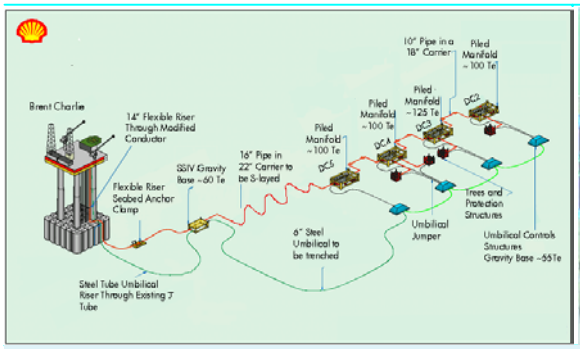
High Temperature/ High Pressure

High pressure and high temperature reservoirs are typically, but not exclusively, gas condensate fields. They are technically more complex to develop because of the inherently higher energy in the well fluids. Although initially developed exclusively by dry tree systems, subsea HP/HT developments are now commonplace. The HP/HT envelope is continually being pushed outwards and fields with well head pressures and temperatures of the order of 700 bar and 160 °C are now being developed



CHALLENGES

High Pressure

High pressure (HP) has a major impact on the design of wellhead and other equipment, such as manifold valves, in terms of strength, materials and reliability. For piping, flowlines and risers, HP can also lead to very high wall thicknesses. Equipment manufacture and linepipe fabrication and installation becomes more complex.

High Temperature

High temperature (HT) has a wider impact, as the whole system has to operate over a greater temperature range between non-producing situations, such as: installation and shut down, and the operational case. Also, due to the uncertainty of material response at elevated temperatures, the industry Codes of Practice are approaching their limits of applicability. Additionally, corrosion and corrosion protection throughout the system becomes a challenge for hotter systems.

SOLUTIONS

Materials

Rigorous equipment specification is required, paying particular attention to material selection for components, such as glands and seals. In addition, increased use of exotic materials, such as CRAs, either solid or as liners, throughout the system.

HIPPS

HIPPS (High Integrity Pressure Protection System) philosophy is used to enable flowlines to operate at reduced pressures, lowering risks and reducing line costs.

Insulation

Pipe-in-pipe and bundled flowline solutions are used to provide adequate insulation to maintain the energy in the well fluids. Novel coatings are required for elevated temperatures.

Snake-Lay

“Snake Lay” flowline configurations can overcome lateral and upheaval buckling issues.

CAPABILITY

Control systems and equipment

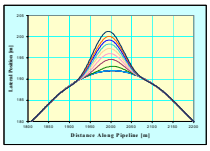
J P Kenny has built up a substantial track record of developing subsea HP/HT control system and equipment specifications, over a long involvement in HP/HT projects. The team has provided technical support for the procurement, system integration testing and commissioning of subsea HP/HT components and systems.

HIPPS

The team has successfully completed the design of several HIPPS systems. Of particular importance is the control system, which demands careful design and testing to ensure that the appropriate level of reliability is achieved. Reliability analysis techniques have been used to select the appropriate System Integrity Level (SIL) and optimum pipe wall thickness. Some pipelines have also been designed for a 'bursting' case reflecting partial failure of the HIPPS system. In addition, some HIPPS lines have been externally reinforced close to other facilities, so that in the unlikely event of HIPPS failure, any resulting line failure would be at a remote location.

Pipelines

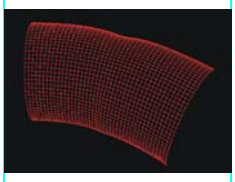
J P Kenny has pioneered the 'snake lay' philosophy for managing the high axial effective forces through controlled lateral buckling. The team uses J P Kenny's SIMULATOR package to design the 'snake lay' configuration. The 'snake lay' approach has been successfully adopted on flowlines and more recently has been used on both pipe-in-pipe configurations and large diameter export lines. Limit state design Codes are typically utilised in conjunction with structural reliability procedures.



