Report on air quality comparative testing

Canadian Artic

Performed by Roberto Draganic using the ISEEE 1.002
In-Field Testing Method

Test machines: LHT #1, #2, and LHT #3

August 14-15, 2020

Introduction

On August 14, 15, and 16th, testing was done to determine the air quality within three Large Haul Trucks (LHTs) which travel over gravel roads carrying heavy loads.

The test evaluated the dust concentration levels, CO_2 concentrations and cab pressurization while in real-time, real-world operations.

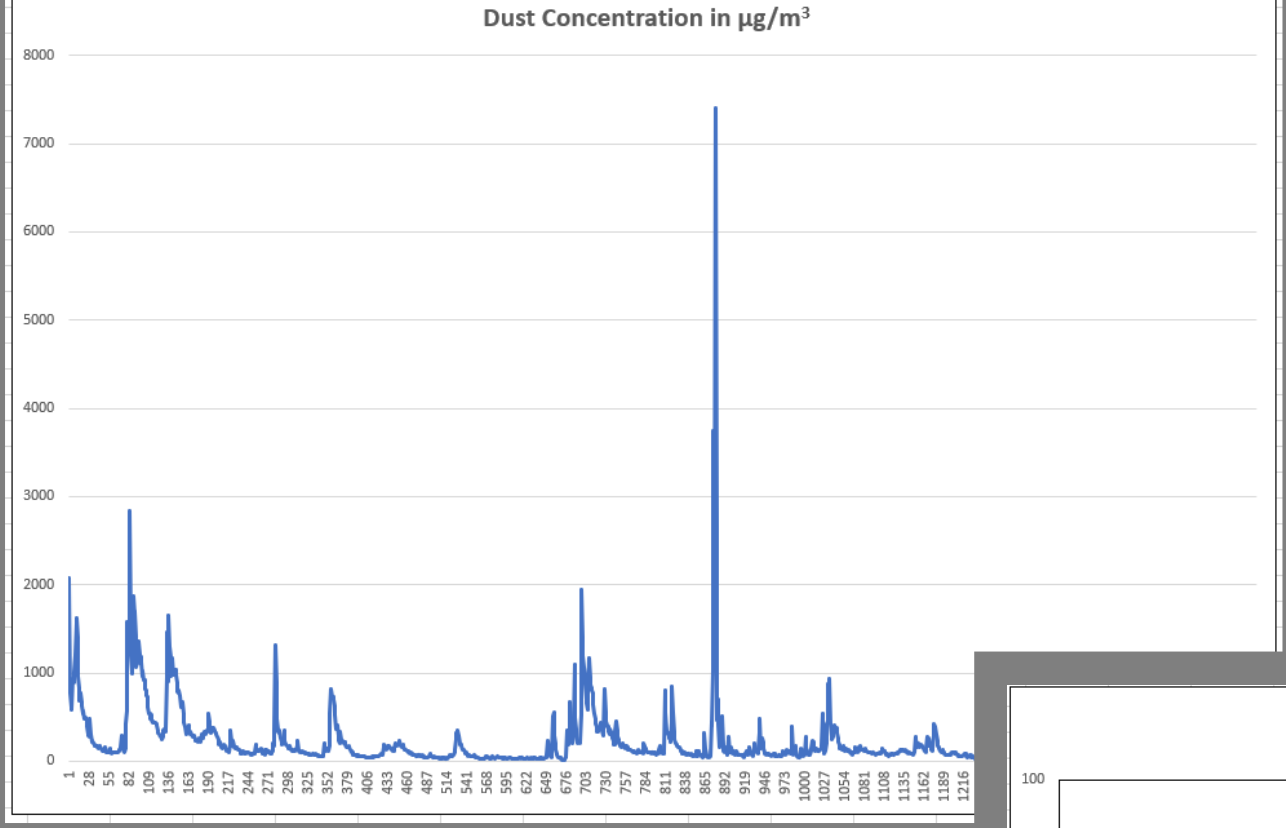
Test were performed using the International Society of Environmental Enclosure Engineers (ISEEE) test belt and in-field test method. The results of the test are evaluated as a part of this study.

Recommendations given are based upon the best practice approach to operator enclosure engineering requirements as described in the ISEEE Advanced Cab Theory Workbook.

LHT-#2 modified with

- RESPA®-CF2 Fresh Air Intake
- RESPA®-CFX2 Powered recirculation filtration
- Sy-Klone® Pressure Monitor

