TECHNICAL SCIENCES

IMPROVEMENT OF CARGO OPERATIONS CONTROL METHODS ON BULK VESSELS

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Abstract

Transportation of bulk cargoes by the fleet of tankers is carried out in different climatic zones with significant fluctuations in the ambient temperature. At the same time, bulk cargo will increase its volume when its temperature increases. There is a risk of the cargo spilling onto the ship's deck. When transporting any bulk cargoes, it is allowed to use only 98% of the cargo capacity of the tanker, the remaining 2% is called the safety factor, i.e. the reserve volume for unforeseen expansion of the cargo when sailing in different climatic zones.

The captain of the vessel and the captain's senior assistant (cargo assistant) should not start loading if they do not have complete information about the cargo: its physical and chemical properties, the temperature at which it will be loaded into the tanks, densities. The sender of the cargo is responsible for the correctness of the cargo information. When loading a tanker, the captain's senior assistant must manage the progress of cargo operations, and the watch assistant must constantly monitor the filling level of each tank and the weight of cargo in each tank. To monitor the level of bulk cargo in real time, various models of bulk cargo level gauges are used: float, pneumatic, ultrasonic, magnetostrictive, microwave, and others, but mainly of the radar type.

Keywords: *bulk cargo, tanker, level gauges, safety factor.*

Formulation of the problem. When transporting various types of petroleum products on a tanker, the ship's crew faces the task of carrying out the transportation with high quality, delivering the cargo in full volume and in the appropriate condition, while preserving its physical and chemical characteristics. In order to avoid the risk of spillage of oil cargo on the deck of the tanker or overboard, regulatory documents require the use of only 98% of the cargo capacity of the tanker, i.e. leaving 2% of the reserve volume for thermal expansion of the cargo when sailing in different climatic zones (but in some cases, senior the assistant together with the captain can decide to use less than 98% of the volume). To achieve this goal, the ship's crew must constantly monitor the filling of the tanks during the loading of the ship. Different types of level gauges (level gauges) are used to determine the height of the bulk cargo level in real time.

Review of recent reseach and publications. Transportation of crude oil and petroleum products is regulated by international conventions and codes, and tankers transporting bulk cargoes must be equipped in accordance with their requirements and recommendations [1, 2, 3]. The technology of transportation of four types of oil products on the tanker "JO PROVEL" is described in the paper [4], and the transportation of bulk chemical cargoes is presented in the publication [5]. Types of different sensors, liquid level meters are given in publications [6, 7], a device for a laser liquid meter is described in the material [8], laser meters for bulk goods are given in information [9], and radars and radar waveguide level meters are shown in the publication [10].

Formulation of the goals of the article. Level gauges (level gauges) for petroleum products, gasoline, diesel fuel, kerosene, and other bulk cargoes are called level indicators. This is equipment that allows you to control the level of liquids in containers, reservoirs, cargo tanks, as well as measure a number of other liquid parameters (density, temperature).

Levels for oil products are used: in stationary oil storages, in the process of filling tanks and shipping oil products from them; on oil tankers to control the filling level in cargo tanks; at gas stations, when filling tank trucks and in other cases.

Level gauges for petroleum products must ensure high accuracy of readings, since the main purposes of their use are cargo mass control (for coastal structures/vessels) and safety issues when carrying out cargo operations on various types of tankers. Due to certain characteristics of light petroleum products, such as low dielectric constant, some level gauges (for example, capacitive ones) are not suitable for them.

Levels for fuel are classified according to a number of criteria:

- in terms of functionality - alarms (monitor the maximum or minimum filling point) and actual level gauges, which allow for continuous monitoring of the level;
- by type, principle of measurement - pneumatic, hydrostatic, magnetostrictive, ultrasonic, radar;
- by type of indicator – mechanical and digital (electronic). The first are non-volatile, the second require a power source;
- according to the design, the place of installation

- for installation from above, from the side of containers, as well as submersible ones;

- by measurement method - contact and non-contact.

The important characteristics of level gauges include the range of measurements, the range of operating temperatures, the maximum depth, and the diameter of the fuel tank.

