Information Paper

Interpretation of the recommendations contained in the Appendix IV of SSG-26 (Rev. 1) - 2018 Edition

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NB

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The information presented is valid as per April 2020.

01

Introduction

This document introduces and describes leading industry practice for the safe retention of packages for transport. It has been developed by members of the World Nuclear Transport Institute (WNTI) and is intended to share their leading practices with other industry participants. It describes the practices that Consignors should adopt in order to fulfil their obligations to ensure the safety of the communities and environments through which their radioactive material is transported. It should be read in conjunction with applicable national and international regulations for the safe transport.

02

The IAEA Approach to Retention Systems

The new edition of the Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (SSG-26 (Rev. 1) – 2018 Edition) contains recommendations for “package stowage and retention during transport” in Appendix IV. The content of Appendix IV has been completely reviewed and redrafted by a dedicated TRANSSC Working Group (being the Tie-Down WG) which met from 2013 to 2015, and to which WNTI actively contributed and participated.

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Scope

The purpose of this information paper is to explain how the new recommendations of Appendix IV of SSG-26 were established and what are the main principles that have been adopted. This document also provides adequate recommendations for the correct use of the Appendix IV of IAEA SSG-26 (Rev.1) and indicates the standards for rail, road, sea and air carriage that may be used.

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References

IAEA SSG-26 (Rev.1): Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2018 Edition) (Draft Safety Guide DS496 as validated during TRANSSC 39).

CTU Code: IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (CTU Code) – 2014

CSS Code: IMO Code of Safe Practice for Cargo Stowage and Securing (CSS Code) – 2011

EN 12195-1:2010 European Standard - Load restraining on road vehicles-Safety-Part 1: Calculation of securing forces

North American Cargo Securement Standard: base for **NSC Standard 10** Canada National Safety Code for Motor Carriers - Standard 10 – Cargo Securement 2013 and **FMCSA – Cargo Securement Rules -** USA - Federal Motor Carrier Safety Administration (FMCSA) – Cargo Securement Rules 2004

National Transport Commission & Roads & Traffic Authority NSW - Load Restraint Guide – Australia - Guidelines and Performance Standards for the Safe Carriage of Loads on Road Vehicles – Second Edition – 2004

UIC Loading Guidelines: Code of practice for the loading and securing of goods on railway wagons

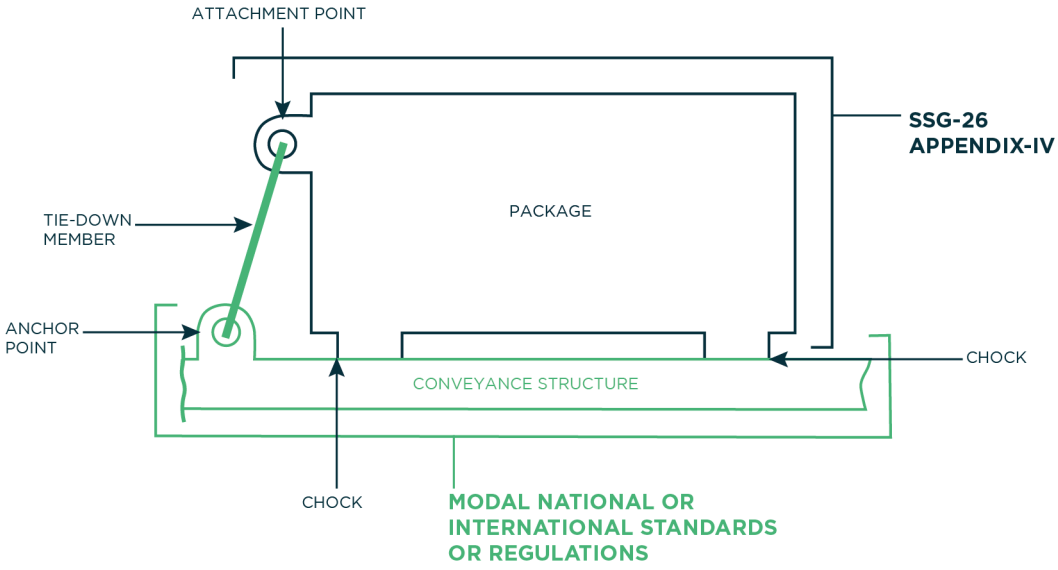
EN 16860:2019 European Standard - Railway applications - Requirements and general principles for securing payload in rail freight transport

