Tons and Tonnages: Ship Measurement and Shipping Statistics, c. 1870-1980

Yrjö Kaukiainen

Introduction

Students of early modern maritime history are well aware of the perplexing variety of national units and rules for ship measurement.[1] The adoption of the British "Moorsom" system by most maritime nations between 1864 and 1885 was therefore a major advance, not least for the cross-national comparability of shipping statistics.[2] In fact, scholars have become so convinced of its superiority that its validity as a universal gauge of carrying capacity is seldom discussed.[3] But people engaged in practical ship measurement soon learned it was less than perfect.[4] The best proof was that a new international agreement on ship measurement was concluded in 1969 under the auspices of the International Maritime Organization (IMO). This accord introduced some major changes in the principles of ship measurement and led to significant increases in the

[1] See, for example, Simon Ville, "The Problem of Tonnage Measurement in the English Shipping Industry, 1780-1830," *International Journal of Maritime History*, I, No. 2 (December 1989), 65-83; David R. MacGregor, *Fast Sailing Ships. Their Design and Construction, 1775-1875* (2nd rev. ed., London, 1988), 97-98, 151-152, appendix 1.

[2] John Lyman, "Register Tonnage and its Measurement, Part II," *American Neptune*, V, No. 4 (October 1945), 311, 315; Nils Gustaf Nilsson, "Skeppsmätning," in Nils Gustaf Nilsson and Gustav Åsbrink (eds.), *Sveriges sjöfart* (Stockholm, 1921), 342-343.

[3] It is illustrative of the consensus that the best-known guide to sources in maritime history, Robert G. Albion (comp.), *Naval and Maritime History: An Annotated Bibliography* (4th rev. ed., Mystic, CT, 1972), fails to include measurement as a subject.

[4] The following employees and former employees of the Finnish National Board of Navigation agreed to be interviewed for this article: Councillor Heikki Valkonen; former Councillor Oso Siivonen; Inspector Anders Fabritius; and former Inspector Åke Wiberg.

International Journal of Maritime History, VII, No. 1 (June 1995), 29-56.

tonnages of certain types of vessels. While the agreement took effect in 1982, remeasurement of older vessels became obligatory only in 1994.[5]

In this article I will examine some of the main problems with the Moorsom system after 1867, when the modern principle of net tonnage was introduced. The most important questions are whether any substantial discrepancies developed between measured tonnage and actual carrying capacity and, if so, whether this was so common that the validity of shipping statistics – which were usually based on register tonnages – were endangered. Since the practical problems affected only steamers and other machine-propelled ships, I will focus on them.

The most important source problem for this kind of study is that since most statistics and official lists long recorded only register tonnages, the availability of alternative gauges of size, such as deadweight tonnage or the actual capacity of the holds, is poor. The Finnish official list of ships (*Suomen kauppalaivasto – Finlands handelsflotta*), for example, only started to record deadweight tonnages in 1935 and cargo capacity (in cubic feet, grain and/or bales) in the early 1950s.[6] Fortunately, Finland's merchant fleet still included some very old vessels, which makes it possible to collect relevant data for fairly typical steamers over a lengthy time span. I have thus relied solely on this source, supplemented by a few other published Finnish ship lists, for my empirical data.[7] This limitation means that the focus will be on "handy-size" ships used in the Baltic, although some examples of larger vessels are included. This should not be too serious a drawback, however, since measurement problems depended on technical features rather than size.

The Troubled History of the Moorsom Ton

Any system of ship measurement should be able to cope successfully with challenges (or troubles) arising from both technical problems and economic pressures. The economic pressures derive from the fact that

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[5]In Finland, the accord was published in the official series of agreements (*Suomen asetuskokoelma, sopimussarja*), 24/6/1982/31.

[6]By international standards, Finland was not particularly late in so doing. One remarkable exeption is the Danish official list of ships (*Danmarks skibsliste*), which in the 1920s included deadweight tonnage and was also unusually detailed in other respects.

[7]For a complete list of these sources, see the notes to the appendices.

most shipping charges, such as port dues, pilotage fees and navigation levies, are based on the officially certified tonnage (most often net tons), which is understood to represent carrying (and earning) capacity. This creates an inducement to build ships with low official tonnages, while maximizing carrying capacity. This pressure was accentuated in the late nineteenth century when many major ports increased their dues to compensate for substantial modernization costs. Accordingly, this especially affected liners that served several such ports.

The technical challenge is created by the great variety of cargoes carried and their different stowage requirements. On the most basic level, these reflect the differences between cargoes characterized by either weight or volume. The former, such as metals and ores, have high specific gravities, do not require large amounts of space per unit, but need a ship with sufficient reserve buoyancy (the volume between the waterline planes when empty and laden) to carry a "full" cargo without sinking "below the marks." On the other hand, lighter cargoes, such as cotton, softwood, or even automobiles, require much space; indeed, part of the cargo often must be carried on deck before the ship is "loaded down." The most extreme case of a volume cargo is passengers: even nineteenth-century emigrant vessels had twice as much volume per passenger as a ton of cotton.[8]

A ship's ability to carry weight cargoes is of course best gauged by a weight unit, such as the old north European *läst* and the modern deadweight ton (dwt).[9] The actual volume of cargo space – which was emulated by the Moorsom net register ton (nrt)– reflects the capacity to load volume cargoes. There is not – and cannot be – any single measurement to describe accurately both aspects of carrying capacity, a point clearly understood by shipbuilders and owners when they privately started to use deadweight tonnage at the beginning of the Moorsom era.

It is important to note that the Moorsom ton only emulates cargo space; the cargo holds were never actually measured. While gross tonnage (grt) represented virtually the ship's entire underdeck volume

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[8]See, for example, Yrjö Kaukiainen, *A History of Finnish Shipping* (London, 1993), appendix 1.

[9]In theory, even the Moorsom gross ton can provide some idea of the amount of reserve buoyancy, but its shortcoming is that it pays no attention to a ship's displacement when empty. For example, two ships with identical gross tonnages but with different machinery and accommodation may have widely divergent deadweight tonnages.

(including closed deckhouses but excluding so-called "open spaces"), post-1867 nrt was calculated by subtracting the cubic volume of space intended for purposes other than cargo, such as engine and boiler rooms, bunkers, water ballast tanks, shaft tunnels, living quarters, galleys, toilets and navigation rooms.[10] These were all measured, but British Board of Trade rules (as well as most other national regulations) allowed a percentage deduction (in relation to gross tonnage minus living quarters) for machinery, or "propelling power," that was larger than the combined volume of relevant spaces: it amounted to between 2.5 and 1.75 times actual volumes. While this could be rationalised by the fact that on longer routes many ships carried more coal (often on deck) than their bunkers could accommodate, in real life it resulted in significant "tax free" tonnage. The bonus was largest when the volume of machine rooms and bunkers amounted to about thirteen percent of the total – if the volume fell below this limit, net tonnage rose disproportionately.[11]

These rules were adopted by most nations, the only important deviations being the so-called Danube, Suez and German rules. The last, applied in Germany (1873-1895) and Sweden (1880-1957), actually followed Moorsom's original idea by deducting only the actual volumes of eligible spaces, including permanent bunkers. The other two were compromises between the British and German systems; the Danube rule was used in the US from 1882 (when nrt was introduced) until 1895.[12]

From the outset, a ship's grt excluded spaces below "hurricane" decks or other shelters only partially protected from the elements. But in colder climates even the sides of such shelters were more or less covered, until they resembled closed underdeck spaces. Liners in particular were built with relatively light, full-length "spar" or "awning"

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[10] In certain cases, some of these (ballast-tanks within a double bottom, toilets and galleys in superstructures) could even be exempted from the gross tonnage.

