Vessel Performance Management

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Presentation Contents

Vessel Performance Management

- Basic principles for performance monitoring
- Noon reports versus autologging
- Performance analysis
- Operational measures
- KPIs and change management
- ABS Vessel Performance services

Do you know how Vessel Performance affects your bottom line? We do.
Fuel Efficient Vessel Operation

- Newbuilding
  - Design for operational profile
  - Energy efficient ships, yard spec., contract details
  - Optimization, cost effective solutions

- Retrofit on existing fleet
  - Propulsion optimization, bow, propeller/ME etc.
  - Machinery optimization for new operational profile
  - Energy-saving devices
  - Increase cargo capacity

- Operational vessel performance
  - Technical
  - Operational optimization

- Environmental compliance
  - SEEMP, EEDI
  - SOx, NOx, ECA areas
  - MRV
  - Ballast water treatment
Fuel-savings: Technical & Operational

- Technical
  - Hull and propeller maintenance
  - Main engine efficiency
  - Base load
    - Minimize energy consumption
    - Optimize energy production

- Operational
  - Optimized bunkering, quantity, fuel sourcing
  - Optimize voyage conditions
  - Voyage optimization
  - Trim optimization
Fuel-savings: Hull & Propeller Maintenance

- **Drydocking**
  - Full blast – spot blast
  - Paint systems, new technologies not always performing?
  - Evaluation of treatment

- **In Operation**
  - Trending of performance
  - Hull cleaning – intervals, type of cleaning on different paint types
  - Propeller polish
  - Evaluation of treatment

- Close monitoring, optimization and analysis is required to learn
Fuel-savings: Main Engine Efficiency

- Engine must be maintained for efficiency and to reduce maintenance costs
- Engine efficiency
  - Measure fuel and power
- Trending of SFOC
- Engine test
  - High Pmax – High SFOC
  - Engine balance
  - ISO correction for ambient conditions
- Slow steaming – low load operation
- No easy catch
  - Continuous monitoring and follow-up required
Fuel-savings: Base Load – Production

- Minimize energy consumption
  - Turn off unnecessary lights, aircondition etc.
  - Change to EE bulbs
  - Proper maintenance of consumers
  - And a lot more

- Optimize energy production (energy management)
  - “Classic” – verify that auxiliaries are run at optimum load, i.e. avoid low load operation on several engines
  - SFOC on auxiliary engines
  - PTO, WHR options, are the crews using it optimally?

- Measuring fuel consumption for auxiliaries and energy production not always prioritized

- Base load monitoring and feedback required
Fuel-savings: Optimize Voyage Conditions

- Minimize time in harbor
- Communication of voyage conditions at an early stage, fast communication of ETA changes
- Loading for minimum ballast and optimum trim
- Procedures for speed instructions giving optimum voyage planning
- Monitor and measure voyage parameters to improve
Fuel-savings: Voyage Optimization

- Some captains, speed up in good weather, slow down in bad weather – or vice versa
- Most optimum voyage?
  - Constant speed
  - Constant power
  - Constant RPM
- Speed profile optimization, just in time, constant power/RPM is a good first order approximation
- Weather routing is a key tool
Fuel-savings: Trim Optimization

- Tables of optimum trim as function of speed and displacement
  - Model tests
  - CFD calculations
  - Self-learning algorithms from full scale
- Verification? Absolute numbers are important.
- Loading of container vessels done by stowage, need to understand, link to loading computer
- Monitoring and follow-up required, optimum trim not the only parameter
Fuel efficient operation: all parties need to work together
Ship Management (including Vessel Crew)

- Ship management makes decisions on:
  - Maintenance of equipment (main engine, auxiliary, sensors, etc.)
  - Drydockings – hull treatment, antifouling, propeller
  - Hull cleanings, propeller polish
  - Newbuilding design
  - Crew composition
The ship crew makes decisions on:
- Optimize base load (minimize consumption, optimize production)
- Vessel – shore communication
- Voyage efficiency (speed profile, route optimization)
- Maintenance and equipment optimization
- Performance monitoring and engine testing

Charter party conditions are important
Shipowner

- The value of a vessel will become closely correlated to how fuel efficient it is
- Owner must know efficiency of each vessel class
- Owner must know current performance of each individual vessel
- Owner negotiates charter party conditions with ship operator
- Closely work together with ship management
- Responsible for fleet composition, asset management:
  - Newbuilds, owner must know fuel efficiency of yard prospects – how to do that?
  - Retrofit – identify solutions with reasonable ROI – track improvement
  - Let go of less efficient tonnage, or?
Ship Operator

- Fuel efficiency is important
- Fleet composition should match cargo composition
- Optimize fleet composition
  - Seek fuel efficient tonnage
- Optimize operations:
  - Right ship for right cargo
  - Utilization
  - Speed and capacity optimization
  - Harbor operations
- Structured process around expected performance/charter parties
- Monitor charter parties/expected performance – feedback loop
Charter Parties: Historically & Going Forward

- Historically
  - Bulk carriers: strong follow-up on charter party conditions, claims normal
  - Tankers – weaker follow-up
  - Containerships – little tradition for follow-up or claims

- Loaded, ballast speed and consumption, “About”

- The near future, or now?
  - Operators will increase monitoring, closer follow-up, more strict charter parties, different incentive schemes?
  - Operators will require fuel efficient ships and they will check it

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From BIMCO

18. PERFORMANCE OF VESSEL - SPEED AND CONSUMPTION

18.1 Unless otherwise ordered by Charterers, the Vessel shall perform all voyages at the service speed stated in the Questionnaire.

