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CDPHE APCD

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PDC appreciates the Air Pollution Control Division's ("APCD") decision to accept the Clean Connect monitoring system as a new Alternative Approved Instrument Monitoring Method ("AIMM") to the current Regulation 7 AIMM requirement (Part D, §II.E). This newly approved technology will allow industry to monitor more effectively, to improve response time to leaks and to reduce emission in the Denver-Julesburg ("DJ") Basin.

The approved Alternative AIMM limits the functionality of the Clean Connect system to 18.6 meters; however, PDC requests that the APCD reconsider this decision and approve the use of this technology for leak detection at greater distances. To justify this request, PDC Personnel performed testing on October 20th and 21st, 2022, in accordance with the APCD approved field testing methodology (Exhibit A) at the Ridge State facility (AIRS ID123-A109) ("facility"). The field test was designed to prove the Clean Connect systems ability to detect leaks at distances as far as 120 meters. To demonstrate the capability of the Clean Connects technology, the test protocol was conducted at 40 meters (Exhibit B), 60 meters (Exhibit C), 80 meters (Exhibit D), 100 meters (Exhibit E), 120 meters (Exhibit F).

During the field testing, upon the detection of a gas release, the Clean Connect system sent "alarm packages" (details of the detection) to PDC's alarm management system. These alarm packages included a description of the alarm type and a recorded video of the suspected leak. PDC personnel used the details contained in these alerting packages to populate the results of the field testing on the APCD approved data form at each distance and included a link to the video clip of each release event on the data entry form (the detailed results for the field tests at each distance can be found in exhibits B through F).

Of note, due to time constraints, the field tests completed at 100 meters were only performed ten times (in lieu of the approved 15 times) before moving to the 120 meter distance and continuing the testing procedure. If necessary, to maintain the integrity of the protocol, the eight tests completed at 120 meters could and should satisfy the remaining five tests at 100 meters.

Based on the results of these field tests, PDC requests that the APCD approved the Clean Connect monitoring system as an alternative AIMM for distances of up to 120 meters. Approval of the revolutionary technology will allow industry to monitor and improve its response time to leaks and in turn reduce emission in the Denver-Julesburg ("DJ") Basin more effectively.



Proposed Clean Connect Field Testing Methodology

To establish further maximum detection ranges

DATE: 2022-07-18

TEAM

Clean Connect and Highwood Emissions Management

PREPARED FOR CDPHE



1. Introduction

As per the June 23rd, 2022, meeting with CDPHE, Clean Connect and Highwood, CDPHE will be granting Clean Connect AA/MM application approval with a maximum deployable distance of 18.6m. It was stated that the approval could be amended to reflect further detection capabilities, should Clean Connect prove these further detection capabilities through blinded, controlled release testing. The goal of this report is to establish the testing methodology which can be used to verify the performance of the Clean Connect monitoring system at distances greater than 18.6m.

2. Methodology

The goal of the testing will be to establish **the maximum distance** at which the Clean Connect monitoring system can detect a natural gas emission of **2 kg/hr**. The Clean Connect system will monitor a series of 2 kg/hr releases and “non-releases” (to test for false positives) at increasing distances. The distances from the Clean Connect monitoring camera to the emission source will be targeted as 40, 60, 80 and 100m (these distances are the goal, however, testing site layout may result in slight variations).

Each of the proposed distances will stand as a unique test with an associated testing form. For example, a day of testing will be devoted to the 40m distance, and a single testing form will be populated for this distance.

For each given distance (unique test), the following will take place:

1. 15, 5-minute, 2 kg/hr releases are set off.
2. After each 2 kg/hr release, a 5-minute period of “non-release” will take place in which no natural gas is released from the release point. This non-release window is designed to test for false positives.
3. The system operates completely autonomously, potentially sending alert packages to the Operator who fills out the testing form.

Upon completion of each test, the testing form will be sent to the CDPHE (desired recipients can be specified at a later date). CDPHE will then approve operation at that given distance should the following testing criteria be met:

If the Clean Connect monitoring system detects the 2 kg/hr releases 87% of the time or greater (13 or more of the 15 releases), the system is automatically approved for that given distance (with a maximum distance of 100m).

3. Ensuring testing is blind

The methodology to ensure the testing is blinded to Clean Connect is as follows:

The test will be run entirely by an Operator at the active site used for testing. During testing, the Clean Connect monitoring system will operate autonomously as it would during a typical deployment. The Clean Connect monitoring system will send “alerting packages” (details on detections) to the Operator. The Operator will use the details contained in these alerting packages to populate the testing form as the testing progresses.

The testing form will be a tabular data entry form. Some fields of the form will detail experimental conditions (release timing, wind speed, etc.) while some fields detail results (alert

received, correct result). The Operator will fill out all fields of the testing form. The form will contain a letterhead with the Operator company details and will be signed off on by the Operator once testing is completed.