ISO 16049-2:2005 ISO Standard - Air cargo equipment – Restraint straps - Part 2: Utilization guidelines and lashing calculations

05

Main changes introduced in the new version of the Appendix IV of the IAEA SSG-26

The recommendations contained in Appendix IV of the IAEA SSG-26 (Rev.1) apply only to the design of components of the retention system that are part of the package (such as trunnions, lifting lugs, corner fittings). This is reflected in para IV-2 of Appendix IV.



Retention system acceleration values that are not part of the package

It was agreed that the most appropriate requirements/ rules for the design of the other components of the retention system that are not part of the package (bracing, shoring, straps, net, transport frame, etc.), should be those specified in international or national standards, guidelines or regulations applicable in the country (countries) where the transport takes place for the transport mode(s) used.

Based on a general review of the existing standards, guidelines and regulations applicable for the retention of general cargoes for the different modes of transport, it was determined that the static loads based on the following G-values represent the maximum forces that could act upon a package during routine conditions of transport (see Table 1 hereunder, not provided in the SSG-26). G-values on a single line may act simultaneously.

Table 1- G-values usable to determine the forces acting on a package during routine conditions of transport - usable to design components which are not part of the package

MODE	ACCELERATION FACTORS		
	LONGITUDINAL	LATERAL	VERTICAL[a]
ROAD[b]	0.8g	-	1g down ± 0.2g
	-	0.5g	1g down ± 0.2g
RAIL	1.0g/4.0g[c]	-	1g down ± 0.3g
	-	0.5g	1g down ± 0.3g
SEA/WATER	0.4g	-	1g down ± 0.8g
	0.24g	0.8g	1g down ± 0.48g
AIR	1.0g	-	1g down
	-	1.0g	1g down
	-	-	2.0g up, 2.0g down

- a The effect of gravity is included
- b For packages transported in vehicles lighter than 3,500 kg, higher acceleration values should be considered (ref EN 12195)
- c 1.0g should be used if wagons equipped with long-stroke shock-absorbers or if fly shunting operations are explicitly excluded

The values for road are those from the EN 12195-1 Standard and the CTU Code with account of the recommendations contained in the North American Cargo Securement Standard and Australian Load Restraint Guide for the vertical direction to consider variations generated by vibrations and rough roads (potholes, donkey backs) that may decrease or increase the gravity.

The values for rail are those from the UIC Loading Guidelines (also in EN 16860, partly in EN 12195-1 and the CTU Code). As in road transport, vertical dynamic accelerations resulting from vibrations and state of the rail track may decrease or increase the gravity.
The values for sea/water are those from the CTU Code (for unrestricted seas) combined with those of the CSS Code (100% of the transverse acceleration may combine with 60% of the longitudinal acceleration and 60% of variation of acceleration in the vertical direction).

The values for air are those used in the ISO 16049-2 Standard corresponding to the Limit Load (2/3 of the Ultimate Load). Effectively, for air transport, the rule is that, taking account of the ultimate load factors given for longitudinal, transversal and vertical directions in the Weight and Balance Manual (WBM) of the Aircraft being used for the transport, the Ultimate Load of the restraining equipment (straps, nets, ULD) shall not been exceeded. The ultimate load is a single force of very short duration resulting from an emergency landing for example. It is generally considered that this ultimate load can be experienced only one time in the life of a retention system. It was considered and agreed between the participants, that the Limit Load (2/3rd of the ultimate load) is appropriate to describe the routine conditions of transport, and that it could be considered as the maximum service load during routine conditions of transport. The values considered are then 2/3rd of the Ultimate Load Factors as specified for undetermined aircraft type as specified in § 6.1.3 of the ISO 16049-2 Standard.