[11] John Lyman, "Register Tonnage and its Measurement, Part I," *American Neptune*, V, No. 3 (July 1945), 233. The excessive "propelling power deduction" was not conceived by Moorsom but by an advisor to the Board of Trade, Admiral Beechey. Later the Board sought to amend the rule but Parliament failed to concur. Not until the 1947 Oslo Agreement was this rule modified slightly.

[12] Lyman, "Register Tonnage," I, 233; II, 315-316; Karl Joachim Klüver, "Von der Commerzlast zur Bruttoraumzahl," in *1888-1988. 100 Jahre Schiffsvermessungsamt* (Bundesamt für Schiffsvermessung, 1988), 18-28; Nilsson, "Skeppsmätning," 342.

decks above the main deck; they were useful because general cargo and even third-class passengers could be carried underneath. By the late 1870s the Board of Trade was forced to define the minimum openings required for space to be "open" and hence exempt from grt. Since this was an interpretation rather than a new rule, national practices differed for some time. Germany, for example, only accepted the principle of exempting open spaces in 1895, while the US and the Panama Canal authorities waited until 1915.[13]

Originally, an open space was required to have openings, which could not be closed permanently, on the sides or the transverse bulkheads. For example, a deckhouse with two openings of at least three by four feet on its aft bulkhead ("backside") was considered open regardless of length. Although spaces under an awning-deck normally had no scuppers and were logically regarded as closed (and hence included in grt), those under a partial awning-deck might be exempted if, for example, there was even a short well-deck (with normal scuppers) between the aft bulkhead and the poop.[14] By the turn of the century, this configuration was developed so that the well could be covered if there was a hatch on the weather deck that could not be closed permanently. The minimum size of such a "tonnage hatch," as it was soon dubbed, was so small (only four feet long and at least as broad as the aftermost cargo hatch) that it was of no practical use in loading or unloading; it existed only to offload a ship's tonnage. This was the genesis of the open shelter-decker, which became the prototype for all so-called "rule-cheaters."[15]

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[13]On the other hand, all deckhouses above the main (measurement) deck were exempted in the US. Lyman, "Register Tonnage," II, 317-318; Klüver, "Von der Commerzlast," 24-25, 30-33.

[14]Until 1873 Lloyd's required that awning-deckers had "scuppers and ports at the main deck through the side to discharge water;" thereafter, newly-built vessels could dispense with them. See Lloyd's *Register of British and Foreign Shipping*, circulars 306, 314, 340, 354. The circulars were often issued as appendices to the *Registers*.

[15]Nils Gustaf Nilsson, "Fartygstypernas utveckling under senare tider," in Nilsson and Åsbrink (eds.), *Sveriges sjöfart*, 196-197; J.C. Arkenbout Schokker, *et al.*, *The Design of Merchant Ships: A Manual for Determining the Principal Dimensions, Engine Power and Internal Arrangement, Freeboard and Tonnage Measurement, and the Calculation of the Period of Vibration and the Strength of the Hull* (2nd ed., Haarlem, 1953), 256-59, 267-269.

In addition to measurement concerns, the development of open shelter-deckers was stimulated by loadline regulations. From the 1870s British ships were required to mark lines on their sides for minimum freeboard allowed (the so-called "Plimsoll lines"); in 1890, Lloyd's Register was entrusted with their determination. Lloyd's freeboard tables (which actually date from the early 1880s) made a distinction according to how strongly the upper decks or superstructures were built; thus a spar-decker could not be loaded as deeply as a proper two-decker, and an awning-decker was required to have an even higher freeboard. In 1906, the Board of Trade published a revised set of rules to allow deeper loading of ships with long superstructures. Since a partial awning- or shelter-deck was technically regarded as a superstructure, this change increased loading, or deadweight, capacity. It also made loadlines compulsory for foreign ships entering British ports, and during the next few years these rules, or national variations, were adopted by most maritime states.[16]

It was this rule that made shelter-deckers economically viable. According to freeboard tables, such vessels could be loaded deeper than comparable "three-island" ships; even compared with true two-deckers, the difference between loadlines was normally smaller than the vertical height of typical tweendeck-spaces. If this space were exempted, the grt deduction was thus larger than the loss of deadweight capacity. In the liner trades, where volume normally counted for more than the ability to carry heavy loads, this was fully acceptable. And since it was possible to close all tonnage openings temporarily with wooden covers and tarpaulins, the space under the shelter-deck was sufficiently weatherproof for general cargo. It is no wonder that from the 1920s until the container revolution, open shelter-deckers dominated liner shipping.

During the First World War, when demand for tonnage was high, many British open shelter-deckers were closed by fitting more permanent covers on tonnage hatches and bulkhead openings and closing the tonnage-well scuppers. Although their upper-deck structures were of

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[16] *Lloyd's Register of British and Foreign Shipping. Rules and Regulations*, various years; Ronald Hope, *A New History of British Shipping* (London, 1990), 321-322, 344-345; *Det norske veritas. Bretning til 75 årsjubileet 1939* (Oslo, 1939), 34-35; A. Campbell Holms, *Practical Shipbuilding* (London, 1918), 65-67. An appendix to the International Agreement of Loadlines, finalized in London on 5 August 1930, lists all relevant national rules which, because of a "grandfather clause," remained applicable. See *Suomen asetuskokoelma, sopimussarja*, 16/1932.

smaller scantlings than the hull, surveyors allowed them loadlines similar to proper two-deckers and thus increased dwt. Although this was a temporary wartime exception, the idea of changing loadlines and register tonnage according to the nature of the cargo was quite attractive. With advances in steel technology, the increased weight of a shelter-decker with full-strength upper decks became less prohibitive. In the interwar era many two-deckers were designed with alternative deck arrangements so they could be surveyed as either open or closed shelter-deckers. This naturally widened the ship's cargo spectrum and many nations began to issue double measurement certificates to cover both alternatives.[17]

In addition to the deduction for propulsion and shelter-decks, there were some other minor problems in the Moorsom system. The exemption of water-ballast tanks and certain deckhouse spaces both changed over time and varied across national frontiers, as did the deductions for pumphouses, winchrooms and other technical spaces. There was a general increase in the amount and variety of spaces exempted, which more or less paralleled technological developments.

Another trend was that national measurement systems converged over time. Although no universal agreement was achieved, many countries simply followed the Board of Trade's revisions and additions. For example, when Britain in 1913 increased the maximum propulsion power deduction from fifty to fifty-five percent of grt, Denmark, Germany, Greece, Italy, Norway, Russia and Spain followed immediately. Most countries even accepted British measurement certificates.[18] Since Britain was "shipbuilder to the world," this was not surprising. Yet the decision to copy the UK likely depended more on economics than international cooperation. Competition was increasing, particularly in the liner trades, and the avoidance of dues conferred an advantage. Few countries could afford rules which would have increased the tonnages of ships flying their flags above levels in Britain and elsewhere.[19]

Plans for a uniform international measurement system were developed by the League of Nations in the 1930s, but these materialized only in 1947, when nine European countries, including all the Scandina-

[17]Nilsson, "Fartygstypernas utveckling," 198-199; *Det norske veritas*, 35.

