A CASE STUDY ON THE SPARE PARTS REQUIREMENT FOR A 55,500 DWT GEARED BULK CARRIER

By

Mr Lampros Valiazis

Student number: MN10010

Department of Maritime Study

Degree of Masters of Maritime Study

Dissertation

Supervisor: V. Tselentis

16th September 2012

This dissertation is dedicated to my parents, Filippos and Anneta, for supporting and encouraging all my sea dreams.

CONTENTS PAGE AND BRIEF DESCRIPTION

TABLE OF CONTENTS.....1

ABSTRACT.....3

AUTHOR'S DECLARATION.....4

ACKNOWLEDGEMENTS.....5

LIST OF FIGURES, GRAPHS AND TABLES.....6

GLOSSARY OF SHIPPING INDUSTRY TERMS.....7

CHAPTER No 1
Introduction
Brief description of the structure of the project, sequence of approach and deliverables.....8

CHAPTER No 2
Scope of Study
(DEFINITIONS, ASSUMPTIONS, LIMITATIONS)
2.1. Vessel definition (will describe characteristics of the vessel in question).....10
2.2. Trade definition (will describe the trading pattern and areas of operation).....15
2.3. Spare parts market definition (will briefly describe the current market sources for spare parts supply).....18
2.4. Assumptions.....23
2.4.1. Study will be carried out for maintenance purposes only, hence unexpected/ unpredictable damage will not be taken into account.....23
2.4.2. Maintenance philosophy will comply with Classification Society rules (established IACS member – most possibly DNV).....23
2.4.3. Although study will be carried out solely for a specific vessel, some systems/machinery data will be obtained by sister vessels or the same machinery which belongs to other vessels.....24
2.4.4. Financial data will be considered real and the product of unknown negotiations between the manager of the subject vessel and the market players. (I.e. manager's commercial value will not be excluded from final figures).....25
2.4.5. Rates for currency conversion on a certain date/table.....25
2.5. Limitations.....26
2.5.1. Selected spare parts represent the basic structure of the vessel at a percent of 90% approximately. There are other spare parts that have not been included in the study since their importance was considered low during initial planning.....26

CHAPTER No 3
Overhauling Intervals (Mean time between overhauls – MTBO)
3.1. For M/E according to maker's recommendations……..27
3.2. For D/G according to maker's recommendations……...32
3.3. For remaining machinery systems according to the manager's policy……....34

CHAPTER No 4
Replacement Percentage
(Survey by means of a questionnaire over a minimum of 7 active fleet managers and C/E, to determine for each part, replacement percentage at specified overhauling intervals. Average of estimation will be used to calculate how many parts are required for maintenance purposes over 5 years)…….....37

CHAPTER No 5
Associated Costs
5.1. Cheapest – most expensive suppliers definition……49
5.2. Obtain cheapest and most expensive prices for each item under survey. (Usually and up to our now realization maker's prices are the most expensive)……. 50
5.3. Brief discussion on areas that above costs apply and forwarding value add-up……..50

CHAPTER No 6
Results
6.1. Plot out all above on a spreadsheet, summing up costs……..…51
6.2. Comparison between cheapest suppliers and makers' total sums…….....62
6.3. Determine risk involvement in compromising quality over price…….…….....63
6.4. Obtain a final spreadsheet recommended to managers with 5-year total cost requirements on spare parts for their budgeting efforts…….....64

CHAPTER No 7
Discussion and Conclusions of Research Results
End up project in a standard fashion, recapping findings, satisfying deliverables, and evaluating effort……..80

CHAPTER No 8
References…….....84

APPENDICES ……..…….87

NOTE: An appendices volume will also might be developed with supporting documentation and literature used throughout the project.

ABSTRACT

The purpose of this piece of work is to determine the economical requirements of a certain type vessel; trading at a certain route, under certain market environment and based on a certain Technical Management Company. Moreover, at the same time, our aim is to focus on what the key factors are and in what ways they are able to have an effect on the demand and supply of the market. In addition, with the view to achieving a perfect understanding of the role that each factor plays in the Technical Department, we use one model ship (Ultra-Handymax 55,426 DWT) and we are making an attempt to calculate the spare parts running costs for a 5 year interval. Of course, such an effort involves the collection of proper data which will determine the whole procedure leading us to the desirable result. In some cases, a Shipping Company may be obliged to follow certain regulations in order to succeed in reaching the actual target.

AUTHOR'S DECLARATION

I declare that all of my work that has been carried out in this Dissertation is my own original work. In areas where it has been necessary to use author's works it has been clearly quoted.

I further declare that this Dissertation will be submitted only for Masters of Maritime Study.

Signed_____

Lampros Valiazis

ACKNOWLEDGEMENTS

I would like to express my deepest thanks to the ''THENAMARIS'' SHIPPING COMPANY, because they gave me the permission to have access to their software programs using all the appropriate data and information.

Furthermore, I have to thank my supervisor V. Tselentis for giving me the opportunity to complete my Final Project.

Finally, I would like to thank Mr Tasso Sotiriou for advising me in this Dissertation.

LIST OF FIGURES, GRAPHS, PHOTOS AND TABLES

- Figure No 1: Sheer Plan……(page 10)
- Figure No 2: MAN B & W, 6S50MC-C, VERTICAL, 2-STROKE, SINGLE ACTION……(page 13)
- Figure No 3: Duration in Ports……(page 16)
- Figure No 4: Vessel Positions on the Global Map…..……(page 17)
- Figure No 5: Position List……..……..(app. No 9)
- Figure No 6: Spare Parts Requisition……..……...(page 18)
- Figure No 7: Order Form…..……..(page 20)
- Figure No 8: Stock List……(page 21)
- Figure No 9: Det Norke Veritas, Class Status Report, Current Status……(page 24)
- Figure No 10: Analysis Table – Spare Price Quotations……..……...(page 49)
- Table No 1: Currency Exchange Values……..……..(page 25)
- Table No 2: Guiding Overhaul Intervals and Expected Life……...(page 29)
- Table No 3: Maintenance Checking for Diesel Generator
  according to Makers' Recommendations……..……(page 32)
- Table No 4: Overhauling Intervals for Remain Machinery Systems
  according to the Managers' Policy……(page 34)
- Table No 5: Replacement Percentage……..……..…(page 37)
- Table No 6: Results from the Associated Costs……..……..…(page 51)
- Table No 7: Total Sums Between Cheapest Suppliers
  and the Most Expensive Makers……(page 62)
- Table No 8: A Final Spreadsheet on Parts for the Budgeting Efforts……..……...(page 64)
- Table No 9: A Profit from the Risk……..……..…(page 82)
- Graph No 1: American Dollars to 1 EURO……..……...(page 25)
- Photos No 1-2-3-5: Vessel M/V SEABOSS (private photo)……..…...(pages 14-15-23-83)
- Photo No 4: Piston from the Vessel M/V SEABOSS……..……..……(page 47)

GLOSSARY OF SHIPPING INDUSTRY TERMS

Following are definitions of shipping terms used in this dissertation

- Handymax – A dry bulk carrier of approximately 40,000 dwt to 60,000dwt.
- Bulk Carriers – Vessels which are primary designed and built to carry large volumes of cargo on a bulk cargo form.
- Bulk – Unpackaged homogeneous cargo poured loose in the hold of a vessel.
- Dry bulk – Non-liquid cargoes of commodities shipped in an unpackaged state.
- Dry docking – The removal of a vessel from water for inspection, painting and-or repair of submerged parts.
- Dwt – A deadweight ton, which is a unit of a vessel capacity for cargo , fuel oil, stores, and crew, measured in metric tons of 1,000 kilograms. A vessel's dwt or total deadweight is the total weight the vessel can carry when loaded in a particular load line.
- Lwt – Lightweight tonnage, is used to measure the scrap metal content of a ship's hull, machinery and fittings destined to be scrapped.
- Gross Ton – Unit of 100 cubic feet or 2,831 cubic meters used in arriving at the calculation of gross tonnage.
- Hull – The shell or body of a vessel.
- Newbuilding – A new vessel under construction or just completed.
- Classification Society – An independent organization which certifies that a vessel has been built and maintained in accordance with the rules of such organization and complies with the applicable rules and regulations of such vessel and the international conventions of which that country is a member.
- Annual Survey – The inspection of a vessel by a classification society, on behalf of a flag state that takes place every year.
- Intermediate Survey – The inspection of a vessel by a classification society surveyor which takes place between two and three years before and after each special survey for such vessel pursuant to the rules of international convention and classification societies.
- Special Survey – The inspection of a vessel by a Classification Society surveyor which takes place a minimum of every four and a maximum of every five years, and is obligatory to maintain vessel's Class Status.

CHAPTER No 1

Introduction

Bulk carriers, container vessels and tankers are the three largest groups of vessels. The bulk carrier market therefore is very attractive, which has caused a boost in new buildings. Of a total world merchant fleet of some 700,000,000 dead weight tons, about 215,000,000 tons dead weight is represented by the dry bulk and combination carrier fleet.

The term ''bulk'' is used to describe commodities such as oil, grain, iron ore, and coal whose homogeneous physical characteristics lead itself to bulk handling and transport.

This dissertation is going to focus on the spare parts needed for the specified interval of one specific geared bulk-carrier. Moreover, the discussion includes:

- Vessel definition – including Main Engine, Diesel Generators.
- Trade definition – Ports and Chartering
- Spare parts – Named all spare parts on the Main Engine, Diesel Generators, Emergency diesel generator, Various Machinery, Various Pumps and finally the Navigation-Communication Equipment, etc.
- Working PCS/SET – We calculate how many machinery pieces are working on its machinery part.
- We calculate the necessary replacement percentage at every overhauling and therefore the total pieces needed for a 5-year interval.
- We state the maker's price per machinery unit and we put one risk on our calculation about the cheapest suppliers' provision, based on information given with the courtesy of managers.
- Overhauling intervals - of the Main Engine, Diesel Generator and rest equipment, associated with overhauling hours.

- Replacement intervals - associated with the percentage derived from a statistical questionnaire on 7 active experienced Superintendent Engineers and Chief Engineers.
- Associated costs - We explain why the cheapest and most expensive suppliers were selected. Also, we define the cheapest and most expensive spare parts.

Moreover, detailed calculations for each option must be under consideration for the projected market achievement under the best choice of parts according to the Service Letters of the manufacturing companies (e.g. Man B&W). Further details concerning every calculation will be provided in the next corresponding chapters.

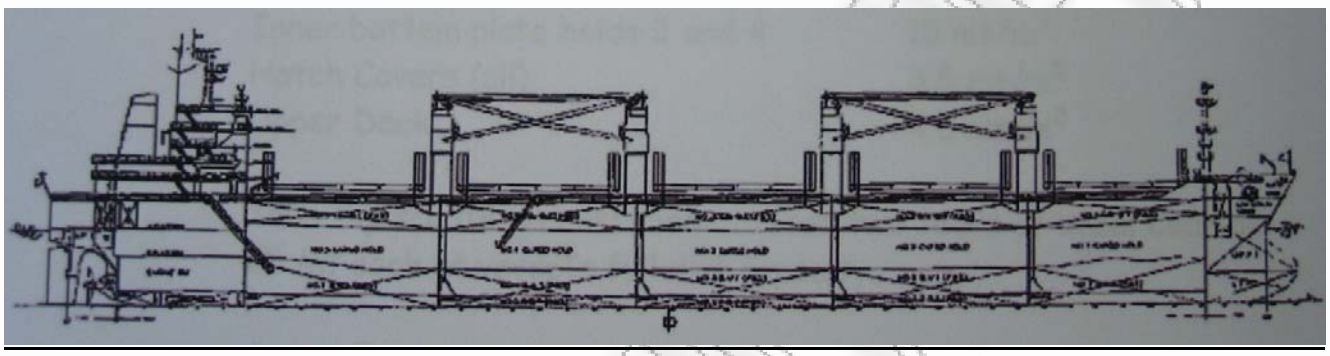
The information and data on this dissertation have been provided by the Service Letters, the average estimation by the 7 questionnaires and the global market prices per unit according to the dynamically updated files of a Shipping Company. Finally, we use some specific software systems to estimate the right position (arrival date-time / sailed date) at sea of the examined ship, according to how it will cost to the ship-owner concerning the forwarding machinery parts of the vessel.

CHAPTER No 2

Scope of Study
(DEFINITIONS, ASSUMPTIONS, LIMITATIONS)

Vessel definition

M/V SEABOSS



(**Fig. No 1**, Sheer Plan of Vessel M/V SEABOSS, 2004)

PARTICULARS OF M/V SEABOSS

YEAR BUILDING	:	2004 HUDONG HEAVY MACHINERY SHANGHAI / CHINA
CLASS	:	DNV
FLAG	:	MALTA

PRINCIPAL DIMENSIONS

L.O.A	:	189.9 M (LENGTH OVERALL)
L.B.P	:	185.5 M (LENGTH BETWEEN PERPENDICULARS)
B.M	:	32.26 M (BREADTH MOULED)
D.M	:	17.80 M (DEPTH MOULED)

LOADING CAPACITY

D.W.T	:	55,426 MT
L.S.	:	9,500 MT (LIGHT SHIP)
G.T	:	30,936 (GROSS TONNAGE)
N.T	:	18,158 (NET TONNAGE)
No. OF CARGO HOLDS	:	5
No OF HATCHES	:	5
TYPE OF HATCH COVER	:	FOLDING
CARGO HOLD (GRAIN)	:	ABT. 69,970 M^3
CARGO HOLD(BAIL)	:	ABT. 67,680 M^3
FUEL OIL TANK	:	ABT. 2,470 M^3
DIESEL OIL TANK	:	ABT. 193 M^3
FRESH WATER	:	ABT. 395 M^3
WATER BALLAST TANK	:	ABT. 29,100 M^3

STRENGHTS

INNER BOTTOM PLATE HOLDS 1,3 &5	:	25 MT/M^2
INNER BOTTOM PLATE HOLDS 2 &4	:	19 MT/M^2
HATCH COVERS	:	3.6 MT/M^2
UPPER DECK	:	4.7 MT/M^2

CARGO HANDING GEAR

FOUR (4) OF SINGLE JIP ELECTRO-HYDRAULIC DRIVEN FIXED DECK CRANES.

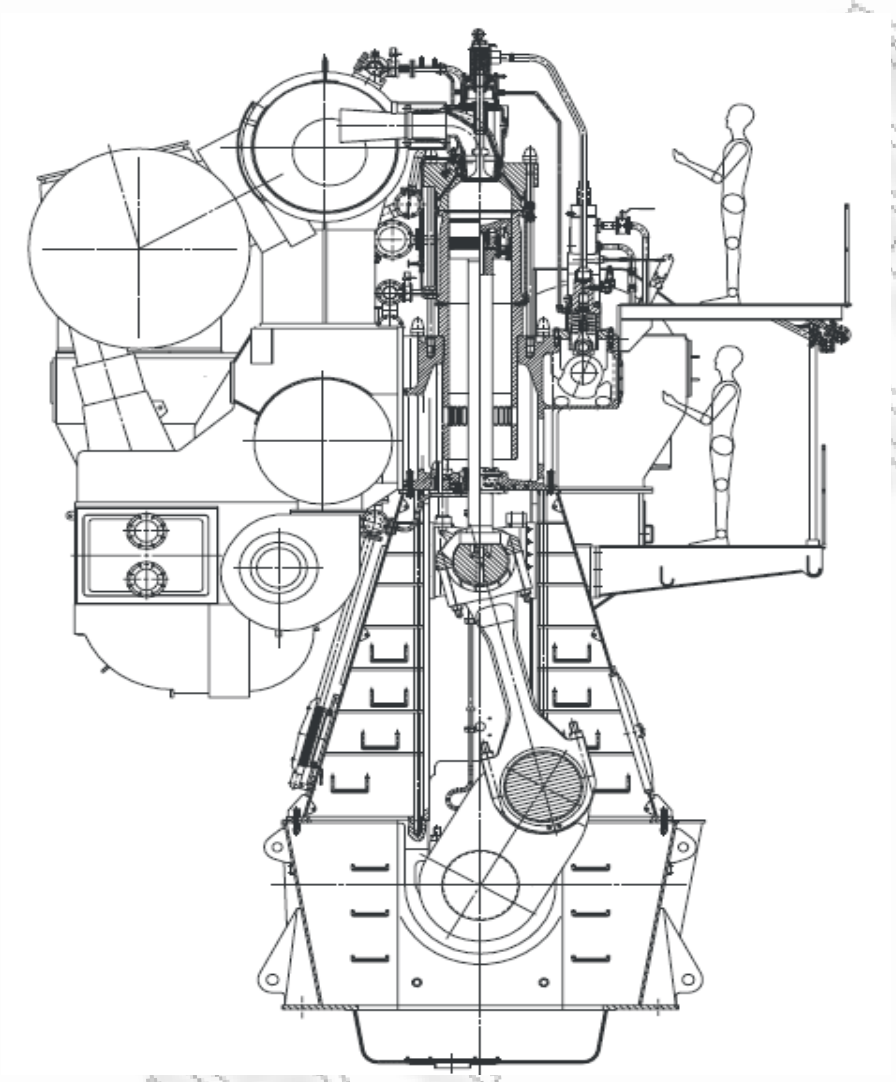
CAPACITY 4 X 30 OR TONS S.W.L. X 22 OR 24 M WORKING RADIUS, HOISTING

SPEED: ABT. 20 M/MIN.

CRANES ARE FITTED BETWEEN HOLDS, 1&2, 2&3, 3&4, 4&5.

MAIN ENGINE

TYPE	:	MAN B & W , 6S50MC-C, VERTICAL, 2-STROKE, SINGLE ACTION, REVERSIBLE CONSTANT, PRESSURE TURBOCHARGED MARINE DIESEL ENGINE.
SET	:	1
RPM	:	110
B.H.P	:	10,996
T/C	:	TYPE ABB TPL 77-B11
FUEL	:	M/E CAN OPERATE WITH HEAVY FUEL OIL WITH VISCOSITY UP TO 6,000SEC. RWI 100 FAR.DEGR. AND GRAVITY LES THAN OR EQUAL TO 0.991.



(**Fig. No 2**, MAN B & W, 6S50MC-C,VERTICAL , 2-STROKE, SINGLE ACTION, Ref. [16])

DIESEL GENERATORS

TYPE	:	YANMAR 6N21LUV
B.H.P	:	896
R.P.M	:	720
KW	:	600
FUEL	:	CAN BE OPERATED WITH HEAVY FUEL OIL WITH VISCOSITY UP TO 6,000SEC RWI 100 FAR. DEGR.

AND SPECIFIC GRAVITY LESS THAN OR EQUAL TO 0.991 AT NORMAL LOAD CONDITION, M.D.O AT START, STOP AND LOW LOAD CONDITION.

SET	:	3
VOLT	:	440/220
HZ	:	60
T/C	:	TYPE I.H.I RH 143/163 (VER Y)

EMERGENCY DIESEL GENERATOR

DIESEL OIL BURNING DIESEL FOUR STROKE ENGINE DRIVEN

SET	:	1
A/C	:	450V
HZ	:	60, 3-PH BRUSHLESS

PROPELLER

PROPELLER SOLID BLADED KEYLESS TYPE , ALUMINIUM BRONZE
5-BLADE PROPELLER

(**Photo No 1**, Vessel M/V SEABOSS, Anchorage of Singapore 2007, Ref. [17])

Trade definition

Major bulk commodities consist of coal, iron ore and grain, while minor bulk commodities include steel products, forest products, agricultural products, bauxite and alumina, phosphates, petcock, cement, sugar, salt, minerals, scrap metal and pig iron.

This vessel (M/V SEABOSS) is fitted with five cargo holds and five hatches and retains a high degree of trading flexibility as their cargo enables them to load and / or discharge at ports with limited facilities. This bulk carrier generally trades in both short – haul and long – haul routes across various geographies. The decisive factor in whether a ship trades over a short or long distance is the type of commodity carried. Typically, low value raw materials are seldom carried over long distances by this type of vessel (Handymax), while high-value commodities are transported in a shorter distance by smaller categories like Handysize.

(**Photo No 2**, Vessel M/V SEABOSS, Discharging Port of Villanueva 2012, Ref. [17])

Major bulk commodities (i.e. coal, iron ore, and grain) are accounted for approximately 64% of the dry bulk carrier trade by volume, based on the vessel cargo carrying capacity in 2005.

The relative significance of the major bulks has risen substantially since the mid-1990s, when they collectively accounted for 56% of the total seaborne dry bulk trade. Minor bulk commodities accounted for approximately 40% of the dry carrier trade by volume based on vessel cargo carrying capacity in 2004; with Handymax dry bulk carriers handling approximately 80% of this trade.

