

# **FUEL SAVING PROJECT**

## **RCL SHIP MANAGEMENT (PTE) LTD.**



## EXECUTIVE SUMMARY

A fuel efficiency project involved tests performed for engine improvements in both controlled conditions and during real time operation over a year period with RCL Shipping. Engine efficiency improvements were evaluated using the M/E indicator diagram results, representing the measurement of fuel oil consumption per horsepower per hour (Grm/BHP/Hr). The results showed that mXt9 helped get on average 11.92% better efficiency.

During the real time operation data on fuel consumption *before use* and *during use* of mXt9<sup>TM</sup> was collected. The data collected included the average slip, the rate of fuel consumption (litres per hour), and the displacement (load carry by the ship). With the majority of displacements found in the range of 13,000 – 20,999, the ratios of fuel per displacement were calculated and results indicate a fuel saving 11.92%. More advantages of mXt9<sup>TM</sup> were also noted during positive slip conditions where the engine needed more power to overcome the external resistance.

In summary, mXt9<sup>TM</sup> had a significant effect, enabling a more complete combustion of fuel oil to occur, thereby obtaining maximal energy from the internal combustion reaction. The cargo ship has run smoothly throughout the year's usage without any negative effects.

# Contents

1	Product Information	4
	1.1) What is mXt9 <sup>TM</sup>	4
	1.2) How does mXt9 <sup>TM</sup> works	5
2	Addition of mXt9 <sup>TM</sup>	7
3	Fuel savings engine efficiency improvement results	8
4	Fuel savings at the real time operations	18
	4.1) Calculation	19
	4.2) More advantages during positive slip	25
5	Conclusions	26
	Literature cited	27
	Appendix A : Real time operating data before using mXt9 <sup>TM</sup>	28
	Appendix B : Real time operating data after using mXt9 <sup>TM</sup>	29

# 1 Product Information

## 1.1 What is mXt9<sup>TM</sup> ?

liquid mXt9<sup>TM</sup> is a revolutionary fuel catalyst specifically designed for all grades of Bunker Oil (HFO), which lowers fuel consumption, improves engine performance, and significantly reduces the pollution of unburnt fuel particles and other toxins from exhaust emissions. It's easy to use, completely safe and non-hazardous. It is suitable to mix with fuel oil at the ratio of 1:34000 resulting in better combustion efficiency of fuel oil. mXt9<sup>TM</sup> neutralizes the intermolecular forces that attract fuel oil molecules forming clusters, and yields the separated single fuel oil molecules ready for combustion. The combustion is more complete, reducing emissions and reducing overall fuel costs. This technology has been proven in many applications, as shown in figure 1.

*Figure1: mXt9<sup>TM</sup> used in steel factories and boiler applications.*

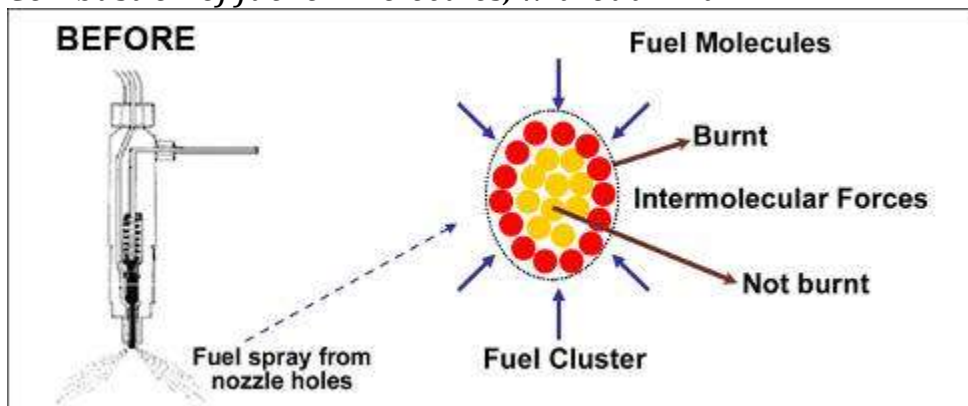


## 1.2 How does mXt9™ work ?

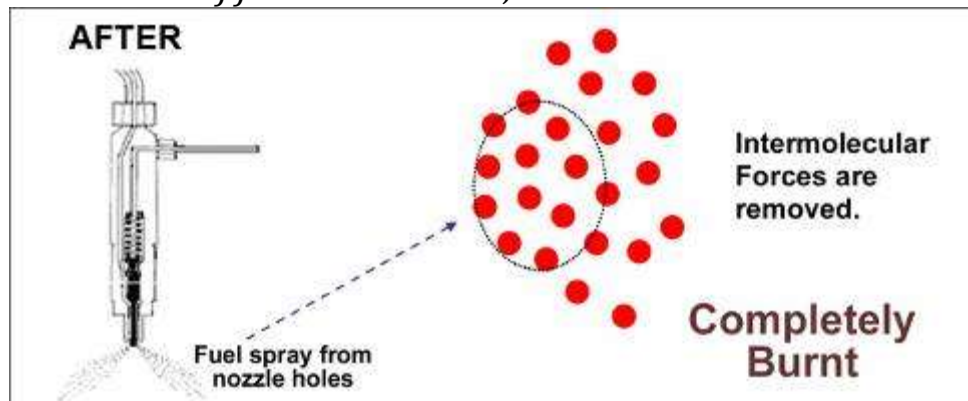
When liquid flows in the pipes, fuel oil molecules naturally move, interact, or hit each other and the side wall of pipe. The interactions that occur between the atoms of a molecule with the other atoms of the other molecules cause forces of attraction to occur; these forces are known as intermolecular forces. These intermolecular forces cause the molecules to adhere together and form molecular clusters. When these clusters enter the combustion chamber, combustion is generally not completed, leading to emission being produced.

mXt9™ reduces the forces which cause clusters to occur. This is achieved by the ability of mXt9™ to store naturally occurring charges, neutralize the forces between fuel oil molecules and finally break down the clusters of fuel oil into separated single molecules. Therefore, all single fuel molecules can then be burnt with each other in the combustion chamber. The reaction of these single molecules is faster and easier than before; in another word, the kinetics of combustion reaction is increased.

*Figure 2: Combustion of fuel oil molecules, without mXt9™*



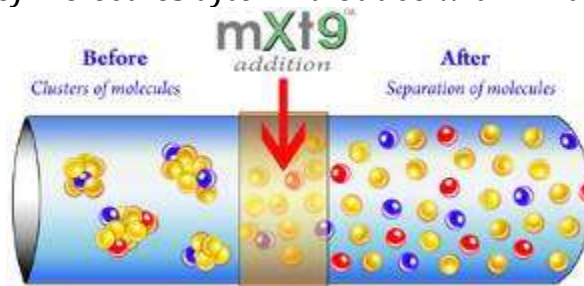
*Figure 3: Combustion of fuel oil molecules, with mXt9™*



## Benefits of mXt9™

mXt9™ improves the kinetics of combustion reaction of fuel oil, which can be observed by the increase of light intensity of the combustion fire. The increase of light intensity shows the change in rays and spectrum of light and represents more molecules being burnt at the burner. Very importantly, once the combustion is more completed at the burner, the amount of excess oxygen necessarily needed for combustion can be reduced. It lets the combustion engineer able to adjust the better combustion ratio of fuel and air for the energy savings (figures 4).

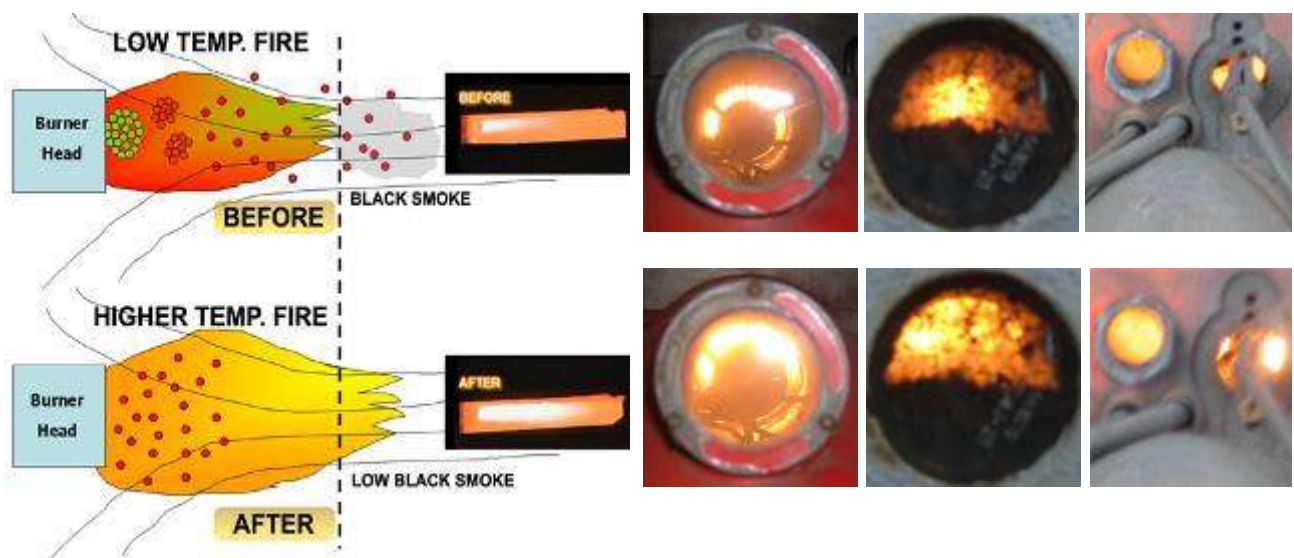
Figure 4: Separation of molecules after introduce with mXt9™



## Advantages of mXt9™

1. Instantly use, no downtime required
2. Instantly seen the results, the changes of combustion flame in terms of light intensity and spectrum of light can be seen by the naked eyes, as shown in figure 5.

Figure 5: Comparisons of flame and light intensity, with and without using mXt9™



## 2 Addition of mXt9<sup>TM</sup>

mXt9<sup>TM</sup> is suitable to mix with fuel oil at the proportional of 1:34,000.

### **ENGINE TYPE AND SPECIFICATIONS**

ENGINE TYPE: HYUNDAI MAN B&W 6L60MC

M.C.R.: 14,160 BHP x 117 RPM.

