StopLoss

Flexitanks in the supply chain

Defining safe operations

TT CLUB
IS MANAGED
BY **THOMAS MILLER**

CONTAINER OWNERS ASSOCIATION

Contents

StopLoss series

StopLoss briefings are developed on a broad range of topics that give rise to recurring problems. They seek to provide a straightforward summary of an issue, essential good practice advice and, where applicable, sources of further information. The complete series and further information is available at www.ttclub.com/lossprevention and printed copies are available from the TT Club's Regional Centres.

Acknowledgements

TT Club gratefully acknowledges the assistance of Bill Brassington (ETS Consulting), Lynn Stacy III and Clint Sandridge (OEC Liquid Logistics Solutions) and the Container Owners Association in the development of this briefing.

Disclaimer


American Rice, Inc.
tex

Abstract

An increasing number of shippers recognise the perceived benefits of shipping their bulk liquid cargoes in flexitanks. The demand continues to grow globally, with the consequence that manufacturing and use proliferate.

In essence a flexitank is a large single use bladder with valves designed to fit inside a general purpose freight container. The flexitank operates as part of a system which includes the container, flexitank, its fittings and restraining system.

While there are potential advantages, the use of flexitanks as a form of packaging to contain and transport liquids does introduce additional considerations and risks at various stages of the supply chain. This StopLoss seeks to identify the applicable risks, highlight good practice and provide practical risk mitigation guidance for those in the supply chain who procure, fit, pack, unpack and handle cargoes being shipped in flexitanks.

Who is this for?

- Shippers of bulk liquids
- Receivers of bulk liquids
- NVOCC
- Freight forwarders
- Haulage operators (road/rail)
- Container (CTU) operators
- Terminals and facilities handling packed CTUs

1

Introduction

In this section:

- History of the industry
- Market position
- Objective and scope of guidance

1.1 History

The container industry is widely recognised for innovation to meet the demands to transport different types of cargo, leading to the introduction of temperature controlled units, tank containers and bulk containers (for transport of goods such as grain). Equally important to the logistics industry have been developments in packaging intended to leverage the versatility of the box and accommodate differing cargoes and trades successfully.

An example of such packaging developments has seen the replacement of fabric bags, used to retain dry bulk cargoes, with plastic bags fitted inside the container, capable of holding bulk liquids in a similar way to a "tank container". The perceived benefits are that the number of empty container movements can be reduced and cleaning costs can be nearly eliminated, because the plastic bags used ("flexitanks"/"flexis") are generally single use. See Section 6 for a discussion of disposal and recycling.

The flexitank concept emerged in the mid-1970s, initially experimenting with heavy duty rubberised bladders. These were reuseable, albeit they required specialist cleaning and servicing.

In the early 1990s, the rubber flexis were replaced with those made of thermo-plastic (PVC) materials. Early adopters included chemical shippers for the transport of non-regulated liquid shipments. A key benefit for such cargoes was the lower tare weight compared to packing drummed material. A 20-foot container may typically handle 80 drums of about 16,000 litres, compared to 24,000 litres in a containerised flexitank. In order to facilitate the flexitank supply chain, businesses selling the bags started offering "supply and fit" services.

In late 2001 newer and cheaper flexitanks made from multiple layers of thin polyethylene entered the market, overtly becoming one-way, disposable packaging. Growth in this marketplace has attracted attention, both in terms of defining and maintaining quality, as well as a general acceptance of issues relating to the deformation of container side and end walls, and broader risks of operation. An important point to note is that flexitanks are not an approved form of packaging under the International Maritime Dangerous Goods Code (IMDG Code[1]); consequently, cargoes that are classified within the Dangerous Goods regulations shall not be transported in flexitanks.

[1] https://www.imo.org/en/OurWork/Safety/Pages/DangerousGoods-default.aspx#:~:text=The%20IMDG%20Code%20was%20developed,prevent%20pollution%20to%20the%20environment

1.2 Market position

There is clear evidence that the number of packed containers fitted with a flexitank is growing, although there are a number of reasons why an exact number is difficult to establish, including:

- Manufacturers may be reluctant to provide accurate information;
- Data may relate to sales, rather than packing or transport of cargo;
- Shippers using flexitanks may be reluctant to provide data on their consignments; and
- Buyers of flexitanks may be using them for storage rather than transport.

Nevertheless, various industry data have been compiled over the last decade. In general, it would appear that the market for flexitanks continues to grow strongly and is likely to be now well in excess of one million shipments each year. In that context, this briefing aims to identify risk factors that need to be considered, together with guidance on good practice.

1.3 Objective and scope of guidance

Environmental issues and logistics costs have contributed to the change in the transport of liquid cargoes, most notably wines and oils, and the introduction of the flexitank meant that did not have to rely on the availability of tank containers. However, the use of the flexitank does not come without risk and environmental impact. In particular, the nature of the flexitank means that if a failure occurs the entire cargo can be lost, sometimes with substantial costs to the shipper.

The transport of bulk liquids in dry freight containers is growing rapidly but has a history of serious damage and failures, often caused by manufacturers and operators not fully understanding the stresses and forces that containers are subjected to in the transport chain.

This document considers all of the issues associated with the selection, fitting, filling and transport of bulk liquid cargoes using a flexitank system. It should be read in conjunction with the IMO/ILO/UNECE Code of Practice for Packing Cargo Transport Units (CTU Code[2]) and the Container Owners Association's (COA) Flexitank Code of Practice[3]. This guidance will reference and build on the issues and topics covered in both.

It has been written to provide guidance on the safe and reliable containment of the flexitank cargo and to ensure the freight container is used and handled without detriment to its structural integrity, the cargo or other interests in the freight supply chain.

The transport of bulk liquids in dry freight containers is growing rapidly

2. https://unece.org/transportintermodal-transport/imoilounece-code-practice-packing-cargo-transport-units-ctu-code
3. https://www.containerownersassociation.com/wp-content/uploads/2018/03/COA-Flexitank-Code-of-Practice-V6-O-Operators-07.2019a.pdf

2

Physical characteristics

In this section:

- Flexitank features, types & accessories
- Construction quality

2.1 Flexitank features

There are two primary types of flexitank, most commonly produced from polyethylene (PE), in the market – Single Layer and Multilayer. Both have individual benefits. The most commonly used are Multi-layer units, typically being more cost-effective to manufacture and providing a more rigid design.

Single layer flexitanks cost more to manufacture, but translucency enables sight of the cargo. They are not as readily available in the market.

2.2 Single Layer Flexitanks (SLF)

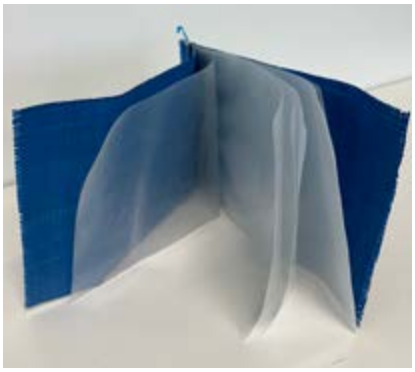
In general, single layer flexitanks are manufactured from a single sheet of co-extruded PE – approximately 40mil or 1000mu (micron) in thickness. They are more suitable for recycling.

SLFs use materials such as ethylene vinyl alcohol (EVOH[4]) and aluminium as barriers. These barriers are added to single layer flexitanks as external sleeves.

2.3 Multilayer Flexitanks (MLF)

Multilayer flexitanks consist of between two and five layers of PE, generally with a polypropylene layer outer shell. The number of layers is determined by what cargo the flexitank is intended to carry (e.g. cargoes that require a taint/barrier layer would have at least four inner plies of material, one of which would be the barrier layer).

Generally, the thickness of material ranges from 100mu through to 500mu per layer. An external layer of material is usually present on MLFs. Each manufacturer will have their own preference or design – most commonly used is a cross woven layer of PE.



Picture 1 – example of a MLF
(Image Courtesy of OEC Group)

4. Ethylene–vinyl alcohol (EVOH) is a copolymer of ethylene and vinyl alcohol. It has excellent barrier resistance to certain cargoes and therefore used to enhance packaging properties.

2.4 Permeation and transmission

Due to PE type materials' ability to absorb and release odours, and sensitivity of certain cargoes (e.g. wine) to contamination or environmental impacts, flexitanks should include an efficient barrier material against exterior factors. The barrier material needs to perform well under varied conditions, such as transport in seasonal and geographic heat and humidity.

Equally, the flexitank material should be of such a thickness that contaminants cannot penetrate it within a reasonable time. PE materials will, after a certain amount of time, allow penetration, but generally thick material will form a longer lasting barrier than thin material. The speed of degradation will depend on various factors, including the cargo within the flexitank (e.g. solvents or oils) and the external environment (e.g. temperature). It is essential that the shipper is aware of the time the cargo is likely to be held in the flexitank.

It is recommended that the shipper interacts with the manufacturer in relation to the product, environmental factors and duration to mitigate the risks of permeation and impact on product quality.