By using the specific software program from the Shipping Company, we can observe the last 4 months trade definitions, plus the duration of the importation and exportation in the port.

THENAMARIS INC. DURATION IN PORT DATE:05/07
---TECHNICAL DEPT 01/04 - 05/07 PAGE 1

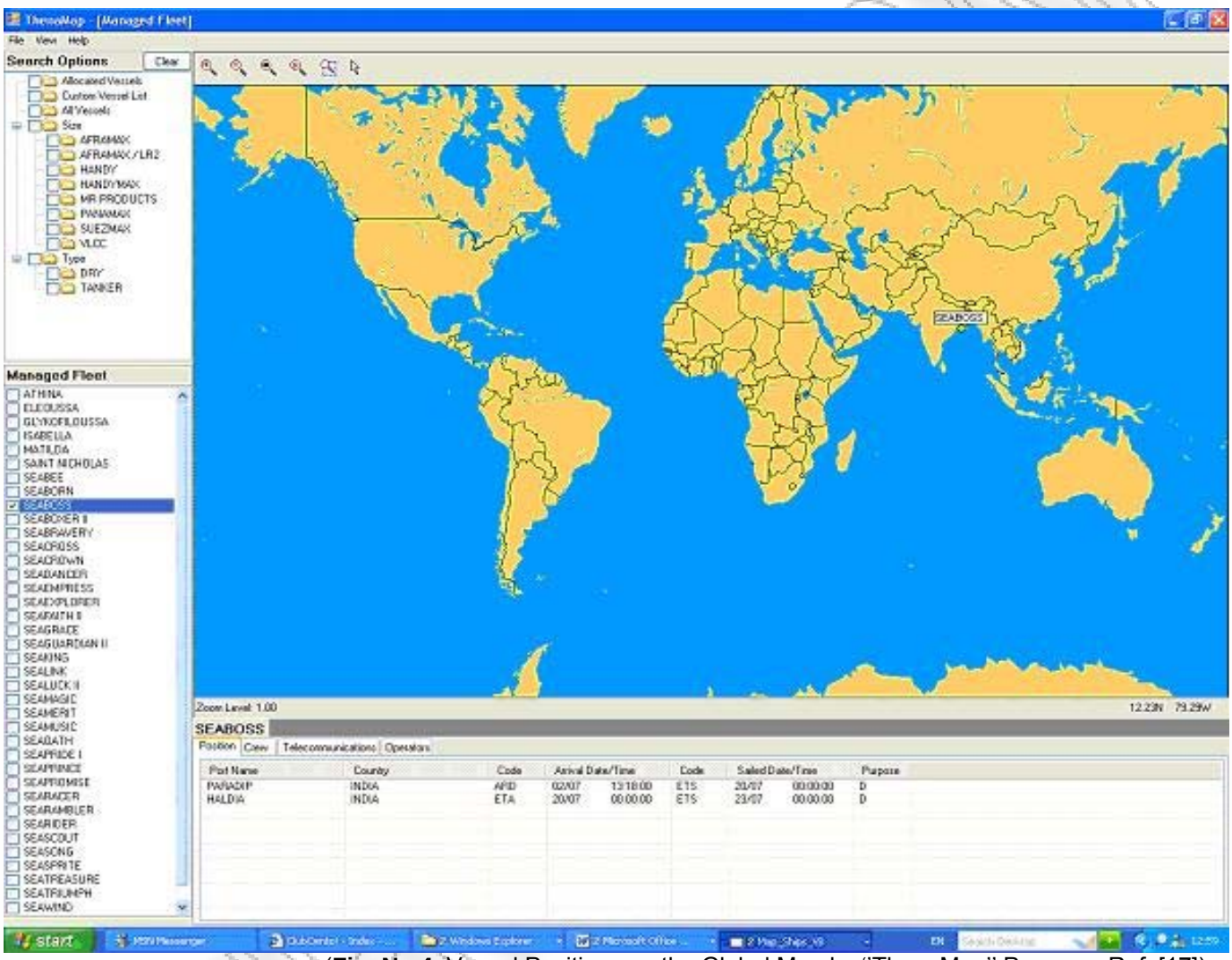
PORT	VOY	ARRIVED	FULL AWAY	PUR	DURATION
VESSEL: MD - SEABOSS					
TOYOHASHI	06/ 13 TCLP ARD	02/04 2340	SLD 05/04 1652	D	2 17 12
YOKKAICHI	06/ 13 TCLP ARD	05/04 2015	SLD 06/04 2048	D	1 33
JURONG ANCH.	06/ 13 TCLP ARD	14/04 1710	SLD 19/04 1430	L	4 21 12
VILLANUEVA	06/ 13 TCLP ARD	23/04 0300	SLD 26/04 0800	D	3 5
TANJUNG BARA	06/ 13 TCLP ARD	28/04 1100	SLD 30/04 2100	L	2 10
AMAMAPARE	06/ 13 TCLP ARD	05/05 0130	SLD 15/05 1224	D	10 10 54
TANJUNG BARA	06/ 13 TCLP ARD	19/05 0718	SLD 22/05 0430	L	2 21 12
BALIKPAPAN	06/ 13 TCLP ARD	22/05 1642	SLD 23/05 0248	B	10 6
AMAMAPARE	06/ 13 TCLP ARD	27/05 1330	SLD 04/06 1700	D	8 3 30
HAY POINT	06/ 13 TCLP ARD	09/06 0010	SLD 16/06 2100	L	7 20 42
SINGAPORE	06/ 13 TCLP ARD	27/06 0854	SLD 27/06 1812	B	9 18
PARADIP	06/ 13 TCLP ARD	02/07 1310	ETS 20/07 0000	D	17 10 42

TOTAL RECORDS: 12
TOTAL DURATION (EXC. OFF-HIRE & TRANSFER: 61 20 21
Total lines 25 recsiz-100

(**Fig. No 3**, Duration in Ports by ‘‘CRT’’ Program, Ref. [17])

As we can see from the above screen, the average days between arrivals and departures are 3-5 days. Moreover, we can observe the duration of staying at each port on the right hand side. This information is rather useful for spare parts supply needs. For more details, we can see the Position List by ‘‘CRT’’ Program, *Appendix No 9*.

Therefore, we are informed at anytime about the specific vessel position and the history voyage plan, due to the arrangement for sending any spare parts items to our vessel in emergency situations because of a machinery fault or machinery breakdown.



(**Fig. No 4**, Vessel Positions on the Global Map by ''ThenaMap'' Program, Ref. [17])

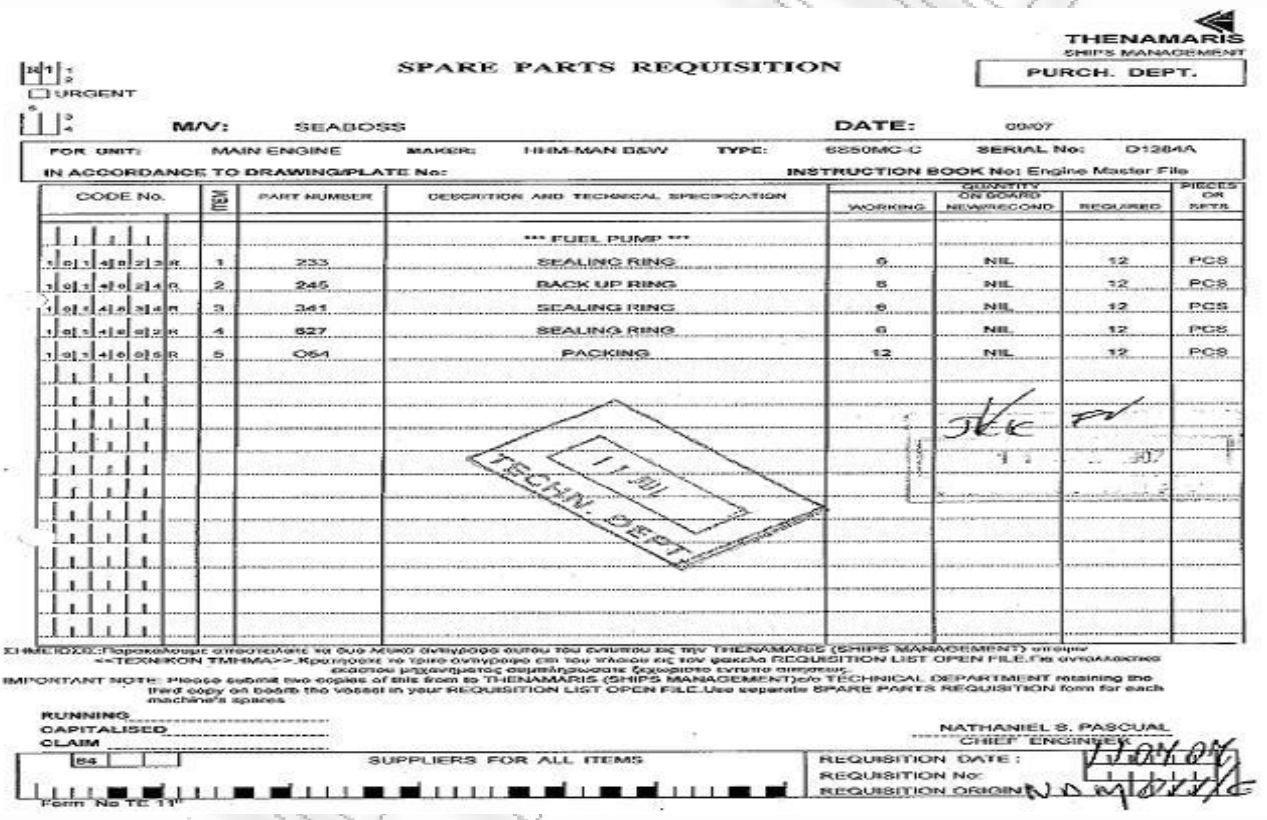
We can observe at this point on the global map (*Figure No 4*) where the vessel line is. In this specific program, we are informed about the position, the crew, the telecommunication and the operators of each vessel of the Shipping Company. Therefore, our examined vessel (M/V SEABOSS), is in Paradip port and goes to Haldia port (India) where the arrival date/time is 23/07/2012 and 00:00

Spare parts market definition

We will try to discuss the total procedure of order and delivery of the spare parts from the supplier to the vessel.

The order of spare parts follows this procedure:
As usual, we order spare parts on the vessel using the form of ''Spare Parts Requisition'' which an A' Engineer and a Lieutenant have to fill out according to their own supervision.

Below we can observe a completed form (Spare Parts Requisition).



THENAMARIS
SHIPS MANAGEMENT

SPARE PARTS REQUISITION

PURCH. DEPT.

☐ URGENT

M/V: SEABOSS DATE: 09/07

FOR UNIT: MAIN ENGINE MAKER: MAN-B&W TYPE: 6S50MC-C SERIAL No: D1284/A

IN ACCORDANCE TO DRAWING/PLATE No: INSTRUCTION BOOK No: Engine Master File

CODE No.	ITEM	PART NUMBER	DESCRIPTION AND TECHNICAL SPECIFICATION	QUANTITY ON BOARD WORKING	QUANTITY ON BOARD NEW/REGOND	REQUIRED	PIECES OR SETS
			*** FUEL PUMP ***				
1 0 1 4 0 2 2 R	1	233	SEALING RING	6	NIL	12	PCS
1 0 1 4 0 2 4 R	2	245	BACK UP RING	6	NIL	12	PCS
1 0 1 4 0 3 4 R	3	341	SEALING RING	6	NIL	12	PCS
1 0 1 4 0 4 2 R	4	827	SEALING RING	6	NIL	12	PCS
1 0 1 4 0 9 5 R	5	054	PACKING	12	NIL	12	PCS

TECHN. DEPT.

ΣΗΜΕΙΩΣΗ: Παρακαλούμε απαραιτήτως τα δύο λευκά αντίγραφα αυτού του εντύπου να αποσταλούν στην THENAMARIS (SHIPS MANAGEMENT) υπόψιν κ. «ΤΕΧΝΙΚΟΝ ΤΜΗΜΑ». Κρατήσατε το τρίτο αντίγραφο επί του πλοίου στο φάκελο REQUISITION LIST OPEN FILE. Για αντιμετώπιση εκάστου μηχανήματος αναπληρώστε ξεχωριστό έντυπο αιτησεως.

IMPORTANT NOTE: Please submit two copies of this from to THENAMARIS (SHIPS MANAGEMENT) c/o TECHNICAL DEPARTMENT retaining the third copy on board the vessel in your REQUISITION LIST OPEN FILE. Use separate SPARE PARTS REQUISITION form for each machine's spares

RUNNING
CAPITALISED
CLAIM

NATHANIEL S. PASCUAL
CHIEF ENGINEER

84 SUPPLIERS FOR ALL ITEMS

REQUISITION DATE : 1/10/07
REQUISITION No:
REQUISITION ORIGIN

Form No TE 11

(**Fig. No 6**, Spare Parts Requisition from the Purch. Dept., App. [8])

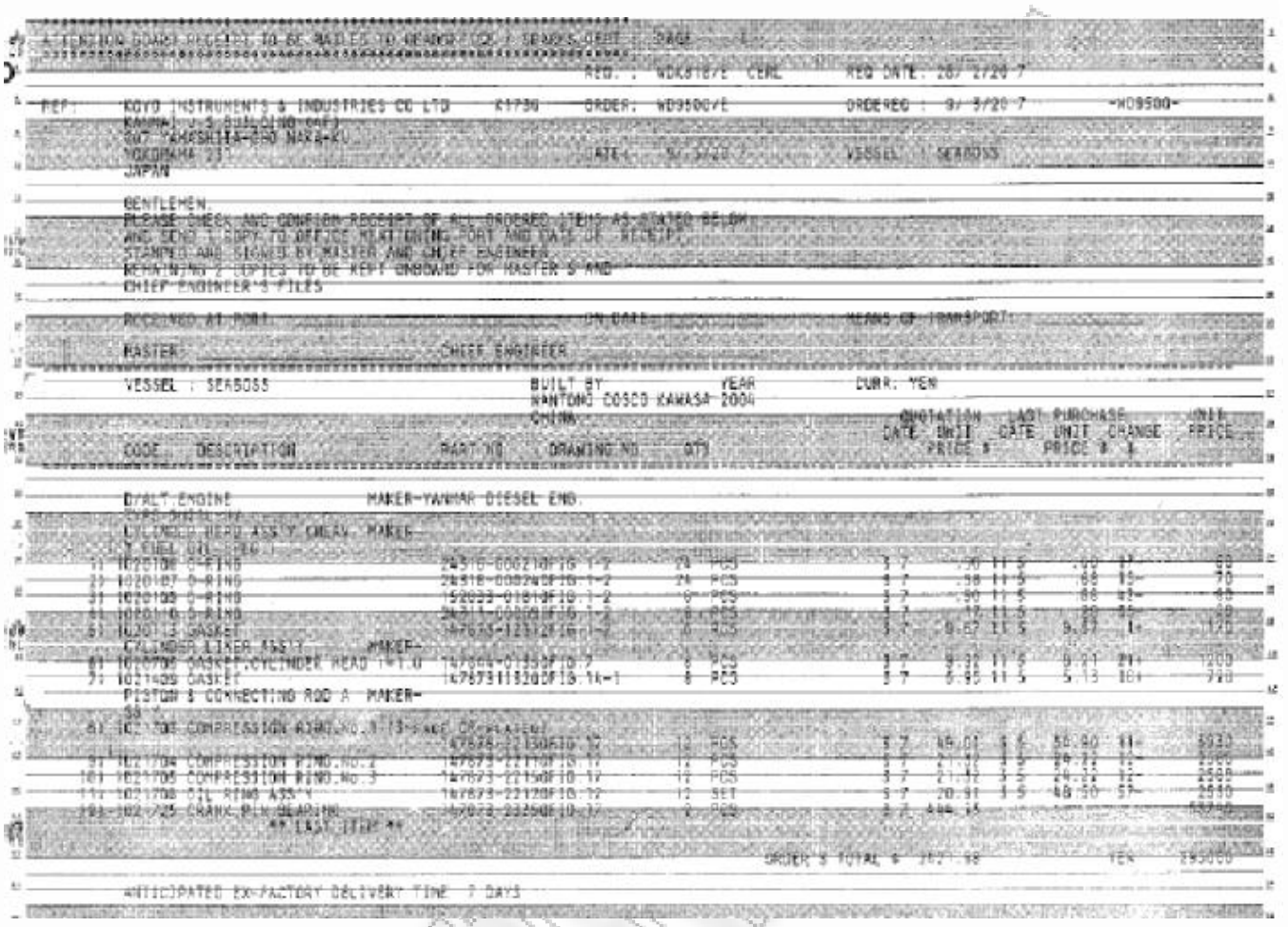
The ''SPARE PARTS REQUISITION'' for the supply of spare parts is submitted in triplicate by the Chief Engineers of the Shipping Company. For a more analytical observation we can see the *Appendix No 8*. The original and one copy of it (white page) are sent to the Office, while the other copy (red page) is kept in the vessel's file.

This form includes all necessary information about the requisition of spares and if all columns are properly filled out, the supply of spare parts will be the natural outcome. The headings in the requisition form require the Chief Engineer to give the ''NAME OF THE VESSEL'', the ''DATE'' of application, the ''UNIT'' (for example Main Engine etc.), the ''MAKER'', the ''SERIAL No'' of the unit, the ''DRAWING No'', where the spare part is mentioned, and the book identification where the part number was obtained. In the column ''CODE No'' the seven-digit code numbers of the required item from the computerized stock list are entered, if any.

Additional columns include the ''ITEM No'' (i.e. 1,2, etc.) the ''PART No'' according to the drawing, the ''DESCRIPTION'', the ''WORKING'' column with the number of pieces or sets of the part working onboard, the ''ON BOARD NEW/RECORD'' with the number of pieces or sets of the required part existing onboard new or reconditioned (i.e. 5/3 that means 5 New and 3 Re-conditioned) and ''REQUIRED'' with the number of pieces or sets required for the future use.

Once the requisition is received in the Headquarters, all written particulars are checked for their correctness (including the code number of each requisition) and then it is submitted to the Purchasing Department for the quotations (i.e. Prices from the various manufacturers or suppliers). For a more analytical observation we can see the *Fig. No 10* or *the Appendix No 8*.

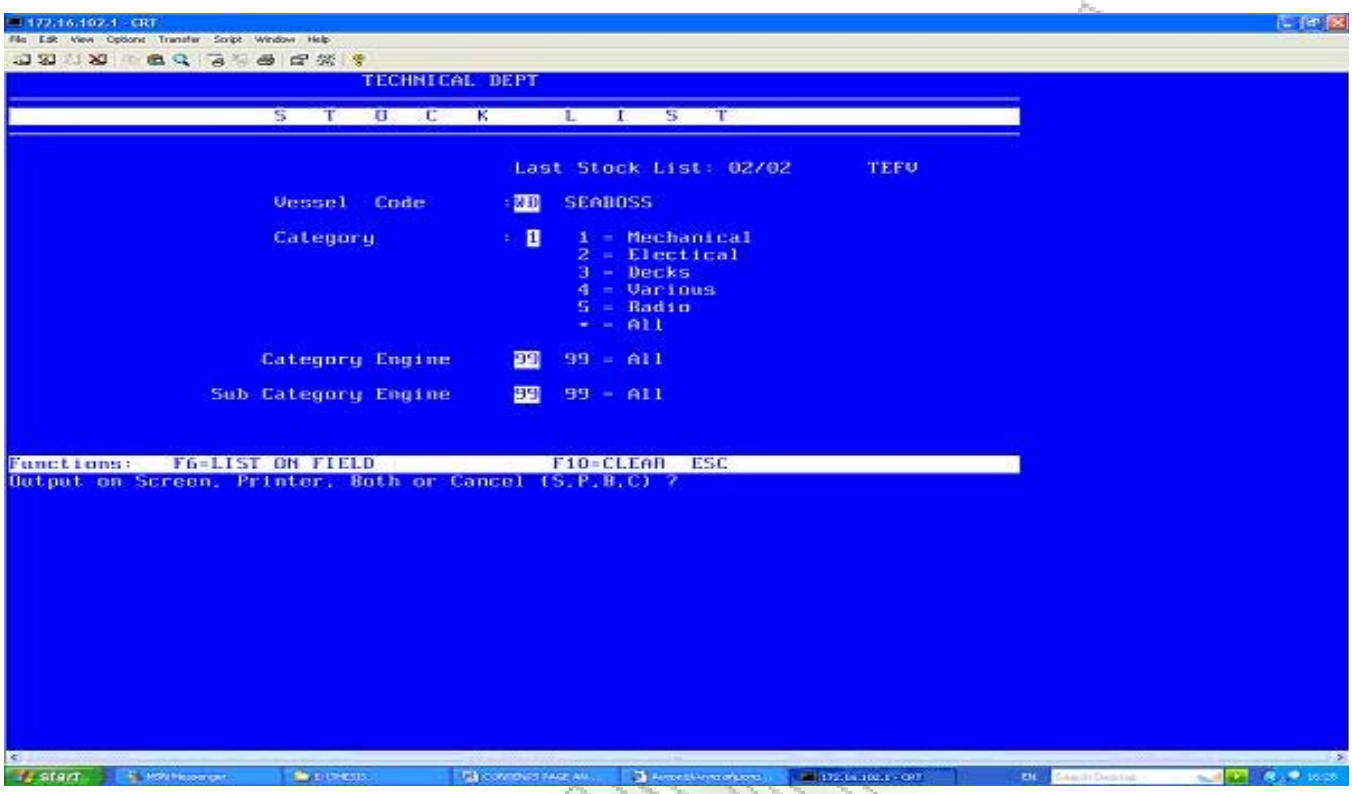
The Purchasing Department requests suppliers / makers for the availability of the spares, their prices and delivery time for comparison. Once a decision is reached, a ''PURCHASE ORDER'' is issued with the quantity of the ordered parts and the anticipated delivery time (we can observe the *Fig. No 7*). Three copies of this Purchase Order (P.O.) are sent onboard.
We have to keep in mind that a requisition, from the date received by the Company to the date that spares will be received onboard via normal transportation (i.e. by sea or land), requires at least four to six weeks under the best circumstances. Always we prepare the Spare Parts Requisition beforehand, in order to allow ample time until delivery onboard.



