IRCLASS
Indian Register of Shipping

GUIDELINES ON CONTAINER STOWAGE AND SECURING

JULY 2025

Guidelines

Container Stowage and Securing

July 2025

Contents

Sections

Introduction

Adequate container stowage and securing is essential to ensure that losses of containers from ships especially on voyages during rough weather are prevented. Improper installation and/or application of container stowage and securing systems onboard can lead to loss of containers in rough weather. which can pose navigation hazards to other ships and also cause environmental damage. Therefore, it is essential that stowage and securing of containers onboard is carried out in a proper manner.

Part 5, Chapter 5 of the IRS *Rules and Regulations for the Construction and Classification of Steel Ships* (hereinafter referred to as the Main Rules) recognize this important aspect and stipulate requirements for container securing arrangements as well as the lashing software which may be installed onboard (**CLS** notation). The stowage and securing of containers onboard are to be in accordance with the Cargo or Container Securing Manual for every ship. However, it would also be useful to have lashing software installed especially for those ships which carry thousands of containers, so as to ensure accurate computation of the forces on container securing arrangements as well as reduce/ eliminate possible human error in such evaluations.

Section 1

General

1.1 Scope & Objective

1.1.1 This document provides guidance on container stowage and securing arrangements and their strength evaluation.

1.1.2 Compliance is also to be ensured with the statutory regulations as may be applicable (e.g. the IMO Code for Safe Practice of Cargo Stowage and Securing (CSS Code) and its associated circulars, the IMO Code for Carriage of Dangerous Goods (IMDG Code) etc.). Any other specific requirements of the flag Administration are also to be taken cognizance of.

1.1.3 The operational aspects covered by these Guidelines (although not a matter of Classification) are derived from practices which have been applied over the years and, do not intend to bypass the judgement of the Master. The final authority on the stowage and securing of containers onboard lies with the Master.

1.1.4 These Guidelines do not address specific events such as the occurrence of parametric rolling which could lead to higher angles of roll and higher accelerations which may lead to container shifting. It is advised that the parametric roll event should be addressed by providing the Master with adequate information and awareness so as to avoid its occurrence.

1.2 General Principles

1.2.1 The containers to be stowed onboard along with the container securing fittings should be approved and certified in accordance with the IRS Classification Note: *Certification of Containers*. IRS may however consider containers and container securing fittings approved and certified in accordance with schemes from other IACS Member Societies.

1.2.2 The Guidelines provide methodology for evaluation of the applicable forces on the container components (e.g. corner posts, corner fittings) and the container securing components (e.g. lashing cones, twist-locks, lashing rods, turnbuckles etc.) so as to evaluate their safe stowage. This methodology should also be addressed in the software developed for evaluation of container securing arrangements.

Section 2

Container Stowage and Securing Arrangements

2.1 General

2.1.1 Container stowage and securing arrangements are to comply with Part 5, Chapter 5, Section 9 of the Main Rules. Additional guidance is provided in this section on the arrangements which can be adopted for container stowage and securing.

2.1.2 In general, Container stowage and securing arrangements are divided into two main categories

- Stowage in Cargo Hold
- Stowage on Deck

2.1.3 The containers being stowed and secured could be standard 20 feet containers or 40 feet containers. Non-Standard containers are to be specially considered.

2.1.4 The guidance provided in this section aims to ensure that the containers stowed in a single bay are connected appropriately with container securing elements so that they function collectively as a single block (or commonly referred to as a 'stack') as well as transfer the applicable weight and environmental loads safely to the hull. In turn, the hull should be adequately strengthened so as to withstand the loads which are transferred from the container stacks.