[18]Klüver, "Von der Commerzlast," 32, 35.

[19]Even Swedish measurement authorities issued Board of Trade certificates for Swedish ships in international traffic; Nilsson, "Skappsmätning," 347.

vian nations and Finland, signed a measurement agreement in Oslo. This was based wholly on Board of Trade rules; indeed, its aim was to create a uniform and precise interpretation of an old tradition rather than to forge a new system. Accordingly, changes in tonnages of existing vessels were fairly small.[20] Later, the number of signatories rose to sixteen, and even the US, Britain and the USSR followed the agreement. About half of all world tonnage sailed under the flags of the signatories and followers of the Oslo rule.[21]

Despite being more precise, the Oslo rule did not affect the principles of deducting for propulsion and open spaces. As a result, the old problems remained while new ones developed. For instance, although steam turbines and diesels made it possible to have smaller machine rooms, the over-generous propulsion power deduction made it profitable to inflate volumes to meet the magical thirteen-percent limit. This often was achieved by including smokestacks, ventilators and other peripheral structures, although it was possible to exempt them altogether.[22]

Under the Oslo rule techniques for exempting cargo space from measured tonnage developed even further. The seaworthiness of open shelter-deckers caused concern since the 1920s; in the 1960s, the new international maritime organization, IMCO (later IMO), passed a resolution recommending that the critical openings be permanently closed without any change in measured tonnage. The signers of the Oslo convention (all also members of IMCO) reacted favourably and in 1965 the rules were amended.[23] In practice, the new rules allowed a ship with more than one deck to exempt tween-deck cargo spaces as long as the loadline was appropriately determined. In most countries that signed the Oslo agreement, it even became possible for open/closed shelter-deckers

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[20]Gross tonnages normally declined by one to five percent because the Oslo rule made it possible to exempt more spaces, such as stores and toilets, located in superstructures. Net tonnages, however, did not necessarily change proportionately — there were even examples of these increasing.

[21]Yrjö Kaukiainen, *Navigare necesse* (Jyväskylä, 1992), 241-242; Klüver, "Von der Commerzlast," 36-39.

[22]Klüver, "Von der Commerzlast," 38. On the other hand, according to the Oslo rule, deductions below the thirteen-percent level were proportional, while according to the Board of Trade rule, there was a sudden drop at that point.

[23]*Ibid.*, 39-40.

to choose between their alternative tonnages without being surveyed. They could have a special low-tonnage loadline placed below the proper full-cargo plimsolls so that the tonnage according to which they were sailing could be determined simply by flotation. This rule made such craft rather privileged; accordingly they were called "free-deckers."[24]

Yet the development of shelter-deckers – and freedeckers, in particular – was universally regarded as so important a loophole that a totally new measurement system was necessary. A new international agreement in 1969 did away with the large free under-deck spaces by including all covered compartments in gross volume and excluding only spaces in the immediate vicinity of openings in the weather deck or the ship's sides. Moreover, nrt was to be computed by directly measuring the volume of cargo holds instead of subtracting non-cargo spaces, a change that abolished excessive machine room deductions.[25]

Because the agreement was ratified slowly it did not become effective until July 1982 and applied only to new vessels until July 1994. Shipbuilders and owners thus had plenty of time to adapt. But in the interim the container revolution gained momentum and transformed not only the loading but also the stowage of goods. Since containers are weather-proof and can be piled on top of each other, shelter-decks lost most of their allure. Indeed, loading is easier if the upper cargo deck is uncovered. This was not fully understood when the new rule was drafted, and open decks were therefore not included in either nrt or grt, even when such a deck had high railings or bulwarks. Moreover, the formula to compute net volume includes a coefficient that reduces the resulting figure for ships with high freeboards and low drafts (and dwt) – that is, volume ships like container carriers and "ro-ro" vessels. Accordingly, such vessel types are as good at minimizing duties as open shelter-deckers. The race between rules and their evasion is still in progress.

National Rules and Tonnages

The short review above should suffice to show that the Moorsom ton was not a simple and straightforward unit of measurement. As far as cross-

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[24]*Ibid.*, 39-41; *Navigator*, No. 3-4 (1967), 14-15. In the case of discontinuous decks, the new rule made it possible to exempt some spaces above the projected deck level. This possibility was soon exploited to reduce measured tonnage.

[25]Klüver, "Von der Commerzlast," 45-47.

national differences are concerned, it is obvious that they were the principal source of problems before the mid-1890s. It should also be recalled that during the transition to register tons, old measurements were valid for some time or were converted by fixed-rate multipliers.[26] In reality, no single fomula worked satisfactorily for both sail and steam.[27]

After the change to the register ton, many national statistics only provided nrt, although this was not always clearly specified (it is thus especially important to read the fine print). This was not very satisfactory since nrt, measured according to different rules, varied more than grt. Before 1882, there was no net ton at all in the US, and between 1882 and 1895 the typical American propulsion deduction was twenty percent compared with the thirty-two percent allowed under the Board of Trade rule.[28] This meant that US steamers normally measured about a fifth more net than similar-sized British vessels, and ships measured according to the German rule might rate even higher.

Variations in the rules concerning shelter-deck exemptions – or the absence of such allowances – produced differences as large or larger. Although most nations followed the British practice, some minor technical definitions were still crucial. The 1920 Finnish measurement rule, for example, required slightly larger tonnage openings than the British, with the result that the tonnages of some second-hand vessels with minimum openings were substantially inflated when remeasured in Finland. Pressure from shipowners forced the Finnish Board of Navigation to revise the rules in 1933 and 1934.[29]

Because of the problems with net tons, many statistics gradually began to record both grt and nrt. While this made figures more comparable, two significant problems remained: variatons in the exemption for

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[26]This is also what has been happening since 1982, when the 1969 convention became effective. Until 1994, old and new measurements were used in parallel, which means that shipping statistics have mixed two different conceptions of tonnage.

[27]See, for example, Yrjö Kaukiainen, *Sailing into Twilight. Finnish Shipping in an Age of Transport Revolution, 1860-1914* (Jyväskylä, 1991), 38-39. The official conversion rate was 1 *läst* = 1.85 net tons, which conformed well for sailing vessels that were remeasured. For steamships, however, the actual ratio was close to 1 to 2.8.

[28]Lyman, "Register Tonnage," II, 323-324.

[29]Kaukiainen, *Navigare necesse*, 131-132.

shelter-deck spaces and the American exclusion of deckhouses. The change in conventions also created difficulties in analysing long-term trends in the ratio of sail to steam tonnages. Since nrt averaged close to ninety percent of grt in sail but only fifty-five or sixty percent in steam, the alternative measurements produced very different ratios.[30]

It is not easy to make an overall assessment of cross-national differences or, later, between Oslo-rule fleets and others, since this would require a fairly large number of cases of the same ship (or extremely similar vessels) being measured in different countries.[31] While examples certainly can be found in the Lloyd's and Veritas' registers, a proper study would need the archives of various national measurement authorities. The material in the appendices is not ideal in this regard since it is drawn solely from Finnish measurement certificates or certificates approved by Finnish authorities.

