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STANDARD FOR PORTABLE LIQUID NITROGEN PUMPER SYSTEMS

FIRST EDITION

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Work Item 18-103

Bulk Distribution Equipment and Standards Committee

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1 Introduction

Portable liquid nitrogen pumper systems supply high pressure nitrogen gas to customers. These systems are typically used for purging, inerting, drying, or pressurizing customer systems and oilfield applications. Systems are typically temporary and not meant to serve as permanent systems.

Pumper systems can have maximum discharge pressures up to 15 000 psi (103 400 kPa) and maximum flow rates greater than 500 000 scfh (2620 m³/hr).^{1,2} Operating temperature can range from –320 °F to 650 °F (–196 °C to 343 °C).

2 Scope

This standard contains minimum requirements for siting, selecting equipment for, installing, filling, starting up, operating, maintaining, and removing portable liquid nitrogen pumper systems, referred to as pumper systems in this publication.

Pumper systems can be built as any of the following configurations:

- Truck systems, where the pumper system is mounted on a straight or bobtail truck that fully supports itself with front and rear axles. The truck is driven to the customer site and parked as a complete unit;
- Semi-trailer systems, where the pumper system is mounted on a semi-trailer that supports itself only on the rear axles and the front is supported by a truck. The semi-trailer is driven to the customer site, may be disconnected from the truck, and parked without the truck; and
- Skid-mounted systems, where the pumper system is mounted on a framework that is delivered on a semi-trailer and unloaded for use at the customer site.

The scope is limited to truck and semi-trailer systems and does not include skid-mounted systems.

This standard does not apply to pumper systems that supply gases other than nitrogen.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

¹ psi, bar, and kPa shall indicate gauge pressure unless otherwise noted as (psia; bar, abs; and kPa, abs) for absolute pressure or (psid; bar, dif; and kPa, dif) for differential pressure. All kPa values are rounded off per CGA P-11, *Guideline for Metric Practice in the Compressed Gas Industry* [1].

² References are shown by bracketed numbers and are listed in order of appearance in the reference section.

3.2 Technical definitions

3.2.1 Check valve

Valve that only permits flow in one direction and that automatically closes upon flow in the opposite direction.

3.2.2 Cordoned area

Designated safety hazard area created to separate workers who are not properly trained from equipment or piping systems.

3.2.3 Customer

End user whose equipment is fed with nitrogen from the pumper system.

3.2.4 Maximum allowable working pressure (MAWP)

Maximum gauge pressure permissible at the top of a vessel in its operating position for a designated temperature.

3.2.5 Operator

Supplier personnel who manually operate the pumper system.

3.2.6 Personal protective equipment (PPE)

Equipment worn by personnel to decrease the risk of injury due to exposures to process hazards.

3.2.7 Pressure relief device (PRD)

Pressure- and/or temperature- activated device that may be used to prevent the pressure from rising above a predetermined maximum and thereby prevent equipment or container failure due to overpressurization.

3.2.8 Risk assessment

Overall process of risk identification, risk analysis, and risk evaluation.

3.2.9 Rupture disk

Non-reclosing PRD actuated by inlet static pressure and designed to function by the rupturing of a disk.

3.2.10 Supplier

Business that produces, fills, or distributes compressed gases and compressed gas cylinders.

4 Health and safety considerations

4.1 General

For detailed information about the properties and safe handling of liquid and gaseous nitrogen, see the following publications:

- CGA P-9, *The Inert Gases: Argon, Nitrogen, and Helium* [2];
- CGA P-12, *Safe Handling of Cryogenic Liquids* [3]; and
- CGA P-76, *Hazards of Oxygen-Deficient Atmospheres* [4].

All work on pumper systems shall be performed by trained personnel.

4.2 Personal protective equipment

Proper personal protective equipment (PPE) is required before working on pumper systems. Specific PPE requirements depend on the product and site hazards.

Personnel inside the cordoned area of the pumper systems shall wear PPE required by written procedures and customer requirements. PPE shall be chosen based upon the temperature, pressure, sound, and ambient atmosphere hazards present inside the cordoned area and the immediate surrounding area where the pumper system is operating.

The minimum PPE should include:

- hard hat;
- hearing protection;
- personal ambient atmospheric oxygen monitor;
- safety glasses with side shields;
- steel toed boots with ankle support;
- work gloves (use insulated gloves for handling cryogenic liquids); and
- face shield (only when handling cryogenic liquids in open containers or during transfer operations).

Work clothing shall be specified by procedure or customer requirements. Work clothing typically consists of a long sleeve shirt and pants with no cuffs.

4.3 Pressure hazards

Pumper systems contain fluids at elevated pressure. The main fluid is nitrogen, but a pumper system can also use other fluids such as engine oil, hydraulic oil, antifreeze, diesel fuel, propane, or other control fluids.

Nitrogen is contained inside the piping at pressures up to 15 000 psi (103 400 kPa). The rapid release of pressure from a hose or piping either by opening a valve or by loss of containment can lead to serious injury or death. Pumper system operators shall follow operating and inspection procedures provided by the pumper system supplier.

4.4 Temperature hazards

4.4.1 Low temperature hazards

Liquid nitrogen is extremely cold and exists as an atmospheric liquid at -320°F (-196°C). It can rapidly freeze human tissue and cause many common materials to become brittle or fracture under stress.

