Informal meeting on Code of Practice for Packing of Cargo Transport Units

at the request of the United Nations Economic Commission for Europe Working Party on Intermodal Transport and Logistics

Geneva and virtual, 12-13 July 2022

Package stability

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The packing of CTU requires that the packer fully understands the stability of the packages and the requirements for proper securing. This document proposes a new section to be added into annex 7 – Packing and securing cargo in CTUs

This document proposed a new term – Transport Stability Level (TSL) which, when attributed to a package, can be used to assist the packer when deciding the degree of blocking or lashing required.

The document also proposes changes to appendix 5 - Practical inclination test for determination of the efficiency of cargo securing arrangements which assists the consignor in the identification of the TSL for each of their packages to be transported.

Proposal for a new section 4.2 of Annex 7:

4.2 Transport Stability Level, TSL

4.2.1 Introduction

The term “package” is used in this document to refer to any goods that are enclosed within one or more layers of packaging or secured on, or to, a packaging accessory.

Consignors should ensure that formed packages are capable of withstanding the hazards of environmental exposure, storage, handling and transport. Packages in the form of overpacks should retain their integrity during transport, failure to do so increases the risk of the cargo being damaged or the CTU stability being adversely affected.

To assist Packers in their role, the transport stability of the packages may be determined by practical tests, in which the packages capability of withstanding horizontal forces without substantial deformation is verified. Upon completion of such tests, the package may be marked with its corresponding Transport Stability Level (TSL), as given in table 1.

Transport Stability Level TSL	**Horizontal acceleration a**
TSL 1	$a \geq 1,0\ g^a$
TSL 2	$0,8\ g \leq a < 1,0\ g$
TSL 3	$0,5\ g \leq a < 0,8\ g$
TSL 4	$0,35\ g \leq a < 0,5\ g$
TSL 5	$0,18\ g \leq a < 0,35\ g$
[a] *g* = gravity acceleration 9,81 m/s^2 **Note**: Below 0.18 g no TSL marking allowed	

Table 1 – Transport Stability Level

The TSL when associated with the CTUs boundary strength can indicate the need for additional securing of the cargo and should be determined in each specific case.

4.2.2 Determine the TSL

The TSL of a package can be determined through practical tests by exposing the package to the horizontal acceleration corresponding to the sought TSL level according to table 1, for example by inclination tests as described in Appendix 5, with the addition that the maximum inclination angle shall be retained for at least 5 seconds and that the required inclination angle, to simulate the desired horizontal acceleration, shall be determined based on the internal friction of the goods in the package.

During the tests, the package should be prevented from sliding on the test platform by a measure that does not influence the package stability.

The package shall be tested 3 times in the lengthwise as well as in the sideways direction respectively. Asymmetrical cargo shall be tested in the most unstable directions. A separate test sample may be used in each test direction. No correction of the test samples may be done during the test.

After the test sequence, the permanent deformation of any part of the test sample from the primary location shall not exceed 60 mm in any direction. The maximum deformation may be measured on the front or back side of the test sample based on the primary vertical projection.

Furthermore, the test sample may not tip up or fall over during the tests.

No signs of visible leakage from the test sample are allowed after the test.

4.2.3 Marking of TSL

All packages which have a tested TSL should be marked with this, either on a separate label or incorporated with other markings on the units.

The TSL marking should:

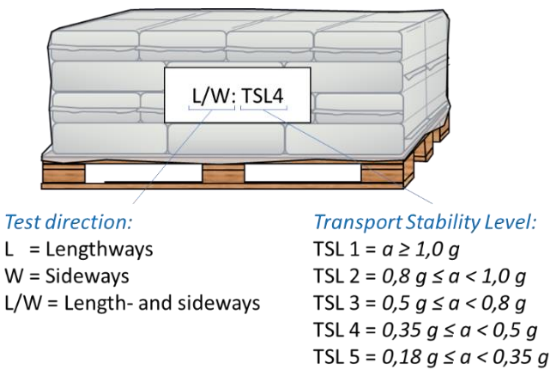
a) be marked on at least one side of each package,