The Importance of Technical Loopholes in National Measurements: Some Empirical Evidence

The widespread adoption of the Oslo rule in the 1950s narrowed considerably the national variations in ship measurement. But not all the old shortcomings were eliminated. Indeed, technical developments placed new strains on a rule which dated from the days of the hegemony of sail. New generations of naval architects and marine engineers not only produced new vessel types, more efficient machinery and better cargo-handling systems but also devised configurations aimed solely at reducing register tonnages. While national differences narrowed over time, this was offset to a certain extent by the latter phenomenon.

Whether the various loopholes in the Board of Trade and Oslo rules were of real importance can be tested by comparing register tonnages with other gauges of vessel size (see appendices 1-3). The Finnish empirical data provide examples of "typical" ships from different periods for which evidence on register and dwt, as well as the actual volume of cargo space, were available. Although the total number of

[30] In Finland, for example, steam comprised only about a quarter of total net tonnage in 1913. According to estimated gross tonnages the ratio would have been close to half.

[31] An illustration of the problem concerns the title of "biggest ship in the world," which sometimes depended on where the contenders were measured. Lyman, "Register Tonnage," II, 324-325.

examples may seem low, the variety of different types as well as the chronolgical span is wide enough to see the consistency in tonnages produced by the Moorsom system. In principle, by comparing grt with dwt tons we can see whether exemptions from the former affected its use as a gauge of a ship's size, while the ratio of nrt to grt gives some idea of the value of the different deductions. Finally, by comparing nrt with the actual volume of cargo holds (expressed here for convenience in terms of 100 cubic feet, that is register tons) and dwt, it is possible to see how much official "paying" tonnages deviated from actual capacity. Such ratios were computed for all ships presented in the appendices and the results for the largest (and most heterogenous) group, dry cargo vessels, are also presented in figures 1-3.

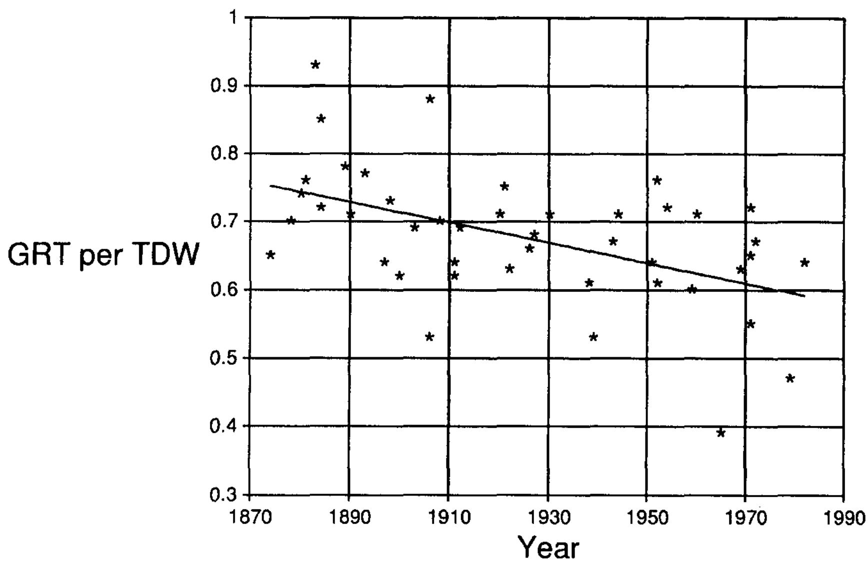
If register tonnages were able to present the carrying capacities of different vessels reasonably well, some consistency should be expected between them and the alternative gauges of capacity. The first glance at figures 1 and 3 shows such large variances (and low values for r squared) that this obviously was not the case. With all the reservations that can be made against the representativeness of the sample in question, it is obvious that register tonnages and the alternative gauges present quite different pictures of the carrying capacities of ships. Of course, this was a heterogenous group, the statistical representativity of which may be open to debate. In the late nineteenth century, grt/dwt ratios differed substantially between single-, spar- and awning-decked ships. Moreover, these variations seem to have increased over time, which of course is an indication of the gradual specialization of vessels. But if different ships' gross tonnages – only for vessels from roughly the same period – varied between forty and seventy-five percent of corresponding tdw, or if net tonnages varied between twenty and 110 percent of the actual volume of cargo spaces, it seems clear that one or the other – or maybe both – of the gauges are directly misleading. In light of what has been presented before, the obvious scapegoat is the register ton.

The figures also depict the chronolgical trends of these ratios. In all the figures there was a clear sinking trend: compared with the respective indicators of real carrying capacity, grt shrunk by a fifth and nrt by more than a third.[32] Equally pronounced was the increasing disparity between net and gross tonnages, which in many cases was a

[32] A roughly similar decline was also found when nrt was compared with dwt.

"second power" result from exemptions when computing grt.[33] While these overall trends do not necessarily concern all types of ships, it is instructive to note the even steeper decline in the minimum values for different periods. This phenomenon seems to indicate that loopholes were exploited increasingly successfully.

Figure 1
The Ratio of Gross Register Tonnage to Deadweight Tonnage in a Sample of Dry Cargo Ships, c. 1870-1980



Note: $R = -0.498$; $R^2 = 0.248$.

Source: See text.

The trends, however, were related to a substantial increase in ship size. The mean size of the ten earliest vessels in figures 1-3 was 1211 grt (1604 dwt), while the last ten (excluding *Oihonna*, which was measured to the new rule) averaged 7390 grt (11,002 dwt); the corresponding grt/dwt ratios were 0.75 and 0.67. Yet there was no linear correlation between the measures. Dwt depends on the position of

[33]It is clear that if a substantial part of underdeck spaces could be excempted, even a moderate machine room (and other spaces eligible for propelling-power deduction) amounted to over thirteen percent of grt minus living quarters.

loadlines (normally the so-called "summer" line) or minimum safe freeboards. About 1900 prevailing opinion among naval architects was that the height of the freeboard (or the amount of reserve buoyancy) was crucial to performance in riding the waves. The longer the ship the more buoyancy was needed at each end; a large ship's freeboard thus was proportionately greater than that of a small one.[34] Since early freeboard tables were computed using this theory, small vessels could be loaded deeper and gained better dwt than large ones. It seems that among ships from the same period there was no systematic connection between size and grt/dwt ratio.[35] But the 1966 international loadline agreement significantly reduced the minimum freeboards of large ships; since big ships could then be loaded deeper, the grt/dwt ratio must have decreased.[36]

The fact that even the nrt/grt ratio diminished is, on the other hand, contrary to technical logic. Not only did the actual space required by machinery decrease but the rise in ship size normally meant that a smaller percentage had to be devoted to such compartments. The excessive propulsion deductions often led to configurations that were irrational technically. While there has been a contrary trend as far as accommodation, navigation rooms and other special compartments were concerned, these have seldom offset the former. It is noteworthy that on simple bulk carriers, such as the well-known "Liberty" ships (see *Tranvik* in appendix 1) and tankers (see appendix 2), total deductions from grt seldom reach thirty percent.

