Appendix H: Guide to Deep-Draft Vessel Operating Costs

by

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Acknowledgements

This Deep-Draft Vessel Operating Costs Guide is an important resource document for performing economic analysis of Corps of Engineers deep draft navigation projects. Ms. Lillian Almodóvar of the Institute for Water Resources (IWR) was the project manager for this effort. Mr. Kevin Knight (IWR) is the main author of this document. Mr. Ian Mathis (IWR) provided substantial input. Significant contributions to this effort were provided by Maritime Strategies Ltd, Cockett Marine while additional input was provided by experts from the U.S. Maritime Administration and the U.S. Naval Academy.

Valuable review comments were provided by Dr. David Moser (IWR), Dr. Norm Starler (IWR), Steve Cone (IWR), Erin Rooks (IWR), Lillian Almodóvar (IWR) and field economists. Thank you to all others who showed interest, offered ideas and encouraged development of this guide.

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APPENDIX H: VESSEL OPERATING COSTS GUIDE

H.1 – Introduction

Purpose of this Guide

This guide provides more details on the Deep Draft Vessel Operating Costs (DDVOCs) and explains the procedures and data sources currently used to develop them. The DDVOCs were developed for a variety of vessel types and sizes and are applied specifically to studies involving waterborne transportation cost savings. Less-frequently claimed benefits such as reduced vessel damages or foregone revenues are not covered in this guide and would require alternate sources of data. Moreover, not every type of vessel calling at U.S. ports is among those listed in the DDVOC tables, (e.g., military vessels, large ferries). In any case, the guide sheds more light on the “nuts and bolts” of costs and characteristics for the primary classes of cargo vessels calling at U.S. ports. More detailed information on transportation cost savings computations can be found in the NED Procedures Manual for Deep Draft Navigation.

Target Audience

This guide was written for Corps economists, particularly for those with considerable experience with Corps deep-draft navigation studies. Other disciplines may find some utility in this guide since it provides an overview of the DDVOCs, the various characteristics of vessels, as well as a description of the main drivers of the DDVOCs.

What are Deep-Draft Vessel Operating Costs?

Deep-draft vessel operating costs are a main component in the evaluation of economic benefits of deep-draft or coastal waterway improvement projects. From a practical standpoint, the DDVOCs are used to estimate waterborne transportation costs (as well as the reduction in transportation costs, which comprise the National Economic Development benefits) for a wide variety of vessels in the world fleet[1]. The DDVOCs are published in the form of datasheets and provide useful information on vessel specifications such as length, beam and draft requirements. The DDVOCs are developed at the national level to ensure consistency across projects and to ease the burden on districts in compiling their transportation costs. Deep-draft navigation studies require a tremendous amount of empirical data, which often need to be validated by secondary data sources, surveys and/or expert elicitation. Providing DDVOCs that are

[1] Chapter 11 of the National Economic Development (NED) Manual contains detailed procedures on applying the waterborne transportation costs to Deep Draft Navigation studies.

readily available to the districts helps reduce the burden on Corps economists to not only develop these costs but also to defend them, thus providing standards for all deep-draft navigation studies.

Since the 1960's, the DDVOC datasheets have been compiled and published by the Institute for Water Resources (IWR) of the U.S. Army Corps of Engineers (USACE) in accordance with economic analysis procedures stated in current Corps guidance. The Director of the Corps' Planning and Policy Division distributes vessel operating cost estimates and supporting documentation to Division/District planning and operations personnel. IWR developed the methodology for compiling the items in the datasheets and continually updates it as new information becomes available and as guidance is revised.

A snapshot of a DDVOC datasheet for a U.S. flag foreign-service containership is shown in Figure 1. The vessels are arranged by sizes (deadweight tonnage or DWT) specified by the Corps. The headings across the top denote the vessel type and size ranges whereas the entries along the side contain the various data components. The characteristics (dimensions, horsepower, crew requirements) for each vessel are shown in **red font**. Fixed or quasi/fixed cost data (which will be explained later) appear in **green font**. Variable operating costs are shown in **blue font** and other voyage cost data, such as fuel costs as well as the average combined costs, are shown separately, in **black font at the bottom of the datasheets**.

USACE Aggregate Vessel Operating Costs (VOCs)
Deep-Draft Self-Propelled Carriers
Fully Cellular Containerships (Open Registry Flag)

Confidential Commercial DDVOC Information, Do Not Disclose

Generated:	**2008**
Price Level:	**CY 2008**
Currency:	**U.S. Dollars**

General Vessel Specifications		
General Vessel Type	**Grd FCC**	**Grd FCC**
Deadweight Tonnage (DWT; Metric Tonnes)	**9,500**	**15,000**
Light Displacement Tonnage (LDT; Metric Tonnes)		
Displacement (Metric Tonnes)		
TEU Capacity; Nominal		
TEU Capacity; Homogeneous		
Volumetric Capacity (Cubic Meters)		
Grain Cubic		
Bale Cubic		
Liquid Cubic		
Average Vessel Age (Years)		
Average Functional Service Life (Years)		
Length Overall (LOA; Feet)		
Length Between Perpendiculars (LBP; Feet)		
Extreme Breadth or Beam (XB; Feet)		
Summer Loadline Draft (Feet)		
Immersion Rate (Metric Tonnes Per Inch or TPI)		
Horsepower (Total)		
Service Speed (Knots)		
Manning or Crew		
Bunkerage Consumption (Metric Tonnes/Day)		
At-Sea		
Propulsion\Prime Mover(s)		
Service Speed		
Economic Speed		
Half-Power		
Base Idle		
Auxiliary Power Generation (for Specified Propulsion Speed\Power)		
Full Service Load		
Applied Average Load At-Sea; Service Speed		
Applied Average Load At-Sea; Economic Speed		
Half-Power		
Base Idle		
In-Port		
Propulsion\Prime Mover(s)		
Within-Harbor\Channel Transit		
Maneuvering		
Base Idle		
Auxiliary Power Generation		
Full Service Load		
Within-Harbor\Channel Transit		
Maneuvering		
At the Dock; Static Condition		

Figure H-1: General Vessel Specifications Portion of DDVOC Table

Annual Discount\Interest Rate (%)
CRF (for specified rate & period)

Hull Asset Capital Costs (Fixed Capital Asset)
Replacement Cost(s) [1.]
Scrap Value; Baseline
Scrap Value; Adjusted (Discount of Future Value)
Replacement Costs Adjusted for Scrap
Average Annual Capital Asset Cost (Adjusted for Scrap)

Figure H-2: Hull Asset Capital Costs Portion of DDVOC Table

Operating Costs (Quasi Fixed\Variable Costs)
Crew Cost
Lubes & Stores
Maintenance & Repair
Insurance
Administration
Average Annual Operating Costs

Figure H-3: Variable Costs Portion of DDVOC Table

Intensity of Employment

Applied Allowances for Temporary Withdrawals from Service (Days) [2.]
Applied Average Operating Days per Year:
Applied Operational Hours Per Day

Average Daily Total Capital & Operating Costs (Excluding Bunkerage)

Average Daily Bunkerage Costs (Variable)

At-Sea

Propulsion\Prime Mover(s) (PPMV)
- Service Speed
- Economic Speed
- Half-Power
- Base Idle

Auxiliary Power Generation (APG)
- Service Speed
- Economic Speed
- Half-Power
- Base Idle

In-Port

Propulsion\Prime Mover(s) (PPMV)
- Within-Harbor\Channel Transit
- Maneuvering
- Base Idle

Auxiliary Power Generation (APG)
- Within-Harbor\Channel Transit
- Maneuvering
- At the Dock; Static Condition

Average Daily Total Vessel Costs; Inclusive

At-Sea

Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
- Service Speed
- Economic Speed
- Half-Power
- Base Idle

In-Port

Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
- Within-Harbor\Channel Transit
- Maneuvering
- Base Idle
- Dockside\Static Condition

Average Hourly Total Vessel Costs; Inclusive

At-Sea

Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)

Service Speed

Economic Speed

Half-Power

Base Idle

In-Port

Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)

Within-Harbor\Channel Transit

Maneuvering

Base Idle

Dockside\Static Condition

Applied Bunkerage Cost(s) & Scrap\Breakage Value (Per Metric Tonne)

HVO Price (Heavy Vicosity Oil)

IFO Price (Intermediate Fuel Oil)

MDO Price (Marine Diesel Oil;)

MGO Price (Marine Gasoline Oil)

Scrap Price (Per Light Displacement Tonne)

Note(s) ***[1.] Excludes cost of containers for containerized cargo carriers (where applicable).***

[2.] Annual average number of days for drydocking or repairs and involuntary lay-up.

Figure H-4: Variable Costs (w/ Bunkerage) Portion of DDVOC Table

Vessel operating costs can be applied in a number of ways. They are most commonly used to calculate the voyage costs for a selected fleet of vessels. A simple example which appears in the NED Manual for Deep-Draft Navigation applies a 2004 version of a DDVOC datasheet for a 50,000 deadweight ton general cargo vessel (Figure 5):

> *…Assuming that a one-way voyage from Asia to the U.S. West Coast is 6,000 nautical miles, the 50,000-DWT vessel would need 428 hours of sailing time given its service speed of 14 knots. The vessel would also incur costs of approximately $599 per hour at sea and $399 per hour at port. Based on the hourly costs and time at sea, its total sea cost is $256,000. Assuming this particular vessel remains in port for 48 hours as it unloads and reloads cargo, its port costs would then be $19,000. Due to channel constraints, the vessel can only load 25,000 tons presently. The total origin to destination cost is the sum of the at sea and in port costs…*

Foreign Flag General Cargo Vessel (U.S. 2004 Price Levels)

Deadweight Tonnage (DWT)	35,000	50,000	80,000
Replacement Cost (s)	$17,272,000	$19,662,000	$25,046,000
⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮ ⋮
Hourly Total Costs			
Hourly Total Costs, at Sea	$539.00	$599.00	$705.00
Hourly Total Costs, at Port	$359.00	$399.00	$466.00
⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮ ⋮

Length at sea: 6,000 nautical miles/14 knots per hour = 428 hours

Costs at sea: ($599/hr at sea) x (428 hrs at sea) = $256,372
Costs at port: ($399/hr at port) x (48 hours at port) = $19,152
Total origin to destination costs = $256,372 + $19,152 = $275,524
Unit costs without a project = ($275,524/25,000 tons) = $11.02/ton

Unit costs with a project = A lower cost per ton made possible via a switch to larger vessels or more fully-loaded vessels (NED benefits)

Figure H-5: Example of DDVOC Application

By providing hourly sea costs, port costs, vessel speed and other factors in the DDVOC tables, the voyage costs can be estimated. A vessel's immersion rate which is provided in the DDVOC tables could be used to calculate the additional cargo that can be accommodated with a particular project improvement.

More advanced transportation cost computations could involve segregating portions of the voyage to account for slower speeds, queuing delays (base idle, half power, and the like) as well as adjustments in types of fuel carried, etc. Finally, many of the vessel dimensions and characteristics that appear in the DDVOC datasheets are routinely used to create "prototype vessels" in waterborne transportation cost models.

