INTERNATIONAL MARITIME ORGANIZATION

IMO

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SUB-COMMITTEE ON DANGEROUS GOODS, SOLID CARGOES AND CONTAINERS
10th session
Agenda item 7

DSC 10/INF.4
22 July 2005
ENGLISH ONLY

AMENDMENTS TO THE CSS CODE

Report of the Correspondence Group

Documents considered by the Correspondence Group

Submitted by the Russian Federation as the Co-ordinator of the Correspondence Group

SUMMARY	
Executive summary:	This submission is associated with document DSC 10/7/1 (Russian Federation) which provides the results of the work of the Correspondence Group on Amendments to the CSS Code
Action to be taken:	Paragraph 2
Related document:	DSC 10/7/1, paragraph 3

1 The Sub-Committee, at its ninth session, established a Correspondence Group under the co-ordination of Mr. E. Karpovich (Russian Federation), on Amendments to the CSS Code. The annex to this submission provides documents which were circulated for consideration during the work of the Correspondence Group and comments were received from six members of the Correspondence Group.

Action requested of the Sub-Committee

2 The Sub-Committee is invited to note the information provided.

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ANNEX

DOCUMENTS WHICH WERE CIRCULATED DURING THE WORK OF THE CORRESPONDENCE GROUP

C O N C E P T
PART I - POLICY

1 **Policy** in the field of maritime safety, including carriage of cargoes by sea, is regulated by the International Convention for the Safety of Life at Sea (SOLAS -74).

Within the limits of our Correspondence Group, I suppose we will discuss the ways of implementation of the applicable requirements of the SOLAS-74, as amended in the best way, i.e. with the best results for the safety of human life at sea.

1.1 Hope, it would be convenient to quote here some of the provisions of Chapter VI "Carriage of Cargoes" of the SOLAS-74, as amended, in the order they should be fulfilled during transportation of cargoes by sea:

“Regulation VI-2
Cargo information

1 The **shipper shall provide the master** or his representative with **appropriate** information on the cargo sufficiently in advance of loading **to enable the precautions which may be necessary for proper stowage and safe carriage of the cargo to be put into effect**. Such information **shall be confirmed in writing** and by appropriate shipping documents prior to loading the cargo on the ship. For the purpose of this regulation the cargo information required in subchapter 1.9 of the Code of Safe Practice for Cargo Stowage and Securing, adopted by the Organization by resolution A.714(17), as may be amended, shall be provided...

2 The cargo information shall include:

.1 **in the case of general cargo, and of cargo carried in cargo units**, a general description of the cargo, the gross mass of the cargo or of the cargo units, and **any relevant special properties** of the cargo;

Regulation VI-5
Stowage and securing

1 Cargo and cargo units carried on or under deck shall be so loaded, stowed and secured as to prevent **as far as is practicable**, **throughout the voyage,** damage or hazard to the ship and the persons on board, and loss of cargo overboard.

…

6 All cargoes, other than solid and liquid bulk cargoes, **shall be loaded, stowed and secured** throughout the voyage **in accordance with the Cargo Securing Manual** approved by the Administration. In ships with ro-ro cargo spaces, as defined in regulation II-2/3, all securing of such cargoes, in accordance with the Cargo Securing Manual, shall be completed before the ship leaves berth. The Cargo Securing Manual shall be drawn up to a standard at least equivalent to relevant guidelines developed by the Organization.

Regulation VI-1
Application

1 **This chapter applies to the carriage of cargoes** (except liquids in bulk, gases in bulk and those aspects of carriage covered by other chapters) **which, owing to their particular hazards to ships or persons on board, may require special precautions in all ships to which the present regulations apply and in cargo ships of less than 500 tons gross tonnage…**

2 To supplement the provisions of parts A and B of this chapter, **each Contracting Government shall ensure that appropriate information on cargo and its stowage and securing is provided**, specifying, in particular, precautions necessary for the safe carriage of such cargoes."

1.2 Clearly formulated duty of the Shipper to provide information on cargo allows to organize investigations on its transport characteristics and properties **prior to the ship's loading** rather than after its **wreck** (See **1.5**).

However, clear requirements for the form and content of **Cargo Information** as well as requirements for control over actual presentation of such Information to the ship's Master are not established yet. In fact, this provision is not fulfilled in most of the ports; the ship's Master is provided with no additional information, except for that contained in customs cargo documents (Bills of Lading and Cargo Manifests).

Moreover, insurance premium at the rate of 110% of the cost of the cargo carried, obtained by the insurer of the cargo in case of total loss of the ship and cargo, puts shippers off their interest in the safe delivery of the cargo.

According to the emergency statistical data, presented by the Royal Institute of Naval Architects, the incidents with general cargo vessels lead to loss of 90 ships and 170 human lives every year.

General cargo vessels, quantity of which constitutes about 20% of the world merchant fleet, bring over 40% of the total loss and about 40% of the accidents with people that exceeds indices of any other type of ships.

In these circumstances **responsibility of the Contracting Governments** for the effectiveness of control over fulfillment of the requirements of the Convention, provided in Regulation VI-1.2, increases.

1.3 The requirement, that the cargo shall be loaded, stowed and secured throughout the voyage in accordance with the ship's **Cargo Securing Manual**, means that at any port of the world **the same cargo** should be stowed and secured on board the ship in **the similar manner**.

Each Contracting Government shall ensure that appropriate Cargo Information and a statement confirming the fact that stowage and securing of the cargo have been performed in accordance with the ship's Cargo Securing Manual are provided.

All these measures are aimed to secure the concerns of both shippers and ship-owners, as confirming taking by them of all the necessary and sufficient efforts to provide secure and safe delivery of cargo.

1.4 The given **concept** of interpretation of the requirements established in SOLAS-74 Chapter VI for the Contracting Governments, which allows to ensure uniform and consistent implementation of these requirements with respect to cargoes representing utmost danger when transported by sea (packaged dangerous substances, bulky, heavyweight and metal cargoes, timber cargoes), **seeks for your support** now.

1.5 List of vessels of Russian merchant marine which have wrecked or suffered distressed due to shift of cargoes

In former times it was necessary a ship disaster with human victims to happen to initiate investigations on transport characteristics and properties of cargoes. Some of the participants of the correspondence group have more than once been members of commissions investigating ship casualties and remember themselves trying to mentally get into holds of a sank ship and imagine which properties of the cargo had been the cause of the casualty.

Researches carried out by Central Marine Research & Design Institute, Ltd (CNIIMF) Saint-Petersburg, Russia, when investigating the causes of wrecks of ships, which sank due to shift of cargoes, have served as a basis for the development of a number of Russian regulatory documents on safe and secure carriage of general cargoes by sea.

Vessel Name	**Date of wreck or distress; geographic area**	**Cause of wreck or distress**	**Title of a Russian national regulatory document developed by CNIIMF as a result of investigations of the reasons of wreck or distress**
1. «Velikiy Ustug» "Великий Устюг"	Sank in north of the Atlantic Ocean in 1968.	Shift of containers of the CK-2-5 type loaded with cobalt concentrate	
2. «Tavrichanka» "Тавричанка"	Suffered distress in the Pacific Ocean in January 1975.	Shift of flour in bags	
3. «Komsomoletz Kalmykii» "Комсомолец Калмыкии"	Lost with some members of the crew on 31.12.1974.	Shift of reinforcing steel in bundles	Performance specifications for the safety of carriage of reinforcing steel by sea, 1977.
4. «Morshansk» "Моршанск"	Suffered distress in the Indian Ocean on 24.06.1976.	Shift of metal scrap	Performance specifications for the safety of carriage of metal scrap by sea, 1977.
5. «Tavrichanka» "Тавричанка"	Lost with all members of the crew on 14.11.1976.	Shift of steel L-bars in bundles	Performance specifications for the safety of carriage of profile rolled stock by sea, 1977.
6. «Rechitza» "Речица"	Lost with almost all members of the crew on 26.11.1976.	Shift of rolled wire in coils	Temporary performance specifications for the safety of carriage of rolled wire in coils by sea, 1978.
7. «Buhtarma» "Бухтарма"	Suffered distress in the Norwegian sea on 15.01.1978.	Shift of rolled wire in packages	Temporary performance specifications for the safety of carriage of rolled wire in coils by sea, 1978.
8. «Kabona» "Кабона"	Sank in the Baltic sea on 17.03.1978.	Shift of pig iron	Performance specifications for the safety of carriage of pig iron by sea, 1979.
9. «Bolsheretzk» and BBS-4 "Большерецк" и ББС-4	Lost with all members of the crew on 01.02.1979.	Shift of logs in loose/bulk	Regulations for the safety of carriage of timber cargoes by sea, 1981.

10. «Komsomoletz Nakhodki» "Комсомолец Находки"	Lost with all members of the crew on 21.02.1981.	Shift of iron bars in bundles	Performance specifications for the safety of carriage of profile rolled stock by sea, 1977.
11. «Mariinsk» "Мариинск"	Suffered distress in the Indian sea on 06.07.1981.	Shift of pipes	Regulations for the safety of carriage of metal products by sea, 1982.
12. «Mechanic Tarasov» "Механик Тарасов"	Lost with almost all members of the crew in north of the Atlantic Ocean on 16.02.1982.	Shift of paper in coils, containers, steel shafts	Regulations for the carriage of paper and cardboard on seagoing vessels, 1981.
13. «Komsomoletz Kirghizii» "Комсомолец Киргизии"	Sank in north of the Atlantic Ocean on 15.03.1987.	Shift of flour in bags which had been formed into packages and strapped by slings	Regulations for the safety of carriage of packaged cargoes by sea, 1987.
14. «Polessk» "Полесск"	Lost with almost all members of the crew in south of the Atlantic Ocean in 1993.	Shift of fish flour in flexible intermediate bulk containers	
15. «Salvador Alyende» "Сальвадор Альенде"	Lost with almost all members of the crew in the Indian Ocean in 1994.	Shift of a bulk cargo in flexible intermediate bulk containers	
16. «Ryazan» "Рязань"	Sank in the Okhotsk Sea on 07.11.2000.	Shift of a cargo inside 20' containers	
17. «Helena» "Елена"	Sank in the Caspian Sea on 10.11.2000.	Shift of steel coils	
18. «Kodima» former «Capitan Glotov»	Left by the crew and thrown out by waves on to the shore on February 1, 2002	Shift of lumber deck cargo	Circular letter № 262 by the Ministry of Transport of the Russian Federation (MT of RF) dated 19.12.2004 with amendments to the Regulations for the safety of carriage of timber cargoes by sea, 1997.
19. “Ajax” «Аякс»	Suffered distress in the Japan Sea in January 2004	Shift of fore-and-aft logs in loose	Circular letter № 262 by MT of RF dated 19.12.2004 with amendments to the Regulations for the safety of carriage of timber cargoes by sea, 1997.
20. «West»	Lost with almost all members of the crew in the Japan Sea on November 2, 2004	Shift of fore-and-aft logs in loose	Circular letter № 262 by MT of RF dated 19.12.2004 with amendments to the Regulations for the safety of carriage of timber cargoes by sea, 1997.

The above given list of vessels of Russian merchant marine which suffered distress for the time period from 1960-s to 2004 is far from being exhaustive.

C O N C E P T
PART II - CARGO INFORMATION

2.1 From CSS Code dated November 1991:

"1.9 Cargo information

1.9.1 Prior to shipment the shipper should provide all necessary information about the cargo to enable the shipowner or ship operator to ensure that:

- the different commodities to be carried are compatible with each other or suitably separated;
- the cargo is suitable for the ship;
- the ship is suitable for the cargo; and
- the cargo can be safely stowed and secured on board the ship and transported under all **expected conditions during the intended voyage**.