A template testing form has been supplied as an additional document. An example of a filled-out testing form follows:

Release or non-release # (Key)	Release or Non-release	Distance (m)	Period Start (YYYY-MM-DD_00:00)	Period End (YYYY-MM-DD_00:00)	Wind Speed (m/s)	Clean Connect detection/alert received*	Correct Result**	Link to OGI Video***
1	Release	40	2022-07-12_08:00:00	2022-07-12_08:05:00	8	1	1	www.ccogivid.com
2	Non-Release	40	2022-07-12_08:05:00	2022-07-12_08:10:00	7	0	1	www.ccogivid.com
3	Release	40	2022-07-12_08:10:00	2022-07-12_08:15:00	12	1	1	www.ccogivid.com
4	Non-Release	40	2022-07-12_08:15:00	2022-07-12_08:20:00	12	1	1	www.ccogivid.com
5	Release	40	2022-07-12_08:20:00	2022-07-12_08:25:00	15	1	1	www.ccogivid.com
6	Non-Release	40	2022-07-12_08:25:00	2022-07-12_08:30:00	18	0	1	www.ccogivid.com
7	Release	40	2022-07-12_08:30:00	2022-07-12_08:35:00	3	1	1	www.ccogivid.com
8	Non-Release	40	2022-07-12_08:35:00	2022-07-12_08:40:00	5	0	1	www.ccogivid.com
9	Release	40	2022-07-12_08:40:00	2022-07-12_08:45:00	8	0	0	www.ccogivid.com
10	Non-release	40	2022-07-12_08:50:00	2022-07-12_08:55:00	10	0	1	www.ccogivid.com
...

*Detection / alert received values: 1 = alert received, 0 = no alert received

**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

***The operator receives a link to the associated OGI video with each alert which they can provide

Testing Results Follow

Exhibit B

The 40 meter test site was located on the North West side of the facility at 40.396749°, -104.812311° (Lat, Long) which is ~40 Meters from the Clean Connect OGI Camera located at 40.396702°,-104.811827° (Lat, Long)





The following are the results of controlled release testing of the Clean Connect monitoring system by Beau R. Hastings at the Ridge State facility on 10-20-2022. All release rates are **2 kg/hr**.