H.2 – Guidance on Vessel Operating Costs

The Principles & Guidelines (P &G) and the Corps Planning Guidance Notebook (ER 1105-2-100) explain the procedures for evaluating the benefits of solutions to many types of water resource problems including deep-draft navigation improvements. The detailed procedures appear in Section VII of the P & G and page E-47, paragraph (b) Vessel Operating Costs of ER1105-2-100, which direct the Corps:

> *"To estimate transportation costs, obtain* ***deep-draft vessel operating costs for various types and classes of foreign and United States flag vessels expected to benefit from using the proposed improvement****. Since vessel operating costs are not readily available from ocean carriers or from any central source,* ***the Corps of Engineers, Water Resources Support Center, will develop and provide such costs on an annual basis for use in plan evaluation****. Planners should determine to what extent these estimates of vessel costs must be modified to meet the needs of local conditions.* ***Document and display vessel operating costs in the report.****"*

When calculating the economic benefits of a deep-draft navigation project (one in which the NED benefits of the project are expressed as reduced overall transportation costs), planners develop transportation cost savings models which can range from simple spreadsheets to complex Monte Carlo simulations. Many models employ the DDVOC datasheets as "look up tables" which populate the vessel dimensions, service speeds and costs directly into the computations.

With input from IWR, the Corps Headquarters publishes Economic Guidance Memoranda (EGM) which provide vessel operating cost data. The EGMs are generally published every two years (detailed analysis is performed once every four years with a limited update every two years). Besides costs, the DDVOC datasheets list vessel dimensions, conventional service speeds and other factors for the most common vessel types and sizes. The EGMs often contain notes describing the adjustments or changes from previous publications.

Access Restrictions

In the past, DDVOCs were shared freely throughout the Corps as well as with external users. The EGMs were distributed to District offices in the form of hard copies. By 2001, they were readily available on the Corps' website. However, given that the shipping environment is extremely competitive and since much of the cost information is proprietary (even if the costs are not actual rates charged by shippers), the Corps decided to post the costs to a restricted intranet site **that is only accessible to Corps users**. Access to the PDF file requires a password that is provided by the Corps'

Planning and Policy Division at HQUSACE, with a clear requirement that the costs are intended to be used solely for the evaluation of Corps projects.

Should a non-federal sponsor or other outside party wish to view the vessel operating cost tables, he or she would need to sign a non-disclosure agreement, which as stated under Section 4 of the Federal Freedom of Information Act, **emphasizes the sensitivity and proprietary nature of the details** comprising the DDVOCs[2]. Even within the Corps, planners are discouraged from revealing too many details on costs in their decision documents. Except in rare cases, **only the summary costs of transporting annual cargo volumes should be shown**, and never those for individual vessels. Certain parameters such as vessel dimensions or speeds may be permissible, but others such as asset management costs (administrative costs, labor, fuel, etc.) are not. Two sample non-disclosure agreement letters (one for the Federal government, the other for a non-Federal party) appear at the end of this guide.

Economic versus Financial Costs

A careful distinction must be made between the financial costs and economic costs of vessel operation. For some, generally to those outside the Corps, the rates shippers charge for moving cargo reflect resource costs and should be considered in the evaluation of navigation improvements. However, these rates are often based on what the market will bear at a given time and can be highly volatile or skewed by too much or too little competition or by other external forces. A more accurate measure is based on the fixed and operating costs derived from analysis of the shipping industry. The actual rates at a snapshot in time are often referred as financial or accounting costs whereas those derived from detailed analysis of the shipping industry are referred as economic costs. The Corps requires the use of economic costs in project evaluation.

Present Worth/Annualizing Costs

Guidance on deep draft navigation projects direct planners to present cost information in present worth terms and in the form of Average Annual Equivalent (AAEQ) estimates by using the applicable water resource discount rate, and applicable functional life cycle or economic asset life. Vessel costs contained in the DDVOCs account for the base year costs plus those of new vessels, secondhand vessels and scrapped vessels (which contain implicit salvageable values) over a 50-year period of analysis. As will be explained later, all of these factors are taken into account when deriving the total economic cost of operating a vessel.

[2] Note: Federal agencies such as FHA, DOT and NOAA have also requested Corps' vessel operating cost information for their impact studies.

Types of Vessels that Appear in the DDVOCs

The International Maritime Organization (IMO) classifies vessels by usage, size and a host of other characteristics. There are approximately 300 categories of vessels in the world fleet. Naturally, not every type of vessel is included in the dataset of vessels studied by the Corps, (e.g., military vessels). Nevertheless, the DDVOCs do capture the ***primary*** carrier types which conduct the majority of trade in U.S. deep-draft ports. These vessels include general cargo, bulk carriers, tankers, and containerships. Each of these are presented in a separate tab in the spreadsheet.

- FCC = Fully Cellular Containerships
- Tankers
- Bulk Carriers
- General Cargo Vessels

Detailed descriptions and photographs of vessel types appear in the NED for Deep-Draft Navigation Manual.

Flag or Registry (U.S. versus Foreign-Flag)

The deep-draft vessel operating costs are developed for two general classifications of flag (or registry) and four specified types of carrier. Specific to registry, the two general classifications for hull registry, or flag, for all applicable vessel or carrier types are:

- U.S. Flag
- Foreign Flag

With regard only to containerized carriers, there are additional sub-groupings within the U.S. registry. These are:

- U.S. Flag - Domestic Service
- U.S. Flag - Foreign Service

Vessels of U.S. registry must comply with maritime laws and regulations of the United States with respect to construction and ongoing operations. This tends to set them apart from the rest of the world fleet both in terms of what trade they may be engaged in and their associated costs of acquisition and ongoing operations. Consequently, the operating costs can be significantly higher than those of foreign flag or foreign service vessels.

The U.S. Flag and U.S. Flag Domestic Services generally involve the trade between U.S. domestic ports. Such trade is governed by the Cabotage laws of the United States what is commonly known as the Jones Act[3]. This act mandates that trade between U.S. ports be conducted on vessels compliant with certain requirements such as:

- Keel laid & primary superstructure/accoutrements fabricated in the United States and constructed or assembled in a shipyard of the United States
- Complement of crew, both officer and able-bodied ratings are to be of U.S. citizenry
- Ownership, depending on circumstance, either primary or entirely by U.S. interests
- Compliant with U.S. Coast-Guard regulations for construction, crewing, safety, and accounting or conduct of business

(Un) Allowable Adjustments

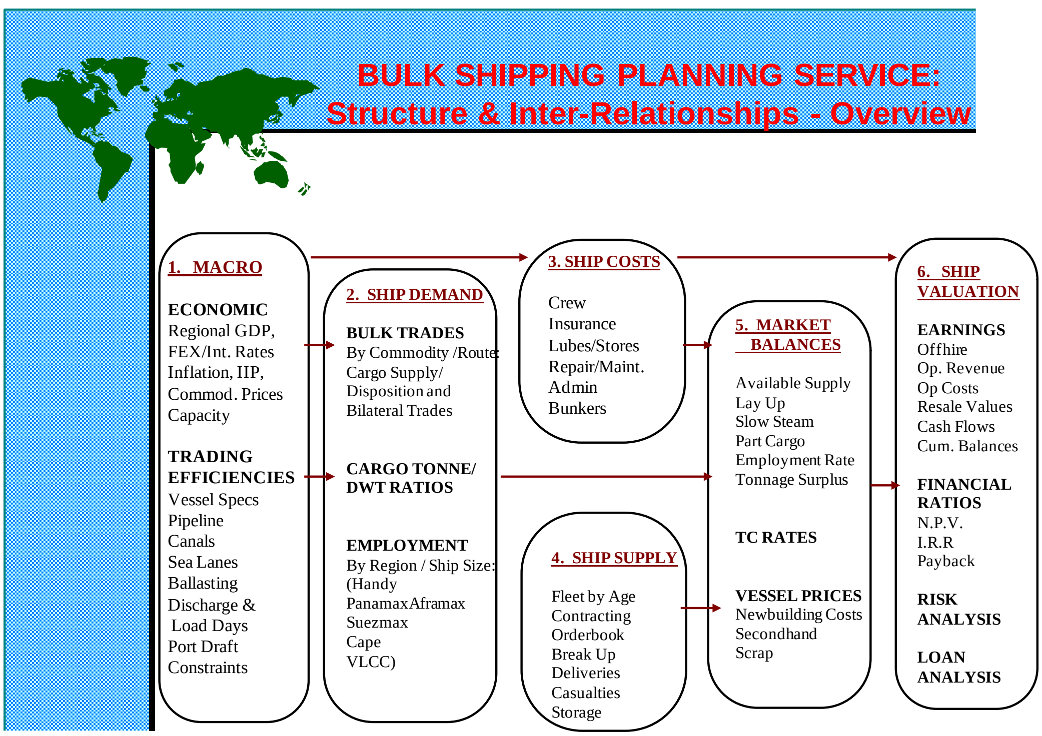
In some cases, values within the datasheets could be adjusted. For example, it could be discovered that due to recent automations, the size of the crew could be lower than the average value cited in the datasheet. In this case, it is recommended to reduce the crew costs downward by the same proportion as the reduction in crew. Administration costs could also be adjusted slightly since a portion of those costs is commensurate to the size of the crew. As will be explained later, fuel costs could also be modified if a port rotation contains few calls and when the costs are grossly different from the weighted average fuel costs provided. It is best not to adjust items that are tied to a vessel's value, however, since these costs are considered to be the most reflective and consistent with industry. Of course, any deviations from the figures provided within the tables require prior approval from HQUSACE.

[3] Very few ships are still constructed in the U.S. with the exception of Westinghouse and Bath Ironworks in Maine.

H.3 – Methodology for Development of Vessel Operating Costs

There DDVOC datasheets are comprised of three basic categories: (**1) Vessel Characteristics; (2) Vessel (Hull) Capital Costs; and (3) Vessel Operating Costs**[4]**.**

The methodology, data requirements, and classifications are first developed by the Corps' Institute for Water Resources (IWR). Following this, IWR oversees the compilation of highly confidential fiscal and business data derived from the work of a consulting firm specializing in vessel forecasting and valuation. IWR essentially leverages the results of the firm's business which involves assessing the vessel market and providing financial advice to ship owners, shipyards, brokers, investors, insurers and equipment providers. As one would expect, the consulting firm is privy to a wealth of global market data and administers a wide range of primary and secondary surveys. A summary of some of the data that the firm compiles for the bulk trade appear in Figure 6. Much of this information such as ship costs displayed in Item 3 and vessel prices displayed in Item 6 are used in developing the DDVOC datasheets[5].



Source: Maritime Strategies International

[4] In practice, the Corps uses the term, "Vessel Operating Costs" as a broader category, recognizing these costs incorporate fixed (hull) costs as well as the operating (variable) costs.
[5] Items shown in the Figure 6 include vessel specifications, ship costs, fleet by age, and vessel prices. The Ship Costs category in Circle 3 refers to the actual costs for crew and other items.

Figure H-6: Bulk Shipping Structure and Interrelationships

The firm carries out three separate strands of research (vessel characteristics, vessel (hull) capital costs and vessel operating costs), all of which influence the development of the DDVOCs. The firm compiles this data from its available primary or secondary data sources, followed by surveys and interviews with vessel operators as well as other maritime interests. Some of the specifics include literature research, published journals and verification by knowledgeable experts in the industry. IWR reviews the findings several times throughout the process to ensure quality. At times, statistical analysis is performed to establish the upper and lower statistical bounds and test statistics for costs to support sensitivity analysis.

The vessel (hull) construction costs contain more records of sales and published data whereas the operation and maintenance costs rely more on surveys and contain more sensitive data.

1. Vessel Specifications

Vessel specifications refer to the characteristics of a vessel itself (dimensions, deadweight tonnage capacity, speed, etc) and can be used in a variety of ways. The average speed of a 50,000 DWT tanker (listed in one table as 23 knots), for example, could be divided into the voyage distance to calculate its total sailing time, which then represents part of the voyage cost.

