

VIBRATION AGENT

Guard against stick-slip without the need for downhole sensors or specialized rig equipment

The Exebenus Spotter Vibration Agent uses artificial intelligence and machine learning technology to tackle the challenges posed by torsional vibration and ensure more effective drilling operations.

VIBRATION JEOPARDIZES PERFORMANCE

Excessive vibration during drilling degrades drilling performance. The impact is multifaceted: It becomes impossible to maintain optimal rate of penetration (ROP); hole cleaning is interrupted, increasing the likelihood of stuck pipe and the risk of stick-slip events and twist-off; equipment integrity and wellbore stability are compromised. When measurement-while-drilling (MWD) or logging-while-drilling (LWD) is part of the program, vibration interferes with the quality of data gathered, resulting in unreliable information for decision making, and may also damage the downhole tools.

Left unchecked, vibration reduces the overall safety and effectiveness of well operations, adds to drilling time, and leads to higher project costs.

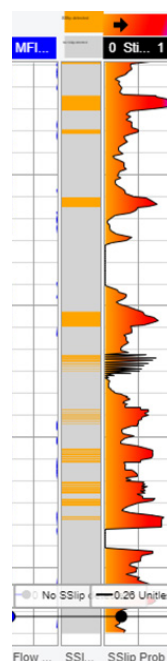
SPOT SYMPTOMS AND ACT QUICKLY TO SAFEGUARD OPERATIONS

Exebenus Spotter Vibration Agent uses machine learning to analyze patterns in readily available real-time surface data, such as torque and RPM, to identify signs of stick-slip.

The real-time vibration risk index (ranging from 0-1) estimates the probability of stick-slip symptoms being present. Higher probabilities are proxy for higher severities. The agent provides output every 30 seconds and issues notifications as severity increases.

EXCEPTIONAL BENEFITS

- Improves safety and preserves equipment by averting stick-slip events
- Boosts drilling efficiency by enhancing ROP Agent's recommendations
- Optimizes equipment performance
- Lowers costs by extending the life of equipment and minimizing downtime
- Preserves wellbore stability by enabling smoother drilling
- Safeguards MWD/LWD data gathering from vibration-induced interference



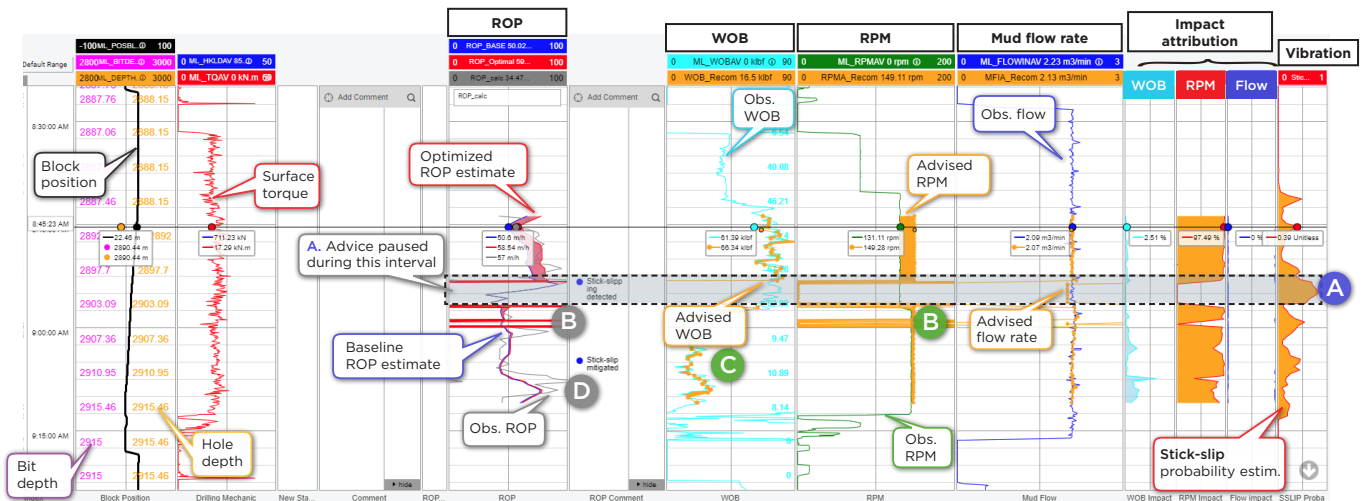
INCREASE DRILLING EFFICIENCY AND REDUCE WELL COSTS

The **Vibration Agent** helps minimize vibration-induced wear on equipment, motors, and drill bits—particularly the outer cutters—and thereby extends tool life and reduces drilling time and costs. Excessive bit wear lowers ROP and leads to costly downtime for replacements, underscoring the importance of effective vibration management.

