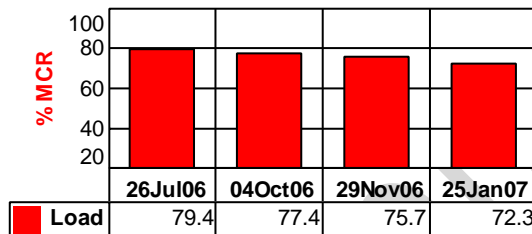


**Cylinder Oil Drain Analysis & Engine Performance Report**

Samples Landed : SINGAPORE - 26 Jan 07  
 Received at Analysis Labs : 29 Jan 07  
 Engine :SAMSUNG MAN B&W 12K90MC  
 MCR : 74,640 bhp @ 94 rpm  
**Next Samples Due** : 33,700 Engine Hours (approx.)

**Conditions at time of Sampling**

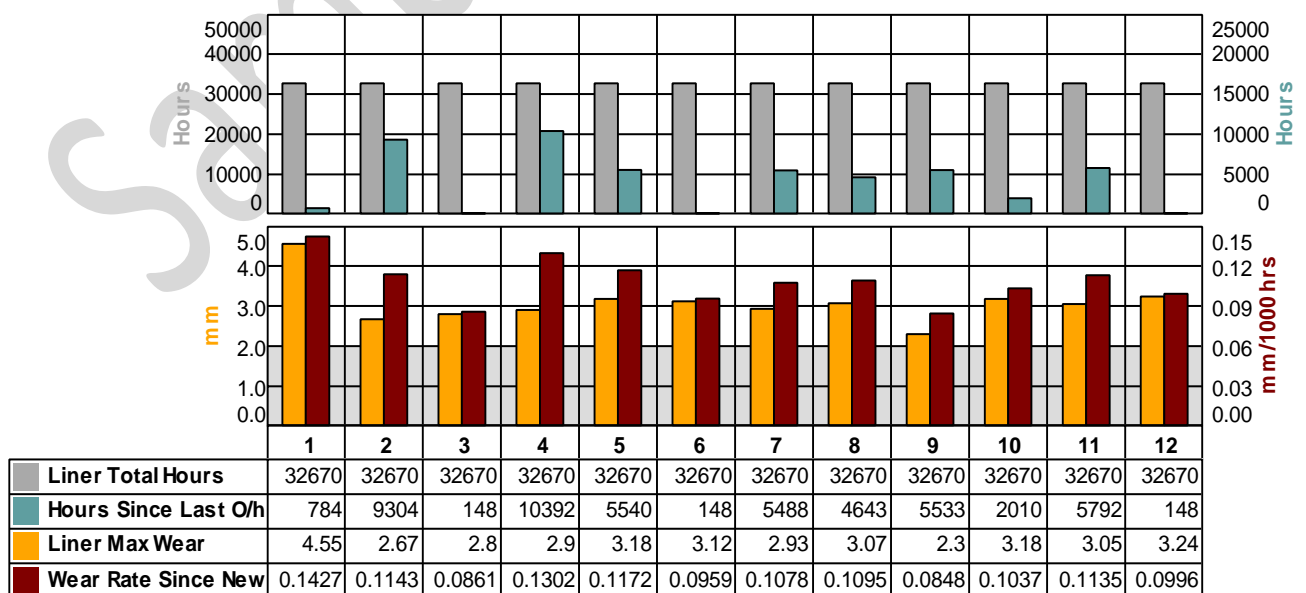
Total Engine Running Hours : 32,670 hours  
 Engine rpm at time of sampling : 90.6 rpm  
 Cylinder Oil Consumption : 30.5 Litres/hr  
 Sulphur % content of fuel : 2.6% (Before Engine)  
 Vanadium content of fuel : 87 ppm  
 Atmospheric Humidity / Temperature : 93% / 26°C



Red - Higher Blue - Lower	Sample Submission Form	Flame Marine Calculation
Power (bhp)	54,090	53,975
% MCR	64.0	72.3
Feed Rate (g/BHPH)	0.51	0.51

- Source of power reported in Sample Submission Form is not indicated. Effective Power from Diesel Analyser is used in Flame Marine calculation.

**Running Hours and Wear Rates**



- The wear rate since new at last overhaul is high for Units 1, 2, 4, 5, 7, 8, 10 and 11
- Liner maximum wear of unit 1, 5, 6, 8, 10, 11 and 12 is high.

## Findings & Recommendations

### Power and Performance Condition

- **Power by Diesel Analyser indicates that engine load is lower than 29<sup>th</sup> Nov 2006 report.**
- **Measured Averages compared to indication in the Engine Shop Test Performance Curve for the load of 72.3% MCR show:**
  - **True load is close to 72.3% MCR** - indicated by low variance in Engine rpm, Fuel Rack, Turbo-charger rpm and Pscav.
  - **Torque is high** - indicated by higher Fuel Rack relative to Engine speed.
  - **Combustion may be late** - indicated by lower Pmax-Ptdc.
- **Power balance is disrupted by high deviation in MIP for Units 1, 6 and 12.**
- **Rate of pressure change line (dp/da) is not displayed to check if positioning of the TDC line is correct on the indicator diagrams.**

Please ensure that TDC line is correctly adjusted after recording performance and provide diagrams with the dp/da line displayed.

### Fuel Oil

- **Fuel corresponding to RMG380 was delivered on 17 Jan 07 at Singapore.**

Cat-fines, although well within specification, are high enough to cause abrasion in the engine. Care should be taken to ensure efficient clarification of the fuel.
- **Fuel Oil Temperature at 129°C before Main Engine is within recommended range for current 296cst fuel oil in use.**

We suggest that fuel temperature at inlet to the fuel pump be maintained at higher end of the recommended range in DnVPS bunker analysis report, to allow for heat loss between measuring point and inlet to main engine injection pumps.

### Combustion

- **Unstable combustion is indicated by:**
  - Fuel contamination in all Units.
  - Burning of cylinder lubricant in Units 6, 7, 8, 10 and 11.
  - Incomplete combustion in Units 3 and 6 to 11.
  - Signs of late combustion in Units 1, 3 and 6 to 11.
  - High Soot in Units 3 and 6 to 11.

We recommend to check injectors of Units 3, 6, 8, 10 and 11.

### Wear

- **Influence of combustion on wear**
  - Combustion conditions are influencing wear in Units 1, 3 and 6.
- **Skirt Abrasion**
  - Skirt abrasion is influencing wear in Units 1 and 7.
  - Skirt abrasion is influencing wear in Units 3 and 6 which should reduce as running-in is completed.
  - Units 8, 10, 11 and 12 are also affected by skirt abrasion.
- **Ring Groove Wear**
  - High Chromium in Units 1, 3, 6 and 7 indicates wear of the piston ring groove coating.
- **Cat-fines** are causing abrasive wear in Units 1, 3, 6 and 7.

## Findings & Recommendations

- **Wear is lower in most units than previous report.**

Wear in Unit 6 is higher than normal but should reduce as running-in is completed. All other units are within limits of normal wear.

We recommend to inspect pistons of Units 1 and 6

### Water

---

- **High Water in all Units poses risk of emulsification and disruption of cylinder lubricant.**

There are signs that high Water in Units 3 and 6 may be causing emulsification/ increase of viscosity, and contributing to wear.

There are signs that high Water in Unit 11 is causing emulsification/ increase in Viscosity but water does not appear to be having any influence on Wear.

As a precaution, we recommend that the Air Cooler and Water Separator serving Units 3 and 6 are inspected and drains checked for obstructions in order to eliminate water ingress.

Sampling Procedure should be followed carefully as incorrect sampling can cause high Water in the CDO samples. It is important that a correct reading for water is obtained as it is the indicator for unusual Water ingress into the combustion space.

Note that the first liquid from the Sampling Cock should be run off to waste as water may accumulate in the line prior to commencement of sampling.

### System Oil Contamination

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- System oil reserve is adequate to maintain satisfactory lubrication and crankcase cleanliness. The amount of contamination by cylinder drain oil is within acceptable limits.

### Feed Adjustment

---

- **HMI Setting: 65%**

The directly calculated feed rate is within the recommended range for fuel Sulphur of 2.64%.

- **Cylinder Drain Oil (CDO) analyses indicate adequate reserve for current Fuel and Engine Load when account is taken of Fuel and System Oil contamination.**

The cause of combustion instability need to be addressed in order to maintain both piston cleanliness and low wear.

