



Shell's Brazil Deepwater R&D Program on FPSO Technology

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Principal Topsides Engineer
Shell Brazil

FPSO Research Forum - Wednesday, 9th of November 2022

Theme: A future towards lower carbon footprint operations



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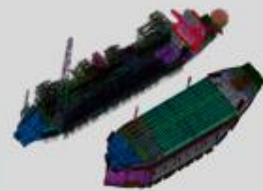
Brazil Technology – Technology Programs Upstream and Energy Transition

“Develop differentiated & affordable technologies through open innovation, enabled by the Levy, to deliver clean energy solutions driven by a collaborative and empowered multidisciplinary team”

Investment in R&D - Levy
Multi-disciplinary team

15 Universities and Accredited
Institutions
1600 people

Upstream and Beyond



TOPSIDES / SUBSEA TECHNOLOGY

- Offshore Innovation - Decarbonization and Sustainability
- Next Generation FPSOs/Subsea and Digital
- Robotic Program for Offshore
- Flexible Risers and Flowlines

- **SUBSURFACE TECHNOLOGY**
- **WELLS TECHNOLOGY**
- **CO2 ABATEMENT**
- **NEW ENERGY LONG RANGE RESEARCH**



Offshore Engineering Innovation

Develop Technologies that (i) reduce HSSE risks & the carbon intensity of the portfolio; (ii) improve the energy efficiency from the subsea & topsides operations; (iii) contribute to FPSO decarbonization and electrification; (iv) maximize asset availability & uptime; and (v) lead to operational excellence through digital solutions



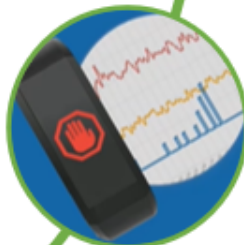
Novel Processes / Smart Offshore Operations

Solutions with the potential to revolutionize the offshore subsea & topsides design, development and wider operations through improving or reinventing current processes and ways of working



Low Carbon Offshore Power

Reduce the overall life cycle unit cost of DW developments and operations whilst reducing GHG emissions of offshore productions



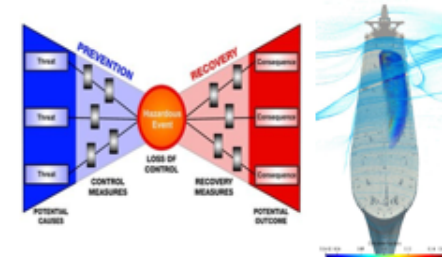
Health, Safety & Environment

Emerging technologies to reduce people exposure in the operational environment, including unmanned solutions and technologies that are capable of predicting accidents and actions of personnel in real time

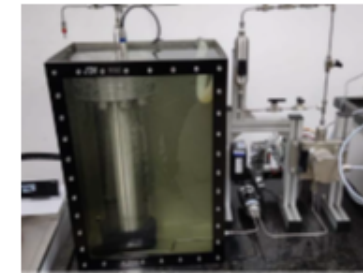
FPSO Life Extension



Asset Integrity Bow Tie & CFD Oil Spill Detection



Multiphase Flow



Decarbonisation of Diesel Engines with Alternative Fuels



- Technical Options of Alternative Fuels for Maritime Reciprocating Engines:
 - 1. Maritime diesel/ethanol/biodiesel blends with co-solvent;
 - 2. Ethanol additive in compression ignition engine;
 - 3. Ammonia and its blends in compression ignition engine;
 - 4. Heavy Fuel Oil / bio-fuel
 - 5. Green H2 injection
- Significant R&D achievement with engines for automobile industry
- Partnership with Raizen (Shell JV in Downstream Market): engineering know-how in developing bio-fuels, support commercial and logistics for deployment (#1 Ethanol)



