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PREVENTION OF AIR POLLUTION FROM SHIPS

Trials using the draft Guidelines for Ship CO_2 emission indexing based on operational data

Submitted by the Republic of the Marshall Islands

SUMMARY

Executive summary:	The purpose of this document is to inform the Committee of additional trials undertaken to apply CO_2 emission indexing specifically to container ships to both provide further input on CO_2 index levels for this class of ship and to evaluate the practicality and accuracy of different approaches to "cargo mass"
Strategic direction:	SD 7; Indicators 9(b) and (c)
High-level action:	7.1.2
Planned output:	7.1.2.7
Action to be taken:	Paragraph 10
Related documents:	MEPC/Circ.471; MEPC 56/WP.6 and MEPC 56/23

Introduction

1 During the discussions at MEPC 56 within the Working Group on Air Pollution from Ships, it was pointed out that there are large differences in CO_2 index assigned for a container ship on a voyage with fully laden containers and on a voyage carrying empty containers. There was also discussion on the appropriateness of the use of TEUs as a measure of cargo mass for container ships. Accordingly, Marshall Islands indicated that data was being collected for further evaluation of these issues and the relationship between numbers of full and empty containers and actual deadweight of ships and cargoes. This submission provides the results of that data collection and conclusions and observations based on those results. Previous, Marshall Islands' CO_2 indexing trials were performed using data for Suezmax and Aframax crude oil tankers and LNG tankers.

Data collection

2 The data collection included historical and real-time operational data collected from seven container ships of varying TEU capacity, spanning a period of about four to nine months, depending on the vessel. The data involved a variety of voyages and voyage legs ranging in time from hours to 33 days involving both short-sea and trans-ocean voyages with a wide variety of loading conditions. Figure1 provides some basic characteristics of the ships involved along with the average CO_2 index of all voyages and voyage legs. Ships A and B and ships C, D and E are two groups of sister vessels.

Ship	DWT	GT	LBP m	KW ME Power	TEU	Index Ship DWT	Index Cargo DWT	Index Container
A	18445	14241	158.67	10010/18kt	1129	25.66	49.25	80.80
B	18449	14241	158.75	10010/18kt	1129	22.88	49.52	59.99
C	29210	23722	194.06	17200/21kt	1804	24.89	39.98	59.26
D	29260	23722	194	17200/21kt	1804	23.94	40.38	52.68
E	29266	23722	194	17200/21kt	1804	29.89	73.98	96.15
F	33691	25703	197.19	19810/21kt	2524	20.17	35.85	51.76
G	68383	54193	294.07	41130/24.3kt	5060	21.07	39.37	41.03