LHT-#2 Nunavut Canada



LHT #1 – Factory system

Test time: 15:40:35 to 17:54:55

Total time 2:14:20

Average dust concentration 212.64 µg/m³

Max 7397 µg/m³

Min 13.08 µg/m³

Long Haul Truck #2 – With RESPA®CF2/CFX2/Pressure Monitor

Time of test 8/15/2020 12:55:10 to 14:49:40

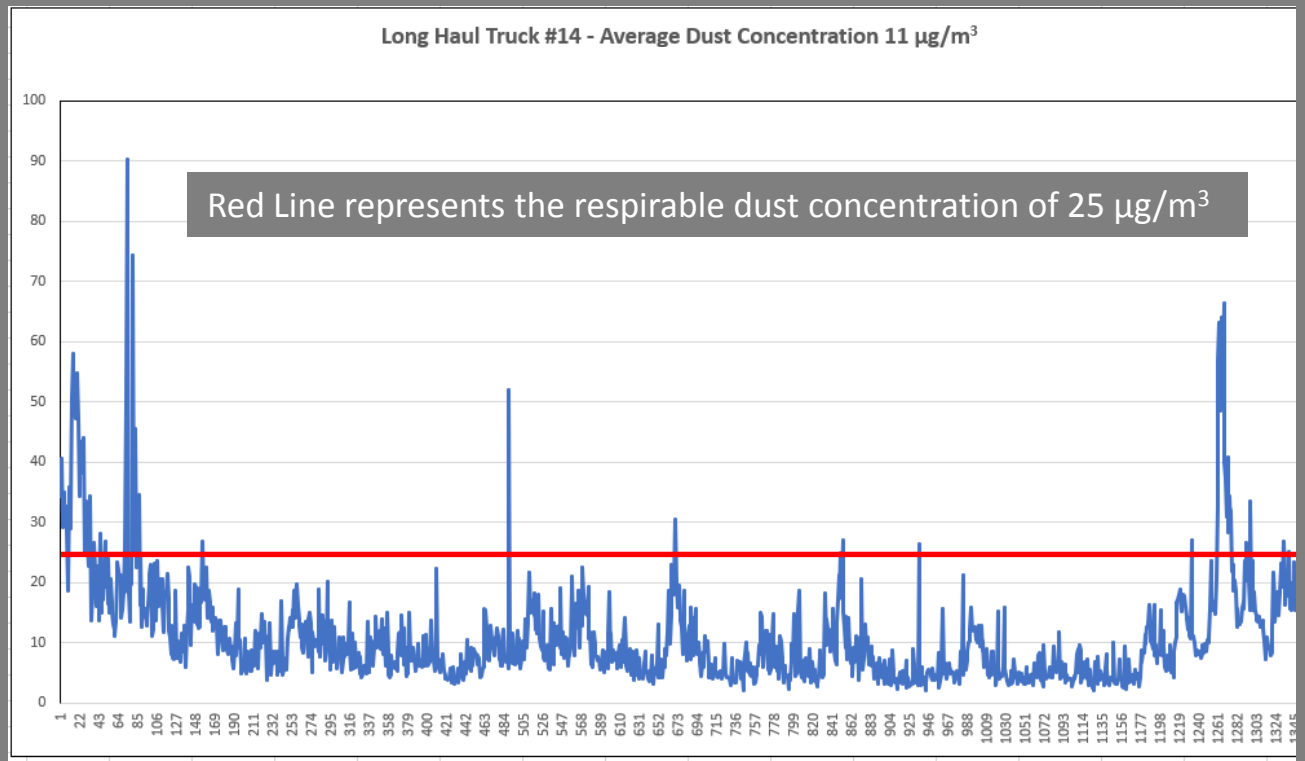
Total Time: 1:55:30

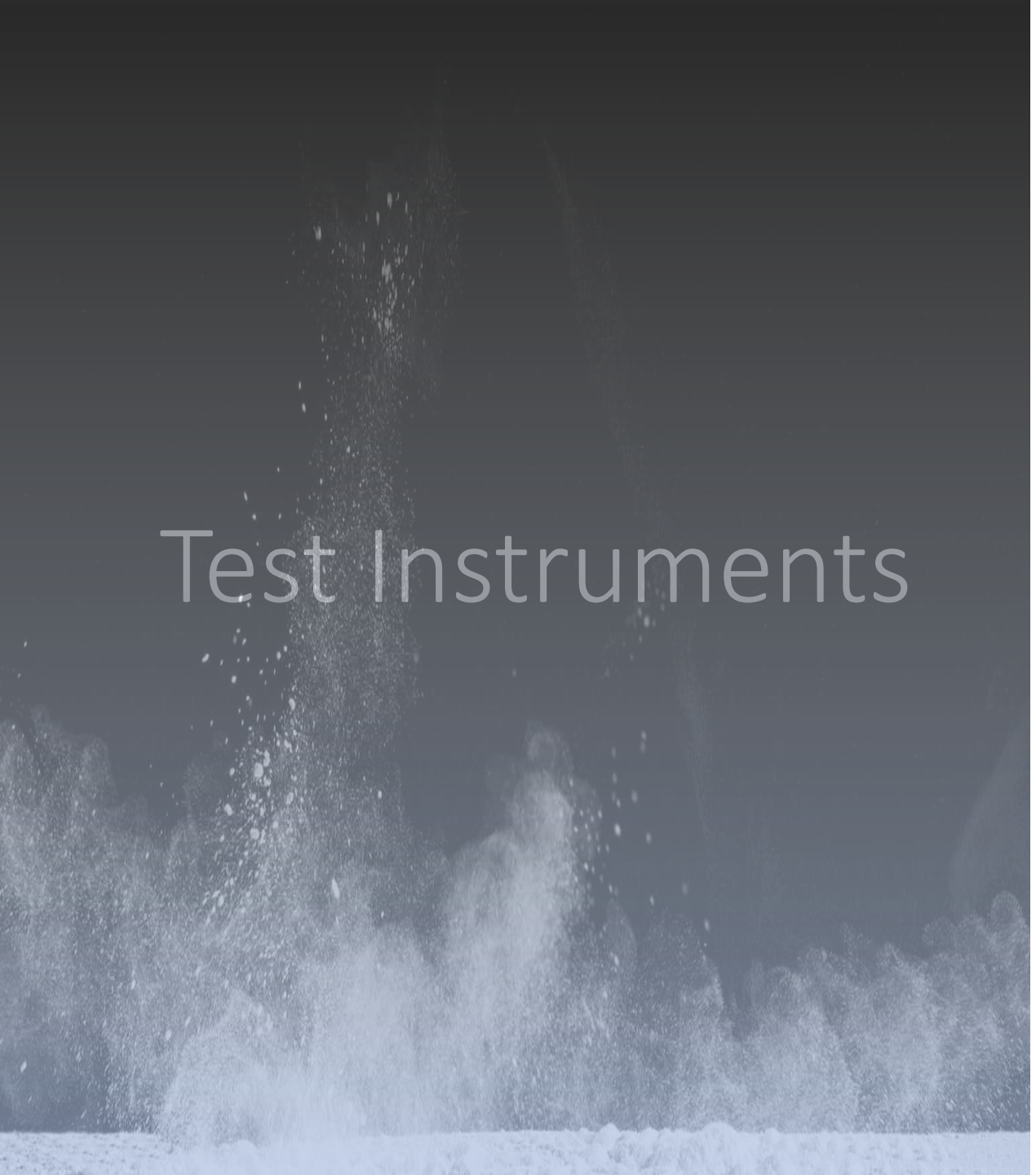
