Introduction to
DSME R&D Institute

Daewoo Shipbuilding & Marine Engineering Co., Ltd.
1. DSME Introduction

### DSME, World Leader in Ocean Technology

<table>
<thead>
<tr>
<th>Company name</th>
<th>Daewoo Shipbuilding &amp; Marine Engineering Co., Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of incorporation</td>
<td>October 11, 1973</td>
</tr>
<tr>
<td>Revenue</td>
<td>Over 14 billion USD (2013)</td>
</tr>
<tr>
<td>Yard</td>
<td>5 million m$^3$</td>
</tr>
<tr>
<td>Employees</td>
<td>40,000 (Design and research engineers : 4,000)</td>
</tr>
<tr>
<td>Production capacity</td>
<td>Commercial vessels : 70 vessels / year</td>
</tr>
<tr>
<td></td>
<td>Specialty vessels : 5 vessels / year</td>
</tr>
<tr>
<td></td>
<td>Offshore &amp; onshore plants : 10 units / year</td>
</tr>
<tr>
<td>Website</td>
<td><a href="http://www.dsme.co.kr/">http://www.dsme.co.kr/</a></td>
</tr>
</tbody>
</table>

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1. DSME Introduction

### Affiliates & Overseas Branch Office

- **Overseas Branch Offices**
- **Local Affiliates**
- **Domestic Affiliates**
- **Joint Ventures**

- **Canada** (DSME Trenton)
- **USA**
  - Houston Office
  - PAENAL Shipyard
- **Brazil**
- **Ecuador**
- **Luanda Office**
- **Oslo Office**
- **London Office**
- **Germany**
- **Greek Office**
- **Germany**
- **NIDAS Shipping**
- **Kuala Lumpur Office**
- **Singapore Office**
- **Singapore Office**
- **Tokyo Office**
- **China**
  - DSME Shandong Co., Ltd.
  - Shanghai Office
- **Shanghai Office**
- **ZVEZDA-DSME Shipyard**
  - Commercial ships
  - Offshore Products and Naval Ships
- **Dubai Office**
  - DSME Oman
  - Ship repair Shipyard
- **PAENAL Shipyard**
  - Offshore Products
- **Jakarta Office**
- **DECI**
  - (DSME Engineering Center Indonesia)
- **Perth Office**

- **Domestic Affiliates**
  - Daewoo Mangalia Heavy Industries
  - Shipbuilding & Repair
- **Joint Ventures**
  - DeWind (DSME Trenton)
  - DMHI (DSME Engineering Center Indonesia)
  - Daewoo Mangalia Heavy Industries
  - OMAN (DSME Engineering Center Indonesia)
  - PAENAL Shipyard
  - NIDAS Shipping
  - Kuala Lumpur Office
  - Jakarta Office
  - Tokyo Office
  - Edmonton Office
  - PAENAL Shipyard
  - NIDAS Shipping
  - Kuala Lumpur Office
  - Jakarta Office
  - Tokyo Office
  - Edmonton Office
  - PAENAL Shipyard
  - NIDAS Shipping
  - Kuala Lumpur Office
  - Jakarta Office
  - Tokyo Office
  - Edmonton Office

### Notes
- Local Affiliates
- Domestic Affiliates
- Joint Ventures
- Overseas Branch Offices
DSME Vision

Total Solution Provider for the OCEANS

Effective, Trust-Worthy Vessels
- Very Large Carriers
- Arctic Vessels
- Special Purpose Vessels
- Battleships

Leader in the Shipbuilding and Offshore Plant Market

Products for Developing Future Energy
- Marine Wind-Power Plant
- Subsea Plant
- DME/GTL FPSO

Pioneer in the Energy Products and Plant Facility Market

Competitively Advantageous Marine Plants
- A Next-Generation Drillship
- LNG-FPSO

Complete Packages for Oil and Gas

Ship building

Energy

Offshore

Plant
**DSME Performance Record**

**FPSO Projects**

**Halliburton Canada Inc. (Canada)**
- **Terra Nova FPSO**
  - Hull: 17,000 Ton
  - Del: 2000. 3. 15

**Chevron (Nigeria)**
- **Agbami FPSO**
  - Hull: 70,000 Ton
  - Topside: 34,000 Ton
  - Del: 2007. 10. 3

**Total (Angola)**
- **Clov FPSO**
  - Hull: 77,000 Ton
  - Topside: 32,000 Ton
  - Del: 2Q 2014 (First Oil)

**Total (Angola)**
- **Dalia FPSO**
  - Topside: 14,000 Ton
  - Del: 2006. 2. 28

**Total (Angola)**
- **Pazflor FPSO**
  - Hull: 81,000 Ton
  - Topside: 41,000 Ton
  - Del: 2011. 1. 5

**Inpex (Australia)**
- **Ichthys FPSO**
  - Hull: 84,000 Ton
  - Topside: 33,000 Ton
  - Del: 2015. 9.
The Pazflor FPSO Starts up Oil Production

