

Tonnage Measurement

Old and New



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Managing the tonnage measurement program offers the Marine Safety Center (MSC) some unique challenges and opportunities. Tonnage measurement is the process of assigning gross and net tonnages and registered dimensions to vessels of all sizes, and its impact is far reaching. Though tonnage measurement today has much in common with what "admeasurers" have done for centuries, the "tools of the trade" and complexity of measurement rules and systems have undergone many changes, especially in the last 40 years. This article examines where we have been and where we are today with the tonnage measurement program.

Gross and net tonnages are measures of carrying capacity. The words "ton" and "tonnage" are derived

from the old English word "tun," meaning "barrel," and in the middle ages, taxes were assessed on wine barrels carried in trade between France and England. By the late 1700s, systems were in place in Europe to assign tonnages to reflect vessel carrying capacity in "tons" of roughly 100 cubic feet each (related to the size of a standardized barrel). These early systems derived tonnage using a product of the vessel's principal dimensions. The First Congress of the United States adopted a variant of the British system in use at the time and established a network of Customs surveyors and collectors to measure vessels and collect tonnage taxes.

In 1854, the British started using a more sophisticated method of determining tonnage (referred to as

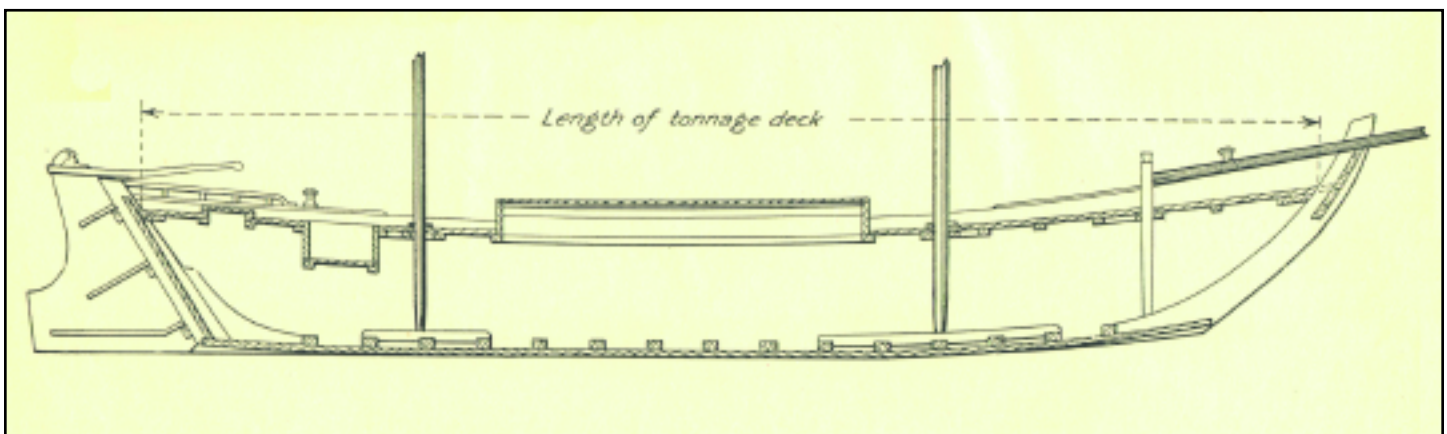


Figure from tonnage regulations of 1895 illustrating how the "tonnage length" is measured for a small sailing vessel. Establishing the tonnage length is one of the first steps in calculating the "under-deck tonnage" using the Moorsom measurement system.



Tonnage certificates issued by the MSC are needed for Suez Canal transits of warships, such as the guided missile destroyer USS Oscar Austin (DDG 79). Courtesy U.S. Navy.

self-propelled vessels of all sizes. Finally, in 1983, the United States ratified the International Tonnage Convention of 1969, which introduced an accurate and more consistent method to arrive at gross and net tonnage based on naval architectural principals. This new convention measurement system was applied to certain vessels domestically in 1986.

In addition to the many changes in the tonnage rules since 1965, there have also been major changes in the way the tonnage measurement program operates. In 1967, the 35 Customs surveyors at ports around the country were transferred to the Coast Guard when it became part of the new Department of Transportation. Twenty years later, tonnage measurement under the standard, dual and convention

the "Moorsom" system for the naval architect who devised it). This system relied on modern calculus to derive volumes based on a series of internal measurements. The United States followed suit in 1864 with its own Moorsom system. It is still in use today as an option for measurement of any U.S. flag vessel and is now known as the standard measurement system.

In former years, the tools of the trade were tape measures, specialized measuring devices and preprinted forms for recording measurements and helping with the lengthy hand calculations involved. The MSC is in possession of a set of "lift rods," formerly used to suspend a measuring tape overhead in the upper reaches of a vessel's hold. MSC files contain a number of the original calculations from the early 1900s, many done in ink with exquisite care, which serve as a testament to the craftsmanship of our predecessors in the business.