1.9.2 The master should be provided with **adequate** information regarding the cargo to be carried so that its stowage may be properly planned for handling and transport."

2.2 Later the **MSC/Circ.663 "Form for Cargo Information"** dated December 1994, was issued. In general this Form for Cargo Information was intended for bulk cargoes and required some amendments for general cargoes and cargo units in order to completely take into account **some** other **relevant special properties** (Regulation VI-2.2) of the cargo such as:

Permissible stacking height, metres and/or tiers;
Static stability angle of a stack, deg;
Coefficients of friction for pairs: cargo-cargo, cargo-steel, cargo-wood etc.;
Cargo permeability factor (when flooding a cargo space) etc.

2.3 In order to specify **expected conditions during the intended voyage** a new box:

Navigation range and sea waves' height $h_{3\%} \leq$___ m

has been added.

Similar approach for division of navigation ranges for different sea conditions is used in **prEN 12195-1 Load restraint assemblies on road vehicles — Safety — Part 1: Calculation of lashing forces.** In this standard different acceleration coefficients during sea transport are established for different Navigation ranges: A (Baltic sea), B (Southern part of North sea & Mediterranean sea) and C (Unrestricted) as shown on Fig. 2.1 below.

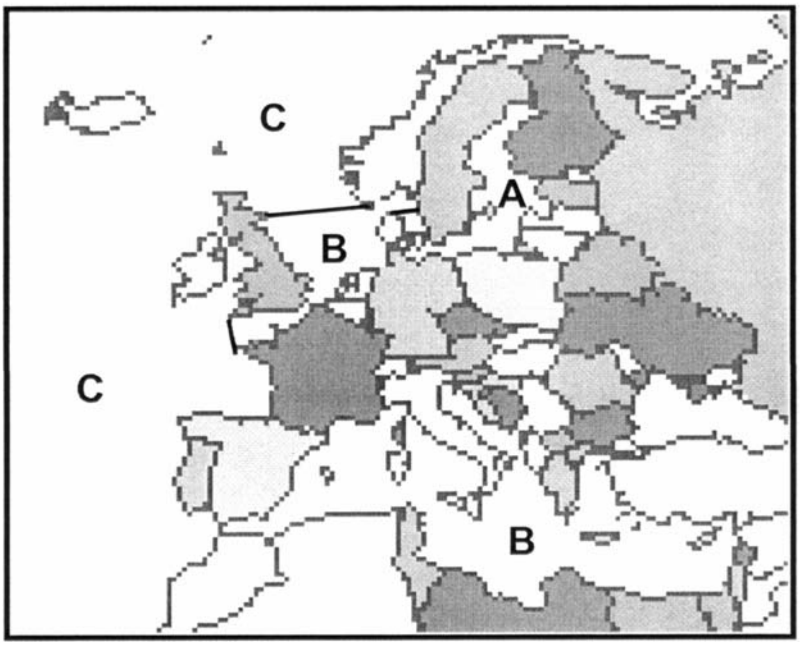

Figure 2.1

2.4 **New box** has been added:

Requirements for cargo stowage and securing

with reference to the ship's Cargo Securing Manual and, if a cargo is absent in the ship's CSM, to the Annex of the Information.

2.5 **The other boxes should be filled in** according to the Appendix 6 - Guidelines for the preparation of Cargo Information.

2.6 **To provide uniform** and consistent implementation of relevant provisions with regard to cargoes representing utmost danger when transported by sea **(packaged dangerous substances, bulky, heavyweight and metal cargoes, timber cargoes)**, the shipper shall entrust the development of Cargo Information to a recognized organization (IMO Resolution A.739 (18)).

2.7 **Examples of filled forms** of Cargo Information for two cargoes: STEEL ROLLED SECTIONS in packages (bundles) and COPPER CATHODES in packages, are given in the attached two separate .pdf files on 3 and 2 pages accordingly. Figure A.6.2 of the draft Appendix 6 - Guidelines for the preparation of Cargo Information - shows how static stability angle of a stack of COPPER CATHODES was determined.

In the light of safety problems when transporting cargoes by sea, let me pay your attention to some new scientific reports on researches carried out lately:

- www.mariterm.se "EQUIPMENT FOR RATIONAL SECURING OF CARGO ON RAILWAY WAGONS (jvgRASLA)";

- www.tfk.se or www.mariterm.se - "VERIFICATION OF LEVEL OF BASIC PARAMETERS IMPORTANT FOR THE DIMENSIONING OF CARGO SECURING ARRANGEMENTS (VERIFY)".

The first report (jvgRASLA) presents results of researches on securing of cargoes on railway wagons (see page 42). The second Report (VERIFY) presents experiments with securing cargoes on road vehicles (see pages 24-34). These experiments were carried out to determine the loads acting in the securing arrangements. The experiments were carried out by inclination of a platform with the tested cargo on it. The same method is proposed in the draft Appendix 6 to the CSS Code.

Investigations of incidents with loss of seagoing vessels are frequently speculative, since the objects often lay on the seabed and cannot be examined. That is why it so actual to study transport characteristics and properties of cargoes before they are presented for shipment.

C O N C E P T
PART III - METHOD OF CALCULATION

of non-shift criterion and strength of the securing devices to be applied for securing of structurizing cargoes

Here is presented a particular example from a ship Cargo Securing Manual provided with stowage and securing schemes for coils of steel sheet and calculations based on the proposed "Method of calculation…".

As an example let us consider two stowage patterns for coils loaded in cargo spaces of a ship: when coils are stowed "on the side" in the fore-and-aft direction having the top tier supported by the sides and when coils are stowed "on the side" in the fore-and-aft direction having the top tier unsupported by the sides.

When coils in the top tier are not rested against the sides, static stability angle of such a structure is 30°, which is often insufficient to provide stability of the coils of the top tier, therefore, these coils should be secured by lashings.

When the coils in the top tier rest against the sides static stability angle of this structure is 50°, which provides the so-called "securing stowage", i.e. the coils of the top tier, tightly stowed from side to side, do not require securing by lashings.

A few common pages from the Cargo Securing Manual for mv “Northern Wind” are given in the respective attached .pdf file on 20 pages.

CARGO INFORMATION

Shipper	Registration number **CI 21.02.41/___-04** Valid until: **December 31, 2005** Name of the cargo: **STEEL ROLLED SECTIONS in packages (bundles) according to GOST 7566**
Consignee	Carrier

Name/means of transport **mv__________________**	Port/place of departure	Navigation range and sea waves height $h_{3\%} \leq$___ m **Unrestricted, Restricted I, Restricted II on sea waves with height $h_{3\%} \leq$___ m up to ship's class permit**

Port of destination	Requirements on cargo stowage and securing **Should be given in ship's Cargo Securing Manual, if not provided, see the Annex to the Information**
General description of the cargo (shape, overall dimensions, mass, package) **Steel sections are joined in packages or bundles of 2000-14000 mm length, 300-1000 mm breadth, 100-1000 mm height and up to 10 t mass. Tied up with steel wire, steel rope or steel band.**	Gross mass of cargo (kg/tonnes) ☑ General cargo - Num. of units ______ pcs Gross Mass ______ t

Transport characteristics of the cargo*:

Stowage factor, m^3/t	**0.5 – 1.0**
Permissible stack height, m and/or tiers	**Unlimited**
Static stability angle of a stack without dunnage, deg., when stowing each tier of the cargo on timber dunnage, deg.	**18°** **27°**
Friction coefficients for pairs: steel plating-cargo / cargo-timber dunnage	**0.32/0.50**
Factor of permeability of cargo (when flooding of cargo space)	**0.5 – 0.8**
Chemical properties ** and other potential hazards	**Not any**

* As applicable and known
** For example: the class by IMO, UN No., EmS No.

Relevant special properties of the cargo **- timber dunnage under the 1st and the last tiers;** **- sectioning of 2 upper tiers when securing;** **- supporting by sides for a multi-tier stack;** **- in tweendeck – lashing to sides.**	Additional documents ☑ Certificates on securing devices ☑ Certificate of the Safe Stowage and Securing of cargo
DECLARATION I hereby declare, that the cargo (consignment) is fully and accurately described and that the given tests results and instructions correspond to the best of my knowledge and belief and can be considered appropriate for the cargo to be loaded and conditions of the forthcoming voyage.	Name/status, company/organization of signatory Signature on behalf of the Shipper Place and date **December 2, 2004**

Original received: ____
(Post / Name / Signature / Date)

Basic requirements on stowage and securing of rolled sections in packages (bundles)

Stowage and securing of rolled sections bundles should be effected in the following way:

1 A preliminary stowage plan of bundles is drawn up depending on their longitudinal-transverse dimensions and permissible loads on a deck. The number of stacks should be minimum, and their height – nearly maximum.

2 Required quantity and length of lashings are determined (at least 2 loops on a bundle lengthwise) and places of their installation with securing to on-board lashing eyes and eye-bolts are assigned, where it is required.

3 Prior to loading timber dunnage of not less than 25×80 mm section should be placed on cargo deck in a plane of transverse framing elements with 1.5-2.0 m spacing.

4 Rolled sections in bundles should be stowed fore-and-aft tier-by-tier forming a stable stack supported by sides. When having on bundles lifting bindings for lifting purposes it is allowed not to place timber dunnage under tiers, except for the two upper ones. Bundles in each tier should be stowed tightly to each other from side to side.

5 The surface of a stack should be nearly horizontal and plane, and the ends of bundles should be placed in one and the same vertical plane. To facilitate slinging when unloading it is allowed to shift the bundles during stowage up to 1 m lengthways relatively to each other.

6 If non-shift criterion, determined according to the ship's Cargo Securing Manual or by elaborator of the Certificate of the safe stowage and securing of cargo for the particular cargo space, proved to be less than 1, then to provide non-shiftability of the cargo two upper tiers of the bundles in a stack should be sectioned throughout the ship's breadth into 3 - 5 blocks tied up by overlapped rope loops in a section plane according to one of the patterns shown in Fig. A.1.

7 When the surface of a stack of bundles is located under side slope of the under deck tanks or within a hatch it is recommended to perform stowage and securing according to the scheme in Fig. A.1, d.

8 Tension of the lashings should not be excessive. Lashings may require monitoring during voyage only in case of a storm warning being received.