(**Fig. No 7**, Order Form from the Tech. Dept. App. [8])

Spare parts are delivered onboard by Company agents. When the spare parts, which are written on the Purchase Order (P.O.), are received, we check carefully if the delivered quantities agree with those on the P.O.(*Fig. No 7*); and are sent to the Master (Captain) who will counter-sign and stamp it with the vessel's seal.
This copy with the ''DELIVERY CONFIRMATION'' is sent to the office and the order is closed. For a more analytical observation, also we can see the *Appendix No 8*.

In case of a difference between the ordered and the delivered quantities (PARTIAL DELIVERY), we can make the relative remarks on the copy and advise the office accordingly to send a copy of the packing list (found in the box) or a letter to the office with explanatory remarks.



(**Fig. No 8**, Stock List by ''CRT'' Program, Ref. [17])

The company has established a computer Database for the following spares (i.e. Order, delivery etc.) which is efficient and easy to use. In order to update the system in operation, the Company has issued a ''Stock List'' in which essential and more frequently-used spares for all machinery (Mechanical-Electrical) are codified by assigning a code number to each spare part. We can observe at this point on the above screen (*Fig. No 8*) the software program for the Stock List, where it used by the Shipping Company.

Moreover, each spare part found in the Stock List is represented by a seven (7) digit code number which never changes. In case of an emergency, instead of giving all particulars of the machinery and the description of the requested spares, only with a telex of the code number and quantity; the Company will know directly from the stock list exactly what is requested.

The stock list helps the information of the inventory list and the arrangement of spare parts since everything is readily found on the stock list; so we only have to complete the number of pieces or sets which exist onboard as spares.

The inventory list of spares is necessary to be carried out and sent to this office properly filled and as soon as possible, since all transactions concerning spares i.e. order purchase, delivery etc. are automatically processed. The reason for computerizing spares is to relieve Chief Engineers from the responsibility of follow-up; by using it, Chief Engineers are always familiar with what exists onboard and what spares are necessary for the near future.

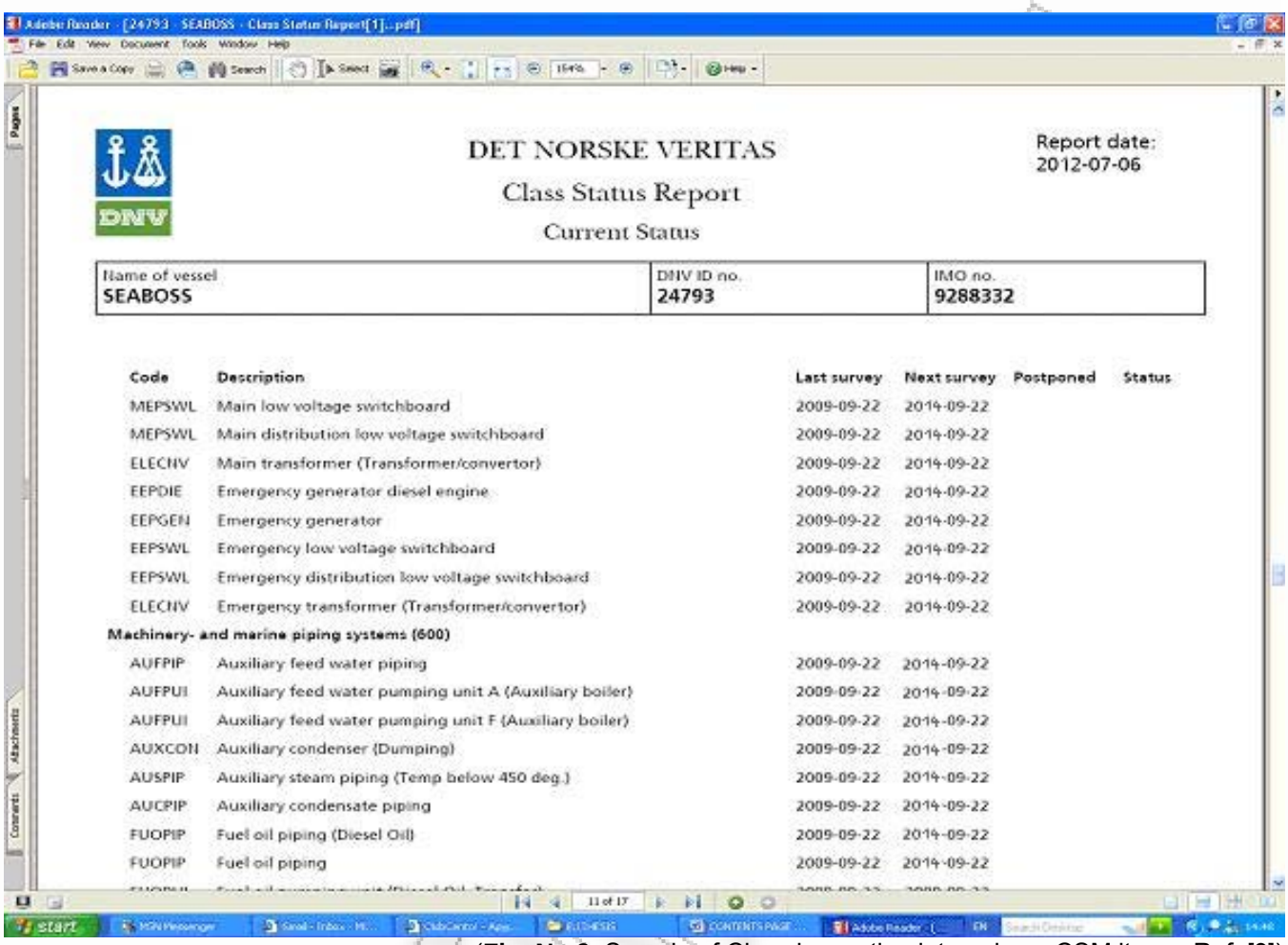
Assumptions

This study will be carried out for maintenance purposes only, hence unexpected or unpredictable damage will not be taken into account. Furthermore, it is very hard to predict future damage due to the existence of external factors or issues where the human effect is very low.


(Photo No 3, Vessel M/V SEABOSS, Discharging Port of Villanueva 2007, Ref. [17])

The vessel including its hull, machinery and equipment is built with certain Classification Society requirements, suitable notations on account of strengthened heavy cargoes with holds 2 and 4 empty, Hold No. 3 Ballast hold and unattended machinery. IACS Procedural Requirements demand member societies to provide monthly reports on ships according to class; class suspensions lasting more than 7 days, reinstatements, withdrawals, reassignments, transfers, and ISM Code and ISPS Code certificates are also issued.

In addition, we collected the Class status reports, the vessel Certificates (Class, Statutory), the vessel survey (Class, Statutory), but the most important status for our needs, are the Surveys of machinery items. Therefore, we have analytical descriptions and codes for the Propulsion and Steering, Electrical Power, Machinery- and Marine Piping Systems, Navigation, Communication and Control.



DET NORSKE VERITAS

Class Status Report

Current Status

Report date: 2012-07-06

Name of vessel	DNV ID no.	IMO no.
SEABOSS	24793	9288332

Code	Description	Last survey	Next survey	Postponed	Status
MEPSWL	Main low voltage switchboard	2009-09-22	2014-09-22		
MEPSWL	Main distribution low voltage switchboard	2009-09-22	2014-09-22		
ELECNV	Main transformer (Transformer/convertor)	2009-09-22	2014-09-22		
EEPDIE	Emergency generator diesel engine	2009-09-22	2014-09-22		
EEPGEN	Emergency generator	2009-09-22	2014-09-22		
EEPSWL	Emergency low voltage switchboard	2009-09-22	2014-09-22		
EEPSWL	Emergency distribution low voltage switchboard	2009-09-22	2014-09-22		
ELECNV	Emergency transformer (Transformer/convertor)	2009-09-22	2014-09-22		
Machinery- and marine piping systems (600)					
AUFPIP	Auxiliary feed water piping	2009-09-22	2014-09-22		
AUFPUI	Auxiliary feed water pumping unit A (Auxiliary boiler)	2009-09-22	2014-09-22		
AUFPUI	Auxiliary feed water pumping unit F (Auxiliary boiler)	2009-09-22	2014-09-22		
AUXCON	Auxiliary condenser (Dumping)	2009-09-22	2014-09-22		
AUSPIP	Auxiliary steam piping (Temp below 450 deg.)	2009-09-22	2014-09-22		
AUCPIP	Auxiliary condensate piping	2009-09-22	2014-09-22		
FUOPIP	Fuel oil piping (Diesel Oil)	2009-09-22	2014-09-22		
FUOPIP	Fuel oil piping	2009-09-22	2014-09-22		

(**Fig. No 9**, Sample of Class inspection intervals on CSM items, Ref. [9])

For more details, we can observe the whole Class Status Report in the *Appendix No 4.*

Although this study will be carried out solely on one specific vessel, some systems / machinery data will be obtained by sister vessels or the same machinery which belongs to other vessels. In addition, when we have the opportunity to export the data from the sister vessels, we save time and money because of the fact that both knowledge and experience exist in the Technical Staff and as a result, we achieve the direct delivery of the particular item.

Financial data will be considered real and the product of unknown negotiations between the manager of the subject vessel and the market players. (I.e. manager's commercial value will not be excluded from the final figures). Therefore, we have one *Table* and one *Graph* below, where we can observe the currency exchange values (based on Nov 05, 2012).

	USD	GBP	CAD	EUR	AUD
USD	1	0.62626	0.99728	0.78205	0.96652
GBP	1.59679	1	1.59244	1.24876	1.54333
CAD	1.00273	0.62797	1	0.78418	0.96916
EUR	1.27869	0.80079	1.27522	1	1.23589
AUD	1.03464	0.64795	1.03182	0.80913	1

(**Table No 1**, Currency Exchange Values, Ref. [15])

(**Graph No 1**, American Dollars to 1 EUR, Ref. [15])

Limitations

Selected spare parts represent the basic structure of the vessel at a percent of 90% approximately. There are other spare parts that have not been included in the study since their importance was considered low during initial planning. Moreover, during their five-year function it is very hard to estimate their damage, either due to low running hours during their function, or because of the unnecessary machinery parts in a spare part. Therefore, we have selected the basic part numbers which are mentioned, either due to frequent difficulties observed on the spare parts or because of the continual supervision and check which are determined by the DNV.

CHAPTER No 3

Overhauling Intervals

For M/E according to maker's recommendations

MAN B&W RHRS 6S50MC-C SL03-423

MAN B&W Diesel A/S

Service Letter SL03-423/UM
March 2003

Mean Time Between Overhaul
Piston Overhaul
Action Code: WHEN CONVENIENT

Dear Sirs

On the basis of positive feedback from owners with large bore engines, we changed, in early 2002, our recommended "Guiding Overhaul Intervals" for piston overhauls from 8,000 hrs. to 12-16,000 hrs., and new instruction books were changed accordingly. At the same time, we also changed the interval for small and medium bore engines from 8,000 hrs. to 12,000-16,000 hrs., see the enclosure "Guiding Overhaul Intervals and Expected Service Life".

It is possible to obtain the above MTBO (mean time between overhaul) for engines fitted with the latest introduced features in the combustion chamber, i.e.:

- PC ring
- Pistons with high topland
- CPR (controlled pressure relief) top piston ring
- Piston rings with Alu-bronze coating
- Piston skirts with bronze rings

For engines with slide fuel valves, a further increase of MTBO can be expected for pistons and rings.

Against this background, we wish to present a more flexible approach to piston overhaul, taking also the type of vessel into consideration.

Generally, a well-lubricated piston with a good appearance and with an intact CPR piston ring should not be overhauled. An intact CPR ring means that the remaining pressure-relief grooves should be at least 1 mm deep.

HEAD OFFICE (& Postal address)
Teglholmsgade 41
DK-2450 Copenhagen SV
Telephone: +45 33 85 11 00
Telex: 16592 manbw dk
Telefax: +45 33 85 10 30
E-mail: manbw@manbw.dk
http://www.manbw.dk

DIESEL SERVICE
Teglholmsgade 41
DK-2450 Copenhagen SV
Telephone: +45 33 85 11 00
Telex: 31197 manbw dk
Telefax: +45 33 85 10 49
E-mail: diesel-service@manbw.dk

PRODUCTION
Teglholmsgade 35
DK-2450 Copenhagen SV
Telephone: +45 33 85 11 00
Telex: 19023 manfw dk
Telex: 19042 manfw dk
Telefax: +45 33 85 10 17
E-mail: manufacturing/copenhagen@manbw.dk

FORWARDING
Teglholmsgade 35
DK-2450 Copenhagen SV
Telephone: +45 33 85 11 00
Telex: 19023 manfw dk
Telex: 19042 manfw dk
Telefax: +45 33 85 10 16

MAN B&W Diesel A/S
Denmark
CVR.No.: 39 66 13 14

For containerships and bulk carriers, the piston overhauls should be based on regular inspections of the condition through the scavenge air ports, as per the instruction book, and only pistons which need overhauling according to such inspection should be pulled.

For tankers where piston overhauls could result in expensive off-hire due to lack of permission for immobilisation at the tanker terminals, planned overhaul at fixed intervals, for instance during dockings, is recommended.

For these reasons, we have introduced an overhauling interval instead of a fixed time, hereby giving the chief engineers the option to pull the pistons when most convenient.

Questions or comments regarding this SL should be directed to our Dept. 2300.

Yours faithfully
MAN B&W Diesel A/S

Ole Grøne Mikael C Jensen

Thanks to the above Service Letter, from the MAN B&W, we can calculate the mean time between overhauls during the function of every spare part. Putting the following table into practice, we will have the overhauling intervals we are in need of for the five-year function of the vessel. For a more analytical observation we can see the *Appendix No 5.*

MAN B&W Diesel A/S

Guiding Overhaul Intervals and Expected Service Life

Component	Overhauling intervals (in hours)	Expected service life in hours, based on average wear	Remarks
Cylinder liner	12-16,000	98MC 80,000 90MC 80,000 80MC 70,000 70MC 70,000 60MC 60,000 50MC 60,000 46MC 50,000 42MC 50,000 35MC 50,000 26MC 40,000	Overall cylinder condition to be checked frequently through scavenge ports, preferably once every month
Piston rings	12-16,000	12-16,000	
Piston crown	12-16,000	Same as for cylinder liner for the respective type	Pressure test at every second piston overhaul
		Rechroming of ring grooves when need indicated by measurements, typically at every second scheduled overhaul	
		Reconditioning of piston crown by welding-up is possible two times	
Stuffing box	12-16,000	12-24,000	Renewal of lamellas
Exhaust valve spindle and bottom piece (cage)	Grinding of seats: 98-70MC 1) 6,000 2) 16,000 60-26MC 1) 3,000 2) 16,000 1) Initial inspection 2) Subsequent inspections	100,000 for Nimonic exhaust valves 60,000 for austenitic steel spindles Reconditioning of seat (hard facing) and possible welding-up of spindle disc underside for austenitic steel spindles	Originally chrome-plated spindle stem may be reconditioned by either rechroming or by HVOF-coating. Originally HVOF-coated stem or HVOF reconditioned stem will normally not need reconditioning

MAN B&W Diesel A/S 2

Component	Overhaul intervals	Expected lifetime	Remarks
Actuator gear	32,000 hydraulic system	64,000	
Fuel valve	8,000 depending on fuel quality	8,000 valve nozzle 16,000 spindle guide	Overhaul, and replace nozzle every 8,000 hours
Fuel pump plunger and barrel, suction valve and shock absorber	16,000 based on engine observations	40,000 renewal or reconditioning	Change sealing rings on barrel, plunger and suction valve
Cylinder cover		96,000	Check for burned grooves at fuel valve nozzle holes. Perform welding-up if required
Starting valve, safety valve and indicator cock	12,000	Total engine lifetime	
Cylinder lubricator	Mechanical lubricator 16,000	Total engine lifetime	Cleaning of oil reservoir, filter and pumps. Checking of timing and adjustment
	Alpha Lubricator 16,000	Total engine lifetime	Accumulators to be refilled
Crosshead bearings Main bearings Crank bearings Thrust bearing	6-8,000 (every year) checking of clearances and crankshaft deflection	64,000 crosshead bearings 96,000 main bearings 96,000 crank bearings 96,000 thrust bearing	Bearings should only be opened up if bearing material fragments fall out. Inspections according to classification requirements
Roller guide for fuel pump and exhaust valve	1,500 check condition in situ	Total engine lifetime	Check running surfaces and free rotation of roller
Chains	3-4,000 (every six months). Retightening of chains	96,000	

MAN B&W Diesel A/S 3

Component	Overhaul intervals	Expected lifetime	Remarks
Chain wheels and rubber guide bars	3-4,000 visual inspection	96,000 chain wheels 32,000 guide bars	First inspections and retightening after 500, 1,000 and 1,500 hours in total service
Reversing and regulating gear	3-4,000 checking of moving parts	Total engine lifetime	Pneumatic/hydraulic governor: Oil change every 4,000 hours
Tie rods including bracing screws	6-8,000 retightening (every year)	Total engine lifetime	
Holding down bolts	6-8,000 retightening (every year)	Total engine lifetime	
Turbocharger	Dry cleaning normally once a day. Manual cleaning and condition check of nozzle ring, turbine blades and shroud ring based on observations, normally once a year	According to maker's recommendations	See manufacturer's special recommendations
Air cooler(s) Air filters	Cleaning based on engine observations	40-50,000	Cleaning before differential pressure has increased by 50% compared to sea trial value
Flaps and butterfly valves in scavenge air receiver	Check movement at every scavenge port inspection	Total engine lifetime	
Various fuel and lubricating oil filters. Camshaft filters and TCS filters, if any	Cleaning based on engine observations		
Lubricating oil bottom tank	16,000 cleaning		

2300/PXN/JCB
March 2003

(**Table No 2**, Guiding Overhaul Intervals and Expected Life, Ref. [1])

For D/G according to maker's recommendations

6. MAINTENANCE CHECKING (Engine Using Heavy Fuel Oil) YANMAR 6N21(A)L-V

Table 6-3. Checking Table for Engine Using Heavy Fuel Oil (R.W. No.1 at 100°F 1,500 ~ 7,000-sec. Equivalent Fuel Oil) (1/3)

An asterisk (*) given in the following tables refers to the timing of initial check after the initial start or part replacement. Perform the check from the second time and onward at the ordinary frequency.

