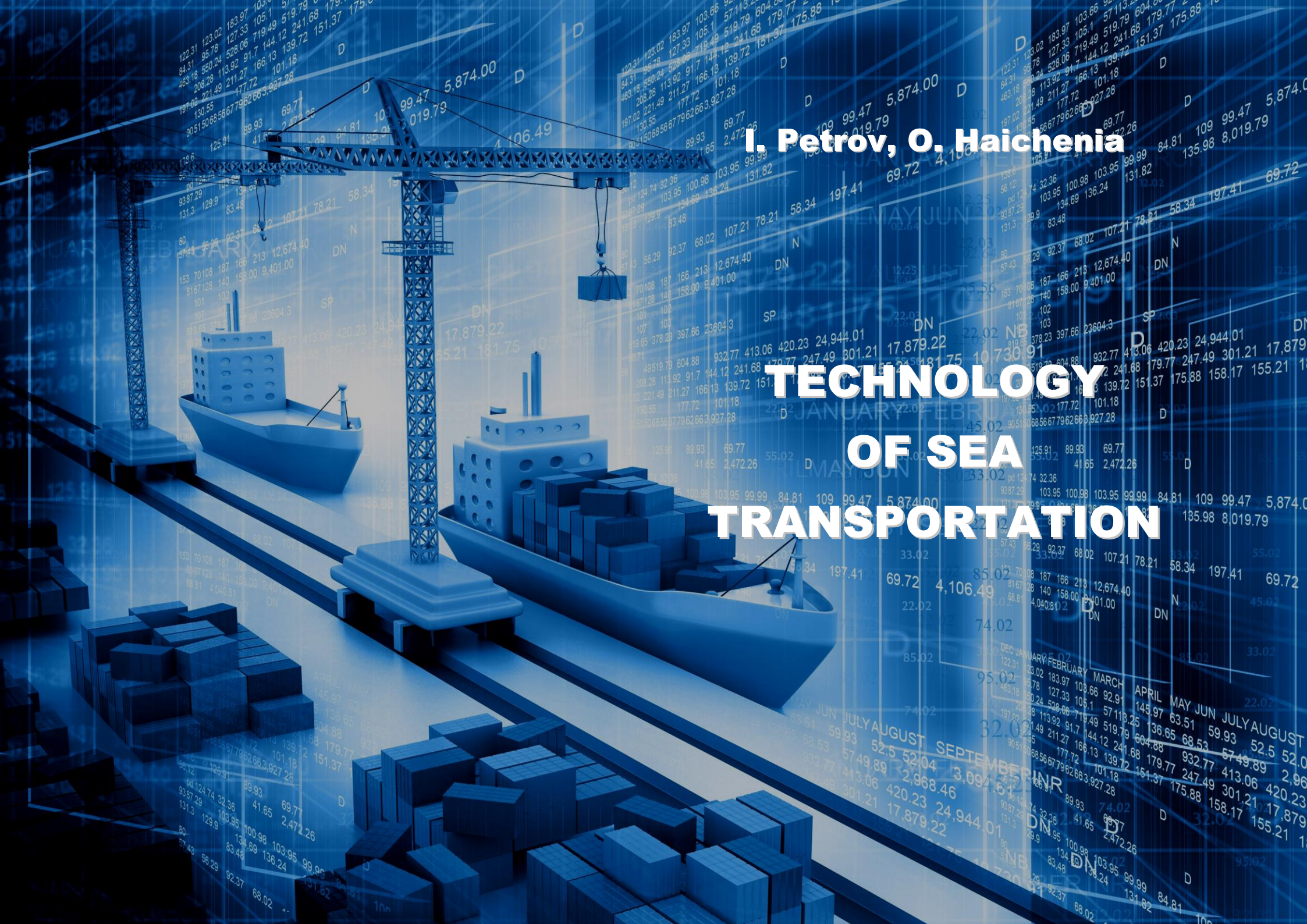

I. Petrov, O. Haichenia

# TECHNOLOGY OF SEA TRANSPORTATION

Міністерство освіти і науки України
НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ «ОДЕСЬКА МОРСЬКА АКАДЕМІЯ»

І. М. Петров, О. В. Гайченя

# Technology of Sea Transportation

Навчальний посібник

Одеса – 2022

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П30

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Наведено класифікація та транспортні характеристики вантажів, які перевозяться морським транспортом. Розглянуто механізм регулювання теплового та вологового обміну у вантажних приміщеннях судна. Викладено основи технологій перевезення вантажів на суднах різних типів, та вимоги щодо забезпечення безпеки життя людини при проведенні вантажних операцій на судні та під час рейсу.

Навчальний посібник розроблено відповідно до робочої програми навчальної дисципліни «Технологія перевезення вантажів», яка є обов'язковим компонентом освітньо-професійної програми підготовки бакалавра зі спеціальності 271 «Морський та внутрішній водний транспорт», спеціалізація 271.01 «Навігація і управління морськими суднами».

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**CONTENTS**

# INTRODUCTION

*The academic discipline ensures the implementation of the requirements of section A-II/1 (function: "Handling and stowage of cargo at the operational level") and section A-II/2 (function: "Handling and stowage of cargo at the management level") of the Seafarers' Training and Certification Code and watchkeeping, as amended and IMO Model Courses 7.01 and 7.03 (in accordance with STCW Convention & Model Courses IMO 7.01 and 7.03)*

Sea transportations play an important role for Ukraine with more than 1,500 km of coastline and its economy. However, the importance of sea transportations in the life of the world's population and particularly in Ukraine is not highly considered, and not taken into account. Here are some statistics:

– 90% of cargoes of world trade are carried by sea transport which it is impossible to replace;

– international transportations involve about 85,000 vessels and 160 countries have their own vessels;

– world merchant fleet employs more than 1 million 200 thousand seafarers who represent almost all existing nations on the Earth;

– sea transportations are the cheapest in the world. For the last 40 years their volume grew annually by 10% but the freight rate increased only by 7%;

– sea transport is one of the most environmentally clean and contributes only 12% of environmental pollution by transport.

All of these factors require development of new directions in order to provide high-quality and effective functioning of cargo transportation systems taking into account up-to-date requirements of cargo owners and charterers.

One of the directions is to help navigation cadets and in future officers and masters of transport vessels to acquire modern knowledge on cargo transportation technologies of different cargoes at a high level in order to further use in practice.

Thus, the aim of studying the disciple «Cargo Transportation Technologies» is teaching cadets the principles of safe and secure loading, cargo stowage in cargo spaces, its securing, transportation on vessels, unloading, ensuring the safety of human life and saving the environment.

## ADDITIONAL WORDS AND EXPRESSIONS FOR ORGANIZATION

Methodological Guidance (MG) – Методические указания

Practical Work (PW) – практическая работа

Laboratory Work – лабораторная работа

To recall the main provisions from the lecture. – Вспоминать главные положения лекции

No screen sharing required. – Нет необходимости демонстрации экрана

To highlight them in yellow. – Выделить (подсветить) их желтым

To stay in touch. – Оставаться на связи

Wish you success! – Желаю успеха!

In §1 understands... – В §1 разбирается…

In §1 provides… – В §1 приводится…

This is about… – Речь идет о…

Student's Record Book – зачетная книжка

Register Form / List – ведомость (деканата)

| | | |
|---|---|---|
| class mates | [klɑːs meɪts] | одногруппники |
| roll-call, call-over | [ˈrəʊlkɔːl, kɔːl-ˈəʊvə] | перекличка |
| continuation | [kənˌtɪnjʊˈeɪʃən] | продолжение |
| column | [ˈkɒləm] | колонка, столбец |
| formula | [ˈfɔːmjʊlə] | формула |
| ratio | [ˈreɪʃɪəʊ] | отношение, пропорция |
| numerator | [ˈnjuːməreɪtə] | числитель |
| denominator | [dɪˈnɒmɪneɪtə] | знаменатель |
| upper index | [ˈʌpər ˈɪndɛks] | верхний индекс |
| lower index | [ˈləʊər ˈɪndɛks] | нижний индекс |
| latter | [ˈlætə] | последний (из двух) |

# 1. CARGOES CLASSIFICATION AND TRANSPORT CHARACTERISTICS

## 1.1. Cargoes nomenclature and classification

Cargoes transport characteristics are a set of cargo properties which determines their transportation technology, loading and storage.

Goods become cargoes when they are taken for transportation.

Form of presenting goods for carriage has affected the fleet specialization.

**Cargo classification.**

According to transportation methods cargoes are divided into:

– packaged cargoes (general cargoes).

Among them *"long length"* (L≥ 9 m) and

*"heavy-weight"* (P ≥ 3 t*)* cargoes stand out.

– bulk cargoes. It is a big amount of commodities of different volume and weight, e.g. coals, ores;

– bulk flowing cargoes. Homogeneous particles, e.g. grain;

– liquid cargoes;

– enlarged cargo units (ECU) – a single item or a number of items, packed or arranged in a specified manner and capable of being handled as a unit. Unitization may be accomplished by placing the item or items in a container/ on a pallet or by banding them securely together.

**According to physical and chemical properties:**

– hygroscopic (sugar, salt);

– self-heating and self-flammable (coal, grain, cotton);

– explosives (powder, dynamite);

– poisonous;

– inflammable (petrol, kerosene);

– emitting hazardous gases (sulfur, oil);

– caking due to high temperatures (agglomerate):

– freezing (ores and ore concentrates);

– caking in storage cargoes (salt)

– dusting (apatite, cement);

– emitting specific smells, odourous (raw skins);

– perceiving foreign smells (fruits, tea);

– susceptible to natural weight loss;

**According to transportation conditions:**

– without specific transportation conditions;

– with specific transportation conditions.

**By compatibility:**

Cargoes are divided into 3 groups:

– with aggressive properties;

– susceptible to aggressive factors (perishable when under the influence of heat, humidity, dust, picking up smells;

– neutral towards other cargoes.

The possibility of compatibility is usually determined with the use of table in which:

– lines indicate cargoes with aggressive properties;

– columns indicate cargoes susceptible to aggressive factors impact.

Table cells contain numbers from 1 to 7 which mean:

1 – «Cannot be carried on one vessel»;

2 – «1 compartment from…» for example, emitting smells and picking them up;

3 – «In ajacent compartment from …»;

4 – «In one compartment but in different spaces»;

5 – «In one space providing separation by a cargo which is neutral to other two»;

6 – «In one space, but with separation»;

7 – «Joint stowage is allowed without restrictions».

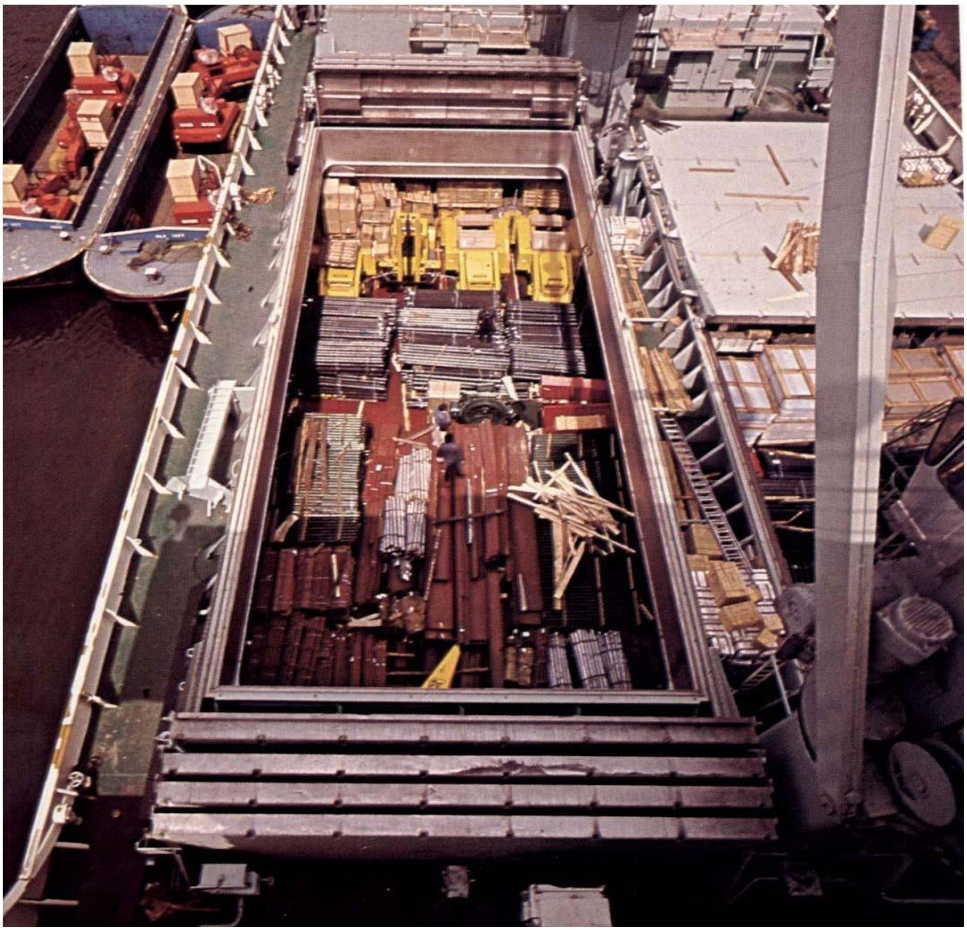


Fig 1. Joint stowage of cargoes in the hold

## 1.2. Linear, volumetric and mass characteristics of cargoes

Each cargo piece is described by linear dimensions: length *l*, width (breadth) *b*, height *h*, diameter *d*, mass *m*, volume *V*.

Payment for carriage of goods (freight) is fixed in mass units (*metric ton*) and volume units ($m^3$), in items (containers).

The International System of Units (SI) is in force in the most countries and in Ukraine. However, some countries use old national measure units. For example, for timber «standards», «axes», «lods», etc. are used.

Countries where old measurement system is used:

– in England it is «English long ton» (1016 kg);

– in the USA it is «American short ton» (907 kg).

1 pound (merchant) = 0,454 kg.

1 foot (ft) = 0,3048 m.

1 gallon imperial (gal imperial) = 4,546 l.

1 gallon (gal american) = 3,785 l.

1 barrel (bl) (for oil) = 159 l.

1 bushel (bu) (for grain) = 35,24 l.

In order to perform loading calculations it is necessary to know cargo weight with packing (gross weight) and without packing (net weight).

When carrying bulk cargoes its volume depends on the density, i e. on separate cargo small parts/ particles dimensions and form and empty spaces between them.

*Volumetric mass (density of small parts of cargo)* is defined as a body mass ($q$) to its volume ($V_0$) ratio.

$$d_0 = q/V_0 .$$

*Porosity* is defined as void spaces (pores and capillaries) to cargo particles volume ratio.

$$P = \frac{V_0 - V_m}{V_0} .$$

*Poroing* is defined as void spaces between separate cargo particles to total cargo volume ratio.

$$C = \frac{V - V_0}{V} .$$

*Flowing mass (density)* is a mass of bulk or flowing bulk cargo to its volume ratio.

$$d = Q/V ,$$

where $Q$ – cargo weight.

*Specific volume of the cargo piece ($m^3/t$)* is a volume of a unit of mass of cargo, i.e. cargo piece volumes sum to total gross weight of these cargo piece ratio.

$$U_м = \frac{\sum V_м}{\sum q}.$$

Volume which 1 ton of cargo takes up in vessel's hold is called *Specific Cargo Loading Volume, or Stowage Factor (SF)* and is indicated ( $\mu$ ), $m^3/t$:

$$\mu = \frac{W_s}{\sum Q},$$

where $W_s$ – ship's (hold's) cargo capacity, $m^3$;

$Q$ – cargo weight, t.

*Coefficient of hold stowage* is a hold's cargo capacity to total cargo pieces volume ratio.

$$K_h = \frac{W_h}{\sum V_M}.$$

If the coefficient of hold stowage is known, then it is possible to calculate the quantity of cargo pieces ($N$), which can be loaded in the hold

$$N = \frac{W_h}{U_M K_h}.$$

It is possible to calculate *SF* for given cargo and corresponding cargo space if the $U_M, K_h$ are known.

$$\mu = U_M \cdot K_h.$$

Thus, cargo weight which could be loaded into the hold with such capacity $W_h$ is calculated as:

$$Q = \frac{W_h}{\mu}.$$

## 1.3. Tare, packing and marking of cargoes

### 1.3.1. Tare

All cargoes that are transported are divided into 3 groups:

– transported in tare;

– transported without tare;

– transported without tare but with partial protection of separate units (e.g. tractor cabins are covered with plywood sheets).

Tare is classified as:

**By designation:**

– consumers' (bottles, scent-bottles, jars, boxes);

– additional (to protect against climate and aggressive exposure – bags, cases, cardboard boxes);

– transport (for cargoes preliminary packed in consumer or additional tare – boxes, barrels, bags).

**Depending on construction and ability to keep the original shape:**

– rigid (barrels, boxes, cans, tanks, bottles);

– semi-rigid (baskets, cardboard boxes, plastic);

– soft (fabrics, paper, film, polymer materials).

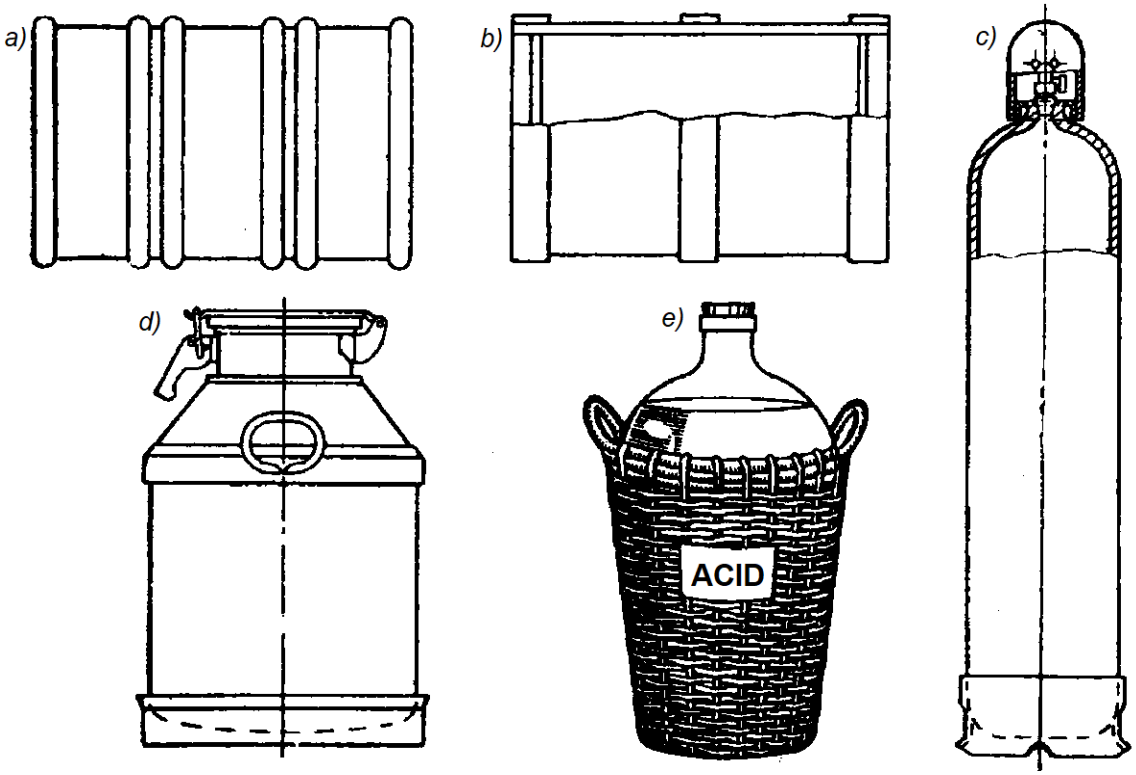



Fig. 2. Rigid and semi-rigid round tare:
a – metal barrel; b – plywood drum; c – can; d – glass bottle (carboy) for acids;
e – cylinder for liquefied gases

Cargo carried by sea could have such tare defects:

– tare swelling up;

– tare (squeezing);

– insufficient inner packing inside tare;

– incomplete tare closing.

It is important to know that following items are not considered as tare but only perform its functions:

– containers;

– pallets.

In international sea practice tare should withstand such loads:

– 1 t/m$^2$ – if cargo is carried in containers;

– 2 t/m$^2$ – if cargo is carried on general cargo vessels with the stacking height 8–9 m.

### 1.3.2. Packing

Packaging should protect from the impact of 3 factors:

– mechanic (pushes, strokes, friction, vibration, static loads);

– climate (presipitation, temperature, humidity, radiation);

– biological (activity of microbes, insects, rodents).

Gasket and wrapping materials are used for packing (paper, cardboard, wood shaving, wadding, plastic foam etc.)

### 1.3.3. Marking

Marking is application of signs, letters and pictures on cargo for its identification and indication of ways of transportation, handling and storage.

Marking can be:

– trade/ marketable (applied by the manufacturer);

– shipping. Contains: cargo piece number, consignment pieces' number, consignor and consignee names, departure and destination names;

– transport. It is applied in the port of departure and contains consignment ordinal number, consignment pieces' number;

– special.

**By content** marking include inscriptions:

– main (contract data; cargo piece number; consignment pieces number; destination name);

– additional (exporter and departure names);

– information (cargo piece dimensions, net and gross weight, volume of piece).

Manipulation signs show how to handle of cargo. For example:

«Handle with care, fragile»;

«Use no hooks»;

«Top. Do not turn over»;

«Protect from heat»;

«Sling here»;

«Keep dry»;

«Centre of gravity»;

«Open here»;

«Not to drop».


Fig. 3. Manipulation signs

Marking is applied with indelible paint on tare or tags while transportation by sea.

Tag sizes:

– of plywood ≥ 150 $cm^2$;

– of tin-plates ≥ 60 $cm^2$.

Dangerous cargoes and containers marking will be explained in corresponding chapters.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| nomenclature | [nəʊˈmɛnkləʧə] | номенклатура |
| packaged cargoes | [ˈpækɪʤd ˈkɑːgəʊz] | тарно-штучные грузы |
| bulk flowing cargoes | [bʌlk ˈfləʊɪŋ ˈkɑːgəʊz] | насыпные грузы |
| homogeneous | [ˌhəʊməˈʤiːniəs | однородный |
| particles | [ˈpɑːtɪklz] | частицы |
| enlarged cargo unit (ECU) | [ɪnˈlɑːʤd ˈkɑːgəʊ ˈjuːnɪt] | укрупненная грузовая единица |
| hygroscopic | [ˌhaɪgrəʊˈskəʊpɪk] | гигроскопический |
| self-heating | [sɛlf-ˈhiːtɪŋ] | самонагревающиеся |
| self-flammable | [sɛlf-ˈflæməbl] | самовозгорающиеся |
| explosives | [ɪksˈpləʊsɪvz] | взврывчатые |
| powder | [ˈpaʊdə] | порох |
| dynamite | [ˈdaɪnəmaɪt] | динамит |
| poisonous | [ˈpɔɪznəs] | ядовитые |
| inflammable | [ɪnˈflæməbl] | огнеопасные |
| to emit | [ɪˈmɪt] | выделять, испускать |
| caking, clinker | [ˈkeɪkɪŋ] | спекающиеся |
| agglomerate | [əˈglɒmərɪt] | агломерат |
| freezing | [ˈfriːzɪŋ] | смерзающиеся |
| ore concentrate | [ɔː ˈkɒnsəntreɪt] | рудный концентрат |
| caking in storage | [ˈkeɪkɪŋ ɪn ˈstɔːrɪʤ] | слеживающиеся |
| dusting | [ˈdʌstɪŋ] | пылящие |
| apatite | [ˈæpətaɪt] | аппатиты |
| cement | [sɪˈmɛnt] | цемент |
| odourous | [odourous] | груз с запахом |
| raw skins | [rɔː skɪnz] | сырые шкуры |
| to perceive, -ing | [pəˈsiːvɪŋ] | воспринимать, -ющий |
| foreign smells | [fɒrɪn smɛlz] | посторонние запахи |
| susceptible | [səˈsɛptəbl] | подверженный |
| natural weight loss | [ˈnæʧrəl weɪt lɒs] | естественная убыль |

| | | |
|---|---|---|
| transportation conditions | [ˌtrænspɔ: ˈteɪʃən kənˈdɪʃənz] | режим перевозки |
| compatibility | [kəmˌpætəˈbɪlɪti**]** | совместимость |
| neutral | [ˈnju:trəl] | нейтральный |
| impact | [ˈɪmpækt] | удар, попадание |
| linear | [ˈlɪnɪə] | линейный |
| volumetric and mass | [ˌvɒljʊˈmɛtrɪk ænd mæs] | объемно-массовый |
| to fix | [fɪks] | устанавливать (плату) |
| item | [ˈaɪtəm] | штука |
| pound | [paʊnd] | фунт (веса) |
| gallon | [ˈgælən] | галлон (3,785 л) |
| barrel | [ˈbærəl] | барель (159 л) |
| bushel | [ˈbʊʃl] | бушель (35,24 л) |
| packing | [ˈpækɪŋ] | упаковка |
| density | [ˈdɛnsɪti] | плотность |
| small parts | [smɔ:l pɑ:ts] | частица |
| ratio | [ˈreɪʃɪəʊ] | отношение, пропорция |
| porosity | [pɔ:ˈrɒsɪti] | пористость |
| void space | [vɔɪd ˈspeɪs] | свободное пространство |
| pore | [pɔ:] | пора |
| capillar | [kəˈpɪlər] | капилляр |
| poroing | [poroing] | скважистость |
| flowing mass (density) | [ˈfləʊɪŋ mæs **(**ˈdɛnsɪti**)]** | |
| flowing bulk cargo | [ˈfləʊɪŋ bʌlk ˈkɑ:gəʊ] | насыпной груз |
| specific volume | [spɪˈsɪfɪk ˈvɒljʊm] | удельный объем |
| to take up | [teɪk ʌp] | занимать место |
| Specific Cargo Loading Volume, Stowage Factor (SF) | [spɪˈsɪfɪk ˈkɑ:gəʊ ˈləʊdɪŋ ˈvɒljʊm**,** ˈstəʊɪʤ ˈfæktə] | удельный погрузочный объем (УПО) |
| cargo capacity | [ˈkɑ:gəʊ kəˈpæsɪti] | грузовместимость |
| coefficient of hold stowage | [ˌkəʊɪˈfɪʃənt ɒv həʊld ˈstəʊɪʤ] | коэффициент трюмной укладки |
| designation | [ˌdɛzɪgˈneɪʃən] | назначение (цель) |
| consumer, s’ | [kənˈsju:mə] | потребитель, -ская |
| scent-bottles | [sɛnt-ˈbɒtlz] | флакон духов |
| jar | [ʤɑ:] | банка, кувшин |
| case | [ˈkeɪs] | футляр, ящик, чехол |
| cardboard | [ˈkɑ:dbɔ:d] | картон |
| can | [kæn] | бидон |

| | | |
|---|---|---|
| fabric | [ˈfæbrɪk] | ткань |
| film | [fɪlm] | пленка |
| acid | [ˈæsɪd] | кислота |
| cylinder | [ˈsɪlɪndə] | баллон |
| to swell up | [ˈswɛlɪŋ ʌp] | вспучиваться |
| to squeeze, -ing | [ˈskwiːzɪŋ] | сдавливать, -ние |
| to withstand | [wɪðˈstænd] | противостоять |
| load | [ləʊd] | нагрузка, груз |
| push | [ˈpʊʃ] | толчок |
| stroke | [strəʊks] | удар |
| friction | [ˈfrɪkʃən] | трение |
| vibration | [vaɪˈbreɪʃən] | вибрация |
| microbe | [ˈmaɪkrəʊb] | микроб |
| rodent | [ˈrəʊdənt] | грызун |
| wood shaving | [wʊd ˈʃeɪvɪŋ] | деревянная стружка |
| wadding | [ˈwɒdɪŋ] | вата |
| plastic foam | [ˈplæstɪk fəʊm] | пенопласт |
| marketable marking | [ˈmɑːkɪtəbl] | товарная маркировка |
| shipping marking | [ˈʃɪpɪŋ] | отправительская -«»- |
| cargo piece | [ˈkɑːgəʊ piːs] | грузовое место |
| consignment | [kənˈsaɪnmənt] | партия груза |
| consignor, грузоотпр-ль | [kənˈsaɪnə] | грузоотправитель |
| consignee | [ˌkɒnsaɪˈniː] | грузополучатель |
| ordinal No | [ˈɔːdɪnl] | порядковый № |
| inscription | [ɪnˈskrɪpʃən] | надпись |
| destination | [ˌdɛstɪˈneɪʃən] | назначение |
| departure | [dɪˈpɑːʧə] | отправление |
| dimension | [dɪˈmɛnʃən] | измерение |
| manipulation sign | [məˌnɪpjʊˈleɪʃən saɪn] | манипуляционный знак |
| fragile | [ˈfrædʒaɪl] | хрупкий |
| hook | [hʊk] | крюк |
| to sling | [slɪŋ] | стропить, строп |
| centre of gravity | [ˈsɛntər ɒv ˈgrævɪti] | центр тяжести |
| indelible | [ɪnˈdɛlɪbl] | несмываемый |
| tin, tin-plate | [ˈtɪn] | олово, консерв. Банка |
| | [ˈtinpleit] | жестяная пластинка |

# 2. ENSURING CARGO SAFETY

## 2.1. Reasons of damage to cargoes

Divided into 6 groups:

1. Damage caused by the fault of the shipper or the port of departure even before the start of transportation. They can be identified by the vessel's administration during loading.

2. Damage revealed during cargo operations. Can be caused by dockers who violate the cargo handling technology. This can be inefficient work of cranemen, the use of hooks, crowbars, levers in the work, dragging cargo pieces, falling of cargo, the wrong choice of cargo handling devices, improper slinging of cargo, lack of separation.

3. Damage due to improper disposition and improper stowage. This is:

– wetness (from joint due to stowage with cargoes that release moisture);

– damage due to the picking up foreign smells;

– crushing during transportation due to exceeding the permissible stacking height;

– friction of cargo pieces against the elements of the hull framing due to vibration;

– shifting of insufficiently secured cargo.

4. Damage resulting from the carrier's violation of the obligation to provide the vessel in a seaworthy condition. This can be wetness due to water leak, damage from rodents (rats, mice), insects, molds and bacteria.

5. Damage occurring during the passage by sea as a result of omissions by the vessel's administration, for example:

– wetness due to untimely pumping out of water from bilges;

– improper use of the ventilation system.

6. Damage resulting from the revealing of hidden properties of the cargo, not known to the carrier. This also includes the reasons when the cargoes come into contact with the environment, the lack of the Certificates for the goods.

## 2.2. Reasons for the shortage of cargoes

Shortage of cargoes is a decrease in the amount of cargo during transportation.

There are 2 known forms of cargo shortage:

– weight reduction;

– shortage of whole cargo pieces.

The reasons for the shortages are:

– miscalculations in the tally account;

– underload at the port of departure;
– fall of cargo pieces;
– theft in the port and on the vessel;
– loss in a storm;
– combustion of cargoes in case of fire;
– throwing cargo overboard in order to save the vessel (jettison).

Crushed tare can be the reason for the shortage of quantity of cargo pieces.

The reason for the shortage of cargo weight may be:

– crushing;
– theft;
– natural loss of goods. This is a decrease in the weight of the cargo during the period of transportation or storage, arising from the physical characteristics of the cargo or biochemical processes occurring in it. For example, for perishable goods and grain, due to the course of biochemical processes, losses can be 10-15%. Natural loss of goods also includes:
– spraying;
– leakage;
– scattering, for example, grain, seeds in tare.

Natural loss rates are established on the basis of statistical accounts.

A decrease or increase in the weight of the cargo affects the seaworthiness of the vessel (list, trim, stability).

For each case of unsafe transportation of cargo, the Captain conducts a departmental investigation.

### 2.3. Registration of cases of unsafe transportation of goods

In coastal navigation, the shortage is recorded in Taking-Delivery Sheet in its columns:

"Listed according to documents" – "revealed during unloading".

In foreign navigation:

– when unloading imports in home ports, Delivery Reports are drawn up (for each B/L and are listed in the General Form Statement;
– when unloading exports in foreign ports:
– if the consignee accepts the cargo, he signs B/L and can make a corresponding remark;
– if the cargo is accepted by the port, an Outturn Report (with a remark) is drawn up, or Damage Outturn Report.

In home ports, upon revealing of commercial defect, the following statements are drawn up:

– "General Form Statement" – when the nature of unsafe transportation requires a detailed description;

– "Carrier's (Commercial) Statement" – when the cargo is delivered from the vessel directly to the consignee or transferred to another mode of transport.

## 2.4. Legislative base for ensuring safe and secure transportation

There are 2 levels:

– international. These are:

– International Conventions;

– UN Resolutions;

– IMO Codes.

– national. These are Tariff Guidelines, Laws of Ukraine, By-laws, Orders of the Ministry of Infrastructure of Ukraine.

**International level:**

– International Convention on Load Lines, 1966;

– International Convention on the Safety of Containers (CSC, 1972) as amended by 1981 and 1983;

– International Convention for Prevention of Pollution from Ships, 1973/78 (MARPOL 73-78);

– International Convention on the Training and Certification of Seafarers, 1978 (STCW-78) as amended by the 1995 Conference and the 2010 Manila Amendments;

– International Convention for the Safety of Life at Sea, 1974 (Consolidated Text of the SOLAS 74 Convention, 1993), as amended.

**By type of cargoes:**

For general cargoes:

– Code of Safe Practice for Cargo Stowage and Securing 1994;

– Code of Safe Practice for Ships Carrying Timber Deck Cargoes 1991.

For dangerous goods:

– International Maritime Dangerous Goods (IMDG) Code 1990;

– The Code for the Safe Transportation of Nuclear Fuel Waste, Plutonium and Highly Radioactive Waste in Containers on Board (SNF Code);

– UN Recommendations on the Transport of Dangerous Goods, Model Regulations;

For food cargoes:

– International Code for the Safe Carriage of Grain in Bulk (International Grain Code) 1994;

– European Agreement on the International Carriage of Perishable Foodstuffs and on the Special Transport Facilities to be Used for Such Carriage (ATP);

For liquid cargoes:

– International Safety Guide for Oil Tankers and Terminals (ISGOTT);

– International Code for the Construction and Equipment of Ships Carrying Chemical Cargo in Bulk (IBC Code);

– International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).

For bulk cargoes:

– International Code of Safe Practice for the Transport of Solid Bulk Cargoes, 1994 (IC BC);

– International Code of Safe Practice for Loading and Unloading Bulk Carriers (BLU Code);

– International Code for the Safe Carriage of Grain in Bulk (Grain Code).

**National level:**

– "General and Special Rules for the Carriage of Cargoes", Vol. 1, 2;

– "Rules for the Carriage of Dangerous Goods by Sea";

– "Rules for the Carriage of Food Cargoes by Sea";

– "General and Special Rules for the Carriage of Liquid Cargoes";

– "Rules for the Safe Carriage of Non-Grain Bulk Cargoes by Sea".

## 2.5. Preparing the vessel for receiving cargoes

Conducted in accordance with the requirements of the “Code of Safe Practice for Cargo Stowage and Securing”.

Each category of cargo has its own requirements for the preparation of holds, but there are general requirements.

Cleaning of holds – carried out by the crew or stevedore gangs at the request of the vessel after the completion of discharging.

The holds are washed with salty seawater, after the holds should be poured over with fresh water. Bilges and collecting wells are inspected and cleaned of water residues. When preparing to receive bulk cargoes, they must be closed with dustproof covering. The measuring tubes are checked during bilge cleaning.

Installation of fencing devices (batten, wooden flooring and shields) is carried out in order to exclude contact of cargo with the vessel's hull and framing.

The draining system of the vessel is checked before each loading of the vessel, and in tween-decks the drainage scuppers going down to the drainage wells are checked.

Electrical cables and plug boxes must be checked by an electrician.

Ladders should be carefully inspected and missing brackets should be welded on. Necks and hatch-ports leading to the hold should be inspected closed in preparation for a vessel to sail.

Fire-fighting equipment should be carefully checked so that the internal pipes of the steam and carbon dioxide extinguishing system and smoke detectors are not plugged or broken.

The ventilation system is checked when the hold is empty, and the temperature and humidity control sensors in the hold air are also inspected.

Hatch covers are tested for watertightness. The preparation of the vessel for the carriage of general cargoes also includes the selection of cushioning, separation and fastening materials – wire ropes, shackles and lanyards.

Preparation of refrigerated holds includes, in addition to cleaning, washing and drying, work on removing the snow coat from the cooling coil-pipes. Before loading, the holds are cooled to a temperature of ≥ 48 hours, 1-2 ° below the temperature of cargo transportation. When preparing the holds of a ship, it may be necessary to perform the following works: disinfection; disinsection; deratization; fumigation; degassing; deodorization.