During 2020-2022, one of the authors carried out research on improving the monitoring of cargo operations on the product tankers "JO PROVEL" and "JO PINARI" (tankers of the same type, of the same project, built at the STX Offshore and Shipbuilding shipyard, South Korea) and was the directions for further improvement of the control over the volume of bulk cargo, which is supplied from the shore to the ship, taking into account the "human factor" - as one of the most important indicators during cargo operations and its influence on their safe execution - have been determined.

Flight observations were also carried out to develop ways to further improve the automation of control over the level of filling in cargo tanks at all stages of operations, to achieve the specified amount of cargo (inflow), in accordance with the approved cargo plan or the required level, and to reduce the risks associated with the "human factor" ", in order to prevent the occurrence of emergency situations, namely overflow and environmental pollution in the port.

To develop a system for monitoring the loading and unloading of large-tonnage tankers, it is necessary to take into account the modern technical aspects of ensuring the performance of cargo operations.

The following elements of the cargo system are installed on the specified tankers:

Electro-hydraulic control system of cargo and ballast valves. Control panels for ballast and cargo systems are presented in photos 1, 2.

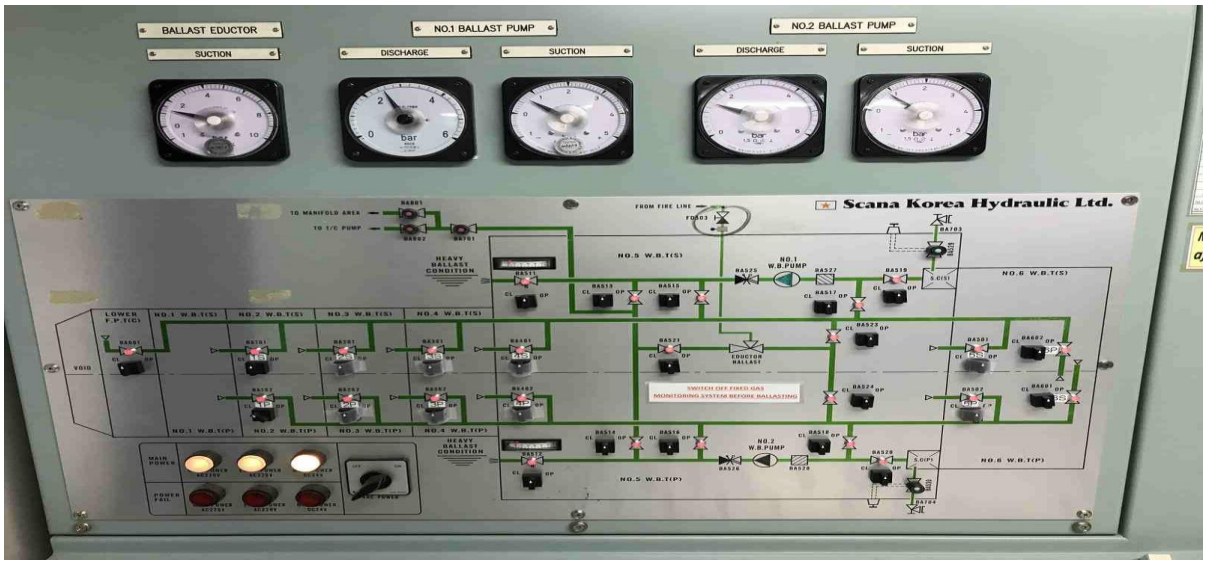


Photo 1. Ballast system control panel

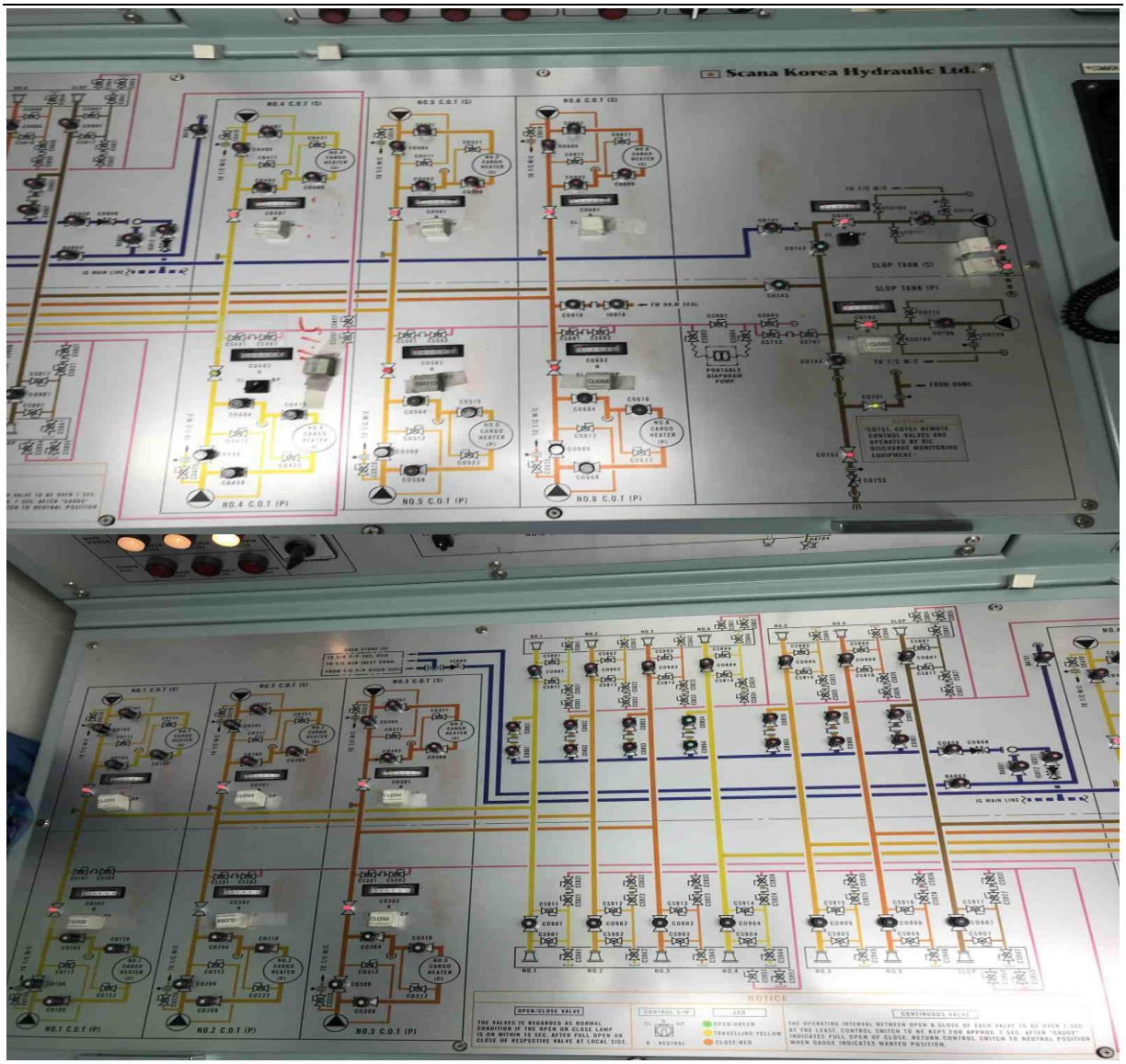


Photo 2. Cargo system control panels

The cargo tank from the inside, where you can see: 95% and 98% fill gauge pipes, tank washer nozzles, pump piping, drain level and cargo temperature radar is presented in photo 3.

