



Recommendation for converting Inland Tank-Barges from Open to Closed Cargo Operations in South and Central America

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Glossary

Approved equipment Equipment of a design that has been tested and approved by an appropriate authority, such as a government department or classification society. The authority should have certified the equipment as safe for its intended use in a specified hazardous or dangerous area.

Closed cargo operations Ballasting, loading, or discharging operations carried out without recourse to opening ullage and sighting ports. The aim of closed cargo operations is to avoid any escape of vapours to the atmosphere. During closed cargo operations, seagoing and inland tankers will require the means to enable closed monitoring of tank contents, either by a fixed gauging system or by using portable equipment passed through a vapour lock.

CMR substance A substance that is carcinogenic, mutagenic or reprotoxic.

Competent person A person who has been adequately trained to undertake the tasks they are required to perform within their job description. For personnel in the shipping industry, they should be able to demonstrate this competence by the production of certificates recognised by the inland tankers administration.

Degassing An operation (gas-freeing) with the aim of lowering the concentration of dangerous gases and vapours in empty or unloaded cargo tanks by emitting them to the atmosphere or to reception facilities.

Explosion-proof (also referred to as ‘flame-proof’) Electrical equipment is defined and certified as explosion-proof when it is enclosed in a case that can withstand the explosion within it of a hydrocarbon gas/air mixture or other specified flammable gas mixture. It must also prevent the ignition of such a mixture outside the case either by spark or flame from the internal explosion or because of the temperature rise of the case following the internal explosion. The equipment must operate at such an external temperature that a surrounding flammable atmosphere will not be ignited.

Flame arrester A permeable matrix of metal, ceramic or other heat-resisting materials which can cool even an intense flame, and any following combustion products, below the temperature required for the ignition of the flammable gas on the other side of the arrester.

Flammable (also referred to as ‘combustible’) Capable of being ignited and of burning. For the purposes of this guide, the terms ‘flammable’ and ‘combustible’ are synonymous.

Flammable range (also referred to as ‘explosive range’) The range of hydrocarbon gas concentrations in air between the Lower and Upper Flammable Limits. Mixtures within this range are capable of being ignited and of burning.

Flashpoint The lowest temperature at which a liquid gives off sufficient gas to form a flammable gas mixture near the surface of the liquid. It is measured in a laboratory in standard apparatus using a prescribed procedure.

Flow rate The linear velocity of flow of liquid in a pipeline, usually measured in metres per second (m/s). The determination of the flow rates at locations within cargo pipeline systems is essential when handling static accumulator cargoes.

Inland tanker (barge) Any cargo vessel for the transport of bulk liquid cargoes for inland and port navigation. This includes self-propelled inland tanker, tank barge without propulsion operated by tugboats (push or towing).

Inland tanker Master/crew Either the Master/crew of the self-propelled inland tanker or the captain/crew of the tugboat when operating tank barges.

Intrinsically safe An electrical circuit, or part of a circuit, is intrinsically safe if any spark or thermal effect produced normally (i.e., by breaking or closing the circuit) or accidentally (e.g., by short circuit or earth fault) is incapable, under prescribed test conditions, of igniting a prescribed gas mixture.

Loading rate The volumetric measure of liquid loaded within a given period, usually expressed as cubic metres per hour (m³/h) or barrels per hour (bbls/h).

Management of Change (MoC) To establish procedures for evaluating and managing changes to operations, procedures, equipment, or personnel to ensure that all risks are identified and mitigated prior to implementing change.

Maximum Allowable Relief Valve Setting (MARVS) As stated on the inland tanker's Certificate of Fitness or equivalent.

Maximum Vapour Pressure (MVP) The maximum pressure exerted by a vapour in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in a closed system.

Oxygen analyser or oxygen meter An instrument for determining the percentage of oxygen in a sample of the atmosphere drawn from a tank, pipe, or compartment.