Figure 1: Ship Basic Characteristics and Average CO_2 Index Summary

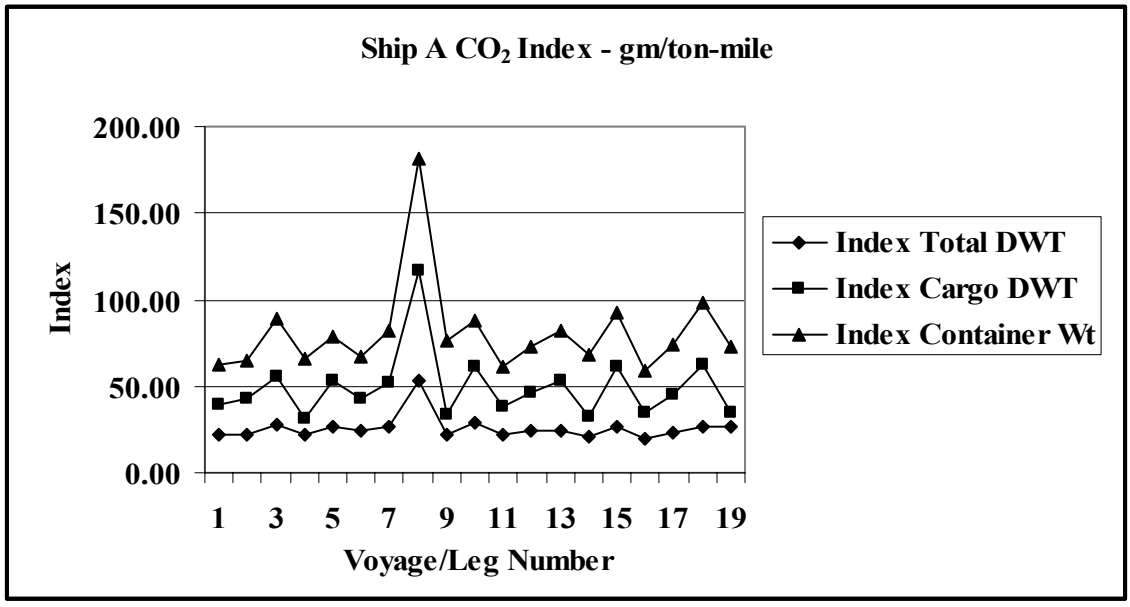
3 In addition to distance sailed, fuel data and numbers of full and empty TEUs, data concerning total ship DWT (including light ship, cargo, fuel, water, store, etc.) and cargo DWT based upon the ship's capacity plan, using draft readings at the beginning of a voyage or voyage leg, were recorded. Accordingly, three different calculations of CO_2 index were performed for each voyage and voyage leg and then averaged to obtain the data shown in the three right columns of Table 1.