2.1.5 For the purpose of these guidelines, the container securing elements are considered to include the following components but not limited to :

a) Lashing Cones including Double Stacking Cones (both transverse and longitudinal)
b) Twistlocks
c) Turnbuckles
d) Lashing Rods
e) Bridge Fittings
f) Cell Guides
g) Elephant Foot and Sockets
h) Corner Hooks
i) Cell Guide Heads
j) Buttress Devices
k) Tensioning Devices

2.2 Container Stowage in Cargo Hold

2.2.1 When cell guides are fitted, in general, rolled angle or tee sections are to be provided with a minimum web and flange thickness of 12 [mm] in order to ensure proper stacking of the containers. These cell guides may be welded or bolted (if temporary) to the primary hull structure.

2.2.2 Longitudinal and transverse supports should be provided to the cell guides in form of cross tie structures. Guide heads should be provided at the entry point of the cell guide structures in order to facilitate smooth introduction of the container within the cell. The local structures in proximity to the entry points should be provided with structural strengthening in order to withstand any accidental impact from the container being loaded.

2.2.3 Containers within a container stack should be secured to each other as well as the bottom of the cargo hold as applicable using components such as lashing cones (typical) or twistlocks.

2.2.4 For containers with cell guides, clearances should be maintained as per ISO 3874:2017.

2.3 Container Stowage on Hatch Covers

2.3.1 It should be ensured that the containers do not overhang the ship's sides.

2.3.2 Containers should be stacked on deck in multiple tiers using fittings such as twistlocks. The bottom tier in the stack should be secured to the hatch cover using twistlocks. For the outermost container stacks along the beam, the securing is done typically to the dedicated stanchions provided on deck. For container stacks typically higher than four tiers, bridge fittings can be applied for the topmost containers in the tiers in order to help connect the adjoining stacks, to provide better restraint. Lashing rods may also be used additionally to secure the containers typically at the bottom tiers of the stack.

2.3.3 For container ships with TEU Capacity of 4000 and above, it is recommended that lashing bridges (raised platforms fitted above the deck to which the containers are lashed thus enabling stacks of higher number of tiers) be provided for stowage. Bridge fittings should be used for containers in the uppermost tier.

2.3.4 Longitudinal and transverse supports should be provided to the cell guides in the form of cross tie structures. Guide heads should be provided at the entry point of the cell guide structures in order to facilitate smooth introduction of the container within the cell.

2.3.5 The local structures in proximity to the entry points should be provided with structural strengthening in order to withstand any accidental impact from the container being loaded.

2.3.6 Cell guides may also be considered to be fitted on the weather deck to help enable container stowage (though this is not common practice). The containers should be adequately secured against the transverse and longitudinal racking forces.

2.3.7 Appropriate cross tie structures should be provided in order to help laterally support the cell guide structures.

2.3.8 A breakwater should be installed forward of the foremost cargo hold to protect the exposed container stacks against green sea loads. Calculations should be submitted to demonstrate adequate strength of the breakwater considering applicable loads as provided in Part 3, Chapter 5 of the Main Rules.

2.3.9 For containers with cell guides, clearances should be maintained as per ISO 3874:2017.

2.4 Stowage of 20 ft Containers in 40 ft bays in Cargo Hold

2.4.1 If it is considered necessary to utilize the empty bays for 40 ft. containers to transport 20 ft. containers, then, this may be achieved by installation of temporary or permanent appendages within the bay.

2.4.2 Temporary cell guides may be installed in order to provide lateral support to the container stack. Such guides are usually bolted to the deck below. Mid bay guides should be considered in order to restrain the transverse movement of the 20 ft. containers at the bottom of the stack

2.4.3 The containers in a stack should be connected to each other using loose fitting devices such as stacking cones or twist locks. Block stowage employing utilization of double stacking cones is also preferred.

2.4.4 20 ft containers should not be stowed over 40 ft containers.

2.5 Special Arrangements

2.5.1 Other special or non-standard arrangements may be necessary for stowage and securing of containers, especially those which may not be standard 20 ft or 40 ft containers. Details of such non-standard arrangements (if intended to be used) should be submitted to IRS and will be separately considered in terms of the applicable loads and the allowable forces in the container structural components.

