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Conducting a Draft Survey on a RoPax Vessel

Finding The Ship's Lightweight

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Conducting a Draft Survey on a RoPax Vessel – Finding the Ship's Lightweight

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ABSTRACT

This thesis was created to better understand the practical sides of draft surveys conducted onboard passenger vessels, using a lightweight survey done on the passenger vessel M/S Finlandia belonging to Eckerö Line as an example. Despite the specific example used, this thesis does not have a client.

In this thesis the process of a lightweight survey is gone through step by step, documented in such a way that even an inexperienced person outside the maritime industry can understand the main principles of it. Through this thesis a maritime student may also expand their knowledge on the subject previously learned through academic material and courses.

A Lightweight survey, the main focus of this thesis, is performed to find out the weight of an "empty" but ready for seagoing vessel. The Procedure compares the ships weight of displacement to the previous known lightweight through various inspection phases, and the results are compared to find out the current lightweight of the vessel, which can change throughout the ship's lifespan due to possible alterations or renovations done to the vessel.

When going through the results of the survey it was agreed that the vessel's weight changes do not exceed the mandatory requirements for stability issued by the International Maritime Organization (IMO), and therefore the vessel can continue to operate without undergoing any further testing, until the next draft survey is conducted.

Keywords: draft survey, lightweight survey, passenger ship, ship stability, ship draught, ro-ro vessel

FOREWORD

A Special thanks to Sten Rosenqvist for the professional and immensely helpful mentoring on the subject of draft surveys and all things ship stability. Thank you also for the crew of M/S Finlandia for suggesting me this thesis idea and doing the preparation work needed onboard for the lightweight survey.

23.11.2023

SISÄLLYS

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SYMBOLS AND ABBREVIATIONS

Draught/Draft = vertical distance between the keel and the waterline of the ship.

LW = Lightweight, the mass of an empty vessel

Lpp = Length between perpendiculars

LCG = Longitudinal centre of gravity

TCG =Transverse centre of gravity

VCG = Vertical centre of gravity

Dm = Mean draft, the arithmetic mean of the vessels drafts from aft, midships and forward.

IMO = International Maritime Organization

SOLAS = Safety of Live at Sea, IMO convention governing maritime safety (Rosenqvist, 2022)

IACS = International Association of Classification Societies, non-governmental organization overseeing construction, maintenance and surveys for ships and marine facilities

CHAPTER 1

1.1 On the subject of draft surveys

Archimedes, the well-known Ancient Greek mathematician and physicist, was the first person to discover that the buoyant force exerted on a body submerged partially or fully in a fluid is equal to the amount of weight of the fluid displaced. (Toomer, 2024). This now commonly known Archimedes' principle is the very basis to a draft survey performed onboard ships, enabling the most efficient and safe carriage of cargo and passengers onboard.

Draft Survey as a term includes a variety of weight surveys done onboard vessels, all sharing the same goal of finding out how much the ship can safely load or discharge cargo within the limits of its own structure and stability (Dibble & Mitchell , 2009).
The principle of the process is technically not a complicated one; reading the vessel's drafts from the draft marks whilst the vessel is empty, or carrying varying amounts of cargo, passengers, fuel, ballast water and other substances onboard, then comparing the results to find out the changes in the weight displacement (Rosenqvist, 2022).

Official draft surveys are most often done by professional surveyors, but it is good practise for the masters and officers onboard to also know how to perform them. A Draft survey should be carried out with such precision that every surveyor, professional or not, should achieve more or less the same results from the conducted survey, if assumed that they have been using the correct formulas for calculations. (Dibble & Mitchell , 2009, s. 3.)

1.2 Theory first, practise second

Most of the objective information gathered regarding this thesis is acquired via verbal communication with M/S Finlandia's immensely helpful crew, and what information was still lacking has been filled through the wonderful manual *On the subjects of drafts surveys* written by misters Dibble and Mitchell. These two information sources will be the focus for the theory part.

