ENERGY EFFICIENT SHIP OPERATION

SHIP ENERGY EFFICIENCY REGULATIONS AND RELATED GUIDELINES

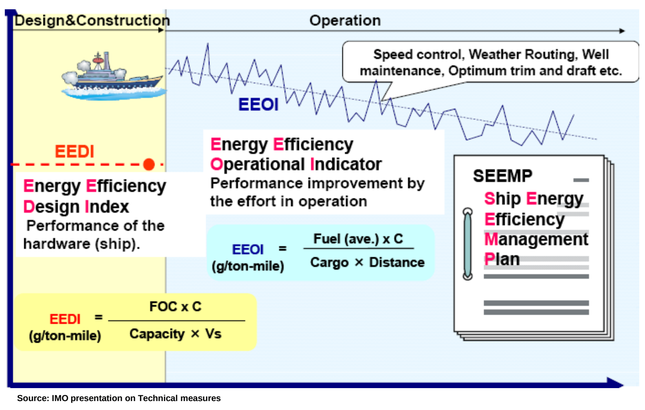
Chronology of IMO Regulatory Developments:

- **1997:** Started debate on GHG emissions from ships.
- **2000:** Carried out the first major study on GHG emissions from shipping.
- **2003:** IMO Assembly adopted resolution A.963(23) on relevant policies.
- **2005**: First draft of the EEOI published.
- **2009**: Drafts on voluntary use of EEDI, SEEMP and EEOI developed and circulated.
- **2009:** Second IMO GHG Study 2009 published.
- **2011:** Mandatory regulations for use of EEDI and SEEMP were adopted; to come into force in 2013.
- **2013:** Debate on further energy efficiency measures focussed on "IMO data collection system".
- **2014:** Third IMO GHG Study 2014 published.
- **2015:** Debate on "data collection" continued.

Chapter 4 of MARPOL Annex VI Regulations:

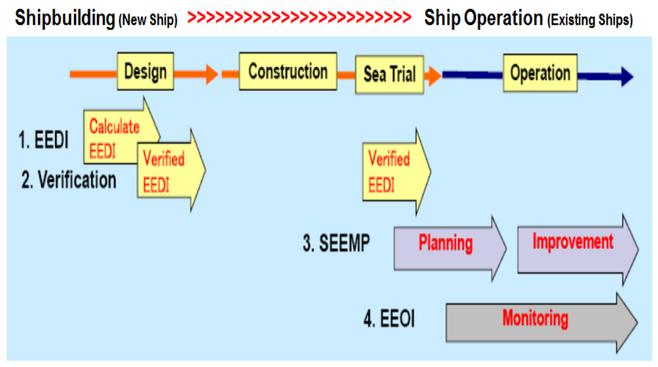
IMO MEPC in July 2011 adopted the following set of regulations as the first ever international energy efficiency standard of its kinds for ship:

- Regulation 19 - Application
- Regulation 20 - Attained EEDI
- Regulation 21 - Required EEDI
- Regulation 22 - SEEMP
- Regulation 23 - Promotion of technical co-operation and transfer of technology



Source: IMO presentation on Technical measures

Energy efficiency regulations for ships covers both ship design and ship operation as shown in the above and below figures



