LIQUID OXYGEN, NITROGEN, AND ARGON CRYOGENIC TANKER LOADING SYSTEMS

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Prepared by AHG-3.28 of Industrial Gases Council

As part of a programme of harmonisation of industry standards, the European Industrial Gases Association, (EIGA) has published EIGA Doc 179, *Liquid Oxygen Nitrogen and Argon Cryogenic Tanker Loading Systems*, jointly produced by members of the International Harmonisation Council and originally published by the Compressed Gas Association as CGA P-31, *Liquid Oxygen Nitrogen and Argon Cryogenic Tanker Loading Systems*.

This publication is intended as an international harmonised standard for the worldwide use and application of all members of the Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), European Industrial Gases Association, and Japan Industrial and Medical Gases Association (JIMGA). Each association's technical content is identical, except for regional regulatory requirements and minor changes in formatting and spelling.

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1 Introduction

This publication gives information relating to the loading of cryogenic liquid oxygen, liquid nitrogen, and liquid argon.

2 Scope and purpose

2.1 Scope

This publication describes requirements for new installations designed and constructed after date of publication used for the loading of oxygen, nitrogen, or argon as cryogenic liquids. This publication may be used for existing cryogenic liquid oxygen, liquid nitrogen, and liquid argon loading systems. However, application of this publication may benefit existing installations or those in the project phase. Furthermore, to the extent that they exist, national laws may supersede the practices included in this publication. All local regulations, tests, safety procedures, or methods are not included in this publication and abnormal or unusual circumstances can warrant additional requirements.

This publication covers cryogenic liquid oxygen, liquid nitrogen, and liquid argon 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 ADR (*European Agreement Concerning the International Carriage of Dangerous Goods by Road*), and ISO 20421-1, *Cryogenic vessels—Large transportable vacuum-insulated vessels—Part 1: Design, fabrication, inspection and testing* [1, 2].[1]

This publication does not cover cryogenic railcars, nor does it cover tankers unloading at a customer station or other user locations.

2.2 Purpose

The purpose of this publication is to provide information regarding safety in the design, installation, operation, and maintenance of cryogenic liquid oxygen, liquid nitrogen, and liquid argon 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 emphasises prevention of releases rather than mitigation of consequences following a release.

This publication is intended to facilitate proper decisions in the design, implementation, and modification of materials and equipment for the efficient handling of cryogenic liquid oxygen, liquid nitrogen, and liquid argon in filling cryogenic tankers.

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

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

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.

3.2 Technical definitions

3.2.1 Cryogenic liquid

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

3.2.2 Filling area

Location where tankers are parked, connected, and filled with cryogenic liquid.

NOTE The filling area includes the loading hoses, piping, valves, and related equipment.

3.2.3 Oxygen-deficient atmosphere

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

3.2.4 Oxygen-enriched atmosphere

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

3.2.5 Tanker

Vacuum insulated pressure vessel designed to carry refrigerated liquefied gases. It may be self-propelled or pulled by a motor vehicle.

NOTE Also referred to as a cryogenic trailer or trailer.

3.2.6 Vacuum-jacketed pipe

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, odourless, and tasteless gas that comprises approximately 21% by volume of the earth's atmosphere. Liquid oxygen is a clear liquid with a pale blue colour. Oxygen by itself is not flammable; however, the presence of oxygen or another oxidiser 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 non-flammable as described in EIGA Doc 23.03, *Oxygen* [3].

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 colourless, odourless, 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 also EIGA Doc 44, *Hazards of Oxygen-Deficient Atmospheres* [4].

4.3 Personnel exposures

Physical contact with vapours, 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 liquid oxygen, liquid nitrogen, and liquid argon systems is essential to maintain containment of the cryogenic fluids. Additional information about material embrittlement can be found in EIGA Doc 133, *Cryogenic Vaporisation Systems - Prevention of Brittle Fracture of Equipment and Piping* [5].

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.

4.6 Vapour clouds

Vapour 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 vaporises into still or moving ambient air. The extent of the visible fog is determined by the distance it takes for the vaporised gas to warm to the dew point or frost point of the ambient air. When the vaporised 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 EIGA Doc 04 *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres* [6]. For information regarding oxygen-deficient atmospheres, see EIGA Doc 44 [4].

4.7 Overpressurisation

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 overpressurise 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 vaporise 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).

If a warm tanker is filled with cryogenic liquid, overpressurisation can occur when cryogenic liquid vaporises and generates pressure greater than the MAWP of the tanker. Procedures shall be developed for filling warm tankers to minimise the risk of overpressurisation.

For information on overpressurisation protection of tankers, see EIGA Doc 151, *Prevention of Excessive Pressure During Filling of Cryogenic Vessels* [7].

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.

