



U. S. Department of Labor  
Occupational Safety and Health Administration  
Directorate of Science, Technology & Medicine  
Office of Science and Technology Assessment

Deaths Involving the Inadvertent Connection of Air-line  
Respirators to Inert Gas Supplies

Safety and Health Information Bulletin

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## Introduction

The National Institute for Occupational Safety and Health (NIOSH) and the Bureau of Labor Statistics (BLS) have recently completed a national survey of respirator use in the private sector.<sup>1</sup> The results of that survey are currently being analyzed and prepared for publication. However, one finding suggests that many employers may not be exercising the proper care necessary to prevent a type of fatal accident that can result from improper use of air-line respirators. This Safety and Health Information Bulletin is to alert the reader to fatalities that have occurred due to the inadvertent connection of air-line respirators to inert gas supplies.

## Background

Based on information obtained from Occupational Safety and Health Administration (OSHA) investigation reports from 1984 through 1995 and more recently from the BLS, OSHA determined that most worker fatalities involved regulatory and procedural violations and could have been prevented by proper training and compliance with existing regulations.<sup>1,2,3</sup> A number of the deaths indicated that coupling compatibility problems and lax supervisory oversight were major factors in the inappropriate supply of non-respirable gas to the respirators worn by these workers.

This Safety and Health Information Bulletin is **not** a standard or regulation, and it creates no new legal obligations. The Bulletin is advisory in nature, informational in content, and is intended to assist employers in providing a safe and healthful workplace. The Occupational Safety and Health Act requires employers to comply with hazard-specific safety and health standards. In addition, pursuant to Section 5(a)(1), the General Duty Clause of the Act, employers must provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. Employers can be cited for violating the General Duty Clause if there is a recognized hazard and they do not take reasonable steps to prevent or abate the hazard. However, failure to implement any recommendations in this Safety and Health Information Bulletin is not, in itself, a violation of the General Duty Clause. Citations can only be based on standards, regulations, and the General Duty Clause.

OSHA regulation (29 CFR 1910.134(i)(8)) and the American National Standards Institute (ANSI) standard Z88.2, "Practices for Respiratory Protection," specify that respirator air-line couplings must be **incompatible** with outlets for other gas systems to prevent inadvertent servicing of air-line respirators with non-respirable gases or oxygen.

If an inert gas (e.g., helium, argon, nitrogen) is inadvertently supplied to an air-line respirator rather than breathable air, the results can be fatal. Inert gases such as helium, argon, and nitrogen are widely used in industrial settings as fire suppression blankets for flammable work in confined spaces, to operate pneumatic equipment, and to prevent oxidation in industrial processes.

Air-line respirators are typically used in painting, cleaning, some manufacturing operations, and abrasive blasting. An air-line respirator, whether configured with a hood, helmet, coverall, or facepiece, must have a hose with terminal detachable couplings. When a respirator's air line is connected to a source of inert gas rather than to breathable air, the respirator wearer who trusts his/her sense of breathlessness to determine whether he/she is connected to breathing air has little warning before losing consciousness. This is because the buildup of carbon dioxide, not a lack of oxygen, ordinarily causes the sensation of breathlessness that may alert the individual wearing the respirator. Consequently, the victim is fooled because there is no clear indication that anything is amiss. Blackout occurs quickly, without warning.

Victims wearing respirators connected to inert gas lines are in a zero percent oxygen atmosphere, and unconsciousness can occur in about 12 seconds<sup>2</sup> and death in a matter of minutes. The situation continues to be critical because victims are still wearing respirators and continue to breathe inert gas after they collapse.

### **Case Histories**

Some case histories that appeared in the referenced articles are presented below:

#### **Case #1**

An employee was using an air hammer to chip residue out of a furnace at an aluminum foundry. He was wearing an air-line respirator. Two

compressed gas lines with universal access couplings were attached to a nearby post. The one on the right was labeled "natural gas." The gas line on the left had a paper tag attached with the word "air" handwritten on it; however, this line actually contained pure nitrogen. A splitter diverted one part of the gas stream to the air hammer and the other part of the stream to the air-line respirator. The employee was asphyxiated and killed when exposed to pure nitrogen.

#### **Case #2**

A contractor crew was assigned to abrasively blast inside a reactor vessel at a petrochemical refinery. Although verbal company policy called for contractors to supply all breathing air, this crew, with supervisor's knowledge, had on several occasions used plant air to supply breathing air. A crew member mistakenly hooked up his air-line respirator to an unlabeled nitrogen line (only the shut-off valve was labeled) used by the refinery for purging confined spaces. Plant nitrogen and air lines were identical, and both had couplings compatible with the coupler on the respirator.

#### **Case #3**

An employee hooked the fresh air line of his supplied-air respirator into a plant's compressed air lines and began abrasive blasting. The plant operators, unaware that their plant air was being used as breathing air, shut down the fresh air compressor for routine, scheduled maintenance and pumped nitrogen into the system to maintain pressure and control the valves in the refinery. The employee was overcome by the nitrogen in the air lines and died of nitrogen asphyxia.

