids, and all other surfaces subject to damage by blast-cleaning, will be cleaned in accordance with SSPC-1, 2, or 3, as applicable, then primed and painted as above following final assembly of the system.

Flares subject to high temperatures are painted with FTC-251H, a direct to metal paint that doesn't require a primer.

No painted surface shall be in direct contact with unburned landfill gas.

* PEI standard paint color. Please see color chart later in this section.

Paint Code	Color
6307	Sand
251H800	Sand

APPENDIX B

ABSTRACT OF SURFACE PREPARATION SPECIFICATIONS*

SPECIFICATION & SUBJECT	PHOTO SSPC-Vis 1	PURPOSE
SSPC-SP 1 Solvent Cleaning	—	Removal of oil, grease, dirt, soil, salts, and contaminants by cleaning with solvent, vapor, alkali, emulsion or steam.
SSPC-SP 2 Hand Tool Cleaning	B St 2 C St 2 D St 2	Removal of loose rust, loose mill scale, and loose paint to degree specified, by hand chipping, scraping, sanding and wire brushing.
SSPC-SP 3 Power Tool Cleaning	B St 3 C St 3 D St 3	Removal of loose rust, loose mill scale, and loose paint to degree specified, by power tool chipping, descaling, sanding, wire brushing and grinding.
SSPC-SP 4 Flame Cleaning of New Steel	—	Dehydrating and removal of rust, loose mill scale, and some tight mill scale by use of flame, followed by wire brushing.
SSPC-SP 5 White Metal Blast Cleaning	A Sa3 B Sa3 C Sa3 D Sa3	Removal of all visible rust, mill scale, paint and foreign matter b blast cleaning by wheel or nozzle (dry or wet) using sand, grit or shot. (For very corrosive atmosphere where high cost of cleaning is warranted.)
SSPC-SP 10 Near- White Blast Cleaning	A Sa 2½ B Sa 2½ C Sa 2½ D Sa 2½	Blast cleaning nearly to White Metal cleanliness, until at least 95% of each element of surface area is free of all visible residues. (For high humidity, chemical atmosphere, marine or other corrosive environments.)
SSPC-SP 6 Commercial Blast Cleaning	B Sa 2 C Sa 2 D Sa 2	Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues. (For rather severe conditions of exposure.)
SSPC-SP 7 Brush-Off Blast Cleaning	B Sa 1 C Sa 1 D Sa 1	Blast cleaning of all except tightly adhering residues of mill scale, rust and coatings, exposing numerous evenly distributed flecks of underlying metal.
SSPC-SP 8 Pickling	—	Complete removal of rust and mill scale by acid pickling, duplex pickling or electrolytic pickling. May passify surface.
SSPC-SP 9 Weathering Followed by Blast Cleaning	—	Weathering to remove all or part of mill scale followed by blast cleaning to one of the above standards as required.

* Steel Structures Painting Manual, Volume 2, 1969 Printing, Steel Structures Painting Council, Pittsburgh, Pa. 15213.

Commercial Performance Coatings

ALK-200

CPC 2

Acrylic Modified Alkyd Enamel

PRODUCT DESCRIPTION

ALK-200 ACRYLIC MODIFIED ALKYD ENAMEL
(Pigmented)

TYPE: Acrylic Modified Alkyd

RECOMMENDED USE
ALK-200 is a fast drying interior/exterior enamel intended for industrial use on properly prepared and/or primed metal surfaces. Suitable applications include metal fabrication, castings, cabinets, machinery, and heavy equipment.

ALK-200 provides a wide balance of performance properties, including excellent flow and leveling, film hardness and good exterior durability.

COLORS: Virtually any new or existing color standard can be quickly and precisely matched using PPG's COLOR ACCURATE™ instrument matching and dispensing system. Once formulated, batches as small as one gallon can be reproduced time after time without the color drift problems associated with manual small batch methods. All colors supplied from the COLOR ACCURATE™ system will be formulated to meet Federal standards concerning the amount of lead in the dried film.

PHYSICAL CONSTANTS

WEIGHT PER U.S. GALLON (MIXED)
(varies by color) 7.8 - 10.1 lbs/gal

PERCENT SOLIDS BY WEIGHT (MIXED)
(varies by color) 36.7% - 48.6%

PERCENT SOLIDS BY VOLUME (MIXED)
(varies by color) 32.8% - 39.0%

FLASH POINTS
Pensky-Martens 79°F (26°C)

VOC (MIXED) 4.84 - 5.37 lbs/gal
(varies by color)

READY TO SPRAY VISCOSITY (varies by color) #3 Zahn N/A #2 Zahn 20-30 seconds

PERFORMANCE FEATURES

PENCIL HARDNESS
HB - H (varies by color)

FLEXIBILITY (CONICAL MANDREL)
Pass

FADE RESISTANCE
Exposure studies confirm that the fade resistance of the ALK-200 finish is significantly better than that of most interior/exterior alkyd enamels.

96 HOUR HUMIDITY RESISTANCE
Excellent

SHEEN
ALK-200 is supplied as a gloss finish (80 - 90 on a 60° gloss meter). However, the sheen can be adjusted by the PPG distributor to an eggshell, satin or semi-gloss finish.

ADHESION
Excellent

IN SERVICE TEMPERATURE LIMITATIONS
200°F
Note: As you approach 200°F, depending on the pigmentation, the color may change, but film integrity will be maintained until 200°F.

CHEMICAL/SOLVENT RESISTANCE

10% Sulfuric Acid	Good	10% Hydrochloric Acid	Very Good
10% Ammonia	Very Good	10% Sodium Hydroxide	Very Good
Xylene	Fair	Isopropyl Alcohol	Very Good
Oil	Very Good	Gasoline	Good
500 Hours Salt Spray	Good		

WATER RESISTANCE: Resistant to intermittent exposure. **Not recommended for immersion**

PPG

SURFACE PREPARATION

The surface to be coated must be sanded, free of all contamination, including dust, dirt, oil, grease and oxidation. Chemical treatment or the use of a conversion coating will improve the adhesion and performance properties of the finished coat.

Metal	Recommended Primers	Direct To Properly Treated Substrate
Cold Rolled Steel	EPX-900, HBA-3035, HSP-900/902, VAP-9XX	Very Good
Hot Rolled Steel	EPX-900, HBA-3035, HSP-900/902, VAP-9XX	Very Good
Galvanized	EPX-900, HSP-900/902	Not Recommended
Galvaneal	EPX-900, HSP-900/902	Not Recommended
Aluminum	EPX-900, VAP-9XX	Fair
Plastic/Fiberglass	Surface should be free of all contamination. Because of the variability of plastic/fiberglass substrates, coating performance should be confirmed on the actual plastic/fiberglass substrate being used.	

APPLICATION DATA

MIXING DIRECTIONS
Stir thoroughly before and occasionally during use.

THINNING
Thinning is not normally required; however, under adverse conditions, small amounts (10% or less) of xylene or aromatic 100 may be added.

POT LIFE
N/A

RECOMMENDED WET FILM BUILD (unreduced)
Spray Application: 2.8 - 3.3 mils

RECOMMENDED DRY FILM BUILD
1.5 - 2.0 mils

Film in excess or below these recommended film builds may cause problems such as, adhesion failure, pigment floatation, solvent popping, slow cure, and accelerated gloss and color failure.

APPLICATION EQUIPMENT
Conventional Spray: 30-40 psi at the gun.

DRYING TIME
3 mils wet at 77°F (25°C) and 50% relative humidity.

To Touch:	15 to 30 minutes
To Handle:	1 hour*
Dry:	10 hours**
Recoat:	Before 6 hours or after 30 hours to 4 days***
Force Dry:	(allow 10 minutes air dry)
Bake:	10 minutes @ 180°F

* This condition does not mean that the paint film has reached full cure. It is a stage where handling can be achieved without loosening, wrinkling or otherwise marring the film under minimal pressure from fingers or hands. Drying time listed may vary, depending upon film build, color selection, temperature, humidity and degree of air movement.

** Paint film is not fully cured for 7 days.

*** IMPORTANT! If this product is recoated between 6 and 30 hours, lifting of the previous finish will occur. Before 6 hours, the coating is adequately solubilized to prevent lifting, while after 30 hours to 4 days, cure has progressed to a point where solvent resistance is achieved.

Application of film thickness in excess of that recommended for this product will substantially extend dry time and lengthen the recoat window.

RECOMMENDED SPREADING RATE
526-626 sq. ft. at 1.0 mil dry film per U.S. gallon (varies by color). Coverage figures do not include losses due to mixing, transfer or application of coating or losses due to surface irregularities or porosity.

CLEAN UP
Toluene or Xylene

APPLICATION PRECAUTIONS AND LIMITATIONS
Apply only when air, product or surface temperature is above 50°F (10°C) and when surface temperature is at least 5°F (3°C) above the dew point.

Brush and roller application is not recommended.

To the best of our knowledge, the technical information in this bulletin is accurate; however, since PPG Industries, Inc. is constantly improving its coatings and paint formulas, the current technical data may vary somewhat from what was available when this bulletin was printed. Contact your PPG Distributor for the most up-to-date information

SAFETY

These materials are designed for application only by professional, trained personnel, using proper equipment under controlled conditions and are not intended for sale to the general public.
Safe application of paints and coatings requires knowledge of equipment materials and individual training. Directions and precautionary information on both equipment and products should be carefully read and strictly observed for personal safety and property protection. Consideration must be given to eliminate conditions, which may generate hazardous atmospheres during spray application or subject operators or bystanders to injury or illness. Special precautions must be taken when utilizing spray equipment, particularly airless equipment. High-pressure injection of coatings into the skin by airless equipment may cause serious injury requiring immediate medical attention at a hospital. Treatment advice may also be obtained from Poison Centers. Air quality should be maintained with adequate ventilation; applicators can achieve additional protection by wearing respirators and other protective garments such as gloves and overalls. In all cases, wear protective eye equipment. During the application of all coatings materials, all flames, welding and smoking must be prohibited. Explosion proof equipment must be used when coating these materials in confined areas.

PRECAUTIONARY INFORMATION
Before using the products listed herein, carefully read each product label and follow directions for its use. Please read and observe all warnings and precautionary information on all product labels. Prevent all contact with skin and eyes and breathing of vapors and spray mist. Repeated inhalation of high vapor concentrations may cause a series of progressive effects including irritation of the respiratory system, permanent brain and nervous system damage and possible unconsciousness and death in poorly ventilated areas. Eye watering, headaches, nausea, dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.
KEEP OUT OF THE REACH OF CHILDREN

MEDICAL RESPONSE
Emergency Medical or Spill Control Information (304) 843-1300. CANADA (514) 645 - 1320 Have label information available.

MATERIAL SAFETY DATA SHEET
Material Safety Data Sheets for the PPG products mentioned in this publication are available through your PPG Distributor.
FOR ADDITIONAL INFORMATION REGARDING THIS PRODUCT, SEE THE MSDS AND LABEL INFORMATION.

PPG Industries
Commercial Coatings
We're Everywhere You Look

 www.ppgrefinish.com

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15272

EMERGENCY PHONE NUMBERS (24 hours/day): **(412) 434-4515 (U.S.)**
(514) 645-1320 (Canada)
01-800-00-21-400 (Mexico)
0532-83889090 (China)

TECHNICAL INFORMATION:	(440) 572-2800 (STRONGSVILLE OHIO) 8:00 a.m. - 5:00 p.m. EST
PRODUCT SAFETY/MSDS INFORMATION:	(412) 492-5555 7:00 a.m. - 4:30 p.m. EST
Product ID:	ALK-200 (0808-T0)
PRODUCT NAME:	ACRYLIC MODIFIED ALKYD ENAMEL
SYNONYMS:	None
ISSUE DATE:	06/21/2006
EDITION NO.:	2
CHEMICAL FAMILY:	Acrylic

EMERGENCY OVERVIEW:

Extremely flammable. Vapors may cause flash fires. Keep away from heat, sparks, flames, and other sources of ignition. Do not smoke. Extinguish all flames and pilot lights. Turn off stoves, heaters, electrical motors, and other sources of ignition during use and until all vapors/odors are gone.CAUSES SEVERE EYE IRRITATION. MAY CAUSE MODERATE SKIN IRRITATION. MAY BE ABSORBED THROUGH THE SKIN.VAPOR AND/OR SPRAY MIST MAY BE HARMFUL IF INHALED. VAPOR IRRITATES EYES, NOSE, AND THROAT. VAPOR GENERATED AT ELEVATED TEMPERATURES IRRITATES EYES, NOSE AND THROAT.HARMFUL IF SWALLOWED.

SECTION 2 - COMPOSITION INFORMATION

The following ingredient(s) marked with an "x" are considered hazardous under applicable U.S. OSHA and/or Canadian WHMIS regulations. If no ingredients are listed, then there are no U.S. OSHA and/or Canadian WHMIS hazardous ingredients in this product.

Material/ CAS Number	Percent	Hazardous
N-BUTYL ACETATE 123-86-4	10 - 30	X
ACETONE 67-64-1	10 - 30	X
TITANIUM DIOXIDE 13463-67-7	10 - 30	X
1-METHOXY-2-PROPYL ACETATE 108-65-6	10 - 30	X
CARBON BLACK 1333-86-4	1 - 5	X
ALUMINUM POWDER 7429-90-5	1 - 5	X
TOLUENE 108-88-3	1 - 5	X
XYLENES 1330-20-7	1 - 5	X
AROMATIC HYDROCARBON 64742-94-5	1 - 5	X
NAPHTHA 8052-41-3	0.5-1.5	X
ETHYL BENZENE 100-41-4	0.1-1.0	X
2-METHOXY-1-PROPYL ACETATE 70657-70-4	0.1-1.0	X

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
Causes severe eye irritation. Redness, itching, burning sensation and visual disturbances may indicate excessive eye contact.
SKIN CONTACT:
May cause moderate skin irritation. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.
SKIN ABSORPTION:
May be absorbed through the skin.
INHALATION:
Vapor and/or spray mist may be harmful if inhaled. Vapor irritates eyes, nose, and throat. Vapor generated at elevated temperatures irritates eyes, nose and throat.
INGESTION:
Harmful if swallowed.
SIGNS & SYMPTOMS OF OVEREXPOSURE:
Repeated exposure to high vapor concentrations may cause irritation of the respiratory system and permanent brain and nervous system damage. Eye watering, headaches, nausea, dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Not applicable.
CHRONIC OVEREXPOSURE EFFECTS
Avoid long-term and repeated contact.
Repeated exposure to vapors above recommended exposure limits (see Section 8) may cause irritation of the respiratory system and permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal. Prolonged exposure to an ingredient(s) in this product may cause kidney and/or liver damage. This product contains toluene. Toluene inhalation in animals (greater than 1500 ppm) and intentional inhalation of toluene-containing products by humans (e.g. glue) has caused adverse fetal development effects. High exposures to xylenes in some animal studies have been reported to cause health effects on the developing embryo and fetus. These effects were often at levels toxic to the mother. There is some evidence that repeated exposure to organic solvent vapors in combination with constant loud noise can cause greater hearing loss than expected from exposure to noise alone.
The effects of long-term, low level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the prevention of all contact with this material to avoid any effects from repetitive acute exposures. See Section 11, of this MSDS for a detailed list of chronic health effects information available on individual ingredients in this product.

SECTION 4 - FIRST AID MEASURES

If ingestion, irritation, any type of overexposure or symptoms of overexposure occur during or persists after use of this product, contact a POISON CONTROL CENTER, EMERGENCY ROOM OR PHYSICIAN immediately; have Material Safety Data Sheet information available.
EYE CONTACT:
Remove contact lens and pour a gentle stream of warm water through the affected eye for at least 15 minutes. If irritation persists, contact a poison control center, emergency room, or physician as further treatment may be necessary.
SKIN CONTACT:
Run a gentle stream of water over the affected area for 15 minutes. A mild soap may be used if available. If any symptoms persist, contact a poison control center, emergency room, or physician as further treatment may be necessary.

INHALATION:
Remove from area to fresh air. If symptomatic, contact a poison control center, emergency room or physician for treatment information.
INGESTION:
Gently wipe or rinse the inside of the mouth with water. Sips of water may be given. Never give anything by mouth to an unconscious person. Contact a poison control center, emergency room or physician right away as further treatment may be necessary.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
FLASHPOINT: 4 Degrees F (-16 Degrees C)
FLASHPOINT TEST METHOD:
Pensky-Martens Closed Cup
UEL: Not Available.
LEL: 2.5
AUTOIGNITION TEMPERATURE:
Not Available.
EXTINGUISHING MEDIA:
Use National Fire Protection Association (NFPA) Class B extinguishers (carbon dioxide, dry chemical, or universal aqueous film forming foam) designed to extinguish NFPA Class IB flammable liquid fires. Water spray may be ineffective. Water spray may be used to cool closed containers to prevent pressure build-up and possible autoignition or explosion when exposed to extreme heat.
PROTECTION OF FIREFIGHTERS:
Fire-fighters should wear self-contained breathing apparatus and full protective clothing.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
Keep this product away from heat, sparks, flame, and other sources of ignition (i.e., pilot lights, electric motors, static electricity). Invisible vapors can travel to a source of ignition and flash back. Do not smoke while using this product. Keep containers tightly closed when not in use. Closed containers may explode when overheated. Do not apply to hot surfaces. Toxic gases may form when this product comes in contact with extreme heat. May produce hazardous decomposition products when exposed to extreme heat. Extreme heat includes, but is not limited to, flame cutting, brazing, and welding.

SECTION 6 - ACCIDENTAL RELEASE MEASURE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Provide maximum ventilation. Only personnel equipped with proper respiratory, skin, and eye protection should be permitted in the area. Remove all sources of ignition. Take up spilled material with sand, vermiculite, or other noncombustible absorbent material and place in clean, empty containers for disposal. Only the spilled material and the absorbant should be placed in this container.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORAGE:
Vapors may collect in low areas. If this material is part of a multiple component system, read the Material Safety Data Sheet(s) for the other component or components before blending as the resulting mixture may have the hazards of all of its parts. Containers should be grounded when pouring. Avoid free fall of liquids in excess of a few inches.
STORAGE:
Do not store above 120 degrees F.(48 degrees C.). Store large quantities in buildings designed and protected for storage of NFPA Class IB flammable liquids.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION

ENGINEERING CONTROLS:
Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 8 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.

PERSONAL PROTECTIVE EQUIPMENT
EYES:
Wear chemical-type splash goggles and full face shield when possibility exists for eye contact due to splashing or spraying liquid, airborne particles, or vapors.
SKIN/GLOVES:
Wear protective clothing to prevent skin contact. Apron and gloves should be constructed of: neoprene rubber. No specific permeation/degradation testing have been done on protective clothing for this product. Recommendations for skin protection are based on infrequent contact with this product. For frequent contact or total immersion, contact a manufacturer of protective clothing for appropriate chemical impervious equipment. Clean contaminated clothing and shoes.
RESPIRATOR:
Overexposure to vapors may be prevented by ensuring proper ventilation controls, vapor exhaust or fresh air entry. A NIOSH- approved air purifying respirator with the appropriate chemical cartridges or a positive-pressure, air-supplied respirator may also reduce exposure. Read the respirator manufacturer's instructions and literature carefully to determine the type of airborne contaminants against which the respirator is effective, its limitations, and how it is to be properly fitted and used. Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 2 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.
GENERAL HYGIENE - ESTABLISHED EXPOSURE LIMITS
If Threshold Limit Values (TLVs) have been established by ACGIH, OSHA, Ontario or PPG, they will be listed below. These limits are intended for use in the practice of industrial hygiene as guidelines or recommendations in the control of potential workplace health hazards. These limits are not a relative index of toxicity and should not be used by anyone without industrial hygiene training.

Material/ CAS Number	Percent	ACGIH TLV	ACGIH STEL	OSHA PEL	OSHA STEL
N-BUTYL ACETATE 123-86-4	10 - 30	150 PPM	200 ppm	150 ppm	200 ppm
ACETONE 67-64-1	10 - 30	500 ppm	750 ppm	750 ppm	1000 ppm
TITANIUM DIOXIDE 13463-67-7	10 - 30	10 mg/m^3	Not established	10 mg/m^3	Not established
CARBON BLACK 1333-86-4	1 - 5	3.5 mg/m^3	Not established	3.5 mg/m^3	Not established
ALUMINUM POWDER 7429-90-5	1 - 5	10 MG/m^3	Not established	R- 5 mg/m^3	Not established
TOLUENE 108-88-3	1 - 5	S- 50 ppm	Not established	100 ppm	150 ppm
XYLENES 1330-20-7	1 - 5	100 ppm	150 PPM	100 ppm	150 ppm
NAPHTHA 8052-41-3	0.5-1.5	100 ppm	Not established	100 ppm	Not established
ETHYL BENZENE 100-41-4	0.1-1.0	100 ppm	125 ppm	100 ppm	125 ppm

Material/ CAS Number	Percent	Ontario TWA	Ontario STEL	PPG IPEL	PPG STEL
N-BUTYL ACETATE 123-86-4	10 - 30	150 ppm	200 ppm	Not established	Not established
ACETONE 67-64-1	10 - 30	500 PPM	750 PPM	Not established	Not established
TITANIUM DIOXIDE 13463-67-7	10 - 30	10 MG/m³	Not established	Not established	Not established
1-METHOXY-2-PROPYL ACETATE 108-65-6	10 - 30	50 PPM	Not established	100 ppm	Not established
CARBON BLACK 1333-86-4	1 - 5	3.5 mg/m³	Not established	Not established	Not established
ALUMINUM POWDER 7429-90-5	1 - 5	5 mg/m³	10 MG/m³	Not established	Not established
TOLUENE 108-88-3	1 - 5	50 PPM	Not established	Not established	Not established
XYLENES 1330-20-7	1 - 5	100 ppm	150 ppm	Not established	Not established
NAPHTHA 8052-41-3	0.5-1.5	525 MG/m³	Not established	Not established	Not established
ETHYL BENZENE 100-41-4	0.1-1.0	100 PPM	125 PPM	Not established	Not established

Key: ACGIH=American Conference of Governmental Industrial Hygienists; OSHA=Occupational Safety and Health Administration; TLV=Threshold Limit Value; TWA=Time Weighted Average; PEL=Permissible Exposure Limit; IPEL=Internal Permissible Exposure Limit; Ceiling=TLV or PEL Ceiling Limit; STEL=TLV or PEL Short-Term Exposure Limit; Skin= Skin Absorption Designation. [C- Ceiling Limit; S-Potential Skin Aborption; R-Respirable Dust]
Additional Information Not applicable.

SECTION 9 - PHYSICAL & CHEMICAL PROPERTIES
(FORMULA VALUES, NOT SALES SPECIFICATIONS)

SPECIFIC GRAVITY:	1.194
PHYSICAL STATE:	Liquid
Percent Solids:	31-81
Percent Volatile by Volume:	44-75
pH:	Not available.
ODOR THRESHOLD:	Not available.
Vapour Pressure:	<3.8 mmHg
ODOR/APPEARANCE:	Viscous liquid with an odor characteristic of the solvents listed in Section 2.
VAPOR DENSITY:	HEAVIER THAN AIR
Evaporation Rate:	<38
BOILING POINT OR RANGE:	214- 401Degrees F
Freezing Point or Range:	Not Applicable.
Melting Point or Range(°C):	Not Applicable.
Partition coefficient (n-octanol/water):	Not Applicable.
WEIGHT PER GALLON:	9.95 (U.S.) / 11.9 (IMPERIAL)

SECTION 10 - STABILITY AND REACTIVITY

STABILITY:
This product is normally stable and will not undergo hazardous reactions.
CONDITIONS TO AVOID:
None Known.
INCOMPATIBLE MATERIALS:
Avoid contact with strong alkalies, strong mineral acids, or strong oxidizing agents.
HAZARDOUS POLYMERIZATION:
None Known.
HAZARDOUS DECOMPOSITION PRODUCTS:
- Carbon monoxide - Carbon dioxide - Oxides of aluminum - Lower molecular weight polymer fractions

SECTION 11 - TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Material/ CAS Number	Percent	ORAL LD50 (g/kg)	DERMAL LD50 (g/kg)	INHALATION LC50 (mg/l)
N-BUTYL ACETATE 123-86-4	10 - 30	10.77 g/kg	17.60 g/kg	Not Available
ACETONE 67-64-1	10 - 30	1.80 g/kg	20.00 g/kg	76.00 g/L. 4 hr.
TITANIUM DIOXIDE 13463-67-7	10 - 30	10.00 g/kg	Not Available	Not Available
1-METHOXY-2-PROPYL ACETATE 108-65-6	10 - 30	8.53 g/kg	5.00 g/kg	Not Available
CARBON BLACK 1333-86-4	1 - 5	15.40 g/kg	3.00 g/kg	Not Available
TOLUENE 108-88-3	1 - 5	.64 g/kg	8.39 g/kg	12.50 g/L. 4 hr.
XYLENES 1330-20-7	1 - 5	4.30 g/kg	1.70 g/kg	21.88 g/L. 4 hr.
AROMATIC HYDROCARBON 64742-94-5	1 - 5	3.20 g/kg	1.69 g/kg	.59 g/L. 4 hr.
NAPHTHA 8052-41-3	0.5-1.5	5.00 g/kg	Not Available	5.50 g/L. 4 hr.
ETHYL BENZENE 100-41-4	0.1-1.0	3.50 g/kg	17.80 g/kg	Not Available

CHRONIC TOXICITY
Ingredient Target Organ/Chronic Effects:
- Teratogen - Fetotoxin - Ear - Kidney - Liver - Carcinogen - Embryotoxin
- Reproductive - Brain - Central nervous system - Lung

Mutagenicity Toxicity:
This has not been tested for this product.
Reproductive Toxicity:
This has not been tested for this product.

SUPPLEMENTAL HEALTH INFORMATION:

Material/ CAS Number	Percent	Ingredient Specific Animal Data:
TITANIUM DIOXIDE 13463-67-7	10 - 30	This product contains titanium dioxide. Animals inhaling massive quantities of titanium dioxide dust in a long-term study developed lung tumors. Studies with humans involved in manufacture of this pigment indicate no increased risk of cancer from exposure.
CARBON BLACK 1333-86-4	1 - 5	This product contains carbon black which has been rated an IARC 2B carcinogen due to animal data.
ETHYL BENZENE 100-41-4	0.1-1.0	Ethylbenzene has been reported by NTP to cause cancer in laboratory animals following a chronic (2 year) inhalation exposure. Dose levels of 75, 250 and 750 ppm were used, with evidence of carcinogenicity found in the kidneys of rats and the lung and liver of mice at 750 ppm. The No Observed Effect Level (NOEL) was 75 ppm. The relevance of these findings to humans is uncertain, but appropriate safeguards should be employed to reduce or eliminate inhalation exposure to ethylbenzene.
2-METHOXY-1-PROPYL ACETATE 70657-70-4	0.1-1.0	Possible reproductive hazard. An ingredient(s) in this product has adversely affected reproductive tissues and fetal development in test animals.

SECTION 12 - ECOLOGICAL INFORMATION

POTENTIAL ENVIRONMENTAL EFFECTS
Ecotoxicity: No Information Available.

ENVIRONMENTAL FATE

Mobility: No information available.
Biodegradation: No information available.
Bioaccumulation: No Information Available.

PHYSICAL/CHEMICAL

Hydrolysis: No information available.
Photolysis: No information available.

SECTION 13 - DISPOSAL CONSIDERATIONS

Provide maximum ventilation, only personnel equipped with proper respiratory and skin and eye protection should be permitted in the area. Take up spilled material with sawdust, vermiculite, or other absorbent material and place in containers for disposal.

Waste material must be disposed of in accordance with federal, state, provincial and local environmental control regulations. Empty containers should be recycled by an appropriately licensed reconditioner/salvager or disposed of through a permitted waste management facility. Additional disposal information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.

SECTION 14 - TRANSPORTATION INFORMATION

Proper Shipping Name: NOT AVAILABLE
NOS Technical Name: NOT AVAILABLE
Hazard Class: N.A.
Subsidiary Class(es): N.A.
UN Number: N.A.
Packing Group: N.A.

USA - RQ Hazardous Substances: NOT AVAILABLE
USA-RQ Hazardous Substance Threshold Ship Weight: NOT AVAILABLE
Marine Pollutant Name: NOT AVAILABLE

SECTION 15 - REGULATORY INFORMATION

INVENTORY STATUS

U.S. TSCA: This product and/or all of its components are listed on the U.S. TSCA Inventory or is otherwise exempt from TSCA Inventory reporting requirements.

FEDERAL REGULATIONS

US Regulations

Material/ CAS Number	Percent	CERCLA HS - RQ (LBS)	SARA EHS- TPQ (LBS)	SARA 313
N-BUTYL ACETATE 123-86-4	10 - 30	5000 lbs	Not Listed	Not Listed
ACETONE 67-64-1	10 - 30	5000 lbs	Not Listed	Not Listed
TITANIUM DIOXIDE 13463-67-7	10 - 30	Not Listed	Not Listed	Not Listed
1-METHOXY-2-PROPYL ACETATE 108-65-6	10 - 30	Not Listed	Not Listed	Not Listed
CARBON BLACK 1333-86-4	1 - 5	Not Listed	Not Listed	Not Listed
ALUMINUM POWDER 7429-90-5	1 - 5	Not Listed	Not Listed	Listed
TOLUENE 108-88-3	1 - 5	1000 lbs	Not Listed	Listed
XYLENES 1330-20-7	1 - 5	100 lbs	Not Listed	Listed
AROMATIC HYDROCARBON 64742-94-5	1 - 5	Not Listed	Not Listed	Not Listed
NAPHTHA 8052-41-3	0.5-1.5	Not Listed	Not Listed	Not Listed
ETHYL BENZENE 100-41-4	0.1-1.0	1000 lbs	Not Listed	Listed
2-METHOXY-1-PROPYL ACETATE 70657-70-4	0.1-1.0	Not Listed	Not Listed	Not Listed

SARA 311/312

Health (acute): Yes
Health (chronic): Yes
Fire (flammable): Yes
Pressure: No
Reactivity: No

WHMIS HAZARD CLASS: - Class B, Division 2 - Class D, Division 2, Subdivision A - Class D, Division 2, Subdivision B

STATE/PROVINCIAL REGULATIONS

CALIFORNIA PROP. 65: WARNING: This product contains a chemical(s) known to the State of California to cause cancer and birth defects or other reproductive harm.

Additional Information

Material/ CAS Number	Percent	IARC Group 1(Known Human Carc.)	IARC Group 2A (Probable Carc.)	IARC 2B (Suspected Carc.)	ACGIH Carc.	NTP Known Carc.	OSHA Carc.
CARBON BLACK 1333-86-4	1 - 5	N	N	Y	N	N	Y
ETHYL BENZENE 100-41-4	0.1-1.0	N	N	Y	N	N	Y

Key: IARC- International Agency on the Research of Cancer; ACGIH- American Conference of Governmental Industrial Hygienists; NTP- National Toxicology Program *Denotes chemical as NTP Known Carcinogen; + Denotes NTP Possible Carcinogen; OSHA- Occupational Safety and Health Administration.

SECTION 16 - OTHER INFORMATION

Hazard Rating Systems
NFPA Rating: 2 3 0
HMIS Rating: 2*3 0

Rating System: 0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe, *=Chronic Effects.

HMIS=Hazardous Materials Identification System; NFPA=National Fire Protection Association;

Safe handling of this product requires that all of the information on the MSDS be evaluated for specific work environments and conditions of use.

PREPARED BY: Product Safety Department
REASON FOR REVISION: Section 9 has been updated. Date. Edition. Updated MSDS
format.

This Material Safety Data Sheet has been prepared in accordance with Canada's Workplace Hazardous Materials Information System (WHMIS) and the OSHA Hazard Communication Standard (29 CFR 1910.1200), the supplier notification requirements of SARA Title III, Section 313 and other applicable right-to-know regulations.
Additional environmental information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.
ALK200 000000 (00410380.002)(06/20/06)
060619, 000, 0808

*** END OF MSDS ***

251H Series

Technical Data Sheet

GENERIC TYPE

Silicone

PRODUCT DESCRIPTION

A Silicone/Zinc high temperature coating designed for application on ferrous and non-ferrous metal with exterior exposure.

Benefits

High heat resistance
Superior coverage
Excellent corrosion resistance
Excellent durability

PHYSICAL PROPERTIES

Property	Result
Volume Solids	**29 - 33%**
Weight Solids	**50 - 55 %**
Density	**10 - 11 lbs./gallon**
Coating VOC	**420 grams/L** **3.3 lbs./gallon**
Viscosity	**65 – 70 KU**
Gloss @ 60°	**2- 7**
Theoretical coverage at 1 mil (25.4 µm)	**480 ft.²/ gallon** **11.78 m²/L**
Recommended DFT	**2.0 – 3.0 mils** **50.8 – 76.2 µm**
Dry to handle	**30 minutes**
We recommend allowing to air dry for 24 hours before putting into service	
Heat set	**30 minutes at 400°F (204°C)**
Reducer/Clean-up	**Acetone @ 10% max**
Salt spray Aluminized Cast aluminum CRS	 **Pass 500 hours** **Pass 500 hours 50% of panel** **Pass 250 hours, no rust or blisters**

FORREST Technical Coatings
1011 McKinley Street
Eugene, OR 97402 USA
www.forrestpaint.com
info@forrestpaint.com
Ph: (800) 537-7201
(541) 342-1821

251H Series

Technical Data Sheet

APPEARANCE

Colors:	251H219	Black	251H800	Sand
	251H201	Charcoal		
	251H102	Off White		
Gloss:	Flat			

SURFACE PREPARATION

Proper product selection, surface preparation and application will affect the coating performance. Coating integrity and service life will be reduced by improperly prepared surfaces, as high as 80% of all coating failures are directly attributed to inadequate surface preparation. This will affect the coating adhesion to the substrate. Selection of the proper method of surface preparation depends on the substrate.

Recommended surface preparation is a white blast conforming to SSPC-SP 5 OR SP6. The unit should be painted immediately after sandblasting. Apply to sandblasted steel only. Sandblasting should be done with compressed air blasting or a centrifugal wheel using proper abrasives. Blasting should attain a profile of 0.5-0.75 mils (12.7-19.05 microns). Do not reuse contaminated sand or flint abrasives. Apply coating within 8 hours of blasting or before surface rusting occurs.

APPLICATION

Mechanically stir the product for 10-15 minutes before using. Conventional or airless spray equipment may apply this coating. When spraying in temperatures over 80°F reduce the product with Forrest Paint thinner 80T004. The product should never be thinned more than 10% by volume; this lowers the solids which could have an effect on the overall performance of the coating. Apply coating at: 7 to 10 wet mil thickness. Dry Film Thickness: 2 to 3 mils DFT. Do not apply over 12 mils wet (4mils dry). Loss of adhesion on heating may occur. Continuous measurements during application and a final dry film thickness check should be performed before unit is heated. Inadequate film build will shorten the life span of the material to resist corrosion. Any breaks in the film should be repaired by touchup before unit is heated. Be sure to remove all rust before repainting.

CLEAN UP

Clean spills and splatters immediately with paint thinner or a commercially available cleaner. Follow manufacturer's safety recommendations when using Xylene based cleaners. Allow 24 hours cure time @ 70°F before heating in service.

CAUTION

Adequate health and safety precautions should be observed during storage, handling, use and curing periods.

READ SAFETY DATA SHEETS BEFORE USING THIS PRODUCT

DISCLAIMER

The technical data and suggestions for use in this product data sheet are currently correct to the best of our knowledge, but are subject to change without notice. Because application and conditions vary, and are beyond our control, we are not responsible for results obtained in using this product, even when used as suggested. The user should conduct tests to determine the suitability of the product for the intended use under then existing conditions. Our liability for breach of warranty, strict liability in tort, negligence or otherwise is limited exclusively to replacement of the product or refund of its price. Under no circumstances are we liable for incidental or consequential damages.

FORREST Technical Coatings
1011 McKinley Street
Eugene, OR 97402 USA
www.forrestpaint.com
info@forrestpaint.com
Ph: (800) 537-7201
(541) 342-1821

1910- Recommended Spare Parts

Each site has unique and site specific requirements for uptime. Some parts on the flare are readily available off the shelf, others, such as flame arrester elements have lead times measured in months. We recommend that each site conduct a Risk Analysis and have appropriate spares on hand.

PEI Part #	Name	Tags	Suggested #
14477	Self-Checking UV Scanner	FLR-BE-501	1
5408	Lens for UV Scanner	FLR-BE-501	1
14143	Ignition Cable	FLR-CBL-1	20 feet
10362	Louver Motor	FLR-FCV-401..2	1
79	Crank Arm	FLR-FCV-401..2	1
78	Ball Joint	FLR-FCV-401..2	1
5499	Weather kit for Louver Motor	FLR-FCV-401..2	1
8249	Shutdown Valve Solenoid	FLR-FV-401..2	1
12399	Flare Thermocouple	FLR-TE-501..3	2
15681	Flame Arrester Gaskets	FLR-TSE-301	2
15682	Flame Bank Kit	FLR-TSE-301	1
65	Ignitor	FLR-IGN-1	1
68	Ignition Transformer	FLR-IGN-1	1
56	Pilot Solenoid	FLR-FV-101	1
3995	Pilot Pressure Regulator	FLR-PCV-101	1

Manufacture’s Literature

Manufacture’s literature follows. This literature has the PEI tag number, the product selection, and supporting information and calculations that document why this product was selected.

Blowers, Purge

The flare has a purge blower that runs prior to starting the flare. This blower is tagged FLR-BLR-401. It is a Cincinnati LMF-4, and has a 1/3 HP, 120 VAC motor. This blower will move about 320 SCFM through the flare. The Flare has an ID of 32", and is 25' tall- giving an internal volume of about 140 cubic feet. Boilers, etc typically have four air changes prior to ignition, this will take about 2 minutes.

A pressure switch is used to confirm air flow, it is tagged FLR-PS-401, and is a Dwyer 1950-02-2S

Purge Blower Sizing Sheet

Project #	1910		
Project Name	Leichner		
Created By	ETB	Date	19-May-20

Flare OD	40	Inches
Insulation	4	Inches
Flare ID	36	Inches
Flare CSA	7	Sq. Ft
Flare Height	25	Feet
Flare Volume	177	Cubic Feet
Air Changes per purge	4	
Air Purge Volume	707	Cubic Feet

Purge Blower Selection

Make	Cincinnati Fan	
Model	LMF-4	4.7 X 2.9 Wheel
SCFM @ 1" WC	319	
Motor HP	0.3	
Voltage	120	
Phase	1	
Purge Cycle Time	2.2	Minutes

LM & LMF SERIES DIRECT DRIVE RATING TABLES

CFM and BHP at Static Pressure Shown

Ratings at 70°F., .075 Density, Sea Level

MODEL NO.	NOMINAL WHEEL SIZE	FAN RPM	1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/4" SP		1 1/2" SP		1 3/4" SP		2" SP	
			CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
LMF-3	4.7 x 2.4	3450	230	.08	214	.07	196	.07	175	.06	150	.05	118	.03				
LM-4	4.3 x 2.9	1750	119	.02														
&	4.7 x 2.9	1750	163	.04														
LMF-4	4.3 x 2.9	3450	293	.16	273	.15	253	.15	232	.15	209	.14						
	4.7 x 2.9	3450	377	.34	356	.32	337	.31	319	.30	300	.29	280	.27	256	.26		
LM-6	6.3 x 2.5	1150	256	.04														
&	6.3 x 3.5	1150	284	.04														
LMF-6	6.3 x 2.5	1750	439	.16	405	.15	344	.12										
(See Note 1.)	6.3 x 3.5	1750	507	.18	452	.16	388	.14										
	6.3 x 2.5	3450	901	1.29	690	1.28	878	1.26	865	1.24	850	1.22	834	1.19	815	1.16	794	1.13
	6.3 x 3.5	3450	1072	1.50	1048	1.46	1023	1.42	996	1.38	970	1.34	942	1.30	913	1.25	884	1.21
LM-8	8.3 x 1.5	1150	351	.10	209	.08												
&	8.3 x 3.0	1150	534	.14	427	.12												
LMF-8	8.3 x 4.1	1150	1044	.35	894	.25	688	.17										
	8.3 x 1.5	1750	611	.39	552	.37	490	.35	407	.32	203	.25						
	8.3 x 3.0	1750	913	.53	835	.49	766	.47	697	.44	620	.40	512	.35				
	8.3 x 4.1	1750	1704	1.44	1617	1.28	1525	1.12	1427	.97	1319	.84	1194	.71	1037	.59		

Purge Blower
FLR-BLR-401
Part # LMF-4, 4.7x 2.9 Wheel, CW-TH,
ARR #4hm, 1/3 HP, 120 VAC, 1 phase

cincinnati fan

OEM and Industrial Air Handling Specialist

SERIES LM & LMF

CAST ALUMINUM VOLUME BLOWERS

7697 Snider Road, Mason, OH 45040-9135

Telephone: 513-573-0600

Visit us at www.cincinnatifan.com for more information.

Cat. No. LM-308

Supersedes LM-702

FEATURES

A. Round inlets and outlets for convenient slip fit of duct work or hose.

B. Commercial grade 319 cast aluminum housing for increased strength and AMCA Type C spark-resisitance.

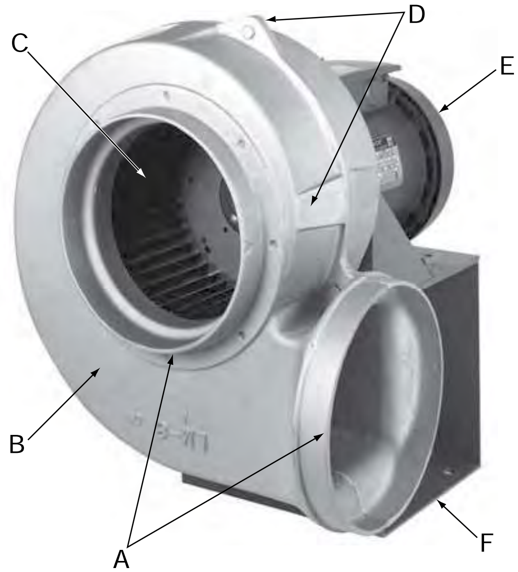
C. Steel multivane wheels for high volume and low noise levels. Aluminum wheels available for AMCA Type B spark-resistance on all models except LM-6 or LMF-6 above 1800 RPM.

D. Tapered housing lugs and stiffener pads for additional strength.

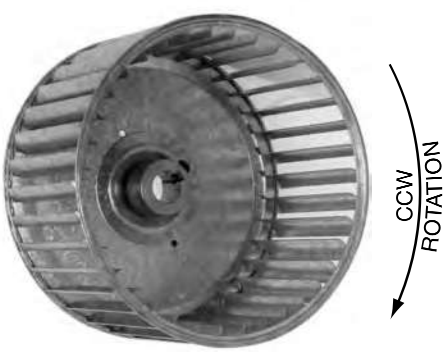
E. Continuous duty, ball bearing, industrial motors are standard.

F. All fan bases are minimum 12 gauge steel.

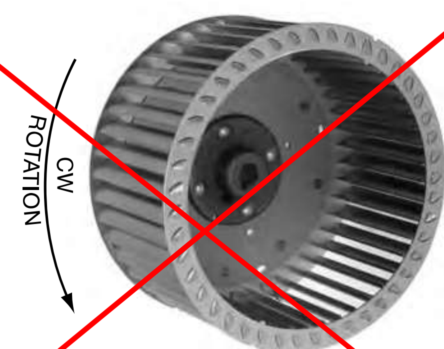
G. All model LMF blowers (not shown here) have a discharge flange cast as an integral part of the housing for rigid support by the flange only. See pages 3 and 10.



BLOWER WHEELS



Standard wheels are steel. Some have internal hubs and some have external hubs. Aluminum wheels available on most sizes, but extended deliveries may occur. **For limitations, see chart on page 7.**



Standard steel wheel for LMF-3, LM-4, LMF-4, LM-6 and LMF-6. All LMF models are clockwise rotation only.

~~Standard steel wheel for LM-8 and LMF-8.~~

SPARK-RESISTANT CONSTRUCTION

AMCA Type A: All parts in contact with airstream are of nonferrous material. Consult factory.

AMCA Type B: With the addition of an aluminum wheel, the fan will be AMCA type "B" spark-resistant. **Maximum Temperature 150°F (66°C).** Not available on LM-6 or LMF-6 above 1800 RPM.

⚠ WARNING

The use of aluminum or aluminum alloys in the presence of steel which has been allowed to rust requires special consideration. Research by the U.S. Bureau of Mines and others has shown that aluminum impellers rubbing on rusty steel may cause high intensity sparking.

The use of the above Standard in no way implies a guarantee of safety for any level of spark resistance. Spark-resistant construction also does not protect against ignition of explosive gases caused by catastrophic failure or from any airstream material that may be present in a system.

9 STANDARD ARRANGEMENTS OF LM MODELS

Arrangement 4
(Foot & flange motor)

Arrangement 4
(Flange mount-footless motor)

Arrangement 4
(Foot mounted motor)

Arrangement 4HM
(Horizontal mount)
(See page 8)

Arrangement 4D
(Double blower unit)

Arrangement 8
(shown with optional discharge flange)

Arrangement 2

Arrangement 1

Arrangement 9

4 SIZES OF LMF MODELS

NOTE: All LMF models are available in clockwise (CW) rotation, arrangement 4HM only.

LMF-3

LMF-6

LMF-4

LMF-8

All LMF models include an integral cast discharge flange for mounting and a neoprene flange gasket. For discharge flange dimensions, see page 10.

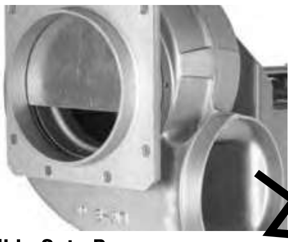
OPTIONAL ACCESSORIES

Inlet Filters
Many layered fine wire mesh. Pleated, paper media available on all sizes for LM and LMF fans.

Shaft and/or Heat Slinger Guard
Available on arrangement 1 and 9. Covers bearings and shaft between fan housing and belt guard. Has extended lube lines. Meets OSHA standards. **Painted safety yellow.**

Teflon Shaft Seal
1/8" thick teflon shaft seal good to 300°F.

Inlet/Outlet Flange
Cast aluminum drilled to ANSI-125 pound flange bolt circle dimensions if requested. Dimensions on page 11. **Outlet flange not available in Down Blast configuration.**



Slide Gate Damper
Available for 4, 5, 6 and 8 inch inlets or outlets. Cast aluminum frame, galvanized steel gate. Suitable for duct work. Dimensions on page 11. **Add inlet/outlet guard if not ducted. Not available on outlet for Down Blast discharge position.**

Inlet/Outlet Guard
Spiral guard with nickel/chrome/ lacquer finish. OSHA type. Available on 4, 5, 6 and 8 inch inlets or outlets. **Required by OSHA on non-ducted inlet and/or discharge.**

Belt Guard – Standard Arr. 9
Bearing side is enclosed. Not available unless Cincinnati Fan mounts motor. **Painted safety yellow.**

Drain
1/2" drain with plug. Not required on bottom horizontal discharges.

HIGH TEMPERATURE CONSTRUCTION

Standard Construction: All arrangements suitable to 150°F (66°C).

151°-300°F. Construction: Standard fan with heat slinger and slinger guard on all arrangements. Arrangements 4, 4HM and 4D also includes a shaft extension.

Fan performance tables are developed using standard air which is 70°F., 29.92" barometric pressure and .075 lbs. per cubic foot. Density changes resulting from temperature or barometric pressure variations (such as higher altitudes) must be corrected to standard conditions before selecting a fan based on standard performance data.

Temperature and/or altitude conversion factors are used in making corrections to standard conditions.

TEMPERATURE - ALTITUDE CONVERSIONS

AIR TEMP. F°	ALTITUDE IN FEET ABOVE SEA LEVEL										
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0°	.87	.91	.94	.98	1.01	1.05	1.09	1.13	1.17	1.22	1.26
40°	.94	.98	1.02	1.06	1.10	1.14	1.19	1 23	1.28	1.32	1.36
70°	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.30	1.35	1.40	1.45
80°	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48
100°	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48	1.54
120°	1.09	1.14	1.18	1.23	1.28	1.32	1.38	1.43	1.48	1.53	1.58
140°	1.13	1.18	1.22	1.27	1.32	1.37	1.42	1.48	1.54	1.58	1.65
160°	1.17	1.22	1.26	1.31	1.36	1.42	1.47	1.53	1.59	1.64	1.70
180°	1.21	1.26	1.30	1.36	1.41	1.46	1.52	1.58	1.64	1.70	1.75
200°	1.25	1.29	1.34	1.40	1.45	1.51	1.57	1.63	1.69	1.75	1.81
250°	1.34	1.39	1.45	1.50	1.56	1.62	1.68	1.74	1.82	1.88	1.94
300°	1.43	1.49	1.55	1.61	1.67	1.74	1.80	1.87	1.94	2.00	2.08

EXAMPLE:

Required fan performance is 800 CFM at 1" SP at 250°F., and 7000' altitude.

STEP 1. From the table, the conversion factor for 250° and 7000' is 1.74.

STEP 2. Correct static pressure is: 1.74 x 1" SP = 1.74" SP at standard conditions.

STEP 3. Make fan selection from table on page 5. We select an LM-6, 6.3 x 2.5 wheel at 3450 RPM to provide 815 CFM at 1.75" SP and 1.16 BHP.

STEP 4. Correct the BHP for the lighter air: 1.16 ÷ 1.74 = .67 BHP. A 3/4 HP motor will suffice at 250°F., and 7000' altitude but not at standard conditions. Special motor insulation may be required above 3500' altitude. Also, BHP correction might need to be modified if blower will be subject to “cold starts”, ie: starting at 70°F. at 7000 feet altitude.

LM & LMF SERIES DIRECT DRIVE RATING TABLES

CFM and BHP at Static Pressure Shown **Ratings at 70°F., .075 Density, Sea Level**

MODEL NO.	NOMINAL WHEEL SIZE	FAN RPM	1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/4" SP		1 1/2" SP		1 3/4" SP		2" SP	
			CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
LMF-3	4.7 x 2.4	3450	230	.08	214	.07	196	.07	175	.06	150	.05	118	.03				
LM-4 & LMF-4	4.3 x 2.9	1750	119	.02														
	4.7 x 2.9	1750	163	.04														
	4.3 x 2.9	3450	293	.16	273	.15	253	.15	232	.15	209	.14						
	4.7 x 2.9	3450	377	.34	356	.32	337	.31	319	.30	300	.29	280	.27	256	.26		
LM-6 & LMF-6 (See Note 1.)	6.3 x 2.5	1150	256	.04														
	6.3 x 3.5	1150	284	.04														
	6.3 x 2.5	1750	439	.16	405	.15	344	.12										
	6.3 x 3.5	1750	507	.18	452	.16	388	.14										
	6.3 x 2.5	3450	901	1.29	890	1.28	878	1.26	865	1.24	850	1.22	834	1.19	815	1.16	794	1.13
	6.3 x 3.5	3450	1072	1.50	1048	1.46	1023	1.42	996	1.38	970	1.34	942	1.30	913	1.25	884	1.21
LM-8 & LMF-8	8.3 x 1.5	1150	351	.10	209	.08												
	8.3 x 3.0	1150	534	.14	427	.12												
	8.3 x 4.1	1150	1044	.35	894	.25	688	.17										
	8.3 x 1.5	1750	611	.39	552	.37	490	.35	407	.32	203	.25						
	8.3 x 3.0	1750	913	.53	835	.49	766	.47	697	.44	620	.40	512	.35				
	8.3 x 4.1	1750	1704	1.44	1617	1.28	1525	1.12	1427	.97	1319	.84	1194	.71	1037	.59		

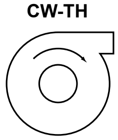
MODEL NO.	NOMINAL WHEEL SIZE	FAN RPM	2 1/4" SP		2 1/2" SP		2 3/4" SP		3" SP		3 1/4" SP		3 1/2" SP		3 3/4" SP	
			CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
LM-6 & LMF-6 (See Note 1.)	6.3 x 2.5	3450	769	1.09	740	1.04	705	.99	664	.93						
	6.3 x 3.5	3450	853	1.17	821	1.13	788	1.09	753	1.05	714	1.01	672	.96	623	.91

NOTE 1: Aluminum wheels not available at 3450 RPM. See chart on page 7.

ROTATION & DISCHARGE POSITIONS

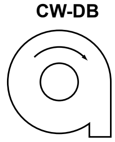
8 STANDARD POSITIONS AVAILABLE.* 45° DISCHARGE POSITIONS AT ADDITIONAL CHARGE.
Discharges shown are determined by viewing fan from motor or drive side.

CW-TH



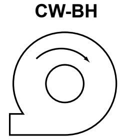
Clockwise Top Horizontal Discharge

CW-DB



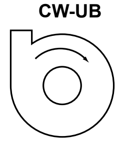
Clockwise Down Blast Discharge

CW-BH



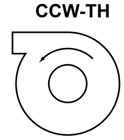
Clockwise Bottom Horizontal Discharge

CW-UB



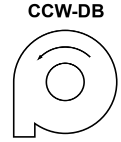
Clockwise Up Blast Discharge

CCW-TH



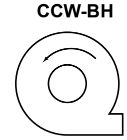
* Counter-Clockwise Top Horizontal Discharge

CCW-DB



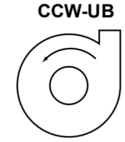
* Counter-Clockwise Down Blast Discharge

CCW-BH



* Counter-Clockwise Bottom Horizontal Discharge

CCW-UB



* Counter-Clockwise Up Blast Discharge

*** All LMF Models are available in clockwise (CW) rotation only.**

NOTE: THESE RATINGS ARE FOR 50 CYCLE MOTORS ONLY.

CFM and BHP at Static Pressure Shown — **Ratings at 70°F., .075 Density, Sea Level**

MODEL NO.	NOMINAL WHEEL SIZE	FAN RPM	1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/4" SP		1 1/2" SP		1 3/4" SP		2" SP	
			CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
LMF-3	4.7 x 2.4	2850	184	.08	163	.08	137	.07	101	.06								
LM-4 &	4.3 x 2.9	2850	234	.09	210	.08	185	.08										
LMF-4	4.7 x 2.9	2850	303	.19	280	.18	257	.16	233	.16								
LM-6 &	6.3 x 3.5	950	195	.02														
LMF-6	6.3 x 2.5	1425	345	.08	279	.07												
(See Note 1.)	6.3 x 3.5	1425	391	.09	315	.07												
	6.3 x 2.5	2850	740	.72	726	.71	710	.69	691	.67	668	.65	640	.62	604	.58	559	.53
	6.3 x 3.5	2850	877	.83	846	.80	814	.77	781	.73	746	.70	710	.67	672	.63	630	.60
	8.3 x 1.5	950	250	.05														
LM-8 &	8.3 x 3.0	950	401	.07														
LMF-8	8.3 x 4.1	950	807	.17	584	.10												
	8.3 x 1.5	1425	473	.21	398	.19	275	.16										
	8.3 x 3.0	1425	709	.27	623	.25	536	.23	413	.19								
	8.3 x 4.1	1425	1352	.73	1241	.60	1117	.49	969	.38	746	.28						

NOTE 1: Aluminum wheels not available at 2850 RPM. See wheel specification chart below.

DIMENSIONS and SPECIFICATIONS

NOTE: The table below contains blower housing dimensions common to all arrangements on pages 8 & 9.

DIMENSIONS IN INCHES ± 1/8" — DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL NO.	C	D	J	M	N	O	P	R	S	T	③ AA	③④ DD
LM-4	1	3 7/8	2 15/16	2 13/16	1 3/4	3 5/8	4 1/2	5	4 1/16	1	5	4
LM-6	1	4 13/16	3 3/8	4 1/4	1 3/4	4 3/16	6 1/4	6 1/2	5 9/16	1	6	6
LM-8	1	6 1/16	4	5 9/16	1 5/8	5 1/4	7 13/16	8 11/16	6 7/8	1	8	8

③ LM-4 ONLY; INLET AND DISCHARGE FLANGE NOT AVAILABLE DUE TO INTERFERENCE.
④ ALL MODELS, DISCHARGE FLANGE NOT AVAILABLE FOR DOWN BLAST POSITION.

WHEEL SPECIFICATIONS

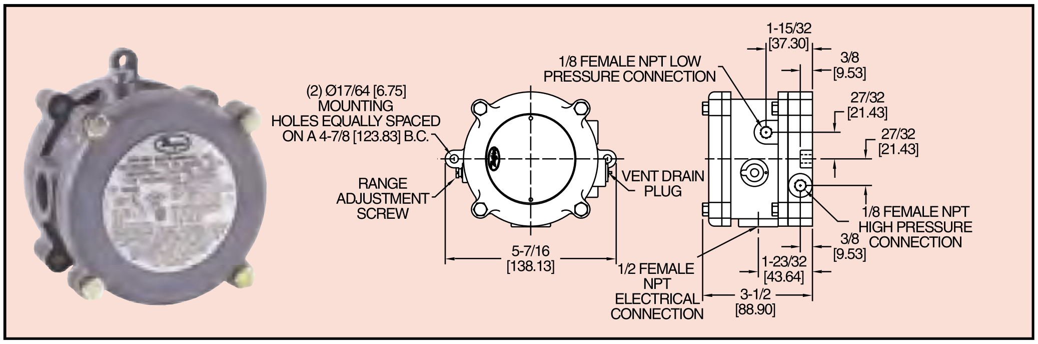
FAN MODEL	NOMINAL WHEEL SIZE	ACTUAL WHEEL DIAMETER & WIDTH	STANDARD STEEL		OPTIONAL ALUMINUM	
			Max. RPM	HUB	Max. RPM	HUB
LMF-3 ★	4.7 x 2.4 ●	4 11/16 x 2 7/16 ●	4000	INT.	4000	INT.
LM-4 &	4.3 x 2.1	4 1/4 x 2 15/16	4000	INT.	3500 ■	INT.
LMF-4	4.7 x 2.9 ●	4 11/16 x 2 7/8 ●	4000	INT.	3500	INT.
LM-6 &	6.3 x 2.5	6 5/16 x 2 1/2	3500	EXT.	1800 ■	EXT.
LMF-6	6.3 x 3.5 ●	6 1/4 x 3 1/2 ●	3500	INT.	1800	INT.
LM-8 &	8.3 x 1.5	8 1/4 x 1 1/2	1800	EXT.	1800 ■	EXT.
LMF-8	8.3 x 3.0	8 1/4 x 3	1800	INT.	1800 ■	INT.
	8.3 x 4.1 ●	8 1/4 x 4 1/8 ●	1800	INT.	1800	INT.

● These wheel sizes are the original wheel sizes for LM blowers prior to September, 1998.
■ Aluminum wheels in these sizes will extend delivery. Contact your local CF sales office for assistance.
INT. = Internal hub EXT. = External hub
★ Available in CW rotation only.

Purge Blower Pressure Switch
Part # 1950-02-2S

Explosion-Proof Differential Pressure Switches

Compact, Low Cost, Explosion-proof and Weatherproof



Model 1950 Explosion-Proof Differential Pressure Switch combines the best features of the popular Dwyer series 1900 with an integral explosion-proof and weather-proof housing, making it an exceptional value for either application. It is CE, UL and CSA listed, FM approved for use in Class I, Div 1, Groups C and D, Class II Groups E, F, and G and Class III hazardous atmospheres (NEMA 7 & 9), Raintight (NEMA 3). Weather-proof features include a drain plug and O-ring seal in cover. Electrical connections are easily made by removing front cover. For convenience the set point adjustment screw is located on the outside of the housing. Twelve models offer set points from .03 to 20″ w.c. (7.5 to 5 kPa) and from .5 to 50 psi (0.035 to 3.5 bar). The unit is very light and compact – about half the weight and bulk of other explosion-proof or weather-proof switches with separate enclosures.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult factory.
Temperature Limits: -40 to 140°F (-40 to 60°C); 0 to 140°F (-17.8 to 60°C) for 1950P-8, 15, 25, and 50. -30 to 130°F (-34.4 to 54.4°C) for 1950-02.
Pressure Limits:
Continuous: 1950's - 45″ w.c. (0.11 bar); 1950P's - 35 psi (2.41 bar); 1950P-50 only - 70 psi (4.83 bar).
Surge: 1950's - 10 psi (0.69 bar), 1950P's - 50 psi (3.45 bar), 1950P-50 only - 90 psi (6.21 bar).
Enclosure Rating: IP64, NEMA 3, 7 and 9.
Switch Type: Single-pole double-throw (SPDT).
Electrical Rating: 15 A @, 125, 250, 480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz.
Electrical Connections: 3 screw type, common, normally open and normally closed.
Process Connections: 1/8″ female NPT.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Set Point Adjustment: Screw type on top of housing.
Weight: 3.25 lb (1.5 kg); 1950-02 model, 4.4 lb (2 kg).
Agency Approvals: CE, UL, CSA, FM.

SERIES 1950 SWITCHES - STOCKED MODELS, OPERATING RANGES AND DEAD BANDS

Model Number	Range, Inches W.C.	Approximate Dead Band at Min. Set Point	Approximate Dead Band at Max. Set Point
1950-02-2S	.03 to .10	.025	.05
1950-00-2F	.07 to .15	.04	.05
1950-0-2F	.15 to .50	.10	.15
1950-1-2F	.4 to 1.6	.15	.20
1950-5-2F	1.4 to 5.5	.30	.40
1950-10-2F	3 to 11	.40	.50
1950-20-2F	4 to 20	.40	.60

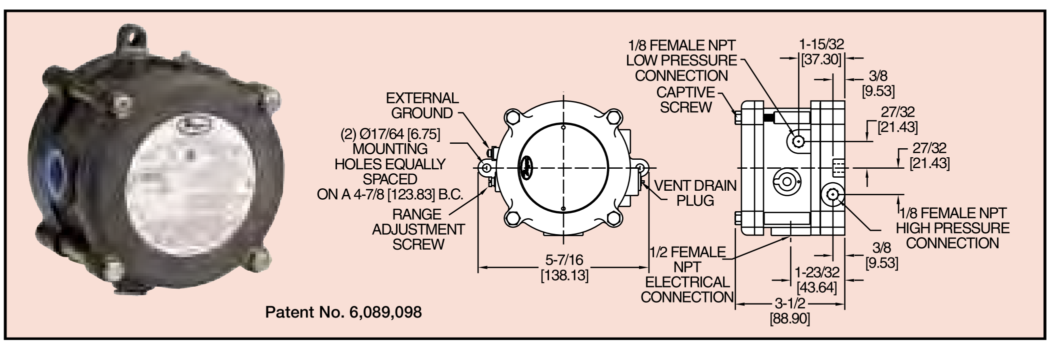
Model* Number	Range, PSID	Approximate Dead Band at Min. Set Point	Approximate Dead Band at Max. Set Point
1950P-2-2F	0.5 to 2	.3	.3
1950P-8-2F	1.5 to 8	1.0	1.0
1950P-15-2F	3 to 15	.9	.9
1950P-25-2F	4 to 25	.7	.7
1950P-50-2F	15 to 50	1.0	1.5

CAUTION: For use only with air or compatible gases. Applications with hazardous atmospheres and a single positive pressure may require special venting.
*P=PSID range models

Series 1950G

Explosion-Proof Differential Pressure Switch

Explosion-Proof, Weatherproof, Compatible with Natural Gases



Patent No. 6,089,098

The Model 1950G Explosion-Proof Switch combines the best features of the popular Dwyer Series 1950 Pressure Switch with the benefit of natural gas compatibility. Units are rain-tight for outdoor installations, and are UL listed for use in Class I, Groups A, B, C, & D; Class II, Groups E, F, & G and Class III atmospheres, Directive 94/9/EC (ATEX) Compliant for CE Ex 11 2 G EExd IIB & Hydrogen T6 and CSA & FM approved for Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G and Class III atmospheres. The 1950G is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

Easy access to the SPDT relay and power supply terminals is provided by removing the top plate of the aluminum housing. A supply voltage of 24 VDC, 120 or 240 VAC is required. A captive screw allows the cover to swing aside while remaining attached to the unit. Adjustment to the set point of the switch can be made without disassembly of the housing.

SPECIFICATIONS

Service: Air and compatible combustible gases.
Wetted Materials: Contact Factory.
Temperature Limits: 0 to 140°F (18 to 60°C). Note: Set point drift may occur with ambient temperature changes.
Pressure Limits: 45″ w.c. (11.2 kPa) continuous; 10 psig (68.95 kPa) surge.
Enclosure Rating: IP64, NEMA 3, 7 and 9.
Switch Type: 1 Form C relay (SPDT).
Electrical Rating: 10A, 120/240 VAC, 28 VDC. Resistive 50mA, 125 VDC.
Power Requirements: 24 VDC ±10%. 120 or 240 VAC ±10% optional.
Electrical Connections: Internal terminal block.
Process Connections: 1/8″ female NPT.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Set Point Adjustment: Screw type on top of housing.
Weight: 2 lb, 15.7 oz (1.35 kg).
Agency Approvals: CE, UL, CSA, FM, ATEX.

POPULAR MODELS

Model Number[1]	Range, Inches W.C.	Approximate Dead Band at Min. Set Point	Approximate Dead Band at Max. Set Point
1950G-00-B-24	.07 to .15	.04	.06
1950G-0-B-24	.15 to .50	.06	.11
1950G-1-B-24	.4 to 1.6	.11	.29
1950G-5-B-24	1.4 to 5.5	.4	.9
1950G-10-B-24	3 to 11	.9	1.8
1950G-20-B-24	4 to 20	1.2	3.0

[1]Note: For alternate supply voltages change 24 to 120 or 240. Example: 1950G-00-B-120.

Burner Controller

PEI is supplying a Honeywell Burner Controller, shipped loose. This controller consists of the following parts:

A) A Honeywell RM7896D1019 7800 Series Relay Module. This is also called a "Flame Switch" or a "Burner Controller". This is a microprocessor based integrated burner control that manages the complete ignition process. As discussed earlier, UL and FM certified devices are massed produced, and intended for use on power burners, therefore the burner blower is used for purge, and the controller typically expects to see the proof of fan for the complete run cycle.
B) A Honeywell R7861A1026 amplifier card that is compatible with the supplied Honeywell self-checking UV sensor.
C) A Honeywell ST7800A1070 2 ½ minute purge card, the time of this card matches the purge blower calculations for 4 air changes through the flare before attempting start up.
D) A Honeywell Q7800A1005 sub base for mounting A) above
E) A Honeywell S7800A1001 UV Sensor Display/Interface for A) above
F) A Honeywell 221818C 120" long extension cable for the Display/Interface.

CP-BS-1
Part # RM7896D1019

Honeywell

RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D 7800 SERIES Relay Modules

INSTALLATION INSTRUCTIONS

APPLICATION

The RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D are microprocessor-based integrated burner controls for automatically fired gas, oil, or combination fuel single burner applications. They are intended to replace the R4795 and R7795 Primary Controls. The RM7895A,B,C,D/EC7895A; RM7896A,B,C,D systems consist of a relay module, subbase, amplifier, and purge card. Options include keyboard display module (KDM), Personal Computer Interface, Data ControlBus™ Module, remote display mounting, expanded annunciator and Combustion System Manager® Software.

Functions provided by the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D include automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics and troubleshooting. The RM7896 provides a postpurge function.

This document provides installation and static checkout instructions. Other applicable publications are:

Publication No.	Product
63-2278	Q7700 Network Interface Unit Product Data
65-0084	Q7800A,B 22-Terminal Wiring Subbase Product Data
65-0090	S7800A Keyboard Display Module Product Data
65-0091	S7810A Data ControlBus Module™ Product Data
65-0095	S7820 Remote Reset Module Product Data
65-0097	221729C Dust Cover Packing Instructions
65-0101	S7830 Expanded Annunciator Product Data
65-0102	ZM7850A Combustion System Manager™ Operating Instructions
65-0109	R7824, R7847, R7848, R7849, R7851, R7861, R7886 Flame Amplifiers for the 7800 Series Product Data
65-0131	221818A Extension Cable Assembly Product Data
65-0229	7800 SERIES Relay Modules Checkout and Troubleshooting Product Data.
65-0092	QS7800A ControlBus™ Module, Standard
65-0227	QS7800B ControlBus™ Module, Multidrop

SPECIFICATIONS

Electrical Ratings (See Table 3):
Voltage and Frequency:
RM7895/RM7896: 120 Vac (+10/-15%), 50/60 Hz (± 10%).
EC7895A,C: 220/240 Vac (+10%/-15%), 50/60 Hz (±10%)
Power Dissipation: 10W maximum.
Maximum Total Connected Load: 2000 VA.
Fusing Total Connected Load: 15A Fast Blow, type SC or equivalent.

Environmental Ratings:
Ambient Temperature:
Operating: -40°F to 140°F (-40°C to +60°C).
Storage: -40°F to 150°F (-40°C to +66°C).
Humidity: 85% relative humidity continuous, noncondensing.
Vibration: 0.5G environment.

Approvals:
RM7895/RM7896:
Underwriters Laboratories Inc. Listed: File No. MP268, Guide No. MCCZ.
Canadian Standards Association Certified: LR9S329-3.
Factory Mutual Approved: Report No. J.I.1V9A0.AF.
IRI Acceptable.
Federal Communications Commission: Part 15, Class B, Emissions.
EC7895A,C:
Factory Mutual Approved.

66-1090-06

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for the application.
3. Installer must be a trained, experienced, flame safeguard service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

⚠ WARNING

Fire or Explosion Hazard.
Can cause property damage, severe injury, or death.
Follow applicable safety requirements when installing a control on a burner to prevent death or severe injury.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.
Disconnect power supply before beginning installation.

IMPORTANT

1. *Wiring connections for the relay modules are unique; refer to Fig. 2 and 3 or the appropriate Specifications for proper subbase wiring.*
2. *Wiring must comply with all applicable codes, ordinances and regulations.*
3. *Wiring must comply with NEC Class 1 (Line Voltage) wiring.*
4. *Loads connected to the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D must not exceed those listed on the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D label or the Specifications; see Table 1.*
5. *Limits and interlocks must be rated to simultaneously carry and break current to the ignition transformer, pilot valve, and main fuel valve(s).*
6. *All external timers must be listed or component-recognized by authorities who have proper jurisdiction.*
7. *For on-off gas-fired systems, some authorities who have jurisdiction prohibit the wiring of any limit or operating contacts in series between the flame safeguard control and the main fuel valve(s).*
8. *Two flame detectors can be connected in parallel with the exception of Infrared Flame Detectors (C7015).*
9. *This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, can cause interference with radio communications. It has been tested and found to comply with the limits for a Class B computing device of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference, in which case, the users, at their own expense, may be required to take whatever measures are required to correct this interference.*
10. *This digital apparatus does not exceed the Class B limits for radio noise for digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.*

Location

Humidity

Install the relay module where the relative humidity never reaches the saturation point. The relay module is designed to operate in a maximum 85% relative humidity continuous, noncondensing, moisture environment. Condensing moisture can cause a safety shutdown.

Vibration

Do not install the relay module where it can be subjected to vibration in excess of 0.5G continuous maximum vibration.

Weather

The relay module is not designed to be weather tight. When installed outdoors, protect the relay module in an approved weather-tight enclosure.

Mounting Wiring Subbase

1. Mount the subbase in any position except horizontally with the bifurcated contacts pointing down. The standard vertical position is recommended. Any other position decreases the maximum ambient temperature rating.
2. Select a location on a wall, burner or electrical panel. The Q7800 can be mounted directly in the control cabinet. Be sure to allow adequate clearance for service, installation, access or removal of the RM7895A,B,C,D/ EC7895A,C; RM7896A,B,C,D, expanded annunciator, keyboard display module, flame amplifier, flame amplifier signal voltage probes, run/test switch, electrical signal voltage probes and electrical field connections.
3. For surface mounting, use the back of the subbase as a template to mark the four screw locations. Then drill the pilot holes.
4. Securely mount the subbase using four no. 6 screws (not provided).

Wiring Subbase

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.
Disconnect the power supply before beginning installation.

The internal block diagram of the RM7895A,B,C,D/ EC7895A,C;RM7896A,B,C,D is shown in Fig. 1.

1. For proper subbase wiring and sequence chart, refer to Fig. 2 and 3.
2. For remote wiring of the Keyboard Display Module, refer to the Specifications for the Keyboard Display Module (65-0090), Network Interface Unit (63-2278), Data ControlBus™ Module (65-0091) or Extension Cable Assembly (65-0131).
3. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect can be required.
4. All wiring must comply with all applicable electrical codes, ordinances and regulations. Wiring, where required, must comply with NEC, Class 1 (Line Voltage) wiring.
5. For recommended wire size and type, see Table 1.
6. For recommended grounding practices, see Table 2.

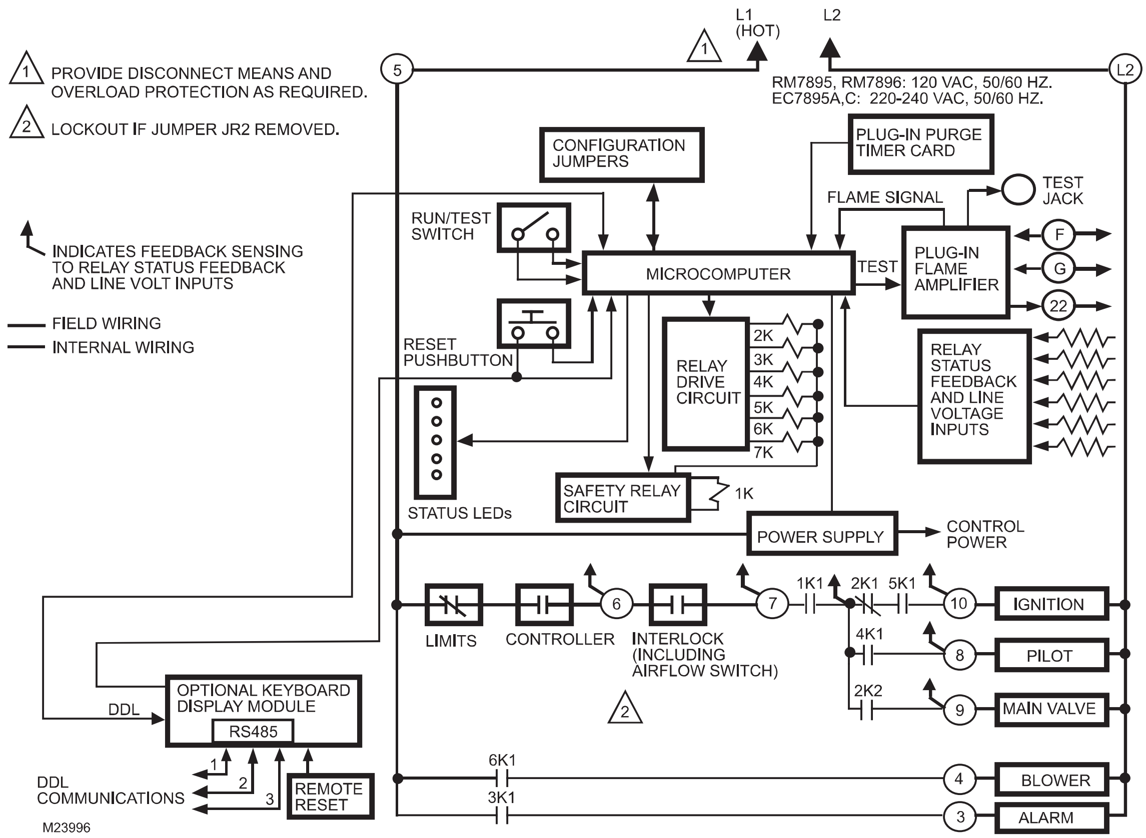
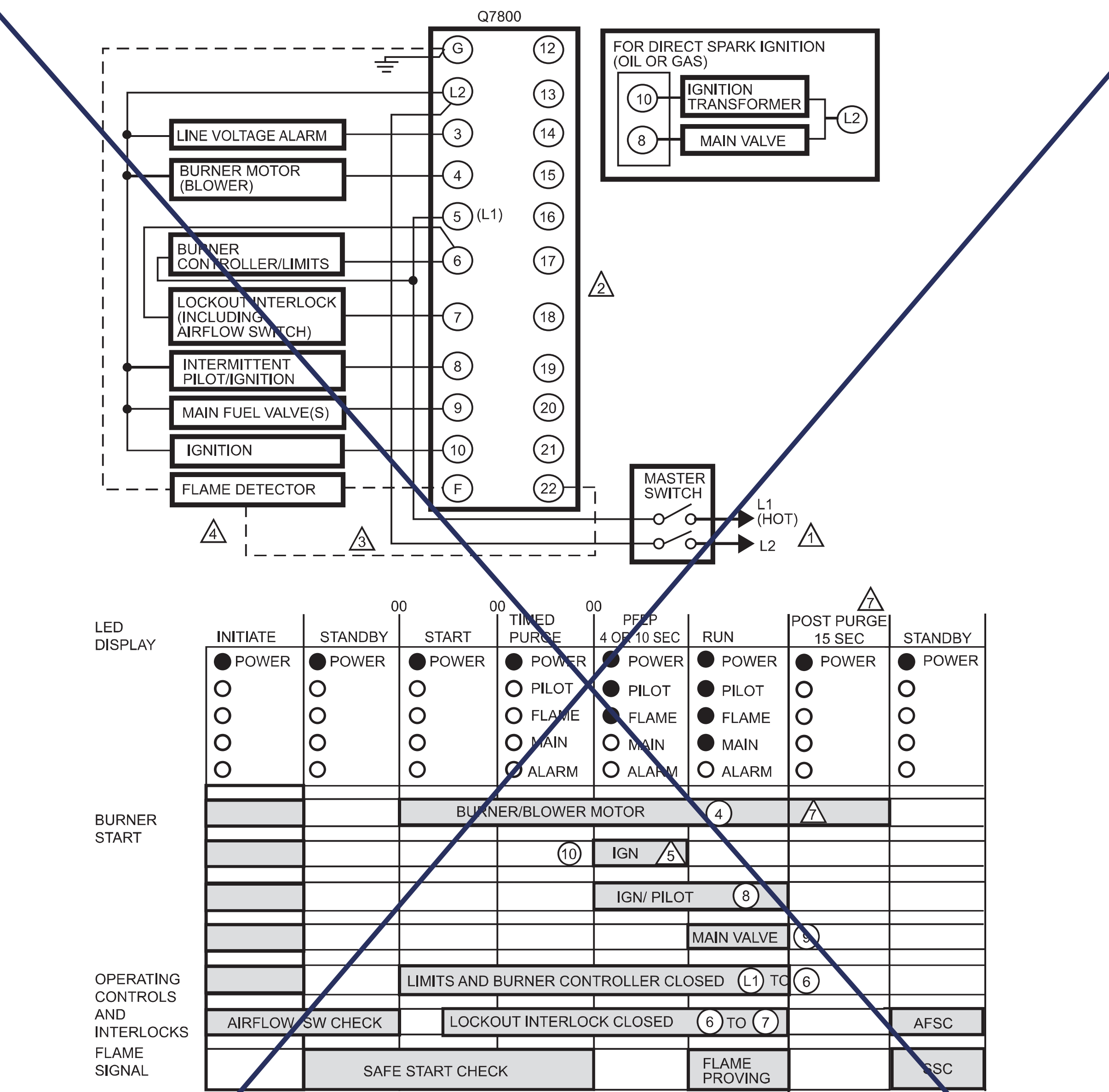


Fig. 1. Internal block diagram of RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D (see Fig. 2 and 3 for detailed wiring instructions).



1. RM7895, RM7896: 120 VAC , 50/60 HZ; EC7895: 220-240 VAC, 50/60 HZ POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2. DO NOT CONNECT ANY WIRES TO UNUSED TERMINALS.

3. FOR EC7895, A 220 TO 240 VAC TO 120 VAC, 10 VA MINIMUM STEPDOWN TRANSFORMER (NOT PROVIDED) MUST BE USED TO DRIVE THE SHUTTER.

4. SEE FLAME DETECTOR SPECIFICATIONS FOR CORRECT WIRING.

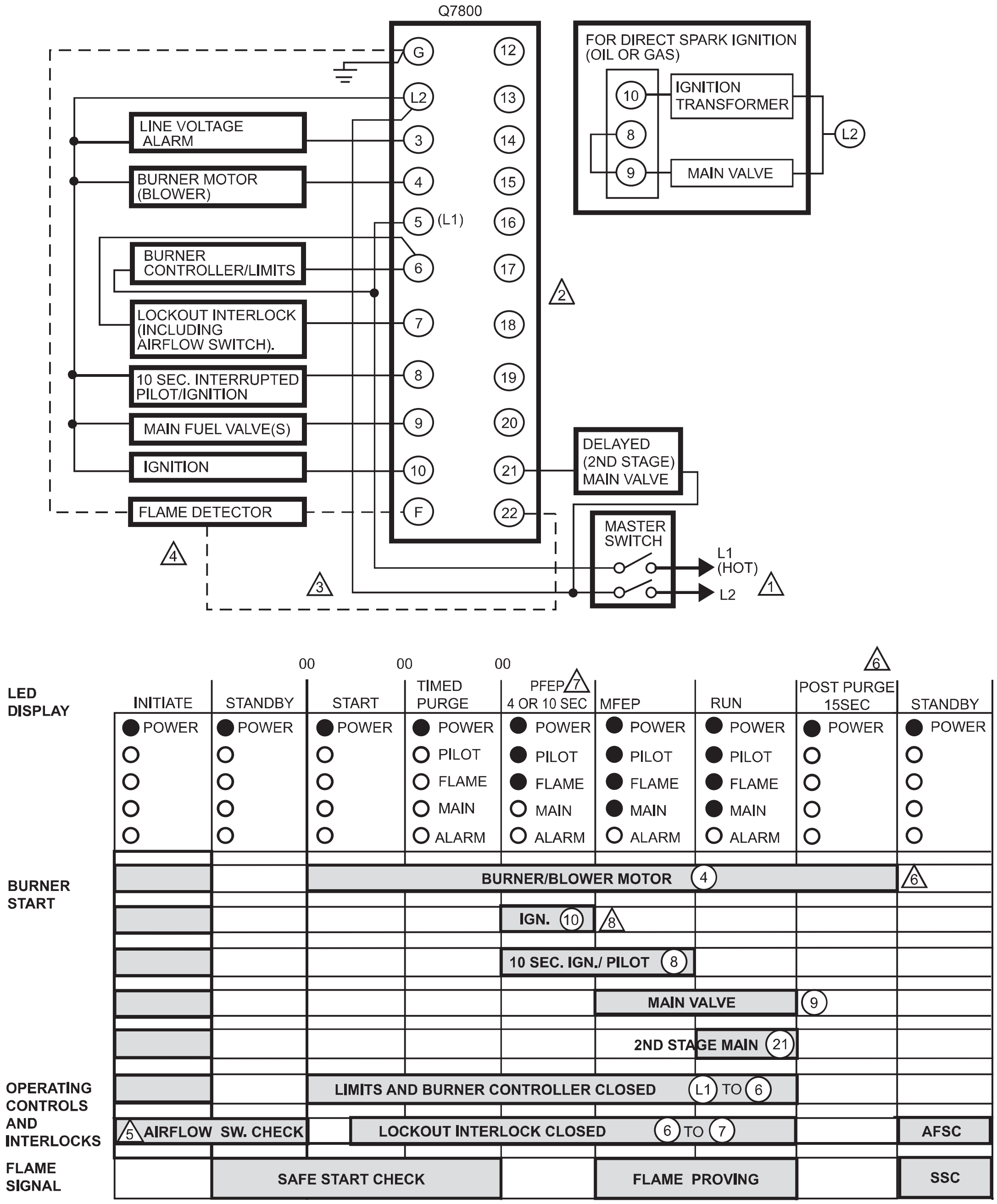
5. FOR RM7895A1048 (ONLY), IGNITION TERMINAL 10 IS DE-ENERGIZED WHEN FLAME IS PROVEN.

6. AIRFLOW SWITCH CHECK FEATURE IS FOR THE RM7895B,RM7896B.

7. RM7896A,B ONLY.

M23997

Fig. 2. Wiring subbase and sequence chart for RM7895A,B/EC7895A; RM7896A,B.



1. RM7895, RM7896: 120 VAC , 50/60 HZ; EC7895: 220-240 VAC, 50/60 HZ POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.
2. DO NOT CONNECT ANY WIRES TO UNUSED TERMINALS.
3. FOR EC7895, A 220 TO 240 VAC TO 120 VAC, 10 VA MINIMUM STEPDOWN TRANSFORMER (NOT PROVIDED) MUST BE USED TO DRIVE THE SHUTTER.
4. SEE FLAME DETECTOR SPECIFICATIONS FOR CORRECT WIRING.
5. AIRFLOW SWITCH CHECK FEATURE IS FOR THE RM7895D, RM7896D.
6. RM7896C,D ONLY.
7. RM7895C1020, RM7896C1036 PFEP 10 SECONDS ONLY; RM7895C1053 PFEP 4 SECONDS ONLY, 3 SECONDS ONLY SOFTWARE REVISION 4151.
8. RM7895C1020, RM7896C1036: DURING FIRST 8 SECONDS OF PFEP, WHEN A FLAME SIGNAL IS DETECTED, TERMINAL 10 IS DE-ENERGIZED. IF FLAME SIGNAL IS LOST, TERMINAL 10 WILL RE-ENERGIZE.

M23998

Fig. 3. Wiring subbase and sequence chart for RM7895C,D/EC7895C; RM7896C,D.

Table 1. Recommended Wire Sizes and Part Numbers.

Application	Recommended Wire Size	Recommended Part Numbers
Line voltage terminals.	14, 16 or 18 AWG copper conductor, 600 volt insulation, moisture-resistant wire.	TTW60C, THW75C, THHN90C.
Keyboard Display Module	22 AWG two-wire twisted pair with ground, or five-wire.	Belden 8723 shielded cable or equivalent.
Data ControlBus™ Module[a]	22 AWG two-wire twisted pair with ground, or five-wire.	Belden 8723 shielded cable or equivalent.
Remote Reset Module	22 AWG two-wire twisted pair, insulated for low voltage.	—
Communications Interface ControlBus™ Module[a]	22 AWG two-wire twisted pair with ground.	Belden 8723 shielded cable or equivalent.
13 Vdc full-wave rectified transformer power input.	18 AWG wire insulated for voltages and temperatures for given application.	TTW60C, THW75C, THHN90C.

[a] The KDM, Data ControlBus™ Module (for remote mounting or communications) or Communication Interface ControlBus™ Module must be wired in daisy chain configuration, 1(a)-1(a), 2(b)-2(b), 3(c)-3(c). The order of interconnection of all the devices listed above is not important. Be aware that modules on the closest and farthest end of the daisy chain configuration string require a 120 ohm (1/4 watt minimum) resistor termination across terminals 1 and 2 of the electrical connectors for connections over 100 feet (31 meters).

Table 2. Recommended Grounding Practices.

Ground Type	Recommended Practice
Earth ground (subbase and relay module).	1. Use to provide a connection between the subbase and the control panel of the equipment. Earth ground must be capable of conducting enough current to blow the 20A fuse (or breaker) in the event of an internal short circuit. 2. Use wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire is required, use 14 AWG copper wire. 3. Make sure that mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.
Signal ground (Keyboard Display Module, Data ControlBus™ Module, Communications Interface ControlBus™ Module.	Use the shield of the signal wire to ground the device to the signal ground terminal 3(c) of each device. Connect the shield at both ends of the daisy chain to earth ground.

7. Recommended wire routing of leadwires:
   a. Do not run high voltage ignition transformer wires in the same conduit with the flame detector, Data ControlBus Module™, or Remote Reset Module wiring.
   b. Do not route flame detector, Data ControlBus™ Module, or Remote Reset Module leadwires in conduit with line voltage circuits.
   c. Enclose flame detector leadwires without armor cable in metal cable or conduit.
   d. Follow directions in flame detector, Data ControlBus™ Module, or Remote Reset Module Instructions.
8. The KDM is powered from a low voltage, energy limited source. It can be mounted outside of a control panel if it is protected from mechanical damage.

NOTE: A 13 Vdc power supply must be used any time more than one KDM is used.

9. Maximum wire lengths:
   a. RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D leadwires: The maximum leadwire length is 300 feet to terminal inputs (Control, Running/Lockout Interlock).
   b. Flame Detector leadwires: The maximum flame sensor leadwire length is limited by the flame signal strength.
   c. Remote Reset leadwires: The maximum length of wire is 1000 feet (305 meters) to a Remote Reset pushbutton.
   d. Data ControlBus Module™: The maximum Data ControlBus™ Module cable length depends on the number of system modules connected, the noise conditions and the cable used. The maximum length of all Data ControlBus™ Module interconnecting wire is 4000 feet (1219 meters).
10. Be sure loads do not exceed the terminal ratings. Refer to the label on the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D or to the terminal ratings in Table 3.

Final Wiring Check

1. Check the power supply circuit. The voltage and frequency tolerance must match those of the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D. A separate power supply circuit can be required for the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D. Add the required disconnect means and overload protection.
2. Check all wiring circuits and complete Static Checkout in Table 6 before installing the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D on the subbase.
3. Install all electrical connectors.
4. Restore power to the panel.

Table 3. Terminal Ratings.

Terminal Number	Description	Ratings	
		RM7895/RM7896	EC7895
G	Flame Sensor Ground	—	—
Earth G	Earth Ground[a]	—	—
L2(N)	Line Voltage Common	—	—
3	Alarm	120 Vac, 1A pilot duty.	220-240 Vac, 1A pilot duty.
4	Burner Motor	120 Vac, 9.8A AFL, 58.8 ALR (inrush).	220-240 Vac, 4A at PF = 0.5, 20A inrush.
5	Line Voltage Supply (L1)	120 Vac (+10/-15%), 50 or 60 Hz (±10%).[b]	220-240 Vac (+10/-15%), 50 or 60 Hz (±10%).
6	Burner Controller and Limits	120 Vac, 1 mA.	220-240 Vac, 1 mA.
7	Lockout Interlock	120 Vac, 8A run, 43A inrush.	8A at PF = 0.5, 40A inrush, 2A at PF = 0.2.
8	Pilot Valve/Ignition	120 Vac[c]	220-240 Vac, 4A at PF = 0.5, 20A inrush.
9	Main Fuel Valve	120 Vac[c]	220-240 Vac, 4A at PF = 0.5, 20A inrush.
10	Ignition	120 Vac[c]	220-240 Vac, 2A at PF = 0.2
F(11)	Flame Sensor	60 to 220 Vac, current limited.	60 to 220 Vac, current limited.
12 to 20	Unused	—	—
21	2nd Stage Main Valve (EC7895C, RM7895C,D; RM7896C,D)	120 Vac[c]	220-240 Vac, 4A at PF = 0.5, 20A inrush.
22	Shutter	120 Vac, 0.5A	220-240 Vac[d]

[a] See Table 2.

[b] 2000 VA maximum load connected to RM7895A,B,C,D/EC7895A,C/RM7896A,B,C,D Assembly.

[c] See Tables 4 and 5.

[d] Requires 220-240 Vac, 10 VA minimum, stepdown transformer to operate the shutter.

Table 4. Combinations for Terminals 8, 9, 10 and 21.

Combination Number	Pilot Fuel 8	Main 9	Ignition 10	Delayed Main Valve 21
1	C	F	No Load	No Load
2	B	F	No Load	No Load
3	F[a]	No Load	A	No Load
4	F	F	A	No Load
5	F[a]	No Load	A	F
6	D	F	A	No Load
7	D[a]	No Load	A	D
8	D	D	A	No Load
9	D[a]	No Load	A	D

[a] RM7895C,D: EC7895C, RM7896C,D only, jumper terminals 8 to 9.

Table 5. Composition of each Combination.

A	B	C	D	F
4.5A ignition	50 VA Pilot Duty[a] plus 4.5A ignition.	180 VA Ignition plus motor valves with: 660 VA inrush, 360 VA open, 240 VA hold.	2A Pilot Duty.[a]	65 VA Pilot Duty[a] plus motor valves with: 3850 VA inrush, 700 VA open, 250 VA hold.

[a] Pilot Duty refers to solenoid-type valves.

STATIC CHECKOUT

After checking all wiring, perform this checkout before installing the EC7895A,C/RM7895A,B,C,D/RM7896A,B,C,D on the subbase. These tests verify the Q7800 Wiring Subbase is wired correctly, and the external controllers, limits, interlocks, actuators, valves, transformers, motors and other devices are operating properly.

⚠ WARNING

Fire or Explosion Hazard.
Can cause property damage, severe injury or death.
Close all manual fuel shutoff valve(s) before starting these tests.

Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.

Ensure proper selection of configuration jumpers before starting the burner operation.

⚠ CAUTION

Electrical Hazard.
Can cause equipment damage or failure.
Do not perform a dielectric test with the relay module installed. Internal surge protectors can break down, allowing relay module to fail the dielectric test and destroy the internal lightning and high current protection.

1. Open the master switch before installing or removing a jumper on the subbase.
2. Before continuing to the next test, be sure to remove the test jumper(s) used in the previous test.
3. Replace all limits and interlocks that are not operating properly. Do not bypass limits and interlocks.

Equipment Recommended

1. Voltmeter (1M ohm/volt minimum sensitivity) set on the 0 to 300 Vac scale.
2. Two jumper wires, no. 14 wire, insulated, 12 in. (304.8 mm) long with insulated alligator clips at both ends.

General Instructions

1. Perform all applicable tests listed in Static Checkout, Table 6, in the order listed.
2. Make sure all manual fuel shutoff valve(s) are closed.
3. For each test, open the master switch and install the jumper wire(s) between the subbase wiring terminals listed in the Test Jumpers column.
4. Close the master switch before observing operation.
5. Read the voltage between the subbase wiring terminals listed in the Voltmeter column.
6. If there is no voltage or the operation is abnormal, check the circuits and external devices as described in the last column.
7. Check all wiring for correct connections, tight terminal screws, correct wire, and proper wiring techniques. Replace all damaged or incorrectly sized wires.
8. Replace faulty controllers, limits, interlocks, actuators, valves, transformers, motors and other devices, as required.
9. Make sure normal operation is obtained for each required test before continuing the checkout.
10. After completing each test, be sure to open the master power switch and remove the test jumper(s) before proceeding to the next test.

⚠ WARNING

Explosion hazard.
Can cause serious injury or death.
Be sure all manual fuel shutoff valves are closed.

Table 6. Static Checkout .

Test Number	Relay Module Model	Test Jumpers	Voltmeter	Normal Operation	If Operation is Abnormal, Check Items Listed Below
1	All	None	5-L2	Line voltage at terminal 5.	1. Master switch. 2. Power connected to master switch. 3. Overload protection (fuse, circuit breaker, etc.) has not opened power line.
2	All	None	6-L2	Line voltage at terminal 6.	1. Limits. 2. Burner controller.
3	All	4-5	7-L2	1. Burner motor (fan or blower) starts. 2. Line voltage at terminal 7 within 10 seconds.	1. Burner motor circuit. a. Manual switch of burner motor. b. Burner motor power supply, overload protection and starter. c. Burner motor.
4	All	5-10	—	1. Ignition spark (if ignition transformer is connected to terminal 10).	1. Watch for spark or listen for buzz. a. Ignition electrodes are clean. b. Ignition transformer is okay.

Table 6. Static Checkout (Continued).

Test Number	Relay Module Model	Test Jumpers	Voltmeter	Normal Operation	If Operation is Abnormal, Check Items Listed Below
5	All	5-8	—	1. Ignition spark (if ignition transformer is connected to terminal 8). 2. Automatic pilot valve opens (if connected to terminal 8). NOTE: Refer to wiring diagram of system being tested.	1. Watch for spark or listen for buzz. 2. Listen for click or feel head of valve for activation. a. Actuator if used. b. Pilot valve.
6	All	5-9	—	Automatic fuel valve(s) open(s). If using direct spark ignition, check first stage fuel valve(s) instead of pilot valve.	Same as test 5. If using direct spark ignition, check first stage fuel valve(s) instead of pilot valve.
7	EC7895C; RM7895C,D; RM7896C,D	5-21	—	Automatic second stage main fuel valve(s) open(s).	1. Listen for and observe operation of second stage main fuel valve(s) and actuator(s). 2. Valve(s) and actuator(s).
8	All	5-3	—	Alarm (if used) turns on.	1. Alarm.
Final	All	⚠ **CAUTION** **Equipment Damage Hazard.** **Can cause equipment damage.** After completing these tests, open master switch and remove all test jumpers from subbase terminals. Also remove bypass jumpers, if used, from low fuel pressure limits.			

Mounting RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D Relay Module

1. Mount the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D vertically on the Q7800 Subbase or mount horizontally with the knife blade terminals pointing down. When mounted on the Q7800A, the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D must be in an electrical enclosure.
2. When mounting in an electrical enclosure, provide adequate clearance for servicing, installation and removal of the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D, KDM, flame amplifier, flame amplifier signal voltage probes, electrical signal voltage probes and electrical connections.
   a. Allow an additional two inches (51 mm) below the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D for the flame amplifier mounting.
   b. Allow an optional three-inch (76 mm) minimum on both sides of the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D for electrical signal voltage probes.
3. Make sure no subbase wiring is projecting beyond the terminal blocks. Tuck in wiring against the back of the subbase so it does not interfere with the knife blade terminals or bifurcated contacts.

IMPORTANT

The RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D must be installed with a plug-in motion rather than a hinge action.

4. Mount the RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D by aligning the four L-shaped corner guides and knife blade terminals with the bifurcated contacts on the wiring subbase and securely tightening the two screws without deforming the plastic.

Mounting Other System Components (Fig. 4)

Refer to the applicable specifications for mounting other system components.

PRINCIPAL TECHNICAL FEATURES

The RM7895 provides all customary flame safeguard functions as well as significant advancements in safety, annunciation, and system diagnostics.

Safety Shutdown (Lockout) Occurs if:

1. INITIATE PERIOD
   a. Purge card is not installed or removed.
   b. Purge card is bad.
   c. Configuration jumpers have been changed (after 200 hours)—Fault Code 110.
   d. AC line power errors occurred, see Operation.
   e. Four minute INITIATE period has been exceeded.

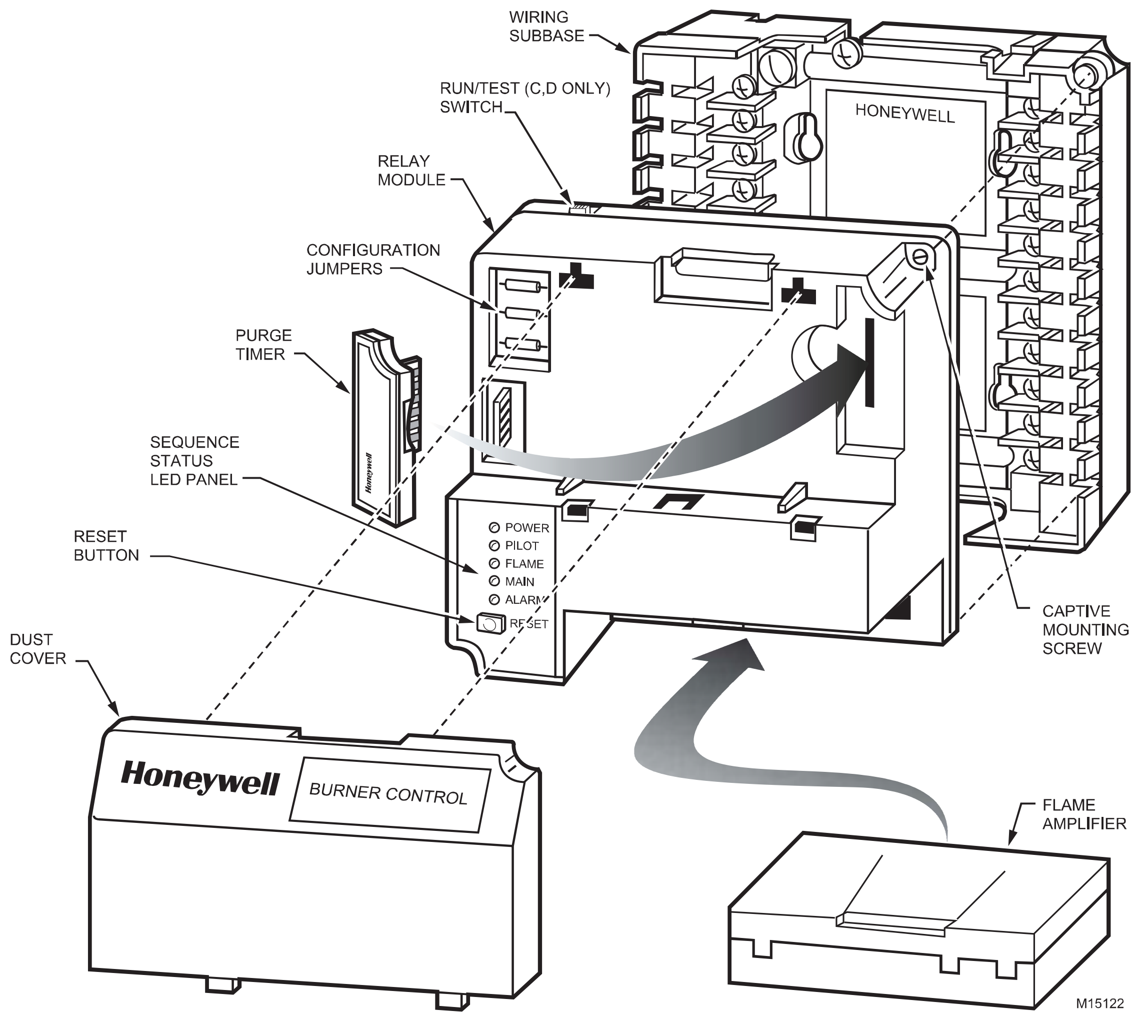


Fig. 4. RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D Relay Module, exploded view.

2. STANDBY PERIOD
   a. Airflow lockout feature is enabled and the airflow switch does not close after ten seconds or within the specified purge card timing.
   b. Flame signal is detected after 30 seconds.
   c. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   d. Main valve terminal is energized.
   e. Delayed main valve terminal is energized (RM7895C,D).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.
3. PREPURGE PERIOD
   a. Airflow lockout feature is enabled and the airflow switch opens.
   b. Ignition/pilot valve terminal is energized.
   c. Main valve terminal is energized.
   d. Delayed main valve terminal is energized (RM7895C,D).
   e. Internal system fault occurred.
   f. Purge card is removed.
   g. Purge card is bad.
   h. Flame signal is detected.
4. PILOT FLAME ESTABLISHING PERIOD (PFEP)
   a. Airflow lockout feature is enabled and the airflow switch opens.
   b. No flame signal at end of PFEP.
   c. Ignition/pilot valve/intermittent pilot valve terminal is not energized.

NOTE: For the RM7895C1020 and RM7896C1036, during the first 8 seconds of PFEP, when a flame signal is detected, terminal 10 is de-energized. If the flame signal is lost, terminal 10 will re-energize.

   d. Main valve terminal is energized.
   e. Delayed (second stage) main valve terminal is energized (RM7895C,D/EC7895C; RM7896C,D).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.

5. MAIN FLAME ESTABLISHING PERIOD (MFEP) (RM7895C, RM7896C,D; EC7895C)
   a. Airflow lockout feature is enabled and the airflow switch opens.
   b. Ignition terminal is energized.
   c. Ignition/pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. Delayed main valve terminal is energized.
   f. No flame signal at end of Flame Failure Response Time.
   g. Internal system fault occurred.
   h. Purge card is removed.
   i. Purge card is bad.
6. RUN PERIOD
   a. No flame present.
   b. Airflow lockout feature is enabled and the airflow switch opens.
   c. Interrupted pilot valve terminal is energized (RM7895C, RM7896C,D; EC7895C).
   d. Main valve terminal is not energized.
   e. Delayed main valve terminal is not energized (RM7895C, RM7896C,D; EC7895C).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.
   i. Ignition terminal is energized.

OPERATION

Sequence of Operation

The RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D has the operating sequences listed below; see Fig. 2 and 3. The RM7895A,B,C,D/EC7895A,C; RM7896A,B,C,D LED provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM.

Initiate

The EC7895A,C/RM7895A,B,C,D;RM7896A,B,C,D Relay Module enters the INITIATE sequence when the relay module is powered. The EC7895A,C/RM7895A,B,C,D; RM7896A,B,C,D can also enter the INITIATE sequence if the relay module verifies voltage fluctuations of +10/-15% or frequency fluctuations of ±10% during any part of the operating sequence. The INITIATE sequence lasts for ten seconds unless the voltage or frequency tolerances are not met. When not met, a hold condition is initiated and displayed on the optional KDM for at least five seconds; when met, the INITIATE sequence restarts. If the condition is not corrected and the hold condition exists for four minutes, the EC7895A,C/RM7895A,B,C,D; RM7896A,B,C,D locks out. Causes for hold conditions in the INITIATE sequence:

1. AC line dropout detection.
2. AC line noise that can prevent a sufficient reading of the line voltage inputs.
3. Low line voltage brownouts.

The INITIATE sequence also delays the burner motor starter from being energized and de-energized from an intermittent AC line input or control input.

Standby

The EC7895A,C/RM7895A,B,C,D;RM7896A,B,C,D is ready to start an operating sequence when the operating control input determines a call for heat is present. The burner switch, limits, operating limit control and all microcomputer-monitored circuits must be in the correct state for the relay module to continue into the PREPURGE sequence.

Normal Start-Up Prepurge

The EC7895A,C/RM7895A,B,C,D/RM7896A,B,C,D Relay Module provides PREPURGE timing selectable from two seconds to thirty minutes with power applied and the operating control indicating a call for heat.

1. The Airflow Interlock, burner switch, Run/Test switch and all microcomputer-monitored circuits must also be in the correct operating state.
2. The motor output, terminal 4, is powered to start the PREPURGE sequence.
3. The Airflow Interlock input closes ten seconds into PREPURGE or within the specified purge card timing; otherwise, a recycle to the beginning of PREPURGE or lockout occurs, depending on how the Airflow Switch selectable jumper (JR3) is configured.

Ignition Trials

1. Pilot Flame Establishing Period (PFEP):
   a. When the PFEP begins:
      (1) The pilot valve and ignition transformer, terminals 8 and 10, are energized. The EC7895A, RM7895A,B, and RM7896A,B have an intermittent pilot valve, terminal 8. The EC7895C, RM7895C,D, and RM7896C,D have an interrupted pilot valve, terminal 8.
      (2) Flame must be proven by the end of the ten second PFEP (four seconds if Configuration Jumper JR1 is clipped) to allow the sequence to continue. If a flame is not proven by the end of PFEP, a safety shutdown occurs.
   b. With flame proven, the ignition, terminal 10, is de-energized.

NOTE: For the RM7895C1020 and RM7896C1036, during the first 8 seconds of PFEP, when a flame signal is detected, terminal 10 is de-energized. If the flame signal is lost, terminal 10 will re-energize.

2. Main Flame Establishing Period (MFEP):
   a. After PFEP, and with the presence of flame, the main fuel valve, terminal 9, is powered. If a flameout occurs, the relay module locks out or recycles (depending on status of jumper JR2) within 0.8 or 3 seconds, depending on the Flame Failure Response Time (FFRT) of the amplifier.
   b. The EC7895C, RM7895C,D and RM7896C,D have a ten second MFEP. After the Ignition Trials, the pilot valve, terminal 8, is de-energized. If a flameout occurs, the relay module locks out or recycles (depending on status of jumper JR2) within 0.8 or 3 seconds, depending on the Flame Failure Response Time (FFRT) of the amplifier.

Run

1. The EC7895C, RM7895C,D, RM7896C,D has a delayed main valve that is energized once the RUN period is entered.
2. The relay module is now in RUN and remains in RUN until the controller input, terminal 6, opens, indicating that the demand is satisfied or a limit has opened.

Post Purge (RM7896A,B,C,D Only)

After demand is satisfied or a limit opens, de-energizing terminal 6, the Ignition/Pilot valve, main valve and delayed main valve, terminals 8, 9 and 21, are de-energized. The blower motor, terminal 4, remains powered for 15 seconds.

Run/Test Switch (RM/EC7895C,D; RM7896C,D only)

The Run/Test Switch is located on the top side of the relay module, see Fig. 5. The Run/Test Switch allows the burner sequence to be altered as follows:

1. In the measured PREPURGE sequence, the Run/Test Switch, placed in the TEST position, causes the PREPURGE timing to stop.
2. In the Pilot Flame Establishing Period, the Run/Test Switch, placed in the TEST position, stops the timer during the first eight seconds of a ten-second PFEP selection or during the first three seconds of a four-second PFEP selection. It also allows for pilot turn-down test and other burner adjustments. This activates a fifteen-second flameout timer that permits pilot flame adjustment without nuisance safety shutdowns. The Run/Test Switch is ignored during PFEP for the C and D relay modules if terminals 8 and 9 or 9 and 21 are jumpered.

IMPORTANT

When the relay module is switched to the TEST mode, it stops and holds at the next Run/Test Switch point in the operating sequence. Make sure that the Run/Test Switch is in the RUN position before leaving the installation.

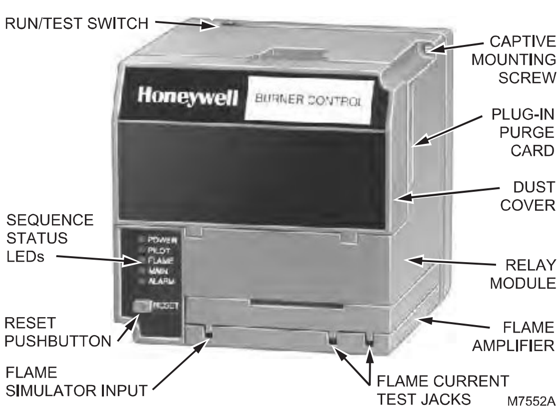


Fig. 5. Sequence Status LEDs.

SETTINGS AND ADJUSTMENTS

Selectable Site-Configurable Jumpers

The relay module has three site-configurable jumper options, see Fig. 6 and Table 6. If necessary, clip the site-configurable jumpers with side cutters and remove the resistors from the relay module.

SERVICE NOTE: Clipping and removing a site-configurable jumper enhances the level of safety.

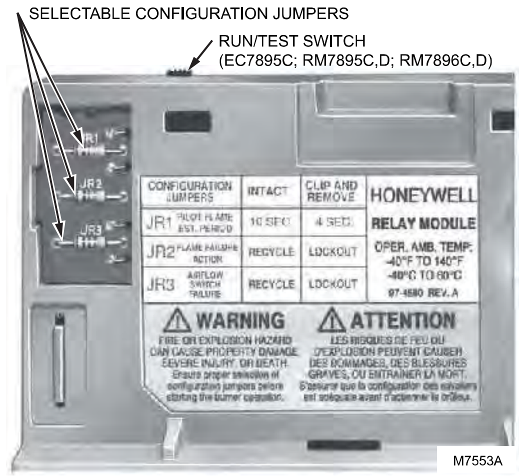


Fig. 6. Selectable site-configurable jumpers.

Table 7. Site-configurable jumper options.

Jumper Number	Description	Intact	Clipped
JR1[a, b]	Pilot Flame Establishing Period (PFEP)	10 seconds	4 seconds
JR2[c]	Flame Failure Action	Recycle	Lockout
JR3	Airflow Switch (ILK) Failure	Recycle	Lockout

[a] The RM7895C1020 and RM7896C1036 have fixed PFEP of ten seconds and do not have jumper JR1 (3 seconds software revision 4151 or greater).

[b] The RM7895C1053 has fixed PFEP of four seconds and does not have jumper JR1.

[c] The RM7895C1053 locks out on Flame Failure Action and does not have jumper JR2.

IMPORTANT

Clipping and removing a jumper after 200 hours of operation causes a nonresettable Fault 110. The relay module must then be replaced.

Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9

Honeywell

66-1090—06 M.S. Rev. 06-07

Printed in U.S.A. on recycled paper containing at least 10% post-consumer paper fibers.

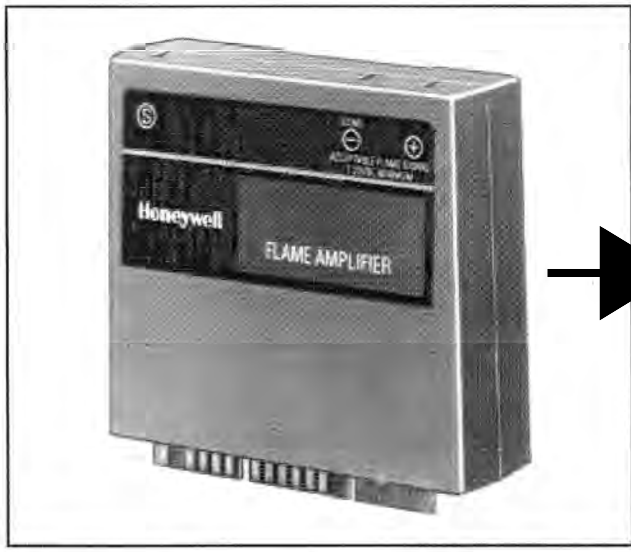
CP-BS-1

Honeywell

Amplifier Card
Part # R7861A1026

R7824, R7847, R7848, R7849, R7851, R7861, R7886 Amplifiers for 7800 SERIES Relay Modules

SPECIFICATION DATA



APPLICATION

The R7824C Rectification Flame Amplifier is a solid state plug-in amplifier that responds to a rectified signal from a C7024E,F Self-Check Ultraviolet Flame Detector to indicate the presence of flame when used with an RM7824 Relay Module.

The R7847A,B Rectification Flame Amplifiers are solid state plug-in amplifiers that respond to a rectified signal from a rectification type flame detector to indicate the presence of flame when used with 7800 SERIES Relay Modules.

The R7847C Self-Check Rectification Flame Amplifier is a solid state plug-in amplifier that responds to a rectified signal from a C7012E,F Self-Check Ultraviolet Flame Detector to indicate the presence of flame when used with 7800 SERIES Relay Modules. This is not European Community (CE) approved for EC7810, EC7820, EC/RM7830 or EC/RM7850 Relay Modules.

The R7848A,B Infrared Flame Amplifiers are solid state plug-in amplifiers that respond to an infrared signal from a C7015 Infrared Flame Detector to indicate the presence of flame when used with 7800 SERIES Relay Modules.

The R7849A,B Ultraviolet Flame Amplifiers are solid state plug-in amplifiers that respond to an ultraviolet signal from a C7027, C7035 or C7044 Ultraviolet Flame Detector to indicate the presence of flame when used with 7800 SERIES Relay Modules.

The R7851B Optical Flame Amplifiers are solid state plug-in amplifiers that respond to optical signals from C7927, C7935, C7915 and C7962 Flame Detectors to indicate the presence of flame when used with 7800 SERIES Relay Modules.

he R7861A Self-Check Ultraviolet Flame Amplifier is a solid state plug-in amplifier that responds to an ultraviolet signal from a C7061A Self-Check Ultraviolet Flame Detector to indicate the presence of flame when used with 7800 SERIES Relay Modules.

The R7886A Dynamic Self-Check Ultraviolet Amplifier is a solid state plug-in amplifier that responds to a pulsed direct current signal from a C7076A,C Ultraviolet Flame Detector with adjustable sensitivity to indicate the presence of flame when used with 7800 SERIES Relay Modules.

FEATURES

- **Flame failure response time (FFRT) of 0.8 or 1 second; or 2.0 or 3.0 seconds, depending on the amplifier and relay module selected. See Table 1.**
- **Plug-in to 7800 SERIES Relay Module through printed circuit board edge connector keyed for proper orientation.**
- **Flame signal test jacks measure amplifier flame signal voltage.**
- **0.0 to 5.0 Vdc Flame signal strength reading range.**
- **Color coded label identifies flame detection type (see Table 2):**
  - **Green—rectification.Red—infrared.**
  - **Purple—ultraviolet.Blue—pulsed rectification.**
  - **White—optical.**
- **R7847B, R7848B, R7849B Dynamic Ampli-Check® circuitry tests all flame amplifier components 12 times per minute. The 7800 SERIES Relay Module locks out on safety shutdown with amplifier failure.**

66-2034-3

- **R7824C and R7847C Dynamic Self-Check Rectification Amplifier, R7861 Self-Check Ultraviolet Flame Amplifier and R7886A Dynamic Self-Check Ultraviolet Amplifier test the detectors and all electronic components in the flame detection system 12 times per minute. The 7800 SERIES Relay Module locks out on safety shutdown with flame detection system failure.**

NOTE: R7824C, Series 2 or greater, and R7847C, series 4 or greater, pulse shutter when signal of 1.5 Vac is sensed.

SPECIFICATIONS

Models:
Flame Detection Systems (see Table 2):
Rectification:
R7824C for use with C7024E,F Solid State Ultraviolet Detectors.
R7847A for use with flame rods, rectifying photocells or C7012A,C Solid State Ultraviolet Detectors.
R7847B for use with flame rods, rectifying photocells or C7012A,C Solid State Ultraviolet Detectors.
R7847C for use with C7012E,F Solid State Ultraviolet Detectors.
Infrared:
R7848A for use with C7015 Infrared (lead sulfide) Detector.
R7848B for use with C7015 Infrared (lead sulfide) Detector.
Ultraviolet:
R7849A for use with C7027/C7035/C7044 Minipeeper Ultraviolet Detectors.
R7849B for use with C7027/C7035/C7044 Minipeeper Ultraviolet Detectors.
R7861A for use with C7061A Ultraviolet Detector.
R7886A for use with C7076A,D Ultraviolet Detectors with adjustable sensitivity.
Optical:
R7851B for use with C7927, C7935, C7915 and C7962 Flame Detectors.

Flame Failure Response Time : See Table 1.

Table 1. Relay Module Flame Failure Response Time (FFRT).

Relay Module	Flame Failure Response Time (FFRT)	
	0.8 or 1.0 second	**2.0 or 3.0 seconds**
EC7810, EC7820, EC/RM7830, EC/RM7850	1.0	2.0
EC/RM7823, EC/RM7885, EC/RM7890, EC/RM7895, EC/RM7896, EC/RM7888, EC/RM7838, EC/RM7800, EC/RM7840	0.8	3.0
RM7824	N/A	3.0

Flame Signal (Volts dc):
Minimum Acceptable: 1.25 Vdc.
Flame Signal Voltage Range (displayed on Keyboard Display Module or measured with a 1M ohm voltmeter plugged into amplifier test jacks): 0.0 to 5.0 Vdc.

Environmental Ratings:
Ambient Temperature:
Operating: -40°F to 140°F (-40°C to 60°C).
Storage: -40°F to 150°F (-40°C to 65°C).
Humidity: Operating 85% rh continuous, noncondensing.
Vibration: Continuous 0.5G environment.

Dimensions: See Fig. 1.

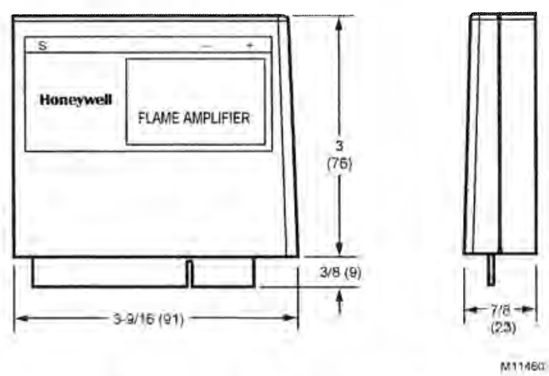


Fig. 1. Flame amplifier dimensions in in. (mm).

Weight: 2.5 oz (71 g), unpacked.

Approvals:
Underwriters Laboratories Inc. Listed: File no. MP268, guide no. MCCZZ: R7847A, R7847B, R7847C, R7861A, R7886A, R7848A, R7848B, R7849A, R7849B, R7851B.
Underwriters Laboratories Inc. Component Recognized: File no. MP268, guide no. MCCZZ: R7824C.
Canadian Standards Association Certified: LR95329-3.
Factory Mutual Approved: Report J.I.1V9A0.AF.
Industrial Risk Insurers Acceptable.

NOTE: EN298 Approved: When these amplifiers are used with an EC7810, EC7820, EC/RM7830, or EC/RM7850 Relay Module.

Accessories:
Flame Simulators:
Rectification: Part no. 123514A.
Ultraviolet: Part no. 203659.
Flame Detectors ordered separately:

⚠ CAUTION

Equipment Damage Hazard.
Can cause equipment damage and failure.
Incorrect combination of relay module, amplifier and flame detector can cause equipment damage.

In infrared applications (C7015 Infrared Flame Detector and R7848 Amplifier) using the RM7890 Relay Module with soft revision 4004 or less requires a ten second delay to start sequence. This applies only to the initial powering of the RM7890.

Table 2. Flame Detection Systems.

Plug-in Flame Signal Amplifiers				Applicable Flame Detectors			
Type	Color	Self-Checking	Model	Flame Failure Response Time (sec)[a]	Fuel	Type	Models
Rectification	Green	Dynamic Self-Check	R7824C[b,c,i]	3	Gas, oil, coal	Ultraviolet (Purple Peeper)	C7024E,F.
		No	R7847A[h]	0.8/1 or 2/3	Gas	Rectifying Flame Rod Holders[j]	C7004, C7007, C7011, Complete Assemblies: C7008, C7009, Q179.
		No	R7847A[h]	0.8/1 or 2/3	Oil	Rectifying Photocell	C7003, C7010, C7013, C7014.[d]
		No	R7847A[h]	2/3	Gas, oil, coal	Ultraviolet (Purple Peeper®)	C7012A,C.
		Dynamic AMPLI-CHECK®	R7847B[e,h]	0.8/1 or 2/3	Gas	Rectifying Flame Rod Holders[b]	C7004, C7007, C7011, Complete Assemblies: C7008, C7009, Q179.
		Dynamic AMPLI-CHECK®	R7847B[e,h]	0.8/1 or 2/3	Oil	Rectifying Photocell	C7003, C7010, C7013, C7014.[d]
		Dynamic AMPLI-CHECK®	R7847B[e,h]	2/3	Gas, oil, coal	Ultraviolet (Purple Peeper®)	C7012A,C.
		Dynamic Self-Check	R7847C[c,f,i]	2/3	Gas, oil, coal	Ultraviolet (Purple Peeper®)	C7012E,F.
Infrared	Red	No	R7848A	2/3	Gas, oil, coal	Infrared (Lead Sulfide)	C7015.
		Dynamic AMPLI-CHECK®	R7848B[e]	3 sec	Gas, oil, coal	Infrared (Lead Sulfide)	C7015.
Ultraviolet	Purple	No	R7849A	0.8/1 or 2/3	Gas, oil	Ultraviolet (Minipeeper)	C7027, C7035, C7044[g].
		Dynamic AMPLI-CHECK®	R7849B[d]	0.8/1 or 2/3	Gas, oil	Ultraviolet (Minipeeper)	C7027, C7035, C7044[g].
		Dynamic Self-Check	R7861A[c,f]	0.8/1 or 2/3	Gas, oil, coal	Ultraviolet	C7061.
	Blue	Dynamic Self-Check	R7886A[c,f]	2/3	Gas, oil, coal	Ultraviolet (Adjustable Sensitivity)	C7076.
Optical	White	Dynamic AMPLI-CHECK®	R7851B	0.8/1 or 2/3	Gas, oil, coal	Optical (UV, IR, Visible Light)	C7927, C7935, C7915, C7962

[a] Flame Failure Response Time (FFRT) depends on selection of amplifier and 7800 SERIES Relay Module selection.

[b] R7824C is used only with the 24 Vdc RM7824 Relay Module and C7024E,F Flame Detectors. Order flame rod separately; see flame detector Instructions for holder.

[c] Circuitry tests all electronic components in flame detection system (amplifier and detector) 12 times a minute during burner operation and shuts down burner if detection system fails.

[d] Use only Honeywell part no. 38316 Photocell.

[e] Circuitry tests flame signal amplifier 12 times a minute during burner operation and shuts down burner if amplifier fails.

[f] 200/220/240 Vac applications require a 120 Vac, 10 VA minimum stepdown transformer (not provided) to drive the shutter. Applies to R7847C series 3 or greater; R7886A series 2 or greater; R7861, series 1 or greater. Figure 2 shows flame detector wiring.

[g] Use C7027, C7035 and C7044 Flame Detectors only on burners that cycle on-off at least once every twenty-four hours. Use C7012E,F Flame Detector with R7847C Amplifier, C7061A Ultraviolet Detector with R7861A Amplifier or C7076A Flame Detector with R7886A Amplifier as ultraviolet flame detection system for appliances with burners that remain on for twenty-four hours continuously or longer.

[h] R7847A,B Amplifiers with 0.8/1 second FFRT should not be used with C7012A,C Solid State Ultraviolet Detectors.

[i] R7824C Series 2 and greater and R7847C Series 4 and greater check flame detector system when flame reaches 1.5 Vdc or at 4.5 seconds, whichever occurs first.

[j] Order flame rod separately; see flame detector instructions for holder.

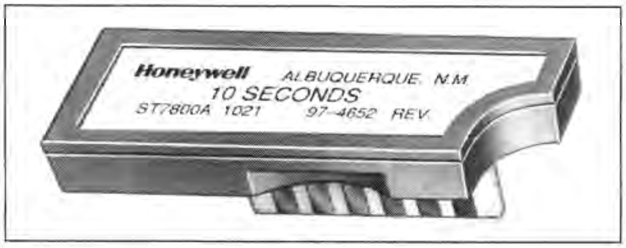
CP2-BS-1..2

Honeywell

Purge Timer
2 1/2 Minute
Part # ST7800A1070

7800 SERIES
ST7800A,C Plug-In Purge Timer

INSTALLATION INSTRUCTIONS



APPLICATION

The ST7800A,C Plug-in Purge Timers provide the prepurge timing for the 7800 SERIES Relay Modules. See Table 1.

INSTALLATION

⚠ WARNING

Fire or Explosion Hazard.
Can cause severe injury, death or property damage.
Perform verification of safety requirements EACH TIME the control is installed to prevent possible hazardous burner operation.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury or death.
Disconnect power supply before installing Purge Time to prevent electrical shock or equipment damage. More than one power supply disconnect can be involved.

1. Remove the Keyboard Display Module (KDM), Dust Cover, Data ControlBus Module™ or Remote Reset Module.
2. Remove the current ST7800A,C (if installed) from the 7800 SERIES Relay Module by pulling upward on the plastic support cover. See Fig. 1.
3. Make sure the new ST7800A,C selected has the desired timing period. The timing is listed on the device label.
4. Properly orient the plug-in purge timer with the opening in the relay module, and insert the purge timer into the opening of the relay module compartment. See Fig. 1.

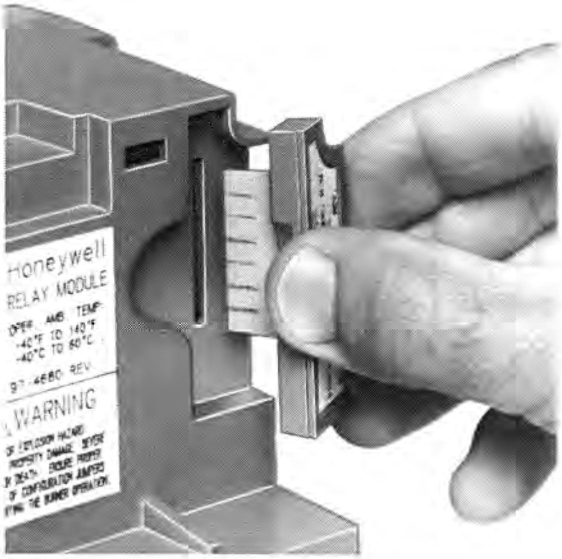


Fig. 1. Purge card installation.

5. Reinstall the KDM, Dust Cover, Data ControlBus Module™ or Remote Reset Module and restore power to the device. Run the burner system through at least one complete cycle to make sure that the system is operating as desired.

Table 1. ST7800 Purge Timer Prepurge Timing.

ST7800A Number	ST7800C Number[a]	Prepurge Timing
ST7800A1005	—	2 seconds
ST7800A1013	ST7800C1003	7 seconds
ST7800A1021	—	10 seconds
—	ST7800C1011	20 seconds
ST7800A1039	—	30 seconds
ST7800A1047	—	40 seconds
ST7800A1054	—	60 seconds
ST7800A1062	—	90 seconds
ST7800A1070	—	2.5 minutes
ST7800A1088	ST7800C1029	4 minutes
ST7800A1096	ST7800C1037	6 minutes
—	ST7800C1045	8 minutes
ST7800A1104	—	9 minutes
—	ST7800C1052	10 minutes
ST7800A1112	ST7800C1060	12 minutes
—	ST7800C1078	14 minutes
ST7800A1120	—	15 minutes
—	ST7800C1086	16 minutes
—	ST7800C1094	18 minutes
—	ST7800C1102	20 minutes
ST7800A1138	ST7800C1110	22 minutes
—	ST7800C1128	24 minutes
ST7800A1146	ST7800C1136	30 minutes
—	ST7800C1144	45 minutes

[a] ST7800C for RM7838C only. A mechanical interlock prevents ST7800A from being installed.

Honeywell

Home and Building Control
Honeywell Inc.
Honeywell Plaza
P.O. Box 524
Minneapolis, MN 55408-0524

Home and Building Control
Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario
M1V 4Z9

65-0089—2 G.R. Rev. 01-01

Printed in U.S.A. on recycled paper containing at least 10% post-consumer paper fibers.

www.honeywell.com

Honeywell

Sub Base to mount Relay Module
Part # Q7800A1005

7800 SERIES Q7800A,B 22-Terminal Universal Wiring Subbase

PRODUCT DATA

FEATURES

- **Quick-mount wiring subbase for all 7800 SERIES Relay Modules and S7830 Expanded Annunciator.**
- **Allows wiring of control system before installation of relay module.**
- **Can be panel mounted (Q7800A) or burner or wall mounted (Q7800B).**
- **Access slots provided for electrical measurement.**
- **NEMA 1 enclosure.**
- **Electrical access slot covers provided with Q7800B; available as an option for Q7800A.**

APPLICATION

The Q7800A,B is a universal wiring subbase for the 7800 SERIES Relay Modules and Expanded Annunciator (S7830A). The universal wiring subbase provides terminals for field wiring. Knife blade terminals located on the 7800 SERIES Relay Module or S7830A engage the Q7800 bifurcated contacts to make electrical connections.

The Q7800A1005 (2-sided) subbase is available for panel mounting applications. The Q7800B1003 and Q7800B1011 (4-sided) subbases are available for burner or wall mount applications. Knockouts are provided in the back, top and bottom for conduit connections.

Contents

SPECIFICATIONS

Weight:
Q7800A: 7 ounces.
Q7800B: 1 pound, 3 ounces.

Dimensions:
See Fig. 1, 2 and 3.

Enclosure:
NEMA 1.

Terminal Screw Torque:
12 pound-inches typical; 13 pound-inches maximum.

Approvals:
Underwriter Laboratories Inc. Component Recognized: File no. MP268, Guide no. MCCZ2 (Q7800A),
Listed: File no. MP268, Guide no. MCCZ (Q7800B).
Canadian Standards Association Certified: LR95329-3.
To meet EN60730 approval, the Q7800 subbase must be mounted in a secured panel which meets IP40 class of protection.

Accessories:
221779 Electrical Access Slot Covers (supplied with Q7800B, optional for Q7800A).

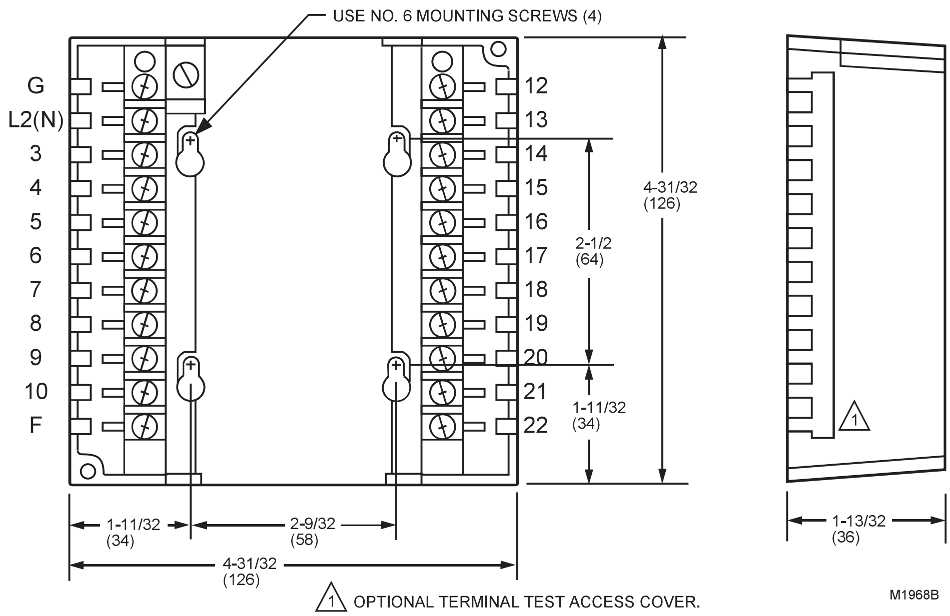


Fig. 1. Top and front view of Q7800A1005 Wiring Subbase (2-sided) with dimensions in in. (mm).

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Home and Building Control Sales Office (check white pages of your phone directory).
2. Home and Building Control Customer Relations
   Honeywell, 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

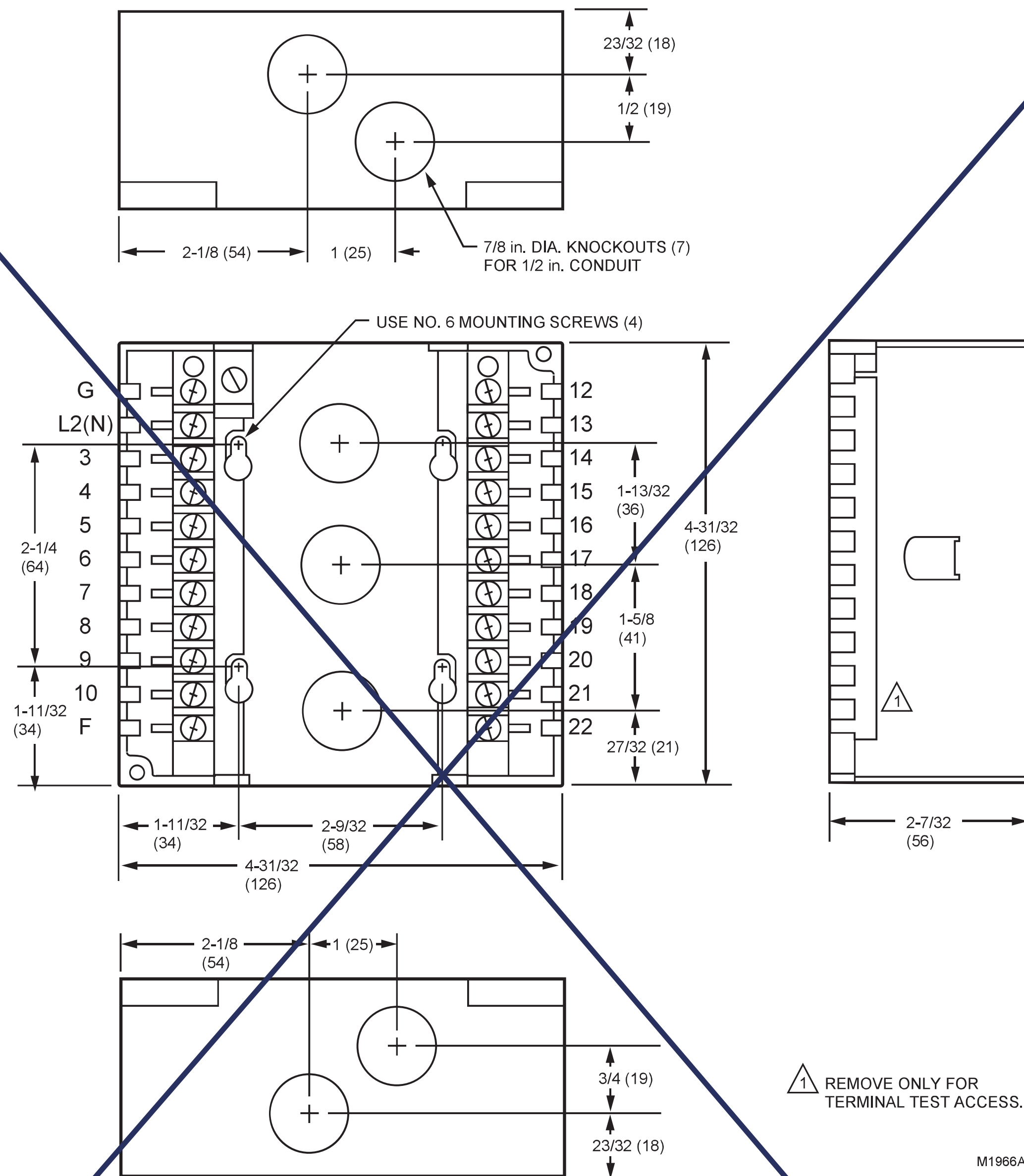


Fig. 2. Top and front view of Q7800B1003 Wiring Subbase (4-sided) with dimensions in in. (mm).

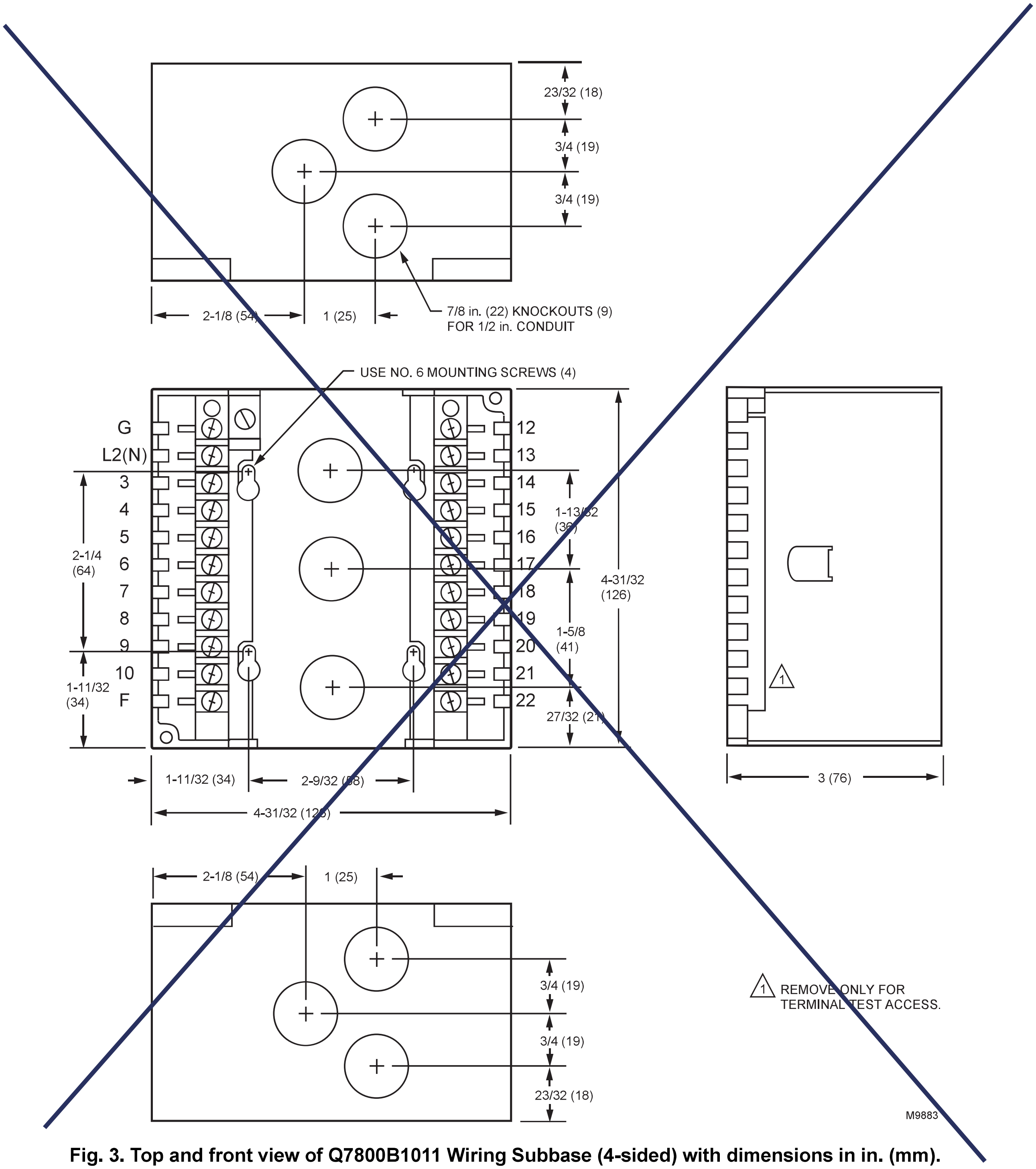


Fig. 3. Top and front view of Q7800B1011 Wiring Subbase (4-sided) with dimensions in in. (mm).

