Energy Efficient Safe SHip OPERAtion

WP6: Application / Case Studies

Dr. Reddy DN
Lloyd’s Register
Background
WP6 - Objectives
WP6 - Roles of Participants
WP6 - Overview
Task 6.1 – Identification of cases to be investigated
Task 6.2 – Case Studies
Task 6.3 – Evaluation of Case Studies
Task 6.4 – Assessment and analysis of project results
Action plan & Way Ahead
Energy Efficiency Design Index (EEDI) Reference lines as a function of DWT

Table 1 Reduction factors (in percentage) for the EEDI relative to the EEDI Reference line

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Size</th>
<th>Phase 0 1 Jan 2013 – 31 Dec 2014</th>
<th>Phase 1 1 Jan 2015 – 31 Dec 2019</th>
<th>Phase 2 1 Jan 2020 – 31 Dec 2024</th>
<th>Phase 3 1 Jan 2025 and onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk carrier</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Gas carrier</td>
<td>10,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>10,000 – 20,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>2,000 – 10,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Tanker</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4,000 – 20,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Container ship</td>
<td>15,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>15,000 – 15,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td>General Cargo ships</td>
<td>15,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>3,000 – 15,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-15*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Refrigerated cargo carrier</td>
<td>5,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>3,000 – 5,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-15*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Combination carrier</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4,000 – 20,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
</tbody>
</table>

*Reduction factor to be linearly interpolated between the two values dependent upon vessel size. The lower value of the reduction factor is to be applied to the smaller ship size. n/a means that no required EEDI applies.
Achieving the required EEDI:
- One of the options is to reduce the installed power (in other words through DESIGN Speed Reduction)
### Energy Efficiency Design Index (EEDI) Reference lines as a function of DWT

**Table 1 Reduction factors (in percentage) for the EEDI relative to the EEDI Reference line**

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Size</th>
<th>Phase 0 1 Jan 2013 – 31 Dec 2014</th>
<th>Phase 1 1 Jan 2015 – 31 Dec 2019</th>
<th>Phase 2 1 Jan 2020 – 31 Dec 2024</th>
<th>Phase 3 1 Jan 2025 and onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk carrier</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>10,000 – 20,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>10,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2,000 – 10,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>0-4,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>4,000 – 20,000 DWT</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>15,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>10,000 – 15,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>15,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>3,000 – 15,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>5,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>3,000 – 5,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td></td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>0-4,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Container ship</td>
<td>2,000 – 20,000 DWT</td>
<td>n/a</td>
<td>0-10*</td>
<td>0-20*</td>
<td>0-30*</td>
</tr>
<tr>
<td>Gas carrier</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination carrier</td>
<td>Logics and Technical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Reduction factors are linearly interpolated between the two values dependent upon vessel size. The lower value of the reduction factor is to be applied to the smaller ship size. n/a means that no required EEDI applies.

### Number of ships considered for EEDI and Minimum power formulations

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>EEDI formulations</th>
<th>Min. Power formulations (Level 1 for Phase 0)</th>
<th>Ships excluded in Phase 0</th>
<th>Ships excluded after Phase 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Carrier</td>
<td>2512</td>
<td>2361</td>
<td>151</td>
<td>78</td>
</tr>
<tr>
<td>Gas Carrier</td>
<td>354</td>
<td>167</td>
<td>187</td>
<td>39</td>
</tr>
<tr>
<td>Tanker</td>
<td>3655</td>
<td>2210</td>
<td>1445</td>
<td>311</td>
</tr>
<tr>
<td>Container ship</td>
<td>2406</td>
<td>1864</td>
<td>542</td>
<td>217</td>
</tr>
<tr>
<td>General Cargo ship</td>
<td>1932</td>
<td>154</td>
<td>2086</td>
<td>405</td>
</tr>
<tr>
<td>Refrigerated cargo carrier</td>
<td>61</td>
<td>47</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Combination carrier</td>
<td>3661</td>
<td>2216</td>
<td>1445</td>
<td>311</td>
</tr>
</tbody>
</table>
Background