On behalf of ______________________________

The Cargo Information elaborator ____________

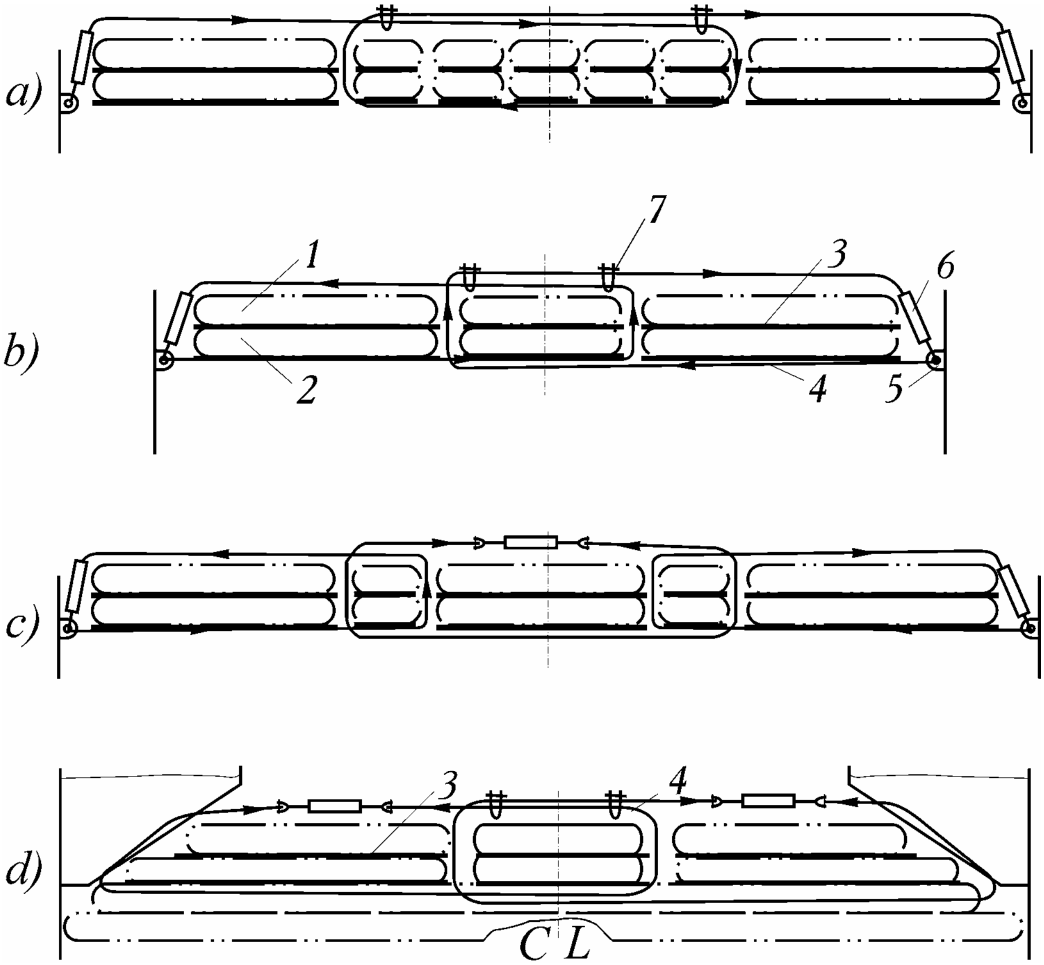

Fig. A. 1. Stowage and securing of rolled sections by overlapped lashings:

1- the top tier; 2- the under-surface tier; 3 – timber dunnaging;
4 – rope lashing; 5 – lashing eye (eye-bolt); 6 – turnbuckle; 7 – squeeze clamp;

a) – securing by one rope;
b) – securing by two ropes;
c) – securing of round bundles by three ropes;
d) – stowage and securing under side slopes of under deck tanks by two ropes.

CARGO INFORMATION

Shipper	Registration number **CI 21.02.42/___-04** Valid until: **December 31, 2005** Name of the cargo: **COPPER CATHODES (GOST 546) in packages**
Consignee	Carrier

Name/means of transport **mv__________________**	Port/place of departure	Navigation range and sea waves height $h_{3\%} \leq$___ m **Unrestricted, Restricted I, Restricted II on sea waves with height $h_{3\%} \leq$___ m up to ship's class permit**
Port of destination		Requirements on cargo stowage and securing **Should be given in ship's Cargo Securing Manual, if not provided, see the Annex to the Information**

General description of the cargo (shape, overall dimensions, mass, package) **Copper cathodes are packed into a package of 1900 kg gross mass, 1300×900×440 mm or less dimensions, with a pair of timber dunnage boards or copper bars. A package is tied up lengthwise and/or crosswise 4 times by steel wire of not less than 6 mm diameter or by steel packing band of 0.7×32 mm section.** **Configurations of packages are specified in Annex.**	Gross mass of cargo (kg/tonnes) ☑ General cargo - Num. of units ______ pcs Gross Mass ______ t

Transport characteristics of the cargo:

Stowage factor, m^3/t	**0.3 – 0.45**
Distributed unit load, tf/m^2	**1.75**
Permissible stack height, m and/or tiers	**unlimited**
Static stability angle of a stack, degrees	**34°**
Friction coefficients for pairs: cargo-steel/cargo-cargo/cargo-timber	**0.34/0.46/0.67**
Cargo permeability coefficient (when flooding cargo space)	**0.61 – 0.42**
Chemical properties ** and other potential hazards	**Not any**

* As applicable and known
** For example: the class by IMO, UN No., EmS No.

Relevant special properties of the cargo – **when banded slack, shifting of sheets within a package is possible;** – **stowage on the weather deck is allowed upon agreement of parties only**	Additional documents ☑ Hygiene Certificate ☑ Certificate of the Safe Stowage and Securing of cargo
DECLARATION I hereby declare, that the cargo (consignment) is fully and accurately described and that the given tests results and instructions correspond to the best of my knowledge and belief and can be considered appropriate for the cargo to be loaded and conditions of the forthcoming voyage.	Name/status, company/organization of signatory Signature on behalf of the Shipper Place and date **December 2, 2004**

Original received: ____
(Post / Name / Signature / Date)

CONFIGURATIONS OF PACKAGES OF COPPER CATHODES

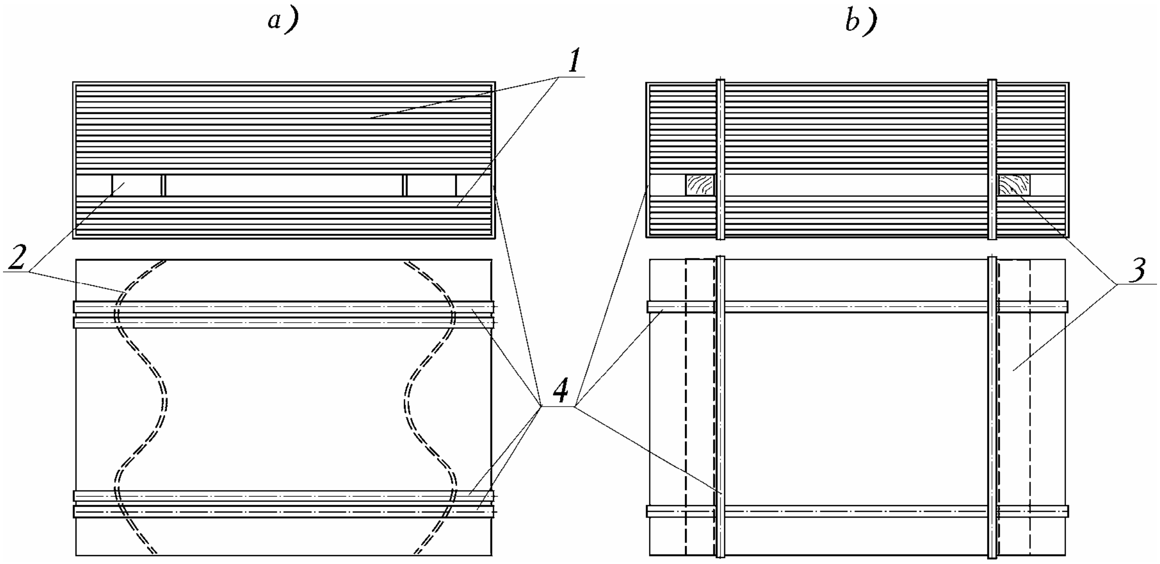

Fig. 1. Configurations of packages:

1 - copper cathodes; 2 – curved copper dunnage for handling by a fork-lift;
3 – timber dunnage for handling by a fork-lift;
4 – banding steel wire or steel packing band;
a), b) – ways of banding.

REQUIREMENTS FOR STOWAGE AND SECURING OF PACKAGED COPPER CATHODES

1 At any stowage variant in cargo spaces of ships each package in the bottom and in the two upper tiers should be stowed on two timber dunnage boards of not more than 40 mm thickness and 2500 mm length located in a plane of transverse framing elements.

2 Stowage of packages should be started from sides to the centreline and from transverse bulkheads to a hatchway as tight as possible alternating, if necessary, athwartships stowage with fore-and-aft one to form from tier to tier a stable stack supported by sides and bulkheads.

3 When stowing more than three tiers high it is necessary to place timber dunnage under the bottom and two upper tiers; other tiers can be stowed without dunnage.

4 If the specified in the Cargo Information value of static 34° stability angle of a stack when calculating the non-shift criterion in accordance with Annex 5 to RD 31.11.21.16-96 or upon diagrams of the ship Cargo Securing Manual meets the conditions of safe sailing of the ship in the forthcoming voyage, then no additional measures to ensure non-shiftability of the cargo shall be taken.

5 If the given value of static stability angle of a stack in any cargo space (possibly in tweendecks) does not meet the conditions of safe carriage in the forthcoming voyage, then the surface of the stack shall be secured additionally by filling the transverse voids between the packages in the top tier with stable cages of beams.

When the top tier is loaded partially, packages in the last athwartship row shall be secured by a chain or rope lashing stretched from side to side along the vertical surface of the row.

6 Not more than one athwartship row may be left partially loaded in a cargo space.

On behalf of ______________________________

The Cargo Information elaborator ______________

PART III

METHOD OF CALCULATION

of non-shift criterion and strength of the securing devices to be applied for securing of structurizing cargoes.

Here is presented a particular example from the ship’s Cargo Securing Manual provided with stowage and securing schemes for coils of steel sheet and calculations based on the proposed "Method of calculation".

As an example let us consider two stowage patterns for coils loaded in cargo spaces of a ship: when coils are stowed "on the side" in the fore-and-aft direction having the top tier supported by the sides and when coils are stowed "on the side" in the fore-and-aft direction having the top tier unsupported by the sides.

When coils in the top tier are not rested against the sides, static stability angle of such a structure is 30°, which is often insufficient to provide stability of the coils of the top tier, therefore, these coils should be secured by lashings.

When the coils in the top tier rest against the sides **static stability angle** of this structure is 50°, which provides the so-called "securing stowage", i.e. the coils of the top tier, tightly stowed from side to side, do not require securing by lashings.

From the beginning here are a few common pages from the Cargo Securing Manual for mv "Northern Wind".

Blue Sun Ltd.

V Ships (UK) Ltd.

ЭКЗЕМПЛЯР КАПИТАНА

НАСТАВЛЕНИЕ ПО КРЕПЛЕНИЮ ГРУЗОВ НА Т/Х «NORTHERN WIND»

92-12/2938-CSM-198

CARGO SECURING MANUAL mv «Northern Wind»

ОДОБРЕНО:	**APPROVED:**	**РАЗРАБОТАНО:**
Российским Морским Регистром Судоходства	**The Russian Maritime Register of Shipping**	
по поручению морской Администрации Мальты	**on behalf of Maritime Administration of Malta**	**ЦНИИМФ**

Начальник службы классификации судов ГУР

_________ В.И.Евенко

„16" ноя 1999 _________ 1999 г.