b) use letters or numbers of at least 12 mm height,

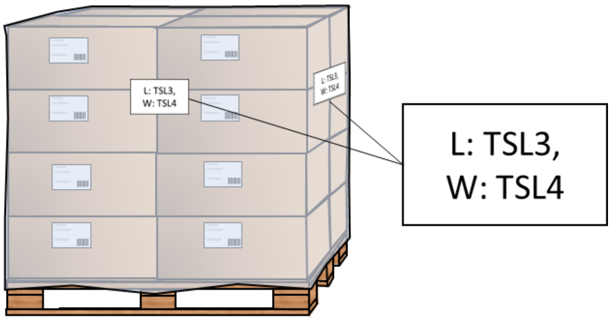
c) be visible and readable,

d) be displayed on a background of contrasting colour on the external surface of the package,

It is possible that test results for TSL differ in different directions depending on the shape of the package and therefore the lowest value for length and width directions should be displayed as per examples 1 and 2 below.



Example 1 – Marking of Transport Stability Level 4 in both length (L) and width (W) directions.



Example 2 – Marking of Transport Stability Level 3 in length (L) and 4 in width (W) directions

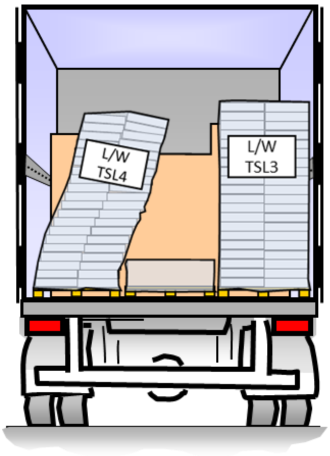
4.2.4 Practical applications for packages with known TSL

4.2.4.1 Bottom blocking

If the value of the directional TSL for a package (see table 1) is equal to or exceeds the directional acceleration coefficients (see chapter 5) for the intended transport mode, bottom blocking should be sufficient to prevent the cargo from sliding. Table 2 below indicates the lowest required TSL for solely using bottom blocking to secure cargo in different directions and different modes of transport.

The lowest required TSL for using bottom blocking for securing the cargo			
Mode of transport	**Sideways**	**Forward**	**Backward**
Road	TSL3	TSL2	TSL3
Rail	TSL3	TSL3	TSL3
Sea Area A	TSL3	TSL2	TSL2
Sea Area B	TSL2	TSL1	TSL1
Sea Area C	TSL2	*Not advised*	*Not advised*

Table 2 – Required TSL for bottom blocking as cargo securing method



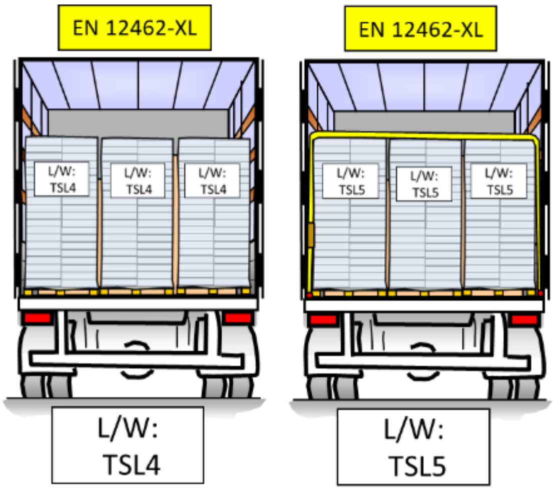
Example 3 – A package marked with TSL 3 or better may be bottom blocked sideways during road transport, while a package marked with TSL 4 risk collapsing in this situation.

4.2.4.2 Blocking against the side of the CTU

The TSL of the package indicates if the strength of the boundaries of the CTU is sufficient for blocking the packages or if additional securing methods are required by other means, e.g. lashings, in order not to overstress the CTU's boundary walls.

