Environmental Issues for the Maritime Industry

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Overview of Environmental Issues & ABS Activities

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Environmental Issues Impacting Shipping & Shipbuilding

- Regulatory Compliance
  - Emissions – MARPOL Annex VI
  - Ballast Water – BWM Convention
  - Recycling – Recycling Convention

- Energy efficiency and carbon emissions
  - IMO regulatory development
  - Industry initiatives
Environmental Issues Impacting Shipping & Shipbuilding

- Environmentally-friendly designs and operations combine regulatory compliance and energy efficiency
- ABS Guide for Environmental Protection (ENVIRO, ENVIRO+)
Emissions

- Impact of MARPOL Annex VI and Regional Regulations
  - NOx: Engine selection (Tier II, Tier III)
  - SOx: Fuel system design (HFO, LSFO, MDO/MGO)
  - Fuel switching (California, EU ports, ECA)
- Alternatives
  - Exhaust gas cleaning systems
  - Alternative fuels and propulsion
  - Cold ironing
Drivers for Search for Alternative Fuels

- Regulatory developments
- Fuel price uncertainty
- Initiatives for environmentally-friendly operation
- Demonstration of corporate social responsibility

Source: Poten & Partners, Inc.
MARPOL Annex VI: Emission Control Areas

- North Sea and Baltic ECA
- North America ECA extends 200 nm from coastline – August 2012
- ECA sulfur limit in 2015 is 0.1%
IMO CO₂ Regulatory Development

- Technical measures: EEDI, EEOI, SEEMP
- Market-based measures
- If IMO fails to introduce mandatory measures local and regional measures may be introduced to regulate CO₂ from shipping
- Price on CO₂
- Further motivation for alternatives
Alternatives

- Technology in development
  - Fuel cells
  - Bio fuel
  - Solar
  - Wind

- Available technology
  - Nuclear
  - LNG
Relative Cost of LNG vs. HFO

- Cost advantage of LNG fuel at the current level outweigh the increase of the initial investment and additional maintenance cost

<table>
<thead>
<tr>
<th>Cost</th>
<th>LNG vs HFO</th>
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<tbody>
<tr>
<td>Capital</td>
<td>High</td>
</tr>
<tr>
<td>Maintenance</td>
<td>High</td>
</tr>
<tr>
<td>Fuel</td>
<td>Low</td>
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</table>
ABS Activities

- ABS Guides under development
  - Cold Ironing and Alternatives
  - Gas Fueled Power Plants
  - Fuel Cell Powered Ships
  - Hybrid Propulsion

- ABS Advisory published
  - Fuel Switching Advisory Notice

- ABS Guide for Propulsion Systems for Gas Carriers
Ballast Water

- BWM Convention
  - Closer to entry into force
  - New construction installations
  - Installations on existing vessels
BWT System Selection

- Evolving technology with little in-service experience
- Selection of a system that best suits the demands of the ship and service
- Cost of the system, installation, operation
- Availability of the system, support, parts for maintenance
- ABS BWT Advisory Notice
US Ballast Water Regulations

- Several national regulations and numerous regional jurisdictions
- Adding uncertainty to owners trading in US waters
- ABS Advisory on US National and State Regulations for Ballast Water
BWT System Approval: Administration

- Documentation review and approval
- Environmental testing by an approved laboratory
- Land-based and shipboard performance testing
- **Type Approval Certificate**
- **BWM Certificate**
BWT System Approval: Administration

- Additional approval process for systems with active substances
- Basic approval: no unacceptable risk to the environment, human health, property, resources
- Final approval: further evaluation of risks and cumulative effects
- GESAMP-BWWG
BWT System Approval: Class

- Compliance of the system and its integration to vessel systems with class requirements
- **ABS Guide for Ballast Water Treatment**
Recycling

- International Convention for the Safe and Environmentally Sound Recycling of Ships
  - Entry into force requires ratification by States with GT and States with recycling capacity and will take some time
  - Convention requires:
    - Inventory of hazardous materials
    - Approval of recycling facilities
    - Approval of ship for recycling
  - Optional early compliance
- ABS Ship Recycling Guide update under development
Energy Efficiency & Carbon Emissions