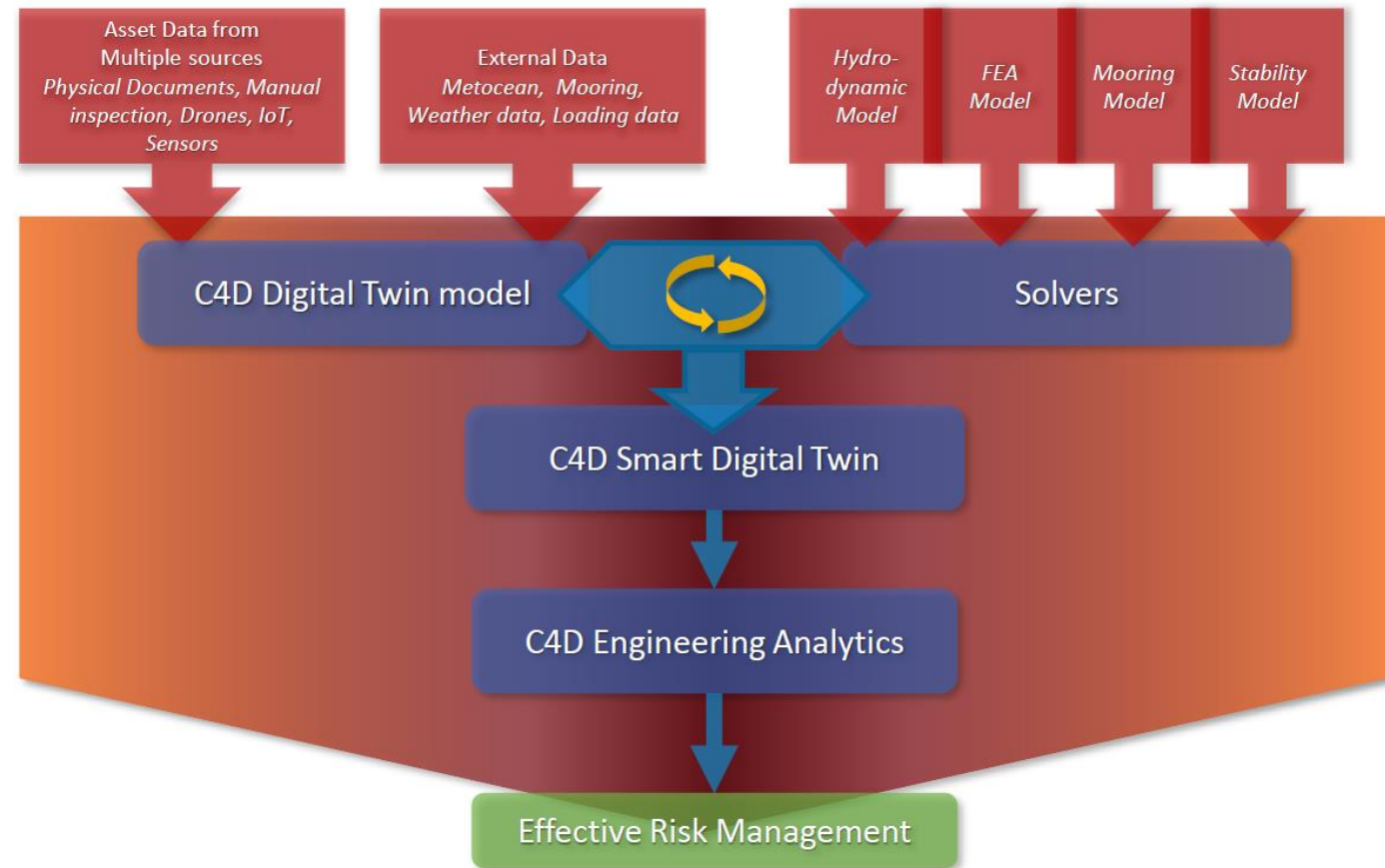
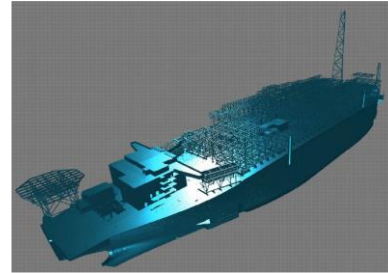
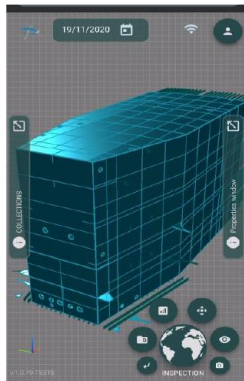
FPSO Digital TWIN