While filling, the tanker shall be stationary and should be level. If a tanker is loaded on scales, the levelness and materials of the loading area are 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 shutoff systems shall be in place according to 5.9.

During periods of inactivity, the storage system design (including vessels, equipment, and piping) should not build and store pressure significantly greater than 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 liquid nitrogen and liquid argon can be tightened during filling operations. If liquid oxygen fittings and hose connections are observed to be leaking, the filling operation should be shut down and the leaking fitting should be tightened using non-sparking tools as appropriate.

Excessive force should not be used when tightening a fitting (for example, cryogenic hose fitting).

Ensure that the transfer hose and fittings are visibly clean from oils, grease, or other contaminants.

If there is a need to hold a cryogenic hose while using the non-sparking tools to tighten hose fittings, make sure that the tools cannot strike any part of the glove used by the operator. The hand should be positioned so any leaking liquid product does not come into contact with the glove.

An operator presence device, which shuts the system off (for example when not pressed at set intervals), may be considered to help guarantee that the operator remains close to the filling point and monitors when filling.

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 liquid oxygen 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 liquid oxygen handling shall not be asphalt. Spilling liquid oxygen on asphalt can cause violent reactions, which can result in death or serious injury.*

- Working surfaces for liquid nitrogen or liquid argon 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, which can lead to injury.*

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

- Filling operations may be automated in whole, in part, or may be completely manual; and

- Rainwater or stormwater drains should not be located near the tanker filling area to prevent cryogenic liquid from entering the drain system.

5.4 Liquid oxygen pumps

Pumping liquid oxygen is accompanied by some degree of hazard that needs to be recognised and addressed. Information about the installation of liquid oxygen pumps is found in EIGA Doc 148, *Installation Guide for Stationary, Electric-Motor-Driven, Centrifugal Liquid Oxygen Pumps* [8].

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.

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 be provided with caps or plugs as appropriate, these may comply with EIGA Doc 909, *Cryogenic Gases Couplings for Tanker Filling* [9].

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 can 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, and then placed in an extremely fine mesh copper-alloy screen. For information on getters in vacuum-jacketed piping, see EIGA Doc 217, *Vacuum-Jacketed Piping in Liquid Oxygen Service* [10].

5.5.4 Piping layout

In drive-through filling installations, piping shall be elevated sufficiently above the highest possible component of the tractor tanker 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 can provide fuel for an energy release, which can result in death or serious injury.*

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 ensure 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

Liquid oxygen system cleanliness is critical and shall comply with EIGA Doc 33, *Cleaning of Equipment for Oxygen Service* [11].

Liquid nitrogen and liquid argon systems shall be cleaned according to company internal procedures. Typically, liquid nitrogen and liquid argon systems are cleaned to the same standard as liquid oxygen systems. Specific applications, such as medical grade use, should meet cleanliness requirements in accordance with the requirements of the authority having jurisdiction (AHJ).

5.5.6 Change of service

If a liquid nitrogen or liquid argon tanker is changed to liquid oxygen service, oxygen cleanliness requirements of EIGA Doc 33 shall be met [11]. See EIGA Doc 87, *Conversion of Cryogenic Transport Tanks to Oxygen Service* [12].

5.6 Product analysis

Product handling procedures lead to the distinct possibility of contamination. Product analysis can be required based on service.

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 shall be mechanically strong enough to handle the weights generated by fully laden tankers. Where tankers may be disconnected from the tractor, the surfaces shall be mechanically strong enough to support the landing legs to prevent sinking or tipping of the tanker.

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. Sufficient 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 personnel enter/exit the tanker 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 personnel's ability to safely place the tanker in the correct position for filling.

5.9 Operator controls

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

The operator shall be trained in the use of low point drains to prevent injury and equipment damage (freezing tanker tires, scale damage, etc.). Low point drains are typically manually operated. Operators shall be instructed to check for open low point drain valves and leaks during tanker fill.

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 33 000 gal (125 000 L) shall follow the tank isolation requirements of EIGA Doc 127, *Bulk Liquid Oxygen, Nitrogen, and Argon Storage Systems at Production Sites* [13].

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 labelled 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, for example, medical oxygen and medical nitrogen, the systems shall be validated in accordance with prevailing regulations and company policies and procedures. For further guidance, see EIGA Doc 219, *Guideline for Validation of Air Separation Unit and Cargo Transport Unit Filling for Medical Oxygen and Medical Nitrogen* [14].

5.10 Parking position of fill hose

When the fill hose is not in use, the hose should be secured to avoid whipping and contamination.

6 Inadvertent tow-away

A tow-away incident occurs when flexible hose(s) used to transfer product between a delivery vehicle and stationary equipment is not disconnected prior to moving the vehicle. When this occurs, flexible hoses and the interconnecting piping can be damaged or fail.