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, Flame Safeguard service technician.
4. Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
5. All wiring must comply with applicable local electrical codes, ordinances, and regulations.
6. All wiring must be NEC Class 1 (Line Voltage).

7. After installation is complete, check out product operation as provided in these instructions.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or property damage.
Disconnect power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.

Follow the equipment manufacturer instructions if available; otherwise, proceed as follows below.

Mounting

NOTE: For installation dimensions, see Fig. 1 and 2.

1. Place the subbase in a location within the ambient temperature rating of the 7800 SERIES Relay Module and S7830A being used. Refer to the appropriate Instructions.
2. Mount the subbase in any position except horizontally with the bifurcated contacts pointing down. The standard vertical position is recommended.
3. Select a wall, burner or electrical panel location. Or mount the Q7800 directly in the control cabinet. Be sure to allow adequate clearance for servicing, installation, access or removal of the 7800 SERIES Relay Module, S7830A, Keyboard Display Module, Run/Test switch, flame amplifier signal voltage probes, electrical signal voltage probes and electrical field connections.

IMPORTANT
Do not mount the wiring subbase horizontally with the bifurcated contacts pointing down.

4. For surface mounting, use the back of the subbase as a template to mark the four screw locations. Drill the pilot holes.
5. Insert the mounting screws using four no. 6 screws tightened securely.

WIRING

1. Refer to the equipment manufacturer's wiring information and the appropriate 7800 SERIES Relay Module or S7830A Specifications for correct subbase wiring.
2. Provide overload protection and disconnect means as required. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
3. All wiring must comply with appropriate electrical codes, ordinances and regulations. Use NEC Class 1 (Line Voltage) wiring.
4. Recommended wire size and type is to use up to two no. 14, 16, or 18 copper conductors TTW60C, THW75C or THHN90C, 600 volt insulation wire for all Line Voltage terminals. For high temperature installations, use wire selected for a temperature rating above the noted maximum operating temperature. The flame detector leadwires should be moisture resistant.
   a. For the ignition leadwire, use Honeywell specification no. R1061012 Ignition Cable or equivalent. (This wire is rated at 350°F (177°C) for continuous duty, and up to 500°F (260°C) for intermittent use. It has been tested to 25,000 volts.)
   b. For the flame detector F leadwire, use Honeywell specification no. R1298020 or equivalent. (This wire is rated at 400°F (204°C) for continuous duty. It is tested for operation up to 600 volts and breakdown up to 7500 volts.)
   c. For ignition installation in a contaminating environment, use Honeywell specification no. R1239001 High Tension Ignition Cable or equivalent. (This wire is resistant to severe conditions of oil, heat and corona, and is tested to withstand high voltages up to 25,000 Vrms in a salt bath for one minute without breakdown. It is rated at 200°F (93°C) for continuous duty, and up to 350°F (177°C) for intermittent use.)
5. Recommended grounding practices:
   a. Each 7800 SERIES Relay Module or S7830A will have an earth ground terminal G that must be grounded to the metal control panel with wire as short as practical. Each ground wire must be capable of carrying a fault current equal to the rating of the protective fuse (15 amperes maximum, type SC or equivalent, fast-blow fuse); a number 14 copper conductor is adequate.
   b. The earth ground provides a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 15A maximum, type SC or equivalent, fast-blow fuse (or breaker) in event of an internal short circuit. The 7800 SERIES Relay Module needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors that have maximum surface areas. Wide straps or brackets are preferred rather than leadwires. Be careful to ensure that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and have corrosion-protected mating surfaces.
6. Recommended wire routing for flame detector leadwires:
   a. Do not run high voltage ignition transformer wires in the same conduit with the flame detection wiring.
   b. Do not route scanner wires in the same conduit with line voltage circuits.
   c. Scanner wiring not utilizing armor cable should be enclosed in metal cable or conduit.
   d. Follow directions in Flame Detector Instructions.
7. Maximum wire lengths for flame detector leadwires are limited by the flame signal strength.
8. Make sure that loads do not exceed terminal ratings; refer to the labels on the 7800 SERIES Relay Module, or S7830A, or ratings in the 7800 SERIES Relay Module or S7830A Specifications.

9. Check the power supply circuit. The voltage and frequency tolerance must match those of the 7800 SERIES Relay Module or S7830A. Do not connect the 7800 SERIES Relay Module or S7830A to a power supply circuit that is subject to line voltage variations, such as would occur with on-off switching of heavy loads. A separate power supply circuit may be required for the 7800 SERIES Relay Module or S7830A. Add the required disconnect means and overload protection.

10. Check all the wiring circuits and complete a *Static Checkout* according to the 7800 SERIES Relay Module or S7830A Specifications before installing the 7800 SERIES Relay Module or S7830A on the subbase.

11. Install the 7800 SERIES Relay Module or S7830A.

12. Restore power to the panel.

IMPORTANT

Do not run high voltage ignition transformer wires in the same conduit with the flame detector wiring.

IMPORTANT

Make sure no subbase wiring is projecting beyond the terminal blocks. Tuck wiring in against the back of the subbase so it does not interfere with the knife blade terminals or bifurcated contacts.

CHECKOUT

After installation, perform a complete checkout of the system. Follow information supplied by equipment manufacturer and instructions furnished with the 7800 SERIES Relay Module or S7830A.

SERVICE NOTE:

Voltage checks can be accomplished by using the electrical access slots on the sides of the Q7800A,B. Remove the electrical access slot covers on the Q7800B before making the voltage checks.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or property damage.
Always replace the electrical access slot covers on the Q7800B after performing voltage checks or anytime they are removed, to prevent the possibility of electrical shock.

Honeywell

Automation and Control Solutions
Honeywell
1985 Douglas Drive North
Golden Valley, MN 55422

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario
M1V 4Z9

Honeywell International
Control Products
Honeywell Building
17 Changi Business Park Central 1
Singapore 486073

Honeywell Europe S.A.
3 Avenue du Bourget
1140 Brussels
Belgium

Honeywell Latin American Region
480 Sawgrass Corporate Parkway
Suite 200
Sunrise FL 33325

Display Module/User Interface
Part # S7800A1001

Honeywell

7800 SERIES
S7800A Keyboard Display Module

PRODUCT DATA

APPLICATION

The S7800A Keyboard Display Module (KDM) provides first-out annunciation and system diagnosis using a two-row by twenty-column readout. The KDM provides local or remote annunciation of operation and fault information, remote reset, report generation, burner control data and diagnostic information. The KDM is part of the 7800 SERIES of microprocessor-based burner controls for gas, oil, coal or combination fuel single burner applications.

The 7800 SERIES is programmed to provide a level of safety, functional capabilities and features beyond the capacity of conventional controls.

FEATURES

- **Application flexibility.**
- **Communication interface capability.**
- **Dependable, long-term operation provided by microcomputer technology.**
- **First-out annunciation and system diagnostics provided by a 2-row by 20-column display.**
- **First-out expanded annunciation with 24 limit and interlock Light Emitting Diodes (LED).**
- **Local or remote annunciation of operation and fault information.**
- **UL Class 4 rating when P/N 204718A,C NEMA 4 cover is used.**
- **Remote reset.**
- **Report generation.**
- **Burner controller data:**
  - **Sequence status.**
  - **Sequence time.**
  - **Hold status.**
  - **Lockout/alarm status.**
  - **Flame signal strength.**
  - **Expanded annunciator status.**
  - **Total cycles of operation.**
  - **Total hours of operation.**
  - **Fault history of six most recent faults:**
    - **Cycles of operation at time of fault.**
    - **Expanded annunciator data at time of fault.**
    - **Fault message and code.**
    - **Hours of operation at time of fault.**
    - **Sequence status at time of fault.**
    - **Sequence time at time of fault.**

Contents

65-0090-4

— **Diagnostic information:**
- **Device type.**
- **Flame amplifier type.**
- **Flame failure response time (FFRT).**
- **Manufacturing code.**
- **On-Off status of all digital inputs and outputs.**
- **PREPURGE time selected.**
- **Software revision and version of 7800 SERIES Relay Module and KDM.**
- **Status of configuration jumpers.**
- **Status of Run/Test Switch.**

SPECIFICATIONS

Electrical Ratings:
Voltage and Frequency: 13 Vdc peak full wave rectified (+20/-15%).
Power Dissipation: 7W maximum.
VA Consumption: 2 VA maximum.

Terminal Ratings:
Power: 13 Vdc peak full wave rectified.
Earth Ground.

Environmental Ratings:
Ambient Temperature Ranges:
Operating: -40°F (-40°C) to +140°F (+60°C).
Storage: -60°F (-51°C) to +150°F (+66°C).
Humidity: 85 percent relative humidity continuous, noncondensing.

NOTE: UL Class 4 rating when P/N 204718A,C NEMA 4 Cover is used.

Vibration: 0.5G environment.

Mechanical:
Dimensions: See Fig. 1.
Weight: 4 ounces (124 grams), unpacked.

Display: 40 character (2 rows by 20 columns).

Languages:
S7800A1001 English language display.
S7800A1035 French language display.
S7800A1043 German language display.
S7800A1050 Italian language display.
S7800A1068 Spanish language display.
S7800A1118 Japanese (Katakana) language display.
S7800A1126 Portuguese language display.

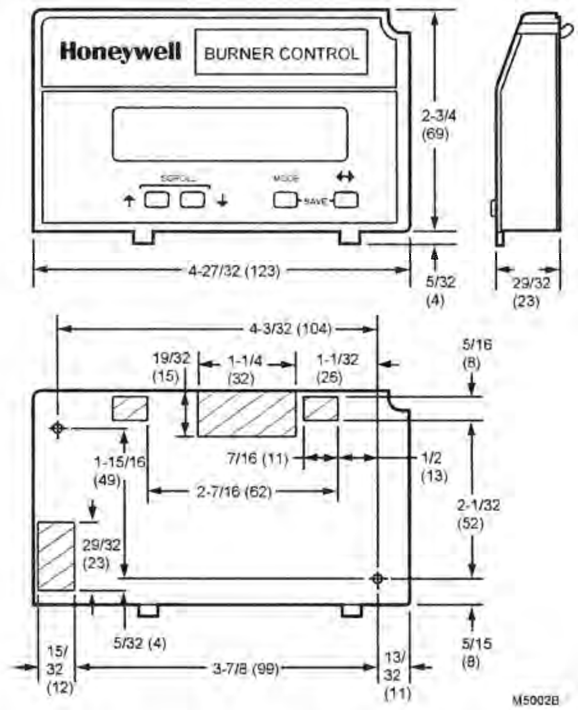


Fig. 1. Approximate dimensions of S7800 in in. (mm).

Approvals:
Underwriters Laboratories Inc. Listed File No. MP268, Guide No. MCCZ.
Canadian Standards Association Certified: No. LR9S329-3.
Factory Mutual Approved: Report No. J.I.1V9A0.AF.
IRI: Acceptable.
Federal Communications Commission: Part 15, Class B emissions.
EN60730: For compliance with remote KDM mounting requirements, provide electrical insulation separation by insulation using double or reinforced insulation. Do this by: Optically isolating the communication or remote reset lines from the control cabinet, or provide physical separation

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:
1. Your local Home and Building Control Sales Office (check white pages of your phone directory).
2. Home and Building Control Customer Relations
   Honeywell, 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

from the communication or remote display cover assembly (part number 204718A) or other suitable enclosure that meets the IP40 class of protection.

Accessories:

203541 ControlBus 5-wire Electrical Connector.
S7810A1009 Data ControlBus Module™.
203765 Remote Display Mounting Bracket.
221818A 60 in. (1.5m) Extension Cable Assembly.
221818C 120 in. (3m) Extension Cable Assembly.
204718A NEMA 4 Cover Assembly for S7800A KDM.
204718B NEMA 1 Cover Assembly for S7800A KDM.
204718C NEMA 4 Cover Assembly for S7800A KDM with reset button.
205321B Remote Display Flush Mount Kit.

INSTALLATION

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury or death.
Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one power supply disconnect can be involved.

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, flame safeguard service technician.
4. After installation is complete, check out the product operation as provided in these instructions.
5. Be sure wiring complies with all applicable codes, ordinances and regulations.
6. See Fig. 5, 6 and 7 for S7800A unique wiring connections.

IMPORTANT

1. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, can cause interference to radio communications. It has been tested and found to comply with the limits for a Class B computing device of Part 15 of FCC rules which are designed to provided reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area can cause interference, in which case, users, at their own expense, can be required to take whatever measures are required to correct this interference.

2. This digital apparatus does not exceed the Class B limits for radio noise for digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Humidity

Install the S7800A where the relative humidity never reaches the saturation point. The S7800 is designed to operate in a maximum 85% RH continuous, noncondensing, moisture environment.

Vibration

Do not install the S7800A where it can be subjected to vibration in excess of 0.5G continuous maximum vibration.

Weather

The S7800A is not designed to be weather tight. If installed outdoors, the S7800A must be protected by an approved weather-tight enclosure such as the 204718A or 204718C NEMA 4 Enclosure listed in Accessories.

Mounting KDM on 7800 SERIES Relay Module.

1. Align the two interlocking ears of the KDM with the two mating slots on the 7800 SERIES Relay Module. See Fig. 2.

Fig. 2. Keyboard display module mounting.

2. Insert the two interlocking ears into the two mating slots and, with a hinge action, push on the lower corners of the KDM to secure it to the 7800 SERIES Relay Module.
3. Make sure the KDM is firmly in place.

Remote Mounting KDM

The KDM can be mounted either on the face of a panel door or on other remote locations. See Fig. 3. When mounting the KDM on the face of a door panel, closely follow these instructions:

Door Panel Mounting

Fig. 3. Panel mounting of a keyboard display module.

1. Select the location on the door panel for flush mounting.
2. Pay attention to the insertion dimensions of the two KDM screws, two interlocking ears, and the two plug-in connections to allow for sufficient clearance.
3. Use the KDM or Data ControlBus Module™ as a template (Fig. 16) and mark the two screw locations, interlocking ear locations and the two plug-in connector locations.
4. Drill the pilot holes for the mounting screws.
5. Cut holes in the door panel for the interlocking ears and the two plug-in connectors.
6. Mount the KDM, securing it with the two screws provided in the KDM bag assembly.

Remote Display Mounting Bracket

Use the 203765 Remote Display Mounting Bracket when mounting the KDM on a wall or remote location:

1. Use the 203765 Remote Display Mounting Bracket as a template to mark the four screw locations.
2. Drill the pilot holes for the four mounting screws.
3. Mount the 203765 Remote Display Mounting Bracket by securing the four no. 6 screws (M3.5 x 0.6). See Fig. 4.
4. Mount the KDM by aligning the two interlocking ears with the two mating slots on the remote mounting bracket.
5. Insert the two interlocking ears into the two mating slots.
6. Push on the lower corners of the KDM to secure it to the remote mounting bracket.
7. Make sure the KDM is firmly in place.

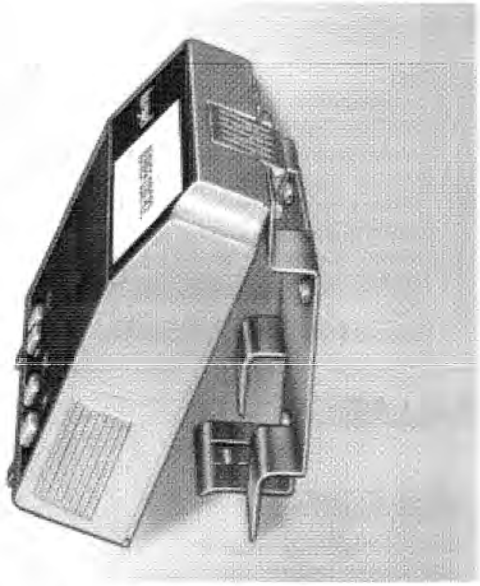


Fig. 4. Remote mounting of a keyboard display module using a 203765 Remote Display Mounting Bracket.

WIRING

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury or death.
To prevent electrical shock and equipment damage, disconnect the power supply from the main disconnect before beginning installation. More than one disconnect can be involved.

1. Refer to Fig. 5, 6, and 7 for proper wiring.
2. Make sure all wiring complies with all applicable electrical codes, ordinances and regulations.
3. For recommended wire size and type, see Table 1.
4. For Recommended grounding practices, see Table 2.
5. For KDM: The KDM is powered from a low voltage, energy-limited source. It can be mounted outside of a control panel if it is protected from mechanical damage.

NOTE: A 13 Vdc power supply must be used any time more than one KDM is used. A maximum of two KDM, Data ControlBus Modules™ or S7810B Multi-Drop Switch Modules are allowed in any combination.

Table 1. Recommended Wire Size and Part Number.

Application	Recommended Wire Size	Recommended Part Number
Keyboard Display Module	22 AWG two-wire twisted pair with ground, or five-wire.	Belden 8723 shielded cable or equivalent.
Data ControlBus™ Module	22 AWG two-wire twisted pair with ground, or five-wire.	Belden 8723 shielded cable or equivalent.
Remote Reset Module	22 AWG two-wire twisted pair, insulated for low voltage.	—
Communications Interface ControlBus Module™	22 AWG two-wire twisted pair with ground.	Belden 8723 shielded cable or equivalent.
13 Vdc full wave rectified transformer power input.	18 AWG wire, insulated for voltages and temperatures for given applications.	TTW60C, THW75C, THHN90C

Table 2. Recommended Grounding Practices.

Ground Type	Recommended Practice
Signal ground (KDM, Data ControlBus™ Module, Communications Interface ControlBus Module™).	Use the shield of the signal wire to ground the device to the signal ground terminals [3(c)] of each device. Connect the shield at both ends of the daisy chain to ground.

6. Recommended wire routing:
   a. ControlBus:
      (1) Do not route the ControlBus cable in conduits that carry line voltage circuits.
      (2) Avoid routing the ControlBus cable close to ignition transformer leadwires.
      (3) Route the ControlBus cable outside of conduit if properly supported and protected from damage.
   b. Remote Reset:
      (1) Do not run high voltage ignition transformer wires in the same conduit with the Remote Reset wiring.
      (2) Do not route Remote Reset wires in conduit with line voltage circuits.
7. Maximum wire lengths:
   a. KDM: The maximum length interconnecting wire is 4000 ft (1219m).
   b. Remote Reset leadwires: The maximum length wire is 1000 ft (300m) to a Remote Reset push-button.
8. Install all electrical connectors.
9. Restore power to the panel.

Note that cable between Relay Module & display is included- see next part

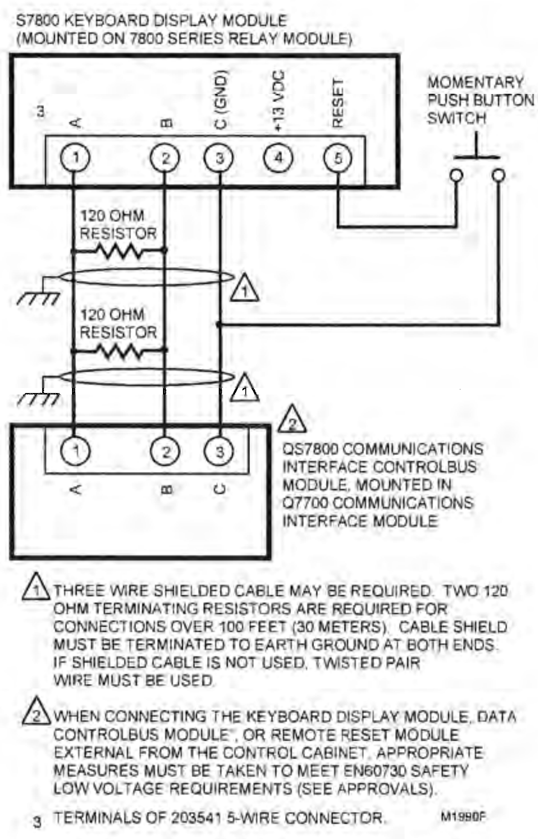
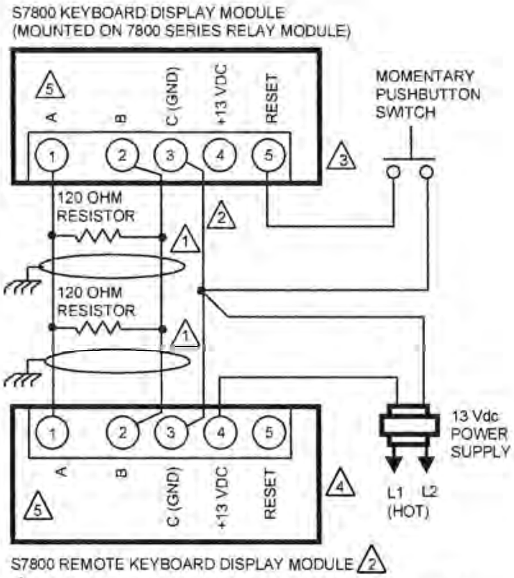


Fig. 5. Wiring the keyboard display module.



1. THREE WIRE SHIELDED CABLE MAY BE REQUIRED. TWO 120 OHM TERMINATING RESISTORS ARE REQUIRED FOR CONNECTING OVER 100 FEET [30 METERS]. CABLE SHIELD MUST BE TERMINATED TO EARTH GROUND AT BOTH ENDS. IF SHIELDED CABLE IS NOT USED, TWISTED PAIR WIRE MUST BE USED.

2. WHEN CONNECTING THE KEYBOARD DISPLAY MODULE DATA CONTROLBUS MODULE™, OR REMOTE RESET MODULE EXTERNAL FROM THE CONTROL CABINET, APPROPRIATE MEASURES MUST BE TAKEN TO MEET EN60730 SAFETY LOW VOLTAGE REQUIREMENTS (SEE APPROVALS).

3. 7800 SERIES RELAY MODULE CAN SUPPORT ONE S7800 KEYBOARD DISPLAY MODULE. A 13 Vdc POWER SUPPLY IS REQUIRED FOR EACH ADDITIONAL DISPLAY.

4. UP TO 36 S7800 KEYBOARD DISPLAYS CAN BE CONNECTED TO A SINGLE 7800 RELAY MODULE NOT TO EXCEED 4000 FEET (1219M) TOTAL LEADWIRE RUN. DAISY CHAIN 1 TO 1, 2 TO 2, 3 TO 3 AND PROVIDE 13 Vdc POWER SUPPLY FOR EACH S7800 DISPLAY.

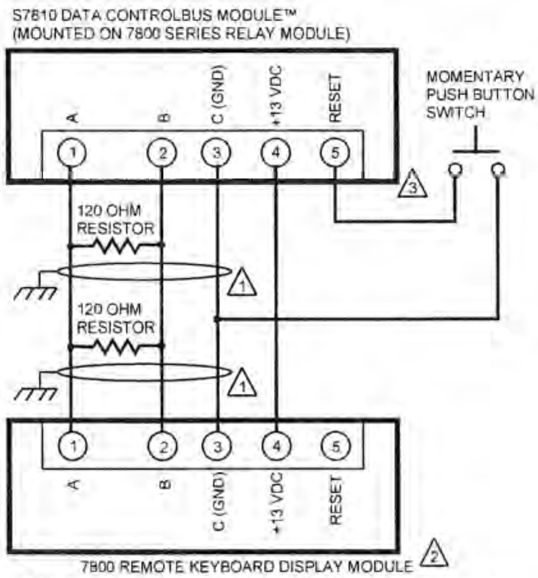
5. TERMINALS OF 203541 5-WIRE CONNECTOR.

M5006G

Fig. 6. Wiring for multiple keyboard display modules.

KDM Display

The first line of the KDM display provides current status of the burner sequence (STANDBY, PURGE, PILOT IGN, MAIN IGN, RUN and POSTPURGE), timing information (PURGE, PILOT IGN, MAIN IGN and POSTPURGE) in minutes and seconds, hold information (PURGE HOLD), and lockout information (Lockout, Fault Code, Message and Sequence), see Fig. 8. The extreme right side of the first line will be either blank or will show a small arrow pointing to the second line followed by a two-letter code (DI—Diagnostic Information, Hn—Fault History Information (where n equals the number of the fault), and EA—Expanded Annunciator). When the arrow and two-letter code are displayed, it indicates the second line is showing a selectable message submenu. The second line will display selectable or preemptive messages. A selectable message supplies information for flame strength, system status indication, system or self-diagnostics and troubleshooting. A preemptive message has parentheses around the message and supplies a detailed message to support the sequence status information. A preemptive message can also be a lockout message. A preemptive message replaces a selectable message to support the sequence status information. It also replaces a selectable message after 60 seconds if it or a lockout message is available. The 7800 SERIES Relay Module LED provide positive visual indication of the Relay Module sequence. The LED is energized simultaneously with the correct sequence description.



1. THREE WIRE SHIELDED CABLE MAY BE REQUIRED. TWO 120 OHM TERMINATING RESISTORS ARE REQUIRED FOR CONNECTIONS OVER 100 FEET. CABLE SHIELD MUST BE TERMINATED TO EARTH GROUND AT BOTH ENDS. IF SHIELDED CABLE IS NOT USED, TWISTED PAIR WIRE MUST BE USED.

2. WHEN CONNECTING THE KEYBOARD DISPLAY MODULE DATA CONTROLBUS MODULE™, OR REMOTE RESET MODULE EXTERNAL FROM THE CONTROL CABINET, APPROPRIATE MEASURES MUST BE TAKEN TO MEET EN60730 SAFETY LOW VOLTAGE REQUIREMENTS (SEE APPROVALS).

3. 221818A OR C EXTENSION CAN BE USED IN PLACE OF THE S7810 DATA CONTROLBUS MODULE™ IF DISPLAY IS TO A CABINET DOOR.

M5285C

Fig. 7. Wiring keyboard display module for remote mounting.

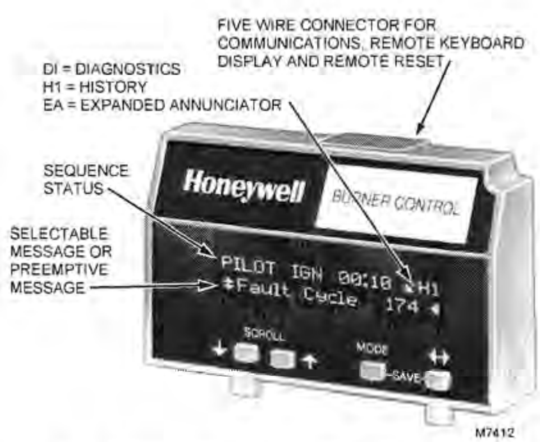


Fig. 8. S7800 Keyboard Display Module.

Keyboard Functions

The keyboard contains four push-buttons with separate functions (SCROLL-down, SCROLL-up, MODE, and CHANGE-LEVEL). The MODE and CHANGE-LEVEL, when pressed together, provide a SAVE function.

1. SCROLL down-up push-buttons (↕). See Fig. 9. The SCROLL down-up push-buttons (↕) are used to scroll through the selectable messages. The double-headed arrow (↕), which is located in the lower left position of the second line of the display, represents the SCROLL down-up push-buttons. The SCROLL down-up push-buttons (↕) can be pressed to display the selectable messages one at a time or held down to scroll through the selectable messages at the rate of two per second. When the last item of the selectable message is viewed, the display wraps around and displays the first selectable message again.
2. CHANGE-LEVEL push-button (⟷), see Fig. 10. The CHANGE-LEVEL push-button is used to change between the first hierarchy of selectable messages to a subset of selectable messages. The CHANGE-LEVEL push-button can also be used to change from a subset message to a first level selectable message. The symbol (<), located on the second line in the lower right corner of the display, represents a subset of selectable messages.
3. MODE push-button, see Fig. 11. Use the MODE push-button to instantaneously switch the display from a second-line selectable message to a second-line preempted message. The sixty second time-out function can also be used for this task. The MODE push-button only works if there is a second-line preempted message or a lockout message.

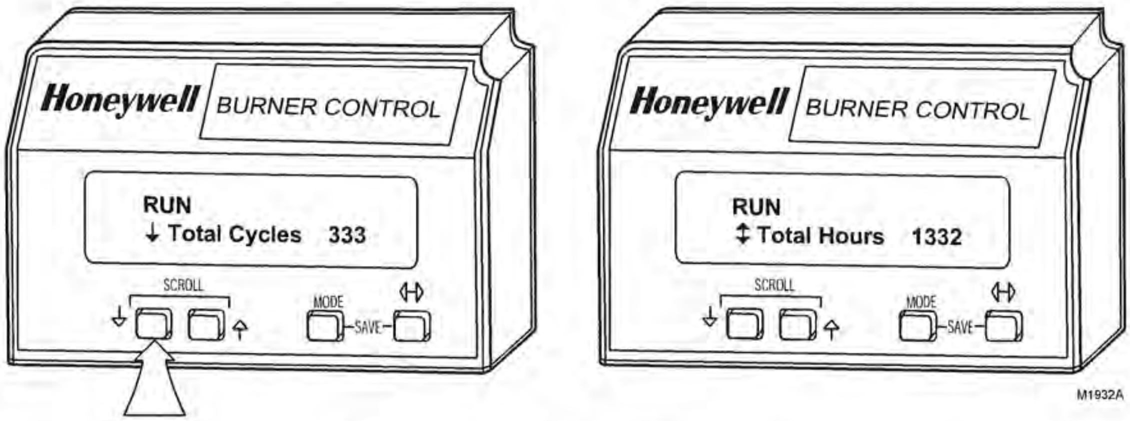


Fig. 9. SCROLL (↕) push-button function.

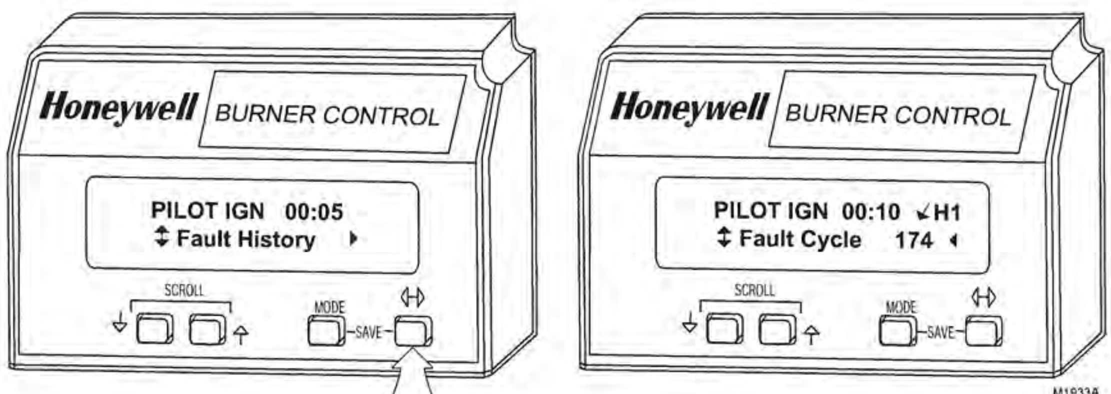


Fig. 10. CHANGE-LEVEL (⟷) push-button function.

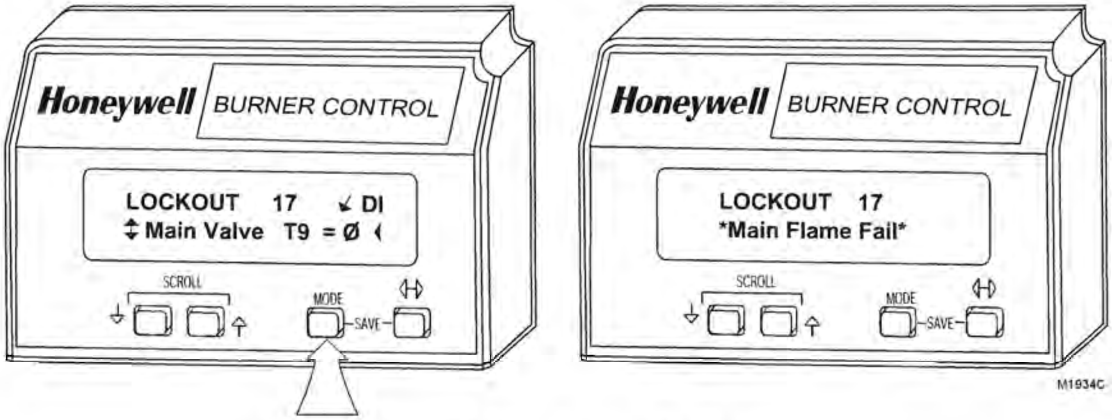


Fig. 11. MODE push-button function.

4. SAVE function, see Fig. 12. The SAVE function enables users to identify the selectable message they want to view upon power restoration. The second line selectable message are restored to the most recently saved selection when power returns. The SAVE function is performed is by pressing and holding the MODE key and then pressing the CHANGE-LEVEL key ('). The second line of the display briefly notes "... SAVING..." to confirm the keys were pressed.

Selectable Messages

For the second line display, two-level hierarchy, see Table 3.

The display values are as follows:

n represents a numbered value.

T represents the terminal number.

x represents the suffix letter of the Relay Module.

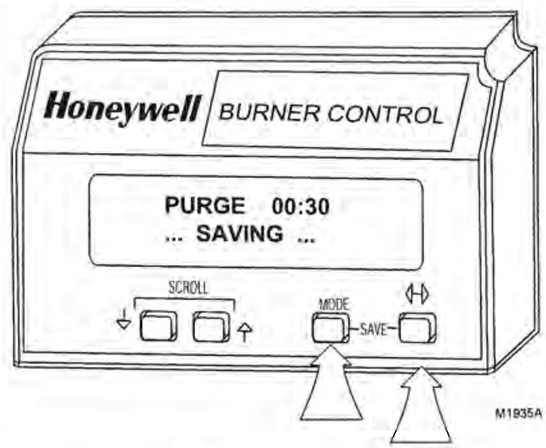


Fig. 12. SAVE function.

Table 3. Selectable Messages.

Table 3. Selectable Messages .

Selectable Message/Display	Description	Possible States/ Range (Terminals)	Comments
↕Flame Signal	Flame signal strength.	0 - 5.0 Vdc Flame Amp (+ and - (Com))	Flame relay pull-in and drop-out value 1.25 Vdc.
↕Total Cycles	Total number of equipment operating cycles.	0 - 99,999 (250,000) cycles[a]	Cycle will be updated each time main valve is energized.
↕Total Hours	Total number of equipment operating hours.	0 - 99,999 (250,000) hours[a]	Hour will be updated each time main valve output is energized for 60 minutes.
↕Fault History > (Six most recent faults)	First level prompt for history information. Has subset level.	—	—
Fault Cycle ↙ H1	Cycle when fault occurred.	0 - 99,999 cycles (250,000) cycles	—
Fault Hours ↙ H1	Run hour when fault occurred.	0 - 99,999 (250,000) hours[a]	—
Fault Code ↙ H1	Number that identifies the reason for lockout.	0 - 999	—
Fault Message ↙ H1	Indicates cause of lockout.	—	—
Sequence Message ↙ H1	Indicates where in the sequence the lockout occurred.	—	—
(Second Line Message) ↙ H1	Second line message explains any further information that is available from the 7800 SERIES or may be blank if there is not a preemptive second-line. H2...H6 etc.	—	—
Diagnostic Information >	First level prompt for diagnostic information. Has subset level.	—	—
Device	Device type number.	RM78XXX or EC78XXX	—
Device Suffix	Device suffix number.	nnnn	—
Run/Test Sw.	Position of Run/Test Switch.	RUN or TEST	Indicates if 7800 SERIES is in RUN or TEST mode.
OperControl T6	Operating Control Input.	= 1 or 0	Indicates if input is on or off, energized or de-energized.
Interlock T7	Running/Lockout Interlock.	= 1 or 0	Indicates if input is on (1) or off (0), energized or de-energized.
Pilot Valve	T8 Pilot Valve.	= 1 or 0	Indicates if output terminal is on or off, energized or de-energized.
Main Valve	T9 Main Fuel Valve.	= 1 or 0	Indicates if output terminal is on or off, energized or de-energized.
Ignition	T10 Ignition.	= 1 or 0	Indicates if output terminal is on or off, energized or de-energized.
LowFire Sw	T18 Low Fire Switch.	= 1 or 0	Indicates if input is on or off, energized or de-energized.
HighFireSw	T19 High Fire Switch.	= 1 or 0	Indicates if input is on or off, energized or de-energized.
PreIgn ILK	T20 or T17[b] Preignition Interlock	= 1 or 0	Indicates if input is on or off, energized or de-energized.

Table 3. Selectable Messages (Continued).

Selectable Message/Display	Description	Possible States/ Range (Terminals)	Comments
Valv/Start	T21 Interrupted/Intermittent Pilot Valve, First Stage Oil Valve or Start Input.	= 1 or 0	Indicates if output is on or off, energized or de-energized.
Jumper 1	Pilot Flame Establishing Period (PFEP).	INTACT/CLIPPED	Display shows state of PFEP jumper. If jumper is intact, 7800 SERIES was 10 second PFEP. If jumper is clipped, 7800 SERIES has 4 second PFEP.
	First Safety Time (for RM/ EC7850).	INTACT/CLIPPED	Display shows state of First Safety Time (EC7850) jumper. If jumper is intact, EC7850 has 5 second First Safety Time. If jumper is clipped, the EC7850 has 3 second First Safety Time.
Jumper 2	Pilot Valve.	INTACT/CLIPPED	Display shows state of Pilot Valve (terminal no. 21). If jumper is intact, RM7800G has Intermittent Pilot Valve. If jumper is clipped, RM7800G has 15 or 30 second Interrupted Pilot Valve.
	Main Trial Time (for RM/ EC7850).	INTACT/CLIPPED	Display shows state of Main Trial Time (EC7850)Valve (terminal no. 21). If jumper is intact, EC7850 has 5 second Main Trial Time. If jumper is clipped, EC7850 has 3 second Main Trial Time.
Jumper 3	Start-up Airflow Switch (AFS) check.	INTACT Disabled/CLIPPED Enabled	Display shows state of Start-up AFS check jumper. If jumper is clipped, RM7800 AFS check is enabled and if jumper is intact, AFS check is disabled.
Amp Type	Defines type of amplifier installed.	STANDARD/AMP-CHECK/ SHUTTER	Display shows type of flame detection system installed (i.e., as STANDARD, AMP-CHECK/ AMPLI-CHECK™ and SHUTTER/ Dynamic Self-Checking).
Flame Response	Amplifier Flame Failure Response Time (FFRT) in seconds.	.8s, 1s, 2s, or 3s	—
Purge Time	Timing value of purge card.	mm:ss	Two seconds to 30 minutes.

[a]European Approved Controls.

[b] Preignition Interlock Terminal 17 or 20 is model dependent.

Expanded Annunciator Messages (Table 4)

The Expanded Annunciator (EA) may or may not be connected because it is an optional device. If the EA is not connected, a display message of "(EA not connected)" is shown. If the EA is connected, display messages are shown; see Table 4 (Note that 1 means ON and 0 means OFF). When accessing Expanded Annunciator messages, follow the same operations as used with the Selectable messages.

Table 4. Expanded Annunciator.

Selectable Message[a] (Second Line)	Display Value (Second Line)	First Line Message
↕Expanded Annunciator↔		
↕Expanded Annunciator (EA not connected)<		↓EA
↕Current Status (CS:)[a]	EA Message<	↓EA
↕Valve Closure (Valve Close)	T5 = 1 or 0<	↓EA
↕Burner Switch (Burner Sw.)	T5 = 1 or 0<	↓EA
↕Operating Control (OperControl)	T6 = 1 or 0<	↓EA
↕Auxiliary Limit (Aux Limit 1)	T7 = 1 or 0<	↓EA
↕Auxiliary Limit (Aux Limit 2)	T8 = 1 or 0<	↓EA
↕Low water Cutoff (LWCO)	T9 = 1 or 0<	↓EA
↕High Limit (High Limit)	T10 = 1 or 0<	↓EA
↕Auxiliary Limit (AuxLimit 3)	T11 = 1 or 0<	↓EA
↕Oil Selection Switch (Oil Select)	T12 = 1 or 0<	↓EA
↕High Oil Pressure Switch (Hi OilPres)	T13 = 1 or 0<	↓EA
↕Low Oil Pressure Switch (LowOilPres)	T14 = 1 or 0<	↓EA
↕High Oil Temperature Switch (Hi OilTemp)	T15 = 1 or 0<	↓EA
↕Low Oil Temperature Switch (LowOilTemp)	T16 = 1 or 0<	↓EA
↕Atomizing Switch (Atomize Sw)	T19 = 1 or 0	↓EA
↕Gas Selection Switch (Gas Select)	T17 = 1 or 0<	↓EA
↕High Gas Pressure Switch (Hi GasPres)	T18 = 1 or 0<	↓EA
↕Low Gas Pressure Switch (LowGasPres)	T19 = 1 or 0<	↓EA
↕Airflow Switch (Airflow Sw)	T20 = 1 or 0<	↓EA
↕Auxiliary Interlock (Aux ILK 4)	T21 = 1 or 0<	↓EA
↕Auxiliary Interlock (Aux ILK 5)	T22 = 1 or 0<	↓EA
↕EA Fault Code	nnn<	↓EA
↕Software Revision (SW Rev.)	nnnn<	↓EA

TROUBLESHOOTING

After the KDM is installed, return the 7800 SERIES to normal operation, restore power and run the system through at least one complete automatic cycle. For complete Troubleshooting and System Checkout information, see form 65-0229.

7800 SERIES System Diagnostics

Troubleshooting control system equipment failures is made easier with the 7800 SERIES self-diagnostics and first-out annunciation. The S7800 provides visual annunciation by displaying a fault code and fault or hold message on the display.

Self-diagnostics of the 7800 SERIES enables it to detect and annunciate both external and internal system problems. Internal faults and external faults such as interlock failures, flame failures and false flame signals are annunciated by the KDM via the 7800 SERIES Relay Module.

The KDM displays a sequence status message indicating STANDBY, PREPURGE, PREIGNITION, SAFETY 1, PILOT IGN, PILOT STAB., MAIN IGN, RUN or POSTPURGE, as appropriate. The selectable messages also provide visual indication of current status and historical status of the equipment, such as: Flame Signal, Total Cycles, Total Hours, Fault History, Diagnostic Information and Expanded Annunciator terminal status (if used). With this information, most problems can be diagnosed without extensive trial-and-error testing.

Table 5 provides the sequence and status hold messages.

Table 5. Keyboard Display Module Sequence and Status Hold Messages .

Sequence	Status
INITIATE mm:ss	The Keyboard Display Module (KDM) indicates the burner status, INITIATE, a stabilization period for the relay module to check for any fluctuations in ac line voltage inputs or control inputs on power up or during normal operation. The timing of the INITIATE period is either two seconds or ten seconds, depending on the model, before entering STANDBY.
If the relay module is in an INITIATE HOLD status, the following conditions could exist:	
INITIATE HOLD: (AC Frequency/Noise)	The KDM indicates the burner status and that it is waiting for excess line noise to clear up, which prevents sufficient reading of the line voltage inputs. The burner sequence does not advance into STANDBY until the excess line noise ceases or a line frequency error occurs; this is caused by using a 60 Hz device on a 50 Hz line, or vice versa on devices with a date code earlier than 9804, is corrected.
INITIATE HOLD: (AC Line Dropout)	The KDM indicates the burner status and that ac line power has momentarily dropped out. The burner sequence does not advance into STANDBY until the ac line voltage has stabilized throughout the INITIATE sequence.
INITIATE HOLD: (AC Frequency)	The KDM indicates the burner status and that line frequency is faster than the expected value. The burner sequence does not advance into STANDBY until the line frequency returns to the proper value; this is perhaps caused by using a 60 Hz device on a 50 Hz line for devices with a date code earlier than 9804.
INITIATE HOLD: (Low Line Voltage)	The KDM indicates the burner status and that low line voltage (10% lower than rated voltage) has occurred. The burner sequence does not advance into STANDBY until the line voltage is at a sufficient level for proper operating parameters.
STANDBY	The KDM indicates the burner status, STANDBY. The burner can be placed in STANDBY by opening the burner switch or if the operating controller indicates its setpoint is satisfied. If a demand is present for burner operation, the burner sequence does not advance from STANDBY to PURGE until the recycle limits close. If an Expanded Annunciator is connected, the display messages are enhanced.
If the relay module is in a STANDBY HOLD status, the following conditions could exist:	
STANDBY HOLD: F/G (Flame Detected)	The KDM indicates the burner status and that a flame is detected. A demand is present for burner operation. The sequence does not advance to PREPURGE until the flame signal clears. If the flame signal does not clear within 40 seconds, the relay module locks out.
STANDBY HOLD: T20 (Preignition Interlock)	The KDM indicates the burner status and that the Preignition Interlock is not closed. A demand is present for burner operation, but the burner sequence does not advance to PREPURGE until the Preignition Interlock proves closed. If this time exceeds a 30 second hold, the relay module locks out.
STANDBY HOLD: T7 (Lockout Interlock)	The KDM indicates the burner status and that the Lockout Interlock is closed. A demand is present for burner operation, but the burner sequence does not advance to PREPURGE until the Lockout Interlock proves open. If this time exceeds the 120 second hold, the relay module locks out.
STANDBY HOLD: T7 (Running Interlock) EC/RM7850	The KDM indicates the burner status and that the Running Interlock is closed. A demand is present for burner operation, but the burner sequence does not advance to PREPURGE until the Running Interlock proves open. If this time exceeds the 120 second hold, the relay module locks out.
PURGE	The KDM indicates the burner status, PURGE, which is the period of time the blower motor is running before the Ignition period. The timing of the PURGE period is selectable.
If the relay module is in a PURGE HOLD status, the following conditions could exist:	
PURGE HOLD: T19 (High Fire Switch)	The KDM indicates the burner status and that the High Fire Switch is not closed. The firing rate motor is driving to its PURGE rate position. If this time exceeds four minutes and fifteen seconds, the relay module locks out.
PURGE DELAY: T19 (High Fire Switch Jumpered)	The KDM indicates the burner status and that the High Fire Switch is jumpered. The High Fire Switch is bypassed, welded or otherwise prematurely closed. The system automatically adds 30 seconds to allow the firing rate motor additional drive time to reach or near the open damper position before starting the PURGE sequence.
PURGE HOLD: TEST (Run/Test Switch)	The KDM indicates the burner status and that the Run/Test Switch is in the TEST position. The sequence does not continue until the Run/Test Switch is placed in the RUN position.
PURGE HOLD: T18 (Low Fire Switch Jumpered)	The KDM indicates the burner status and that the Low Fire Switch is jumpered. The Low Fire Switch is bypassed, welded or otherwise prematurely closed. The system automatically adds 30 seconds to allow the firing rate motor additional drive time to reach or near the closed damper position before starting the ignition sequence.

Table 5. Keyboard Display Module Sequence and Status Hold Messages (Continued).

Sequence	Status
PURGE HOLD: F/G (Flame Detected)	The KDM indicates the burner status and that a flame is detected. The burner sequence does not advance through PREPURGE because a flame is detected as being present. The sequence holds waiting for the flame signal to clear. If the time exceeds 30 seconds, the relay module locks out.
PURGE HOLD: T18 (Low Fire Switch)	The KDM indicates the burner status and that the Low Fire Switch is not closed. The firing rate motor is driving to its Low Fire position in preparation for Ignition Trials. If this time exceeds four minutes and fifteen seconds, the relay module locks out.
PURGE HOLD: T7 (Running Interlock)	The KDM indicates the burner status and that the Running Interlock is not closed. The sequence does not advance to ignition until the Running Interlock proves closed. If this time exceeds 30 seconds, the relay module locks out.
PILOT IGN mm:ss	The KDM indicates the burner status, PILOT IGN, and the timing of the PILOT IGN trial begins, in seconds. During this period, the relay module permits the pilot valve to open and the pilot flame to establish.
If the relay module is in a PILOT HOLD status, the following conditions could exist:	
PILOT HOLD: TEST (Run/Test Switch)	The KDM indicates the burner status, PILOT IGN, and that the Run/Test Switch is in the TEST position. The sequence does not continue until the Run/Test Switch is placed in the RUN position.
MAIN IGN mm:ss	The KDM indicates the burner status, MAIN IGN, and the timing of the MAIN IGN trial begins, in seconds. During this period, the relay module permits the main valve to open and the main flame to establish.
RUN	The KDM indicates the burner status, RUN, which is the period of time after the Ignition Trials and before the operating controller setpoint is reached. During this time, the burner is firing under control of the firing rate control.
If the relay module is in a RUN HOLD status, the following condition could exist:	
RUN LOWFIRE: TEST (Run/Test Switch)	The KDM indicates the burner status and that the Run/Test Switch is in the TEST position. Normal modulation or operation does not continue until the Run/Test Switch is placed in the RUN position.
POSTPURGE mm:ss	The KDM indicates the burner status, POSTPURGE, which is the period of time after the RUN period when the blower motor continues to run. The timing of the POSTPURGE period is fifteen seconds.
Waiting for connection...	The KDM has power but is waiting to receive a signal from the relay module to continue operation.
RESET/ALARM TEST	The KDM indicates the burner status, RESET/ALARM TEST. This condition indicates that the reset button is pressed. If it is held for more than four seconds, the alarm output is energized. The alarm output is de-energized when the reset button is released.
Additional Sequence Status Information When An Expanded Annunciator is Connected to the Relay Module:	
BURNER OFF: T6 (Burner Switch)	The KDM indicates the Burner Switch is not closed. The burner sequence does not advance to PREPURGE until the Burner Switch closes.
STANDBY	The KDM indicates the burner status, STANDBY, and that the Operating Control is not closed. The burner sequence does not advance to PREPURGE until the Operating Control closes.
STANDBY HOLD: T6 (EA Hold Message)	The KDM indicates the burner status, STANDBY, and that a limit is not closed. The burner sequence does not advance to PREPURGE until one or all limits close downstream from the Operating Control.
STANDBY HOLD: T6 (Circuit Fault)	The KDM indicates the burner status, STANDBY, and that the control input is not closed. The burner sequence does not advance to PREPURGE until the control input closes.

The S7800 provides diagnostic information to aid the service mechanic in obtaining information when troubleshooting the system. See Table 6 for information on accessing historical and diagnostic selectable messages. Information available in the Diagnostic Information includes Device Type, Device Suffix, Software Revision, Manufacturing Code, Flame Amplifier Type, Flame Failure Response Time (FFRT), Selectable Jumper Configuration Status, Run/Test Switch Status and Terminal Status.

Historical Information Index

The S7800 displays historical information for the six most recent lockouts. Each of the six lockout records retains the cycle when the fault occurred, a fault code, a fault message, and burner status when the fault occurred. See Table 6.

Table 6. Accessing Historical and Diagnostic Selectable Messages.

Step	Operation	Press	Display	Comments
1.	Press SCROLL key to access Diagnostic Information.	(↕)	STANDBY ↕Diagnostic Info>	Use the Down/Up SCROLL keys to access the selectable message. The second line will display Diagnostic Information.
2.	Press Change Level key to Access Diagnostic Information.	(↔)	STANDBY ↕Diagnostic Info>	Use the Change Level key to access the Diagnostic Information.
3.	Continue display of Diagnostic Information.	(↕)	STANDBY ⇙ DI ↕Device RM7800<	Push the (↕) SCROLL key to scroll to the next Diagnostic Message.
4.	Continue through remaining Diagnostic Information display following step 3 as required.	—	—	—
5.	Press the Change Level key to return to the first level of Diagnostic Information data prompt or to other selectable messages.	(↔)	STANDBY ↕Diagnostic Info>	Another display can be selected or discontinue accessing Diagnostic Information review.

SERVICE NOTE: If the Keyboard Display Module screen is scrambled, remove and reinstall the Keyboard Display Module and reset the 7800 SERIES Relay Module.

SERVICE NOTE: Reset the 7800 SERIES Relay Module by pressing the reset pushbutton on the relay module or pressing a remote reset pushbutton wired through the Keyboard Display Module, Data ControlBus™ Module or Remote Reset Module. A power-up reset will cause an electrical reset of the 7800 SERIES Relay Module but will not reset a lockout condition.

Lockout Messages

When the 7800 SERIES is locked out, it displays a repeating cycle of messages. See Table 8. There are four states in the cycle:

1. State 1 (Fig. 13). A first state message display lasts six seconds. First line displays the word LOCKOUT followed by the fault code number and possibly a lower case letter if an Expanded Annunciator is connected. The letter corresponds to the first-out code supplied by the Expanded Annunciator. The lockout reason corresponding to the fault code number is displayed on the second line, highlighted by asterisks on each side.

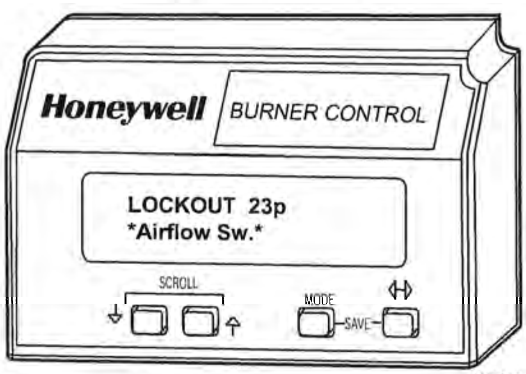


Fig. 13. Lockout message, State 1.

2. State 2 (Fig. 14). Display of the second state message lasts two seconds.

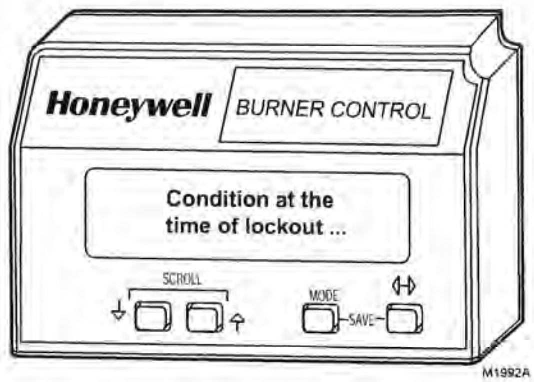


Fig. 14. Lockout message, State 2.

3. State 3 (Fig. 15). Display of the third state message lasts three seconds. It is a replica of the burner status as it existed at the time of the lockout. The second line is blank if the burner status at the time of lockout did not include a preemptive message (in parentheses) for the second line.

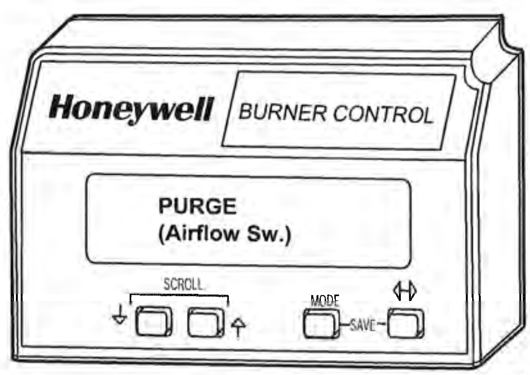


Fig. 15. Lockout message, State 3.

4. State 4: In the fourth state, both lines are blanked for one-half second, then the display sequences to the first state.

NOTE: For further explanation of Lockout Messages, Troubleshooting and Checkout, refer to form 65-0229.

Table 7. Hold and Fault Message Summary.

Fault Code	System Failure	Recommended Troubleshooting
Fault 1 *No Purge Card*	No card is plugged into the purge card slot.	1. Make sure the purge card is seated properly. 2. Inspect the purge card and connector on the relay module for damage or contaminants. 3. Reset and sequence the relay module. 4. If the fault code reappears, replace the purge card. 5. Reset and sequence the relay module. 6. If the fault persists, replace the relay module.
Fault 2 *AC Frequen/Noise	Excess noise or device running on slow ac.	1. Check the relay module and display module connections. 2. Reset and sequence the relay module. 3. Check the relay module power supply and make sure that both frequency and voltage meed the specifications. 4. Check the backup power supply, as appropriate.
Fault 3 *AC Line Dropout	Ac line dropout detected.	
Fault 4 *AC Frequency*	Device running on fast ac.	
Fault 5 *Low Line Voltage*	Low ac line detected.	
Fault 6 *Purge Card Error*	Purge card timing changed since card was initially read.	1. Make sure the purge card is seated properly. 2. Inspect the purge card and connector on the relay module for damage or contaminants. 3. Reset and sequence the relay module. 4. If the fault code reappears, replace the purge card. 5. Reset and sequence the relay module. 6. If the fault persists, replace the relay module.
Fault 7 *Flame Amplifier*	Flame sensed when flame not present.	1. Check wiring and correct any errors. Make sure that the flame sensor wires are in separate conduits. Check for noise coupling into the flame detector leadwires. 2. Make sure that flame detector and flame amplifier are compatible. 3. Remove the flame amplifier and inspect connections. Reset the flame amplifier. 4. Reset and sequence the relay module. 5. If the code reappears, replace the amplifier. 6. If the fault persists, replace the flame detector. 7. If the fault persists, replace the relay module.
Fault 8 *Flame Amp/Shutr*	Flame sensed when no signal expected during shutter-check or Ampli-Check™ versions.	
Fault 9 *Flame Detected*	Flame sensed when no flame is expected during STANDBY.	1. Check that flame is not present in the combustion chamber; correct any errors. 2. Check wiring and correct any errors. Make sure that flame sensor wires are in separate conduits. Check for noise coupling into flame detector leadwires. 3. Remove the flame amplifier and inspect its connections. Reset the amplifier. 4. Reset and sequence the relay module. 5. If the code reappears, replace the amplifier and/or the flame detector. 6. If the fault persists, replace the flame detector. 7. If the fault persists, replace the relay module.
Fault 10 *Preignition ILK*	Preignition Interlock fault during STANDBY	1. Check wiring and correct any errors. 2. Check Preignition Interlock switches to assure proper functioning. 3. Check fuel valve operation. 4. Reset and sequence the relay module; monitor the Preignition Interlock status. 5. If the code persists, replace the relay module.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 11 *Running ILK On*	Running Interlock powered at improper sequence point.	1. Check wiring to make sure that interlocks are connected properly between terminals 6 and 7. Correct any errors. 2. Reset and sequence the relay module. 3. If the fault persists, measure the voltage between terminals 6 and L2(N) (ground), then terminals 7 and L2(N). If there is line supply voltage present at terminal 6 when the controller is off, the controller switch may be bad or jumpered. 4. If steps 1 through 3 are correct and there is line supply voltage present at terminal 7 when the controller is closed and the fault persists, check for a welded or jumpered Running Interlock, Lockout Interlock, or Airflow Switch. Correct any errors. 5. If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 12 *Lockout ILK On*	Lockout Interlock powered at improper sequence point.	
Fault 13 *Airflow Sw. On*	Combustion airflow interlock fault during STANDBY.	
Fault 14 *High Fire Sw.*	High Fire Interlock Switch failure to close during PREPURGE.	1. Check wiring and correct any errors. 2. Reset and sequence the relay module. 3. Use either the manual motor potentiometer to drive the motor to the High Fire position or use the Run/Test Switch option, if available. Sequence to Prepurge drive to High Fire and place in the Test position. Adjust the High Fire Switch while in this state to make sure that it closes properly. 4. Measure the voltage between terminal 19 and L2(N) while in the Prepurge drive to High Fire state. Line supply voltage should be present. If not, the switch adjustment is incorrect and/or the switch is defective and needs replacing. 5. Reset and sequence the relay module. If the line supply voltage was present between the High Fire Switch and terminal 19, and the fault still persists, replace the relay module.
Fault 15 *Flame Detected*	Flame sensed when no flame is expected during STANDBY.	1. Check that the flame is not present in the combustion chamber; correct any errors. 2. Make sure that the flame amplifier and flame detector are compatible. 3. Check wiring and correct any errors. 4. Remove the flame amplifier and inspect the connections. Reset the flame amplifier. 5. Reset and sequence the relay module. 6. If the code reappears, replace the amplifier and/or the flame detector. 7. If the fault persists, replace the relay module.
Fault 16 *Flame-Out Timer*	No-flame detected during Pilot Flame Establishing Period.	1. Measure the flame signal. If one exists, make sure it meets specifications. Make any necessary burner adjustments using manufacturer instructions. 2. Make sure that the flame amplifier and flame detector are compatible. 3. If the code reappears, replace the amplifier and/or the flame detector. 4. If the fault persists, replace the relay module.
Fault 17 *Main Flame Fail*	Main flame failure during RUN after flame is established an on for at least 10 seconds.	1. Inspect the main fuel valve(s) and connection(s). 2. Make sure that the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Check the flame detector sighting for adequate flame signal throughout the burner firing rate.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 18 *Flame Detected*	Flame sensed when the shutter is open and no flame is expected during PREPURGE.	1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame amplifier and flame detector are compatible. 3. Check the wiring and correct any errors. Make sure F and G wires are in individual conduits and protected from stray noise pickup. 4. Remove the flame amplifier and inspect the connectors. Reset the flame amplifier. 5. Reset and sequence the relay module. 6. If the code reappears, replace the flame amplifier and/or the flame detector. 7. If the fault persists, replace the relay module.
Fault 19 *Main Flame Ign.*	Flame was lost during MFEP or the first 10 seconds of the RUN state.	1. Inspect the main fuel valve(s) and connection(s). 2. Make sure the fuel pressure is high enough to supply fuel to the combustion chamber. 3. Make sure the flame detector is positioned to obtain the required flame signal strength; reset and recycle.
Fault 20 *Low Fire Sw. Off*	Low Fire Interlock switch failure to close during PREPURGE.	1. Check wiring and correct any errors. 2. Reset and sequence the relay module. 3. Use either the manual motor potentiometer to drive the motor to the Low Fire position or use the Run/Test Switch option, if available. Sequence to Prepurge drive to Low Fire and place in the Test Position. Adjust the Low Fire Switch to make sure it closed properly. 4. Measure the voltage between terminal 18 and L2(N) while in the Prepurge drive to Low Fire state. Line supply voltage should be present. If not, the switch adjustment is incorrect and/or the switch is defective and needs replacing. 5. Reset and sequence the relay module. If line supply voltage was present between the Low Fire Switch and terminal 18, and the fault still persists, replace the relay module.
Fault 21 *Running ILK*	Running Interlock fault during PREPURGE.	1. Check wiring and correct any errors. 2. Inspect the fan; make sure there is no blockage of the air intake and that it is supplying air. 3. Make sure the Interlock Switches are working properly and that all switch contacts are free of contaminants. 4. Reset and sequence the relay module to PREPURGE (place the Run/Test Switch in the Test position, if available). Measure the voltage between terminals 7 and L2(N). Line voltage should be present. 5. If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 22 *Lockout ILK*	Lockout Interlock fault during PREPURGE.	
Fault 23 *Airflow Switch*	Combustion airflow interlock fault during PREPURGE.	
Fault 24 *Call Service*	The flame interlock (relay module) was on when it should be off.	1. Check for F leadwire routing. Make sure routing is in its conduit and isolated from noise-producing circuits.
Fault 25 *Call Service*	The flame interlock (relay module) was off when it should be on.	
Fault 26 *Man-Open Sw. Off*	The Manual Open Valve Switch was off when it should be on (Device specific).	1. Check wiring and correct any errors. 2. Make sure that the Manual Open Valve Switch is fully open. 3. Make sure that the Manual Open Valve Switch is functioning properly and that the switch contacts are free from contaminants. 4. Reset and sequence the relay module. 5. Make sure that the Manual Open Valve Switch provides an electrical path when closed. Verify that the relay module is receiving power at terminal 17. 6. If steps 1 through 5 are correct and the fault persists, replace the relay module.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 27 *Start Switch On*	Start Switch was on during PREPURGE (Device specific).	**1.** Start Switch held on too long. **2.** Check wiring; verify that Start Switch is correctly connected. **3.** Make sure that the Start Switch is functioning properly and that the switch contacts are free of contaminants. **4.** Reset and sequence the relay module to PREPURGE; set the Run/Test Switch to Test. Make sure there is no power at terminal 6 during PREPURGE. **5.** If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 28 *Pilot Flame Fail*	Pilot flame failure.	**1.** Check pilot valve wiring and operation. Correct any errors. **2.** Check fuel supply. **3.** Check pilot pressure and repeat pilot turndown test. **4.** Check ignition transformer electrode, flame detector, flame detector sighting and flame amplifier. **5.** If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 29 *Lockout ILK*	Lockout Interlock fault.	**1.** Check wiring and correct any errors. **2.** Inspect the fan; make sure that there is no blockage of the air intake and that it is supplying air. **3.** Make sure that the Lockout Interlock Switches are working properly and that all switch contacts are free from contaminants. **4.** Reset and sequence the relay module to PREPURGE (place the Run/Test Switch in the Test position, if available). Measure the voltage between terminals 7 and L2(N). Line voltage should be present. **5.** If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 30 *Running ILK*	Running Interlock fault.	**1.** Inspect the Running Interlocks, including the Airflow Switch, and the connections. **2.** Make sure that the Running Interlocks, including the Airflow Switch, are functioning properly and that switch contacts are free from contaminants. **3.** Reset and sequence the relay module to PREPURGE. Set the Run/Test Switch, if available, to Test. Measure the voltage between terminal 7 and L2(N). Line voltage should be present. **4.** If steps 1 through 3 are correct and the fault persists, replace the relay module.
Fault 31 *Low Fire Sw. Off*	Low Fire Interlock Switch failure to close during RUN (Device specific).	**1.** Check wiring and correct any errors. **2.** Reset and sequence the relay module. **3.** Use either the manual motor position to drive the motor to the Low Fire position, or use the Run/Test Switch option, if available. Sequence to Run drive to Low Fire and place the switch in the Test position. Adjust the Low Fire Switch while in this state to make sure it is closing properly. **4.** While in Run, drive to Low Fire state, measure the voltage between terminal 18 and L2(N). Line voltage should be present. If not, the switch adjustment is incorrect and/or the switch is defective and needs replacement. **5.** Reset and sequence the relay module. If line voltage was present between the Low Fire Switch and terminal 18, and the fault persists, replace the relay module.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 32 *Airflow Switch*	Combustion Airflow Interlock fault.	**1.** Check wiring and correct any errors. **2.** Inspect the fan; make sure there is no blockage of the air intake and it is supplying air. **3.** Make sure the Airflow Interlock Switches are working properly and all switch contacts are free from contaminants. **4.** Reset and sequence the relay module to PREPURGE. Place the Run/Test Switch in the Test position, if available. Measure the voltage between terminals 7 and L2(N). Line voltage should be present. **5.** If steps 1 through 4 are correct and the fault persists, replace the relay module.
Fault 33 *Preignition ILK*	Preignition Interlock fault.	**1.** Check wiring and correct any errors. **2.** Inspect the Preignition Interlock switches and make sure they function properly. **3.** Check fuel valve operation. Valve must close within five seconds. **4.** Reset and sequence the relay module. **5.** During STANDBY or PREPURGE, measure the voltage between terminal 20 and L2(N). Line voltage should be present. If not, the Preignition Interlock switches can be defective and need replacing. **6.** If the fault persists, replace the relay module.
Fault 34 *Control On*	CTL input was energized at the wrong time for the relay module. This fault implies a field wiring error.	**1.** Check wiring and correct any errors. **2.** Reset and sequence the relay module. **3.** If fault persists, replace the relay module.
Fault 35 *Call Service*	Safety relay was off when it should be on or the internal fuse has blown.	**1.** Reset and sequence the relay module. If fault repeats, replace relay module, but be sure to test for excessive loads on appropriate terminals described by fault code. **2.** If fault does not repeat on next cycle, check for electrical noise being coupled into the relay module through the loads on appropriate terminals described by the fault code. **3.** Possibly check for bouncing running on Lockout Interlock. **4.** If fault persists, replace the relay module.
Fault 36 *Call Service*	Main valve terminal was off when it should be on, or the internal fuse has blown.	
Fault 37 *Call Service*	Pilot (ignition) valve terminal was off when it should be on, or the internal fuse has blown.	
Fault 38 *Call Service*	Ignition terminal was off when it should be on, or the internal fuse has blown.	
Fault 39 *Call Service*	V2S valve terminal (usually terminal 21) was off when it should be on, or the internal fuse has blown.	
Fault 40 *Call Service*	Safety relay was on when it should be off.	
Fault 41 *Main Valve On*	Main valve terminal was on when it should be off.	**⚠ WARNING** **Explosion Hazard.** **Can cause severe injury, death or property damage.** 1. Remove system power, turn off fuel supply. 2. Check for wiring errors that could provide power to terminals described by the fault. Correct any errors. 3. Re-power system; reset and sequence the relay module. 4. If fault persists, replace the relay module. 5. When fault is corrected, turn on fuel supply.
Fault 42 *Pilot Valve On*	Pilot (ignition) valve terminal was on when it should be off.	
Fault 43 *Ignition On*	Ignition terminal was on when it should be off.	
Fault 44 *Pilot Valve 2 On*	V2S valve terminal, used as a pilot, is on when it should be off.	

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 45 *Low Fire Sw. Off*	Low Fire Interlock switch failure to close or stay closed.	**1.** 1. Check wiring and correct any errors. **2.** 2. Reset and sequence the relay module. **3.** 3. Use either the manual motor position to drive the motor to the Low Fire position, or use the Run/Test Switch option, if available. Sequence to Run, drive to Low Fire and place in the Test position. Adjust the Low Fire Switch while in this state to make sure it is closing properly. **4.** 4. While in Run, drive to Low Fire state, measure the voltage between terminal 18 and L2(N). Line voltage should be present. If not, the switch adjustment is incorrect and/or the switch is defective and needs replacement. **5.** 5. If steps 1 through 4 are correct and the fault still persists, replace the relay module.
Fault 46 *Flame Amp Type*	Device specific.	**1.** Remove power to the device. **2.** Reset the flame amplifier and reset and sequence the relay module.
Fault 47 *Jumpers Changed*	The configuration jumpers differ from the sample taken at startup.	**1.** Inspect the jumper connections. Make sure that clipped jumpers are completely removed. **2.** Reset and sequence the relay module. **3.** If fault persists, replace the relay module.
Fault 48 *Delayed MV On* (2nd Stage Valve)	V2S valve terminal, used as a delayed main valve, was on when it should be off.	**WARNING** **Explosion Hazard.** **Can cause severe injury, death or property damage.** 1. Remove system power, turn off fuel supply. 2. Check wiring; correct any errors. 3. Inspect the V2S Fuel Valve and its connections. Make sure the switch is working correctly and is not jumpered or welded. 4. Reset and sequence the relay module. 5. If fault persists, replace the relay module.
Fault 49 *Man-Open Sw. On*	The manual open switch was on when it should be off.	**WARNING** **Explosion Hazard.** **Can cause severe injury, death or property damage.** 1. Remove system power, turn off fuel supply. 2. Check wiring; correct any errors. 3. Inspect the Manual-Open Switch and its connections. Make sure the switch is working correctly and is not jumpered or welded. 4. Reset and sequence the relay module. 5. If fault persists, replace the relay module.
Fault 50 *Jumpers Wrong*	The sequence logic detected a combination of jumpers that is illegal for the sequence, e.g., if it is correct to clip jumper JR1 or Jumper JR2, but not both, this fault would be used when both are clipped (Device specific).	**1.** Inspect the jumpers and refer to the installation instructions for compatible jumper configurations. **2.** Make sure that clipped jumpers are completely removed. **3.** Reset and sequence the relay module. **4.** If fault persists, replace the relay module.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 51 *Flame Too Strong*	Flame signal value is too high to be valid.	**1.** Make sure that flame detector and flame amplifier are compatible. **2.** Remove the flame amplifier and inspect the connections. Reset the flame amplifier. **3.** Reset and sequence the relay module. **4.** Check the flame detector sighting position, reset and cycle. **5.** Verify that no ignition noise is present in the F lead due to wire routing. **6.** Measure the flame strength. Verify it meets specifications. If not, refer the flame amplifier and/or flame detector checkout procedures. **7.** If the code reappears, replace the flame amplifier. **8.** If the code reappears, replace the flame detector. **9.** If the fault persists, replace the relay module.
Fault 52 *Call Service*	Pilot Valve 2 (terminal 21) was off when it should be on.	**1.** Inspect terminal 21 and connections. Make sure that the valve is operating properly. **2.** Reset and sequence the relay module. **3.** If the fault persists, replace the relay module.
Fault 53 *Lockout Switch*	Lockout Input fault (EC/RM7850 only).	**1.** Check wiring and correct any errors. **2.** Inspect the Lockout Switch to make sure it is working properly. **3.** Reset and sequence the relay module. During STANDBY or PREPURGE, measure the voltage between terminal 20 and L2(N). Supply voltage should be present. If not, the lockout switch is defective and needs replacing. **4.** If the fault persists, replace the relay module.
Fault 54 *Comb. Pressure*	Combustion pressure switch fault (Fulton pulse only).	**1.** Check wiring and correct any errors. **2.** Inspect the Combustion Pressure Switch to make sure it is working correctly. **3.** Reset and sequence the relay module. **4.** During STANDBY and PREPURGE, measure the voltage between terminal 20 and L2(N). Supply voltage should be present. If not, the Combustion Pressure Switch is defective and needs replacing. **5.** If the fault persists, replace the relay module.
Fault 55 *Purge Fan Sw. On*	Purge fan switch is on when it should be off (Fulton pulse only).	**1.** Check wiring and correct any errors. **2.** Inspect the Purge Fan Switch terminal 18 and its connections. Make sure the switch is working correctly and is not jumpered or welded. **3.** Reset and sequence the relay module. **4.** If the fault persists, replace the relay module.
Fault 56 *Block Intake*	Block intake fault (Fulton pulse only).	**1.** Check wiring and correct any errors. **2.** Inspect the Block Intake Switch and make sure it is working properly. **3.** Reset and sequence the relay module. **4.** During PREPURGE, measure the voltage between terminal 7 and L2(N). Supply voltage should be present. If not, the Block Intake Switch is defective and needs replacing. **5.** If the fault persists, replace the relay module.
Fault 57 *Purge Fan Sw. Off*	Purge Fan Switch is off when it should be on (Fulton pulse only).	**1.** Inspect the Prepurge Fan Switch terminal 18 and the connections. Make sure the fan is working properly. **2.** Reset and sequence the relay module. **3.** If the fault persists, replace the relay module.
FAult 58 - 66 *Call Service*	Unused faults.	—
Fault 67 *AC Phase*	L1 and L2 miswired/exchanged (EC/RM7850 only).	**1.** Check L1 and L2 for proper line phasing.

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 68 *Preignition ILK*	Preignition Interlock fault.	**1.** Check wiring and correct any errors. **2.** Inspect the Preignition Interlock switches and make sure they work properly. **3.** Check fuel valve operation. Valve must close within five seconds. **4.** Reset and sequence the relay module. **5.** During STANDBY or PREPURGE, measure the voltage between terminal 17 and L2(N). Supply voltage should be present. If not, the Preignition Interlock switches are defective and need replacing. **6.** If the fault persists, replace the relay module.
Faults 69 - 70 *Call Service*	Unused faults.	—
Fault 71 *Dynamic LFS*	Low Fire Switch closed, High Fire Switch must be open (EC/RM 7850 only).	**1.** Check firing rate position switches (usually in Modutrol® Motor) for proper operation. **2.** Check wiring and correct any errors. **3.** Reset and sequence the relay module. **4.** If the fault persists, replace the relay module.
Fault 71 *Limits Complete*	Limit Input (terminal 7) is off when it should be on (RM7888 only).	**1.** Check limits to make sure they are satisfied after resetting. **2.** Check electrical connections to terminal 7 of wiring subbase. **3.** Reset relay module. **4.** If the fault persists, replace the relay module.
Fault 72 *Dynamic HFS*	High Fire Switch closed; Low Fire Switch must be open (EC/RM7850 only).	**1.** Check firing rate position switches (usually in Modutrol® Motor) for proper operation. **2.** Check wiring and correct any errors. **3.** Reset and sequence the relay module. **4.** If the fault persists, replace the relay module.
Fault 72 *Spec.Func.2*	Special Function 2 Input (terminal 17) is off when it should be on (Device specific).	**1.** Check operation of Special Function 2 of PLC. **2.** Check electrical connection to terminal 17 of wiring subbase and confirm presence of supply power when Special Function 2 is activated. **3.** Reset relay module. **4.** If the fault persists, replace the relay module.
Fault 73 *Spec.Func.3*	Special Function 3 Input (terminal 19) is off when it should be on (Device specific).	**1.** Check operation of Special Function 3 of PLC. **2.** Check electrical connection to terminal 19 of wiring subbase and confirm presence of supply power when Special Function 2 is activated. **3.** Reset relay module. **4.** If the fault persists, replace the relay module.
Fault 75 *Flame Proven Feedback*	Flame Indication Feedback (terminal 21) either on when it should be off or off when it should be on (Device specific).	**1.** Remove wire to terminal 21 and reset relay module. **2.** If the fault persists, replace relay module. **3.** Reconnect wire to terminal 21. If the fault returns, verify wiring.
Faults 76 - 93 *Accessory Fault*	—	—
Faults 94 - 104 *Call Service*	—	—
Fault 105 *Call Service*	Relay Module self-test failure.	**1.** Reset and sequence the relay module. **2.** If the fault reappears, remove power from the relay module and reapply the power; reset and sequence the relay module. **3.** If the fault persists, replace the relay module.
Fault 106 *Call Service*	Relay Module self-test failure.	
Fault 107 *Call Service*	Relay Module flame signal crosscheck failure.	—

Table 7. Hold and Fault Message Summary (Continued).

Fault Code	System Failure	Recommended Troubleshooting
Fault 109 *Call Service*	Negative cycle test failed, earth ground absent or line voltage phasing improper.	**1.** Make sure a good earth ground connection exists at the installation site and all earth ground connections are complete and correct. **2.** Make sure the relay module and all loads operate at the same line voltage phase. **3.** Reset and sequence the relay module. **4.** If the fault persists, replace the relay module.
Fault 110 *Call Service*	The configuration jumpers differ from stored values.	**1.** Inspect the jumper connections. Make sure they match the original selection and clipped jumpers are completely removed. **2.** Reset and sequence the relay module. **3.** If the fault persists, replace the relay module. **4.** Configuration jumpers must be selected prior to 200 hours of operation. If configuration jumpers are changed after 200 hours of operation, lockout 110 occurs. Relay module *cannot* be reset and *must* be replaced.
Fault 111 *Call Service*	Relay Module configuration jumper test failure.	**1.** Inspect the jumper connections. Make sure they match the original selection and clipped jumpers are completely removed. **2.** Reset and sequence the relay module. **3.** If the fault persists, replace the relay module.
Fault 112 - 126 *Call Service*	Relay Module self-test failure.	**1.** Reset and sequence the relay module. **2.** If the fault persists, replace the relay module.
Fault 127 *Call Service*	Safety relay feedback circuit was in an improper state.	**1.** Reset and sequence the relay module. **2.** If the fault persists, replace the relay module.

Expanded Annunciator Messages

If an Expanded Annunciator is wired to the limit control and interlock control strings, and connected to the 7800 SERIES Relay Module, additional hold messages, fault messages or code numbers enhance the original hold messages, fault messages or code numbers. See the Expanded Annunciator specification, form 65-0101, for detailed information. The message demonstrates which device opened first in a monitored string of limits or interlocks.

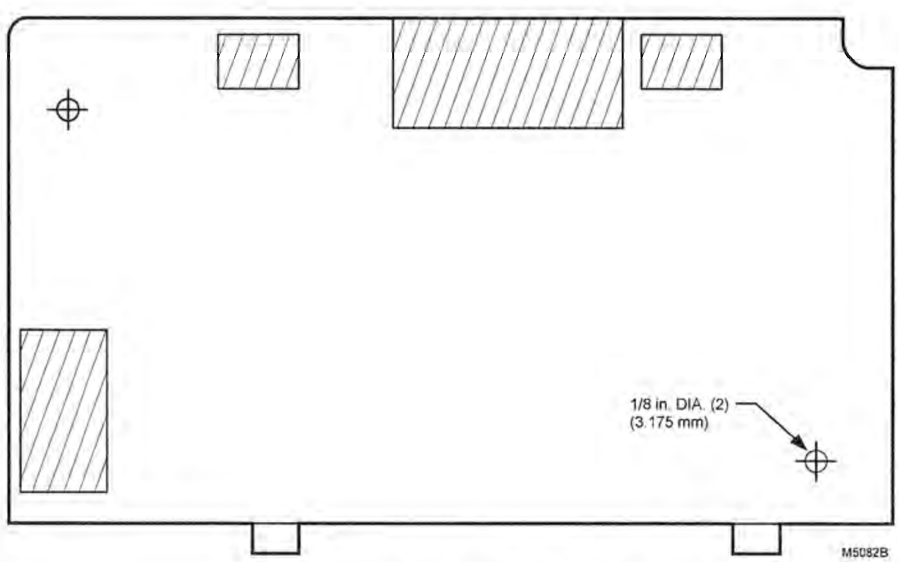


Fig. 16. KDM flush mounting outline.

Honeywell

Automation and Control Solutions
Honeywell
1985 Douglas Drive North
Golden Valley, MN 55422

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario
M1V 4Z9

Honeywell International
Control Products
Honeywell Building
17 Changi Business Park Central 1
Singapore 486073

Honeywell Europe S.A.
3 Avenue du Bourget
1140 Brussels
Belgium

Honeywell Latin American Region
480 Sawgrass Corporate Parkway
Suite 200
Sunrise FL 33325

65-0090—4 G.R. Rev. 07-02

Printed in U.S.A. on recycled paper containing at least 10% post-consumer paper fibers.

www.honeywell.com

Extension cable to connect Relay Module (Burner Controller) to display.
Part # 221818C 120" long

Honeywell

7800 Series
221818A,C Extension Cable Assembly

INSTALLATION INSTRUCTIONS

APPLICATION

The Extension Cable Assembly consists of a cover that provides protection for the configuration jumpers and the plug-in purge timers, if applicable. The cover contains a connector that interfaces with the computer bus connector of the 7800 SERIES device which, through the attached cable assembly, provides connection to the remotely-mounted S7800 Keyboard Display Module. The 221818A Extension Cable Assembly has a 60 inch (1524 mm) cable assembly; the 221818C Extension Cable Assembly has a 120 inch (3048 mm) cable assembly. See Fig. 1.

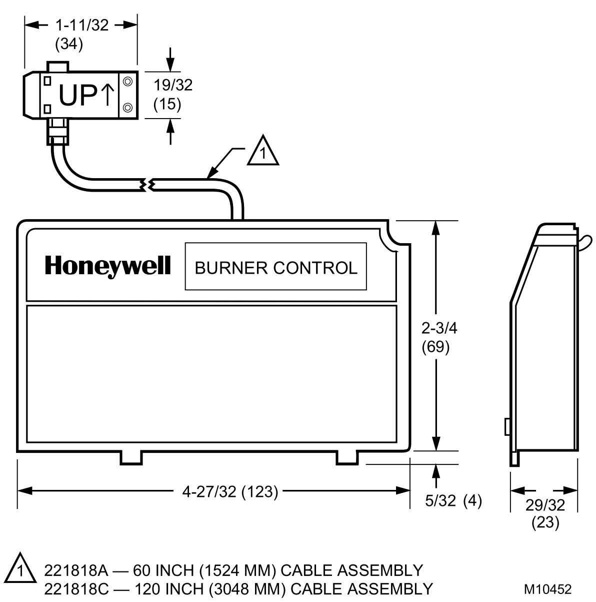


Fig. 1. Connector cover, connector dimensions, and cable length in in. (mm).

INSTALLATION

Mounting the Connector Cover (See Fig. 2)

1. Align the two interlocking ears of the connector cover with the two mating slots on the relay module.
2. Insert the two interlocking ears into the two mating slots and, with a hinge action, push on the lower corners of the connector cover to secure it.
3. Verify that the connector cover is in place.

Fig. 2. Connector cover mounting on relay module.

Remote Panel Mounting the Keyboard Display Module (VFD) (See Fig. 3)

1. Mount the keyboard display module (VFD) remotely from the relay module with either the 221818A 60 in. (1524 mm) Cable Assembly or the 221818C 120 in. (3048 mm) Cable Assembly), either on the face of a panel door or on another remote location.

Fig. 3. Flush panel mounting of keyboard display module.

2. When mounting the keyboard display module on the face of the door panel, closely follow these instructions:
   a. Select the location on the door panel for flush mounting. Allow for the insertion dimension of the Keyboard Display Module two screws, two interlocking ears and the two plug-in connectors to assure sufficient clearance (1/4 inch minimum from the surface of the door panel).
   b. Using the keyboard display module or data controlbus module as a template, see Fig. 6, mark the two screw locations, two interlocking ear locations and the two plug-in connector locations. Drill the pilot holes for the mounting screws. Provide two holes on the door panel for the interlocking ears and plug-in connector holes A and B (shaded portions of Fig. 6).
   c. Insert the extension cable assembly connector through the plug-in connector hole A. Use the 208702 Retainer Bracket on the display to reduce movement and relieve strain on the connector. See Fig. 7. Be sure that the two flanges are between the keyboard display module and the panel.
   d. Mount the keyboard display module, securing the two no. 4 screws.

Remote Bracket Mounting the Keyboard Display Module (VFD) (See Fig. 4)

1. When mounting the keyboard display module on a wall or remote location up to 120 in. (3048 mm) from the relay module, use the 2037656 Remote Mounting Bracket.
   a. Using the remote mounting bracket as a template, mark the four screw locations and drill the pilot holes.
   b. Mount the remote mounting bracket by securing the four no. 6 screws (see Fig. 4).
   c. On the extension cable assembly connector, with a pair of needle nose pliers, bend the two metal sides completely back and snap off the center of the connector at its score markings (see Fig. 5).
   d. Insert the extension cable assembly connector to the keyboard display module connector A. See Fig. 6.

Fig. 4. Remote mounting of keyboard display module using remote mounting bracket.

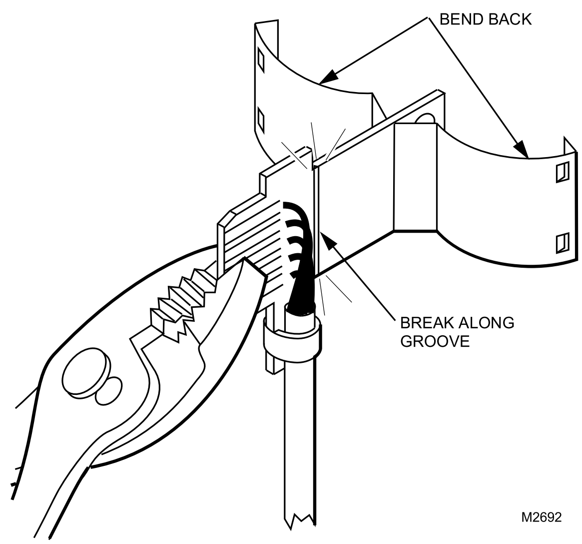


Fig. 5. Modified connector for bracket mounting.

   e. Mount the keyboard display module by inserting the two interlocking ears into the two mating slots on the remote mounting bracket; then push on the lower corners to secure it.
   f. Assure that the keyboard display module is firmly in place.

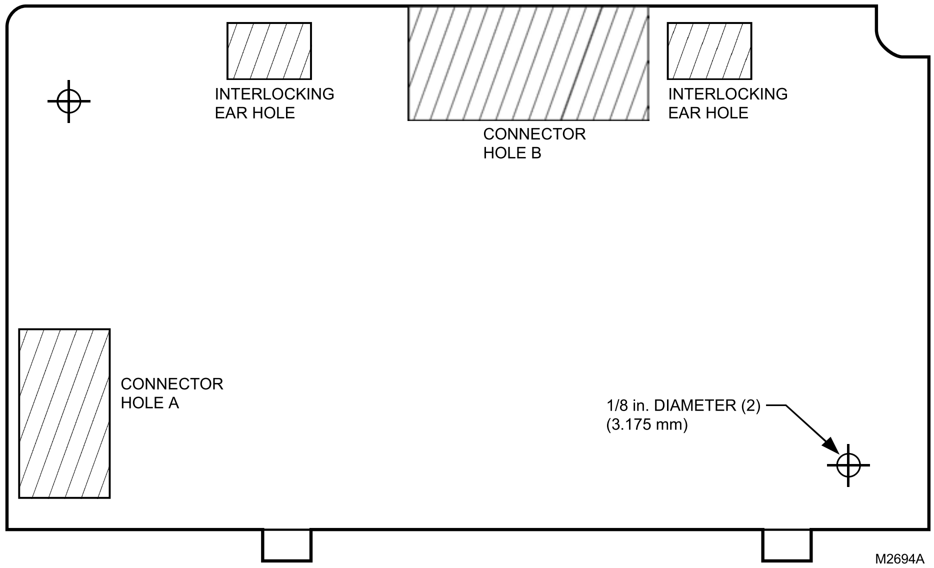


Fig. 6. Flush mounting of keyboard display module.

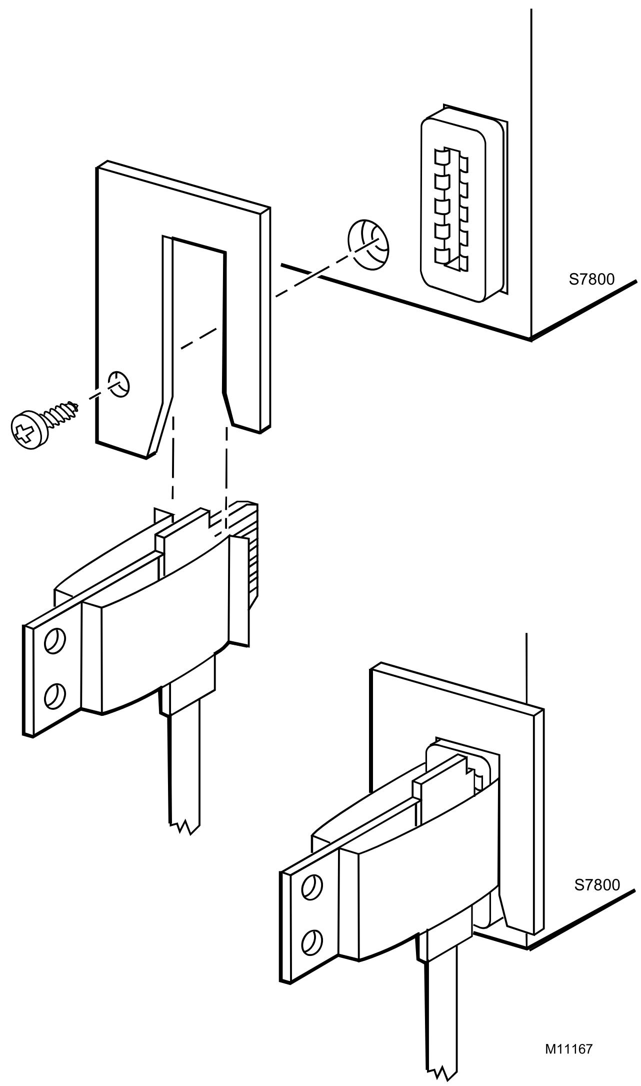


Fig. 7. Mounting 208702 Retainer Bracket.

Honeywell

Home and Building Control
Honeywell Inc.
Honeywell Plaza
P.O. Box 524
Minneapolis MN 55408-0524

Home and Building Control
Honeywell Limited-Honeywell Limitée
155 Gordon Baker Road
North York, Ontario
M2H 2C9

Helping You Control Your World®

65-0131—2 G.H. Rev. 2-97 Printed in Mexico

Flame Arrester

The proposed flame Arrester is a Groth Model 7628-03-11-FOZ. It will have an ATEX certification, not FM as stated in the following literature.

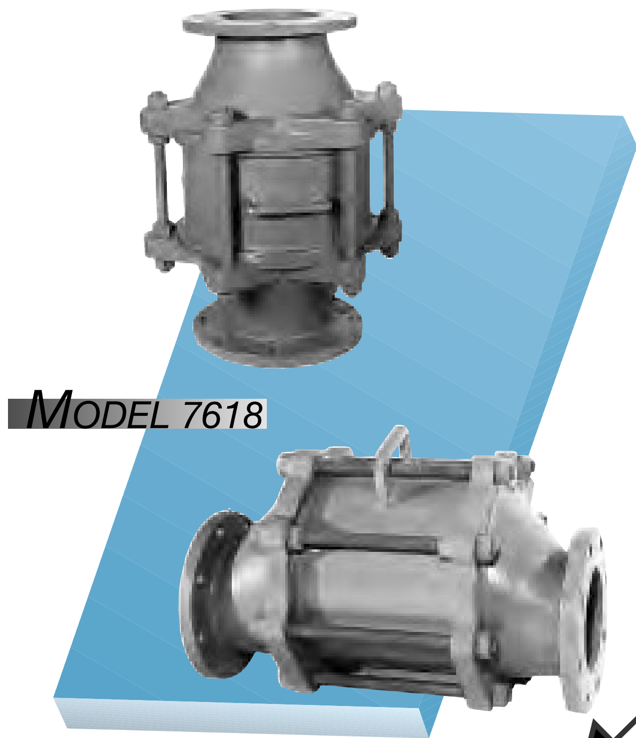
Digester Gas Control

FLR-TSE-301
Part 7626-03-11-FOZ

FLAME ARRESTERS

MODELS 7618 AND 7628

- Sizes 2" through 30", horizontal or vertical
- Available in aluminum (type 356), carbon steel, stainless steel, and other materials
- Wafer design for quick and easy maintenance and cleaning
- Unique recessed seating for positive seal
- Factory Mutual approved for standard sizes and materials including non-asbestos gaskets
- Proven spiral wound, crimped ribbon, flame element



MODEL 7618

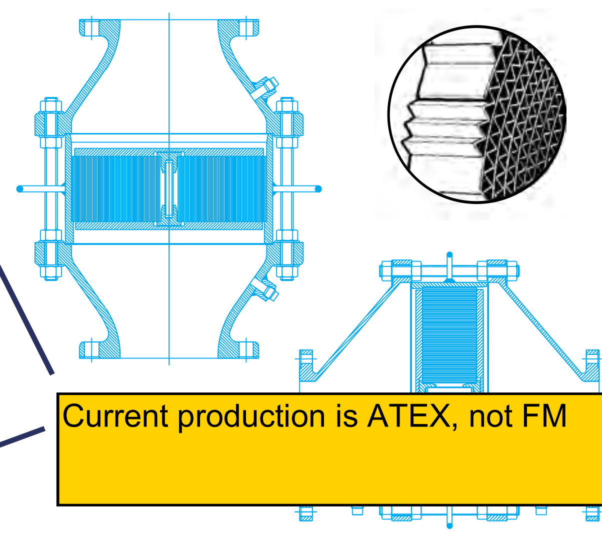
MODEL 7628

FLAME ARRESTER

Both Models are designed to inhibit flame propagation in gas piping systems and to protect digesters containing flammable gases. Groth flame arresters protect from externally caused sources of heat and ignition. This provides increased fire protection and safety. Model 7628 (horizontal) is specifically designed to prevent liquid accumulation in the flame bank assembly.

SPECIAL FEATURES

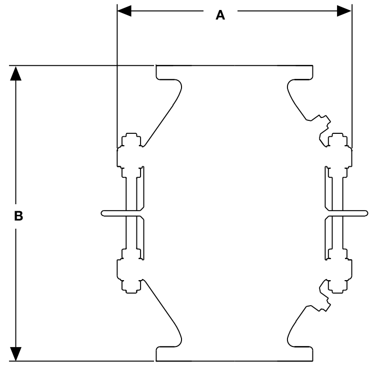
Both Models are built of corrosion resistant materials throughout. Wafer design construction affords easy accessibility to the flame bank. Additionally, jack screws aid in the removal from the shell assembly. All Groth flame arrester flame banks utilize spiral wound, crimped ribbon constructed flame elements. These proven, Factory Mutual approved elements have been reported, by NTIS of the Dept. of Commerce, to provide the best flame quenching performance for the least pressure drop. Groth's special recessed flame bank seating construction uniquely provides an extra measure of protection against leakage and possible flame propagation. All Groth flame arresters are standard tested at 10 PSIG. Consult factory for higher working pressure requirements.

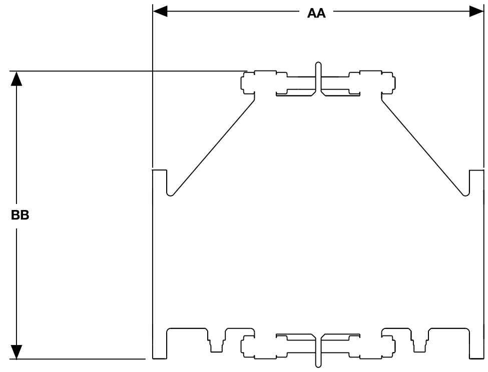


Current production is ATEX, not FM

GROTH, THE CAPABILITY COMPANY

As with all Groth products, every Model 7618 and 7628 is factory inspected and tested to meet your critical requirements and special needs. Groth is ISO 9001 Certified to insure reliable quality.





SPECIFICATION TABLE • MODELS 7618 / 7628

Specifications subject to change without notice. Certified dimensions available upon request.

Size*†	A Width (Metric)	B Height (Metric)	AA Length (Metric)	BB Height (Metric)	MAWP 7618◊ Aluminum (Metric)	MAWP 7618◊ Carbon or SS (Metric)	MAWP 7628◊ Aluminum (Metric)	MAWP 7628◊ Carbon or SS (Metric)	Approx. Ship. Wt. Lbs. (Aluminum)
2" (51 mm)	8 3/4" (221)	14" (356)	13 3/4" (349)	9 1/2" (241)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	150 PSIG (1035 kPa)	350 PSIG (2415 kPa)	18 (8kg)
3" (76 mm)	9 1/2" (241)	16" (406)	15 3/4" (400)	11" (279)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	140 PSIG (966 kPa)	325 PSIG (2242 kPa)	25 (11 kg)
4" (102 mm)	11 1/2" (292)	18 1/4" (464)	18" (457)	12 1/2" (318)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	140 PSIG (966 kPa)	325 PSIG (2242 kPa)	40 (18 kg)
6" (152 mm)	16 1/2" (419)	21" (533)	21" (533)	16 1/2" (419)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	140 PSIG (966 kPa)	325 PSIG (2242 kPa)	70 (32 kg)
8" (203 mm)	21" (533)	25" (635)	25" (635)	20 1/2" (521)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	90 PSIG (621 kPa)	200 PSIG (1380 kPa)	135 (61 kg)
10" (254 mm)	24 3/4" (629)	30" (762)	30" (762)	24 1/2" (622)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	75 PSIG (517 kPa)	150 PSIG (1035 kPa)	235 (107 kg)
12" (305 mm)	28 5/8" (727)	32 1/2" (826)	32 1/2" (826)	28 1/2" (724)	50 PSIG (345 kPa)	100 PSIG (690 kPa)	75 PSIG (517 kPa)	150 PSIG (1035 kPa)	345 (156 kg)

* Larger sizes available on special application. †150# A.N.S.I. drilling compatibility, F.F. on aluminum and R.F. on carbon steel and stainless steel alloys. ◊Pneumatic tested to 15 PSI as standard.

HOW TO ORDER

FOR EASY ORDERING, SELECT PROPER MODEL NUMBER

MODEL # — SIZE — MATERIAL — OPTIONS

MODEL #
- 7618 Vertical
- 7628 Horizontal

SIZE
- 02" Thru 60"

MATERIAL
- Flame element winding
- Body Material
  - 1 = Aluminum
  - 3 = Carbon Steel
  - 5 = 316 SS
  - Z = Special

OPTIONS
- 0 = No Options
- Z = Special Options
- 0 = No Jacket
- J = Steam Jacket
- F = Flanged outlet (in-line design)
- W = Weatherhood (replaces flanged outlet)

NOTES

Include model number when ordering.
For special options, consult factory.
When ordering steam jacket, include steam pressure/temperature.

EXAMPLE 7 6 2 8 — 0 2 — 1 5 — F 0 0

Indicates a 2" Model 7628 with Aluminum Body, 316 SS Flame Element Winding, Flanged Outlet and no other options.

GROTH CORPORATION®

GROTH IS COMMITTED TO THE TOTAL QUALITY IMPROVEMENT PROCESS

1202 Hahlo • P.O. Box 15293
Houston, Texas USA 77220-5293
713/675-6151 FAX 713/675-6739
Groth Products Group: 1-800-552-2960 (Except Tex. & La.)

Visit us at our internet site:
http://www.grothcorp.com

Groth Products Group E-mail address:
gpg@grothcorp.com

Accredited by the Dutch Council for Certification
ABS Quality Evaluations, Inc. • Quality Assurance Certification
ACCREDITED REGISTRAR ANSI-RAB
ISO 9001
Certificate Number: 30128

Form No 5M1197

GROTH CORPORATION

In-Line

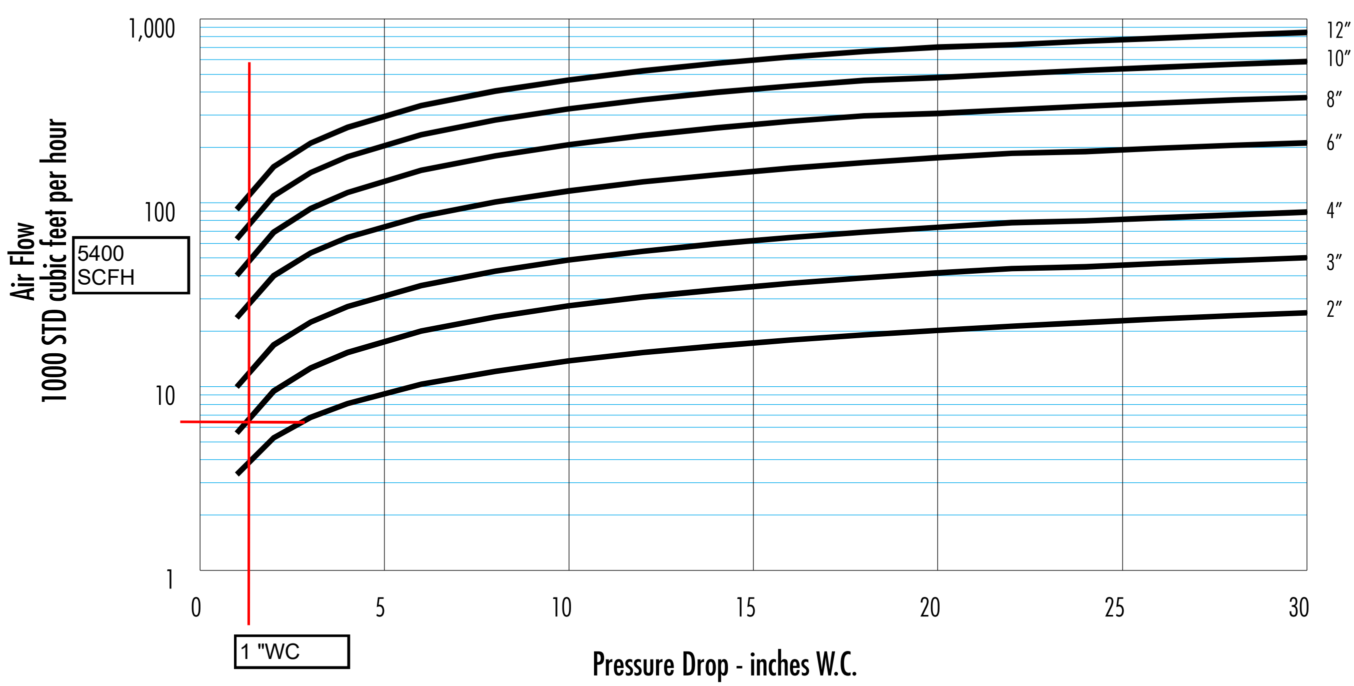
Pressure Relief Capacity of Groth Flame Arrester

Model 7628/7618

Pressure Drop		Air Flow - 1000 Standard Cubic feet per Hour						
In W.C.	oz/sq in	2"	3"	4"	6"	8"	10"	12"
1	0.6	3.32	5.58	9.92	23.6	40.2	63.4	91.8
2	1.2	5.27	9.44	16.8	40.0	69.1	109	157
3	1.7	6.79	12.6	22.4	53.3	93.0	146	211
4	2.3	8.08	15.3	27.2	64.8	113.8	178	257
6	3.5	10.3	20.0	35.5	84.5	150	234	337
8	4.6	12.1	23.9	42.5	101	180	282	405
10	5.8	13.8	27.5	48.8	116	207	324	466
12	6.9	15.3	30.7	54.5	130	232	363	522
14	8.1	16.6	33.6	59.8	142	255	398	573
16	9.2	17.9	36.4	64.7	154	277	431	620
18	10.4	19.1	39.0	69.3	165	297	463	665
20	11.6	20.2	41.5	73.7	176	306	480	701
22	12.7	21.3	43.8	77.9	186	320	502	723
24	13.9	22.3	44.8	79.7	190	335	524	756
26	15.0	23.3	46.6	82.9	198	348	545	786
28	16.2	24.3	48.4	86.0	205	362	566	816
30	17.3	25.2	50.1	89.1	212	374	586	845

1. Flow facility and equipment comply with API 2000.
2. Flow measurement accuracy verified by an independant research organization.
3. Flow capacity is based on actual tests and certified by Groth Corporation.
4. Flow data are for in-line mounting and does not include entrance losses or exit losses.

Note: Flow stated in cubic feet of air can be corrected for gas at 0.7 specific gravity by multiplying all flows by 1.2 factor.



Flame Sensor

A Honeywell C7061A1038 self checking UV Scanner (Purple Peeper) is provided. It mounts on the flare with a provided swivel mount, this is shipped in a box for protection. It is provided with a 124204 focusing lens installed.

This device is compatible with the provided Amplifier, relay module, cable, etc.

FLR-BE-501
Part # C7061A1038 with 124204 fused Quartz lens installed.

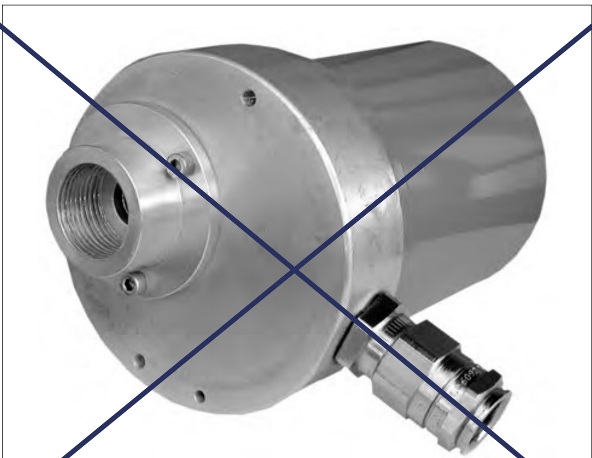
Honeywell

C7061 A/F

DYNAMIC SELF CHECK ULTRAVIOLET FLAME DETECTOR

PRODUCT HANDBOOK

model C7061A



model C7061F

APPLICATION

The C7061A is a dynamic self-checking flame detector for sensing the ultraviolet radiation generated by the combustion of gas, oil, or other fuels.
This flame detector is available in two versions:
model C7061A for use in Standard applications, and model C7061F for use in installations requiring explosion-proof packaging. The flame detector is designed for use with either,

R7061 Dynamic Self-Check Ultraviolet amplifier and
- R4348 Flame Switch or,

or with,

~~R7861A Dynamic Self-Check Ultraviolet amplifier and,~~
- ~~7800 SERIES Burner Programmers.~~

~~These configurations provide a closed-loop, self-checking circuit which insures the integrity of both amplifier and flame detector. Improper response simulated flame loss results in a safety shutdown and/or alarm.~~

CONTENTS

GENERAL

DESCRIPTION

The C7061A1020 and C7061F1003 detector models are identical except for housings.
Model C7061F detector is for use in installations requiring explosion proof packaging. The housing is conform the EExd IIC T6 classification. More details for the explosion proof housing can be found in the chapter Standards and Approvals.
The C7061F model has a 1-inch NPT tapping for mounting onto a sight pipe. For allowable mounting positions of model C7061A and model C7061F, see Page 9.

The terminal block on both models is of wire clamp type with removable screws and is situated in the compartment of the C7061. The UV cell contains an ultraviolet sensing tube, shutter assembly, terminal block and magnifying lens. The UV sensor can be mounted from the programmer/flame switch up to a length of 300 m.

FEATURES

- Oscillating shutter interrupts ultraviolet radiation reaching the UV Sensor 12 times per minute (when used with R7861 amplifier in combination with 7800 SERIES) to provide the UV Sensor tube checking function. When used with the R7061 amplifier in combination with R4348 flame switch, the shutter frequency is 60 times per minute. Amplifier circuitry components are checked from the microprocessor in the 7800 SERIES Control.
- Detectors can be mounted horizontally, vertically or at any angle in between. The self-checking C7061 models require faceplate alignment and have integral locating reference points to assure proper operation of the shutter mechanism.
- Ultraviolet radiation sensing tube and quartz viewing window are field replaceable.
- Two flame detectors can be wired in parallel to reduce nuisance shutdowns in difficult flame sighting applications.
- A swivel mount is available to facilitate flame sighting.
- -40°C (-40°F) rated ultraviolet sensing tube is available.
- Incorporates UV Sensor tube checking feature; used with R7061 and R7861 Dynamic Self-Check amplifiers.
- High pressure 50 psi (345 kPa) quartz viewing window, magnifying lens and antivibration mount are available as accessories.
- Housing meets IP67 enclosure standards.
- C7061 F only: explosion-proof housing, meets EExd IIC T6 classification.
- Protective heat block built into mounting flange.

ORDERING INFORMATION

When ordering specify:

- Complete model number.

Order separately:

- R7061 Dynamic Self-Check Ultraviolet Amplifier.
- R7861A Dynamic Self-Check Ultraviolet Amplifier.
- Replacement parts, if desired.
- Accessories, if desired
- Flame safeguard control

TECHNICAL DATA

SPECIFICATION

Models

C7061A: Self checking UV flame detector in standard housing.
C7061F: Self checking UV flame detector in explosion proof housing. Designed for use with either,
R7061 Dynamic Self-Check Ultraviolet amplifier and
- R4348 Flame Switch

or with,
R7861A Dynamic Self-Check Ultraviolet amplifier and,
- 7800 SERIES Burner Programmers

Ambient Operating temperature ratings

C7061A -40°C to +70°C (-40°F to +160°F) (derate ambient 1°F for every 13°F of aspirator temperature over 160°F).
C7061F: -20°C to +70°C (-22°F to +160°F)

Storage temperature ratings

- -51°C to +85°C (-60°F to +185°F)

Voltage and Frequency

C7061A1004 120 VAC, 50/60 Hz
C7061A1020 115/230 VAC, 50/60 Hz
C7061F1003 115/230 VAC, 50/60 Hz
The System operates correctly at a nominal voltage (-15%, +10%), 50/60 Hz.

Flame Signal

Measured at the flame current meter jack.
C7061 Detector: 1.4 to 5.5 micro amps (nominal).
R7061A Amplifier: 2.5 to 5.5 micro amps (nominal).
R7861A Amplifier: 1.25 to 5.0 Volts (On keyboard display module).

□□□□□□□□□□□
R7061A Dynamic Self-Check Ultraviolet amplifier
R7861A Dynamic Self-Check Ultraviolet amplifier
(Order separately)

Interchangeability

Models C7061A and C7061F are **not** interchangeable with other flame detector models.

Shutter frequency

0.2 Hz, nominal (when used in combination with 7800 SERIE). Interrupts the line-of-sight of the detector about 12 times per minute to provide self-checking. Any malfunction in the flame detection system results in a safety shutdown. 1 Hz nominal when used with R4348 in combination with R7061 amplifier.

Pressure rating of quarz viewing window

C7061A: 138 kPa (20 psi) maximum.
C7061F: 690 kPa (100 psi) maximum

Dimensions

C7061A: see figure 1.
C7061F: see figure 2.

Housing

C7061A:
Construction: cast-aluminum cover.
Color: Violet.
Mounting flange (with heat block) and faceplate are separate to provide heat insulation and seal-Off.

C7061F:
Meets requirements (explosion-proof): EEx d IIC T6
Construction: cast-aluminum Cover.
Color: Violet. Mounting flange (with heat block) and faceplate are separate to provide heat insulation and seal-Off.

Enclosure

C7061A: Meets IP66 enclosure requirements (indoor, outdoor protection; rain-tight, dust-tight, hose-directed water).
Optional water jacket available.
C7061F: IP65 according to DIN 40050

Weight

C7061A: 3.3 kg (7.3 lb)
C7061F: 6.3 kg (13.9 lb)

Mounting and orientation

C7061A : Mounting flange with 3/4 inch NPT internal threads for attaching to sight pipe.
C7061F: Mounting flange with 1 inch NPT internal threads for attaching to sight pipe.
For allowable mounting positions of model C7061A and F, see Page 9.

Wiring Connections

C7061A1004:
NEC Class 1 color coded leadwire.
Length: 8 ft (2.4m).

C7061A1020:
Terminal block
Threaded leadwire opening in faceplate:
1/2-14 NPSM internal threads for attaching conduit.
One brass cable gland standard with housing.

For C7061F only:
Terminal block:
Terminal block inside the housing, wire clamp type, removable screws (terminal lugs can be used).
Cable entry holes:
One brass cable gland Ex classification: EExdII C, is standard provided in the housing.
Inner sheath diameter 6 to 12 mm
Outer sheat diameter 8.5 to 16 mm
Tightening torque:
- cable gland into rear cover plate: 20 Nm
- cap into cable gland: 3 Nm

Serviceability

Field replaceable viewing window and ultraviolet sensing tube, coil and shutter assembly.

Maximum cable length

300 meter between sensor and amplifier

Design life

Ultraviolet sensing tube: limited life, see sections Troubleshooting and Service.

STANDARDS AND APPROVALS

Models C7061A and F

C7061A and F Ultraviolet Flame Detector conform with following EC-Directives:

- Gas Appliance Directive (90/396/EEC).
  according to European Standard:
  EN298 approved with R7861 and R7061 flame amplifiers.
- Low Voltage Directive (73/23/EEC)
  according to European Standard:
  EN60730-2-5
- Electro Magnetic Compatibility Directive (89/336/EEC)
  according European Standards:
  EN55011 class B regarding emission.
  EN50082-2 industrial level regarding immunity.

Model C7061F

In addition to above information, C7061F conforms with:

- Explosive Atmospheres Directive (94/9/EC)
  according to European Standards:
  EN50014
  EN50018
  EN50019

Other approvals (C7061A only)

Underwriters Laboratories Inc. Listed.
Canadian Standards Association Certified: Master File LR95329-1.
Factory Mutual Approved: 14740.01.
Industrial Risk Insurers Acceptable.

REPLACEMENT PARTS AND ACCESORIES

Replacement parts for model C7061A and C7061F

129464M Uttraviolet Sensing Tube.
129464N Ultraviolet Sensing Tube; for -40°F (-40°C) operation.
190971B Coil and Shutter Assembly.

Replacement parts for model C7061A

114372 Quartz Viewing Window; rated for 20 Psi (138 kPa).
114465 Gasket, Silicone rubber; for installing viewing window (three required).
120739 Gasket, fiber-neoprene; heat insulation and seal-off for mounting flange.

Accessories for model C7061A and C7061F

118367A Swivel mount.
118369 Bushing, galvanized iron, with 3/4 inch NPT internal threads on one end and 1 inch NPT external threads on the other end. For adapting a detector with 1 inch NPT internal threads (for mounting) to a 3/4 inch sight pipe, or to the pipe nipple and tee for connecting an air supply.
120934 Mounting Flange, aluminum, with 3/4 inch NPT internal threads for attaching to sight pipe.
124198 Mounting Flange, aluminum, with 1 inch NPT internal threads for attaching to sight pipe.
123539 Antivibrtation Mount.
124204 Quartz Focusing Lens, rated for 20 Psi (138 kPa); for increasing the detector-sensed ultraviolet radiation.

Accessories for model C7061A

122748 Quartz Viewing Window, rated for 50 Psi (345 kPa).
190105 Water Jacket.

DIMENSIONAL DRAWING

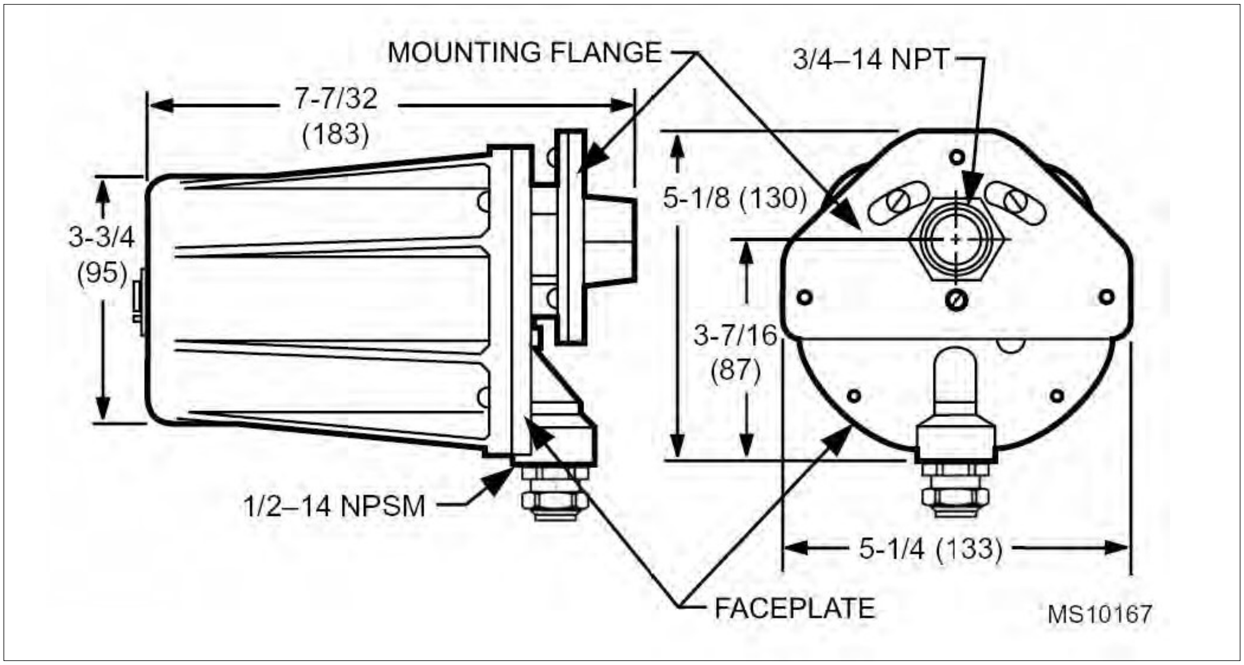


Fig. 1. Dimensional drawing C7061A in inches (mm)

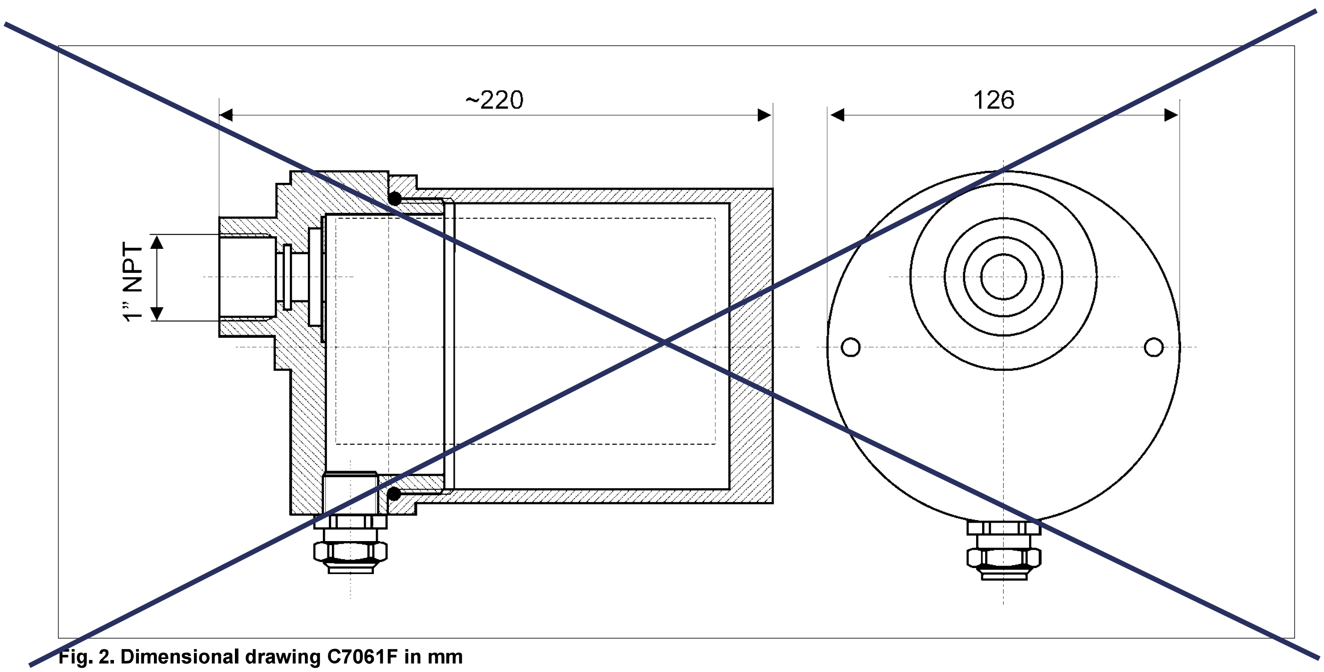


Fig. 2. Dimensional drawing C7061F in mm

INSTALLATION AND OPERATION

PLANNING THE INSTALLATION

Proper flame detector application is the back of a safe and reliable flame safeguard installation. Refer to the burner manufacturer's instructions as well to those included here. Follow all instructions carefully.

CAUTION

1. Do not connect these detectors to non-Honeywell manufactured controls (primaries, programmers, multiburner systems, and burner management systems). Unsafe conditions could result.
2. Disconnect power supply before beginning installation to prevent electrical chock and equipment damage. More than one disconnect may be involved.
3. All wiring must be NEC Class 1 (line voltage).
4. Voltage and frequency of the power supply-connected to this detector must agree with the values marked on the detector.
5. Sight the detector so it does not respond to ignition spark.
6. On multiburner installations, each detector must respond only to the flame of the burner it is supervising.

IMPORTANT
Do not connect more than two C7061A/F flame detectors in parallel.

Basic Requirements

The combustion flames of most carbon-based fuels emit sufficient ultraviolet radiation to enable the C7061A/F Solid State (Purple Peeper) ultraviolet flame detector to prove the presence of a flame in a combustion chamber. The detector mounted outside the combustion chamber. Its mounting flange or union is threaded to one end of a sight pipe inserted through the wall of the combustion chamber. The ultraviolet sensing tube in the flame detector sights the flame through the pipe.
When a flame is present, the UV tube in the C7061A/F senses the ultraviolet radiation emitted. The C7061A/F produces a signal that is sent to the amplifier in the flame safeguard control. The amplified signal pulls in the flame relay in the control to allow proper operation of the system.
Because it is necessary for the UV sensing tube to actually see the flame, it is best to locate the detector as close to flame as physical arrangement, temperature, and other restrictions permit. These restrictions are described in detail in the following paragraphs.

Determine the location

Before beginning the actual installation, estimate the best location for mounting the detector based upon these factors:

1. Temperature
Install the flame detector where the surrounding temperature will remain within the specified ambient operating temperature ratings.
For the C7061A/F, to keep the detector temperature within specifications. If the temperature rating is exceeded, the introduction of cooling air will be necessary.

2. Vibrations
Do not install the detector where it could be subject of excessive vibration; it shortens the life of the electronic components. Vibrations with a magnitude greater than 1g will require an anti-vibration mount to cushion the detector.

3. Clearance
Make sure there will be enough room to remove the cover of the detector for servicing.

Radiation sour□□□□□□□□□□

Examples of radiation sourses, other than flame, which could actuate the detection system:

Ultraviolet sources

- Radiant surfaces above 1200°C (2200°F).
- Sparks from ignition transformers and welding arcs.
- Gas lasers
- Sun lamps
- Halogen lamps
- Germicidal lamps
- Incandescent lamps held close to the sensing tube
- Filament above 1200°C (2200°F).

Gamma ray and X-ray sources

- Diffraction analyzers
- Electron microscopes
- Radiographic X-ray machines
- High voltage vacuum switches
- High voltage condensers
- Radioisotopes

Except under very unusual circumstances, none of these sources, except a radiant surface or ignition spark, would be present in or near the combustion chamber. The detector may respond to a radiant surface at a temperature above 1200°C (2200°F) if both of the following conditions are present the surface represents a significant percentage of detector's field of view.
If the temperature or a radiant surface causes the flame relay (in the flame safeguard control) to pull in, re-aim the sight pipe so the detector views a cooler area, or the sensitivity of the detector decreases. Ignition sparks is a rich source of ultraviolet radiation.

IMPORTANT
When installing the detector, make sure it does not respond to ignition spark.

Single burner requirements
The detector must have an unobstructed view of the flame it is supervising under all firing conditions. This implies a proper sighting angle and the minimization of screening effects.

Sighting angle
The first 30 percent of a flame (the root) radiates the most intense ultraviolet energy. The low angle sighting permits the detector to view a greater depth of the flame root, thus reducing the effects of irregularities in the flame pattern. The best sighting angle is nearly parallel to the axis of the flame, as shown in Figure 3.

NOTE: When possible, it is desirable to tilt the detector and sight pipe downwards to prefent the build up of soot in the pipe or on the viewing lens.

In most installations, the detector will need to respond to the, pilot flame alone, then to the pilot and main burner flame together and finally to the main burner flame alone. The detector must meet all sighting requirements which apply:

1. Pilot flame alone - the smallest pilot flame that can be detected must be capable of reliable ignition the main burner.
2. Pilot and main burner flame together - the detector must sight the junction of both flames.
3. Main burner flame alone - the detector must sight the most stable part of the flame for all firing rates

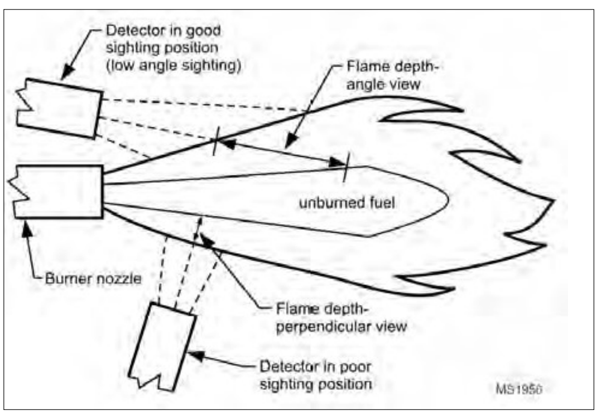


Fig. 3. Sighting angle

Screening effects
Smoke, fuel mist, dirt and dust are masking agents that absorb ultraviolet radiation from the flame. They create a screen that reduces the amount of ultraviolet radiation reaching the detector and may cause flame signal deterioration resulting in a shutdown. The adverse affects of Screening may be minimized by proper burner adjustment, increasing the detector viewing area (shorten sight pipe and/or increase its diameter).

Multifuel requirements
In addition to meeting the requirements for a single burner, a multiburner installation also requires flame discrimination.
Flame discrimination may be defined as the location of all flame detectors such that each detector responds only to the flame(s) produced by the burner it is supervising.

Multiburner requirements
In multiple burner systems, not every detector can be positioned so its line of sight does not intercept flames from other burners. This situation occurs in front-fired boiler furnaces having more than one row of burners, or in multi-level opposed-fired furnaces where the burners face each other. When planning such an installation, locate each flame detector so that it has the best possible view of the root of the flame(s) it is supervising and the worse possible view of all other flames.

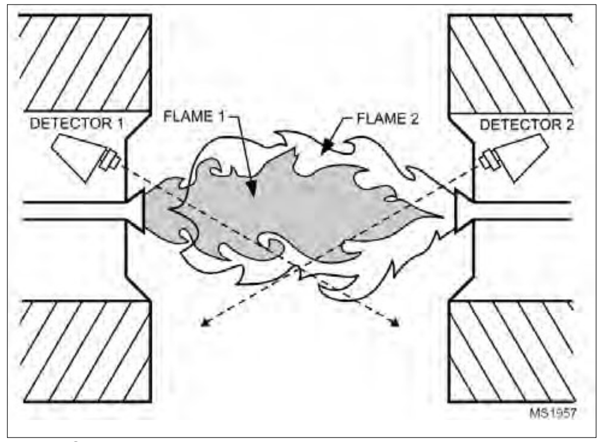


Fig. 4. Critical detector application problem

Figure 4. illustrates a critical detector application Problem requiring flame discrimination. Flame discrimination is accomplished by detector 1 by reducing its sensitivity until the flame relay (in the flame safeguard control) does not respond to flame 2. Note that detector 1 is aimed at the root of Flame 1 where UV (ultraviolet) energy is most intensive. Although it sights flame 2 is not aimed at the root of flame 2. The sensitivity of detector 1 is reduced to a point that ensures maximum sensitivity to flame 1 while rejecting flame 2. similarly, detector 2 is adjusted to ensure maximum sensitivity to flame 2 while rejecting flame 1.
If the sensitivity control on a detector is set at its minimum position and flame discrimination cannot be achieved, insert an orifice plate in the sight pipe. An orifice of the proper diameter will reduce the ultraviolet radiation reaching the detector so that the sensitivity can be adjusted to effect flame discrimination.

P□□□□□□□□□□□s
Two C7061A/F detectors can be connected in parallel to the same flame signal amplifier and still provide independent sensitivity adjustment. This capability is particular useful for multiburner, multifuel applications.
Shifting flame patterns, commonly encountered on burners with wide turndown ratios, may require parallel detectors to prove the flame at the highest and lowest firing rates. In this case, one detector supervises the pilot (interrupted) and both detectors supervise the main burner flame. During the main burner "run" period, either detector is capable of maintaining system operation.
In addition to assuring more reliable flame detection, parallel detectors facilitate maintenance during burner operation.
Each detector can be removed in turn without shutting down the supervised burner. However, a flame simulating failure occurring in the flame signal amplifier or in either detector will cause a shutdown.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced flame safeguard control serviceman.
2. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
3. All wiring must comply with applicable local electrical codes, ordinances and regulations.
4. Voltage and frequency of power supply connected to this detector must agree with the values marked on the detector.
6. On multiburner installation, each detector must respond only to the flame(s) producted by the burner it is supervising.
7. Do not connect more than two detectors in parallel to a single R7061 or R7861A Dynamic Self-Check Ultraviolet amplifier.
8. Perform all required adjustments and checkout tests after installation is complete.

Install the Sight Pipe

After you have determined the location and sighting angle, select the sight pipe. A black iron pipe with a diameter of at least 1-1/2 in. (38.1 mm) is recommended. Do not use stainless steel or galvanized pipe because they reflect ultraviolet radiation internally and complicate aiming the pipe.
Sight pipes with diameters 2 to 3 in. (51 to 76 mm) produce better results for horizontal rotary burners, which require wide viewing angles. A wide viewing angle can also be obtained by using a short sight pipe.

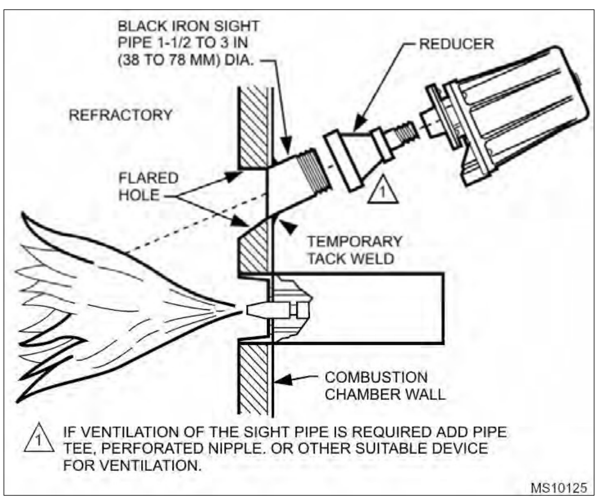


Fig. 5. Typical mounting of C7061A/F

Prepare Hole in Wall of Combustion Chamber

Cut or drill a hole of the proper diameter for the sight pipe in the wall of the combustion chamber at the selected location.
Flare the hole to leave room for small adjustments of the sighting angle. The taper of the hole should be about 1 in. for every 3 in. (25 mm for every 76 mm) of Wall thickness.

Mount Sight Pipe

Thread one end of the pipe to fit the mounting flange, union,or required coupling. Cut the pipe to the desired length (as short as practical) and at an angle so it fits flush with the wall of the combustion chamber. Tack weld the pipe to the wall in a trial position. Do not weld the sight pipe permanently in place until after completing the Adjuctments and Checkout.

Install Fittings

In some cases, the sight pipe does not directly fit the C7061A/F mounting flange or union. Also, it may be desirable or necessary to ventilate the sight pipe. You may also want to use a swivel mount or an antivibration mount. Each of these cases may require additional fittings.

Reducer

For sight pipes of larger diameter than the mounting flange connector or union, install a reducer as illustrated in Fig. 5. The reducer will require a close nipple with these external threads: 3/4 or 1 inch. NPT.

Sight Pipe Ventilation

It may be necessary to ventilate the sight pipe to cool the detector or to clear a viewing path through UV radiation attenuating material.
For a negative pressure combustion chamber, drilling a few holes in the section of the sight pipe outside of the combustion chamber will allow air at atmospheric pressure to flow through the sight pipe and into the chamber. A perforated pipe nipple between the sight pipe and the detector can also be used.
For a positive pressure combustion chamber, connect a supply of pressurized air from the burner blower to flow through the sight pipe and into the chamber. The air pressure must be greater than the chamber pressure.

Swivel Mount (C7061A only)

To facilitate proper flame sighting, use part no. 118367A Swivel Mount (not supplied). The swivel mount requires a reducer of the proper size to mount it onto the sight pipe. It also requires a one-inch close nipple for mounting to a C7061 with a one-inch connector. (For 118367A Swivel Mount mounting details, refer to form 60-0361).

Antivibration Mount

The detector withstands normal burner vibration. If the vibration is excessive, part no. 123539 Antivibration Mount is available. (For mounting details, see form 60-0361). If you use this mount, install it before positioning and sighting the detector.

Mount the Detector

Mount the detector onto the sight pipe, reducer, or other fitting. The C7061A/F Self-Checking flame detectors incorporate an oscillating shutter mechanism and, therefore, require special consideration for mounting positions other than vertically sighting downward or upward, as illustrated in Fig. 6. The C7061A/F has notch and arrow indicators (see Fig. 7 and 9) on the faceplate to facilitate mounting in positions other than those shown in Fig. 7. The notch and arrow must be vertically aligned with the notch in the up position and the arrow pointing downward (see Fig. 7). The C7061A/F must be mounted with the conduit opening located approximately 45 degrees below the horizontal (see Fig. 7).

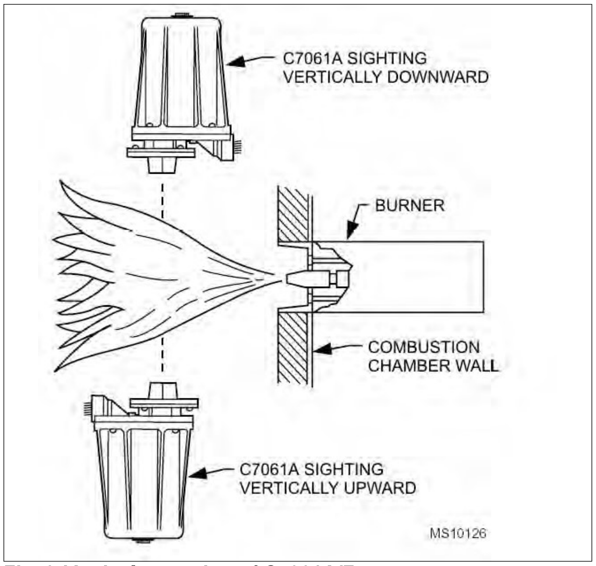


Fig. 6. Vertical mounting of C7061A/F

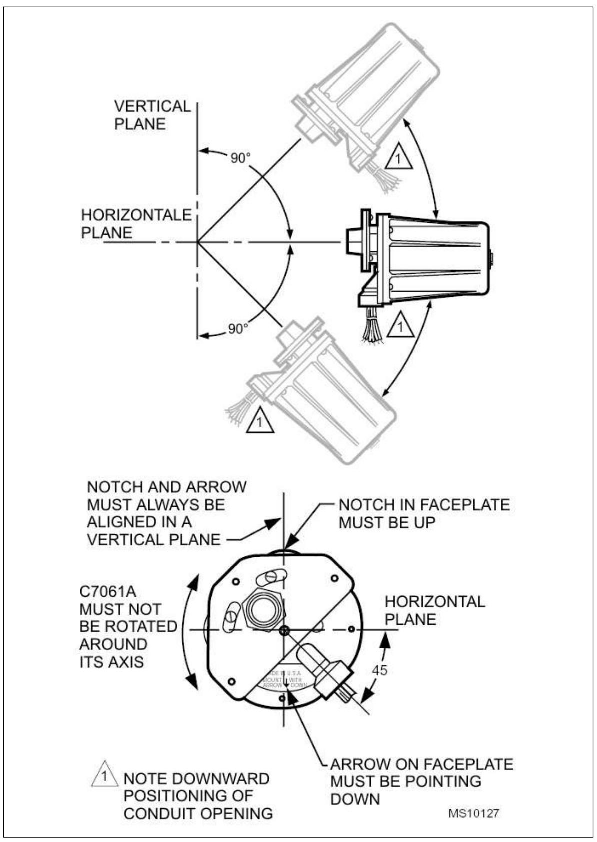


Fig. 7. C7061A mounting Positions

IMPORTANT

The notch and arrow on the faceplate must be aligned in a vertical plane with the notch up and the arrow pointing down.
The housing must be mounted with the conduit opening approximately 45° below horizontal (see Fig. 7)

To mount a C7061A (Fig. 8):

A The mounting flange is in two pieces. Loosen (but do not remove) the three screws holding the flange together.

B Slightly rotate the detector so the slots in the back section of the mounting flange clear the screws in the front section; then separate the two sections.

C Screw the front section of the mounting flange onto the sight pipe, reducer, or other fitting.

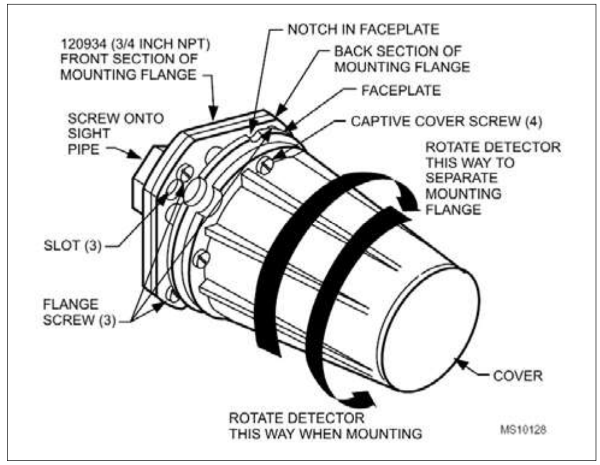


Fig. 8. Mounting the C7061A detector

D Fit the slots in the back section of the mounting flange (with the detector) over the three screws in the front section, and rotate the detector so the screws hold the flange together.

E Tighten the screws securely.

Fig. 9. Mounting the C7061F detector

IMPORTANT

The rivit on on the faceplate must be at the top (see figure 9). The C7061F can be mounted with increments of 120°.

The C7061F has a rivet on the blank alurninium holder. The cell must be positioned so that this rivet is at the top of the installed cell. In certain applications the sensor must be turned in order accoomplish this.

To turn the C7061 (Figure 9).

A Loose the 3 screws between the pipe connection and bottom part of.

B Turn the C7061F in the most favorable position.

C Tighten the screws securely.