Div.	Part to Be Checked	Nature of Service	Checking & Servicing Frequency (hrs.) 3 mo. or 1,000 ~ 1,500	6 mo. or 2,000 ~ 2,500	1 yr. or 4,000 ~ 5,000	2 ~ 3 yr. or 8,000 ~ 10,000	5 yr. or 16,000 ~ 20,000	
Cylinder head	Fuel injection valve	Drawing-out check & adjustment	1,500 ~ 2,000					1st time:500~600hrs
	Cylinder head	Check & adjustment of the valve head clearance	○					
		Check of valve spring			○			
		Check disassembly & check of valve rotator			○			
		Disassembly, check & cleaning			○			
		Grinding of suc./ehx. valve seat			○			
		Scale cleaning & hydraulic test of water chamber				○		
		Replacement of stem seal (Suc./Ehx. Valve)				○		
		Check of cyl. head bolt tightening force		*	○			
Major Moving Parts	Piston	Drawing-out, cleaning, checking & measurement of piston				○		
		Check & measurement of piston rings				○		
		Check & measurement of piston pin				○		
	Connecting rod	Check & measurement of piston pin metal				○		
		Check & measurement of crank-pin metal				○		
		Check of connecting rod bolt tightening force				○		
		Change of connecting rod bolts						20,000 hrs.
	Cyl. liner	Inner dia. checking, cleaning & measurement				○		
		Drawing-out, check & cleaning of water jacket part					○	
	Crankshaft	Measurement of crank pin outer dia. & journal				○		
		Measurement & adjustment of deflection		○				
	Main bearing	Disassembly, metal checking & measurement				○		
		Check on tightening force of main bearing clamping bolts				○		
		Check on tightening force of side bolts				○		
	Camshaft	Check of cam & roller bearing			○			
		Disassembly & check of fuel pump tappet				○		
		Disassembly, check & measurement of swing arm				○		
		Drawing-out of crankshaft & bearing check & measurement					○	
	Timing gear	Check of tooth bearing & backlash				○		
		Disassembly of idle gear & check & measurement of bearing					○	
		Check of idle gear mounted shaft tightening force					○	

6. MAINTENANCE CHECKING(Engine Using Heavy Fuel Oil) YANMAR 6N21(A)L-V

Table 6-3. Checking Table for Engine Using Heavy Fuel Oil (R.W. No.1 at 100°F 1,500 ~ 7,000-sec. Equivalent Fuel Oil) (3/3)

Div.	Part to Be Checked	Nature of Service	Checking Servicing Cycle (hrs.)						
			3 mo. or 1,000 ~ 1,500	3 mo. or 2,000 ~ 2,500	1 yr. or 4,000 ~ 5,000	2 ~ 3 yr. or 8,000 ~ 10,000	5 yr. or 16,000 ~ 20,000		
Cooling Water System	Thermostatic valve	Disassembly, check & cleaning		○					
	Cooling water pump	Disassembly, check & measurement			○				
		Replacement of mechanical seal			○				
	Fresh water cooler	Disassembly, check, cleaning & hydraulic test			○				
	Cooling water (Fresh water)	Change (depended on results of property analysis)			○				
	Sea water cooling parts	Check of anticorrosive zinc & replacement (Air cooler & Lub. oil cooler)	○						
Other	Turbocharger	Disassembly & cleaning			○				
	Boost air cooler	Disassembly, check, cleaning & hydraulic test			○				
	Starting air motor	Disassemble and clean the muffler element. (Clean with neutral detergent.)						Every 6 months	
		Remove the starting motor from the engine and turn the pinion gear manually, check that it turns smoothly and it emits no abnormal sound.						Every 6 months	
		Disassembly, inspection, cleaning and replacement of grease of moving parts. replacement of o-ring, first reduction gear bearing and special grease inside the reduction gear.				○			
		Disassembly, inspection, cleaning and replacement of grease of moving parts. replacement of o-ring, 1st & 2nd reduction gear bearings and special grease inside the reduction gear.					○		
	Engine tachometer	Calibration of indication			○				
	Alarm switch	Actuation test		○					

(**Table No 3**, Maintenance Checking for Diesel Generator according to Makers' Recommendations, Ref. [5])

Using the same idea from the Maintenance checking, we can create one list (in the Microsoft Office Program-Excel) where we notice the most important parts of the Engine Using Heavy Fuel Oil. We can see the *Appendix No 5* for a more analytical observation.

For remaining machinery systems according to the manager's policy

Below we create one list of the most important parts, which depict the rest of the most important machinery parts in the vessel, including the ''Various Machinery'', ''Various Pumps'' and the ''Navigation-Communication Equipment''.

''Various Machinery''

1. H.F.O. SEPARATOR
BOWL SPINDLE
FRICTION BLOCK

2. L.O. SEPARATOR
BOWL SPINDLE
FROCTION BLOCK

3. BOILER - F.O. BURNER & ACCESS
F.O. ATOMISER
D.O. ATOMISER
FLAME EYE
FLAME DETECTOR
FIRING ELECTRODES
MANHOLE GASKETS
WATER LEVEL GAUGES

4. MAIN COMPRESSOR
PISTON (STAGE I/LP)
PISTON (STAGE II/HP)
PISTON RINGS (I/LP)
PISTON RINGS (II/HP)
CYL. BLOCK
CYL. HEAD
CON. ROD (LP-HP)
MAIN BEARING (FLYWH SIDE)
MAIN BEARING (VENT-SIDE)
CON. ROD BEARINGS
SUCT V/V (STAGE I/LP)
DELY V/V (STAGE I/LP)
SUCT V/V (STAGE II/LP)
DELY V/V (STAGE II/LP)

5. PROPELLER & SHAFTING
PROPELLER
PROPELLER SHAFT
SIMPLEX SEALS FWD
SIMPLEX SEALS AFT
SIMPLEX LINER FWD
SIMPLEX LINER AFT

6. RUDDER
RUDDER PINTLE BUSH
RUDDER PINTLE BUSH

7. ANCHOR
ANCHOR
ANCHOR SWIVELS
ANCHOR KENTER SHA
ANCHOR D SHACKLES

''Various Pumps''

1. STEER GEAR HYDR. P/P
PISTONS / VANES
SUCTION V/V
OIL SEALS

2. M/E L.O. PUMP
MECHANICAL OIL SEALS
BEARINGS

3. STERN TUBE L.O. P/P
BEARINGS

4. JACKET COOL F.W. PUMP
IMPELLER
SHAFT
MOUTH RINGS
SHAFT SLEEVES

5. CENTRAL COOL F.W. P/P
IMPELLER
SHAFT
MOUTH RINGS
SHAFT SLEEVES

6. EVAPOR. DISTILLED PUMP
IMPELLER
SHAFT
MECHANICAL SEALS

7. CENTRIFICAL BOILER FEED PUMP
IMPELLER
SHAFT
MOUTH RINGS
CASING RINGS
SHAFT SLEEVES

8. MAIN S.W. COOL PUMP
IMPELLER
SHAFT
MECHANICAL SEAL
MOUTH RING
SHAFT SLEEVE

10. PISTON BILGE PUMP
PISTON
LINER
PISTON RINGS
SUCTION VALVES
DELIVERY VALVES
BEARINGS

11. EVAP. EJECTOR PUMP
IMPELLER
SHAFT
MECHANICAL SEALS

12. M/E BOOSTER PUMP
GEAR SET
BEARINGS

13. BOILER F.O. BURN PUMP
MECHANICAL SEALS
BEARINGS

14. EMERG. FIRE PUMP
IMPELLER
SHAFT
MECHANICAL SEALS
MOUTH RINGS
SHAFT SLEEVES

15. BALLAST PUMP
IMPELLER
SHAFT
MECHANICAL SEALS
MOUTH RINGS
SHAFT SLEEVES
BEARINGS

16. HYDR. PUMP/MOTOR FOR DECK MACHINERY
HYDRAULIC P/P COMPL.
HYDRAULIC MOTOR COMPL.
PISTON / VANES
MECHANICAL SEALS
BEARINGS

9. GEN.SERVIS & FIRE P/P	**17. DECK CRANES**
IMPELLER	HYDR. P/P FOR HOISTING
SHAFT	DOUBLE GEAR P/P FOR LUFFING
MECHANICAL SEALS	HYDR. P/P FOR SLEWING
MOUTH RINGS	HYDR. MOTOR FOR HOISTING
CASING RINGS	HYDR. MOTOR FOR SLEWING
SHAFT SLEEVES	ROTARY GROUP
	TRIPLE GEAR P/P
	ROLLER BEARINGS
	CABLE

''Navigation/Communication Equipment''

1. NAVIGATION - COMM. EQUIP.	**4. GMDSS**
NAVIGATION LIGHT BUILBS	FURUNO, RELAY 24V DC, BATT, CHARGED
ALDIS LAMP SPARE BUILBS	FURUNO, BRIDGE RECTIFIER BATT. CHARGER
	ILLUMINATION LAMPS
2. RADAR	
CARBON BRUSHES FOR SCANNER DRIVE MOTOR	**5. INMARSAT A / B**
MAGNETRON TUBE FOR No1 RADAR	INMARSAT A / B , AZIMOUTH BELT FOR ANTENNA
MAGNETRON TUBE FOR No2 RADAR	INMARSAT A / B , ELEVATION BELT FOR ANTENNA
MODULATOR TUBE FOR No1 RADAR	VARIOUS FUSES
MODULATOR TUBE FOR No2 RADAR	
MIYER DIODES	**6. RADIO BATTERIES**
FUSES	BATTERIES
ILLUMINATION LAMPS	
	7. E.P.I.R.B.
3. GYROCOMPASS	E.P.I.R.B.
ILLUMINATION LAMPS FOR GYROREPEATERS	
VARIOUS FUSES	**8. G.P.S.**
GYROSHERE	G.P.S.

(**Table No 4**, Overhauling Intervals for Remain Machinery Systems according to the Managers' Policy)

In addition, in the *Appendix No 6* we can observe an extra questionnaire answered by the Superintendent Engineers and Chief Engineers, which is based on the average of running hours (overhauling interval) as per experience, apart from the above makers' recommendations.

CHAPTER No 4

Replacement Percentage

This survey relies on the questionnaire over a minimum of 7 active fleet managers and C/E, to determine for each part, replacement percentage at specified overhauling intervals. The average of estimation will be used to calculate how many parts are required for maintenance purposes over 5 years.

SPARES	TOTAL AVERAGE OF REPLACEMENT AT EVERY OVERHAUL	S.E.1	S.E.2	S.E.3	S.E.4	S.E.5	C.E.1	C.E.2
MAIN ENGINE								
1. CYLINDER COVER								
CYL. COVER	**0%**	0%	0%	0%	0%	0%	0%	0%
2. PISTON W/ROD								
PISTON ROD	**7%**	7%	5%	9%	4%	10%	7%	7%
PISTON CROWN	**7%**	7%	7%	10%	4%	9%	5%	7%
PISTON SKIRT	**0%**	0%	0%	0%	0%	0%	0%	0%
PISTON RINGS	**100%**	80%	100%	120%	90%	110%	100%	100%
TELESCOPIC PIPES	**5%**	5%	7%	3%	10%	2%	3%	5%
3. CYLINDER LINER								
CYL. LINER	**0%**	0%	0%	0%	0	0%	0%	0%
CYL. COOLING JACKET	**4%**	4%	6%	2%	5%	3%	4%	4%
4. CONN. ROD & CROSSHEAD								
CROSSHEAD PIN	**0%**	0%	0%	0%	0%	0%	0%	0%
CROSSHEAD BEARINGS (SET)	**0%**	0%	0%	0%	0%	0%	0%	0%
CRANKPIN BEARINGS (SET)	**0%**	0%	0%	0%	0%	0%	0%	0%
5. MAIN BEARING								
MAIN BEARING	**0%**	0%	0%	0%	0%	0%	0%	0%
6. EXHAUST V/V								
EXH. V/V COMPLETE	**3%**	3%	2%	4%	5%	2%	2%	3%
EXH. SPINDLE	**20%**	25%	25%	20%	12%	18%	17%	23%
EXH. SEAT	**20%**	25%	23%	17%	18%	22%	15%	20%

7. FUEL V/V								
FUEL V/V COMPL.	**3%**	3%	2%	2%	5%	4%	2%	3%
FUEL V/V NOZZLES	**20%**	25%	20%	15%	22%	18%	17%	23%
FUEL V/V GUIDE	**20%**	25%	20%	15%	22%	18%	23%	17%
8. STARTING V/V								
STARTING V/V COMPL.	**3%**	3%	2%	4%	5%	2%	2%	3%
9. RELIEF V/V								
RELIEF V/V COMPL.	**3%**	4%	2%	3%	3%	2%	2%	5%
10. FUEL P/P								
FUEL P/P COMP.	**2%**	2%	1%	1%	4%	2%	2%	2%
FUEL P/P BLOCK ONLY	**2%**	1%	1%	2%	4%	2%	2%	2%
FUEL P/P PLUNGER - BAREL	**25%**	25%	20%	27%	30%	23%	22%	28%
11. THRUST BEARINGS								
THRUST BRNG PADS	**0%**	0%	0%	0%	0%	0%	0%	0%
W/SENSOR POCKETS	**0%**	0%	0%	0%	0%	0%	0%	0%
12. CAMSHAFT BEARING								
CAMSHAFT BRNGS	**0%**	0%	0%	0%	0%	0%	0%	0%
13. CAMSHAFT								
FUEL P/P CAMS	**0%**	0%	0%	0%	0%	0%	0%	0%
EXH. V/V CAMS	**0%**	0%	0%	0%	0%	0%	0%	0%
14. INDICATING PUMP								
INDICATOR V/V COMPLETE	**10%**	8%	12%	10%	10%	7%	13%	10%
15. CYL. LUBRICATING PUMP								
CYL. LUBR. P/P COMPL. SET	**1.5%**	1.50%	1.30%	1.70%	2%	1%	1.6%	1.40%
CYL. LUBR. P/P ELEMENTS	**12%**	10%	14%	12%	15%	10%	11%	12%
16. TURBOCHARGER								
T/C ROTOR COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%
T/C BEARING BLOWER	**100%**	120%	100%	80%	100%	100%	90%	110%
T/C BEARING TURBINE	**100%**	80%	100%	120%	90%	110%	100%	100%
T/C CASING (OUTLET)	**0%**	0%	0%	0%	0%	0%	0%	0%
T/C CASING (INLET)	**0%**	0%	0%	0%	0%	0%	0%	0%
17. M/E GOVERNOR								
M/E GOVERNOR COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%

18. M/E AIR COOLER								
M/E AIR COOLER COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%

DIESEL GENERATORS

1. PISTON & CONN. ROD								
PISTON HEAD	**5%**	5%	3%	2%	12%	3%	5%	5%
PISTON PIN	**8%**	8%	6%	10%	8%	9%	7%	8%
PISTON PIN BUSH	**8%**	8%	7%	9%	8%	10%	6%	8%
PISTON RINGS	**100%**	80%	100%	120%	90%	110%	100%	100%

2. CONN. ROD								
CONN. ROD	**12%**	10%	14%	12%	15%	10%	11%	12%
CONN. ROD BOLTS	**14%**	14%	16%	12%	15%	13%	14%	14%
CRANKPIN BEARING SET	**15%**	10%	12%	20%	12%	17%	17%	17%

3. CYLINDER LINER								
CYLINDER LINERS	**3%**	5%	4%	2%	3%	3%	2%	2%

4. CYLINDER HEAD								
CYL. COVERS	**5%**	10%	3%	7%	5%	5%	3%	2%

5. INLET V/V								
INLET V/V SEATS	**25%**	25%	20%	27%	30%	23%	22%	28%
INLET V/V SPINDLES	**25%**	28%	22%	23%	30%	27%	20%	25%

6. EXHAUST V/V								
EXH. V/V SEATS	**25%**	25%	25%	25%	25%	25%	25%	25%
EXH. V/V SPINDLES	**25%**	27%	20%	25%	28%	22%	23%	30%

7. FUEL VALVES								
FUEL V/V COMPL.	**25%**	25%	25%	25%	25%	25%	25%	25%
FUEL V/V NOZZLES	**25%**	20%	25%	28%	22%	23%	30%	27%

8. INDICATOR & SAFETY V/V								
SAFETY VALVES	**7%**	5%	7%	7%	7%	10%	4%	9%
INDICATOR VALVES	**7%**	9%	5%	7%	7%	7%	10%	4%

9. STARTING VALVE								
STARTING V/V COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%
SERVICE KIT FOR TURBO STATER COMPLETE	**10%**	7%	10%	10%	12%	8%	10%	13%

10. VALVE ROTATOR								
ROTATOR COMPL.	**25%**	28%	22%	23%	30%	27%	20%	25%
11. V/V OPERATING DEVICE								
INLET V/V ROCKER ARMS	**7%**	4%	9%	5%	7%	7%	7%	10%
EXH. V/V ROCKER ARMS	**7%**	7%	7%	10%	4%	9%	5%	7%
12. FUEL PUMPS								
FUEL P/P COMPL.	**5%**	3%	2%	10%	3%	7%	5%	5%
FUEL P/P PLUNGER & BARREL	**10%**	13%	7%	10%	10%	12%	8%	10%
13. CRANKSHAFT								
CRANKSHAFT	**0%**	0%	0%	0%	0%	0%	0%	0%
14. MAIN BEARINGS								
MAIN BEARING SET	**0%**	0%	0%	0%	0%	0%	0%	0%
THRUST BEARING SET	**0%**	0%	0%	0%	0%	0%	0%	0%
15. CAMSHAFT								
CAMSHAFT	**0%**	0%	0%	0%	0%	0%	0%	0%
FUEL V/V CAMS	**0%**	0%	0%	0%	0%	0%	0%	0%
INLET V/V CAMS	**0%**	0%	0%	0%	0%	0%	0%	0%
EXHAUST V/V CAMS	**0%**	0%	0%	0%	0%	0%	0%	0%
CAMSHAFT BRNG SET	**0%**	0%	0%	0%	0%	0%	0%	0%
16. TURBOCHARGER								
T/C ROTOR COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%
T/C ROTOR	**0%**	0%	0%	0%	0%	0%	0%	0%
T/C CASINGS	**0%**	0%	0%	0%	0%	0%	0%	0%
T/C BEARING (BLOWER SIDE)	**60%**	60%	50%	70%	55%	65%	60%	60%
T/C BEARING (TURBINE SIDE)	**60%**	60%	60%	65%	55%	70%	50%	60%
17. G/E GOVERNOR								
GOVERNOR COMPLETE	**0%**	0%	0%	0%	0%	0%	0%	0%
18. LUBRICATING OIL P.P								
GEAR SET	**12%**	12%	11%	10%	15%	12%	14%	10%
BEARINGS	**12%**	10%	14%	12%	15%	10%	11%	12%
19. COOLING WATER P/P								
IMPELLER	**5%**	2%	10%	3%	7%	5%	5%	3%
SHAFT	**5%**	3%	10%	2%	3%	5%	5%	7%
MECHANICAL SEALS	**20%**	17%	23%	25%	20%	15%	22%	18%
MOUTH RINGS	**20%**	20%	15%	22%	18%	17%	23%	25%

EMERGENCY DIESEL

1. GENERATOR								
PISTON RINGS	**2%**	1%	4%	2%	2%	2%	2%	1%
NOZZLES	**2%**	1%	1%	4%	2%	2%	2%	2%
FUEL FILTER ELEMENT	**5%**	5%	7%	3%	10%	2%	3%	5%
LUB. OIL FILTER ELEMENT	**5%**	5%	3%	2%	10%	3%	7%	5%
MAIN BEARING	**0%**	0%	0%	0%	0%	0%	0%	0%
CRANKPIN BEARING	**0%**	0%	0%	0%	0%	0%	0%	0%
F.O. INJ. P/P PLUNGER W/BARREL	**0%**	0%	0%	0%	0%	0%	0%	0%

VARIOUS MACHINERY

1. H.F.O. SEPARATOR								
BOWL SPINDLE	**40%**	40%	45%	35%	42%	38%	40%	40%
FRICTION BLOCK	**60%**	50%	70%	55%	65%	60%	57%	63%

2. L.O. SEPARATOR								
BOWL SPINDLE	**40%**	40%	40%	38%	42%	35%	45%	40%
FROCTION BLOCK	**60%**	63%	57%	60%	65%	55%	70%	50%

3. BOILER - F.O. BURNER & ACCESS								
F.O. ATOMISER	**25%**	25%	20%	27%	30%	23%	22%	28%
D.O. ATOMISER	**25%**	28%	22%	23%	30%	27%	20%	25%
FLAME EYE	**0%**	0%	0%	0%	0%	0%	0%	0%
FLAME DETECTOR	**0%**	0%	0%	0%	0%	0%	0%	0%
FIRING ELECTRODES	**20%**	17%	18%	22%	15%	20%	25%	23%
MANHOLE GASKETS	**40%**	40%	45%	35%	42%	38%	40%	40%
WATER LEVEL GAUGES	**10%**	12%	10%	10%	7%	13%	10%	8%

