City University Jack-up Conference

J-REG Joint Industry Project – Technical Highlights

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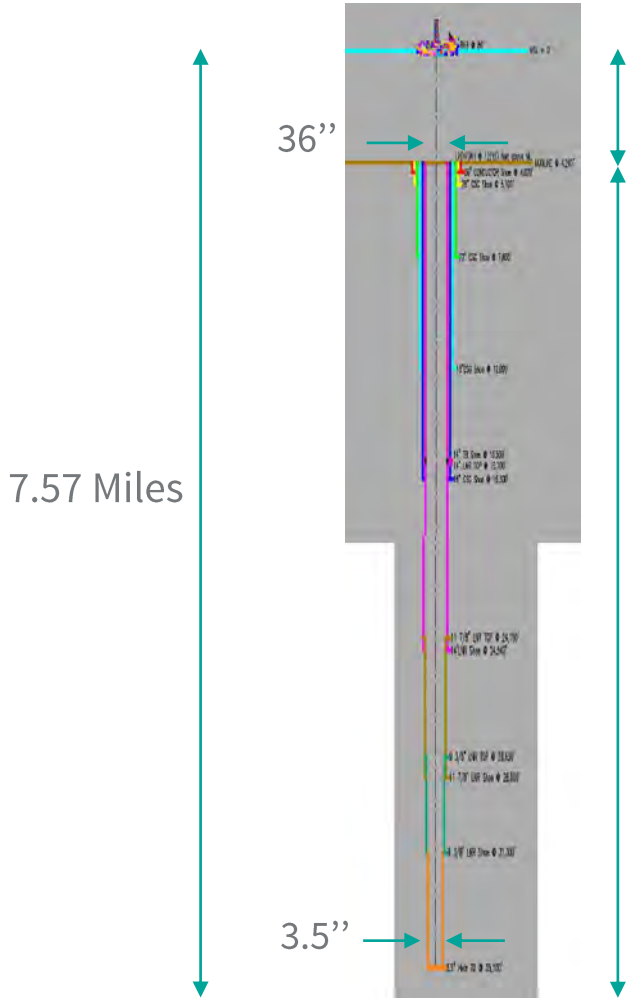
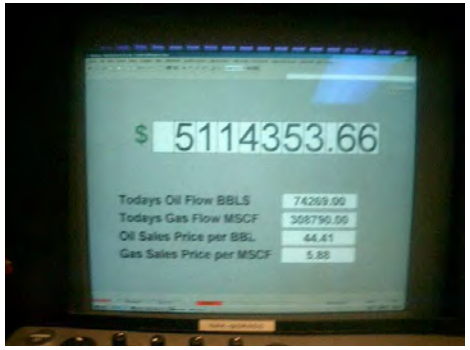
From O&G to Wind