The lowest required TSL to block the cargo against the boundary walls of the CTU (evenly distributed cargo)						
Standard	**EN 12642:2016**				**EN 283**	**ISO 1496**
CTU	**L-vehicle**			**XL-vehicle**	**Swap-body**	**Container**
Mode of transport	**Box**	**Drop-sides**	**Curtain-sider**	**Box/Dropside/ Curtainsider**		
Road	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Rail	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Sea Area A	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Sea Area B	TSL3	TSL3	TSL3	TSL4	TSL3	TSL5
Sea Area C	TSL3	TSL3	TSL2	TSL3	TSL3	TSL5

Table 3 – Required TSL for blocking against the sides of CTUs



Example 4 – During transport in a road vehicle complying with standard EN 12642-XL, packages marked with TSL 4 or better may be secured solely by blocking against the CTU's sides, whilst packages marked with TSL 5 needs additional securing measures, e.g. top-over lashings.

4.2.4.3 TSL in combination with the Quick Lashing Guides

The lashing tables in the Quick Lashing Guides (QLG) in Informative material IM5 are based on rigid packages and the assumption that sliding occurs between the bottom of the package or package accessory and the CTU floor. However, this is not the case for packages with low transport stability, which may tip earlier than indicated by their shape and structure indicates due to substantial deformation or sliding may occur within the package.

When using the Quick Lashing Guide (QLG) to identify the number of lashings required to prevent a package, with a given cargo mass, from sliding the maximum friction factor for a declared TSL can be identified in table 4 below.

Transport Stability Level TSL	**Maximum friction factor for deciding μ**
TSL 1	*1.0*
TSL 2	*0.80*
TSL 3	*0.50*
TSL 4	*0.35*
TSL 5	*0.15*

Table 4 – Maximum friction factors to use in the QLG for different TSLs

4.2.4.4 Selecting packaging to minimize breakage

If frequent breakage occurs during transport, the packaging may need improving. In such case, testing of TSL may be used as a tool for investigating the cause of the breakage, deciding on additional measures or new methods for packaging and verifying that these new measures provide a better transport stability.

Furthermore, a consignor or consignee may implement requirements of a minimum TSL for their packages, for themselves or for contracted partners, to minimize the risk of breakage and to make the cargo securing more efficient and safer.

Subsequent paragraphs to be renumbered

CTU code Annex 7 – Changes in Appendix 5

Appendix 5. Practical inclination test for determination of the efficiency of cargo securing arrangements

1 The efficiency of a securing arrangement or the transport stability level (TSL) of a package can be tested by a practical inclining test in accordance with the following description.

2 The cargo (alternatively one section of the cargo) is placed on a road vehicle platform or similar and secured in the way intended to be tested.

3 To obtain the same loads in the securing arrangement or package in the inclining test as in calculations, the securing arrangement or package or package should be tested by gradually increasing the inclination of the platform to an angle, α, in accordance with the diagrams below.

4 The inclination angle that should be used in the test is a function of the horizontal acceleration $c_{x,y}$ for the intended direction (forward, sideways or backward) and the vertical acceleration c_z.

(a) To test the efficiency of the securing arrangement in the lateral direction, the greatest of the following test angles should be used:

- The angle determined by the friction factor μ (for the sliding effect), or
- The angle determined by the ratio of $\frac{B}{n \cdot H}$ (for the tilting effect).

(b) To test the efficiency of the securing arrangement in the longitudinal direction, the greatest of following test angles should be used:

- The angle determined by the friction factor μ (for the sliding effect), or
- The angle determined by the ratio of $\frac{L}{H}$ (for the tilting effect).

(c) To test the TSL of a package in any direction the following test angles should be used:

- The angle determined by the internal friction factor μ on package without any package accessory.

5. Test of cargo securing arrangements

5.1 The lowest friction factor, between the cargo and the platform bed or between packages if over-stowed should be used. The definition of H, B, L and n is according to the sketches in figures 7.61 and 7.62.

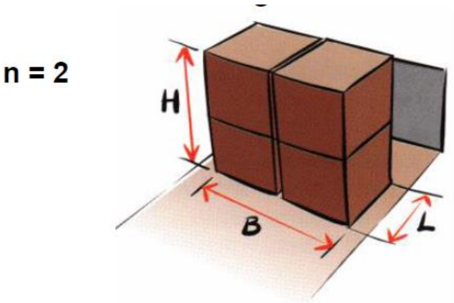


Figure 7.61

Package or section with the centre of gravity close to its geometrical centre (L/2, B/2, H/2).

