OECD Directorate for
Science, Technology and Industry (STI)

COUNCIL WORKING PARTY ON SHIPBUILDING

COMPENSATED GROSS TON (CGT) SYSTEM

Contact:

Mr. Danny Scorpecci, Structural Policy Division, Directorate for Science, Technology and Industry, OECD
Tel: +33 1 45 24 94 33 - Fax: +33 1 44 30 62 57 - E- mail: danny.scorpecci@oecd.org

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT 2007

A NEW COMPENSATED GROSS TON (CGT) SYSTEM - 2007

BACKGROUND

1. The compensated gross tons (cgt) concept was first devised by shipbuilder associations, and adopted by the OECD Council Working Party on Shipbuilding (WP6), in the 1970s to provide a more accurate measure of shipyard activity than could be achieved by the usual gross ton (gt) and deadweight ton (dwt) measures.

2. The concept underwent a number of revisions, with the present system introduced in 1984 and most recently updated in 1994. Since that time the shipbuilder associations have undertaken a major overhaul of the concept, in order to improve accuracy and to better reflect changes in both shipbuilding designs and working methods in shipyards.

3. The new cgt system described in this document was jointly developed by the Community of European Shipyards Associations (CESA), the Shipbuilders' Association of Japan (SAJ) and the Korean Shipbuilders Association (KSA), who together represent around 75% of world shipbuilding output. The cgt system is widely used in the shipbuilding industry, and there has been an expectation for some time that a revision of the existing system would be undertaken.

4. As in the past, this new cgt system has been adopted and promulgated by the OECD Council Working Party on Shipbuilding in order to give the system a solid basis for its continued widespread use within the industry. The Working Party decided that the new system would come into force on 1 January 2007.

5. This document is a user guide for practitioners, and provides detailed information on the concepts behind the new cgt system as well as the formula (instead of the coefficients that were used in the old system) used to convert the gross ton (gt) measurement of vessels to the compensated gross ton (cgt) equivalent.

THE NEW CGT SYSTEM

As well as giving the details of the new system, this document also reflects ideas, concepts and some facts for those interested in a more fundamental explanation of the cgt system.

The purpose of the cgt system

6. The question of establishing a consistent unit of measurement for new building production by shipyards was considered at meetings in 1966 and 1967 between the Community of European Shipyards Associations - CESA (at that time named the Association of West European Shipbuilders - AWES) and the Shipbuilders' Association of Japan - the SAJ. A joint system for calculating compensated gross tonnage (cgt) was introduced by the associations in 1968, and this was subsequently adopted and promulgated by the OECD.

7. Since then, a number of revisions have been undertaken. These have taken into account the development of shipbuilding technology and new ship types, but the scope and definition of compensated tonnage has been unchanged, that is:

"Compensated gross tonnage, (cgt), is a unit of measurement intended to provide a common yardstick to reflect the relative output of merchant shipbuilding activity in large aggregates such as "World", "Regions" or "Groups of many yards".

8. The cgt-system is a statistical tool developed in order to enable a more accurate macro-economic evaluation of shipbuilding workload than is possible on a pure deadweight tons (dwt) or gross tons (gt) basis.

9. Statistical information on new ships completed is available on a country or global basis in gross tons, as well as partly in deadweight tons. Figures in gross tons are available for all ship types, but not the number of man-hours, the use of materials and the amount of yard-hardware used in their production. Resources used to build one gross ton differ widely with the size and type of ship. By multiplying figures in gross tons with cgt coefficients, which reflect the work content of each type and size of ship, it is possible to convert the ever changing product mix into cgt figures, which reflect with some accuracy worldwide shipbuilding activity.

10. However, the system has some limitations, as the macro-economic focus of the system has meant that certain simplifications have been necessary, and if applied for micro-economic evaluations the compensated tons system might give misleading results.

Introduction

11. The system of conversion coefficients for calculating compensated gross tons that is being replaced by the new system was elaborated by CESA and the SAJ during 1982/83, and implemented by the OECD in 1984. It has since been recognised as superior to gross tons as a tool for measuring workload and output of shipyards.

12. At that time it was also anticipated that the development of new ship types, and of new shipbuilding technology, would from time to time create the need for revision of the system. Such a revision became necessary following developments in shipbuilding during the 1980s, and in 1993 CESA and SAJ revised the system through a series of partial and intermediate revisions of selected cgt coefficients. These were agreed to and promulgated by the OECD in 1994.