Since there are thousands of vessels in the world fleet today, with no two vessels truly alike, it is very difficult to characterize a “typical” vessel without performing detailed analysis of vessels. The firm analyzes the world fleet and performs regression analyses to calculate the characteristics of “prototypical vessels” defined in the Corps’ DDVOC tables. The regression analysis describes the relationship between the size of the vessel (DWT, TEU, etc) and its length, beam, immersion rate, horsepower, speed, and fuel consumption. Data for the vessel specification analysis is provided by Lloyd’s Register Fairplay (LRF) as well as Clarksons and Fearnleys. These databases contain the specifications for thousands of vessels above 100 Gross Tons. The specifications are gathered directly from owners, shipyards and classification societies. Figure 7 shows the number of observations by vessel type used in the vessel specification analysis for the 2010 estimate of DDVOCs. Several categories are later combined to comply with IWR’s vessel categories shown in the DDVOC tables. The 12,895 observations mark a dramatic improvement over the 35 vessel observations used in previous DDVOC tables.

Vessel Type	Total Number of Observations
Bulkers	6,250
Oil Tankers	3,059
Containerships	1,432
General Cargo Vessels	728
Gas Ships	198

Chemical Tankers	195
Reefers	457
Ro/Ro Vessels	235
Cruise Ships	311
Total	12,865

Source: Maritime Strategies International

Figure H-7: Data Observations by Vessel Type (2010)

Figure 8 provides the regression equations and relationships for many of the vessel specifications.

EQUATIONS-- NOTE: METRIC UNITS ARE USED IN ALL EQUATIONS Conversion Factors: 1m = 39.37 inches = 3.281 feet			
Tankers	Inches	R^2	Standard Error
(m) Draft =0.445265 * DWT^0.304761	*39.37	0.94	0.09253
(m) Beam = 1.004917 * DWT^0.321321	*39.37	0.97	0.06220
(m) LOA = 8.49089 * DWT^0.291101	*39.37	0.97	0.06020
Horsepower = 6808.521943+0.088546*DWT		0.89	2594.52
Service Speed (knots) = 10.468702 * DWT^0.030071		0.20	0.05458
Fuel Consumption = 0.007035 * HP^0.903943		0.88	0.16511
Immersion Rate (tpc) = 0.055218*DWT^0.639204	*2.5 tpi	0.98	0.07394
Bulkers			
(m) Draft = 0.398082 * DWT^0.315559	*39.37	0.93	0.11011
(m) Beam = 1.291376 * DWT^0.291742	*39.37	0.97	0.06508
(m) LOA = 7.945414 * DWT^0.300942	*39.37	0.95	0.08869
Horsepower = 7617.479147+0.081132*DWT		0.60	2738.93
Service Speed (knots) = 14.000+		n/a	
Fuel Consumption = 0.00466*HP^0.954379		0.78	0.17016
Immersion Rate (tpc) = 0.063512*DWT^0.623346	*2.5 tpi	0.91	0.12336
Containerships			
(m) Draft = 0.390122*DWT^0.320449	*39.37	0.92	0.83500
(m) Beam = 1.529934*DWT^0.285778	*39.37	0.92	0.07294
(m) LOA = 4.089324*DWT^0.380157	*39.37	0.95	0.08208
Horsepower = 0.863133*DWT^-1905.119291		0.90	5993.96
Service Speed = 3.117881*DWT^0.182018		0.81	0.06951
Fuel Consumption = 0.05775*HP^0.932771		0.96	0.14063
Immersion Rate (tpc) = 0.036395*DWT^0.696855	*2.5 tpi	0.98	0.18181
General Cargo Ships			
(m) Draft = 0.302447*DWT^0.35294	*39.37	0.86	0.13556
(m) Beam = 1.459624*DWT^0.320306	*39.37	0.90	0.09045
(m) LOA = 6.839439*DWT^0.320306	*39.37	0.90	0.10501
Horsepower = 748.110621+0.551910*DWT		0.74	2090.97
Service Speed = 3.718947*DWT^0.150243		0.60	0.11798

Fuel Consumption = 0.008882*HP^0.880101	0.90	0.21177
Immersion Rate (tpc) = no data	*2.5 tpi	

Figure H-8: Vessel Characteristic Equations

The equations illustrate the relationship between deadweight tonnage (DWT) and a host of other vessel characteristics. A 50,000 DWT tanker would have an approximate design draft of 39.5 feet based on the relationship shown in the equation.

Equation
Draft (m) = 0.445265 x (DWT) ^ 0.304761
12.04 m = 0.445265 x (50,000)^0.304761
12.04 m = 39.50 feet

2. Vessel (Hull) Capital Costs

The vessel itself (also called the "hull") is a major cost that is accounted for in the overall operating costs of a vessel. Much like a mortgage or a car payment, the cost is converted into a series of equal annual payments. These are often referred as the fixed costs of a vessel.

While the Corps uses the term "Vessel Operating Costs", these costs include the fixed costs of a vessel as well as the operating costs. The fixed costs are annualized and combined with the operating costs to derive the total costs of operating a vessel.

With thousands of vessels in the world fleet with varying levels of depreciation, the consulting firm performed an analysis of (1) newbuild prices, (2) scrap prices (for their salvageable value), and (3) secondhand resale prices in order to derive the average annual costs (Figure 9). Annual average newbuild price and scrap prices time series are determined for standard vessel sizes within each vessel category, while secondhand resale prices are determined via analysis of vessel depreciation. The capital asset costs were annualized over the life of the vessel (generally 25-29 years) using the current federal discount rate.

In the past, Corps policy called for vessels to be priced as new since Corps studies contemplated investments in new harbor works. Nowadays, a 5-year moving average of the entire population of vessels is used. This provides a more accurate representation of the replacement cost or true economic cost of a vessel in the world fleet at a given time. The vessel's replacement cost minus its salvageable value is annualized to derive the annual asset cost. To better understand this concept, consider the analogy of a car. The car's fixed monthly payments are derived from the car's selling price. The maintenance, gas, insurance and other costs are ongoing throughout the year, and can vary depending on frequency of use, the age of driver, etc. Likewise, when shipping companies invest in a ship, they pay an up-front capital cost (the ship itself), which is paid off in the manner of paying off a new car or home. The shipping company also incurs maintenance, fuel, insurance and other ongoing costs each year which can vary depending on frequency of use, vessel age, etc.

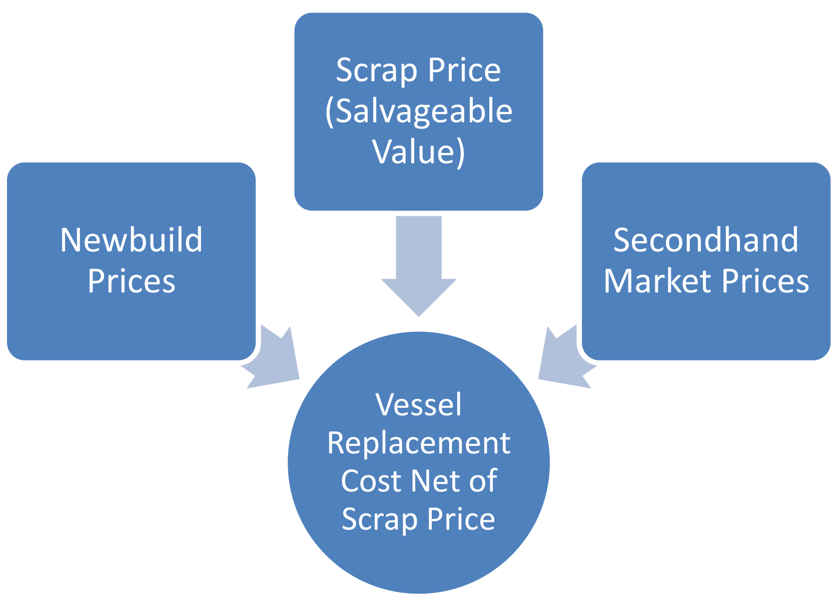


Figure H-9: Derivation of Vessel Capital Costs

Analysis of Newly-Built Vessels

To determine the annual average newbuild prices, the consulting firm combined and compared two sources of data: (1) actual signed contracts and (2) broker estimates of market levels. Details of actual signed contracts are gained from Lloyds-Register Fairplay (providing coverage of around 50 percent of transactions) and the values thus gained are cross-referenced with other sources to ensure accuracy. The advantage of this data is that it shows what payments were actually made. The disadvantage is that the vessels contracted do not necessarily correspond to with standard benchmark vessel types. Standard vessel prices are gained from broker assessments. These reflect what price a standard vessel could have been contracted for on the day of the assessment. By averaging all this data over a year, a newbuild price can be determined.

Figure 10 presents the logic behind developing the vessel capital costs. Data from sales, supported by surveys and actual transaction data, from 1990, was collated[6]. The values were then converted into present worth terms. Then, a 5-year moving average was applied to smooth out the volatility in costs from year to year. For years, the Corps had applied a 10-year moving average to the capital asset costs, but have recently adopted a 5-year moving average, which is considered to be more reflective of a standard business cycle (of recession, growth, recovery and decline). Regression analyses are performed to determine the costs for other vessel sizes specified by the Corps.

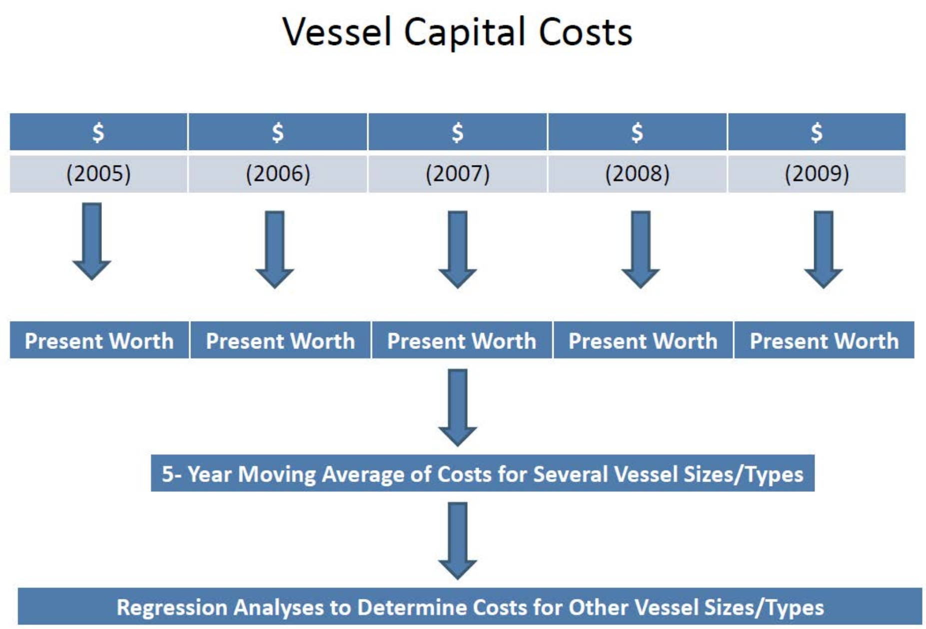


Figure H-10: Vessel Capital Cost Flowchart

Analysis of Scrap Prices

Vessel scrap prices are determined in a similar way to newbuild prices and represent a salvageable value of the ship at the end of its useful life. Average values of vessel scrap are determined by comparing actual demolition sales with standard broker reports. The historical volatility of scrap price provides the error in the scrap value.

