

Hazards Associated with the Release of Liquid Nitrogen and Carbon Dioxide During Flash Freezing Processes

Frozen food production can be hazardous to workers. Although nitrogen and carbon dioxide can quickly freeze food products if released into the work area they can displace oxygen in the air, which can be fatal to workers. Fundamental safety and operational precautions such as systems to prevent nitrogen and carbon dioxide from entering and accumulating in the work area, alarms to detect low oxygen levels, emergency ventilation, and worker training are essential for ensuring hazard awareness and employee escape from oxygen-deficient areas.

Background

In food processing, spiral and immersion freezers (Figure 1) rapidly freeze food to preserve product quality. Food products are brought into contact with nitrogen or carbon dioxide in solid, liquid and vapor forms inside flash freezers. If the nitrogen or carbon dioxide spills out of the equipment during operation, high concentrations can accumulate in the work area, replace the oxygen in the air, and asphyxiate workers. OSHA has recently investigated several fatal incidents related to nitrogen and carbon dioxide releases from flash freezers. These releases can be the result of equipment failure, improper equipment operation, or even food product changes. In one case, a release of nitrogen at a flash freezing facility killed six workers and injured others due to equipment failure, inadequate training and procedures, insufficient atmospheric monitoring and faulty emergency ventilation. Tragically, additional workers were killed in seconds when they entered the room unprotected to rescue the fallen workers.

Protecting Workers from Asphyxiation and Cryogenic Hazards

Employers must always ensure a safe workplace by controlling hazards from flash-freezing operations. As discussed in a prior [OSHA Letter of Interpretation](#), several OSHA standards and guidance relate to protecting workers from the known hazards of nitrogen. Additionally, the General Duty Clause of the Occupational Safety and Health Act requires employers to provide their workers "employment and



Figure 1: Six workers died from a low oxygen atmosphere when nitrogen was released from flash freezing equipment.

a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm." 29 USC 654(a)(1).

Some important elements of a successful program to minimize the hazards of flash freezing operations include, but are not limited to:

- Conduct a hazard analysis to identify, evaluate, and control hazards and minimize the severity and likelihood of hazardous releases of nitrogen and carbon dioxide.
- Ensure use and maintenance of proper equipment to prevent releases and to protect workers in the event of exposure to an oxygen deficient atmosphere. Proper equipment to control hazards include, but is not limited to:
 - Process equipment such as flash freezing vessels, pumps, piping, controls and instruments to prevent releases of nitrogen and carbon dioxide from the equipment to the work area.
 - Oxygen detectors, both fixed and hand-held, to detect and monitor areas where nitrogen and carbon dioxide releases from equipment may pose a hazard to workers by migrating into occupied areas.
 - Alarms to alert workers before entering an oxygen deficient atmosphere, either in a continuously monitored location or with a recognizable audible and visual alarm.
 - Emergency ventilation systems to vent nitrogen and carbon dioxide releases to a safe location.
- Train workers and contractors on:
 - Hazards of flash-freezing operations.
 - Controls in place to ensure that work can be done safely in these work areas.
 - Operating and maintenance procedures.
 - Safe work practices (e.g., lockout/tagout and permit required confined space).
 - How to raise concerns they may have about safety and health hazards and conditions.
 - What to do if they believe there is an operational malfunction the controls are not properly in place or properly working.
 - Preventing access to work areas when nitrogen or carbon dioxide is released.
- Ensure workers and contractors have access to PPE to protect against cryogenic exposure hazards and respiratory hazards. PPE includes, but is not limited to: cryogenic gloves and proper fitting respiratory protection consisting of either a self-contained breathing apparatus (SCBA) or a combination full-facepiece pressure-demand supplied-air respirator (SAR) with an auxiliary self-contained air supply. Note: air purifying respirators DO NOT protect workers from this hazard.

Lastly, employers should carefully review, evaluate and manage any changes to the flash freezing process, such as equipment upgrades, changeouts, or different service vendors. This includes conducting a thorough risk assessment, considering the impact on worker safety and health, and ensuring that all necessary safety measures are in place prior to startup. This is crucial to ensure that these changes will not adversely affect the flash freezing process or compromise a safe work environment. By maintaining a rigorous review and evaluation process, employers can effectively manage potential risks.

Training and Planning for Emergencies Protects Workers

Employers are responsible for preparing workers and contractors for emergency response and safe evacuation during emergencies. This involves training workers on emergency response and evacuation procedures in a language they understand. The training must include what to do if an emergency alarm sounds, where to evacuate (i.e., the location of emergency exits), and procedures to assist in a safe and orderly evacuation, including active communication with local emergency response services such as fire department/emergency response agencies.

Industry Codes and Standards

Employers can minimize hazards of flash freezing processes by incorporating relevant codes and standards (discussed below), applying a safety and health management system approach to manage hazards, and utilizing the [Hierarchy of Controls](#) (elimination, substitution, engineering controls, administrative controls and PPE), to reduce the risk of a release. The below industry codes and standards provide safety guidelines on the design, installation, operation and maintenance of flash freezing equipment to ensure safe operations. Utilizing these codes and standards, the employer can develop and implement operating and maintenance procedures and training programs to minimize the possibility of releases from flash freezing equipment.

- Compressed Gas Association (CGA) Standards:
 - P-12: Safe Handling of Cryogenic Liquids
 - P-18: Standard for Bulk Inert Gas Systems at Consumer Sites
 - P-39: Oxygen Rich Atmospheres
 - P-76: Hazards of Oxygen-Deficient Atmospheres
 - G-6: Carbon Dioxide

- National Board Inspection Code, Part 1 – Installation
- National Fire Protection Association (NFPA): NFPA 55 (Compressed Gases and Cryogenic Fluids Code)
- International Organization for Standardization (ISO): ISO 5149

How OSHA Can Help

We have compliance assistance specialists throughout the nation who can provide information to employers and workers about OSHA standards, short educational programs on specific hazards or OSHA rights and responsibilities, and additional compliance assistance resources. Contact your [local OSHA office](#) for more information.

OSHA's On-Site Consultation Program offers no cost and confidential services to help small and medium-sized businesses find and fix workplace hazards. On-site consultation services are separate from enforcement and do not result in penalties or citations. Visit the nearest [Consultation office](#), or call 1-800-321- OSHA (6742).

Workers' Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For additional information on workers' rights, visit [osha.gov/workers](https://www.osha.gov/workers).

How to Contact OSHA

OSHA's mission is to assure America's workers have safe and healthful working conditions free from unlawful retaliation. For more information, visit [osha.gov](https://www.osha.gov) or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

This hazard alert is not a standard or regulation, and it creates no new legal obligations. It contains recommendations as well as descriptions of mandatory safety and health standards. The recommendations are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace. The Occupational Safety and Health Act requires employers to comply with safety and health standards and regulations promulgated by OSHA or by a state with an OSHA-approved state plan. In addition, the Act's General Duty Clause, Section 5(a)(1), requires employers to provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. There are 22 OSHA-approved state plans, covering both private sector and state and local government workers and seven State Plans covering only state and local government workers. State plans are required to have standards and enforcement programs that are at least as effective as OSHA's and may have different or more stringent requirements.

