

# Oilfield History Moment



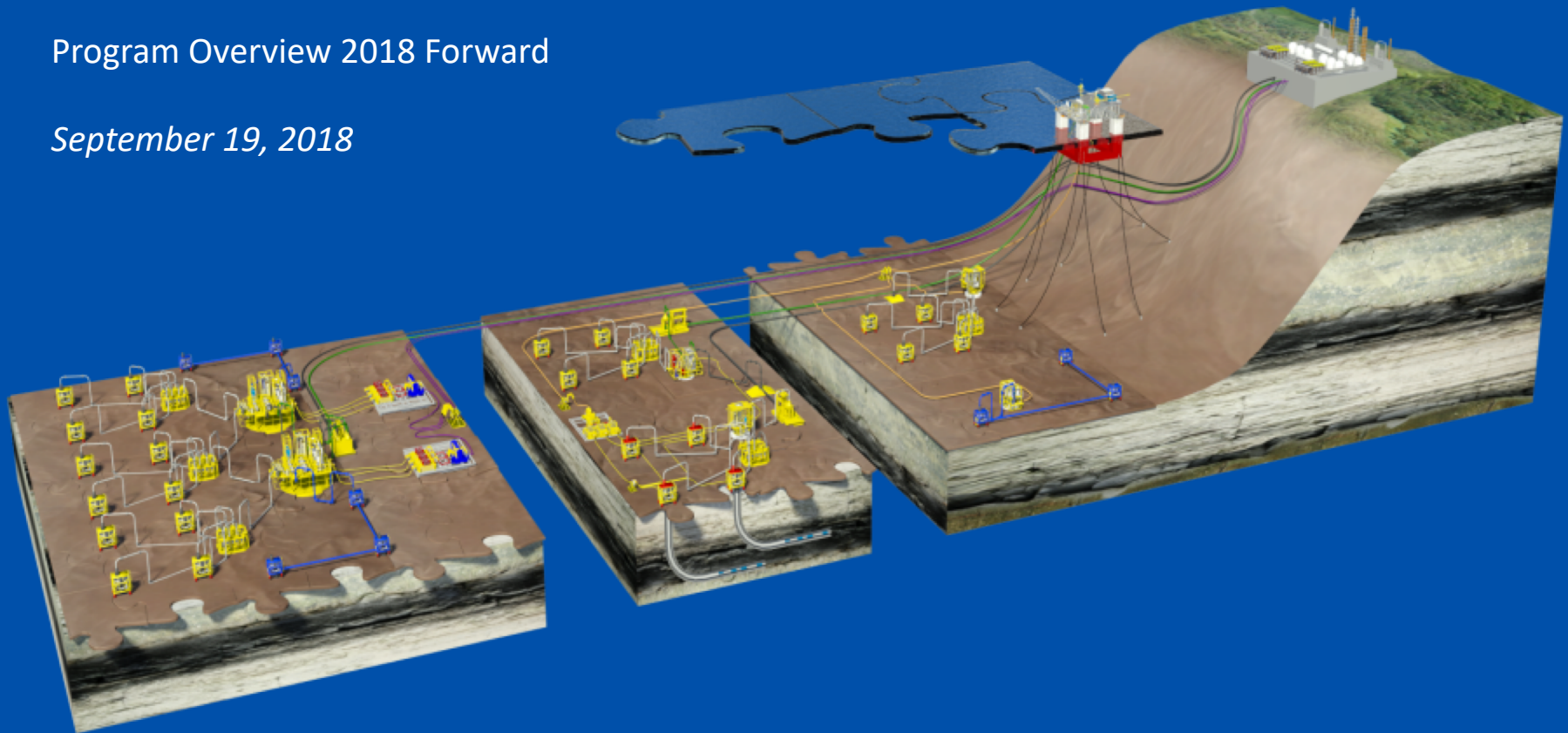
# DEEPSTAR®

A Global Offshore Technology Development Consortium



Program Overview 2018 Forward

*September 19, 2018*



# Agenda

- Deepstar – Functional Footprint
- Body of Work Since Inception
- Recent History DC&I Committee – 2017
- 2018 and the ‘Forward Hopper’
- Details



# Functional Footprint - Holistic approach, focus on Technology



Floating Systems

Flow Assurance

Subsea Systems

Drilling & Completions

Out of Scope:  
Regulatory Advocacy



# DeepStar<sup>®</sup> 2018 Organizational Structure



**Management Committee (Core Members)**  
Senior Advisors

**DeepStar Director**  
Shakir Shamshy

**DeepStar Staff**  
Joseph Gomes – Project Manager  
Jonathan Nunn - Project Specialist

**Potential Participants to Core Program / Satellite Projects**

- Apache
- Aramco
- BP
- HESS
- Kosmos Energy
- LLOG
- INPEX
- PEMEX
- PETRONAS
- Repsol

