JAVA OFFSHORE

Webinar on

CASE STUDY - GEOHAZARD INVESTIGATION FOR OFFSHORE DRILLING SITES

Denny Tami, Ph.D

5th June 2020, 5pm (India) / 730pm (KL)

Organised by:
Dr. Parthasarathy
Chairman of the Indian Geotechnical Society (IGS) - Bengaluru Chapter
Webinar ID: 856 4942 2593 - Password: 888306

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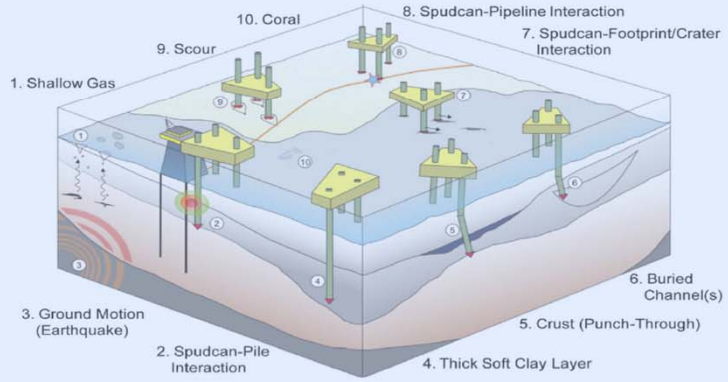
Webinar Overview

Geohazard Investigation or Survey is performed throughout a well life cycle from exploration, development, production, monitoring and decommissioning. The purposes of geohazard investigation are to identify, map and evaluate or quantify the impact of geohazards on planned activities and well operations. Hence, costly stability problems and dangerous accidents during offshore drilling activities due to various geohazards can be prevented.



PCSB 3D Conceptual Block Model for Jack-up Foundation Hazards
Source: OTC-28345-MS, Regional Suitability Mapping PRSM Project – An Update (Rohani et al, 2018)

The term geohazards refer to features of the geologic origin or human-made, on and/or beneath the seafloor, that poses a threat to engineered structures. The main devastating effects of geohazards are loss of lives, rig sinking, pipeline burst, environmental pollution, or structure collapse. The less harmful impacts have severe financial consequences as well as significant project delays.

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About the Presenter

Dr. Denny Tami

Personal Info

- Indonesian / Singapore PR
- BSc in Civil (ITB 1995, *cumlaude*); MSc (ITB 1998, *cumlaude*); Ph.D (NTU Singapore 2003)

25-year experience in geotechnical field

- 5 years at Bandung Institute of Technology, Indonesia
- 3 years at Nanyang Technological University, Singapore
- 4 years at CSC Piling Specialist, Singapore
- 6 years at Fugro, Singapore
- 7 recent years at Java Offshore, Singapore - KL - Jakarta

Current role & responsibility

- VP | GeoConsulting – Java Offshore

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Acknowledgments

Organizer

Dr. Parthasarathy
Chairman of the Indian Geotechnical Society (IGS) - Bengaluru Chapter

Java Offshore

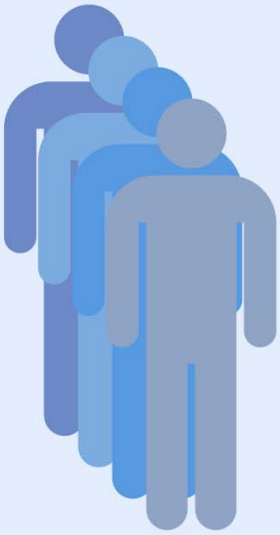
Support and Permission from the Management
Assistance in reviewing of the slides

Source of materials

Clients' data
Previous employers and colleagues
Internet

Participants

for the time and the attention



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Who we are?

JAVA OFFSHORE - Brief Introduction

Established in 2012 from:

- Earlier incorporation of PT Offshore Works Indonesia in 2010
- Acquiring of Asian Geos Sdn Bhd in 2017

Java Offshore owns and operates:

- 7 dedicated geophysical and geotechnical vessels
- > 120 skilled permanent team members.
- > 80 contract staff operating.

Kuala Lumpur, Malaysia Office
Asian Geos Sdn Bhd
Level 2, Wisma Sin Heap Lee,
346, Jalan Tun Razak,
50400 Kuala Lumpur,
Malaysia

Jakarta, Indonesia Office
PT Offshore Works Indonesia
Jalan Mahakam 1 No.11 B, Kramat
Pela, Kebayoran Baru
Jakarta Selatan, 12130, Indonesia

- ISO 9001:2015;
- ISO 14001:2015;
- OHSAS 18001:2007 Certified

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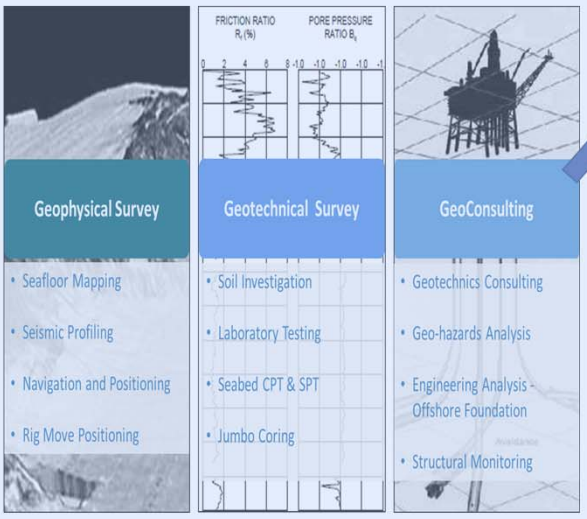
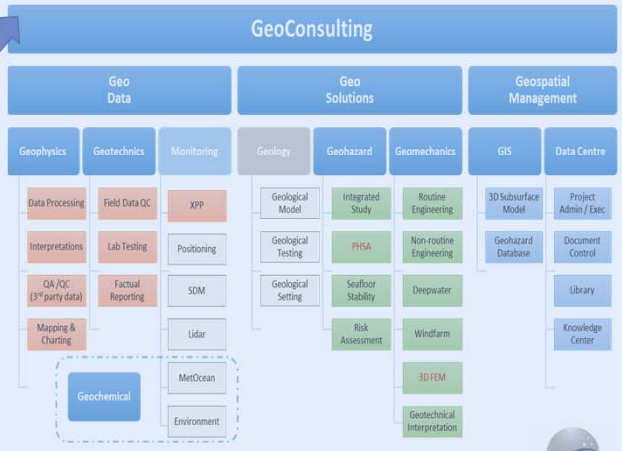
What we do?