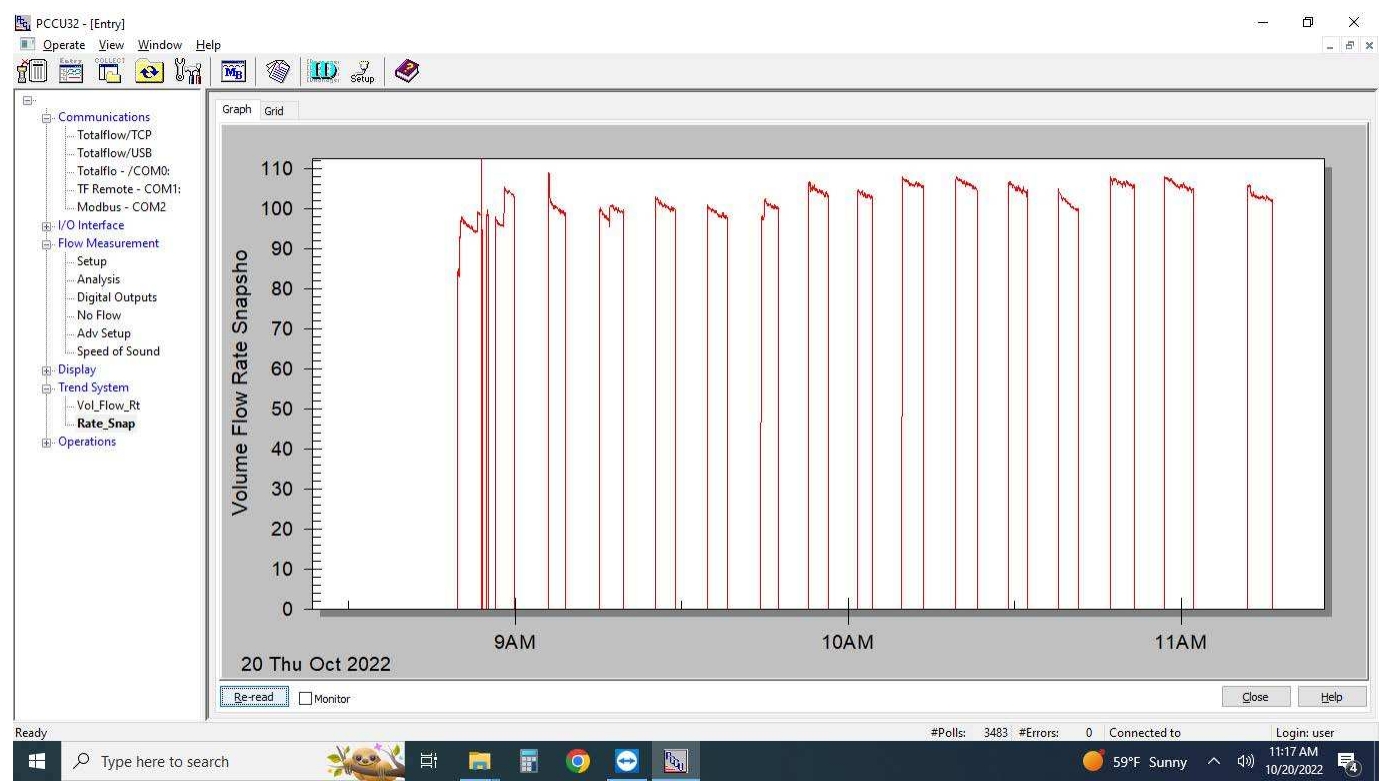
Period # (Key)	Release or Non-release	Distance (m)	Period Start (YYYY-MM-DD_00:00)	Period End (YYYY-MM-DD_00:00)	Wind Speed (m/s)	Clean Connect detection/alert received*	Correct Result**	Link to OGI Video
1	Release	40	2022-10-20_8:56AM	2022-10-20_8:59AM	0	1	1	Link
2	Non-Release	40	2022-10-20_9:00AM	2022-10-20_9:05AM	0	0	1	
3	Release	40	2022-10-20_9:06AM	2022-10-20_9:08AM	1.788	1	1	Link
4	Non-Release	40	2022-10-20_9:09AM	2022-10-20_9:14AM	1.56	0	1	
5	Release	40	2022-10-20_9:15AM	2022-10-20_9:17AM	0.89	1	1	Link
6	Non-Release	40	2022-10-20_9:19AM	2022-10-20_9:24AM	0.357	0	1	
7	Release	40	2022-10-20_9:25AM	2022-10-20_9:27AM	0.76	1	1	Link
8	Non-Release	40	2022-10-20_9:29AM	2022-10-20_9:34AM	0.1	0	1	
9	Release	40	2022-10-20_9:34AM	2022-10-20_9:37AM	0.9	1	1	Link
10	Non-release	40	2022-10-20_9:39AM	2022-10-20_9:44AM	0.6	0	1	
11	Release	40	2022-10-20_9:44AM	2022-10-20_9:47AM	1.4	1	1	Link
12	Non-Release	40	2022-10-20_9:47AM	2022-10-20_9:52AM	1.2	0	1	
13	Release	40	2022-10-20_9:52AM	2022-10-20_9:56AM	1.3	1	1	Link
14	Non-Release	40	2022-10-20_9:56AM	2022-10-20_10:01AM	3.2	0	1	
15	Release	40	2022-10-20_10:01AM	2022-10-20_10:02AM	0.8	1	1	Link
16	Non-Release	40	2022-10-20_10:04AM	2022-10-20_10:09AM	1.9	0	1	
17	Release	40	2022-10-20_10:09AM	2022-10-20_10:13AM	2.5	1	1	Link
18	Non-Release	40	2022-10-20_10:13AM	2022-10-20_10:18AM	1.9	0	1	
19	Release	40	2022-10-20_10:19AM	2022-10-20_10:23AM	1.3	1	1	Link
20	Non-Release	40	2022-10-20_10:23AM	2022-10-20_10:28	1.2	0	1	
21	Release	40	2022-10-20_10:28AM	2022-10-20_10:32AM	0.6	1	1	Link
22	Non-Release	40	2022-10-20_10:32AM	2022-10-20_10:37AM	0.9	0	1	
23	Release	40	2022-10-20_10:37AM	2022-10-20_10:41AM	1.3	1	1	Link
24	Non-Release	40	2022-10-20_10:41AM	2022-10-20_10:46AM	0	0	1	
25	Release	40	2022-10-20_10:47AM	2022-10-20_10:51AM	1.5	1	1	Link
26	Non-Release	40	2022-10-20_10:51AM	2022-10-20_10:56AM	1.6	0	1	
27	Release	40	2022-10-20_10:57AM	2022-10-20_11:01AM	1.2	0 (Model Caught Leak, bug in communication)	0	Link

28	Non-Release	40	2022-10-20_11:06AM	2022-10-20_11:11AM	0.4	0	1	
29	Release	40	2022-10-20_11:11AM	2022-10-20_11:16AM	0	1	1	Link
30	Non-Release	40	2022-10-20_11:16AM	2022-10-20_11:21AM	1.2	0	1	

*Detection / alert received values: 1 = alert received, 0 = no alert received

**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

Below is the trend data for the flow rates during testing at this distance, as measured by a Total Flow G4 Meter through a 2" meter tube and 0.375" Orifice Plate, using sales grade fuel gas, which confirms the desired flow rate of approximately 2kg/hour.



Operator Signature:

Beau Hastings

CDPHE Distance Approval Certification:

Exhibit C

The 60 meter test site was located on the West side of the facility at 40.396390°, -104.812425° (Lat, Long) which is ~60 Meters from the Clean Connect OGI Camera located at 40.396702°, -104.811827° (Lat, Long)





The following are the results of controlled release testing of the Clean Connect monitoring system by Beau R. Hastings at the Ridge State facility on 10-20-2022. All release rates are 2 kg/hr.