[6] It should be mentioned that not all of the vessels in the data goes back to 1990. Newer classes of vessels such as large Post-Panamax containerships only have data going back to 1998 whereas some classes of oil tankers contain data going back to 1980.

The volume of ship deletions and the age at which they are scrapped is highly sensitive to market conditions. In strong markets, vessels are repaired, put through special surveys and kept trading far longer than in weak ones, while in distressed markets ships can be scrapped very prematurely. The age at which ships are scrapped is therefore highly volatile. Life expectancy is therefore based on an analysis of re-sale prices. The net resale price (i.e., the resale price net of the scrap value) is plotted against the age of the vessel. The age at which net price equals zero (i.e., when the market resale price equals its scrap price) is then assigned to be the average functional life expectancy of the vessel.

	2001	2002	2003	2004	2005	2006	2007
Average Scrap Price ($/LDT)	165.0	151.6	228.8	380.1	381.6	387.8	383.1
GDP Deflator (1980=100)	189.5	192.8	196.9	202.5	208.6	214.7	218.7
Real Scrap Price ($/LDT)	87.1	78.7	116.2	187.7	182.9	180.6	175.1
5-year Moving Average Scrap Price ($/LDT)	163.4	156.1	173.7	225.3	272.3	320.4	**368.6**

Table H-1: Moving Average Computations for Vessel Scrap Costs

Instead of applying a straight average scrap price, a moving average is applied to help smooth out the volatility of scrap prices from year to year[7]. A moving average continually recalculates data as new data becomes available. It progresses by dropping the earlier value and adding the latest value, hence the term “moving”.

As an example in Figure 7, the following is a moving average formula for the year 2007, using the present worth scrap price (measured in $ per light displacement ton) for the 5 years prior to 2007:

$$(\textit{GDP Price Deflator}_{2007}) \times 0.2 \times ((\textit{Real Scrap Price}_{2003} + \textit{Real Scrap Price}_{2004} + \ldots)/100)$$

This 2007 moving average value, which appears at the very bottom of the DDVOC tables under the heading “scrap/breakage value”, is then multiplied by the amount of LDT for each vessel in order to derive the scrap value.

Analysis of Secondhand Vessel Market

Finally, an analysis of the secondhand vessel market is performed and the rates at which newly-built vessels depreciated are examined as a means of deriving the 5-year old vessel’s replacement value. The rates of depreciation vary by size and class of vessel. This analysis is also used to approximate a vessel’s remaining useful life, which is important when annualizing its costs as well as converting the scrap value into present worth terms. The representation in Figure 11 shows the depreciation of a 75,000 DWT bulk carrier. It also highlights that the average working life of this tanker is about 27 years. The secondhand resale price of net residual scrap value is then determined as a percentage of the contracting price (net of scrap value). Several regressions on a vessel’s depreciation are performed, using a “peak earnings”

[7] A moving average can also help account for downturns in the market (price of steel, etc.).

environment and a "trough earnings" environment. The line of best fit incorporates all of these economic environments.

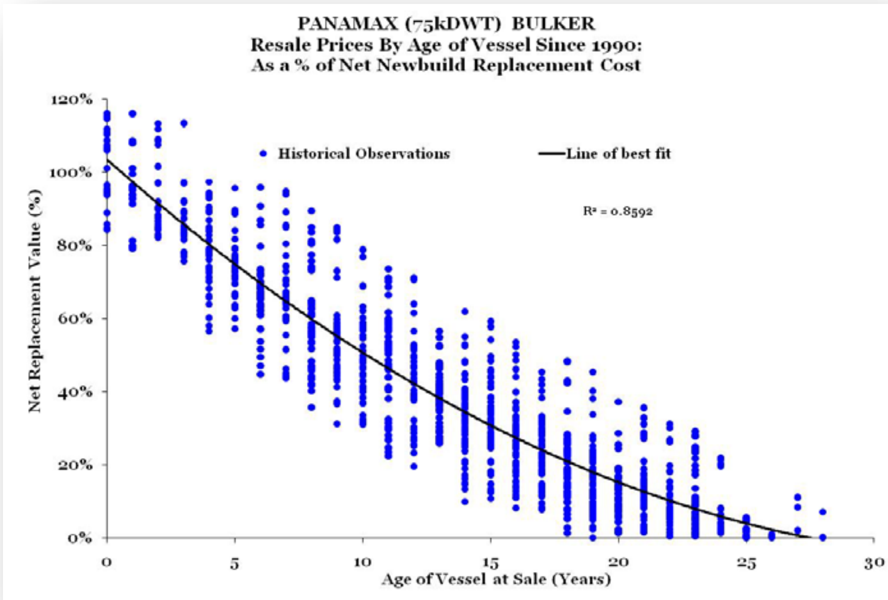


Figure H-11: Depreciation Curve for a 75,000 DWT Bulk Carrier

The DDVOC tables display the replacement cost, the scrap value (baseline), the equivalent adjusted scrap value (which is the present worth of its future value), and an adjustment of replacement cost minus its scrap (or salvageable value). That figure is then annualized to determine the average annual capital asset cost.

$$Replacement\ Costs - Adjusted\ Scrap\ Value = Adjusted\ Replacement\ Costs$$

3. Vessel Variable Operating Costs

The final component of the DDVOCs involves the ongoing costs of vessel operation. These are often considered to be variable costs or "quasi fixed/variable" costs and consists of six main categories:

- Crew Costs
- Lubes and Stores
- Maintenance and Repair
- Insurance
- Administration
- Bunkerage (fuel)

Each of these cost elements were derived via survey for each type of vessel.

For some vessel sizes, values were based on the regression relationship between DWT and cost.

Some operating costs could be considered to be "quasi-fixed/variable" costs and are acknowledged in the DDVOCs as such. For example, a vessel constantly at sea may need to be painted more frequently, or require more spot repairs than a vessel that is being laid up during a down economy. However, even if a vessel is not used at all, some minimal degree of maintenance would be required. This makes maintenance both a fixed and variable cost.

In compiling the data for vessel operating costs, a large number of vessel operators are surveyed over a period of several years. An example of the survey is presented in Figure 12. The number of "full-response responders" ranges from 800 to 1,200 per survey cycle and cover the vessel types shown in Figure 7.

1. VESSEL DETAILS	VALUES	UNITS
Vessel Size		TEU
Geared		Y/N
Open Registry Flag		Y/N
Year of Build		YYYY
On-Board Crew-including officers		Total Number
Average Fuel Consumption: @Sea		Tonnes/Day
Average Fuel Consumption: @Port		Tonnes/Day
Country of Build		Country
2. AVERAGE COSTS	**VALUES**	**UNITS**
Y. Crew Costs		US$/Year
Z. Lubes and Stores		US$/Year
AA. Maintenance and Repair		US$/Year
AB. Insurance		US$/Year
AC. Administration/Overhead		US$/Year

3. TRADING DATA	VALUES	UNITS
Offhire Days		Days/Year
Port Days		Days/Year
Laden Days @Sea		Days/Year
Unladen Days @Sea		Days/Year
Average Voyage Speed		Knots

Figure H-12: Example of Survey Used in Determining the Vessel Specifications and Costs

The results of the survey are consolidated and a 3-year moving average is developed with the mean values and standard error[8] for each of the categories. For vessels not included in the surveys, costs were developed using regression analyses.

Fuel Costs

Fuel or bunkerage costs comprise an important variable of the vessel operating costs and represent true "variable costs" since the costs can vary directly by a vessel's speed and how often the vessel is used. And since fuel prices can vary significantly from one region of the world versus another, the **Corps has applied a weighted average of 52 ports in 13 regions** worldwide[9] (Figure 13). Finally, since fuel prices are subject to market fluctuations, **a moving average of 3 years** was applied on top of the average fuel costs. Brokers Crockett Marine provides about 2/3 of the data whereas Praxis provides the other 1/3.

Escalating future fuel costs is not permissible; however, adjustments to fuel costs could be made in special situations where all vessels are found to be confined to a specific trade route with few port calls. It may be appropriate, for example, to apply an average fuel cost of the ports of Tokyo, Singapore and Los Angeles, rather than applying the weighted average of 52 ports[10] if it is shown that all of the vessel voyages are exclusive to those specific ports. Deviations to using the fuel costs must get prior approval by HQUSACE while the individual port costs should be provided by IWR (since they possess the fuel costs for each of the ports).

Figure H-13: **Bunker Ports by Region**
1. U.S. East Coast
New York, New York
Norfolk, Virginia
Houston, Texas
New Orleans, Louisiana

[8] The standard errors are provided as a means of showing the robustness of the sample.

[9] Anecdotally, vessels tend to fuel up in regions providing the lowest fuel costs, especially since fuel comprises a large share of the total vessel operating costs. Also, it is believed that a select number of port cities (20 or so) provide over 90 percent of the total bunkerage.

[10] Trade routes for specific vessels must be documented as to their source and may be obtained from a variety of sources like the carriers themselves, Lloyds Movements Database (available for unitized movements to all USACE offices) and web sites.

2. US Pacific Coast
Los Angeles, California
San Francisco, California
Seattle, Washington
3. Pacific Northwest
Seattle, Washington
Vancouver, Canada
4. Great Lakes
Montreal, Canada
5. Caribbean
La Libertad, El Salvador
Venezuelan Ports
Cristobal, Panama
6. East Coast Latin America
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Cristobal, Panama
7. Pacific Coast Latin America
Cristobal, Panama
Valparaiso, Chile
8. UK/Continent
Antwerp, Belgium
Falmouth, UK
Great Belt, Denmark
Hamburg, Germany
Le Havre, France
Lisbon, Portugal
Rotterdam, Netherlands
9. Mediterranean
Gibraltar
Algericas, Spain
Augusta, Italy
Ceuta, Spain
Cyprus
Fos/Lavera, France
Istanbul, Turkey
Piraeus, Greece
Valetta, Malta
Las Palmas, Spain
Suez, Egypt
10. Middle East/Indian Sub-Continent
Suez, Egypt
Dammam, Saudi Arabia
Jeddah, Saudi Arabia
Khor Fakkan, UAE
Kuwait

Aden, Yeman
Colombo, Sri Lanka
11. West/South Africa
Dakar, Senegal
Lagos, Nigeria
Durban, South Africa
12. Far East
Bangkok, Thailand
Hong Kong
Keelung, Taiwan
People’s Republic of China
Singapore
South Korea
Tokyo, Japan
13. Oceania
Sydney, Austalia

Summary of the Factors Used in Developing Vessel Operating Costs

- In calculating the **Vessel Capitalization (hull) costs, a 5-year moving average was applied**. It is believed that this time period helps to reduce the cost volatility and best captures a typical (and robust) business cycle. Since WWII, most business cycles have averaged 4 to 7 years in length.

- In determining **Operation and Maintenance costs, an average vessel age of 5-years was specified by USACE**. There are several rationales for this assumption. First, vessels undergo a major special survey (which is analogous to a major inspection) after 5 years[11]. Much of the data on the vessel is recorded during the special survey and is readily available. Cost data that is older than 5 years is considered to be less reliable (even after adjusting for inflation).

- The fuel costs are obtained quarterly from Cockett Marine and were based on 3-year moving averages prices from approximately 52 ports worldwide. **Oil prices** may fluctuate as well but are considered more stable than vessel hull costs and so a shorter, **3-year moving average was found to be acceptable**. Additional discussion is provided in Section 6.