ENGINE NO.: B 647

HULL NO.: N-618

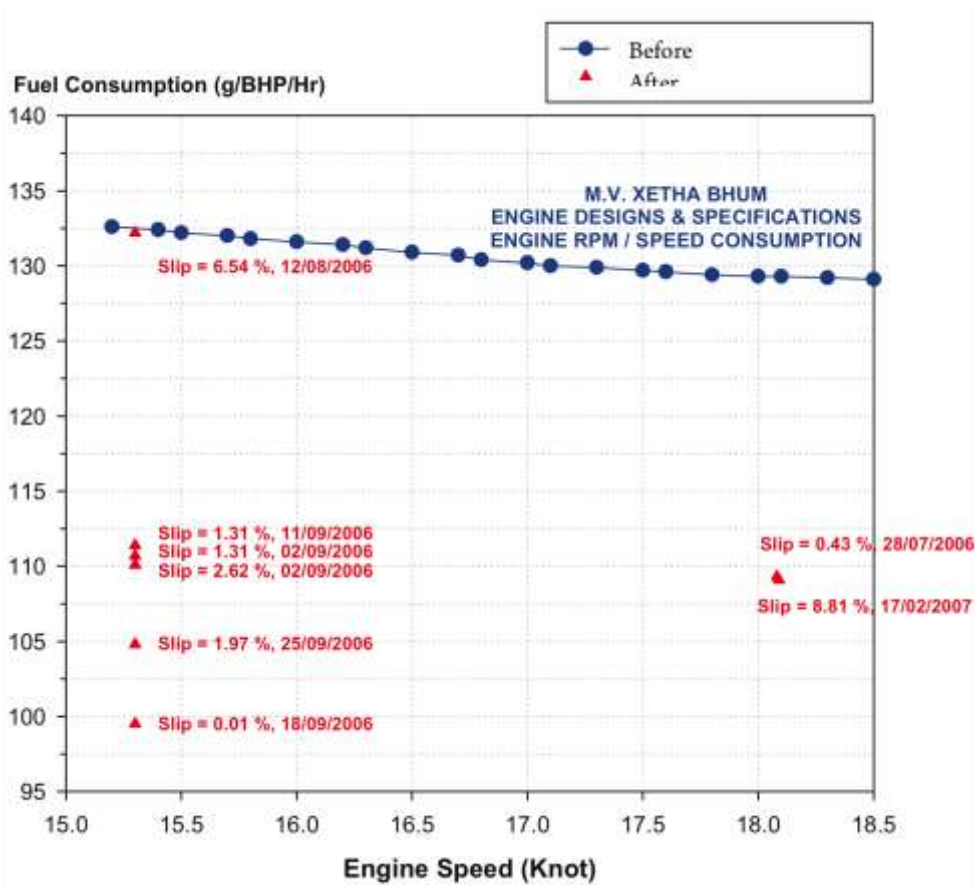
*Figure 6: Addition of mXt9<sup>TM</sup> into the fuel oil pipe line.*



# 3 Fuel saving engine efficiency improvement results

Engine efficiency improvements are shown on the M/E indicator diagram results, which represent *the measurement of fuel oil consumption per horsepower per hour (Grm/BHP/Hr)* and many other mechanic parameters. Figure 7 shows the results plotted between the engine speed (knot) and the fuel consumption (g/BHP/Hr) *before and during* using mXt9™.

Figure 7 : Comparisons on fuel consumption between before and during use with mXt9™



At Slip = zero (0.01 %),  

$$\% \text{ Fuel Consumption Saving} = \frac{(132.5 - 99.5)}{132.5} \times 100 \% = 24.90 \%$$

The data shown in Figure 7 are taken from the ship information Tables 1 – 8. Table 1 shows engine characteristics prior to use mXt9<sup>TM</sup> and tables 2 – 8 are the M/E test results after using mXt9<sup>TM</sup>. It is found that fuel consumption *without* using mXt9<sup>TM</sup> (blue line) is normally in the range of 129.1 – 132.6, whereas the fuel consumption *with* mXt9<sup>TM</sup> (red dots) are much lower than the blue line. At the same engine speed 15.3 knot and zero slip, the different fuel consumption is up to 24.90%.

Table 1 : Ship engine RPM / Speed / Consumption BEFORE using mXt9<sup>TM</sup>

**M.V. XETHA BHUM.**  
**ENGINE RPM/SPEED/CONSUMPTION**

RPM.	LOAD. %	Pump Mark %	T/C RPM	SCAV. AIR PRESS.	FUEL CONSUMPTION		CONSUMPt. g/BHP/Hr.	ENG. SPEED Knot.	RPM
					MT/Day.	Lts/Watch			
93	52	60.7	9,430	1.13	23.4	4,245	132.6	15.2	93
94	53	61.7	9,667	1.18	24.0	4,347	132.4	15.4	94
95	54	62.6	9,840	1.23	24.3	4,395	132.2	15.5	95
96	55	63.7	10,048	1.30	24.7	4,470	132.0	15.7	96
97	56	64.8	10,256	1.36	25.2	4,571	131.8	15.8	97
98	58	66.0	10,464	1.43	25.9	4,699	131.6	16.0	98
99	60	67.1	10,672	1.49	26.8	4,854	131.4	16.2	99
100	62	68.2	10,880	1.56	27.6	5,006	131.2	16.3	100
101	64	69.2	11,037	1.62	28.5	5,158	130.9	16.5	101
102	66	70.3	11,195	1.68	29.3	5,310	130.7	16.7	102
103	68	71.3	11,352	1.74	30.1	5,461	130.4	16.8	103
104	70	72.4	11,510	1.80	31.0	5,611	130.2	17.0	104
105	72	73.4	11,667	1.86	31.8	5,764	130.0	17.1	105
106	74	74.6	11,800	1.93	32.7	5,917	129.9	17.3	106
107	76	75.8	11,934	2.00	33.5	6,070	129.7	17.5	107
108	78	76.9	12,067	2.06	34.3	6,222	129.6	17.6	108
109	80	78.1	12,200	2.13	35.2	6,373	129.4	17.8	109
110	83	79.4	12,350	2.20	36.3	6,569	129.3	18.0	110
111	85	80.7	12,500	2.27	37.3	6,764	129.3	18.1	111
112	88	81.9	12,650	2.33	38.4	6,959	129.2	18.3	112
113	90	83.2	12,800	2.40	39.5	7,153	129.1	18.5	113

PROPELLER PITCH = 5040 mm.

REVOLUTION FACTOR ( DISTANCE ) = 0.00272 MILES.

RPM. FACTOR ( SPEED ) = 0.1633 KNOTS.

Table 2 : M/E Indicator Diagram Result (28/07/06)

**M.V. XETHA BHUM**

XTB/F1-02  
 PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date : 28/07/06 Time : 1600-1700 Hrs. Voyage : 654-S  
 Run Hrs. 73,284 Hrs. From BANGKOK To S'PORE  
 M/E Rev. 110.7 Handle 9.3 Load Ind. 76.0 Gov. Actr. 73.0  
 Atm. Temp. 27 E/R Temp. 47 S/W Temp. 30 Humidity 8  
 T/C Rev. 12,400 Exh. In T. 450 Exh. Out T. 320 P-Drop 26  
 A/C. In T. 16 A/C. Out T. 41 Scav. Press. 2.20 P-Drop 36  
 CFW. In T. 73 CFW. Out T. 84 CFW. Press. 2.70 F.O. Press. 7.50  
 L.O. In T. 44 L.O. Press. 2.80 CS Oil In T. 47 CSO. Press. 3.60 **SPRING = 0.3**

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW. Out °C	AREA Sq. mm.	LENGTH mm.
1	120.0	84.0	17.11	78.0	6.4	335	84	390	76.0
2	118.0	82.0	17.79	78.0	6.0	340	84	395	74.0
3	119.0	83.0	17.33	76.0	6.2	330	83	390	75.0
4	118.0	83.0	17.33	75.0	6.8	330	82	390	75.0
5	118.0	84.0	17.33	76.0	6.5	325	82	390	75.0
6	120.0	81.0	17.81	76.0	6.9	335	82	390	73.0
<b>Average</b>	<b>118.8</b>	<b>82.8</b>	<b>17.45</b>	<b>76.5</b>	<b>6.5</b>	<b>333</b>	<b>83</b>	<b>391</b>	<b>74.7</b>

OUT PUT 96.11 % L.H.P. = 14,437 B.H.P. = 13,609 Mech. Eff. = 94.27 %

\* FUEL OIL \* :- Serv. Tk. °C 94  
 F.O./L °C 125 Density = 0.9828 Obs. Den. = 0.9113  
 Consump.: 1,632 Lt/Hr. 35.69 MT/Day. 109.3 Grm/BHP/Hr.

\* CYLINDER OIL \* :- Serv. Tk. °C 49 Density = 0.9300 Obs. Den. = 0.9086  
 Consump.: 10.4 Lt/Hr. 250 Lt/Day. 0.695 Grm/BHP/Hr.

\* WIND \* :- Direction W Force 4 Sea Cond. 4  
 \* SPEED \* :- Ship 18.00 Engine 18.08 Slip 0.43 %  
 \* DRAFT \* :- Fwd. Mtr. 6.00 Aft. Mtr. 6.30 Mean 6.15 Mtr.

\* DISPLACEMENT \* : 18,564 M/T.

REMARKS :

.....  
 SECOND ENGINEER

.....  
 CHIEF ENGINEER



Table 4 : M/E Indicator Diagram Result (02/09/06)

**M.V. XETHA BHUM**

XIB/F1-02  
PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date :	02/09/06	Time :	0700-0800	Hrs.		Voyage :	659-S
in Hrs.	73,791	Hrs.		From	BKK	To	SINGAPORE
/L Rev.	93.7	Handle	7.4	Load Ind.	59.0	Gov. Actr.	59.0
im.Temp.	31	E/R Temp.	45	S/W Temp.	30	Humidity	8
C Rev.	9,500	Exh. In T.	420	Exh. Out T.	360	P-Drop	10
/C. In T.	110	A/C. Out T.	46	Scav.Press.	1.10	P-Drop	175
FW. In T.	70	CFW. Out	83	CFW.Press.	2.70	F.O.Press.	8.00
O. In T.	44	L.O.Press.	3.00	CS Oil in T	47	CSO.Press.	3.40

SPRING = 0.3

Cylinder No.	P. Max. bar	P.Comp.	P.Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW.Out °C	AREA Sq.mm.	LENGTH mm.
1	79.0	55.0	14.04	36.0	6.2	345	84	320	76.0
2	79.0	54.0	14.86	34.0	6.3	345	83	330	74.0
3	81.0	56.0	14.22	36.0	5.9	320	82	320	75.0
4	81.0	55.0	14.22	34.0	5.8	330	82	320	75.0
5	80.0	56.0	14.22	34.0	5.7	320	81	320	75.0
6	81.0	54.0	14.61	36.0	5.8	325	81	320	73.0
Average	80.2	55.0	14.26	35.0	6.0	331	82	322	74.7

OUT PUT **66.08** % I.H.P. **10,067** R.H.P. = **9,357** Mech Eff = **93.04** %

\* FUEL OIL \* :- Serv.Tk °C **96**  
 F.O.I/L °C **133** Density = **0.9902** Obs.Den. = **0.9135**  
 Consump.: **1,128** Lt/Hr. **24.73** MT/Day. **110.1** Grm/BHP/Hr.