The readiness of cargo spaces for taking in cargo is checked by the vessel's commission. After the completion of the preparation of the vessel for cargo operations, the Captain submits to the port or the shipper a "*Notice of Readiness*", in which he formally states the actual readiness of the vessel for loading.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| shipper | [ˈʃɪpə] | грузоотправитель |
| to reveal | [rɪˈviːl] | обнаруживать, открывать |
| to violate | [ˈvaɪəleɪt] | нарушать (закон, технологии) |
| craneman | [creinman] | крановщик |
| hook | [hʊk] | крюк |
| crowbar | [ˈkrəʊbɑː] | лом |
| lever | [ˈliːvə] | рычаг |
| to drag | [dræg] | тащить, волочить |
| cargo piece | [ˈkɑːgəʊ piːs] | грузовое место |
| cargo handling devices | [ˈkɑːgəʊ ˈhændlɪŋ dɪˈvaɪsɪz] | грузозахват |
| sling, -ing | [ˈslɪŋɪŋ] | строп, строповка |
| lack | [læk] | недостаток, отсутствие |
| disposition of cargo | [ˌdɪspəˈzɪʃən] | размещение груза |

| | | |
|---|---|---|
| stowage | [ˈstəʊɪʤ] | укладка |
| wetness | [ˈwɛtnəs] | подмочка |
| to release moisture | [rɪˈliːs ˈmɔɪsʧə] | выделять влагу |
| perception of foreign smells | [pəˈsɛpʃən ɒv ˈfɒrɪn smɛlz] | восприимание посторонних запахов |
| to crush, -ing | [ˈkrʌʃɪŋ] | раздавливать, -ние |
| to exceed | [ɪkˈsiːd] | превышать |
| hull framing | [hʌl ˈfreɪmɪŋ] | набор корпуса |
| shifting | [ˈʃɪftɪŋ] | сдвиг |
| water leak | [ˈwɔːtə liːk] | водотечность |
| rodent | [ˈrəʊdənt] | грызун |
| rat | [ræt] | крыса |
| mice | [maɪs] | мышь |
| insect | [ˈɪnsɛkt] | насекомое |
| mold | [məʊld] | плесень |
| bacteria | [bækˈtɪərɪə] | бактерия |
| omission | [əˈmɪʃən] | упущение |
| untimely | [ʌnˈtaɪmli] | несвоевременный |
| to hide | [ˈhaid] | прятать, скрывать |
| to come into contact | [kʌm ˈɪntuː ˈkɒntækt] | вступить в контакт |
| shortage | [ˈʃɔːtɪʤ] | недостача |
| miscalculation | [ˌmɪsˌkælkjʊˈleɪʃən] | просчет |
| underload | [ˌʌndəˈləʊd] | недогруз |
| theft | [θɛft] | кража |
| death | [dɛθt] | гибель |
| combustion | [kəmˈbʌsʧən] | сгорание |
| throwing cargo overboard (jettison) | [ˈθrəʊɪŋ ˈkɑːgəʊ ˈəʊvəbɔːd (ˈʤɛtɪsn)] | выбрасывание груза за борт (джеттисон) |
| natural loss | [ˈnæʧrəl lɒs] | естественная убыль |
| to arise | [əˈraɪz] | возникать, происходить |
| perishable goods | [ˈpɛrɪʃəbl] | скоропортящиеся грузы |
| spraying | [ˈspreɪɪŋ] | распыление |
| leakage | [ˈliːkɪʤ] | утечка |
| scattering | [ˈskætərɪŋ] | раструска |
| statistical accounts | [stəˈtɪstɪkəl əˈkaʊnts] | статистическая отчетность |
| list | [lɪst] | крен |
| trim | [trɪm] | дифферент |

| | | |
|---|---|---|
| stability | [stəˈbılıti] | остойчивость |
| departmental | [ˌdiːpɑːtˈmɛntl] | ведомственный |
| coastal navigation | [ˈkəʊstəl ˌnævɪˈgeɪʃən] | каботажное плавание |
| foreign navigation | [ˈfɒrɪn ˌnævɪˈgeɪʃən] | заграничное плавание |
| Taking-Delivery Sheet | [ˈteɪkɪŋ-dɪˈlɪvəri ʃiːt] | Приемо-сдаточная ведомость |
| home port | [həʊm pɔːt] | отечественный порт |
| foreign port | [ˈfɒrɪn pɔːt] | заграничный порт |
| Delivery Report | [dɪˈlɪvəri rɪˈpɔːt] | Акт-извещение |
| remark | [ˈrɪˈmɑːk] | оговорка (при подписании) |
| Damage Outtorn Report | [ˈdæmɪʤ əʊtən rɪˈpɔːt] | Приемный акт (в з/плавании) |
| commercial reject | [kəˈmɜːʃəl ˈriːʤɛkt] | коммерческий брак |
| General Form Act | [ˈʤɛnərəl fɔːm ækt] | Акт общей формы |
| Carrier’s (Commercial) Statement | [ˈkærɪəz (kəˈmɜːʃəl) ˈsteɪtmənt] | Коммеческий акт |
| to leave cargo | [liːv ˈkɑːgəʊ] | сдать груз |
| mode of transport | [məʊd ɒv ˈtrænspɔːt] | вид транспорта |
| Tariff Guidelines | [ˈtærɪf ˈgaɪdlaɪnz] | Тарифное руководство |
| by-law | [ˈbaɪlɔː] | подзаконный акт |
| stevedore gang | [ˈstiːvɪdɔː gæŋ] | бригада грузчиков |
| completion | [kəmˈpliːʃən] | завершение |
| to pour over | [pɔːr ˈəʊvə] | окатить |
| residue | [ˈrɛzɪdjuː] | остаток, осадок |
| dustproof | [ˈdʌstpruːf] | пыленепроницаемый |
| covering | [ˈkʌvərɪŋ] | покрытие |
| measuring tube | [ˈmɛʒərɪŋ tjuːb] | мерительная трубка |
| fencing device | [ˈfɛnsɪŋ dɪˈvaɪs] | ограждающее устройство |
| batten | [ˈbætn] | рыбинс |
| flooring | [ˈflɔːrɪŋ] | настил |
| draining system | [ˈdreɪnɪŋ ˈsɪstɪm] | осушительная система |
| drainage scupper | [ˈdreɪnɪʤ ˈskʌpə] | сточный шпигат |
| drainage well | [ˈdreɪnɪʤ wɛl] | сточный колодец |
| electrical cable | [ɪˈlɛktrɪkəl ˈkeɪbl] | электрический кабель |
| plug box | [plʌg bɒks] | штепсельная коробка |
| bracket | [ˈbrækɪt] | скоба (трапа) |
| neck | [nɛk] | горловина |

| | | |
|---|---|---|
| hatch-port | [hæʧ-pɔːt] | лацпорт |
| to plug | [plʌg] | закупоривать |
| sensor | [ˈsɛnsə] | датчик |
| watertightness | [ˈwɔːtətaɪtnəs] | водонепроницаемость |
| wire rope | [ˈwaɪə rəʊp] | трос, стальной конец |
| shackle | [ˈʃækl] | скоба |
| lanyard | [ˈlænjəd] | талреп |
| coil-pipe | [kɔɪl-paɪp] | змеевик |
| disinfection | [ˌdɪsɪnˈfɛkʃən] | дезинфекция |
| disinsection | [ˌdisinˈsɛkʃən] | дезинсекция |
| deratization | [ˌderatiˈzeiʃən] | дератизация |
| fumigation | [ˌfjuːmɪˈgeɪʃən] | фумигация |
| degassing | [dɪˈgæsɪŋ] | дегазация |
| deodorization | [ˌdeodoriˈzeiʃən] | деодорация |
| to submit | [səbˈmɪt] | представлять (на рассмотрение) |

# 3. REGULATION OF HEAT AND MOISTURE EXCHANGE OF CARGOES WITH THE ENVIRONMENT

## 3.1. Fluctuations in temperature and humidity of the environment during cargoes transportation by sea

*The environment* – is atmospheric air and seawater that surrounds the ship's hull.

*Atmospheric air* is a mixture of various gases and water vapor.

In the conditions of sea transportation of cargoes, it is customary to distinguish the following three types of temperature fluctuations in the outside air:

Episodic fluctuations in temperature.

They are associated with local navigation conditions, changes of weather and can fluctuate within a few degrees per hour. Occasional fluctuations in temperature often exceed the values of the average daily fluctuations.

Daily fluctuations in temperature.

Vary widely depending on the properties of materials, color of objects, surface shape, solar radiation. The lowest air temperature is observed before sunrise, the highest (above the sea surface) – around noon. In the ports of the equatorial zone, the maximum daily fluctuations in air temperature are about 20°C, in the ports of the tropical zone – about 12°C. In temperate latitudes, temperature fluctuations are about 7°C, and in the ports of the polar zone, they are even less. The amplitude of daily fluctuations in water far from the coast is usually no more than 1°C.

General voyage temperature fluctuations.

Can reach 30–50°C when the vessel makes a passage between both hemispheres.

## 3.2. Air properties and determination of its parameters

Atmospheric air is a mixture of various gases and water vapor.

The air temperature $t°$ can be measured:

– on the thermodynamic (absolute) scale in degrees Kelvin, denoted by K, temperature – T;

– international (centigrade) scale in degrees Celsius, denoted by the symbol °C, and the temperature by the letter $t$.

1°C = 274.15 K.

*Air density* at $t$ = 0°C and pressure $h$ = 760 mm. mercury column equals 1.293 kg/m$^3$, and the density of water vapor = 0.768 kg/m$^3$. From this it follows that humid air is lighter than dry air.

*Absolute humidity* is the mass of water vapor in 1 m$^3$ of the mixture:

$$\text{Absolute humidity} = \frac{\text{mass of water vapor}}{\text{mass of } 1\text{m}^3 \text{ of the mixture}}.$$

Air is considered saturated when it contains the maximum amount of moisture that can be absorbed at a given $t°$.

When the temperature of saturated air decreases, $t°_{\text{sat.air}} \downarrow$, condensation of water vapor contained in it occurs.

When the temperature of saturated air rises $t°_{\text{sat.air}} \uparrow$, such air ceases to be saturated and acquires the ability to retain more water vapor.

*Relative air humidity* $\varphi$ is the ratio of the actual mass of water vapor to the maximum mass of water vapor that the air would contain at full saturation, i.e.:

$$\varphi = \frac{\text{actual mass of steam}}{\text{mass of water vapor at full air saturation}}.$$

*The dew point temperature* ($\tau°$) is the critical (maximum) air temperature $t_{\text{crit}}$, at which the moisture begins to fall out in the form of condensation. In other words, if the air is cooled to this temperature, it will become saturated.

### 3.3. Regulation of temperature and humidity in the holds

If the dew point temperature of the outside (ventilation) air is higher than the temperature of the cargo and the hull of the vessel, $\tau° \geq t_{\text{cargo and hull}}$, condensation of water vapor occurs.

Otherwise, that is, at $\tau° \leq t_{\text{cargo and hull}}$, condensation does not occur.

Whether ventilation is appropriate or not is decided on a case-by-case basis by comparing the dew point temperatures of the outside and hold air.

If the dew point of the outside air is less than the dew point of the hold air

$$\tau°_{\text{outside air}} \leq \tau°_{\text{hold air}},$$

cargo safety is ensured by forced ventilation. In this case, natural ventilation is not very effective.

If the dew point of the outside air is greater than the dew point of the hold air

$$\tau°_{\text{outside air}} \geq \tau°_{\text{hold air}},$$

such air must not be introduced into the hold and the interruption of ventilation can lead to the fact that inside the hold the dew point will rise to the outside air level, so it will not be possible to control it.

Full dew point control is only possible when the hold can be supplied with low dew point air, which is provided by the air conditioning unit (air dryer).

### 3.4. Determination of the dew point in various ways

All methods of determining the dew point temperature are based on the knowledge of the actual air temperature $t_{air}$ and its relative humidity φ, as well as for further conclusions on ventilation – sea water temperature $t_{sw}$.

Consider two production situations:

– the voyage is real and measurements are made on board the vessel;

– the constructions are made for training purposes on shore.

In the first case, temperature and relative humidity measurements are required on board.

In the second case, all necessary values are taken from the Pilot Book of navigation areas and reference materials.

Determination of the relative humidity of the outside air.

A device called a psychrometer is used to determine φ. As shown in fig. 1, the psychrometer consists of two thermometers. One of the thermometers, ordinary, called dry, measures the temperature $t$ of the air. Another thermometer is placed with its balloon in a glass of distilled water, covered with a light cloth – gauze or calico, cambric. The water on the fabric constantly wets the bulb of the thermometer. This thermometer is called humid or wet and measures the air temperature with a wet thermometer $t_w \leq t$. Due to the heat consumption for evaporation, the temperature of the wet and dry bulb will be different.

After taking readings, to determine φ are consult the tab. 1.

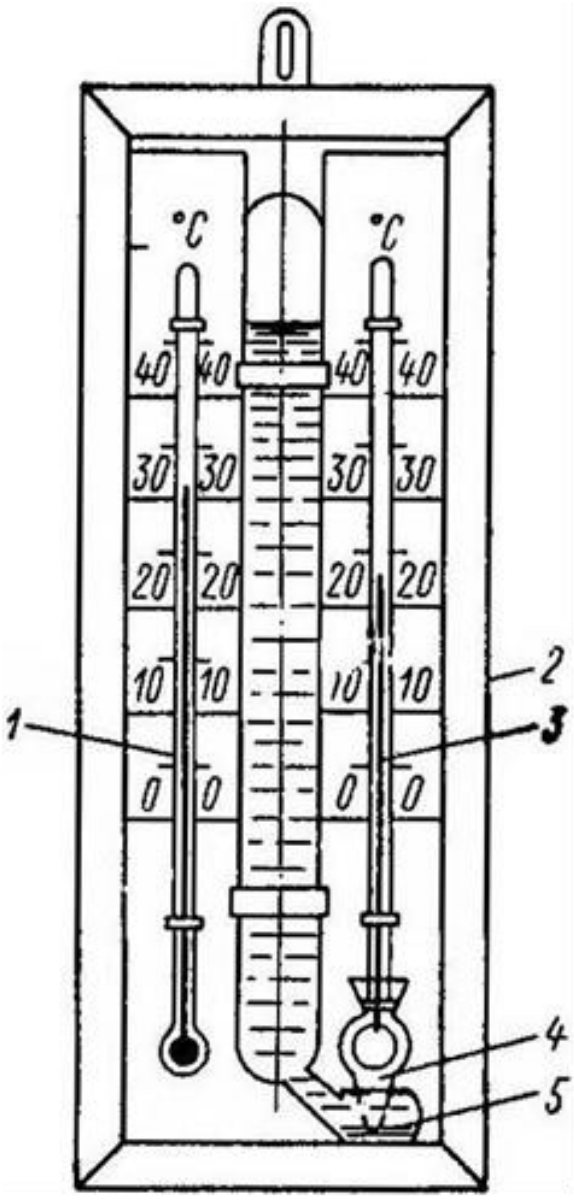



Fig.1. Psychrometer of August: 1 – dry thermometer; 2 – wood panel; 3 – wet thermometer; 4 – cover (fabric); 5 – a vessel with water

Table 1

| Readings of dry thermometer, °C | Difference between readings of dry and wet thermometers, °C | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Relative humidity, % | | | | | | | | | | |
| 12 | 100 | 89 | 78 | 68 | 57 | 48 | 38 | 29 | 20 | 11 | – |
| 13 | 100 | 89 | 79 | 69 | 59 | 49 | 40 | 31 | 23 | 14 | 6 |
| 14 | 100 | 89 | 79 | 70 | 60 | 51 | 42 | 34 | 25 | 17 | 9 |
| 15 | 100 | 90 | 80 | 71 | 61 | 52 | 44 | 36 | 27 | 20 | 12 |
| 16 | 100 | 90 | 81 | 71 | 62 | 54 | 46 | 37 | 30 | 22 | 15 |
| 17 | 100 | 90 | 81 | 72 | 64 | 55 | 47 | 39 | 32 | 24 | 17 |
| 18 | 100 | 91 | 82 | 73 | 65 | 56 | 49 | 41 | 34 | 27 | 20 |
| 19 | 100 | 91 | 82 | 74 | 65 | 58 | 50 | 43 | 35 | 29 | 22 |
| 20 | 100 | 91 | 83 | 74 | 66 | 59 | 51 | 44 | 37 | 30 | 24 |
| 21 | 100 | 91 | 83 | 75 | 67 | 60 | 52 | 46 | 39 | 32 | 26 |
| 22 | 100 | 92 | 83 | 76 | 68 | 61 | 54 | 47 | 40 | 34 | 28 |
| 23 | 100 | 92 | 84 | 76 | 69 | 61 | 55 | 48 | 42 | 36 | 30 |
| 24 | 100 | 92 | 84 | 77 | 69 | 62 | 56 | 49 | 43 | 37 | 31 |
| 25 | 100 | 92 | 84 | 77 | 70 | 63 | 57 | 50 | 44 | 38 | 33 |

Methods of determining the dew point

**1. Analytical**

The following formula is used:

$$\lg(\varphi/100) = 7.5\left(\frac{\tau}{238+\tau} - \frac{t}{238+t}\right).$$

Converting it to the form

$$\frac{\tau}{238+\tau} = \frac{\lg(\varphi/100)}{7.5} + \frac{t}{238+t},$$

and denoting the right-hand side α, we obtain the working formula

$$\tau = \frac{238\alpha}{1-\alpha}.$$

**2. According to the nomogram of humid air**

A nomogram of humid air has been developed and used (Fig. 2), where three air parameters are related: temperature, dew point, relative humidity.

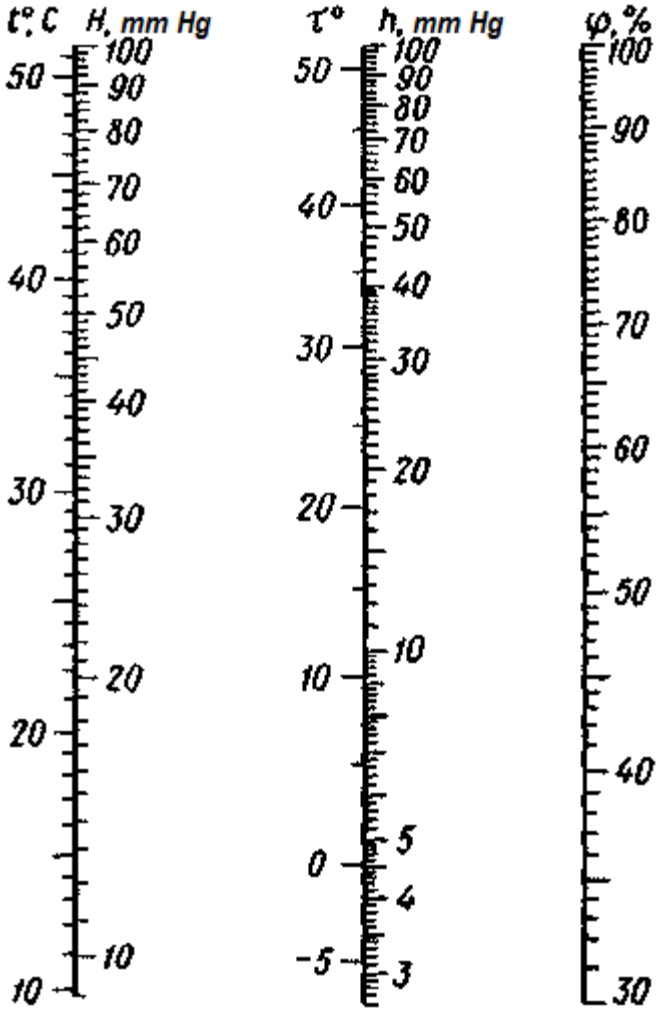
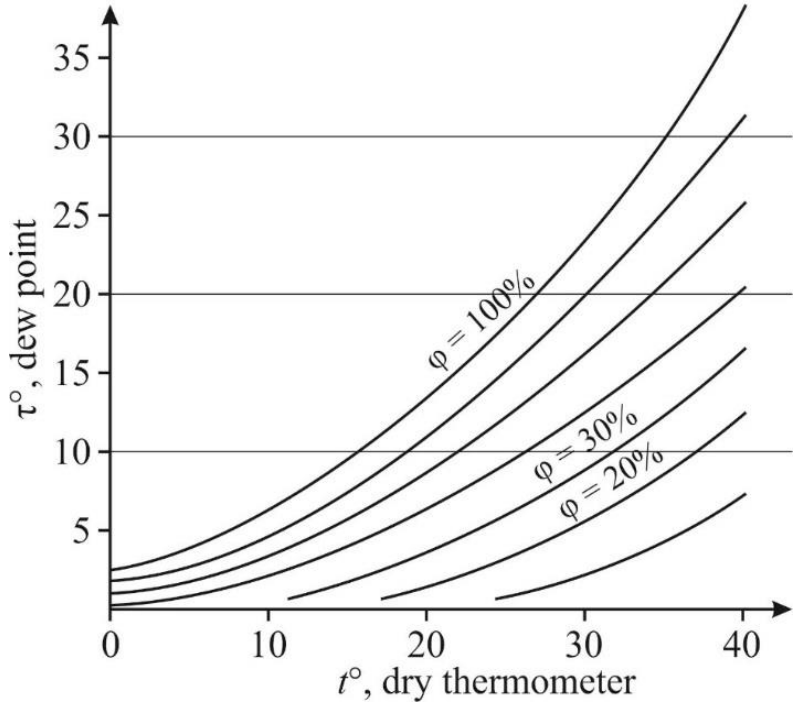



Fig. 2. Humid air nomogram

3. According to psychrometric diagrams



**4. Tabular method**

For a quick calculation of the dew point, use the table of its calculation.

Table 2 – Dew point determination

| Air temperature, °C | Relative air humidity, % | | | | | | |
|---|---|---|---|---|---|---|---|
| | 30% | 35% | 40% | 45% | 50% | 55% | 60% |
| +18 | 0.2 | 2.3 | 4.2 | 5.9 | 7.4 | 8.8 | 10.1 |
| +19 | 1.0 | 3.2 | 5.1 | 6.8 | 8.3 | 9.8 | 11.1 |
| +20 | 1.9 | 4.1 | 6.0 | 7.7 | 9.3 | 10.7 | 12.0 |
| +21 | 2.8 | 5.0 | 6.9 | 8.6 | 10.2 | 11.6 | 12.9 |
| +22 | 3.6 | 5.9 | 7.8 | 9.5 | 11.1 | 12.5 | 13.9 |
| +23 | 4.5 | 6.7 | 8.7 | 10.4 | 12.0 | 13.5 | 14.8 |
| +24 | 5.4 | 7.6 | 9.6 | 11.3 | 12.9 | 14.4 | 15.8 |
| +25 | 6.2 | 8.5 | 10.5 | 12.2 | 13.9 | 15.3 | 16.7 |

So, for example, at an air temperature of 20°C and a relative humidity of 40%, condensation will occur on surfaces with temperature of 6°C and below.

In technical calculations, there is a concept of "*standard atmosphere*", which is usually understood as atmospheric pressure equal to 760 mm at an air temperature of +20°C and its relative humidity of 70%.

For solving the problems of air conditioning and cargo in the holds of ships, as well as to maintain the equilibrium moisture content of goods, the concept of "temperature reserve" is used. *The temperature margin* (θ) is the difference between the air temperature and the dew point, it is taken equal to 3ºC.

## 3.5. Methods of ventilation of cargo spaces of ships when sailing in different climatic zones

There are guidelines for determining the need for ventilation of cargo spaces depending on the temperature and humidity state of the system *"external environment – hold air – cargo"*.

In accordance with the recommendations developed by L. P. Andronov, the need and expediency of ventilation of cargo spaces during the passage can be determined from the graph of the change in temperature of air, water and dew point for the passage (Fig. 3, 4).

If they make a passage from a cold zone to a warm one (fig. 3), then compare the temperature of the cargo with the dew point of the outside air. To do this, a horizontal line is drawn from the point of air temperature in the port of departure (it is the temperature of the cargo) until it intersects the curve of dew point of the outside air. By lowering the perpendicular from the point of intersection to the distance scale,

a point on the route is obtained, where the border of the possibility and expediency of ventilation of the holds with outside air passes.

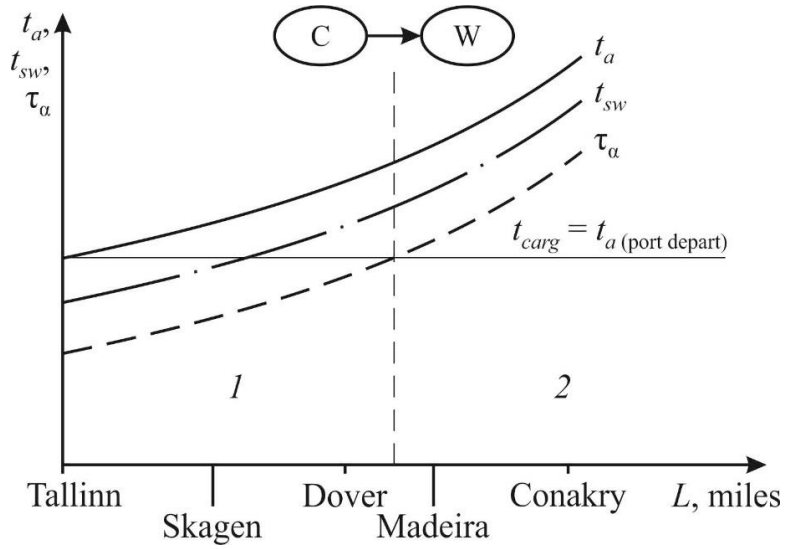



Fig. 3. Graph of changes of temperature of air, sea water and dew point for the passage from a cold zone to a warm one

On route I, where $\tau_a \leq t_{carg}$ , ventilation of the holds is possible. On route II, where $\tau_a \geq t_{carg}$ , ventilation with outside air will cause the cargo to become damp.

If the passage is made from a warm zone to a cold one (Fig. 4), the dew point of the hold air is compared with the temperature of the outside environment (it is also the temperature of the hold fence), for which a horizontal line is drawn from the dew point of the air in the port of departure to intersection with the temperature of the external environment (air and water).

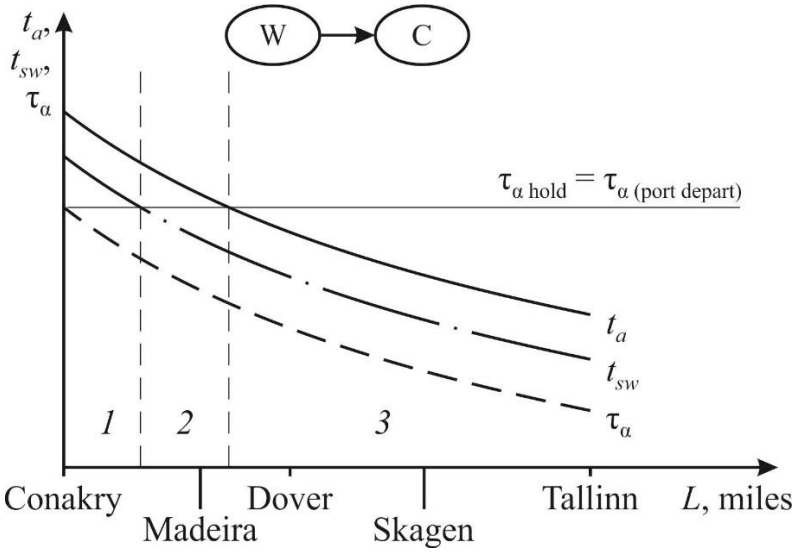



Fig. 4. The graph of changes in the temperature of air, sea water and dew point for the transition from a warm zone to a cold one

The intersection of the horizontal line with the line, indicating the water temperature will show the moment when moisture condensation begins on internal surfaces of the hold guard. The intersection with the line indicating the temperature of the air will show the moment when moisture condensation begins on the twin decks. Before the ship arrives at this point, the holds may not be ventilated; at the further passage, ventilation of the holds becomes compulsory.

On route *I*, where $\tau_{\alpha} \leq \tau_{\alpha\ hold}$, ventilation is possible. Ventilation is required on route *II*, lack of ventilation will lead to moisture condensation in the holds; on section *III* is also compulsory – lack of ventilation will lead to condensation of moisture on tweendecks.

The ventilation mode of the holds can be prescribed in the addendum to the Charter for the transportation of a specific cargo.

## 3.6. Technical means of natural and forced ventilation. Control over the moisture content of cargo spaces

According to the degree of equipment with technical means of holds ventilation, sea going vessels are divided into three groups:

– having a naturally-forced ventilation system;

– equipped with a mechanical ventilation system;

– equipped with an air conditioning system in cargo spaces.

On the vessels with a naturally-forced ventilation (*general type of ventilation system)*, air is supplied to holds and tweendecks through a system of deflectors and air ducts. In this case, the air ducts are made in the form of a system of telescopic pipes, and the deflectors are made in the form of a windscoop, an exhaust ejection head, a ball non-refillable head and various other constructions (Fig. 5).

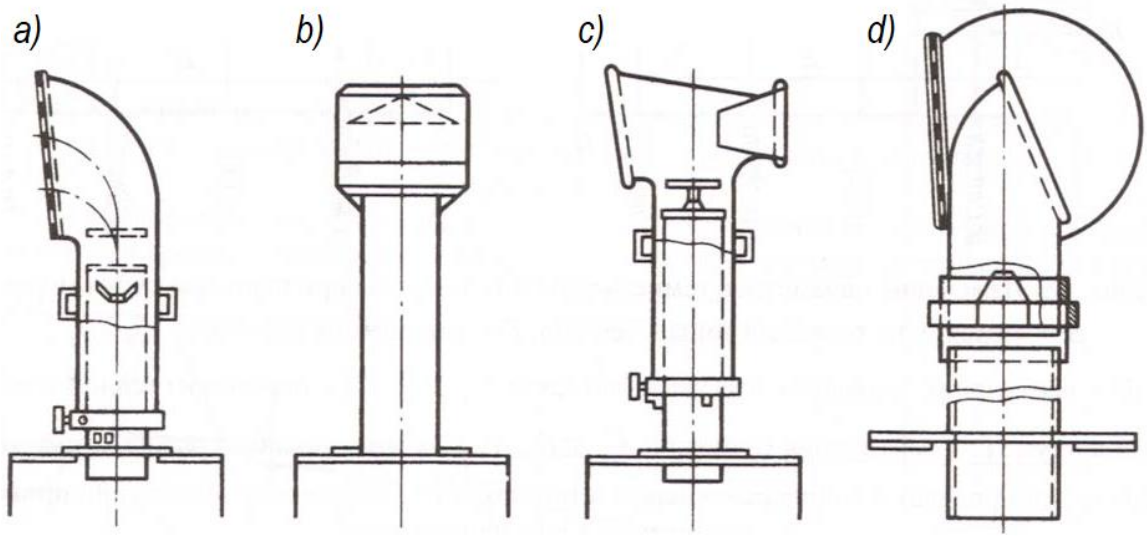



Fig. 5. Types of deflectors:
a) “windscoop” type; b) exhaust; c) ejection head; d) ball

Vessels with mechanical ventilation are equipped with an air distribution system and electric fans. Air distribution is provided by a system of air ducts, through which air is supplied to various places in the cargo spaces and is sucked out of them. Air supply to the hold is provided by fans, the performance of which depends on the set rate of air exchange. For ordinary universal ships, 5–7 times of air exchange per hour is sufficient, and on ships that transport fruits, vegetables and other specific cargo, it is necessary to provide 15–20 times of air exchange per hour. Fans, depending on their design, operate in the supply or exhaust or reverse mode.

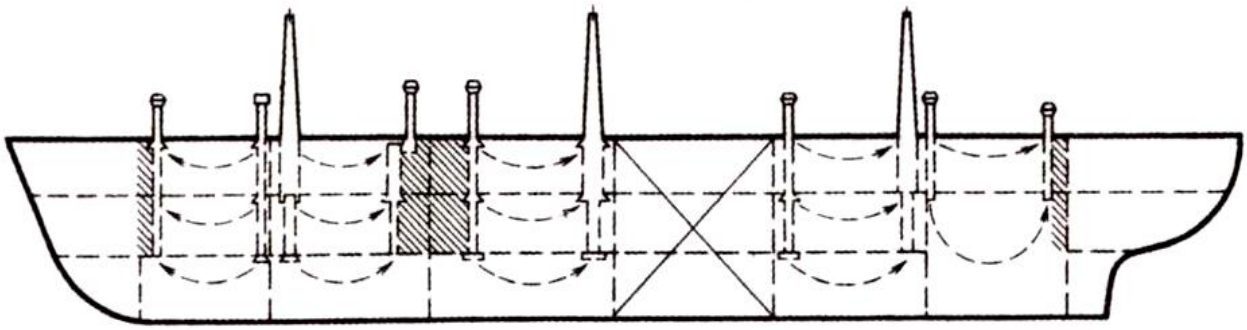


Fig. 6. Mechanical ventilation scheme for ship cargo spaces

A naturally-forced ventilation system provides from 0.3 to 3 air changes per hour, and ventilation of the bow holds is more efficient, since the speed of the air flow in the bow holds is about 2 times higher than in the aft holds. This is taken into account when drawing up the cargo plan.

The volume of air entering the hold can be calculated using the formula

$$V = S \cdot v,$$

where $S$ – the sectional area of the ventilation duct, $m^2$;

$v$ – the speed air flow, m/sec.

On vessels with an air conditioning system (ACS), the air supplied to the hold in the hold is processed – drying, humidification, heating or cooling. ACS can process outside and hold air. They are subdivided: according to the type of heat and humidity treatment of air; by the method of heat and moisture treatment of air; on the design of equipment for heat and moisture treatment of air; according to the composition of the processed air to direct-flow, closed, connected.

### 3.7. Getting of moisture into cargo spaces due to defects in hatch covers

Wetness of cargo is one of the main problems of its safety for insurers of the vessel and cargo. According to the P&I Clubs, most of the wetting is due to hatch defects.

Various designs of hatch covers are used on ships. These are:

– Folding Covers, having a hydraulic, cable or chain drive;

– Rolling Covers – when usually 2 large closing panels roll down to the sides, and rise and rolling (Piggy-Back or Lift-and-Roll);

– Stacking Covers, consisting of separate panels that can roll along the length of the hold to the area where the hydraulic cylinders are installed;

– Pontoon closures (Ponton, Lift-away Hatch Covers), consisting of pontoon panels that are installed using a shore or ship crane;

– outdated and rarely found wooden hatches, covered with tarpaulins.

Structurally, all types of hatch covers have a bar on the hatch coaming and a sealing rubber in a special groove on the hatch covers. After installing the hatch covers in place, they are pressed using special stoppers (Quick-Setting Cleats). Over time, the rubber "ages", it develops a groove. The covers themselves can deform, and as a result of this, the rubber adhesion is broken. The tightening of the stoppers is sometimes not enough to lead leaks.

The main defects of hatch covers, leading to a grease of goods, are defects:

– sealing rubber and channels in which it is laid;

– bolts, tight-fitting covers, and wedges at transverse joints panels;

– pontoons and panels of hatch covers;

– drainage channels and non-return valves;

– compression bar.

To detect defects in hatch covers, the following control methods are used: Watering (Hose Test).

Covers are tightened. Places of contact with coamings and transverse joints between panels are poured on the deck from a hose at a pressure of 2 Bar ~ 2 atm. The second person with a lantern in the hold watches for bruises.

Disadvantages of the method:

– not applicable in cold weather;

– 2 people are required for carrying out.

Chalking. The watertightness of the closure is ensured by a rubber seal between the lid and the coaming, as well as between the individual lid hatches. For tight compression of the rubber seal, the hatches are pressed against one another with wedge clamps. The cover is pressed against the hatch coaming with screw-backs or wedges.

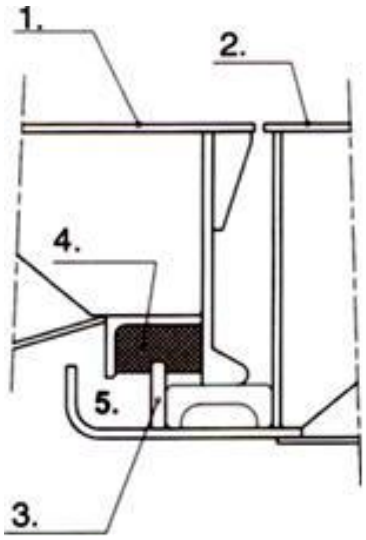



Fig. 7. Scheme of sealing the joint of caps with coaming:
1. Upper cover; 2. Lower cover; 3. Compression bar; 4. Rubber gasket

The top edge of the compression bar is chalked. The lid laid and tightened. The sections are then shifted or lifted. There will be no chalk mark on the rubber where there is no fit to the bar. On some hatch systems there is no way to look under the cover.

Ultrasonic Test.

An inspector descends into the hold with an ultrasound generator, which has several emitters. Ultrasonic waves, reflecting from the sides, deck and covers, uniformly "fill" the hold. The operator walks around the perimeter of the hatch cover with the receiver. The signal level is used to determine the amount of leakage. These places are marked with chalk.

It should be summed up that the complete picture is given by the Hose Test and the Ultrasonic Test.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| fluctuation | [ˌflʌktjʊˈeɪʃən] | колебание |
| customary | [ˈkʌstəməri] | привычный, принятый |
| solar | [ˈsəʊlə] | солнечный |
| density | [ˈdɛnsɪti] | плотность |
| humidity | [hju(:)ˈmɪdɪti] | влажность |
| to saturate | [ˈsæʧəreɪt] | насыщать |
| dew point | [dju: pɔɪnt] | точка росы |
| vapor | [ˈveɪpə] | пар |
| case-by-case | [keɪs-baɪ-keɪs] | от случая к случаю |
| balloon | [bəˈlu:n] | баллон, -чик |
| gauze | [[gɔ:z] | марля |
| calico | ˈkælɪkəʊ] | бязь |
| cambric | [ˈkeɪmbrɪk] | батист |
| to wet | [wɛt] | мокнуть |
| to take readings | [teɪk ˈri:dɪŋz] | снимать показания |
| equilibrium | [ˌi:kwɪˈlɪbrɪəm] | равновесие, -ный |
| guidelines | [ˈgaɪdlaɪnz] | методические рекомендации |
| graph | [grɑ:f] | график |
| to intersect, -tion | [ˌɪntə(:)ˈsɛkt ˌ -kʃən] | пересекать(ся), -чение |

| | | |
|---|---|---|
| curve | [kɜːv] | кривая, изгиб |
| lack | [læk] | недостаток |
| naturally-forced ventilation | [ˈnæʧrəli-fɔːst ˌvɛntɪˈleɪʃən] | естественно-принудительная вентиляция |
| deflector | [dɪˈflɛktə] | дефлектор |
| air duct | [eə dʌkt] | воздуховод |
| windscoop | [windskuːp] | раструб |
| ball non-refillable head | [bɔːl nɒn-ˌriːˈfɪləbl hɛd] | шаровая незаливаемая головка |
| groove | [gruːv] | паз, канавка |
| stopper | [ˈstɒpə] | стопор |
| adhesion | [ədˈhiːʒən] | прилегание |
| leaks | [liːks] | протечки, неплотности |
| drainage non-return valve | [ˈdreɪnɪʤ nɒn-rɪˈtɜːn vælv] | дренажный невозвратный клапан |
| bruise | [bruːz] | подтек, синяк |
| lid | [lɪd] | крышка |
| screw-back | [skruː-bæk] | винтовая задрайка |
| wedge | [ˈwɛʤ] | клин, забивать клин |
| to descend | [dɪˈsɛnd] | спускаться |
| emitter | [ɪˈmɪtə] | эмиттер, излучатель |
| to reflect | [rɪˈflɛkt] | отражать |
| to sum up | [sʌm ʌp] | подводить итоги |

## ADDITIONAL WORDS AND EXPRESSIONS (for Practical Work)

| | | |
|---|---|---|
| providing/ensuring | [prəˈvaɪdɪŋ/ɪnˈʃʊərɪŋ] | обеспечение |
| efficient | [ɪˈfɪʃənt] | продуктивный, эффективность |
| expediency | [ɪkˈspiːdiənsi] | соответствие, целесообразность |
| serviceable | [ˈsɜːvɪsəbl] | пригодные, прочные |
| manhole/scuttle | [ˈmænhəʊl/ˈskʌtl] | лаз |
| main/pipeline | [meɪn/ˈpaɪplaɪn] | магистраль |
| joint | [ʤɔɪnt] | стык |
| sluice/gate valve | [sluːs/geɪt vælv] | клинкет |
| pump room | [pʌmp ruːm] | помповое отделение |
| flywheel | [ˈflaɪwiːl] | маховик |
| canvas | [ˈkænvəs] | парусина |

| | | |
|---|---|---|
| sack cloth/burlap | [sæk klɒθ/ˈbɜːlæp] | мешковина |
| sounding pipe | [ˈsaʊndɪŋ paɪp] | замерная трубка |
| throat/neck | [θrəʊt/nɛk] | горловина |
| steam firefighting system | [stiːm ˈfaɪəˌfaɪtɪŋ ˈsɪstɪm] | система паротушения |
| foreign matter | [ˈfɒrɪn ˈmætə] | посторонние предметы |
| additive | [ˈædɪtɪv] | примесь |
| feeder hatch | [ˈfiːdə hætʃ] | досыпной (питатель) лючок |
| to emit | [ɪˈmɪt] | испускать свет, тепло, запахи |
| containment humidity | [kənˈteɪnmənt hjuːˈmɪdɪti] | влагосодержание |
| shipper | [ˈʃɪpə] | грузоотправитель |
| consignee | [ˌkɒnsaɪˈniː] | грузополучатель |
| cargo owner | [ˈkɑːgəʊ ˈəʊnə] | грузовладелец |
| temperature reserve | [ˈtɛmprɪʧə rɪˈzɜːv] | температурный запас |
| saturation curve | [ˌsæʧəˈreɪʃən kɜːv] | кривая насыщения |

**NOTES**

1. To overload with technical terms. – Быть перегруженной (о лекции) техническими терминами.

2. Ventilation is possible and desirable. – Вентиляция возможна и желательна.

3. Ventilation is unacceptable and will cause dampness of the cargo. – Вентиляция недопустима и приведет к отсыреванию груза

4,5. Ventilation is required. Lack will cause moisture to build-up in holds/ on tween decks. – Вентиляция обязательна. Отсутствие приведет к образованию влаги в трюмах/ на твиндеках.