Customized to Industrialized



GOM Deep Water Well



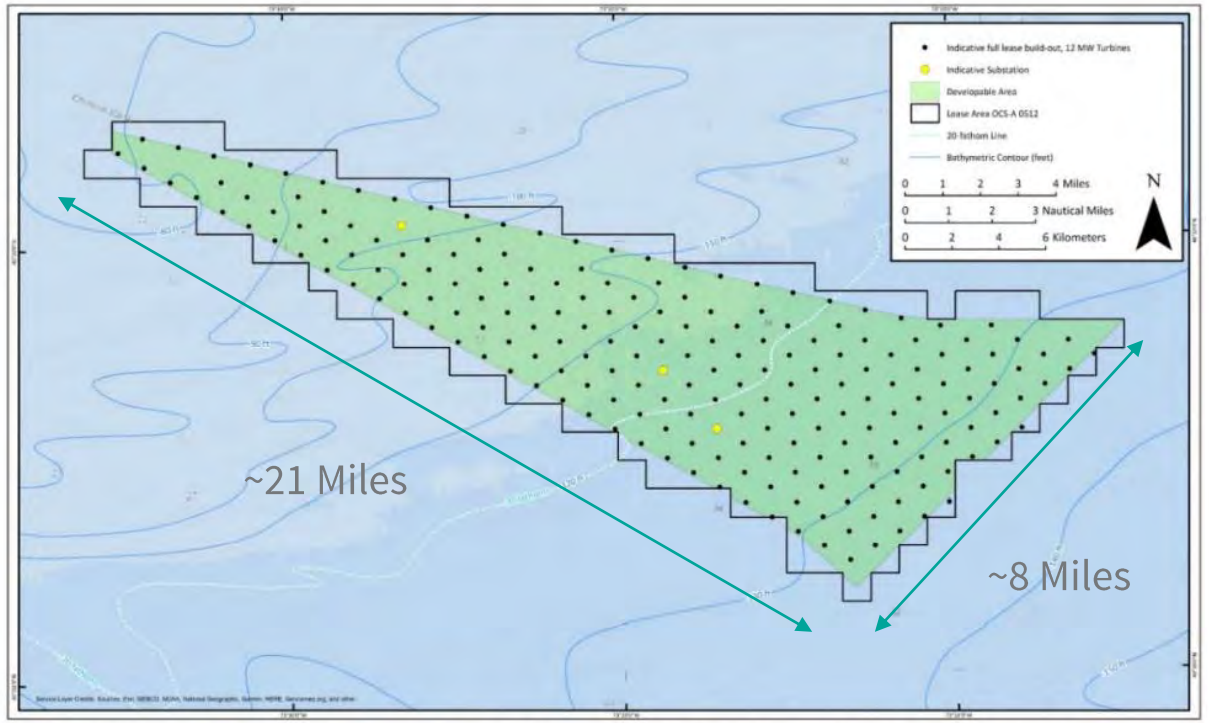


Figure 5: Indicative full Lease Area build out, three individual phases totalling 200 x 12MW wind turbines, minimum spacing 0.71 nm

Empire Wind public consultation (2019)

equinor-empire-boardwalk-wind-farm-layouts-consultations-september2019 (1).pdf

How big are they?

	NG14000-XL	CJ70
Hull length (m)	142	88.8
Hull width (m)	50	102.5
Approx. Envelope Area (m2)	7100	4550
Football Field (m2)	5350	5350
Hull Depth (m)	11	12
# Legs	4	3
Leg Type	Triangular Open Truss X-braced	Triangular Open Truss X-braced
POB	up to 130	up to 150
Leg length max.	109	206.7
Max. Water Depth (survival)	65	150
Pre-load per Leg (t)	14,000	20,000
Rig moves	150 / year	less than 10 / year
Stationkeeping	DP2	N.A.
Transit Speed (knots)	11	N.A.
Main Power (kW)	20,040	12,000 - 16,000
# Jacking Units	4 Layers x 24	4 Layers x 18
Jacking Speed @ max hull lift [m/min]	0.80	0.45 (normal)
Jacking Speed @ max leg handling [m/min]	1.20	0.68

Note: Approximate and Generic Values

Eiffel Tower
~ 10,000 t

Saturn V thrust
~ 3,500 t

Football Field – 5,350 m^2

GustoMSC Solutions

1. WTI / WFI jack-up vessel
2. Liftboat feeders (N/A)
3. New-build feeder jack-up
4. Floating barge feeder – along jack-up (Mooring)
5. Floating barge feeder – docked
6. Motion compensated feeder barge or vessel
7. Sjøhest / Seahorse blade installation solution


1.

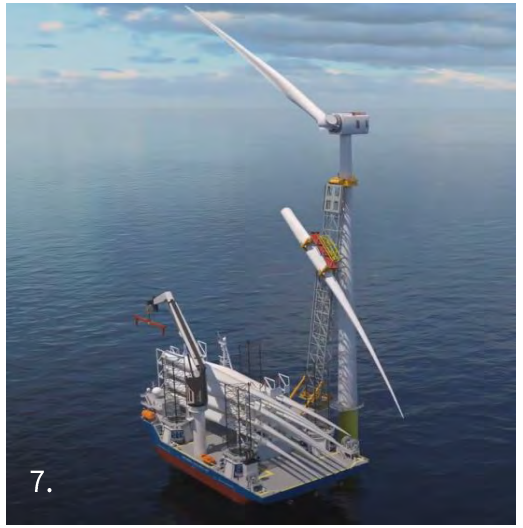

2.


3.