Dibble and Mitchell's manual focuses mostly on draft surveys in general and is helpful for anyone wanting to familiarize themselves with the subject. The main focus in this thesis however is lightweight surveys, a subject that proved to be slightly more difficult to find material on. This partly led to the choice of highlighting lightweight surveys in this thesis, along with the fact that the draft survey the author was partaking in was a lightweight survey specifically.

Before conducting any kind of draft survey, it is recommended to familiarise oneself with the theoretical aspect of the work, to ensure that the practical side of the survey goes as smoothly as possible (Rosenqvist, 2022).
The very first source of information to go through would be IMO's publications on the subject, since IMO's regulations are arguably the sole reason to why draft surveys are performed. In this thesis the important IMO publications will be gone through in chapter 1, section 1.3.

Information on a superficial level on the subject was first gained through academic courses regarding ship stability. Before attending the lightweight survey on M/S Finlandia, the following materials were studied: M/S Finlandia's hydraulic tables, results from previously conducted survey from 2017, drawings of the vessel's general arrangement and tank plans, provided excel sheets for the lightweight calculations and general material from IMO regarding the subject. (Rosenqvist, Pre-Survey Procedure for Light Weight Survey, 2022.) This was done to make sure all participants were at least somewhat aware of the basic principles of lightweight surveys.

An introduction to an inclination test was also made. An Inclination test Is a procedure gone through to find out the vessel's stability information. It is performed to all new vessels, and older vessels where larger renovations are done to find out if the added weights have altered the vessel's stability. (IACS, 1990.) The testing is done if it's found in the draft survey that the change in relation to the previous test exceeds 2% in the weight displacement or 1% in the longitudinal centre of gravity (Rosenqvist, 2022).

As pointed out by Dibble and Mitchell, while theoretical information is useful, experience in conducting surveys cannot be substituted for (2009, s. 4). An experienced surveyor will know what factors to consider when conducting the survey and notice possible errors in calculations, figures and end results.

1.3 Regulations from IMO and IACS

The International Maritime Organization regulates the conducting of draft surveys and sets the goals for the wanted results (IMO, International code of intact stability, 1993). IMO's intact stability code works as a manual for ship stability. Ensuring safe seafaring by providing important formulas and step by step instructions in how to calculate stability is the main goal of the booklet (IMO, 1993). Basic regulations concerning M/S Finlandia regarding the lightweight survey and stability can be found from the following IMO publications:

SOLAS chapter II -1, regulation for the timeline for draft surveys concerning passenger vessels. As directly stated in SOLAS:

> At periodical intervals not exceeding five years, a lightweight survey shall be carried out on all passenger ships to verify any changes in lightship displacement and longitudinal center of gravity. The ship shall be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding 2% or a deviation of the longitudinal center of gravity exceeding 1% of L is found or anticipated. (IMO, Convention for the Safety of Life at Sea, 1980).

SOLAS chapter II -1: SOLAS 90 stability standards, regulations for damage stability concerning passenger vessels. From damage stability code:

> The harmonized SOLAS regulations on subdivision and damage stability, as contained in SOLAS chapter II-1, are based on a probabilistic concept which uses the probability of survival after collision as a measure of ships' safety in a damaged condition. This probability is referred to as the "attained subdivision index A" in the regulations. It can be considered an objective measure of ships' safety and, ideally, there would be no need to supplement this index by any deterministic requirements. (IMO, Convention for the Safety of Life at Sea, 1980).

IMO res. A.749 International Code for Intact Stability, regulations in intact stability that are applicable to a vessel like M/S Finlandia. From IS-manual:

> A Light-weight survey involves taking an audit of all items which should be added, deducted or relocated on the ship at the time of the inclining test so that the observed condition of the ship can be adjusted to the lightship condition…The transverse center of gravity (TCG) may also be determined for mobile offshore drilling units (MODUs) and other ships which are asymmetrical about the centerline or whose internal arrangement or outfitting is such that an inherent list may develop from off-center weight. (IMO, 1993).

