

Subsea (SURF) Installation Engineering

A Contractor's Perspective from Shallow to Deep

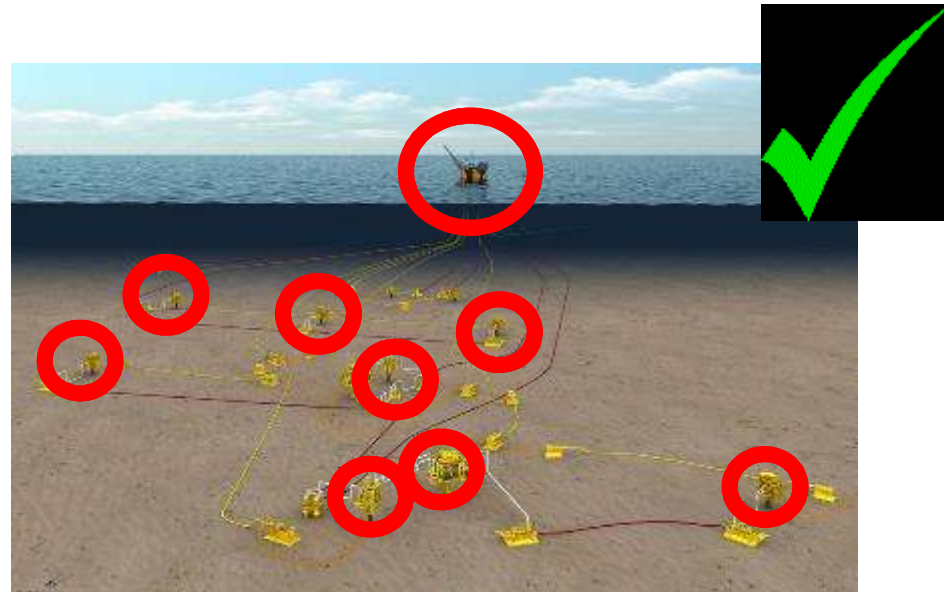


Agenda

- **An Introduction to SURF**
 - **What is SURF?**
 - **Why SURF?**
 - **What makes SURF different?**
- **Design Considerations**
- **Installation Methods**
- **Advances in SURF**

What is SURF?

- **S – Subsea**
- **U – Umbilicals**
- **R – Risers, and;**
- **F – Flowlines**
- **All the components required to produce hydrocarbons from reservoirs located under water without the well being directly connected to a host facility**



Why SURF?

- **Economics**
 - **CAPEX is generally lower for a SURF development in deeper water than an equivalent directly connected host facility**
 - **A SURF development will generally provide earlier first hydrocarbons**
 - **SURF is better suited to phased developments**
 - **Delays commitment to full CAPEX expenditure**
 - **Offers the opportunity to stop further expenditure if field performs poorly**
 - **Host costs are often already committed and only small incremental cost to make subsea tie-backs**
 - **Offers flexibility to cater for reservoir uncertainty and nearby new discoveries**

What makes SURF different?

- There is not normally any technical problem seen in a SURF development that is not seen in conventional or onshore oil & gas
- The key difference is in the magnitude of those problems and where they occur.
- SURF developments typically;
 - Are in deeper waters
 - Have more complex reservoirs and fluid properties
 - Experience more extreme environmental conditions
 - Are in more remote locations
 - Have more diverse supply chains