"Analysis of Pipeline Lateral Buckling"

Finite Element Analysis

For HP/HT systems, a detailed understanding of thermally induced stresses and strains is critical to delivering system integrity. The team have undertaken numerous finite element analyses, particularly where complex configurations, such as pipe-in-pipe arrangements have been used.



"Local Stress Analysis of pipe system"

Materials and Welding

For both equipment and flowlines a critical component of successful design for HP/HT is a thorough understanding of the materials and welding issues. This includes the management of detailed materials testing. J P Kenny can provide an in-depth knowledge of these aspects through its specialist material, welding and corrosion division, Ionik.

"Welding of Pipe-in-pipe system"

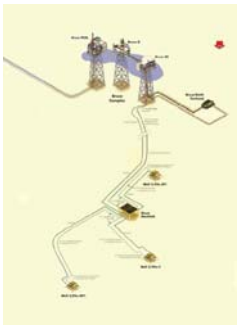
EXPERIENCE

BP - Rhum

The Rhum system comprises the tie-back of three wells to a subsea manifold utilising 8-inch trenched and buried pipe-in-pipe insulated infield flowlines. The design pressure is for the full well shut-in pressure of 709bar with a design temperature of 120 deg C. The lines are to be installed by reeling and required detailed finite element analysis to confirm reelability and operability.

The manifold is tied back to Bruce platform via a trenched and buried 16-inch pipe-in-pipe insulated pipeline. A HIPPS system is located on the manifold, this allows the pipeline to be designed for a lower pressure of 210bar, with a temperature of 110 deg C.

Due to the corrosive nature of the product all linepipe materials are constructed from corrosion resistant alloy material. The pipeline configuration is designed to keep fluids above hydrate formation temperatures.

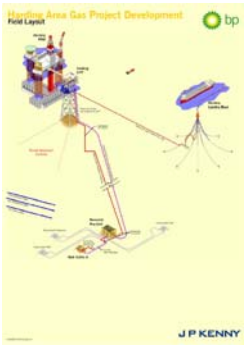


TOTAL – Forvie Central Development

Forvie Central is gas condensate accumulation with a drill centre approximately 5.5km from the existing Forvie main manifold. Flowrates indicate that an 8-inch flowline will be used and this will be fabricated from 22% Cr duplex linepipe. Design conditions include a pressure of 560barg with temperatures ranging from +115degC to -60degC. A choking skid will be incorporated in the system to control the entry pressure into the Forvie system, and will include a cryogenic spool to control the thermal performance of the system.

BP - Devenick Field Development

Devenick is an HP-HT subsea tie-back, producing gas with about 5 mol % CO2 and up to 25 ppm H2S; the design level of H2S is 0.0155 bar partial pressure. Water and wax-containing condensate will also be produced. The tie-back host will be Harding, at which a new Gas Processing Platform will be installed. The tie-back flow path will be hot i.e.insulated to give a minimum arrival temperature at Harding of around 40°C. The maximum wellhead flowing temperature will be around 130 - 140oC; the expected closed-in tubing head pressure will be around 620barg.



Shell - Penguins

The team performed the detailed design for EMC of the Shell Penguins PIP flowline system, which included 3.6km of 10"/16" and 62km of 16"/22" PIP pipe-in-pipe sections, designed to laid in a snaked configuration to withstand 110°C and 200 bar. This tieback is the longest in the UKCS and the longest known snaked-lay PIP tieback in the world. The project included lateral buckling behaviour analysis using SIMULATOR, limit state design using HOTPIPE criteria addressing operation and trawlgear interaction, risk and reliability design procedures, soils testing to establish lateral friction factors, full scale bend test of the field joints and FE analysis of the bulkheads.

J P KENNY

ABERDEEN
+44 1224 347300

HOUSTON
+1 281 675 1000

LONDON
+44 1784 417200

MELBOURNE
+613 9211 6400

NEW DELHI
+91 11 2642 7700

JAKARTA
+62 21 8370 2455

KUALA LUMPUR
+60 3 2162 1266

PERTH
+61 8 9 4818222

NORWAY
+47 5195 1821

www.jpkenny.com