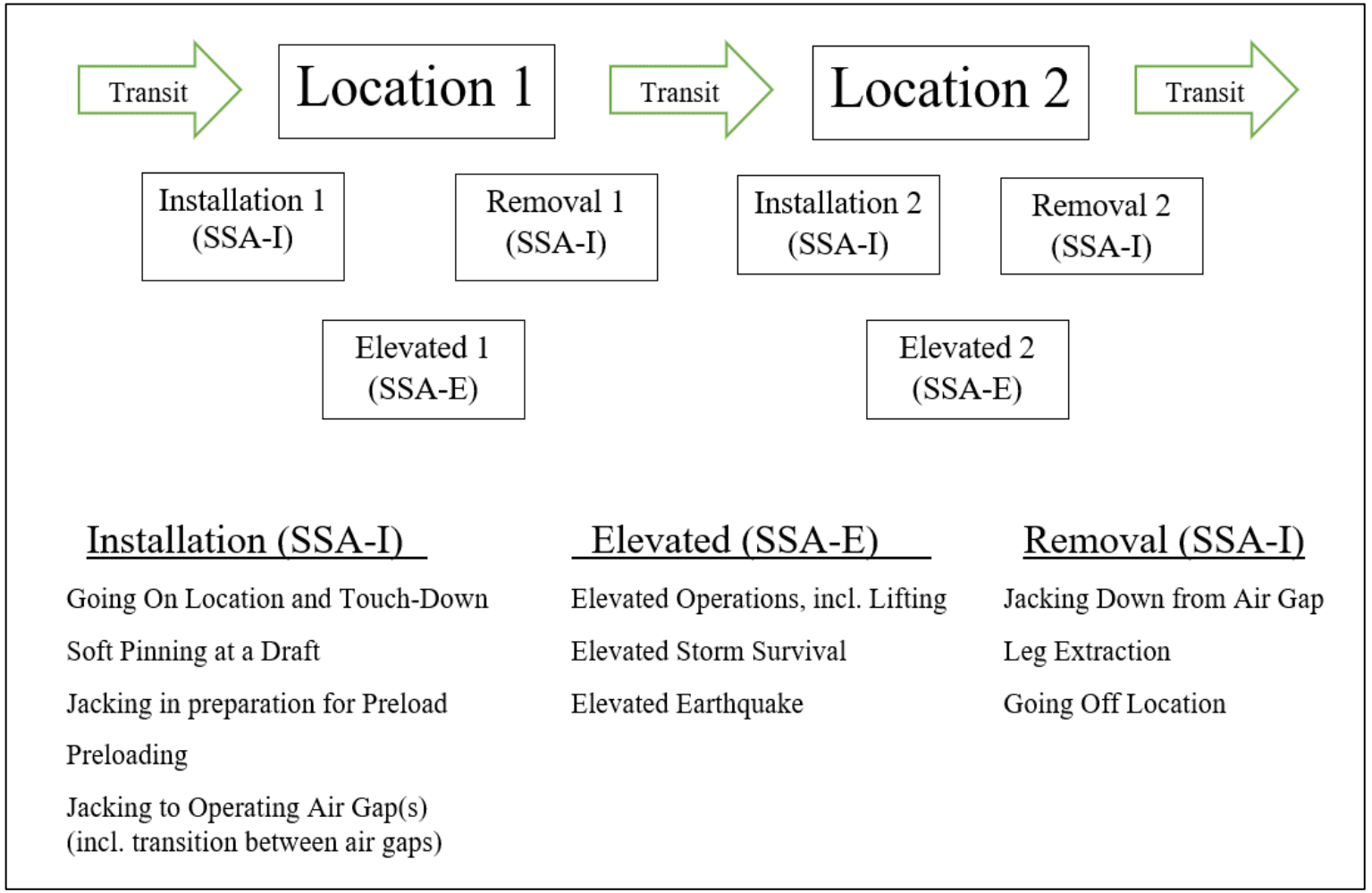

4.


5.

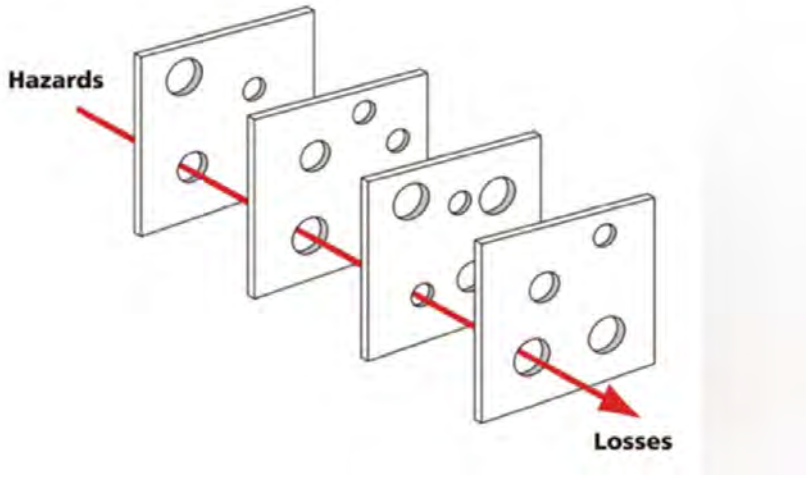

6


7.

Scope of Site-Specific Assessment (SSA-I, SSA-E)
Site vs. Location



Operational Framework



- SSA is one Barrier
- Location Specific Procedure (LSP) & Positioning
- Dynamic Positioning
- Data Gathering and Distribution
- Roles, Responsibilities and Training
- Regulatory Requirements, Standards and Guidelines
- MWS, Surveys, Inspections and Trials
- Integrity Management: Structural, Foundation, Watertight
- Operational Risk Assessment and Mitigation
    - HAZID, HAZOP, FMEA, RTM, RRTM

Operational Framework

The parties that will coordinate each stage of the project should be identified and supervise the timely acquisition and flow of accurate information. The project organization should be documented with a chain of command as well as lines of communication and reporting between all parties involved with reference to the roles, responsibilities, and authority of each party.

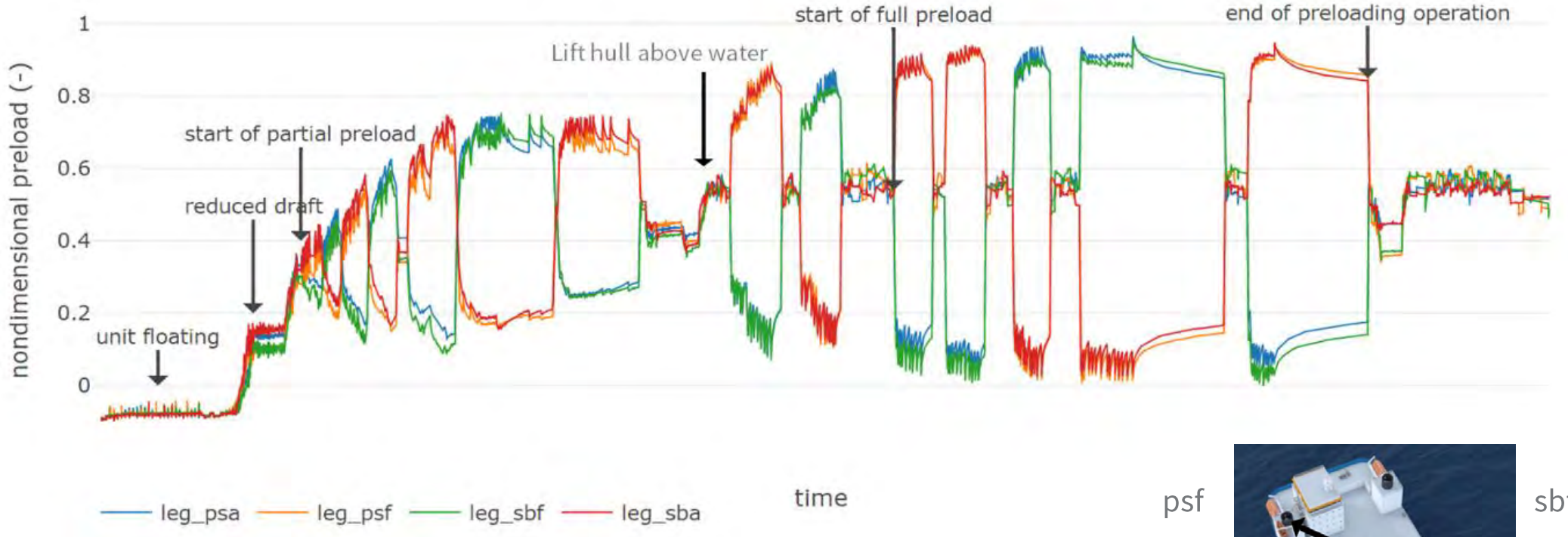
The Hold and Trigger points should be defined together with acceptance protocols, information retention and comprehensive interfacing plans.

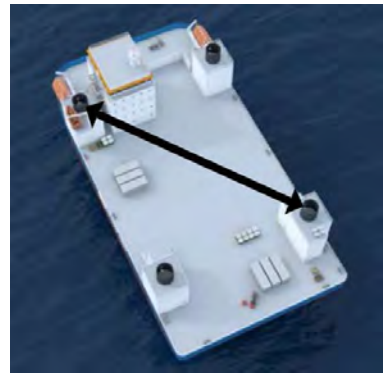
A Management of Change (MOC) process should be in place that identifies factors that materially affect the SSA, and any such changes should be communicated back to the Assessor.

All such risk identification and mitigation activities should mobilize competent personnel, defined as having suitable and sufficient experience in the fields that they work in to understand the hazards and risks involved with the work, the operating environment and equipment, and the type of personnel they need to work with, and the ability to communicate critical information to all the necessary personnel in a clear and comprehensible manner. A formal verification program is encouraged where competence of key personnel is demonstrated through a combination of education, training, experience, and certification.

