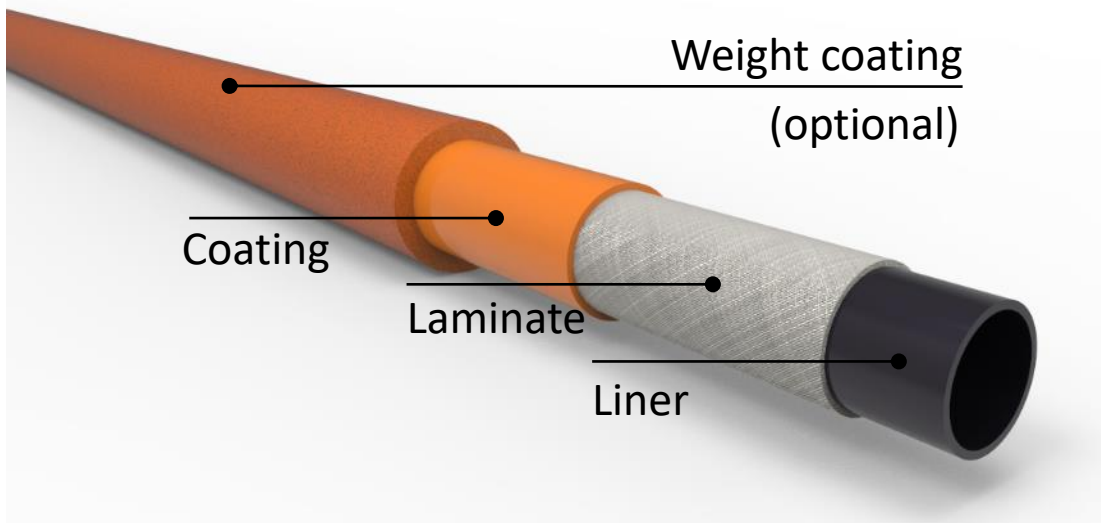
Installation of the worlds first subsea Thermoplastic Composite Flowline for hydrocarbon service

Martin van Onna
Airborne Oil & Gas

Presentation Overview

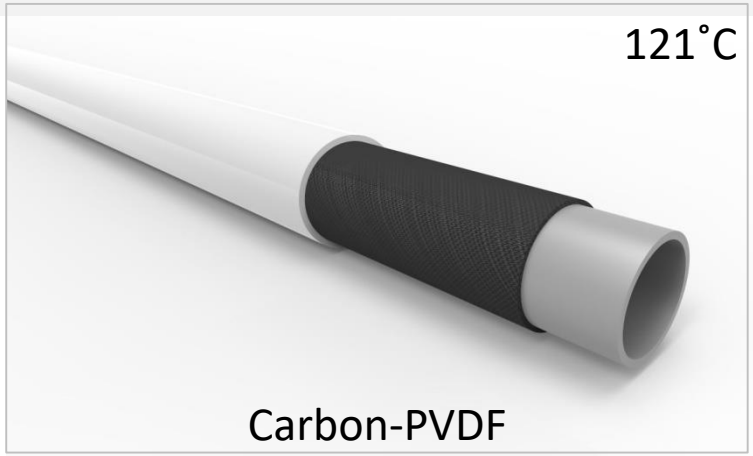
- **Introduction:**
  - Thermoplastic Composite Pipe (TCP)
  - TCP End fitting & Termination
  - Qualification approach
- **Installation:**
  - General installation methods - overview
  - Installation of the world's first TCP hydrocarbon flowline
- **Conclusions:**
  - Lessons learned

Thermoplastic Composite Pipe (TCP)



- Solid pipe structure: bonded
- Fit for purpose polymer: liner, matrix & coating
- Glass or carbon fibres fully embedded (true composite)
- Optional weight coating for on-bottom stability