Real-time
Readings and
Inspection



Structured
Field Data

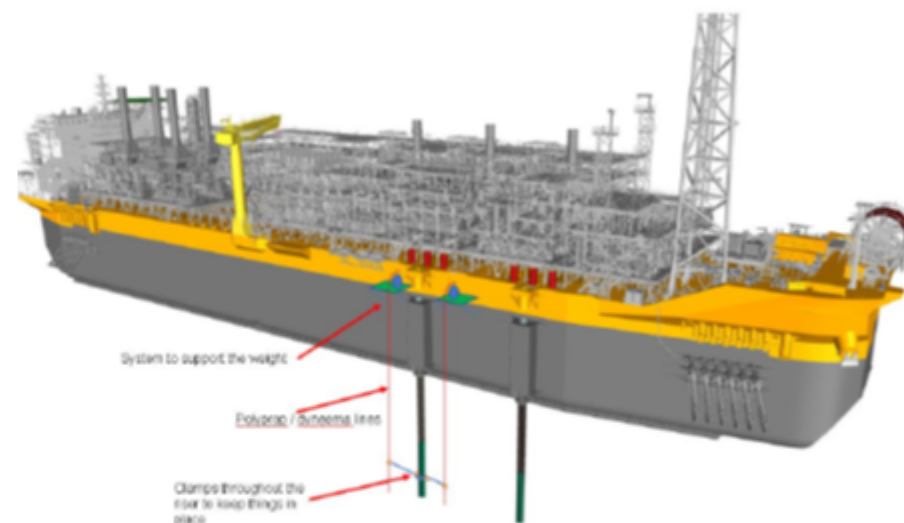


SWIR Sea Water Intake Riser



Timeline and Project Overview

Target Unit	New Build Hull
Design Life	35 Years
Location	Brazil, Santos Basin
WD	2,200m
Mooring system	Spread Moored
Sea Water Intake Riser	2 x 700 m length range (7°C sea water)
Sump tank	Side WBT @ Midship



Qualification and Approval in Principle

SWIR System



THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

Nemko AS has issued an IQNet recognized certificate that the organization:

Pipelife Norge AS (Surnadal)
Hamnesvegen 97, 6650 Surnadal, Norway

has implemented and maintains a
Quality Management System

for the following scope:

Production and product development, marketing and sales of plastic
pipe systems made of PVC, PP and PE

which fulfils the requirements of the following standard

ISO 9001:2015

Issued on: 2019-06-05
Validity date: 2022-06-19

This attestation is directly linked to the IQNet Partner's original certificate and shall not be
used as a stand-alone document

Registration Number: NO-800036



Alex Stoichitoiu
Alex Stoichitoiu
President of IQNet



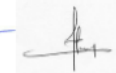
Kristin Hoff Hadland
Kristin Hoff Hadland
Nemko AS



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HDPE Pipe fabrication

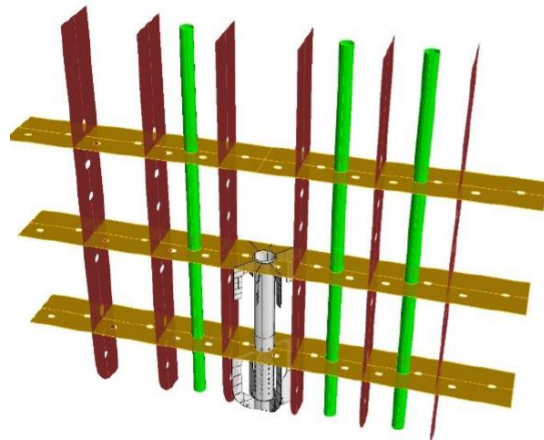
 BUREAU VERITAS MARINE & OFFSHORE CERTIFICATE OF TYPE APPROVAL N° E&P/12137-C-2015-001 REV.2	
This is to confirm that the general certification procedure described in Appendix C has been satisfactorily applied, with respect to conformity of TRELLEBORG INDUSTRIE design and manufacturing procedures versus API 17K 3 rd edition (August 2017), and results successfully evaluated for	
Product	TRELLEBORG flexible bonded water suction hoses for static and dynamic application
Place of Manufacture	TRELLEBORG – Clermont-Ferrand, France
Description*	Internal diameter : from 500 mm (20 inch) to 1200 mm (48 inch) Bonded hose without nipples reinforced by helically wound cables embedded in rubber, with the following typical cross sections : - Main carcass: from 0 to 2 steel cables layers laid at the equilibrium angle, - reinforcement steel rings, - Reinforcement carcass: from 1 to 3 pairs of steel cables layers, - longitudinal steel cables layers located in flange area, - rubber materials for the inner liner, intermediate / filling and outer cover layers.
Maximum design pressure*	Up to 15 bars (including water hammer effect)
Operation MBR	Four (4) times the internal hose diameter
Operation temperature	Ambient seawater temperature (typically from 4°C to 30°C)
Service	Sea Water + hypochlorite solution
Application	Static and Dynamic applications
Pipe Datasheets of the tested specimens**	First-off & Reinforced Main Line hoses: FS250 1000 x 9,5 – W Main Line & Last Off hoses: MS230 – 1000 x 9,5 – W
* Depending on the hose cross-section, the maximum design pressure can change; see Appendix C for more information ** see also Appendices A & B for more details on the structures	
In the process, - Design rules have been ascertained and the main flexible pipes behaviour prediction and failure modes prediction methodologies, based on analytical or finite element calculation tools, have been confirmed as validated through correlation with burst, bending, axial and fatigue full scale tests (see Appendix B). - Materials qualification have been confirmed, - Fabrication, Repair and Control procedures have been assessed (for ability to implement design parameters and maintain Quality with good continuity). - QA / QC system has been confirmed as independently certified to ISO 9001.	
The results of this evaluation being satisfactory, within the limitations specified in the technical reports n°R1478/E&P12137-R-2015-001 and n°R17011/E&P12250E-R-2021-001, the present certificate has been delivered for a period of three years from the date of issue, within the scope of the BUREAU VERITAS General Conditions of Service, to whom it may concern.	
This document and all its appendices form the entire certificate and cannot be used separately.	
Paris, 01 st February 2021, Rev.2  H-D. PHAM/ F. MIGEON Lead Engineers	For and on behalf of BUREAU VERITAS  M. BAERT Offshore Pipelines & Structures BU Manager

This certificate is delivered within the scope of the BUREAU VERITAS General Conditions of Service.

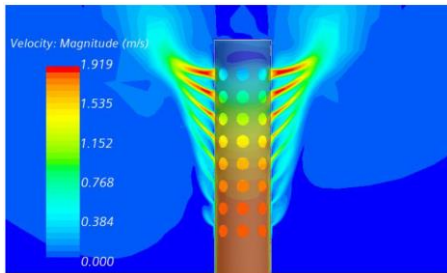
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Stress Joint Type Approval
(up to 48 in)

The SWIR SYSTEM PHILOSOPHY



3D Model of internal structures



CFD Simulations – Velocity distribution and flow pattern

QUICK SUMMARY:

- **Communicating Vessels Concept**
- Captures water at ~700m water depth
- Water at 8°C -> CM and SW systems mainly impacted
- Systems are installed in New Builds / During Conversion
- 2 SWIRs per FPSO
- Systems are **100% redundant**
- **SWLPs are located inside the tank** and captures water from inside of the tank
- Water Ballast tanks will be converted to **Sump tanks**
- System is located at Starboard (Opposite from Riser Balcony)

Topsides Optimization

OVERALL TOPSIDE IMPACT EVALUATION



Lower Seawater Supply Temperature

Lower SW Lift Pumps flowrate and power.
Improved consumers efficiencies.
Lower heat transfer areas.