\* CYLINDER OIL \* :- Serv.Tk °C **48** Density = **0.9300** Obs.Den. = **0.9092**  
 Consump.: **10.4** Lt/Hr. **250** Lt/Day. **1.012** Grm/BHP/Hr.

\* WIND \* :- Direction **S** Force **3** Sea Cond. **3**  
 \* SPEED \* :- Ship **14.90** Engine **15.30** Slip **2.62** %  
 \* DRAFT \* :- Fwd. Mtr. **6.10** Aft. Mtr. **6.40** Mean **6.25** Mtr.

\* DISPLACEMENT \* : **15,355** MT.

MARKS :-

M. V. XETHA BHUM

  
 2nd Engineer  
 SECOND ENGINEER

M.V. XETHA BHUM

  
 Chief Engineer  
 CHIEF ENGINEER

Table 5 : M/E Indicator Diagram Result (02/09/06)

**M.V. XETHA BHUM**

XTB/F1-02  
PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date : 02/09/06 Time : 1100-1200 Hrs. Voyage : 659-S  
 Run Hrs. 73,865 Hrs. From BANGKOK To S'PORE  
 M/E Rev. 93.7 Handle 7.5 Load Ind. 58.0 Gov. Actr. 59.0  
 Atm. Temp. 31 E/R Temp. 47 S/W Temp. 30 Humidity 8  
 T/C Rev. 9,400 Exh. In T. 420 Exh. Out T. 360 P-Drop 10  
 A/C. In T. 110 A/C. Out T. 45 Scav. Press. 1.10 P-Drop 175  
 CFW. In T. 40 CFW. Out 84 CFW. Press. 2.70 F.O. Press. 8.00  
 L.O. In T. 44 L.O. Press. 2.90 CS Oil In T 46 CSO. Press. 3.30 SPRING = 0.3

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW. Out °C	AREA Sq. mm.	LENGTH mm.
1	79.0	53.0	13.16	36.0	6.2	340	83	300	76.0
2	77.0	54.0	15.77	35.0	6.3	350	83	350	74.0
3	80.0	55.0	14.22	35.0	5.9	335	81	320	75.0
4	80.0	55.0	13.78	34.0	6.0	340	82	310	75.0
5	79.0	56.0	13.78	34.0	5.8	330	80	310	75.0
6	81.0	54.0	14.61	36.0	5.7	330	80	320	73.0
Average	79.3	54.5	14.22	35.0	6.0	338	82	318	74.7

CVT EFF = 65.37 % IHP = 9956 BHP = 9256 Mech EFF = 92.97 %

\* FUEL OIL \* :- Serv. Tk. °C 97  
 F.O./L °C 126 Density = 0.9902 Obs. Den. = 0.9181  
 Consump.: 1,116 Lt/Hr. 24.59 MT/Day. 110.7 Grm/BHP/Hr.


\* CYLINDER OIL \* :-  
 Serv. Tk. °C 48 Density = 0.9300 Obs. Den. = 0.9092  
 Consump.: 10.4 Lt/Hr. 250 Lt/Day. 1.023 Grm/BHP/Hr.

\* WIND \* :- Direction WS Force 3 Sea Cond. 3  
 \* SPEED \* :- Ship 15.10 Engine 15.30 Slip 1.31 %  
 \* DRAFT \* :- Fwd. Mtr. 6.10 Aft. Mtr. 6.40 Mean 6.25 Mtr.

\* DISPLACEMENT \* : 15,355 M/T.

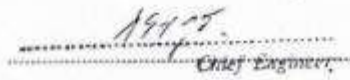
REMARKS :

M. V. XETHA BHUM



.....  
 Second Engineer

M.V. XETHA BHUM



.....  
 Chief Engineer

Table 6 : M/E Indicator Diagram Result (11/09/06)

**M.V. XETHA BHUM**

XTB/F1-02  
PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date :	11/09/06	Time :	1100-1200	Hrs.		Voyage :	661-N
Run Hrs.	74,018	Hrs.		From	S'PORE	To	LCB
M/E Rev.	93.7	Handle	7.4	Load Ind.	57.0	Gov. Actr.	55.0
Atm. Temp.	31	E/R Temp.	47	S/W Temp.	30	Humidity	8
T/C Rev.	9,400	Exh. In T.	430	Exh. Out T.	370	P-Drop	6
A/C. In T.	105	A/C. Out T.	40	Scav. Press.	1.00	P-Drop	170
CFW. In T.	70	CFW. Out T.	82	CFW. Press.	2.70	F.O. Press.	8.10
I.O. In T.	44	I.O. Press.	2.90	CS Oil In T.	47	CSO. Press.	3.40
						SPRING	= 0.3

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW. Out °C	AREA Sq. mm	LENGTH mm.
1	77.0	51.0	13.16	36.0	6.2	340	83	300	76.0
2	75.0	51.0	13.51	35.0	6.3	350	83	300	74.0
3	77.0	52.0	12.89	35.0	5.9	335	81	290	75.0
4	78.0	52.0	12.89	34.0	6.0	340	82	290	75.0
5	80.0	54.0	12.44	34.0	5.8	350	80	280	75.0
6	78.0	52.0	13.24	36.0	5.7	330	80	290	73.0
Average	77.5	52.0	13.02	35.0	6.0	338	82	292	74.7

OUT PUT    59.45    % I.H.P. = 9.119    R.H.P. = 8.418    Mech. Eff. = 92.32 %

\* FUEL OIL \* :-    Serv. Tk. °C    94  
 F.O./L. °C    122    Density = 0.9888    Obs. Den. = 0.9193  
 Consump. :    1,020    Lt/Hr.    22.50    Mt/Day.    111.4    Gm/BHP/Hr.


\* CYLINDER OIL \* :-  
 Serv. Tk. °C    48    Density = 0.9300    Obs. Den. = 0.9092  
 Consump. :    10.4    Lt/Hr.    250    Lt/Day.    1.124    Gm/BHP/Hr.

\* WIND \* :-    Direction    WS    Force    3    Sea Cond.    3  
 \* SPEED \* :-    Ship    15.10    Engine    15.30    Slip    1.31 %  
 \* DRAFT \* :-    Fwd. Mtr.    6.10    Aft. Mtr.    6.40    Mean    6.25 Mtr.

\* DISPLACEMENT \* : 14,973 MT.


REMARKS :

M. V. XETHA BHUM



SECOND ENGINEER

M.V. XETHA BHUM



CHIEF ENGINEER

Table 7 : M/E Indicator Diagram Result (18/09/06)

**M.V. XETHA BHUM**

XTB/F1-02  
PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date : 18/09/06 Time : 1700-1800 Hrs. Voyage : 662-N  
 Run Hrs. 74,129 Hrs. From S'PORE To LCB  
 M/E Rev. 93.7 Handle 7.4 Load Ind. 58.0 Gov. Actr. 56.0  
 Atm. Temp. 31 E/R Temp. 44 S/W Temp. 30 Humidity 8  
 T/C Rev. 9,200 Exh. In T. 420 Exh. Out T. 370 P-Drop 8  
 A/C. In T. 106 A/C. Out T. 46 Scav. Press. 1.05 P-Drop 170  
 CFW. In T. 70 CFW. Out T. 81 CFW. Press. 2.70 F.O. Press. 8.40  
 L.O. In T. 44 L.O. Press. 3.00 CS Oil In T. 46 CSO. Press. 3.50 **SPRING = 0.3**

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW. Out °C	AREA Sq. mm.	LENGTH mm.
1	79.0	53.0	13.16	36.0	6.0	340	82	300	76.0
2	77.0	52.0	13.96	35.0	6.0	345	82	310	74.0
3	82.0	54.0	14.67	35.0	6.0	335	80	330	75.0
4	79.0	54.0	14.67	34.0	6.2	335	81	330	75.0
5	83.0	56.0	14.67	34.0	5.7	325	80	330	75.0
6	83.0	55.0	15.53	36.0	6.0	345	79	340	73.0
Average	80.5	54.0	14.44	35.0	6.0	338	81	323	74.7

OUT PUT 66.47 % I.H.P. = 10,112 B.H.P. = 9.412 Mech. Eff. = 93.08 %

\* FUEL OIL \* :- Serv. Tk. °C 100  
 F.O. I/L °C 124 Density = 0.9888 Obs. Den. = 0.9180  
 Consump.: 1,020 Lt/Hr. 22.47 MT/Day. 99.5 Grm/BHP/Hr. \*


\* CYLINDER OIL \* :-  
 Serv. Tk. °C 48 Density = 0.9300 Obs. Den. = 0.9092  
 Consump.: 10.4 Lt/Hr. 250 Lt/Day. 1.006 Grm/BHP/Hr.

\* WIND \* :- Direction W Force 4 Sea Cond. 4  
 \* SPEED \* :- Ship 15.30 Engine 15.30 Slip 0.01 %  
 \* DRAFT \* :- Fwd. Mtr. 6.80 Aft. Mtr. 7.40 Mean 7.10 Mtr.

\* DISPLACEMENT \* : 16.675 M/T.

