ENERGY EFFICIENT SHIP OPERATION

ENERGY MANAGEMENT PLANS AND SYSTEMS

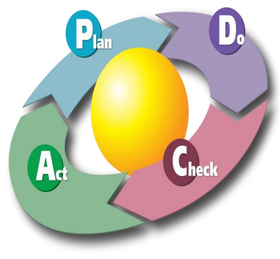
Management Systems in Shipping

- **ISM Code**: The most prominent management system that is already mandatory in shipping. Safety is at its core.
- **ISO 9001**: Quality Management System
- **ISO 14001**: Environmental Management System
- **OHSAS 18001**: Health and safety systems.
- **ISO 50001:** Energy Management System

PDCA Cycle

Plan-Do-Check-Act refers to the continuous improvement cycle. PDCA is the most basic framework for any management system.

- **Plan:** Develop an action plan of the activities that need to be done together with all relevant implementation details.
- **Do:** Implement the action plan and the selected efficiency measures.
- **Check:** Monitor the results of the implementation via effective data analysis and assessments.
- **Act:** Review the effectiveness of the plan and set new targets.



Commonalities of Management Systems

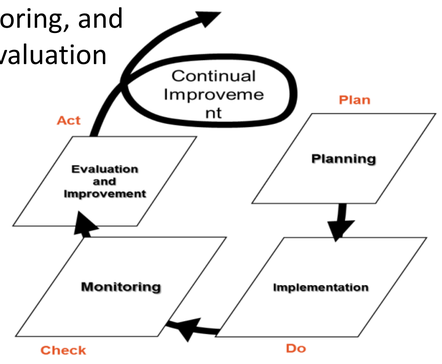
It can be demonstrated that all the management standards have common features in areas of:

- Need for defining objectives and policies
- Need for top management engagement and commitment.
- PDCA cycle approach for continuous improvement
- Need for training of human resources
- Need for monitoring and inspection

IMO SEEMP Framework

The SEEMP works through four steps:

- Planning,
- Implementation
- Monitoring, and
- Self-evaluation



SEEMP is:

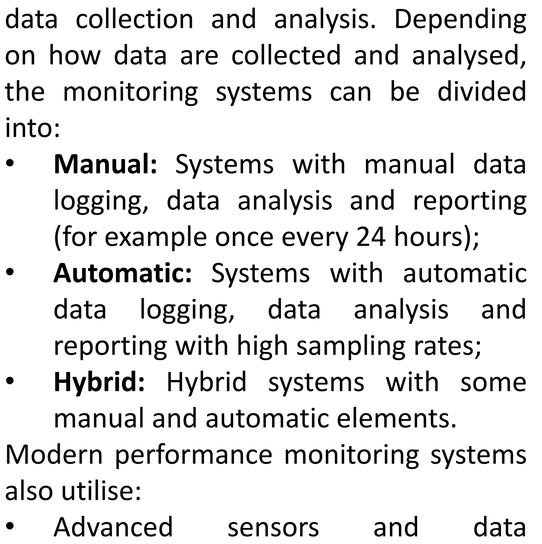
Ship-specific → Includes a number of EEM → Implementation oriented

Management commitment is the cornerstone of implementation of any management system including energy management plans and systems

ISO 50001 Energy Management

ISO 50001 is based on PDCA principle and the main aspects include:

- Energy policy
- Energy planning
- Implementation
- Checking
- Management review



Source: ISO 50001:2011

Company Energy Policy

A "company energy policy" sets the agenda for the corporate-wide energy saving and reduction of GHG emissions . Based on ISO 50001, it needs to be developed and endorsed by top management. The energy policy would deal, inter alia, with the following topics:

- Aims, objectives and targets
- A commitment to continual improvement
- A commitment to ensure the availability of resources to achieve objectives and targets;
- A commitment to comply with applicable legal and other requirements;
- A framework for setting and reviewing energy objectives and targets;
- A commitment to training staff and engaging major external stakeholders.
- Support for purchase of energy-efficient products / services

Commitment from the management at the highest level should be demonstrated via energy policy endorsement and its wide communication to staff at all levels.

Shipping Company Approach to Energy Management

Two tier approach:

- SEEMP for ship-level energy management according to IMO Guidelines
- CEnMS (Company Energy Management System) for fleet-level energy management based on ISO 50001.

A CEnMS needs to deal with both shore-based and ship-based energy efficiency aspects. In this approach, SEEMP will be a sub-set of the CEnMS. A CEnMS will thus be in harmony with ship-board SEEMP and vice a versa.

Other aspects of the CEnMS include:

- Energy policy development
- Planning for ships via development and improving SEEMPs across fleet.
- Planning the fleet-level energy management plan
- Gathering fleet data, monitoring and benchmarking
- Managing the investment on capital-intensive energy saving projects such as ship technology upgrades.
- Fleet-wide training of staff
- Coordination with all stakeholders such as ports, charterers, shipyards, etc.

Ship Energy Audit/Review

Development of a SEEMP based on IMO guidelines or a CEnMS based on ISO 50001 will involve planning activities. An energy audit or review is best for this purpose. Also, audits could be used for monitoring of SEEMP or CEnMS effectiveness. Depending on the area of application, the energy audit scope and objectives may be different.

A ship energy audit normally aims to identify a set of EEMs for implementation purposes. As part of the audit/review, all aspects of the ship including hull, propeller, engines, auxiliary machinery , voyage, route, trim, training, etc. will be assessed.

A ship energy audit/review may involve a number of phases.