Pressure/vacuum relief valve (P/V valve) A device that provides for the flow of the small volumes of vapour, air or inert gas mixtures caused by thermal variations in a cargo tank.

Pump purging The operation of clearing liquid from submerged pumps.

Responsible officer (or person for loading or unloading) A person appointed by the company or the Master of the inland tanker and empowered to take all decisions relating to a specific task, and having the necessary qualifications, knowledge, and experience for that purpose.

Safety Data Sheet (SDS) A document identifying a substance and all its constituents. It provides the recipient with all necessary information to manage the substance safely. Guidance on the format and content of an SDS is given in the United Nations' Globally Harmonized System (GHS) of classification and labelling of chemicals.

Safety Management System (SMS) A formal, documented system required by the International Safety Management (ISM) Code, compliance with which should ensure that all operations and activities on board an inland tanker are carried out in a safe manner.

Sounding pipe A pipe extending from the top of the tank to the bottom through which the contents of the tank can be measured. The pipe is usually perforated to ensure the level of liquid in the pipe is the same as the level of liquid in the body of the tank and to prevent the possibility of spillages. The pipe should be electrically bonded to the inland tanker's structure at the deck and at its lower end.

Spread loading The practice of loading several tanks simultaneously to avoid static electricity generation when loading static accumulator cargoes.

Static electricity The electricity produced by movement between dissimilar materials through physical contact and separation.

Stripping The final operation in draining liquid from a tank or pipeline.

Topping-off The operation of completing the loading of a tank to a required ullage.

Topping-up The introduction of inert gas into a tank that is already in the inert condition with the object of raising the tank pressure to prevent any ingress of air.

Toxic cargo Cargos classified as toxic are listed in the relevant publication (for example ADN, IBC Code, IGC Code).

Ullage The space above the liquid in a tank, conventionally measured as the distance from the calibration point to the liquid surface.

Ullage Indicator (UI) A detector used to measure the ullage on a tanker.

Ullage Temperature Interface (UTI) A detector used to measure the ullage, temperature, and the oil-water interface onboard tankers.

Vapour Gas suspended in air (a mixture of gas from the cargo and the atmosphere).

Vapour balancing The transfer of vapour displaced by incoming cargo from the tank of a vessel receiving cargo into a tank of the vessel or facility delivering cargo via a vapour collection system.

Vapour Emission Control System (VECS) An arrangement of piping and equipment used to control vapour emissions during inland tanker operations, including inland tanker and shore vapour collection systems, monitoring and control devices and vapour processing arrangements.

Vapour lock system Equipment fitted to a tank to enable the measuring and sampling of cargoes without release of vapour or inert gas pressure.

Vapour Pressure (VP) The pressure produced by a vapour in contact with its liquid or solid form at a given temperature in a closed container. See also: Maximum Vapour Pressure.

Abbreviations

CMR	Carcinogen Mutagen Reprotoxic (substance)
GHS	Globally Harmonized System (of classification and labelling of chemicals)
kPa	Kilopascal
MARVS	Maximum Allowable Relief Valve Setting
MoC	Management of Change
P/V valve	Pressure/Vacuum relief valve
SCA	South and Central America
SDS	Safety Data Sheet
SMS	Safety Management System
UI	Ullage Indicator
UTI	Ullage Temperature Interface detector
VECS	Vapour Emission Control System
VOC	Volatile Organic Compound
VP	Vapour Pressure

Bibliography

European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) (UNECE)

Globally Harmonized System (GHS) (UNECE)

International Convention for the Safety of Life at Sea (SOLAS) (IMO)

International Maritime Dangerous Goods (IMDG) Code (IMO)

International Safety Guide for Inland Tank-barges and Terminals, Second Edition (CCNR/OCIMF)

International Safety Guide for Oil Tankers and Terminals, Sixth Edition (IAPH/ICS/OCIMF)

International Safety Management (ISM) Code (IMO)

ISO 16852 Flame Arresters: Performance Requirements, Test Methods and Limits for Use

Recommendations for Best Management Practices to Control and Reduce Inadvertent Cargo Vapor Emissions in the Tank Barge Community (CTAC/LDEQ/TCEQ/USCG/AWO)

1 Introduction

This information paper gives technical guidance to regional barge companies in South and Central America (SCA) on how to build or convert their inland barges for cargo operations under closed conditions, to conform to international standards and industry guidance. OCIMF publications and industry good practice form the basis of this guidance, which addresses the procedures and equipment needed to comply with this safety precaution during cargo operations at terminals or between two barges.