Section 3

Strength Evaluation of Container Stowage and Securing Arrangements

3.1 General

3.1.1 This Section provides guidance on evaluation of the structural adequacy of the container stowage and securing system.

3.1.2 The methodology in this Section is focused on use of the Main Rules as regards calculation of Ship accelerations. However, IRS will also accept methodology which uses the applicable accelerations as provided in the IMO CSS Code as amended. Direct calculations are permitted and indicated where necessary in these guidelines to calculate ship motions and accelerations. In case of any discrepancy between these Guidelines and the Main Rules, the requirements in the Main Rules will prevail.

3.2 Loads

3.2.1 The following loads should be considered as minimum for the evaluation:

- Total weight of the Container with the packed contents
- Environmental Loads
    - Ship Motions and Accelerations
    - Wind Loads
    - Green Sea Loads (as applicable)
    - Loads due to Whipping and Springing phenomena (as applicable)

3.3 Container Weights

3.3.1 Declared Gross Container weight should be used to determine the adequacy of the container securing arrangements for a given stack. However, the Container weight should not be less than or more than the values given in Table 3.3.1

Table 3.3.1 Maximum and Minimum Container Weights to be considered

Container Type	Minimum Weight (tonnes)	Maximum Weight (tonnes)
20 ft	2.5	30.5
40 ft	3.5	30.5

3.4 Wind Loads

3.4.1 Wind loads should be applied to all exposed containers. The wind load should not be taken lesser than the values given in Table 3.4.1.

Table 3.4.1 Maximum and Minimum Wind Loads to be considered

Container Type	Transverse (kN)	Longitudinal (kN)
20 ft	15.7	6.4
40 ft	31.6	6.4

3.4.2 For non-standard containers or container sizes different from those mentioned in Table 3.4.1, the wind load should be evaluated considering a pressure not less than 1 kN/m^2 on the exposed container side.

3.5 Ship Motions and Acceleration Loads

3.5.1 General

3.5.1.1 The loads to be used for evaluation due to ship motions and accelerations are indicated in this section and should not be taken less than the values provided in this section. However, IRS may accept the values of accelerations (as applicable), as prescribed in the IMO CSS Code, as may be amended, in lieu (also refer Section 3.2.2).

3.5.1.2 The motions and accelerations should be computed in accordance with Part 3, Chapter 5 of the Main Rules.

3.5.2 Ship Motions and Accelerations

3.5.2.1 Ship motions and accelerations should be evaluated as per Part 3, Chapter 5 of the Main Rules, as shown below:

.1 Wave Coefficient – Main Rules, Part 3, Chapter 5
.2 Common Acceleration Parameter – Main Rules, Part 3, Chapter 5
.3 Angle of Roll – Main Rules, Part 3, Chapter 5, Section 2 however not to be taken less than 25° for ships with B < 32.2m
.4 Angle of Pitch – Main Rules, Part 3, Chapter 5, Section 2
.5 Accelerations – Main Rules, Part 3, Chapter 5, Section 2

3.5.3 Acceleration Loads

3.5.3.1 Transverse Loads

3.5.3.1.1 Transverse Loads on Containers in a stack should be evaluated as shown below:

$$F_{ti} = M_i a_t^i$$

Where:
F_{ti} Transverse Load on i^{th} Container in the stack which is being evaluated
a_{ti} Transverse Acceleration of the i^{th} Container in the stack, which is the maximum acceleration to be evaluated in accordance with Main Rules, Part 3, Chapter 5, Section 2.2.3.2
M_i Mass of the i^{th} Container in the stack which is being evaluated (Mass is to be in accordance with Section 3.3)

3.5.3.2 Longitudinal Loads

3.5.3.2.1 Longitudinal Loads on Containers in a stack should be evaluated as shown below:

$$F_{li} = M_i a_l^i$$

Where:
F_{li} Longitudinal Load on i^{th} Container in the stack which is being evaluated
a_{li} Longitudinal Acceleration of the i^{th} Container in the stack, which is the maximum acceleration
to be evaluated in accordance with Main Rules, Part 3, Chapter 5, Section 2.2.3.1
M_i Mass of the i^{th} Container in the stack which is being evaluated (Mass is to be in accordance with Section 3.3)

