LIQUID OXYGEN, NITROGEN AND ARGON CRYOGENIC TANKER LOADING SYSTEMS

AIGA 085/13

Based on CGA P-31 – 2013 3rd edition

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NOTE—Technical changes from the previous edition are underlined.

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1 Introduction

This document has been prepared by member associations of the International Harmonization Council, under the lead of CGA and is intended for the worldwide use and application by all members of the International Harmonization Council. The International Harmonization Council is composed of members from the Asia Industrial Gases Association, Compressed Gases Association, CGA, European Industrial Gases Association, EIGA, and the Japanese Industrial and Medical Gases Association. Regional editions may use non SI units and refer to national, and or regional legislation.

This document has been compiled in response to the demand for information relating to the loading of cryogenic liquid oxygen (LOX), nitrogen (LIN), and argon (LAR).

2 Scope and purpose

2.1 Scope

This publication describes requirements for installations designed and constructed after the publication date of this document used for the loading of oxygen, nitrogen, or argon as cryogenic liquids. This publication may be used for existing cryogenic LOX, LIN, and LAR loading systems. Application of this publication to existing installations is an individual company or storage system owner's decision.

This publication covers cryogenic LOX, LIN, and LAR tanker loading systems for loading by gravity, pressure, or pump filling. It covers the design of the tanker loading systems and the period of time and activities between when a tanker enters the filling area and when it departs from the filling area.

This publication focuses on the factors affecting the transfer of oxygen, nitrogen, and argon as cryogenic liquids between a source and appropriately designed tankers used for the transportation of these products. The source can be either a storage tank or directly from the plant.

For the appropriate design of tankers, refer to the mandatory standards to be followed in the countries.

For the appropriate design of tankers (applicable to the United States of America), refer to CGA-341, *Standard for Insulated Cargo Tank Specification for Nonflammable Cryogenic Liquids*; ASME Boiler & Pressure Vessel Code - Section XII *Rules for the Construction & Continued Service of Transport Tanks;* International Standard ISO 20421-1 *Cryogenic vessels - Large transportable vacuum-insulated vessels - Part.1: Design, Fabrication, Inspection and Testing*; Title 49 of the U.S. *Code of Federal Regulations* (49 CFR) Part 178.338; CSA B620, *Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods*; and CSA B622, *Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods, Class 2* [1, 2, 3, 4, 5, 6].[1]

It does not cover cryogenic rail cars nor does it cover tankers unloading at a customer station or other user location.

2.2 Purpose

The purpose of this publication is to provide information regarding safety in the design, installation, operation, and maintenance of cryogenic LOX, LIN, and LAR tanker loading systems. The intent of this publication is to ensure that a uniform level of safety is provided throughout the industrial gas industry for the protection of the public and industry employees. The information presented does not replace but is intended to complement national, state, provincial/territorial, local, and insurance company safety requirements.

Through implementation of procedures, instrumentation, equipment inspection, testing, and system design criteria, this publication presents recommendations to reduce the potential for large releases of stored materials from storage systems or tankers. It emphasizes prevention of releases rather than mitigation of consequences following a release.

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

This publication is intended to facilitate proper decisions in the design, implementation, and modification of materials and equipment for the efficient handling of cryogenic LOX, LIN, and LAR in filling cryogenic tankers.

This publication is written for designers, owners, and operators of cryogenic liquid tanker loading systems.

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 Can

Indicates a possibility or ability.

3.2 Cryogenic liquid

Liquid with a boiling point below –130 °F (–90 °C) at atmospheric pressure.

3.3 Filling area

Location where tankers are parked, connected, and filled with cryogenic liquid. The filling area includes the loading hoses, piping, valves, and related equipment.

3.4 Getter

Material that, when used in closed containers, reduces the gas or vapor content of the container.

NOTE—A getter can react with the gas or vapor in the container to form a solid nonvaporizable material, absorb the gas or vapor, or reduce the amount of the gas or vapor in the container in any other way. The material might be a getter for one gas or vapor and might not have any effect upon another gas or vapor.

3.5 Liquid argon (LAR)

Argon in a cryogenic liquid state.

3.6 Liquid nitrogen (LIN)

Nitrogen in a cryogenic liquid state.

3.7 Liquid oxygen (LOX)

Oxygen in a cryogenic liquid state.

3.8 Oxygen-deficient atmosphere

An atmosphere in which the concentration of oxygen is less than 19.5% by volume.

