

**Trial of Local Ferries
Using Ultra Low Sulphur Diesel
Trial Report**

**Trial Monitoring Committee
December 2011**

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Chapter 1 Introduction

Objective

1.1 The Chief Executive announced in his 2007 Policy Address that Hong Kong would study the feasibility of requiring all vessels plying the harbour to use high-quality fuel. To take forward this policy initiative, a trial was launched in end-August 2009 to ascertain the technical feasibility of local ferries¹ using diesel of quality no inferior to ultra-low sulphur diesel (collectively denoted as "ULSD") and to collect essential operation data such as fuel consumption, engine power, fuel refilling requirement, maintenance requirement, etc. The findings will help the Government map out the way forward to reduce the emissions of local ferries.

Background

1.2 The sulphur content of land-based diesel has been capped at the level of 0.005% for industrial and commercial activities and 0.001% for vehicles, while the sulphur content of local marine light diesel (MLD) is in general capped at 0.5%. In recent years, overseas countries such as the USA, Canada, the European Union, Australia and New Zealand have tightened their caps on the sulphur content of the fuel for their domestic vessels to 0.1% or below. In line with this international trend and to reduce the emissions of sulphur dioxide (SO₂) and particulate matters for the people residing or working near to ferry routes, we, together with ferry operators, launched a trial of powering ferries with ULSD.

¹ Hereunder in this report, "local ferries" refers to *non-kaito ferries* unless otherwise stated.

Chapter 2 Arrangements of the Trial

2.1 The inter-departmental Working Group on Maritime Emissions of the Government² drew up the trial scheme in 2008. The Government invited ferry operators to participate in the trial by contributing their trial ferries on a voluntary basis, and issued a tender to engage an oil supplier to bunker ULSD for the participating ferries.

2.2 A **Trial Monitoring Committee** comprising a professor in Marine Engineering, officials from the Environmental Protection Department (EPD), the Marine Department, the Transport Department (TD), and representatives from local ferry operators was set up to assist the Government in overseeing the trial. Altogether four meetings were held. The membership and terms of reference of the Committee are at **Appendices A and B** respectively.

2.3 The trial commenced on 25 August 2009 with three ferry operators namely New World First Ferry Services Ltd. (NWFF), Hong Kong & Kowloon Ferry Ltd. (HKKF) and The Hongkong and Yaumati Ferry Co., Ltd. (HKYF) contributing altogether five ferries to the trial. The relevant engine-makers had advised that the engines of these five participating ferries could run on ULSD. These three ferry operators completed the trial on 31 May 2010. On 21 April 2010, the "Star" Ferry Company, Limited (SF) joined the trial by contributing one passenger ferry and the 1000-hour trial was completed on 31 July 2010. A table of the participating ferry operators is shown below:

New World First Ferry Services Ltd.	3 passenger ferries
Hong Kong & Kowloon Ferry Ltd.	1 passenger ferry
The Hongkong and Yaumati Ferry Co., Ltd.	1 dangerous goods vehicular ferry
The Star Ferry Co., Ltd.	1 passenger ferry

² The inter-departmental Working Group on Maritime Emissions, comprising representatives of the Environment Bureau, Transport and Housing Bureau, Environmental Protection Department, Marine Department and Transport Department, was set up in 2008 to examine and recommend practicable measures to reduce emissions from marine vessels.

To better understand the implications of the fuel switch, the participating ferry operators also assigned five control ferries for comparison. The profile of the trial ferries and respective control ferries is at **Appendix C**.

2.4 Through open tendering, the Government awarded a contract to Sinopec (Hong Kong) Petroleum Co., Ltd. ("Sinopec") for setting up an oil barge in the waters in Cheung Sha Wan to bunker ULSD for the trial ferries during the trial period. The location of the oil barge is shown in the map at **Appendix D**. Under the contract, Sinopec could, based on fuel price in international market, adjust its ULSD price in step with the fluctuation of Sinopec's motor diesel retail price at their petrol filling stations.

2.5 To spare the participating ferry operators from the additional fuel cost, each of them was only required to pay Sinopec the same cost of MLD as what it paid for other ferries not participating in the trial. The Government paid Sinopec the price differential between ULSD and MLD. As a matter of prudent accounting, EPD regularly inspected the monthly payment statements of the ferry operators and double-checked ULSD price adjustments of Sinopec against the adjustments of its motor diesel retail prices.