2.5 Contaminant and oxygen barriers

Most multilayer flexitanks have a barrier layer, consisting of either EVOH or a metallised (aluminiumised) barrier or an aluminium foil. The selection and installation of an appropriate barrier layer is critical.

Some cargoes – such as wine – are sensitive to oxygen as well as chemical contaminants. However, while EVOH may be appropriate for the movement of wine, aluminium will dissolve when in contact with wine. Conversely, aluminium barrier material may be appropriate for solvents and white oils to prevent permeation.

There appears to be a correlation between oxygen barrier properties and barrier properties to other compounds. However, this has not been thoroughly investigated.

Table 1 – General comparison of SLF and MLF

		Single layer	Multilayer
1	Translucent	●	○
2	Cargo Heat Tolerance	●	●
3	Pliability, especially in colder weather	○	●
4	One way, disposable, recyclable	●	●
5	Risk of cargo entrapment between layers	○	●

Advantage ● Disadvantage ○

2.6 Flexitank Accessories

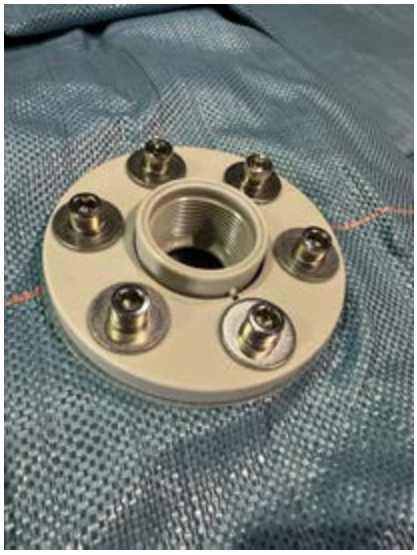
2.6.1 Valves

Flexitanks should be fitted with valve collars that are secured to the flexitank material using mechanical fixings which are capable of withstanding the pressures associated with the approval testing (Picture 2).

The tank may be fitted with a top valve, with a bottom valve or with both. Either construction may allow the tank to empty completely, depending on exterior conditions, e.g. ground slope and pumps.

Pictures 3 to 5 show examples of common valves used.

- Valves are generally ball or butterfly designs
- Valve diameter is generally 2" and 3", although larger diameters are also available.



Picture 2 – Valve collar
(Image Courtesy of OEC Group)

Picture 4 – Butterfly design valve
(Image Courtesy of OEC Group)

Picture 3 – Butterfly design valve
(Image Courtesy of OEC Group)

Picture 5 – Ball design valve
(Image Courtesy of OEC Group)

2.6.2 Other fittings

Some flexitanks may be fitted with a pressure relief valve. This allows for gassing that may happen from cargoes, such as wine, certain juices and products with 'live' bacteria (e.g. liquid fertilizer), enabling CO2 to escape if:

- CO2 is produced from the cargo as a consequence of raising temperatures, turbulence during transport or an elevated CO2-content;
- post fermentation occurs due to residual sugars, insufficient filtration or deficient hygiene measures taken at the time of filling.

A sample valve is rarely fitted. However, it is possible to take multi-level samples from the top valve. For a bottom valve tank, a cap with a sample valve may be fitted, which will allow the drawing of samples.

2.6.3 Bulkheads & side wall reinforcement

There are various designs of bulkhead provided by the flexitank manufacturers, using materials such as steel frame and polypropylene (with steel bars).

The various designs of bulkhead have a number of materials used as backing to provide additional strength, including cardboard, corrugated plastic, EPS polystyrene and, to a lesser extent, plywood.

Bulkhead design differs for the flexitanks with bottom discharge, which require a port through which the filling/discharge valve is fitted.

Bulkheads need to be sufficiently strong so as to prevent the flexitank applying any pressure onto either door. Once in place, they should also be strong enough to support an operator climbing into the container safely if access is required during the filling or discharge process.

Reinforcement of the container side wall, placing rectangular hollow section bars in the corrugations, may be used to reduce deformation.

Picture 6 - An example fitted bulkhead (Image Courtesy of OEC Group)

2.6.4 Heating mats/pads

Heating mats or pads are produced with steam or electrical heating elements and are designed to fit under the flexitank to reheat the cargo evenly before unpacking. Cargoes with a low melting point solidify when subjected to low temperatures; a heating mat allows the cargo to return to the liquid state again for discharging.

Generally, heating mats permit the user to choose the size of the heating element, as well as the energy source, and precisely define the desired heat distribution. Thus, round heating foil elements, 3D heating elements or even flexible heating mats for seat heating are possible.

2.7 Construction quality (COA Code of Practice & PAS1008:2016)

The COA played a leading role in improving the safety of flexitanks through the development of a Code of Practice (CoP) and a Publicly Available Specification (PAS) which describe procedures for accreditation and a series of test programmes. The COA initiative arose from industry concerns that container assets are damaged or weakened by side wall deformation due to flexitank static and surge forces.

The CoP[5] has been amended regularly and provides manufacturers and users of flexitanks with important information with regard to the obligations of the four main participant groups:

COA

The providers of the Code of Practice for a single use flexitank system, managing the COA Quality Conformance (CQC) system and the Flexitank Quality List (FQL).

Flexitank Manufacturers

Ensuring that flexitank systems meet the specified quality and design, and are fit for purpose, together with providing operating instructions and training procedures to enable operators to have the necessary competencies to provide safe and reliable transport.

Flexitank Operators

Undertaking a risk assessment to ensure that the use of a flexitank container system is only when the outcome supports safe and reliable transport, operating it in accordance with the manufacturer's instructions and best practice, transporting only cargoes that are classified as non-regulated (non-dangerous) and are entirely compatible and suitable for the flexitank system, and managing recycling and disposal of used flexitank systems in an environmentally responsible fashion.

Ocean Carriers (Shipping lines)

Ensuring that the flexitank system fulfils the carrier's requirements for its conditions of carriage, by undertaking a risk assessment of the flexitank system and the cargo, including referring to the COA Flexitank Quality List.

5. TG-07 CODE OF PRACTICE FLEXITANK CONTAINER SYSTEMS 2021.

In partnership with the British Standards Institute (BSI), COA worked on a "Specification for the manufacturing process and testing of flexitanks", which was published in 2014 as Publicly Available Specification[6] (PAS) 1008; this was amended and the current version was published in 2016.

The PAS specifies requirements for:

i. the material properties of the flexitank film and, where fitted, the sleeve;

ii. the leak tightness of the filling/discharging valve(s);

iii. the flexitank system's resistance to a rail impact defined as a 2g (gravitational unit) retardation or acceleration force;

iv. the provision of flexitank information.

It describes a method for testing the leak tightness of the filling/discharging valve(s) and a method of determining suitability for intermodal transport by means of a rail impact test of the flexitank when installed in a general purpose freight container together with its restraining system.

The PAS and the CoP have jointly reduced the risk of a failure to flexitank systems mainly by the introduction of consistent and meaningful testing.

Flexitanks undergo *rail impact tests*, prior to supplying the system on a general commercial basis, to determine whether the system has satisfactory performance characteristics to be suitable for the intended application.

Sample tests are tests performed on material samples taken from completed components or the system, at a specified frequency.

Routine tests are tests performed on manufactured items to check whether the given item meets the specified requirements.

Three sets of tests are carried out as described in the following paragraphs.

The CQC also includes an installation and training manual, recognising that installation is crucial to safe transport, Shippers should require that operatives are trained in accordance with the manufacturer's manual. Quality management programmes (such as ISO 9001 or 14001) may also be expected to enhance the reliability of flexitank operations.

2.7.1 Materials

The flexitank film shall be subject to sample testing to determine whether the material properties determined in accordance with test standards specified in Clause 4 of the PAS have been maintained. Sample testing shall be carried out at a minimum once per 100 flexitanks manufactured per material specification/size irrespective of the flexitank design or capacity and where a new material roll from a new batch or a new batch of material is used.

2.7.2 Filling and discharging valves

Each filling and discharging valve shall be subject to routine testing to determine whether it conforms to Clause 5 of the PAS for leakage. The routine testing shall be carried out in accordance with Annex D of the PAS, a maximum of 72 hours before dispatch of the valve to the finished goods inventory.

2.7.3 Flexitank system rail impact test

The flexitank system shall be subject to testing to determine whether it conforms to Clause 6 of the PAS for performance. This should be repeated following changes to the design (e.g. change in flexitank film used) or manufacture (e.g. change of supplier of a flexitank film) of the flexitank.

6. Publicly Available Specification (PAS) is a standard developed by BSI British Standards commissioned by an external organization. Such external bodies have included, UK Government, trade associations and private companies.

2.8 COA Flexitank Quality List (FQL)

The Code of Practice requires that the COA membership of flexitank manufacturers and operators comply with the COA quality management system and submit to independent quality audits and tests of the flexitank.

Conformance with the Code of Practice forms part of the COA shipping line (carriers) risk assessment process when evaluating container flexitank systems for carriage by sea.

On satisfactory completion of five audits and the tests, the manufacturer achieves COA Quality Conformance (CQC) and may be entered onto the Flexitank Quality List (FQL).