- MEPC60
  - Draft amendment to MARPOL Annex VI making the energy efficiency design index (EEDI) and ship energy efficiency management plan (SEEMP) mandatory
  - Establish expert group on GHG market-based measures (MBM)
  - Many considered the time used for technical discussion on EEDI evaluation inadequate
Energy Efficiency Design Index (EEDI)

- Objective to stimulate innovation and technical development
- Speed limit for the seas?
  - Speed reduction easiest way to improve the index
  - Different from slow steaming
- Not sensitive to changes in steel weight

Engine Power \times SFC \times CF

\text{Capacity} \times \text{Speed}

$y = 1950.7x^{0.5337}$

$R^2 = 0.9687$

1ABS/HEC Study: Influence of Design Parameters on the EEDI
Ship Energy Efficiency Management Plan (SEEMP)

- Approach to monitor, manage and improve energy efficiency of a ship’s operation
- Best practices for fuel-efficient operations of ships
- Company-specific: integral element of a broader company’s environmental management system
- Ship-specific, preferably
- Four-steps: planning, implementation, monitoring and self-evaluation/improvement
- **Examples of energy efficiency measures:** weather routing, trim adjustment, hull and propeller cleaning intervals
- **ABS is reviewing performance monitoring tools available at various levels of complexity**
Energy Efficiency

Engine
- Improving engine fuel efficiency
- Waste heat recovery
- Low load operations
- Engine de-rating

Propeller
- Propeller optimization
- Cleaning
- Speed optimization

Hull
- Hull shape optimization
- Anti-fouling coatings/cleaning
- Air bubble lubrication
- Weather routing/trim optimization

Alternative Energy Source
- Gas
- Renewable energy
- Shore power

Engine losses
- Heat
- Exhaust
- Transmission loss

Propeller losses
- Frictional loss
- Rotational loss
- Axial loss
- Weather & waves
- Residual resistance

Hull losses
- Hull resistance
- Air resistance
- Wave generation

Loss % (Bunker = 100%)
Some CFD Applications

- Effect due to different distance between propeller and rudder
  - J = 0.833, propeller-rudder distance: 0.9D, 1.0D, 1.1D

<table>
<thead>
<tr>
<th>J = 0.833</th>
<th>Propeller $K_t$</th>
<th>Rudder Resistance</th>
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<tbody>
<tr>
<td>Open propeller</td>
<td>0.1598</td>
<td></td>
</tr>
<tr>
<td>Prop/rudder 0.9D</td>
<td>0.1784</td>
<td>0.00526 2.95% $K_t$</td>
</tr>
<tr>
<td>Prop/rudder 1.0D</td>
<td>0.1778</td>
<td>0.00474 2.67% $K_t$</td>
</tr>
<tr>
<td>Prop/rudder 1.1D</td>
<td>0.1772</td>
<td>0.00448 2.53% $K_t$</td>
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</table>
Some CFD Applications

- Propeller/hull interaction
Communicating with Industry

- Joint development projects
- ABS seminars worldwide
- Conferences
- ABS Chairman of IACS EG/Environment
Eco-friendly & Energy Efficient Ships

**Engine room discharges**
- bilge water; oily water; waste oil, accidental bunker discharge, cooling water, seepage thru machinery seals

**Engine and combustion emissions**
- SOx, NOx, PM, CO₂

**Discharges from accommodations**
- sewage; gray water; garbage disposal; refrigerant leakages

**Cargo-related discharges**
- oil; chemical; tank washing; accidental discharges; cargo in packaged form; vapor emission

**Ballast water discharges**
- transfer of harmful non-indigenous marine species

**Deck discharges**
- cargo residue deck cleaning/washing anchor and chain washing

**Hull coating**
- anti-fouling coating

**Ship recycling**
- safety and pollution to recycling facilities

**Bio-fouling**
- transfer of non-indigenous marine species

**Other**
- underwater noise collision with whales
- emission during fire
- shipbuilding and ship repair facilities

**CO₂ emission reduction**
- ships’ energy efficiency (design and operational)
- CO₂ reduction market-based measures

**Note:** Red categories addressed by **ENVIRO** and **ENVIRO+** notations