Shelter-deckers consistently had lower than average ratios. The exemption of a substantial cargo space from grt automatically inflates the proportion of machine and other similar rooms. Most notably, of course, the ratio between nrt and actual cargo volume is decreased. One of the earliest vessels in appendix 1 to take advantage of this loophole, *Canopus* (ex-*San Mateo*, built 1911), had an nrt less than half of grt, and its cargo

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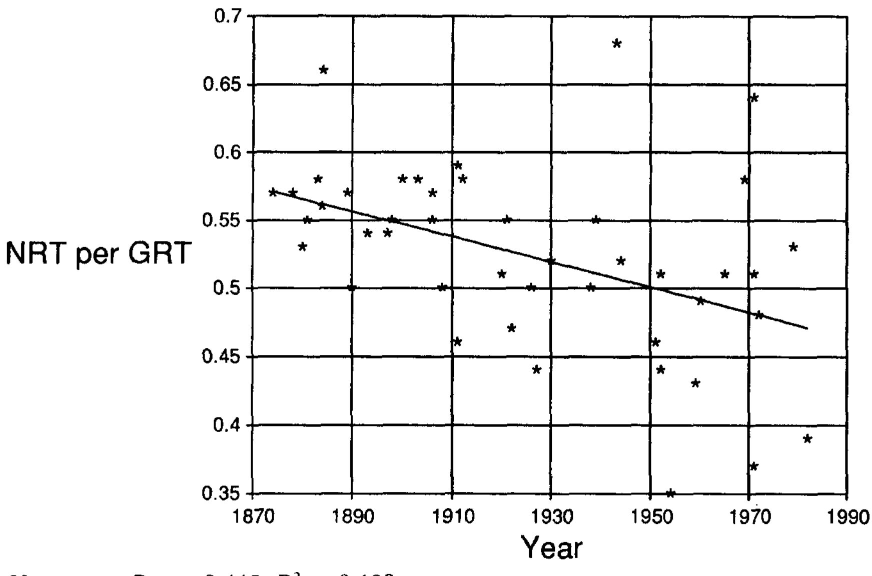
[34]Holms, *Practical Shipbuilding*, 67.

[35]In addition to the cases in appendix 1, comparisons were made among Danish steamers built between 1900 and 1913 using *Danmarks skibsliste, 1922* (Copenhagen, 1923).

[36]In Finland the agreement was published in *Suomen asetuskokoelma, sopimussarja*, 1968/52. The reduction was greatest among tankers, but all vessels longer than about 150 metres gained, and the difference grew with length.

volume was more than twice nrt. The ratios also suggest that "free" shelter-deck space amounted to about forty percent of all cargo spaces. These ratios were already quite close to the optimum that could be achieved in this configuration: the figures for shelter-deckers in the 1920s, 1930s and even 1950s were basically similar (see, for example, *Orion*, built 1951). It was only on later permanently-closed shelter-deckers that more extreme proportions became possible. *Capella* (1965), while larger than most late nineteenth-century cargo carriers of 700-800 nrt, measured only 255 nrt when open, a mere fifth of its dwt and less than a quarter of actual cargo hold volume. No less than seventy percent of total cargo space was classified as "open." The corollary, of course, was that *Capella*'s "closed" tonnages were relatively high.

Figure 2
The Ratio of Net to Gross Register Tonnage in a Sample of Dry Cargo Ships, c. 1870-1980

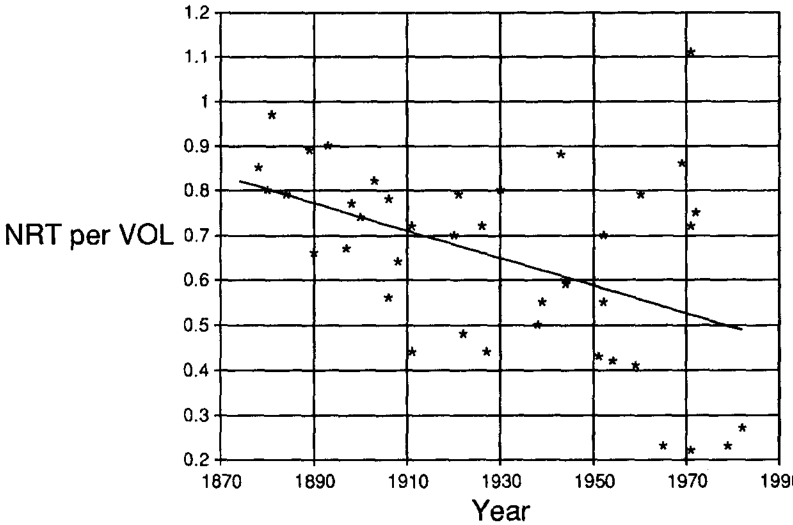


Note: $R = -0.445$; $R^2 = 0.198$.

Source: See text.

The Finnish material also shows that modern container ships and cargo ferries were equally effective at exploiting measurement rules. The "ro-ro" cargo ferry *Juno* (1971) measured as low as the *Capella*, but the larger *Arcturus* (1982) did not manage quite such impressive ratios. Yet while the latter carries containers and other cargo on three decks, its measured tonnage only comprised the lowest hold, the so-called "tank-top." It is not surprising that a sister ship, *Oihonna* (1984), measured according to the new rule (but still excluding the open top deck), had a net volume twice as high – yet this is just half the total volume of its cargo spaces. Indeed, both are able to stow as much cargo as late nineteenth-century 10,000-nrt single-deckers.

Figure 3
The Ratio of Net Register Tonnage to the Volume of Cargo Spaces (in 100 cu.ft.) in a Sample of Dry Cargo Ships, c. 1870-1980



Note: R = - 0.458; R^2 = 0.210.

Source: See text.

The existence of vessels with such extreme ratios did not, however, depend only on loopholes. The huge cargo spaces of modern cargo ferries are useless for anything other than relatively light cargo.[37] While bulk carriers, both old and new, normally had fifty cubic feet of cargo hold per dwt, the corresponding figure for ro-ro and comparable

[37]Many have been designed always to carry some empty containers.

vessels is more than twice that. Still, it is remarkable that a rule based on measuring volumes was unable accurately to measure volume ships.

The most extreme type of volume ship is the passenger vessel. Although such craft long combined passenger compartments with cargo holds – as do modern passenger/car ferries – their grt/dwt ratios were high. Each vessel presented in appendix 3 had a ratio of at least one to one, and on more recent passenger ships with little or no cargo space it approaches ten to one (*Ilmatar*, built 1964). Although modern car ferries need more weight-carrying capacity, the grt/dwt ratios remain high.