The COA Flexitank Quality List (FQL) provides a list of flexitank original equipment manufacturers (OEM) and operators of flexitanks that have been awarded the COA Quality Conformance (CQC).

An OEM is the company that manufacturers the flexitank, constructing the flexitank from materials purchased from suppliers. The OEM designs, develops and undertakes quality assurance, but might additionally manufacturer flexitanks designed or modified by a flexitank operator or another company.

An Operator procures and manages the use of the flexitank including providing services such as supply, cargo risk assessment, transport logistics, arranging installation into the container and removal of the used flexitank and recycling. Some operators might design flexitanks to meet their own requirements and arrange manufacture of their design by an OEM.

Both OEMs and operators may offer more than one design of flexitank. Each design must undergo CQC auditing, repeated where there is a change of design or materials.

The FQL is used as a reference for shipping line risk assessment and is regularly updated.

Table 1 lists COA member companies that achieved the COA Quality Conformance (CQC)

The FQL seeks to define effective incident management and provides information to carriers for use as part of their risk assessment process[7]. The CoP requires that the carrier, shipper, operator, manufacturer or other contracted party or emergency responder, should immediately take actions to safeguard the health and safety of personnel, the public, the environment and take measures to minimise any leakage. The emergency plan should be enacted as appropriate.

The COA Flexitank Quality List (FQL) provides a list of flexitank original equipment manufacturers (OEM) and operators of flexitanks that have been awarded the COA Quality Conformance (CQC)

[7] https://www.containerownersassociation.com/coa-fqml/


CMA CGM
BEST
1171
761 625
TRANSWORLD
EQUIPMENT
732-389-1836
TRANSWORLD
EQUIPMENT
732-389-1836

3

Operations

In this section:

- Flexitank selection for shipment
- Cargo compatibility
- Transit considerations

3.1 Selection for shipment

3.1.1 Cargo considerations

When considering whether a cargo is suitable for transport in a flexitank consider the process on the oposite page.

Most common cargoes carried and the risks that they present;

The most common cargoes shipped in flexitanks are:

- foodstuffs – molasses, glycerine, fruit juices, egg products
- wines and spirits – wine, beer, water
- chemicals – bio-diesel, glycol, polyol
- oils – base oils, edible oils
- industrial products – latex
- pharmaceutical products

Certain cargoes (as identified in 2.6.2 above) may be subject to fermentation during transport and the selection of the flexitank must be appropriate. Improper selection may result in the flexitank expanding and damaging the container structure.

Many of the cargoes carried in flexitanks (such as foodstuffs, wines and spirits) present less material risk should there be a serious leak, while others (such as oils and latex) may severely impact the operation of a facility (ship, terminal, roadway etc) should a leak occur. For these cargoes, a leak can result in significant disruption and clean-up costs.

Further, environmental controls may also mean that a leak of some easily disposed of cargoes, such as wine, beer and fruit juices, require containment, dilution or cleaning before it enters the waste water system.

3.1.2 Flexitank selection

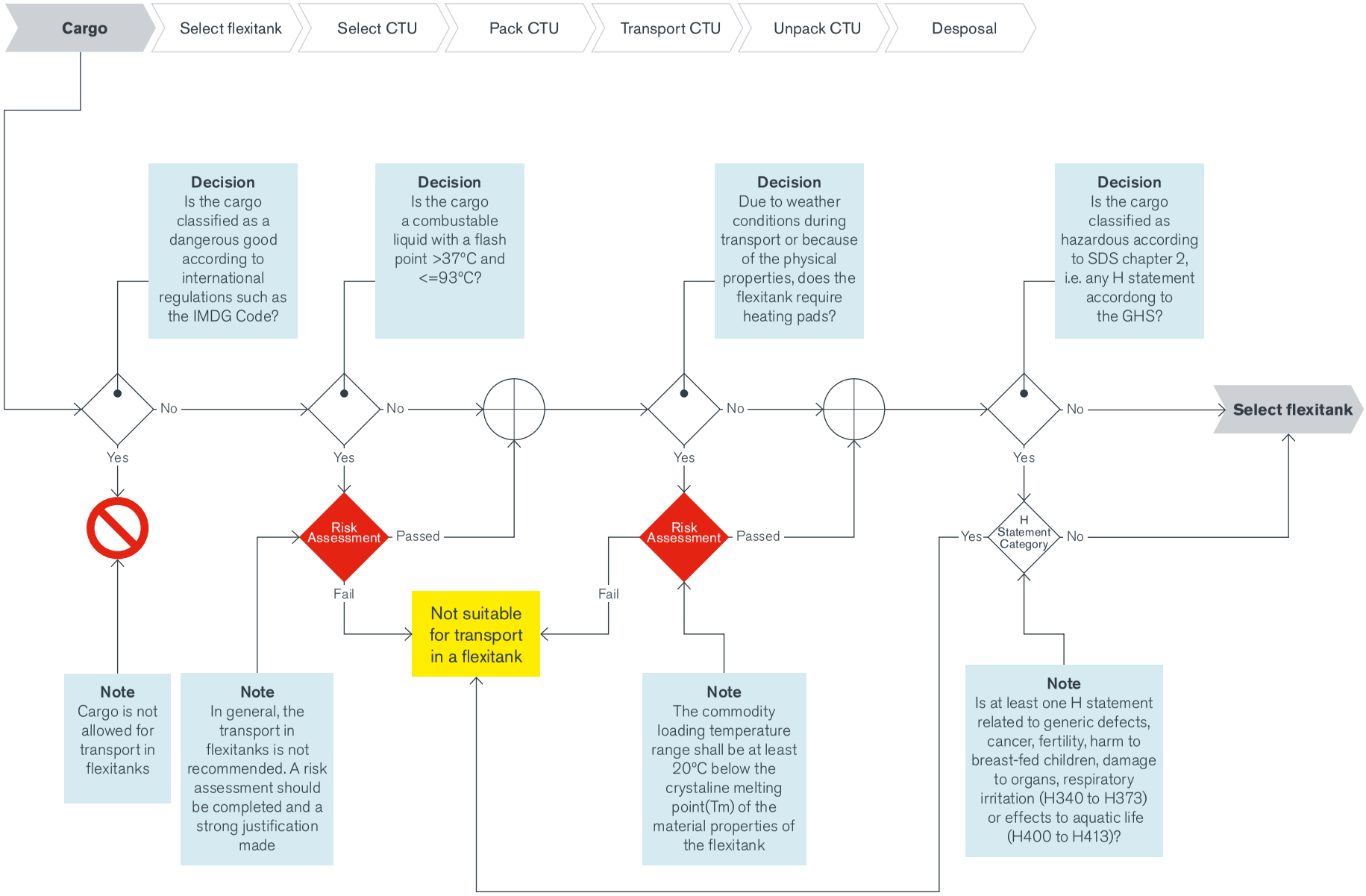
Although the term 'flexitank' is used in this document, it should be properly described as a flexitank system which refers to a system used for the transport of a liquid cargo and comprised of a flexitank, a restraining system[8], if used, a constraining system[9], if used, and a general purpose CTU.

When the system is used, all parts of the tested and audited system should be operative. That means that restraining or constraining systems must be identical to that tested. Failure to do so nullifies the COA CQC process.

In order to meet the requirements of the latest edition of the COA CoP and the latest version of PAS1008, a flexitank needs to be manufactured out of virgin, high quality, food contact approved materials (not recycled).

8. Structure that is used to prevent the flexitank from making contact with the door of the CTU.
9. Structure that is used to reduce the pressure of the flexitank on the walls of the CTU.

Figure 1 – Flexitank Transport process – Cargo



(Courtesy of ETS Consulting)

3.1.3 Cargo compatibility

The material used to construct the flexitank and components must be compatible with the intended cargo; the compatibility of new cargoes must be tested in advance. Where a new cargo has similar chemical properties to other cargoes already being carried, further compatibility testing may not be required.

The material of the flexitank must not be damaged or weakened by the cargo carried. Conversely, the cargo needs to be protected from potential contamination from the material used in the construction of the flexitank.

Cargoes that oxidise for example or can be affected by external atmospheric conditions may require an appropriate barrier layer to be incorporated into the manufacture of the flexitank, or necessitate additional accessories to be used.

Flexitank operators should develop and follow a strict cargo compatibility approval process, nominating an expert or company who is sufficiently qualified to determine if the cargo being shipped requires a specific type of flexitank or accessory to ensure containment and safe shipment.

Some operators will conduct their own cargo compatibility testing through static loading for defined period, immersion testing or heat trial testing.

When considering selection of an appropriate flexitank system, the following process should be considered:

Selecting a flexitank is more than just finding a flexitank and fitting it into a container.

Its starts with a partnership between the manufacturer and the operator or shipper.

Manufacturers should provide:

- flexitanks that are fit for purpose.
- flexitanks that, as a minimum, meet the provisions of the CoP.
- provide installation and operating instructions to the operator or shipper to ensure best practice and safe, reliable transport.