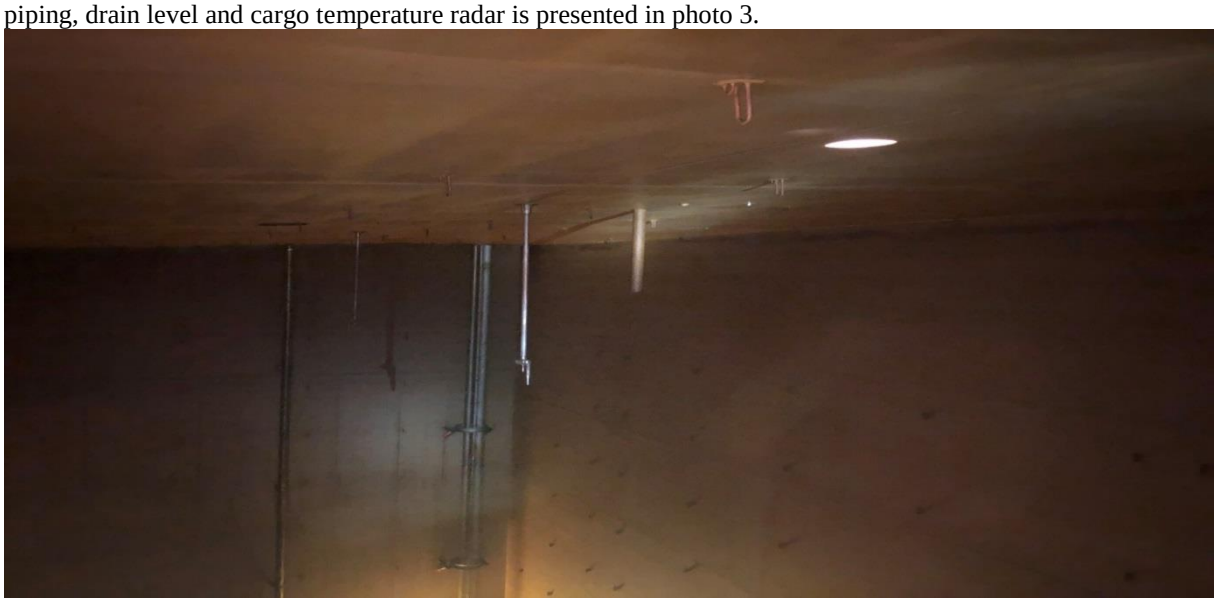


Photo 3. Cargo tank

The electro-hydraulic valve, which is automatically adjusted in the cargo hold using the central cargo and ballast panels (photos 1, 2) is presented in photo 4.

Photo 4. Electro-hydraulic valve.

The cargo flap (during repair) is shown in photo 5. The system includes: a special pump to maintain a constant pressure of hydraulic oil in the system, electro-hydraulic valves on the ballast and cargo systems, contour distribution in zones in order to cut them off in emergency situations with further ability manual opening or closing of valves. There is also a special delay in the opening or closing of one or another valve, in order to reduce the risk of water hammer in the pipeline.

Photo 5. Cargo flap (during repair)

The vessels are equipped with sensors of the control and signaling system of critical levels of filling cargo tanks - 95% and 98% (manufactured by Scanjet Macron Co., Ltd). They are installed in each tank separately, have an electromagnetic principle of operation, are calibrated according to the physical dimensions of each tank (Fig. 1, 2, 3). The system consists of: level sensors, intrinsically safe barrier panel, plug, reed switch, test rod, flanges, flexible hose and control panel. The magnetic float, moving up with an increase in the level, moves the hermetic magnetic reed switch inside the rod, and when it reaches the magnet, it is deactivated. This switch will be in the open position, which will result in the output of an emergency audible and visual alarm on the monitor installed at the cargo operations control post, as well as an external alarm and siren installed externally on the navigation bridge deck. A filling level of 95% of the volume usually corresponds to a high level alarm, and 98% of the volume corresponds to an overfill alarm.

The most critical moments in carrying out cargo operations are the achievement of the specified levels in the tanks, when the maximum concentration of attention of the watch assistant is required in order to accurately reach the calculated surface level and load the given volume and mass of cargo into the tank (usually the cargo plan provides for filling the tanks by 95-

98% , depending on the charterers' requirements). Also, the moment of starting the unloading of tanks is critical, when the pumps are started and there is a gradual increase in their supply to deliver the cargo to the shore. At this moment, it is necessary to carefully monitor the level of the surface of the cargo in other tanks so that it does not change, and on the deck it is necessary to carry out visual control by the deck team, in order to prevent the overflow of the cargo, which will lead to an emergency situation and spillage of oil products in the port.

