Safety Information

Prepared by WG-6 Cryogenic Vessels

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# Indoor Low-Pressure Cryogenic Liquid Applications

## Cryogenic Liquid Applications

Liquid Nitrogen (but may apply to other gases) is often used in applications for freezing and cooling purposes such as food freezing tunnels, cryogenic batch freezers and biomedical and tissue bank storage/freezers.

- These applications commonly have liquid pressure at point of use of between 1 barg and 4 barg.
- The application equipment is normally located within a building and has specific hazards that shall be addressed to ensure safe operation and prevent asphyxiating atmospheres inside the building.
- Liquid supply to this equipment is normally achieved from a standard cryogenic vessel that is made for a Maximum allowable pressure (PS) higher than the pressure at point of use in these applications.

Low pressure liquid applications can create serious hazards to health, if not all the parts of the installation (cryogenic vessel, equipment, piping, application) are considered together. Additionally, the rooms where the Nitrogen is used, are more and more sealed, almost hermetically, to ensure hygiene and building efficiency. This will increase the risk of anoxia with inert gas vapours generated from leaks of liquid cryogenic gases

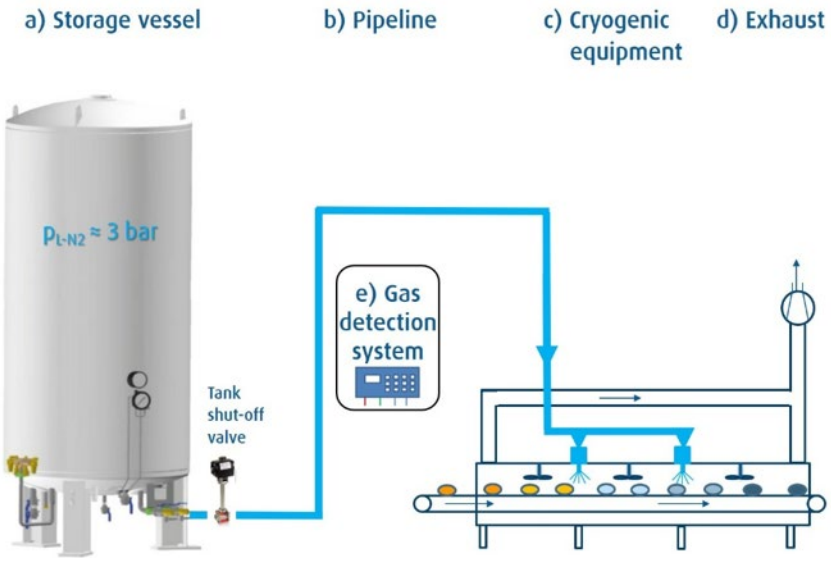



**Figure 1: Example of a food freezing installation using cryogenic gas**

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## How to prevent accidents

The whole installation (cryogenic vessel, equipment, piping, application) shall be covered by a risk assessment considering but not limited to following safety critical elements:

- Prevention on hazards of oxygen-deficient atmospheres as defined in EIGA Doc 44 [1],
- Installation of a main shut off valve in the liquid supply line, activated by Oxygen monitoring or Emergency-stop according to DOC174 [2],
- **Safe removal of gaseous nitrogen used by the application**

  Exhaust and vents from application equipment shall be designed to remove all the (GAS) nitrogen supplied to the equipment to a safe location outdoors. Factors to be considered include but not limited to:

  - Length of exhaust;
  - Pressure drop;
  - Outdoor location of exhaust; and
  - Potential blocking of exhaust by trapping of moisture in the vent line (e.g. by snow)
  - Operational run time of equipment and snow accumulation.
  - Sufficient fresh air supply into the facility so that the exhaust system cannot suffer from a back-drafting effect.

- **Relief valves on the storage tanks, piping and application equipment**

  To prevent the liquid supply storage vessel being discharged through piping or the applications equipment (thermal)relief valves, cascading relief valve set pressures from application equipment (highest set pressure) towards the vessel (lowest set pressure) is needed.

  - Verify relief valve set pressure on applications equipment is at its PS.
  - Downrating main storage vessel relief valve setpoint
    - Pressure drop calculation of the relief valve inlet piping at lower setpoint is needed
    - RV sizing because of lower pressure setpoint
    - Setpoint to take into account the max liquid head possible, as this has influence on the pressure of the liquid going to the application
    - Max capacity of vessel relief valve at 110% of its set pressure
  - Additional pressure control on main storage tank, for example automated vents, economizers.
  - Pipe vents on relief valves located on application equipment to a safe location, typically outdoors.

  NOTE If set pressure is lower than main storage tank be aware they can vent liquid for extended periods.

  - Remote and/or automated shut off valves to isolate supply to applications equipment.
  - (Thermal) Relief valves piped back into the upstream nitrogen line.
  - Operation of shut off valves such that thermal expansion is minimized on equipment shut down.
  - Another factor that can affect the flow of asphyxiant into the equipment is the delivery pressure. So, it should be assumed that the maximum working pressure is applied for any equipment sizing even though the working pressure may be lower.

- **Monitoring the atmosphere in the room and alarms**

  Oxygen monitors and alarms shall be installed in rooms where application equipment is located and provide automated shut-off valves on liquid supply. An oxygen monitoring system shall be installed as per the manufacturers' recommendations, ensuring that safe occupancy and entering of any facility is achieved. Typically, a master panel will be positioned in a safe area outside the risk area to alert any personnel before entry.

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Handheld oxygen monitoring is also strongly recommended for key staff working in production areas where asphyxiation is a risk.

- **Room ventilation[1]**

  Rooms containing application equipment shall be provided with adequate ventilation, with a recommendation of a minimum supply of fresh air so that any extraction system cannot suffer from back drafting and also offer dilution of any spilt gas that could occur. The minimum amount of fresh air should match the extraction system design as this is directly proportional to the risk associated with the gas flow rate.

All customers shall be trained in the hazards associated with nitrogen and asphyxiation, especially highlighting the dangers of nitrogen in enclosed spaces. A comprehensive risk assessment shall be carried out by the end user with appropriate systems and procedures developed as required.

## References

[1] EIGA Doc 44 *Hazards of Oxygen Deficient Atmospheres,* www.eiga.eu

[2] EIGA Doc 174 *Guidelines for the Safe Installation and Use of Cryogenic Food Freezing and Cooling Equipment,* www.eiga.eu

## Further information

EIGA Doc. 136 *Selection of Personal Protective Equipment,* www.eiga.eu

EIGA Safety Leaflet SL 01 *Dangers of Asphyxiation,* www.eiga.eu

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