Зам.генерального директора
Ю.М.Иванов

Руководитель темы
Е.Б.Карпович

· Санкт-Петербург · 1999

1.2 Ship's Particulars

1	Name		**"Northern Wind "** (fig. 1.1)
2	Project No		92-12
3	Shipyard		Slovenske Lodenice, Komarno, Slovakia
4	Date of building		8.1997
5	Hull number		2938
6	Port of Registry		La Valletta
7	Reg. No. of Germanischer Lloyd		093468
8	IMO No.		9171058
9	Class of Germanischer Lloyd		GL ✠ 100 A5 "E" "G"
10	Area of navigation		Unrestricted
11	Ship's purpose		Equipped for Carriage of Containers
12	Constant restrictions		Non
13	Speed		11.7 knots
14	Hull particulars:		
	Length (overall)	L_{OA}	87,90 m
	Length between perpendiculars	L_{PP}	81,00 m
	Breadth moulded	B	12,80 m
	Depth	H	7,10 m
	Draught (summer)	d	5,49 m
	Displacement	Δ	2446 t
15	Bilge keels area		17.68 m^2
16	Cargo spaces		1 hold - see tab. 1.1 and fig. 1.2

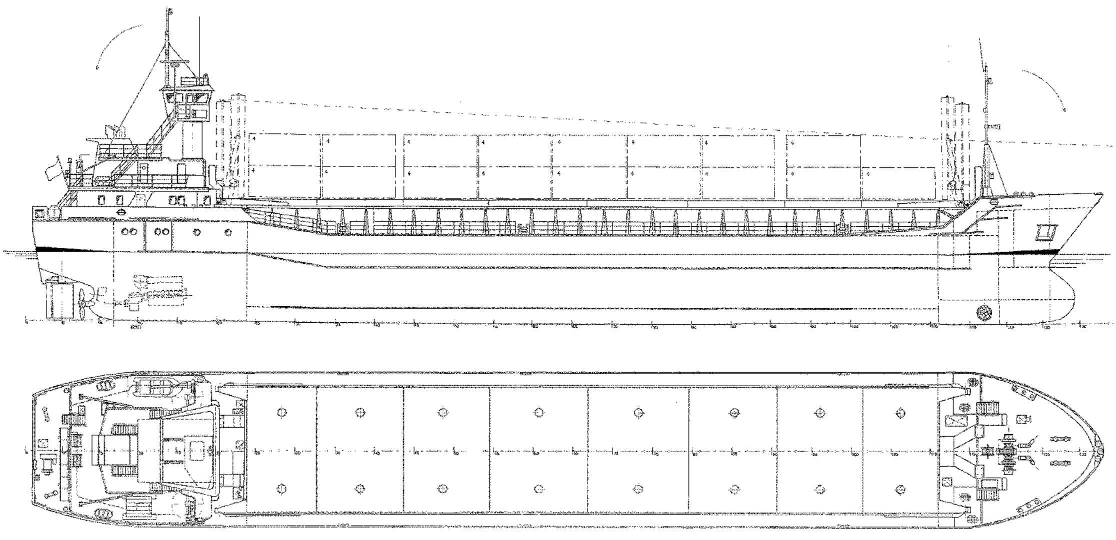

Fig. 1.1. General arrangement.

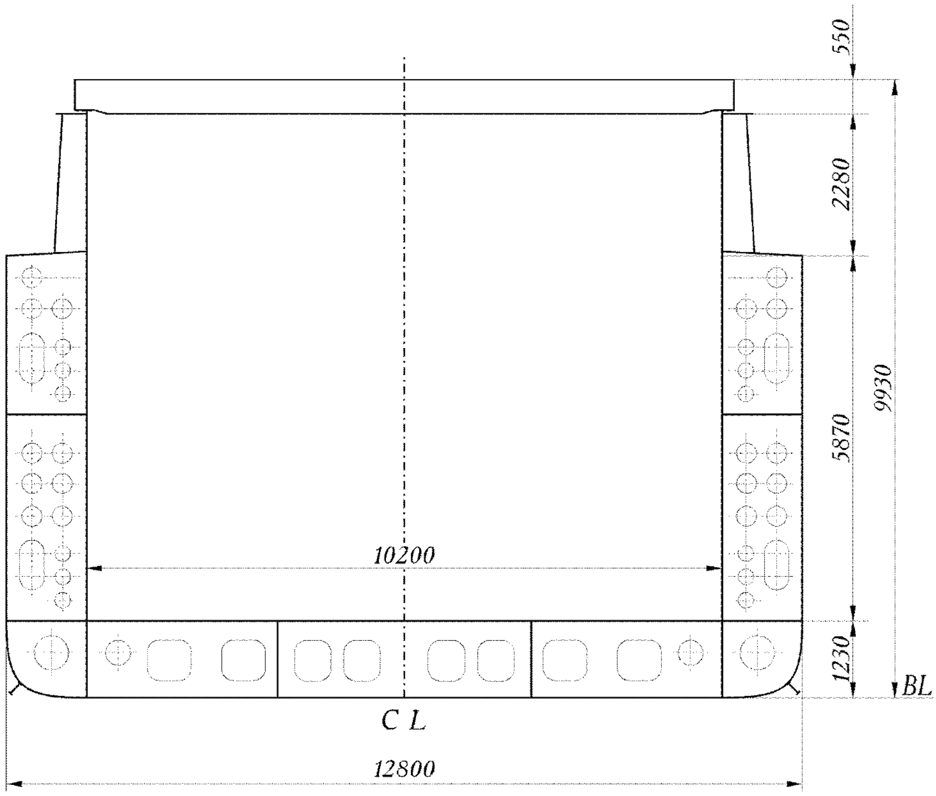

Fig. 1.2. The transverse section with main dimensions (along 24-111 fr.).

Table 1.1

Hold and hatch covers particulars

Cargo compartment	Squire, m²	Capacity, m³		Dimensions, m			Cargo weight capacity/SC, t/m³/t	Permissible load, q, ts/m²
		grain	bale	length	width	height		
Hold	579.87	4650	4620	56.55	10.20	8.15	3320/1.39	15.00
Hatch covers	583.50	-		56.65	10.30	0.55	-	1.56

Further more here are the section 4.4 from the Cargo Securing Manual:

4.4 Stowage and securing of metal products

4.4.1 Coiled sheet steel

Cargo information

Configuration, dimensions and mass of a cargo unit	Stowage factor μ, m^3/t	Distributed unit load q_a, t/m^2	Cargo stack static stability angle, χ, grad.		Cargo permeability coefficient, k
Coils of steel sheets, outside diameter d=1150-1200 mm, length (height) 1250 mm, average mass about 7.5 t	0.23	Coils placed on the rounds 4.66	Coils not resting against the sides - 30°	Coils resting against the sides - 50°	0.31

The shipper should provide the master with at least the following information:

- dimensions of coils (inside and outside diameter, length (height);
- thickness of a coiled sheet;
- number of coils and gross mass of coiled steel sheets of particular outer diameter and thickness;
- distributed unit load;
- characteristics of packaging devices, if available.

When developing a stowage pattern for specific coils in a specific cargo compartment of a ship, it is advisable to sequentially determine the following parameters:

- permissible number of tiers in a stack formed of steel sheet coils, loaded in a hold, should be determined by the formula, given in section 4.2, depending upon the distributed load;
- permissible number of athwartship rows of steel sheet coils and their distribution along ship in the hold; the necessary trimm and stability as well as the necessity of resting of coils of each row against inner half-bulkheads in side ballast deep-tanks should be having in mind;
- odd or even amount of coils to be stowed in a fore-and-aft direction in the upper and bottom tiers of an athwartship row in the hold;
- non-multiplicity factor r = (b/d - [b/d])* of the width **b** of a cargo compartment with regards to the coil diameter **d**:

$$\mathbf{r} \le 0.3;$$

$$0.3 \le \mathbf{r} \le 0.5;$$

$$0.5 \le \mathbf{r} \le 0.7;$$

$$0.7 \le \mathbf{r}.$$

* [b/d] - integer part of a number, non-multiplicity is a residual after subtraction of the integer part.

When stowage in two or more tiers is permitted for the coils with the outside diameter up to 1500 mm and the non-multiplicity factor on the level of the top tier, is equal to, or exceeds 0.3

i.e.: $\mathbf{r} \leq 0.3$,

it is advisable that the following stowage pattern be applied: both outside coils of the top tier should rest against the ship's sides (see fig. 4.4.1) through the timber dunnage. The thickness of the dunnage at each side of the row of coils should compensate half of the non-multiplicity factor. Stowage of coils in the **lower** tier should always start from the ship's centreline (CL). The first two coils should be loaded directly on a CL (see fig. 4.4.1), if the number of coils to be stowed across the entire space of the hold will be determined to be even, or the first one coil, if this number will be determined to be odd.

The coils of the second tier should be stowed in the voids between the coils of the lower tier with the final coils in a row resting against the hold's sides at places supported by semi-bulkheads. The semi-bulkheads are always situated behind the loading cup and on every half distance. This pattern of stowage ensures an increased stability sufficient for ensuring non-shifting of the cargo (see Annex 4 fig. A.4.4 and Table 4.4.1).

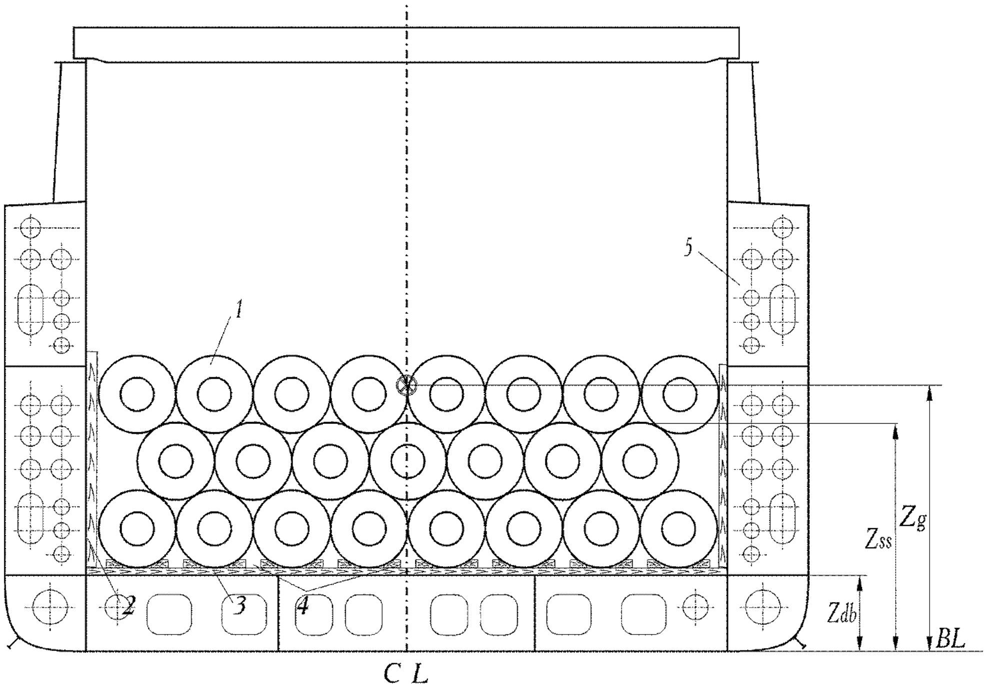

Fig. 4.4.1. Stowage pattern for coils in three tiers resting against both sides in the top tier:

1 - coil; 2, 3 - timber dunnage; 4 - timber wedges; 5 - semi-bulkhead.

When a two-and-more tiers stowage is permitted and the non-multiplicity factor on the top tier level varies within the 0.5-0.7 range, i.e.:

$$0.5 \leq \mathbf{r} \leq 0.7 ,$$

the following stowage pattern should be applied: only one of the outside coils of the top tier should rest against the ship's side through the timber dunnage (fig. 4.4.2). Stowage of coils of the **lower** tier should commence from one side of the hold to the other.