The **Vibration** and **ROP** agents work closely together to balance and optimize key drilling parameters, such as RPM, weight on bit (WOB), and mud flow rates. If the risk index exceeds a threshold value, the **ROP Agent** may be set up to stop issuing recommendations, to prevent actions that could exacerbate the vibration issue. Once the situation has stabilized, the agents revert to normal. In an alternative configuration with loose-coupling, recommendations are not interrupted, and the **Vibration Agent** may be used as a real-time diagnostic tool.

Together, the agents provide operators with a comprehensive and effective solution for controlling and safeguarding operations. They enhance efficiency, protect personnel and equipment, and ultimately reduce project costs.

THE VIBRATION AND ROP AGENTS WORK CLOSELY TOGETHER TO ENHANCE EFFICIENCY, PROTECT CREW AND EQUIPMENT, AND ULTIMATELY REDUCE PROJECT COSTS.

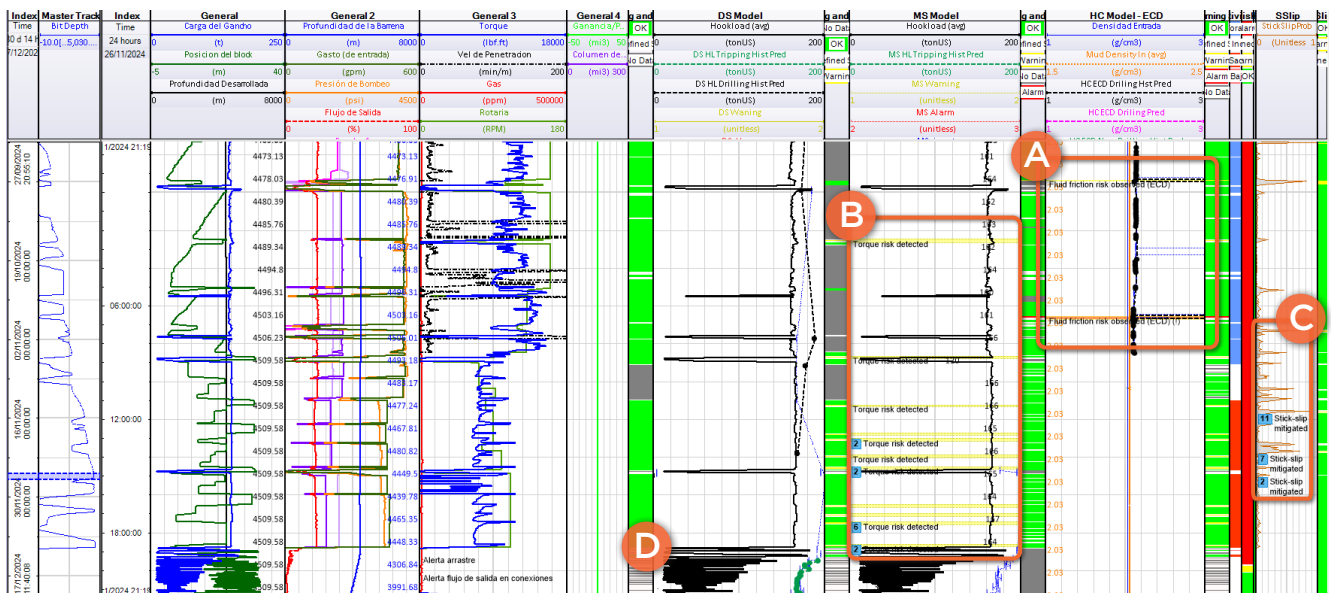


In this Middle Eastern operation, the **ROP Agent** paused drilling parameter advice during periods with high stick-slip probabilities. During the shaded region (A), towards the end of an interval with higher WOB values, high stick-slip probabilities were observed, triggering a stick-slip symptom notification. During this period, the ROP (grey curve) fell sharply. At point (B), the rig reduced the WOB and increased rotary speed, resulting in a decrease in stick-slip probability and a brief increase in ROP. Around point (C), where WOB was relatively low, the optimizer advised a 10% WOB increase. This adjustment was implemented while maintaining higher rotary speed and improved ROP at point (D), from approximately 45 m/h to an ROP average of 75 m/h for the remainder of the stand. During the final drilling phase, stick-slip probabilities remained low, further indicating enhanced drilling efficiency.

PINPOINT ROOT CAUSE OF STUCK PIPE RISK

Running the **Vibration Agent** and **Stuck Pipe Agent** in combination provides two important benefits to the monitoring engineers when rotating off-bottom, which support informed decision-making on mitigating actions:

- **Additional indicator of mechanical restriction:** The **Vibration Agent** helps pinpoint the likely sticking mechanism when warnings are issued by the Stuck Pipe Agent.
- **Added contextual information during operation:** Large torque spikes during stick-slip conditions which would be typically flagged by the Stuck Pipe Agent may be instead linked to vibration. The Vibration Agent can assist in correctly interpreting these situations.

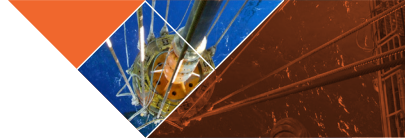


In this Gulf of Mexico well, after drilling the 28-degree 10 5/8” x 12 1/4” section, the operator performed a wiper-trip from 4473 m back to 4000 m to clean the wellbore. This action was taken in response to multiple torque (A) and fluid friction alerts (B) triggered several hours earlier by the **Stuck Pipe Agent**, as well as significant stick-slip (C) conditions detected by the **Vibration Agent** while reaming off bottom. These warnings were observed above a salt layer at a depth of approximately 4500 m and were interpreted as indications of a sticky or tight formation—likely caused by salt creeping into the formation (a “dirty formation” scenario). The preventive wipe trip (D) successfully prevented stuck pipe incidents.

SAFEGUARDING DATA QUALITY AND EQUIPMENT

Well construction teams always strive to balance risk and reward, weighing safety, efficiency and cost factors. The **Vibration Agent** empowers operators with the insight required to achieve that balance, and to make well-informed decisions.

- **Data quality:** In MWD/LWD operations in particular, minimizing excess vibration is key to ensuring high-quality data is collected. The ML agent provides real-time visual insight into downhole vibration severity without relying on downhole data, serving as a first-line safeguard of vibration management.
- **Equipment integrity:** As a first-line monitoring tool, the agent also helps to protect drilling equipment from vibration-induced damage without halting the operation, thereby saving time and cost.
- **Timeliness of risk detection:** Given typical time periods between up-linking of data from downhole tools of 5-8 minutes, real-time vibration monitoring can support earlier identification of risk symptoms between up-links, providing an edge for mitigation even if utilizing downhole tools.



OUT OF THE BOX AND INTO PLAY

The Exebenus Spotter Vibration Agent is an out-of-the-box, plug and play solution. It requires no well-to-well training, nor time-consuming configuration.

The agent requires only WITSML surface data, available in every operation regardless of location, to generate results. No need for costly downhole sensors, and no special tool installations or drilling control system modifications required.

CONSISTENT, PROACTIVE, INTELLIGENT

Exebenus Spotter **Vibration Agent** delivers reliable, real-time stick-slip severity information, allowing immediate awareness and action. No downhole tools are needed, no vendor lock-in—just pure, reliable information from the surface data.

The agent enables operators to establish a consistent operational process for identifying and responding to early indicators of stick-slip hazards across all well types and geographic locations.

POWERFUL INDIVIDUALLY. STRONGER TOGETHER.

The Exebenus Spotter suite includes three targeted AI/ML agents.

Stuck Pipe Agent including supporting models for			ROP Agent	Vibration Agent	Exebenus Spotter agents are available as standalone or bundled solutions. When working together, they support each other's predictions or recommendations. Combined, the agents address interconnected challenges, leading to even better results than any can achieve alone.
Differential sticking	Mechanical sticking	Hole cleaning			

INTELLIGENT DRILLING WITH EXEBENUS SPOTTER AGENTS

Exebenus Spotter is a cloud-based, standalone software as a service (SaaS) solution. The agents can be hosted on any public cloud, installed on your corporate cloud or on your premises.

Exebenus Spotter agents are designed based on our deep understanding of drilling and completion operations and data sciences.