Energy Efficiency Design Index (EEDI) Reference lines as a function of DWT

Table 1 Reduction factors (in percentage) for the EEDI relative to the EEDI Reference line

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Size</th>
<th>Phase 0 1 Jan 2013 - 31 Dec 2014</th>
<th>Phase 1 1 Jan 2015 - 31 Dec 2019</th>
<th>Phase 2 1 Jan 2020 - 31 Dec 2024</th>
<th>Phase 3 1 Jan 2025 and onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk carrier</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>10,000 - 20,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td></td>
<td>10,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2,000 - 10,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td>Gas carrier</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4,000 - 20,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td>Tanker</td>
<td>15,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>10,000 - 15,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td></td>
<td>3,000 - 15,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td>General Cargo ships</td>
<td>20,000 DWT and above</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5,000 - 10,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td>Refrigerated cargo carrier</td>
<td>3,000 - 5,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
<tr>
<td>Combination carrier</td>
<td>4,000 - 20,000 DWT</td>
<td>n/a</td>
<td>0 - 10*</td>
<td>0 - 20*</td>
<td>0 - 30*</td>
</tr>
</tbody>
</table>

*Reduction factor to be linearly interpolated between the two values dependent upon vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

Level 1: Empirical Formulations as a function DWT
- pocket calculator

Level 2: Simplified Assessment
- model tests in regular waves in head seas,
- Spread sheet calculations

Level 3: Comprehensive Assessment
- model tests and/or numerical computations

Only Level 1 and 2 are in the guidelines, that too only for Bulk Carriers and Tankers & Combination Carriers
WP6: Objectives

WT3: Work package description

WP6: Application / Case Studies

1. Conduct investigations on the impact of the proposed new guidelines for the assessment of the minimum propulsion power to maintain manoeuvrability in adverse conditions on the design and operational characteristics of various ship types, by implementation of the developed integrated/holistic optimisation procedure in a series of case studies.

2. To assess in addition ship types currently not covered by the EEDI provisions, like tugs and Offshore Support Vessels.

3. To assess and analyse the results of all work packages, leading to the development of new guidelines for the required minimum propulsion power and steering performance to maintain manoeuvrability in adverse conditions.

4. To establish minimum propulsion power / steering performance and likely new EEDI requirements ensuring safe operation for various types of ships.

Description of work and role of partners

Task 6.9 Technical Management (LR)
- LR will be responsible for the technical management of the WP and for the coordination of its technical interventions with the other WPs. This will include the management of the required contributions by all involved partners, as follows:
- Ship designers (including shipyards participating through their design departments, i.e. FOS, UI, NLP) will have a leading role in the case studies (T6.2). They will therefore also be involved in the identification of the case studies and the assessment of the results (T6.3 and T6.4).
- Operations (DNV, P&F, CAL) will participate in the case studies (T6.2) providing actual operational data and their contribution will be particularly valuable also in T6.1 where they will provide input from the commercial/industrial side for the definition of the case studies for the various ship types. Similarly, in T6.3 and T6.4 they will participate in the evaluation and analysis of the results, providing the synthesis of the industry’s viewpoint.
- The role of classification societies (GL, DNV, LR, RINA) will also be important in all four Tasks due to their strong technical background in design support and consultancy, and especially in the related regulatory framework. They will therefore have an important role in the identification and the implementation of the case studies (T6.1) and a leading role in the evaluation and analysis of the results (T6.3 and T6.4).
- Universities (NTUA, IST, UDE, SU) have a leading role in WP2, WP4 and WP6, and their participation in the identification of the case studies (T6.1) and in the analysis of the results (T6.3 and T6.4) will be vital. In particular, the role of NTUA will be particularly increased in the analysis of the results due to its role as project coordinator, as this activity will represent the culmination of the entire project’s technical output. NTUA, IST and SU will also participate in the case studies (T6.2), based on their strong ship design background. Overall, this Task will link all the other Tasks within the WP as well as the WP to the other ones, ensuring the smooth progress of the technical work.
3. To assess and analyse the results of all work packages, leading to the development of new guidelines for the required minimum propulsion power and steering performance to maintain manoeuvrability in adverse conditions.

