VANNING HANDBOOK

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INTRODUCTION

Two recent mandates in the freight and logistics industry have brought to the fore the issues of securing and weighing cargo placed in container transport units (CTUs). The CTU Code of Practice emphasises proper cargo handling, packing, securing, loading and unloading, while the amendments to the International Convention for the Safety of Life at Sea (SOLAS) Chapter VI, Part A, Regulation 2 — Cargo information require shippers to provide verification of the gross mass of a container before it can be loaded onto a ship.

Accidents involving improperly secured cargo, as well as cargo with excess weight or wrongly positioned centre of gravity (COG), have spurred the mandates. The risks and repercussions include:

- *damage to the CTU*
- *damage to cargo*
- *loss of cargo*
- *CTUs tipping over or falling from vehicle/vessel*
- *damage to vehicle/vessel*
- *loss of vehicle/vessel*
- *injured workers, drivers, pedestrians*
- *hefty fines*
- *lawsuits*
- *loss of life*

The CTU Code of Practice stresses responsibility on all players in the supply chain, while the SOLAS weighing verification requirements place the main responsibility of providing a verified gross weight on the shoulders of shippers. Compliance with the SOLAS requirements helps one achieve the standards set by the new CTU Code in the area of proper weighing and positioning of COG.

This handbook aims to serve as an introductory guide to securing cargoes in CTU, as well as to instruct users on loading using the Tynecat container loading system. Main considerations in preparing cargo for transport include but are not limited to:

Chapter I. Stresses on Cargo and Container During Transport
Chapter II. Planning and Packing
Chapter III. Securing Cargo
Chapter IV. Loading Cargo

CHAPTER I.
STRESSES ON CARGO AND CONTAINER DURING TRANSPORT

Even though a CTU is bound for a ship, it will be carried on a truck or train on its way to the port. Thus, when packing cargo, it's important to consider the stresses that the CTU – and consequently, the cargo – will be exposed to in transit. These include dynamic and static mechanical stress, chemical stress, and climatic stress.

1. Dynamic Mechanical Stress
Dynamic mechanical stress arises from operations such as packing, moving and securing cargo, and transporting CTUs.

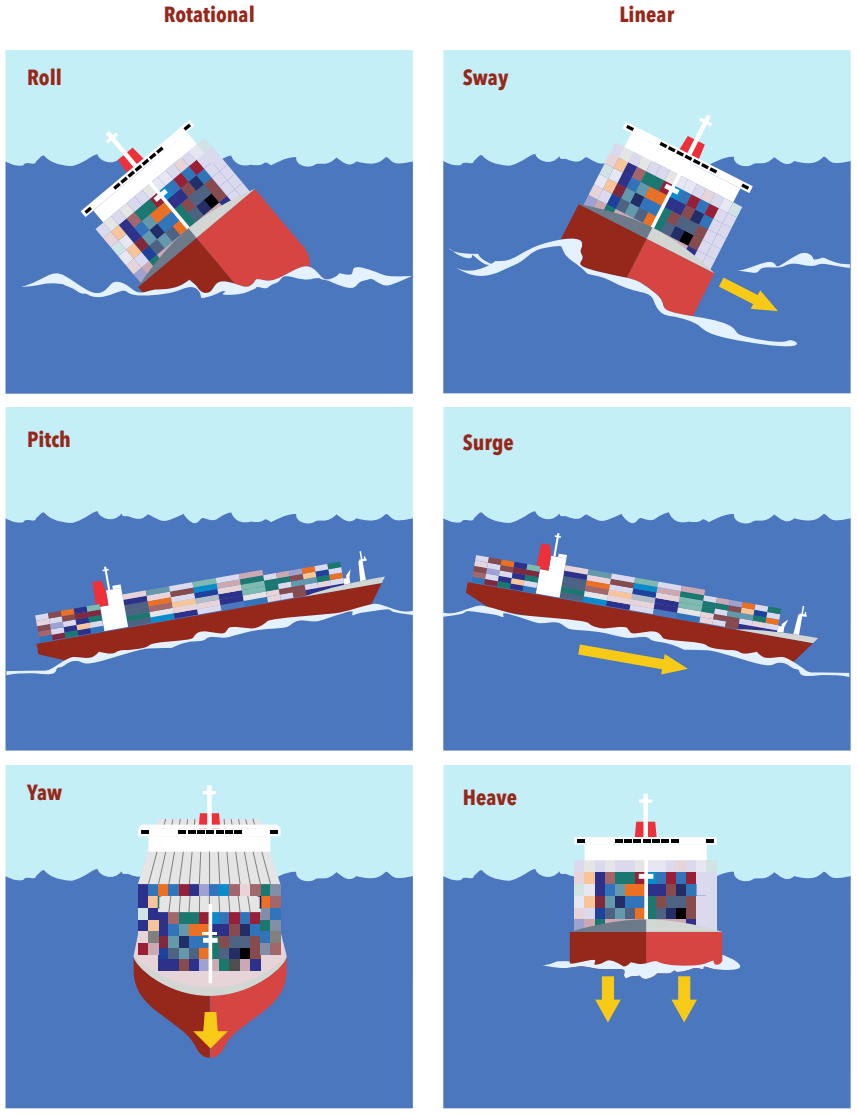
During cargo handling, one can expect stresses of approximately 1g, even with skilled personnel. Higher stresses result from manual packing and loading compared to using a mechanical stacker, rotator, and loader, as the former presents a higher risk of dropping, bumping, and abrupt setting down. Infrastructure such as steep ramps in terminals can contribute to cargoes' exposure to stress.