Fig. 1. General view of the level meter of 95% and 98%
(taken from the ship's technical documentation of the system)

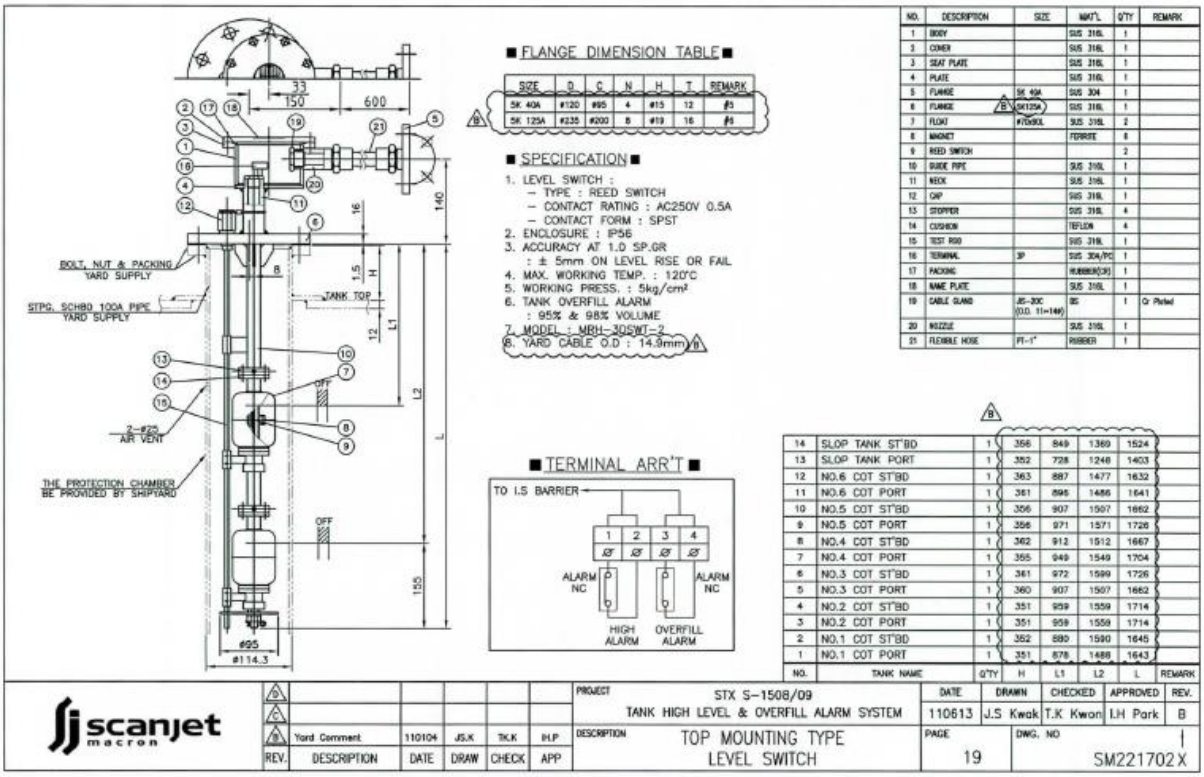


Fig. 2. Design of the level gauges of the 95% and 98% tank filling notification system (taken from the ship's technical documentation of the system)