18.2 Owners warrant that the Vessel is and shall remain capable of maintaining throughout the Charter Period, the speeds and bunker consumptions for propulsion described in the Questionnaire under normal working conditions and in moderate weather (which for the purpose of this Clause shall exclude any periods of winds exceeding Force 5 on the Beaufort Scale). Charterers shall have the right to make deductions from hire in respect of any time lost and any additional bunkers consumed by reason of the Vessel’s failure to maintain the warranted capability.
The Vessel Performance Management System (VPMS)
Data Logging

Data logged manually or automatic
Logging of Performance Data

- **Parameters (Propulsion)**
  - Ship speed through water and GPS speed
  - Ship draft and trim
  - ME fuel consumption
  - ME power
  - ME RPM
  - Water depth
  - Wind speed and direction
  - Sea state; wave spectrum, wind driven and swell
  - Rudder angle
  - Temperatures, water and air
  - Salinity

- **Parameters (Base load)**
  - Auxiliary engine consumption
  - Auxiliary engine production
  - PTI and PTO
  - WHR
  - Other equipment
    - Boilers
    - Cargo heating
    - Cargo pumps

![Diagram of Voyage Phases](image)
Noon Reports

- Manual reported data
- Varying quality of data
- Environmental parameters are not constant over 24-hour period
  - Average and over longer time, uncertainties level out
- Careful data collection and on-board validation:
  - 24 hours average values can be used
- Noon reports is part of existing procedures on most ships
- Noon reports; expect longer response time to sudden changes
- Logging of events
Automated Data Logging

- No man-in-the-loop – avoid human error – or manipulation
- Less burden for the crew
- Possibility for automation of alarms, link to other systems
- Rely on sensors, some sensors might drift, out of order etc., i.e. fault diagnostics or alarm system required.
- Electronic sensors
- How to generate crew awareness?
- In reality, full auto-logging is seldom fully automated (draught, bunkering, stock, sludge, etc.)
Automated Data Logging

● Automated Data?
  ■ From Noon to Autolog
  ■ Increase data amount (transfer & storage)

● Automated Data Analytics
  ■ Traditional analytics and storage inadequate
  ■ Include parameters in analytics
  ■ “Hidden” information in data

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• 2800 sensors hardwired into vessel’s main control system
• 200 sensors in a modern main engine room measuring temperature, pressure and operation
• 2TB data generated every 100 days by a modern vessel

(source: Maersk Line)
Performance Monitoring Set Up

- Capture the basics
Performance Data Validation

- Sensor performance
  - Outliers & spikes
  - Drifting
  - Malfunctions

- Environment
  - Wind & waves
  - Current
Performance Data Validation

- Data validation procedures at input
  - Based on vessel particulars/vessel model/statistical data
  - Warnings and Triggers

- Data quality checks before analysis
  - Sufficient data to perform an analysis
  - Missing values
  - Combination of values inside acceptable ranges
  - Validation towards external systems

- Feedback in the system
Full Voyage Performance

- Capture the full voyage
Principles for Performance Monitoring

- Basic principle for performance monitoring
  - Compare measurements with expected values
  - Typical examples of reference vessel performance models
    - Propulsion power, speed versus power for different draughts (trim)
    - Main engine specific fuel oil consumption
Establishing the Baseline for Performance

- Compare logged data and analytics to a baseline
  - Physical Model
  - Model based on data
  - Combination
Vessel Baseline Model

- Hydrodynamic Model based on
  - Sea Trials
  - Model tests
  - CFD simulations
ABS Vessel Performance

- ABS Nautical System Fleet Management software
- Voyage Performance Manager module
  - Data logging (noon & auto)
  - Data Interpretation
  - Data Analysis
    - Operational Efficiency
    - Environmental Compliance
    - Voyage Efficiency
- Available in a web application (Cloud or internal server)
Vessel Performance Analysis in NS

Level 1: data validation and interpretation
Service: VPMS data checks & parameter plots

Level 2: baselines and daily performance analysis
Service: Level 1 + ABS support – vessel benchmark & voyage trends

Level 3: detailed performance trends and actionable alerts
Service: Level 2 + ABS VP analysis & dashboards
Operational Data Logging

- Noon Data reporting:
  - Excel based template or NS Application
  - Includes calculations and validations
- Data transfer to NS database
- Data Visualization in NS cloud solution
- Performance Analysis by OEP team

- Autologging
  - NS Autologger installation on board
  - Connection to relevant sensors or to installed historian (if available)
  - Data transfer to NS database
  - Performance Analysis by OEP team
Fleet Operational Overview

Consumption (mt)
Reported Date: 13-Apr-2016
Data Interpretation

Time Vs Parameter

Main Engine - Avg RPM (rpm)
14-Nov-2015 to 13-Mar-2016

Main Engine - Avg RPM (rpm): 70.1
Date Range: 13-Dec-2015
Number of Records found: 1
Consumption Overview

Consumption by Equipment

All Equipments (mt)
14-Nov-2015 to 13-Mar-2016

Mean Draft (m)
Select Trend Line
Performance Analytics

- Hull & Propeller
ISO 19030 - Measurement of changes in hull and propeller performance

- Hull and propeller performance refers to the relationship between the condition of a ship’s underwater hull and propeller and the power required to move the ship through water at a given speed.

