ESP Bend™
Key Capabilities and Workflow
Key Capabilities

• ESPBend is an engineering analysis tool that allows users to assess the deflection, stress, and reliability of ESP components at different intervals in a deviated well.

• ESPBend was designed to facilitate:

  1. Detailed bending analysis and visualization
  2. Transparent, vendor agnostic comparisons
  3. Reliability-based decisions
Detailed Bending Analysis and Visualization

- ESPBend uses a 3D finite element analysis algorithm based on linear elastic, static beam deflection theory.

- Can consider:
  - **Tortuous 3D well trajectories**
    - e.g. as characterized by gyro surveys
  - **Detailed equipment models** including dimensions, weights, and stiffness values

- Outputs include deflected shape, shear stress, bending moment, component curvature, and housing stress.

- User can visualize the wellbore trajectory in 3D.
• ESPBend is vendor agnostic, allowing “apples-to-apples” comparisons between ESPs from different ESP manufacturers

• User can define properties for each section of the assembly:
  – Element weight
  – Element length and OD
  – Flexural stiffness
  – Bending stress/curvature limits
• ESPBend can generate an equipment reliability estimate for a given ESP system design, based on correlations from historical field data

• Allows users to assess the economic tradeoffs between reliability and other key driving factors (upfront costs, production rate, etc.)
ESPBend Workflow
Manage Designs

- Create, edit, and organize designs company-wide using the case manager tree
Enter Wellbore Trajectory Data

- Directional survey data can be copy/pasted directly into ESPBend
Visualize Wellbore

• Plot dogleg severity values on a 3D visualization of the wellbore
Create Equipment Models

• User can create ESP component models, where each component consists of a series of cylindrical beam elements.

• For each element, define:
  - Dimensions and weights
  - Stiffness values
  - Acceptable curvature and stress limits

• Custom components can then be added to assemblies (next slide)
Select Equipment

• For each case, the user selects casing, tubing and ESP equipment (pump, intake, seal, motor) from databases
  – Casing and tubing databases are built-in to ESPBend
  – Database of ESP components can be populated manually using the Custom Equipment tool (previous slide), or built-in to ESPBend if a batch of equipment data is provided to C-FER
  – Assemblies can include tandem equipment
Analysis Results: Summary

• Analysis results can be plotted on the 3D visualization of the wellbore, or viewed as a table

• The following results can be plotted vs. landing depth:
  – Maximum ESP Component Curvature
  – Maximum ESP Housing Stress
  – Estimated Failure Rate
    • Requires separate analysis of historical dataset

• Results can be plotted for entire system or for a component of interest
Analysis Results: Detailed

- Plot detailed results at any given landing depth, including:
  - Component housing curvature
  - Bending stress
  - Shear stress
  - Bending moment

- Charts can be expanded or exported as images
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