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## Development of an Expandable Drill-in Liner Hanger for Use in Problem Well Scenarios: Case History

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### Abstract

Modern drilling techniques now have capabilities to drill tortuous well paths so that reserves previously considered inaccessible can be recovered. Often, however, the wellbores will require specialized drilling tools and considerable planning in order to drill through depleted sands or problematic formations. In many of these cases, the liner cannot be run to bottom. When this situation occurs, the required remedial work along with the resulting delays to first production can cost millions of dollars.

This paper will discuss an expandable liner hanger system that has been developed to address these problems by allowing drill-in of the liner through tight or collapsed formations in previously drilled holes, and in some cases, can be drilled in to make a new hole. The considerations for drilling with the liner hanger system include:

1. ROP (rate of penetration)
2. Torque (surface, at bit and through hanger system)
3. WOB (weight on bit)
4. Circulation rate
5. Design of drill bit.

These factors must be considered to anticipate how the forces will act on the liner hanger system. In addition to the liner drill-in application, the paper will discuss the planning involved to successfully drill a new hole with the liner as an integral part of the drilling assembly.

The above applications are planned, but another drill-in application can result when running a liner through a weak or problem formation. Although the installation had not been planned originally as a drill-in, the liner hanger still must withstand similar forces.

The drill in liner hanger was developed using Finite Element Analysis (FEA) to predict the failure mode of the hanger system. Prototype testing was conducted to confirm the FEA model, and finally, field use of the system was

conducted to verify the model capabilities. A case history will illustrate the different types of formation problems in which the drill-in expandable liner hanger was used as well as the results that were gained.

### Introduction

Advances in drill-in liner technology have provided operators with the ability to drill in casing and liners through depleted zones and other problem formations. To fully make use of the capabilities of this technology for liner installations, the liner hanger and its running tool must be designed to allow for high torque transmission, compressive and tensile loading, and high circulation rates. While conventional liner hangers have been upgraded to allow them to be used in drill-in applications, there have been reliability issues, many of which have been caused by the complex design of the liner hanger. Conventional hangers use slips and cone technology, which disturbs the flow path around the hanger and can cause cuttings to build up. This can restrict flow, which then can lead to increased equivalent circulating density (ECD). In the worst case scenarios, increased ECD can cause lost circulation, and there is also the possibility that this condition can preset the hanger or packer mechanically. In addition, the force to set the conventional hangers and release the setting tools is hydraulically applied, leading to limitations on circulation rates, plugging off, and other conditions that can cause differential pressure to occur.

An expandable liner hanger has been developed to address the shortcomings of the conventional liner hanger designs for problematic wellbore scenarios. **Fig. 1** shows a basic comparison of a conventional liner hanger system and the new expandable liner hanger system. The liner hanger body is designed with a clean outer diameter with no moving components.

In addition to providing solutions to many of the previously encountered problems with conventional liner systems, An additional benefit of the new design is its increased cementing efficiency. The capability to rotate and reciprocate during the cement job improves cement placement, reducing channeling and micro-annuli. This leads to successful zonal isolation across the liner, eliminating the need for remedial squeeze jobs.

Finite Element Analysis (FEA) modeling was used to support analytical calculations and small scale modeling of critical components to ensure that the hanger was capable of supporting the liner loads and pressure requirements after