



Fuel Savings and Reduced Emissions through Optimising Vessel Performance – A Practical Approach

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Tanker Operator – Norshipping

June 2005



Ship Emission Reduction Through Monitoring Vessel Performance

BACKGROUND TO THE WORK

Teekay Shipping:

- Founded in 1973 by the late Torben Karlshøj
- Core Value: Responsible Environmental Practices
- Largest crude oil tanker company measured by market capitalisation, enterprise value, and fleet size
 - Transports over 10% of the world's seaborne crude oil
 - Ships more oil per year than BP and Chevron Texaco combined produce in a year
 - World's largest medium-size spot tanker franchise
 - World's largest shuttle tanker operator



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BACKGROUND TO THE WORK

OBJECTIVES

- Reduced emissions – Environmental responsibility
- Reduce fuel consumption
- Increase service speed

2-5% savings equate \$M / Annum



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BACKGROUND TO THE WORK

- | | | |
|-----------------------------------|---|----------------|
| • Cost of Fuel Oil Per Year | ➔ | \$250 million |
| • 5% Savings in Fuel Oil Per Year | ➔ | \$12.5 million |






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BACKGROUND TO THE WORK

Increased availability of time charter days

$\frac{1}{2}$ knot speed increase / ship / hr = 12 nautical miles / day
= 3,000 additional nautical miles / ship / year

= 214 additional time charter hours  >\$10.5 million
OR 8.9 time charter days per year



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BACKGROUND TO THE WORK

So if we can find ways to improve vessel performance
then the savings are very significant:

FUEL

SPEED

EMISSIONS

WIN

WIN

WIN

“Doing what we currently do....but better through improving
vessel performance”





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WHAT DO WE MEAN BY VESSEL PERFORMANCE



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WHY MEASURE OR MONITOR?

- Need knowledge of vessel's current / historic performance
- Identify trends and opportunities
- Feedback forms part of the necessary on-board training
"Fuel consumption **IS** a variable"
- Track changes and monitor improvements



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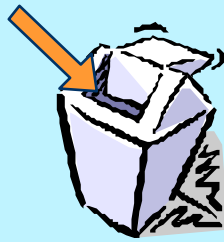
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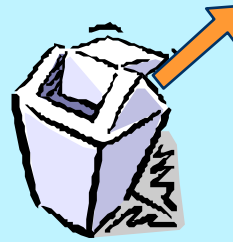
WHY MEASURE OR MONITOR?

Rubbish In



=

Rubbish Out



Important to have quality data which means a quality reporting process



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THE APPROACH MADE BY BMT AND TEEKAY

- Competitive Tender 4Q 2003
- Ship Audit 1Q 2004
- Glasgow Workshop 2Q 2004
- Contract Definition and Approval 3Q 2004
- Model Tests – Conducted Jan 2005





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TEEKAY PROJECT

EXISTING REPORTING
PROCESS



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EXISTING REPORTING PROCESS

- Manual Data Entry



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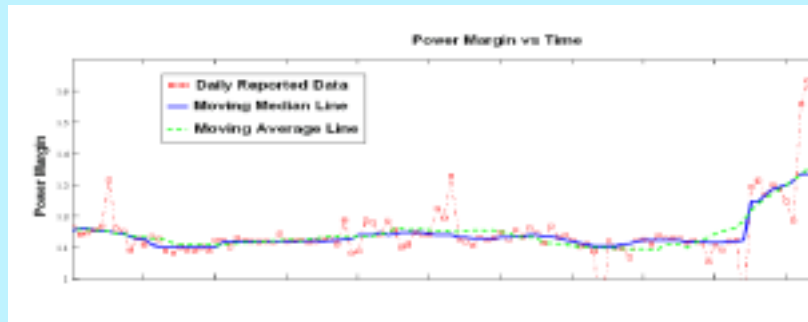
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EXISTING REPORTING PROCESS

- Manual Data Entry
- Successfully used to Identify 'Events'
for example: a vessel which incurred propeller damage