# 4. REGULATION OF THE FREEBOARD AND CALCULATION OF THE CARGO PLAN OF THE VESSEL

## 4.1. Problems of accidents in world shipping

According to statistics, 8,000 vessels meet with an accident every year, 200 of them lost.

In this case, the lives of 6,000 sailors are in immediate danger, 2,000 of them are lost life. The causes of accidents are:

– 10% – force majeure;

– 15% – miscalculations of designers;

– 75% – "human factor".

The freeboard provides:

– unsinkability of a ship – the ability of a ship to maintain buoyancy and stability when one or more compartments are filled;

– flooding reduction;

– preservation of stability – the ability of the vessel, taken out of the state of equilibrium by external forces, to return to the initial position of equilibrium again after the discontinuance of the action of these forces.

If the freeboard is small, then at small heel angles the deck enters the water, while the moment of inertia of the area S of the acting waterline decreases and, accordingly, *M* restoring.

The amount of capsized vessels due to their overload is 30% of all lost. In this case, the number of victims is 2 times ≥ than in case of damage to the hull, and 6 times ≥ than during fires.

With each new victim, under the arches of the Lloyd's London office, the bell is struck from the legendary French frigate “Lutin”, and the herald announces the name of the lost ship. It is listed in Lloyd's Red Book – of large format covered in purple morocco binding – under the “Are Missing” section.

## 4.2. History of freeboard regulating. International Conventions on Load Lines

The oldest mention of the loading of a ship was found off the coast of Tunisia. The ship belonged to Carthage (146 year BC). There is an inscription on the plate:

"... the skipper swears by Zeus and all the gods of Olympus to keep the terms of the contract sacred and inviolable and not to accept additional cargo."

The development of shipping required legislative regulation. The first laws appeared on Rhodes island in the Aegean Sea, Venice, Genoa, Pisa, Ancona. They were most fully developed in Marseille and Barcelona.

In the middle ages, in Spain, the load line was designated +, in Sardinia, ○. The laws were in Venice, Iceland, the Hanseatic League.

The English Lloyd (founded by Edward Lloyd, 1760) is considered the first classification society to supervise the construction of ships. In 1774 Lloyd published the Register Book. In 1834 Lloyd's Register was formed. According to its requirements, the safe freeboard was defined as 3 inches for each foot of the hold depth 3″ by 1′ of the depth of the hold.

In 1878, the max draft began to be indicated by a red diamond with letters on the sides “L” and “R”.

The activity should be noted of the deputy of the British Parliament in Derby, Samuel Plimsol, who was not a seaman, but was the owner of breweries and coal mines. He opposed the overloading of vessels and wrote the book “Our Sailors”. The Plimsol Disc is named after him.

In 1900, the freeboard began to be regulated in Germany

$$F = 1/32\ (L - B).$$

In the United States, until 1917, the freeboard was determined by the law of the country where the trading operations were carried out.

In Russia, the freeboard was assigned from 1909 as in Germany. In 1914 the Russian Register was formed. In 1928 the Register of the USSR published the "Rules for the determination of the freeboard and the application of a load mark on them.

*"International Convention on Load Lines, 1930.*

Adopted at the International Conference in 1930, entered into force on January 1, 1933. For all types of ships, the size of the tabular freeboard was determined by the length of the ship *L*

$$F = L / 15.$$

The 1930 Convention was in force until 1966. Reasons for revision:

– improvement of vessels’ constructions;

– the introduction of new types of vessels;

– improving knowledge in the field of seaworthiness;

– accumulation of knowledge about the state of the weather on Earth.

*International Convention on Load Lines, 1966*.

Adopted in July 1966 by the governments of 15 countries. Of these, 7 had a fleet with a gross tonnage of ≥1 million *reg. t* (1 *reg. t* = 2, 83 $m^3$ – old measure, not used). The USSR was signed by the Ambassador to Great Britain Smirnovsky.

Applies to all ships on international voyages. Does not apply:

– to warships;

– to new vessels $L \leq 24$ m;

– to existing vessels $GT \leq 150$ reg. t;

– to pleasure yachts;

– to fishing vessels.

According to the Convention, all vessels are divided into types:

– type "A" – vessels designed for transporting only liquid bulk cargo;

– type "B" – all others.

Differences from the 1930 Convention:

– the tabular freeboard is significantly reduced for vessels with $L \geq 61$ m;

– the assignment of the World Ocean areas to "seasonal zones" and "seasonal areas" has been revised.

In seasonal zones, the vessel is loaded with the same load line throughout the year. There are 2 zones: summer and tropical. Rules for determining "zones": in "summer" during the year ≤10% of the time winds blow with a force of ≥8 on the Beaufort scale (34 knots); in “tropical” ≤1% of the time, winds of ≥8 on the Beaufort scale (34 knots) blow and ≤1 tropical storm has been observed in the last 10 years.

In seasonal areas, different load marks are used throughout the year. There are also 2 regions: tropical and winter.

According to the new Convention, the "Summer Seasonal Zone" includes the entire Atlantic coast of the United States, the Mediterranean, Black, Azov and Baltic seas.

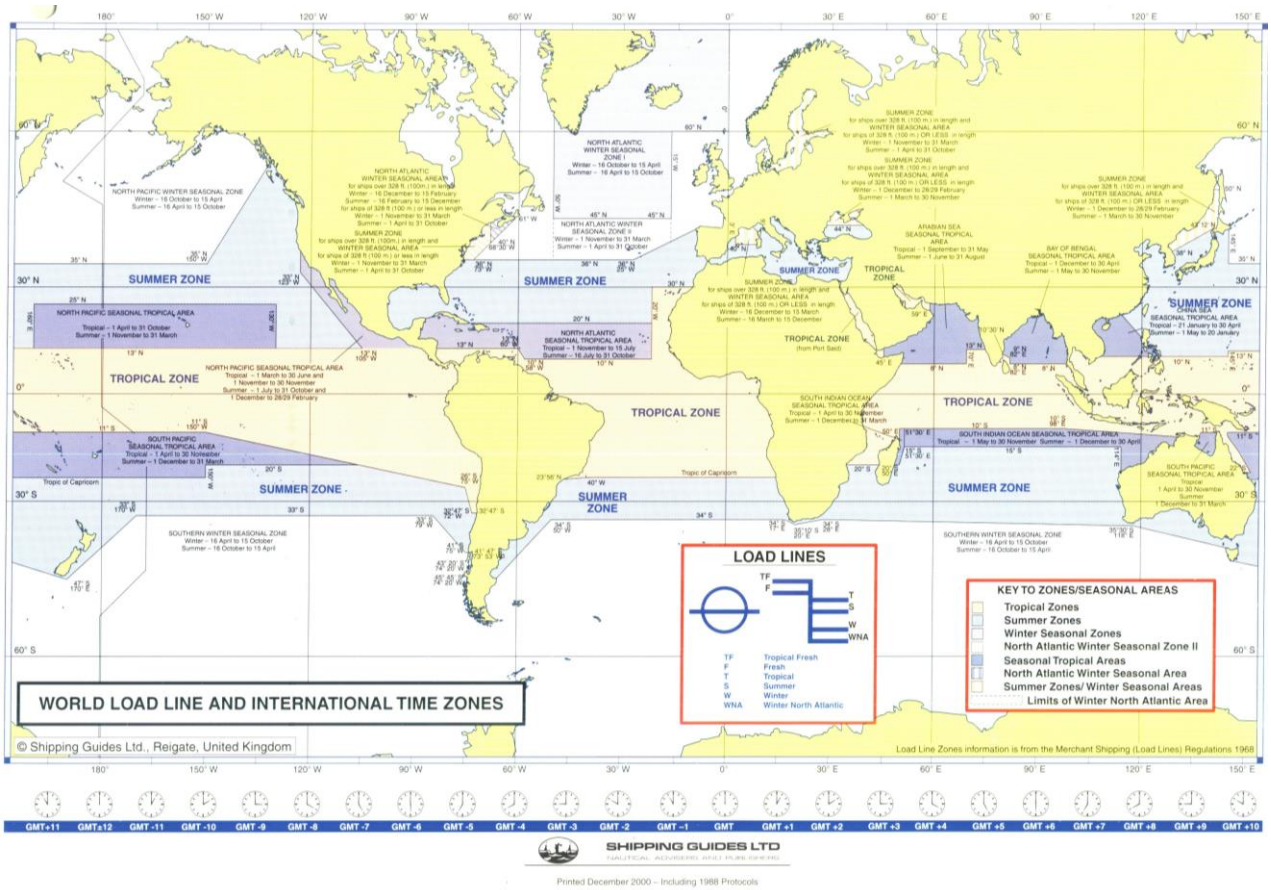



Fig. 1. The Map of Zones and Seasonal Areas

According to Rule 6 of the Convention, the marks that mark the load waterlines must be horizontal lines that are applied to the bow and perpendicular to the vertical line.

The following marks are used:

a) Summer Load Line indicated by line S;

b) Winter Load Line, indicated by line W;

c) Winter North Atlantic Load Line is indicated by the WNA line;

d) Tropical Load Line indicated by line T.

e) Summer Fresh Water Load Line is indicated by line F. The difference between the Summer Fresh Water Load Line and the Summer Load Line represents the correction for fresh water load for other load lines.

f) Tropical Freshwater Load Line as indicated by the TF line.

Cargo load lines are shown on fig. 2.

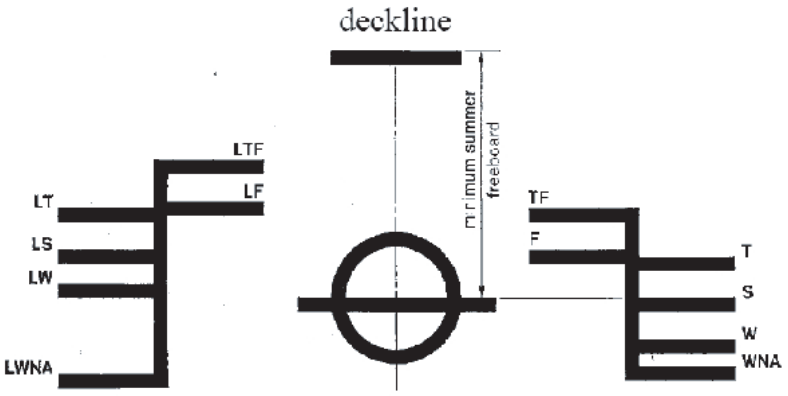



Fig. 2. Cargo load lines and the Plimsol Disc

If a timber freeboard is assigned to the ship, Timber load lines are applied in addition to the normal load lines. The word "timber" is added to the title.

An additional load line marked with a "C" sign is applied on a passenger ship.

When taking measurements during a draft survey, it is important to know that the thickness of all horizontal lines indicating load lines is 25 mm.

According to Rule 40 of the Convention, freeboards are

– Summer freeboard $H_s$

– Tropical freeboard $N_T$

$$H_m = H_s + 1/48 \cdot T_s,$$

where $T_s$ is the draft of the Summer load line, cm;

– Winter freeboard $H_w$

$$H_w = H_s – 1/48 \cdot T_s;$$

– Winter freeboard in the North Atlantic. For vessels $L \leq 100$ m, it is equal to $H_w$ + 50 mm. For ships $L \geq 100$ m, the winter freeboard in the North Atlantic shall be the winter freeboard.

$$H_{WSA} = H_s - 1/48 \cdot T_s;$$

– Freeboard in fresh water $H_{fw}$

$$H_{fw} = H_s - \Delta_s / 40 \text{ m},$$

where $\Delta_s$ is the ship's displacement in salt water at the summer cargo waterline;

$m$ is the number of tons per 1 cm of draft, t/cm;

– Freeboard tropical in fresh water

$$H_{mf} = H_m - \Delta_s / 40 \text{ m}.$$

Formulas for calculating the displacement $\Delta_c$ for sailing zones:

– summer – tropics

$$\Delta_c = \Delta_s$$

– winter – summer – tropics

$$\Delta_c = \Delta_w$$

– North Atlantic winter – winter – summer – tropics

$$\Delta_p = \Delta_{WNA}$$

– tropics – summer

$$\Delta_c = \Delta_s + \sum P_m \leq \Delta_m$$

– summer – winter

$$\Delta_c = \Delta_w + \sum P_s \leq \Delta_s$$

– winter – North Atlantic winter

$$\Delta_c = \Delta_{wna} + \sum P_w \leq \Delta_w$$

– tropics – summer – winter

$$\Delta_c = (\Delta_w + \sum P_s \leq \Delta_s) + \sum P_m \leq \Delta_m$$

– summer – winter – North Atlantic winter

$$\Delta_c = (\Delta_{wna} + \sum P_w \leq \Delta_w) + \sum P_s \leq \Delta_s$$

– tropics – summer – winter – North Atlantic winter

$$\Delta_c = [((\Delta_{wna} + \sum P_w \leq \Delta_w) + \sum P_s) \leq \Delta_s] + \sum P_m \leq \Delta_m.$$

where $\Delta_c$ – calculated displacement;

$\Delta_s$, $\Delta_w$, $\Delta_т$, $\Delta_{wna}$ – displacement at the summer, winter, tropical, winter North Atlantic cargo waterline.

Note that from the moment of construction, the vessel's forms contain data on displacement, deadweight and draft according to the summer load line ($\Delta_s$, $\Delta w_s$, $T_s$). These values are unchanged for the entire period of operation of the vessel.

If in parentheses the left side of the inequality turns out to be greater than the right, then the extreme left value of $\Delta$ should be taken as $\Delta_c$, and the further calculation is stopped. In the same way, if the left side of the inequality in square

brackets turns out to be greater than the right one (for example, $\Delta_{wna} + \sum P_w + \sum P_s > \Delta_s$), then $\Delta_s$ is taken as $\Delta_c$ and no further calculation is performed.

When determining the value of the calculated displacement, in addition to the zones and seasonal areas of applicability of a particular load line, it is necessary to take into account possible draft restrictions on passage and in ports.

Each vessel must have:

– International Load Line Certificate, 1966;

– Regional Certificate of Load Line (for vessels making international voyages between ports of 2 or more states);

– International Certificate of Exception for Load Line (for vessel with new structural features);

– Single Voyage Permit (for a single voyage of a coastal vessel).

### 4.3. General requirements for drawing up a vessel's Cargo Plan

A Cargo Plan is a graphic representation on a ship's drawing of the disposition of each lot of cargo in the ship's cargo spaces for a given voyage. To draw it up, it is necessary to provide:

– profitable use of the cargo carrying capacity and the cargo capacity of the vessel;

– the ability to carry out loading and unloading in the shortest possible time;

– observance of the order of loading cargoes;

– maintaining the necessary stability, trim and strength;

– safe navigation of the vessel;

– safe and timely delivery of cargoes;

– compliance with safety and labor protection standards;

– achieving economic efficiency based on the maximum freight.

To draw up a cargo plan, you need to know detailed data about the vessel, cargo and conditions of the intended voyage.

In order to distribute cargoes among the premises, it is necessary to solve the problem of maximizing the use of cargo capacity and cargo carrying capacity by selecting a combination of "light" and "heavy" cargoes.

If the vessel takes cargo for several ports, it is necessary that the cargo to be unloaded at the 1st port is on top of other cargo. When loading and unloading at several intermediate ports is envisaged, the rotation of the ports of call should be taken into account.

*A preliminary Cargo Plan* is drawn up by the port of loading; by the end of loading, an *executive Cargo Plan* is drawn up.

To draw up a Cargo Plan, it is necessary to solve a number of tasks:

– determine the mass of cargoes that can be taken on a given voyage;

– select cargoes to ensure full use of cargo carrying capacity and cargo capacity, or maximum profit;

– calculate the distribution of weight loads in the cargo compartments of the vessel;

– to distribute the cargoes in the premises, taking into account their compatibility;

– determine the trim of the vessel for departure and correct it;

– to calculate the stability for the vessel's departure from the port of loading and upon arrival. Accounting for the cargo carrying capacity and cargo capacity of the vessel for the voyage.

With a large number of cargoes, they are grouped into "heavy" and "light", i.e. the problem is reduced to solving equations with 2 unknowns.

When distributing cargo, it is necessary to ensure that there is no damage to the local and longitudinal strength of the ship's hull.

Cargoes picking is a creative process, but it takes into account:

– in one cargo compartment only compatible cargo is placed, as well as cargo for the transportation of which the same microclimate is required;

– cargoes are stowed in the lower part of the compartment in a strong tare;

– cargo must be arranged strictly as per B/Ls lots;

– cargo, during the transportation of which it is necessary to observe the temperature regime, must be removed from the heated bulkheads, sides and deck.

Verification of the implementation of the IMO recommendations on stability is compulsory when drawing up the Cargo Plan of the vessel before its voyage. It is also necessary to ensure that these requirements are met when the vessel is on passage at sea, that is, when variable supplies (fuel, water, etc.) are consumed. Each ship must have a *Stability Booklet, Trim and Stability Book*.

## 4.4. Calculation of the Cargo Plan of the vessel

To determine the calculated displacement tonnage (full) $\Delta_c$ for the voyage, it is necessary to determine the valid load lines using the Map of Zones and Seasonal Areas.

By choosing the displacement tonnage of the vessel according to the summer load line $\Delta_s$ from the TOC (transport-operating characteristics) of the vessel, you can get the displacement tonnage according to the tropical $\Delta_T$ or winter $\Delta_w$ load lines

$$\Delta_w = \Delta_s - 1/48 \cdot T_s \cdot m;$$

$$\Delta_T = \Delta_s + 1/48 \cdot T_s \cdot m,$$

where: $T_s$ is draft according to the Summer load line, cm;

$m$ is the number of tons per 1 cm of draft, t/cm.

It is necessary to determine such $\Delta_c$, for which at no stage of the passage the ship's load line is below water.

Full cargo carrying capacity (deadweight, DWCC) of the vessel $\Delta w$:

$$\Delta w = \Delta_c - \Delta_0 ,$$

where $\Delta_0$ is the light displacement of the vessel, t.

Cargo carrying capacity (or deadweight cargo capacity, DWCC) – quantity of cargo to be loaded $\Delta_{carg}$ ($\Delta_{DWCC}$)

$$\Delta_{carg} = \Delta w - \sum_{j=1}^{n} P_{sup\,j}$$

where $\sum_{j=1}^{n} P_{sup\,j}$ – voyage supplies,

$$\sum_{j=1}^{n} P_{sup\,j} = P_{sup}^{way} + P_{sup}^{stay} ,$$

where: $P_{sup}^{way}$ – running supplies for the voyage when vessel under way;

$P_{sup}^{stay}$ – stay supplies for the voyage when vessel is lying at the berth (or riding at anchor).

$$P_{sup}^{way} = P_{way}^{fuel} + P_{way}^{w} + P_{way}^{oil} ,$$

where $P_{way}^{fuel}$, $P_{way}^{w}$, $P_{way}^{oil}$ are the corresponding running supplies of fuel, water and oil. Determined by similar formulas,

$$P_{way}^{fuel} = q_{way}^{fuel} \cdot t_{way} \cdot (1 + k_{st}),$$

Where: $q_{way}^{fuel}$, $q_{way,}^{w}$ $q_{way}^{oil}$ are daily consumption rate of fuel, water, oil underway, t/day;

$k_{st}$ is coefficient of storm reserve.

$t_{way}$ – running time, days

$$t_{way} = \frac{L}{24 \cdot v} + t_{del} ,$$

where $L$ is the distance of the passage, miles;

$v$ is speed of the vessel, knots;

$t_{del}$ is time of delays underway, days;

Stay supplies (supplies for the voyage when vessel is lying at the berth (or riding at anchor).

$$P_{sup}^{stay} = P_{stay}^{fuel} + P_{stay}^{w} + P_{stay}^{oil} ,$$

where, respectively, the amount of fuel, water, oil to ensure the stay of the vessel at the ports of loading and unloading, i.e.

$$P_{stay}^{fuel} = q_{stay}^{fuel} \cdot t_{stay},$$

where: $q_{stay}^{fuel}$ is the daily rate of fuel consumption during stay, t/day;

$t_{stay}$ is the stay time, days.

$$t_{cm} = \sum_{i=1}^{n} \frac{Q_i}{M_i \cdot k_i},$$

where: $Q_i$ is the amount of the *i*-consignment, t;

*n* is the number of consignments;

$M_i$ – gross rate of cargo operations of the i-consignment, t/day.

$k_i$ – correction coefficient to $M_i$.

Further, we bear in mind, that

$$\sum_{i=1}^{n} Q_i = \Delta w$$

The amount of cargo taken for transportation depends on:

– the cargo capacity of the vessel *W*;

– specific cargo capacity of the vessel $\omega = \frac{W}{\Delta_{carg}}$;

– specific cargo loading volume of cargo (SF) – *u*.

If "heavy" goods are presented for transportation ($u < \omega$ ), then

$$\sum_{i=1}^{n} Q_i = \Delta_{carg}.$$

If "light" goods ($u > \omega$ ), are presented for transportation, then:

$$\sum_{i=1}^{n} Q_i = \frac{W}{u}$$

If both "light" and "heavy", the system of equations is solved

$$\begin{cases} Q_{light} + Q_{heavy} = \Delta_{carg}; \\ Q_{light} \cdot u_{light} + Q_{heavy} \cdot u_{heavy} = W \end{cases}.$$

To determine the amount of the cargo loaded into each cargo space, the principle of weight distribution load is used in proportion to the cubic capacity of the cargo spaces using the coefficient of commensuration of the cargo capacity of each cargo space $k_{c_i}$

$$k_{c_i} = \frac{W_i}{W},$$

where: $W_i$ is the cargo capacity of the *i*-cargo space, $m^3$;

*W* is the cargo capacity of the vessel, $m^3$;

The value of the distributed cargo mass for the *i*-cargo space ($Q_i$)

$$Q_i = k_{c_i} \cdot Q_{vsl}$$

where $Q_{vsl}$ is the volume of the ship's consignment, t.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| freeboard | [ˈfriːbɔːd] | надводный борт |
| unsinkability | [ˌʌnsɪŋkəˈbɪlɪti] | непотопляемость |
| buoyancy | [ˈbɔɪənsi] | плавучесть |
| flooding | [ˈflʌdɪŋ] | заливаемость |
| state of equilibrium (balance) | [steɪt ɒv ˌiːkwɪˈlɪbrɪəm (ˈbæləns)] | состояние равновесия |
| accidents | [ˈæksɪdənts] | аварийность |
| inertia | [ɪˈnɜːʃə] | инерция |
| discontinuance (stopping) | [ˌdɪskənˈtɪnjʊəns **(**ˈstɒpɪŋ**]** | прекращение |
| herald | [ˈhɛrəld] | глашатай, трибун |
| morocco binding | [məˈrɒkəʊ ˈbaɪndɪŋ] | сафьяновый переплет |
| to brew, brewery | [bruː**,** ˈbrʊəri] | варить пиво, пивзавод |
| load mark (line) | [ləʊd mɑːk **(**laɪn**)]** | грузовая марка |
| load line mark | [ləʊd laɪn mɑːk] | марка углублений |
| pleasure yacht | [ˈplɛʒə jɒt] | прогулочная яхта |
| consignment | [kənˈsaɪnmənt] | партия груза |
| weight load | [weɪt ləʊd] | весовая нагрузка |
| cargoes picking | [ˈkɑːgəʊs ˈpɪkɪŋ] | комплектация грузов |
| specific cargo loading | [spɪˈsɪfɪk ˈkɑːgəʊ ˈləʊdɪŋ] | удельный погрузочный |
| volume, (stowage factor, SF) | ˈvɒljʊm] | объем, (УПО) |
| displacement tonnage | [dɪsˈpleɪsmənt ˈtʌnɪʤ] | весовое водоизмещение |
| light displacement | [laɪt dɪsˈpleɪsmənt] | водоизмещ-е порожнем |
| deadweight, DW, Δw, | [dɛd ’weit] | дедвейт |
| all tonnage deadweight, DWAT | [ɔːl ˈtʌnɪʤ dɛd ’weit] | дедвейт**,** полная грузоподъемность |
| full cargo carrying capacity | [fʊl ˈkɑːgəʊ ˈkæriɪŋ kəˈpæsɪti] | дедвейт, полная грузоподъемность |
| deadweight cargo | [dɛd’weit ˈkɑːgəʊ kəˈpæsɪti] | чистая |

| | | |
|---|---|---|
| capacity, DWCC | | грузоподъемность г/п |
| cargo carrying capacity | [ˈkɑːgəʊ ˈkæriɪŋ kəˈpæsɪti] | чистая г/п |
| cargo deadweight | [ˈkɑːgəʊ dɛd ’weit] | чистая г/п |
| to consum\|e, – bles | [kənˈsjuːm**,** **-**əblz] | расходовать, расходы |
| running (working) supplies | [ˈrʌnɪŋ **(**ˈwɜːkɪŋ**)** səˈplaɪz] | ходовые запасы |
| stay supplies | [steɪ səˈplaɪz] | стояночные запасы |
| speed | [spiːd] | скорость |
| running time | [ˈrʌnɪŋ taɪm] | ходовое время |
| stay time | [steɪ taɪm] | стояночное время |
| gross rate of cargo operations | [grəʊs reɪt ɒv ˈkɑːgəʊ ˌɒpəˈreɪʃənz] | валовая норма грузовых работ |
| cargo capacity | [ˈkɑːgəʊ kəˈpæsɪti] | грузовместимость |
| specific cargo capacity | [spɪˈsɪfɪk ˈkɑːgəʊ kəˈpæsɪti] | удельн. грузовместим. |
| coefficient of commensuration | [ˌkəʊɪˈfɪʃənt ɒv kɒmensʊˈreɪʃən] | коэффициент соизмерения |
| parentheses | [pəˈrɛnθɪsiːz] | круглые скобки |
| numerator | [ˈnjuːməreɪtə] | числитель |
| denominator | [dɪˈnɒmɪneɪtə] | знаменатель |

# 5. TECHNOLOGY OF GENERAL CARGOES TRANSPORTATION

## 5.1. Classification of general cargoes

The name of this category of cargoes comes from the English «general» – common. The general cargoes include cargoes packed in boxes, bales, barrels, drums, bags, cans, bottles, baskets.

A feature of the transportation of general cargoes is that in one cargo premises it is necessary to place dozens, and sometimes more than a hundred names of cargoes with different properties, which requires the carrier to carefully study and take into account their transport characteristics and compatibility. Before transportation, the Shipper must provide:

– Declaration of Cargo (Chapter VI SOLAS);

– Certificate of Origin (SSt «Preparation of goods for transportation»).

The Shipowner must provide a Cargo Securing Manual. The administration of the vessel is obliged to prepare the vessel for loading, facilitate the survey of the cargo.

The Shipper (freight forwarder) must submit the cargo in such a way that it:

– is marked;

– is in a serviceable tare;

– has serviceable locks and seals;

– does not have traces of wetness, sweepings;

– has no signs of spoilage, damage, theft of cargo.

General cargoes classification is carried out according to:

– the mass of a separate package;

– linear dimensions;

– storage modes;

– methods of transportation and handling;

– physical and chemical properties, etc.

Transportation of general cargo is carried out in accordance with «General and special rules for the carriage of cargoes», «Safety rules for the carriage of general cargoes by sea». All general cargoes are divided into categories and groups depending on the type of tare, packaging and the nature of the cargo itself.

## 5.2. Transportation of boxed cargoes

Depending on the material of manufacture, the boxes are made of:

– plank crates (lathing);

– plywood (reinforced with wooden laths along the perimeter);

– cardboard (corrugated cardboard).

Some goods are pre-packed in consumer tare before packing in boxes – cartons, packages, bottles, cans.

Stowage of boxes.

Wooden boxes are placed on the vessel depending on the size, weight, strength of the tare. In this case, heavy boxes are stowed in the lower part of the hold, light boxes – on top. In the first tier, free spaces are filled with separation materials.

In the hold, boxes are stowed in longitudinal or transversal direction, or on the butt end – depending on their size, characteristics of the cargo, strength of the tare.

According to general rules, boxes are stowed from the sides to the middle, from the transverse bulkheads to the clear space with maximum thickness. When the ratio of the length of the box to the width is ≥ 2, in order to ensure the strength of the stack, one tier of boxes is stowed lengthwise, the other – athwartship.

Cardboard and small wooden boxes are lined up using the brick stowage method.

Plank crates on tween-decks and in holds are stacked at a height ≤ height of the cargo space ≈ 4 m. If the cargo is in glass tare in the crates, no other cargo is loaded on top of them.

Boxes with glass are stowed vertically on a long edge fore-and-aft line.

Fastening of a stack of fragile boxes is made by boards laid across the vessel through 5-6 tiers of cargo. The boards should rest against the sides, overlap each other in length ≥ 400-500 mm. 3-4 tiers of boxes are stacked on the top boards.

## 5.3. Transportation of bagged cargoes

When loading cargoes in bags into the hold, under the bottom tier of bags, a flooring of boards is laid, on the top of which 1-2 layers of paper are lined. The stacking is carried out along the transverse bulkheads from the sides to the middle. The bags are stowed lengthwise the vessel.

If the creation of «air channels» is required, along the sides and bulkheads, the stack is fastened with boards after 5-6 tiers, on the upper tiers – after 3–4 tiers.

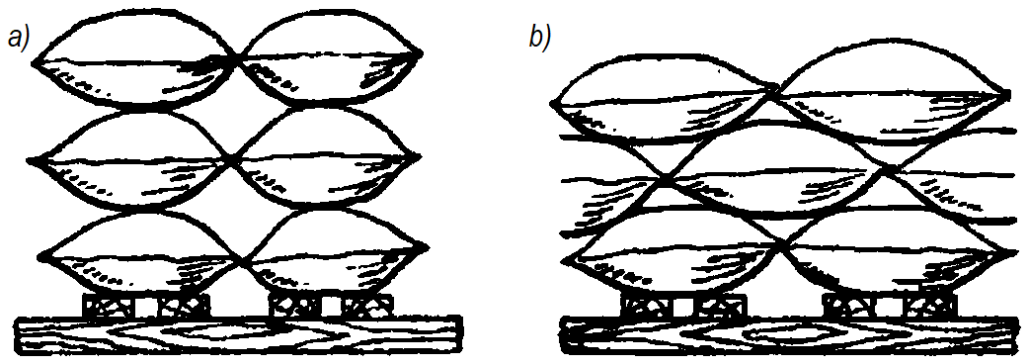



Fig. 1. Stowage of bag cargoes:
a – «bag over bag»; b – «half-bag way»

Stowage of fabric bags with finely dispersed bulk cargo (flour, talcum powder, chalk – capable of penetrating the fabric layer) is done as tightly as possible athwartship.

In the square of the hatch, bags are loaded in tiers 1–1.2 m high with board liners under each tier.

The height of the stack depends on the properties of the cargo. So, for

– cocoa beans in jute bags $h$ = 12 tiers;

– coffee beans $h$ = 20 tiers;

– cement in craft-paper bags $h$ = 30 tiers;

– grain cargoes in fabric bags $h$ = 18 tiers.

### 5.4. Transportation of pressed baled and baled cargoes

Fibrous cargoes and products are transported in pressed bales and bales.

The pressed bales are formed under the press, sewed with material, tightened with metal ties. Geometrically, it is a parallelepiped with 2 convex sides.

Bales are non-pressed cargoes.

The bales are stowed along the transverse bulkheads in a cushion stack. Stack width 1–2 bales, height 1-3 bales. The clearance between the bales and the side on the bilge slant is laid with hard separation with a step of 150-200 mm. The bales are stowed tightly to each other.

### 5.5. Transportation of rolled-barreled cargoes, in drums and cylinders

Metal barrels are welded or rolled up with stiffening belts or wrapped iron hoops.

Barrels are cylindrical and conical in shape.

Metal drums are cylindrical in shape.

Wooden barrels are filled with liquid and dry cargo.

Liquid and semi-liquid products are transported in barrels. There is a cork on the bottom of the barrel or on the side (when loading, there is a cork on top).

Dry food products and powdered chemical products are transported in dry barrels.

Plywood drums are made of 3-layer glued plywood. They carry dry food products, chemical products. Capacity is 10–00 *litres*, weight is 15–175 *kg*.

Metal drums are made from sheet iron. They carry fusible and dry chemical products. Capacity 50–200 *litres*.

Barrels are stacked horizontally on the generatrix (on the sides) and vertically on the butt end.

When laying horizontally, barrels are stowed from the middle of the hold to the sides in transverse rows. Each barrel of the first tier is laid on soft wood lining with a section of 50x50 mm. The emptinesses at the sides and in the corners are filled with separation. Each barrel of the second tier is placed in a hollow between 4 barrels of the first tier («bull's-eye»).

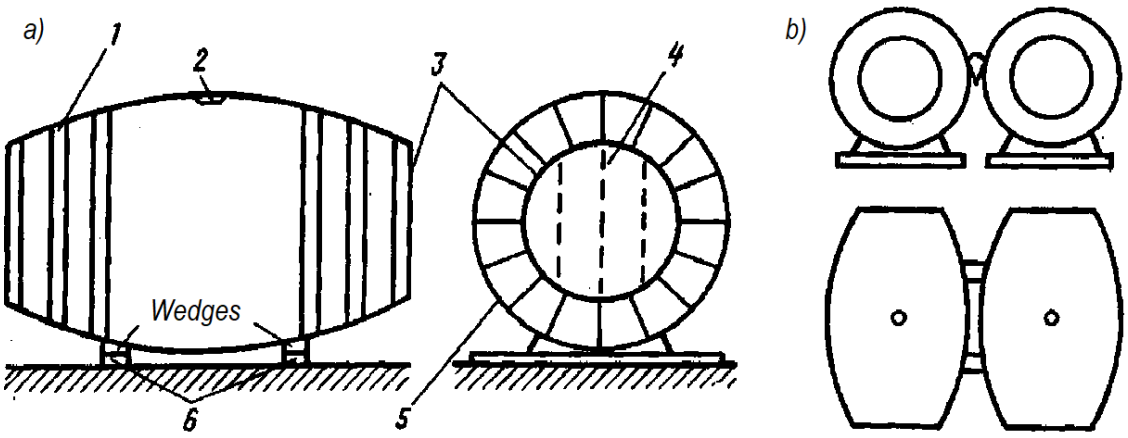



Fig. 2. Barrels wedging:
1 – quarter hoops; 2 – cork; 3 – chime; 4 – bottom; 5 – bulge; 6 – cushion

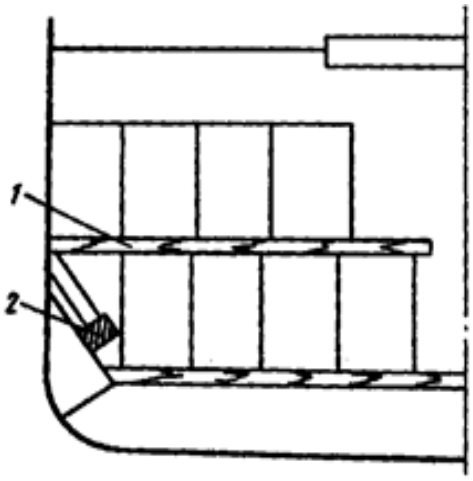



Fig. 3. Stowing barrels on the butt end:
1 – lining under the cargo; 2 – spacers and chocks

When the barrels are stacked vertically («on the end»), they are stowed along the sides in rows with a passageway on the center line. Barrels are chocked and tomed up in the way of the bilge slants. Continuous separation of boards is laid between the tiers of the barrels. The stacking height at the end is for 100-liter barrels up to 9 tiers; 200–250 liters up to 8 tiers.

Wire rope in coils are transported on the «butt end» position,

Cable in coils are «on the generatrix (side)» position.

The cylinders are transported «on the generatrix (side)» position athwartship, stowed on a continuous layer of separation of boards or plywood.

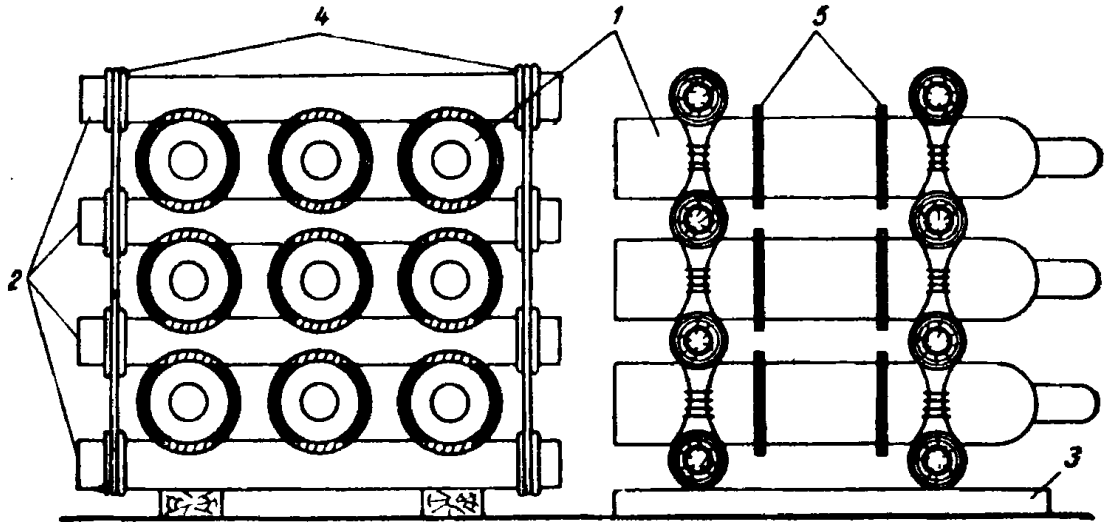



Fig. 4. Stowing cylinders for transportation on deck of a ship:
1 – cylinders; 2 – gaskets; 3 – linings; 4 – wire ties; 5 – amortization rings

## 5.6. Transportation of cotton and other fibrous cargoes

Fibrous cargoes are classified as natural or artificial. Natural fibrous goods are:
– vegetable (cotton, flax, jute, hemp, beckoning, sisal, agave);
– animals (wool, natural silk);
– mineral (asbestos).

