Guidance on best practices for fuel efficient operation of ships

- Improved Voyage Planning: Different software tools for executing optimum voyage planning are now available for this purpose. The optimum route and improved efficiency can be achieved by careful planning and execution of the voyages. (For a deeper study, if so interested, you may refer to the IMO Resolution A. 893(21) on "Guidelines for voyage planning".
- Weather routing: This has a high potential for savings in fuel efficiency, on specific routes. It is commercially available for every ship type and for many trading areas. Significant savings can be achieved, true, but could also lead to increased fuel consumption for a given voyage.
- Just-in-time: Precise early communication with the next port in order to give maximum notice of berthing as may be available and facilitate the use of optimum speed so that utmost use could be made of the port operational procedures. All involved parties should consider the inclusion of efficiency measures in their operations, both individually and collectively. The port authorities ought to be encouraged to maximize efficiency and minimize delay in ship's operations.
- Speed optimization: This can be seen to be producing significant savings. Optimum speed, however, means, the speed at which the fuel used per tonne-mile is at the minimum level for that voyage. It does not imply that the speed is at a minimum. Sailing at less than the optimum speed will make the engine consume more fuel, rather than less. For this purpose, a reference should be made to the engine manufacturer's power / consumption curve and the ship's propeller curve. Of course, there could be other adverse effects for slower speed operations such as, increased vibrations and problems with soot deposits in combustion chambers and the exhaust systems, which need to be taken into account.
- Due account needs to be taken of the need to coordinate the arrival times with the ready availability of loading/ discharge berths. The number of ships plying in a particular trade route may be taken into account while considering speed optimizing. A gradual increase in speed while leaving a port, whilst keeping the engine load within certain limits, could help to reduce fuel consumption.
- While negotiating the terms of charter parties, charterers / operators need to encourage laying-down the condition that the ship is to operate at the optimum speed so that the energy efficiency could be maximized.
- Optimized shaft power: Operation at a constant shaft rpm can be more efficient than continuously having to adjust the speed, through the engine power. Automated engine management systems to control the speed rather than relying on having humans to interfere, may be more rewarding.
- Optimum trim: For most ships set trim conditions are specified, so that a designated amount of cargo at a certain speed for a certain fuel consumption, can be the laid down. Whether the ship is loaded or not, trim does have a significant influence on the resistance of the ship ploughing through the water. Optimizing the trim will minimize the resistance and in effect, give significant fuel savings. Some ships have the facility of assessing the optimum trim conditions for fuel efficiency continuously throughout the voyage.

- Optimum ballast: The ballast ought to be optimally adjusted(by referring to the Ballast Water Management Plan of the vessel for ascertaining the limits and conditions if any), by taking into consideration the need for complying with the optimum trim and the steering conditions for the ship. This is possible by adhering to good cargo planning practices. Ballast conditions have a good bit of impact on the steering conditions and the autopilot settings. After all you need to bear in mind that less ballast water does not necessarily imply the highest efficiency.
- Optimum Propeller and Propeller inflow considerations: Improvements in guiding the water in-flow to the propeller by way of fins and / or nozzles could increase the propulsive efficiency power and reduce the fuel consumption. It however ought to be borne in mind that the propeller plays a major role, though not the only role, in the propulsion train and a change in propeller in isolation may not have an effect on the fuel efficiency and, on the contrary lead to a rise in fuel consumption.
- Optimum use of rudder and heading control systems(auto-pilots): Better course control through less frequent and less frequent and smaller corrections will reduce the losses due to rudder resistance. An integrated Navigation and Command System can achieve good amount of fuel savings by reducing the distance veered out from the required track. Retrofitting of more efficient auto-pilots to the existing ships is indicative of adding to the fuel economy of the ship. However, during excessive maneuvering (i.e. say approaching ports), it is difficult to use the autopilot efficiently since, the rudder has to quickly respond to the bridge-commands. Besides, retro-fitting with "twist-flow" rudders (having improved rudder blade design) have also shown promising results with respect to increase of energy efficiency.
- Hull Maintenance: Docking of the vessel ought to be integrated with the ship operator's ongoing assessment of the ship's performance. Power lost in overcoming the ship's hull resistance can be overcome by new-technology (self-polishing coatings) coating systems, possibly in combination with cleaning intervals. Other steps to be taken for increasing fuel efficiency include, regular in-water inspection of the hull condition; propeller cleaning and polishing; removal and replacement of the underwater paint systems to avoid the increase of hull roughness. It may be remembered that smoother the hull, the better the fuel efficiency of the vessel
- Propulsion systems: The use of marine Diesel engines gives a high thermal efficiency, say about 50%, which can only be exceeded by fuel cell technology which, has an average 60% thermal efficiency on account of its systematic minimization of heat and mechanical loss. The latest intelligent marine Diesel-engines do also provide a rise in energy efficiency. Staff operating these engines would however require training for getting optimum returns out of these propulsion systems. Maintenance of the propulsion system as per the manufacturer's instructions as incorporated in the company's planned maintenance schedule, will also contribute towards maintaining the efficiency. Additional means to improve the engine efficiency may include, use of fuel additives; adjustment of cylinder lubrication oil consumption; valve improvements; torque analysis and automated engine monitoring systems