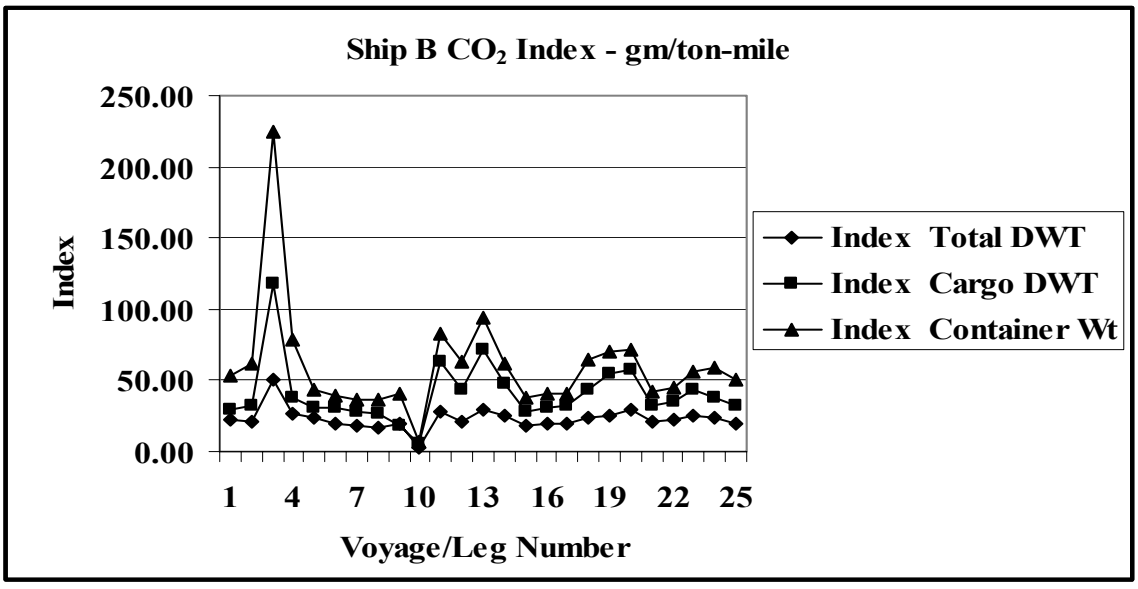
Calculation of CO_2 Index

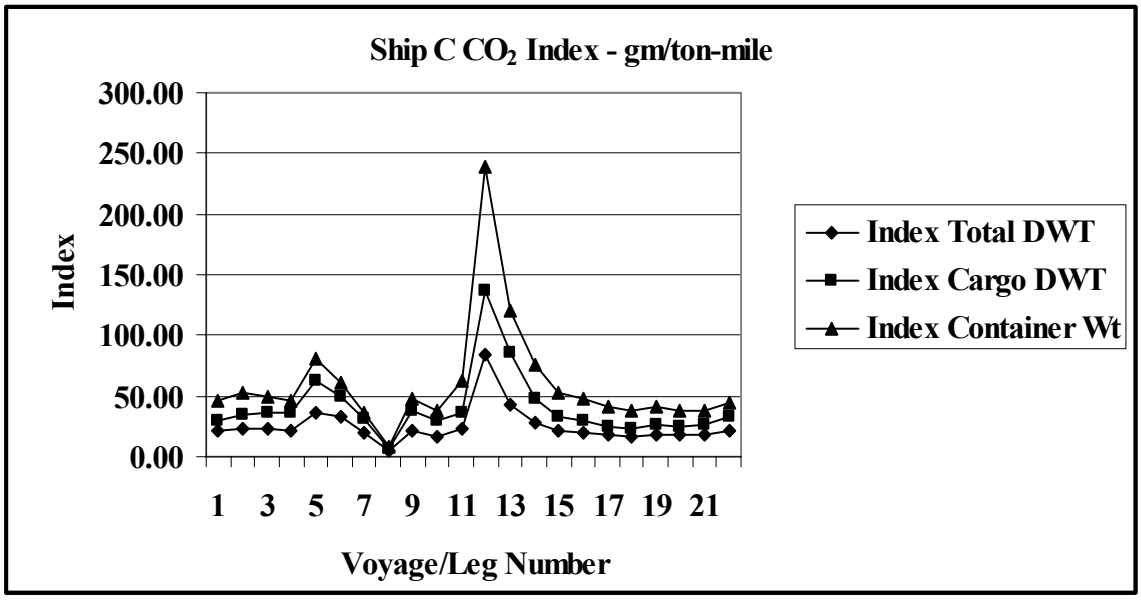
4 The CO_2 index basic calculations were made using the Interim Guidelines for Voluntary Ship CO_2 Emission Indexing for Use in Trials, MEPC/Circ.471. For the calculation, the numerator was as in the Guidelines standard formula: fuel consumption in MT multiplied by the appropriate C_{carbon}. For the denominator: distance sailed in nautical miles multiplied by cargo mass. However, three different approaches were taken for cargo mass. First using a denominator consisting of actual total ship DWT in MT multiplied by distance; second, a denominator consisting of the actual cargo DWT in MT multiplied by distance; and, third, cargo mass in MT based upon the Guideline assumption of 10MT for a full container and 2MT for an empty container, multiplied by distance. The results were then compared, observations made and conclusions drawn. The actual calculations were accomplished by inserting the raw data provided by shipowners into an Excel spreadsheet set up with appropriate formulas based upon the Guidelines. The spreadsheets are available for review by any interested party by contacting the Marshall Islands Administration.