13. Further work has since been undertaken to further improve and simplify the cgt system, while at the same time seeking to maintain continuity by preserving the macro-economic scope of the system.

14. The Korean Shipbuilders Association - the KSA, took part in this additional work.

Difficulties in the evaluation of cgt factors

15. At a first glance, the calculation of cgt factors seems to be a simple task: for each ship type, and ship size, collect information on the workload necessary to build a single gross ton, relate these data to a basic ship type, and the results will be the cgt factor.

16. However, when it comes to details, practically no shipyard builds a ship in the same way as its competitors. One of the major differences is the production depth *i.e.* the amount of parts and blocks produced in the shipyard, relative to the amount which is subcontracted to outside suppliers.

17. The traditional style of construction is where yards build ships by buying in only raw materials, and handcrafting even the nails for wooden constructions within the yard, whereas modern yards may base their production to a large extent on assembling large sections of steel blocks produced by external suppliers. In some cases even whole hulls may be outsourced. As a consequence, the man-hours used within each yard will differ widely in these cases.

18. Similarly the degree of rationalisation and the range of shipbuilding equipment, such as cranes and machine tools, will vary considerably and these will also influence the man-hours necessary for the building of a specific ship.

19. For ships of the same size and type, differences in hull-form, maximum speed and the means of propulsion, the equipment and quality level, will all result in differences of workload for the building of a single gross ton.

20. Keeping in mind that the purpose of the cgt factors is to allow the drawing of certain conclusions at the macro-economic level, the associations decided to restrict the number of ship types and conversion factors to a manageable number, and to accept that although this will produce results which are sufficiently accurate for the purpose for which they are intended, they will not be perfect.

21. It should also be kept in mind that most data sources used for cgt calculations contain only part of the detailed information which may be needed for more detailed evaluations.

22. One way to overcome the problems resulting from the difference in production depth is to define a certain production depth as an average, and then based on this starting point to calculate the cgt factors as workload (expressed in man-hours) per gross ton.

23. A different methodology was used in the calculation of the original cgt coefficients. There, a certain type of vessel was defined as the base and given a compensation factor of 1. The relative workload per gt for other types of vessels and sizes, in proportion to that basic ship, was then used to calculate index figures.

24. It may be assumed in all cases that the production depth of a certain yard is more or less independent of the type and size of ships which are produced.

25. It has been demonstrated on a trial basis that the existing cgt coefficients enable the drawing of certain conclusions on man-hours for individual yards or groups of yards with similar production depth. Based on cgt calculations, a relationship has been found between man-hours and cgt produced for the specific yard in question. This proves the value of the present system.

26. However, it has also been shown that one of the main problems in drawing these conclusions is the format in which the factors are available. Due to several difficulties at the time of the development of the present cgt coefficients, it was only possible to present them in a simple table split into types of ships, with the effect of size of the vessel being accounted for by step calculations, which yielded the different cgt coefficients. These steps took into account the prevailing vessel sizes at the time, and relevant cgt coefficients were established for the typical size of ship in each group**.**

27. An inevitable consequence of the step function approach was that for ships with a tonnage near the size boundaries - particularly for smaller ships - this produced some inaccuracies. For example, the calculated cgt of a passenger vessel with a planned size of 9 950 gt, delivered with a tonnage of 10 050 gt, would be reduced from 29 850 cgt to 20 100 cgt due to this relatively small increase in gross tonnage.

28. Furthermore, the use of cgt coefficients for the comparison of production efficiency expressed in cgt output per year and number of employees for different shipyards (a measure often found even in serious publications), is misleading as long as the production depth of the yards being compared is not taken into account. A yard or a group of yards with low production depth would wrongly appear to have a high efficiency compared to a yard with higher production depth, if the comparison only takes into account the cgt delivered in a year divided by the number of direct employees of those yards.

29. It seemed appropriate that a revision should take into account not only the influences of new technology, *e.g.* double-hulls or other ecologically friendly design features or the shift to different LNG tank-constructions, but also introduce a curve based system in place of the existing one based on step functions. Introducing a curve based system would not only improve accuracy, but would also reduce the need for regular reviews in order to compensate for the effect of changes in the size of typical ships in the different ship type groups.

30. The new curve based system that has been adopted also uses gross tonnes (gt) as the basis for all cgt calculations, rather than the former grouping of vessels according to their dwt measurement. This is because in many cases dwt figures are not exactly comparable, as the announced figures may be based on different conditions, like summer or winter draft or scantling or design draft, all matters which are not easy to check. In addition, in the case of some vessels (such as passenger ships and other non-cargo carrying vessels) dwt measurements are not available, a fact which created some problems with the existing system.