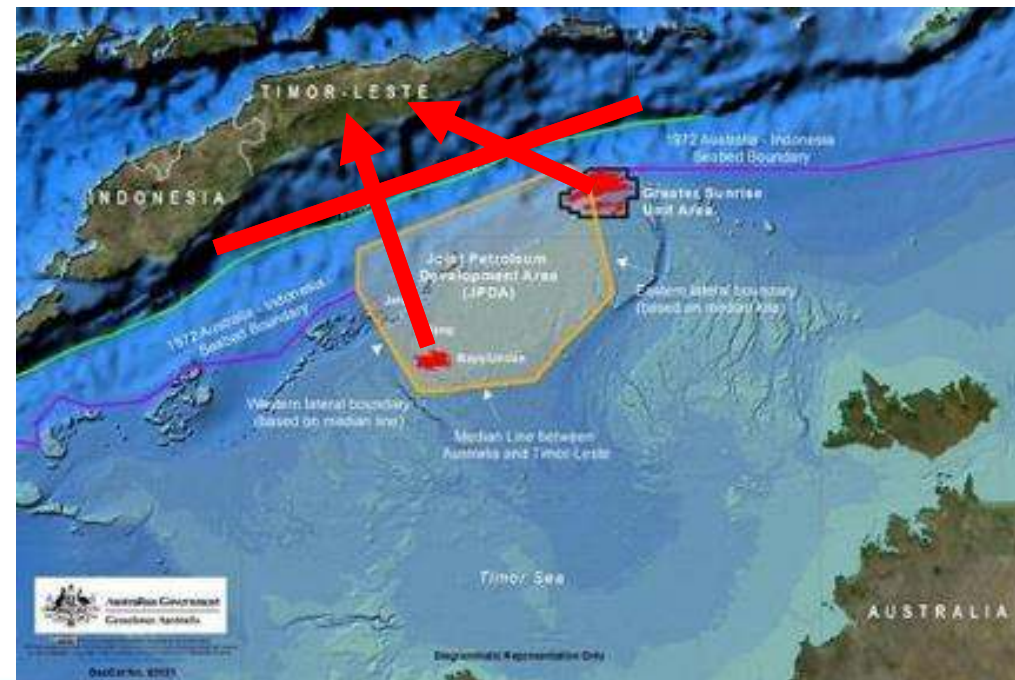
Design Considerations

- **Pipeline Systems**
 - **Route Selection**
 - **Flow Assurance**
 - **Pipeline Material Selection**
 - **Thermal Expansion & On-Bottom Stability**

- **Umbilical's & Control Systems**
 - **Control Methodology & Umbilical Make-up**
 - **Route Selection**
 - **On-Bottom Stability**

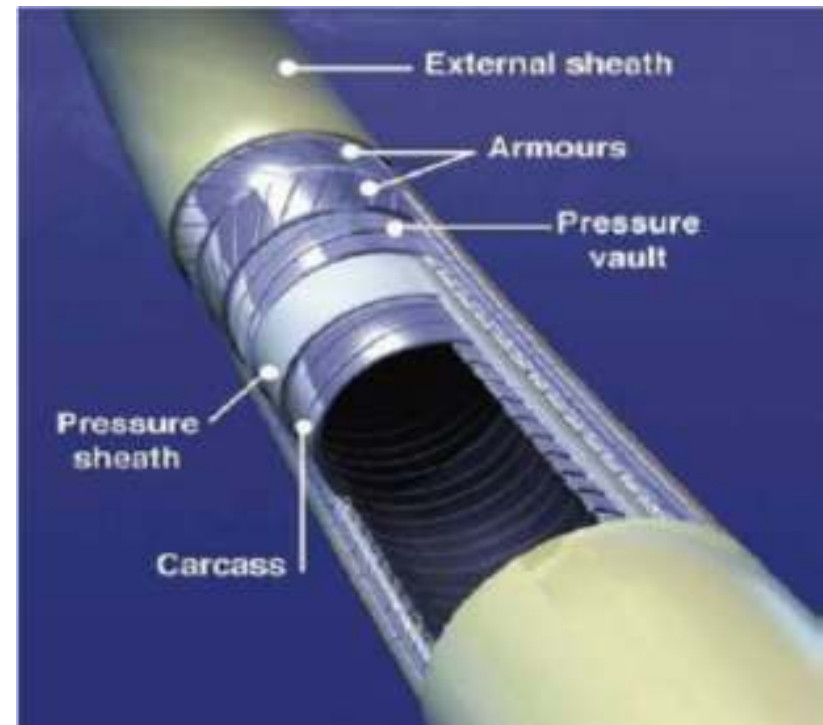
Route Selection

- Pipeline route should be selected based on:
 - Lowest total cost – direct and shortest route vs cost of avoiding hazards and installation complications
 - Seabed topography and avoiding slopes, unstable areas, faults etc
 - Obstructions & debris
 - Marine activities – fishing and shipping
 - Existing assets
 - Installability