CAUTION

When using a C7061A/F with an R7061 or R7861 Dynamic Self-Check amplifier, be careful not to short the white shutter lead wires together (by wiring incorrectly, leaving an incorrect jumper wire, or stripping the insulation too much so the bare lead wires can touch).

If the shutter leadwires are shorted during the operation, the amplifier can be permanently damaged and nonoperative.

1. All wiring must comply with applicable local electrical codes, ordinances, and regulations. Use NEC class 1 wiring.
2. Keep the flame signal lead wires as short as possible from the flame detector to the terminal strip or wiring sub base. Capacitance increases with lead wire length, reducing the signal strength. The maximum permissible lead wire length depends on the type of lead wire and conduit type and diameter. The ultimate limiting factor in flame signal lead wire length is the signal current.
3. The C7061A1004 detector has color-coded plastic-insulated, no. 18 lead wires, 8 ft (2.4m) long, rated for 105°C (221°F). These wires must be run in a conduit.
4. If the lead wires are not long enough to reach the terminal strip or wiring sub base, make the required splices in a junction box.
5. If splicing is necessary, use moisture-resistant no. 14 wire suitable for at least 75°C (167°F) if the detector is used with a flame safeguard primary control, or at least 90°C (194°F) if used with a flame safeguard programming control.
6. For high temperature installations, use Honeywell specification no. R1298020 wire or equivalent for the F lead wire. This wire is rated up to 204°C (400°F) for continuous duty. It is tested for operation up to 600 volts and for breakdown up to 7500 volts. For the other lead wires, use moisture-resistant no. 14 wire selected for a temperature rating above the maximum operating temperature.
7. Refer to Fig. 10. for wiring connections

IMPORTANT

Do not run the flame detector wiring in the same conduit with high voltage ignition transformer wires.

Connecting Detectors in Parallel

For a flame that is difficult to sight, using two parallel C7061 flame detectors reduces nuisance shutdowns. If only one of the parallel detectors loses the flame signal, the other indicates the presence of the flame and keeps the burner running. If two parallel C7061A setectors are used, a flame-simulating failure in either detector causes the burner to shut down. Two C7061A setectors can be connected in parallel to the same terminals on 120 volt flame safeguard controls.

CAUTION

When using the C7061 in conjunction with an R4348 flame relay at 230VAC, parallel sensores can **not** be used.

To avoid exceeding the rating of the solid-state shutter switch in the R7861 flame signal amplifier, do not connect more than two C7061A detectors in parallel.

IMPORTANT

Voltage and frequency rating of the C7061A must match the power supply of the flame safeguard control.

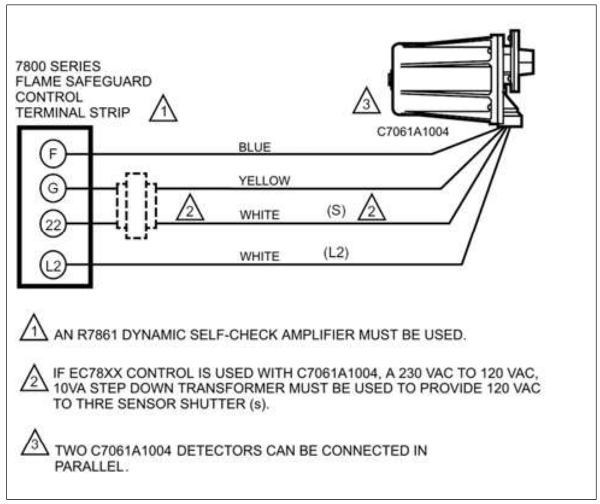


Fig. 10_1. Wiring diagram for C7061A1004 detectors with 7800 SERIES Flame Safeguard controls with shutter drive circuitry.

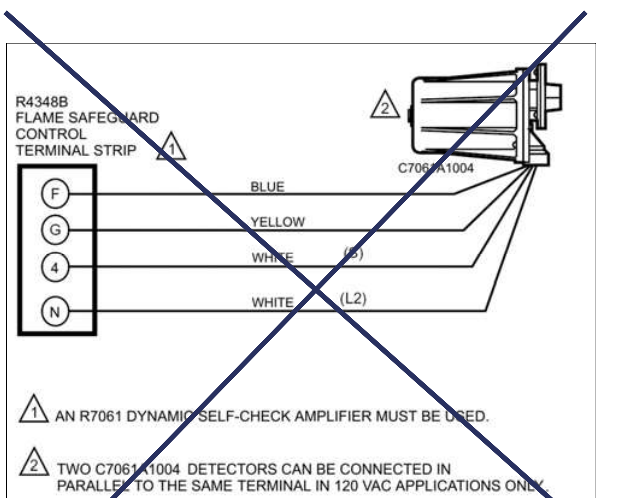


Fig. 10_2. Wiring diagram for C7061A1004 detector with R4348 Flame Safeguard controls with shutter drive circuitry.

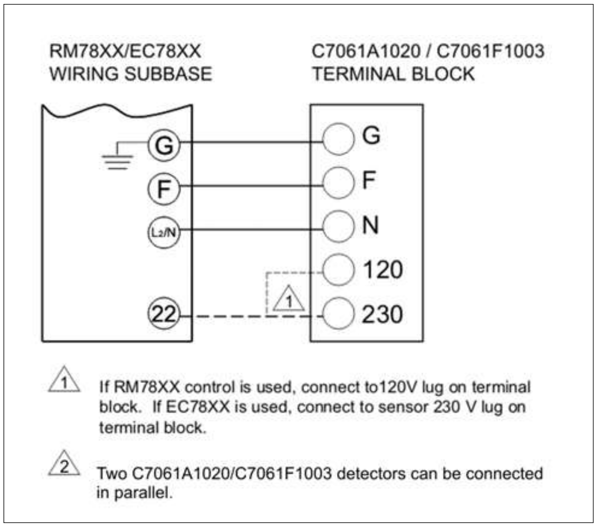


Fig. 10_3. Wiring diagram for C7061A1020/C7061F1003 detector with 7800 SERIES Flame Safeguard controls with shutter drive circuitry.

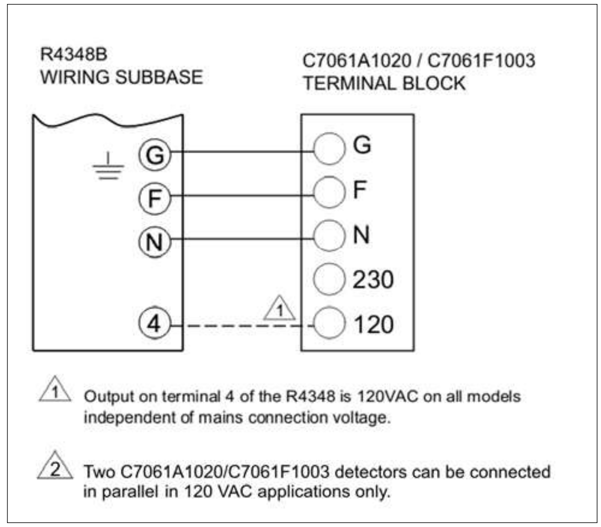


Fig.10_4. Wiring diagram for C7061A1020/C7061F1003 detector with R4348B Flame Safeguard controls with shutter drive circuitry.

Adjust Detector Sighting

With the flame detector installed and the burner running, adjust the sighting position of the detector for optimum flame signal. It is suggested that a volt-Ohm meter with a minimum sensitivity of one megohm/volt and a zero to five or ten Vdc scale be used for R7861 amplifier flame signal measurements.

Measure the flame signal as illustrated in Fig. 11. Be careful to make the proper connections of positive (red) meter lead to positive (+) control jack and negative (black) meter lead to negative (-) or (-Com) jack with 7800 SERIES controls. When the 7800 SERIES control has the keyboard display module, a zero to five Vdc voltage is displayed on the module.

NOTE: The flame Signal must be steady.
Use a W136 test meter (or similar) when measuring the current on an R7061 amplifier.

Move the detector and sight pipe around to sight the flame from various positions and angles. Try to get a maximum steady (or stable) reading on the meter. The signal must be above the minimum acceptable voltage listed in Table 1.

Measure the flame signal for the pilot alone, the main burner flame alone, and both together (unless monitoring only the pilot flame when using an intermittent pilot, or only the main burner flame when using direct spark ignition). Also measure the flame signal at low and high firing rates and while modulating in between (as applicable). With the detector in its final position, all required flame signals must be steady (or stable) and as specified in Table 1. If you cannot obtain the proper signal, refer to the Troubleshooting section.

Fig. 11. Measuring voltage □ □ □ Signal with 7800 SERIES controls

Table 1. Flame signal

Flame detector	□ □ □ □ □	min. acceptable steady signal	max. acceptable steady signal
C7061A1004	R7061	3,0 µA	——
C7061A1020 C7061F1003	R7861	1,25 VdC	5,0 VdC

Pilot Turndown Test

If the detector is used to prove a pilot flame before the main fuel valve(s) can be opened, perform a pilot turndown test before welding the sight pipe into position. Follow the procedures in the flame safeguard control instructions and in the burner manufacturer instructions.

Ignition Spark Response Test

Test to make certain that ignition spark is not actuating the flame relay in the flame safeguard control.

A Close the pilot and main burner manual shutoff valves.

B Start the burner and run through the Ignition period. Ignition spark should occur, but the flame LED must not light. The flame signal should not be greater than 0.25 Vdc.

C If the flame relay does pull in, reposition the detector farther from the spark, or relocate/resight the detector to eliminate/reduce the detector response to reflected UV radiation. It may be necessary to construct a barrier to block the ignition spark from the detector view. Continue adjustments until the flame signal due to ignition spark is less than the flame signal values indicated in step B.

Response to other Ultraviolet Radiation Sources

Some sources of artificial light produce small amounts of ultraviolet radiation. Under certain conditions, an ultraviolet detector responds to them as if it is sensing a flame. Do not use an artificial light source to check the response of an ultraviolet flame detector. To check for proper detector operation, conduct flame failure response tests under all operating conditions.

Weld the Sight Pipe

When the flame signal is acceptable after all adjustments are made, remove the detector and weld the sight pipe in its final position. (If you are using a swivel mount, the pipe may already be welded). Then reinstall the detector.

Final Checkout

Before putting the burner into service, check out the installation using the checkout procedures in the instructions for the appropriate flame safeguard control. After completing the checkout, run the burner through at least one complete cycle to verify correct operation.

CAUTION

Do not put the system into operation until all checkout tests in the instructions for the appropriate flame safeguard control and any others specified in the burner installation instructions are satisfactorily completed.

VARIOUS

TROUBLESHOOTING

CAUTION

1. Be extremely careful while troubleshooting the detector; line voltage is present on some of the terminals when power is on.
2. Open the master switch to disconnect power before removing or installing the detector or its cover. More than one disconnect may be involved.

Equipment Required

A volt-Ohm meter with a minimum sensitivity of one megohm / Volt and a zero to five or ten Vdc scale is suggested. When the keyboard display module is available, a flame signal displays on the module. For revision of a flame safeguard control using the R7061 amplifier, use the W136 or a similar test meter. For replacement parts, see specifications section.

UV Sensor Tube Test

see UV sensor tube test section.

Unsatisfactory Flame Signal

If a satisfactory flame signal (see Table 1) cannot be obtained while adjusting the sighting position of the detector, follow these procedures. If you encounter other problems in the system, refer to the Troubleshooting section in the instructions for the appropriate flame safeguard control.

NOTE: For instructions for replacing the viewing window, sensing tube, and coil and shutter assembly, see the service section.

Troubleshooting Procedures

First perform the preliminary inspection. Then follow the applicable procedures for either a low reading or a zero reading on the meter. After reinstalling the detector or replacing its cover, recheck the meter reading. To try to obtain the proper flame signal, adjust the position of the detector. If you complete all of the procedures and still cannot obtain a proper flame signal, replace the detector.

Preliminary Inspection

A Check for the proper line voltage. Make sure the master switch is closed, connections are correct, and power supply is of the correct voltage and frequency.

B Check the detector wiring for defects:
   a. Incorrect connections.
   b. Wrong type or size of wire.
   c. Deteriorated wire.
   d. Open circuits.
   e. Short circuits.
   f. Leakage paths caused by moisture, soot, or dirt.

C With the burner running, check the temperature at the detector. If it exceeds 79°C (175°F):
   a. Add additional insulation between the wall of the combustion chamber and the detector.
   b. Add a shield or screen to reflect radiated heat away from the detector, or
   c. Add cooling (refer to sight pipe ventilation and accessories sections).

Removing the Detector from the Sight Pipe

C7061A:

Loosen the three screws holding the mounting flange together; rotate the detector slightly so the screws clear the slots in the back section of the flange; separate the flange; and pull off the back section (with the UV Sensor).

NOTE: The detector will be free as soon as the collar is unscrewed; do not drop it.

C7061F:

Carefull unscrew from sight pipe

Procedure for a Zero Meter Reading

A Replace the plug-in amplifier. Then recheck the flame signal.
B Replace the ultraviolet sensing tube (see Service section). Then recheck the flame signal.
C Replace the coil and shutter assembly (see Service below). Then recheck the flame signal.
D If you still cannot obtain a meter reading, replace the detector.

IMPORTANT

At the completion of troubleshooting, be sure to perform the adjustments and checkout procedures.

CAUTION

Open the master switch to disconnect power before removing or installing the detector or its cover. More than one disconnect can be involved.

Periodic Maintenance

A Clean the viewing window (or focusing lens) when necessary. Remove the detector (see Troubleshooting section) and use a clean cloth over the eraser end of a pencil. Do not remove the window (or lens) to clean it. If it is broken or damaged or it is coated with a substance that cannot be cleaned off, replace it (see Fig. 14).
B Keep the flame detection system adjusted for the smoothest, most reliable operation as recommended by the burner manufacturer.
C Replace the sensing tube, coil and shutter assembly, or viewing window only when necessary to obtain proper operation.

Removing the Detector Cover

Open the Master Switch

C7061A: Unscrew the four captive cover screws (Fig. 8 and 9) and carefully slide off the cover.
NOTE: These bolts are removable. Put them in a safe place to avoid losing them.

C7061F Carefully unscrew the cover from the detector cap.

Replacing the Ultraviolet Sensing Tube

A Open the master switch and remove the cover from the detector (see instructions above).
B Locate the UV sensing tube.

IMPORTANT
Be very careful not to kink or otherwise damage the flexible shutter.

C Gently bend the alignment guid just enough to free the tip of the tube.
D Insert a screwdriver between the tube base and socket, and gently pry the tube out of its socket.
E Pull the tube out of its socket.
F Insert the new tube through the openings in the shutter assembly.
G Align the three pins on the new tube with the holes in the socket.
H Carefully push the new tube firmly into the socket; the alignment guide will snap into place around the tip of the tube.
I Make sure the new UV sensor tube is seated securely.
J Replace the detector cover.

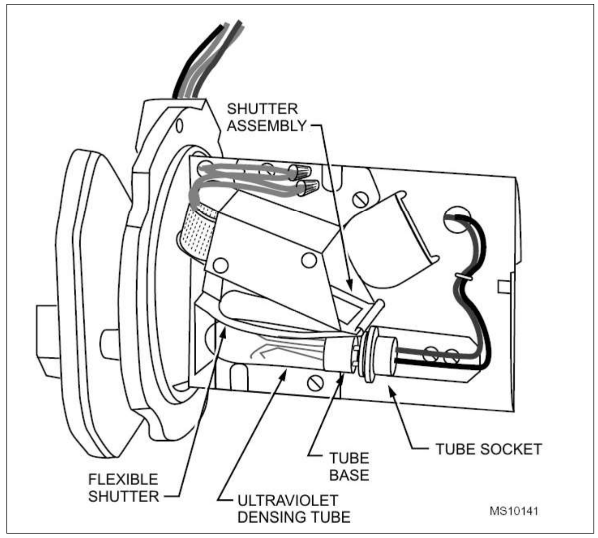


Fig. 12. Replacing ultraviolet radiation sensing tube.

Replacing the Coil and Shutter Assembly

NOTE: Use only a 190971 B coil and shutter assembly.

A Open the master switch and remove the detector cover (see Removing the Detector Cover section).
B Remove the ultraviolet sensing tube (steps A through E of Replacing the Ultraviolet Sensing Tube section).
C Cut the white wires as close as possible to the crimped connectors, and remove the crimped connectors.
D Remove the three mounting screws from the base of the coil and shutter assembly. Put the screws in a safe place.
E Remove the coil and shutter assembly.
F Put the new coil and shutter assembly into place.

IMPORTANT
Be very careful not to kink or otherwise damage the flexible shutter.

G Insert the three mounting screws into the base of the coil and shutter assembly and tighten securely.
H Remove sufficient insulation from each of the two white lead wires remaining on the detector, and also from each of the two white leadwires on the new coil.
I Using solderless connectors, connect one of the coil wires to one of the remaining white leadwires. Connect the other coil wire to the other remaining white leadwire.
J Reinstall the sensing tube (steps F through I of Replacing the Ultraviolet Sensing Tube section).
K Replace the detector cover.

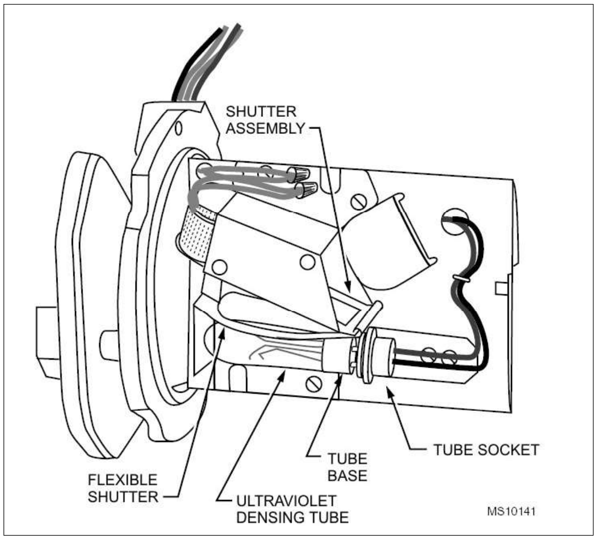


Fig. 13. Replacing coil and shutter assembly.

Replacing the Quartz Viewing Window (or Focusing Lens) C7061A Only

IMPORTANT
A quartz window or lens must be used. Ordinary glass absorbs or filters out ultraviolet radiation.

A Open the master switch; remove the detector from the sight pipe and remove the detector cover. (see appropriate sections.)
B Remove the ultraviolet sensing tube (steps A through E of Replacing the Ultraviolet Sensing Tube section).
C Loosen the three screws holding the back section of the mounting flange to the faceplate. Carefully remove and keep together the three screws, the gray asbestos- neoprene gasket, the red rubber washer, and the back section of the mounting flange.

NOTE: if the viewing window (with its rubber mounting gaskets) is stuck to the mounting flange. skip step D.

IMPORTANT
Be very careful not to kink or otherwise damage the flexible shutter.

D Using the eraser end of a pencil, push out the viewing window (with its rubber mounting gaskets) from the inside of the faceplate.
E Insert one rubber mounting gasket into the window aperture in the faceplate.
F Insert the new quartz viewing window (or focusing lens).
G Insert two rubber mounting gaskets (only one gasket when replacing a focusing lens) into the aperture.
H Put the back section of the mounting flange, rubber washer, and asbestos-neoprene gasket in place on the faceplate, and securely tighten the three mounting screws.

NOTE: Make sure the red rubber washer between the gray fiber-neoprene gasket and the back section of the mounting flange does not protrude over the window aperture or otherwise obscure the detector line-of-sight.

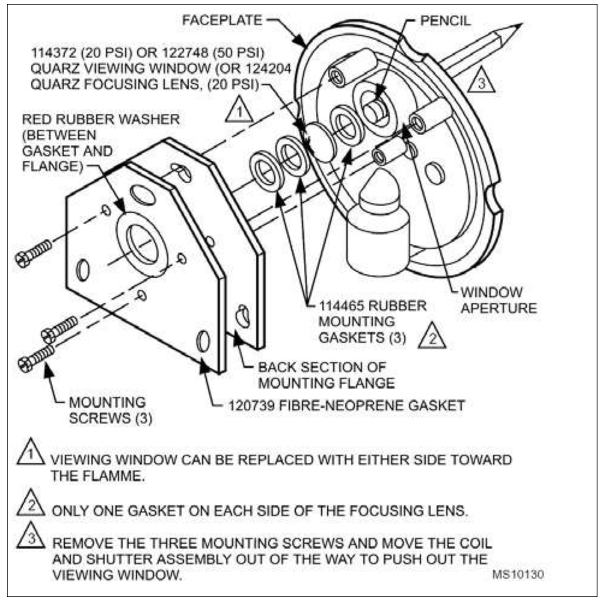


Fig. 14. Replacing quartz viewing window or focusing lens

I Clean the viewing window (or focusing lens) on both sides using a clean cloth placed over the eraser end of a pencil.
J Reinstall the sensing tube (steps F through I of Replacing the Ultraviolet Sensing Tube section).
K Replace the detector cover and reinstall the detector on the sight pipe.

Replacing Focusing Lens C7061F Only

IMPORTANT
A quartz window or lens must be used. Ordinary glass absorbs or filters out ultraviolet radiation.

A Remove the detector from the sight pipe (see Fig. 15).
B Remove the 3 screws from the threaded flange (pipe connection) which houses the 124204 Focusing Lens.
C Replace the lens and tighten the 3 screws.

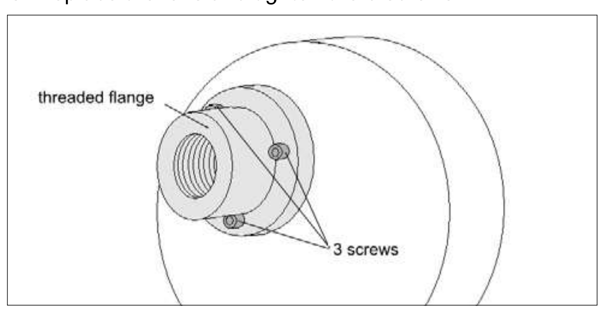


Fig. 15. Replacing focusing lens on C7061F1003

Honeywell

Honeywell Burner & Boiler Control Europe
Satronic AG
Honeywell-Platz 1
CH-8157 Dielsdorf
Switzerland
Phone +41 1 855 22 11
Fax +41 1 855 22 22

Flare

The Flare is designed and manufactured by Perennial Energy at our facilities in West Plains, Missouri. The data sheet in the earlier part of this submittal gives details on height, diameter and wall thickness. The Top Assembly drawing in the following drawing details the mounting feet, ladder, louvers, etc.

The burner assembly is based on the 30 year proven PEI design, and is constructed of stainless steel. It has a single burner port with a cast ceramic burner pot that provides outstanding performance on lean LFG. The burner pot is heavy and ships in a crate, therefore we also provide a lifting apparatus to lower this burner pot into place.

Typically as gas production declines the flare is challenged to maintain temperature. We are including a second 7” burner pot and a reducer spud to meet this challenge. Additionally, we have included a 2” aux fuel port, this is not required by the specification & may never be needed, however, it is trivial to include this during construction at the factory- adding this in the field 10 years in the future will be difficult & expensive. If this port is not needed it does no harm.

The flare stack is ASTM A36 carbon steel, ¼” thick. There are two lifting lugs, each is rated for the full weight of the flare. The maximum operational temperature of the flare is 2,000 F, and the maximum skin temperature is less than 250 F.

The flare has a floor that provides a 4” air gap above the concrete, and it is insulated with 3 layers of ceramic fiber totaling 4” thick. The layers are staggered, two 1” thick layers of 8# material are provided, and one 2” thick layer of 4# material are used. The insulation is held in place with Inconel pins & retainers. A layer of rigidizing agent is applied to the ceramic fiber.

The flare has a manway with 22” x 22” external dimensions. Five 2” view ports are provided, located so that they offer a view at the level of the thermocouples. Four thermocouple ports are provided for three Type K thermocouples (the lowest port is used at turn down). The flare has four EPA compliant source ports.

As noted in the initial comments, the flare burner has a 3” inlet flange, and is made from 304L stainless steel and has a single ceramic burner pot. The flare is provided with a pilot system as shown on the P&ID drawing.

Two motor operated louvers are provided for temperature control. Flare feet are as shown on the Top Assembly drawing. Three NEMA 4 junction boxes are provided on the flare- one for the 6000 volt ignition transformer, one for the 120 VAC connections, and one for the 24 VDC and thermocouple connections.

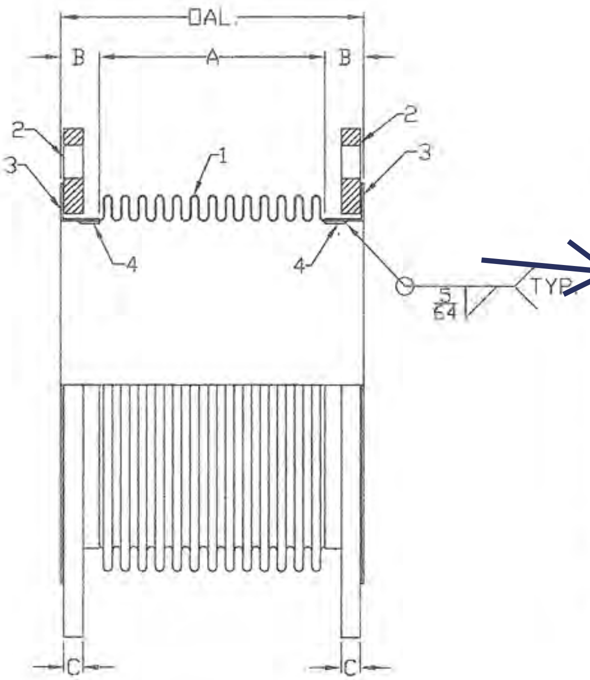
The flare is provided with a purge blower and proof of purge pressure switch.

The flare has an OSHA compliant ladder to service the thermocouples. Harness tie offs are provided at each thermocouple location.

Flex Connector

The flare is provided with a 3” diameter flex connection that is 6” long. This flex allows for pipe thermal expansion, movement, and slight misalignment. The flex reduces the loading on the aluminum housing of the flame arrester. The flex is manufactured by DME Expansion Joints, and is part FJ-300. The flanges on the flex joint are hot dipped galvanized steel, the bellows are stainless steel.

REV	DESCRIPTION	DATE	APPROVED



☐ WITH FLOW LINER
☐ WITHOUT FLOW LINER

MODEL #	SIZE	OAL	A	B	C	AXIAL	LATERAL	AXIAL SPRING RATE LB/INCH	LATERAL SPRING RATE LB/INCH
FJ-150	1.5"	6"	3.5"	1.25"	.50"	1.6"	.15"	141	72
FJ-200	2"	6"	4"	1.00"	.50"	1.6"	.062"	166	115
FJ-300	3"	6"	3.9"	1.05"	.50"	1.7"	.062"	238	351
FJ-400	4"	7"	5"	1.00"	.50"	2"	.062"	125	217
FJ-500	5"	8"	5.6"	1.2"	.50"	2.8"	.250"	127	204
FJ-600	6"	8"	6.3"	.85"	.50"	2.8"	.250"	146	321
FJ-800	8"	8"	6.75"	.625"	.50"	2.8"	.250"	141	531
FJ-1000	10"	8"	5.67"	1.16"	.50"	2.7"	.250"	199	1140
FJ-1200	12"	9"	5.67"	1.66"	.50"	3.2"	.250"	212	1221
FJ-1400	14"	9"	6.3"	1.35"	.50"	2.8"	.125"	193	1851
FJ-1600	16"	9"	6"	1.5"	.50"	2.8"	.125"	216	2645

FROM FJ-150 TO FJ400 BELLOWS 2 PLY X .010" THK.

FROM FJ-500 TO FJ1600 BELLOWS 2 PLY X .015" THK.

ADD -L AT THE END OF PART NUMBER FOR DROP-IN FLOW LINER.

ITEM	QTY	DESCRIPTION	MATERIAL
1	1	BELLOWS, -- I.D. X -- PLY --" THK.	A 240 T-321
2	2	FLANGE, FLOATING, --" -125/150# X 1/2" THK.	HOT DIP GALVANIZED
3	2	VANSTONE STUB, --" PIPE BOS. X .050" THK.	A 240 T-321
4	2	INTERNAL BAND, 1/2" WIDE X .062" THK.	A 240 T-321

ALL DIMENSIONS ARE IN INCHES.

GENERAL NOTES:
1. DESIGN AND FABRICATE IN ACCORDANCE WITH THE EJMA STANDARDS (EXPANSION JOINT MANUFACTURER'S ASSOCIATION).
2. WELDING SHALL BE IN ACCORDANCE WITH ASME SECTION IX.
3. COMPLETED ASSEMBLY SHALL BE CLEAN AND FREE OF ALL LOOSE FOREIGN MATTER.
4. SHIPPING BARS SHALL BE EQUALLY SPACED, PAINTED YELLOW AND TAGGED "REMOVE AFTER INSTALLATION."

DESIGN SPECIFICATIONS

DESIGN PRESS:	30 PSIG	NON-CONCURRENT MOVEMENTS	
DESIGN TEMP:	450°F	COMPRESSION:	±--
MEDIA:	—	EXTENSION:	—
CYCLE LIFE:	2000	LATERAL OFFSET:	--
TEST:	NONE	ANGULAR:	--
TEST PRESS.		AXIAL SPRING RATE:	--LBS/IN
APPROX. WEIGHT:	--LBS	LATERAL SPRING RATE:	--LBS/IN

TOLERANCES: UNLESS OTHERWISE SPECIFIED TOLERANCES ARE AS FOLLOWS:
EXP. JOINTS: OAL ± 1/8" UP THRU 36", ± 1/4" 36" THRU 144", ± 3/8" OVER 144"
HOSE ASSY. OAL ±1/8" PER FT.
OUT OF ROUNDNESS: MEASURED DIFFERENCE BETWEEN MAJOR & MINOR DIA: 1% MAX.
FRACTIONS: ±1/8"; DEC. XX: ±.03"; DEC. XXX: ±.010"; ANGLE: ±2°; DIAMETRICAL: ±5% OT O.D.

DESIGNED BY: A.A.
DRAWN BY: L.T.
CHECKED BY:
SALESMAN:
QC #:
THIRD ANGLE PROJECTION

DME
14001 MARQUARDT AVE.
SANTA FE SPRINGS, CA 90670
TEL: 562-921-0464 FAX: 562-802-7489

DESCRIPTION: EXPANSION JOINT
CUSTOMER: PERENNIAL ENERGY LLC
JOB NUMBER: --
DWG NO.: FJ
ORIG. DATE: 10-07-2015
CURR. DATE: 10-08-2015
SHEET: 1 OF 1
REV: 0
SCALE: NTS

Z:\FJ\FJ-400 REV 0 NEW BLOCK.dwg, 10/24/2015 8:03:19 AM, BY LT

Two pressure gauges are provided.

Pressure Gauge FLR-PI-101 is in the pilot line & is used to measure the propane pressure at the pilot. It is scaled 0-30” WC and is a WIKA 611.10. This gauge is tagged FLR-PI-101.

The pressure before and after the flame arrester is measured with a Dwyer Capsuhelic Pressure Gauge, scaled 0-20” WC. It is part number 2020LT. The tag for this pressure gauge is FLR-PI-301.

FLR-PI-101
Part # 611.10
Scaled 0-30" WC

Low Pressure Capsule Gauges
Type 611.10, Standard Design, Copper Alloy Wetted Parts
Type 631.10, Stainless Steel Wetted Parts

Applications

- Low pressure gauge for applications in a controlled environment
- Ideal for measuring pressure, vacuum in medical, environmental, and laboratory applications for content and filter monitoring
- For gaseous, dry and non-aggresive media
- Model 631.10 also suited for aggresive (dry) media

Capsule Pressure Gauge Model 611.10

Product Features

- Front zero adjustment
- Special connections on request
- Scale ranges from 0/10 InWC (25 mbar)

Specifications

Design
Per EN 837-3

Nominal size
2” (50 mm), 2½” (63 mm)

Accuracy
± 1.6 of full scale value

Standard ranges
2”: 0...25 InWC (60 mbar) to 0...250 InWC (600 mbar)
2½”: 0...10 InWC (25 mbar) to 0...250 InWC (600 mbar)
or all other equivalent vacuum or combined pressure and vacuum ranges

Standard scales
InH_2O/mmH_2O
$oz/sq.in/mmH_2O$
$oz/sq.in/InH_2O$
PSI

Pressure limitation
Steady: full-scale value
Fluctuating: full-scale value

Permissable temperature
Ambient: -4 °F... +140 °F (-20 °C... +60 °C)
Media: +212 °F (5100 °C) maximum

Temperature error
Additional error when temperature changes from reference temperature of 68 °F (20 °C) ± 0.5% of span for every 18 °F (10 °K) rising or falling

Ingress protection
NEMA 2 (IP 32 per EN 60529 / IEC 529)

Process connection
Model 611.10: copper alloy
Model 631.10: Stainless steel
Lower mount (LM) or back mount (CBM)
2” back mount only
¼” NPT male (14 mm wrench flats)

Process element
Model 611.10: copper alloy
Model 631.10: Stainless steel

Sealing
NBR

Movement
Copper alloy

Zero adjustment
At the front

WIKA®

Dial
Aluminum, white, black lettering

Pointer
Aluminum, black

Case
Steel, black

Window
Clear plastic

Options
- Other process connection
- Stainless steel case
- Overpressure and vacuum safety with
  scale ranges < 16 InWC (40 mbar): 3X full scale value
  scale ranges ≥ 16 InWC (40 mbar): 10X full scale value
- Slip-on bezel [1)]
- Triangular bezel with clamp [1)]

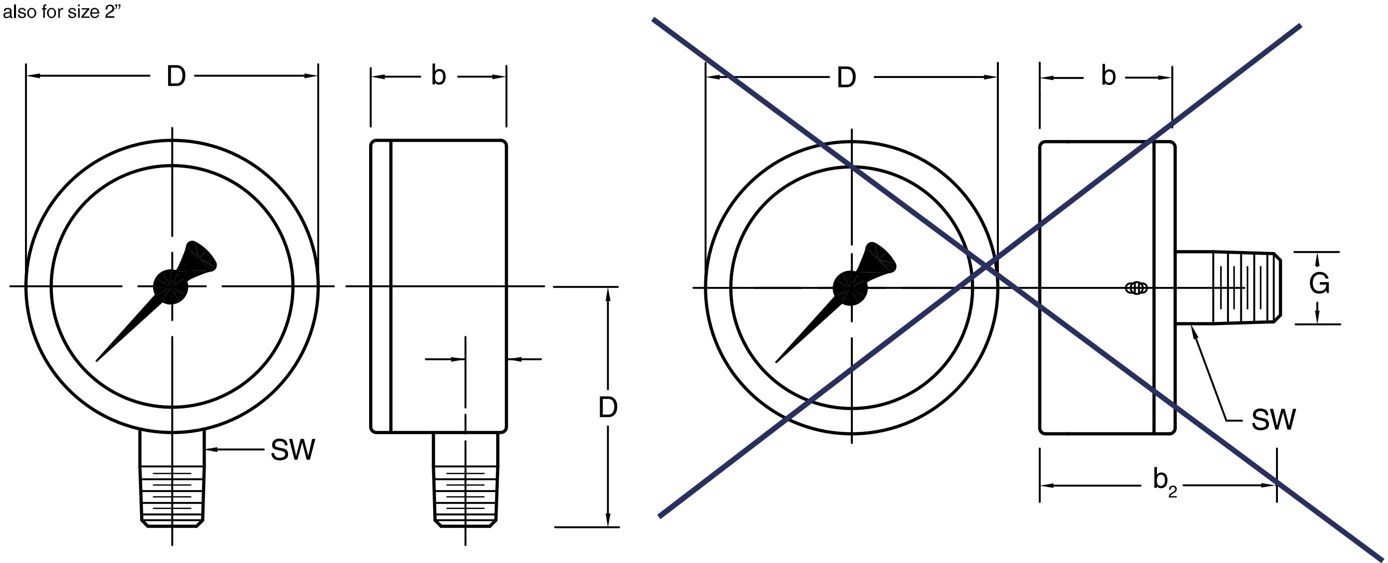
[1)] also for size 2"

Approvals
- **GOST,** metrology/measurement technology, Russia
- **GOST R**, import certificate, Russia

Certicates [2)]
- 2.2 test report per EN 10204 (e.g. state-of-the-art manufacturing, material proof, indication accuracy)
- 3.1 inspection certificate per EN 10204 (e.g. material proof for wetted metallic parts, indication accuracy)

[2)] Option

Approvals and certificates - see website



Size	Dimension in inches								Weight in LBS
	a	b	b_1	b_2	D	G	h + 1	SW	
2"	-	-	1.10	1.89	50	1/4" NPT	-	.55	0.20
2½"	.37	1.57	1.44	2.19	63	1/4" NPT	2.00	.55	0.44

Ordering information
Model / Connection location / Wall mount or panel mount / Inner dimensions of the threaded pressure connection / Scale range / Options

Ordering information
Pressure gauge model / Nominal size / Scale range / Size of connection / Optional extras required
Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing.
Modifications may take place and materials specified may be replaced by others without prior notice.

Recommended panel cut-out: D + 1mm

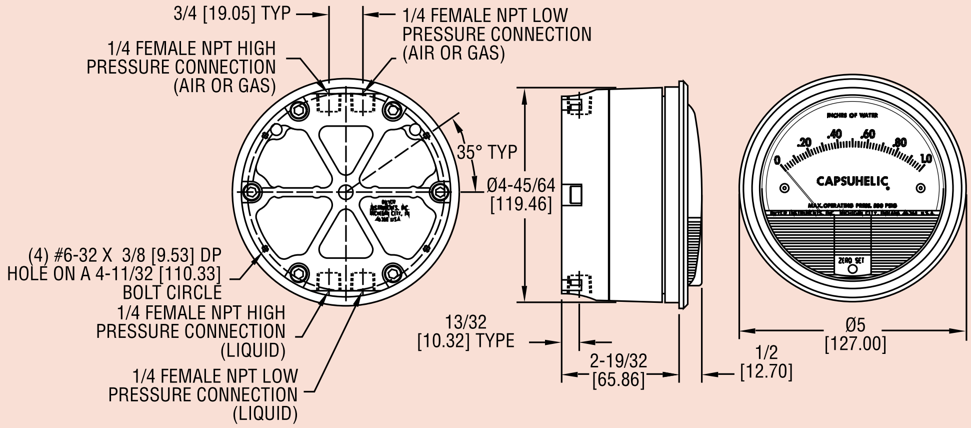
WIKA Instrument, LP
1000 Wiegand Boulevard
Lawrenceville, GA 30043-5868
Tel: 888-WIKA-USA • 770-513-8200
Fax: 770-338-5118
E-Mail: info@wika.com
www.wika.com

FLR-PI-301
Part # 4020LT with A-370 mount.

Series 4000

Capsuhelic® Differential Pressure Gages

Measures Pressure, Vacuum or Differential, Suitable for Internal Pressures to 500 psig



Capsuhelic® Pressure Gage has a large, easy-to-read 4" (102 mm) dial.

The Capsuhelic® gage is designed to give fast, accurate indication of differential pressures. The gage may be used as a readout device when measuring flowing fluids, pressure drop across filters, liquid levels in storage tanks and many other applications involving pressure, vacuum or differential pressure.

Using the basic design of Dwyer's time-proven Magnehelic® gage, the Capsuhelic® gage contains a simple, frictionless movement that permits full scale readings as low as 0.5 in w.c. The pressure being measured is held within a capsule which is an integral part of the gage. This containment of the pressure permits the use of the gage on system pressures of up to 500 psig, even when differentials to be read are less than 0.1 in w.c.

The diaphragm-actuated Capsuhelic® gage requires no filling liquid which might limit its outdoor applications. Zero and range adjustments are made from outside the gage, and there is no need to disassemble the gage in normal service.

Note: May be used with hydrogen where pressures are less than 35 psi. Order with a Buna-N diaphragm.

SPECIFICATIONS

Service: Aluminum case: Air and compatible gases and oil based liquids; Brass case: Air and compatible gases and water based liquids.
Wetted Materials: Consult factory.
Housing: Die cast aluminum with impregnated hard coating, standard. Optional forged brass housing is required for water or water based fluids. Special material diaphragms available, contact factory.
Accuracy: ±3% of FS at 70°F (21.1°C). (±4% on 4200, 4210, 4215, 4220, 4300, 4400, and 4500).
Pressure Limits: -20˝ Hg to 500 psig. (-0.677 bar to 34.4 bar).
Temperature Limits: 20 to 200°F (-6.67 to 93.3°C).
Size: 4˝ (101.6 mm) diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/4˝ female NPT high and low pressure taps, duplicated - one pair top for air and gas, and one pair bottom for liquids.
Weight: 3 lb, 3 oz (1.45 kg) aluminum case; 7 lb, 13 oz (3.54 kg) brass case.
Standard Accessories: Two 1/4˝ NPT plugs for duplicate pressure taps, four flush mounting adapters with screws and four surface mounting screws.

MOUNTING

Capsuhelic® gages may be flush mounted in a panel or surface mounted. Hardware is included for either. For flush mounting, a 4-13/16˝ diameter cutout in panel is required. Where high shock or vibration are problems, order optional A-496 Heavy Duty flush mount bracket. Optional A-610 kit provides simple means of attaching gage to 1-1/4˝-2" horizontal or vertical pipe. Installation is same as Magnehelic® gage shown on page 4. All standard models are calibrated for vertical mounting. Gages with ranges above 5 in w.c. can be factory calibrated for horizontal or inclined mounting on special order.

Flush mounted in panel.

Back view shows flush mounting adapters.

Back view for surface mounting.

OPTIONS & ACCESSORIES

Adjustable Signal Flag
Integral with plastic gage cover; has external reset screw. May be ordered factory installed on gage or separately for field installation. Specify ASF suffix after model number.

A-314 Bleed Fitting
For easier, safer purging of trapped air when using gage with liquids. Also useful for draining condensate when installed in lower ports. To open, simply loosen hex nut. Solid brass.

Forged Brass Case
For applications involving water or water based liquids. To order, add suffix "B" after model number. Example: 4205B.

Transparent Scale Overlays
Available in bright red, green or yellow to accent critical pressure zones. Specify which color and portion of scale to be covered with each.

A-471 Portable Kit
Includes plastic case, mounting bracket, A-309 3-way manifold valve, (two) A-230 high pressure hoses and all necessary fittings. Assembly required. Gage not included.

Straightforward design assures maintenance-free performance

Top low pressure connection (*for Air or Gas*) connects to chamber in back of diaphragm. High pressure air or gas port (cut away; not shown) connects with chamber in front of diaphragm through passageways in case.

Precision made case is offered in two materials. Standard is die cast aluminum coated inside for resistance to most oils and similar fluids. Optional forged brass case is recommended when using water or water based liquids. One case size for all pressure ranges — can be either surface or flush mounted.

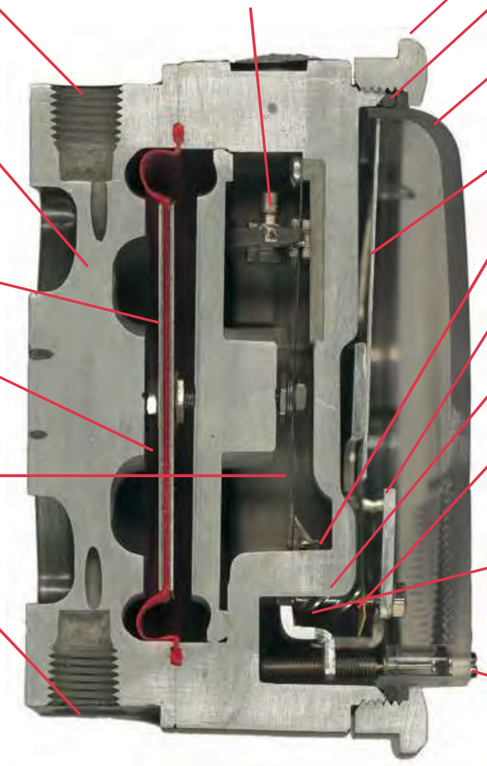
Silicone rubber diaphragm with integrally molded O-ring is sealed between the case and backplate. Diaphragm motion is restricted to prevent damage due to over-pressure.

Diaphragm support plate of stainless steel minimizes position or attitude sensitivity.

Calibrated range spring is a flat leaf of nickel plated spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length factory adjusted for calibration.

Bottom high pressure connection *(for Liquids)* connects to chamber in front of diaphragm. Low pressure liquid connection (not visible) connects with chamber in back of diaphragm through passageways in case.

Range spring calibration is set by custom camlock. Rate adjust and rate adjust lock are coaxial and are factory set and sealed.



Bezel provides flange for flush mounting in panel.

O-ring seal for cover assures dust tight integrity of case.

Clear plastic front cover is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision scale, screen printed on aluminum, is accurate and easy to read.

Samarium cobalt magnet mounted at end of range spring rotates helix without mechanical linkages.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Thin wall magnetic "window" is well braced and of minimum area for maximum pressure capability.

Jeweled bearings for helix are shock resistant mounted. They provide virtually friction-free rotation for helix. Rotation is damped with high viscosity silicone fluid.

Helix is precision milled from an alloy of high magnetic permeability, mounted in jeweled bearings, and rotates to align with magnetic field of magnet and transmit pressure indication to pointer.

Zero adjustment screw is conveniently located in plastic cover, accessible without removing cover. "O" ring seal provides dust seal.

Series 4000 Capsuhelic® Gage
Scales reading directly in flow, heights, etc., are also available.

Model	Range, Inches of Water	Model	Range Zero Center Inches of Water
***4005**	0-5.0	**4310**	5-0-5
***4006**	0-6.0	**4330**	15-0-15
***4010**	0-10	**Model**	**Range PSID**
***4015**	0-15		
***4020**	0-20	**4205**	0-5
***4025**	0-25	**4210**	0-10
***4030**	0-30	**4215**	0-15
***4040**	0-40	**4220**	0-20
***4050**	0-50		
***4060**	0-60		
***4080**	0-80		
***4100**	0-100		
***4200**	0-200		

*These ranges available for vertical scale position only.

ACCESSORIES
A-298, Flat Flush Mounting Bracket
A-309, 3-way Manifold Valve
A-314, Bleed Fitting
A-370, Mounting Bracket
A-471, Portable Kit
A-496, Flush Mount Bracket
A-610, Pipe Mount Kit

OPTIONS
Add Options as Suffix, Example 4001-ASF
-ASF (Adjustable Signal Flag)
B (Brass Case)
Scale Overlays - Red, Green, Mirrored or combination. Specify Locations

The flare pilot assembly is manufactured by Perennial Energy. The pilot may be removed for service while the flare is running. The pilot assembly is shipped assembled and on the flare, except the ceramic burner pot and ignitor are shipped in a crate for protection.

The pilot itself consists of a gas orifice, a burner tile, a gas mixer, and an ignitor (spark plug). An electrically operated solenoid valve controls the flow of gas to the orifice, and a propane pressure regulator is provided to control the gas pressure. A spark generator provides the power for the ignitor. An ignition cable (spark plug wire) connects the spark generator to the ignitor. Two flex hoses are provided as shown on the P&ID.

The Ignition cable is tagged FLR-CBL-1, and is Allied Wire & cable part # 3257-14, it is rated for 25,000 volts.

The Spark Generator is a Honeywell Q624A1014, and is tagged FLR-E/E-1. This spark generator is specifically designed to work with the Purple Peeper, as the spark from this generator does not produce false positive flame signals. Honeywell states the spark generator produces 15,000 Volts.

The Propane solenoid is tagged FLR-FV-101, and is an Asco EF8215G20.

The stainless steel flex connectors are made by Hose Master, the flex connected to the pilot is 1/2:" diameter by 12" long, it is tagged FLR-FX-101, and is part # CA321B0050-012-AF4750. The flex at the inlet to the pilot system is tagged FLR-FX-102, is 18" long, and is part # CA321B0050-018-AF4750.

The Ignitor (spark plug) is an Auburn I-64-3 that is modified by PEI, and is tagged FLR-IGN-1.

The pressure regulator is tagged FLR-PCV-101, and is a Fisher R622.

FLR-CBL-1

Ignition Wire (UL 3257)

Ignition Wire, UL 3257 Hook Up Wire
Silicone Rubber Wire
UL Recognized Lead Wire

RoHS Compliant

Ignition Wire Construction:

- **Conductor:** Stranded nickel plated copper
- **Insulation:** Extruded SR, silicone rubber (78 mils min average, 70 mils minimum at any point to meet UL Style 3257)
- **Insulation Color:** Red
- **Sizes:** Available in sizes ranging from 22 AWG - 12 AWG

Ignition Wire Ratings and Approvals:

- **Temperature Rating:** -80°C to 250°C
- **Voltage Rating:** 10KV AC, 25KV DC
- **Flame Resistance:** Passes UL Horizontal Flame Test
- **UL Recognized:** meets UL 3257 specification
- **UL Appliance Wiring Material** (AWM wire) under UL 758 standard

Ignition Wire Applications:

- UL 3257 wire may be used for internal wiring in gas-fired heaters and furnaces where it is protected from damage during handling, installation, and servicing. This UL approved wire may also be used in oil-burner ignition circuits and gas appliance ignition systems where it is not subject to repeated flexing.

Part Number: 3257-14

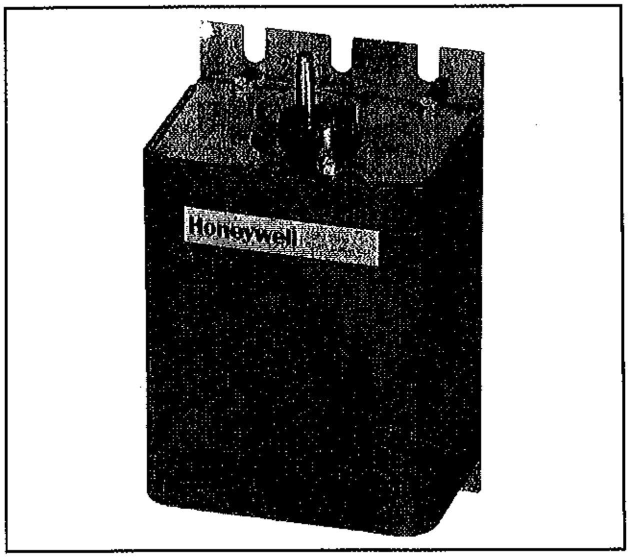
AWG Size	14
Conductor Stranding	41/30
No. of Strands	41
Strand Size	30
Nom. Insul. Thick. (in)	.078
Nom. O.D. (in)	0.2360
UL Style	3257
Nom. Dia. of Cond.	.080
Approx LBS/MFT	34.00
Min. Temp	-80°C
Max. Temp	250°C
Cond. Material	Nickel-Plated Copper
Insul. Material	Silicone Rubber
Voltage	25000

FLR-E/E-1

Honeywell

Q624A Solid State Spark Generator

PRODUCT DATA



FEATURES

- Ignites gas pilots with spark gaps up to 1/4 inch (6 millimeters) in length.
- 15,000 volts peak voltage for reliable lightoff.
- Prevents detection of the ignition spark when properly applied in a flame detection system with the C7027,C7035, or C7044 Minipeeper® or C7061 Dynamic Self-Check Ultraviolet Flame Detector.
- Ignition spark and ultraviolet detector are synchronized by the alternating current supply voltage; spark occurs on one half of the ac cycle and detector operates on the opposite half cycle.
- Recommended for interrupted ignition applications only.
- Mounts in the same space used by conventional ignition transformer.
- Q624 mounting holes are the same as standard transformers; no adapter plate needed.
- Impervious to humidity up to 95 percent relative humidity.
- Weighs 3 pounds (1.4 kilograms) versus 8-1/2 pounds (3.9 kilograms) for standard transformers.

APPLICATION

The Q624A is a solid state spark generator (transformer) for use on commercial or industrial gas burners.

SPECIFICATIONS

IMPORTANT
The specifications given in this publication do not include normal manufacturing tolerances. Therefore, this unit may not match the listed specifications exactly. Also, this product is tested and calibrated under closely controlled conditions, and some minor differences in performance can be expected if those conditions are changed.

Models:
Q624A1014 with threaded terminal nut high voltage electrode.

Electrical Ratings:
Voltage and Frequency: 120 Vac, 50/60 Hz.
Output Voltage: 10,000 volts.

Primary VA Rating: 66 VA at 120 Vac.

Spark Characteristics:
Firing Rage: 60 sparks per second.
Voltage, peak-to-peak: 22,000 volts nonsinusoidal.
Firing cycle peak voltage: 15,000 volts ±500 volts, open circuit.
Energy Discharge: 200 millijoules per spark.
Discharge Time: 0.3 milliseconds per spark.
Power Dissipation: approximately 12 watts per second.

Maximum High Voltage Lead Length: 15 ft. (4.6 m)

Maximum Spark Gap: 1/4 in. (6 mm).

Ambient Temperature Range: -40°F to +125°F (-40°C to +52°C).

Maximum Ambient Humidity: 95 percent RH.

Type of Service: All types of gas ignition; not recommended for use when igniting oil.

Mounting: Surface.

Dimensions: See Fig. 1.

Weight: 3 lb. (1.4 kg).

Approvals:
Underwriters Laboratories Inc. Component Recognized: File No. MH7453, Guide No. JHYR2; tested and accepted for use in ambient temperatures ranging from -40°F to + 125°F (-40°C to +52°C).
Canadian Standards Association Certified: File No. LR95329.

Accessories:
C7005 Gas Pilot, with ignition electrode.
Q179 Gas Pilot, with ignition electrode.
134666 Insulator; may be used to cover terminal, to prevent contamination, and to give added terminal protection.
32004766-001 24 in. (610 mm) Ignition Cable Assembly.
32004766-002 120 in. (3.05 m) Ignition Cable Assembly.
32004766-003 Ignition Cable (per foot, specify required length).
32004766-004 60 in. (1.52 m) Ignition Cable Assembly.
Cable should be rated for 25kV at 482°F (250°C).

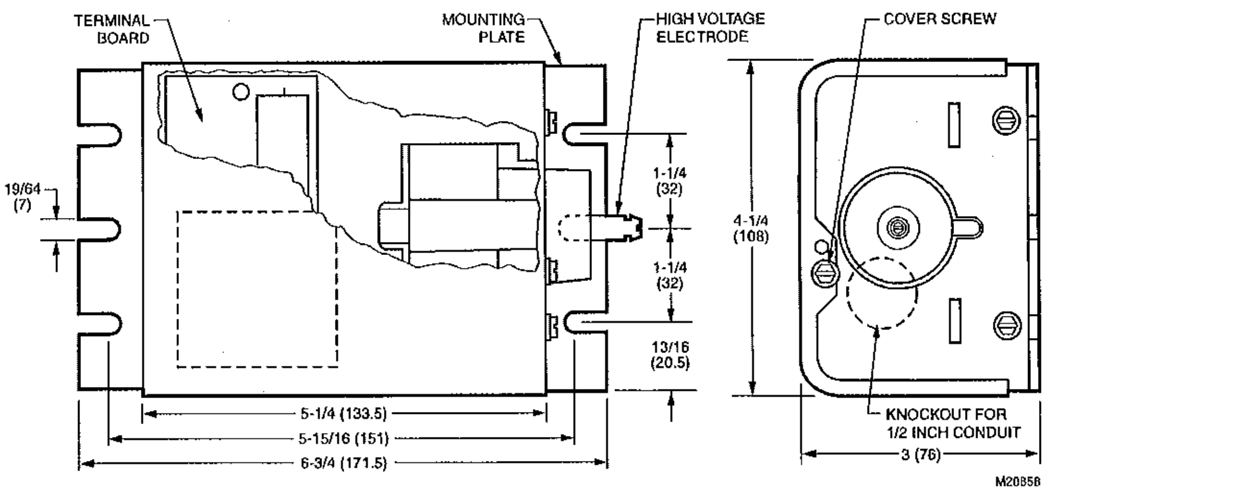


Fig. 1. Q624A Solid State Spark Generator dimensions in in. (mm).

INSTALLATION

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, flame safeguard control technician.
4. After installation is complete, check out product operation as provided in these instructions.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:
1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Toronto, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

WARNING

Electrical Shock Hazard.
Can cause serious injury, death or property damage.
Disconnect power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be required.

CAUTION

Equipment Damage Hazard.
Improper grounding can damage equipment.
Be sure that the mounting chassis of the Q624A is properly grounded at all times, even during bench testing. Otherwise, device may burn out.

Mounting

The Q624A mounts in the same space required by a standard ignition transformer, using the same mounting holes. It may be mounted in any position.

WIRING

WARNING

Electrical Shock Hazard.
Can cause serious injury, death or property damage.
Disconnect power supply before beginning wiring to prevent electrical shock and equipment damage. More than one disconnect may be required.

1. All wiring must comply with applicable local electrical codes, ordinances and regulations.
2. Voltage and frequency of the power supply connected to theQ624A must be 120 Vac, 60 Hz.
3. Be sure the mounting chassis of the Q624A is properly grounded.

IMPORTANT

When connecting wires to the screw terminals of the Q624A, wrap the wire 2/3 to 3/4 of the distance around the screw without overlapping (see Fig. 2). Use an appropriately sized screwdriver to securely tighten the screw (at least 12 inch-pounds of torque). Do not use a push-type ratchet screwdriver.

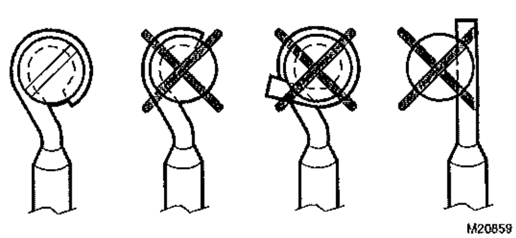


Fig. 2. Correct and incorrect wire wraps around terminal screws.

1. Loosen the cover screw (FIg. 1) and remove the cover.
2. Insert two leads (NEC CLass 1) through the 1/2 in. (13 mm) conduit knockout (Fig. 1) and connect them to the screw terminals on the terminal board, and to the terminal strip or wiring subbase of the flame safeguard control (see Table 1 and Fig. 3 or 4).
3. Replace the cover and tighten the cover screw.
4. Connect the high voltage electrode (Fig. 1) to the ignition electrode on the pilot burner, using the appropriate Ignition Cable Assembly or Ignition Cable (see Accessories in the Specifications section).

IMPORTANT

The ignition cable should not exceed 15 feet (4.6 meters) in length.

To ground the Q624 to the burner assembly:
1. Use a No. 16 or No. 18 wire.
2. Attach one end of the wire to the Q624 ignition transformer end (GND).
3. Wrap the wire around the igniter (high tension) lead as shown in Fig. 3. Four or five wraps are sufficient.
4. Connect the other end of the wire to the burner assembly (GND).

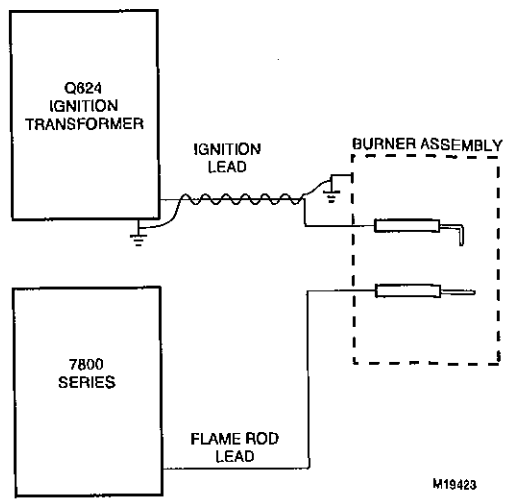


Fig. 3. Grounding the Q624 to the burner assembly.

WARNING

Fire or Explosion Hazard.
Can cause serious injury, death or property damage.
If flame detector and ignition transformer are not properly connected, detector may sense ignition spark, which could open a main gas valve and cause a hazardous condition.

Wiring of terminals T1 and T2 on the Q624A to the proper terminals of the flame safeguard control must be in accordance with Table 1.

Table 1. Wiring Connections.

Flame Safeguard Control Model	Q624A Terminal	Flame Safeguard Control Terminal
RA890G and R4795	T1 T2	4 L2
R4126, R4127, R4140, and BC7000	T1 T2	Appropriate ignition terminal as specified on programmer instruction sheet. L2
R4150	T1 T2	L2 Appropriate ignition terminal as specified on programmer instruction sheet.
RM7800	T1 T2	10 L2

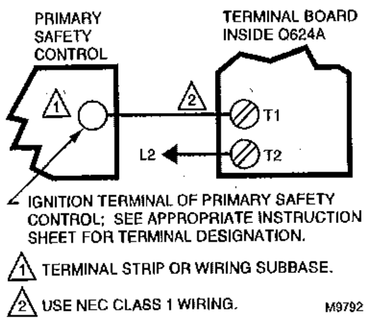


Fig. 4. Q624A connections for RA890G, R4795, R4126, R4127, R4140, BC7000 and 7800 SERIES flame safeguard controls.

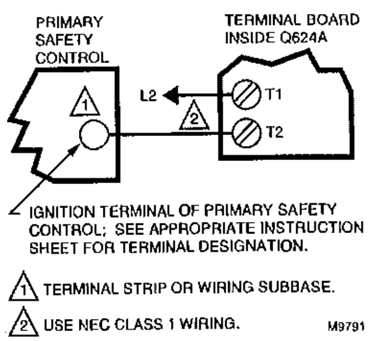


Fig. 5. Q624A connections for R4150 flame safeguard control.

CHECKOUT

After the Q624A installation and wiring has been completed, make the following checks to ensure that the system is working properly.

Ignition Spark Response Test

The flame relay should not respond (pull in) to ignition spark. To determine flame detector sensitivity to ignition spark, perform the following steps:

1. Shut off the fuel supply to both pilot and main fuel valves manually.
2. Start system by raising the controller set point or by pressing the Start button.
3. Energize the Q624A Solid State Spark Generator so ignition spark is produced between electrode and ground.
4. Check to be sure that ignition has not occurred (there should be no flame). Repeat steps 1 through 3 above until there is no flame.
5. Check the flame relay on the flame safeguard control. If the relay has not pulled in, the system is operating properly. Continue checkout with the pilot turndown test.
6. If the flame relay pulls in, stop the system, replace the Q624A, and repeat steps 2 through 5.
7. If the flame relay pulls in after replacing the Q624A, stop the system, replace the flame safeguard control, and repeat steps 2 through 5.
8. If the flame relay pulls in after replacing the flame safeguard control, contact the local Honeywell branch office.

Pilot Turndown Test

Refer to the flame safeguard control instructions for the exact procedure to be used in performing the pilot turndown test.

Final Checkout

After other checks have been completed, restore the system to normal operation and observe at least one complete cycle of operation to be sure of satisfactory burner operation.

Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9

Honeywell

60-2049—08 M.S. Rev. 02-09

Printed in U.S.A. on recycled paper containing at least 10% post-consumer paper fibers.

FLR-FV-101
Part # EF8215G20

ASCO RedHat

Direct Acting or Piloted

Aluminum Body Solenoid Valves

1/8" to 3" NPT

2/2 SERIES 8040 8215

2-WAY

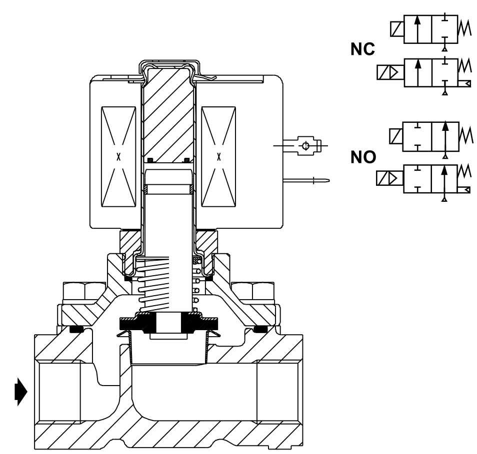
Features

- Lightweight, low-cost valves for air service
- Ideal for low pressure applications
- Provides high flow, Cv up to 138 (Kv 118)
- Air and vacuum service

Construction

Valve Parts in Contact with Fluids	
Body	Aluminum
Seals, Diaphragms, Disc	NBR
Disc-Holder	PA (10.1 and 11.6 watt Normally Open only)
Core Guide	POM
Core Tube	305 Stainless Steel
Rider Rings	PTFE
Core and Plugnut	430F Stainless Steel
Springs*	302 Stainless Steel
Shading Coil	Copper

* For 8040H006, 8040H007, 8040H008, spring material is 17-7 PH



8040

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part No.			
	DC	AC			General Purpose		Explosionproof	
	DC Watts	Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	-	6.1	16	40	238210	-	238214	-
F	11.6	10.1	25	70	238610	238710	238614	238714
F	15.8	15.4	27	160	99257	501695	99257	501696
F	-	28.2	50	385	206409	-	206409	-

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz), 6, 12, 24, 120, 240 volts DC. Must be specified when ordering. Other voltages available when required. (Note: 24 volt AC, 60 Hz not available with 28.2 watt coil)

Solenoid Enclosures

Standard: RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X; RedHat - Type I.

Optional: RedHat II - Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9; RedHat - Explosionproof and Raintight, Types 3, 7, and 9. (Except EF8215A40 and EF8215A90, which are suitable for Types 3 and 7 (C and D) only and have a T2B temperature rating code.)
To order, add prefix "EF" to catalog number.

See Optional Features Section for other available options.

Nominal Ambient Temp. Ranges

Series	AC	DC
	RedHat II/RedHat	RedHat II
8040	-40˚F to 125˚F (-40˚C to 52˚C)	-
8215	32˚F to 125˚F (0˚C to 52˚C)	32˚F to 104˚F (0˚C to 40˚C)

Refer to Engineering Section for details.

Approvals:

CSA certified to:

8040 Series:

1) Standard C22.2 No. 139 "Electrically Operated Valves," File 10381.
2) Automatic Gas Valves Z21.21 (6.5) C/I, File 112872.
3) Automatic Gas Safety Shutoff Valves (3.9), File 112872.

8215 Series Normally Closed:

1) Standard C22.2 No. 139 "Electrically Operated Valves," File 10381.
2) Automatic Gas Valves Z21.21 (6.5) C/I, File 112872.

8215 Series Normally Open:

1) Standard C22.2 No. 139 "Electrically Operated Valves," File 10381.

UL listed, as indicated. FM approved (Normally Closed only, except Catalog Numbers 8215A090, 8215A040 8215G001, 8215G002, and 8215G003). RedHat II meets applicable CE directives.

Refer to Engineering Section for details.

ASCO®

Specifications (English units)

Pipe Size (in)	Orifice Size (in)	Cv Flow Factor	Gas Capacity Btu/hr ⑥	Operating Pressure Differential (psi) Min.	Max. AC Air-Fuel Gas	Max. DC Air-Fuel Gas	Max. Fluid Temp. °F AC	Max. Fluid Temp. °F DC	Aluminum Body Catalog Number	Const. Ref. AC	Const. Ref. DC	UL ⑤ Listing	Watt Rating/Class of Coil Insulation ② AC	Watt Rating/Class of Coil Insulation ② DC
NORMALLY CLOSED (Closed when de-energized)														
1/8	5/16	1.0	53,700	0	15	-	125	-	8040H006 ⑩	11		❍	6.1/F	-
1/4	5/16	1.1	59,000	0	15	-	125	-	8040H007 ⑩	11		❍	6.1/F	-
3/8	5/16	1.2	64,400	0	15	-	125	-	8040H008 ⑩	11		❍	6.1/F	-
3/8	3/4	3.4	183,000	0	50	25	125	104	8215G010 ⑩	2		❍	10.1/F	11.6/F
3/8	3/4	3.5	-	5	125	125	125	104	8215G001 ①	1		❍	6.1/F	11.6/F
1/2	3/4	5.4	291,000	0	2	-	125	-	8040G022 ⑩	13A		❍	10.1/F	-
1/2	3/4	4.4	238,500	0	50	25	125	104	8215G020 ⑩	2		❍	10.1/F	11.6/F
1/2	3/4	4.8	-	5	125	125	125	104	8215G002 ①	1		❍	6.1/F	11.6/F
3/4	3/4	9.5	512,000	0	2	-	125	-	8040G023 ⑩	13B		❍	10.1/F	-
3/4	3/4	5.1	247,500	0	50	25	125	104	8215G030 ⑩	4		❍	10.1/F	11.6/F
3/4	3/4	5.1	-	5	125	125	125	104	8215G003 ①	3		❍	6.1/F	11.6/F
1	1 5/8	21	1,119,000	0	25	-	125	-	8215B050 ③	6		❍	15.4/F	-
1	1 5/8	21	1,119,000	0	-	25	-	104	8215G050 ③⑧⑨	16		❍	-	15.8/F
1 1/4	1 5/8	32	1,730,000	0	25	-	125	-	8215B060 ③	6		❍	15.4/F	-
1 1/4	1 5/8	32	1,730,000	0	-	25	-	104	8215G060 ③⑧⑨	16		❍	-	15.8/F
1 1/2	1 5/8	35	1,900,000	0	25	-	125	-	8215B070 ③	6		❍	15.4/F	-
1 1/2	1 5/8	35	1,900,000	0	-	25	-	104	8215G070 ③⑧⑨	16		❍	-	15.8/F
2	2 3/32	60	3,251,000	0	25	-	125	-	8215B080 ③	7		❍	15.4/F	-
2	2 3/32	60	3,251,000	0	-	15	-	104	8215G080 ③⑧⑨	17		❍	-	15.8/F
2 1/2	3	117	5,821,000	0	5	-	125	-	8215A090 ⑦	8		❍	28.2/F	-
3	3	138	7,430,000	0	5	-	125	-	8215A040 ⑦	8		❍	28.2/F	-
NORMALLY OPEN (Open when de-energized)														
3/8	3/4	3.2	172,500	0	125	125	125	104	8215G013	9		●	10.1/F	11.6/F
1/2	3/4	4	206,250	0	125	125	125	104	8215G023	9		●	10.1/F	11.6/F
3/4	3/4	4.6	247,500	0	125	125	125	104	8215G033	10		●	10.1/F	11.6/F
1	1 5/8	22	1,191,750	0	25	15	125	104	8215C053	12	-	●	15.4/F	-
1	1 5/8	22	1,191,750	0	25	15	125	104	8215G053 ⑧⑨	-	18	●	-	15.8/F
1 1/4	1 5/8	33	1,793,250	0	25	15	125	104	8215C063	12	-	●	15.4/F	-
1 1/4	1 5/8	33	1,793,250	0	25	15	125	104	8215G063 ⑧⑨	-	18	●	-	15.8/F
1 1/2	1 5/8	37	1,988,250	0	25	15	125	104	8215C073	13	-	●	15.4/F	-
1 1/2	1 5/8	37	1,988,250	0	25	15	125	104	8215G073 ⑧⑨	-	18	●	-	15.8/F
2	2 3/32	58	3,100,000	0	25	15	125	104	8215C083	14	-	●	15.4/F	-
2	2 3/32	58	3,100,000	0	25	15	125	104	8215G083 ⑧⑨	-	19	●	-	15.8/F
2 1/2	3	117	6,290,000	0	5	-	125	-	8215B093 ④⑦	15		●	28.2/F	-

① Do not use for Fuel Gas.
② On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
③ FM Approved Process Control Valves. *See Engineering Section (Approvals) for details.*
④ Type I enclosure only.
⑤ ❍ = Safety Shutoff Valve; ● = General Purpose Valve. *Refer to Engineering Section (Approvals) for details.*
⑥ 1" W.C. Drop @ 2" W.C. Inlet Pressure, 1,000 Btu/cu.ft. or more, 0.64 Specific Gravity Gas.
⑦ Not available with 24 volt, 60 Hz coil.
⑧ Coil options EF, HT, and HC only.
⑨ Not available with 6 VDC coil. ⑩ FM Approved Safety Shutoff Valves. *Refer to Engineering Section (Approvals) for details*

FLR-IGN-1
Part # I 64-3

Product	Dimension B
I-64-1	1.72 inches
I-64-3	3.75 inches
I-64-4	1.12 inches

Auburn Ignitor

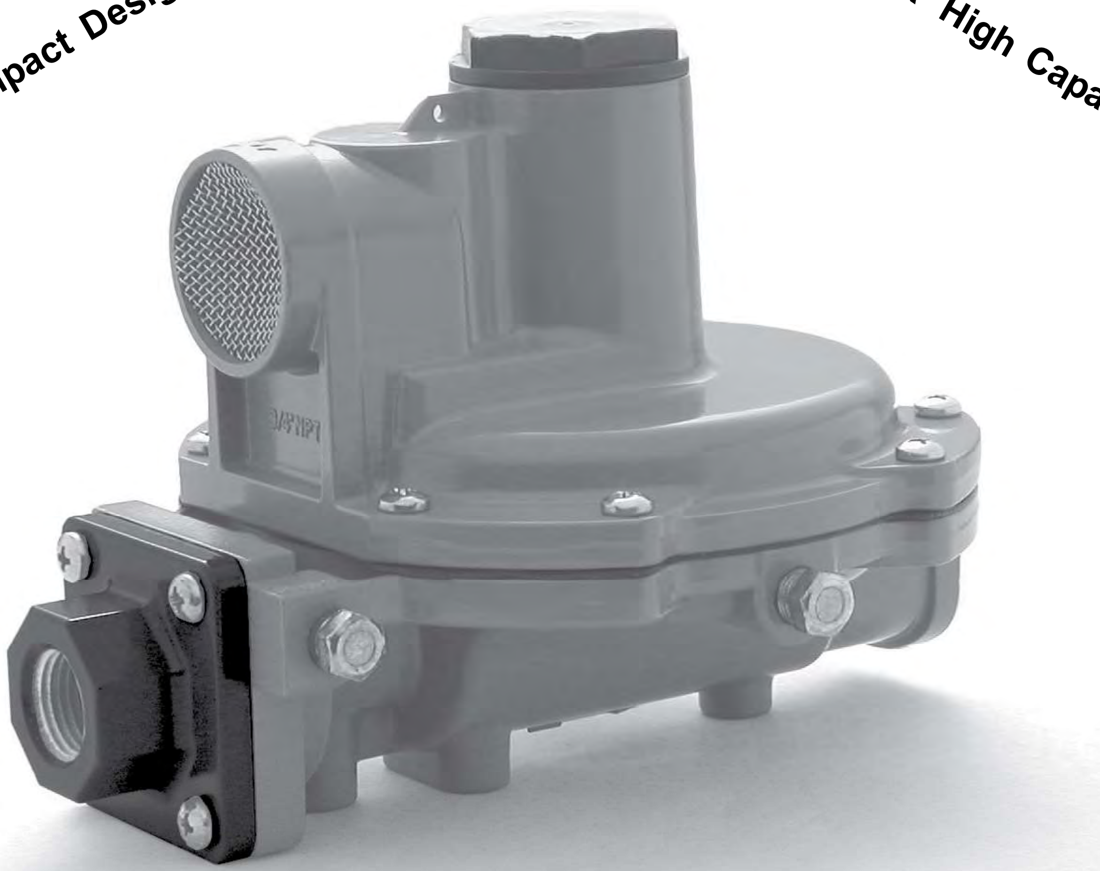
FLR-PCV-101
Part # R622, 1/2" 9-13" WC

March 2004

Type R622 Pressure Reducing Regulator

☆ Compact Design

☆ High Capacity



W8806

☆ Protective Inlet Screen

☆ Internal Relief

☆ Light Weight

☆ Inlet and Out Pressure Gauge Taps

D103094X012

FISHER®

www.FISHERregulators.com

EMERSON™
Process Management

Specifications

Body Size and End Connection Style[1]
1/2-inch (DN 15) inlet and outlet NPT

Maximum Allowable Inlet Pressure[1]
Operating: 125 psig (8,62 bar)
Emergency: 125 psig (8,62 bar)
Except 1.8 to 2.2-inches w.c. (4 to 5 mbar) spring range which has operating and emergency pressures of 60 psig (4,14 bar)

Maximum Allowable Outlet (Casing) Pressure[1]
Operating to Avoid Internal Part Damage:
3 psid (0,21 bar d) above outlet pressure setting
Emergency: 20 psi (1,38 bar)

Outlet Pressure Ranges
See table 1

Orifice Sizes and Flow Coefficients
1/8-inch (3,18 mm) orifice
Wide-Open C_g for relief sizing = 12.5

Flow Capacities
See table 2

Pressure Registration
Internal

Internal Relief Performance
Start to Discharge is 8 to 22-inches w.c. (20 to 55 mbar) for setpoints from 1.8 to 20-inches w.c. (4 to 48 mbar)
Start to Discharge is 140 to 200% over setpoint from 20-inches w.c. to 2.2 psig (48 to 152 mbar)

Spring Case Vent Connections
3/4-inch NPT with removable screen

Maximum Temperature Capabilities[1]
–20° to 160°F (–29° to 71°C)

Approximate Weight
2.35 pounds (1,1 kg)

Construction Materials
Body, Spring Case, Diaphragm Plate, and Orifice: Aluminum
Diaphragm, Disc and O-ring: Nitrile (NBR)
Adjusting Screw and Pushpost: Delrin[2]
Closing Cap: ASA Thermoplastic (UV-Ray Resistant)
Control Spring: Spring wire
Inlet Screw, Flange Screw, Spring Seat and Lever: Plated steel
Valve Stem: Zinc
Relief Valve Spring, Relief Spring Retainer, Lever Pin and Vent Screen: Stainless steel

1. The pressure/temperature limits in this bulletin or any applicable standard limitation should not be exceeded.
2. Trademark of E.I. duPont De Nemours Co.

Introduction

Type R622 direct-operated, spring-loaded regulators provide economical pressure reducing control in a variety of residential, commercial, and industrial applications. These regulators can be used with natural, manufactured, or liquefied petroleum gases and have the same inlet and outlet pressure capabilities.

In addition, Type R622 regulators have internal relief across the diaphragm to help minimize overpressure. Any outlet pressure above the start-to-discharge point of the nonadjustable relief valve spring moves the diaphragm off the relief valve seat, allowing excess pressure to bleed out through the screened spring case vent.

Principle of Operation

Refer to figure 2. When downstream demand decreases, the pressure under the diaphragm increases. This pressure ovrecomes the regulator setting (which is set by a spring). Through the action of the pusher post assembly, the valve disk moves closer to the orifice and reduces gas flow. If demand downstream increases, pressure under the diaphragm decreases. Spring force pushes the pusher post assembly downward and the valve disk moves away from the orifice. Type R622 regulators include an internal relief valve for overpressure protection.

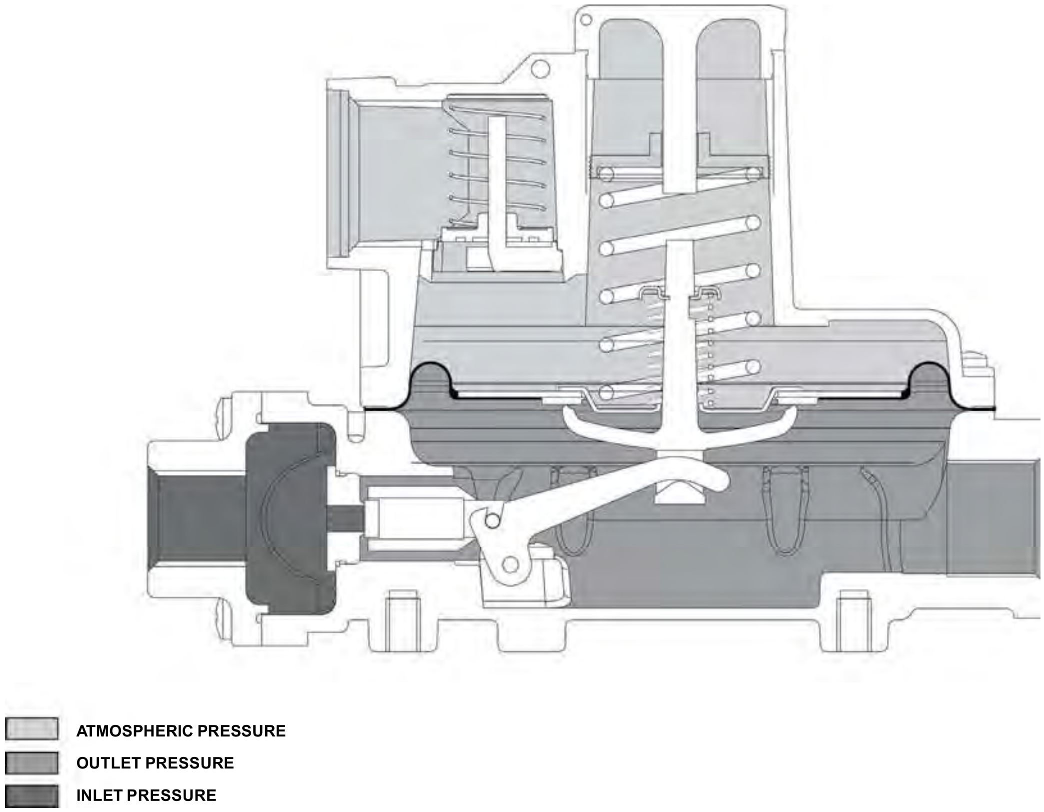


Figure 2. *Type R622 Regulator Construction Features*

Table 1. *Outlet Pressure Ranges*

REGULATOR TYPE NUMBER	OUTLET PRESSURE RANGE	CONTROL SPRING PART NUMBER	CONTROL SPRING COLOR CODE
R622	1.8 to 2.2-inches w.c. (4 to 5 mbar)	T14453T0012	Purple
	5 to 7-inches w.c. (12 to 17 mbar)	T14398T0012	Orange
	6.5 to 9-inches w.c. (16 to 22 mbar)	T14399T0012	Yellow
	9 to 13-inches w.c. (22 to 32 mbar)	T14400T0012	Silver
	13 to 20-inches w.c. (32 to 48 mbar)	T14401T0012	Gray
	16 to 35-inches w.c. (40 to 87 mbar)	T14402T0012	Pink
	1 to 2.2 psig (69 to 152 mbar)	T14403T0012	Light Blue

Overpressure Protection

The wide-open C_g for relief sizing (see Specifications section) along with the capacity information should be used in choosing appropriate overpressure protection devices to ensure that none of the limits in the Specifications section are exceeded.

Overpressuring any portion of a regulator or associated equipment may cause leakage, parts damage, or personal injury due to bursting of pressure-containing parts or explosion of accumulated gas. Regulator operation within ratings does not prevent the possibility of damage from external sources or from debris in the pipeline. A regulator should be inspected for damage after any overpressure conditon.

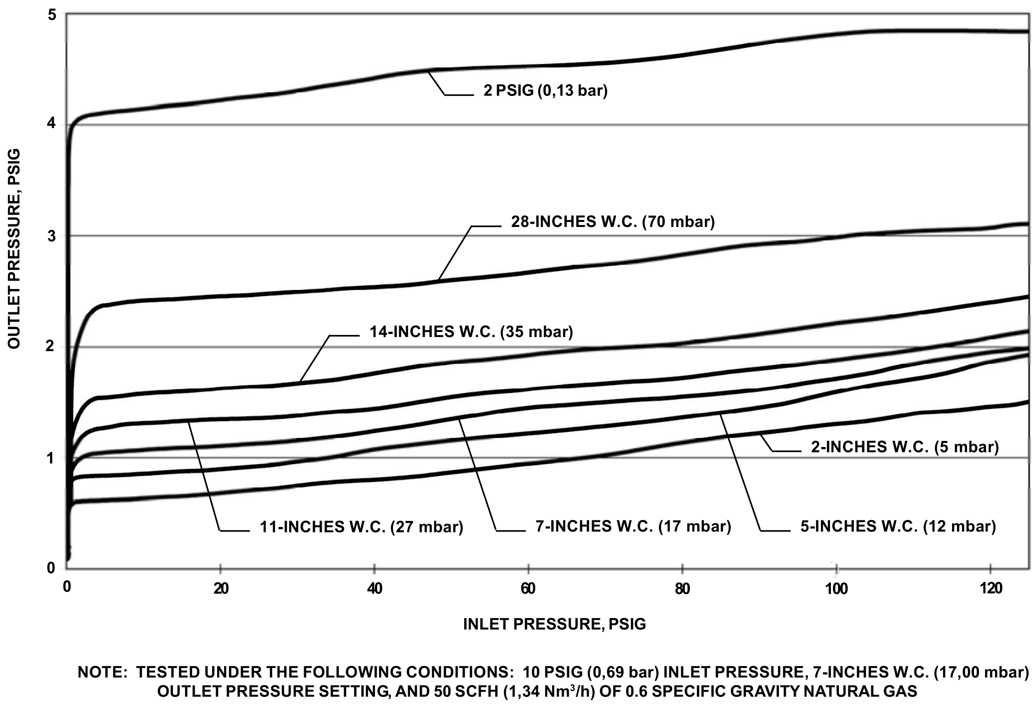


Figure 3. *Industrial Relief Performance*

Capacity Information

The high efficiency flow-through design provides maximum capacity for a given orifice size. Table 2 gives Type R622 regulator flow capacities at selected inlet pressures and outlet pressure settings. Flow are in SCFH (at 60°F and 14.7 psia) and Nm^3/h (at 0°C and 1,01 bar) of 0.6 specific gravity natural gas at 60°F. To determine equivalent capacities for air, propane, butane, or nitrogen, multiply the listed SCFH capacity by the following appropriate conversion factor: air–0.775 for air, propane–0.628, butane–0.548, nitrogen–0.789. For gases of other specific gravities, multiply the given SCFH capacity by 0.775 and divide by the square root of the appropriate specific gravity. If capacity is desired in Nm^3/h, multiply SCFH by 0.0268.

For Critical Pressure Drops

Use this equation for critical pressure drops (absolute outlet pressure equal to one-half or less than one-half the absolute inlet pressure).

$$Q = P_{1(abs)}C_g(1.29)$$

For Non-Critical Pressure Drops

For pressure drops lower than critical (absolute outlet pressure greater than one-half of absolute inlet pressure), using the following formula:

$$Q = \sqrt{\frac{520}{GT}}\, C_g P_1 \text{SIN}\left(\frac{3417}{C_1}\sqrt{\frac{\Delta P}{P_1}}\right)\text{DEG}$$

where,

- Q = gas flow rate, SCFH
- G = specific gravity of the gas
- T = absolute temperature of gas at inlet, °Rankine
- C_g = gas sizing coefficient
- P_1 = absolute inlet pressure, psia
- C_1 = flow coefficient
- ΔP = pressure drop across the regulator, psi

Then, if capacity is desired in normal cubic meters per hour at 0°C and 1,01 bar, multiply SCFH by 0.0268.

Table 2. *Typical regulating capacities in SCFH (Nm³/h) of 0.6 specific gravity natural gas for Type R622 regulator*

OUTLET PRESSURE SETTING, CONTROL SPRING RANGE, SPRING PART NUMBER, AND DROOP	INLET PRESSURE, psig (bar)	1/2-INCH INLET AND 1/2-INCH OUTLET
Setting: 2-inches w.c (5 mbar) Range: 1.8 to 2.2 inches w.c. (4,00 to 5,00 mbar) T14453T0012, Purple Droop: 1-inch w.c. (2,5 mbar)	5 (0,34)	287 (7,69)
	10 (0,69)	380 (10,2)
	25 (1,7)	451 (12,1)
	50 (3,4)	493 (13,2)
	60 (4,14)	506 (13,6)
Setting: 5-inches w.c. (12 mbar) Ranges: 5 to 7 inches w.c. (12 to 17 mbar) 4.2 to 7 inches w.c. 10 to 17 mbar) T14398T0012, Orange Droop: 1 inch w.c. (2,5 mbar)	5 (0,34)	271 (7,26)
	10 (0,69)	367 (9,84)
	25 (1,7)	468 (12,5)
	50 (3,4)	484 (13,0)
	60 (4,14)	428 (11,5)
	75 (5,2)	444 (11,9)
	100 (6,9)	536 (14,4)
	125 (8,63)	536 (14,4)
Setting: 7 inches w.c. (17 mbar) Range: 6.5 to 9-inches w.c (16 to 22 mbar) T14399T0012, Yellow Droop: 1 inch w.c. (2,5 mbar)	5 (0,34)	246 (6,59)
	10 (0,69)	347 (9,30)
	25 (1,7)	451 (12,1)
	50 (3,4)	469 (12,6)
	60 (4,14)	477 (12,8)
	75 (5,2)	445 (11,9)
	100 (6,9)	507 (13,6)
	125 (8,63)	511 (13,7)
Setting: 11 inches w.c. (27 mbar) Range: 9 to 13 inches w.c. (22 to 32 mbar) T14400T0012, Silver Droop: 2-inches w.c. (5 mbar)	5 (0,34)	274 (7,34)
	10 (0,69)	401 (10,8)
	25 (1,7)	623 (16,7)
	50 (3,4)	708 (19,0)
	60 (4,14)	735 (19,7)
	75 (5,2)	676 (18,1)
	100 (6,9)	721 (19,3)
	125 (8,63)	738 (19,8)
Setting: 14-inches w.c. (35 mbar) Range: 13 to 20 inches w.c. (32 to 50 mbar) T14401T0012, Grey Droop: 2-inches w.c. (5 mbar)	5 (0,34)	246 (6,59)
	10 (0,69)	364 (9,76)
	25 (1,7)	551 (14,8)
	50 (3,4)	641 (17,2)
	60 (4,14)	661 (17,7)
	75 (5,2)	614 (16,5)
	100 (6,9)	677 (18,1)
	125 (8,63)	727 (19,5)
Setting: 1psig (0,069 bar) Range 16 to 35 inches w.c. (40 to 87 mbar) T14402T0012, Pink Droop: 10%	5 (0,34)	174 (4,66)
	10 (0,69)	337 (9,03)
	25 (1,7)	533 (14,3)
	50 (3,4)	679 (18,2)
	60 (4,14)	708 (19,0)
	75 (5,2)	756 (20,3)
	100 (6,9)	762 (20,4)
	125 (8,63)	796 (21,3)
Setting: 2psig (0,14 bar) Range: 1.2 to 2.2 psi (0,08 to 0,15 bar) T14403T0012, Light Blue 10% droop	5 (0,34)	222 (5,95)
	10 (0,69)	381 (10,2)
	25 (1,7)	630 (16,9)
	50 (3,4)	923 (24,7)
	60 (4,14)	976 (26,5)
	75 (5,2)	1007 (27,0)
	100 (6,9)	1285 (34,4)
	125 (8,63)	1028 (27,6)

Installation

Type R622 regulator may be installed in any position. However, the spring case vent should be pointed downward. If gas escaping through the Type R622 internal relief valve could constitute a hazard, the spring case vent must be piped to a location where escaping gas will not be hazardous. If the vented gas will be piped to another location, obstruction-free tubing or piping at least equal to the vent, and the end of the vent pipe must be protected from anything that might clog it.

Dimensions are shown in figure 4.

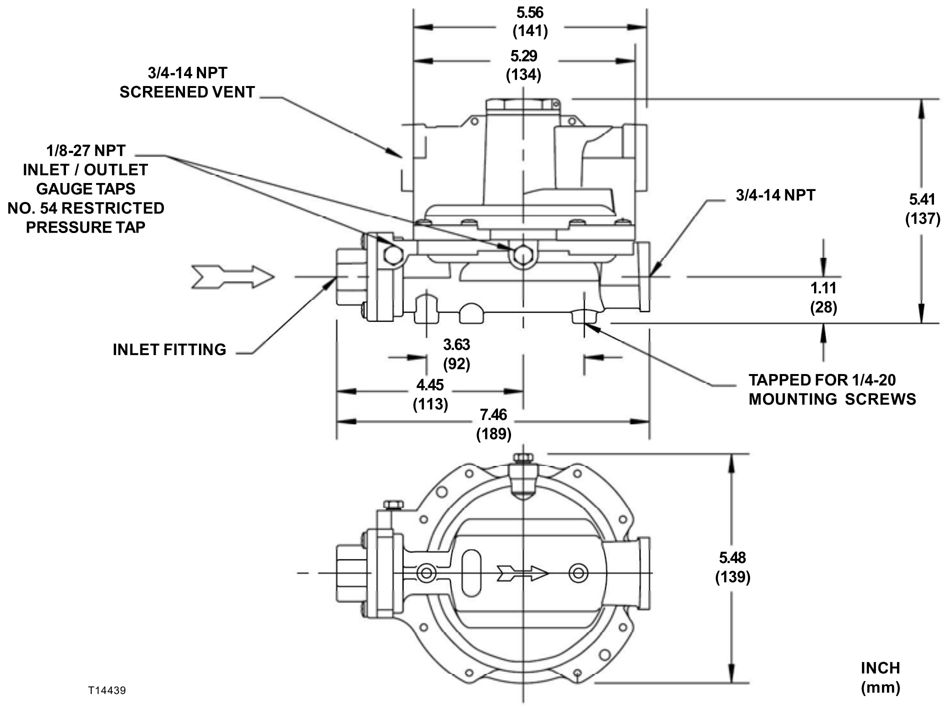


Figure 4. *Dimensions*

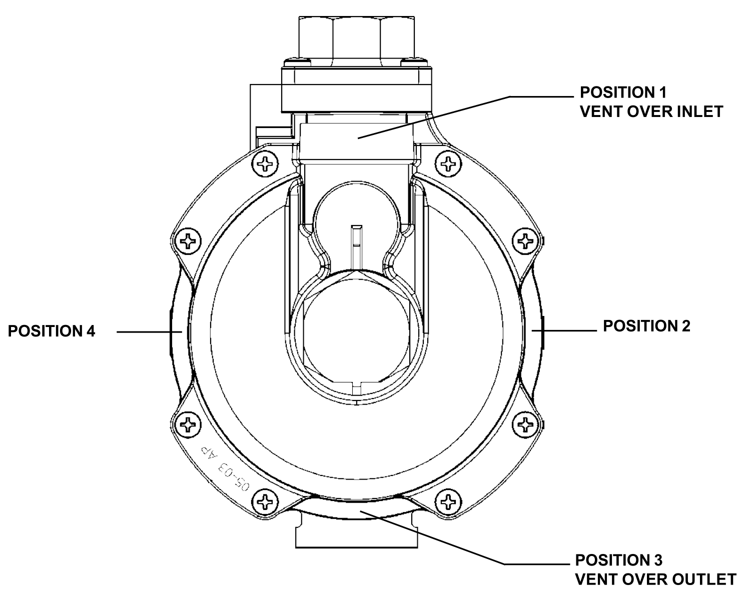


Figure 5. *Vent Location*

Ordering Information

Carefully review each specification and complete the Ordering Guide. Send the Ordering Guide to your local Sales Representative or Sales Office.

Ordering Guide

Outlet Pressure Range (select one)

- ☐ 1.8 to 2.2-inches w.c. (4 to 5 mbar)
- ☐ 5 to 7-inches w.c. (12 to 17 mbar)
- ☐ 6.5 to 9-inches w.c. (16 to 22 mbar)
- ☐ 9 to 13-inches w.c. (22 to 32 mbar)
- ☐ 13 to 20-inches w.c. (32 to 48 mbar)
- ☐ 16 to 35-inches w.c. (40 to 87 mbar)
- ☐ 1 to 2.2 psig (69 to 152 mbar)

Vent Position (select one)

- ☐ Position 1 (vent over inlet)
- ☐ Position 2
- ☐ Position 3 (vent over outlet)
- ☐ Position 4

For information, contact Fisher:
Marshalltown, Iowa 50158 USA
McKinney, Texas 75070 USA
28320 Gallardon, France
40013 Castel Maggiore (BO), Italy
Sao Paulo 05424 Brazil
Singapore 128461

www.FISHERregulators.com

Louvers

The flare has two louvers that are used to regulate flare temperature, more air equals a colder flare. The louver position is controlled by an actuator motor that receives a 4-20 mA signal from the control panel. PEI's controls are based on percent *closed*, and 4 mA is 0% closed, 20 mA is 100% closed.

The louver apparatus consists of the louver itself, the actuator motor, a weather proofing kit for the motor, a crank arm, and a ball joint.

The louver actuator motors are not spring return, the are powered both directions. When the flare is not running the louvers power to 0% closed (4 mA, fully open) to ventilate the flare.

The louver actuator motors each have two auxiliary switches that supervise louver position, only one switch is used in each actuator and it closes when the louvers are 100% closed. The switch from each louver motor is brought out to the low voltage junction box on the flare to facilitate trouble shooting.

The actuator motors are Honeywell part # M7284C1000, it has a 90-degree stroke and a 30 second travel time. As noted above, 120 VAC power is required at all times, and a 4-20 mA signal controls position. They are fitted with a Honeywell 4074ERU weather kit.

The crank arms are Honeywell part # 221455A. The ball joints are Honeywell part #102546.

The louvers are made by Ruskin/Swartout, they are part # 822A3-OB.

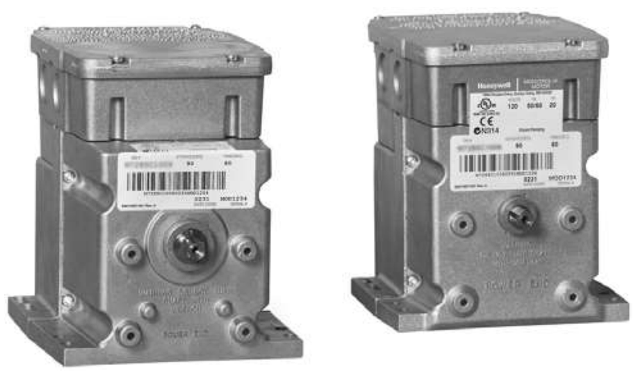
.

Part # 7284C1000 with 2 Aux Switches
4074ERU Weather proof kit

Honeywell

Series 71, 72, and 76 Modutrol IV™ Motors

PRODUCT DATA



APPLICATION

The Series 71, 72 and 76 Modutrol IV Motors are spring return and non-spring return motors used to control dampers and valves. The motors accept a current or voltage signal from an electronic controller to position a damper or valve at any point between open and closed.

FEATURES

- **Replaces M734H,J,; M744S,T,Y; and M745L,S,T,Y Motors.**
- **M7164, M7261, M7284, and M7294 are non-spring return motors; M7282, M7285, M7286 and M7685 are spring return motors.**
- **Integral spring return returns motor to normal position when power is interrupted.**
- **Integral junction box provides NEMA 3 weather protection.**
- **Motor and circuitry operate from 24 Vac. Models available with factory installed transformer, or a field added internal transformer.**
- **Quick-connect terminals are standard—screw terminal adapter is available.**
- **Adapter bracket for matching shaft height of older motors is available.**
- **Most motors have field adjustable stroke (90° to 160°).**
- **Die-cast aluminum housing.**
- **Integral auxiliary switches are available factory mounted, or can be field added.**
- **Nominal timing standard of 30 seconds (90° stroke), and 60 seconds (160° stroke). Other timings available.**
- **Spring return motors can operate valve linkages from power end or auxiliary end shafts for normally closed or normally open valve applications.**
- **All models have dual shafts (slotted and tapped on both ends).**
- **All models have auxiliary switch cams.**
- **Fixed torque throughout the entire voltage range.**
- **Motors are designed for either normally open or normally closed valves and dampers.**
- **Models available with adjustable start (zero) and span.**
- **Models available with 4 to 20 mA input signal.**
- **Models available with 2 to 10 Vdc input signal.**

Contents

SPECIFICATIONS

Models: TRADELINE models are selected and packaged to provide ease of stocking, ease of handling and maximum replacement value. TRADELINE model specifications are the same as those of standard models unless specified otherwise.

IMPORTANT

The specifications given in this publication do not include normal manufacturing tolerances. Therefore, an individual unit may not exactly match the listed specifications. Also, this product is tested and calibrated under closely controlled conditions and some minor differences in performance can be expected if those conditions are changed.

Modutrol IV Order Number Guide: See Table 4.

Dimensions: See Fig. 2.

Lifetime
60,000 Full Stroke Cycles
Repositions: 1.5 Million

Controller: These motors can be used with any electronic controller that provides a stable noise-free proportional current output as specified in Electrical Ratings, Input Range below.

Electrical Ratings:
Power Consumption: See Table 1.
Input Range:
- Current, Nonadjustable: 4 to 20 mA nominal, 25 mA maximum.
- Current, Adjustable: 4 to 20 mA adjustable, 50 mA maximum.
- Zero/Null (Motor Closed): 0.0 to 18 mA.
- Span: 1.8 to 20 mA.
- Voltage, Nonadjustable: 2 to 10 Vdc.

Input Impedance:
- 4 to 20 mA Input: 100 ohms.
- 2 to 10 Vdc Input: 400K ohms.

Auxiliary Switch Ratings (in Amps): See Table 2.

Stroke: Most models available with field adjustable strokes from 90° to 160°. Stroke adjusted by means of potentiometers located in the wiring compartment.

Timing: Nominal 30 seconds for 90° stroke and 60 seconds for 160° stroke.

Dead Weight Load On Shaft: 200 lb (91 kg) on motor power or auxiliary end; maximum combined load of 300 lb (136 kg).

Ambient Temperature Ratings: -40 to 150°F (-40 to 66°C).

Shaft: 3/8 in. (9.5 mm) square.

Motor Rotation:
Closed: Counterclockwise rotation limit as viewed from motor power end.
Mechanically Normally Closed: Spring return. Normally closed motors rotate to closed position on power loss.
Electrically Normally Closed: Both spring return and non-spring motors return to closed position on minimum signal.

Table 1. Series 72 Modutrol IV Motor Power Consumption Ratings (at 120 Vac, 50/60 Hz).

Model	Power Consumption	
	VA	Watts
M7261	15	13
M7282	20	18
M7284	15	13
M7285	20	18
M7286	20	18
M7294	15	13

Table 2. Auxiliary Switch Ratings (in Amps).

One Contact Rating[a]	120V	240V
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

[a] 40 VA pilot duty, 120/240 Vac on opposite contact.

Approvals:
Underwriters Laboratories Inc. Listed: File No. E4436; Guide No. XAPX for USA and Canada.
U.S. Patents: pending

Table 3. Primary 50017460-001 Color Code

Lead Color	Primary Voltage
Brown	24 VAC
White	120 VAC
Blue	230 VAC
Black	Common

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number. If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Environmental and Combustion Controls Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386
3. http://customer.honeywell.com or http://customer.honeywell.ca

International Sales and Service Offices in all principal cities of the world. Manufacturing in Belgium, Canada, China, Czech Republic, Germany, Hungary, Italy, Mexico, Netherlands, United Kingdom, and United States.

M7284C1000

Fig. 1. Stroke

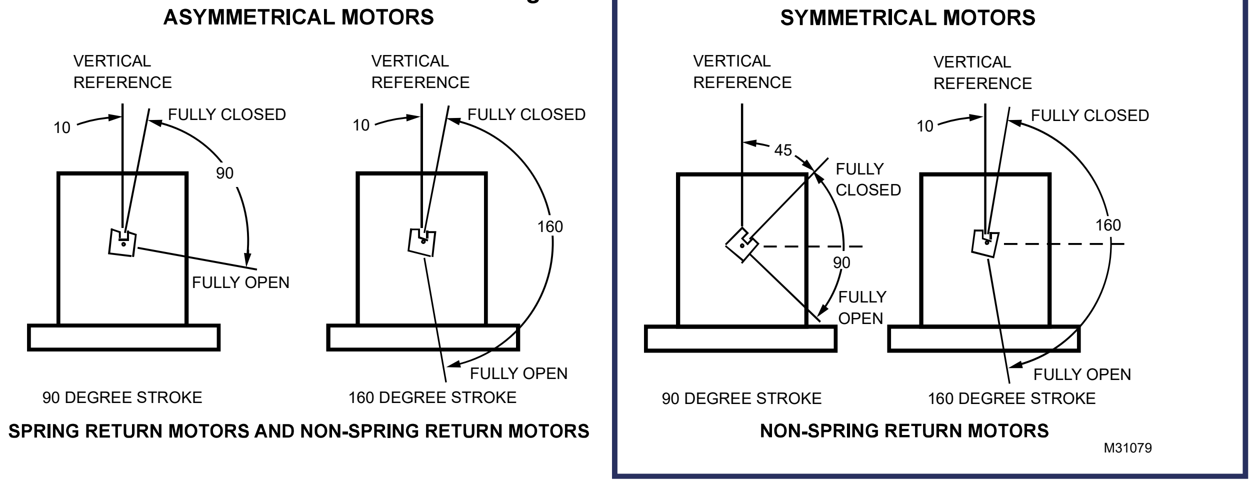


Table 4. Modutrol IV Motors Series 2 and 3 Model Number Guide.

M	Motor						
	71	10.5 - 13.5 Vdc voltage input					
	72	4-20 mA or 2-10 Vdc Control					
	76	14-17 dc voltage control with minimum position capability					
		6	—		35 lb-in. Non-Spring Return		
		7	—		75 lb-in. Non-Spring Return		
		8	60 lb-in. Spring Return		150 lb-in. Non-Spring Return		
		9	—		300 lb-in. Non-Spring Return		
			2	Dual-ended shaft		Normally Closed Spring Return	
			4			Non-Spring Return	
			5			Normally Closed Spring Return	
				A	0 Auxiliary Switches	Adjustable Stroke *	Normally Closed
				B	1 Auxiliary Switch		
				C	2 Auxiliary Switches		
				D	0 Auxiliary Switch		
				Q[a]	2 Auxiliary Switches		
M	**72**	**8**	**4**	**A**	**XXXX**	See Tradeline Catalog for Complete Model Number	

[a] Adjustable zero and span.
* Fixed stroke on M7284C1083, M7284C1091, M7284Q1082, and M7284Q1090

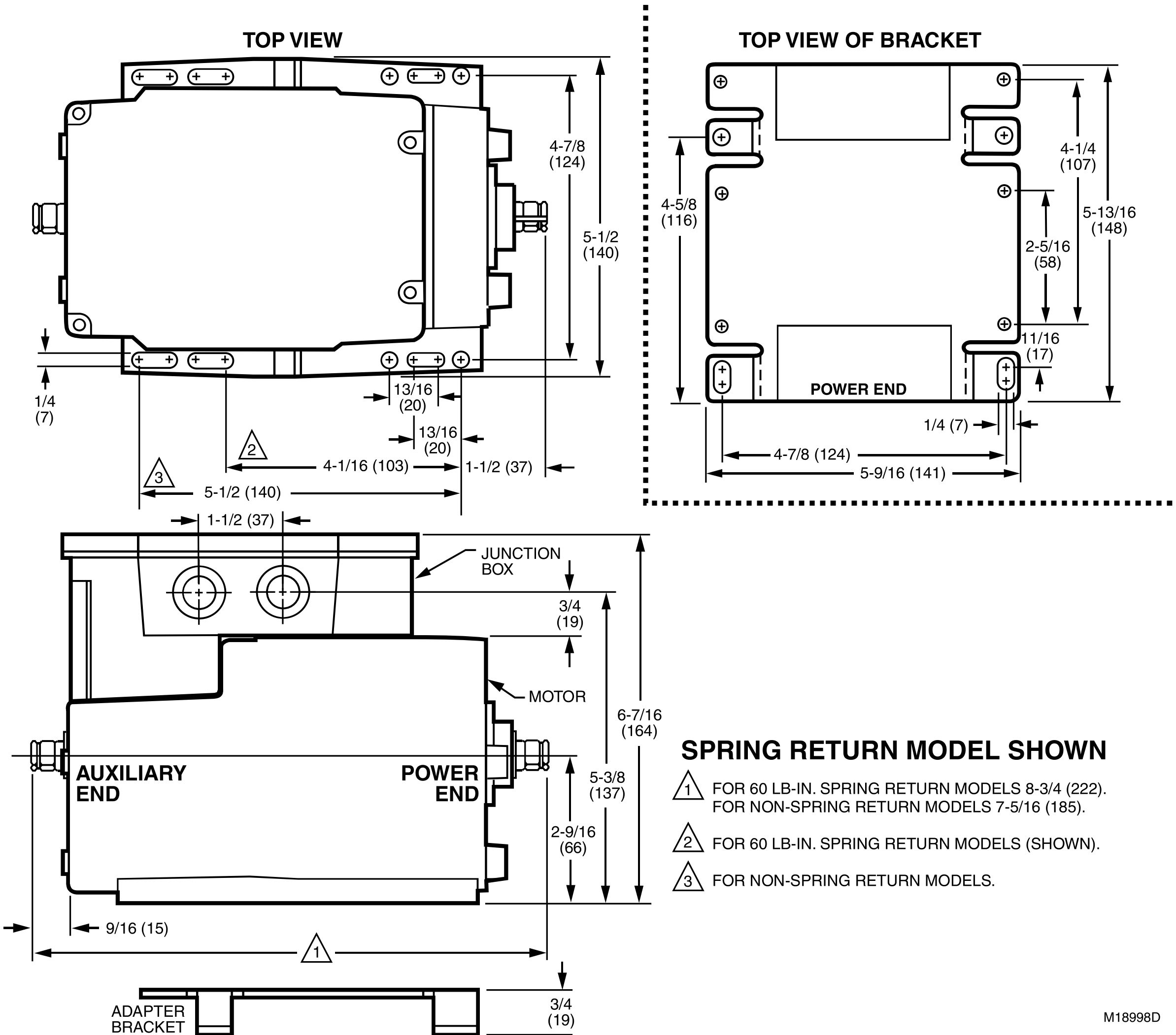


Fig. 2. Series 72 Modutrol IV Motor dimensions in inches (mm).

Accessories:
220736A Internal Auxiliary Switch Kit; one switch. Can be field-installed.
220736B Internal Auxiliary Switch Kit; two switches, can be field-installed on TRADELINE models.
220738A Adapter Bracket raises motor shaft height by 3/4 in (19 mm) to match that of previous Modutrol Motor models.
220741A Screw Terminal Adapter converts the standard quick-connect terminals to screw terminals.
221455A Infinitely Adjustable Crank Arm, can rotate through downward position and clear motor base without requiring an adapter bracket.
4074ERU Weatherproofing Kit provides NEMA 3 rating for Modutrol IV Motors mounted in position other than upright.
50017460-001 Internal Transformer; 24/120/230 Vac 50/60 Hz primary, 24 Vac secondary, quick connect terminals.
50017460-003 Internal Transformer; 120 Vac 50/60 Hz primary, 24 Vac secondary, quick connect terminals.
7617ADW Crank Arm, can rotate through downward position and clear motor base without requiring an adapter bracket.
Q100 Linkage connects Modutrol Motor to V51 Butterfly Valve. Requires the 220738A Adapter Bracket.
Q181 Auxiliary Potentiometer for sequence or unison control of 1 to 4 additional modulating (Series 90) motors.
Q209E,F Manual Potentiometer for Modutrol Motors
Q5001 Bracket and Linkage Assembly connects Modutrol IV Motor to water or steam valve.
Q605 Damper Linkage connects motor to damper. Includes motor crank arm.
Q607 External Auxiliary Switch controls auxiliary equipment as a function of motor position.
ES650-117 Explosion-Proof Housing encloses motor for use in explosive atmospheres. Also required, a 7617DM coupling assembly from Honeywell to use with the cover. Not for use with Q5001 (or any other valve linkages). To order ES650-117, contact EGS Enclosures at (281) 449-6271, ask for the sales department and for distribution in your area.

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ **CAUTION**
Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation. Motors with auxiliary switches can have more than one disconnect.

⚠ **CAUTION**
Equipment Damage Hazard.
Can damage the motor beyond repair.
Never turn the motor shaft by hand or with a wrench. Forcibly turning the motor shaft damages the gear train and stroke limit contacts.

IMPORTANT
Always conduct a thorough checkout when installation is complete.

Location

Allow enough clearance for accessory installation and motor servicing when selecting a location (see Fig. 2). If located outdoors, use liquid-tight conduit connectors with the junction box to provide NEMA 3 weather protection. If mounted outdoors in a position other than upright, install a 4074ERU Weatherproofing Kit and liquid-tight connectors to provide NEMA 3 protection.

⚠ **CAUTION**
Motor Damage Hazard.
Deteriorating vapors and acid fumes can damage metal parts.
Install motor in areas free of acid fumes and other deteriorating vapors.

In excessive salt environments, mounting base and screws should be zinc or cadmium plated, not stainless steel or brass. Use the 220738A Adapter Bracket for mounting on these surfaces.

Mounting

Use the following guidelines for proper motor mounting:
- Always install motors with the crankshaft horizontal.
- Mounting flanges extending from motor housing base are drilled for 1/4 inch (6.4 mm) machine screws or bolts.
- Non-Spring Return Motors are shipped from the factory in the closed position (at the counterclockwise rotation limit, as viewed from the motor power end).
- Spring Return Motors are shipped from the factory in their normal position.
- Normally closed models are shipped at the counterclockwise rotation limit, as viewed from the motor power end.

Adapter Bracket

The 220738A Adapter Bracket, positioned between the motor and the equipment, raises motor shaft height by 0.75 in. (19 mm) to match that of previous Modutrol Motor models.

The following applications require this bracket:
- Q607 External Auxiliary Switch.
- Damper linkage applications requiring added clearance to allow:
  — Crank arm rotation through the downward position.
  — Sufficient damper linkage to reach the motor shaft.
- All valve linkages except the Q5001.

NOTE: **When the bracket is not used in a replacement application, the damper linkage requires adjustment for the new shaft position.**

To mount the motor with the bracket:
1. Mount the bracket to the equipment with existing or standard bolts.
2. Using the provided bolts, mount the motor to the bracket threaded holes. See Fig. 3.

For valve linkage applications (other than the Q5001):
1. Mount the bracket to the linkage.
2. Position the motor on the bracket to align the motor shaft with the linkage.

3. Attach the motor to the bracket with the four bolts provided. See Fig. 4.

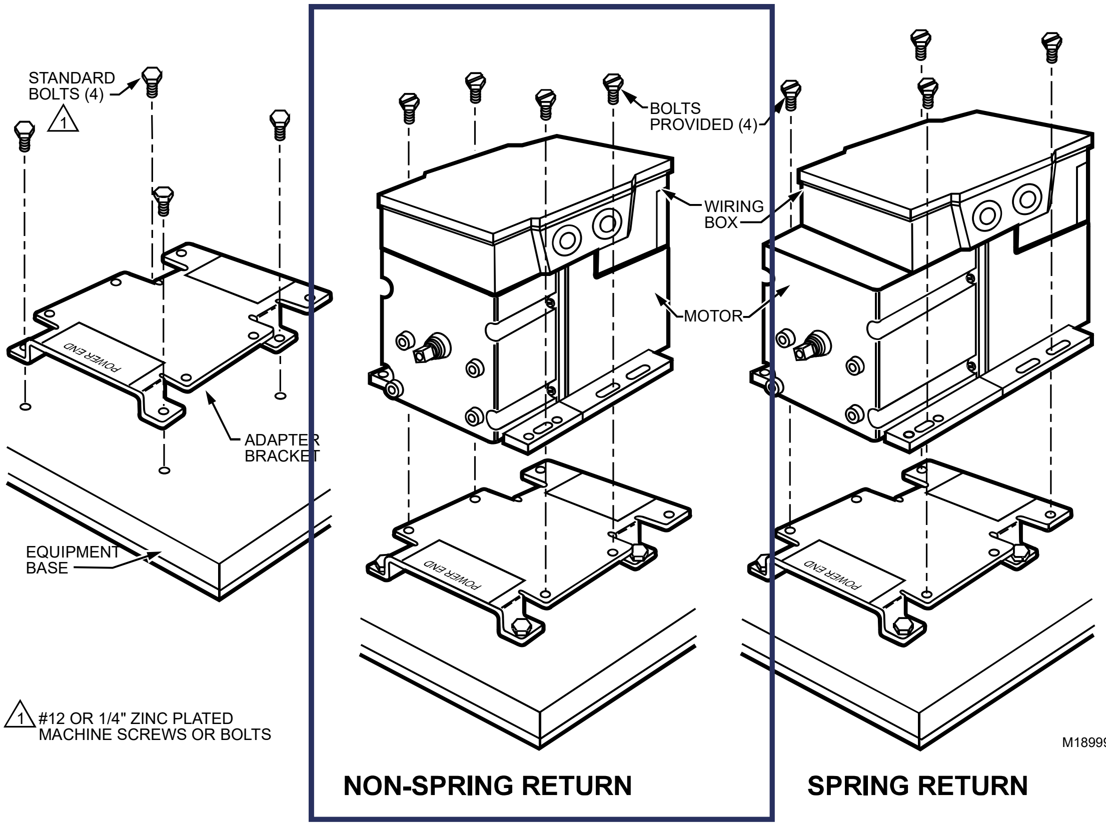


Fig. 3. Mounting the motor with an adapter bracket.

Damper Linkages

The motor does not include a crank arm. Order the crank arm separately (see Accessories in the Specifications section). For detailed instructions on the assembly of specific linkages, refer to the Installation Instructions packed with the linkage.

⚠ CAUTION

Equipment Damage Hazard.
Stalling a motor can damage the drive shaft.
Ensure installation of motors and linkages allows the motor to drive through full stroke without obstruction.

Valve Linkages

The Q100 Linkage requires a 220738A Adapter Bracket for all valve applications. Applications with the Q5001 Valve Linkage do not require the 220738A Adapter Bracket (see Fig. 4).

For detailed instructions on specific linkage assemblies, refer to the instruction sheet packed with the linkage. In general, check the following points when installing a motor and linkage:

- Adjust valve and louver-type damper linkages so the damper or valve moves through only the maximum required distance while the motor moves through its full stroke.
- With modulating control, maximum damper opening should be no more than 60 degrees. Little additional airflow is provided beyond this point.
- Do not exceed load and torque ratings in any application.

Junction Box

When used with liquid-tight conduit connectors, the junction box provides NEMA 3 weather protection for the motor. The junction box, standard with replacement motors, encloses the terminals and provides knockouts for wiring conduits. Housing an internal transformer or internal auxiliary switches requires using a junction box.

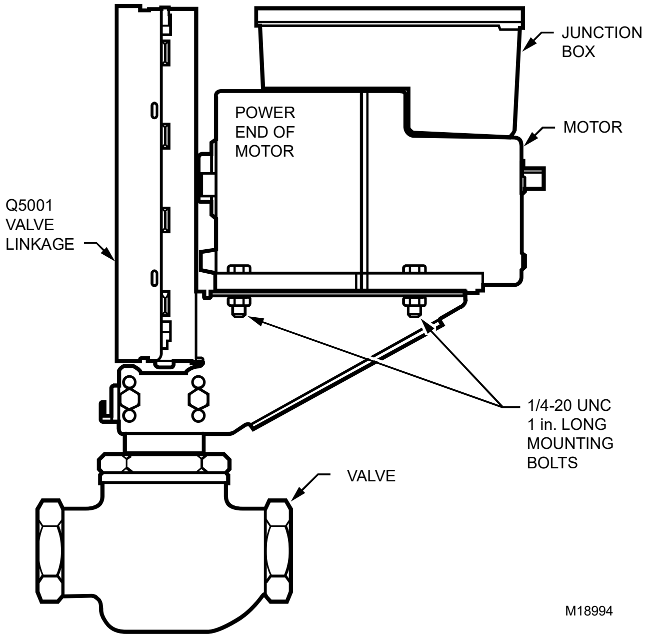


Fig. 4. Mounting the motor on a Q5001 Valve Linkage.

Wiring

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation.
Motors with auxiliary switches can have more than one disconnect.

IMPORTANT

All wiring must agree with applicable codes, ordinances and regulations.

1. Ensure that the voltage and frequency stamped on the motor correspond with the power supply characteristics.
2. When connecting several motors in parallel, ensure that the power supply VA rating is large enough to provide power to all motors used without overloading.
3. Fig. 10 shows that motor terminals are quick-connects located on top of the printed circuit board.
4. To access the wiring compartment:
   a. Remove the four screws from the junction box top.
   b. Lift off the cover.
5. Refer to Fig. 5 through 8 for wiring.

Wire the motor as follows:

1. Remove the wiring box cover by removing the four screws holding the cover to the motor.
2. Wire motor to system using quick-connect terminals in wiring box.
3. Replace wiring box cover.

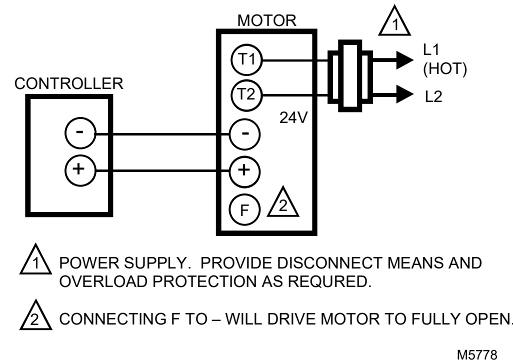


Fig. 5. Typical system wiring.

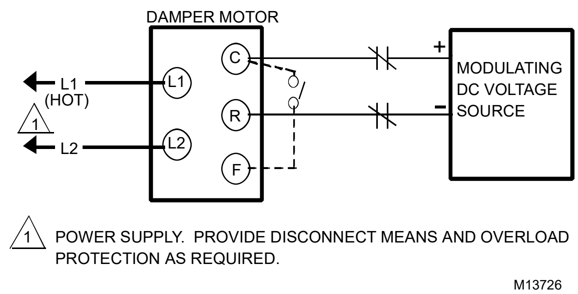


Fig. 6. Series 71 optional override switches to drive motor open or closed.

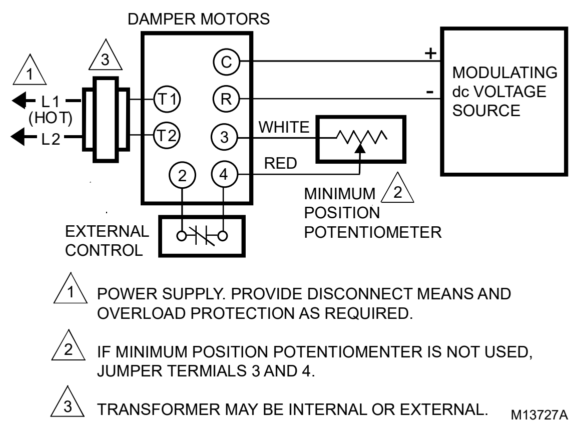


Fig. 7. M7685 Typical application wiring.

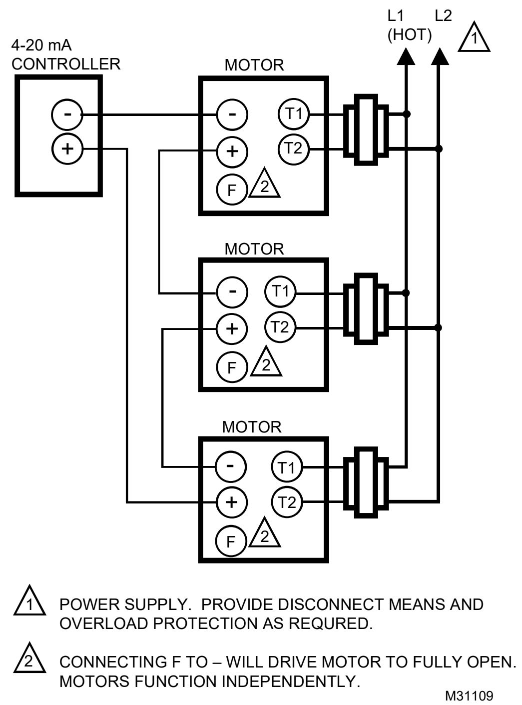


Fig. 8. Driving up to six motors from one 4 to 20 mA controller.

SETTINGS AND ADJUSTMENTS

Before Setting Stroke

1. Remove the top cover from the motor.
2. Disconnect the controller from the motor.
3. For models with an internal transformer (line voltage motors), ensure that power (and nothing else) remains connected to the motor.

IMPORTANT

Detach linkage from motor before adjusting stroke.

! CAUTION

Careless Installation Hazard.
Use of excessive force while adjusting cams damages the motor.
To avoid damaging motor end switches, set cams by moving only the screwdriver top.

! CAUTION

Equipment Damage Hazard.
Can damage the motor beyond repair.
Never turn the motor shaft by hand or with a wrench. Forcibly turning the motor shaft damages the gear train and stroke limit contacts.

Adjustable Stroke

All models except for M7284C1083, M7284C1091, M7284Q1082, and M7284Q1090.

When viewing from the power end of the motor, the stroke potentiometer is to the far left. To set the stroke to 160° (maximum position) turn the potentiometer fully clockwise , using a 1/8 in. straight-blade screwdriver. To set the stroke at 90° (minimum position) turn the potentiometer fully counter-clockwise . Setting the potentiometer anywhere between fully clockwise and fully counter-clockwise will set the stroke between 160° and 90°.

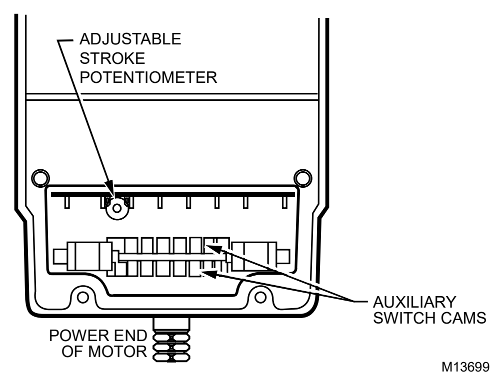


Fig. 9. Stroke adjustment setup

Zero and Span Adjustment for M7284Q, M7285Q, and M7294Q

M7284Q, M7285Q, and M7294Q actuators have the capability of adjustable zero and span. Fig. 10 shows the module with the zero and span potentiometers.

Zero: Sets input voltage to define the 0% angle of rotation. It is factory set to minimum position and can be adjusted to the maximum position of 20mA or 10V.

Span: Adjusts motor response to travel a full stroke through the selected input span. It is factory set to maximum position, and is adjustable from 4-20mA or 2-10Vdc.

1. Adjust the start potentiometer fully clockwise (maximum zero) and the span potentiometer fully counterclockwise (minimum span). See Fig. 10.
2. Set the controller current to the value required to drive the motor to the closed position.
3. Turn the start potentiometer slowly counterclockwise until the motor begins to open. This is defined as the start or zero setting.
4. Set the controller current to the value required to drive the motor to the fully open position. The motor will open.
5. Turn the span potentiometer clockwise until the motor starts to close. The difference between the fully open span position current and the zero position current is defined as the operating span.
6. Recheck the start and readjust the span potentiometer if necessary. Turn the start potentiometer clockwise to increase the zero position.
7. Recheck the span and readjust the span potentiometer if necessary. Turn it clockwise to increase the full span position.
8. For sequential operation, as shown in Fig. 11, repeat the above steps for each motor.

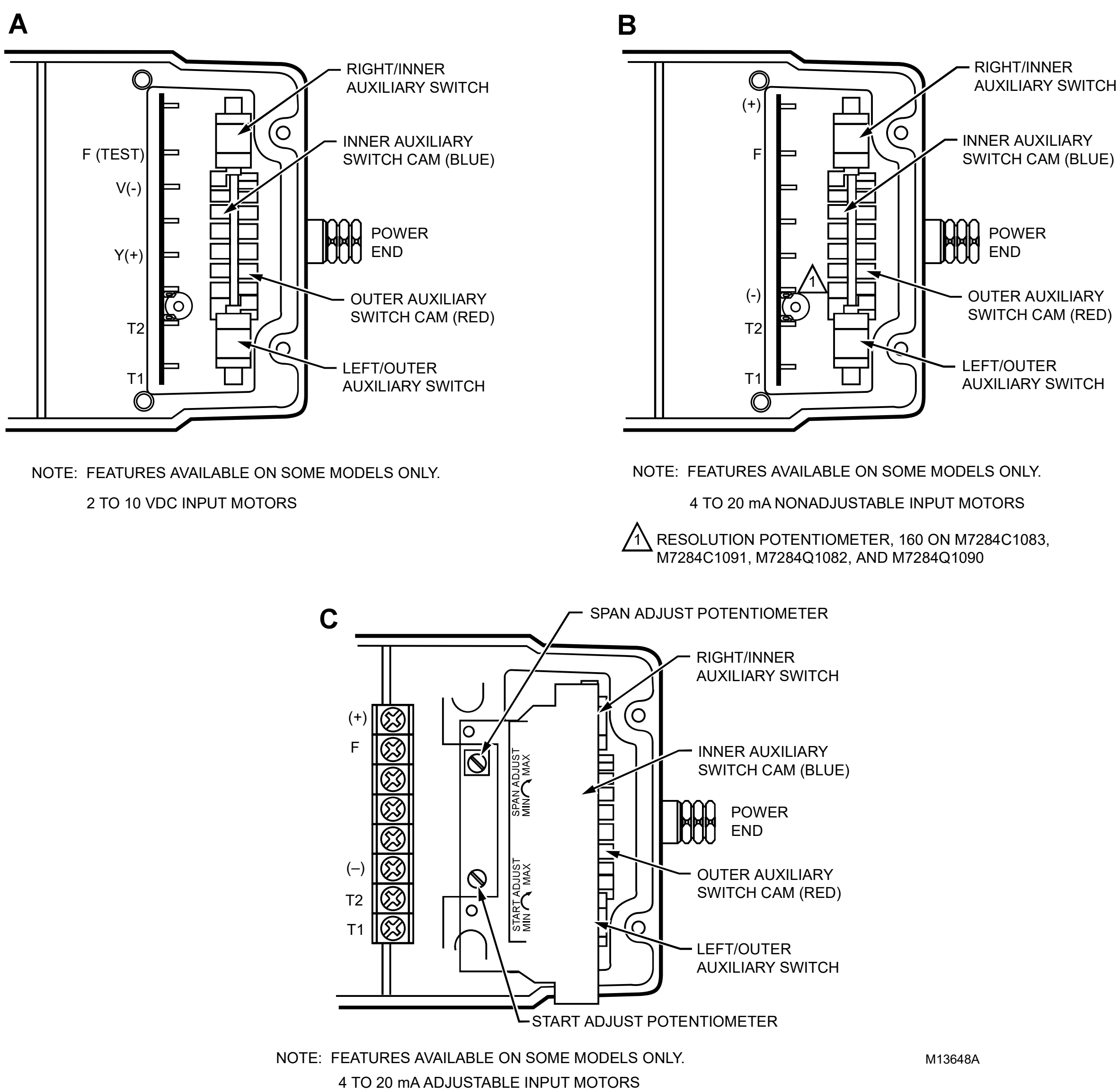
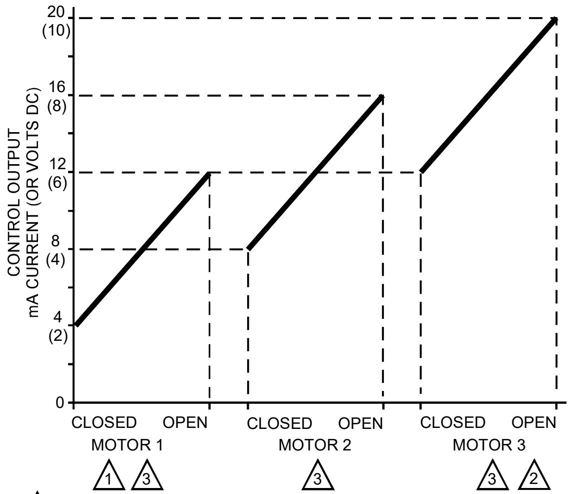


Fig. 10. Terminals and adjustments.

SEQUENTIAL OPERATION FOR ADJUSTABLE ZERO AND SPAN MODELS



1. MOTOR 1 PROPORTIONS BETWEEN 4 AND 12 mA; FULLY CLOSED AT 4 mA, FULLY OPENED AT 12 mA.

   MOTOR 2 PROPORTIONS BETWEEN 8 AND 16 mA; FULLY CLOSED AT 8 mA, FULLY OPENED AT 16 mA.

   MOTOR 3 PROPORTIONS BETWEEN 12 AND 20 mA SIGNAL; FULLY CLOSED AT 12 mA, FULLY OPENED AT 20 mA.

2. UP TO 6 MOTORS CAN BE DRIVEN SEQUENTIALY OR IN UNISON FROM ONE CONTROLLER.

3. ADJUST ZERO ADJUST AND SPAN ADJUST POTENTIOMETERS TO ACHIEVE DESIRED SEQUENCE.

M2893A

Fig. 11. Sequential operation of motors.

Enhanced Resolution M7284C1083, M7284C1091, M7284Q1082, and M7284Q1090

These four motors have enhanced resolution with 160 repositions (steps) from 90 degrees to 160 degrees stroke.

Auxiliary Switches

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation. Motors with auxiliary switches can have more than one disconnect.

⚠ CAUTION

Equipment Damage Hazard.
Can damage the motor beyond repair.
Never turn the motor shaft by hand or with a wrench. Forcibly turning the motor shaft damages the gear train and stroke limit contacts.

Adjustable cams actuate the auxiliary switches. These cams can be set to actuate the switches at any angle within the motor stroke. Select switch differential of 1° or 10°.

Motors with factory added auxiliary switches are shipped in the closed position (fully counterclockwise, as viewed from the motor power end) with auxiliary cams set to actuate switches 30° from the closed position and to provide 1° degree differential. With the motor in the closed (fully counterclockwise) position, the auxiliary switch breaks contacts R-B. See Fig. 12 for auxiliary switch wiring.

Series 2 Motors are shipped with auxiliary switch cams that permit acceptance of 220736A,B Internal Auxiliary Switch Kits. Refer to form 63-2228 for 220736A,B Installation Instructions.

Auxiliary Switch Adjustment

IMPORTANT

When adjusting the auxiliary switch cams use the following procedure:
1. *Insert 1/8 in. screwdriver blade into a slot on cam and move the screwdriver top as far as possible in the required direction. See Fig. 12.*
2. *Repeat step 1 in successive cam slots until the cam is in the required position.*

NOTE: Series 2 Motors are shipped with auxiliary switch cams that permit acceptance of 220736A,B Internal Auxiliary Switch Kits. Refer to Form no. 63-2228 for 220736A,B Installation Instructions.

Use the following procedure to obtain the desired auxiliary switch settings:
1. Remove the top cover from the motor to gain access to the motor terminals and auxiliary cams.
2. Disconnect the controller from the motor.
3. Connect a current source to the positive and negative terminals.
4. Drive the motor to the position where the auxiliary equipment is to be switched by increasing or decreasing the current.
5. For a switch differential of 1°, check continuity of auxiliary switch contacts R-B and rotate the cam as follows:
   a. If the contacts are open, rotate the cam clockwise until the R-B contacts close.
   b. If the contacts are closed, rotate the cam counterclockwise until the R-B contacts open.
6. For a switch differential of 10° rotate the cam approximately 180° so the slow-rise portion of the cam actuates the switch.
7. Check continuity of the auxiliary switch contacts R-B.
8. Rotate the cam as follows:
   a. If the contacts are open, rotate the cam counterclockwise until the R-B contacts close.
   b. If the contacts are closed, rotate the cam clockwise until the R-B contacts open.
   c. Make final adjustment in the proper direction to obtain contact make or break at the desired position.
9. Check for the proper differential and switching of the auxiliary equipment by driving the motor though the full stroke in both directions.
10. Disconnect power, remove current source, reconnect the controller, and replace the top cover on the motor.

NOTE: Changing the differential from 1° to 10° reverses the switching action. For example, with a 10° differential, switch contacts R-B make and R-W break on a counterclockwise (closed) rotation. With a 1° differential, switch contacts R-W make and R-B break on a counterclockwise (closed) rotation.

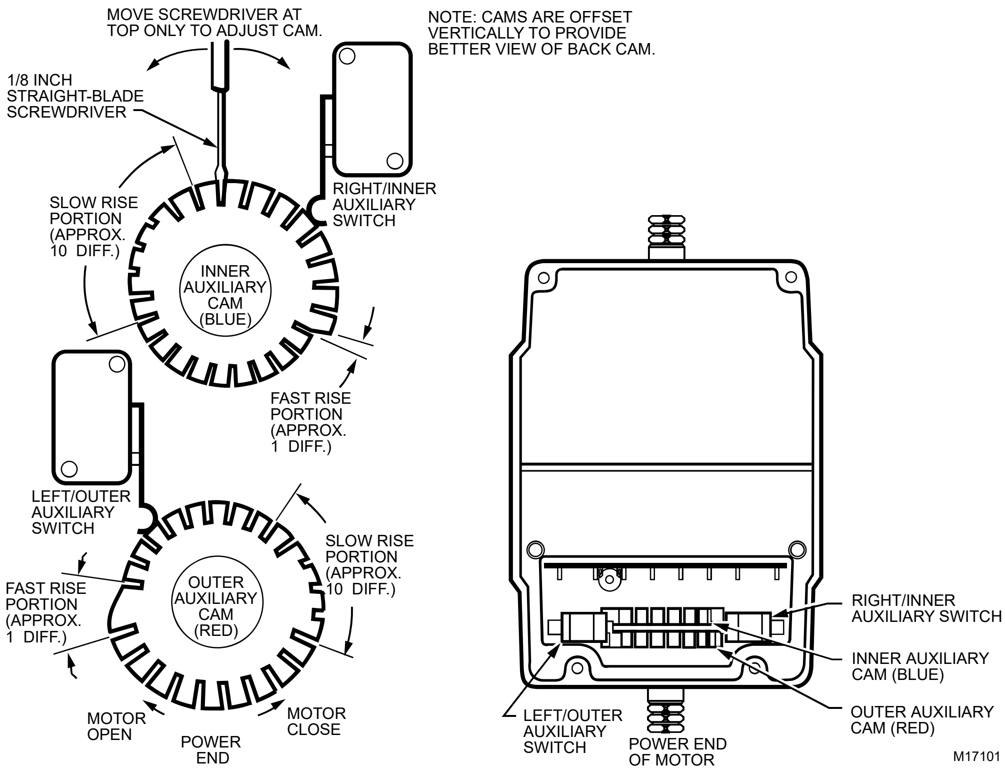


Fig. 12. Auxiliary switch adjustment.

OPERATION AND CHECKOUT

Operation

The internal shaft position feedback potentiometer in conjunction with the actuator microprocessor and modulating input circuit form a control loop. When the external controller's output remains at a fixed amplitude the actuator's shaft position is held at a position proportional to that input amplitude. When the value of the external controllers output changes the actuator responds by initiating movement of the motor to proportionately compensate for the change in input amplitude. When the motor reaches the control loop balance point the system is again in a static state and the actuator holds position until the next change of input from the external controller.

M7685 motor also have a minimum position feature. An external 130 ohm potentiometer wired to terminals 3 and 4 establishes a position beyond which the control input cannot close the motor. If power to the T1-T2 is interrupted the M7685 motor will spring close.

Checkout

After installation and linkage adjustment, operate the motor through the controller. Make sure that:
- The motor properly operates the damper or valve.
- The motor responds properly as the input is varied.
- The auxiliary switch, if used, operates at the desired point of motor rotation.

Inspect the motor, linkage, and valve or damper to see that all mechanical connections are correct and secure.

In damper installations, the pushrod should not extend more than a few inches past the ball joints. Check to see that there is adequate clearance for the linkage to move through its stroke without binding or striking other objects.

See controller or system instructions for additional checkout procedures.

Motor Operation Checkout

For motors with F, + and - terminals:
To close the motor, open terminals +, -, and F.
To open the motor connect terminal F to positive (+) or negative (-).
NOTE: DO NOT SHORT + to -

M7164A1017 and M7164G1030 do not have + or – terminals, and operate as follows:
The motor closes if it does not receive an input to F.
To open the motor, short F to C.

M7685A1025 is a normally open motor, and operates as follows:
To close the motor, short 3 to 4 or short 3 to C.
The motor opens if it does not have an input to 3.

Automation and Control Solutions
Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

63-2640—08 M.S. Rev. 10-12
Printed in United States

Part # 221455A

Honeywell

221455A INFINITELY ADJUSTABLE CRANK ARM KIT FOR MODUTROL IV MOTORS

APPLICATION

The 221455A Crank Arm Kit is used with Modutrol IV Motors. It also fits other Honeywell Modutrol motors. The 221455A Crank Arm is 0.75 inch shorter than the 4074ELY and 7616BR Crank Arms (see Fig. 1). Its shorter length assures clearance in damper applications where a Modutrol IV motor is used without an adapter bracket. To install the crank arm follow the instructions below.

INSTALLATION

WHEN INSTALLING THIS PRODUCT...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete check out product.

INSTALLING

1. Install the crank arm assembly on the motor shaft (see Fig. 2).

NOTE: Adaptor should be flush with the end of the motor shaft.