➢ No corrosion
➢ Flexible
➢ Light weight



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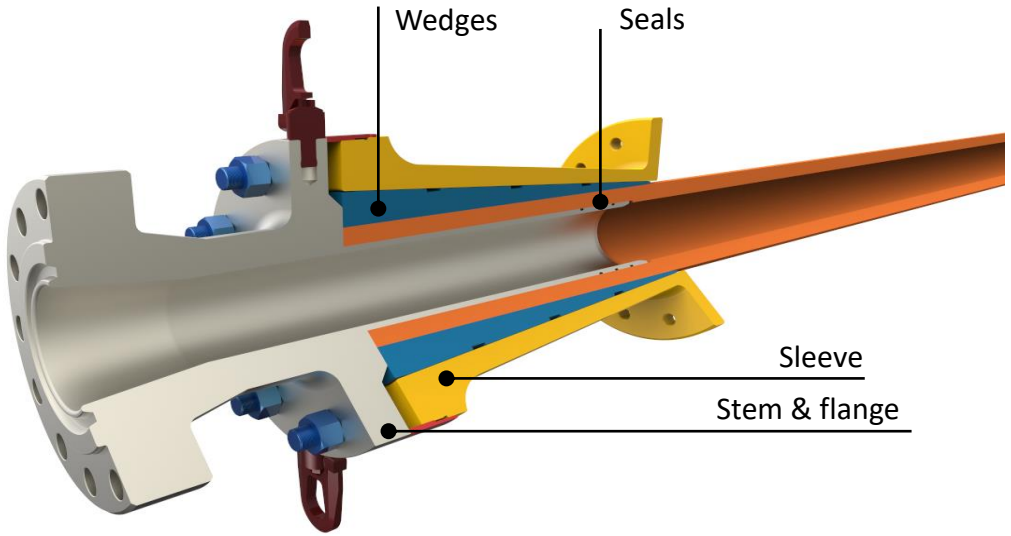
DEEPWATER DEVELOPMENT

TCP End fitting & Termination



- Terminated within hours
- Can be terminated in the field
- Allows for cutting pipe to length offshore
- Fully qualified and field proven
- Various flange and material options available

Termination onsite allows for flexibility in tie-in as well as pulling through I/J-tubes without end-fitting

The liner is reamed prior to stem insert, maximising bore dimensions to enable pigging