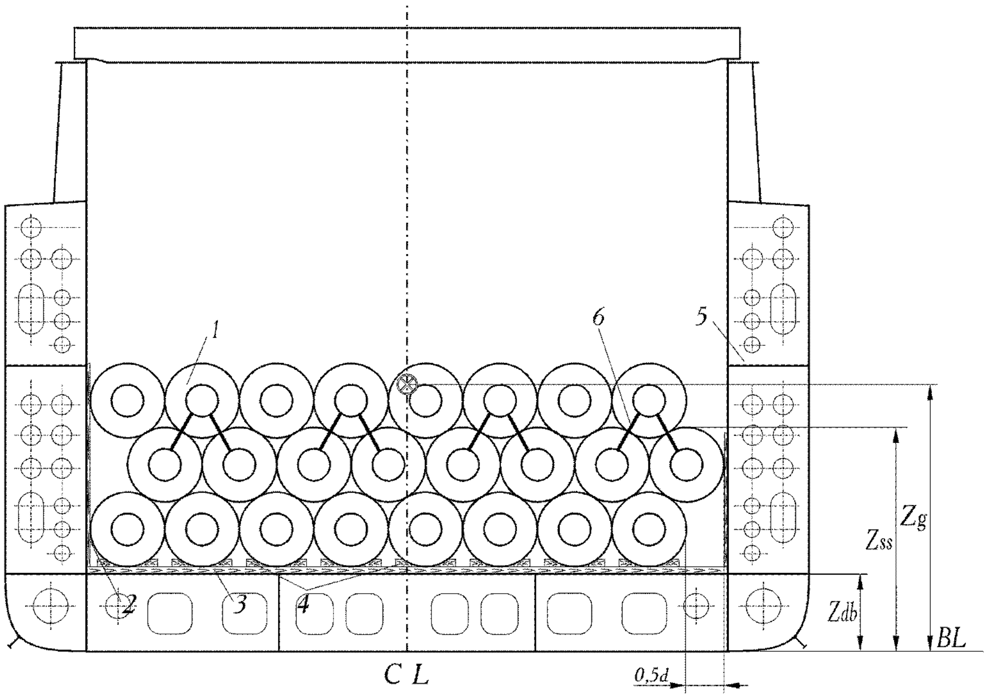

Fig. 4.4.2. Pattern of stowage of coils in three tiers, with the outside coils resting against one of the ship's sides in each tier:

1 - coil; 2, 3 - timber dunnage; 4 - timber wedges;
5 - semi-bulkhead; 6 - steel tape securing.

If the void between the final outermost coil of the bottom tier and the hold side exceeds 0.5 diameter of a coil, the coil of the second tier should be placed upon the bottom tier coil, resting against the hold side through a strong vertical timber dunnage (fig. 4.4.2). A thickness of such vertical timber dunnage should form a void space between the coil and the side timber dunnage being equal to 0.5 coil diameter.

When two-tier stowage is permitted and the non-multiplicity factor on the top tier level varies within the 0.3-0.7 range, i.e.:

$$0.3 \leq \mathbf{r} \leq 0.7,$$

it is recommended that the outermost top tier coils (see fig. 4.4.3) should not be supported by the ship's sides. Should this be the case, stowage of coils of the **lower** tier should commence from the hold sides towards the centreline plane of the ship.

As general rule coils should be stowed on their rounds with their axes in the fore-and-aft direction in regular athwartship rows from side to the centreline plane of the ship. The distance between the rows should provide an even distribution of load along the length of the cargo compartment; the necessary trimm and stability as well as the necessity of resting of coils of each row against inner half-bulkheads in side ballast deep-tanks should be having in mind.

Each row should be formed from coils having identical or similar diameters and lengths. In each row, the coils of the second and consequent tiers should be inserted in the voids between the coils on the surface of the lower tier.

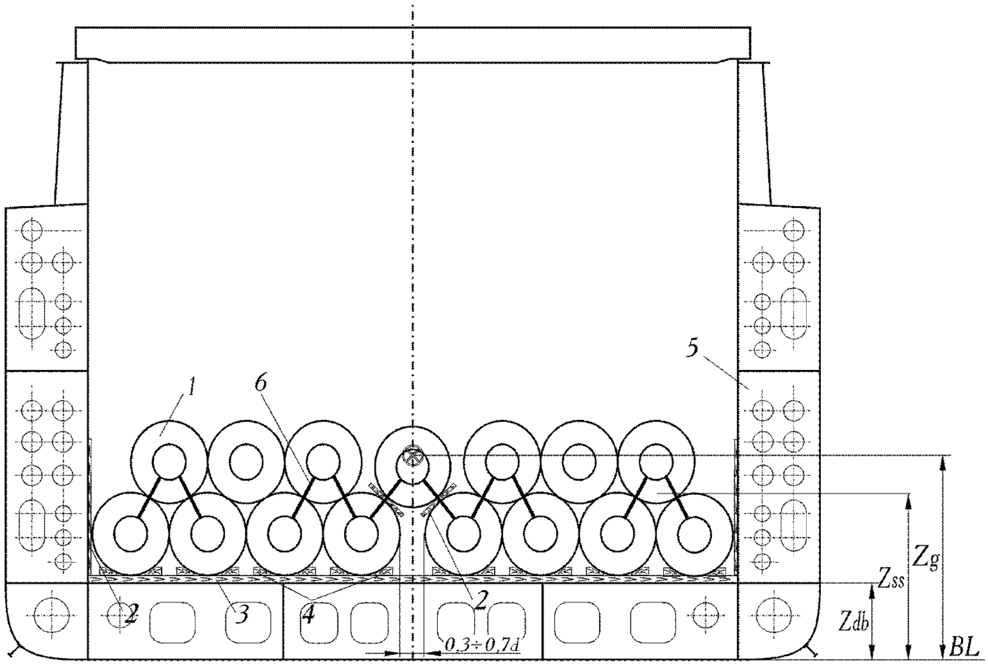

Fig. 4.4.3. Pattern of stowage of coils in two tiers with no coils resting against the ship's sides in the upper tier:
1 - coil; 2, 3 - timber dunnage; 4 - timber wedges;
5 - semi-bulkhead; 6 - steel tape securing.

To ensure a tight and regular stowage of coils in the topmost tier, coils, the diameter and mass of which exceeds the average diameter and mass of coils in given consignment, should be laid on the double bottom plating. The topmost tier should be formed from coils, which diameter (mass) is less than the average diameter (mass) of coils in given consignment.

To provide a uniform distribution of a coil pressure within the projection on the horizontal plane, timber boards with a cross section of at least 40×150 mm should be laid on each frame of the double bottom plating. One or two timber wedges should be laid under each coil, the thickness of the wedges being at least 0.1 of the coil's diameter. The first two wedges should be choked off the bare side of the coil as soon as the coil is loaded, while the third wedge should be choked from the opposite side.

To make a decision about the necessity of securing coils according to the stowage pattern, the ship's stability calculations were carried out for stowage of coils in one, two and three tiers, the stowage factor exceeding 0.23 m^3/t.

The results of stability calculations to be submitted for approval of the Germanischer Lloyd are given in a special booklet.

The non-shift criterion calculations, according to the method described in Annex 3, were carried out on the basis of the results of the stability calculations. The results of the non-shift criterion calculations are represented in table 4.4.1 and the curves of the coils dynamic stability angles were plotted with regard for the stowage pattern with or without coils resting against the ship's sides (see Annex 4, figure A.4.3 - A.4.5).

Table 4.4.1

Calculation of the Non-shift Criterion for steel coils (SF=0.23 m^3/t) stowed in the ship's hold

Number of tiers of coils in a stack	Static stability angle of a stack, deg.	Height of the surface of shifting above the base plane, Z_{ss}, m	Height of CG of a loaded ship above the base plane, Z_g, m	$Z_{ss} - Z_g$, m	Metacentric height, m	Period of roll, sec.	Dynamic stability angle of a cargo, Θ_s, deg.	Amplitude of roll, Θ_{dyn}, deg.	Non-shift criterion $\frac{\Theta_s}{\Theta_{din}} = \lambda \geq 1$	Total strength of the required securing devices per each side $Q = P_i(tg\Theta_{dyn} - tg\Theta_s)$	Number of athwartships lashings per each side of the ship
3	30	3.4	4.20	-0.80	1.27	9.98	24,2	29,3	$\lambda_s<1$	P×0.11	3
3	50	3.4	4.20	-0.80	1.27	9.98	42,8	29.3	$\lambda_s>1$	0	0
2	30	2.5	3.24	-0.74	2.24	7.25	19.2	32.3	$\lambda_s<1$	P×0.28	5
2	50	2.5	3.24	-0.74	2.24	7.25	36.0	32.3	$\lambda_s>1$	0	0
1	45	1.3	2.81	-1.51	2.67	6.85	28.1	33.0	$\lambda_s<1$	P×0.12	Cage

As the accepted value of the static stability angle for the coils of the top tier not supported by the ship's sides **does not meet** the safety requirements, coils in each athwartship row should be secured by means of pneumatic machines of "TITAN", "SIGNODA" type or alike. Lashings made of certified steel band with a breaking strength of at least 46 kN (4.6 t(f)) should be passed through the top coil and two lower coils.

According to the calculations (see table 4.4.1) number of lashings **N** per each side should correspond to load **Q**, t, defined by the formula A. 3.10:

for a three-tier stack (fig. 4.4.2):

$$N = Q/SWL = (8\times7.5\times0.11) / (4.6\times0.7) = 2.04 \approx 3,$$

for a two-tier stack (fig. 4.4.3):

$$N = Q/SWL = (7\times7.5\times0.28) / (4.6\times0.7) = 4.6 \approx 5,$$

where:

SWL=4.6×0.7 - safety (maximum) working load of a steel band lashing, t(f),

that is at least four coils (see Cargo Information) out of eight coils in the top tier of a three-tier stack or at least five coils out of seven coils in the top tier of a two-tier stack should be secured to coils in the lower tiers.

When transporting heavy coils with a distributed unit load varying from 10.0 to 15.0 t(f)/m^2, such coils should be given a one-tier stow from the ship's sides to the centreline plane of the ship. If there is a void space between the coils in the centreline plane, timber cross bars should be inserted between the lower wedges around the void, the cross section of the cross bar being equal to that of the wedges. On top of each of them, two more additional wedges with a crossbar in between should be choked under the coils; angle of slope side of such wedges being to 45°.

The wedges and crossbars should be nailed to the lower crossbars to provide strength and connect the crossbars by boards to ensure their stability (fig. 4.4.4, pos. 5).

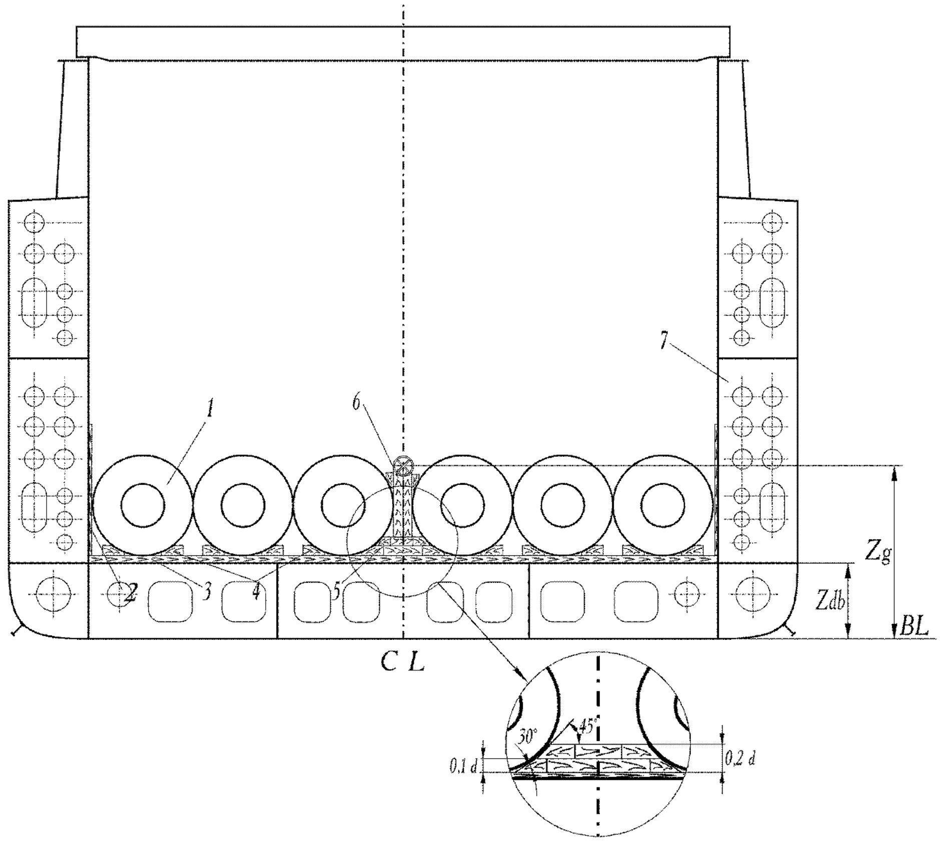

Fig. 4.4.4. One-tier stowage and securing of coils:
1 - steel sheet coil; 2, 3 - timber dunnage; 4 - timber wedges;
5 - timber cross-bars, made of wedges and bars; 6 - bar cages;
7 - semi-bulkhead.

