

## Most Common Reason for Failing CGA Grade E Specs

Excess carbon dioxide (CO<sub>2</sub>) is the most common reason found by Trace Analytics' laboratory for dive retailers to fail the Compressed Gas Association (CGA) Grade E air quality specification. The ANSI/CGA G-7.1 Grade E standard which is recommended for sport diving up to 130 feet limits carbon dioxide to 500 parts per million (ppm). (Author's Note: Std revised in '97, released in 1Q98, CO<sub>2</sub> limits now 1000 ppm.)

A large majority of Trace's diving customers routinely pass this air standard. Most of those that do not, share some common factors, e.g., the compressor is located in a small room without good ventilation, the air intake is located inside the building, in some cases the purification system is inadequate, and filter cartridges are either due to be changed out in a few hours or past due. The following addresses why these situations can cause failure and corrective actions that can be taken.

### Compressor & intake location crucial

The location of a compressor and its air intake are crucial to the quality of the air produced and the performance of the compressor. The compressor should be located in a well ventilated area that is free from contaminants such as harmful fumes, engine exhaust, and solvents (found in paints, cleaning supplies, and many other commonly used products). Locations which also include water heaters, boilers, or any combustion type equipment should be avoided due to high temperatures and potential contamination from exhausts. The life of a filter cartridge is affected by high temperatures. If your compressor is running too hot, which can occur if the compressor is located in a small room with little or no ventilation, it will shorten the life of your filter.

It is important to provide fresh, uncontaminated air to the compressor's intake. Gross contamination of the intake air will affect the efficiency of the purification filters which could subsequently affect the air quality produced by the compressor. When dealing with a 500 ppm limit for CO<sub>2</sub>, assuring that the intake air quality is acceptable is especially important. As a point of interest, outside fresh air in most areas around the country is about 330 ppm. This is air unpolluted by vehicle exhaust or other outside factors.

### When an inside air intake is unacceptable

CO<sub>2</sub> is a by-product of motor exhaust and human respiration. Purification filters containing catalysts can also cause a slight elevation in CO<sub>2</sub> because they are designed to convert CO to CO<sub>2</sub>. This is actually beneficial since carbon monoxide (CO) even at low levels is more harmful than CO<sub>2</sub>. Any time a number of people are inside closed quarters, levels can easily reach 600 ppm or more. HVAC systems in offices or retail stores usually do not bring enough fresh air from the outside to significantly reduce the level of CO<sub>2</sub> that can build up. When facing CO<sub>2</sub> levels that are slightly over the 500 ppm limit, opening windows/doors, using fans, and raising the intake location to ceiling height may help. This must be done each time the

compressor is used to charge a cylinder. However, if levels are consistently higher than 600 ppm, the most common solution is moving the intake location outside.

### Determining if an outside location is the best solution

Prior to moving the intake, take a survey of the neighborhood at different times of the day, for several days. Keep in mind that outside air can be contaminated by exhausts from such common sources as dry cleaners, beauty salons, paint/body shops, heavy industry, and of course vehicle/motor exhaust. These conditions can cause the outside air to be an inappropriate source for your compressor intake. If unsure, air samples can be taken and submitted for laboratory analysis. If you have an outside intake, you should always be alert to outside conditions that might affect your air quality throughout the year.

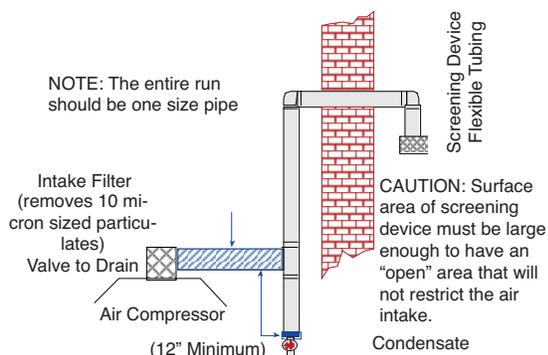
### Determining intake pipe size

Generally speaking, the intake pipe can be sized in accordance with the following guidelines:

- ✓ For every 10 feet, double the size of the pipe, e.g. if inlet on compressor is
  - 1"; then pipe should be no more than 10 feet,
  - 2"; then pipe should be no more than 20 feet,
  - 4"; then pipe should be no more than 30 feet,
- ✓ If more than 4 elbows are used, every 2 90° elbows should be treated as 10 feet of pipe,
  - The entire run should be one size pipe,
  - Install a moisture trap with a drain valve prior to the compressor inlet (see drawing). This should be checked periodically and included in routine maintenance checks.

It is best to keep the piping as short and straight as possible. Minimum height should be 8-10 feet, but we've found that above roof line almost always works. Do not place downwind of heating or air conditioning vents. 90° elbows and the total distance of intake piping should be kept to a minimum to prevent any restriction of the air flow.