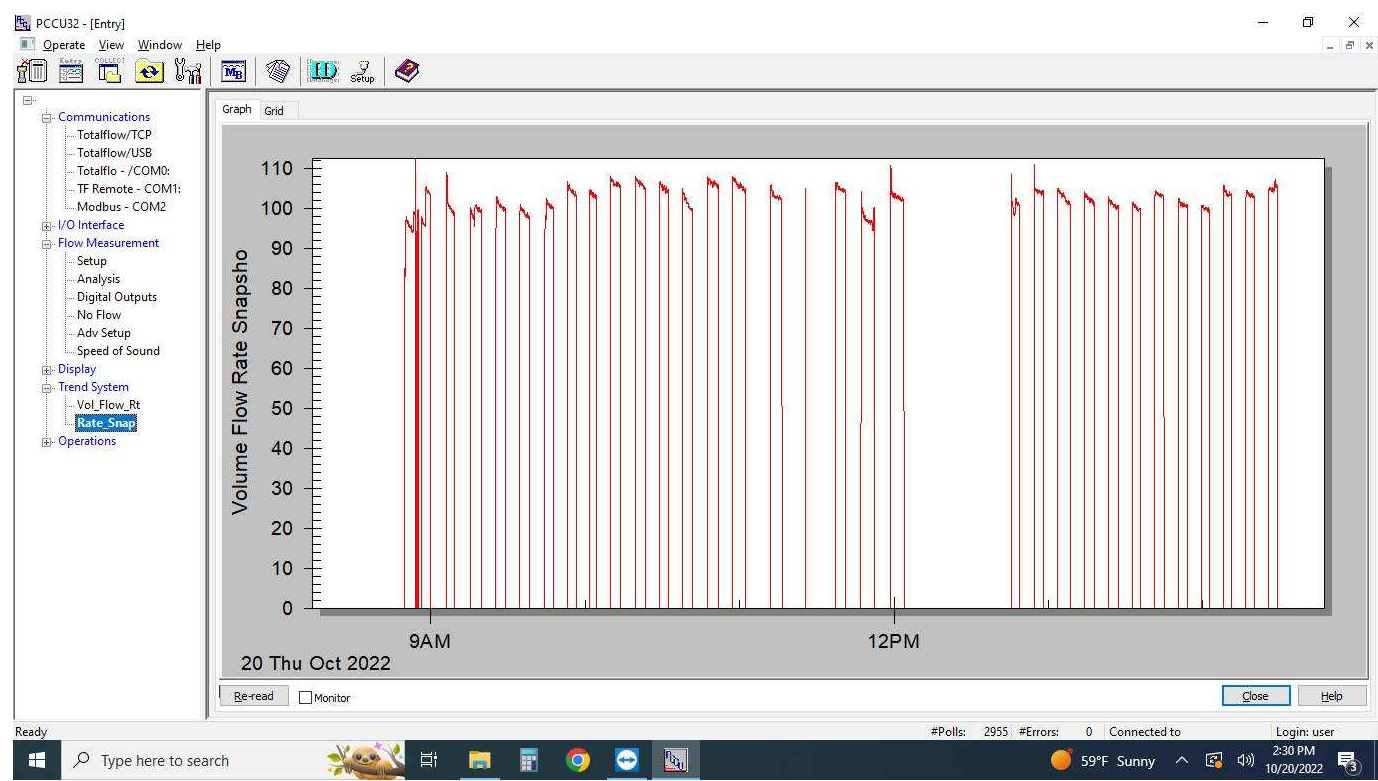
Period # (Key)	Release or Non-release	Distance (m)	Period Start (YYYY-MM-DD_00:00)	Period End (YYYY-MM-DD_00:00)	Wind Speed (m/s)	Clean Connect detection/alert received*	Correct Result**	Link to OGI Video
1	Release	60	2022-10-20_11:37AM	2022-10-20_11:40AM	1.0	1	1	Link
2	Non-Release	60	2022-10-20_11:41AM	2022-10-20_11:46AM	1.5	0	1	
3	Release	60	2022-10-20_11:47AM	2022-10-20_11:52AM	1.9	1	1	Link
4	Non-Release	60	2022-10-20_11:53AM	2022-10-20_11:58AM	1.7	0	1	
5	Release	60	2022-10-20_11:58AM	2022-10-20_12:03PM	2.9	1	1	Link
6	Non-Release	60	2022-10-20_12:40PM	2022-10-20_12:45PM	1.7	0	1	
7	Release	60	2022-10-20_12:45	2022-10-20_12:47PM	1.6	1	1	Link
8	Non-Release	60	2022-10-20_12:49PM	2022-10-20_12:54PM	0.8	0	1	
9	Release	60	2022-10-20_12:54PM	2022-10-20_12:56PM	2.0	1	1	Link
10	Non-release	60	2022-10-20_12:58PM	2022-10-20_1:03PM	2.6	0	1	
11	Release	60	2022-10-20_1:03PM	2022-10-20_1:08PM	0.8	1	1	Link
12	Non-Release	60	2022-10-20_1:08PM	2022-10-20_1:13PM	2.3	0	1	
13	Release	60	2022-10-20_1:14	2022-10-20_1:17PM	3.8	1	1	Link
14	Non-Release	60	2022-10-20_1:17PM	2022-10-20_1:22PM	2.4	0	1	
15	Release	60	2022-10-20_1:23PM	2022-10-20_1:27PM	2.6	1	1	Link
16	Non-Release	60	2022-10-20_1:27PM	2022-10-20_1:32PM	1.9	0	1	
17	Release	60	2022-10-20_1:32PM	2022-10-20_1:35PM	2.5	1	1	Link
18	Non-Release	60	2022-10-20_1:36PM	2022-10-20_1:41PM	2.7	0	1	
19	Release	60	2022-10-20_1:41PM	2022-10-20_1:45PM	3.6	1	1	Link
20	Non-Release	60	2022-10-20_1:45PM	2022-10-20_1:50PM	1.8	0	1	
21	Release	60	2022-10-20_1:50PM	2022-10-20_1:53PM	4.0	1	1	Link
22	Non-Release	60	2022-10-20_1:54PM	2022-10-20_1:59PM	2.2	0	1	
23	Release	60	2022-10-20_1:59PM	2022-10-20_2:02PM	3.6	1	1	Link
24	Non-Release	60	2022-10-20_2:02PM	2022-10-20_2:07PM	3.0	0	1	
25	Release	60	2022-10-20_2:08PM	2022-10-20_2:13PM	3.1	1	1	Link
26	Non-Release	60	2022-10-20_2:11PM	2022-10-20_2:16PM	1.9	0	1	
27	Release	60	2022-10-20_2:16PM	2022-10-20_2:20PM	3.2	1	1	Link