If metacentric height of the ship being loaded exceeds 2.14 m, voids between the coils around the centreline plane should be filled with a stable bar cage (fig. 4.4.4, pos. 6).

Further more here are the sub-section 4 from the Annex 3 of the Cargo Securing Manual:

4 Graphs of Ship's Roll Amplitudes

Graphs of ship's roll amplitudes, plotted by paragraph 2.2.2 for the drafts T = 4,90 m, T = 5,09 m & T = 5,51 m, with bilge keels taken into account, are given in fig. A.3.1 - A.3.3 accordingly, and static and dynamic diagrams of the ship with timber deck cargo on the hatch covers with the scheme of determination of the ship's dynamic angle of heel in unrestricted area of navigation are given in fig. A.3.4.

The amplitudes of roll for intermediate drafts should be received by linear interpolation.

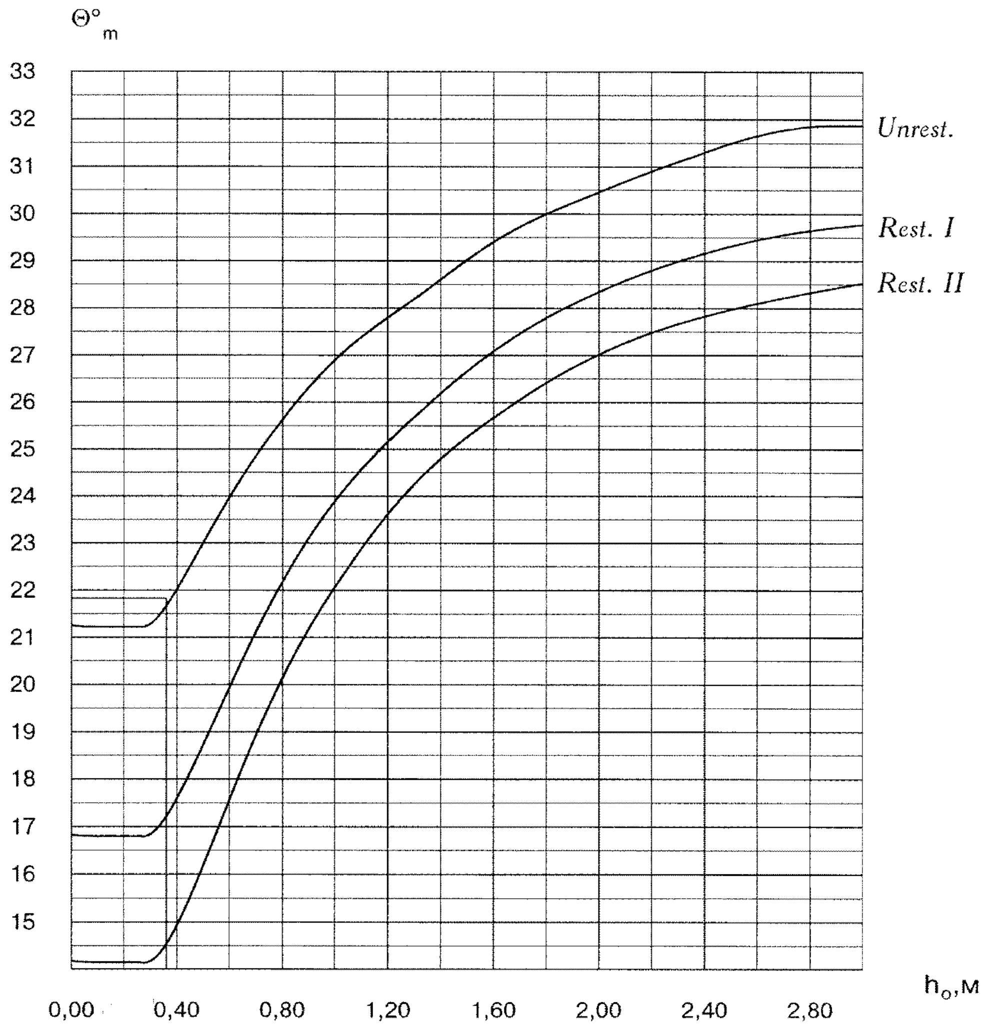

Fig. A.3.1. Ship's roll amplitudes for the draft T=4.90 m.

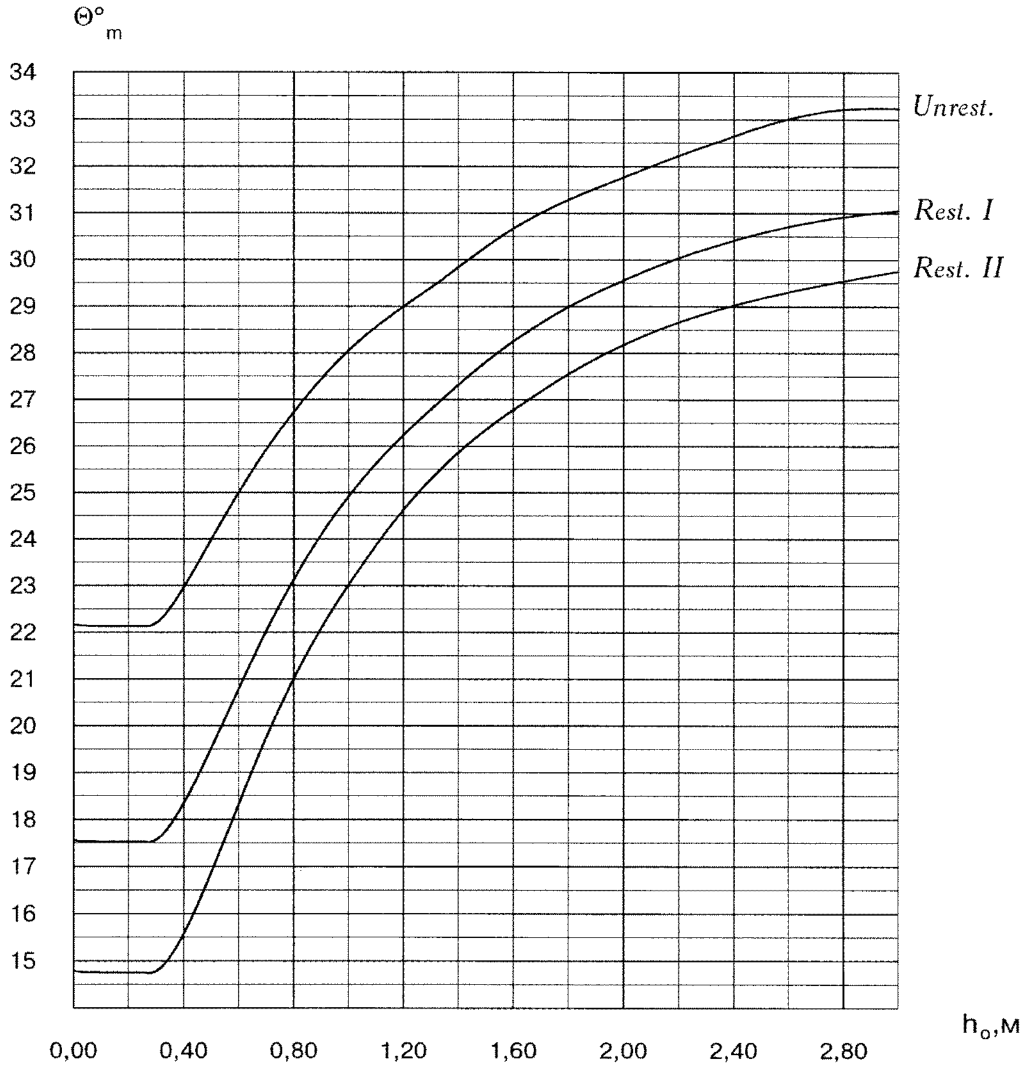

Fig. A.3.3. Ship's roll amplitudes for the draft T=5.50 m.

Further more here are the Annex 4 of the Cargo Securing Manual:

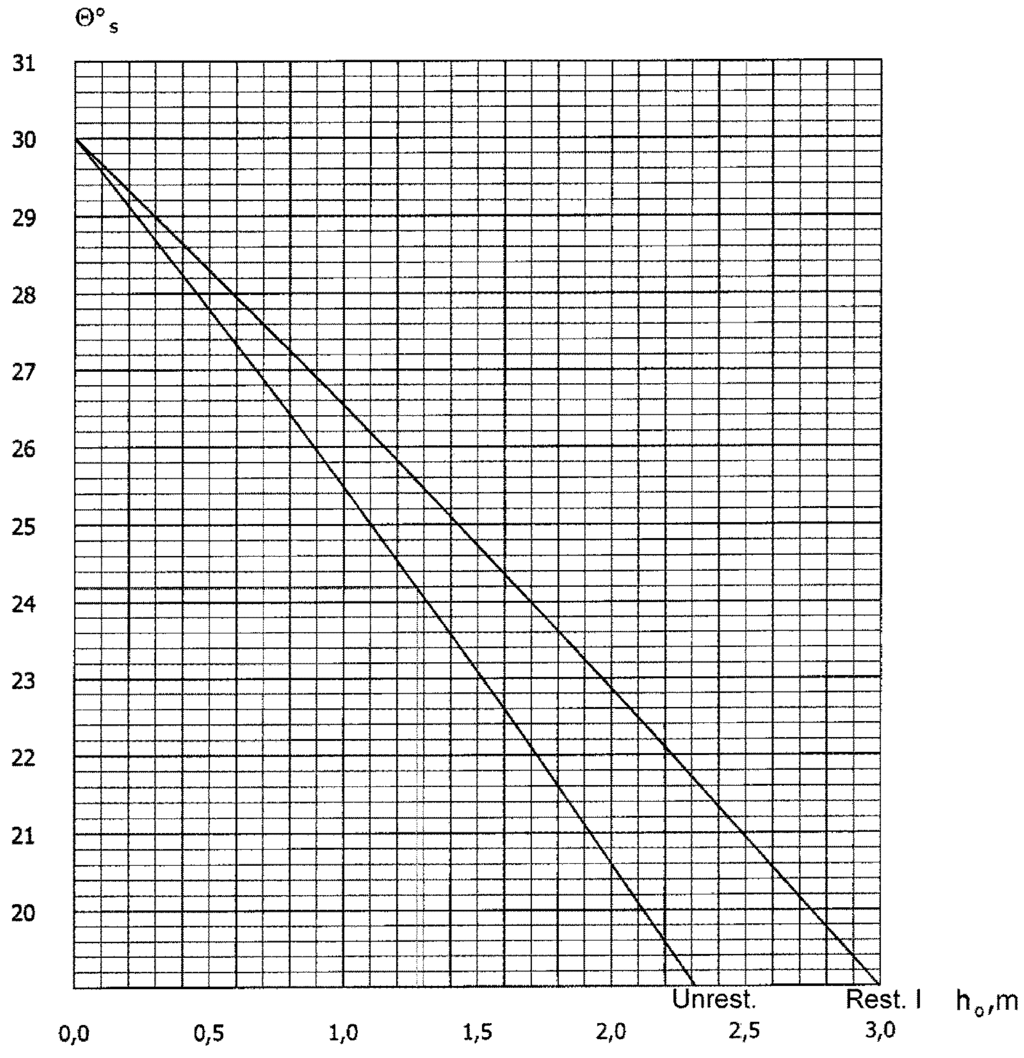

Fig. A.4.3. The cargo dynamic stability angles Θ_s for coils, stowed as **not** resting against the ship's side in the upper tier, the angle χ being equal to 30°.