Working alongside IMO in providing mariners with recommendations and instructions is the International Association of Classification Societies (IACS). In M/S Finlandia’s lightweight survey, the following IACS publication was used:

IACS Rec. 31. Example from the manual:

> When a surveyor of the Society is requested to attend the inclination test, his responsibility is to verify that the test is conducted according to

> accepted procedures and that all basic measurements and data are correctly taken and recorded. (IACS, 1990, s. 1)

In addition to these, Finlandia, built 2000-2001 and operating regularly between two ports in European waters, also follows The Stockholm Agreement, a complimentary agreement to SOLAS 90, originally between Denmark, Finland, Germany, Ireland, Netherlands, Norway, Sweden and the United Kingdom, regulating damage stability to ro-ro vessels (Rosenqvist, 2022).

The Stockholm Agreement, regulations for damage stability concerning ro-ro/passenger vessels. From the agreement:

> A Ferry must withstand 500 mm of water on its watertight vehicle deck when the residual freeboard in a damaged condition is below 0.3m. (The Stockholm Agreement, 1996).

Both IMO and IACS provide well written and clear instructions concerning ship stability, and it is recommended by the author that any seafarer makes themselves familiar with these materials.

CHAPTER 2

2.1 Preparing for the survey

The idea for a thesis based on a draft survey came from one of M/S Finlandia’s Chief Officer. Since the vessel’s stability is something important to have a good understanding of when working as officers and masters, partaking in such an event as the vessel’s lightweight survey is nothing but beneficial for any maritime student aspiring to understand the phenomenon that is a huge metal piece gracefully floating in the vast sea (Dibble & Mitchell , 2009). From this thought it was moved to the practical side of conducting a lightweight survey.

First it is a must to familiarize oneself with the vessel in question. For starters it is good to read the vessel's previous lightweight survey results, which give an indication for what to expect from the final results of the survey being conducted. For example, if it is known that larger weights such as ice reinforcements have been added to the vessel since the previous survey, it is well expected that the results will have changes over 2% in weight displacement and over 1% in LCG. (Rosenqvist, 2022.) Below is an example of final results from a previous survey conducted on M/S Finlandia:

8 Final Results

Change between 2012-12-07 and 2017-12-04:

DATE	LIGHT SHIP WEIGHT	LCG FOR LIGHT SHIP	COMMENTS
Light ship condition 2017-12-04	14404,60 t	70,83 m from frame 0.	Lightweight survey Helsinki Länsisatama #6 12/2017
Light ship condition 2012-12-07	14196,70 t	71.04 m from frame 0.	Inclining test report according to Intact Stability Booklet approved by TRAFI n. 1/13, FI3/600/2013

A. The change of light ship weight = **207,90 tonnes**

The change of light ship weight (%) = **1,46 %**

B. The change of LCG = **0,21 m (aft)**

The change of LCG compared to Lpp (%) = **0,13 %**

Figure 1. 2017 results from lightweight survey (Rosenqvist S. & Eckerö Line, 2022).

The lightship weight displacement from figure 1. will be used as comparison for the weight of displacement resulting from the new survey.

As previously mentioned in chapter one, other theoretical information was also gone through to help prepare for the survey, including the vessel's hydraulic tables, IMO publications and drawings of the vessel's general layout (Rosenqvist, 2022).

When preparing the vessel for a draft survey all tanks were sounded to determine the amount of fluids onboard. The general average weight for a crew member was taken and decided to be 75+25kg, though it is stated that the added weights of crew onboard is usually not significant enough to change the survey results. It is only important to know the estimated location of most of the crew at the time of the survey to make sure no extra weight in random places is counted as weight from crewmembers. (Rosenqvist, Pre-Survey Procedure for Light Weight Survey, 2022.)

Exel sheet for ligthweight caluculations was prepared using a sheet made for previous surveys. Below is an attached photo of the sheet.