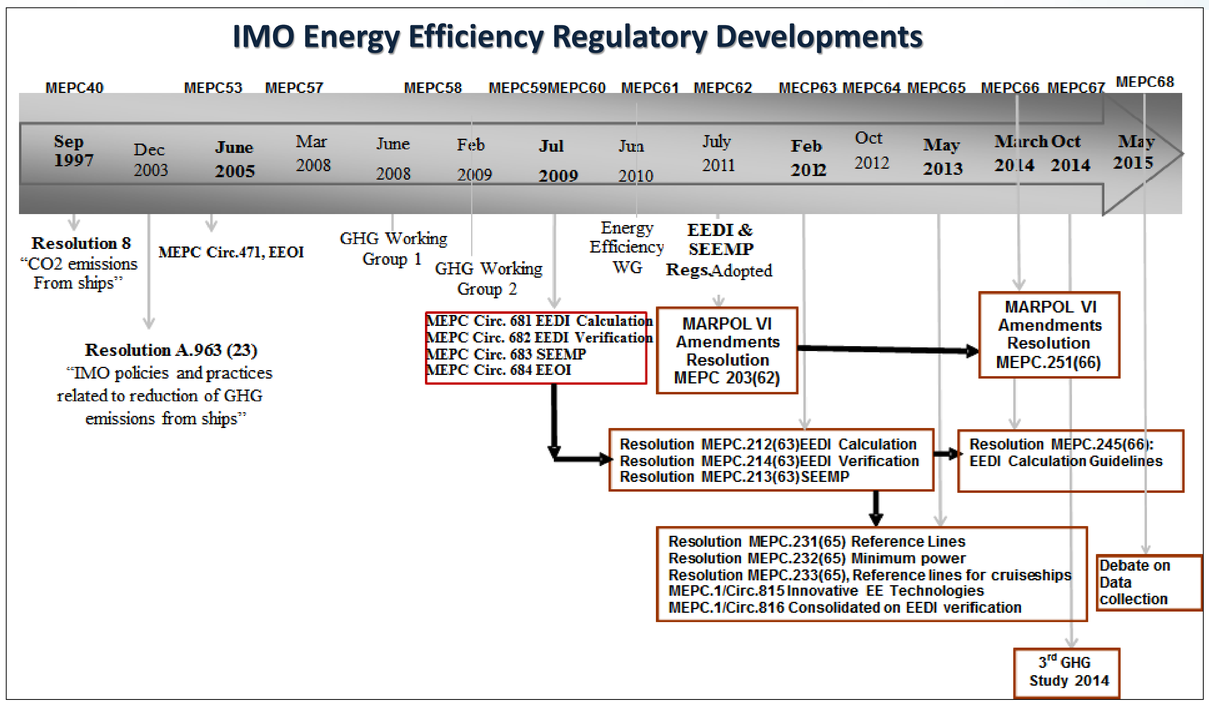
EEOI (Energy Efficiency Operational Indicator (EEOI) for Voluntary Use

EEOI is an IMO key performance indicator for measurement and monitoring of a ship's energy performance. It is calculated using the actual fuel consumption and actual distance travelled and actual cargo carried by the ship.

EEOI is calculated according to the following formula using the relevant IMO guidelines:

$$EEOI = \frac{\sum_j FC_j \times C_{Fj}}{m_{cargo} \times D}$$

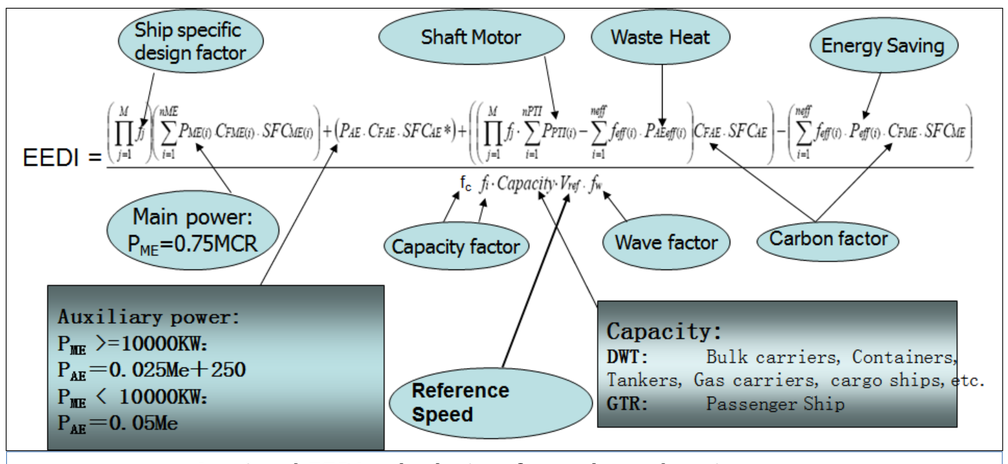
Where: ***j*** is the fuel type; ***i*** is the voyage number; FC_j is the mass of consumed fuel *j* at voyage *I;* C_{Fj} is the fuel mass to CO_2 mass conversion factor for fuel *j;* m_{cargo} is cargo mass (tonnes) or work done (number of TEU , passengers, etc.) depending on ship type; and ***D*** is the distance in nautical miles corresponding to the cargo carried.