Data point taken in 5 second intervals

Average dust concentration 11 µg/m3

Max 90.19 µg/m3

Min 2.07 µg/m3

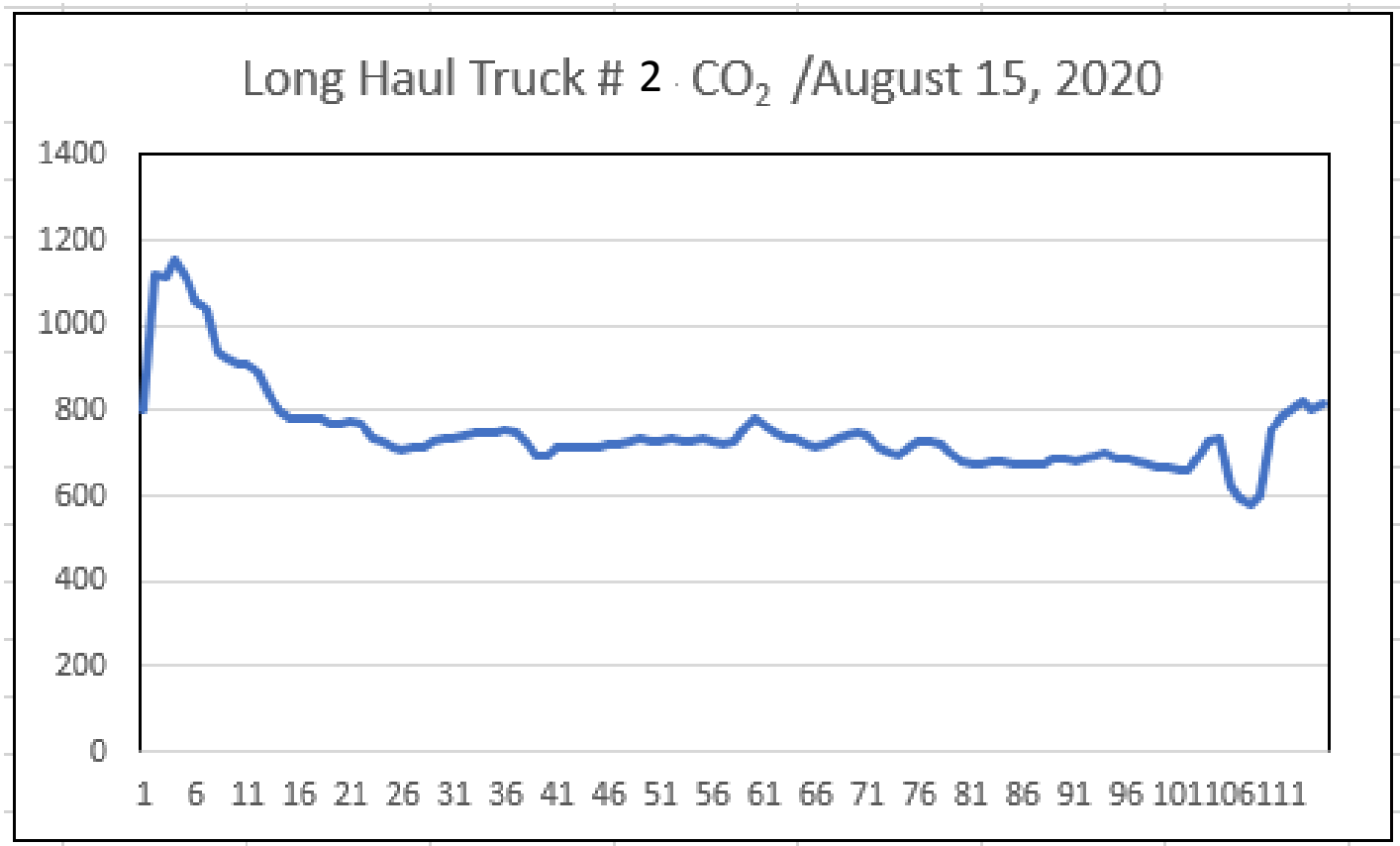




Test Instruments

- Hobo Energy Logger s/n 10466906
- Sy-Klone Pressure Monitor
- TelAire NDIR CO2 monitor s/n 1091701
- Thermo Fisher Scientific Personal Data Ram (pDR)1500 s/n CM1511008