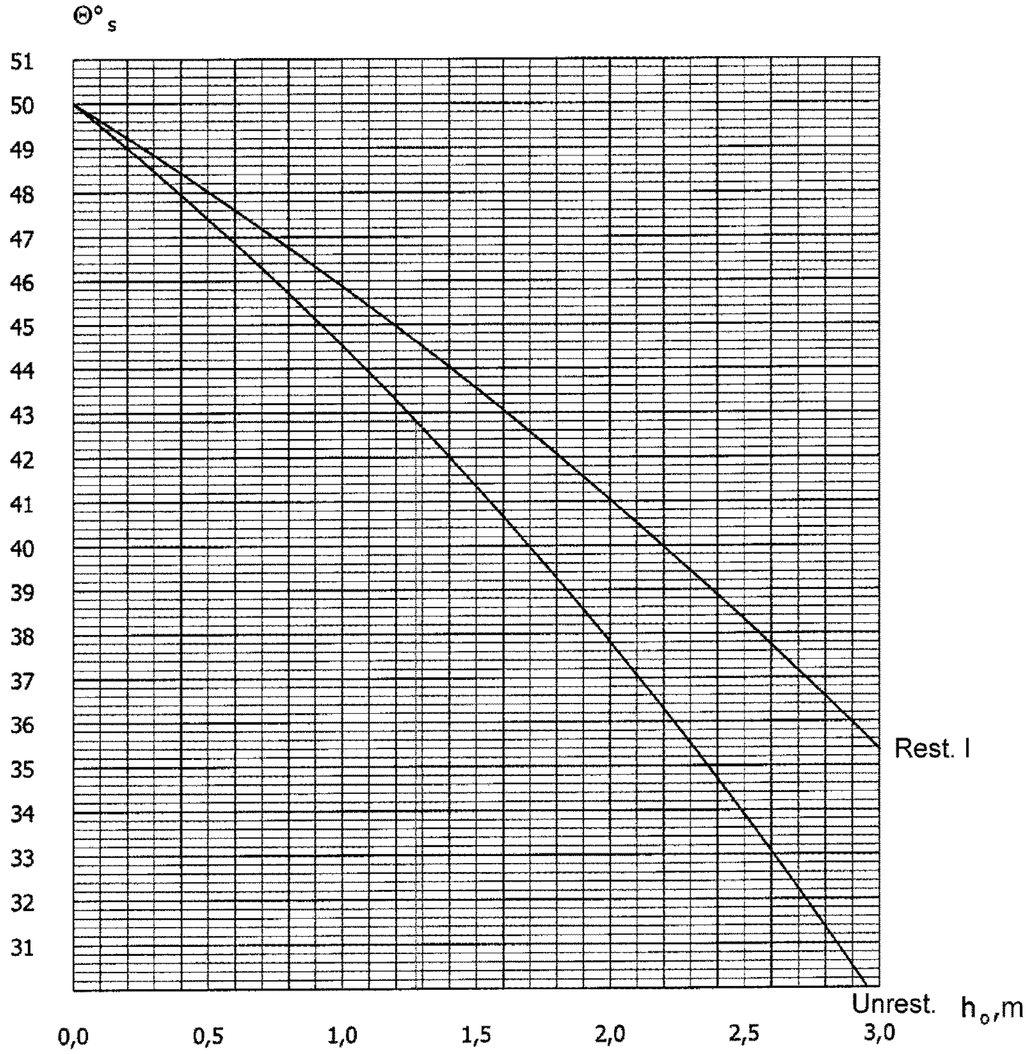

Fig. A.4.4. The cargo dynamic stability angles Θ_s for coils stowed as resting against the ship's sides in the upper tier, the angle χ being equal to 50°.

Further more here are the examples of receiving of figures containing in Table 4.4.1 on page 71 for coils in 3 tiers:

Calculation of Non-Shift Criterion

Name of the Ship: **т\х Nothern Wind**

Notes: **with Coils SF= 0,23 m3/t in 3 tiers with X=30 degr.**

Main Characteristics of the Ship :		**Characteristics of the Ship with Cargo :**	
Length of the Ship Between PP, m :	81,32	Actual Draught, m :	5,52
Ship's Breadth, m :	12,80	Metacentric Height, m :	1,27
Depth, m :	7,10	Height of the Surface of Shifting Above the Base Plane, m :	3,4
Draught (summer), m :	5,60	Position of the Cargo from Aft Perpendicular, m :	70,00
Bilge Keels Squire, m^2 :	17,68	Ship's Inertia Factor :	0,88
Speed of the Ship, knots :	10,00	Static Stability Angle of Cargo Stack, deg :	30,00

Method of Calculations : Amplitude of Ship's Roll
River Register : No
Area of Navigation : Unrestricted
Height of Wave, m : 11,00
Water Density, t/m^3: 1,025

Mass and Position of Center of Gravity of the Ship and Cargoes :

№	Items	Mass, t	Position X,m	Position Z,m	Calc.?	Length, m	Height, m	Calc.?
1	Light ship	1199,27	36,39	5,177	Yes	88	2,9	Yes
2	Crew	3	8	8,9	Yes	0	0	No
3	Stores	56	39	5,83	Yes	0	0	No
4	Coils in holds	3512	43,4	3,95	Yes	0	0	No
5	Lashing materials	24	42	5,83	Yes	0	0	No
6	Water ballast	115,4	21,8	0,53	Yes	0	0	No
7	Diesel Oil	7,02	12,9	4,2	Yes	0	0	No
8	Dirty Water	6,1	11,6	0,67	Yes	0	0	No
9	Fresh Water	4,8	2,72	3,42	Yes	0	0	No
10	Lub Oil	9,28	13,98	3,87	Yes	0	0	No
	TOTAL:	4936,870	40,936	4,197				

Outcomes of Cargo Shifting Calculations :

Height of the Above Water Side, m :	**1,580**		Arm of Heeling Moment, m :	**0,016**	
Ship's Sail Squire, m^2 :	**383,703**		Arm of Capsizing Moment, m :	**0,446**	
Volume Displacement, m^3 :	**4816,459**		Weather Criterion :	**27,475**	
Ship's Block Coefficient :	**0,838**		Acceleration Criterion :	**2,594**	
Period of Roll, sec :	**9,977**		Dynamic Stability Angle of a Cargo, deg :	**24,179**	tan: **0,449**
Amplitude of Ship's Roll, deg :	**29,295**	tan : **0,561**	Non-Shift Criterion :	**0,825**	
Ship's Dynamic Angle of Heel, deg :	**30,816**	tan : **0,597**			
				Deficit of tan:	**0,112**

Calculation of Non-Shift Criterion

Name of the Ship: т\х **Nothern Wind**

Notes: **with Coils SF= 0,23 m3/t in 3 tiers with X=50 degr.**

Main Characteristics of the Ship :

Length of the Ship Between PP, m :	81,32
Ship's Breadth, m :	12,80
Depth, m :	7,10
Draught (summer), m :	5,60
Bilge Keels Squire, m^2 :	17,68
Speed of the Ship, knots :	10,00

Characteristics of the Ship with Cargo :

Actual Draught, m :	5,52
Metacentric Height, m :	1,27
Height of the Surface of Shifting Above the Base Plane, m :	3,4
Position of the Cargo from Aft Perpendicular, m :	70,00
Ship's Inertia Factor :	0,88
Static Stability Angle of Cargo Stack, deg :	50,00

Method of Calculations : Amplitude of Ship's Roll

River Register : No

Area of Navigation : Unrestricted

Height of Wave, m : 11,00

Water Density, t/m^3: 1,025

Mass and Position of Center of Gravity of the Ship and Cargoes :

№	Items	Mass, t	Position X,m	Position Z,m	Calc.?	Length, m	Height, m	Calc.?
1	Light ship	1199,27	36,39	5,177	Yes	88	2,9	Yes
2	Crew	3	8	8,9	Yes	0	0	No
3	Stores	56	39	5,83	Yes	0	0	No
4	Coils in holds	3512	43,4	3,95	Yes	0	0	No
5	Lashing materials	24	42	5,83	Yes	0	0	No
6	Water ballast	115,4	21,8	0,53	Yes	0	0	No
7	Diesel Oil	7,02	12,9	4,2	Yes	0	0	No
8	Dirty Water	6,1	11,6	0,67	Yes	0	0	No
9	Fresh Water	4,8	2,72	3,42	Yes	0	0	No
10	Lub Oil	9,28	13,98	3,87	Yes	0	0	No
	TOTAL:	4936,870	40,936	4,197				

Outcomes of Cargo Shifting Calculations :

Height of the Above Water Side, m :	**1,580**	
Ship's Sail Squire, m^2 :	**383,703**	
Volume Displacement, m^3 :	**4816,459**	
Ship's Block Coefficient :	**0,838**	
Period of Roll, sec :	**9,977**	
Amplitude of Ship's Roll, deg :	**29,295**	tan : **0,561**
Ship's Dynamic Angle of Heel, deg :	**30,816**	tan : **0,597**

Arm of Heeling Moment, m :	**0,016**	
Arm of Capsizing Moment, m :	**0,446**	
Weather Criterion :	**27,475**	
Acceleration Criterion :	**2,594**	
Dynamic Stability Angle of a Cargo, deg :	**42,824**	tan: **0,927**
Non-Shift Criterion :	**1,462**	

Deficit of tan: **-0,366**

At last here are the other way of receiving of figures containing in Table 4.4.1 on page 71 for coils in 3 tiers from the next two tables:

Static Stability Angle of Cargo Stack χ , deg.	**30**
Height of the Surface of Shifting Above the Base Plane, m	**3,4**
Rated Wave Height with 3% Probability, m	**11**