- The size ranges within the IWR tables go back several decades. In order to maintain consistency for comparisons, reviewers, updates, IWR found it appropriate to publish the same size ranges. Larger, newer vessels have been added to the tables, but with a warning that economies of scale are not always realized immediately for those particular vessels. It is widely believed that with time and as the population of such vessels increases, the cost curves for them will exhibit the more traditional economies of scale.

- Average functional service life of a vessel is based on published sources as well as a methodology developed by the contracted firm.

- The capital recovery factor used in annualizing the vessel costs is based on the Federal Discount Rate applicable to water resource projects.

- Average hourly costs are based on a 24-hour working day and 348 days per year.

[11] The success of the inspection dictates whether or not a vessel remains insurable by the Protection & Indemnity club, which is operated similarly to insurance firms for banks. Having a suspended class or worse yet, a “withdrawn from service” may force a shipper to sell its vessel.

Other Considerations

Service Speed and Other Speeds

The speeds cited in the DDVOCs are based on a vessel's service speed, which is commonly defined as the fastest speed the vessel could reasonably operate given ideal conditions. Shippers will generally operate their vessels at their "economic" speed, i.e., the speed which produces the best possible financial result for the owner. The vessel's economic speed is sometimes equivalent to its service speed, but it can also be 14 to 18 percent below its service speed. Applying economic speeds could create challenges in analysis. Lower speeds reduce fuel costs but could increase crew costs if the voyage is significantly lengthened. The value and perishability of the goods and timeliness needed are further considerations when using reduced speeds.

Occasionally, vessels deliberately slow their speed even further, below their economic speeds, in order to conserve fuel. This practice is known as "slow steaming". Bulkers and tankers engaged in slow steaming in the 1970s and 1980s and more recently in 2008 when fuel prices were very high. Presently, this practice has all but ceased, but could reoccur if fuel prices rise to high levels. To deviate from the default operating speeds, one must fully document the rationale and reason behind doing so.

In Port versus at Sea Costs

In the past, planners referred to "in-port costs" as the costs in the dockside or static condition. The DDVOCs provide estimates for varying power within-harbor/channel transit, maneuvering, base idle, and the dockside/static condition of vessel service.

Vessels incur separate costs while at sea or in port. Vessels in motion require an enormous amount of power as their propulsion units are fully engaged. Vessels within the port slow down (or begin speeding up upon exit), require delicate maneuvering, or sit idle while cargo is loaded and off-loaded. In essence, a vessel's fuel consumption can be grossly different from those at sea versus in port. Typically, in port fuel consumption is derived from the full-service load consumption of auxiliary plants or "gensets" from where vessels are housed. Consumption at sea is based mainly on published figures such as Lloyds as well as interviews with naval architects at the U.S. Naval Academy.

H.4 – Vessel Operating Cost Components

These definitions are presented in order of appearance in the DDVOC datasheets. The numbers on the left column indicate the actual row in the sheet. Several rows are blank,

General Vessel Specifications				
14.	General Vessel Type	**Grd FCC**	**Grd FCC**	**Grd FCC**
15.	Deadweight Tonnage (DWT; Metric Tonnes)	**9,500**	**15,000**	**17,800**
16.	Light Displacement Tonnage (LDT; Metric Tonnes)			
17.	Displacement (Metric Tonnes)			
18.	TEU Capacity; Nominal			
19.	TEU Capacity; Homogeneous			
20.	Volumetric Capacity (Cubic Meters)			
21.	Grain Cubic			
22.	Bale Cubic			
23.	Liquid Cubic			
24.	Average Vessel Age (Years)			
25.	Average Functional Service Life (Years)			
26.	Length Overall (LOA; Feet)			
27.	Length Between Perpendiculars (LBP; Feet)			
28.	Extreme Breadth or Beam (XB; Feet)			
29.	Summer Loadline Draft (Feet)			
30.	Immersion Rate (Metric Tonnes Per Inch or TPI)			
31.	Horsepower (Total)			
32.	Service Speed (Knots)			
33.	Manning or Crew			
34.	Bunkerage Consumption (Metric Tonnes/Day)			

which make the datasheets easier to read. The data appears in **red font**.

General Vessel Specifications

Row 14: General Vessel Type

This category refers to the type of carrier (containership, bulker, tanker and general cargo vessels) applied to a particular deep-draft navigation study. Navigation economists within the Corps determined the list to be included in the DDVOCs based on knowledge of the shipping industry and experience with Corps deep-draft navigation studies. The vessels in the DDVOCs represent the primary vessel types calling at U.S. ports. Non-conventional vessels, e.g., military vessels, are not included in the list. Careful examination of this item shows different categories for various sizes. Small containerships show "Grd FCC" which stands for Geared Fully Cellular Containership, meaning that the ships often carry their own cranes on board. Larger containerships are denoted by "Gls FCC" which stands for Gearless Fully Cellular Containership, which means they would rely on port cranes to load and unload cargo. There are also two categories listed for Tankers: Products (for vessels ranging in size of 20,000 to 70,000

DWT) and Crude (for vessels 80,000 DWT and larger). General cargo vessels also have the "MPP" under this item, which is shorthand for Multi-Purpose Ship.

Row 15: Deadweight Tonnage (DWT, Metric Tons)

This refers to the total carrying capacity of the vessel, including the volume of fuel, storage, ballast and other items (engines, cranes, equipment). The deadweight tonnage of a vessel helps the planner determine the maximum tonnage that could be carried on a vessel which is useful in determining a vessel's maximum draft. This value could also establish a basis for light loading analysis. The DWT demarcations and ranges in the DDVOC datasheets were specified by IWR and were based on standard vessel classifications in the shipping industry. Sizes for tankers, for example, begin at 20,000 DWT and contain increments of 10,000 DWT. The larger tankers have larger spreads.

Row 16: Light Displacement Tonnage (LDT)

This refers to the weight of the ship itself. Shippers often consider the vessel's LDT when bidding on the price of a ship. As such, the larger the vessel, the more steel and materials required and the larger the sticker price. The firm performed an analysis of vessel dimensions using information contained in Lloyd's Registry as well as vessel classification societies.

Row 17: Displacement Tonnage

This refers to the total amount of weight displaced in the water. It can be computed as the sum of the DWT (both for cargo and non-cargo) plus the light displacement tonnage (Figure 14). Cargo generally accounts for 90 percent of a vessel's total deadweight tonnage whereas non-cargo accounts for the remaining 10 percent. As aforementioned, the light displacement tonnage represents the weight of the vessel itself.

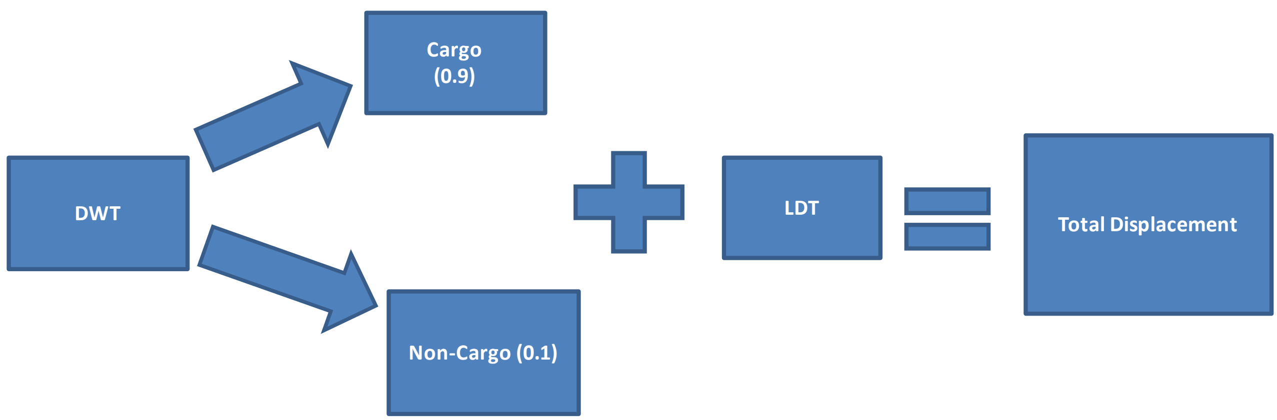


Figure H-14: Total Displacement Components

Row 18: TEU Capacity

This represents the volumetric capacity of a containership, which is most often measured by twenty-foot equivalent units or TEUs, given a variety of cargo. The DDVOCs also display the equivalent DWT for those containerships. For tankers and other vessels, it reads, “Not Applicable” under that category.

Row 19: TEU Capacity; Homogeneous

This is the capacity of a containership assuming all of its cargo is all of the same size and density (as opposed to heterogeneous cargo as defined by Item E). The homogeneous rating is sometimes used for forecasting since it provides consistency from ship to ship (often based on 14 metric tons per TEU) and can help establish breakpoints or thresholds between various vessel classes. These Homogeneous TEU capacities are often higher than those under the nominal TEU capacity category, though it is not the case for the largest containerships.

Row 20: Volumetric Capacity

Row 21: Grain Cubic
Row 22: Bale Cubic
Row 23: Liquid Cubic

These capacities refer to non-standard cargo. The grain cubic capacity refers to product that is mainly loose and broken; bale capacity refers to material in standardized bales (1m x 1m x 1m); and liquid cubic refers to tankers or combo carriers. Navigation analysts consider volumetric weight to help check a vessel’s draft requirements and to determine when a vessel “bulks out” as opposed to “drafting out”.

Row 24: Average Vessel Age (Years)

While the replacement costs of the hulls were determined via a 5-year moving average, an average vessel age of 5 years was assumed when determining the maintenance and repair costs for each class and type of vessel. The team from IWR and the consulting firm felt this to be an appropriate age since much of the information is compiled during a vessel’s Special Survey (comparable to a major inspection) at the 5-year age mark.

Row 25: Average Functional Service Life (Years)

Given the average vessel age, this represents the average remaining functional life of the vessel, which is useful in determining its overall replacement cost. Some of the larger vessels have shorter functional lives (roughly 2-5 years shorter) than the smaller ones. A common way of determining a vessel’s service life is to examine the age at which vessels are scrapped. However, the volume of ship deletions and age at which they are scrapped is highly sensitive to market conditions. To get a better estimate of the average functional life, the firm examines a vessel’s rate of depreciation and assumes that a vessel reaches its functional life when its market resale value drops far enough to equal its scrap price[12].

Row 26: Length Overall (LOA; Feet)

This represents the total length of a ship and is useful when evaluating the turning basins or berthing areas. This item is derived by the firm's analysis of the vessel specifications.

Row 27: Length between Perpendiculars (LBP; Feet)

Another reference of length of the ship, this is a subset of the LOA and provides a reasonable idea of a ship's capacity by measuring the ship's length at the summer loadline. Figure 15 provides a graphical representation of the LOA and LBP. This item is derived by the firm's analysis of the vessel specifications.

Row 28: Extreme Breadth or Beam (XB; Feet)

A naval architectural term, this describes the width of a vessel and is useful when performing widening analyses. This item is derived by the firm's analysis of the vessel specifications.

Row 29: Summer Loadline Draft (Feet)

An important metric that identifies the depth of water needed to transit safely. This item is derived by the firm's analysis of the vessel specifications and is more often called the **design draft**.

[12] This provides a strong economic rationale for when shippers decide to scrap or hold onto their vessels.

