

**Altitude Control Technology
Control System Witness Report
TERPconsulting Project #19.1590**

TERPconsulting has prepared the following letter at the request of the Telluride Fire Prevention Bureau. This letter documents that TERPconsulting witnessed that the Altitude Control Technology (ACT) Control System functioned as it is designed.

OPERATION TEST DESCRIPTION

The test was completed in Denver, CO at 5,377 ft above sea level on 8 August 2019. The ACT Controller was placed in a contained compartment to simulate a closed room in which the system would be installed. The controller communicates with an oxygen generator connected via a CAT 5 cable. Discharge tubing from the generator was run back into the compartment to simulate the oxygen ports that would be installed in an active system. The controller was located approximately 18" from the discharge tubing.

Calibration

The controller was calibrated at the start of the operational test to ensure proper readings. The control unit compared readings from two separate oxygen sensors labeled O²-1 and O²-2 on the user interface respectively. The oxygen sensors read the percent oxygen within the compartment. The system was considered calibrated once the two sensors read the same value of 20.94% oxygen, which is the amount of oxygen found in the unaltered atmosphere.

Pressure Reading

The system contains a pressure sensor and displays current atmospheric pressure on the end-user interface. The pressure displayed by the system during the test was verified against the National Oceanic and Atmospheric Administration (NOAA) values reported at the same time for the area and elevation at which the test was conducted. The values read by the system were within an acceptable range compared to the NOAA reported values. The system showed 836.2 mb in atmospheric pressure which converts to 0.8253 atm.

Oxygen Concentration

The test showed the test apparatus was oxygenated to an effective altitude of 815 ft. This value was determined automatically by the controller, based on the current pressure readings as being the lowest possible effective altitude the system could create without getting within 1% of creating an oxygen enriched atmosphere as defined by NFPA 99B. During the test, the user was able to select a lower elevation than this, but the system automatically re-set to the lowest safe effective altitude.

AS defined by NFPA 99B Section 3.3.3.3, an atmosphere containing a percent oxygen greater than the quotient of 23.45 divided by the square root of the total pressure in atmospheres is considered an *atmosphere of increased burning rate*. This is shown by Equation 1 below:

$$\text{Equation 1: } \frac{23.45\% O^2}{\sqrt{.8253 \text{ atm}}} = 25.8\% O^2$$

As shown by Equation 1, the maximum oxygen content allowed by NFPA 99B is 25.8% O². The system was demonstrated to bring the compartment to a percent oxygen no greater than 24.75% O² during the test to provide a 1% safety factor from the NFPA allowed value. The oxygen generator automatically shut down once this value was reached. As the oxygen content began to drop due to expected leakage which would normally be present, the generator was cycled on and off to maintain an average oxygen concentration of 24.64% O² while never exceeding 24.75% O².

Automatic Shut Down

The controller communicates with the oxygen generator via a CAT 5 cable directly connected to the controller and the generator. The generator is programmed to automatically shut down on any communication failure between the controller and generator. This was demonstrated during the test by physically disconnecting the CAT 5 cable from the generator while it was running. Upon disconnection of the CAT 5 cable TERP consulting personnel witnessed the generator stop running.

CONCLUSION

The equipment provided as part of the bench test functioned as designed during the witnessed test. The pressure sensor provided an accurate pressure reading in millibars when compared to actual atmospheric conditions, and this real-time reading was used to limit the degree of permitted oxygenation. The system was demonstrated to bring the test compartment to this maximum concentration while not exceeding the values set forth by NFPA for an atmosphere of increased burning rate. As a result of this test, TERP consulting verifies that the equipment witnessed was calibrated and performed as intended.

If you have any questions regarding the information included in the report above, please do not hesitate to contact our office.

TERP consulting

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