	ITEM	WEIGHT (tonnes)	LCG fwd AP (m)	LONGITUDINAL MOM. Fwd AP (tonnesm.)	VCG (m)	VERTICAL MOM. (tonnesm.)	TCG PS = Neg. (m)	TRANSVERSAL MOM. (tonnesm.)	MOM. Of Inertia
4	**LIGHTSHIP CALCULATION**								
5	$WEIGHT_{TEST}$	15985,754	73,702	1178182,041					
6	DECK 10	0,000	0,000	0,000	0,000	0,000	0,000	0,000	
7	DECK 9	-3,020	66,219	-199,980	0,000	0,000	0,000	0,000	
8	DECK 8	-13,500	80,788	-1090,643	0,000	0,000	0,000	0,000	
9	DECK 7	-1,550	48,113	-74,575	0,000	0,000	0,000	0,000	
10	DECK 6	-57,900	134,090	-7763,794	0,000	0,000	0,000	0,000	
11	DECK 5 (HCD)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	
12	DECK 5	-0,400	15,645	-6,258	0,000	0,000	0,000	0,000	
13	DECK 4	-17,150	119,413	-2047,931	0,000	0,000	0,000	0,000	
14	DECK 3 +2,8m	-4,800	72,265	-346,872	0,000	0,000	0,000	0,000	
15	DECK 3	-37,500	66,517	-2494,372	0,000	0,000	0,000	0,000	
16	DECK 2	-60,550	78,901	-4777,462	0,000	0,000	0,000	0,000	
17	DECK 1	-214,070	104,173	-22300,338	0,000	0,000	0,000	0,000	
18	ONBOARD PERSONS (146)	-14,375	26,908	-386,804	0,000	0,000	0,000	0,000	
19									
20	TANKS	-1331,354	99,850	-134992,648	2,229	-2967,931	-0,422	561,510	6022,900
21	ADDED WEIGHTS	0,900	98,340	88,506	0,000	0,000	0,000	0,000	
22									
23									
24									
25									
26									
27	**LIGHTSHIP**	**14230,485**	**70,397**	**1001788,872**	**-0,209**	**-2967,931**	**0,039**	**561,510**	
28									
29									

Figure 2. Excel sheet for lightweight calculations. (Rosenqvist S. , 2022.)

All figures in the sheet are from the previous lightweight survey. The weight of displacement of the vessel is calculated by reading the draft marks, correcting the drafts if the draft marks are away from perpendiculars (as is in the normal case) and making trim corrections if the vessel is not on even keel. After the

mean drafts (dm) are gotten through the draft corrections they are converted to weight of displacement using the vessel's hydraulic tables. (Dibble & Mitchell , 2009.)
The weight of the displaced water is calculated by multiplying it's volume by it's density. From the aquired weight all additional weigths (see further down 2.3 for reference) are deduced to get the lightship weight. Since the vessel is determined to be floating on somewhat even keel in this case, LCB from hydrostatic tables = LCG used in the exel sheets (Rosenqvist, 2022).

After all necessary preparations are done and an estimate can be made for the survey conditions, a pre-survey procedure application has to be made and submitted to the responsible survey authority (Rosenqvist, 2022). In M/S Finlandia's case that is the Finnish surveyor/certification service company Bureau Veritas. In this pre-survey procedure application at least the following things are listed: relevant ship data, survey details, test conditions, applicable regulations, lightship history and planned timeline for survey. After the appliucation is approved, the survey can begin. (Rosenqvist, Pre-Survey Procedure for Light Weight Survey, 2022.)

Below is an example photo of the test conditions during the 2022 lightweight survey on M/S Finlandia, as stated in the survey report.

3. Test Conditions

Wind direction/speed:	SW / 4 m/s
Air temperature:	+ 10,0 ° C
Sea temperature:	+ 9,0 ° C
Mean seawater density:	1,0015 g/cm^3
Sea state/wave height:	Calm / 0,0 – 0,1 m
Additional conditions:	Vessel free floating with all ramps secured, slacked moorings lines and no gangway connected.