28	Non-Release	60	2022-10-20_2:20PM	2022-10-20_2:25PM	1.4	0	1	
29	Release	60	2022-10-20_2:25PM	2022-10-20_2:29PM	2.4	1	1	Link
30	Non-Release	60	2022-10-20_2:29PM	2022-10-20_2:34PM	2.6	0	1	

*Detection / alert received values: 1 = alert received, 0 = no alert received

**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

Below is the trend data for the flow rates during testing at this distance, as measured by a Total Flow G4 Meter through a 2" meter tube and 0.375" Orifice Plate, using sales grade fuel gas, which confirms the desired flow rate of approximately 2kg/hour.



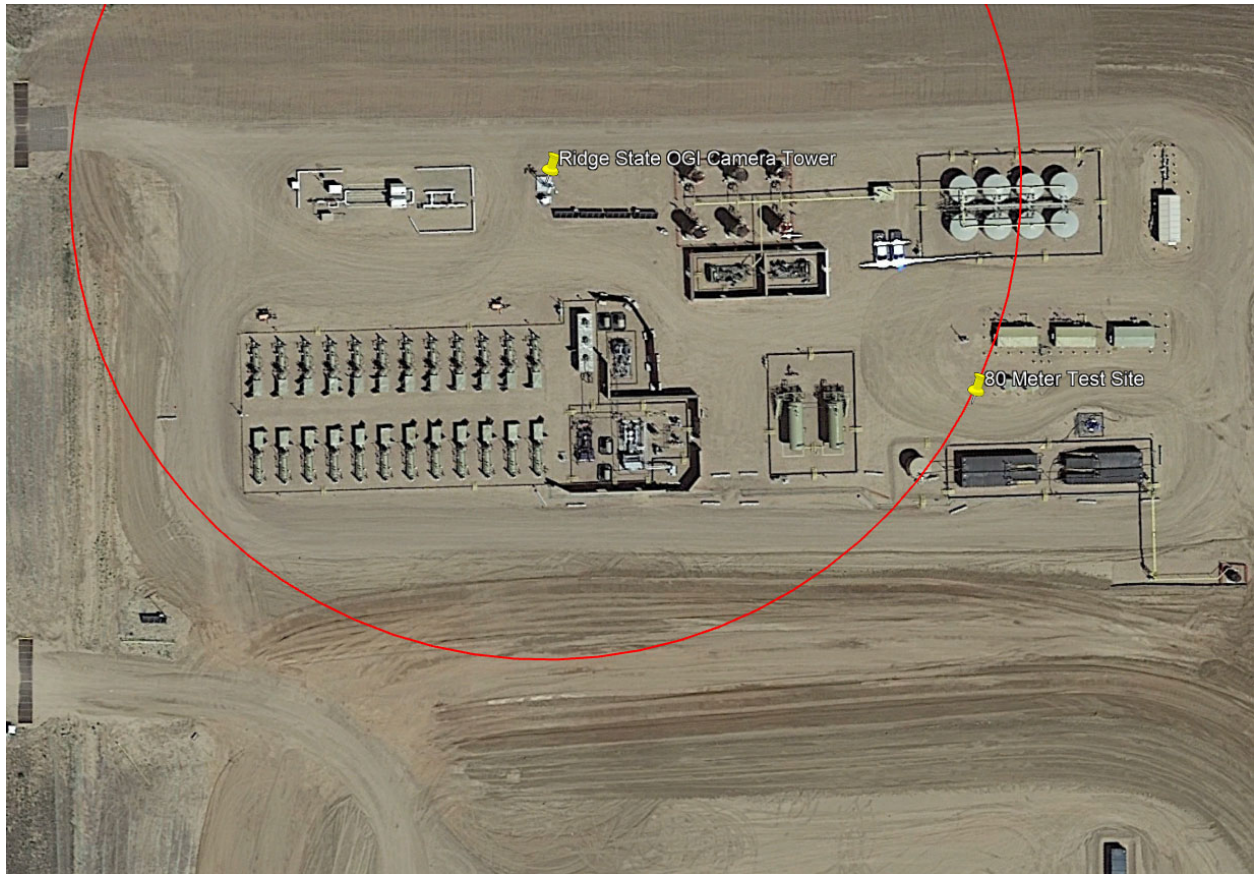
Operator Signature:

Beau Hastings

CDPHE Distance Approval Certification:

Exhibit D

The 80 meter test site was located on the South East side of the facility at 40.396368°, -104.810978° (Lat, Long) which is ~80 Meters from the Clean Connect OGI Camera located at 40.396702°,-104.811827° (Lat, Long)





The following are the results of controlled release testing of the Clean Connect monitoring system by Beau R. Hastings at the Ridge State facility on 10-20-2022. All release rates are 2 kg/hr.