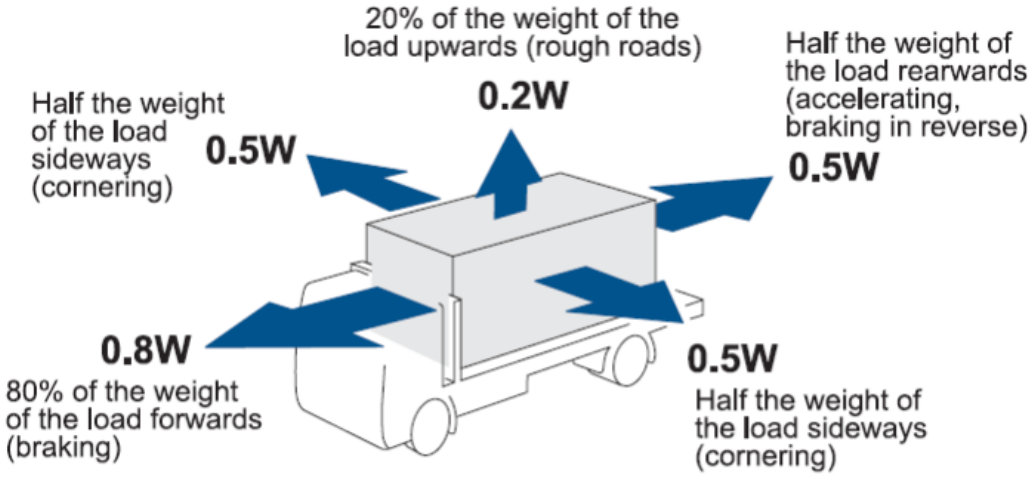


Figure extracted from the Australian Load Restraint Guide

Package attachment point acceleration values

The components of the retention system (i.e. attachment points) that are part of the package must be capable of being used for the complete life of the packaging. As well, the attachment points must ensure that in case of an overload in the retention system the point of breakage should preferably be one of the components that are not part of the packaging. As such, an additive factor of 1.25 was applied to these G values, rounded to the upper decimal place, to determine the G values to be used for design of the retention system components (i.e. attachment points) part of the packaging. These values are those of the Table IV.1 of the Appendix IV of the IAEA SSG-26 (Rev.1), reproduced hereunder in Table 2.

Table 2- G-values usable to design components which are part of the package

MODE	ACCELERATION FACTORS		
	LONGITUDINAL	LATERAL	VERTICAL[a]
ROAD[b]	1.0g	-	1g down ± 0.3g
	-	0.7g	1g down ± 0.3g
RAIL	1.3g/5.0g[c]	-	1g down ± 0.4g
	-	0.7g	1g down ± 0.4g
SEA/WATER	0.4g	-	1g down ± 1.0g
	0.3g	1.0g	1g down ± 0.6g
AIR	1.3g	-	1g down
	-	1.3g	1g down
	-	-	-2.5g up, 2.5g down

- a The effect of gravity is included
- b For packages transported in vehicles lighter than 3,500 kg, higher acceleration values should be considered (ref EN 12195)
- c 1.3g should be used if wagons equipped with long-stroke shock-absorbers or if fly shunting operations are explicitly excluded

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WNTI Recommendations

General Recommendations

G-values listed in table IV-1 of the SSG-26 (rev.1) (Table 2 of the present document) should be used only for design of attachment points which are part of the package (trunnions, tie-down lugs, corner fittings, ...). Without specific knowledge of the itinerary of international transports, or in absence of specific standards, guidelines or regulations in a given country, it is recommended to use the G-values as stated in the Table 1 of this document to design the retention system of packages inside means of transport.
When well identified standards, guidelines or regulations are applicable for a given mode of transport in a given region, then the design of the retention system shall be as required in these standards, guidelines or regulations.

Appendix 1

Glossary

Abbreviations

ADR – European Agreement concerning the International Carriage of Dangerous Goods by Road.