2. Tighten the tension screw securely after locating the crank arm in the desired position (see Fig. 3).

NOTE: When connecting linkage to the crank arm, make sure that it does not interfere with the screw bosses on the motor when operated through the full stroke.

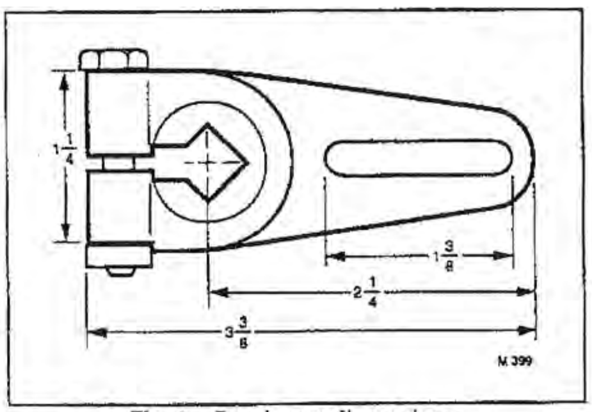


Fig. 1—Crank arm dimensions.

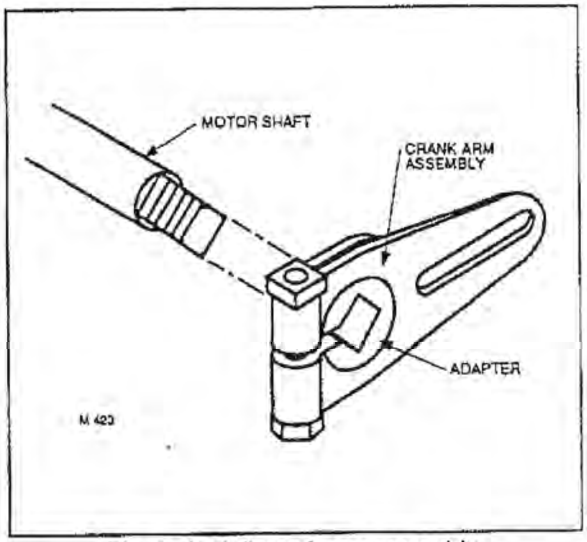


Fig. 2—Install crank arm assembly.

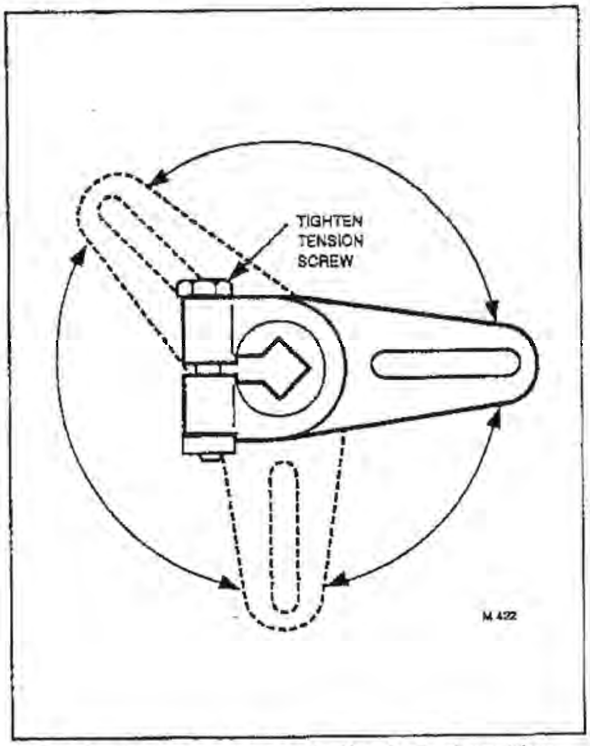


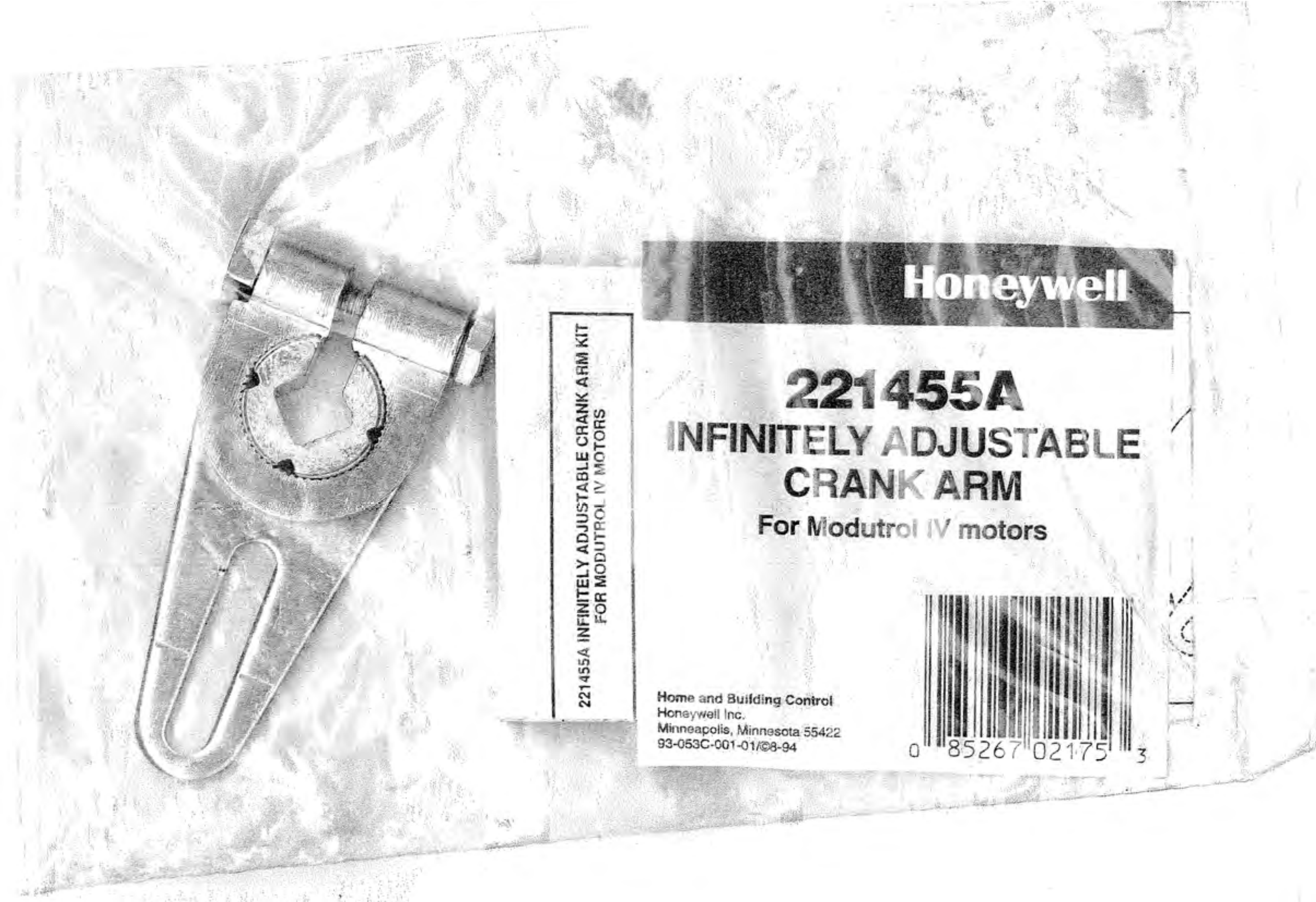
Fig. 3—Locate crank arm to the desired position.

Honeywell Inc.
1885 Douglas Drive N.
Golden Valley, MN 55422—4386

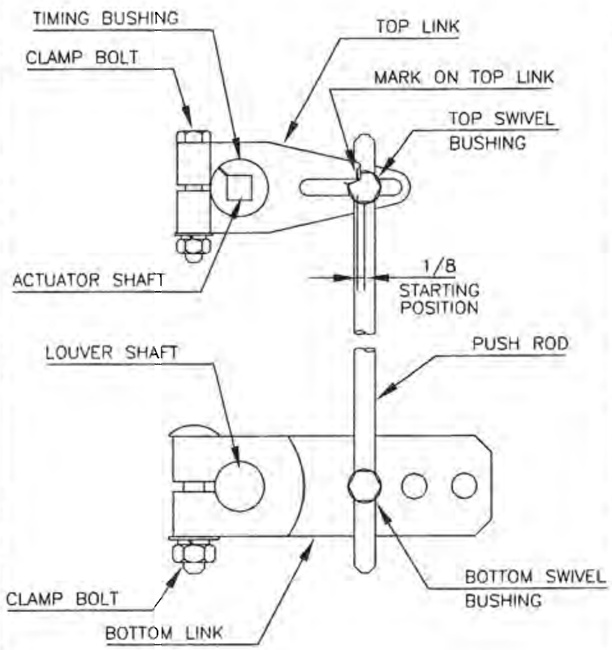
International Sales Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.
PRINTED IN U.S.A.

P.B.
2-90

Form Number 63-2229

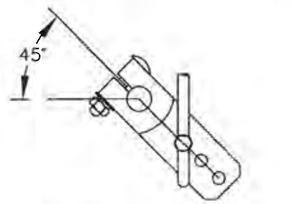

Honeywell
221455A
INFINITELY ADJUSTABLE
CRANK ARM
For Modutrol IV motors
221455A INFINITELY ADJUSTABLE CRANK ARM KIT
FOR MODUTROL IV MOTORS
Home and Building Control
Honeywell Inc.
Minneapolis, Minnesota 55422
93-053C-001-01/©8-94
0 85267 02175 3


102546



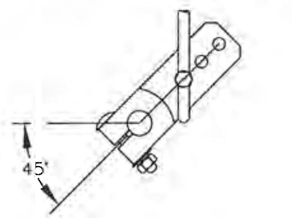
SHOWN AT 50% OPEN

DETAIL A



BOTTOM LINK POSITION WITH LOUVER AT FULL OPEN

DETAIL B



BOTTOM LINK POSITION WITH LOUVER AT FULL CLOSED

DETAIL C

NOTE: LINKAGE TO BE ASSEMBLED TO AUX END OF HONEYWELL ACTUATOR MOTOR.

AFTER ASSEMBLING LINKAGE:

THE CL OF THE ACTUATOR SHAFT AS THE BOTTOM SWIVEL BUSHING IS FROM THE CL OF THE LOUVER SHAFT. (SHOULD BE JUST BEYOND MARK ON TOP LINK-SEE DETAIL A) TIGHTEN TOP SWIVEL BUSHING TO TOP LINK.

2. SET ACTUATOR TO 50% OPEN. LOOSEN TOP CLAMP BOLT. SET SLOT IN TOP LINK TO BE INLINE WITH CL OF ACTUATOR SHAFT. (TOP LINK SHOULD BE HORIZONTAL) TIGHTEN CLAMP BOLT.
3. LOOSEN BOTTOM SWIVEL BUSHING. SET BOTTOM LINK TO BE PARALLEL TO TOP LINK. (BOTTOM LINK SHOULD BE HORIZONTAL) TIGHTEN BOTTOM SWIVEL BUSHING.
4. LOOSEN BOTTOM CLAMP BOLT. SET LOUVER ACTUATOR TO FULL OPEN. MANUALLY MOVE LOUVER TO FULL OPEN POSITION. (SEE DETAIL B) TIGHTEN CLAMP BOLT.
5. SET LOUVER ACTUATOR TO 90% CLOSED. MAKE CERTAIN THAT NO BINDING IS EXPERIENCED IN LINKAGE OR LOUVER.
6. CHECK LOUVER FOR ADDITIONAL TRAVEL TO CLOSED POSITION TO INSURE THAT ACTUATOR DOES NOT TRY TO OVERDRIVE LOUVER WHEN TAKEN TO FULL CLOSED POSITION.
7. SET LOUVER ACTUATOR TO FULL CLOSED. LOUVER SHOULD HAVE A SMALL AMOUNT OF TRAVEL LEFT SO THAT ACTUATOR DOES NOT PUT EXCESSIVE FORCE ON LINKAGE. -IF LOUVER CLOSES BEFORE ACTUATOR IS AT CLOSED POSITION THEN RESET TOP SWIVEL BUSHING SLIGHTLY CLOSER TO THE CL OF THE ACTUATOR SHAFT AND THEN REPEAT STEPS 1 THRU 7.

LTR	DESCRIPTION	DATE	APPROVED
1	REVISED TITLE BLOCK	4/12/05	

REVISIONS

APPLICABLE JOB NO(S). STD STANDARD

PEI PERENNIAL ENERGY
1280 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES	DATE
DESIGNED BY: T.LANDERS	2/13/96
DRAWN BY: T.CREECH/TPH	2/13/96

TITLE: LOUVER LINKAGE SETUP PROCEDURE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30

SIZE: B 34x22

DWG. NO.: PP-042-0009

MATERIAL: AS NOTED | A | SCALE AS NOTED | FILE NO PP-042-0009 R0 S1.DWG | SHEET 1 OF 1

Part # 822A3-OB, 250 Degree F, 14" H x 12" W

SWARTWOUT

3900 Dr. Greaves Rd. • Kansas City, MO 64030 • (816) 761-7476 • FAX (816) 765-8955

822A3 and 822A4 INDUSTRIAL CONTROL DAMPER

GALVANIZED STEEL

STANDARD CONSTRUCTION

FRAME

822A3 – 8" x 2" x 12 gage (203 x 51 x 2.8) steel channel.
822A4 – 8" x 2" x 10 gage (203 x 51 x 3.5) steel channel.

BLADE

822A3 – 5¾" to 7¾" (146 to 197) wide, double skin airfoil type of 16 gage (1.6) steel for blade lengths to 48" (1219) and 14 gage (2) steel for 48" to 60" (1219 to 1524) blade lengths.

822A4 – 5¾" to 7¾" (146 to 197) wide, double skin airfoil type of 12 gage (2.8) steel for blade lengths to 48" (1219) and 10 gage (3.5) steel for 48" to 60" (1219 to 1524) blade lengths.

LINKAGE

Side linkage out of airstream. 3/16" x ¾" (4.8 x 19) plated steel tie bars. ⅜" (9.5) diameter stainless steel pivot pins with lock type retainers. 10 gage (3.5) galvanized steel clevis arms.

AXLES

822A3 – ¾" (19) diameter plated steel.
822A4 – ¾" (19) diameter plated steel for blade lengths up to 48" (1219). 1" (25.4) diameter plated steel for 48" to 60" (1219 to 1524) blade lengths.

BEARINGS

Stainless steel sleeve bolted to frame.

OPERATING LEVER

Hand Quadrant (HQ) for manual operation or Crank Lever (CL) for motor operation.

FINISH

Mill.

MAXIMUM TEMPERATURE

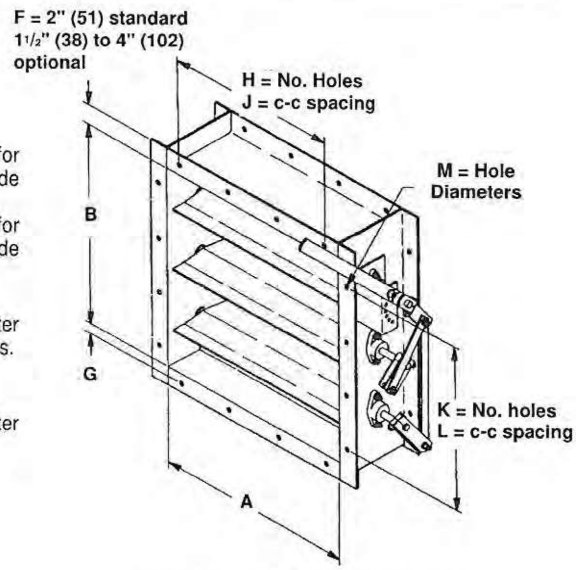
250°F (121°C) is standard. Damper can be supplied for temperatures between 250°F (121°C) and 400°F (204°C) by increasing clearance between blade ends and frame. Advise Swartwout of maximum operating temperature.

MINIMUM SIZE

Single blade, parallel action – 6"w x 6"h (152 x 152).
Two blade, parallel or opposed action – 6"w x 12"h (152 x 305).

MAXIMUM SIZE

60"w x 96"h (1524 x 2438).



ILLUSTRATED WITH OPTIONAL BOLT HOLES IN FLANGES

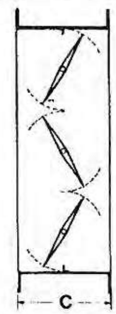
VARIATIONS

Additional variations to those listed in table are available. Consult Swartwout for pricing.

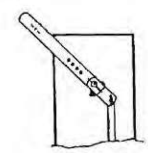
- Higher temperature construction
- Other materials/heavier construction
- Special finishes.

Dimensions in parenthesis (   ) indicate millimeters

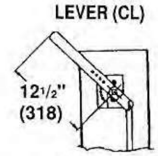
8" (203)
STANDARD
PARALLEL BLADE
(PB)



8" (203)
STANDARD
OPPOSED BLADE
(OB)



CRANK
LEVER (CL)



HAND
QUADRANT
(HQ)

FRAME	BLADES	AXLES	BEARINGS	LINKAGE	SEALS (OPT)	ACCESSORIES
12 GA (2.8) GALVANIZED STEEL	16 GA (1.6) to 48" (1219) 14 GA (2) to 60" (1524) GALV	¾" (19) DIA. PLATED STEEL	SS SLEEVE IN CAST HSG BOLTED TO FRAME	SIDE LINKAGE (CONCEALED)	BLADE SEALS EPDM 250°F (121°C) MAX	HAND QUADRANT (HQ)
10 GA (3.5) GALVANIZED STEEL	12 GA (2.8) to 48" (1219) 10 GA (3.5) to 60" (1524) GALV	¾" (19) DIA. PLATED STEEL to 48", 1" (25.4) DIA PLTD STL OVER 48" (1219) to 60" (1524)	BRGS BOLTED TO FRAME W/INTEGRAL SHAFT SEALS (OPT)		BLADE SEALS SILICONE 400°F (200°C) MAX	CRANK LEVER (CL)
12 GA (2.8) 304SS	16 GA (1.6) 304SS to 48" (1219) 14 GA (2) 304SS to 60" (1524)	1" (25.4) DIA PLTD STL (OPT)	OUTBOARD BRGS W/SHAFT SEALS (OPT)		SS JAMB SEALS	BOLT HOLES ONE FLANGE (OPT)
10 GA (3.5) 304SS	12 GA (2.8) 304SS to 48" (1219) 10 GA (3.5) 304SS to 60" (1524)	¾" (19) DIA. SS (Opt)				BOLT HOLES BOTH FLANGES (OPT)
12 GA (2.8) 316SS	16 GA (1.6) 316SS to 48" (1219) 14 GA (2) 316SS to 60" (1524)	1" (25.4) DIA.SS (Opt)				PNEUMATIC ACTUATOR (OPT)
10 GA (3.5) 316SS	12 GA (2.8) 316SS to 48" (1219) 10 GA (3.5) 316SS to 60" (1524)					ELECTRIC ACTUATOR (OPT)
						1½" (38) TO 4" (102) FLANGES (OPT)

QTY.	MODEL	BLADE ACTION		DIMENSIONS												COMMENTS	TAG
		PB	OB	A	B	C	F	G	H	J	K	L	M				

PROJECT

ARCH./ENGR.

REPRESENTATIVE

LOCATION:

CONTRACTOR

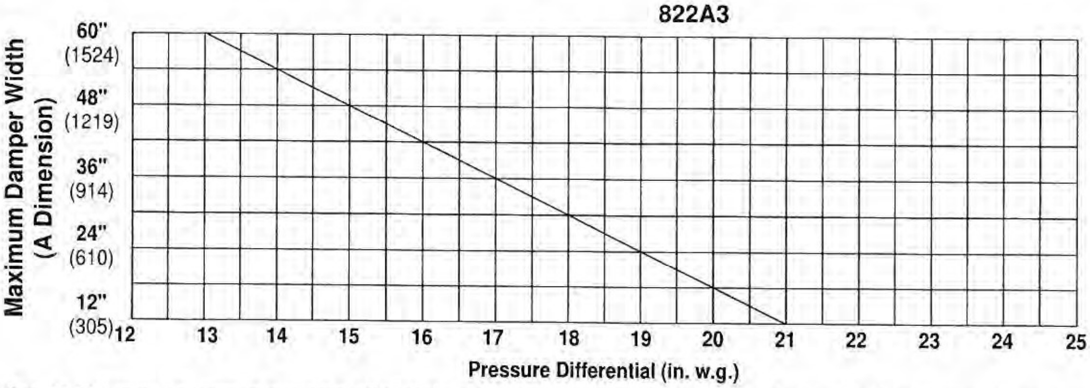
DATE

ALL STATED SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE OR OBLIGATION.

Differential pressure is due to purge blower at start up, stack effect during operation. In both cases this is well under 1" WC

822A3 and 822A4 PERFORMANCE DATA

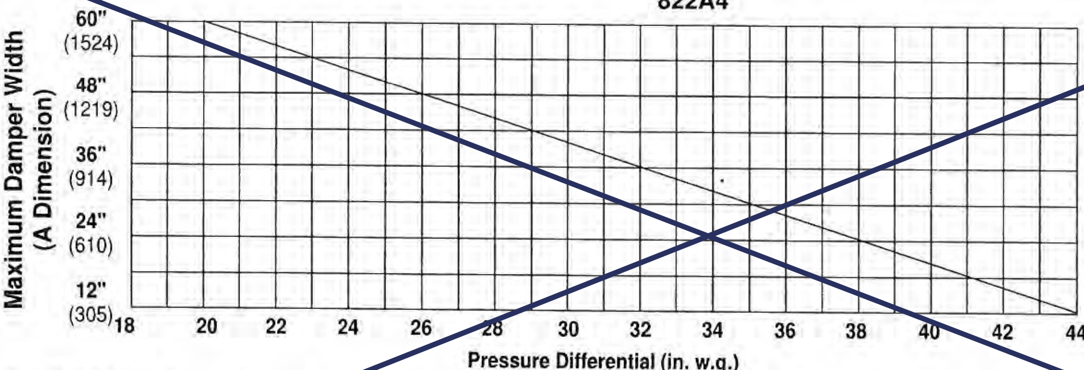
822A3



Pressure limitations shown on charts at left allow maximum blade deflection of 1/180 of span on 60" (1524) damper widths. Deflections in other damper widths, (less than 48" [1219]) at higher pressures shown will result in blade deflection substantially less than 1/180 of span.

The 822A3 may be used in systems with total pressure exceeding 13" w.g. by reducing the damper section with as indicated in the chart. A maximum design total pressure of 17" w.g. would require at 822A3 damper with maximum section width of 36" (914).

822A4



***NOTE:** Damper should be specified for fan shut off pressure. Pressure differential is **not** system pressure, but is the maximum pressure the damper will encounter with blades closed.

The 822A4 may be used in systems with total pressure exceeding 20" w.g. by reducing the damper section width as indicated in the chart. A maximum design total pressure of 26" w.g., for example, would require an 822A4 damper with maximum section width of 48" (1219).
The 822A dampers may tolerate higher pressure limitations than those shown here. Conservative ratings are presented intentionally in an effort to avoid misapplication. Consult Swartwout or your Swartwout representative when a damper is to be applied in conditions exceeding recommended maximums.

822A3 SUGGESTED SPECIFICATION

Furnish and install, at locations shown in plans or in accordance with schedules, industrial grade control dampers meeting the following construction standards: Frame shall be minimum 8" deep x 2" flanged 12 gage (203 x 51 x 2.8), galvanized steel channel. Blades shall be double skin airfoil design, maximum 7¾" (197) wide and minimum 16 gage (1.6) galvanized steel for blade lengths up to 48" (1219) and 14 gage (2) galvanized steel from 48" (1219) thru 60" (1524). Axles shall be minimum ¾" (19) diameter plated steel rod. Bearing shall be stainless steel sleeve pressed into cast housing bolted to the damper frame. Oil impregnated bronze or press fit bearings are not acceptable. Linkage shall be located in jamb out of airstream and constructed of minimum 10 gage (3.5) steel clevis arms with 3/16" x ¾" (4.8 x 19) plated steel tie bars pivoting on ⅜" (9.5) diameter stainless steel pivot pins with lock type retainers. Face linkage in airstream is not acceptable. Standard construction shall include (specifier choose) locking hand quadrant for manual operation or crank lever for motor operation. Submittal data must include leakage, pressure drop and maximum pressure data based on AMCA Standard 500 testing. Data shall be for full range of damper sizes. Data from one size sample test is not acceptable. Damper shall be Swartwout model 822A3 Control Damper.

ADD TO SPECIFICATION IF REQUIRED:
Dampers shall be equipped with blade and jamb seals for low leakage application. Blade seals shall be mechanically attached to blade. Adhesive type seals are not acceptable. Jamb seals shall be flexible stainless steel located between blade edge and jamb for maximum sealing compression. Wind stops or sponge seals are not acceptable.

822A4 SUGGESTED SPECIFICATION

Furnish and install, at locations shown in plans or in accordance with schedules, industrial grade control dampers meeting the following construction standards: Frame shall be minimum 8" deep x 2" flanged 10 gage (203 x 51 x 3.5), galvanized steel channel. Blades shall be double skin airfoil design, maximum 7¾" (197) wide and minimum 12 gage (2.8) galvanized steel for blade lengths up to 48" (1219) and 10 gage (3.5) galvanized steel from 48" (1219) thru 60" (1524). Axles shall be minimum ¾" (19) diameter plated steel rod for blade lengths up to 48" (1219) and 1" (25.4) diameter for 48" (1219) to 60" (1524) blade lengths. Bearing shall be stainless steel sleeve pressed into cast housing bolted to the damper frame. Oil impregnated bronze or press fit bearings are not acceptable. Linkage shall be located in jamb out of airstream and constructed of minimum 10 gage (3.5) steel clevis arms with 3/16" x ¾" (4.8 x 19) plated steel tie bars pivoting on ⅜" (9.5) diameter stainless steel pivot pins with lock type retainers. Face linkage in airstream is not acceptable. Standard construction shall include (specifier choose) locking hand quadrant for manual operation or crank lever for motor operation. Submittal data must include leakage, pressure drop and maximum pressure data based on AMCA Standard 500 testing. Data shall be for full range of damper sizes. Data from one size sample test is not acceptable. Damper shall be Swartwout model 822A4 Control Damper.

ADD TO SPECIFICATION IF REQUIRED:
Dampers shall be equipped with blade and jamb seals for low leakage application. Blade seals shall be mechanically attached to blade. Adhesive type seals are not acceptable. Jamb seals shall be flexible stainless steel located between blade edge and jamb for maximum sealing compression. Wind stops or sponge seals are not acceptable.

PRESSURE DROP INFORMATION

AREA FACTOR TABLE

Model	B Dim. Height In Inches (mm)	Dimension A – Width In Inches 6" (152)	9" (229)	12" (305)	15" (381)	18" (457)	21" (533)	24" (610)	27" (686)	30" (762)	33" (838)	36" (914)	39" (991)	42" (1067)	45" (1143)	48" (1219)	51" (1295)	54" (1372)	57" (1448)	60" (1524)
A3	6" (152)	6.55	4.37	3.28	2.62	2.18	1.87	1.64	1.46	1.31	1.19	1.09	1.01	.94	.87	.82	.77	.73	.69	.66
A4		6.65	4.43	3.33	2.66	2.22	1.90	1.66	1.48	1.33	1.21	1.11	1.02	.92	.89	.83	.85	.80	.76	.72
A3	9" (229)	3.89	2.60	1.95	1.56	1.30	1.11	.97	.87	.78	.71	.65	.60	.56	.52	.49	.46	.43	.41	.39
A4		3.93	2.62	1.96	1.57	1.31	1.12	.98	.87	.79	.71	.65	.60	.56	.52	.49	.48	.46	.43	.41
A3	12" (305)	2.72	1.81	1.36	1.09	.91	.78	.68	.60	.54	.49	.45	.42	.39	.36	.34	.32	.30	.29	.27
A4		2.75	1.84	1.38	1.10	.92	.79	.69	.61	.55	.50	.46	.42	.39	.37	.34	.34	.33	.31	.29
A3	15" (381)	2.03	1.35	1.01	.81	.68	.58	.51	.45	.41	.37	.34	.31	.29	.27	.25	.24	.23	.21	.20
A4		2.05	1.37	1.02	.82	.68	.59	.51	.46	.41	.37	.34	.32	.29	.27	.26	.25	.24	.23	.21
A3	18" (457)	1.72	1.14	.86	.69	.57	.49	.43	.38	.34	.31	.29	.26	.25	.23	.21	.20	.19	.18	.17
A4		1.74	1.16	.87	.69	.58	.50	.43	.39	.35	.32	.29	.27	.25	.23	.22	.22	.20	.19	.18
A3	24" (610)	1.25	.84	.63	.50	.42	.36	.31	.28	.25	.23	.21	.19	.18	.17	.16	.15	.14	.13	.13
A4		1.27	.85	.63	.51	.42	.36	.32	.28	.25	.23	.21	.20	.18	.17	.16	.16	.15	.14	.13
A3	30" (762)	.95	.64	.48	.38	.32	.27	.24	.21	.19	.17	.16	.15	.14	.13	.12	.11	.11	.10	.10
A4		.96	.64	.48	.39	.32	.28	.24	.21	.19	.18	.16	.15	.14	.13	.12	.12	.11	.11	.10
A3	36" (914)	.79	.53	.40	.32	.26	.23	.20	.18	.16	.14	.13	.12	.11	.11	.10	.09	.09	.08	.08
A4		.80	.53	.40	.32	.27	.23	.20	.18	.16	.15	.13	.12	.11	.11	.10	.10	.09	.09	.08
A3	42" (1067)	.68	.45	.34	.27	.23	.19	.17	.15	.14	.12	.11	.10	.10	.09	.08	.08	.08	.07	.07
A4		.68	.46	.34	.27	.23	.20	.17	.15	.14	.12	.11	.11	.10	.09	.09	.08	.08	.08	.07
A3	48" (1219)	.59	.39	.30	.24	.20	.17	.15	.13	.12	.11	.10	.09	.08	.08	.07	.07	.07	.06	.06
A4		.60	.40	.30	.24	.20	.17	.15	.13	.12	.11	.10	.09	.09	.08	.07	.07	.07	.07	.06
A3	54" (1372)	.52	.35	.26	.21	.17	.15	.13	.12	.10	.10	.09	.08	.07	.07	.07	.06	.06	.06	.05
A4		.53	.35	.26	.21	.18	.15	.13	.12	.11	.10	.09	.08	.08	.07	.07	.07	.06	.06	.06
A3	60" (1524)	.46	.31	.23	.19	.15	.13	.12	.10	.09	.08	.08	.07	.07	.06	.06	.05	.05	.05	.05
A4		.47	.31	.23	.19	.16	.13	.12	.10	.09	.08	.08	.07	.07	.06	.06	.06	.05	.05	.05
A3	66" (1776)	.42	.28	.21	.17	.14	.12	.11	.09	.08	.08	.07	.06	.06	.06	.05	.05	.05	.04	.04
A4		.42	.28	.21	.17	.14	.12	.11	.09	.08	.08	.07	.07	.06	.06	.05	.05	.05	.04	.04
A3	72" (1829)	.39	.26	.19	.16	.13	.11	.10	.09	.08	.07	.06	.06	.06	.05	.05	.05	.04	.04	.04
A4		.39	.26	.19	.16	.13	.11	.10	.09	.08	.07	.06	.06	.06	.05	.05	.05	.04	.05	.04
A3	78" (1981)	.36	.24	.18	.14	.12	.10	.09	.08	.07	.06	.06	.05	.05	.05	.04	.04	.04	.04	.04
A4		.36	.24	.18	.14	.12	.10	.09	.08	.07	.07	.06	.06	.05	.05	.04	.04	.04	.04	.04
A3	84" (2134)	.33	.22	.17	.13	.11	.09	.08	.07	.07	.06	.06	.05	.05	.04	.04	.04	.04	.04	.03
A4		.33	.22	.17	.13	.11	.10	.08	.07	.07	.06	.06	.05	.05	.04	.04	.04	.04	.04	.03
A3	90" (2286)	.31	.21	.16	.12	.10	.09	.08	.07	.06	.06	.05	.05	.04	.04	.04	.04	.03	.03	.03
A4		.31	.21	.16	.12	.10	.09	.08	.07	.06	.06	.05	.05	.04	.04	.04	.04	.04	.04	.03
A3	96" (2438)	.29	.19	.14	.11	.10	.08	.07	.06	.06	.05	.05	.04	.04	.04	.04	.03	.03	.03	.03
A4		.29	.19	.14	.12	.10	.08	.07	.06	.06	.05	.05	.04	.04	.04	.04	.04	.03	.03	.03

DETERMINING PRESSURE DROP

Use the Area Factor Table and Pressure Drop Chart to determine pressure drop through Swartwout 822A3/822A4 control dampers.

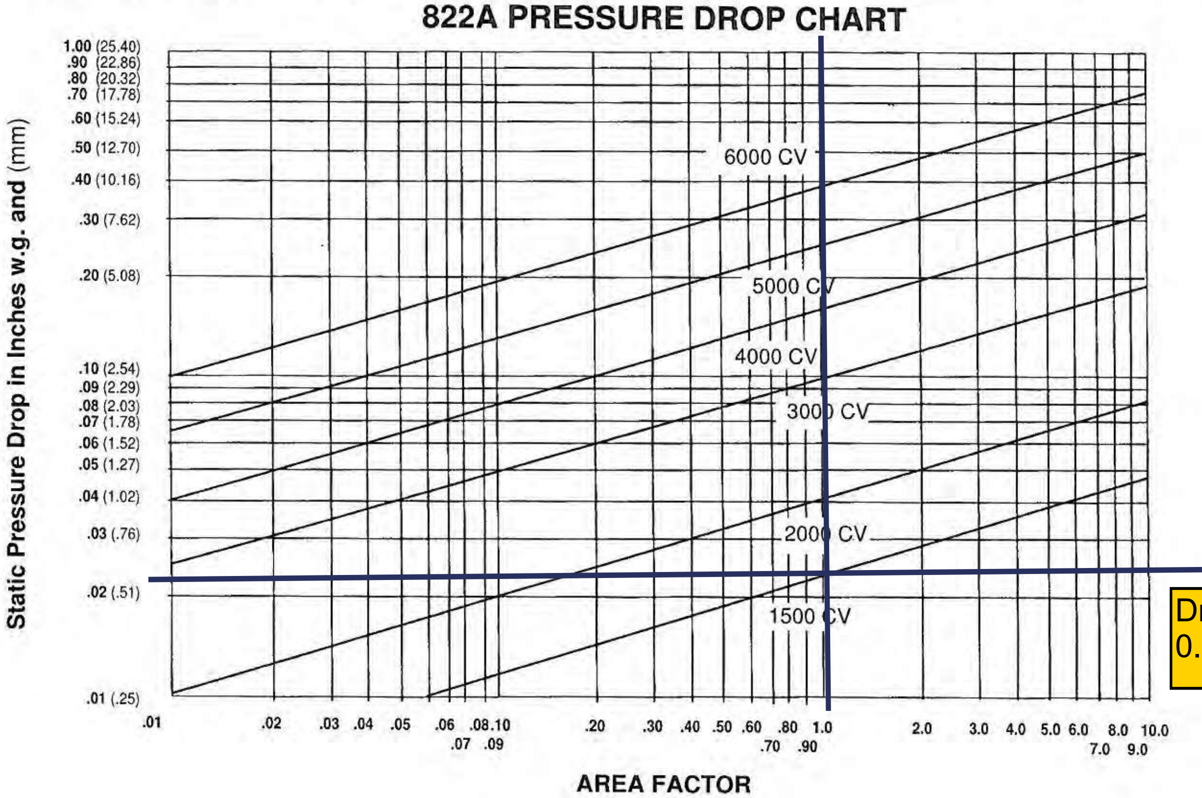
1. Determine area factor for damper by entering the area factor table with duct width and height.
2. Find the conversion velocity (CV) by multiplying the selected size damper 's area factor by the flow rate in CFM: **CV = Area Factor x CFM.**
3. Enter the pressure drop chart at the determined area factor and proceed up to appropriate conversion velocity (CV) line. Then, read across to pressure drop at left side of chart.

Air Flow at 3 MM BTU/Hr is 1510 SCFM. CV= 1525

EXAMPLE:
1. Find the pressure drop across a 18" wide x 18" (457 x 457) high Model 822A4 control damper handling 8570 CFM. From the Area Factor Table,area factor is determined to be .58.
2. **CFM x AREA FACTOR EQUALS CONVERSION VELOCITY.** Therefore, CV (Conversion Velocity) = 8570 CFM x .58 = 5000. Using the Pressure Drop Chart, pressure drop = .22 inches water gage.

NOTES:
1. Ratings are based on AMCA Standard 500 using Test Setup Apparatus Figure 5.3 (damper is installed with duct upstream and downstream).
2. Static Pressure and Conversion Velocities are corrected to .075 lb./cu. ft. air density.

822A PRESSURE DROP CHART



Drop= 0.022" WC

822A3 and 822A4 PERFORMANCE DATA

822A3								
DAMPER WIDTH INCHES (MM)	MAX. SYSTEM PRESSURE	MAX. SYSTEM VELOCITY	Leakage w/o Seals*		Leakage with Seals*		Ultra-Low Leakage**	
			Percent of Max. Flow	CFM/Sq. Ft.	Percent of Max. Flow	CFM/Sq. Ft.	Percent of Max. Flow	CFM/Sq. Ft.
60" (1524)	13.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
48" (1219)	15.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
36" (914)	17.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
24" (610)	19.0" w.g.	6000	0.67	40.0	0.13	8.0	0.10	5.8
12" (305)	21.0" w.g.	6000	1.00	60.0	0.22	13.0	0.16	9.5

822A4								
DAMPER WIDTH INCHES (MM)	MAX. SYSTEM PRESSURE	MAX. SYSTEM VELOCITY	Leakage w/o Seals*		Leakage with Seals*		Ultra-Low Leakage**	
			Percent of Max. Flow	CFM/Sq. Ft.	Percent of Max. Flow	CFM/Sq. Ft.	Percent of Max. Flow	CFM/Sq. Ft.
60" (1524)	20.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
48" (1219)	26.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
36" (914)	32.0" w.g.	5000	0.64	32.0	0.08	4.0	0.06	2.9
24" (610)	35.0" w.g.	6000	0.67	40.0	0.13	8.0	0.10	5.8
12" (305)	44.0" w.g.	6000	1.00	60.0	0.22	13.0	0.16	9.5

*Leakage information based on pressure differential of 1" w.g. tested per AMCA Std. 500.
**For details on "ULltra-Low Leakage," contact Swartwout.

LEAKAGE CORRECTION FACTOR

Static Pressure (in. w.g.)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Correction Factor	1.0	1.4	1.7	2.0	2.2	.24	2.6	2.8	3.0	3.2	3.3	3.5	3.6	3.7	3.9	4.0	4.1	4.2	4.4	4.5

DETERMINING LEAKAGE

To determine leakage per square foot at static pressure differentials higher than one inch water gage, multiply leakage at one inch (determined from appropriate table above) by correction factor for higher static pressure (determined from the Leakage Correction Factor Table).

Example: Find leakage per square foot for a 36" wide (914) damper equipped with optional blade and jamb seals at 3" water gage: 4 CFM per sq. foot x 1.7 = 6.8 CFM per sq. foot leakage at 3 inches water gage.

Leakage ratings are based on AMCA Standard 500 using Test Setup Apparatus Figure 5.5. Torque applied holding damper closed at 10 in. lbs. per sq. ft. of damper with minimum of 20 in. lbs.

INSTALLATION

For proper operation, damper must be installed square and free from racking. Opposed blade dampers must be operated from a power blade on the drive axle.

NOTE:

Dampers are designed for operation with blades running horizontally. Dampers to be installed with vertical blades require thrust collars be added at time of damper manufacture and at additional cost. Some standard features are not available with vertical bladed dampers.

3900 Dr. Greaves Rd.
Kansas City, MO 64030
(816) 761-7476
FAX (816) 765-8955
www@Swartwout.com

Sight Glasses

Five Stemmerich view ports are provided to allow visualization of the combustion process. They are tagged FLR-BG-501-505, and are part # P1030-8.

FLR-BG-501-505
Part # Figure 540 P 1030-8

Stemmerich, Inc.

SIGHT WINDOWS THREADED CONNECTION

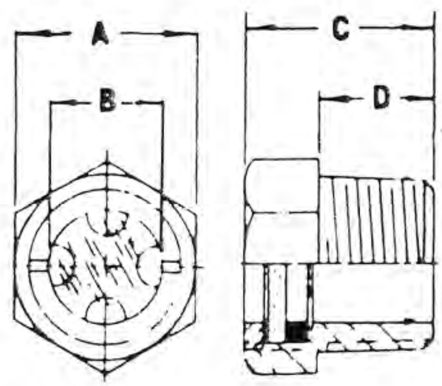
LOW PRESSURE

CONSTRUCTION: BRASS, CARBON STEEL, STAINLESS STEEL

Fig. 540

With Reflector

Fig. 540S



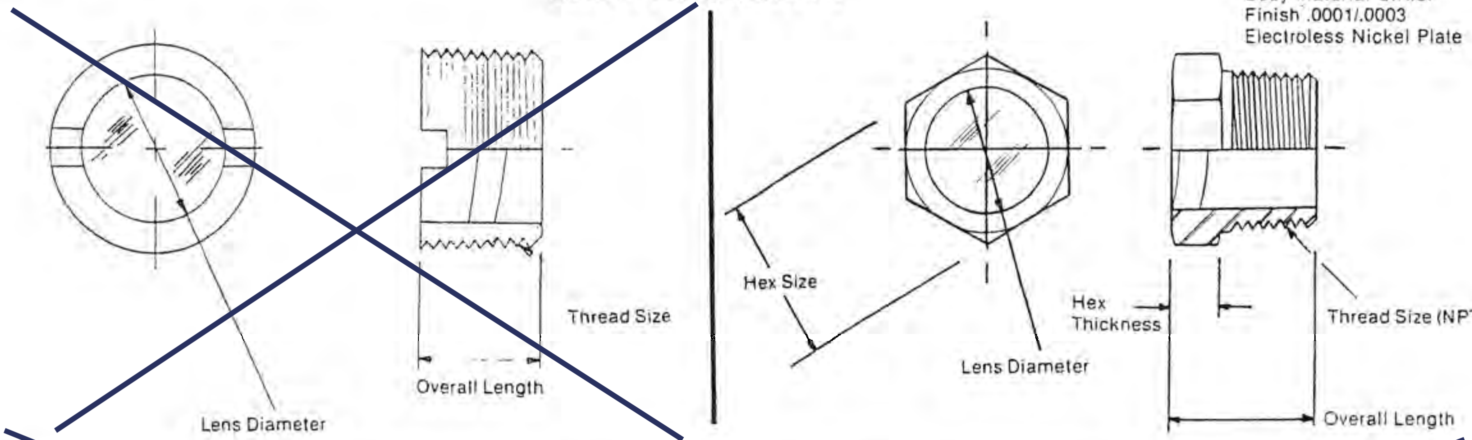
NPT Conn.	Dimensions in Inches				Pressure Rating (P.S.I.)	
	A	B	C	D	Brass	St. Steel / Carbon Steel
3/8	7/8	15/32	7/8	1/2	100	300
1/2	1	19/32	7/8	1/2	90	275
3/4	1-1/8	11/16	1	9/16	80	250
1	1-3/8	15/16	1-1/8	11/16	60	200
1-1/4	1-7/8	1-1/4	1-1/4	11/16	35	150
1-1/2	2-1/8	1-1/2	1-1/4	11/16	25	100
2	2-1/2	1-1/2	1-1/4	11/16	25	N/A

4728 GRAVOIS AVENUE, BOX 2708
ST. LOUIS, MO 63116
PHONE: 314 832-7726

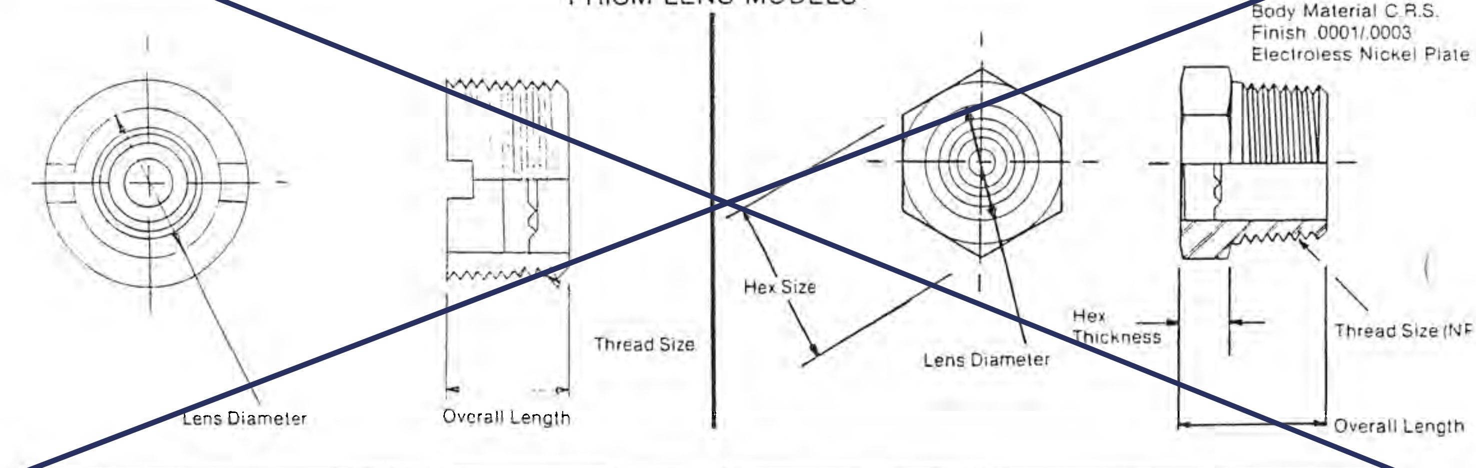
800-325-9528
314-832-7799 (FAX)

Stemmerich, Inc.

CLEAR LENS MODELS



PRISM LENS MODELS



Replace those obsolete gasket type sight glass assemblies with hermetically sealed sight glass windows and take advantage of their many inherent features such as attractive pricing, leakproof service, greater mechanical strength, and easy installation.

On the prism lens models circular "vee" shaped grooves are moulded into the glass during the hermetic sealing process. The reflective surfaces of these grooves will reflect light in the absence of any liquid. Therefore, low liquid level conditions are readily detected. For better liquid level indication, specify prism lens style sight glasses.

SPECIFICATIONS

HEX MODEL NO./CLEAR LENS	P-1030-1	P-1030-2	P-1030-3	P-1030-4	P-1030-5	P-1030-6	P-1030-7	P-1030-8
HEX MODEL NO./PRISM LENS	N/A	P-1022-2	P-1022-3	P-1022-4	P-1022-5	P-1022-6	P-1022-7	P-1022-8
SLOTTED MODEL NO./CLEAR LENS	P-1014-1	P-1014-2	P-1014-3	P-1014-4	P-1014-5	P-1014-6	P-1014-7	P-1014-8
SLOTTED MODEL NO./PRISM LENS	N/A	P-1140-2	P-1140-3	P-1140-4	P-1140-5	P-1140-6	P-1140-7	P-1140-8
THREAD SIZE (N.P.T.)	1/4-18	3/8-18	1/2-14	3/4-14	1-11 1/2	1 1/4-11 1/2	1 1/2-11 1/2	2-11 1/2
LENS DIAMETER	.343	.437	.562	.750*	.937	1.187	1.437	1.875**
OVERALL LENGTH (HEX MODEL)	5/8	23/32	25/32	15/16	1 1/4	1 7/32	1 7/32	1 5/32
OVERALL LENGTH (SLOTTED MODEL)	7/16	1/2	9/16	5/8	3/4	13/16	13/16	7/8
HEX SIZE	5/8	3/4	15/16	1 1/16	1 3/8	1 3/4	2	2 1/2
HEX THICKNESS	3/16	7/32	7/32	5/16	5/16	13/32	13/32	13/32

* I.D. ON SLOTTED MODELS (−4 SIZE) IS .718

** I.D. ON SLOTTED MODELS (−8 SIZE) IS 1.760

Typical Design Pressures (Clear Lens Models)

Lens Diameter	.343	.437	.562	.750	.937	1.187	1.437	1.875
Design Pressure (PSIG)	4000	3700	2500	3000	2500	2000	1500	1000

Note: Actual working pressure to which these units are subjected should be chosen by the user to assure a proper margin of safety.
Maximum operating temperature 500° F

Temperature Switch

A temperature switch is provided to protect the flame arrester from burn back. This switch is normally closed, and opens when the temperature exceeds setpoint.

This switch is tagged FLR-TS-301, and is an Ashcroft part # T7-24-TS-040-235/375F.

FLR-TS-301
Part # T7-24-TS-040-235/375, NEMA 7

ASHCROFT®
Trust the shield.™

B-Series Temperature Switches

FEATURES

B-Series switches have proven reliable in such harsh environments as:

- ***Offshore oil rigs***
- ***Chemical and petrochemical plants***
- ***Pulp and paper mills***
- ***Steel mills***
- ***Power plants***
- ***Water and sewage-treatment plants***
- ***Other corrosive environments***

Ashcroft Inc. supplies highly reliable Ashcroft® switches and controls for industrial and process applications. We begin with rock-solid designs, matching the most appropriate technology with the safety and reliability requirements of the applications. The materials of construction are specified to Ashcroft's exacting standards, and product is built to last in the toughest applications. Our modern, responsive manufacturing facility is supported by an extensive network of stocking distributors and factory sales offices located in virtually every part of the world. Special application assistance is always just a telephone call away.

The Ashcroft B-Series switch line is designed to satisfy most switch requirements. Materials of construction have been selected for long life. A wide variety of precision switch elements are available to meet every application requirement, including hermetically sealed contacts for added reliability and safety. The actuators we use have been proven in more than 20 years of service in the world's plants and mills. Special designs are available for fire safety, NACE, limit control and other more stringent requirements. Simplicity and ease of use are stressed to improve reliability of the installation.

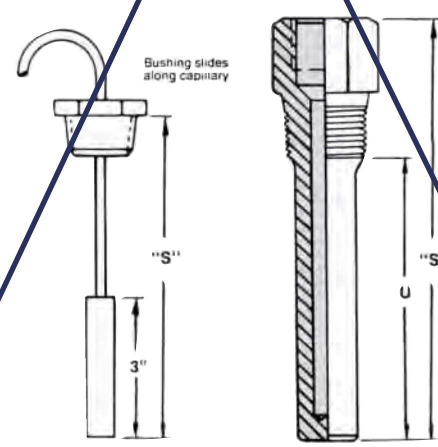
Applications include: pumps, compressors, washers, filters, degreasers, evaporators, recovery systems, food processing, ground support equipment, reverse osmosis systems, heat exchangers, hydraulic systems, lubrication systems, marine equipment, textile machinery, heating and air conditioning equipment.

Thermowells

Thermowells must be used on any application where the stem of the temperature switch may be exposed to pressure, corrosive fluids or high velocity. Additionally, the use of a thermowell permits instrument interchange or calibration check without disturbing or closing down the process.

Ashcroft temperature switches have bulb diameters to match ⅜″ nominal bore thermowells. The bulbs have a sensitive portion length of 2″ which can be used with 2½″ "U" dimensioned thermowells or longer. For maximum accuracy, a thermowell's "U" dimension should be selected to permit complete immersion of the sensitive portion plus 1″ when measuring the temperature of liquids; an extra 3″ should be allowed when measuring the temperature of gases.

Thermowell bushings should be used with remote mount temperature switches. We recommend the standard 3″ bulb and code 69 Series bushings for use with any thermowell "U" dimension. A split rubber grommet allows easy installation and "S" dimension adjustment.



Ashcroft Inc., 250 East Main Street, Stratford, CT 06614 USA
Tel: 203-378-8281 • Fax: 203-385-0408
email: info@ashcroft.com • www.ashcroft.com

B-Series Temperature Switches

Temperature Switches

B-Series temperature switches feature a SAMA Class II vapor pressure thermal system. This system provides quick, accurate response to process temperature changes with negligible ambient temperature effects. This is inherent in the design due to the precise relationship that exists between temperature and pressure according to the vapor pressure laws. A wide selection of sensing bulb and armored capillary lengths is available. The vapor pressure system design features small bulb sizes, making installation easy and cost-effective.

All models feature ±1.0% percent of span setpoint repeatability with very high overtemperature ratings.

These standard designs perform well in applications where shock and vibration could be a problem and should be used with Ashcroft thermowells for bulb protection and ease of installation and maintenance.

STANDARD TEMPERATURE RANGE SELECTION

Nominal Range(1),(5)		Maximum Temperature	Approximate Deadband(1) Switch Element(4)				
°F	°C	°F	20, 26, 27	21, 24, 31	50	22	32, 42
–40 to 60	–40 to 16	400	1.0-2.0	3.0-8.0	1.5-5.5	1.4-6.0	8.0-16.0
0 to 100	–20 to 40	400	1.5-3.0	5.0-12.0	2.2-8.5	1.5-7.5	9.0-20.0
75 to 205	20 to 95	400	1.5-3.5	8.0-16.0	2.5-12.0	2.0-9.0	10.0-24.0
150 to 260	65 to 125	400	1.5-3.0	5.0-12.0	2.2-8.5	2.0-9.0	10.0-24.0
235 to 375	110 to 190	500	1.5-3.5	5.0-12.0	2.5-8.5	2.0-9.0	10.0-24.0
350 to 525(3)	175 to 275	700	2.0-4.5	8.0-16.0	3.2-12.0	2.5-10.0	15.0-34.0
500 to 750(2)	260 to 400	900	4.0-8.0	16.0-30.0	7.2-24.0	5.0-23.0	30.0-50.0

NOTES:

1 All deadbands given in °F.
2 Available with remote mount thermal systems only.
3 Not available with 2¾˝ stem.
4 Dual switch element multiply single switch element value by 1.6 for approximate deadband.
5 Set and reset points must fall within the adjustable range.

B-Series Temperature Switches

B-SERIES TEMPERATURE SWITCH MODEL NUMBER:

To specify the exact switch desired, select entries from appropriate tables as shown in example below.

1		2		3			4	5			6
T	4	2	0	T	0	5	030	X	N	H	150° to 260°F

1 – ENCLOSURE	
T4	Temperature switch, Type 400, watertight enclosure meets NEMA 3, 4, 4X, 13 and IP66 requirements.
T7	Temperature switch, Type 700, explosion-proof enclosure meets Div. 1 & 2, NEMA 7, 9 and IP66 requirements.

2 – SWITCH ELEMENT SELECTION		
Order Code	**Switch Elements UL/CSA Listed SPDT**	
20(7)	Narrow deadband ac	15A, 125/250 Vac
21	Ammonia service	5A, 125/250 Vac
22(6)	Hermetically sealed switch, narrow deadband	5A, 125/250 Vac
23	Heavy duty ac	22A, 125/250 Vac
24(1)	General purpose	15A, 125/250/480 Vac ½A, 125 Vdc ¼A, 250 Vdc; 6A, 30 Vdc
25	Heavy duty dc	10A, 125 Vac or dc, ⅛ HP, 125 Vac or dc
26(7)	Sealed environment proof	15A, 125/250 Vac
27	High temperature 300°F	15A, 125/250 Vac
28(5)	Manual reset trip on increasing	15A, 125/250 Vac
29(5)	Manual reset trip on decreasing	15A, 125/250 Vac
31	Low level (gold) contacts	1A, 125 Vac
32	Hermetically sealed switch, general purpose	11A, 125/250 Vac 5A, 30 Vdc
42	Hermetically sealed gold contacts	1A, 125 Vac
50	Variable deadband	15A, 125/250 Vac
UL/CSA Listed Dual (2 SPDT)		
61(7)	Dual narrow deadband	15A, 125/250 Vac
62(7)	Dual sealed environment proof	15A, 125/250 Vac
63	Dual high temp. 300°F	15A, 125/250 Vac
64	Dual general purpose	15A, 125/250/480 Vac ½A, 125 Vdc ¼A, 250 Vdc
65	Dual ammonia service	5A, 125/250 Vac
67(4,6)	Dual hermetically sealed switch, narrow deadband	5A, 125/250 Vac
68(4)	Dual hermetically sealed switch, general purpose	11A, 125/250 Vac 5A, 30 Vdc
70	Dual low level gold contacts	1A, 125 Vac
71(4)	Dual hermetically sealed switch, gold contacts	1A, 125 Vac

3 – THERMAL SYSTEM SELECTION			
Direct Mount			
Order Code	**System Material**	**Style**	
TS	316 SS	Rigid	
Remote Mount			
Order Code	**System Material**	**Line Length**	**Style(9)**
T05	316 SS	5′	Capillary with 302 SS Spring Armor
T10	316 SS	10′	
T15	316 SS	15′	
T20	316 SS	20′	
T25	316 SS	25′	

4 – BULB LENGTH SELECTION		
Direct Mount		
Order Code	**"S" Dimension**	**Minimum Thermowell "U" Dimension**
027(8)	2¾″	–
040	4″	2½″
060	6″	4½″
090	9″	7½″
120	12″	10½″
Remote Mount		
030(9)	3″	2½″

5 – OPTIONS
Use table on page 7

6 – STANDARD TEMPERATURE RANGE SELECTION	
Adjustable Range	
°F	**°C**
–40 to 60	–40 to 16
0 to 100	–20 to 40
75 to 205	20 to 95
150 to 260	65 to 125
235 to 375	110 to 190
350 to 525	175 to 275
500 to 750(2)	260 to 400

NOTES:

1 Standard switch.
2 Available with remote mount thermal systems only.
3 Dual switches are 2 SPDT snap-action switches, not independently adjustable.
4 Wires cannot be terminated inside T400 switch enclosure.
5 Not available with Type 700 enclosure.
6 Estimated dc rating, 2.5A, 28 Vdc (not UL listed).
7 Estimated dc rating, 0.4A, 120 Vdc (not UL listed).
8 Not available on 350 to 525°F.
9 Consult factory on remote mount for bulb lengths other than 3″.

Thermocouples

Three Type K thermocouples are provided to measure combustion temperature. They are shipped wired to the control panel, but removed from the flare and wire tied to the flare so that the main burner pot can be lowered into the flare using the burner pot lifting jig. Once the burner pot is in place insert the thermocouples into the flare.

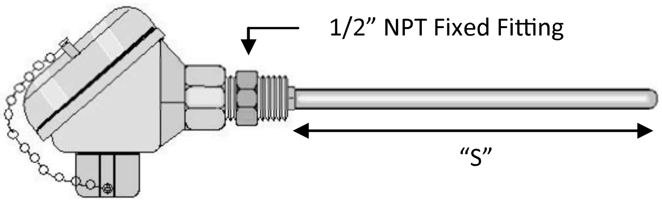
The thermocouples are tagged FLR-TE-501-503, and are ThermX Southwest part KMI9-24-6UD-OO-AX.

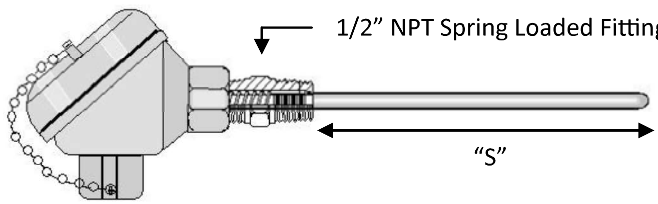
It is critical that Type K extension wire is used between the flare & the control panel, contact PEI if there are issues sourcing this wire, we keep significant stock on hand.

FLR-TE-501-503
Part # KMI9-24-6UD-00-AX

INDUSTRIAL THERMOCOUPLES
MI STYLE

- *ALL HEX FITTINGS ARE MADE OF 316 SS*
- *BRAZED FITTINGS ARE STANDARD, WELDED AVAILABLE*
- *SPRING LOADED FITTINGS ARE AVAILABLE*
- *SPECIAL LIMITS OF ERROR MATERIAL*





ASSEMBLY NO.

K	MI	9	2	4	6	U	D	0	0	I	0

CALIBRATION

K = Chromel®/Alumel®
J = Iron/Constantan®
T = Copper/Constantan®
E = Chromel®/Constantan®
N = Nicrosil®/Nisil®

SHEATH DIAMETER

5 = .125"
7 = .250"
8 = .188"
9 = .375"
X = Special

SHEATH LENGTH "S"

01 to 99 (whole inches)
Consult factory for lengths over 99"

SHEATH MATERIAL

1 = 310 SS
3 = 316 SS
6 = Alloy 600
X = Special

JUNCTION TYPE

SINGLE ELEMENT	DUAL ELEMENT
G = Grounded	**D** = Grounded
U = Ungrounded	**I** = Ungrounded Isolated

MOUNTING FITTING

D = 1/2" NPT Fixed Double End Fitting
F = 1/2" NPT Fixed Single End Fitting
S = 1/2" x 1/2" NPT Spring Loaded Fitting
X = Special

PROTECTION HEAD

A = Cast Aluminum
I = Cast Iron
E = Explosion Proof (FM/CSA)
W = Miniature Aluminum
V = Polypropylene

SPECIAL REQUIREMENT

If required, enter "X"
and Consult Factory

The 3” flare shutoff valve also ships off the flare in a crate for protection.

This valve is pneumatically operated, and is spring closed. Power to the 120 VAC solenoid allows air into the operator and opens the valve. This valve is supplied with both visual and electronic supervision.

The valve itself is an ABZ 102-961-001-ISO, CI/SS/VIT. It has a cast iron body, stainless steel interior parts, and a resilient Viton Seat.

The pneumatic operator is an Elomatic ES0200-4, with an Asco EF8551A1MS 120 VAC solenoid.

Supervision is provided by a TopWorx DXPM21GNEB device that has a red/green beacon for closed/open and two internal switches inside a NEMA 7 housing. Typically PEI only supervises the Closed position, the second switch can be used or ignored as the client wishes.

FLR-FV-301
Valve is a part # 102-961-001-ISO
Cast Iron Body, Stainless internals, Viton seat

Resilient Seated Butterfly Valves

ABZ VALVE
A GFT COMPANY

Figures 101/108/102

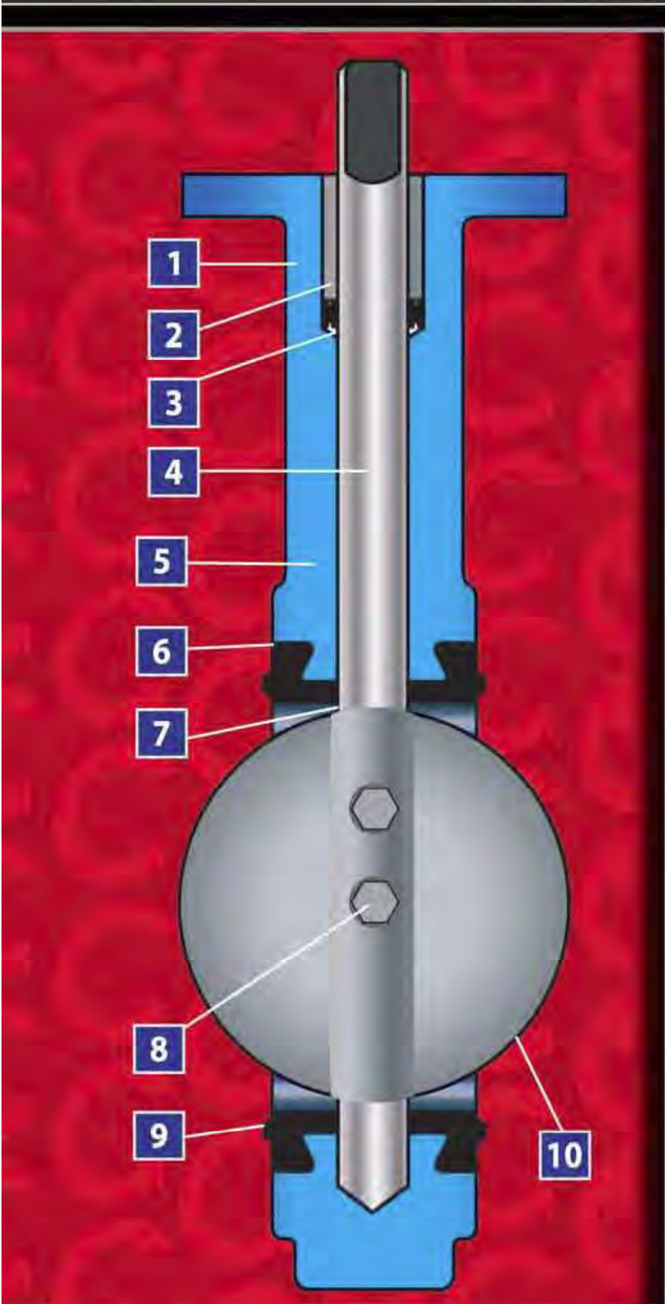
Sizes
2" - 12"
Rated Up To 175 PSI

ABZ VALVES & CONTROLS
PO Box 157 • 113 W. Main • Madison, KS 66860
620-437-2440 • FAX 620-437-2435
www.abzvalve.com • info@abzvalve.com

ABZ Precision Built Butterfly Valves

Resil-O-Seat™ Seated Valves for Chemical and Abrasion Resistance Applications.

The figures 101/102/108 provide excellent flexibility with a variety of trim materials. These are available for a wide selection of applications.



1 Body machined to high tolerances. Guaranteed standard dimensions for interchangeability of parts and actuators.

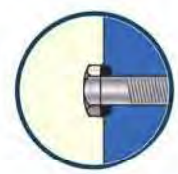
2 Top bushings protect the stem from side thrust of operators. They are made of impact and corrosion resistant materials.

3 Special double-V-shape of stem seal self-adjusts to protect the stem area for either vacuum or pressure use.

4 Stem extends through disc and aligns with socket in body. Stem end has standard dimensions for operator interchangeability.

5 Long neck allows for insulation requirements.

6 The special snap-in Resil-O-Seat™ design fixes seat in place without bonding. The Resil-O-Seat™ is 100% field replaceable - no special tools required.



7 Stem and body are isolated from the line media by the interference fit of the primary seal created between the disc and seat.

8 Stainless steel cap screws securely hold disc to stem. O-ring seal prevents leakage into the stem area and creates a positive connection.

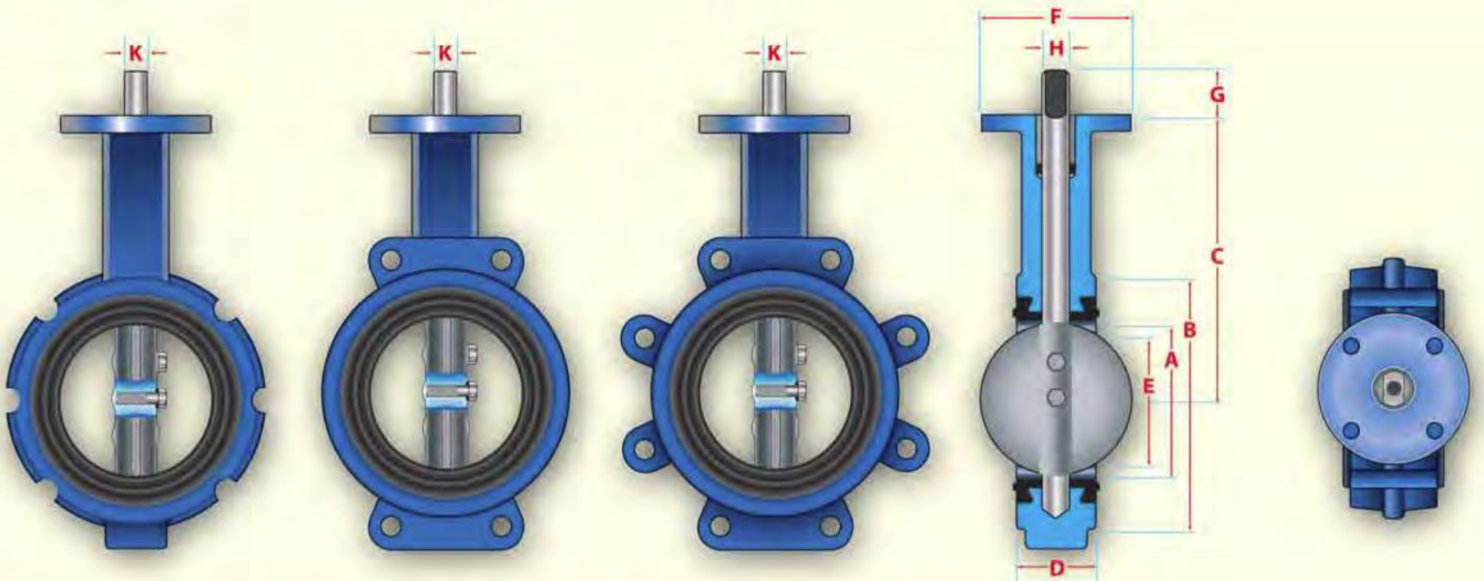
9 Resil-O-SeatTM forms a seal against all standard ANSI 125/150 flanges. Gasketing requirements are eliminated.

10 Disc edge is individually processed through machining and hand buffing for a smooth edge, providing a bubble tight shutoff and maximum seat life.

101 is a wafer style body
108 is semi-lug style body
102 is a full lug style body

FIGURES 101/108/102

Valve Dimensions



All standard seats are Food Grade with the exception of Viton

Valve Size	DIMENSIONS									TOP PLATE DRILLING			TAPPED LUG DATA				WEIGHT (POUNDS)		
	A	B	C	D	E	F	G	H	K	Bolt Circle	No. Holes	Hole Dia.	Bolt Circle	No. Holes 102	No. Holes 108	Tap	101	108	102
2	2 1/8	4 1/8	5 1/2	1 5/8	1 11/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	4 3/4	4	4	5/8-11 UNC	7	8	8
2 1/2	2 9/16	4 7/8	6	1 3/4	2 3/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	5 1/2	4	4	5/8-11 UNC	8	9	9
3	3 1/8	5 3/8	6 1/4	1 3/4	2 7/8	4	1 1/4	9/16	3/8	3 1/4	4	7/16	6	4	4	5/8-11 UNC	9	10	10
4	4 1/8	6 7/8	7	2	3 7/8	4	1 1/4	5/8	7/16	3 1/4	4	7/16	7 1/2	8	4	5/8-11 UNC	13	17	20
5	5 3/16	7 5/8	7 1/2	2 1/8	5	4	1 1/4	5/8	7/16	3 1/4	4	7/16	8 1/2	8	4	3/4-10 UNC	19	20	23
6	6 1/8	8 3/4	8	2 1/8	6	4	1 1/4	5/8	7/16	3 1/4	4	7/16	9 1/2	8	4	3/4-10 UNC	20	24	27
8	8 1/8	11	9 1/2	2 1/2	8	6	1 1/4	3/4	1/2	5	4	9/16	11 3/4	8	4	3/4-10 UNC	36	38	43
10	10 1/8	13 3/8	10 3/4	2 1/2	10 1/16	6	1 1/4	7/8	5/8	5	4	9/16	14 1/4	12	4	7/8-9 UNC	49	55	63
12	12 1/8	16 1/8	12 1/4	3	11 15/16	6	2	1 1/8	1/4	5	4	9/16	17	12	4	7/8-9 UNC	70	82	90

STANDARD CONSTRUCTION SPECIFICATIONS:

Body: Cast Iron, Ductile Iron (Lug) and Aluminum (Wafer)

Disc: 316 Stainless Steel, Aluminum Bronze, Ductile Iron, Epoxy Coated Ductile Iron

Stem: 316 Stainless Steel, 416 Stainless Steel, Carbon Steel

Resilient Seat: EPDM, Buna-N, Viton, Natural Rubber, White Buna, White Neoprene.

Stem Bushing: Teflon® – Graphite Impregnated

Stem Packing: Buna-N and Viton

Additional materials are available for a wide selection of applications.

NOTES:

1. Dimension "K" not applicable to 12″ size. The 12″ stem is round with ¼″ Key.
2. The figures 101, 102 and 108 cannot be used on pipe or flange with an inside diameter less than the "E" dimension.
3. Valves are rated up to 175 PSI bi-directional service and 85 PSI end of line rating. Undercut disc is rated up to 50 PSI bi-directional service and 25 PSI end of line rating. Preferred direction is with disc bolts on downstream side of disc.
4. Designed in accordance with sections of API 609 Catagory A, ASME 16.1/16.5, ASME 16.34 and MSS SP67. Design tested in accordance with API 598.
5. Compatible with ANSI Class 125/150 flange standards.

Rated Flow Coefficient (Cv) - Figure 101/108/102

Valve Size	ANGLE OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	1.67	7.7	17	29	48	74	115	145	195
2 1/2	2.50	11.0	25	44	69	109	174	237	307
3	3.33	15.7	37	64	105	165	276	377	487
4	5.00	27.7	63	110	177	278	472	671	827
5	8.33	43.7	99	177	276	443	752	1,083	1,325
6	13.33	58.7	136	242	385	616	1,075	1,521	1,883
8	20.00	107.3	247	434	687	1,094	1,821	2,671	3,239
10	31.67	174.0	394	696	1,092	1,770	2,983	4,288	5,210
12	47.0	251.7	578	1,002	1,665	2,654	4,398	6,466	8,026

Cv is defined as the volume of water in U.S.G.P.M. that will flow through a given restriction or valve opening with a pressure drop of one (1) p.s.i. at room temperature. Recommended control angles are between 25°-70° open.

Torque Chart - Figure 101/108/102

Valve Size	NORMAL CONDITIONS					SEVERE CONDITIONS				
	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175
2	221	230	240	250	254	373	384	400	406	410
2 1/2	269	283	288	302	311	454	464	475	486	497
3	322	341	365	379	392	540	568	589	611	634
4	480	514	542	576	590	816	848	886	918	936
5	653	706	754	806	854	1,102	1,162	1,220	1,274	1,301
6	907	1,008	1,109	1,210	1,260	1,529	1,642	1,756	1,868	1,926
8	1,512	1,714	1,915	2,112	2,215	2,549	2,776	3,002	3,229	3,343
10	2,318	2,621	2,900	3,224	3,372	3,910	4,250	4,590	4,931	5,101
12	3,125	3,629	4,138	4,637	6,112	5,270	5,838	6,404	6,971	7,258

Undercut disc available.

All torques shown in inch lbs. 20% Safety factor already included.

ABZ VALVES & CONTROLS, INC.
A Global Flow Technologies Company
P.O. Box 157 • 113 West Main • Madison, KS 66860
PHONE: 620-437-2440 • FAX: 620-437-2435
www.abzvalve.com • www.globalflowtech.com
info@abzvalve.com

Certified System ISO 9001-2008

Pneumatic Valve Actuator
ES0200-4 Fail Close

Pneumatic Rack & Pinion Actuators and Accessories

Reliable actuators to "Fit and Forget"

EL-O-MATIC

EMERSON
Process Management

El-O-Matic is renowned as an industry benchmark for delivering the range of features and benefits required from a rack & pinion actuator

A proven track record of over 35 year's service in over 2 Million applications

High reliability offering second to none service levels

A flexible modular package offering multiple configurations and $/torque value for money

Optimum performance

As a manufacturer, Emerson Process Management - Valve Automation realise that performance of our pneumatic actuators is vitally important to your production process. An actuator that does not function well can have serious consequences for the outcome of the process which can cost you dearly in down-time and loss of production. That is why for over 35 years and well over two million actuators produced, reliability has been our primary concern in actuator development. **El-O-Matic** pneumatic actuators are manufactured to worldwide industry standards and directives that ensures the production of reliable, quality products, continuously providing the optimum "Fit and Forget" performance to a wide range of end-user applications in process industries such as Chemical, Refining, Power Generation, Pulp & Paper and the utilities areas of Pharmaceuticals and Food & Beverage.

El-O-Matic ¼ turn rotary actuators have a unique cast aluminium alloy body and a two component polyurethane paint finish, ensuring many years of faithful performance against harsh environments. In addition, actuators are built inclusive of features that are well proven in their required application environments.

Application and Features

For use on ball, plug and butterfly valves.

- Compact rack & pinion design.
- Choice of thirteen sizes, with a torque range from 12Nm to 4000 Nm (106 in/lbs to 36,474 in/lbs)
- Also used in other ¼ turn applications, such as dampers and pressure regulators.
- High duty aluminium alloy provides optimum strength and corrosion resistance.
- Can be supplied in single (spring return) or double acting versions.
- Mounting for solenoid valves and position signallers to the NAMUR standard (VDI / VDE 3845).
- Valve mounting and drive dimensions to the ISO 5211 or DIN 3337 standard.
- Pinion provided with removable insert for low cost, versatile, direct mounting to valve stem.
- Pinion with anti blow-out design.

Operating principle

Both the double acting and single acting (spring return) versions of these pneumatic actuators are designed in such a way that there are no moving parts on the outside (with the exception of the position indicator). This makes them safe, easy to install and virtually maintenance free.

Furthermore, the compact rack and pinion construction means that actuators are lightweight and occupy a minimum of space, allowing users to install them in any orientation between close pipe configurations.

Ample choice of spring packages

Spring return, single acting actuators are used in the majority of systems as a fail-safe method of either closing or opening the valve to suit the application. Their ability to automatically return the valve to its fail-safe position upon air failure provides the vital link for ultimate system safety and shut down. El-O-Matic spring return actuators contain modular spring cartridges, which enable them to be easily configured, by adding or subtracting individual springs, to provide combinations that cover a wide variety of torque capabilities under different supply pressures and operating parameters.

Application

The choice of actuator size depends primarily on the torque requirement of the valve and with El-O-Matic you have the wide choice of 13 basic model sizes covering a torque range from 12 Nm to 4000 Nm. (106 in/lbs to 36,474 in/lbs)

However for optimum actuator sizing many factors may need consideration, so to provide the best "Fit and Forget" option, the El-O-Matic range is matched against all available relevant technical data on the majority of major quarter-turn valve manufacturers in the world. This electronic database enables us to select just the right actuator for you, whatever the valve type: ball, butterfly or plug valve.

Long life span

The 3-point guiding system of the enclosed pistons allows for a smooth operation with the aid of fully synthetic bearings and a rack & pinion gearing. The high precision gear cutting methods provide close tolerances between the rack and pinion teeth to ensure minimum gear backlash and avoid mechanical hysteresis, all of which helps limit-switch point accuracy and contributes to a very long working life. El-O-Matic actuators are guaranteed to perform in high cycle applications according to the CEN standard exceeding 500,000 cycles, and perform extremely well in comparison to any rack and pinion actuator in the industry.

Inserts

All actuator sizes up to 1600 Nm are fitted with removable drive inserts, to accommodate different valve stem profiles. This enables actuators to be directly mounted on to suitable valves and eliminates the need for a bracket and coupling type mounting kit. The use of direct mount inserts significantly cuts the cost of the valve / actuator assembly. Standard actuators are fitted with square drive inserts in accordance with ISO 5211 (or DIN 3337 as required) but a wide variety of other inserts are also available. Special inserts may have oversize or undersize squares or made with double-D profile or shaft key-way forms. These can be supplied on factory built actuators or as separate spare part items. Drive inserts are easily replaceable at distributor or end user level.

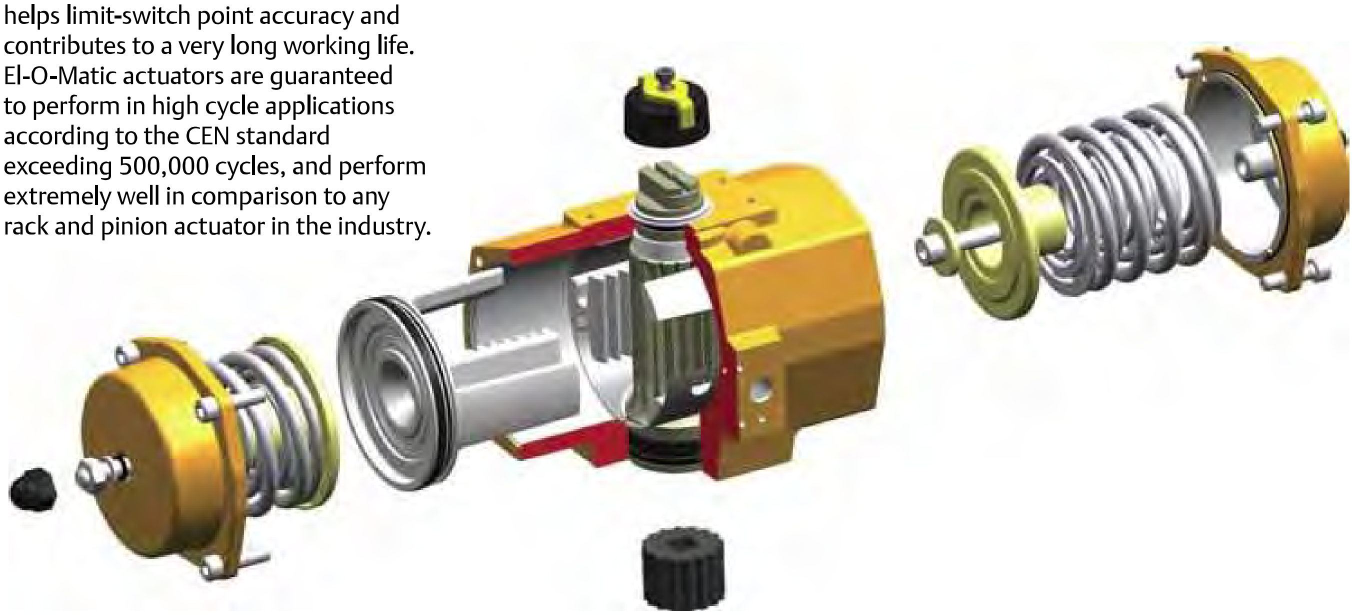
Where direct mounts are not possible, for instance on valves with exposed gland packing or high bonnets, the use of inserts often simplifies the design of the mounting kit, saving time and money in installation.

Limit stops

A limit stop bolt, used for switch setting, is necessary where the open position of the valve requires precise adjustment. These are standard on all actuators up to 1600 Nm. and optional on the two larger sizes. Actuators with double stroke adjustment are also available for those applications on high performance butterfly valves, for example, to ensure confirmation of the closed position.

Standardisation

El-O-Matic actuators comply fully with all the relevant industry standards for interfaces and connections. Control interfaces for solenoid valves, switch boxes and position controllers satisfy the NAMUR standard (VDI / VDE 3845). Valve mounting and drive dimensions conform to the ISO 5211 standard (with an option for DIN 3337).



Design and construction based on the “Fit and Forget” Principles

Fit and forget - Reliability

One of the main-stay’s in the development of our El-O-Matic actuator product is the “Fit and Forget” principle: Reliability is key to customer satisfaction and so actuators and their accessories must be quick and easy to install and function faultlessly through a long working life. This is made possible by the high degree of modular construction in our products, ensuring that mass produced components are made to a high degree of quality assurance and comply with ISO 9001.

Fit and Forget - Innovation

While El-O-Matic was traditionally a manufacturer of only actuators, Emerson’s Valve Automation business strives to maintain the brand in a leadership position by the introduction of new developments to support the “Fit and Forget” principle. Our policy continues to be focused on the supply of all the automation components located between the hardware of the valve and the software of the process-control system. This means a continuous activity of updates, new development and product innovation.

Fit and Forget - Modular construction

Our actuators and accessories are mainly made up of standard components. This means that they can be assembled and delivered fast in a variety of frequently used configurations. In order to meet new and ever demanding market requirements, our products are the subject of continuous refinement, adapting to multiple industry applications.

Fit and Forget – Proven Track Record

Based on proven technology with an installed base of over two million actuators worldwide the El-O-Matic brand is well recognised as the industry ‘benchmark’ for a multitude of process industry applications.
The robust, corrosion resistance design offers an easy to install actuator which functions faithfully giving many years of dependable performance.

Fit and Forget - Comprehensive offering

With single and double acting actuator in 13 sizes, ranging from 12Nm to 4100Nm (106 in/lbs to 36,474 in/lbs), El-O-Matic offers an even more versatile and competitive actuator range giving excellent $/torque value.

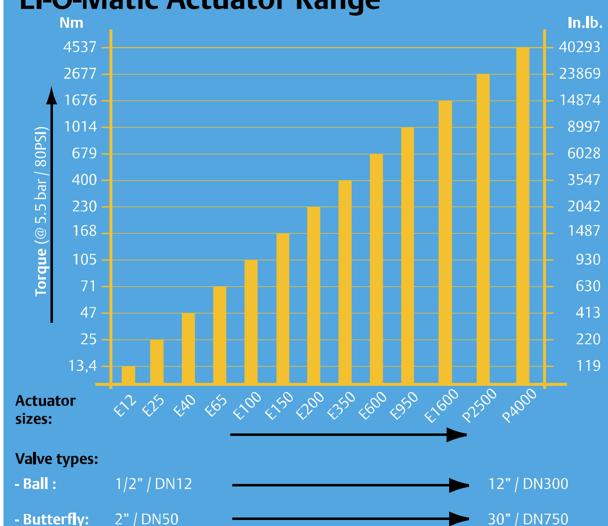
Fit and Forget - Cost effectiveness

Standardised mounting interfaces offer easy valve and accessory assembly. Dual valve flange drilling patterns and an interchangeable insert drive system allows for direct mounting capability, reduces the need for maintenance and increasing plant efficiency.

El-O-Matic E and P series actuators means:

More	Lower
Process reliability	Capital cost
Plant up-time	Assembly cost
Plant and operator safety	Installation cost
	Maintenance cost

El-O-Matic Actuator Range

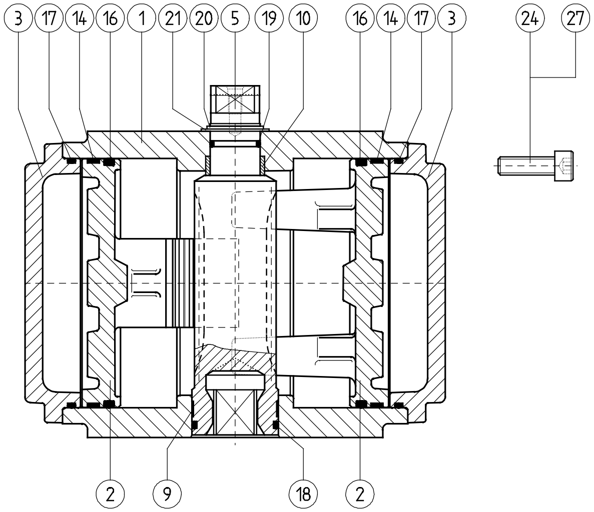


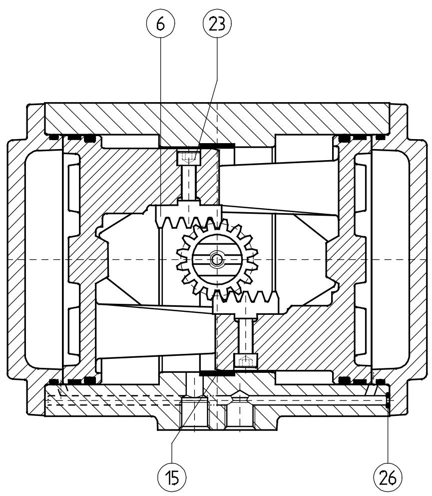
Specifications:

Pressure:	Double acting	0.2 to 8 Barg 3 to 116 Psig
	Spring return	3 to 8 Barg 43.5 to 116 Psig
Temperature:		-20°C to +80°C -4°F to +176°F
Materials:	Housing:	Aluminium alloy.
	Pinion:	Hard anodise aluminium alloy.
Finish:		Polyester non-TGIC based powder coating.
Life span:		Minimum of 500.000 cycles.

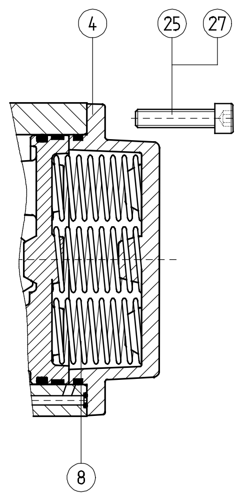
For more detailed technical information see our online documentation under **www.El-O-Matic.com**. Document number **[DOC.DSE.PN.UK]**

CONSTRUCTION, PARTS AND MATERIALS P-SERIE ACTUATORS





DOUBLE ACTING PD



SINGLE ACTING PS

Parts				Materials		Excecutions		
Nr.		**Description**	**Qty.**	**Description**	**Specification**	**Std**	**S.S. Shaft**	**CSR**
1		Body	1	Aluminum Alloy	UNS A13600, ASTM B85	-	-	6
2		Piston	2	Aluminum Alloy	UNS A03560, ASTM B26	-	-	-
3		Endcap PDA	2	Aluminum Alloy	UNS A13600, ASTM B85	-	-	6
4		Endcap PSA	2	Aluminum Alloy	UNS A13600, ASTM B85	-	-	6
5		Drive pinion	1	Aluminum Alloy	UNS 1 77075, ASTM 7075 T6	1	4	4
6		Gear Rack	2	Steel	UNS G10950, ASTM A108	-	-	-
8		Spring	14	Carbon Spring Steel	UNS G10860, ASTM A228	2	2	2
9	*	Bearing Bush	1	Nylatron GS	PA6.6 + MoS2	-	-	-
10	*	Bearing Bush	1	Delrin	POM	-	-	-
14	*	Guide band	2	PTFE, Carbon filled	PTFE + 25% C	-	-	-
15	*	Guide band	2	PTFE, Carbon filled	PTFE + 25% C	-	-	-
16	*	O-ring	2	Nitrile Rubber	Buna N	-	-	-
17	*	O-ring	2	Nitrile Rubber	Buna N	-	-	-
18	*	O-ring	1	Nitrile Rubber	Buna N	-	-	-
19	*	O-ring	1	Nitrile Rubber	Buna N	-	-	-
20	*	Spring Clip	1	Carbon Spring Steel	MIL - R-212 48B	2	5	5
21	*	Thrust Washer	1	ZEDEX 100 K	-	-	-	-
23		Bolt	4	Alloy Steel	12.9 ASTM F568	-	-	-
24		Endcap bolt PDA	20	Alloy Steel	8.8 ASTM F568	2	4	4
25		Endcap bolt PSA	20	Alloy Steel	8.8 ASTM F568	2	4	4
26	*	O-ring	2	Nitrile Rubber	Buna N	-	-	-
27		Threaded insert	20	Steel	UNS G10430, ASTM A29	3	3	3

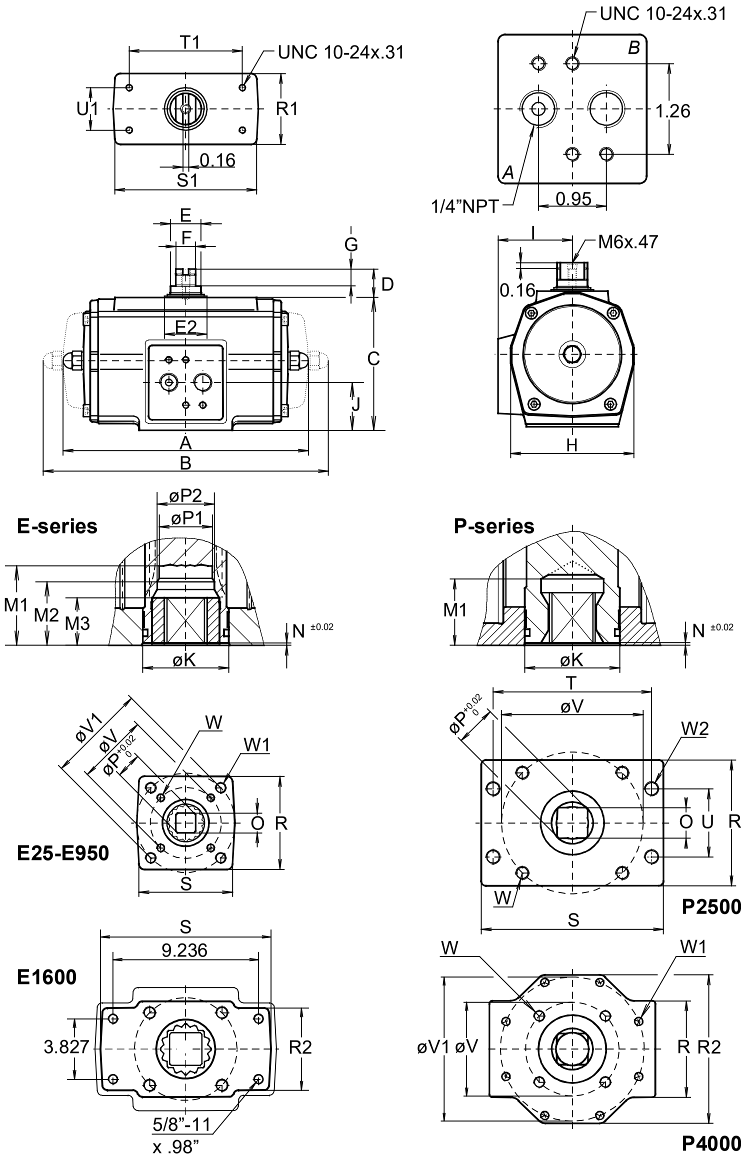
* Recommended spare parts (contained in Repair kit)

Notes
1 Hard anodized
2 Deltatone® Coating
3 Zinc plated and passivated
4 Stainless Steel AISI 304
5 Stainless Steel, X35CrM017
6 CSR Coating (see A4.204.02)
7 P4000 has a stainless steel (AISI 304) locking ring between spring clip (20) and thrust washer (21)
8 P4000 has in the springs a guiding bush (PVC)

Remark
All materials are European origin, listed are the nearest US equivalents

Finish
Standard : Polyester non-TGIC based powder coating (see data sheet A4.204.01)
CSR : CSR Coating (see data sheet A4.204.02)

DIMENSION SHEET STANDARD ACTUATOR - ISO



Dim. in inch	E 12	E 25	E 40	E 65	E100	E150	E200	E 350	E600	E950	E1600	P2500	P4000
	Actuators E-series											P-series	
A DA	For E12 dimensions see data sheet A1.103.102	6.26	7.09	7.83	8.70	10.00	11.14	12.01	15.24	16.69	20.31	14.88	19.76
B SR		6.77	8.03	9.80	10.51	12.20	14.17	15.24	18.78	20.35	25.08	22.44	32.83
C		3.15	3.66	4.13	4.65	5.51	5.63	7.13	8.66	10.20	11.69	14.02	14.96
D		0.79	0.79	0.79	0.79	0.79	0.79	0.79	1.18	1.18	1.18	1.18	1.18
E		0.63	0.87	0.87	0.87	1.42	1.42	1.42	2.17	2.17	2.52	2.17	2.52
E2		0.91	1.18	1.18	1.18	1.77	1.77	1.77	2.56	2.56	2.95	2.56	3.15
F		0.39	0.55	0.55	0.55	0.75	0.75	0.75	1.42	1.42	1.42	1.42	1.42
G		0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.39	0.39	0.39	0.39	0.39
H		2.91	3.39	3.86	4.25	4.76	5.04	6.81	8.15	9.09	10.43	13.78	14.96
I		1.81	2.09	2.26	2.48	2.76	2.87	3.71	4.45	4.96	5.59	7.28	7.87
J		1.26	1.32	1.54	1.59	1.59	1.99	2.85	3.33	4.15	4.74	7.01	7.48
K		0.94	1.30	1.30	1.50	2.17	2.17	2.17	2.68	2.95	3.74	3.35	4.72
M1		1.36	1.36	1.36	1.36	1.97	1.97	1.97	2.05	2.52	3.23	2.60	3.03
M2		-	-	-	1.06	-	1.46	1.46	-	-	-	-	-
M3		0.669	0.669	0.669	0.787	0.787	1.161	1.161	1.161	1.949	2.303	-	-
N		0.04	0.04	0.04	0.06	0.04	0.06	0.06	0.06	0.06	0.06	0.12	0.06
O max.		0.437	0.556	0.556	0.753	0.871	0.871	1.068	1.068	1.424	1.817	1.817	2.173
O min.		0.433	0.551	0.551	0.748	0.866	0.866	1.063	1.063	1.417	1.811	1.811	2.165
P		0.555	0.713	0.713	0.992	1.110	1.110	1.425	1.425	1.898	2.370	2.370	2.843
P1		0.555	0.713	0.831	0.909	1.303	1.303	1.303	1.437	1.909	2.382	-	-
P2		-	-	-	0.988	1.264	1.264	1.264	-	-	-	-	-
R		2.05	2.56	2.76	2.76	3.39	3.54	4.49	4.88	5.12	6.06	6.69	6.69
R1		1.97	1.97	1.97	2.36	2.36	2.36	2.36	3.54	3.54	4.92	6.30	6.30
R2		-	-	-	-	-	-	-	-	-	5.20	-	10.31
S		2.05	2.56	2.76	2.76	3.62	3.54	4.49	4.88	5.59	11.02	11.42	11.42
S1		3.94	3.94	3.94	3.94	3.94	3.94	3.94	6.69	6.69	8.27	9.65	9.65
T1		3.150	3.150	3.150	3.150	3.150	3.150	3.150	5.118	5.118	5.118	5.118	5.118
U1		1.181	1.181	1.181	1.181	1.181	1.181	1.181	1.181	1.181	1.181	1.181	1.181
		F03	**F05**	**F05**	**F05**	**F07**	**F07**	**F07**	**F10**	**F10**	**F16**	**F16**	**F16**
V		1.417	1.969	1.969	1.969	2.756	2.756	2.756	4.016	4.016	6.496	6.496	6.496
W		10-24 x.31"	1/4"-20 x.39"	1/4"-20 x.39"	1/4"-20 x.39"	5/16"-18 x.39"	5/16"-18 x.39"	5/16"-18 x.39"	3/8"-16 x.63"	3/8"-16 x.63"	3/4"-10 x1.14"	3/4"-10 x1.14"	3/4"-10 x1.14"
		F05	**F07**	**F07**	**F07**	**F10**	**F10**	**F10**	**F12**	**F14**	**-**	**-**	**F25**
V1		1.969	2.756	2.756	2.756	4.016	4.016	4.016	4.921	5.512	-	-	10.000
W1		1/4"-20 x.39"	5/16"-18 x.39"	5/16"-18 x.39"	5/16"-18 x.39"	3/8"-16 x.63"	3/8"-16 x.63"	3/8"-16 x.63"	1/2"-13 x.79"	5/8"-11 x.98"	-	-	"5/8""-11 x.98"

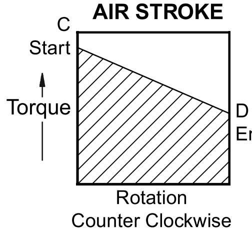
Note
1. Flange and square drive to ISO 5211
2. Top and solenoid flange to VDI/VDE 3845 (NAMUR)
3. For P-series actuators with limit stops see A1.501.01

EMERSON
Process Management

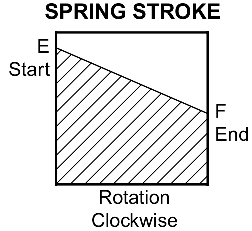
SPRING RETURN ACTUATOR TORQUE (In.lb.) 90°

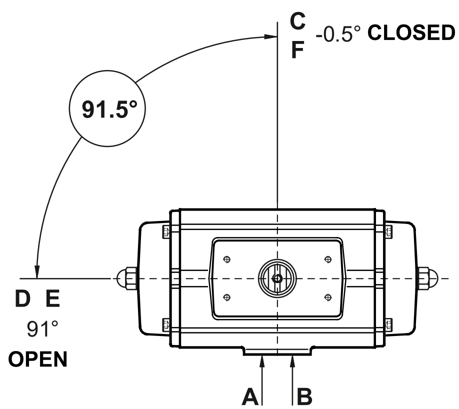
SINGLE ACTING TORQUE

AIR STROKE



SPRING STROKE





Note

1. Emerson Process Management recommends that the valve manufacturer supply the maximum required torque values (Including any adjustments or suggested safety factors for valve service conditions or application).
   Additionally, the valve manufacturer must identify at which position(s) and direction(s) of rotation (Counter Clock Wise or Clock Wise) these maximum requirements occur.
2. If in doubt, or you require any assistance with sizing actuators, do not hesitate to contact your nearest Emerson's Valve Automation Division representative.
3 Pressure on port "A" opens the actuator*
4 The actuator is shown in closed position*
(* code A, data sheet A1.504)

Actuator Type	Springset nr.	Air Stroke (lbf/in) SUPPLY PRESSURE (in PSI) 40 C	40 D	60 C	60 D	80 C	80 D	100 C	100 D	120 C	120 D	Spring Stroke (lbf/in) E	F
ES 12	2	-	-	48	24	80	55	111	87	143	119	63	40
ES 25	2	71	44	130	103	189	162	248	221	306	280	62	39
	3	48	8	107	67	166	126	225	185	284	244	94	59
	4	-	-	85	31	144	90	203	149	262	208	125	78
	5	-	-	-	-	121	54	180	113	239	172	156	98
	6	-	-	-	-	99	18	158	77	217	136	188	117
ES 40	2	133	82	243	193	354	303	464	414	575	524	117	73
	3	91	15	201	125	312	236	422	346	533	457	176	110
	4	-	-	159	58	270	169	380	279	491	390	234	146
	5	-	-	-	-	228	101	338	212	449	322	293	183
	6	-	-	-	-	185	34	296	144	406	255	351	220
ES 65	2	196	117	365	285	533	454	701	622	870	790	186	117
	3	129	10	297	178	466	347	634	515	802	683	279	176
	4	-	-	230	71	398	240	567	408	735	576	372	234
	5	-	-	-	-	331	133	500	301	668	470	465	292
	6	-	-	-	-	264	26	432	194	601	363	558	351
ES 100	2	303	192	552	441	801	690	1050	939	1299	1188	258	161
	3	211	44	460	293	709	542	958	791	1206	1039	387	242
	4	-	-	367	144	616	393	865	642	1114	891	516	323
	5	-	-	-	-	523	245	772	494	1021	743	646	403
	6	-	-	-	-	430	96	679	345	928	594	775	484
ES 150	2	485	297	884	696	1283	1094	1681	1493	2080	1892	423	259
	3	337	54	735	453	1134	852	1533	1250	1931	1649	634	388
	4	-	-	587	210	985	609	1384	1007	1783	1406	845	517
	5	-	-	-	-	837	366	1235	764	1634	1163	1056	647
	6	-	-	-	-	688	123	1087	522	1485	920	1268	776
ES 200	2	656	406	1202	952	1747	1498	2293	2043	2838	2589	579	362
	3	448	74	994	619	1539	1165	2085	1710	2631	2256	868	542
	4	-	-	786	287	1332	832	1877	1378	2423	1924	1158	723
	5	-	-	-	-	1124	500	1669	1045	2215	1591	1447	904
	6	-	-	-	-	916	167	1462	713	2007	1258	1736	1085
ES 350	2	1105	684	2053	1632	3001	2580	3949	3528	4897	4476	1025	658
	3	727	95	1675	1043	2623	1991	3571	2939	4519	3887	1537	987
	4	-	-	1297	455	2245	1403	3193	2351	4141	3299	2049	1317
	5	-	-	-	-	1866	814	2814	1762	3762	2710	2561	1646
	6	-	-	-	-	1488	225	2436	1173	3384	2121	3074	1975
ES 600	2	1920	1183	3531	2794	5142	4405	6753	6016	8364	7628	1723	1082
	3	1298	193	2909	1804	4520	3415	6131	5026	7742	6637	2585	1624
	4	-	-	2287	814	3898	2425	5509	4036	7120	5647	3446	2165
	5	-	-	-	-	3276	1434	4887	3046	6498	4657	4308	2706
	6	-	-	-	-	2654	444	4265	2055	5876	3666	5169	3247
ES 950	2	2898	1777	5303	4182	7708	6587	10113	8992	12518	11397	2563	1587
	3	1986	304	4391	2709	6796	5114	9201	7519	11606	9924	3844	2381
	4	-	-	3479	1236	5884	3641	8288	6046	10693	8451	5125	3175
	5	-	-	-	-	4971	2168	7376	4573	9781	6978	6407	3968
	6	-	-	-	-	4059	695	6464	3100	8869	5505	7688	4762
ES 1600	2	4765	2988	8741	6964	12716	10939	16692	14915	20668	18890	4193	2646
	3	3244	578	7220	4554	11196	8530	15171	12505	19147	16481	6289	3970
	4	-	-	5699	2145	9675	6120	13650	10096	17626	14071	8385	5293
	5	-	-	-	-	8154	3711	12129	7686	16105	11662	10481	6616
	6	-	-	-	-	6633	1301	10608	5277	14584	9252	12578	7939

Actuator Type	Springset nr.	Air Stroke (lbf/in) SUPPLY PRESSURE (in PSI) 40 C	40 D	60 C	60 D	80 C	80 D	100 C	100 D	120 C	120 D	Spring Stroke (lbf/in) E	F
PS 2500	6	6881	4278	12875	10273	18869	16267	24863	22261	30858	28255	7013	4401
	8	5251	1781	11245	7775	17239	13769	23233	19764	29228	25758	9351	5868
	10	-	-	9615	5278	15609	11272	21603	17266	27597	23260	11689	7335
	12	-	-	7985	2780	13979	8774	19973	14768	25967	20763	14026	8803
	14	-	-	-	-	12349	6277	18343	12271	24337	18265	16364	10270
PS 4000	6	11701	7310	21862	17472	32024	27633	42185	37795	52347	47956	11835	7429
	8	8949	3096	19111	13257	29272	23419	39434	33580	49595	43742	15780	9905
	10	-	-	16359	9042	26521	19204	36682	29365	46844	39527	19725	12381
	12	-	-	13608	4828	23770	14989	33931	25150	44093	35312	23670	14857
	14	-	-	-	-	21018	10774	31180	20936	41341	31097	27615	17333

EMERSON
Process Management

Valve Supervision Part # DXPM212GNEB

Valvetop DXP

502.969.8000

Flame Proof - Explosion Proof - Intrinsically Safe

FOUNDATION DeviceNet HART

Valvetop DXP

The Valvetop DXP discrete valve controller combines bus networking, pilot valve and position sensors into a single, globally certified, explosion proof enclosure that attaches to any automated valve package.

Features: Zone 0 Intrinsically Safe
Zone 1 Flameproof/Explosion Proof
Tropicalized Aluminum Enclosure

Options: GO Switch Leverless Limit Switches
FOUNDATION Fieldbus
AS-Interface
DeviceNet
4-20mA Position Transmitter
HART Protocol
Proximity Switches
Mechanical Switches

FAST TRACK DELIVERY

DXP-L21G_EB
(2) GO Switches
Explosion Proof

DXP-L21G_EB1A2
(2) GO Switches
Explosion Proof
24VDC 5/4 Aluminum pilot valve

DXP-FF□G_EBPA2
FOUNDATION Fieldbus
Exp. Proof or Intr. Safe
5/4 Aluminum pilot valve

DXP-AS1G_EB1A2
AS-Interface
Explosion Proof
5/4 Aluminum pilot valve

DXP-AS1G_EB
AS-Interface
Explosion Proof

DXP-0XG1_EB
4-20 mA Transmitter
Explosion Proof

DXP-DN1G_EB1A2
DeviceNet
Explosion Proof
5/4 Aluminum pilot valve

DXP-DN1G_EB
DeviceNet
Explosion Proof

DXP-M21G_EB
(2) Mechanical Switches
Explosion Proof

□For Area Class, choose **0** (I.S. or **1** (Exp. Proof)
__ For Shaft, choose **S** or **N** (both in stock)

Enclosure

DXP

Enclosure: Die-cast, aluminum; Epoxy-coated O-Ring sealed

Coating: Tropicalized inside and out

Cover bolts: 6 stainless steel captive cover bolts

Terminal Strip: Standard 12 pt. molded nylon

Temperature Rating: Determined by internal components - Consult Factory

Environment: Built to last in the most demanding applications

Ordering Guide
Fill in the boxes to create your 'ordering number.'

Bus/Sensor

Bus Network

AS	AS-Interface
FF	FOUNDATION Fieldbus (Pilot P, R, or U only)
DN	DeviceNet

Partial Stroke Test

ES	ESD/PST Module with GO Switch

GO Switches (SPDT hermetic seal)

L2	(2) GO Switches
L4	(4) GO Switches

Mechanical Switches
(Area Class 1, C, B, or W)

M2	(2) Mech SPDT
M4	(4) Mech SPDT
M6	(6) Mech SPDT
T2	(2) Mech DPDT
K2	(2) Mech SPDT gold contacts
K4	(4) Mech SPDT gold contacts

Proximity Switches

PS	(2) hermetically sealed proximity switch module w/BriteLite LED indication
PN	(2) hermetically sealed proximity switch module

Inductive NAMUR Sensors

E2	(2) p+f NJ2+V3-N
E4	(4) p+f NJ2+V3-N

Analog Output (Available with 2-switch options only for L, M, K, E, T)
_**X** 4-20mA transmitter
_**H** 4-20mA transmitter with HART

Examples:
LX =(2) GO Switches with transmitter
OX =4-20mA transmitter no switches
LH =(2) GO Switches with HART transmitter

Classification

0 **Intrinsically Safe*** (Bus/Sensor must be FF, L, PN, E, or _H)
Class I Div 1 & 2, Groups A-D
Zone 0 (ATEX) EEx ia IIC II1G
IP67; Type 4, 4X

1 **Flame Proof/Explosion Proof**
Class I Div 1-2, Groups C-D
Class I Div 2, Groups A-D
(Groups A & B must be hermetically sealed)
Zone 1, (ATEX/IECEx)
Ex/EEx d IIB+H2 II2G
IP67; Type 4, 4X, 7

2 **Non-Incendive** (Not available for Sensor options M, T, or K)
Class I Div 2, Groups A-D
Class II Div 2, Groups E-G
Zone 2 (ATEX/IECEx)
Ex/EEx nC tD II3GD
IP67; Type 4, 4X

C **(ATEX/IECEx)**
Ex/EEx d IIC II2G
IP67

B **INMETRO (Brasil)**

W **IP67/No approvals**

* With appropriate I.S. barrier

IECEx CE Ex UL

Visual Display

Visual Display: Impact resistant polycarbonate; O-ring sealed; 360° adjustable

G	Standard 90° Green OPEN, Red CLOSED
B	90º Black OPEN, Yellow CLOSED
4	45º Green OPEN, Red CLOSED
X	45º Black OPEN, Yellow CLOSED
Y	90º Yellow OPEN, Black CLOSED
1	3 way, 90º
3	3 way, 90º
5	3 way, 90º
7	3 way, 180º
9	3 way, 180º

Shaft

Shaft: Stainless steel; O-ring sealed

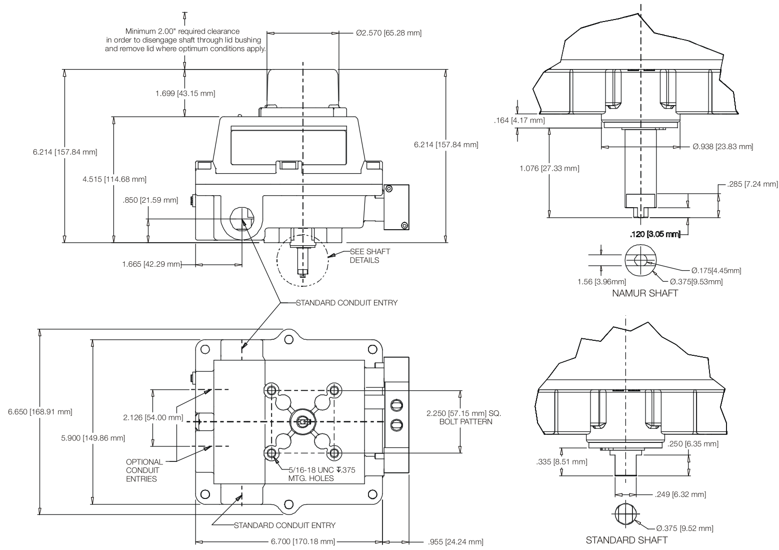
Shaft Retainer: Stainless steel

S	1/4” DD 304 Stainless Steel
N	NAMUR 304 stainless steel

See next column

Enclosure	Bus/Sensor	Classification	Visual Display	Shaft
DXP				

Dimensions



Conduit Entries

- **E** (2) 3/4" NPT
- **4** (2) 3/4" NPT, (2) 1/2" NPT
- **M** (2) M20
- **3** (4) M20
- **6** (4) 3/4" NPT

O-Rings

- **B** Buna N
- **E** EPDM
- **S** Silicone
- **V** Viton

Pilot

- **Blank** No pilot device(s)
- **1** (1) 24 Vdc pilot, .5W, fail open/closed
- **2** (2) 24 Vdc pilots, .5W, fail last position
- **3** (2) 24 Vdc pilots, .5W, block center
- **4** (1) 220 Vac pilot, 1.9W, fail open/closed
- **5** (2) 220 Vac pilots, 1.9W, fail last position
- **6** (2) 220 Vac pilots, 1.9W, block center
- **7** (1) 110 Vac pilot, 1.1W, fail open/closed
- **8** (2) 110 Vac pilots, 1.1W, fail last position
- **9** (2) 110 Vac pilots, 1.1W, block center
- **P** (1) piezo pilot, fail open/closed (FF only)
- **R** (2) piezo pilots, fail last position (FF only)
- **U** (2) piezo pilots, block center (FF only)

Spool Valve

- **Blank** No spool valve
- **A** Aluminum Hard coat anodized
- **S** 304 Stainless steel
- **6** 316 Stainless steel

Valve Cv

- **Blank** No spool valve
- **2** 1.2 Cv (1/4" NPT Ports)
- **3** 3.0 Cv (1/2" NPT Ports) (Spool Valve A only)
- **C** Cold temperature valve to -50ºC 1.0 Cv (1/4" NPT Ports) (Sensor L2; O-Ring E or S only) (Spool Valve must be S or 6)

Don't forget!

Filtered air is required for proper valve operation. Reference www.topworx.com for additional Air Filter information.

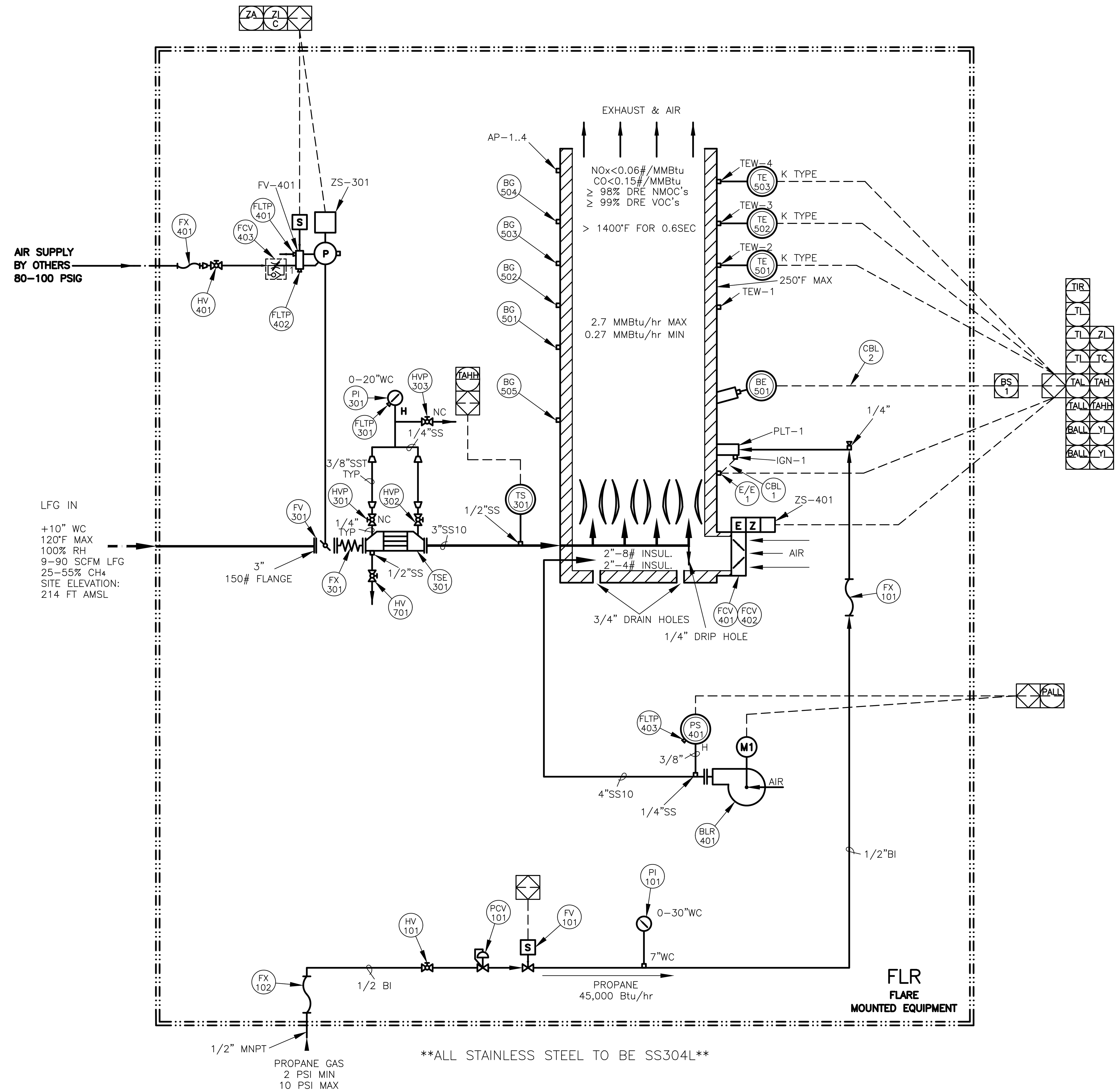
Manual Override

- **Blank** No spool valve
- **1** Single Pushbutton Momentary/Latching
- **2** Dual Pushbutton Momentary/Latching
- **3** Single Pushbutton Momentary
- **4** Dual Pushbutton Momentary
- **5** Manual Reset No voltage release latching with pushbutton (Spool Valve 6 only)
- **A** Single palm actuator Momentary/Latching
- **B** Dual palm actuator Momentary/Latching
- **C** Single palm actuator Momentary
- **D** Dual palm actuator Momentary
- **E** Manual Reset No voltage release latching with palm actuator (Spool Valve 6 only)
- **T** Partial stroke test button with lockable cover (Sensor ES only) (Conduit Entries 4 or 3 only)

Conduit Entries	O-Rings	Pilot	Spool Valve	Valve Cv	Manual Override

Appendix B

Equipment Layout and Process Flow Diagrams



ALL STAINLESS STEEL TO BE SS304L

CONTROL PANEL MOUNTED LOGIC ELEMENTS REFERENCE DESIGNATORS OF LOGIC OR CONTROL PANEL MOUNTED EQUIPMENT. IDENTIFICATION LETTERS CONFORM TO ISA'S INSTRUMENTATION SYMBOLS AND IDENTIFICATION MANUAL TABLE #1

MANUAL VALVES ARE NORMALLY OPEN DURING SYSTEM OPERATION UNLESS DESIGNATED BY "NC"

PIPING MATERIALS LEGEND

AL: ALUMINUM
BI: BLACK IRON
CI: CAST IRON
CS: CARBON STEEL
CPVC: CHLOROPOLYVINYLCHLORIDE
SS: STAINLESS STEEL
EPDM: ETHYLENE PROPYLENE DIENE MONOMER
FRP: FIBERGLASS REINFORCED PLASTIC

10: SCH 10 PIPE
40: SCH 40 PIPE
80: SCH 80 PIPE
H: I.D. HOSE
T: O.D. TUBING

(EXAMPLE: 6"AL40 = 6" ALUMINUM SCHEDULE 40 PIPE)

LINES LEGEND

ELECTRICAL CONNECTIONS
MAIN PIPING
SUB PIPING
AIR LINE
CONDENSATE LINE
CUSTOMER SUPPLIED MAIN PIPING
CUSTOMER SUPPLIED SUB PIPING
LOCATION BORDER
FUTURE/PENDING PIPING BORDER
GLYCOL/WATER PIPING

FLUID DESIGNATORS

Ref Des	Fluid
1XX	Fossil Fuels
2XX	Oils
3XX	Biogas
4XX	Air
5XX	Combustion Exhaust
6XX	Coolants
7XX	Condensate
8XX	Inert Gases
9XX	Digester Fluids

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, INC.

LTR	DESCRIPTION	DATE	APPROVED
1	ADDED PARTS LIST (5/22/20) AP		

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES
DESIGNED BY: E.BOYS DATE 5/8/20
DRAWN BY: B.HOLMAN DATE 5/8/20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30

TITLE: GAS HANDLING SYSTEM P&ID

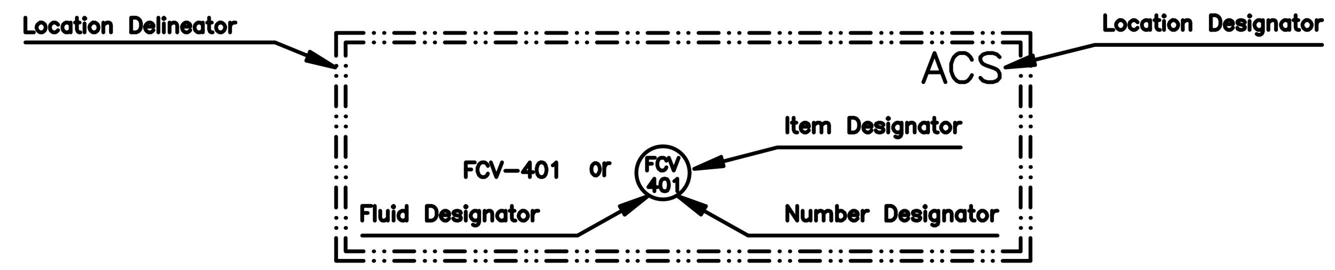
SIZE D 34x22
DWG. NO. ME-010-0166

MATERIAL: AS NOTED
SCALE AS NOTED
FILE NO. ME-010-0166 R1.DWG
SHEET 1 OF 2

Location Designators

Ref Des	Location
ACS	Air Compressor Skid
CDS	Condensate Destruction System
COGS	Cogeneration Skid
CP	Control Panel
CST	Condensate Storage Tank
EG	Engine Generator
FLR	Flare
GAC	Gas Analysis Cabinet
GCS	Gas Compression Skid
GHS	Gas Handling Skid
ITC	Ignition Transformer Cabinet
MCC	Motor Control Center
MISC	Loose Parts
PCS	Precooler Skid
PIP	Piping Not On Skid

Parts Reference Designators

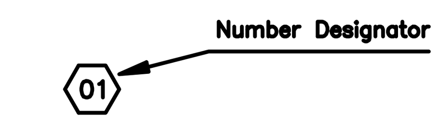


-If the Reference Designator is in a bubble, then the item will be listed on that drawing's material list.
-If the Reference Designator is not in a bubble, then it is referring to an item listed on another drawing's material list or it is supplied by others or as an integral part of another item called out by a bubbled reference designator.

Fluid Designators

Ref Des	Fluid
1XX	Fossil Fuels
2XX	Oils
3XX	Biogas
4XX	Air
5XX	Combustion Exhaust
6XX	Coolants
7XX	Condensate
8XX	Inert Gases
9XX	Digester Fluids

Drawing Reference Designators



Drawing Number	Drawing Name
COVER-1910	Cover Page
ME-010-0166	Gas Handling System P&ID
EE-005-0584	120VAC & Instrumentation Elementary
PA-001-1037	Flare Station Top Assembly

Item Designators

Ref Des	Reference Item	Typical Usage/Description
AC	Air Conditioner	Air Conditioner
ACF	Activated Carbon Filter	Condensate Tank Vent Filter
AD	Auto Dialer	Auto Dialer
AI	Analog Input	PLC Analog Input Module
AIO	Analog Input Output	PLC Analog Input Output Module
AO	Analog Output	PLC Analog Output Module
AP	Analysis Port	Gas Sample Ports
BALL	Burner Alarm Low Low	Flame Fail Shutdown
BE	Burner Element	UV Sensor
BG	Burner Glass	View Ports
BLR	Blower	Air or Gas Blower
BN	Burner	Boiler, Hot Water Heater
BS	Burner Switch	Flame Recognition Switch
CBL	Cable	Cables, Specialty Wiring Between Devices
CGT	Combustible Gas Transmitter	LEL Transmitter
CHR	Chart Recorder	Paper or Paperless Chart Recorder
CMP	Compressor	Air or Gas Compressor
D	Diode	Diode
DI	Digital Input	PLC Digital Input Module
EDP	Electrical Distribution Panel	Load Centers, Breaker Panels
E/E	Voltage Transformer	Electrical Transformers, Power Supplies
EI	Voltage Indicator	System Voltage Monitoring
ES	Exhaust Silencer/Ethernet Switch	Muffler/Ethernet Switch
FAH	Flow Alarm High	High Flow Alarm
FAHH	Flow Alarm High High	High Flow Shutdown
FAL	Flow Alarm Low	Low Flow Alarm
FALL	Flow Alarm Low Low	Low Flow Shutdown
FC	Flow Controller	PID Loop Flow Controller, Burner Plug
FCV	Flow Control Valve	Actuated or Hand Modulating Valves, Dampers
FD	Fused Disconnect	Fused Disconnect
FE	Flow Element	Pitot Tube, Hot Wire Anemometer, Orifice Plate
FI	Flow Indicator	Flow Rate Gauge
FIR	Flow Indicating Recorder	Paper or Paperless Chart Recorder
FLT	Filter	Liquid or Gas Filter
FLTP	Port Filter	Unused Port Filter
FO	Flow Orifice	Flow Alarms
FQI	Flow Totalization Indicator	Chart Recorder
FSV	Flow Safety Valve	Check Valve
FT	Flow Transmitter	Flow Transmitter
FU	Fuse	Fuse
FUH	Fuse Holder	Fuse Holder
FV	Flow Valve	Open or Closed Valve not Modulating, Solenoid Valve, Shutdown Valve
FX	Flex	Expansion and Vibration Isolators, Hoses
GBK	Ground Block	Ground Block
HS	Hand Switch	Hand Operated Electrical Switches and Pushbuttons
HT	Heat Trace	Heat Trace
HTR	Heater	Electrical Heaters
HV	Hand Valve	Open or Closed Hand Operated Valve
HVP	Hand Valve Port	Gauge, Manometer and Sample Ports
I/I	Current Transformer	Alternating Current to Current Transformer
IAB	Current Bounce	Blower Surge Shutdown
IAH	Current Alarm High	High Current Alarm
IAHH	Current Alarm High High	High Current Shutdown, Blower Overload
IAL	Current Alarm Low	Low Current Alarm, Blower Surge Alarm
IALL	Current Alarm Low Low	Low Current Shutdown, Blower Surge Shutdown
IGN	Ignitor	Spark Plugs, Spark Ignitors
II	Current Indicator	Motor Current
IIR	Current Indicating Recorder	Paper or Paperless Chart Recorder
IT	Current Transmitter	Current Transmitter
ITC	Ignitor Transformer Cabinet	Flare Ignitor
JB-HV	Junction Box-High Voltage	Interconnection Wiring
JB-LV	Junction Box-Low Voltage	Interconnection Wiring
KI	Time Indicator	Hour Meter
LAH	Level Alarm High	High Liquid Level Alarm
LAHH	Level Alarm High High	High Liquid Level Shutdown
LAL	Level Alarm Low	Low Liquid Level Alarm
LALL	Level Alarm Low Low	Low Liquid Level Shutdown
LC	Level Controller	Liquid Level Controller, Drip Trap
LCH	Level Control High	Condensate Pump Control
LCL	Level Control Low	Condensate Pump Control
LE	Level Element	Liquid Level Measuring Element, Capacitance Probe
LI	Level Indicator	Condensate Measurement
LMP	Lamp	Lights, Lamps, Beacons
LS	Level Switch	Liquid Level Switch
LT	Level Transmitter	Liquid Level Measuring Transmitter

Ref Des	Reference Item	Typical Usage/Description
LUB	Air Lubricator	Air Lubricator
LZ	Level controller	Air Vent
MAL	Methane Alarm Low	Low Methane Level Alarm
MALL	Methane Alarm Low Low	Low Methane Level Shutdown
MI	Methane Indicator	Methane Level Gauge
MIR	Methane Indicating Recorder	Paper or Paperless Chart Recorder
MOD	Modem	Modem
MV	Mixer Valve	Engine Carburetor
NBK	Neutral Block	Neutral Block
OAH	Oxygen Alarm High	High Oxygen Level Alarm
OAHH	Oxygen Alarm High High	High Oxygen Level shutdown
OE	Oxygen Element	Oxygen Sensor
OI	Oxygen Indicator	Oxygen Level Gauge
OIR	Oxygen Indicating Recorder	Paper or Paperless Chart Recorder
OT	Oxygen Transmitter	Oxygen Level Transmitter
PAH	Pressure Alarm High	High Pressure Alarm
PAHH	Pressure Alarm High High	High Pressure Shutdown
PAL	Pressure Alarm Low	Low Pressure Alarm
PALL	Pressure Alarm Low Low	Low Pressure Shutdown
PC	Pressure Controller	PID Loop Pressure Controller, Valve Operator Logic
PCV	Pressure Control Valve	Regulators, Actuated or Hand Modulating Valves
PDI	Pressure Differential Indicator	Differential Pressure Gauge
PDT	Pressure Differential Transmitter	DP Flow Meter
PH	Phone	Phone
PI	Pressure Indicator	Pressure Gauge
PIA	Pressure Indicator & Alarm	Pressure Gauge w/Switch
PIR	Pressure Indicating Recorder	Paper or Paperless Chart Recorder
PLC	Programmable Logic Controller	Programmable Logic Controller
PLT	Pilot	Pilot Mixing Assembly
PMP	Pump	Liquid Pump
PR	Pressure Recorder	Paper or Paperless Recorder
PS	Pressure Switch	Pressure Switch
PSE	Pressure Safety Element	Rupture Disk
PSW	Pipe Spool Weldment	Pipe Spool Weldment
PT	Pressure Transmitter	Pressure Transmitter
R	Relay	Control Relay
RCP	Receptacle	Electrical Receptacle
RES	Resistor	Resistor
RM	Relay Module	PLC Relay Module
SGN	Sign	Sign
SI	Speed Indicator	Speed or Frequency Meter
SSR	Surge Arrestor	Surge Protectors, Lightning Arrestors
TAH	Temperature Alarm High	High Temperature Alarm
TAHH	Temperature Alarm High High	High Temperature Shutdown
TAL	Temperature Alarm Low	Low Temperature Alarm
TALL	Temperature Alarm Low Low	Low Temperature Shutdown
TB	Terminal Block	Terminal Block
TC	Temperature Controller	Thermostat
TCV	Temperature Control Valve	Control Valves
TE	Temperature Element	Thermocouple, RTD, Thermister
TES	Temperature Element Switch	Thermocouple Switch
TEV	Thermostatic Expansion Valve	Thermostatic Expansion Valve
TEW	Temperature Element Well	Port for Thermocouple, RTD or Thermister
TI	Temperature Indicator	Temperature Gauge
TIA	Temperature Indicator & Alarm	Temperature Gauge w/Switch
TIR	Temperature Indicator Recorder	Paper or Paperless Chart Recorder
TK	Tank	Propane Tank, Condensate Storage Tank
TSE	Temperature Safety Element	Flame Arrestor, Flame Check
TSV	Temperature Safety Valve	Valved Fusible Link
TT	Temperature Transmitter	Temperature Transmitter
TX	Heat Exchanger	Heat Exchanger
UPS	Uninterruptable Power Supply	Uninterruptable Power Supply
VAH	Vibration Alarm High	High Vibration Alarm
VAHH	Vibration Alarm High High	High Vibration Shutdown
VFD	Variable Frequency Drive	Variable Frequency Drive
VI	Vibration Indicator	Vibration Gauge
VIR	Vibration Indicating Recorder	Paper or Paperless Chart Recorder
VT	Vibration Transmitter	Vibration Transmitter
YASD	Event Alarm	VFD Faults
YI	Event Indicator	Run Lamps
YIC	Event Indicator Controller	Touch Screens, Setpoint/Display Panels, VFD Keypads, UV Sensor Interface Panels
ZA	Position Alarm	Valve Fail To Open, Close
ZC	Position Controller	PID Loop Position Controller
ZI	Position Indicator	Valve or Damper Position Indicator
ZS	Position Switch	Valve Open, Close Switches

WEST PLAINS, MISSOURI USA

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, LLC

0			
LTR	DESCRIPTION	DATE	APPROVED

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES

DESIGNED BY:	DATE
E.T.BOYS	5/27/20
DRAWN BY:	DATE
A.PARKER	5/27/20

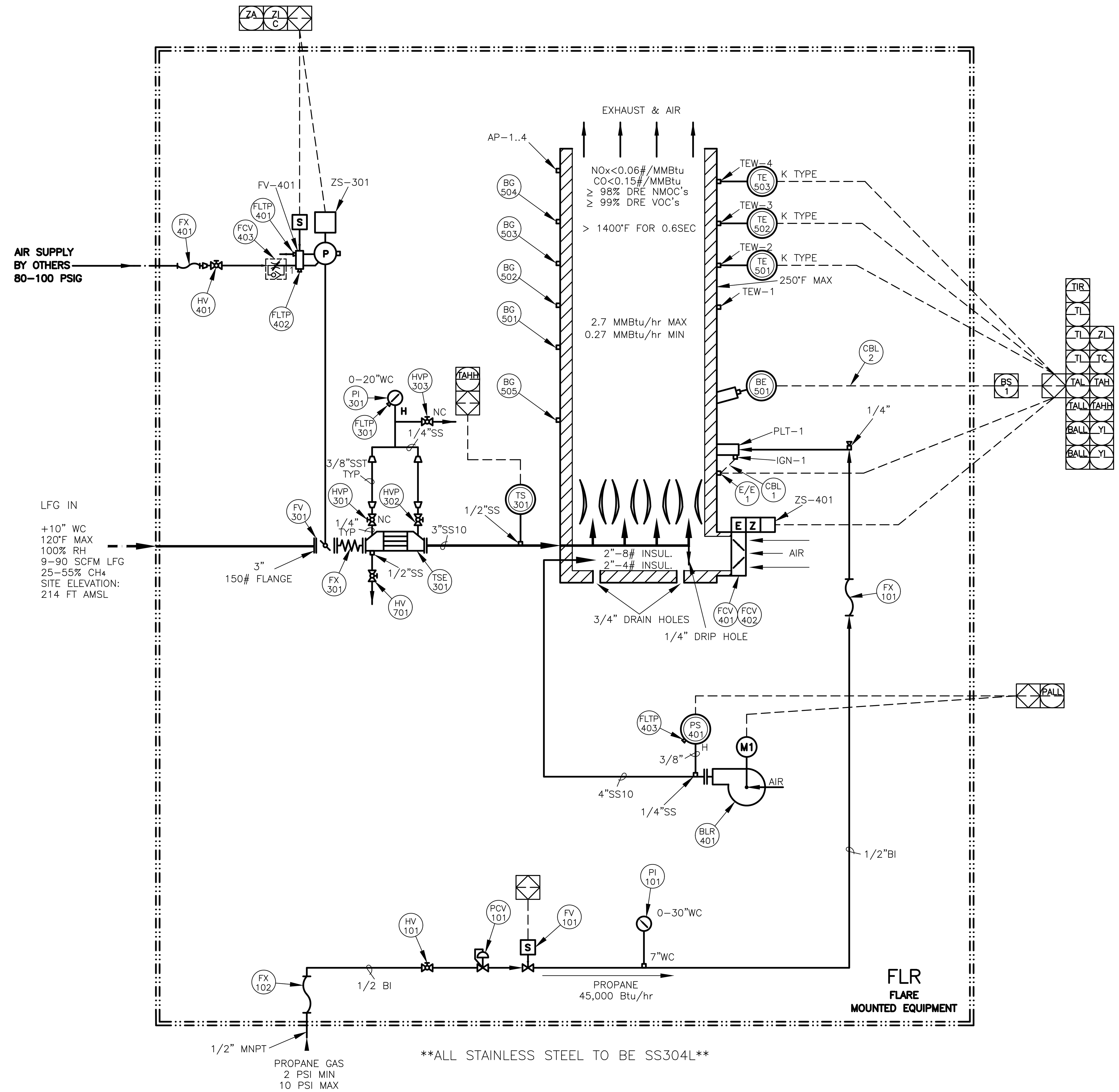
TITLE: COVER PAGE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

FRACT	.XX	ANGLES
±1/16	±.03	±0°30

SIZE D 34x22 | DWG. NO. COVER-1910

MATERIAL: AS NOTED | SCALE AS NOTED | FILE NO. COVER-1910 R0.DWG | SHEET 1 OF 1



ALL STAINLESS STEEL TO BE SS304L

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, INC.

CONTROL PANEL MOUNTED LOGIC ELEMENTS REFERENCE DESIGNATORS OF LOGIC OR CONTROL PANEL MOUNTED EQUIPMENT. IDENTIFICATION LETTERS CONFORM TO ISA'S INSTRUMENTATION SYMBOLS AND IDENTIFICATION MANUAL TABLE #1

MANUAL VALVES ARE NORMALLY OPEN DURING SYSTEM OPERATION UNLESS DESIGNATED BY "NC"

PIPING MATERIALS LEGEND

AL: ALUMINUM
BI: BLACK IRON
CI: CAST IRON
CS: CARBON STEEL
CPVC: CHLOROPOLYVINYLCHLORIDE
SS: STAINLESS STEEL
EPDM: ETHYLENE PROPYLENE DIENE MONOMER
FRP: FIBERGLASS REINFORCED PLASTIC

10: SCH 10 PIPE
40: SCH 40 PIPE
80: SCH 80 PIPE
H: I.D. HOSE
T: O.D. TUBING

(EXAMPLE: 6"AL40 = 6" ALUMINUM SCHEDULE 40 PIPE)

LINES LEGEND

ELECTRICAL CONNECTIONS
MAIN PIPING
SUB PIPING
AIR LINE
CONDENSATE LINE
CUSTOMER SUPPLIED MAIN PIPING
CUSTOMER SUPPLIED SUB PIPING
LOCATION BORDER
FUTURE/PENDING PIPING BORDER
GLYCOL/WATER PIPING

FLUID DESIGNATORS

Ref Des	Fluid
1XX	Fossil Fuels
2XX	Oils
3XX	Biogas
4XX	Air
5XX	Combustion Exhaust
6XX	Coolants
7XX	Condensate
8XX	Inert Gases
9XX	Digester Fluids

LTR	DESCRIPTION	DATE	APPROVED
1	ADDED PARTS LIST (5/22/20) AP		

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

This Drawing Contains Proprietary Data and May Not Be Duplicated, Copied, Reproduced or Otherwise Used In Any Manner Not in the Best Interest of Perennial Energy, Inc. All Ideas and Concepts Remain the Property of Perennial Energy, Inc.