REMARKS :

**M. V. XETHA BHUM**

  
 .....  
 SECOND ENGINEER


  
 .....  
 CHIEF ENGINEER

Table 8 : M/E Indicator Diagram Result (25/09/06)

**M.V. XETHA BHUM**

XTB/F1-02  
PAGE 1/3

**M/E INDICATOR DIAGRAM RESULT**

Date : 25/09/06 Time : 1600-1700 Hrs. Voyage : 663-N  
 Run Hrs. 74,242 Hrs. From S'PORE To LCB  
 M/E Rev. 93.7 Handle 7.4 Load Ind. 59.0 Gov. Actr. 59.0  
 Atm. Temp. 31 E/R Temp. 46 S/W Temp. 30 Humidity 8  
 T/C Rev. 9,000 Exh. In T. 435 Exh. Out T. 380 P-Drop 8  
 A/C. In T. 105 A/C. Out T. 44 Scav. Press. 1.00 P-Drop 160  
 CFW. In T. 70 CFW. Out T. 81 CFW. Press. 2.70 F.O. Press. 8.30  
 L.O. In T. 43 L.O. Press. 2.95 CS Oil In T. 47 CSO. Press. 3.25 **SPRING = 0.3**

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW Out °C	AREA Sq. mm.	LENGTH mm.
1	79.0	51.0	12.72	60.0	3.8	350	83	290	76.0
2	76.0	51.0	12.61	59.0	3.0	345	82	280	74.0
3	77.0	53.0	14.22	60.0	3.6	355	80	320	75.0
4	79.0	54.0	13.78	60.0	3.3	340	80	310	75.0
5	81.0	55.0	13.78	58.0	3.2	340	82	310	75.0
6	82.0	54.0	15.53	60.0	3.8	350	80	340	73.0
Average	79.0	53.0	13.77	59.5	3.5	347	81	308	74.7

OUT PUT 63.16 % I.H.P. = 9,644 B.H.P. = 8,944 Mech. Eff. = 92.74 %

\* FUEL OIL \* :- Serv. Tk. °C 100  
 F.O./L °C 123 Density = 0.9888 Obs. Den. = 0.9186  
 Consump.: 1,020 Lt/Hr. 22.49 MT/Day. 104.8 Grm/BHP/Hr.

\* CYLINDER OIL \* :- Serv. Tk. °C 48 Density = 0.9300 Obs. Den. = 0.9092  
 Consump.: 10.4 Lt/Hr. 250 Lt/Day. 1.058 Grm/BHP/Hr.

\* WIND \* :- Direction W Force 5 Sea Cond. 5  
 \* SPEED \* :- Ship 15.00 Engine 15.30 Slip 1.97 %  
 \* DRAFT \* :- Fwd. Mtr. 6.70 Aft. Mtr. 7.10 Mean 6.90 Mtr.

\* DISPLACEMENT \* : 16,509 M/T.

REMARKS :

**M. V. XETHA BHUM**

*[Signature]*  
 SECOND ENGINEER

**M.V. XETHA BHUM**

*[Signature]*  
 CHIEF ENGINEER

Table 9 : M/E Indicator Diagram Result (17/02/07)

M.V. XETHA BHUM

XIB-F1-02  
PAGE 1/3

M/E INDICATOR DIAGRAM RESULT

Date: 17/02/07 Time: 1600-1800 Hrs. Voyage: 683-5  
 Run Hrs. 76520,141 Hrs. From ~~SINGAPORE~~ ~~BRK~~ To ~~BRK~~ SINGAPORE.  
 M/E Rev 90,2110.8 Handle 2.5 9.1 Load Ind. 43 78.0 Gov. Actr 40.1 77.0  
 Atm. Temp. 31 F.R. Temp. 45 47 S/W Temp. 29 30 Humidity 80  
 T/C Rev 9,050 11,800 Exh. In T. 496 445 Exh. Out T. 390 340 P-Drop 16 32  
 A/C. In T. 105 152 A/C. Out T. 116 46 Scav. Press. 1.05 1.90 P-Drop 175 265  
 CFW. In T. 71 70 CFW. Out T. 76 74 CFW. Press. 1.70 2.70 F.O. Press. 9.40 7.90  
 L.O. In T. 43 44 L.O. Press. 2.90 2.85 CS Oil In T. 47 45 CSO. Press. 3.40 3.80 SPRING = 0.3

Cylinder No.	P. Max. bar	P. Comp.	P. Ind. bar	Fuel Rack	VIT	Exh. Gas °C	CFW. Out °C	AREA Sq. cm.	LENGTH mm.
1	95 120.0	53 76.0	17.54	99 75.0	5.5 8.5	350 360	83 86	400	76.0
2	78 117.0	52 75.0	17.12	59 76.0	4.0 8.3	350 340	81 84	380	74.0
3	91 120.0	51 77.0	17.78	59 75.0	5.0 8.4	355 340	80 82	400	75.0
4	71 118.0	53 76.0	16.44	61 77.0	3.4 8.0	350 350	83 86	370	75.0
5	95 119.0	54 78.0	16.00	60 77.0	3.7 8.5	350 360	81 84	360	75.0
6	83 122.0	59 78.0	18.72	66 75.0	5.5 8.5	370 370	80 82	410	73.0
Average	119.3	76.7	17.27	75.8	8.0	353	84	387	74.7

OUTPUT 95.12 % I.H.P. = 14,298 B.H.P. = 13,470 Mech. Eff. = 94.21 %

\* FUEL OIL \* :- Serv. Tk. °C 91 94  
 F.O. IL °C 130 130 Density = 0.9883 Obs. Den. = 0.9136  
 Consump. = 1,898 Lt/Hr. 35.26 MT/Day. 109.1 Gm/BHP/Hr.  
 1,020

\* CYLINDER OIL \* :- Serv. Tk. °C 47 Density = 0.9300 Obs. Den. = 0.9098  
 Consump. = 10.1 Lt/Hr. 250 Lt/Day. 0.703 Gm/BHP/Hr.

\* WIND \* :- Direction NE Force 3 Sea Cond. 3  
 \* SPEED \* :- Ship 16.50 Engine 18.09 Slip 8.81 %  
 \* DRAFT \* :- Fwd. Mtr. 6.70 Aft. Mtr. 6.50 Mean 6.35 Mtr.

\* DISPLACEMENT \* :- 13,245 MT.

REMARKS:

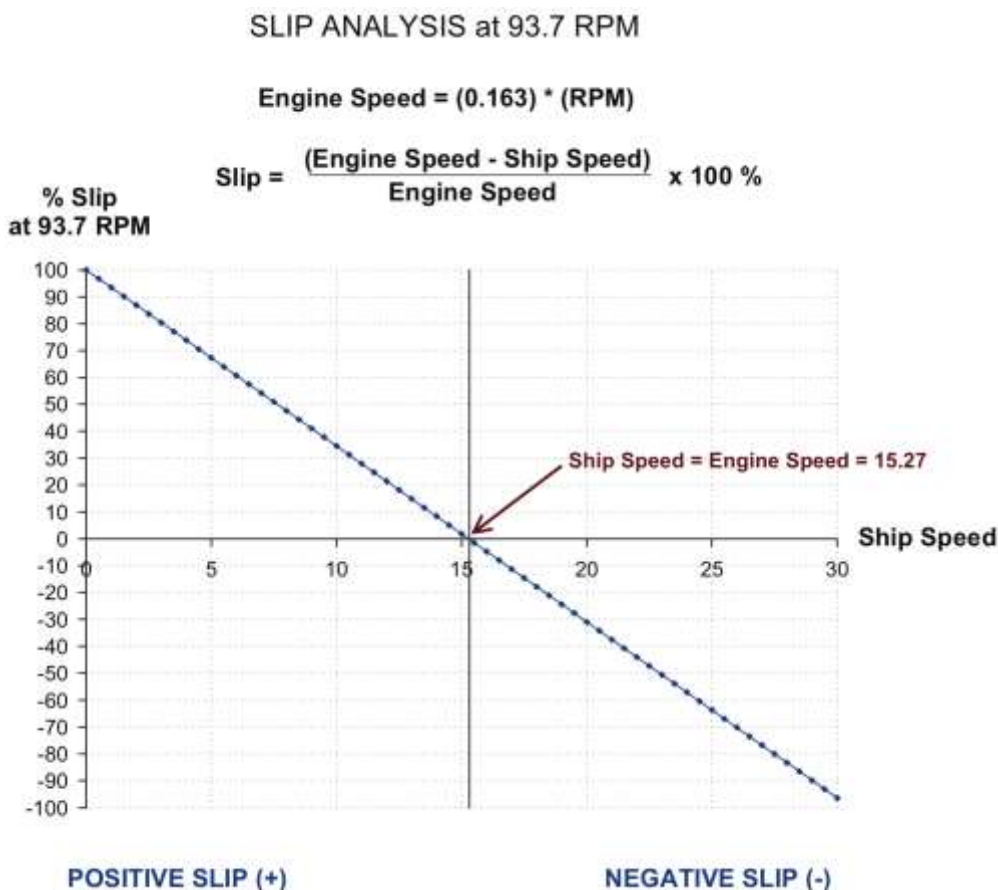
SECOND ENGINEER

CHIEF ENGINEER

## 4 Fuel savings - real time operations

Several factors affecting to the real time operation of the ship include: ship engine power, ship speed, the external resistance such as water flow direction, local weather condition, and the like. The effects of these factors result in the consumption of fuel quantity during the ship travelling from Bangkok – Singapore and Singapore – Lamchabang. To summarize these effects, the ship has measured the real *ship speed* (using satellite measurement) compared with the *engine speed* produced by the engine. Slip, as a calculation parameter, is used for this purpose to represent the percentage difference between the real ship speed and the engine speed.

Figure 9 : Description of slip. Example of engine speed at 93.7 RPM



## 4.1) Calculations

The operating data on fuel consumption of *before* and *during* use of mXt9™ are shown in Appendices A and B respectively. Each trip (Bangkok – Singapore, or Singapore – Lamchabang) has been recorded, including the parameters of:

- ◆ Average Slip,
  - ◆ Rate of fuel consumption (litres per hour),
  - ◆ Displacement, which represents to the load carry on the ship.
1. Average slip is important information to understand. At positive slip, the ship is travelling opposite to the direction of water flow. The ship needs more engine power to overcome the resistance, and therefore uses more quantity of fuel.
  2. Rate of fuel consumption indicates the average fuel use per hour during the trip. The total fuel quantity should be averaged by time to indicate the normal working conditions (litre per hour).
  3. Displacement is important because it is the resistance load that the ship engine has to overcome. At the same condition, the more the displacement, the more the fuel consumption.
  4. The ratio of fuel per displacement load is calculated. It indicates the fuel consumption per each load that the ship can carry to produce profit.

The statistic data on slip, fuel consumption, displacement, and ratio of fuel per displacement are shown in Table 10. The number of statistical data (travelling trip) is 100. Load distribution of displacement using the statistic histogram is shown in Figure 10.

The histogram shows that the majority of displacements for both *without* and *with* mXt9™ are similar. The similar displacements range from 13,000 – 20,999 and will be used for the comparison on fuel savings (Table 11) between *without* and *with* using mXt9™.