In transporting cargo, stress comes from acceleration caused by changes in direction or speed. Vibration of the engine and the vehicle/vessel occurs periodically and frequently, while jolting occurs occasionally and abruptly.

Cargo transported by road and rail are often subjected to longitudinal stress caused by the force of gravity and inertia. On trucks, cargo must be secured to counteract 1g or its own weight force to avoid breaking loose during abrupt braking, steep curves, and undesirable conditions such as driving over potholes or unpaved roads. On rails, shunting can subject containers to a force of 4g. High-performance shock absorbers can reduce this impact to about half.

Onboard ships, containers experience both longitudinal and lateral stress caused by pitching, rolling, heaving, surging, yawing or swaying. In heavy weather, a ship can roll as much as 30 degrees, while in long, rough voyages it can roll as many as 60,000 times. While acceleration values on a ship tend to be much lower than those experienced on the road and rail, they are much more frequent.

SHIP MOTIONS IN A HEAVY SEAWAY



Safe Transport of Containers by Sea: Guidelines on Industry Best Practices
(International Chamber of Shipping; World Shipping Council)

3. Climatic Stress
Even when cargo is packed in dry air, changing climatic conditions during transport will affect the conditions inside a CTU. In the course of a journey, a CTU may pass through warm and cold areas; it may pass through winter and summer, or from temperate to tropical climates.

Along with cyclic variations in temperature from day to night, it may also be exposed to solar radiation, UV light, sea spray, rain, and snow.

One common adverse consequence of these climatic influences and varying conditions is the development of condensation inside the CTU. Moisture inside a CTU can lead to:

- staining
- collapse of stacks within CTU
- discolouration
- rust
- peeling off of labels
- sticking together of packaging

Moisture can also be dangerous when it comes into contact with substances that emit flammable gases when wet.

To minimise conditions for condensation, avoid packing moisture-inherent cargo with cargo that easily gets damaged when wet. Ensure that all dunnage and materials for packaging, packing, and securing cargo are dry. Pack in a dry, clean environment, and use desiccants to absorb moisture.

4. Chemical Stress
This typically occurs with hazardous goods as they are exposed to heat, moisture, and movement. Cargo with incompatible substances may also react with each other.

5. Biotic/Biological Stress
This tends to be 'home-grown' stress, or that which comes from the cargo rather than from factors outside the CTU. The cargo might have been infected before packing, or insects may have entered the CTU during loading. Biotic/biological stress can come in the form of insects and infestation, especially with mould and bacteria.