Pipeline Materials

- Typical subsea developments don't have facilities to remove contaminants close to the wellhead
 - More corrosion problems
 - Leads to higher incidence of Corrosion Resistant Alloys (CRA) being used



Flow Assurance

- Ensures production fluid gets from reservoir to point of sale by addressing;
 - Hydraulic performance
 - Pressure drop
 - Multiphase flow issues
 - Potential pipeline blockages
 - Production fluid & chemistry issues

- Why is it more important for subsea or SURF developments?
 - Operational nuisances elsewhere become challenges in deep water
 - Environmental factors increase the frequency of problems and amplify the consequences
 - Lower temperatures, higher pressures
 - Limited access to intervene & high cost of failure



(a) Asphaltene



(b) Wax



(c) Hydrate

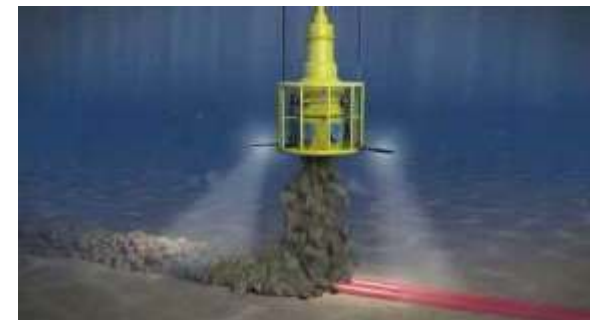
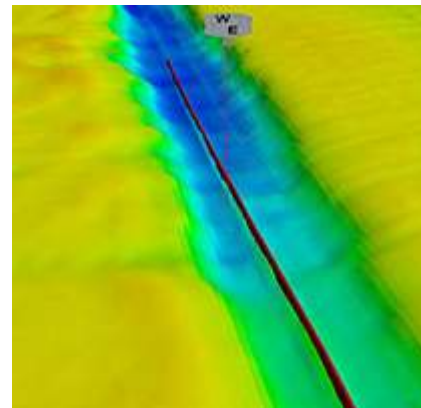
Control Methodology & Umbilicals

- Unlike surface production facilities process intervention and control must be done remotely in a subsea development
 - Control signals
 - Monitoring & measurement of the production process
 - Power
 - Chemicals to be injected into the production system
- Typically by umbilical
 - Hydraulic
 - Electrical
 - Fibre Optic
 - Combination



Thermal Expansion & Stability

- Similar issues to that seen in pipelines and cables anywhere
- Amplified subsea because of
 - Greater temperature differentials
 - Deepwater current phenomena
 - Added difficulties in burial or installing components
 - Load bearing limitations of diver-less connectors



Installation Methods

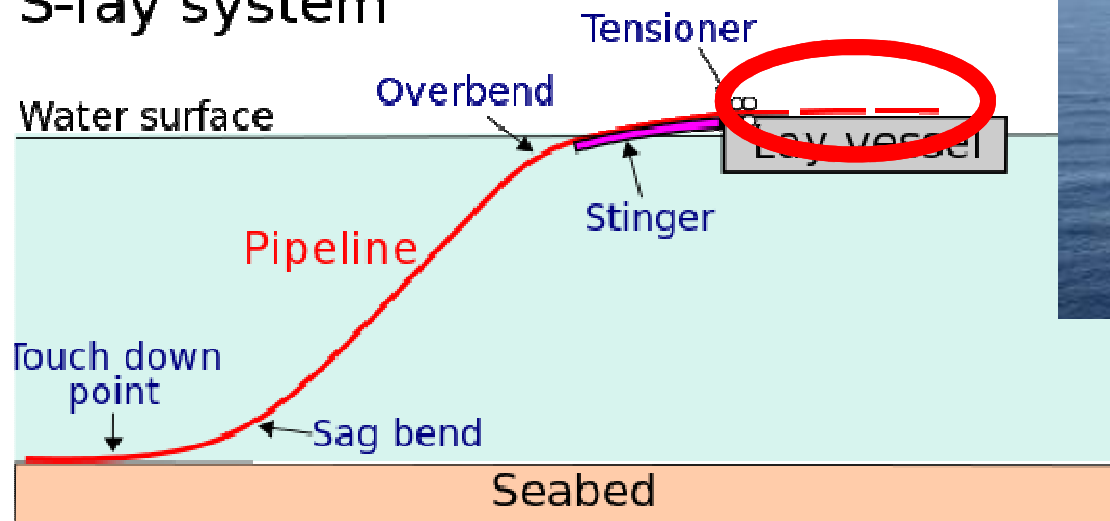
- **Rigid Pipeline Lay Methods**
 - S-lay
 - J-lay
 - Reel Lay
- **Tie-ins**