- Measurement of changes in ship specific hull and propeller performance over time makes it possible to indicate the impact of hull and propeller maintenance, repair and retrofit activities on the overall energy efficiency of the ship in question.

Deterioration in hull & propeller performance between dry-dockings accounts for 10% of world-fleet fuel costs and GHG emissions.
Required Data for the ISO 19030

- Auto-logged data (15 sec frequency), preferably including rudder angle measurements.
- The data shall be of at least two years, one year before (reference period) and one year after (evaluation period) an event (i.e. dry-docking).
- The ship owner will get deep insight into the performance of the vessel.
Performance Analytics

- Main Engine
Performance Analytics

- Charter Party
- Trim
- Base Load
Environmental Performance Analytics

- SEEMP updates & evaluation (Voyage based)
- Emissions reporting
- Emissions based on conversion factors
- ECA areas & Fuel switching overview
- MRV reporting
Voyage Performance Analytics

- Capture all voyage events
- SEEMP/EEOI/Emissions
- Voyage Planning & Prediction
- Industry Benchmarking
- Include external data e.g. AIS, Hind Cast/Fore Cast & Design data
Integrate in a Fleet Management System

- NS Fleet Management

![Diagram showing various management systems and processes](image)

- Structural Performance
- Maintenance
- Fuel & Energy Optimization
- Emissions Monitoring
- Class Surveys
- Ballast Compliance
- Fuel Switching Compliance
- Machinery Performance
Key Performance Indicators (KPIs)

Individual KPI ➔ Scorecard/Dashboard

- Define baseline
- Define target
- Define KPI function
- Define weight of KPI
- Add to scorecard

KPI score
KPI score & weight
KPI score & weight
KPI score & weight
KPI score & weight
KPI score & weight
KPI score & weight
KPIs

**Example**

**KPI Score Function:**
- Assign good score if target is met.
- Incentive to be better than target.
- Below baseline, lower KPI score.

**Principles for Target-setting:**
- Relative or absolute?
- Baseline individual or sister ships?
Weighting of KPIs

- Weights can be assigned using different principles:
  - Based on dollar impact value
  - Using expert judgement where most impact can be obtained quickly
  - Areas with special focus (safety?)
  - Areas where stakeholders can influence most (largest potential)
  - Based on strategic decisions
KPIs, Examples

- **Ship Management**
  - ME efficiency – SFOC
  - Hull and propeller efficiency
  - Base load
  - Voyage efficiency
  - Measure for energy management
  - Measure for cylinder oil consumption
  - Measure for quality of reporting

- **Ship Operations**
  - ETA communication
  - Harbor efficiency
  - Speed instructions
  - Utilization
  - Energy Efficiency Operational Indicator (EEOI)
  - Fleet composition, benchmarking
Closing Remarks: Operational Performance

- A general framework for performance monitoring, performance management and operational performance has been outlined

- Companies are different
  - Objectives
  - Culture
  - Strategy

- No "one size fits all" solution

- Operational performance is a continuous process:
  - Own development
  - Partnerships with existing providers of performance monitoring services
The solution does not come for free; owners, operators and ship managers should plan for a long term strategy.

Logical step to include the ship specific SEEMP and perhaps the company specific ISO 50001 as an integrated part of the process.

Fuel efficiency
- Systems and monitoring is required; but
- Fuel efficiency comes mainly from actions of human beings.
Training Package

- Training packages for software use and information flow are available when software is installed.
- Training in “Best Practices for Fuel Efficient Operations” for onboard/onshore personnel is seen as a key parameter to succeed with improving operations.
- A training package is offered based on industry best practices.
- Training updates, based on experience gained across the fleet, are recommended at regular intervals e.g. at Officer’s seminars or similar events.
The Vessel Performance Management System

- Next Generation System

**ON LINE STREAMING OF DATA**

**ONLINE DATA INTERPRETATION**

**ON DEMAND REPORTING**
- Performance reports
- Bunker reports
- Departure / Arrival reports
- Engine reports
- SEEMP

**DECISION SUPPORT INCLUDING**
- Hydrodynamic Loads
- Structural Loads
- Machinery Condition
- Forecasting and Prediction
Summary

● Fuel efficient vessel operations require:
  ■ Monitoring and a framework
  ■ Cooperation and transparency
  ■ The human factor – communication, training

● ABS vessel performance, preparing for the future:
  ■ A performance management framework – a strategy
  ■ A performance management service – capabilities and tools
  ■ NS Software Platform
  ■ ABS Training packages