The number of loaded rows, n, in above section is 2.

L is always the length of one section also when several sections are placed behind each other.

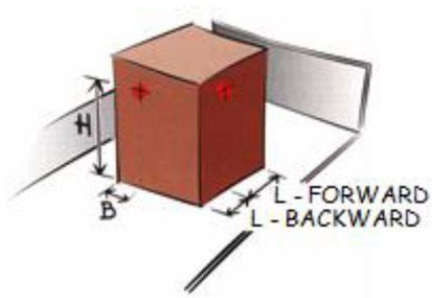


Figure 7.62

Package with the centre of gravity away from its geometrical centre.

The required test angle α as function of $c_{x,y}$ (0.8 g, 0.7 g and 0.5 g) as well as μ, $\frac{B}{n \cdot H}$ and $\frac{L}{H}$ when c_z is 1.0 g is taken from the diagram shown in figure 7.63 or from the table below.

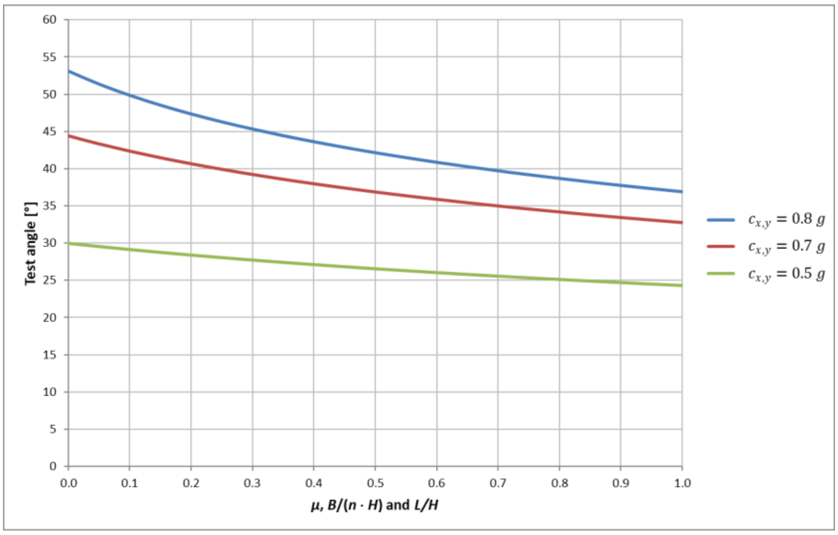


Figure 7.63

Example :

If μ and $\frac{B}{n-H}$ is 0.3 ~~at~~ for sideways accelerations ~~sideways at~~in transport in sea area B (c_y = 0.7g) the cargo securing arrangement should be able to be inclined to approximately 39°, according to ~~the diagram~~figure 7.63 and table 1

In the table below the inclination *α* is calculated for different γ factors at the horizontal accelerations ($c_{x,y}$ = *0.8* g, *0.7* g and *0.5* g and c_z = *1.0* g).

The *γ* factor is defined as follows:

μ, *B/(n · H)* and *L/H*, as required in section 4 of this appendix.

$c_{x,y}$	0.8g	0.7g	0.5g
ϒ factor	Required test angle α in degrees		
0.00	53.1	44.4	30.0
0.05	51.4	43.3	29.6
0.10	49.9	42.4	29.2
0.15	48.5	41.5	28.8
0.20	47.3	40.7	28.4
0.25	46.3	39.9	28.1
0.30	45.3	39.2	27.7
0.35	44.4	38.6	27.4
0.40	43.6	38.0	27.1
0.45	42.8	37.4	26.8
0.50	42.1	36.9	26.6
0.55	41.5	36.4	26.3
0.60	40.8	35.9	26.0
0.65	40.2	35.4	25.8
0.70	39.7	35.0	25.6
0.75	39.2	34.6	25.3
0.80	38.7	34.2	25.1
0.85	38.2	33.8	24.9
0.90	37.7	33.4	24.7
0.95	37.3	33.1	24.5
1.00	36.9	32.8	24.3

Table 1

~~6~~5.2 The securing arrangement is regarded as complying with the requirements if the cargo is kept in position with limited movements when inclined to the prescribed inclination *α*.

