

# Dangers of Oxygen-Deficient Atmospheres

## 空气缺氧的危险

### General

#### 概述

Workers have lost their lives or been overcome by high concentrations of nontoxic, inert gases, such as nitrogen. Oxygen is the only constituent of the air that we breathe capable of supporting life. The normal oxygen content in air is approximately 21%. Nitrogen is the other primary component of air at 78%, with other trace components totaling approximately 1%. The presence of any additional gas in the air, with the exception of oxygen, dilutes the oxygen concentration and can create an oxygen-deficient atmosphere. As the oxygen concentration in the air diminishes, certain physiological effects take place in the human body. They can range all the way from giddiness, mental confusion, loss of judgment, loss of coordination, weakness, nausea, fainting, and up to and including death.

工人已经失去了他们的生命或者被高浓度无毒不活泼气体，如氮控制。氧是我们呼吸的空气中唯一能够支持生命的成分。空气中的正常氧浓度大约是21%。氮是空气的另一个主要成分，占78%，其它微量成分总共占大约1%。除了氧以外，空气中任何额外气体的存在都稀释了氧的浓度，造成缺氧空气。随着空气中氧浓度的下降，在人体内确定的生理影响发生了。它们包括眩晕、精神错乱、失去判断力、失去协调性、虚弱、恶心、昏晕和一直到死亡。

### What Happens When We Breathe An Oxygen-Deficient Atmosphere?

#### 当我们呼吸缺氧空气时会发生什么？

As blood passes through the lungs, it gives up carbon dioxide and accepts oxygen through the thin walls of tiny air sacs. Oxygen-rich blood from the lungs takes less than 10 seconds to reach the brain. If an individual takes a few breaths of gas containing no oxygen (for example, pure nitrogen or helium), oxygen is washed from the lungs as it is replaced by the gas. Blood flowing through the lungs receives insufficient oxygen because no oxygen has been inhaled. In fact, the blood gives up what little oxygen it is carrying in an effort to equalize the oxygen content in the lungs.

当血液通过肺的时候，它放出二氧化碳，通过薄薄的微小气囊壁接受氧气。来自肺的富氧血液用不到10秒的时间到达大脑。如果人呼吸几次不含氧的气体（例如纯氮或氦），该气体就会取代氧，氧被清洗出肺部。因为没有吸入氧，流经肺的血液得不到充分的氧。事实上，为了平衡肺内的氧含量，血液会释放出它携带的哪怕是很少的氧。

Blood, severely depleted of oxygen, then travels to the brain, where tissues rapidly become oxygen-deficient. The result is swift unconsciousness because brain tissue is the body component most sensitive to the lack of oxygen. Within five seconds after inhaling only a few breaths of oxygen-free gas, there is a rapid drop in the oxygen content of the blood. Mental failure and coma follow a few seconds later. Symptoms or warnings are generally absent, but even if present, the loss of mental competence and the weakness, loss of coordination, or fainting prevent victims from helping themselves or even summoning help. Death follows in just two to four minutes.

严重缺氧的血液流到大脑，大脑组织迅速变得缺氧。因为脑组织是人体对缺氧最敏感的部分，结果是迅速的失去知觉。在只吸入几次无氧气体之后的五秒钟以内，血液的氧含量就会迅速下降。几秒钟之后会神智不清和昏迷。一般没有症状和警告，但是即使有的话，神智不清、丧失思维能力、虚弱、丧失协调能力或昏晕也阻止了受害人自救或甚至求救。仅仅2到4分钟后就会死亡。

## Effects of Continued Breathing of Oxygen-Deficient Atmospheres

### 持续呼吸缺氧空气的影响

The effects of continued exposure to oxygen-deficient atmospheres depend on several factors:

持续呼吸缺氧空气的影响同几个因素有关:

- Degree of oxygen deficiency

缺氧程度

- Degree of physical exertion

身体努力程度

- Individual susceptibility (e.g., smoker vs. nonsmoker)

个人易感性 (举例来说, 吸烟者对不吸烟者)

- Individual health (e.g., emphysema)

个人健康 (举例来说, 肺气肿)

- Altitude (e.g., locations above 2,000 ft. elevation)

海拔高度 (举例来说, 海拔高度2,000英尺以上的地点)

Table 1 lists signs and symptoms for persons at rest exposed to various degrees of oxygen deficiency.

表1列出了静止的人暴露于不同程度的缺氧的征兆和症状。

**Any exercise increases the body's requirement for oxygen. Consequently, symptoms of oxygen deficiency will occur more rapidly, or at lesser degrees of oxygen deficiency in those who are actively exercising, than would be the case among persons at rest.**

任何运动都增加了人体对氧的需求。因此, 缺氧症状在那些大量运动的人身上比在静止的人身上发生得更迅速。

Air at higher altitudes contains the same concentration of oxygen, but the air is "thinner" and personnel tire more quickly. In a similar manner, personnel working strenuously will show signs and symptoms of low blood oxygen at air oxygen levels above those indicated on the table.

高海拔地方的空气含有同样浓度的氧, 但空气更稀薄, 人会更快疲劳。同样的道理, 在比表中所列空气中氧气水平高的地方, 工作强度高的人会显示出低血氧的迹象和症状。

## Precautions

### 防范

Use of a continuous oxygen monitor is strongly recommended in work areas where significant quantities of an inert gas, such as nitrogen, are being used in systems that are not gas tight.

强烈推荐在大量不活泼气体, 如氮正用于非气密系统的地方使用连续型氧监测器。

Workers in such areas should know and understand the physical properties of the gas being used. Gases that are lighter than air, such as helium, can collect near the ceiling. Conversely, gases that are heavier than air or very cold may tend to collect at or near the floor, or in low spots or depressions such as culverts, ditches, or manholes. These areas may contain little or no oxygen, while surrounding areas have normal air composition.

