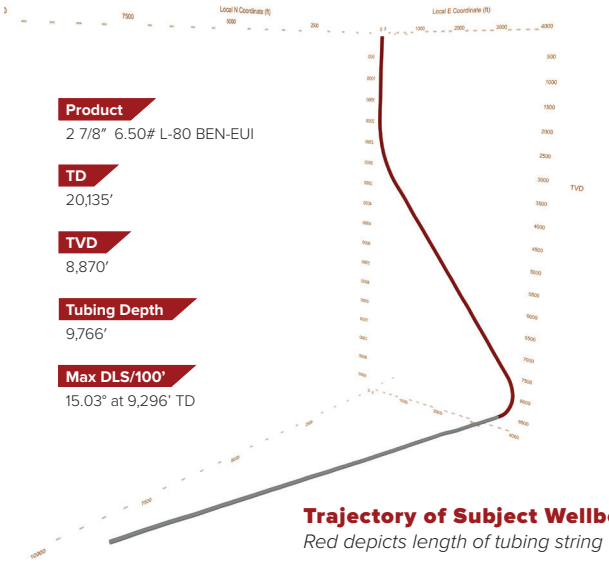
CASE STUDY
BEN-EUI – Highly Deviated Wells

CHALLENGE
Develop a cost effective connection solution for a series of highly deviated wells where sealability under bending loads was essential.

AREA OF OPERATION
Permian Basin – Midland County – City of Midland

ALTERNATIVE SOLUTIONS
API EUE 8rd which finite element analysis indicated would fail under load or premium threaded and coupled connections which may be cost prohibitive.



Trajectory of Subject Wellbore
Red depicts length of tubing string

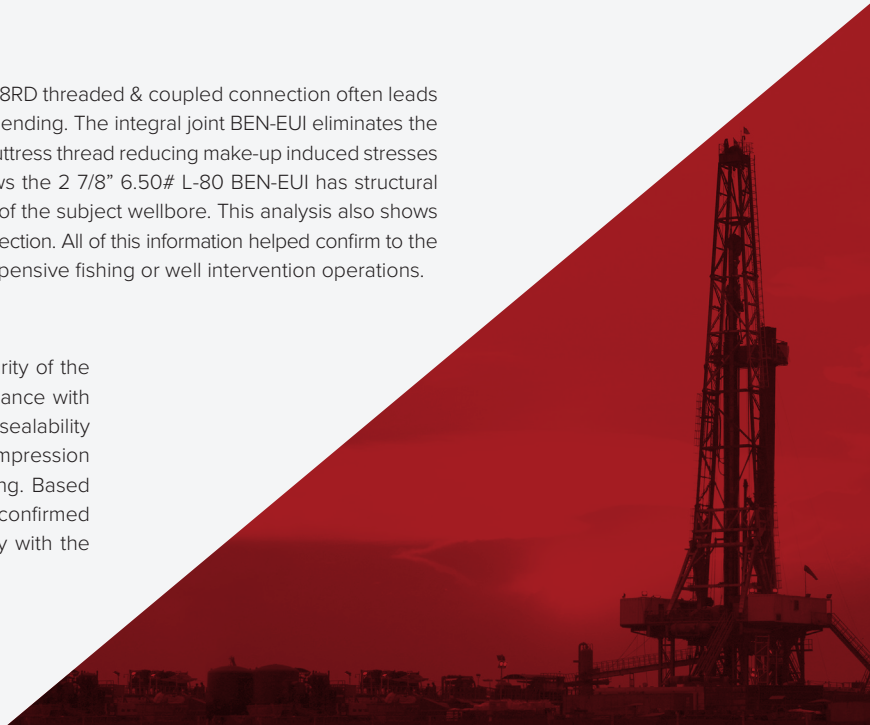
THE SOLUTION
BEN-EUI with proven strength and sealability during bending.

INNOVATIVE APPROACH
An operator in the Permian basin completing a six well pad needed a tubing connection with bending performance that they could rely on. The target zones were underneath developed areas of Midland and the wells had to be drilled from a pad on unused land about a mile away in the middle of the city. The wellbore trajectory had to bend and turn underneath the city and a Texas State Highway to reach the target production zones.