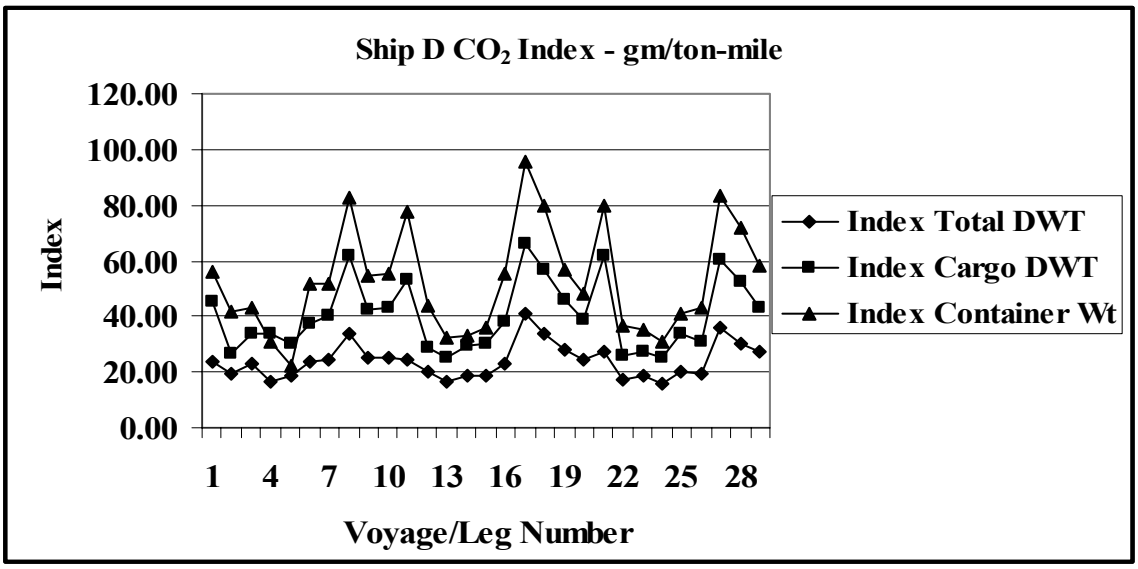
Data results

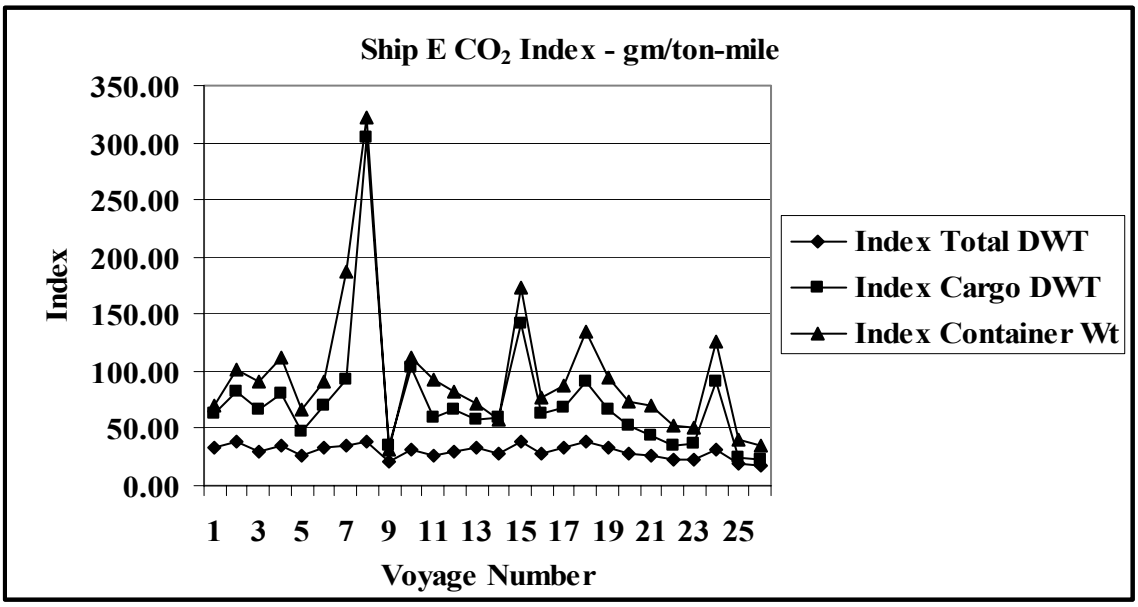
5 The following charts summarize the actual voyage or voyage leg versus calculated CO_2 index. The charts were developed from the Excel spreadsheets noted above.

