

# Case Study

## BP

### Pig Analysis

#### Background

BP has been in Azerbaijan, one of the world's oldest oil exporters, since 1992. They are currently involved in the exploration and development of offshore oil and gas fields in the Caspian Sea. Part of this work involves the construction and commissioning of the export pipelines that carry



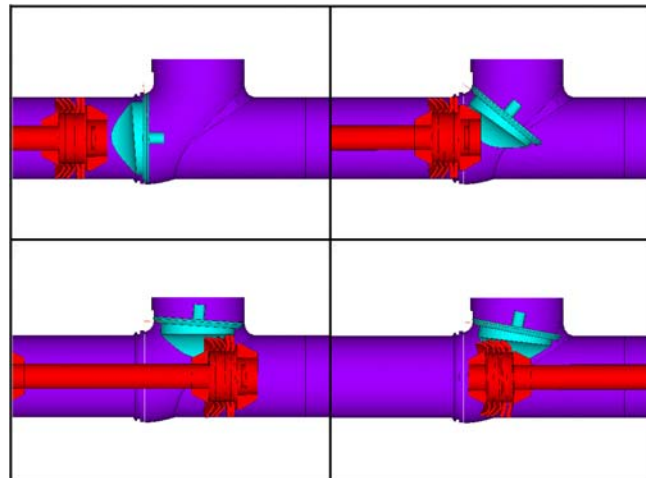
the oil and gas from the Azeri, Chirag and Gunashli (ACG) fields to the terminals. The Chirag portion is currently producing up to 140,000 barrels per day (bpd). To keep the pipelines free of debris and oil residue, so-called “scraper pigs” are sent through the piping systems to scrape and clean the pipe

surfaces.

#### Scope of Project

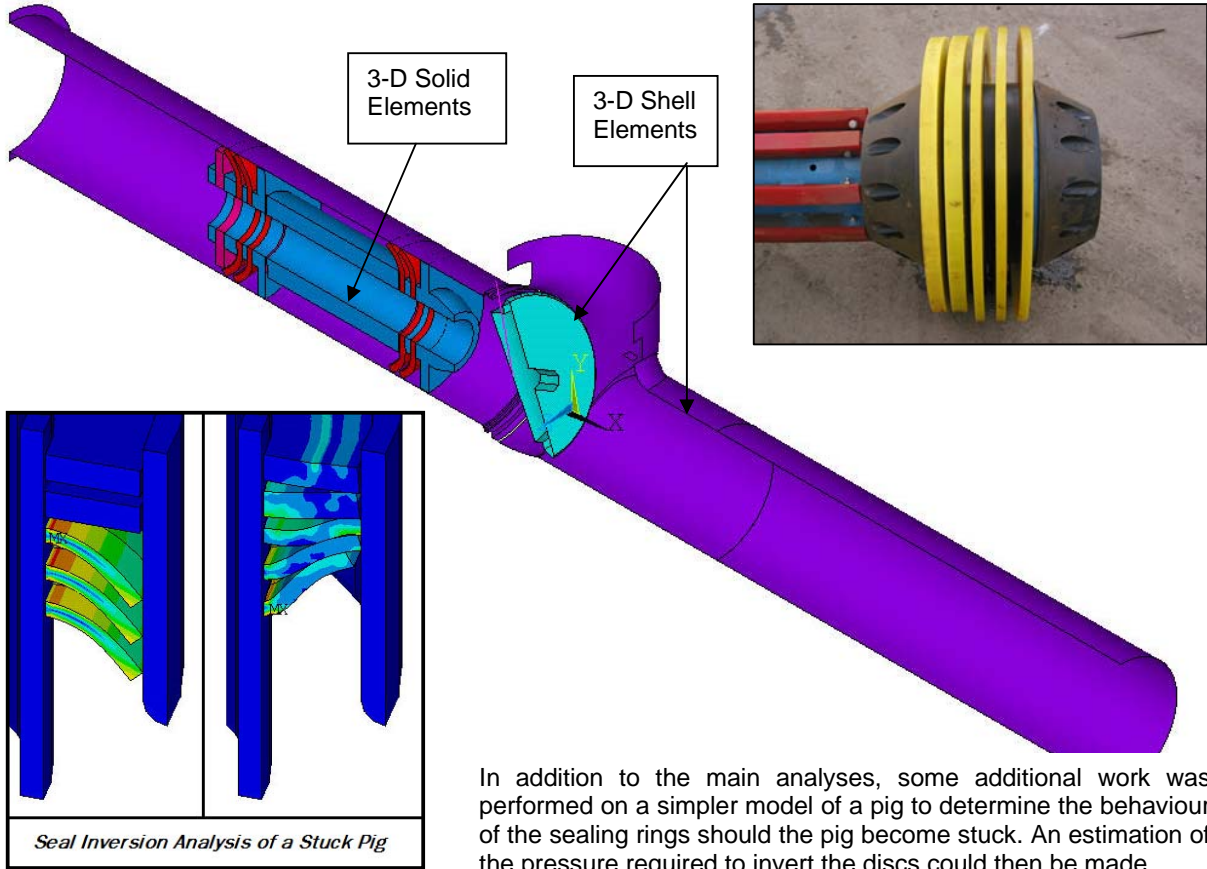
The purpose of this ongoing project is to analyse the interactions between a family of scraper pigs and the subsea check valves and wye pieces located in a number of oil and gas pipelines. This includes:

- The specification and analysis of the upper-bound flow conditions, to calculate the highest impact loads on the pigs, check valves and wye pieces.
- The specification and analysis of the lower-bound flow conditions, to assess the worst-case “piggability” scenarios; i.e. will the pigs stall or get stuck when attempting to negotiate the check valves and wye pieces?



## Simulation Details

The analyses are performed in ANSYS LS-DYNA. 3-D solid elements are used to model the flexible parts of the pig comprising the polyurethane noses and sealing discs. 3-D shell elements are used to model the rigid surfaces of the pipe, check valve, wye piece and pig.



In addition to the main analyses, some additional work was performed on a simpler model of a pig to determine the behaviour of the sealing rings should the pig become stuck. An estimation of the pressure required to invert the discs could then be made.

## Benefits

The analyses allow BP to investigate loading scenarios without having to construct additional expensive test facilities. For example, they have been used to determine the largest feasible load that would be experienced by the pig, so that an equivalent drop test of the pig may be performed to verify its integrity. They also allow BP to review the forces on the check valve hinges during the pig impact events and to predict whether the pigs will negotiate the check valves at the lowest flow rate and the wye pieces at various flow rates.