- **We recommend to maintain current feed setting until the next set of samples confirms possibility to reduce.**

Flame Marine

**Cylinder Lubricator Setting & Feed Rate**

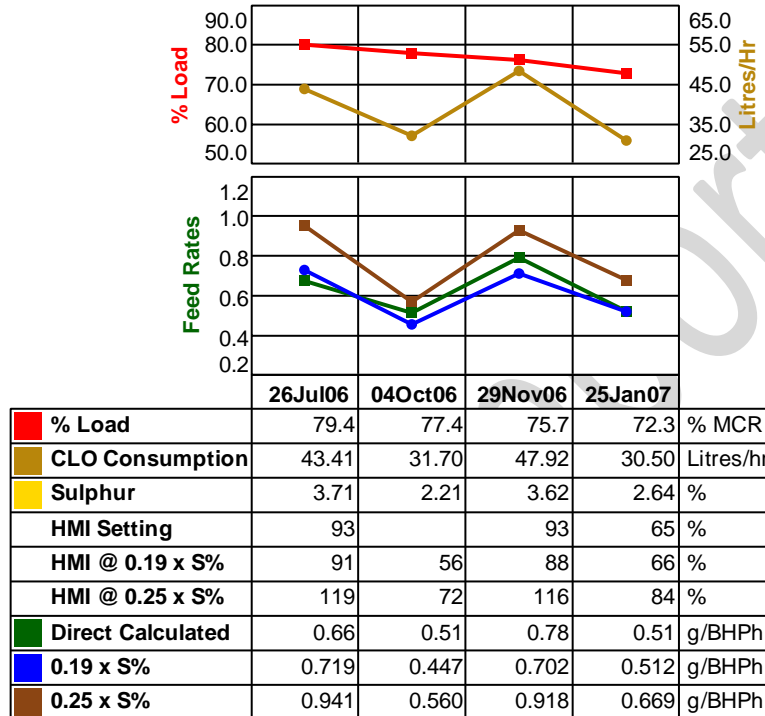
**Sulphur Content of Fuel:** 2.64%<sub>Before Engine</sub>  
**Reported Consumption:** 31 Litres/hr @50°C  
**Effective Power:** 53,975 bhp = 72.3% MCR

**BN of Cylinder Oil In Use:** 70  
**Source:** Sample Submission Form  
**Source:** Diesel Analyser

**Feed Setting**

- **HMI Setting:** 65%

**Specific Feed Rate**



- Using effective power of 53,975 bhp, consumption of 30.5 Litres/hr and SG of 0.93 @ 15°C corrected to 0.908 for oil temp of 50°C, feed rate calculates as follows:

$$\text{Specific Feed by direct calculation: } \frac{\text{Litres/hr} \times \text{SG}_{@ 50^\circ\text{C}} \times 10^3}{\text{bhp}}$$

**Specific Feed = 0.51 g/BHPH**

Density correction factor of 0.00064 per °C is used in Flame Marine calculation.

The directly calculated Feed Rate is within the recommended range for fuel Sulphur of 2.64%.

**Accuracy of calculated feed rate is subject to reliability of reported Consumption and Effective Power.**

**Fuel Oil**

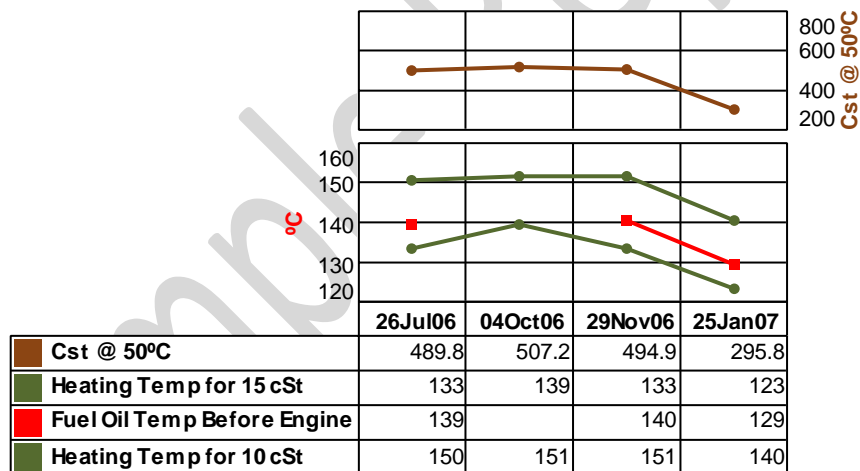
**Fuel Oil Analysis**

Fuel of 296 cst was delivered at Singapore on 17 Jan 2007.

	H2O	MCR	S	V	Na	Al	Si	Fe	Ni	Ca
<b>ABS</b>	0.3	11.16	2.54	87	16	30	35			15
<b>Before Purifier</b>	0.05	11.3	2.58	83	12	15	9	14	21	11
<b>Before Engine</b>	0.05	12	2.64	87	13	7	1	11	24	8

- Water content in ABS Bunker Analysis is satisfactory.
- High Cat-fines pose high risk of abrasion in fuel pumps, injectors and cylinder units. Caution should be exercised in the treatment of the fuel to ensure efficient separation and filtration. .
- High Cat-fines in Before Purifier sample relative to ABS analysis on 17<sup>th</sup> Jan 2007 indicates poor settling.
- Lower Cat-fine content in Before Engine fuel sample relative to the Before Purifier sample suggests satisfactory clarification.

**Fuel Oil Temperature (Inlet to Engine)**



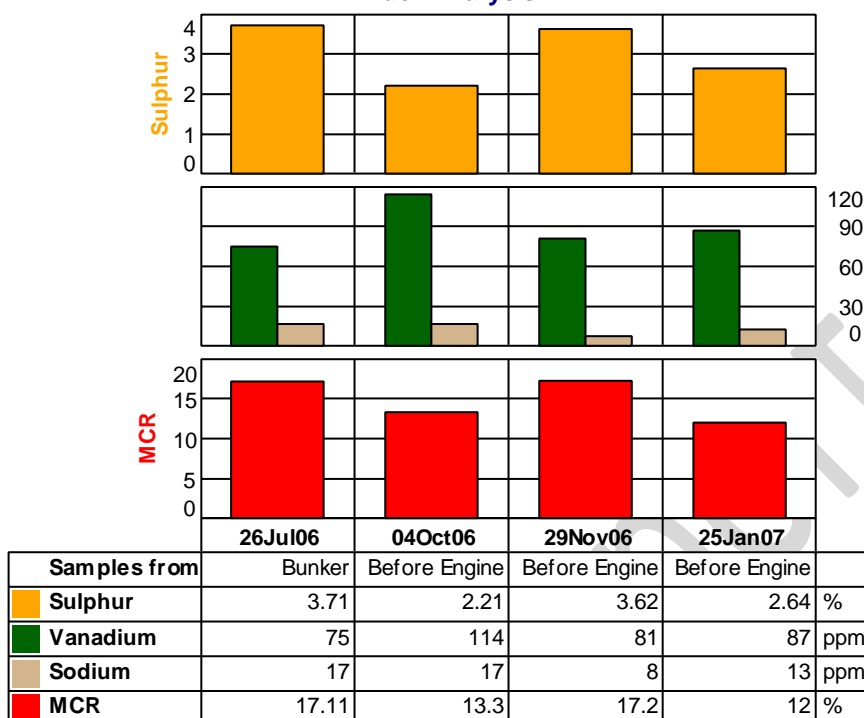
- Fuel Oil Temperature at 129°C before Main Engine is within recommended range for current 296cst fuel oil in use.

We suggest that fuel temperature at inlet to the fuel pump be maintained at higher end of the recommended range in ABS bunker analysis report, to allow for heat loss between measuring point and inlet to main engine injection pumps.

**Fuel Oil**

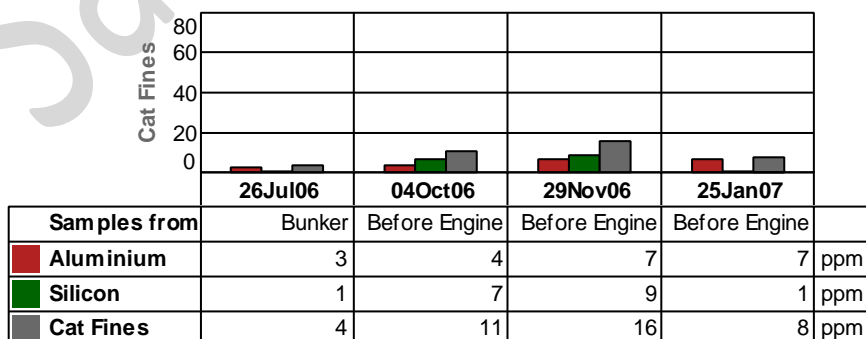
**Fuel Oil Trends**

**Fuel Analysis**



- **Sulphur** at 2.64% is lower than 29 Nov 2006. Amount of acid condensation is expected to be lesser due to lower Sulphur and reduced Fuel consumption at lower Engine Load.
- **Vanadium** at 87 ppm is similar to 29 Nov 06, posing similar risk of Vanadium deposits in the nozzle rings and on the blades of the turbo-chargers.
- **Sodium** at 13 ppm is low. Sodium:Vanadium ratio is outside the 3:1 danger zone and should not affect the melting point of Vanadium nor increase the risk of Vanadium deposits.
- **MCR** (Micro Carbon Residue) at 12% is normal and should allow complete combustion with low risk of carbon deposits. MCR is a measure of the ability of the fuel to burn completely.