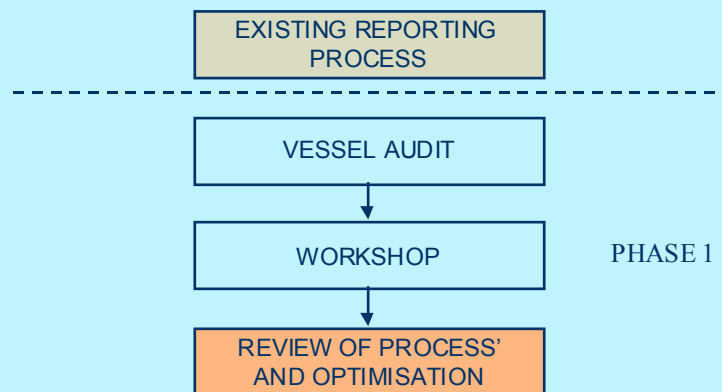
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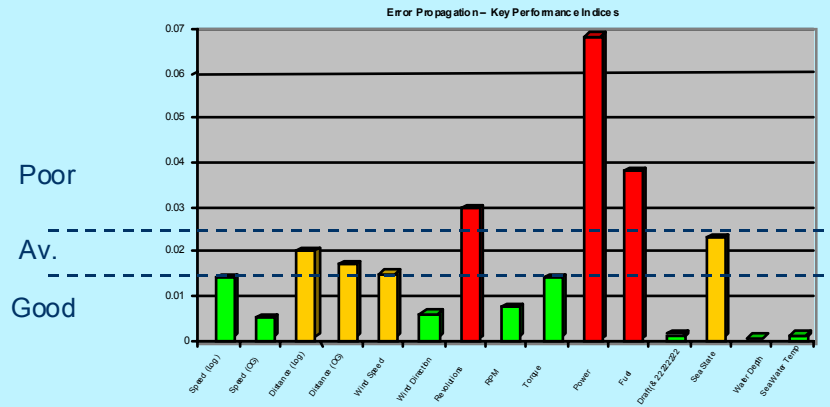
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Process Optimisation - Before



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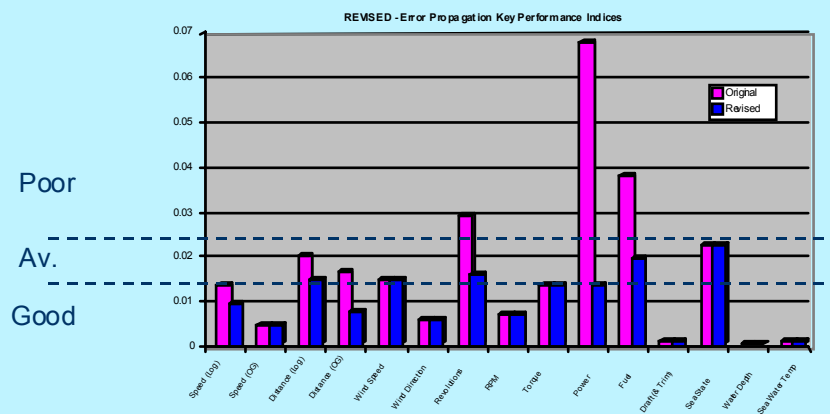
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Process Optimisation - After



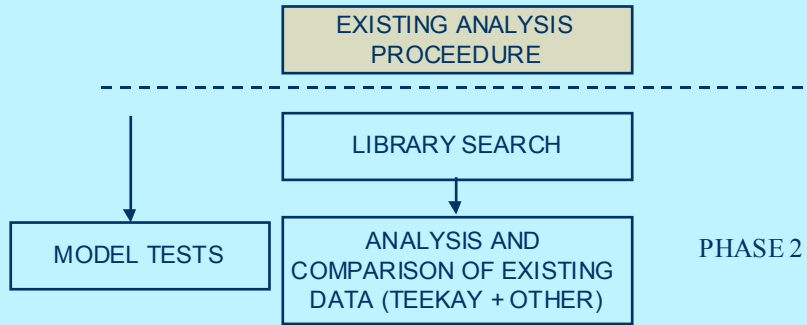
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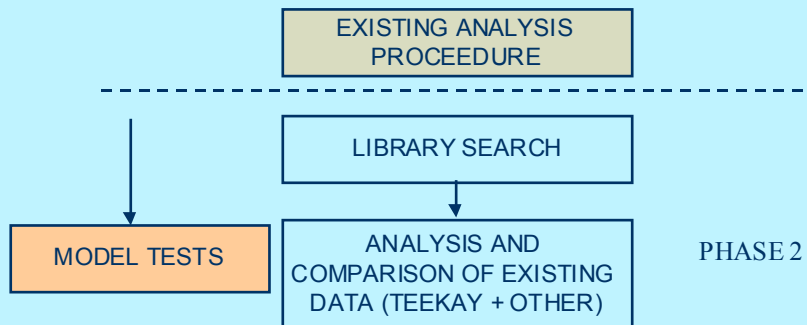
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TEEKAY PROJECT