Operators and *shippers* should:

- select a flexitank manufacturer who has had their flexitank tested, audited and listed in the COA Flexitank Quality Management List – FQML[10] with the status COA Member Certificate of Compliance.
- operate the flexitank system in accordance with the manufacturer's instructions and best practice to ensure safe and reliable outcome.
- carry out appropriate risk assessments of the flexitank system and the cargo.
- transport only cargoes that are classified as non-regulated (non-dangerous) and are compatible with the flexitank system.

Using a flexitank that has not been tested, audited and listed in the COA FQL does not mean that it is not suitable for the cargo, but the risk of an incident or damage to the CTU may be increased and carrier due diligence processes may impose additional requirements or lead to the booking being rejected.

3.2 Transit considerations

Where practicable, intermodal terminal operators must be made aware of the presence of a flexitank system and, if appropriate, the cargo carried.

Depending on the transit length as well as modes of transport employed, considerations need to be made in relation to the loading parameters and flexitank system used.

Flexitanks have load tolerances +/- the nominal volumetric capacity allowing for a spectrum depending on the capability of the filling facility to measure cargo volume. When taking into consideration multi-modal transport over long distances, ensuring that the flexitank is (at minimum) filled to its nominal capacity or even slightly more should be part of the SOP for the flexitank operator. This is especially so when moving flexitank systems by rail or long distances over the road. This will mitigate the risks associated with free surface movement. Cargo surges in transit can place additional stress on the flexitank system, increasing the likelihood of failure and the occurrence of containment issues.

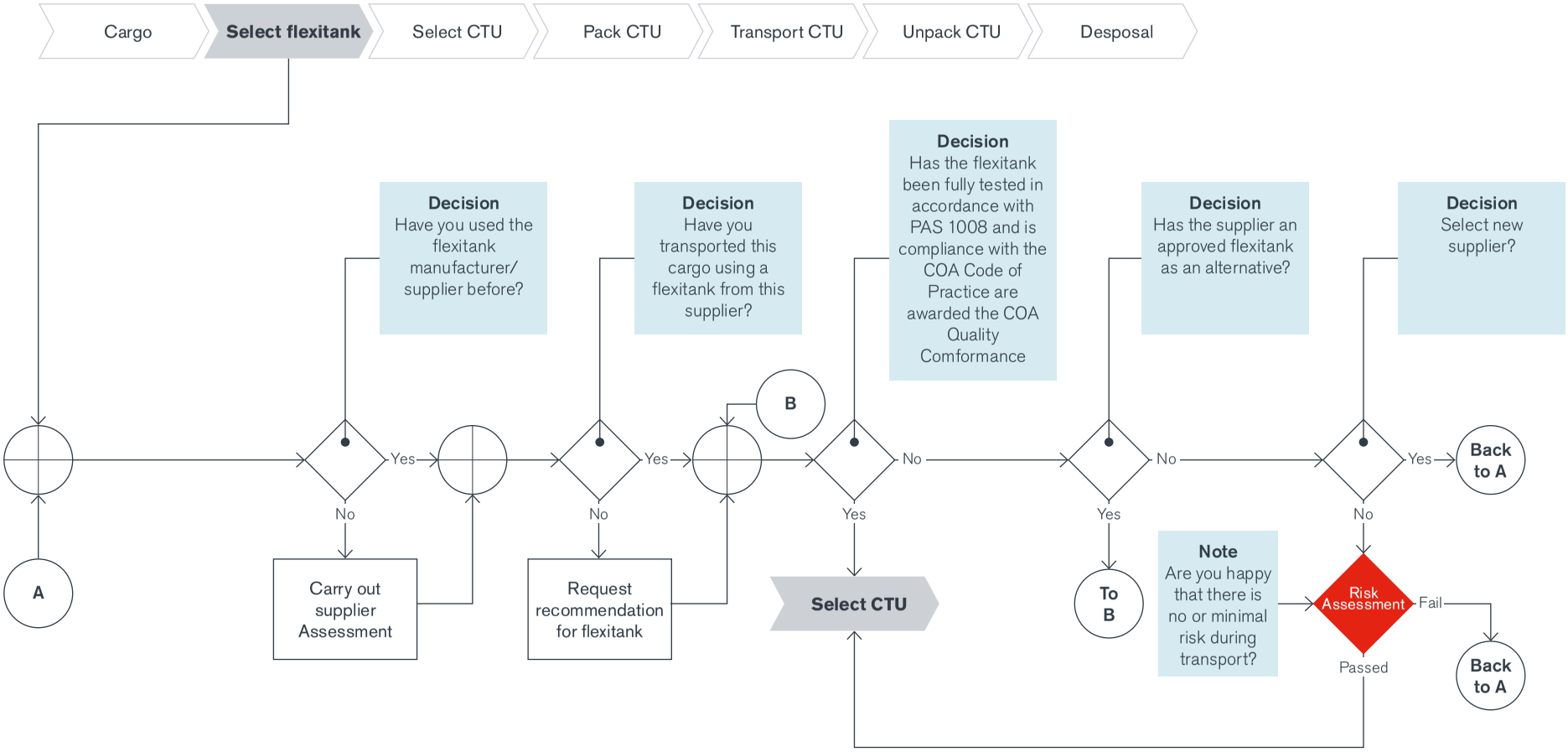
Placarding should also be a primary consideration when shipping flexitank systems in containers, alerting operators who are handling the CTU that a flexitank system is being transported within and to handle with additional care.

In the event of a leak during handling at an intermodal terminal, the container should be placed in a bunded area or containment equipment used to prevent the spread of the leak and protect drainage channels.

Flexitanks held in intermodal terminals should ideally not be stored near drainage channels mitigating the chances of contamination to ground water, in the event of a leak.

10. https://www.containerownersassociation.com/technical-resource/flexitanks/

Figure 2 – Flexitank Transport process – Flexitank selection



(Courtesy of ETS Consulting)

4

Container (CTU) selection

In this section:

- Container (CTU) selection and checks
- Fitting, filling and securing
- Container markings
- Discharging

4.1 Selection & checks

Flexitanks are almost exclusively carried in 20' general purpose freight containers. There is, however, limited use of 40' and reefer units and potential for further innovation. Despite this, this section adopts the generic term 'Cargo Transport Unit' (CTU).

CTUs for the carriage of flexitanks must be in good serviceable condition and fit for purpose.

When selecting an appropriate CTU, the following process should be considered:

On arrival the CTU should be checked in accordance with Chapter 8, sections 1 and 2 of the CTU Code. Deficiencies to the Safety Approval Plates, to the structural integrity of the CTU or its suitability for installing or transporting a flexitank system should be notified to the CTU operator and returned for replacement.

While containers should be supplied that comply with industry repair standards, those to be used for transporting a flexitank should comply with the COA CoP (see Flexitank Container Condition table).

Of particular importance are:

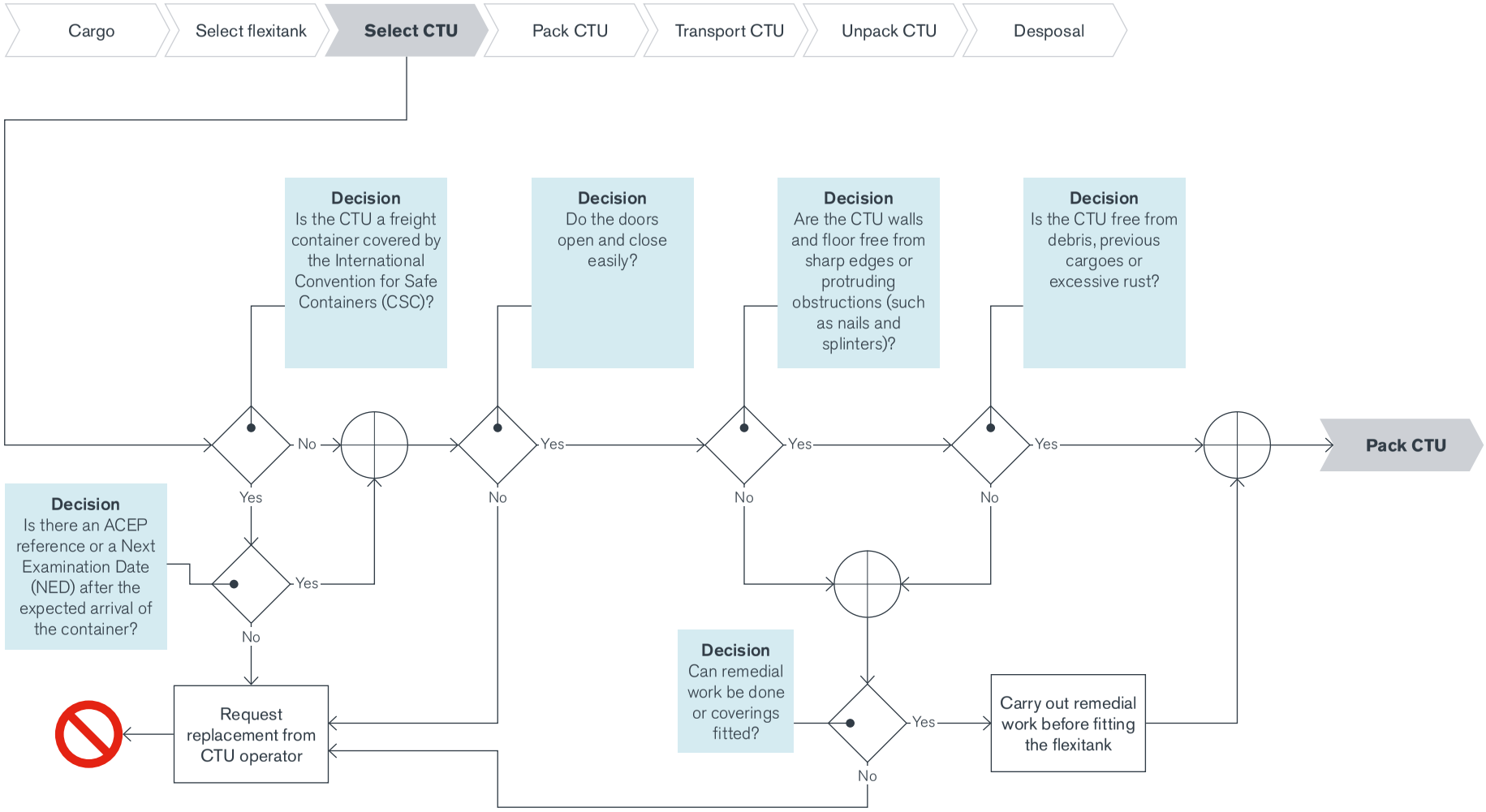
- Doors – these should operate easily and should not require forcing to turn the locking gear, or to open or close the doors. If there is concern about their operation, contact the CTU Operator and request remedial action or a replacement CTU.
- Deficiencies that may puncture the flexitank – the CoP identifies a number of deficiencies that could damage the flexitank including:
  - nails and screws
  - splinters and broken flooring
  - gouges in the flooring
  - miss-aligned flooring or walls
  - sharp edges at welds and repairs
  - Sidewall corrugation creases