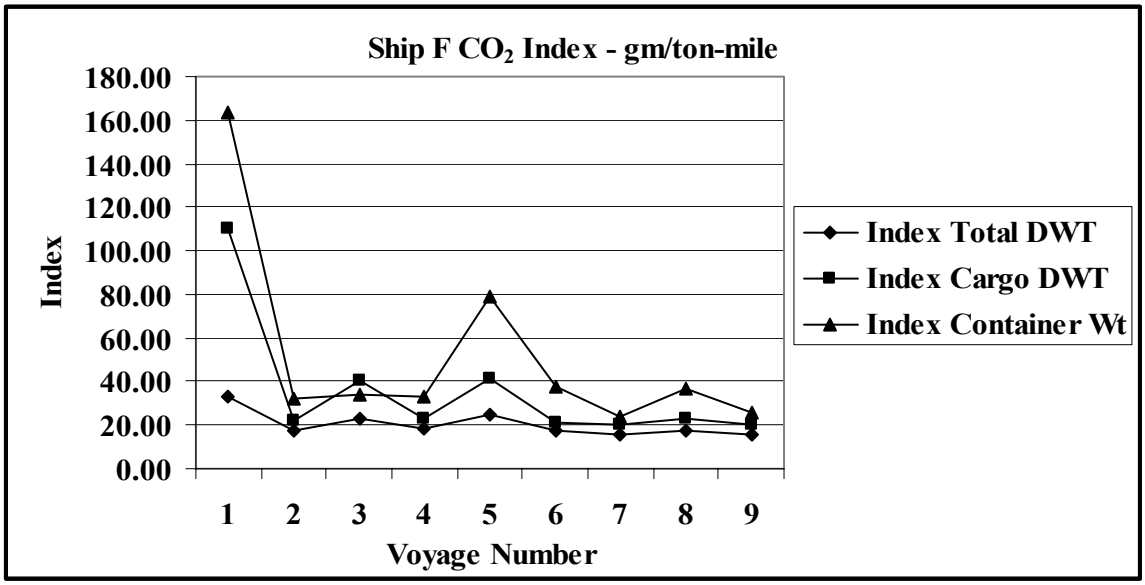


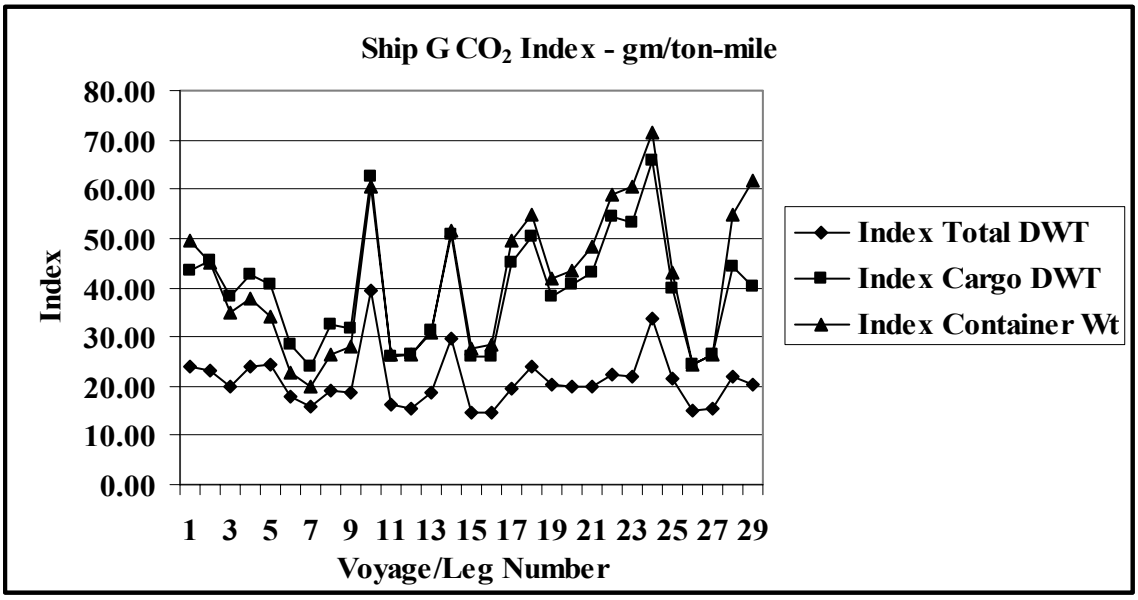



Ship C CO_2 Index - gm/ton-mile
Index
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 3 5 7 9 11 13 15 17 19 21
Voyage/Leg Number
Index Total DWT
Index Cargo DWT
Index Container Wt


Ship D CO_2 Index - gm/ton-mile
Index
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1 4 7 10 13 16 19 22 25 28
Voyage/Leg Number
Index Total DWT
Index Cargo DWT
Index Container Wt


Ship E CO_2 Index - gm/ton-mile
Index
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25
Voyage Number
Index Total DWT
Index Cargo DWT
Index Container Wt





Observations and conclusions

CO_2 Index Variation

6 Calculated CO_2 indexes varied considerably as experienced in past efforts at container ship CO_2 indexing trials. Examination of the data from these trials would indicate that this reflects the following:

.1 Cargo mass, by definition, is a critical factor and part of the index calculation. The number of full containers carried by any ship during the trial period varied considerably and never approached maximum capacity. The index calculation uses the total fuel consumed for the trial period so the fuel consumed during the voyage where less cargo was carried was apportioned to a lower tonnage of cargo mass with consequent higher resulting index. While a ship with less cargo may require less fuel, there is a point of diminishing returns as cargo is reduced;

.2 Voyage length is also a critical factor where long trans-ocean voyages with the ship operating at design speed experiencing a lower index as compared to ships on short voyages where a greater proportion of time is spent at a less efficient lower transit or manoeuvring speed;

.3 The combination of low cargo mass combined with short duration voyages is significant resulting in high index extremes; and

.4 Generally, larger ships with higher TEU/DWT capacity had a lower index, depending on voyage length and cargo loading.

Cargo Mass for Container Ships

