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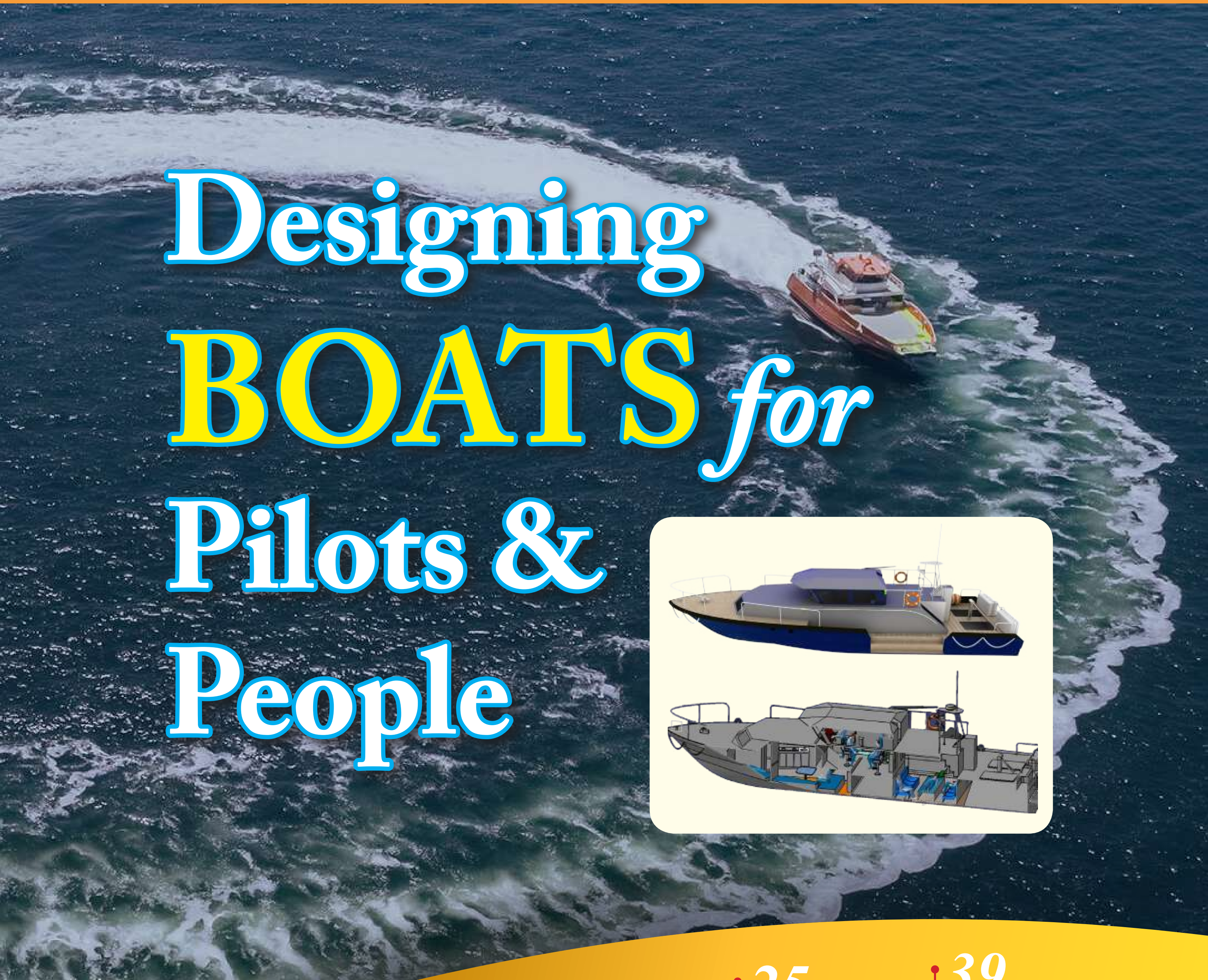

Designing BOATS *for* Pilots & People

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15. Adoption of advanced technologies – Digitalization and Autonomous ships.
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26. Emerging Materials and Marine Coating Technologies
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28. Advanced marine propulsion systems
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- The time allotted for each paper presentation is about 20 mts.
- All selected papers will be printed in the souvenir and also likely to be published in Marine Engineers Review journal.
- Last date for receiving papers is 1st Nov.2025
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- The approved papers which cannot be presented in Seminar will be published in the souvenir.

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Theme

Maritime India-Innovations & Collaboration

Date

29-30 JANUARY 2026

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The Institute of Marine Engineers is a premier body of marine engineering professionals of India. We have more than 13,000 members, many of the serving in India and overseas in key positions. The head quarters is in Mumbai and eight branches function at different locations in India. The Institute actively provides facilities to enhance knowledge of the members and extends a wide range of services encompassing from professional growth to welfare of members. The objectives of IMEI are to promote the scientific development of Marine Engineering, enable marine engineers to exchange ideas and information. To uphold the status of Members, to co-operate with other institutions, Classification societies and industry and the furtherance of education in engineering.

About the COMARSEM 2026

COMARSEM, **CO**chin **MAR**ine **SEM**inar is periodically conducted by the Kochi Branch of The Institute of Marine Engineers India. COMARSEM-26 is an international seminar being organized in January 2026. This mega event will bring eminent stake holders from various fields of maritime industry under one umbrella in National & International level. This event will host panel discussions, technical presentations, and interactive sessions on the theme "**Maritime India – Innovations and Collaborations**" and deliberate on the progress of Indian maritime industry and explore the possibilities of adopting suitable strategies to fulfil our dream of becoming one of the Maritime Superpowers. The event will feature, focused panel discussions, addressing key themes such as establishing a superior technology baseline, involving non-traditional stakeholders, accelerating greener technology adoption, innovative training methodologies and establishment of maritime cluster to cop up with the emerging challenges indigenously. These discussions will foster cross-industry collaboration, drawing insights from both Indian and international stakeholders, while exploring the financial and technological pathways required to achieve these ambitious targets.

India's Maritime Strength and Advantages .

1. India with a coastline of approximately 7517 km, is strategically located on the world's shipping routes.
2. Being a part of the world's busiest trade route elevates the economic prominence of India's maritime sector. About 95% of India's foreign trade and 70% of its total trade in terms of value takes place through seaways.
3. India is home to 12 major ports, over 200 other ports, 30 shipyards and a comprehensive hub of diverse maritime service providers.
4. India has one of the largest merchant shipping fleets among the developing countries and is ranked 20th in the world.
5. During the last financial year, the country's major ports have demonstrated substantial enhancements in their crucial operational metrics. They have efficiently managed increased cargo volumes and expedited loading and unloading processes, resulting in quicker ship turnaround times.
6. India's maritime sector is poised for a significant transformation following the unveiling of a comprehensive roadmap at last year's Global Maritime India Summit organised by Ministry of Ports, Shipping & Waterways with FICCI as the Industry partner.
7. The substantial potential of the maritime sector can serve as a crucial driver in propelling the economic trajectory towards achieving a self- reliant India by 2047.
8. The Amrit Kaal Vision 2047, outlined by the Ministry of Ports, Shipping & Waterways, expands upon the objectives set forth in the Maritime India Vision 2030. It strives to elevate ports to global standards while advancing inland water transport & coastal shipping and fostering sustainable practices within the maritime sector.
9. The percentage of Indian seafarers in the global shipping industry is expected to rise to 20% within the next ten years

Areas of Interest

1. Promote Domestic Ship Building, Repair & Recycling
2. Enhance India's Global Stature & Maritime Cooperation
3. Lead the World in Safe, Sustainable & Green Maritime Sector
4. Become Top Seafaring Nation with World Class Education,Research & Training.
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EDITORIAL

No man ever steps in the same river twice, for it's not the same river and he's not the same man.

- Heraclitus

The month gone by had flash floods and many marine news flashes for the future. The first 'high-five' can be for the five Bills which passed through the Parliament during the monsoon session: The Merchant Shipping Act (MSA); Indian Ports Act (IPA); Coastal Shipping Act (CSA); Carriage of Goods by Sea Bill (CGSB) and Bills of Lading Act (BL). The last three went through after the Presidential assent. These Bills reflect the needs of the times… the mood to ring in the changes… the posturing towards progress. The objectives are manifold.

The MSA focus: boosting national tonnage, alignment with international conventions, environment protection and safety, expanding ship-ownership, enabling registration of chartered vessels in India etc. The IPA's thrust is on ports based development. Data based decision making, MSW (Maritime Single Window), waste management and coastal state empowerment are some of the features this Bill will address.

The CSA has takeaways in the form of exemption to Indian vessels from registration, a strategic plan for inland/coastal shipping, simplified laws etc. The CGSB sheds the garb of archaic laws and adopts internationally relevant and accepted forms (Hague-Visby needs a mention). The BLA brings the much needed freshness to the ways of doing shipping business.

In the long run strengthening self-reliance (and lesser dependence on foreign ships), quality seafarer training (and increasing employment scope), lowering logistics costs, swifter dispute resolutions, growth of coastal states, transparency etc., are some benefits to be netted.

Another event worth a mention is the Mar-a-thon inaugurated at IIT Madras and the consent signing for establishment of Maritime Innovation Hubs. The Mar-a-thon will be open to prospective entrepreneurs and others to ponder on about 40+ problem statements hosted on the site. When the consent turns into understanding and plans, an exclusive maritime start-up ambience will be a part of IMU* ecosystem in near times to come.

With the maritime visons for 2030, 2047 and Atmanirbhar, the maritime stakeholders will find changing habits and practices. Neither the men, nor the seas will be the same.

IMU* Indian Maritime University

In this issue

We start with an absorbing design discussion. Prabu Duplex presents the set of considerations and specifications for a Pilot Boat. The article starts with descriptions and moves on to the technical details for the design. The takeaway is the deliberation on the 'Design Spiral' by J.H. Evans. The very brief 'critique' on the Spiral ends with a proposal for adopting a 'Systems Engineering' approach leaving the reader wanting more. This is an interesting, easily understandable article for marine engineers as well Naval Architects.

We have a few readers (from the experienced stock) who have shown interest in the insurance and legal side of shipping and operations. MER had carried a number of discussions swerving away from the core ME topics. Considering the relevance of cyber security and having access to a latest study (thanks to Ms. Mody), we have hosted the discussion of GNSS/GPS.

The Global Satellite Navigation System [GNSS] involves an array of satellites to basically provide data on position and time (on the earth, of course). This is a more encompassing system as compared with the Global Positioning System [GPS] though both are somewhat similar in purpose and way of functioning.

This discussion is on the chance of possible spoofing (falsified data from cyber security perspective) of these and the responsibility and the liability arising from such spoofing. Possible harm: The navigator, depending on this 'spoofed' data (vessel's actual position is different from the position provided) might cause a grounding etc. The summary is based on this scenario and the insurance claim that might arise. The discussion converges on the 'burden of proving harmful intent'. This is some different food for thought for the engineers.

The next one is a photo essay on expeditions to Antarctica. This is pulled out from the many articles we had collected for the special issue on the polar regions. Dr. Elango takes us through the voyage to the Antarctica and the Indian presence in those regions. The description and the photos of Dakshin Gangotri, Maitri and Bharathi are delectable. The takeaways: Ozone hole disappearance and the Aural displays. This is an easily digestible read and sight.

The MER Archives from September 1985 has an article of relevance to modern times on crane automation and one thought provoking Transaction on closed cycle Diesel engines.

Here is the September 2025 issue for your reading pleasure.

Dr Rajoo Balaji
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Approaches to a Pilot Boat Design

Prabu Duplex

1. Abstract

Pilot service is the logistic activity provided to ships to facilitate the entry and exit in a specific port, which are knowledgeable about the area and the manoeuvres to be performed. Where there is a high maritime traffic of merchant ships, which require a pilot service for entry and exit to the port, this service must be accompanied by a means to mobilise the pilot to the point of boarding the ship, serving as a logistical transport necessary to fulfil a role of comprehensive maritime security for the assistance of these ships that require the service to enter the port. Therefore, every port has the need to have its own design for this type of vessel complying with all national and international regulations established. This work presents structural design, stability calculations, propulsion design and general layout performed for a pilot transfer vessel.

2. Introduction

The focus is on designing a purpose-built vessel for transporting pilots and other personnel. It emphasises the crucial role of transportation in enabling pilots to move efficiently from the port, where they board ships etc. Designing these vessels involves analyses of variables to match the mission and required functions.

The study specifically examines the design of a pilot boat, capable of reaching designated speed requirements. The required draft conditions influence the hull shapes, ensuring they meet all operational requirements for the vessel's mission. The design is of aluminium construction. It features reinforced sides, an enclosed main deck, and an enclosed wheelhouse. This established crew concept has been in reliable service for years globally. This vessel is expected to be utilised extensively for transporting pilots and personnel, averaging 4,000 operational hours per year. Various pilot boats worldwide are studied a priori from the Significant Small Ships journal, which share similar primary dimensional characteristics of the pilot boat being designed.

3. General arrangement

3.1 Main particulars

Key particulars of the boat under design are shown in the Table 1. It is defined based on the project requirements. The general arrangement and seating layout is shown in the **Figures 1 and 2.**

Table 1: Key particulars

Length over all (LOA)	16.5 m
Draft	0.875 m
Breadth over all	5 m
Depth	1.6 m
Displacement	33.99 tons
Speed range	20-25 knots
Load	10 pilots + 2 crews
Range of navigation	48 hours at operating speed