**Current Technical Subcommittees**

**Drilling, Completions & Intervention**

Dave Barrow (CVX)  
Halvor Kjørholt (EQNR)  
Umar Singh (EQNR)

**Subsea Systems Engineering**

Antonio Critsinelis (CVX)  
Ole Økland (EQNR)

**Flow Assurance**

Julie Morgan (WPL)  
Siva Subramanian (CVX)

**Floating Systems & MetOcean**

Jim Stear (CVX)  
Christina Waggoner (PBR)

**Technical Subcommittees to be added in the future**

- Geoscience
- Reservoir
- Operations

# DeepStar Drilling Advancement 27 Years of Development

**12501 – 20Ksi Well Drilling System MODU Upgrade;**

**12502 - 20 ksi HPHT Completion Design Considerations and Well Intervention Systems;**

**12503 - Standardized Materials Selection Basis of Design and Equipment Testing Criteria;**

**12504 -Real Time Monitoring for Critical Barriers**

**12505 -Analysis of current technology and capabilities for shearing**

**11501 – ESP Systems for Deepwater Applications - Validation Testing Protocols for Wellhead Connectors and Packer Penetrators;**

**10501 - Develop highly reliable & high power ESPs**

**10502 - Dual Gradient Drilling Flow Stop Valve, Phase I**

**9501 - GoM Ultra-deep Riserless Mud Recovery JIP—Feasibility Study and Planning**

**9502 Drilling Riser Structural Damping Test**

**8502 - Deepwater Subsea Artificial Lift Study**

**8503 - Annular Pressure Buildup Analysis, Model & Mitigation for XHPHT Wells**

**7501 - D&C Gaps for HPHT in Deepwater**

**6501 - Rig Dynamic Positioning System Reliability**

**6502 - DGD Riserless mud return Top-Hole Applications for Deep Water**

**5502 - Update Shallow Water Flow Database**

**5503 - Development of Revision to API RP 16Q**

**4501 - Bottom Driven Casing Test**

**4502 - Deepwater Riser and Wellhead Systems Design and Operational**

**4503 - Well Control Evaluation Software Package**

**4506 - Reliability Forecast Methodology for Prototype Completions**

**4507 - Link IWC Reliability Forecast to North Sea**

**3501 - Unconventional Methods for SWF Conductor Installation**

**3503 - Permeability Impairment of Shallow Waterflows**

**3504 - Shallow Water Gas Shut Off Material for Deepwater Applications**

**3505 - Well Control Evaluation Software Package**

**3506 - Bottom Driven Casing Study**

**2A-1001 Various Drilling Water Flow Reports**

**2A-1002 Well Testing Procedures for Deep Water**

**2A-1003 Dropped BOP Statistics**

**2A-1004 Circulation Temperature and Composite Risers**

**2-1002 Completion Design for Deepwater Gulf of Mexico**

**2-1010 Surface Controlled Subsurface Safety Valve Risk**

**2-1020 Downhole Intervention Analysis**

**2-1025 Drilling Risers Study**

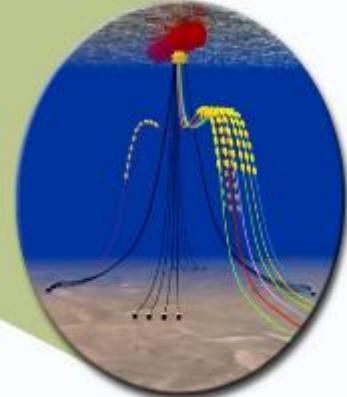
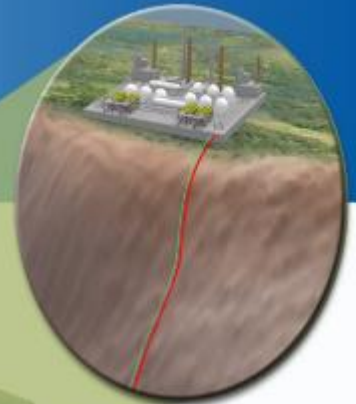
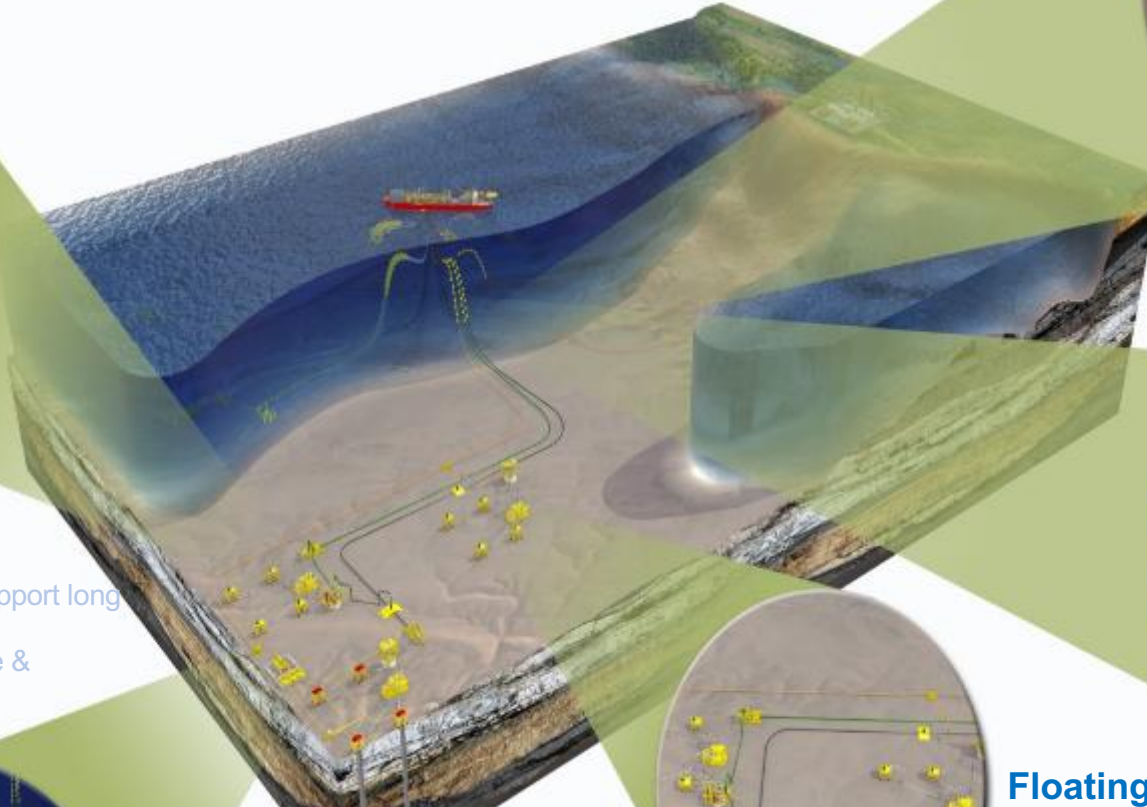
**2-1031 Vendor Independent Information**

# DeepStar 2017 Projects



## Subsea Systems Engineering

- Power buoy design to support long distance subsea tieback
- Subsea chemical storage & injection
- 20 K Systems Validation



## Drilling, Completions & Intervention:

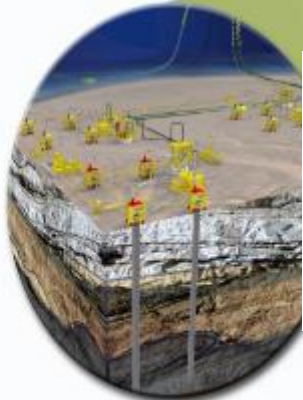
- Shear Ram Systems
- ESP Monitoring & Control Systems
- Surface Controlled Subsurface Safety Valves

## Floating Systems & MetOcean

- Integrity management of marine systems
- Low-Cost FPSO alternative
- Improving mooring reliability & better standards

## Flow Assurance

- Development of Testing Benchmarks for LDHIs using Rock-Flow Cell
- Hydrate Blockage Remediation - Electric Squid
- Measurements of Gas Hydrates Phase Equilibria





# DeepStar 2017 Projects

## Drilling, Completions & Intervention:

- Shear Ram Systems
- ESP Monitoring & Control Systems
- Surface Controlled Subsurface Safety Valves

### Subsea Systems Engineering

- Power buoy and distance subsea
- Subsea chemical injection
- 20 K Systems Validation

### Floating Systems & MetOcean

- Integrity management of marine systems
- Low-Cost FPSO alternative
- Improving mooring reliability & better standards
- Riser continued service

### Flow Assurance

- Development of Testing Benchmarks for LDHIs using Rock-Flow Cell
- Hydrate Blockage Remediation - Electric Squid
- Measurements of Gas Hydrates Phase Equilibria

# Shear Ram Workshop at Stress Engineering 'Core'

- Champion – R. Cummings (CVX)
- Principal Investigator – Stress Engineering ( Felipe Freitas )
- Purpose: Reveal 'State of the Art', relative to Shear Rams on Subsea Wells.
- Industry-wide Workshop focused on reviewing the technologies being development from all the industry manufactories and technology suppliers.

Companies that presented:

- Axon, Baker Hughes (GE company), Bastion Technologies, BOP Technologies, Balanced Solutions, Cameron, Electrical Subsea Drilling, Enovate Systems Limited, Interventek Subsea Engineering, Kinetic Pressure Control Ltd, NOV

# ESP Monitoring and Control

- Champion – D. Harris (CVX)
- Principal Investigator – tbd
  
- Purpose: Develop Software to optimize variable speed ESP's.
  - Improve reliability
  - Extend Service Lifetime
  
- Related – New developments to extend lifetime of ESP Power Cables.



# Insert WRSCSSV for failed Deepwater, 15K TRSCSSV

- Champion – R. Chauvin (CVX)
- Principal Investigator – tbd – Proposals Received.
- Purpose: Develop WRSCSSV for use in commonly used 15K TRSCSSV
- RFP from Suppliers and Engineers for fixed cost to develop
- Collaboration across vendors to confirm feasibility of installation
  - ‘Cut Test’ – October 1, 2018
- Go - No-Go Decision based on outcome from ‘Cut Test’

# DeepStar Future Development



CORE Program



Partnerships with

Nippon Foundation  
Department of Energy  
and others



Satellite Program

# 2018 Subcommittee Technical Topics- 'The Hopper' - Drilling, Completions & Intervention

- 20-year downhole cable.
- Automation and demanning of platforms
- BOP Reliability
- Multi-year review of Containment Approaches and Effectiveness
- Dual Gradient Drilling / Subsea Mud lift Device / New 'High Availability' Rotating Control Device
- **Early Kick Detection**
- Hard Rock Drilling; Improve ROPs in drilling/under-reaming hard formations
- Electric Tree
- ESP Monitoring and Control
- Optimization for Improved Service Life
- Extended Reach – Finding a new technical limit
- Fluid balanced ESP (removing reliance on the thrust bearings)
- **Insert SCSSV for 15K Deepwater SCSSV**
- Inflow Control Devices - IP Review and Gap Assessment (Commanded Downhole Valves to improve conformance across the length of the Completion).
- Investigation of barriers behind pipe
- Mud Cap Drilling
- Sand Control including Primary and Remedial
- SCSSV (Enable better long step tiebacks)
- Shearing - Assurance for BOP Rule 2020
- Top Hole Drilling by LWI Vessel – Proposal Received
- Thermite for well P&A
- Use of Pressurized Mud Cap Drilling (Pressurized/Floating) for drilling severely depleted zones
- Well Containment - Comparative Review of Regulations and Cost
- Wellhead and Conductor Fatigue [Understanding both Capacity and Load]



# Early Kick Detection ('Core')

- Champion – D. Fett (TOT)
- Principal Investigator – tbd
  
- Purpose: Examine prospect of measuring annulus fluid density across the length of a BHA.
- Can a sudden reduction in density signal a kick?

# DeepStar 2018 Members



ExxonMobil



Amog Consulting	Aker Solutions	Baker Hughes A GE Company
Colorado School of Mines	DNVGL	EnergO / KBR
INTECSEA / WorleyParsons	JETRO	National Oilwell Varco
SBM Offshore	Stress Engineering	WOOD

# Discussion?

## Thank you . . .

Dave Barrow  
Chevron; Senior Advisor Subsea Completions  
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(Please join DeepStar and collaborate )  
[www.theDeepStar.com](http://www.theDeepStar.com)

### Contacts

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[Shakir@Chevron.com](mailto:Shakir@Chevron.com)

**Joseph Gomes** – DeepStar Project Manager  
[Joe@theooc.us](mailto:Joe@theooc.us)

### Sub Committee Contacts

**Dave Barrow, Halvor Kjørholt** – Drilling, Completions & Intervention Chairs

**Siva Subramanian, Julie Morgan** – Flow Assurance Chairs

**Antonio Critsinelis, Ole Okland** – Subsea Systems Engineering Chairs

**Jim Stear, Cristina Waggoner** – Floating Systems & MetOcean Chairs





# Additional Information

# DeepStar®

## Global Offshore Technology Development Consortium 27 Years of Industry Excellence

### DeepStar Recruiting Members for DeepStar 2018 .....

DeepStar is the industry's longest running and most successful offshore technology development consortium and it has generated significant value by providing technology transfer to its members and the industry. There is an increased need in the industry for an operator-driven, collaborative technology development program.

### DeepStar® CORE + Satellite Model

#### CORE Program

DeepStar CORE Program focuses on all members' common collaborative technology needs; discusses industry technology issues and develops ideas for larger, elective satellite projects.

#### Satellite Projects

Focuses on elective Satellite Projects in which the technology advancement is aided by collaborative among interested parties.