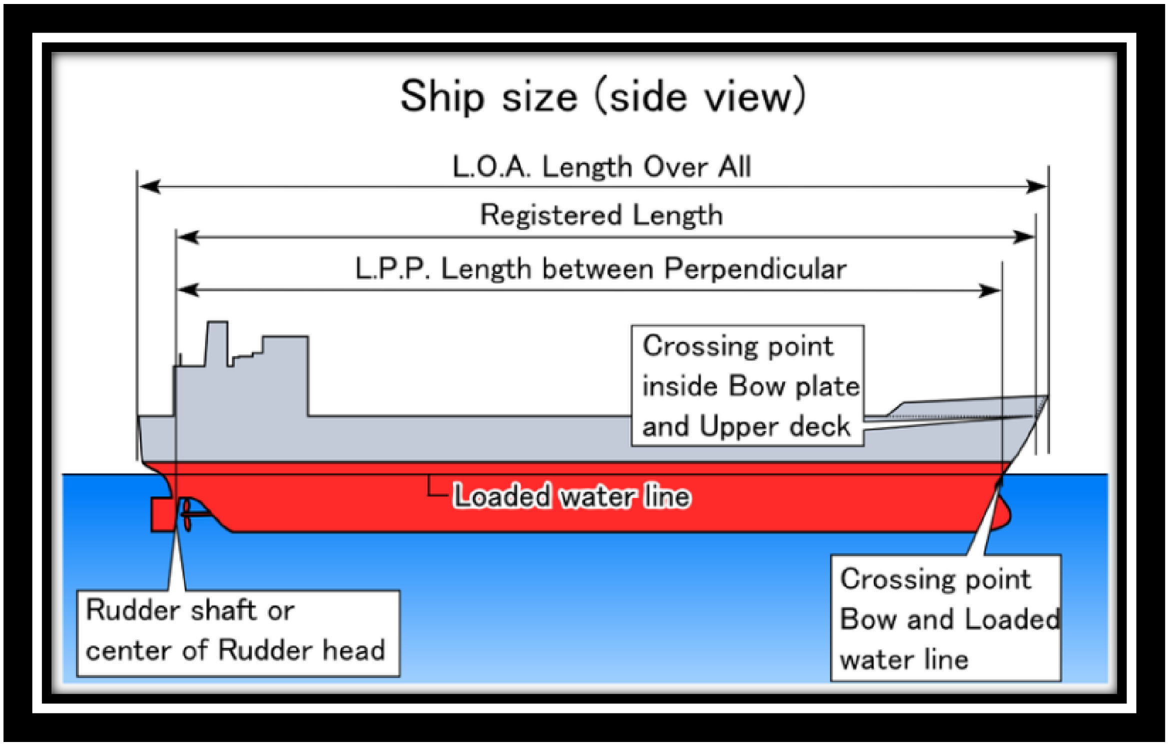


Figure H-15: Vessel Dimensions

<u>Source</u>: Turpin, Edward A.; McEwen, William A. (1980). Merchant Marine Officers' Guide (4th ed.). Centreville, MD: Cornell Maritime Press.

Row 30: Immersion Rate (Metric Tonnes per Inch or TPI)

A vessel's immersion rate is related to the carrying capacity of a vessel and is defined as the relationship between a change in a vessel's load and a change in its draft. The rate generally increases with size of the vessel. By applying the vessel's immersion factors provided by DDVOC datasheets, the amount of additional cargo can be calculated for each subsequent foot of water depth. This is critical when estimating the unit cost savings. The immersion rates are derived by the firm's analysis of the vessel specifications.

Details on applying immersion rates are contained in the NED Manual, but a simplistic example is shown as follows:

> Assume a vessel's immersion rate is 140 tons per inch and that a deepening project is calling for three additional feet of channel depth:
>
> Immersion Rate = 140 (tpi) x 12 inches/foot x 3 additional feet = 5,040 additional tons

Row 31: Horsepower (Total)

This is defined as the rate at which the engine(s) can perform while thrusting through water. In general, the horsepower increases linearly as the size of the vessel increases. 1 hp is equivalent to 746 watts of energy. Most of the horsepower ranges from 6,200 hp to over 32,000 hp for the largest tankers and relates to the level of fuel consumption. The horsepower figures are derived by the firm’s analysis of the vessel specifications.

Row 32: Service Speed (Knots)

This is often defined to be the optimal sailing speed of a vessel under ideal shipping conditions. 1 knot is equivalent to 1 nautical mile per hour or 1.15 equivalent land miles per hour. The service speeds are derived by the firm’s analysis of the vessel specifications.

Row 33: Manning or Crew

This is the average number of crew members per vessel. This item is determined by means of a survey to ship-owners supported by secondary analysis on standard practices.

Row 34: Bunkerage Consumption (Metric Tonnes/Day)

This represents the amount of fuel expended per day. The amount varies based on speed applied as well as the type of vessel deployed.

The bunkerage consumption category has recently been revised to account for variation in speeds. For a variety of reasons, shippers adjust their speeds and run on different modes of power throughout their voyage. As a result, vessels burn fuel and incur costs at different rates.

The “dockside” category, for example, refers mainly to vessels held at the dock while being loaded or unloaded. The vessel is not completely shut off during this time. Auxiliary generators are still running at a lower power (it appropriately has the lowest average costs). The “base idle” condition is applied when there are significant delays for a vessel upon departure (generally no longer than 3 hours) or delays at sea, which forces vessels to remain powered, but not for deliberate propulsion needs. Consumption estimates for “half-power” are provided for possible reductions in speed associated with traffic management offshore or environmental restrictions, e.g., to reduce ship strike of right whales.

Within the harbor speed and its corresponding fuel burn rate is commonly applied when evaluating ports with long channels (e.g., Houston, Savannah) since channels represent a transitional zone for vessels either slowing down or speeding up.

Finally, the maneuvering speed and consumption rate is often applied when analyzing general navigation features such as turning basins where measurable vessel time is required for turning and similar maneuvers or transitions.

Vessel (Hull) Capital Costs

This area of the DDVOC tables relate to the fixed costs of the vessel. This information appears in **green font.** The numbers on the left column indicate the row in the spreadsheet.

59.	**Annual Discount\Interest Rate (%)**	4.625%	4.625%
60.	**CRF (for specified rate & period)**	0.0622975	0.0622975
62.	**Hull Asset Capital Costs (Fixed Capital Asset)**		
63.	Replacement Cost(s) [1.]		
64.	Scrap Value; Baseline		
65.	Scrap Value; Adjusted (Discount of Future Value)		
66.	Replacement Costs Adjusted for Scrap		
67.	**Average Annual Capital Asset Cost (Adjusted for Scrap)**		

Row 59: Annual Discount Rate/Interest Rate (%)

This represents the interest rate used in annualizing the vessel's capital cost. The Principles and Guidelines require applying the water resources applicable discount rate to convert future monetary values to present values as well as when annualizing future streams of costs. The interest rate is established each fiscal year in accordance with Section 80 of Public Law 93-251. The Corps Headquarters obtains the rate from U.S. Treasury Department, which computes it as the average yield on interest-bearing marketable securities of the United States having 15 or more years to maturity. The computed rate is effective as of 1 October of each year.

Row 60: Capital Recovery Factor (CRF)

The capital recovery factor is used to convert the vessel's present value into a stream of equal annual payments over a specified time, using the specified discount rate[13]. The CRF is provided in the table and is based on the following formula:

$$i\,(1+i)^{n}/(1+i)^{n-1}$$

where i = discount rate and n = the number of years

Row 62: Hull Asset Capital Cost (Fixed Capital Asset)

This line is blank as it introduces the category.

[13] This is comparable to a mortgage payment of a home.

Row 63: Replacement Cost

This refers to the total replacement cost of the vessel and is discussed in more detail in Section 5. There is also a footnote stating that for containerships, this cost does not include the costs of the actual boxes.

Row 64: Scrap Value (Baseline)

This refers to the depreciated replacement cost of the vessel at the end of its useful life. It is discussed in more detail in Section 5.

Row 65: Scrap Value; Adjusted (Discount of Future Value)

This category refers to the adjusted cost of the vessel, which is discounted from its future value through the following formula, where FV is the future value and PV is the present value, and n is the vessel's functional life (in years):

$$PV = FV/(1+i)^n$$

Row 66: Replacement Cost; Adjusted for Scrap

This is defined as the replacement cost minus its adjusted scrap value.

Row 67: Average Annual Capital Asset Cost

This represents the annual equivalent cost of the total capital (net of scrap) value of the vessel. It can be calculated by multiplying the Replacement Cost; Adjusted for Scrap by the CRF.

Variable Operating Costs

These costs refer to the variable operating costs of the vessels and appear in **blue font**.

69.	**Operating Costs (Quasi Fixed\Variable Costs)**
70.	Crew Cost
71.	Lubes & Stores
72.	Maintenance & Repair
73.	Insurance
74.	Administration
75.	**Average Annual Operating Costs**

Row 70: Crew Costs

Crew costs comprise the greatest share of the overall operating costs and include the salaries, pensions, medical benefits, crew travel expenses, meals, overtime, and training costs. These costs also include supplemental or fringe employment benefits paid relative to company employment policies, crew ranking and qualifications, as well as governing regulations where applicable for nationality or citizenry and conditions of service. Subsistence costs include the cost of care and sustainment of the crew while at sea or under active employment away from home as appropriate. Larger, newer vessels are often equipped with gym equipment, swimming pools and even DVD players and video games since the crew is often at sea for a long time. Pilots and officers tend to earn decent wages, whereas most of the crew, many of whom come from low-wages countries like the Philippines or India, earns relatively little. The balance or shares of direct compensation versus subsistence within the total level of compensation can vary notably depending on conditions for employment and labor agreements whether for crewing citizenry from highly developed nations versus lesser developed or developing countries. The manning/crew per vessel appears at the bottom of the DDVOC Tables. Generally, the required crew increases with vessel length, though there are slight economies of scale. The size of the crew ranges from 26 through 31 per vessel, depending on the type and the size. The crew costs were obtained from the consulting firm’s shipping survey and validated by a team of experts within the consulting firm.

Row 71: Lubes and Stores

Vessels need other materials to safely operate and navigate in rough waters. These include lubrication of machinery, propulsion systems, as well as stores such as (ice, water and others). Lube oils, spare parts, tools, deck and engine parts are also supplied for their long voyages. These costs make up the smallest share of overall operating costs and were based on survey results which drew on actual costs.

Row 72: Maintenance & Repair

Analogous to a fleet of cars, shippers need to perform periodic maintenance and repairs to their ocean-going vessels. As the vessel ages, it requires additional maintenance and may experience larger and more lengthy repairs. The costs within the maintenance category include routine maintenance, classification fees and provision for 5-year Special Survey and Drydocking costs.

Row 73: Insurance

Again, to take the analogy of a car, as a vessel ages, the cost of insuring it goes down. Alternatively, it would cost more to insure a brand new vessel. The insurance costs include both Hull and Machinery and Protection and Indemnity (liability) Insurance. Various maritime activities are covered by a notable array of instruments for insurability whether for loss of vessel assets, loss of life to the crew, liabilities for cargo loss or damage or liabilities incurred due to negligence in vessel operations. In estimation of insurance costs as included in vessel operating cost estimates is for protection and indemnity (P&I).

Row 74: Administration

Administrative costs largely refer to the costs of vessel management. These do not include owner profits. Related expenses include (but are not necessarily limited to logistical support, communications, shore-based support, scheduling of deployments and withdrawals from service for maintenance, crew management, marketing and adaptive management of operations to market conditions. Administration costs may be difficult to explicitly quantify specific to one vessel among a fleet of vessels and therefore survey efforts may target a typical average estimate of costs based total costs for a given fleet. The administrative costs were based on the consulting firm's shipping survey; however, there is very little published information on administrative costs to substantiate the survey-based data; therefore this category may be subject to the greatest levels of uncertainty.