Where such deficiencies are found steps must be taken to rectify the issue (sweeping/ repairing/covering) and a risk assessment should be undertaken to determine the likelihood of the deficiency causing a problem in transit. If the risk is considered too high, then a replacement CTU should be requested.

CTU cleanliness – the CTU should be clean as defined in the CTU Code.

If the deficiency cannot be rectified, then a replacement CTU should be requested.

Figure 3 – Flexitank Transport process – CTU Selection



(Courtesy of ETS Consulting)

4.2 Fitting, filling & securing

The following chart can be referred to when fitting a flexitank system within a CTU.

4.2.1 Preparation

Manufacturers are required to take measures to ensure that operators of its supplied flexitanks are properly instructed in the procedures and training that ensure competency to operate a safe and reliable flexitank system.

The manufacturer should provide an Operating Instruction and Training Manual for the operator's use, the content of which provides best practice for operating the manufacturer's design and type of flexitank.

The operator of the flexitank should also provide an Operating Instruction and Training Manual for the use of its personnel and filling or discharge facility personnel. The manual should incorporate the manufacturer's instructions and provide the additional requirements to meet the operator's specific job function and country of activity.

The preparation and fitting of the flexitank should be carried out by parties that have been trained in accordance with the COA CoP.

Before the flexitank is filled, the CTU must be prepared:

- The inner walls and floors of the CTU should be lined with a protective covering that provides protection against abrasion and that extends to the full height of the filled flexitank. The covering may be corrugated cardboard or, more commonly, polypropylene sheet. Polyethylene liners with embedded magnets offer efficient installation.
- If the cargo has a viscous consistency and requires heating to improve unpacking then heating pads (water or electric) should be installed underneath or to the sides of the flexitank. The heating pads may require a protective mat between them and the flexitank; ensure that the maximum temperature set by the flexitank manufacturer will not be exceeded.
- If the flexitank system includes a constraint system[11], this should be installed in accordance with the manufacturer's installation instructions.
- The flexitank itself should be installed according to the manufacturer's installation instructions using trained personnel.
- If the flexitank system includes a restraint system[12], this should be installed in line with the manufacturer's installation instructions. The restraint system may be in the form of a solid or semi-solid bulkhead or webbing straps separate to, or attached to, the flexitank.
- The filling/discharge valve should not obstruct the operation of the door and the door should not be displaced by the closing of the doors.
- Vent tubes and other pipework should be positioned so that they are not trapped during the filling process.

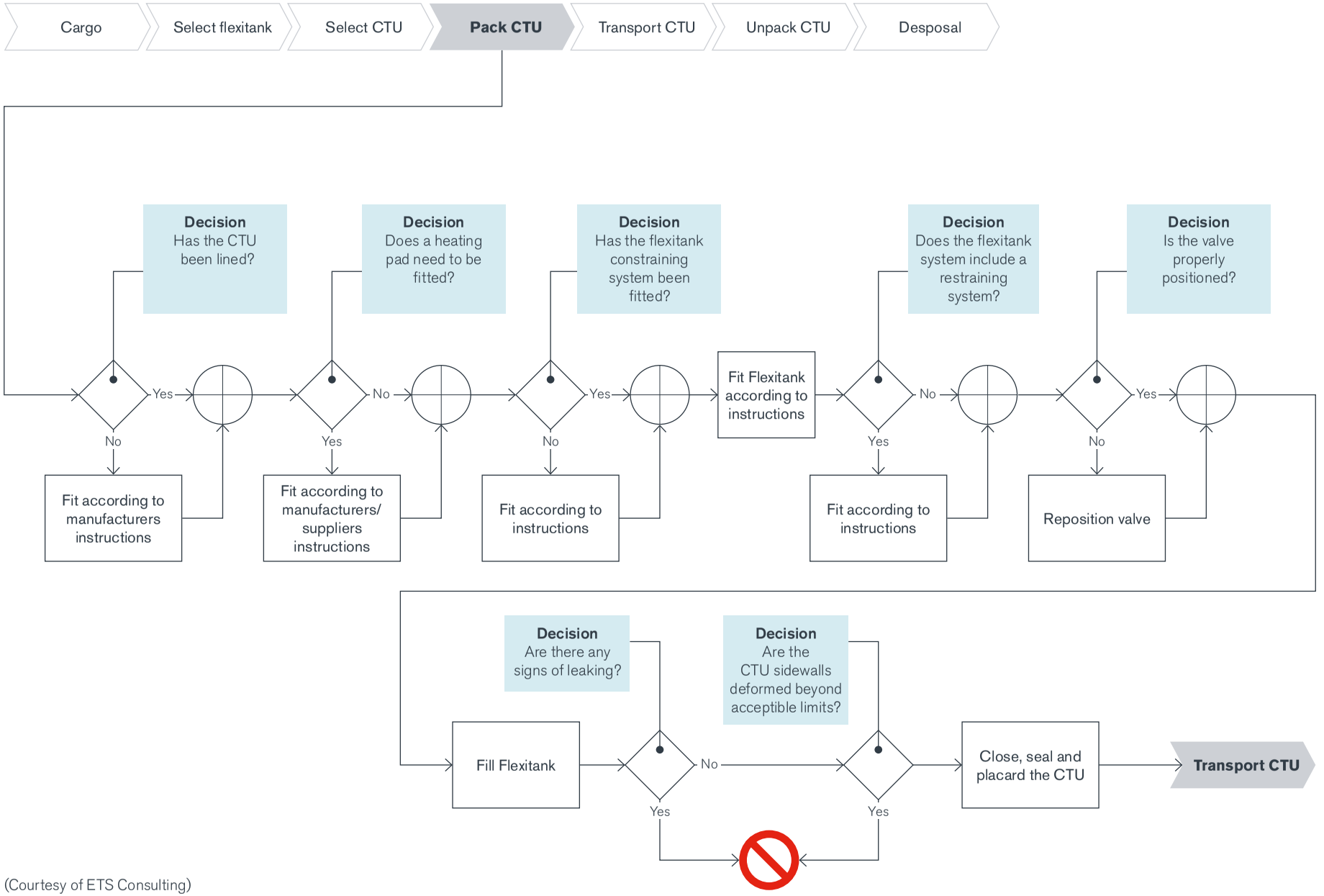
During the preparatory stage shoe covers should be worn inside the container to protect the flexitank material from damage and to guarantee a clean surface. It is preferable that installers should not physically step on the flexitank in order to minimise the risk of damage.

Before filling starts, the installation should be checked to ensure the system has been fitted in accordance with the manufacturer's instructions and that there are no signs of damage to any constituent part of the flexitank system.

Furthermore, steps should be taken to prevent unexpected movement of the CTU during the filling process. For example, the vehicle may need to be secured with wheel chocks.

11. Structure that is used to reduce the pressure of the flexitank on the walls of the CTU.
12. Structure that is used to prevent the flexitank from making contact with the door of the CTU.