Attained EEDI (Energy Efficiency Design Index)

According to Chapter 4 of MARPOL Annex VI:

- The attained EEDI shall be calculated for every applicable "new ship".
- The attained EEDI is calculated using the relevant guidelines developed by the IMO that fully describes the "attained EEDI calculation formula" as shown below.
- The attained EEDI shall be verified using the relevant guidelines developed by the IMO.



Attained EEDI calculation formula and main terms

Required EEDI

For the applicable ships, and based on Chapter 4 regulations, the following applies:

- **Attained EEDI ≤ Required EEDI** ; and
- Required EEDI = (1-X/100) * reference line value

Where

- X is the reduction factor
- "Reference line value" is estimated from EEDI Reference line.

SEEMP (Ship Energy Efficiency Management Plan)

Based on regulation 22 of MARPOL Annex VI:

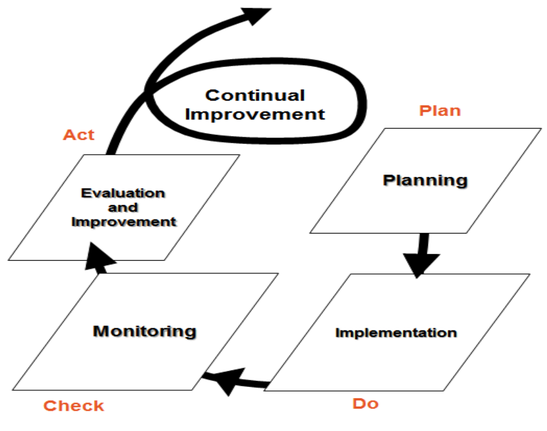
- Each ship shall keep on board a ship specific SEEMP. This may form part of the ship's Safety Management System (SMS)
- The SEEMP shall be developed taking into account guidelines adopted by the IMO.

SEEMP Framework

The SEEMP works according to the continuous improvement cycle and comprises four steps:

- Planning
- Implementation
- Monitoring
- Self-evaluation

Relevant IMO guidelines provides details of the above 4 step and how a SEEMP should be developed..



SEEMP framework

Ship Energy Efficiency Regulations: Related Guidelines (as at November 2015)

MEPC.245(66) and its amendments (MEPC.263(68)): 2014 Guidelines on the method of calculation of the attained EEDI for new ships.

MEPC.254(67) and its amendments (MEPC.261(68)): 2014 Guidelines on survey and certification of the EEDI.

MEPC.232(65) and its amendments (MEPC.255(67) and MEPC.262(68)): 2013 Interim guidelines for determining minimum propulsion power to maintain the manoeuvrability … in adverse conditions.

MEPC.233(65): 2013 guidelines for calculation of reference lines for …. for cruise passenger ships having non-conventional propulsion.

MEPC.231(65): 2013 Guidelines for calculation of reference lines for use with the EEDI.

MEPC.229(65): Promotion of technical co-operation and transfer of technology relating to ….. energy efficiency of ships.

MEPC.213(63): 2012 Guidelines for the development of a ship energy efficiency management plan (SEEMP).

MEPC.1/Circ.815: 2013 Guidance on … innovative energy efficiency technologies for calculation and verification of the attained EEDI.

MEPC.1/Circ.796: interim Guidelines for the calculation of the coefficient fw … in a representative sea condition for trial use.