The Pazflor, the world’s largest FPSO has successfully achieved first oil in Angola on August 24th. The Pazflor FPSO arrived at its offshore site in April this year, 84 days after sailing from the Okpo shipyard. “First oil” means that the FPSO is successfully working and is able to start offshore production. DSME was able to start first oil 22 days ahead of the expected date. It is possible to attribute this early start to the high quality completion of work in the shipyard and thorough management of process controls at the local site. The positive support provided to DSME site members by the members of TOTAL, the owner of this project, also contributed to this startling result. This FPSO accomplished its safety goals without incurring any injuries or accidents.

In regards to the FPSO, this is turn-key contract which means DSME has the responsibility to make both the hull and top side module. This FPSO is 325m long, 61m wide, 32m deep, and the weight is 120,000 tons. The Pazflor FPSO will reach a production plateau of 220,000 barrels of crude oil per day and has the capacity to store up to approximately 1,900,000 barrels in volume.

DSME will continue the offshore hook-up and commissioning work until the final delivery to TOTAL, scheduled for November 2011.
King FLNG pre-FEED for Hull
Topside by KBR
2012. 3 ~ 2012. 8

PTT Cash-Maple FLNG pre-FEED for Hull
Topside by KBR
2012. 3 ~ 2012. 8

DSME Standard FLNG Pre-Feed for Hull
Topside by APCI
2009. 6 ~ 2010. 2

Hoegh FLNG FEED for Hull
Topside by CB&I
2008. 5 ~ 2012. 3

PETROBRAS FLNG FEED for Hull
Topside by SBM/Chiyoda
2012. 3 ~

Petronas / MISC FLNG EPCIC
2012. 3 ~
DSME continues to lead the world’s shipbuilding industry with expertise in building LNGC. The membrane type LNGCs built by DSME always ensure a superior performance, fast speed and excellent steering at lower building and fuel costs.

- Total Deliveries: 82 Vessels (LNGC, LNG-RV/FSRU)
- Order Book: 16 Vessels

As of Jan. 2013
## DSME Performance Record

### Building Experience

<table>
<thead>
<tr>
<th>Type of Vessel</th>
<th>No. of Vessel</th>
<th>Sub Total</th>
<th>Delivered</th>
<th>On Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Ship (A)</td>
<td>1,079</td>
<td>982</td>
<td>97</td>
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<tr>
<td>Oil Tankers</td>
<td>368</td>
<td>342</td>
<td>26</td>
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<tr>
<td>ULCC / VLCC</td>
<td>168</td>
<td>151</td>
<td>17</td>
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<tr>
<td>Suezmax TK</td>
<td>72</td>
<td>72</td>
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<td></td>
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<tr>
<td>Aframax TK</td>
<td>48</td>
<td>39</td>
<td>9</td>
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<tr>
<td>Panamax TK</td>
<td>14</td>
<td>14</td>
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<tr>
<td>Shuttle Tanker</td>
<td>5</td>
<td>5</td>
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</tr>
<tr>
<td>Product Oil Carrier</td>
<td>43</td>
<td>43</td>
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<tr>
<td>Chemical Tanker</td>
<td>13</td>
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<tr>
<td>Ore/Bulk/Oil Carrier</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Bulk Carriers</td>
<td>193</td>
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<tr>
<td>Handy - Kamsarmax</td>
<td>107</td>
<td>107</td>
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<tr>
<td>Capesize BC &amp; Above</td>
<td>86</td>
<td>86</td>
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<tr>
<td>Containerships</td>
<td>285</td>
<td>256</td>
<td>29</td>
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<tr>
<td>Below 5,000TEU</td>
<td>113</td>
<td>113</td>
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<tr>
<td>5,000 ~ 10,000TEU</td>
<td>70</td>
<td>67</td>
<td>3</td>
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<tr>
<td>Above 10,000TEU</td>
<td>102</td>
<td>76</td>
<td>26</td>
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<tr>
<td>LNG Carriers</td>
<td>118</td>
<td>91</td>
<td>27</td>
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<tr>
<td>LNGC</td>
<td>109</td>
<td>83</td>
<td>26</td>
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<tr>
<td>LNG RV / FSRU</td>
<td>9</td>
<td>8</td>
<td>1</td>
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<tr>
<td>Ro/Ro, Car Carriers</td>
<td>64</td>
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<td>Ferries</td>
<td>10</td>
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<tr>
<td>LPG Carriers</td>
<td>37</td>
<td>22</td>
<td>15</td>
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<tr>
<td>Heavy Lift</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Naval &amp; Specialty Ship (B)</td>
<td>79</td>
<td>57</td>
<td>22</td>
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</tr>
<tr>
<td>Naval Ships</td>
<td>68</td>
<td>46</td>
<td>22</td>
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<tr>
<td>Special Vessels</td>
<td>11</td>
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<tr>
<td>Offshore &amp; Plant (C)</td>
<td>113</td>
<td>85</td>
<td>28</td>
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<tr>
<td>FPSO</td>
<td>7</td>
<td>6</td>
<td>1</td>
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<tr>
<td>LNG FPSO</td>
<td>1</td>
<td>1</td>
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<td></td>
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<tr>
<td>OSV / TIV</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>FPU</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>TLP</td>
<td>5</td>
<td>5</td>
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</tr>
<tr>
<td>Fixed Platforms</td>
<td>31</td>
<td>25</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Semi-Rig</td>
<td>25</td>
<td>20</td>
<td>5</td>
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<tr>
<td>Drilling Barge</td>
<td>1</td>
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<tr>
<td>Drillship</td>
<td>29</td>
<td>17</td>
<td>12</td>
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<tr>
<td>Jack-Up</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Modular Plants</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sub Total (A+B+C)</td>
<td>1,271</td>
<td>1,124</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>Wind Turbine (D)</td>
<td>678</td>
<td>668</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>0.6~1.25 MW Grade</td>
<td>521</td>
<td>521</td>
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<td></td>
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<tr>
<td>2MW Grade</td>
<td>157</td>
<td>147</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Grand Total (A ~ D)</td>
<td>1,949</td>
<td>1,792</td>
<td>157</td>
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</tbody>
</table>
## DSME Performance Record