ENGINEERING SIGNATURES

	DATE
DESIGNED BY: E.BOYS	5/8/20
DRAWN BY: B.HOLMAN	5/8/20

TITLE: GAS HANDLING SYSTEM P&ID

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

FRACT	.XX	ANGLES
±1/16	±.03	±0°30

SIZE: D 34x22
DWG. NO. ME-010-0166

MATERIAL: AS NOTED
SCALE: AS NOTED
FILE NO. ME-010-0166 R1.DWG
SHEET 1 OF 2

(XX) REFERENCED PARTS

Part ID	Section	Drawing ID	RefDes	RefDesQty	UnitQty	TotalQty	Component	MFG / Material / Type	Description
5408	FLR	ME-010-0166	FLR-BE-501	1 ea	1 ea	1 ea	Lens-Focusing	Honeywell	124204, Fused quartz lens
14477	FLR	ME-010-0166	FLR-BE-501	1 ea	1 ea	1 ea	UV Scanner	Honeywell	C7061A1038 3/4" sight Tube
139	FLR	ME-010-0166	FLR-BG-501..5	5 ea	1 ea	5 ea	Port-View	Stemmerich	P1030-8, 2" Plated Outdoor Use
2307	FLR	ME-010-0166	FLR-BLR-401	1 ea	1 ea	1 ea	Blower-Purge	Cincinnati	LMF-4, 4.7 x 2.9 wheel, CW-TH, Arr #4HM, 1/3HP TEFC, w/inlet guard, 120 V, 60 Hz
14143	FLR	ME-010-0166	FLR-CBL-1	1 ea	1 ft	1 ft	Cable-Ignition	Allied Wire & Cable	3257-14 UL Listed Ignition Cable, 25,000 volt
4101	FLR	ME-010-0166	FLR-CBL-2	1 ea	1 ea	1 ea	Cable-UV Scanner	Woodhead	105000A01F120, 12ft long
68	FLR	ME-010-0166	FLR-E/E-1	1 ea	1 ea	1 ea	Transformer	Honeywell	Q624A1014
10362	FLR	ME-010-0166	FLR-FCV-401,2	2 ea	1 ea	2 ea	Actuator	Honeywell	M7284C1000, 30 sec, 90 deg, 150 in lbs, w/2 aux switches
79	FLR	ME-010-0166	FLR-FCV-401,2	2 ea	1 ea	2 ea	Arm-Crank	Honeywell	221455A, Infinitely Adjustable Motor Crank Arm
78	FLR	ME-010-0166	FLR-FCV-401,2	2 ea	1 ea	2 ea	Joint-Ball	Honeywell	#102546
14668	FLR	ME-010-0166	FLR-FCV-401,2	2 ea	1 ea	2 ea	Louver	Ruskin	822A3-OB w/CRKL, 250 DEG F, 14" H X 12" W
5499	FLR	ME-010-0166	FLR-FCV-401,2	2 ea	1 ea	2 ea	Weatherproof Kit	Honeywell	4074ERU, NEMA 3 Kit for Modutrol IV Motors
4829	FLR	ME-010-0166	FLR-FCV-403	3 ea	1 ea	3 ea	Valve-Flow Control	Ingersoll-Rand	2F851 - Flow Control Valve, 1/4 male NPT x 1/4 female NPT, 150 psi max IR 119307-250
5813	FLR	ME-010-0166	FLR-FLTP-401..3	3 ea	1 ea	3 ea	Filter	McMaster-Carr	4427K82, 1/4" NPT, High Flow
3629	FLR	ME-010-0166	FLR-FV-101	1 ea	1 ea	1 ea	Valve-Solenoid	Asco	EF8215G20, 1/2" NPT, 120 VAC, Explosion Proof
9148	FLR	ME-010-0166	FLR-FV-301	1 ea	1 ea	1 ea	Valve-Actuated Package	ABZ	3", 102-961-001-ISO, CI/SS/VIT, w/Elomatic ES0200-4 Fail Close Pneumatic actuator, EF8551A1MS solenoid valve,120 Volt, Topworx DXPM21GNEB Nema 4/7 Limit Switch
11180	FLR	ME-010-0166	FLR-FX-101	1 ea	1 ea	1 ea	Flex-Hose	Hose Master	CA321B0050-012-AF4750, 1/2" ID x 12" L SS, braided hose, MNPT x Union FNPT
11804	FLR	ME-010-0166	FLR-FX-102	1 ea	1 ea	1 ea	Flex-Hose	Hose Master	CA321B0200-018-AF4750, 2" ID x 18" L SS, Braided Hose, MNPT x Union FNPT
11583	FLR	ME-010-0166	FLR-FX-301	1 ea	1 ea	1 ea	Flex-Floating	DME Expansion Joints	FJ- 300-L, 3" pipe, 6" O.A.L., w/ drop in liner, w/hot dipped galvanized flanges
767	FLR	ME-010-0166	FLR-FX-401	1 ea	1 ea	1 ea	Flex	Western Enterprises	WES-PF-4-36
4954	FLR	ME-010-0166	FLR-HV-101	1 ea	1 ea	1 ea	Valve-Ball	Apollo	76F-103, 1/2" NPT, SS, full port. Made in USA
4953	FLR	ME-010-0166	FLR-HV-401	1 ea	1 ea	1 ea	Valve-Ball	Apollo	76F-101, 1/4" NPT, SS, full port. Made in USA.
11814	FLR	ME-010-0166	FLR-HV-701	1 ea	1 ea	1 ea	Valve-Ball	Apollo	76-103-01, 1/2" NPT, SS
4953	FLR	ME-010-0166	FLR-HVP-301..3	3 ea	1 ea	3 ea	Valve-Ball	Apollo	76F-101, 1/4" NPT, SS, full port. Made in USA.
3995	FLR	ME-010-0166	FLR-PCV-101	1 ea	1 ea	1 ea	Regulator	Fisher	R622, 1/2 " NPT for 9" WC to 13" WC range
11328	FLR	ME-010-0166	FLR-PI-101	1 ea	1 ea	1 ea	Gauge-Pressure	WIKA	611.10, 0-30"wc, 1/4" connection, 2 1/2" face, bottom mount
1098	FLR	ME-010-0166	FLR-PI-301	1 ea	1 ea	1 ea	Gauge-Pressure	Dwyer	Capsuhelic #4020LT, 0-20" WC
73	FLR	ME-010-0166	FLR-PI-301	1 ea	1 ea	1 ea	Mount-Gauge	Dwyer	A-370, panel mount
7539	FLR	ME-010-0166	FLR-PS-401	1 ea	1 ea	1 ea	Switch-Pressure	Dwyer	1950-02-2S, 0.03 TO 0.10" WC
12399	FLR	ME-010-0166	FLR-TE-501..3	3 ea	1 ea	3 ea	Thermocouple	ThermX Southwest	KMI9-24-6UD-00-AX, 24" length, 3/8" Inconel 600 sheath, Aluminum head, Mineral insulated, ungrounded. 1/2" x1/2"
12552	FLR	ME-010-0166	FLR-TS-301	1 ea	1 ea	1 ea	Switch-Temperature	Ashcroft	T7-24-TS-040-235/375F, NEMA 7
14748	FLR	ME-010-0166	FLR-TSE-301	1 ea	1 ea	1 ea	Flame Arrester	Groth	Model # 7628-03-11-FOZ, 3" horiz., Stainless element, 1/4" pressure taps, 1/2" drain

LTR	DESCRIPTION	DATE	APPROVED
1	ADDED PARTS LIST (5/22/20) AP		

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES

DESIGNED BY: E.BOYS DATE 5/8/20

DRAWN BY: B.HOLMAN DATE 5/8/20

TITLE: GAS HANDLING SYSTEM P&ID

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

FRACT	.XX	ANGLES
±1/16	±.03	±0°30

SIZE D 34x22 — DWG. NO. ME-010-0166

MATERIAL: AS NOTED — SCALE AS NOTED — FILE NO. ME-010-0166 R1.DWG — SHEET 2 OF 2

XX **REFERENCED PARTS**

Part ID	Section	Drawing ID	RefDes	RefDesQty	UnitQty	TotalQty	Component	MFG / Material / Type	Description
4030	CP	EE-005-0584	CP-BS-1	1 ea	1 ea	1 ea	Amplifier	Honeywell	R7861A1026
11258	CP	EE-005-0584	CP-BS-1	1 ea	1 ea	1 ea	Flame Switch	Honeywell	RM7896D1019
10189	CP	EE-005-0584	CP-BS-1	1 ea	1 ea	1 ea	Purge Card	Honeywell	ST7800A1070, 2.5 min. Purge
443	CP	EE-005-0584	CP-BS-1	1 ea	1 ea	1 ea	Sub Base	Honeywell	Q7800A1005
2757	CP	EE-005-0584	CP-CBL-1	1 ea	1 ea	1 ea	Cable-Display	Honeywell	221818C, 120" length
473	CP	EE-005-0584	CP-YIC-1	1 ea	1 ea	1 ea	UV Sensor Display	Honeywell	S7800A1001

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, INC.

0			
LTR	DESCRIPTION	DATE	APPROVED

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES

	DATE
DESIGNED BY: E.T.BOYS	5/22/20
DRAWN BY: B.HOLMAN	5/22/20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30

TITLE: 120VAC INSTRUMENTATION ELEMENTARY

SIZE: D 34x22
DWG. NO. EE-005-0584

MATERIAL: AS NOTED
SCALE: AS NOTED
FILE NO. EE-005-0584 R0. DWG
SHEET 1 OF 1

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, INC.

LTR	DESCRIPTION	DATE	APPROVED
0			

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES

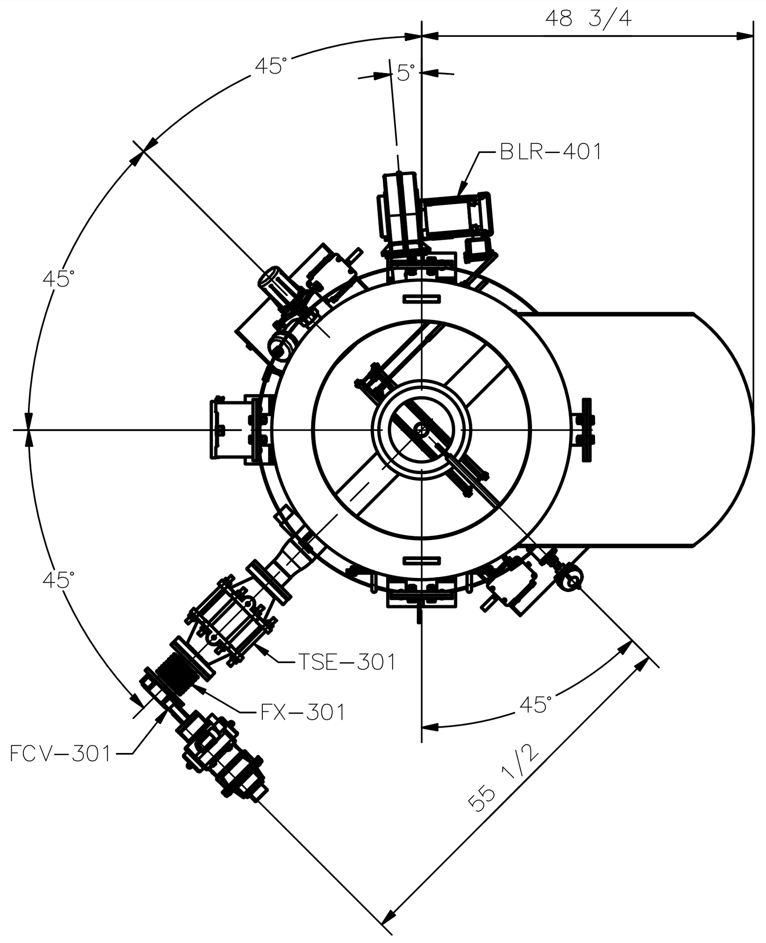
	DATE
DESIGNED BY: E.T BOYS	5/20/20
DRAWN BY: B.HOLMAN	5/20/20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30

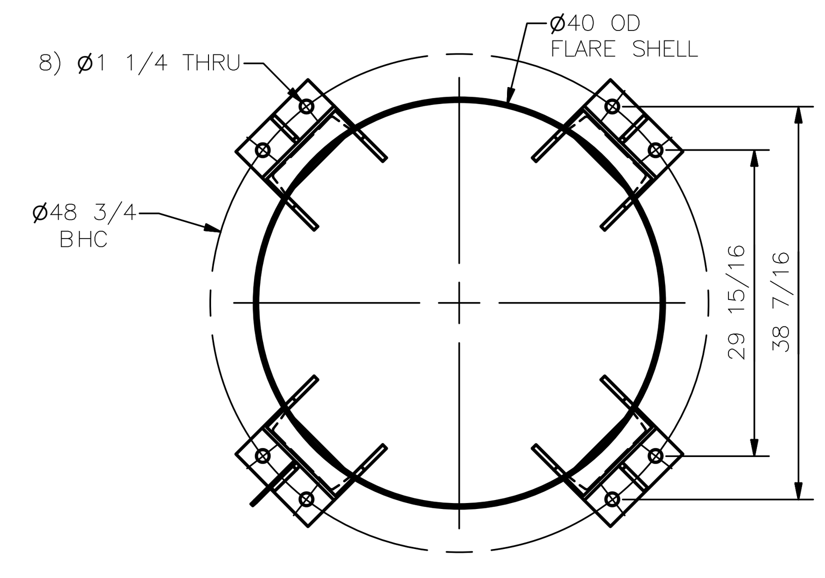
TITLE
INTERCONNECTION WIRING DIAGRAM

SIZE D 34x22
DWG. NO. EE-018-0255

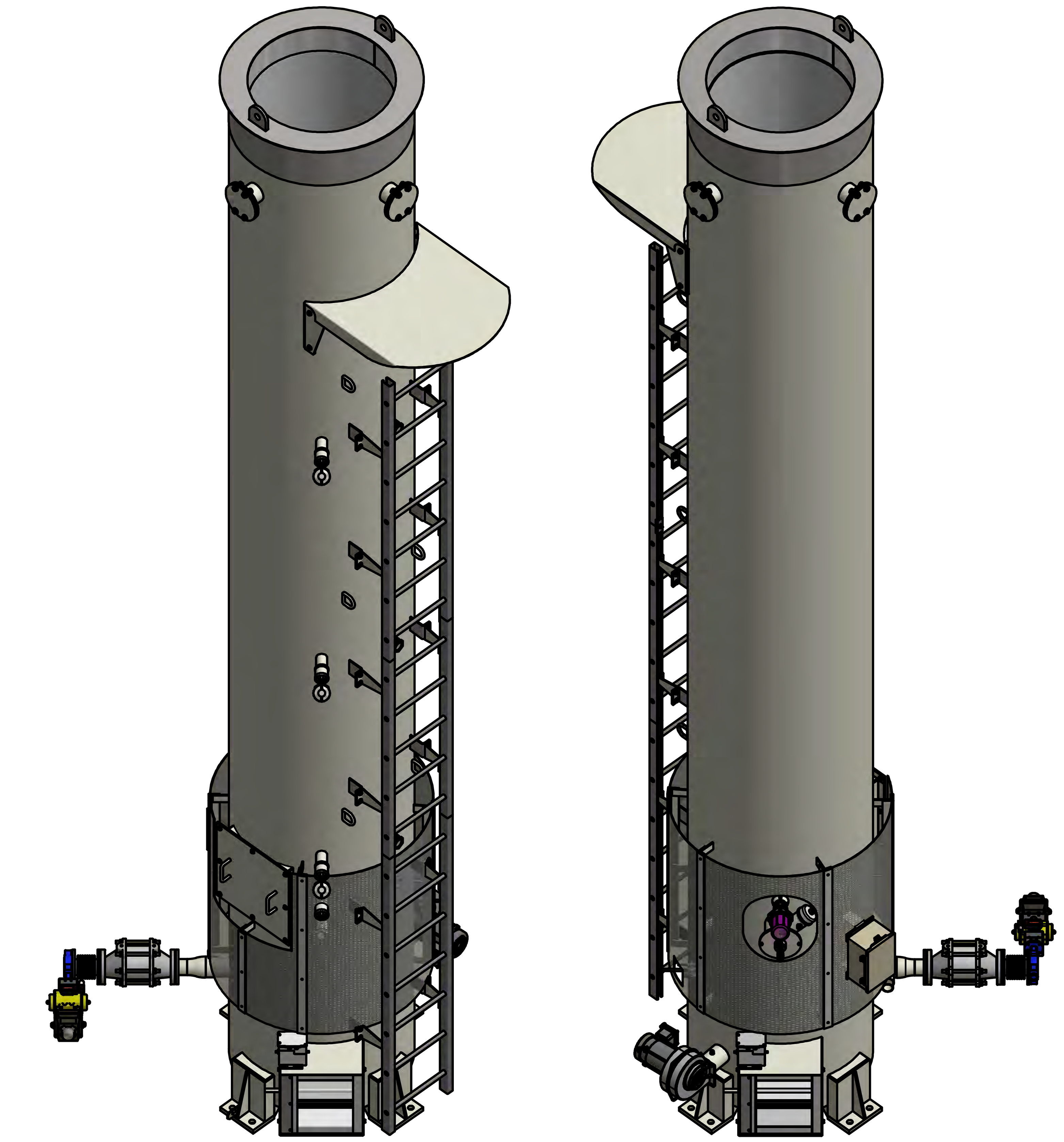
MATERIAL: AS NOTED
SCALE AS NOTED
FILE NO. EE-018-0255 R0. DWG
SHEET 1 OF 1



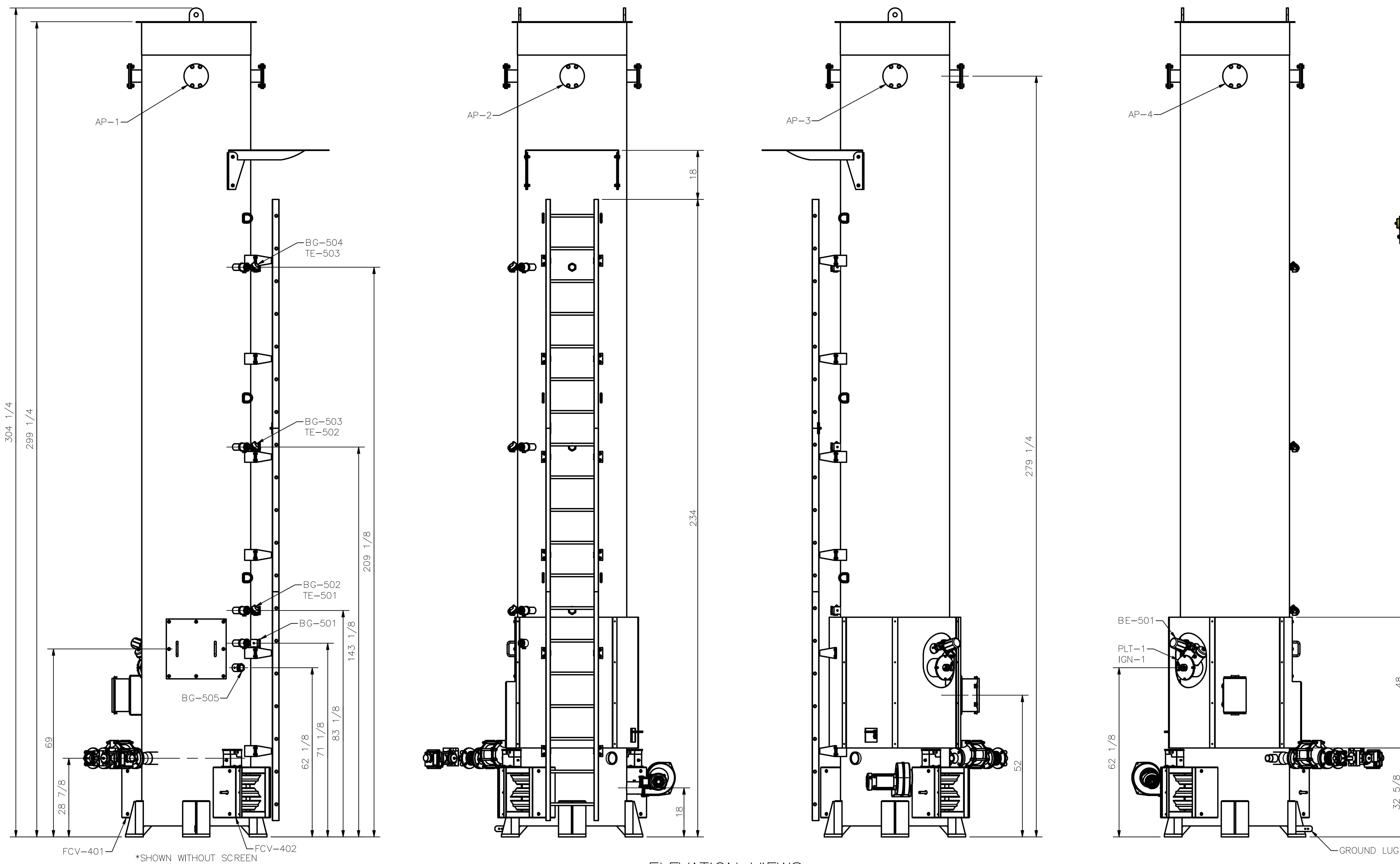
PLAN VIEW
SCALE 1:24



FOOT DETAIL
SCALE 1:16



ISOMETRIC VIEWS
SCALE 1:24



ELEVATION VIEWS
SCALE 1:24

PRELIMINARY
FOR REVIEW/INFO.
ONLY
PERENNIAL ENERGY, LLC

REDUCED
FROM ORIGINAL
SIZE

APPROXIMATE WEIGHT: 4,000 LBS
NOTE: FLARE IS IN AN UNCLASSIFIED AREA.

LTR	DESCRIPTION	DATE	APPROVED
0			

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF MEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES		TITLE:
DESIGNED BY: E.T.BOYS	DATE: 5/8/20	FLARE TOP ASSEMBLY
DRAWN BY: D.SMITH	DATE: 5/8/20	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30'

SIZE: D
DWG. NO. PA-001-1037

MATERIAL: AS NOTED
SCALE: AS NOTED
FILE NO. PA-001-1037.dwg
SHEET 1 OF 1

5/27/2020 2:15:45 PM I:\ACAD\1900-1950\1910 Leichner LF mEGF\PA-001-1037.dwg D.SMITH

XX REFERENCED PARTS

Part ID	Section	Drawing ID	RefDes	RefDesQty	UnitQty	TotalQty	Component	MFG / Material / Type	Description
78	Spares	SP-001-0192	Ball Joint	1 ea	1 ea	1 ea	Joint-Ball	Honeywell	#102546
11258	Spares	SP-001-0192	Burner Switch	ea	1 ea	ea	Flame Switch	Honeywell	RM7896D1019
79	Spares	SP-001-0192	Crank Arm	ea	1 ea	ea	Arm-Crank	Honeywell	221455A, Infinitely Adjustable Motor Crank Arm
12399	Spares	SP-001-0192	Flare Thermocouples	ea	1 ea	ea	Thermocouple	ThermX Southwest	KMI9-24-6UD-00-AX, 24" length, 3/8" Inconel 600 sheath, Aluminum head, Mineral insulated, ungrounded. 1/2" x1/2"
14143	Spares	SP-001-0192	Ignition Cable	ea	1 ft	ft	Cable-Ignition	Allied Wire & Cable	3257-14 UL Listed Ignition Cable, 25,000 volt
68	Spares	SP-001-0192	Ignition Transformer	ea	1 ea	ea	Transformer	Honeywell	Q624A1014
65	Spares	SP-001-0192	Ignitor	ea	1 ea	ea	Ignitor	Auburn	I-64-3 (modified)
10362	Spares	SP-001-0192	Louver Motor	ea	1 ea	ea	Actuator	Honeywell	M7284C1000, 30 sec, 90 deg, 150 in lbs, w/2 aux switches
3629	Spares	SP-001-0192	Pilot Solenoid	ea	1 ea	ea	Valve-Solenoid	Asco	EF8215G20, 1/2" NPT, 120 VAC, Explosion Proof
3995	Spares	SP-001-0192	Propane Regulator	ea	1 ea	ea	Regulator	Fisher	R622, 1/2 " NPT for 9" WC to 13" WC range
5408	Spares	SP-001-0192	Scanner Lens	ea	1 ea	ea	Lens-Focusing	Honeywell	124204, Fused quartz lens
8249	Spares	SP-001-0192	Shutdown Valve Solenoid	ea	1 ea	ea	Valve-Solenoid	Asco	EF8551A1MMS, 120V, Explosion Proof
14477	Spares	SP-001-0192	UV Scanner	ea	1 ea	ea	UV Scanner	Honeywell	C7061A1038 3/4" sight Tube
5499	Spares	SP-001-0192	Weather Kit	ea	1 ea	ea	Weatherproof Kit	Honeywell	4074ERU, NEMA 3 Kit for Modutrol IV Motors

REDUCED FROM ORIGINAL SIZE

PRELIMINARY FOR REVIEW/INFO. ONLY PERENNIAL ENERGY, INC.

LTR	DESCRIPTION	DATE	APPROVED
0			

REVISIONS

APPLICABLE JOB NO(S). 1910
LEICHNER LF mEGF

PEI PERENNIAL ENERGY
1375 COUNTY ROAD 8690
WEST PLAINS, MO 65775
www.PerennialEnergy.com

ENGINEERING SIGNATURES

DESIGNED BY: E.T.BOYS DATE 5/27/20

DRAWN BY: A.PARKER DATE 5/27/20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT ±1/16 .XX ±.03 ANGLES ±0°30

TITLE SPARE PARTS LIST

SIZE D 34x22 DWG. NO. SP-001-0192

MATERIAL: AS NOTED | SCALE AS NOTED | FILE NO. SP-001-0192 R0.DWG | SHEET 1 OF 1

Appendix C

Leichner Landfill Air Discharge Permit and Technical Support Document No. 20-3433, Effective October 1, 2020

SWCAA
Southwest Clean Air Agency

11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
(360) 574-3058
www.swcleanair.org

October 1, 2020

Mr. Mike Davis, Landfill Manager
Clark County Public Health – Solid Waste Services
PO Box 9825
Vancouver, WA 98666-9825

Subject: Final Air Discharge Permit for Replacement Landfill Gas Flare

Dear Mr. Davis:

A final determination to issue Air Discharge Permit 20-3433 (ADP 20-3433) has been completed for Air Discharge Permit (ADP) Application CL-3138 pursuant to Section 400-110(4) of the General Regulations for Air Pollution Sources of the Southwest Clean Air Agency (SWCAA). Public notice for ADP Application CL-3138 was published in the permit section of SWCAA's internet website on August 6, 2020. SWCAA did not receive a request for a public comment period in response to the public notice and has concluded that significant public interest does not exist for this determination. Therefore, a public comment period will not be provided for this permitting action. Electronic copies of ADP 20-3433 and the associated Technical Support Document are available for public review in the permit section of SWCAA's internet website (http://www.swcleanair.org/permits/adpfinal.asp). Original copies are enclosed for your files.

This Air Discharge Permit may be appealed directly to the Pollution Control Hearings Board (PCHB) at P.O. Box 40903, Olympia, Washington 98504-0903 within 30 days of receipt as provided in RCW 43.21B.

If you have any comments, or desire additional information, please contact me or Wess Safford at (360) 574-3058, extension 126.

Sincerely,

Uri Papish
Executive Director

UP:wls
Attachment

SWCAA
Southwest Clean Air Agency

AIR DISCHARGE PERMIT
20-3433

Final Date: October 1, 2020

Facility Name: Leichner Landfill
Physical Location: 9411 NE 94th Avenue
Vancouver, WA 98662

SWCAA ID: 1239

PAUL T. MAIROSE
STATE OF WASHINGTON
21507
REGISTERED PROFESSIONAL ENGINEER

REVIEWED BY:
Paul T. Mairose, Chief Engineer

APPROVED BY:
Uri Papish, Executive Director

TABLE OF CONTENTS

1. Equipment/Activity Identification

ID No.	Generating Equipment/Activity	# of Units	Control Measure/Equipment	# of Units
1	Landfill	1	Enclosed flare (Perennial Energy – 2.7 MMBtu/hr)	1

2. Approval Conditions

The following tables detail the specific requirements of this permit. In addition to the requirements listed below, equipment at this facility may be subject to other federal, state, and local regulations. The permit requirement number is identified in the left-hand column. The text of the permit requirement is contained in the middle column. The emission unit, equipment, or activity to which the permit requirement applies is listed in the right-hand column.

This Permit supersedes Air Discharge Permit 07-2714 in its entirety.

Emission Limits

No.	Emission Limits	Equipment/ Activity
1.	Combined emissions from landfill operation (flare and fugitive) must not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> VOC (as hexane) — 4.14 tpy Annual emissions must be calculated by summing flare and fugitive emissions. Fugitive VOC emissions must be calculated from estimated landfill gas generation, a gas capture efficiency of 75% and emission factors from the Technical Support Document for this Air Discharge Permit.	1
2.	Emissions from the Landfill Gas Flare shall not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> NO_X — 0.060 lb/MMBtu (1-hr avg) 0.72 tpy CO — 0.15 lb/MMBtu (1-hr avg) 1.79 tpy NMOC/VOC (as hexane) — 0.050 lb/MMBtu (1-hr avg) or 98% destruction 0.60 tpy SO_2 — 0.016 lb/MMBtu (1-hr avg) 0.18 tpy Annual emissions must be calculated from actual landfill gas combustion and emission factors from the Technical Support Document for this Air Discharge Permit or more recent source test data if available.	1

No.	Emission Limits	Equipment/ Activity
3.	Visible emissions from the Landfill Gas Flare shall not exceed zero percent opacity for more than 3 minutes in any one-hour period as determined in accordance with SWCAA Method 9 (See Appendix A of SWCAA 400).	1

Operating Limits and Requirements

No.	Operating Limits and Requirements	Equipment/ Activity
4.	Reasonable precautions must be taken at all times to prevent and minimize fugitive emissions from plant operations.	Facilitywide
5.	The permittee must use recognized good practice and procedures to reduce odors to a reasonable minimum.	Facilitywide
6.	Each pollution control device/measure must be in use whenever the associated production equipment is in operation. Control devices must be operated and maintained in accordance with the manufacturer's specifications and operated in a manner that minimizes emissions.	1
7.	Emission units identified in this Permit must be maintained and operated in total and continuous conformity with the conditions identified in this Permit. SWCAA reserves the right to take any and all appropriate action to maintain the conditions of this Permit, including directing the facility to cease operations until corrective action can be completed.	1
8.	Prior to the initial emission test, the Landfill Gas Flare must be operated at a minimum temperature of 1,400°F (1-hr avg). Thereafter, the flare must be operated within the range of operating temperatures (1-hr avg) at which compliance with the permitted emission limits was demonstrated during the most recent source emissions test.	1

Monitoring and Recordkeeping Requirements

No.	Monitoring and Recordkeeping Requirements	Equipment/ Activity
9.	With the exception of data logged by a computerized data acquisition system, each record required by this Permit must include the date and the name of the person making the record entry. If a control device or process is not operating during a specific time period, a record must be made to that effect.	1
10.	All records required by this Permit must be kept for a minimum period of no less than three years and must be maintained in a form readily available for inspection by SWCAA representatives.	1
11.	Excess emissions and upset conditions must be recorded for each occurrence.	1

No.	Monitoring and Recordkeeping Requirements	Equipment/ Activity
12.	The permittee must monitor and record the following information: (a) Quantity of landfill gas burned in the Landfill Gas Flare (scf) — Recorded monthly (b) Landfill Gas Flare operating temperature — Monitored continuously, Recorded daily (c) Methane content of the landfill gas* — Recorded at least once every 12 calendar months (d) Air quality related complaints and results of subsequent investigation or corrective action — Recorded for each occurrence (e) Upset conditions that cause excess emissions — Recorded for each occurrence (f) Maintenance activities that may affect air emissions — Recorded for each occurrence * Methane content must be determined with a portable field instrument that has been calibrated with a gas standard of a known methane concentration onsite prior to monitoring, EPA Method 3C, or other methods approved by SWCAA.	

Emission Monitoring and Testing Requirements

No.	Emission Monitoring and Testing Requirements	Equipment/ Activity
13.	The permittee must conduct initial and periodic emission testing of the Landfill Gas Flare as described in Appendix A of this Permit.	1

Reporting Requirements

No.	Reporting Requirements	Equipment/ Activity
14.	All air quality related complaints received by the permittee must be reported to SWCAA within three days of receipt.	Facilitywide
15.	An annual emissions inventory report must be submitted in accordance with SWCAA 400-105(1). In addition to the emissions information required under SWCAA 400-105(1), each annual report must include an estimate of annual emission quantities for each TAP compound listed in the Technical Support Document for this Permit.	1
16.	Excess emissions must be reported to SWCAA as follows: • As soon as possible, but no later than 12 hours after discovery for emissions that represent a potential threat to human health or safety; • As soon as possible, but no later than 48 hours after discovery for emissions which the permittee wishes to claim as unavoidable pursuant to SWCAA 400-107; and • No later than 30 days after the end of the month of discovery for all other excess emissions.	1

No.	Reporting Requirements	Equipment/ Activity
17.	The following emission-related information must be reported to SWCAA no later than March 15th for the previous calendar year: (a) The total amount of landfill gas burned in the Landfill Gas Flare; (b) The average methane content of the landfill gas burned in the Landfill Gas Flare; and (c) Air emissions of criteria air pollutants, volatile organic compounds, and toxic air pollutants (TAPs).	1
18.	Emission test results must be reported to SWCAA in writing within 45 days of test completion.	1
19.	The permittee shall notify SWCAA in writing within 10 days after completing initial installation of new equipment. This will allow proper inspections and observations to be conducted for the new equipment.	1

3. General Provisions

No.	General Provisions
A.	For the purpose of ensuring compliance with this Permit, duly authorized representatives of the Southwest Clean Air Agency must be permitted access to the permittee's premises and the facilities being constructed, owned, operated and/or maintained by the permittee for the purpose of inspecting said facilities. These inspections are required to determine the status of compliance with this Permit and applicable regulations and to perform or require such tests as may be deemed necessary.
B.	The provisions, terms and conditions of this Permit bind the permittee, its officers, directors, agents, servants, employees, successors and assigns, and all persons, firms, and corporations acting under or for the permittee.
C.	The requirements of this Permit survive any transfer of ownership of the source or any portion thereof.
D.	This Permit must be posted conspicuously at or be readily available near the source.
E.	This Permit will be invalid if construction has not commenced within eighteen (18) months from date of issuance, if construction is discontinued for a period of eighteen (18) months or more, or if construction is not completed within a reasonable time.
F.	This Permit does not supersede requirements of other Agencies with jurisdiction and further, this Permit does not relieve the permittee of any requirements of any other governmental Agency. In addition to this Permit, the permittee may be required to obtain permits or approvals from other agencies with jurisdiction.
G.	Compliance with the terms of this Permit does not relieve the permittee from the responsibility of compliance with SWCAA General Regulations for Air Pollution Sources, previously issued Regulatory Orders, RCW 70.94, Title 173 WAC or any other applicable emission control requirements, nor from the resulting liabilities and/or legal remedies for failure to comply.
H.	If any provision of this Permit is held to be invalid, all unaffected provisions of the Permit will remain in effect and be enforceable.
I.	No change in this Permit will be made or be effective except as may be specifically set forth by written order of the Southwest Clean Air Agency upon written application by the permittee for the relief sought.

No.	General Provisions
J.	The Southwest Clean Air Agency may, in accordance with RCW 70.94 impose such conditions as are reasonably necessary to assure the maintenance of compliance with the terms of this Permit, the Washington Clean Air Act, and the applicable rules and regulations adopted under the Washington Clean Air Act.

Air Discharge Permit 20-3433 - Appendix A
Emission Testing Requirements
Landfill Gas Flare

1. **Introduction:**
The purpose of this testing is to quantify emissions from the Landfill Gas Flare, determine NMOC destruction efficiency in the Landfill Gas Flare, and demonstrate compliance with the requirements of this Permit and applicable air quality regulations.

2. **Testing Requirements:**
   a. **Testing Schedule.** Initial emission testing of the Landfill Gas Flare must be conducted no later than 90 days after commencing regular operation. Subsequent emission testing of the Landfill Gas Flare must be conducted every 5 years thereafter, no later than the end of the calendar month in which the initial emission test was performed. Emission testing conducted more than three months prior to a scheduled due date will not satisfy the periodic source emission testing requirement unless prior written approval is obtained from SWCAA.

   b. **Test Plan.** A comprehensive test plan must be submitted to SWCAA for review and approval at least 10 business days prior to testing. SWCAA personnel must be informed at least 5 business days prior to testing so that a representative may be present during testing.

   c. **Test Runs/Reference Test Methods.** Unless otherwise specified, a minimum of 3 test runs must be conducted at each location for each constituent listed below to ensure the data are representative. Compliance must be demonstrated by averaging the results of the individual sampling runs.

Test location: Flare Outlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2	N/A
O_2, CO_2 content	EPA Method 3 or 3A	N/A
Moisture content	EPA Method 4	60 minutes
SO_2	EPA Method 6, 6C, mass balance	60 minutes
NO_X	EPA Method 7E	60 minutes
Opacity	SWCAA Method 9	10 minutes
CO	EPA Method 10	60 minutes
NMOC	EPA Method 25C	~60 minutes[1]

Test location: Flare Inlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2 or approved inline flowmeter	N/A
O_2, CO_2 content	EPA Method 3 or 3A	60 minutes
Fuel factor, CH_4, CO_2, O_2, N_2	EPA Methods 3C & 19	N/A
NMOC	EPA Method 25C	~60 minutes[1]

[1] A sampling time of approximately 60 minutes must be targeted. This is a grab sample method so establishing a precise collection time may not be practical.

3. **Source Operation:**
   a. **Source Operations.** Source operations during emissions testing must be representative of the most challenging of the intended operating conditions. The Permittee may choose to conduct the testing across a temperature range representative of the intended operating conditions. If this option is chosen, at least one sampling run must be conducted at the maximum and operating temperature, and at least one sampling run must be conducted at the minimum operating temperature.

   b. **Record of Production Parameters.** Production related parameters and equipment operating conditions must be recorded during emissions testing to correlate operating conditions with emissions. All recorded production parameters must be documented in the test results report. At a minimum, the following parameters must be recorded:
      (1) Landfill gas consumption rate,
      (2) Average flare temperature during each emission test as measured by the permanent flare temperature monitoring device,
      (3) Flare temperature setpoint during each emission test, and
      (4) Startup and shutdown events.

4. **Reporting Requirements:**
   a. **Test Report.** A final emission test report must be prepared and submitted to SWCAA within 45 calendar days of test completion. Test reports must be provided in hard copy (paper) and an electronic format acceptable to SWCAA. Each test report must include, at a minimum, the following information:
      (1) Description of the source including manufacturer, model number and design capacity of the equipment, and the location of the sample ports or test locations,
      (2) Time and date of the test and identification and qualifications of the personnel involved, including SWCAA personnel who observed the testing,
      (3) Summary of results, reported in units and averaging periods consistent with the applicable emissions standard or unit,
      (4) Summary of control system or equipment operating conditions,
      (5) Summary of production related parameters cited in Section 3,
      (6) A description of the test methods or procedures used including all field data, quality assurance/quality control procedures and documentation,
      (7) A description of the analytical procedures used including all laboratory data, quality assurance/quality control procedures and documentation,
      (8) Copies of field data and example calculations,
      (9) Chain of custody information,
      (10) Calibration documentation,
      (11) Discussion of any abnormalities associated with the results, and
      (12) A statement signed by the senior management official of the testing firm certifying the validity of the source test report.

5. **Changes to Testing Requirements:**
   The source test must be conducted as specified in the sections above. The Permittee may submit a written request to SWCAA for approval of minor modifications to the requirements above or the testing schedule. Upon review of the request and in accordance with EPA delegation, SWCAA will inform the Permittee in writing of any approved modifications.

SWCAA
Southwest Clean Air Agency

11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
(360) 574-3058
www.swcleanair.org

State Environmental Policy Act

DETERMINATION OF SEPA EXEMPT - SWCAA 20-036

Description of proposal:

ADP Application CL-3138: Installation of a replacement landfill gas flare. Proponent proposes to replace an existing landfill gas flare with a new flare of smaller capacity and similar design. No other changes or installations are proposed. This project is exempt from SEPA requirements pursuant to WAC 197-11-800(3) since it only involves repair, remodeling, maintenance, or minor alteration of existing structures, equipment or facilities, and does not involve material expansions or changes in use.

Proponent: Leichner Landfill (Mike Davis, Landfill Manager)

Location of proposal, including street address if any:
9411 NE 94th Avenue, Vancouver, WA 98662

Lead agency: Southwest Clean Air Agency

The lead agency for this proposal has determined that the proposed project is exempt from SEPA under WAC 197-11-800(3) as follows: "The repair, remodeling, maintenance, or minor alteration of existing private or public structures, facilities or equipment, including utilities, recreation, and transportation facilities involving no material expansions or changes in use beyond that previously existing; ..." .The proposed project is identified as maintenance of existing equipment and as such it does not have a probable significant impact on the environment. Neither an environmental checklist nor an environmental impact statement (EIS) is required under RCW 43.21C.030(2)(c). This decision was made by the lead agency after review of the proponent's proposal and the information on file with the lead agency. This information is available to the public on request.

☒ **This project/permitting action by SWCAA is SEPA exempt.**

Responsible official: Paul T. Mairose, P.E.
Position/title: Chief Engineer

Address: Southwest Clean Air Agency
11815 NE 99th St, Suite 1294
Vancouver, WA 98682-2322
Phone: (360) 574-3058, ext 130

Signature: Paul T Mairose

Date: 10/1/2020

TECHNICAL SUPPORT DOCUMENT

Air Discharge Permit ADP 20-3433
ADP Application CL-3138

Leichner Landfill
SWCAA ID - 1239

Issued: October 1, 2020

Prepared By: Wess Safford
Air Quality Engineer
Southwest Clean Air Agency

TABLE OF CONTENTS

Abbreviations

ADP	Air Discharge Permit
AP-42	Compilation of Emission Factors, AP-42, Fifth Edition, Volume 1, Stationary Point and Area Sources – published by the US Environmental Protection Agency
ASIL	Acceptable source impact level identified in WAC 173-460
BACT	Best Available Control Technology
BART	Best Available Retrofit Technology
Btu	British thermal unit
CAS #	Chemical Abstracts Service registry number
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
CO	Carbon monoxide
EPA	U.S. Environmental Protection Agency
HAP	Hazardous air pollutant listed pursuant to Section 112 of the Federal Clean Air Act
LAER	Lowest achievable emission rate
lb/hr	Pounds per hour
lbs	Pounds
lb/MMscf	Pounds per million standard cubic feet
lb/yr	Pounds per year
MMBtu	Million British thermal units
MMBtu/hr	Million British thermal units per hour
NMOC	Non-methane organic compound
NO_X	Nitrogen oxides
PM	Particulate matter with an aerodynamic diameter less than or equal to 100 micrometers (includes both filterable particulate matter measured by EPA Method 5 that is less than 100 micrometers and condensable particulate matter measured by EPA Method 202)
PM_{10}	Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (includes both filterable particulate matter measured by EPA Method 201 or 201A and condensable particulate matter measured by EPA Method 202)
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers (includes both filterable particulate matter measured by EPA Method 201 or 201A and condensable particulate matter measured by EPA Method 202)
ppm	Parts per million by volume
PSD	Prevention of Significant Deterioration
RACT	Reasonably Available Control Technology
RCW	Revised Code of Washington
scfm	Standard (68°F, 1 atmosphere) cubic feet per minute
SQER	Small Quantity Emission Rate listed in WAC 173-460
SO_2	Sulfur dioxide
SWCAA	Southwest Clean Air Agency
TAP	Toxic air pollutant pursuant to Chapter 173-460 WAC
T-BACT	Best Available Control Technology for toxic air pollutants
tpy	Tons per year
VOC	Volatile organic compound
WAC	Washington Administrative Code

1. FACILITY IDENTIFICATION

Applicant Name:	Clark County Public Health – Solid Waste Services
Applicant Address:	PO Box 9825, Vancouver, WA 98666-9825
Facility Name:	Leichner Landfill
Facility Address:	9411 NE 94th Avenue, Vancouver, WA 98662
SWCAA Identification:	1239
Contact Person:	Mike Davis, Landfill Manager
Primary Process:	Closed municipal solid waste landfill
SIC/NAICS Code:	4953 / 562213
Facility Classification:	Natural Minor

2. FACILITY DESCRIPTION

Leichner Landfill is a municipal solid waste landfill located in Clark County. The landfill ceased active operation in 1991. The facility is now maintained and supervised by Clark County Public Health –Solid Waste Services (Clark County).

3. CURRENT PERMITTING ACTION

This permitting action is in response to Air Discharge Permit application number CL-3138 (ADP Application CL-3138) dated August 6, 2020. Clark County submitted ADP Application CL-3138 requesting approval of the following:

- Replacement of the existing landfill gas fare with a smaller capacity flare of similar design. The project is being taken in response to decreasing landfill gas production. No other change in facility operation is proposed.

The current permitting action provides approval for the replacement landfill gas flare as proposed. ADP 07-2714 will be superseded in its entirety by this permitting action.

4. PROCESS DESCRIPTION

4.a Landfill Gas Collection and Treatment. As solid waste ages in the landfill, it decomposes and generates landfill gas, consisting of methane, carbon dioxide, and other constituents. Landfill gas is either collected and routed to a control device or emitted to the atmosphere as fugitive gas. Landfill gas is controlled and collected by applying a vacuum to a network of subsurface landfill gas collection wells on the closed landfill. Collected landfill gas is directed to the condensate knockout where condensate is removed from the gas stream and collected in an onsite tank. Dry landfill gas is directed to a single enclosed flare. Flare operation is currently continuous but is expected to transition to intermittent operation as the landfill ages and gas generation falls over time.

5. EQUIPMENT/ACTIVITY IDENTIFICATION

5.a Landfill (*modified*). Emissions from the landfill consistent of emissions from operation of the landfill gas flare and fugitive gas emissions through the surface of the waste cells. The landfill gas flare is described as follows:

Existing Flare

Make / Model:	Landfill Gas Specialties, LLC / EF52514
Rated Capacity:	300 scfm landfill gas (~50% methane), 9.0 MMBtu/hr
Flare Dimensions:	Fully enclosed, 5' diameter round flare, 25' tall
Location:	Southwestern corner of closed landfill (location of previously existing South Flare)
Destruction Efficiency:	Designed for 99% destruction of total hydrocarbons, 98% of non-methane organic compounds (NMOCs)
Turndown Ratio:	6:1 (50 scfm required to maintain stable flame and 99% THC destruction)
Minimum Methane:	30% to maintain stable flame and 99% THC destruction
Flare Pilot:	40,000 Btu/hr Propane (fires only when flame scanner indicates no flame)

Temperature	Retention Time (300 scfm, 50% methane)	Excess Air
1,400 °F	1.062 seconds	230%

Proposed Flare

Make / Model:	*Perennial Energy, Inc / FL-40-25-E*
Rated Capacity:	*2.7 MMBtu/hr, 90 scfm landfill gas (50% methane)*
Flare Dimensions:	*Fully enclosed, 42" diameter round flare, 25' tall*
Location:	*Southwestern corner of closed landfill (location of previously existing South Flare)*
Destruction Efficiency:	*99% destruction of total hydrocarbons (THC)* *98% of non-methane organic compounds (NMOC)*
Turndown Ratio:	*10:1 (9 scfm required to maintain stable flame and 99% THC destruction)*
Minimum Methane:	*~24.7% by volume*
Flare Pilot:	*Propane fired (operates only during flare startup)*

Temperature	*Retention Time (90 scfm, 50% methane)*	*Excess Air*
1,400 °F	*0.6 seconds*	*--*

ADP Application CL-3138. Clark County proposes to install a smaller capacity flare, similar in design to the existing flare. Landfill gas generation is decreasing to the point where generation rates are too low to support proper operation of the existing flare.

5.b Equipment/Activity Summary:

ID No.	Generating Equipment/Activity	# of Units	Control Equipment	# of Units
1	Landfill	1	Enclosed flare (Perennial Energy – 2.7 MMBtu/hr)	1

6. EMISSIONS DETERMINATION

Emissions to the ambient atmosphere from landfill operations, as proposed in ADP Application CL-3138, consist of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter (PM) sulfur dioxide (SO_2), toxic air pollutants (TAPs), and hazardous air pollutants (HAPs).

6.a Landfill. Emissions from the landfill consist of combustion emissions from the landfill gas flare and fugitive emissions from the landfill surface. The magnitude of emissions will be directly related to the amount of landfill gas generated and captured. Published estimates of landfill gas capture rates range from (65% - 90%) for municipal waste landfills. SWCAA has utilized a capture rate of 75% consistent with Clark County's application and the default value suggested by EPA in AP-42 Section 2.4 (10/08).

The total amount of landfill gas generated at any specific time depends on the quantity of waste, the methane generation potential of the waste, and the rate at which the waste degrades. Potential emissions from operations proposed in ADP Application CL-3138 are calculated based on total landfill gas generation of 154.4 scfm, a capture rate of 75% and a flared gas rate of 90 scfm (normalized to 50% methane).

Landfill Gas Flaring - Combustion Products

Gas heat content =	505.5	Btu/scf	Assumed methane content =	50%
Avg gas flow rate to flare =	90	scfm	Assumed sulfur content =	46.9 ppmv
Total heat content =	2.73	MMBtu/hr	Assumed destruction efficiency =	98%
Gas Consumption =	47.30	MMscf/yr		

Pollutant	EF lb/MMBtu	EF lb/MMscf	lb/hr	tpy	EF Souce
NOx	0.06	30.33	0.16	0.72	BACT
CO	0.15	75.83	0.41	1.79	BACT
NMOC/VOC (as hexane)	0.05	25.28	0.14	0.60	BACT
SOx as SO_2	0.15	7.80	0.04	0.18	AP-42 Section 2.4
PM		7.50	0.04	0.18	DRAFT AP-42 Sec. 1.4 (10/08)
PM_{10}		7.50	0.04	0.18	DRAFT AP-42 Sec. 1.4 (10/08)
$PM_{2.5}$		7.50	0.04	0.18	DRAFT AP-42 Sec. 1.4 (10/08)

CO_2 Content = 35 ppmv

Greenhouse Gases	kg/MMBtu	GWP	CO_2e lb/MMBtu	CO_2e lb/MMscf	tpy, CO_2e	
CO_2 - Combustion	52.07	1	114.79	58,029	1,372	40 CFR 98
CO_2 - in Biogas		1			0.09	mass balance
CH_4		25			246	assumes 100% operation
N_2O	0.00063	298	0.414	209.22	5	40 CFR 98
Total GHG - CO_2e					1,623	

Landfill Gas Fugitives

Estimated vent rate = 38.6 scfm
20.30 MMscf/yr

Pollutant	Uncontrolled ppmvd	Mwt	EF lb/MMscf	lb/hr	tpy	Emission Factor Souce
CO	140	28.01	10.2	0.02	0.10	EPA LandGEM
VOC	1,557	86.18	348.5	0.81	3.54	39% of NMOC
NMOC	4,000	86.18	895.4	2.08	9.09	EPA LandGEM
CH_4	500,000	16	20,779.2	48.16	210.92	EPA LandGEM
CO_2e			519,669	1204.3	5274.98	EPA LandGEM

Municipal solid waste landfill gas typically contains a large number of chemicals, many of which are listed as Toxic Air Pollutants in WAC 173-460. Some of these chemicals are created by microbial activity and some of the chemicals are volatilized from materials placed in the landfill. Emissions are calculated from estimated landfill gas generation and constituent concentrations from the Waste Industry Air Coalition (2001) and EPA AP-42 Section 2.4 (10/08).

Pollutant	CAS Number	Category	Potential Emissions (lb/yr)	Project Increase (lb/yr)	WAC 173-460 SQER (lb/yr)
1,1,2,2-Tetrachloroethane	79-34-5	HAP/TAP B	0.029	0.0	1,750
1,1-Dichloroethane	75-34-3	HAP/TAP B	0.10	0.0	43,748
1,1-Dichloroethene	75-35-4	HAP/TAP B	0.022	0.0	10,500
1,2-Dibromoethane	106-93-4	HAP/TAP A	0.021	0.0	0.5
1,2-Dichloroethane	107-06-2	HAP/TAP A	0.029	0.0	10
1,2-Dichloropropane	78-87-5	HAP/TAP A	0.0064	0.0	500
Acetone	67-64-1	TAP B	0.87	0.0	43,748
Acrylonitrile	107-13-1	HAP/TAP A	0.0047	0.0	10
Benzene	71-43-2	HAP/TAP A	0.19	0.0	20
Butane	106-97-8	TAP B	0.72	0.0	43,748
Carbon disulfide	75-15-0	HAP/TAP B	0.06	0.0	17,500
Carbon tetrachloride	56-23-5	HAP/TAP A	0.0026	0.0	20
Carbonyl sulfide	463-58-1	HAP/TAP B	0.027	0.0	--
Chlorobenzene	108-90-7	TAP B	0.063	0.0	22,750
Chlorodifluoromethane (Freon 22)	75-45-6	HAP/TAP B	0.075	0.0	43,748
Chloroethane (Ethyl chloride)	75-00-3	HAP/TAP B	0.038	0.0	43,748
Chloromethane (Methyl chloride)	74-87-3	HAP/TAP B	0.031	0.0	43,748
Dichlorofluoromethane	75-43-4	TAP B	0.44	0.0	22,750
Dichlorobenzene	106-46-7	HAP/TAP A	0.58	0.0	500
Dichlorodifluoromethane (Freon 12)	75-71-8	TAP B	0.52	0.0	43,748
Dichloromethane (Methylene chloride)	75-09-2	HAP/TAP A	0.71	0.0	50
Ethanol	64-17-5	TAP B	13.0	0.0	43,748
Ethyl mercaptan	75-08-1	TAP B	0.21	0.0	175
Ethylbenzene	100-41-4	HAP/TAP B	1.8	0.0	43,748
Hexane	110-54-3	HAP/TAP B	0.49	0.0	22,750
Hydrogen chloride	7647-01-0	TAP B	4.2	0.0	175
Hydrogen sulfide	7783-06-4	TAP B	2.0	0.0	175
Isopropyl alcohol	67-63-0	TAP B	1.2	0.0	43,748
Mercury (elemental)	7439-97-6	HAP/TAP B	0.00014	0.0	175
Methyl chloroform	71-55-6	HAP/TAP B	0.055	0.0	43,748
Methyl Ethyl Ketone	78-93-3	TAP B	1.9	0.0	43,748
Methyl Isobutyl Ketone	108-10-1	HAP/TAP B	0.18	0.0	43,748
Methyl mercaptan	74-93-1	HAP B	0.15	0.0	175
Pentane	109-66-0	TAP B	2.6	0.0	43,748
Tetrachloroethylene	127-18-4	HAP/TAP A	0.48	0.0	500
Toluene	108-88-3	HAP/TAP B	8.5	0.0	43,748
Trichloroethylene	79-01-6	HAP/TAP A	0.22	0.0	50

Pollutant	CAS Number	Category	Potential Emissions (lb/yr)	Project Increase (lb/yr)	WAC 173-460 SQER (lb/yr)
Trichloromethane (Chloroform)	8013-54-5	HAP	0.0062	0.0	--
Vinyl chloride	75-01-4	HAP/TAP A	0.17	0.0	10
Xylenes	1330-20-7	HAP/TAP B	4.3	0.0	43,748

7. REGULATIONS AND EMISSION STANDARDS

Regulations that have been used to evaluate the acceptability of the proposed facility and establish emission limits and control requirements include, but are not limited to, the regulations, codes, or requirements listed below.

7.a Title 40 Code of Federal Regulations (40 CFR) 60.30c et seq. (Subpart Cc) "Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills" established non-methane organic compound control guidelines for municipal solid waste landfills for which construction, reconstruction or modification was commenced before May 30, 1991 that meet specific size criteria. The applicant's facility is smaller (~2.4 million tons) than the facilities affected by this guidance (greater than or equal to ~2.76 million tons). Therefore, this regulation is not applicable to this facility.

7.b 40 CFR 60.750 et seq. (Subpart WWW) "Standards of Performance for Municipal Solid Waste Landfills" established emission standards, recordkeeping, monitoring, and reporting requirements for municipal solid waste landfills meeting certain size criteria that commenced construction, reconstruction or modification on or after May 30, 1991. The applicant's facility did not commence construction, reconstruction or modification after May 30, 1991 and does not meet the size criteria of the subpart. Therefore, this regulation is not applicable to this facility.

7.c 40 CFR 63.1930 et seq. (Subpart AAAA0 "National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills" applies to municipal waste landfills subject to 40 CFR 60 Subpart WWW. This facility is not subject to 40 CFR 60 Subpart WWW. Therefore, this regulation is not applicable to this facility.

7.d Revised Code of Washington (RCW) 70.94.141 empowers any activated air pollution control authority to prepare and develop a comprehensive plan or plans for the prevention, abatement and control of air pollution within its jurisdiction. An air pollution control authority may issue such orders as may be necessary to effectuate the purposes of the Washington Clean Air Act [RCW 70.94] and enforce the same by all appropriate administrative and judicial proceedings subject to the rights of appeal as provided in Chapter 62, Laws of 1970 ex. sess.

7.e RCW 70.94.152 provides for the inclusion of conditions of operation as are reasonably necessary to assure the maintenance of compliance with the applicable ordinances, resolutions, rules and regulations when issuing an Air Discharge Permit for installation and establishment of an air contaminant source.

7.f WAC 173-401 "Operating Permit Regulation" requires all major sources and other sources as defined in WAC 173-401-300 to obtain an operating permit. This regulation is not applicable because this source is not a potential major source and does not meet the applicability criteria set forth in WAC 173-401-300.

7.g WAC 173-460 "Controls for New Sources of Toxic Air Pollutants" requires Best Available Control Technology for toxic air pollutants (T-BACT), identification and quantification of emissions of toxic air pollutants and demonstration of protection of human health and safety. SWCAA implements WAC 173-460 as in effect on August 21, 1998.

7.h WAC 173-476 "Ambient Air Quality Standards" establishes ambient air quality standards for PM_{10}, $PM_{2.5}$, lead, sulfur dioxide, nitrogen dioxide, ozone, and carbon monoxide in the ambient air, which shall not be exceeded.

7.i SWCAA 400-040 "General Standards for Maximum Emissions" requires all new and existing sources and emission units to meet certain performance standards with respect to Reasonably Available Control Technology (RACT), visible emissions, fallout, fugitive emissions, odors, emissions detrimental to persons or property, sulfur dioxide, concealment and masking, and fugitive dust.

7.j SWCAA 400-050 "Emission Standards for Combustion and Incineration Units" requires that all provisions of SWCAA 400-040 be met and that no person shall cause or permit the emission of particulate matter from any combustion or incineration unit in excess of 0.23 grams per dry cubic meter (0.1 grains per dry standard cubic foot) of exhaust gas at standard conditions.

7.k SWCAA 400-060 "Emission Standards for General Process Units" prohibits particulate matter emissions from all new and existing process units in excess of 0.1 grains per dry standard cubic foot of exhaust gas.

7.l SWCAA 400-109 "Air Discharge Permit Applications" requires that an Air Discharge Permit application be submitted for all new installations, modifications, changes, or alterations to process and emission control equipment consistent with the definition of "new source". Sources wishing to modify existing permit terms may submit an Air Discharge Permit application to request such changes. An Air Discharge Permit must be issued, or written confirmation of exempt status must be received, before beginning any actual construction, or implementing any other modification, change, or alteration of existing equipment, processes, or permits.

7.m SWCAA 400-110 "New Source Review" requires that SWCAA issue an Air Discharge Permit in response to an Air Discharge Permit application prior to establishment of the new source, emission unit, or modification.

7.n SWCAA 400-111 "Requirements for Sources in a Maintenance Plan Area" requires that no approval to construct or alter an air contaminant source shall be granted unless it is evidenced that:
(1) The equipment or technology is designed and will be installed to operate without causing a violation of the applicable emission standards;
(2) Emissions will be minimized to the extent that the new source will not exceed emission levels or other requirements provided in the maintenance plan;
(3) Best Available Control Technology will be employed for all air contaminants to be emitted by the proposed equipment;
(4) The proposed equipment will not cause any ambient air quality standard to be exceeded; and
(5) If the proposed equipment or facility will emit any toxic air pollutant regulated under WAC 173-460, the proposed equipment and control measures will meet all the requirements of that Chapter.

8. RACT/BACT/BART/LAER/PSD/CAM DETERMINATIONS

The proposed equipment and control systems incorporate Best Available Control Technology (BACT) for the types and amounts of air contaminants emitted by the processes as described below:

8.a BACT Determination – Landfill Gas Flare: The proposed use of a gas capture system and flare unit capable of low emission combustion (<0.06 lb/MMBtu NO_X, <0.15 lb/MMBtu CO), a non-methane organic compound destruction efficiency of 98% and a total hydrocarbon destruction efficiency of 99% has been determined meet the requirements of BACT for landfill gas treatment at this facility. Inlet VOC concentrations can vary significantly during system operation so an upper limit on VOC emissions is established at 20 ppmvd as hexane @ 3% O_2. This limit is equivalent to the requirements in 40 CFR 60 Subpart WWW "Standards of Performance for Municipal Solid Waste Landfills."

Other Determinations

8.b Prevention of Significant Deterioration (PSD) Applicability Determination: The potential to emit of this facility is less than applicable PSD applicability thresholds. Likewise, this permitting action will not result in a potential increase in emissions equal to or greater than the PSD thresholds. Therefore, PSD review is not applicable to this action.

8.c Compliance Assurance Monitoring (CAM) Applicability Determination. CAM is not applicable to any emission unit at this facility because it is not a major source and is not required to obtain a Part 70 permit.

9. AMBIENT IMPACT ANALYSIS

9.a TAP Small Quantity Review. The new equipment and modifications proposed in ADP Application CL-3138 will not increase TAP emissions from landfill operations.

Conclusions

9.b Replacement of the landfill flare, as proposed in ADP Application CL-3138, will not cause the ambient air quality requirements of Title 40 Code of Federal Regulations (CFR) Part 50 "National Primary and Secondary Ambient Air Quality Standards" to be violated.

9.c Replacement of the landfill flare, as proposed in ADP Application CL-3138, will not cause the requirements of WAC 173-460 "Controls for New Sources of Toxic Air Pollutants" (as in effect 8/21/98) or WAC 173-476 "Ambient Air Quality Standards" to be violated.

9.d Replacement of the landfill flare, as proposed in ADP Application CL-3138, will not cause a violation of emission standards for sources as established under SWCAA General Regulations Sections 400-040 "General Standards for Maximum Emissions," 400-050 "Emission Standards for Combustion and Incineration Units," and 400-060 "Emission Standards for General Process Units."

10. DISCUSSION OF APPROVAL CONDITIONS

SWCAA has made a determination to issue ADP 20-3433 in response to ADP Application CL-3138. ADP 20-3433 contains approval requirements deemed necessary to assure compliance with applicable regulations and emission standards as discussed below.

10.a Supersession of Previous Permits. ADP 20-3433 supersedes ADP 07-2714 in its entirety.

10.b General Basis. Permit requirements for equipment affected by this permitting action incorporate the operating schemes proposed by the applicant in ADP Application CL-3138. Permit requirements established by this action are intended to implement BACT, minimize emissions, and assure compliance with applicable requirements on a continuous basis.

10.c Monitoring and Recordkeeping Requirements. ADP 20-3433 establishes monitoring and recordkeeping requirements sufficient to document compliance with applicable emission limits, ensure proper operation of approved equipment and provide for compliance with generally applicable requirements. Specific monitoring requirements are established for landfill gas methane content, the quantity of landfill gas combusted and flare operating temperature.

10.d Reporting Requirements. ADP 20-3433 establishes general reporting requirements for annual air emissions, upset conditions and excess emissions. Specific reporting requirements are established for landfill gas methane content and the quantity of landfill gas combusted. Reports are to be submitted on an annual basis.

10.e Emission Limits: All of the emission limits were established consistent with BACT and at levels that will not have a significant adverse impact on ambient air quality. SWCAA established short-term concentration limits (lb/MMBtu) and annual emission limitations for the Landfill Gas Flare. Because of the potential for an exceptionally low inlet non-methane organic (NMOC) concentration loading that could make it difficult for the Permittee to demonstrate compliance with the 98% destruction efficiency representative of BACT, the permit provides an alternative standard of 0.050 lb/MMBtu at the flare outlet. This is equivalent to the relevant NSPS limit of 20 ppm as hexane @ 3% O_2. This limitation also provides an upper bound on NMOC emissions regardless of the inlet non-methane organic compound concentration. This value was used to establish the annual non-methane hydrocarbon emissions limit and is expected to provide adequate operational margin to account for variable flare efficiency and variable inlet non-methane hydrocarbon loading.

10.f Operating Limits and Requirements: The flare must be operated within a narrow range ($\pm$ 50 °F) of temperatures around which compliance with the permitted emission limits has been demonstrated, or within a wider range of temperatures if compliance in that range has been demonstrated during a source test. The operating temperature limit was established because emissions can vary depending on the operating temperature of the flare. As the operating temperature increases, the flare may produce greater levels of nitrogen oxides. As the operating temperature decreases, the destruction efficiency of the flare may decrease.

11. START-UP AND SHUTDOWN/ALTERNATIVE OPERATING SCENARIOS/POLLUTION PREVENTION

11.a Start-up and Shutdown Provisions. Pursuant to SWCAA 400-081 "Start-up and Shutdown", technology based emission standards and control technology determinations shall take into consideration the physical and operational ability of a source to comply with the applicable standards during start-up or shutdown. Where it is determined that a source is not capable of achieving continuous compliance with an emission standard during start-up or shutdown, SWCAA shall include appropriate emission limitations, operating parameters, or other criteria to regulate performance of the source during start-up or shutdown.

The applicant did not identify any start-up and shutdown periods during which affected equipment is not capable of achieving continuous compliance with applicable technology determinations or approval conditions. To SWCAA's knowledge, this facility can comply with all applicable standards during startup and shutdown.

11.b Alternate Operating Scenarios. SWCAA conducted a review of alternate operating scenarios applicable to equipment affected by this permitting action. The permittee did not propose or identify any applicable alternate operating scenarios. Therefore, none were included in the permit requirements.

11.c Pollution Prevention Measures. SWCAA conducted a review of possible pollution prevention measures for the facility. No pollution prevention measures were identified by either the permittee or SWCAA separate or in addition to those measures required under BACT considerations. Therefore, none were included in the permit requirements.

12. EMISSION MONITORING AND TESTING

12.a Emission Testing – Landfill Gas Flare. Emission testing of the landfill gas flare is required on a continuing 5-year cycle. All emission testing shall be conducted in accordance with the provisions of ADP 20-3433, Appendix A.

13. FACILITY HISTORY

13.a Previous Permitting Actions. SWCAA has previously issued the following Permits for the Leichner Landfill facility:

Permit Number	Application Number	Date	Purpose
07-2714	CL-1759	2/15/2007	Replacement of existing south flare with new Gas Specialties model EF52514 flare (300 scfm). *To be superseded by ADP 20-3433.*
94-1637	CL-1039	7-21-1994	Installation of condensate injection system and modification of operating temperature requirements for existing enclosed flares. Superseded by ADP 07-2714.
91-1388	CL-896	1-6-1992	Installation of south landfill gas flaring system. Estimated 99% destruction of total hydrocarbons using enclosed flare.
88-973	CL-670A	3-10-1988	Installation of north flare (enclosed). *Removed from service.*
87-950	CL-670	3-2-1988	Installation of a temporary open landfill gas flaring system rated at 1,150 scfm. *Obsolete.*

13.b Compliance Status. A search of source records on file at SWCAA did not identify any outstanding compliance issues at this facility.

14. PUBLIC INVOLVEMENT OPPORTUNITY

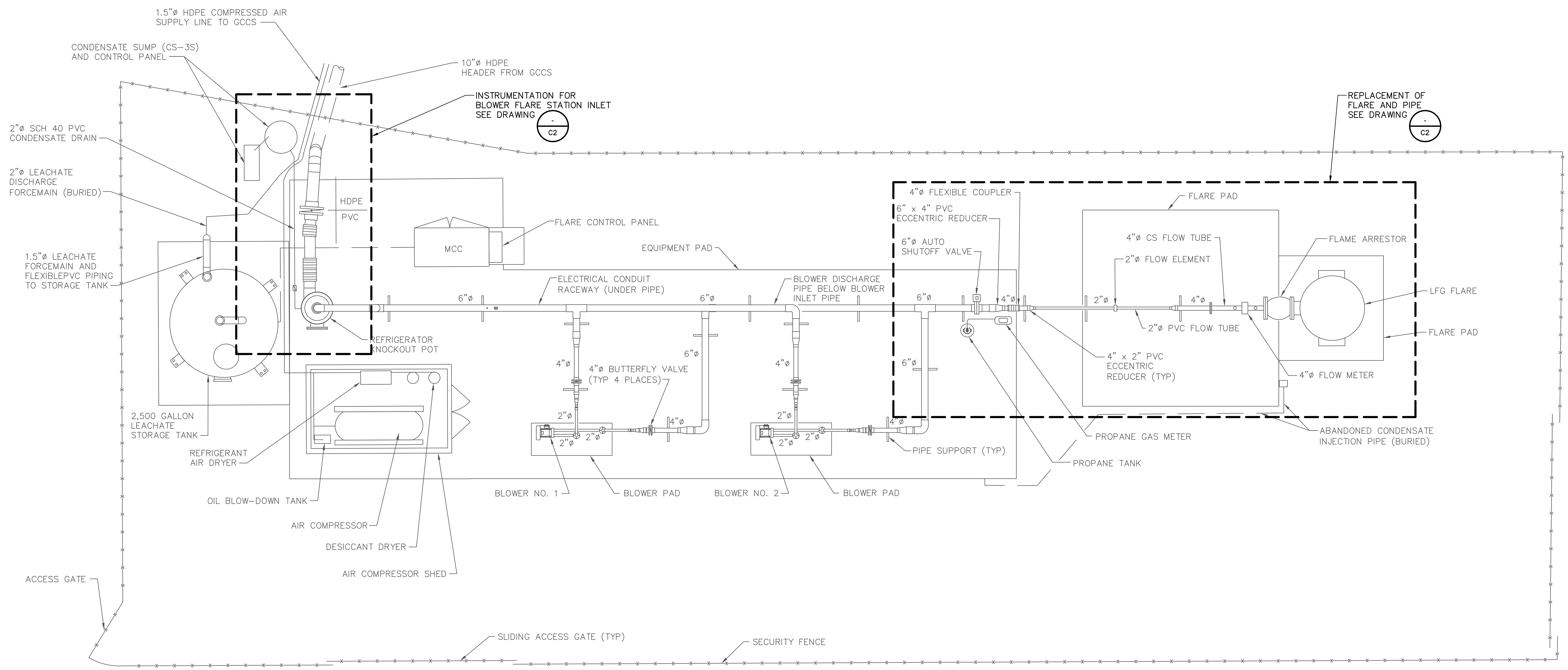
14.a Public Notice for ADP Application CL-3138. Public notice for ADP Application CL-3138 was published on the SWCAA internet website for a minimum of (15) days beginning on August 6, 2020.

14.b Public/Applicant Comment for ADP Application CL-3138. SWCAA did not receive specific comments, a comment period request or any other inquiry from the public regarding this ADP application. Therefore no public comment period was provided for this permitting action.

14.c State Environmental Policy Act. This project is exempt from SEPA requirements pursuant to WAC 197-11-800(3) since it only involves repair and/or maintenance of existing structures, equipment or facilities, and will not involve material expansions or changes in use. SWCAA issued SEPA Exempt Determination 20-036 dated October 1, 2020.

Appendix D

Site Installation Drawings



BLOWER FLARE STATION

EXISTING EQUIPMENT AND PIPING PLAN

SCALE: 1/4" = 1'-0"

JOHN M. RICHARDS STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER 27065

NO.	REVISION	DATE
1	ISSUED FOR REVIEW	09/14/2020
2	ISSUED FOR CONSTRUCTION	09/25/2020

SHEET TITLE
EXISTING BLOWER FLARE STATION PLAN

PROJECT TITLE
FLARE REPLACEMENT
GAS COLLECTION AND CONTROL SYSTEM
LEICHNER LANDFILL
VANCOUVER, WASHINGTON

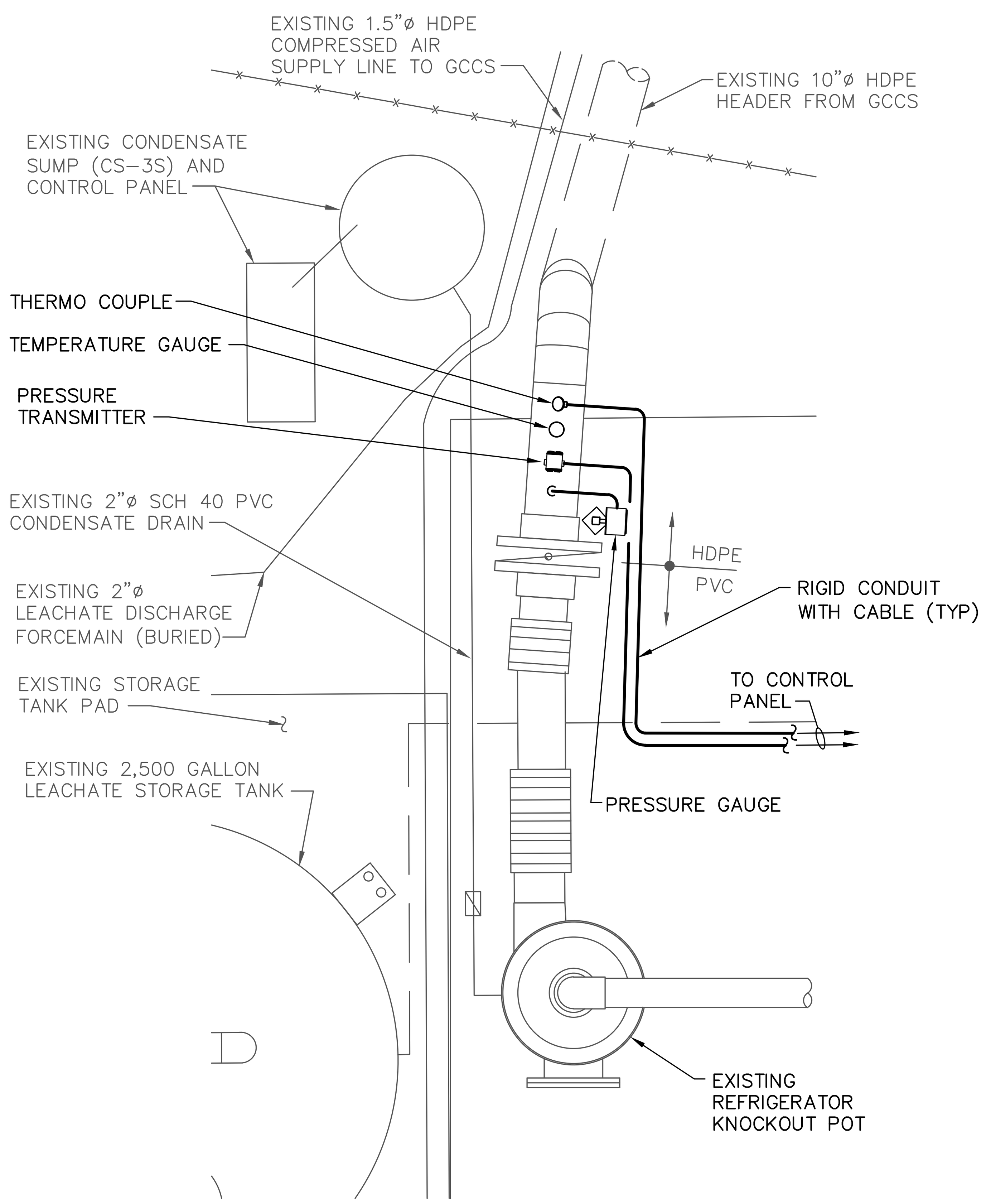
SCS ENGINEERS
Environmental Consultants and Contractors
2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005
(425) 746-4600 FAX: (425) 746-6747

PROJ. NO. 04220030.16 | DWN. BY: LEL | ACAD FILE: C1
DSN. BY: TAM | CHK. BY: TAM | APP. BY: JMR

DATE: SEPTEMBER 2020

SCALE: AS SHOWN

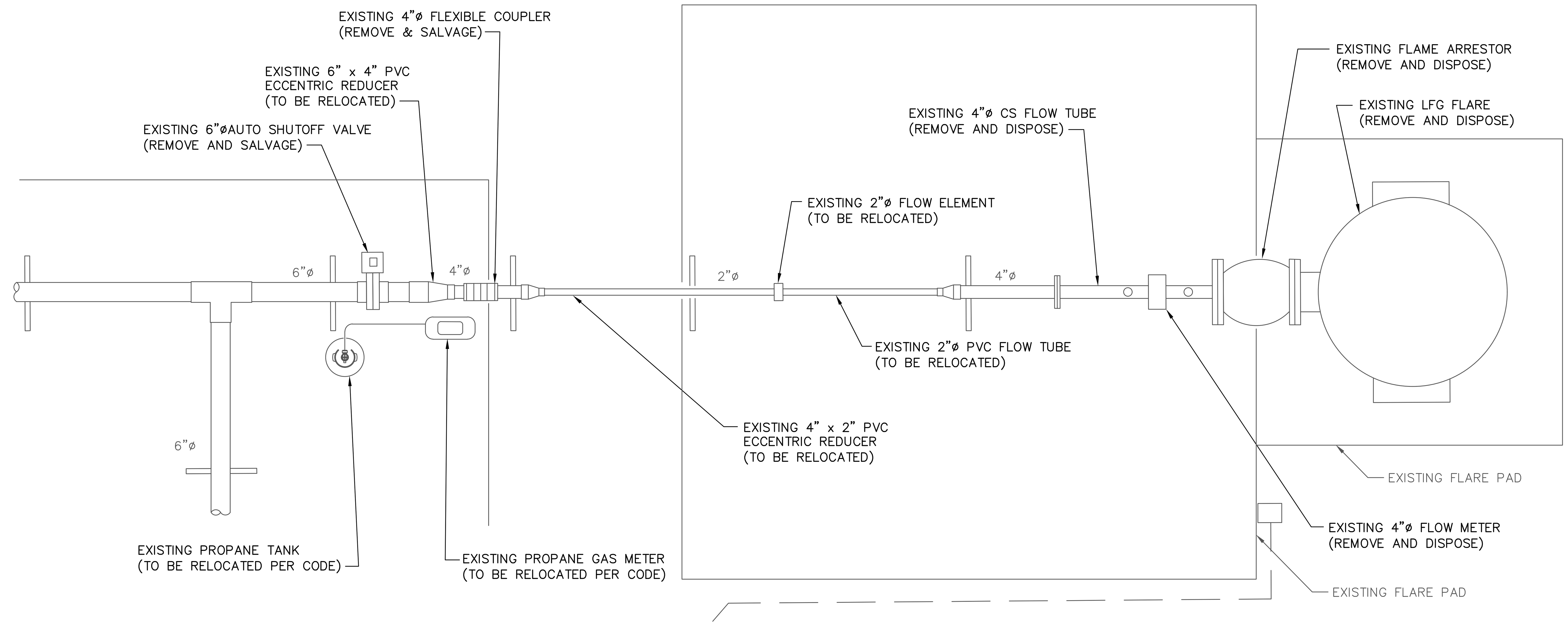
DRAWING NO. C1



BLOWER FLARE STATION

PROPOSED INSTRUMENTATION PLAN

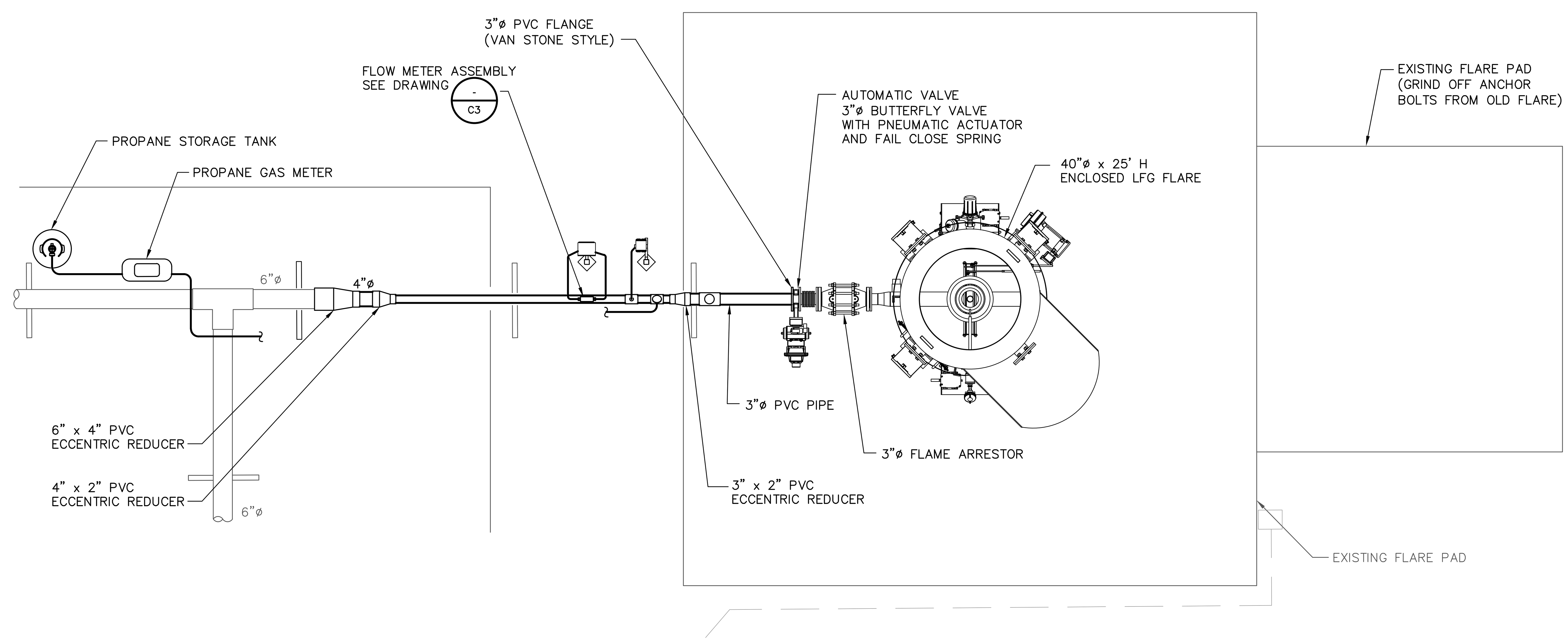
SCALE: 1/2" = 1'-0"



BLOWER FLARE STATION

EXISTING EQUIPMENT AND PIPING PLAN

SCALE: 1/2" = 1'-0"



BLOWER FLARE STATION

PROPOSED EQUIPMENT AND PIPING PLAN

SCALE: 1/2" = 1'-0"

NO.	REVISION	DATE
1	ISSUED FOR REVIEW	09/14/2020
2	ISSUED FOR CONSTRUCTION	09/25/2020

SHEET TITLE: EQUIPMENT AND PIPING PLANS

PROJECT TITLE: FLARE REPLACEMENT GAS COLLECTION AND CONTROL SYSTEM

LEICHNER LANDFILL
VANCOUVER, WASHINGTON

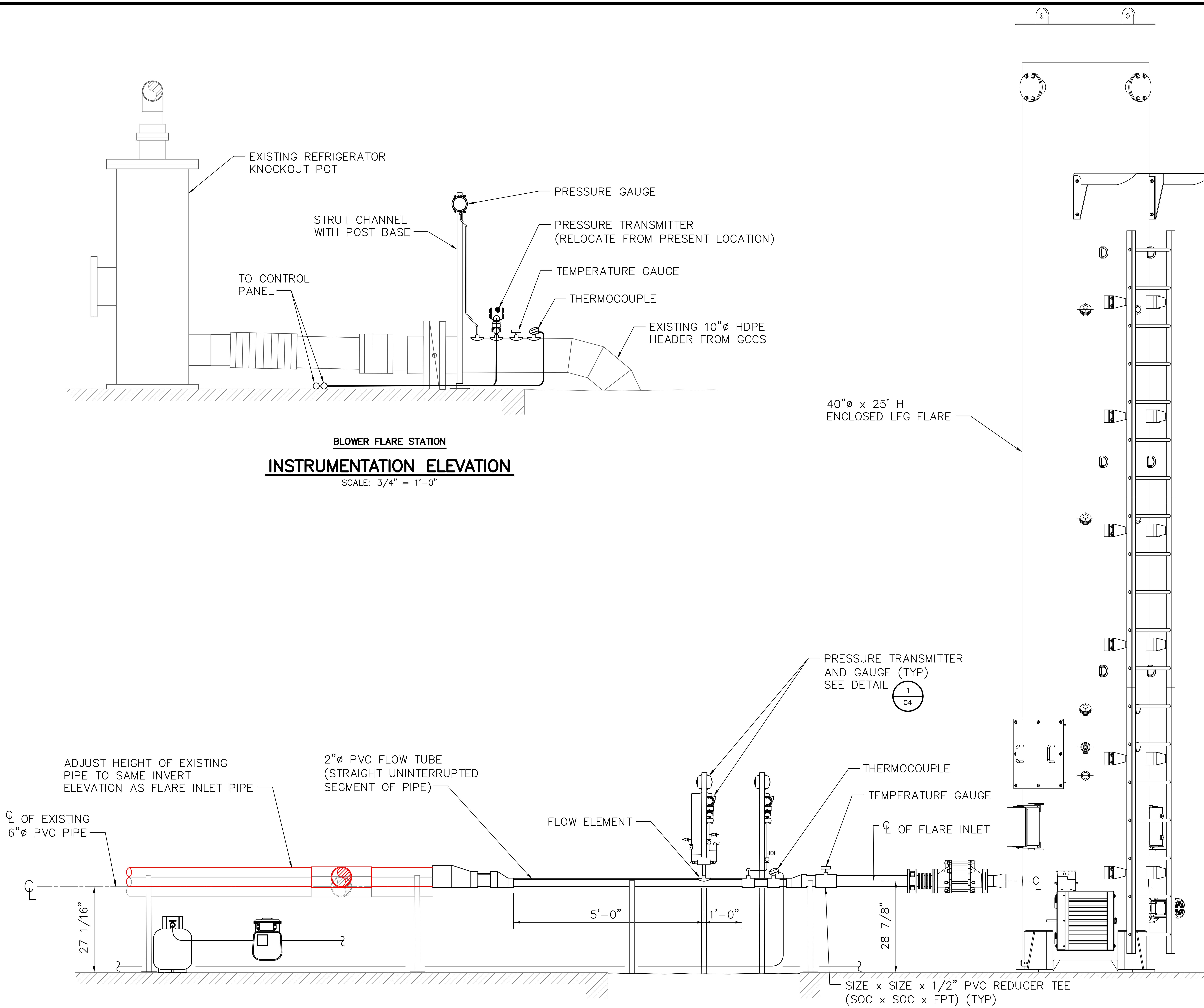
SCS ENGINEERS
Environmental Consultants and Contractors
2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005
(425) 746-4600 FAX: (425) 746-6747

PROJ. NO.: 04220030.16 | DSN. BY: TAM | DWN. BY: LEL | CHK. BY: TAM | ACAD FILE: C2 | APP. BY: JMR

DATE: SEPTEMBER 2020

SCALE: AS SHOWN

DRAWING NO. C2



BLOWER FLARE STATION

INSTRUMENTATION ELEVATION

SCALE: 3/4" = 1'-0"

BLOWER FLARE STATION

EQUIPMENT AND PIPING ELEVATION

SCALE: 3/4" = 1'-0"

JOHN M. RICHARDS, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER

NO.	REVISION	DATE
1	ISSUED FOR REVIEW	09/14/2020
2	ISSUED FOR CONSTRUCTION	09/25/2020

SHEET TITLE
EQUIPMENT AND PIPING ELEVATIONS

PROJECT TITLE
FLARE REPLACEMENT
GAS COLLECTION AND CONTROL SYSTEM
LEICHNER LANDFILL
VANCOUVER, WASHINGTON

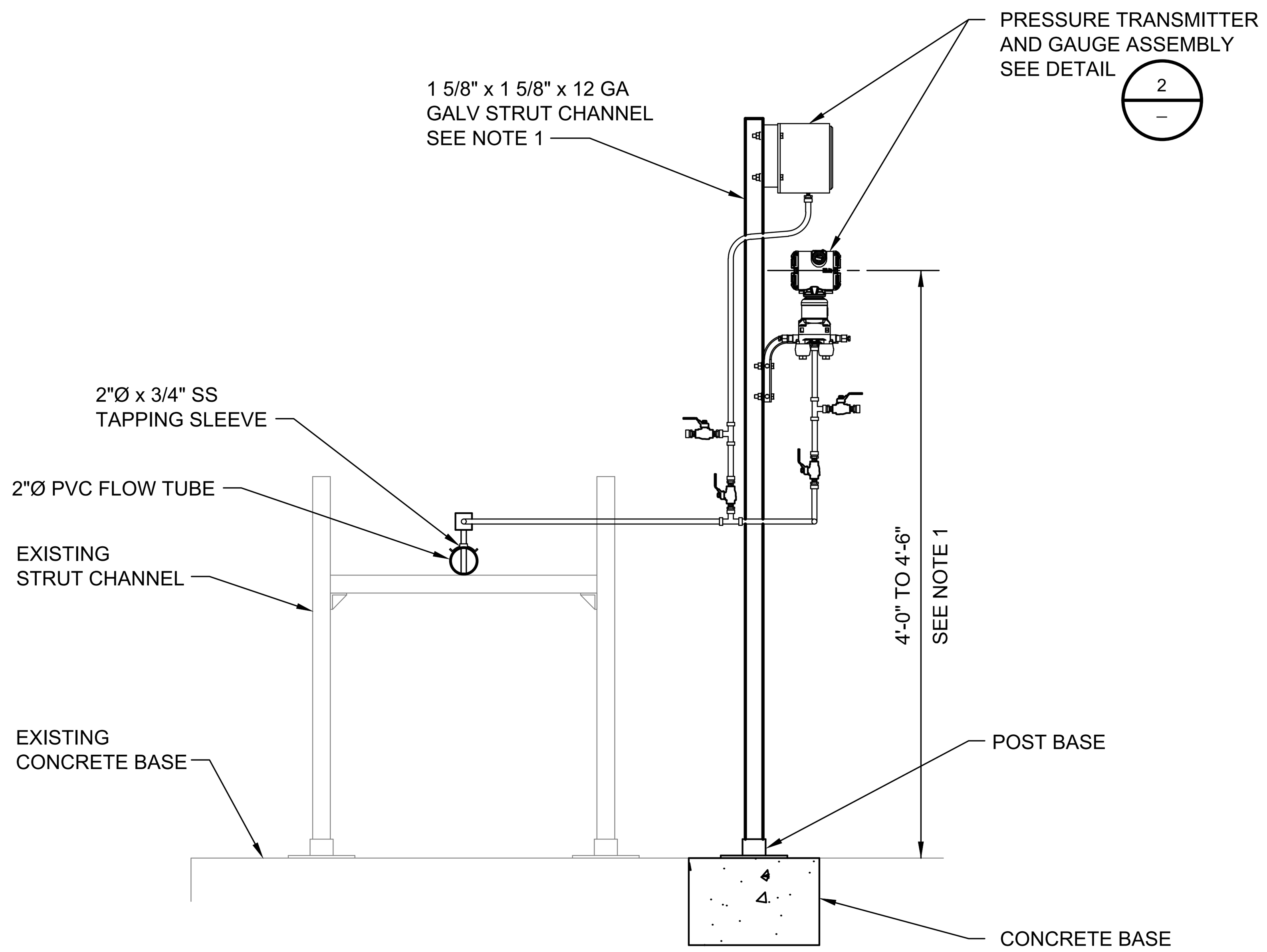
SCS ENGINEERS
Environmental Consultants and Contractors
2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005
(425) 746-4600 FAX: (425) 746-6747

PROJ. NO.: 04220030.16 | DSN. BY: TAM | DWN. BY: LEL | CHK. BY: TAM | ACAD FILE: C3 | APP. BY: JMR

DATE: SEPTEMBER 2020

SCALE: AS SHOWN

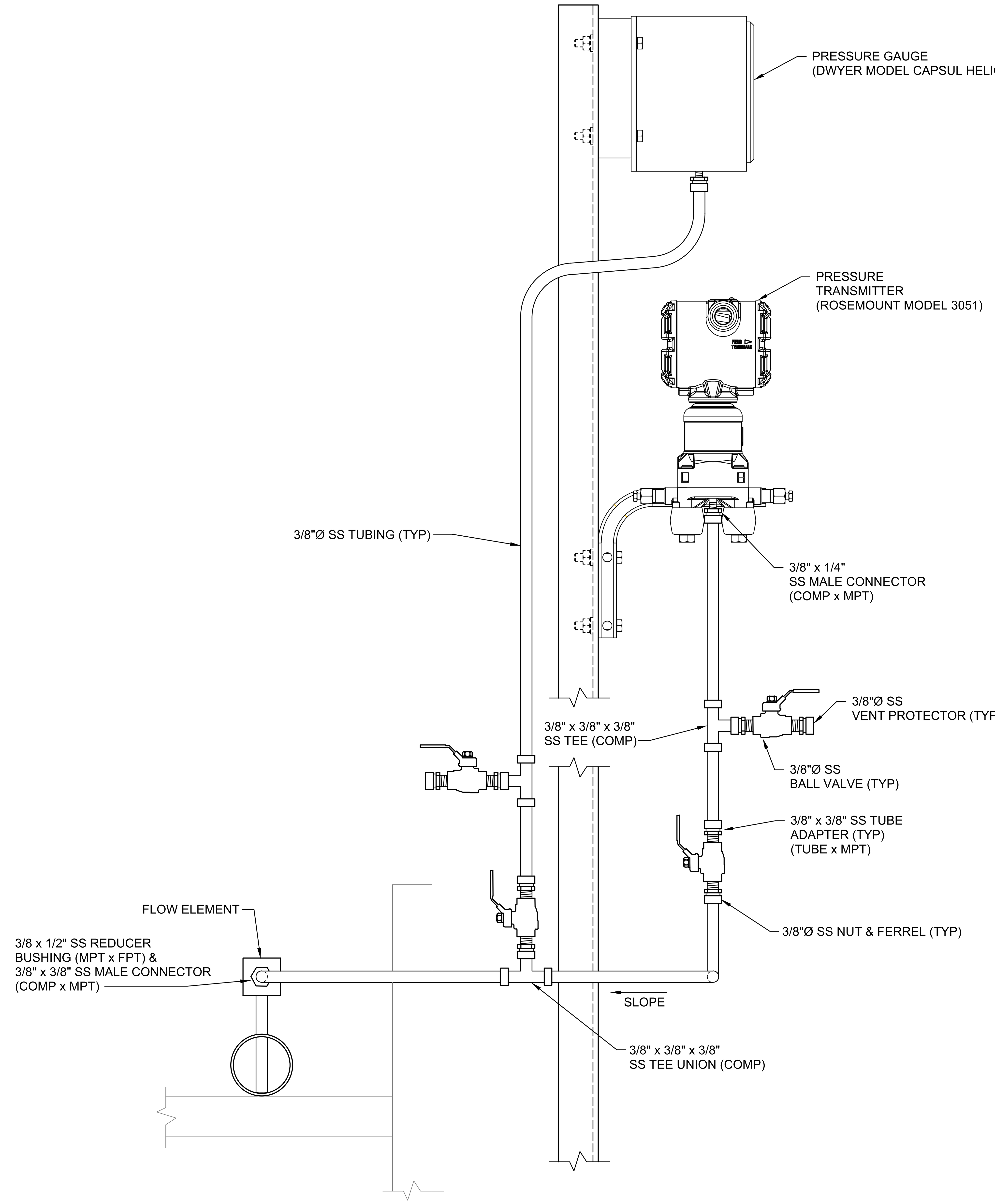
DRAWING NO. C3



INSTRUMENT TAPPING SLEEVE

DETAIL 1
-

SCALE: NTS



PRESSURE TRANSMITTER ASSEMBLY

DETAIL 2
-

SCALE: NTS

NOTES

1. HEIGHT AS DIRECTED BY ENGINEER.

NO.	REVISION	DATE
	ISSUED FOR REVIEW	09/14/2020
	ISSUED FOR CONSTRUCTION	09/25/2020

SHEET TITLE
INSTRUMENT CONNECTION DETAILS

PROJECT TITLE
FLARE REPLACEMENT
GAS COLLECTION AND CONTROL SYSTEM
LEICHNER LANDFILL
VANCOUVER, WASHINGTON

SCS ENGINEERS
Environmental Consultants and Contractors
2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005
(425) 746-4600 FAX: (425) 746-6747

PROJ. NO. 04220030.16	DWN. BY: LEL	ACAD FILE: C4	
DSN. BY: TAM	CHK. BY: TAM	APP. BY: JMR	

DATE: SEPTEMBER 2020

SCALE: AS SHOWN

DRAWING NO.
C4

Appendix E

Installation, Testing, and Commissioning Photo Log

August 14, 2020 - Flare shell during construction at Perennial manufacturing facility

August 17, 2020 - Top of flare with lifting lugs and top ring in place at Perennial manufacturing facility

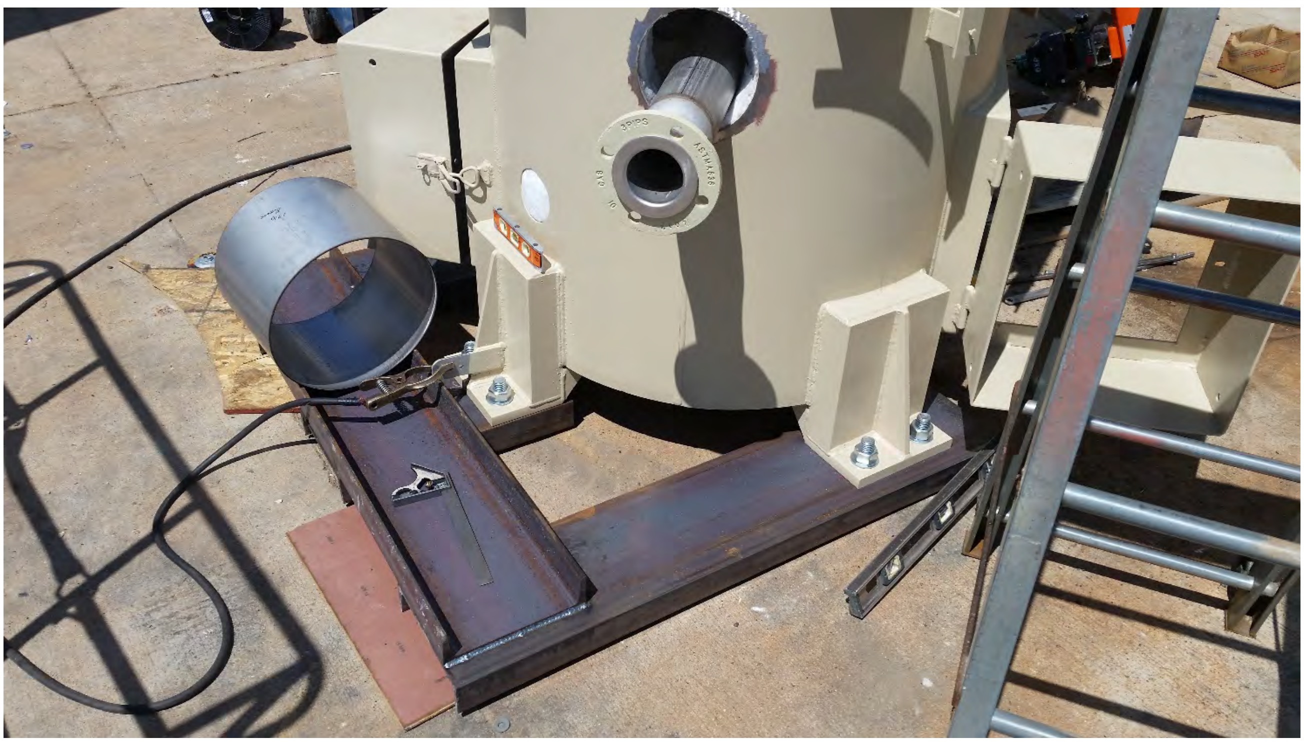
August 20, 2020 – installation of flare installation pins during construction at Perennial manufacturing facility

August 25, 2020 – Looking up flare stack with flare insulation at Perennial manufacturing facility

August 25, 2020 – Flare burner manifold at Perennial manufacturing facility

August 25, 2020 – Flare burner pot at Perennial manufacturing facility

August 25, 2020 – Looking into flare louver boxes at Perennial manufacturing facility



August 25, 2020 – Flare feet bolted to shipping stand and burner inlet placed prior to welding at Perennial manufacturing facility

August 25, 2020 – Flare assembled and upright (right) prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare control panel prior to shipment at Perennial manufacturing facility

September 24, 2020 – Flare control panel prior to shipment at Perennial manufacturing facility

September 24, 2020 – Inside flare control panel prior to shipment at Perennial manufacturing facility

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Flare on delivery truck at Leichner Landfill, morning of installation

September 28, 2020 – Ness Campbell crane setup

September 28, 2020 – Ness Campbell crane setup

September 28, 2020 – Flare bolt alignment template for flare pad

September 28, 2020 – Preparation of old flare for removal by attaching lift cords

September 28, 2020 – Preparation of old flare for removal by attaching lift cords

September 28, 2020 – Preparation of old flare for removal by attaching lift cords

September 28, 2020 – Getting ready to remove old flare

September 28, 2020 – Lifting old flare from existing flare pad

September 28, 2020 – lifting flare off of flare pad

September 28, 2020 – lifting flare off of flare pad

September 28, 2020 – setting flare down prior to placement on truck

September 28, 2020 – setting flare on its side prior to placement on truck

September 28, 2020 – connecting flare to lift cables prior to placement on truck for transport

September 28, 2020 – placement of flare on truck bed for transport

September 28, 2020 – cleanup of old flare pad (right) prior to placement of new flare on new flare pad (left)

September 28, 2020 – New flare pad with 3 of 4 sets of pre-drilled bolt holes

September 28, 2020 – Lift of control panel for placement inside flare compound

September 28, 2020 – Lift of control panel for placement inside flare compound

September 28, 2020 – placement of flare control panel inside flare compound

September 28, 2020 – lifting of parts and components to flare station compound

September 28, 2020 – Preparation of new flare for lift to flare station compound

September 28, 2020 – Lifting new flare off of truck

September 28, 2020 – lifting new flare off of truck

September 28, 2020 – setting new flare on ground to remove shipping stand

September 28, 2020 – flare on ground to remove shipping stand and connect flare at lifting lugs for placement on flare pad

September 28, 2020 – looking inside flare from top

September 28, 2020 – connections to lifting lugs and getting ready to lift flare to flare pad

September 28, 2020 – lifting flare to flare pad

September 28, 2020 – lifting flare to flare pad

September 28, 2020 – lifting flare to flare pad

September 28, 2020 – lifting flare to flare pad

September 28, 2020 – aligning flare on flare pad

September 28, 2020 – aligning flare over bolts on flare pad

September 28, 2020 – aligning flare on bolts on flare pad

September 28, 2020 – flare alignment adjustments on flare pad

September 28, 2020 – repositioning bolts in flare pad

September 28, 2020 – alignment of flare feet on flare pad after enlargement of bolt holes

September 28, 2020 – removal of lifting cables after flare alignment on flare pad and preparation for burner pot placement

September 28, 2020 – preparing to place burner pot

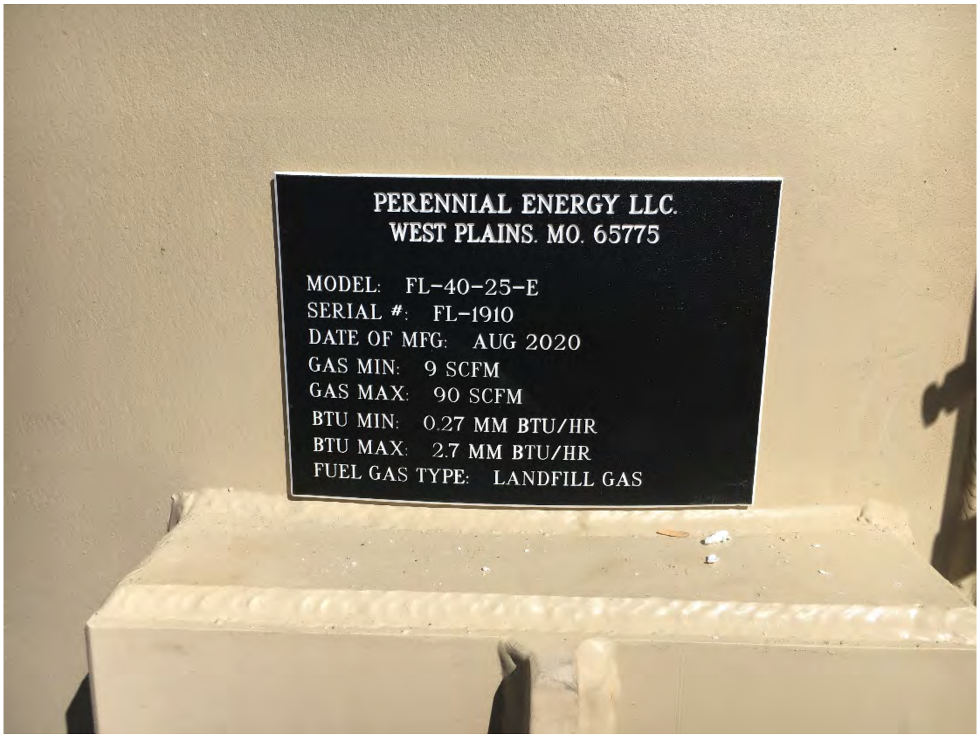
September 28, 2020 – placement of burner pot

September 28, 2020 – side hatch door removal for burner pot placement

September 28, 2020 – inside side access hatch

September 28, 2020 – alignment of burner pot inside flare

September 28, 2020 – flare burner pot alignment



September 28. 2020 – flare manufacturer's tag

September 28, 2020 – flare foot, no modifications

September 28, 2020 – flare foot, no modifications

September 28, 2020 – flare foot where bolt holes were enlarged for alignment purposes

September 28, 2020 – flare louver

September 30, 2020 – GCCS piping to flare inlet

September 30, 2020 – GCCS piping to flare inlet

October 2, 2020 – Rosemount flow transmitters

October 2, 2020 – GCCS piping and nitrogen tanks

Appendix F

Perennial Testing and Commissioning Documentation

On Site Startup Packet

V1.1

Job # 1910

Job Name: Leichner mEGF & Control Panel

General Information		**Tab #**
	Address, Contact information, Project description	1
Forms to be Completed (Attached)		**Tab #**
	All Skids Test Form	2
	GCS Skids Test Form	3
	Enclosed Ground Flare Test Form	4
	Flow Meter Test Form	5
	Modem & HMI Test Form	6
	Alarm & Safety Check List	7
	Transmitter Test Forms	8
	Data Log	9
	Customer Sign Off	10
Reference Documents Attached:		**Tab #**
	Start up Scope of Work	11
	IP Configuration	12
	Control Narrative	13
	Shop Tests	14
	Verabar Flow Rate Vs DP Chart	15
Drawing List Attached:		**Tab #**
	P & ID Drawing	16
	120 VAC & Control Drawing	
	Top Assembly Drawings	
	Interconnection Drawing	
Save on Server after Completion:		
	PLC Program	
	HMI Program	
	Set Point Pictures	

Created By: Date:

Reviewed & Approved By:

Req'd?	Item	Complete	Notes
Standardized Test Packet			
V 1.0			
Project number		1910	
Project name		Leichner mEGF & Control Panel	
Req'd?	Item	Complete	Notes
	1.0 General System Inspection		
	Inspect system for any visible physical mechanical or electrical defects that would be prevent the system from being started or be harmful to equipment or personnel.		Need Enclosure for O_2 transducer termination. TC wires for Inlet and outlet gas temp run with cord grips thro
	Are the work areas free of trip hazards?	X	Rosemont transmitters
	1.1 Mechanical Inspection		
	Are the skids and equipment placed, leveled, anchored & grounded per PEI standards and project specifications?	X	need external seal tight grounds for Blowers
	Is the electrical service installed and terminated at the proper location(s)?	X	
	Are the gas inlet & outlet pipe(s) properly installed?	X	
	Are the condensate drains properly installed & heat traced to a sump or other device that is suitable for the pressures or vacuums present?	X	
	Verify that the condensate drains don't create a short circuit around the flame arrestor(s).	X	
	Verify that the propane pilot fuel tanks are full and connected.	X	
	Verify that the shutdown valves are provided with properly connected dry compressed air or full nitrogen tanks.	X	nitrogen @ 100 PSI
	Verify that control panel doors are free to swing & open, and have at least NEC Minimum working clearance.	X	Removed wall of Building to provide clearance
	Verify that inlet & outlet flange bolts have been torqued & marked		
	Verify that Spare Parts have been received & provided to owner or representative.	X	
	Confirm that incoming gas lines are at the pressures & temperatures shown on the P&ID.	X	7.2" WC inlet
	1.2 Electrical Inspection		
	Verify all appropriate electrical panel, skid, blower, and earth grounds are properly installed	X	need grounds on Blowers
	Verify all power wires are landed on proper terminals for breakers, VFD's starters, and motors	X	
	Verify all fuses and relays are properly installed	X	
	Disengage all breakers and fuses before applying power.	X	
	Check incoming 120 VAC, verify voltage between N-G is less than 5 volts	X	
	Verify that all interconnecting wires are per Interconnection Drawings	X	
	Verify Junction boxes, junction blocks are per Interconnection drawing	X	

	1.3 System Startup		
	Charge UPS. Install & Confirm voltages.	X	
	Test E-Stop, confirm E-Stop is working properly per the 120 VAC drawings	X	
	Confirm IP Addresses per the attached	X	
	2.0 System Operation		
	Test and record the alarms and shutdowns per the attached Alarm & Shutdown List	X	
	Verify devices per the attached transmitter list	X	need new inlet transmitter (vacuum)
	Record the system set points on the attached System Set point Form	X	
	Verify the system starts and runs in Automatic Mode.	X	
	Verify the system starts in the proper sequence	X	added VFD Fault delay timer
	Verify the system stops in the proper sequence	X	
	Verify each sub-system operates in the "TEST" and "Auto" modes.	X	
	Verify each subsystem stops in the "OFF" Mode.	X	
	Verify that all metering & Monitoring instrumentation is functional & producing believable data. Use transmitter test form.	X	
	Confirm Panel Heater(s) Functionality	X	

Gas Compression Skids				
	Look over the existing system before starting, refer non conformities to client.			
Req'd?	Item	Complete	Notes	
	1.0 General System Inspection			
	Operate all hand valves. Ensure that they open and close fully & freely	X		
	Is the system piping aligned?	X	slightly off center	
	Are flex fittings in a bind?	X		
	1.1 Electrical Inspection			
	Is the frame of the motor properly grounded to the blower base & skid?	X	regen blower could use external ground	
	Verify Rotation BLR-301	X		
	Verify Rotation BLR-302	X		
	Confirm Connections to VFDs	X		

Flare needs earth ground.

	2.0 System Operation			
	Start & run blowers & fans one at a time. Confirm no excessive vibration or noise	X		
	Confirm functionality of Vacuum control	X		
	Confirm functionality of flow control	X		
	Confirm Functionality of Rotation Management	X	using only 1 Blower in manual	
	Confirm Functionality of High Availability			
	Tune Flow& Vacuum Control Loops. Record the following 3 data points once the system is stable & final adjustments are in place:	X		

Vacuum Control			
Lowest Vacuum Set point, Inches WC		Vacuum Variation, Inches WC	
Mid Vacuum Set point, Inches WC		Vacuum Variation, Inches WC	
Highest Vacuum Set point, Inches WC		Vacuum Variation, Inches WC	
Flow Control			
Lowest Flow Rate Set point, SCFM	30	Flow Variation, SCFM	3
Mid Flow Rate Set point, SCFM	60	Flow Variation, SCFM	5
Higher Flow Rate Set point, SCFM	90	Flow Variation, SCFM	5

non functional inlet Vacuum transmitter, can not test

Enclosed Ground Flare

Req'd?	Item	Complete	Notes	
	1.0 General visual System Inspection			
	Verify Shipping Cover has been removed from top of flare.	X		
	Verify weatherproof kits in Modutrol motors	X	top gasket installed	
	Verify burner tile is in place	X		
	Verify Fireye in place, connected	X		
	Verify pilot tile & ignitor are installed.	X		
	Verify Fireye is correctly oriented	X		
	Verify Flame Arrestor is correctly installed, drain doesn't short circuit flame arrestor.	X		
	Verify Shutdown valve is installed to minimize freezing shut.	X	replaced noisy solenoid	
	Verify Nitrogen line connected to shutdown valve	X		
	Verify piping drains away from shutdown valve.	X		
	1.1 Pre-startup Inspection			
	Verify Fireye cable is connected	X		
	Verify thermocouple extension wire is correct type	X		
	Verify louvers operate, open/ close as indicated on 4-20 mA signal	X		
	Verify purge blower operation	X		
	Verify that when the purge blower is running the pressure switch contacts change state.	X		
	Verify that pilot will light and Fireye show flame when pilot is running.	X		
	Verify interconnection wiring is per print.	X		
	2.0 System Operation			
	Verify that the flare goes through correct purge procedure.	X		
	Verify that flare will light & start.	X		
	Verify that the thermocouples produce reasonable data	X		
	Verify that the Fireye produces best signal when the flare is running.	X		
	Verify that the flare shuts down in the correct sequence.	X		
	Tune Temperature Control Loops. Record the following data points once the system is stable & final adjustments are in place:			
	At 1450 degree set point			
	Flow Rate , SCFM		Temperature Variation, degrees F	
	At 1550 degree set point			
	Flow Rate , SCFM		Temperature Variation, degrees F	
	At 1650 degree set point			
	Flow Rate , SCFM		Temperature Variation, degrees F	

Flow Meters			
Req'd?	Item	Complete	Notes
	1.0 General System Inspection		
	Verify that the meter is correctly installed for the direction of flow	X	
	Verify that the meter is square & plumb to the pipe	X	
	Verify that the meter insertion depth is correct.	X	
	Flow Meter Settings		
	Verify the Gas Composistion is correct	X	Per GEM reading
	2.0 Operation Check		
	Verify that the indicated flow from the flow meter reasonably matches the blower curve.	X	

Modem & HMI			
	SCS is moving existing equipment into our panel. Observe & assist as needed.		
Req'd?	Item	Complete	Notes
	1.0 General Inspection		
	Verify that antenna is present to final location, including all bulk heads, fittings, etc.	X	
	2.0 Functional Testing		
	Conduct Modem Tests with Control Cabinet Doors fully closed.	X	Per Jimmy
	Verify that System is recording data per Configuration Document	X	
	Verify that system will transmit data per configuration document	X	
	Verify that system will transmit alarms & shutdowns per configuration document	X	
	Verify that the system can be accessed per configuration document	X	

SAFETY ALARM & SHUTDOWN TEST REPORT

Job: 1910 Leichner

Date:

Tester

Tester	Device AL	Device SD	Address	Comment
✓	X	X	High Inlet Vacuum	
✓	X	X	Low FLow Rate	
✓	X	X	Flare 1 Low Temperature	
✓	X		Utility Outage	
✓		X	System E-Stop	
✓		X	Flare 1 Pilot Fail	
✓		X	Flare 1 Flame Fail	
✓		X	Flare 1 Selected Thermocouple Fail	
✓		X	Flare 1 Low Purge Pressure Shutdown	
✓	X		Low Outlet Pressure	
✓	X		Control Panel Low Temperature	
✓		X	Blower 301 Run Signal Fail Shutdown	
✓		X	Blower 302 Run Signal Fail Shutdown	
✓		X	Aux Fuel VLV Fail to Close	installed jumper
	X		AUX Fuel VLV Fail to Open	
✓	X		Flare 1 Bottom TC Fail	
✓	X		Flare 1 Middle TC Fail	
✓	X		Flare 1 Top TC Fail	
✓		X	VFD-1 Fault Shutdown	
✓		X	VFD-2 Fault Shutdown	
✓		X	Purge BLR Fail to Run	
✓	X	X	High Inlet Temp	
✓	X	X	[FLR 1] High Flame Temp	
✓	X		High Flow Rate	
	X	X	High Oxygen	
✓		X	High Condensate Level	installed Jumper
✓	X	X	High Outlet Gas Temp	
✓		X	SDV Fail to Close	

Tester	Device		Address	Comment
	AL	SD		
✓		X	SDV Fail to Open	
✓	X		Control Panel High Temperature	

Transmitter list/check off form

Job #		1910				
Job Name:		Leichner				

Pressure Transmitters

Location	Identifier	Units	4 mA	20 mA	Tests OK?	HMI Reads OK?
GHS	PT-301	IN WC	0		NO	NO
GHS	PDT-301	IN WC	0	15	✓	✓
GHS	PT-302	IN WC	0	10	✓	✓

NOTE: GHS-PT-301 CONFIRM & RECORD SCALING, ENSURE PLC & HMI Match

Thermocouples

Req'd	Identifier	Type			Tests OK?	HMI Reads OK?
GHS	TE-301	K			✓	✓
GHS	TE-302	K			✓	✓
FLR	TE-301	K			✓	✓
FLR	TE-501	K			✓	✓
FLR	TE-502	K			✓	✓
FLR	TE-503	K			✓	✓
CP	TE-401	K			✓	✓

FLARE STATION DATA LOG

PERENNIAL ENERGY

Project # 1910 Project Name: Leichner EGFS (Min 9 SCFM, Max 90 SCFM)

Tester Colby Bain				
Date 10/9/20				
Time 3:00 PM				
Sky Conditions Cloudy				
Ambient Temperature, deg F ~~70~~	70			
Inlet Temperature, deg F (GHS-TI-301)	~~96~~ NA			
Demister Inlet Valve Position, % Open (GHS-HV-301)	100			
LFG Vacuum, In WC (GHS-PI-301)	7.2	→ via	monometer	
Demister Filter Delta P (GHS-PDI-301)	~~7~~ N/A			
Demister Exit Pressure, In WC (GHS-PI-302)	N/A			
Demister Exit Temperature, deg F (GHS-TI-302)	N/A			
Blower 301 Inlet Valve Position, % Open (GHS-HV-303)	100%			
Blower 301 Discharge Valve Position, % Open (GHS-HV-305)	100%			
Blower 302 Inlet Valve Position, % Open (GHS-HV-302)	0			
Blower 302 Discharge Valve Position, % Open (GHS-HV-304)	0			
Discharge Header Pressure, In WC (GHS-PI-303)	N/A	→ not Hoo	ked up	
Discharge Header Temperature, deg F (GHS-TI-303)	78° F			
Flame Arrester Inlet Pressure, In WC (FLR-PI-301)	7"			
Flame Arrester Outlet Pressure, In WC (FLR-PI-301)	5"			
Flame Arrester Delta P, In WC (FLR-PI-301)	2"			
Blower 301 Frequency, Hz (CP-YIC-2)	50.7 Hz			
Blower 301 Current, Amps (CP-YIC-2)	~~8~~ N/A			
Blower 302 Frequency, Hz (CP-YIC-3)	0			
Blower 302 Current, Amps (CP-YIC-3)	0			

FLARE STATION DATA LOG

PERENNIAL ENERGY

Project # 1910 Project Name: Leichner EGFS (Min 9 SCFM, Max 90 SCFM)

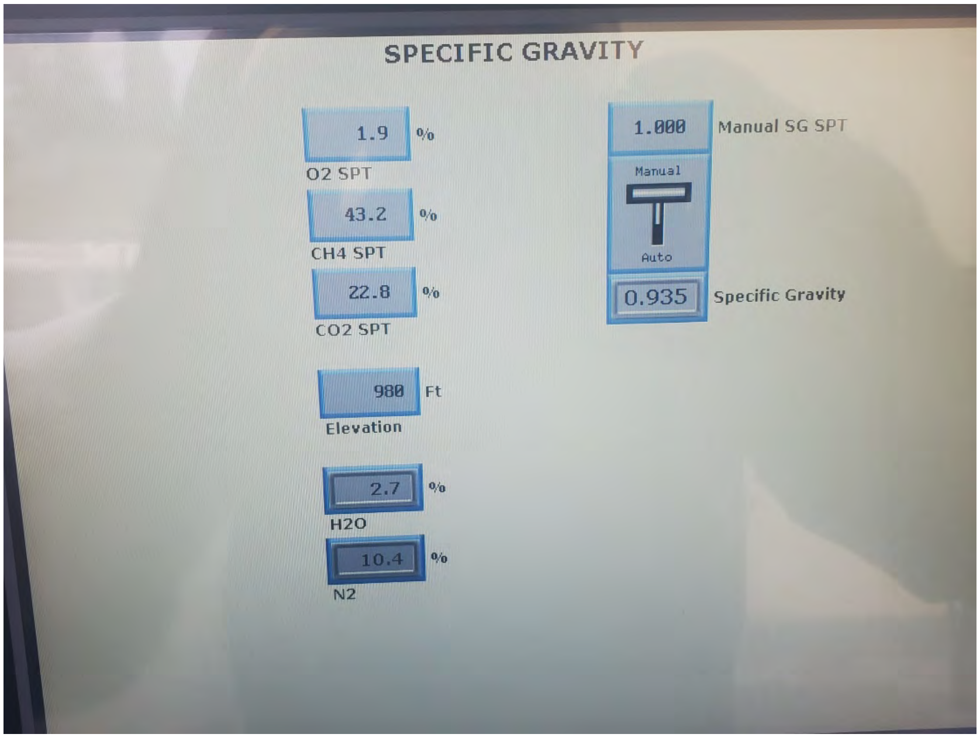
YIC-1 From Main Menu Screen				
ANALOG DATA MENU				
* **PROCESS OVERVIEW**				
PT-301, InWC	N/A	→ not	working	
OE-301, O2%	N/A	→ not	wired in	
TE-301, DegF	92°			
TE-401, DegF				
Vacuum/Flow	manual Blower %			
Vacuum Control PV	N/A	> Transmitter		not
Vacuum Control SP	N/A	working		
Flow Control PV	85%			
Flow Control SP	75			
BLR302 Speed, %	~~85~~ 0			
BLR302 Meter, Hrs	0			
BLR301 Speed, %	85%			
BLR301 Meter, Hrs	70			
PT-302, InWC	6.8			
FT-301, SCFM	70			
TE-302, DegF	85			
BLR401 Meter, Hrs	0			
Flare PV	1425			
Flare SP	1450			
TE-503, DegF	1425			
TE-502, DegF	1561			
TE-501, DegF	1673			
FCV-401..2, % Clsd	52%			

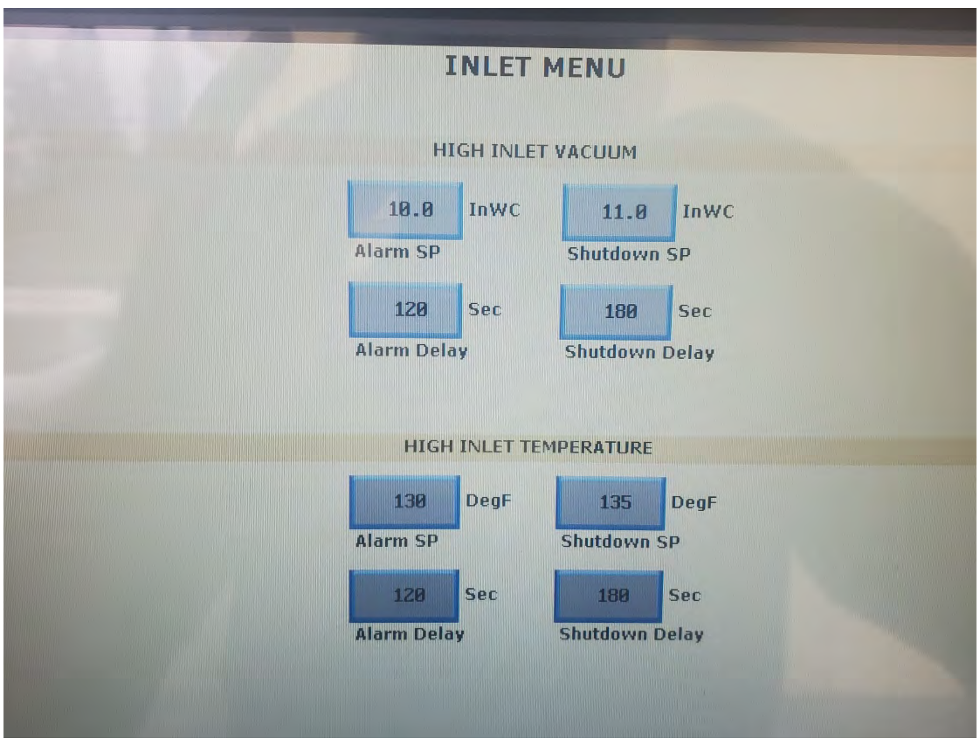
1910 Leichner IP Scheme

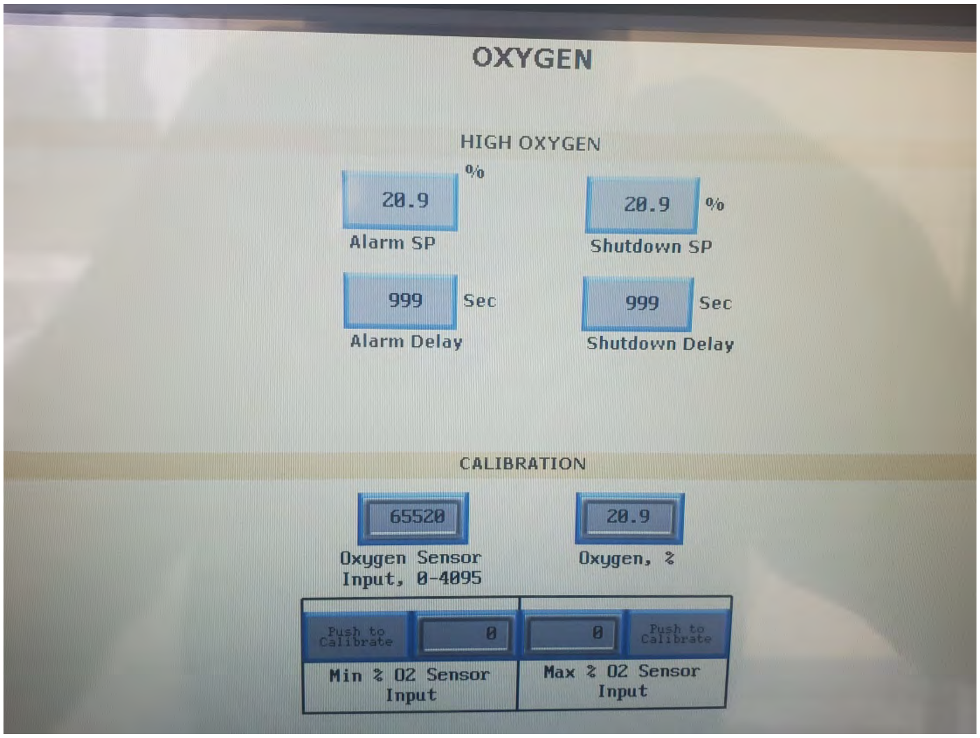
subnet 255.255.255.192
gateway 172.16.110.62

CMore (HMI or Touchscreen or YIC 1) 172.16.110.1
PLC: 172.16.110.11
Service Laptop: 172.16.110.12

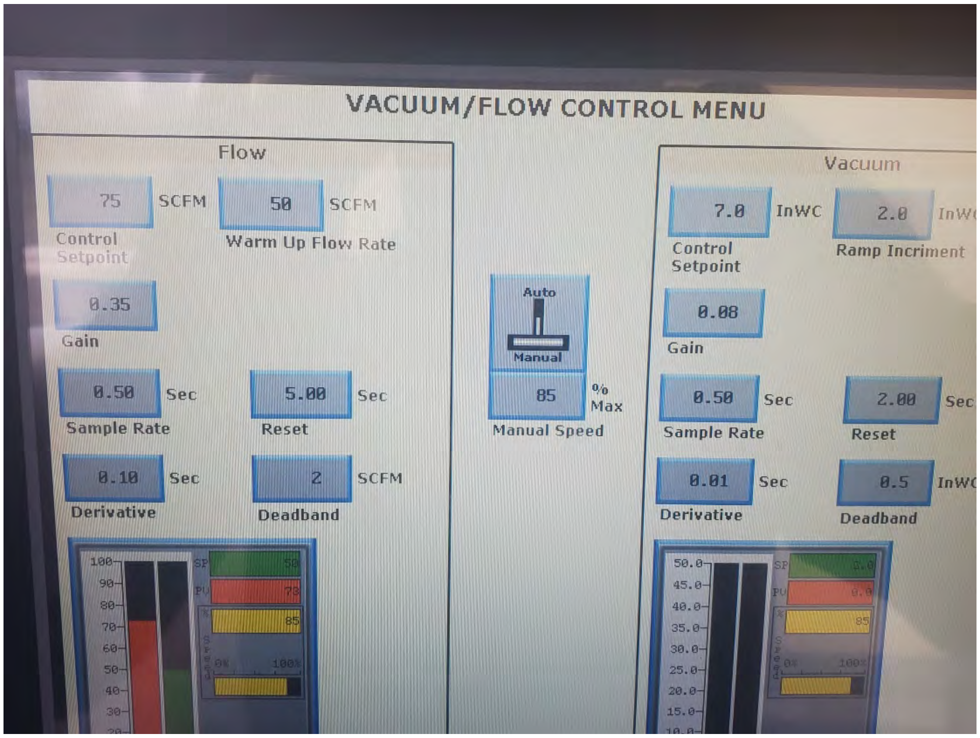
PERENNIAL STARTUP AND COMMISSIONING PHOTOS



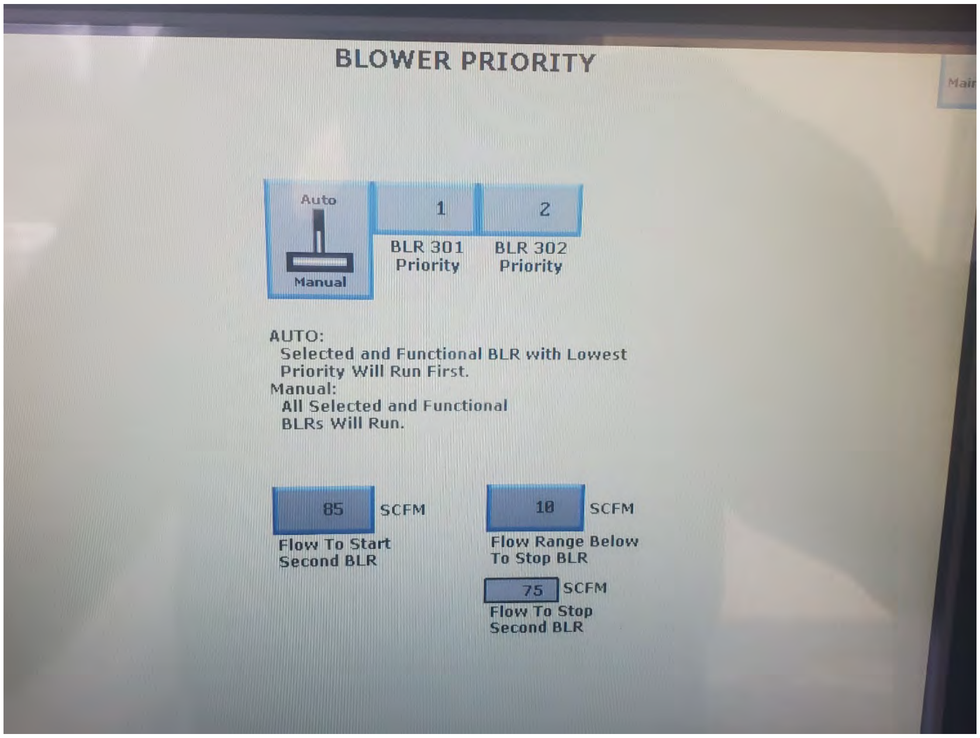


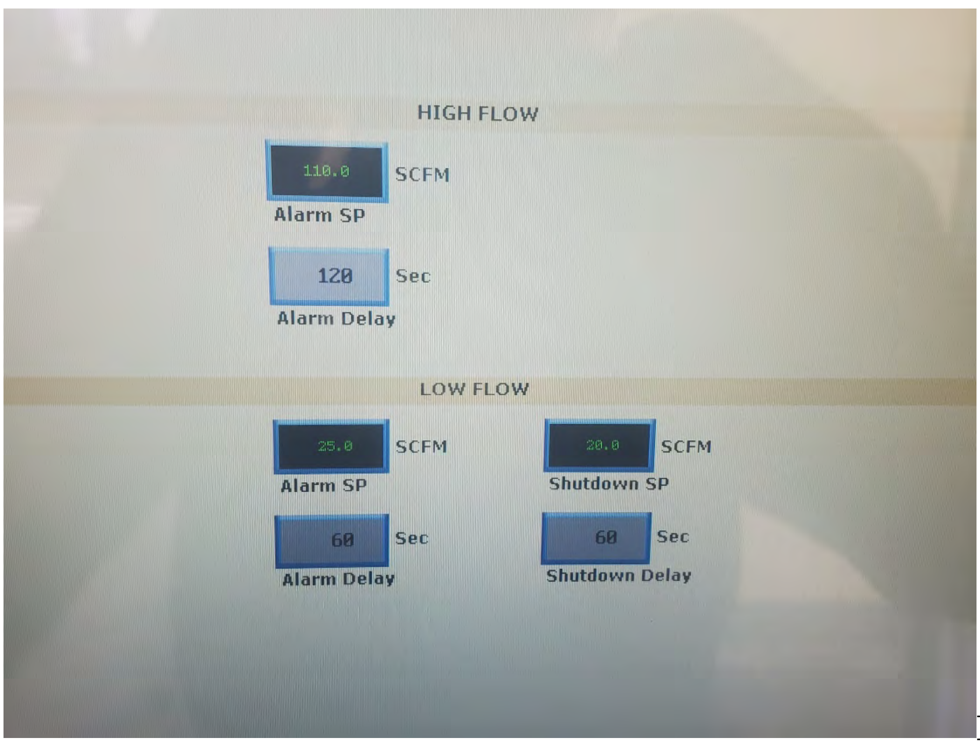


OXYGEN
HIGH OXYGEN
%
20.9
Alarm SP
20.9
%
Shutdown SP
999
Sec
Alarm Delay
999
Sec
Shutdown Delay
CALIBRATION
65520
Oxygen Sensor
Input, 0-4095
20.9
Oxygen, %
Push to Calibrate
0
0
Push to Calibrate
Min % O2 Sensor
Input
Max % O2 Sensor
Input

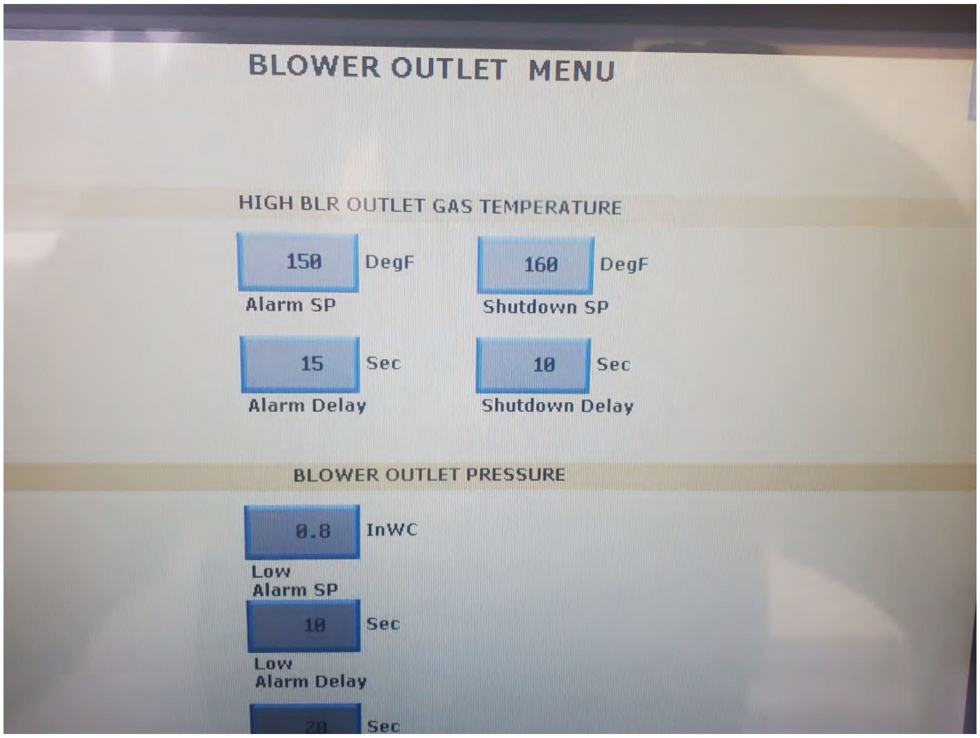


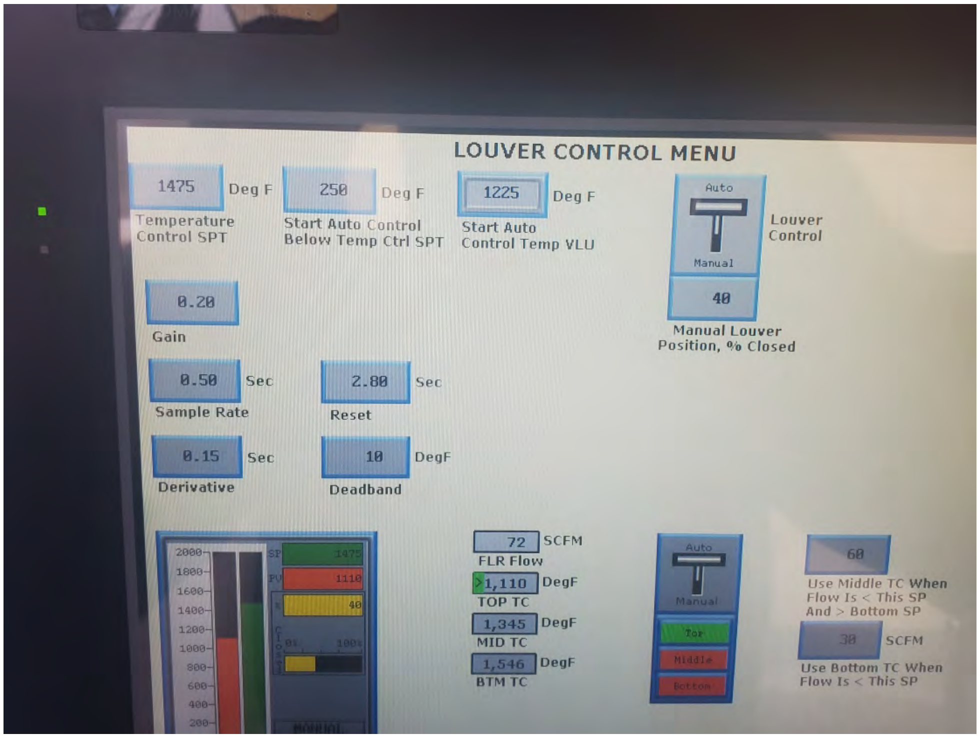
VACUUM/FLOW CONTROL MENU
Flow
75
SCFM
Control
Setpoint
50
SCFM
Warm Up Flow Rate
0.35
Gain
0.50
Sec
Sample Rate
5.00
Sec
Reset
0.10
Sec
Derivative
2
SCFM
Deadband
Auto
Manual
85
%
Max
Manual Speed
Vacuum
7.0
InWC
Control
Setpoint
2.0
Ramp Incriment
0.08
Gain
0.50
Sec
Sample Rate
2.00
Sec
Reset
0.01
Sec
Derivative
0.5
Deadband

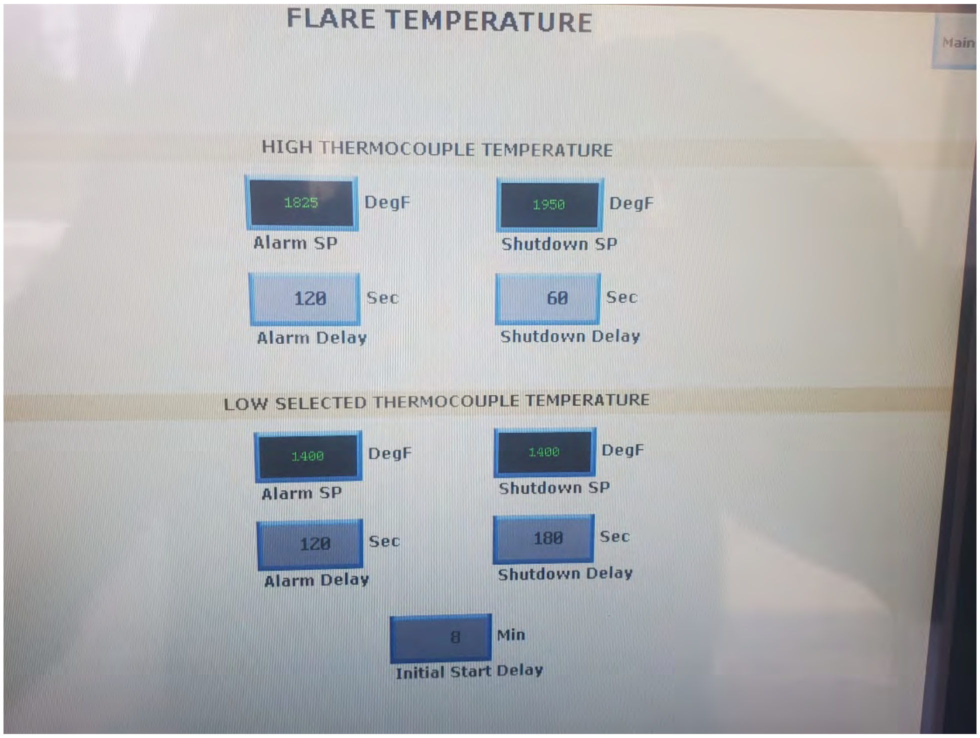

BLOWER PRIORITY
Auto
Manual
1
2
BLR 301
Priority
BLR 302
Priority
AUTO:
Selected and Functional BLR with Lowest
Priority Will Run First.
Manual:
All Selected and Functional
BLRs Will Run.
85
SCFM
Flow To Start
Second BLR
10
SCFM
Flow Range Below
To Stop BLR
75
SCFM
Flow To Stop
Second BLR

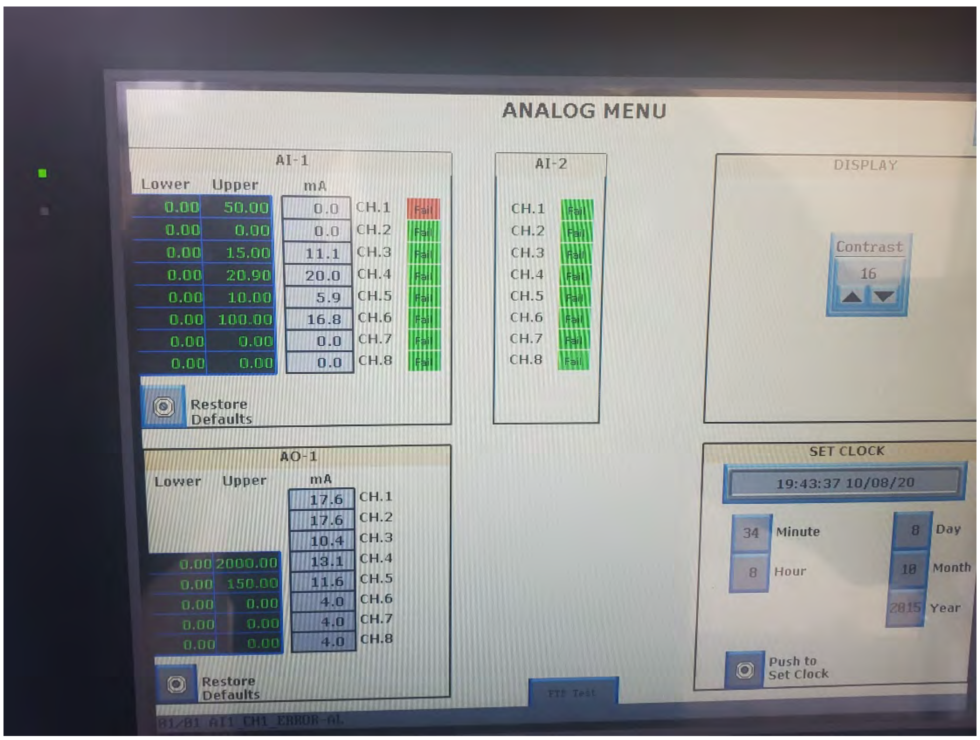

HIGH FLOW
110.0
SCFM
Alarm SP
120
Sec
Alarm Delay
LOW FLOW
25.0
SCFM
Alarm SP
20.0
SCFM
Shutdown SP
60
Sec
Alarm Delay
60
Sec
Shutdown Delay

]


BLOWER OUTLET MENU
HIGH BLR OUTLET GAS TEMPERATURE
150 DegF
Alarm SP
160 DegF
Shutdown SP
15 Sec
Alarm Delay
10 Sec
Shutdown Delay
BLOWER OUTLET PRESSURE
0.8 InWC
Low Alarm SP
10 Sec
Low Alarm Delay
Sec


LOUVER CONTROL MENU
1475 Deg F
Temperature Control SPT
250 Deg F
Start Auto Control Below Temp Ctrl SPT
1225 Deg F
Start Auto Control Temp VLU
Auto
Manual
Louver Control
40
Manual Louver Position, % Closed
0.20
Gain
0.50 Sec
Sample Rate
2.00 Sec
Reset
0.15 Sec
Derivative
10 DegF
Deadband
72 SCFM
FLR Flow
1,110 DegF
TOP TC
1,345 DegF
MID TC
1,546 DegF
BTM TC
60
Use Middle TC When Flow Is < This SP And > Bottom SP
30 SCFM
Use Bottom TC When Flow Is < This SP


FLARE TEMPERATURE
Main
HIGH THERMOCOUPLE TEMPERATURE
1825 DegF
Alarm SP
1950 DegF
Shutdown SP
120 Sec
Alarm Delay
60 Sec
Shutdown Delay
LOW SELECTED THERMOCOUPLE TEMPERATURE
1400 DegF
Alarm SP
1400 DegF
Shutdown SP
120 Sec
Alarm Delay
180 Sec
Shutdown Delay
8 Min
Initial Start Delay


ANALOG MENU
AI-1
Lower Upper mA
0.00 50.00 0.0 CH.1
0.00 0.00 0.0 CH.2
0.00 15.00 11.1 CH.3
0.00 20.90 20.0 CH.4
0.00 10.00 5.9 CH.5
0.00 100.00 16.8 CH.6
0.00 0.00 0.0 CH.7
0.00 0.00 0.0 CH.8
Restore Defaults
AI-2
CH.1
CH.2
CH.3
CH.4
CH.5
CH.6
CH.7
CH.8
DISPLAY
Contrast
16
AO-1
Lower Upper mA
17.6 CH.1
17.6 CH.2
10.4 CH.3
0.00 2000.00 13.1 CH.4
0.00 150.00 11.6 CH.5
0.00 0.00 4.0 CH.6
0.00 0.00 4.0 CH.7
0.00 0.00 4.0 CH.8
Restore Defaults
SET CLOCK
19:43:37 10/08/20
34 Minute
8 Hour
8 Day
10 Month
2015 Year
Push to Set Clock

Appendix G

Source Test Plan

November 20, 2020

Subject: Compliance Test Plan, Landfill Flare
Mike Davis, Leichner Landfill
Vancouver, WA
Air Discharge Permit No.: 20-3433
Montrose Document Number W021ASAS-2687-PP-585

Enclosed please find the compliance test plan for the above-referenced facility and source. The test plan documents the details of the testing that will be performed by Montrose Air Quality Services, LLC (Montrose) at Leichner Landfill on December 9-10, 2020.