7 With regard to the most appropriate approach to the issue of "cargo mass" to be used in trials, generally, on a voyage by voyage basis, with the exception of ship G, use of the container estimate of 10MT for full containers and 2MT for empty containers resulted in a higher calculated index than using actual cargo DWT to calculate the index. The average index for each ship was less for actual cargo DWT compared to using the TEU estimated approach and use of total DWT resulted in an even lower index. Accordingly, use of the actual cargo DWT, based on a ship's capacity plan, using draft readings at sailing, probably provides a more accurate assessment of CO_2 index. It also allows comparison to trials involving bulk carriers, tankers and general cargo ships.

Comparison to Other Vessel Classes

8 Compared to Marshall Islands past trials involving crude oil and LNG tankers, the container ship trials resulted in much more variation, index extremes and, overall, a considerably higher average index as compared to crude oil tankers. Examination of the data would indicate that this reflects the following:

.1 The crude oil and LNG tankers involved in the trials operate during cargo voyage legs at full seasonal cargo load and generally on long trans-ocean voyages. It should be noted that this is quite different than container ship operating conditions described above; and

.2 Much higher tanker DWT cargo capacity.

Vessel Class Indexing Differences

9 The wide variation observed in these trials between container ships compared with previous tanker trials support the concept that separate CO_2 index baselines must be developed for different classes of vessels. However, use of a common measure of actual cargo mass such as cargo DWT might provide a useful means of comparison between classes as previously noted.

Action requested of the Committee

10 The Committee is invited to take note of the information provided in this document and take action as appropriate.