Royal Institution of Naval Architects

"Marine vessels and structures are technically complex and operate in a challenging environment. The Institution is committed to contributing to a reduction of their environmental impact and improving energy efficiency by providing guidance on their design, construction, maintenance and operation in order to achieve more sustainable use of resources and mitigate climate change."

"DESIGN FOR THE MARITIME ENVIRONMENT"

Environmental Considerations in the Design of Marine Vessels and Structures

Society expectation and regulation require that the maritime industry be fully sensitive to the environment through the reduction of gas emissions, contamination of the seas and more efficient use of sustainable resources. The thoughtful design and construction of marine vessels and structures can have significant influence in achieving these.

This aide memoire describes those aspects of marine vessels and structures that have an impact on the environment, and how that impact can be mitigated through design. It is intended to provide a broad overview of environmental design considerations and not a detailed reference to design and associated regulation.

Design Area	Design Objective	Design Aim	Design Achievement	Environmental Benefit
Hull Form	• Minimise fuel consumption. • Reduce wake • Maximise comfort	• Optimise hull form, appendages and strength for intended duty and speed. • Minimise hull resistance	• Use computer modelling • Use test tank • Give hull slippery coating • Review hull appendage requirement • Design appendages for minimum drag (streamline)	• Reduced emissions • Reduced seabed and coastal erosion
Hull Life	• Reduce maintenance, • Reduce material and energy requirements	• Design for predicted life, and consider materials used	• Select materials to be used based on past experience and technical recommendations • Use appropriate coatings • Sacrificial anodes and/or impressed current	• Reduced energy demand.
Propeller(s)	• Minimise fuel consumption • Reduce noise.	• Optimise propeller design for intended duty and speed • Optimise interaction with hull and rudder	• Choose propeller type - shafted, fixed thrusters, azimuth thrusters • Chose type of propulsion – mechanical or electric drive • Choose Ahead/astern drive or variable pitch • Model interaction with hull and rudders using test tank/computer simulation for all types of propeller specification and compare results • Apply effective algorithm for multiple propellers when manoeuvring	• Reduced emissions • Reduced seabed and coastal erosion • Reduced impact on marine life
Compartment division and configuration	• Maximise operational efficiency • Minimise time in harbour • Minimise human effort	• Arrange cargo configuration to provide ease of loading and unloading • Arrange bilge pumping system to separate potential	• Provide sufficient space/volume for cargo to be carried • Provide framing and structure sufficient to carry	• Reduced energy requirement • Increased safety • Eliminate pollution

	• Minimise use of material	pollutants from other systems. • Arrange compartments to maximise crew effectiveness in ship operation	specified cargo load in anticipated worst weather conditions • Optimise for single cargo or multi cargo carrying requirement.	
Superstructure	• Minimise wind resistance • Minimise windage effects for ship handling • Reduce fuel consumption	• Design for intended duty and speed	• Use wind tunnel testing of model. • Use computer simulation of wind effects on computer model • Provide comfortable and logical crews quarters • Meet hierarchy and gender accommodation requirements • Provide bridge with maximum visibility for safe ship operation • Consider aesthetic impact - pleasing to the eye	• Reduced emissions • Increased safety
Machinery Location	• Minimise maintenance and repair downtime • Minimise maintenance manpower and energy requirement	• Design for ease of installation, operation, repair and replacement • Optimise loading	• Pre-assign routes for machinery maintenance and removal • Provide efficient access and escape routes for crew • Provide protected routes/conduits for machinery controls and cables • Prescribe fall-back methods of operation in the event of machinery failure	• Reduced energy requirement
Machinery Uptakes and Downtakes	• Increase machinery efficiency • Reduce fuel consumption • Reduce noise	• Optimise to reduce friction and pressure losses and improve combustion efficiency	• Chose optimum locations for waste heat recovery systems	• Reduced emissions • Reduced noise pollution

Tank arrangements	• Reduce contamination risk • Minimise ship resistance/energy requirement • Minimise sullage discharge to sea	• Design to minimise spill risk • Configure for ease of liquid filling and transfer to optimise heel and trim • Design for ease of cleaning, sullage transfer and storage • Maximise integrity of fuel supplies to ships machinery • Avoid single skin separation from sea. • Position tanks containing pollutants away from side areas vulnerable to collision/allision damage • Build-in tank capacity for containment of accidental spills.and/or routine washing. • Include separation arrangements to reduce water content of reclaimed pollutants	• Arrange tanks for hull structural integrity for varying fill quantities	• Reduced emissions • Reduced risk of environmental damage • Reduced risk of propulsion failure resulting in pollution.
Coatings	• Maximise time between recoating • Extended ship life • Reduce energy requirements	• Specify long life eco-friendly low VOC paint systems • Use fuel saving coatings	• Review in-use paint systems and historic data • Review past experience with paint schemes	• Reduced impact on marine environment • Reduced emissions
Detailed design	• Reduce construction time and effort • Reduce use of materials	• Minimise number and scope of construction activities	• Liaise with shipbuilder for practical shipbuilding input and best construction methodology • Consider nesting of plates • Arrange best size of plates and framing with steel supplier	• Reduced energy requirement
Modern materials	• Reduce weight • Extend life • Reduce corrosion • Reduce fuel consumption	• Optimise material use. • Maximise use of lightweight and composite materials	• Refer to published works on state of the art materials and experience with them to date • Liaise with users of	• Reduced emissions • Reduced energy requirement

			lightweight and composite materials for experience gained • Refer to relevant conferences on modern materials	
Propulsion	• Reduce carbon based fuel consumption	• Maximise use of renewable energy sources	• Consider choice of propulsion - sails, wind turbines, solar panels, nuclear	• Reduced emissions
Modernisation and upgrades	• Allow for possible change requirements to initial design with minimal work	• Anticipate any changes that may be required during the ship life	• Liaise with shipowner for likely changing future ship tasking requirements	• Reduced material use • Reduced energy requirement
Recycling	• Minimise recycling effort and impact	• Maximise use of recyclable materials • Minimise use of toxic materials	• Incorporate a material and a recycling specialist into the design effort • Consider disposal requirements and toxicity of man made materials	• Reduced waste material • Reduced energy demand • Reduced toxin pollution