Pre-Driving of Four-Leg WTIV

No Ballast, Load on Diagonally Opposite Legs, Active or Passive

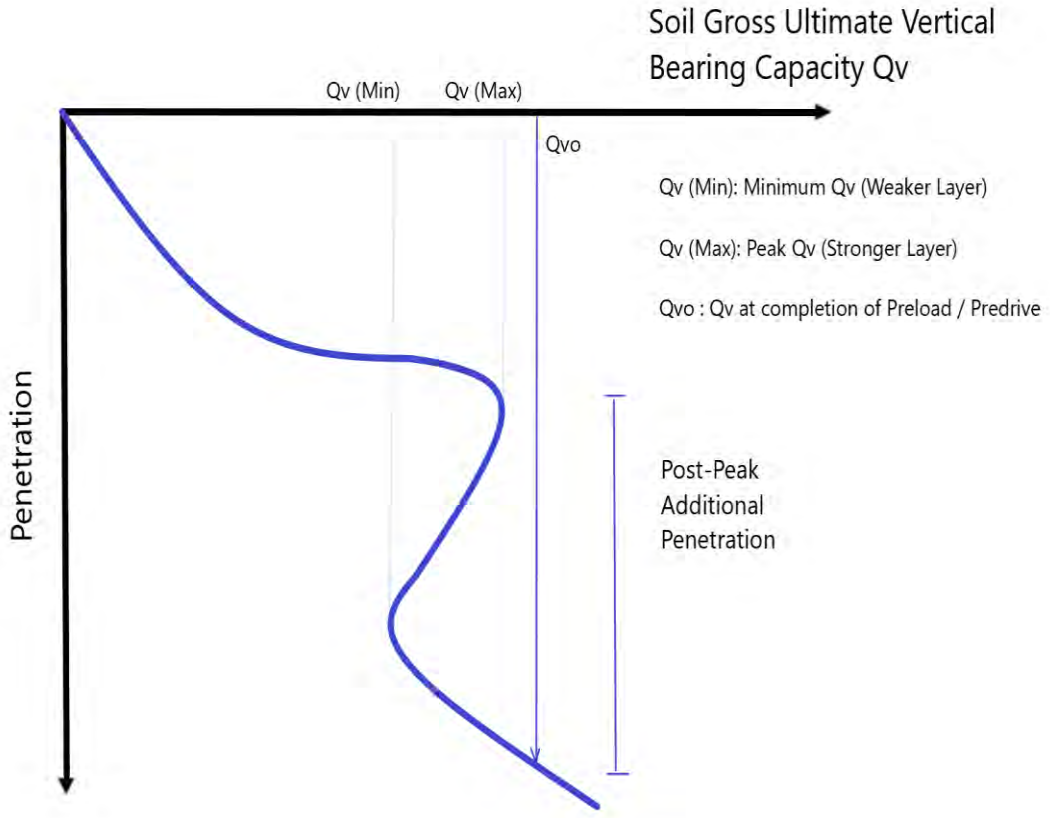




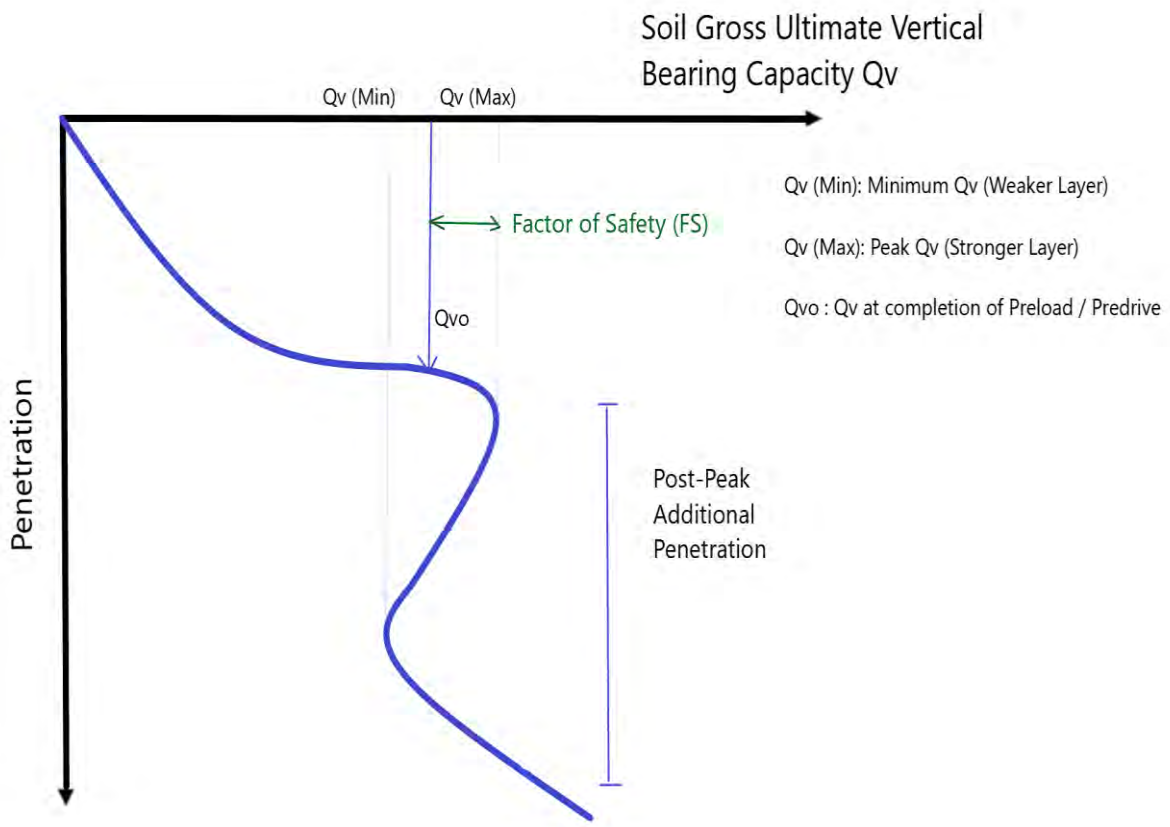
Credit: Vanderheggen, K., Meredith, N., Janssen, J., Morandi, A.C., 'Bringing Big Data Technology to Wind Turbine Installation Vessels', SNAME Maritime Convention, Providence, 25-29 October 2021.