2.6 EPD also tested the lubrication oils of the trial ferry engines via a laboratory to verify their technical compatibility with the ULSD used. As such, from main engines and auxiliary engines, the participating ferry operators regularly collected samples of lubrication oils for EPD to check for abnormality, if any. For NWFF, HKKF and HKYF, monthly tests were done in the first three months of the trial and bimonthly tests in the remaining six months. For SF, the test was done monthly during its trial period from end-April to end-July 2010.

2.7 In addition to testing the lubrication oils, EPD also asked the participating ferry operators to report on findings and observations of engine performance and environmental performance by returning monthly questionnaires. A copy of the blank questionnaire is at **Appendix E**.

Chapter 3 Findings of the Trial

3.1 A summary of the key findings is given in the table below.

Parameters	Overall Findings
Fuel price premium	Average \$0.93 per litre, i.e. 21% above the average cost of MLD (\$4.4 per litre)
Fuel consumption	<ul style="list-style-type: none">- 5 trial ferries recorded a change of -2.6% to +2.2%, while one recorded a +10.4% change- Reference laboratory test: net calorific value of ULSD lower than that of MLD by 1%
Engine maintenance requirement	No noticeable change (except that SF considers this not applicable to its fleet because of its specific 2-stroke low-speed engine design)
Engine power and speed	Slightly reduced
Fuel lubricity	ULSD and MLD have similar lubricity
Environmental nuisance	Odour and smoke emission slightly improved. However SF reported observing an increase in exhaust smoke emission. SF considers that this is due to its nature of operation, which involves frequent reversion of propulsion in short journeys.

Fuel Prices

3.2 The average import price gap between MLD and ULSD during the trial period was \$0.08/L. The average price premium of \$0.93/L was much higher than the import price gap because ULSD was not the major fuel for vessels in the local maritime trade. According to the meetings held among EPD, TD and major oil companies, the small size of the trial fleet and hence the small amount of fuel consumption would cause a high logistic overhead cost and fuel handling cost for providing ULSD fuelling services for the trial fleet. Discovery Bay Transportation Services Limited has also advised that tankage inventory costs and other overhead costs, together with pricing strategies, could be attributed to such price difference.

3.3 The table below compares the prices of ULSD supplied by Sinopec with the concurrent average MLD prices of the participating ferry operators in the trial period. The average price premium was \$0.93/L.

Month/Year	Average MLD Price of Participating Operators (\$/L)	Average Premium of ULSD over MLD (\$/L)	Average Premium of ULSD over MLD (%)
Sep 2009	3.93	1.05	26%
Oct 2009	4.19	0.89	21%
Nov 2009	4.41	0.92	21%
Dec 2009	4.33	0.85	20%
Jan 2010	4.52	0.96	21%
Feb 2010	4.26	0.97	22%
Mar 2010	4.45	0.96	22%
Apr 2010	4.90	0.82	17%
May 2010	4.81	0.95	20%
Average	4.42	0.93	21%

3.4 The table above depicts the average MLD prices for operators over the trial period. However, the MLD prices (and hence the price premium of ULSD over MLD prices) for individual operators could vary with their quantity of demand, bargaining power and market fluctuations.

3.5 The price comparison above has its limitations because the ULSD price was obtained by Government through open tendering in mid-2009, whereas ferry operators' MLD prices were obtained under different fuel contracts signed by different parties in different times and in different supply modes. Moreover, during the trial period, the ULSD price for the trial fleet was adjusted in step with the retail motor diesel price, which was broadly in line with the fluctuation of international fuel prices. On the other hand, the MLD prices of the ferry operators had their own adjustment mechanisms, which might not be the same as that stipulated in the ULSD contract for this trial. To further gauge the market price difference of the two fuels, ferry operators, including Discovery Bay Transportation Services Limited which did not participate in the trial, were asked to seek quotations for ULSD from their fuel suppliers. However, as reflected by the ferry operators, some oil companies were quite reluctant to give quotations probably on the belief that the fleets had no genuine and imminent need for ULSD. In the end, only two operators received quotations in April 2010 at a premium of \$0.44 and \$1 per litre over MLD. Given the conservative position of the oil companies, the price premium obtained as such might not be representative for the trade.