Long Haul Truck #2 Data and Analysis

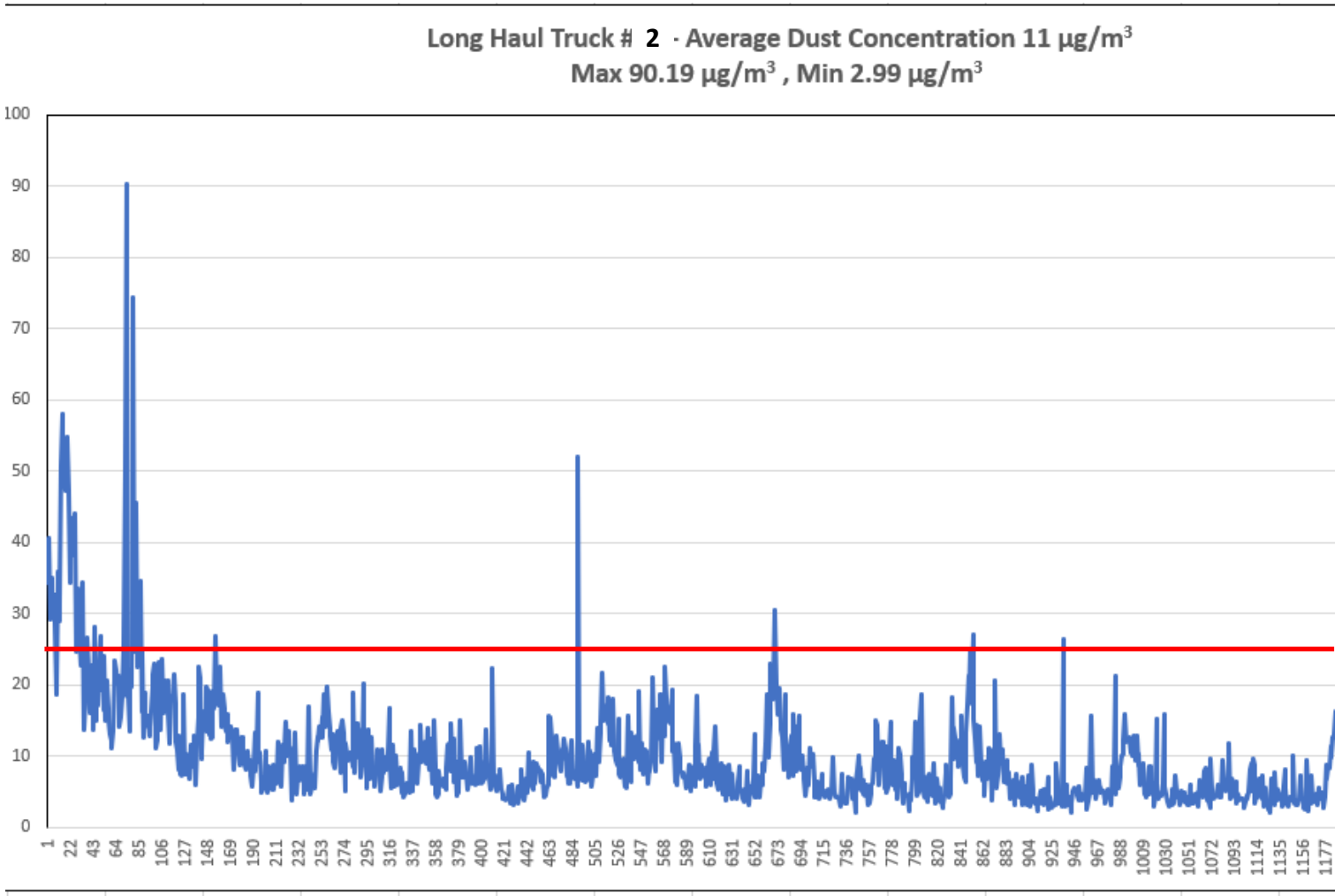


Long Haul Truck #2

Time of test 8/15/2020
12:55 to 14:47

Data point taken in
one-minute intervals

Average CO2 conc.
750 PPM



Long Haul Truck #2

Time of test 8/15/2020
12:55:10 to 14:49:40

Total Time: 1:55:30

Data point taken in 5 second intervals

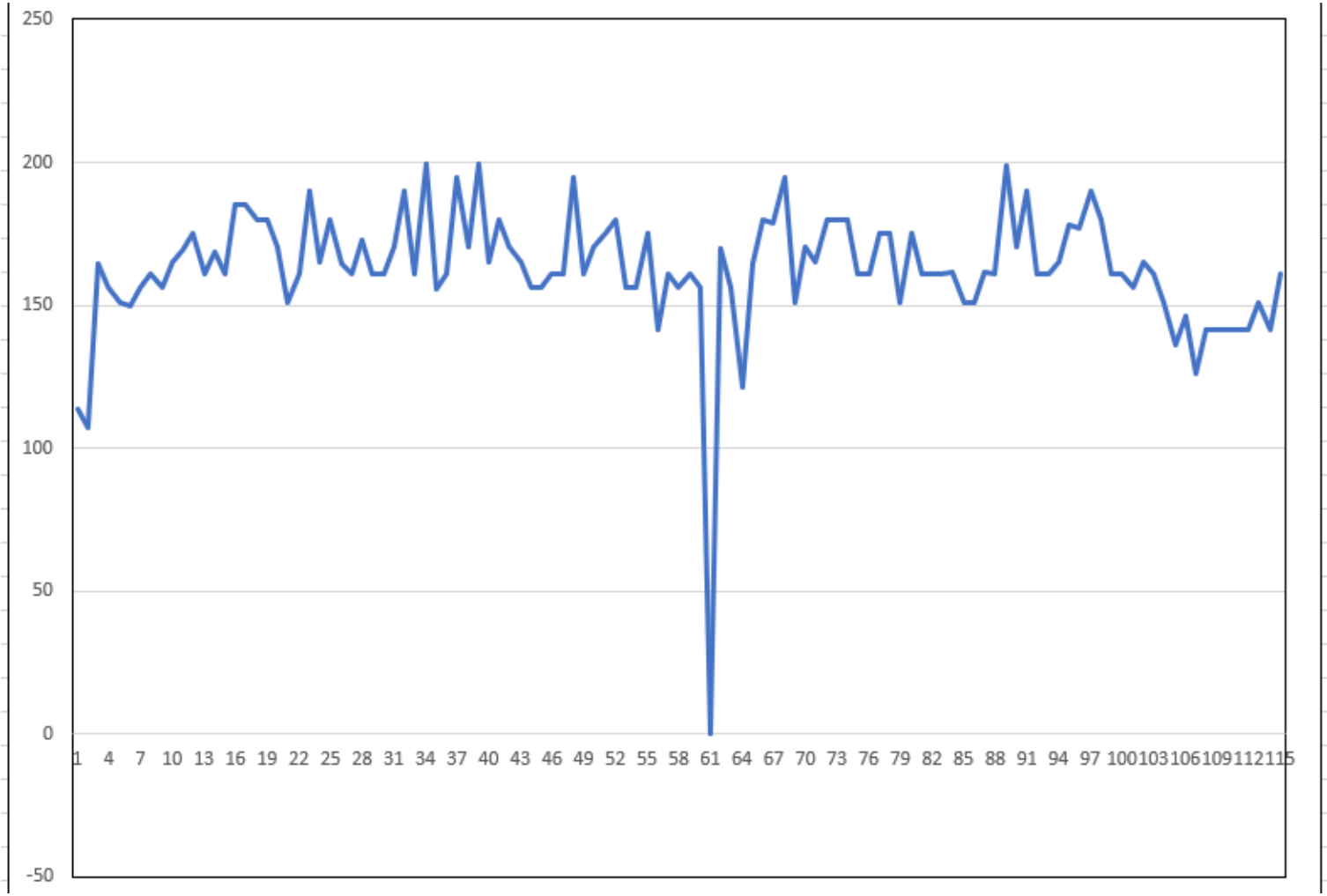
Average dust concentration
11 µg/m^3

Max 90.19 µg/m^3

Min 2.07 µg/m^3

Average Decay Time
From Peak to ≥ 25 µg/m^3
<1 minute

Red Line represents the OEL of 25 µg/m^3



Long Haul Truck #2

Time of test 8/15/2020
12:55:10 to 14:49:40

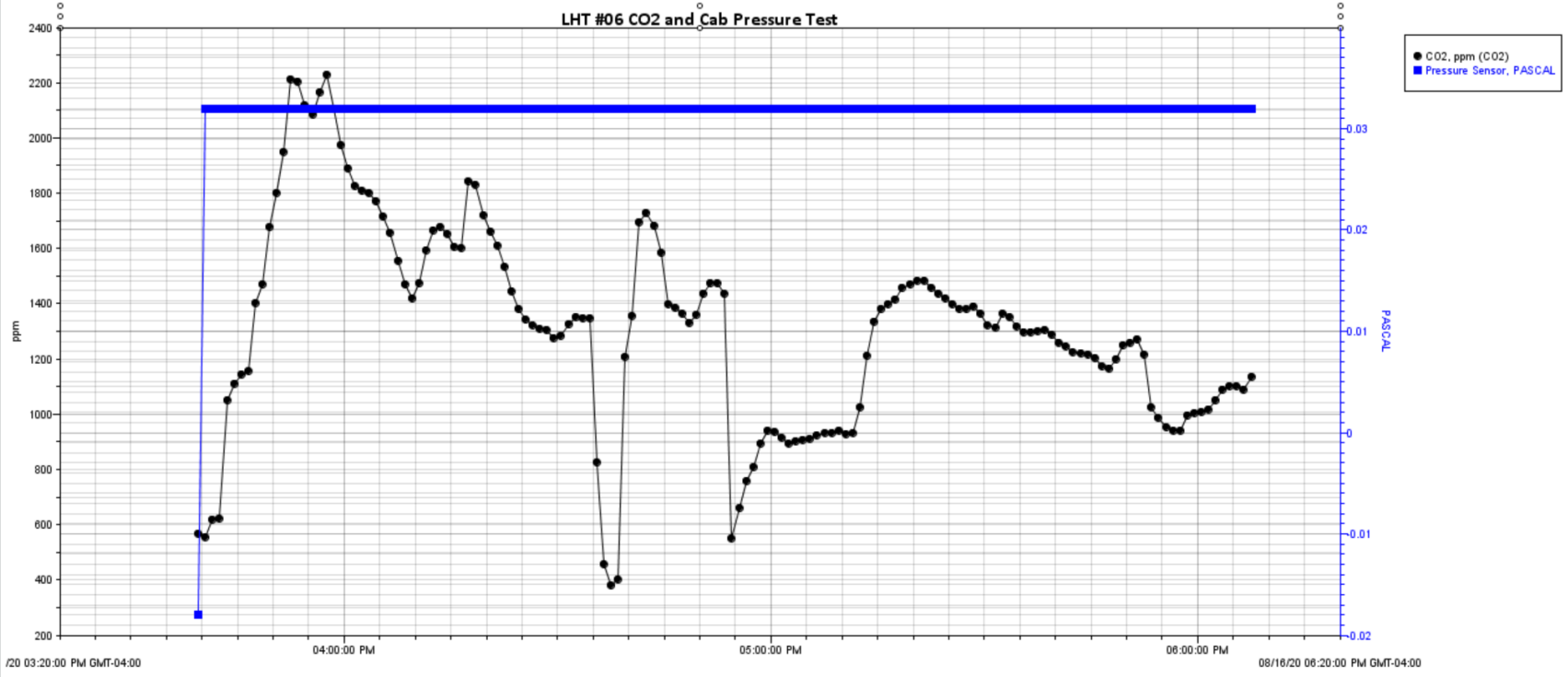
Data point taken in 1 minute intervals

Average Cab Pressure
162 Pascal

Analysis

- The dust conditions on Saturday, when LHT #2 was tested, were moderate to light. Dust concentrations levels were kept well below the OEL of 25 $\mu g/m^3$.
- While the design of the vehicle causes dust to flow from under the hood into the area of the fresh air intake, LHT #2 did not experience a rise in interior dust conditions. With an average of 11 $\mu g/m^3$ the cab stayed free from perceptible dust.
- The cab was equipped with a recirculation filtration system which demonstrated to b highly effective in removing particles from the air that came in when the doors were opened. The noise associated with the powered recirculation unit were also well below the range which would be irritating to the driver. The noise in the truck from the road and HVAC blower exceeded the noise that was coming from the recirc unit.
- CO_2 levels averaged 750 PPM, a relatively low level for a two-operator cab. This demonstrates the effectiveness of the fresh air intake system to accomplish both consistent cab pressure and provide a fresh air exchange.
- Summary: the cab air quality performance complies with ISO 23875 requirements for CO2, dust concentrations and cab pressurization.