31. Therefore, the associations decided that the base for the new cgt system should be gross tons (gt), which are available for all ship types. It is acknowledged that some exemptions still apply to the calculation of gt for some ships in national and coastal waters, but these will not greatly affect the revised cgt system.

32. Another weak point in the present cgt system is the definition of ship types. For example, many of today's general cargo vessels are far removed from the old liner or even the Liberty type that replaced them, and are now more similar to bulk carriers. Again, many so-called product tankers may have more similarity with a simple tanker than with a chemical tanker, with which they are grouped in the existing system.

33. A careful review of ship type classification was therefore undertaken, in order to minimise these difficulties in the proposed revision.

The new system

34. Two main changes have been made compared to the existing method:

- Instead of a table of cgt coefficients, depending on type and dwt size of the ships, the new calculation is based on a formula.
- Instead of dwt as the base for the choice of the coefficients, the whole system is now based on gt.

35. The new formula is:

$$cgt = A * gt^{B}$$

where A represent mainly the influence of ship type, and B is the influence of ship size and gt is the gross tonnage of the vessel.[1] A brief User Guide is given in the Annex to this document.

36. The A and B factors are shown in the table below.

Ship type	A	B
Oil tankers (double hull)	**48**	**0.57**
Chemical tankers	**84**	**0.55**
Bulk carriers	**29**	**0.61**
Combined carriers	**33**	**0.62**
General cargo ships	**27**	**0.64**
Reefers	**27**	**0.68**
Full container	**19**	**0.68**
Ro ro vessels	**32**	**0.63**
Car carriers	**15**	**0.70**
LPG carriers	**62**	**0.57**
LNG carriers	**32**	**0.68**
Ferries	**20**	**0.71**
Passenger ships	**49**	**0.67**
Fishing vessels	**24**	**0.71**
NCCV	**46**	**0.62**

37. Besides the change from a matrix system to a formula based system, it has to be mentioned that in the new system product tankers are now grouped together with oil tankers, whereas in the old system they were grouped with chemical tankers.

38. As well, in developing the proposed new cgt system, an effort has been made to maintain a certain level of statistical continuity between the two systems.

Number of ship types

39. The creation of the new cgt system also offered the opportunity of revising the specification of ship types, and the possible introduction of new categories. For example, it might have been feasible to classify LNG-tankers according to the type of tanks carried (membrane or spherical) or to include new categories of non-cargo carrying ships, where there were big cgt differences between the many sub-types included in that group. However, the lack of a sufficiently large quantity of data to create a solid base made it impossible for such an evaluation to be carried out, so even though new ship types could have been introduced the approach taken by the Associations was to avoid tampering with the list as much as possible, in order to keep the system simple.

[1] B is itself defined as B=b+1 where the letter little "b" represents the diminishing influence of ship size on the work input required to build a single gross ton; this factor having been derived from a substantial sampling of shipyard outputs.

40. The proposed revised system is based on the ship type-classification which was developed by Lloyd's at the beginning of the 1990s. The release by Lloyd's Register – Fairplay of a revised vessel type coding system[2] in mid-2006 did not materially affect the revised cgt system.

Series effects

41. Yard data has been collected as a base for the recalculation of cgt. In this connection, some yards reported information which allows the evaluation of the series effect (or learning curve) on man-hours used for specific ship designs built in series. As can be seen from Figure 1, this effect strongly reduces the number of man-hours involved in the building of those ships. In the definition of the cgt factor it has been assumed that the factor reflects the workload for the first ship in a series, without any adjustment for subsequent increases in efficiency as workers become more familiar with their tasks.

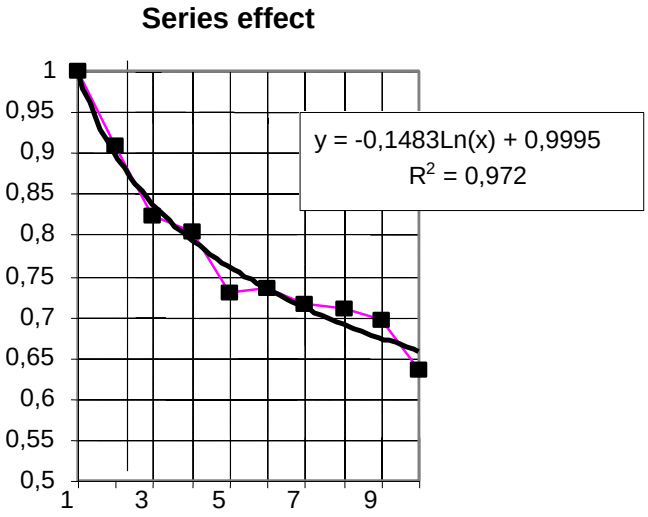

Fig. 1: Reduction of workload (series effect) from the first to the 10th ship.