Moving the vehicle while delivery hose(s) are still connected to fixed equipment creates the potential for equipment damage and a hazardous atmosphere. Personal injury can be caused due to:

- a large quantity of gas or liquid under pressure being released by the ruptured hose(s) and the production of a potentially hazardous atmosphere (oxygen-enriched or deficient) that can lead to cold burns, asphyxiation, fire or explosion; and
- the vehicle, in certain cases, pulling away part or all of the fixed equipment or damaging the delivery vehicle pipework.

Any system to prevent tow-aways should include the following elements:

- procedures or work instructions;
- training and competency testing of drivers and/or operators; and
- technical solutions such as:
  - interlock with the braking system
  - interlock with a barrier and
  - system consisting of visible and / or audible alarms.

There are also systems to minimise the consequences of tow-aways.

For details on protection and mitigation systems, see EIGA Doc 63, *Prevention of Tow-Away Incidents* [15].

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:

- maximising 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 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 or oxygen-enriched atmosphere, or a vapour cloud that creates poor visibility. Plant evacuation or emergency response procedures shall be implemented as well as incident reporting as required by regulation. Refer to EIGA Doc 44, EIGA Doc 04, and EIGA Doc 60, *Seveso Documents - Guidance on Applicability, Assessment and Legal Documents for Demonstrating Compliance of Industrial Gases Facilities with Seveso Directive(s)* [4, 6, 16].

7.4 System design and operating considerations

The back end of a tanker is typically where the fill hose and sample connections for quality assurance are located. This area of the tanker 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. Means such as making the pit visible to the operator, level indications, or temperature indications may be used to reduce the risk of overfilling of the drain pit.

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.

WARNING: If the flow of product to the tanker is greater than the capacity of the relief system, the pressure in the tanker can rise significantly greater than its MAWP and potentially result in vessel rupture and loss of containment, leading to serious injury or death.

Preventive measures and recommendations to manage this risk are found in EIGA Doc 151 [7].

9 Contamination

9.1 Fittings

The design of EIGA couplings is unique for each liquid oxygen, liquid nitrogen, and liquid argon product to prevent personnel from connecting a liquid tanker to the wrong product tank and vice versa.

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

9.2 Quality assurance for incoming tankers

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 liquid oxygen, liquid nitrogen, and liquid argon. They shall be 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. In Europe, ADR details these requirements [1].

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:

- potential hazards of oxygen, argon, or nitrogen as appropriate;
- site safety regulations;
- emergency procedures;
- firefighting equipment;
- use of personal protective equipment (PPE) 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 loading line, see ADR [1].

10.2 Emergency procedures

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

Emergency procedures shall include action to be taken in the event of emergencies associated with tanker loading operations. Local emergency responders such as 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 minimise 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, ground level vapour 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] *European Agreement Concerning the International Carriage of Dangerous Goods by Road* (ADR), www.eunece.org.

[2] ISO 20421-1, *Cryogenic vessels—Large transportable vacuum-insulated vessels—Part 1: Design, fabrication, inspection and testing*, www.iso.org.

[3] EIGA Doc 23.03, *Oxygen*, www.eiga.eu.

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

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[5] EIGA Doc 133, *Cryogenic Vaporisation Systems - Prevention of Brittle Fracture of Equipment and Piping*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[6] EIGA Doc 04 *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[7] EIGA Doc 151, *Prevention of Excessive Pressure During Filling of Cryogenic Vessels*, www.eiga.eu.

NOTE This publication is part of an international harmonisation program for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[8] EIGA Doc 148, *Installation Guide for Stationary, Electric-Motor-Driven, Centrifugal Liquid Oxygen Pumps*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[9] EIGA Doc 909, *Cryogenic Gases Couplings for Tanker Filling*, www.eiga.eu.

[10] EIGA Doc 217, *Vacuum-Jacketed Piping in Liquid Oxygen Service*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[11] EIGA Doc 33, *Cleaning of Equipment for Oxygen Service*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[12] EIGA Doc 87, *Conversion of Cryogenic Transport Tanks to Oxygen Service*, www.wiga.eu.

[13] EIGA Doc 127, *Bulk Liquid Oxygen, Nitrogen, and Argon Storage Systems at Production Sites*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[14] EIGA Doc 219, *Guideline for Validation of Air Separation Unit and Cargo Transport Unit Filling for Medical Oxygen and Medical Nitrogen*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[15] EIGA Doc 63, *Prevention of Tow-Away Incidents*, www.eiga.eu.

NOTE This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[16] EIGA Doc 60, *Seveso Documents - Guidance on Applicability, Assessment and Legal Documents for Demonstrating Compliance of Industrial Gases Facilities with Seveso Directive(s)*, www.eiga.eu.

12 Additional references

References not used in the publication but useful.

EIGA Doc 23, *Safety Training of Employees*, www.eiga.eu.