**Cotton.**

There are 7 grades of cotton. The weight of the bale, depending on its moisture content, is 205-215 kg. Bale size up to 1 m long, 60 cm wide, 75 cm high.

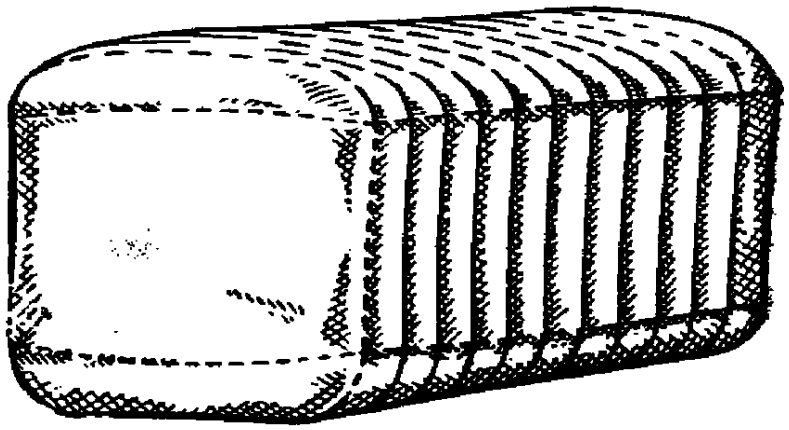


Fig. 5. Standard packing cotton bale

According to contamination, cotton is divided into 3 classes. The cargo is classified as dangerous. A spark can cause smouldering and fire. Therefore,

– spark arresters are placed on the exhaust pipes of the forklift trucks;

– hatch coamings are fenced with wooden shields to protect against sparks during loading when the cargo pendant rubs against metal.

It can smolder and ignite spontaneously from oxidation by oxygen in the air, from oil, for example, from the cylinder of a forklift truck, and even from the ingress of water on the bale. When wet, cotton becomes moldy, self-heating.

When transporting cotton, heat sources must be shielded with wooden shields. The electrical wiring must be in good condition. Portable «cluster lights» for lighting holds at night must be rated for $V \leq 100$ V. The metal parts of the hull are covered with tarpaulins, mats.

When transporting cotton, carbon dioxide and steam extinguishing systems must be tested and in good working order.

Cotton is a dusty cargo. At high temperatures or ventilation with dry air, cotton loses its elasticity, becomes brittle and tough.

**Jute.**

Jute is the fibre of an annual plant. Is used for
– production of fabrics;
– production of ropes.

The cargo is water-absorbing and accumulates moisture. Rotting processes take place in the middle of the bale. Therefore, when loading, do not accept wet bales, allow contact with oil, fat.

It is often infected with insects, therefore fumigation is carried out.

**Flax.**

Its properties are close to cotton. The cargo is clean and dry, liable to damage by moisture. Flammable.

**Cópra.**

Cópra is the dried oily endosperm of the coconut tree. Copra cake is a good feed for livestock, it contains 30-40% coconut oil. It is a raw material for the production of margarine, industrial oils, glycerin, soap and napalm.

**Ropes and mats are made of copra.**

Copra is liable to damage by moisture, it quickly rots.

## 5.7. Transportation of paper and cellulose

The initial products are:

– wood;

– synthetic fibres;

– mineral fibres.

Basic properties of paper, cardboard and cellulose:

– hygroscopicity;

– heat capacity;

– susceptibility to pollution, mechanical stress, the action of moldy funguses and bacterias, discoloration, fire hazard.

Rolled paper is packed in 3-6 layers of wrapper, the ends are protected with 5 layers of wrapping paper.

The paper to be printed is wrapped in plastic.

Sheet paper is transported in:

– bales;

– boxes weighing ≤ 200 kg.

The cardboard is transported in rolls wrapped in paper and strapped with steel packing tape.

Cellulose is transported in bales wrapped in 2 layers of unbleached cellulose. The bales are covered with a steel tape in 2 belts.

When transporting paper on non-specialized vessels, the holds are arranged:

– wooden enclosures at bilge slants;

– stepped platforms with the flare of the sides.

Rolls of paper are stowed «on the butt end». Allowable stacking height $h_{\text{allow}}$:

– paper for printing – 5.5 m;

– other types of paper – 7.5 m.

Paper – the cargo is clean, it can be transported with other cargo that does not emit moisture.

Before loading, a thorough cleaning, washing, drying of cargo spaces is carried out. The necks of tanks, fuel and air pipelines, drainage, ballast and hydraulic

systems, hatch coamings, closures and flaps of ventilation openings are carefully sealed. It is desirable to invite surveyors.

### 5.8. Transportation of caoutchouc and rubber-technical products

*Caoutchoúc* (English caoutchouc, came from the language of the Peruvian Indians). There are several types of caoutchouc transported in the form of sheets, which:

– are packed in boxes;

– are pressed into bales.

1. «Smoked Shield». It is transported in the form of sheets of 50×100 cm, smoked and packed in bales. Color from amber yellow to brown.

2. «Crepe» – sheets of 50×60 cm, non-smoked, white.

3. CMP brands – transported in the form of continuous rubber mass. It is transported in plastic bags weighing up to 1 ton, stacked on pallets.

The average size of transported caoutchouc bales is 400×500×600 cm, weight is 101–113 kg. The bales are covered with caoutchouc sheets of the same brand. The bales are marked with RSS or Crepe.

Natural caoutchouc contains protein substances – a breeding ground for bacteria and molds. At the same time, heat is released, which accelerates the decay process.

Bales are easily contaminated with soil and sand.

During transportation, the following may take place:

– bale deformation;

– leakage of bales between parts of the framing;

– fusion of bales.

Caoutchouc has the maximum elasticity at $t$ = +15÷20°C. With an increase in $t\uparrow$, it passes into an amorphous state.

Contact with solvents must be avoided.

When transporting bales of caoutchouc of higher grades are located at the bottom, and lower (softer bales) – at the top. Maximum stacking height $H_{max} \leq 18$ tiers of bales.

On the deck of the cargo compartment, planks are placed at intervals of 5-10 cm, on top – plywood planking is 6-10 mm. The sides and bulkheads are covered with plywood sheets. Each tier of bales is separated with plywood treated with a special emulsion (kaolin, kerosene, talc) and sprinkled with talc. The top layer of the bale is covered with a film to prevent condensation from entering. It is prohibited to load other goods on top of caoutchouc. When transporting caoutchouc:

– The humidity in the cargo area is measured 2 times a day;

– the holds are ventilated when the outside air humidity is $\varphi \leq 76–78\%$;

– at least once every 2 days, the temperature and humidity of the air $t$, $\varphi$ in the cargo space are measured.

**Synthetic caoutchouc.**

It is transported in rolls lined with burlap or a cloth impregnated with nitro-lacquer. It can be in the form of a tape wound in rolls.

**Latex.**

Latex is an aqueous solution of natural and synthetic caoutchouc. It is transported in drums with an additional valve for relieving excess pressure. The barrels are stowed «on the butt end».

*t* in the cargo space must be ≥ +10°C.

Stacking height allowed $H \leq 6$ tiers. With fewer tiers, after the separation has been laid, other cargoes can be loaded on top.

When exposed to air, latex forms a sticky mass. To prevent it from clotting, additives (ammonia, creosote) are added.

Rubber and products.

It is transported as products:

– technical (tires, insulating tapes, dielectric rugs and gloves, cuffs, sleeves);

– household goods (rubber shoes, children's toys, household goods).

Their transportation does not require special treatment. The temperature in the hold is t –10 ÷ +20°C, for some –30 ÷ +40°C.

## 5.9. Transportation of light industry products

Light industry products include:

– products of the textile, garment, knitwear, footwear industry;

– haberdashery;

– perfumery;

– other household goods.

Products of the textile, clothing, knitwear, footwear industries.

These include fabrics from:

– cotton. Capable of absorbing moisture from the environment;

– flax. They are also liable to getting soaked with salty sea water (mold-fungus is formed);

– wool. They can get spoiled by moths, then disinsectization and survey control of the cargo are carried out;

– silk. Less moisture absorption. Spots remain when wet;

– synthetic. They absorb little moisture, but are sensitive to an increase of *t*.

The transported fabrics are packed in bales. The pressed bales are covered with 2 layers of moisture-resistant paper, then 1-layer of wrapping cloth and the edges are tightened with metal or wire bands.

When transporting woolen and silk fabrics, the bales will be sealed.

**Carpets.**

They are transported in rolls covered in 1 layer of packing fabric. *Garment (sewing) products.*

They are transported in cardboard boxes or in bales covered with control wire or steel tape, factory-sealed «in a lock».

**Textile cargoes.**

These are second materials – textile scraps; old rags; cleaning materials. Accepted for carriage if there is a certificate of disinfection. They are classified as flammable substances.

**Products of the leather and footwear industry.**

These include:

– leathers. There are:

– leathers of a hard type. They are transported in packs of 5–10 pieces;

– soft leather types. They are transported in packs, rolls.

– patent leather. They are transported when spreaded (right side to right side) in plywood boxes of 20 leathers.

– leather goods. Among them are shoes. Packaging requirements apply to it: pairs of shoes are packed in consumer packaging – cardboard boxes. They are already in shipping tare – board, plywood or cardboard boxes.

When transporting leather and leather shoes it is necessary:

– reliable ventilation in the holds, $t \geq 25°C$;

– stack height $H \leq 2.5$ m;

– cargo pieces ≤ 0.5 m from pipelines, instruments, bulkheads with increased *t.*

– protect from moisture (mold forms), dryness (loses elasticity).

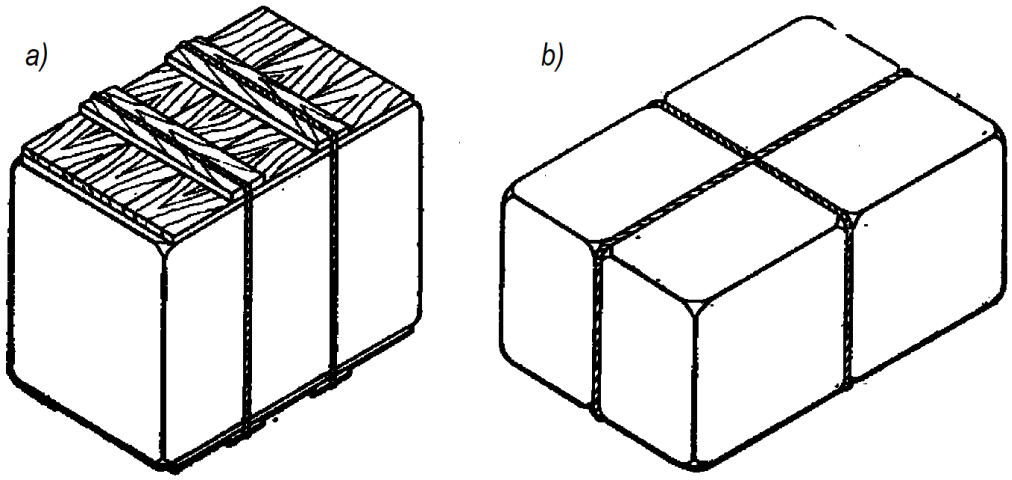



Fig. 6. Bale tare:
a – a bale of garments, knitwear, fur and leather goods; b – a bale of leather and garments

**Perfumes and haberdashery.**

They are transported packed in tight wooden boxes; in containers – in cardboard boxes.

Perfumery emits a strong and persistent odor and must not be transported with food products. Contains flammable and volatile essential oils, therefore should not be transported close to heat sources.

## 5.10. Transportation of metal products, sheet and coiled steel

Transported in bulk; in bundles, packages, packs, boxes; in separate places without packaging. A small $u \leq 1$ m$^3$/t is typical.

Transportation safety is ensured by:

– compliance with stability standards;

– calculation of longitudinal and local strength;

– proper fastening;

– the use of lining materials;
– the use of mechanization.

**Sheet steel.**

It is transported in the form:
– tapes of width $B \leq 400$ mm – in rolls;
– sheet and strip $\leq 4$ mm thick – in packs;
$\geq 4$ mm – in packs and by the piece.

If the steel sheets have $L \geq 2$ m and a thickness of $\leq 3$ mm, wooden or metal bars are attached to the bundles from below. The height of the stack of sheet steel in bundles is $H \leq 4$ m, each tier is separated by gaskets.

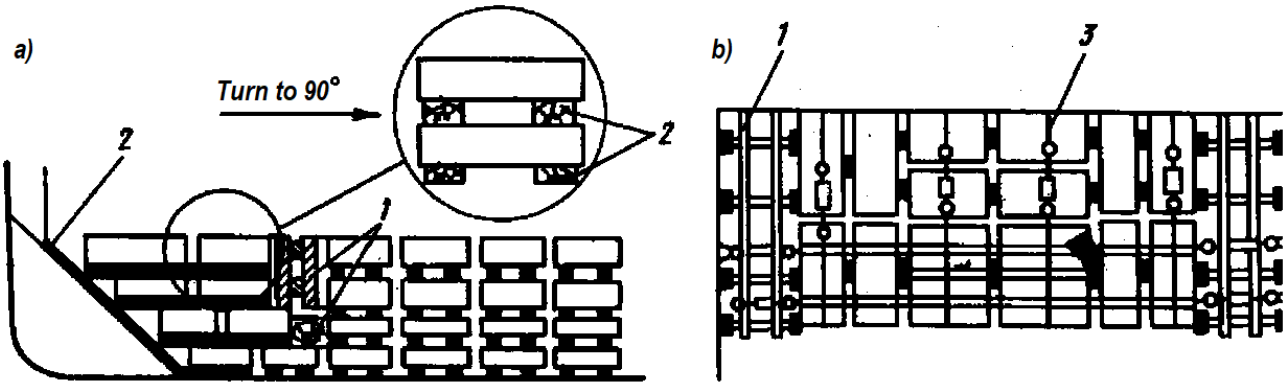



Fig. 7. Laying and fixing sheet steel in bundles:
1 – wooden spacers; 2 – gaskets; 3 – lashing

**White tin in bundles.**

In bundles (packs) of 1000 sheets. Packs are wrapped in moisture-proof paper or lined with bituminized corrugated cardboard. From above and below, the packs are covered with sheets of defective black tin or cardboard and fastened with steel strips to a wooden pallet with support beams 60 x 60 mm.

**Coiled steel.**

Rolls can be transported horizontally (on the generatrix) and vertically (on the butt end). Wood lining is installed under each roll. The rolls are fastened with steel ropes.

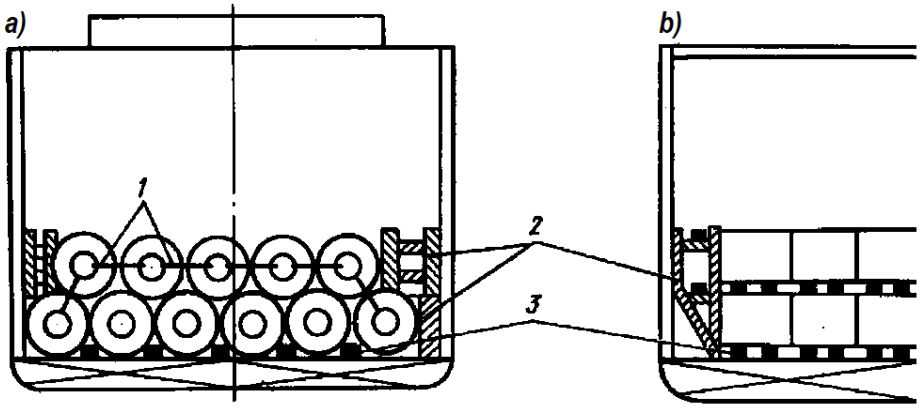



Fig. 8. Stowing and securing coiled steel:
a – horizontal(on the side/ generatrix) ; b – vertical (on the butt end)

**Bar steel.**

If the thickness of the bar is ≤ 20 mm, it is transported in coils; ≥ 20 mm, – in bundles tied every 2–3 m.

**Non-ferrous metals.**

They are transported in the form of: pigs; sheets; skeins of wire. Zinc and lead pigs are transported in packages on wooden beams. Packages are tied with packing tape.

**Pig iron.**

Transported in bulk.

**Rails, beams.**

Stowed along the ship. Gaskets are installed between the tiers for possible slinging and avoiding slippage.

**Wire.**

Transported: in skeins; wrapped in moisture-proof paper and laid in wooden boxes; wrapped in burlap; without packaging.

**Wire rod.**

Stowed athwartship in tights rows from side to side. Planks are laid on the metal flooring of the hold.

**Hardware (metal wares).**

These are bolts, nails, nuts, screws, chains, ropes, metal nets. They are transported in wooden boxes or rolls.

## 5.11. Transportation of pipes

Pipes are available in small, medium and large diameters.

**Small diameter pipes.**

They are transported in packages (bundles), in boxes.

**Medium diameter pipes (steel and cast iron).**

They are transported in bundles tied with wire in 4 places. Threaded pipes are supplied with couplings.

**Large diameter pipes.**

Used in the construction of main pipelines. Length $L$ = 8-12 m Separation from boards is placed under the bottom row. They are transported in the holds and on the deck by a welded joint upward parallel to the Diametrical plane.

A free space of about 1 m is left in the upper part of the hold. On the deck they are fastened with lashing chains $D$ = 19 mm; steel cable $D$ = 22 mm.

## 5.12. Transportation of reinforced concrete products

Transportation features: variety of forms; fragility of products. Each product must be marked with mass, support points, loops or holes for slinging. Stacked:

– lightweight concrete, as well as products with a thickness of ≤ 200 mm – on a narrow edge;

– columns, piles, bearings and piers of Power Lines and bridges – horizontally and on wooden lining;

– foundation slabs – in several tiers.
Stacking height ≤ 2 m.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| wetness | [ˈwɛtnəs] | подмочка |
| sweepings | [ˈswiːpɪŋz] | россыпь |
| spoilage | [ˈspɔɪlɪʤ] | порча |
| damage | [ˈdæmɪʤ] | повреждение |
| theft | [θɛft] | хищение |
| linear | [ˈlɪnɪə] | линейный |
| lathing | [ˈlɑːθɪŋ] | планка, рейка, дранка |
| perimeter | [pəˈrɪmɪtə] | периметр |
| corrugated cardboard | [ˈkɒrʊgeɪtɪd ˈkɑːdbɔːd] | рифленный картон |
| carton | [ˈkɑːtən] | коробки |
| on the butt end | [ɒn ðə bʌt ɛnd] | на торец |
| on the generatrix (side) | [ɒn ðə ˈʤɛnərеɪtrɪks **(**saɪd**)]** | на образующую |
| thickness | [ˈθɪknɪs] | толщина |
| athwartship | [əˈθwɔːtʃɪp] | поперек судна |
| lengthwise ship | [ˈlɛŋθwaɪz] | вдоль судна |
| tight stowage | [taɪt ˈstəʊɪʤ] | плотная укладка |
| brick stowage method | [brɪk ˈstəʊɪʤ ˈmɛθəd] | метод «кирпич. кладки» |
| diametrical flatness, | [ˌdaɪəˈmɛtrɪkəl ˈflætnɪs] | диаметральная плоскость |
| fore and aft overlap | [fɔːr ænd ɑːft] [ˌəʊvəˈlæp] | перекрывать |
| layer | [ˈleɪə] | слой |
| flooring of boards, boardings | [ˈflɔːrɪŋ ɒv bɔːdz, ˈbɔːdɪŋz] | настил из досок |
| plank crate | [plæŋk kreɪt] | планка, рейка, дранка |
| finely dispersed | [ˈfaɪnli dɪsˈpɜːst] | мелко дисперсионные |
| talcum powder | [ˈtælkəm ˈpaʊdə] | тальк |
| square of the hatch | [skweər ɒv ðə hæʧ] | просвет люка |
| liner | [ˈlaɪnə] | Прокладка |
| fibre | [ˈfaɪbə] | волокно |
| fibrous | [ˈfaɪbrəs] | волокнистый |
| pressed bale | [prɛst beɪl] | кипа |
| bale | [beɪl] | тюк |
| to sew | [səʊ] | шить, зашивать |

| | | |
|---|---|---|
| hoop | [hu:p] | обруч |
| convex | [ˈkɒnˈvɛks] | выпуклый |
| cork | [kɔ:k] | пробка |
| fusible | [ˈfju:zəbl] | плавкий |
| cushion stack | [ˈkʊʃən stæk] | штабель-подушка |
| bilge slant | [bɪldʒ slɑ:nt] | льяльный скос |
| emptiness | [ˈɛmptɪnɪs] | пустота |
| bullˈs eye | [bʊlˈɛs aɪ] | «в яблочко» |
| bottom | [ˈbɒtəm] | днище |
| cushion | [ˈkʊʃən] | *техн*. подушка |
| lining | [ˈlaɪnɪŋ] | подкладка |
| spacer | [ˈspeɪsə] | распорка |
| chock | [ʧɒk] | клин |
| wedging | [ˈwɛʤɪŋ] | расклинивание |
| cylinder | [ˈsɪlɪndə] | баллон |
| gasket | [ˈgæskɪt] | прокладка |
| vegetable | [ˈvɛʤtəb(ə)l] | растительный |
| flax | [flæks] | лен |
| hemp | [hɛmp] | пенька |
| beckoning | [ˈbɛkənɪŋ] | манила |
| sisal | [ˈsaɪsəl] | сизаль |
| agave | [əˈgeɪvi] | агава |
| asbestos | [æzˈbɛstɒs] | асбест |
| grade | [greɪd] | сорт |
| contamination | [kənˌtæmɪˈneɪʃən] | засорение (груза) |
| smouldering | [ˈsməʊldərɪŋ] | тление |
| forklift truck | [ˈfɔ:klɪft trʌk] | погрузчик (с вилочным захватом) |
| cargo pendant | [ˈkɑ:gəʊ ˈpɛndənt] | грузовой шкентель |
| to rub | [rʌb] | тереть |
| electrical wiring | [ɪˈlɛktrɪkəl ˈwaɪərɪŋ] | электропроводка |
| cluster lights | [ˈklʌstə laɪts] | люстра (переносная) |
| elastic | [ɪˈlæstɪk] | эластичный |
| elasticity | [ˌɛlæsˈtɪsɪti] | эластичность |
| brittle | [ˈbrɪtl] | хрупкий, ломкий |
| to infect | [ɪnˈfɛkt] | заражать |
| cópra | [ˈkɒprə] | копра |
| cake | [ˈkeɪk] | жмых |
| margarine | [ˌmɑ:ʤəˈri:n] | маргарин |

| | | |
|---|---|---|
| glycerin | [ˌglɪsəˈriːn] | глицерин |
| napalm | [ˈneɪpɑːm] | напалм |
| cellulose | [ˈsɛljʊləʊs] | целлюлоза |
| fungus | [ˈfʌŋgəs] | грибок |
| unbleached | [ʌnˈbliːʧt] | небеленый |
| enclosure | [ɪnˈkləʊʒə] | выгородка |
| flare of the sides. | [fleər ɒv ðə saɪdz] | развал бортов |
| caoutchoúc | [ˈkaʊtʃʊk] | каучук |
| to decay | [dɪˈkeɪ] | гнить |
| soil | [sɔɪl] | земля |
| framing | [ˈfreɪmɪŋ] | набор корпуса судна |
| fusion | [ˈfjuːʒən] | слияние объединение |
| film | [fɪlm] | пленка |
| to impregnate | [ˈɪmprɛgneɪt] | пропитывать |
| nitro-lacquer | [nitrɔ-ˈlækə] | нитролак |
| additive | [ˈædɪtɪv] | присадка |
| cuff | [kʌf] | манжет |
| garment | [ˈgɑːmənt] | одежда |
| garment industry | [ˈgɑːmənt ˈɪndəstri] | швейная промышленность |
| knitwear | [ˈnɪtweə] | трикотаж |
| haberdashery | [ˈhæbədæʃəri] | галантерея |
| moth | [mɒθ] | моль, мотылек |
| disinsectization | [ˌdɪsɪnˌsektə′zeɪʃ(ə)n] | дезинсекция |
| spot | [spɒt] | пятно |
| scraps | [skræps] | обрезки |
| rags | [rægz] | тряпье |
| patent leather | [ˈpeɪtənt ˈlɛðə] | лакированная кожа |
| right side | [raɪt saɪd] | лицевая сторона |
| volatile, essential | [ˈvɒlətaɪl ɪˈsɛnʃəl] | *хим.* летучий, эфирный |
| non-ferrous metals | [ˈnɒnˈfɛrəs] | цветные металлы |
| pig iron | [pɪg ˈaɪən] | чугун (в чушках) |
| skein of wire | [skeɪn] | моток проволоки |
| rail | [reɪl] | рельс |
| slippage | [slipɪʤ] | проскальзывание |
| hardware (metal wares) | [ˈhɑːdweə (ˈmɛtl weəz)] | метизы |
| coupling | [ˈkʌplɪŋ] | муфта |
| main pipelines | [meɪn ˈpaɪplaɪnz] | магистрал. трубопровод |
| welded joint | [ʤɔɪnt] | *техн*. сварной шов |

| | | |
|---|---|---|
| reinforced concrete | [ˌriːɪnˈfɔːst ˈkɒnkriːt] | железобетонный |
| support point | [səˈpɔːt pɔɪnt] | точка опоры |
| loop | [luːp] | петля |
| pile | [paɪl] | свая |
| bearing, pier | [ˈbeərɪŋ, pɪə] | столб, свая, мол |
| Power Lines | [ˈpaʊə laɪn] | линия электропередач |

# 6. TECHNOLOGY OF BULK AND GRAIN CARGOES TRANSPORTATION

## 6.1. Classification and physical properties of bulk cargoes

Bulk cargoes includ a wide range of cargoes transported in bulk without tare: ore, coal, salt, sugar, grain, fertilizers, construction materials. If the cargo consists of homogeneous particles of the same shape and mass, these cargoes are subdivided into bulk flowing cargoes. In accordance with the transport classification, all bulk cargoes are divided into 2 classes: non-grain and grain bulk cargoes.

The transportation of bulk cargoes is associated with the danger that can be caused by: shifting of the cargo and a dangerous list of the vessel; liquefaction of cargo under the influence of vibration and overflowing of cargo to the side; self-heating and spontaneous combustion of the cargo; increased concentration of explosive or poisonous gases; damage to the longitudinal and local strength of the vessel, corrosion of the hull and mechanisms, etc.

The physical composition of any bulk cargo consists of solid particles, water and air. Basic physical and chemical properties:

– density – mass of a unit of its volume, $t/m^3$;

– specific loading volume (stowage factor SF) – volume of a unit of mass of cargo, $m^3/t$;

– shrinkage – the difference between the height of the stack of cargo at its maximum and minimum compaction;

– moisture – the ratio of the difference in masses before and after drying to the weight before drying, %. Depending on the content of moisture types, bulk cargoes are: dry; air dry and humid.

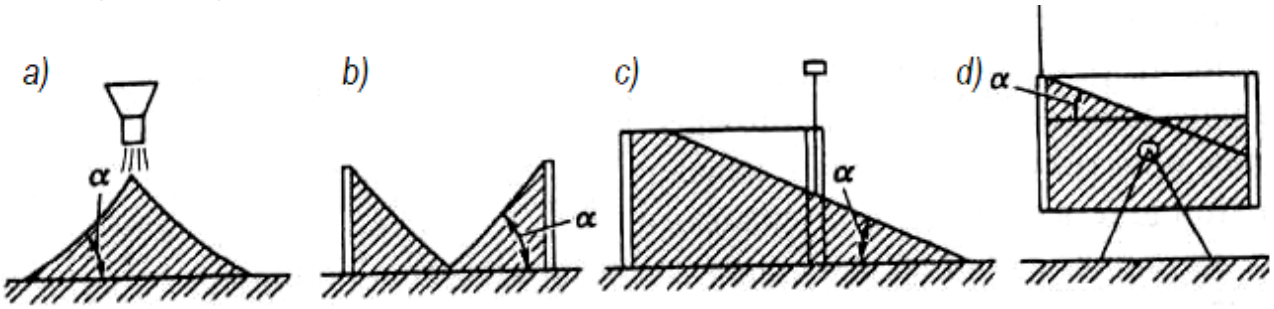



Fig. 1. The angle of natural repospe of the bulk cargo:
a – flowing off cargo from above; b – excavation from the stack; c – removal of the stack's wall; d – slope of the vessel

The most important transport characteristic is flowability, which determines the degree of mobility and is characterized by the angle of natural repose $\alpha$. Bulk cargo is divided into 2 groups: subject to "dry" shifting; subject to shifting when wet (so-called thixotropic). Cargoes subject to dry shifting are classified into adhesion

(имеющие сцепление) and non-adhesion cargoes. Cargoes without adhesion are divided into 3 groups: with $\alpha \leq 30^{o}$, with $\alpha$ = 30-35$^{o}$ and with $\alpha \geq 35^{o}$. The criterion of "dry" non-displacement is $\alpha = 35^{o}$. Cement, bauxite, clay, coal, scrap metal, ore have such an angle. These are "conditionally" non-hazardous cargoes by dry displacement.

Thixotropic cargoes pose a great danger to the vessel. Liquefaction occurs as a result of moisture "squeezing" from the lower layers of the cargo to the upper ones.

### 6.2. Dangers associated with the transportation of coal and iron ore

When transporting coal, it is necessary to take into account self-heating and spontaneous combustion, freezing, and the ability to grind. Wet and freshly mined coals, as well as coals that contain a large amount of fines and dust, are sujected to self-heating and ignition. Under the influence of low temperatures, coals can freeze; in order to avoid this, it is necessary to reduce the moisture content of coal to 5%, at which the coals practically do not freeze. During cargo works, the coals are subject to crushing, the amount of fines can be 10-15%. When transporting coal, $CH_4$ methane is emitted. Ensuring the safe transportation of coal and proper seaworthiness of the vessel is regulated by the "Rules for the carriage of bulk and bulk flowing cargoes". According to them:

– vessels must have equipment for extinguishing steam or carbon dioxide extinguishing, means for temperature control of the stack of the cargo, rescue oxygen devices;

– all electrical equipment in the cargo spaces of the ship must be reliably isolated from the cargo;

– holds must be clean, no oiled ropes, tow, chips, burlap and other materials are allowed.

To prevent spontaneous combustion of cargo, you must:

– not allow loading coal with a temperature of 35°C and above;

– machinery, boiler rooms or other heated bulkheads of cargo spaces should be insulated from contact with coal;

– to observe the temperature control regime and changes in the temperature of the cargo during the watch, the readings of the thermometers should be entered in the Logbook;

– upon detection of an increase in the temperature of the cargo up to 60 °C, it is necessary to take urgent measures to eliminate the hotbed of self-heating, namely: to stop air access to the cargo space while using the fire extinguishing equipment available on the ship.

It is strictly forbidden to transport coal together with fire hazardous cargo, as well as cargo that must not be contaminated or are incompatible for other reasons.

Ores with a high sulfur content (pyrite, some types of iron ores) are susceptible to self-heating and spontaneous combustion. Therefore, when transporting them, one should be guided by the requirements applicable to the transportation of coal.

Most of the ores are freezing, and lose their free flowing properties at sub-zero temperatures. This is prevented by:

– freezing of cargo in separate lumps or small pieces;

– periodic flowing of cargo with excavators and grabs;

– flowing the cargo with quicklime, sawdust, sodium chloride and calcium chloride;

– uniform placing of straw, straw chaff, reeds and peat fines between the cargo layers;

– lubrication of the floor and walls of wagons and platforms and spraying of cargo with mineral and coal oils.

In order to avoid damage to the longitudinal strength of the vessel during loading, it is necessary to load the ore evenly and load the middle holds first, and then fill all the spaces of the vessel. It is advisable to place ore in the forward hold closer to the aft bulkhead, and in the aft hold, when the ER is located in the middle part, to the forward bulkhead. During the voyage, the holds must be ventilated and the temperature of the cargo in them must be controlled.

### 6.3. Regulatory documents governing the carriage of non-grain bulk cargoes

IMO developed the Code of Safe Practice for Solid Balk Cargoes, adopted in London in 1991 with amendments in 1992. The Code is advisory in nature and is now in its 3rd edition. On the basis of the "Code", SOLAS-74 and others, a system of safety criteria was developed, including:

*The criterion of non-shifting* is the limit of the equilibrium state of the bulk cargo in the conditions of sea transportation; *non-liquefaction cr*iterion – the limit of the state of plasticity of the bulk cargo; *stability criterion* of a vessel when bulk cargo liquefies – a set of additional requirements for the stability of a vessel in the case when cargo is loaded onto the vessel in violation of the criterion of non-liquefaction. *The criterion for the stability of a vessel with a "dry" shifting* of a bulk cargo is a set of additional requirements for the stability of a vessel. In this case, the stability of a vessel carrying non-grain shifting bulk cargoes, taking into account the correction for the effect of free surfaces of ship's liquid stores and cargo, but without taking into account icing, should be such that, under the influence of the conventional heeling moment $M_{sc}$ from the shifting cargo, the angle of the vessel's static heel $\theta_{sc}$ does not

exceed 12°, the residual area of the static stability diagram, calculated from the angle of static heel to the angle of 40° or the pouring angle $\theta_f$ (whichever is less), was not less than 0.12 m rad., the metacentric height *h* under the worst sailing conditions was not less than 0.7 m.

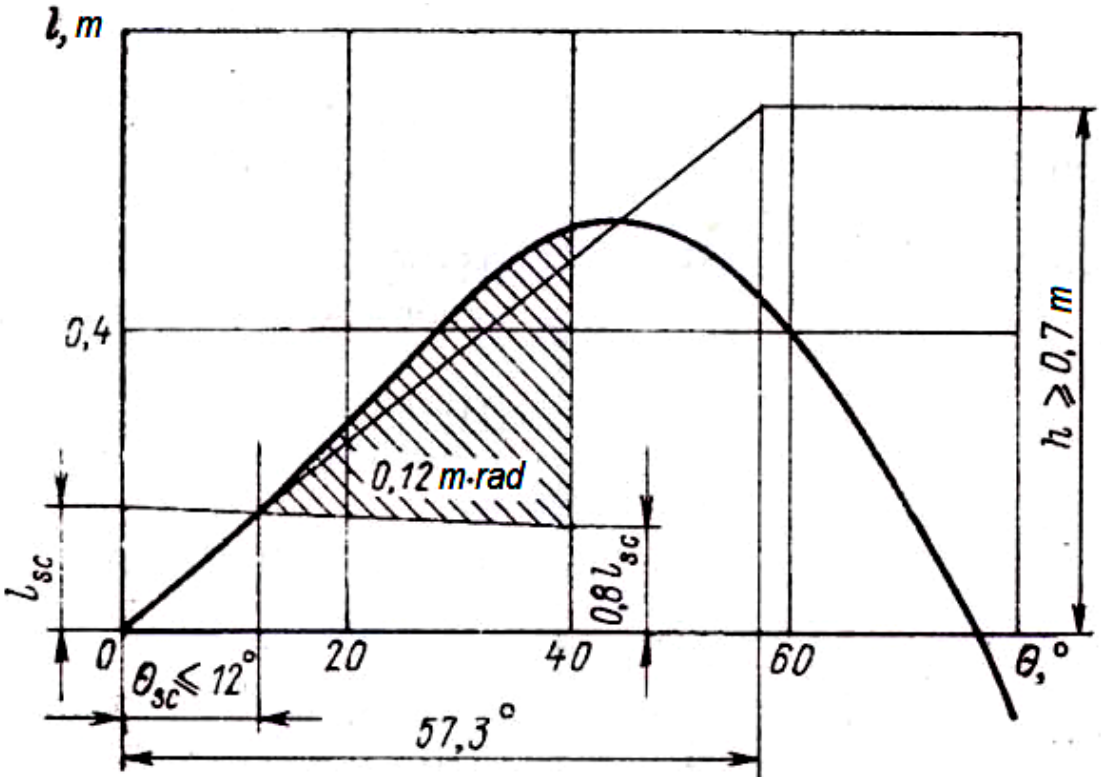



Fig. 2. Diagram of static stability of a vessel with bulk cargo, which is dangerous for dry displacement

*The Non-combustible criterion* – the limit of the state of non-combustible cargo.

*The criterion for the non-gas content of the atmosphere of cargo spaces* is the limit of the condition of the atmosphere of cargo spaces loaded with bulk cargo that is non-hazardous with respect to explosion or human health.

Dangerous bulk cargo is presented in classes 4–9. IMO has approved the compatibility conditions for dangerous bulk cargo.

In addition, IMO has adopted a Code of Safe Practice for Loading and Unloading Vessels for Carriage of Dry and Bulk Cargoes (BLU Code). The Code includes 6 sections and 5 appendices.

Chapter VI of the International Convention for the Safety of Life at Sea SOLAS 74/78 is devoted to the transportation of cargoes. It contains sections:

– A – General provisions;

– B – Special requirements for bulk cargo other than grain;

– C – Transportation of grain.

Chapter VII describes the requirements for the carriage of Dangerous Goods, including bulk cargo.

The national legislation includes:

– "Safety rules for the carriage of non-grain bulk cargo (liable to liquefaction and hazardous chemical properties)".

## 6.4. Vessels for the carriage of bulk cargo, the procedure for their loading and unloading

About 3 billion tons of bulk cargo are transported in the world annually. Since the 50$^{th}$ of the 20$^{th}$ century, bulk carriers vessels began to be built for these purposes. This type of vessel has a single hull, double bottom, large cargo holds, upper and lower side tanks. To exclude stowage of cargo, suspended tanks are placed under the main deck and bilge bevels are performed.