S-Lay

- Pipeline is assembled on board the installation vessel from pipe joints
- Assembled pipeline lays horizontally across the installation vessel and is supported into an S shape down to the seabed
- Fast provided enough stations are available in the “factory” on board
- Better suited to shallow waters or lighter pipelines where stresses in the S can be managed

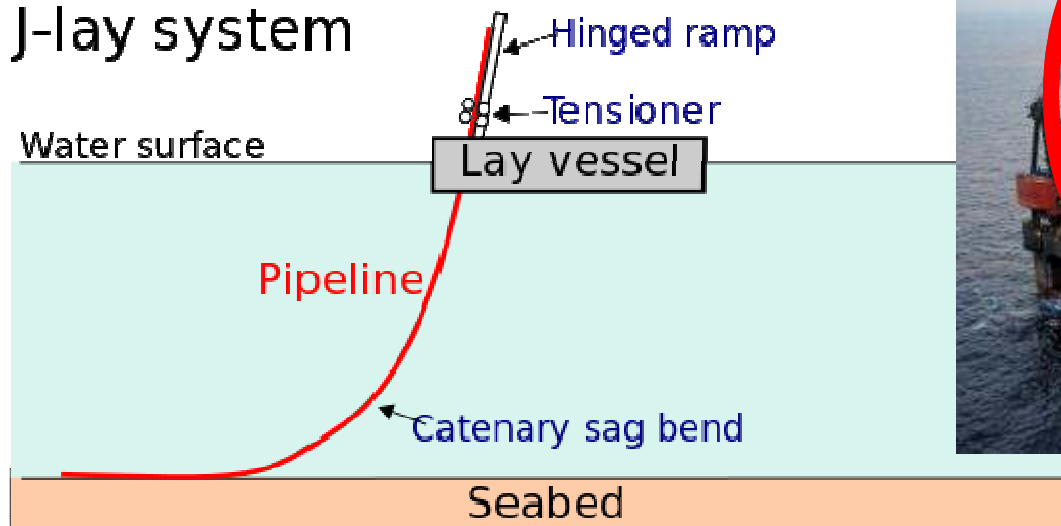
S-lay system



J-Lay

- Pipeline is pre-assembled onshore and then completed on board the installation vessel
- Assembled pipeline hangs vertically from the installation vessel
- Best suited for deep waters with heavy pipe and accessories
- Slow & requires expensive equipment