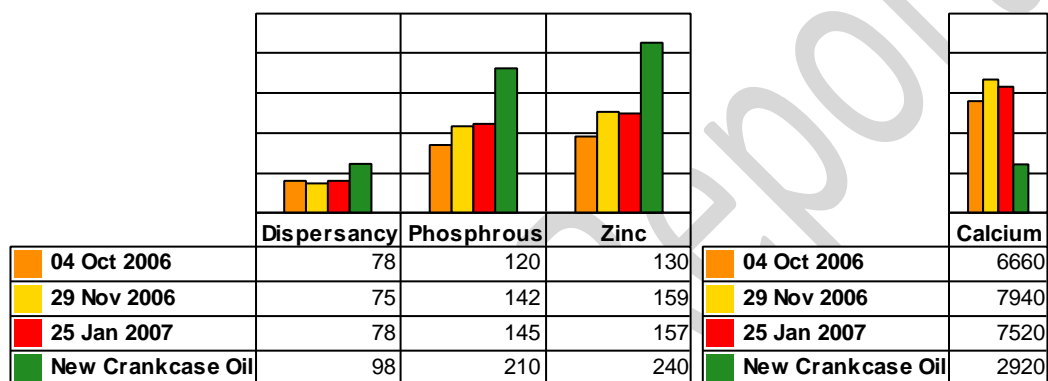
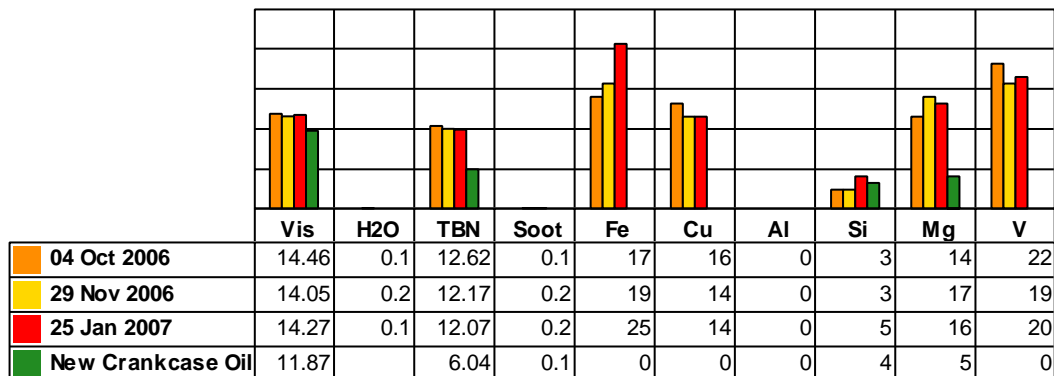
**Cat Fines**



- **Cat-fines** (Al + Si) at 8 ppm are low and should not pose any risk of abrasion in the engine.

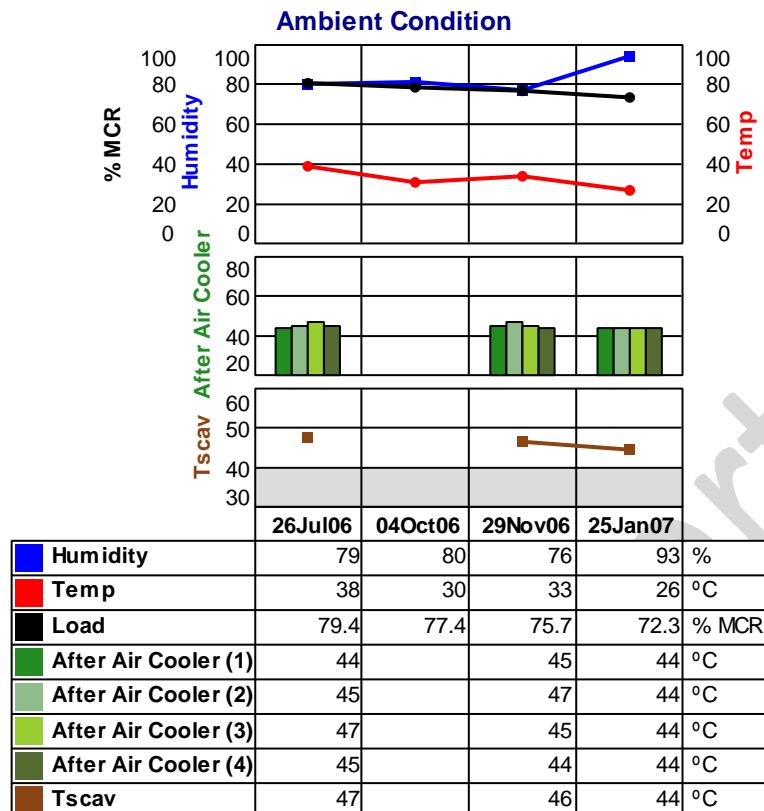
**System Oil**

- System oil reserve is adequate to maintain satisfactory lubrication and crankcase cleanliness. The amount of contamination by cylinder drain oil is within acceptable limits.



- Small increase in Viscosity, TBN, Vanadium and Calcium, relative to New Oil, points to minor contamination by Cylinder Drain Oil.
- Dispersancy is high and adequate to maintain piston cleanliness. Soot is slightly higher than normal.
- Water is within the advised level of 0.2%, and the recommended limit of 0.5%

**Ambient Condition**

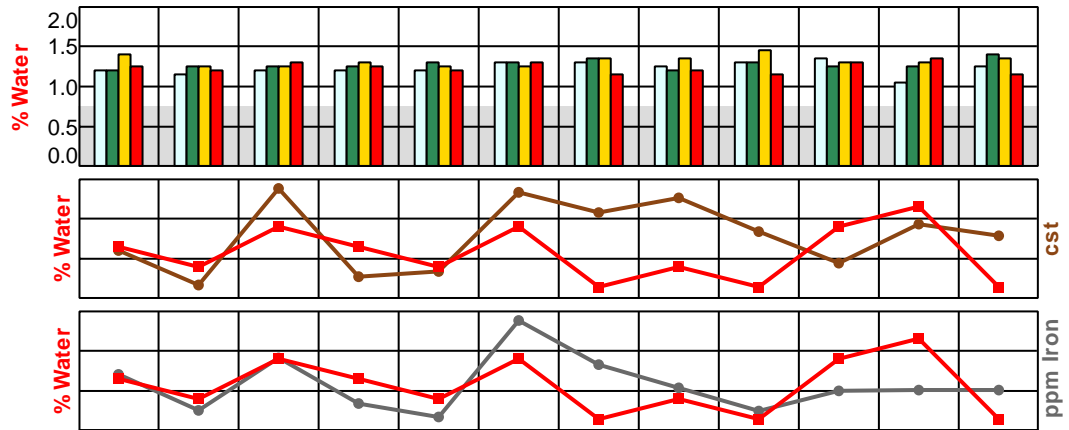


- Variations in atmospheric humidity and temperature influence the amount of Water entering the turbo-chargers with the mass of air required for given engine load.
- Current satisfactory scavenge air temperature after air coolers of 44, 44, 44 and 44°C should assist efficiency of water condensation at the air-cooler and amount of water that can be removed from the scavenge air. Eventual amount of water entrained in the scavenge air will depend on efficiency of the water separators and drainage arrangements.



**Ambient Condition**

**Water/ Wear Comparison**

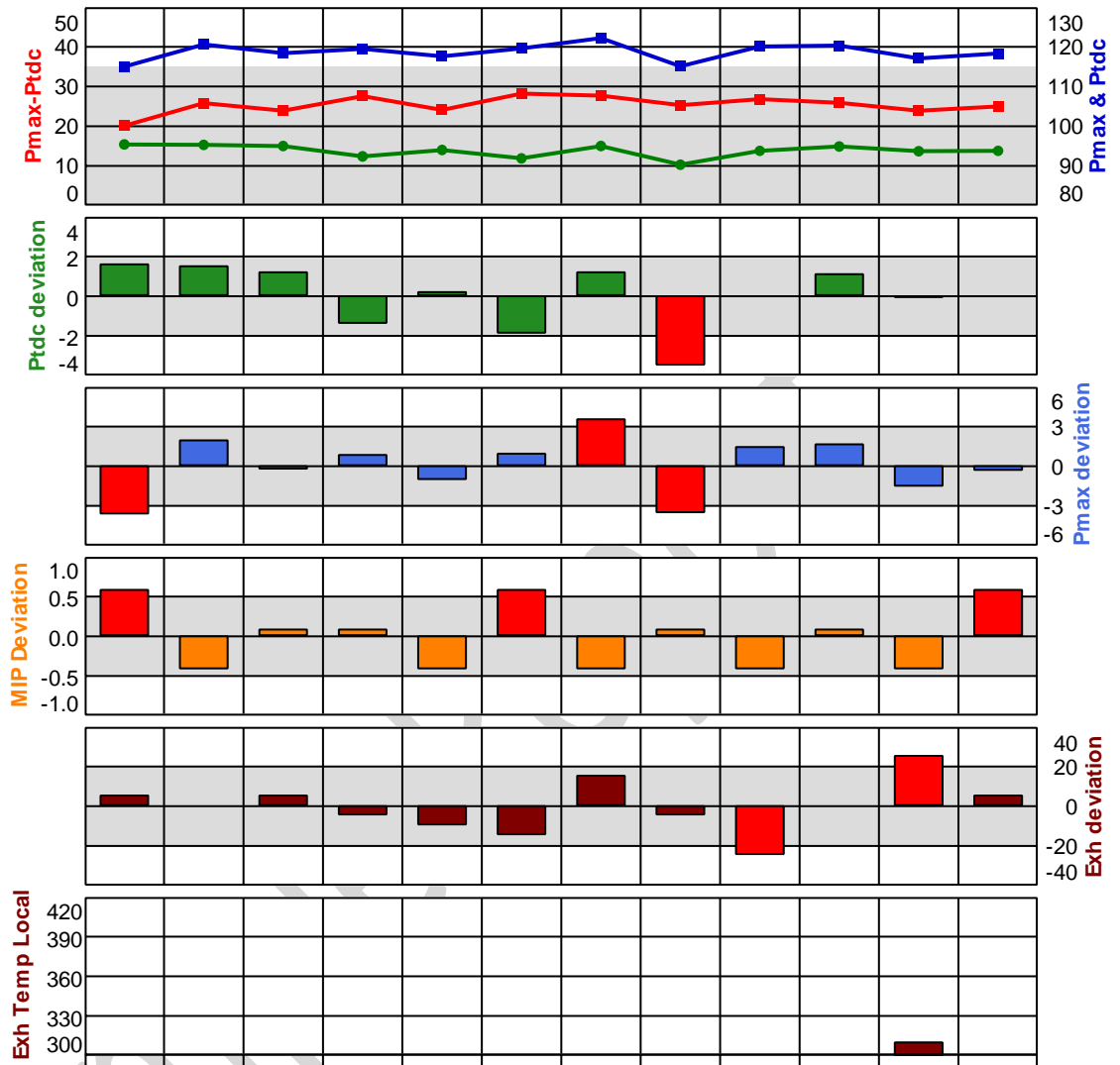


	1	2	3	4	5	6	7	8	9	10	11	12
<b>26 Jul 2006</b>	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.1	1.3
<b>04 Oct 2006</b>	1.2	1.3	1.3	1.3	1.3	1.3	1.4	1.2	1.3	1.3	1.3	1.4
<b>29 Nov 2006</b>	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.5	1.3	1.3	1.4
<b>25 Jan 2007</b>	1.25	1.2	1.3	1.25	1.2	1.3	1.15	1.2	1.15	1.3	1.35	1.15
<b>Viscosity</b>	22.75	21.5	24.99	21.8	21.99	24.85	24.12	24.65	23.43	22.29	23.7	23.28
<b>Iron</b>	116	68	138	77	59	188	129	98	67	94	95	95

