IADD EXTENDED – LUNCHEON SERIES

"Creating a High-Capacity BHA" Extended Luncheon Series Part 3

Thursday, September 28, 2017 10:00 a.m. – 2:00 p.m. RELEVANT TOPICS – INSIGHTFUL DISCUSSIONS – GREAT FOOD

MWD Shock and Vibration: Key Principles & Mitigation

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Fundamental Shock and Vibration Theory

- m: Mass of the System
 - \rightarrow The MWD string itself
- µ: Coefficient of friction
 - \rightarrow Centralizers/Fins against ID of Collar
- c: Damping Coefficient
 - → If tight fit, friction between fins & collar provides some damping
 - \rightarrow In either case, a variable to control
- **k**: Spring rate:
 - \rightarrow MWD is generally a rigid system
 - \rightarrow Becomes a variable we can control
- **x**: Displacement:
 - \rightarrow System **must** <u>move</u> to mitigate shock or vibration



Forced Response Systems

Base Excited



- Automotive Suspension System
- MWD System

Mass Excited



- Engine Mounts
- Washing Machine



Shock; *G_{in}, t*₀ Half Sine Pulse



Shock; *G_{in}, t*₀ Non-Isolated System







Shock; G_{in} , t_0 Isolated System



With isolation:

Same amount of energy, but spread out over time→ Requires movement to accomplish this

> Consider a sledge hammer on concrete floor *with* slab of rubber on top



Time, ms

Three Modes of Dynamic Inputs to the BHA



LORD Axial Inline Isolator, J-28348-52 (Gen 3.3)



Protect MWD/LWD Electronics

- Reduces the magnitude and occurrence of shock and vibration transmitted to the MWD tool string from the BHA and other drill string excitations
- Utilizes proprietary elastomer formulation to endure the harshest drilling environments
- Replaceable working elastomer section
- Robust design allowing for broad operating envelope



Size & Location in MWD String



Exploded View



Design Methods/Non-linear Spring





Another important feature and lesson that we learned was to achieve the soft spring rate with elastomer in compression, as shown on the right. This also provides a non-linear spring rate to accommodate changes in the static loading from varied mud pressure and viscous drag effects.

Case 2 S/N 10.1 Shock & Vibe



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Case 2 S/N 10.1 Vibration Only



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Case 2 S/N 10.1 Vibration Histograms

Run 1 (without LORD Axial Isolator)

Vibration Histogram



Run 2 (with LORD Axial Isolator)

Vibration Histogram 129 Hrs, 1 Mins 9 Mins 1 Mins 0 Mins 0 Mins ociation ina g < 5 $5 \le g \le 8$ $8 \le g \le 12$ 12 ≤ g... 15 ≤ g

Case 2 S/N 10.1 Shock



Oct 14, 2015 5:46:08 PM

Case 2 S/N 10.1 Count of Shock Events



rectional Drilling

Case 2 S/N 10.1 Count of Shock Events



Multi-Stage Shock and Vibe Solutions

- Snubbers
- SoftShoe[™] Isolator
- Lateral Isolator (next challenge)



LORD High Torque Mud Motor Transmission

- 500 Series is commercial
 - \rightarrow 20,000 ft-lbs stall
 - \rightarrow 10,000 15,000 ft-lbs nominal
- 700 Series in field trials
 - \rightarrow 50,000 ft-lbs stall
 - → 15,000 20,000 ft-lbs nominal







Thank You

For more information on Shock and Vibration Theory, please visit the LORD video series on YouTube:

Shock Basics: https://www.youtube.com/watch?v=aTg08scpxbA

Vibration Basics: https://www.youtube.com/watch?v=07cDEzxwaKg