3.5.3.3 Vertical Loads

3.5.3.3.1 Vertical Loads on Containers in a stack should be evaluated as shown below:

$$F_{vi} = M_i a_v^i$$

Where:
F_{vi} Vertical Load on i[th] Container in the stack which is being evaluated
a_v^i Vertical acceleration of the i[th] Container in the stack to be evaluated as shown below:

For evaluation of compressive force on cornerposts:

$$a_v^i = g + a_v$$

For evaluation of tensile force on cornerposts:

$$a_v^i = g$$

Where:
g: acceleration due to gravity 9.81 m/s^2
a_v: to be evaluated in accordance with Main Rules, Part 3, Chapter 5, Section 2.2.3.3

M_i Mass of the i[th] Container in the stack which is being evaluated (Mass is to be in accordance with Section 3.3)

3.5.4 Load Combinations

3.5.4.1 The evaluation should consider at least the following load combinations:

.1 Gravity Loads + Dynamic Loads from Sway, Roll and Heave Accelerations
.2 Gravity Loads + Dynamic Loads from Surge, Pitch and Heave Accelerations

3.6 Evaluation of Forces in Container Securing Arrangements

3.6.1 Effects of application of Lashing rods/Turnbuckles/Chains/Wires

3.6.1.1 The use of lashing rods/turnbuckles/chains/wires leads to imposition of additional loads on the container corner castings which should be checked in order to keep them below permissible limits. The guidance in this sub-section is applicable to stowage of containers on hatch-covers.

3.6.1.2 The stiffness of the ends of the container as well as the lashing rods/turnbuckle/chains/wires should be considered while evaluating the final forces arriving at the container corner posts, container corner castings as well the lashing rods/turnbuckles/chains/wires themselves. These should be considered from actual data, however indicative values are mentioned as below:

Container Closed End ($k_{c\text{-}cl}$): 15.7 kN/mm
Container Door End ($k_{c\text{-}de}$): 3.7 kN/mm

3.6.1.3 The stiffness (k_l)of the lashing rod/turnbuckle/wire/chain should be evaluated using values declared by the manufacturer. In case of such values not being readily available, the following equation may be used to obtain an indicative estimate:

$$k_l = \frac{EA}{l}$$

Where:
k_l: Stiffness constant of the lashing rod/turnbuckle/chain/wire (kN/mm)

E: Effective Elastic Modulus of the material of the Lashing Rod/Turnbuckle/Chain/Wire (kN/mm^2).
A: Effective Cross-Sectional Area (mm^2)

3.6.1.4 The effects of possible deformation of the lashing bridges, hatch cover or compression forces in the lashing rod/turnbuckle/chain/wire should be taken into account when using the stiffness calculation of the lashing rod/turnbuckle/chain/wire.

3.6.2 Application of Loads

3.6.2.1 The typical loads (wind, weight, inertial) on a container stack in the transverse direction are shown in Figure 3.6.2.1.