- High Water in all Units poses risk of emulsification and disruption of cylinder lubrication.
- Water is diluted by System Oil contamination in Units 10 and 11.
- High Water in Units 3, 6 and 11 appears to be causing emulsification/increase in Viscosity and to be causing wear in Units 3 and 6.

**Performance & Combustion**

**Cylinder Parameters**



	1	2	3	4	5	6	7	8	9	10	11	12	
<b>Pmax</b>	114.5	120.1	117.9	119	117.1	119.1	121.7	114.6	119.6	119.8	116.6	117.8	kg/cm <sup>2</sup>
<b>Ptdc</b>	94.9	94.8	94.5	91.9	93.5	91.4	94.5	89.8	93.3	94.4	93.2	93.3	kg/cm <sup>2</sup>
<b>Pmax-Ptdc</b>	20	25	23	27	24	28	27	25	26	25	23	25	kg/cm <sup>2</sup>
<b>MIP</b>	15.5	14.5	15	15	14.5	15.5	14.5	15	14.5	15	14.5	15.5	kg/cm <sup>2</sup>
<b>Exh Temp Local</b>	290	285	290	280	275	270	300	280	260	285	310	290	°C

- Data from the SEMS Diesel Analyzer indicate:
  - Ptdc** - Deviation from mean is high for Unit 8
  - Pmax** - Deviation from mean of Units 1, 7 and 8 exceeds recommended limits of +/- 3 kg/cm<sup>2</sup>.
  - Pmax-Ptdc** - Pressure rise is within B&W recommended safe limit of 35 kg/cm<sup>2</sup>.
  - MIP** - Deviation from mean of Units 1, 6 and 12 exceeds recommended limit of +/-0.5 kg/cm<sup>2</sup>, disrupting the power balance.
  - Exh Temp** - Deviation from mean of Units 9 and 11 are high.

**Performance & Combustion**

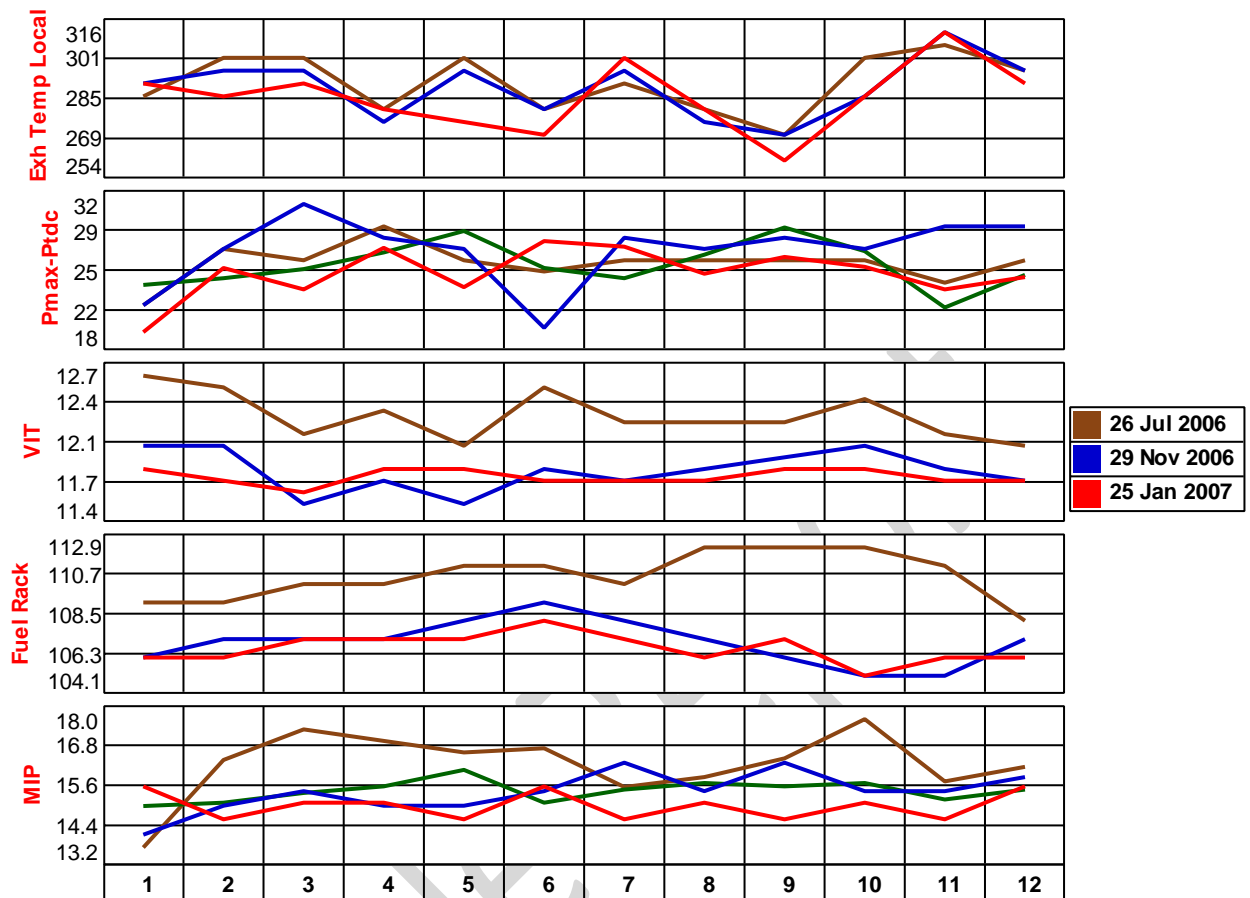
**Comparison with Engine Shop Test Performance Curve**

Red - Higher Blue - Lower		Performance Curve (72.3% MCR)	Measured Average	% Variance
Engine speed	rpm	93.2	90.6	2.79
Fuel Rack	mm	101.6	106.5	4.82
Ptdc	Kg/cm <sup>2</sup>	95.4	93.3	2.20
Pmax	Kg/cm <sup>2</sup>	126.1	118.2	6.26
Pmax-Ptdc	Kg/cm <sup>2</sup>	30.7	24.9	18.89
MIP	Kg/cm <sup>2</sup>	15.5	14.9	3.87
Turbo-Charger	rpm	9,106	9,302	2.15
Pscav	Kg/cm <sup>2</sup>	-	2.0	-
Exh Temp	°C	276.5	284.6	2.93

- Measured Averages compared to indication in the Engine Shop Test Performance Curve for the load of 72.3% MCR show:
  - **True load is close to 72.3% MCR** - indicated by low variance in Engine rpm, Fuel Rack, Turbo-charger rpm and Pscav.
  - **Torque is high** - indicated by higher Fuel Rack relative to Engine speed.
  - **Combustion may be late** - indicated by lower Pmax-Ptdc.