- **Phase I** – Pre-survey activities such as preliminary data gathering and data reviews
- **Phase II** – Ship survey: The ship visit is planned and carried out by the auditor, facilitated by ship personnel
- **Phase III** – Analysis of data for the identified measures and reporting.

A shipping company energy review or audit will follow the same format but areas to be investigated will be different and the concentration will be on common high-level issues of the fleet.

Performance Monitoring

The scope of the company's performance monitoring activities could include any aspect of the fleet/ship including voyage analysis, hull and propeller condition, engines condition, auxiliary machinery utilisation and so on.

Performance monitoring invariably rely on data collection and analysis. Depending on how data are collected and analysed, the monitoring systems can be divided into:

- **Manual:** Systems with manual data logging, data analysis and reporting (for example once every 24 hours);
- **Automatic:** Systems with automatic data logging, data analysis and reporting with high sampling rates;
- **Hybrid:** Hybrid systems with some manual and automatic elements.

Modern performance monitoring systems also utilise:

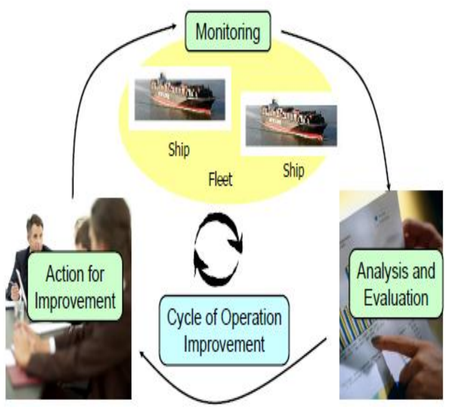
- Advanced sensors and data communication technologies;
- Ship-shore communication; and
- Big data analysis capability.

Hull performance monitoring

For hull performance monitoring, various techniques are used including:

- Assessment of ship speed-power curve relative to a baseline;
- Assessment of level of added resistance relative to a baseline;
- Use of divers to visually inspect the hull and propeller conditions.

In practice, a combination of the above methods will be most satisfactory.

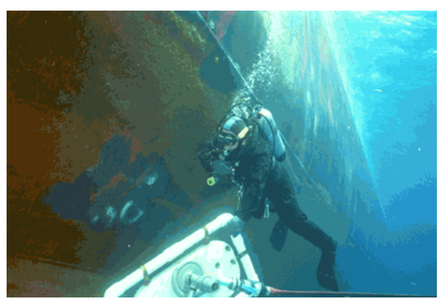


Engine Performance / Condition Monitoring

These systems are primarily based on analysis of cylinder pressure data. Cylinder pressure is measured and processed for:

- Maximum cylinder pressure
- Angle of this maximum
- Cylinder compression pressure
- Ignition angle – The angle at which combustion starts
- Indicated power as measured on top of the piston

In addition, current day systems collect other data such as engine brake power, scavenge pressure, turbocharger speed, fuel injection pressure diagram, etc. in support of the analysis.



Data Collection and Reporting

IMO data collection system is currently under development and advocates the collection of ships' fuel consumption and some other parameters.

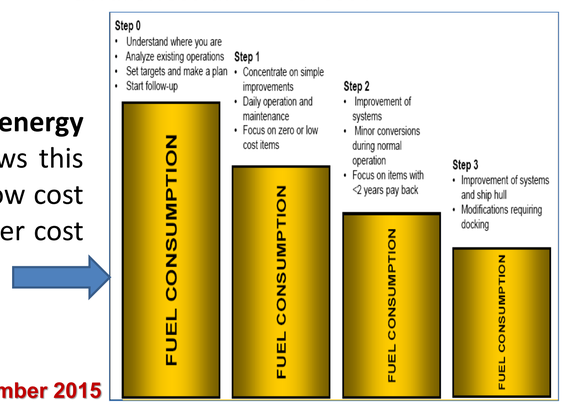
The system aims to have three main elements:

1. Data collection by ships
2. Flag State functions of data verification
3. Establishment of a centralised database at the IMO.

Although not final yet, some general agreement has been reached in areas of:

- Applicable to ships greater than 5000 GT.
- Annual reporting
- Use of the IMO number for ship identification
- Registered owner will be responsible for submission of data.
- Flag Administration will be responsible for data verification.

Step by step approach to energy management: Diagram shows this approach by starting from low cost measures to moving to higher cost ones.



How to Train or Incentivize Staff

Increasing awareness and incentives of staff are key to a successful energy management campaign. This may be done via a number of ways:

- Training either direct or through distance-learning, 'Computer Based Training (CBT)' programs
- Regular on-board meetings on the subject.
- Poster campaign and communication of energy policy.
- Collection of ship-level seafarers ideas, and their documentation and implementation.
- Develop competition for energy efficiency, e.g. between ships..
- Use of company magazine or other publicity documents for raising awareness and interest .

Marginal Abatement Cost Curves (MACC).

A simple and effective way of presenting the EEMs for a ship or a fleet is by plotting a MACC. A MACC can be developed through the following steps

- Step 1 – Identify EEMs and their energy saving levels.
- Step 2 – Calculate the cost of implementation of the EEMs.
- Step 3 - From fuel consumption , estimate annual CO2 reductions (X axis).
- Step 4 - From steps 2 and 3 calculate, the cost-effectiveness ($cost per tonne CO2 reduced) (Y-axis).
- Step 5 – Rank the EEMs from the lowest MAC to highest MAC.
- Step 6 – Plot the MACC using the measures according to their rank.