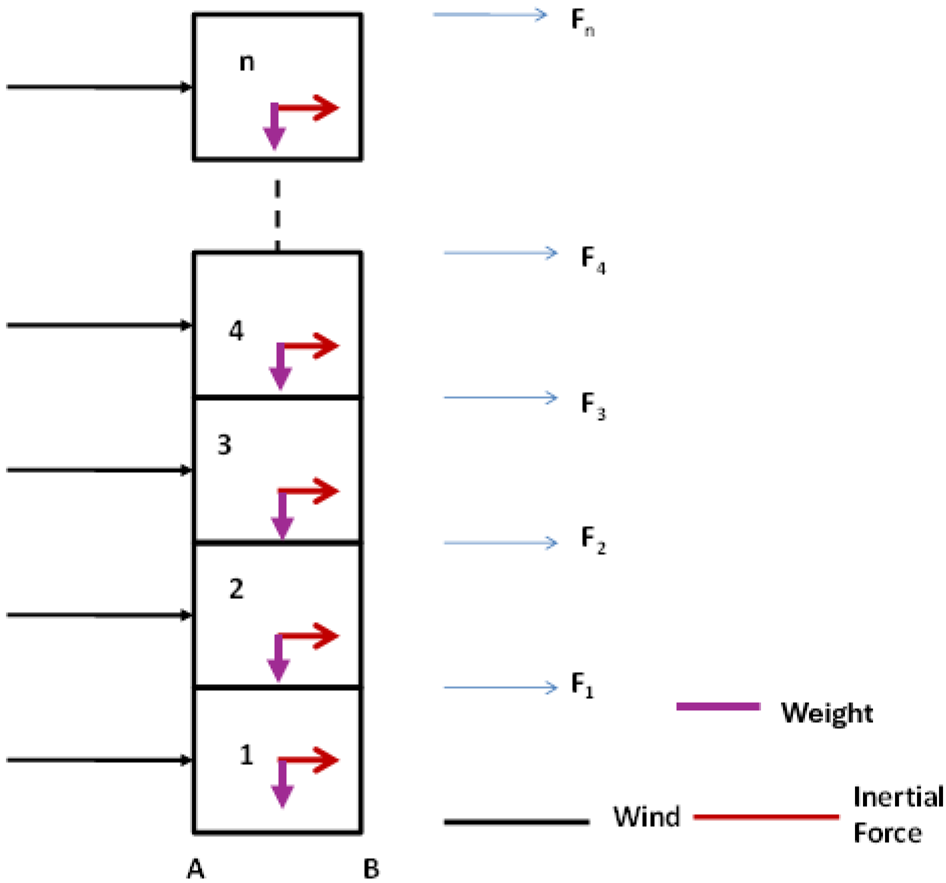

Figure 3.6.2.1: Schematic of Loads on a Container Stack in the transverse direction

3.6.2.2 The vertical forces on the container should be distributed equally on the four corner posts or alternatively on the two ends of the container. The force distribution due to weight is expressed as follows:

$$F_{V-cp} = \frac{M(a_v^i)}{4}$$
$$F_{V-cte} = \frac{M(a_v^i)}{2}$$

Where:

$F_{V\text{-}cp}$: Vertical Load on the Container Corner fittings (at the bottom of the container)
$F_{V\text{-}cte}$: Vertical Load on the ends of the Container

3.6.2.3 The wind load on the Container should be divided equally amongst both ends (fore and aft) of the container. Thereafter, it may be divided equally between the top and bottom levels of the container.

3.6.2.4 The acceleration loads on the Containers should be divided equally on the container ends. Thereafter these should be further distributed between the top and bottom levels of the container considering that these loads act at the centre of gravity of the container. In absence of data for centre of gravity, this may be considered as being located at the following co-ordinates:

Longitudinally:	$0.5L_c$
Vertically:	$0.45H_c$
Transversely:	$0.5W_c$

Where:
L_c: Length of the Container
H_c: Height of the Container
W_c: Width of the Container

3.6.3 Evaluation of the Forces in the Container Securing Systems for Container Stacks on Hatch-Covers

3.6.3.1 Transverse Racking Forces

3.6.3.1.1 The Equivalent Transverse Forces at the top of each container should be evaluated using the equations below:

$$F_{i-t} = f_i F_t^i + (1 - f_i) F_t^{i+1} + 0.5F_W^i + 0.5F_W^{i+1} \forall 1 \leq i < n$$

$$F_{n-t} = f_n F_t^n + 0.5F_W^n$$

Where:
F_{i-t} : Equivalent force at top of i^{th} container in the stack at one container end frame
f_i : Fraction of the vertical centre of gravity with respect to height of the i^{th} container
F_t^i : Transverse force due to ship motions on the i^{th} container at one container end frame
F_W^i : Wind force on the i^{th} container at one container end frame

3.6.3.1.2 Once the Equivalent Transverse Forces at the top of each container in the stack are evaluated, the Transverse Racking Force should be evaluated as shown below:

$$Q_{i-t} = \sum_{k=i}^{n} F_{k-t}$$

Where:
Q_i: Transverse Racking Force at the top of the i^{th} container
F_k: Equivalent Transverse Force at the top of the k^{th} container evaluated using 3.6.3.1.1.