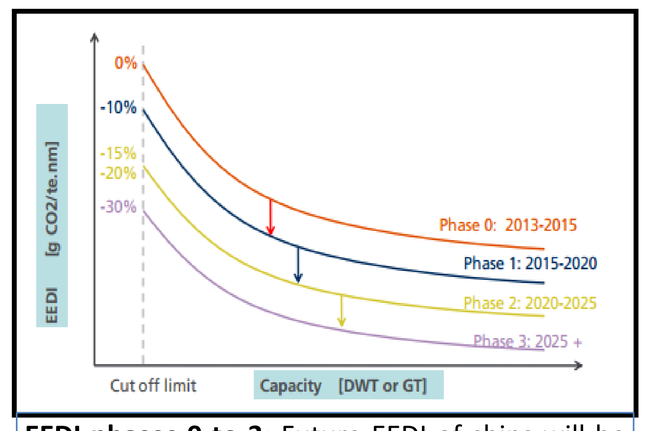
MEPC.1/Circ.684: Guidelines for voluntary use of the Ship Energy Efficiency Operational Indicator (EEOI).

International Energy Efficiency (IEE) Certificates for Ship

- An IEE Certificate must be issued to all applicable ships of 400 gross tonnage and above that are going to be engaged in voyages to ports or offshore terminals under the jurisdiction of other Parties.
- The IEE Certificate will be valid throughout the life of the ship unless there is a major conversion of the ship or a transfer of flag to another State.

Promotion of Technical Co-operation and Transfer of Technology

- MARPOL Annex VI regulation 23 specifies that all maritime Administrations, in co-operation with the IMO and other international bodies, should promote and provide support, especially to developing States.
- In particular, they should co-operate actively with other Parties to promote the development and transfer of technology and exchange of information to States which request technical assistance, particularly developing States, for implementation of energy efficiency regulations.



EEDI phases 0 to 3: Future EEDI of ships will be reduced via setting lower reduction factor (X), thus lower Required EEDI as shown above.

EEDI Condition

The EEDI needs to be calculated and verified for a specific ship condition. This is referred to as "EEDI Condition" and includes the following:

- **Draft:** Summer load line draft.
- **Capacity:** Deadweight (or gross tonnage for passenger ships) for the above draft (container ship will be 70% value).
- **Weather condition:** Calm with no wind and no waves.
- **Propulsion shaft power:** 75% of main engine MCR; with some provisions for shaft motor or shaft generator or shaft-limited power cases.
- **Reference speed :** is the ship speed under the above conditions

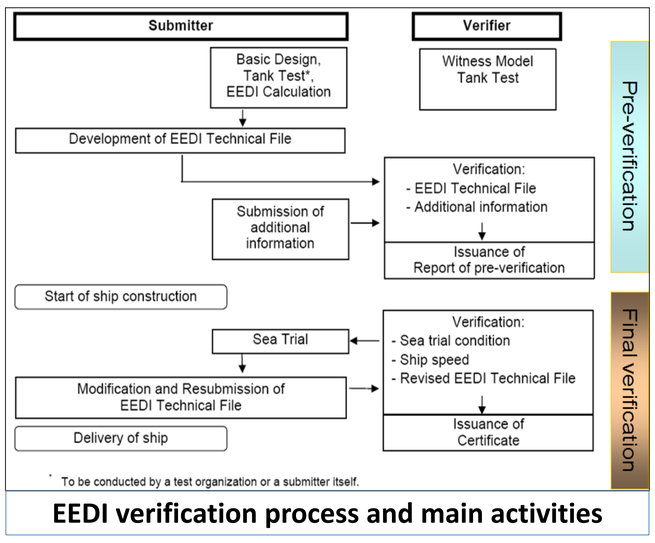
EEDI Verification Process

EEDI verification is performed in two stages:

- **Preliminary verification** at design stage; based on model tank test results.
- **Final verification** at the ship delivery; based on actual ship's speed trial data.

As part of the verification process:

- The ship's speed power curve needs to be developed using actual trial results, tank test data, speed trial data plus use of ISO 15016 standard for data correction.
- The calculations must be documented in an **EEDI Technical File** and submitted as part of the verification documents.
- Verifier is required to witness both tank test and sea trials.



EEDI verification process and main activities