Fuel Consumption

3.6 One objective of the trial is to ascertain whether the fuel switch will entail additional fuel consumption because of the possible difference in energy contents between ULSD and MLD. Therefore, the fuel consumptions of the participating ferries during the trial period were compared with the baseline consumption levels, i.e. the fuel consumption a year ago when using MLD. The changes are as follows:

Set	Trial ferry		Change (Trial vs Baseline)
A	NWFF	First Ferry III (Central-Mui Wo)	-0.5%
B	NWFF	First Ferry III (Central-Cheung Chau)	-1.4%
C	NWFF	First Ferry VIII (Central-Mui Wo)	-1.5%

D	NWFF	First ferry VIII (Central-Cheung Chau)	-0.9%
E	NWFF	Xin Ying	-1.7%
F	HKYF	Man Foo	-2.4%
G	SF	Meridian Star	Not applicable because baseline data not available
H	HKKF	Sea Strike	+14.4%

3.7 Apart from the fuel switch, the above change in fuel consumption could also be caused by **external factors** such as variation in engine loadings, weather conditions, sea conditions, operation mode, passenger loading, journey of ferries, vessel hull conditions, etc. Following commonly adopted practice for trials and experiments, "**control**" was arranged in an attempt to offset the impact of external factors as far as possible. Five control ferries which had similar physical properties to and ran the same routes as those of the trial ferries were identified and their fuel consumptions logged during the trial period. Since the trial ferry and control ferry were affected by the external factors to a similar extent, the impacts were offset as far as possible by comparing their fuel consumption changes against baselines.

3.8 The table below depicts the percentage change of fuel consumption of trial ferries (against baseline) over their respective control ferries. Overall, the change is mild (-2.6% to +2.2%) except for HKKF's Sea Strike (+10.4%). It is noted that before or during the trial, many control ferries and trial ferries had undergone regular service works, which were scheduled irrespective of the trial. These works include hull cleaning or annual overhaul. It is also noted that engines were replaced on one trial ferry and one control ferry of NWFF. Such services are remarked in the analysis below to help readers appreciate the possible impacts on fuel performance, even though such impacts cannot be quantified. Besides, the inconsistent hull and engine conditions between the trial and control ferries could also have resultant effect on fuel consumption.

**Percentage Change of Fuel Consumption of Trial Ferries
Over Control Ferries**

Note: *In the table below, unless otherwise indicated, the un-shaded boxes indicate change of ferry fuel consumption during trial period over their baseline consumption.*

(A) First Ferry III of NWFF, Central - Mui Wo

Trial: First Ferry III	-0.5%	Remark: <u>First Ferry III</u> : Annual docking in Aug 2009. <u>First Ferry V</u> : annual docking in Nov 2009 and engine replaced in Feb 2010.
Control: First Ferry V	+0.6%	
change (Trial vs Control):	-1.1%	

(B) First Ferry III of NWFF, Central - Cheung Chau

Trial: First Ferry III	-1.4%	Ditto
Control: First Ferry V	-3.1%	
Change (Trial vs Control)	+1.7%	

(C) First Ferry VIII of NWFF, Central - Mui Wo

Trial: First Ferry VIII	-1.5%	Remark: <u>First Ferry VIII</u> : engine replaced in Aug 2009 and annual docking in Oct 2009. <u>First Ferry V</u> : annual docking in Nov 2009 and engine replaced in Feb 2010.
Control: First Ferry V	+0.6%	
Change (Trial vs Control)	-2.1%	

(D) First Ferry VIII of NWFF, Central - Cheung Chau

Trial: First Ferry VIII	-0.9%	Ditto
Control: First Ferry V	-3.1%	
Change (Trial vs Control)	+2.2%	

(E) Xin Ying of NWFF, Central - Mui Wo

Trial: Xin Ying	-1.7%	Remark: <u>Xin Ying</u> : annual docking in
Control: Xin Jie	+0.9%	

Change (Trial vs Control)	-2.6%	March 2009. Hull bottom cleaned and overhauled in Sept 2009. <u>Xin Jie</u> : annual docking in Jan 2009 and Feb 2010.
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(F) Man Foo of HKYF, Kwun Tong - North Point

Control: data not available	N/A	Remark: <u>Man Foo</u> : overhaul in July 2009; minor repairs in Oct 2009 to Mar 2010.
Trial: Man Foo	-2.4%	

(G) Meridian Star of SF, Central - Tsim Sha Tsui

Trial: Meridian Star	4.34 L/km*	Remark: <u>Meridian Star</u> : Hull cleaning / annual overhaul in Jan 2010 <u>Twinkling Star</u> : Hull cleaning / annual overhaul in Sept 2010 SF considers the increase in fuel consumption smaller than it should be. Its rationale is in paragraph 3.12.
Control: Twinkling Star	4.26 L/km*	
Change (Trial vs Control)	+1.8%	

*Baseline data are not available from SF. The absolute fuel consumptions of the trial ferry and control ferry were taken for comparison.