3.6.3.1.3 If lashing rods/turnbuckles/chains/wires are additionally used for container securing, then the Transverse Racking Force obtained from 3.6.3.1.2 should be revised as shown below:

$$Q_{i-trev} = Q_{i-t} - T_i \cos \omega_i$$

Where:
Q_i: Racking Force on the i^{th} container calculated in accordance with Section 3.6.3.1.2
Q_{i-trev}: Revised Racking Force on the ^{ith} container
T_i: Tension in the lashing rod/turnbuckle/wire/chain
ω_i: Angle of the lashing rod/turnbuckle/wire/chain

3.6.3.2 Longitudinal Racking Forces

3.6.3.2.1 The Equivalent Longitudinal Forces at the top of each container should be evaluated using the equations below:

$$F_{i-l} = f_i F_l^i + (1 - f_i) F_l^{i+1} 1 \leq i < n$$

$$F_n = f_n F_l^n$$

Where:
F_i : Equivalent force at top of i^{th} container in the stack at one container end frame
f_i : Fraction of the vertical centre of gravity with respect to height of the i^{th} container
F_l^i : Longitudinal force due to ship motions on the i^{th} container at one container end frame

3.6.3.2.2 Once the Equivalent Longitudinal Forces at the top of each container in the stack are evaluated, the Longitudinal Racking Force should be evaluated as shown below:

$$Q_{i-l} = \sum_{k=i}^{n} F_{k-l}$$

Where:
Q_{i-l}: Transverse Racking Force at the top of the i^{th} container
F_{k-l}: Equivalent Transverse Force at the top of the k^{th} container evaluated using 3.6.3.2.1.

3.6.3.3 Corner Post Compressive Force

3.6.3.3.1 The resultant corner post compressive force at the bottom of the i^{th} tier container from effects arising due to transverse accelerations should be evaluated as shown below:

$$P_C^i = \frac{\sum_i^n F_W^k h_c^k + \sum_i^n F_t^k h_w^k + \sum_i^n 0.25 M_k (a_v^k) W}{W}$$

Where:
P_C^i : Compressive Force at the bottom of i^{th} tier container
h_c^k : Height of the centre of the k^{th} container from the bottom of the i^{th} container
h_w^k : Height of the centre of gravity of the k^{th} container from the bottom of the i^{th} container
M_k : Gross Mass of the container at one end of the container
a_v : Vertical acceleration of the container including the static and dynamic components
W : Width of the container
H_c : Height of the container

3.6.3.3.2 The resultant corner post compressive force at the bottom of the i^{th} tier container from effects arising due to longitudinal accelerations should be evaluated without consideration of wind loads as shown below:

$$P_C^i = 0.5 \frac{\sum_i^n F_l^k h_w^k + \sum_i^n 0.5 M_k (a_v^k) L}{L}$$

Where the symbols have the similar meanings described in the sections above and
L: Length of the Container

3.6.3.3.3 The effect of the lashing rod tensions and/or green sea loads should also be evaluated and the corner post compression force should be accordingly re-evaluated for those containers for which lashing is installed.