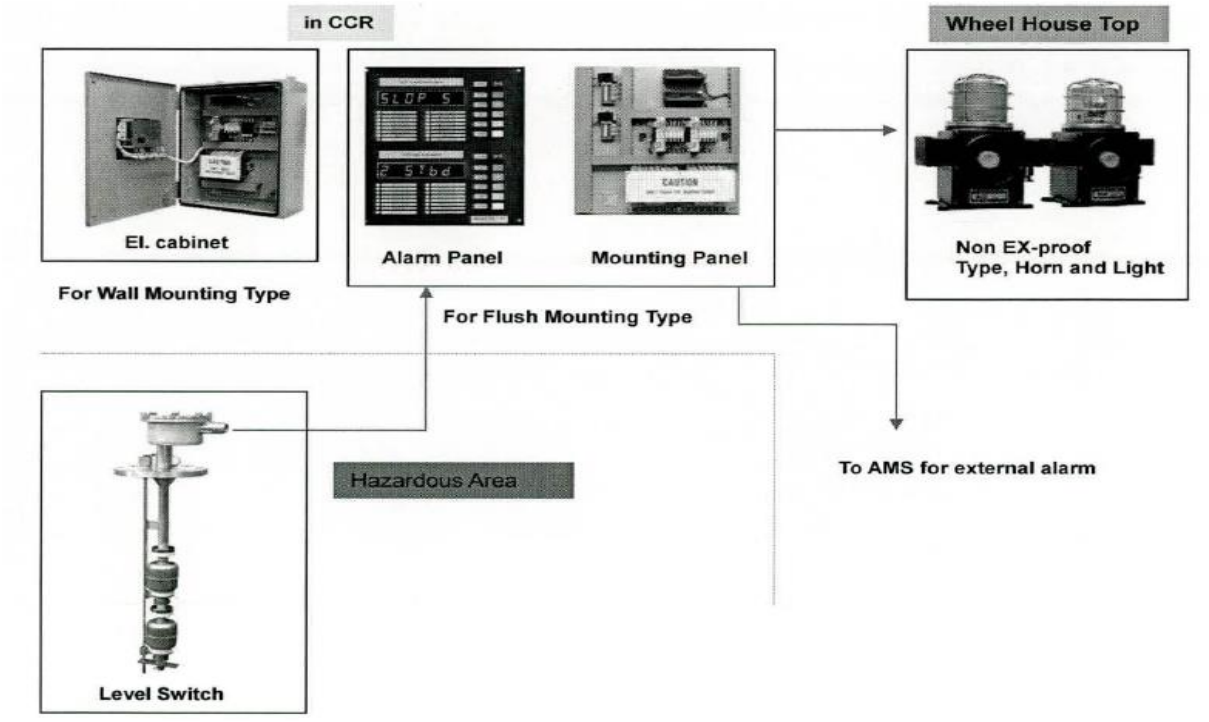


Fig. 3. Operation scheme of the tank filling notification system (taken from the ship's technical documentation of the system)

Proposals for optimizing and improving the monitoring of cargo operations. In our opinion, today a promising direction of development in the tanker sector is the improvement of methods of control over the execution of cargo operations with bulk cargoes. Increasing the automation of the tanker loading process and reducing the "human factor" associated with the development and implementation (or improvement of the existing) system for controlling the inflow level and automatic control of shut-off valves on cargo lines. The proposals are based on practical observations during many years of operation on oil tankers. It is proposed to create a chain of interaction of the measuring sensor (radar) in the tank(s) and the

electro-hydraulic valve of the cargo tank with the output of warning messages for the operator on the monitor, and to introduce this addition to the computer cargo programs.

In addition, it is proposed to replace the existing type of level gauges from radar to laser, using high-precision lasers, the technical characteristics of which will allow operation in the aggressive environment of oil tankers. Such systems must be developed and installed on tankers in factory conditions. Today, there are no companies engaged in the development of at least experimental systems of this type, and the existing safety measures and rules on tankers and terminals are strictly regulated by international conventions and codes, and cannot be ignored, therefore it is forbidden to conduct any experiments on ships.

A control system is proposed, which will include the following functions:

1. The operator (senior or watch captain's assistant) will be able to set the pre-calculated surge level on the computer in order to load the specified volume and mass of the oil product, taking into account the following parameters: density and temperature of the cargo, trim and roll of the ship; or, in another option, when the drain level reaches 95%, the valve will be automatically closed by the computer to reduce the flow rate of the cargo into the tank, and when it reaches 98%, the valve will be completely closed.

2. The operator will be able to receive messages on the monitor of the cargo computer, which will be classified as follows:

- "warning" (yellow color) - i.e. you need to pay attention to the tank, because the surface level is already approaching the set value, it can also be set by the operator, for example, 50 cm before the final level. Also, a warning will be sent when the last tanks are left and it will be necessary to notify the terminal about a decrease in the speed of the cargo flow;