42. A similar effect, though of a smaller degree, may also be present if a shipyard is building a certain type of ship with only limited size variations, as the workers then become more familiar with many of the details.

43. The series-effect should be taken into account when evaluating shipyard capacity, otherwise the conclusion could be drawn that a yard building a long series of a particular ship type has increased physical capacity, whereas in fact the man-hours used were constant, but were used more efficiently.

Critical review of some results

44. The following critical comments on the results reached are offered as remarks to explain the possibilities and limitations of the macro-economic cgt system.

---

[2] Lloyd's Register – Fairplay, Statcode 5 – New Improved Vessel Type Coding System.

45. The group of full-container-vessels is used as the example, as this ship type created serious problems when information was being evaluated to derive the cgt factors. Similar, but smaller problems can be found in several other ship types.

Full container-vessels (FCV)

46. The data samples for the group of container ships have many entries, spread well over a wide range of ship sizes. It therefore can be assumed that these data will give representative results.

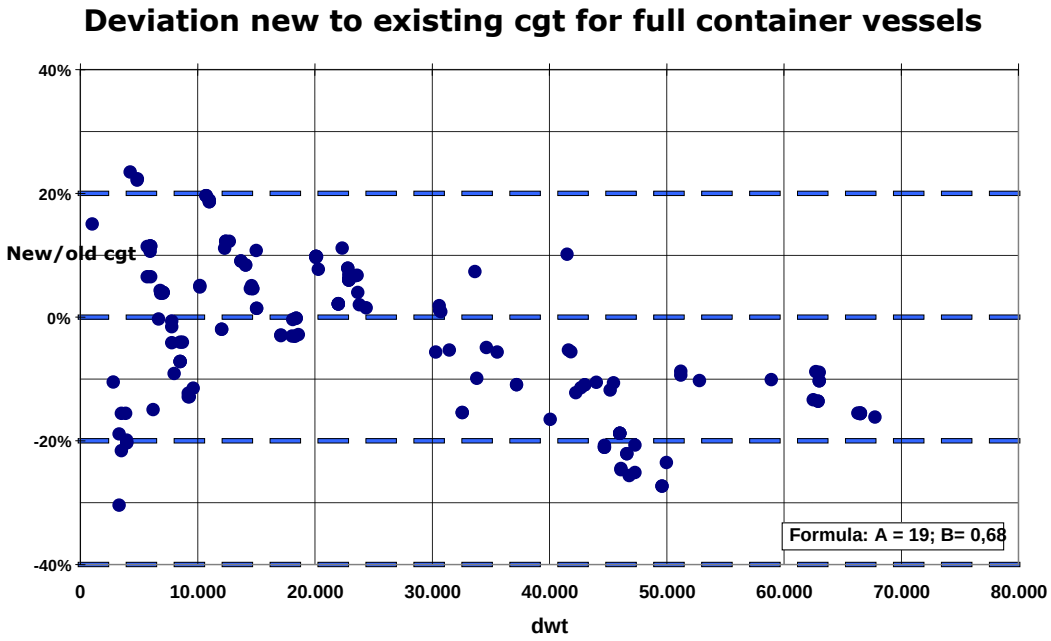

Fig. 2: Deviations between new cgt and old cgt.

47. Figure 2 (above) and Figure 3 (below) illustrate how a sample of (actual shipyard) data for containerships compares between the proposed and existing cgt systems.

48. Besides the size effect, a number of other factors influence the reported actual workload involved in building containerships. These include:

- Several of the large vessels are equipped with complicated cell guide systems to allow the transportation of all the existing different container sizes mixed in one guide.
- Post-panamax vessels have a larger beam, but more or less the same height as panamax vessels. The extreme beam/height values may need completely different steel structures to reach the hull's required rigidity, resulting in higher man-hour figures for their building.
- Not all containerships (especially smaller sizes) have cell-guides on the main deck or at all, which gives a difference in work content.