**Performance & Combustion**

**Performance Evaluation**



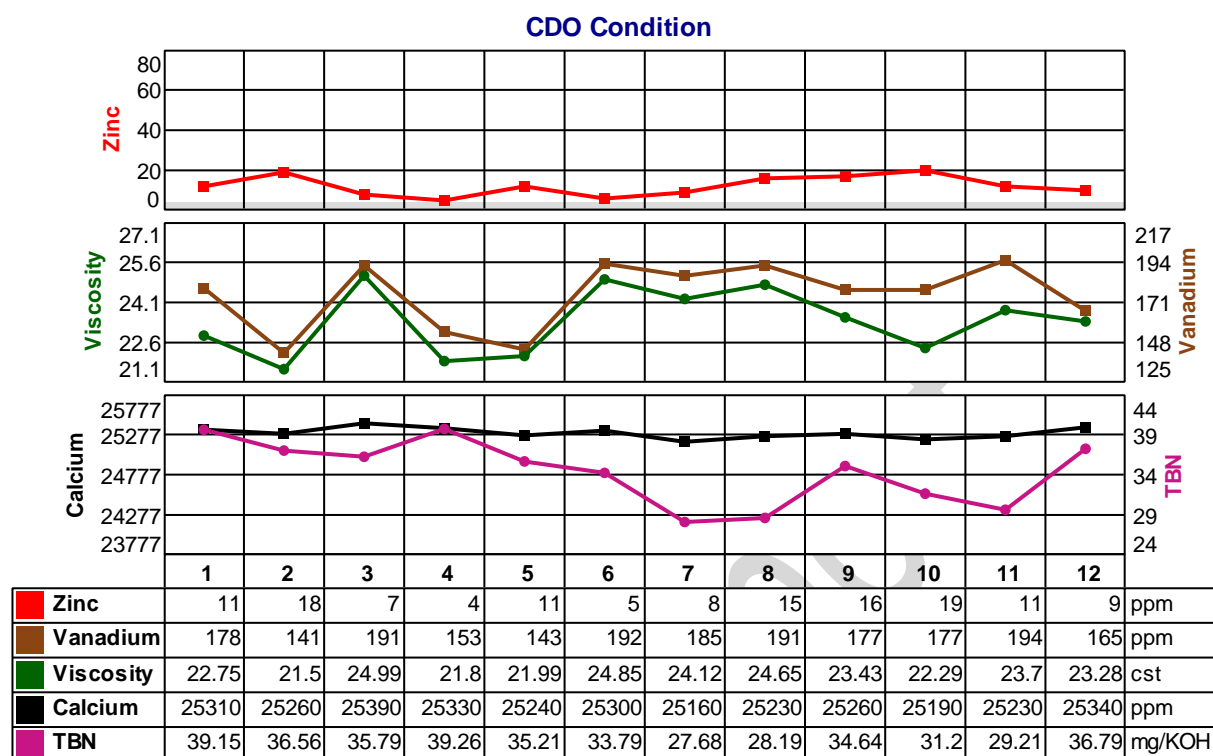
- Higher Exhaust and lower Pmax-Ptdc suggest that combustion is later than 29 Nov 06 report for Units 4, 7 and 8
- Higher Pmax-Ptdc and lower Exhaust in Unit 6 suggest that combustion is earlier than 29 Nov 2006.

**Indicator Diagram**

- Rate of pressure change line dp/da is not displayed to check if positioning of the TDC line is correct on the indicator diagrams.  
If TDC line is not correctly positioned, Ptdc and MIP will not be reliable and will provide a false indication of the Engine power balance.

**Performance & Combustion**

**CDO Condition**

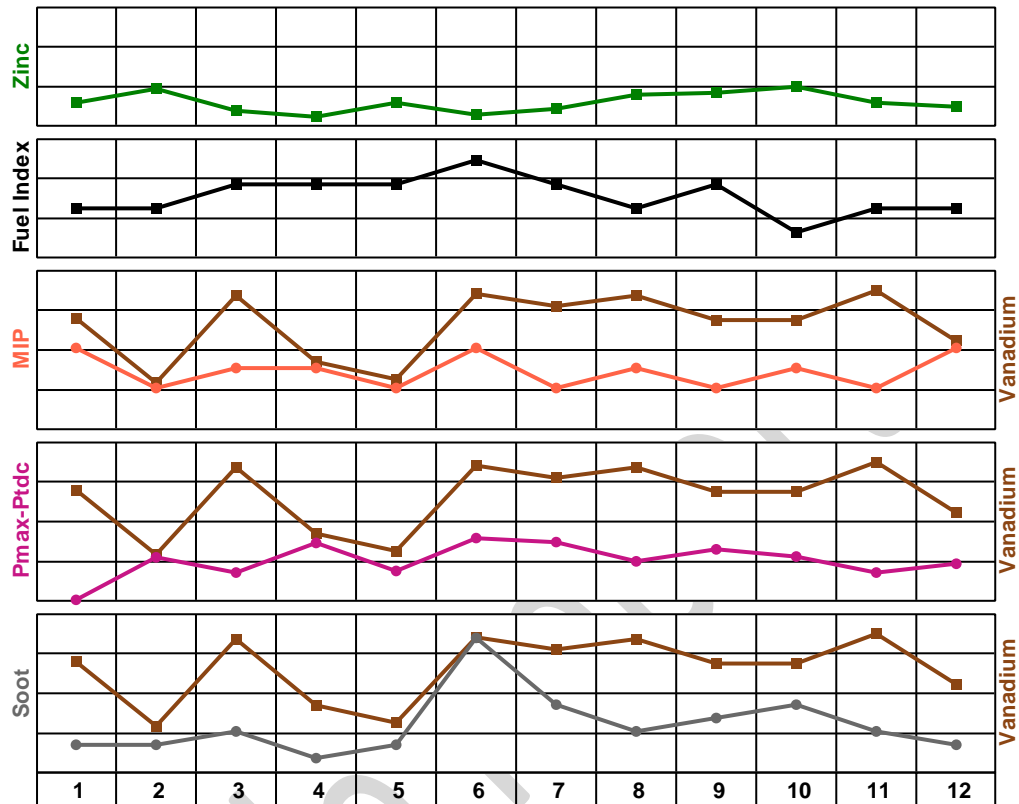


- **Zinc** indicates:
  - leakage of system oil into under-piston space of all Units is normal.
- **Vanadium/ Viscosity** indicate:
  - high contamination of CDO by unburned fuel in all Units.
  - contamination of CDO by unburned fuel and system oil in Units 10 and 11.
- **TBN/ Calcium** indicate:
  - dilution of CDO by Fuel and/or System Oil in Units 7, 8, 10 and 11.
  - burning of Cylinder lubricant in Units 6, 7, 8, 10 and 11

**Performance & Combustion**

**Combustion Evaluation**

**Combustion Evaluation**



Zinc	11	18	7	4	11	5	8	15	16	19	11	9	ppm
Vanadium	178	141	191	153	143	192	185	191	177	177	194	165	ppm
Fuel Index	106	106	107	107	107	108	107	106	107	105	106	106	mm
MIP	15.5	14.5	15	15	14.5	15.5	14.5	15	14.5	15	14.5	15.5	kg/cm <sup>2</sup>
Pmax-Ptdc	19.6	25.3	23.4	27.1	23.6	27.7	27.2	24.8	26.3	25.4	23.4	24.5	kg/cm <sup>2</sup>
Soot	0.4	0.4	0.5	0.3	0.4	1.2	0.7	0.5	0.6	0.7	0.5	0.4	%

• **Engine Performance/ CDO analysis point to:**

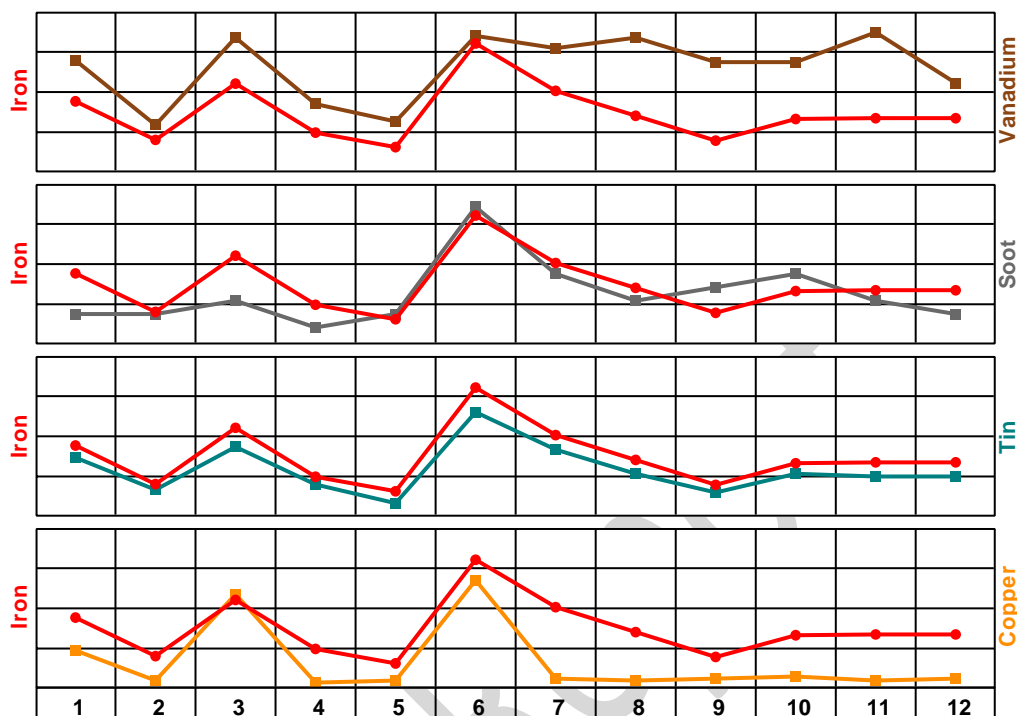
- **Incomplete** combustion in Units 3 and 6 to 11
- **Late** and/or **Incomplete** combustion in Units 1, 3 and 6 to 11
- **Possibility of Blow-by** in Units 3 and 6 to 11.