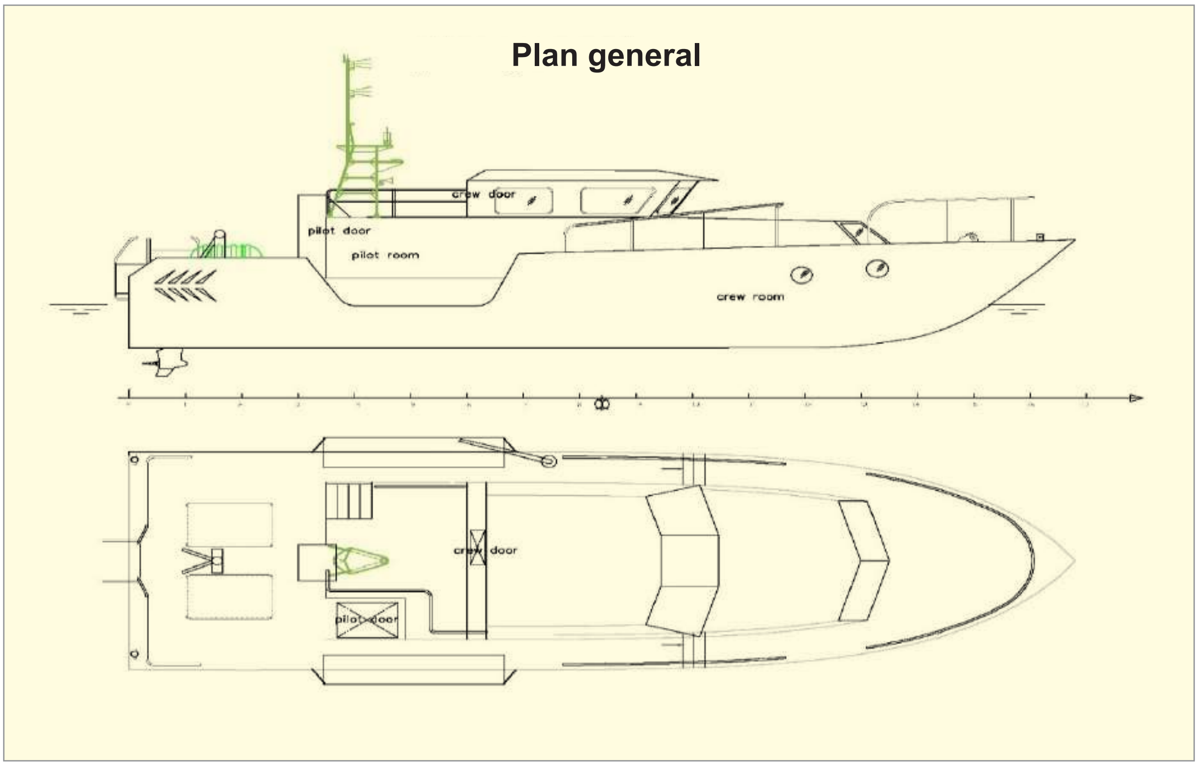

Figure 1: Plan general

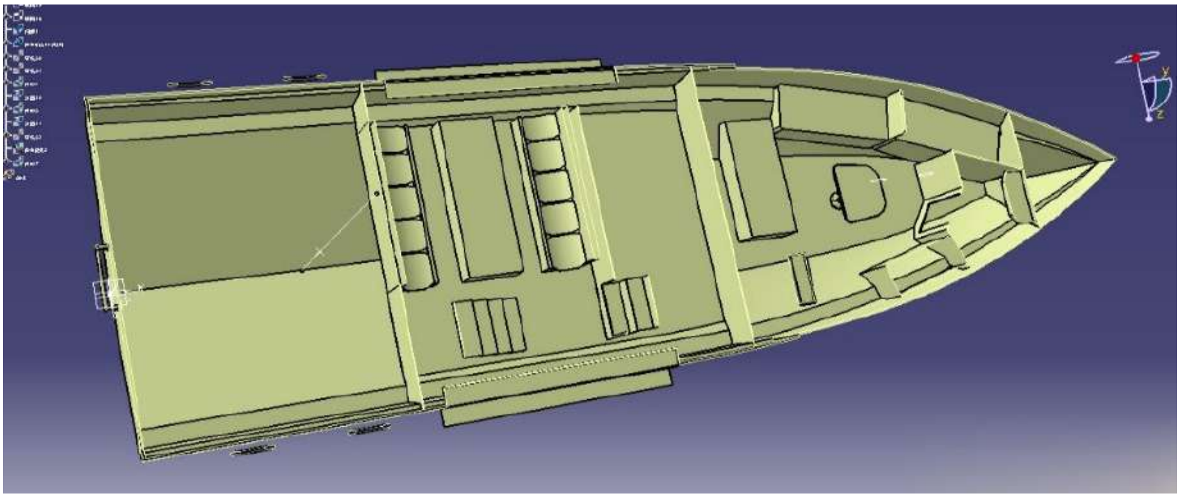

Figure 2: Seating layout

3.2 Arrangement of hull and superstructure

3.2.1 General

This boat has 4 watertight bulkheads, dividing the ship into 5 spaces from the stern to bow as engine room, saloon pilot, tool room, workshop and forepeak.

3.2.2 Sections arrangement

Section1-3.5: There are 2 storage boxes, 2 hatch covers, 1 access to go into and come from the sea with a handrail in case of rescuing some persons and a water tap for washing in the deck.

Section 3.5-6: There is a salon pilot and a door is provided in the starboard to go into the salon by 2 stairs and to go into deck and navigation Bridge. A door in the salon joins the engine room. There are 8 chairs for pilots and a table. There are 4 portholes with a first aid kit. The oil tanks are located below the salon.

Section6-9.5: There is a tool room and a navigation bridge. The tool room is located below the navigation Bridge, for general maintenance. A door is provided to go into the tool room beside the stair joining the salon and navigation bridge. In the navigation room there are 3 stairs, to go into the upper deck, salon pilot, and workshop respectively.

Section 9.5-13.5: There is a workshop, living room, cooking place and toilet. In the workshop there are 4 chairs, 4 cabinets, and a table. 2 portholes are there in each side of hull. Two beds are in the living room; the

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upper one is a collapsible bed. There are armoire and television provided in the living room and 1 porthole in the hull and 2 big portholes in the superstructure. In washing room, a hand basin, stool and sprinkler heads for shower are provided. In cooking place there are 2 electric fireplaces and 1 refrigerator.

Section13.5-17: There is a forepeak and chain locker room.1 hatch cover is there in the deck.

There are handrails on all the decks. Handrails are provided in the superstructure also for safety. On the side of boat there are rubber fenders.

3.2.3 Mooring arrangement

8 bollards, 2 Mooring line and a mooring winch constitutes the mooring arrangement. 1 windlass, 1 mooring winch and 2 anchor throwing appliance are there in the forepeak with a 60 m anchor chain.

3.2.4 Lifesaving and firefighting equipment

There are 2 life buoys with 30 m lifeline in each side of superstructure handrail. 13 life jackets, 11 life jackets in the bridge house and 2 in the storage boxes back the deck respectively. 5 parachute signals, 8 red pyrotechnic signals and 2 orange pyrotechnic signals are also available.

5 portable fire extinguishers are available and located as follows:1 in engine room, 1 in salon pilot, 1 in living room, 1 in navigation room and 1 in anchor room. 1 automatic fire extinguishing system is exclusively provided in the engine room.

3.3. Arrangement in engine room:

This boat is twin stern ship and engine room is 3.5m long. There are two hatches in the back of deck and a door in pilot saloon to access the engine room. The key engine room layout comprises of the following: 2 Main engine, 2 Gear box, 1 Generator, 1 AC Bilge Pump, 1 Main cooling sea water pump, 1 Fresh water pump, 2 Engine-room fan, 1 sludge pump, 2 sets of storage battery, 4 fixed fire extinguishers and 1 hand hose extinguishing system.

3.4 Ship system arrangement

3.4.1. Ventilation system

There are two ventilators in front of the engine room, outlet is behind the engine room. There is a centralised air-conditioned system, and an exhaust fan is available in washing room.

3.4.2. Sewage system

There is a sewage tank (500 litres) in the bottom of section10-12. An electric pump can both drain away sewage water outside of boat or draining into sewage tank. An auxiliary manual pump beside it can be used in case of maintenance. There is shore connection from dewatering tank through starboard in deck.

3.4.3. Fresh water system

Fresh water tank (500 litres) is in section 12-14 with a freshwater pump.

3.4.4. Air conditioning system

A centralised air-conditioning system is there in this boat. Cooled air goes through air duct and grating to navigation room, salon and cabinet.

3.5. Marine electrical arrangement

The 3-phase generator’s key specifications: Caterpillar marine generator setC12 Acert compact; 30KW at 1500 RPM, 50 Hertz AC.

3.5.2. DC power supply system

There are 2 groups of storage batteries (DC 24V /200AH), and separate sets for starting main engine. Inverter rating is 2000 VA with output voltage of 24 V. Two Series 3 Parallelly connected Individual batteries are of 200 AH capacity. It has 18 Hours back up time for lighting and navigation equipment.

3.6 Shore power system

There is an AC shore power socket in ship to receive the connection from the shore and is in the main deck.

3.7 Navigation

3.7.1 Illumination and windscreen wiper.

All the rooms have illumination and 2 windscreen wipers in the window of navigation bridge.

3.7.2 Communication, navigation, signalling equipment

Two VHF intercom in the boat, this antenna is fixed in the radar stand. Frequency is of 156 162 MHZ**.** A Ritchie F-50 magnetic compass, rudder angle indicator and a navigator (including electronic chart, GPS and sounding) is provided. A waterproof telescope is also available in ship. A starboard light and a port side light is fixed on both side of superstructure. There is a riding light and a truck light on radar stand. In front of deck there is a spotlight. A flag is on the radar stand.

4. Structural design

The boat is designed to have continuous main deck, forecastle and poop. A structural analysis (rule based) is required to ensure the vessel could withstand anticipated loading conditions. Calculations are done according to rule Bureau Veritas standard (BV chapter 12). The structure is traversal. Aluminium alloy AA5083 H321, is chosen as is highly favoured in marine applications for its excellent resistance to intergranular corrosion in seawater. The chosen material has a yield stress of 228 Mpa, tensile stress, 317 Mpa, Young's modulus 70.3 Gpa, density 2.66 g/cm3 and Poisson's coefficient 0.3. Bureau Veritas design rules offer guidance to determine the minimum thickness required for each structural component based on local and global loads. Bottom structure, side structure, deck structure and transverse and longitudinal bulkhead structure are designed accordingly. The scantling of plates, primary, and secondary reinforcements chosen based on the design rules is shown in the **Figure 3.**

5. Weight estimation

After the scantling design, deadweight and lightship estimations are done as a prerequisite to hydrostatic analysis. The resultant centre of gravity (COG) is shown in the Table 2. The lightship refers to the total weight of the vessel once construction is complete and it is ready to sail, excluding cargo, passengers, stores, consumables, and crew; but including fluids in equipment and piping.

The remaining weight constitutes the deadweight, which is the difference between the displacement at a specific load line or draft and the displacement of the vessel in lightship condition. In the deadweight calculations, Marine Diesel Oil (MDO) fuel weight and volume are included along with lubricants and crew weight. This collective sum yields the deadweight which subsequently determines the displacement at a specific draft.

To calculate the fuel weight, data from an existing vessel where the main engine power of 455 kW and specific fuel consumption of 175.63 g/kW-h, with an autonomy of 200 nautical miles operating at 85% of Maximum Continuous Rating (MCR), as specified plus a 15% margin is chosen. The calculation for fresh water for the cooling system of onboard equipment is initially set at 100 litres. For provisions, a daily consumption rate of 5 kg per person is chosen. Given that the vessel will not operate more than two days away from port, a total weight of 80 kg per person is estimated for the 10 pilots and 2 crew members.

"The lightship refers to the total weight of the vessel once construction is complete and it is ready to sail, excluding cargo, passengers, stores, consumables, and crew; but including fluids in equipment and piping"

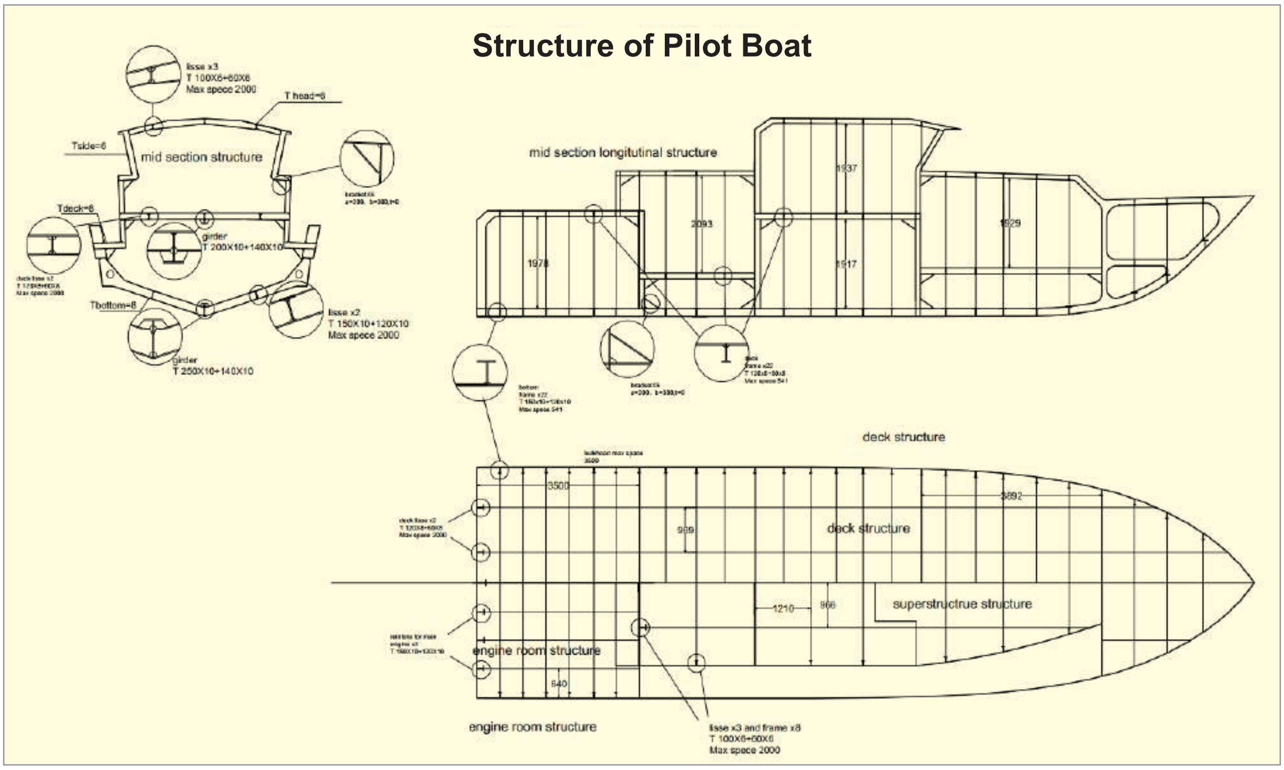

Figure 3: Pilot boat structure

Table 2: COG calculations

Weight	Units (kg)	Global centre of gravity (x, y, z coordinates in m)		
Lightship	27430.76	6.27885094	0.00379136	1.08020633
Dead weight	33900.00	6.5562352	0.00308754	0.9833249

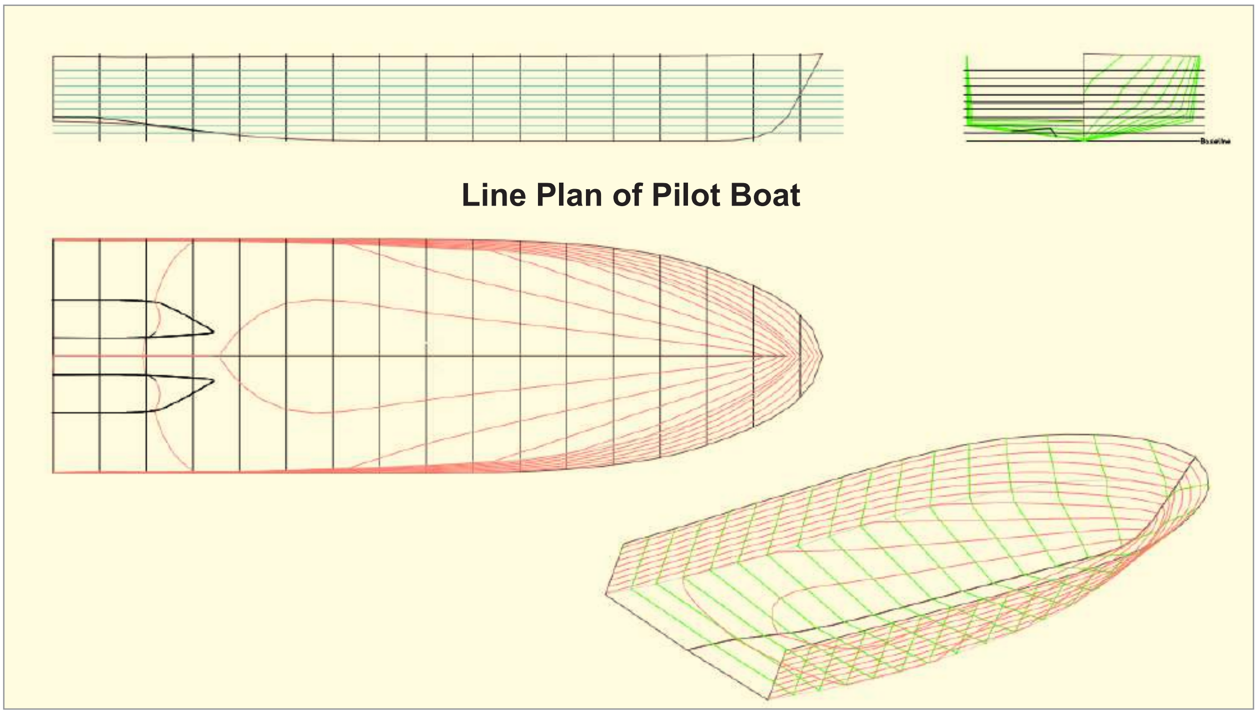

Figure 4: Lines plan

In the deadweight calculations, Marine Diesel Oil (MDO) fuel weight and volume are included along with lubricants and crew weight. Given that the vessel will not operate more than two days away from port, a total weight of 80 kg per person is estimated for the 10 pilots and 2 crew members

6. Forms and stability analysis

The shape generation defines the geometric model, adhering to form coefficients and shapes derived from the sizing process. The Maxsurf Modeller program is utilised to adjust the shapes. A parametric transformation is employed to achieve the specified and defined dimensions, based on selecting a hull that meets the required criteria. **Figure 4** illustrates the characteristic shape typical of fast vessels known for their favourable seakeeping qualities. This includes a mirrored stern and a forward body that occupies more than half of the vessel's length, with minimal aft body presence.