Open conditions are those in which ballasting, cargo operations are carried out with ullage and sighting ports open. In the SCA region, around 70% of barges inspected under OCIMF's BIRE inspection programmes are currently only equipped to operate under open loading conditions, potentially exposing personnel working on or near the tank-barge to vapours associated with the cargo. Open loading also raises the risk of fire or explosion during port calls when exiting tank vapours mix with the surrounding air, increasing the risk of developing a combustible atmosphere. Entering the flammable range, the vapours can ignite when exposed to an ignition source. This becomes a dangerous situation if equipment in the area is not properly grounded and maintained to ensure intrinsic safety.

Closed cargo operations take place without opening ullage or sighting ports, which lowers the safety risks outlined above.

Closed cargo operations can also lessen the environmental impact of loading and discharging cargo through better control of emissions.

1.1 Barriers to converting to closed cargo operations

A number of factors have slowed the expansion of closed cargo operations in South and Central America. These include the following:

- Inadequate conversions of existing barges.
- Lack of clear legal rules and guidelines for this region.
- Inadequate awareness and training of crew members, jetty personnel and industry stakeholders.
- Lack of guidance provided by industry stakeholders.
- Some terminals do not have the appropriate facilities.
- Some barges are not designed and/or well equipped to operate in closed conditions.

This paper offers guidance, helping to build awareness among personnel and industry stakeholders and to improve future barge conversions.

Inland barging operations in SCA region encompass several countries, waterways, different regulations and varying resources for construction, maintenance and service providers. Bearing in mind these complicating factors, this information paper aims to outline a process for closed cargo operations, which can be implemented throughout the region.

2 Closed cargo operations

The *International Safety Guide for Inland Navigation Tank-barges and Terminals*, Second Edition (ISGINTT 2) and the *International Safety Guide for Oil Tankers and Terminals*, Sixth Edition (ISGOTT 6) recommend that ballasting, loading and discharging operations should be carried out without opening ullage and sighting ports, to avoid any escape of vapours to the atmosphere. During closed cargo operations, inland tankers will need the means to enable closed monitoring of tank contents.

The following guidance on closed cargo operations is from *ISGINTT 2*, section 11.1.6.6A:

For effective closed loading, cargo should be loaded with the ullage, sounding and sighting ports securely closed.

For most volatile products, local, national, or international legislation may prohibit the venting of cargo vapours to the atmosphere. If this is the case, closed loading must be used in conjunction with vapour balancing with the loading terminal. In this case, the terminal must ensure that the maximum vapour pressure inside the cargo tank of the tanker will not reach the setting of the high-pressure velocity valve at any stage of the operation.

If the cargo vapours displaced by the incoming cargo cannot be balanced to the terminal, and as for a safety measurement, it must be possible to vent these vapours to the atmosphere through high-velocity valves to ensure these gases are taken clear of the cargo deck. Devices fitted to vent stacks to prevent the passage of flames should be regularly checked to confirm they are clean, in good condition and correctly installed.

To undertake closed loading, the vessel should be equipped with ullaging equipment that allows the tank contents to be monitored without opening tank apertures.

There is a risk of overfilling a cargo tank when loading under normal closed conditions. Due to the reliance placed on closed gauging systems, they should be fully operational, and a backup provided in the form of an independent overfill alarm arrangement. The alarm should provide audible and visual indication and be set at a level that will enable operations to be stopped before the tank is overfilled. Under normal operations, the cargo tank should never be filled higher than the level set for the overfill alarm.