Period # (Key)	Release or Non-release	Distance (m)	Period Start (YYYY-MM-DD_00:00)	Period End (YYYY-MM-DD_00:00)	Wind Speed (m/s)	Clean Connect detection/alert received*	Correct Result**	Link to OGI Video
1	Release	80	2022-10-20_2:50PM	2022-10-20_2:54PM	0.9	1	1	Link
2	Non-Release	80	2022-10-20_2:54PM	2022-10-20_2:59PM	3.6	0	1	
3	Release	80	2022-10-20_2:59PM	2022-10-20_3:03PM	1.1	1	1	Link
4	Non-Release	80	2022-10-20_3:03PM	2022-10-20_3:08PM	4.7	0	1	
5	Release	80	2022-10-20_3:08PM	2022-10-20_3:12PM	2.1	1	1	Link
6	Non-Release	80	2022-10-20_3:12PM	2022-10-20_3:17PM	3.4	0	1	
7	Release	80	2022-10-20_3:18PM	2022-10-20_3:22PM	2.1	1	1	Link
8	Non-Release	80	2022-10-20_3:22PM	2022-10-20_3:27PM	3.1	0	1	
9	Release	80	2022-10-20_3:27PM	2022-10-20_3:31PM	1.9	1	1	Link
10	Non-release	80	2022-10-20_3:31PM	2022-10-20_3:36PM	1.8	0	1	
11	Release	80	2022-10-20_3:37PM	2022-10-20_3:40PM	1.6	1	1	Link
12	Non-Release	80	2022-10-20_3:40PM	2022-10-20_3:45PM	1.9	0	1	
13	Release	80	2022-10-20_3:46PM	2022-10-20_3:49PM	0.9	1	1	Link
14	Non-Release	80	2022-10-20_3:49PM	2022-10-20_3:54PM	1.6	0	1	
15	Release	80	2022-10-20_3:54PM	2022-10-20_3:58PM	3.9	1	1	Link
16	Non-Release	80	2022-10-20_3:59PM	2022-10-20_4:04PM	1.3	0	1	
17	Release	80	2022-10-20_4:04PM	2022-10-20_4:09PM	2.0	1	1	Link
18	Non-Release	80	2022-10-20_4:09PM	2022-10-20_4:14PM	1.5	0	1	
19	Release	80	2022-10-20_4:14PM	2022-10-20_4:17PM	0.7	1	1	Link
20	Non-Release	80	2022-10-20_4:17PM	2022-10-20_4:22PM	0.5	0	1	
21	Release	80	2022-10-20_4:22PM	2022-10-20_4:27PM	1.3	1	1	Link
22	Non-Release	80	2022-10-20_4:27PM	2022-10-20_4:32PM	2.2	0	1	
23	Release	80	2022-10-20_4:32PM	2022-10-20_4:36PM	1.7	1	1	Link
24	Non-Release	80	2022-10-20_4:36PM	2022-10-20_4:41PM	0.7	0	1	
25	Release	80	2022-10-20_4:41PM	2022-10-20_4:45PM	1.8	1	1	Link
26	Non-Release	80	2022-10-20_4:45PM	2022-10-20_4:50PM	2.8	0	1	
27	Release	80	2022-10-20_4:50PM	2022-10-20_4:54PM	2.9	1	1	Link

28	Non-Release	80	2022-10-20_4:54PM	2022-10-20_4:59PM	3.2	0	1	
29	Release	80	2022-10-20_4:59PM	2022-10-20_5:03PM	0.6	1	1	Link
30	Non-Release	80	2022-10-20_5:03PM	2022-10-20_5:08PM	0.8	0	1	

*Detection / alert received values: 1 = alert received, 0 = no alert received

**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

Below is the trend data for the flow rates during testing at this distance, as measured by a Total Flow G4 Meter through a 2" meter tube and 0.375" Orifice Plate, using sales grade fuel gas, which confirms the desired flow rate of approximately 2kg/hour.



Operator Signature:

Beau Hastings

CDPHE Distance Approval Certification:

Exhibit E

The 100 meter test site was located on the South West side of the facility at 40.395881°, -104.812327° (Lat, Long) which is ~100 Meters from the Clean Connect OGI Camera located at 40.396702°,-104.811827° (Lat, Long)