Long Haul Truck #1
Data and Analysis



LHT #1 CO_2 Concentration

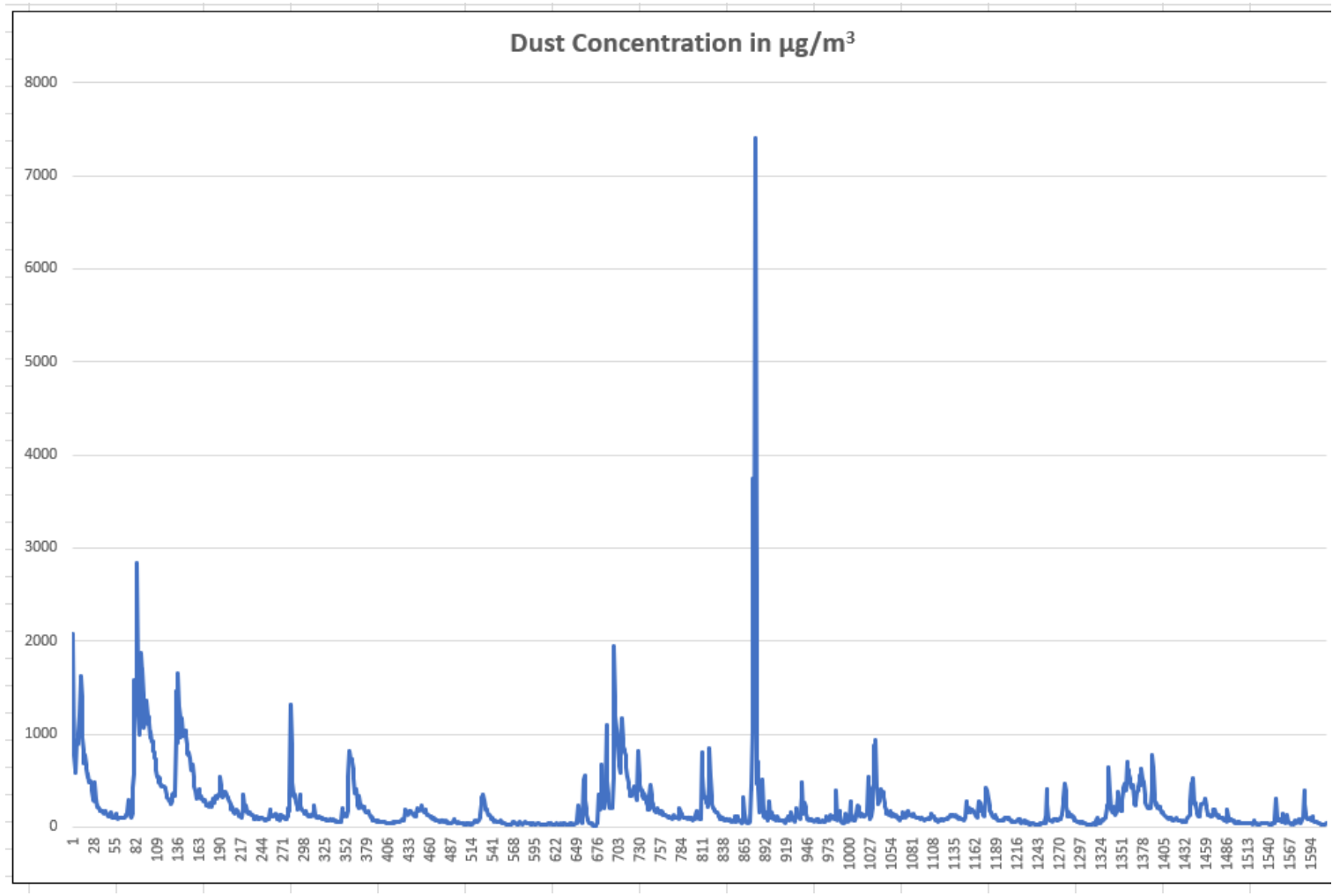
Data point taken in 1-minute intervals

Average 1303 PPM

Max 2229 PPM

Ambient 564 PPM

Blue line represents cab pressure Cab pressure which was showing .03 Pa. The reading was effectively zero because it is below the device's ability to read pressure