COTIF - The Intergovernmental Organisation for International Carriage by Rail.

CSS Code - IMO Code of Safe Practice for Cargo Stowage and Securing.

CTU – Cargo Transport Unit.

GCU – The General Contract of Use for Wagons.

IAEA – The International Atomic Energy Agency.

IMDG Code – The International Maritime Dangerous Goods Code.

IMO – The International Maritime Organization.

INF - Irradiated nuclear fuel.

ISO – The International Organization for Standardization.

RID – The Regulation concerning the International Carriage of Dangerous Goods by Rail.

UIC – the International Union of Railways.

ULD – Unit Load Device

WBM - The weight and balance manual

Definitions

ADR - The European agreement setting out provisions for the safe international transport of Dangerous Goods by Road.

COTIF - The Intergovernmental Organisation for International Carriage by Rail is an intergovernmental organisation governing international rail transport.

Attachment point – A fitting on the package to which a retention member is secured.

Anchor point – A fitting on the conveyance to which a retention member is secured.

Carrier - An individual or legal entity that is the business of transporting goods for hire. Shipping lines, airlines, trucking companies and railroad companies are all carriers. The carrier may also be an actual carrier (called an under carrier) or a “non-equipment-operating” carrier such a non-vessel operating common carrier or airfreight consolidator. (See also Shipping Line Carrier and Overseas on-Carrier)

Consignor – Any government, organization or person that prepares a consignment for transport. That is, the dispatcher of a shipping container of uranium ore concentrate cargo.

CSS Code - The IMO Code of Safe Practice for Cargo Stowage and Securing provides an international standard to promote the safe stowage and securing of cargoes being transported by sea.

CTU – A Cargo Transport Unit can be a freight container, swap body, vehicle, railway wagon or any other similar unit in particular when used in intermodal transport.

CTU Code – The aim of the IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (CTU Code) is to provide advice on the safe packing of cargo transport units (CTUs) to those responsible for the packing and securing of the cargo and by those whose task it is to train people to pack such units.

GCU – The General Contract of Use for Wagons (GCU) is a multilateral contract based on the international convention COTIF 1999 and Annex CUV. The GCU specifies the mutual rights and obligations of Wagon Keepers (K) and Railway Undertakings (RU) with regard to the use of rail freight wagons as a means of transport throughout Europe and beyond.

INF - Irradiated Nuclear Fuel is material containing uranium, thorium and/or plutonium isotopes that have been used to maintain a self-sustaining nuclear chain reaction.

INF Code – A mandatory code reviewed and amended as required by the IMO, renamed the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Waste on Board Ships.

ISO Container – A freight container constructed to the specifications of ISO 1496-1.

Limit Load – The maximum load factor authorized during flight. Limit load is constant for all weights above design gross weight.

Overseas on-Carrier - In this context the Carrier engaged by the Consignor/Producer to transport the cargo by road, rail and or inland waterway from the final overseas discharge port to the Consignee/ Converter facility.

Package – The complete product of the packing operation, consisting of the packaging and its contents prepared for transport.

Retention – The use of mechanical devices to prevent the movement of the package on the conveyance.

Retention member – A mechanical device such as dunnage, braces, block, tie-down, stillages, net, flange, including attachment points and anchor points

Retention system – An assembly consisting of an attachment point, an anchor point, and a retention member as applicable

Shipping Line Carrier – In this context is the Carrier engaged by the Consignor/Producer to transport the cargo by sea from the point of export to the final overseas discharge port.

UIC – The worldwide professional association representing the railway sector and promoting rail transport.

UIC Loading Guidelines – The standard reference document for safe loading of cargo and securing of goods on railway wagons. Volume 1, the 'Principles' sets out the rules to be observed with Volume 2 the 'Goods' provides loading guidelines for specific types of goods, that have been developed in compliance with the 'Principles' based upon experiences and carriage tests.

Ultimate Load - An aerospace engineering terminology, the ultimate load is a statistical figure used in calculations and should (hopefully) never actually occur. With respect to aircraft structure and design, ultimate load is the amount of load applied to a component beyond which the component will fail.