4. MAIN COMPRESSOR								
PISTON (STAGE I/LP)	**10%**	13%	7%	10%	10%	12%	8%	10%
PISTON (STAGE II/HP)	**10%**	10%	10%	7%	13%	10%	8%	12%
PISTON RINGS (I/LP)	**40%**	40%	38%	42%	35%	45%	40%	40%
PISTON RINGS (II/HP)	**40%**	42%	35%	40%	40%	38%	40%	45%
CYL. BLOCK	**0%**	0%	0%	0%	0%	0%	0%	0%
CYL. HEAD	**0%**	0%	0%	0%	0%	0%	0%	0%
CON. ROD (LP-HP)	**0%**	0%	0%	0%	0%	0%	0%	0%
MAIN BEARING (FLYWH SIDE)	**10%**	10%	13%	7%	10%	10%	12%	8%
MAIN BEARING (VENT-SIDE)	**10%**	12%	10%	10%	7%	13%	10%	8%

CON. ROD BEARINGS	**10%**	12%	10%	10%	7%	13%	10%	8%
SUCT V/V (STAGE I/LP)	**30%**	30%	20%	40%	50%	20%	20%	30%
DELY V/V (STAGE I/LP)	**30%**	20%	30%	30%	20%	20%	50%	40%
SUCT V/V (STAGE II/LP)	**30%**	50%	40%	20%	20%	30%	30%	20%
DELY V/V (STAGE II/LP)	**30%**	20%	50%	40%	20%	30%	30%	20%

5. PROPELLER & SHAFTING								
PROPELLER	**0%**	0%	0%	0%	0%	0%	0%	0%
PROPELLER SHAFT	**0%**	0%	0%	0%	0%	0%	0%	0%
SIMPLEX SEALS FWD	**100%**	110%	90%	120%	100%	80%	100%	100%
SIMPLEX SEALS AFT	**100%**	120%	90%	80%	100%	110%	100%	100%
SIMPLEX LINER FWD	**50%**	70%	30%	50%	45%	50%	55%	50%
SIMPLEX LINER AFT	**50%**	70%	30%	45%	50%	55%	50%	50%

6. RUDDER								
RUDDER PINTLE BUSH	**100%**	100%	100%	100%	100%	100%	100%	100%
RUDDER PINTLE BUSH	**100%**	100%	100%	100%	100%	100%	100%	100%

7. ANCHOR								
ANCHOR	**0%**	0%	0%	0%	0%	0%	0%	0%
ANCHOR SWIVELS	**5%**	5%	5%	5%	5%	5%	5%	5%
ANCHOR KENTER SHA	**5%**	5%	5%	5%	5%	5%	5%	5%
ANCHOR D SHACKLES	**5%**	5%	5%	5%	5%	5%	5%	5%

VARIOUS PUMPS

1. STEER GEAR HYDR. P/P								
PISTONS / VANES	**10%**	10%	10%	12%	8%	7%	13%	10%
SUCTION V/V	**10%**	10%	10%	12%	8%	7%	13%	10%
OIL SEALS	**20%**	25%	20%	15%	22%	18%	17%	23%

2. M/E L.O. PUMP								
MECHANICAL OIL SEALS	**80%**	70%	90%	75%	85%	80%	70%	90%
BEARINGS	**100%**	80%	100%	120%	90%	110%	100%	100%

3. STERN TUBE L.O. P/P								
BEARINGS	**100%**	100%	100%	100%	100%	100%	100%	100%

4. JACKET COOL F.W. PUMP								
IMPELLER	**50%**	50%	70%	30%	45%	55%	50%	50%
SHAFT	**50%**	50%	70%	30%	45%	55%	50%	50%
MOUTH RINGS	**80%**	90%	70%	80%	85%	75%	90%	70%
SHAFT SLEEVES	**80%**	75%	85%	90%	70%	80%	70%	90%

5. CENTRAL COOL F.W. P/P								
IMPELLER	**50%**	50%	55%	45%	30%	70%	50%	50%
SHAFT	**50%**	50%	50%	50%	70%	30%	45%	55%
MOUTH RINGS	**80%**	70%	80%	85%	75%	90%	70%	90%
SHAFT SLEEVES	**80%**	70%	90%	70%	90%	75%	85%	80%

6. EVAPOR. DISTILLED PUMP								
IMPELLER	**50%**	50%	50%	50%	50%	50%	50%	50%
SHAFT	**50%**	30%	45%	55%	50%	50%	50%	70%
MECHANICAL SEALS	**80%**	90%	70%	90%	70%	80%	85%	75%

7. CENTRIFICAL BOILER FEED PUMP								
IMPELLER	**50%**	50%	55%	45%	30%	70%	50%	50%
SHAFT	**50%**	30%	45%	55%	50%	50%	50%	70%
MOUTH RINGS	**80%**	75%	85%	90%	70%	80%	70%	90%
CASING RINGS	**80%**	90%	70%	80%	85%	75%	90%	70%
SHAFT SLEEVES	**80%**	70%	80%	85%	75%	90%	70%	90%

8. MAIN S.W. COOL PUMP								
IMPELLER	**40%**	45%	35%	42%	40%	40%	38%	40%
SHAFT	**40%**	40%	45%	35%	42%	38%	40%	40%
MECHANICAL SEAL	**80%**	90%	70%	90%	70%	80%	85%	75%
MOUTH RING	**80%**	75%	85%	90%	70%	80%	70%	90%
SHAFT SLEEVE	**80%**	70%	80%	85%	75%	90%	70%	90%

9. GEN.SERVIS & FIRE P/P								
IMPELLER	**50%**	50%	55%	45%	30%	70%	50%	50%
SHAFT	**50%**	50%	70%	30%	45%	55%	50%	50%
MECHANICAL SEALS	**80%**	90%	70%	90%	70%	80%	85%	75%
MOUTH RINGS	**80%**	70%	80%	85%	75%	90%	70%	90%
CASING RINGS	**80%**	90%	70%	80%	85%	75%	90%	70%
SHAFT SLEEVES	**80%**	75%	85%	90%	70%	80%	70%	90%

10. PISTON BILGE PUMP								
PISTON	**50%**	50%	50%	50%	50%	50%	50%	50%
LINER	**50%**	50%	50%	50%	50%	50%	50%	50%
PISTON RINGS	**80%**	70%	90%	75%	85%	80%	70%	90%
SUCTION VALVES	**80%**	80%	70%	90%	70%	90%	75%	85%
DELIVERY VALVES	**80%**	70%	90%	70%	90%	75%	85%	80%
BEARINGS	**80%**	90%	70%	90%	75%	85%	80%	70%

11. EVAP. EJECTOR PUMP								
IMPELLER	**35%**	37%	32%	40%	30%	32%	37%	35%
SHAFT	**35%**	32%	40%	30%	32%	37%	35%	37%
MECHANICAL SEALS	**75%**	70%	80%	77%	73%	75%	72%	78%
12. M/E BOOSTER PUMP								
GEAR SET	**25%**	20%	27%	30%	28%	22%	23%	25%
BEARINGS	**100%**	100%	100%	100%	100%	100%	100%	100%
13. BOILER F.O. BURN PUMP								
MECHANICAL SEALS	**100%**	100%	100%	100%	100%	100%	100%	100%
BEARINGS	**100%**	100%	100%	100%	100%	100%	100%	100%
14. EMERG. FIRE PUMP								
IMPELLER	**50%**	50%	50%	50%	50%	50%	50%	50%
SHAFT	**50%**	50%	70%	30%	45%	55%	50%	50%
MECHANICAL SEALS	**100%**	100%	100%	100%	100%	100%	100%	100%
MOUTH RINGS	**100%**	80%	100%	120%	90%	110%	100%	100%
SHAFT SLEEVES	**100%**	100%	100%	100%	100%	100%	100%	100%
15. BALLAST PUMP								
IMPELLER	**50%**	50%	55%	45%	30%	70%	50%	50%
SHAFT	**50%**	30%	55%	50%	50%	70%	50%	45%
MECHANICAL SEALS	**100%**	100%	100%	100%	100%	100%	100%	100%
MOUTH RINGS	**100%**	80%	100%	120%	90%	110%	100%	100%
SHAFT SLEEVES	**100%**	110%	100%	100%	100%	80%	120%	90%
BEARINGS	**100%**	100%	100%	100%	100%	100%	100%	100%
16. HYDR. PUMP/MOTOR FOR DECK MACHINERY								
HYDRAULIC P/P COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%
HYDRAULIC MOTOR COMPL.	**0%**	0%	0%	0%	0%	0%	0%	0%
PISTON / VANES	**5%**	5%	3%	2%	10%	3%	7%	5%
MECHANICAL SEALS	**100%**	90%	90%	80%	100%	110%	110%	120%
BEARINGS	**100%**	100%	100%	100%	100%	100%	100%	100%
17. DECK CRANES								
HYDR. P/P FOR HOISTING	**0%**	0%	0%	0%	0%	0%	0%	0%
DOUBLE GEAR P/P FOR LUFF.	**0%**	0%	0%	0%	0%	0%	0%	0%
HYDR. P/P FOR SLEWING	**0%**	0%	0%	0%	0%	0%	0%	0%
HYDR. MOTOR FOR HOISTING	**0%**	0%	0%	0%	0%	0%	0%	0%
HYDR. MOTOR FOR SLEWING	**0%**	0%	0%	0%	0%	0%	0%	0%
ROTARY GROUP	**0%**	0%	0%	0%	0%	0%	0%	0%
TRIPLE GEAR P/P	**0%**	0%	0%	0%	0%	0%	0%	0%
ROLLER BEARINGS	**0%**	0%	0%	0%	0%	0%	0%	0%
CABLE	**10%**	12%	10%	10%	7%	13%	10%	8%

NAVIGATION / COMM. EQUIPMENT

1. NAVIGATION - COMM. EQUIP.								
NAVIGATION LIGHT BUILBS	**5%**	10%	2%	3%	5%	5%	7%	3%
ALDIS LAMP SPARE BUILBS	**0%**	0	0%	0	0%	0%	0%	0%

2. RADAR								
CARBON BRUSHES FOR SCANNER DRIVE MOTOR	**0%**	0%	0%	0%	0%	0%	0%	0%
MAGNETRON TUBE FOR No1 RADAR	**40%**	45%	35%	42%	38%	40%	40%	40%
MAGNETRON TUBE FOR No2 RADAR	**40%**	35%	42%	38%	40%	40%	40%	45%
MODULATOR TUBE FOR No1 RADAR	**40%**	42%	38%	40%	40%	40%	45%	35%
MODULATOR TUBE FOR No2 RADAR	**40%**	38%	40%	40%	40%	45%	35%	42%
MIYER DIODES	**21%**	25%	20%	22%	18%	17%	23%	25%
FUSES	**100%**	100%	100%	100%	100%	100%	100%	100%
ILLUMINATION LAMPS	**20%**	25%	20%	15%	22%	18%	17%	23%

3. GYROCOMPASS								
ILLUMINATION LAMPS FOR GYROREPEATERS	**0%**	0%	0%	0%	0%	0%	0%	0%
VARIOUS FUSES	**100%**	100%	100%	100%	100%	100%	100%	100%
GYROSHERE	**20%**	22%	15%	20%	25%	23%	17%	18%

4. GMDSS								
FURUNO, RELAY 24V DC, BATT, CHARGED	**14%**	14%	16%	12%	10%	18%	13%	15%
FURUNO, BRIDGE RECTIFIER BATT. CHARGER	**0%**	0%	0%	0%	0%	0%	0%	0%
ILLUMINATION LAMPS	**20%**	20%	20%	20%	20%	20%	20%	20%

5. INMARSAT A / B								
INMARSAT A / B , AZIMOUTH BELT FOR ANTENNA	**20%**	17%	18%	22%	15%	20%	25%	23%
INMARSAT A / B , ELEVATION BELT FOR ANTENNA	**20%**	20%	20%	20%	20%	20%	20%	20%
VARIOUS FUSES	**100%**	100%	120%	90%	110%	100%	100%	80%

6. RADIO BATTERIES								
BATTERIES	**25%**	25%	20%	27%	30%	23%	22%	28%
7. E.P.I.R.B.								
E.P.I.R.B.	**25%**	28%	22%	23%	30%	27%	20%	25%
8. G.P.S.								
G.P.S.	**25%**	27%	30%	23%	22%	28%	25%	20%

(**Table No 5**, Replacement Percentage, App.[6])

On this *Table No 5*, S.E.1, S.E.2, S.E.3, S.E.4, S.E.5 are the Superintendent Engineers, and CE1, CE2 are the Chief Engineers.

At this point we will try to explain what we mean ''Total Average of Replacement At every Overhauling'' and how we can calculate it. We have tried to collect information about the percentage replacement, from experienced Superintendent Engineers (total number: ''5'') and Chief Engineers (total number: ''2'') in the Shipping Company. For more details about each questionnaire, we can study the *Appendix No 6*. Our purpose is to find out the average of prices for replacement at every overhaul, so that we can use them for the calculation of total pieces needed for the 5-years interval.

By using two accidental examples (green marks) of calculations from the above *Table (No 5)*, we can observe that:

- For the ''MAIN ENGINE'' the Piston Crown needs **7%** replacement at every overhaul, where this 7% results from the average of the seven questionnaires (see Appendix No 6),

(S.E.1+S.E.2+S.E.3+S.E.4+S.E.5+C.E.1+C.E.2) ÷ 7 =

(7 + 7 + 10 + 4 + 9 + 5 + 7) ÷ 7 =

49 ÷ 7 =

7 → **7%**

, where this means that the 7% of the Piston Crown needs replacement at every 16,000 running hours (see page 29 -Guiding Overhaul Intervals- in Appendix *No 5*). As we can observe, the range is ''between'' 12,000h to 16,000h but we choose the 16,000h from the list ''Total Average of Running Hours as Per Experience'' (see *Appendix No 7*), as it results from the 7 questionnaires (see *Appendix No 6*).

(**Photo No 4**, Overhauling of Piston Crown at Vessel M/V SEABOSS, Ref.[17])

- For the ''DIESEL GENERATOR'' the Piston Head needs **5%** replacement at every overhaul, where this 5% results from the average of the seven questionnaires (see also Appendix No 6)

(S.E.1+S.E.2+S.E.3+S.E.4+S.E.5+C.E.1+C.E.2) ÷ 7 =

(5 + 3 + 2 + 12 + 3 + 5 + 5) ÷ 7 =

35 ÷ 7 =

5 → **5%**

, where it means that the 5% of the Piston Head needs replacement at every 10,000 running hours (see page 32-Maintenance Checking- also in *Appendix No 5*). As we can observe, the range is between 2~3 yr. or 8,000h to 10,000h but we choose the 10,000h from the list ''Total Average of Running Hours as Per Experience'' (see *Appendix No 7*), as it results from the 7 questionnaires. So, the final *Table No5* results from the above procedure.

Some spares need additional particulars, besides the MAKER, TYPE, SERIAL, NUMBER, DRAWING NO, and PART NUMBER.

To avoid long messages for this additional information, the Chief Engineer, when preparing a requisition, is to use the following codes for such parts and their relevant information.

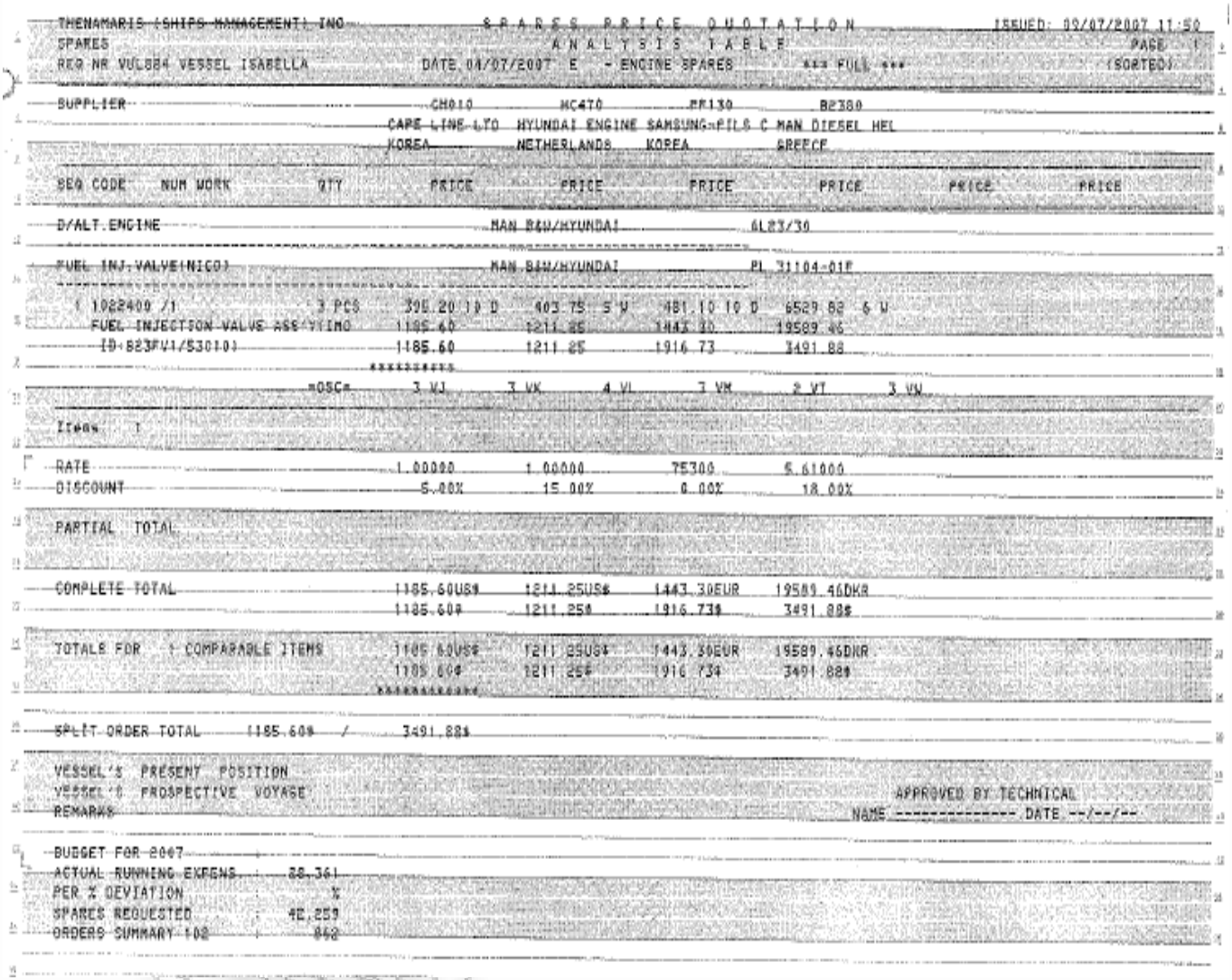
Such spares are:

- Fuel oil injection pumps
- Fuel oil injection valves
- M/E cylinder liners
- Gears
- Governors
- Turbochargers
- D/G pistons
- Pistons rings
- Filters
- Thermometers/pyrometers/ tachometers
- Impellers
- Electrical spares

CHAPTER No 5

Associated Costs

The prices of the cheapest suppliers and most expensive makers result from the corresponding department of the ''Thenamaris'', Shipping Company (Purchasing Department), which has the total number of prices of the suppliers on a data form.



THENAMARIS (SHIPS MANAGEMENT) INC — SPARES PRICE QUOTATION — ISSUED: 09/07/2007 11:50
SPARES — ANALYSIS TABLE — PAGE 1
REQ NR VUL884 VESSEL ISABELLA — DATE 04/07/2007 E - ENGINE SPARES — *** FULL *** — (SORTED)

SUPPLIER		CH010	MC470	PR130	B2380
		CAPE LINE LTD KOREA	HYUNDAI ENGINE SAMSUNG NETHERLANDS	PILS C KOREA	MAN DIESEL HEL GREECE
SEQ CODE	NUM WORK QTY	PRICE	PRICE	PRICE	PRICE	PRICE	PRICE
D/ALT.ENGINE			MAN B&W/HYUNDAI		6L23/30		
FUEL INJ.VALVE(NICO)			MAN B&W/HYUNDAI		PL 31104-01F		
1 1022400 /1	3 PCS	395.20 10 D	403.75 5 W	481.10 10 D	6529.82 6 W		
FUEL INJECTION VALVE ASS'YIMO		1185.60	1211.25	1443.30	19589.46		
ID:823FV1/53010)		1185.60	1211.25	1916.73	3491.88		
	=OSC=	3 VJ	3 VK	4 VL	3 VM	2 VT	3 VW
Items: 1							
RATE		1.00000	1.00000	.75300	5.61000		
DISCOUNT		5.00%	15.00%	0.00%	18.00%		
PARTIAL TOTAL							
COMPLETE TOTAL		1185.60US$	1211.25US$	1443.30EUR	19589.46DKR		
		1185.60$	1211.25$	1916.73$	3491.88$		
TOTALS FOR 1 COMPARABLE ITEMS		1185.60US$	1211.25US$	1443.30EUR	19589.46DKR		
		1185.60$	1211.25$	1916.73$	3491.88$		
SPLIT ORDER TOTAL 1185.60$ / 3491.88$							

VESSEL'S PRESENT POSITION
VESSEL'S PROSPECTIVE VOYAGE
REMARKS — APPROVED BY TECHNICAL
NAME ---------- DATE --/--/---

BUDGET FOR 2007
ACTUAL RUNNING EXPENS 38,361
PER % DEVIATION %
SPARES REQUESTED 42,259
ORDERS SUMMARY 102 842

(**Fig. No10**, Analysis Table – Spare Price Quotations, App.[8])

We observe the above table ‘’*Analysis Table*’’ of the four suppliers, the shipping company has selected (CH010, HC470, PF130, B2380) in order to get the ‘’Fuel Injection Valve Ass’y’’.
Moreover, every supplier offers the corresponding rate discount, which together with the basic price of the spare part is assessed by the Technical Department of the Shipping Company. Finally, thanks to this *Analysis Table*, we have in our hands, a split order total, which in our example the price is 1,185.60$ / 3,491.88$ .This means that the best solution is to order the specific item from Korea (Cape Line LTD) instead of Greece (Man Diesel HEL), as the difference between these two prices is approximately ≈2,306.28$ (=3,491.88$ – 1,185.60$). For a more analytical observation we can see the *Appendix No 8*.