Packaging and securing materials, such as wooden pallets, may also carry with them insects and microorganisms.

CHAPTER II.
PLANNING AND PACKING

The CTU Code provides the following principles of packing:
1. The load is properly distributed in the CTU
2. Stowage and packing techniques are suitable to the nature of the cargo
3. Operational safety hazards are taken into account

1. Proper load distribution
This entails knowing both the weight and the centre of gravity of the cargo. The recently amended SOLAS weight verification requirements make shippers responsible for providing the CTU's verified gross mass using either of two methods:

1. Upon the conclusion of packing and sealing a container and using calibrated and certified equipment, the shipper may weigh, or have arranged that a third party weigh, the packed container.
2. Weigh the cargo and all packing and securing materials before ingress, and add this to the CTU's tare mass

Using the Tynecat, weighing and calculation of COG take place during ingress without adding minutes or tedious steps to the loading process (see chapter 4, Tynecat methodology).

Below are the maximum gross mass and maximum payload mass of ISO containers, which commonly come in 20ft and 40ft lengths.

CTU length	Typical Gross Mass	Typical Payload Mass
20 ft (6.1 m)	24,000 kg	22,000 kg
40 ft (12 m)	30,480 kg	27,000 kg

1.1. The load's COG must be at the centre of the CTU both laterally and longitudinally, although eccentricity is permitted by a maximum of +5%. This means loading not more than 60% of the cargo's total mass in 50% of the length of the CTU.

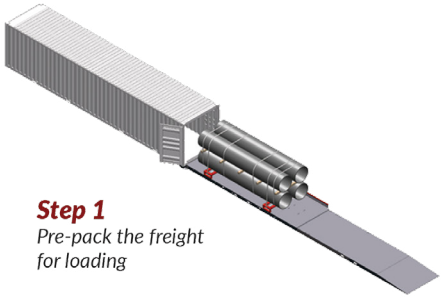
Follow these general guidelines for positioning the COG of packed cargo:

- longitudinal direction – within allowed limits
- transverse direction – close to the half width of the CTU
- vertical direction – below half the height of the CTU's cargo space

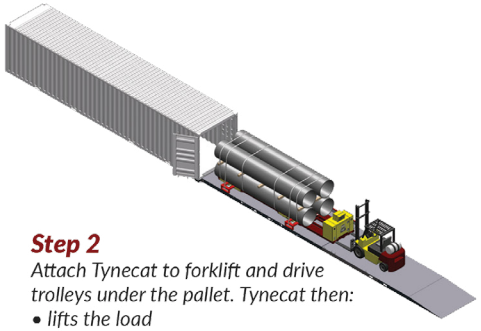
1.2. Eccentricity of COG beyond allowed limits will lead to overstressing of the CTU floor, tipping over of both cargo and CTU, and CTU damage. Note that the higher and narrower the cargo, the more susceptible it is to tipping over. Irregularly shaped cargo, such as logs and steel coils, can easily tip due to imbalance or having their COG positioned at the top or sides (see Chapter 3, Securing).

If, however, the cargo item's weight is densely concentrated, use timber beams or steel beams to transfer some of the weight to the CTU's four corners.

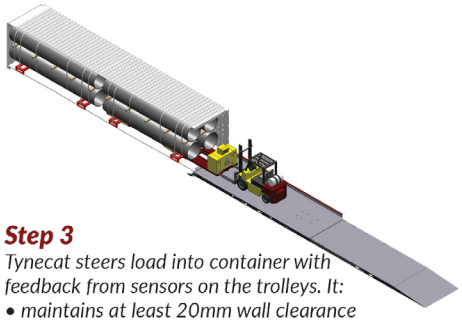
Loading and Weight Verification



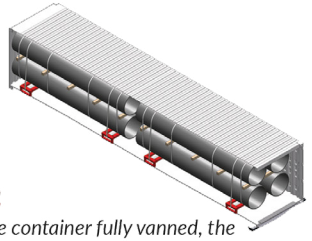
Step 1
Pre-pack the freight for loading



Step 2
Attach Tynecat to forklift and drive trolleys under the pallet. Tynecat then:
- *lifts the load*
- *weighs the load*
- *determines the COG of the load*



Step 3
Tynecat steers load into container with feedback from sensors on the trolleys. It:
- *maintains at least 20mm wall clearance*
- *COG of each shot registered relative to the container for final and overall container gross mass and COG.*



Step 4
With the container fully vanned, the touch-screen on the control panel displays and prints the verified gross mass and COG (CTU weight verification law).