Figure 3 Test conditions during the survey (Rosenqvist S. & Eckerö Line, 2022)

2.2 Equipment needed and ideal survey/weather conditions

For a lightweight survey to be performed, the following equipment is needed (Dibble & Mitchell , 2009):

- A Camera, for capturing images of the deductible weights onboard. These images will help memorize all the weights that need to be deducted in the final calculations.
- A Copy of the vessel’s deck plan for easier navigation inside the ship, and to cross off areas that have been gone through already.
- A Smaller sized raft or a boat that can be used to check draft marks. It is very important to get accurate draft readings so drafts should be taken as precisely as possible.
- A Couple of cartons to take water samples into.
- A Hydrometer, for measuring water density.
- Other equipment regarding the survey conditions, i.e. a flashlight if draught readings are done after sunset.

Figure 4 Inserting a hydrometer into the water sample (Forsberg M., 2022)

Once all equipment is at hand the weather is checked to see if it is possible to perform the survey. A Clear, calm weather with a minimum amount of wind and waves is ideal for the survey. (Dibble & Mitchell , 2009.) The vessel should be free floating with minimum amount of movement during the draft reading, and the presence of waves or wind will make the drafts harder to read accurately (Rosenqvist, 2022.) The survey should not be done in icy, stormy or otherwise bad conditions. It is recommended to check weather reports in advance before planning the survey date. (Dibble & Mitchell , 2009.)

In addition to weather conditions, there are couple things to take into account in choosing the area where the survey will take place. A Sheltered, calm harbour area would be ideal for the survey. Areas with strong currents, heavy vessel traffic, sludge disposal tube exit points, or in general anything that could potentially mix up the seawater should be avoided to minimize inaccuracies in the water density samples. (Dibble & Mitchell , 2009).

2.3 Walkthrough of the ship

When conducting any kind of a draft survey, especially a lightweight survey, one very important aspect is the weights that need to be deducted from the vessel's overall weight that was taken through the draughts. This includes all "added" weights to the ship's lightweight, such as ballast waters, fuel oil, crew, and basically all equipment/materials that are not permanently part of the vessel, but rather consumable items. (Rosenqvist, 2022.)

It is good to note that in the IMO wording describing what a vessel in lightweight is, it is said that the vessel should be ready for seagoing. This could be interpreted as the vessel having a small amount of oils in its tanks amongst other necessary fluids, since without them the vessel technically is not ready for seagoing. There is usually no harm in including those weights in the vessel's lightweight when calculating the survey results, since if the surveyor decides they should be removed it will just lighten the vessel which in turn makes the possibility of having too much added weight onboard in comparison to the previous survey less likely. (Rosenqvist, 2022.)

Tank soundings are routinely performed for various reasons, to get an estimate of what liquids are onboard. It is also easy to put an estimate on personnel's weight by taking an average weight from a few crew members. For store items and other consumable items however, a walkthrough of the vessel is needed to make an estimate of how much each added item weights. For a passenger vessel especially, this task takes some time due to the large size of the vessel and the many added items onboard. (Rosenqvist, 2022.)

The practical side of the walkthrough is very simple, but time consuming. The whole vessel is gone through step by step to count all added items and their weights, such as proviant store items that are sold to passengers, metal scraps in the engine room and all the plates and glasses from the galley (Rosenqvist, 2022).

Even though they are not physically part of the vessel’s structure, items that are not part of these “extra” weights onboard include, for example, all emergency/safety equipment since without them the vessel is not seaworthy or ready for seagoing. Items that aren’t necessarily consumable, for example tables and chairs in passenger lounge areas, are also considered to be “part of the vessel” therefore making them non-deductible weights. (Rosenqvist, 2022.)