Table 10 : The statistical data on slip, fuel consumption, displacement, and ratio of fuel per displacement (all data)

(a) Data during January 2006 – May 2006, from Appendix A : WITHOUT using mXt9™

Voy No.	Port	Date	RPM	Slip	Fuel Oil (Litres)	Displacement	Hr	Fuel per Hour	Fuel per Hour per Displacement (E+02)
627	SIN - LCH	01/01/06 - 04/01/06	96.30	3.70	59,080	15,000	51	1,158	7.72
	BKK-SIN	05/01/06 - 08/01/06	93.66	-9.50	51,960	14,500	60.3	862	5.94
628	SIN - LCH	08/01/06 - 11/01/06	100.20	5.40	70,300	15,750	50	1,406	8.93
	BKK-SIN	12/01/06 - 15/01/06	101.97	2.17	65,040	19,850	53.4	1,218	6.46
629	SIN - LCH	15/01/06 - 18/01/06	93.66	1.95	59,070	15,600	50	1,191	7.57
	BKK-SIN	19/01/06 - 21/01/06	90.77	-1.87	51,730	16,600	53	976	5.25
630	SIN - LCH	22/01/06 - 25/01/06	97.47	4.97	64,860	17,750	47	1,386	7.77
	BKK-SIN	26/01/06 - 29/01/06	89.37	-4.34	49,990	16,400	53	943	5.75
631	SIN - LCH	29/01/06 - 1/02/06	85.54	1.24	56,650	13,900	56	1,030	7.41
	BKK-SIN	2/02/06 - 05/02/06	95.77	-1.30	55,790	17,400	52	1,073	6.17
632	SIN - LCH	05/02/06 - 08/02/06	96.14	2.50	62,900	14,500	51	1,225	8.45
	BKK-SIN	09/02/06 - 12/02/06	99.00	4.80	63,600	20,250	53	1,200	5.93
633	SIN - LCH	13/02/06 - 16/02/06	94.67	3.34	59,570	15,600	57	1,045	6.70
	BKK-SIN	17/02/06 - 19/02/06	98.74	1.44	61,950	19,150	51	1,213	6.33
634	SIN - LCH	19/02/06 - 22/02/06	98.44	4.70	64,570	15,750	51	1,266	8.04
	BKK-SIN	23/02/06 - 26/02/06	97.67	3.87	62,320	20,250	53	1,176	5.61
635	SIN - LCH	26/02/06 - 01/03/06	95.34	0.64	60,270	14,500	51	1,162	8.15
	BKK-SIN	02/03/06 - 05/03/06	97.17	5.20	62,350	20,600	54	1,155	5.60
636	SIN - LCH	5/03/06 - 08/03/06	96.97	1.57	60,950	15,750	51	1,195	7.59
	BKK-SIN	09/03/06 - 12/03/06	101.94	1.60	66,260	19,150	49	1,352	7.06
637	SIN - LCH	12/03/06 - 15/03/06	101.90	3.60	64,100	16,200	47	1,364	8.42
	BKK-SIN	16/03/06 - 19/03/06	99.34	2.20	72,060	19,990	53	1,360	6.80
638	SIN - LCH	19/03/06 - 22/03/06	92.00	-0.10	60,330	15,250	52	1,168	7.61
	BKK-SIN	23/03/06 - 26/03/06	97.30	3.17	66,660	20,250	54	1,234	6.10
639	SIN - LCH	26/03/06 - 30/03/06	97.30	0.64	62,730	15,250	57	1,101	7.22
	BKK-SIN	31/03/06 - 02/04/06	98.67	2.94	67,590	20,250	52	1,300	6.42
640	SIN - LCH	02/04/06 - 05/04/06	96.77	1.87	62,310	15,750	53	1,176	7.46
	BKK-SIN	06/04/06 - 09/04/06	93.67	0.54	64,060	19,150	56	1,158	6.06
641	SIN - LCH	24/04/06 - 28/04/06	107.39	5.98	78,040	18,250	47	1,660	9.10
	BKK-SIN	27/04/06 - 30/04/06	95.94	-2.97	65,570	17,400	56	1,171	6.73
642	SIN - LCH	30/04/06 - 03/05/06	94.94	-3.30	59,060	15,600	58	1,016	6.53
	BKK-SIN	04/05/06 - 07/05/06	87.00	-7.47	51,100	13,900	58	881	6.34
643	SIN - LCH	07/05/06 - 10/05/06	92.90	-3.44	51,920	17,200	60	865	5.03
	BKK-SIN	11/05/06 - 14/05/06	91.74	3.77	51,220	15,000	60	854	5.69
644	SIN - LCH	14/05/06 - 17/05/06	93.07	1.14	52,730	18,250	59	894	4.90
	BKK-SIN	18/05/06 - 21/05/06	83.67	-2.20	54,940	15,600	61	901	5.77
645	SIN - LCH	21/05/06 - 24/05/06	92.80	-5.37	53,700	16,600	60	895	5.39
	BKK-SIN	25/05/06 - 28/05/06	89.34	-3.04	54,780	15,600	58	944	6.05
646	SIN - LCH	28/05/06 - 31/05/06	92.70	-0.94	54,420	16,400	61	892	5.44

Number of Trip = 39

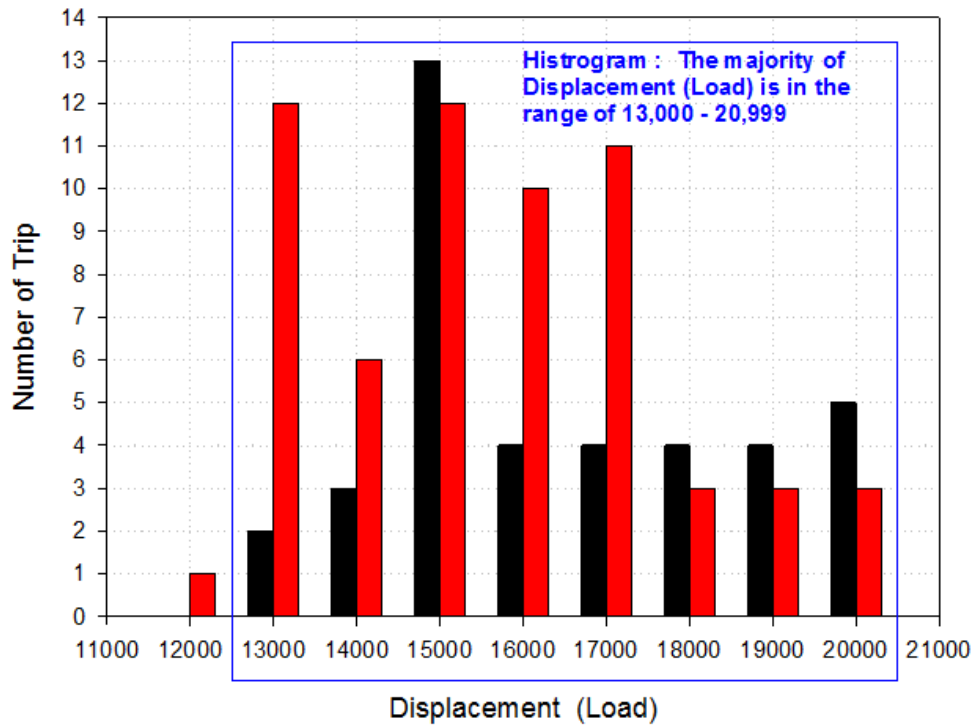
(b) Data during June 2006 – December 2006, from Appendix B : WITH using mXt9™