(when account is taken of variation in dilution by Fuel and System Oil contamination)

**Performance & Combustion**

**Wear Evaluation**

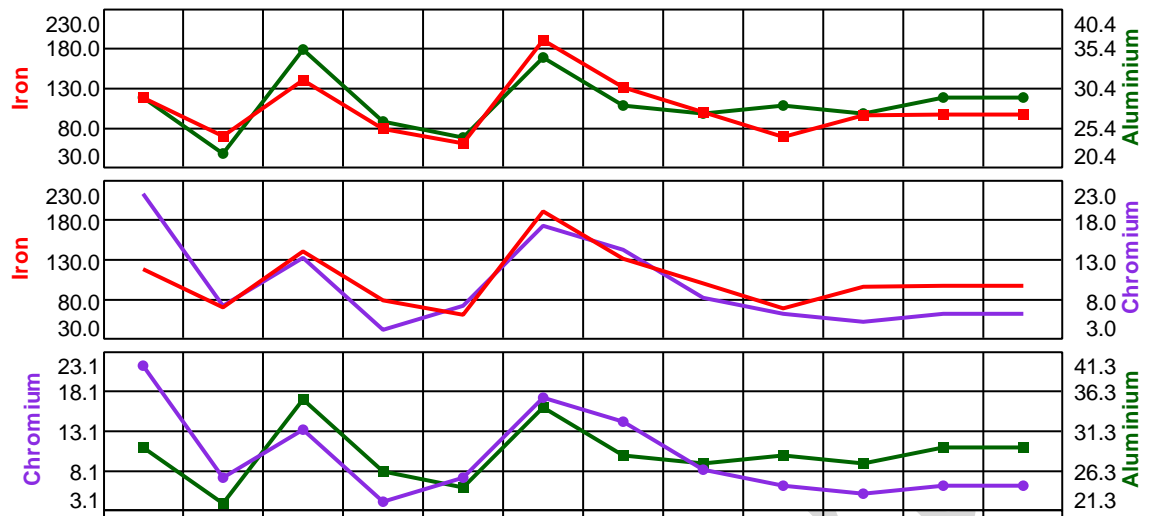
**Wear Evaluation**



	1	2	3	4	5	6	7	8	9	10	11	12	
<b>Vanadium</b>	178	141	191	153	143	192	185	191	177	177	194	165	ppm
<b>Iron</b>	116	68	138	77	59	188	129	98	67	94	95	95	ppm
<b>Soot</b>	0.4	0.4	0.5	0.3	0.4	1.2	0.7	0.5	0.6	0.7	0.5	0.4	%
<b>Tin</b>	27	15	31	17	10	44	30	21	14	21	20	20	ppm
<b>Copper</b>	18	3	46	2	3	53	4	3	4	5	3	4	ppm

- **Influence of combustion on wear**
  - Combustion conditions are influencing wear in Units 1, 3 and 6.
  - There are no signs that combustion conditions are having any significant influence on wear in Units 2, 4 and 6 to 12.
- **Skirt Abrasion**
  - Units 1, 3, 6, 7, 8, 10, 11 and 12 appear to be affected by abrasion between piston skirt and liner wall.
  - Low Tin and Iron in Units 2, 4, 5 and 9 indicate normal free movement of the pistons, and that abrasion between piston skirt and liner wall is insignificant.

**Performance & Combustion**



Aluminium	29	22	35	26	24	34	28	27	28	27	29	29	ppm
Iron	116	68	138	77	59	188	129	98	67	94	95	95	ppm
Chromium	21	7	13	4	7	17	14	8	6	5	6	6	ppm
Chromium	21	7	13	4	7	17	14	8	6	5	6	6	ppm

• **Influence of Cat-fines on Wear**

- Cat-fines are influencing wear of the liner, rings and ring grooves in Units 1, 3, 6 and 7 as indicated by correlation of Aluminium, Chromium and Iron.
- There are no signs that Cat-fines are having any significant influence on Wear in Units 2, 4, 5 and 8 to 12.

• **Ring Groove Wear**

- High Chromium indicates wear of ring groove in Units 1, 3, 6 and 7.

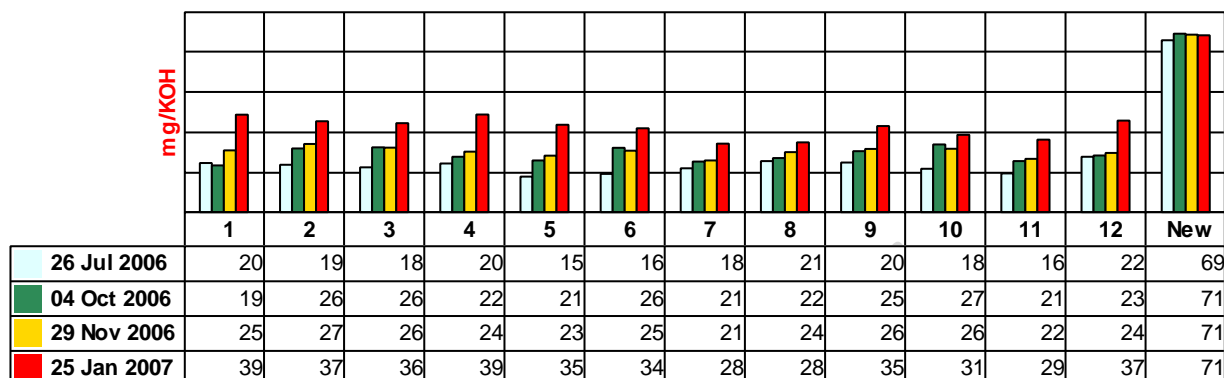


**Cylinder Drain Oil Analysis Trends**

**CDO Contamination & Condition**

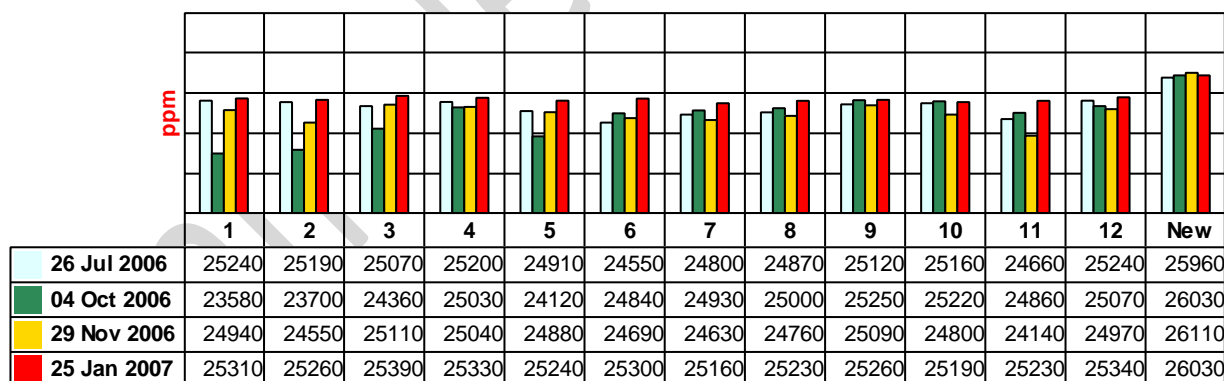
A sample of Chevron Taro Special HT 70 from Sample Ship dated 25<sup>th</sup> Jan 2007 is used to compare the change in properties of the Cylinder Drain Oil (CDO).

**TBN**



- Less acid condensation than 29<sup>th</sup> Nov 2006 is expected with current Sulphur and reported Engine Load.
- The same TBN of the CDO as 29 Nov 06 is expected with current acid condensation and reported lubricant consumption.
- Variation in TBN between Units is due to dilution by fuel and system oil contamination.
- Units 7, 8 and 11 have more contamination than other Units.
- Units 1 and 4 have less contamination than other Units.
- Alkaline reserve appears to be adequate for current fuel and engine load.

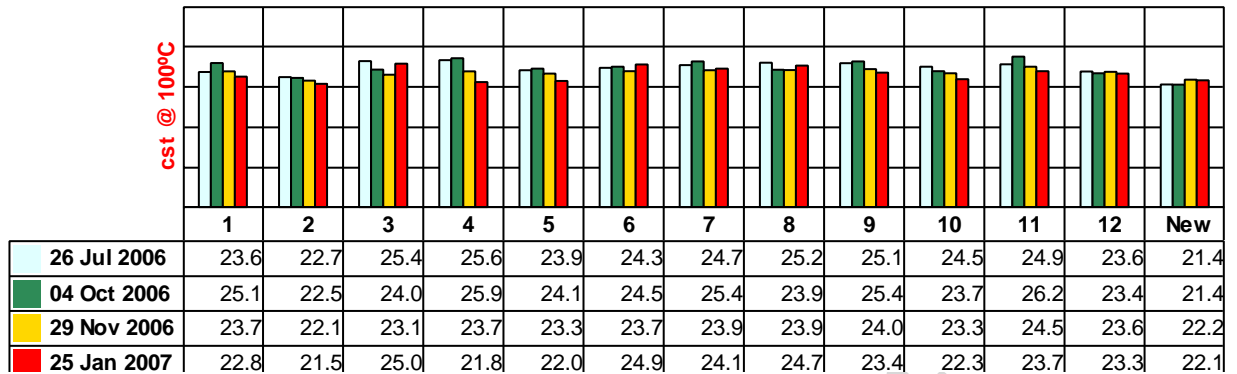
**Calcium**



- Calcium is higher than previous reports due to reduced dilution by fuel and system oil contamination.