3.9 Oxygen-enriched atmosphere

An atmosphere in which the concentration of oxygen is greater than 23.5% by volume.

3.10 Safe working atmosphere

Considered to be 19.5% to 23.5% oxygen by volume.

NOTE—Normal oxygen content of air is 20.9% by volume.

3.11 Vacuum jacketed
Insulating system using two coaxial pipes with a vacuum in the annular space; the innermost pipe carries the cryogenic liquid.

4 Hazards

4.1 Enhanced flammability

Oxygen is a transparent, odorless, and tasteless gas that comprises approximately 21% by volume of the Earth's atmosphere. Liquid oxygen is a clear liquid with a pale blue color. Oxygen by itself is not flammable; however, the presence of oxygen or another oxidizer is necessary to support combustion. An oxygen-enriched atmosphere can enhance very rapid combustion and cause combustion of some materials normally regarded as being relatively nonflammable as described in AIGA 005, *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres* [7].

4.2 Asphyxiation

The presence of oxygen in the earth's atmosphere is necessary to support life. When the oxygen content in the atmosphere is reduced, the ability of the atmosphere to support life is compromised. Nitrogen and argon are colorless, odorless, and chemically inert gases that are classified as simple asphyxiants. If these materials are released into the atmosphere and reduce the oxygen concentration, the atmosphere's ability to support life can be compromised. See AIGA 008, *Hazard of Inert Gases* [8].

4.3 Personnel exposures

Physical contact with vapors, liquids, or equipment at cryogenic temperatures can produce severe burns, frostbite, and damaged tissue.

4.4 Material embrittlement

Materials such as carbon steel and plastic become brittle at low temperatures and are subject to failure. The use of appropriate materials compatible with the cryogenic conditions present in LOX, LIN, and LAR systems is essential to maintain containment of the cryogenic fluids. Additional information about material embrittlement can be found in AIGA 027, *Cryogenic Vaporization Systems: Prevention of Brittle Fracture of Equipment and Piping* [9].

4.5 Fog

Fog can be created in the atmosphere from contact with cold surfaces of equipment and piping, or by a release of cryogenic liquid or gas. Fog is capable of limiting visibility outside and/or inside plant boundaries. The fog is composed of atmospheric water condensed by the cooling effect of the cryogenic fluid. Vapor clouds

4.6 Vapor clouds

Vapor clouds are created by the release of a cryogenic fluid(s) and can create a visible fog that can obscure visibility and/ or an oxygen enriched or deficient atmosphere, inside or outside of site boundaries.

The visible fog is produced by the significant cooling effect of a cryogenic fluid(s) when it vaporizes into still or moving ambient air. The extent of the visible fog is determined by the distance it takes for the vaporized gas to warm to the dew point or frost point of the ambient air. When the vaporized fluid is warmed sufficiently, it can no longer cool the air and condense out moisture. The oxygen enriched or deficient atmosphere can extend beyond the visible fog. For information regarding oxygen enriched atmospheres, see AIGA 005, [7]. For information regarding oxygen deficient atmospheres, see AIGA 008 [8].

4.7 Overpressurization

If a high pressure source capable of exceeding the maximum allowable working pressure (MAWP) of the tanker is used for fill operations, it is possible to overpressurize the tanker if preventative measures are not sized appropriately for pressure and flow capacity.

If a cryogenic liquid is trapped in equipment or piping, it will vaporize due to heat leak from the surroundings. This can result in dangerously high pressure if the equipment or piping is not protected by adequate pressure relief devices (PRDs) See CGA P-12, *Safe Handling of Cryogenic Liquids* [10].

If a warm tanker is filled with cryogenic liquid, overpressurization can occur when cryogenic liquid vaporizes and generates pressure above the MAWP of the tanker. Procedures should be developed for filling warm trailers to minimize the risk of overpressurization.

5 System design considerations

5.1 Filling area layout

The design of the filling area shall consider personnel safety, adjacent area exposure, public ways, and safe movement of the cryogenic tanker. All approaches should be as level as possible. Grade changes should consider the physical size of tankers being serviced and the ability of personnel to repeatedly traverse the affected area.

The design of the site shall consider safe transfer of the cryogenic fluid(s) from storage or source into the tanker.

Filling operations shall be conducted so that the attending personnel are not exposed to the risk of tanker traffic.