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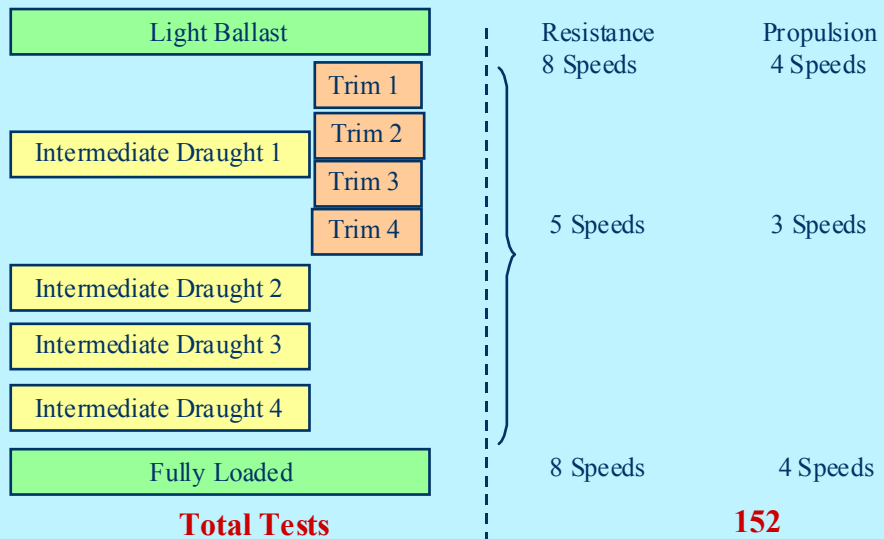
Why Model Test?

Better understand effects of draught and trim

- Optimise ship operation – immediate gains
- Normalise performance data – trend analysis



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Example from the Model Test Results

For Ship Speed = 16 knots

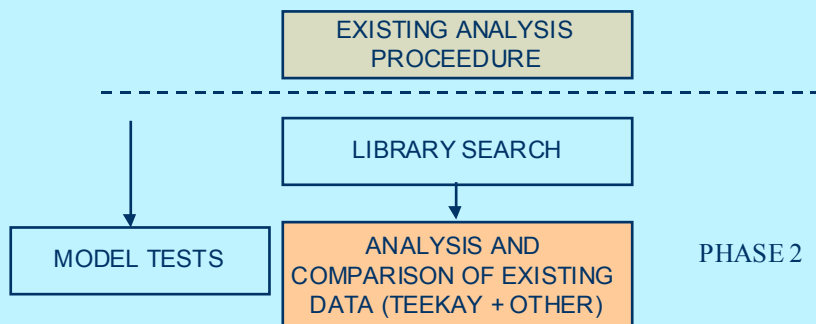
Displacement (Tons)	Trim (m)															
	-2	-1.5	-1	-0.5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
4800									0.00%	0.30%	1.0%	1.9%	3.1%	4.7%	6.9%	9.9%
5700									0.00%	0.24%	0.8%	1.6%	2.7%	4.2%	6.3%	9.2%
6700									0.00%	0.20%	0.7%	1.4%	2.4%	3.7%	5.4%	7.9%
7000									0.00%	0.17%	0.6%	1.2%	2.1%	3.2%	4.7%	6.8%
8000	0.00%	0.22%	0.8%	1.6%	2.6%	3.9%	5.5%	7.3%	9.3%	11.5%	13.9%	16.5%	19.3%	22.3%	25.5%	
8800	0.00%	0.20%	0.7%	1.4%	2.3%	3.5%	5.0%	6.7%	8.7%	10.9%	13.3%	15.9%	18.7%	21.7%	24.9%	
11000	0.00%	0.18%	0.6%	1.2%	2.0%	3.1%	4.5%	6.2%	8.1%	10.3%	12.7%	15.3%	18.1%	21.1%	24.3%	
12500	0.00%	0.16%	0.5%	1.0%	1.7%	2.7%	3.9%	5.4%	7.2%	9.3%	11.6%	14.1%	16.8%	19.7%	22.8%	
14500	0.00%	0.14%	0.4%	0.8%	1.4%	2.2%	3.3%	4.6%	6.2%	8.1%	10.3%	12.7%	15.3%	18.1%	21.1%	