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Outline & Objective

What to expect from this webinar:

- Survey Design *(planning for survey)*
- Geophysical Survey *(for non-specialist)*
- Geohazard Assessment Case Studies *(drilling related)*
- Geotechnical Investigation *(shallow water regime)*
- Geotechnical Engineering Case Studies *(drilling sites)*

- Understanding the need both Geophysical & Geotechnical surveys
- Sharing case studies, related to geohazard in offshore drilling sites

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- **Survey Design** *(planning for survey)*
- **Geophysical Survey** *(for non-specialist)*
- **Geohazard Assessment** *(drilling related)*
- **Geotechnical Investigation** *(shallow water regime)*
- **Offshore Geotechnical Engineering** *(drilling sites)*

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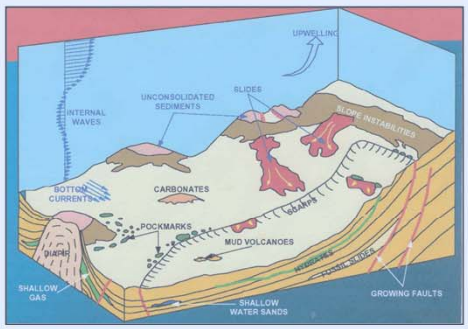
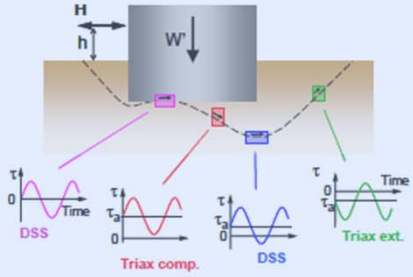
Why perform Survey?

#1: Control of ground risk:

- Blowout, due to Shallow Gas
- Deep / Uneven / Slow spudcan penetration
- Shallow Water Flows





#2: Obtain ground parameters:

- Leg Penetration Analysis & Other Designs
- Punch through & Rapid uncontrolled leg run
- Location approval

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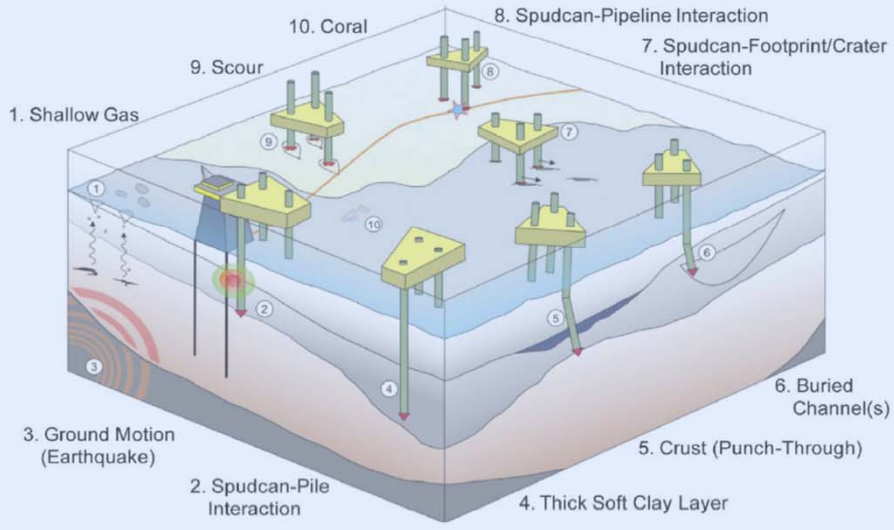
What Geohazard for Drilling Site is?



Source: Regional Suitability Mapping PRSM Project – An Update (Rohani et al, 2018)

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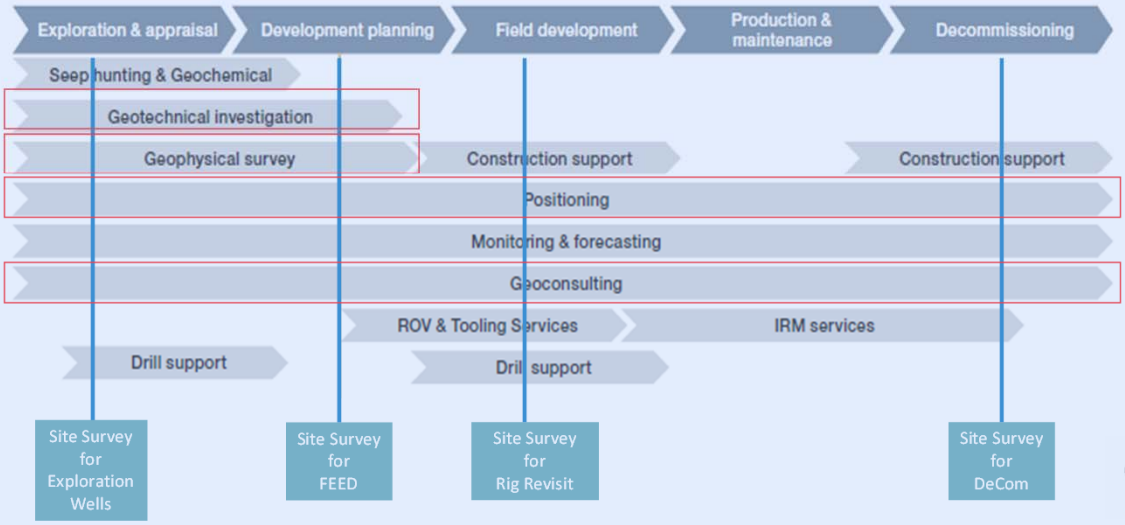
When to Conduct Survey?

Lifecycle Of Offshore Facilities
Survey needed in almost each phases



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Which factors need to considere?

Objectives of the Investigation?
→ Type of Survey & Method

Environment, Water Depth (Where the Location is)?
→ Survey System, Techniques, Safety

Stand Alone or Combined/Integrated Investigation?
→ Mode of Operations, Type of Vessel

Regulations, Standards, Permits, Code of Practices for Marine Activities?
→ Specifications, Safety, Legal & Financial Consequences

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Industry Legislation, Regulations, Guidelines?