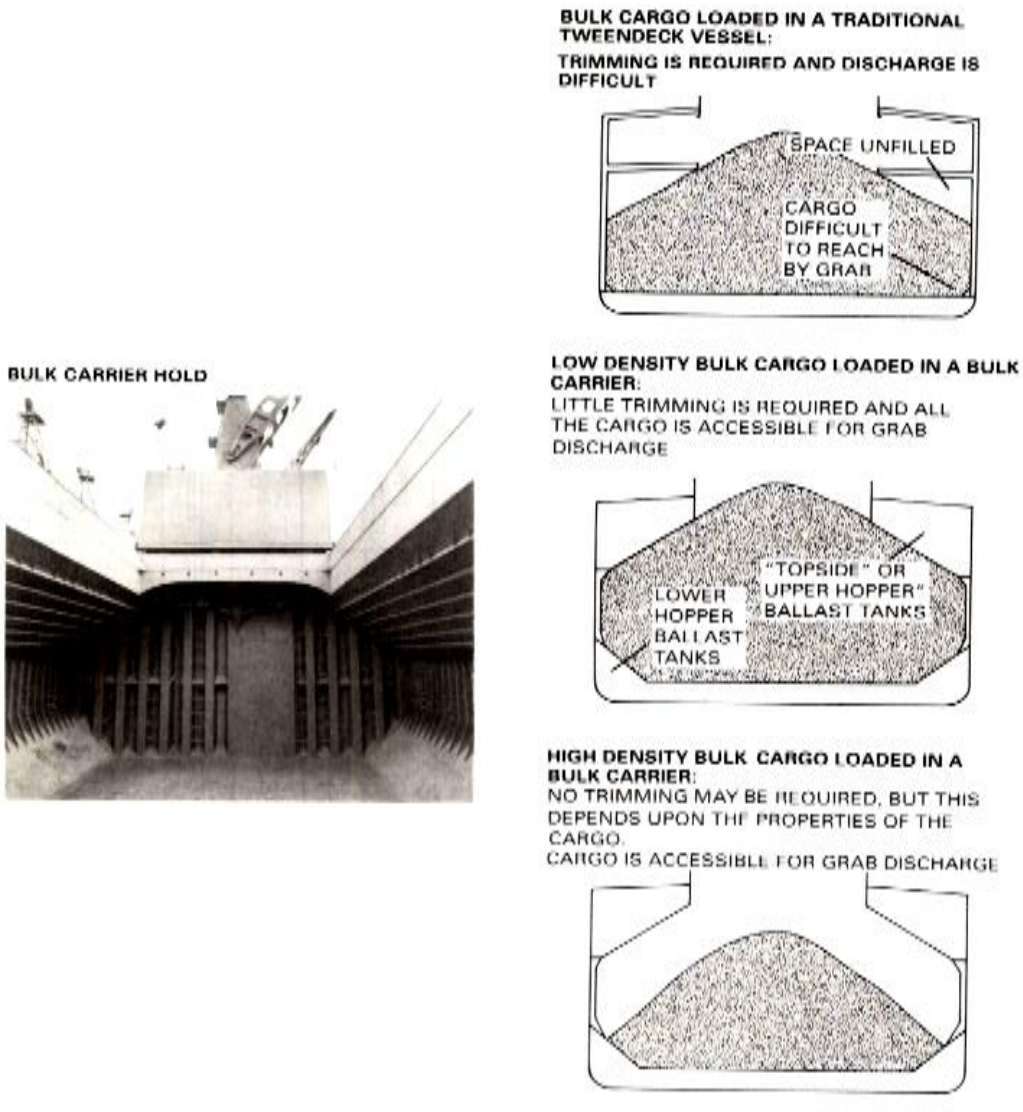



Fig. 3 Stowage of bulk cargoes in the hold of the bulk carrier

Since the 70th, bulk carriers DW ≥ 200 thousand tons have been built. Hatchway coefficient $k_h$ = 0.6–0.8.

The following types of bulk carriers are distinguished:

– Minibulker..... ≤ 10 thousand tons;

– Handybulker.....10–30 thousand tons;

– Handymax .....30–50 thousand tons;

– Panamax.....50–80 thousand tons;

– Capesize.....100–160 thousand tons.

Bulk carriers of the VLBC type have a *DW* of 200 thousand tons. The largest bulk carrier in terms of size was built in 2010.

This is m/v “Vale Brazil”. *DW* = 402 thousand tons, *L* = 362 m.

There may be such variants for loading of bulk carriers:

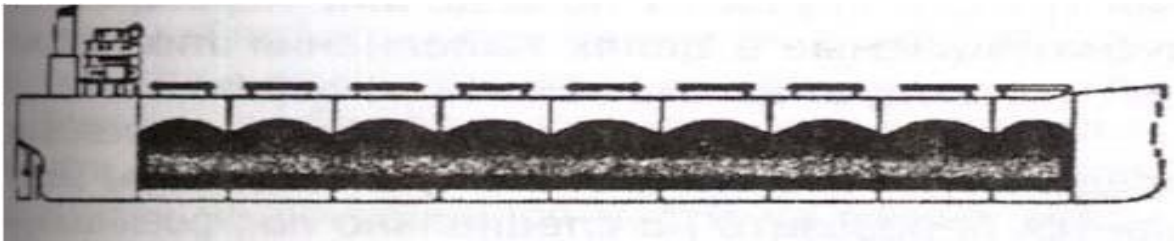


Fig. 4. Uniform distribution of cargo in the holds

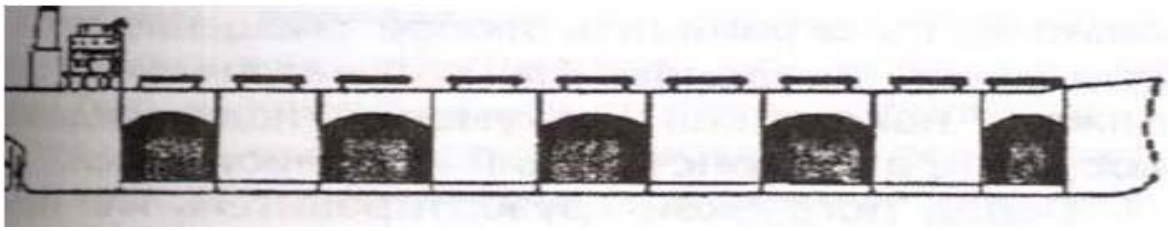


Fig. 5. Distribution of cargo in every other(through) hold

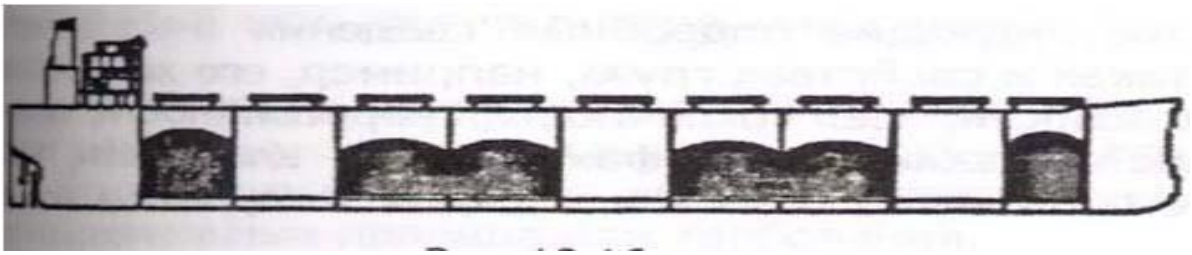


Fig. 6. Block-by-block distribution of cargo

Light cargoes are evenly distributed over the holds.

Stowage in every other hold or block-by-block (in 2 or more adjacent holds) is performed when transporting ore, pigs, scrap metal. In this case, permission from the Classification Society is required. When unloading, the cargo area can be conditionally divided into 3 zones:

– The clear space of the hold. "Cream digging" zone;

– Depth of the hold. Free digging zone;
– Side and bulkhead area. Collection of cargo residues (“trimming”).

## 6.5. Properties of grain bulk cargoes

All grain cargoes are conventionally divided into 3 groups:
– cereals (rye, wheat, oats, barley, millet, corn, rice;
– beans (peas, French beans, soybeans, peanuts;
– oilseeds (seeds of sunflower, flax, sesame, hemp.

The main distinguishing feature of grain cargo is *flowability*. The value of the natural angle of repose α, in addition to external dynamic factors, is greatly influenced by the degree of moisture of the cargo. With an increase in the moisture content of the cargo, α grows to certain limits, and then sharply decreases when the cargo reaches a liquid-fluid state. α for wheat – 16–38°, rye – from 17–38°, barley – from 16–45°, oats – from 18–54°, peas from 20–35°, flaxseed from 14–34°. At increased to (≥ 50°C) grain flowability decreases and it starts to deteriorate. It should be borne in mind that an increase in *t*° of moistened grain forms poisonous and explosive gases, that can cause spontaneous combustion. The main reason for grain deterioration during transportation is moisture. Therefore, ventilation is performed with outside air. Cereals goods are not accepted for transportation with a moisture content of ≥ 15.5% – rye, rice, oats, wheat, corn; 16% – peas, beans, cereals and compound feed; without Phytosanitary Certificates: seed grain contaminated with quarantine weeds ; infected with pests of cereals, etc.

Another property is shrinkage and poroing. Grain stowage is less dense if the loading is done by “jet”, and more dense if it is “rain”.

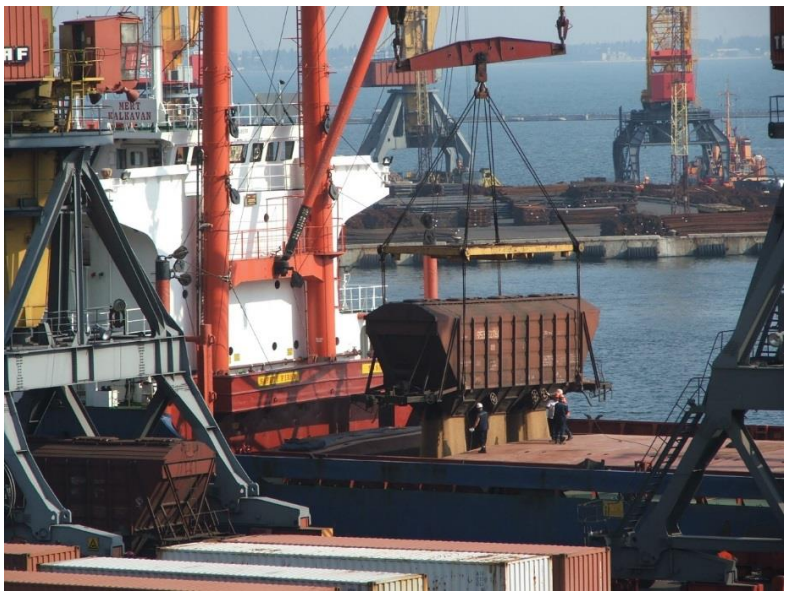


Fig. 7 Grain loading according to the direct variant "wagon-ship"

## 6.6. Regulation of transportation of grain bulk cargoes

The requirements for ensuring the safety of a ship during the carriage of grain are based on the assumption that there are below-deck voids in every cargo space, even if it is completely filled. Taking into account the properties of grain cargoes and types of hazards, a set of rules has been developed that regulate the conditions of transportation and storage:

– Chapter VI of the International Convention for the Safety of Life at Sea SOLAS 74/78. Section C – "Transportation of grain".

– "International Grain Code, IGC, (International Code for the Safe Carriage of Grain in Bulk).

– Rules of the Register of Shipping;

– "Rules for the carriage of food by sea".

On the basis of these documents, every ship carrying grain in bulk must have on board a *"Document of Permit"*. It should be issued to each vessel on behalf of the Ship's Flag Administration if the ship complies with the requirements of the IGC. A vessel that does not have a "Document of Permit" may be allowed to load grain in bulk, provided that: the total weight of grain in bulk is $Q \leq 1/3\ DW$; in all "filled compartments with trimming" diametrical bulkheads must be installed along the entire length of the compartments; in partially filled compartments, all free surfaces of the grain must be leveled and secured in accordance with the recommendations of the IGC; throughout the voyage, the metacentric height corrected for free surface should be 0.3 m.

In accordance with the IGC, all cargo spaces of the vessel are divided into 4 categories according to the nature of their filling with grain:

– "filled compartment with trimming" – a compartment in which the grain, after loading and trimming, reaches the highest possible level;

– "filled compartment without trimming" – the maximum amount of grain is immersed in the hatch square, but not trimmed outside the square of the hatch;

– "partially filled compartment" – a compartment loaded in a different way than indicated in the previous two cases;

– specially adapted.

**Stability of ships carrying grain in bulk.**

The static stability diagram of a ship with grain is drawn in the same way as the static stability diagram of a vessel with a bulk cargo, which is dangerous by dry shifting. Only the residual area of the diagram and the metacentric height have other values. Stability must meet the requirements:

1) The angle of static heel $\theta_g$ after the application of the conditional heeling moment should be ≤ 12° or (for vessels of unlimited navigation area) the angle of the deck's entry into the water $\theta_\alpha$, if it is ≤ 12°.

2) The residual area of the static stability diagram between the curves of the restoring and heeling arms up to the list angle corresponding to the maximum difference between the ordinates of the two curves $\theta_{max}$ or 40°, or the pouring angle $\theta_f$ ; depending on which of them ≤, under all loading conditions should be ≤ 0.075 m·rad;

3) The initial metacentric height after correction for the effect of free surfaces of liquid cargoes should be ≥ 0.3 m;

4) the stability of a vessel carrying grain should be checked over the entire range of specific cargo volumes.

$$\lambda^{\circ}_{40} = \frac{\text{Conditional volumetric heeling moment from transverse grain shifting}}{\text{Specific gravity } x \text{ displaysment}},$$

$\lambda^{\circ}_{40} = 0.8\lambda^{\circ}_{0}$.

**Grain loading, vessel at sea and cargo unloading.**

The hold should be ventilated if the ventilation air *t* is below its τ**.** The hold cannot be ventilated when τ (dew point) of the ventilation air is equal to or more than the *t* of the cargo and if the *t* of the outside air is higher than the *t* of the cargo. When the ventilation air is colder than the cargo, the appropriateness of the hold ventilation is determined depending on the ratio *t* and τ of the outside air, cargo and hold’s air.

**Unloading process.**

When unloading the cargo, it is necessary: to prevent the vessel from heeling more than 2º; control the mass of the unloaded cargo based on the drafts readings; timely carry out ballast operations; monitor the stability and observance of the longitudinal strength of the ship's hull.

## 6.7. Transportation of grain in bulk in cargo spaces and methods of securing

In order to prevent the emergency shifting of the cargo, the following methods are used for the safe transportation of grain:

1. "Free loading", or "no-shift" method of transportation of grain. All but one of the holds and twin decks, as well as the cargo compartments, are loaded to the level of the hatch covers. Sometimes you have to take water ballast.

2. A group of methods limiting the flowing of grain cargo. This is achieved with the help of additional equipment (devices) that reduces the free surface area of the cargo or dividing the volume containing it into narrower compartments. For

example, feeders are arranged – volumes of grain fenced off by bulkheads, connected to the underlying cargo. The free surface may be limited by grain in bags stowed along the bulkheads of the cargo area. Sometimes the grain is divided by longitudinal bulkheads (shiftingboards).

3. A group of methods to prevent grain flowing. This is achieved by creating additional pressure on the surface of the grain. These include:

– *bagging*, i.e. overloading the grain surface with tiers of bags with grain or other piece cargo. The platform or separation cloth should be covered with bags of grain, packed tightly to a height of at least 1/16 of the width of the free surface of the grain, or 1.2 m, whichever is greater;

– *bundling*, which is an extensive film or cloth container with a boarding, filled with grain and placed on top of the main grain cargo (Fig. 8);

– *slinging* – a semi-rigid blanket made of fabric, boards and steel ropes, located on the surface of the grain (Fig. 9);

– *pneumatic slinging*, based on inflated covers.

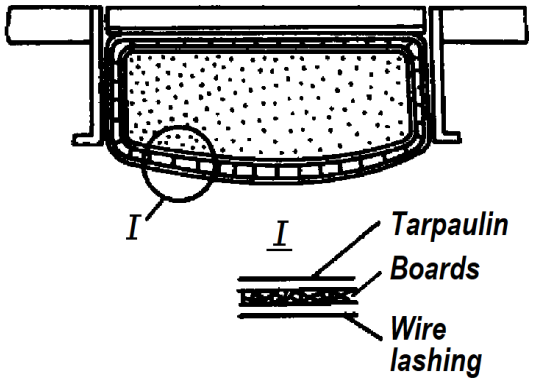



Fig. 8 Securing grain using the "bundling" method

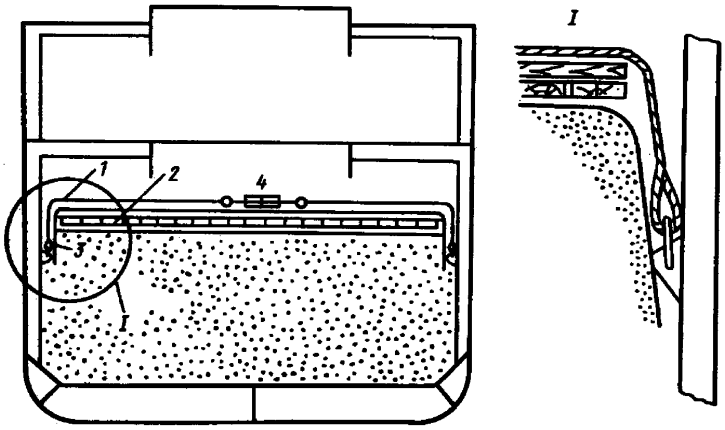



Fig. 9. Securing grain in the hold by the "slinging" method: 1– lashings; 2 – boards; 3 – tarpaulin; 4 – lanyard

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| bulk cargoes | [bʌlk ˈkɑːgəʊz] | навалочные грузы |
| bulk flowing cargoes | [bʌlk ˈfləʊɪŋ ˈkɑːgəʊz] | насыпные грузы |
| shifting | [ˈʃɪftɪŋ] | смещение |
| liquefaction | [ˌlɪkwɪˈfækʃən] | разжижение |
| overflowing | [ˌəʊvəˈfləʊɪŋ] | пересыпание |
| specific loading volume (stowage factor SF) | [spɪˈsɪfɪk ˈləʊdɪŋ ˈvɒljʊm] (ˈstəʊɪʤ ˈfæktər)] | удельный погрузочный объем (УПО) |

| | | |
|---|---|---|
| shrinkage | [ˈʃrɪŋkɪʤ] | усадка |
| compaction | [kəmˈpæk·ʃən] | уплотнение |
| flowability | [fləʊəˈbɪlɪti] | сыпучесть |
| angle of natural repose | [ˈæŋgl ɒv ˈnæʧrəl rɪˈpəʊz] | угол естествен. откоса |
| thixotropic | [ˈθɪksəˈtrɒpik] | тиксотропный |
| adhesion | [ədˈhiːʒən] | сцепление |
| conditionally | [kənˈdɪʃənli] | условно |
| designation | [ˌdɛzɪgˈneɪʃən] | обозначение |
| flowing off (from) | [ˈfləʊɪŋ ɒf **(**frɒm**)]** | отсыпка (из) |
| excavation (taking out) | [ˌɛkskəˈveɪʃən] | выемка |
| stack | [stæk] | штабель |
| slope | [sləʊp] | наклон |
| vessel | [ˈvɛsl] | сосуд |
| to squeez\|e, -\|ing | [ˈskwiːz, -ɪŋ] | выжимать, отжим |
| to grind | [tuː graɪnd] | измельчать |
| layer | [ˈleɪə] | слой (груза) |
| fines | [faɪnz] | мелочь (в углях) |
| crushing | [ˈkrʌʃɪŋ] | раздробление (в углях) |
| tow | [təʊ] | пакля |
| chip | [ʧɪp] | стружка, щепка |
| burlap | [ˈbɜːlæp] | мешковина |
| lump | [lʌmp] | кусок, глыба |
| quicklime | [ˈkwɪklaɪm] | негашеная известь |
| sawdust | [ˈsɔːdʌst] | опилки |
| sodium chloride | [ˈsəʊdiəm ˈklɔːraɪd] | поваренная соль |
| calcium chloride | [ˈkælsɪəm ˈklɔːraɪd] | хлористый кальций |
| straw | [strɔː] | солома |
| straw chaff | [strɔː ʧɑːf] | соломенная сечка |
| reed | [riːd] | камыш |
| peat | [piːt] | торф |
| even, -ly | [ˈiːvən] | ровный, равномерно |
| criterion | [kraɪˈtɪərɪən] | критерий |
| non-shifting | [nɒn-ˈʃɪftɪŋ] | не смещаемость |
| non-liquefaction | [nɒn-ˌlɪkwɪˈfækʃən] | не разжижаемость |
| conventional (conditional) heeling moment | [kənˈvɛnʃənl **(**kənˈdɪʃənl**)** ˈhiːlɪŋ ˈməʊmənt] | условный кренящий момент |
| recidu\|\|e, -al | [ˈrɛzɪdjuː], [rɪˈzɪdjʊəl] | остато\|\|к, -чный |

| | | |
|---|---|---|
| bilge bevels | [bɪldʒ ˈbɛvəlz] | льяльные скосы |
| hatchway coefficient | [ˈhætʃweɪ ˌkəʊɪˈfɪʃənt | коэфф-ент лючности |
| to distribut\|e, -ion | [dɪsˈtrɪbju(ː)t, -ʃən] | распредел\|\|ять, -ние |
| stowage | [ˈstəʊɪdʒ] | погрузка, укладка |
| uniform | [ˈjuːnɪfɔːm] | равномерный |
| pig | [pɪg] | чушка (чугуна) |
| rye | [raɪ] | рожь |
| wheat | [wiːt] | пшеница |
| oats | [əʊts] | овес |
| barley | [ˈbɑːli] | ячмень |
| millet | [ˈmɪlɪt] | просо |
| peas | [piːz] | горох |
| French beans | [frɛntʃ biːnz] | фасоль |
| soybeans | [ˈsɔɪbiːnz] | соя |
| flax | [flæks] | лен |
| sesame | [ˈsɛsəmi] | кунжут |
| hemp | [hɛmp] | конопля |
| liquid/fluid | [ˈlɪkwɪd/ˈflu(ː)ɪd] | текучий |
| to contaminat\|\|e, ion | [kənˈtæmɪneɪt] | засор\|\|ять, -ние (груза) |
| weed | [wiːd] | сорняк |
| to infect | [ɪnˈfɛkt] | заражать |
| poro\|\|us, -ing | [ˈpɔːrə\|\|s, – ɪŋ] | скважист\|\|ый, -ость |
| square of the hatch | [skweər ɒv ðə hætʃ] | просвет люка |
| timely | [ˈtaɪmli] | своевременный |
| boarding | [ˈbɔːdɪŋ] | настил из досок |
| lashing | [ˈlæʃɪŋ] | найтов |
| lanyard | [ˈlænjəd] | талреп |
| cover | [ˈkʌvə] | *mex*. покрытие |

# 7. TECHNOLOGY OF DANGEROUS CARGOES TRANSPORTATION

## 7.1. Classification of dangerous cargoes

Dangerous cargoes or goods (DG) include substances that have dangerous properties and require special measures during transportation and storage precautions. The dangerous properties of goods include: explosiveness, flammability, poisonousness (toxicity), infectiousness, radiation hazard, oxidative effects and corrosiveness.

Transportation of DG must be carried out in compliance with the requirements of "International Maritime Dangerous Goods Code" (IMDG Code) IMO. All DG are divided into 9 classes and subclasses:

Class 1. Explosives. According to the degree of danger, they are divided into 6 subclasses.

Class 2. Gases compressed, liquefied and dissolved under pressure. Divided into 4 subclasses.

Class 3. Inflammable liquids (IFL). Divided into 3 subclasses.

Class 4. Inflammable substances (ILS). Divided into 3 subclasses.

Class 5. Oxidizing substances (OS) and organic peroxides (OP). Divided into 2 subclasses.

Class 6. Poisonous (PS) and infectious (IS) substances. Divided into 2 subclasses.

Class 7. Radioactive substances (RS). Divided into categories and groups.

Class 8. Caustic and corrosive substances (CS). Divided into 3 subclasses.

Class 9. Other dangerous goods not classified in classes 1-8.

## 7.2. Regulation of the carriage of dangerous goods

The carriage of dangerous goods is regulated by the following documents:

1) International Maritime Dangerous Goods Code (IMDG Code);

2) International Convention for the Safety of Life at Sea, 1974 (The International Convention for the Safety of Life at Sea, SOLAS 1974);

3) International Convention for the Prevention of Pollution from Ships, MARPOL 73/78).

The main document regulating the carriage of dangerous goods by sea is the IMDG Code, which consists of 2 volumes and an Appendix.

Structure of the IMDG Code.

Volume 1:

Part 1: General provisions, definitions and training of personnel;

Part 2: Classification;

Part 3: List of dangerous goods (found in 2nd volume);
Part 4: Packing and tank provisions;
Part 5: Shipping procedures;
Part 6: Construction and testing of tare;
Part 7: Provisions concerning transport operations.
The Addendum contains the following basic documents:
– Emergency situation procedures for ships carrying DG (The EmS Guide);
– Guide to first aid in cases of dangerous cargo (MFAG);

### 7.3. Preparation of dangerous goods for carriage

In accordance with the requirements described in chapter 5.2 of the IMDG Code, each DG must be specially marked (danger signs), which indicates the type and degree of danger using color labels and symbols.

If the cargo has several types of danger, then signs indicating all types of danger are applied on the package or container.

The general requirements for DG packing are:

– the packing must be of good quality, be in good condition;

– the inner surface, with which the packaged substance may come in contact, has not been affected by these substances.

The packaging for the transport of DG is tested by the manufacturer for:

– pressure (hydraulic) in accordance with the established limits for each cargo;

– fall – dropping from a height of 0.8-1.8 m depending on the hazard class;

– static load – stack height up to 8 m;

– tightness;

– limit fluctuations of $t$ –20° ÷ +70° C and of humidity 30–100%;

– interaction with sea water and precipitation, for deck cargo.

On the tare, in addition to marking, hazard signs must be applied.


The stowage of dangerous goods on a ship, their segregation relatively to each other is carried out in accordance with the requirements of the provisions on stowage and segregation given in part 7 of the 1st volume of the IMDG Code. There are 5 categories of stowage: A, B, C, D, E.

When stowage dangerous goods, it is necessary to take into account their properties and the possibility of

interaction with each other in cases of damage to the package. In order to avoid dangerous situations, such goods must be stowed relativly to each other in accordance with the requirements of the provisions on segregation.

There are 4 main provisions for stowage dangerous cargoes relative to each other:

– away from;

– separate from;

– through one compartment or hold from;

– longitudinally through one intermediate compartment or hold from.

When transporting by sea:

– dangerous cargoes must be properly and safely stowed in accordance with the properties of the cargo, incompatible cargoes should be transported separately from each other;

– explosives should be stowed in a separate premises that is securely closed for the entire duration of the voyage, such cargo is transported separately from detonators;

– cargoes emitting dangerous vapors must be loaded into well-ventilated cargo spaces or on deck;

– substances subject to self-heating should not be transported without precautions to prevent fire.

**Cargo documents.**

According to the requirements of the IMDG Code, the vessel must have a Certificate for the carriage of dangerous goods, which indicates which classes of dangerous goods are allowed for carriage and the requirements for their stowage on board.

Upon presentation of dangerous goods for transportation, a package of documents must be presented, which is required for normal categories of cargo. In addition to them, a Certificate or Declaration must be attached stating that the presented cargo can be accepted for carriage. The following documents must be attached to the DG Declaration:

– Application for the carriage of dangerous goods. Served by the shipper to the carrier;

– Certificate of Compliance with the IMDG Code Rules for the shipment of dangerous goods. Submitted by the shipper;

– Dangerous Goods Packaging Compliance Certificate;

– Certificate of loading a container with dangerous goods;

– Declaration of loading a vehicle with dangerous goods

## 7.4. Preparing a vessel to receive dangerous goods

Requirements for vessels carrying dangerous goods depend on the properties of the cargo being transported and the dangers they have in relation to the crew, vessel, jointly carried cargoes and the environment.

The constraction of the cargo hatch covers of the upper and lower decks should ensure smooth and shockless movement of hatch covers, excluding sparking.

Enclosed cargo premises are recommended to be equipped with stationary systems for measuring cargo temperature, as well as temperature, relative humidity and composition space air. In the absence of such systems, other methods of determining these parameters should be provided.

Before loading dangerous goods, the cargo premises of the vessel should be cleaned, washed and dried. They check for the presence of battens in the regular places, the presence of piping sheathing and protruding metal parts in the hold. The bilge covers are opened, the bilges are cleaned, the drainage system is checked in operation.

Vessels intended for loading dangerous cargoes must have:

– Certificate of Construction and Equipment Compliance with the requirements of SOLAS;

– Technological Act establishing the degree of the vessel's fitness for the carriage of dangerous goods. It is recommended to attach schemes of cargo premises to the Act.

## 7.5. Requirements for the training of the crew

When transporting dangerous goods, there is a set of requirements for the training of the vessel's crew.

The vessel's administration is obliged to conduct:

1) briefing the crew members on how to handle this category of dangerous goods;

2) provide them with personal protective equipment;

3) members of the emergency party must undergo special training in the techniques and methods of emergency work with dangerous goods, the use of protective equipment and the use of control devices.

### WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| inflammable | [inˈflæməbl] | легковоспламеняемый |
| caustic substances | [ˈkɔːstɪk ˈsʌbstənsɪz] | едкие вещества |
| covering, tare | [ˈkʌvərɪŋ, teə] | тара |

| | | |
|---|---|---|
| packing, package | [ˈpækıŋ, ˈpækıʤ] | упаковка |
| static load | [ˈstætık ləʊd] | статическая нагрузка |
| to fluctuat‖e, -ions | [ˈflʌktjʊeı‖t, – ʃən] | колеба‖ться, -ние |
| interaction | [ıntərˈækʃən] | взаимодействие |
| intermediate | [ˌıntəˈmiːdiət] | Промежуточный |
| smooth | [smuːð] | плавный |
| shock, -less | [ʃɔk, -lɛs] | удар, безударный |
| battens | [ˈbætnz] | рыбинсы |
| sheath‖ -ing, -e | [ˈʃiːð, -ıŋ] | футляр, обшив‖ка, -ть |
| briefing /instructing | [ˈbriːfıŋ /ınˈstrʌktıŋ] | инструктаж |
| to protrude‖e, -ing | [ prəˈtruːd, -ıŋ] | выдаваться наружу, выступат‖ь, -ющий |

# 8. TECHNOLOGY OF FOOD CARGOES TRANSPORTATION

## 8.1. Classification of food cargoes

Food cargo includes cargo of plant and animal origin, which require certain modes of transportation:

– given storage *t*;

– air exchange in cargo spaces;

– regulation of the gas composition of the air;

– fulfillment of quarantine requirements.

Transportation of food cargoes is accompanied by the presence of certificates:

– Quality Certificate;

– Phytosanitary Certificate;

– Veterinary Certificate;

– Hygiene Certificate.

In accordance with «Rules for the Carriage of Food by Sea» the class «Food Cargo» is divided into 2 subclasses:

– «Perishable»;

– «Non-perishable».

Perishable ones require special modes of transportation and storage, for example, refrigeration, conservation.

Non-perishable ones do not require special modes of transportation and storage and can retain their food and nutritious properties for a long time.

Also, all food cargoes are divided into 2 types:

– requiring air exchange;

– not requiring air exchange.

According to the *temperature regime of transportation* they are divided into:

– frozen (–4°C and below);

– chilled (–4°C ÷ +12.5°C);

– not chilled (without observing control *t*).

*By common origin*, they are divided into:

– fruits and vegetables – vegetables and fruits of the temperate zone;

– subtropical zone;

– tropical zone;

– meat cargoes (meat, smoked meats, bacon, lard, corned beef, poultry, game, rabbits, offal);

– fish cargoes (frozen fish; fish products);

– egg cargoes (fresh eggs, egg white, yolk, melange);

– fats (kitchen; melted butter; margarines);

– dairy (butter; milk; sour cream; cottage cheese);

– canned products:

– meat, dairy, vegetable, fish, fruit and berry in metal cans and bottles;

– sour, pickled and salted vegetables in barrels;

– grain cargoes and cargoes under quarantine control.

According to the community of transportation, cargoes are divided into:

– after industrial processing (their biological activity is suppressed – ferments are destroyed);

– without industrial processing (they have the vital activity of microorganisms – bacteria and mould). The greatest activity at $t = +10 \div +25°C$; at $t = 0°C$ and below – many cease their activities.

The influence of the environment is:

– *t* environment;

– air humidity;

– the gas composition of the air;

– light;

– the intensity of the air flow.

*Depending on the t environment*, fermental processes – at 0°C they slow down, they can be neglected;

– at +50°C weaken;

– at +70°C the property of catalysts is lost.

Influence of relative humidity φ:

– at low $\varphi \leq 80\%$ – fruit withering;

– deterioration in taste;

– loss of resistance to air microorganisms;

– at high humidity $\varphi \geq 90\%$

– favorable environment for the activity of microorganisms;

– condensation on the surface of the cargo.

– at $\varphi = 80 \div 90\%$ – optimum humidity.

Oxygen content $O_2$:

Normal oxygen content ensures the safety of those foods capable of gas exchange with the environment, absorbing $O_2$ and emitting $CO_2$, ethylene, heat and water. This gas exchange is called aerobic.

At a reduced oxygen content, $O_2$ is taken away from the substances that make up the product, destroying primarily acids. This gas exchange is called anaerobic. In this case, oxidation products are released – alcohols, acetaldehydes. Dying off of tissue of fruit and their premature withering occurs.

Carbon dioxide content $CO_2$:

An increased content of $CO_2$ increases the internal respiration of fruits, which leads to an increase in the release of ethylene.

$CO_2$ content should be ≤ 1%, but shippers often require 0.1 ÷ 0.3%. Control over the content of $CO_2$ is carried out 2 times a day. If the $CO_2$ content changes even by 0.1 %, the cargo of the fruits is checked and those that begin to ripen are removed.

Influence of light.

Light affects the rate of ripening processes. In the dark, the ripening processes are slowed down. The sun rays especially affect frozen fruits.

The intensity of the air flow.

Some food cargoes require increased ventilation, some require minimal ventilation, for example, frozen meat (otherwise it will dry out).

## 8.2. Methods for the safe transportation of food cargoes on various types of vessels

Modern vessels can be conditionally divided into the following types:

– refrigerated vessels with battery cooling system for cargo spaces;

– refrigerated vessels with an air cooling system for cargo spaces;

– «ventilated» vessels (with natural forced, mechanical ventilation systems; with air conditioning systems ACS);

– transporting food goods in refrigerated containers or insulated containers. Refrigerated vessels with a battery cooling system transport meat, oils, various fats, fish products frozen or cooled to –25°C. Air-cooled refrigerated vessels transport fruits and vegetables. The safety of goods is achieved by reducing *t* (while vital processes are reduced to min). Emission of gases – min, therefore the inflow of fresh air – min. The ventilating plant operates in the hold air recirculation mode, capacity ≥ 4 volumes/hour. Various ventilation systems are used on fruit carriers:

– horizontal;

– longitudinal;

– horizontal transverse;

– circular horizontal longitudinal;

– vertical ascending (or descending).

Refrigerated vessels provide high-quality transportation of fruits and vegetables, but from an economic point of view, it is more profitable to transport over short and medium distances on ordinary universal vessels equipped with a reliable ventilation system. Excessive ventilation is undesirable, as it leads to increased gas emission from the fruit. A 10-multiple exchange per hour is considered optimal.

The directions of transportation of fruits are mainly South-North. In this case, the *t* of air and sea water decreases, and the cargo is insignificant. The hull of the vessel cools faster than the mass of the cargo, and the supplied air causes severe sweating and damping of the cargo. This requires «drying» of the supplied air, which

is achieved by using ACS. In recent years, technologies for transportation in refrigerated containers have been introduced. Only containers with an autonomous refrigeration unit are allowed on deck.

## 8.3. Preparation of food cargoes for transportation and their specific properties

Food cargoes are transported in a serviceable tare – new, dry, clean, free of foreign odors.

Food products are specially processed:

– conservation;

– cold treatment;

– sealing;

– sterilization;

– salting;

– fermentation.

The following packaging is used:

– troughs (for berries and some types of fruits);

– boxes-cells (for vegetables and melons);

– wooden boxes and half boxes (for potatoes, vegetables, fruits);

– cardboard boxes (for fruit).

As an exception, potatoes may be transported in bags.

*Meat* in the form of carcasses is transported wrapped in materials made of light fabric – coarse calico, gauze, plastic wrap.

Fig. 1. Reloading of carcasses from refrigerated wagons to pallets

Meat is a cargo with high water content (50÷75 %). There are 3 known t ranges for meat transportation:

–0.5 ÷ –1.5°C – chilled meat;

–12 ÷ –13°C – frozen meat;

–18 ÷ –30°C – deep frozen meat.

The most valuable is chilled meat (cell juice is stored in its cells). At $t \leq -2$°C, the meat freezes.

It is easier to transport frozen and heavily frozen meat. It is recommended to freeze meat to $t = -18$°C by an accelerated method for 16–24 hours, while large ice crystals do not form in the cells. Frozen meat is stored for up to 1.5 years. It is kept without noticeable deterioration of properties for 15–17 days.

Sub-products (offal) – heads, tongues, brains, kidneys, hearts, livers, stomachs – are transported in boxes and cases.

Smoked meat products are transported in:

– boxes with openings to ensure free air circulation;

– barrels with filling of free space with melted food fat.

Food fats are:

– animal, including butter. They are divided into:

– raw (from internal fat of cattle, sheep, pigs);

– melted (by melting raw animal fat).

Food fats are packed in:

– wooden barrels;

– wooden and cardboard boxes weighing 30 kg;

– cans weighing up to 10 kg.

– combined fats (margarine, hydro fat, coconut oil) are transported in barrels weighing up to 150 kg; wooden boxes weighing up to 50 kg.

– vegetable oils (sunflower, mustard, cottonseed, corn, soybean, olive (Provencal), coconut, cocoa butter) are transported:

– in bulk in deep tanks of cargo ships;

– in barrels;

– in metal cans;

– in bottles.

Fish products include:

– fish frozen and chilled. The optimal storage term is 10–12 days. During transportation $t = -18$°C. Little or no ventilation is needed, as it leads to evaporation.

– dried fish is transported in cardboard boxes weighing 27, 30, 33 kg.

– salted fish is transported in wooden barrels;

– canned fish is transported in metal tare;

– technical fats of fish and sea animals in tanks and barrels.

Dairy products:

– butter. It is transported in wooden, plywood and cardboard boxes and barrels;

– cheeses. They are transported in wooden boxes or drums.

Egg products:

– fresh eggs. They are transported in wooden boxes, between the rows – safety pads;

– frozen or dried egg products. No ventilation is required when transporting them.

*Fruit and vegetable cargoes*. These include fruits and vegetables. They are transported in cardboard, wooden boxes or bags.

## 8.4. Preparing the vessel for receiving food cargo

The holds are pre-cooled in 48 hours.

The holds are cleaned, washed and dried. Devices for remote control of *t*, humidity, $CO_2$ contents are checked. A refrigeration unit is prepared (the density of the freon, the filling level is checked). A supply and exhaust ventilation system is prepared. Preparation of refrigerated holds includes work on removing the snow coat from the cooling coils, followed by removing moisture from the hold and drying it. Refrigerated holds are cooled before loading. The temperature should be brought below the optimal mode of transportation:

– for refrigerated cargo at 2–3°C;

– for bananas and pineapples at 5–6°C;

– for frozen cargo at 6–7°C.