Mean Draught, m	Position Zg Center of Gravity of Loaded Ship, m																Parameter
	3,9	4	4,1	4,2	4,3	4,4	4,5	4,6	4,7	4,8	4,9	5	5,1	5,2	5,3	5,4	Zg, м
5	22,993	23,48	23,964	24,444	24,921	25,393	25,863	26,328	26,79	27,248	27,702	28,152	28,599	29,042	29,481	29,917	θs
	29,353	28,95	28,535	28,133	27,713	27,235	26,632	25,996	25,22	24,367	23,441	22,422	21,794	21,425	21,425	21,425	θdyn
	0,783	0,811	0,84	0,869	0,899	0,932	0,971	1,013	1,062	1,118	1,182	1,256	1,312	1,356	1,376	1,396	λs
	0,138	0,119	0,099	0,08	0,061	0,04	0,017	-0,007	-0,034	-0,062	-0,091	-0,123	-0,145	-0,163	-0,173	-0,183	tgθdyn - tgθs
5,1	22,953	23,441	23,925	24,405	24,882	25,355	25,824	26,29	26,752	27,21	27,665	28,116	28,563	29,006	29,445	29,881	θs
	29,69	29,284	28,864	28,458	28,036	27,566	26,959	26,32	25,549	24,692	23,764	22,743	22,071	21,647	21,647	21,647	θdyn
	0,773	0,8	0,829	0,858	0,887	0,92	0,958	0,999	1,047	1,102	1,164	1,236	1,294	1,34	1,36	1,38	λs
	0,147	0,127	0,108	0,088	0,069	0,048	0,025	0,001	-0,026	-0,054	-0,084	-0,115	-0,139	-0,158	-0,168	-0,178	tgθdyn - tgθs
5,2	22,908	23,396	23,88	24,361	24,838	25,311	25,781	26,247	26,71	27,168	27,623	28,074	28,522	28,965	29,405	29,841	θs
	30,02	29,612	29,189	28,778	28,353	27,893	27,283	26,641	25,878	25,019	24,089	23,067	22,346	21,861	21,861	21,861	θdyn
	0,763	0,79	0,818	0,847	0,876	0,907	0,945	0,985	1,032	1,086	1,147	1,217	1,276	1,325	1,345	1,365	λs
	0,155	0,136	0,116	0,096	0,077	0,056	0,033	0,009	-0,018	-0,047	-0,076	-0,108	-0,132	-0,152	-0,162	-0,172	tgθdyn - tgθs
5,3	22,858	23,347	23,831	24,312	24,79	25,263	25,734	26,2	26,663	27,122	27,577	28,029	28,476	28,92	29,361	29,797	θs
	30,344	29,933	29,507	29,091	28,664	28,216	27,604	26,959	26,206	25,345	24,414	23,394	22,618	22,066	22,066	22,066	θdyn
	0,753	0,78	0,808	0,836	0,865	0,895	0,932	0,972	1,017	1,07	1,13	1,198	1,259	1,311	1,331	1,35	λs
	0,164	0,144	0,124	0,105	0,085	0,065	0,041	0,017	-0,01	-0,039	-0,068	-0,1	-0,126	-0,147	-0,157	-0,167	tgθdyn - tgθs
5,4	22,805	23,293	23,778	24,26	24,738	25,212	25,682	26,149	26,612	27,072	27,527	27,979	28,428	28,872	29,313	29,75	θs
	30,48	30,069	29,644	29,225	28,799	28,353	27,756	27,113	26,376	25,519	24,594	23,582	22,753	22,133	22,133	22,133	θdyn
	0,748	0,775	0,802	0,83	0,859	0,889	0,925	0,964	1,009	1,061	1,119	1,186	1,249	1,304	1,324	1,344	λs
	0,168	0,148	0,128	0,109	0,089	0,069	0,045	0,021	-0,005	-0,034	-0,063	-0,095	-0,122	-0,145	-0,155	-0,165	tgθdyn - tgθs
5,5	22,748	23,237	23,723	24,204	24,683	25,157	25,628	26,096	26,559	27,019	27,475	27,927	28,376	28,821	29,262	29,699	θs
	30,526	30,117	29,694	29,273	28,849	28,406	27,828	27,189	26,471	25,621	24,705	23,704	22,822	22,183	22,133	22,133	θdyn
	0,745	0,772	0,799	0,827	0,856	0,886	0,921	0,96	1,003	1,055	1,112	1,178	1,243	1,299	1,322	1,342	λs
	0,17	0,151	0,131	0,111	0,091	0,071	0,048	0,024	-0,002	-0,03	-0,06	-0,091	-0,119	-0,142	-0,154	-0,164	tgθdyn - tgθs
5,6	22,689	23,178	23,664	24,147	24,625	25,1	25,572	26,04	26,504	26,964	27,42	27,873	28,322	28,768	29,209	29,647	θs
	30,575	30,167	29,745	29,323	28,901	28,46	27,903	27,268	26,57	25,727	24,819	23,83	22,893	22,265	22,133	22,133	θdyn
	0,742	0,768	0,796	0,823	0,852	0,882	0,916	0,955	0,998	1,048	1,105	1,17	1,237	1,292	1,32	1,339	λs
	0,173	0,153	0,133	0,113	0,094	0,074	0,051	0,027	0,001	-0,027	-0,056	-0,087	-0,117	-0,14	-0,152	-0,162	tgθdyn - tgθs

Static Stability Angle of Cargo Stack χ , deg.	50
Height of the Surface of Shifting Above the Base Plane, m	3,4
Rated Wave Height with 3% Probability, m	11

Mean Draught, m	Position Zg Center of Gravity of Loaded Ship, m																Parameter
	3,9	4	4,1	4,2	4,3	4,4	4,5	4,6	4,7	4,8	4,9	5	5,1	5,2	5,3	5,4	Zg, м
5	41,215	41,882	42,536	43,176	43,803	44,417	45,018	45,608	46,184	46,75	47,303	47,845	48,376	48,896	49,406	49,905	θ_s
	29,353	28,95	28,535	28,133	27,713	27,235	26,632	25,996	25,22	24,367	23,441	22,422	21,794	21,425	21,425	21,425	θ_{dyn}
	1,404	1,447	1,491	1,535	1,581	1,631	1,69	1,754	1,831	1,919	2,018	2,134	2,22	2,282	2,306	2,329	λ_s
	-0,314	-0,344	-0,374	-0,404	-0,434	-0,465	-0,499	-0,534	-0,571	-0,61	-0,65	-0,692	-0,726	-0,754	-0,775	-0,795	$tg\theta_{dyn} - tg\theta_s$
5,1	41,16	41,828	42,483	43,124	43,752	44,367	44,97	45,56	46,138	46,704	47,258	47,801	48,333	48,854	49,365	49,865	θ_s
	29,69	29,284	28,864	28,458	28,036	27,566	26,959	26,32	25,549	24,692	23,764	22,743	22,071	21,647	21,647	21,647	θ_{dyn}
	1,386	1,428	1,472	1,515	1,561	1,61	1,668	1,731	1,806	1,891	1,989	2,102	2,19	2,257	2,28	2,304	λ_s
	-0,304	-0,334	-0,365	-0,395	-0,425	-0,456	-0,49	-0,525	-0,562	-0,602	-0,642	-0,684	-0,718	-0,748	-0,768	-0,789	$tg\theta_{dyn} - tg\theta_s$
5,2	41,098	41,767	42,423	43,065	43,695	44,311	44,915	45,506	46,085	46,652	47,207	47,752	48,284	48,807	49,318	49,819	θ_s
	30,02	29,612	29,189	28,778	28,353	27,893	27,283	26,641	25,878	25,019	24,089	23,067	22,346	21,861	21,861	21,861	θ_{dyn}
	1,369	1,41	1,453	1,496	1,541	1,589	1,646	1,708	1,781	1,865	1,96	2,07	2,161	2,233	2,256	2,279	λ_s
	-0,294	-0,325	-0,355	-0,385	-0,416	-0,447	-0,481	-0,516	-0,554	-0,593	-0,633	-0,675	-0,711	-0,741	-0,762	-0,783	$tg\theta_{dyn} - tg\theta_s$
5,3	41,029	41,7	42,357	43,001	43,631	44,249	44,854	45,446	46,027	46,595	47,152	47,697	48,231	48,754	49,266	49,769	θ_s
	30,344	29,933	29,507	29,091	28,664	28,216	27,604	26,959	26,206	25,345	24,414	23,394	22,618	22,066	22,066	22,066	θ_{dyn}
	1,352	1,393	1,435	1,478	1,522	1,568	1,625	1,686	1,756	1,838	1,931	2,039	2,132	2,209	2,233	2,255	λ_s
	-0,285	-0,315	-0,346	-0,376	-0,407	-0,438	-0,472	-0,507	-0,544	-0,584	-0,624	-0,666	-0,703	-0,735	-0,756	-0,777	$tg\theta_{dyn} - tg\theta_s$
5,4	40,955	41,627	42,286	42,931	43,563	44,182	44,788	45,382	45,964	46,533	47,091	47,638	48,173	48,697	49,211	49,714	θ_s
	30,48	30,069	29,644	29,225	28,799	28,353	27,756	27,113	26,376	25,519	24,594	23,582	22,753	22,133	22,133	22,133	θ_{dyn}
	1,344	1,384	1,426	1,469	1,513	1,558	1,614	1,674	1,743	1,823	1,915	2,02	2,117	2,2	2,223	2,246	λ_s
	-0,279	-0,31	-0,34	-0,371	-0,401	-0,432	-0,466	-0,501	-0,538	-0,578	-0,618	-0,66	-0,698	-0,731	-0,752	-0,773	$tg\theta_{dyn} - tg\theta_s$
5,5	40,876	41,55	42,211	42,857	43,491	44,111	44,719	45,314	45,897	46,468	47,027	47,575	48,112	48,637	49,152	49,657	θ_s
	30,526	30,117	29,694	29,273	28,849	28,406	27,828	27,189	26,471	25,621	24,705	23,704	22,822	22,183	22,133	22,133	θ_{dyn}
	1,339	1,38	1,422	1,464	1,508	1,553	1,607	1,667	1,734	1,814	1,904	2,007	2,108	2,193	2,221	2,244	λ_s
	-0,276	-0,306	-0,337	-0,367	-0,398	-0,429	-0,462	-0,497	-0,534	-0,573	-0,613	-0,655	-0,694	-0,728	-0,75	-0,771	$tg\theta_{dyn} - tg\theta_s$
5,6	40,794	41,47	42,132	42,78	43,415	44,037	44,647	45,243	45,828	46,4	46,961	47,51	48,048	48,575	49,091	49,596	θ_s
	30,575	30,167	29,745	29,323	28,901	28,46	27,903	27,268	26,57	25,727	24,819	23,83	22,893	22,265	22,133	22,133	θ_{dyn}
	1,334	1,375	1,416	1,459	1,502	1,547	1,6	1,659	1,725	1,804	1,892	1,994	2,099	2,182	2,218	2,241	λ_s
	-0,272	-0,303	-0,333	-0,364	-0,394	-0,425	-0,458	-0,493	-0,529	-0,568	-0,608	-0,65	-0,69	-0,724	-0,747	-0,768	$tg\theta_{dyn} - tg\theta_s$

Photo 1
Coils, stowed as **not** resting against the ship's side in the upper tier, the angle χ being equal to 30°.

Photo 2
Coils stowed as resting against the ship's sides in the upper tier, the angle χ being equal to 50°.

The example given shows how the master can, making use of the in advance calculated by the developer of the Cargo Securing Manual graphs and tables, with adequate accuracy and quickly determine the required characteristics of cargo securing devices for possible variants of the ship's metacentric height (i.e. variant of loading) and the area of the forthcoming voyage (Unrestricted or Restricted I).

This is particularly important when transporting cargoes which represent utmost danger when transported by sea (packaged dangerous substances, bulky, heavyweight and metal cargoes, timber cargoes) and this is especially important for ship's master who very often have fight the stevedores and shippers to prove that additional securing devices having high strength characteristics are no good at all. And now it is in your power make the life of a ship's master a little bit easier.