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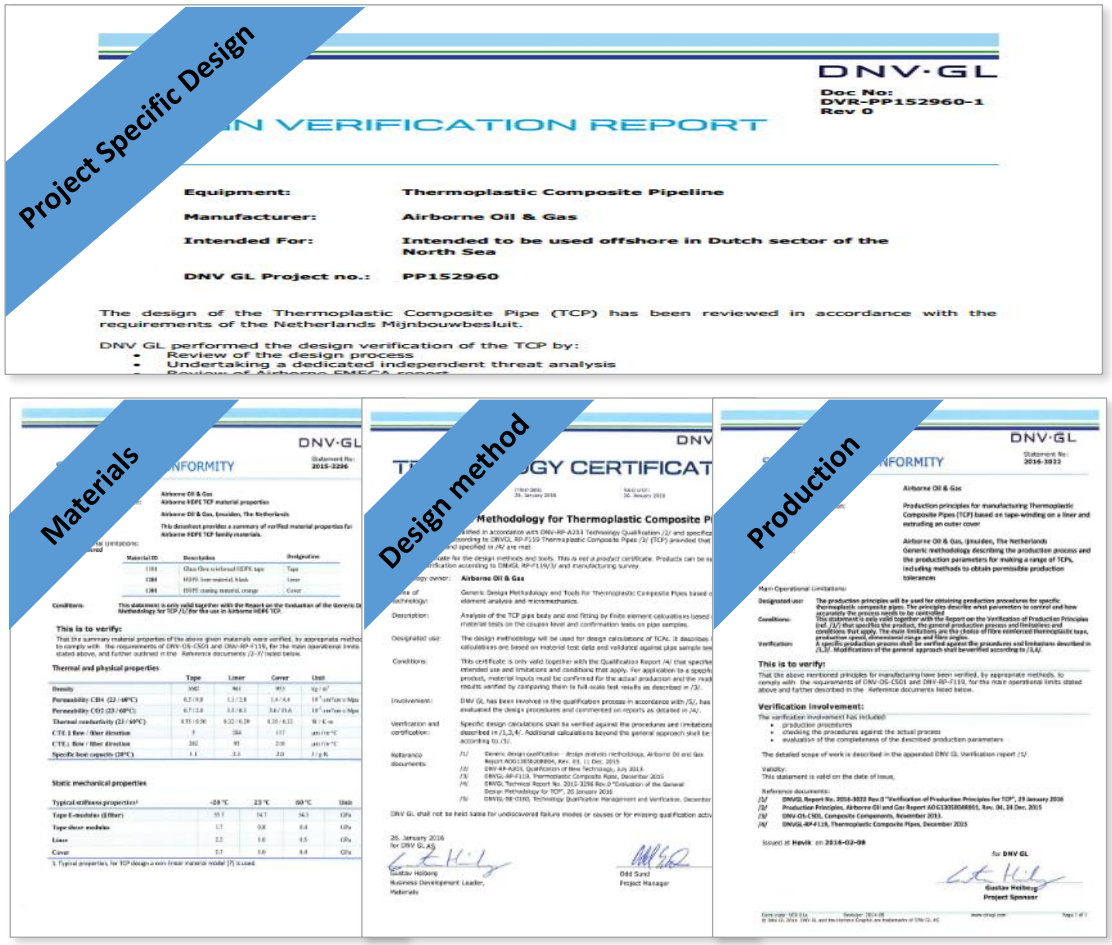
TCP Qualification

DNV Qualifications



Product & Client qualification

Jumper Spools

Chevron · Shell · PremierOil · subsea 7 · SAIPEM · TOTAL

Flowlines

Shell · Chevron · PETRONAS · SAIPEM · subsea 7 · dana PETROLEUM · PremierOil · PERTAMINA

Dynamic jumpers

TULLOW OIL plc · Chevron · Shell · OCEANEERING · OneSubsea A Cameron & Schlumberger Company · WILD WELL CONTROL

Downlines

Shell · IKM Testing AS · SAIPEM · Chevron · subsea 7

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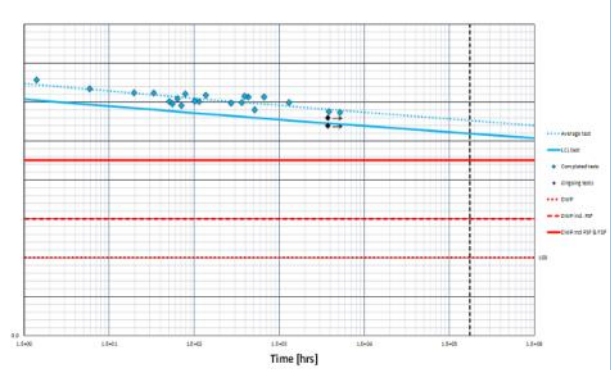
A qualification and testing approach that benefits future users

Qualification testing

Start: 2012
Duration: 5 years

- Regression testing internal pressure
- Fatigue testing
- External pressure testing
- Tensile testing
- Material qualifiction testing