The hydrostatic characteristics are also evaluated in Maxsurf. Stability analysis included assessing the vessel's self-righting capability and static behaviour at sea. The hydrostatic analysis results for 100 % load case are shown in the **Figures 5 and 6.** As shown, it has complied with key SOLAS requirements.

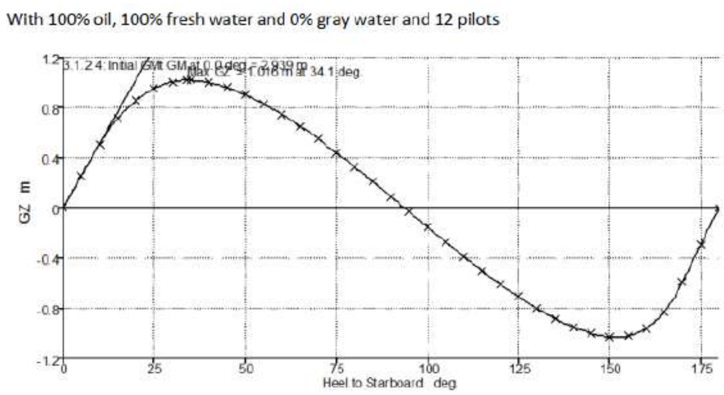

Figure 5: Case 1

	Criteria	Value	Units	Actual	Status
1	Area 0 to 30				Pass
	shall not be less than (>=)	3.151	m.deg	19.020	Pass
2	Area 30 to 40				Pass
	shall not be less than (>=)	1.719	m.deg	10.108	Pass
3	Max GZ at 30 or greater				Pass
	shall not be less than (>=)	0.200	m	1.016	Pass
4	3Initial GMt				Pass
	shall not be less than (>=)	0.150	m	2.939	Pass
5	Angle of maximum GZ				Pass
	shall not be less than (>=)	25.0	deg	34.1	Pass
6	Turn: angle of equilibrium				Pass
	shall not be greater than (<=)	10.0	deg	0.0	Pass

	Angle
Down Flooding Angle	50 degree
Angle of Vanishing Stability	90 Degree

Loading	Criteria	Value	Units	Actual	Status
100% Loading	8.6.3: Margin line immersion				Pass
	shall be greater than (>)	0.000	m	0.875	Pass
50% Loading	8.6.3: Margin line immersion				Pass
	shall be greater than (>)	0.000	m	0.909	Pass
10% Loading	8.6.3: Margin line immersion				Pass
	shall be greater than (>)	0.000	m	0.934	Pass
Lightship	8.6.3: Margin line immersion				Pass
	shall be greater than (>)	0.000	m	0.944	Pass

Figure 6: Equilibrium comparison

7. Propulsion system

Using the Maxsurf Hullspeed module, resistance was evaluated at 25 knots, suitable for displacement or semi-displacement vessels. The results are obtained for the bare hull, excluding appendages and assumed free-water navigation conditions. The propeller and engine selection are done based on it.

The original B-series results were presented in the form used by Taylor. Oosterveld, et al modified it [1] and published two new sets of charts, based on the thrust and torque polynomials. The first set gives curves of open water efficiency , and of constant 1/J, plotted on a grid of 0.1739 and pitch ratio, P/D. With the rotative speed of the propeller known, the optimum diameter and possible thrust from selected propeller is found from this specially prepared chart. The synopsis of these calculations and chosen propeller type is shown in the Table 3. Additionally, the propeller is ensured cavitation free by checking with Keller's cavitation criteria as shown in the same table.

The chosen marine propulsion engine is Scania DI16 072M series (assumed to have steerable propeller without rudder). This is chosen based on considering the sea margin of 10% and Maximum Continuous Rating MCR of 4% (this margin needs to be at least 10% that requires additional feasibility study). The chosen engine power is of 478 kW and engine revolutions are 2050 RPM. The selected IMO Tier II, EU stage IIIA complied engine has the following characteristics: Bore X stroke: 130x 154mm, Compression ratio- 16.7:1 and SFOC range of 195g/kwh under normal operating conditions. The operational regimes for the 2-engine configuration have been analysed as shown in **Figure 7.**

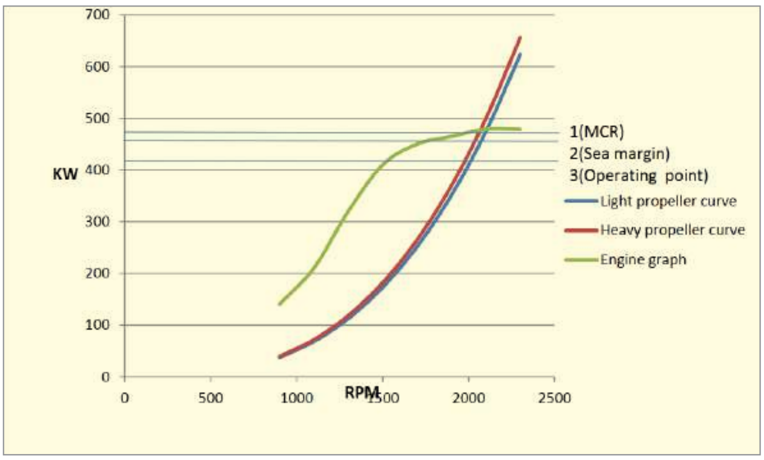

Figure 7: Ship propulsion point

Table 3: Propeller calculations

Parameter	Unit	Value	Comments
Ship resistance (R)	kN	47	From hull speed with 90% Efficiency
Ship speed (V)	knots	25	Project requirement
	m/s	12.86	
Effective power (Pe)	kW	410	From engine graph
Engine revolutions at optimization point	RPM	2000	From engine graph
	rps	33	
Gear reduction		1.8	
Propeller revolutions (n)	rps	19	RPM=1111
Wake fraction(w)		0.2	From lecture slides
Hull speed (V.a)	m/s	16.08	Augmented by few percentages as an assumption to cater uncertainties in resistance prediction (in reality V.a<V)
Effective power (P.e)	kW	755.59	
Propulsive efficiency (η.d)		0.8	From lecture slides
Delivered power (two propellers)	kW	944.49	
Delivered power	kW	472.24	For one propeller
K.Q/J^5	-	0.071	
(K.Q/J^5)^0.25	-	0.52	
Number of Blades	-	4	
Propeller selected	-	-	Wageningen series B4-100
A.e/A.o	-	1	
P/D	-	1.2	
1/J	-	1.11	From K.q-J^5 graph
η.0	-	0.67	
J	-	0.9	
Propeller Diameter (D)	m	0.77	
Thrust coefficient(t)	-	0.2	From K.t; K.q - J graph
Thrust from selected propeller	kN	24.83	should be >23.5(Half of ships resistance considered)
Keller's cavitation criteria			
K	-	0	
Propeller shaft immersion depth	m	0.8	
EAR (A.e/A.o)	-	0.95	
Cavitation check			OK

8. Electrical analysis

The initial electrical balance must consider the estimated electrical power demand (kW) required by various auxiliary systems. This is then given as an input for the selection of the generator set. This preliminary assessment is crucial and is based on data from the similar vessels.

To proceed, a table is created like the one showed in the **Figure 8** [3], listing the planned consumers and analysing the varying load demand scenarios corresponding to each operation mode established for the vessel. This table will help outline the comprehensive electrical requirements necessary for effective generator set selection and integration into the vessel's electrical system. The apparent power calculation is essential for selecting the appropriate generator set for each consumer onboard. The preliminary electrical balance provides estimated values for active power (kW), apparent power (kVA), and reactive power (kVAR) under various electrical load conditions. In this calculation, an additional margin of 20% has been factored into account for losses and equipment not initially considered. This ensures that the generator set chosen can reliably meet the vessel's electrical demands, including unexpected loads and operational contingencies. The selected generator capacity based on these discussions is of 30 kW and electrical load under consideration is 25 kW. Similarly, the emergency load is 2.6 kW, and the selected generator is of 3.5 kW.

System	Consumer	#	Unit power (kW)	Total output	Power demanded (kW)	FP
Propulsion System	Starting Equipment	2	0,8	0,93	0,86	0,8
	Drive Motor	2	200	0,97	206,19	0,93
Steering System	Servomotor	2	10	0,98	10,20	0,92
Fuel System	Racking Pump	2	0,2	0,98	0,20	0,92
	Feed Pump	2	0,15	0,98	0,15	0,92
	Circulation Pump	2	0,15	0,98	0,15	0,92
Cooling System	Cooling Pump	1	8	0,98	8,16	0,92
Ventilation System	MR fan	2	0,2	0,98	0,20	0,92
	MR exhaust fan	2	0,15	0,98	0,15	0,92
Ballast System	Ballast Pump	1	0,29	0,98	0,30	0,93

Figure 8: Electrical power demand calculations [3]

The preliminary electrical balance provides estimated values for active power (kW), apparent power (kVA), and reactive power (kVAR) under various electrical load conditions

9. Discussion

If one wants to upscale this work, they can think of spiral design or systems approach as discussed in this section and shown in the **Figure 9**. Traditionally the design of a ship is performed by making use of the well-known 'Design Spiral', which was originally introduced by J. H. Evans. Evans intended to develop a rational comprehensive design procedure for a surface cargo ship, enabling the trade-off process and the convergence toward solution efficiently and possibly taking advantage of automatic tools.

Over the decades, several attempts have been made to improve the original spiral in terms of model representation and inclusion of aspects not considered previously [2]. The efforts to modernise the original design spiral model and the evolution of the design techniques emphasised that the spiral approach cannot well represent the entire life-cycle process of the ship, requiring a wider vision. One of the most discussed weak points of the design spiral is the lack of a proper approach to define the ship requirements and explore the problem domain well before formulating trade-off analysis of possible solutions. This is because the traditional design spiral starts its process when requirements have been already defined in agreement with the client and use them as input to develop a balanced solution.

Thus, some researchers started to find a way to integrate the elucidation of requirements into the ship design spiral process, for example, to merge the ship requirements definition in the spiral process. The Design Spiral seems to work well in a further phase of the design process once the requirements have been defined and they need to be put together in a final balance solution. The definition of requirements in the early design stages is often executed using the 'experts' perspective and rule of thumb, constraining the design by previously known and workable technical solutions.

Moreover, the time-consuming efforts for the several iterations necessary to achieve the final result usually favour the adoption of a past and already consolidated reference model, limiting the project merely to a tuning and customisation process that can certainly meet the operational requirements, but which is not necessarily the best possible solution. Thus, the spiral process addresses mainly the engineering of the vessel once the main requirements and functions have been made.

From all the above discussions it derives how the design spiral method needs to evolve to keep pace with modern systems and industry needs. **The lack of a mode in the design spiral process to assess the solution's effectiveness demands a quantitative methodology to assist the designers and the customers in the decisional process, which is the foundation to identify and design the needed ship solution.**

Thus, to upgrade the traditional ship design methodology and apply a whole system vision, the Systems Engineering (SE) approach is a sound resource [2], that applies the systems approach to observe large and complex systems design exploration, development, and problem-solving through systematic and systematic processes.

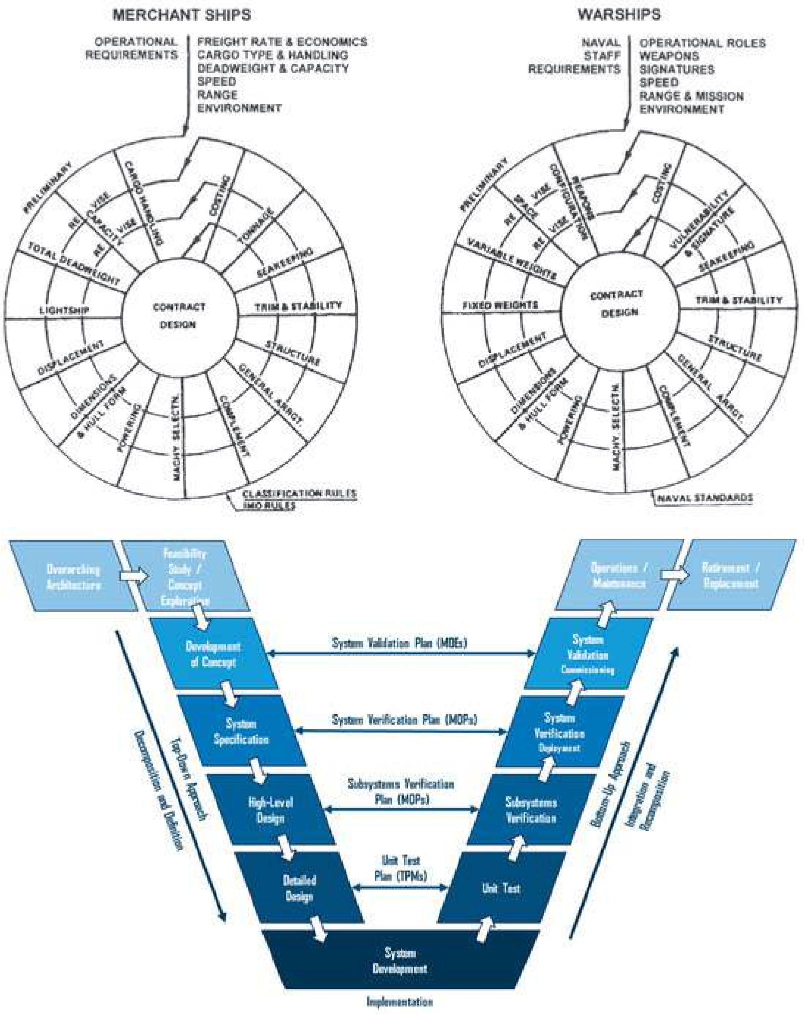

Figure 9: Proposed design directions [2]

> *Evans intended to develop a rational comprehensive design procedure for a surface cargo ship, enabling the trade-off process and the convergence toward solution efficiently and possibly taking advantage of automatic tools*

10. Conclusion

A boat has been designed for practical piloting capable of reducing reliance on imported vessels. The design included its form, general layout, and structural analysis at the conceptual stage and can be upscaled as required. This work has been presented as a proof of concept. However, as the results are promising it can be upscaled by spiral or systems approach to better realise the project.