### Current Back Log

**Total 147 Projects (in USD 41.19 billion)**

<table>
<thead>
<tr>
<th>Offshore &amp; Plant</th>
<th>Commercial Ships</th>
<th>Naval Ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPSO</td>
<td>VLCC</td>
<td>Naval Ship</td>
</tr>
<tr>
<td>LNG FPSO</td>
<td>Aframax PC</td>
<td></td>
</tr>
<tr>
<td>Fixed Platform</td>
<td>Containership</td>
<td></td>
</tr>
<tr>
<td>Semi-Rig/Sub-Rig</td>
<td>LNG Carrier</td>
<td></td>
</tr>
<tr>
<td>Drillship</td>
<td>LPG Carrier</td>
<td></td>
</tr>
<tr>
<td>Jack-Up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modular Plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSV/TIV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28 Projects in USD 22.19 billion

97 Vessels in USD 13.87 billion

22 Projects in USD 5.13 billion
LNG & Gas Value Chain - Special Deliverables

Drilling & Development

Production & Storage

Transportation & Naval Escort

Supply & Service

MAJOR PRODUCTS

- Drilling & Development
- Production & Storage
- Transportation & Naval Escort
- Supply & Service
LNG & Gas Value Chain - Special Deliverables

**DSME LNG FPSO**

- **Dynamic Positioning**
- **Fluid Analysis using CFD**
  - Cavitation Check and Arrangement of pumps inside MoonPool
  - Airflow Analysis around Helideck

- **Tandem Offloading**
- **Ship to Ship Transfer**
- **Mooring / Riser / Hull Coupled Motion**
  - Design procedure of sloshing
  - Coupled Sloshing and Ship Motion
  - Sloshing Analysis for LNG Shuttle tanker and FPSO

**Development of Tandem Offloading System**
- Operability Analysis
- Design of Bow Loading System of a Shuttle Tanker

**Enhancement of Side-By-Side LNG Transfer**
- Dock & Mooring Analysis
- Development of LNG Transfer System for Bunker Vessel

**Deep Sea Mooring (Synthetic Rope)**
- Non-Linear Coupled Analysis for Floater, Mooring, Riser, unbolics
- Mooring, Riser Monitoring System
- Transportation & installation of moorings
DSME has developed its own procedure for motion and acceleration analysis. Input parameters such as damping coefficients are calibrated based on the measurement of seakeeping model tests.
DSME has developed own strength estimation tool for load mapping and balancing and applied it to several projects.
Offshore structure requires precise fatigue life estimation. DSME has developed own fatigue analysis tool based on stochastic approach for wave loads. Fatigue damage from cargo loading or wind is calculated separately and added for total fatigue damage estimation.
The turret-moored offshore structures such as FPSO and FLNG, the turret supporting structure is affected by mooring and riser loads that are transferred through turret systems.