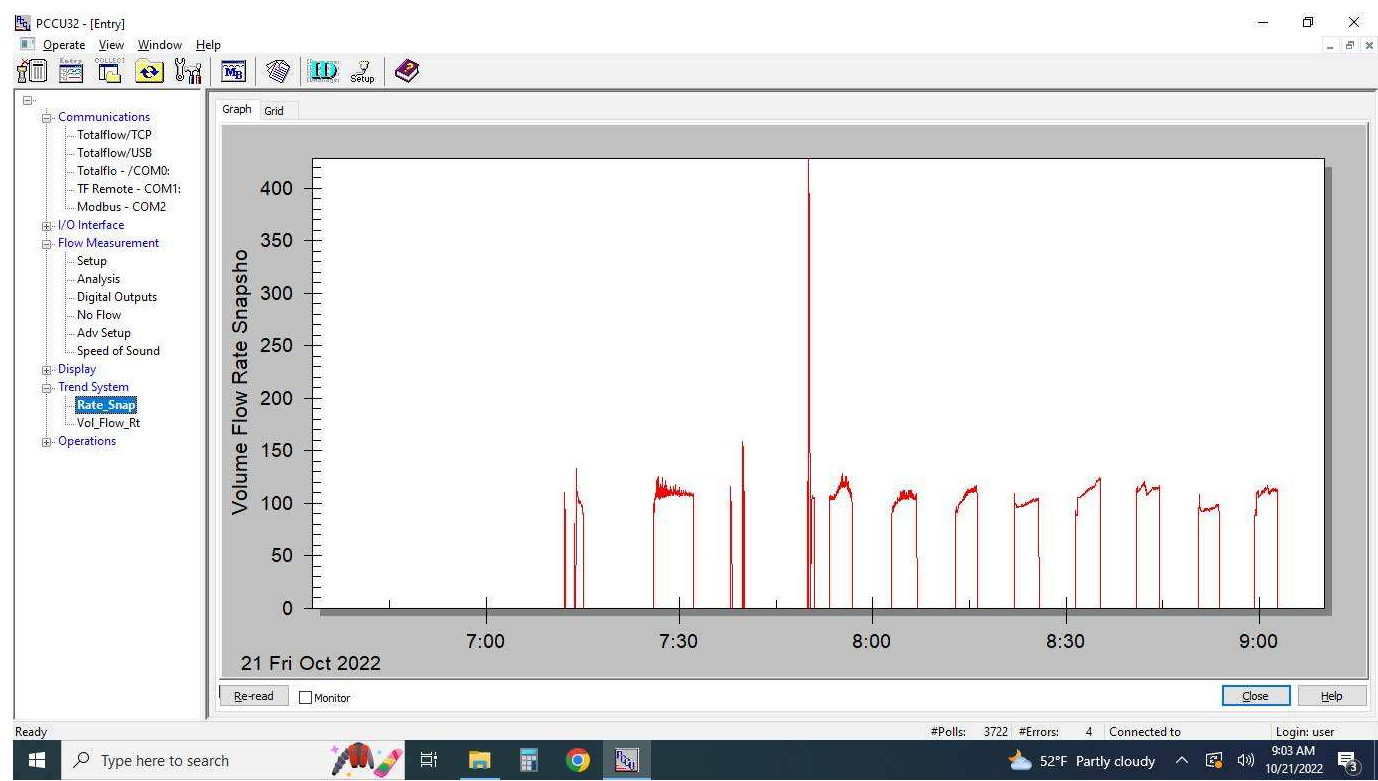


The following are the results of controlled release testing of the Clean Connect monitoring system by Beau R. Hastings at the Ridge State facility on 10-21-2022. All release rates are 2 kg/hr.

Period # (Key)	Release or Non-release	Distance (m)	Period Start (YYYY-MM-DD_00:00)	Period End (YYYY-MM-DD_00:00)	Wind Speed (m/s)	Clean Connect detection/alert received*	Correct Result**	Link to OGI Video
1	Release	100	2022-10-21_7:25AM	2022-10-21_7:29	0.8	1	1	Link
2	Non-Release	100	2022-10-21_7:32AM	2022-10-21_7:37AM	1.1	0	1	
3	Release	100	2022-10-21_7:37AM	2022-10-21_7:42AM	0	1	1	Link
4	Non-Release	100	2022-10-21_7:44AM	2022-10-21_7:49AM	0	0	1	
5	Release	100	2022-10-21_7:53AM	2022-10-21_7:57AM	1.5	1	1	Link
6	Non-Release	100	2022-10-21_7:57AM	2022-10-21_8:02AM	1.9	0	1	
7	Release	100	2022-10-21_8:02AM	2022-10-21_8:05AM	1.4	1	1	Link
8	Non-Release	100	2022-10-21_8:07AM	2022-10-21_8:12AM	1.9	0	1	
9	Release	100	2022-10-21_8:12AM	2022-10-21_8:15AM	0.9	1	1	Link
10	Non-release	100	2022-10-21_8:16AM	2022-10-21_8:21AM	1.5	0	1	
11	Release	100	2022-10-21_8::22AM	2022-10-21_8:25AM	0.6	1	1	Link
12	Non-Release	100	2022-10-21_8:26AM	2022-10-21_8:31AM	1.9	0	1	
13	Release	100	2022-10-21_8:31AM	2022-10-21_8:34AM	1.7	1	1	Link
14	Non-Release	100	2022-10-21_8:35AM	2022-10-21_8:40AM	0	0	1	
15	Release	100	2022-10-21_8:40AM	2022-10-21_8:43AM	1	1	1	Link
16	Non-Release	100	2022-10-21_8:44AM	2022-10-21_8:49AM	0.8	0	1	
17	Release	100	2022-10-21_8:50AM	2022-10-21_8:53AM	1.8	1	1	Link
18	Non-Release	100	2022-10-21_8:54AM	2022-10-21_8:59AM	1.7	0	1	
19	Release	100	2022-10-21_8:59AM	2022-10-21_9:02AM	1.9	1	1	Link
20	Non-Release	100	2022-10-21_9:02AM	2022-10-21_9:07AM	3.4	0	1	

*Detection / alert received values: 1 = alert received, 0 = no alert received
**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

Below is the trend data for the flow rates during testing at this distance, as measured by a Total Flow G4 Meter through a 2" meter tube and 0.375" Orifice Plate, using sales grade fuel gas, which confirms the desired flow rate of approximately 2kg/hour.