Since ordinary passenger vessels – for obvious reasons – were unable to take substantial advantage of shelter-deck exemptions, and since deckhouses were not exempt outside America, their gross tonnages give a fairly good idea of total hull volume. On the other hand, the proportion of deductions gradually increased until the car ferry era. This may have resulted from the increase of catering personnel and their accommodation, but other service and technical spaces (their deductions were often negotiated with the measurers) also increased. Moreover, since their large kitchens, if located above the main deck, were exempt, a significant amount of "free" tonnage was produced. The most important loophole, however, was that the Oslo rules, as amended in 1965, permitted the exemption of car-decks on passenger/car ferries, which involved volumes comparable to the classical open shelter-deck spaces.[38] Unfortunately, it is difficult to determine any systematic trends because the alternative gauges applied to cargo vessels have no real meaning for passenger ships. As well, such parameters as the number of passengers or cabins are difficult to convert to tons or cubic feet.

Loopholes and Total Tonnages

It is quite clear – and must have been equally apparent to contemporaries – that old register tonnages often had remarkably little to do with actual carrying capacity. The Finnish examples are by no means unique; similar, or even more dramatic cases, can be found in many countries. Moreover, it was not only nrt which designers tried to manipulate: grt received equal attention. For example, a 1980 German motor coaster measured 499 grt, almost 2000 dwt and was seventy-three metres long; at the end of the nineteenth century a ship with similar grt would have

[38]This is in article 57 of the Oslo agreement, as amended in 1965.

had a dwt of 600 or less and been about twenty metres shorter. The economic importance of gross measurement increased sharply in the 1950s, when many big European ports started to charge dues on grt.[39]

But if there are numerous dramatic examples of maximizing carrying capacity while minimizing measurement, it is equally clear that some vessels have followed both the letter and spirit of the rules. Bulk carriers and tankers are prime examples. For both, cargoes are of the weight type, which requires a good dwt and leaves little scope for complicated structural manipulations. Such ships are also inexpensive. A good idea of how different various types of vessels measured can be seen by examining how the new international measurement system changed grt and nrt. According to the International Chamber of Shipping the ratios of new volumes to old tonnages were as shown in table 1.

A recent Finnish study has suggested even higher increases for ro-ro ships and passenger/car ferries.[40] This makes sense, since exemptions for cargo and car spaces above the main deck probably are most common in the Baltic. In any case, these comparisons corroborate earlier suggestions that the under-rating of cargo capacity was connected with the carriage of light cargo on regular lines. The overall effect on national tonnages is a function of the proportion of such ships in various fleets. Because this not only varied by nation but also changed over time, no universal ratios can be established. But that national statistics may have been substantially altered is shown by a Finnish example. Before 1972, shelter-deckers with variable tonnages were recorded by their open (smaller) tonnages. Thereafter, the convention was changed and they were entered using their closed (higher) tonnages. This was enough to boost *total* Finnish tonnage by nine percent.[41] I also estimated the growth ratios of Finnish steam (and motor) tonnages between 1913 and 1978. Although in 1913 the statistics contained only nrt, fairly reliable

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[39]See Klüver, "Von der Commerzlast," 44-45, and the sources mentioned in the appendices.

[40]Eeropekka Koivumäki, "Aluksen vetoisuuksien laskentaohjelman laadinta ja soveltaminen eräisiin laivatyyppeihin" (Unpublished thesis for engineer's diploma, Helsinki Polytechnical University, 1983), 39, 70. This study concluded that the greatest increases occured in the nrt of ro-ro ships (2.5-4 times old tonnages); for passenger/car ferries the factor was 1.2-1.6.

[41]Kaukiainen, *A History of Finnish Shipping*, table 48.

nrt/grt and nrt/dwt ratios were computed from a large sample, making it possible to estimate total tonnages.[42] The growth ratios were 24.6 (nrt), 23.3 (grt) and 33.3 (dwt), which shows that development looked fairly similar if measured by either nrt or grt, but that growth seems more rapid using dwt. By this method, the average size of a register ton contracted by a third in sixty-five years compared to deadweight.

Table 1
New (1969 Rule) to Old (Oslo Rule) Tonnage Ratios, Various Vessel Types

Type	*Gross*	*Net*
Tankers	0.95	1.02
Dry Bulk vessels	0.97	0.84
Single-deck General-Cargo vessels	1.15	1.02
Open Shelter-Deckers	2.47	1.43
"Ro-ro" ships	3.92	2.40
Passenger vessels	1.01	0.80
Ferries	1.60	1.26

Source: Martin Forsén, "Aluksenmittaus" (Unpublished mss., Finnish National Board of Navigation, Ship Technical Office, 1986), 27-28.

The proportion of tanker tonnage has increased substantially during the last half century – by 1978 tankers comprised half of Finnish tonnage – and dry bulk carriers followed a similar trend from the 1960s. Since these vessels have fairly true register tonnages, this has counteracted any statistical errors due to loopholes. On the other hand, the relative decrease in liner tonnage was exaggerated by its unreasonably low register tonnage, especially before 1972. Register tonnages clearly provide a rather skewed picture of fleet structure and there is no doubt that this conclusion applies as well to merchant tonnage elsewhere.

A much better picture of the long-term development of carrying capacity could be gained if gauges like dwt could be used. But there are two barriers to this. First, dwt is much more difficult to find than official register tonnage. Although owners and builders used dwt from the 1880s, such measurements were unofficial and hence cannot be found in shipping statistics but must be estimated from samples of ships for which

[42]The ratios were: grt/nrt, 1.75; dwt/nrt, 1.87.

dwt can be found. Moreover, reliable dwt requires a consistent system of measurement in which the loaded condition is determined by a more or less official loadline. Before about 1905 this was the case only for British ships and those classified by Lloyd's and a few other major registers. It was only in 1930 that the first international loadline agreement, based on the 1906 British rule, was concluded.[43] Although it did not apply to vessels in domestic coastal traffic, the availability of dwt has been much better ever since. On the other hand, the 1966 agreement, as mentioned before, reduced minimum freeboards of larger vessels and increased dwt proportionately.[44] Thus, even this unit must be used with care. The other weak point of dwt is its inability to give an accurate picture of the size of passenger vessels (and other volume ships); this is why register tons were universally used to describe such ships. It seems certain that different gauges must be used for ships carrying different types of cargo. The difficulty, of course, is making weight and volume units compatible. Moreover, in the case of shelter-deckers, container ships and similar craft the situation is even more complicated: because their nrt is far below actual carrying capacity, hold volumes must be used instead.[45]

Corrections to existing statistics are not always possible or feasible. Maritime historians often will have to live with what exists. Yet this does not imply accepting the statistics as perfect and reliable. Instead, scholars need to understand why, and to what extent, they are faulty and to take this into account in their analyses.

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[43]Kaukiainen, *Navigare necesse*, 75.

[44]For example, for a 100-metre dry-cargo vessel the agreement decreased minimum freeboard by 0.1 metres; for a 200-metre vessel, the decrease was 0.36 meters. For tankers the corresponding reductions were larger, 0.15 and 1.0 metres, respectively.

[45]One way to solve conversion problems would be to determine a ratio between nrt, actual volumes and dwt for "average" vessels and to use the alternative gauges only in cases when these normal ratios are exceeded. In the Finnish material, such ratios might be, nrt/dwt = 0.45, and volume of holds/dwt = 0.5. In other words, if a vessel's nrt multiplied by 2.2 or the volume of holds multiplied by 2.0 exceeds its dwt, the larger figure is used instead of dwt. Since the conversion must be made ship by ship, this can be tedious. An application of this system in late 1970s to Finnish tonnage indicated that the revised figures for volume ships increased total dwt by almost five percent.