5.2 Filling operations

To prevent creating a hazardous atmosphere, filling should occur only outdoors in well-ventilated and well-illuminated areas. A properly designed overhead cover is permissible.

While filling, the tanker shall be stationary and should be level. If a trailer is loaded on scales, the levelness and materials of the loading area are usually covered by local or regional requirements for measuring systems.

The system shall be designed to rapidly and safely interrupt the flow of cryogenic liquids for either safety or normal process reasons. Safety shut-off systems shall be in place according to section 5.9.

During periods of inactivity, the storage system design (including vessels, equipment, and piping) should not build and store pressure significantly above its normal operating pressure. The system should be designed to prevent contamination of the plant piping or product transfer system from occurring and to ensure storage product integrity when the equipment is idle between tanker fills.

Fill personnel should visually monitor fittings and hose connections to verify that they do not leak during filling operations. Leaking fittings for LIN and LAR can be tightened during filling operations. If LOX fittings and hose connections are observed to be leaking, the filling operation should be shut down and the leaking fitting should be tightened using nonsparking tools as appropriate.

5.3 Design choices

System efficiency, measured by volume handled per unit time, area, and the number of tankers, greatly affects complexity and cost. The following choices shall be carefully considered:

Tankers are filled in either drive-through or back-in loading stations. Visual obstructions should be kept to a minimum;

Tankers are filled on scales or on a solid, level surface. The amount of product transferred to the tanker may be measured by weight, by differential pressure, by volume, or by metering using a level measurement device or metering equipment. Cryogenic liquids may be transferred by gravity, pressure, or pumps;

Hoses are connected to fixed piping or to piping with swivel joints;

Filling piping may be vacuum jacketed, insulated, or uninsulated. All insulation in oxygen service shall be oxygen compatible;

Working surfaces where LOX fill connections are made and tankers are blown down shall be concrete or metal. If used, metal should be compatible for cryogenic service. When metal is used, this can present a slip hazard that should be addressed.

> **WARNING**: Working surfaces for LOX handling shall not be asphalt. Spilling LOX on asphalt can cause violent reactions.

Working surfaces for LAR or LIN should be concrete, metal, gravel, or asphalt.

> **CAUTION**: Cryogenic spillage can erode work surfaces; work surfaces can also become uneven or slippery, resulting in a potential safety hazard.

Weather protection may be provided over the filling area. If this is done, the filling area shall be adequately vented; and

Filling operations may be automated in whole or in part or may be completely manual.

5.4 Liquid oxygen pumps

Pumping liquid oxygen is accompanied by some degree of hazard that needs to be recognized and addressed. Information about the installation of liquid oxygen pumps can be found in the AIGA 055, *Installation Guide for Stationary, Electric Motor Driven, Centrifugal Liquid Oxygen Pumps* [11].

5.5 Piping

Pipe, tube, or hose may be used to convey the cryogenic liquid into the tanker.

5.5.1 Piping design

Piping shall be capable of handling all of the fluid pressures encountered as well as the mechanical influences caused by repeated connections, disconnections, and atypical activities (see Section 6).

Pipe stress shall be considered carefully. Tanker filling causes repeated thermal cycling from ambient to cryogenic temperatures. Incorrectly designed systems can be prone to leakage and breakage under extreme conditions.

5.5.2 Fittings and components

Sufficient low point drains should be provided to ensure that all liquid can be removed.

A thermal relief valve of sufficient flow capacity shall be installed in sections of piping where liquid can be trapped.

Pipe fittings shall be of the comparable mechanical strength as the piping and shall be suitable for the intended service.

All fitting terminations or equipment shall use dedicated fill connections, and these may comply with AIGA 024, Connections for transportable & static bulk storage tanks [12] and be provided with caps or plugs as appropriate.

5.5.3 Getters in vacuum-jacketed piping

When used on vacuum-jacketed piping systems, getters help maintain a good vacuum. Some getter materials used to absorb hydrogen may react and produce heat if exposed to oxygen or air. Getter materials shall be packaged to thermally isolate them from multilayer insulating materials. The amount of getter material contained in each packet also should be considered. In many cases, getter materials are wrapped in a microfiber glass paper, which are then placed in an extremely fine mesh copper-alloy screen.

5.5.4 Piping layout

In drive-through filling installations, piping shall be elevated sufficiently above the highest possible component of the tractor trailer combination. Below-grade piping shall be sufficiently protected beneath the roadway so as to be unaffected by the movement or weight of the tanker.