Installation trials & in use testing

Start: 2014
Duration: 2 years

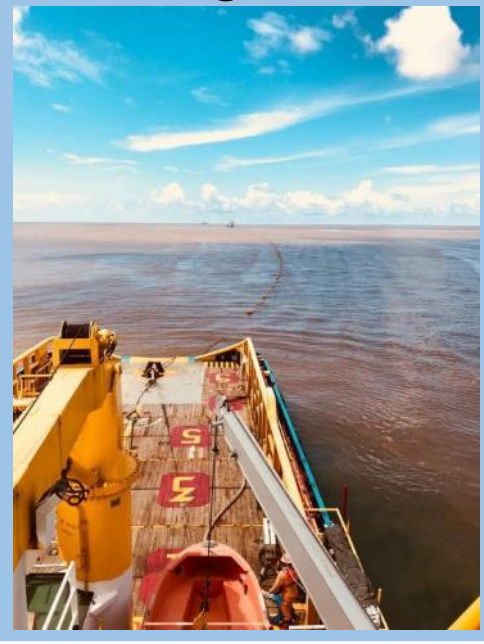
- Impact testing
- Fire resistance testing
- Erosion testing
- On Bottom Stability Testing

Full scale installation trials in South China Sea

Engineering & installation

Start: 2017
Duration: 1 year

First time right installation



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Installation methods

Horizontal lay

Main characteristics

- TCP spooled on drum, unspooling by Reel Drive System
- No need for tensioner
- On-Bottom Stability integrated in pipe design or added on-deck during installation
- Pull through I/J-tubes

Advantages

- Low transport cost for TCP
- Enables use of small vessels
- No need for divers, no connections on the seabed (<3 km)
- Fast installation

Tow out method

- TCP prepared onshore/near shore in river
- TCP towed to location and laid down
- I/J-tube / riser preparation separately
- Connections on seabed

- Low transport cost for TCP
- Cheapest vessel option
- Enables low cost on-bottom stability methods such as chains
- Fully proven in South China Sea

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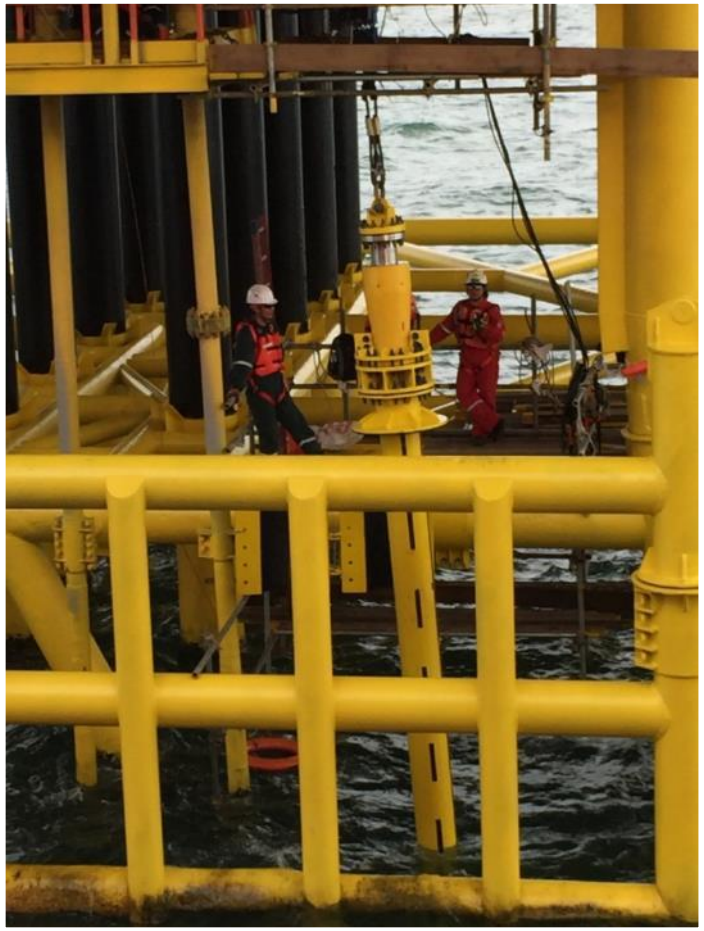
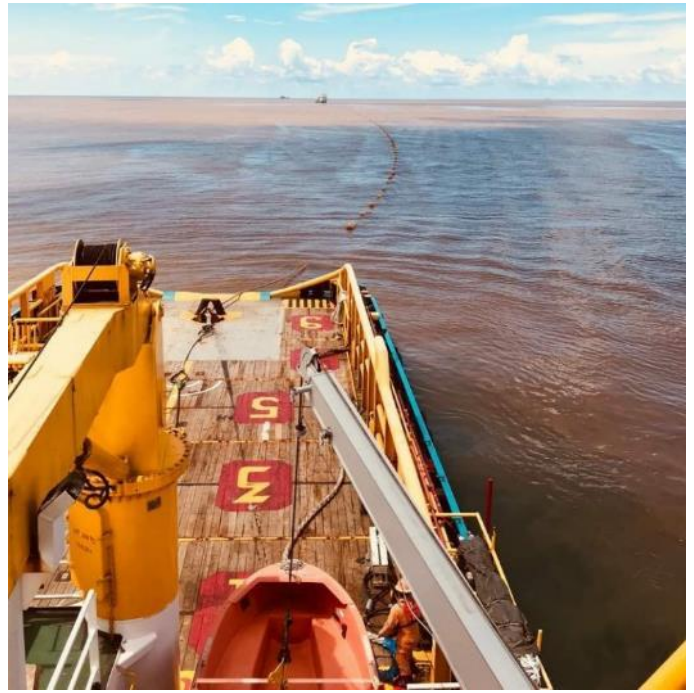
TCP installation using tow-out method