ULD – A Unit Load Device (ULD) is either an aircraft pallet and pallet net combination, or an aircraft container. ULDs are removable aircraft parts subject to strict civil aviation authorities' requirements from design, testing, production, and operations, to repair and maintenance. An airworthy ULD must be structurally capable of restraining the loads and providing adequate protection to the aircraft systems and structure during flight.

WBM - The weight and balance manual is a critical part of an aircraft's operating documentation.

Appendix 2

Existing standards, guidelines or regulations that can be used for cargo securing onboard conveyances.

Road transport

This mode of transport is the one for which numerous national or regional Standard, guidelines or regulations have been developed and made mandatory.

In the European Union (EU) and in European Free Trade Association (EFTA) countries, as well as in other signatory countries of the ADR, dangerous goods cargo secured in accordance with EN 12195-1:2010 Standard are deemed to comply with the ADR requirements.

In North America, NSC Standard 10 shall be complied with in Canada, and FMCSA – Cargo Securement Rules shall be complied with in the USA.

In Australia, the use of the Load Restraint Guide drafted by the Roads & Traffic Authority NSW (RTA) and published by the National Transport Commission of Australia is highly recommended.

Rail transport in Europe.

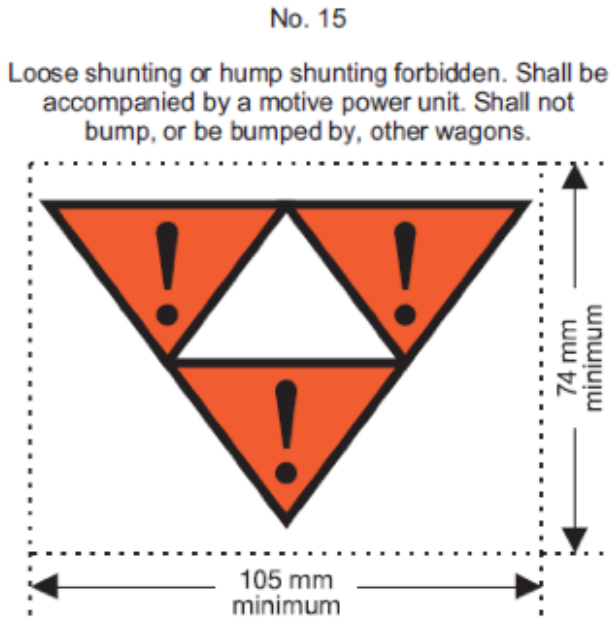
In countries being signatories to COTIF and which applies the RID for carriage of dangerous goods by rail, generally, stowage and securing in accordance with the UIC Loading Guidelines are satisfactory. In particular, all Railway Companies being signatories to the General Contract of Use for Wagons (GCU) (https://www.gcubureau.org) accept cargos secured as required in UIC Loading Guidelines (see article 29 of the GCU Contract).

G-values given in the Table 1 of this document are those of the UIC Loading Guidelines.

At the request of the European Commission and the European Free Trade Association (EFTA), a new standard in EU countries (EN 16860:2019) "Railway applications - Requirements and general principles for securing payload in rail freight transport" has been issued. The standard supports essential requirements within EU Directive 2008/57/EC on the interoperability of the rail system and is planned to become mandatory. The G-values are those of the UIC Loading Guidelines.

In case of transport by use of freight containers on container wagons, the longitudinal acceleration to be considered is 1g. Where a doubt exists on the choice of 1g or 4g, and when the securing cannot be assured for 4g, a requirement can be put to the Carrier to add shunting labels No 15 as shown in 5.3.4.2 of the RID, and reported hereunder, onto the wagons.

Figure extracted from the RID



Sea/water transport

A cargo stowed and secured inside a freight container which having been designed by applying the G-values in Table 1 will meet compliance with the CTU Code.

The CTU Code may have been made mandatory by certain countries (this is the case for France) for stowage and securing of cargoes inside freight containers.