Our standard measurement continued as the only measurement system of the United States for just more than a century, although it underwent many changes (more about this later). Then, in 1965, standard measurement was joined by a new international variant on the Moorsom system (called the dual measurement system) aimed at making shelter deck vessels safer. One year later, a formula-based simplified measurement system was adopted for recreational vessels and this system was extended in 1982 to smaller commercial vessels and to non-

Tonnage Openings in Wartime

In 1941, President Roosevelt made it possible for compliance with navigation and inspection laws to be waived for war purposes.

With this authority, the sealing of tonnage openings was allowed for the duration of the war, to prevent downflooding on damaged merchant ships.

In 1965, the dual measurement system provided safer alternatives to placing unsealed tonnage openings in and below the weather decks.

120

218012

TONNAGE ADMEASUREMENT of Schooner *Rachel* of Mobile

W. H. McDaniel, Master.

District of Mobile (No 19) Port of Pascagoula, Miss. May 8, 1919

Register Length 147.6 Net Tonnage 109.7 No. of Decks 1
 Register Breadth 36.85 Net. Volume of Tonnage 10. No. of Masts 2
 Register Depth (Middy Section) 14.6 Net. Tonnage (Middy Section) 14.6 Net. Gross Tonnage 14.920
 Right and Left Side Net. No. Bottom of Tonnage Deck 4 Net. U.S. Census Internal Volume 4-973

BREATHS AND PRODUCTS EXPRESSED IN FEET AND TENTHS OF A FOOT.

SECTION I		SECTION II		SECTION III		SECTION IV		SECTION V		SECTION VI		SECTION VII		SECTION VIII		SECTION IX	
172	172	225	225	305	305	311	311	320	319	319	317	315	301	301	285	285	
171	171	263	263	307	307	314	314	320	319	319	316	314	301	301	285	285	
115	115	227	227	281	281	312	312	313	313	313	313	313	313	313	313	313	
85	85	155	155	225	225	277	277	284	284	284	284	284	284	284	284	284	
11	11	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	
1319		2066		3153		3793		3949		3908		3100		3180		1774	
177		130		12		112		112		112		112		112		112	
1389		2066		3153		3793		3949		3908		3100		3180		1774	
140576		250990		389716		515336		570163		588300		469990		479990		27776	

Handwritten note: Nothing

LONG HAND ARITHMETIC:

<p>Deck</p> <p>Deck 1</p> <p>Deck 2</p> <p>Deck 3</p> <p>Deck 4</p>	<p>Cabin Area</p> <p>Deck 1</p> <p>Deck 2</p> <p>Deck 3</p> <p>Deck 4</p>	<p>Deck Area</p> <p>Deck 1</p> <p>Deck 2</p> <p>Deck 3</p> <p>Deck 4</p>
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NET TONNAGE:

Net Tonnage Deck 1: 83.77

Net Tonnage Deck 2: 11.68

Net Tonnage Deck 3: 11.57

Net Tonnage Deck 4: 12.75

Net Tonnage Deck 5: 7.00

Net Tonnage Deck 6: 2.78

Net Tonnage Deck 7: 7.10

TOTAL NET TONNAGE: 138.65

NET VOLUME:

Net Volume Deck 1: 10.97

Net Volume Deck 2: 1.00

Net Volume Deck 3: 1.00

Net Volume Deck 4: 1.00

Net Volume Deck 5: 1.00

Net Volume Deck 6: 1.00

Net Volume Deck 7: 1.00

TOTAL NET VOLUME: 14.97

REGISTER TONNAGE:

Register Tonnage Deck 1: 147.6

Register Tonnage Deck 2: 36.85

Register Tonnage Deck 3: 14.6

Register Tonnage Deck 4: 14.6

Register Tonnage Deck 5: 14.6

Register Tonnage Deck 6: 14.6

Register Tonnage Deck 7: 14.6

TOTAL REGISTER TONNAGE: 251.16

NET TONNAGE CERTIFICATE:

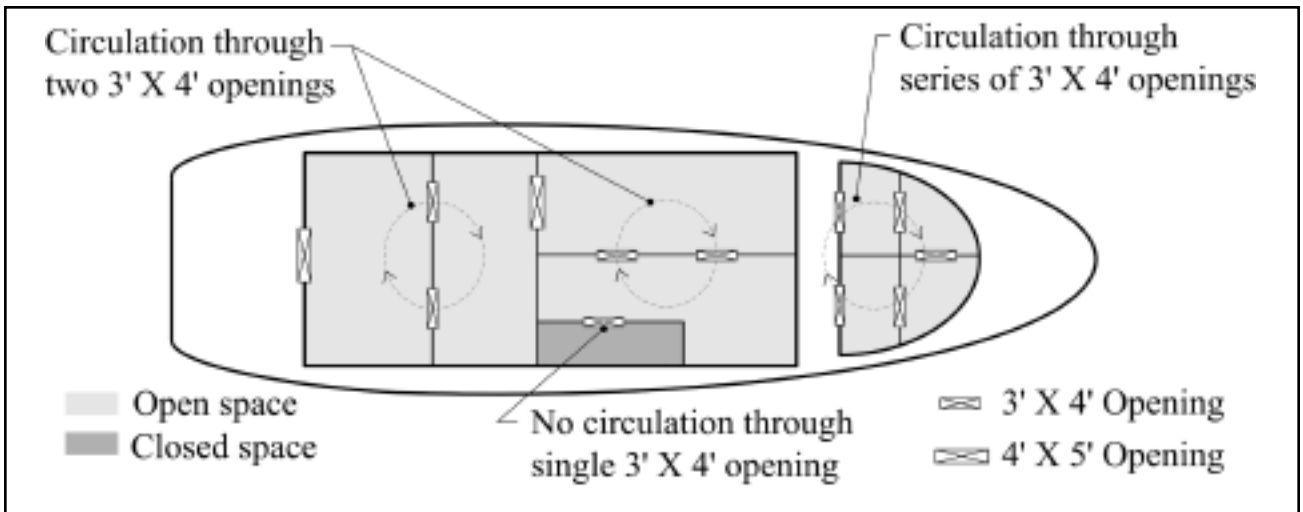
W. H. McDaniel
 Register Tonnage 138.65
 Net Tonnage 138.65
 Net Volume 14.97

Excerpted portion of a 1924 tonnage calculation sheet for the schooner *Rachel* (O/N 218012) from MSC files. Note the “long hand” arithmetic needed before the advent of mechanical and electronic computational tools.

systems was turned over to authorized classification societies for all vessels except warships and Coast Guard cutters, with Coast Guard Headquarters maintaining responsibility for overall management of the tonnage measurement program. In 1995, this function was transferred to the MSC. Since then, MSC has increasingly engaged in partnership and oversight activities with the classification societies, of which five now measure vessels on behalf of the United States.

The world of tonnage measurement has become decidedly more complex. MSC is grateful for the arsenal of modern tools at its disposal to improve efficiency, reduce error rates and focus resources on broader program issues. For example, MSC uses

computer models and other electronic tools (some developed in-house) to establish tonnages under all the measurement systems. MSC maintains a number of different databases, including one for policy, which contains over 4,000 records that span 150 years of tonnage measurement decision making. MSC utilizes modern desktop publishing tools to produce and update a variety of graphics-intensive documents available on its Web site, most notably MSC Technical Note (MTN) 01-99, Tonnage Technical Policy. A Web-based tool MSC created allows members of the public to calculate tonnages of vessels measured under the simplified measurement system. MSC easily communicates through the Internet with Coast Guard field personnel, Customs and Border Patrol inspectors and its coun-



An illustration taken from MTN 01-99 depicting the circulation of open space within a superstructure. A change notification subscription service for this MTN is available through the MSC's Web site: www.uscg.mil/hq/msc.

terparts in foreign governments around the world. In these respects, what MSC does today is very different from what its predecessors did in 1789.

But with these advancements have come challenges. One of the biggest is sorting out when tonnages assigned under the various measurement systems can be used. For example, U.S. law and international treaties provide for certain vessels to be regulated according to their tonnages assigned under the older measurement systems in some cases, but not in others. MSC produced Navigation and Vessel Inspection Circular (NVIC) 11-93 that addresses this matter for U.S. flag vessels and is working to expand and improve guidance of this nature. With more than 1,000 requirements under U.S. law and international conventions that are based on tonnage, the task is sometimes daunting.

Another major challenge is in applying 19th century measurement systems to 21st century vessel designs. Many of the tonnage rules have been altered over the years to favor certain industry segments or achieve other objectives that are not related to determining a vessel's size (like providing better living conditions through crew space deductions). The result is that modern day "admeasurers" must apply tonnage measurement rules that are far more complex than in former times.