Operator Signature:
Beau Hastings

CDPHE Distance Approval Certification:

Exhibit F

The 120 meter test site was located on the South West side of the facility at 40.395650° , - 104.812187° (Lat, Long) which is ~120 Meters from the Clean Connect OGI Camera located at 40.396702° , - 104.811827° (Lat, Long)





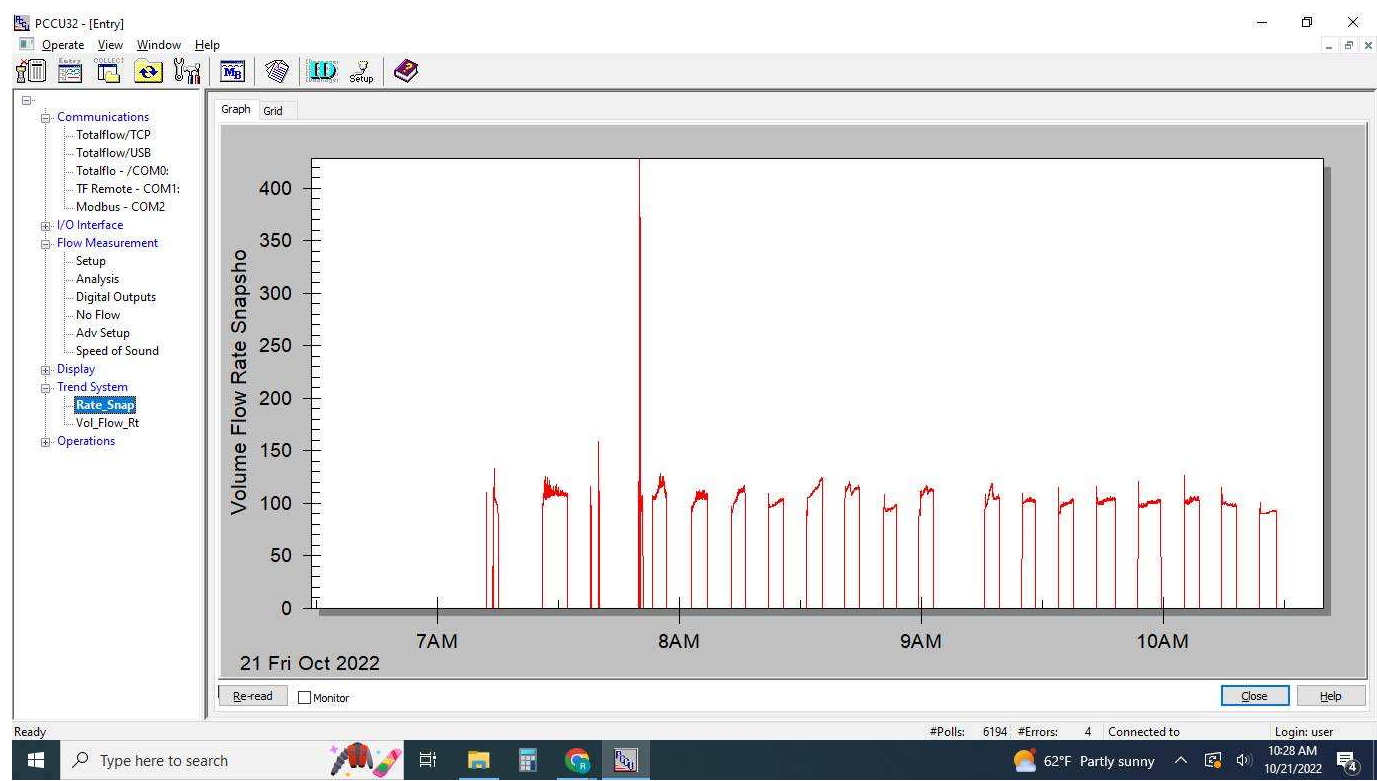
The following are the results of controlled release testing of the Clean Connect monitoring system by Beau R. Hastings at the Ridge State facility on 10-21-2022. All release rates are 2 kg/hr.

[illegible]

*Detection / alert received values: 1 = alert received, 0 = no alert received

**Result values: 1 = True positive (alert received for a release) or true negative (no alert received for a non-release), 0 = False negative (no alert received for a release) or false positive (alert received for a non-release)

Below is the trend data for the flow rates during testing at this distance, as measured by a Total Flow G4 Meter through a 2" meter tube and 0.375" Orifice Plate, using sales grade fuel gas, which confirms the desired flow rate of approximately 2kg/hour.



Operator Signature:

Beau Hastings

CDPHE Distance Approval Certification:
