Block Island Wind Farm CVA
Status of verification activities

Presented by
Rain Byars
Senior Engineer

February 10, 2015

ABS Group

Overview of Phases

Design Verification

- Site Assessment – Complete

- Design Basis – Complete

- Load Simulation – in Process

- Detailed Design – in Process

Manufacturing Verification

- Jacket Fabrication – in process

- Wind Turbine Manufacturing – in process

ABS Group

Site Assessment

Inputs

Meteorological Reports

Metocean Reports

Geophysical Survey

Geotechnical Survey

Geotechnical Interpretation Reports

Applicable laws, lease and permits

Interconnection requirements

ABS Group

Site Assessment

Analysis

Annual wind charcteristics

Extreme event analysis

Directional Joint probability analysis

Geotechnical and Geophysical data collection

Soil-Pile interaction: pile capacity, P-y, T-z, Q-z curves

ABS Deliverables

ABS BIWF Report - Site Assessment Verification 2014-11-26-r0

ABS Group

Design Basis

Inputs:

- Designers' interpretation of design inputs based on site assessment

- Preliminary Design

  Substructure – Keystone

  Substructure Design Basis
  Preliminary Design Report
  Preliminary Design Drawings

  Wind Turbine – Alstom

  Tower Structure Design Basis
  Tower Internals Design Basis
  Wind Conditions
  Turbine General Description
  Technical descriptions BIWF site-specific equipment

ABS Group

Design Basis

Analysis

Review of regulations and standards applied

Reduction of wind and ocean data
- Wind bins and annual probability distribution
- Wind, wave, and current direction distribution
- Extreme event modeling

ABS Deliverables

ABS BIWF Report - Design Basis Review - 2014-12-08-r0

ABS Group

Load Simulation

Inputs

Substructure – Keystone

- DLC list
- Modeling and Analysis Methodology
- Data exchange with Turbine designer
- Model Calibration
- Natural Frequency Analysis to determine driving location
- SACS Input files
  - Structure, soil, wind, wave, and current definition, marine growth
- SACS Output files
- Load Reports

ABS Group

Load Simulation

Inputs

Wind Turbine – Alstom

DLC list

Modeling and Analysis Methodology

Data exchange with Substructure designer

Model Calibration

Bladed Input files

Structure, soil stiffness matrix, 3-d wind field,
wave and current definition, marine growth

Bladed time series

sea surface profile, interface loads

Load Reports

ABS Group

Load Simulation

Analysis

    DLC list – consistency with site assessment data

    Modeling and Analysis Methodology

        Best practice

        Best available tools

        Simplification– acceptable when results are conservative

    Detailed comparison of SACS and Bladed models

        Structural properties

        Wind, wave, and current definition

        Dynamic response

        Loop 1 – errors found – soil coordinate systems, export SACS to Bladed

        Corrected in Loop 2

    Results

        Compare ULS and FLS results from Loop 2

ABS Deliverables

    ABS BIWF - Calibration Verification Report

    ABS BIWF – Load Report – Expected March 2015

Load Simulation – ABS Independent Modeling

Overview

- Turbine and structure are modeled in Bladed and SACS with different levels of detail

- Time domain simulations according to the DLC list

    - Xxx ULS simulations
    - Xxx FLS simulations

- Force time histories at the tower base flange are output from Bladed to SACS to apply turbine and tower aerodynamic and operational loads to the substructure

- Sea surface profiles are output from Bladed to SACS for identical wave definition

ABS Group

Load Simulation – ABS Independent Modeling

Bladed

- Integrated turbine, tower, and jacket structure modeled as beam elements
- 3-d wind field
- Blade aerodynamic characteristics
- Combined wind and wave forces
- Turbine operational behavior modeled in detail
- Soil-structure interaction is modeled as a 3-d stiffness matrix
- Substructure complex members (grouted members, racetrack) are modeled with equivalent mass, stiffness, moments of inertia
- Full capture of combined environmental, operational, and dynamic loading
- Bladed results are used for tower site specific design

ABS Group

Load Simulation – ABS Independent Modeling

SACS

- Integrated tower and jacket structure modeled as beam elements, RNA included as a point mass for natural frequency analyisis
- Mode shapes include tower and RNA dynamics
- Wave definition identical to Bladed
- Piles and grouted members are included in structural model
- Soil-pile interaction modeled with P-y, T-z, and Q-z curves applied along the pile
- Wind, operational, and dynamic loading from RNA and tower is input from Bladed at the tower bottom flange
- Hydrodynamic and dynamic loading on the

- Bladed results are used for tower site specific design

ABS Group

Load Simulation – ABS Independent Modeling

Bladed

Use Alstom .prj file with encrypted blade

Use Alstom encrypted turbine and pitch controller .dll

RNA and controller must be consistent with type certified design

Tower is site specific design by Alstom

Substructure is site specific design by Keystone

ABS Group

ABS Reports

ABS BIWF Report - Site Assessment Verification 2014-11-26-r0

ABS BIWF Report - Design Basis Review - 2014-12-08-r0

ABS BIWF Report – Calibration Verification 2014-02-23-r0

ABS BIWF Report – Blade Manufacuring Verification

ABS BIWF Report – Jacket Flange Manufacuring Verification

ABS BIWF Report – TP Manufacuring Verification

ABS BIWF Report – Jacket Pile Manufacuring Verification - DRAFT

ABS BIWF Report – Casting Manufacuring Verification - DRAFT

Challenges

ABS Group

Next Steps

ABS Group