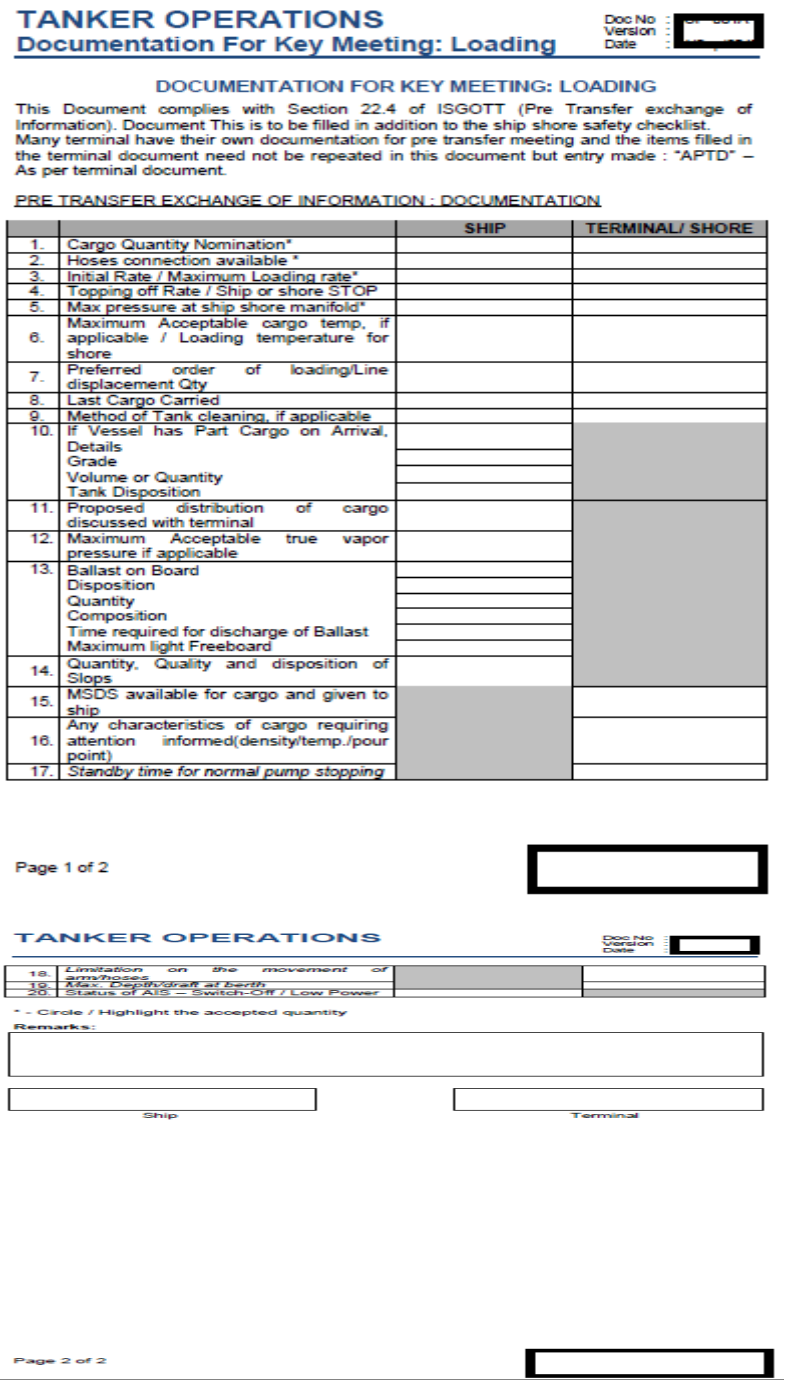
- "alarm" (red color) - the level has reached the set value and the valve is closed by the system, in this case the operator will need to check on the control panel, and the watch sailors - on the deck to make sure that the system has worked correctly and the valve has closed;

- “control error” (red flashing color) – the system could not execute the command and the valve did not close, i.e. the system failed.

To implement such a system, it will be necessary to develop a new type of software in which all input data will be updated in real time, and the operator will be able to adjust some physical parameters that change dynamically during the tanker loading process.

It is known that before the start of any operations between the terminal and the tanker, there is a process of emergence of key issues regarding the safe conduct of cargo operations and all accompanying secondary actions. The representative from the terminal side is the head/loading master, from the ship side - the captain or senior assistant. The result is the signing of the following documents: A typical form of a letter of agreement before the start of cargo operations, is presented in (Fig. 4) (Key meeting form (loading/unloading) and a letter of verification of the fulfillment of the requirements of international conventions and codes. (Ship-shore safety checklist).

The speed of loading is also specified in the above forms : initially, during and at the final stage, we will apply this information further when describing the proposed improvements.