Moreover, concerning the choice of the two suppliers, the exact position of our vessel must be taken into account, as the transport expenses play an important role in the final decision of which supplier we are going to choose.

In particular, if our vessel is in Europe, then it is profitable to order the spare item from the Netherlands (Hyundai Engine), as it costs 1,211.25$. So the transport expenses will be much fewer than Korea. On the contrary, if the vessel is in Asia, then it is much more preferable to choose the Cape Line LTD than the Korean supplier. Therefore, we must examine the most economical ways of sending the items to the specific ports, before their arrival at the vessel.

The above procedure of choice applies to all spare parts with the view to achieving the best possible delivery time based on economical issues. We will try to collect all the information about the prices, after getting the Shipping Company’s permission, in order to gather the appropriate results between the cheapest supplier and the most expensive maker.

CHAPTER No 6

Results

SPARE PART NAME	CHEAPEST SUPPLIES UNIT PRICE ($)	MAKER UNIT PRICE ($)	TOTAL CHEAPEST SUPPLIERS ($)	TOTAL MAKERS ($)
MAIN ENGINE				
1. CYLINDER COVER				
CYL. COVER	30,520	31,237	0	0
2. PISTON W/ROD				
PISTON ROD	4,500	17,301	4,500	17,301
PISTON CROWN	4,661	8,136	4,661	8,136
PISTON SKIRT	527	2,013	0	0
PISTON RINGS	218	744	3,052	10,416
TELESCOPIC PIPES	750	1,050	750	1,050
3. CYLINDER LINER				
CYL. LINER	5,500	6,668	0	0
CYL. COOLING JACKET	3,595	6,149	3,595	6,149
4. CONN. ROD & CROSSHEAD				
CROSSHEAD PIN	4,500	5,508	0	0
CROSSHEAD BEARINGS (SET)	1,917	4,235	0	0
CRANKPIN BEARINGS (SET)	2,250	4,282	0	0
5. MAIN BEARING				
MAIN BEARING	2,045	4,050	0	0
6. EXHAUST V/V				
EXH. V/V COMPLETE	8,200	9,500	8,200	9,500
EXH. SPINDLE	3,182	4,292	19,092	25,752
EXH. SEAT	909	1,537	5,454	9,222
7. FUEL V/V				
FUEL V/V COMPL.	682	868	1,364	1,736
FUEL V/V NOZZLES	610	759	6,710	8,349
FUEL V/V GUIDE	727	876	7,997	9,636

8. STARTING V/V				
STARTING V/V COMPL.	1,420	3,150	1,420	3,150
9. RELIEF V/V				
RELIEF V/V COMPL.	1,297	1,301	1,297	1,301
10. FUEL P/P				
FUEL P/P COMP.	13,200	16,910	13,200	16,910
FUEL P/P BLOCK ONLY	7,200	8,500	7,200	8,500
FUEL P/P PLUNGER - BAREL	1,033	1,352	2,066	2,704
11. THRUST BEARINGS				
THRUST BRNG PADS	1,450	2,050	0	0
W/SENSOR POCKETS	1,540	2,280	0	0
12. CAMSHAFT BEARING				
CAMSHAFT BRNGS	932	2,223	0	0
13. CAMSHAFT				
FUEL P/P CAMS	1,388	2,865	0	0
EXH. V/V CAMS	1,068	2,398	0	0
14. INDICATING PUMP				
INDICATOR V/V COMPLETE	571	695	1,713	2,085
15. CYL. LUBRICATING PUMP				
CYL. LUBR. P/P COMPL. SET	4,800	6,900	4,800	6,900
CYL. LUBR. P/P ELEMENTS	18	25	558	775
16. TURBOCHARGER				
T/C ROTOR COMPL.	208,498	236,998	0	0
T/C BEARING BLOWER	160	345	480	1,035
T/C BEARING TURBINE	184	186	552	558
T/C CASING (OUTLET)	58,500	68,653	0	0
T/C CASING (INLET)	49,000	58,000	0	0
17. M/E GOVERNOR				
M/E GOVERNOR COMPL.	5,500	6,850	0	0
18. M/E AIR COOLER				
M/E AIR COOLER COMPL.	6,200	8,058	0	0
			98,661	151,165

DIESEL GENERATORS

1. PISTON & CONN. ROD				
PISTON HEAD	548	2,432	1,096	4,864
PISTON PIN	55	666	165	1,998
PISTON PIN BUSH	120	315	360	945
PISTON RINGS	22	153	2,794	19,431
2. CONN. ROD				
CONN. ROD	1,093	1,339	4,372	5,356
CONN. ROD BOLTS	36	79	324	711
CRANKPIN BEARING SET	390	981	1,950	4,905
3. CYLINDER LINER				
CYLINDER LINERS	238	1,462	238	1,462
4. CYLINDER HEAD				
CYL. COVERS	804	1,641	3,216	6,564
5. INLET V/V				
INLET V/V SEATS	17	123	272	1,968
INLET V/V SPINDLES	70	215	1,120	3,440
6. EXHAUST V/V				
EXH. V/V SEATS	85	175	1,360	2,800
EXH. V/V SPINDLES	89	318	1,424	5,088
7. FUEL VALVES				
FUEL V/V COMPL.	50	300	2,000	12,000
FUEL V/V NOZZLES	30	150	1,200	6,000
8. INDICATOR & SAFETY V/V				
SAFETY VALVES	14	180	70	900
INDICATOR VALVES	38	220	190	1,100
9. STARTING VALVE				
TURBOSTATER COMPLETE	4,500	4,500	0	0
SERVICE KIT FOR TURBO STATER COMPLETE	800	1,400	800	1,400
10. VALVE ROTATOR				
ROTATOR COMPL.	150	1,143	1,950	14,859
11. V/V OPERATING DEVICE				
INLET V/V ROCKER ARMS	23	440	115	2,200

EXH. V/V ROCKER ARMS	23	440	115	2,200
12. FUEL PUMPS				
FUEL P/P COMPL.	188	435	376	870
FUEL P/P PLUNGER & BARREL	28	105	112	420
13. CRANKSHAFT				
CRANKSHAFT	9,210	62,000	0	0
14. MAIN BEARINGS				
MAIN BEARING SET	410	990	0	0
THRUST BEARING SET	502	580	0	0
15. CAMSHAFT				
CAMSHAFT	15,000	25,000	0	0
FUEL V/V CAMS	525	1,950	0	0
INLET V/V CAMS	507	1,850	0	0
EXHAUST V/V CAMS	508	1,850	0	0
CAMSHAFT BRNG SET	45	220	0	0
16. TURBOCHARGER				
T/C ROTOR COMPL.	17,350	19,908	0	0
T/C ROTOR	1,370	19,284	0	0
T/C CASINGS	1,552	5,458	0	0
T/C BEARING (BLOWER SIDE)	203	1,399	812	5,596
T/C BEARING (TURBINE SIDE)	76	467	0	0
17. G/E GOVERNOR				
GOVERNOR COMPLETE	2,690	3,317	0	0
18. LUBRICATING OIL P.P				
GEAR SET	60	322	0	0
BEARINGS	5	7	15	21
19. COOLING WATER P/P				
IMPELLER	80	834	160	1,668
SHAFT	65	575	65	575
MECHANICAL SEALS	3	5	3	5
MOUTH RINGS	3	18	3	18
			26,981	111,232

EMERGENCY DIESEL

1. GENERATOR				
PISTON RINGS	18	97	18	97
NOZZLES	22	115	22	115
FUEL FILTER ELEMENT	14	42	14	42
LUB. OIL FILTER ELEMENT	19	37	19	37
MAIN BEARING	235	650	0	0
CRANKPIN BEARING	225	630	0	0
F.O. INJ. P/P PLUNGER W/BARREL	25	95	0	0
			73	291

VARIOUS MACHINERY

1. H.F.O. SEPARATOR				
BOWL SPINDLE	264	1,395	1,056	5,580
FRICTION BLOCK	36	45	324	405

2. L.O. SEPARATOR				
BOWL SPINDLE	268	1,040	1,072	4,160
FROCTION BLOCK	12	37	108	333

3. BOILER - F.O. BURNER & ACCESS				
F.O. ATOMISER	66	165	66	165
D.O. ATOMISER	14	17	14	17
FLAME EYE	48	50	0	0
FLAME DETECTOR	187	398	0	0
FIRING ELECTRODES	23	30	23	30
MANHOLE GASKETS	25	41	25	41
WATER LEVEL GAUGES	115	297	115	297

4. MAIN COMPRESSOR				
PISTON (STAGE I/LP)	191	193	191	193
PISTON (STAGE II/HP)	91	113	91	113
PISTON RINGS (I/LP)	8	12	8	12
PISTON RINGS (II/HP)	7	9	7	9
CYL. BLOCK	4,200	5,100	0	0
CYL. HEAD	2,632	2,726	0	0
CON. ROD (LP-HP)	391	1,498	0	0
MAIN BEARING (FLYWH SIDE)	68	121	68	121
MAIN BEARING (VENT-SIDE)	68	121	68	121
CON. ROD BEARINGS	104	189	104	189

SUCT V/V (STAGE I/LP)	222	233	222	233
DELY V/V (STAGE I/LP)	222	233	222	233
SUCT V/V (STAGE II/LP)	155	161	155	161
DELY V/V (STAGE II/LP)	155	161	155	161
5. PROPELLER & SHAFTING				
PROPELLER	162,000	185,000	0	0
PROPELLER SHAFT	97,000	105,000	0	0
SIMPLEX SEALS FWD	4,499	4,860	4,499	4,860
SIMPLEX SEALS AFT	6,759	6,997	6,759	6,997
SIMPLEX LINER FWD	4,578	5,085	4,578	5,085
SIMPLEX LINER AFT	6,791	7,406	6,791	7,406
6. RUDDER				
RUDDER PINTLE BUSH	367	1,000	367	1,000
UPPER				
RUDDER PINTLE BUSH	290	389	290	389
LOWER				
7. ANCHOR				
ANCHOR	6,600	7,500	0	0
ANCHOR SWIVELS	1,650	1,950	1,650	1,950
ANCHOR KENTER SHA	395	750	395	750
ANCHOR D SHACKLES	215	1,555	215	1,555
			29,638	42,566

VARIOUS PUMPS

1. STEER GEAR HYDR. P/P				
PISTONS / VANES	38	49	76	98
SUCTION V/V			0	0
OIL SEALS	14	18	14	18
2. M/E L.O. PUMP				
MECHANICAL OIL SEALS	113	115	226	230
BEARINGS	21	32	42	64
3. STERN TUBE L.O. P/P				
BEARINGS	6	8	24	32
4. JACKET COOL F.W. PUMP				
IMPELLER	88	950	88	950
SHAFT	240	1,250	240	1,250

MOUTH RINGS	73	90	219	270
SHAFT SLEEVES	77	120	154	240
5. CENTRAL COOL F.W. P/P				
IMPELLER	86	920	172	1,840
SHAFT	220	1,160	440	2,320
MOUTH RINGS	65	82	325	410
SHAFT SLEEVES	70	105	210	315
6. EVAPOR. DISTILLED PUMP				
IMPELLER	74	540	74	540
SHAFT	163	1,018	163	1,018
MECHANICAL SEALS	70	350	70	350
7. CENTRIFICAL BOILER FEED PUMP				
IMPELLER	85	850	85	850
SHAFT	228	893	228	893
MOUTH RINGS	30	103	120	412
CASING RINGS	24	67	48	134
SHAFT SLEEVES	63	313	252	1,252
8. MAIN S.W. COOL PUMP				
IMPELLER	91	1,025	182	2,050
SHAFT	252	1,362	504	2,724
MECHANICAL SEAL	105	950	420	3,800
MOUTH RING	81	349	648	2,792
SHAFT SLEEVE	92	428	368	1,712
9. GEN.SERVIS & FIRE P/P				
IMPELLER	89	1,002	89	1,002
SHAFT	240	1,170	240	1,170
MECHANICAL SEALS	110	980	110	980
MOUTH RINGS	72	330	72	330
CASING RINGS	21	106	21	106
SHAFT SLEEVES	59	328	59	328
10. PISTON BILGE PUMP				
PISTON	498	850	498	850
LINER	510	1,050	510	1,050
PISTON RINGS	9	14	9	14
SUCTION VALVES	225	248	225	248
DELIVERY VALVES	225	248	225	248
BEARINGS	14	16	14	16

11. EVAP. EJECTOR PUMP				
IMPELLER	172	199	172	199
SHAFT	69	88	69	88
MECHANICAL SEALS	58	280	116	560

12. M/E BOOSTER PUMP				
GAER SET	613	5,531	613	5,531
BEARINGS	12	14	96	112

13. BOILER F.O. BURN PUMP				
MECHANICAL SEALS	15	45	15	45
BEARINGS	5	8	5	8

14. EMERG. FIRE PUMP				
IMPELLER	850	1,350	850	1,350
SHAFT	610	712	610	712
MECHANICAL SEALS	75	320	75	320
MOUTH RINGS	102	107	204	214
SHAFT SLEEVES	87	280	87	280

15. BALLAST PUMP				
IMPELLER	185	1,442	185	1,442
SHAFT	161	1,125	161	1,125
MECHANICAL SEALS	102	890	102	890
MOUTH RINGS	120	150	120	150
SHAFT SLEEVES	100	130	100	130
BEARINGS	18	29	18	29

16. HYDR. PUMP/MOTOR FOR DECK MACHINERY				
HYDRAULIC P/P COMPL.	10,200	16,200	0	0
HYDRAULIC MOTOR COMPL.	9,756	15,321	0	0
PISTON / VANES	42	55	42	55
MECHANICAL SEALS	120	950	120	950
BEARINGS	235	410	470	820

17. DECK CRANES				
HYDR. P/P FOR HOISTING	6,250	9,722	0	0
DOUBLE GEAR P/P FOR LUFFING	1,785	9,270	0	0
HYDR. P/P FOR SLEWING	4,545	9,519	0	0
HYDR. MOTOR FOR HOISTING	3,205	8,173	0	0
HYDR. MOTOR FOR SLEWING	1,785	9,902	0	0
ROTARY GROUP	1,818	5,375	0	0

TRIPLE GEAR P/P	750	3,205	0	0
ROLLER BEARINGS	911	984	0	0
CABLE	2,271	2,300	2,271	2,300
			13.965	50.216

NAVIGATION / COMM.EQUIPMENT

1. NAVIGATION - COMM. EQUIP.				
NAVIGATION LIGHT BUILBS	18	20	36	40
ALDIS LAMP SPARE BUILBS	35	40	0	0

2. RADAR				
CARBON BRUSHES FOR SCANNER DRIVE MOTOR	60	70	0	0
MAGNETRON TUBE FOR No1 RADAR	450	1,700	900	3,400
MAGNETRON TUBE FOR No2 RADAR	450	1,700	900	3,400
MODULATOR TUBE FOR No1 RADAR	480	520	960	1,040
MODULATOR TUBE FOR No2 RADAR	480	520	960	1,040
MIYER DIODES	4	5	16	20
FUSES	4	5	200	250
ILLUMINATION LAMPS	2.5	3	15	18

3. GYROCOMPASS				
ILLUMINATION LAMPS FOR GYROREPEATERS	9	10	0	0
VARIOUS FUSES	4	5	240	300
GYROSPHERE	4,000	6,000	4,000	6,000

4. GMDSS				
FURUNO, RELAY 24V	42	50	210	250
FURUNO, BRIDGE RECTIFIER BATT. CHARGER	160	180	0	0
ILLUMINATION LAMPS	14	20	84	120

5. INMARSAT A / B				
INMARSAT A / B , AZIMOUTH BELT FOR ANTENNA	70	150	70	150
INMARSAT A / B , ELEVATION BELT FOR ANTENNA	70	150	70	150
VARIOUS FUSES	4	5	200	250

6. RADIO BATTERIES				
BATTERIES	500	1,600	1,500	4,800

7. E.P.I.R.B.				
E.P.I.R.B.	1,000	1,500	2,000	3,000
8. G.P.S.				
G.P.S.	1,000	1,500	3,000	4,500
			15,361	28,728

(**Table No6**, Results from the Associated Costs)

We plot out all above on a spreadsheet in order to sum up the total costs. At this point we have to explain how we calculate the ''Total Cheapest Suppliers'' and ''Total Makers'' by using two examples of calculations (green marks).

First of all, we have to clarify the basic calculations for the ''MAIN ENGINE'' and the ''DIESEL GENERATOR''.

- The ''Main Engine'' works over 5 years:

- Approximately it works 19 hours per day → 19 x 365 = 6,935 ≈ 7,000 hours per year. Therefore,
  7,000 x 5 = **35,000** hours over five years.
- In order to calculate how many total pieces are need for the 5-years interval, we have:
  (Total hours over 5 years ÷ Makers recommended overhauling interval) x (Replacement percentage at every overhaul) x (Working pcs-set). So,
  (35,000 ÷ 16,000) x 7% x 6 = 2.1875 x 0.07 x 6 = **0.91875**
  But as it is not possible to order 0.91875 of Piston Crown; therefore, we make it an integer (always positive values): 0,91875 → **1** piece of Piston Crown, needed at 5-years interval.
- Total from Cheapest Suppliers: 1 x 4,661$ = **4,661**$
  Total Makers: 1 x 8,136$ = **8,136**$

For a more analytical observation we can see the *Final Table No 8.*

- The ''Diesel Generator'' works over 5 years:

- It works 24 hours per day → 24 x 365 = 8,760 hours per year.
  But in the vessel, it is unlikely to work with only one Diesel Generator, due to maneuvering or the importation and exportation in the port and so on.

Therefore, we estimate that the average working Diesel Generators over 5 years, is 1.2 (From Technicians' experience)

So,

8,760 x 1.2 = 10,512 hours per year. Therefore,

10,512 x 5 = **52,560** hours over 5 years

- To calculate how many total pieces are needed for the 5-years interval, we have:

  [(Total hours over 5 year ÷ Makers recommended overhauling interval) ÷ 3] x (Replacement percentage at every overhaul) x (Working pcs-set). So,

  [(52,560 ÷ 10,000) ÷ 3] x 5% x 18 = **1.5768**

  ↕

  (We divide by 3 because we have 3 diesel generators)

  But as it is not possible to order 1.5768 of Piston Head; therefore, we make it an integer (always positive values): 1.5768 → **2** pieces of Piston Head needed for the 5-years interval.

- Total from Cheapest Suppliers: 2 x 548$ = **1,096**$

  Total Makers: 2 x 2,432$ = **4,864**$

For a more analytical observation we can see also the *Final Table No 8.*

Below we can observe the comparison between the cheapest supplier and the most expensive maker from the *Table No 6*.

SPARES	TOTAL CHEAPEST SUPPLIERS ($)	TOTAL MAKERS ($)
MAIN ENGINE	98,661	151,165
DIESEL GENERATORS	26,981	111,232
EMERGENCY DIESEL	73	291
VARIOUS MACHINERY	29,638	42,566
VARIOUS PUMPS	13,965	50,216
NAVIGATION / COMM.EQUIPMENT	15,361	28,728
	184,679	384,198

(**Table No 7**, Total Sums Between Cheapest Suppliers and the Most Expensive Makers)

As we can see from the total sums between the cheapest suppliers and the most expensive makers, the difference is **199,519**$ (384,198$ – 184,679$).