Since it would not be practical to actually weight every single smaller-sized item, only an estimate is made of the weights and that is used in the calculations. It is also good to note that these smaller added items most likely won’t have an impact on the draft survey calculations due to insignificant weight, but draft surveys tend to be done thoroughly and it never hurts to be accurate. (Rosenqvist, 2022.)

Below is an example photo of storage items, all weights that will later be added to the deductibles. In Finlandia’s case, larger deductible weights came from market storage items, such as heavy beer pallets.

Figure 5 Deductible weights in ship storage (Forsberg M.,2022)

2.4 Draft readings

After arrival on Tallinn harbour during the evening the vessel was moored and after discharging passengers and cargo, all ramps and gangways were secured, and the mooring ropes were slacked leaving the vessel free-floating in the harbour pool. Since the weather was alright for draft survey, there were no obstacles in the way of the survey (Rosenqvist, 2022).

The draft readings were done via an inflatable boat which could fit under the vessel's "ducktail". The initial drafts had been taken beforehand during the daytime after the vessel had finished loading. The vessel was more or less on an even keel. During the draft readings a water sample was also collected to find out the water density at the harbour, which in this case was found to be 1,002 g/cm^3 via the hydrometer, and later confirmed by a professional laboratory to be more precisely 1,0015 g/cm^3. (Rosenqvist, 2022.)

Below is an attached image of draft readings being done under the vessel's "ducktail".

Figure 6 Reading aft draft marks (Forsberg M., 2022)

CHAPTER 3

3.1 Calculations and results

Once all drafts and weights are taken, the calculations can begin. For this, a previously mentioned excel sheet was used, only this time with updated figures.

ITEM	WEIGHT (tonnes)	LCG fwd AP (m)	LONGITUDINAL MOM. Fwd AP (tonnesm.)	VCG (m)	VERTICAL MOM. (tonnesm.)	TCG PS = Neg. (m)	TRANSVERSAL MOM. (tonnesm.)	MOM. Of Inertia
LIGHTSHIP CALCULATION								
$WEIGHT_{TEST}$	15985,754	73,702	1178182,041					
DECK 10	0,000	#DIV/0!	0,000	0,000	0,000	0,000	0,000	
DECK 9	-7,600	51,175	-388,927	0,000	0,000	0,000	0,000	
DECK 8	-14,900	73,383	-1093,399	0,000	0,000	0,000	0,000	
DECK 7	-1,350	50,329	-67,944	0,000	0,000	0,000	0,000	
DECK 6	-38,250	122,117	-4670,964	0,000	0,000	0,000	0,000	
DECK 5 (HCD)	0,000	#DIV/0!	0,000	0,000	0,000	0,000	0,000	
DECK 5	-0,250	13,261	-3,315	0,000	0,000	0,000	0,000	
DECK 4	-10,850	68,681	-745,186	0,000	0,000	0,000	0,000	
DECK 3 +2,8m	-2,500	64,368	-160,920	0,000	0,000	0,000	0,000	
DECK 3	-16,600	55,231	-916,834	0,000	0,000	0,000	0,000	
DECK 2	-50,550	70,478	-3562,665	0,000	0,000	0,000	0,000	
DECK 1	-138,550	102,359	-14181,783	0,000	0,000	0,000	0,000	
ONBOARD PERSONS (146)	-12,800	33,769	-432,249	0,000	0,000	0,000	0,000	
TANKS	-1274,910	103,103	131447,101	2,232	-2845,109	0,057	-72,994	6022,900
ADDED WEIGHTS	0,000	#DIV/0!	0,000	#DIV/0!	0,000	#DIV/0!	0,000	
LIGHTSHIP	**14416,644**	**89,022**	**1283404,956**	**-0,197**	**-2845,109**	**-0,005**	**-72,994**	
Weights	-281,400	91,65578269	-25791,937					
Persons								
Tanks								
Added wieghts								

Figure 7 lightship calculations, new figures (Rosenqvist S., Eckerö Line, 2022)