11. Acknowledgement

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About the Author

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A Discussion Concerning the Interplay between Traditional Marine Perils, GNSS/GPS Spoofing and Cyber Exclusions

MER wishes to thank Ms. Leena Mody for providing the discussion. The permission for publishing the discussion from The Association of Average Adjusters is gratefully acknowledged.

The Inquiry

An inquiry was received by the Association as to whether a Shipowner is covered for damage caused by a grounding if that grounding was a result of (or contributed to by) "GPS spoofing".

Given the open nature of this inquiry, it has not been possible to provide a definitive view. All cases will be fact specific. In the opinion below, the Advisory Committee discuss what GNSS/GPS Spoofing is and some of the legal and policy interpretation issues which will arise, and in particular some of the aspects of the standard Cyber Exclusions (i.e. LMA5403) in grounding and similar cases where GNSS/GPS Spoofing may have played a part.

SUMMARY

GNSS/GPS Spoofing involves someone transmitting a fake GNSS or GPS signal which deceives the receivers on a vessel leading to the navigational and other equipment on the vessel reporting a false position for the vessel to the crew. The difference in position can be considerable and it can readily be seen that where a crew is relying on the GPS data, a vessel may be deceived into going in to shallow water and grounding.

The standard Cyber Exclusions found in Hull and Machinery policies (such as LMA5403) exclude:

> *"...loss, damage, liability or expense directly or indirectly caused by or contributed to, by or arising from the use or operation, as a means of inflicting harm, of any computer, computer system, computer software programme, malicious code, computer virus or process or any other electronic system."*

It is clear that any GPS Spoofing will be derived from some form of *"electronic system"*.

The extent to which GPS Spoofing may play a part in any particular grounding will be fact specific. Below we discuss in more detail some of the issues with this and the extent to which GPS Spoofing may be considered to have directly or indirectly caused or contributed to a casualty.

The more difficult question is with regard to the exclusions requirement that the actions need to be a *"means on inflicting harm"* and on whom the burden of proving or denying this falls.

It is in the nature of GPS Spoofing that it may be difficult, if not impossible, to positively identify the party responsible. However, the overall context may be sufficient to give rise to a presumption that the motives behind spoofing have harmful intent.

For example, if a vessel is sailing through a known high-risk area with increased political tensions when suddenly she experiences GPS spoofing, the Courts may view that there is a rebuttable presumption that the spoofer intended harm. It would then be for the assured to offer up a plausible alternative argument which supports the view that the spoofing was in fact not intended to be harmful.

On the other hand, if some random GPS signal disruption occurs whilst the vessel is not in a "hot spot" area of the world, then insurers will have a much harder task to show harmful intent was involved and would likely have to establish more specific details to support their case, e.g the identity of the perpetrators, the motivation, etc. - in such circumstances the bar to meet the burden of proof on harmful intent would be much higher for insurers.

Conclusions

Whilst the question points to the fact that GPS spoofing may generally be intended to have some harmful intent, it is not inconceivable that the activation may be accidental or not intended to cause harm. Equally in most cases the spoofing having had a genuine causal effect on the grounding, but there may be cases where it can be shown this is not the case. We do not believe that it will be sufficient for an insurer to simply show that some element of GPS spoofing has occurred.

The reality is that it is not possible to draw definitive conclusions on how applicable the Cyber Exclusion will be in every case. It should also be emphasised that all cases will be fact specific. It may be dependent of the particular location of the loss, the likely party or parties who may have been involved and their motivations and, consequently, who may have the burden of proving or denying harmful intent.

If in doubt, assured's can always take out additional Cyber Buy-back clauses which, for additional premium, allow the insured to get cover for many losses which would not be covered as a result of the cyber exclusions. All such wordings would need to be reviewed in detail but many would cover a grounding resulting from GPS spoofing regardless of the motivation of the party responsible or the causal connection between the spoofing and grounding.

DISCUSSION

What is GNSS/GPS Spoofing?

GNSS and **GPS** (Global Positioning System) have been rapidly integrated in modern navigation and are generally highly reliable but may be susceptible to spoofing.

GNSS / GPS systems use signals received from a number of satellites to accurately calculate the vessel's position in real time. GNSS provided Positioning, Navigation and Timing (PNT) data inputs are also integrated with other navigational and communication systems onboard.

"GNSS / GPS Spoofing" involves transmitting a fake GNSS signal to deceive the receiver on a vessel, causing the system to compute incorrect PNT data. This will provide the crew with an inaccurate position for the vessel on the affected system and may indicate the vessel's position to be a considerable distance from her actual position. As a result, a vessel may ground despite her

navigational system indicating that she is in a channel or deep water.

Whilst there maybe other iterations of manipulation of onboard systems which could lead to groundings, this discussion only considers the example outlined above.

Traditional coverage for grounding in marine policies

Accidental grounding is a peril of the seas and covered by all of the main Hull & Machinery standard policy conditions. As a result, if a vessel were to ground as a result of the crew being deceived by GPS spoofing, the loss would *prima facie* be covered by the policy.

> **GNSS/GPS Spoofing involves someone transmitting a fake GNSS or GPS signal which deceives the receivers on a vessel leading to the navigational and other equipment on the vessel reporting a false position for the vessel to the crew**

It is perhaps noteworthy that there are various domestic and international standards of navigation and seamanship which should, in theory, mean that any manipulation of GNSS/GPS is detected by the watchkeepers on duty at the time and that these systems should not be solely relied on in any event. For example, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) provides:

> *"...On taking over the watch the relieving officer shall satisfy himself as to the ship's estimated or true position and confirm its intended track, course and speed and shall note any dangers to navigation expected to be encountered during his watch..."*

The regulations only increase when close to shore or in dangerous or congested waters - and other systems such as the radar, echo sounders, bearings etc. should be used to confirm the vessel's position. However, even if the crew were negligent in not undertaking such verification work, the grounding would be considered a "peril of the seas" per s.55 (2) (a) of the Marine Insurance Act 1906, which states:

> *"...The insurer is not liable for any loss attributable to the wilful misconduct of the*

assured, but, unless the policy otherwise provides, he is liable for any loss proximately caused by a peril insured against, even though the loss would not have happened but for the misconduct or negligence of the master or crew…"

In the absence of any exclusions regarding the issue, it seems clear that a claim can arise under most marine policies for a grounding, despite the fact that GPS spoofing may have played a role.

All of these clauses have similar wordings with regard to the issue and LMA5403 (currently the most commonly used) which states: -

MARINE CYBER ENDORSEMENT

1. *Subject only to paragraph 3 below, in no case shall this insurance cover loss, damage, liability or expense directly or indirectly caused by or contributed to, by or arising from the use or operation, as a means for inflicting harm, of any computer, computer system, computer software programme, malicious code, computer virus, computer process or any other electronic system.*
2. *Subject to the conditions, limitations and exclusions of the policy to which this clause attaches, the indemnity otherwise recoverable hereunder shall not be prejudiced by the use or operation of any computer, computer system, computer software programme, computer process or any other electronic system, if such use or operation is not as a means for inflicting harm.*
3. *Where this clause is endorsed on policies covering risks of war, civil war, revolution, rebellion, insurrection, or*

Effect of cyber exclusions

Once a "prima facie" claim has been established on a policy, the burden of proving that an exclusion applies falls on the insurers.

Most modern marine wordings, have exclusions for certain types of cyber risk. These are: -

- Institute Cyber Attack Exclusion Clause 10.11.03 (CL 380)

- Marine Cyber Exclusion LMA5402 (11.11.19)

- Marine Cyber Endorsement LMA5403 (11.11.19) *civil strife arising therefrom, or any hostile act by or against a belligerent power, or terrorism or any person acting from a political motive, paragraph 1 shall not operate to exclude losses (which would otherwise be covered) arising from the use of any computer, computer system or computer software programme or any other electronic system in the launch and/or guidance system and/or firing mechanism of any weapon or missile.*

Sub-clause 2 merely emphasizes the need for the motive of inflicting harm.

3. The thing used to cause the spoofing must fall within one of: ***any computer, computer system, computer software programme, malicious code, computer virus, computer process or any other electronic system***...

Electronic system

There is little doubt that a system which transmits a false GNSS/GPS signal or otherwise manipulates a vessel's onboard systems would fall within the broad definition

provided for in point 3 above - in particular *any other electronic system*.

Sub-clause 3 carves out of the exclusion those cases where an electronic system is used as a means for launching a weapon or missile which, self-evidently, would have harmful intent.

Sub-clause 1 comprises the actual exclusion and has three main requirements that need to be satisfied in order to take effect, namely:

1. The loss or expense must have been ***directly or indirectly caused by or contributed to, by or arising from***.....use or operation computer systems, etc.
2. Such use or operation must have been ***as a means for inflicting harm***...

Directly or indirectly cause by or contributed to, by or arising from...

Under point 1, the insurers have the burden of proof of showing that the GPS spoofing has played a part in the causal chain leading to the loss. However, the question remains as to the degree of causal effect the spoofing must ultimately have had. Caused 'directly by' or 'arising from' are phrases relatively easy to deal with as they are legally akin to *proximately caused by*, a concept which

marine practitioners are well versed in. If this was the only test, then it is suggested that the exclusion would not apply as the grounding would ultimately be either a marine peril or a shipowner could likely also point to some navigational negligence which allowed the grounding to occur.

However, the exclusion goes further to bring in situations in which the GPS spoofing has 'indirectly caused' or 'contributed to' the grounding. The words allow for insurers to rely on events in the causal chain, which may not be quite so immediate (or proximate) but which have certainly had some genuine effect on events. There is a useful analysis of these terms (or similar terms) in *Arc Capital Partners Limited v Brit Syndicates Limited [2016] EWHC 141*. Based on this widening of the causal 'net', we can see that it may be relatively easy for insurers to again reverse the burden of proof back to owners that spoofing has not had a significant role in a loss.

In such situations, it is perhaps difficult for a shipowner to rebut the insurers' reliance on the Cyber Exclusion, by pointing to the fact that the crew should have done better in terms of their reliance of navigational aids, etc. as the incorrect position reporting of the GPS spoofing is more often than not likely to have played some part in the decision making on deck.

In all cases an analysis of the specific facts would be required.

For example, it might be shown that a grounding was inevitable irrespective of any manipulation of the GPS system, simply by reason of inadequate passage planning or crewmembers having been asleep on watch, so that whether some element of spoofing had occurred is not material. Equally, the longer the spoofing occurs prior to the eventual casualty, the more opportunities would have been missed to have detect and counter the spoofing. At some stage, the spoofing should lose most (if not all) its potency so that it no longer plays a role in the causal chain. For example, and in view of the STCW provision cited above, if the spoofing occurs on one watch but the grounding does not occur until three watches later, there have been numerous points at which the real-time position and track of the vessel should have been checked independently of GPS.

Whether the spoofing still has enough of a causal connection to the grounding will be a question for the Courts based on the specific facts of every case.

Means of inflicting harm

Assuming that insurers have been able to demonstrate that the use of a computer system, etc. to spoof an insured vessel's GPS system has played a genuine causative role in a casualty, then they must finally be able to demonstrate that this was as "*a means of inflicting harm*" (point 2).

As this is an exclusion, the burden of proving this falls, initially, upon the insurers.

It is intuitive that anyone operating the electronic system which results in GPS Spoofing must intend some detrimental effect, or harm, will be felt by those targeted and, at best, indifferent to any impact it may have on those close by to the target who may be collaterally affected.

The exclusion does not specify any particular degree of harm that needs to be felt or that the harm needs to necessarily be physical damage. They may intend to just disrupt trade or inflict economic losses, etc.

It is in the nature of GPS Spoofing that it may be difficult, if not impossible, to positively identify the party responsible and, accordingly, their motives.

However, the overall context may be sufficient to give rise to a rebuttable presumption that the motives behind spoofing have harmful intent.

For example, if a vessel is sailing through a known high-risk area with increased political tensions when suddenly she experiences GPS spoofing, the Courts may take the view that there is a rebuttable presumption that the spoofer intended harm. It would then be for the assured to offer up a plausible alternative argument which supports the view that the spoofing was in fact not intended to be harmful (such as the spoofing was intended to try and disrupt the guidance systems of missiles or drones and which had no intent to cause harm (quite the reverse) but the ship becomes collateral damage).

On the other hand, if some random GPS signal disruption occurs whilst the vessel is not in a "hot spot" area of the world, then insurers will have a much harder task to show harmful intent was involved and would likely have to establish more specific details to support their case, e.g the identity of the perpetrators, the motivation, etc. - in such circumstances the bar to meet the burden of proof on harmful intent would be much higher.

In either case, we would suggest that the burden of positively proving harmful intent or denying it (if it can be inferred from the overall context of a casualty) may be quite difficult unless the responsible party identify themselves and provide their motivations (as is seen with terrorist groups claiming responsibility for bombing etc.).-

About the Authors

Leena Mody, Joseph Shead & Willum Richards (ADR Panel, Association of Average Adjusters).

Life and Science in Antarctica

Elango Paramasivan

Introduction

It is so interesting and excited to think about the journey to the wonderland, the dream world, 'Antarctica', the pristine icy continent. How many of us know or had the chance to see and experience its wildest cold, ranging from + 1 or 2 deg. C in the coastal area during summer times and around -40 deg. C during peak winter in our research stations Maitri and Bharati and to a breath-taking low temperature of around -80 deg. C in the interior regions. The spine-chilling blizzards during winter times, usually go up to two weeks sometimes, accumulating huge snow around the station areas. Awesome snowfalls, give us a nice feeling during zero wind days.

Can anybody think of seeing the Sun in the mid-night here...?

Yes, it's possible in Antarctica to see the Sun round the clock during summer months, that is for about two and a half months in East Antarctica, in our research stations Maitri and Bharati. Also, it would be interesting to know that there will be no Sun for about more than two months, making mental discomforts to members to some extent.

Yes, it is a different experience to travel to Antarctica and be there in that pristine environment and do our scientific research. National Centre for Polar and Ocean Research (NCPOR), Goa, an autonomous body under Ministry of Earth Sciences, has been sending a team of Scientists to do scientific work there and collect valuable data and samples for our better understanding of the past and future. A supporting logistics team is also sent, which consists of doctors, engineers, technicians and chefs to maintain the health of the men and machines throughout the year.