WARNING: *Oxygen piping should not be run in an open trench in which water or debris can accumulate. If an oxygen leak occurs, debris in the trench may provide fuel for an energy release.*

The use of flex hoses should be carefully considered to give adequate freedom of movement without unduly burdening the operator with unnecessary weight. Likewise, when using swivel joints, consider the various stresses and ensure that the system support is adequate for the intended purpose. All materials, equipment, and products selected shall be suitable for the intended duty. The equipment shall be maintained to assure that excessive operator effort is not required for proper operation.

Disconnected hoses and piping equipment shall not deposit residual product on personnel walking through the fill area, on working surfaces, or on nearby pipe supports. Disconnected hoses shall be protected against contamination ingestion. Disconnected fill hoses should be suitably supported so they do not impede or are not damaged by the movement of people, vehicles, or equipment. In the case where unvented hose caps that could trap pressure are used to protect station piping from contamination ingestion, the loading piping and flexible hoses shall be protected by PRDs.

5.5.5 System cleaning requirements

LOX system cleanliness is critical and shall comply with AIGA 012, *Cleaning Equipment for Oxygen Service* [13].

LIN and LAR systems shall be cleaned according to internal procedures. Special applications, such as medical grade use, should meet cleanliness requirements in accordance with the requirements of the authority having jurisdiction.

5.6 Product analysis

Product handling procedures lead to the distinct possibility of contamination. Product analysis is suggested.

The analytical system design should allow for enough flexibility and freedom that peak filling operations are not impeded by the analytical process and do not compromise the reliability of the analysis.

5.7 Working surfaces

Weather has a significant impact on tanker filling operations. In certain climates or where freezing occurs, special considerations should be given to the surfaces that impact tanker and personnel movement. The surfaces specified should provide traction for personnel and vehicles under all anticipated conditions. Due consideration shall be given to drainage and snow removal as required for the filling system area. The surfaces specified should be mechanically strong enough to handle the weights generated by fully laden tankers.

The surfaces specified shall be compatible with all cryogenic liquids loaded at the site.

5.8 Lighting

Tanker filling can be conducted on a 24-hour-per-day basis. Proper illumination should be provided for filling operations. Lighting design should consider the impact of inclement weather.

Area lighting should illuminate the overall fill area and especially include the area where drivers enter/exit the tractor while parked in the filling area. Direct area lighting should be installed or available to illuminate the tanker filling connection area.

Illumination should not interfere with the driver’s ability to safely place the tanker in the correct position for filling.

5.9 Operator controls

Filling operations may be automated in whole or in part or may be completely manual.

The area/system can be manually isolated using manual valves, by controls activated by stop buttons or process sensors which isolate automatic valves. Tanks having an individual capacity greater than 125,000 L shall follow the tank isolation requirements of AIGA 031, Bulk oxygen, nitrogen & argon storage systems at production sites [14].

When designing the loading system, the need for redundant operator controls should be considered.

Automatically activated emergency stop controls shall be configured to perform the intended purpose without spurious activation. Manually operated stop systems shall be accessible both locally to the loading area and remotely from the loading area. The stop systems shall be clearly labeled as to product handled. All devices attached to the emergency stop shall fail to the safe condition, with the loading stopped and isolation devices closed.

When loading systems are used for medical products (e.g. LOX and LIN), the systems shall be in accordance and validated as applicable with the monograph for the product.

6 Inadvertent pull away

6.1 Definition of hazard

Breaking the flexible hose or fixed equipment to which it is attached can produce a serious accident if the driver or operator forgets to disconnect the flexible hose before the tanker is moved.

6.2 Filling area

Driving a tanker away from the filling area while the tanker is still connected to fixed equipment can break the flexible hose, damage the fixed equipment, damage or break equipment on the trailer, and cause a serious accident.

The large quantity of gas or liquid released under pressure can produce a potentially hazardous atmosphere and possibly cause oxygen enrichment or deficiency, cold burns, asphyxiation, fire, or explosion.

In case the hose resists the pulling effort and does not break, the vehicle can pull away part of or the entire fixed equipment, thus damaging the fill piping and other fixed equipment.