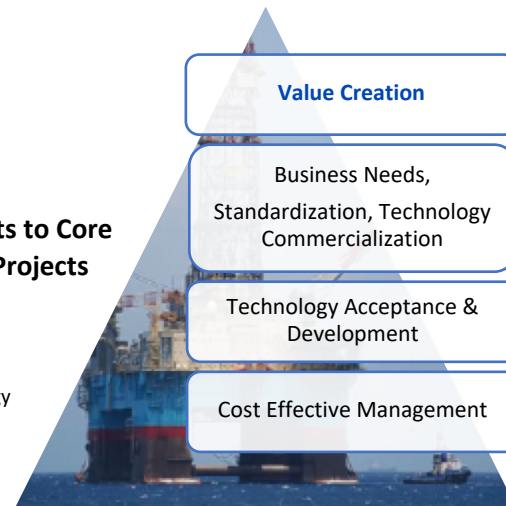
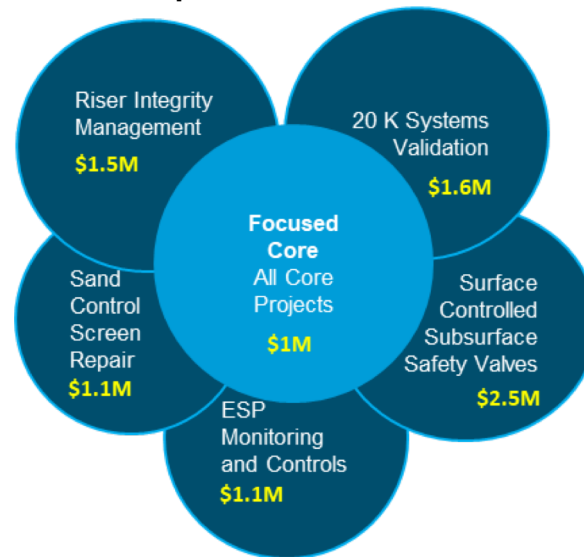
#### CORE Members



#### Potential Participants to Core Program / Satellite Projects

Apache  
Aramco  
BP  
HESS  
Kosmos Energy  
LLOG  
INPEX  
PEMEX  
PETRONAS  
Repsol

### DeepStar 2018 Model



### DeepStar® Technical Subcommittees:

- **Drilling, Completion and Intervention**
  - Drilling Operations
  - Downhole Early Kick Detection
- **Flow Assurance**
  - Concurrent Wax and Hydrates Deposition
  - Plugged Flowline Diagnostic Technologies
  - Quantifying the Effect of Insulation on Hydrate Deposition in Gas-Filled Deadlegs
- **Subsea Systems Engineering**
  - Thermoplastic Composite Pipe in Deepwater
  - Subsea Asset Integrity – Docking Station Standardization
  - Subsea Composite Flowlines
  - Subsea Electrical Fail-Safe Valves
  - Subsea Leak Detection with AUV
  - Integrated Flowline cost reduction program
  - HPHT Systems Review & Validation
- **Floating Systems & Met-Ocean**
  - Integrity Management
  - Riser Continued Service
  - Accurate and Reliable Surface Measurement
  - Data Standardization for Digital Lifecycle

### Potential Technical Subcommittees

- **Geoscience**
- **Reservoir**
- **Operations**

### DeepStar Membership Fee

- **CORE Member (\$100,000 - annual)**
- **Associate Member (\$15,000 - annual)**

# DeepStar 2017 Program Project Status

## Flow Assurance

**1. Hydrate Blockage Remediation** (Electric Squid): Oceaneering, \$50,000. (25% Complete)

Development of hydrate blockage remediation tool for “difficult” shaped subsea hardware e.g. trees / manifolds / jumpers.

- **Deliverables:** Feasibility document outlining the development of subsea deployable thermal heating apparatus for complex subsea architecture components.

**2. Measurements of Gas Hydrates Phase Equilibria:** Colorado School of Mines, \$55,000 (90% Complete)

Completion fluids used in deepwater wells must be properly formulated to prevent formation of hydrates. Reliable predictions for hydrate equilibrium conditions are important to developing/ selecting the proper completion brine.

- **Deliverables:** Technical report and Excel database of multi brine blends hydrate formation onset points.

**3. Development of Testing Benchmarks for LDHIs using Rock-Flow Cell;** Colorado School of Mines, \$80,000 (50% Complete)

To benchmark the rock-flow cell as an effective lab-scale testing device for LDHIs by performing tests that are representative to field conditions in terms of pressure, subcooling, oil (condensate), liquid loading, water cut, LDHI type and concentration, and GOR.

- **Deliverables:** Guidance document and recommendation to operators on requirements and parameters for benchmarking rock-flow cell as an effective lab-scale testing device for LDHIs.

## Subsea Systems Engineering

**4. Subsea Chemical Storage & Injection:** National Oilwell Varco, \$25,000 (Phase I Complete, Phase II 100% Complete)

Subsea production systems require both continuous and intermittent injection of chemicals to support their day to day operations. Subsea chemical storage and injection is an opportunity to reduce initial field development costs, allow additional wells to be tied in beyond what was originally planned, or to supplement the umbilical in the event it is damaged. Several companies are developing such units, so this study is to understand better their products, deployment opportunities, technology readiness and interface requirements.

- **Deliverables:** Development plan of action documented with current TRL levels and current state of the industry related to Subsea Chemical Storage Systems and Subsea electrical pumps.

**5. Power Buoy Design to support Long Distance Subsea Tieback:** Aker Solutions, \$25,000 (100% Complete)

To understand better the opportunities for power buoys to support subsea production systems. These would allow subsea production support equipment to be installed close to the wells, with minimum new technology and interfaces with the host facility.

- **Deliverables:** Topside design document, with summary PowerPoint presentation outline minimum needs for topside requirements for a normal unmanned facilities.

# DeepStar 2017 Program Project Status

## Drilling, Completions & Intervention

**6. Shear Ram Systems:** Stress Engineering Services, \$15,000. (100% Complete)

This project will survey and document new BOP technology and capability for shearing within the industry.

- Deliverables:** Technical output document which surveyed new BOP technology and capability for shearing within the industry from all identified major and minor manufacturers and technology providers.

## Floating Systems & MetOcean

**7. Integrity Management of Marine Systems:** Energo, \$50,000 (75% Complete)

While work has been completed on integrity management (IM) focused on structural issues, no guidance has been developed in IM of marine systems such as controls, ballast, safety, etc. this work will provide this missing guidance.

- Deliverables:** Guidance document and recommendation to API 2 FSI related to Integrity Management of marine systems such as controls, ballast, safety, etc.

## Floating Systems & MetOcean

**8. Low-Cost FPSO Alternative:** IntecSea, \$100,000 (100% Complete)

A quest for step-change cost reduction solution via an innovative floating concept. This project will evaluate technical merits and cost comparisons of a simpler FPSO hull concept that offers multiple development options at lower costs.

- Deliverables:** Case Studies detailing the design, cost requirements and comparison to traditional FPSO design for both Dry/Wet Tree facility development.

**9. Improving Mooring Reliability & Better Standards:** Kwan Engineering Services, \$50,000 (90% Complete)

Improve reliability of mooring systems and prevent multi-line failures through improved Standards. Develop codes and standards to close critical gaps.

- Deliverables:** Recommendation / Output document detailing the current Mooring standards, and identifying either gaps between standards, and providing a recommendation on technical topics/research project needed to acquire more effective use or industry agreement.

**10. Riser Continued Service:** Stress Engineering Services, \$60,000 (Phase I, 100% Completed)

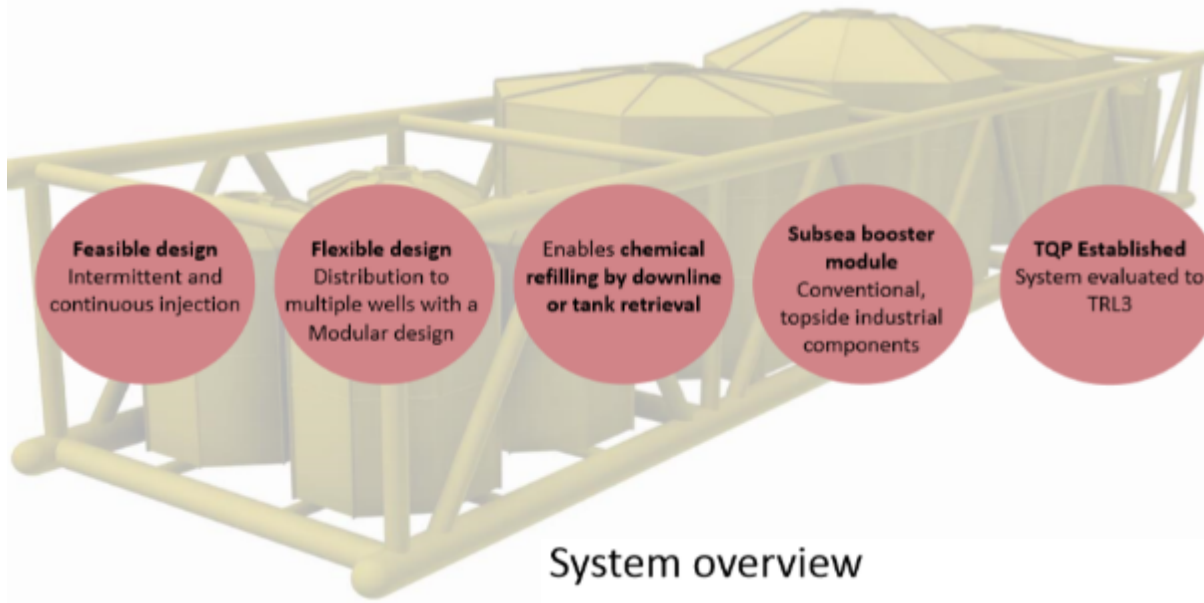
Evaluate fitness of existing risers and capability of current in-situ inspection methods; develop a process to safely maximize the use of existing riser systems.

- Deliverables:** Guidance document for the retrieval and long-term storage procedures to save retired risers for future testing and analysis. Detailed project plan and testing protocol for testing retired riser to assist in determining material life, to generate a riser database to gain approval for continuous service for risers.