2. Suitable stowage and packing techniques

Plan the stowage of cargo far ahead in advance. Consider factors such as the cargoes' weight, shape, and chemical properties.

General Guidelines in Packing Cargo

2.1. Do not stack heavy cargo on top of:

- light cargo,
- cargo placed inside cardboard or plastic boxes, or
- cargo containing fragile items.

2.2. In handling, packing, protecting and securing an item, follow manufacturer's recommendations as closely as possible.

2.3. Check cargo for damage before loading. If you do transport cargo with damage, indicate so on the accompanying documentation. The Tynecat app allows you to take a photo of the cargo before ingress and store this file along with its identifying data.

2.4. Use appropriate packaging to protect the cargo from humidity and pollutants (see Chapter 1, Stresses).

- Ensure the cleanliness of the CTU and use humidity absorbers as needed.
- Check that the covers on the CTU's ventilation slats are in good condition to prevent the entry of insects.
- Prevent any liquid from entering the CTU during ingress.
- Check packing and securing materials made of wood for insect infestation.

2.5. Palletisation creates a unitised cargo, making it easier to create a tight stow and to be weighed for SOLAS weight verification compliance using method 2 (for more on SOLAS compliance using the Tynecat, see Chapter IV, Loading). Palletisation also makes handling and loading more efficient, cutting down on minutes required to prepare the cargo for ingress.

2.6. Observe symbols, such as those indicating COG and the right side up. Remove or cover any irrelevant symbols posted on the CTU. The CTU Code (Annex 7, Appendix 1) provides a list of packaging marks and their meanings.

2.7. When vanning different types of cargo inside one CTU, ensure that they are not incompatible or do not react adversely with one another. For instance, if one cargo tends to emit moisture or odour, do not stow it in the same container as cargo that is sensitive to moisture or odour, respectively.

2.8. Observe industry-specific guidelines and requirements for the stowage of foodstuff and liquids.

2.9. Pack cargo in a way that makes unloading it safe and easy. For instance, you must ensure that cargo does not fall off when the CTU door is opened (see section on COG, and chapter 3, Securing).

2.10. Packing may aim to produce either a tight stow or a secure stow. A tight stow maximises the container's interior space and leaves little space between the cargo and the CTU's inner walls. A secure stow may not fill the CTU's inner space.

2.10.1. When stowing packages with different shapes, secure them in an interlocking pattern. For example, pipes may be stacked into the grooves of the layer below.

2.10.2. When stowing uniform packages, minimise lost space. Stow drums in regular lines or into the CTU's vertical grooves.

3. Operational safety hazards are taken into account

3.1. Ensure that personnel wear proper protective gear and are instructed in the ergonomics of handling cargo. Only the necessary personnel must be at the loading area. The Tynecat requires minimal personnel to stack cargo and requires only the forklift driver for loading the cargo.

3.2. The loading and unloading area must be checked for possible causes of injuries such as slipping, tripping, and falling. Remove unnecessary equipment from the ingress and egress area. Ensure that all equipment is functioning correctly. Do not use forklifts burning LPG fuel inside the container's confines, especially with cargo that emits vapours or fumes.