J-lay system



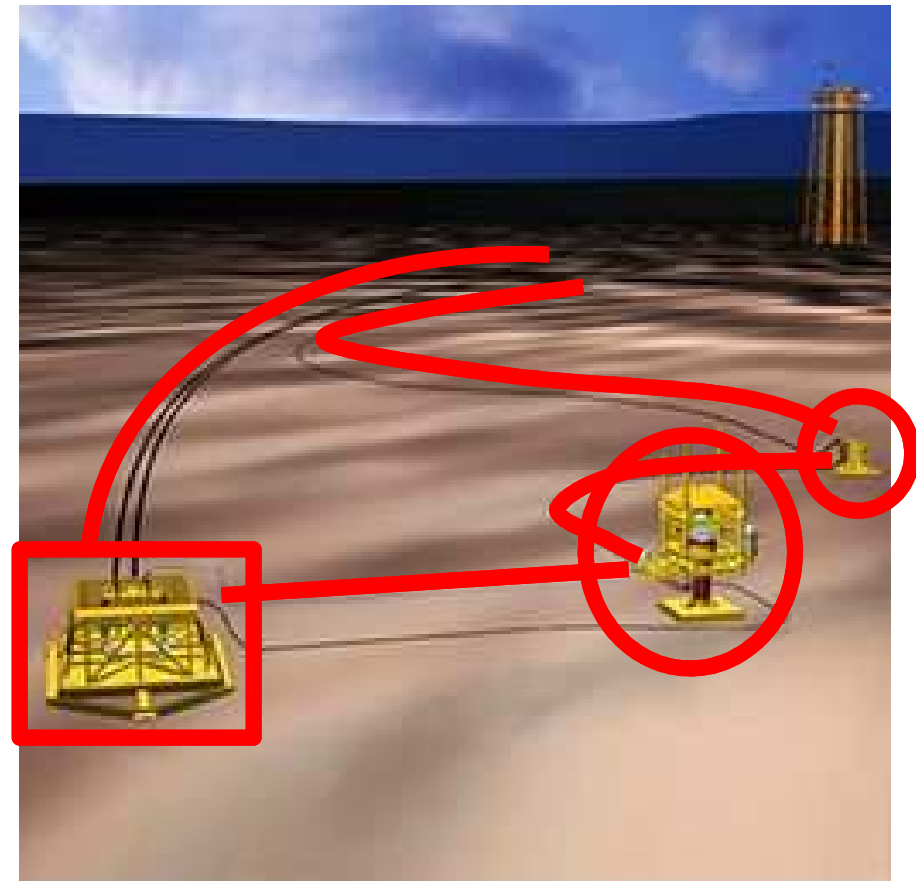
Reel Lay

- Pipeline is assembled onshore in a Spoolbase and reeled onto the installation vessel
- Pipeline is then reeled off the vessel onto the seabed
- Moves most of the slow assembly task onshore, reducing offshore time and cost
- Best suited to locations where a Spoolbase is close or developments where the pipelines fit within the installation vessel reel capacity



Tie-ins

- Provide the connections between installed components of the development
- Most engineered of all the components of a Subsea development
- Most prone to not working or failing during installation
- Typically contain proprietary connection systems