The sea tides do rise to more than 15 metre heights and the big expedition vessels would be rolling and pitching in high tides, creating sea sickness to all expeditioners

The journey to Antarctica by ship

In the beginning, the expeditioners used to travel to Antarctica by ship right from Goa and take a halt in Mauritius for a short while, and reach Antarctica in a period of almost a month. It used to be an Ice class or Ice Cutter type of ship. We do not have this type of ships in India and hence we hire these expedition vessels mostly from Europe; like Norway, Russia, Finland etc,. They have the capacity to break the ice sheets of thickness of about 1 meter.

The ship sailing used to be very smooth and comfortable nearer to the equator but sea becomes very rough and tough with high tides after 35 deg. south. The sea tides do rise to more than 15 metre heights and the big expedition vessels would be rolling and pitching in high tides, creating sea sickness to all expeditioners.

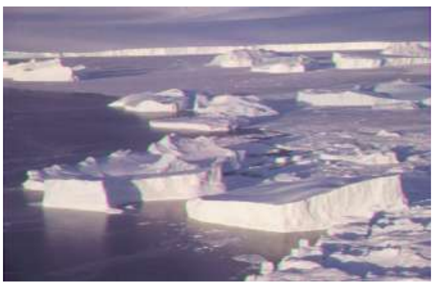
The members would be in discomfort in roaring 40s, furious 50s and severing 60s., i.e., during 40 deg. To 50 deg. latitudes, the sea would be very furious with rolling and pitching and when the ship enters 60 deg. it would be very cold and members would be severing in cold.

While entering into Antarctic circle, we encounter first pack ice, then fast ice, i.e., the sea water would freeze and form an ice sheet and thickness may be around one meter. The expedition vessel would manoeuvre slowly through the cracks in the ice that develop due to under water dynamics.

The ship would stay there in Antarctic waters, if the ice sheet thickness is more than 1 meter. Since, it would be in the flying range, the leader of the expedition would ask the pilots to get the helicopters ready to fly to the station. It will be a 'courtesy sortie', in which senior members would fly to station, with some gift items.

The Expedition vessel

Ice class Vessel MV Ivan Pappanin – 29 ISEA



2. Pack ice and fast ice (Ice sheet stretch)

Pack ice illuminated by Sun rays in the evening time.

Change of Transport:

IL 76 –Charted flight landing on the ice Air strip with members and all cargo

From the 19th Indian Scientific Expedition (19 ISEA-1999) onwards, members got the opportunity to fly from Mumbai to Cape Town, South Africa and then take their expedition vessel from there with all cargo loaded for the expedition and sail towards our station, Maitri.

Then, from 26th ISEA (2006), the winter members got the opportunity to fly up to Antarctica by a charter flight (IL-76) which was operated by

> *The expedition vessel would manoeuvre slowly through the cracks in the ice that develop due to under water dynamics*

a Russian company called ALCI, from Cape Town, South Africa.

It will be a great experience to fly in that IL-76 flight from Cape Town to Antarctica, as the flight would be very thrilling, especially for the first timers to think about the landing on the ice. This special flight is piloted by Test Pilots from Russia. They are very efficient in flying this machine during bad weather days also. If needed, even during heavy blizzards, they would take off from NOVO runway to Cape Town.

Then the members and their materials are shifted to their respective stations of different countries by small Basler flights; that can carry about 18 members along with their personal and official luggage.

Our station Maitri is just 7 kms from the runway. This runway is being maintained meticulously by the Russian station crews. The runway manager and his staff are stationed there to handle the cargo and members of all neighbouring stations.

When the IL-76 landing on the ice runway, our Maitri station members will be eagerly waiting near the runway to receive the new team members. Each member welcomes their counterpart, as they will replace the wintered over member. Once the new team arrives, the station would become very active and colourful with the new faces.

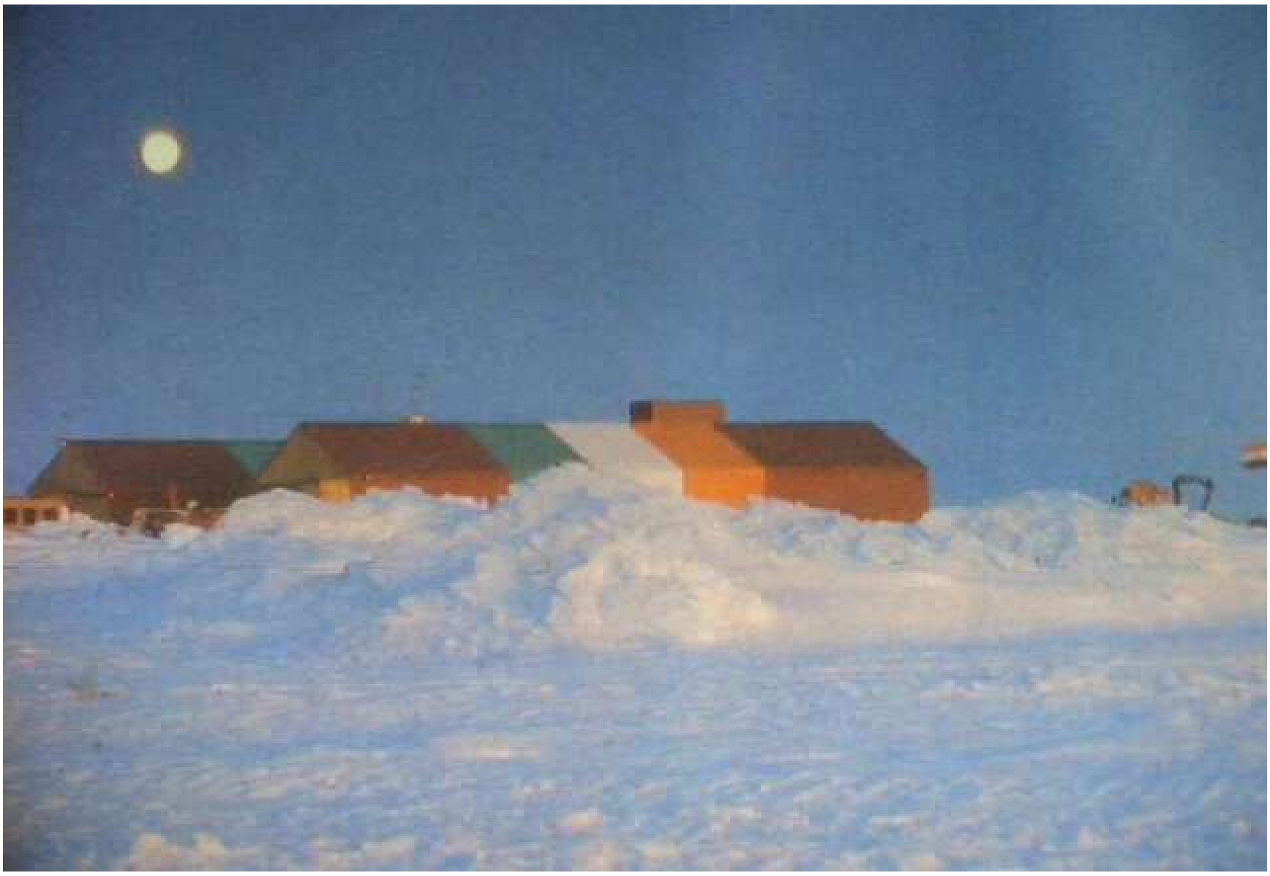
DG under construction during the summer of 3rd Indian Scientific expedition

Dakshin Gangotri station on completion

IL-76 – on the runway. Offloading men and materials of different stations

Construction of first Indian Research Station, Dakshin Gangotri (DG)

The First Indian Research Station, Dakshin Gangotri (DG) was constructed during the summer period of 3rd expedition, i.e., 1983-1984, under the able leadership of Dr. Harsh. K. Gupta, a young and dynamic Seismologist. It was a herculean task and the DG construction was not so easy. It was accomplished because of sheer hard work and determination of our scientific and logistics team, comprising of Army, Air force and Navy. A blood freezing Mi-8 helicopter fall into the Antarctic



DG station got buried up to roof level in 1987-88

waters along with the Air force crews, and luckily all survived.

As the first station DG got buried up to roof level, the second station Maitri was constructed in a rocky area, Schirmachar Oasis, near Russian station Novalevoraskya (NOVO), at the straight distance of 4.5 kms, by our Army, Air force and Navy team and DRDO team together. At Maitri, for the first time the team wintered under the leadership of a scientist, Rasik Ravindra, a Senior Geologist

Second station- Maitri-constructed in 1988-89 during summer time

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Maitri station after a snow fall

from Geological Survey of India (GSI), Faridabad. (Later he became, the Director of NCPOR, Goa). Till 8th ISEA at DG, the Station commanders used to be Army officers. From 9th ISEA, the wintering teams were led by Scientists.

Construction of Bharati Station

The preparatory work for the construction of third research station Bharati was started during the summer

Aerial view of Bharati station at Larsemann hills

Front view of Bharati Station during summer

of 29 ISEA, (2009-2010) under the able supervision of Dr. Rajesh Asthana of GSI. He was the voyage leader of a dynamic summer voyage team. He was deputed by NCPOR, 3 times as voyage leader to monitor the construction of Bharati station. First phase of construction work was done by Norwegians and the second and finishing phase was done by Germans. A world class station Bharati was dedicated to scientific work in 2012.

The station has the capacity to accommodate nearly 50 members (25 winter + 25 summer) during summer time. Though there is a summer accommodation unit, which is not in operation as of now. During winter a maximum of 25 members will stay in the station. This station has an air handling unit, which is not there in Maitri. Both the station has libraries, which are having books from different languages to cater the needs of the members.

The expeditions consist of two groups: 1. Summer team 2. Winter team

Life at Antarctic stations: Summer team

The summer team will be generally in for a period of 3 to 5 months. They complete their scientific works during

Summer camp and Laboratories at Maitri

summer periods and return back in summer itself. The Summer team members, who have field works used to do camping in Mountain areas and collect samples and data with their equipment. It is a different type of experience altogether, because camping members cannot have their bath till they return to the main station. They cannot litter around, till they complete their camping. Summer period will have 24 hrs Sunlight, and no nights. All the time, Sun will be shinning. So, the sleeping cycle will be totally disturbed for the first timers. The summer members who do not have field works, will stay in summer camps at Maitri and do their scientific works.

Previously, i.e., till 26th ISEA, the Summer members used to stay at lofts of the laboratories, like Nandadevi, Tirumala, NPL hut and Annapoorna hut. Senior Scientists, used to get single occupation huts, like Camet, Aravalli, Nilgiri etc.,. Blue colour container accommodations were installed during 27 ISEA, after which Summer members got a comfortable stay there. Three Summer members can stay in a container which has heater facility too.

> *All the time, Sun will be shinning. So, the sleeping cycle will be totally disturbed for the first timers*

Snow fall and Blizzards

The temperature during summer time, would be around + 1 deg. C in day time to -15 deg. C during night hours, though there is no night as such. The Summer members have to come to Maitri station for their food. Sometimes, it will be a tough job, if the weather is bad. Sometimes, snow fall would be there with zero winds. It would be fun to walk out of the station to enjoy the snow fall and take pictures. Sometimes, katabatic winds (flow of high density air mass to lower density air mass sections) make it very difficult to walk to the station, even for food. Summer members have a chance to take tea and coffee in the summer area itself. Arrangements are made at Tottabeta hut, but no food there.

A person fallen down in heavy blizzard and the other person is supporting him to get up

While snow fall is fun to watch and walk out and enjoy, it becomes so tough and risky if the winds pick up. When the systems are very big, blizzards will be heavy and dump huge amount of snow around the stations and make outside activity stand still. The visibility will be zero, if the blizzard is very much intense, even during summer time.

During blizzards, strictly members are not allowed to venture out unless they are on station duties. Single person is not allowed to go anywhere in Antarctica. Always a buddy system is followed to avoid any untoward incidents.

Members struggling to walk because of high winds, during a blizzard in summer time

Organizations participating for summer expeditions:

1. Geological Survey of India (GSI)
2. Survey of India (SOI)
3. Botanical survey of India(BSI)
4. Baba Atomic Research Centre(BARC)

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5. National Centre for Polar and Ocean Research (NCPOR)
6. National Remote Sensing Centre (NRSC), ISRO
7. Satellite Application Centre (SAC), ISRO
8. National Geophysical Research Institute (NGRI)
9. National Institute of Ocean Technology (NIOT)
10. Indian Institute of Tropical Meteorology (IITM)

The above are some of the important and regular institutes who participate in summer expeditions. Also, many university departments send their representatives to Antarctica to do their experiments and collect data here.

Organizations participating for Winter expeditions:

1. Indian Meteorological Department (*IMD*)
2. Indian Institute of Geomagnetism (*IIG*)
3. National Geophysical Research Institute (*NGRI*)
4. Snow and Avalanche Study Establishment (*SASE*)
5. National Physical Laboratory (*NPL*)
6. National Remote Sensing Centre (NRSC), ISRO
7. Baba Atomic Research Centre (BARC)
8. National Centre of Polar and Ocean Research (NCPOR)

The above are the regular winter participant organisations and continuing their ongoing programs.

Summer activities:

Many institutes do their summer scientific activities in a meticulous way without wasting a single good weather day. Much of the science is done during summer time as many scientific organisations do participate in every summer. Here are few summer scientific activities of various institutions at Maitri and Bharati.

16. NIOT -Polar ROV assembled for operation in Priyadharshini Lake, Antarctica

A six member team from NIOT, Chennai participated in the summer of 34 ISEA at Maitri and tested their Polar ROV at Priyadharshini lake. After a successful testing at the lake the same system was taken to ship and tested in the ocean as well. The underwater camera fixed in the ROV system worked well and it had captured the pictures of the items lying at the bottom of the lake.

NIOT team with their ROV system

A Summer Scientist from Kolkatta university, is working in a shallow water lake

Polar ROV dived down to the bottom of the lake

A geologist on field work with GPS

Polar ROV is under test in the Antarctic Ocean

Sample collection in a deep water later with the help of a floating platform

Cryoconite holes were sampled to study the seasonal variation in the biogeochemistry of the cryoconite hole ecosystem

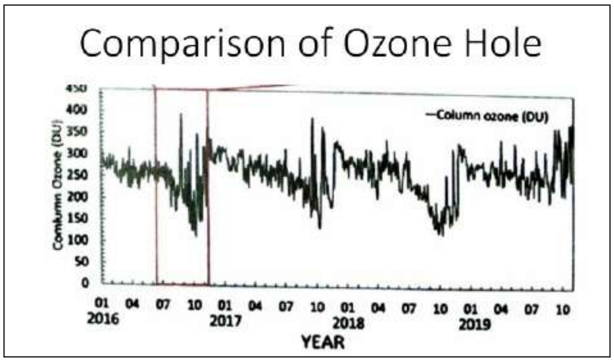
Female scientists from NCPOR on their field work to collect samples from the Cryoconite holes during the summer at Bharati station.

Winter Activities: Scientific activities of winter are continuous and ongoing programs.

IMD scientists are launching a balloon to study the various weather parameters at Maitri

Ozonesonde is being launched at Bharati

IMD is a regular participant right from the first expedition and the programs are continuous and ongoing. The members from IMD take Synoptic observations and recording weather parameter like, temperature, wind speed, wind direction, pressure and precipitation. Another important measurement is Ozone concentration in the stratosphere. IMD team is doing weather forecasting for the convoy team and field workers at Maitri and Bharati.