Appendices

The data for appendices 1-3 were collected from the following sources:

Pietikäinen, Matti and Bengt Sjöström (eds.). *The Ships of Our First Century. The Effoa Fleet 1883-1983.* Keuruu, 1983.
Suomen kauppalaivasto – Finlands handelsflotta. Vol. XXI. Helsinki, 1940.
Vapaalahti, Hannu (ed.). *Suomen kuvitettu laivaluettelo 1991.* Tampere, 1991.
[Vidén, Henrik]. *Wasa-Nordsjö Ångbåts Ab 1873-1923.* Helsingfors, 1923.

Names of ships are those used under the Finnish flag; earlier names are in parenthesis.

LOA = overall length
B = breadth
Dr = draft to summer load line
IHP = indicated horsepower (steamers)
BHP = brake horsepower (motorships)
comp. = compound engine
tr. = triple engine
quad. = quadruple engine
msi = motorship, indicated horsepower
msb = motorship, brake horsepower
GRT = gross register ton
NRT = net register ton
DWT = tons deadweight
V = volume of holds in units of 100 cubic feet (register ton), normally grain capacity, bale capacity indicated by "b"
N/G = nrt/grt
N/V = nrt/vol. of holds
G/D = grt/dwt
N/D = nrt/dwt

Appendix 1
Particulars of Selected Dry Cargo Ships

Name and description	Built	LOA	B	Dr	IHP BHP	GRT	NRT	DWT	V	N/G	N/V	G/D	N/D
Fennia one deck	P.Glasgow 1874	50.3	7.0	..	..	366	210	560	..	0.57	.	0.65	0.38
Ellen (*Hathersage*)	W.Hartlepool 1878	81.2	10.6	5.9	770 comp?	1597	904	2270	1060	0.57	0.85	0.70	0.40
Marius (*Zorro*)	Sunderland 1880	78.4	10.8	5.7	850 comp?	1376	735	1850	920	0.53	0.80	0.74	0.40
Roine (*Ribjörn*)	Newcastle 1881	70.7	9.6	5.2	610 comp?	1085	599	1425	620	0.55	0.97	0.76	0.42
Rhea (*Isla*) one d. & spar. d.	Dundee 1883	66.4	9.1	5.0	500 comp.	1144	666	1230	..	0.58	.	0.93	0.54
Sirius one d. & awn. d.	Bremen 1884	65.3	9.0	4.7	500 comp.	1003	664	1183	..	0.66	.	0.85	0.56
Ulea (*Zilos*)	Newcastle 1884	82.0	11.1	6.0	890 .. (ss)	1711	952	2350	1200	0.56	0.79	0.72	0.41
Ceres one deck (well d.)	Newcastle 1889	66.3	9.6	5.0	700 tr.	1027	587	1324	660	0.57	0.89	0.78	0.44
Savonia (*Egholm*)	Newcastle 1890	82.4	11.4	5.8	1000 .. (ss)	1911	962	2700	1450	0.50	0.66	0.71	0.36
Jan (*Cito*)	Greenock 1893	66.8	9.7	4.8	630 .. (ss)	889	479	1150	530	0.54	0.90	0.77	0.42
Wanda (*Skander-borg*)	Helsingör 1897	88.3	12.3	5.8	1000 .. (ss)	1918	1028	2995	1530	0.54	0.67	0.64	0.34

Name and description	Built	LOA	B	Dr	IHP **BHP**	GRT	NRT	DWT	V	N/G	N/V	G/D	N/D
Pollux one d. & awn. d.	Campbeltown 1898	73.2	10.0	5.4	700 tr.	1335	734	1830	950	0.55	0.77	0.73	0.40
Dagmar one deck	Helsingör 1900	92.0	13.0	5.5	1180 .. (ss)	2153	1252	3500	1690	0.58	0.74	0.62	0.36
Hektos one d. & pt awn.	Newcastle 1903	88.5	12.2	5.8	1000 tr.	2092	1205	3048	1470	0.58	0.82	0.69	0.40
Vega two decks	Grimstad 1906	61.6	9.4	4.9	710 tr.	975	535	1105	690	0.55	0.78	0.88	0.48
Najaden (*Boscia*) awn. (shelter?) d.	Helsingör 1906	89.1	12.8	6.3	1070 tr.	1989	1126	3759	2020	0.57	0.56	0.53	0.30
Leda one deck	Bergen 1908	72.7	10.7	4.9	730 tr.	1228	620	1750	970	0.50	0.64	0.70	0.35
Canopus (*San Mat-eo*), o. shelt.	Newcastle 1911	86.2	12.4	6.4	1440 tr.	1555	715	2500	1640	0.46	0.44	0.62	0.29
Equator (*Turkis-tan*), two decks	W.Hartlepool 1911	117.3	15.3	7.7	3000 tr.	4725	2766	7350	3840	0.59	0.72	0.64	0.38
Tornator (*Selan-dia*), ms, awn.d.	Copenhagen 1912	117.9	16.2	7.4	2680 **msb**	5057	2941	7385	..	0.58	.	0.69	0.40
Carelia one deck (3 isl.)	Helsinki 1920	69.0	10.6	4.9	785 tr.	1083	547	1524	780	0.51	0.70	0.71	0.36
Argo one d. & awn. d.	Rotterdam 1921	75.5	11.3	6.3	1050 tr.	1824	1007	2430	1270	0.55	0.79	0.75	0.41
Saimaa (*Trinacria*) o. shelterd.	Göteborg 1922	92.3	13.2	5.7	1720 **msb**	1997	939	3180	1960	0.47	0.48	0.63	0.30

Name and description	Built	LOA	B	Dr	IHP BHP	GRT	NRT	DWT	V	N/G	N/V	G/D	N/D
Eira	St.Nazaire 1926	85.7	12.8	6.1	1110 .. (ss)	2321	1170	3530	1630	0.50	0.72	0.66	0.33
Dagny (*Empire Consistence*)	Wesermünde 1927	89.9	12.9	5.3	2070 .. (ss)	1734	760	2555	1710	0.44	0.44	0.68	0.30
Wappu (*Gower*) one deck	Goole 1930	79.2	11.6	5.2	960 tr.	1444	758	2032	950	0.52	0.80	0.71	0.37
Aldebaran o. shelterd.	Helsinki 1938	94.5	12.5	5.9	1550 tr.	1832	915	2987	1840	0.50	0.50	0.61	0.31
Inkeri Nurminen (*Argyll*), dry cargo	Newcastle 1939	131.6	17.8	7.7	1905 tr.	4778	2642	9015	4790	0.55	0.55	0.53	0.29
Tranvik (*Joseph K. Toole*), "Liberty"	Richmond 1943	133.6	17.4	8.5	3500 ss/oil	7303	4964	10850	5620	0.68	0.88	0.67	0.46
Clio o. shelterd.	Helsinki 1944	83.6	11.9	5.4	1340 4 cyl.	1487	766	2098	1300	0.52	0.59	0.71	0.37
Orion o. shelterd.	Hardinxveld 1951	107.5	14.2	6.0	4005 **msb**	2517	1159	3934	2670	0.46	0.43	0.64	0.29
Ceres one deck	Hardinxveld 1952	75.9	11.3	4.9	1100 **msb**	1347	599	1763	850	0.44	0.70	0.76	0.34
Finnsailor dry cargo	Hardinxveld 1952	126.1	16.6	7.1	5600 **msb**	4048	2066	6604	3790	0.51	0.55	0.61	0.31
Rhea o. shelterd.	Hardinxveld 1954	96.0	13.3	5.7	2430 quad	2198	762	3058	1800	0.35	0.42	0.72	0.25
Pollux (*Fruen*) o/c. shelterd.	Nijmegen 1959	78.7	12.5	5.1 6.1	1700 **msb**	1326 1999	568 1189	2210 3058	1400	0.43 0.59	0.41 0.85	0.60 0.65	0.26 0.39