~~7~~5.3 The test method will subject the securing arrangement to stresses and great care should be taken to prevent the cargo from falling off the platform during the test. If large masses are to be tested the entire platform should be prevented from tipping as well.

~~8~~5.4 Figure 7.64 and figure 7.65 show tests to confirm the securing arrangements of a large package for acceleration forces in longitudinal and transverse directions.

Figure 7.64

Figure 7.65

6 Test of Transport Stability Level (TSL)

6.1 The required test angle α as a function of chosen TSL (1 – 5) is taken from the diagram shown in figure 7.66 or from the table below.

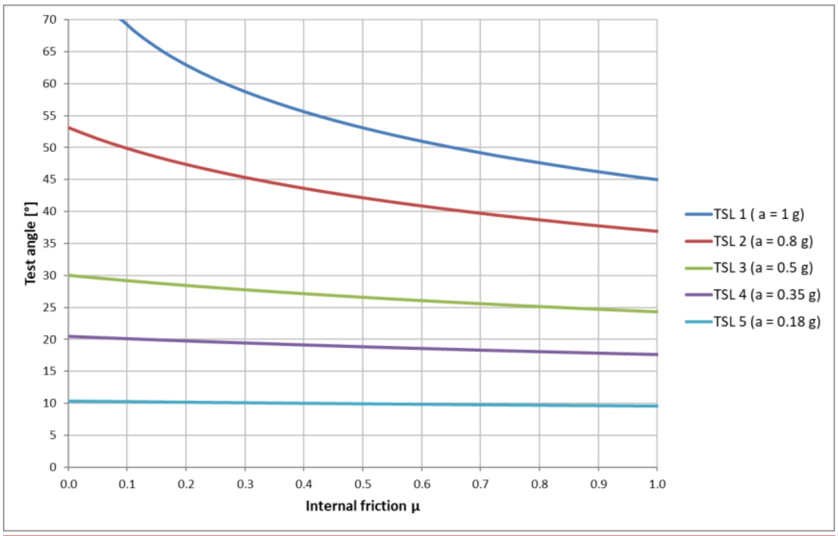


Figure 7.66

Example :

If the internal friction of a package is determined to µ = 0.40 and transport stability level chosen to be tested is TSL 3 the package should be able to be inclined to approximately 27°, according to the diagram

In table 2 the inclination *α* is calculated for different internal friction of a package at different TSL (1-5).

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Internal friction µ	Required test angel α in degrees				
0.00	90.0	53.1	30.0	20.5	10.4
0.05	74.5	51.4	29.6	20.3	10.3
0.10	69.3	49.9	29.2	20.1	10.3
0.15	65.7	48.5	28.8	19.9	10.2
0.20	63.0	47.3	28.4	19.8	10.2
0.25	60.7	46.3	28.1	19.6	10.1
0.30	58.8	45.3	27.7	19.4	10.1
0.35	57.1	44.4	27.4	19.3	10.1
0.40	55.6	43.6	27.1	19.1	10.0
0.45	54.3	42.8	26.8	19.0	10.0
0.50	53.1	42.1	26.6	18.9	9.9
0.55	52.0	41.5	26.3	18.7	9.9
0.60	51.0	40.8	26.0	18.6	9.9
0.65	50.1	40.2	25.8	18.5	9.8
0.70	49.2	39.7	25.6	18.3	9.8
0.75	48.4	39.2	25.3	18.2	9.7
0.80	46.9	38.2	24.9	18.0	9.7
0.85	46.2	37.7	24.7	17.9	9.6
0.90	45.6	37.3	24.5	17.7	9.6
0.95	45.0	36.9	24.3	17.6	9.6
1.00	90.0	53.1	30.0	20.5	10.4

Table 2

6.2 Figure 7.67 shows inclining tests to confirm the TSL of a packages and figure 7.68 shows measuring of the permanent deflection after three tests with the same specimen in one direction.

Figure 7.67

Figure 7.68