Benoit's Engineering Team worked with the operator to collect information on the most deviated wellbore of the six, and to complete a well analysis to determine an appropriate tubing connection. The critical metric for this analysis was dogleg severity or DLS, measured in degrees/100'. Utilizing information collected from the MWD survey Benoit was able to determine that the wellbore had considerable DLS. At the heel of the wellbore at 9,296' TD the DLS reached a maximum of 15.03°/100'. The operator wanted to run tubing through this deviation to approximately 9,750' TD.

STRUCTURAL INTEGRITY
It is commonly known in the oilfield that the round thread form of EUE 8RD threaded & coupled connection often leads to thread "jump-out" when exposed to tensile loads combined with bending. The integral joint BEN-EUI eliminates the coupling and use of a round thread form utilizing instead a modified buttress thread reducing make-up induced stresses and the potential for thread jump-out. Finite Element Analysis shows the 2 7/8" 6.50# L-80 BEN-EUI has structural bending strength of 107°/100', much greater than the maximum DLS of the subject wellbore. This analysis also shows that the BEN-EUI has superior stress distribution throughout the connection. All of this information helped confirm to the operator that the BEN-EUI would not jump-out or part, leading to expensive fishing or well intervention operations.

BENDING WITH SEALABILITY
Beyond jump-out, the operator wanted to ensure the sealing integrity of the tubing string. The BEN-EUI has been successfully tested in accordance with API 5C5 / ISO 13679 CAL II Series B protocols. This protocol includes sealability testing of the connection under combined loads of tension and compression at 100% of pipe body, 100% internal pressure, and 20°/100' bending. Based on the test data and FEA specific to the wellbore, Benoit engineers confirmed that Benoit's BEN-EUI tubing connection would maintain sealability with the maximum DLS of 15.03°/100'.



BEN-EUI

BENEFITS

Performance tested to API 5C5: 2018

100% performance under tension loads and 80% to 100% performance under compression loads

Available in two designs, with or without the need for re-cuts

Smaller diameter than API EUE 8RD allowing better clearance

Internal and External torque stop/shoulders

Rugged buttress style thread form for improved strength

Easily lined for corrosion protection

Flush I.D. eliminates the “J” area turbulence and resulting erosion / corrosion to erosion and corrosion

CAL II SERIES B

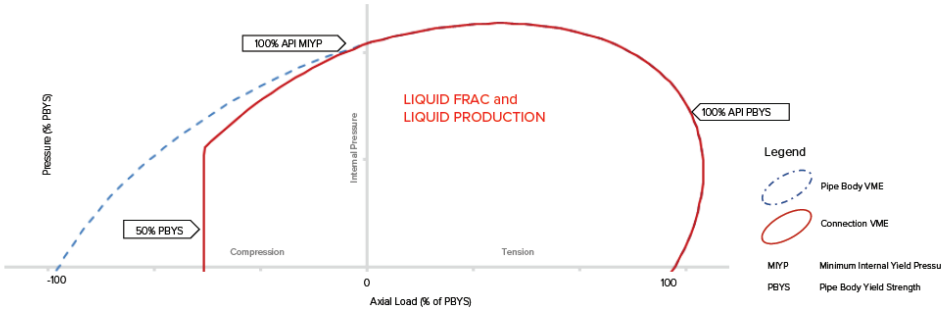
MODIFIED TESTING

FRAC CYCLING

The test consisted of cycling two samples through 30 frac cycles each, with 15 cycles at ambient temperature and 15 cycles at an elevated temperature of 275°F. Combined loads were applied at 90% of the connection VME envelope. Frac pressures applied were 100% of pipe body MIYP. Bending at 20 degrees per 100ft was also applied.

SEALABILITY TESTING

The fluid-tight sealability testing consisted of cycling two samples through 241 load steps, each of different applied tension and compression loads plus internal pressures and bending. Tensile and compressive loads of 100% and 80% of pipe body were applied. Fluid pressures applied were 100% of API calculated burst of the pipe body. Bending at 20 degrees per 100ft was also applied.



HOUSTON (281) 709-4878 | 19450 State Hwy 249, Suite 140 | Houston, TX 77070 **ENNIS** 5750 West Ennis Ave | Ennis, TX 75119
HOUMA (985) 879-2497 | 3400 Industrial Park Drive | Houma, LA 70363
www.benoit-inc.com