Voy No	Port	Date	RPM	Slp	Fuel Oil (Liters)	Displacement	Hr	F / Hr	Fuel per Hour per Displacement (E+O2)
646	BKK-SIN	01/06/06 - 04/06/06	92 00	-2.34	54 900	16 200	57	963	5.96
647	SIN - LCH	04/06/06 - 07/06/06	92 10	-1.40	54 200	16 600	51	1 063	5.33
	BKK-SIN	08/06/06 - 11/06/06	88 17	-1.00	56 140	13 900	58	968	6.96
648	SIN - LCH	11/06/06 - 14/06/06	92 77	-3.00	51 290	17 200	57	900	5.23
	BKK-SIN	14/06/06 - 18/06/06	85 97	-2.97	55 150	13 500	61	904	6.70
649	SIN - LCH	18/06/06 - 21/06/06	92 90	-5.17	50 720	19 450	59	860	4.42
	BKK-SIN	21/06/06 - 25/06/06	93 24	-4.14	55 960	14 500	57	982	6.77
650	SIN - LCH	25/06/06 - 28/06/06	90 33	-4.16	49 890	17 400	49	1 017	5.85
	BKK-SIN	29/06/06 - 2/07/06	102 40	8.84	55 120	20 650	51	1 081	5.23
651	SIN - LCH	02/07/06 - 05/07/06	102 67	-2.97	44 620	17 400	45	992	5.70
	BKK-SIN	06/07/06 - 09/07/06	96 67	2.37	47 200	13 900	56	843	6.06
652	SIN - LCH	10/07/06 - 12/07/06	91 50	-6.20	45 890	15 750	49	937	5.95
	BKK-SIN	13/07/06 - 16/07/06	87 76	-1.10	53 950	13 450	61	884	5.88
653	SIN - LCH	16/07/06 - 19/07/06	93 20	-5.40	51 260	19 750	55	932	4.72
	BKK-SIN	20/07/06 - 22/07/06	91 30	-2.63	53 980	13 900	58	929	6.68
654	SIN - LCH	23/07/06 - 26/07/06	91 93	-7.60	45 950	16 300	49 1	918	5.63
	BKK-SIN	27/07/06 - 29/07/06	93 27	-2.13	54 150	14 750	57	950	6.44
655	SIN - LCH	30/07/06 - 2/08/06	91 27	-6.93	43 300	15 600	48	902	5.78
	BKK-SIN	3/08/06 - 5/08/06	95 60	-6.20	61 160	17 400	58	1 054	6.06
656	SIN - LCH	6/08/06 - 9/08/06	92 60	-2.15	43 550	20 700	52	838	4.06
	BKK-SIN	10/08/06 - 13/08/06	92 30	-0.66	53 450	14 750	57	938	6.36
657	SIN - LCH	14/08/06 - 16/08/06	96 80	-4.20	40 050	17 200	47	852	4.96
	BKK-SIN	17/08/06 - 20/08/06	95 40	0.37	58 080	13 500	58	1 001	7.42
658	SIN - LCH	21/08/06 - 23/08/06	90 93	-6.67	44 350	15 600	51	870	5.57
	BKK-SIN	24/08/06 - 26/08/06	90 30	-0.33	54 390	14 500	60	907	6.25
659	SIN - LCH	27/08/06 - 30/08/06	92 70	-7.20	51 820	16 200	58	890	5.49
	BKK-SIN	31/08/06 - 2/09/06	91 20	-0.93	54 910	15 000	57	963	6.42
660	SIN - LCH	3/09/06 - 6/09/06	92 43	-4.96	45 980	16 600	51	900	5.42
	BKK-SIN	7/09/06 - 9/09/06	92 83	-2.60	52 690	14 500	57	924	6.37
661	SIN - LCH	10/09/06 - 13/09/06	93 00	-4.03	48 140	15 600	61	789	5.06
	BKK-SIN	14/09/06 - 16/09/06	92 30	-3.13	51 110	13 900	55	929	6.69
662	SIN - LCH	17/09/06 - 20/09/06	92 30	2.50	51 810	17 750	50	1 036	5.84
	BKK-SIN	21/09/06 - 23/09/06	90 30	-3.93	52 220	14 500	57	916	6.32
663	SIN - LCH	24/09/06 - 27/09/06	92 23	1.13	51 170	17 200	62	825	4.80
	BKK-SIN	28/09/06 - 30/09/06	88 33	0.13	65 320	15 750	59	938	5.95
664	SIN - LCH	1/10/06 - 4/10/06	93 80	-2.90	49 330	16 600	56	881	5.31
	BKK-SIN	5/10/06 - 7/10/06	92 53	-2.20	54 250	13 500	56	969	7.18
665	SIN - LCH	8/10/06 - 11/10/06	93 20	-4.20	49 920	15 600	63	792	5.08
	BKK-SIN	12/10/06 - 14/10/06	89 67	-3.50	50 920	13 500	58	878	6.50
666	SIN - LCH	15/10/06 - 19/10/06	92 83	0.50	53 630	17 400	60	894	5.14
	BKK-SIN	19/10/06 - 21/10/06	90 80	-2.73	51 690	13 900	57	907	6.52
667	SIN - LCH	22/10/06 - 24/10/06	93 33	0.73	54 710	17 750	60	912	6.14
	BKK-SIN	26/10/06 - 28/10/06	86 26	-8.73	52 110	12 250	58	898	7.33
668	SIN - LCH	29/10/06 - 31/10/06	93 10	1.27	56 860	17 200	61	932	5.42
	BKK-SIN	2/11/06 - 4/11/06	92 37	-4.37	52 260	15 250	56	933	6.12
669	SIN - LCH	5/11/06 - 8/11/06	92 76	2.70	54 840	16 650	62	885	5.31
	BKK-SIN	9/11/06 - 11/11/06	91 73	-5.90	51 290	13 900	55	933	6.71
670	SIN - LCH	12/11/06 - 15/11/06	92 77	5.03	57 750	18 531	52	1 111	5.99
	BKK-SIN	16/11/06 - 18/11/06	97 40	8.56	58 930	18 307	54	1 091	6.69
671	SIN - LCH	19/11/06 - 22/11/06	91 85	2.75	52 130	18 850	54	965	5.12
	BKK-SIN	23/11/06 - 25/11/06	90 37	-7.65	52 730	15 000	58	909	6.06
672	SIN - LCH	26/11/06 - 28/11/06	93 40	0.33	53 880	15 750	58	929	5.90
	BKK-SIN	30/11/06 - 2/12/06	92 33	-1.66	51 950	16 800	57	910	5.41
673	SIN - LCH	3/12/06 - 6/12/06	88 63	0.63	53 740	17 200	52	1 033	6.01
	BKK-SIN	7/12/06 - 9/12/06	91 90	0.63	51 080	13 500	59	868	6.41
674	SIN - LCH	10/12/06 - 13/12/06	90 25	5.60	56 460	19 450	52	1 066	5.58
	BKK-SIN	14/12/06 - 17/12/06	88 88	4.05	51 040	15 600	58	880	5.64
675	SIN - LCH	17/12/06 - 20/12/06	93 20	12.55	60 630	20 750	54	1 123	5.41
	BKK-SIN	21/12/06 - 24/12/06	96 83	1.20	62 200	16 600	64	972	5.85
676	SIN - LCH	24/12/06 - 27/12/06	92 80	3.70	58 400	15 750	51	1 165	7.39
	BKK-SIN	27/12/06 - 31/12/06	93 27	-0.86	54 940	18 600	56	981	5.27

Number of trip = 61

Figure 10 : Histogram on Displacement (Load) of all data

### Displacement (Load) Distribution



Without mXt9™, Number of Trip = 39

With mXt9™, Number of Trip = 61

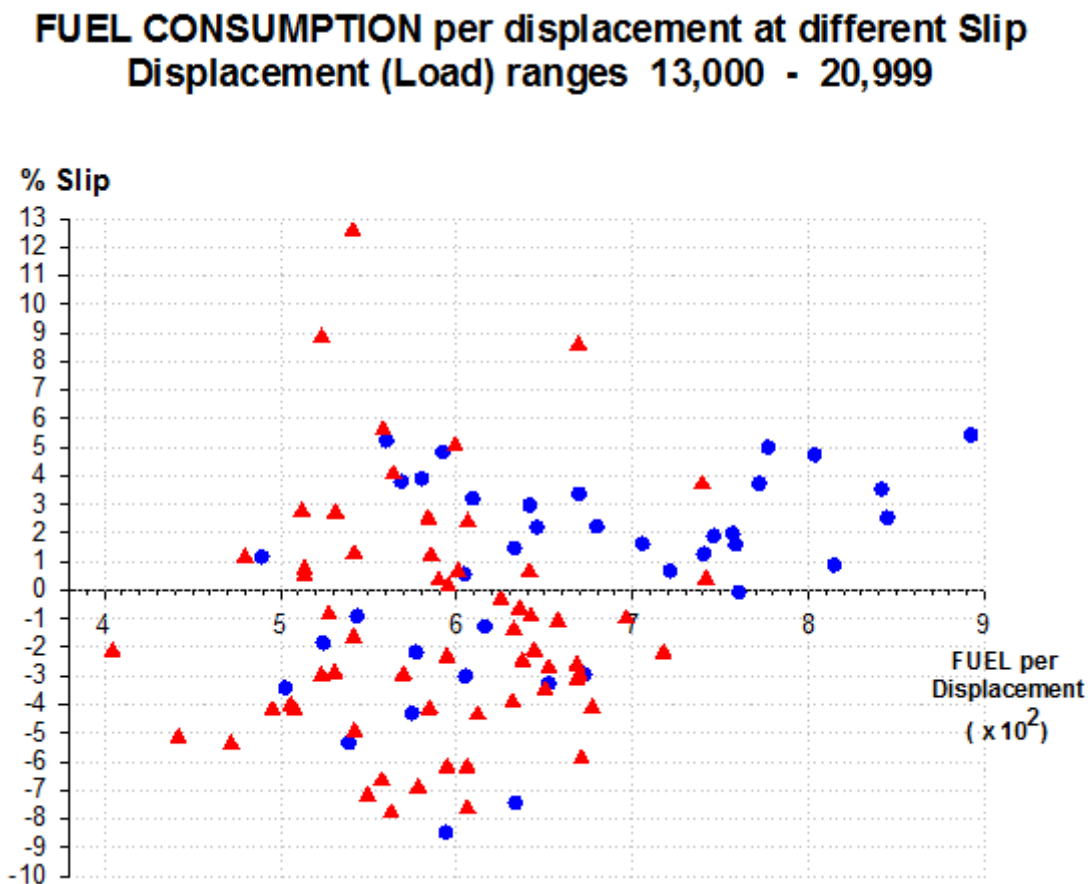
Number of statistical data : Number of Trip = 39 + 61 = 100 data

Table 11 : The statistic data on slip, fuel consumption, displacement, and ratio of fuel per displacement. The displacements are 13,000 – 20,999.