As seen from the figure above, after all deductions from the vessel's weight, the final lightship weight was determined to be around 14416,644 tonnes longitudinal centre of gravity was around 89,022m forward from aft perpendicular, longitudinal momentum was around 131447,101 t/m, vertical centre of gravity was around -0,197m, vertical momentum was around -2845,109 t/m, transverse centre of gravity (port side) was -0,057m, transversal momentum was -72,994 t/m and moment of inertia around 6022,900. (Rosenqvist, 2022.) From these, comparison to the previous survey was drawn and the differences noted as follows in the figure below:

	WEIGHT (tonnes)	LCG fwd AP (m)	VCG (m)	TCG PS= Neg. (m)
Lightship condition December 2022	14416,644	89,022	-0,197	-0,005
Lightship condition December 2012	14196,700	71,040	13,470	0,000
CHANGE	**219,944**	**17,982**	**13,667**	**-0,005**

100 % Lpp 162,1

The change of lightship weight =	**219,944**	**tonnes**
The change of lightship weight % =	**1,549 %**	
The change of LCG =	**17,982**	**m (Fwd)**
The change of LCG compared to Lpp (%) =	**11,093 %**	
The change of VCG =	**13,667**	**m (down)**

Figure 8 Lightship calculations (Rosenqvist S., Eckerö Line, 2022)

The change of lightship weight was around 219,944 tonnes more than the previous survey year, LCG had moved 17,982 meters forwards in regard to the previous survey year, VCG had risen up slightly from previous year and from TCG it can be seen that the vessel has slightly listed to port side compared to the previous survey year. (Rosenqvist, 2022.)

The changes were converted to percentages to find out if the vessel is still within its assigned limits. The change in weight was around 1,549 %, the change in LCG compared to Lpp was around 11,093 % and the change of VCG was 13,667m (down). (Rosenqvist, 2022).

These are not the final survey figures, as some corrections to the calculations were made later on, such as changing the water density from 1,002 to 1,0015 and removing lube oil from the vessels lightweight and adding it to the deductibles, making the vessel lighter. (Rosenqvist, 2022.) It is also good to note that the LCG change in this is compared to length between perpendiculars (Lpp), not lightship, which will be the final LCG change figure.

8 Final Results

Change between 2012-12-07 and 2022-11-01:

DATE	LIGHT SHIP WEIGHT	LCG FOR LIGHT SHIP	COMMENTS
Light ship condition 2022-11-01	14454,1 t	70,90 m from frame 0.	Lightweight survey Tallinn Old City Harbour.
Light ship condition 2012-12-07	14196,7 t	71,04 m from frame 0.	Inclining test report according to Intact Stability Booklet approved by TRAFI n. 1/13, FI3/600/2013

A. The change of light ship weight = **257,4 t**

The change of light ship weight (%) = **1,81 %**

B. The change of LCG = **0,14 m (aft)**

The change of LCG compared to Ls (%) = **0,09 %**

Figure 9 Final results from calculations, 2022 edition (Rosenqvist S., Eckerö Line, 2022)

The final calculations conducted that the change in lightship weight was 1,81% and the change of LCG 0,09%. Although the vessel has gotten slightly heavier, it is still within the appropriate limits, and is good to go for another 5 years unless larger weights are added, or other changes are made to the vessel. (IMO,1980.)

3.2 Finished survey report

The preliminary results were submitted to the survey authority Burea Veritas, and by their suggestions all the needed corrections were made. After the re-visited version was gone through, the final survey report was sent to and ap-proved by the administration. (Rosenqvist, 2022.)

The final survey report includes the following information: relevant vessel data, survey details, test conditions, applicable regulations, lightship history, displacement calculations, calculation of Lightship weight and LCG and the final results of the survey. Signatures (and, of course, the date of signatures) from concerned parties are also added, as this is the official survey report. When the next survey is conducted, the results will be compared to this surveys official survey report, which is why it is so important to have reliable, correct data available. (Rosenqvist, 2022.)

