Universal foundation concept

*A SCM approach to industrialization*

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Universal Foundation Concept – A SCM Approach to Industrialization
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Abstract
Supply Chain Management (SCM) is a driving factor in the development of new technology and the vision of industrialization, series/mass production and installation of foundations for offshore wind farms. As the sites are getting larger in the future wind farm developments, and in most cases more complicated in a geotechnical and logistic sense, it is a must to find more feasible ways to configure standard structures and procedures into unique foundations for each wind turbine position using the philosophy of systematic mass customization and to optimize the supply chain with a focus on the industrialization process.

Background
The development of the UFC system is initially based on the flexibility and characteristics of the bucket foundation concept as known today. The bucket foundation is a hybrid combining features from the gravitation platform and the monopile, but with the ability to vary more parameters for diameter, penetration depth and dead load than the traditional concepts.

Bucket Foundation Principle
The bucket foundation (B) is a hybrid combining features from the gravitation platform (A) and the monopile (C) in a cylindrical section coned upper part.

Development
The innovative foundation concept, inspired of the well know offshore technology suction anchors, was initiated by a research program in a joint venture formed by Marcon, Bladt Industries, MBD and Aalborg University. As it is a new concept, a design procedure had to be developed based on laboratory test and certified by DNV. The full scale foundation for the Vestas V90 3 MW turbine was built in Frederikshavn and transported to and installed in the semidry NearshoreLAB test site in October 2002.

Project Development Approach – Industrialized Product Development
From project development to development projects:
- Focus on total supply chain
- Coordinated B&O in each link of the supply chain
- Active use of feedback

Technology Transfer
- Not only using a product in a different location
- It is adapting technology to new physical environment
- It is adapting the organization culture
- It is adapting the knowledge and education

UFC Philosophy – A Framework for Project Development

Organisation
The database is containing description of principles, methods, procedures, structures, stipulation the operation parameters and cost estimates for each element. The database is also updated with operation project experiences to ensure an efficient feedback to be used in future projects. The project configuration system is a program defining the application range for each structure and procedure and the rules for combining the different elements to cover the entire wind farm. The system contains a decision support facility with the ability to estimate the involved cost-risk in the different project phases. The documentation facility is based on standard output formats for each of the project phases, feasibility study, conceptual design, tender design, detail design, construction documentation and “as build” documentation.

The UFC / SCM facilitator:
The implementation of the concept is conducted by a facilitator organization with access to the IP-rights of the bucket concept and in close cooperation with the project developer/owner of the wind farm project. The functions of the facilitator are to ensure that the technology, methodologies and procedures is optimized throughout the entire supply chain as well as ensure that the contract relations between the different stakeholder is managed to utilize the full potential of the concept.

The UFC is a concurrent process, adding new experiences and processes to a database, used by a configuration methodology to produce the required documentation in each step of the wind farm projects focusing on:
- The optimal foundation for each turbine position
- Design is parameter driven
- Structure based on scalable modules and elements
- Production based on series or mass production
- Installation in widest possible weather window
- Installation based on common available transport and installation vessels

Table:

<table>
<thead>
<tr>
<th>Tower</th>
<th>Weight tonns</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6MW</td>
<td>30 45 60</td>
</tr>
<tr>
<td>5MW</td>
<td>30 45 60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structure</th>
<th>Weight tonns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft</td>
<td>297 445 603</td>
</tr>
<tr>
<td>Lid</td>
<td>115 126 133</td>
</tr>
<tr>
<td>Skirt</td>
<td>195 210 237</td>
</tr>
<tr>
<td>Total</td>
<td>607 780 974</td>
</tr>
</tbody>
</table>

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UFC / SCM Facilitator
Concept IP-rights / Configuration / Contract Consultant

Document / Material Flow
Design / Methods / Procedures / Feed-back