3.3. Prevent accidents and overstressing the CTU floor by not overloading the CTU, the loading machine (e.g., hand pallet trucks, forklifts, mechanical loaders), and the ingress infrastructure (e.g., platforms). The use of certain forklifts may overstress the CTU floor and limit package masses to approximately 3 to 3.5 tonnes. Tynecat, on the other hand, can be attached to the front of a forklift truck and eliminates the need for the truck to fully enter the CTU. It weighs only 1.45 tonnes and can carry loads as heavy as 28 tonnes spread over 28 rollers. Equating to only 1T maximum per roller.

3.4. Dangerous goods

3.4.1 Classify and mark dangerous goods, as well as CTUs that have been fumigated.
3.4.2. Only trained personnel may handle, pack, and secure dangerous goods.
3.4.3. Prohibit smoking in the vicinity of dangerous goods.
3.4.4. Properly seal hazardous materials

CHAPTER III.
SECURING CARGO

1. Proper and adequate securing of cargo in a CTU prevents it from shifting or tipping over, potentially causing the CTU to tip over. This is done by creating friction between the cargo layers, as well as between the cargo and the packing materials or platforms. Securing methods, with the help of protecting materials, must also prevent deformation of cargo.

2. Loads may be placed tightly within the boundaries of the side and front walls of the CTU to produce a tight stow, provided that the cargo does not exceed the maximum allowed gross mass according to the CSC (International Convention for Safe Containers), national road regulations, and national rail regulations. On the other hand, loads that do not fill the container space must be secured by blocking and/or lashing.

3. Consider the stresses the cargo might be exposed to throughout the course of the CTU's journey – in transit from the warehouse to the port either via road or rail, its stowage position on the ship, during the sea voyage, and during unloading. This should inform your choice of securing materials and styles.

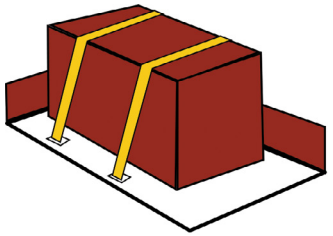
4. Principles of cargo securing include:

- direct securing – uses blocking, lashings, shores or locking devices
- friction securing – is achieved using tie-down or top-over lashings
- compact securing – is used in combination with either of the above. It is achieved by bundling, strapping or wrapping.

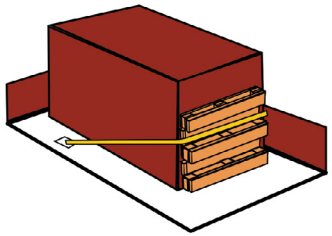
5. Securing Styles

5.1. Blocking is done by placing cargo in tight stows. The cargo must be blocked at the sides, top, and bottom. Stanchions, the CTU walls, and other blocking devices may be used for blocking cargo in a CTU. To prevent tipping of the cargo, ensure that the blocking device reaches up to the load's COG. Fill empty spaces between cargoes or between the cargo and the CTU walls with dunnage bags, battens, or empty pallets.

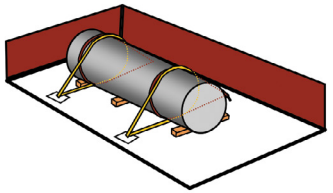
5.2. When lashing cargo to minimise its movement within the CTU in transit, keep the lashing material as short as practicable and keep the direction of the lashing as close as possible to the direction of the intended restraining effect. Depending on the size, shape, and number of cargo, you may use one or a combination of several lashing methods.



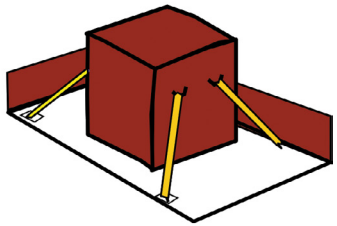
TOP-OVER LASHING



SPRING LASHING



LOOP LASHING



STRAIGHT LASHING

5.3. Mechanical locking is applicable when both the cargo and the CTU have locking devices.

6. Securing Materials

6.1. Bedding Materials

Certain cargo require bedding before they can be placed in a CTU. As a rule of thumb, cargo does not require bedding if it:

- can stand on its own securely
- will not damage or contaminate the container floor
- does not exceed the weight restriction per running metre.