When sea carriage is happening in restricted seas as defined in the CTU Code, it should be acceptable to use the values as specified for those restricted seas (e.g. Baltic Sea, North Sea, English Channel).

Packages being shipped onboard any given ship shall always be stowed and secured as per the requirements detailed within the Cargo Securing Manual (CSM) in accordance with (Regulation 5, Chapter VII, Part A of SOLAS Convention).

The INF Code (published in the Supplement to the IMDG Code) shall be applied in addition for INF cargoes. The CSM of any INF ship contains the specific requirements related to the stowage and securing of INF Cargoes.

Air transport

Forces evaluated in the securing system (straps, nets, Unit Load Device (ULD) walls) by use of the G-values in Table 1 of this document shall be compared to the Limit Load of the securing equipment, not to the Ultimate Load.

Forces developed in the securing system (straps, nets, ULD walls) using the ultimate load factors as stated in the ISO 16049-2 standard or in the Weight and Balance Manual (WBM) of the aircraft to be used shall be compared to the Ultimate Load of the securing equipment.

In all cases, the securing shall comply with the requirements of the WBM of the aircraft being used. The direct securing of the cargo in the aircraft or in ULDs is of the responsibility of the airline operator. It is not the case for packages loaded in a freight container to be carried by air: in this case the responsibility for the correct securing of the packages inside the container relies on the person responsible for packing of this container.

G-values given in the Table 1 are compatible with most of the large airplanes in operation.

When planning and preparing for a freight container containing radioactive cargoes to be carried by air, the Airline should always be provided with details relating to the ultimate load factors that you have applied (used) for securing the cargo inside the freight container. (When the G-values in Table 1 are used, the ultimate load factors can be obtained by multiplying these G-values by 1.5). This 1.5 value provides, to some extent, for loads higher than those expected under routine conditions of transport.

Appendix 3

Practical Example for UOC Drums

Considering that:

- The drums are completely enclosed in the structure of the freight container, and that stacking is only possible on 2 layers,
- The maximum stacking force acting on the base of a drum will be at maximum 2 x m x 1.8g = 3.6 x mg: this is acceptable (equivalent to stacking of 2.6 time the gross mass of a drum on the tested drum),
- Vertically, except for the stacking, the worst conditions are those with the lowest acceleration (this will decrease the effectiveness of the friction between drums and the floor),
- In rail transport the 4g in longitudinal direction is non-applicable (for containers on container car, the maximum G-value to consider is 1g),

The worst case resulting configurations to be check are the following:

MODE	ACCELERATION FACTORS		
	LONGITUDINAL	LATERAL	VERTICAL[a]
ROAD	0.8g	-	0.8g down
	-	0.5g	0.8g down
RAIL	1.0g[c]	-	0.7g down
	-	0.5g	0.7g down
SEA/WATER	0.4g	-	0.2g down
	0.24g	0.8g	0.52g down

Notes:

- In sea transport, 130.8 g is the same as : 0.2 g down to 1.8g down (the resulting forces are acting on the drums downwards for both cases),
- Same in road or rail transport,
- However for the longitudinal restrain, the maximum G-value (0.4g) will have to be combined with the minimum downward (0.2g) because this will reduce the restraining force provided by the friction between the drums and the floor of the container,
- Same in rail transport, the maximum longitudinal G-value (1g) will have to be combined with the minimum downward (0.7g) because this will reduce the efficiency of the friction between the drums and the floor of the container,
- And for sea transverse maximum G-values, it is recommended to use the combination of 0.8g lateral + 0.24 g longitudinal + 0.52 g down (reduction of the efficiency of the friction between the drums and the floor of the container).

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Aviation House
125 Kingsway
London, WC2B 6NH
United Kingdom

Tel: +44 (0)20 7580 1144
Fax: +44 (0)20 7580 5365
Web: www.wnti.co.uk
Email: wnti@wnti.co.uk

INTERPRETATION OF THE RECOMMENDATIONS CONTAINED IN THE APPENDIX IV OF SSG-26 (REV. 1) – 2018 EDITION