Voy No	Port	Date	RPM	Slip	Fuel Oil (Liters)	Displacement	Hr	F / Hr	Fuel per Hour per Displacement (E+02)
646	BKK-SIN	01/06/06 - 04/06/06	92.00	-2.34	54.900	16.200	57	963	5.96
647	SIN - LCH	04/06/06 - 07/06/06	92.10	-1.40	54.200	16.800	51	1.063	6.33
	BKK-SIN	08/06/06 - 11/06/06	88.17	-1.00	56.140	13.900	58	968	6.96
648	SIN - LCH	11/06/06 - 14/06/06	92.77	-3.00	51.290	17.200	57	900	5.23
	BKK-SIN	14/06/06 - 18/06/06	86.97	-2.97	56.150	13.500	61	904	6.70
649	SIN - LCH	18/06/06 - 21/06/06	92.90	-5.17	50.720	19.450	59	860	4.42
	BKK-SIN	21/06/06 - 25/06/06	93.24	-4.14	56.960	14.500	57	982	6.77
650	SIN - LCH	25/06/06 - 28/06/06	90.33	-4.16	49.850	17.400	49	1.017	5.85
	BKK-SIN	29/06/06 - 2/07/06	102.40	8.84	56.120	20.650	51	1.081	5.23
651	SIN - LCH	02/07/06 - 05/07/06	102.67	-2.97	44.620	17.400	46	992	5.70
	BKK-SIN	06/07/06 - 09/07/06	96.67	2.37	47.200	13.900	56	843	6.06
652	SIN - LCH	10/07/06 - 12/07/06	91.50	-6.20	45.890	15.750	49	937	5.95
	BKK-SIN	13/07/06 - 16/07/06	87.76	-1.10	53.950	13.450	61	884	6.68
653	SIN - LCH	16/07/06 - 19/07/06	93.20	-5.40	51.260	19.750	56	932	4.72
	BKK-SIN	20/07/06 - 22/07/06	91.30	-2.63	53.880	13.900	58	929	6.68
654	SIN - LCH	23/07/06 - 26/07/06	91.93	-7.80	45.950	16.300	49.1	918	5.63
	BKK-SIN	27/07/06 - 29/07/06	93.27	-2.13	54.150	14.750	57	950	6.44
655	SIN - LCH	30/07/06 - 2/08/06	91.27	-6.99	43.300	15.600	48	902	5.78
	BKK-SIN	3/08/06 - 5/08/06	96.60	-6.20	61.160	17.400	58	1.054	6.06
656	SIN - LCH	6/08/06 - 9/08/06	92.60	-2.15	43.550	20.700	52	838	4.05
	BKK-SIN	10/08/06 - 13/08/06	92.30	-0.66	53.460	14.750	57	938	6.36
657	SIN - LCH	14/08/06 - 16/08/06	96.80	-4.20	40.050	17.200	47	852	4.96
	BKK-SIN	17/08/06 - 20/08/06	95.40	0.37	58.080	13.500	58	1.001	7.42
658	SIN - LCH	21/08/06 - 23/08/06	90.93	-6.67	44.350	15.600	51	870	5.57
	BKK-SIN	24/08/06 - 26/08/06	90.30	-0.33	54.390	14.500	60	907	6.25
659	SIN - LCH	27/08/06 - 30/08/06	92.70	-7.20	51.620	16.200	58	880	5.49
	BKK-SIN	31/08/06 - 2/09/06	91.20	-0.93	54.910	15.000	57	963	6.42
660	SIN - LCH	3/09/06 - 5/09/06	92.43	-4.96	45.880	16.600	51	900	5.42
	BKK-SIN	7/09/06 - 9/09/06	92.93	-2.50	52.680	14.500	57	924	6.37
661	SIN - LCH	10/09/06 - 13/09/06	93.00	-4.03	48.140	15.600	61	789	5.06
	BKK-SIN	14/09/06 - 16/09/06	92.30	-3.13	51.110	13.900	56	929	6.69
662	SIN - LCH	17/09/06 - 20/09/06	92.30	2.50	51.810	17.750	50	1.036	5.84
	BKK-SIN	21/09/06 - 23/09/06	90.30	-3.93	62.220	14.500	67	916	6.32
663	SIN - LCH	24/09/06 - 27/09/06	92.23	1.13	51.170	17.200	62	825	4.80
	BKK-SIN	28/09/06 - 30/09/06	88.33	0.13	56.320	15.750	59	938	5.95
664	SIN - LCH	1/10/06 - 4/10/06	93.80	-2.90	49.330	16.600	56	881	5.31
	BKK-SIN	5/10/06 - 7/10/06	92.53	-2.20	54.250	13.500	56	969	7.18
665	SIN - LCH	8/10/06 - 11/10/06	93.20	-4.20	49.920	15.600	63	792	5.08
	BKK-SIN	12/10/06 - 14/10/06	88.67	-3.60	50.920	13.500	58	878	6.50
666	SIN - LCH	15/10/06 - 18/10/06	92.83	0.50	53.630	17.400	60	894	5.14
	BKK-SIN	19/10/06 - 21/10/06	90.80	-2.73	51.680	13.900	57	907	6.52
667	SIN - LCH	22/10/06 - 24/10/06	93.33	0.73	54.710	17.750	60	912	5.14
	BKK-SIN	26/10/06 - 29/10/06	86.26	-8.73	52.110	12.250	58	896	7.33
668	SIN - LCH	29/10/06 - 31/10/06	93.10	1.27	56.860	17.200	61	932	5.42
	BKK-SIN	2/11/06 - 4/11/06	92.37	-4.37	52.260	15.250	56	933	6.12
669	SIN - LCH	5/11/06 - 8/11/06	92.76	2.70	54.840	16.650	62	866	5.31
	BKK-SIN	9/11/06 - 11/11/06	91.73	-5.90	51.290	13.900	56	933	6.71
670	SIN - LCH	12/11/06 - 15/11/06	92.77	5.03	57.750	18.531	52	1.111	5.99
	BKK-SIN	16/11/06 - 18/11/06	97.40	8.56	58.930	16.307	54	1.091	6.69
671	SIN - LCH	19/11/06 - 22/11/06	91.95	2.75	52.130	18.850	54	965	5.12
	BKK-SIN	23/11/06 - 25/11/06	90.37	-7.65	52.730	15.000	58	908	6.06
672	SIN - LCH	26/11/06 - 28/11/06	93.40	0.33	53.880	15.750	58	929	5.90
	BKK-SIN	30/11/06 - 2/12/06	92.33	-1.66	51.950	16.800	57	910	5.41
673	SIN - LCH	3/12/06 - 6/12/06	88.63	0.63	53.740	17.200	52	1.033	6.01
	BKK-SIN	7/12/06 - 9/12/06	91.90	0.63	51.080	13.500	59	866	6.41
674	SIN - LCH	10/12/06 - 13/12/06	90.25	5.60	56.460	19.450	52	1.086	5.98
	BKK-SIN	14/12/06 - 17/12/06	88.88	4.06	51.040	15.600	58	880	5.64
675	SIN - LCH	17/12/06 - 20/12/06	93.20	12.55	60.630	20.750	54	1.129	5.41
	BKK-SIN	21/12/06 - 24/12/06	96.83	1.20	62.200	16.600	64	972	6.86
676	SIN - LCH	24/12/06 - 27/12/06	92.80	3.70	59.400	15.750	51	1.165	7.39
	BKK-SIN	27/12/06 - 31/12/06	93.27	-0.86	54.840	18.600	56	961	5.27
			Average Slip =	-1.40		Average Fuel per Hour per displacement =		5.91	
	Load < 13,000								

The statistical data from Tables 10 and 11 are plotted between the fuel consumption per displacement (X – axis) and the slip (Y – axis) as shown in Figure 11. Without mXt9™ (blue circle symbols) the data is scattered and has an average fuel consumption of 6.71 and an average slip of 0.77. With mXt9™ (red triangle symbols) the data is not scattered and has an average fuel consumption of 5.91 and the average slip of -1.40.

Figure 11 : Fuel consumption per displacement at different slip



Without mXt9™, Fuel consumption = 6.71, Average Slip = 0.77

With mXt9™, Fuel consumption = 5.91, Average Slip = -1.40

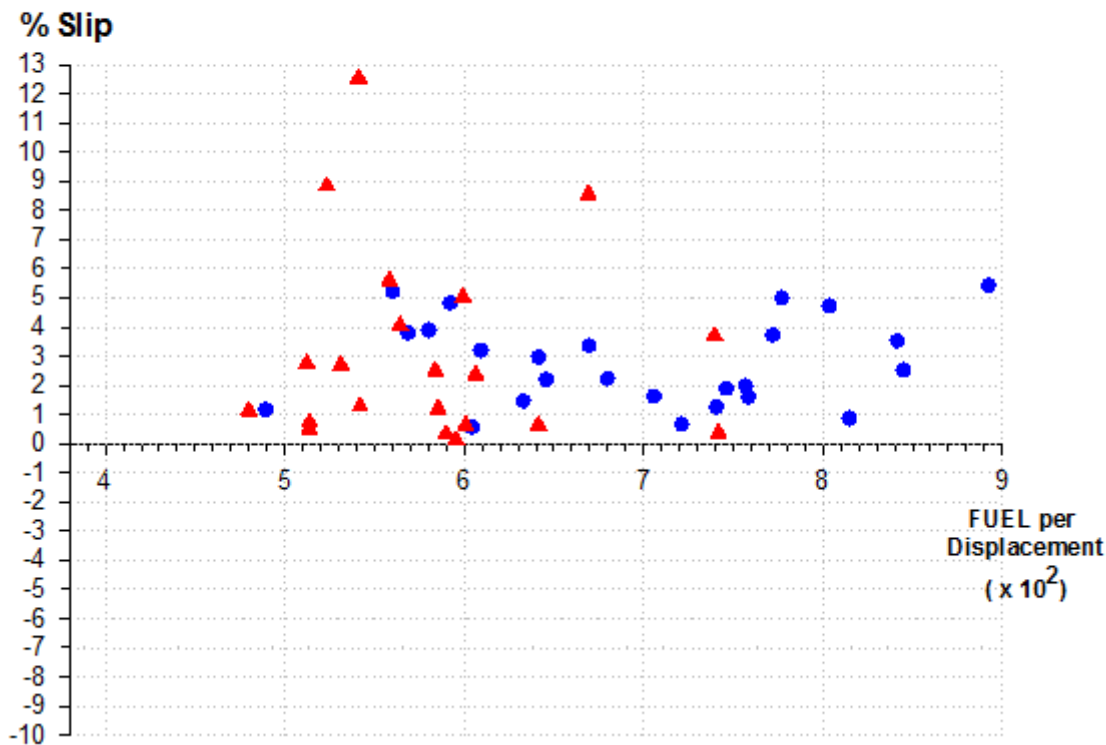
$$\text{The fuel savings is} = \frac{(6.71-5.91)}{6.71} \times 100\% = 11.92\%$$

## 4.2) More advantages during positive slip

More advantages of mXt9™ are found during the positive slip. With mXt9™ the molecular clusters of fuel molecules are broken apart and enable the complete combustion to maximum energy. The combustion takes place at the top of piston in the cylinder and pushes the piston moving faster and gives more power to overcome the positive slip resistance. The data in Figure 11 are re-plotted only where there was positive slip, as shown in Figure 12.

Figure 12 : Fuel consumption per displacement at the positive slip

### FUEL CONSUMPTION per displacement at positive Slip Displacement (Load) ranges 13,000 - 20,999



Without mXt9™, Fuel consumption = 7.06 , Average Slip = 2.89

With mXt9™, Fuel consumption = 5.82, Average Slip = 3.12

$$\text{The fuel savings is} = \frac{(7.06 - 5.82)}{7.06} \times 100\% = 17.56\%$$

## 5 Conclusions

The fuel saving study has been performed during the real time operations between January 2006 – December 2006. Engine efficiency improvements have been conducted using the M/E indicator diagram results, to represent the measurement of fuel oil consumption per horsepower per hour (Grm/BHP/Hr). The results showed that at the same condition (zero slip) mXt9<sup>TM</sup> can save fuel by up to 24.90%.

During the real time operation (January 2006 – December 2006), the operating data on fuel consumption of *before* and *during* use of mXt9<sup>TM</sup> were collected including the average slip, the rate of fuel consumption (litres per hour), and the displacement (load carried by the ship). With the majority of displacements found in the range of 13,000 – 20,999, the average fuel saving was 11.92%. More advantages of mXt9<sup>TM</sup> are found during times of positive slip where the engine needs more power to overcome the external resistance. During positive slip, fuel saving was found 17.56%.

It is concluded that mXt9<sup>TM</sup> does have a powerful positive effect in completing combustion of fuel oil to obtain the maximum energy possible for the engine's internal combustion. The ship has run smoothly without any negative effects by mXt9<sup>TM</sup>. mXt9<sup>TM</sup> is safe and able to reduce fuel consumption considerably.

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## APPENDIX A

### REAL TIME OPERATING DATA

### BEFORE USING MXT9™

### JANUARY 1<sup>ST</sup> 2006 – MAY 29<sup>TH</sup> 2006

Summary Voyage No. 627 – 646.