The separation is preloaded to cool it.

Washing and deodorization of holds. The holds are treated with deodorant agents:

– 1% potassium permanganate;

– 10% ammonia solution;

– 5% solution of copper sulfate;

– 6% hydrogen peroxide solution;

– 5% formalin solution.

Ozonation of holds is in progress.

## 8.5. Reception and stowage of food cargoes

Before the start of loading, you need to obtain from the shipper: a Quality Certificate; Phytosanitary or Veterinary Certificate.

The carrier conducts a preliminary inspection, measures *t* pulp of frozen meat, fruits.

During precipitation, cargo operations are prohibited. In the hold, the cargo is packed in such a way as to ensure:

– uniform flow of cold and fresh air to each cargo piece;

– immobility of both the entire stack and individual cargo items;

– maximum use of cargo capacity;

– safety and non-contamination of tare.

When transporting meat, boxes with frozen products are stowed close to each other; chilled – with spaces between rows and tiers.

It is impossible to load pork and mutton in the same room for destinations in the ports of the Near and the Middle East.

On fruit carriers, deck gratings or bars are installed in the direction of the air flow.

Separation is done with boards or nets. Separating materials that impede air movement (tarpaulins, mats) are not recommended.

When transporting on non-refrigerated vessels, all metal parts of the plating must be insulated with wood. If the decks do not have grating, beams are laid before loading, followed by planking. Free spaces of 20-30 cm are left between the cargo stacks and the side.

If the transportation of food cargoes is carried out in consolidated lots, then the possibility of compatibility is determined according to special tables.

## 8.6. Transportation of grain cargoes in tare

Grain cargoes includes:

– grain cargoes of all types – wheat, rye, oats, barley, millet, corn, buckwheat, hemp, rice, cotton seeds, beans and oilseeds, coffee grains, cocoa beans;

– compound feed and bran (cakes and meal), flour and cereals of all kinds;

– nuts (peanuts, cashews, almonds).

Grain goods are packed in cloth bags, clean, dry, without foreign odors. To isolate from contact with metal parts, the floor and sides are covered with a clean, dry separation material.

Bags are stacked from bulkheads to the center by methods:

– «bag on bag» – provides reliable circulation;

– «in a half-bag» – provides more denser stowage.

*Flour and cereals* are susceptible to odors. Optimum humidity $\varphi = 60 \div 75\%$.

*Beans* – French beans, peas, soybeans – are self-heating.

*Corn* – is capable to release a lot of moisture. It cannot be transported with other hygroscopic goods.

*Rice* can be grinded, polished and crushed. It is capable of both giving and receiving moisture. Weight loss from evaporation is 2–3%. A ventilation system is required due to the device of longitudinal, transverse and vertical channels.

### 8.7. Transportation of coffee beans and cocoa beans

The fruits of coffee and cocoa are processed – the grains are freed from the pulp and shell of the fruit, fermented by lactic acid fermentation, and then dried. In storage warehouses, after the completion of drying, the moisture content of coffee should not be ≥ 6%, cocoa beans – 8%. Air humidity φ = 78% corresponds to this state.

The color of the grains at the break should be chocolate brown. The grains should be free of moldy and musty odor. The taste of cocoa beans is buttery-nutty, neither bitter nor sour. Before loading, coffee and cocoa are fumigated in the warehouse. The vessels for carriage are twin-deck, equipped with a forced ventilation system or ACS. The stack is insulated from the transverse bulkheads with kraft paper. It is necessary to arrange 2 longitudinal and 1-2 transverse channels in the cargo pile. Stacking height ≤ 25 tiers. There must be ≥ 300 mm between the top load tier and the ceiling of the upper deck. On top, the stack is covered with 2–3 layers of kraft paper or plastic wrap.

### 8.8. Transportation of spices, tea, sugar, salt, flour and confectionery

Spices include: bay leaf, basil, sweet savory, saffron, cloves, nutmeg, cumin, pepper, mustard, vanilla, barberry, cinnamon, ginger and others. They give off odors and are themselves sensitive to odors. Cannot be shipped together, even related ones such as red and black pepper. Requires secure packaging. Not only humid air is harmful to spices, but also dry (aromatic substances sublimate).

Spices are transported in:

– linen-jute bags (cloves, mustard, pepper, chicory, cumin);

– in fabric wrappers, pressed bales, bales (bay leaf);

– in cardboard, plywood or wooden boxes (basil, vanilla, cardamom).

*Tea* are loose (long tea) and tiled – black and green. Tea easily picks up moisture and odors, so it should not be transported in new containers, as varnishes and paints give off odors. Tea is dusty, susceptible to the activity of microorganisms, and can be affected by pests. Tea is accepted for transportation in:

– paper bags, usually with a polyethylene liner;

– in plywood boxes lined with foil and parchment;

– in cardboard boxes (packaged, tiled).

*Sugar* can be:

– granulated sugar, transported in fabric or synthetic bags with a polyethylene liner;

– refined sugar;

– raw sugar. Has a light brown colour. Under certain conditions, with increased moisture content, it is prone to fermentation with the absorption of $O_2$ and the release of $CO_2$. Able to shrink, reducing the volume by 5%.

*Salt* is transported in bulk, in bags, in plywood boxes. The main properties of salt are similar to sugar. They are:

– hygroscopicity;

– tendency to shrinkage;

– ability to lumping.

When transporting salt, the corrosive processes of the metal structures of the hull are activated, therefore, they must be whitewashed with lime mortar before loading.

Macaroni is transported in boxes weighing 30 kg. Can be affected by foreign odors. Macaroni should be white with a yellowish tint, free from bitterness, odor and mold.

Flour confectionery:

– biscuits and cakes – are transported in ordinary boxes;

– ship's biscuits – in a sealed tare for long-term storage.

*Molasses* (aqueous glucose solution). Depending on the amount of dissolved sugars, it can be: caramel, boiled, glucose. It is transported either in bulk on tankers or in barrels. The barrels have 2 plugs, one of them for the release of gases as a result of fermentation. Due to the likelihood of spillage, the barrels are placed in the lower part of the hold.

*Hone*y is transported in:

– glass jars;

– plastic boxes;

– wooden barrels.

Tare with honey should not be placed near warm bulkheads and pipes.

*Starch* is a processed product of potatoes, rice, wheat and corn. It is hygroscopic, easily absorbs moisture, and therefore rots.

*Confectionery* – hygroscopic, easily absorbs odors.

At $t \geq$ recommended, the sugar content crystallizes;

at $t \leq$ recommended, products delaminate and crumble;

at $t \geq 25$°C white colour appears on chocolate products.

WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| cargo space | [ˈkɑːgəʊ speɪs] | грузовое помещение |
| hygiene | [ˈhaɪʤiːn] | гигиена |
| nutritious properties | [nju(ː)ˈtrɪʃəs ˈprɒpətiz] | питательные свойства |
| frozen | [ˈfrəʊzn] | мороженный |
| chilled | [ʧɪld] | охлажденный |
| fruits and vegetables | [fruːts ˈvɛʤtəb(ə)lz] | фруктово-овощные грузы |
| bacon | [ˈbeɪkən] | бекон |
| lard | [lɑːd] | шпиг, топленое сало |
| corned beef | kɔːnd biːf] | солонина |
| poultry | [ˈpəʊltri] | домашняя птица |
| game | [geɪm] | дичь |
| rabbit | [ˈræbɪt] | кролик |
| offal | [ˈɒfəl] | субпродукты |
| egg white | [ɛg waɪt] | белок (яичный) |
| yolk | [jəʊk] | желток (яичный) |
| melange | [mɛˈlanʤ] | меланж (яичный) |
| margarine | [ˌmɑːʤəˈriːn] | маргарин |
| dairy | [ˈdeəri] | молочная продукция |
| sour cream | [ˈsaʊə kriːm] | сметана |
| cottage cheese | [ˈkɒtɪʤ ʧiːz] | творог |
| can‖, -ned products | [kæn,kænd ˈprɒdʌkts] | банка, – консерв‖ов, -ы |
| fruits and berries | [fruːts ænd ˈbɛriz] | плодово-ягодная прод-я |
| sour | [ˈsaʊə] | квашены |
| pickled | [ˈpɪkld] | маринованный |
| salted | [ˈsɔːltɪd] | соленый |
| community | [kəˈmjuːnɪti] | общность |
| ferment | [ˈfɜːmɛnt] | фермент |
| microorganism | [ˌmaɪkrəʊˈɔːgənɪzm] | микроорганизм |
| bacterium, *pl.* bacteria | bæk‖ˈtɪərɪəm,-ˈtɪərɪə] | бактери‖я, -и |
| mould | [məʊld] | плесень |
| to cease | [siːs] | прекращать, -ся |
| catalyst | [ˈkætəlɪst] | катализатор |
| fruit withering | [fruːt ˈwɪðərɪŋ] | увядание фруктов |
| ethylene | [ˈɛθɪˌliːn] | этилен |
| aerobic | [eəˈrəʊbɪk] | аэробный |
| anaerobic | [ˌæneəˈrəʊbɪk] | анаэробный |
| oxidation | [ˌɒksɪˈdeɪʃən] | окисление |

| | | |
|---|---|---|
| alcohol | [ˈælkəhɒl] | алкоголь |
| acetaldehyde | | ацетальдегид |
| tissue of fruits | [ˈtɪʃuː ɒv fruːts] | ткань плодов (мякоть) |
| premature withering | [ˌprɛməˈtjʊə ˈwɪðərɪŋ] | преждевремен. увядание |
| to ripe, -n | [raɪp, -ɛn] | зреть, созревать, зрелый |
| condition, -al, ally | [kənˈdɪʃən, -əl, ˈəlɪ] | условие, условн\|\|ый, -но |
| ventilating plant | [ˈvɛntɪleɪtɪŋ plɑːnt] | вентиляцион. установка |
| capacity | [kəˈpæsɪti] | производительность |
| ascending | [əˈsɛndɪŋ] | восходящий |
| descending | [dɪˈsɛndɪŋ] | нисходящий |
| profit, -able | [ˈprɒfɪt, -ˈəbl] | выгода, выгодный |
| optimal | [ˈɒptɪməl] | оптимальный |
| in recent years | [ɪn ˈriːsnt jɪəz] | в последние годы |
| 9-multiple | [ˈmʌltɪpl] | 9-кратный |
| trough | [trɒf] | лоток |
| box-cell | [bɒks-sɛl] | ящик-клетка |
| melons | [ˈmɛlənz] | бахчевые |
| cardboard box | [ˈkɑːdbɔːd bɒks] | картонный ящик |
| carcass | [ˈkɑːkəs] | каркас, туша |
| coarse calico | [kɔːs ˈkælɪkəʊ] | бязь |
| gauze | [gɔːz] | марля |
| plastic wrap | [ˈplæstɪk ræp] | пластиковая упаковка |
| reloading | [ˌriːˈləʊdɪŋ] | перегрузка (груза) |
| melted food fat | [ˈmɛltɪd fuːd fæt] | топленый пищевой жир |
| soybean | [ˈsɔɪbiːn] | соя |
| cocoa | [ˈkəʊkəʊ | какао |
| storage term | [ˈstɔːrɪʤ tɜːm] | срок хранения |
| plywood | [ˈplaɪwʊd] | фанера |
| pad | [pæd] | мягкая прокладка |
| cooling coils | [ˈkuːlɪŋ kɔɪlz] | змеевик |
| potassium permanganate | [pəˈtæsiəm pɜːˈmæŋgən ɪt] | марганцово-кислый калий |
| ammonium | [əˈməʊnjəm] | аммиак |
| copper sulfate | [ˈkɒpə ˈsʌlfeɪt] | медный купорос |
| hydrogen peroxide | [ˈhaɪdrɪʤən pəˈrɒksaɪd | перекись водорода |
| formalin | [ˈfɔːməlɪn] | формалин |
| uniform | [ˈjuːnɪfɔːm] | единообразный |
| Immobile, -ity | [ˌɪməʊˈb\|\|ail, -ɪlɪti] | неподвижн\|\|ый, -ость |
| contamination | [kənˌtæmɪˈneɪʃən] | загрязнение, заражение |

| | | |
|---|---|---|
| pork | [pɔːk] | свинина |
| beef | [biːf] | говядина |
| mutton | [ˈmʌtn] | баранина |
| Near, the Middle East | [nɪər ˈmɪdl iːst] | Ближний, Средний Восток |
| grating | [ˈgreɪtɪŋ] | решетка |
| plating | [ˈpleɪtɪŋ] | обшивка |
| wheat | [wiːt] | пшеница |
| rye | [raɪ] | рожь |
| oat | [əʊt] | овёс |
| barley | [ˈbɑːli] | ячмень |
| millet | [ˈmɪlɪt] | просо |
| corn | [kɔːn] | кукуруза |
| buckwheat | [ˈbʌkwiːt] | гречиха |
| hemp | [hɛmp] | конопля |
| rice grinded | [raɪs ˈgraɪndɪd] | рис шлифованный |
| – polished | [ˈpɒlɪʃt] | – полированный |
| – crushed | [krʌʃt] | – дробленый |
| cotton seeds | [ˈkɒtn siːdz] | хлопковое семя |
| beans and oilseeds | [biːnz ɔɪlsiːdz] | бобовые и масличные |
| coffee grains | [ˈkɒfi greɪnz] | кофейные зерна |
| cocoa beans | [ˈkəʊkəʊ biːnz] | какао-бобы |
| compound feed | [ˈkɒmpaʊnd fiːd] | комбикорма |
| bran (cakes, meal) | bræn (keɪks miːl)] | отруби (жмых, шрот) |
| cereals | [ˈsɪərɪəlz] | крупы |
| peanuts | [ˈpiːnʌts] | арахис |
| cashew | [kæˈʃuː] | кешью |
| almond | [ˈɑːmənd] | миндаль |
| French beans | [frɛnʧ biːns] | фасоль |
| peas | [piːz] | горох |
| soybeans | [ˈsɔɪbiːnz] | соя в бобах |
| hygroscopic | [ˌhaɪgrəʊˈskəʊpɪk] | гигроскопичный |
| fruits | [fruːts] | плоды |
| lactic acid fermentation | [ˈlæktɪk ˈæsɪd | молочно-кислое брожение |
| chocolate brown | [ˈʧɒkəlɪt braʊn] | шоколадно-коричневый |
| mold‖ -y | [ˈməʊldi] | плес‖ень, -невелый |
| must‖ -y | [ˈmʌsti] | затхл‖ость, -ый |
| buttery-nutty | [ˈbʌtəri-ˈnʌti] | маслянисто-ореховый |
| kraft paper | [kraft ˈpeɪpə] | крафт-бумага |
| to insulate | [ˈɪnsjʊleɪt] | изолировать |

| | | |
|---|---|---|
| spices | [ˈspaɪsɪz] | пряности |
| bay leaf | [beɪ liːf] | лавровый лист |
| basil | [ˈbæzl] | базилик |
| sweet savory | [swiːt ˈseɪvəri] | душистый чáбер |
| saffron | [ˈsæfrən] | шафран |
| clove | [kləʊv] | гвоздика |
| nutmeg | [ˈnʌtmɛg] | мускатный орех |
| cumin | [ˈkʌmɪn] | тмин |
| vanilla | [vəˈnɪlə] | ваниль |
| barberry | [ˈbɑːbəri] | барбарис |
| cinnamon | [ˈsɪnəmən] | корица |
| ginger | [ˈʤɪnʤə] | имбирь |
| pressed bale | [prɛst beɪl | кипа |
| bale | [beɪl] | тюк |
| loose (long tea) | [luːs (lɒŋ tiː)] | рассыпной (байховый) чай |
| tiled tea | [taɪld tiː] | плиточный чай |
| varnish | [ˈvɑːnɪʃ] | лак |
| foil | [fɔɪl] | фольга |
| parchment | [ˈpɑːʧmənt] | пергамент |
| granulated sugar | [ˈgrænjʊleɪtɪd ˈʃʊgə] | сахар-песок |
| refined sugar | [rɪˈfaɪnd ˈʃʊgə] | сахар-рафинад |
| raw sugar | [rɔː ˈʃʊgə] | сахар-сырец |
| prone to | [prəʊn tuː] | склонный к |
| to shrink, -age | [ʃrɪŋk, -eɪʤ] | давать усадку, усадка |
| ability to lumping | [əˈbɪlɪti tuː ˈlʌmpɪŋ] | способность к слеживанию |
| to whitewash | [ˈwaɪtwɒʃ] | белить |
| lime | [laɪm] | известь |
| mortar | [ˈmɔːtə] | раствор |
| macaroni | [ˌmækəˈrəʊni] | макароны |
| yellowish tint | [ˈjɛləʊɪʃ tɪnt] | желтоватый оттенок |
| bitterness | [ˈbɪtənɪs] | горечь, злоба |
| flour confectionery | [ˈflaʊə kənˈfɛkʃnəri] | мучные кондитерские |
| biscuit | [ˈbɪskɪt] | печенье, бисквит, сухарь |
| cake | [keɪk] | пряник |
| ship’s biscuits | [ʃɪps ˈbɪskɪts] | галеты |
| molasses (aqueous glucose solution) | [məʊˈlæsɪz (ˈeɪkwɪəs ˈgluːkəʊs səˈluːʃən)] | патока (водный раствор глюкозы) |
| caramel | [ˈkærəmɛl] | карамель |
| plug | [plʌg] | пробка |

| | | |
|---|---|---|
| likelihood (probability) | [ˈlaɪklɪhʊd] | вероятность |
| honey | [ˈhʌni] | мед |
| jar | [ʤɑː] | кувшин, банка |
| starch | [stɑːʧ] | крахмал |

# 9. TECHNOLOGY OF LIQUID CARGOES TRANSPORTATION

## 9.1. Classification. Physical and chemical properties of liquid cargoes

Liquid cargoes include:

– crude oil and oil products;

– oils; molasses;

– water;

– wine;

– wine alcohol;

– syrup;

– chemical cargo;

– liquefied gas.

Oil and oil products account for 95% of the volume of liquid cargoes transported. Let's consider their classification and properties.

Generally:

– light oil products (gasoline, kerosene, diesel fuel);

– dark oil products (crude oil, fuel oil, motor fuel, tar and others).

By the danger of explosion and fire:

– flammable substances;

– medium flammable;

– hardly flammable.

By flash point:

– especially dangerous, *t* flash ≤ –18°C;

– constantly dangerous, *t* flash from –18°C to +23°C;

– dangerous at high temperature, *t* flash from +23°C to +61°C.

In addition to the flash point *t*, there are:

– flammability *t*;

– *t* self-ignition;

– *t* solidification;

– density – ratio of liquid mass to its volume;

– dynamic, kinematic, conventional viscosity.

Dangerous charges of static electricity can form in oil and oil products when:

– movement through pipelines at a speed of ≥ 1 m/s;

– a freely falling jet of cargo;

– blowing with compressed air or steam from cargo hoses.

The composition of some grades of oil includes a dangerous gas – hydrogen sulfide $H_2S$. The shipper is obliged to notify the Master of this in writing.

## 9.2. Classification and design features of oil tankers, chemical tankers, gas carriers, combined type

**Oil tankers.**

Classification of tankers:

– up to 5 thousand *t* DW – low-tonnage;

– up to 30 thousand *t* – medium tonnage;

– ≥ 30 thousand *t* – large tonnage.

In more detail by DW they are classified:

– 30–70 thousand *t* – Supertanker;

– 80 thousand *t* – Panamax;

– 150–00 thousand *t* – VLCC;

– 300–800 thousand *t* – ULCC;

– 1 million *t* – Mega tanker.

Prior to the entry into force of MARPOL 73/78, there was an increase in cargo carrying capacity (cargo deadweight) – this is due to a decrease in transportation costs. The largest tanker was "Seawise Giant" (renamed "Happy Giant") with a net cargo deadweight of 568 thousand tons. $L \times B \times D \times d$ = 458 m ×69 m ×30 m ×24.6 m. SPP is a steam-gas turbine with a capacity of 50 thousand hp. It entered operation in 1981, in 1986 it was sunk in the Strait of Hormuz by Iraqi Air Force planes, in 1988 it was raised from the bottom. In 2004 under the name "Knock Nevis" it was converted into FSO – a complex for the storage of oil products in Dubai, then in Qatar.

The world's widest tanker was built in 1978 in Sweden and was called "Nanny". B = 79.0 m.

In the world tanker building, in addition to the growth in size,

– they eliminated the dry cargo hold (it was on tankers built in the 50$^{th}$);

– the middle superstructure was eliminated (it became a wheelhouse) and a bridge;

– the length *L* of cargo tanks increased, therefore, the number of transverse bulkheads (and the mass of the hull) decreased;

– the productivity of cargo pumps increased to 9 thousand m$^3$/hour.

The growth of striving for gigantism was stopped by a series of disasters and the MARPOL Convention 73/78.

In 1978, the m/t "Amaco Cadiz" crashed. 223 thousand tons of oil spilled into the sea in the Bay of Biscay near the resorts of France. Under requirements of MARPOL, the number of cargo tanks was increased on vessels DW ≥ 150 thousand tons.

In 1999, the m/t "Erica" with a cargo of 30 thousand tons of oil perished in the Bay of Biscay. Tankers without double bottom and double sides were withdrawn from operation.

In 2002, off the coast of Spain, the tanker “Prestige” received a crack in the bottom 50 m long with 77 thousand tons of fuel oil on board. 65 thousand tons were poured into the sea. Cleaning the sea and shores costs $12 billion. The damage to the ecosystem is impossible to assess.

**Chemical tankers.**

Depending on the degree of aggressiveness and hazard of the transported chemical goods on chemical carriers, additional structural protection of 3 levels is provided.

On the vessels with the 1st degree cargo tanks should be located at least $\geq 1/5\ B$ to the sides. On these vessels, the height of the double bottom $H \geq 1/5\ B$ of the vessel.

On the vessels with the 2nd degree – not closer than 76 cm to the outer plating.

On the vessels with the 3rd degree – not limited.

All chemical tankers must have a two-compartment standard of unsinkability, that is, if 2 adjacent compartments are damaged, stay afloat.

The maximum capacity of cargo tanks, depending on the degree of structural protection, is also regulated.

On the 1st degree chemical carriers, the volume is 1250 $m^3$;

On the 2nd degree, the volume is 3000 $m^3$;

On the 3rd degree – not limited.

**Gas tankers.**

Divided into groups:

– LNG (liquefied natural gas). They transport liquefied natural gas methane;

– LPG (liquefied petroleum gas) They transport liquefied petroleum gases associated with oil production (propane, butane);

– transporting ammonia.

Gases are transported when:

– normal $t$ and high pressure;

– low $t$ and normal pressure;

– cooling and slightly increased pressure.

Liquefied gas carriers are structurally:

– pressure (gas under pressure);

– semi-refrigerated (gas at low $t$ and high pressure);

– refrigerated (gas in deep cooling).

Natural gas at $t = –161.6°C$ turns into a liquid state.

Tanks on gas carriers are:

– inserted (their thickness is 72 mm);

– membrane type (membrane thickness 0.5–1.2 mm)

Recently, floating plants for the production of LNG began to come into operation. Raw materials are delivered on board directly from wells, processed into liquefied gas, and loaded onto LNG carriers for delivery to shore. For example, the largest such plant, “Prelude”, is anchored, without its own power plant, 200 km off the coast of Australia in the Timor Sea due to a prohibition on “Shell” from building onshore processing plants. The vessel was built in 2013 in South Korea. Its DW ≈ 600 thousand t, the total gas storage capacity = 463 thousand $m^3$.

**Combined type vessels.**

They are being built due to the long length of ballast crossings.

There are:

– oil-ore carriers (OB, Oil-Bulk). Oil is transported in the tanks located on the sides, and ore is transported in the holds, between the tanks;

– oil-bulk-ore carriers (OBO, Oil-Bulk-Ore). In cargo spaces, ore and oil are transported in turn.

## 9.3. Preparation of tankers for oil transportation. Tanks cleaning

Before starting tank cleaning, you need to determine the content of oxygen and hydrogen sulphide $H_2S$ in the tanks and, depending on this, determine the washing strategy. It can be:

– preliminary ventilation of tanks;

– using an inert gas system;

– washing without using an inert gas system.

There are ways to wash tanks:

– manual;

– mechanical with the help of washing machines;

– chemical with the use of detergents;

– combined.

If the tanker transports light oil products, tanks are first steamed with live steam, then washed with hot water with caustic soda, after which residues from the bottom are removed.

If the tanker is delivered for the carriage of food cargo, then, for example, after the transportation of leaded gasoline, it must make at least 2 voyages with diesel fuel or kerosene.

Tank washing is carried out in a closed cycle with collection of washing water in holding tanks (Slop Tanks). Washing is carried out both with stationary and portable washing machines under a pressure of 7–12 $kg/cm^2$.

Tank washing in a closed cycle is carried out in 2 ways:

– without preliminary filling of water in Slop Tanks;

– with a preliminary filling of water in the Slop Tanks.

The wash water is preliminarily filled into one of the Slop Tanks, where it is heated in coil-pipes to a certain temperature and supplied to the cargo tank. Waste water is fed to another Slop Tank, where it settles, flows into another Slop Tank and is used for the next cycle.

After washing the tanks, it is necessary to bring the oxygen content $O_2$ to 21% by ventilation and then take out the residues. After washing with seawater, the tanks are rinsed with fresh water for 10–15 minutes and the tanks are inerted.

SOLAS-74 contains recommendations for washing tanks with crude oil. Before arriving at the port of unloading, the vessel is obliged to obtain the consent of the terminal. For high-quality washing with crude oil, the following conditions must be met:

– oil should not have a high viscosity;

– *t* of oil must be at least 10°C ≥ *t* of the pour point;

– the trim of the vessel should be ≥ 3 m;

– the pressure in the washing machines should be 7–12 kg/cm$^2$.

The process of washing with crude oil is no different from washing tanks with water. In this case, the system of inert gases must constantly operate, ensuring the level of $O_2$ in tanks ≤ 8% of the volume.

Requirements for tank washing are given in the International Convention MARPOL 73/78. It is allowed to dump not more than 30 liters of oil products into the sea at a distance of 1 mile at a speed of not more than 4 knots. The amount of oil dumped into the sea should not exceed 1/30 000 of the amount of cargo transported on the voyage.

Some companies practice transporting crude oil in tanks on top of leftovers from previous voyages.

## 9.4. Tanker inert gas system

In accordance with the requirements of the SOLAS-74 Convention and its Supplements, on all new tankers DW ≥ 20,000 tons, inert gas systems (SIG) must be installed and used.

The SOLAS-74 Convention requires the $O_2$ concentration produced by the SIG plant to be ≤ 5% by volume and the $O_2$ concentration in the cargo space to be ≤ 8%.

The inert gas produced by the SIG plant contains such components as a percentage of the volume:

– nitrogen $N_2$ – 77%;

– carbon dioxide $CO_2$ – 14%;

– oxygen $O_2$ – 3%;

– atomized water $H_2O$ – 5%;

– sulfur dioxide HS – 0.3%;

– carbon monoxide CO – 0.7%.

After production by the SIG plant, the inert gas enters the scrubber (gas purifier), and then either each tank or the cargo line.

The inert gas system SIG is used only:

– when unloading oil products;

– when washing tanks with crude oil.

When loading, the SIG is not used.

## 9.5. Carrying out cargo operations

**Loading.**

Performed when the vessel is moored at the berth, mono-buoy or supply vessel.

Loading at the berth is carried out by means of standers or hoses. The maximum loading rate $Q$ max in $m^3/h$ is limited to

$$Q_{max} = 3.14\ d^2\ P_{max}/4,$$

where $d$ is the diameter of the ship's cargo pipes in inches;

$P_{max}$ – maximum working pressure in $kg/cm^2$.

The terminal is responsible for the quality of the shore connections.

During loading, SIG are not used.

On Fig. 1 shown variant of tanker mooring. The numbers in yellow circles represent the order of delivery to the berth and fastening of ship's mooring lines. The numbers of the ship's mooring winches are shown in the yellow squares. This diagram shows a specific version of tanker mooring with a stem against the current, in which the bow mooring lines were fed and fastened first: springs (1 and 2), breast lines (3 and 4) and fore-and-aft (5, 6 and 7), and then aft mooring lines: breast lines (8 and 9) and spring (10).

Loading a tanker through a mono-buoy or a supply vessel, ridden at mooring anchors, do not differ from each other. In both cases, the tanker approaches them and is moored by the bow. From the stern of the tanker, a mooring line is placed on the tug, which holds the vessel in one direction and prevents the tanker from approaching the mono-buoy (supply vessel).

**Unloading.**

After mooring, the cargo on board is counted by measuring the voids and temperature in each tank. Tanker mooring should be carried out with operating SIG switched to pay out gas into the atmosphere.

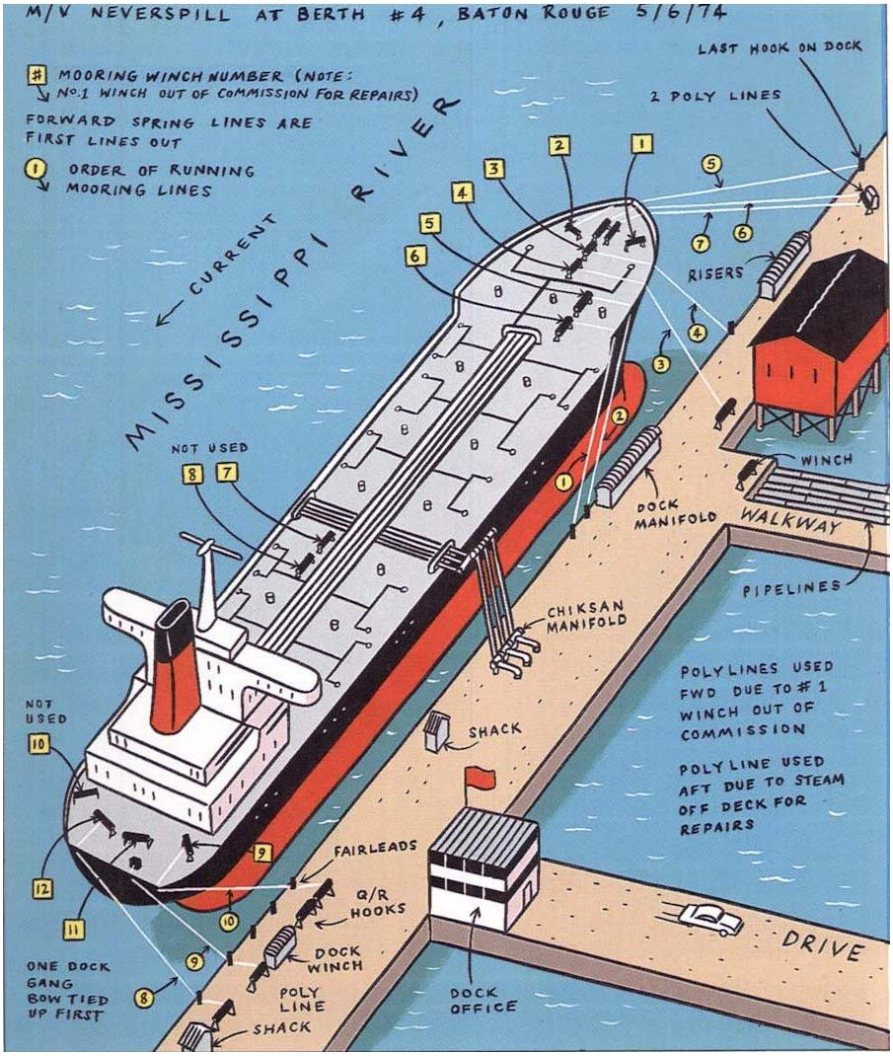



Fig.1. Variant of tanker mooring at cargo terminal


Fig. 2. Loading the tanker at the buoy terminal

| | | |
|---|---|---|
| molasses | [məʊˈlæsɪz] | меласса, патока |
| syrup | [ˈsɪrəp] | сироп |
| gasolene | [ˈgæsəliːn] | бензин |
| kerosene | [ˈkɛrəsiːn] | керосин |
| diesel fuel | [ˈdiːzəl fjʊəl] | дизельное топливо |
| crude oil | [kruːd ɔɪl] | сырая нефть |
| fuel oil | [fjʊəl ɔɪl] | мазут |
| tar | [tɑː] | гудрон, дёготь |
| Ship’s Power Plant (SPP) | [ʃɪps ˈpaʊə plɑːnt] | СЭУ |
| flammability | [ˌflæməˈbɪlɪti] | воспламенение |
| self-ignition | [sɛlf ɪgˈnɪʃən] | самовозгорание |
| solidification | [səlidifiˈkeɪʃən] | застывание, отвердение |
| cargo carrying capacity | [ˈkɑːgəʊ ˈkæriɪŋ kəˈpæsɪti] | чистая г/п |
| deadweight cargo capacity (DWCC) | [dɛd ’weitˈkɑːgəʊ kəˈpæsɪti] | чистая грузоподъемность г/п |
| cargo deadweight | [ˈkɑːgəʊ dɛd ’weit] | чистая г/п |
| wheelhouse | [ˈwiːlhaʊs] | рулевая рубка |
| to strive | [straiv] | добиваться, стараться |
| methane | [ˈmiːθeɪn] | метан |
| propane | [ˈprəʊpeɪn] | пропан |
| butane | [ˈbjuːteɪn] | бутан |
| membrane | [ˈmɛmbreɪn] | мембрана |
| oil-ore carriers (OB) | [ɔɪl ɔː ˈkærɪəz] | нефтерудовозы **(**OB) |
| oil-bulk-ore carriers (OBO) | [ɔɪl bʌlk-ɔː ˈkærɪəz] | нефтенавалочники (OBO) |
| inert gas system (SIG) | [ɪˈnɜːt gæs ˈsɪstɪm] | система инертн. газов |
| detergent | [dɪˈtɜːʤənt] | моющее средство |
| to steam | [stiːm] | пропаривать, пар |
| live steam | [ləɪv stiːm] | «острый» пар |
| caustic soda | [ˈkɔːstɪk ˈsəʊdə] | каустическая сода |
| residues | [ˈrɛzɪdjuːz] | остатки |
| leaded gasolene | [ˈlɛdɪd ˈgæsʊliːn] | этилированный бензин |
| coil-pipes | [kɔɪl-paɪps] | змеевик |
| consent | [kənˈsɛnt] | согласие |
| stem | [stɛm] | форштевень |
| to ride at mooring (dump) anchor | [raɪd æt ˈmʊərɪŋ dʌmp ˈæŋkə] | стоять на мертвом якоре |
| voids | [vɔɪdz ] | пустоты |
| to pay out | [peɪ aʊt] | стравливать (давление) |

ADDITIONAL WORDS AND EXPRESSIONS (for Practical Work)

| | | |
|---|---|---|
| specific gravity | [spɪˈsɪfɪk ˈgrævɪti] | удельный вес |
| volume expansion | [ˈvɒljʊm ɪksˈpænʃən] | расширение объема |
| objective | [əbˈʤɛktɪv] | цель |
| relative density | [ˈrɛlətɪv ˈdɛnsɪti] | относительная плотность |
| to omit | [əˈmɪt] | пренебрегать |
| height | [haɪt] | высота |
| homogeneous | [həʊməˈʤiːniəs] | однородный |
| consumables/ supplies | [kənˈsjuːməblz/ səˈplaɪz] | расходы |

# 10. TECHNOLOGY OF TIMBER CARGOES TRANSPORTATION

## 10.1. Regulation of transportation of timber cargoes

The peculiarity of transportation of timber (or wood) cargoes on sea vessels is that 30–35% of them are transported on deck. Metacentric height h = 0.1–0.2 m and may be insufficient.

Transportation is regulated by the following rules:

International:

– Code of Safe Practice for Ships Carrying Timber Deck Cargo, 2011;

– International Convention on Load Lines, 1966.

National:

– Rules of the Register of Shipping in terms of vessel stability and freeboard assignment;

– Rules for the Safety of Sea Transportation of Timber Cargoes.

Physical properties of wood include:

– moisture ($W$). This is the ratio $\frac{\text{mass of moisture in wood}}{\text{mass of absolutely dry wood}}$, %.

Two forms of moisture are known:

– bound (hygroscopic). It is stored in cells;

– free (capillary). It remains in the intercellular spaces.

– swelling (α) – an increase in the volume of wood and its linear dimensions;

– shrinkage (β) – a process opposite to swelling (due to a decrease in moisture);

– porosity ($P$). This is the ratio $\frac{\text{volume of internal voids}}{\text{volume of wood in an absolutely dry state}}$;

– density (ρ) – mass of natural wood per unit volume.

Wood defects are the main grade-forming factor.

Wood defects include:

– cracks;

– knots;

– curvature;

– wormhole:

– rot;

– blue.

## 10.2. Types and nomenclature of timber cargoes

Timber (wood) cargoes includes:

– Saw-timber (boards, trim boards, beams, bars. Saw-tmber is subdivided into edged and unedged):

a) a four-edged bar;
b) a three-edged bar;
c) a two-edged bar;
d) an edged sleeper;
e) an unedged sleeper;
f) a slab.

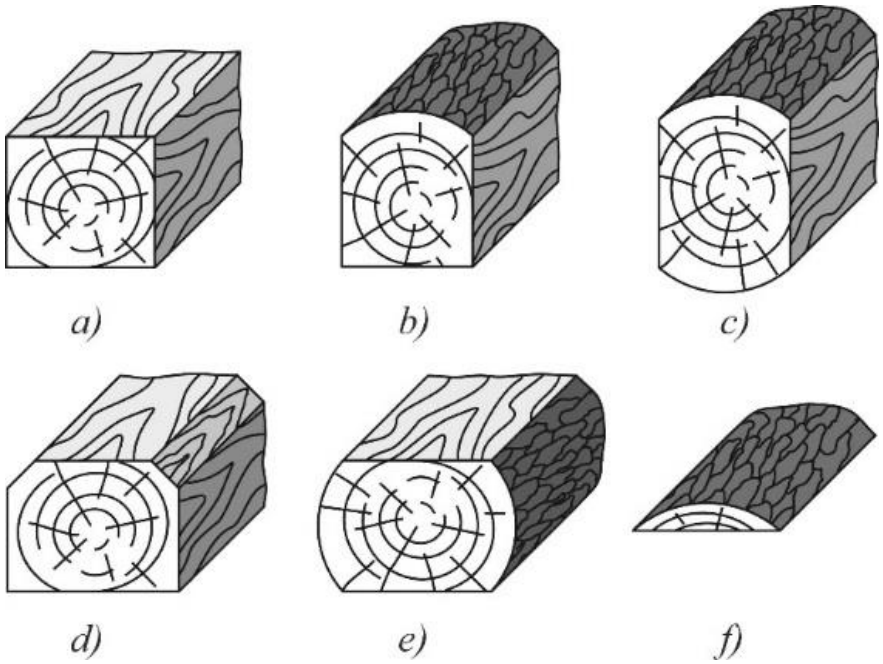



Fig.1. Subdivision of saw-timber

– The saw logs (round logs). It is subdivided by assortments into:
  – short ($L \leq 2$ m);
  – medium ($L = 2.0 \div 6.5$ m);
  – long ($L \geq 6.5$ m).