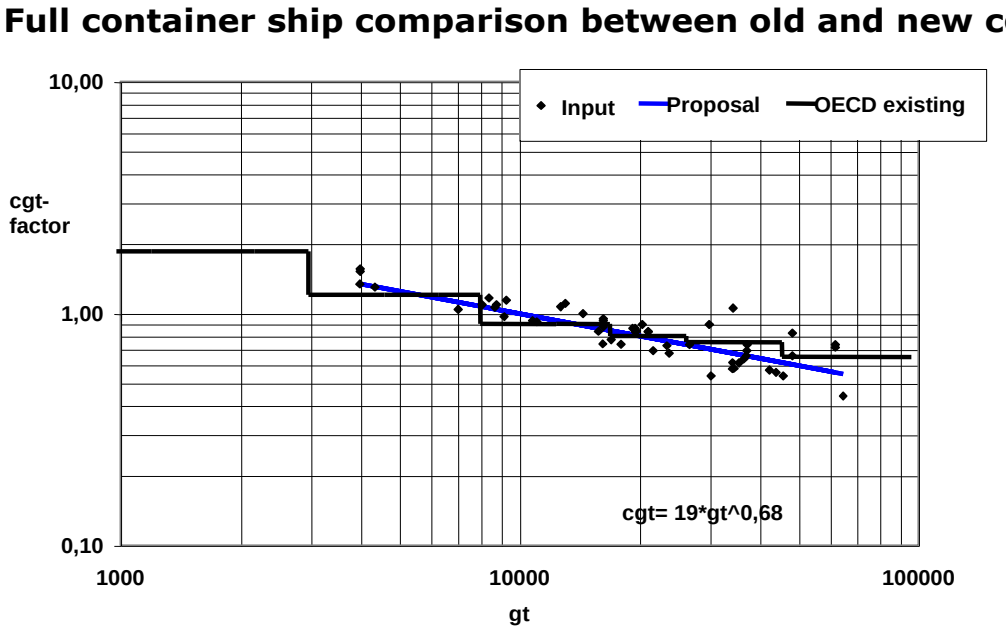

Fig. 3: Deviations between sample-cgt and formula-cgt.

49. Evaluations show that it can be expected that the proposed cgt factors give results which are roughly within +/-15% of the "correct" workload for individual ships. However, it is assumed that in calculations involving large numbers of ships the deviations which can be found for individual ships will balance each other out, and give results which can be used with relative confidence for evaluations at the macro-level.

SUMMARY

50. The OECD's Council Working Party on Shipbuilding (WP6) has accepted the proposal made by shipbuilder associations for the new, formula-based compensated gross ton system (cgt) to replace the former system based on coefficient that it endorsed in 1994.

51. Users of cgt in their statistical collections and analyses are encouraged to commence utilising the new cgt system from 1 January 2007, which has been adopted by the WP6 as the formal commencement date.

ANNEX

OECD COUNCIL WORKING PARTY ON SHIPBUILDING

COMPENSATED GROSS TON SYSTEM – REVISED 1 JANUARY 2007

USER GUIDE

i) The formula to be used in the calculation of cgt is: $\mathbf{cgt = A * gt^B}$

where: gt is the declared gross tonnage of the vessel;

A is the factor in Table 1 which represent the influence of ship type;

B is the factor in Table 1 which represents the influence of ship size.[3]

TABLE 1: A and B factors for cgt calculations

Ship type	A	B
Oil tankers (double hull)	**48**	**0.57**
Chemical tankers	**84**	**0.55**
Bulk carriers	**29**	**0.61**
Combined carriers	**33**	**0.62**
General cargo ships	**27**	**0.64**
Reefers	**27**	**0.68**
Full container	**19**	**0.68**
Ro ro vessels	**32**	**0.63**
Car carriers	**15**	**0.70**
LPG carriers	**62**	**0.57**
LNG carriers	**32**	**0.68**
Ferries	**20**	**0.71**
Passenger ships	**49**	**0.67**
Fishing vessels	**24**	**0.71**
NCCV	**46**	**0.62**

Calculation of cgt using Microsoft Excel

Microsoft Excel users can calculate cgt with a formula based on the following format:

=A*(gt^B) where the symbol ^ is the Excel function POWER.

This can also be written in Excel as:

=A*(POWER(gt,B))

As an example, a passenger vessel of 3 950 gt (thus factor A=49 and factor B=0.67) yields a result of 12 587 cgt.

[3] B is itself defined as B=b+1 where the letter "b" represents the diminishing influence of ship size on the work input required to build a single gross ton. This factor was derived from a substantial sampling of shipyard outputs.