0.5m Δtrim = circa 2% ΔPower



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TEEKAY DATA

BMT ACQUIRED DATA

- Manual Process
- Noon-Noon (1 / day)
- Circa 15% post filtering
- Automated System
- 5 min averages (288 / day)
- Circa 25% post filtering



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Measured parameter	Teekay Filters	BMT Filters
Ship Status	✓	
Power	✓ (Calculated)	✓
Power SD		✓
RPM	✓ (Total Rev)	✓
RPM SD		✓
Fuel Consumption		✓
Fuel Consumption SD		✓
Wind Speed	✓	✓
Wind Speed SD		✓
Wind Dir		✓
Wind Dir SD		✓
Log	✓	✓
Log SD		✓
SOG	✓	✓
SOG SD		✓
Heading		✓
Heading SD		✓
Advanced Stat. Methods		✓



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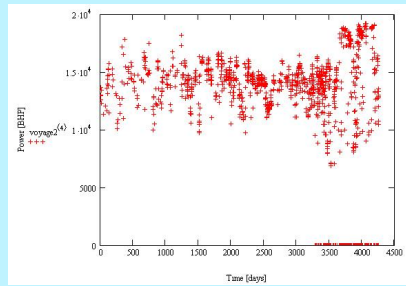
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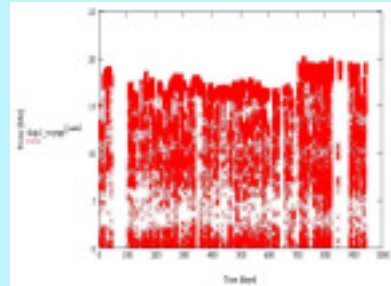
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Raw Data



Teekay (4200 days)



BMT (950 days)



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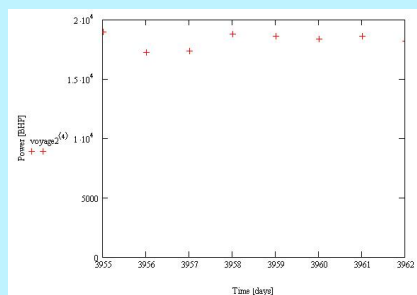
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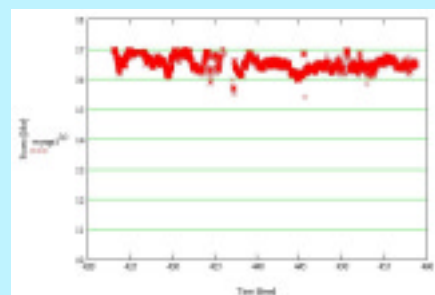
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Filtered Data



Teekay (7 day voyage)



BMT (35 day voyage)