### Outside Intake Location Guidelines



The end of the intake piping should point downward to avoid excess water from entering the compressor intake. It should be covered with a fine mesh screen to eliminate blockage by dirt, leaves, bird nests. Caution should be taken to assure the surface area is large enough so that it will not restrict the air intake.

Intake piping should be made of a type of material like PVC, that will not contribute to contamination by corrosion or chemical interaction. If using glue, allow sufficient time for glue vapors to dissipate before using. (If PVC cement used, allow 4 weeks to off-gas, if silicone rubber sealant used, use only on outside of piping and allow 2 days to off-gas.) Connection of piping to the compressor can be accomplished with a short piece of flexible tubing. Do not use rubber or collapsible tubing. Corrugated vacuum cleaner hose or pool vacuum hose works well. The compressor's intake filter should not be removed but left in service.

## Why purification filters do not remove excess CO<sub>2</sub>

What needs to be understood about the purification process of high pressure compressed breathing air is that the technology available today cannot produce inexpensive filters to efficiently and consistently remove carbon dioxide for the entire life of the cartridge. During the first few hours of operation of a new filter cartridge that contains molecular sieve, CO<sub>2</sub> levels can be reduced. This is due to the absorption of CO<sub>2</sub> by the molecular sieve. The filter will then perform as designed which means that moisture will be preferentially removed from the air stream. CO<sub>2</sub> displaced by the water will then be released from the molecular sieve and cause an increase in the CO<sub>2</sub> level above the ambient concentration.

Filter life is determined by the moisture content of the air being delivered to the filter cartridge. Water content is a function of how effective the compressor separators remove liquid water entrained in the air stream and the air temperature. Assuming the separators are 100% efficient, the amount of water in vapor form that reaches the desiccant (molecular sieve) per unit mass of gas compressed is a function of temperature, e.g. the higher the temperature the more water vapor. Most high pressure breathing air compressors on the market now can function in an environment as high as 100°F. If an environmental temperature this high can be avoided by good room ventilation, etc. it will ultimately translate into cooler air temperatures entering the filter system and longer filter life. Filter life (in terms of processed air volume) can be directly correlated with the amount of water vapor that must be removed from a saturated air stream to the CGA Grade E limit.

For example: If a compressor is located in a closet-like room, without access to outside, fresh air; temperatures (even if air conditioned) can rise to 100°F at the separator inlet. This can drastically reduce the actual number of hours the filter

can be used. It is feasible that a filter rated for 40 hours, could only safely be used for 20 hours under the above noted conditions. For further information, write down your compressor's make, model, scfm, and psi, filter brand and stock number, and typical ambient temperatures or if possible separator inlet temperatures. Then, contact your compressor manufacturer to discuss your specific situation.

## Pressure drops, rotating filters, can be source of problem

As mentioned earlier, filters are designed to remove carbon monoxide by converting it to CO<sub>2</sub>. The filter will then hold the CO<sub>2</sub> along with other removed impurities. If a sudden pressure drop should occur, like when the bleed valve to the purification chamber is opened too quickly or a sudden failure of the pressure maintaining valve occurs, then CO<sub>2</sub> and other contaminants can be released into the air stream. Another scenario that can cause high CO<sub>2</sub> levels is when a purification filter is not removed but moved up the chain of cartridges to a front position or when it has reached its maximum efficiency. Some filters have a moisture indicator strip on the outside of the cartridge. Even though the strip may not indicate that it is time to be removed, it should not be assumed that the filter is "good as new." A filter is like a sponge, it can hold on to unknown quantities of CO<sub>2</sub> or gaseous hydrocarbons. When it becomes completely saturated, like a sponge, it will not continue to remove but allow contaminants to simply pass through. If a pressure drop occurs at this point, large amounts of CO<sub>2</sub> and/or gaseous hydrocarbons can be released.

## General Guidelines

To provide the best conditions for a safe air supply that complies with CGA Grade E specifications, follow these guidelines:

- ✓ Locate compressor in a clean, well ventilated area
- ✓ Intake location is crucial – determine what is best for your situation
- ✓ Operate and maintain compressor according to manufacturer's guidelines
- ✓ Allow only trained, conscientious personnel to operate and maintain the compressor
- ✓ Use filters recommended for your compressor, determine how long they are supposed to last based on the rated volume per filter cartridge, your compressor's capacity (CFM), separator inlet temperature, and any correction factors due to separator inlet temperatures above or below 70°F.
- ✓ Maintain a log of all work performed on the compressor, including running hours, inlet temperatures, and filter changes.
- ✓ Use a reputable, accredited laboratory for analysis of air samples on a quarterly basis as a part of your safety program. Additional tests should be taken if the compressor is moved or major work is performed.

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