(including STANDARDS, PRACTICES, PERMITS)

- International / Local **Maritime** Standards *(IMO, IMCA, UKOOA, MIGAS, BP MIGAS, etc.)*
- International (Offshore) **Oil and Gas Industry** Standards and Code of Practices *(API, DNV, SNAME, etc.)*
- International **Soil Mechanics/Geotechnical/Geophysical** Standards and Code of Practices *(ASTM, BS, IAGC, etc.)*
- **Local Permits** that Vary from Country to Country *(Operating, Immigration, Customs/Import and Re-Export, Security Clearance, Dispensation, Work Permits, etc.)*

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- **Survey Design** *(planning for survey)*
- **Geophysical Survey** *(for non-specialist)*
- **Geohazard Assessment** *(drilling related)*
- **Geotechnical Investigation** *(shallow water regime)*
- **Offshore Geotechnical Engineering** *(drilling sites)*

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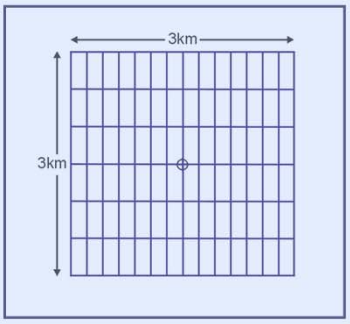
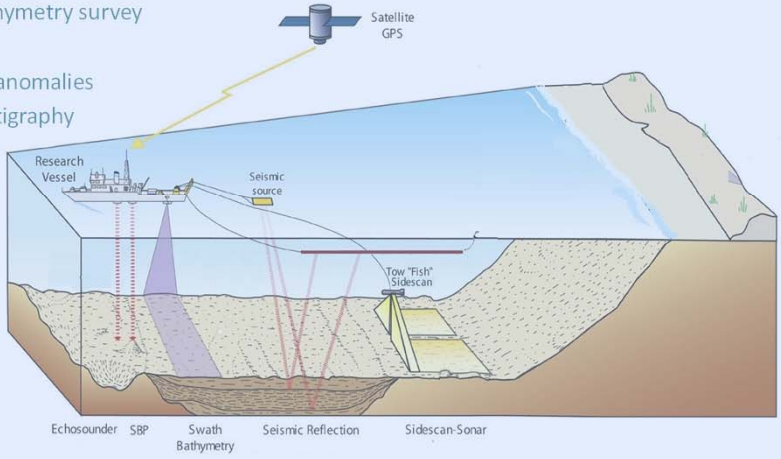
SYSTEMS ARRANGEMENT – SINGLE PASS

Geophysical site survey for Drilling Site typically consists of:

1. Echo Sounding → water depth / bathymetry survey
2. Sonar Systems → seabed features
3. Magnetometer survey → magnetic anomalies
4. Sub Bottom Profilers → ground stratigraphy
5. 2D Hi-Res → shallow gas detection





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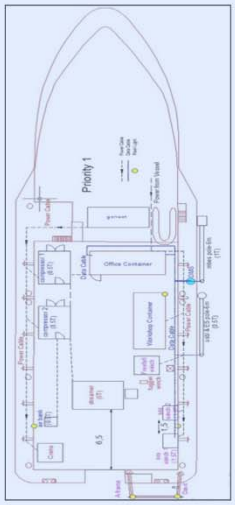
JAVA OFFSHORE's Dedicated Geophysics Survey Vessels


SV Java Imperia – Indonesia Flag


MV Java Istoria – Malaysia Flag


RV Java Insignia – Malaysia Flag


SV Java Ilena – Indonesia Flag



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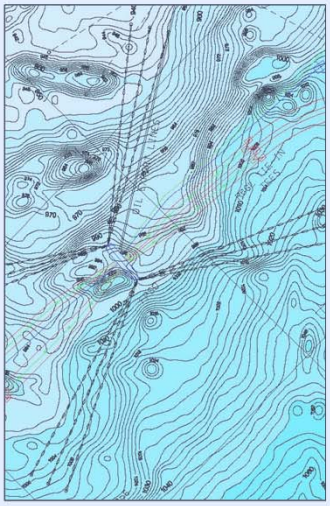
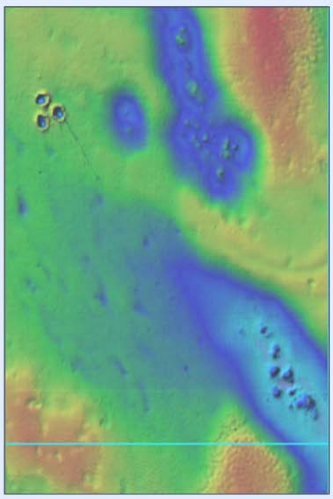
1. WATER DEPTH / BATHYMETRY EXAMPLES





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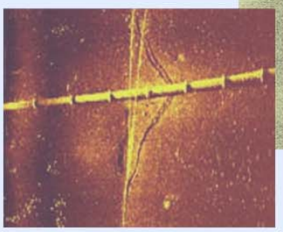
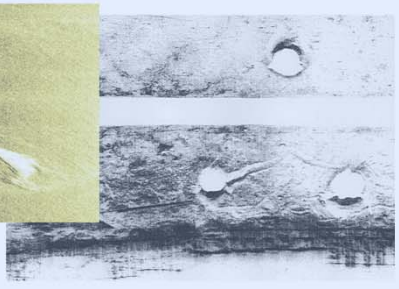
2/3. SIDE SCAN SONAR IMAGES

- Identify Objects
  - Pipelines & cables
  - Wrecks
  - Debris
  - Seafloor topography
    - Rocks
    - Sand waves
    - Spudcan Footprints
    - Scars (trawling) and Ice Scouring
    - Pockmarks
- Seabed Sediments
  - High Backscatter
    - Gravel and coarse sands
  - Medium Backscatter
    - Fine to Medium Sands
  - Low Backscatter
    - Clays and silts





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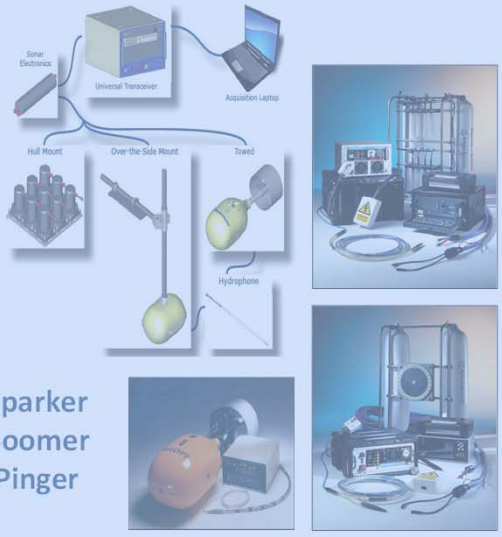
4. SUB-BOTTOM PROFILERS (SBP)



Sparker
Boomer
Pinger

SBP image removed

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PENETRATION vs FREQUENCY

Source	Function	Frequency	Vertical Resolution	Penetration through seabed
Multibeam Echo Sounder	Bathymetry	200 kHz	n/a	0 m
Sub-bottom Profiler (Pinger)	Pipelines Foundation zone	1.4 – 4.5 kHz	<0.3 m	10-100 m
High-resolution seismic (2D or 3D)	Shallow hazards	150 Hz	<3 m	<1500 m
Conventional 3D seismic	Reservoir exploration	50 Hz	<10 m	>3000 m

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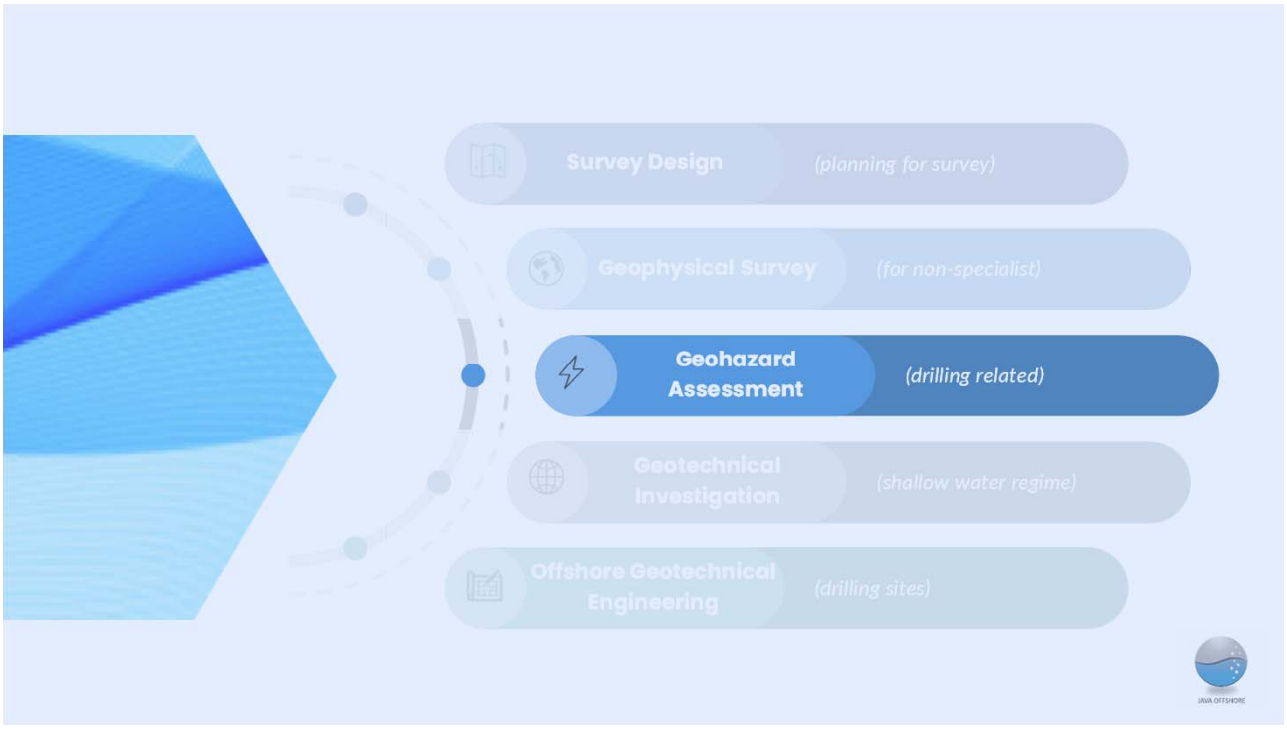
Survey Design
(planning for survey)
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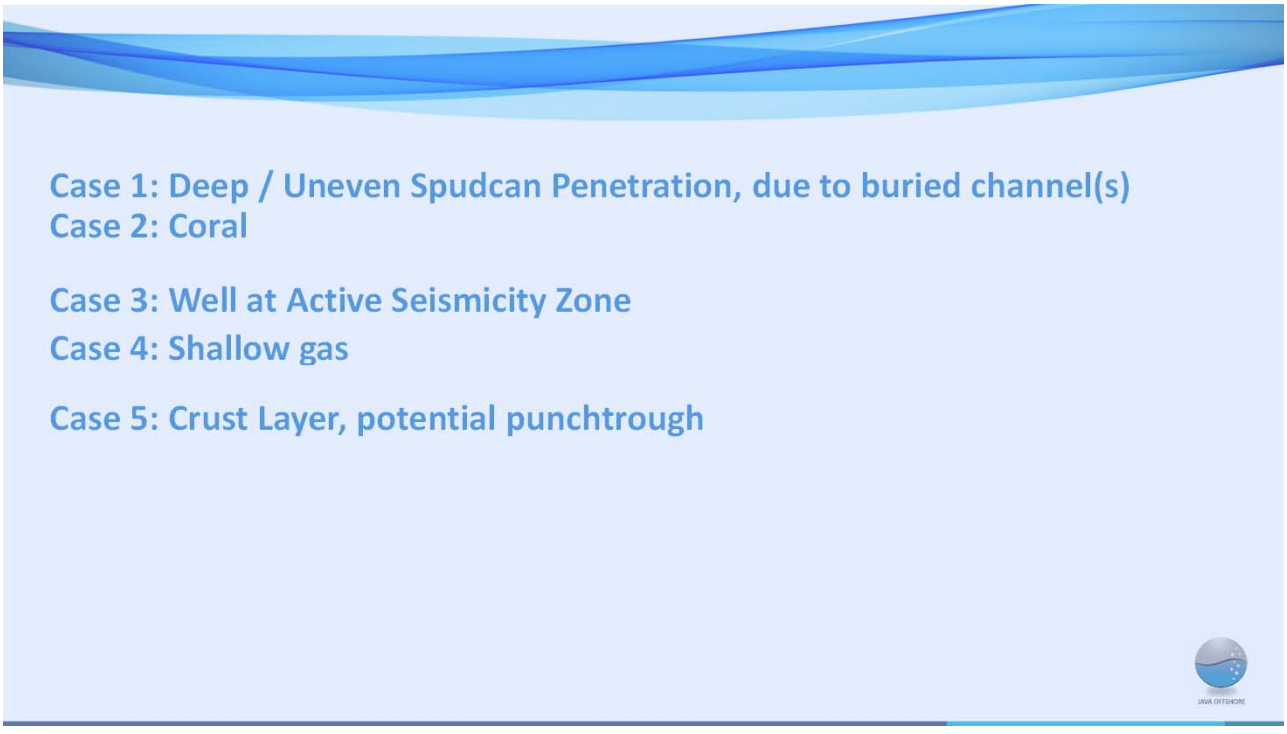
Case 1: Deep / Uneven Spudcan Penetration, due to buried channel(s)
Case 2: Coral
Case 3: Well at Active Seismicity Zone
Case 4: Shallow gas
Case 5: Crust Layer, potential punchtrough

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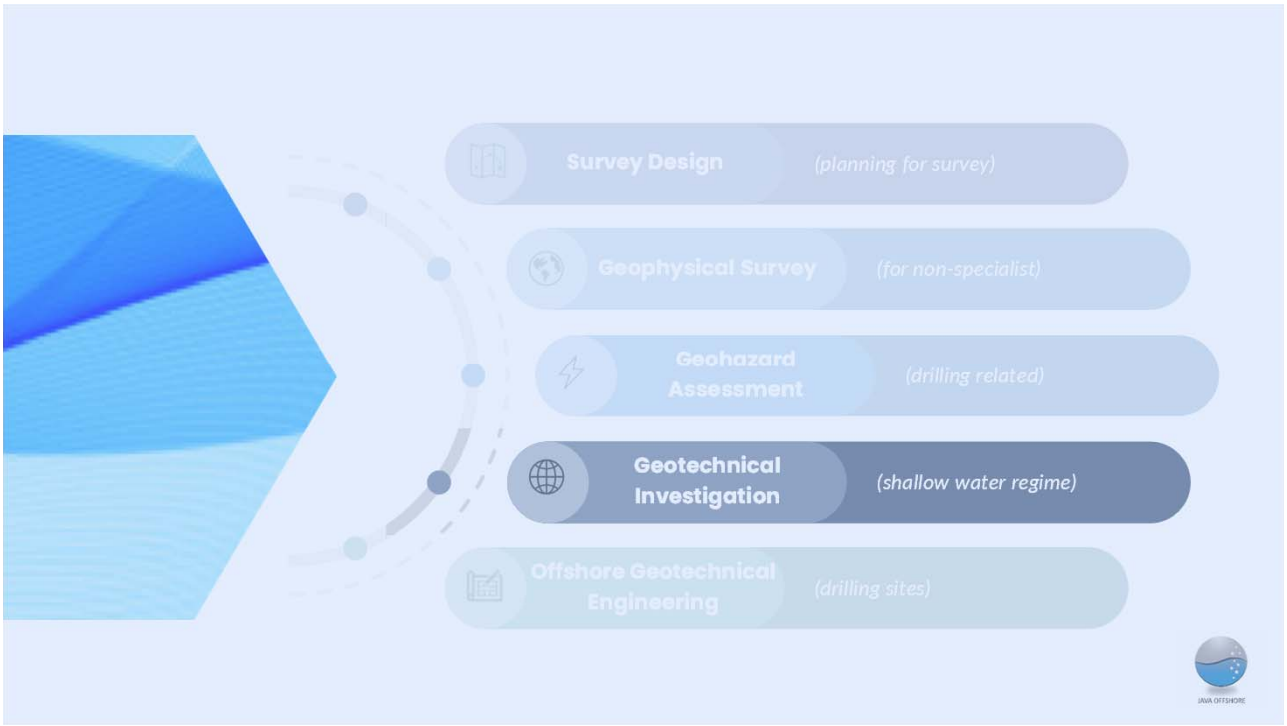

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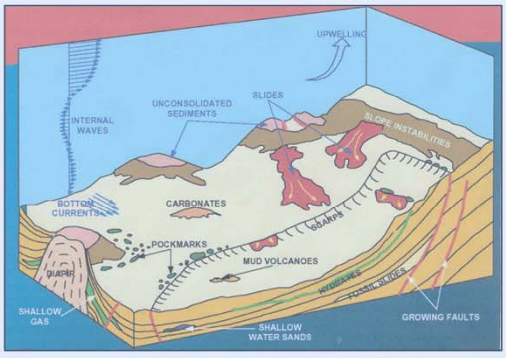
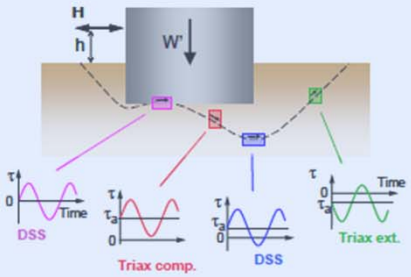
Recall: Why need to do surveys:

#1: Control of ground risk





#2: Obtain ground parameters

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Main Purposes: To Obtain Soil Geotechnical Parameters

Basic Soil Parameters Required for LPA (Leg Penetration Analysis)

Sand	Clay
Grain size	Grain Size
Relative Density	Atterberg Limits
Max/Min Density	Water Content
Friction Angle	Unit Weight
	Undrained shear strength
	Remoulded shear strength

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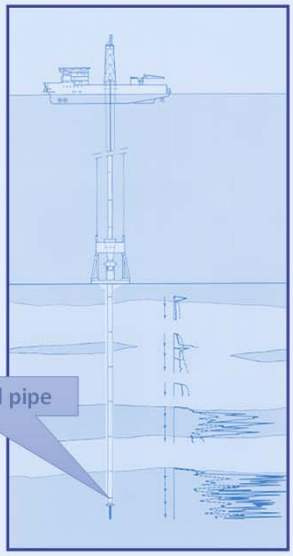
Methods of Offshore Geotechnical Investigation

seabed systems: penetration depth typically 6-12m but can be as deep as 40m in very soft deposit

Seabed based

Downhole in drill pipe

downhole system (drilling): penetration depth 250 m possible



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Downhole Mode - Drilling Equipment


Derrick


Top Drive


Rooster Box


Drill Bits


Motion Compensator

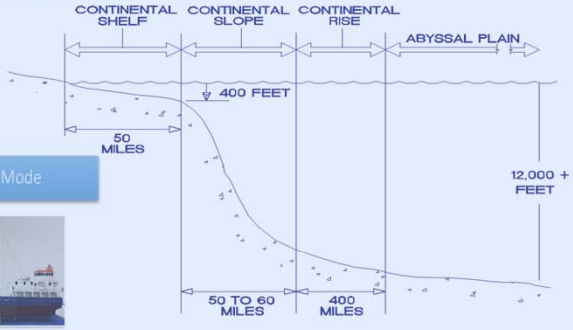

Pipe Rack & Drill Pipe


Drawork & sampling winch


Seabed Frame

Which Vessel to use?

Water Depth	Seabed Mode		Downhole Mode	
< 10m Nearshore / Riverbank	A frame		LCT Jack-up Barge	
10m – 120m Continental Shelf	DP1/DP2		4-point mooring	
> 120m Continental Slope to Deepwater	DP2/DP4		DP2/DP4	



CONTINENTAL MARGIN

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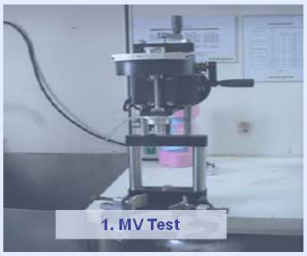
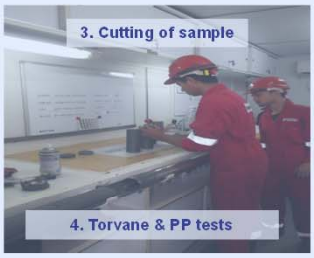
ONBOARD LABORATORY


1. MV Test


2. Sample Extrusion


3. Cutting of sample

4. Torvane & PP tests

5. Visual description

6. Photograph


7. Moisture content test


8. UU Triaxial

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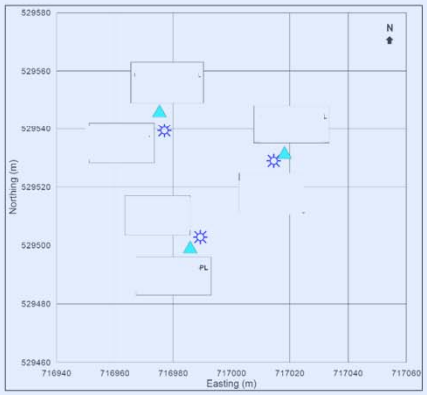
SOIL CONDITIONS
Results of Geotechnical Survey

Boring Logs (client data) removed

Borehole Plan



Bow Port Starboard

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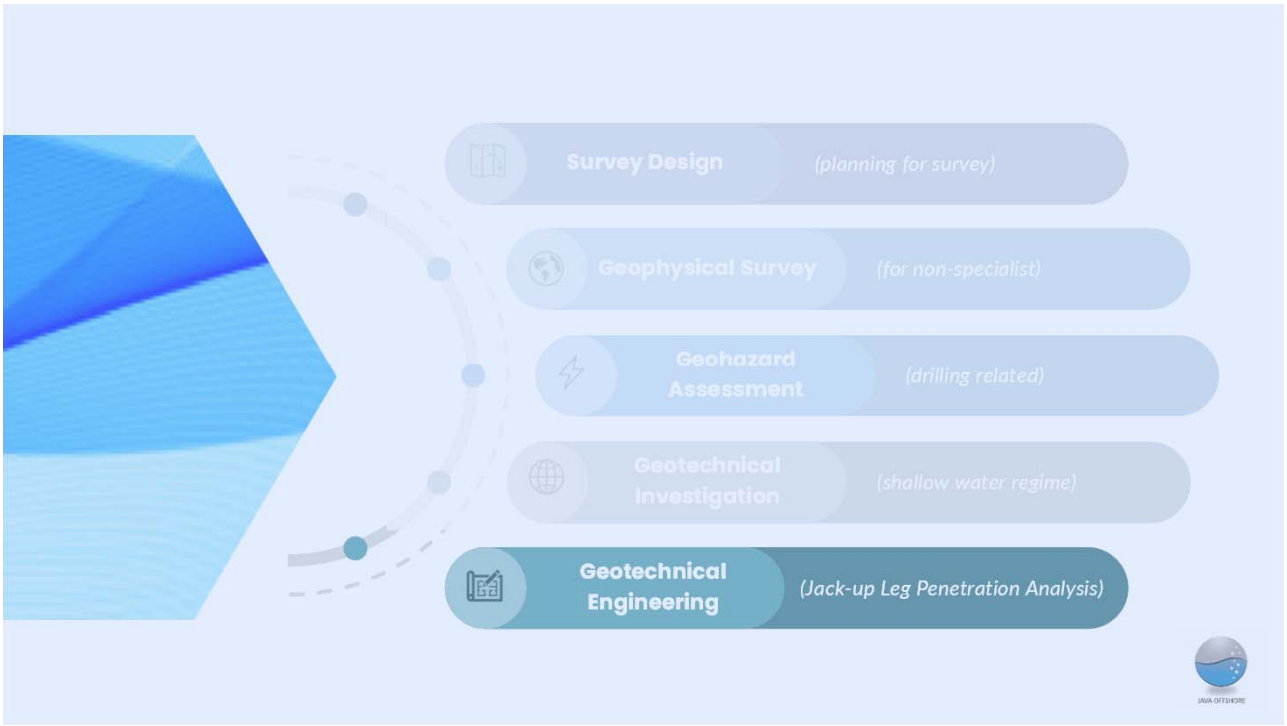
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(planning for survey)
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(shallow water regime)
Geotechnical Engineering
(Jack-up Leg Penetration Analysis)