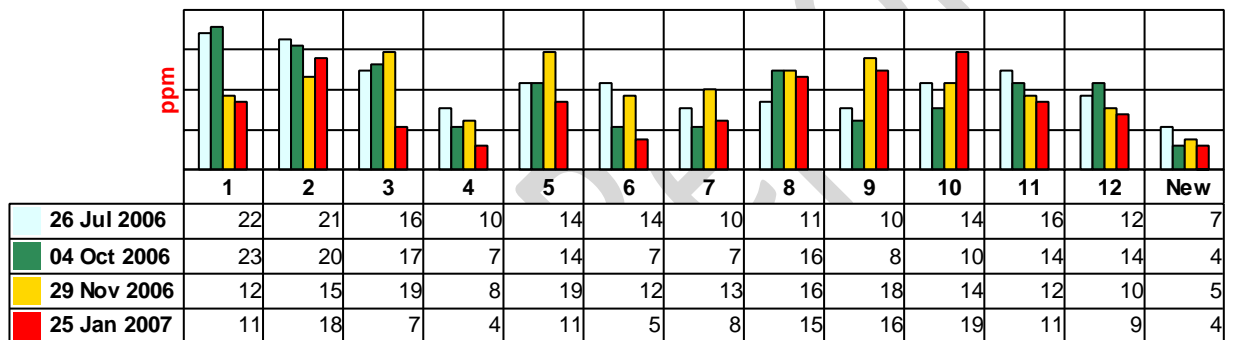
**Cylinder Drain Oil Analysis Trends**

**Viscosity**



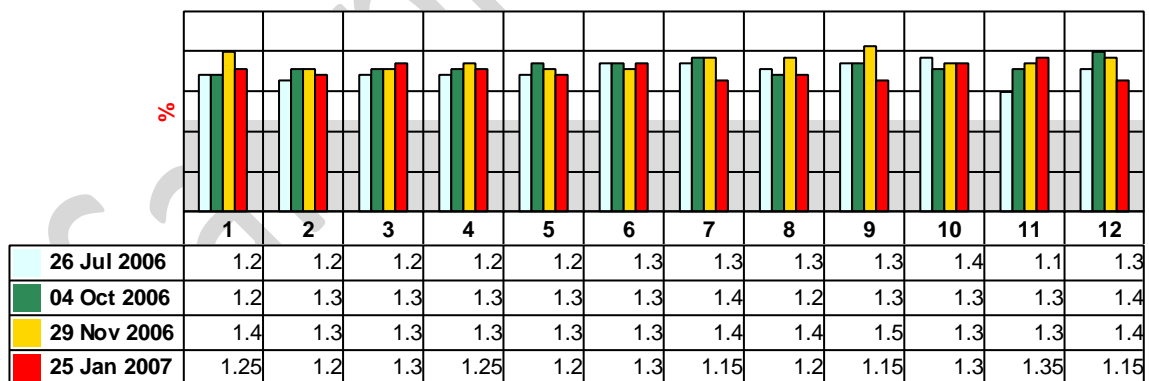
- Low Viscosity in Units 1, 2, 4, 5 and 9 to 12 can be due to reduced fuel contamination and/ or system oil contamination.
- Normal Viscosity is maintained for Units 3, 6, 7 and 8.

**Zinc**



- Leakage of System Oil into the under-piston spaces is low and normal for all Units.

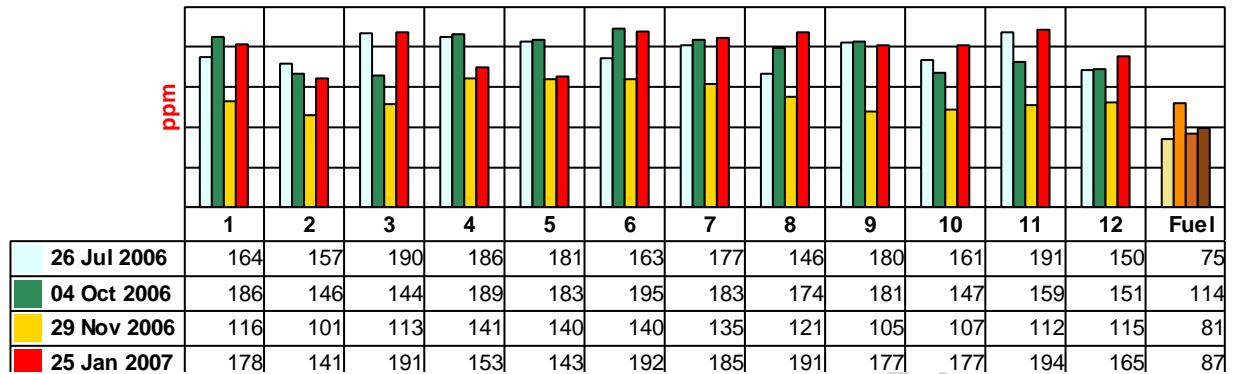
**Water**



- High Water in all Units poses risk of emulsification and disruption of cylinder lubrication.
- Water is diluted by System Oil contamination in Units 10 and 11.

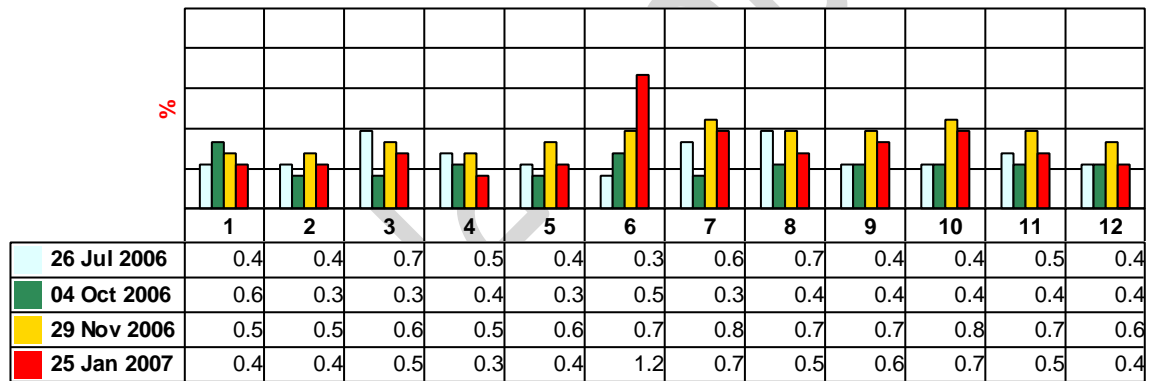
**Cylinder Drain Oil Analysis Trends**

**Vanadium (Before Engine)**



- Vanadium in all Units is higher than 29 Nov 06 due to higher vanadium fuel.
- High Vanadium in all Units relative to vanadium content of the fuel indicates that the amount of fuel or fuel ash passing the ring pack is higher than normal.
- Units 6, 7, 8 and 11 are most affected by fuel contamination.
- System Oil contamination is diluting Units 10 and 11 meaning that the Fuel contamination is higher than the analyses indicate.

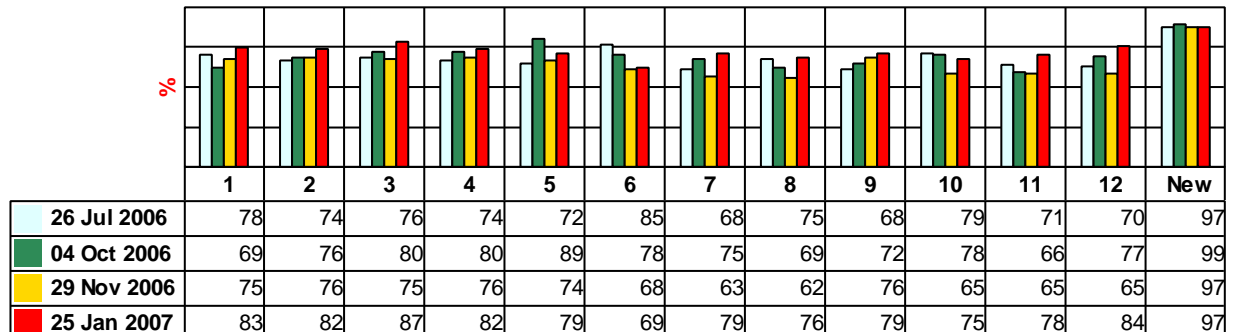
**Soot**



- High Soot in Units 1, 2, 3 and 5 to 12 indicates unstable combustion.
- Normal Soot in Unit 4 indicates satisfactory combustion.
- System Oil contamination is diluting Units 10 and 11 meaning that combustion instability is greater than the analyses indicate.

**Cylinder Drain Oil Analysis Trends**

**Dispersancy**



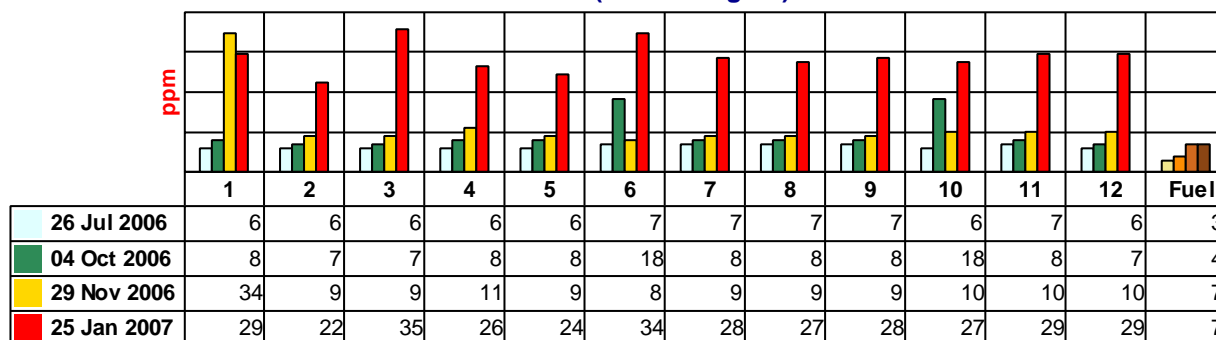
- Dispersancy in all Units indicates that CDO is lightly burdened with fuel and lubricant debris.
- Dispersant reserve in all Units is adequate to maintain piston cleanliness.
- Dilution of the CDO samples by System oil leakage in Units 10 and 11 means that debris is greater than the analyses indicate.