6.3 Design considerations

Precautions to be taken to avoid pull away incidents include the following:

- Selection of appropriate safety systems should consider the cryogenic liquid transported, the type of vehicle, the plant system design, the type of loading system (automatic or manual), and the frequency of trailer loading; and
- The complexity and reliability of the safety response system shall be considered in the selection of protective systems. A fully automatic system or a simple mechanical device may be considered. Automatic systems shall be designed with a predominantly fail-safe failure mode.

6.4 Operating and design practices

To satisfy the safety requirements for a trailer loading system installation, the systems engineer should consider one or more of the following safety devices or systems:

- Periodic training given to drivers and operators to make them aware of the potential dangers associated with the products transported and the various safety systems used to prevent such incidents;
- Portable signs placed in front of the unit while the unit is being filled. The signs may be positioned in front of the cab so they are visible and clearly legible to the driver when he/ she is in the cab. The portable sign

should be light enough that it can be moved easily by the operator, yet heavy enough that the wind cannot blow the sign over. Signs may have wording such as UNIT CONNECTED, FILL HOSE CONNECTED, DO NOT MOVE SIGN BEFORE DISCONNECTING HOSE, or may include a pictorial symbol. UNIT CONNECTED signs may be mounted from “swing arms” that are mounted from an overhead position. The sign should not be removed until the fill hose is disconnected;

- Wheel chocks placed in front of and behind the trailer tires to prevent forward and backward movement of the trailer while it is being filled. The wheel chocks should be made of nonsparking materials, should be of contrasting color that can be easily seen by the operator or the driver, and may include a handle with a sign or symbol that indicates wheel chocks are in place. These blocks are to be removed after the fill hose is disconnected;

- A key management system to prevent starting the tractor before the fill hose is disconnected. Examples of some commonly used key management systems are as follows:

  - Keys placed on a ring and then attached to the fill hose. This will prevent the tractor from being started until the fill hose is disconnected.

  - Keys given to the operator and kept in their possession until the fill process is completed.

  - Keys placed on a hook on the UNIT CONNECTED sign or on a hook on the handle attached to the wheel chocks.

- Disconnecting the air hoses between the tractor and trailer while being filled, and a HOSE CONNECTED sign attached to a dummy glad hand and then attached to the air hose connections;

- Red and green signal lights installed to indicate that the fill hose is connected. If used, red and green signal lights should be installed in such a manner that the status is readily observable when seated in the cab of the tractor. The red light would be activated by removing the hose from a hose storage rack. Replacing the hose on the rack would turn off the red light and turn on the green light;

- Orange highway marker cones placed in front of the tractor and near the driver’s door. If used, the cones should be marked “Fill Hose Connected.” The driver or operator should be required to place the cones before connecting the fill hose and remove the cones after disconnecting the fill hose; and

- Requiring the driver to be out of the tractor while the unit is being filled. Drivers should be provided with an area that protects them from the weather, yet gives a clear view of and access to the trailer.

6.5 Anti-pull away devices

6.5.1 Interlock system

Interlock systems may be installed on tankers to prevent the unit from being moved while it is being filled. These interlock systems disable the trailer and prevent it from being moved while connected to piping.

A common type of interlock system uses a flag arrangement that can be rotated before connecting the product transfer hose. When the flag is rotated, a vent valve is operated on the vehicle brake system, which immobilizes the vehicle. Systems can be configured to interlock the position of the tanker’s control panel cabinet doors to the tractor or trailer brakes, so the tractor cannot be moved if the doors are open. Other common systems require the movement of a flag or similar device covering the fill connection before the fill hose can be attached.

WARNING: *Modification of the braking system of the tractor or trailer may require re-inspection by the regional transportation authority. The braking system shall be designed to prevent the unintended activation of the interlock system when the tanker is moving.*

Another type of interlock system consists of a warning light installed on the vehicle control panel that indicates DO NOT MOVE VEHICLE. This system alerts the driver that the cabinet doors are open or that a safety lever is not in the correct position.

6.5.2 Tollgates

Tollgates may be mounted in the fill lanes and positioned at eye level and may include appropriate warning signs.

6.6 Damage control devices

Damage control devices are used to minimize the consequential damage of an inadvertent pull away while the tanker is still connected to the fill piping.

6.6.1 Breakaway couplings

Breakaway couplings, which break apart if the driver attempts to drive the tanker from the filling area while a hose is connected, may be installed in the fill line and, if present, the vapor recovery line. Such couplings should be linked to quick-closing valves (with a predominant fail-close action) that shut off the flow to the tanker if the coupling breaks. Such a feature can be vendor supplied or it can be fabricated locally by grinding a groove or notch in the fitting that reduces the yield strength of the fitting, causing it to break under stress. Technically qualified personnel should calculate the depth of the groove.