Name and description	Built	LOA	B	Dr	IHP BHP	GRT	NRT	DWT	V	N/G	N/V	G/D	N/D
Capella o/c. shelterd.	Turku 1965	75.3	11.7	4.1 5.4	2130 **msb**	498 1716	255 1189	1280 2288	1100 b	0.51 0.69	0.23 1.08	0.39 0.75	0.20 0.52
Vallila (*Sugar Carrier*) blk, one d.	Aberdeen 1960	131.5	17.7	7.8	6300 **msb**	6166	3011	8646	3804	0.49	0.79	0.71	0.35
Tellus (*Evamo*) bulk, one deck	Emden 1969	163.5	22.9	10.0	10500 **msb**	14318	8243	22580	9618	0.58	0.86	0.63	0.37
Aurora two decks	Middlesbor. 1971	159.8	22.1	9.2	14850 **msb**	8854	4592	13537	6320	0.51	0.72	0.65	0.34
Taurus bulk, one deck	Pula 1971	179.0	26.0	11.1	23200 **msb**	20715	13187	28873	11820	0.64	1.11	0.72	0.46
Juno Ro-Ro two decks	Kristiansand 1971	118.4	16.0	6.0	9000 **msb**	2311	848	4170	3800 b	0.37	0.22	0.55	0.20
Eira bulk, one deck	Varna 1972	134.0	18.2	7.5	4900 **msb**	7201	3447	10716	4600	0.48	0.75	0.67	0.32
Kirk Challenger (*Dana Minerva*) Ro-Ro	Helsingör 1979	105.6	19.0	5.0	4460 **msb**	1599	840	3390	3602 b	0.53	0.23	0.47	0.25
Arcturus Ro-Ro two decks	Rauma 1982	154.9	25.1	8.5	17934 **msb**	8425	3314	13090	12313 b	0.39	0.27	0.64	0.25
Oihonna Ro-Ro two decks	Rauma 1984	154.9	25.1	8.5	17934 **msb**	20203	*6601	12870	12714 b	0.33	0.52	1.57	0.51

Appendix 2
Particulars of Selected Tankers

Name and description	Built	LOA	B	Dr	IHP **BHP**	GRT	NRT	DWT	V	N/G	N/V	G/D	N/D
Sigrid	Ardrossan 1928	66.1	11.2	4.5	810 msi	1224	463	1200	..	0.38	.	1.02	0.39
Josefina Thordén	Göteborg 1932	128.8	16.8	9.9	2400 msi	6549	3733	9765	..	0.57	.	0.67	0.38
Ronny (Tank Empress)	Malmö 1950	184.8	23.5	9.7	7000 msb	15751	9367	24380	12078	0.59	0.78	0.65	0.38
Wipunen	Yokohama 1955	172.7	22.8	8.7	6100 msi	12423	7165	19744	9140	0.58	0.78	0.63	0.36
Presto	Heusden 1959	170.4	21.9	9.1	7500 msb	12874	7264	20271	9272	0.56	0.78	0.64	0.36
Montana (Okeanos)	Göteborg 1959	184.6	23.5	10.2	9700 msb	15742	9436	26543	11692	0.60	0.81	0.59	0.36
Fanny	Oslo 1967	258.5	39.0	15.3	21000 msb	50895	36289	99999	40432	0.71	0.90	0.51	0.36
Bonny	Uddevalla 1969	255.3	39.0	14.4	23200 msb	49898	33853	97743	39481	0.68	0.86	0.51	0.35
Alandia Nord (Kurushima Maru)	Imabari 1973	246.0	38.3	13.3	21000 msb	40506	31437	84040	37247	0.78	0.84	0.48	0.37
Sanna (Lembulus)	Rotterdam 1974	344.3	51.9	19.9	31550 stb	129974	104772	254146	110238	0.81	0.95	0.51	0.41
Singa Star (Holy Queen)	Mihara 1975	245.4	39.0	13.6	20300 msb	44572	33237	87281	39984	0.75	0.83	0.51	0.38

Appendix 3
Particulars of Selected Passenger Vessels

Name and description	Built	LOA	B	Dr	IHP **BHP**	GRT	NRT	DWT	V	Total N Pass.	N/G	G/D	N/D
Jakobstad two decks	Stockholm 1976	52.5	7.6	..	700 comp.	604	392	592	..	..	0.65	1.02	0.66
Astraea one d. & spar d.	Newcastle 1891	70.6	9.8	5.8	1500 triple	1186	635	970	..	242	0.54	1.22	0.65
Oihonna one d. & awn. d.	Dundee 1898	64.0	9.6	5.5	1400 tr.	1072	470	366	180	96	0.44	2.93	1.28
Arcturus one d. & spar d.	Dundee 1899	89.0	11.6	6.0	3250 tr.	2067	1117	1217	570	352	0.54	1.70	0.92
Titania one d. & spar d.	Dundee 1908	100.6	13.7	..	4500 triple	3495	1997	1940	..	739	0.57	1.80	1.02
Oberon three decks	St. Nazaire 1925	92.3	13.4	6.6	4500 triple	3007	1513	1800	..	336	0.50	1.67	0.84
Ilmatar two decks	Copenhagen 1929	86.4	12.7	5.6	2300 triple	2348	1186	1450	..	150	0.51	1.62	0.82
Aallotar two decks	Helsingör 1937	90.1	13.8	5.9	3160 co/4 c	2915	1607	1345	..	181	0.55	2.17	1.19
Aallotar II two decks	Helsingör 1952	92.4	14.3	5.0	3300 quadr.	2776	1201	991	230	230	0.43	2.80	1.21
Ilmatar II three decks	Helsinki 1964	108.3	16.4	4.5	4500 **msb**	5171	2510	570	-	332	0.49	9.07	4.40

Name and description	Built	LOA	B	Dr	IHP BHP	GRT	NRT	DWT	V	Total N Pass.	N/G	G/D	N/D
Floria p&car, 3 decks	Turku 1970	101.6	18.5	5.0	8520 msb	4051	1684	1220	car deck	1000	0.42	3.32	1.38
Wellamo III p&car, 2 decks	Nantes 1975	153.0	22.0	5.8	24000 msb	12348	6198	1720	car deck	1200	0.50	7.18	3.60
Finlandia IV p&car, 3 decks	Turku 1981	166.1	28.5	6.7	31200 msb	25905	14015	3898	car deck	2000	0.54	6.65	3.59