The following distribution was provided for this project.

Name	Company/Agency	No. of Copies	Electronic Copy
Mike Davis	Leichner Landfill Mike.Davis@clark.wa.gov	N/A	Emailed PDF, 11/20/20
Alexa Deep	SCS Engineers ADeep@scsengineers.com	N/A	Emailed PDF, 11/20/20
Gerald Strawn	SWCAA gerry@swcleanair.org	N/A	Emailed PDF, 11/20/20

Please do not hesitate to call our Seattle office at 253-480-3801 if you have any questions.

Sincerely,

Kristina Schafer
PNW Hub District Manager
Montrose Air Quality Services, LLC

SOURCE TEST PLAN
2020 COMPLIANCE TESTING
LEICHNER LANDFILL
LANDFILL GAS FLARE
VANCOUVER, WASHINGTON

Prepared For:

Leichner Landfill
9411 NE 94th Avenue
Vancouver, WA 98662

For Submittal To:

Southwest Clean Air Agency
11815 NE 99th Street, Suite 1294
Vancouver, WA 98682

Prepared By:

Montrose Air Quality Services, LLC
4150 B Place NW, Suite 106
Auburn, WA 98001

Document Number: **W021AS-2687-PP-585**
Proposed Test Dates: **December 9-10, 2020**
Submittal Date: **November 20, 2020**

ACCREDITED
TO ASTM D7036 ONLY
CERT #3925.01

MONTROSE
AIR QUALITY SERVICES

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Leichner Landfill (Leichner) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test program on the Landfill Flare at the Leichner Landfill facility located in Vancouver, Washington. The tests are conducted to determine compliance with the Southwest Clean Air Agency (SWCAA) Air Discharge Permit (ADP) No. 20-3433.

The specific objectives are to:

- Measure concentrations of NMOC at the inlet of the flare
- Measure emissions of CO, NO_X, SO_2, NMOC, and VE at the outlet of the flare
- Conduct the test program with a focus on safety

Montrose will provide the test personnel and the necessary equipment to measure emissions as outlined in this test plan. Facility personnel will provide the process and production data to be included in the final report. A summary of the test program and proposed schedule is presented in Table 1-1.

TABLE 1-1
SUMMARY OF TEST PROGRAM AND PROPOSED SCHEDULE

Proposed Test Dates	Unit ID/ Source Name	Activity/ Parameters	Test Methods	No. of Runs	Duration (Minutes)
December 9-10, 2020	Flare Inlet & Outlet	Velocity/Vol. Flow Rate/Temperature	EPA 1 & 2	3	~60 minutes
"	Flare Inlet	Fuel Factor	EPA 3C & 19	3	~60 minutes
"	Flare Inlet & Outlet	O_2, CO_2	EPA 3A	3	60 minutes
"	Flare Outlet	Moisture	EPA 4	3	60 minutes
"	Flare Outlet	SO_2	EPA 6C	3	60 minutes
"	Flare Outlet	NO_x	EPA 7E	3	60 minutes
"	Flare Outlet	Opacity	EPA 9	3	10 minutes
"	Flare Outlet	CO	EPA 10	3	60 minutes
"	Flare Inlet & Outlet	NMOC	EPA 25C	3	~60 minutes
"	Flare Inlet & Outlet	Post-test thermocouple calibration check	EPA ALT-011	N/A	N/A

To simplify this test plan, a list of Units and Abbreviations is included in Appendix A. Throughout this test plan, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

1.2 APPLICABLE REGULATIONS AND EMISSION LIMITS

The results from this test program are presented in units consistent with those listed in the applicable regulations or requirements. The reporting units and emission limits are presented in Table 1-2.

TABLE 1-2
REPORTING UNITS AND EMISSION LIMITS

Unit ID/ Source Name	Parameter	Reporting Units	Emission Limit	Emission Limit Reference
Landfill Gas Flare	Volumetric flow rate	acfm, scfm, dscfm	--	--
Landfill Gas Flare	O_2 & CO_2	% vd	--	--
Landfill Gas Flare	Moisture	%	--	--
Landfill Gas Flare	SO_2	lb/MMBtu tpy	0.016 0.18	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	NO_x	lb/MMBtu tpy	0.060 0.72	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	Opacity	%	0	ADP Condition 3
Landfill Gas Flare	CO	lb/MMBtu tpy	0.15 1.79	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	NMOC/VOC (as hexane)	lb/MMBtu tpy	0.050 0.60	ADP Condition 2 ADP Condition 2

1.3 KEY PERSONNEL

A list of project participants is included below:

Facility Information

Source Location:	Leichner Landfill 9411 NE 94th Avenue Vancouver, WA 98662
Project Contact:	Mike Davis
Role:	Solid Waste Operations Specialist
Company:	Leichner Landfill
Telephone:	564-397-7343
Email:	Mike.Davis@clark.wa.gov

Agency Information

Regulatory Agency:	Southwest Clean Air Agency
Agency Contact:	Gerald Strawn
Telephone:	360-574-3058 x113
Email:	gerry@swcleanair.org

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC (Montrose)	
Contact:	Peter Becker	Kristina Schafer
Title:	Client Project Manager	PNW Hub District Manager
Telephone:	330-285-6884	253-480-3801
Email:	pbecker@montrose-env.com	kschafer@montrose-env.com

Laboratory Information

Laboratory:	Atmospheric Analysis and Consulting
City, State:	Ventura, CA
Method:	EPA Methods 3C and 25C

Subcontractor (or Consultant) Information

Company:	SCS Engineers
Contact:	Alexa Deep, EIT
Telephone:	425-289-5441
Email:	adeep@scsengineers.com

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS DESCRIPTION, OPERATION, AND CONTROL EQUIPMENT

The Leichner Landfill flare is an enclosed style landfill gas (LFG) flare manufactured by Perennial Energy, Inc. with a rated maximum capacity of 2.7 MM Btu/hr (i.e., 90 scfm at 50 percent methane) with a turndown capability of 10 to 1. This flare has been installed to replace the existing enclosed flare to accommodate current and future declining LFG generation and recovery rates.

The LFG extraction plant (blowers) provides the driving force or vacuum to the gas conveyance system and extraction network (gas wells), and pull the LFG from the refuse to the blowers. The LFG enters a moisture separator vessel (i.e., Knockout pot or scrubber) upstream of the blowers where excess moisture is removed from the gas stream. Landfill gas exits the moisture separator and enters the regenerative style blowers, which push the LFG to the enclosed flare at a low inlet pressure of 10 inches of water column. The enclosed flare uses the LFG for combustion fuel and controls the combustion temperature with quench air from automated louvers responding to a feedback loop from thermocouples mounted inside of the flare stack.

2.2 FLUE GAS SAMPLING LOCATIONS

Actual stack measurements, number of traverse points, and location of traverse points will be evaluated in the field as part of the test program. Table 2-1 presents the anticipated stack measurements and traverse points for the sampling locations listed.

TABLE 2-1
SAMPLING LOCATIONS

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance Downstream EPA "B" (in./dia.)	 Upstream EPA "A" (in./dia.)	Number of Traverse Points
Flare Outlet	57	216 / 3.8	30 / 0.5	Flow: 16 (8/port); Gaseous: one

The inlet to the flare is a horizontal, cylindrical duct that runs near ground level into a flame arrester and then into the bottom section of the flare. The inlet samples will be taken from a valve at the base of the stack near the flowmeter.

Sample locations are verified in the field to conform to EPA Method 1. Acceptable cyclonic flow conditions are confirmed prior to testing using EPA Method 1, Section 11.4. Appendix A presents stack schematics and process flow diagrams.

2.3 OPERATING CONDITIONS AND PROCESS DATA

Emission tests are performed while the unit is operating at the most challenging of the intended operating conditions. Leichner may choose to conduct the testing across a temperature range representative of the intended operating conditions. If this option is chosen, at least one sampling run must be conducted at the maximum operating temperature, and at least one sampling run must be conducted at the minimum operating temperature.

Plant personnel are responsible for establishing the test conditions and collecting all applicable unit-operating data. Data collected includes the following parameters:

- Landfill gas consumption rate
- Average flare temperature as measured by the permanent flare temperature monitoring device
- Flare temperature setpoint during each emission test
- Startup and shutdown events

2.4 PLANT SAFETY

Montrose will comply with all safety requirements at the facility. The facility Client Sponsor, or designated point of contact, is responsible for ensuring routine compliance with plant entry, health, and safety requirements. The Client Sponsor has the authority to impose or waive facility restrictions. The Montrose test team leader has the authority to negotiate any deviations from the facility restrictions with the Client Sponsor. Any deviations must be documented.

2.4.1 Safety Responsibilities

Planning

- Montrose must complete a field review with the Client Sponsor prior to the project date. The purpose of the review is to develop a scope of work that identifies the conditions, equipment, methods, and physical locations that will be utilized along with any policies or procedures that will affect our work.
- We must reach an agreement on the proper use of client emergency services and ensure that proper response personnel are available, as needed.
- The potential for chemical exposure and actions to be taken in case of exposure must be communicated to Montrose. This information must include expected concentrations of the chemicals and the equipment used to identify the substances.
- Montrose will provide a list of equipment being brought to the site, if required by the client.

Project Day

- Montrose personnel will arrive with the appropriate training and credentials for the activities they will be performing and the equipment that they will operate.
- Our team will meet daily to review the Project Scope, Job Hazard Assessment, and Work Permits. The Client Sponsor and Operations Team are invited to participate.
- Montrose will provide equipment that can interface with the client utilities previously identified in the planning phase and only work with equipment that our client has made ready and prepared for connection.

- We will follow client direction regarding driving safety, safe work permitting, staging of equipment, and other crafts or work in the area.
- As per 40 CFR Part 60 Subpart A, Section 60.8, the facility must provide the following provisions at each sample location:
  - Sampling ports, which meet EPA minimum requirements for testing. The caps should be removed or be hand-tight.
  - Safe sampling platforms.
  - Safe access to the platforms and test ports, including any scaffolding or man lifts.
  - Sufficient utilities to perform all necessary testing.
- Montrose will use the client communication system, as directed, in case of plant or project emergency.
- Any adverse conditions, unplanned shutdowns or other deviations to the agreed scope and project plan must be reviewed with the Client Sponsor prior to continuing work. This will include any safe work permit and hazard assessment updates.

Completion

- Montrose personnel will report any process concerns, incidents or near misses to the Client Sponsor prior to leaving the site.
- Montrose will clean up our work area to the same condition as it was prior to our arrival.
- We will ensure that all utilities, connection points or equipment have been returned to the pre-project condition or as stated in the safe work permit. In addition, we will walk out the job completion with Operations and the Client Sponsor if required by the facility.

2.4.2 Safety Program and Requirements

Montrose has a comprehensive health and safety program that satisfies State and Federal OSHA requirements. The program includes an Illness and Injury Prevention Program, site-specific safety meetings, and training in safety awareness and procedures. The basic elements include:

- All regulatory required policies/procedures and training for OSHA, EPA and FMCSA
- Medical monitoring, as necessary
- Use of Personal Protective Equipment (PPE) and chemical detection equipment
- Hazard communication
- Pre-test and daily toolbox meetings
- Continued evaluation of work and potential hazards.
- Near-miss and incident reporting procedures as required by Montrose and the Client

Montrose will provide standard PPE to employees. The PPE will include but is not limited to; hard hats, safety shoes, glasses with side shields or goggles, hearing protection, hand protections, and fall protection. In addition, our trailers are equipped with four gas detectors to ensure that workspace has no unexpected equipment leaks or other ambient hazards.

The detailed Site Safety Plan for this project is attached to this test plan in Appendix “S”.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 TEST METHODS

The test methods for this test program were presented previously in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - N/A
- Method Exceptions:
  - None anticipated

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - S-type pitot tube coefficient is 0.84
  - Shortridge multimeter may be used to measure velocity
- Method Exceptions:
  - None anticipated

3.1.3 EPA Methods 3A, 6C, 7E, and 10, Determination of Oxygen, Carbon Dioxide, Sulfur Dioxide, Nitrogen Oxides, and Carbon Monoxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedures)

Concentrations of O_2, CO_2, SO_2, NO_x, and CO are measured simultaneously using EPA Methods 3A, 6C, 7E, and 10, which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - No filter is used since low PM is expected
  - A dry extractive sampling system is used to report emissions on a dry basis
  - A paramagnetic analyzer is used to measure O_2
  - A nondispersive infrared analyzer is used to measure CO_2
  - An ultraviolet absorption analyzer is used to measure SO_2
  - A chemiluminescent analyzer is used to measure NO_x
  - A gas filter correlation nondispersive infrared analyzer is used to measure CO
  - NO and NO_2 are measured separately and summed to report NO_x emissions
- Method Exceptions:
  - For gaseous emissions sampling, MDL are calculated for each analyzer. The ISDL is equal to the sensitivity of the instrumentation, which is 2% of the span value.
- Target and/or Minimum Required Sample Duration: 60 minutes

3.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Condensed water is measured gravimetrically
  - Since it is theoretically impossible for measured moisture to be higher than psychrometric moisture, the psychrometric moisture is also calculated, and the lower moisture value is used in the calculations
- Method Exceptions:
  - Moisture sampling is performed as a stand-alone method at a single point in the centroid of the stack
- Target and/or Minimum Required Sample Duration: 60 minutes
- Target and/or Minimum Required Sample Volume: 21 scf

3.1.5 EPA Method 3C, Determination of Carbon Dioxide, Methane, Nitrogen, and Oxygen from Stationary Sources

EPA Method 3C is a manual method used to measure O_2, CO_2, CH_4, and N_2 concentrations. EPA Method 3C is used to calculate the molecular weight of the stack gas from municipal solid waste landfills and other sources when specified in an applicable subpart. Samples are collected for percent-level measurements of the concentration of O_2, CO_2, CH_4, and N_2 in the stack gas. A portion of the sample is injected into a gas chromatograph (GC) and the O_2, CO_2, CH_4, and N_2 concentrations are determined using a thermal conductivity detector (TCD) and integrator.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
    - Response factors of uncorrected component concentrations (wet basis) may be generated using instrumental integration
    - Peak height may be used instead of peak area throughout this method
- Method Exceptions:
    - None anticipated
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, California

3.1.6 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is a manual method used to determine (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions. This method provides data reduction procedures, but does not include any sample collection or analysis procedures.

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
    - F factor is calculated from composition data collected on the test day and analyzed by EPA Method 3C
- Method Exceptions:
    - None anticipated

3.1.7 EPA Method 25C, Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases

A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide

(CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - N/A
- Method Exceptions:
  - None anticipated
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, California

3.2 PROCESS TEST METHODS

The applicable regulations do not require process samples to be collected during this test program.

4.0 QUALITY ASSURANCE AND REPORTING

4.1 QA AUDITS

Montrose has instituted a rigorous QA/QC program for its air quality testing. Quality assurance audits are performed as part of the test program to ensure that the results are calculated using the highest quality data available. This program ensures that the emissions data we report are as accurate as possible. The procedures included in the cited reference methods are followed during preparation, sampling, calibration, and analysis. Montrose is responsible for preparation, calibration, and cleaning of the sampling apparatus. Montrose will also perform the sampling, sample recovery, storage, and shipping. Approved contract laboratories may perform some of the preparation and sample analyses, as needed.

4.2 QUALITY CONTROL PROCEDURES

Montrose calibrates and maintains equipment as required by the methods performed and applicable regulatory guidance. Montrose follows internal procedures to prevent the use of malfunctioning or inoperable equipment in test programs. All equipment is operated by trained personnel. Any incidence of nonconforming work encountered during testing is reported and addressed through the corrective action system.

4.2.1 Equipment Inspection and Maintenance

Each piece of field equipment that requires calibration is assigned a unique identification number to allow tracking of its calibration history. All field equipment is visually inspected prior to testing and includes pre-test calibration checks as required by the test method or regulatory agency.

4.2.2 Audit Samples

When required by the test method and available, Montrose obtains EPA TNI SSAS audit samples from an accredited provider for analysis along with the samples. Currently, the SSAS program has been suspended pending the availability of a second accredited audit sample provider. If the program is reinstated, the audit samples will be ordered. If required as part of the test program, the audit samples are stored, shipped, and analyzed along with the emissions samples collected during the test program. The audit sample results are reported along with the emissions sample results.

4.3 DATA ANALYSIS AND VALIDATION

Montrose converts the raw field, laboratory, and process data to reporting units consistent with the permit or subpart. Calculations are made using proprietary computer spreadsheets or data acquisition systems. One run of each test method is also verified using a separate example calculation. The example calculations are checked against the spreadsheet results and are included in the final report. The “Standard Conditions” for this project are 29.92 inches of mercury and 68 °F.

4.4 SAMPLE IDENTIFICATION AND CUSTODY

The on-site Field Project Manager will assume or assign the role of sample and data custodian until relinquishing custody. The sample custodian will follow proper custody procedures before departing from the test site including:

- Assign the unique sample identification number to each sample
- Attach sample labels and integrity seals to all samples
- Complete COC form(s), ensuring that the sample identification numbers on the samples match the sample identification numbers on the COC
- Pack and store samples in accordance with the test method requirements in appropriate transport containers for protection from breakage, contamination, or loss
- Keep samples in a secure locked area if not in the direct presence of Montrose staff

The sample custodian will follow proper custody procedures upon arriving at the Montrose office including:

- Remove samples and COC documents from vehicles and check into designated secure sample holding areas
- Store samples requiring additional measures such as refrigeration or dry ice appropriately

4.5 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the appendices. The content of this test plan is modeled after the EPA Emission Measurement Center Guideline Document (GD-042).

4.6 REPORTING

Montrose will prepare a final report to present the test data, calculations/equations, descriptions, and results. Prior to release by Montrose, each report is reviewed and certified by the project manager and their supervisor, or a peer. Source test reports will be submitted to the facility or appropriate regulatory agency (upon customer approval) within 45 days of the completion of the field work. The report will include a series of appendices to present copies of the intermediate calculations and example calculations, raw field data, laboratory analysis data, process data, and equipment calibration data.

4.6.1 Example Report Format

The report is divided into various sections describing the different aspects of the source testing program. Table 4-1 presents a typical Table of Contents for the final report.

TABLE 4-1
TYPICAL REPORT FORMAT

Cover Page	
Certification of Report	
Table of Contents	
Section	
1.0	INTRODUCTION
2.0	PLANT AND SAMPLING LOCATION DESCRIPTIONS
3.0	SAMPLING AND ANALYTICAL PROCEDURES
4.0	TEST DISCUSSION AND RESULTS
5.0	INTERNAL QA/QC ACTIVITIES
Appendices	
A	FIELD DATA AND CALCULATIONS
B	FACILITY PROCESS DATA
C	LABORATORY ANALYSIS DATA
D	QUALITY ASSURANCE/QUALITY CONTROL
E	REGULATORY INFORMATION

4.6.2 Example Presentation of Test Results

Table 4-2 presents the typical tabular format that is used to summarize the results in the final source test report. Separate tables will outline the results for each target analyte and compare them to their respective emissions limits.

TABLE 4-2
EXAMPLE CO EMISSIONS RESULTS -
LANDFILL GAS FLARE

Run Number	**1**	**2**	**3**	**Average**
Date	X	X	X	--
Time	X	X	X	--
Process Data				
Landfill gas consumption rate	X	X	X	X
Average flare temp	X	X	X	X
Flare temp setpoint	X	X	X	X
Flue Gas Parameters				
O_2, % volume dry	X	X	X	X
CO_2, % volume dry	X	X	X	X
flue gas temperature, °F	X	X	X	X
moisture content, % volume	X	X	X	X
volumetric flow rate, dscfm	X	X	X	X
CO				
ppmvd	X	X	X	X
tons/yr	X	X	X	X
lb/MMBtu	X	X	X	X

APPENDIX A
SUPPORTING INFORMATION

Appendix A.1
Units and Abbreviations

UNITS AND ABBREVIATIONS

@ X% O_2	corrected to X% oxygen (corrected for dilution air)
|CC|	absolute value of the confidence coefficient
|d|	absolute value of the mean differences
ºC	degrees Celsius (centrigade)
ºF	degrees Fahrenheit
ºR	degrees Rankine
" H_2O	inches of water column
13.6	specific gravity of mercury
ΔH	pressure drop across orifice meter, inches H_2O
ΔP	velocity head of stack gas, inches H_2O
θ	total sampling time, minutes
µg	microgram
ρ_a	density of acetone, mg/ml
ρ_w	density of water, 0.9982 g/ml or 0.002201 lb/ml
acfm	actual cubic feet of gas per minute at stack conditions
A_n	cross-sectional area of nozzle, ft^2
A_s	cross-sectional area of stack, square feet (ft^2)
Btu	British thermal unit
B_{ws}	proportion by volume of water vapor in gas stream
C_a	particulate matter concentration in stack gas, gr/acf
C_{Avg}	average unadjusted gas concentration, ppmv
C_{Dir}	measured concentration of calibration gas, ppmv
cf or ft^3	cubic feet
cfm	cubic feet per minute
C_{Gas}	average gas concentration adjusted for bias, ppmv
C_M	average of initial and final system bias check responses from upscale calibration gas, ppmv
cm or m^3	cubic meters
C_{MA}	actual concentration of the upscale calibration gas, ppmv
C_O	average of initial and final system bias check responses from low-level calibration gas, ppmv
C_p	pitot tube coefficient
C_s	particulate matter concentration in stack gas, gr/dscf
CS	calibration span, % or ppmv
C_S	measured concentration of calibration gas, ppmv
C_V	manufactured certified concentration of calibration gas, ppmv
D	drift assessment, % of span
dcf	dry cubic feet
dcm	dry cubic meters
D_n	diameter of nozzle, inches
D_s	diameter of stack, inches
dscf	dry standard cubic feet
dscfm	dry standard cubic feet per minute
dscm	dry standard cubic meters
F_d	F-factor, dscf/MMBtu of heat input
fpm	feet per minute
fps	feet per second
ft	feet
ft^2	square feet
g	gram
gal	gallons
gr	grains (7000 grains per pound)

UNITS AND ABBREVIATIONS

gr/dscf	grains per dry standard cubic feet
hr	hour
I	percent of isokinetic sampling
in	inch
k	kilo or thousand (metric units, multiply by 10^3)
K	kelvin (temperature)
K_3	conversion factor 0.0154 gr/mg
K_4	conversion factor 0.002669 ((in. Hg)(ft^3))/((ml)(°R))
kg	kilogram
K_p	pitot tube constant (85.49 ft/sec)
kwscfh	thousand wet standard cubic feet per hour
l	liters
lb/hr	pounds per hour
lb/MMBtu	pounds per million Btu
lpm	liters per minute
m	meter or milli
M	thousand (English units) or mega (million, metric units)
m^3	cubic meters
m_a	mass of residue of acetone after evaporation, mg
M_d	molecular weight of stack gas; dry basis, lb/lb-mole
meq	milliequivalent
mg	milligram
Mg	megagram (10^6 grams)
min	minute
ml or mL	milliliter
mm	millimeter
MM	million (English units)
MMBtu/hr	million Btu per hour
m_n	total amount of particulate matter collected, mg
mol	mole
mol. wt. or MW	molecular weight
M_s	molecular weight of stack gas; wet basis, lb/lb-mole
MW	molecular weight or megawatt
n	number of data points
ng	nanogram
nm	nanometer
P_{bar}	barometric pressure, inches Hg
pg	picogram
P_g	stack static pressure, inches H_2O
P_m	barometric pressure of dry gas meter, inches Hg
ppb	parts per billion
ppbv	parts per billion, by volume
ppbvd	parts per billion by volume, dry basis
ppm	parts per million
ppmv	parts per million, by volume
ppmvd	parts per million by volume, dry basis
P_s	absolute stack gas pressure, inches Hg
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
P_{std}	standard absolute pressure, 29.92 inches Hg
Q_a	volumetric flow rate, actual conditions, acfm

MONTROSE AIR QUALITY SERVICES

UNITS AND ABBREVIATIONS

Q_s	volumetric flow rate, standard conditions, scfm
Q_{std}	volumetric flow rate, dry standard conditions, dscfm
R	ideal gas constant 21.85 ((in. Hg) ($ft^{3)}$)/((°R) (lbmole))
SB_{final}	post-run system bias check, % of span
SB_i	pre-run system bias check, % of span
scf	standard cubic feet
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
scm	standard cubic meters
scmh	standard cubic meters per hour
sec	second
sf, sq. ft., or ft^2	square feet
std	standard
t	metric ton (1000 kg)
$T_{0.975}$	t-value
T_a	absolute average ambient temperature, ºR (+460 for English)
T_m	absolute average dry gas meter temperature, ºR (+460 for English)
ton or t	ton = 2000 pounds
tph or tons/hr	tons per hour
tpy or tons/yr	tons per year
T_s	absolute average stack gas meter temperature, ºR (+460 for English)
T_{std}	absolute temperature at standard conditions
V	volt
V_a	volume of acetone blank, ml
V_{aw}	volume of acetone used in wash, ml
V_{lc}	total volume H_2O collected in impingers and silica gel, grams
V_m	volume of gas sampled through dry gas meter, ft^3
$V_{m(std)}$	volume of gas measured by the dry gas meter, corrected to standard conditions, dscf
V_{ma}	stack gas volume sampled, acf
V_n	volume collected at stack conditions through nozzle, acf
V_s	average stack gas velocity, feet per second
$V_{wc(std)}$	volume of water vapor condensed, corrected to standard conditions, scf
$V_{wi(std)}$	volume of water vapor in gas sampled from impingers, scf
$V_{wsg(std)}$	volume of water vapor in gas sampled from silica gel, scf
W	watt
W_a	weight of residue in acetone wash, mg
W_{imp}	total weight of impingers, grams
W_{sg}	total weight of silica gel, grams
Y	dry gas meter calibration factor, dimensionless

ACRONYMS

AAS	atomic absorption spectroscopy
ACDP	air contaminant discharge permit
ACE	analyzer calibration error, percent of span
AD	absolute difference
ADL	above detection limit
AETB	Air Emissions Testing Body
AS	applicable standard (emission limit)
ASTM	American Society For Testing And Materials
BACT	best achievable control technology
BDL	below detection limit
BHP	brake horsepower
BIF	boiler and industrial furnace
BLS	black liquor solids
CC	confidence coefficient
CD	calibration drift
CE	calibration error
CEM	continuous emissions monitor
CEMS	continuous emissions monitoring system
CERMS	continuous emissions rate monitoring system
CET	calibration error test
CFR	Code of Federal Regulations
CGA	cylinder gas audit
CHNOS	elemental analysis for determination of C, H, N, O, and S content in fuels
CNCG	concentrated non-condensable gas
CO	catalytic oxidizer
COC	chain of custody
COMS	continuous opacity monitoring system
CPM	condensible particulate matter
CPMS	continuous parameter monitoring system
CT	combustion turbine
CTM	conditional test method
CTO	catalytic thermal oxidizer
CVAAS	cold vapor atomic absorption spectroscopy
D_e	equivalent diameter
DE	destruction efficiency
Dioxins	polychlorinated dibenzo-p-dioxins (pcdd's)
DLL	detection level limited
DNCG	dilute non-condensable gas
ECD	electron capture detector
EIT	Engineer In Training
ELCD	electoconductivity detector (hall detector)
EMPC	estimated maximum possible concentration
EPA	US Environmental Protection Agency
EPRI	Electric Power Research Institute
ES	emission standard (applicable limit)
ESP	electrostatic precipitator
EU	emission unit
FCCU	fluid catalytic cracking unit
FGD	flue gas desulfurization
FI	flame ionization
FIA	flame ionization analyzer
FID	flame ionization detector
FPD	flame photometric detector
FPM	filterable particulate matter

ACRONYMS

FTIR	Fourier-transform infrared spectroscopy
FTPB	field train proof blank
FTRB	field train recovery blank
Furans	polychlorinated dibenzofurans (pcdf's)
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
GFAAS	graphite furnace atomic absorption spectroscopy
GFC	gas filter correlation
GHG	greenhouse gas
HAP	hazardous air pollutant
HC	hydrocarbons
HHV	higher heating value
HPLC	high performance liquid chromatography
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectroscopy
HRSG	heat recovery steam generator
IC	ion chromatography
ICAP	inductively-coupled argon plasmography
ICPCR	ion chromatography with a post-column reactor
IR	infrared radiation
ISO	International Standards Organization
kW	kilowatts
LFG	landfill gas
LHV	lower heating value
LPG	liquified petroleum gas
MACT	maximum achievable control technology
MDI	methylene diphyenyl diisocyanate
MDL	method detection limit
MNOC	maximum normal operating conditions
MRL	method reporting limit
MS	mass spectrometry
NA	not applicable or not available
NCASI	National Council For Air And Steam Improvement
NCG	non-condensable gases
NDIR	non-dispersive infrared
NESHAP	National Emissions Standards For Hazardous Air Pollutants
NG	natural gas
NIOSH	National Institute For Occupational Safety And Health
NIST	National Institute Of Standards And Technology
NMC	non-methane cutter
NMOC	non-methane organic compounds
NMVOC	non-methane volatile organic compounds
NPD	nitrogen phosphorus detector
NSPS	New Source Performance Standards
OSHA	Occupational Safety And Health Administration
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl compounds
PCWP	plywood and composite wood products
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances (PFAS)
PI	photoionization
PID	photoionization detector
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter

MONTROSE AIR QUALITY SERVICES

ACRONYMS

POM	polycyclic organic matter
PS	performance specification
PSD	particle size distribution
PSEL	plant site emission limits
PST	performance specification test
PTE	permanent total enclosure
PTM	performance test method
QA/QC	quality assurance and quality control
QI	Qualified Individual
QSTI	Qualified Source Testing Individual
RA	relative accuracy
RAA	relative accuracy audit
RACT	reasonably available control technology
RATA	relative accuracy test audit
RCTO	rotary concentrator thermal oxidizer
RICE	stationary reciprocating internal combustion engine
RM	reference method
RTO	regenerative thermal oxidizer
SAM	sulfuric acid mist
SCD	sulfur chemiluminescent detector
SCR	selective catalytic reduction system
SD	standard deviation
Semi-VOST	semivolatile organic compounds sample train
SRM	standard reference material
TAP	toxic air pollutant
TBD	to be determined
TCA	thermal conductivity analyzer
TCD	thermal conductivity detector
TGNENMOC	total gaseous non-ethane non-methane organic compounds
TGNMOC	total gaseous non-methane organic compounds
TGOC	total gaseous organic compounds
THC	total hydrocarbons
TIC	tentatively identified compound
TO	thermal oxidizer
TO	toxic organic (as in EPA Method TO-15)
TPM	total particulate matter
TSP	total suspended particulate matter
TTE	temporary total enclosure
ULSD	ultra-low sulfur diesel
UV	ultraviolet radiation range
VE	visible emissions
VOC	volatile organic compounds
VOST	volatile organic sample train
WC	water column
WWTP	waste water treatment plant

CHEMICAL NOMENCLATURE

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
C	carbon
Cd	cadmium
CdS	cadmium sulfide
CH_2O	formaldehyde
CH_3CHO	acetaldehyde
CH_3OH	methanol
CH_4	methane
C_2H_4O	ethylene oxide
C_2H_6	ethane
C_3H_4O	acrolein
C_3H_6O	propionaldehyde
C_3H_8	propane
C_6H_5OH	phenol
Cl_2	chlorine
ClO_2	chlorine dioxide
CO	carbon monoxide
Co	cobalt
CO_2	carbon dioxide
Cr	chromium
Cu	copper
EtO	ethylene oxide
EtOH	ethyl alcohol (ethanol)
H_2	hydrogen
H_2O	water
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
H_2SO_4	sulfuric acid
HCl	hydrogen chloride
Hg	mercury
IPA	isopropyl alcohol
MDI	methylene diphyenyl diisocyanate
MEK	methyl ethyl ketone
MeOH	methanol
Mn	manganese
N_2	nitrogen
NH_3	ammonia
Ni	nickel
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_2	oxygen
P	phosphorus
Pb	lead
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
Sb	antimony
Se	selenium
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_x	sulfur oxides
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TGOC	total gaseous organic concentration
THC	total hydrocarbons
Tl	thallium
TRS	total reduced sulfur compounds
Zn	zinc

Appendix A.2
Accreditation Information/Certifications

STAC
STACK TESTING ACCREDITATION COUNCIL

A2LA

American Association for Laboratory Accreditation

Accredited Air Emission Testing Body

A2LA has accredited

MONTROSE AIR QUALITY SERVICES

In recognition of the successful completion of the joint A2LA and Stack Testing Accreditation Council (STAC) evaluation process, this laboratory is accredited to perform testing activities in compliance with ASTM D7036:2004 - Standard Practice for Competence of Air Emission Testing Bodies.

Presented this 11th day of February 2020.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3925.01
Valid to February 28, 2022

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
CORPORATE SEAL 1978
DISTRICT OF COLUMBIA
A2LA

This accreditation program is not included under the A2LA ILAC Mutual Recognition Arrangement.

Appendix A.3
Air Discharge Permit

SWCAA
Southwest Clean Air Agency

11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
(360) 574-3058
www.swcleanair.org

October 1, 2020

Mr. Mike Davis, Landfill Manager
Clark County Public Health – Solid Waste Services
PO Box 9825
Vancouver, WA 98666-9825

Subject: Final Air Discharge Permit for Replacement Landfill Gas Flare

Dear Mr. Davis:

A final determination to issue Air Discharge Permit 20-3433 (ADP 20-3433) has been completed for Air Discharge Permit (ADP) Application CL-3138 pursuant to Section 400-110(4) of the General Regulations for Air Pollution Sources of the Southwest Clean Air Agency (SWCAA). Public notice for ADP Application CL-3138 was published in the permit section of SWCAA's internet website on August 6, 2020. SWCAA did not receive a request for a public comment period in response to the public notice and has concluded that significant public interest does not exist for this determination. Therefore, a public comment period will not be provided for this permitting action. Electronic copies of ADP 20-3433 and the associated Technical Support Document are available for public review in the permit section of SWCAA's internet website (http://www.swcleanair.org/permits/adpfinal.asp). Original copies are enclosed for your files.

This Air Discharge Permit may be appealed directly to the Pollution Control Hearings Board (PCHB) at P.O. Box 40903, Olympia, Washington 98504-0903 within 30 days of receipt as provided in RCW 43.21B.

If you have any comments, or desire additional information, please contact me or Wess Safford at (360) 574-3058, extension 126.

Sincerely,

Uri Papish
Executive Director

UP:wls
Attachment

SWCAA
Southwest Clean Air Agency

AIR DISCHARGE PERMIT
20-3433

Final Date: October 1, 2020

Facility Name:	Leichner Landfill
Physical Location:	9411 NE 94th Avenue Vancouver, WA 98662
SWCAA ID:	1239

REVIEWED BY: Paul T Mairose

Paul T. Mairose, Chief Engineer

PAUL T. MAIROSE
STATE OF WASHINGTON
21507
REGISTERED
PROFESSIONAL ENGINEER

APPROVED BY:

Uri Papish, Executive Director

TABLE OF CONTENTS

1. Equipment/Activity Identification

ID No.	Generating Equipment/Activity	# of Units	Control Measure/Equipment	# of Units
1	Landfill	1	Enclosed flare (Perennial Energy – 2.7 MMBtu/hr)	1

2. Approval Conditions

The following tables detail the specific requirements of this permit. In addition to the requirements listed below, equipment at this facility may be subject to other federal, state, and local regulations. The permit requirement number is identified in the left-hand column. The text of the permit requirement is contained in the middle column. The emission unit, equipment, or activity to which the permit requirement applies is listed in the right-hand column.

This Permit supersedes Air Discharge Permit 07-2714 in its entirety.

Emission Limits

No.	Emission Limits	Equipment/ Activity
1.	Combined emissions from landfill operation (flare and fugitive) must not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> VOC (as hexane) — 4.14 tpy Annual emissions must be calculated by summing flare and fugitive emissions. Fugitive VOC emissions must be calculated from estimated landfill gas generation, a gas capture efficiency of 75% and emission factors from the Technical Support Document for this Air Discharge Permit.	1
2.	Emissions from the Landfill Gas Flare shall not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> NO_X — 0.060 lb/MMBtu (1-hr avg) 0.72 tpy CO — 0.15 lb/MMBtu (1-hr avg) 1.79 tpy NMOC/VOC (as hexane) — 0.050 lb/MMBtu (1-hr avg) or 98% destruction 0.60 tpy SO_2 — 0.016 lb/MMBtu (1-hr avg) 0.18 tpy Annual emissions must be calculated from actual landfill gas combustion and emission factors from the Technical Support Document for this Air Discharge Permit or more recent source test data if available.	1

No.	Emission Limits	Equipment/ Activity
3.	Visible emissions from the Landfill Gas Flare shall not exceed zero percent opacity for more than 3 minutes in any one-hour period as determined in accordance with SWCAA Method 9 (See Appendix A of SWCAA 400).	1

Operating Limits and Requirements

No.	Operating Limits and Requirements	Equipment/ Activity
4.	Reasonable precautions must be taken at all times to prevent and minimize fugitive emissions from plant operations.	Facilitywide
5.	The permittee must use recognized good practice and procedures to reduce odors to a reasonable minimum.	Facilitywide
6.	Each pollution control device/measure must be in use whenever the associated production equipment is in operation. Control devices must be operated and maintained in accordance with the manufacturer's specifications and operated in a manner that minimizes emissions.	1
7.	Emission units identified in this Permit must be maintained and operated in total and continuous conformity with the conditions identified in this Permit. SWCAA reserves the right to take any and all appropriate action to maintain the conditions of this Permit, including directing the facility to cease operations until corrective action can be completed.	1
8.	Prior to the initial emission test, the Landfill Gas Flare must be operated at a minimum temperature of 1,400°F (1-hr avg). Thereafter, the flare must be operated within the range of operating temperatures (1-hr avg) at which compliance with the permitted emission limits was demonstrated during the most recent source emissions test.	1

Monitoring and Recordkeeping Requirements

No.	Monitoring and Recordkeeping Requirements	Equipment/ Activity
9.	With the exception of data logged by a computerized data acquisition system, each record required by this Permit must include the date and the name of the person making the record entry. If a control device or process is not operating during a specific time period, a record must be made to that effect.	1
10.	All records required by this Permit must be kept for a minimum period of no less than three years and must be maintained in a form readily available for inspection by SWCAA representatives.	1
11.	Excess emissions and upset conditions must be recorded for each occurrence.	1

No.	Monitoring and Recordkeeping Requirements	Equipment/ Activity
12.	The permittee must monitor and record the following information: (a) Quantity of landfill gas burned in the Landfill Gas Flare (scf) — Recorded monthly (b) Landfill Gas Flare operating temperature — Monitored continuously, Recorded daily (c) Methane content of the landfill gas* — Recorded at least once every 12 calendar months (d) Air quality related complaints and results of subsequent investigation or corrective action — Recorded for each occurrence (e) Upset conditions that cause excess emissions — Recorded for each occurrence (f) Maintenance activities that may affect air emissions — Recorded for each occurrence * Methane content must be determined with a portable field instrument that has been calibrated with a gas standard of a known methane concentration onsite prior to monitoring, EPA Method 3C, or other methods approved by SWCAA.	

Emission Monitoring and Testing Requirements

No.	Emission Monitoring and Testing Requirements	Equipment/ Activity
13.	The permittee must conduct initial and periodic emission testing of the Landfill Gas Flare as described in Appendix A of this Permit.	1

Reporting Requirements

No.	Reporting Requirements	Equipment/ Activity
14.	All air quality related complaints received by the permittee must be reported to SWCAA within three days of receipt.	Facilitywide
15.	An annual emissions inventory report must be submitted in accordance with SWCAA 400-105(1). In addition to the emissions information required under SWCAA 400-105(1), each annual report must include an estimate of annual emission quantities for each TAP compound listed in the Technical Support Document for this Permit.	1
16.	Excess emissions must be reported to SWCAA as follows: • As soon as possible, but no later than 12 hours after discovery for emissions that represent a potential threat to human health or safety; • As soon as possible, but no later than 48 hours after discovery for emissions which the permittee wishes to claim as unavoidable pursuant to SWCAA 400-107; and • No later than 30 days after the end of the month of discovery for all other excess emissions.	1

No.	Reporting Requirements	Equipment/ Activity
17.	The following emission-related information must be reported to SWCAA no later than March 15th for the previous calendar year: (a) The total amount of landfill gas burned in the Landfill Gas Flare; (b) The average methane content of the landfill gas burned in the Landfill Gas Flare; and (c) Air emissions of criteria air pollutants, volatile organic compounds, and toxic air pollutants (TAPs).	1
18.	Emission test results must be reported to SWCAA in writing within 45 days of test completion.	1
19.	The permittee shall notify SWCAA in writing within 10 days after completing initial installation of new equipment. This will allow proper inspections and observations to be conducted for the new equipment.	1

3. General Provisions

No.	General Provisions
A.	For the purpose of ensuring compliance with this Permit, duly authorized representatives of the Southwest Clean Air Agency must be permitted access to the permittee's premises and the facilities being constructed, owned, operated and/or maintained by the permittee for the purpose of inspecting said facilities. These inspections are required to determine the status of compliance with this Permit and applicable regulations and to perform or require such tests as may be deemed necessary.
B.	The provisions, terms and conditions of this Permit bind the permittee, its officers, directors, agents, servants, employees, successors and assigns, and all persons, firms, and corporations acting under or for the permittee.
C.	The requirements of this Permit survive any transfer of ownership of the source or any portion thereof.
D.	This Permit must be posted conspicuously at or be readily available near the source.
E.	This Permit will be invalid if construction has not commenced within eighteen (18) months from date of issuance, if construction is discontinued for a period of eighteen (18) months or more, or if construction is not completed within a reasonable time.
F.	This Permit does not supersede requirements of other Agencies with jurisdiction and further, this Permit does not relieve the permittee of any requirements of any other governmental Agency. In addition to this Permit, the permittee may be required to obtain permits or approvals from other agencies with jurisdiction.
G.	Compliance with the terms of this Permit does not relieve the permittee from the responsibility of compliance with SWCAA General Regulations for Air Pollution Sources, previously issued Regulatory Orders, RCW 70.94, Title 173 WAC or any other applicable emission control requirements, nor from the resulting liabilities and/or legal remedies for failure to comply.
H.	If any provision of this Permit is held to be invalid, all unaffected provisions of the Permit will remain in effect and be enforceable.
I.	No change in this Permit will be made or be effective except as may be specifically set forth by written order of the Southwest Clean Air Agency upon written application by the permittee for the relief sought.

No.	General Provisions
J.	The Southwest Clean Air Agency may, in accordance with RCW 70.94 impose such conditions as are reasonably necessary to assure the maintenance of compliance with the terms of this Permit, the Washington Clean Air Act, and the applicable rules and regulations adopted under the Washington Clean Air Act.

Air Discharge Permit 20-3433 - Appendix A
Emission Testing Requirements
Landfill Gas Flare

1. **Introduction:**
The purpose of this testing is to quantify emissions from the Landfill Gas Flare, determine NMOC destruction efficiency in the Landfill Gas Flare, and demonstrate compliance with the requirements of this Permit and applicable air quality regulations.

2. **Testing Requirements:**
   a. **Testing Schedule.** Initial emission testing of the Landfill Gas Flare must be conducted no later than 90 days after commencing regular operation. Subsequent emission testing of the Landfill Gas Flare must be conducted every 5 years thereafter, no later than the end of the calendar month in which the initial emission test was performed. Emission testing conducted more than three months prior to a scheduled due date will not satisfy the periodic source emission testing requirement unless prior written approval is obtained from SWCAA.

   b. **Test Plan.** A comprehensive test plan must be submitted to SWCAA for review and approval at least 10 business days prior to testing. SWCAA personnel must be informed at least 5 business days prior to testing so that a representative may be present during testing.

   c. **Test Runs/Reference Test Methods.** Unless otherwise specified, a minimum of 3 test runs must be conducted at each location for each constituent listed below to ensure the data are representative. Compliance must be demonstrated by averaging the results of the individual sampling runs.

Test location: Flare Outlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2	N/A
O_2, CO_2 content	EPA Method 3 or 3A	N/A
Moisture content	EPA Method 4	60 minutes
SO_2	EPA Method 6, 6C, mass balance	60 minutes
NO_X	EPA Method 7E	60 minutes
Opacity	SWCAA Method 9	10 minutes
CO	EPA Method 10	60 minutes
NMOC	EPA Method 25C	~60 minutes[1]

Test location: Flare Inlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2 or approved inline flowmeter	N/A
O_2, CO_2 content	EPA Method 3 or 3A	60 minutes
Fuel factor, CH_4, CO_2, O_2, N_2	EPA Methods 3C & 19	N/A
NMOC	EPA Method 25C	~60 minutes[1]

[1] A sampling time of approximately 60 minutes must be targeted. This is a grab sample method so establishing a precise collection time may not be practical.

3. **Source Operation:**
   a. **Source Operations.** Source operations during emissions testing must be representative of the most challenging of the intended operating conditions. The Permittee may choose to conduct the testing across a temperature range representative of the intended operating conditions. If this option is chosen, at least one sampling run must be conducted at the maximum and operating temperature, and at least one sampling run must be conducted at the minimum operating temperature.

   b. **Record of Production Parameters.** Production related parameters and equipment operating conditions must be recorded during emissions testing to correlate operating conditions with emissions. All recorded production parameters must be documented in the test results report. At a minimum, the following parameters must be recorded:
      (1) Landfill gas consumption rate,
      (2) Average flare temperature during each emission test as measured by the permanent flare temperature monitoring device,
      (3) Flare temperature setpoint during each emission test, and
      (4) Startup and shutdown events.

4. **Reporting Requirements:**
   a. **Test Report.** A final emission test report must be prepared and submitted to SWCAA within 45 calendar days of test completion. Test reports must be provided in hard copy (paper) and an electronic format acceptable to SWCAA. Each test report must include, at a minimum, the following information:
      (1) Description of the source including manufacturer, model number and design capacity of the equipment, and the location of the sample ports or test locations,
      (2) Time and date of the test and identification and qualifications of the personnel involved, including SWCAA personnel who observed the testing,
      (3) Summary of results, reported in units and averaging periods consistent with the applicable emissions standard or unit,
      (4) Summary of control system or equipment operating conditions,
      (5) Summary of production related parameters cited in Section 3,
      (6) A description of the test methods or procedures used including all field data, quality assurance/quality control procedures and documentation,
      (7) A description of the analytical procedures used including all laboratory data, quality assurance/quality control procedures and documentation,
      (8) Copies of field data and example calculations,
      (9) Chain of custody information,
      (10) Calibration documentation,
      (11) Discussion of any abnormalities associated with the results, and
      (12) A statement signed by the senior management official of the testing firm certifying the validity of the source test report.

5. **Changes to Testing Requirements:**
   The source test must be conducted as specified in the sections above. The Permittee may submit a written request to SWCAA for approval of minor modifications to the requirements above or the testing schedule. Upon review of the request and in accordance with EPA delegation, SWCAA will inform the Permittee in writing of any approved modifications.

11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
(360) 574-3058
www.swcleanair.org

State Environmental Policy Act

DETERMINATION OF SEPA EXEMPT - SWCAA 20-036

Description of proposal:

ADP Application CL-3138: Installation of a replacement landfill gas flare. Proponent proposes to replace an existing landfill gas flare with a new flare of smaller capacity and similar design. No other changes or installations are proposed. This project is exempt from SEPA requirements pursuant to WAC 197-11-800(3) since it only involves repair, remodeling, maintenance, or minor alteration of existing structures, equipment or facilities, and does not involve material expansions or changes in use.

Proponent: Leichner Landfill (Mike Davis, Landfill Manager)

Location of proposal, including street address if any:
9411 NE 94th Avenue, Vancouver, WA 98662

Lead agency: Southwest Clean Air Agency

The lead agency for this proposal has determined that the proposed project is exempt from SEPA under WAC 197-11-800(3) as follows: "The repair, remodeling, maintenance, or minor alteration of existing private or public structures, facilities or equipment, including utilities, recreation, and transportation facilities involving no material expansions or changes in use beyond that previously existing; ..." .The proposed project is identified as maintenance of existing equipment and as such it does not have a probable significant impact on the environment. Neither an environmental checklist nor an environmental impact statement (EIS) is required under RCW 43.21C.030(2)(c). This decision was made by the lead agency after review of the proponent's proposal and the information on file with the lead agency. This information is available to the public on request.

☒ **This project/permitting action by SWCAA is SEPA exempt.**

Responsible official: Paul T. Mairose, P.E.
Position/title: Chief Engineer

Address: Southwest Clean Air Agency
11815 NE 99th St, Suite 1294
Vancouver, WA 98682-2322
Phone: (360) 574-3058, ext 130

Signature: Paul T Mairose

Date: 10/1/2020

APPENDIX "S"
FIELD WORK SAFETY PLAN

MONTROSE
AIR QUALITY SERVICES

SITE SAFETY PLAN BOOKLET

Project: 021AS-2687

Customer: Leichner Landfill

Location: Vancouver, WA

Units: Landfill Flare

Client Project Manager: Peter Becker

Revision Date: December 2, 2019

Site Safety Plan and JHA Purpose and Instructions

Purpose

Employee safety is the top priority of Montrose Environmental Group. All employees must be trained to assess and mitigate hazards. The District Manager and Project Manager are responsible to ensure all hazards have been properly identified and managed. All employees have Stop Work Authority in all situations where an employee feels they or their co-worker cannot perform a job safely or if there is a task for which they have not been adequately trained.

The Site Safety Plan (SSP) has been developed to help assist Montrose test crews with identifying physical and health hazards and determining how the hazards will be managed. Additionally, the SSP will help each crew manage the safety of the employees by providing emergency procedures and information. The booklet contains a several safety forms that may be required in the field.

Instructions

The SSP consists of the following:

1. A Pre-Mobilization Test Plan – To be completed in it's entirety by the client project Manager prior to the test.

2. A Job Hazard Analysis is a standardized, two-page, fillable form that is used to evaluated the task/site's particular hazards and controls. The form also includes a daily toolbox topic and daily hazard review with sign off by the team. The client Project Manager is responsible to complete the JHA form through section 8. Upon arrival at the test site, the team will review the form for accuracy, making any corrections required and complete the remainder of the JHA. Section 9 will require at least three tasks, hazards and controls be identified for the project. Each team member has the option to discuss making changes or adding to the JHA and must sign on the Job Hazard Analysis form in agreement and sign in Section 10. The JHA is to be modified when conditions change. A toolbox meeting with a daily topic in addition to a review of the hazard analysis is required daily for the duration of the test. An additional sheet of paper with the toolbox topic and signatures can be added to the SSP packet.

3. Hazard Control Matrix - contains useful information on both engineering and administrative controls that a crew can use to reduce or eliminate the hazards they have observed plus applicable PPE that may be required.

4. Additional Forms, as applicable

    a. Aerial Lift Inspection Form

    b. Heat Stress Prevention Form Based on Heat Index

    c. Extended Hours Form

The SSP is a living document. The Project Manager should continually update their SSPs as new information and conditions change or if new hazards are presented.

Each completed SSP should be maintained with the Test Plan in the office for a period of 3 years. There will be an audit process developed for the Site Safety Plans.

PRE-MOBILIZATION TEST INFORMATION

PROJECT NAME/LOCATION: Leichner Landfill PROJECT #: ____________

TEST DATE: ____________ PROJECT MANAGER: Peter Becker

TEST SCOPE: ____________

SITE CONTACT: Name: ____________ Contact Phone: ____________

Source Type: New Source: ____ Revisit: ____ Prj#/Date/Tech: ____________

Coal Fired Electric Utility: ____ Ethanol Plant: ____ Chemical Mfg. of ____________

Cement/Lime Kiln Plant: ____ Specialty Mfg. of: ____________ Other: ____________

Anticipated Effluent Composition – check all that apply and fill in expected concentration in ppm/%

☐ CO ☐ NO_X ☐ SO_2 ☐ VOC ☐ other

If other, explain: ____________

Flammable: ________ **Toxic:** ________ **Corrosive:** ________ **Dust:** ________

Engineering Controls to be Implemented:

____

____

Additional Safety Equipment Required:

Personal gas monitors: ____

Respiratory Protection:

Half Face____ Full Face____ HEPA Filters____ Supplied Air: _____ (Safety Dept. Approval)

Approximate Flue Gas Temperatures, (F)

☐ below 210 ☐ 210 to 450 ☐ 450 to 950 ☐ above 950 ☐ other

If other, explain: ____________

Approximate Duct Pressure, (iwg):

☐ below -3 ☐ -3 to +3 ☐ +3 to +7 ☐ above +7 ☐ other

If other, explain: ____________

MONTROSE AIR QUALITY SERVICES

PRE-MOBILIZATION TEST INFORMATION

Sampling Location: **Stack Port ____** **Duct Port ____**

Approximate Sampling Platform Height, (ft)

☐ below 6 ☐ 6 to 50 ☐ 50 to 100 ☐ above 100 ☐ other

If other, explain: ____

Access and Protection:

Elevators: ____ Ladders: ____ Aerial Lift: ____ Scaffold: ____ Equipment Hoist: ____

Guardrails: ____ Toe plate: ____ Engineered Tie Off Points: ____ Heat Shield: ____

Other:____

Describe how equipment will be mobilized to the sampling location:

____

____

Additional Information:

____

____

Effluent Chemical Regulatory Limits

Gas Name	Chemical Formula	Cal OSHA PEL[1] (ppm)	Cal OSHA STEL[2] (ppm)	NIOSH REL TWA[3] (ppm)	Cal OSHA Ceiling (ppm)	IDLH[4] (ppm)
Carbon Monoxide	CO	25	200	35	200	1,200
Nitric Oxide	NO_x	25	ND[5]	25	ND	100
Sulfur Dioxide	SO_2	2	5	2	ND	100
Hydrogen Chloride	HCl	0.3	2	ND	2	50
Hydrogen Sulfide	H_2S	10	15	10 (10 min.)[C]	50	100

California Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) based on an 8-hour shift;
2: Cal OSHA Short-term Exposure Limit (STEL) based on a 15-minute period;
3: National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) Time-weighted Average (TWA) based on an 8-hour shift;
4: Immediately Dangerous to Life or Health (IDLH);
5: Not Defined (ND);
C: Ceiling Limit - Maximum allowable human exposure limit for an airborne or gaseous substance, which is not to be exceeded, even momentarily.

Prepared by: ______________________________ Date: ________________

Reviewed by: ______________________________ Date: ________________

Job Hazard Analysis

1.

Client		Contact Name		Date	
Facility		SSP Writer		PM	
Client Rep					

Job Preparation

- ☐ Job Site Walk Through Completed
- ☐ Site Specific Training Complete
- ☐ Safe Work Permit Received from Client

All hazards and mitigation steps must be documented. If this JHA does not cover all the hazards identified, use Section 9 to document that information.

If the heat index is expected to be above 91°, fill out the Heat Stress Prevention Form.

2. Facility Information/Emergency Preparedness

If non-emergency medical attention is needed, call: AXIOM #: 877-502-9466.

Plant Emergency # ____________ Certified First Aid Person: ____________

EMS Location | Evacuation Routes | Rally Point

Severe Weather Shelter Location | Eye Wash & Safety Shower Location

Operational: ☐ Yes ☐ No

Source Information: (list type): ____________

Stack Gas Temp. (°F) ______ Stack Gas Press. ("H_2O) ______ Stack Gas Components: ____________

Stack Gas Inhalation Potential? ☐ Yes ☐ No If yes, see List of Hazard Chemicals.

3. Error Risk

☐ Time Pressure	☐ Remote Work Location	☐ > 12 hr shift	☐ Working > 8 consecutive days
☐ Lack of procedures	☐ Extreme temps, wind >30mph	☐ Personal illness/fatigue	☐ Vague work guidance
☐ Monotonous Activity	☐ First day back after time off	☐ Multiple job locations	☐ Other:

4.

Physical Hazards	**Hazard Controls**
Dust Hazards	☐ Dust Mask ☐ Goggles ☐ Other: ____________
Thermal Burn	☐ Hot Gloves ☐ Heat Shields ☐ Other Protective Clothing: ____________
Electrical Hazards	☐ Connections Protected from Elements ☐ External GFCI ☐ Other: ____________ ☐ XP Rating Requirement ☐ Intrinsically Safe Requirement
Inadequate Lighting	☐ Install Temporary Lighting ☐ Headlamps
Slip and Trip	☐ Housekeeping ☐ Barricade Area ☐ Other: ____________
Hand Protection	☐ Cut Resistant Gloves ☐ Pinch Pts. ☐ General ☐ Electrical ☐ Impact Resistant ☐ Other: ____________

Potential Hazards for Consideration

Secondary Permits	☐ Hot Work ☐ Confined Space ☐ Excavation
Working from Heights **See also Sect. 7**	☐ Falling objects ☐ Fall protection ☐ Drop zone protection ☐ Platform load ratings ☐ Scaffold inspection ☐ Ladder inspection ☐ Barricades for equipment
Electrical	☐ Exposed wire/connector ☐ Verify equipment grounding ☐ Arc Flash
Lifting	☐ Crane lift plan ☐ Rigging inspection ☐ Tag lines used ☐ Hoists in place
Respiratory **See also Sect. 8**	☐ Unexpected exposure ☐ Chemical ☐ Dust (combustible) ☐ PEL provided ☐ Cartridges or supplied air available ☐ Gas detection equipment

5. Required PPE

☐ Hard Hats	☐ Safety Glasses	☐ Safety Toe Shoe/Boot	☐ Hearing Protection	☐ Safety Spotter
☐ Hi-Vis Vests	☐ Harness/Lanyard*	☐ Goggles	☐ Personal Monitor Type: ____________	
☐ Metatarsal Guards	☐ Hot Gloves	☐ Face Shield	☐ Respirator Type: ____________	
☐ Nomex/FRC	☐ Other PPE:			

Additional Work Place Hazards

6. **Critical Procedures** – check all that apply – *indicates additional form must be completed or collected from client

☐ Heat Stress Prevention* ☐ Confined Space* ☐ Aerial Work Platform* ☐ Roof Work ☐ Scaffold
☐ Cold Weather Work ☐ Hazardous Energy Control* ☐ Exposure Monitoring ☐ Other: ______

7. **Working From Heights**

Fall Protection	☐ Fixed Guardrails/Toe boards ☐ Fall Prevention PPE Warning Line System
Falling Objects Protection	☐ Barricading ☐ Netting ☐ House Keeping ☐ Tethered Tools ☐ Catch Blanket or Tarp
Fall Hazard Communication	☐ Adjacent/Overhead Workers ☐ Contractor Contact ☐ Client Contact

8. **Other Considerations**

Environmental Hazards - Weather Forecast

☐ Heat/Cold ☐ Lightning ☐ Rain ☐ Snow ☐ Ice ☐ Tornado ☐ Wind Speed

Steps for Mitigation:

Electrical Safety Planning

Plant Hook up: ☐ 110V ☐ 220/240V ☐ 480V ☐ Generator ☐ Hard wired into panel
Electrical Classified Area: ☐ Yes ☐ No Trailer Grounded: ☐ Yes ☐ No Plug Type ______
Electrical Hook Up Responsibility: ______

List of Hazardous Chemicals

☐ Acetone ☐ Nitric Acid ☐ Hydrogen Peroxide ☐ Compressed Gases
☐ Hexane ☐ Sulfuric Acid ☐ Isopropyl Alcohol ☐ Flammable Gas
☐ Toluene ☐ Hydrochloric Acid ☐ Liquid Nitrogen ☐ Non-Flammable Gas
☐ H2S ☐ Carbon Monoxide ______ ______

Other Chemicals: ______ ______ ______ ______

Steps for Mitigation:

Wildlife/Fauna in Area

☐ Poison Ivy ☐ Poison Oak ☐ Insects: ______ ☐ Wildlife: ______

Personnel w/ known allergies to bees stings or other allergens? ☐ Yes ______ ☐ No

9. **Observed Hazards and Mitigation Steps**

Task	Potential Hazard(s)	Steps for Mitigation
•	1	1
	2	2
	3	3
•	1	1
	2	2
	3	3
•	1	1
	2	2
	3	3
•	1	1
	2	2
	3	3

10. **JHA REVIEW: Crew Names & Signatures**

Printed Name	Signature	Date	Printed Name	Signature	Date

11. **Daily JHA Meeting & Review**

Items to review:

- Change in conditions
- New workers or contractors
- Extended work hours
- Occurrence of near misses or injuries
- Daily Safety Topic

Initialing demonstrates that site conditions and hazards have not changed from the original SSP. If changes did occur, make the necessary updates to this JHA and add notes as applicable in Section 9.

Day	Discussion Topic	Initials
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Daily Aerial Lift Inspection Form

All checks must be completed prior to each work shift, before operation of the aerial lift. This checklist must be used at the beginning of each shift or following 6 to 8 hours of use.

Aerial Lift Model #:	**Serial Number:**
Make:	**Rented or Owned:**

- Check "Yes" if an item is adequate, operational, and safe.
- Check "No" to indicate that a repair or other corrective action is required prior to use.
- Check "N/A" to indicate "Not Applicable."

Items to be Inspected	Yes	No	N/A
1. All aerial lift components are in working condition (i.e. no loose or missing parts, torn or loose hoses, etc.) – if something can be easily loosened by hand then it is not sufficient.	☐	☐	☐
2. Hydraulic fluid level is sufficient, with the platform fully lowered	☐	☐	☐
3. Hydraulic system pressure (see manufacturer specs) is acceptable. If the pressure is low, determine cause and repair in accordance with accepted procedures as outlined in service manual.	☐	☐	☐
4. Tires and wheel lug nuts (for tightness)	☐	☐	☐
5. Hoses and cables (i.e. worn areas or chafing)	☐	☐	☐
6. Platform rails and safety gate (no damage present)	☐	☐	☐
7. Pivot pins secure	☐	☐	☐
8. Welds are not cracked and structural members are not bent or broken	☐	☐	☐
9. Warning and instructional labels are legible and secure, and load capacity is clearly marked.	☐	☐	☐
10. Manufacturer's Instruction Manual is present inside the bucket	☐	☐	☐
11. Base controls (switches and push buttons) can be properly operated	☐	☐	☐
12. Platform conditions are safe (i.e. not slippery)	☐	☐	☐
13. Fire extinguisher is present, mounted and fully charged, located inside the bucket	☐	☐	☐
14. Headlights, safety strobe light and back-up alarm are functional	☐	☐	☐
15. Workplace is free of hazards (overhead powerlines, obstructions, level surface, high winds, etc.) ***Do not operate if winds are 20 mph, unless otherwise specified by manufacturer recommendations.**	☐	☐	☐

Operator Name & Signature   Location   Date

Ground Control Name & Signature   Location   Date

Harness Inspections:

Printed Name   Signature   Date

Printed Name   Signature   Date

Printed Name   Signature   Date

Extended Hours Safety Audit

Project Number: ____________________ Date: ____________ Time: __________________

When a project is expected to extend past a 14-hour work day, this form must be completed to evaluate the condition of the crew, and the safety of the work environment.

Permission to proceed into extended work hours must come from a District Manager (DM) or Regional Vice President (RVP). Technical RVPs can authorize moving forward, if they are in the field or if they are managing the project.

1. Hold test crew meeting **Test crew initials:** ______________________________

The test leader should look for signs of the following in their crews:

• Irritability • Lack of motivation • Headaches • Giddiness	• Fatigue • Depression • Reduced alertness, lack of concentration and memory

The test leader should assess the environmental and hazardous concerns:

• Temperature and weather • Lighting • Working from Heights	• Hoisting • PPE (i.e. respirators, etc.) • Pollutant concentration in ambient air (SO_2, H_2S, ect.)

2. Notify DM or RVP

The PM must contact either the DM or RVP to discuss the safety issues that may arise due to the extended work period. During this time, they can come to an agreement on how to proceed. Items to discuss include:

- Reason for extended hours
- Reason for delay
- Production limitations
- Impending Weather

3. Contact the client

The PM, DM or RVP must discuss with client any identified safety concerns, the client's needs and mutually agree on how to proceed. Discussion should also include the appropriate rest period needed before the next day's work shift can begin. The DM and/or a RVP must be informed on the final decision.

Final Outcome:	
Approver:	

THIS IS THE LAST PAGE OF THIS DOCUMENT

If you have any questions, please contact one of the following individuals by email or phone.

Name: Mr. Peter Becker
Title: Client Project Manager
Region: West
Email: pbecker@montrose-env.com
Phone: 330-285-6884

Name: Ms. Kristina Schafer
Title: PNW Hub District Manager
Region: West
Email: kschafer@montrose-env.com
Phone: 253-480-3801

Appendix H

Source Test Results

SOURCE TEST REPORT
2020 COMPLIANCE TESTING
LEICHNER LANDFILL
LANDFILL GAS FLARE
VANCOUVER, WASHINGTON

Prepared For:

Leichner Landfill
9411 NE 94th Avenue
Vancouver, WA 98662

For Submittal To:

Southwest Clean Air Agency
11815 NE 99th St. Suite 1294
Vancouver, WA 98682-2322

Prepared By:

Montrose Air Quality Services, LLC
4150 B Place NW, Suite 106
Auburn, WA 98001

Document Number:	**W021AS-005198-RT-1281**
Test Dates:	**December 9-10, 2020**
Submittal Date:	**January 21, 2021**

STAC STACK TESTING ACCREDITATION COUNCIL

A2LA ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

MONTROSE AIR QUALITY SERVICES

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: Peter Becker Date: 01 / 21 / 2021

Name: Peter Becker Title: Client Project Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: Andy Vella Date: 01 / 21 / 2021

Name: Andy Vella Title: Reporting/ QC Manager

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Leichner Landfill (Leichner) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test program on the Landfill Gas Flare at the landfill facility located in Vancouver, Washington. The tests were conducted to determine compliance with the emission limits listed in permit number 20-3433 issued by Southwest Clean Air Agency (SWCAA).

The specific objectives were to:

- Measure concentrations of NMOC and LFG components at the inlet of the flare
- Measure emissions of CO, NO_X, SO_2, NMOC, and VE at the outlet of the flare
- Perform the above testing at two conditions
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

TABLE 1-1
SUMMARY OF TEST PROGRAM

Test Dates	Unit ID/ Source Name	Activity/ Parameters	Test Methods	No. of Runs	Duration (Minutes)
12/9-12/10, 2020	Flare Outlet	Velocity/Vol. Flow Rate/Temperature	EPA 1 & 2	6	~10
""	Flare Outlet	O_2, CO_2	EPA 3A	6	60
""	Flare Inlet	CH_4, CO_2, O_2, N_2	EPA 3C	6	60
""	Flare Outlet	Moisture	EPA 4	6	60
""	Flare Outlet	SO_2	EPA 6C	6	60
""	Flare Outlet	NO_x	EPA 7E	6	60
""	Flare Outlet	Opacity	SWCAA 9	6	6
""	Flare Outlet	CO	EPA 10	6	60
""	Flare Inlet	Fuel Factor & Heating Value	EPA 19	6	na
""	Flare Inlet & Outlet	NMOC	EPA 25C	6	60
""	Flare Outlet	Post-test thermocouple calibration check	EPA ALT-011	--	--

To simplify this report, a list of Units and Abbreviations is included in Appendix D.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Table 1-2. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The testing was conducted by the Montrose personnel listed in Table 1-3. The tests were conducted according to the test plan (protocol) dated November 20, 2020 that was submitted to the SWCAA.

TABLE 1-2
SUMMARY OF AVERAGE COMPLIANCE RESULTS -
LANDFILL GAS FLARE OUTLET
DECEMBER 9-10, 2020

Parameter/Units	Condition 1	Condition 2	Emission Limits[1]
Sulfur Dioxide (SO_2)			
ppmvd	< 0.55	< 0.55	--
lb/hr	< 0.0062	< 0.0073	--
ton/yr[2]	< 0.027	< 0.032	0.18
lb/MMBtu	< 0.0024	< 0.0029	0.016
Nitrogen Oxides (NO_x as NO_2)			
ppmvd	19	16	--
lb/hr	0.15	0.15	--
ton/yr[2]	0.68	0.66	0.72
lb/MMBtu	0.060	0.059	0.060
Carbon Monoxide (CO)			
ppmvd	1.8	3.7	--
lb/hr	0.0089	0.022	--
ton/yr[2]	0.039	0.095	1.79
lb/MMBtu	0.0035	0.0085	0.15
Total Non-Methane Hydrocarbons (NMOC), as Hexane[3]			
ppmvd	< 1.1	< 1.0	--
lb/hr	< 0.017	< 0.018	--
ton/yr[2]	< 0.072	< 0.078	0.60
lb/MMBtu	< 0.0065	< 0.0070	0.050
% DE	> 80	> 77	98
Visible Emissions			
% opacity	0	0	0[4]

1 Permit No. 20-3433
2 Assumes 8760 hr/yr and 2000 lb/ton.
3 The limit for NMOC/VOC as hexane is 0.050 lb/MMBtu OR 98% destruction efficiency
4 Visible emission from the landfill gas flare shall not exceed zero percent opacity for more than three minutes in any one-hour period. There were no readings above zero.

1.2 KEY PERSONNEL

A list of project participants is included below:

Facility Information

Source Location:	Leichner Landfill 9411 NE 94th Avenue Vancouver, WA 98662
Project Contact:	Mike Davis
Role:	Solid Waste Operations Specialist
Company:	Leichner Landfill
Telephone:	564-397-7343
Email:	Mike.Davis@clark.wa.gov

Agency Information

Regulatory Agency:	Southwest Clean Air Agency
Agency Contact:	Gerald Strawn
Telephone:	360-574-3058 x113
Email:	gerry@swcleanair.org

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC	
Contact:	Peter Becker	Kristina Schafer
Title:	Client Project Manager	PNW Hub District Manager
Telephone:	330-285-6884	253-480-3801
Email:	pbecker@montrose-env.com	kschafer@montrose-env.com

Laboratory Information

Laboratory:	Atmospheric Analysis and Consulting
City, State:	Ventura, CA
Method:	EPA Methods 3C and 25C

Subcontractor (or Consultant) Information

Company:	SCS Engineers
Contact:	Alexa Deep, EIT
Telephone:	425-289-5441
Email:	adeep@scsengineers.com

Test personnel and observers are summarized in Table 1-3.

TABLE 1-3
TEST PERSONNEL AND OBSERVERS

Name	Affiliation	Role/Responsibility
Peter Becker	Montrose	Project Manager/Field Team Leader/Qualified Individual (QI)/Trailer operator/Sample recovery/Visible Emissions
Austin Goracke	Montrose	Sample train operator
Duncan Hume	Montrose	Sample train operator
Mike Wallace	Montrose	Calculations and report preparation
Mike Davis	Leichner Landfill	Observer/Client Liaison/Test Coordinator
Alexa Deep	SCS Engineers	Consultant
Gerald Strawn	SWCAA	Agency Contact

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS DESCRIPTION, OPERATION, AND CONTROL EQUIPMENT

The Leichner Landfill flare is an enclosed style landfill gas (LFG) flare manufactured by Perennial Energy, Inc. with a rated maximum capacity of 2.7 MMBtu/hr (i.e., 90 scfm at 50 percent methane) with a turndown capability of 10 to 1. This flare has been installed to replace the existing enclosed flare to accommodate current and future declining LFG generation and recovery rates.

The LFG extraction plant (blowers) provides the driving force or vacuum to the gas conveyance system and extraction network (gas wells), and pulls the LFG from the refuse to the blowers. The LFG enters a moisture separator vessel (i.e., knockout pot or scrubber) upstream of the blowers where excess moisture is removed from the gas stream. Landfill gas exits the moisture separator and enters the regenerative style blowers, which push the LFG to the enclosed flare at a low inlet pressure of 10 inches of water column. The enclosed flare uses the LFG for combustion fuel and controls the combustion temperature with quench air from automated louvers responding to a feedback loop from thermocouples mounted inside of the flare stack.

2.2 FLUE GAS SAMPLING LOCATIONS

Information regarding the sampling locations is presented in Table 2-1.

TABLE 2-1
SAMPLING LOCATIONS

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance		Number of Traverse Points
		Downstream EPA "B" (in./dia.)	Upstream EPA "A" (in./dia.)	
Flare Outlet	D = 30.5 (circular stack)	252 / 8.3	20 / 0.66	Flow: 16 (8/port); Gaseous: 12 (6/port)

Notes: Stack inside diameter is measured from both ports.

The inlet to the flare is a horizontal, cylindrical duct that runs near ground level into a flame arrester and then into the bottom section of the flare. The inlet samples were taken from a valve at the base of the stack near a flowmeter. The flare that was tested during this source test is a newly installed flare with a stack diameter that is different than was measured on the old flare tested in 2017.

Sample locations were verified in the field to conform to EPA Method 1. Acceptable cyclonic flow conditions were confirmed prior to testing using EPA Method 1, Section 11.4. See Appendix A.1 for more information.

2.3 OPERATING CONDITIONS AND PROCESS DATA

Emission tests were performed while the unit was operating across a temperature range that was representative of the intended operating conditions. Testing was conducted at two different temperature (flare set point) conditions: 1475°F and 1300°F. These temperature represent the maximum and minimum intended operating conditions.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The process data that was provided is presented in Appendix B. Data collected includes the following parameters:

- Landfill gas consumption rate
- Average flare temperature as measured by the permanent flare temperature monitoring device
- Flare temperature setpoint during each emission test

2.4 PROCESS DATA CALCULATIONS

The process data listed in Section 2.3 is presented in Appendix B, but was not used for calculations. Calculation of annual emissions assumed constant operation (8,760 hours per year).

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 TEST METHODS

The test methods for this test program were presented previously in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - N/A
- Method Exceptions:
  - N/A

The sample port and traverse point locations are detailed in Appendix A.

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - S-type pitot tube coefficient is 0.84
  - Shortridge multimeter is used to measure velocity
- Method Exceptions:
  - N/A

3.1.3 EPA Methods 3A, 6C, 7E, and 10, Determination of Oxygen, Carbon Dioxide, Sulfur Dioxide, Nitrogen Oxides, and Carbon Monoxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedures)

Concentrations of O_2, CO_2, SO_2, NO_x, and CO are measured simultaneously using EPA Methods 3A, 6C, 7E, and 10, which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - No filter is used since low PM is expected
  - A dry extractive sampling system is used to report emissions on a dry basis
  - A paramagnetic analyzer is used to measure O_2
  - A nondispersive infrared analyzer is used to measure CO_2
  - An ultraviolet absorption analyzer is used to measure SO_2
  - A chemiluminescent analyzer is used to measure NO_x
  - A gas filter correlation nondispersive infrared analyzer is used to measure CO
  - Calibration span values are 20.93% O_2, 18.55% CO_2, 27.52 ppmvd SO_2, 56.2 ppmvd NO_x, and 9.919 ppmvd CO
- Method Exceptions:
  - For gaseous emissions sampling, MDL are calculated for each analyzer. The ISDL is equal to the sensitivity of the instrumentation, which is 2% of the span value.
- Minimum Required Sample Duration: 60 minutes

3.1.4 EPA Method 3C, Determination of Carbon Dioxide, Methane, Nitrogen, and Oxygen from Stationary Sources

EPA Method 3C is a manual method used to measure O_2, CO_2, CH_4, and N_2 concentrations. EPA Method 3C is used to calculate the molecular weight of the stack gas from municipal solid waste landfills and other sources when specified in an applicable subpart. Samples are collected for percent-level measurements of the concentration of O_2, CO_2, CH_4, and N_2 in the stack gas. A portion of the sample is injected into a gas chromatograph (GC) and the O_2, CO_2, CH_4, and N_2 concentrations are determined using a thermal conductivity detector (TCD) and integrator.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Peak height may be used instead of peak area throughout this method
- Method Exceptions:
  - N/A
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, CA

3.1.5 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Condensed water is measured gravimetrically
  - Since it is theoretically impossible for measured moisture to be higher than psychrometric moisture, the psychrometric moisture is also calculated, and the lower moisture value is used in the calculations
- Method Exceptions:
  - Moisture sampling is performed as a stand-alone method at a single point in the centroid of the stack
- Minimum Required Sample Duration: 60 minutes
- Minimum Required Sample Volume: 21 scf

3.1.6 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is a manual method used to determine (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions. This method provides data reduction procedures, but does not include any sample collection or analysis procedures.

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - F factor is calculated from composition data collected on the test day and analyzed by EPA Method 3C
  - The flow rate of the inlet gas to the flare was metered, recorded during testing, and determined per EPA Method 19 from the measured exhaust flow rate, the exhaust oxygen concentration, the higher heating value, and the F-factor determined from the landfill gas analysis
- Method Exceptions:
  - N/A

3.1.7 EPA Method 25C, Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases

A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Pilot probe procedures for sample probe installation were followed
- Method Exceptions:
  - Options
- Target Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, CA

3.1.8 SWCAA Method 9, Determination of the Opacity of Emissions

SWCAA Method 9 is used to observe the visual opacity of emissions (opacity). The observer stands at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to their back. The line of vision is perpendicular to the plume direction and does not include more than one plume diameter. Observations are recorded at 15-second intervals and are made to the nearest 5% opacity. The opacity standard is exceeded if there is a three-minute period during any 60-minute period for which an opacity greater than the standard is recorded. Alternatively, if 13 readings in a 1-hour period or less exceed the established opacity limit, the limit is exceeded. The qualified observer is certified according to the requirements of EPA Method 9, section 3.1.

- Method Options:
  - NA

3.1.9 EPA Method ALT-011, Alternative Method 2 Thermocouple Calibration

EPA Approved Alternative Method 011 (ALT-011) is used as an alternative to the EPA Method 2 two-point thermocouple calibration. This procedure involves a single-point in-field check using a reference thermometer to confirm that the thermocouple system is operating properly. The temperatures of the thermocouple and reference thermometers shall agree to within ±2 °F.

3.2 PROCESS TEST METHODS

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 TEST DISCUSSION AND RESULTS

4.1 FIELD TEST DEVIATIONS AND EXCEPTIONS

No field deviations or exceptions from the test plan or test methods occurred during this test program.

4.2 PRESENTATION OF RESULTS

The average results are compared to the permit limits in Table 1-2. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-4. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

During Run 2, condition 1, the EPA 25C/3C tank fill was paused at 11:07, and resumed at 11:11. This pause was caused by the team believing that the process went down. They stopped to check and found the process was not down so they continued testing.

During Run 1, condition 2, the EPA Method 4 test was paused at 8:30, and resumed at 8:33. This pause was also about checking the process.

All the SO_2 results were below 2% of the span value (0.55 ppmv). The results are reported at the 2% of span value.

All the outlet NMOC results were non-detects and are reported at the sample reporting limit (SRL) provided by the lab.

TABLE 4-1
INLET NMOC EMISSIONS RESULTS -
LANDFILL GAS FLARE – CONDITION 1

Run Number	1	2	3	Average
Date	12/9/2020	12/9/2020	12/9/2020	--
Time	0830-0933	1100-1203	1246-1347	--
Process Data				
LFG flow rate, scfm	71.0	70.5	71.3	70.9
Flare temperature, °F	1,476	1,483	1,467	1,475
Flare set-point, °F	1,475	1,475	1,475	1,475
Flue Gas Parameters				
O_2, % volume dry	1.3	1.1	1.1	1.2
CO_2, % volume dry	22.2	22.5	22.3	22.3
N_2, % volume dry	29.1	28.4	26.6	28.0
CH_4, % volume dry	47.4	48.1	50.0	48.5
CO, % volume dry	< 0.2	< 0.1	< 0.1	< 0.1
H_2, % volume dry	< 1.5	< 1.5	< 1.5	< 1.5
HHV, Btu/scf	471.7	478.2	497.6	482.5
F_d, dscf/MMBtu	9,598	9,591	9,514	9,568
LFG flow rate, scfm (Calc)	89.0	90.1	87.0	88.7
Inlet Non-Methane Organic Compounds, as Hexane (NMOC)				
ppmvd	67.5	71.3	75.0	71.3
lb/hr	0.081	0.086	0.088	0.085

TABLE 4-2
OUTLET SO_2, NO_X, CO, AND NMOC EMISSIONS RESULTS -
LANDFILL GAS FLARE – CONDITION 1

Run Number	1	2	3	Average
Date	12/9/2020	12/9/2020	12/9/2020	--
Time	0830-0933	1100-1203	1246-1347	--
Process Data				
LFG flow rate, scfm	71.0	70.5	71.3	70.9
Flare temperature, °F	1,476	1,483	1,467	1,475
Flare set-point, °F	1,475	1,475	1,475	1,475
Flue Gas Parameters				
O_2, % volume dry	13.4	13.3	13.4	13.4
CO_2, % volume dry	5.7	5.8	5.6	5.7
flue gas temperature, °F	1,356	1,313	1,325	1,331
moisture content, % volume	8.7	6.9	7.0	7.5
volumetric flow rate, dscfm	1,117	1,138	1,144	1,133
Sulfur Dioxide (SO_2)				
ppmvd	< 0.55	< 0.55	< 0.55	< 0.55
lb/hr	< 0.0061	< 0.0062	< 0.0062	< 0.0062
tons/yr	< 0.027	< 0.027	< 0.027	< 0.027
lb/MMBtu	< 0.0024	< 0.0024	< 0.0024	< 0.0024
Nitrogen Oxides (NO_x as NO_2)				
ppmvd	19.1	19.4	18.7	19.1
lb/hr	0.15	0.16	0.15	0.15
tons/yr	0.67	0.69	0.67	0.68
lb/MMBtu	0.061	0.061	0.059	0.060
Carbon Monoxide (CO)				
ppmvd	2.5	1.5	1.4	1.8
lb/hr	0.0124	0.0076	0.0068	0.0089
tons/yr	0.054	0.033	0.030	0.039
lb/MMBtu	0.0049	0.0029	0.0026	0.0035
Total Non-Methane Hydrocarbons, as Hexane (NMOC/VOC)				
ppmvd	< 1.4	< 0.84	< 1.0	< 1.1
lb/hr	< 0.021	< 0.013	< 0.016	< 0.017
tons/yr	< 0.092	< 0.056	< 0.069	< 0.072
lb/MMBtu	< 0.0084	< 0.0050	< 0.0060	< 0.0065
destruction efficiency, %	> 73.9%	> 85.1%	> 82.1%	> 80.3%
Time	0842-0848	1113-1119	1305-1311	--
Visible Emissions (VE)				
% opacity	0	0	0	0

MONTROSE AIR QUALITY SERVICES

TABLE 4-3
INLET NMOC EMISSIONS RESULTS -
LANDFILL GAS FLARE – CONDITION 2

Run Number	1	2	3	Average
Date	12/10/2020	12/10/2020	12/10/2020	--
Time	0827-0930	1057-1157	1246-1346	--
Process Data				
LFG flow rate, scfm	72.0	71.0	70.3	71.1
Flare temperature, °F	1,301	1,306	1,302	1,303
Flare set-point, °F	1,300	1,300	1,300	1,300
Flue Gas Parameters				
O_2, % volume dry	2.3	1.1	1.2	1.5
CO_2, % volume dry	21.4	22.8	22.6	22.3
N_2, % volume dry	28.1	24.6	25.2	26.0
CH_4, % volume dry	48.2	51.4	51.0	50.2
CO, % volume dry	< 0.1	< 0.1	< 0.1	< 0.1
H_2, % volume dry	< 1.4	< 1.4	< 1.4	< 1.4
HHV, Btu/scf	479.7	512.0	507.5	499.8
F_d, dscf/MMBtu	9,465	9,459	9,466	9,464
volumetric flow rate, dscfm	87.8	84.4	83.1	85.1
Inlet Non-Methane Organic Compounds, as Hexane (NMOC)				
ppmvd	63.7	70.2	68.7	67.5
lb/hr	0.075	0.079	0.077	0.077

TABLE 4-4
OUTLET SO_2, NO_X, CO, AND NMOC EMISSIONS RESULTS -
LANDFILL GAS FLARE – CONDITION 2

Run Number	1	2	3	Average
Date	12/10/2020	12/10/2020	12/10/2020	--
Time	0827-0931	1057-1159	1246-1347	--
Process Data				
LFG flow rate, scfm	72.0	71.0	70.3	71.1
Flare temperature, °F	1,301	1,306	1,302	1,303
Flare set-point, °F	1,300	1,300	1,300	1,300
Flue Gas Parameters				
O_2, % volume dry	14.7	14.5	14.6	14.6
CO_2, % volume dry	4.8	4.8	4.7	4.8
flue gas temperature, °F	1,173	1,193	1,156	1,174
moisture content, % volume	5.4	6.1	5.3	5.6
volumetric flow rate, dscfm	1,351	1,327	1,333	1,337
Sulfur Dioxide (SO_2)				
ppmvd	< 0.55	< 0.55	< 0.55	< 0.55
lb/hr	< 0.0074	< 0.0072	< 0.0073	< 0.0073
tons/yr	< 0.032	< 0.032	< 0.032	< 0.032
lb/MMBtu	< 0.0029	< 0.0028	< 0.0029	< 0.0029
Nitrogen Oxides (NO_x as NO_2)				
ppmvd	15.7	16.0	15.2	15.6
lb/hr	0.15	0.15	0.15	0.15
tons/yr	0.66	0.67	0.64	0.66
lb/MMBtu	0.060	0.059	0.057	0.059
Carbon Monoxide (CO)				
ppmvd	4.3	3.5	3.4	3.7
lb/hr	0.025	0.020	0.020	0.022
tons/yr	0.111	0.089	0.086	0.095
lb/MMBtu	0.0100	0.0078	0.0078	0.0085
Total Non-Methane Hydrocarbons, as Hexane (NMOC/VOC)				
ppmvd	< 1.2	< 0.89	< 0.86	< 1.0
lb/hr	< 0.022	< 0.016	< 0.015	< 0.018
tons/yr	< 0.098	< 0.069	< 0.068	< 0.078
lb/MMBtu	< 0.0088	< 0.0061	< 0.0061	< 0.0070
destruction efficiency, %	> 70.2%	> 80.1%	> 79.8%	> 76.7%
Time	0854-0900	1102-1108	1302-1308	--
Visible Emissions (VE)				
% opacity	0	0	0	0

5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA/QC AUDITS

The meter box and sampling trains used during sampling performed within the requirements of their respective methods. All post-test leak checks, minimum metered volumes, and minimum sample durations met the applicable QA/QC criteria.

EPA Method 3A, 6C, 7E, and 10 calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks. During testing it was determined that stack conditions were minimally stratified with all runs below 10% difference.

The NO_2 to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiency met the criteria.

EPA Method 9 was performed by a certified Visible Emissions Evaluator. For quality assurance, the observer obtained a view of the emissions with the best available contrasting background and with the sun oriented in the 140° sector to their back. Readings were taken every 15 seconds and made to the nearest 5% opacity.

EPA Method 25C analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

EPA Method 3C analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

5.2 QA/QC DISCUSSION

All QA/QC criteria were met during this test program.

5.3 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

APPENDIX A
FIELD DATA AND CALCULATIONS

Appendix A.1
Sampling Locations

MONTROSE AIR QUALITY SERVICES

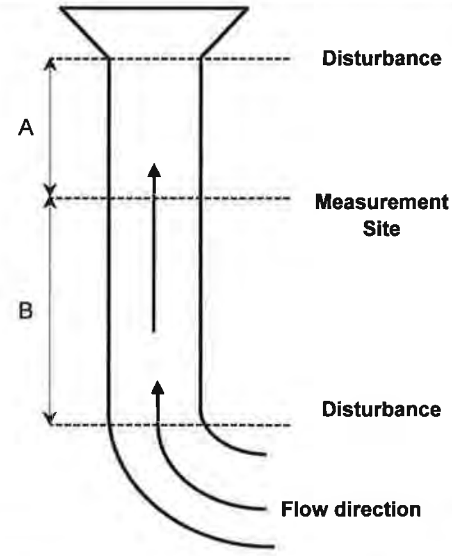
EPA METHOD 1 FIELD DATA

Project Information

Client / Facility	SCS Engineers / Leichner Landfill	Date	12/9/2020
Source / Location	Flare outlet	Data taken by	AG

Duct Measurements

Type of duct (circular, rectangular, elliptical)	Circular
Far wall to outside of port distance, in.: M1	40.5
Port length, in. (confirm flush with inside wall): M2	10 inches
Duct inner diameter, in. (M1 - M2)	30.5
Duct ID using adjacent, 90° port (for elliptical ducts)	—
Upstream distance (A), in.	20 inches
Downstream distance (B), in.	21 feet
Number of ports (for circular, must be 90° to each other)	2
Internal width (for rectangular ducts only), in. *	—
Port inner diameter, in.	4 inches



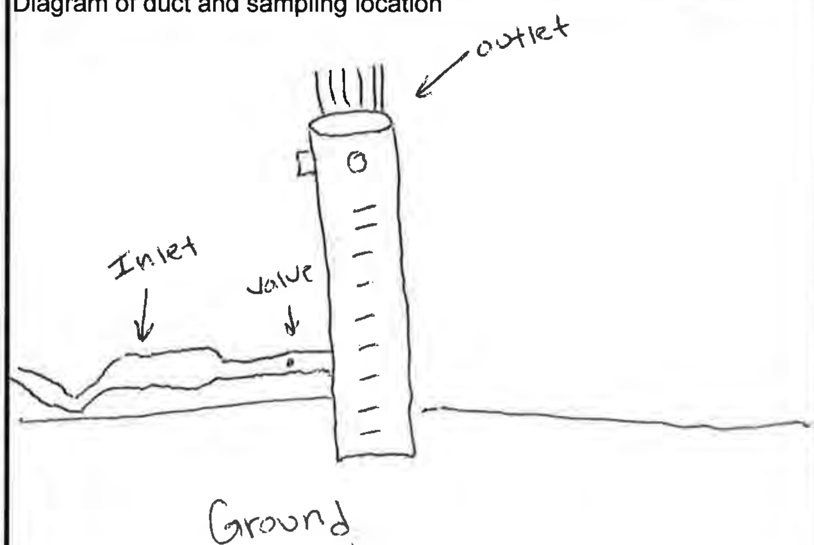
Duct Parameters

Material (steel, fiberglass, PVC)	Steel
Type of port (flange, npt nipple, etc.)	nipple
Orientation (vertical, horizontal, if diagonal specify angle)	Vertical
Elevation of ports above ground, ft.	30 ft

Cyclonic flow expected?	NO
Pitot ID	175-TP-6
Manometer ID	1G
Angle finder / protractor ID	700

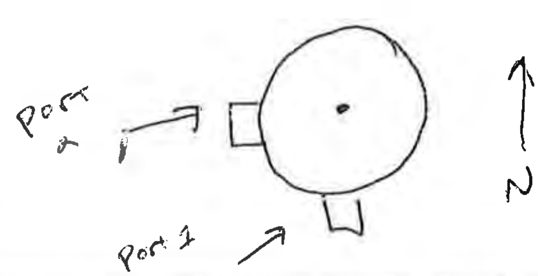
Traverse point	Outside port distance, in.	Null angle, α
1	11.0	0
2	13.2	2
3	15.9	2
4	19.9	0
5	30.6	3
6	34.6	0
7	37.3	2
8	39.5	1
1	11.0	0
2	13.2	2
3	15.9	3
4	19.9	0
5	30.6	0
6	34.6	1
7	37.3	2
8	39.5	0
Average of absolute α		1.1

Diagram of duct and sampling location



Cross-section sketch showing port locations and numbering

Label the following: port number 1, 2, etc.
north direction or other landmark
flow direction - ⊗ into page ⊙ out of page



*If schematics are unavailable, internal width can be estimated by measuring the portion of the port length not visible on the outside of the duct, which would be an estimate of the insulation thickness. Double this distance and subtract it from the outside width.

Appendix A.2
EPA 2/4 Data Sheets

MONTROSE AIR QUALITY SERVICES

EPA METHOD 2 - VELOCITY TRAVERSE DATA

Project Information

Client / Facility	SCS Engineering / Leichner Landfill	Page	1 of 1
Source / Location	Flare outlet (Normal operation) Scenario 1	Method	2
Run no. 1-3	Date 12.9.20	Operator / Assistant AG / DH	Project No. PROJ-005198

ALT-011 TC Check	
Std. TC ID	170865315
Std. TC temp., °F	52.1
Stack TC temp., °F	53
Continuity check + or -	+

Equipment Identification	
Pitot ID	175-TP-6
Pitot Cp	0.84
Manometer ID	SRH1
Sensitivity	0.001

Ambient Conditions	
Baro. press., in. Hg	30.32
Ambient temp., °F	47

Notes

Run No.	1		2		3			
Start Time	0840		1101		1247			
End Time	0851		1115		1255			
Pre-test pitot checks Leak chk.: in H₂O @ in. H₂O Visual: circle one	Leak chk + 0.00 @ 5 - 0.00 @ 4 Visual: aligned / damaged		Leak chk + 0.00 @ 4.5 - 0.00 @ 4 Visual: aligned / damaged		Leak chk + 0.00 @ 5 - 0.00 @ 4.5 Visual: aligned / damaged		Leak chk + ____ @ ____ - ____ @ ____ Visual: aligned / damaged	
Post-test pitot checks Leak chk.: in H₂O @ in. H₂O Visual: circle one	Leak chk + 0.001 @ 4.5 - 0.00 @ 5 Visual: aligned / damaged		Leak chk + 0.00 @ 5 - 0.00 @ 5 Visual: aligned / damaged		Leak chk + 0.00 @ 6 - 0.00 @ 5 Visual: aligned / damaged		Leak chk + ____ @ ____ - ____ @ ____ Visual: aligned / damaged	

Port	Point	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F
1	1	0.0151	1380	0.0088	1291	0.0113	1339		
	2	0.0321	1386	0.0098	1297	0.0278	1341		
	3	0.0273	1390	0.0120	1303	0.0305	1340		
	4	0.0235	1397	0.0236	1301	0.0282	1334		
	5	0.0150	1355	0.0243	1297	0.0164	1312		
	6	0.0115	1351	0.0320	1289	0.0073	1300		
	7	0.0097	1338	0.0176	1293	0.0080	1303		
	8	0.0055	1325	0.0111	1298	0.0071	1297		
2	1	0.0098	1330	0.0115	1335	0.0163	1341		
	2	0.0140	1340	0.0192	1334	0.0213	1337		
	3	0.0197	1350	0.0235	1330	0.0181	1336		
	4	0.0202	1354	0.0210	1340	0.0195	1337		
	5	0.0184	1360	0.0243	1342	0.0254	1345		
	6	0.0217	1357	0.0151	1332	0.0274	1335		
	7	0.0254	1350	0.0165	1319	0.0131	1310		
	8	0.0167	1331	0.0091	1308	0.0091	1294		
Static (Pg), in. H_2O		-0.0310		-0.0341			-0.0429		
Wet bulb temp., °F									

Comments:

MAQS M2FieldDataSheet R0

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Page i of 1

Project Information	
Date	12/9/2020
Project #	PROJ-005198
Customer/Facility	SCS Engineers/Leichner Landfill
Unit ID/Sample Location	Flare Outlet (Normal Operation)
Run #	1
Operator	AG

Sampling Conditions	
Static Pressure, in. H_2O	-0.0310
Ambient Temp, °F	47
Barometric Pressure, in. Hg	30.32
Ref. Barometer ID	NOAA
Wind Speed / Direction	3 ESE
Precipitation, Y / N, type	None
Probe / Filter Temp Range, °F	—

ALT 011	TC ID:	Ambient °F	Ref. °F
Stack			
Probe	See		
Filter Box	Final		
Filter Exit	Run		
Meter outlet			
Impinger Exit			
Other			

Ref. Thermometer ID

Continuity Check ☐ Continuity w/ Proper Polarity

Notes:

Sampling Equipment IDs	
Meterbox ID	MB24
Umbilical ID	PDK-20-1
Nozzle ID	—
Pitot / Probe ID	SS
Manometer ID	SR#1
Sensitivity	0.001

Calibration	
Meterbox Y	0.9989
Meterbox ΔH@, in. H_2O	1.6732
Nozzle diameter, Dn, in.	—
Pitot coefficient, Cp	0.84
Manometer zero and level	☑ yes
K-Factor	—

Equipment Checks	Pre	Mid	Post
Pitot (+), pass @ in. H_2O	☑ @	☐ ~~@~~	☑ @
Pitot (-), pass @ in. H_2O	☐ @	☐ ~~@~~	☐ @
Pitot visual inspection	☐ pass	~~☐ pass~~	☐ pass
Nozzle visual inspection	~~☐ pass~~	~~☐ pass~~	~~☐ pass~~
Meter, cfm @ in. Hg	0.003 @ 10.0	— @	0.002 @ 8.0
Intermediate leak check volume, ft^3		/	/

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Orifice Pressure Differential, ΔH Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Filter Temp, °F Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Dry Gas Meter Temperature, °F Outlet		Pump Vacuum, in. Hg
1	0	8:30	44.456	See Flow Data Sheet	1.0	1.0	See Flow Data Sheet				50		50		4.0
	5		47.450		1.0	1.0					54		50		4.0
	10		50.380		1.0	1.0					55		51		4.0
	15		53.360		1.0	1.0					56		51		4.0
	20		56.212		1.0	1.0					56		53		4.0
	25		59.200		1.0	1.0					56		54		4.0
	30		62.175		1.0	1.0					56		55		4.0
	35		64.866		1.0	1.0					56		56		4.0
	40		67.710		1.0	1.0					66		66		4.0
	45		70.560		1.0	1.0					54		57		4.0
	50		73.405		1.0	1.0					52		58		4.0
	55		76.256		1.0	1.0					52		59		4.0
	60	9:30	79.131												
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By RD Team Leader RD

001AS-QMS-FM-225

Scenario 1

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Project Information
Date 12/9/2020 Project # PROJ-005198
Customer/Facility SCS Engineers/Leichner Landfill
Unit ID/Sample Location Flare Outlet
Run # 2 Operator AG

Sampling Conditions
Static Pressure, in. H_2O -0.0341 Ambient Temp, °F 50
Barometric Pressure, in. Hg 30.36 Ref. Barometer ID NOAA
Wind Speed / Direction 5 ESE Precipitation, Y / N, type None
Probe / Filter Temp Range, °F —

ALT 011	TC ID:	Ambient °F	Ref. °F
Stack			
Probe	See		
Filter Box			
Filter Exit	Final		
Meter outlet	Run		
Impinger Exit			
Other			

Ref. Thermometer ID
Continuity Check ☐ Continuity w/ Proper Polarity
Notes:

Sampling Equipment IDs
Meterbox ID MB24
Umbilical ID PDX-20-1
Nozzle ID —
Pitot / Probe ID SS tubing
Manometer ID SZ#1
Sensitivity 0.001

Calibration
Meterbox Y 0.9989
Meterbox ΔH@, in. H_2O 1.6732
Nozzle diameter, Dn, in. —
Pitot coefficient, Cp 0.84
Manometer zero and level ☑ yes
K-Factor —

Equipment Checks	Pre	Mid	Post
Pitot (+), pass @ in. H_2O	☑ @	~~☐ @~~	☑ @
Pitot (-), pass @ in. H_2O	~~☐ @~~	~~☐ @~~	~~☐ @~~
Pitot visual inspection	~~☐ pass~~	~~☐ pass~~	~~☐ pass~~
Nozzle visual inspection	~~☐ pass~~	~~☐ pass~~	~~☐ pass~~
Meter, cfm @ in. Hg	0.000 @ 15.0	~~@~~	0.000 @ 5.0
Intermediate leak check volume, ft^3		/	/

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Orifice Pressure Differential, ΔH Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Filter Temp, °F Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Dry Gas Meter Temperature, °F Outlet		Pump Vacuum, in. Hg
	0	11:00	79.323	See Flow Data Sheet	1.0	1.0	See Flow Data Sheet				51		60		3.0
	5		82.210								47		60		3.0
	10		85.120								46		60		3.0
	15		87.45								47		60		3.0
	20		90.900								48		61		3.5
	25		93.800								49		61		3.5
	30		96.610								49		62		3.5
	35		99.605								49		62		3.5
	40		102.485								50		63		3.6
	45		105.470								50		63		3.6
	50		108.365								50		64		3.6
	55		111.160		1.0	1.0					49		64		3.5
	60	12:00	114.960								50		64		3.5
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By PB Team Leader PB

001AS-QMS-FM-225

Scenario 1

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Page 1 of 1

Project Information	
Date	12/19/2020
Project #	PROJ-005198
Customer/Facility	SCS Engineers/Leichner Landfill
Unit ID/Sample Location	Flare Outlet
Run #	3
Operator	AG

Sampling Conditions			
Static Pressure, in. H_2O	-0.0429	Ambient Temp, °F	52
Barometric Pressure, in. Hg	30.33	Ref. Barometer ID	NOAA
Wind Speed / Direction	4 ESE	Precipitation, Y / N, type	None
Probe / Filter Temp Range, °F	N/A		

ALT 011	TC ID:	Ambient °F	Ref °F
Stack			
Probe	—	—	—
Filter Box	—	—	—
Filter Exit	—	—	—
Meter outlet	MB24	52	52.1
Impinger Exit	GN-7	52	52.1
Other			

Ref. Thermometer ID 1708 G5315

Continuity Check ☑ Continuity w/ Proper Polarity

Notes:

Sampling Equipment IDs	
Meterbox ID	MB24
Umbilical ID	PDX-70-1
Nozzle ID	—
Pitot / Probe ID	SS tubing
Manometer ID	SR#1
Sensitivity	0.001

Calibration	
Meterbox Y	0.9989
Meterbox ΔH@, in. H_2O	1.6732
Nozzle diameter, Dn, in	—
Pitot coefficient, Cp	0.84
Manometer zero and level	☑ yes
K-Factor	—

Equipment Checks	Pre	Mid	Post
Pitot (+), pass @ in. H_2O	☐ @	☐ @	☐ @
Pitot (-), pass @ in. H_2O	☐ @	☐ @	☐ @
Pitot visual inspection	☐ pass	☐ pass	☐ pass
Nozzle visual inspection	☐ pass	☐ pass	☐ pass
Meter, cfm @ in. Hg	0.000 @ 15.0	@	0.000 @ 5.0
Intermediate leak check volume, ft^3		/	/

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Orifice Pressure Differential, ΔH Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Filter Temp, °F Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Dry Gas Meter Temperature, °F Outlet		Pump Vacuum, in. Hg
	0	12:45	114.250		1.0	1.0					53		61		3.0
	5		117.450	See			See				49		61		3.0
	10		119.995								48		61		3.0
	15		123.980	Flow			Flow				49		61		3.0
	20		126.830								50		61		3.0
	25		128.690								51		62		3.0
	30		131.530	Data			Data				51		62		3.0
	35		134.380								51		63		3.0
	40		137.235								52		63		3.0
	45		140.080	Sheet			Sheet				52		64		3.0
	50		142.910								52		64		3.0
	55		145.760		1.0	1.0					53		65		3.0
	60	13:45	148.685												
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By AB Team Leader AB

001AS-QMS-FM-225

EPA 4

MONTROSE AIR QUALITY SERVICES

Sample Recovery & Calibration Check Datasheet

Project Information

Date 12/8/2020 Project # PROJ-005198

Customer / Facility SCS Engineers / Leichner Landfill

Unit ID / Sample Location Flare Exhaust

Run # 1-3 Operator PB

Equipment Identification

Ref. Thermometer /

Hygrometer /

Field Balance 624

Check Weights 10640

Calipers /

Balance Audit (Field balance must be within 0.5g of check weight mass)

Date	12.8.20	12.9.20	
Standard mass, g	500.0	500.0	
Field balance mass, g	499.9	499.7	

Ambient Conditions (Mobile Lab)

Relative humidity, % /

Temperature, °F 68

Mobile lab # TV-4

Moisture Determination

	Contents	Run1 Initial	Run1 Final	Run1 Net	Run 2 Initial	Run 2 Final	Run 2 Net	Run 3 Initial	Run 3 Final	Run 3 Net
Knockout										
Impinger 1	H2O	686.1	749.8	63.7	695.9	748.8	52.9	723.4	772.0	48.6
Impinger 2	H2O	744.0	744.7	0.7	763.7	763.1	-0.6	751.2	751.6	0.4
Impinger 3	MT	648.1	648.9	0.8	598.9	598.7	-0.2	639.7	640.3	0.6
Impinger 4										
Impinger 5										
Impinger 6										
Impinger 7										
Impinger 8										
Silica Gel	Silica	959.0	967.0	8.0	926.7	932.5	~~57.9~~ 5.8	866.7	873.2	6.5
Line Rinse										
Train Net Gain (Vlc)				73.2			57.9			56.1

Nozzle Measurements (Difference between any two measurements must not be more than 0.004 in (0.1 mm))

Nozzle 1 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle 2 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle 3 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle Material ☐ quartz ☐ glass ☐ steel ☐ titanium ☐ inconel ☐ other ______

Probe Type ☐ heated ☐ unheated ☐ air-cooled ☐ water-cooled ☐ other ______

Probe Liner ☐ quartz ☐ glass ☐ steel ☐ Teflon ☐ other ______

Filter Information

Front Half: ☐ quartz fiber ☐ glass fiber ☐ Teflon ☐ Teflon/quartz ☐ other ______

Filter Number: Run 1: ______ Run 2: ______ Run 3: ______ Run ______

Back Half: ☐ quartz fiber ☐ glass fiber ☐ Teflon ☐ Teflon/quartz ☐ other ______

Reagent Information

Type	Lot Number

Sample Observations

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓

Checked by: PB Team Leader: PB

001AS-QMS-FM-226

MONTROSE AIR QUALITY SERVICES

EPA METHOD 2 - VELOCITY TRAVERSE DATA

Project Information

Client / Facility: SCS Engineering / Leichner Landfill — Page 1 of 1
Source / Location: Flare outlet (Scenario 2) — Method 2
Run no. 1-3 — 12.10.2020 Date ~~12/9/2020~~ — Operator / Assistant AG — Project No. PROJ-005918

ALT-011 TC Check	
Std. TC ID	170865315
Std. TC temp., °F	52.1
Stack TC temp., °F	53.0
Continuity check + or -	+

Equipment Identification	
Pitot ID	175-TP-6
Pitot Cp	0.84
Manometer ID	SP#1
Sensitivity	0.001

Ambient Conditions	
Baro. press., in. Hg	30.14
Ambient temp., °F	37

Notes

Run No.	1		2		3			
Start Time	0828		1100		1150			
End Time	0837		1109		1200			
Pre-test pitot checks Leak chk: in. H_2O @ in. H_2O	+ 0.00 @ 5; - 0.00 @ 4	Visual: aligned / damaged	+ 0.00 @ 5; - 0.00 @ 5	Visual: aligned / damaged	+ 0.00 @ 4.5; - 0.00 @ 5	Visual: aligned / damaged	+ @ ; - @	Visual: aligned / damaged
Post-test pitot checks Leak chk: in. H_2O @ in. H_2O	+ 0.00 @ 5.5; - 0.00 @ 5	Visual: aligned / damaged	+ 0.00 @ 4.5; - 0.00 @ 5	Visual: aligned / damaged	+ 0.00 @ 5; - 0.001 @ 6	Visual: aligned / damaged	+ @ ; - @	Visual: aligned / damaged

Port	Point	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F	ΔP inches H_2O	Stack temp. °F
1	1	0.0118	1217	0.0257	1225	0.0177	1172		
	2	0.0340	1206	0.0310	1223	0.0201	1170		
	3	0.0306	1204	0.0400	1217	0.0333	1173		
	4	0.0273	1199	0.0383	1211	0.0298	1170		
	5	0.0260	1180	0.0167	1193	0.0157	1160		
	6	0.0084	1167	0.0133	1187	0.0105	1152		
	7	0.0063	1150	0.0066	1163	0.0072	1145		
	8	0.0095	1138	0.0085	1157	0.0067	1139		
2	1	0.0159	1176	0.0179	1179	0.0167	1160		
	2	0.0240	1168	0.0233	1181	0.0315	1159		
	3	0.0262	1166	0.0275	1184	0.0357	1157		
	4	0.0365	1168	0.0264	1191	0.0326	1157		
	5	0.0304	1170	0.0347	1194	0.0282	1162		
	6	0.0306	1165	0.0162	1197	0.0218	1150		
	7	0.0236	1153	0.0125	1194	0.0182	1140		
	8	0.0201	1141	0.0195	1189	0.0216	1129		
Static (Pg), in. H_2O		-0.0384		-0.0361		-0.0351			
Wet bulb temp., °F									

Comments:

MAQS M2FieldDataSheet R0

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Page 1 of 1

Project Information
Date: 12/10/20 Project #: PROJ-005198
Customer/Facility: SCS Engineers/Leichner Landfill
Unit ID/Sample Location: Flare outlet (scenario 2)
Run #: 1 Operator: AG

Sampling Conditions
Static Pressure, in. H_2O: -0.0384 Ambient Temp, °F: 37
Barometric Pressure, in. Hg: 30.04 Ref. Barometer ID: NOAA
Wind Speed / Direction: 0 N Precipitation, Y / N, type: N
Probe / Filter Temp Range, °F: —

ALT 011	TC ID:	Ambient °F	Ref. °F
Stack			
Probe		See	
Filter Box			
Filter Exit		Final	
Meter outlet		Run	
Impinger Exit			
Other	MB-24	52.1	52

Ref. Thermometer ID: 176865315
Continuity Check: ☑ Continuity w/ Proper Polarity
Notes:

Sampling Equipment IDs
Meterbox ID: MB24
Umbilical ID: —
Nozzle ID: —
Pitot / Probe ID: —
Manometer ID: MB24
Sensitivity: 0.01

Calibration
Meterbox Y: 0.9989
Meterbox ΔH@, in. H_2O: 1.6732
Nozzle diameter, Dn, in.: —
Pitot coefficient, Cp: 0.84
Manometer zero and level: ☑ yes
K-Factor: —

Equipment Checks	Pre	Mid	Post
Pitot (+), pass @ in. H_2O	~~☐ @~~	☐ @ —	~~☐ @~~
Pitot (-), pass @ in. H_2O	~~☐ @~~	☐ @ —	~~☐ @~~
Pitot visual inspection	~~☐ pass~~	~~☐ pass~~	~~☐ pass~~
Nozzle visual inspection	~~☐ pass~~	☐ pass	☐ pass
Meter, cfm @ in. Hg	0.000 @ 15.0	— @ —	0.000 @ 6.5
Intermediate leak check volume, ft^3		/	/

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Orifice Pressure Differential, ΔH Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Filter Temp, °F Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Dry Gas Meter Temperature, °F Outlet		Pump Vacuum, in. Hg
1	0	8:27	148.748		1.0	1.0					42		44		4.0
	5	8:30/8:33	151.641	See			See				49		45		4.0
	10		154.720								50		45		4.0
	15		157.723	Flow			Flow				49		46		4.0
	20		160.430								49		47		4.0
	25		163.275								48		48		4.0
	30		166.150	Data			Data				48		48		4.0
	35		169.080								48		48		4.0
	40		~~177.000~~ 172.000								48		48		4.0
	45		174.985	Sheet			Sheet				47		52		4.0
	50		177.740								47		52		4.0
	55		180.710								47		52		4.0
	60	9:30	183.610								47		52		4.0
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By RP Team Leader RR

001AS-QMS-FM-225

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Page 1 of 1

Project Information	
Date	12/10/2020
Project #	PROJ-005198
Customer/Facility	SCS Engineers/Leichner Landfill
Unit ID/Sample Location	Flare outlet (Scenario 2)
Run #	2
Operator	AG

Sampling Conditions	
Static Pressure, in. H_2O	-0.0361
Ambient Temp, °F	43
Barometric Pressure, in. Hg	30.02
Ref. Barometer ID	NOAA
Wind Speed / Direction	3 S
Precipitation, Y / N, type	None
Probe / Filter Temp Range, °F	—

ALT 011	TC ID:	Ambient °F	Ref. °F
Stack			
Probe		See	
Filter Box			
Filter Exit		Final	
Meter outlet		Run	
Impinger Exit			
Other			

Ref. Thermometer ID

Continuity Check ☐ Continuity w/ Proper Polarity

Notes:

Sampling Equipment IDs	
Meterbox ID	~~MB24~~ MB-33
Umbilical ID	PDX-20-1
Nozzle ID	—
Pitot / Probe ID	—
Manometer ID	M324
Sensitivity	0.01

Calibration	
Meterbox Y	1.0017 ~~0.9989~~
Meterbox ΔH@, in. H_2O	~~1.6732~~
Nozzle diameter, Dn, in.	1.6853
Pitot coefficient, Cp	0.84
Manometer zero and level	☑ yes
K-Factor	—

Equipment Checks	Pre	Mid	Post
Pitot (+), pass @ in. H_2O	☐ @ —	☐ @ —	☐ @ —
Pitot (-), pass @ in. H_2O	☐ @ —	☐ @ —	☐ @ —
Pitot visual inspection	☐ pass —	☐ pass —	☐ pass —
Nozzle visual inspection	☐ pass —	☐ pass —	☐ pass
Meter, cfm @ in. Hg	0.000 @ 15.0	— @ —	0.000 @ 10.0
Intermediate leak check volume, ft^3		/	/

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Orifice Pressure Differential, ΔH Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Filter Temp, °F Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Dry Gas Meter Temperature, °F Outlet		Pump Vacuum, in. Hg
1	0	10:57	541.245		1.0	1.0					42		47		3.0
	5		544.150	See			See				42		47		3.0
	10		547.00								42		48		3.0
	15		549.780				Flow				43		48		3.0
	20		552.600	Flow							44		49		3.0
	25		555.465								46		50		3.0
	30		558.365	Data			Data				47		50		3.0
	35		561.310								48		51		3.0
	40		564.235								49		52		3.0
	45		567.180	Sheet			Sheet				50		53		3.0
	50		570.130								50		54		3.0
	55		573.100								50		54		3.0
	60	11:57	576.050								51		55		3.0
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By PD Team Leader PD

001AS-QMS-FM-225

MONTROSE AIR QUALITY SERVICES

EPA Method 4 Field Datasheet (Isokinetic)

Page 1 of 1

Project Information		Sampling Conditions		ALT 011	TC ID:	Ambient °F	Ref. °F
Date 12/10/2020	Project # PROJ-005199	Static Pressure, in. H_2O -0.0351	Ambient Temp, °F 43	Stack	175-TP-6		
Customer/Facility SCS Engineers/Leichner Landfill		Barometric Pressure, in. Hg 29.99	Ref. Barometer ID NOAA	Probe	—	—	—
Unit ID/Sample Location Flare outlet (scenario 2)		Wind Speed / Direction 5 WSW	Precipitation, Y / N, type None	Filter Box	—	—	—
Run # 3	Operator AG	Probe / Filter Temp Range, °F —		Filter Exit	—	—	—
				Meter outlet	MB33	52	52.1
				Impinger Exit	GN-2	52	52.1
				Other			

Sampling Equipment IDs		Calibration		Equipment Checks	Pre	Mid	Post
Meterbox ID	~~MB24~~ MB 33	Meterbox Y	~~0.9909~~ 1.0017	Pitot (+), pass @ in. H_2O	☐ @ —	☐ @ —	☐ @ —
Umbilical ID	—	Meterbox ΔH@, in. H_2O	~~1.6732~~	Pitot (-), pass @ in. H_2O	☐ @ —	☐ @ —	☐ @ —
Nozzle ID	—	Nozzle diameter, Dn, in.	~~1.6953~~	Pitot visual inspection	☐ ~~pass~~	☐ ~~pass~~	☐ ~~pass~~
Pitot / Probe ID	—	Pitot coefficient, Cp	0.84	Nozzle visual inspection	☐ ~~pass~~	☐ ~~pass~~	☐ ~~pass~~
Manometer ID	MB24	Manometer zero and level	☑ yes	Meter, cfm @ in. Hg	0.000 @ 15.0	— @ —	0.000 @ 10.0
Sensitivity	0.01	K-Factor	—	Intermediate leak check volume, ft^3		/	/

Ref. Thermometer ID i 70805315

Continuity Check ☑ Continuity w/ Proper Polarity

Notes:

Traverse Point #	Elapsed Time	Clock Time 24hr	DGM Reading, Vm, ft^3	Velocity Head, ΔP in H_2O	Orifice Pressure Differential, ΔH Target	Actual	Stack Temp, °F	Probe Temp, °F	Filter Temp, °F Box	Exit	Impinger Exit Temp, °F	Dry Gas Meter Temperature, °F Inlet	Outlet		Pump Vacuum, in. Hg
1	0	12:46	576.282	See Flow Data Sheet	1.0	1.0	See Flow Data Sheet				50		59		3.0
	5		579.100								50		59		3.0
	10		582.050								48		59		3.0
	15		584.950								46		59		3.0
	20		587.850								48		59		3.0
	25		590.710								49		59		3.0
	30		593.600								49		59		3.0
	35		596.470								50		59		3.0
	40		599.360								50		59		3.0
	45		602.220								50		59		3.0
	50		605.090								50		58		3.0
	55		607.960								50		58		3.0
	60	13:46	610.836								50		58		3.0
Averages															

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓ Checked By RB Team Leader AP

001AS-QMS-FM-225

Scenario 2

MONTROSE AIR QUALITY SERVICES

Sample Recovery & Calibration Check Datasheet

Page 1 of 1

Project Information		**Equipment Identification**	
Date	12.9.20	Ref. Thermometer	
Project #	Pro5-005198	Hygrometer	
Customer / Facility	SCS Engineering / Leichner Landfill	Field Balance	624
Unit ID / Sample Location	FLARE Exhaust (Scenario 2)	Check Weights	10640
Run #	1-3	Calipers	–
Operator	DB		

Balance Audit (Field balance must be within 0.5g of check weight mass)

Date	12.9.20	12.9.20	
Standard mass, g	500.0	500.0	
Field balance mass, g	499.7	499.7	

Ambient Conditions (Mobile Lab)

Relative humidity, %	
Temperature, °F	68
Mobile lab #	TV-4

Moisture Determination

	Contents	Run1 Initial	Run1 Final	Run1 Net	Run 2 Initial	Run 2 Final	Run 2 Net	Run 3 Initial	Run 3 Final	Run 3 Net
Knockout										
Impinger 1	100mL	749.8	790.2	40.4	~~748.8~~			772.0	808.7	
Impinger 2	100mL	744.7	744.1	-0.6	~~703.1~~			751.6	751.6	
Impinger 3	empty	648.9	648.2	-0.7	~~598.7~~			640.3	640.4	
Impinger 4	Silica	967.0	971.9	4.9	~~932.5~~			873.2	878.7	
Impinger 5										
Impinger 6					705.0	745.8	40.8			
Impinger 7					715.8	716.3	0.5			
Impinger 8					598.2	598.7	0.5			
Silica Gel					931.9	940.3	8.4			
Line Rinse										
Train Net Gain (Vlc)				44.0			50.2			

Nozzle Measurements (Difference between any two measurements must not be more than 0.004 in (0.1 mm))

Nozzle 1 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle 2 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle 3 diameters ______ D1 ______ D2 ______ D3 ______ Average

Nozzle Material ☐ quartz ☐ glass ☐ steel ☐ titanium ☐ inconel ☐ other ______

Probe Type ☐ heated ☐ unheated ☐ air-cooled ☐ water-cooled ☐ other ______

Probe Liner ☐ quartz ☐ glass ☐ steel ☐ Teflon ☐ other ______

Filter Information

Front Half: ☐ quartz fiber ☐ glass fiber ☐ Teflon ☐ Teflon/quartz ☐ other ______

Filter Number: Run 1: ______ Run 2: ______ Run 3: ______ Run ______

Back Half: ☐ quartz fiber ☐ glass fiber ☐ Teflon ☐ Teflon/quartz ☐ other ______

Reagent Information		**Sample Observations**
Type	**Lot Number**	

QA/QC Check: Completeness ✓ Legibility ✓ Accuracy ✓ Specifications ✓

Checked by: DB Team Leader: PD

001AS-QMS-FM-226

Appendix A.3
EPA 25C/3C Data Sheets

MONTROSE AIR QUALITY SERVICES

TANK/TRAP/CANISTER DATA

Project Information

Client / Facility	SCS Engineers/Leichner Landfill	Page	1 of 1
Source / Location	Flare Outlet (Normal operation)	Method	25C/3C
Pollutant(s) 25C	Date 12/9/2020 Operator PB	Project No.	PROJ-005198

Sample Container (circle):

Tedlar bag   Summa canister   Tank   Trap   Tube   Other: ______

Run Data

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Time	0830	0930	1100	1204	1245	1345
Bar. Press., in. Hg:	30.32	30.32	30.32	30.32	30.33	30.33
Ambient Temp., °F:	47	47	48	48	52	~~53~~ 55
Static Press., in H_2O:	-0.0310	-0.0310	-0.0341	-0.0341	-0.0429	-0.0429
Stack Temp., °F:	1350	1350	1350	1350	1330	1330
Summa Can Information						
Vacuum, in. Hg:	>30.00	20.00	>30.00	10.00	>30.00	15.00
Summa Can ID:	000329		000149		000546	
Orifice ID						
Vacuum Gauge ID:						
Vacuum should not drop below 1 psi						
Draeger Tube Information						
Concentration, ppm	—		—		—	
Number of strokes	—		—		—	
Draeger Tube ID/Lot #	—		—		—	
Sorbent Tube Information						
Vacuum, in. Hg:	—	—	—	—	—	—
System Leak Checks:						
Start Vac., in. Hg:	—	—	—	—	—	—
End Vac., in. Hg:	—	—	—	—	—	—

The system must not lose more than 1 inch of vauum in two minutes

Notes:

Pause on run 2 tank at 11:07, resume at 11:11

MAQS TankTrapSumma R0

MONTROSE AIR QUALITY SERVICES

TANK/TRAP/CANISTER DATA

Project Information

Client / Facility: SCS Engineers/Leichner Landfill
Page 1 of 1
Source / Location: Flare Inlet (Normal operation) Scenario 1
Method: 25C/3C
Pollutant(s): 3C, 25C
Date: 12/9/2020
Operator: RB
Project No. PROJ-005198

Sample Container (circle):

Tedlar bag Summa canister Tank Trap Tube Other: ______

Run Data

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Time	8:31	9:31	11:00	12:00	12:45	13:45
Bar. Press., in. Hg:	30.32	30.36	30.36	30.33	30.33	30.31
Ambient Temp., °F:	47	50	50	52.0	52.0	51
Static Press., in H_2O:						
Stack Temp., °F:	~~474~~					
Summa Can Information						
Vacuum, in. Hg:	28	8.0	30.0	8.0	28	8.0
Summa Can ID:	001314		000825		000936	
Orifice ID	4FLP7B		4FLP7B		4FLP7B	
Vacuum Gauge ID:	4FLP7B		4FLP7B		4FLP7B	

Vacuum should not drop below 1 psi

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Draeger Tube Information						
Concentration, ppm	–		–		–	
Number of strokes	–		–		–	
Draeger Tube ID/Lot #	–		–		–	
Sorbent Tube Information						
Vacuum, in. Hg:	–	–	–	–	–	–
System Leak Checks:						
Start Vac., in. Hg:	–	–	–	–	–	–
End Vac., in. Hg:	–	–	–	–	–	–

The system must not lose more than 1 inch of vauum in two minutes

Notes:

Run 1
Scfm 71
Temp 67°F
TE-301

R 2
Scfm 71
TEmp 72°F
TE -301

Run 3
Scfm 71
TEmp 69°F
TE -301

DATA TO Be Provided by Facility Das System

MAQS TankTrapSumma R0

MONTROSE AIR QUALITY SERVICES

TANK/TRAP/CANISTER DATA

Project Information

Client / Facility	SCS Engineers / Leichner Landfill	Page	1 of 1
Source / Location	FLARE Inlet (Scenario 2)	Method	3C, 25C
Pollutant(s) 3C, 25C	Date 12.10.20	Operator PB	Project No. PROJ-005198

Sample Container (circle):

Tedlar bag Summa canister Tank Trap Tube Other: ____

Run Data

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Time	8:27	9:23	10:57	11:57	12:46	13:46
Bar. Press., in. Hg	30.04	30.02	30.02	29.99	29.99	30.00
Ambient Temp., °F:	37 °F	43	43	43	43	42
Static Press., in H_2O:						
Stack Temp., °F:						
Summa Can Information						
Vacuum, in. Hg:	28.0	8.0	28	6.0	28	8
Summa Can ID:	000947		000941		000952	
Orifice ID	4FLP7B		4FLP7B		4FLP7B	
Vacuum Gauge ID:	4FLP7B		4FLP7B		4FLP7B	

Vacuum should not drop below 1 psi

	Run 1	Run 2	Run 3
Draeger Tube Information			
Concentration, ppm			
Number of strokes			
Draeger Tube ID/Lot #			

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Sorbent Tube Information						
Vacuum, in. Hg:						
System Leak Checks:						
Start Vac., in. Hg:						
End Vac., in. Hg:						

The system must not lose more than 1 inch of vauum in two minutes

Notes:

Run 1
72
Scfm

Run 2
71
Scfm

Run 3
71
Scfm

TE 301
60°F

TE 301
65°F

TE 301
67°F

Production DATA will be Provided by Client

MAQS TankTrapSumma R0

MONTROSE AIR QUALITY SERVICES

TANK/TRAP/CANISTER DATA

Project Information

Client / Facility: SCS Engineers / Leichner Landfill — Page 1 of 1

Source / Location: Flare Exhaust (Scenario 2) — Method 25C

Pollutant(s): VOC — Date 12.10.20 — Operator AG — Project No. PROJ-005198

Sample Container (circle):

Tedlar bag — Summa canister — Tank — Trap — Tube — Other: ______

Run Data

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Time	0827	0927	1057	1157	1247	1347
Bar. Press., in. Hg:	30.04	30.04	30.02	29.99	29.99	~~29.99~~ 30.00
Ambient Temp., °F:	37	38	43	43	43	~~43~~ 42
Static Press., in H_2O:	-0.0384	-0.0384	-0.0361	-0.0381	-0.0351	-0.0351
Stack Temp., °F:	1200	1200	1200	1200	1150	1150
Summa Can Information						
Vacuum, in. Hg:	730.00	18.00	730.00	12.00	730.00	10.00
Summa Can ID:	001308		001319		0012614	
Orifice ID	4FLP7B		4FLP7B		4FLP7B	
Vacuum Gauge ID:	"		"		"	

Vacuum should not drop below 1 psi

	Run 1 Start	Run 1 End	Run 2 Start	Run 2 End	Run 3 Start	Run 3 End
Draeger Tube Information						
Concentration, ppm	–		–		–	
Number of strokes	–		–		–	
Draeger Tube ID/Lot #	–		–		–	
Sorbent Tube Information						
Vacuum, in. Hg:	–	–	–	–	–	–
System Leak Checks:						
Start Vac., in. Hg:	–	–	–	–	–	–
End Vac., in. Hg:	–	–	–	–	–	–

The system must not lose more than 1 inch of vauum in two minutes

Notes:

MAQS TankTrapSumma R0

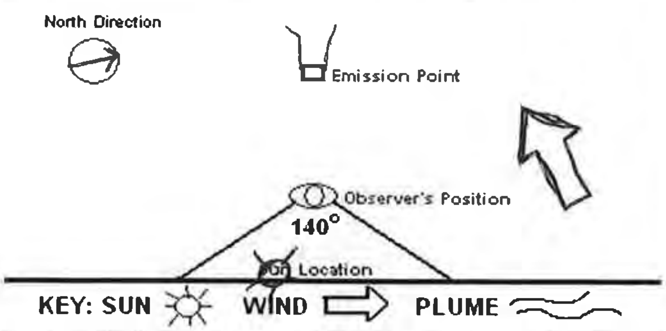
Appendix A.4
EPA 9 Data Sheets

MONTROSE AIR QUALITY SERVICES

VISIBLE EMISSION OBSERVATIONS

Project Information	
Client / Facility	SCS Engineering / Leichner Landfill
Source / Location	FLARE Exhaust
Project No.	PROS-005198
Operation Mode/Output Rate	Scenario 1 ~1475°F
Control Equipment	N/A
Control Eq. Operation Mode	

Plume Information	Start	End
Emission Point Description	end of Stack	"
Height Above Ground	20 ft	"
Height Relative to Observer	20 ft	"
Distance from Observer	60 ft	"
Direction from Observer	NW	"
Plume Type: Continuous	N/A	"
Intermittent	N/A	"
Fugitive	N/A	"
Plume Color	Clear	"
Water Droplets Present?	No	"
Attached Plume		"
Detached Plume	N/A	"
Point in the plume at which the opacity was observed	end of Stack	"
Description of Background	Cloudy Sky	"
Color of Background	Grey	"
Condition of Sky	Cloudy	Cloudy
Wind Speed (mph)	3	3
Wind Direction (From)	ESE	ESE
Ambient Temp (°F)	47	47
Relative Humidity (%)	83	83



Comments:

Observation Record

Test Method 9 Date 12.9.20

Start 8:42 Stop 8:48

Min	0	15	30	45	Min	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Range of Opacity Readings	Maximum	0	%
	Minimum	0	%
Number of readings above 0 % =		0	
Average Opacity for 24 readings =		0	%

Observer's Name (print)	Peter Becker
Organization	Montrose Air Quality Services, LLC
Certified By	Smoke School Inc
Certification Date	10.30.20 Expiration Date 4.30.21
Observer's Signature	Peter Becker

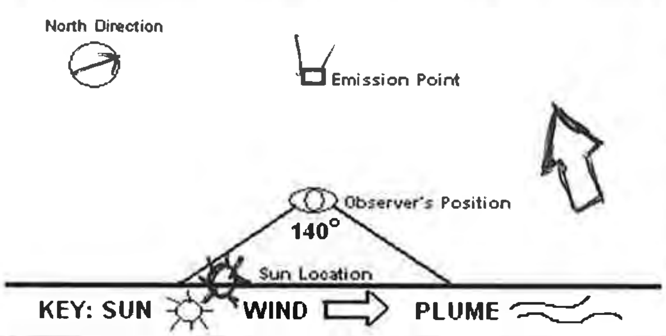
MAQS VE R1

MONTROSE AIR QUALITY SERVICES

VISIBLE EMISSION OBSERVATIONS

Project Information	
Client / Facility	SCS Engineering / Leichner
Source / Location	FLARE Exhaust
Project No.	PROS-005198
Operation Mode/Output Rate	Scenario 1 ~1475°F
Control Equipment	N/A
Control Eq. Operation Mode	

Plume Information	Start	End
Emission Point Description	end of Stack	''
Height Above Ground	~20	''
Height Relative to Observer	~20	''
Distance from Observer	~60	''
Direction from Observer	NW	''
Plume Type: Continuous	N/A	''
Intermittent	N/A	''
Fugitive	N/A	''
Plume Color	Clear	''
Water Droplets Present?	N/A	''
Attached Plume	N/A	''
Detached Plume	N/A	''
Point in the plume at which the opacity was observed	end of exhaust stack	''
Description of Background	Cloudy Sky	''
Color of Background	Grey Clouds	''
Condition of Sky	Cloudy	''
Wind Speed (mph)	5	''
Wind Direction (From)	ESE	''
Ambient Temp (°F)	50	50
Relative Humidity (%)	76%	76%



Comments:

Observation Record

Test Method 9 Date 12.9.20

Start 11:13 Stop 11:19

	Seconds					Seconds			
Min	0	15	30	45	Min	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Range of Opacity Readings: Maximum 0 %, Minimum 0 %

Number of readings above 0 % = 0

Average Opacity for 24 readings = 0 %

Observer's Name (print): Peter Becker

Organization: Montrose Air Quality Services, LLC

Certified By: Smoke School Inc

Certification Date: [illegible]0.30.20 Expiration Date: ~~4.30.20~~ 4.30.21

Observer's Signature: Peter Becker

30.36

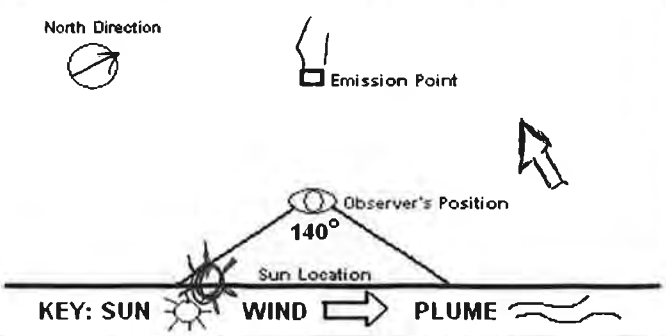
MAQS VE R1

MONTROSE AIR QUALITY SERVICES

VISIBLE EMISSION OBSERVATIONS

Project Information	
Client / Facility	SCS Engineering / Leichner
Source / Location	FLARE Exhaust
Project No.	PROS-005198
Operation Mode/Output Rate	Scenario 1 - 1475
Control Equipment	N/A
Control Eq. Operation Mode	

Plume Information	Start	End
Emission Point Description	end of Stack	''
Height Above Ground	~20	''
Height Relative to Observer	~20	''
Distance from Observer	~60	''
Direction from Observer	NW	''
Plume Type: Continuous	N/A	''
Intermittent	N/A	''
Fugitive	N/A	''
Plume Color	Clear	''
Water Droplets Present?	N/A	''
Attached Plume	N/A	''
Detached Plume	N/A	''
Point in the plume at which the opacity was observed	end of exhaust Stack	''
Description of Background	Cloudy Sky	''
Color of Background	Grey Clouds	''
Condition of Sky	Cloudy	''
Wind Speed (mph)	4	4
Wind Direction (From)	ESE	ESE
Ambient Temp (°F)	52	52
Relative Humidity (%)	76%	76%



Comments:

Observation Record

Test Method 9 Date 12.9.20

Start 13:05 Stop 13:11

	Seconds					Seconds			
Min	0	15	30	45	Min	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Range of Opacity Readings: Maximum 0 %, Minimum 0 %