The Ozone hole phenomena was discovered in Antarctica in 1984 at Halley station of UK. It was found that the ozone concentration was almost zero for about

> *The pollutants (CFCs) in the stratosphere dissociate the Ozone molecules into O2 + O and hence ozone is absent in the stratosphere*

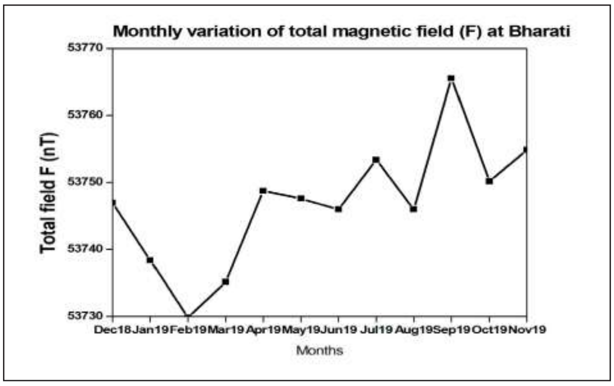
two months from the second week of September to second week of November. The pollutants (CFCs) in the stratosphere dissociate the Ozone molecules into O2 + O and hence ozone is absent in the stratosphere. This is because of the strong circumpolar vortex that develops in the second week of September and no atmospheric mixing. **This ozone hole was present till 2018, but from the above comparison graph, it is clear that the ozone concentration is regained its original value and no ozone depletion in 2019.** This ozone measurement was done at Bharati during 2019. This is a great news for the mankind.

IIG is yet another regular participant right from the inception of the expedition. Main work is the Geomagnetism, which is the magic of all geophysical process in the atmosphere. Geomagnetic measurements are important both at equatorial and polar regions. The magnetic field configuration is totally different at equatorial and polar regions. The field lines are parallel to the surface at equatorial region and perpendicular to the surface at polar regions.

> *When atomic oxygen is excited, they release yellowish green colour light. Molecular oxygen will give out a red colour display*

At Maitri, the total magnetic field is decreasing rapidly for the last few decades and that is called South Atlantic Anomaly. As per Dr. Gabbins, there is a chance of accumulation of negative field elements in the southern hemisphere that causes the rapid decrease of magnetic field value in the southern region. The rate of decrease is also found to be decreasing.

Magnetic measurements at Bharati station does not show any decrease in the total field value.



Geomagnetic storms and Auroral displays

When the Sun is active, it releases Solar Flares, that has huge amount of energies that cause Coronal Mass Ejections (CME) and they hit the Earth's magnetic fields and create geomagnetic storms. During storms, huge amount of high energy particles enter into the atmosphere and create secondary ionisation. The molecular and atomic oxygen particles are excited by the bombardment of high energy particles and go to higher energy levels. These higher energy levels are not stable and hence they release the excess energy in the form of light and come down to ground state. When atomic oxygen is excited, they release yellowish green colour light. Molecular oxygen will give out a red colour display. If the particles are highly energetic and penetrate deeper into the atmosphere, they will ionise the atomic and molecular Nitrogen. Then we can see a colourful display of aurora with violet, purple, and blue colours.

Some of the auroral displays captured at our research stations Maitri and Bharati.

Pictures of Aurora captured at Bharati during 2018. Colourful display of Aurora at Bharati in 2019

Auroral display at Maitri

Conclusion:

IMD, IIG, NGRI, SASE, NRSC (ISRO), NCPOR and BARC are the organisations participating in winter expeditions regularly and conduct experiments and collect good quality data throughout the year. Data collected during the winter periods are analysed back in India and results are being published regularly.

About the Author

Dr. Elango Paramasivan, is a retired Senior Technical Officer from Indian Institute of Geomagnetism. He served for 33 years, and retired from the Equatorial Geophysical Research Laboratory, Tirunelveli, which is a regional centre of Indian Institute of Geomagnetism, Navi Mumbai. He has been involved with the Indian Antarctic Program from 1996 onwards. He had participated in five wintering expeditions; four at Maitri research Station and one at Bharati Station. He had been a member of the expedition in 1996 and 2004 and had been the leader of the Indian Antarctic expeditions three times. He holds the distinction of being the first in India to have commanded both the Antarctic research stations Maitri and Bharati.

Email: elango.iig@gmail.com

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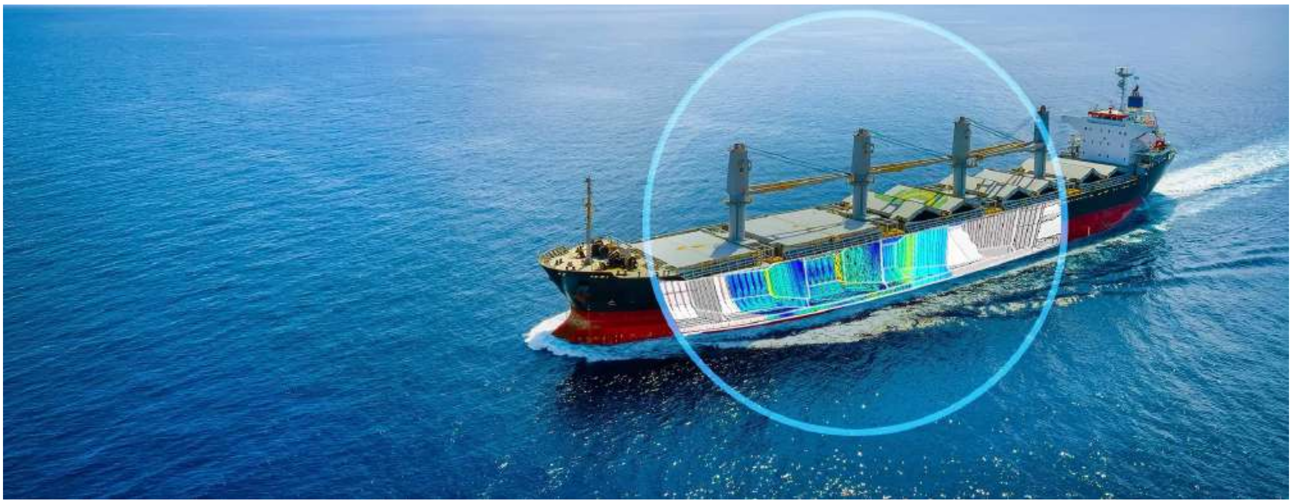
My Transition into Ship Design – An Insight for Marine Engineers



George Varkey
Consultant, Smart Engineering & Design Solutions, Cochin.

Dear Editor,

After a long sea career of about 30 years, I wished to give up sailing and thought of an early retirement. Many opportunities though came in my way to continue in industry related jobs, the most exciting was an offer from Bahamas based M/s GTR Campbell Marine Consultants to work with their Owner's representative team looking after New Building in Cochin Shipyard. It turned out to be the most successful new building project in Indian Ship Building industry, completing the construction of six Bulk Carriers in a record time of three years.

Encouraged by the outcome of the Bulk Carrier project in India, M/s GTR Campbell headed by Mr Antony Prince – who himself is a marine engineer turned ship designer, ventured into ship design in India by opening up a full-fledged ship design house of international standards, - Smart Engineering and Design Solutions Ltd in Cochin. It was a commitment to build ship design capabilities in India without having to depend on foreign countries.

This gave me an opportunity to contribute further to the industry whereby I started as a Marine Consultant and grew up to the position of Chief Technology Officer, eventually retiring in 2023 after 16 years in ship design.

The value I could add in ship design was beyond my imagination and expectation. My long operating experience coupled with newly found exposure to building and designing ships helped me to draw out benchmark designs.

My skillset was my ability to fully visualise a front-to-end design of a ship in the very preliminary stage itself, weigh its pros and cons especially with the operational aspects, remain proactive and perfect it in every respect.

A marine engineer is not expected to be well versed in software design computing tools and technology, albeit preferable to have some basic or intermediate knowledge. The key role of a marine engineer in designing ships is to utilise the designers to their best capability and produce error free drawings based on the superlative experiences that they have earned while on duty.

Today with more than seventy designers SEDS stands out as the leading ship building design house in India with ongoing Naval and Commercial projects in all the major ship yards in India, a national contribution to exchequer saving millions of foreign exchanges.

Currently I continue to remain as a consultant for this design house which highlights the significance of a marine engineer's contribution in ship design.

A designer should have a passion and a commitment to perfect a design without taking any shortcuts, rectifying a fault in the initial stages is vital as failure to do so can cause a long-term impact to the vessel. In this context, a marine engineer should not be content with just their operational expertise, but need to keep abreast with ever-demanding requirements of the industry with regard to rules, regulations and fast-advancing technologies. A design needs to be constantly upgraded adapting to the latest trends and requirements of the industry, henceforth a designer's commitment to remain updated to latest trends is paramount and their goal should always be to create a viable, cost efficient, sustainable and innovative design.

It is essential for a designer to review the requirements and adapt to constraints of the specific design than just follow the standardised requirements of Original Equipment Maker (OEM) as failure to do so can hamper the operations and maintenance perhaps throughput the entire life of the vessel. Deep technical expertise is crucial in the ship design process, where the integration and optimisation of different systems can significantly impact a vessel's performance, safety, and operational efficiency.

Marine Engineer's familiarity with issues that arise during ship operations, such as equipment failures, maintenance challenges, and the impact of harsh marine environments enable them to anticipate potential problems in the design phase, proposing solutions that enhance the reliability and maintainability of ship system. Having worked on different types of vessels, they understand the day-to-day challenges faced by crew members and the operational demands placed on ship systems. This practical experience is invaluable in the design process, where theoretical designs must be translated into functional and reliable systems that perform under practical conditions.

Marine engineer's bitter experiences in the past owing to poor designs or equipment can act as a catalyst to eliminate set-backs or inferior equipment while creating new designs. Being familiar with multiple equipment and makes based on a marine engineer's previous experience enable them to be creative and selective and optimise its best use. Also, simple operational problems that they experienced in the past, for example in dewatering a compartment that would have been caused owing to an equipment failure, system design or accessibility will immediately prompt him/her to make any correction required in the new design. New trends in an ever-changing scenario like emission control, uncertainties regarding best green fuel choices makes a designer's work difficult and is virtually creating a race in the industry prompting a significant role to R&D as never seen before. Innovations in new designs with retrofit readiness to adapt to new technologies has become a way forward and a marine engineer's contribution can bring big value addition.

Ability of marine engineers to bridge the gap between different disciplines of a design house with effective collaboration ensure a well- integrated design. The Typical design cycle - concept, basic and production design, involvement of each department is indicated below for the general understanding of newcomers in design.

As the maritime industry continues to evolve, the role of marine engineers will only become more critical in shaping the future of ship design. Marine Engineers are not aware of their hidden opportunities in ship design, hope my success story will be an encouragement to many who wish to take up shore job, an opportunity to continue with their treasure of professional and technical capabilities, partnering in the 'Make in India' initiative of our great country.

Navigating Green Waters: A Comprehensive Analysis of EEDI, EEXI, and CII Initiatives in the Maritime Industry

Ansh Singh Rajpal[1], Anirudh P.S. Parihar[2]

Abstract

The maritime sector is currently buzzing with two acronyms: EEXI and CII. You may also come across EEDI, but this is a term well-known within our industry. EEXI stands for the Energy Efficiency Existing Ship Index, which essentially involves applying the Energy Efficiency Design Index (EEDI) calculation to existing ships. On the other hand, CII stands for the Carbon Intensity Indicator. While both EEXI and CII have phases for reducing emissions, CII requires periodic recalculations. EEXI, much like EEDI, pertains to the vessel's design, whereas CII focuses on the vessel's operational aspects. As per DNV's assessment, approximately 80% of the existing fleet covered by EEXI regulations do not meet the compliance standards and must implement corrective actions by this year. ABS, on the other hand, reports that within the tanker category, approximately 20% of vessels, 46% of bulk carriers, and 25% of container ships are struggling to achieve the necessary EEXI reduction targets. This challenge arises from their current performance levels, which fall 15-30% below the most recent EEDI benchmarks. This paper delves into the complexities of calculating and reporting CII, highlighting its significance in monitoring and optimising fleet efficiency. The paper also discusses compliance challenges, identifies potential solutions, and examines their impact on port operations. Case studies and best practices in our paper showcase successful implementations of these initiatives, providing valuable insights for industry stakeholders. Beginning January 1, 2023, compliance with EEXI is not a choice but a mandatory requirement as per IMO regulations. Investing in overridable EPL or ShaPoLi is not an optional path. In situations where a vessel needs to significantly reduce its EEXI and engine operating power, ESDs alone cannot achieve the required rate without the support of EPL or ShaPoLi. Nonetheless, the incorporation of ESDs enables vessels to regain their pre-EEXI speeds, ensuring that there will be minimal changes in the operational profiles of most ships starting in 2023. This paper will also delve into the economic and technical feasibility studies related to these measures.

> *This framework, comprising operational and technological measures, aims to curb emissions, aligning with efforts to combat climate change*

Keywords: EEXI, CII, EPL, ShaPoLi, ESDs, Maritime efficiency**Top of Form**

Introduction and background

Maritime transport plays a pivotal role in sustainable development by facilitating global, cost-effective, and energy-efficient transit for essential resources. To ensure sustainability, the focus lies on resource conservation, safety, security, environmental preservation, and operational efficiency within the maritime transportation system. Addressing energy efficiency is vital in reducing CO2 emissions from international shipping, constituting 2.7% of global anthropogenic emissions in

2007. Without regulatory actions, these emissions were projected to surge by 200–300% by 2050. Consequently, the International Maritime Organization (IMO) implemented an energy-efficiency framework in 2013 under Annex VI of MARPOL, foreseeing a potential reduction of up to 1.3 gigatonnes of CO_2 annually by 2050 if effectively implemented. This framework, comprising operational and technological measures, aims to curb emissions, aligning with efforts to combat climate change. Successful execution of these measures could significantly contribute to mitigating global CO_2 emissions, considering the magnitude of global energy-related emissions in 2012, estimated at 31.6 gigatonnes by the International Energy Agency (IEA).

Technical and operational energy-efficiency measures

The Energy Efficiency Design Index (EEDI) stands as a mandatory benchmark dictating the minimum energy-efficiency standards for newly constructed ships above 400 gross tonnes. Focused on the largest and most energy-intensive sectors of the merchant fleet, it aims to progressively enhance new vessel efficiency without specifying the technologies to be used, allowing flexibility while ensuring compliance. The EEDI targets a potential 30% increase in energy efficiency by 2025 compared to ships built between 1999 and 2009, ultimately encompassing approximately 85% of international shipping emissions with the inclusion of new ship types.

Complementing this, the Ship Energy Efficiency Management Plan (SEEMP), obligatory for ships exceeding 400 gross tonnes, serves as an operational strategy fostering cost-effective means to enhance a vessel's energy efficiency beyond conventional practices. It facilitates continuous monitoring of a ship's performance, utilising tools like the Energy Efficiency Operational Indicator (EEOI) for benchmarking.

According to IMO studies, SEEMP initiatives promise substantial short-to-medium-term impacts, while the EEDI's influence is anticipated to grow progressively over the long term. The EEDI's lasting impact is expected as fleets renew and integrate emerging technologies. Both the EEDI and SEEMP together aim to encourage innovation and ongoing advancements in the maritime industry, fostering energy-efficient designs and operational practices for a sustainable future.