LHT #1 dust concentration data

Test time: 15:40:35 to 17:54:55

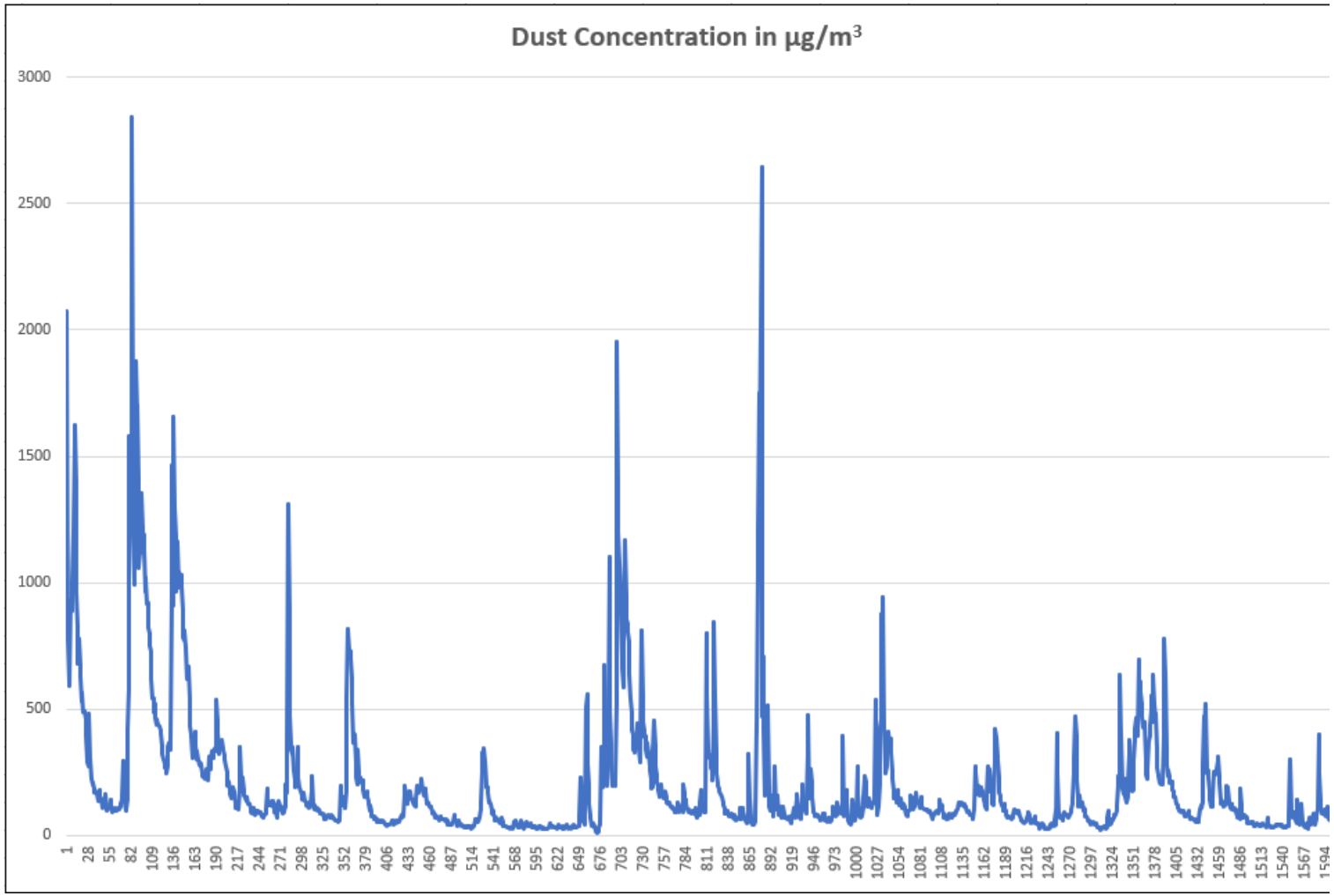
Total time 2:14:20

Average dust concentration 212.64 µg/m^3

Max 7397 µg/m^3

Min 13.08 µg/m^3

Average Decay Time
From Peak to ≥ 25 µg/m^3
Not Achieved



Two data points that skewed the data were modified to allow the graph to rescale and make it more readable

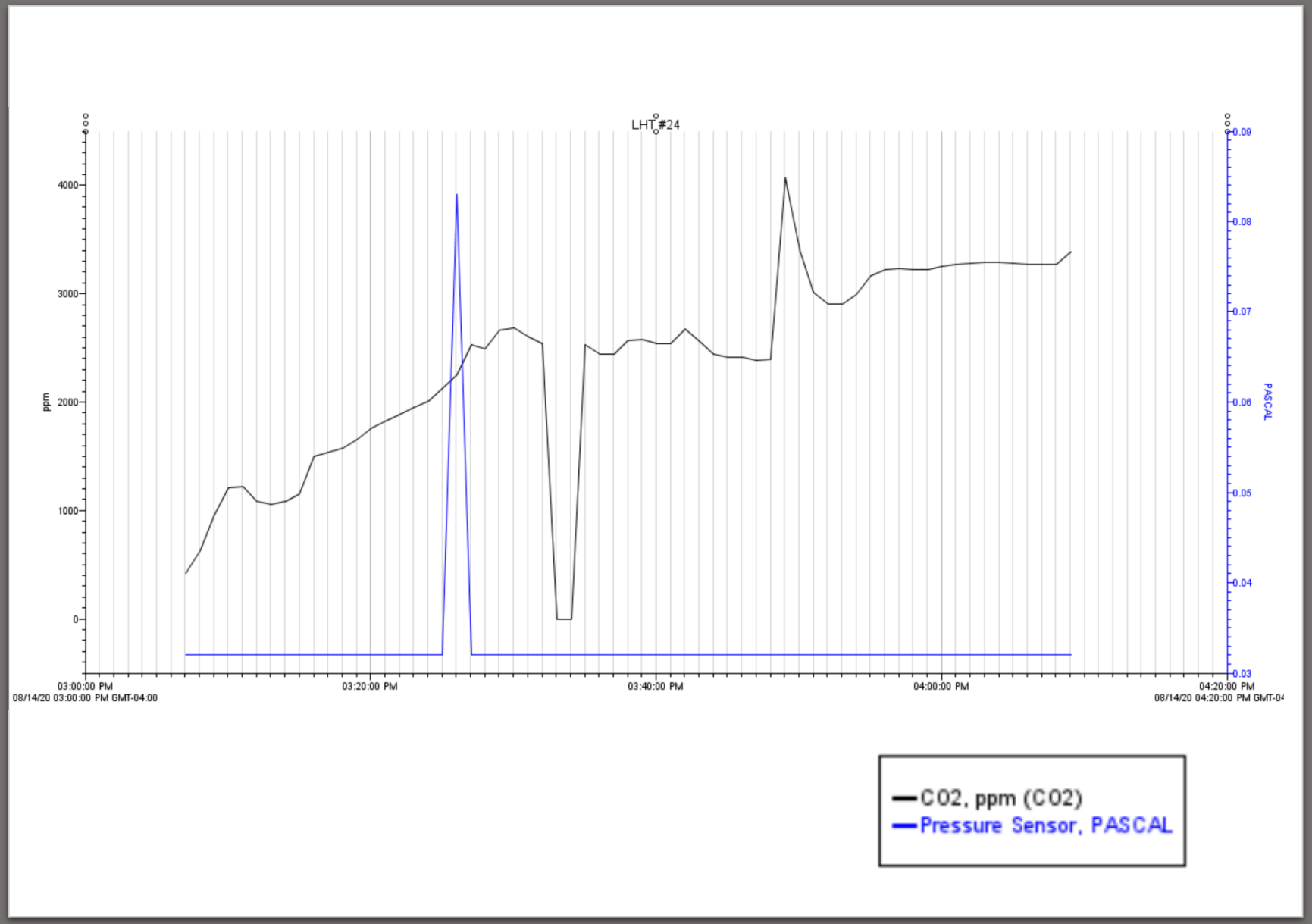
Data point 876 which was 3738.88 was replaced with the value of 1200

Data point 879 which was 7397 and replaced it with a data value of 2000

Analysis

- The dust conditions on Friday, when LHT #1 was tested, were moderate to light. However, even with light dust conditions the dust levels in the cab were 212.64 µg/m^3 , significantly above the OEL for silica.
- When the truck went up-hill and the engine cooling fans started dust was blown from under the hood into the fresh air intake and interior dust conditions climbed as can been seen on the dust graph.
- Without a recirculation filter or a meaningful intake filter the air quality control system had no way to address any type of particulate. High dust concentrations in the cab ten times the OEL for silica, are primary contributors to premature HVAC failure and operator lung disease.
- Average CO_2 levels of 1303 PPM were above the ISO 23875 recommended CO_2 levels. On relatively low dust days the operator will open the fresh air intake to allow more fresh air into the cab. However, when ambient dust conditions are high, the fresh air intake will be opened as needed to overcome condensation on the windows. The CO_2 levels will need to be measured on high dust days to determine the extent of the CO2 build up in the enclosure. High CO_2 levels contribute to operator drowsiness, headaches and CO_2 poisoning.

