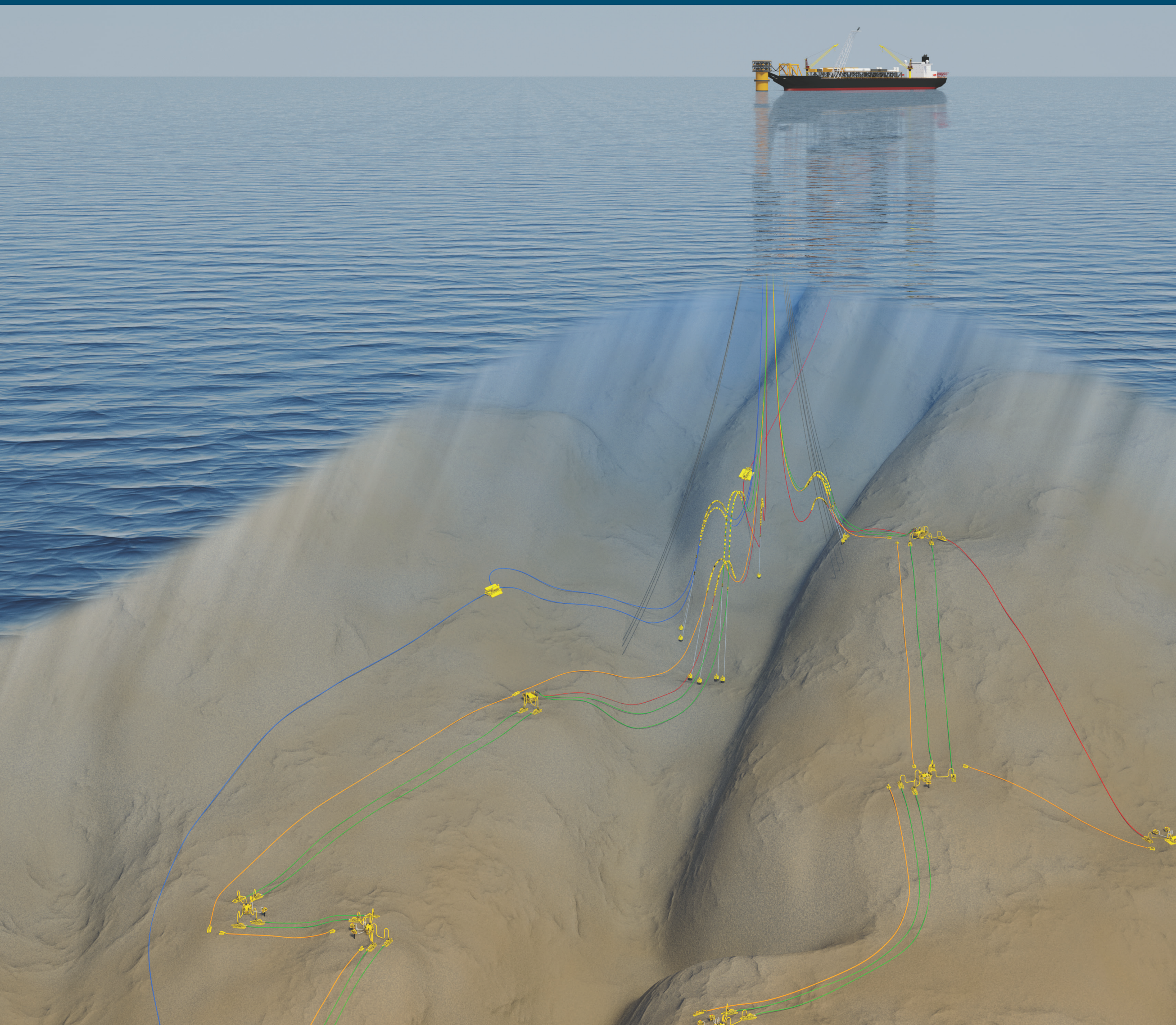
INTECSEA
WorleyParsons Group

# Flow Assurance

## Capability & Experience



# System can be designed to operate economically

The successful design and operation of a multiphase production system must consider design parameters and issues for the entire system from the reservoir to the processing and export facilities.