- Successful installation of the first TCP hydrocarbon flowline
- Preparation low cost & controlled environment
- Installation short & cost effective
- TCP Flowline & I tube separately installed





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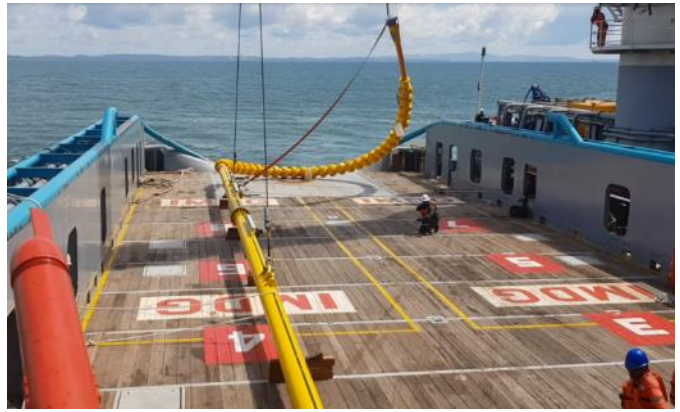
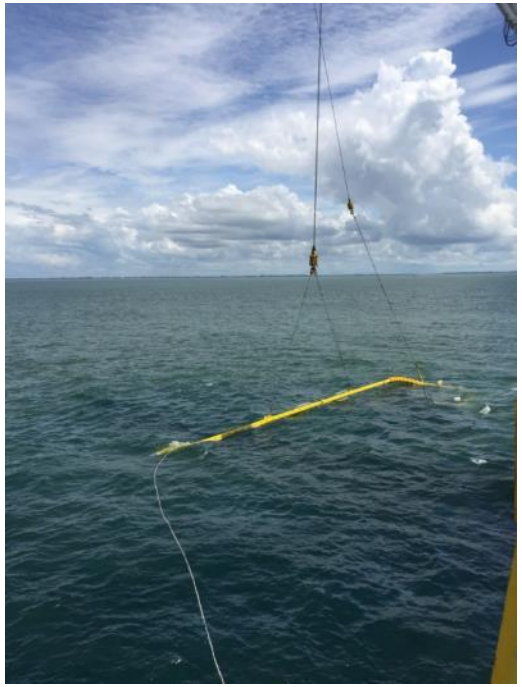
Riser I-tube preparation