We have to specify that some of the selections, between supplier and maker, hide one risk, as we can observe on the following table in the last column. Therefore, our technical experience says that we can combine the cheapest spare parts with the most expensive ones and make very clear thoughts and choices in order to prevent any mistake, which will cost us a lot of money.

At this point, we have to mention that sometimes when the cheapest suppliers save money this may involve great profits on the part of the ship-owner and in particular when the latter possesses a lot of vessels. On the other hand, most of the times we select no original items from the cheapest suppliers but we run the risk of their not functioning as well as being inefficient.

Therefore, in the Technical Department the experienced technical staff of the Shipping Company, is in the position to know which machinery parts are less efficient as far as their function is concerned.

In our project, we are making an attempt to classify which spare parts we can obtain from the cheapest suppliers in contrast to makers and vice versa. This idea, undoubtedly, may lead to a serious problem concerning the choice of items, which is not a common practice, as it does not apply to all vessels and shipping companies, as well.

Below we can observe the *FINAL spreadsheet* recommended to managers with 5-year total cost requirements on spare parts for their budgeting efforts. We can see from the Final List the most important machinery parts in the vessel (from the ‘’Main Engine’’, ‘’Diesel Generators’’, ‘’Emergency Generator’’, ‘’Various Machinery’’, ‘’Various Pumps’’ and the ‘’Navigation-Communication Equipment’’). In addition we can see the total number working pieces/set for each machinery part. Finally, we create one list (Risk) on the right hand side, as it results from the ‘’Risk Supplier’’ vertical list, where ‘’Y’’ it means that we will take the risk of the cheapest supplier. (‘’Y’’ → ‘’YES’’)

SPARE PART NAME	WORKING PCS/SET	MAKER'S RECOMMEND OVERHAULING INTERVAL	REPLACEMENT PERCENTAGE AT EVERY OVERHAUL	TOTAL PIECES NEEDED AT A 5-YEARS INTERVAL	INTEGER -	CHEAPEST SUPPLIES UNIT PRICE ($)	MAKER UNIT PRICE ($)	RISK SUPPLIER	TOTAL CHEAPEST SUPPLIERS ($)	TOTAL MAKERS ($)	RISK ($)
MAIN ENGINE											
1. CYLINDER COVER											
CYL. COVER	6	16,000	0%	0.0000	0	30,520	31,237		0	0	0
2. PISTON W/ROD											
PISTON ROD	6	16,000	7%	0.9188	1	4,500	17,301		4,500	17,301	17,301
PISTON CROWN	6	16,000	7%	0.9188	1	4,661	8,136	Y	4,661	8,136	4,661
PISTON SKIRT	6	16,000	0%	0.0000	0	527	2,013		0	0	0
PISTON RINGS	6	16,000	100%	13.1250	14	218	744	Y	3,052	10,416	3,052
TELESCOPIC PIPES	6	16,000	5%	0.6563	1	750	1,050		750	1,050	1,050
3. CYLINDER LINER											
CYL. LINER	6	16,000	0%	0.0000	0	5,500	6,668		0	0	0
CYL. COOLING JACKET	6	16,000	4%	0.5250	1	3,595	6,149	Y	3,595	6,149	3,595
4. CONN. ROD & CROSSHEAD											
CROSSHEAD PIN	6	35,000	0%	0.0000	0	4,500	5,508		0	0	0
CROSSHEAD BEARINGS (SET)	6	35,000	0%	0.0000	0	1,917	4,235		0	0	0
CRANKPIN BEARINGS (SET)	6	35,000	0%	0.0000	0	2,250	4,282		0	0	0

5. MAIN BEARING											
MAIN BEARING	6	35,000	0%	0.0000	0	2,045	4,050		0	0	0
6. EXHAUST V/V											
EXH. V/V COMPLETE	6	8,000	3%	0.7875	1	8,200	9,500		8,200	9,500	9,500
EXH. SPINDLE	6	8,000	20%	5.2500	6	3,182	4,292	Y	19,092	25,752	19,092
EXH. SEAT	6	8,000	20%	5.2500	6	909	1,537	Y	5,454	9,222	5,454
7. FUEL V/V											
FUEL V/V COMPL.	12	8,000	3%	1.5750	2	682	868		1,364	1,736	1,736
FUEL V/V NOZZLES	12	8,000	20%	10.5000	11	610	759		6,710	8,349	8,349
FUEL V/V GUIDE	12	8,000	20%	10.5000	11	727	876		7,997	9,636	9,636
8. STARTING V/V											
STARTING V/V COMPL.	6	8,000	3%	0.7875	1	1,420	3,150		1,420	3,150	3,150
9. RELIEF V/V											
RELIEF V/V COMPL.	6	8,000	3%	0.7875	1	1,297	1,301	Y	1,297	1,301	1,297
10. FUEL P/P											
FUEL P/P COMP.	6	35,000	2%	0.1200	1	13,200	16,910		13,200	16,910	16,910
FUEL P/P BLOCK ONLY	6	35,000	2%	0.1200	1	7,200	8,500		7,200	8,500	8,500
FUEL P/P PLUNGER - BAREL	6	35,000	25%	1.5000	2	1,033	1,352		2,066	2,704	2,704

11. THRUST BEARINGS											
THRUST BRNG PADS	7	35,000	0%	0.0000	0	1,450	2,050		0	0	0
W/SENSOR POCKETS	1	35,000	0%	0.0000	0	1,540	2,280		0	0	0
12. CAMSHAFT BEARING											
CAMSHAFT BRNGS	6	35,000	0%	0.0000	0	932	2,223		0	0	0
13. CAMSHAFT											
FUEL P/P CAMS	6	35,000	0%	0.0000	0	1,388	2,865		0	0	0
EXH. V/V CAMS	6	35,000	0%	0.0000	0	1,068	2,398		0	0	0
14. INDICATING PUMP											
INDICATOR V/V COMPLETE	6	8,000	10%	2.6250	3	571	695	Y	1,713	2,085	1,713
15. CYL. LUBRICATING PUMP											
CYL. LUBR. P/P COMPL. SET	2	25,000	1.5%	0.0420	1	4,800	6,900		4,800	6,900	6,900
CYL. LUBR. P/P ELEMENTS	36	5,000	12%	30.2400	31	18	25		558	775	775
16. TURBOCHARGER											
T/C ROTOR COMPL.	1	16,000	0%	0.0000	0	208,498	236,998		0	0	0
T/C BEARING BLOWER	1	16,000	100%	2.1875	3	160	345		480	1,035	1,035
T/C BEARING TURBINE	1	16,000	100%	2.1875	3	184	186		552	558	558
T/C CASING (OUTLET)	1	16,000	0%	0.0000	0	58,500	68,653		0	0	0
T/C CASING (INLET)	1	16,000	0%	0.0000	0	49,000	58,000		0	0	0

17. M/E GOVERNOR											
M/E GOVERNOR COMPL.	1	35,000	0%	0.0000	0	5,500	6,850		0	0	0
18. M/E AIR COOLER											
M/E AIR COOLER COMPL.	1	25,000	0%	0.0000	0	6,200	8,058	Y	0	0	0
									98,661	151,165	126,968

DIESEL GENERATORS

1. PISTON & CONN. ROD											
PISTON HEAD	18	10,000	5%	1.5768	2	548	2,432	Y	1,096	4,864	1,096
PISTON PIN	18	10,000	8%	2.5229	3	55	666		165	1,998	1,998
PISTON PIN BUSH	18	10,000	8%	2.5229	3	120	315		360	945	945
PISTON RINGS	72	10,000	100%	126.1440	127	22	153		2,794	19,431	19,431
2. CONN. ROD											
CONN. ROD	18	10,000	12%	3.7843	4	1,093	1,339	Y	4,372	5,356	4,372
CONN. ROD BOLTS	36	10,000	14%	8.8301	9	36	79		324	711	711
CRANKPIN BEARING SET	18	10,000	15%	4.7304	5	390	981		1,950	4,905	4,905
3. CYLINDER LINER											
CYLINDER LINERS	18	10,000	3%	0.9461	1	238	1,462		238	1,462	1,462

4. CYLINDER HEAD											
CYL. COVERS	18	5,000	5%	3.1536	4	804	1,641	Y	3,216	6,564	3,216
5. INLET V/V											
INLET V/V SEATS	18	5,000	25%	15.7680	16	17	123		272	1,968	1,968
INLET V/V SPINDLES	18	5,000	25%	15.7680	16	70	215		1,120	3,440	3,440
6. EXHAUST V/V											
EXH. V/V SEATS	18	5,000	25%	15.7680	16	85	175		1,360	2,800	2,800
EXH. V/V SPINDLES	18	5,000	25%	15.7680	16	89	318		1,424	5,088	5,088
7. FUEL VALVES											
FUEL V/V COMPL.	18	2,000	25%	39.4200	40	50	300	Y	2,000	12,000	2,000
FUEL V/V NOZZLES	18	2,000	25%	39.4200	40	30	150	Y	1,200	6,000	1,200
8. INDICATOR & SAFETY V/V											
SAFETY VALVES	18	5,000	7%	4.4150	5	14	180		70	900	900
INDICATOR VALVES	18	5,000	7%	4.4150	5	38	220	Y	190	1,100	190
9. STARTING VALVE											
TURBOSTATER COMPLETE	3	10,000	0%	0.0000	0	4,500	4,500		0	0	0
SERVICE KIT FOR TURBO STATER COMPLETE	3	10,000	10%	0.5256	1	800	1400	Y	800	1,400	800
10. VALVE ROTATOR											
ROTATOR COMPL.	72	10,000	10%	12,6144	13	150	1,14 3	Y	1.950	14.859	1.950

11. V/V OPERATING DEVICE											
INLET V/V ROCKER ARMS	18	5,000	7%	4.4150	5	23	440		115	2,200	2,200
EXH. V/V ROCKER ARMS	18	5,000	7%	4.4150	5	23	440		115	2,200	2,200
12. FUEL PUMPS											
FUEL P/P COMPL.	18	10,000	5%	1.5768	2	188	435	Y	376	870	376
FUEL P/P PLUNGER & BARREL	18	10,000	10%	3.1536	4	28	105		112	420	420
13. CRANKSHAFT											
CRANKSHAFT	3	10,000	0%	0.0000	0	9,210	62,000		0	0	0
14. MAIN BEARINGS											
MAIN BEARING SET	21	10,000	0%	0.0000	0	410	990		0	0	0
THRUST BEARING SET	6	10,000	0%	0.0000	0	502	580		0	0	0
15. CAMSHAFT											
CAMSHAFT	3	10,000	0%	0.0000	0	15,000	25,000		0	0	0
FUEL V/V CAMS	18	10,000	0%	0.0000	0	525	1,950		0	0	0
INLET V/V CAMS	18	10,000	0%	0.0000	0	507	1,850		0	0	0
EXHAUST V/V CAMS	18	10,000	0%	0.0000	0	508	1,850		0	0	0
CAMSHAFT BRNG SET	7	10,000	0%	0.0000	0	45	220		0	0	0
16. TURBOCHARGER											
T/C ROTOR COMPL.	3	5,000	0%	0.0000	0	17,350	19,908		0	0	0
T/C ROTOR	3	5,000	0%	0.0000	0	1,370	19,284		0	0	0

T/C CASINGS	3	5,000	0%	0.0000	0	1,552	5,458		0	0	0
T/C BEARING (BLOWER SIDE)	3	10,000	60%	3.1536	4	203	1,399		812	5,596	5,596
T/C BEARING (TURBINE SIDE)	3	10,000	60%	3.1536	0	76	467		304	1,868	1,868
17. G/E GOVERNOR											
GOVERNOR COMPLETE	3	25,000	0%	0.0000	0	2,690	3,317		0	0	0
18. LUBRICATING OIL P.P											
GEAR SET	3	10,000	12%	0.6307	1	60	322		0	0	0
BEARINGS	12	10,000	12%	2.5229	3	5	7	Y	15	21	15
19. COOLING WATER P/P											
IMPELLER	6	25,000	5%	0.2102	1	80	834		160	1,668	1,668
SHAFT	6	25,000	5%	0.2102	1	65	575		65	575	575
MECHANICAL SEALS	6	25,000	20%	0.8410	1	3	5	Y	3	5	3
MOUTH RINGS	6	25,000	20%	0.8410	1	3	18	Y	3	18	3
									26.981	111.232	73.396

EMERGENCY DIESEL

1. GENERATOR											
PISTON RINGS	18	3 YEARS	2%	0.6000	1	18	97		18	97	97
NOZZLES	6	1 YEAR	2%	0.0068	1	22	115	Y	22	115	22
FUEL FILTER ELEMENT	1	1 YEAR	5%	0.0029	1	14	42	Y	14	42	14
LUB. OIL FILTER ELEMENT	1	1 YEAR	5%	0.0029	1	19	37	Y	19	37	19

MAIN BEARING	7	3 YEARS	0%	0.0000	0	235	650		0	0	0
CRANKPIN BEARING	6	3 YEARS	0%	0.0000	0	225	630		0	0	0
F.O. INJ. P/P PLUNGER W/BARREL	6	3 YEARS	0%	0.0000	0	25	95		0	0	0
									73	291	152

VARIOUS MACHINERY

1. H.F.O. SEPARATOR											
BOWL SPINDLE	2	1 YEAR	40%	4.0000	4	264	1,395		1,056	5,580	5,580
FRICTION BLOCK	3	1 YEAR	60%	9.0000	9	36	45	Y	324	405	324
2. L.O. SEPARATOR											
BOWL SPINDLE	2	1 YEAR	40%	4.0000	4	268	1,040		1,072	4,160	4,160
FROCTION BLOCK	3	1 YEAR	60%	9.0000	9	12	37	Y	108	333	108
3. BOILER - F.O. BURNER & ACCESS											
F.O. ATOMISER	1	3,000	25%	0.7500	1	66	165	Y	66	165	66
D.O. ATOMISER	1	3,000	25%	0.7500	1	14	17	Y	14	17	14
FLAME EYE	1	3,000	0%	0.0000	0	48	50		0	0	0
FLAME DETECTOR	1	3,000	0%	0.0000	0	187	398		0	0	0
FIRING ELECTRODES	1	3,000	20%	0.6000	1	23	30	Y	23	30	23
MANHOLE GASKETS	6	3 YEARS	40%	0.8219	1	25	41	Y	25	41	25
WATER LEVEL GAUGES	1	3 YEARS	10%	0.0342	1	115	297	Y	115	297	115

4. MAIN COMPRESSOR											
PISTON (STAGE I/LP)	2	5 YEARS	10%	0.0502	1	191	193		191	193	193
PISTON (STAGE II/HP)	2	5 YEARS	10%	0.0502	1	91	113		91	113	113
PISTON RINGS (I/LP)	8	5 YEARS	40%	0.8037	1	8	12		8	12	12
PISTON RINGS (II/HP)	8	5 YEARS	40%	0.8037	1	7	9		7	9	9
CYL. BLOCK	2	5 YEARS	0%	0.0000	0	4,200	5,100		0	0	0
CYL. HEAD	2	5 YEARS	0%	0.0000	0	2,632	2,726		0	0	0
CON. ROD (LP-HP)	4	5 YEARS	0%	0.0000	0	391	1,498		0	0	0
MAIN BEARING (FLYWH SIDE)	2	5 YEARS	10%	0.0502	1	68	121		68	121	121
MAIN BEARING (VENT-SIDE)	2	5 YEARS	10%	0.0502	1	68	121		68	121	121
CON. ROD BEARINGS	4	5 YEARS	10%	0.1005	1	104	189		104	189	189
SUCT V/V (STAGE I/LP)	2	5 YEARS	30%	0.1507	1	222	233		222	233	233
DELY V/V (STAGE I/LP)	2	5 YEARS	30%	0.1507	1	222	233		222	233	233
SUCT V/V (STAGE II/LP)	2	5 YEARS	30%	0.1507	1	155	161		155	161	161
DELY V/V (STAGE II/LP)	2	5 YEARS	30%	0.1507	1	155	161		155	161	161
5. PROPELLER & SHAFTING											
PROPELLER	1	5 YEARS	0%	0.0000	0	162,000	185,000		0	0	0
PROPELLER SHAFT	1	5 YEARS	0%	0.0000	0	97,000	105,000		0	0	0
SIMPLEX SEALS FWD	1	5 YEARS	100%	0.7991	1	4,499	4,860		4,499	4,860	4,860
SIMPLEX SEALS AFT	1	5 YEARS	100%	0.7991	1	6,759	6,997		6,759	6,997	6,997
SIMPLEX LINER FWD	1	5 YEARS	50%	0.3995	1	4,578	5,085		4,578	5,085	5,085
SIMPLEX LINER AFT	1	5 YEARS	50%	0.3995	1	6,791	7,406		6,791	7,406	7,406

6. RUDDER											
RUDDER PINTLE BUSH	1	5 YEARS	100%	0.7991	1	367	1,000	Y	367	1,000	367
UPPER											
RUDDER PINTLE BUSH	1	5 YEARS	100%	0.7991	1	290	389	Y	290	389	290
LOWER											
7. ANCHOR											
ANCHOR	2	5 YEARS	0%	0.0000	0	6,600	7,500		0	0	0
ANCHOR SWIVELS	2	5 YEARS	5%	0.0027	1	1,650	1,950	Y	1,650	1,950	1,650
ANCHOR KENTER SHA	2	5 YEARS	5%	0.0027	1	395	750	Y	395	750	395
ANCHOR D SHACKLES	2	5 YEARS	5%	0.0027	1	215	1,555	Y	215	1,555	215
									29,638	42,566	39,226

VARIOUS PUMPS

1. STEER GEAR HYDR. P/P											
PISTONS / VANES	16	5 YEARS	10%	1.4064	2	38	49	Y	76	98	76
SUCTION V/V	2	5 YEARS	10%	0.1758	1				0	0	0
OIL SEALS	2	5 YEARS	20%	0.3516	1	14	18	Y	14	18	14
2. M/E L.O. PUMP											
MECHANICAL OIL SEALS	2	5 YEARS	80%	1.4064	2	113	115	Y	226	230	226
BEARINGS	2	5 YEARS	100%	1.7580	2	21	32	Y	42	64	42

3. STERN TUBE L.O. P/P											
BEARINGS	4	5 YEARS	100%	3.5160	4	6	8	Y	24	32	24
4. JACKET COOL F.W. PUMP											
IMPELLER	2	5 YEARS	50%	0.8790	1	88	950		88	950	950
SHAFT	2	5 YEARS	50%	0.8790	1	240	1,250		240	1,250	1,250
MOUTH RINGS	4	5 YEARS	80%	2.8128	3	73	90	Y	219	270	219
SHAFT SLEEVES	2	5 YEARS	80%	1.4064	2	77	120	Y	154	240	154
5. CENTRAL COOL F.W. P/P											
IMPELLER	3	5 YEARS	50%	1.3185	2	86	920		172	1,840	1840
SHAFT	3	5 YEARS	50%	1.3185	2	220	1,160		440	2,320	2,320
MOUTH RINGS	6	5 YEARS	80%	4.2192	5	65	82	Y	325	410	325
SHAFT SLEEVES	3	5 YEARS	80%	2.1096	3	70	105	Y	210	315	210
6. EVAPOR. DISTILLED PUMP											
IMPELLER	1	5 YEARS	50%	0.4395	1	74	540		74	540	540
SHAFT	1	5 YEARS	50%	0.4395	1	163	1,018		163	1,018	1,018
MECHANICAL SEALS	1	5 YEARS	80%	0.7032	1	70	350	Y	70	350	70
7. CENTRIFICAL BOILER FEED PUMP											
IMPELLER	2	5 YEARS	50%	1.0000	1	85	850		85	850	850
SHAFT	2	5 YEARS	50%	1.0000	1	228	893		228	893	893
MOUTH RINGS	4	5 YEARS	80%	3.2000	4	30	103	Y	120	412	120
CASING RINGS	2	5 YEARS	80%	1.6000	2	24	67	Y	48	134	48
SHAFT SLEEVES	4	5 YEARS	80%	3.2000	4	63	313	Y	252	1,252	252