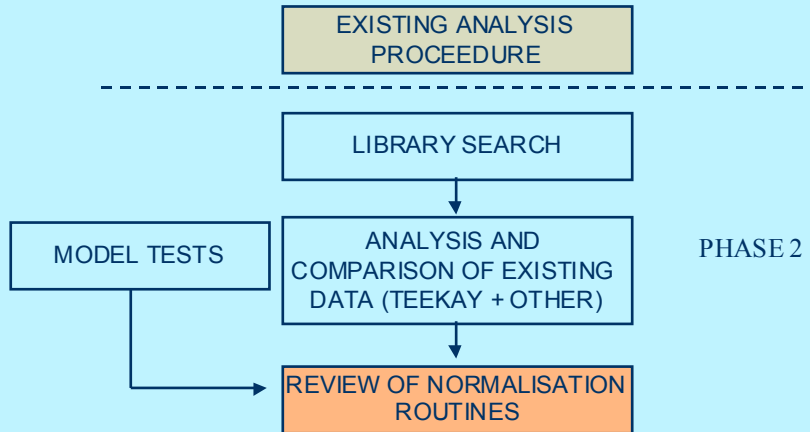
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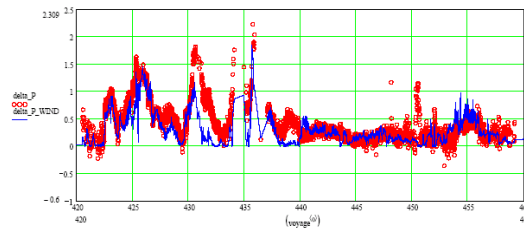
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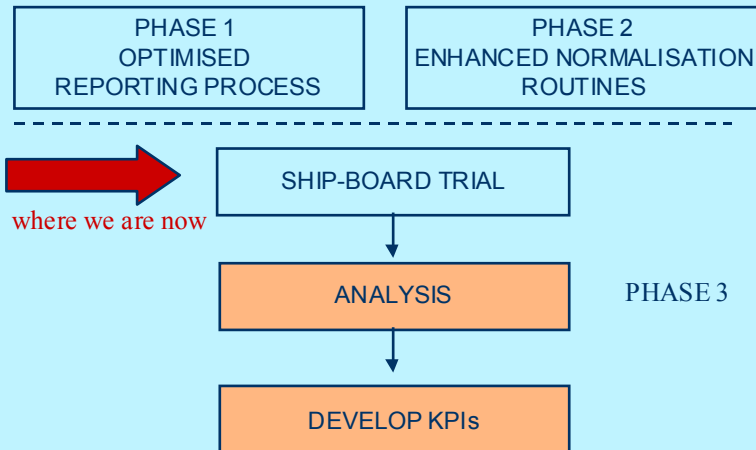
Environmental Normalisation





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THE NEXT STEP

- Re-validate and Roll-out to Teekay Fleet (up to 160 vessels)
- Develop training materials to support the revised process
- Update KPIs to be more meaningful ashore
- Provide the Master with a pro-active tool to optimise Drafts and Trim for given DWT
- Identify and quantify performance trends – comparison between vessels, fleets, routes etc





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FUTURE APPLICATIONS

Knowledge, Understanding and Competence

- Improve accuracy of the stated Charter Speed and reduce the possibility of future claims – better judgment of speed during passage and long-term hull degradation
- Algorithms feed-forward into Weather Routing predictions
- Development of Economic Management tools to aid decision making e.g. when to clean the hull
- Facilitate development of enhanced automated system SMART^{POWER}

Reduced Emissions



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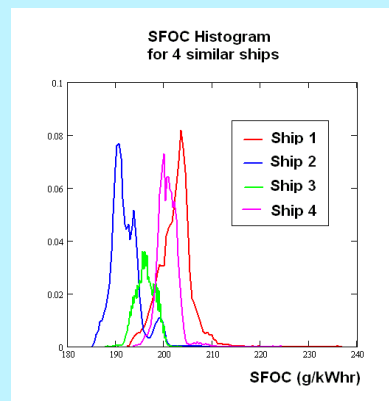
CONCLUSIONS

- Few ships are operated at their most efficient point
Engine – Hull - Propeller

For example: SFOC for 4 VLCCs

Ships 1 & 2 are Sisterships
Ships 3 & 4 are Sisterships

(not Teekay vessels)





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CONCLUSIONS

- Few ships are operated at their most efficient point
Engine – Hull - Propeller
- Traditional manual reporting systems (with some tweaks) can provide meaningful data upon which the vessel performance can be optimised given commercial and other constraints
- Automated systems provide additional benefits
- Savings through pro-active use of the acquired management information are significant (2-5% anticipated)
- **Win, Win, Win**



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