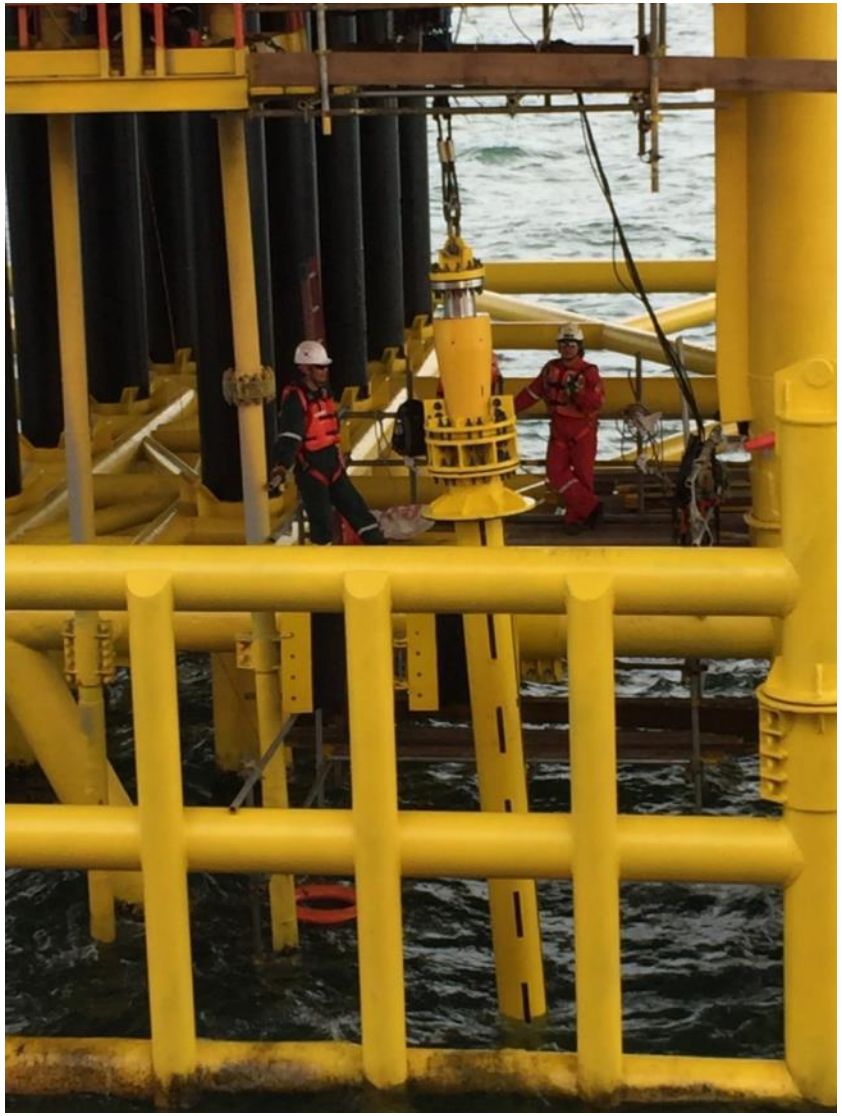
- TCP pull through I-tube onshore
  - I-tube marginally larger than TCP OD
  - Controlled environment
- TCP terminated on-site

Riser I-tube installation

- Riser assembly installed by DP2 vessel
- Assembly pulled-in behind riser guards