Breakaway couplings or notched pipe, when used, shall be located to minimize damage to the fill piping and prevent uncontrolled liquid spillage. A defined spill area of concrete, stainless steel, or other material suitable for cryogenic spill containment should exist in the vicinity of the breakaway coupling or notched pipe. Asphalt or other combustible material shall not be used.

Another type of breakaway coupling incorporates an automatic sealing system: the coupling allows free flow of product in normal operation but in case of a tow-away incident resulting in the coupling bolts breaking, each half of the coupling seals immediately preventing major spillage of product.

6.6.2 Control systems

A control system such as an automatic system that closes fill isolation valves and that shuts down fill pumps may be specified.

Alarms should be provided to alert the operator or remote monitoring personnel that a pull away condition has occurred. The alarms are activated by the quick-closing valve.

7 Overfill protection

A system or procedure shall be in place to prevent overfilling the tanker. Efficient distribution from a liquid-producing facility requires filling the tanker as full as practical with due consideration given to:

- maximizing fill volume relative to container volume and legal weight limitations; and
- avoiding overfilling, which has personnel safety, legal, and equipment damage implications.

7.1 Definition of overfill

Overfilling can describe either of two undesirable conditions as follows:

- Exceeding a desired fill level without discharging product out of the vehicle (i.e., exceeding weight or legal limit). Considerations include gross vehicle weight allowed by the state or province, axle weights allowed by the state or province, and federal and provincial bridge laws; or
- Exceeding desired fill level resulting in discharge of product out of the vehicle (i.e., personnel/equipment hazard).

7.2 Overfilling avoidance

Means to prevent overfilling include:

- Automated control system using weight-based fill termination that shuts off product flow at a predetermined set point (i.e., systems based on the tanker weight and volume);
- Manual or automated control system using differential pressure or other liquid level measurements that terminate the vehicle fill based on the liquid level in the tanker. The desired level is programmed into the fill control system and the filling process is automatically terminated when the level is reached. Individual tanker capacities are sometimes entered into the fill system, which allows the tankers to be filled by their unit identification number;
- Manual or automated control systems using metered flow into the tanker; and
- Manual or automated control systems that shut off the product flow based on sensing of the flow of product discharging out of the vehicle's full trycock lines (i.e., visual or automatic by using a sensing device in the overfill indicating/full trycock line).

7.3 Response to overfilling

If a tanker is overfilled creating a spill hazard, area isolation or system isolation responses shall occur. Depending upon the nature or complexity of the system, these area/system isolations can occur manually or automatically.

If the nature of the overfilling is such that the tanker is excessively loaded but did not discharge product to the atmosphere or ground, a procedural method shall be in place to off load excessive product from the tanker before it leaves the plant.

If the nature of overfilling caused a spill to the ground or atmosphere, the following actions shall be considered:

- Verify that tanker tires are not frozen. Attempting to move a tanker in such a condition can burst the tires and pose a road safety or physical impact hazard to personnel. Verify that the outer jacket of the tanker and adjacent equipment have not been damaged; and
- If a large spill occurs, it can create a local oxygen-deficient, oxygen-enriched atmosphere, or a vapor cloud that creates poor visibility. Plant evacuation or emergency response procedures shall be implemented as well as incident reporting as required by local or national organizations of jurisdiction. Refer to AIGA 008, Hazards of inert gases and oxygen depletion and AIGA 005, Fire hazards of oxygen and oxygen enriched atmospheres.

7.4 System design and operating considerations

The back end of a trailer is typically where the fill hose and sample connections for quality assurance are located. This area of the tanker-trailer should be visible from the area where filling is initiated, such as the control room, local pump/valve station, or via a remote visual monitoring system. The operator shall follow all applicable regulations and laws regarding attending the vehicle while loading. Individual companies shall develop procedures and practices regarding attendance at filling operations.

All instrumentation used for the filling operation should comply with the plant's routine calibration and maintenance procedures, as these activities should reduce the probability of inadvertent overfilling of tankers. Records of these procedures should be kept in accordance with company policy.