ID	Title	Status	Completion
1.0.1	DeepStar 2017 Program Project	Open	2017-12-31
1.0.2	DeepStar 2017 Program Project	Open	2017-12-31
1.0.3	DeepStar 2017 Program Project	Open	2017-12-31
1.0.4	DeepStar 2017 Program Project	Open	2017-12-31
1.0.5	DeepStar 2017 Program Project	Open	2017-12-31
1.0.6	DeepStar 2017 Program Project	Open	2017-12-31
1.0.7	DeepStar 2017 Program Project	Open	2017-12-31
1.0.8	DeepStar 2017 Program Project	Open	2017-12-31
1.0.9	DeepStar 2017 Program Project	Open	2017-12-31
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1.0.12	DeepStar 2017 Program Project	Open	2017-12-31
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1.0.49	DeepStar 2017 Program Project	Open	2017-12-31
1.0.50	DeepStar 2017 Program Project	Open	2017-12-31

# DeepStar 2017 Project Deliverables

## Enhanced subsea architecture



**Feasible design**  
Intermittent and continuous injection

**Flexible design**  
Distribution to multiple wells with a Modular design

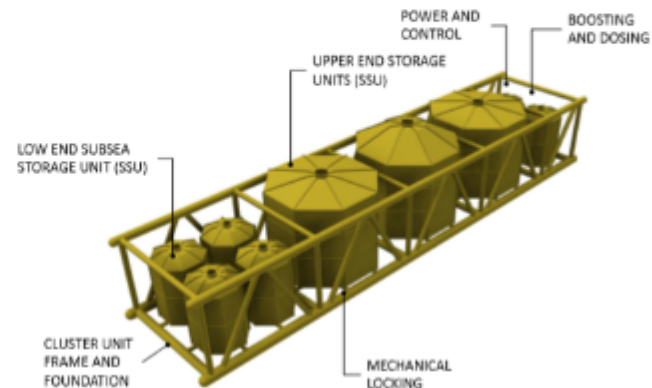
**Enables chemical refilling by downline or tank retrieval**

**Subsea booster module**  
Conventional, topside industrial components

**TQP Established**  
System evaluated to TRL3

### System overview

- Subsea chemical storage units incl. protection structure and membrane
- Fluid transfer and isolation system (piping, valves, connectors etc.)
- Subsea injection booster module
- Control and instrumentation
- Power supply
- Structure and foundation



- METHANOL
- MEG
- LDH
- SEMI-CLAYER
- CORROSION
- ASPHALTENE
- SCALE
- WAX

**EXECUTIVE SUMMARY**  
 NOV Subsea Products has performed an engineering study for DeepStar to assess the possible use of NOV's Subsea Chemical Storage and Injection System (SSU) as a part of a generic production scenario for deep-water oil fields. The study is limited to transfer of an unprocessed single phase oil well stream in a low flow regime. Subsea production systems require both continuous and intermittent injection of chemicals to improve their oil recovery operations. Traditionally, these chemicals have been applied from the local production host through a multi-function umbilical, which can deliver these chemicals as required. During steady state operation the requirement is to allow the hydraulic formation separation for the given products in the flow line to improve in-field wellbore injection technology provides for potential extension of the period of time possible for unprocessed flow line transfer under passive and active thermal management. This study will assess the feasibility of using the SSU to store and inject chemicals at production host start and end of production stop. Low volume (single) chemical injection is typically based on continuous injection during steady state production.

The NOV Subsea Storage and Injection System can reduce wellhead development costs, and offers a cost-effective alternative for supply of chemicals to a remote well centre location requiring long distance (downhole, surface), it allows the use of additional wells and is general injection control. This technology can also be used to replace existing umbilicals in the event of a damaged or otherwise no longer suitable for service. The primary objectives of this study have been to further evaluate and optimize the SSU solution while identifying technology gaps close opportunities by assessing the following technical subjects:

- Storage facility, storage unit and membrane
- Installation of storage facility
- Multi-operations and logistics
- Pressure handling
- Control and instrumentation
- Location and safety
- Transmission and distribution of electrical power

NOV considers the Subsea Storage and Injection System technically feasible, flexible and applicable for both continuous and intermittent injection.



Figure 1. NOV Subsea Storage and Injection System (SSU) (ft)



# DeepStar 2017 Project Deliverables

Lower cost floating system alternatives

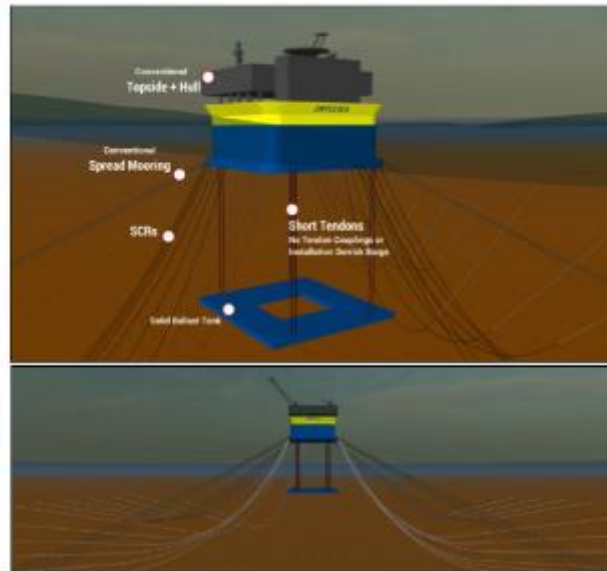


Figure 3-1 - LM-FPSO Orcaflex Fully-Coupled Model

**Low Cost FPSO Alternative Project  
DeepStar® 2018  
CTR # 17403;  
DRAFT REPORT  
Wet Tree LM-FPSO Design Report**

## Design Case Study

Wet-Tree Low Motion FPSO Case

- Basis of Design
- Hull and Mooring Design
- Tendon Design
- Hull and SBT Structure
- SCR Design