(H) Sea Strike of HKKF, Central – Peng Chau

Trial: Sea Strike	+14.4%	Remark: <u>Sea Strike</u> : overhaul in Nov 2009. <u>Sea Smart</u> : overhaul in Jan 2009 and services done in Dec 2009. In view of the relatively high increase compared with other trial ferries, further analysis has been done and is reported in paragraph 3.10-3.11.
Control: Sea Smart	+4%	
Change (Trial vs Control)	+10.4%	

3.9 Among the six trial ferries, five of them with altogether seven set of fuel consumption data [Set (A) – (G)] recorded a change from -2.6% to +2.2% [rounded up to approximately within $\pm 2\%$] against their respective control ferries except for HKKF's trial ferry (Sea Strike), whose fuel consumption increased by 10.4%. SF considers that the trial might have under-estimated the change in fuel consumption of its Meridian Star. The cases of HKKF and SF are further analyzed and discussed below.

Fuel Consumption of HKKF

3.10 On the relatively high fuel consumption change (+10.4%) of its trial ferry (Sea Strike), HKKF suspects that this might be caused by Sea Strike operating under almost engine full load condition. Therefore, even though in principle the engine power loss arising from switching to ULSD is small, the engine might have to consume much more fuel to make up for the power loss. This proposition is however disproved by the further analysis of the relative fuel consumption of the two ferries (i.e. Sea Strike and Sea Smart) after the trial.

3.11 To minimize the influence of external factors, according to the advice of the expert (Professor C S Cheung of Hong Kong Polytechnic University), we have done further analysis on the fuel consumption of Sea Strike and Sea Smart **after the trial** (from September 2010 to May 2011) when both ferries were using MLD against those of the two ferries during the trial period. The findings in the following table show that the fuel consumption change of Sea Strike, as compared with Sea Smart, was nearly unaffected by the switch from MLD to ULSD (and vice versa). The trial ferry (Sea Strike), after switching back from ULSD to MLD, did not record reduction in fuel consumption.

Average Fuel Consumption (L/trip)

	Sept 2009 – Apr 2010 (ULSD Trial Period)	Jun 2010 – May 2011 (i.e. MLD)	Difference
Sea Strike	95.1 <i>ULSD</i>	95.9 MLD	+0.8%
Sea Smart	101.9 MLD	103.4 MLD	+1.5%
Difference			-0.7%

Fuel Consumption of SF

3.12 Regarding the fuel consumption implications of powering its ferries by ULSD, SF had the following views -.

- (a) the trial findings (i.e. the aggregate fuel consumption of the control ferry during the trial period being marginally lower than that of the trial ferry by 2%) could have underestimated the fuel consumption implications of the switch to ULSD. When using ULSD, the coxswains had driven the trial ferry slowly to avoid excessive emissions, thereby reducing the fuel consumption. If they had not done so, the trial should have shown the trial ferry to use more fuel when powered by ULSD. Moreover, SF's previous trial of ULSD and emulsified fuel reported that ULSD caused a loss of propulsion power of about 10%, which would lead to higher fuel consumption;
- (b) the trial ferry had its hull cleaned during the annual overhaul in January 2010 (i.e. three months before trial commencement). However, the hull of the control ferry was cleaned in September 2009, i.e. about four months earlier than the trial ferry. In other words, the trial ferry had a cleaner hull compared with the control ferry. Based on SF's experience, the MLD consumption of a classic ferry three months and seven months after completion of its hull cleaning work can be 30.5 litres and 45 litres per hour respectively. This is because the longer the period after hull cleaning services, the more the marine growth would accumulate on its hull surface. Should that be taken into account, SF opined that the trial ferry should have incurred a fuel consumption increase of 10% when using ULSD.