CHAPTER 4

4.1 Learned lessons

When choosing a topic for a thesis it is always a bonus if the topic not only somehow benefits the whole academic community it is part of, but also helps the thesis writer to gain new knowledge on subjects that might be useful for them later in their career.
With that in mind, it was an easy decision to take on the opportunity being offered to me to not only write about draft surveys from a theoretical aspect, but to participate in one myself, from start to finish. Albeit the subject first seemed a tad bit scary and complicated to a second-year student who had not yet learned much about ship stability in school, it proved to be a good learning opportunity nonetheless.

As mentioned in the beginning of the thesis before, learning about draft surveys in detail is beneficial for officers of all levels; after all it teaches a person quite a lot about the very principles on how a vessel is operating at sea and at port. Since drafts surveys are so deeply intertwined with ship stability, performing one will familiarize the person with the vessel in question, thus helping the person understand loading and discharging operations better.

In addition to vessel stability, very basic skills needed for officers and masters can also be learned; I had never read vessel draughts from draft marks before participating in this project, but thanks to the survey that was gone through thoroughly as well. Overall, the theoretical knowledge gained in school and through academic writings became much clearer when put into hands-on practice. Hydraulic tables were also first introduced to me through this project, although those became fully familiar to me through multiple calculation exercises in academic learning.

In addition to learning the ways of draft surveys, multiple new regulations and writings from the IMO and other governing authorities became much more familiar to me through the project. I was fortunate enough to have a mentor who was eager to provide me with as much knowledge as possible regarding his area of speciality, and who was kind enough to recommend various reliable sources of information that could be useful to me in the thesis, including for example the mentioned IMO publications.

In the survey itself it is very practical to have multiple people perform it, creating a perfect opportunity for cross-checking the figures and measurements for errors between the participating surveyors, which helps to ensure that everything is correct in the final calculations. In surveys like these, the amount of different figures is enormous and errors might go unnoticed in the vast sea of numbers on a screen or paper, though an experienced surveyor most likely will pay attention to a seemingly strange final results.

CONCLUSION

A Draft survey is a necessary procedure where the vessel's weight and relevant stability information is found out. It lets the vessel owner know whether the vessel is seaworthy, and how much cargo it can safely take onboard, in other words how much money the vessel owner can make with their asset. (Dibble & Mitchell , 2009.) For M/S Finlandia the draft survey was performed, and it was found out that the vessel is still within the limits of the regulations and can safely operate for at least the next 5 years in the future (IMO, 1980).

In the beginning of the lightweight survey research was done on the subject beforehand, and it was found out that lightweight surveys are harder to find materials on compared to draft surveys in general, thus solidifying one of the reasons for the existence of this thesis; to make a guide for the practical side of lightweight surveys for maritime students and anyone interested in maritime management. The first and foremost reason was to develop a better understanding of ship stability and to get familiar with regulations concerning ropax-vessels.

In the beginning of the practical research of the survey, draft survey publications were gone through, and vessel information was investigated. Hydraulic tables and previous survey results were studied to get a good understanding of what was going to happen with the survey itself. (Rosenqvist, 2022.)
Before the actual survey a pre-survey application was sent to the governing survey authority (Rosenqvist, Pre-Survey Procedure for Light Weight Survey, 2022). The Survey began with initial draft readings which were taken during a "normal" loading operation. Next, all extra weights onboard were accounted for and written down during a walkthrough of the vessel. When the vessel arrived at Tallinn harbour, all cargo was discharged, and the vessel was left free floating in the harbour pool with slacked mooring lines and secured ramps and gangways. Then, another set of more precise draft readings were taken to be

compared with the initial drafts, and a water sample was collected from the harbour area to find out water density. (Rosenqvist, 2022.)

After all figures were taken, a previously prepared excel sheet was used to calculate survey results. It was found out that although the vessel’s weight had increased, the LCG and weight changes did not exceed the given limits in percentages, which meant that the vessel “passed” the survey and no inclination test was needed (IACS, 1990).

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