Row 75: Average Annual Operating Costs

These are defined as the sum of the costs for crew, lubes and stores, maintenance and repair, insurance and administration.

Row 77: Average Annual Total Fixed Capital Asset & Operating Costs

This is defined as the sum of the Average Annual Fixed Capital Cost (Row 67) and Average Annual Operating Costs (Row 75).

Rows 79-82: Intensity of Employment of Vessels

When calculating the Average Daily Cost, adjustments are made to account for "off-service" time including the number of days in dry dock or repairs and/or involuntary lay-ups. As shipping responses are usually insufficient to determine days for each vessel size/type segment, an overall average figure of 17 days is assumed, yielding an average of 348 operating days out of the 365 days in a calendar year.

Row 84: Average Daily Total Capital & Operating Costs (Excluding Bunkerage)

This category represents the sum of the daily capital plus operating costs. It does not include the costs for bunkerage (fuel). These figures are computed by dividing the total capital and operating costs (AD) by the number of operational days, shown in Row 81.

$$Total\ Average\ Annual\ Fixed\ and\ Variable\ Costs/348\ operating\ days$$

Fuel Costs

The fuel costs appear at the bottom of the tables and shown in **black font**.

86.	**Average Daily Bunkerage Costs (Variable)**
	At-Sea
88.	Propulsion\Prime Mover(s) (PPMV)
89.	Service Speed
90.	Economic Speed
91.	Half-Power
92.	Base Idle
93.	Auxiliary Power Generation (APG)
94.	Service Speed
95.	Economic Speed
96.	Half-Power
97.	Base Idle
	In-Port
99.	Propulsion\Prime Mover(s) (PPMV)
100.	Within-Harbor\Channel Transit
101.	Maneuvering
102.	Base Idle
103.	Auxiliary Power Generation (APG)
104.	Within-Harbor\Channel Transit
105.	Maneuvering
106.	At the Dock; Static Condition
108.	**Average Daily Total Vessel Costs; Inclusive**
	At-Sea
110.	Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
111.	Service Speed
112.	Economic Speed
113.	Half-Power
114.	Base Idle
	In-Port
116.	Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
117.	Within-Harbor\Channel Transit
118.	Maneuvering
119.	Base Idle
120.	Dockside\Static Condition

Rows 86-97: Average Daily Bunkerage Costs (Variable) - At Sea

This represents the fuel costs under various degrees of propulsion. As mentioned previously, the service speed is the fastest reasonable speed a vessel operator could apply. The economic speed is the most economically-efficient speed. The half-power speed is used mainly in compliance with traffic management or environmental regulations (e.g., reduced whale strikes). And the “base idle” speed is applied when the vessel is experiencing significant delays at sea.

Rows 98-106: Average Daily Bunkerage Costs (Variable) – In Port

This represents the fuel costs under various degrees of propulsion within the port. There is no cost for service and economic speed, but there are costs for within harbor, maneuvering, base idle and docking (the costs decrease in that particular order).

Rows 108-114: Average Daily Total Capital & Operating Costs (Including Bunkerage) – At Sea

This category combines the fixed and operating costs with the costs of bunkerage (fuel), thus the term “inclusive”. Rows 110-114 provide the total costs (including bunkerage) at sea.

Rows 115-120: Average Daily Total Capital & Operating Costs (Including Bunkerage) – In Port

This category combines the fixed and operating costs with the costs of bunkerage (fuel), thus the term “inclusive”. Rows 115-120 provide the total costs (including bunkerage) within the port.

122.	**Average Hourly Total Vessel Costs; Inclusive**
	At-Sea
124.	Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
125.	Service Speed
126.	Economic Speed
127.	Half-Power
128.	Base Idle
	In-Port
130.	Propulsion\Prime Mover(s) & Auxiliary Power Generation (PPMV&APG)
131.	Within-Harbor\Channel Transit
132.	Maneuvering
133.	Base Idle
134.	Dockside\Static Condition

Rows 122-134: Average Hourly Total Vessel Costs (Including Bunkerage)

These costs represent the hourly equivalent costs which appear in Rows 108 through 120. (Daily Cost divided by 24 hours).

Rows 137-142: Average Bunkerage Cost (per metric tonne)

Further Stratification of Fuel Costs

Rows 137 through 142 in the DDVOCs provide cost information on four types of fuel, which are delineated by their viscosity levels and degree of refinement. Vessels often rely on several types of bunkerage throughout its voyage.

137. Applied Bunkerage Cost(s) & Scrap\Breakage Value (Per Metric Tonne)

139. HVO Price (Heavy Vicosity Oil)
140. IFO Price (Intermediate Fuel Oil)
141. MDO Price (Marine Diesel Oil)
142. MGO Price (Marine Gasoline Oil)

143. Scrap Price (Per Light Displacement Tonne)

Row 143: Scrap Price "Breakage Value"

This refers to the price of the steel and metals used in the vessel's construction. It is measured per light displacement metric ton (tonne). The value could also be derived by dividing the scrap value shown in Line X by the light displacement tonnage shown in Line C of the DDVOC datasheets.

Recent refinements of transportation models account for various operating speeds throughout its voyages. For example, as a vessel slows down, the length of time needed to complete its voyage lengthens. Given that many voyages require thousands of nautical miles, the hours of operation can indeed add up.

H.5 – Other Application of DDVOCs

Procedures for calculating waterborne transportation savings are well-documented in the NED Procedures Manual for Deep Draft Navigation Projects.

- To calculate vessel dimensions that do not fall neatly within the realm of those shown in the data tables, use the formulas for relating deadweight to draft and other characteristics shown in Appendix B of the DDVOC tables. The relationships (and standard errors) between DWT and draft, beam, LOA, horsepower, service speed, fuel consumption and immersion rate appear separately for each type of vessel.

- The latest compilation of DDVOCs represents the most comprehensive set ever published, but planners may still encounter a fleet (or sample) of vessels that do not fall neatly into a category defined by the DDVOCs. To calculate operating costs for vessels outside the markers in the DDVOC tables, linear interpolation or extrapolation of costs or regression is appropriate. There are several ways to interpolate data. One way involves calculating the data points via proportions within the markers provided. Regression goes one step further by examining the correlations of one variable to another, then developing an equation to fit the data points.

- When interpolating data for containerships, be sure to apply the vessel's tonnage (and not TEU) since much of the related information is tied to tonnage and not TEUs.

- For unique vessels (i.e., ones that are not among the vessel types provided in the DDVOC datasheets), it is best to consult with the Corps' Deep Draft Center of Expertise, to determine the best approach to calculate costs.

H.6 - Future Refinements/Improvements to DDVOCs

There have been several proposals made by the field and IWR, which may ultimately be included in future DDVOC sheets.

- Account for Real Rate of Return of Capital to the Shipping Companies: Companies invest in ships in the same way investors buy stocks, to receive higher earnings later on. Vessel owners expect some form of return on their investments. The long term returns average 14 to 15 percent on average, with its economic standard peaks and valleys. The Corps is considering applying the real cost of capital, as opposed to the present Federal discount rate, for shipping services as a potential future refinement.

- Account for Burn Rates of Fuel for Light-Loaded Vessels: Another potential refinement to the DDVOCs tables would involve further delineation of fuel consumption rates (and costs) under various loading practices. The loaded weight of a vessel influences the amount of fuel expended per voyage. Fully loaded vessels, for example, encounter more resistance since the vessel is pushed lower in the water. Consequently, this vessel would require more fuel.

- Further stratification of Foreign Flag Vessels: There is a sizable variation in the costs from one foreign vessel to another and so there is talk of providing an Upper, Middle and Lower Category to Foreign Flag vessels.

- Removing all historic costs of tankers that are not double-hulled, as the present laws call for the gradual phasing out of single-hulled tankers.

- Including vessel’s “air drafts” or height to top of its mast. Air drafts are generally not readily available presently, but they have been found to be quite useful when evaluating a vessel’s clearance under bridges, for instance.

H.7 – Conclusions

The cost data and vessel characteristics within the DDVOC datasheets are indispensible when determining the waterborne transportation costs and subsequent savings as a result of navigation improvements (NED benefits). IWR has long history in the development of the DDVOCs, which are derived through an extensive analysis of the shipping industry. We welcome any feedback you have on this guide, the DDVOC datasheets in particular, or the challenges faced with applying them in practice.

References

Turpin, Edward A.; McEwen, William A. (1980). Merchant Marine Officers' Guide (4th ed.). Centreville, MD: Cornell Maritime Press.

Durden, Susan; Horn, Kevin; Knight, Kevin; Rooks, Erin (2010) National Economic Development (NED) Manual for Deep Draft Navigation 2010-NED-R-4 *April 2010*

MSI Documentation of vessel operating costs memoranda

Federal Employee Deep Draft Vessel Operating Cost (DDVOC) Information Nondisclosure Acknowledgment

I, ____, an employee of

____ (federal agency), acknowledge

that unauthorized disclosure of the confidential, commercial Deep Draft Vessel Operating Cost ("DDVOC") information, defined below and authorized to be received by me as indicated, could reasonably be expected to cause substantial competitive harm. I also acknowledge my obligation to protect such information from disclosure to the maximum extent permitted or required by:

- 5 USC § 552(b)(4) (Freedom of Information Act);
- Executive Order 12600 (Predisclosure Notification Procedures for Confidential Commercial Information);
- 18 USC § 1905 (Trade Secrets Act);
- 18 USC § 1831 et seq. (Economic Espionage Act); and
- Any other statute, regulation, or requirement applicable to Government employees.

I understand that DDVOC information comprises four (4) categories of information, any or all of which may be disclosed to me, or disclosed to me only in summary form as indicated below subject to an HQUSACE representative's authorization, and my initials acknowledging receipt of the stated category of DDVOC information. IWR will accompany DDVOC information disclosed to me with a Scope of Work stating the authorized purpose for which I may use the information.

Disclosure Authorized	Recipient's Acknowledgment	DDVOC Information Category Being Disclosed By IWR to Recipient
_________	_________	General Vessel Specifications
_________	_________	Annual Discount/Interest Rate, Cost Recovery Factor (CRF), and Hull Asset Capital Costs
_________	_________	Operating Costs
_________	_________	Average Annual Total Fixed Capital Asset & Operating Costs, Intensity of Employment, Average Daily Total Capital & Operating Costs, and Applied Bunkerage Costs & Scrap/Breakage Value
_________	_________	Summary Estimates by Operating Condition perUnit of Time

IWR will mark each page containing DDVOC information that is subject to the non-disclosure requirements of this Acknowledgment as "Confidential Commercial DDVOC Information, Do Not Disclose," or by any reasonable method to indicate that IWR considers the disclosed DDVOC information to be subject to the nondisclosure requirements of this Acknowledgment. If in doubt, I agree to contact IWR for a status determination prior to disclosing the information. The terms Confidential, Secret and Top Secret are established security classifications within the U.S. Government and shall not be used to mark or identify DDVOC information.

I acknowledge that my non-disclosure obligations apply to any and all documents containing DDVOC information identified as stated above, and also to any reports, letters, memoranda, electronic mail, or other communications containing information generated or derived by me from disclosed DDVOC information.

I also acknowledge that I may not disclose DDVOC information to any firm, entity (including government agencies and employees), or person without prior written approval from HQUSACE based on a justified need related to Headquarters USACE-sponsored studies, nor may I use DDVOC information, or estimates and information derived therefrom for any purpose other than the purpose stated in my Scope of Work.