Long Haul Truck #3 Data and Analysis



LHT #3
CO_2 Concentration

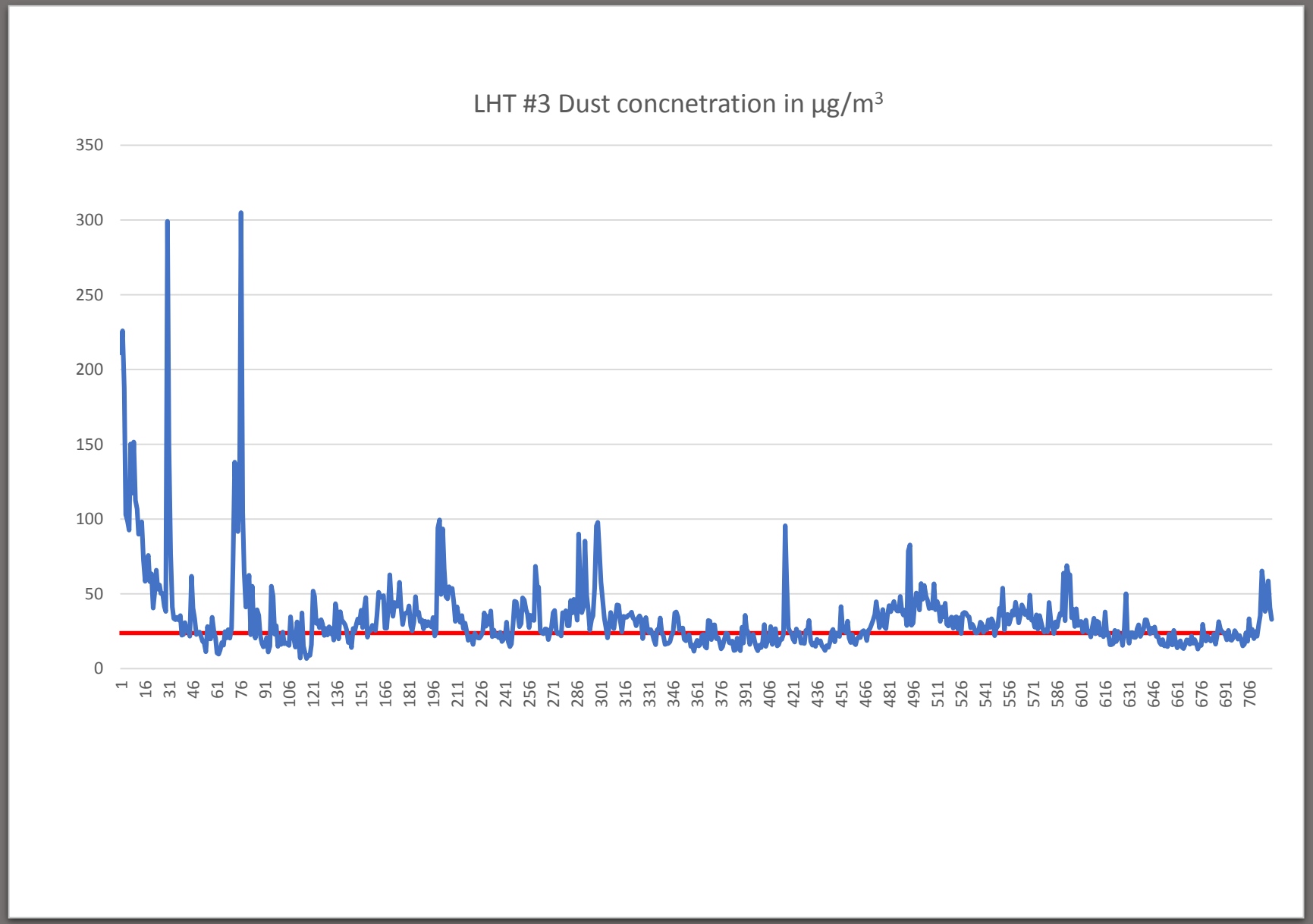
Data point taken in 1-minute intervals

Average 2342 PPM

Max 4075 PPM

Ambient 423 PPM

Blue line represents cab pressure Cab pressure which was showing 0.03 Pa. The reading was effectively zero because it is below the device's ability to read pressure



Long Haul Truck #3

Time of test 8/15/2020
12:55:10 to 14:49:40

Total Time: 1:55:30

Data point taken in 5 second intervals

Average dust concentration
33.84 µg/m^3

Max 305.07 µg/m^3

Min 6.69 µg/m^3

Average Decay Time
From Peak to ≥ 25 µg/m^3
Unable to determine as decay rate is not effected by cab filtration

Red Line represents the OEL of 25 µg/m^3

Analysis

- The dust conditions on Friday, when LHT #3 was tested, were light. However, even with light dust conditions the dust levels in the cab were above the OEL for silica.
- When the truck went up-hill and the engine cooling fans started dust was blown from under the hood into the fresh air intake and interior dust conditions climbed as can been seen on the dust graph.
- Without a recirculation filter or a meaningful intake filter the decay rate cannot be determined. On high dust days particulate counts would not decay below 25 $\mu g/m^3$. To see the full impact of no filtration the test should be repeated on a high ambient dust day.
- CO_2 levels were consistently above 2000 PPM indicating insufficient fresh air exchange. With CO_2 levels getting into the 4000 PPM range, consideration should be given to lowering CO_2 levels below the action level of 2500 PPM. ISO 23875 recommends that CO_2 levels be kept below ambient level plus 400 PPM. In this case ambient was at 423 PPM. CO_2 should have remained below 823 PPM during this test.

Conclusion

- To protect the LHT HVAC system from premature failure, and unnecessary prolonged operator dust exposures it is recommended to install an air quality system on each LHT
- LHT’s should be retrofitted to comply with ISO 23875 for which a certificate of compliance with the standard should be received.
- ISO 23875 is a life-cycle standard that addresses the retrofit requirements, maintenance instructions and ongoing performance testing of the enclosure to ensure the continuous air quality in the enclosure meets the OEL of the jurisdiction in which the machine is operated.

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