Figure 4 – Flexitank Transport process – CTU Packing



(Courtesy of ETS Consulting)

4.2.2 Filling (packing)

Filling must be done exclusively with tested, dedicated hoses that are stored in an appropriate manner by the Packer. The filling hose should be connected and secured to reduce the stress on the valve and must be secured by using a hose support at the level of the valve to prevent stress on the hose and coupling.

Spill protection devices like a collecting bag or drip tray should be placed into position to collect any cargo that may leak during the filling process.

During filling it is important that unexpected gases (air, nitrogen) do not enter the flexitank. Blow down of lines and hoses before or after filling should not be allowed unless a pressure relief valve is part of the flexitank system.

After starting the pump, the tightness of the connections of pump and hoses should be checked.

It is recommended to start the filling process with a lower filling rate to avoid stress on the flexitank or damage to the CTU, taking account of the viscosity and mass of the cargo. Further, it is recommended that the filling rate for flexitanks should not exceed 1,000 litres per minute[13]. The cargo flow rate should be gradually lowered before completion, to avoid overfilling.

Additionally, to reduce the risk of deformation of the CTU, the mass of the liquid in the flexitank should not exceed a value agreed with the CTU operator.

The PAS and CoP state that:

"The flexitank is required to be filled to the manufacturer's specified filling capacity and within a tolerance of +/- 3% of the flexitank nominal capacity. The maximum payload (cargo mass) shall be 24,000kg."

Overfilling a flexitank can result in damage to the CTU and loss of cargo.

Stop filling:

- once the target volume has been reached
- if the flexitank or any constituent parts becomes trapped
- there are signs of the flexitank or the valve leaking.

Do not restart filling until the deficiency has been rectified.

Once filling has been completed remove the filling hose and check if there are any visually detectable leakages from the flexitank. No part of the flexitank or restraining system should touch the doors when fully filled.

Check if there are any visible deformations of the CTU after filling.

Overfilling a flexitank can result in damage to the CTU and loss of cargo

[13] Volumetric flow rate unit conversion for 1 litre per minute is 0.26417287472922 US gallons per minute or 1 US gallon per minute is 3.7854 litres per minute.

4.2.3 On completion of filling (packing)

On completion of filling the flexitank the CTU should be closed and marked and the transport documentation prepared by the Shipper according to the CTU Code Chapter 11.

Before closing the right-hand door, the packer should check that the flexitank restraint system does not place any pressure on the left-hand door. The packer should also satisfy themselves that the filling/discharge valve does not obstruct the door operation or be forced out of position when closing the door.

When required, the shipper should ensure that the CTUs being transported internationally are sealed with a seal bearing a unique identification code. Countries may require that such seals meet the standard of ISO 17712.

The CTU should be weighed after the doors have been closed so that an accurate gross mass can be determined.

Transport documents should be prepared by the Shipper and submitted to the Carrier in a timely manner. Such documents may be in hard copy or by electronic data interchange (EDI) or by electronic data processing (EDP).

4.3 Container Markings

The CTU is required to be marked with a flexitank warning mark, as described in the COA CoP, on the outside of the rear left-hand door (see Picture 7), to alert anyone approaching the CTU of the potential risks.

This briefing additionally recommends that a warning triangle should be applied to all four (vertical) sides of the CTU and potentially the roof (see Figure 5). This would provide appropriate alerts to all supply chain operators, including those involved in road transport and terminal operations. As noted in 6.2.3 below, all placards/marks fitted to the exterior of the CTU shall be removed once the flexitank has been discharged and cleared from the CTU.

Picture 7
(Image Courtesy ETS Consulting)

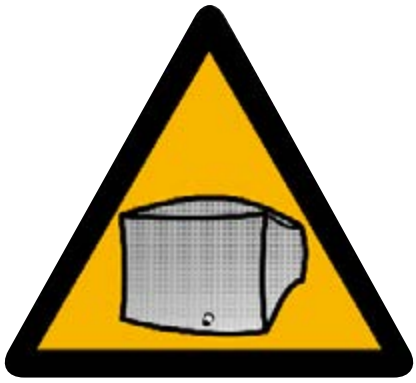


Figure 5 – Flexitank warning triangle
(Courtesy ETS Consulting)

4.4 Discharging cargo

Annex 5 of the CTU Code covers "Receiving CTUs" and the following sections should be complied with:

3 Removing Seals

4 Preparing to open the right-hand door

5 Measuring gases

6 Opening the right-hand door

Only the right-hand door should be opened until the cargo has been discharged from the flexitank.

The discharge hose can be connected to the valve and spill protection devices like a collecting bag or drip tray should be placed into position to collect any cargo that may leak during the discharge process.

If heating pads have been requested and fitted, then these should be activated before the discharge process starts.

It is recommended to consider the following non-exhaustive elements:

- the capability of the heating system to raise the cargo temperature should be taken into account, considering ambient cargo and environmental temperatures
- ensure that only trained and competent personnel conduct the heating
- do not exceed the maximum temperature set by the flexitank manufacturer
- avoid localised hot spots and potential loss of integrity due to thinning
- the CTU and cargo should remain static during heating,
- heating should be carried out close to the discharge point.

The internal pressure of the flexitank will force the majority of the cargo out of the flexitank, but additional procedures may be required to discharge the flexitank fully, such as tilting the CTU or using a pump.

It is probable that a small amount of residue will remain in the flexitank once the discharge process has been completed.


OK
COR-TEN STEEL
CONTAINER
BUREAU VERITAS
1828
CAUTION
BULK LIQUID
NON HAZARDOUS
FLEXITANK CONTAINER
DO NOT LOOSE SHUNT
OEC GROUP
www.oecgroup.com
DO NOT OPEN LEFT HAND DOOR
UNTIL DISCHARGE COMPLETED
INLET

5

Modal transport

In this section:

- Road transport
- Rail transport
- Terminal handling
- Marine transport

5.1 Road transport

The driver should be made aware that the CTU is carrying a filled flexitank as the handling characteristics may be different. Where possible, only use experienced drivers accustomed to handling bulk liquids in tank containers or within CTUs.

Caution! – Wherever possible the driver should avoid sudden alteration of direction or breaking as the contents of the flexitank are unhampered, and the flexitank material is flexible. Therefore, the load moves heavily and unpredictably.

The driver should inspect the CTU for signs of leakage prior to starting and at scheduled stops during the journey to the destination. If there are signs of leakage, then the driver should park the CTU in a position that will not cause a hazard or undue traffic congestion and away from any drains, rivers or waterways, and notify the shipper/consignee.

If the route should take the CTU over/through a bridge/tunnel where leaked material may cause a major disruption to transport, then the driver should check the CTU for leakage before crossing/entering. The CTU should not be opened.

Care should be taken when approaching and negotiating roundabouts, sharp corners, sudden changes in carriageway or uneven surfaces which may cause the liquid within the flexitank to swill from side to side causing the CTU and chassis/trailer to overturn.

When braking, the driver may experience a sudden forward force as the liquid within the flexitank moves within the container. As when driving with tank containers or road tankers, it is recommended to allow additional stopping distance and to brake more gradually than when driving a non-liquid load.

Uneven surfaces and twisting roads can cause the cargo to move within the flexitank. Abrupt movements could cause cargo surge that could result in the end, or side walls being damaged (see Picture 8). If the driver notices such damage, it should be reported when the load is dropped at its destination.

Picture 8 – Damaged side wall following road transport
(Image Courtesy ETS Consulting)

5.2 Rail transport

Some flexitank operators may not recommend railway transport due to high stress on flexitank and CTU.

The CTU should be inspected for signs of leakage prior to starting and at scheduled stops during the journey to the destination. If there are signs of leakage, then the shipper/consignee should be notified.

Shunting wagons with CTUs carrying flexitanks should be only carried out with caution.

5.3 Terminal handling

Lifting CTUs carrying a flexitank with a forklift truck should not be permitted. While many 20 ft containers are fitted with fork pockets, which enables lifting with a suitable forklift truck, the dynamic forces associated with liquids are similar to those experienced by tank containers.

When handling a flexitank system:

- the CTU doors should be closed, and the lock rod handles secured in their retainers.
- When lifting and lowering it is important to recognise that the liquid within the CTU will continue to move even though the CTU has stopped.
- Lifting and lowering speeds should be restricted so that the static/ accelerated liquid can make a smooth transition without damaging the CTU or the lifting equipment.
- When swinging or moving a flexitank system transversely care should be taken when attempting to position the CTU within a slot or on a chassis/ trailer.