Pulpwood and props predominate among short-sized round timber.

Pulpwood is scraps from spruce, pine, fir, larch, cedar, birch. $L = 1 \div 3$ m.

Props are mine stanchions. $L = 0.9 \div 3.0$ m; $D = 6.3 \div 25$ cm.

By the type of disbarking saw logs are:
  – clean disbarking (complete removal of bark, bust);
  – coarse disbarking (bark is removed completely, the bast layer remains).

– Cut and chopped wood (these are bars, sleepers, firewood);
– Technological chips. Carried in bulk;
– Plywood.

The classification of saw-timber according to the terminology of foreign buyers is known:

| Name of assortments | Species | Cross-section, cm | | Length, m |
|---|---|---|---|---|
| | | thickness | width | |
| Dills | Pine, spruce boards | 5–10 | ≥ 23 | ≥ 2.5 |
| Battens | – ,, – | 5–10 | 20–40 | ≥ 2.5 |
| Boards | – ,, – | ≤ 5 | ≥ 10 | ≥ 2.5 |
| Ends | – ,, – trims | ≤ 5 | ≥ 10 | – |
| Sketlings | – ,, – trims | 5.0–7.5 | 7.5–14 | – |
| Baguettes | Pine, spruce laths | 7.5–15 | 7.5–2.5 | – |

### 10.3. Measurement of timber cargoes quantity

*Export saw-timber* – quantity measured in $m^3$. For this, there are special tables, where the volume of the 1 unit depends on the length, width, thickness.

*Sawlogs*. The unit of volume is $m^3$. Sawlogs accounting is carried out:

– in a dense measure (dense $m^3$ – a unit of measurement of clean wood, excluding voids);

– in a store measure (storage $m^3$, stock $meter^3$ – a unit of measurement of clean wood, taking into account voids).

To convert the storage $meters^3$ to dense $m^3$, the full wood content coefficients $k_{fw}$ are used

$$k_{fw} = \frac{\text{volume of dence mass of wood}}{\text{total volume of the stack}}.$$

To resolve the outlines of loading, the following is taken into account:

– volumetric mass of wood $\gamma$ – mass of a unit of volume in a dense (store) measure

$$\gamma = \frac{Q}{V}, \quad t/m^3;$$

– specific gravity SG (loading volume)

$$u = \frac{W_{bc}}{Q}, \quad m^3/t,$$

where $W_{bc}$ is the bale cargo capacity of the vessel, $m^3$;

$Q$ is the mass of the cargo, *t.*

The amount of cargo received is corrected by the stowage density coefficient

$$k_{ds} = \frac{V_{dm}}{W_{bc}},$$

where $V_{dm}$ is volume of timber in a dense measure;

$W_{bc}$ is the bale cargo capacity of the vessel.

## 10.4. Marking of timber cargoes

**Saw-timber marking.**

All boards are marked if width $B \geq 75$ mm; thickness $\sigma \geq 16$ mm; length $L \geq 1$ m.

In addition, they are marked individually from 2 ends, if $B \geq 100$ mm; $\sigma \geq 22$ mm.

When shipping saw-timber tied in packages, except for cargo piece marking, packages are marked on the top and side planes at a distance of 100–150 mm from the edge. Red paint is applied to a stamp containing

– Bill of Lading number;

– lot (consignement) number;

– section dimensions in mm;

– length in m.

**Sawlogs marking.**

All logs are marked individually if $D \geq 14$ cm. The exception is sawlogs length $L \leq 2$ m and firewood length $L \leq 3$ m.

**Marking of sleepers and bars.**

They are marked on one of the ends.

## 10.5. Unitization of timber cargoes

Saw-timber is unitized if it has the same width *B* and thickness σ. Different lengths *L* of a single unit in the package are allowed.

The packages must have a rectangular cross-section. A ledged section is also allowed.

Packages are provided with gaskets.

Packages are tied with tapes (chains for sawlogs) which are valid for one occasion or reusable.

## 10.6. Preparing the vessel for timber transportation

Timber is transported on the vessels:

– universal;

– specialized timber carriers, conventional and package carriers;

– Ro-Ro carriers.

Fig.2. Specialized timber carrier

If transported by timber carrier, a timber freeboard mark is applied on board.

The suitability of the vessel for timber transportation is determined by the vessel's commission.

If the vessel is sailing in within the winter seasonal mark, vessels are equipped with a double-bottom tank heating system.

When transporting sawlogs, dry cleaning of holds is performed.

When transporting saw-timber, cargo spaces are washed, dried and ventilated.

Accepting of the bunker is carried out before loading the timber, in extreme cases – before loading on deck.

By the time the loading is completed, all tanks should be pressed in.

Ballast is pumped out only from those tanks that, according to the Stability Information, should be drained.

The presence of free surface is allowed only in tanks of washing and drinking water.

When loading well-dried saw-timber, the maximum amount of ballast is accepted. Even then, the allowable draft is not always fully utilized.

## 10.7. Loading and stowage timber in holds

**Saw-timber.**

When loading, under the first layer of cargo, gaskets 13-16 mm thick are placed in the direction across the vessel or diagonally to the DP of the vessel. For the

convenience of unloading, each B/L log is stowed from side to side (wing to wing) and marked with paint of a certain color.

The sleepers are impregnated with antiseptics – coal, creosote or shale oils. Before loading, all vessel constructions inside the hold are whitewashed with a thick layer of slaked lime. A layer of sawdust 10 mm thick is laid on the floor.

**Sawlogs.**

Heavy types of sawlogs are loaded into the hold – larch, birch.

Loading of timber is carried out under the supervision of the vessel's administration.

Fig. 3. Stowage of packaged timber in the hold

Fig. 4. Stowage of sawlogs loose in the hold

## 10.8. Loading and stowage of timber on deck

The timber deck caravan must be supported by the side posts (stencils). They are either metal beams, or logs cut at the end for installation in the nests on the deck in the bulwark area, or stacked together 3–4 boards.

For fastening, lashing strength of 133 kN is used, which are constantly tightened during voyage. The information is entered into the Ship's Log. For emergency return of the caravan at sea in a storm in case of loss of the screw propeller, the ends of the lashings are attached to the verb-hook.

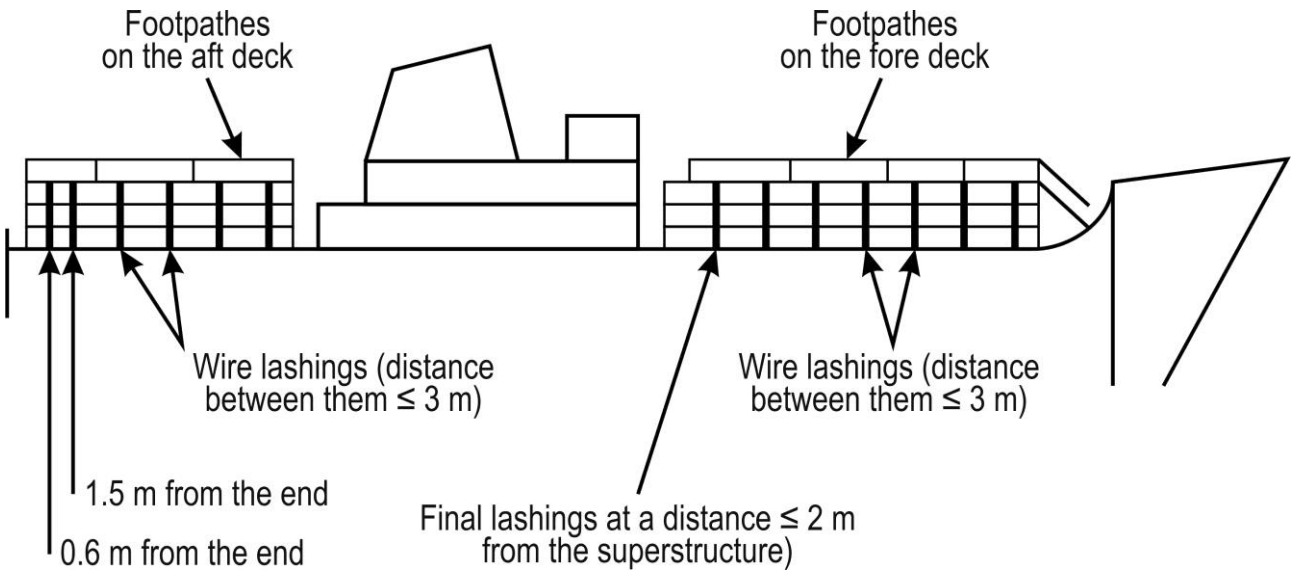



Fig. 5. Schematic diagram of stowage of timber deck cargo

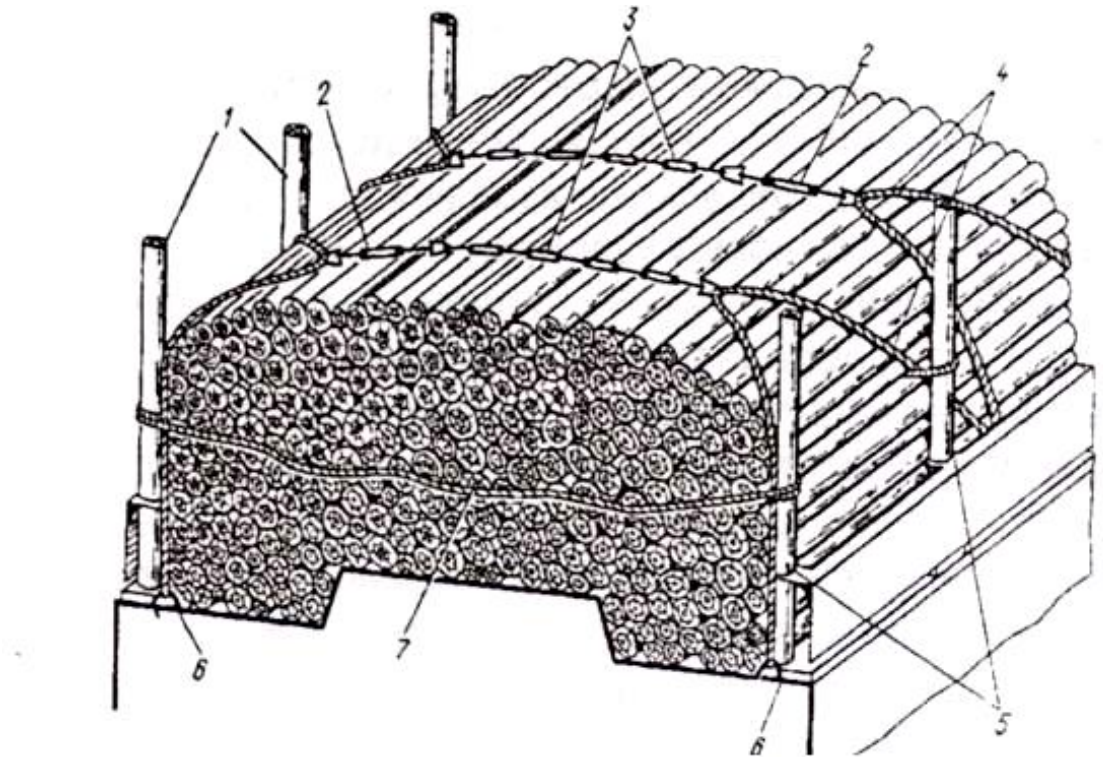



Fig. 6. Securing the saw logs caravan on the upper deck
1 – side posts; 2 – lanyard (turn-buckle) with a verb-hook; 3 – long link chain; 4 – wire rope; 5 – fastening the post to the bulwark; 6 – wire rope attachment point; 7 – tie

## 10.9. Stability requirements for vessels carrying timber cargoes

Stability should always be positive and calculated taking into account:
– increase in the weight of timber due to wetting, icing;
– changes in consumable supplies;

– influence of free surfaces in tanks;

– weight of water accumulated between logs.

Before going to sea, the vessel should not have a list; have sufficient stability.

The height of the deck caravan *H* is limited by the following factors:

– the need for visibility;

– to maintain the required level of stability;

– any part of the caravan should not protrude beyond the ship's hull and be exposed to the slams of the head sea waves;

– the weight of the deck cargo should not exceed the permissible deck load.

The inclination method can be used to check the accuracy of calculating the metacentric height *h*. To do this:

– the weight m of the selected package is measured with a dynamometer;

– the vessel's crane (boom) moves the draft to a distance *b* from the vessel's DP (the fore-and-aft centerline) and position it on a vertical at a height corresponding to the upper level of the caravan;

– using a high-precision inclinometer (liquid) determine the inclination angle Θ on each side and determine the average $\Theta_{av}$;

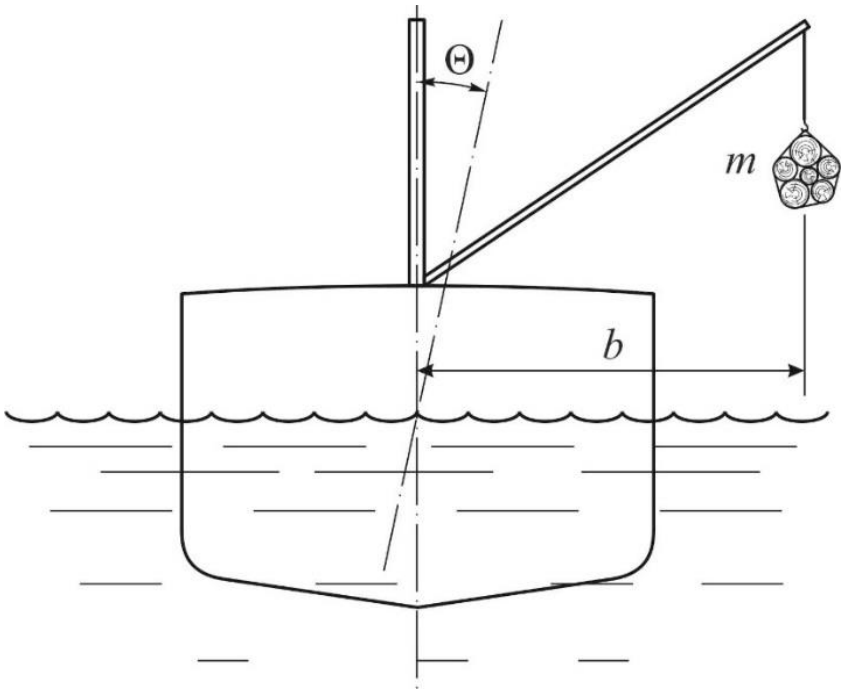



Fig. 7. Using method of calculating of inclination angle Θ

– knowing the displacement tonnage of the vessel Δ, calculate the initial metacentric height $h_o$

$$h_0 = 57.3\frac{m \cdot b}{\Delta \cdot \Theta},$$

where inclination angle (list) Θ is counted in radians.

Also, choosing the minimum admissible value *h* from the Stability Information, we calculate the inclination angle Θ at which loading should be stopped

$$\Theta = 57.3\frac{m \cdot b}{\Delta \cdot h_0}.$$

For approximate preliminary calculations of the height of the deck caravan of the wood, one sometimes uses the expression

$$H = 0.75\ (B - D),$$

where *B* – width of the vessel, m;

*D* – depth from the keel to the main deck, m.

There is another empirical criterion for safe loading with timber cargo $B \geq 2d$, that is, the doubled draft of the vessel should be less than its width.

Additional requirements for the stability of the timber carrier: if the specific gravity of timber cargo $u$ is not known, $u = 2.3$ m$^3$/t.

The corrected metacentric height $h'$ is taken:

$h' \geq 0.1$ m for the full load and the weight of the supplies $P_з = 100\%$.

$h' \geq 0.05$ m for full load and $P_з = 10\%$.

$h' \geq 0.15$ m for an empty vessel and $P_з = 100$ % and $P_з = 10\%$.

In the absence of data on the wetting of the cargo, it is recommended in the calculations to increase its mass by 10%.

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| peculiarity | [pɪˌkjuːlɪˈærɪti] | особенность |
| wood, timber, *ам.* lumber | [wʊd, ˈtɪmbə, ˈlʌmbə] | лес (материал) |
| timber-carrier | [ -ˈkærɪə] | лесовоз |
| board, plank | [bɔːd, plæŋk] | доска |
| swelling | [ˈswɛlɪŋ] | разбухание |
| shrinkage | [ˈʃrɪŋkɪʤ] | усущка |
| porosity | [pɔːˈrɒsɪti] | пористость |
| density | [ˈdɛnsɪti] | *физ.* плотность |
| grade-forming | [greɪd-ˈfɔːmɪŋ] | сортообразующий |
| factor | [ˈfæktə] | фактор |
| crack | [kræk] | трещина |
| knot | [nɒt] | сучок |
| curvature | [ˈkɜːvəʧə] | кривизна, изгиб |
| wormhole | [ˈwɜːmhəʊl] | червоточина |
| rot | [rɒt] | гниль, гниение |

| | | |
|---|---|---|
| blue | [bluː] | синева |
| nomenclature | [nəʊˈmɛnkləʧə] | номенклатура |
| bar | [bɑː] | брус |
| sleeper | [ˈsliːpə] | шпала *ж-д* |
| slab | [slæb] | *мех.* горбыль, плита |
| saw log | [sɔː lɒg] | бревно пиловочное |
| saw-timber | [sɔːˈtɪmbə] | пиломатериалы |
| pulpwood | [pulpwood] | балансы |
| props | [prɒps] | пропсы |
| spruce | [spruːs] | ель |
| pine | [paɪn] | сосна |
| fir | [fɜː] | пихта |
| larch | [lɑːʧ] | лиственница |
| cedar | [ˈsiːdə] | кедр |
| birch | bɜːʧ] | береза |
| stanchion, prop | [ˈstɑːnʃən, prɒp] | стойка |
| bark, disbarking | [bɑːk, disbarking] | кора, окорка древесины |
| bust | [bʌst] | луб (слой круглого леса) |
| cut and chopped wood | [kʌt ænd ʧɒpt wʊd] | тесаный и колотый лес |
| firewood | [ˈfaɪəwʊd] | дрова |
| technological chips | [ˌtɛknəˈlɒʤɪk(ə)l ʧɪps] | технологическая щепа |
| plywood | [ˈplaɪwʊd] | фанера |
| species | [ˈspiːʃiːz] | *биол.* вид, порода |
| trims | [trɪmz] | обрезки |
| baguettes | [bæˈgɛts] | багеты |
| to resolve | [rɪˈzɒlv] | решать |
| full wood content coefficient | [fʊl wʊd ˈkɒntɛnt kəʊɪˈfɪʃənt] | коэффициент полнодревесности |
| stowage density coefficient | [ˈstəʊɪʤ ˈdɛnsɪti kəʊɪˈfɪʃənt] | коэффициент полноты укладки |
| plane | [pleɪn] | плоскость (пакета) |
| edge | [ɛʤ] | край (пакета) |
| unitization | [unitization] | пакетирование грузов |
| ledge‖ -d | [lɛʤ, id] | уступ (в штабеле), -чатый |
| gasket | [ˈgæskɪt] | прокладка |
| valid for one occasion | [ˈvælɪd fɔː wʌn əˈkeɪʒən] | разовый |
| reusable | [riːˈjuːzəbl] | многократный |
| suitabeness | [suitabeness] | пригодность |
| to impregnate‖ -d | [ɪmˈprɛgneɪt, -id] | пропит‖ывать, -анный |

| | | |
|---|---|---|
| to whitewash\|\| -ed | [ˈwaɪtwɒʃ, -ɛd] | побел\|\|ить, -енный |
| shale | [ʃeɪl] | слан\|\|ец, -цевый |
| slaked lime | [sleɪkt laɪm] | гашеная известь |
| quick lime | [kwɪk laɪm] | негашеная известь |
| sawdust | [ˈsɔːdʌst] | опилки |
| floor | [flɔː] | пайол |
| side posts (stencils) | [saɪd pəʊsts (ˈstɛnslz)] | стензели |
| screw propeller | [skruː prəˈpɛlə] | гребной винт |
| verb-hook | [vɜːb-hʊk] | глаголь-гак |
| lanyard, turn-buckle | [ˈlænjəd, tɜːn ˈbʌkl] | талреп |
| tie | [taɪ] | оттяжка |
| to protrude | [prəˈtruːd] | выступать, торчать |
| to expose | [ɪksˈpəʊz] | подвергаться |
| slam of the head sea wave | [slæm ɒv ðə hɛd siː weɪv] | удар о встречную волну |
| inclination method | [ˌɪnklɪˈneɪʃən ˈmɛθəd] | метод кренования |
| inclination angle | [ˌɪnklɪˈneɪʃən ˈæŋgl] | угол накренения |
| high-precision inclinometer | [haɪ-prɪˈsɪʒən ˌɪnklɪˈnɒmɪtə] | высокоточный кренометр |
| draft | [drɑːft] | подъем (груза за 1раз) |
| in the DP (the fore-and -aft centerline position | [fɔːr ænd ɑːft sentə’lain pəˈzɪʃən] | в ДП (диаметральной плоскости) |

# 11. TECHNOLOGY OF ENLARGED CARGO UNITS (ECU) TRANSPORTATION

## 11.1. Means of Consolidation of Cargoes in Marine Transport

In accordance with the "Rules for the carriage of general cargo", the following classification of mobile equipment and means of consolidation of cargoes has been adopted:

– self-propelled vehicles – these are cars and trucks, tractors, excavators, lifting and transport, building, road, agricultural and other wheeled and caterpillar self-propelled vehicles;

– trailers – high– and low-bed platforms with axes in front and behind, used for the transportation of cargoes along the main roads;

– semi-trailers – high-frame platforms used for the transportation of goods along the main roads;

– roll trailers – low-loader semitrailers without brakes and signal lights, connected to a tractor with a special device (gooseneck), used for transportation and storage of cargoes in the port territory;

– containers;

– pallets;

– flats – cargo platforms with end stanchions of folding or removable types. Sometimes referred to as a collapsible container;

– bolsters – cargo platforms without side stanchions with corner fittings;

Any enlarged cargo units (ECU) can be called a “unit”. For example, this term can be used in official correspondence.

ECU are used in transport and technological systems (TTS) in sea going transport.

## 11.2. Transport and technological systems in sea going transport

TTS is a complex of coordinated and interrelated technical, technological, economic, organizational and commercial-legal measures that allow, with maximum effect and the least labor costs, to ensure the transportation of certain types and groups of cargoes in specific directions from the shipper to the consignee.

The components of any TTS are cargo, fleet and ports.

The development of progressive TTS is focused on expanding the use of such intensive technologies as container, Ro-Ro, transportation in heavy modules (block-packages, adapters, lighters), on carrying out cargo handling with multi-tiered stowage of cargo items (containers, lighters), on increasing the volume of cargo operations on the roads conditions.

Today, more than 90 thousand ships of a total deadweight of 1.97 billion tons are operated in the world. It is predicted that the ships of the future will have increased reliability, safety, environmental friendliness, comfort, will be handled and serviced in the ports of a new look – in smaller territories, directly "from the wheels."

## 11.3. Types of containers, their classification

Containers can be classified according to the following factors:

– by designation:

– universal;

– specialized;

– by construction:

– indoor and outdoor;

– waterproof and hermetically unsealed;

– metal and from polymer materials;

– in terms of gross and net weight:

– low-tonnage (weight up to 2.5–3 tons);

– medium tonnage (up to 10 tons);

– large-capacity (≥ 10 t);

– by the sphere of circulation:

– international;

– trunk lines;

– in-plant.

The International Organization for Standardization (ISO) organized the Technical Committee TC-104 "Freight containers", which established the main parameters and scope of containers.


Fig.1. The main types of large-capacity containers

For containers of the “1” series, a single cross-section of 2438×2438 mm is established. This corresponds to the dimensions of 2 pallets 1200×1200 mm in width, and 2 in height of the container. A deviation from these values is allowed in height. Most companies widely use containers with a height of 9' (2743 mm), 9.5' (2896 mm) and more. The limiting factor for the introduction of such containers is the size of the rolling stock of railways and road transport.

In world shipping, each container must meet the construction and technical condition of the requirements of the International Convention for Safe Containers (CSC-72). According to them, the container is subject to certification by the country's administrative body, which issues a certificate "On Approval for Safety." The initial validity period of the Certificate is 5 years, subsequent re-certification – every 2 years. According to the Rules for the manufacture of containers of the Register, the container must withstand stacking in 6 tiers.

If the container carries out the transportation of goods under the customs seal, then by construction it must comply with the 1972 Customs Convention and have a plate with the inscription "Approved for carriage under customs stamps and seals."

The construction of the universal containers is standard. They have steel frames. Fittings are welded to the corners of the end frames from the beams. The frame is sheathed with 2 mm thick sheet steel with corrugation. The floor is wooden in the form of a flooring made of antiseptic grooved boards 35 mm thick. The thresholds are covered with steel sheets. The container doors are 2-leaf, open at an angle of 270°.

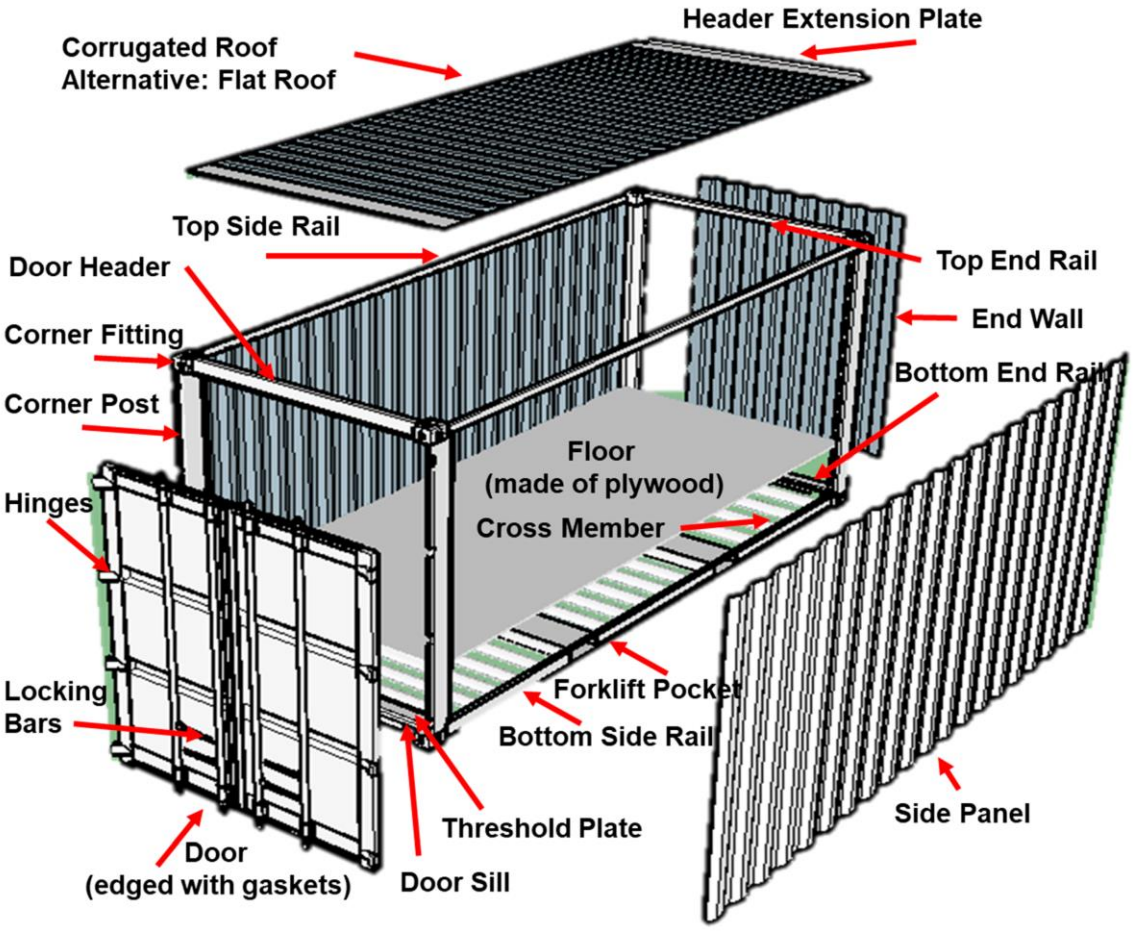



Fig. 2. Structural elements of a large-capacity container

Containers are also produced from Al, water-resistant plywood, reinforced plastic.

Specialized containers include:

– containers with a removable roof;

– open (can be covered with a tent);

– tank containers (for powdery cargo, liquid cargo and gases), for liquid chemicals (with plating inside), heated (for oils);

– isothermal (including vacuum thermal insulation);

– refrigerated (autonomous with mounted diesel-generators or connected to an external power source).

Fig. 3. ISO tank-containers


Fig. 4. Reefer container High Cube

## 11.4. Container vessels

A container vessel is a 1-deck cargo vessel with holds' dimensions that are suitable to the dimensions of standard containers.

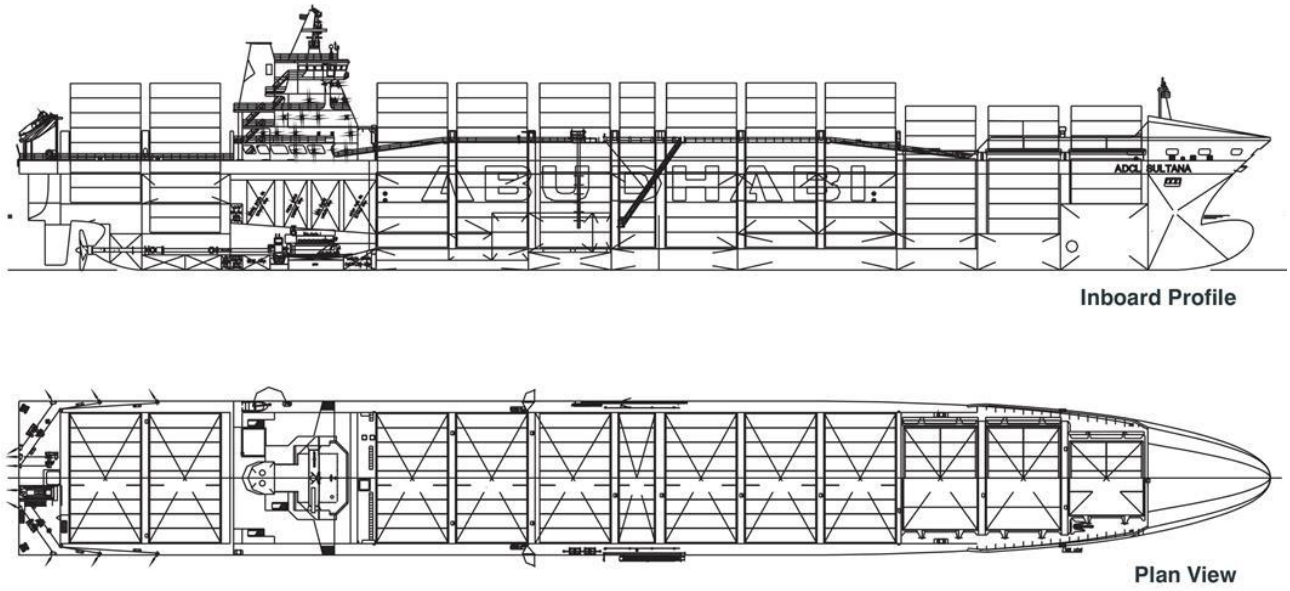



Fig. 5. Container vessel

Container vessels are classified:
– ocean-going (mainline);
– feeder.

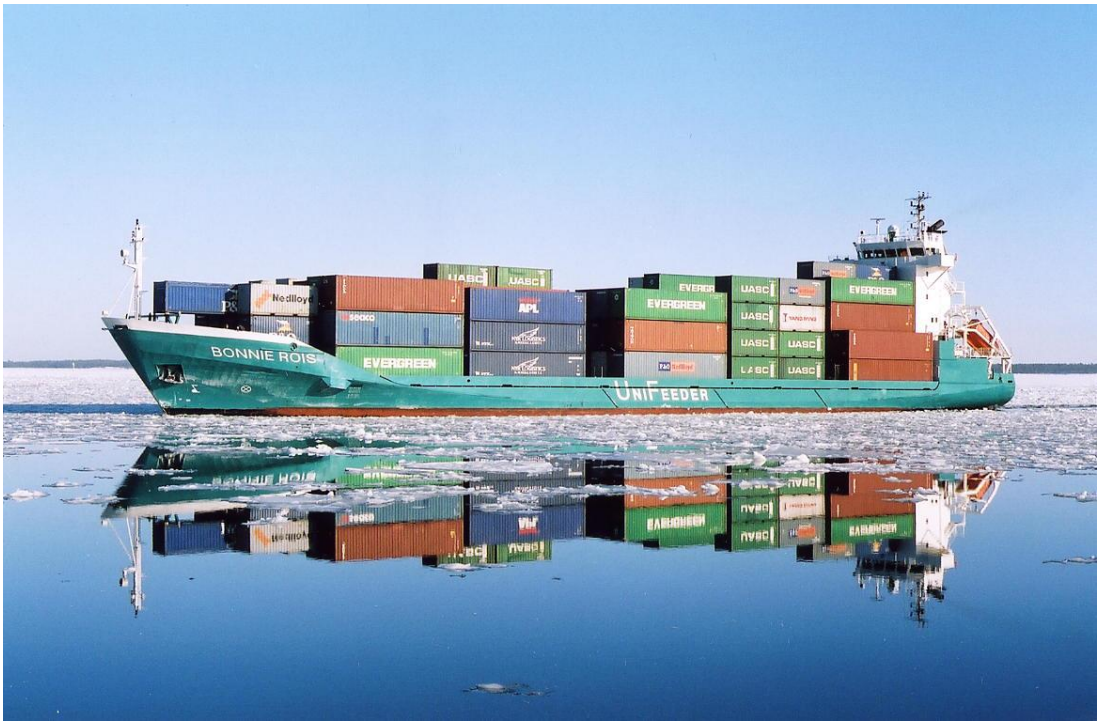



Fig. 6. Feeder container vessel

The holds of container vessels are box-shaped, formed by transverse watertight bulkheads and bulkheads of side tanks. Each hold is divided into cells (bays) by means of movable vertical guide stanchions, set to the size of the containers. Pontoon-type covers allow convenient stowage of containers on the deck and must withstand the breaking moment of a stack of containers installed on them. The absence of a cargo device and the shifted superstructure free up the entire deck for storing containers.

To protect containers from sea waves, some ships build an elongated forecastle and a special bow chock plate.

The most difficult problem is stability assurance under different loading options. When operating over long distances, large changes in ship's stores occur, which requires taking of a large amount of ballast. To store fuel and water, not only double bottom tanks are used, but also side tanks. The location of the fuel and ballast tanks in the area of the second bottom is staggered, which allows the vessel to be trimmed under any operating conditions. The total capacity of ballast tanks is 20-40 % DW.

Feeder container vessels have capacity of up to 1,000 containers. They serve the smaller ports of the region, which determines the construction of ships with aft ramps and deck cranes.

For cargo operations, shore container loaders/ handlers with a retractable console are used, on which a spreader is suspended. The grips of the spreader, when applied to the container, unfold in the fitting holes and the slinging / unslinging takes place.

The starting point in the history of container shipping is considered to be 1956, when the first container vessel "Ideal X", converted from an old oil tanker, departed from Newark to Houston with 58 35'containers. The American Malcolm McLean is considered to be the inventor of the container. The first container ships with a cell system with a capacity of 800 TEU appeared in the early 70s. Currently, ships with a container capacity of 24,000 TEU are being built at the shipyards of South Korea.

### 11.5. Securing containers on vessels

Fastening means are:

– rigid guides-limiters. They are made of a steel angle profile with dimensions of 120 x 165 or 100 x 100 mm. The rails are bolted or welded to the deck, which allows you to change the length of the cells;

– embedded devices. There are 3 types:

– centering (double and single cones and pyramids, upper brackets);

– manual rotary locks. Their part is a shaped pin with conical hammer-shaped heads, which, when turned, grip the container by the corner fittings;

– semi-automatic spring locks. These are konlocks, twistlocks, the elements of which unfold and grip containers under the pressure of the weight of the container.

– lashing braces. There are 3 types:

– bar. The most convenient and safe. They are made of separate links L = 1200 mm;

– chain. Used on non-specialized vessels;

– cable. The same as chain.

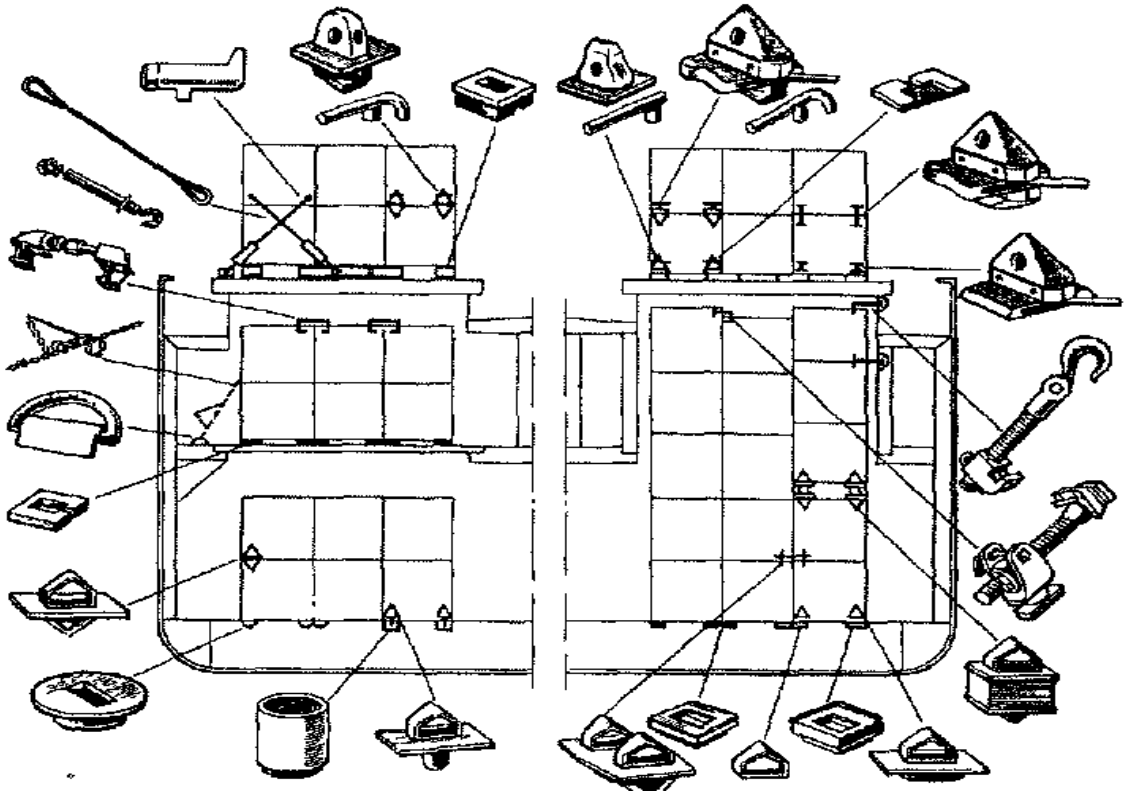


Fig. 7. Set of standard container lashings /fasteners

The choice of fastening schemes for the vessel is not precisely regulated, it depends on the construction type, the number of tiers. Usually variants of fastening schemes are attached by the shipyard-builders in the form of Appendices to the "Information on stability".