Number of readings above 0 % = 0

Average Opacity for 24 readings = 0 %

Observer's Name (print) Peter Becker

Organization Montrose Air Quality Services, LLC

Certified By Smoke School Inc

Certification Date 10.30.20 **Expiration Date** 4.30.21

Observer's Signature

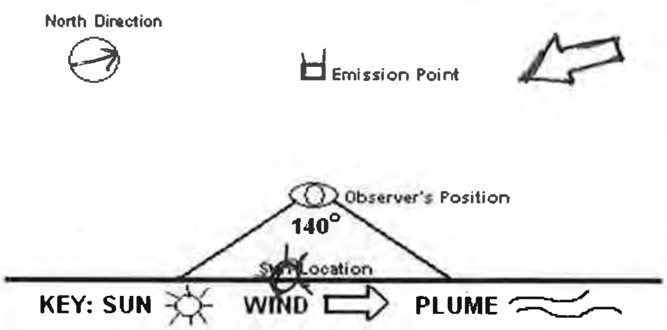
MAQS VE R1

MONTROSE AIR QUALITY SERVICES

VISIBLE EMISSION OBSERVATIONS

Project Information	
Client / Facility	SCS Engineering / Lechner
Source / Location	Leichner Landfill / Flare Exhaust
Project No.	PROJ-005918
Operation Mode/Output Rate	Scenario 2 (~1300F)
Control Equipment	N/A
Control Eq. Operation Mode	

Plume Information	Start	End
Emission Point Description	Circular Stack	"
Height Above Ground	~20	"
Height Relative to Observer	~20	"
Distance from Observer	~60	"
Direction from Observer	NW	"
Plume Type: Continuous	N/A	"
Intermittent	N/A	"
Fugitive	N/A	"
Plume Color	CLEAR	"
Water Droplets Present?	NO	"
Attached Plume	N/A	"
Detached Plume	N/A	"
Point in the plume at which the opacity was observed	end of exhaust stack	"
Description of Background	Grey Sky	"
Color of Background	Grey	"
Condition of Sky	Cloudy	"
Wind Speed (mph)	0	0
Wind Direction (From)	N	N
Ambient Temp (°F)	37	37
Relative Humidity (%)	93	93



Comments:

Observation Record

Test Method 9 Date 12.10.20

Start 8:54 Stop 9:00

Min	0	15	30	45	Min	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Range of Opacity Readings: Maximum 0 %, Minimum 0 %

Number of readings above 0 % = 0

Average Opacity for 24 readings = 0 %

Observer's Name (print) Peter Becker

Organization Montrose Air Quality Services, LLC

Certified By Smoke School Inc

Certification Date 10.30.20 **Expiration Date** 4.30.21

Observer's Signature Peter Becker

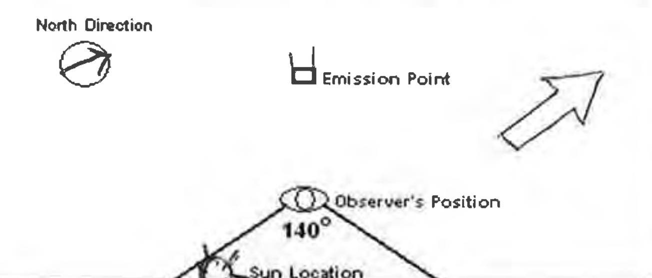
MAQS VE R1

VISIBLE EMISSION OBSERVATIONS

MONTROSE AIR QUALITY SERVICES

Project Information	
Client / Facility	SCS Engineering / Leichner
Source / Location	Leichner LANDFill / Flare Exh...
Project No.	Proj -005918
Operation Mode/Output Rate	Scenario 2 (~1300F)
Control Equipment	N/A
Control Eq. Operation Mode	

Plume Information	Start	End
Emission Point Description	end of Stack	"
Height Above Ground	~20	"
Height Relative to Observer	~20	"
Distance from Observer	~60	"
Direction from Observer	NW	"
Plume Type: Continuous	N/A	"
Intermittent	N/A	"
Fugitive	N/A	"
Plume Color	Clear	"
Water Droplets Present?	N/A	"
Attached Plume	N/A	"
Detached Plume	N/A	"
Point in the plume at which the opacity was observed	end of exhaust stack	"
Description of Background	Cloudy Sky	"
Color of Background	Grey	"
Condition of Sky	Cloudy	"
Wind Speed (mph)	3	"
Wind Direction (From)	S	"
Ambient Temp (°F)	43	"
Relative Humidity (%)	81%	81%



KEY: SUN WIND PLUME

Comments:

Observation Record

Test Method 9 Date 12.10.20

Start 11:02 Stop 11:08

Min	0	15	30	45
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Min	0	15	30	45
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

Range of Opacity Readings: Maximum 0 %, Minimum 0 %

Number of readings above 0 % = 0

Average Opacity for 24 readings = 0 %

Observer's Name (print) Peter Becker

Organization Montrose Air Quality Services, LLC

Certified By Smoke School Inc

Certification Date 10.30.20 **Expiration Date** 4.30.21

Observer's Signature Peter Becker

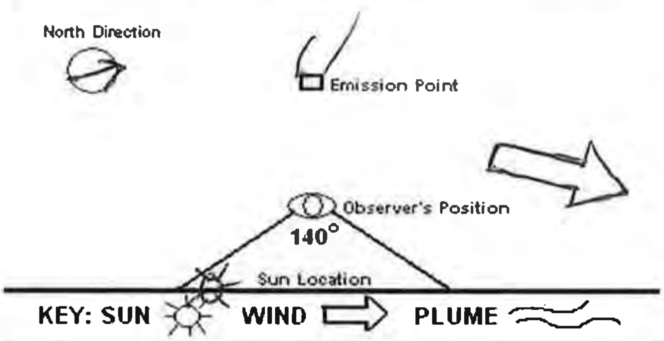
MAQS VE R1

MONTROSE AIR QUALITY SERVICES

VISIBLE EMISSION OBSERVATIONS

Project Information	
Client / Facility	SCS Engineering / Leichner
Source / Location	Leichner Landfill / Flare Exhaust
Project No.	Proj-005918
Operation Mode/Output Rate	Scenario 2 (~1300F)
Control Equipment	N/A
Control Eq. Operation Mode	N/A

Plume Information	Start	End
Emission Point Description	end of stack	"
Height Above Ground	~20	"
Height Relative to Observer	~20	"
Distance from Observer	~60	"
Direction from Observer	NW	"
Plume Type: Continuous	N/A	"
Intermittent	N/A	"
Fugitive	N/A	"
Plume Color	Clear	"
Water Droplets Present?	N/A	"
Attached Plume	N/A	"
Detached Plume	N/A	"
Point in the plume at which the opacity was observed	end of exhaust stack	"
Description of Background	Cloudy Sky	"
Color of Background	Grey	"
Condition of Sky	Cloudy	"
Wind Speed (mph)	5	5
Wind Direction (From)	WSW	WSW
Ambient Temp (°F)	43	43
Relative Humidity (%)	75	75



Comments:

Observation Record

Test Method 9 Date 12.10.20

Start 13:02 Stop 13:08

Min	0	15	30	45	Min	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Range of Opacity Readings: Maximum 0 %; Minimum 0 %

Number of readings above 0 % = 0

Average Opacity for 24 readings = 0 %

Observer's Name (print): Peter Becker

Organization: Montrose Air Quality Services, LLC

Certified By: Smoke School Inc

Certification Date: 10.30.20 Expiration Date: 4.30.21

Observer's Signature: Peter Becker

MAQS VE R1

Appendix A.5
Instrumental Test Method Data

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 1 Average Results - Scenerio 1 Run 1

08:30:00 - 09:33:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 9 2020	08:31:00	13.19	5.703	18.34	2.974		-1.072		
Dec 9 2020	08:32:00	13.14	5.731	18.54	3.083		-1.241		
Dec 9 2020	08:33:00	13.12	5.741	18.61	3.074		-1.391		
Dec 9 2020	08:34:00	13.15	5.743	18.66	3.102		-1.406		
Dec 9 2020	08:35:00	13.07	5.798	18.77	3.039		-1.393		
End of port 1 point 1									
Dec 9 2020	08:36:00	13.02	5.835	18.85	2.941		-1.497		
Dec 9 2020	08:37:00	13.01	5.836	19.04	2.779		-1.496		
Dec 9 2020	08:38:00	13.11	5.776	18.82	2.866		-1.504		
Dec 9 2020	08:39:00	13.12	5.767	18.72	2.921		-1.483		
Dec 9 2020	08:40:00	13.01	5.844	19.09	2.659		-1.407		
End of port 1 point 2									
Dec 9 2020	08:41:00	13.13	5.753	18.73	3.040		-1.723		
Dec 9 2020	08:42:00	13.02	5.826	19.08	2.986		-1.707		
Dec 9 2020	08:43:00	13.05	5.818	18.87	2.898		-1.720		
Dec 9 2020	08:44:00	13.10	5.777	18.88	2.768		-1.846		
Dec 9 2020	08:45:00	13.19	5.701	18.58	2.622		-1.746		
End of port 1 point 3									
Dec 9 2020	08:46:00	13.10	5.783	18.89	2.870		-1.797		
Dec 9 2020	08:47:00	13.09	5.783	18.84	2.845		-1.883		
Dec 9 2020	08:48:00	13.13	5.681	18.73	2.757		-2.099		
Dec 9 2020	08:49:00	13.21	5.637	18.56	2.780		-2.011		
Dec 9 2020	08:50:00	13.14	5.748	18.89	2.712		-1.796		
End of port 1 point 4									
Dec 9 2020	08:51:00	13.19	5.717	18.74	2.704		-2.095		
Dec 9 2020	08:52:00	13.29	5.646	18.41	2.737		-2.134		
Dec 9 2020	08:53:00	13.24	5.684	18.49	2.622		-2.121		
Dec 9 2020	08:54:00	13.33	5.611	18.25	2.702		-2.286		
Dec 9 2020	08:55:00	13.23	5.683	18.52	2.626		-2.389		
End of port 1 point 5									
Dec 9 2020	08:56:00	13.20	5.713	18.65	2.615		-2.300		
Dec 9 2020	08:57:00	13.27	5.665	18.50	2.505		-2.362		
Dec 9 2020	08:58:00	13.21	5.713	18.80	2.528		-2.226		
Dec 9 2020	08:59:00	13.23	5.696	18.73	2.515		-2.473		
Dec 9 2020	09:00:00	13.29	5.648	18.69	2.668		-2.530		
End of port 1 point 6									
Dec 9 2020	09:04:00	13.32	5.623	18.45	2.383		-2.413		
Dec 9 2020	09:05:00	13.16	5.746	18.92	2.521		-2.528		
Dec 9 2020	09:06:00	13.24	5.701	18.72	2.464		-2.702		
Dec 9 2020	09:07:00	13.28	5.654	18.58	2.564		-2.754		
Dec 9 2020	09:08:00	13.23	5.693	18.72	2.688		-2.902		
End of port 2 point 1									
Dec 9 2020	09:09:00	13.26	5.677	18.67	2.713		-2.822		
Dec 9 2020	09:10:00	13.24	5.693	18.71	2.537		-2.790		
Dec 9 2020	09:11:00	13.26	5.675	18.65	2.700		-2.695		
Dec 9 2020	09:12:00	13.22	5.707	18.74	2.670		-2.925		
Dec 9 2020	09:13:00	13.29	5.659	18.45	2.710		-2.908		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 9 2020	09:14:00	13.36	5.613	18.27	2.491		-3.028		
Dec 9 2020	09:15:00	13.31	5.642	18.39	2.098		-2.925		
Dec 9 2020	09:16:00	13.22	5.713	18.78	2.528		-3.128		
Dec 9 2020	09:17:00	13.24	5.698	18.63	2.573		-3.008		
Dec 9 2020	09:18:00	13.21	5.709	18.76	2.504		-3.065		
End of port 2 point 3									
Dec 9 2020	09:19:00	13.19	5.715	18.73	2.592		-3.038		
Dec 9 2020	09:20:00	13.40	5.573	18.23	2.623		-3.345		
Dec 9 2020	09:21:00	13.24	5.692	18.64	2.737		-3.225		
Dec 9 2020	09:22:00	13.34	5.625	18.38	2.633		-3.301		
Dec 9 2020	09:23:00	13.29	5.656	18.43	2.645		-3.402		
End of port 2 point 4									
Dec 9 2020	09:24:00	13.28	5.657	18.43	2.540		-3.439		
Dec 9 2020	09:25:00	13.35	5.626	18.31	2.517		-3.311		
Dec 9 2020	09:26:00	13.37	5.605	18.30	2.037		-3.286		
Dec 9 2020	09:27:00	13.34	5.638	18.27	1.954		-3.284		
Dec 9 2020	09:28:00	13.28	5.679	18.53	2.617		-3.521		
End of port 2 point 5									
Dec 9 2020	09:29:00	13.24	5.718	18.70	2.477		-3.363		
Dec 9 2020	09:30:00	13.22	5.722	18.70	2.505		-3.599		
Dec 9 2020	09:31:00	13.26	5.698	18.68	2.524		-3.612		
Dec 9 2020	09:32:00	13.12	5.814	19.19	2.365		-3.616		
Dec 9 2020	09:33:00	13.12	5.801	19.08	2.335		-3.593		
End of port 2 point 6									

	Average:	13.21	5.708	18.66	2.653		-2.478		
	Max:	13.40	5.844	19.19	3.102		-1.072		
	Min:	13.01	5.573	18.23	1.954		-3.616		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	13.12	5.758	18.69	3.066		-1.336		
1	2	13.04	5.823	18.96	2.796		-1.522		
1	3	13.09	5.784	18.92	2.862		-1.878		
1	4	13.13	5.730	18.75	2.848		-2.006		
1	5	13.23	5.686	18.51	2.700		-2.148		
1	6	13.26	5.657	18.68	2.545		-2.350		
2	1	13.26	5.678	18.75	2.562		-2.714		
2	2	13.24	5.691	18.67	2.704		-2.728		
2	3	13.27	5.665	18.52	2.405		-3.034		
2	4	13.30	5.643	18.36	2.629		-3.407		
2	5	13.29	5.662	18.39	2.318		-3.247		
2	6	13.12	5.817	19.14	2.415		-3.514		
	Strat diff:	0.104	0.107	0.445	0.412		1.154		
	Strat %:	1.181	1.869	2.380	9.388		-9.544		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 1 Post run bias - Scenerio 1 Run 1

08:30:00 - 09:33:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Run summary data

	Raw Avg:	13.21	5.708	18.66	2.653		-2.478		
	Max:	13.40	5.844	19.19	3.102		-1.072		
	Min:	13.01	5.573	18.23	1.954		-3.616		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	0.021	0.018	0.020	0.051		-0.200		
	Low reading:								
	Mid reading:	10.11	10.05	26.96	4.953		15.18		
	High reading:	20.85	18.54	56.23	9.964		27.30		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		-0.727		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		0.000		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.799		

Initial Bias Data

	Zero reading:	0.057	0.070	0.212	0.198		0.689		
	Span reading:	9.908	9.883	26.52	4.828		14.37		
Zero % bias:	**<5.0**	0.172	0.280	0.342	1.482		3.230		
Span % bias:	**<5.0**	-0.965	-0.900	-0.783	-1.260		-2.943		

Final Bias Data

	Zero reading:	0.030	0.095	0.112	0.375		0.047		
	Span reading:	9.913	10.12	27.57	4.907		14.29		
Zero % bias:	**<5.0**	0.043	0.415	0.164	3.267		0.898		
Span % bias:	**<5.0**	-0.941	0.377	1.085	-0.464		-3.234		
Zero % drift:	**<3.0**	0.129	0.135	0.178	1.784		2.332		
Span % drift:	**<3.0**	0.024	1.277	1.868	0.796		0.291		

Bias Corrected Averages

	Cor Avg:	13.36	5.734	19.11	2.537		-3.094		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 2 Average Results - Scenario 1 Run 2

11:00:00 - 12:03:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 9 2020	11:01:00	13.13	5.740	18.65	1.909		-0.613		
Dec 9 2020	11:02:00	13.12	5.744	18.67	1.887		-0.637		
Dec 9 2020	11:03:00	12.98	5.845	19.21	2.008		-0.600		
Dec 9 2020	11:04:00	12.98	5.846	19.23	1.878		-0.712		
Dec 9 2020	11:05:00	13.06	5.806	18.88	1.698		-0.777		
End of port 1 point 1									
Dec 9 2020	11:06:00	13.07	5.776	18.94	1.824		-0.888		
Dec 9 2020	11:07:00	13.07	5.790	18.99	1.829		-0.783		
Dec 9 2020	11:08:00	12.93	5.889	19.30	1.721		-0.631		
Dec 9 2020	11:09:00	13.01	5.836	18.78	1.726		-0.626		
Dec 9 2020	11:10:00	13.04	5.799	18.78	1.634		-0.703		
End of port 1 point 2									
Dec 9 2020	11:11:00	13.08	5.787	19.13	1.919		-0.729		
Dec 9 2020	11:12:00	13.01	5.830	19.23	2.117		-0.655		
Dec 9 2020	11:13:00	13.07	5.808	19.16	2.096		-0.702		
Dec 9 2020	11:14:00	13.13	5.746	18.89	2.001		-0.722		
Dec 9 2020	11:15:00	13.11	5.770	19.04	1.761		-0.656		
End of port 1 point 3									
Dec 9 2020	11:16:00	13.03	5.815	19.32	1.345		-0.689		
Dec 9 2020	11:17:00	13.06	5.799	19.24	1.531		-0.709		
Dec 9 2020	11:18:00	13.27	5.645	18.47	1.625		-0.724		
Dec 9 2020	11:19:00	13.24	5.677	18.74	1.922		-0.900		
Dec 9 2020	11:20:00	13.29	5.623	18.52	2.181		-0.840		
End of port 1 point 4									
Dec 9 2020	11:21:00	13.29	5.631	18.60	1.981		-0.933		
Dec 9 2020	11:22:00	13.34	5.594	18.44	2.010		-0.766		
Dec 9 2020	11:23:00	13.06	5.801	19.21	1.644		-0.829		
Dec 9 2020	11:24:00	13.19	5.705	18.76	1.492		-0.802		
Dec 9 2020	11:25:00	13.10	5.781	18.97	1.560		-0.942		
End of port 1 point 5									
Dec 9 2020	11:26:00	13.16	5.735	18.67	1.428		-0.894		
Dec 9 2020	11:27:00	13.13	5.748	18.96	1.506		-0.917		
Dec 9 2020	11:28:00	13.14	5.752	18.94	1.595		-0.798		
Dec 9 2020	11:29:00	13.10	5.760	18.93	1.481		-1.028		
Dec 9 2020	11:30:00	13.10	5.772	18.99	1.380		-0.966		
End of port 1 point 6									
Dec 9 2020	11:34:00	13.30	5.613	18.45	1.706		-0.882		
Dec 9 2020	11:35:00	13.19	5.691	18.76	1.630		-0.987		
Dec 9 2020	11:36:00	13.27	5.638	18.66	1.470		-1.035		
Dec 9 2020	11:37:00	13.21	5.673	18.76	1.603		-1.025		
Dec 9 2020	11:38:00	13.29	5.606	18.59	1.752		-0.983		
End of port 2 point 1									
Dec 9 2020	11:39:00	13.18	5.689	18.85	1.438		-1.002		
Dec 9 2020	11:40:00	13.17	5.708	18.94	1.455		-0.794		
Dec 9 2020	11:41:00	13.26	5.630	18.68	1.682		-1.034		
Dec 9 2020	11:42:00	13.23	5.654	18.62	1.707		-0.953		
Dec 9 2020	11:43:00	13.22	5.664	18.86	1.587		-0.975		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 9 2020	11:44:00	13.28	5.629	18.58	1.654		-0.719		
Dec 9 2020	11:45:00	13.23	5.660	18.59	1.396		-0.992		
Dec 9 2020	11:46:00	13.23	5.662	18.75	1.331		-1.016		
Dec 9 2020	11:47:00	13.18	5.699	18.93	1.507		-0.894		
Dec 9 2020	11:48:00	13.17	5.714	18.92	1.597		-0.907		
End of port 2 point 3									
Dec 9 2020	11:49:00	13.21	5.670	18.80	1.443		-0.934		
Dec 9 2020	11:50:00	13.12	5.656	19.12	1.565		-0.892		
Dec 9 2020	11:51:00	13.24	5.549	18.72	1.633		-1.000		
Dec 9 2020	11:52:00	13.17	5.685	18.90	1.566		-0.858		
Dec 9 2020	11:53:00	13.17	5.692	18.94	1.454		-0.808		
End of port 2 point 4									
Dec 9 2020	11:54:00	13.20	5.679	18.78	1.413		-0.919		
Dec 9 2020	11:55:00	13.18	5.688	18.79	1.523		-0.783		
Dec 9 2020	11:56:00	13.19	5.679	18.86	1.596		-0.901		
Dec 9 2020	11:57:00	13.18	5.692	18.87	1.388		-0.916		
Dec 9 2020	11:58:00	13.28	5.605	18.54	1.684		-0.877		
End of port 2 point 5									
Dec 9 2020	11:59:00	13.20	5.674	18.82	1.538		-1.132		
Dec 9 2020	12:00:00	13.24	5.656	18.67	1.456		-0.966		
Dec 9 2020	12:01:00	13.25	5.625	18.31	1.734		-1.013		
Dec 9 2020	12:02:00	13.09	5.758	19.07	1.418		-1.077		
Dec 9 2020	12:03:00	13.25	5.645	18.73	1.576		-0.953		
End of port 2 point 6									

	Average:	13.16	5.712	18.84	1.653		-0.857		
	Max:	13.34	5.889	19.32	2.181		-0.600		
	Min:	12.93	5.549	18.31	1.331		-1.132		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	13.04	5.807	18.88	1.847		-0.655		
1	2	13.03	5.825	18.95	1.770		-0.756		
1	3	13.10	5.775	18.98	1.944		-0.684		
1	4	13.17	5.720	18.90	1.754		-0.757		
1	5	13.15	5.744	18.98	1.734		-0.837		
1	6	13.07	5.810	19.07	1.420		-0.834		
2	1	13.25	5.644	18.68	1.628		-0.921		
2	2	13.23	5.650	18.76	1.578		-0.968		
2	3	13.19	5.691	18.77	1.511		-0.923		
2	4	13.22	5.633	18.84	1.522		-0.874		
2	5	13.22	5.656	18.81	1.518		-0.889		
2	6	13.22	5.672	18.58	1.543		-1.025		
	Strat diff:	0.092	0.106	0.220	0.297		0.189		
	Strat %:	0.969	1.855	1.432	8.281		-9.414		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 2 Post run bias - Scenario 1 Run 2

11:00:00 - 12:03:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Run summary data									
	Raw Avg:	13.16	5.712	18.84	1.653		-0.857		
	Max:	13.34	5.889	19.32	2.181		-0.600		
	Min:	12.93	5.549	18.31	1.331		-1.132		

Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings									
	Zero reading:	0.021	0.018	0.020	0.051		0.035		
	Low reading:								
	Mid reading:	10.11	10.05	26.96	4.953		15.08		
	High reading:	20.85	18.54	56.23	9.964		27.51		

EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		0.127		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		-0.363		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.036		

Initial Bias Data									
	Zero reading:	0.057	0.070	0.212	0.198		0.399		
	Span reading:	9.908	9.883	26.52	4.828		13.95		
Zero % bias:	**<5.0**	0.172	0.280	0.342	1.482		1.323		
Span % bias:	**<5.0**	-0.965	-0.900	-0.783	-1.260		-4.106		

Final Bias Data									
	Zero reading:	-0.066	0.093	0.150	0.180		-0.198		
	Span reading:	9.877	10.01	27.40	4.951		13.75		
Zero % bias:	**<5.0**	-0.416	0.404	0.231	1.301		-0.847		
Span % bias:	**<5.0**	-1.113	-0.216	0.783	-0.020		-4.833		
Zero % drift:	**<3.0**	0.588	0.124	0.111	0.181		2.170		
Span % drift:	**<3.0**	0.148	0.684	1.566	1.240		0.727		

Bias Corrected Averages									
	Cor Avg:	13.31	5.770	19.35	1.530		-1.057		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 3 Average Results - Scenario 1 Run 3

12:46:00 - 13:47:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 9 2020	12:47:00	13.31	5.584	18.24	1.336		1.004		
Dec 9 2020	12:48:00	13.31	5.591	18.32	1.183		0.816		
Dec 9 2020	12:49:00	13.30	5.590	18.41	1.332		0.901		
Dec 9 2020	12:50:00	13.27	5.596	18.44	1.292		0.777		
Dec 9 2020	12:51:00	13.41	5.438	18.07	1.413		0.545		
End of port 1 point 1									
Dec 9 2020	12:52:00	13.23	5.631	18.46	1.166		0.476		
Dec 9 2020	12:53:00	13.17	5.690	18.67	0.950		0.439		
Dec 9 2020	12:54:00	13.21	5.648	18.63	1.033		0.494		
Dec 9 2020	12:55:00	13.21	5.657	18.66	1.098		0.599		
Dec 9 2020	12:56:00	13.10	5.741	18.82	0.766		0.391		
End of port 1 point 2									
Dec 9 2020	12:57:00	13.24	5.614	18.36	0.961		0.450		
Dec 9 2020	12:58:00	13.17	5.683	18.77	1.014		0.321		
Dec 9 2020	12:59:00	13.11	5.730	18.86	0.952		0.397		
Dec 9 2020	13:00:00	13.26	5.624	18.39	1.066		0.506		
Dec 9 2020	13:01:00	13.27	5.613	18.55	1.375		0.257		
End of port 1 point 3									
Dec 9 2020	13:02:00	13.28	5.611	18.35	1.369		0.236		
Dec 9 2020	13:03:00	13.24	5.645	18.57	1.252		0.367		
Dec 9 2020	13:04:00	13.23	5.636	18.46	1.238		0.319		
Dec 9 2020	13:05:00	13.21	5.666	18.65	1.236		0.268		
Dec 9 2020	13:06:00	13.21	5.658	18.66	1.222		0.372		
End of port 1 point 4									
Dec 9 2020	13:07:00	13.23	5.643	18.50	1.204		0.461		
Dec 9 2020	13:08:00	13.37	5.543	18.20	1.444		0.319		
Dec 9 2020	13:09:00	13.27	5.604	18.55	1.479		0.177		
Dec 9 2020	13:10:00	13.26	5.626	18.51	1.501		0.195		
Dec 9 2020	13:11:00	13.35	5.553	18.07	1.451		0.282		
End of port 1 point 5									
Dec 9 2020	13:12:00	13.24	5.651	18.47	1.259		0.254		
Dec 9 2020	13:13:00	13.29	5.609	18.26	1.286		0.298		
Dec 9 2020	13:14:00	13.31	5.588	18.28	1.361		0.279		
Dec 9 2020	13:15:00	13.19	5.669	18.62	1.345		0.237		
Dec 9 2020	13:16:00	13.40	5.531	18.05	1.321		0.231		
End of port 1 point 6									
Dec 9 2020	13:18:00	13.27	5.621	18.42	1.350		0.170		
Dec 9 2020	13:19:00	13.35	5.549	18.24	1.512		0.358		
Dec 9 2020	13:20:00	13.31	5.586	18.31	1.208		0.262		
Dec 9 2020	13:21:00	13.17	5.685	18.80	1.029		0.275		
Dec 9 2020	13:22:00	13.20	5.668	18.83	1.177		0.321		
End of port 2 point 1									
Dec 9 2020	13:23:00	13.19	5.677	18.99	1.096		0.210		
Dec 9 2020	13:24:00	13.02	5.794	19.41	0.959		0.332		
Dec 9 2020	13:25:00	13.10	5.750	19.12	1.016		0.196		
Dec 9 2020	13:26:00	13.38	5.538	18.27	1.487		0.104		
Dec 9 2020	13:27:00	13.39	5.526	18.05	1.569		0.224		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 9 2020	13:28:00	13.42	5.515	18.05	1.833		0.229		
Dec 9 2020	13:29:00	13.35	5.556	18.23	1.800		0.356		
Dec 9 2020	13:30:00	13.32	5.601	18.35	1.464		0.157		
Dec 9 2020	13:31:00	13.36	5.566	18.22	1.602		0.060		
Dec 9 2020	13:32:00	13.36	5.553	18.26	1.828		-0.060		
End of port 2 point 3									
Dec 9 2020	13:33:00	13.35	5.542	18.24	1.769		0.217		
Dec 9 2020	13:34:00	13.33	5.500	18.27	1.561		0.251		
Dec 9 2020	13:35:00	13.07	5.772	19.02	1.539		0.257		
Dec 9 2020	13:36:00	13.05	5.803	19.15	1.186		0.339		
Dec 9 2020	13:37:00	12.99	5.834	19.33	1.494		0.024		
End of port 2 point 4									
Dec 9 2020	13:38:00	13.04	5.801	19.26	1.458		0.036		
Dec 9 2020	13:39:00	13.24	5.653	18.62	1.740		0.302		
Dec 9 2020	13:40:00	13.35	5.555	18.13	1.984		0.064		
Dec 9 2020	13:41:00	13.33	5.579	18.31	1.815		0.154		
Dec 9 2020	13:42:00	13.27	5.615	18.44	1.887		-0.009		
End of port 2 point 5									
Dec 9 2020	13:43:00	13.21	5.650	18.69	2.111		0.202		
Dec 9 2020	13:44:00	13.13	5.651	18.93	1.660		-0.055		
Dec 9 2020	13:45:00	13.01	5.806	19.45	1.563		0.153		
Dec 9 2020	13:46:00	13.02	5.797	19.32	1.607		0.185		
Dec 9 2020	13:47:00	13.20	5.661	18.63	1.895		0.243		
End of port 2 point 6									

	Average:	13.24	5.634	18.55	1.385		0.304		
	Max:	13.42	5.834	19.45	2.111		1.004		
	Min:	12.99	5.438	18.05	0.766		-0.060		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	13.24	5.588	18.48	1.280		0.686		
1	2	13.09	5.729	18.76	0.917		0.450		
1	3	13.21	5.662	18.61	1.117		0.351		
1	4	13.27	5.623	18.41	1.278		0.324		
1	5	13.30	5.581	18.37	1.436		0.336		
1	6	13.32	5.589	18.19	1.337		0.187		
2	1	13.29	5.606	18.72	1.233		0.304		
2	2	13.21	5.654	18.78	1.272		0.296		
2	3	13.33	5.585	18.41	1.686		0.197		
2	4	13.13	5.696	18.83	1.484		0.232		
2	5	13.27	5.625	18.43	1.791		0.115		
2	6	13.16	5.697	18.88	1.811		0.095		
	Strat diff:	0.095	0.093	0.307	0.424		0.388		
	Strat %:	1.096	1.646	2.059	8.280		8.816		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 3 Post run bias - Scenario 1 Run 3

12:46:00 - 13:47:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Run summary data

	Raw Avg:	13.24	5.634	18.55	1.385		0.304		
	Max:	13.42	5.834	19.45	2.111		1.004		
	Min:	12.99	5.438	18.05	0.766		-0.060		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	0.021	0.018	0.020	0.051		0.035		
	Low reading:								
	Mid reading:	10.11	10.05	26.96	4.953		15.08		
	High reading:	20.85	18.54	56.23	9.964		27.51		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		0.127		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		-0.363		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.036		

Initial Bias Data

	Zero reading:	-0.066	0.093	0.150	0.180		-0.198		
	Span reading:	9.877	10.01	27.40	4.951		13.75		
Zero % bias:	**<5.0**	-0.416	0.404	0.231	1.301		-0.847		
Span % bias:	**<5.0**	-1.113	-0.216	0.783	-0.020		-4.833		

Final Bias Data

	Zero reading:	-0.082	0.124	0.170	-0.162		0.104		
	Span reading:	9.891	10.04	27.46	5.021		14.11		
Zero % bias:	**<5.0**	-0.492	0.571	0.267	-2.147		0.251		
Span % bias:	**<5.0**	-1.046	-0.054	0.890	0.686		-3.525		
Zero % drift:	**<3.0**	0.076	0.167	0.036	0.342		1.098		
Span % drift:	**<3.0**	0.067	0.162	0.107	0.706		1.308		

Bias Corrected Averages

	Cor Avg:	13.38	5.633	18.73	1.358		0.381		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 1 Average Results - Scenario 2 Run 1

08:27:00 - 09:31:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 10 2020	08:28:00	14.40	4.951	15.93	3.137		-0.272		
Dec 10 2020	08:29:00	14.41	4.922	15.77	3.257		-0.173		
Dec 10 2020	08:30:00	14.38	4.935	15.93	3.352		-0.402		
Dec 10 2020	08:34:40	14.43	4.916	15.86	3.659		-0.674		
Dec 10 2020	08:35:40	14.50	4.871	15.67	3.629		-0.760		
End of port 1 point 1									
Dec 10 2020	08:36:40	14.57	4.798	15.50	3.949		-0.623		
Dec 10 2020	08:37:40	14.57	4.799	15.50	4.296		-0.706		
Dec 10 2020	08:38:40	14.53	4.817	15.46	4.473		-0.847		
Dec 10 2020	08:39:40	14.60	4.783	15.35	4.405		-0.869		
Dec 10 2020	08:40:40	14.53	4.832	15.61	4.357		-0.669		
End of port 1 point 2									
Dec 10 2020	08:41:40	14.53	4.839	15.66	4.046		-0.731		
Dec 10 2020	08:42:40	14.63	4.771	15.44	4.540		-0.925		
Dec 10 2020	08:43:40	14.47	4.905	15.93	4.349		-1.121		
Dec 10 2020	08:44:40	14.48	4.881	15.75	4.096		-1.077		
Dec 10 2020	08:45:40	14.43	4.911	15.88	4.225		-1.099		
End of port 1 point 3									
Dec 10 2020	08:46:40	14.60	4.798	15.51	4.707		-1.157		
Dec 10 2020	08:47:40	14.59	4.802	15.50	4.652		-1.047		
Dec 10 2020	08:48:40	14.59	4.804	15.51	4.335		-1.217		
Dec 10 2020	08:49:40	14.65	4.761	15.31	4.380		-1.176		
Dec 10 2020	08:50:40	14.64	4.777	15.43	4.001		-1.338		
End of port 1 point 4									
Dec 10 2020	08:51:40	14.68	4.728	15.31	4.138		-1.381		
Dec 10 2020	08:52:40	14.52	4.840	15.78	4.084		-1.412		
Dec 10 2020	08:53:40	14.52	4.839	15.71	4.173		-1.324		
Dec 10 2020	08:54:40	14.53	4.824	15.87	3.772		-1.484		
Dec 10 2020	08:55:40	14.61	4.778	15.53	3.450		-1.378		
End of port 1 point 5									
Dec 10 2020	08:56:40	14.51	4.850	15.84	3.657		-1.477		
Dec 10 2020	08:57:40	14.46	4.896	15.97	3.986		-1.601		
Dec 10 2020	08:58:40	14.52	4.852	15.85	3.562		-1.601		
Dec 10 2020	08:59:40	14.65	4.749	15.34	4.004		-1.470		
Dec 10 2020	09:00:40	14.63	4.759	15.39	4.418		-1.736		
End of port 1 point 6									
Dec 10 2020	09:02:00	14.50	4.856	15.81	4.323		-1.489		
Dec 10 2020	09:03:00	14.64	4.756	15.48	4.605		-1.666		
Dec 10 2020	09:04:00	14.73	4.684	15.16	4.766		-1.583		
Dec 10 2020	09:05:00	14.69	4.728	15.28	5.044		-1.754		
Dec 10 2020	09:06:00	14.82	4.615	14.86	4.791		-1.844		
End of port 2 point 1									
Dec 10 2020	09:07:00	14.81	4.629	14.94	4.739		-1.847		
Dec 10 2020	09:08:00	14.78	4.650	15.01	4.615		-2.045		
Dec 10 2020	09:09:00	14.79	4.628	14.96	4.749		-1.800		
Dec 10 2020	09:10:00	14.80	4.627	15.00	4.692		-1.843		
Dec 10 2020	09:11:00	14.72	4.693	15.15	5.160		-2.050		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 10 2020	09:12:00	14.76	4.657	15.04	5.195		-2.081		
Dec 10 2020	09:13:00	14.37	4.937	16.01	4.150		-2.149		
Dec 10 2020	09:14:00	14.41	4.920	16.03	3.527		-2.208		
Dec 10 2020	09:15:00	14.41	4.908	16.00	3.560		-2.086		
Dec 10 2020	09:16:00	14.62	4.731	15.40	4.334		-2.093		
End of port 2 point 3									
Dec 10 2020	09:17:00	14.82	4.578	14.73	4.806		-2.053		
Dec 10 2020	09:18:00	14.78	4.594	14.82	4.563		-2.167		
Dec 10 2020	09:19:00	14.80	4.560	14.70	4.656		-2.295		
Dec 10 2020	09:20:00	14.80	4.563	14.85	4.389		-2.213		
Dec 10 2020	09:21:00	14.88	4.480	14.43	4.774		-2.471		
End of port 2 point 4									
Dec 10 2020	09:22:00	14.84	4.507	14.56	4.600		-2.344		
Dec 10 2020	09:23:00	14.84	4.487	14.53	4.592		-2.431		
Dec 10 2020	09:24:00	14.89	4.431	14.38	4.715		-2.355		
Dec 10 2020	09:25:00	14.77	4.525	14.78	5.040		-2.400		
Dec 10 2020	09:26:00	14.64	4.605	14.96	4.519		-2.598		
End of port 2 point 5									
Dec 10 2020	09:27:00	14.70	4.559	14.83	4.671		-2.600		
Dec 10 2020	09:28:00	14.74	4.518	14.79	4.730		-2.597		
Dec 10 2020	09:29:00	14.69	4.549	14.87	5.015		-2.538		
Dec 10 2020	09:30:00	14.68	4.547	14.91	4.503		-2.650		
Dec 10 2020	09:31:00	14.54	4.643	15.22	4.249		-2.580		
End of port 2 point 6									

	Average:	14.62	4.736	15.34	4.319		-1.610		
	Max:	14.89	4.951	16.03	5.195		-0.173		
	Min:	14.37	4.431	14.38	3.137		-2.650		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	14.37	4.945	15.90	3.403		-0.423		
1	2	14.54	4.827	15.60	4.295		-0.871		
1	3	14.54	4.844	15.56	4.255		-1.027		
1	4	14.64	4.751	15.45	4.388		-1.263		
1	5	14.51	4.860	15.82	3.943		-1.389		
1	6	14.59	4.783	15.74	3.985		-1.530		
2	1	14.75	4.676	15.08	4.788		-1.787		
2	2	14.78	4.643	15.05	4.823		-1.894		
2	3	14.53	4.816	15.61	4.086		-2.116		
2	4	14.84	4.534	14.62	4.625		-2.289		
2	5	14.85	4.454	14.52	4.703		-2.361		
2	6	14.56	4.630	15.10	4.621		-2.621		
	Strat diff:	0.225	0.215	0.563	0.497		1.208		
	Strat %:	1.744	5.840	5.330	8.859		-9.570		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 1 Post run bias - Scenario 2 Run 1

08:27:00 - 09:31:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		
Run summary data									
	Raw Avg:	14.62	4.736	15.34	4.319		-1.610		
	Max:	14.89	4.951	16.03	5.195		-0.173		
	Min:	14.37	4.431	14.38	3.137		-2.650		
Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		
Calibration Readings									
	Zero reading:	-0.029	-0.001	0.007	-0.068		0.068		
	Low reading:								
	Mid reading:	10.01	9.843	26.96	5.008		14.95		
	High reading:	20.90	18.54	56.23	9.763		27.42		
EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	-0.139	-0.005	0.012	-0.686		0.247		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	0.968		-0.836		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-1.573		-0.363		
Initial Bias Data									
	Zero reading:	0.015	0.034	0.198	0.287		-0.031		
	Span reading:	9.933	9.978	26.81	4.776		13.95		
Zero % bias:	**<5.0**	0.210	0.189	0.340	3.579		-0.360		
Span % bias:	**<5.0**	-0.368	0.728	-0.267	-2.339		-3.634		
Final Bias Data									
	Zero reading:	-0.038	0.020	0.185	0.183		-0.178		
	Span reading:	9.927	9.853	27.35	5.053		14.00		
Zero % bias:	**<5.0**	-0.043	0.113	0.317	2.531		-0.894		
Span % bias:	**<5.0**	-0.397	0.054	0.694	0.454		-3.452		
Zero % drift:	**<3.0**	0.253	0.076	0.023	1.049		0.534		
Span % drift:	**<3.0**	0.029	0.674	0.961	2.793		0.182		
Bias Corrected Averages									
	Cor Avg:	14.73	4.814	15.65	4.287		-1.623		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 2 Average Results - Scenario 2 Run 2

10:57:00 - 11:59:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 10 2020	10:58:00	14.01	4.995	16.52	2.669		-0.404		
Dec 10 2020	10:59:00	14.07	4.926	16.30	2.947		-0.408		
Dec 10 2020	11:00:00	14.10	4.893	16.24	2.900		-0.266		
Dec 10 2020	11:01:00	14.24	4.810	16.12	2.600		-0.394		
Dec 10 2020	11:02:00	14.33	4.734	15.61	3.419		-0.418		
End of port 1 point 1									
Dec 10 2020	11:03:00	14.27	4.782	15.65	3.192		-0.546		
Dec 10 2020	11:04:00	14.14	4.844	16.21	3.189		-0.637		
Dec 10 2020	11:05:00	14.28	4.762	15.60	3.240		-0.591		
Dec 10 2020	11:06:00	14.34	4.722	15.58	3.304		-0.572		
Dec 10 2020	11:07:00	14.40	4.668	15.35	3.643		-0.713		
End of port 1 point 2									
Dec 10 2020	11:08:00	14.67	4.481	14.59	3.920		-0.811		
Dec 10 2020	11:09:00	14.65	4.485	14.55	3.873		-0.941		
Dec 10 2020	11:10:00	14.58	4.548	14.77	3.902		-0.538		
Dec 10 2020	11:11:00	14.65	4.519	14.60	4.461		-0.736		
Dec 10 2020	11:12:00	14.55	4.570	14.83	3.728		-0.926		
End of port 1 point 3									
Dec 10 2020	11:13:00	14.42	4.658	15.16	3.688		-0.999		
Dec 10 2020	11:14:00	14.81	4.373	14.26	3.747		-0.916		
Dec 10 2020	11:15:00	14.57	4.563	14.81	3.927		-0.964		
Dec 10 2020	11:16:00	14.54	4.586	15.00	3.806		-0.963		
Dec 10 2020	11:17:00	14.69	4.485	14.60	4.153		-0.794		
End of port 1 point 4									
Dec 10 2020	11:18:00	14.68	4.493	14.63	4.433		-0.863		
Dec 10 2020	11:19:00	14.84	4.383	14.15	4.313		-0.917		
Dec 10 2020	11:20:00	14.72	4.478	14.46	4.479		-0.958		
Dec 10 2020	11:21:00	14.54	4.607	14.83	4.248		-0.077		
Dec 10 2020	11:22:00	14.54	4.612	14.90	4.115		-0.086		
End of port 1 point 5									
Dec 10 2020	11:23:00	14.54	4.610	14.92	4.200		0.037		
Dec 10 2020	11:24:00	14.50	4.639	15.03	4.021		0.013		
Dec 10 2020	11:25:00	14.50	4.638	15.08	3.801		-0.240		
Dec 10 2020	11:26:00	14.62	4.558	14.74	3.860		-0.080		
Dec 10 2020	11:27:00	14.74	4.458	14.36	4.373		-0.184		
End of port 1 point 6									
Dec 10 2020	11:30:00	14.65	4.533	14.53	4.456		-0.169		
Dec 10 2020	11:31:00	14.66	4.533	14.57	4.519		-0.215		
Dec 10 2020	11:32:00	14.48	4.639	15.00	4.309		-0.270		
Dec 10 2020	11:33:00	14.49	4.641	15.03	4.091		-0.609		
Dec 10 2020	11:34:00	14.34	4.746	15.41	3.952		-0.290		
End of port 2 point 1									
Dec 10 2020	11:35:00	14.22	4.829	15.96	3.049		-0.357		
Dec 10 2020	11:36:00	14.30	4.775	15.61	3.037		-0.304		
Dec 10 2020	11:37:00	14.37	4.720	15.29	3.563		-0.176		
Dec 10 2020	11:38:00	14.30	4.774	15.62	3.478		-0.261		
Dec 10 2020	11:39:00	14.58	4.573	14.81	4.015		-0.378		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 10 2020	11:40:00	14.26	4.790	15.61	4.183		-0.371		
Dec 10 2020	11:41:00	14.06	4.937	16.27	3.578		-0.335		
Dec 10 2020	11:42:00	14.00	4.987	16.55	2.915		-0.369		
Dec 10 2020	11:43:00	14.09	4.909	16.22	2.828		-0.252		
Dec 10 2020	11:44:00	14.07	4.909	16.12	3.096		-0.370		
End of port 2 point 3									
Dec 10 2020	11:45:00	14.02	4.952	16.49	3.093		-0.513		
Dec 10 2020	11:46:00	13.95	4.991	16.67	2.921		-0.221		
Dec 10 2020	11:47:00	14.06	4.908	16.28	2.682		-0.345		
Dec 10 2020	11:48:00	13.92	5.016	16.55	2.643		-0.423		
Dec 10 2020	11:49:00	13.99	4.964	16.29	2.603		-0.494		
End of port 2 point 4									
Dec 10 2020	11:50:00	13.89	5.016	16.46	2.801		-0.384		
Dec 10 2020	11:51:00	13.95	5.000	16.33	2.748		-0.373		
Dec 10 2020	11:52:00	13.95	5.039	16.21	2.748		-0.246		
Dec 10 2020	11:53:00	14.05	4.961	16.06	2.680		-0.522		
Dec 10 2020	11:54:00	13.88	5.101	16.50	3.020		-0.490		
End of port 2 point 5									
Dec 10 2020	11:55:00	13.98	5.020	16.28	3.145		-0.528		
Dec 10 2020	11:56:00	13.99	4.994	16.24	3.054		-0.613		
Dec 10 2020	11:57:00	14.02	4.974	16.09	2.750		-0.456		
Dec 10 2020	11:58:00	13.95	5.021	16.32	2.652		-0.539		
Dec 10 2020	11:59:00	14.31	4.751	15.19	2.694		-0.612		
End of port 2 point 6									

	Average:	14.32	4.748	15.50	3.491		-0.473		
	Max:	14.84	5.101	16.67	4.519		0.037		
	Min:	13.88	4.373	14.15	2.600		-0.999		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	14.13	4.889	16.25	3.001		-0.467		
1	2	14.29	4.774	15.54	3.391		-0.649		
1	3	14.63	4.518	14.69	4.009		-0.740		
1	4	14.66	4.509	14.54	3.852		-0.900		
1	5	14.61	4.556	14.73	4.303		-0.333		
1	6	14.64	4.549	14.75	4.125		-0.082		
2	1	14.45	4.656	15.11	4.178		-0.288		
2	2	14.44	4.664	15.26	3.522		-0.322		
2	3	14.06	4.947	16.20	3.197		-0.344		
2	4	13.99	4.975	16.43	2.726		-0.383		
2	5	14.01	4.989	16.16	2.847		-0.540		
2	6	14.12	4.906	15.86	2.863		-0.572		
	Strat diff:	0.324	0.245	0.970	0.802		0.386		
	Strat %:	2.412	5.157	6.274	8.688		-92.171		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 2 Post run bias - Scenario 2 Run 2

10:57:00 - 11:59:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		
Run summary data									
	Raw Avg:	14.32	4.748	15.50	3.491		-0.473		
	Max:	14.84	5.101	16.67	4.519		0.037		
	Min:	13.88	4.373	14.15	2.600		-0.999		
Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		
Calibration Readings									
	Zero reading:	-0.029	-0.001	0.007	0.061		-0.086		
	Low reading:								
	Mid reading:	10.01	9.843	26.96	5.064		15.00		
	High reading:	20.90	18.54	56.23	9.906		27.34		
EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	-0.139	-0.005	0.012	0.615		-0.313		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	1.532		-0.654		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-0.131		-0.654		
Initial Bias Data									
	Zero reading:	0.015	0.034	0.198	0.018		0.131		
	Span reading:	9.933	9.978	26.81	5.085		13.68		
Zero % bias:	**<5.0**	0.210	0.189	0.340	-0.434		0.789		
Span % bias:	**<5.0**	-0.368	0.728	-0.267	0.212		-4.797		
Final Bias Data									
	Zero reading:	-0.092	0.160	0.183	-0.230		0.088		
	Span reading:	9.868	9.755	26.61	4.802		13.93		
Zero % bias:	**<5.0**	-0.301	0.868	0.313	-2.934		0.632		
Span % bias:	**<5.0**	-0.679	-0.474	-0.623	-2.641		-3.888		
Zero % drift:	**<3.0**	0.511	0.679	0.027	2.500		0.157		
Span % drift:	**<3.0**	0.310	1.202	0.356	2.853		0.909		
Bias Corrected Averages									
	Cor Avg:	14.46	4.813	16.03	3.499		-0.646		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 3 Average Results - Scenario 2 Run 3

12:46:00 - 13:47:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
Dec 10 2020	12:47:00	14.37	4.672	14.73	2.971		0.352		
Dec 10 2020	12:48:00	14.43	4.626	14.52	3.105		0.459		
Dec 10 2020	12:49:00	14.30	4.740	14.96	3.203		0.464		
Dec 10 2020	12:50:00	14.24	4.769	15.13	2.767		0.545		
Dec 10 2020	12:51:00	14.42	4.648	14.59	3.058		0.509		
End of port 1 point 1									
Dec 10 2020	12:52:00	14.51	4.596	14.35	3.052		0.335		
Dec 10 2020	12:53:00	14.51	4.604	14.30	3.068		0.353		
Dec 10 2020	12:54:00	14.32	4.745	14.76	2.884		0.342		
Dec 10 2020	12:55:00	14.33	4.723	14.77	2.964		0.378		
Dec 10 2020	12:56:00	14.32	4.737	14.88	3.019		0.566		
End of port 1 point 2									
Dec 10 2020	12:57:00	14.37	4.699	14.73	3.454		0.429		
Dec 10 2020	12:58:00	14.03	4.909	15.60	2.781		0.324		
Dec 10 2020	12:59:00	14.22	4.772	15.12	2.649		0.250		
Dec 10 2020	13:00:00	14.14	4.852	15.41	2.887		0.285		
Dec 10 2020	13:01:00	14.46	4.645	14.49	2.717		0.299		
End of port 1 point 3									
Dec 10 2020	13:02:00	14.37	4.684	14.67	3.242		0.390		
Dec 10 2020	13:03:00	14.60	4.519	14.01	3.401		0.308		
Dec 10 2020	13:04:00	14.29	4.769	14.95	3.311		0.259		
Dec 10 2020	13:05:00	14.31	4.757	14.90	2.991		0.369		
Dec 10 2020	13:06:00	14.31	4.723	14.81	3.322		0.418		
End of port 1 point 4									
Dec 10 2020	13:07:00	14.38	4.678	14.72	3.275		0.469		
Dec 10 2020	13:08:00	14.45	4.633	14.50	3.089		0.266		
Dec 10 2020	13:09:00	14.18	4.820	15.35	2.932		0.346		
Dec 10 2020	13:10:00	14.36	4.688	14.73	2.910		0.295		
Dec 10 2020	13:11:00	14.53	4.565	14.22	3.476		0.322		
End of port 1 point 5									
Dec 10 2020	13:12:00	14.47	4.589	14.45	3.418		0.214		
Dec 10 2020	13:13:00	14.51	4.512	14.34	3.792		0.284		
Dec 10 2020	13:14:00	14.41	4.569	14.77	3.495		0.277		
Dec 10 2020	13:15:00	14.44	4.547	14.55	3.516		0.206		
Dec 10 2020	13:16:00	14.42	4.563	14.57	3.291		0.356		
End of port 1 point 6									
Dec 10 2020	13:18:00	14.45	4.550	14.46	3.117		0.409		
Dec 10 2020	13:19:00	14.67	4.381	13.86	3.477		0.477		
Dec 10 2020	13:20:00	14.62	4.415	13.95	3.615		0.297		
Dec 10 2020	13:21:00	14.68	4.371	13.94	3.698		0.250		
Dec 10 2020	13:22:00	14.48	4.527	14.45	3.528		0.249		
End of port 2 point 1									
Dec 10 2020	13:23:00	14.15	4.760	15.24	2.729		0.200		
Dec 10 2020	13:24:00	14.22	4.708	15.09	3.080		0.376		
Dec 10 2020	13:25:00	14.49	4.535	14.42	2.979		0.315		
Dec 10 2020	13:26:00	14.63	4.443	13.95	3.713		0.298		
Dec 10 2020	13:27:00	14.71	4.390	13.79	3.935		0.424		

MAQDAQ 1.0

Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

End of port 2 point 2									
Dec 10 2020	13:28:00	14.58	4.458	14.11	3.872		0.189		
Dec 10 2020	13:29:00	14.55	4.493	14.24	3.782		0.354		
Dec 10 2020	13:30:00	14.46	4.565	14.36	3.385		0.334		
Dec 10 2020	13:31:00	14.35	4.644	14.78	2.965		0.379		
Dec 10 2020	13:32:00	14.38	4.636	14.61	3.049		0.320		
End of port 2 point 3									
Dec 10 2020	13:33:00	14.34	4.642	14.77	2.891		0.496		
Dec 10 2020	13:34:00	14.61	4.469	14.10	3.397		0.355		
Dec 10 2020	13:35:00	14.61	4.462	14.11	3.546		0.239		
Dec 10 2020	13:36:00	14.56	4.505	14.10	3.243		0.165		
Dec 10 2020	13:37:00	14.31	4.686	14.84	2.925		0.357		
End of port 2 point 4									
Dec 10 2020	13:38:00	14.37	4.639	14.71	2.663		0.294		
Dec 10 2020	13:39:00	14.52	4.538	14.44	2.798		0.284		
Dec 10 2020	13:40:00	14.49	4.538	14.36	3.327		0.265		
Dec 10 2020	13:41:00	14.62	4.454	13.96	3.509		0.265		
Dec 10 2020	13:42:00	14.68	4.423	13.77	3.461		0.228		
End of port 2 point 5									
Dec 10 2020	13:43:00	14.51	4.537	14.19	3.601		0.239		
Dec 10 2020	13:44:00	14.32	4.694	14.89	3.188		0.338		
Dec 10 2020	13:45:00	14.24	4.751	15.00	2.801		0.294		
Dec 10 2020	13:46:00	14.35	4.667	14.72	2.968		0.226		
Dec 10 2020	13:47:00	14.22	4.723	15.07	2.904		0.294		
End of port 2 point 6									

	Average:	14.42	4.616	14.57	3.203		0.331		
	Max:	14.71	4.909	15.60	3.935		0.566		
	Min:	14.03	4.371	13.77	2.649		0.165		

Stratification Results

Port	**Point**	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
1	1	14.28	4.743	15.01	3.081		0.430		
1	2	14.45	4.639	14.45	3.044		0.372		
1	3	14.23	4.752	15.21	2.886		0.299		
1	4	14.44	4.637	14.47	3.203		0.320		
1	5	14.41	4.656	14.74	3.199		0.310		
1	6	14.46	4.540	14.43	3.479		0.234		
2	1	14.52	4.476	14.25	3.526		0.392		
2	2	14.58	4.471	14.13	3.338		0.293		
2	3	14.30	4.689	14.87	3.373		0.273		
2	4	14.43	4.591	14.65	3.186		0.393		
2	5	14.56	4.485	14.16	3.275		0.209		
2	6	14.28	4.705	15.02	2.988		0.343		
	Strat diff:	0.168	0.137	0.594	0.311		0.108		
	Strat %:	1.261	3.127	4.065	9.679		9.100		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Run 3 Post run bias - Scenario 2 Run 3

12:46:00 - 13:47:00

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		
Run summary data									
	Raw Avg:	14.42	4.616	14.57	3.203		0.331		
	Max:	14.71	4.909	15.60	3.935		0.566		
	Min:	14.03	4.371	13.77	2.649		0.165		
Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		
Calibration Readings									
	Zero reading:	-0.029	-0.001	0.007	0.061		-0.086		
	Low reading:								
	Mid reading:	10.01	9.843	26.96	5.064		15.00		
	High reading:	20.90	18.54	56.23	9.906		27.34		
EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	-0.139	-0.005	0.012	0.615		-0.313		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	1.532		-0.654		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-0.131		-0.654		
Initial Bias Data									
	Zero reading:	-0.092	0.160	0.183	-0.230		0.088		
	Span reading:	9.868	9.755	26.61	4.802		13.93		
Zero % bias:	**<5.0**	-0.301	0.868	0.313	-2.934		0.632		
Span % bias:	**<5.0**	-0.679	-0.474	-0.623	-2.641		-3.888		
Final Bias Data									
	Zero reading:	-0.061	0.063	0.128	-0.330		0.282		
	Span reading:	9.809	9.759	26.36	4.720		13.84		
Zero % bias:	**<5.0**	-0.153	0.345	0.215	-3.942		1.337		
Span % bias:	**<5.0**	-0.960	-0.453	-1.068	-3.468		-4.215		
Zero % drift:	**<3.0**	0.148	0.523	0.098	1.008		0.705		
Span % drift:	**<3.0**	0.282	0.021	0.445	0.827		0.327		
Bias Corrected Averages									
	Cor Avg:	14.64	4.721	15.20	3.394		0.162		

Appendix A.6
Gaseous Emissions Calculations/Results

SOURCE TEST DATA SUMMARY

TGNMO EMISSIONS

Client	Leichner Landfill
Unit / Location	Flare Condition 1
Stack area, square feet	5.074
Reference temperature, °F	68

Test number	Run 1	Run 2	Run 3	Average
Date	12/9/2020	12/9/2020	12/9/2020	--
Start / Stop time	0830-0933	1100-1203	1246-1347	--
FUEL DATA				
Fuel "F" factor @ 68°F, dscf/MMBtu	9,598	9,591	9,514	9,568
Fuel higher heating value (HHV @ 68°F & 1 ATM), Btu/scf	471.7	478.2	497.6	482.5
Fuel flow, scfh (Inlet)	4,260	4,230	4,278	4,256
Fuel flow, scfm (Inlet fuel data)	71.0	70.5	71.3	70.9
Fuel MMBtu/hr (Inlet)	2.01	2.02	2.13	2.05
Fuel MMBtu/hr (Outlet flow & Fd)	2.52	2.59	2.60	2.57
Fuel flow, scfh (Inlet)(Calculated from HHV and Outlet flow)	5,340	5,406	5,217	5,321
Fuel flow, scfm (Inlet)(Calculated from HHV and Outlet flow)	89.0	90.1	87.0	88.7
SAMPLE TRAIN DATA				
Meter box number/ID	MB4	MB4	MB4	--
Pitot coefficient	0.84	0.84	0.84	0.84
Meter calibration, Yd	0.9989	0.9989	0.9989	0.999
Barometric pressure, in Hg	30.34	30.35	30.32	30.34
Meter box volume, acf	34.675	35.637	34.435	34.916
Impinger liquid volume, gm	73.2	57.9	56.1	62.4
Meter temperature, °F	54.1	61.8	62.3	59.4
Meter pressure, (Delta H) iwg	1.00	1.00	1.00	1.00
Velocity head, (Delta P) iwg	0.01713	0.01683	0.01713	0.01703
Static pressure, iwg	-0.031	-0.034	-0.0429	-0.0360
Stack temperature, °F	1,356	1,313	1,325	1,331
ANALYZER DATA				
O_2 % volume dry	13.36	13.31	13.38	13.35
CO_2 % volume dry	5.73	5.77	5.63	5.71
EPA Method 25C DATA				
*TGNMO (Outlet) emissions as methane, ppm volume wet	7.70	4.70	5.70	6.03
*TGNMO (Outlet) emissions as hexane, ppm volume wet	1.28	0.78	0.95	1.01
TGNMO (Inlet) emissions as methane, ppm volume wet	405.00	428.00	450.00	427.67
TGNMO (Inlet) emissions as hexane, ppm volume wet	67.50	71.33	75.00	71.28
VOLUMETRIC FLOW RATE				
Standard sample volume, dscf	36.161	36.615	35.318	36.031
Water vapor volume, scf	3.4514	2.7300	2.6451	2.9422
Moisture fraction, nondimensional	0.0871	0.0694	0.0697	0.0754
Stack gas molecular weight, dry	29.452	29.456	29.436	29.448
Stack gas molecular weight, wet	28.454	28.661	28.640	28.585
Absolute stack pressure, in Hg	30.338	30.342	30.317	30.332
Stack gas velocity, ft/sec	13.633	13.300	13.478	13.471
Stack flow rate, acfm	4,150	4,049	4,103	4,101
Stack Flow Rate (wscfm)	1,224	1,223	1,230	1,225
Stack flow rate - based on pitot, dscfm	1,117	1,138	1,144	1,133
EMISSIONS (Outlet)				
TGNMO concentrations, ppm-Hexane volume dry	1.41	0.84	1.02	1.09
TGNMO mass emissions, lb/hr as Hexane	0.021	0.013	0.016	0.017
TGNMO mass emissions, tons/yr as Hexane	0.0923	0.0563	0.0687	0.0724
TGNMO mass emissions, lb/MMBtu as Hexane	0.0084	0.0050	0.0060	0.0065
EMISSIONS (Inlet)				
TGNMO concentrations, ppm-Hexane volume dry	67.50	71.33	75.00	71.28
TGNMO mass emissions, lb/hr as Hexane	0.081	0.086	0.088	0.085
TGNMO mass emissions, tons/yr as Hexane	0.3531	0.3778	0.3833	0.3714
TGNMO mass emissions, lb/MMBtu as Hexane	0.0320	0.0334	0.0337	0.0330
Destruction	73.9%	85.1%	82.1%	80.3%

Note(s): Outlet results were non-detects and are reported at the sample reporting limit (SRL)

SOURCE TEST DATA SUMMARY

TGNMO EMISSIONS

Client	Leichner Landfill
Unit / Location	Flare Condition 2
Stack area, square feet	5.074
Reference temperature, °F	68

Test number	Run 1	Run 2	Run 3	Average
Date	12/10/2020	12/10/2020	12/10/2020	--
Start / Stop time	0827-0930	1057-1157	1246-1346	--
FUEL DATA				
Fuel "F" factor @ 68°F, dscf/MMBtu	9,465.2	9,459.1	9,466.3	9,463.5
Fuel higher heating value (HHV), Btu/scf	479.7	512.0	507.5	499.8
Fuel flow, scfh (Inlet)	4,320	4,260	4,218	4,266
Fuel flow, scfm (Inlet fuel data)	72.0	71.0	70.3	71.1
Fuel MMBtu/hr (Inlet)	2.07	2.18	2.14	2.13
Fuel MMBtu/hr (Outlet flow & Fd)	2.53	2.59	2.53	2.55
Fuel flow, scfh (Inlet)(Calculated from HHV and Outlet flow)	5,270	5,065	4,986	5,107
Fuel flow, scfm (Inlet)(Calculated from HHV and Outlet flow)	87.8	84.4	83.1	85.1
SAMPLE TRAIN DATA				
Meter box number/ID	MB4	MB4	MB4	--
Pitot coefficient	0.84	0.84	0.84	0.84
Meter calibration, Yd	0.9989	1.0017	1.0017	1.001
Barometric pressure, in Hg	30.03	30.01	30.00	30.01
Meter box volume, acf	34.862	34.825	34.554	34.747
Impinger liquid volume, gm	44.0	50.2	42.3	45.5
Meter temperature, °F	48.2	50.6	58.8	52.6
Meter pressure, (Delta H) iwg	1.00	1.00	1.00	1.00
Velocity head, (Delta P) iwg	0.02142	0.02119	0.02063	0.02108
Static pressure, iwg	-0.038	-0.036	-0.0351	-0.0365
Stack temperature, °F	1,173	1,193	1,156	1,174
ANALYZER DATA				
O_2, % volume dry	14.73	14.46	14.64	14.61
CO_2, % volume dry	4.81	4.81	4.72	4.78
EPA Method 25C DATA				
*TGNMO (Outlet) emissions as methane, ppm volume wet	7.00	5.00	4.90	5.63
*TGNMO (Outlet) emissions as hexane, ppm volume wet	1.17	0.83	0.82	0.94
TGNMO (Inlet) emissions as methane, ppm volume wet	382.00	421.00	412.00	405.00
TGNMO (Inlet) emissions as hexane, ppm volume wet	63.67	70.17	68.67	67.50
VOLUMETRIC FLOW RATE				
Standard sample volume, dscf	36.400	36.260	35.397	36.019
Water vapor volume, scf	2.0746	2.3669	1.9944	2.1453
Moisture fraction, nondimensional	0.0539	0.0613	0.0533	0.0562
Stack gas molecular weight, dry	29.359	29.348	29.341	29.350
Stack gas molecular weight, wet	28.747	28.653	28.736	28.712
Absolute stack pressure, in Hg	30.027	30.002	29.992	30.007
Stack gas velocity, ft/sec	14.455	14.494	14.123	14.357
Stack flow rate, acfm	4,400	4,412	4,299	4,371
Stack Flow Rate (wscfm)	1,428	1,414	1,408	1,417
Stack flow rate - based on pitot, dscfm	1,351	1,327	1,333	1,337
EMISSIONS (Outlet)				
TGNMO concentrations, ppm-Hexane volume dry	1.23	0.89	0.86	0.99
TGNMO mass emissions, lb/hr as Hexane	0.022	0.016	0.015	0.018
TGNMO mass emissions, tons/yr as Hexane	0.0979	0.0692	0.0676	0.0782
TGNMO mass emissions, lb/MMBtu as Hexane	0.0088	0.0061	0.0061	0.0070
EMISSIONS (Inlet)				
TGNMO concentrations, ppm-Hexane volume dry	63.67	70.17	68.67	67.50
TGNMO mass emissions, lb/hr as Hexane	0.075	0.079	0.077	0.077
TGNMO mass emissions, tons/yr as Hexane	0.3287	0.3481	0.3354	0.3374
TGNMO mass emissions, lb/MMBtu as Hexane	0.0297	0.0306	0.0303	0.0302
Destruction	70.2%	80.1%	79.8%	76.7%

Note(s): Outlet results were non-detects and are reported at the sample reporting limit.

Appendix A.7
NMOC Calculations/Results

SOURCE TEST DATA SUMMARY

TGNMO EMISSIONS

Client	Leichner Landfill
Unit / Location	Flare Condition 1
Stack area, square feet	5.074
Reference temperature, °F	68

Test number	Run 1	Run 2	Run 3	Average
Date	12/9/2020	12/9/2020	12/9/2020	--
Start / Stop time	0830-0933	1100-1203	1246-1347	--
FUEL DATA				
Fuel "F" factor @ 68°F, dscf/MMBtu	9,598	9,591	9,514	9,568
Fuel higher heating value (HHV @ 68°F & 1 ATM), Btu/scf	471.7	478.2	497.6	482.5
Fuel flow, scfh (Inlet)	4,260	4,230	4,278	4,256
Fuel flow, scfm (Inlet fuel data)	71.0	70.5	71.3	70.9
Fuel MMBtu/hr (Inlet)	2.01	2.02	2.13	2.05
Fuel MMBtu/hr (Outlet flow & Fd)	2.52	2.59	2.60	2.57
Fuel flow, scfh (Inlet)(Calculated from HHV and Outlet flow)	5,340	5,406	5,217	5,321
Fuel flow, scfm (Inlet)(Calculated from HHV and Outlet flow)	89.0	90.1	87.0	88.7
SAMPLE TRAIN DATA				
Meter box number/ID	MB4	MB4	MB4	--
Pitot coefficient	0.84	0.84	0.84	0.84
Meter calibration, Yd	0.9989	0.9989	0.9989	0.999
Barometric pressure, in Hg	30.34	30.35	30.32	30.34
Meter box volume, acf	34.675	35.637	34.435	34.916
Impinger liquid volume, gm	73.2	57.9	56.1	62.4
Meter temperature, °F	54.1	61.8	62.3	59.4
Meter pressure, (Delta H) iwg	1.00	1.00	1.00	1.00
Velocity head, (Delta P) iwg	0.01713	0.01683	0.01713	0.01703
Static pressure, iwg	-0.031	-0.034	-0.0429	-0.0360
Stack temperature, °F	1,356	1,313	1,325	1,331
ANALYZER DATA				
O_2, % volume dry	13.36	13.31	13.38	13.35
CO_2, % volume dry	5.73	5.77	5.63	5.71
EPA Method 25C DATA				
*TGNMO (Outlet) emissions as methane, ppm volume wet	7.70	4.70	5.70	6.03
*TGNMO (Outlet) emissions as hexane, ppm volume wet	1.28	0.78	0.95	1.01
TGNMO (Inlet) emissions as methane, ppm volume wet	405.00	428.00	450.00	427.67
TGNMO (Inlet) emissions as hexane, ppm volume wet	67.50	71.33	75.00	71.28
VOLUMETRIC FLOW RATE				
Standard sample volume, dscf	36.161	36.615	35.318	36.031
Water vapor volume, scf	3.4514	2.7300	2.6451	2.9422
Moisture fraction, nondimensional	0.0871	0.0694	0.0697	0.0754
Stack gas molecular weight, dry	29.452	29.456	29.436	29.448
Stack gas molecular weight, wet	28.454	28.661	28.640	28.585
Absolute stack pressure, in Hg	30.338	30.342	30.317	30.332
Stack gas velocity, ft/sec	13.633	13.300	13.478	13.471
Stack flow rate, acfm	4,150	4,049	4,103	4,101
Stack Flow Rate (wscfm)	1,224	1,223	1,230	1,225
Stack flow rate - based on pitot, dscfm	1,117	1,138	1,144	1,133
EMISSIONS (Outlet)				
TGNMO concentrations, ppm-Hexane volume dry	1.41	0.84	1.02	1.09
TGNMO mass emissions, lb/hr as Hexane	0.021	0.013	0.016	0.017
TGNMO mass emissions, tons/yr as Hexane	0.0923	0.0563	0.0687	0.0724
TGNMO mass emissions, lb/MMBtu as Hexane	0.0084	0.0050	0.0060	0.0065
EMISSIONS (Inlet)				
TGNMO concentrations, ppm-Hexane volume dry	67.50	71.33	75.00	71.28
TGNMO mass emissions, lb/hr as Hexane	0.081	0.086	0.088	0.085
TGNMO mass emissions, tons/yr as Hexane	0.3531	0.3778	0.3833	0.3714
TGNMO mass emissions, lb/MMBtu as Hexane	0.0320	0.0334	0.0337	0.0330
Destruction	73.9%	85.1%	82.1%	80.3%

Note(s): Outlet results were non-detects and are reported at the sample reporting limit (SRL)

SOURCE TEST DATA SUMMARY

TGNMO EMISSIONS

Client	Leichner Landfill
Unit / Location	Flare Condition 2
Stack area, square feet	5.074
Reference temperature, °F	68

Test number	Run 1	Run 2	Run 3	Average
Date	12/10/2020	12/10/2020	12/10/2020	--
Start / Stop time	0827-0930	1057-1157	1246-1346	--
FUEL DATA				
Fuel "F" factor @ 68°F, dscf/MMBtu	9,465.2	9,459.1	9,466.3	9,463.5
Fuel higher heating value (HHV), Btu/scf	479.7	512.0	507.5	499.8
Fuel flow, scfh (Inlet)	4,320	4,260	4,218	4,266
Fuel flow, scfm (Inlet fuel data)	72.0	71.0	70.3	71.1
Fuel MMBtu/hr (Inlet)	2.07	2.18	2.14	2.13
Fuel MMBtu/hr (Outlet flow & Fd)	2.53	2.59	2.53	2.55
Fuel flow, scfh (Inlet)(Calculated from HHV and Outlet flow)	5,270	5,065	4,986	5,107
Fuel flow, scfm (Inlet)(Calculated from HHV and Outlet flow)	87.8	84.4	83.1	85.1
SAMPLE TRAIN DATA				
Meter box number/ID	MB4	MB4	MB4	--
Pitot coefficient	0.84	0.84	0.84	0.84
Meter calibration, Yd	0.9989	1.0017	1.0017	1.001
Barometric pressure, in Hg	30.03	30.01	30.00	30.01
Meter box volume, acf	34.862	34.825	34.554	34.747
Impinger liquid volume, gm	44.0	50.2	42.3	45.5
Meter temperature, °F	48.2	50.6	58.8	52.6
Meter pressure, (Delta H) iwg	1.00	1.00	1.00	1.00
Velocity head, (Delta P) iwg	0.02142	0.02119	0.02063	0.02108
Static pressure, iwg	-0.038	-0.036	-0.0351	-0.0365
Stack temperature, °F	1,173	1,193	1,156	1,174
ANALYZER DATA				
O_2, % volume dry	14.73	14.46	14.64	14.61
CO_2, % volume dry	4.81	4.81	4.72	4.78
EPA Method 25C DATA				
*TGNMO (Outlet) emissions as methane, ppm volume wet	7.00	5.00	4.90	5.63
*TGNMO (Outlet) emissions as hexane, ppm volume wet	1.17	0.83	0.82	0.94
TGNMO (Inlet) emissions as methane, ppm volume wet	382.00	421.00	412.00	405.00
TGNMO (Inlet) emissions as hexane, ppm volume wet	63.67	70.17	68.67	67.50
VOLUMETRIC FLOW RATE				
Standard sample volume, dscf	36.400	36.260	35.397	36.019
Water vapor volume, scf	2.0746	2.3669	1.9944	2.1453
Moisture fraction, nondimensional	0.0539	0.0613	0.0533	0.0562
Stack gas molecular weight, dry	29.359	29.348	29.341	29.350
Stack gas molecular weight, wet	28.747	28.653	28.736	28.712
Absolute stack pressure, in Hg	30.027	30.002	29.992	30.007
Stack gas velocity, ft/sec	14.455	14.494	14.123	14.357
Stack flow rate, acfm	4,400	4,412	4,299	4,371
Stack Flow Rate (wscfm)	1,428	1,414	1,408	1,417
Stack flow rate - based on pitot, dscfm	1,351	1,327	1,333	1,337
EMISSIONS (Outlet)				
TGNMO concentrations, ppm-Hexane volume dry	1.23	0.89	0.86	0.99
TGNMO mass emissions, lb/hr as Hexane	0.022	0.016	0.015	0.018
TGNMO mass emissions, tons/yr as Hexane	0.0979	0.0692	0.0676	0.0782
TGNMO mass emissions, lb/MMBtu as Hexane	0.0088	0.0061	0.0061	0.0070
EMISSIONS (Inlet)				
TGNMO concentrations, ppm-Hexane volume dry	63.67	70.17	68.67	67.50
TGNMO mass emissions, lb/hr as Hexane	0.075	0.079	0.077	0.077
TGNMO mass emissions, tons/yr as Hexane	0.3287	0.3481	0.3354	0.3374
TGNMO mass emissions, lb/MMBtu as Hexane	0.0297	0.0306	0.0303	0.0302
Destruction	70.2%	80.1%	79.8%	76.7%

Note(s): Outlet results were non-detects and are reported at the sample reporting limit.

SCS ENGINEERS / LEICHNER LANDFILL

12/9/2021 - 12/10/2021	CONDITION #1				CONDITION #2			
Data Summary	Run 1	Run 2	Run 3	AVG	Run 1	Run 2	Run 3	AVG
HHV Btu / scf = @ 68 ^{o}F / 29.92 inHg	471.7	478.2	497.6	482.5	479.7	512.0	507.5	499.8
LHV Btu / scf = @ 68 ^{o}F / 29.92 inHg	425.1	431.0	448.4	434.8	432.3	461.5	457.4	450.4
Btu / lb =	6,999.5	7,107.2	7,470.7	7,192.5	7,168.4	7,714.7	7,640.3	7,507.8
lb./scf = @ 60 ^{o}F / 30 inHg	0.0686	0.0685	0.0678	0.0683	0.0681	0.0676	0.0676	0.0678
Fd"(60)= (O_2 Based)	9,452.7	9,445.7	9,369.6	9,422.7	9,321.8	9,315.7	9,322.9	9,320.1
Fd"(68)= (O_2 Based)	9,598.1	9,591.0	9,513.7	9,567.6	9,465.2	9,459.1	9,466.3	9,463.5
O2 (Oxygen)…………………………………	1.3	1.1	1.1	1.2	2.3	1.1	1.2	1.5
N2 (Nitrogen)………………………………	29.1	28.4	26.6	28.0	28.1	24.6	25.2	26.0
CO (Carbon Monoxide)……………………	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
CO2 (Carbon Dioxide)……………………	22.2	22.5	22.3	22.3	21.4	22.8	22.6	22.3
C1 (Methane-CH4)………………………	47.4	48.1	50.0	48.5	48.2	51.4	51.0	50.2
H2 (Hydrogen)……………………………	< 1.5	< 1.5	< 1.5	< 1.5	< 1.4	< 1.4	< 1.4	< 1.4

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/09/20 - SCENARIO #1 -Run #1

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft³	Fractioned Btu/ft³	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft³	Fractioned Btu/ft³		ATOMS / MOLE C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
O_2 (Oxygen)……	31.9988	**1.30**	1.300	41.60	1.60	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)……	28.0134	**29.10**	29.100	815.19	31.42	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)……	28.0104	< 0.2	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)……	44.0098	**22.20**	22.200	977.02	37.66	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)……	16.0428	**47.40**	47.400	760.4	29.31	1,013.20	480.26	23,879.00	6,999.47	913.10	432.81		1	4	0	0
C_2 (Ethane-C_2H_6)……	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene……	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)……	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8) ……	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene ……	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)……	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)……	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)……	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane).	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)……	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)……	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)……	2.0160	< 1.5	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		100.0000	100.00	2594.23	100.00		480.26		6,999.47		432.81	Sum	69.60	189.60	47.00	58.20
													835.97	191.10	751.97	815.19
Weight, %			100.00										32.22	7.37	28.99	31.42
Gas molwt	25.9423															

HHV Btu / scf =	480.26	@ 60 °F / 30 inHg	HHV Btu / scf =	471.72	@ 68 °F / 29.92 inHg
LHV Btu / scf =	432.81	@ 60 °F / 30 inHg	LHV Btu / scf =	425.11	@ 68 °F / 29.92 inHg
Btu / lb =	6,999.47				
lb./scf =	0.06861	@ 60 °F / 30 inHg			
Fd"(60)=	9,452.67	(O_2 Based)			
Fd"(68)=	9,598.10	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2
Gases are reported at 60 °F and 30 inHg

Calculations:
Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb
Fc"(60) = Fc"(68) * 520 R / 528 R

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/09/20 - SCENARIO #1 -Run #2

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft^3	Fractioned Btu/ft^3	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft^3	Fractioned Btu/ft^3		ATOMS / MOLE C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
O_2 (Oxygen)……	31.9988	**1.10**	1.099	35.16	1.36	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)……	28.0134	**28.40**	28.372	794.79	30.69	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)……	28.0104	< 0.1	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)……	44.0098	**22.50**	22.478	989.23	38.19	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)……	16.0428	**48.10**	48.052	770.9	29.76	1,013.20	486.86	23,879.00	7,107.16	913.10	438.76		1	4	0	0
C_2 (Ethane-C_2H_6)……	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene……	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)……	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8)……	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene……	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)……	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)……	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)……	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane).	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)……	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)……	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)……	2.0160	< 1.5	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		100.1000	100.00	2590.07	100.00		486.86		7,107.16		438.76	Sum	70.53 847.13	192.21 193.73	47.15 754.42	56.74 794.79
Weight, %			100.00										32.71	7.48	29.13	30.69
Gas molwt	25.9007															

HHV Btu / scf =	486.86	@ 60 °F / 30 inHg	HHV Btu / scf =	478.21	@ 68 °F / 29.92 inHg
LHV Btu / scf =	438.76	@ 60 °F / 30 inHg	LHV Btu / scf =	430.96	@ 68 °F / 29.92 inHg
Btu / lb =	7,107.16				
lb./scf =	0.06850	@ 60 °F / 30 inHg			
Fd"(60)=	9,445.69	(O_2 Based)			
Fd"(68)=	9,591.01	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2
Gases are reported at 60 °F and 30 inHg

Calculations:
Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb
Fc"(60) = Fc"(68) * 520 R / 528 R

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/09/20 - SCENARIO #1 -Run #3

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft^3	Fractioned Btu/ft^3	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft^3	Fractioned Btu/ft^3		ATOMS / MOLE C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
O_2 (Oxygen)……	31.9988	**1.10**	1.100	35.20	1.37	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)……	28.0134	**26.60**	26.600	745.16	29.06	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)……	28.0104	< 0.1	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)……	44.0098	**22.30**	22.300	981.42	38.28	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)……	16.0428	**50.00**	50.000	802.1	31.29	1,013.20	506.60	23,879.00	7,470.73	913.10	456.55		1	4	0	0
C_2 (Ethane-C_2H_6)……	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene……	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)……	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8) ……	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene ……	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})……	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)……	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)……	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)……	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane).	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)……	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)……	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)……	2.0160	< 1.5	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		100.0000	100.00	2563.91	100.00		506.60		7,470.73		456.55	Sum	72.30	200.00	46.80	53.20
													868.40	201.58	748.77	745.16
Weight, %			100.00										33.87	7.86	29.20	29.06
Gas molwt	25.6391															

HHV Btu / scf =	506.60	@ 60 °F / 30 inHg	HHV Btu / scf =	497.59	@ 68 °F / 29.92 inHg
LHV Btu / scf =	456.55	@ 60 °F / 30 inHg	LHV Btu / scf =	448.43	@ 68 °F / 29.92 inHg
Btu / lb =	7,470.73				
lb./scf =	0.06781	@ 60 °F / 30 inHg			
Fd"(60)=	9,369.59	(O_2 Based)			
Fd"(68)=	9,513.74	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2
Gases are reported at 60 °F and 30 inHg

Calculations:
Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb
Fc"(60) = Fc"(68) * 520 R / 528 R

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/10/20 - SCENARIO #2 -Run #1

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft³	Fractioned Btu/ft³	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft³	Fractioned Btu/ft³		ATOMS / MOLE C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
O_2 (Oxygen)…	31.9988	**2.30**	2.300	73.60	2.86	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)…	28.0134	**28.10**	28.100	787.18	30.56	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)…	28.0104	< 0.1	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)…	44.0098	**21.40**	21.400	941.81	36.56	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)…	16.0428	**48.20**	48.200	773.3	30.02	1,013.20	488.36	23,879.00	7,168.42	913.10	440.11		1	4	0	0
C_2 (Ethane-C_2H_6)…	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene…	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)…	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8)…	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene…	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})…	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})…	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)…	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)…	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)…	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane).	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)…	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)…	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)…	2.0160	< 1.4	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		100.0000	100.00	2575.85	100.00		488.36		7,168.42		440.11	Sum	69.60	192.80	47.40	56.20
													835.97	194.32	758.37	787.18
Weight, %			100.00										32.45	7.54	29.44	30.56
Gas molwt	25.7585															

HHV Btu / scf =	488.36	@ 60 °F / 30 inHg	HHV Btu / scf =	479.68	@ 68 °F / 29.92 inHg
LHV Btu / scf =	440.11	@ 60 °F / 30 inHg	LHV Btu / scf =	432.29	@ 68 °F / 29.92 inHg
Btu / lb =	7,168.42				
lb./scf =	0.06813	@ 60 °F / 30 inHg			
Fd"(60)=	9,321.78	(O_2 Based)			
Fd"(68)=	9,465.19	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2
Gases are reported at 60 °F and 30 inHg

Calculations:
Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb
Fc"(60) = Fc"(68) * 520 R / 528 R

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/10/20 - SCENARIO #2 -Run #2

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft³	Fractioned Btu/ft³	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft³	Fractioned Btu/ft³		C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
												ATOMS / MOLE				
O_2 (Oxygen)	31.9988	**1.10**	1.101	35.23	1.38	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)	28.0134	**24.60**	24.625	689.82	27.00	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)	28.0104	< 0.1	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)	44.0098	**22.80**	22.823	1004.43	39.31	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)	16.0428	**51.40**	51.451	825.4	32.31	1,013.20	521.31	23,879.00	7,714.70	913.10	469.80		1	4	0	0
C_2 (Ethane-C_2H_6)	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8)	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane)	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)	2.0160	< 1.4	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		99.9000	100.00	2554.91	100.00		521.31		7,714.70		469.80	Sum	74.27	205.81	47.85	49.25
													892.11	207.43	765.54	689.82
Weight, %			100.00										34.92	8.12	29.96	27.00
Gas molwt	25.5491															

HHV Btu / scf =	521.31	@ 60 °F / 30 inHg	HHV Btu / scf =	512.04	@ 68 °F / 29.92 inHg
LHV Btu / scf =	469.80	@ 60 °F / 30 inHg	LHV Btu / scf =	461.45	@ 68 °F / 29.92 inHg
Btu / lb =	7,714.70				
lb./scf =	0.06757	@ 60 °F / 30 inHg			
Fd"(60)=	9,315.74	(O_2 Based)			
Fd"(68)=	9,459.06	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2
Gases are reported at 60 °F and 30 inHg

Calculations:
Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb
Fc"(60) = Fc"(68) * 520 R / 528 R

FUEL F-FACTOR CALCULATIONS
SCS ENGINEERS / LEICHNER LANDFILL
12/10/20 - SCENARIO #2 -Run #3

SPECIES	Molwt	MOLE %	MOLE % (normalized)	MW*%	% by Wt	HHV[1] Btu/ft^3	Fractioned Btu/ft^3	HHV[1] Btu/lb	Fractioned Btu/lb	LHV[1] Btu/ft^3	Fractioned Btu/ft^3		ATOMS / MOLE C 12.0110 lb/lbmol Count	H 1.0079 lb/lbmol Count	O 15.9994 lb/lbmol Count	N 14.0067 lb/lbmol Count
O_2 (Oxygen)	31.9988	**1.20**	1.200	38.40	1.50	0.00	0.00	0.00	0.00	0.00	0.00		0	0	2	0
N_2 (Nitrogen)	28.0134	**25.20**	25.200	705.94	27.61	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0	2
CO (Carbon Monoxide)	28.0104	< 0.1	0.000	0.00	0.00	321.80	0.00	4,347.00	0.00	321.80	0.00		1	0	1	0
CO_2 (Carbon Dioxide)	44.0098	**22.60**	22.600	994.62	38.90	0.00	0.00	0.00	0.00	0.00	0.00		1	0	2	0
C_1 (Methane-CH_4)	16.0428	**51.00**	51.000	818.2	32.00	1,013.20	516.73	23,879.00	7,640.33	913.10	465.68		1	4	0	0
C_2 (Ethane-C_2H_6)	30.0696	--	0.000	0.00	0.00	1,792.00	0.00	22,320.00	0.00	1,641.00	0.00		2	6	0	0
C_2 (Ethene-C_2H_4)/ Ethylene	28.0500	--	0.000	0.00	0.00	1,613.80	0.00	21,644.00	0.00	1,513.20	0.00		2	4	0	0
C_2 (Acetylene-C_2H_2)	26.0400	--	0.000	0.00	0.00	1,499.00	0.00	21,500.00	0.00	1,448.00	0.00		2	2	0	0
C_3 (Propane-C_3H_8)	44.0962	--	0.000	0.00	0.00	2,590.00	0.00	21,661.00	0.00	2,385.00	0.00		3	8	0	0
C_3 (Propene-C_3H_6)/Propylene	42.0804	--	0.000	0.00	0.00	2,336.00	0.00	21,041.00	0.00	2,186.00	0.00		3	6	0	0
C_4 / N-C_4 (n-Butane-C_4H_{10})	58.1200	--	0.000	0.00	0.00	3,370.00	0.00	21,308.00	0.00	3,113.00	0.00		4	10	0	0
ISO C_4 (Isobutane-C_4H_{10})	58.1200	--	0.000	0.00	0.00	3,363.00	0.00	21,257.00	0.00	3,105.00	0.00		4	10	0	0
C_4 / (Butene-C_4H_8)	56.1060	--	0.000	0.00	0.00	3,084.00	0.00	20,840.00	0.00	2,885.00	0.00		4	8	0	0
C_5 / N-C_5 (Pentane / n-Pentane)	72.1500	--	0.000	0.00	0.00	4,016.00	0.00	21,091.00	0.00	3,709.00	0.00		5	12	0	0
ISO C_5 (Isopentane)	72.1500	--	0.000	0.00	0.00	4,008.00	0.00	21,052.00	0.00	3,716.00	0.00		5	12	0	0
Neo-C_5 (Neopentane / dimethylpropane)	72.1500	--	0.000	0.00	0.00	3,993.00	0.00	20,970.00	0.00	3,693.00	0.00		5	12	0	0
C_{6+} (Hexane+)	86.1800	--	0.000	0.00	0.00	4,762.00	0.00	20,940.00	0.00	4,412.00	0.00		6	14	0	0
H_2O (Water)	18.0153	--	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	2	1	0
H_2 (Hydrogen)	2.0160	< 1.4	0.000	0.00	0.00	325.00	0.00	61,100.00	0.00	275.00	0.00		0	2	0	0
Ave. / Total		100.0000	100.00	2557.14	100.00		516.73		7,640.33		465.68	Sum	73.60	204.00	47.60	50.40
													884.01	205.61	761.57	705.94
Weight, %			100.00										34.57	8.04	29.78	27.61
Gas molwt	25.5714															

HHV Btu / scf =	516.73	@ 60 °F / 30 inHg	HHV Btu / scf =	507.55	@ 68 °F / 29.92 inHg
LHV Btu / scf =	465.68	@ 60 °F / 30 inHg	LHV Btu / scf =	457.40	@ 68 °F / 29.92 inHg
Btu / lb =	7,640.33				
lb./scf =	0.06763	@ 60 °F / 30 inHg			
Fd"(60)=	9,322.92	(O_2 Based)			
Fd"(68)=	9,466.35	(O_2 Based)			

[1] All gas data from "Steam/its generation and use" Babcock & Wilcox 1978, Table 1 Combustion Constants, page 6-2

Gases are reported at 60 °F and 30 inHg

Calculations:

Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb

Fd"(60) = Fd"(68) * 520 R / 528 R

Fc"(68) = 10^6 * [0.321 * (C%)] / HHV, Btu/lb

Fc"(60) = Fc"(68) * 520 R / 528 R

Appendix A.8
Example Calculations

SCS Engineering - Leichner Landfill Run 1	PROJ-005198		M. Wallace	1/7/21	
(1/3)					Fraction
	%Mass		Btu/lb		Btu/lb
O2 (Oxygen)……	0.01603	x	0	=	0
N2 (Nitrogen)……	0.31423	x	0	=	0
CO (Carbon Monoxide)……	0.00000	x	4,347	=	0
CO2 (Carbon Dioxide)……	0.37661	x	0	=	0
C1 (Methane-CH4)……	0.29312	x	23,879	=	6,999
C2 (Ethane-C2H6)……	0.00000	x	22,320	=	0
C2 (Ethene-C2H4)/ Ethylene……	0.00000	x	21,644	=	0
C2 (Acetylene-C2H2)……	0.00000	x	21,500	=	0
C3 (Propane-C3H8) ……	0.00000	x	21,661	=	0
C3 (Propene-C3H6)/Propylene ……	0.00000	x	21,041	=	0
C4 / N-C4 (n-Butane-C4H10)……	0.00000	x	21,308	=	0
ISO C4 (Isobutane-C4H10)……	0.00000	x	21,257	=	0
C4 / (Butene-C4H8)……	0.00000	x	20,840	=	0
C5 / N-C5 (Pentane / n-Pentane)……	0.00000	x	21,091	=	0
ISO C5 (Isopentane)……	0.00000	x	21,052	=	0
Neo-C5 (Neopentane / dimethylpropane)……	0.00000	x	20,970	=	0
C6+ (Hexane+)……	0.00000	x	20,940	=	0
H2O (Water)……	0.00000	x	0	=	0
H2 (Hydrogen)……	0.00000	x	61,100	=	0
	0.99999			sum	6,999

			C		
			12.0110		
	%Volume		lb/lbmol		
O2 (Oxygen)……	0.01300	x	0	=	0.00000
N2 (Nitrogen)……	0.29100	x	0	=	0.00000
CO (Carbon Monoxide)……	0.00000	x	1	=	0.00000
CO2 (Carbon Dioxide)……	0.22200	x	1	=	0.22200
C1 (Methane-CH4)……	0.47400	x	1	=	0.47400
C2 (Ethane-C2H6)……	0.00000	x	2	=	0.00000
C2 (Ethene-C2H4)/ Ethylene……	0.00000	x	2	=	0.00000
C2 (Acetylene-C2H2)……	0.00000	x	2	=	0.00000
C3 (Propane-C3H8) ……	0.00000	x	3	=	0.00000
C3 (Propene-C3H6)/Propylene ……	0.00000	x	3	=	0.00000
C4 / N-C4 (n-Butane-C4H10)……	0.00000	x	4	=	0.00000
ISO C4 (Isobutane-C4H10)……	0.00000	x	4	=	0.00000
C4 / (Butene-C4H8)……	0.00000	x	4	=	0.00000
C5 / N-C5 (Pentane / n-Pentane)……	0.00000	x	5	=	0.00000
ISO C5 (Isopentane)……	0.00000	x	5	=	0.00000
Neo-C5 (Neopentane / dimethylpropane)……	0.00000	x	5	=	0.00000
C6+ (Hexane+)……	0.00000	x	6	=	0.00000
H2O (Water)……	0.00000	x	0	=	0.00000
H2 (Hydrogen)……	0.00000	x	0	=	0.00000
	1.00000			sum	0.69600
				x	12.0110
					8.3597

(2/3)

	%Volume		H 1.0079 lb/lbmol		
O2 (Oxygen)……………………………………	0.01300	x	0	=	0.00000
N2 (Nitrogen)……………………………………	0.29100	x	0	=	0.00000
CO (Carbon Monoxide)…………………………	0.00000	x	0	=	0.00000
CO2 (Carbon Dioxide)…………………………	0.22200	x	0	=	0.00000
C1 (Methane-CH4)………………………………	0.47400	x	4	=	1.89600
C2 (Ethane-C2H6)………………………………	0.00000	x	6	=	0.00000
C2 (Ethene-C2H4)/ Ethylene…………………	0.00000	x	4	=	0.00000
C2 (Acetylene-C2H2)……………………………	0.00000	x	2	=	0.00000
C3 (Propane-C3H8) ……………………………	0.00000	x	8	=	0.00000
C3 (Propene-C3H6)/Propylene …………………	0.00000	x	6	=	0.00000
C4 / N-C4 (n-Butane-C4H10)…………………	0.00000	x	10	=	0.00000
ISO C4 (Isobutane-C4H10)……………………	0.00000	x	10	=	0.00000
C4 / (Butene-C4H8)……………………………	0.00000	x	8	=	0.00000
C5 / N-C5 (Pentane / n-Pentane)………………	0.00000	x	12	=	0.00000
ISO C5 (Isopentane)……………………………	0.00000	x	12	=	0.00000
Neo-C5 (Neopentane / dimethylpropane)………	0.00000	x	12	=	0.00000
C6+ (Hexane+)…………………………………	0.00000	x	14	=	0.00000
H2O (Water)……………………………………	0.00000	x	2	=	0.00000
H2 (Hydrogen)…………………………………	0.00000	x	2	=	0.00000
	1.00000			sum	1.89600
				x	1.0079
					1.9110

	%Volume		O 15.9994 lb/lbmol		
O2 (Oxygen)……………………………………	0.01300	x	2	=	0.02600
N2 (Nitrogen)……………………………………	0.29100	x	0	=	0.00000
CO (Carbon Monoxide)…………………………	0.00000	x	1	=	0.00000
CO2 (Carbon Dioxide)…………………………	0.22200	x	2	=	0.44400
C1 (Methane-CH4)………………………………	0.47400	x	0	=	0.00000
C2 (Ethane-C2H6)………………………………	0.00000	x	0	=	0.00000
C2 (Ethene-C2H4)/ Ethylene…………………	0.00000	x	0	=	0.00000
C2 (Acetylene-C2H2)……………………………	0.00000	x	0	=	0.00000
C3 (Propane-C3H8) ……………………………	0.00000	x	0	=	0.00000
C3 (Propene-C3H6)/Propylene …………………	0.00000	x	0	=	0.00000
C4 / N-C4 (n-Butane-C4H10)…………………	0.00000	x	0	=	0.00000
ISO C4 (Isobutane-C4H10)……………………	0.00000	x	0	=	0.00000
C4 / (Butene-C4H8)……………………………	0.00000	x	0	=	0.00000
C5 / N-C5 (Pentane / n-Pentane)………………	0.00000	x	0	=	0.00000
ISO C5 (Isopentane)……………………………	0.00000	x	0	=	0.00000
Neo-C5 (Neopentane / dimethylpropane)………	0.00000	x	0	=	0.00000
C6+ (Hexane+)…………………………………	0.00000	x	0	=	0.00000
H2O (Water)……………………………………	0.00000	x	1	=	0.00000
H2 (Hydrogen)…………………………………	0.00000	x	0	=	0.00000
	1.00000			sum	0.47000
				x	15.9994
					7.5197

SCS Engineering - Leichner Landfill Run 1	PROJ-005198		M. Wallace	1/7/21	
(3/3)	%Volume		**N** **14.0067** lb/lbmol		
O2 (Oxygen)…………………………………	0.01300	x	0	=	0.00000
N2 (Nitrogen)………………………………	0.29100	x	2	=	0.58200
CO (Carbon Monoxide)…………………………	0.00000	x	0	=	0.00000
CO2 (Carbon Dioxide)…………………………	0.22200	x	0	=	0.00000
C1 (Methane-CH4)……………………………	0.47400	x	0	=	0.00000
C2 (Ethane-C2H6)……………………………	0.00000	x	0	=	0.00000
C2 (Ethene-C2H4)/ Ethylene…………………	0.00000	x	0	=	0.00000
C2 (Acetylene-C2H2)…………………………	0.00000	x	0	=	0.00000
C3 (Propane-C3H8) ……………………………	0.00000	x	0	=	0.00000
C3 (Propene-C3H6)/Propylene ………………	0.00000	x	0	=	0.00000
C4 / N-C4 (n-Butane-C4H10)…………………	0.00000	x	0	=	0.00000
ISO C4 (Isobutane-C4H10)……………………	0.00000	x	0	=	0.00000
C4 / (Butene-C4H8)……………………………	0.00000	x	0	=	0.00000
C5 / N-C5 (Pentane / n-Pentane)………………	0.00000	x	0	=	0.00000
ISO C5 (Isopentane)…………………………	0.00000	x	0	=	0.00000
Neo-C5 (Neopentane / dimethylpropane)………	0.00000	x	0	=	0.00000
C6+ (Hexane+)………………………………	0.00000	x	0	=	0.00000
H2O (Water)…………………………………	0.00000	x	0	=	0.00000
H2 (Hydrogen)………………………………	0.00000	x	0	=	0.00000
	1.00000			sum	0.58200
				x	14.0067
					8.1519

8.3597 + 1.9110 + 7.5197 + 8.1519 = 25.9423

			%Mass
C	8.3597 / 25.9423	=	32.22%
H	1.9110 / 25.9423	=	7.37%
O	7.5197 / 25.9423	=	28.99%
N	8.1519 / 25.9423	=	31.42%
			100.00%

Fd"(68) = 1,000,000 x [3.64 x (H%) + 1.53 x (C%) + 0.14 x (N%) - 0.46 x (O%)] / HHV, Btu/lb

Fd"(68) = 1,000,000 x [3.64 x (7.37) + 1.53 x (32.22) + 0.14 x (31.42) - 0.46 x (28.99)] / 6,999

3.64	x	7.37	=	26.81
1.53	x	32.22	=	49.30
0.14	x	31.42	=	4.40
-0.46	x	28.99	=	-13.33
				67.18

Fd = (1,000,000 x 67.18) / 6,999 = 9,598.7 dscf/MMBtu

* There may be differences due to rounding.

INLET FLOW RATE:

Given:

Qsd	=	1,117 dscf/min
Fd	=	9,598 dscf/MMBtu
HHV	=	471.7 Btu/scf
O2 %	=	13.36%
Moisture	=	0.0871
Hexane molwt	=	86.18 lb/lbmol
Outlet-NMOC	=	< 7.7 ppmv as Methane (wet) (Reported at SRL)
Inlet-NMOC	=	405 ppmv as Methane (wet)

Heat Input:

MMBtu /hr = Qsd x 60 / Fd x (20.9 – O2)/20.9

= 1,117 x 60 / 9,598 x (20.9 – 13.36) / 20.9

= 2.519 MMBtu/hr

Fuel Flow Rate:

Qf dscf/hr = MMBtu/hr x 10^6 (Btu/MMBtu) / HHV

$$= \frac{2.519 \times 10^6}{471.7 \times 60}$$

= 89.0 dscf/min

Mass Rate as Hexane:

Outlet:

$$= \frac{60 \times NMOC \times Qsd \times 86.18}{6 \times 385.3 \times 10^6 \times (1-0.0871)}$$

= < 0.0211 lb/hr Hexane

Inlet:

$$= \frac{60 \times NMOC \times Qf \times 86.18}{6 \times 385.3 \times 10^6}$$

= 0.0806 lb/hr Hexane

Destruction:

$$= \frac{0.0806 - 0.0211}{0.0806}$$

= > 0.7382 or 73.8%

Results may differ due to rounding.

EXAMPLE CALCULATIONS

STACK GAS VOLUMETRIC FLOW RATE WITH EPA SATURATION ~~AND ISOKINETIC DETERMINATION~~

Project name:	SCS ENGR.-LEICHNER	**Project number:**	W021AS-005198
Computed by:	MWALLACE PE	**Calculation date:**	1/11/2021
Run number:	RUN 1 - CON 1		

SAMPLE TRAIN DATA

Meter calibration factor, Y_d	0.9989	Y
Stack area, square feet	5.074	A_s
Pitot Coefficient	0.84	C_p
Barometric pressure, in Hg	30.34	P_{bar}
Meter box volume, acf	34.675	V_m
Impinger liquid volume, g	73.2	V_{lc}
Meter temperature, °R	514.1	T_m = (ºF plus 460)
Meter pressure, (delta H) iwg	1.0	ΔH
Velocity head, (delta P) iwg	0.01713	ΔP
Static pressure, iwg	-0.031	P_{sg}
Stack temperature, °F	1356	T_s
Stack temperature, °R	1816	T_s = (ºF plus 460)
Stack O_2, % volume dry	13.36	O_2
Stack CO_2, % volume dry	5.73	CO_2
Stack N_2, % volume dry	80.91	$N_2 = (100- \% O_2 - \% CO_2)$
Nozzle area, square feet	NA	$A_n = \pi \left(\frac{D_n}{2}\right)^2 \left(\frac{1\,ft}{12\,in}\right)^2$
PM sampling time, minutes	NA	Θ
Reference temperature, °R	528	T_{std} (ºF plus 460)

Note: The results calculated in the pages that follow may differ slightly from the results presented in the final report. This difference can be attributed to "significant digit round-off errors" common when comparing computer spreadsheets results with those derived from using a calculator.

1. VOLUMETRIC FLOW RATE

a. Standard sample gas volume, dscf

$$V_{m\,std} = (V_m)(Y)\frac{(T_{std})\left[P_{bar} + \left(\frac{\Delta H}{13.6}\right)\right]}{(T_m)(P_{std})}$$

$$V_{m\,std} = (34.675)(0.9989)\frac{(528)\left[30.34 + \left(\frac{1.0}{13.6}\right)\right]}{(514.1)(29.92)}$$

$V_{m\,std}$ = 36.160 dscf

b. Water vapor volume, scf

$$V_{w\,std} = (0.04715)(V_{lc})\left(\frac{T_{std}}{528}\right)$$

$$V_{w\,std} = (0.04715)(73.2)\left(\frac{528}{528}\right)$$

$V_{w\,std}$ = 3.4514 scf

c. Moisture content, non-dimensional

$$B_{ws} = \left(\frac{V_{w\,std}}{V_{m\,std} + V_{w\,std}}\right)$$

$$B_{ws} = \left(\frac{3.4514}{36.160 + 3.4514}\right)$$

B_{ws} = 0.0871 moisture content (multiply by 100 for % by volume)

d. Psychrometry, @ Saturation

$e" = 10\wedge[6.6912 - 3144/(T + 390.86)]$

$e" = 10\wedge[6.6912 - 3144/(\quad + 390.86)]$

$Bws\ (@sat) = \frac{e"}{(Ps)}$

$Bws\ (@sat) = \frac{\quad}{(\quad)}$

$Bws\ (@sat)$ = NA

e. Stack gas molecular weight, lb/lb mole (dry)

$MW_{dry} = [0.44(\%CO_2)] + [0.32(\%O_2)] + [0.28(\%N_2)]$

$MW_{dry} = [0.44(5.73)] + [0.32(13.36)] + [0.28(80.91)]$

MW_{dry} = 29.451 lb/lb mole

f. Stack gas molecular weight, lb/lb mole (wet)

$MW_{wet} = [MW_{dry}(1 - B_{ws})] + [18(B_{ws})]$

$MW_{wet} = [29.451(1 - 0.0871)] + [18(0.0871)]$

MW_{wet} = 28.454 lb/lb mole

g. Absolute stack pressure, in Hg

$P_s = P_{bar} + \left(\frac{P_{sg}}{13.6}\right)$

$P_s = 30.34 + \left(\frac{-0.031}{13.6}\right)$

P_s = 30.338 in. Hg

h. Stack velocity, ft/sec

$$v_s = (85.49)(C_p)(\sqrt{\Delta P})\sqrt{\frac{T_s}{(P_s)(MW_{wet})}}$$

$$v_s = (85.49)(0.84)(\sqrt{0.01713})\sqrt{\frac{1816}{(30.338)(28.454)}}$$

v_s = 13.632 ft/sec

i. Actual stack flow rate, acfm

$$Q = (v_s)(A_s)(60\ min/hr)$$

$$Q = (13.632)(5.074)(60)$$

Q = 4,150.1 acfm

j. Standard stack gas flow rate, wscfm

$$Q_{ws} = (v_s)(A_s)(60\ min/hr)\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$Q_{ws} = (13.632)(5.074)(60)\left(\frac{528}{1{,}816}\right)\left(\frac{30.338}{29.92}\right)$$

Q_{ws} = 1,223.5 wscfm

k. Standard stack gas flow rate, dscfm

$$Q_{ds} = (v_s)(A_s)(60\ min/hr)(1 - B_{ws})\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$Q_{ds} = (13.632)(5.074)(60)(1 - 0.0871)\left(\frac{528}{1{,}816}\right)\left(\frac{30.338}{29.92}\right)$$

Q_{ds} = 1,116.9 dscfm

EXAMPLE CALCULATIONS
GASEOUS EMISSIONS

Project name:	SCS ENGR. - LEICHNER	**Project number:**	W021AS-005198
Computed by:	MWALLACE PE		
Run number:	RUN 1 - CON 1	**Gaseous species:**	NOX
			1/11/2021

EMISSIONS DATA

Reference temperature, °R	528	T_{ref} = (ºF plus 460)
Concentration of gaseous species, ppmvd	19.1	C
Flue gas moisture content, non-dimensional	0.0871	B_{ws}
Dry stack gas flow rate at standard conditions, dscfm	1,117	Q_{ds}
Stack O_2, % volume dry	13.38	O_2
Stack CO_2, % volume dry	5.734	CO_2
"F" factor of fuel based on O_2, dscf/MMBtu @ 0% O_2	9,598	F_d
Molecular weight of gaseous species, lb/lb mole	46.01	MW_s where,

MW_s = 28.01 for CO; 46.01 for NO_X as NO_2; 64.06 for SO_X as SO_2; 17.03 for NH_3; 12.01 for carbon, C; 16.04 for methane (CH_4)

Specific molar volume of an ideal gas at standard conditions, ft^3/lb mole	385.3	SV where,

SV = 379.5 ft^3/lb mole for T_{ref} at 520 °R (60 °F)

SV = 385.3 ft^3/lb mole for T_{ref} at 528 °R (68 °F)

SV = 386.8 ft^3/lb mole for T_{ref} at530 °R (70 °F)

$$SV = (379.5)\left[\frac{\left((T_{ref}\ {}^{\circ}R)\right)}{520}\right]$$ at different reference temperatures

Note: The results calculated in the pages that follow may differ slightly from the results presented in the final report. This difference can be attributed to "significant digit round-off errors" common when comparing computer spreadsheets results with those derived from using a calculator.

1. GASEOUS EMISSIONS

a. Mass emissions, lb/hr

$$M = (C)\,(10^{-6})\left(\frac{MW_s}{SV}\right)(Q_{ds})(60\ min/hr)$$

$$M = (19.1)\,(10^{-6})\left(\frac{46.01}{385.3}\right)(1{,}117)(60)$$

M = 0.1529 lb/hr

b. Emission rate, lb/MMBtu

$$E = (C)\,(10^{-6})\left(\frac{MW_s}{SV}\right)(F_d)\left(\frac{20.9}{20.9-\%\,O_2}\right)$$

$$E = (19.1)\,(10^{-6})\left(\frac{46.01}{385.3}\right)(9{,}598)\left(\frac{20.9}{20.9-13.36}\right)$$

E = 0.0607 lb/MMBtu

0.1529 x 8760 / 2000 = 0.6697 tons/yr

Appendix A.9
General Equations

EMISSION CALCULATIONS

1. Volumetric Flow and Isokinetics

a. Standard sample gas volume, dscf

$$V_{m\,std} = (V_m)(Y)\frac{(T_{std} + 460)\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{(T_m + 460)(P_{std})}$$

b. Water vapor volume, scf

$$V_{w\,std} = (0.04715)(V_{lc})\left(\frac{T_{std} + 460}{528}\right)$$

c. Moisture content, non-dimensional

$$B_{ws} = \frac{V_{w\,std}}{(V_{m\,std} + V_{w\,std})}$$

d. Stack gas molecular weight, lb/lb mole (dry)

$$MW_{dry} = [0.44(\%CO_2)] + [0.32(\%O_2)] + [0.28(\%N_2)]$$

e. Stack gas molecular weight, lb/lb mole (wet)

$$MW_{wet} = \left[MW_{dry}(1 - B_{ws})\right] + [18(B_{ws})]$$

f. Absolute stack pressure, in Hg

$$P_s = P_{bar} + \left(\frac{P_{sg}}{13.6}\right)$$

g. Stack velocity, ft/sec

$$v_s = (85.49)(C_p)(\sqrt{\Delta P})\sqrt{\frac{T_s}{(P_s)(MW_{wet})}}$$

h. Actual stack flow rate, acfm

$$Q = (v_s)(A_s)(60\ min/hr)$$

i. Standard stack gas flow rate, wscfm

$$Q_{ws} = (v_s)(A_s)(60\ min/hr)\left(\frac{T_{std} + 460}{T_s + 460}\right)\left(\frac{P_s}{P_{std}}\right)$$

j. Standard stack gas flow rate, dscfm

$$Q_{ds} = (v_s)(A_s)(60\ min/hr)(1 - B_{ws})\left(\frac{T_{std} + 460}{T_s + 460}\right)\left(\frac{P_s}{P_{std}}\right)$$

k. Percent isokinetic

$$I = \frac{(T_s)(V_{m\,std})(P_{std})(100)}{(T_{std} + 460)(v_s)(\theta)(A_n)(P_s)(60)(1 - B_{ws})}$$

2. Gaseous Emissions

a. Concentration, ppm volume wet (i.e. to calculate wet ppm from dry ppm)

$$C_w = (C)(1 - B_{ws})$$

b. Concentration, ppm @ 3% O_2 dry

$$C_3 = (C)\left[\frac{(20.9 - 3.0)}{(20.9 - \%\ O_2)}\right]$$

c. Concentration, ppm @ 12% CO_2 dry

$$C_{12} = (C)\left(\frac{12.0}{\%\ CO_2}\right)$$

d. Concentration, ppm volume dry (i.e. to calculate dry ppm from wet ppm)

$$C = \left[\frac{C_w}{(1 - B_{ws})}\right]$$

e. Mass emission rate, lb/hr

$$M = (C)(CF)(Q_{ds})(60\ min/hr)$$

where,

CF = conversion factor from ppm to lb/scf:

$$CF_{NOx} = 1.194 \times 10^{-7}\left(\frac{lb/scf}{ppm}\right)$$

$$CF_{SO2} = 1.660 \times 10^{-7}\left(\frac{lb/scf}{ppm}\right)$$

$CF_X = CF_{NOX}\left(\frac{MW_X}{MW_{NOX}}\right)$ for other compounds (x)

f. Emission rate, lb/MMBtu

$$E = (C)(CF)(F_d)\left(\frac{20.9}{20.9 - \%\ O_2}\right)$$

g. Mass emission rate, grams/bhp-hr

$$M_j = (M)\left(\frac{453.59\ g/lb}{J}\right)$$

3. Particulate Emissions

a. Grain loading, gr/dscf

$$G = (0.0154)\left(\frac{G_m}{V_{m\,std}}\right)$$

b. Grain loading corrected to 12% CO_2, gr/dscf @ 12% CO_2

$$G_{12} = (G)\left(\frac{12.0}{\%\ CO_2}\right)$$

c. Mass emission rate, lb/hr

$$M = (G)(Q_{ds})\left(\frac{60\ min/hr}{7{,}000\ gr/lb}\right)$$

d. Emission rate, lb/MMBtu

$$E = (G)\left(\frac{1\ lb}{7{,}000\ gr}\right)(F_d)\left(\frac{20.9}{20.9 - \%\ O_2}\right)$$

4. Fuel Factor "F"

a. Choice #1 – use the values for F_d provided in Method 19, Table 19-1
Choice #2 – if you have fuel ultimate and proximate analysis, calculate F_d (need fuel weight %CHONS, HHV)
Stoichiometric fuel factor at 68 °F, dscf/MMBtu at 0% O_2:

$$F_d = \frac{(10^6)[3.64(\%\ H) + 1.53(\%\ C) + 0.14(\%\ N) + 0.57(\%\ S) - 0.46(\%\ O)]}{HHV, Btu/lb}$$

b. Fuel factor at 60 °F (use if all your volumes and flows are at 60 °F)

$$F_{d\ 60} = F_d\left(\frac{520°R}{528°R}\right)$$

5. Miscellaneous Equations

a. Standard stack gas flow rate, calculated from fuel flow and F factor, dscfm

Note: Q_f and HHV need to be in units of either lb/hr and Btu/lb, or scf/hr and Btu/scf. *Do not mix units!*

(calculation based on stack $\%O_2$)

$$Q_{ds} = (Q_f)(HHV)(10^{-6})(F_d)\left(\frac{20.9}{20.9 - \%\,O_2}\right)/(60\,min/hr)$$

or (calculation based on stack $\%CO_2$ – see EPA Method 19 for values of F_c)

$$Q_{ds} = (Q_f)(HHV)(10^{-6})(F_c)\left(\frac{100}{\%\,CO_2}\right)/(60\,min/hr)$$

b. Destruction efficiency of emission control device, %

$EFF = \left(\frac{C_{in} - C_{out}}{C_{in}}\right)(100\%)$ based on concentrations

or

$EFF = \left(\frac{M_{in} - M_{out}}{M_{in}}\right)(100\%)$ based on mass emission rates

c. Cylinder gas audit, % accuracy

$$A_c = \left(\frac{C_m - C_a}{C_a}\right)(100\%)$$

Nomenclature:

A_c	=	accuracy of CEMS during cylinder gas audit (CGA), % difference
A_n	=	nozzle area, in^2 (π r^2), where π = 3.1416 and r = radius (½ diameter) in inches
A_s	=	stack area, ft^2 (π r^2), where π = 3.1416 and r = radius (½ diameter) in feet
B_{ws}	=	flue gas moisture content (multiply by 100 for % by volume)
C	=	concentration of gaseous species, ppm volume dry
C_a	=	concentration of audit gas, ppm (for CGA, equation 5c)
C_m	=	concentration measured by CEMS, ppm (for CGA, equation 5c)
C_p	=	calibration factor for pitot tube, dimensionless
C_w	=	concentration of gaseous species, ppm volume wet
C_3	=	corrected concentration of gaseous species, ppm @ 3% O_2 dry
C_{12}	=	corrected concentration of gaseous species, ppm @ 12% CO_2 dry
E	=	mass emission rate, lb/MMBtu
EFF	=	destruction or removal efficiency of emission control device, % efficiency
F_c	=	stoichiometric "F" factor of fuel based on CO_2, dscf/MMBtu @ 100% CO_2
F_d	=	stoichiometric "F" factor of fuel based on O_2, dscf/MMBtu @ 0% O_2
G	=	particulate matter grain loading, grains/dscf
G_{12}	=	corrected particulate matter grain loading, grains/dscf @ 12% CO_2
G_m	=	mass of collected particulate matter, mg
HHV	=	higher heating value, Btu/cubic foot
I	=	% isokinetic sampling rate, %
J	=	brake horsepower, bhp
M_j	=	mass emission rate of measured species (s), g/hp-hr
M	=	mass emission rate, lb/hr
MW_{dry}	=	molecular weight of stack gas, dry basis
MW_{wet}	=	molecular weight of stack gas, wet basis
MW_s	=	molecular weight of gaseous species (s), lb/lb mole:

CO:	28.01	(can use 28)	NO_x as NO_2:	46.01	(can use 46)
SO_x as SO_2:	64.06	(can use 64)	Hydrocarbons as C:	12.01	(can use 12)
Hydrocarbons as CH_4:	16.04	(can use 16)	Hydrocarbons as C_3H_8:	44.10	(can use 44)
NH_3:	17.03	(can use 17)			

N_2	=	nitrogen content of stack gas, % volume dry
P_{bar}	=	barometric pressure, in. Hg
P_s	=	stack absolute pressure, in. Hg
P_{sg}	=	stack static pressure, inches of water, gauge (iwg)
Q	=	wet stack gas flow rate at actual conditions, acfm
Q_f	=	fuel flow rate, scfh or lb/hr (be careful of units)
Q_{ds}	=	dry stack gas flow rate at standard conditions, dscfm
Q_{ws}	=	wet stack gas flow rate at standard conditions, wscfm
SV	=	specific molar volume of an ideal gas at standard conditions, ft^3/lb mole
T_m	=	meter temperature, °R
T_{std}	=	reference temperature, °R
T_s	=	stack gas temperature, °R
v_s	=	stack gas velocity, ft/sec
V_{lc}	=	volume of liquid collected in impingers, ml
V_m	=	dry meter volume uncorrected, acf
$V_{m\ std}$	=	dry meter volume corrected to standard conditions, dscf
$V_{w\ std}$	=	volume of water vapor at standard conditions, scf
Y	=	meter calibration coefficient, dimensionless
ΔH	=	average pressure differential across meter, inches water
ΔP	=	average velocity head of stack gas, inches water
Θ	=	sampling time, minutes

APPENDIX B
FACILITY PROCESS DATA

All Data

Date	Time	Setpoint Temp (deg F)	Operating Temp (deg F)	Flow (scfm)
12/9/2020	8:33	1475	1474	71
12/9/2020	9:11	1475	1478	71
12/9/2020	9:34	1475	1472	71
12/9/2020	9:59	1475	1472	71
12/9/2020	10:04	1475	1471	70
12/9/2020	11:25	1475	1487	71
12/9/2020	11:54	1475	1479	70
12/9/2020	12:09	1475	1475	71
12/9/2020	12:30	1475	1480	72
12/9/2020	12:46	1475	1470	71
12/9/2020	13:30	1475	1468	72
12/9/2020	13:41	1475	1464	71
12/10/2020	9:30	1300	1301	72
12/10/2020	11:00	1300	1295	71
12/10/2020	11:58	1300	1316	71
12/10/2020	12:51	1300	1303	70
12/10/2020	13:22	1300	1302	71
12/10/3030	13:39	1300	1302	70

Test Run Averages

Test Date	Run #	Run Time	Setpoint Temp (deg F)	Avg Operating Temp (deg F)	Avg Flow (scfm)
12/9/2020	1	8:30 - 9:30	1475	1476.0	71.0
12/9/2020	2	11:00 - 12:00	1475	1483.0	70.5
12/9/2020	3	12:45 - 13:45	1475	1467.3	71.3
12/10/2020	1	8:27 - 9:27	1300	1301.0	72.0
12/10/2020	2	10:57 - 11:57	1300	1305.5	71.0
12/10/2020	3	12:47 - 13:47	1300	1302.3	70.3

APPENDIX C
LABORATORY ANALYSIS DATA

Appendix C.1
EPA 25C/3C Analyses

Atmospheric Analysis & Consulting, Inc.

CLIENT : Montrose AQS
PROJECT NAME : SCS Engineers / Leichner Landfill
PROJECT NO. : PROJ-05918
AAC PROJECT NO. : 202247
REPORT DATE : 01/04/2021

On December 14, 2020, Atmospheric Analysis & Consulting, Inc. received twelve (12) Six-Liter Summa Canisters for TNMOC analysis by EPA 25C, of which six (6) were also for Fixed Gases analysis by EPA 3C. Upon receipt, the samples were assigned unique Laboratory ID numbers as follows:

Client ID	Lab No.	Return Pressure (mmHg)	Client ID	Lab No.	Return Pressure (mmHg)
Inlet 1-1	202247-15389	601.8	Inlet 2-1	202247-15395	644.3
Inlet 1-2	202247-15390	618.0	Inlet 2-2	202247-15396	636.8
Inlet 1-3	202247-15391	608.7	Inlet 2-3	202247-15397	631.6
Exhaust 1-1	202247-15392	360.7	Exhaust 2-1	202247-15398	388.3
Exhaust 1-2	202247-15393	582.5	Exhaust 2-2	202247-15399	536.3
Exhaust 1-3	202247-15394	482.0	Exhaust 2-3	202247-15400	589.8

This analysis is performed in accordance with AAC's Quality Manual. Test results apply to the sample(s) as received. For detailed information pertaining to specific EPA, NCASI, ASTM and SCAQMD accreditations (Methods & Analytes), please visit our website at www.aaclab.com.

I certify that this data is technically accurate, complete, and in compliance with the terms and conditions of the contract. No problems were encountered during receiving, preparation, and/or analysis of these samples.

The Technical Director or his/her designee, as verified by the following signature, has authorized release of the data.

If you have any questions or require further explanation of data results, please contact the undersigned.

Sucha Parmar
Sucha Parmar, Ph.D.
Technical Director

This report consists of 10 pages.

2225 Sperry Ave., Ventura, CA 93003 www.aaclab.com • (805) 650-1642

Atmospheric Analysis & Consulting, Inc.

Laboratory Analysis Report

CLIENT	: Montrose AQS	SAMPLING DATE	: 12/09-10/2020
PROJECT NO.	: 202247	RECEIVING DATE	: 12/14/2020
MATRIX	: AIR	ANALYSIS DATE	: 12/21-22/2020
		REPORT DATE	: 01/04/2021

EPA 3C & EPA 25C

Client ID	Inlet 1-1	Inlet 1-2	Inlet 1-3
AAC ID	202247-15389	202247-15390	202247-15391
Can Dilution Factor	1.51	1.46	1.48
Analyte	Result	Result	Result
H_2	< 1.5 %	< 1.5 %	< 1.5 %
O_2	1.3 %	1.1 %	1.1 %
N_2	29.1 %	28.4 %	26.6 %
CO	< 0.2 %	< 0.1 %	< 0.1 %
CO_2	22.2 %	22.5 %	22.3 %
CH_4	47.4 %	48.1 %	50.0 %
TNMOC (as Carbon)	405 ppmC	428 ppmC	450 ppmC

Client ID	Inlet 2-1	Inlet 2-2	Inlet 2-3
AAC ID	202247-15395	202247-15396	202247-15397
Can Dilution Factor	1.40	1.45	1.44
Analyte	Result	Result	Result
H_2	< 1.4 %	< 1.4 %	< 1.4 %
O_2	2.3 %	1.1 %	1.2 %
N_2	28.1 %	24.6 %	25.2 %
CO	< 0.1 %	< 0.1 %	< 0.1 %
CO_2	21.4 %	22.8 %	22.6 %
CH_4	48.2 %	51.4 %	51.0 %
TNMOC (as Carbon)	382 ppmC	421 ppmC	412 ppmC

All fixed gases have been normalized to 100% on a dry basis

Sample Reporting Limit (SRL) is equal to Reporting Limit x Analysis Dil. Fac x Canister Dil. Fac

Sucha Parmar, Ph.D.
Technical Director

2225 Sperry Ave., Ventura, CA 93003 www.aaclab.com • (805) 650-1642

Atmospheric Analysis & Consulting, Inc.

Laboratory Analysis Report

Client	: Montrose AQS		**Sampling Date**	: 12/09-10/2020
Project No.	: 202247		**Receiving Date**	: 12/14/2020
Matrix	: AIR		**Analysis Date**	: 12/21-22/2020
Units	: ppmC		**Report Date**	: 01/04/2021

EPA 25C

Reporting Limit: 3.0 ppmC		*Canister Dilution Factor*	*Analysis Dilution Factor*	TNMOC*	SRL (RL x DF's)
Client Sample ID	**AAC ID**				
Exhaust 1-1	202247-15392	2.6	1.0	<SRL	7.7
Exhaust 1-2	202247-15393	1.6	1.0	<SRL	4.7
Exhaust 1-3	202247-15394	1.9	1.0	<SRL	5.7
Exhaust 2-1	202247-15398	2.3	1.0	<SRL	7.0
Exhaust 2-2	202247-15399	1.7	1.0	<SRL	5.0
Exhaust 2-3	202247-15400	1.6	1.0	<SRL	4.9

Sample Reporting Limit (SRL) is equal to Reporting Limit x Analysis Dil. Fac x Canister Dil. Fac.

**Total Non-Methane Organic Carbon*

Sucha Parmar, Ph.D.
Technical Director

2225 Sperry Ave., Ventura, CA 93003 www.aaclab.com • (805) 650-1642

Atmospheric Analysis & Consulting, Inc.

Quality Control/Quality Assurance Report

Date Analyzed : 12/22/2020
Analyst : CH/DL
Units : %

Instrument ID : TCD #1
Calb Date : 10/05/20
Reporting Limit : 0.1%

I - Opening Continuing Calibration Verification - EPA 3C

AAC ID	Analyte	H_2	O_2	N_2	CH_4	CO	CO_2
CCV	Spike Conc	9.9	10.4	20.2	10.0	10.0	10.0
	Result	9.8	10.3	19.9	9.8	9.8	9.6
	% Rec *	98.4	98.9	98.7	98.4	97.6	96.2

II - Method Blank - EPA 3C

AAC ID	Analyte	H_2	O_2	N_2	CH_4	CO	CO_2
MB	Concentration	ND	ND	ND	ND	ND	ND

III - Laboratory Control Spike & Duplicate - EPA 3C

AAC ID	Analyte	H_2	O_2	N_2	CH_4	CO	CO_2
Lab Control Standards	Sample Conc	0.0	0.0	0.0	0.0	0.0	0.0
	Spike Conc	9.9	10.4	20.2	10.0	10.0	10.0
	LCS Result	9.9	10.3	19.8	9.8	9.8	9.7
	LCSD Result	9.9	10.4	20.2	10.0	9.9	9.8
	LCS % Rec *	99.8	99.0	98.3	98.1	97.5	97.0
	LCSD % Rec *	99.4	100.4	100.0	100.2	99.1	98.1
	% RPD ***	0.4	1.4	1.7	2.1	1.6	1.2

IV -Sample & Sample Duplicate - EPA 3C

AAC ID	Analyte	H_2	O_2	N_2	CH_4	CO	CO_2
202247-15397	Sample	0.0	0.9	18.0	36.5	0.0	16.2
	Sample Dup	0.0	0.9	18.1	36.4	0.0	16.2
	Mean	0.0	0.9	18.0	36.5	0.0	16.2
	% RPD ***	0.0	2.4	0.3	0.2	0.0	0.5

V - Matrix Spike & Duplicate- EPA 3C

AAC ID	Analyte	H_2	N_2	CH_4	CO	CO_2
202247-15397	Sample Conc	0.0	9.0	18.2	0.0	8.1
	Spike Conc	9.9	10.1	10.0	10.0	10.0
	MS Result	9.7	20.0	28.0	9.9	17.8
	MSD Result	9.9	19.5	28.7	10.0	18.1
	MS % Rec **	97.5	108.1	97.5	98.8	97.1
	MSD % Rec **	99.8	103.5	104.6	100.2	100.6
	% RPD ***	2.3	4.4	7.0	1.4	3.5

VI - Closing Continuing Calibration Verification - EPA 3C

AAC ID	Analyte	H_2	O_2	N_2	CH_4	CO	CO_2
CCV	Spike Conc	9.9	10.4	20.2	10.0	10.0	10.0
	Result	10.0	10.6	20.4	10.1	10.1	9.9
	% Rec *	100.6	101.8	101.4	101.1	100.6	98.9

** Must be 85-115%*
*** Must be 75-125%*
**** Must be < 25%*
ND = Not Detected
<RL = less than Reporting Limit

Sucha Parmar, Ph.D.
Technical Director

Atmospheric Analysis & Consulting, Inc.

Quality Control/Quality Assurance Report

Analysis Date : **12/21/2020**
Analyst : **DB**
Units : **ppmv**

Instrument ID: **GCTCA#2-FID**
Calibration Date: **11/16/2020**

I - Opening Calibration Verification Standard - Method 25C

Analyte	xRF	DRF	%RPD*
Propane	1047025	1107565	5.6

II - TNMOC Response Factor - Method 25C

Analyte	xRF	CV RF	CV dp RF	CV tp RF	Average RF	% RPD***
Propane	1047025	1107565	1104622	1020845	1077677	2.9

III - Method Blank - Method 25C

AAC ID	Analyte	Sample Result
MB	TNMOC	ND

IV - Laboratory Control Spike & Duplicate - Method 25C

AAC ID	Analyte	Spike Added	LCS	LCSD	LCS % Rec **	LCSD % Rec **	% RPD***
LCS/LCSD	Propane	50.7	54.38	50.26	107.4	99.2	7.9

V - Closing Calibration Verification Standard - Method 25C

Analyte	xCF	dCF	%RPD*
Propane	1047025	1023597	2.3

xCF - Average Calibration Factor from Initial Calibration Curve
dCF - Daily Calibration Factor
* Must be <15%
** Must be 90-110 %
*** Must be <20%

Sucha Parmar, Ph.D.
Technical Director

2225 Sperry Ave., Ventura, CA 93003 www.aaclab.com • (805) 650-1642

Atmospheric Analysis & Consulting, Inc.