5.4 Marine transport

The shipper should advise the carrier that the CTU is carrying a filled flexitank and inform them of any transport restrictions or requirements that may limit their stowage on the ship. Planners can therefore:

- When deciding on routings avoid those with transhipments – particularly in tropical regions where heat exposure is much higher on land than at sea. If transhipment is inevitable, any stop-over should be as brief as possible.
- Temperature sensitive cargoes should not be placed on or near heated bunker tanks, the elevated temperature required to keep the fuel viscosity low may heat or otherwise damage the cargo (red slots below deck in Figure 6). Note the height up the side will depend on the ship's design and may be higher or lower than shown in the figure. CTUs carrying flexitanks should not be stowed adjacent to the engine room bulkhead.
- Above deck, CTUs with flexitanks should not be stowed in the outer and upper most slots as or at the edges of deck covers (red slots above deck in Figure 6) as.
  - The top slots can be subjected to high temperatures from the sun's radiation
  - The outer slots can be subjected to high acceleration loads
  - CTUs placed at the edge of the deck covers may have slightly wider separation and there is an increase in the risk of the side walls being bowed outwards.
- CTUs carrying cargoes that are viscous or that solidify or which become more viscous when released from the containment of the flexitank should not be stowed below deck where a failure of the flexitank may result in the cargo clogging the bilge pumps.
- Water polluting and oily cargoes on the other hand should be stowed below decks where any leakage can be captured within the ship's bilge.

The layout of lashing bridges on many container ships is such that the majority of the slots above deck are allocated to 40 ft containers, with very limited slots for 20 ft units. Additionally, the forward bay and those astern are generally unsuitable for stowing CTUs carrying flexitanks due to the dynamic forces in these bays.

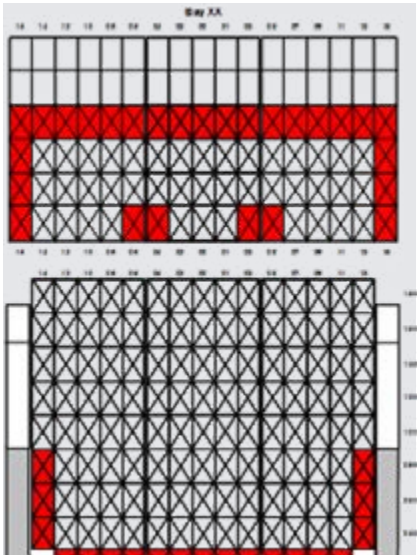
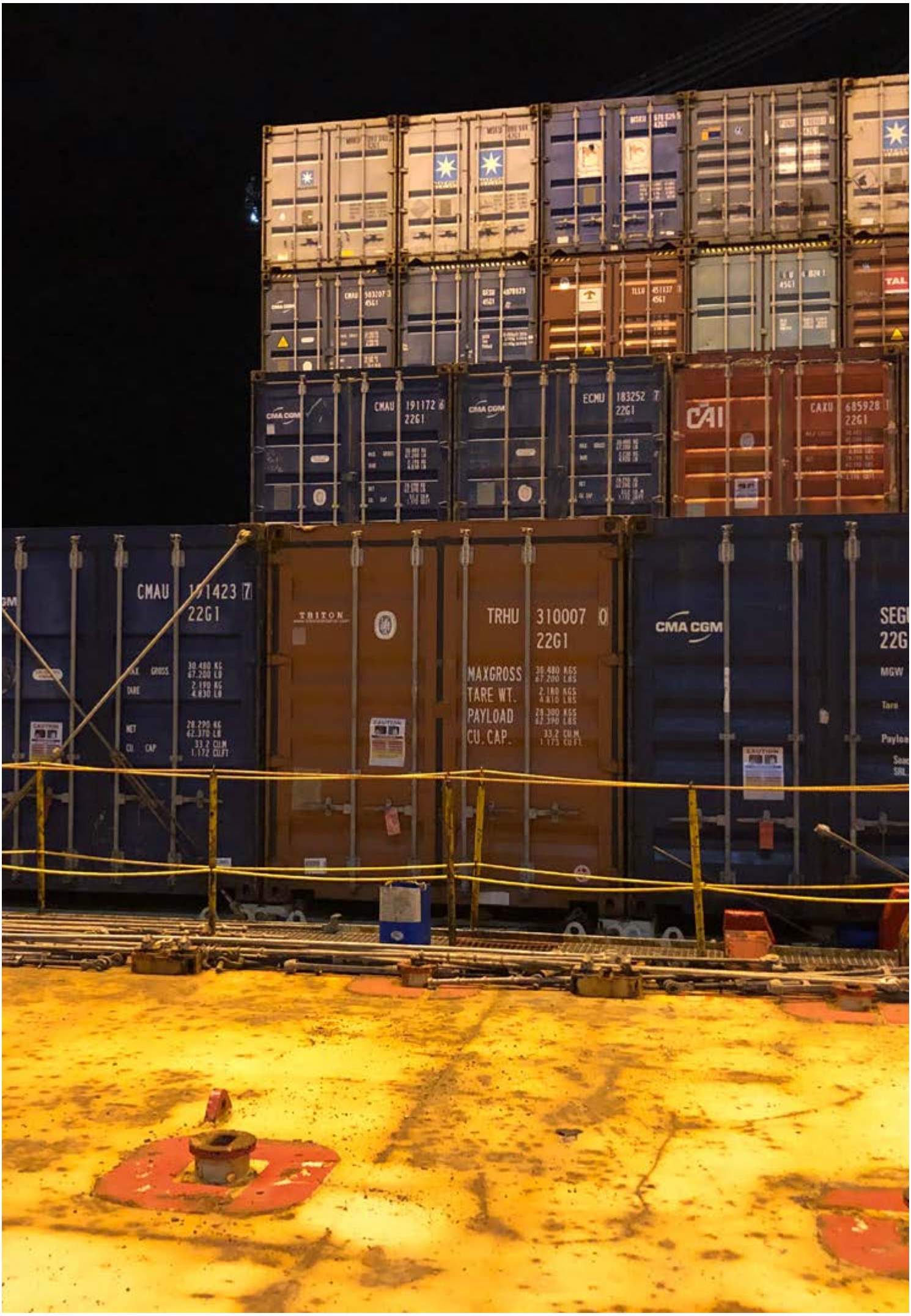


Figure 6 – Positioning flexitanks
(Image Courtesy ETS Consulting)


CMAU 191172 6
22G1
CMA CGM
ECMU 183252 7
22G1
CMA CGM
CAI
CAXU 685928 1
22G1
CMAU 191423 7
22G1
TRITON
TRHU 310007 0
22G1
MAXGROSS
TARE WT.
PAYLOAD
CU. CAP.
CMA CGM

6

Environment: disposal and recycling

In this section:

- Full discharge of cargo
- Recycling

6.1 General principles

After discharge of the cargo, the flexitank, linings and all equipment should be completely removed from the CTU and safely disposed of or recycled for other use, as agreed between the Shipper and the Consignee.

The use of a flexitank for transport of bulk liquid cargo inevitably leads to a reduction in carbon footprint for that supply chain compared with alternative smaller packages. However, as with all non-reusable packaging, recycling of the used flexitank system is a necessary part of the supply chain consideration and an industry priority.

Increasingly, chemical and food producers are facing scrutiny from end-users, consumers and governmental agencies relating to the adoption of practices consistent with ESG[14] principles. It is now common for supply chain stakeholders to formulate, promote, and monitor (or audit) effective environmental policies, incorporating these into purchase decision-making. The recycling of flexitanks is consistent with such industry and societal objectives.

Development and provision of recycling facilities around the globe is part of establishing an infrastructure of specialist plants that enables flexitanks to be recycled appropriately and economically. The COA continues to compile a list of such facilities to assist operators and end-users to identify available service options. Stakeholders are urged to support the COA in this initiative[15].

6.2 Recycling, disposal, and return of CTU

The materials used in the construction of flexitanks are recyclable, but the process requires all the participants in this supply chain to mandate and be prepared to accept the cost of recycling as an essential part of the flexitank offering.

The Consignee generally represents the end-user who is likely to be the contractual instigator of the use of the flexitank. Certainly, the entity taking delivery of the cargo and clearing the CTU for future use bears the primary responsibility for safe and environmentally conscious disposal of all parts of the flexitank system..

In all cases the flexitank and constituent parts, including linings and restraining system, shall be removed from the CTU in order for the unit to be returned to the container operator. All paper-based and metal parts should be recycled or reused. The flexitank components – polypropylene sleeve, PE layers and barrier materials – should be recycled, but exceptionally, if recycling is not possible, safely disposed of in accordance with any local regulations at a licensed site.

Draining the residue of cargo from the flexitank, stripping the outer sleeve and consolidating the material into a viable quantity for recycling adds cost to the operation of the flexitank supply chain, but this is a necessary function of the flexitank operation. The complexity is best managed as part of a consolidated business.

14. Environment, Social and Governance. See TT Club's ESG Toolkit (https://www.ttclub.com/loss-prevention/esg-toolkit/).
15. https://www.containerownersassociation.com/re-cycling-facilities-list/

6.2.1 PE and barrier materials

The recommended process to be adopted for the disposal of the flexitank itself is for the cargo receiver to contract with a recycling consolidation facility in order to drain the flexitank, separate it into its component parts, wash and shred the materials, and prepare them for recycling at a plastics plant.

Flexitanks that have transported substances that cannot readily be drained sufficiently to be suitable for shredding and consolidated with other flexitanks, require prior cleaning.