4. To establish minimum propulsion power / steering performance and likely new EEDI requirements ensuring safe operation for various types of ships.
### WP6: Roles of Participants

#### WP Leader
- LR
- Technical management of the WP 6 & the required contributions by all
- Co-ordination of its technical interrelations with the other WPs
- WP 6 – Culmination of the entire Project’s technical output

#### Designers
- FSG • ULJ • NAP
- (12) (18) (12)
- Provision of expertise in identification of the case studies T6.1
- Leading role in the case studies through provision of Ship data T6.2
- Background expertise in assessment of the results T6.3 & T6.4

#### Operators
- DAN • FNK • CAL
- (10.2) (5) (8.1)
- Commercial/Industry input for the definition of the case studies T6.1
- Leading role in provision of operational data for case studies T6.2
- Evaluation and analysis of the results through synthesis of the industry’s viewpoint T6.3 & T6.4

#### Classification Societies
- DNV • GL • LR • RINA
- (9) (10) (14) (8)
- Important role in identification & implementation of the case studies due to strong technical background in design support and consultancy, and especially in the related regulatory framework T6.1 & T6.2
- Leading role in the evaluation and analysis of the results T6.3 & T6.4

#### Universities
- NTUA • IST • UDE • SU
- (7) (4.5) (1.5) (8)
- Participation in identification of the case studies T6.1
- Participate in case studies (NTUA, IST & SU – Design background) T6.2
- Analysis of results (leading role in WP2, WP4 & WP5) T6.3 & T6.4

---

DoW (P30–31): SU is omitted inadvertently

<table>
<thead>
<tr>
<th>Partners</th>
<th>14 out of 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person months</td>
<td>127.3 out of 514.8 pm</td>
</tr>
<tr>
<td>Deliverables</td>
<td>12 out of 50</td>
</tr>
</tbody>
</table>
### WP6: Overview Schedule

#### SHOPERA WP6 2013 2014 2015 2016

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T6.1</td>
<td>Identification of cases to be investigated</td>
<td>LR</td>
<td>D6.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.2</td>
<td>Case studies</td>
<td>GL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.3</td>
<td>Evaluation of case studies</td>
<td>LR</td>
<td>D6.2 to D6.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.4</td>
<td>Assessment &amp; Analysis of project results</td>
<td>DNV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key:***
- **LR**: Lloyd's Register
- **DNV**: Det Norske Veritas
- **GL**: Guvna Lloyd

**Months:**
- J: January
- F: February
- M: March
- A: April
- M: May
- J: June
- A: July
- S: August
- O: September
- N: October
- D: November
- J: December
- 01: January
- 02: February
- 03: March
- 04: April
- 05: May
- 06: June
- 07: July
- 08: August
- 09: September
- 10: October
- 11: November
- 12: December
### Possible Reallocation of Resources within WP6