TANKER OPERATIONS
Documentation For Key Meeting: Loading

Doc No :
Version :
Date :

DOCUMENTATION FOR KEY MEETING: LOADING

This Document complies with Section 22.4 of ISGOTT (Pre Transfer exchange of Information). Document This is to be filled in addition to the ship shore safety checklist. Many terminal have their own documentation for pre transfer meeting and the items filled in the terminal document need not be repeated in this document but entry made : "APTD" – As per terminal document.

PRE TRANSFER EXCHANGE OF INFORMATION : DOCUMENTATION

		SHIP	TERMINAL/ SHORE
1.	Cargo Quantity Nomination*		
2.	Hoses connection available *		
3.	Initial Rate / Maximum Loading rate*		
4.	Topping off Rate / Ship or shore STOP		
5.	Max pressure at ship shore manifold*		
6.	Maximum Acceptable cargo temp, if applicable / Loading temperature for shore		
7.	Preferred order of loading/Line displacement Qty		
8.	Last Cargo Carried		
9.	Method of Tank cleaning, if applicable		
10.	If Vessel has Part Cargo on Arrival, Details Grade Volume or Quantity Tank Disposition		
11.	Proposed distribution of cargo discussed with terminal		
12.	Maximum Acceptable true vapor pressure if applicable		
13.	Ballast on Board Disposition Quantity Composition Time required for discharge of Ballast Maximum light Freeboard		
14.	Quantity, Quality and disposition of Slops		
15.	MSDS available for cargo and given to ship		
16.	Any characteristics of cargo requiring attention informed(density/temp./pour point)		
17.	*Standby time for normal pump stopping*		

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TANKER OPERATIONS

Doc No :
Version :
Date :

18.	*Limitation on the movement of arms/hoses*		
19.	*Max. Depth/draft at berth*		
20.	Status of AIS – Switch-Off / Low Power		

* - Circle / Highlight the accepted quantity

Remarks:

Ship

Terminal

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Fig. 4. A typical form of a letter of agreement before the start of cargo operations

Conclusions. Conducted cruise observations of the technological processes of loading/unloading of large-tonnage tankers made it possible to prepare proposals for further improvement of automation of control of the level of filling in cargo tanks at all stages of operations, achievement of the specified amount of cargo (inflow), in accordance with the approved cargo plan or the required level, and risk reduction , related to the "human factor", in order to prevent the occurrence of emergency situations, namely overflow and environmental pollution in the port.

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FEATURES OF MOBILE DEVELOPMENT WHEN CREATING CARTOGRAPHIC APPLICATIONS

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ОСОБЕННОСТИ МОБИЛЬНОЙ РАЗРАБОТКИ ПРИ СОЗДАНИИ КАРТОГРАФИЧЕСКИХ ПРИЛОЖЕНИЙ

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Abstract

The paper provides descriptive information regarding the main features, advantages and disadvantages of developing mobile mapping applications.

Аннотация

В работе приведена информация описательного характера касательно основных особенностей, преимуществ и недостатков разработки мобильных картографических приложений.

Keywords: *web-cartography, mobile applications, mobile devices, development, web-technologies*

Ключевые слова: *веб-картография, мобильные приложения, мобильные устройства, разработка, веб-технологии*

В последние годы, в годы небывалого роста и развития технологий, мобильные телефоны стали жизненно важной частью каждого человека. Несмотря на то, что основной функцией мобильных телефонов является телекоммуникация, мобильные приложения сделали возможным многое, что раньше было невозможно вообразить. Декады тому назад на две-три семьи приходился один телефон. Однако сейчас все кардинально изменилось с появлением смартфонов, на данный момент у любого человека имеется личный телефон, и число растет в геометрической прогрессии (см. рис. 1) Главное достоинство мобильных телефонов - портативность, так как их можно носить в карманах куда угодно. Смартфоны открыли новое течение в сфере услуг с изобретением мобильных приложений.

Мобильные приложения — это приложения, предназначенные для выполнения определенной задачи. Потребление времени сократилось с ростом популярности мобильных приложений, и теперь товары и услуги всегда под рукой. Сервисов, которые предоставляют мобильные приложения, предостаточно. Однако стоит вопрос о необходимости использования такого рода приложений, которые впоследствии могли проложить путь до пункта назначения в кратчайшие сроки. К решению данной проблемы приходят картографические приложения.