Dry-Tree Low Motion FPSO Case

- Basis of Design
- Hull and Mooring Design
- Tendon Design
- TTR Design

**Low Cost FPSO Alternative Project  
DeepStar® 2018  
CTR # 17403  
DRAFT REPORT  
Dry Tree LM-FPSO Design Report**



This report is  
issued for  
DeepStar  
OPERATORS



This report is  
issued for  
DeepStar  
OPERATORS

# DeepStar Membership 2018 Core Program

(May 2018 – May 2019)  
\$100,000 fee annually

## Benefits

- **Access to more than \$1 million R&D spend/financial leverage**
  - Project reports for all Core projects
- **Access to multi million dollar funds/partnership leverage** (\$10 million in 4 years – up to **\$3 million in 2019**) through DeepStar partnership with Nippon Foundation and influence the partnership with DOE
  - Partnership Program project reports
- **Reduce satellite project administration cost by 25%** - a Core Member company pays less than 10% and a non Core Member company needs to pay 35% administration fee for joining a DeepStar Satellite project
- **Management role within DeepStar Management Committee to influence the program and partnerships**
  - Management Committee
- **Collaborative Discussion amongst all technical Subcommittees**
  - Technical Forums
- **Technical Workshops to align industry and develop solutions**
  - Industry Workshops



**DEEPSTAR®  
PROJECT**

Leading the technology development to meet the industry's deepwater business needs.

### FINAL REPORT RELEASE

Continuing Service Guidance for Aging Floating Infrastructure

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## **CORE Program**

- Extend the CORE program to include more focus areas - geoscience, reservoir, and operations
- Link the CORE program with partnership funding from Nippon Foundation
  - Subsea Non Contact Remote Inspection, Floating Acid Gas Removal

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## **Satellite Program**

- Develop certain Core projects to Satellite
- Add new Satellite projects

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## **DeepStar Partnerships**

- Launch the DeepStar Nippon Foundation partnership projects along with CORE program
- Finalize the partnership terms with US Department of Energy (DOE)

# Future Direction – 2018 and beyond

# DeepStar 2018 Technology Selection Process

Vetted  
Technology  
Projects

Management  
Approved Business  
Intersect

September  
2018

Technical Ranking of Strategic  
Topics

August  
2018

Screening of Technology Topics –  
Idea Generation



# 2018 Subcommittee Technical Topics- 'The Hopper'

## □ **Drilling, Completions & Intervention**

- 20-year downhole cable.
- Automation and demanning of platforms
- BOP Reliability
- Multi-year review of Containment Approaches and Effectiveness
- Dual Gradient Drilling / Subsea Mud lift Device / New 'High Availability' Rotating Control Device
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- Wellhead and Conductor Fatigue [Understanding both Capacity and Load]

## □ **Floating Systems & MetOcean**

- Continued service / Life extension for floaters – FPSO / turrets
- Lower cost floating system alternatives
- MetOcean monitoring / Design conditions
- Mooring reliability / New mooring design
- Riser optimization

## □ **Flow Assurance**

- Deposit formation in turbulent flow
- Multiphase Flow
  - Flow of dispersions in near vertical pipes
  - Impact of glycol carry-over into export trunklines in terms of pressure drop, liquid holdup
  - Impact of multiphase flow on system design & operability
  - Impact of solids related phenomena on flow patterns, pressure drops
  - Prediction of slugging & pseudo-slugging (size, frequency, loads) in subsea equipment such as jumpers, manifolds, connectors, flowline
  - Qualifying bypass pigs for liquid surge management in deepwater
  - Sand transport and erosion
  - Scale-up of lab emulsions to field emulsions
- Sensing, operations, intervention
  - Accurate sand concentration measurement
  - Detecting and quantifying hydrate deposition – early warning
  - Low cost (fast, safe) hydrate blockage remediation for subsea equipment and pipelines
  - Transient blockage risk in subsea equipment during shutdowns & restarts
- Well productivity loss when Asphaltene onset pressure > Reservoir pressure

## □ **Subsea Systems Engineering**

- Composite pipe
- Enhanced subsea architecture
- High Pressure / High Temperature
- Integrity management
- Long distance tieback (stretch goals and major challenges?)
- Low cost pipelines and installation
- Next generation subsea systems