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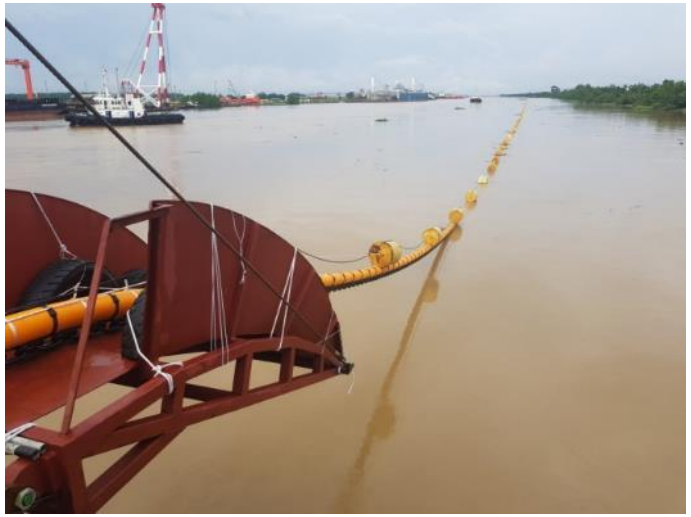
TCP Flowline preparation

- Lightweight TCP Flowline on reel
- Preparation on low-cost barge
- On bottom stability through chain
- Controlled environment



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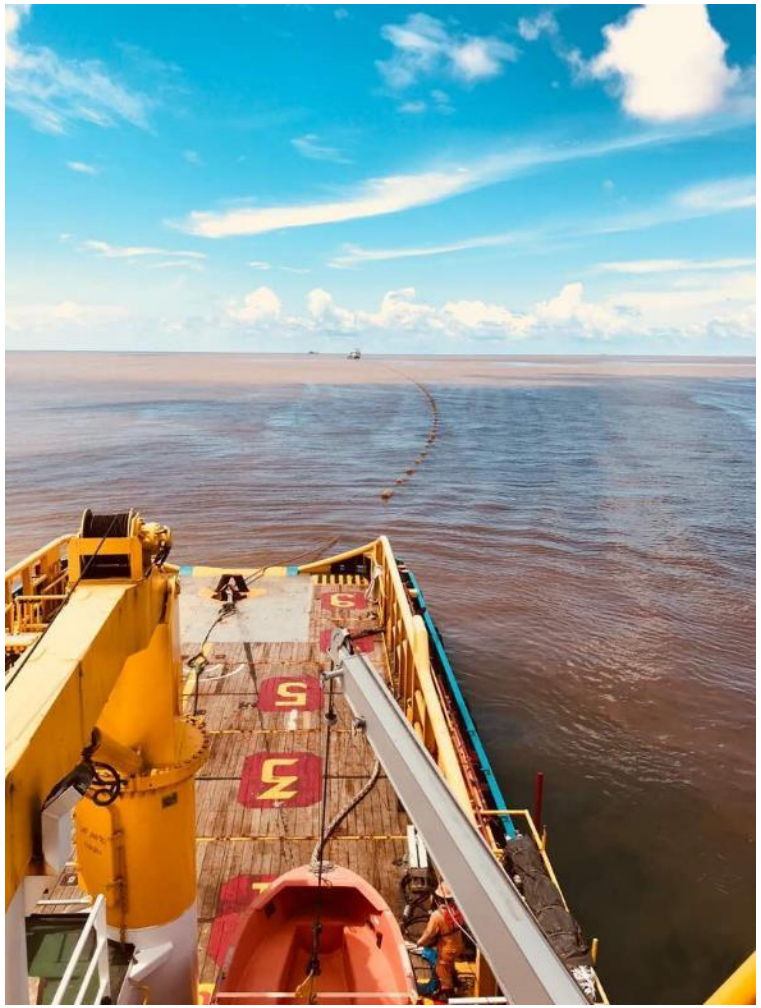
TCP Flowline tow-out, lay-down & tie-in

- Total flowline prepared in river
- Tow-out to location using low-cost tug boats
- Lay-down on seabed including buoyancy recovery



Conclusions

- TCP provides a fully qualified corrosion free solution
- A proper qualification approach de-risks first application
- Installation trials provide key-learning opportunities
- Different methods of installation for different applications and locations
- Collaborative approach & joint teams involving client, installation contractor and material supplier yield best results