Disclosure of DDVOC information shall mean exchanging said information orally, visually, or on any human or machine readable medium including, but not limited to, paper, oral and visual expressions, demonstrations, audio tapes, video tapes, drawings, computer files, memory devices, models, prototypes and samples.

I will take reasonable and appropriate measures to safeguard DDVOCC information from misuse, theft, loss, destruction, and unauthorized disclosure. Such measures shall be no less than the degree of care that I normally take to preserve and safeguard proprietary commercial information and will promptly notify HQUSACE in writing of any unauthorized disclosure and will take immediate action to prevent further disclosure and to recover any DDVOC information already disclosed.

I will protect DDVOC information included in any analyses, reports, or other documents or physical embodiments prepared by me in the same manner as I protect original DDVOC information provided by HQUSACE.

I understand that only HQUSACE may disclose, or authorize disclosure in writing following execution of a nondisclosure agreement or acknowledgment between HQUSACE and an additional recipient.

____

Name

____

Title

____

Signature

____

Date

DEEP DRAFT VESSEL OPERATING COST (DDVOC) INFORMATION NONDISCLOSURE AGREEMENT

THIS AGREEMENT is made by and between:

Headquarters, U.S. Army Corps of Engineers ("HQUSACE")

located at 441 G St, NW, Washington, DC, 20314, and

___________________________________, ("Recipient") an individual or entity whose

principal address is located at

____ to facilitate the following described "Stated Purpose" by protecting confidential, commercial Deep Draft Vessel Operating Cost ("DDVOC") information, defined below, from misuse and unauthorized disclosure, which could reasonably be expected to cause substantial competitive harm. This Agreement shall become effective upon the date of last signature by the authorized representatives of each of the Parties.

Within the context of this agreement "HQUSACE" shall refer to the authorized representative(s) of Headquarters of the U.S. Army Corps of Engineers. "IWR" shall refer to the Institute for Water Resources acting in support or as authorized by HQUSACE.

1. The stated purpose of this Agreement is to protect DDVOC information from disclosure to unauthorized personnel by persons and entities, including, but not limited to, Government contractors and their employees, academic reviewers, and other support staff, authorized under this Agreement to receive such DDVOC information.

2. DDVOC information comprises four (4) categories of information, any or all of which may be disclosed, or disclosed only in summary form to Recipient as indicated below subject to an authorized HQUSACE representative's authorization, and Recipient's initials acknowledging receipt of the stated category of DDVOC information.

Disclosure Authorized	Recipient's Acknowledgment	DDVOC Information Category Being Disclosed By IWR to Recipient
_________	_________	General Vessel Specifications
_________	_________	Annual Discount/Interest Rate, Cost Recovery Factor (CRF), and Hull Asset Capital Costs
_________	_________	Operating Costs
_________	_________	Average Annual Total Fixed Capital Asset & Operating Costs, Intensity of Employment, Average Daily Total Capital & Operating Costs, and Applied Bunkerage Costs & Scrap/Breakage Value
_________	_________	Summary Estimates by Operating Condition per Unit of Time

3. HQUSACE agrees to disclose DDVOC information to Recipient only in conjunction with a separate written summary or statement that describes the authorized purpose(s) in support of studies and investigations sponsored by the U.S. Army Corps of Engineers (USACE) for which the DDVOC data and information may be used by the Recipient in a manner related to the request for its release ("Scope of Work").

4. The Institute for Water resources (IWR), developer of the DDVOC information in support of HQUSACE, agrees to mark each page containing DDVOC information that is subject to the non-disclosure requirements of this Agreement as "Proprietary Commercial DDVOC Information, Do Not Disclose," or by any reasonable method to indicate that IWR considers the disclosed DDVOC information to be subject to the nondisclosure requirements of this Agreement. If in doubt, Recipient agrees to contact HQUSACE or IWR for a status determination prior to disclosing the information. The terms Confidential, Secret and Top Secret are established security classifications within the U.S. Government and shall not be used to mark or identify DDVOC information.

5. Recipient understands and agrees that Recipient's non-disclosure obligations under this Agreement apply to any and all documents containing DDVOC information identified per paragraphs (4) and (5) above, and also to any reports, letters, memoranda, electronic mail, or other communications containing information generated or derived by Recipient from disclosed DDVOC information.

6. Recipient agrees not to disclose DDVOC information to any firm, entity (including government agencies), or person without prior written approval from HQUSACE based on a justified need related to HQUSACE-sponsored studies. Recipient also agrees that DDVOC information, or estimates and information derived therefrom shall not be used for any purpose other than the Scope of Work.

7. Recipient shall not be liable under this Agreement for disclosure of DDVOC information that:

7.1. Was available in the public domain at the time of disclosure and receipt, or subsequently becomes available in the public domain from a source other than Recipient;

7.2. Was in the possession of or known by Recipient prior to receipt from HQUSACE;

7.3. Becomes available to Recipient without restriction as to its disclosure or use from a third party under circumstances permitting its disclosure by Recipient; or

7.4. Is developed at any time by or for Recipient independently of the DDVOC information disclosed by HQUSACE under this Agreement.

8. Disclosure of DDVOC information shall mean exchanging said information orally, visually, or on any human or machine readable medium including, but not limited to, paper, oral and visual expressions, demonstrations, audio tapes, video tapes, drawings, computer files, memory devices, models, prototypes and samples.

9. Recipient shall take reasonable and appropriate measures to safeguard DVOCC information from misuse, theft, loss, destruction, and unauthorized disclosure. Such measures shall be no less than the degree of care that Recipient normally takes to preserve and safeguard its own proprietary or trade secret information. Accordingly, to ensure adequate measures for unauthorized disclosure are enacted, the Recipient shall provide in writing a description of process, procedures and physical means by which data and information shall be safeguarded before release of DDVOC information to Recipient. Recipient may not be held liable for the use or disclosure of DDVOC information used or disclosed despite the exercise of reasonable care provided that, upon discovery of any unauthorized use or disclosure, Recipient promptly notifies HQUSACE in writing and takes prompt and effective action to prevent further disclosure and to recover any DDVOC information already disclosed.

10. Recipient shall include DDVOC information in analyses, reports, or other documents or physical embodiments prepared by Recipient only in a manner sufficient to protect the confidential nature and level of detail corresponding to original DDVOC information as provided by HQUSACE or IWR.

11. Recipient shall not disclose DDVOC information to any person or entity, even if Recipient executes a nondisclosure agreement comparable to this Agreement with the person or entity. Only HQUSACE may disclose, or

authorize disclosure in writing following execution of a nondisclosure agreement between HQUSACE and an additional recipient.

12. The following individuals are designated as the principal points of contact for the transmittal, receipt and disclosure of DDVOC information under this Agreement.

For HQUSACE:

Name: ____________________________

Title: ____________________________

Telephone: ____________________________

E-Mail: ____________________________

For Recipient:

Name: ____________________________

Title: ____________________________

Telephone: ____________________________

E-Mail: ____________________________

13. All DDVOC information disclosed to Recipient, including DDVOC information incorporated in derivative works, shall remain the property of the U.S. Army Corps of Engineers (USACE). Recipient may retain DDVOC information in tangible form after termination or expiration of this Agreement only to the extent expressly authorized by HQUSACE for purposes such as, but not necessarily limited to, post-evaluation and study review. Within thirty (30) days after termination or expiration of this Agreement, or upon receipt of a written demand from HQUSACE or IWR for return of DDVOC information in Recipient's possession, Recipient shall promptly return to HQUSACE (or destroy, if so requested) all tangible forms of DDVOC information received from HQUSACE or IWR or from any other recipient that disclosed DDVOC information to Recipient with or without authorization from HQUSACE or IWR. If HQUSACE or IWR requests destruction of DDVOC information, Recipient will promptly execute such directives and provide written notification to HQUSACE and IWR describing procedures for destruction and certifying that the destruction has been acceptably and competently accomplished.

14. If samples, models, prototypes, computer programs, or other such embodiments are disclosed as DDVOC information, Recipient will not attempt to reverse engineer or otherwise analyze such items without written approval of HQUSACE.

15. Unless otherwise agreed in a document separate to this Agreement, Recipient shall bear its own costs and expenses incurred under or in connection with this Agreement. Nothing in this Agreement shall be construed as an obligation by either Party to enter into a contract, subcontract, or other business relationship with the other Party.

16. This Agreement shall not be construed as a procurement contract, cooperative research and development agreement, grant, teaming agreement, joint venture, or any other such agreement nor shall it be construed as a commitment to procure or provide any specific products or services. Nothing contained herein shall be construed to grant or confer any rights other than to use the DDVOC information for the purpose stated in a separate but related Scope of Work. Nothing in this Agreement shall be construed to grant license or other rights to any patents, trademarks, copyrights or other intellectual property whatsoever. The Parties expressly agree that this is an Agreement for protecting DDVOC information only.

17. Recipient shall accept all DDVOC information and embodiments thereof on an "AS IS" basis. HQUSACE makes no warranty or representation of fitness for any purpose.

18. Either Party, upon thirty (30) days written notice to the other Party, may terminate this Agreement. Unless sooner terminated, this Agreement shall expire the lesser of either one (1) year from its effective date or 30 days after requirements for application of DDVOC information is considered complete for its intended purpose. Upon termination of this agreement the Recipient shall undertake measures for return or destruction of data, information and related materials. Notwithstanding the termination or expiration of this Agreement, all obligations incurred by Recipient regarding protection, use, disclosure and return or destruction of DDVOC information shall survive and remain in effect for as long as subject data and information are in possession of the Recipient, a period generally corresponding to needs or purpose for which DDVOC information was requested, a period not to exceed ________( ) years; _________( ) months and _________( ) days from the date Recipient received the DDVOC information.

19. Recipient may not assign or otherwise transfer this Agreement without HQUSACE's prior written authorization. All obligations incurred by Recipient under this Agreement regarding DDVOC information shall be binding on Recipient's authorized successors and assigns.

20. This Agreement shall be governed by applicable federal laws of the United States including protections from disclosure for subject data and information afforded under Section IV disclosure of the Freedom of Information Act (FOIA) current and as amended.

21. Should Recipient become subject to any legal process that requires production of DDVOC information for inspection or review in a judicial or administrative proceeding, Recipient shall promptly notify HQUSACE and IWR and provide a copy of the legal process to HQUSACE and IWR, so that HQUSACE and IWR may have an opportunity to challenge the legal process or seek a protective order. If, in the absence of a protective order, Recipient is compelled to produce DDVOC information to a tribunal or be found liable in contempt and subjected to a penalty, Recipient may disclose such DDVOC information to the tribunal provided the information so disclosed is clearly marked as Proprietary Commercial Financial Information or an equivalent, as dictated by tribunal rules.

22. This Agreement constitutes the entire agreement between the Parties, and supersedes any prior or contemporaneous agreements, representations and understandings of the Parties with respect the disclosure of DDVOC information covered by this Agreement. This Agreement shall not be suspended, modified, or amended except by written agreement of HQUSACE. The provisions of this Agreement are independent of and separable from each other and no provision shall be affected or rendered invalid or unenforceable by virtue of the fact that any other provision may be found invalid or unenforceable.

The Parties hereby agree to the terms of this Agreement.

For: Headquarters, U S Army Corps of Engineers (HQUSACE) ________________________________

Title: ______________________________________ DATED: __________________

(MM/DD/YY)

For: The "Recipient" ____

Title: ______________________________________ DATED: __________________

(MM/DD/YY)