# Capability Overview

Flow assurance encompasses the thermal-hydraulic design and assessment of multiphase production/ transport systems as well as the prediction, prevention, and remediation of flow stoppages due to solids deposition (particularly due to hydrates and waxes).

Flow assurance designs must consider the capabilities and requirements for all parts of the system throughout the entire production life of the system to reach a successful solution. Successful system designs must be developed with system unknowns and uncertainties in mind and should be readily adapted to work with the system that is found to exist after production starts, even when that system is different from what was assumed during design.

To assure that the entire system can be designed to operate successfully and economically, system designers must consider flow assurance fundamentals such as reservoir characteristics, production profiles, produced fluid chemistry, and environmental conditions.

Important system parameters established as part of the design effort include tubing and flowline diameters, insulation, chemical injection requirements, flow blockage intervention provisions, host facility requirements, capital and operating costs, operating boundaries, and risk mitigation.

## Services

- Life of field analysis (IPM)
- Dynamic/transient analysis
- Wax and asphaltene
- Hydrates remediation and MEG management
- Slugging and slug mitigation/ catching
- End-to-end transient multiphase simulation (OLGA-HYSYS)
- Wellbore (and Reservoir) modelling
- Operational management tools
- Hydrate, wax control and remediation
- Operability reviews
- System design and engineering
- Systems architecture
- Functional interface management
- Flow assurance manuals
- Operating manuals
- Fluid characterization
- Chemical injection design
- Pigging system design

# Engineering Services

## Thermal Hydraulic Simulations

In performing thermal-hydraulic simulations, fluids are modeled with black oil and/or compositional models, as appropriate and as detailed compositions are available. When tuning data is available, fluid characterizations are developed. Insulation characteristics of downhole production tubing and subsea flowlines are realistically modelled. Schlumberger's PIPESIM or FEESA's Maximus multiphase simulator is used for steady state, multiphase, thermal-hydraulic simulation of both single-line and network models. Life of field simulations are performed to examine the operability of the system with time. The OLGA transient multiphase simulator is used for dynamic simulations such as startup, shutdown, slugging, and pigging.

## Slug Prediction and Slug Catcher Sizing

In general, for offshore floating and/or platform-based systems, slug catchers are undesirable from a weight and space perspective. Where possible, and particularly for oil/gas systems, it may be preferable to use separator inlet chokes (possibly brought into play by the level control circuitry) to control separator liquid ingress and/or dump rate, and the resultant separator volume. The use and/or design of slug catchers are part of the overall system hardware and operational design. Liquid management in large complex offshore gas-condensate projects, is a challenging issue. INTECSEA can examine a range of operational constraints to evaluate the slug catcher size and operational procedures.

## Production and Flow System Operability

Operability is intrinsic to the Flow Assurance and System Design Process. INTECSEA has made significant contributions in the assessment of system operability issues and in developing operating philosophies and strategies to avoid the formation of hydrate or wax at any time during system operation. These capabilities have been developed on long-offset, deepwater, subsea development projects for several clients. "Operability" is the set of design provisions and operating strategies that ensure that the production system can be started, operated, and shut down under all conditions (planned and unplanned) throughout the operating life of the total system.

## Production Chemistry – Scale Management

Understanding of scales formation and their prevention/remediation are important for seamless operation of oil and gas production facilities. Scale formation may be due to changes in temperature, pressure, out-gassing, shifts in pH, and contact with incompatible brines. INTECSEA personnel have extensive experience in the management of scales along with their prevention and remediation.