Quality Control/Quality Assurance Report

Analysis Date	**: 12/22/2020**		**Instrument ID:**	**GCTCA#2-FID**
Analyst	**: DB**		**Calibration Date:**	**11/16/2020**
Units	**: ppmv**			

I - Opening Calibration Verification Standard - Method 25C

Analyte	xRF	DRF	%RPD*
Propane	1047025	1103790	5.3

II - TNMOC Response Factor - Method 25C

Analyte	xRF	CV RF	CV dp RF	CV tp RF	Average RF	% RPD***
Propane	1047025	1103790	1084374	1085820	1091328	4.1

III - Method Blank - Method 25C

AAC ID	Analyte	Sample Result
MB	TNMOC	ND

IV - Laboratory Control Spike & Duplicate - Method 25C

AAC ID	Analyte	Spike Added	LCS	LCSD	LCS % Rec **	LCSD % Rec **	% RPD***
LCS/LCSD	Propane	50.7	53.39	53.46	105.4	105.5	0.1

V - Closing Calibration Verification Standard - Method 25C

Analyte	xCF	dCF	%RPD*
Propane	1047025	974803	7.1

xCF - Average Calibration Factor from Initial Calibration Curve
dCF - Daily Calibration Factor
* Must be <15%
** Must be 90-110 %
*** Must be <20%

Sucha Parmar, Ph.D.
Technical Director

2225 Sperry Ave., Ventura, CA 93003 www.aaclab.com • (805) 650-1642

MONTROSE AIR QUALITY SERVICES

CHAIN OF CUSTODY

202247

Portland Location
13585 NE Whitaker Way
Portland, OR 97230
Phone (503) 255-5050 | Fax (503) 255-0505

Lab info:
Atmospheric Analysis and Consulting, Inc.
Ventura, CA

Client / Project: SCS Engineers / Leichner Landfill	**Project / Sample Location:** Flare Inlet (Scenario 1)	**Test / Analytical Method:** EPA 3C / EPA 25C
Project No.: PROJ-05918	**Purchase Order No:**	**Special Analysis / Reporting Instructions:** EPA 3C for fixed gases and EPA 25C for NMOC Client Does Not want Fuel analysis for Fd or HHV
Send Analytical Report To: Portland QA/QC: PortlandQA-QC@montrose-env.com pbecker@montrose-env.com	**Sampler or PM Signature:** Peter Becker	

Run / Sample No.	Date	Time	Containers	Sample Fraction	Reagent	Lab / Sample ID No.
Inlet 1-1	12/9/20	9:31	1	SUMMA Canister (001314)	--	15389
Inlet 1-2	12/9/20	12:04	1	" (000825)	--	15390
Inlet 1-3	12/9/20	13:45	1	" (000936)	--	15391
					--	
					--	
					--	
Total Containers			3			

Relinquished by	Date	Time	Received by	Date	Time	Temp.
			[signature]	12/14/20	1220	

Fx 14x cans (2x unused) +2x 25.3 style FCs
+2x cased 25.3 style FCs

MONTROSE
AIR QUALITY SERVICES

CHAIN OF CUSTODY

202247

Portland Location
13585 NE Whitaker Way
Portland, OR 97230
Phone (503) 255-5050 | Fax (503) 255-0505

Lab info:
Atmospheric Analysis and Consulting, Inc.
Ventura, CA

Client / Project: SCS Engineers / Leichner Landfill	**Project / Sample Location:** Flare Exhaust (Scenario 1)	**Test / Analytical Method:** EPA 25C
Project No.: PROJ-05918	**Purchase Order No:**	**Special Analysis / Reporting Instructions:** EPA 25C for NMOC
Send Analytical Report To: Portland QA/QC: PortlandQA-QC@montrose-env.com pbecker@montrose-env.com	**Sampler or PM Signature:** Peter Becker	

Run / Sample No.	Date	Time	Containers	Sample Fraction	Reagent	Lab / Sample ID No.
Exhaust 1-1	12/9/20	9:30	1	SUMMA Canister (000329)	--	15392
Exhaust 1-2	12/9/20	12:04	1	" (000149)	--	15393
Exhaust 1-3	12/9/20	13:45	1	" (000546)	--	15394
					--	
					--	
					--	
Total Containers			3			

Relinquished by	Date	Time	Received by	Date	Time	Temp.
Peter	12.10.20	18:00				
Relinquished by	Date	Time	Received by	Date	Time	Temp.
Relinquished by	Date	Time	Received by	Date	Time	Temp.
			[signature]	12/14/20	1220	

MAQS Chain of Custody Macro-R2

MONTROSE AIR QUALITY SERVICES

CHAIN OF COUSTODY

202297

Portland Location
13585 NE Whitaker Way
Portland, OR 97230
Phone (503) 255-5050 | Fax (503) 255-0505

Lab info:
Atmospheric Analysis and Consulting, Inc.
Ventura, CA

Client / Project: SCS Engineers / Leichner Landfill	**Project / Sample Location:** Flare Inlet (Scenario 2)	**Test / Analytical Method:** EPA 3C / EPA 25C
Project No.: PROJ-05918	**Purchase Order No:**	**Special Analysis / Reporting Instructions:** EPA 3C for fixed gases and EPA 25C for NMOC Client Does Not want Fuel analysis for Fd or HHV
Send Analytical Report To: Portland QA/QC: PortlandQA-QC@montrose-env.com pbecker@montrose-env.com	**Sampler or PM Signature:** Peter Becker	

Run / Sample No.	Date	Time	Containers	Sample Fraction	Reagent	Lab / Sample ID No.
Inlet 2-1	12/10/20	9:33	1	SUMMA Canister (000947)	--	15395
Inlet 2-2	12/10/20	11:57	1	" (000941)	--	15396
Inlet 2-3	12/10/20	13:46	1	" (000952)	--	15397
					--	
					--	
					--	
Total Containers			3			

Relinquished by	Date	Time	Received by	Date	Time	Temp.
Peter Beck	12.10.20	18:00				
				12/14/20	1220	

MAQS Chain of Custody Macro-R2

MONTROSE AIR QUALITY SERVICES

CHAIN OF CUSTODY

202247

Portland Location
13585 NE Whitaker Way
Portland, OR 97230
Phone (503) 255-5050 | Fax (503) 255-0505

Lab info:
Atmospheric Analysis and Consulting, Inc.
Ventura, CA

Client / Project: SCS Engineers / Leichner Landfill	**Project / Sample Location:** Flare Exhaust (Scenario 2)	**Test / Analytical Method:** EPA 25C
Project No.: PROJ-05918	**Purchase Order No:**	**Special Analysis / Reporting Instructions:** EPA 25C for NMOC
Send Analytical Report To: Portland QA/QC: PortlandQA-QC@montrose-env.com pbecker@montrose-env.com	**Sampler or PM Signature:** Peter Beck	

Run / Sample No.	Date	Time	Containers	Sample Fraction	Reagent	Lab / Sample ID No.
Exhaust 2-1	12/10/20	9:27	1	SUMMA Canister (001308)	--	15398
Exhaust 2-2	12/10/20	11:57	1	" (001319)	--	15399
Exhaust 2-3	12/10/20	13:47	1	" (001268)	--	15400
					--	
					--	
					--	
Total Containers			3			

Relinquished by	Date	Time	Received by	Date	Time	Temp.
Peter Becker	12.10.20	18:00				
				12/14/20	1220	

MAQS Chain of Custody Macro-R2

APPENDIX D
QUALITY ASSURANCE/QUALITY CONTROL

Appendix D.1
Units and Abbreviations

UNITS AND ABBREVIATIONS

@ X% O_2	corrected to X% oxygen (corrected for dilution air)
|CC|	absolute value of the confidence coefficient
|d|	absolute value of the mean differences
ºC	degrees Celsius (centrigade)
ºF	degrees Fahrenheit
ºR	degrees Rankine
" H_2O	inches of water column
13.6	specific gravity of mercury
ΔH	pressure drop across orifice meter, inches H_2O
ΔP	velocity head of stack gas, inches H_2O
θ	total sampling time, minutes
µg	microgram
ρ_a	density of acetone, mg/ml
ρ_w	density of water, 0.9982 g/ml or 0.002201 lb/ml
acfm	actual cubic feet of gas per minute at stack conditions
A_n	cross-sectional area of nozzle, ft^2
A_s	cross-sectional area of stack, square feet (ft^2)
Btu	British thermal unit
B_{ws}	proportion by volume of water vapor in gas stream
C_a	particulate matter concentration in stack gas, gr/acf
C_{Avg}	average unadjusted gas concentration, ppmv
C_{Dir}	measured concentration of calibration gas, ppmv
cf or ft^3	cubic feet
cfm	cubic feet per minute
C_{Gas}	average gas concentration adjusted for bias, ppmv
C_M	average of initial and final system bias check responses from upscale calibration gas, ppmv
cm or m^3	cubic meters
C_{MA}	actual concentration of the upscale calibration gas, ppmv
C_O	average of initial and final system bias check responses from low-level calibration gas, ppmv
C_p	pitot tube coefficient
C_s	particulate matter concentration in stack gas, gr/dscf
CS	calibration span, % or ppmv
C_S	measured concentration of calibration gas, ppmv
C_V	manufactured certified concentration of calibration gas, ppmv
D	drift assessment, % of span
dcf	dry cubic feet
dcm	dry cubic meters
D_n	diameter of nozzle, inches
D_s	diameter of stack, inches
dscf	dry standard cubic feet
dscfm	dry standard cubic feet per minute
dscm	dry standard cubic meters
F_d	F-factor, dscf/MMBtu of heat input
fpm	feet per minute
fps	feet per second
ft	feet
ft^2	square feet
g	gram
gal	gallons
gr	grains (7000 grains per pound)

MONTROSE AIR QUALITY SERVICES

UNITS AND ABBREVIATIONS

gr/dscf	grains per dry standard cubic feet
hr	hour
I	percent of isokinetic sampling
in	inch
k	kilo or thousand (metric units, multiply by 10^3)
K	kelvin (temperature)
K_3	conversion factor 0.0154 gr/mg
K_4	conversion factor 0.002669 ((in. Hg)(ft^3))/((ml)(°R))
kg	kilogram
K_p	pitot tube constant (85.49 ft/sec)
kwscfh	thousand wet standard cubic feet per hour
l	liters
lb/hr	pounds per hour
lb/MMBtu	pounds per million Btu
lpm	liters per minute
m	meter or milli
M	thousand (English units) or mega (million, metric units)
m^3	cubic meters
m_a	mass of residue of acetone after evaporation, mg
M_d	molecular weight of stack gas; dry basis, lb/lb-mole
meq	milliequivalent
mg	milligram
Mg	megagram (10^6 grams)
min	minute
ml or mL	milliliter
mm	millimeter
MM	million (English units)
MMBtu/hr	million Btu per hour
m_n	total amount of particulate matter collected, mg
mol	mole
mol. wt. or MW	molecular weight
M_s	molecular weight of stack gas; wet basis, lb/lb-mole
MW	molecular weight or megawatt
n	number of data points
ng	nanogram
nm	nanometer
P_{bar}	barometric pressure, inches Hg
pg	picogram
P_g	stack static pressure, inches H_2O
P_m	barometric pressure of dry gas meter, inches Hg
ppb	parts per billion
ppbv	parts per billion, by volume
ppbvd	parts per billion by volume, dry basis
ppm	parts per million
ppmv	parts per million, by volume
ppmvd	parts per million by volume, dry basis
P_s	absolute stack gas pressure, inches Hg
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
P_{std}	standard absolute pressure, 29.92 inches Hg
Q_a	volumetric flow rate, actual conditions, acfm

UNITS AND ABBREVIATIONS

Q_s	volumetric flow rate, standard conditions, scfm
Q_{std}	volumetric flow rate, dry standard conditions, dscfm
R	ideal gas constant 21.85 ((in. Hg) ($ft^{3)}$)/((°R) (lbmole))
SB_{final}	post-run system bias check, % of span
SB_i	pre-run system bias check, % of span
scf	standard cubic feet
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
scm	standard cubic meters
scmh	standard cubic meters per hour
sec	second
sf, sq. ft., or ft^2	square feet
std	standard
t	metric ton (1000 kg)
$T_{0.975}$	t-value
T_a	absolute average ambient temperature, ºR (+460 for English)
T_m	absolute average dry gas meter temperature, ºR (+460 for English)
ton or t	ton = 2000 pounds
tph or tons/hr	tons per hour
tpy or tons/yr	tons per year
T_s	absolute average stack gas meter temperature, ºR (+460 for English)
T_{std}	absolute temperature at standard conditions
V	volt
V_a	volume of acetone blank, ml
V_{aw}	volume of acetone used in wash, ml
V_{lc}	total volume H_2O collected in impingers and silica gel, grams
V_m	volume of gas sampled through dry gas meter, ft^3
$V_{m(std)}$	volume of gas measured by the dry gas meter, corrected to standard conditions, dscf
V_{ma}	stack gas volume sampled, acf
V_n	volume collected at stack conditions through nozzle, acf
V_s	average stack gas velocity, feet per second
$V_{wc(std)}$	volume of water vapor condensed, corrected to standard conditions, scf
$V_{wi(std)}$	volume of water vapor in gas sampled from impingers, scf
$V_{wsg(std)}$	volume of water vapor in gas sampled from silica gel, scf
W	watt
W_a	weight of residue in acetone wash, mg
W_{imp}	total weight of impingers, grams
W_{sg}	total weight of silica gel, grams
Y	dry gas meter calibration factor, dimensionless

ACRONYMS

AAS	atomic absorption spectroscopy
ACDP	air contaminant discharge permit
ACE	analyzer calibration error, percent of span
AD	absolute difference
ADL	above detection limit
AETB	Air Emissions Testing Body
AS	applicable standard (emission limit)
ASTM	American Society For Testing And Materials
BACT	best achievable control technology
BDL	below detection limit
BHP	brake horsepower
BIF	boiler and industrial furnace
BLS	black liquor solids
CC	confidence coefficient
CD	calibration drift
CE	calibration error
CEM	continuous emissions monitor
CEMS	continuous emissions monitoring system
CERMS	continuous emissions rate monitoring system
CET	calibration error test
CFR	Code of Federal Regulations
CGA	cylinder gas audit
CHNOS	elemental analysis for determination of C, H, N, O, and S content in fuels
CNCG	concentrated non-condensable gas
CO	catalytic oxidizer
COC	chain of custody
COMS	continuous opacity monitoring system
CPM	condensible particulate matter
CPMS	continuous parameter monitoring system
CT	combustion turbine
CTM	conditional test method
CTO	catalytic thermal oxidizer
CVAAS	cold vapor atomic absorption spectroscopy
D_e	equivalent diameter
DE	destruction efficiency
Dioxins	polychlorinated dibenzo-p-dioxins (pcdd's)
DLL	detection level limited
DNCG	dilute non-condensable gas
ECD	electron capture detector
EIT	Engineer In Training
ELCD	electoconductivity detector (hall detector)
EMPC	estimated maximum possible concentration
EPA	US Environmental Protection Agency
EPRI	Electric Power Research Institute
ES	emission standard (applicable limit)
ESP	electrostatic precipitator
EU	emission unit
FCCU	fluid catalytic cracking unit
FGD	flue gas desulfurization
FI	flame ionization
FIA	flame ionization analyzer
FID	flame ionization detector
FPD	flame photometric detector
FPM	filterable particulate matter

ACRONYMS

FTIR	Fourier-transform infrared spectroscopy
FTPB	field train proof blank
FTRB	field train recovery blank
Furans	polychlorinated dibenzofurans (pcdf's)
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
GFAAS	graphite furnace atomic absorption spectroscopy
GFC	gas filter correlation
GHG	greenhouse gas
HAP	hazardous air pollutant
HC	hydrocarbons
HHV	higher heating value
HPLC	high performance liquid chromatography
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectroscopy
HRSG	heat recovery steam generator
IC	ion chromatography
ICAP	inductively-coupled argon plasmography
ICPCR	ion chromatography with a post-column reactor
IR	infrared radiation
ISO	International Standards Organization
kW	kilowatts
LFG	landfill gas
LHV	lower heating value
LPG	liquified petroleum gas
MACT	maximum achievable control technology
MDI	methylene diphyenyl diisocyanate
MDL	method detection limit
MNOC	maximum normal operating conditions
MRL	method reporting limit
MS	mass spectrometry
NA	not applicable or not available
NCASI	National Council For Air And Steam Improvement
NCG	non-condensable gases
NDIR	non-dispersive infrared
NESHAP	National Emissions Standards For Hazardous Air Pollutants
NG	natural gas
NIOSH	National Institute For Occupational Safety And Health
NIST	National Institute Of Standards And Technology
NMC	non-methane cutter
NMOC	non-methane organic compounds
NMVOC	non-methane volatile organic compounds
NPD	nitrogen phosphorus detector
NSPS	New Source Performance Standards
OSHA	Occupational Safety And Health Administration
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl compounds
PCWP	plywood and composite wood products
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances (PFAS)
PI	photoionization
PID	photoionization detector
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter

ACRONYMS

POM	polycyclic organic matter
PS	performance specification
PSD	particle size distribution
PSEL	plant site emission limits
PST	performance specification test
PTE	permanent total enclosure
PTM	performance test method
QA/QC	quality assurance and quality control
QI	Qualified Individual
QSTI	Qualified Source Testing Individual
RA	relative accuracy
RAA	relative accuracy audit
RACT	reasonably available control technology
RATA	relative accuracy test audit
RCTO	rotary concentrator thermal oxidizer
RICE	stationary reciprocating internal combustion engine
RM	reference method
RTO	regenerative thermal oxidizer
SAM	sulfuric acid mist
SCD	sulfur chemiluminescent detector
SCR	selective catalytic reduction system
SD	standard deviation
Semi-VOST	semivolatile organic compounds sample train
SRM	standard reference material
TAP	toxic air pollutant
TBD	to be determined
TCA	thermal conductivity analyzer
TCD	thermal conductivity detector
TGNENMOC	total gaseous non-ethane non-methane organic compounds
TGNMOC	total gaseous non-methane organic compounds
TGOC	total gaseous organic compounds
THC	total hydrocarbons
TIC	tentatively identified compound
TO	thermal oxidizer
TO	toxic organic (as in EPA Method TO-15)
TPM	total particulate matter
TSP	total suspended particulate matter
TTE	temporary total enclosure
ULSD	ultra-low sulfur diesel
UV	ultraviolet radiation range
VE	visible emissions
VOC	volatile organic compounds
VOST	volatile organic sample train
WC	water column
WWTP	waste water treatment plant

MONTROSE AIR QUALITY SERVICES

CHEMICAL NOMENCLATURE

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
C	carbon
Cd	cadmium
CdS	cadmium sulfide
CH_2O	formaldehyde
CH_3CHO	acetaldehyde
CH_3OH	methanol
CH_4	methane
C_2H_4O	ethylene oxide
C_2H_6	ethane
C_3H_4O	acrolein
C_3H_6O	propionaldehyde
C_3H_8	propane
C_6H_5OH	phenol
Cl_2	chlorine
ClO_2	chlorine dioxide
CO	carbon monoxide
Co	cobalt
CO_2	carbon dioxide
Cr	chromium
Cu	copper
EtO	ethylene oxide
EtOH	ethyl alcohol (ethanol)
H_2	hydrogen
H_2O	water
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
H_2SO_4	sulfuric acid
HCl	hydrogen chloride
Hg	mercury
IPA	isopropyl alcohol
MDI	methylene diphyenyl diisocyanate
MEK	methyl ethyl ketone
MeOH	methanol
Mn	manganese
N_2	nitrogen
NH_3	ammonia
Ni	nickel
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_2	oxygen
P	phosphorus
Pb	lead
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
Sb	antimony
Se	selenium
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_x	sulfur oxides
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TGOC	total gaseous organic concentration
THC	total hydrocarbons
Tl	thallium
TRS	total reduced sulfur compounds
Zn	zinc

Appendix D.2
Manual Test Method QA/QC Data

MONTROSE

EPA Method 5

Meter Box Calibration by Calibrated Critical Orifice, Leak Check, and Thermocouple Calibration Check
English Meter Box Units, English K' Factor

Meter box ID:	MB24
Meter ID (if applicable):	MB24
Orifice set ID:	TV-5
Calibrated by:	CR
Expires:	**12/18/20**

Date:	6/18/20
Location:	OFFICE
No. of orifices used (min. 3)	3
Barometric pressure (in. Hg):	30.08 in. Hg
Theoretical critical vacuum	14.19 in. Hg

Yd:	**0.9989**
ΔH@:	**1.6732**

Meter Box Orifice Calibration

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above
IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

		Volume			Initial Temps.		Final Temps.		Orifice	K' Orifice		– Ambient Temperature –		
ΔH (in H2O)	Time (min)	Initial (cu ft)	Final (cu ft)	Net (cu ft)	Inlet (deg F)	Outlet (deg F)	Inlet (deg F)	Outlet (deg F)	Serial# (number)	Coefficient (see above)	Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.86	11.00	977.371	983.418	6.047	XX	74	XX	76	16	0.4218	23.0	78	78	77.9
1.20	8.00	983.418	988.492	5.074	XX	76	XX	76	18	0.4878	22.0	78	78	78.0
2.10	7.00	988.492	994.307	5.815	XX	76	XX	77	24	0.6312	20.0	78	78	78.1

--- SAMPLE RATE ---
INDICATED VS. ACTUAL

ΔH (in. H2O)	Sample Rate (scfm)
0.86	0.547
1.20	0.633
2.10	0.818

--- DRY GAS METER ---
VOLUME CORRECTED

Vm(std) (cu ft)
6.010
5.038
5.781

--- ORIFICE ---

VOLUME CORRECTED Vcr(std) (cu ft)	VOLUME NOMINAL Vcr (cu ft)
6.017	6.099
5.060	5.131
5.729	5.810

– DRY GAS METER –
CALIBRATION FACTOR Yd

Value (number)	Variation (number)
1.0012	0.002
1.0045	0.006
0.9911	-0.008

--- ORIFICE ---
CALIBRATION FACTOR ΔH@

Value (in H2O)	Variation (in H2O)
1.604	-0.069
1.671	-0.002
1.745	0.072

For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +/-0.02.

For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/-0.2.

QA Criteria:	
Average Yd	0.9989
Average ΔH@	1.6732
Variation of Yd's	PASS
Variation of ΔH@	PASS
Vacuum Criteria	PASS

Meter Box Pressure Leak Check

Test Pressure, (in H_2O):	6	Should be 5-7 in. H_2O
Leak Rate, (in H_2O/min):	0	Must be zero (manometer level stable for 1 minute)

Meter Box Vacuum Leak Check

Test Vacuum, (in. Hg):	28	Coarse adjust valve fully open, fine adjust fully closed, sample inlet plugged
Leak Rate, (cfm):	0	Must be zero (meter dial stable for 1 minute)

Meter Box Thermocouple Readout Calibration Check

Input Temperature	Allowable Temp. Dev.*
25	7
75	8
125	9
250	11
350	12
500	14
700	17
900	20

Stack	Probe	Filter	Exit	Aux	Meter In	Meter Out
28	26	25	28	28	29	28
78	77	74	79	78	79	78
128	127	126	130	128	129	128
253	252	251				
354	352	351				
503						
XX						
XX						

Thermocouple simulator	
Make/Model:	Omega CL-300-500F
Serial No.	647
Cal Date:	1/10/2020

Meter Thermocouple Calibration

Ref. Temp	Allowable Temp. Dev.*	Meter In	Meter Out
77.8	8	79.1	76.8
144.8	9	144.6	141.3

Reference Thermometer	
Make/Model:	Control Company 90205-05
Serial No.	CR
Cal Date:	9/11/2018

* Reading values must be within 1.5% of reference thermometer values (based on absolute temperature scale) for calibration to be acceptable.

Performed by: Name: Colin Rodkey Signature: Date: 6/18/20

Approved by: Name: Peter Becker Signature: Date: 6.18.20

Meter box 6-month calibration form (orifices) R1

EPA Method 5

Meter Box Calibration by Calibrated Critical Orifice, Leak Check, and Thermocouple Calibration Check

English Meter Box Units, English K' Factor

Meter box ID:	MB24
Meter ID (if applicable):	METER ID
Orifice set ID:	TV1
Calibrated by:	AG
Expires:	**6/14/21**

Date:	12/14/20
Location:	Portland
No. of orifices used (min. 3)	3
Barometric pressure (in. Hg):	30.16 in. Hg
Theoretical critical vacuum	14.23 in. Hg

Yd:	0.9852
ΔH@:	1.7321

Meter Box Orifice Calibration

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above

IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

		Volume			Initial Temps.		Final Temps.		Orifice	K' Orifice		-- Ambient Temperature --		
ΔH (in H2O)	Time (min)	Initial (cu ft)	Final (cu ft)	Net (cu ft)	Inlet (deg F)	Outlet (deg F)	Inlet (deg F)	Outlet (deg F)	Serial# (number)	Coefficient (see above)	Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.43	14.00	596.358	601.648	5.290	XX	59	XX	59	44	0.2901	23.0	59	59	59.0
1.20	9.00	601.648	607.208	5.560	XX	59	XX	60	56	0.4702	22.0	59	59	59.0
2.10	7.00	607.208	612.993	5.785	XX	60	XX	61	65	0.6312	20.0	59	59	59.0

-- SAMPLE RATE --
INDICATED VS. ACTUAL

ΔH (in. H2O)	Sample Rate (scfm)
0.43	0.384
1.20	0.622
2.10	0.836

-- DRY GAS METER --
VOLUME CORRECTED

Vm(std) (cu ft)
5.428
5.711
5.943

—— ORIFICE ——

VOLUME CORRECTED Vcr(std) (cu ft)	VOLUME NOMINAL Vcr (cu ft)
5.377	5.245
5.602	5.465
5.849	5.706

-- DRY GAS METER --
CALIBRATION FACTOR Yd

Value (number)	Variation (number)
0.9905	0.005
0.9810	-0.004
0.9842	-0.001

—— ORIFICE ——
CALIBRATION FACTOR ΔH@

Value (in H2O)	Variation (in H2O)
1.682	-0.051
1.785	0.053
1.730	-0.002

For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +/-0.02.

For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/-0.2.

QA Criteria:	
Average Yd	0.9852
Average ΔH@	1.7321
Variation of Yd's	PASS
Variation of ΔH@	PASS
Vacuum Criteria	PASS

Meter Box Pressure Leak Check

Test Pressure, (in H_2O):	5	Should be 5-7 in. H_2O
Leak Rate, (in H_2O/min):	0	Must be zero (manometer level stable for 1 minute)

Meter Box Vacuum Leak Check

Test Vacuum, (in. Hg):	28	Coarse adjust valve fully open, fine adjust fully closed, sample inlet plugged
Leak Rate, (cfm):	0	Must be zero (meter dial stable for 1 minute)

Meter Box Thermocouple Readout Calibration Check

Input Temperature	Allowable Temp. Dev.*
25	7
75	8
125	9
250	11
350	12
500	14
700	17
900	20

Stack	Probe	Filter	Exit	Aux.	Meter In	Meter Out
25	27	25	26	24	25	27
76	74	76	75	73	75	75
126	125	126	122	126	123	126
248	249	253				
352	350	347				
501						
xx						
xx						

Thermocouple simulator	
Make/Model:	Omega
Serial No.	647
Cal Date:	1/10/2020

Meter Thermocouple Calibration

Ref. Temp	Allowable Temp. Dev.*	Meter In	Meter Out
61	8	61.8	62
148.3	9	145.6	145.1

Reference Thermometer	
Make/Model:	Traceable
Serial No.	192188003
Cal Date:	5/17/2019

* Reading values must be within 1.5% of reference thermometer values (based on absolute temperature scale) for calibration to be acceptable

Performed by: Name: Austin Goracke Signature: [signature] Date: 12/14/2020

Approved by: Name: Peter Backer Signature: [signature] Date: 12.14.2020

Meter box 6-month calibration form (orifices) R1

EPA Method 5

Meter Box Calibration by Calibrated Critical Orifice, Leak Check, and Thermocouple Calibration Check
English Meter Box Units, English K' Factor

Meter box ID:	MB33
Meter ID (if applicable):	MB33
Orifice set ID:	IZ
Calibrated by:	CR
Expires:	**12/16/20**

Date:	6/16/20
Location:	OFFICE
No. of orifices used (min. 3)	3
Barometric pressure (in. Hg):	30.04 in. Hg
Theoretical critical vacuum	14.17 in. Hg

Yd:	**1.0017**
ΔH@:	**1.6953**

Meter Box Orifice Calibration

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above

IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min))

		Volume			Initial Temps.		Final Temps.		Orifice	K' Orifice		-- Ambient Temperature --		
ΔH (in H2O)	Time (min)	Initial (cu ft)	Final (cu ft)	Net (cu ft)	Inlet (deg F)	Outlet (deg F)	Inlet (deg F)	Outlet (deg F)	Serial# (number)	Coefficient (see above)	Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.62	17.00	636.454	644.165	7.711	XX	66	XX	68	48	0.3498	21.0	68	68	67.8
1.80	18.00	644.165	658.005	13.840	XX	68	XX	70	63	0.6027	17.0	68	68	67.8
1.10	13.00	658.005	665.777	7.772	XX	70	XX	70	55	0.4514	19.0	68	67	67.5

-- SAMPLE RATE --
INDICATED VS. ACTUAL

ΔH (in. H2O)	Sample Rate (scfm)
0.62	0.457
1.80	0.788
1.10	0.590

--- DRY GAS METER ---
VOLUME CORRECTED

Vm(std) (cu ft)
7.765
13.925
7.792

-------- ORIFICE --------

VOLUME CORRECTED Vcr(std) (cu ft)	VOLUME NOMINAL Vcr (cu ft)
7.776	7.744
14.185	14.129
7.676	7.641

-- DRY GAS METER --
CALIBRATION FACTOR
Yd

Value (number)	Variation (number)
1.0013	0.000
1.0187	0.017
0.9851	-0.017

-------- ORIFICE --------
CALIBRATION FACTOR
ΔH@

Value (in H2O)	Variation (in H2O)
1.677	-0.018
1.634	-0.062
1.775	0.080

For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +/-0.02

For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/-0.2

QA Criteria:	
Average Yd	1.0017
Average ΔH@	1.6953
Variation of Yd's	PASS
Variation of ΔH@	PASS
Vacuum Criteria	PASS

Meter Box Pressure Leak Check

Test Pressure, (in H_2O):	6	Should be 5-7 in. H_2O
Leak Rate, (in H_2O/min):	0	Must be zero (manometer level stable for 1 minute)

Meter Box Vacuum Leak Check

Test Vacuum, (in. Hg):	26	Coarse adjust valve fully open, fine adjust fully closed, sample inlet plugged
Leak Rate, (cfm):	0	Must be zero (meter dial stable for 1 minute)

Meter Box Thermocouple Readout Calibration Check

Input Temperature	Allowable Temp. Dev.*	Stack	Probe	Filter	Exit	Aux.	Meter In	Meter Out
25	7	27	27	21	28	29	27	28
75	8	78	77	71	79	78	78	79
125	9	127	127	121	129	129	127	129
250	11	253	250	246				
350	12	353	349	346				
500	14	503						
700	17	XX						
900	20	XX						

Thermocouple simulator	
Make/Model:	Omega CL-300-500F
Serial No	647
Cal Date:	1/10/2020

Meter Thermocouple Calibration

Ref. Temp	Allowable Temp. Dev.*	Meter In	Meter Out
67.1	8	66	68
210.2	10	212	215

Reference Thermometer	
Make/Model:	Control Company 90205-05
Serial No	CR
Cal Date:	9/11/2018

* Reading values must be within 1.5% of reference thermometer values (based on absolute temperature scale) for calibration to be acceptable.

Performed by: Name: Colin Roakey Signature: Date: 6/16/20

Approved by: Name: Pete Ber Signature: Date: 6.16.20

MONTROSE ENVIRONMENTAL

EPA Method 5

Meter Box Calibration by Calibrated Critical Orifice, Leak Check, and Thermocouple Calibration Check

English Meter Box Units, English K' Factor

Meter box ID:	MB33
Meter ID (if applicable):	METER ID
Orifice set ID:	TV1
Calibrated by:	AG
Expires:	**6/14/21**

Date:	12/14/20
Location:	Portland
No. of orifices used (min. 3)	3
Barometric pressure (in. Hg):	30.16 in. Hg
Theoretical critical vacuum	14.23 in. Hg

Yd:	**0.9852**
ΔH@:	**1.7459**

Meter Box Orifice Calibration

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above

IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in Hg)*(min)).

		Volume			Initial Temps.		Final Temps.					– Ambient Temperature –		
ΔH (in H2O)	Time (min)	Initial (cu ft)	Final (cu ft)	Net (cu ft)	Inlet (deg F)	Outlet (deg F)	Inlet (deg F)	Outlet (deg F)	Orifice Serial# (number)	K' Orifice Coefficient (see above)	Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.75	11.00	611.140	616.588	5.448	XX	58	XX	59	51	0.3779	21.0	59	59	59.0
0.44	15.00	616.588	622.255	5.667	XX	59	XX	59	44	0.2901	22.0	59	59	59.0
1.20	9.00	622.255	627.802	5.547	XX	59	XX	59	56	0.4702	18.0	59	59	59.0

— SAMPLE RATE —
INDICATED VS. ACTUAL

ΔH (in. H2O)	Sample Rate (scfm)
0.75	0.500
0.44	0.384
1.20	0.622

— DRY GAS METER —
VOLUME CORRECTED

Vm(std) (cu ft)
5.600
5.815
5.703

— ORIFICE —

VOLUME CORRECTED Vcr(std) (cu ft)	VOLUME NOMINAL Vcr (cu ft)
5.503	5.368
5.761	5.620
5.602	5.465

— DRY GAS METER —
CALIBRATION FACTOR Yd

Value (number)	Variation (number)
0.9826	-0.003
0.9906	0.005
0.9823	-0.003

— ORIFICE —
CALIBRATION FACTOR ΔH@

Value (in H2O)	Variation (in H2O)
1.730	-0.016
1.721	-0.025
1.787	0.041

For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +/-0.02.

For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/-0.2.

QA Criteria:	
Average Yd	0.9852
Average ΔH@	1.7459
Variation of Yd's	PASS
Variation of ΔH@	PASS
Vacuum Criteria	PASS

Meter Box Pressure Leak Check

Test Pressure, (in H_2O):	5	Should be 5-7 in. H_2O
Leak Rate, (in H_2O/min):	0	Must be zero (manometer level stable for 1 minute)

Meter Box Vacuum Leak Check

Test Vacuum, (in. Hg):	27	Coarse adjust valve fully open, fine adjust fully closed, sample inlet plugged
Leak Rate, (cfm):	0	Must be zero (meter dial stable for 1 minute)

Meter Box Thermocouple Readout Calibration Check

Input Temperature	Allowable Temp. Dev.*
25	7
75	8
125	9
250	11
350	12
500	14
700	17
900	20

Stack	Probe	Filter	Exit	Aux.	Meter In	Meter Out
26	25	26	25	27	25	24
75	74	74	77	76	74	75
128	126	125	125	123	125	125
254	251	248				
351	350	352				
502						
XX						
XX						

Thermocouple simulator	
Make/Model:	Omega
Serial No.	647
Cal Date:	1/10/2020

Meter Thermocouple Calibration

Ref. Temp	Allowable Temp. Dev.*	Meter In	Meter Out
60.1	8	60.5	60.7
146.5	9	145.3	144.9

Reference Thermometer	
Make/Model:	Traceable
Serial No.	192188003
Cal Date:	5/17/2020

* Reading values must be within 1.5% of reference thermometer values (based on absolute temperature scale) for calibration to be acceptable

Performed by: Name: Austin Gorecke Signature: Date: 12/14/20

Approved by: Name: Peter Beck Signature: Date: 12.14.20

Meter box 6-month calibration form (orifices) R1

Critical Orifice Calibration

Client	MONTROSE										1/3/20	Date
Set ID	IZ										in house	Job
DGM (Y) =	1.0046		Fluke ID	526		PLC	0 at		6 inH2O		MG/AG	Calibrated
DGM ID #	19461089		Std Manometer	537		NLC	0 at		22 inHg		JH	QA/QC
Dry Gas Meter			Orifice ID #	40	Orifice ID #	48	Orifice ID #	55	Orifice ID #	63	Orifice ID #	73
K' Critical Orifice Coefficient				**0.23892**		**0.34978**		**0.45142**		**0.60270**		**0.78069**
	Symbol	Units	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2
Initial volume	V_i	ft²	841.525	848.013	854.495	860.350	866.765	872.000	877.295	882.790	888.250	894.345
Final Volume	V_f	ft²	848.013	854.495	860.350	866.710	872.000	877.295	882.790	888.250	894.345	900.420
Difference	V_m	ft²	6.488	6.482	5.855	6.360	5.235	5.295	5.495	5.460	6.095	6.075
Temperatures												
Ambient	T_a	°F	60.0	60.0	61.3	61.3	61.3	61.3	61.3	61.3	61.3	61.3
Absolute ambient	T_a	°R	519.67	519.67	520.97	520.97	520.97	520.97	520.97	520.97	520.97	520.97
Initial Inlet	T_i	°F	61.9	63.7	64.1	65.9	65.6	69.7	70.9	72.7	73.3	77.7
Outlet	T_f	°F	61.8	62	62.5	62.5	62.6	63.1	63.5	63.9	64.4	65.1
Final Inlet	T_i	°F	63.7	64.1	65.9	67.1	69.7	70.9	72.7	73.3	77.7	79.2
Outlet	T_f	°F	62	62.5	62.5	62.8	63.1	63.5	63.9	64.4	65.1	65.8
Avg. Temp	T_m	°R	522.02	522.745	523.42	524.245	524.92	526.47	527.42	528.245	529.795	531.62
Time		min	21	21	13	14	9	9	7	7	6	5
		sec	0	0	0	0	0	0	0	0	0	0
			21.00	21.00	13.00	14.00	9.00	9.00	7.00	7.00	6.00	6.00
SAMPLE RATE		ACFM	0.3078	0.3087	0.4504	0.4543	0.5817	0.5883	0.7850	0.7800	1.0158	1.0125
Orifice man. rdg	dH@	in H_2O	0.30	0.30	0.70	0.70	1.30	1.30	2.20	2.20	4.20	4.20
Barometric. Pressure	Pbar	inHg	30.05	30.05	30.05	30.05	30.05	30.05	30.05	30.05	30.05	30.05
Pump vacuum		inHg	24.0	24.0	22.5	22.5	21.0	21.0	19.0	19.0	16.0	16.0
K' factor			0.2392	0.2386	0.3485	0.3510	0.4495	0.4533	0.6051	0.6003	0.7833	0.7781
K' factor Average				0.2389		0.3498		0.4514		0.6027		0.7807
% Error (+/- 0.5)		%	PASS	0.116%	PASS	0.352%	PASS	0.422%	PASS	0.398%	PASS	0.336%

Critical Orifice Calibration

Client	MONTROSE										1/2/20	Date
Set ID	TV5										in house	Job
DGM (Y) =	1.0046		Fluke ID	526		PLC	0 at		6 inH2O		MG	Calibrated
DGM ID #	19461089		Std Manometer	537		NLC	0 at		22 inHg		JH	QA/QC
Dry Gas Meter			Orifice ID #	12	Orifice ID #	16	Orifice ID #	18	Orifice ID #	24	Orifice ID #	31
K' Critical Orifice Coefficient				**0.31501**		**0.42176**		**0.48775**		**0.63116**		**0.80825**
	Symbol	Units	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2
Initial volume	V_i	ft²	771.310	776.575	781.860	787.320	792.790	797.827	802.925	808.670	815.245	820.505
Final Volume	V_f	ft²	776.575	781.860	787.320	792.790	797.830	802.925	808.670	815.245	820.505	825.780
Difference	V_m	ft²	5.265	5.285	5.460	5.470	5.040	5.098	5.745	6.575	5.260	5.275
Temperatures												
Ambient	T_a	°F	60.3	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1
Absolute ambient	T_a	°R	519.97	519.77	519.77	519.77	519.77	519.77	519.77	519.77	519.77	519.77
Initial Inlet	T_i	°F	60.3	62.9	65.5	67.6	69.6	69.6	72.3	74	76.1	79.8
Outlet	T_f	°F	57.3	60.4	62.1	62.5	62.4	63.7	63.7	64	64.9	64.9
Final Inlet	T_i	°F	62.9	65.5	67.6	69.6	69.6	72.3	74	76.1	79.8	80.9
Outlet	T_f	°F	60.4	61.2	62.5	63.4	63.7	63.7	64	64.9	65.1	66.1
Avg. Temp	T_m	°R	519.895	522.17	524.095	525.445	525.995	526.995	528.17	529.42	531.145	532.595
Time		min	13	13	10	10	8	8	7	8	5	5
		sec	0	0	0	0	0	0	0	0	0	0
			13.00	13.00	10.00	10.00	8.00	8.00	7.00	8.00	5.00	5.00
SAMPLE RATE		ACFM	0.3078	0.4065	0.5460	0.5470	0.6300	0.6372	0.8207	0.8219	1.0520	1.0550
Orifice man. rdg	dH@	in H_2O	0.55	0.55	1.10	1.10	1.40	1.40	2.50	2.50	4.20	4.20
Barometric. Pressure	Pbar	inHg	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09
Pump vacuum		inHg	18.0	18.0	16.5	16.5	15.5	15.5	13.5	13.5	10.5	10.5
K' factor			0.3151	0.3149	0.4219	0.4216	0.4854	0.4901	0.6315	0.6309	0.8082	0.8083
K' factor Average				0.3150		0.4218		0.4878		0.6312		0.8082
% Error (+/- 0.5)		%	PASS	0.038%	PASS	0.037%	PASS	0.477%	PASS	0.048%	PASS	0.006%

Client	MONTROSE										12/11/20	Date
Set ID	TV1										in house	Job
DGM (Y) =	0.9906		Fluke ID	198		PLC	0 at		6 inH2O			Calibrated
DGM ID #	19461089		Std Manometer	537		NLC	0 at		22 inHg			QA/QC
Dry Gas Meter			Orifice ID #	35	Orifice ID #	44	Orifice ID #	51	Orifice ID #	56	Orifice ID #	65
K' Critical Orifice Coefficient				**0.17767**		**0.29011**		**0.37788**		**0.47016**		**0.63117**
	Symbol	Units	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2
Initial volume	V_i	ft²	660.138	667.038	677.750	684.160	690.255	696.168	702.771	710.751	720.250	726.044
Final Volume	V_f	ft²	667.038	674.660	684.160	690.203	696.168	702.575	710.751	719.375	726.044	731.832
Difference	V_m	ft²	6.900	7.622	6.410	6.043	5.913	6.407	7.980	8.624	5.794	5.788
Temperatures												
Ambient	T_a	°F	67.9	66.6	69.7	69.7	70.6	69.8	70.6	69.6	70.9	72.3
Absolute ambient	T_a	°R	527.57	526.27	529.37	529.37	530.27	529.47	530.27	529.27	530.57	531.97
Initial Inlet	T_i	°F	58.4	62	65.5	67.4	67.9	70.9	70.5	74.7	75.7	80.3
Outlet	T_f	°F	59.2	61	60.3	60.6	60.9	61.3	61.6	62.2	62.7	63.4
Final Inlet	T_i	°F	62	62.5	67.4	67.6	70.8	71.9	74.7	75.7	80.1	81.1
Outlet	T_f	°F	61	60	60.6	60.7	61.3	61.7	62.2	62.6	63.4	63.9
Avg. Temp	T_m	°R	519.82	521.045	523.12	523.745	524.895	526.12	526.92	528.47	530.145	531.845
Time		min	30	33	17	16	12	13	10	10	7	7
		sec	0	0	0	0	0	0	0	0	0	0
			30.00	33.00	17.00	16.00	12.00	13.00	13.00	14.00	7.00	7.00
SAMPLE RATE		ACFM	0.2300	0.2310	0.3771	0.3777	0.4928	0.4928	0.6138	0.6160	0.8277	0.8269
Orifice man. rdg	dH@	in H_2O	0.17	0.17	0.47	0.47	0.85	0.85	1.40	1.40	2.50	2.50
Barometric. Pressure	Pbar	inHg	30.16	30.16	30.16	30.16	30.16	30.16	30.16	30.16	30.16	30.16
Pump vacuum		inHg	23.0	23.0	22.0	22.0	20.0	20.0	18.0	18.0	17.0	17.0
K' factor			0.1776	0.1777	0.2900	0.2902	0.3784	0.3773	0.4702	0.4701	0.6321	0.6302
K' factor Average				0.1777		0.2901		0.3779		0.4702		0.6312
% Error (+/- 0.5)		%	PASS	0.031%	PASS	0.024%	PASS	0.145%	PASS	0.019%	PASS	0.146%

Secondary Standard Calibration

DATE: 7/2/2019

Operator: Joe Camodeca

Meter Box No:			19461089	Meter Box H@:		0.0000				Meter Box Yd			1.0046			Barometric Pressure:		29.69
				Standard Meter Gas Volume			Meter Box Gas Volume (ft³)			Std. Meter Temperature (ºF)			Meter Box Temperature (ºF)					
Q	P	H	Yds	Initial	Final	Vf	Initial	Final	Vf	Inlet	Outlet	Avg.	Inlet	Outlet	Avg.	Time	Yd	H@
0.38	-0.50	0.00	1.0000	0.0	5.000	5.000	52.700	57.664	4.964	70.0	70.0	70.0	70.0	70.0	70.0	12.88	1.0085	0.0000
0.38	-0.50	0.00	1.0000	0.0	5.000	5.000	57.664	62.635	4.971	70.0	70.0	70.0	70.0	70.0	70.0	12.88	1.0071	0.0000
0.38	-0.50	0.00	1.0000	0.0	5.000	5.000	62.635	67.593	4.958	70.0	70.0	70.0	70.0	70.0	70.0	12.90	1.0097	0.0000
0.60	-0.60	0.00	1.0000	0.0	5.000	5.000	69.400	74.381	4.981	70.0	70.0	70.0	70.0	70.0	70.0	8.18	1.0053	0.0000
0.61	-0.60	0.00	1.0000	0.0	5.000	5.000	74.381	79.360	4.979	70.0	70.0	70.0	70.0	70.0	70.0	8.15	1.0057	0.0000
0.60	-0.60	0.00	1.0000	0.0	5.000	5.000	79.360	84.336	4.976	70.0	70.0	70.0	70.0	70.0	70.0	8.17	1.0063	0.0000
0.80	-0.70	0.00	1.0000	0.0	6.000	6.000	90.100	96.094	5.994	70.0	70.0	70.0	70.0	70.0	70.0	7.40	1.0027	0.0000
0.80	-0.70	0.00	1.0000	0.0	5.000	5.000	96.094	101.092	4.998	70.0	70.0	70.0	70.0	70.0	70.0	6.17	1.0021	0.0000
0.80	-0.70	0.00	1.0000	0.0	5.000	5.000	101.092	106.081	4.989	70.0	70.0	70.0	70.0	70.0	70.0	6.17	1.0039	0.0000
0.95	-0.80	0.00	1.0000	0.0	5.000	5.000	111.400	116.388	4.988	70.0	70.0	70.0	70.0	70.0	70.0	5.18	1.0044	0.0000
0.95	-0.80	0.00	1.0000	0.0	5.000	5.000	116.388	121.373	4.985	70.0	70.0	70.0	70.0	70.0	70.0	5.18	1.0050	0.0000
0.95	-0.80	0.00	1.0000	0.0	7.500	7.500	121.373	128.843	7.470	70.0	70.0	70.0	70.0	70.0	70.0	7.80	1.0060	0.0000
1.24	-1.00	0.00	1.0000	0.0	5.000	5.000	133.000	138.011	5.011	70.0	70.0	70.0	70.0	70.0	70.0	3.98	1.0003	0.0000
1.24	-1.00	0.00	1.0000	0.0	5.000	5.000	138.011	143.022	5.011	70.0	70.0	70.0	70.0	70.0	70.0	3.97	1.0003	0.0000
1.24	-1.00	0.00	1.0000	0.0	5.000	5.000	143.022	148.030	5.008	70.0	70.0	70.0	70.0	70.0	70.0	3.98	1.0009	0.0000
																AVERAGE	1.0046	0.0000

Millennium Instruments Inc.
2402 Springridge Drive unit A
Spring Grove IL. 60081
PHONE#(815)675-3225
FAX#(815)675-6965
E-mail millennium@millinst.com
www.millinst.com

Calibrated By: Joe Camodeca

Signature:

Vacuum Gauge

(in. Hg)	Gauge
5.0	5.0
10.0	10.0
15.0	15.0
20.0	20.0
25.0	25.0

Secondary Standard Calibration

DATE: 6/20/2020

Operator: Joe Camodeca

Meter Box No:			19461089	Meter Box H@:			0.0000			Meter Box Yd			0.9906			Barometric Pressure:		29.69
				Standard Meter Gas Volume			Meter Box Gas Volume (ft‹)			Std. Meter Temperature (ÞF)			Meter Box Temperature (ÞF)					
Q	P	H	Yds	Initial	Final	Vf	Initial	Final	Vf	Inlet	Outlet	Avg.	Inlet	Outlet	Avg.	Time	Yd	H@
0.41	-1.00	0.00	1.0000	0.0	5.000	5.000	339.600	344.644	5.044	72.0	72.0	72.0	72.0	72.0	72.0	12.00	0.9937	0.0000
0.41	-1.00	0.00	1.0000	0.0	5.000	5.000	344.644	349.673	5.029	72.0	72.0	72.0	72.0	72.0	72.0	12.00	0.9967	0.0000
0.41	-1.00	0.00	1.0000	0.0	5.000	5.000	349.673	354.723	5.050	72.0	72.0	72.0	72.0	72.0	72.0	12.00	0.9926	0.0000
0.60	-1.00	0.00	1.0000	0.0	5.000	5.000	355.287	360.337	5.050	72.0	72.0	72.0	72.0	72.0	72.0	8.25	0.9926	0.0000
0.60	-1.00	0.00	1.0000	0.0	5.000	5.000	360.337	365.400	5.063	72.0	72.0	72.0	72.0	72.0	72.0	8.25	0.9900	0.0000
0.61	-1.00	0.00	1.0000	0.0	5.100	5.100	365.400	370.540	5.140	72.0	72.0	72.0	72.0	72.0	72.0	8.25	0.9947	0.0000
0.78	-1.10	0.00	1.0000	0.0	5.000	5.000	373.737	378.797	5.060	72.0	72.0	72.0	72.0	72.0	72.0	6.33	0.9908	0.0000
0.78	-1.10	0.00	1.0000	0.0	5.000	5.000	378.797	383.872	5.075	72.0	72.0	72.0	72.0	72.0	72.0	6.33	0.9879	0.0000
0.78	-1.10	0.00	1.0000	0.0	5.000	5.000	383.872	388.923	5.051	72.0	72.0	72.0	72.0	72.0	72.0	6.33	0.9926	0.0000
0.98	-1.10	0.00	1.0000	0.0	5.000	5.000	390.040	395.133	5.093	72.0	72.0	72.0	73.0	73.0	73.0	5.00	0.9863	0.0000
0.98	-1.10	0.00	1.0000	0.0	5.000	5.000	395.133	400.211	5.078	72.0	72.0	72.0	73.0	73.0	73.0	5.00	0.9892	0.0000
0.98	-1.10	0.00	1.0000	0.0	5.000	5.000	400.211	405.296	5.085	72.0	72.0	72.0	73.0	73.0	73.0	5.00	0.9878	0.0000
1.43	-1.20	0.00	1.0000	0.0	6.000	6.000	407.165	413.276	6.111	72.0	72.0	72.0	74.0	74.0	74.0	5.05	0.9885	0.0000
1.19	-1.20	0.00	1.0000	0.0	5.000	5.000	413.286	418.382	5.096	72.0	72.0	72.0	74.0	74.0	74.0	4.12	0.9878	0.0000
1.19	-1.20	0.00	1.0000	0.0	5.000	5.000	418.382	423.480	5.098	72.0	72.0	72.0	74.0	74.0	74.0	4.12	0.9874	0.0000
																AVERAGE	0.9906	0.0000

Millennium Instruments Inc.
2402 Springridge Drive unit A
Spring Grove IL. 60081
PHONE#(815)675-3225
FAX#(815)675-6965
E-mail millennium@millinst.com
www.millinst.com

Calibrated By: Joe Camodeca

Signature:

Vacuum Gauge

(in. Hg)	Gauge
5.0	5.0
10.0	10.0
15.0	15.0
20.0	20.0
25.0	25.0

MONTROSE ENVIRONMENTAL

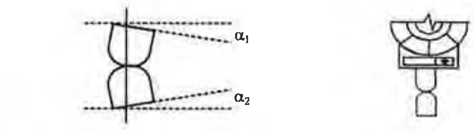
Pitot Tube Calibration Data Sheet

Calibration Date:	October 29, 2020	**Performed by:**	Max Gouveia	**Expiration Date:**	April 29, 2021
		ID No.:	175-TP-6	**No obstructions:**	Yes
Calibrated Pitot Tube:	S-type	**Probe/Pitot ID No:**	175-TP-6	**No damage:**	Yes
Probe Description:	TRAVERSE - Flow & Temp (TP)	**Effective Length (ft):**	6	**Level and Perpendicular:**	Yes
Thermocouple calibration performed?			**Thermocouple passed calibration?**		Yes

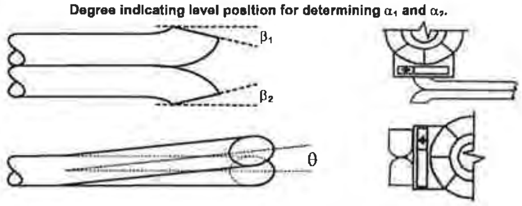
Protractor or Digital Angle Finder ID: 712
Measuring Tape ID: 720
Caliper ID: 702

Calibration performed using the procedures of EPA Method 2, Section 10 1

Alignment and Tubing Dimensions

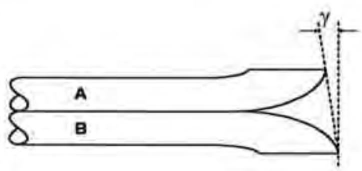


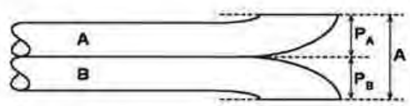
Degree indicating level position for determining α_1 and α_2.



Degree indicating level position for determining θ.

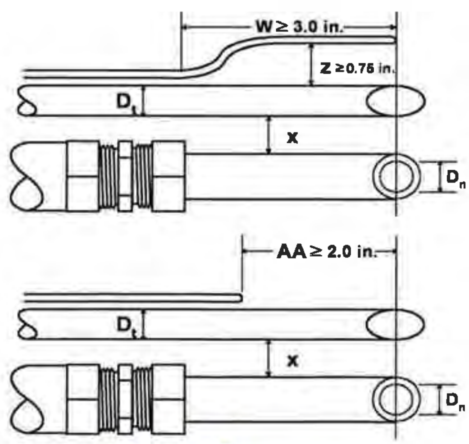
α_1 $(-10° < \alpha_1 < +10°)$	1.0	
α_2 $(-10° < \alpha_2 < +10°)$	2.5	
β_1 $(-5° < \beta_1 < +5°)$	-1.0	
β_2 $(-5° < \beta_2 < +5°)$	-2.0	
γ	1.0	
θ	0.0	
A	0.9145	
z= A tan γ (± 0.125")	0.0160	Pass
w= A tan θ (± 0.03125")	0.0000	Pass
D_t (0.1875" < D_t < 0.375")	0.3740	Pass
P_A (1.05D_t < P_A < 1.5D_t)	0.4573	Pass
P_B (1.05D_t < P_B < 1.5D_t)	0.4573	Pass
$\lvert P_A - P_B \rvert \leq 0.0625$	0.0000	Pass



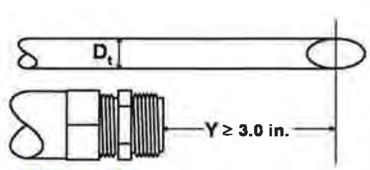


Degree indicating level position for determining γ then calculating Z.

Assembly Inter-Component Spacing Requirements



W (≥ 3.0")			Offset TC only
-or- AA (≥ 2.0")	3.250	Pass	Setback TC only
X			
D_n			
X / D_n (≥ 1.5)			
Y (≥ 3.0")			
Z ≥ 0.75"			Offset TC only



Performed By: Max Gouveia Signature: [signature] Date: 10/29/20

Approved By: Pete Becker Signature: [signature] Date: 10.29.20

MONTROSE
ENVIRONMENTAL

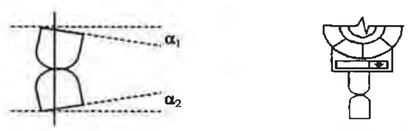
Pitot Tube Calibration Data Sheet

Calibration Date:	December 17, 2020	**Performed by:**	AG	**Expiration Date:**	N/A
		ID No.:	175-TP-6	**No obstructions:**	Yes
Calibrated Pitot Tube:	S-type	**Probe/Pitot ID No:**	175-TP-6	**No damage:**	Yes
Probe Description:	TRAVERSE - Flow & Temp (TP)	**Effective Length (ft):**	6	**Level and Perpendicular:**	Yes
Thermocouple calibration performed?	Yes	**Thermocouple passed calibration?**	Yes		

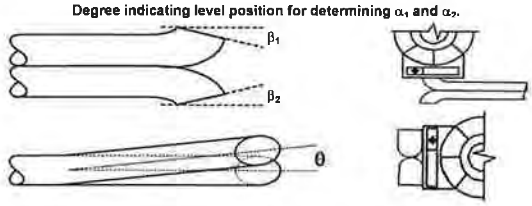
Protractor or Digital Angle Finder ID: 703
Measuring Tape ID: 720
Caliper ID: 702

Calibration performed using the procedures of EPA Method 2, Section 10.1

Alignment and Tubing Dimensions

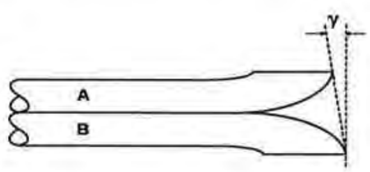


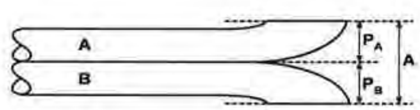
Degree indicating level position for determining α_1 and α_2.



Degree indicating level position for determining θ.

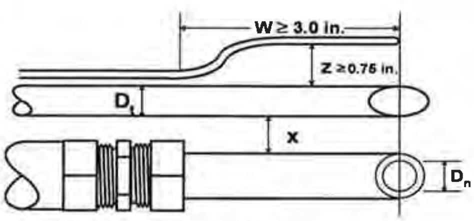
α_1 $(-10° < \alpha_1 < +10°)$	-1.5	
α_2 $(-10° < \alpha_2 < +10°)$	-1.0	
β_1 $(-5° < \beta_1 < +5°)$	-1.8	
β_2 $(-5° < \beta_2 < +5°)$	0.0	
γ	-2.0	
θ	0.0	
A	0.9250	
z= A tan γ (± 0.125")	-0.0323	Pass
w= A tan θ (± 0.03125")	0.0000	Pass
D_t (0.1875" < D_t < 0.375")	0.3749	Pass
P_A (1.05D_t < P_A < 1.5D_t)	0.4625	Pass
P_B (1.05D_t < P_B < 1.5D_t)	0.4625	Pass
$\vert P_A - P_B \vert \leq 0.0625$	0.0000	Pass



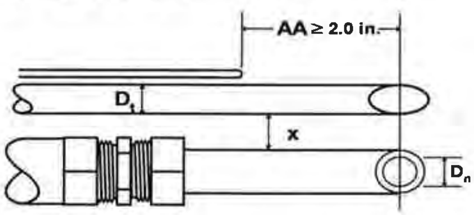


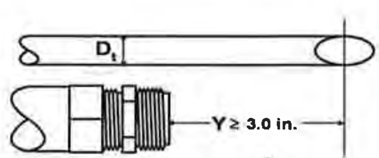
Degree indicating level position for determining γ then calculating Z.

Assembly Inter-Component Spacing Requirements



W (≥ 3.0")			Offset TC only
-or- AA (≥ 2.0")	2.200	Pass	Setback TC only
X			
D_n			
X / D_n (≥ 1.5)			
Y (≥ 3.0")			
Z ≥ 0.75"			Offset TC only





Performed By: Austin Goracke Signature: [signature] Date: 12/17/20

Approved By: James Shackelford Signature: [signature] Date: 12/17/2020

MONTROSE
ENVIRONMENTAL

PRESSURE GAUGE
CALIBRATION DATA FORM

Date	12/17/20
Calibrator	AG
Ambient Temperature, °F	60.5
Test Gauge ID Number	SR#1
Reference Gauge Serial Number	537

Reference Level	Ref. Gauge Pressure, in H_2O	Test Gauge Pressure, in H_2O	Difference, in H_2O	Relative Difference, %	Pass/Fail
Low	0.26	0.2685	0.0085	3	PASS
Medium	0.73	0.7401	0.0101	1	PASS
High	1.3	1.351	0.051	4	PASS

Pressure difference must be ≤ 5% at each level

Performed By: AG Signature: [signature] Date: 12/17/20

Approved By: PB Signature: [signature] Date: 12.17.20

Calibration complies with ISO/IEC 17025, ANSI/NCSL Z540-1, and 9001

ilac-MRA | A2LA ACCREDITED | A2LA Certificate No. 1750.01 Calibration

Cert. No.: 4039-11351525

Traceable® Certificate of Calibration for Water-Proof Thermometer °F/°C

Customer :Montrose Environmental ,13585 NE Whitaker Way ,Portland ,OR-97230 ,U.S.A.

Instrument Identification:

Model: 90205-22, S/N: 170865315 Manufacturer: Control Company

Standards/Equipment:

Description	Serial Number	Due Date	NIST Traceable Reference
Thermistor Module	A27129	04 Feb 2021	1000451212
Temperature Calibration Bath	B16388		
Temperature Probe	5267	21 Feb 2021	C0220028
Temperature Calibration Bath	B3A444		
Thermistor Module	B96382	19 Aug 2020	B9628006
Temperature Probe	5410	13 Sep 2020	B9801031

Certificate Information:

Technician: 420 Procedure: CAL-03 Cal Date: 16 Jun 2020 Cal Due Date: 16 Jun 2021

Test Conditions: 53.14%RH 22.9°C 1019mBar

Calibration Data:

Unit(s)	Nominal	As Found	In Tol	Nominal	As Left	In Tol	Min	Max	±U	TUR
°C	0.00	0.1	Y	0.00	0.1	Y	-1	1	0.058	>4:1
°C	100.00	99.8	Y	100.00	99.8	Y	99	101	0.058	>4:1

This certificate indicates Traceability to standards provided by (NIST) National Institute of Standards and Technology and/or a National Standards Laboratory.

A Test Uncertainty Ratio of at least 4:1 is maintained unless otherwise stated and is calculated using the expanded measurement uncertainty. Uncertainty evaluation includes the instrument under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement : (GUM). The uncertainty represents an expanded uncertainty using a coverage factor k=2 to approximate a 95% confidence level. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement. The results contained herein relate only to the item calibrated. This certificate shall not be reproduced except in full, without written approval of Control Company.

Nominal=Standard's Reading; As Left=Instrument's Reading; In Tol=In Tolerance; Min/Max=Acceptance Range; ±U=Expanded Measurement Uncertainty; TUR=Test Uncertainty Ratio; Accuracy=±(Max-Min)/2; Min=As Left Nominal(Rounded) – Tolerance; Max= As Left Nominal(Rounded) + Tolerance;

Nicol Rodriguez

Nicol Rodriguez, Quality Manager

Marisa Elms

Marisa Elms, Technical Manager

Note :

Maintaining Accuracy:

In our opinion once calibrated your Water-Proof Thermometer °F/°C should maintain its accuracy. There is no exact way to determine how long calibration will be maintained. Water-Proof Thermometer °F/°C change little, if any at all, but can be affected by aging, temperature, shock, and contamination.

Recalibration:

For factory calibration and re-certification traceable to National Institute of Standards and Technology contact Control Company.

Issue Date : 16 Jun 2020

CONTROL COMPANY 12554 Galveston RD Suite B230 Webster TX USA 77598
Phone 281 482-1714 Fax 281 482-9448 sales@control3.com www.traceable.com

Control Company is an ISO/IEC 17025:2005 Calibration Laboratory Accredited by (A2LA) American Association for Laboratory Accreditation, Certificate No. 1750.01.
Control Company is ISO 9001:2015 Quality Certified by DNV GL, Certificate No. CERT-01805-2006-AQ-HOU-ANAB.
International Laboratory Accreditation Cooperation - Multilateral Recognition Arrangement (ILAC-MRA).

Barometric Pressure Determination

Date: 12/09/20

Time: 8:35

Data By: Becker

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 9 Dec 8:11 PDT
Reference Barometer Indication, corrected to sea level	**30.36**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.34
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.34
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.32**

Barometric Pressure Determination

Date: **12/09/20**

Time: **10:55**

Data By: **Becker**

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 9 Dec 10:55 PDT
Reference Barometer Indication, corrected to sea level	**30.40**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.38
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.38
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.36**

Barometric Pressure Determination

Date: 12/09/20

Time: 12:31

Data By: Becker

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 9 Dec 12:32 PDT
Reference Barometer Indication, corrected to sea level	**30.37**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.35
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.35
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.33**

Barometric Pressure Determination

Date: **12/09/20**

Time: **14:10**

Data By: **Becker**

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 9 Dec 13:53 PDT
Reference Barometer Indication, corrected to sea level	**30.35**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.33
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.33
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.31**

Barometric Pressure Determination

Date: 12/10/20

Time: 8:33

Data By: Becker

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 10 Dec 8:05 PDT
Reference Barometer Indication, corrected to sea level	**30.08**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.06
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.06
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.04**

Barometric Pressure Determination

Date: **12/10/20**

Time: **10:35**

Data By: **Becker**

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 10 Dec 10:05 PDT
Reference Barometer Indication, corrected to sea level	**30.06**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.04
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.04
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.02**

Barometric Pressure Determination

Date: 12/10/20

Time: 12:51

Data By: Becker

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 10 Dec 11:35 PDT
Reference Barometer Indication, corrected to sea level	**30.03**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.01
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.01
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**29.99**

Barometric Pressure Determination

Date: 12/10/20

Time: 16:23

Data By: Becker

Reference: http://forecast.weather.gov/MapClick.php?CityName=Orange&state

Reference Barometer ID	**Pearson Airfield (KVUO)**
Reference Barometer Location	Lat: 45.62103 Lon: 122.65419 Elev: 20
Reference Barometer Other Info.	Last Update on 10 Dec 16:05 PDT
Reference Barometer Indication, corrected to sea level	**30.04**
Reference Barometer Reference Elevation	**20**
Reference Barometer Actual Pressure	30.02
Test Barometer Location/Site	**Vancouver WA**
Location/Site Elevation	**20**
Location/Site Barometric Pressure	30.02
Sampling Location Height (above/below site elevation)	**20**
Sampling Location Barometric Pressure	**30.00**

Appendix D.3
Instrumental Test Method QA/QC Data

MONTROSE AIR QUALITY SERVICES

CEMS CONFIGURATION DATA

Project Information

Client / Facility: SCS Engineers / Leichner LANDFILL — Project No. PROJ-005918

Source / Location: FLARE Exhaust — Method(s): 3A, 6C, 7E, 10

Test Dates: 12.9.20 / 12.10.20 — Project Manager / Team (initials): Peter Becker / Austin Goracke, Duncan Howe

Analyzers In Service

Please circle all applicable	O_2	CO_2	CO	NO_x	SO_2			TRS	THC
Response Time (seconds)	46	46	62	45	71				

Filtration (circle)

Filter Type	In-Stack	Out-of-Stack	Sintered		Other
Filter Material	Glass	Quartz	Steel	N/A	Other

Sample Probe (circle)

Length	4'	6'	8'	10'	12'	14'	Other
Material	Steel	Glass	Teflon	Titanium	Quartz	Inconel	Other
Heated	Yes	No					
Probe Temperature	___ °F	N/A					

Conditioner / Moisture Knock-Out (circle)

In Use?	Yes	No		
Coolant	Ice and Water	Anti-Freeze	Electric	Other
Trap Material	Steel	Glass	Teflon	Other

Leak Checks

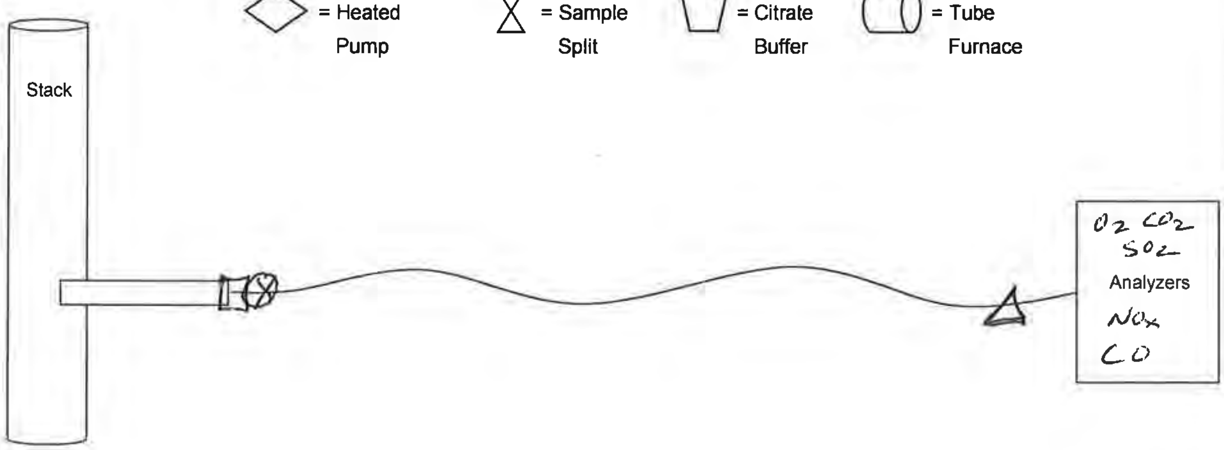
	12.9/12.10	12.9/12.10
Pre-Test	0.00 cfh @ 25 in. Hg	0.00 cfh @ 25 in. Hg
Post-Test	0.00 cfh @ 25 in. Hg	0.00 cfh @ 25 in. Hg
System Flow Rate	6.0 cfh	6.0 cfh
Leak Rate	Post-Test (cfh) / System Flow Rate (cfh) * 100 = 0.00%	0.00 %

Fill in locations of elements of the CEM system, as applicable

Legend

= Cal Tee — = Filter — = Gas Conditioner

= Heated Pump — = Sample Split — = Citrate Buffer — = Tube Furnace



Upstream of conditioner		**Downstream of conditioner**	
Sample Line Length	100 feet	Sample Line Length	6 feet
Sample Line Material	Teflon	Sample Line Material	Teflon
Sample Line Temp.	280 deg. F	Sample Line Temp.	N/A deg. F

If this information is not accurate for all runs, note exceptions here.

CEMS Config Data Sheet - R0

MAQDAQ 1.0

Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Analyzer Configuration

Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
Make/Model:								
25A or 7E:	7E	7E	7E	7E		7E		
Voltage max:	10	10	10	10		9.7		
Voltage offset:	0	0	0	0		0		
Range:	10	10	10	10		10		
Upscale:								
Downscale:								

Cylinder Information

Zero Number:	CC22943	CC22943	CC22943	CC22943		CC22943		
Zero Conc:	0	0	0	0		0		
Low Number:								
Low Conc:								
Mid Number:	CC201277	CC201277	CC701823	EB0085602		CC68637		
Mid Conc:	10.01	10.11	27.77	4.912		15.18		
High Number:	CC40998N	CC40998N	CC157148	CC497277		CC138833		
High Conc:	20.93	18.55	56.2	9.919		27.52		
Bias Number:	CC201277	CC201277	CC701823	EB0085602		CC68637		
Bias Conc:	10.01	10.11	27.77	4.912		15.18		

MAQDAQ 1.0

Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Calibration

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	0.021	0.018	0.020	0.051		-0.200		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.11	10.05	26.96	4.953		15.18		
	High reading:	20.85	18.54	56.23	9.964		27.30		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		-0.727		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		0.000		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.799		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Initial bias

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	0.021	0.018	0.020	0.051		-0.200		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.11	10.05	26.96	4.953		15.18		
	High reading:	20.85	18.54	56.23	9.964		27.30		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		-0.727		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		0.000		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.799		

Initial Bias Data

	Zero reading:	0.057	0.070	0.212	0.198		0.689		
	Span reading:	9.908	9.883	26.52	4.828		14.37		
Zero % bias:	**<5.0**	0.172	0.280	0.342	1.482		3.230		
Span % bias:	**<5.0**	-0.965	-0.900	-0.783	-1.260		-2.943		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Calibration

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings									
	Zero reading:	0.021	0.018	0.020	0.051		0.035		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.11	10.05	26.96	4.953		15.08		
	High reading:	20.85	18.54	56.23	9.964		27.51		

EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		0.127		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		-0.363		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.036		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Initial bias

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	0.021	0.018	0.020	0.051		0.035		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.11	10.05	26.96	4.953		15.08		
	High reading:	20.85	18.54	56.23	9.964		27.51		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	0.100	0.097	0.036	0.514		0.127		
Mid %Err:	**<2.0**	0.478	-0.323	-1.441	0.413		-0.363		
High %Err:	**<2.0**	-0.382	-0.054	0.053	0.454		-0.036		

Initial Bias Data

	Zero reading:	0.057	0.070	0.212	0.198		0.399		
	Span reading:	9.908	9.883	26.52	4.828		13.95		
Zero % bias:	**<5.0**	0.172	0.280	0.342	1.482		1.323		
Span % bias:	**<5.0**	-0.965	-0.900	-0.783	-1.260		-4.106		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Analyzer Configuration

Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
Make/Model:								
25A or 7E:	7E	7E	7E	7E		7E		
Voltage max:	10	10	10	10		9.7		
Voltage offset:	0	0	0	0		0		
Range:	10	10	10	10		10		
Upscale:								
Downscale:								

Cylinder Information

Zero Number:	CC22943	CC22943	CC22943	CC22943		CC22943		
Zero Conc:	0	0	0	0		0		
Low Number:								
Low Conc:								
Mid Number:	CC201277	CC201277	CC701823	EB0085602		CC68637		
Mid Conc:	10.01	10.11	27.77	4.912		15.18		
High Number:	CC40998N	CC40998N	CC157148	CC497277		CC138833		
High Conc:	20.93	18.55	56.2	9.919		27.52		
Bias Number:	CC201277	CC201277	CC701823	EB0085602		CC68637		
Bias Conc:	10.01	10.11	27.77	4.912		15.18		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Calibration

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	-0.029	-0.001	0.007	-0.068		0.068		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.01	9.843	26.96	5.008		14.95		
	High reading:	20.90	18.54	56.23	9.763		27.42		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	-0.139	-0.005	0.012	-0.686		0.247		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	0.968		-0.836		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-1.573		-0.363		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Initial bias

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	-0.029	-0.001	0.007	-0.068		0.068		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.01	9.843	26.96	5.008		14.95		
	High reading:	20.90	18.54	56.23	9.763		27.42		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	-0.139	-0.005	0.012	-0.686		0.247		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	0.968		-0.836		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-1.573		-0.363		

Initial Bias Data

	Zero reading:	0.015	0.034	0.198	0.287		-0.031		
	Span reading:	9.933	9.978	26.81	4.776		13.95		
Zero % bias:	**<5.0**	0.210	0.189	0.340	3.579		-0.360		
Span % bias:	**<5.0**	-0.368	0.728	-0.267	-2.339		-3.634		

MONTROSE ENVIRONMENTAL

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Calibration

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations

	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings

	Zero reading:	-0.029	-0.001	0.007	0.061		-0.086		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.01	9.843	26.96	5.064		15.00		
	High reading:	20.90	18.54	56.23	9.906		27.34		

EPA Method 7E Error Calculations

Zero %Err:	**<2.0**	-0.139	-0.005	0.012	0.615		-0.313		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	1.532		-0.654		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-0.131		-0.654		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust Scenario 2
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

Initial bias

	Name:	O2-741	CO2-741	NOx-695	CO-270		SO2-563		
	Make/Model:								
	25A or 7E:	7E	7E	7E	7E		7E		

Cylinder Concentrations									
	Zero:	0.000	0.000	0.000	0.000		0.000		
	Low:								
	Mid:	10.01	10.11	27.77	4.912		15.18		
	High:	20.93	18.55	56.20	9.919		27.52		

Calibration Readings									
	Zero reading:	-0.029	-0.001	0.007	0.061		-0.086		
	Low reading:	0.000	0.000	0.000	0.000		0.000		
	Mid reading:	10.01	9.843	26.96	5.064		15.00		
	High reading:	20.90	18.54	56.23	9.906		27.34		

EPA Method 7E Error Calculations									
Zero %Err:	**<2.0**	-0.139	-0.005	0.012	0.615		-0.313		
Mid %Err:	**<2.0**	0.000	-1.439	-1.441	1.532		-0.654		
High %Err:	**<2.0**	-0.143	-0.054	0.053	-0.131		-0.654		

Initial Bias Data									
	Zero reading:	0.015	0.034	0.198	0.018		0.131		
	Span reading:	9.933	9.978	26.81	5.085		13.68		
Zero % bias:	**<5.0**	0.210	0.189	0.340	-0.434		0.789		
Span % bias:	**<5.0**	-0.368	0.728	-0.267	0.212		-4.797		

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

NOx Converter Check

Time	NOx reading, ppm	Efficiency, %
14:10:11	46.980	92.2%
14:10:12	47.000	92.3%
14:10:13	47.030	92.3%
14:10:14	47.050	92.4%
14:10:15	47.050	92.4%
14:10:16	47.070	92.4%
14:10:17	47.070	92.4%
14:10:18	47.080	92.4%
14:10:19	47.110	92.5%
14:10:20	47.110	92.5%
14:10:21	47.100	92.5%
14:10:22	47.130	92.5%
14:10:23	47.120	92.5%
14:10:24	47.150	92.6%
14:10:25	47.160	92.6%
14:10:26	47.160	92.6%
14:10:27	47.180	92.6%
14:10:28	47.180	92.6%
14:10:29	47.180	92.6%
14:10:30	47.170	92.6%
14:10:31	47.180	92.6%
14:10:32	47.190	92.7%
14:10:33	47.210	92.7%
14:10:34	47.200	92.7%
14:10:35	47.230	92.7%
14:10:36	47.250	92.8%
14:10:37	47.250	92.8%
14:10:38	47.240	92.8%
14:10:39	47.240	92.8%
14:10:40	47.270	92.8%
14:10:41	47.280	92.8%
14:10:42	47.280	92.8%
14:10:43	47.300	92.9%
14:10:44	47.300	92.9%
14:10:45	47.320	92.9%
14:10:46	47.320	92.9%
14:10:47	47.330	92.9%
14:10:48	47.350	93.0%
14:10:49	47.350	93.0%
14:10:50	47.370	93.0%
14:10:51	47.370	93.0%
14:10:52	47.370	93.0%

14:10:53	47.380	93.0%
14:10:54	47.380	93.0%
14:10:55	47.400	93.1%
14:10:56	47.410	93.1%
14:10:57	47.400	93.1%
14:10:58	47.420	93.1%
14:10:59	47.420	93.1%
14:11:00	47.430	93.1%
14:11:01	47.440	93.1%
14:11:02	47.460	93.2%
14:11:03	47.470	93.2%
14:11:04	47.480	93.2%
14:11:05	47.490	93.2%
14:11:06	47.490	93.2%
14:11:07	47.470	93.2%
14:11:08	47.480	93.2%
14:11:09	47.480	93.2%
14:11:10	47.490	93.2%
14:11:11	47.500	93.3%
14:11:12	47.500	93.3%
14:11:13	47.510	93.3%
14:11:14	47.530	93.3%
14:11:15	47.550	93.4%
14:11:16	47.540	93.3%
14:11:17	47.550	93.4%
14:11:18	47.560	93.4%
14:11:19	47.560	93.4%
14:11:20	47.560	93.4%
14:11:21	47.580	93.4%
14:11:22	47.580	93.4%
14:11:23	47.580	93.4%
14:11:24	47.600	93.5%
14:11:25	47.590	93.4%
14:11:26	47.590	93.4%
14:11:27	47.600	93.5%
14:11:28	47.620	93.5%
14:11:29	47.620	93.5%
14:11:30	47.620	93.5%
14:11:31	47.640	93.5%
14:11:32	47.640	93.5%
14:11:33	47.640	93.5%
14:11:34	47.660	93.6%
14:11:35	47.660	93.6%
14:11:36	47.640	93.5%
14:11:37	47.660	93.6%

14:11:38	47.670	93.6%
14:11:39	47.670	93.6%
14:11:40	47.660	93.6%
14:11:41	47.690	93.6%
14:11:42	47.690	93.6%
14:11:43	47.690	93.6%
14:11:44	47.700	93.7%
14:11:45	47.720	93.7%
14:11:46	47.720	93.7%
14:11:47	47.740	93.7%
14:11:48	47.740	93.7%
14:11:49	47.740	93.7%
14:11:50	47.740	93.7%
14:11:51	47.740	93.7%
14:11:52	47.760	93.8%
14:11:53	47.750	93.8%
14:11:54	47.760	93.8%
14:11:55	47.760	93.8%
14:11:56	47.760	93.8%
14:11:57	47.780	93.8%
14:11:58	47.780	93.8%
14:11:59	47.770	93.8%
14:12:00	47.780	93.8%
14:12:01	47.790	93.8%
14:12:02	47.800	93.9%
14:12:03	47.820	93.9%
14:12:04	47.810	93.9%
14:12:05	47.830	93.9%
14:12:06	47.840	93.9%
14:12:07	47.830	93.9%
14:12:08	47.850	94.0%
14:12:09	47.850	94.0%
14:12:10	47.850	94.0%
14:12:11	47.870	94.0%
14:12:12	47.850	94.0%
14:12:13	47.890	94.0%
14:12:14	47.880	94.0%
14:12:15	47.880	94.0%
14:12:16	47.880	94.0%
14:12:17	47.900	94.1%
14:12:18	47.900	94.1%
14:12:19	47.900	94.1%
14:12:20	47.900	94.1%
14:12:21	47.900	94.1%
14:12:22	47.900	94.1%

MAQDAQ 1.0			
Project Name: SCS Engineers/ Leichner Landfill	Project Number: Proj-005198	CEMS Operator: PB	Unit/Condition: Flare Exhaust
Run Length: 60	Record Interval: 6	Average Interval: 60	Triplicate Sampling: False
Traverse: True	Ports: 2	Points per port: 6	DAQ Device: DT9806(00)

14:12:23	47.890	94.0%
14:12:24	47.900	94.1%
14:12:25	47.910	94.1%
14:12:26	47.920	94.1%
14:12:27	47.910	94.1%
14:12:28	47.910	94.1%
14:12:29	47.920	94.1%
14:12:30	47.920	94.1%
14:12:31	47.920	94.1%
14:12:32	47.910	94.1%
14:12:33	47.930	94.1%
14:12:34	47.930	94.1%
14:12:35	47.930	94.1%
14:12:36	47.940	94.1%
14:12:37	47.930	94.1%
14:12:38	47.940	94.1%
14:12:39	47.950	94.1%
14:12:40	47.950	94.1%
14:12:41	47.960	94.2%
14:12:42	47.960	94.2%
14:12:43	47.970	94.2%
14:12:44	47.970	94.2%
14:12:45	47.970	94.2%
14:12:46	47.990	94.2%
14:12:47	47.980	94.2%
14:12:48	48.010	94.3%
14:12:49	48.010	94.3%
14:12:50	48.000	94.2%
14:12:51	48.030	94.3%
14:12:52	48.030	94.3%
14:12:53	48.030	94.3%
14:12:54	48.040	94.3%
14:12:55	48.040	94.3%
14:12:56	48.040	94.3%
14:12:57	48.050	94.3%

Summary	
Analyzer:	NOx-695
NO2 Cylinder Concentration:	50.93
NO2 Cylinder Number:	CC506616
NOx Analyzer Reading:	48.050
Efficiency:	94.3%

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF BATCH ANALYSIS

Grade of Product: CEM-CAL ZERO

Part Number:	NI CZ15A	Reference Number:	153-401778346-1
Cylinder Analyzed:	CC22943	Cylinder Volume:	142.0 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2000 PSIG
Analysis Date:	Mar 25, 2020	Valve Outlet:	580
Lot Number:	153-401778346-1		

Expiration Date: Mar 25, 2028

ANALYTICAL RESULTS

Component		Requested Purity		Certified Concentration
NITROGEN		99.9995 %		99.9995 %
CARBON DIOXIDE	<	1.0 PPM	<LDL	0.02 PPM
NOx	<	0.1 PPM	<LDL	0.03 PPM
SO2	<	0.1 PPM	<LDL	0.1 PPM
THC	<	0.1 PPM	<LDL	0.04 PPM
CARBON MONOXIDE	<	0.5 PPM	<LDL	0.03 PPM

Permanent Notes: Airgas certifies that the contents of this cylinder meet the requirements of 40 CFR 72.2

Cylinders in Batch:

CC124105&, CC158650, CC22943, CC239976, CC330387, CC352312, CC366996, CC423556, CC432427, CC51856, CC709770, CC95125, EB0097350, EB0108868, SG9150272BAL, SG9162817BAL

Impurities verified against analytical standards traceable to NIST by weight and/or analysis.

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI60E15A2996	Reference Number:	153-401443590-1
Cylinder Number:	CC40998N	Cylinder Volume:	158.9 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72019	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Mar 11, 2019

Expiration Date: Mar 11, 2027

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	19.00 %	18.55 %	G1	+/- 0.6% NIST Traceable	03/11/2019
OXYGEN	21.00 %	20.93 %	G1	+/- 0.3% NIST Traceable	03/11/2019
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060815	CC416643	24.04 % CARBON DIOXIDE/NITROGEN	0.6%	May 16, 2019
NTRM	12062019	CC367606	22.883 % OXYGEN/NITROGEN	0.050%	May 14, 2024

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA-510 SV4MEUTJ CO2	CO2 NDIR (Dixon)	Feb 20, 2019
Horiba MPA-510 W603MM58 O2	O2 Paramagnetic (Mason)	Feb 20, 2019

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI80E15A0138	Reference Number:	153-401643430-1
Cylinder Number:	CC201277	Cylinder Volume:	150.9 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72019	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Nov 05, 2019

Expiration Date: Nov 05, 2027

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	10.00 %	10.11 %	G1	+/- 0.8% NIST Traceable	11/05/2019
OXYGEN	10.00 %	10.01 %	G1	+/- 0.4% NIST Traceable	11/05/2019
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060422	CC413673	7.489 % CARBON DIOXIDE/NITROGEN	0.6%	May 14, 2025
NTRM	11060608	CC338459	14.93 % OXYGEN/NITROGEN	0.2%	Dec 13, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801550 CO2 HCO2	FTIR	Oct 22, 2019
Horiba MPA-510 W603MM58 O2	O2 Paramagnetic (Mason)	Oct 31, 2019

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI94E15A00F8	Reference Number:	153-401494251-1
Cylinder Number:	CC701823	Cylinder Volume:	146.9 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72019	Valve Outlet:	660
Gas Code:	CO,CO2,NO,NOX,BALN	Certification Date:	May 21, 2019

Expiration Date: May 21, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	27.50 PPM	27.77 PPM	G1	+/- 0.9% NIST Traceable	05/14/2019, 05/21/2019
CARBON MONOXIDE	27.50 PPM	27.07 PPM	G1	+/- 0.4% NIST Traceable	05/14/2019
NITRIC OXIDE	27.50 PPM	27.71 PPM	G1	+/- 0.9% NIST Traceable	05/14/2019, 05/21/2019
CARBON DIOXIDE	5.000 %	5.019 %	G1	+/- 1.1% NIST Traceable	05/14/2019
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	150102	KAL003630	24.35 PPM CARBON MONOXIDE/NITROGEN	0.3%	Sep 04, 2021
PRM	12376	D562879	10.01 PPM NITROGEN DIOXIDE/NITROGEN	2.0%	Aug 17, 2018
NTRM	13010612	KAL003486	50.22 PPM NITRIC OXIDE/NITROGEN	0.8%	Sep 23, 2019
GMIS	7301017103	CC506597	4.451 PPM NITROGEN DIOXIDE/NITROGEN	2.0%	Dec 18, 2020
NTRM	08010530	K021127	4.954 % CARBON DIOXIDE/NITROGEN	0.5%	Dec 14, 2023

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801550 CO2 HCO2	FTIR	May 08, 2019
Thermo 48i-TLE 1163640031 CO	CO NDIR (Mason)	May 07, 2019
Nicolet 6700 AHR0801550 NO LNO	FTIR	May 02, 2019
Nicolet 6700 AHR0801550 NO2 impurity	FTIR NO2 impurity	May 02, 2019

Triad Data Available Upon Request

Approved for Release

Airgas

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI94E15A0035	Reference Number:	48-124572446-1
Cylinder Number:	CC157148	Cylinder Volume:	146.9 CF
Laboratory:	124 - Los Angeles (SAP) - CA	Cylinder Pressure:	2015 PSIG
PGVP Number:	B32016	Valve Outlet:	660
Gas Code:	CO,CO2,NO,NOX,BALN	Certification Date:	Sep 08, 2016

Expiration Date: Sep 08, 2024

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	55.00 PPM	56.20 PPM	G1	+/- 1.1% NIST Traceable	09/01/2016, 09/08/2016
CARBON MONOXIDE	55.00 PPM	54.88 PPM	G1	+/- 0.7% NIST Traceable	09/01/2016
NITRIC OXIDE	55.00 PPM	55.99 PPM	G1	+/- 1.1% NIST Traceable	09/01/2016, 09/08/2016
CARBON DIOXIDE	5.000 %	4.994 %	G1	+/- 0.5% NIST Traceable	09/01/2016
NITROGEN	Balance			-	

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	14060755	CC434464	49.88 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Feb 22, 2020
PRM	12328	680179	10.01 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Oct 15, 2014
NTRM	13061209	CC403877	49.40 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Nov 19, 2019
GMIS	1211201301	CC501041	4.950 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Dec 11, 2016
NTRM	10060133	CC307775	5.027 % CARBON DIOXIDE/NITROGEN	+/- 0.4%	Dec 02, 2021

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS 6E CO2	NDIR	Aug 16, 2016
Thermo 48i-TLE 1132250557 CO	NDIR	Aug 05, 2016
Nicolet 6700 AHR0801551 NO	FTIR	Aug 30, 2016
Nicolet 6700 AHR0801551 NO2	FTIR	Sep 06, 2016

Triad Data Available Upon Request

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI99E15A38W6	Reference Number:	153-401817190-1
Cylinder Number:	CC497277	Cylinder Volume:	144.3 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72020	Valve Outlet:	660
Gas Code:	CO,NO,NOX,BALN	Certification Date:	Jun 03, 2020

Expiration Date: Jun 03, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	10.00 PPM	10.19 PPM	G1	+/- 1.1% NIST Traceable	05/27/2020, 06/03/2020
CARBON MONOXIDE	10.00 PPM	9.919 PPM	G1	+/- 0.7% NIST Traceable	05/27/2020
NITRIC OXIDE	10.00 PPM	10.14 PPM	G1	+/- 1.0% NIST Traceable	05/27/2020, 06/03/2020
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08011130	KAL004049	9.855 PPM CARBON MONOXIDE/NITROGEN	0.5%	Jun 05, 2024
NTRM	16060708	CC437400	10.08 PPM NITRIC OXIDE/NITROGEN	1.0%	Oct 16, 2022
NTRM	16060708	CC437400-NOX	10.08 PPM NOx/NITROGEN	1.0%	Oct 16, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Thermo 48i-TLE 1163640031 CO	CO NDIR (Mason)	May 20, 2020
Thermo 42i-LS 1123749327 NO	Chemiluminescence (Mason)	May 11, 2020
Thermo 42i-LS 1123749327 NOx	Chemiluminescence (Mason)	May 11, 2020

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI99E15A1421	Reference Number:	153-401817191-1
Cylinder Number:	EB0085602	Cylinder Volume:	144.3 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72020	Valve Outlet:	660
Gas Code:	CO,NO,NOX,BALN	Certification Date:	Jun 02, 2020

Expiration Date: Jun 02, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	5.000 PPM	5.235 PPM	G1	+/- 1.1% NIST Traceable	05/26/2020, 06/02/2020
CARBON MONOXIDE	5.000 PPM	4.912 PPM	G1	+/- 0.9% NIST Traceable	05/26/2020
NITRIC OXIDE	5.000 PPM	5.223 PPM	G1	+/- 1.1% NIST Traceable	05/26/2020, 06/02/2020
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08011130	KAL004049	9.855 PPM CARBON MONOXIDE/NITROGEN	0.5%	Jun 05, 2024
NTRM	08012126	KAL004291	5.08 PPM NITRIC OXIDE/NITROGEN	1.0%	Jul 05, 2021
NTRM	08012126	KAL004291-NOX	5.08 PPM NOx/NITROGEN	1.0%	Jul 05, 2021

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Thermo 48i-TLE 1163640031 CO	CO NDIR (Mason)	May 20, 2020
Thermo 42i-LS 1123749327 NO	Chemiluminescence (Mason)	May 11, 2020
Thermo 42i-LS 1123749327 NOx	Chemiluminescence (Mason)	May 11, 2020

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E02NI99E15A1848	Reference Number:	153-401304659-1
Cylinder Number:	CC138833	Cylinder Volume:	144.4 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72018	Valve Outlet:	660
Gas Code:	SO2,BALN	Certification Date:	Sep 24, 2018

Expiration Date: Sep 24, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
SULFUR DIOXIDE	27.00 PPM	27.52 PPM	G1	+/- 1.1% NIST Traceable	09/17/2018, 09/24/2018
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	14010330	KAL004439	49.08 PPM SULFUR DIOXIDE/NITROGEN	1.0%	Apr 17, 2024

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801550 SO2 LSO2	FTIR	Sep 13, 2018

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02NI99E15A0383	Reference Number:	153-401683128-1
Cylinder Number:	CC68637	Cylinder Volume:	144.3 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72019	Valve Outlet:	660
Gas Code:	SO2,BALN	Certification Date:	Dec 30, 2019

Expiration Date: Dec 30, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
SULFUR DIOXIDE	15.00 PPM	15.18 PPM	G1	+/- 1.0% NIST Traceable	12/23/2019, 12/30/2019
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	17060716	CC486245	15.90 PPM SULFUR DIOXIDE/NITROGEN	0.9%	Jul 23, 2023

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AMP0900119 SO2 LSO2	FTIR	Dec 11, 2019

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
525 North Industrial Loop Road
Tooele, UT 84074
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02NI99E15A0055	Reference Number:	153-401274149-1
Cylinder Number:	CC506616	Cylinder Volume:	144.0 CF
Laboratory:	124 - Tooele (SAP) - UT	Cylinder Pressure:	2015 PSIG
PGVP Number:	B72018	Valve Outlet:	660
Gas Code:	NO2,BALN	Certification Date:	Aug 28, 2018

Expiration Date: Aug 28, 2021

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NITROGEN DIOXIDE	50.00 PPM	50.93 PPM	G1	+/- 2%	08/21/2018, 08/28/2018
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	7282071710	CC511229	57.89 PPM NITROGEN DIOXIDE/NITROGEN	1.1%	Dec 18, 2020
PRM	12378	D562913	100.1 PPM NITROGEN DIOXIDE/NITROGEN	1.0%	Sep 04, 2018

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
MKS 18143349 NO2	FTIR	Aug 16, 2018

Triad Data Available Upon Request

PERMANENT NOTES:OXYGEN ADDED TO MAINTAIN STABILITY

Approved for Release

INTERFERENCE RESPONSE TEST

Date of Test: 12/5/17 Name: Brett Sherwood
Analyzer: Type / Model: O2/CO2 CAI 700 HE# 741
Serial Number: 1708026

Method Referenced: EPA Method 7E

O_2 Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response %	Interference % of Span (21.42 %)
SO_2	490.2	0.01	0.04
CO_2	19.52	0.02	0.09
NO	475.5	-0.01	0.04
NO_2	50.08	0.13	0.61
H_2	40	0.21	0.98
CO	445.3	0.04	0.19

A Calibration Cylinder containing 21.42% oxygen was used to Span Analyzer

Interference Response Results:

Sum of Absolute Differences	Sum of Individual Gases Percent Interferences	Max Allowable Percent of Span Interference (%)
0.42	1.95	2.5

O_2 Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response %	Interference % of Span (19.52 %)
SO_2	490.2	0.00	0.0
CO_2	4.945	0.00	0.0
NO	475.5	0.00	0.0
NO_2	50.08	0.00	0.0
H_2	40	0.00	0.0
CO	445.3	0.02	0.01

A Calibration Cylinder containing 19.52% carbon dioxide was used to Span Analyzer

Interference Response Results:

Sum of Absolute Differences	Sum of Individual Gases Percent Interferences	Max Allowable Percent of Span Interference (%)
0.02	0.01	2.5

MONTROSE AIR QUALITY SERVICES

INTERFERENCE RESPONSE TEST

Date of Test: 2/7/2018 Name: Sleight Halley
Analyzer: Type / Model: NO_x, O_2 / CAI 700 Series
Serial Number: 92/ PN # 1712003

Method Referenced: EPA Method 7E

NO_x Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response ppmv	Interference % of Span (127.0 ppmv)
SO_2	50.59	-0.1	0.08
O_2	21.1	-0.1	0.08
CO	24.21	-0.1	0.08
CO_2	19.43	-0.1	0.08
CH_4	909	-0.1	0.08

A Calibration Cylinder containing 127.0 ppm NO_x was used to calibrate the analyzer.

Results:

Test Gas	Sum of Absolute Differences	Sum of Individual Gases % Interferences	Max Allowable Percent of Span Interference (%)
NO_x	0.5	0.4	2.5

O_2 Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response %	Interference % of Span (21.1%)
SO_2	50.59	0.01	0.00
CO_2	19.43 / 5.05 O_2	4.97	0.38
CO.	24.21	-0.01	0.00
NO	126.2	-0.01	0.00
NO_2	50.15	0.12	0.57
CH_4	909 / 20.95 O_2	20.95	0.00

A Calibration Cylinder containing 21.1% Oxygen was used to Span Analyzer.

Results:

Test Gas	Sum of Absolute Differences	Sum of Individual Gases % Interferences	Max Allowable Percent of Span Interference (%)
O_2	0.20	0.95	2.5

MONTROSE
AIR QUALITY SERVICES

INTERFERENCE RESPONSE TEST

Date of Test: 1/25/02 Name: Mike Eisele
Analyzer: Type / Model: CO / Thermo Env. 48i Serial Number: 000270

Test Gas	Concentration, ppmv or %	Analyzer Output Response, ppmv	% of Span (1000 ppmv)
SO_2	170.3 ppmv	0	0.0
O_2	20.95 %	-0.1	0.01
*CO_2	9.7%	0	0.0

*Used bottle of CO_2 at 100% concentration and diluted it with 100% N_2 to get a concentration of about 10% CO_2.

Bias Check:

Test Gas	Concentration, ppmv	Analyzer Output Response, ppmv	Bias Check (%)
CO	880	875	0.5

Performance Specifications:

Analyzer	EPA Ref. Method	Allowable Interference (% of analyzer span)	Gas Values To Introduce Into Analyzers (EPA Method 20)
SO_2	6C	7%	200±20 ppm
O_2	6C	7%	20.9±1 percent
CO_2	6C	7%	10±1 percent
CO	20	2%	500±50 ppm

Note: Concentration for SO_2 was slightly lower than listed; 170.3 ppmv was the closest concentration cylinder available at the time of the interference checks.

INTERFERENCE RESPONSE TEST

Date of Test: 3/07/02 Name: Tim Hertel
Analyzer: Type / Model: SO_2 / Ametek 900 Series Serial Number: 000563

Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response, %	% of Span (180 ppmv)
O_2	20.95%	0.0	0.0
*CO_2	10%	0.0	0.0
**CO	512 ppmv	0.6	0.3

*Used bottle of CO_2 at 100% concentration and diluted it with 100% N2 to get a concentration of about 10% CO_2.

**Used CO cylinder with 5% concentration and diluted it with 100% N_2 to get a concentration of about 500 ppmv CO.

Bias Check:

Test Gas	Concentration, ppmv	Analyzer Output Response, ppmv	Bias Check (%)
SO_2	170.3	170.0	0.2

Performance Specifications:

Analyzer	EPA Ref. Method	Allowable Interference (% of analyzer span)	Gas Values To Introduce Into Analyzers (EPA Method 20)
SO_2	6C	7%	200±20 ppm
O_2	6C	7%	20.9±1 percent
CO_2	6C	7%	10±1 percent
CO	20	2%	500±50 ppm

Appendix D.4
Accreditation Information/Certifications

American Association for Laboratory Accreditation

Accredited Air Emission Testing Body

A2LA has accredited

MONTROSE AIR QUALITY SERVICES

In recognition of the successful completion of the joint A2LA and Stack Testing Accreditation Council (STAC) evaluation process, this laboratory is accredited to perform testing activities in compliance with ASTM D7036:2004 - Standard Practice for Competence of Air Emission Testing Bodies.

Presented this 11th day of February 2020.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3925.01
Valid to February 28, 2022

This accreditation program is not included under the A2LA ILAC Mutual Recognition Arrangement.

CERTIFICATE OF COMPLETION

Peter Becker

This document certifies that this individual has passed a comprehensive examination and is now a Qualified Individual (QI) as defined in Section 8.3 of ASTM D7036-04 for the following method(s):

Source Evaluation Society Group 1: *EPA Manual Gas Volume and Flow Measurements and Isokinetic Particulate Sampling Methods*

Certificate Number: 011-2017-10

Tate Strickler, Accreditation Director

DATE OF ISSUE: 8/4/17

DATE OF EXPIRATION: 8/4/22

MONTROSE ENVIRONMENTAL

CERTIFICATE OF COMPLETION

Peter Becker

This document certifies that this individual has passed a comprehensive examination and is now a Qualified Individual (QI) as defined in Section 8.3 of ASTM D7036-04 for the following method(s):

Source Evaluation Society Group 3: *EPA Gaseous Pollutants Instrumental Sampling Methods*

Certificate Number: 006-2020-24

Tate Strickler, Accreditation Director

DATE OF ISSUE: 2/12/20

DATE OF EXPIRATION: 2/12/25

MONTROSE ENVIRONMENTAL

CERTIFICATE OF COMPLETION

Austin Goracke

This document certifies that this individual has passed a comprehensive examination and is now a Qualified Individual (QI) as defined in Section 8.3 of ASTM D7036-04 for the following method(s):

EPA Method 25

Certificate Number: 006-2020-31

Tate Strickler, VP – Quality Systems

DATE OF ISSUE: 3/10/20

DATE OF EXPIRATION: 3/10/25

CERTIFICATE OF COMPLETION

Peter Becker

This document certifies that this individual has passed a comprehensive examination and is now a Qualified Individual (QI) as defined in Section 8.3 of ASTM D7036-04 for the following method(s):

EPA Methods 3C, TO-8, TO-12 & TO-15

Certificate Number: 006-2019-11

Tate Strickler, Accreditation Director

DATE OF ISSUE: 10/7/19

DATE OF EXPIRATION: 10/7/24

MONTROSE ENVIRONMENTAL

Smoke School, Inc.

EPA Reference Method 9 Certification Card

Peter Becker

Cert. No. SS-S19-57 Exp. Date 2021-04-30

Card Reader's Signature

Smoke School Inc. President

Appendix D.5
Quality Assurance Program Summary and Equipment Calibration Schedule

QUALITY ASSURANCE PROGRAM SUMMARY AND CERTIFICATIONS

Montrose Air Quality Services, LLC (Montrose) ensures the quality and validity of its emission measurement and reporting procedures through a rigorous quality assurance (QA) program. The program is developed and administered by internal QA personnel and encompasses seven major areas:

1. Development and use of an internal QA manual
2. QA reviews of reports, laboratory work, and field testing
3. Equipment calibration and maintenance
4. Chain of custody
5. Continuous training
6. Knowledge of current test methods
7. Audit program

Each of these areas is discussed individually below.

Quality Assurance Manual. Montrose has prepared a QA Manual according to EPA guidelines and ASTM D-7036. The manual serves to document and formalize all of Montrose's QA efforts. The manual is constantly updated, and each employee involved in technical services for emission measurements is required to read, understand its contents, and sign a statement that all work they perform will conform to its practices. The manual includes details on the other seven QA areas discussed below.

QA Reviews. Montrose 's review procedure includes review of each source test report by the QA Manager or equivalent position including data input, calculations and averages, and report text. The laboratory manager or equivalent reviews all laboratory work, and the qualified individual on-site reviews all field work and data sheets.

The most important review is the one that takes place before a test program begins. The QA Manager works with testing personnel to prepare and review test protocols. Test protocol review includes selection of appropriate test procedures, evaluation of any interferences or other restrictions that might preclude use of standard test procedures, and evaluation and/or development of alternate procedures.

Equipment Calibration and Maintenance. The equipment used to conduct the emission measurements is maintained according to the manufacturer's instructions to ensure proper operation. In addition to the maintenance program, calibrations are carried out on each measurement device according to the schedule outlined below. The schedules for maintenance and calibrations are given in Tables A-1 and A-2.

Quality control checks are also conducted in the field for each test program. A partial list of checks made as part of each continuous analyzer system test series is included below as an example of the field QA procedures.

- Sample acquisition and conditioning system leak check
- 3-point analyzer calibrations (all analyzers)
- Complete system calibration check ("dynamic calibration" through entire sample system)

- Periodic analyzer calibration checks are conducted at the start and end of each test run. Any change between pre- and post-test readings are recorded.
- All calibrations are conducted using EPA Protocol gases certified by the manufacturer
- Calibration and continuous analyzer performance data are fully documented, and are included in each source test report

Chain of Custody. Montrose maintains full chain of custody documentation on all samples and data sheets. In addition to normal documentation of changes between field sample custodians, laboratory personnel, and field test personnel, Montrose documents every individual who handles any test component in the field (e.g., probe wash, impinger loading and recovery, filter loading and recovery, etc.).

Samples are stored in a locked area to which only laboratory personnel have access. Neither other Montrose employees nor cleaning crews have keys to this area.

Training. Personnel training is essential to ensure quality testing. Montrose has formal and informal training programs which may include some or all of the following:

1. Attendance at EPA-sponsored training courses
2. A requirement for all technicians to read, understand, and sign Montrose 's QA Manual
3. In-house training and Montrose meetings on a regular basis
4. Maintenance of training records
5. Administration of internal qualified individual (QI) tests for all methods performed
6. Participation in the Qualified Source Testing Individual (QSTI) program administered by the Source Evaluation Society (SES)

Knowledge of Current Test Methods. With the constant updating of standard test methods and the wide variety of emerging test methods, it is essential that any qualified source tester keep abreast of new developments. Montrose subscribes to services which provide updates on EPA reference methods, and on EPA and local agency rules and regulations. Additionally, source test personnel regularly attend and present papers at testing and emission-related seminars and conferences.

Audit Program. Montrose participates in the TNI Stationary Source Audit Sample (SSAS) audit program for all methods for which audit samples are available.

TABLE A-1
SAMPLING INSTRUMENTS AND
EQUIPMENT CALIBRATION SCHEDULE

Instrument Type	Frequency of Calibration[1]	Standard of Comparison or Method of Calibration	Acceptance Limits
Orifice Meter(large)	12 months	Calibrated dry test meter	± 2% of volume measured
Dry Gas Meter	6 months or when repaired	Calibrated dry test meter	± 2% of volume measured
Critical Orifice	6 months	Calibrated dry test meter	± 0.5% of average K’
S-Type Pitot (for use with EPA-type sampling train)	6 months	EPA Method 2	Geometric measurements within method-specified ranges
Vacuum Gauges	12 months	NIST-traceable gauge	≤ 1.0 in Hg difference
Temperature Measurement (thermocouples)	12 months	NBS mercury thermometer or NBS calibrated platinum RTD	±4 °F for <400 °F ± 1.5% for >400 °F
Temperature Readout Devices	6 months	Thermocouple simulator	± 2% full scale reading
Analytical Balance	12 months (check prior to each use)	NIST-traceable weights	± 0.5 mg of stated weight
Probe Nozzles	12 months	Nozzle diameter check	Range <± 0.10 mm for micrometer three measurements
Continuous Analyzers	Every field day, Depends upon use, frequency and performance	As specified by manufacturers’ operating manuals, EPA NBS gases and/or reference methods	Satisfy all limits specified in operating specifications

[1] The tabulated calibration frequencies are minimum standards. In certain instances, calibrations are performed more frequently.

TABLE A-2
EQUIPMENT MAINTENANCE SCHEDULE
Based on Manufacturer's Specifications and Montrose's Experience

Equipment	Performance Requirement	Maintenance Interval[2]	Corrective Action
Pumps	1. Absence of leaks 2. Ability to draw manufacturer required vacuum and flow	6 months	1. Visual inspection 2. Clean 3. Replace worn parts 4. Leak check
Flow Measuring Device	1. Free mechanical movement 2. Absence of malfunction	6 months	1. Visual inspection 2. Clean 3. Calibrate
Sampling Instruments	1. Absence of malfunction 2. Proper response to zero, span gas	As required by the manufacturer	As recommended by manufacturer
Mobile Van Sampling Systems	Absence of leaks	Depends on nature of use	1. Change filters 2. Leak check 3. Check for system contamination
Sampling Lines	Sample degradation less than 2%	After each test or test series	Blow filtered air through line until dry

[2] The tabulated maintenance intervals are minimum standards. In certain instances, maintenance is performed more frequently.

APPENDIX E
REGULATORY INFORMATION

Appendix E.1
Regulatory Correspondence

SOURCE TEST PLAN
2020 COMPLIANCE TESTING
LEICHNER LANDFILL
LANDFILL GAS FLARE
VANCOUVER, WASHINGTON

Prepared For:

Leichner Landfill
9411 NE 94th Avenue
Vancouver, WA 98662

For Submittal To:

Southwest Clean Air Agency
11815 NE 99th Street, Suite 1294
Vancouver, WA 98682

Prepared By:

Montrose Air Quality Services, LLC
4150 B Place NW, Suite 106
Auburn, WA 98001

Document Number:	**W021AS-2687-PP-585**
Proposed Test Dates:	**December 9-10, 2020**
Submittal Date:	**November 20, 2020**

STAC
ACCREDITED
TO ASTM D7036 ONLY
CERT #3925.01

MONTROSE
AIR QUALITY SERVICES

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Leichner Landfill (Leichner) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test program on the Landfill Flare at the Leichner Landfill facility located in Vancouver, Washington. The tests are conducted to determine compliance with the Southwest Clean Air Agency (SWCAA) Air Discharge Permit (ADP) No. 20-3433.

The specific objectives are to:

- Measure concentrations of NMOC at the inlet of the flare
- Measure emissions of CO, NO_X, SO_2, NMOC, and VE at the outlet of the flare
- Conduct the test program with a focus on safety

Montrose will provide the test personnel and the necessary equipment to measure emissions as outlined in this test plan. Facility personnel will provide the process and production data to be included in the final report. A summary of the test program and proposed schedule is presented in Table 1-1.

TABLE 1-1
SUMMARY OF TEST PROGRAM AND PROPOSED SCHEDULE

Proposed Test Dates	Unit ID/ Source Name	Activity/ Parameters	Test Methods	No. of Runs	Duration (Minutes)
December 9-10, 2020	Flare Inlet & Outlet	Velocity/Vol. Flow Rate/Temperature	EPA 1 & 2	3	~60 minutes
“	Flare Inlet	Fuel Factor	EPA 3C & 19	3	~60 minutes
“	Flare Inlet & Outlet	O_2, CO_2	EPA 3A	3	60 minutes
“	Flare Outlet	Moisture	EPA 4	3	60 minutes
“	Flare Outlet	SO_2	EPA 6C	3	60 minutes
“	Flare Outlet	NO_x	EPA 7E	3	60 minutes
“	Flare Outlet	Opacity	EPA 9	3	10 minutes
“	Flare Outlet	CO	EPA 10	3	60 minutes
“	Flare Inlet & Outlet	NMOC	EPA 25C	3	~60 minutes
“	Flare Inlet & Outlet	Post-test thermocouple calibration check	EPA ALT-011	N/A	N/A

To simplify this test plan, a list of Units and Abbreviations is included in Appendix A. Throughout this test plan, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

1.2 APPLICABLE REGULATIONS AND EMISSION LIMITS

The results from this test program are presented in units consistent with those listed in the applicable regulations or requirements. The reporting units and emission limits are presented in Table 1-2.

TABLE 1-2
REPORTING UNITS AND EMISSION LIMITS

Unit ID/ Source Name	Parameter	Reporting Units	Emission Limit	Emission Limit Reference
Landfill Gas Flare	Volumetric flow rate	acfm, scfm, dscfm	--	--
Landfill Gas Flare	O_2 & CO_2	% vd	--	--
Landfill Gas Flare	Moisture	%	--	--
Landfill Gas Flare	SO_2	lb/MMBtu tpy	0.016 0.18	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	NO_x	lb/MMBtu tpy	0.060 0.72	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	Opacity	%	0	ADP Condition 3
Landfill Gas Flare	CO	lb/MMBtu tpy	0.15 1.79	ADP Condition 2 ADP Condition 2
Landfill Gas Flare	NMOC/VOC (as hexane)	lb/MMBtu tpy	0.050 0.60	ADP Condition 2 ADP Condition 2

1.3 KEY PERSONNEL

A list of project participants is included below:

Facility Information

Source Location:	Leichner Landfill 9411 NE 94th Avenue Vancouver, WA 98662	
Project Contact:	Mike Davis	
Role:	Solid Waste Operations Specialist	
Company:	Leichner Landfill	
Telephone:	564-397-7343	
Email:	Mike.Davis@clark.wa.gov	

Agency Information

Regulatory Agency:	Southwest Clean Air Agency
Agency Contact:	Gerald Strawn
Telephone:	360-574-3058 x113
Email:	gerry@swcleanair.org

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC (Montrose)	
Contact:	Peter Becker	Kristina Schafer
Title:	Client Project Manager	PNW Hub District Manager
Telephone:	330-285-6884	253-480-3801
Email:	pbecker@montrose-env.com	kschafer@montrose-env.com

Laboratory Information

Laboratory:	Atmospheric Analysis and Consulting
City, State:	Ventura, CA
Method:	EPA Methods 3C and 25C

Subcontractor (or Consultant) Information

Company:	SCS Engineers
Contact:	Alexa Deep, EIT
Telephone:	425-289-5441
Email:	adeep@scsengineers.com

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS DESCRIPTION, OPERATION, AND CONTROL EQUIPMENT

The Leichner Landfill flare is an enclosed style landfill gas (LFG) flare manufactured by Perennial Energy, Inc. with a rated maximum capacity of 2.7 MM Btu/hr (i.e., 90 scfm at 50 percent methane) with a turndown capability of 10 to 1. This flare has been installed to replace the existing enclosed flare to accommodate current and future declining LFG generation and recovery rates.

The LFG extraction plant (blowers) provides the driving force or vacuum to the gas conveyance system and extraction network (gas wells), and pull the LFG from the refuse to the blowers. The LFG enters a moisture separator vessel (i.e., Knockout pot or scrubber) upstream of the blowers where excess moisture is removed from the gas stream. Landfill gas exits the moisture separator and enters the regenerative style blowers, which push the LFG to the enclosed flare at a low inlet pressure of 10 inches of water column. The enclosed flare uses the LFG for combustion fuel and controls the combustion temperature with quench air from automated louvers responding to a feedback loop from thermocouples mounted inside of the flare stack.

2.2 FLUE GAS SAMPLING LOCATIONS

Actual stack measurements, number of traverse points, and location of traverse points will be evaluated in the field as part of the test program. Table 2-1 presents the anticipated stack measurements and traverse points for the sampling locations listed.

TABLE 2-1
SAMPLING LOCATIONS

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance: Downstream EPA "B" (in./dia.)	Distance from Nearest Disturbance: Upstream EPA "A" (in./dia.)	Number of Traverse Points
Flare Outlet	57	216 / 3.8	30 / 0.5	Flow: 16 (8/port); Gaseous: one

The inlet to the flare is a horizontal, cylindrical duct that runs near ground level into a flame arrester and then into the bottom section of the flare. The inlet samples will be taken from a valve at the base of the stack near the flowmeter.

Sample locations are verified in the field to conform to EPA Method 1. Acceptable cyclonic flow conditions are confirmed prior to testing using EPA Method 1, Section 11.4. Appendix A presents stack schematics and process flow diagrams.

2.3 OPERATING CONDITIONS AND PROCESS DATA

Emission tests are performed while the unit is operating at the most challenging of the intended operating conditions. Leichner may choose to conduct the testing across a temperature range representative of the intended operating conditions. If this option is chosen, at least one sampling run must be conducted at the maximum operating temperature, and at least one sampling run must be conducted at the minimum operating temperature.

Plant personnel are responsible for establishing the test conditions and collecting all applicable unit-operating data. Data collected includes the following parameters:

- Landfill gas consumption rate
- Average flare temperature as measured by the permanent flare temperature monitoring device
- Flare temperature setpoint during each emission test
- Startup and shutdown events

2.4 PLANT SAFETY

Montrose will comply with all safety requirements at the facility. The facility Client Sponsor, or designated point of contact, is responsible for ensuring routine compliance with plant entry, health, and safety requirements. The Client Sponsor has the authority to impose or waive facility restrictions. The Montrose test team leader has the authority to negotiate any deviations from the facility restrictions with the Client Sponsor. Any deviations must be documented.

2.4.1 Safety Responsibilities

Planning

- Montrose must complete a field review with the Client Sponsor prior to the project date. The purpose of the review is to develop a scope of work that identifies the conditions, equipment, methods, and physical locations that will be utilized along with any policies or procedures that will affect our work.
- We must reach an agreement on the proper use of client emergency services and ensure that proper response personnel are available, as needed.
- The potential for chemical exposure and actions to be taken in case of exposure must be communicated to Montrose. This information must include expected concentrations of the chemicals and the equipment used to identify the substances.
- Montrose will provide a list of equipment being brought to the site, if required by the client.

Project Day

- Montrose personnel will arrive with the appropriate training and credentials for the activities they will be performing and the equipment that they will operate.
- Our team will meet daily to review the Project Scope, Job Hazard Assessment, and Work Permits. The Client Sponsor and Operations Team are invited to participate.
- Montrose will provide equipment that can interface with the client utilities previously identified in the planning phase and only work with equipment that our client has made ready and prepared for connection.

- We will follow client direction regarding driving safety, safe work permitting, staging of equipment, and other crafts or work in the area.
- As per 40 CFR Part 60 Subpart A, Section 60.8, the facility must provide the following provisions at each sample location:
  - Sampling ports, which meet EPA minimum requirements for testing. The caps should be removed or be hand-tight.
  - Safe sampling platforms.
  - Safe access to the platforms and test ports, including any scaffolding or man lifts.
  - Sufficient utilities to perform all necessary testing.
- Montrose will use the client communication system, as directed, in case of plant or project emergency.
- Any adverse conditions, unplanned shutdowns or other deviations to the agreed scope and project plan must be reviewed with the Client Sponsor prior to continuing work. This will include any safe work permit and hazard assessment updates.

Completion

- Montrose personnel will report any process concerns, incidents or near misses to the Client Sponsor prior to leaving the site.
- Montrose will clean up our work area to the same condition as it was prior to our arrival.
- We will ensure that all utilities, connection points or equipment have been returned to the pre-project condition or as stated in the safe work permit. In addition, we will walk out the job completion with Operations and the Client Sponsor if required by the facility.

2.4.2 Safety Program and Requirements

Montrose has a comprehensive health and safety program that satisfies State and Federal OSHA requirements. The program includes an Illness and Injury Prevention Program, site-specific safety meetings, and training in safety awareness and procedures. The basic elements include:

- All regulatory required policies/procedures and training for OSHA, EPA and FMCSA
- Medical monitoring, as necessary
- Use of Personal Protective Equipment (PPE) and chemical detection equipment
- Hazard communication
- Pre-test and daily toolbox meetings
- Continued evaluation of work and potential hazards.
- Near-miss and incident reporting procedures as required by Montrose and the Client

Montrose will provide standard PPE to employees. The PPE will include but is not limited to; hard hats, safety shoes, glasses with side shields or goggles, hearing protection, hand protections, and fall protection. In addition, our trailers are equipped with four gas detectors to ensure that workspace has no unexpected equipment leaks or other ambient hazards.

The detailed Site Safety Plan for this project is attached to this test plan in Appendix "S".

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 TEST METHODS

The test methods for this test program were presented previously in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - N/A
- Method Exceptions:
  - None anticipated

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - S-type pitot tube coefficient is 0.84
  - Shortridge multimeter may be used to measure velocity
- Method Exceptions:
  - None anticipated

3.1.3 EPA Methods 3A, 6C, 7E, and 10, Determination of Oxygen, Carbon Dioxide, Sulfur Dioxide, Nitrogen Oxides, and Carbon Monoxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedures)

Concentrations of O_2, CO_2, SO_2, NO_x, and CO are measured simultaneously using EPA Methods 3A, 6C, 7E, and 10, which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - No filter is used since low PM is expected
  - A dry extractive sampling system is used to report emissions on a dry basis
  - A paramagnetic analyzer is used to measure O_2
  - A nondispersive infrared analyzer is used to measure CO_2
  - An ultraviolet absorption analyzer is used to measure SO_2
  - A chemiluminescent analyzer is used to measure NO_x
  - A gas filter correlation nondispersive infrared analyzer is used to measure CO
  - NO and NO_2 are measured separately and summed to report NO_x emissions
- Method Exceptions:
  - For gaseous emissions sampling, MDL are calculated for each analyzer. The ISDL is equal to the sensitivity of the instrumentation, which is 2% of the span value.
- Target and/or Minimum Required Sample Duration: 60 minutes

3.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Condensed water is measured gravimetrically
  - Since it is theoretically impossible for measured moisture to be higher than psychrometric moisture, the psychrometric moisture is also calculated, and the lower moisture value is used in the calculations
- Method Exceptions:
  - Moisture sampling is performed as a stand-alone method at a single point in the centroid of the stack
- Target and/or Minimum Required Sample Duration: 60 minutes
- Target and/or Minimum Required Sample Volume: 21 scf

3.1.5 EPA Method 3C, Determination of Carbon Dioxide, Methane, Nitrogen, and Oxygen from Stationary Sources

EPA Method 3C is a manual method used to measure O_2, CO_2, CH_4, and N_2 concentrations. EPA Method 3C is used to calculate the molecular weight of the stack gas from municipal solid waste landfills and other sources when specified in an applicable subpart. Samples are collected for percent-level measurements of the concentration of O_2, CO_2, CH_4, and N_2 in the stack gas. A portion of the sample is injected into a gas chromatograph (GC) and the O_2, CO_2, CH_4, and N_2 concentrations are determined using a thermal conductivity detector (TCD) and integrator.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Response factors of uncorrected component concentrations (wet basis) may be generated using instrumental integration
  - Peak height may be used instead of peak area throughout this method
- Method Exceptions:
  - None anticipated
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, California

3.1.6 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is a manual method used to determine (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions. This method provides data reduction procedures, but does not include any sample collection or analysis procedures.

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - F factor is calculated from composition data collected on the test day and analyzed by EPA Method 3C
- Method Exceptions:
  - None anticipated

3.1.7 EPA Method 25C, Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases

A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide

(CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - N/A
- Method Exceptions:
  - None anticipated
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: AAC, Ventura, California

3.2 PROCESS TEST METHODS

The applicable regulations do not require process samples to be collected during this test program.

4.0 QUALITY ASSURANCE AND REPORTING

4.1 QA AUDITS

Montrose has instituted a rigorous QA/QC program for its air quality testing. Quality assurance audits are performed as part of the test program to ensure that the results are calculated using the highest quality data available. This program ensures that the emissions data we report are as accurate as possible. The procedures included in the cited reference methods are followed during preparation, sampling, calibration, and analysis. Montrose is responsible for preparation, calibration, and cleaning of the sampling apparatus. Montrose will also perform the sampling, sample recovery, storage, and shipping. Approved contract laboratories may perform some of the preparation and sample analyses, as needed.

4.2 QUALITY CONTROL PROCEDURES

Montrose calibrates and maintains equipment as required by the methods performed and applicable regulatory guidance. Montrose follows internal procedures to prevent the use of malfunctioning or inoperable equipment in test programs. All equipment is operated by trained personnel. Any incidence of nonconforming work encountered during testing is reported and addressed through the corrective action system.

4.2.1 Equipment Inspection and Maintenance

Each piece of field equipment that requires calibration is assigned a unique identification number to allow tracking of its calibration history. All field equipment is visually inspected prior to testing and includes pre-test calibration checks as required by the test method or regulatory agency.

4.2.2 Audit Samples

When required by the test method and available, Montrose obtains EPA TNI SSAS audit samples from an accredited provider for analysis along with the samples. Currently, the SSAS program has been suspended pending the availability of a second accredited audit sample provider. If the program is reinstated, the audit samples will be ordered. If required as part of the test program, the audit samples are stored, shipped, and analyzed along with the emissions samples collected during the test program. The audit sample results are reported along with the emissions sample results.

4.3 DATA ANALYSIS AND VALIDATION

Montrose converts the raw field, laboratory, and process data to reporting units consistent with the permit or subpart. Calculations are made using proprietary computer spreadsheets or data acquisition systems. One run of each test method is also verified using a separate example calculation. The example calculations are checked against the spreadsheet results and are included in the final report. The "Standard Conditions" for this project are 29.92 inches of mercury and 68 °F.

4.4 SAMPLE IDENTIFICATION AND CUSTODY

The on-site Field Project Manager will assume or assign the role of sample and data custodian until relinquishing custody. The sample custodian will follow proper custody procedures before departing from the test site including:

- Assign the unique sample identification number to each sample
- Attach sample labels and integrity seals to all samples
- Complete COC form(s), ensuring that the sample identification numbers on the samples match the sample identification numbers on the COC
- Pack and store samples in accordance with the test method requirements in appropriate transport containers for protection from breakage, contamination, or loss
- Keep samples in a secure locked area if not in the direct presence of Montrose staff

The sample custodian will follow proper custody procedures upon arriving at the Montrose office including:

- Remove samples and COC documents from vehicles and check into designated secure sample holding areas
- Store samples requiring additional measures such as refrigeration or dry ice appropriately

4.5 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the appendices. The content of this test plan is modeled after the EPA Emission Measurement Center Guideline Document (GD-042).

4.6 REPORTING

Montrose will prepare a final report to present the test data, calculations/equations, descriptions, and results. Prior to release by Montrose, each report is reviewed and certified by the project manager and their supervisor, or a peer. Source test reports will be submitted to the facility or appropriate regulatory agency (upon customer approval) within 45 days of the completion of the field work. The report will include a series of appendices to present copies of the intermediate calculations and example calculations, raw field data, laboratory analysis data, process data, and equipment calibration data.

Appendix E.2
Permit Excerpts

SWCAA
Southwest Clean Air Agency

AIR DISCHARGE PERMIT
20-3433

Final Date: October 1, 2020

Facility Name:	Leichner Landfill
Physical Location:	9411 NE 94th Avenue Vancouver, WA 98662
SWCAA ID:	1239

PAUL T. MAIROSE
STATE OF WASHINGTON
21507
REGISTERED
PROFESSIONAL ENGINEER

REVIEWED BY: Paul T. Mairose
Paul T. Mairose, Chief Engineer

APPROVED BY:
Uri Papish, Executive Director

1. Equipment/Activity Identification

ID No.	Generating Equipment/Activity	# of Units	Control Measure/Equipment	# of Units
1	Landfill	1	Enclosed flare (Perennial Energy – 2.7 MMBtu/hr)	1

2. Approval Conditions

The following tables detail the specific requirements of this permit. In addition to the requirements listed below, equipment at this facility may be subject to other federal, state, and local regulations. The permit requirement number is identified in the left-hand column. The text of the permit requirement is contained in the middle column. The emission unit, equipment, or activity to which the permit requirement applies is listed in the right-hand column.

This Permit supersedes Air Discharge Permit 07-2714 in its entirety.

Emission Limits

No.	Emission Limits	Equipment/ Activity
1.	Combined emissions from landfill operation (flare and fugitive) must not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> VOC (as hexane) — 4.14 tpy Annual emissions must be calculated by summing flare and fugitive emissions. Fugitive VOC emissions must be calculated from estimated landfill gas generation, a gas capture efficiency of 75% and emission factors from the Technical Support Document for this Air Discharge Permit.	1
2.	Emissions from the Landfill Gas Flare shall not exceed the following: <u>Pollutant</u> — <u>Emission Limit</u> NO_X — 0.060 lb/MMBtu (1-hr avg); 0.72 tpy CO — 0.15 lb/MMBtu (1-hr avg); 1.79 tpy NMOC/VOC (as hexane) — 0.050 lb/MMBtu (1-hr avg) or 98% destruction; 0.60 tpy SO_2 — 0.016 lb/MMBtu (1-hr avg); 0.18 tpy Annual emissions must be calculated from actual landfill gas combustion and emission factors from the Technical Support Document for this Air Discharge Permit or more recent source test data if available.	1

No.	Emission Limits	Equipment/ Activity
3.	Visible emissions from the Landfill Gas Flare shall not exceed zero percent opacity for more than 3 minutes in any one-hour period as determined in accordance with SWCAA Method 9 (See Appendix A of SWCAA 400).	1

Operating Limits and Requirements

No.	Operating Limits and Requirements	Equipment/ Activity
4.	Reasonable precautions must be taken at all times to prevent and minimize fugitive emissions from plant operations.	Facilitywide
5.	The permittee must use recognized good practice and procedures to reduce odors to a reasonable minimum.	Facilitywide
6.	Each pollution control device/measure must be in use whenever the associated production equipment is in operation. Control devices must be operated and maintained in accordance with the manufacturer's specifications and operated in a manner that minimizes emissions.	1
7.	Emission units identified in this Permit must be maintained and operated in total and continuous conformity with the conditions identified in this Permit. SWCAA reserves the right to take any and all appropriate action to maintain the conditions of this Permit, including directing the facility to cease operations until corrective action can be completed.	1
8.	Prior to the initial emission test, the Landfill Gas Flare must be operated at a minimum temperature of 1,400°F (1-hr avg). Thereafter, the flare must be operated within the range of operating temperatures (1-hr avg) at which compliance with the permitted emission limits was demonstrated during the most recent source emissions test.	1

Monitoring and Recordkeeping Requirements

No.	Monitoring and Recordkeeping Requirements	Equipment/ Activity
9.	With the exception of data logged by a computerized data acquisition system, each record required by this Permit must include the date and the name of the person making the record entry. If a control device or process is not operating during a specific time period, a record must be made to that effect.	1
10.	All records required by this Permit must be kept for a minimum period of no less than three years and must be maintained in a form readily available for inspection by SWCAA representatives.	1
11.	Excess emissions and upset conditions must be recorded for each occurrence.	1

Air Discharge Permit 20-3433 - Appendix A
Emission Testing Requirements
Landfill Gas Flare

1. **Introduction:**
The purpose of this testing is to quantify emissions from the Landfill Gas Flare, determine NMOC destruction efficiency in the Landfill Gas Flare, and demonstrate compliance with the requirements of this Permit and applicable air quality regulations.

2. **Testing Requirements:**
   a. **Testing Schedule.** Initial emission testing of the Landfill Gas Flare must be conducted no later than 90 days after commencing regular operation. Subsequent emission testing of the Landfill Gas Flare must be conducted every 5 years thereafter, no later than the end of the calendar month in which the initial emission test was performed. Emission testing conducted more than three months prior to a scheduled due date will not satisfy the periodic source emission testing requirement unless prior written approval is obtained from SWCAA.

   b. **Test Plan.** A comprehensive test plan must be submitted to SWCAA for review and approval at least 10 business days prior to testing. SWCAA personnel must be informed at least 5 business days prior to testing so that a representative may be present during testing.

   c. **Test Runs/Reference Test Methods.** Unless otherwise specified, a minimum of 3 test runs must be conducted at each location for each constituent listed below to ensure the data are representative. Compliance must be demonstrated by averaging the results of the individual sampling runs.

Test location: Flare Outlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2	N/A
O_2, CO_2 content	EPA Method 3 or 3A	N/A
Moisture content	EPA Method 4	60 minutes
SO_2	EPA Method 6, 6C, mass balance	60 minutes
NO_X	EPA Method 7E	60 minutes
Opacity	SWCAA Method 9	10 minutes
CO	EPA Method 10	60 minutes
NMOC	EPA Method 25C	~60 minutes[1]

Test location: Flare Inlet

Constituent	Reference Test Method	Minimum Test Run Duration
Flow rate, temperature	EPA Methods 1 and 2 or approved inline flowmeter	N/A
O_2, CO_2 content	EPA Method 3 or 3A	60 minutes
Fuel factor, CH_4, CO_2, O_2, N_2	EPA Methods 3C & 19	N/A
NMOC	EPA Method 25C	~60 minutes[1]

[1] A sampling time of approximately 60 minutes must be targeted. This is a grab sample method so establishing a precise collection time may not be practical.

Air Discharge Permit 20-3433 - Appendix A
Emission Testing Requirements
Landfill Gas Flare

3. **Source Operation:**
   a. **Source Operations.** Source operations during emissions testing must be representative of the most challenging of the intended operating conditions. The Permittee may choose to conduct the testing across a temperature range representative of the intended operating conditions. If this option is chosen, at least one sampling run must be conducted at the maximum and operating temperature, and at least one sampling run must be conducted at the minimum operating temperature.

   b. **Record of Production Parameters.** Production related parameters and equipment operating conditions must be recorded during emissions testing to correlate operating conditions with emissions. All recorded production parameters must be documented in the test results report. At a minimum, the following parameters must be recorded:
   (1) Landfill gas consumption rate,
   (2) Average flare temperature during each emission test as measured by the permanent flare temperature monitoring device,
   (3) Flare temperature setpoint during each emission test, and
   (4) Startup and shutdown events.

4. **Reporting Requirements:**
   a. **Test Report.** A final emission test report must be prepared and submitted to SWCAA within 45 calendar days of test completion. Test reports must be provided in hard copy (paper) and an electronic format acceptable to SWCAA. Each test report must include, at a minimum, the following information:
   (1) Description of the source including manufacturer, model number and design capacity of the equipment, and the location of the sample ports or test locations,
   (2) Time and date of the test and identification and qualifications of the personnel involved, including SWCAA personnel who observed the testing,
   (3) Summary of results, reported in units and averaging periods consistent with the applicable emissions standard or unit,
   (4) Summary of control system or equipment operating conditions,
   (5) Summary of production related parameters cited in Section 3,
   (6) A description of the test methods or procedures used including all field data, quality assurance/quality control procedures and documentation,
   (7) A description of the analytical procedures used including all laboratory data, quality assurance/quality control procedures and documentation,
   (8) Copies of field data and example calculations,
   (9) Chain of custody information,
   (10) Calibration documentation,
   (11) Discussion of any abnormalities associated with the results, and
   (12) A statement signed by the senior management official of the testing firm certifying the validity of the source test report.

5. **Changes to Testing Requirements:**
The source test must be conducted as specified in the sections above. The Permittee may submit a written request to SWCAA for approval of minor modifications to the requirements above or the testing schedule. Upon review of the request and in accordance with EPA delegation, SWCAA will inform the Permittee in writing of any approved modifications.

SWCAA
Southwest Clean Air Agency

TECHNICAL SUPPORT DOCUMENT

Air Discharge Permit ADP 20-3433
ADP Application CL-3138

Leichner Landfill
SWCAA ID - 1239

Issued: October 1, 2020

Prepared By: Wess Safford
Air Quality Engineer
Southwest Clean Air Agency

1. FACILITY IDENTIFICATION

Applicant Name:	Clark County Public Health – Solid Waste Services
Applicant Address:	PO Box 9825, Vancouver, WA 98666-9825
Facility Name:	Leichner Landfill
Facility Address:	9411 NE 94th Avenue, Vancouver, WA 98662
SWCAA Identification:	1239
Contact Person:	Mike Davis, Landfill Manager
Primary Process:	Closed municipal solid waste landfill
SIC/NAICS Code:	4953 / 562213
Facility Classification:	Natural Minor

2. FACILITY DESCRIPTION

Leichner Landfill is a municipal solid waste landfill located in Clark County. The landfill ceased active operation in 1991. The facility is now maintained and supervised by Clark County Public Health –Solid Waste Services (Clark County).

3. CURRENT PERMITTING ACTION

This permitting action is in response to Air Discharge Permit application number CL-3138 (ADP Application CL-3138) dated August 6, 2020. Clark County submitted ADP Application CL-3138 requesting approval of the following:

- Replacement of the existing landfill gas fare with a smaller capacity flare of similar design. The project is being taken in response to decreasing landfill gas production. No other change in facility operation is proposed.

The current permitting action provides approval for the replacement landfill gas flare as proposed. ADP 07-2714 will be superseded in its entirety by this permitting action.

4. PROCESS DESCRIPTION

4.a Landfill Gas Collection and Treatment. As solid waste ages in the landfill, it decomposes and generates landfill gas, consisting of methane, carbon dioxide, and other constituents. Landfill gas is either collected and routed to a control device or emitted to the atmosphere as fugitive gas. Landfill gas is controlled and collected by applying a vacuum to a network of subsurface landfill gas collection wells on the closed landfill. Collected landfill gas is directed to the condensate knockout where condensate is removed from the gas stream and collected in an onsite tank. Dry landfill gas is directed to a single enclosed flare. Flare operation is currently continuous but is expected to transition to intermittent operation as the landfill ages and gas generation falls over time.

5. EQUIPMENT/ACTIVITY IDENTIFICATION

5.a Landfill (*modified*). Emissions from the landfill consistent of emissions from operation of the landfill gas flare and fugitive gas emissions through the surface of the waste cells. The landfill gas flare is described as follows:

Existing Flare

Make / Model:	Landfill Gas Specialties, LLC / EF52514
Rated Capacity:	300 scfm landfill gas (~50% methane), 9.0 MMBtu/hr
Flare Dimensions:	Fully enclosed, 5' diameter round flare, 25' tall
Location:	Southwestern corner of closed landfill (location of previously existing South Flare)
Destruction Efficiency:	Designed for 99% destruction of total hydrocarbons, 98% of non-methane organic compounds (NMOCs)
Turndown Ratio:	6:1 (50 scfm required to maintain stable flame and 99% THC destruction)
Minimum Methane:	30% to maintain stable flame and 99% THC destruction
Flare Pilot:	40,000 Btu/hr Propane (fires only when flame scanner indicates no flame)

Temperature	Retention Time (300 scfm, 50% methane)	Excess Air
1,400 °F	1.062 seconds	230%

Proposed Flare

Make / Model:	*Perennial Energy, Inc / FL-40-25-E*
Rated Capacity:	*2.7 MMBtu/hr, 90 scfm landfill gas (50% methane)*
Flare Dimensions:	*Fully enclosed, 42" diameter round flare, 25' tall*
Location:	*Southwestern corner of closed landfill (location of previously existing South Flare)*
Destruction Efficiency:	*99% destruction of total hydrocarbons (THC)* *98% of non-methane organic compounds (NMOC)*
Turndown Ratio:	*10:1 (9 scfm required to maintain stable flame and 99% THC destruction)*
Minimum Methane:	*~24.7% by volume*
Flare Pilot:	*Propane fired (operates only during flare startup)*

Temperature	*Retention Time (90 scfm, 50% methane)*	*Excess Air*
1,400 °F	*0.6 seconds*	*--*

ADP Application CL-3138. Clark County proposes to install a smaller capacity flare, similar in design to the existing flare. Landfill gas generation is decreasing to the point where generation rates are too low to support proper operation of the existing flare.

5.b Equipment/Activity Summary:

ID No.	Generating Equipment/Activity	# of Units	Control Equipment	# of Units
1	Landfill	1	Enclosed flare (Perennial Energy – 2.7 MMBtu/hr)	1

6. EMISSIONS DETERMINATION

Emissions to the ambient atmosphere from landfill operations, as proposed in ADP Application CL-3138, consist of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter (PM) sulfur dioxide (SO_2), toxic air pollutants (TAPs), and hazardous air pollutants (HAPs).

6.a Landfill. Emissions from the landfill consist of combustion emissions from the landfill gas flare and fugitive emissions from the landfill surface. The magnitude of emissions will be directly related to the amount of landfill gas generated and captured. Published estimates of landfill gas capture rates range from (65% - 90%) for municipal waste landfills. SWCAA has utilized a capture rate of 75% consistent with Clark County's application and the default value suggested by EPA in AP-42 Section 2.4 (10/08).

THIS IS THE LAST PAGE OF THIS DOCUMENT

If you have any questions, please contact one of the following individuals by email or phone.

Name: Mr. Peter Becker
Title: Client Project Manager
Region: West
Email: pbecker@montrose-env.com
Phone: 330-285-6884

Name: Ms. Kristina Schafer
Title: PNW Hub District Manager
Region: West
Email: kschafer@montrose-env.com
Phone: 253-480-3801

Appendix I

Missing Data Notification

SCS ENGINEERS Environmental Consultants & Contractors

December 17, 2020
File No. 04220030.16

MEMORANDUM

TO: Paul Mairose, Wess Safford, Gerald Strawn, SWCAA

FROM: Alexa Deep, Louis Caruso, Stephen Harquail, Greg Helland, Ted Massart, SCS Engineers

SUBJECT: **Missing Flare Data for the Period of September 28 through December 10, 2020, Leichner Landfill, Clark County, Washington, ADP No. 20-3433**

This memorandum, prepared by SCS Engineers (SCS) on behalf of Clark County Public Health (County), notifies the Southwest Clean Air Agency (SWCAA) of missing flare performance data that was discovered following the installation of a new micro-flare and control panel at the closed Leichner Landfill (Landfill) in late September 2020. The memorandum details the events leading up to the period of missing data, describes what corrective actions have been taken to address the issue, and summarizes the data that is available for the period in question.

SUMMARY OF EVENTS

On December 10, 2020, SCS discovered that the data recorder at the Landfill flare station had malfunctioned, and data for the period of September 28, 2020 through December 10, 2020 was unavailable for review. This included the continuously recorded parameters for landfill gas (LFG) flow sent to the flare, destruction temperature of the flare, and vacuum of the wellfield. The issue was found to be a combination of a programming error and site-wide network issue that prevented data from being stored and uploaded to a remote monitoring and control (RMC) system as intended.

The malfunction began with the replacement of the old flare with the new micro-flare that occurred at the end of September. The old flare was taken offline on September 28, 2020, and replaced with the new flare on the same day. The new flare became operational on October 2, 2020, but was still undergoing final commissioning tests. In the week following installation, the new flare underwent programming as well as startup, shutdown, and malfunction testing by the flare manufacturer (Perennial Energy Inc. [Perennial]) and SCS personnel. The commissioning of the new flare was completed on October 8, 2020. Flare temperature setpoints were programmed by the manufacturer and included 1,475 °F as the operating temperature setpoint as well as 1,400 °F and 1,950 °F as the low and high temperature shutdown setpoints, respectively. These setpoints were documented in Perennial's commissioning report with the photos below:

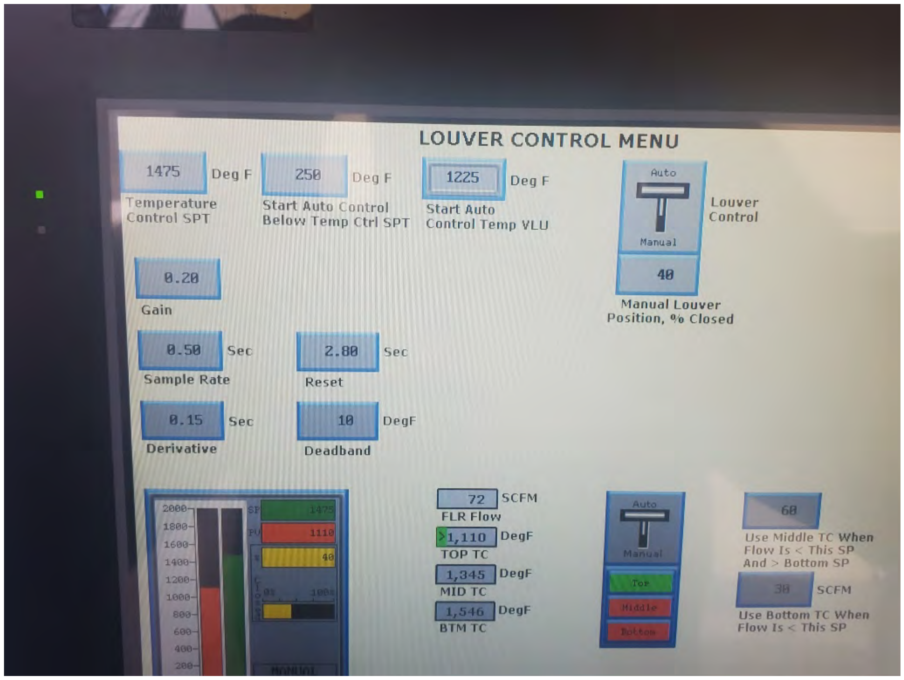


Figure 1. **Flare operating temperature setpoint of 1,475 °F**

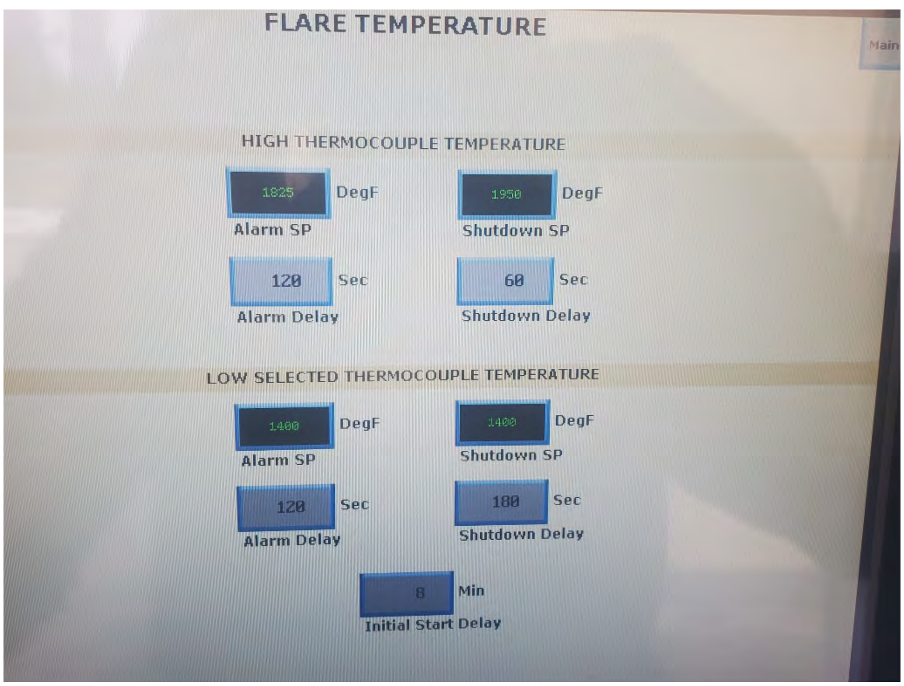


Figure 2. **Flare alarm and shutdown setpoints on high and low temperature**

SCS personnel were onsite to set up the data display and recording systems during the commissioning period, which are intended to provide collection, storage and upload of flare data for remote monitoring purposes. There are two data recording systems for the flare: the programmable logic controller (PLC), which records and stores data onsite; and the C-More, which uploads data to SCS's eTools system for remote monitoring and data analysis. In the field, by displaying the real-time operating conditions, it appeared as though these systems were functioning as intended. However, as previously noted, this data was not able to be retrieved on December 10, 2020. Upon further investigation, it was found that a coding issue was preventing the storing and upload of this data. The tags for the flare parameters for flow, temperature, and vacuum that were set up by the manufacturer were not compatible with SCS's programming. An attempt had previously been made to correct the issue during the initial setup and testing, but it was later discovered that the data was not actually being stored despite appearing to be recorded.

CORRECTIVE ACTIONS

Upon discovery on December 10th, SCS immediately began taking steps to troubleshoot and correct the issue. SCS RMC personnel rebuilt the system for the PLC and C-More so that data began being recorded and stored on December 10th. Further troubleshooting found a network connection issue which was preventing data from being uploaded to SCS's eTools system, which has also been corrected. Continuous data has been recorded and is available for review as of December 10, 2020 at 14:04.

AVAILABLE DATA

As previously noted, continuous flare data is not available from September 28, 2020 0:00 through December 10, 2020 14:04. We understand the implications of this on the recordkeeping and reporting requirements in the Landfill's air discharge permit (ADP) No. 20-3433. However, we are confident that no excess emissions events occurred during this period based on the programmed flare setpoint temperatures as shown in Figures 1 and 2, which would prevent the flare from operating below 1,400 °F for more than 3 consecutive minutes without shutting down. Therefore, we believe that the flare was in compliance with the operating temperature requirement of Condition 8 of the ADP, which states that prior to the source test, the flare must be operated at a minimum temperature of 1,400 °F on a 1-hour average basis.

In addition to records of the programmed setpoints, we have routine monitoring data collected by SCS personnel at the inlet to the flare, which provides information on the gas composition and LFG flow rates sent to the flare during the missing data period. Flare inlet data was collected on the following dates:

- October: 10/12, 10/14, 10/16, 10/28, 10/29
- November: 11/10, 11/12, 11/13, 11/23, 11/24, 11/25
- December: 12/2, 12/3, 12/4

This data can be utilized to estimate the flow rates and emissions information to be submitted in the 2020 annual report, which is due March 15, 2021.

Further, during the source test that was performed by Montrose on December 9th-10th, flare operating parameters (flow, temperature, and vacuum) were logged and photographed by SCS personnel periodically throughout each test run. Conversations with Montrose indicate that these records are adequate for the purposes of their source test calculations. Additionally, Montrose also recorded flare parameter information at the beginning and end of each test run. Because data was logged by other means, we do not feel as though the missing data has impacted the validity of the source test and feel confident in the results, which will be provided to SWCAA for review as required by the permit.