**Cylinder Drain Oil Analysis Trends**

**Wear Indicators**

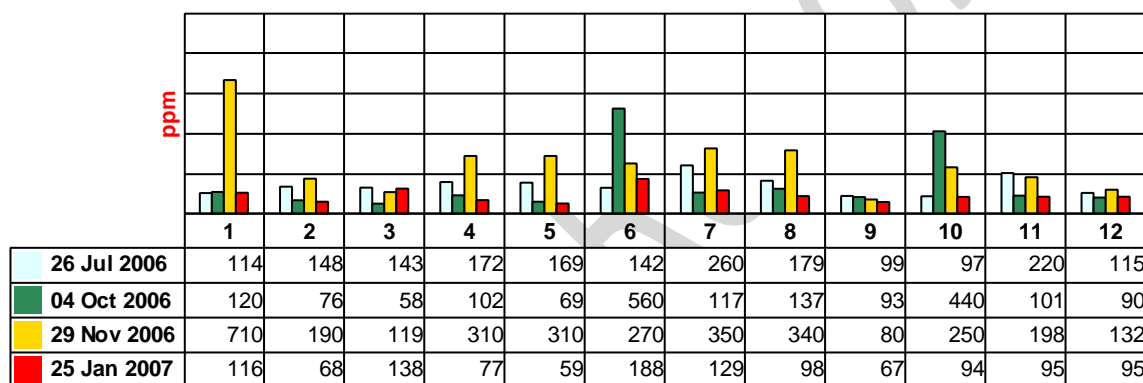
*N.B. Higher contamination by Fuel and System Oil in Units 7, 8 and 11 means that Iron, Tin, Copper and Chromium wear debris may be higher than analyses indicate.*

**Aluminium (Before Engine)**



- High Aluminium in all Units indicates presence of cat-fines and poses risk of abrasion.

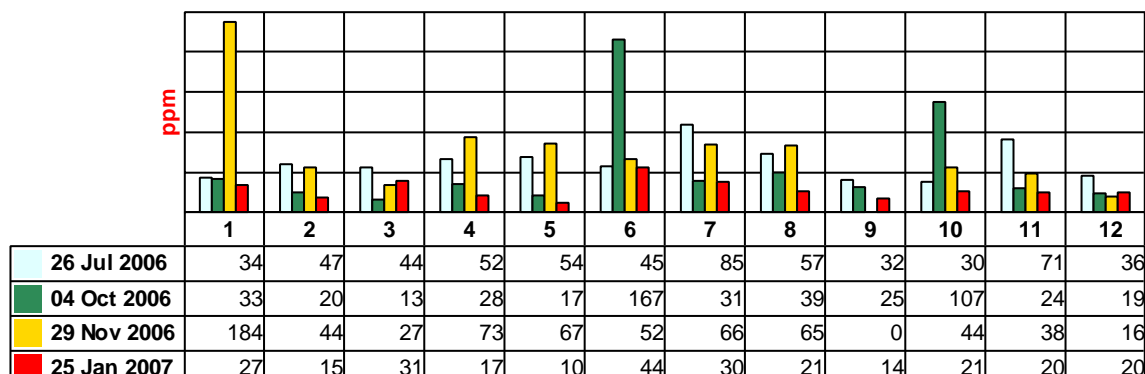
**Iron**



- High wear in Unit 6 is indicated by high Iron ppm.
  - High Iron in Unit 6 should reduce on completion of running-in.
- Normal wear in Units 1 to 5 and 7 to 12 is indicated by low Iron ppm but may be higher in Units 7, 8 and 11 when account is taken of Fuel and System Oil contamination.
- At 148 hours since overhaul wear high Iron in Unit 6 should reduce and stabilise when running-in is completed. At 148 since overhaul wear in Units 3 and 12 is low indicating that running-in is proceeding satisfactorily.
- Wear is slightly higher than 29 Nov 06 in Unit 3.
- Wear is slightly lower than 29 Nov 06 in Unit 9.
- Wear is lower than 29 Nov 06 in Units 1, 2, 4 to 8, 10, 11 and 12.

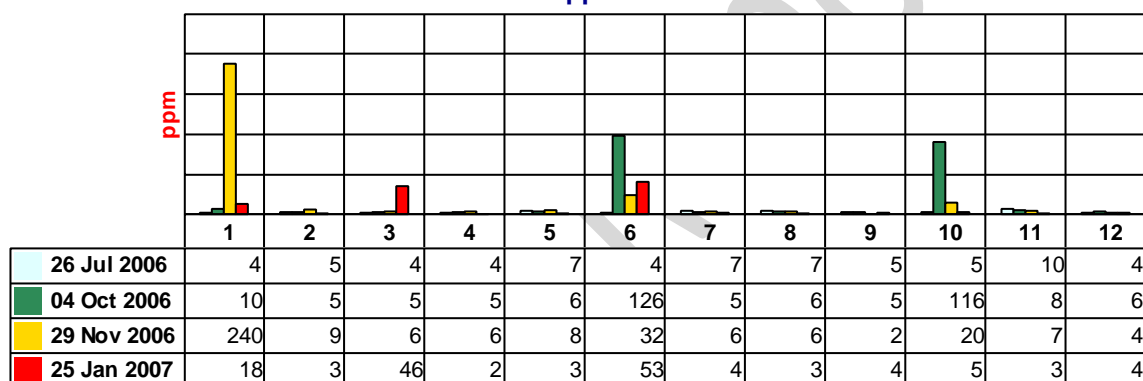
**Cylinder Drain Oil Analysis Trends**

**Tin**



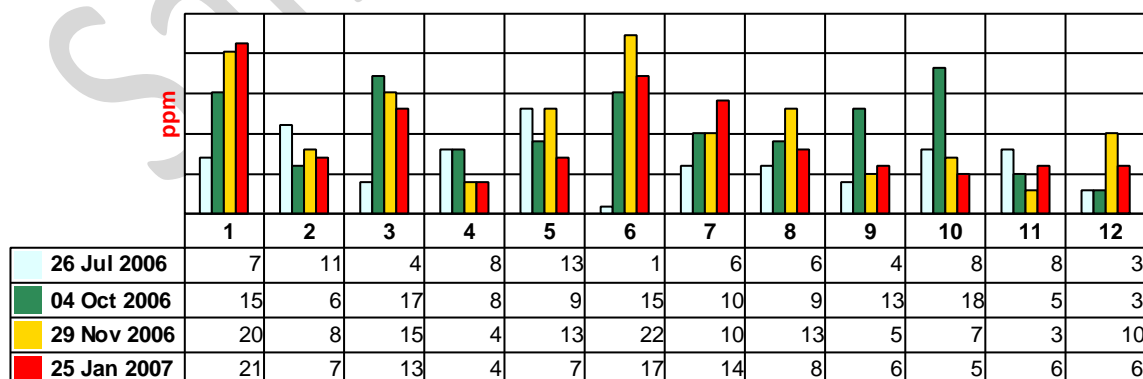
- High Tin in Units 1, 3, 6, 7, 8 and 10 points to a slight disturbance of piston alignment.
- Low Tin in Units 2, 4, 5, 9, 11 and 12 indicates that piston movement is free and normal.
- High Tin in Units 3 and 6 should reduce and stabilise when running-in is completed.

**Copper**



- High Copper in Units 1, 3 and 6 can be due to abrasion between the piston skirt copper band and liner wall or due to abrasion of the piston rod sealing rings.
- High Copper in Units 3 and 6 should reduce and stabilise when running-in is completed.

**Chromium**



- High Chromium in Units 1, 3, 6 and 7 indicates wear of the piston ring groove coating.
- High Chromium in Units 3 and 6 should reduce and stabilise when running-in is completed.

## Sampling Notes

### Please ensure the following:

- Collection of Cylinder Drain Oil (CDO) samples to be synchronized with recording of full Engine Performance Data as scheduled by company Technical Department.  
Fuel Rack to be locked when CDO Samples are being collected and performance recorded (This is in line with MAN B&W recommendation).
- CDO samples to be collected at normal operating load or between 85 to 90% MCR.
- Ensure that piston rod diaphragm is free of excessive sludge when samples are collected. If possible, under-piston space should be cleaned in port prior to sample collection.
- Record HMI setting and stroke setting for each Unit in the Sample Submission Form.
- Measure cylinder oil consumption, as accurately as possible, over 2 to 3 hours during collection of CDO samples and recording of Engine Performance.
- Record Ambient Temperature and Relative Humidity in the shaded area on the wing of the Bridge at the time of sampling. Values to be recorded in the Sample Submission Form.

### Samples Required

#### Fuel Oil

- **Before Purifier** - One sample taken line before Fuel Oil Purifier.
- **Before Main Engine** - One sample taken from line before Main Engine Fuel Injection Pump.

#### System Oil

- **New System Oil** - One sample taken at convenient point in the topping up line.
- **Crankcase Oil** - One sample taken from Main Lubricating Oil pump discharge.

#### Cylinder Oil

- **New Oil** - One sample taken from convenient point on the line to Lubricator Pump.
- **Cylinder Drain Oil** - One sample taken from under-piston drain line of each Unit.

### Documents Required

- Completed Sample Submission Form
- Completed Engine Performance Data sheet (company Standard Form).
- Copy of Main Engine Power Calculation sheet (if available).
- Printout from Electronic Diesel Analyzer (Tabulated Data and Indicator Diagram). If possible, provide archive data on diskette.
- Copy of Bunker Analysis Results for the Fuel in use.
- Copy of Main Engine Shop Test datasheet or Performance Curve - Once only.