Voy No.	Port	Date	RPM	Slip	Fuel Oil ( Liters)	Displacement	Hr.
627	SIN - LCH	01/01/06 - 04/01/06	96.30	3.70	59,080	15,000	51
	BKK-SIN	05/01/06 - 08/01/06	93.65	-8.50	51,960	14,500	60.3
628	SIN - LCH	08/01/06 - 11/01/06	100.20	5.40	70,300	15,750	50
	BKK-SIN	12/01/06 - 15/01/06	101.97	2.17	65,040	18,850	53.4
629	SIN - LCH	15/01/06 - 18/01/06	93.65	1.95	59,070	15,600	50
	BKK-SIN	19/01/06 - 21/01/06	90.77	-1.87	51,730	18,600	53
630	SIN - LCH	22/01/06 - 25/01/06	97.47	4.97	64,860	17,750	47
	BKK-SIN	26/01/06 - 29/01/06	89.37	-4.34	49,990	16,400	53
631	SIN - LCH	29/01/06 - 1/02/06	85.54	1.24	56,650	13,900	55
	BKK-SIN	2/02/06 - 05/02/06	95.77	-1.30	55,790	17,400	52
632	SIN - LCH	05/02/06 - 08/02/06	96.14	2.50	62,500	14,500	51
	BKK-SIN	09/02/06 - 12/02/06	99.00	4.80	63,600	20,250	53
633	SIN - LCH	13/02/06 - 16/02/06	94.87	3.34	59,570	15,600	57
	BKK-SIN	17/02/06 - 19/02/06	98.74	1.44	61,850	19,150	51
634	SIN - LCH	19/02/06 - 22/02/06	98.44	4.70	64,570	15,750	51
	BKK-SIN	23/02/06 - 26/02/06	97.67	3.87	62,320	20,250	53
635	SIN - LCH	26/02/06 - 01/03/06	95.34	0.84	60,270	14,500	51
	BKK-SIN	02/03/06 - 05/03/06	97.17	5.20	62,350	20,600	54
636	SIN - LCH	5/03/06 - 08/03/06	96.97	1.57	60,950	15,750	51
	BKK-SIN	09/03/06 - 12/03/06	101.94	1.60	66,260	19,150	49
637	SIN - LCH	12/03/06 - 15/03/06	101.90	3.50	64,100	16,200	47
	BKK-SIN	16/03/06 - 19/03/06	99.34	2.20	72,060	19,990	53
638	SIN - LCH	19/03/06 - 22/03/06	92.00	-0.10	60,330	15,250	52
	BKK-SIN	23/03/06 - 26/03/06	97.30	3.17	66,660	20,250	54
639	SIN - LCH	26/03/06 - 30/03/06	97.30	0.64	62,730	15,250	57
	BKK-SIN	31/03/06 - 02/04/06	98.67	2.94	67,590	20,250	52
640	SIN - LCH	02/04/06 - 05/04/06	96.77	1.87	62,310	15,750	53
	BKK-SIN	06/04/06 - 09/04/06	93.67	0.54	64,860	19,150	56
641	SIN - LCH	24/04/06 - 26/04/06	107.39	5.98	78,040	18,250	47
	BKK-SIN	27/04/06 - 30/04/06	95.94	-2.97	65,570	17,400	56
642	SIN - LCH	30/04/06 - 03/05/06	94.94	-3.30	59,060	15,600	58
	BKK-SIN	04/05/06 - 07/05/06	87.00	-7.47	51,100	13,900	58
643	SIN - LCH	07/05/06 - 10/05/06	92.90	-3.44	51,920	17,200	60
	BKK-SIN	11/05/06 - 14/05/06	91.74	3.77	51,220	15,000	60
644	SIN - LCH	14/05/06 - 17/05/06	93.07	1.14	52,730	18,250	59
	BKK-SIN	18/05/06 - 21/05/06	83.67	-2.20	54,940	15,600	61
645	SIN - LCH	21/05/06 - 24/05/06	92.80	-5.37	53,700	15,600	60
	BKK-SIN	25/05/06 - 28/05/06	89.34	-3.04	54,780	15,600	58
646	SIN - LCH	28/05/06 - 31/05/06	92.70	-0.94	54,420	16,400	61

# APPENDIX B

## REAL TIME OPERATING DATA

### DURING USE of MXT9™

**JUNE 1<sup>ST</sup> 2006 – DECEMBER 13<sup>TH</sup> 2006**

Voy No.	Port	Date	RPM	Slip	Fuel Oil ( Liters)	Displacement	Hr.
646	BKK-SIN	01/06/06 - 04/06/06	92.00	-2.34	64,900	16,200	67
647	SIN - LCH	04/06/06 - 07/06/06	92.10	-1.40	64,200	16,800	61
	BKK-SIN	08/06/06 - 11/06/06	88.17	-1.00	66,140	13,900	68
648	SIN - LCH	11/06/06 - 14/06/06	92.77	-3.00	61,290	17,200	67
	BKK-SIN	14/06/06 - 18/06/06	85.97	-2.97	65,150	13,500	61
649	SIN - LCH	18/06/06 - 21/06/06	92.90	-5.17	60,720	19,450	69
	BKK-SIN	21/06/06 - 25/06/06	93.24	-4.14	65,960	14,500	67
650	SIN - LCH	25/06/06 - 28/06/06	90.33	-4.16	49,850	17,400	49
	BKK-SIN	29/06/06 - 2/07/06	102.40	8.84	65,120	20,650	51
651	SIN - LCH	02/07/06 - 05/07/06	102.67	-2.97	44,620	17,400	46
	BKK-SIN	06/07/06 - 09/07/06	95.67	2.37	47,200	13,900	56
652	SIN - LCH	10/07/06 - 12/07/06	91.50	-6.20	45,890	15,750	49
	BKK-SIN	13/07/06 - 16/07/06	87.76	-1.10	63,950	13,450	61
653	SIN - LCH	16/07/06 - 19/07/06	93.20	-5.40	61,260	19,750	65
	BKK-SIN	20/07/06 - 22/07/06	91.30	-2.63	63,880	13,900	58
654	SIN - LCH	23/07/06 - 26/07/06	91.93	-7.80	45,050	16,300	49.1
	BKK-SIN	27/07/06 - 29/07/06	93.27	-2.13	64,150	14,750	67
655	SIN - LCH	30/07/06 - 2/08/06	91.27	-6.93	43,300	15,600	48
	BKK-SIN	3/08/06 - 5/08/06	95.60	-6.20	61,160	17,400	68
656	SIN - LCH	6/08/06 - 9/08/06	92.60	-2.15	43,550	20,700	52
	BKK-SIN	10/08/06 - 13/08/06	92.30	-0.66	63,450	14,750	67
657	SIN - LCH	14/08/06 - 16/08/06	96.80	-4.20	40,050	17,200	47
	BKK-SIN	17/08/06 - 20/08/06	96.40	0.37	68,080	13,500	68
658	SIN - LCH	21/08/06 - 23/08/06	90.93	-6.67	44,350	15,600	51
	BKK-SIN	24/08/06 - 26/08/06	90.30	-0.33	64,390	14,500	60
659	SIN - LCH	27/08/06 - 30/08/06	92.70	-7.20	61,620	16,200	58
	BKK-SIN	31/08/06 - 2/09/06	91.20	-0.93	64,910	15,000	67
660	SIN - LCH	3/09/06 - 6/09/06	92.43	-4.96	45,880	16,600	51
	BKK-SIN	7/09/06 - 9/09/06	92.83	-2.60	62,680	14,500	67
661	SIN - LCH	10/09/06 - 13/09/06	93.00	-4.03	48,140	15,600	61
	BKK-SIN	14/09/06 - 16/09/06	92.30	-3.13	61,110	13,900	55
662	SIN - LCH	17/09/06 - 20/09/06	92.30	2.60	61,810	17,750	60
	BKK-SIN	21/09/06 - 23/09/06	90.30	-3.93	62,220	14,500	67
663	SIN - LCH	24/09/06 - 27/09/06	92.23	1.13	61,170	17,200	62
	BKK-SIN	28/09/06 - 30/09/06	88.33	0.13	65,320	15,750	69
664	SIN - LCH	1/10/06 - 4/10/06	93.60	-2.90	49,330	16,600	56
	BKK-SIN	5/10/06 - 7/10/06	92.53	-2.20	64,250	13,500	66
665	SIN - LCH	8/10/06 - 11/10/06	93.20	-4.20	49,920	15,600	63
	BKK-SIN	12/10/06 - 14/10/06	89.67	-3.60	60,920	13,500	68
666	SIN - LCH	15/10/06 - 18/10/06	92.83	0.60	63,630	17,400	60
	BKK-SIN	19/10/06 - 21/10/06	90.80	-2.73	61,690	13,900	67
667	SIN - LCH	22/10/06 - 24/10/06	93.33	0.73	64,710	17,750	60
	BKK-SIN	26/10/06 - 28/10/06	86.26	-8.73	62,110	12,250	68
668	SIN - LCH	29/10/06 - 31/10/06	93.10	1.27	65,860	17,200	61
	BKK-SIN	2/11/06 - 4/11/06	92.37	-4.37	62,260	15,250	66
669	SIN - LCH	5/11/06 - 8/11/06	92.76	2.70	64,840	16,650	62
	BKK-SIN	9/11/06 - 11/11/06	91.73	-5.90	61,290	13,900	65
670	SIN - LCH	12/11/06 - 15/11/06	92.77	5.03	67,750	18,531	62
	BKK-SIN	16/11/06 - 18/11/06	97.40	8.66	68,930	16,307	64
671	SIN - LCH	19/11/06 - 22/11/06	91.85	2.75	62,130	18,850	64
	BKK-SIN	23/11/06 - 25/11/06	90.37	-7.65	62,730	15,000	68
672	SIN - LCH	26/11/06 - 28/11/06	93.40	0.33	63,880	15,750	58
	BKK-SIN	30/11/06 - 2/12/06	92.33	-1.66	61,850	16,800	67
673	SIN - LCH	3/12/06 - 5/12/06	88.63	0.63	63,740	17,200	62
	BKK-SIN	7/12/06 - 9/12/06	91.90	0.63	61,080	13,500	69
674	SIN - LCH	10/12/06 - 13/12/06	90.25	5.60	66,460	19,450	62
	BKK-SIN	14/12/06 - 17/12/06	88.88	4.05	61,040	15,500	68
675	SIN - LCH	17/12/06 - 20/12/06	93.20	12.55	60,630	20,750	64
	BKK-SIN	21/12/06 - 24/12/06	96.83	1.20	62,200	16,600	64
676	SIN - LCH	24/12/06 - 27/12/06	92.80	3.70	69,400	15,750	61
	BKK-SIN	27/12/06 - 31/12/06	93.27	-0.86	64,940	18,600	66