Individual overfill alarms should be tested at the tank before loading starts to ensure they are operating properly, unless the system is provided with an electronic self-testing capability that monitors the condition of the alarm circuitry and sensor and confirms the instrument set point.

After testing the overfill alarms, if it appears the overfill alarm is not working properly loading should not start.

On vessels without inert gas systems, this equipment should comply with the precautions highlighted in section 11.8.2 [of *ISGINTT 2*].

The precautions during discharge are mentioned in *ISGINTT 2*, section 11.1.14.3, as below:

On tankers, discharging, gauging, and sampling should normally be carried out with all ullage, sounding and sighting ports closed. Air should be admitted to the tanks by the dedicated venting system or via the vapour return lines.

If, for any reason, the air admitted via the normal venting system is not at a sufficient rate, air may be admitted via a sighting or ullage port that is fitted with a permanent flame screen. In this situation, the tanker is no longer considered to be closed discharging.

OCIMF strongly recommends closed cargo operations with the use of a vapour return system to the shore facility for products with the following properties (this information can be found in the oil product Safety Data Sheet):

- Flashpoint < 23°C and explosivity range > 15% at 20°C.
- Flashpoint < 23°C and corrosive.
- Auto-ignition temperature < 200°C.
- Toxic substances.
- Halogenated hydrocarbons.
- Benzene and mixtures containing more than 10% benzene.

- Substances that can only be transported while stabilised.
- Substances characterised by acute or chronic aquatic toxicity and Vapour Pressure (VP) at 50°C > 1 kilopascal (kPa).
- Flashpoint < 23°C and chronic 2 or 3 aquatic toxicity.
- Flashpoint < 23°C and floating on water or sinking to the bottom.
- Corrosive substances PG I and II with VP at 50°C > 12.5 kPa.
- Corrosive substances that react dangerously with water.
- Corrosive substances containing gases in solution.
- Acute or chronic toxicity and VP at 50°C > 1 kPa.
- Substances with a long-term effect on health – Carcinogen Mutagen Reprotoxic (CMR). See chapters 3.5, 3.6 and 3.7 of the *Globally Harmonized System (GHS)* of classification and labelling of chemicals.

3 Applying closed cargo conditions onboard inland tankers

This section outlines the recommended equipment and systems to have onboard when carrying out closed cargo operations during loading and discharging. It also gives guidance on inspection and maintenance of equipment.

In some cases, alternative options are given where local conditions may play a part in deciding which systems/equipment to use. In making this decision, the barge company should consider which products are being carried, the available regional maintenance support and local service providers.

Topic	Method	Maintenance and remarks
Ullaging and sampling	Fixed gauging system	Annual review, calibration, and certification of the equipment. Control of status and charge of batteries and associated equipment (solar panels).
	Vapour lock	Certification of valves. Verify valve tightness in each operation.
	Portable Ullage Temperature Interface detector (UTI) or Ullage Indicator (UI)	Confirm functionality in each operation. Annual review, calibration and certification of the equipment as prescribed by the manufacturer. If UI is in use the temperature of the cargo should be taken under closed conditions.
	Portable sampler	Certification of the sampler. Annual review, calibration, and certification of the equipment.
Level alarms	High level alarm (95%) or high-high level alarm (98%)	Verify functionality before each operation. Check visual and audible alarms. Control charge of batteries and associated equipment (solar panels). Annual review, calibration, and certification of the equipment.