Once the used flexitank is processed into a manageable state, the specialist recycling plant is able to convert the waste into a useable form.

6.2.2 Paper-based and metal parts

Metal parts used for restraining the flexitank (bulkheads) can be serviced and re-used or recycled as scrap metal. Cardboard used for lining the containers before installing the flexitank are readily recycled.

6.2.3 Returning the CTU

The CTU should be cleared, such that all debris is removed and the unit prepared for cleaning and recirculation in the supply chain. All placards/marks fitted to the exterior of the CTU shall be removed. The empty CTU should then be returned to the CTU Operator notifying them of any deficiencies or damage that occurred during the flexitank transport process.

7

Risk considerations

In this section:

- Risk assessment
- Incident management

7.1 Risk considerations

The transport of bulk liquids in general purpose CTUs using flexitanks will always present a risk to health, the cargo, the CTU and the infrastructure. This document attempts to reduce the risk by offering sound management practices.

The essentials of risk mitigation:

- ensure that the cargo is safe to transport in a flexitank and fully conforms with regulations. Some non-regulated cargoes are nevertheless hazardous; always check the SDS to ensure that the cargo is safe to transport in flexitanks and validate that the cargo is compatible with the flexitank material of construction
- ensure that the flexitank manufacturer has achieved COA Quality Conformance (CQC) and the flexitank system has been entered on the COA Flexitank Quality List (FQL)
- ensure that the CTU is safe and fit for purpose and does not show any structural deficiencies
- ensure that the interior of the CTU does not have any damage that may puncture the flexitank
- always install all parts of the flexitank system following the manufacturer's installation instructions using trained personnel
- fill the flexitank at a flow rate that avoids its failure or damage to the CTU
- do not underfill or overfill – fill to ±3% of the volumetric capacity of the flexitank. Do not exceed the volume or mass capacity of the CTU (as shown on the door)
- minimise sudden acceleration during transport – shunting, heavy braking, sudden lane changes and repeated bends
- load onto ships in positions where the CTU and flexitank are not likely to be affected by significant heat or acceleration
- ensure that flexitanks carrying cargoes that are harmful to the aquatic environment (marine pollutants) are not loaded on deck
- avoid loading flexitanks carrying viscous cargo into the holds where any leaking cargo may block bilge pumps
- take immediate action if a CTU appears to show signs that the flexitank is leaking
- fully comply with the incident management recommendations provided by PAS 1008 and the COA's Code of Practice

Risk management is a step-by-step process for controlling health and safety risks caused by hazards in the workplace, the tasks below might be undertaken by one or more stakeholders in the transport chain.

Identify

Assess

Control

Record

Review

7.2 Incident management

The PAS and the CoP include instructions for the management of an incident:

"Upon notification of an incident, the responsible person should immediately take actions to safeguard the health and safety of personnel, the public, the environment and to minimise cargo loss. The incident management emergency plan should be enacted as appropriate.

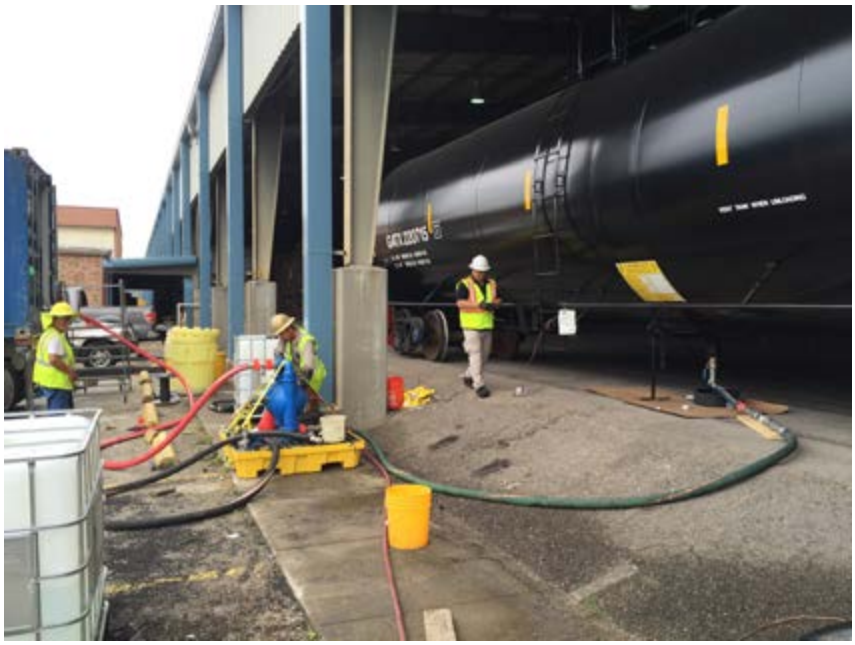
As soon as possible, the incident should be reported to the cargo owner and all other parties relevant to the incident. Actions should be taken promptly to safeguard personnel and the environment and to minimise cargo loss.

It might be necessary to arrange to transfer the flexitank system to a safe location and or transfer the cargo to another suitable flexitank system or to an ISO tank container, IBCs, or drums.

Once the incident is under control and the flexitank secured in a safe place and all relevant permissions obtained, an initial survey and report should be prepared.

The parties involved, including the carrier, shipper (cargo owner), operator, manufacturer and insurer should instruct their surveyor to complete an investigation and provide a report. Arrange a joint survey as might be appropriate.

The flexitank manufacturer and operator should keep records of reported incidents involving their flexitanks. The incident records should be used for improving the flexitank system as part of a process of continuous development."



8

Operator qualification and training

In this section:

- Operator qualification and training
- Due diligence
- Contract review/insurance

8.1 Due diligence

It is critical that due diligence is undertaken to ensure that the appointed contractors are sufficiently qualified, experienced and capable of sourcing, fitting, packing, unpacking, heating and generally handling flexitank systems. A robust due diligence process will help mitigate risk and provide an additional layer of protection to your business.

8.2 Insurance

When contracting services to third party providers, it is prudent to verify that adequate insurance is in place, requesting details of any applicable policies and verifying with the insurer. In particular ensure that coverage extends to include the carriage and handling of bulk liquids (or does not exclude them). Where possible, understand policy limits, satisfying yourself that they are sufficient, and material exclusions.

8.3 Contract review

Ensure that your standard terms and conditions are incorporated into all contracts.

Ensure an acceptable law and jurisdiction clause is in place.

Ensure that all liability terms and limits are within your corporate risk appetite and appropriately protected by your liability insurance policy.

8.4 Training

It is recommended that all operators provide the necessary training and meet the requirements to store, install, remove flexitanks to the COA standards. If these procedures are not provided and followed incidents can/will occur.

Training should be tailored to meet the requirements of each facility and may include:

- Container selection and preparation
- Flexitank installation procedures including container lining, restraining system and ancillary equipment etc.
- Filling procedure, including filling capacity control
- Filling actions in the event of leakage, overspill, excessive container wall bulging etc.
- Marking the container for transport
- CTU transport on roads, rail and barges and handling in terminals and ports, including leak detection and control
- Cargo unpacking procedure, including maximising drainage of cargo
- Stripping the used flexitank and linings from the container, environmental procedures for waste management of used flexitank and equipment
- Recycling preparation procedures to drain, strip sleeve and components, separate material types, shredding and consolidating for recycling
- Recycling of restraining bulkhead and ancillary equipment
- Incident management and emergency plan

Certain entities or stakeholders may require that the shipper/operator can provide suitable certification or endorsement of testing and training before they will permit the loading of a CTU containing a flexitank.


DONGFANG
tex
HAMBURG SÜD
www.yangming.com
YANG M
tex
www.yangming.com
YANG M
UACU 369423 7
2261
UASC
www.uasc.net
CAI

For more information

Please contact us at **riskmanagement@ttclub.com** or visit us at **ttclub.com**

Container Owners Association

The Container Owners Association (COA) is an international organization representing the common interests of all owners of freight containers. Its principle aims are to develop standards in order to enhance industry efficiency, to disseminate information through conferences, training and education, to promote the safe of operation of containers and to strengthen environmental awareness. Full Members of the Association include container shipping lines, leasing companies and intermodal operators, while Associate Membership is open to suppliers of a wide range of container equipment, systems and services.

containerownersassociation.com

TT Club

TT Club is the established market-leading independent provider of mutual insurance and related risk management services to the international transport and logistics industry. TT Club's primary objective is to help make the industry safer and more secure. Founded in 1968, the Club has more than 1100 Members, spanning container owners and operators, ports and terminals, and logistics companies, working across maritime, road, rail, and air. TT Club is renowned for its high-quality service, in- depth industry knowledge and enduring Member loyalty. It retains more than 93% of its Members with a third of its entire membership having chosen to insure with the Club for 20 years or more.

ttclub.com

Thomas Miller

TT Club is managed by Thomas Miller, an independent and international provider of market leading insurance services. Most of the businesses we currently own or manage are acknowledged leaders in their chosen market. Our portfolio includes mutual organisations and, increasingly, specialist insurance services businesses.

thomasmiller.com

ttclub.com