### 11.6. Lighter carrier transport and technological system

The creation of the lighter carrier TTS dates back to the end of the 50s. The basis was the desire to ensure the independence of shipping from ports and their technical equipment.

The lighter is used as a unit of enlargement in the lighter carrier TTS. The lighter is a rectangular metal container. Its hold is equipped with a lockable hatch, smooth vertical walls and a flat bottom. They are adapted for transportation on carrier vessels called lighter carriers, as well as for towing on inland waterways without additional devices. Lighters differ from pushed barges in smaller dimensions, lack of a streamlined bow and specific devices. But lighters cannot be used on the high seas and installed at the head of a pushed caravan.

When choosing the parameters of the lighters, we proceeded from the dimensions of the river barges of the served region. In all cases, *B* lighter = *B* river barge, and *L* lighter = 1/2 or 1/4 of its length. The parameters of the main types of lighters are given in tab.1.

| Type of lighter and barge | *L* × *B* × *H*, m | Lighter weight with cargo, t | DW, t |
|---|---|---|---|
| LASH (Rhine barge) | 18,8 × 9,5 × 3,9 | 460 | 376 |
| Sea-Bee (American "Jumbo") | 29,7 × 10,7 × 5,2 | 1000 | 810 |
| DM (Danube "Europe-II") | 38,3 × 11,0 × 5,3 | 1300 | 1100 |
| B Bako (African barge) | 24,0 × 9,5 × 4,1 | 800 | 720 |
| Bakat (British barge) | 17,0 × 4,7 × 3,6 | 175 | 140 |

The constructive type of lighter carrier vessels depends on 3 factors:

– lighter parameters;

– type of lifting device;

– the purpose of the lighter carrier is oceans-going or feeder.

Let's consider the main types of lighter carriers.

1. LASH type lighter carriers (lighter aboard ship) – vessels with a cellular construction of holds. A gantry crane with a lifting capacity of 510 t moves along the upper deck. The tug brings the lighter into the aft cutout located between 2 consoles, then it is moored, slinged and lifted aboard the vessel. The crane places it in the appropriate cell. LASH-type lighter carriers can transport containers, as well as grain in a non-lighter version. Lighters in the hold are installed in 3-4 tiers, on the deck in 2 tiers. The LASH system was introduced in 1969 with the put into operation of the “Acadia Forest” lighter carrier. This system included the “Aleksey Kosygin” lighter

carrier built in 1983 with a capacity of 82 LASH lighters (BLASCO has 3 vessels of this type – “Indira Gandhi”, “Le Zuan”, and “Che Guevara”.

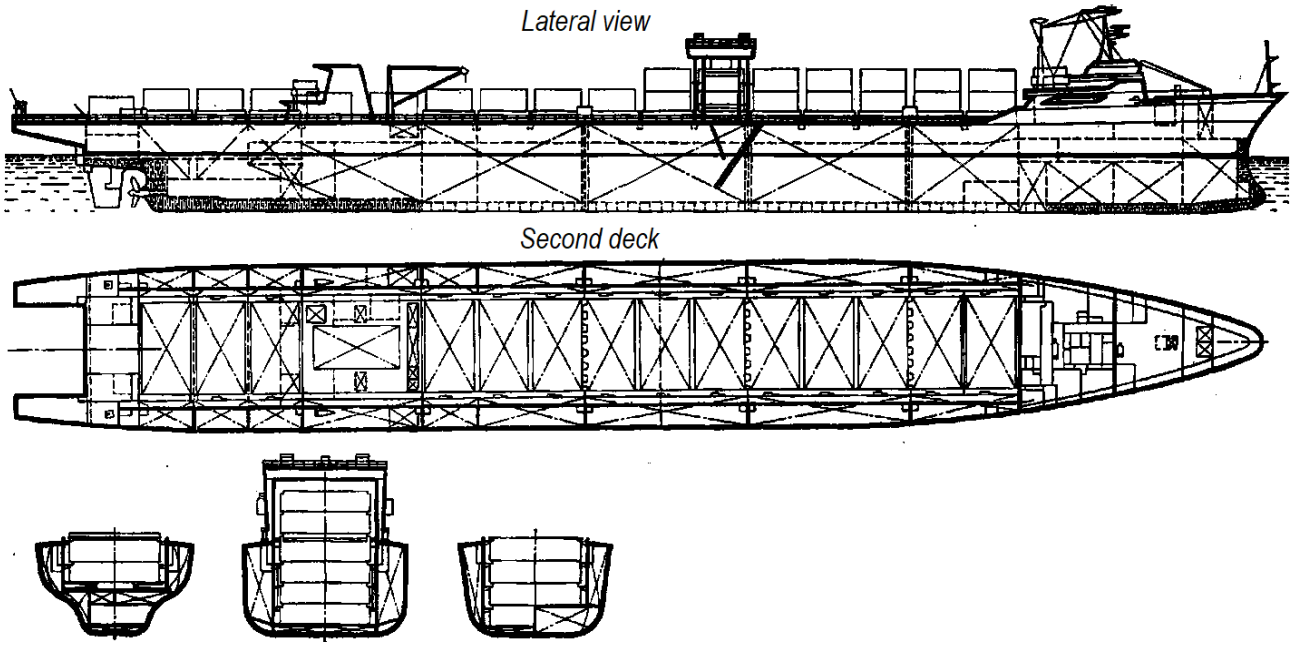



Fig. 8. LASH type lighter carrier

2. Lighter carriers of the Sea-Bee type have a loading device in the form of a synchro-lift. Raised to a specific deck 2 lighters are transported to a specific place. Special platform adapters allow you to take containers on board without re-equipment of vessels. In 1978 vessels of the “Julius Fuchik” series were built. The vessel is constructed to receive 26 DM type lighters or 52 LASH type lighters or 1552 containers. Operated in the Danube Co.

3. Lighter carriers of the Bako type (barge container).

It is designed to carry 12 Bako-type lighters in the hold and 500 containers on the upper deck in 3 tiers. Lighters are loaded into the hold by docking through the bow cargo port.

4. Lighter carriers of the Bakat type (barge aboard catamaran). Firstly, 3 LASH-type lighters are taken on board in the submerged position and 10 Bakat-type lighters to the upper deck with the help of a lift.

It is necessary to mention the first lighter carrier with a nuclear power plant "Sevmorput". Built at the Kerch plant "Zaliv" in 1988. The vessel is capable of taking on board 74 LASH-type lighters or 1336 containers.

In ports, specialized loading complexes include:

– mooring devices for mooring container ships;

– forming roads (serves for the formation of lighter caravans, as well as for short-term lighters stay);

– storage and settling basin (intended for the accumulation of lighters);

– cargo area for handling lighters.

## 11.7. Features of Ro-Ro TTS and its elements

Ro-Ro TTS has a higher operational flexibility than container and lighter carriers. The name comes from the English. “To roll on-to roll off”, which implies the loading of ships by the roll-on method. It is distinguished by the ability to conduct cargo operations at any non-specialized berths, a lower cost of a cargo device compared to cellular container vessels, a lesser dependence of the size of cargo spaces on the size of cargo than that of cellular vessels, the ability to transport cargoes with a very high specific cargo capacity.

The whole variety of ro-ro vessels is divided into groups:

– ocean cargo ro-ro vessels;

– feeder ro-ro vessels;

– car-passenger and rail-road ferries;

– car carriers;

– combined vessels;

– multipurpose vessels.

The number next to the word “Ro” means the capacity of cargo spaces in $m^3$, for example, “Ro-30” means that the capacity of cargo spaces is 30 thousand $m^3$.

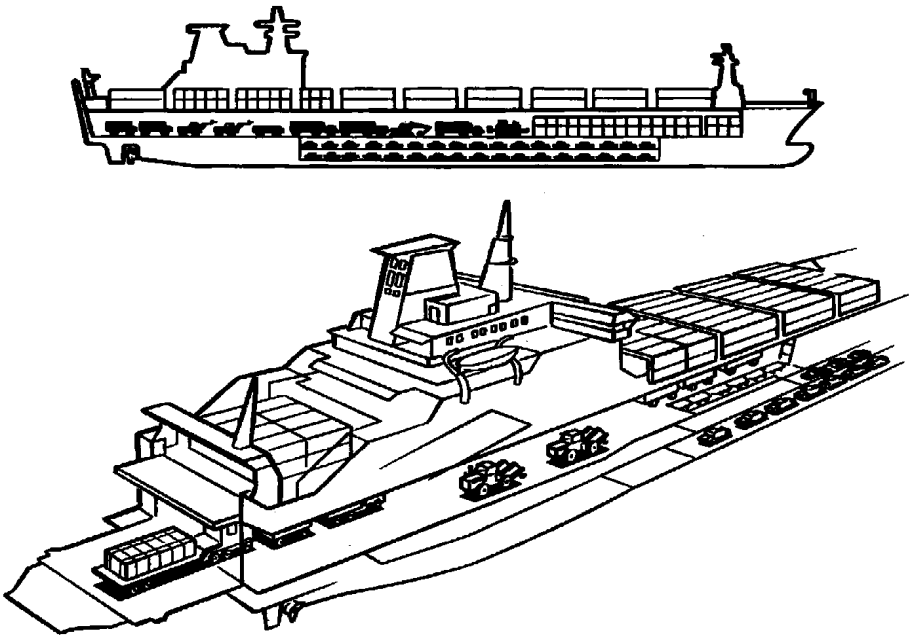


Fig. 9. Ro-Ro vessel

**Cargo complexes of vessels with horizontal handling.**

The device for entering (leaving) a ship includes two elements:

– connecting bridge (ramp);

– housing closing device.

**Freight ramps.**

Cargo ramps can be divided according to the following criteria:

– at the place of installation (bow, side, stern);

– by construction (straight lines or located in the diametrical plane, angular, rotary);

– according to the permissible load (light, medium, for heavy loads).

Fig. 10. Ro-Ro aft ramp

**Panduses and ramps.**

Panduses (fixed ramps) are stationary ramps between two decks located at different levels.

Ramps are elevating inclined walkways located between two decks.

**Cargo lifts.**

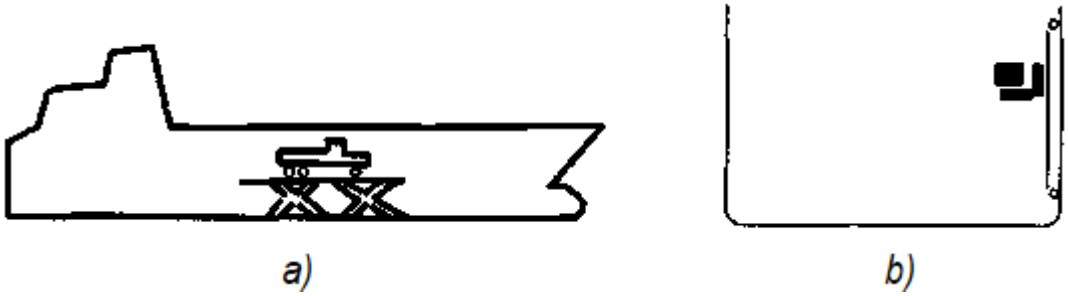



Fig.11. Types of freight lifts:
a) lever ("scissors"); b) L-shaped

Securing equipment on Ro-R0 vessels is shown in accordance with the diagrams in Fig. 12.

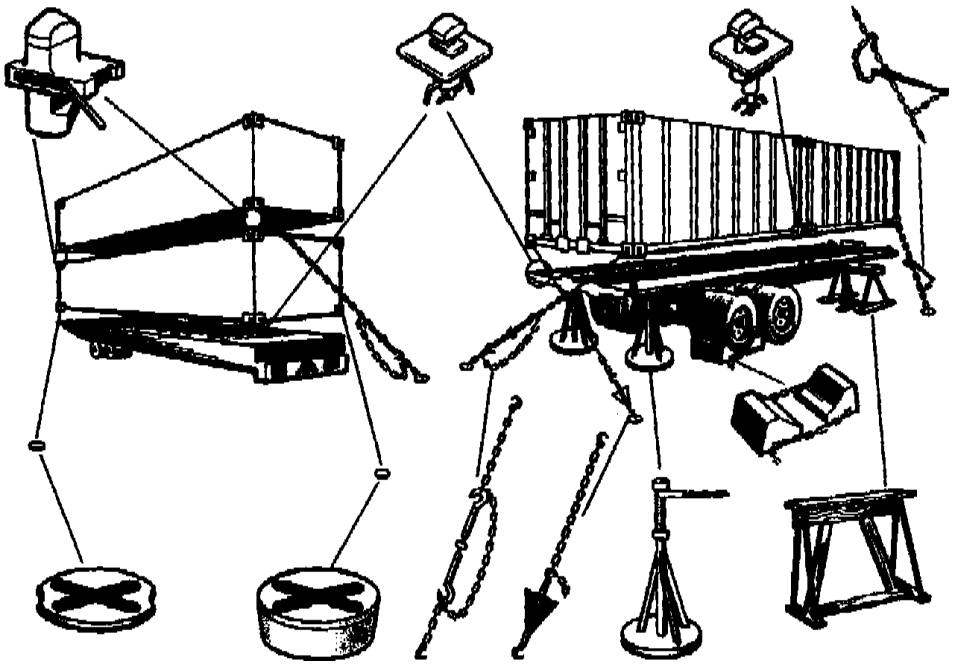


Fig.12. A set of means of securing cargo on Ro-Ro vessels

## 11.8. Requirements for the safety of Ro-Ro vessels

**Fire safety.**

Ro-ro cargo spaces must be equipped with fire detection means, fire alarms, an inert $CO^2$ fire extinguishing system, any other gas or foam extinguishing system that can provide equivalent protection.

The smoke detection system for Ro-Ro is not always effective, therefore systems based on the measurement of air ionization are used.

Television systems are used to monitor the condition of cargo spaces. Ro-Ro garage decks are exempt from the installation of fire bulkheads every 40 m, a water curtain system is adopted as an equivalent. Most Ro-Ro are equipped with carbon dioxide extinguishing stations, allowing the use of high expansion foam systems. The decks should have special passages along the entire length of the vessel – for the possibility of extinguishing a fire and for monitoring the fastening of vehicles.

**Waterproof.**

Since the ro-ro vessels do not have a division of cargo spaces into compartments in the longitudinal direction, the ingress of water into the interior leads to the formation of large free surfaces of the liquid, loss of stability and buoyancy.

The ingress of water into the hull of a ro-ro vessel can occur for the following reasons: through open or loosely closed side air ports, through drain scuppers, as a result of damage to water tanks or ship lines. Interior doors, panduses and ramps are a major challenge. Despite the lack of requirements, projects with watertight bulkheads prevail in shipbuilding practice. Waterproof ro-ro vessels' doors are: hinged; sliding with manual and mechanical drive. The most acceptable hinged doors of the "valve" type, opening over the entire width of the hold. The doors must be closed when the vessel is heeled up to 15 ° to any side.

**Ventilation of ro-ro vessels.**

A large number of air intakes are located on the upper deck along the sides, which carries a potential danger of water penetration into the vessel in emergency situations. The ventilation system of longitudinal and transverse channels should provide for automatic plugs to prevent water from entering the vessel.

Based on IMO recommendations, closed cargo spaces intended for the transport of wheeled vehicles should provide ≥ 6 times air exchange / hour. During loading and unloading operations with forklift trucks, the air exchange rate should be ≥ 20 air changes per hour; on flights when transporting equipment with fuel in tanks ≥ 10 air changes per hour.

The ventilation system must be separate for each cargo space and ensure fast closure of the ducts in all weather conditions. Ventilation shafts, ducts and dampers must be made of steel.

## 11.9. Features of the ferry TTS

The ferry TTS implements the principle of regular transportation of land vehicles and passengers across water obstacles.

Ferry – a seagoing vessel designed for scheduled transportation of land vehicles, passengers, as well as partially enlarged cargo units, overloaded by the rolling method.

Recently, it has been customary to classify ferries only as those rolling-type vessels that have cabins for ≥ 12 passengers who pay their fare, in contrast to such vessels with passenger seats only for persons accompanying cargo (drivers, conductors, refrigerated section mechanics).

Ferries can be classified as follows:

– car ferries;

– train ferries;

– multi-purpose ferries.

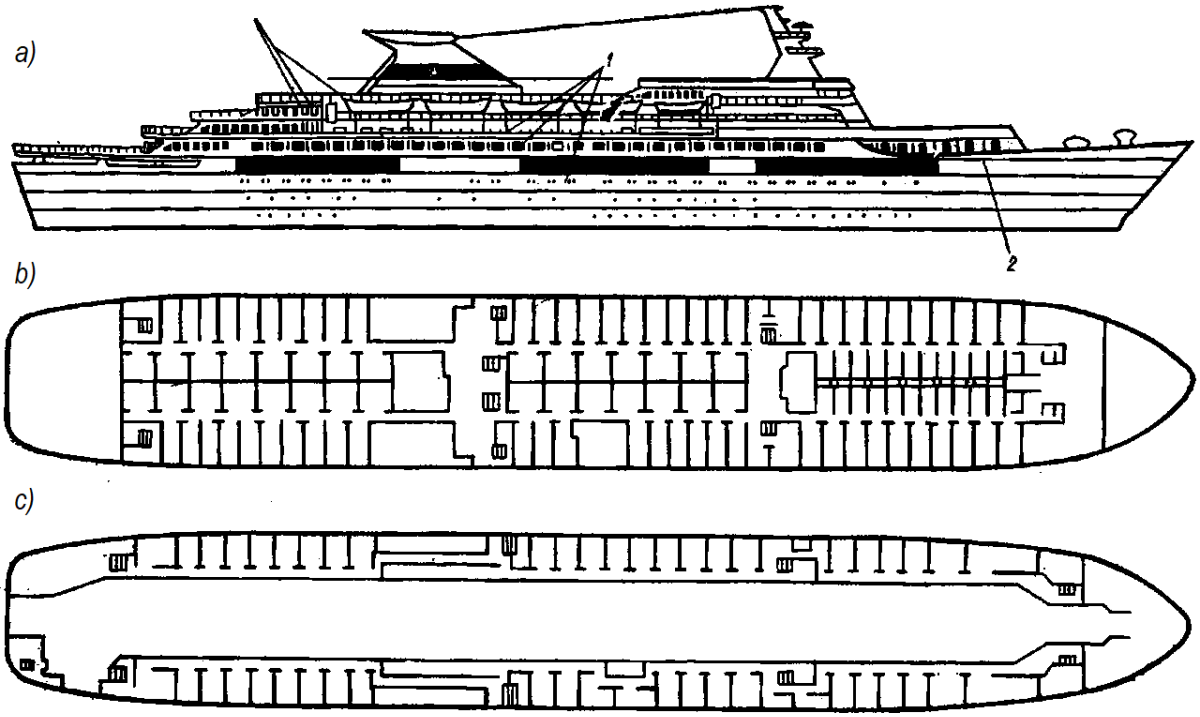



Fig. 13. Car-passenger ferry: a) side view; b) passenger premises; c) garage deck

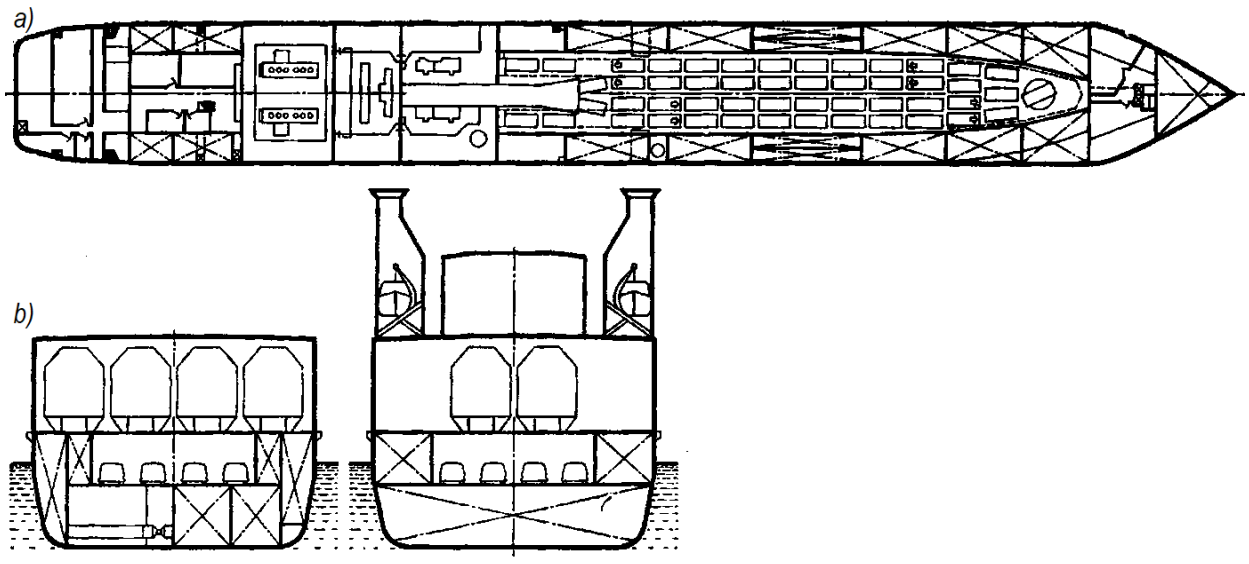



Fig. 14. Railway ferry: a) cargo deck; b) cross section of cargo spaces

Ferry services originated as early as 1904 in Russia on Lake Baikal and in 1928 across the English Channel between the ports of Dover and Dunkerk. At the end points, cars were then overloaded with cranes. The main trends in the development of sea ferry services are:

– the introduction of new lines;

– an increase in the number of shipments on lines already in operation;

– changes in the structure of ferry shipping: relatively slow development, and in some cases the displacement of rail ferry transportation by automobile and passenger;

– change of the operating mode of ferry lines – transformation of seasonal lines into year-round ones;

– an increase in the length of ferry routes and the emergence of more and more lines of medium (100–300 km) and long (≥ 300 km) length. Now in some parts of the world there are lines with a length of ≥ 1000 km.

– an alternative to ferry services in the form of bridges and tunnels. The competition between them should take into account:

Bridges:

– cheaper than a tunnel;

– the throughput is higher than the tunnel;

– more emergency, given the seismicity;

– less comfortable, especially in winter;

– getting into the water of oil, fuel oil, paper, bags and other, that is, environmentally more dirty.

Tunnels:

– do not depend on weather conditions;

– it is easier than on a bridge to lay cables, power lines, water pipelines, gas and oil pipelines;

– more fire hazardous;

– less vulnerable to terrorists;

– more habitable for wild animals.

The construction of tunnels through the Bering and the Straits of Gibraltar, a number of bridge crossings will lead to the creation of a transplanetary transport supersystem, the connection of energy systems, communication cables and product pipelines of the continents into a single network, and will transform the economy of the adjacent territories.


Fig. 15. Africa and Eurasia are currently connected

## WORDS AND EXPRESSIONS

| | | |
|---|---|---|
| Enlarged Cargo Unit (ECU) | [ɪnˈlɑːdʒd ˈkɑːgəʊ ˈjuːnɪt] | укрупненная грузовая единица (УГЕ) |
| excavator | [ˈɛkskəveɪtə] | экскаватор |
| caterpillar | [ˈkætəpɪlə] | гусеничный |
| self-propelled vehicle | [sɛlf-prəˈpɛld ˈviːɪkl] | самоходное средство |
| trailer | [ˈtreɪlə] | прицеп |
| axes, *множ. от* axis | [ˈæksɪz] | оси |
| gooseneck | [ˈguːsnɛk] | гузнек (крюк на тракторе) |
| flat | [flæt ] | флет (со стойками на торце) |
| end stanchion | [ɛnd ˈstɑːnʃn] | торцевая стойка |
| folding | [ˈfəʊldɪŋ] | складной |
| removable | [rɪˈmuːvəbl] | съемный |
| collapsible | [kəˈlæpsəbl] | складной |
| bolster | [ˈbəʊlstə] | болстер (площадка) |
| component | [kəmˈpəʊnənt] | составная часть |
| to sheath | [ʃiːθ] | *техн.* обшивать |
| corrugate | [ˌkɒrʊˈgeɪt] | гофрированный |
| grooved board | [gruːvd bɔːd ] | щпунтованная доска |
| thresholds door sealing | [ˈθrɛʃˌhəʊldz dɔː ˈsiːlɪŋ] | уплотнение порога двери |
| plating | [ˈpleɪtɪŋ] | обшивка |
| door hinge | [dɔː hɪndʒ] | дверная петля |

| | | |
|---|---|---|
| sealing | [ˈsiːlɪŋ] | уплотнение |
| reinforced plastic | [ˌriːɪnˈfɔːst ˈplæstɪk] | армированная пластмасса |
| tent, canopy | [tɛnt, ˈkænəpi] | тент, навес |
| mounted | [ˈmaʊntɪd] | навесной |
| bow chock plate | [baʊ ʧɔk pleɪt] | отбойный козырек (на баке) |
| to be stagger | [ˈstægə] | в шахматном порядке |
| retractable | [rɪˈtræktəbl] | выдвижной, втягивающийся |
| spreader | [ˈsprɛdə] | спредер контейнерный |
| to suspend | [səsˈpɛnd] | вешать, подвешивать |
| grip | [grɪp] | грузозахват |
| to unfold | [ʌnˈfəʊld] | развернуться |
| slinging | [ˈslɪŋɪŋ] | застропка |
| cell | [sɛl] | ячейка |
| rigid guides-limiters | [ˈrɪʤɪd gaɪdz-lɪmɪtəz] | жесткие направляющие-ограничители |
| embedded devices | [ɪmˈbɛdɪd dɪˈvaɪsɪz] | закладные устройства |
| rotary locks | [ˈrəʊtəri lɒks] | поворотный замок |
| pin | [pɪn] | штифт, штырь |
| spring lock | [sprɪŋ lɒk] | пружинный замок |
| lashing brace | [ˈlæʃɪŋ breɪs] | найтов-оттяжка |
| bar | [bɑː] | брусок |
| rectangular | [rɛkˈtæŋgjʊlə] | прямоугольный |
| smooth | [smuːð] | гладкий |
| streamlined | [ˈstriːmlaɪnd] | обтекаемой формы |
| gantry crane | [ˈgæntri kreɪn] | козловой кран |
| cutout | [ˈkʌtaʊt] | вырез (в борту) |
| cargo port | [ˈkɑːgəʊ pɔːt] | лацпорт |
| submerged position | [səbˈmɜːʤd pəˈzɪʃən] | притопленное положение |
| roads (outter, inner) | [rəʊdz] | рейд (внешний, внутренний) |
| vulnerable | [ˈvʌlnərəbl] | уязвимый |
| habitable | [ˈhæbɪtəbl] | обитаемый |

## ADDITIONAL WORDS AND EXPRESSIONS (for Practical Work)

| | | |
|---|---|---|
| to protrude | [prəˈtruːd] | торчать, выдаваться наружу |
| to be flush | [tuː biː flʌʃ] | быть на одном уровне |
| stack | [stæk] | штабель, стог, кипа (бумаг) |
| gasket | [ˈgæskɪt] | прокладка |

| | | |
|---|---|---|
| stiffener | [ˈstɪːfənə] | ребро жесткости |
| transverse set | [ˈtrænzvɜːs sɛt] | поперечный набор |
| bulwark | [ˈbʊlwək] | фальшборт, бастион, вал |
| alley | [ˈæli] | проход (на судне) |
| cross section | [krɒs ˈsɛkʃən] | поперечное сечение |
| permissible load | [pəˈmɪsəbl ləʊd] | допустимая нагрузка |
| actually/ in fact load | [ˈæktʃʊəli/ ɪn fækt ləʊd] | фактическая нагрузка |
| row | [rəʊ] | ряд |
| tier | [ˈtaɪə] | ярус |

## QUESTIONS OF THE EXAMS, DISCIPLINE "TECHNOLOGY OF CARGOES TRANSPORTATION"

CLASSIFICATION OF CARGOES AND THEIR CHARACTERISTICS

1. Classification and tariff nomenclature of cargoes
2. Compatibility of cargoes for sea transportation
3. Transport characteristics of cargoes
4. Linear and volumetric-mass characteristics of cargo

TARE, PACKING AND MARKING OF CARGOES

5. Tare, types and requirements for tare
6. Cargoes packing
7. Marking of goods

ENSURING CARGO SAFETY DURING SEA TRANSPORTATION

8. Reasons of damage to cargoes
9. Reasons for the shortage of cargoes
10. Registration of cases of unsafe transportation of goods
11. Regulatory grounds for safe and secure transportation of cargoes on sea

REGULATION OF HEAT EXCHANGE OF CARGOES WITH THE ENVIRONMENT

12. Fluctuations of environmental parameters during sea transportation
13. Air properties and determination of its parameters
14. Determination of the dew point in various ways
15. Regulation of temperature and humidity in the holds
16. Ventilation technique when passage from a cold to a warm area
17. Ventilation technique when passage from a warm to a cold area
18. Technological means of ventilation of cargo spaces

TECHNOLOGY OF GENERAL CARGO TRANSPORTATION

19. Classification of general cargoes
20. Preparation the vessel for loading cargoes
21. Separation of goods
22. Transportation of boxed cargoes
23. Transportation of bagged cargoes
24. Transportation of cargoes in pressed bales and bales
25. Transportation of barreled cargoes
26. Transportation of cotton and other fibrous cargoes
27. Transportation of paper and cellulose
28. Transportation of rubber and rubber products
29. Transportation of light industry products
30. Transportation of metals and hardware

31. Transportation of sheet and coil steel
32. Transportation of pipes
33. Transportation of reinforced concrete products

TECHNOLOGY OF TIMBER CARGOES TRANSPORTATION

34. Regulation of transportation of timber cargoes
35. Types and nomenclature of timber cargoes
36. Measuring the amount of timber cargoes
37. Marking of timber cargoes
38. Unitization of timber cargoes
39. Preparation of the vessel for the transportation of timber
40. Loading and stowage timber in holds
41. Loading and stowage timber on deck
42. Requirements for stability of ships carrying timber cargoes

FOOD CARGOES TRANSPORTATION TECHNOLOGY

43. Classification of food cargoes
44. Preparation of food cargo for transportation and their specific properties
45. Preparation of the vessel for the acceptance of food cargo
46. Transportation of grain cargoes in tare
47. Transportation of coffee beans and cocoa beans
48. Transportation of spices, tea, sugar, salt, flour and confectionery

DANGEROUS GOODS TRANSPORTATION TECHNOLOGY

49. Classification of dangerous goods
50. International regulation of the carriage of dangerous goods by sea
51. Preparation of dangerous goods for transportation
52. Preparation of the vessel for the carriage of dangerous goods

BULK CARGOES TRANSPORTATION TECHNOLOGY

53. Classification and physical properties of bulk cargoes
54. Transportation of coal and iron ore
55. Normative documents regulating the transportation of non-grain bulk cargoes
56. Vessels for the carriage of bulk cargoes and the procedures of their loading
57. Grain bulk cargoes and documents regulating their transportation
58. Transportation of grain cargoes and their securing

TECHNOLOGY OF LIQUID CARGOES TRANSPORTATION

59. Physical and chemical properties of liquid cargoes
60. Classification and nomenclature of liquid cargoes
61. Classification and constructions features of tankers
62. Washing and cleaning of cargo tanks of a tanker
63. Tanker inert gas systems

64. Tankers for transportation of chemical cargoes
65. Transportation of liquefied gas

CARGO TRANSPORTATION IN ENLARGED CARGO UNITS (ECU)

66. TTS transportation of ECU by sea
67. Types of containers, their classification
68. Vessels for container transportation
69. Securing containers on ships
70. Lighter carrier TTS, advantages and disadvantages
71. Peculiarities of Ro-Ro TTS and Advantages of Ro-Ro carriers
72. Means of enlargement of cargoes transported by Ro-Ro carriers
73. Cargo complexes of Ro-Ro carriers – ramps, lifts, panduses and ramps
74. Requirements for ventilation and watertightness of Ro-Ro carriers
75. Features of the ferry TTS, characteristics of ferries

REGULATION OF LOAD LINE AND FREEBOARD

76. Regulation of the freeboard height. International Convention on Load Line-1966
77. Cargo (Stowage) Plan of the vessel and general requirements for it
78. Calculation of the Cargo Plan of the vessel

## LIST OF LITERATURE (REFERENCES)

### Basic


1. Савчук В.Д. Технологія перевезення вантажів: підручник [для студ. висш. навч. закл.], вид. 2-ге, перероб. і доп. / В.Д. Савчук. – Одеса: НУ «ОМА», 2020. – 390 с.
2. Безкровний Є.М. Технологія морських перевезень: Навчальний посібник / Є.М. Безкровний, І.І. Тихоніна. – Одеса: КУПРІЄНКО СВ, 2015. – 277 с.
3. Васьков Ю.Ю. Портовые формальности в Украине: оформление прихода, отхода и стоянки морских судов / Васьков Ю.Ю., Цымбал Н. Н. – Одесса: Латстар, 2002. – 99 с.
4. Петров И.М. Организационные и коммерческие взаимоотношения морского агента: учебн. пособ. / И.М. Петров. – Севастополь, УМИ, 2007. – 131 с.
5. Ніколаєва Л.Л. Управління процесами морських перевезень: підручник / Ніколаєва Л.Л., Ворохобін І.І. – Одеса: Національний університет «Одеська морська академія», 2022. – 505 с.
6. Николаєва Л.Л. Комерційна експлуатація судна: підручник / Л.Л. Ніколаєва. – Одеса: НУ «ОМА», 2021. – 550 с.
7. Принципи розвитку організації морських перевезень: монографія: [за ред. Л.Л. Ніколаєвої]. − Одеса: НУ «ОМА», 2020. − 254 с.
8. Петриченко Е.А. Применение Кодекса ММОГ при транспортировке опасных грузов морем: учеб. пособ. / Е.А. Петриченко, А.В. Гайченя. – Одесса: Полиграф, 2009. – 148 с.
9. Гайченя А.В. Особенности проведения грузовых операций навалочных и универсальных судов / А.В. Гайченя // Судовождение: сб. научн. трудов. – Одеса: ОНМА, 2016. – № 26. – С. 72-76.
10. Розробка процедури визначення переліку трюмів для прийому навалювальних вантажів у суднових автоматизованих системах прийняття рішень. Друк. фахове вид. Проблеми техніки: Науково-виробничий журнал. – 2014. – № 2. – С. 30-35.


### Additional


11. Кодекс торговельного мореплавства України. – Вид. неофіц.: Друк. з вид. «Ведомости Верховного Совета Украины», 1995. − № 47-52, ст. 349. – Одеса: МП Латстар, 1999. – 128 с.
12. Поправки к приложению к Конвенции по облегчению международного морского судоходства 1965 года (резолюция FAL.12(40)):

[Электронный ресурс] / Международная морская организация ИМО. – Режим доступа: http://www.imo.org /en/OutWork/Facilitation/docs/Pages/
default.aspx.

13. Handbook of Research of Educational Communications and Technology. Third edition / Edited by J.M. Spector, M.D. Merill, J.V. Merrienboer and N.P. Driscoll. – USA: Routledge. Taylor& Francis Group, 2007. – 928 p.

14. Малаксиано А.А. Грузовые комплексы судов с горизонтальным способом обработки / А.А. Малаксиано, И.М. Петров // Сб. научн. трудов «Судовождение». – Одесса: ОНМА, Феникс, 2003. – С. 42-47.

15. Петров И.М. О совершенствовании учета судовых запасов при определении количества груза на борту / И.М. Петров // Судовождение: Сб. науч. трудов / ОНМА. Вып. 18. – Одесса: «ИздатИнформ», 2010. – С. 151-160.

16. Петров И.М. Моделирование параметров судов, влияющих на продолжительность их обслуживания в сервисных эргатических системах / И.М. Петров // Судовождение: Сб. научн. трудов / НУ «ОМА», Вып. 27. – Одесса: «ИздатИнформ», 2017. – С. 118-152.

17. Шибаев А.Г. Подготовка и обоснование решений по управлению перевозками и работой флота морской судоходной компании / А.Г. Шибаев. − Одесса: «ХОРС», 1998. – 208 с.

18. Професійна англійська мова в судноводінні: навч. посіб. курсантів і студентів судноводійних спеціальностей морських вищих навчальних закладів / О.І. Монастирська [та ін.]. – Одеса: ОНМА, 2006. – 192 с.

19. Maritime English. Model course 3.17 / International Maritime Organization. Ashford Open Learning Ltd. London, 2000. – 138 p.

20. Marlins. English for Seafarers. Study pack 1,2. Edinburgh, 2000. – 75-82 pp.

## Information resources on the Internet

21. Міжнародна конвенція про вантажну марку 1966 року URL: https://zakon.rada.gov.ua/laws/show/896_007#Text

22. International Maritime Dangerous Goods Code, 2016 edition. URL: http://asp.mot.gov.il/media/com_form2content/documents/c3/a830/f27/MSC%20406(96).pdf

23. International Maritime Solid Bulk Cargoes Code (IMSBC Code). URL: http://www.axelzone.ro/storage/ttm/_lessons/bulk_carriers/IMSBC%20CODE.pdf

24. Code of Practice for the Safe Loading and Unloading of Bulk (BLU Code). URL: http://www.axelzone.ro/storage/ttm/_lessons/bulk_carriers/blu_ code.pdf

25. International Code for the Safe Carriage of Grain in Bulk (Grain Code). URL:http://www.axelzone.ro/storage/ttm/_lessons/bulk_carriers/INTERNATIONAL%20GRAIN%20CODE.pdf

26. Code of Safe Practice for Ships Carrying Timber Deck Cargoes 2011 (2011 TDC Code). URL: http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Documents/A%20-%20Assembly/1048(27).pdf

27. Code of Safe Practice for Cargo Stowage and Securing. (CSS Code). URL: http://www.axelzone.ro/storage/ttm/_lessons/stowage%20&%20securing/CSS%20Code%202011.pdf

28. Thomas Stowage: The Properties and Stowage of Cargoes [Електронный ресурс]. – Режим доступа: http://www.axelzone.ro/storage/ttm/_lessons/bulk_carriers/thomas_stowage_3rd.pdf

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