Frostbite and burns can occur when exposed skin comes in contact with uninsulated piping or hoses containing liquid nitrogen or cold vapor. Personnel shall wear appropriate PPE to protect against skin contact with cold piping or discharging fluids.

The use of barriers, cordoned areas, insulation, and isolation by guarding shall be used as a means of protecting personnel from cryogenic temperature components.

4.4.2 High temperature hazards

Nitrogen gas can be discharged at temperatures up to 650°F (343°C) depending upon the requirements for each specific job. Skin contact with elevated temperature piping and equipment can lead to serious skin burns, injury, or death. Personnel shall wear appropriate PPE to protect against skin contact with hot piping or discharging fluids.

Use of insulation and isolation through guarding and cordoned areas shall be considered for components at temperatures greater than ambient temperature.

5 Customer and supplier responsibilities

The customer and the pumper system supplier shall ensure that the pumper system installation meets the requirements of this standard and federal, state, and local codes and regulations.

The customer and the supplier shall:

- Comply with applicable federal, state, and local regulations; and
- Develop and agree upon a method of emergency communication between the customer and the supplier during operation of the pumper system.

The customer shall:

- Provide the supplier a site that meets the requirement of this publication for installation and operation of the pumper system;
- Provide utilities required for operation of the pumper system, including but not limited to water, power, instrument gas, and lighting;
- If applicable, notify the supplier of the need to participate in the customer's internal risk assessment prior to installation and/or operation of the pumper system;
- Provide the supplier the operating pressure and temperature ratings of all connecting pipes, valves, and equipment that will be pressurized with nitrogen from the pumper system;
- Verify that piping is designed to accommodate expansion and contraction caused by changes between ambient and operating temperatures;
- Verify that pipe anchoring systems are designed to prevent piping damage and/or excessive loads on equipment nozzles;
- Provide a pressure relief device (PRD) to be located at the connection from the pumper system to the customer equipment. The customer shall ensure that the PRD is sized at the maximum allowable working pressure (MAWP) of the lowest-rated component and is sized for the flow capacity of the pumper system high pressure pump; and
- Provide to the supplier the operational requirements of the system. The requirements should include, but are not limited to, the following:
 - Flow cycle requirements
 - Operation hours
 - Communication requirements
 - Consequences of flow interruption and
 - Response to emergency scenarios.

The supplier shall:

- Provide the customer with all safety data sheets (SDSs) along with pressure, temperature, and flow specifications and limitations of the pumper system equipment, vaporizers, piping, and other ancillary equipment;
- Inspect the proposed site before the installation and startup of the pumper system;
- Provide the customer with appropriate personnel to complete a risk assessment if requested by the customer;
- Train operators to operate the pumper system;
- Participate in any customer required site safety training;
- Complete a pre-startup safety review (PSSR) to verify it is safe to introduce pressurized nitrogen to the customer process piping;
- Establish a cordoned area to keep unauthorized personnel from the area surrounding the pumper system;

- Establish procedures and standards for safe maximum working hours and safe working conditions for operators;
- Provide operator attendance during pumper system operation; and
- Complete a safety and hazard risk assessment prior to commissioning the pumper system.

6 Site selection and preparation

Pumper system installation location shall be based on the following:

- proximity to the customer piping connection;
- availability of site security to prevent unauthorized access;
- ground surface condition or preparation to support the equipment;
- location of walls or any obstruction that can limit natural air circulation;
- lighting;
- access roads and turn-around space that allows delivery trailers to service the pumper system;
- line of sight between pumper truck and customer injection point; and
- location of electrically classified areas.

6.1 Code compliance

The location of a pumper system shall meet federal, state, and local codes and regulations for storage of hazardous materials. Local municipalities typically adopt one or more of the following codes:

- *International Fire Code*® (IFC) has general requirements for industrial gases including inert gases such as nitrogen [5];

NOTE—There are other codes in the ICC family that are not listed because they generally do not apply to pumper system installations.

- NFPA 1, *Fire Code* has general requirements for industrial gases including inert gases such as nitrogen [6]; and
- NFPA 55, *Compressed Gases and Cryogenic Fluids Code*—for more specific site requirements for nitrogen systems (as well as other compressed gases and cryogenic liquids) [7].

To select a suitable site, determine how to meet the required separation distances from on- and off-site exposures. Before taking measurements and selecting a site, the customer shall review local codes for additional requirements. In the absence of a local code, the supplier should select a site for the pumper system in compliance with NFPA 55 [7].

NFPA 55 lists minimum setback distances to exposures such as property lines, buildings, etc. [7]. NFPA 55 also lists which distances can be reduced using firewalls [7]. The IFC and NFPA 1 point to NFPA 55 for exposure distances [5, 6, 7]. The setback distances in NFPA 55 apply to both permanent and temporary supply systems as referenced in the scope of NFPA 55 [7].

Setback distance tables in NFPA 55 are designed to cover a range of hazards. However, a customer site can have an exposure not specifically defined in NFPA 55 [7]. In such a case, the supplier and the customer should determine a setback distance and verify the acceptance of that distance by the authority having jurisdiction (AHJ).

6.2 Site surface requirements

The site shall be inspected prior to the installation of any equipment. The area where the pumper system is to be installed shall have soil load bearing capacity or surface improvement to support the equipment.