Net Calorific Values of the Fuels

3.13 As explained in paragraph 3.7, there are a number of external

factors that could affect the fuel consumption apart from fuel properties. SF's views in the preceding paragraph demonstrated that the use of control ferries might not help fully explain all the uncertainties. Upon the suggestion of Members, EPD had explored and concluded it infeasible to conduct a torque test (which was not suitable for temporary application in ferry) to shed light on the change of fuel consumption. Following the advice of Professor C S Cheung, the expert member, and other members of the Committee, EPD engaged the service of S.G.S. Hong Kong Ltd. and Intertek Testing Services Ltd. to check the net calorific value (NCV) of ULSD and MLD to provide more useful information on the implication of the switch for fuel consumption. Altogether 16 samples from different oil suppliers at different locations and different times were collected for analysis. The test results (**Appendix F**) showed that the ULSD sample had its energy content 1% lower than that of MLD, in more or less the same order as the fuel consumption change found in the trial except for the trial ferry of HKKF.

Summary of Findings and Assessment

3.14 The overall findings and assessment of fuel consumption change are summarized below.

- (a) The fuel consumption changes recorded (against baselines and compared with control ferries) in the trial are as tabulated below.

Set	Ferry / Route	Change	Remark
A	First Ferry III Central to Mui Wo	-1.1%	Both trial and control ferries overhauled before/during trial
B	First Ferry III Central to Cheung Chau	+1.7%	Ditto
C	First Ferry VIII Central to Mui Wo	-2.1%	Ditto
D	First Ferry VIII Central to Cheung	+2.2%	Ditto

	Chau		
E	Xin Jie Central to Mui Wo	-2.6%	Ditto
F	Man Foo Kwun Tong to North Point	-2.4%	Direct comparison of trial vs baseline data because control data unavailable
G	Meridian Star Central to Tsimshatsui	+1.8%	SF opined that the switch to ULSD could have led to a 10% increase in fuel consumption, taking into account the coxswains driving the trial ferry slowly during the trial and the trial ferry having a cleaner hull vis-à-vis the control ferry. (Details in paragraphs 3.12 and 3.13)
H	Sea Strike Central to Peng Chau	+10.4%	The significant deviation could be due to the exceptional low fuel consumption in the baseline period of the trial ferry (i.e. the 12 months before the trial). The trial ferry has not shown any significant reduction in fuel consumption after reverting back to MLD.

- (b) In actual sample test, the NCV (a good measure of the energy content of the fuel) of ULSD was found to be 1% less than that of MLD. Despite the uncertainties associated with the fuel consumption comparison in the trial, the NCV finding was in similar order as the fuel consumption change measured during the trial as shown in the table in (a).

Engine Maintenance Requirement

3.15 The engine lubrication oils of the main engines and auxiliary engines of the participating ferries were regularly tested to check for abnormality, if any. For NWFF, HKKF and HKYF, monthly tests were done in the first three months of the trial and bimonthly tests in the remaining six months. For SF the test was done monthly during its trial period from end-April to end-July 2010. The test regime is at **Appendix G**. Altogether 117 samples of lubrication oils were collected and tested. The test results showed nothing alarming and there was no sign of abnormal wear and tear, except for SF where metal concentrations increase such as chromium, tin, iron and copper were found in its own laboratory tests. The case will be elaborated in paragraph 3.18 below.

3.16 In addition to testing the lubrication oils, EPD also asked the operators to report on findings and observations in engine overhaul/inspection during or after the trial period. NWFF's trial ferry "Xin Ying" and HKYF's trial ferry "Man Foo" were overhauled in July 2010, immediately after the trial, where no abnormality was found. HKKF reported on a case of abnormal wear found in two fuel pumps and in three out of the 12 fuel injectors of the two main engines in an overhaul conducted during the trial period. SF reported on a case of abnormal wear found on the surface of one cylinder liner among the six cylinders of the main engine. The ferry operators' observations are summarised below.

NWFF

No change in maintenance requirement

HKYF

No change in maintenance requirement

SF

Upon an overhaul conducted immediately after the trial, abnormal wear was found on the surface of one cylinder-liner among the six cylinders of the main engine. It was noticed that the wear was

found after switching to ULSD. Moreover, the presence of metals, namely chromium, tin, iron and copper in the lubricating oils could suggest wear of bearing and liners.