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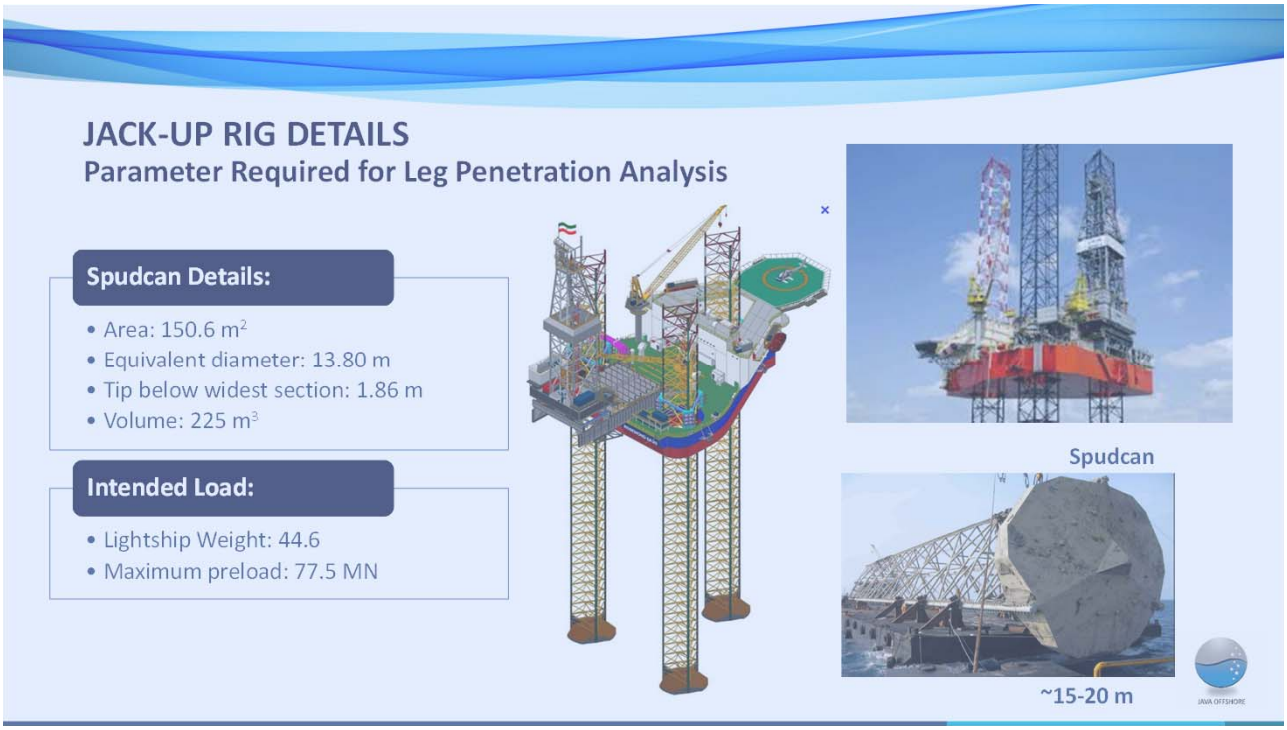
JACK-UP RIG DETAILS
Parameter Required for Leg Penetration Analysis
Spudcan Details:
• Area: 150.6 m²
• Equivalent diameter: 13.80 m
• Tip below widest section: 1.86 m
• Volume: 225 m³
Intended Load:
• Lightship Weight: 44.6
• Maximum preload: 77.5 MN
Spudcan
~15-20 m

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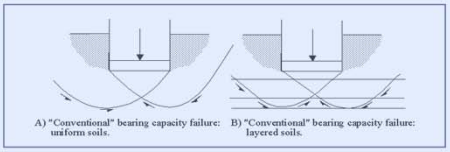
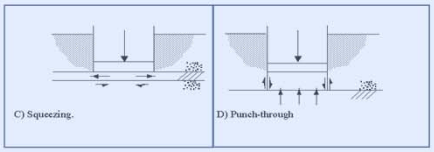
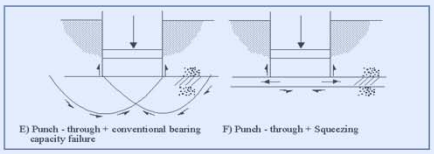
Leg Penetration Analysis (LPA) - Failure Mechanisms

ref: SNAME (2008) & ISO (2012)

- General shear failure (both in layered- as in homogenous soil)
- Punch-through
- Squeezing
- Combination of the above







Notes:

- *Formula for each failure mechanism is given in SNAME or ISO.*
- *Need to understand which mode of failure, given the actual (soil and spudcan) conditions, most likely to occur and apply the formula accordingly.*

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Why Worry About Punch-through ?

Consequential costs of US$1 to US$10 million per failure (source: internet)

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Case 1: Punch Through, due to inaccurate selection of Soil Parameters

- Simplification in necessary, but careful on the critical details
- Always be cautious when observe hard layers or lenses in soft clay deposit.

Case 2: Spudcan Footprint Interaction: penetration into existing footprints

- Most of Leg Penetration Analysis is a one-dimensional (1D) analysis
- But if a footprints, pipeline, foundation exist in the vicinity, it will require a three-dimensional (3D) analysis

Case 3: False-Alarm Punch Through, due to inaccurate analysis method

- In addition of accurate soil parameters (ie, Case 1 earlier), selection of appropriate mode of failures is also critical
- Need good engineering judgment and cannot be relayed totally on software to calculate