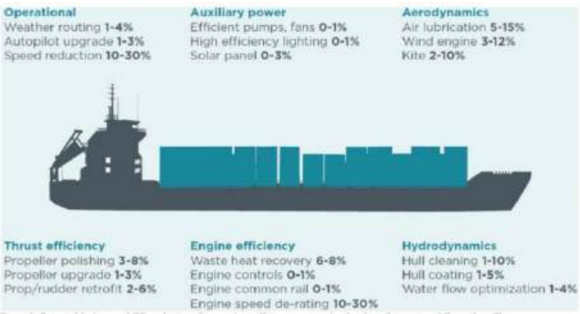


Figure 1: Potential fuel use and CO2 reductions from various efficiency approaches for ships

Possible barriers to the uptake of energy-efficiency measures

Technological barriers in adopting energy-efficient technologies for shipping revolve around scepticism regarding their actual emission reduction capabilities as claimed by manufacturers. Commercial barriers hinder the implementation and widespread use of these

> ***"Contracts in shipping, such as "voyage charters," further impede fuel-saving opportunities due to clauses mandating timely arrivals, constraining the ability to reduce emissions by sailing at slower speeds"***

solutions, notably the "split incentive" problem, where the operator benefiting from fuel savings isn't the same entity handling capital investment and fuel costs, often the ship owner.

Contracts in shipping, such as "voyage charters," further impede fuel-saving opportunities due to clauses mandating timely arrivals, constraining the ability to reduce emissions by sailing at slower speeds. Financial barriers emerge because certain emission-reduction solutions only become financially feasible when fuel prices reach and sustain specific thresholds, ensuring adequate returns on investment. These multifaceted barriers collectively obstruct the seamless integration of energy-efficient shipping solutions, impacting both technological adoption and operational practices within the maritime industry.

Barriers for developing countries

The implementation of IMO-adopted energy-efficiency regulations in developing nations faces challenges due to barriers in technological knowledge and resources. Recognising the critical role of capacity-building, the International Maritime Organization (IMO) established the Integrated Technical Cooperation Programme (ITCP) to assist governments lacking the necessary expertise. Customised country profiles are being developed to identify specific needs, facilitating targeted support.

IMO's focus on enabling technology transfer to developing countries aims to broaden the implementation of regulations. Acknowledged in MARPOL Annex VI's new chapter 4, a special regulation emphasises promoting technical cooperation and technology transfer for enhancing ship energy efficiency. This regulation mandates national Administrations to support and encourage States seeking technical assistance, collaborating with IMO and other international bodies.

It further requires Administrations to actively cooperate with other Parties, facilitating technological development, information exchange, and transfer to assist developing States in meeting Chapter 4 requirements. By emphasising technical cooperation and knowledge exchange, the IMO aims to guide the maritime industry toward sustainability, prioritising assistance for developing nations in adopting and complying with energy-efficiency measures.Top of Form

Implementation

Technical measures for EEXI improvement

According to DNV GL approximately 6500 ships in DNV class will have to comply with EEXI by the end of 2023. Majority of ships will have to apply engine power limitation (EPL) to comply. More generally the plurality of ships will have to install some kind of improvement measure for their energy efficiency. These measures for a shipowner might either be EPL, ShaPoli, ESDs, hull optimisation (installation of sails, flettner rotors, bulbous bow), or at the worst case they might even have to replace their ships with new vessels. EPL and ShaPoli are currently covered by DNV's EEXI calculator

In case someone has calculated EEXI and EEXI is actually higher than the required value, they will have to come up with mitigating actions, which might either be a simple Engine Power Limitation, which is illustrated to the following figure, or a more complex solution such as the installation of Energy Saving Devices.

Figure 2: EEXI improvement measures if attained EEXI>=required EEXI

This regulation mandates national Administrations to support and encourage States seeking technical assistance, collaborating with IMO and other international bodies

In case of a simple power reduction, they also need to provide the related information and form of an approved onboard management manual. After recalculation of EEXI and in case of compliance with the required values they can directly send the approval documentation, so the EEXI technical file and the OMM (in case of EPL) for approval and can directly get a statement of compliance. This statement will be issued before the IEE certificate.

Figure 3: Procedure for issuing a certificate of conformity

Energy saving devices for EEXI improvements

Energy Saving Devices (ESDs) are categorised according to MEPC.1/Circ.815. ESDs are classified as A, B and C according to the terms that the device contributes to the EEXI formula, as it is shown below. For example, devices that can increase reference velocity are in category A, devices that can improve main engine energy efficiency fall within category B, and devices that can improve auxiliary engine energy savings belong to category C. These categories are further subdivided into Category B-1, B-2, Category C-1, and C-2 according to weather dependency of the ESDs

Reduction of Main Engine Power			Reduction of Auxiliary Power	
Category A	Category B-1	Category B-2	Category C-1	Category C-2
Cannot be separated from the overall performance of vessel	Can be treated separately from the overall performance of vessels $f_{eff}=1$	Can be treated separately from the overall performance of vessels $f_{eff}<1$	Effective at all time $f_{eff}=1$	Depending on ambient environment $f_{eff}<1$
• Low friction coating • Bare optimization • Rudder resistance • Propeller design	• Hull air lubrication system (air cavity via air injection to reduce ship resistance) can be switched off	• Wind assistance (Sails, Flettner Rotors, Kites)	• Waste heat recovery system (exhausts gas heat recovery and conversion to electric power)	• Photovoltaic cells

Figure 4: Innovative energy efficiency technologies

Engine Power Limitation (EPL) / Shaft Power Limitation (ShaPoLi)

Engine Power Limitation (EPL) stands as a straightforward option for older ships to comply with Energy Efficiency Existing

> *Engine Power Limitation (EPL) stands as a straightforward option for older ships to comply with Energy Efficiency Existing Ship Index (EEXI) regulations, imposing a semi-permanent maximum power limit on a vessel's engine, impacting its speed*

Ship Index (EEXI) regulations, imposing a semi-permanent maximum power limit on a vessel's engine, impacting its speed. For mechanically controlled engines, a physical stop screw, secured by a wire, restricts fuel intake, while newer electronically controlled engines utilise a software fuel limiter, requiring a password for adjustment. EPL overrides are permissible in emergency situations, mandating documentation and reporting to regulatory bodies.

EPL's effectiveness lies in its ability to significantly reduce fuel consumption and CO2 emissions by slowing down vessel speed, with a 10% speed decrease potentially yielding a 30% reduction in hourly fuel usage due to the cubic relationship between engine load and speed. Despite being widely used for EEXI compliance, debates persist regarding its direct impact on greenhouse gas emissions.

The International Maritime Organization (IMO), aiming for a minimum 40% reduction in CO2 intensity from international shipping by 2030 compared to 2008 levels, noted that a 30% reduction had already been achieved by 2023, largely attributable to widespread adoption of slow steaming practices by ship operators. This data underscores the challenge and importance of further measures beyond EPL to achieve ambitious emission reduction targets set by the IMO.

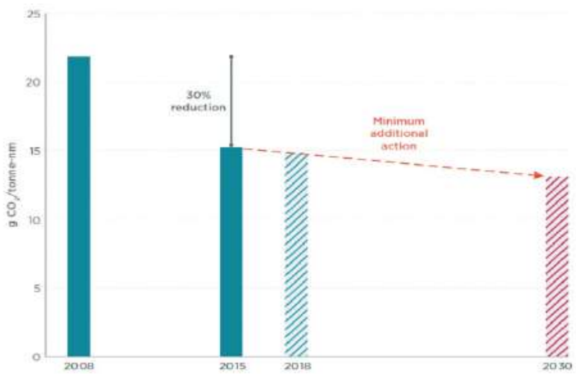


Figure 5: CO2 intensity of international shipping

An EPL of 40-50% would reduce CO2 emissions modestly, between 1% and 4%. Furthermore, an EPL scenario of 60% would reduce this emissions fleetwide in 2030 by 6%, if applied only to ships already in service in 2018 whereas for newer ships this reduction can be tripled.

Regarding the Shaft Power Limitation (SHaPoLi) system, it is an approved and verified system that limits the maximum shaft power through technical means. Shaft Power Limitation (ShaPoLi) serves as a strategy to curtail fuel consumption and greenhouse gas (GHG) emissions by restricting propeller shaft output power on vessels. It proves effective particularly when ships have excess installed propulsion power due to propeller redesign or multiple engines per shaft, optimising propulsion efficiency and blade design. ShaPoLi enhances fuel savings and contributes to CO2 emissions reduction by maximising the ship's propulsion system.

Integrating a ShaPoLi function into a vessel's propulsion control system offers a straightforward, cost-efficient means to swiftly comply with the new Energy Efficiency Existing Ship Index (EEXI) regulations. EEXI mandates reductions in carbon intensity across sailing fleets. Implementing ShaPoLi aligns with this regulatory measure by optimising propulsion systems, facilitating fuel efficiency, and subsequently reducing emissions in line with the EEXI requirements.Top of Form

The OICNW, or the ship's master, is the only person who has the authority to override this system in order to protect the ship's safety or save a life at sea.

> *Shaft Power Limitation (ShaPoLi) serves as a strategy to curtail fuel consumption and greenhouse gas (GHG) emissions by restricting propeller shaft output power on vessels*

According to MEPC.335(76) SHaPoLi system should consist of the following main arrangements:

1. sensors for measuring the torque and rotational speed delivered to the propeller(s) of the ship. The system includes the amplifier and the analogue to the digital converter;
2. a data recording and processing device for tracking and calculation of the data as given in paragraph 2.2.5.1 of these Guidelines; and
3. a control unit for calculation and limitation of the power transmitted by the shaft to the propeller(s)

Calculation of EEXI and CII

The Energy Efficiency Existing Ship Index (EEXI) utilises a methodology akin to the Energy Efficiency Design Index (EEDI) for new ships.

EEXI determines a vessel's CO2 emissions by standardising emissions concerning installed engine

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Course Fee & Schedule for DGS approved Courses at IMEI, Kolkata Branch

Sr. No.	Name of the course	Course Fee	Course Duration	Schedule
1.	Basic Training for Ships using Fuels covered within IGF Code (IGFB)	Rs.15,500/- (including lunch & one time Exit Examination fees)	5 days	8th September-12th September, 2025/ 13th October-17th October, 2025/ 10th November-14th November, 2025/ 8th December-12th December, 2025
2.	Crisis Management & Human Behaviour	Rs. 9,500/- (including lunch & one time Exit Examination fees)	5 days	15th September-19th September, 2025/ 7th -October-11th October, 2025/ 24th November-28th November, 2025/ 1st December-5th December, 2025
3.	Crowd management, Passenger Safety and Safety Training	Rs. 4,000/- (including lunch & one time Exit Examination fees)	3 days	1st September-3rd September, 2025/ 23rd October-25th October, 2025/ 17th November-19th November, 2025/ 15th December-17th December, 2025
4.	Security Training for Seafarer with Designated Security Duties (STSDSD)	Rs. 2,500/- (including lunch & one time Exit Examination fees)	2 days	4th September- 5th September, 2025/ 30th October-31st October, 2025/ 20th November-21st November, 2025/ 18th December-19th December, 2025
5.	Ship Security Officer (SSO)	Rs. 5,000/- (including lunch & one time Exit Examination fees)	3 days	22nd September-24th September, 2025/ 27th October-29th October, 2025/ 3rd November-5th November, 2025/ 22nd December-24th December, 2025

- **Discount of 5% for Group Booking of more than 5 candidates.**
- **Discount of 10% for Group Booking of more than 10 candidates.**
- **For IMEI Member, 10% Discount available.**
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- **If more candidates are available, we can schedule a special batch as and when required.**
- **Special Discount may be available for block booking and student candidates**

power, transport capacity, and ship speed. Calculation involves the main engine's installed power, fuel oil consumption, and a conversion factor translating fuel usage to CO2 mass.

The Carbon Intensity Indicator (CII) for a ship is calculated by dividing the total CO2 emitted by the total transport work completed in a calendar year. A vessel's performance rating is then assessed by comparing its operational carbon intensity against the average performance of similar ship types. Required reductions for each ship type are set to either increase or remain constant over time, ensuring the International Maritime Organization's (IMO) objectives for reducing emissions are met within the international shipping sector. This framework aims to incentivise and encourage improvements in vessel efficiency and emission reduction across various ship types to meet the IMO's established targets.

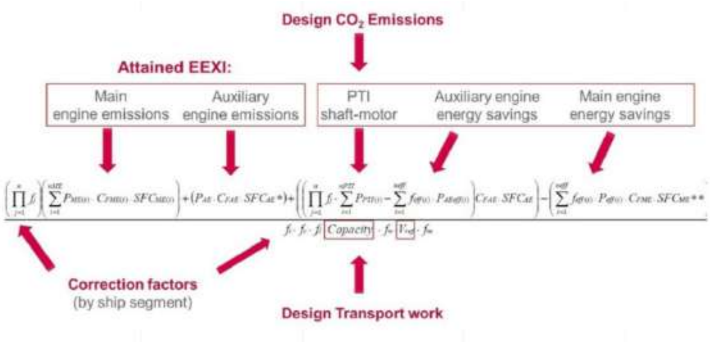

Figure 6: Calculation of CII

Conclusion

The maritime industry stands at a crucial juncture, striving to align with global sustainability goals through stringent regulations and innovative energy-efficiency measures. The International Maritime Organization (IMO) has spearheaded initiatives like the Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP), and Energy Efficiency Existing Ship Index (EEXI), aiming to reduce CO2 emissions from shipping while enhancing operational efficiency.

However, the successful implementation of these measures faces multifaceted challenges, ranging from technological and commercial barriers to disparities in resources and expertise, particularly in developing nations. The introduction of tools like Engine Power Limitation (EPL), Shaft Power Limitation (ShaPoLi), and Energy Saving Devices (ESDs) offers practical solutions, yet debates persist on their direct impact on emissions.

As the industry moves towards compliance with the IMO's emission reduction targets, ongoing collaboration, technology transfer, and capacity-building efforts remain pivotal. The path ahead demands a concerted effort among stakeholders to overcome barriers, adopt innovative technologies, and drive transformative changes for a sustainable future in maritime transportation.

[This paper was presented at the CC Marpol Conference, February 2024]

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Going Astern into MER Archives…

Cover: Launch of Sagar Bhushan from HSL.

The MER September 1985 issue starts with the Editorial talking about the SAR (Search & Rescue), EPIRB (Emergency Position Indicating Radio Beacon) and the proposal for employing the INMARSAT. Incidentally, the write-up mentions the absence of news about 2 Indian vessels.

The first article is on gas tankers highlighting the increase in builds but a dull market. This is followed by an article on Chemical tankers. There is some recallable information on the types of chemicals carried on board on a regular basis etc.