8. MAIN S.W. COOL PUMP											
IMPELLER	3	3 YEARS	40%	1.7580	2	91	1,025		182	2,050	2,050
SHAFT	3	3 YEARS	40%	1.7580	2	252	1,362		504	2,724	2,724
MECHANICAL SEAL	3	3 YEARS	80%	3.5160	4	105	950	Y	420	3.800	420
MOUTH RING	6	3 YEARS	80%	7.0320	8	81	349	Y	648	2.792	648
SHAFT SLEEVE	3	3 YEARS	80%	3.5160	4	92	428	Y	368	1.712	368
9. GEN.SERVIS & FIRE P/P											
IMPELLER	2	5 YEARS	50%	0.2511	1	89	1,002		89	1,002	1,002
SHAFT	2	5 YEARS	50%	0.2511	1	240	1,170		240	1,170	1,170
MECHANICAL SEALS	2	5 YEARS	80%	0.4018	1	110	980	Y	110	980	110
MOUTH RINGS	4	5 YEARS	80%	0.8037	1	72	330	Y	72	330	72
CASING RINGS	2	5 YEARS	80%	0.4018	1	21	106	Y	21	106	21
SHAFT SLEEVES	2	5 YEARS	80%	0.4018	1	59	328	Y	59	328	59
10. PISTON BILGE PUMP											
PISTON	1	5 YEARS	50%	0.1256	1	498	850		498	850	850
LINER	1	5 YEARS	50%	0.1256	1	510	1,050		510	1,050	1,050
PISTON RINGS	2	5 YEARS	80%	0.4018	1	9	14		9	14	14
SUCTION VALVES	2	5 YEARS	80%	0.4018	1	225	248	Y	225	248	225
DELIVERY VALVES	2	5 YEARS	80%	0.4018	1	225	248	Y	225	248	225
BEARINGS	4	5 YEARS	80%	0.8037	1	14	16	Y	14	16	14

11. EVAP. EJECTOR PUMP											
IMPELLER	1	3 YEARS	35%	0.5127	1	172	199		172	199	199
SHAFT	1	3 YEARS	35%	0.5127	1	69	88		69	88	88
MECHANICAL SEALS	1	3 YEARS	75%	1.0987	2	58	280	Y	116	560	116
12. M/E BOOSTER PUMP											
GAER SET	4	5 YEARS	25%	0.8790	1	613	5,531		613	5,531	5,531
BEARINGS	8	5 YEARS	100%	7.0320	8	12	14	Y	96	112	96
13. BOILER F.O. BURN PUMP											
MECHANICAL SEALS	1	5 YEARS	100%	0.2055	1	15	45	Y	15	45	15
BEARINGS	1	5 YEARS	100%	0.2055	1	5	8	Y	5	8	5
14. EMERG. FIRE PUMP											
IMPELLER	1	5 YEARS	50%	0.5000	1	850	1,350		850	1,350	1,350
SHAFT	1	5 YEARS	50%	0.5000	1	610	712		610	712	712
MECHANICAL SEALS	1	5 YEARS	100%	1.0000	1	75	320	Y	75	320	75
MOUTH RINGS	2	5 YEARS	100%	2.0000	2	102	107	Y	204	214	204
SHAFT SLEEVES	1	5 YEARS	100%	1.0000	1	87	280	Y	87	280	87
15. BALLAST PUMP											
IMPELLER	2	5 YEARS	50%	0.1142	1	185	1,442		185	1,442	1,442
SHAFT	2	5 YEARS	50%	0.1142	1	161	1,125		161	1,125	1,125
MECHANICAL SEALS	2	5 YEARS	100%	0.2283	1	102	890	Y	102	890	102
MOUTH RINGS	4	5 YEARS	100%	0.4566	1	120	150	Y	120	150	120
SHAFT SLEEVES	2	5 YEARS	100%	0.2283	1	100	130	Y	100	130	100

BEARINGS	6	5 YEARS	100%	0.6849	1	18	29	Y	18	29	18
16. HYDR. PUMP/MOTOR FOR DECK MACHINERY											
HYDRAULIC P/P COMPL.	4	5 YEARS	0%	0.0000	0	10,200	16,200		0	0	0
HYDRAULIC MOTOR COMPL.	4	5 YEARS	0%	0.0000	0	9,756	15,321		0	0	0
PISTON / VANES	20	5 YEARS	5%	0.1598	1	42	55		42	55	55
MECHANICAL SEALS	4	5 YEARS	100%	0.6393	1	120	950	Y	120	950	120
BEARINGS	8	5 YEARS	100%	1.2785	2	235	410	Y	470	820	470
17. DECK CRANES											
HYDR. P/P FOR HOISTING	4	5 YEARS	0%	0.0000	0	6,250	9,722		0	0	0
DOUBLE GEAR P/P FOR LUFFING	4	5 YEARS	0%	0.0000	0	1,785	9,270		0	0	0
HYDR. P/P FOR SLEWING	4	5 YEARS	0%	0.0000	0	4,545	9,519		0	0	0
HYDR. MOTOR FOR HOISTING	4	5 YEARS	0%	0.0000	0	3,205	8,173		0	0	0
HYDR. MOTOR FOR SLEWING	4	5 YEARS	0%	0.0000	0	1,785	9,902		0	0	0
ROTARY GROUP	4	5 YEARS	0%	0.0000	0	1,818	5,375		0	0	0
TRIPLE GEAR P/P	4	5 YEARS	0%	0.0000	0	750	3,205		0	0	0
ROLLER BEARINGS	16	5 YEARS	0%	0.0000	0	911	984		0	0	0
CABLE	4	5 YEARS	10%	0.0822	1	2,271	2,300		2,271	2,300	2,300
									13,965	50,216	36,793

NAVIGATION / COMM. EQUIPMENT

1. NAVIGATION - COMM. EQUIP.											
NAVIGATION LIGHT BUILBS	14	1 YEAR	5%	1.7500	2	18	20		36	40	40
ALDIS LAMP SPARE BUILBS	1	1 YEAR	0%	0.0000	0	35	40		0	0	0
2. RADAR											
CARBON BRUSHES FOR SCANNER DRIVE MOTOR	2	1 YEAR	0%	0.0000	0	60	70		0	0	0
MAGNETRON TUBE FOR No1 RADAR	1	1 YEAR	40%	2.0000	2	450	1,700		900	3,400	3,400
MAGNETRON TUBE FOR No2 RADAR	1	1 YEAR	40%	2.0000	2	450	1,700		900	3,400	3,400
MODULATOR TUBE FOR No1 RADAR	1	1 YEAR	40%	2.0000	2	480	520		960	1,040	1,040
MODULATOR TUBE FOR No2 RADAR	1	1 YEAR	40%	2.0000	2	480	520	Y	960	1,040	960
MIYER DIODES	4	1 YEAR	20%	4.0000	4	4	5		16	20	20
FUSES	10	1 YEAR	100%	50.0000	50	4	5	Y	200	250	200
ILLUMINATION LAMPS	6	1 YEAR	20%	6.0000	6	2.5	3	Y	15	18	15
3. GYROCOMPASS											
ILLUMINATION LAMPS FOR GYROREPEATERS	12	1 YEAR	0%	0.0000	0	9	10		0	0	0
VARIOUS FUSES	12	1 YEAR	100%	60.0000	60	4	5	Y	240	300	240
GYROSPHERE	1	2 YEARS	20%	1.0000	1	4,000	6,000		4,000	6,000	6,000

4. GMDSS											
FURUNO, RELAY 24V	6	1 YEAR	14%	4.2000	5	42	50	Y	210	250	210
FURUNO, BRIDGE RECTIFIER BATT. CHARGER	2	1 YEAR	0%	0.0000	0	160	180		0	0	0
ILLUMINATION LAMPS	6	1 YEAR	20%	6.0000	6	14	20	Y	84	120	84
5. INMARSAT A / B											
INMARSAT A / B , AZIMOUTH BELT FOR ANTENNA	1	1 YEAR	20%	1.0000	1	70	150	Y	70	150	70
INMARSAT A / B , ELEVATION BELT FOR ANTENNA	1	1 YEAR	20%	1.0000	1	70	150	Y	70	150	70
VARIOUS FUSES	10	1 YEAR	100%	50.0000	50	4	5	Y	200	250	200
6. RADIO BATTERIES											
BATTERIES	2	5 YEARS	25%	2.5000	3	500	1,600	Y	1,500	4,800	1,500
7. E.P.I.R.B.											
E.P.I.R.B.	1	5 YEARS	25%	1.2500	2	1,000	1,500	Y	2,000	3,000	2,000
8. G.P.S.											
G.P.S.	2	5 YEARS	25%	2.5000	3	1,000	1,500	Y	3,000	4,500	3,000
									15,361	28,728	22,449

(**TableNo8**, A Final Spreadsheet on parts for the Budgeting Effort)

CHAPTER No 7

Discussion and Conclusions of Research Results

In this project, we are trying to concentrate on a specific bulk-carrier so as to learn the general policy of the Shipping Company, where its Technical Department can calculate the total cost of the spare parts needed for a specified interval.

Therefore, an effort to estimate the total spare parts requirements, together with their associated costs has been carried out. To enable such an attempt, firstly we described the model used split out in the following areas:

- Description of the vessel under study.
- Description of its operational capabilities.
- Specification of overhauling intervals and estimation of spare parts required on each overhauling (experience gained).
- Description of the methodology that Technical Managers establish for spare parts ordering.

First of all, the way in which a ship is supplied with the necessary spare parts is the following under normal circumstances:

When the Chief Engineer considers which spare parts must be provided to the vessel, he prepares a Spare Parts Requisition on which each machinery is stated with all the details (type, code, number, etc.) and particularly the drawing number and the part number of the specific spare part.

When the order is usual, it is sent by email. In the Shipping Company, the Superintendent Engineer of the ship gets the order and together with the responsible Spares Department arranges the order of the specific spare parts.

The department at the same time is in contact with the Makers and other Suppliers, at least three, and waits for their offers with the corresponding times as well as the delivery time. (We can observe the Table Analysis of spares price quotation – *Figure No 10*)

In order to buy a spare part, we have to examine at first its quality in relation to its price and according to these elements we carry out the order.

When it is a common order, the spares department arranges to send the spare parts to the most convenient port as far as the transport cost and safety are concerned. However, when it is essential for the safe function of the ship the order is given to the supplier who can deliver the specific spare part directly, so the cost is completely different.

Another point of view that we found out in this project is the attempt of a study concerning the calculation of the Overhauling Intervals (mean time between overhauls) for Main Engine according to the makers' recommendations, for Diesel Generator according to the makers' recommendations and finally, for the remain Machinery Systems according to the manager's policy.

Therefore, having the clear model specification (vessel's trade characteristics), we proceeded with the estimation of overhauling intervals based on:

1. Makers guidelines (service letters and manuals)
2. Experience based on datasheets (as expressed on completed questionnaires filled up by Superintendent Engineers and Chief Engineers).

The process output, (expressed on a spreadsheet) enable us to proceed with the next step namely the calculation of pieces required in a five - year interval. Once again we facilitated the experience from the vessel's Technical Management, in order to determine the exact number of each essential spare part over the predetermined period.

Then we focused on the replacement percentage and the associated costs, where we provide summaries of results. In addition, having obtained the number of spare parts, then a process with price quotations was carried out in order to estimate costs. In principal the "cheapest" non – original supplier was selected, as well as the original (maker) supplier. All the quoted prices were plotted on a spreadsheet where

summing up of each individual component was performed to determine the financial extent on behalf of the Technical Managers.
Finally, having a clear picture of the lowest and highest cost, a risk assessment was performed to determine a unique "reliable" cost. Once again that was plotted on a spreadsheet and led us to the desired value.

Taking a quick look at the following table, as it results from the *Final Table No 8*, we can assume that:

SPARES	TOTAL MAKERS ($)	RISK ($)
MAIN ENGINE	151,165	126,968
DIESEL GENERATORS	111,232	73,396
EMERGENCY DIESEL	291	152
VARIOUS MACHINERY	42,566	39,226
VARIOUS PUMPS	50,216	36,793
NAVIGATION / COMM.EQUIPMENT	28,728	22,449
	384,198	298,984

(**Table No9**, A Profit from the Risk)

If we take the risk to choose the spare parts from the cheapest suppliers (non-original supplier), then we have a profit of 85,214$ (384,198$ – 298,984$) in 5 years. Moreover, if we divide by "5" the total risk amount of 298,984$, we will find 59,796.8$ which depict how much money the Ship-owner will spend for each running year. We have to clarify that this risk depends on the purchase of spare parts from both makers (original) and the cheapest suppliers (non-original), whose choice is determined by the appropriate department of the Shipping Company.

The final decision concerning the fluctuation of the total cost-profit will be taken by the ship owner of our vessel. We simply introduce the best possible selection of spare parts from makers and the cheapest suppliers preserving the reliability of the function

of the spare parts according to the choice of the experts from the Technical Staff of the Shipping Company.

This paper refers to the practical part of a Technical Department, where practice takes the place of the theory. Therefore, this procedure completely relies on the experience rather than the theory. For this reason, we had difficulty in learning the function of the Technical Department, as this kind of knowledge is not found in books but it is related to the Technicians' experience.

(**Photo No 5**, Vessel M/V SEABOSS, Anchorage of Paradip 2007, Ref. [17])

CHAPTER No 8

References

Book and Journal Resources

1. HHM – MAN B&W. (2004), ''DIESEL ENGINE – OPERATION'', HUDONG HEAVY MACHINERY Co., Ltd, SHANGHAI – CHINA,2004, MAN B&W RHRS 6S50MC-C SL03-423

2. HHM – MAN B&W. (2004), ''HEAVY FUEL OIL MAINTENANCE'', HUDONG HEAVY MACHINERY Co., Ltd, SHANGHAI – CHINA, 2004, DIESEL ENGINE S50MC-C,

3. W.D. EWART. (1983), ''BULK CARRIES'', 1983 BY FAIRPLAY PUBLICATIONS LTOL, PAGE 37-45,

4. Lloyd's LIST. (2002), ''SIDE FRAME FAILURE BLAMED IN RECENT BULK CARRIER LOSS'', 18 JUNE 2002, PAGE 3,

5. LTD.DESIGN DEPARTMENT NANTONG COSCO KHI. (2004), ''FINISHED PLAN'', SHIP ENGINEERING CO. 2004, INSTRUCTION BOOK FOR GENERATOR DIESEL ENGINE YANMAR RHRS 6n21al-v,

6. YANMAR SERVICE NEWS. (2004), ''LARGE POWER PRODUCTS OPERATIONS DIV'', YANMAR CO.,LTD. 2004, QUALITY ASSURANCE DEPT.,

7. MAN B&M DIESEL A/S. (2001), ''PROPULSION TRENDS IN CONTAINER VESSELS'' COPENHAGEN, DENMARK, FEBRUARY 2001, PAGE 3-5,

8. MAN B&M DIESEL A/S. (2002), ''PROPULSION TREND IN TANKERS'' COPENHAGEN, DENMARK, NOVEMBER 2002, PAGE 5-8,

9. DET NORSKE VERITAS. (2004), ''CLASS STATUS REPORT'', CURRENT STATUS SEABOSS 2004, ABOMA HOLDING LIMITED,

10. DREWRY. (2006), ''SHIPPING INSIGHT 2006'', SHIPPING CONSULTANTS LTD, 2006,

11. THENAMARIS (SHIPS MANAGEMENT) INC. (2007),''INSTRUCTION COVERING SPARE PARTS'', CIRCULAR LETTER No. -700-, 2007,

12. DIESEL ENGINE FUNDAMENTALS. (2007), ''DOE-HDBK-10181-93 –'', FULL TEXT BY THENAMARIS (SHIPS MANAGEMENT) INC, 2007,

13. DAVID BYRNE. (2005), ''HATCH COVER MAINTENANCE AND OPERATION'', A GUIDE TO GOOD PRACTICE, SECOND EDITION BY DAVID BYRNE, 2005 BY NORTH OF ENGLAND P&I ASSOCIATION LIMITED, PAGE 67-69,

Internet Resources

14. THENAMARIS (SHIPS MANAGEMENT) INC. (2012), ''WEBSITE'', 2012, http://www.thenamaris.com , accessed 10-07-2012

15. EXCHANGE VALUES AND X-RATES. (2012), ''WEBSITE'', EXCHANGE VALUES, 2012, http://www.x-rates.com , accessed 05-11-2012

Picture Resources

16. JSEA, PDF- CD. (2005), ‘’SHIPBUILDING AND MARINE ENGINEERING IN JAPAN 2005’’, ENGINES PROPELLERS AND OTHERS, PAGE 87-135,

17. THENAMARIS (SHIPS MANAGEMENT) INC. (2012), PRIVATE FILES & PROGRAMS FROM THE TECHNICAL DEPARTMENT, PLUS VARIOUS PHOTOS FROM THE VESSEL ‘’M/V SEABOSS’’ 2012,

APPENDIX No 1

PROJECT PLANNING

PROJECT PLANNING

PROJECT PROPOSAL

Project Title

A CASE STUDY ON THE SPARE PARTS REQUIREMENT FOR A 55,500 DWT GEARED BULK CARRIER

Student

Lampros Valiazis

Supervisor

V. Tselentis

1. Background

This project contains information on how the technical department of a shipping company works out the correct choice of spare parts for vessel machinery and what the factors are that influence the demand and supply of the market based on our examined bulk-carrier. It analyses in detail all these factors providing the reader with the total methodology concerning the spare parts needed for a specified overhauling interval. For this reason, we study one bulk-carrier where we have specified the definitions, assumptions and limitations. Finally, we focus on the associated cost, mentioning the cheapest and most expensive prices for each item under survey.

2. Research Capability

It refers to our understanding how the shipping company works, in order to carry out this particular study and have access to research papers and software programs of the shipping company, so as to have the skill to read and understand drawing papers and recognize the machinery code items.

3. Aims and Objectives of Project

They are related to the procedure of obtaining the cheapest and most expensive prices for each item under survey, as well as understanding the replacement percentage for each machinery item, acquiring a final spreadsheet recommended to managers on 5-year total cost requirements on spare parts for their budgeting efforts.

4. Methodology

First of all, we clarify the definitions, assumptions and limitations for our examined vessel. Moreover, we make a survey by means of a questionnaire over a minimum of 7 active fleet managers and C/E, to determine for each part the replacement percentage at specified overhauling intervals. The average of estimation is used to calculate how many parts are required for maintenance purpose over 5 years. Finally, we make comparison between the cheapest suppliers' and makers' total sums, providing the managers with the total requirements on spare parts for their budgeting efforts.

5. Work packages

- Wp1: Literature Review

  -Undertake a literature search in the relevant subject areas.

  -Identify key texts, including books, conference papers

  -Prepare an overview of the present state of knowledge in the subject, including summary key texts and reference lists with bibliographic details.

  -Deliverable: Literature review document.

- Wp2 : Information gathering

  -Find information on the shipping company and obtain as many different spare items as we need to determine the cost/prices.

- Wp3 : Financial Information

  -Find particular financial information on running costs, the spare price quotations due to suppliers (makers & cheapest suppliers), and the calculation of the replacement percentage at every overhaul concerning total pieces needed for a 5-year interval.

- Wp4 : Interviews-Questioning List

  -use a questionnaire to fill out the questioning list and obtain the information.

  -Talk about the risk and the total price of each machinery area, including the total cost requirements on spare parts for their budgeting efforts.

- Wp5 : Write up a report

  -Establish the format of a report document and set up templates on the word processor

  -Review all notes, test results, analysis and tentative conclusions of the project work.

  -Formally write up the majority of the project work.

  -Finalize conclusions and write Introduction and Conclusion.

  -Print off the report, collate with appendixes and arrange to bind the report.

  -Prepare the presentation of other items for submission (such as software programs CRT3.3, UNIX® SYSTEM)

  -Deliverable: a bound report (three copies) together with the accompanying material.

6. Schedule of Work

	May		Jun.		Jul.		Aug.		Sept.		Oct.	
Wp1	X	X	X									
Wp2			X	X	X	X						
Wp3							X	X				
Wp4									X	X		
Wp5						X	X	X	X	X	X	X
Meetings	x			x							x	

X → Principal Activity

X → Background Activity

x → Planned Meeting

7. Deliverables

- Wp1: will be finished in total by mid May
- Wp2: will be finished in total by end of June
- Wp3: will be finished in total by end of July
- Wp4: will be finished in total by end of September
- Wp5: will be finished in total by end of October

8. Beneficiaries and Dissemination Strategy

We realize that the people who could mostly benefit from this project are managers and ship-owners due to the fact that they can be informed about the running expenses of a vessel (bulk-carrier) during five years.

In addition, the managers could manage the technical department of the shipping company more sufficiently because they would have a clearer picture of their budgeting efforts.

9. Resource Requirements

Give in detail the resources that are required for the project. This should include the following:

- An estimate of the time commitment of the researchers (student and supervisor separately) which is approximately 400 hours.
- Necessary access to other members of the staff and their time commitment (information officers, technicians, and other academics) are not required.
- The use of any facilities necessary (towing tank, cavitation tunnel, high performance computer, etc.) is not required.
- The construction of any test equipment or models and likely cost are not required.
- Information or data that has to be obtained from outside sources and likely cost. Obtained confidential data and research papers kindly provided by the shipping company for free.
- The service that has to be carried out and likely cost are not required.