

Pipeline Metocean Services

Oceanographic considerations affect the design, installation and repair of sub-sea pipelines.

- Near-bed currents and wave motion impose stresses during installation and operation. They may also induce seabed scouring that undermines the pipeline and threatens its integrity.
- Vertical current profiles may impose loads stresses greater than any stresses designed for when the pipeline is *in situ*.
- Vessel response to wave-induced heave, current velocity shear through depth and meteorological conditions will influence the selection of suitable vessels. These may be limiting factors that can affect the efficiency and timing of pipelaying operations.
- Seabed temperatures are important in a pipeline's design as they determine the behaviour of gases and oil as they travel through it, impacting the flow assurance for the design life.

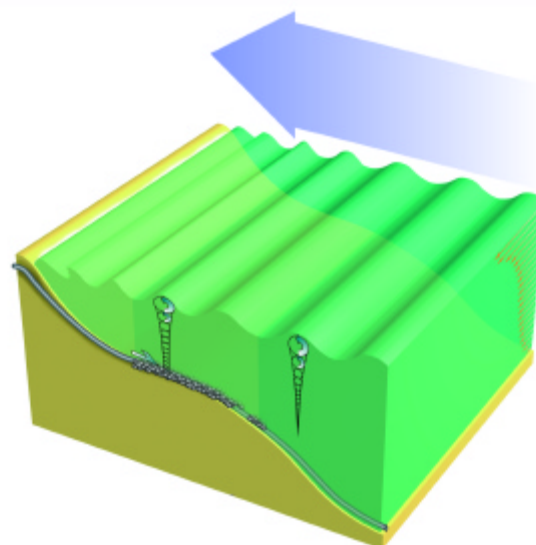
In most locations currents are extremely complex. They are influenced by factors such as tidal motion, large-scale ocean circulation and regional dynamic processes. Therefore conditions will vary over the length of the pipeline as well as with depth and time.

Shallow and Coastal Areas

In these areas, waves will induce strong seabed currents and stresses on the pipeline, and cause turbulence where waves break.



In-situ corrosion tests on pipeline materials



Wind, wave and current: major environmental factors

Typically, landfall sites will have trenching or armouring or both to protect against these effects.

In shallow shelf areas tidal flow is likely to be the dominant current and will be influenced by location, bathymetry and freshwater discharge.

Intermediate Water Depths

The effect of waves decreases with depth: at depths greater than half the surface wave length, wave motion is negligible. For most practical purposes, waves do not have a significant influence on seabeds deeper than about 100 metres. Beyond this, however, armour protection may be needed where there are strong currents.

Deep Ocean Areas

Lay stresses will be of concern during the deployment of the pipeline.

In deep ocean waters near-bed currents are often benign, and pipelines are usually laid unprotected on the seabed. However, in some areas strong currents can induce resonance and vortex shedding, which can be a problem between elevated seabed features, resulting in seabed scour that may leave pipeline spans unsupported.

On the continental slope turbidity currents can have a major impact on pipelines. These flows of dense, sediment-rich water can gather enough momentum to continue their passage far out onto the abyssal plain.

In some deep ocean basins, anoxic conditions may raise concerns about pipeline corrosion.

Metocean Services for Pipeline Routes

Fugro provides the meteorological and oceanographic consultancy, measurement and forecasting services required to address these complex issues. These range from preliminary desk studies of pipeline routes at the feasibility stage, including coastal zone wave modelling for additional information on the effects of refraction, diffraction and shoaling as the waves travel towards the shore; to real-time monitoring of conditions and site-specific weather forecasts during laying.

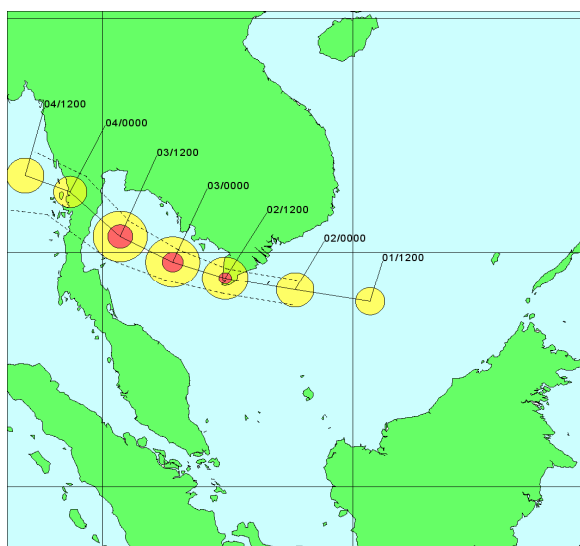
Design Metocean Requirements

Throughout the route:

- assessments of extreme near-bed currents (cross-currents will impose major loading) and sediment stability, and
- extreme and ambient near-bed temperatures.

Near-Shore and Landfall:

- extreme high and low water levels and beach line,
- extreme near-shore wave conditions along the shore approach, and wave run-up level at shoreline (for coastal bund design),
- extreme currents along the shore approach,
- assessment of near-bed wave-induced velocities with increasing water depth, and
- assessment of shore stability in near-shore region.



Typhoon Track Forecast, South China Sea

Installation Metocean Requirements

- Assessment of operational conditions for vessel selection and planning,
- Wave and current modelling of conditions expected,
- Monthly wind, wave and current operational statistics for intended working period,
- Statistical assessment of operational 'windows' (persistence of favourable conditions),
- Weather forecasts and outlooks, and
- Real-time metocean measurements

Cost Benefits

Fugro professional metocean services can reduce project costs by:

- Justifying reduced lengths of trenching and armour protection,
- Optimising the design for ambient conditions,
- Optimal selection of installation techniques, vessels and installation period, and
- Optimal operational planning during installation.

Track Record

Fugro has carried out over 70 pipeline-related projects in the past 20 years. These range from major intercontinental pipe-route surveys to small desk studies.

Major projects include:

Atlantic Richfield - Terang Sirasun Oceanographic Study
 Beicip Franlab - Gibraltar Straits Pipeline Route Study
 BP - Yell Sound Current Study
 Oman Oil Company - Oman-India Gas Pipeline, Baseline Metocean Study
 PeterGaz - Bluestream Black Sea Pipeline Route Oceanographic Study
 PT Alico - Mahakam Delta Pipelay Project, Weather Forecasting Services
 Statoil - Snohvit - Melkoya Pipeline, Current Measurements
 TotalFinaElf Myanmar - Yetagun Gas Pipeline Project Oceanographic Study
 Trans Mediterranean Pipeline Company - Oceanographic Survey Sicily Channel

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