Load-Penetration Assessment (LPA)

Key Parameters in SSA / Manage Risk of Punch-Through



Approach 1: Clear Weaker Soil Layer



Approach 2: Safety Factor to Peak

Metocean Criteria Philosophy

- Weather-restricted operations where the jack-up operations are managed in accordance with the ongoing weather forecasts to ensure the jack-up is not staying on location for a condition that exceeds specified limits.

- Weather-unrestricted operations where the jack-up satisfies storm return period requirements based on long-term statistics of metocean data and permitting consideration of both directionality and seasonality. The jack-up is not relocated ahead of storms.

Metocean Criteria – SSA-E

The SSA-E typically considers maximum operational loads (from crane lifting and handling operations, for example) performed under weather-restricted conditions. Loads due to the interaction with other vessels (such as feeder units) should be considered as applicable.

A storm survival, weather-unrestricted situation with the maximum exposure level (L1) should be considered in the SSA-E if the jack-up is unable to discontinue operations, move off location, and reach a safe condition at a new location (or returning to the marshaling port or moving to a port of refuge) prior to the impact of a storm (for example, due to delay in preloading or leg extraction difficulties). In this case the SSA-E should consider the 100-year joint probability metocean data or, as a conservative alternative, the 50-year independent extremes of metocean data. Seasonal variations and directionality of metocean data may be considered.

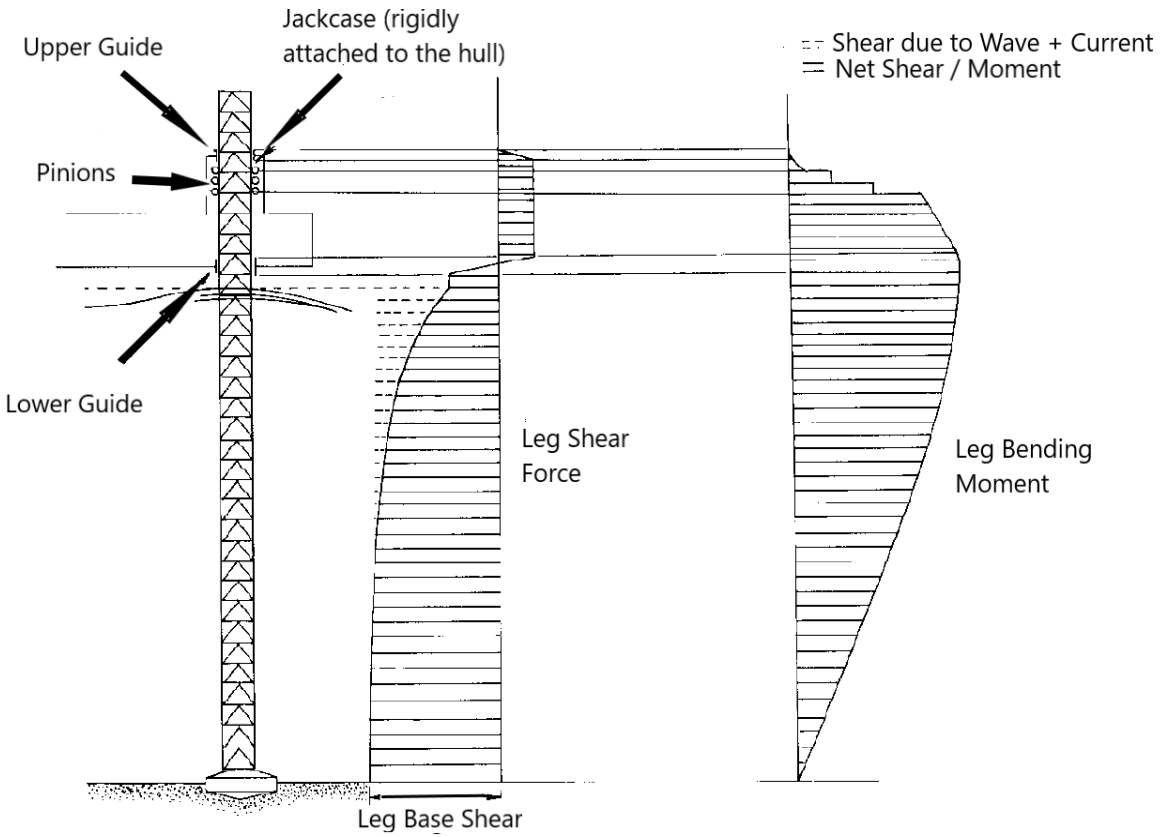
For areas where the L1 exposure level may place excessive demands on the jack-up (such as TRS areas), a storm survival, weather-unrestricted situation with a reduced exposure level (L2) may be considered in the SSA-E if all the following conditions are met:

- Plans for the safe evacuation of personnel are in place so the jack-up is de-manned ahead of storms.
- Damage to the jack-up does not result in significant economic consequences such as a major delay in the OWF installation.
- Damage to the jack-up does not result in significant environmental consequences.
- Reliable metocean data are available to determine the population of storms that can reach the location prior to evacuation

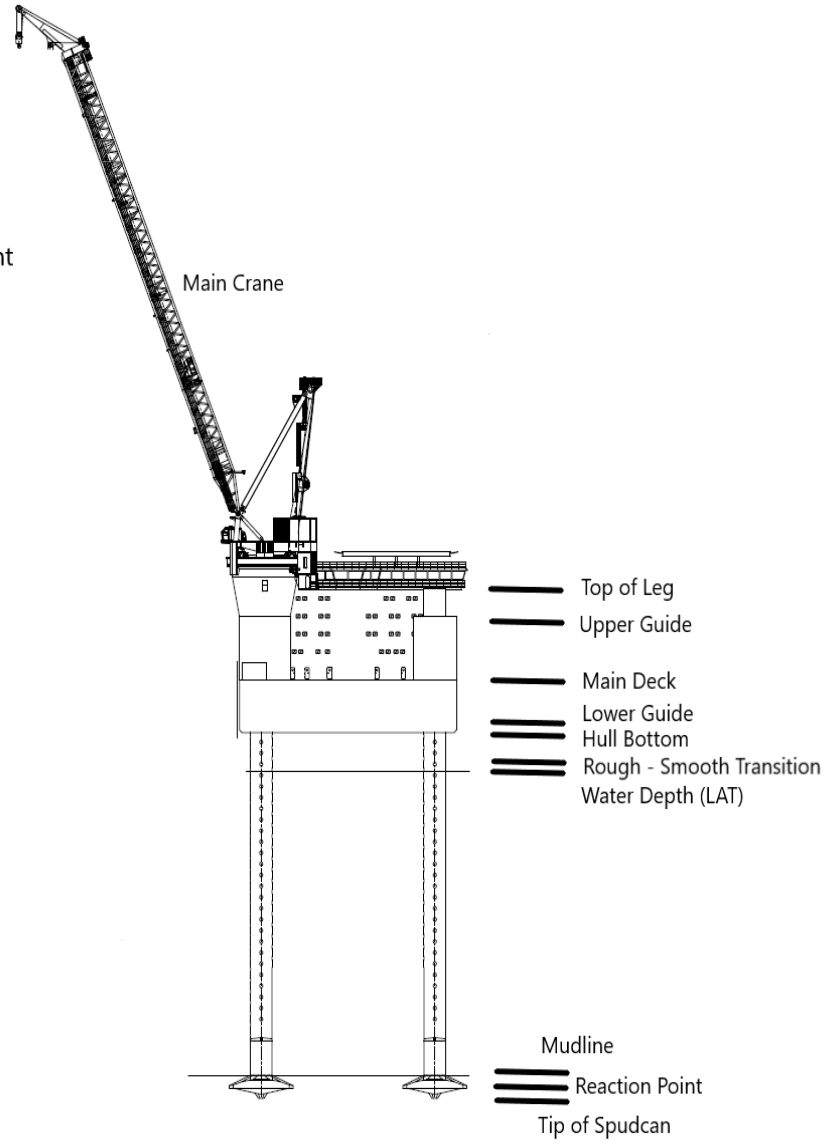
In this case the SSA-E should consider as a minimum the 50-year independent extremes or 100-year joint probability metocean data that can be reached at the location prior to evacuation (e.g. 50-year sudden hurricane in tropical revolving storm areas). The unmanned post-evacuation case should also be considered according to criteria to be agreed between the jack-up owner and the OWF developer.