在这些区域的工作人员应该知道和理解正在使用的气体的物理性质。比空气轻的气体, 如氦可能积累在天花板附近。反过来, 比空气重或非常冷的气体倾向于积累在地面附近, 或低点或洼地, 如管路、沟渠或检修孔。当周围区域空气组成正常时, 这些地方可能含有很少或根本没有氧。

Always provide adequate air movement and ventilation, such as exhaust or floor fans,



when using inert gas systems. Be aware that increases in production rates or gas consumption rates may require additional ventilation.

当使用不活泼气体系统时，总是要提供充分的空气流动或通风，如抽风机或落地扇。要知道提高生产率或气体消耗率要求额外的通风。

A vapor cloud or plume, created by condensing water vapor in the air, can be evidence of the release of cold gas vapors such as nitrogen, argon, or helium. As the gas warms up to ambient temperature, the danger is still present, without the warning of the visible plume, unless adequate dilution of the inert gas has occurred. **Do not rely on the absence of a visible cloud as evidence of a normal air atmosphere.**

空气中的水蒸汽浓缩产生的蒸汽云或蒸汽流可以作为低温气体蒸气，如氮、氩或氦泄露的证据。当气体加热到室温时，尽管没有可见蒸汽流的警告，危险仍然存在，除非该不活泼气体已经充分稀释。不要把没有可见的云雾视做正常空气气氛的证据。

No one must work in or enter atmospheres containing less than 19.5% oxygen\*, unless equipped with self-contained breathing apparatus (SCBA) or a breathing air-supplied facemask. **This is also true for rescue personnel who can be overcome by the same oxygen deficient atmosphere as the initial victim.**

除非配备了自给式呼吸器（SCBA）或空气补给呼吸面罩，任何人禁止工作或进入含氧量低于19.5%的空气。这对救援人员也同样适用。象最初的受害者一样，他们也会被同样的缺氧空气所害。

## Basic Rules

### 基本准则

- Remember, oxygen-deficient atmospheres are an invisible danger. They have no warning properties. Never enter a suspected oxygen-deficient area without a source of supplied air.

记住，缺氧空气是看不见的危险。它们没有警告性。禁止在没有补给空气源的情况下进入被怀疑缺氧的区域。

- The only way to detect an oxygen-deficient atmosphere is with monitoring. Monitoring should be continuous.

使用监测器是探测缺氧空气的唯一办法。监测应该是连续的。

- Provide adequate ventilation in areas where large volumes of inert gas are used.

为大量使用不活泼气体的地方提供充分的通风。

- Review the Material Safety Data Sheets (MSDS) and train workers on the properties and safe handling of inert gases.

浏览产品安全数据表（MSDS），对工作人员进行不活泼气体的性质和安全操作的训练。

- When it is necessary to work in oxygen deficient atmospheres, supplied air must be provided. Air can be supplied with either an air-supplied face mask or self-contained breathing apparatus (SCBA).

当必须工作在缺氧空气中时，必须提供补给空气。使用空气补给面罩或自给式呼吸器（SCBA）来补给空气。

- When working in confined spaces, all the requirements of OSHA's Confined Spaces Regulations must be strictly followed.当工作在狭窄空间内时，必须严格遵守OSHA的狭窄空间规范的要求。

## Signs and Symptoms of Oxygen-Deficient Exposure

### 缺氧空气的迹象和症状

#### Oxygen Content of Air 空气的氧含量

#### Signs and Symptoms of Persons at Rest 静止人员的征兆和症状

15%–19.5% Decreased ability to work strenuously. May impair coordination and may induce symptoms in persons with coronary, pulmonary, or circulatory problems.

高强度工作能力减弱。可能削弱协调性和在人体导致冠状动脉、肺或循环系统问题的症状。



12%–15% Respiration deeper, increased pulse rate, and impaired coordination, perception, and judgment.

呼吸更深，脉搏增加和协调性、理解力和判断力的削弱。

10%–12% Further increase in rate and depth of respiration, further increase in pulse rate, performance failure, giddiness, poor judgment, and blue lips.

进一步增加呼吸频率和深度，进一步增加脉搏，动作失灵，眼花，判断力低下和嘴唇发蓝。

8%–10% Mental failure, nausea, vomiting, fainting, unconsciousness, ashen face, blue lips.

神智不清，恶心，呕吐昏晕，失去知觉，脸色灰白，嘴唇发蓝

6%–8% 8 minutes, may be fatal in 50-100% of exposures; 6 minutes, may be fatal in 25-50% of exposures; 4-5 minutes, recovery with treatment.

8分钟，50-100%暴露者死亡；6分钟，25-50%暴露者死亡；4至5分钟，治疗后恢复。

4%–6% Coma in 40 seconds, convulsions, respiration ceases, death.

40秒内昏迷，抽搐，呼吸停止，死亡。

## **First Aid**

### **急救**

Anyone suffering from lack of oxygen should be quickly moved to an area with a normal atmosphere. If the victim is not breathing, artificial respiration should be administered immediately. Give supplemental oxygen with respiration if oxygen is available.

必须把缺氧的人转移到有正常空气的地方。如果受害者停止了呼吸，立刻进行人工呼吸。如果备有氧气，输氧。

**A coma resulting from the lack of oxygen is not always fatal. Know, practice, and use cardiopulmonary resuscitation (CPR) techniques.**

缺氧造成的昏迷并不总是致命的。了解、练习和使用心肺复苏（CPR）技术。