In the structural design of FPSO and FLNG, the turret structure and its loads are considered in a direct analysis of hull structure. DSME has developed the load analysis procedure using FE analysis method.
For possible accidental loads such as ship collision, explosion and dropping objects, strength verification through direct analysis is carried out for offshore structures.
DSME has developed and applied the two-row LNG Cargo Containment System (CCS) with GTT No.96 membrane for FLNG to minimize the impacts against liquid sloshing and also to strengthen the hull structure for the support of the heavy Topside modules.

To validate the two-row LNG CCS, the sloshing model tests and the Computational Fluid Dynamics (CFD) have been carried out as a part of international Joint Industry Project (JIP) participating DSME, ABS, BV, DNV, LR, Chevron, Exmar, Knutsen, and Excelerate Energy.
DSME developed its own independent LNG cargo containment system which can be applied for not only storage tank of LNG FPSO and shuttle tanker but also fuel tank of LFS.  
1st mock-up test has finished in 2012 and 2nd mock-up test for BOR was finished in 2013.
DSME-9000 is an “excellent global performance” semi-submersible drilling unit, engineered to provide the best economic solution for drilling and exploration in ultra deep sea with harsh environment condition.

DSME e-SMART Drillship

- enhanced
- Safety enhancement
- Maintenance easy
- Advanced operability
- Reliable functionality
- Top comportability
DSME Drilling & Well Control Simulator consists of Driller’s Control Chair Simulator, Well Control Simulator, and 3D Virtual Reality System for a Semi-submersible Rig. The virtual rig which fully integrated with the simulators provides a realistic experience of drilling system for basic understanding and R&D purpose.

- Drilling Operation
- Well Control Operation
- Dynamic Hull Motion
- 3D Virtual Rig
- Drilling Procedure
**Greenship - Special Deliverables**

**Energy**
- LNG Fueled Propulsion
- Solar Powered Ship

**Material**
- Non-Corrosive Material
- Environment Friendly Painting Material
- Advanced A/F Paint
- Consideration of Ship Recycling Convention

**Operation**
- Trim Optimization
- Optimum Weather Routing
- Slow Steaming (Eco-Speed)

**Device**
- Shaft Generator
- Pre-Swirl Stator (PSS)
- Ducted PSS
- Rudder Bulb Fin
- Ballast Water Treatment System (BWTS)
- Waste Heat Recovery System (WHRS)
- NOx Reduction Device
- SOx Reduction Device
- Grey Water Treatment System

**Design**
- Optimized Hull Form Design
- High Efficiency Propeller Design
- Optimized Main Engine Selection and De-rating
- Enhanced Hull Structure
- Electric Driven Deck Machinery
- Bulbous Bow Optimization
### Recent Joint R&D Programs

<table>
<thead>
<tr>
<th>Classification Society</th>
<th>Client</th>
<th>Institute &amp; Corporate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Shell / DSME Joint R&amp;D Program</td>
<td>MARIN FPSO JIPs</td>
</tr>
<tr>
<td>Lloyd's Register</td>
<td></td>
<td>Collaboration with Model Basins - MARINTEK, SSPA, HSVA, MOERI</td>
</tr>
<tr>
<td>DNV</td>
<td>MAERSK</td>
<td>POSCO</td>
</tr>
<tr>
<td>GL</td>
<td>BW Gas</td>
<td>• Fuel Cell Powered Vessel</td>
</tr>
<tr>
<td>Bureau Veritas</td>
<td></td>
<td>• Wind Business</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• SMART Nuclear Reactor</td>
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<td></td>
<td>• SPS</td>
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<tr>
<td></td>
<td></td>
<td>KOGAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• GTL/DME FPSO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• LNG Bunkering</td>
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<tr>
<td></td>
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<td>• LNG Value Chain</td>
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<tr>
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<td></td>
<td>GS Caltex</td>
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<tr>
<td></td>
<td></td>
<td>• Fuel Cell</td>
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<td>DSME</td>
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</tbody>
</table>

- LNG Fueled Ship (LFS)
- Independent Type B LNG Tank [ACT-IB]
- Sloshing Topics
- CCS Structural Assessment
- Risk Assessment
- Offshore Structure & Mooring
- Arctic / Ice Breaking Ships
- SPS (Composite Material) Applications
- Joint Research Project for LFS Feasibility Study
- Energy Saving
- Joint Research Project for Greenship Technology
- De-NOx System
- VOC Reduction System
- CO2 Management System
DSME Global R&D Center

Global Top layered Ship & Offshore R&D Center
Welcome to the 33rd FPSO Research FORUM