

## Khuff Gas Development Project, Abu Dhabi (U.A.E.)

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### assignment

For the purpose of design and operation of a new gas pipeline in the Arabian Gulf offshore Abu Dhabi, extreme and operational/seasonal wind, current and wave conditions were determined on carefully selected locations along the pipeline route, in combination with an evaluation of the offshore and near-shore morphology.

The environmental conditions were examined for basically two pipeline routes offshore Abu Dhabi. The first is the main 42 inch pipeline which runs approximately East-South-East from the Umm Shaif field towards the coast near Ra's Hanjurah. The second is a connecting 30 inch pipeline, running approximately North-East from Umm Shaif to the ABK-field.

The morphological study was required to predict coastline movements and seabed fluctuations over 30 years of the pipeline lifetime so that the bottom trench could be established for the landward 20 km of the pipeline.

For this study a suite of numerical wave and flow models, databases and computer programs were applied, all originating from WL | Delft Hydraulics.

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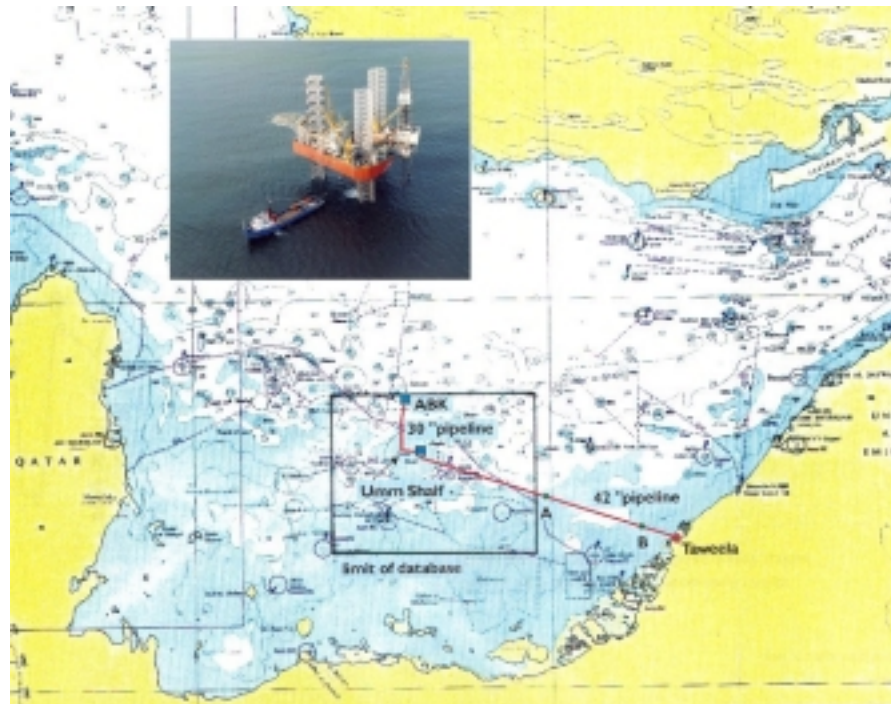
### client

Abu Dhabi National Oil Company (ADNOC) under a sub-contract (No. EC.146/731/2940) between the National Petroleum Construction Company (NPCC) and WL | Delft Hydraulics.

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### period

June 1998 - January 1999



Arabian Gulf with the 42" and 30" pipeline route

keywords:  
environmental design data  
offshore  
submarine pipelines  
Arabian Gulf

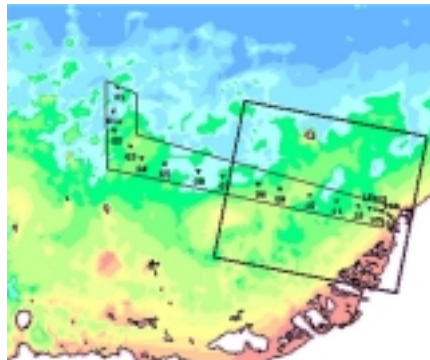


## environmental conditions

### wind and wave conditions

Extreme wave conditions have been determined from an existing database, which covers a rectangular part of the Arabian Gulf including Umm Shaif and ABK. This database, had been set up for ADMA-OPCO by WL | Delft Hydraulics in 1994. Wind data for the database was obtained from hindcasted extreme windfields based on pressure fields using an atmospheric model. The numerical wave propagation model HISWA was used to model the extreme wave conditions for 30 severe Shamal storms in the period 1963 to 1993.

Seasonal wave conditions along the offshore section of the pipeline were determined from the normal (operational) wind climates by running the models WATRON for the off-shore and SWAN for the landward area and using input data from the database. The results were subjected to a statistical analysis program: SCATTER.

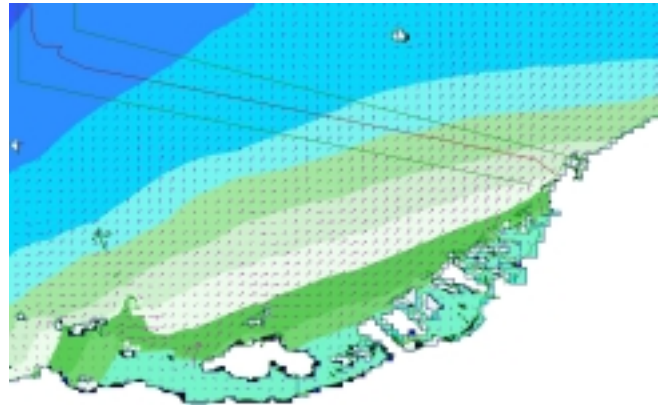


Bathymetry, output locations and layout of SWAN wave model

### current and water level conditions

For the design of the Khuff pipeline, extreme and seasonal current characteristics were required, as well as the associated water levels. Both currents and water levels have a tidal and a wind-induced (surge) component.

Three historical Shamal storms (representing 1 in 1, 10 and 100 year extreme events), the HAT conditions and four seasonal conditions were simulated with DELFT3D-FLOW. For this purpose, the Arabic Gulf Model and the Umm Al Nar Region Model were used; models which have been set-up in past projects by WL | Delft Hydraulics. The results of the model computations were used to extract water level, current speed and direction at the required positions along the pipe route. Near-bed velocities have been computed using a profile method.



Tide and wind-driven flow during a Shamal storm event; computed with DELFT3D-FLOW

## morphological study

The behaviour of the seabed in an offshore area and the relevant processes in that area are different from the development of the coastal profile and the processes in a nearshore zone. Therefore the offshore area and the nearshore area have been studied separately.

In the nearshore area it was envisaged that the landfall section of the pipeline would be trenched and buried in the seabed. Since this part of the pipeline should not be exposed during its 30 year lifetime, insight in trends in the shoreline movement and in fluctuations of the coastal profile have been examined. This was done by computations of long and cross shore sediment movements, with the use of WL | Delft Hydraulics' software package UNIBEST.

Morphological analyses of the estimated seabed variations for the offshore sections were conducted, based upon a review of the 1997 survey information, knowledge of the environmental conditions and preliminary impressions and judgements.

### WL | Delft Hydraulics

Decisive advice: from multidisciplinary policy studies to design and technical assistance on all water-related issues.

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