This is followed by a very interesting article on crane automation. This has relevance to present times when data mining and machine learning are being applied on cargo equipment. **In present scenario, automatic adjustments of container fasteners/stacking, automatic selection (controlling stability) of bulk cargo extraction from holds etc., are already being attempted.**

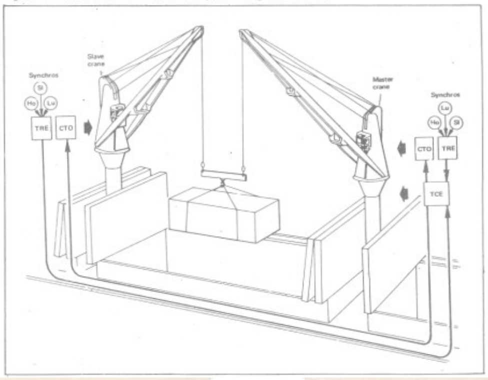
This is followed by a couple of articles on Naval warships.

Another interesting one is on elastomers, which are regularly used on ship equipment. The technical details connect well with the users (marine engineers).

A few other articles later we come to a Transaction on 'Closed Cycle Diesel Engine for Underwater Power'. The Nitro-Diesel proposal is interesting in principle for application in offshore etc., where underwater located engines could be better than those above with umbilical connections etc. If engineers have encountered similar machines, they may communicate.

POSTBAG has a few interesting letters on induction motors, financial management and robot ships.

Fig 1: Team cranes layout. Controls incorporate integrated circuits.



MER ARCHIVES SEPTEMBER 1985

Fig 2: The semi-automatic core probe for reels of paper.

Fig 3: Automatic container spreader equipped with a power swivel.

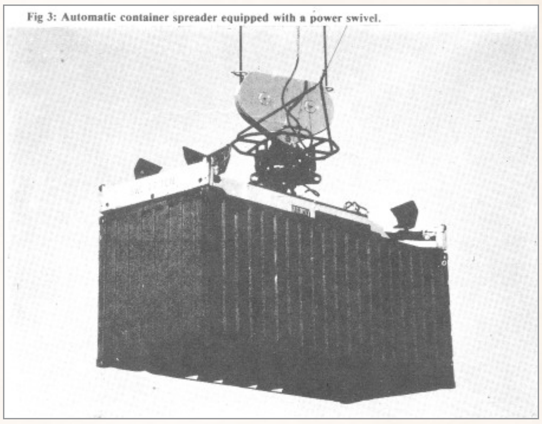
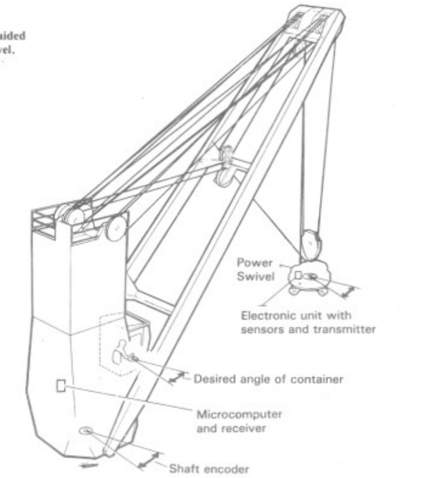


Fig 4: The Steadyline computer-aided power swivel.



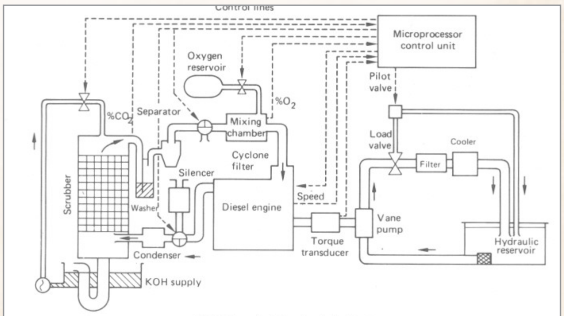


FIG. 1 Schematic of closed-cycle diesel system

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Timber deck cargoes—safety problems that need solving

Sir,
As a consultant ship surveyor I have, over the years, become involved with all aspects of the subjects discussed in the article by Mr W D Ewart on Security of Containerised Cargo (MER July 1985).

I would like to point out one or two aspects of timber deck cargoes which, to my mind, do not appear in current literature dealing with the subject.

Ships and crews have been lost when carrying timber deck cargoes because the cargo could not safely be jettisoned; it remained attached to the vessel.

The regulations which arose in the late 19th and early 20th centuries concerning the carriage of timber deck cargoes were devised with one principal object in view, namely, the safety of the ship and her crew keyed into the ability to jettison the cargo.

On the face of it, this remains the main technical object of the national and international regulatory authorities; but it is partly in conflict with the commercial and legal principles which cargo interests and the Courts would seek to impose on a shipowner, and partly in conflict with existing cargo carriage philosophies.

In an early 20th century sailing vessel or steamer, a full timber deck cargo might weigh no more than 200 t. The standards set for securing arrangements could handle that weight by keeping it safely on board in one block if required, and the standards set for releasing it deliberately to go overboard were basically adequate. The 'meat' of the regulations changed little over the years.

Following current regulations, the lashing arrangements cannot always adequately secure the weights of large timber deck cargoes carried in modern vessels. The means of deliberately and safely jettisoning the cargo are well nigh impracticable. If the cargo is lost (or part-lost) the shipowner pleads his compliance with the regulations but simple arithmetic can show that such lashing arrangements are basically inadequate.

For instance, take a reasonably beamy vessel of, say, 39 000 dwt, with 4000 t of packaged timber block-stowed on the weather-deck to a height of 4 m. The length of the stow will be about 120 m, and the regulations require cross-lashings at 3 m intervals: 41 in all. The weakest component of each lashing is required to bear an ultimate load of 14.1 t. You don't need to be a mathematician to appreciate that $41 \times 14.1 = 578.1$ t, ie, a holding power equal to only $14\frac{1}{2}$% of the static weight of the cargo!

Try to rationalise that result with the Loadline Rules (Deck Cargoes)—not timber deck cargoes—where the UK DTp require the holding power of the lashings to be at least three times the static weight of the cargo. If 4000 t of something other than timber were being carried on the weather-deck, the required holding power would therefore be at least 12 000 t; nearly 21 times greater than that required for the same weight in timber.

It's not that the '3-times-rule' for deck cargoes is too much (experience proves it to be about right); rather, it is a case where the current regulations for securing timber deck cargoes are sometimes inadequate with respect to the lashings' holding power when applied to relatively fast, modern, large cargo vessels if the object is to keep the cargo on board.

The regulations regarding the ability to release/jettison, the cargo overboard involve alternative arrangements of wiggle-wires and/or senhouse slips; the former supposedly operable from a remote position, and the latter requiring personnel to knock adrift the individual slips while standing on the upper surface of the stowage.

To those seafarers who have actually experienced a shift of a timber deck cargo to one side without the lashings breaking—but causing a list to the ship, such that it would have been a joy to let the whole lot go overboard—it is no news that wiggle-wires jam; and sending somebody across the surface of the cargo to knock free the senhouse slips means that you lose a seaman for every block of cargo that goes overboard! It is not so long ago since such a vessel arrived in a UK port with a list of 10 deg to starboard. The problem: how to release the senhouse slips?

A surveyor aboard this vessel could see nothing to prevent someone knocking free the senhouse slips with a sledge-hammer, until he was handed the hammer and requested to demonstrate how it should be done!

Although the slips were in good condition, complied in all senses with the regulations, and were in no way deformed, the sheer weight of the displaced cargo lying against the wire/chain lashings made it impossible for the slips to be released by men wielding heavy sledge-hammers from a large fenced cradle suspended from an overhead crane. In the event, the lashing wires had to be burned through with flame-cutting equipment used from the suspended cradle.

Like many marine technical problems, one's view of them depends upon whether you are in the camp of the cargo interests, the corridors of the regulatory authority, the office of the shipowner, or the Captain's cabin. And these particular problems cannot be settled until one area of conflict is resolved: Do we want to secure timber deck cargoes, in line with other deck cargoes, so that they will neither move nor tend to go overboard?

If the answer to that question is yes, is it reasonable to require a jettison system and, if the answer to that is also yes, do we design and implement a fool-proof system of deliberate quick-release of the cargo without danger to the ship's personnel? This would place upon the shipowner an absolute responsibility to deliver all the cargo to the port of destination, or, alternatively, to show that—as an essential characteristic of the ship's inherent seaworthiness—all or part of the cargo was deliberately jettisoned for sound seamanship reasons.

On the other hand, do we leave the current timber deck cargo regulations (so far as the lashing arrangements are concerned) intact? If so, will cargo interests and the Courts undertake not to hold the vessel in breach of seaworthiness, providing the regulations are complied with in full—even though they conflict with other deck cargo lashing regulations and go against the tide of mounting evidence as to their inadequacy?

In any event, will somebody please design and implement a method of deliberately jettisoning the cargo safely when this course of action is desirable?

While the foregoing problems remain to be solved, the peripheral questions as to the anomalies in the regulations regarding the use of timber uprights and metal corner brackets at the edges of stowages are really of little importance.

John R Knott

Liverpool.

Soft starting of induction motors

Sir,
The article on soft starting in the July issue (p5) was an unusually clear exposition of a technical subject; however, it was marred by several errors.

Fig 1 showed starting currents as 2% and 6% of FLC instead of 200% and 600%. Under the caption Fig 2, Fig 6 was printed, Fig 5 showed Fig 2 and Fig 6 showed Fig 5.

In the text it was stated that if there were two motors geared to a single shaft, and one tripped out, the other would be loaded to 20%, this should clearly have been over 200% (the original load on the motors plus the mechanical losses of the tripped machine).

The above errors were obvious from the contradictions in the text. However, they are not misleading in the way that two other statements by the authors are.

They claim that 'external means can be provided to switch off the device, when not required, to save power'. If by device they mean a motor, then there has never been any difficulty in providing remote start/stop facilities for any conventional starter. If they mean the starter itself, then conventional starters use no power when switched off. So it is impossible to see where the claimed advantage lies.

They also claim that 30% energy savings can be made with 'refrigeration and instrument air compressor applications'. In the Transactions Preprint of the paper, they

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explain that this is due to connecting the soft starter to a pressure switch so that the machine stops when the desired pressure is reached!

I have sailed on 20 ships, some of pre-war design, and I have never yet seen any compressor designed to be left running against its relief valve, as this claim suggests. In all modern ships the compressors, including those for air-conditioning and starting air, are controlled by pressure switches connected to unloading valves and/or a conventional starter.

P S Griffin

South Shields
Tyne & Wear.

● *Actually, Mr Griffin is also wrong with regard to the figures: Fig 2 showed Fig 5, Fig 5 showed Fig 6 and Fig 6 showed Fig 2. We apologise for the transposition of illustrations in the article, which was due to printer's production difficulties. Mr Griffin is quite correct to say that the motor would have been loaded to 200%, not 20%. Any inconvenience caused to readers is greatly regretted.*—Ed

Financial management

Sir,
The 1973 oil crisis that led to a severe world economic recession, marked the beginning of the worst shipping depression in history. The problem continues to be very much with us and has in fact been exacerbated over the years for several reasons:

- National governments subsidising their shipyards to support newbuildings in order to minimise unemployment in a largely labour-intensive industry and, hence, having political implications
- Fierce competition between banks committed to investment in shipping, thus encouraging shipowners to borrow and invest in new ships while prices are cheap
- Countries that had hitherto depended on foreign flags to service their needs, seizing the opportunity to acquire ships and developing their own merchant fleets
- Shipowners misjudging the character of the market and relying on past cyclic upturns which this time failed to materialise.

The plain fact, of course, is that the industry is in a turmoil because of chronic overcapacity. Unless something is done, the problem will not go away. Any upswing in world trade will merely result in more ships being ordered.

Among the solutions proposed, and which merit serious consideration, is that shipowners evolve a joint strategy in partnership with their shipbuilders and financial institutions, possibly including shippers as well, for concerted action. The better managed shipping companies would thus obtain a competitive advantage over their rivals. This is provided that financial institutions, in their own long-term interest, are willing to withhold support to inefficient operators, who would then be in no position to acquire ships.

Shipping is a dynamic activity—ever changing in response to new technology and world economic developments. As with any other business activity, the overall objective must be to make realistic profits: either through cost advantage, by the company being able to undercut its competitors; or by providing a differentiated product, with particular appeal, eg, offering a service that is superior and thus commands a premium price.

Technology is moving so fast, particularly through computer-aided design, that modern ships are significantly more economical to operate. There is little hope for much of the mothballed idle tonnage being re-called into service, or for the old uneconomical ships.

Surprisingly, many shipowners underestimate the high cost of maintaining an idle tonnage. Given the current real cost of capital and overheads—maintenance, staff wages, anchorage costs, deterioration and insurance risks—scrapping has much merit as a cost effective alternative. Companies can thus reduce their managerial burden and divert capital to more profitable endeavours.

May I echo the remarks made by Sir Adrian Swire, Chairman of ICS: 'Today's irresistible bargain becomes tomorrow's millstone to an owner who ignores normal investment criteria'.

B S Makhija

Marine Dept
Hong Kong Government

Robot ships

Sir,
Concerning your July 'Opinion' on the Japanese robot ship project and the MoD's radio controlled trawlers, the following historical reminder may be of interest.

In the 1930s, the old battleship *Centurion* was used as a target ship. After taking off the skeleton crew, the destroyer *Shikari* radio-controlled *Centurion* whilst the fleet shelled her. The destroyer had the capability to steer the battleship and to increase/decrease speed and manoeuvre her engines. After target practice the crew were put back onboard to repair any machinery damage; the critical compartments being protected by armour.

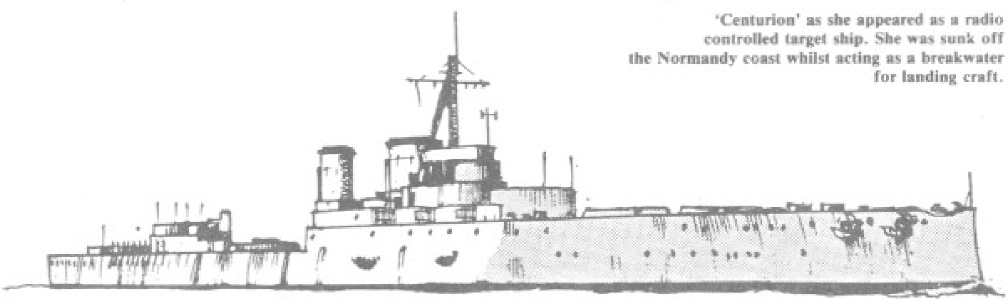
The skill of the technical staff was undoubtedly of a very high order in ensuring that the old boilers and steam machinery, normally labour-intensive in watchkeepers, behaved faultlessly whilst unattended and subjected to constant shock.

During late 1940 *Centurion,* disguised as a *King George V* battleship, steamed (manually) to the Bitter Lakes in the Suez Canal via the Cape, the Mediterranean being impassable. The Eastern Mediterranean fleet had suffered some disastrous losses and *Centurion*'s task was to make the fleet appear somewhat stronger than it actually was. The disguise was quite good apart from the enormous boat davits and ram bow which destroyed the *KGV* illusion when viewed silhouetted against the setting sun.

I believe, although I may be wrong, that this old battleship finished her long career as part of the protective breakwater at the Normandy beachhead.

Lt Cdr G T A Darley RN (rtd)

Plymouth



'Centurion' as she appeared as a radio controlled target ship. She was sunk off the Normandy coast whilst acting as a breakwater for landing craft.

We invite observations, discussion threads from readers, taking cues from these sepia-soaked MER pages. – Hon.Ed.

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