Topic	Method	Maintenance and remarks
Cargo monitoring	Radar tank	Annual review, calibration and certification of the equipment. Control charge of batteries and associated equipment (solar panels). Contrast with the UTI/UI value.
	Fixed indicator gauging indicator	Review, calibrate and certify equipment at each survey or intermediate survey. Contrast with the UTI/UI value.
	Sighting port with screen wiper	Tightness control in each operation. Rubber gaskets and glass wiper should be maintained in good operational condition.
	Radial arm gauge tree	Review, calibrate and certify equipment at each survey or intermediate survey. Device should be certified by a competent entity/ authority.
Venting: primary system	Valves: Pressure/ Vacuum (P/V) hi-jet	One P/V hi-jet valve should be installed per tank. Before cargo operation, test opening pressure and vacuum valves. Periodic cleaning of flame arrestor. Regular maintenance, calibration and certification according to manufacturer and/or local authority.
Venting: secondary system – option 1	Valves: P/V or P/V hi-jet	One P/V or P/V hi-jet valve should be installed per tank. Before cargo operation, test opening pressure and vacuum valves. Periodic cleaning of flame arrestor. Regular maintenance, calibration and certification according to manufacturer and/or local authority.
Venting: secondary system – option 2	Mast riser	If using a mast riser, the line to the mast riser should be equipped with a P/V hi-jet valve. If using a mast riser, barges with two or more segregations must have an independent mast riser per segregation, to avoid contamination of products. Regular maintenance, calibration and certification according to manufacturer and/or local authority.
Venting: secondary system – option 3	Pressure sensor	Regular maintenance, calibration and certification according to manufacturer and/or local authority. Control charge of batteries and associated equipment (i.e. solar panels). Visible and audible alarms should be tested regularly.
Note to all venting options:		If the secondary medium is a P/V hi-jet valve located in the same pipe as the primary medium, it should be set at a maximum pressure 10% higher than the primary medium.

Table 3.1: Systems, equipment and maintenance required for closed cargo operations

4 Risks from inadequate conversion

Inadequate conversion from open to closed cargo operations can increase the following risks:

- Tank deflection/over pressurisation.
- Inadequate product level monitoring.

To avoid these risks, any existing barge being converted from open to closed condition should have:

- Structural and stress review and evaluation, on a technical basis, which should include but not be limited to the calculation of the maximum tolerable pressures per the bulkheads of the loading tanks, cofferdams, and their associated structures, as well as loading and ballast lines and valves (if any).
- Equipment evaluation according to the technical requirements outlined in section 3.
- Evaluation of equipment according to the minimum technical characteristics that are typical of the operation (loading/unloading capacities vs vents). Ventilation arrangements should be considered in such a way as to ensure that neither the pressure nor the vacuum in the cargo tanks exceed the designed parameters.
- Such studies should be endorsed by the Flag Authority in conjunction with the Classification Society. If a barge is not classed, then this should be approved by an equivalent competent authority.

5 Testing and maintenance

Maintenance and periodic testing of the items listed in table 3.1 should be included in the technical operator's Planned Maintenance System. Records of testing should be kept on board.

6 Training

All personnel involved in closed cargo operations (Person in Charge, technical superintendent, vessel crew, etc.) should be trained on the risks and proper use of the equipment. The technical operator's Safety Management System should include closed cargo operations procedures and guidelines for using the related equipment.

7 Class involvement and certification

All equipment installed as stated in table 3.1 should be approved by a class society, or if the barge is not classed then by an equivalent competent authority.

8 Other issues for consideration

Stripping operations: Cargo pumps should be able to complete discharge (final stripping included) in closed condition. If this is not the case, a suitable stripping system should be fitted (dedicated fixed pumps, lines and valves).

It is advised that during topping-off operations, there should be as many UTIs in use as there are tanks topping-off simultaneously. This implies that every UTI should be attended by a person. It is strongly recommended that there be at least one, ideally two, spare UTIs available on board.

Any barge conversion should be accompanied by a Management of Change process. See *ISGINTT 2*, section 9.2.5: Management of Change for guidance.