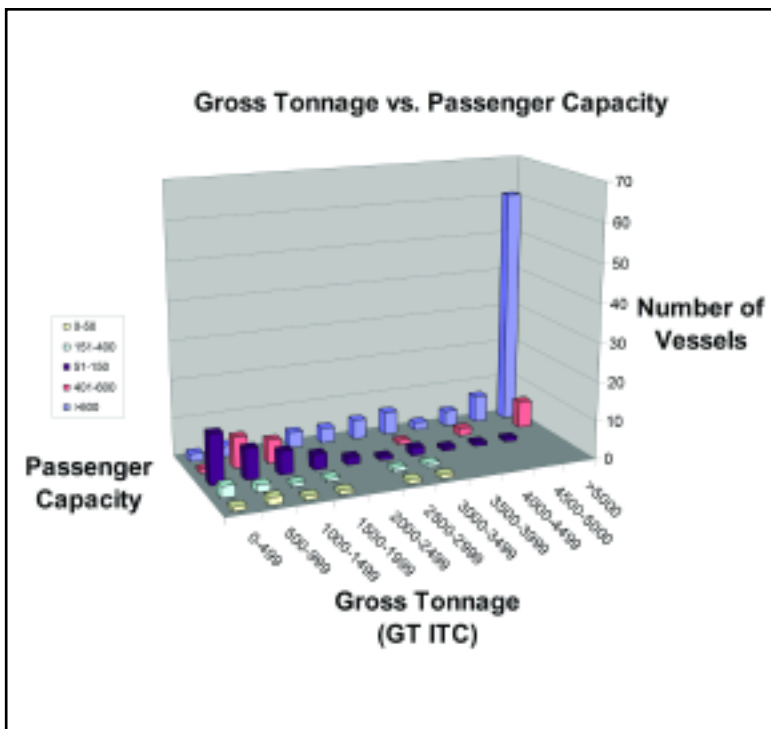
Gross and Net Tonnage
vs.
Weight

Gross and net tonnages are volume measures and were formerly expressed exclusively in units of "tons" of 100 cubic feet each.

Gross ton = measure of overall size

Net ton = measure of carrying capacity

Displacement ton = measure of weight, not volume



In addition to measuring vessels, the MSC performs data analysis to support regulation projects involving tonnage. The graph above is for Subchapter H passenger vessels.

And yet some aspects of the business would be quite recognizable to our predecessors of centuries ago. Perhaps the single greatest constant in the history of tonnage measurement has been the resourcefulness of vessel owners and designers in using tonnage measurement systems to their advantage. To illustrate:

- In the medieval wine trade between France and England, royal agents assessed taxes on wine by physically appropriating barrels of wine ("tuns") from the cargo and reimbursing the owners for less than the market value. The number of tuns collected depended on the number of tuns carried. When taxes were assessed based on every 10 tuns or 20 tuns carried, vessels came to be correspondingly sized to minimize the amount of taxes paid.
- The Moorsom systems came about in response to the manipulation of vessel dimensions to "beat" the formulas previously in effect. Under these formulas, tonnage was calculated using a product of the hull length and the square of its breadth

(breadth divided by two was substituted for the depth because of the difficulty of measuring depth in laden vessels). This led to long, narrow and deep vessels that were subject to capsizing. In fact, the long, over-hanging bows of some clipper ship designs has been attributed to "cheating" the length measurement in this formula.

- Since most tonnage measurement systems account in some way for the total volume of all enclosed spaces, there is great incentive to design vessels with semi-enclosed spaces that can be considered "open to the weather," and therefore not in tonnage. A ruling by the British House of Lords in 1875 on large openings in a spar deck has led to today's practice under the standard measurement system of using "tonnage openings" covered by non-sealing plates to exempt space as open space.
- The passenger space exemption of the measurement system was introduced in 1865 to minimize the economic impact of the transition to the new Moorsom system from



Naval architect Frank Perrini of the MSC's Tonnage Division uses a computer model for volume measurements.





The cruise ship *Sovereign of the Seas* measures 73,192 gross tonnage, but displaces only 34,300 long tons in a fully loaded condition. Courtesy Royal Caribbean International.

the old formula method. The formula ignored volumes of structures on or above the main deck. Since steamboats of the era had large superstructures consisting of passenger space elevated above an open main-deck area, their tonnages went up drastically under the Moorsom system. In response to industry complaints, Congress allowed the exemption from tonnage of all such passenger spaces elevated above the main-deck. This has led to no end of creative methods to qualify additional passenger spaces for exemption by inserting false decks or lowering the main or "uppermost complete" deck to allow for more passenger space decks.

For better or for worse, the time-honored tradition of designing vessels to meet certain tonnage objectives continues. A large part of our business still

involves wrestling with the specifics of how tonnage measurement rules are applied to vessels that may not quite look like what the designers of the rules had in mind. It would have been difficult for anyone in George Moorsom's time to have imagined modern cruise ships or offshore supply vessels, let alone wing-in-ground craft that resemble airplanes more than boats.

Tonnage measurement at the MSC represents the continuation of a very important governmental function and a long and proud tradition. It involves a unique blend of "old" and "new" and has as much relevance today as it did in the early days of our nation. Challenges abound, and at times appear overwhelming, but they certainly keep the job interesting. To learn about the tonnage measurement program, please feel free to contact MSC at (202) 366-6502 or visit the Tonnage Page of its Web site at www.uscg.mil/hq/msc.