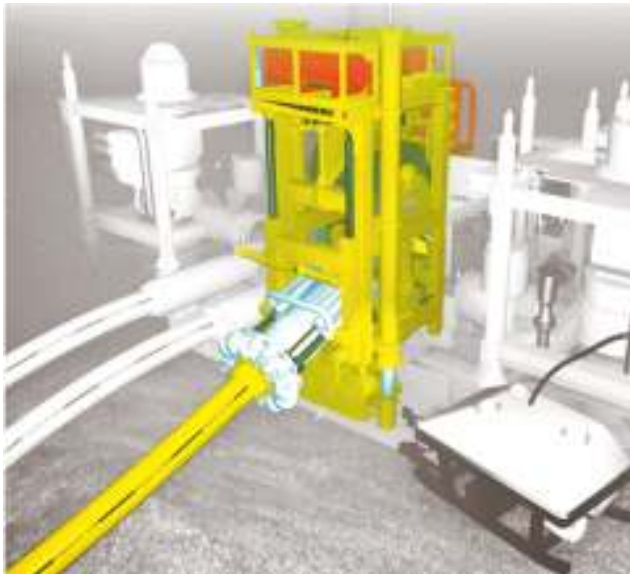
Pipeline Tie-ins

- Various configurations each with their own installation benefits and drawbacks



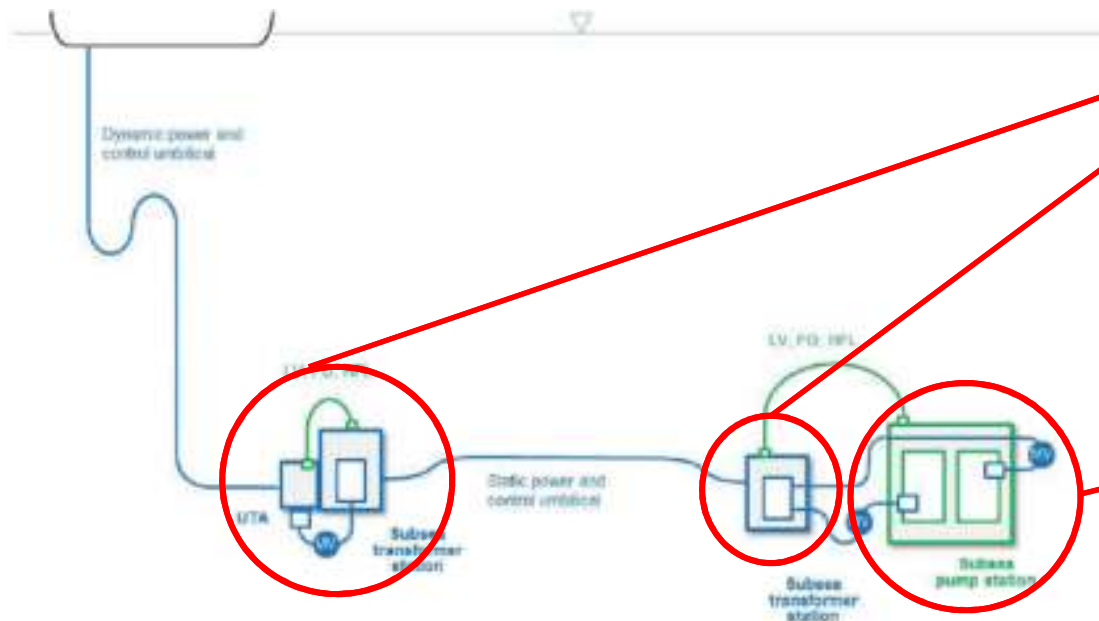
Control System Tie-ins

- Various configurations each with their own installation benefits and drawbacks



Design Advances

- More challenging reservoirs are being developed
 - Subsea pumps & power distribution
 - Downhole & seabed pumps
 - Subsea transformers



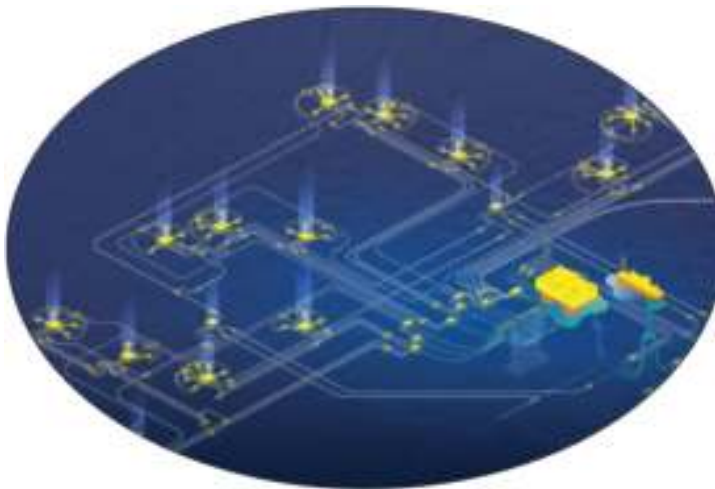
Installation Advances

- Components to be installed continue to get larger and heavier
 - Deep water lowering systems
 - Use of winches instead of cranes
 - PLET handling frames
 - Modularisation



SURF Developments

- Continue to offer more economic access to hydrocarbons in deeper water than directly connected host facilities
- Have their own unique difficulties due to where they are located
- Often take existing technologies and make them work in the subsea environment



Questions & Answers