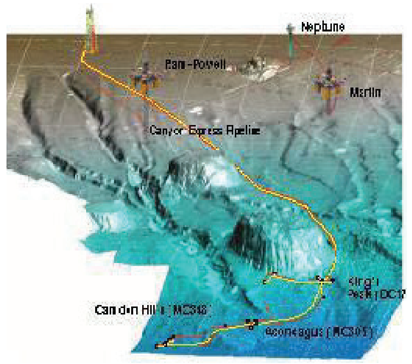
## Production Chemistry – Wax and Asphaltene Management

The selection of chemicals to prevent or inhibit wax and asphaltene deposition is often challenging. It is likely that field experience will be required to reliably determine what chemicals work and at which injection rates they will be required. Chemical inhibition issues strongly influence flow system design, chemical inhibition design, and system operating philosophies/strategies and procedures. For instance, the technical issues and the costs and benefits of chemical inhibition, wellbore and flowline insulation, and pigging for deposition control all have to be considered together to arrive at an overall design solution. INTECSEA can assist customers with inhibitor test plans. Wax deposition modelling with OLGA is an important analytical simulation in determining the impact of wax formation on the development.

## Hydrate Prediction, Inhibition, and Remediation

The prediction of hydrate formation temperatures/pressures and the design of the overall system to prevent plug formation during system startup, steady state operation, and shutdown are fundamental to the design and operability of subsea production systems. Starting from fresh-water hydrate dissociation curve predictions, INTECSEA adjusts those curves to account for formation water salinity. Analytical tools from Calsep (PVTSim) and Infochem (Multiflash) are used to calculate the hydrate dissociation curves and to assess the effect of inhibitors. In designing the system, a choice is often made to prevent hydrate formation by using inhibitors or to prevent them by keeping the fluid warm (insulation) and/or reducing pressure using subsea chokes. Active flowline heating is also an option and can be considered where appropriate.

# Project Experience



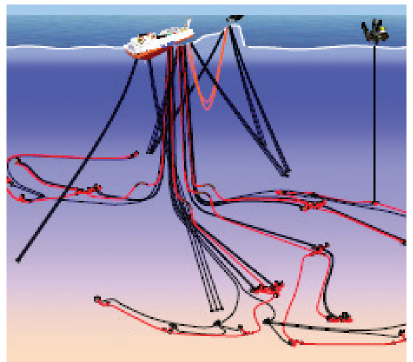

## Canyon Express

CUSTOMER Total, BP, and Marathon

LOCATION Gulf of Mexico, USA

IDENTIFY › EVALUATE › DEFINE › EXECUTE › OPERATE

Canyon Express was a first-of-a-kind industry initiative to jointly develop three gas fields in the Gulf of Mexico. The three separate fields include Aconcagua in Mississippi Canyon 305 operated by Total, King's Peak in Desoto Canyon 177 and 133, and Mississippi Canyon 173 and 217 operated by BP, and Camden Hills in Mississippi Canyon 348 operated by Marathon Oil. A gathering system consisting of dual 12-inch pipelines transport the gas from the three fields approximately 55 miles to Williams Canyon Station Platform located in Main Pass 261 with water depth of 299 ft.



## Agbami Field Development

CUSTOMER Chevron

LOCATION Agbami Field, Nigeria

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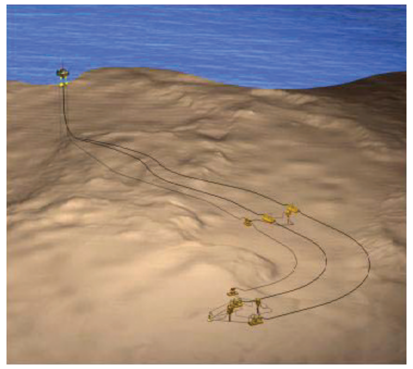
Agbami Field Development concept is based on a new build Floating Production Storage and Offloading (FPSO) system and subsea wells. The export system consists of a single point mooring system with dual rigid pipe offloading lines extending from the FPSO to the SPM. Each of six subsea production systems is configured as a four well cluster with a central manifold to commingle production from each well. The manifolds are tied back to the FPSO by dual 8-inch insulated flowlines and risers. The trees are connected to the manifold using flexible jumpers.