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>NTUA</th>
<th>GL</th>
<th>DNV</th>
<th>LR</th>
<th>IST</th>
<th>UDE</th>
<th>RINA</th>
<th>FSG</th>
<th>ULJ</th>
<th>SU</th>
<th>NAP</th>
<th>DAN</th>
<th>FNK</th>
<th>CAL</th>
<th>PM (DoW)</th>
<th>Reallocation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Number</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>T6.1: Identification of cases to be investigated</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>2.0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>9.5</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>T6.2 Case studies</td>
<td>2.5</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>1.7</td>
<td>3.0</td>
<td>6.0</td>
<td>9.0</td>
<td>3.0</td>
<td>6.0</td>
<td>6.0</td>
<td>2.2</td>
<td>3.0</td>
<td>87.1</td>
<td>51.4</td>
<td></td>
</tr>
<tr>
<td>T6.3 Evaluation of case studies</td>
<td>1.0</td>
<td>4.0</td>
<td>3.0</td>
<td>5.0</td>
<td>1.0</td>
<td>0.1</td>
<td>3.0</td>
<td>4.2</td>
<td>6.2</td>
<td>3.2</td>
<td>4.2</td>
<td>2.4</td>
<td>1.0</td>
<td>3.3</td>
<td>15.1</td>
<td>41.6</td>
</tr>
<tr>
<td>T6.4 Assessment &amp; Analysis of project results</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.6</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>15.6</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>Dissemination</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td><strong>Total Person Months (DoW)</strong></td>
<td>7.0</td>
<td>10.0</td>
<td>9.0</td>
<td>14.0</td>
<td>4.5</td>
<td>1.5</td>
<td>8.0</td>
<td>12.0</td>
<td>18.0</td>
<td>8.0</td>
<td>12.0</td>
<td>10.2</td>
<td>5.0</td>
<td>8.1</td>
<td>127.3</td>
<td>127.3</td>
</tr>
</tbody>
</table>

**SHOPERA – WP6**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T6.1: Identification of cases to be investigated</td>
<td>LR</td>
<td>D6.1</td>
<td>D6.1</td>
<td>D6.2 to D6.10</td>
</tr>
<tr>
<td>T6.2 Case studies</td>
<td>GL</td>
<td>D6.2</td>
<td>D6.11</td>
<td></td>
</tr>
<tr>
<td>T6.3 Evaluation of case studies</td>
<td>LR</td>
<td>D6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.4 Assessment &amp; Analysis of project results</td>
<td>DNV</td>
<td>D6.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task 6.1
Identification of cases to be investigated

WP6: Application/Case Studies

<table>
<thead>
<tr>
<th>Task</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP6.1: Identification of cases to be investigated</td>
<td>LR</td>
<td>D6.1</td>
<td>D6.2 to D6.11</td>
<td></td>
</tr>
<tr>
<td>WP6.2 Case Studies</td>
<td>GL</td>
<td>D6.2</td>
<td>D6.12</td>
<td></td>
</tr>
<tr>
<td>WP6.3 Evaluation of Case Studies</td>
<td>LR</td>
<td>D6.3</td>
<td>D6.13</td>
<td></td>
</tr>
<tr>
<td>WP6.4 Assessment &amp; Analysis of project results</td>
<td>DNV</td>
<td>D3.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task 6.1
Identification of cases to be investigated

High-level criteria

- Vulnerability – Manoeuvrability in adverse sea conditions
  - Coastal, Open seas
- Representativeness – Realistic and of commercial interest in practice for each ship type.
  - Based on T1.2, Accident statistics
  - No of ships in each category (Aframax, etc)
- Variability:
  - Each ship type in sizes and characteristics
  - Bow shape (fine or blunt body)
- Link to current EEDI regulations: Priority target ship types
- Propulsion system characteristics – manoeuvring responsiveness
  - Diesel vs steam turbine for gas carriers, and
  - Various propeller types vs azimuths for passenger vessels/tugs

Detailed criteria

- Deadweight (Loading condition)
- Block coefficient
- Immersed rudder area
- Above waterline area
- Water entry angle (i.e. stem)

Length, Speed?
### Task 6.1
Identification of cases to be investigated

| Subtask 6.2.1 | • Bulk carriers | DNV | D6.2 |
| Subtask 6.2.2 | • Container ships | GL | D6.3 |
| Subtask 6.2.3 | • Tankers | LR | D6.4 |
| Subtask 6.2.4 | • Cruise ships | RINA | D6.5 |
| Subtask 6.2.5 | • Ro-Ro Ferries | NAP | D6.6 |
| Subtask 6.2.6 | • OSVs | FSG | D6.7 |
| Subtask 6.2.7 | • Fishing vessels | ULJ | D6.8 |
| Subtask 6.2.8 | • Tugs | NAP | D6.9 |
| Subtask 6.2.9 | • Gas carriers | ULJ | D6.10 |
## Subtask 6.2.1
- Bulk carriers
  - DNV D6.2
  - 130m, 200m, 300m