The wear was found in one cylinder liner of the engine after the trial, and from an operation point of view, the only variable factor in the trial was changing the fuel from MLD to ULSD. However, there was little change in the metal concentrations in the lubricating oil samples as found in EPD's lubricating oil test reports. There is no conclusion on whether there was a causal link between the abnormal wear and the use of the ULSD.

The detailed investigation is at **Appendix H**.

HKKF

No change in maintenance requirement.

During the overhaul of trial ferry Sea Strike in October 2009 (at the onset of the trial), wear was found in two fuel pumps and in three among all of the 12 fuel injectors of the two main engines of its Cummins diesel engines model KTA19M3. To investigate whether this was related to the fuel switch, EPD had sought technical and expert advice from the ULSD supplier (Sinopec) and the engine maker (Cummins) of the trial ferry. Both Sinopec and Cummins advised that ULSD lubricity is not a matter of concern for the relevant Cummins engine and this engine is compatible with using ULSD.

At the meeting among EPD, HKKF and an expert (Professor C S Cheung, expert member of the Committee) to discuss and review the incident, the meeting concluded that given the observations and findings including the test results of lubricity and NCVs, the lubrication oil tests, and that no abnormality was observed during the ULSD trial after the overhaul, etc., there was no evidence pointing to ULSD as the cause of the abnormal wear.

The detailed investigation is at **Appendix I**.

3.17 In conclusion, there was no evidence in the trial that the switch to ULSD could change the maintenance requirements of ferries bearing in mind that for most participating ferries, their engine-makers have advised that ULSD can be used.

Engine Power and Speed

3.18 Because of technical constraints, it is very difficult to gauge objectively in a field trial the change in engine power and speed as a result of fuel switch. Operators were therefore asked to provide the observations of their coxswains and/or persons-in-charge in the monthly questionnaire returns. The observations are summarised below.

	Engine power	Speed
NWFF	Slight decrease	Slight decrease
HKKF	Slight decrease	Slight decrease
HKYF	No change	No change
SF	Slight decrease	Slight decrease

3.19 The above observations tallied with the findings that ULSD's NCV was about 1% less than that of MLD.

Fuel Lubricity

3.20 To examine whether ULSD has a lower lubricity (that might damage marine engines), EPD had gathered lubricity data during the trial. Firstly, Sinopec, the supplier of ULSD for the trial, provided laboratory test results to confirm that the lubricity of its ULSD is well within the international requirement with a good margin and is comparable to that of MLD, which has a nominal sulphur cap of 0.5%. Secondly, EPD obtained further lubricity information of other oil companies that were all consistent with that of Sinopec's own testing. The details and the test results are at **Appendix J**.

3.21 SF considered that the switch to ULSD might make it difficult for them to source a suitable lubricant (i.e. Shell's Talpa-30) for its ferry engines, which are low-speed 2-stroke engines, a special type of 2-stroke engines which are now unique in Hong Kong. During their operation, the lubricant is burned together with the fuel inside the combustion chamber. NWFF also has ferries using 2-stroke engines but they work on high-speed that do not have the lubricant problem similar to SF.

Environmental Nuisances

3.22 The participating ferry operators were asked to provide feedback on whether reduction in environmental nuisances was observed. The overall feedback is summarized below.

	Tailpipe Exhaust Emission	Odour
NWFF	Slight decrease	Slight decrease
HKKF	Slight decrease	Slight decrease
HKYF	Slight decrease	Slight decrease
SF	Increase when reversing propulsion	No change

In general, the participating ferry operators (except SF) experienced a slight reduction in exhaust emission and odour. The slight reduction in odour could be due to the reduction in the emission of SO₂ that has a pungent smell.

Chapter 4 Conclusion

4.1 Having regard to the trial findings, it is concluded that, from a technical point of view, the participating ferries, which are non-kaito ferries containing a mix of different engine models, engine capacity, vessel features and service modes, could generally replace MLD with ULSD for powering their engines. Nevertheless, SF is still concerned that ULSD is not compatible with its unique low-speed 2-stroke engines.

4.2 The trial has also demonstrated that if ULSD is applied only to a small sector of the local vessels, a logistic overhead cost will be incurred. This would increase the fuel price differential of fuel switch, thereby raising the operating cost and imposing pressure on fare (for the case of ferry services).

END