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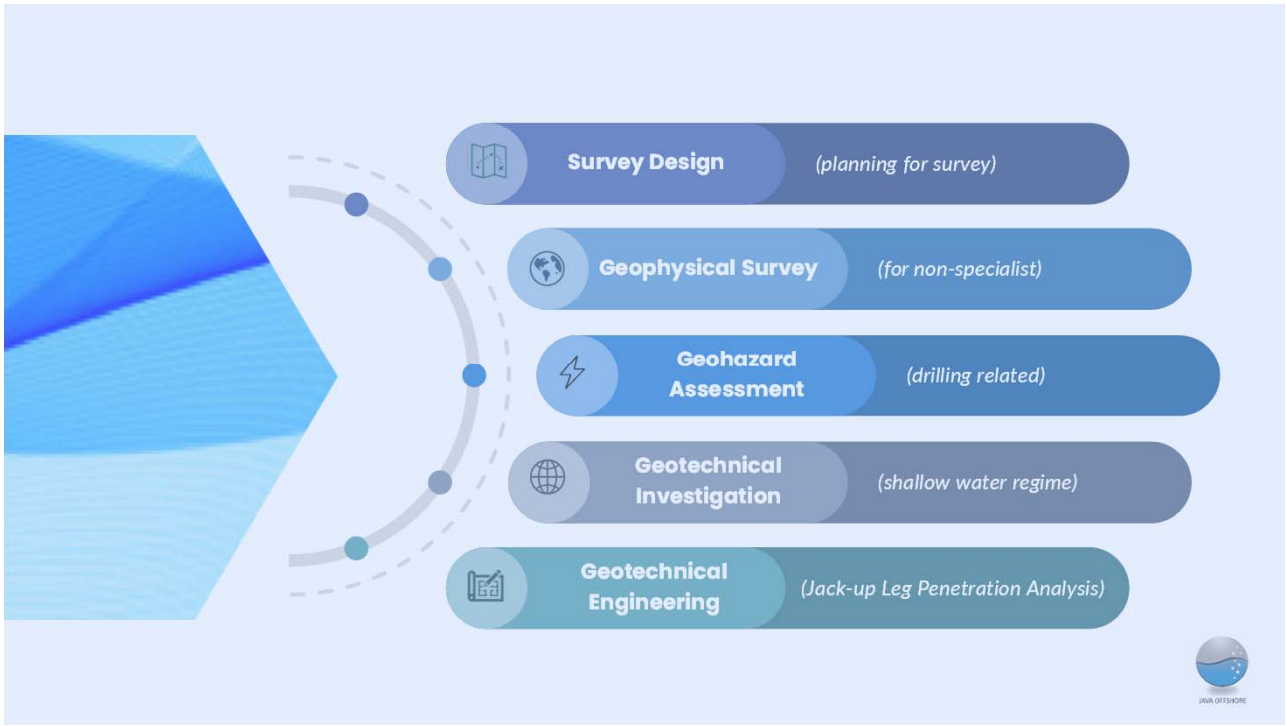

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Summary - Marine Geophysical and Geotechnical Services

for Drilling Site / Rig Entry

	Geophysics	Geotechnics
1. Purposes	Collect subsurface data qualitatively → define any hazard → selection of well location	Collect subsurface data quantitatively → obtain soil parameters for geotechnical analysis → location approval
2. Scope	Analogue and 2D High Resolution Survey from 1km x 1km.. to.. 5km x 5km with line spacing of 100m	Borehole sampling &/or CPTU at location of each jack-up rig leg Pilot hole, if deemed necessary to verify the absent of shallow gas
3. Results	Geohazard mapping → optimal wellhead location → rig approach	Leg Penetration Curves → hazard for rig emplacement → final leg penetration

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The Last but not Least

Learning Point:

- Why we need both Geophysical & Geotechnical surveys.
- Simplifying data is necessary, but failure to understand the data details is fatal (jackup puncht-hrough case)
- Wrong mind "Engineering is the ONLY important process":
  - Always put qualified & experienced people
  - Soil is not homogeneous material, need good judgment.
- Perception that Geophysical & Geotechnical surveys are not seen as important by engineers due to the work being lower value as opposed to EPC work.

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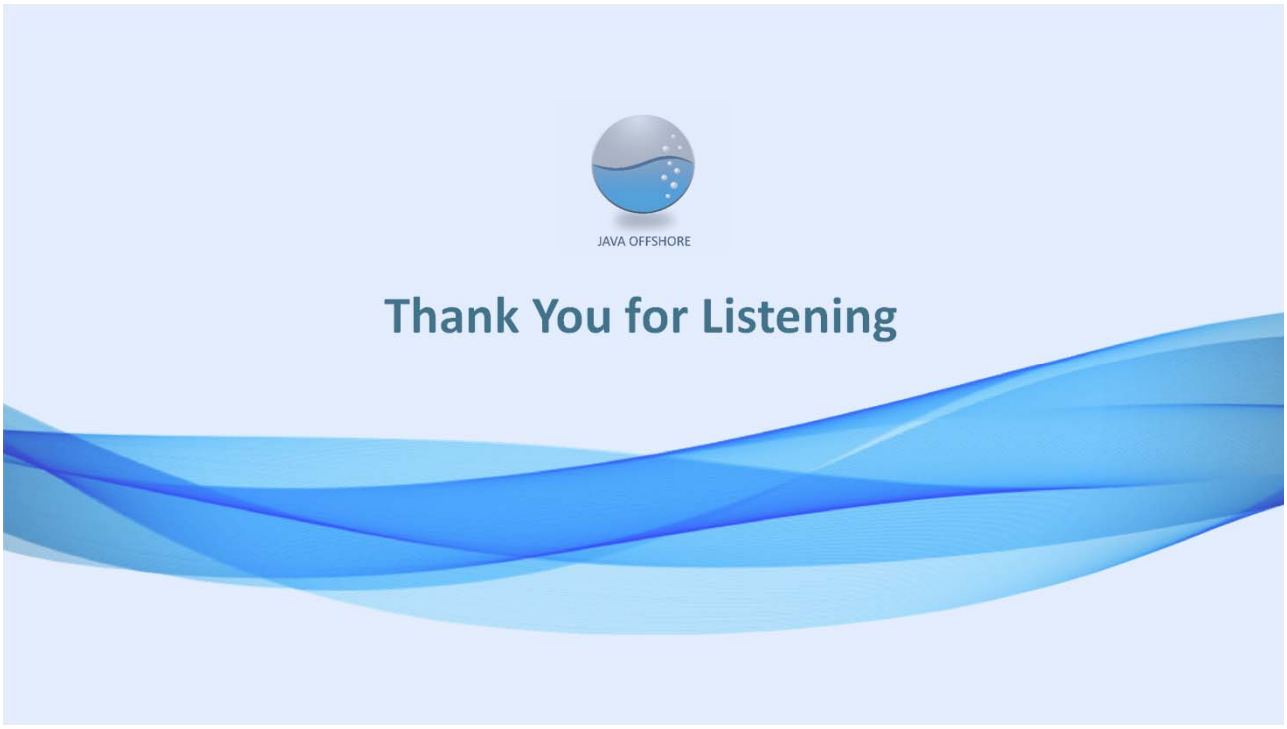

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