## Subtask 6.2.2
- Container ships
  - GL D6.3
  - 200m, 300m

## Subtask 6.2.3
- Tankers
  - LR/ULJ? D6.4
  - 150kGT, 250kGT
  - Two Prop Arr.

## Subtask 6.2.4
- Cruise ships
  - RINA D6.5
  - 130m, 200m+
  - Two Prop Arr.

## Subtask 6.2.5
- Ro-Ro Ferries
  - NAP D6.6
  - 130m, 200m+
  - Two Prop Arr.

## Subtask 6.2.6
- Ro-Ro Cargo ships
  - FSG? D6.7
  - 130m, 200m+
  - Two Prop Arr.

## Subtask 6.2.7
- General Cargo ships
  - ULJ? D6.8
  - 80m, 120m, 160m

## Subtask 6.2.8
- Car Carriers
  - NAP? D6.9
  - 130m, 200m+
  - Two Prop Arr.

## Subtask 6.2.9
- Gas carriers–LNG
  - NAP? D6.10
  - 130m, 200m+
  - Twin screw

## Subtask 6.2.10
- Gas carriers–LPG
  - LR? D6.11
  - 130m, 200m+
  - Twin screw
Level 1: Existing Guidelines

Bulk Carriers

Phase 0: >20k DWT
Phase 1: >10k DWT

Installed Power [Kw] vs Deadweight [T]

- **IACS-Table1 of MEPC 64/4/13**
- **Japan & Korea-Table 1 of MEPC 44/4/42**
- **All BGs within 2σ above the line**
- **Linear (POWER)**

Equation:

\[ y = 0.0687x + 2924.4 \]
Effect of Level 1 on Level 2

Phase 0: 1 Jan 2013–31 Dec 2014

- 10k DWT
  - Hs=5.5m, Vw=19.0m/s
- 113 m
- 3460 Kw

Phase 1: 1 Jan 2015–31 Dec 2019

- 20k DWT
  - Hs=4.0m, Vw=15.7m/s
- 141 m
- 5032 Kw

MEPC 65/ WP.10, ANNEX 5 (2013)

- Power = 23.848x^{0.5404}
  - R² = 0.9227
- LBP = 6.3656x^{0.3125}
  - R² = 0.963

Bulk Carriers

Phase 1: 1 Jan 2015–31 Dec 2019
Is speed an issue to be looked into?

Bulk Carriers
Phase 0: 1 Jan 2013–31 Dec 2014

- Speed = 0.3621ln(x) + 10.381
- \( R^2 = 0.1986 \)

Phase 1: 1 Jan 2015–31 Dec 2019

- Power = 23.848x^{0.5404}
- \( R^2 = 0.9227 \)

Installed Power [kW]
Deadweight [T]

10000 DWT
14.0 Kn
5032 KW
5032 KW
13.7 Kn
3460 kW

- 10000 DWT
- 20000 DWT
Task 6.2
Case studies

WP6: Application/Case Studies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T6.1: Identification of cases to be investigated</td>
<td>LR</td>
<td>D6.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.2 Case Studies</td>
<td>GL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.3 Evaluation of Case Studies</td>
<td>LR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6.4 Assessment &amp; Analysis of project results</td>
<td>DNV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Task 6.2
Results – Case Studies

D6.2–11 [M13–31]
• By applying the appropriately selected tools (WP2 ?)
• By implementing the developed optimisation procedure (WP4&5? )
• With reference to the conditions (Env) defined by WP1, corresponding to priority open sea areas as well as focusing also on the effects of shallow water.