## K2 Field Development Production Facilities

CUSTOMER ENI Petroleum

LOCATION Gulf of Mexico, USA

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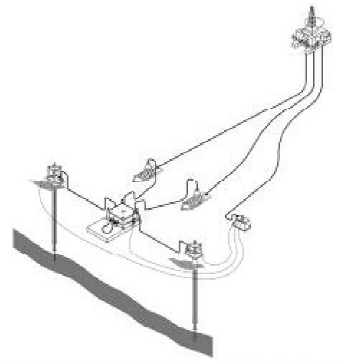
The K2 Project ties-back 3 – 5 subsea oil wells in approximately 3,900 to 4,500 feet of water in Green Canyon Block 562 of the Gulf of Mexico back to Marco Polo TLP, the host facility. The subsea system consists of two well centers tied back to the TLP via dual pipe-in-pipe insulated flowlines in a piggable loop configuration and Steel Catenary Risers (SCRs). One umbilical will be suspended from the host facility in a dynamic catenary configuration.



## DeepStar Flow Assurance Design Guide

CUSTOMER Texaco

LOCATION Project location

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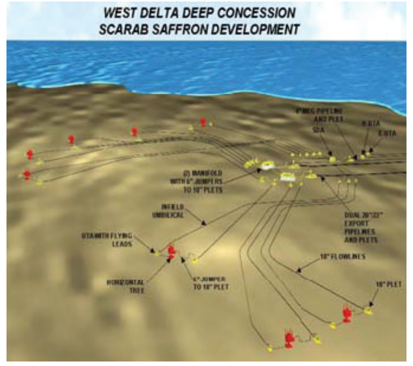
As part of the Texaco-led DeepStar Program, INTECSEA developed a comprehensive Flow Assurance Design Guide. The Flow Assurance Design Guide set forth basic engineering requirements and recommended practice deemed necessary for the reliable and cost effective design and operation of multiphase production systems. Because flow assurance is a multi-discipline activity, the Flow Assurance Design Guide addressed each discipline and explains how each fit in the overall design process.




## West Delta Deep Development

CUSTOMER Burullus Gas

LOCATION Offshore Egypt

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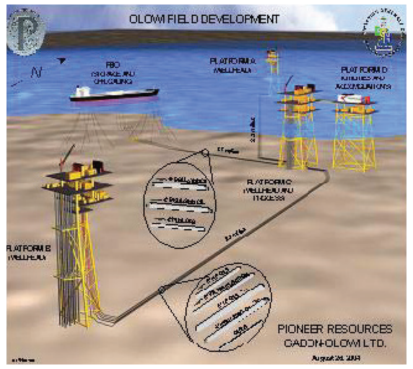
INTECSEA has been working on the West Delta Deep Development since 2001.The water depth in the West Delta Deep Development area ranges from 250 m to 1000 m. The development consists of over 60 wells that will produce 1500 MMSCFD of gas via three export pipelines to an onshore gas processing plant. Following treatment, the gas is exported to a tie-in to the Egyptian National Transmission System.




## Olowi Project – Flow Assurance FEED

CUSTOMER Pioneer Resources

LOCATION Olowi Field, Gabon

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Pioneer is developing the Olowi Field, offshore Gabon, with four fixed platforms. The oil has a high pour point and this poses many flow assurance challenges. The produced oil and gas from wellhead platforms A and B are sent via flowlines to platform C and commingled with production at C and processed. The gas is pressurized and transported back by flowlines and re-injected into the reservoir. Water injection flowlines run from platform C to A and B. Processed oil is exported via two insulated pipelines and flexible risers to a FSO.

Success Through Insight