

SAFETY BULLETIN

OXYGEN-DEFICIENT ATMOSPHERES

An oxygen-deficient atmosphere is defined as a condition where human health and safety can be affected by inhalation of air containing less than the normal oxygen content of air. The Occupational Safety and Health Administration (OSHA) defines an oxygen-deficient atmosphere as less than 19.5 volume % oxygen [1]. The nominal oxygen content of air is 20.9%. Reduced oxygen content in the air, either by combustion or displacement with other gas(es), is a potential hazard to personnel. Poorly ventilated areas, confined spaces, areas immediately outside confined spaces, enclosures, and low grade areas can contain oxygen-deficient atmospheres. Work done in confined spaces shall follow specific regulatory requirements.

An oxygen-deficient atmosphere can bring about unconsciousness without warning. In as little as one or two breaths, an individual's life can be endangered by low oxygen intake. Oxygen-deficient atmospheres might not be limited to only confined spaces. They also can exist outside of a confined space opening. Table 1 describes a quantitative evaluation of the health effects and symptoms that can be expected in humans who inhale air containing less than normal levels of oxygen.

Table 1—Effects at various oxygen breathing levels

Oxygen percent at sea level (atmospheric pressure = 760 mmHg)	Effects
20.9	Normal (below 19.5% is considered oxygen deficient)
19.5 – 10	Increased breathing rates; accelerated heartbeat; and impaired attention, thinking, and coordination.
10 – 6	Nausea, vomiting, lethargic movements, and perhaps unconsciousness.
<6	Convulsions, then cessation of breathing, followed by cardiac standstill (death). These symptoms can occur immediately.
NOTES - Adapted from Title 29 of the U.S. <i>Code of Federal Regulations</i> Parts 1910 and 1926. - These indications are for a healthy average person at rest. Factors such as individual health (such as being a smoker), degree of physical exertion, and high altitudes can affect these symptoms and the oxygen levels at which they occur. - A hazardous atmosphere oxygen concentration range as defined by OSHA is outside the range of 19.5% and 23.5% [1]. - While the percentage of oxygen does not change with altitude, the partial pressure of the atmosphere decreases, which creates physiological effects similar to oxygen deficiency. These effects increase at higher altitudes. Working at altitudes above 8000 ft can have similar effects to working in a 15% oxygen atmosphere and working at altitudes of 14 000 ft can have effects similar to a 12% oxygen atmosphere. Special precautions, such as supplemental oxygen and acclimatization, shall be taken when working at altitudes to protect the employees against the effects of altitude sickness and other physiological effects similar to those experienced with decreasing oxygen concentrations. Consult knowledgeable medical and safety professionals regarding the specific precautions to take when working at high altitudes.	

WARNING: Exposure to atmospheres containing less than 10% oxygen can rapidly overcome an individual and bring about unconsciousness without warning so the individual cannot help or protect himself/herself. Lack of sufficient oxygen can cause serious injury or death.

Workers suddenly involved in emergency activities must not allow emotions to override safe work procedures and training. Only qualified and trained personnel equipped with the necessary safety equipment should attempt a rescue in accordance with safe rescue procedures.

If the potential exists for an area to be oxygen deficient, then the atmosphere shall be tested before any person is exposed to the area. A risk assessment shall be performed to evaluate the need for periodic or continuous monitoring of the area. If an oxygen-deficient atmosphere exists and persons are to enter the area, at a minimum the following precautions shall be taken:

- Workers and rescue personnel shall never enter a suspected oxygen-deficient atmosphere without proper protective breathing apparatus and attendant support;
- Continue to monitor the atmosphere during the work process;
- Train workers on what to expect and how to handle oxygen-deficient atmospheres;
- Isolate any source carrying products that can displace the oxygen in the atmosphere such as gases or cryogenic liquids;
- When it is necessary to work in any oxygen-deficient atmosphere, provide a self-contained breathing apparatus or breathing airline mask for all workers;
- Process equipment and storage vessels could be located within an area that in the event of the release of the product can result in an oxygen-deficient atmosphere. Precautions shall be taken to provide warning (for example, monitoring systems, signs, and/or barriers) to persons entering the area that the potential for an oxygen-deficient atmosphere exists; and
- Follow the relevant authority (for example, OSHA, state-OSHA, local, NFPA, etc.) requirements regarding working or having people in an oxygen-deficient atmosphere.

Other hazards exist with oxygen-enriched atmospheres (greater than 23.5% oxygen). When presented with an oxygen-enriched atmosphere, review CGA P-39, *Oxygen-Rich Atmospheres*, and CGA P-45, *Fire Hazards of Oxygen and Oxygen-Enriched Atmospheres*, for more information [2, 3].

References

Unless otherwise specified, the latest edition shall apply.

[1] *Code of Federal Regulations*, Title 29 (Labor) Parts 1910.146 and 1926, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401. www.gpo.gov

[2] CGA P-39, *Oxygen-Rich Atmospheres*, Compressed Gas Association, Inc., 14501 George Carter Way, Suite 103, Chantilly, VA 20151. www.cganet.com

[3] CGA P-45, *Fire Hazards of Oxygen and Oxygen-Enriched Atmospheres*, Compressed Gas Association, Inc., 14501 George Carter Way, Suite 103, Chantilly, VA 20151. www.cganet.com