Appendix A: Examples of equipment for use in closed cargo operations



Fig 1: Fixed gauging system



Fig 2: Vapour Lock



Fig 3: Portable UTI meter



Fig 4: Portable Sampler



Fig 5: High level alarm (95%) / High-high level alarm 98%



Fig 6: Radar tank

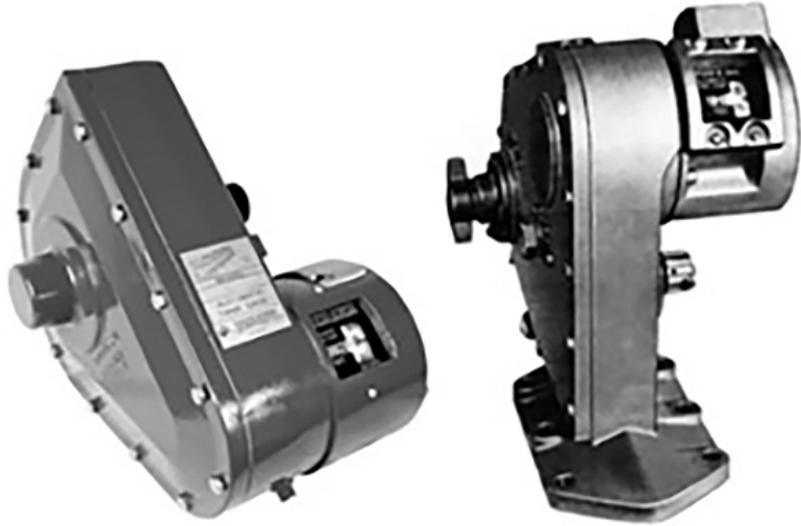


Fig 7: Fixed Gauging Indicator



Fig 8: Sighting port with screen wiper



Fig 9: Radial arm gauge tree

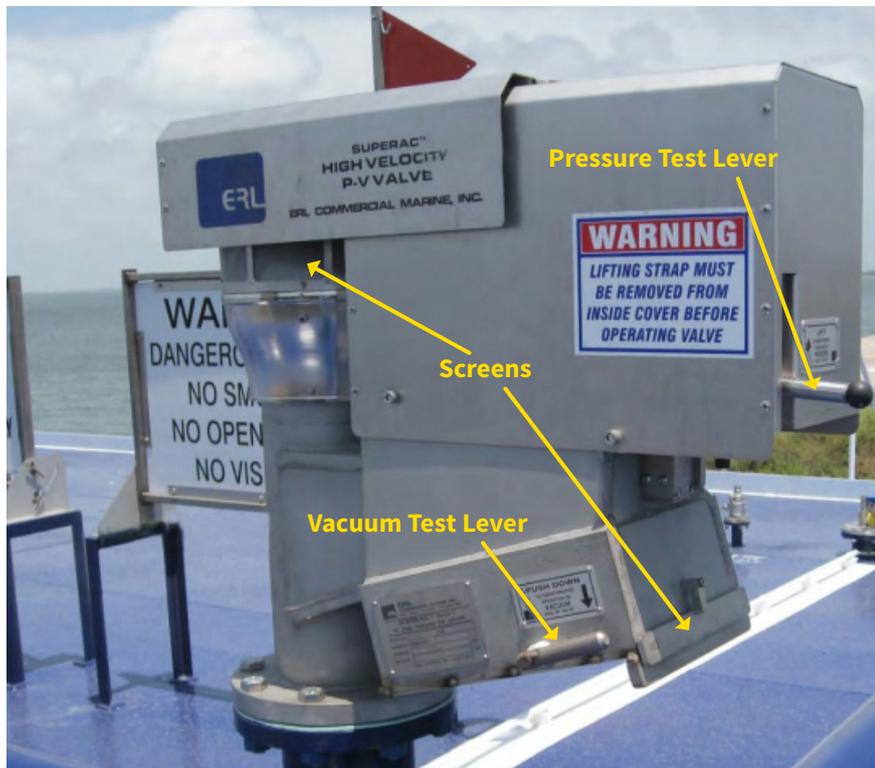


Fig 10: P/V High-Jet



Fig 11: *P/V Valve*



Fig 12: *Mast Riser*



Fig 13: *Pressure sensor*



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