Lower Cooling Medium Supply Temperature

Lower CM Pumps flowrate and power.
Lower heat transfer areas.

Heat Ingress and Insulation for SW and CM Piping

SW and CM piping may require insulation.

GTGs Inlet Air Cooling

Increased GTGs performance.
Increased GTG power output.
Reduced Fuel Gas consumption.
Reduced CO₂ emissions.

Gas Cooling in Gas Processing Plant

Reduced compressors power requirement.
Increase in condensate recycle to oil system.

Gas Cooling for Dehydration

Reduction of Dehydration Package.

Gas Cooling for Hydrocarbon Dew pointing

Reduction or removal of Mechanical Refrigeration Unit.

Increased Oil Recovery

Increase in oil flow to cargo tanks.

Improved Filtration for Water Injection

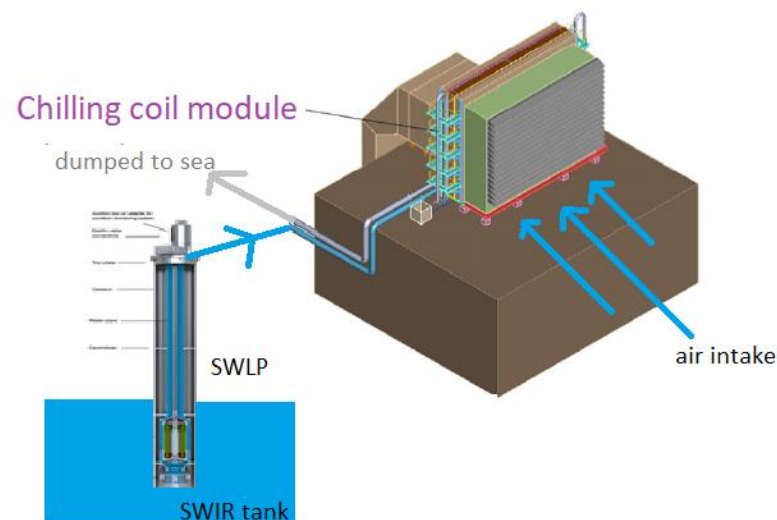
Reduced cleaning frequency for basket filters and back-washable filters.
Reduced cartridges exchange for cartridge filters.

Reduced SRP Membranes Clean In Place and Changeout Frequency

Increased SRP uptime
Increased SRP membranes life-span

Deaeration Vessel

Less dissolved O₂ in seawater
Colder temperature requires more vacuum



The SWIR

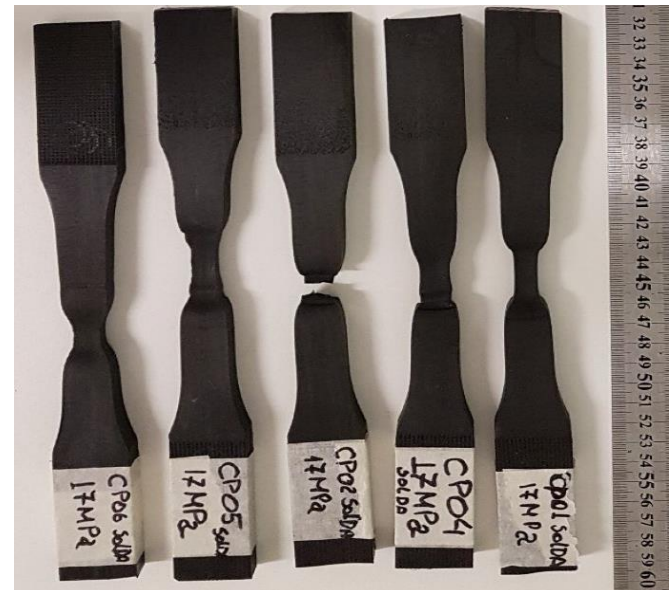
Polymer Pipe Fabrication, Towing and Material Testing



The polymer's neutral weight under water combined with a reduced price when compared to steel and its insulation properties were considered when selecting this material for the SWIR main body



Tensile tests, Fatigue, Creep and Aging



Polymer testing setup with controlled temperature