#### **Case #4**

An abrasive blaster at an air separation plant could not obtain breathing air from an installed line. He adapted unapproved hoses with quick-disconnect couplers so he could connect an abrasive-blasting

respirator to a gas line supplying the blasting pot. This piping was not color coded nor labeled in accordance with company policy. The employee died because he did not know he was connecting to a nitrogen line instead of to compressed air. Nitrogen was a separation by-product at this plant and was piped to operate pneumatic equipment.

#### Case #5

A contract employee was abrasive blasting and painting gratings and railings. The air-line from the abrasive blasting respirator was hooked into the plant air supply. The plant air supply was not Grade D breathing air and was to be used only for valve gauges and pneumatic tools. The air compressor was shut down for maintenance, so nitrogen was backfed into the plant air lines. No one from the company informed the contract employee that the lines now contained nitrogen. When the abrasive blaster donned the abrasive-blasting respirator, he inhaled the nitrogen and was asphyxiated.

#### Discussion

Individuals responsible for the use of air-line respirators are urged to review their respiratory protection programs to ensure that the couplings of the respirator air lines are incompatible with any other fittings used at the worksite. To ensure this

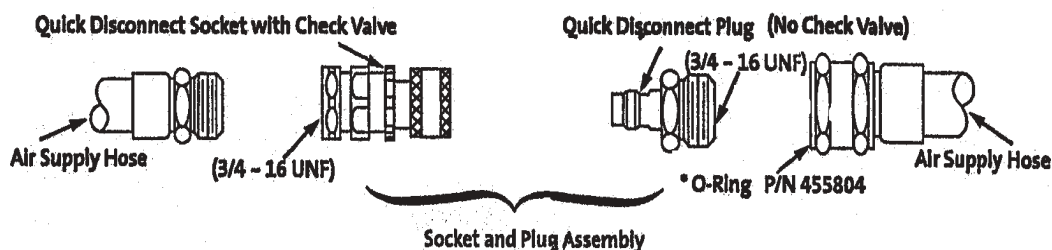
requirement is met, the non-respirator connections must be changed. (The fittings of an air-line respirator are tested and approved by NIOSH as part of the unit. A user cannot make an unapproved change to the respirator.)

Plant safety and health personnel should ensure (determine) that nothing other than Grade D air can enter the breathing air system. The NIOSH approval label found on all air-line respirators specifies that approval is valid only when supplied with Grade D breathing air or equivalent. This is also required by the OSHA respiratory standard and the ANSI Z88.2 standard.

There must be a concerted engineering effort to design and maintain separate gas distribution systems for breathable air, and for pneumatic tools, fire suppression, and other work-related needs, so that improper gas interconnections cannot be made. Implementing color coding and labeling for all gas lines is a good safety practice that should be followed to ensure that mix-ups do not occur.

#### Quick Connectors

The diagram in Figure 1 shows the proper method of coupling sections of air supply hose using locking quick disconnects, which are easily connected by pushing the plug and socket together. To separate, the plug and socket must be pushed



**Figure 1. Quick Connector Diagram**

Quick connectors allow the supply hoses to be connected to specific gas connection points. Insertion into an incorrect outlet is prevented by the use of different shapes for mating portions, different spacing of mating portions, or some combination of these.

together and the sleeve on the socket retracted from the plug.

## Conclusion

To help ensure that workers do not inadvertently hook up to inert gas supplies, the following recommendations should be implemented:

- Ensure that all requirements related to respiratory protection as outlined in 29 CFR 1910.134 are met. Written standard operating procedures governing the selection and use of respirators must be developed and implemented. Requirements for training and instruction in the proper use of respirators and their limitations must be met at all facilities.
- Ensure (determine) that the couplings of the respirator air lines are incompatible with any other couplings/fittings for non-respirable air or gas delivery systems. Replace couplings on non-breathing air systems with another, incompatible type of coupling.
- Ensure that breathable air systems are not in any way interconnected to non-breathable air systems.
- Develop a maintenance procedure to address supply-line identification (labeling) and painting. Stress the purpose of color coding and the importance of completing detail painting in a timely fashion to ensure that this visual cue is always available to aid workers.

## References

1. U.S. Department of Labor, Bureau of Labor Statistics, and the U.S. Department of Health & Human Services, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (CDC). *Survey of Respirator Use and Practices*, 2000.
2. Hudnall, J.B.; Suruda, A.; and Campbell, D.L. *Deaths Involving Air-Line Respirators Connected to Inert Gas Sources*. American Hygiene Association 54(1): 32-35 (1993).
3. Suruda, A.; Milligan, W.; Stephenson, D.; and Sesek, R. *Fatal Injuries Involving Respirators, 1984-1985*. Applied Occupational and Environmental Hygiene 18(4): 289-292, 2003.