8 Overpressure Protection

If the operator or the automatic tanker filling system fails to end the filling process when the required filling level is reached or fails to control the tanker pressure during the fill sequence, the pressure in the tanker can increase and can reach the MAWP causing the relief device(s) to open. If the flow of product to the tanker is greater than the capacity of the relief system, the pressure in the tanker can rise to above its MAWP and potentially result in vessel rupture. There can be a vapor cloud and oxygen enrichment/ deficiency hazard from the resulting loss of containment.

Preventive measures and recommendations to manage this risk can be found in AIGA 054, *Prevention of Overpressure during Filling of Cryogenic Vessels* [15].

9 Contamination

9.1 Fittings

The design of CGA fittings is unique for each LOX, LIN, and LAR product to prevent personnel from connecting a liquid tanker to the wrong product tank and vice versa.

Use of adapters to cross-connect different CGA fittings is strictly prohibited for filling operations. Adapters may be used for maintenance activities under strictly controlled circumstances.

9.2 Quality assurance for incoming trailers

If a tanker is contaminated, the responsible person(s) should be notified of the situation and should specify the course of corrective action to be taken.

10 Operator training emergency response

10.1 Training of personnel

All personnel involved in the operation of the tanker loading system shall be fully informed of the hazards regarding LOX, LIN, and LAR. They shall be properly trained to operate the equipment associated with the loading of the tankers and be trained regarding the safe operation of the loading aspects of the tankers.

Training shall cover those aspects and potential hazards that the operator is likely to encounter. Written or electronic records of such training shall be kept on file.

Training shall cover, but not necessarily be limited to, the potential hazards of oxygen, argon, or nitrogen as appropriate; site safety regulations; emergency procedures; fire-fighting equipment; the use of protective clothing/equipment including eye, hand and foot, and head protection; breathing apparatus where appropriate; first aid treatment for cryogenic burns; and appropriate company procedures.

The training shall contain provisions for refresher courses on a periodic basis or for changes in personnel assignments involving the loading system and plant procedures associated with the loadline.

10.2 Emergency procedures

Emergency telephone numbers shall be posted and readily available for emergency contact should the need arise.

Procedures should be prepared to include action to be taken in the event of emergencies associated with tanker loading operations. Local fire, rescue, and police departments should be familiar with these emergency procedures. Company employees likely to be affected by any emergency associated with the plant and the loading operations should know the actions required to minimize the effects of spills and releases from the storage system or the tanker being loaded. Performance of drills with participation from the local agencies should be considered.

Emergency procedures should be in writing and consider, but not be limited to, overfill liquid spills, grade-level vapor clouds, overpressure of the tanker being loaded, and liquid contacting the outer shell or the tanker being loaded or adjacent equipment or surfaces.

11 References

Unless otherwise specified, the latest edition shall apply.

[1] CGA-341, *Standard for Insulated Cargo Tank Specification for Nonflammable Cryogenic Liquids*, Compressed Gas Association, Inc., 14501 George Carter Way, Suite 103, Chantilly, VA 20151. www.cganet.com

[2] ASME Boiler & Pressure Vessel Code Section XII *Rules for the Construction & Continued Service of Transport Tanks*

[3] International Standard ISO 20421-1 *Cryogenic vessels - Large transportable vacuum-insulated vessels Part.1: Design, Fabrication, Inspection and testing*

[4] *Code of Federal Regulations*, Title 49 CFR, Parts 100-180 (Transportation), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. www.gpo.gov/fdsys

[5] CSA B620, *Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods,* Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada. www.csa.ca

[6] CSA B622, *Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods, Class 2*, Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada. www.csa.ca

[7] AIGA 005, *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres*

[8] AIGA 008, *Hazard of Inert Gases*

[9] AIGA 027 *Cryogenic Vaporization Systems: Prevention of Brittle Fracture of Equipment and Piping*

[10] CGA P-12, *Safe Handling of Cryogenic Liquids*, Compressed Gas Association

[11] AIGA 055, *Installation Guide for Stationary, Electric Motor Driven, Centrifugal Liquid Oxygen Pumps*

[12] AIGA 024, Connections for transportable & static bulk storage tanks

[13] AIGA 012, *Cleaning Equipment for Oxygen Service*

[14] AIGA 031, *Bulk oxygen, nitrogen & argon storage systems at production sites*

[15] AIGA 054, *Prevention of Overpressure during Filling of Cryogenic Vessels*

Additional references

AIGA 009, *Safety Training of Employees*,