Bedding not only secures freight, it also helps distribute the weight of the cargo, especially items with densely concentrated weight.

Materials for bedding include:

- pallets
- timber planks
- steel girders

6.2. Lashing Materials
Lashing materials prevent cargo from sliding or tipping during transport. Lashing materials include:

- shackles, rings, deck eyes
- ropes (fibre, synthetic fibre, wire)
- chains
- web lashings
- steel wires
- nylon belts
- steel straps
- steel turnbuckles

6.3. Filling Materials
These are used to avoid having gaps between cargo, and between cargo and the CTU's inner walls. These serve to protect both the items and the container. Shippers may use:

- dunnage bags/airbags
- empty pallets
- timber

6.4. Protecting Materials
These protect not only the cargo but also the straps and chains used to secure it.

- corner protectors (also called strap protectors, tie-down strap protectors, or vee boards)
- supporting edge beams

6.5. Anti-slip sheets are used to create additional friction between cargo as well as between the cargo and other materials (pallets, securing materials)

Additional Guidelines
6.6. Secure heavy cargo separately from light cargo.

6.7. Before loading, ensure that:

- the CTU contains no residue from previous cargo
- the CTU's lashing and blocking points are in good condition
- no part of the CTU is damaged (twisted, cracked, dented)
- the CTU doors will properly seal
- the CTU's ventilation slats are sealed properly

6.8. The CTU Code advises against placing certain long, heavy and irregular cargo items such as timber logs inside general-purpose CTUs, unless the items are stowed in the shape of a pyramid and secured by lashing. This is extremely difficult to do inside a freight container. However, with the use of the Tynecat stacker, rotator, loader, the lashings can be arranged before loading, allowing proper stowing of long, heavy and irregularly shaped items in standard CTUs.

CHAPTER IV.
LOADING CARGO

This stage tends to expose cargoes to handling stresses and damage from bumping the load against the walls of the CTU, and abrupt lifting and setting down. When using traditional methods there is also an ever present safety risk with people and/or forklifts entering the CTU.

The Tynecat helps eliminate this risk with the use of steering sensors that allow it to place the load as close as 20mm off the CTU wall. The same sensors prevent the load from bumping against the CTU wall, while lifting and setting down are done gently and with precision.

1. Position the CTU in front of the Tynecat platform.

The CTU should be positioned in front of the Tynecat platform, and the Tynecat placed on top of the platform. Other alternatives to the platform may also be used, such as custom plinths.

Tynecat platforms are 2.2 metres wide and vary in length depending on the Tynecat model used.

Tynecat Model Length	Platform Length
6m	12m
8m	15m
12m	18m

Attach the Tynecat to the forklift.

2. Position the packing pallet on the Tynecat.

3. Load cargo onto packing pallet.

- Load the cargo onto the pallets manually, by forklift, or by conveyor. Once loaded, you can use the Tynecats' weighing mechanism to calculate COG and rearrange the load if necessary.

** The forklift does not lift any load, it simply propels the Tynecat.*

4. Secure cargo onto packing pallet.

- Securing the load can come by wrapping, strapping, or utilising the pallet stake pockets to install the optional pallet sides.

5. Load ready for photographing using Tynecat app and adding to specified file.

6. Verify weight and COG. The file will be registered into the system or emailed for use in the shipping documentation.
To comply with SOLAS weight verification requirements, you can use the Tynecat app to add the weight of the palletised load (which includes packing and securing materials used) and add it to the CTU's tare weight. You can also verify COG to ensure its correct positioning in compliance with the CTU Code. The information will upload directly to your network or to an online database.

7. Tynecat lifts and ingresses load into CTU
All it takes is one operator on the forklift pushing the Tynecat into the CTU. The Tynecat also comes with a handheld remote that can be used either by this operator or by a third party standing next to the platform.

8. Final Securing of the Pallet to the CTU
Strapping and any other padding, bracing, or stuffing is performed as per the CTU Code of practice.

9. Inspection performed, checked off, and more photos of vanned load if desired.

10. Packing completed

11. Doors sealed