- Waste heat recovery: Waste heat recovery systems use the thermal heat losses from the exhaust gas for either electricity generation or additional propulsion with a shaft motor. Shipbuilders ought to be encouraged to use new technology into their designs.
- Improved fleet management: Better fleet planning will help in more fruitful utilization of fleet capacity. As an example, if the fleet utilization can be scheduled properly, the wastage incurred in having to undertake long ballast voyages can be reduced to a minimum. Charterers can promote efficiency accordingly by making use of such advanced planning. This can be related to the philosophy of "just in time" arrival.
- Improved Cargo Handling: Efficiency of cargo handling has a direct bearing on minimum port stays and thereby optimum usage of the ship, which yields greater fuel efficiency. Since cargo handling is in the control of ports and stevedores, necessary coordination with them helps in smoother cargo operations vis-a-vis the overall operation of the vessel.
- Miscellaneous Energy Management: An assessment of the electrical appliances on board can identify the source for gains in fuel efficiency. Thermal insulation is a means of saving energy. In some ports, shore-power may be available for specific types of ships, which help in improving the air-quality in the port area. If the shore-power is carbon efficient, it gives net fuel efficiency benefits. Therefore, ships need to utilize shore power as far as practicable, while alongside.
- Fuel Quality: Using of contemporary alternative fuels may be favorably considered as a CO_2-emission reduction method. However, readiness of availability of such fuels will govern the extent of their usage.
- Miscellaneous measures : (i) Efforts are to be made for using fuels of improved quality so that the amount of fuel required to provide a specified power output is reduced; (ii) Wind assisted propulsion is also suitable for consideration; (iii) Other renewable energy-sources such as solar(or photo voltaic) cell technology has improved over the years, may be contemplated for on-board usage as feasible; (iv) A computer software may be developed for precise calculation of fuel consumption and the establishment of emissions footprints. This will help to optimize the ship-operations and in effect will enable the setting of goals for improvement of fuel efficiency and tracking of the progress made in that aspect.
- Compatibility measures: Practices used for ship operations, ought to be area and trade dependent and, likely to require the agreement and support of a number of stakeholders if they are to be utilized most effectively.
- Age and operational service life of a ship: All the measures mentioned under this guidance of best practices are meant to be cost-effective, particularly considering the high oil prices. Under the circumstances, measures considered earlier as unaffordable or commercially unattractive, may now be feasible and worthy of fresh consideration. In considering these measures, the remaining service life of the ship and the extrapolated price of fuel, if possible, need to be factored.
- Trade and sailing area: The guidance given in the foregoing is very likely to be dependent on the trade and sailing area of the vessel, which in turn could depend on the vessel's charterer's requirements. An example is the

unsuitability of wind-enhanced power-sources, for use in the case of short-sea shipping, which generally sail in areas with high traffic densities or in restricted waters. Another aspect is that the oceans of the world and seas, each have their individual characteristics. Therefore, ships designed for particular routes and trades may not obtain identical benefits by adopting the same measures. It may also be possible that some measures will have a greater or lesser effect in different sailing areas.

- The trade a ship is engaged in, may determine the feasibility of invoking the efficiency measures under consideration. As an example, conventional cargo carriers may choose different method(s) for improving the energy-efficiency as compared to those related to OSVs or seismic survey vessels or dredgers etc. The length of the voyage, along with, the relevant trade-specific safety precautions, are of importance. The pathway to the most efficient combination of measures will be unique to each vessel, and ought to be within the reach of the shipping company.