3.6.3.4 Corner Post Tensile Force

3.6.3.4.1 The resultant corner post tensile force at the bottom of the i^{th} tier container from effects arising due to transverse accelerations should be evaluated as shown below:

$$P_T^i = \frac{\sum_i^n 0.25 M_k (a_v^k) W - \sum_i^n F_W^k h_k - \sum_i^n F_t^k \, h_w^k}{W}$$

Where:
P_T^i : Tensile Force at the bottom of i^{th} tier container
Other symbols are already defined in 3.6.3.3.1

3.6.3.4.2 The resultant corner post tensile force at the bottom of the i^{th} tier container from effects arising due to longitudinal accelerations should be evaluated as shown below:

$$P_T^i = 0.5 \frac{\sum_i^n 0.5 M_k (a_v^k) L - \sum_i^n F_l^k h_w^k}{L}$$

3.6.3.4.3 The effect of the lashing rod tensions should also be evaluated and the corner post tensile force should be accordingly revised for those containers for which lashing is installed.

3.6.4 Evaluation of the Forces in the Container Securing Systems for Container Stacks in Cargo Holds with installed Cell Guides

3.6.4.1 For Containers stowed in stacks in the cargo holds which have been installed with Cell Guides, the longitudinal, transverse and vertical forces should be computed as indicated in Section 3.5.

3.6.4.2 The transverse acceleration loads on any container in a stack are considered to be transferred to the corresponding cell guide structure through the four container corner fittings fitted along the particular longitudinal wall of the container. These may be considered to be equally distributed amongst these four container fittings.

3.6.4.3 The longitudinal acceleration loads on any container in a stack are considered to be transferred to the corresponding cell guide structure through the four container corner fittings fitted along the particular door/closed end of the container. These may be considered to be equally distributed amongst these four container fittings.

3.6.4.4 The vertical forces due to container weight and vertical acceleration are considered to be transferred through the container corner post to the containers beneath or for the lower most container in the stack are considered to be transferred to the primary structure of the ship through the container fittings used to secure the container stack. These forces may be considered to be equally distributed on the four corner posts of the relevant container.

3.6.4.5 For container securing arrangements in cargo holds where 20 ft and 40 ft containers are stowed in the same bay, evaluation of the adequacy of such arrangements will be specially considered by IRS.

3.6.5 Direct Analysis Techniques for evaluation of Forces on Container Stacks

3.6.5.1 Notwithstanding Sections 3.6.3 and 3.6.4, direct analysis techniques including finite element-based techniques incorporating non-linear analyses will be specially considered by IRS subject to adequate justification based upon the following aspects but may not be limited to:

.1 Method for finite element modeling of the container stacks including the modeling of structural stiffness of container corner-posts, fittings, door/closed ends, lashing rods/turnbuckles/chains/wires, lashing cones, twistlocks, lashing bridges, cell guides etc.
.2 Loads considered on the container stacks including consideration of environmental conditions and their combination
.3 Methods for simulating the boundary conditions of the container stacks including spring/gap elements and the non-linearities associated therein.
.4 Methods for considering possible interaction of adjacent stacks
.5 Methods for considering hull/hatch cover deformations in the analyses
.6 Methods for solution of the non-linear equations (e.g. solver utilized (e.g. Newton-Raphson solver, Full Transient Dynamic Analysis etc.)

3.6.6 Allowable Forces

3.6.6.1 The allowable forces on various items are listed in Table 3.6.6.1

Table 3.6.6.1: Allowable Forces on Containers and Fittings

Quantity	Allowable Forces (kN)	
	20 ft	40 ft
Transverse Racking Force	150	150
Longitudinal Racking Force	75	75
Tension Force at Corner Casting	250	250
Compression Force on Corner Post	848	848
Horizontal Tension from lashing on the container corner	150	150
Vertical Tension from lashing on Container Corner	225	225
Note: Allowable forces on non-standard containers (i.e. other than 20ft and 40ft) will be specially considered based on manufacturer's recommendations and supporting test reports.		

3.6.6.2 The stresses within the cell guides should not exceed 200 /k for normal stresses, 100/k for shear stresses and 175/k for von mises stresses; (k being the material factor).

3.6.6.3 The loads (tensile, shear and bearing) on the loose container fittings (e.g. cones, twistlocks, lashing rods etc.) should not exceed 85% of their Safe Working Load Limits (SWL).

End of Guidelines