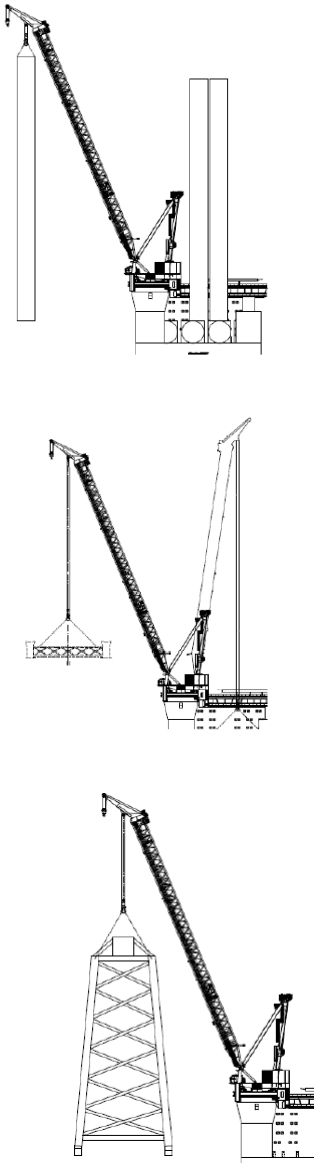
Elevated SSA-E

May be controlled by Operational Cases



Wave + Current

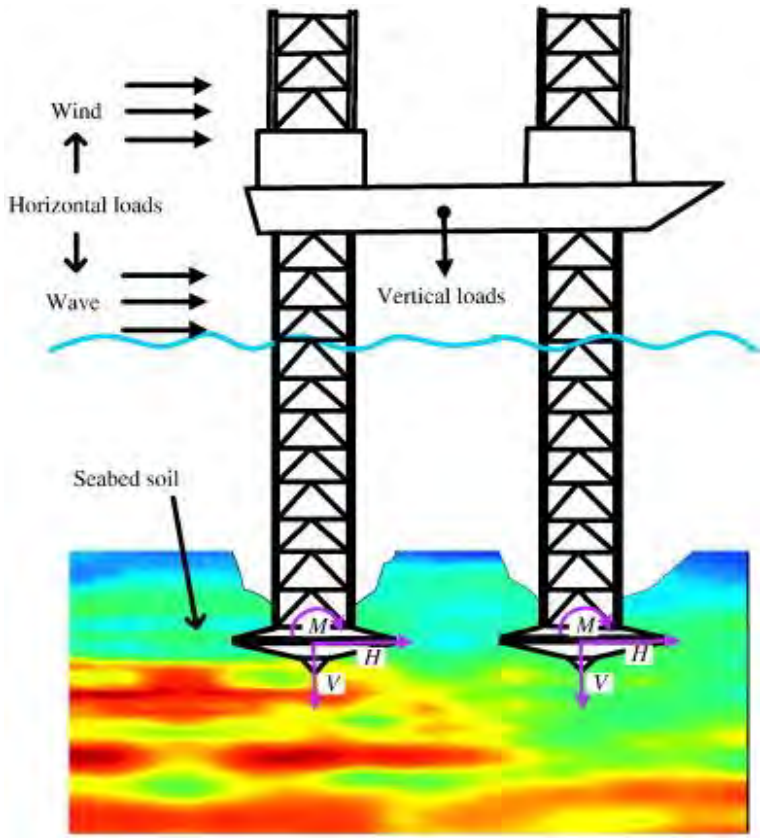




Wind + Inertia + External (feeder e.g.)

(Adaptative) Ground Model

A Jack-up is as Good as its Foundation!



Credit: The bearing capacity of spudcan foundations under combined loading in spatially variable soils, paper by Li Li, Jinhui Li, Jinsong, Huang, Hongjun Liu, Mark Cassidy

- Soil Characterization & Geohazards Mitigation (SCGM)
  - Geophysical and geotechnical data
  - Geohazards
  - ISO 19905-1 Supplements
  - ISO 19905-4 Supplements
- Cyclic Effects
- Scour
- Spudcan-slope Interaction
- Spudcan-footprint interaction
- Spudcan-boulder interaction
- Leg Penetration
- Leg Extraction
- Monitoring

Acceptance Criteria – SSA-E

- Penetration, Air Gap(s) and Leg Length Reserve
- Clearance to Adjacent Structures
- Clearance to Seabed Structures
- Jack-up Limit States (Operational and Storm Survival)
  - Structural strength of legs, spudcan and jacking system
  - Overturning stability
  - Foundation integrity including bearing capacity, sliding capacity, and settlement from exceedance of the capacity envelope
- Earthquake Assessment (ISO 19901-2 and ISO 19901-5)
  - Jack-up in its Operational Condition
  - It is not necessary to perform an earthquake assessment for seismic zone 0
  - An earthquake assessment should be performed for sites where the seismic zone is 2 or above
  - For seismic zone 1, an earthquake assessment should be considered when any of the following conditions apply (ISO 19905-1):
    - Sites with the potential for cyclic mobility (e.g. liquefaction) (ISO 19901-2 site class F)
    - Sites with the potential for unacceptable additional leg penetrations if the preload / pre-drive reactions are exceeded
    - Jack-ups where the ratio between the individual leg preload / pre-drive reaction at the seabed and the maximum still water operating reaction at the seabed is less than 1.25.
    - Detailed seismic assessment procedure proposed by J-REG

Thank you for your kind attention

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