Machinery Operational Optimizations

- Main Engine to be maintained as per manufacturer's instructions in the PMS schedule. Condition monitoring of the main engine performance is a very important tool to maintain high efficiency.
- Controlled reduction in the consumption of specified cylinder oils (assuming the availability of a variable cylinder oil injection system for the engine) in accordance with the maker's instructions for the applicable fuel quality and sulfur content, will result in cost savings, cleaner engines and some reduction in emissions.
- Using a better quality / higher grade of fuel can lead to an improvement in engine efficiency and prevent degradation. The bunker-fuel manufacturers, in pursuit of reducing the levels of sulfur in the bunker fuel, are required to use catalytic fines which are small, highly abrasive particles. These need to be guarded against. Optimum usage of heavy fuel oil and lubrication oil purifiers do reduce wear in the Diesel engines. The most economical amount of bunker may be carried on board. At any cost, mixing of fuels which may not be compatible with each other, should be allowed on board. Such wrong mixing practices may lead to clogged filters and even engine shut down. Fuel bunkered earlier, should as well be consumed earlier, so that dropping-out of the solids in the fuel leading to clogged filters is avoidable.
- Fuel oil additives in some cases improve the combustion characteristics, over all engine performance and the efficiency, as per the manufacturer's advice.
- Installation of a speed / power control unit for the engine room fans or / and pumps is liable to reduce the electrical energy demand, particularly when these units are not required to be operated at their full speed rating.
- Non-essential machinery and equipment not affecting daily safety must be stopped whilst the vessel is in port and at sea, to reduce the load on the generators.
- Short-cycling of the main air-compressors should be avoided by reducing the leakages of compressed air in deck and in the engine room. This will not only

reduce the load on the generators, but also bring down the maintenance costs of the air- compressor.

- Since malfunctioning steam-traps can cause big energy losses, these need to be maintained properly.
- Steam leakages are to be rectified
- Composite boilers may be used during anchorages and such other opportunities. Starting of the auxiliary boilers much in advance of their actual needs, must be avoided.
- Practice of steam-dumping should be brought down to a minimum.
- Steam tracing may be used, but prudently.
- Bunker tank heating may be optimized
- All lagging of valves / pipes are to be duly maintained to minimize energy loss.
- Exhaust gas economizers are to be properly soot-blown so that their efficiencies can be maintained. Besides improving the energy efficiency, this also leads to prevention of exhaust gas boiler fires. Cleanliness of the economizers can be monitored by measuring the exhaust gas temperature difference and the pressure-drop across the economizers. Water-washing should be scheduled during major repairs.
- While draining of fuel oil tanks, only water is to be drained out and not the fuel.
- Fuel oil combustion equipment (say, injectors) is to be maintained in proper condition.
- Number of Engine room ventilator fans running needs to be regulated, especially during the cooler atmospheres.
- In ports / anchorages, temperatures of the main engine jacket water / bunker tanks / fuel oil of main engine needs to be regulated so that the load on the composite boiler sufficiently low.
- Ballast pumps, fire pumps etc. should not be run unnecessarily from sea to sea. After "finished with main engines", lubricating oil pump, camshaft lubricating oil pump etc. should be shut-off after some time.
- Fresh water hydrophore tanks are to be properly charged to prevent cutting-in / cutting-out of the hydrophore pumps.
- Correct amount of the draft-air for the combustion demand should be ensured so that the thermal efficiency of the oil-fired boilers is improved. Too much air, as you know, will cool the boiler and bring down the thermal efficiency.
- Power supply for the mooring winches and windlass is to be switched off from the engine room when not in use. Hydraulic motors should not be run, unless required. Hydraulic leakages must be rectified to ensure efficient functioning of the equipment.
- On oil tankers, if the sensing / sampling lines are not clear, obstructions by way of dirt / condensation in the lines prevent free flow of the sample to the analyzer which shall be truly representative of the atmosphere to be monitored (e.g. the inert gas flowing to the cargo tanks). This is liable to cause fuel wastage as the operating engineers may increase the load on the boiler to produce better O_2.
- For oil tankers, if loading is in operation, the ballast pump is required to run for de-ballasting of the tanks. If the steam-turbine driven ballast pump is running, the auxiliary boiler must be required to run. If the auxiliary boiler is

run, there will be fuel oil consumption. Therefore, if the ballast pump is not required to run, running the auxiliary boiler, will lead to unnecessary fuel oil loss. Therefore, whether the ballast pump needs to be run or not, is possible to be known only if there is good interaction between the departments.