Safety issues or shortcomings for certain ship types or segments, related to inadequate manoeuvrability, will therefore be identified, which will allow specific conclusions to be drawn and subsequent recommendations to be made for each ship type in relation to minimum propulsion power and steering performance to maintain manoeuvrability in adverse conditions.

• Which tools (?), and are these tools made available to all the participants in WP6 ? Revised Level 1 &2 ?
• If the developed optimisation procedure includes model tests, do we expect participants to have model test data for all the case studies ? Not !
WP6: Application/Case Studies

<table>
<thead>
<tr>
<th>WP6:</th>
<th>Application/Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WP6.1:</strong> Definition of case studies (Criteria &amp; Consideration)</td>
<td>D6.1 - M9-12</td>
</tr>
<tr>
<td><strong>WP6.2:</strong> Case Studies</td>
<td>D6.2-11 - M13-31</td>
</tr>
</tbody>
</table>

**Task 6.3**
Evaluation of Case Studies

**T6.4 [M31-35]:**
Assessment & Analysis of project results

**D6.12 [M33]:**
Consolidated report (overall results & conclusions)

**T6.1 [M35-36]:**
Case Studies

**T6.2 [M36-37]:**
Evaluation of Case Studies

**T6.3 [M31-36]:**
Task 6.3

**T6.4 [M31-35]:**
Assessment & Analysis of project results

**D6.12 [M33]:**
Consolidated report (overall results & conclusions)
Task 6.3
Evaluation of case studies

- Impact of the minimum power requirements on the design and on the operational characteristics of the studied ship types
- Generation of requirements for installed power and efficiency of steering and propulsion devices
- Suggested new EEDI curves if necessary
- Assessment of any issues arising from the need to simultaneously comply with potentially conflicting requirements (safety and energy efficiency)
Task 6.4
Assessment & Analysis of project results

WP1: Env. Conditions & req. for diff ships
WP2: Dev. & Ref. of Num. tools
WP3: Exp. Studies
WP4: Val, Sensitivity studies & L1 methods
WP5: Intgn. of tools – Multi objective opt.

WP6: Application/Case Studies

<table>
<thead>
<tr>
<th>WP6.1</th>
<th>WP6.2</th>
<th>WP6.3</th>
<th>WP6.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of cases to be investigated</td>
<td>Case Studies</td>
<td>Evaluation of Case Studies</td>
<td>Assessment &amp; Analysis of project results</td>
</tr>
<tr>
<td>D6.1</td>
<td>D6.2-11</td>
<td>D6.12</td>
<td>D6.13</td>
</tr>
</tbody>
</table>

Task 6.4
Assessment & Analysis of Proj. Results

D6.13 [M35] Assessment and Analysis of Results

T8.1 [M35-36]:

WP6: Application/Case Studies

<table>
<thead>
<tr>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D6.1: Identification of cases to be investigated LR
D6.2: Case Studies GL
D6.3: Evaluation of Case Studies LR
D6.4: Assessment & Analysis of project results DNV
Task 6.4
Assessment and analysis of project results

Trends of safety criteria compared with statistics of existing ship designs
- environmental conditions
- ship type and size
- installed power
- efficiency of steering devices
- windage area

Safety level provided by developed criteria compared with:
- present safety level of different ship types
- safety level implied by the existing criteria and standards for manoeuvrability and intact stability as function of ship type and size

Safety level defined in terms of probability of failure by relating the required adverse conditions to met-ocean data from WP1.

Relevant criteria and recommendations for rational safety standards provided, acceptable both for industry and for regulators.
Task 6.1: Identification of case studies

Firming up of Ship types for case studies, Criteria & Champions (Meeting of all sub task leaders ?)  
M08 (May14)

Firming up of
• High level & Detailed criteria for different ship type case studies  
• Effort allocations for each sub tasks for each participant  
M10 (Jul 14)

Submission of Deliverable D6.1 for review  
M11 (Aug14)
Energy Efficient Safe SHip OPERAtion

WP 6: Application / Case Studies

Dr. Reddy D N
Lloyd’s Register