WORKOVER RIG STABILITY MONITORING SYSTEM

Customer Information Document
Version: R3
Release Date: [18 Feb 2026]
Prepared By: Exploration Drill Rigs Pty Ltd

Applies To: XDR Workover Rig Stability Monitoring System (Load Cell Beam & COG Display)

Document Purpose
This document provides operators, supervisors, HSE personnel, and engineering teams with a clear understanding of the Workover Rig Stability Monitoring System. It explains how the system functions, how to interpret the operator interface, and how to use the system safely and effectively during rig operations.
The information contained herein is intended for customer use and may be distributed to operational crews, site supervisors, and engineering support teams.

XDR Workover Rigs

Disclaimer
This document is provided for general operational guidance. It does not replace site specific safety procedures, regulatory requirements, or professional engineering judgement. Operators must follow all applicable standards, company policies, and instructions provided with the equipment.

1. Purpose of the Stability System

API 4F requires mast and substructure designs to account for longitudinal loads and environmental wind loading, as these are considered part of the normal operating conditions for a certified rig. However, the standard does not provide structural design allowances for lateral operational loads, such as side pull forces, cross well deviations, or off axis pipe handling. These lateral forces fall outside the API 4F design envelope because the mast and substructure are not required to resist significant sideways loading during normal operations.

As a result, even though wind is included in the certification calculations, any lateral load generated by rig operations is treated as a non API compliant condition. This is why managing lateral stability becomes an operational responsibility, and why real time monitoring of the centre of gravity is essential whenever off axis forces may occur.

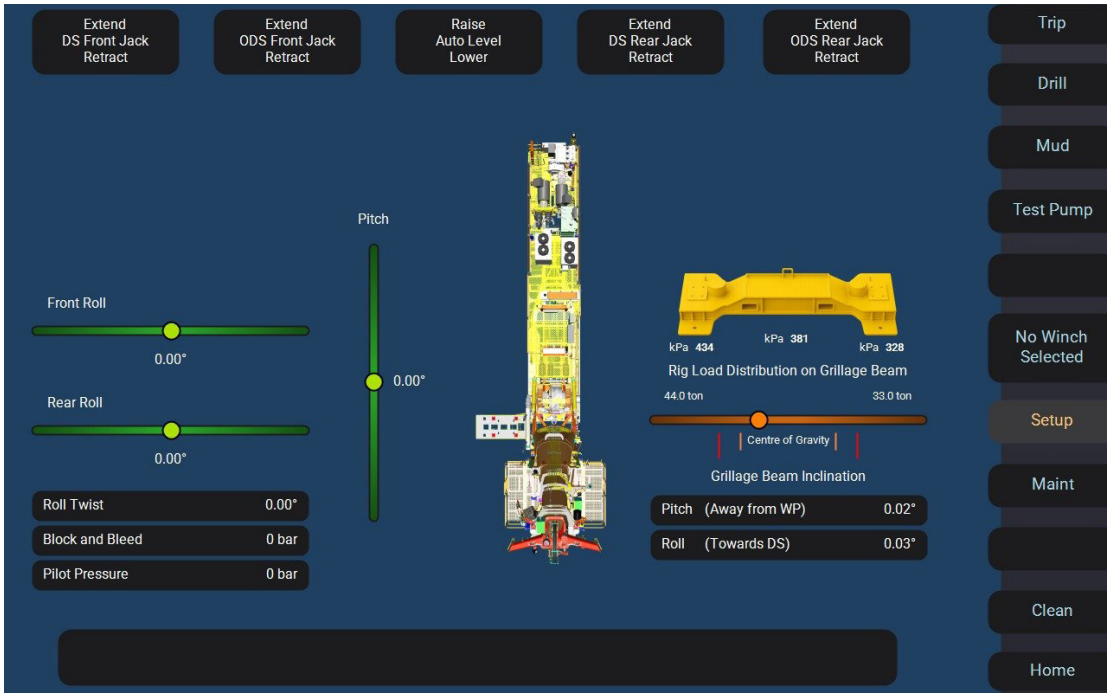
Workover rigs operate in environments where ground conditions, wind, pipe movement, and lateral loading can change rapidly. The invisible effects of these changes on the rig's centre of gravity (COG) will shift the rig's COG, increasing the risk of rollover — often without clear warning for corrective action to be taken.

The Stability Monitoring System provides real-time visibility of how the rig is loading the ground. By continuously measuring the load on each rear jack leg and calculating the lateral COG, the system gives operators a clear, intuitive continuously updated picture of the stability of the rig throughout all workover rig operations.

The system is designed to:

- Reduce rollover risk to the aim of eliminating rig rollover
- Provide early warning before instability develops
- Increase operator awareness and confidence
- Support controlled lateral loading where permitted
- Improve safety without reducing operational efficiency

It enhances safety but does not replace proper rig setup or operator judgement.



HMI Rig setup screen for front and rear jacks. Showing Pitch and Roll of the Rig on the left and the Rig load distribution grillage beam

2. How the System Works

The system uses load sensing support pads beneath the rear jack legs. Each pad contains a load cell that measures the compressive force transmitted through the grillage beam into the ground.

The PLC:

- Receives load data from each rear jack leg
- Calculates the lateral centre of gravity
- Compares it to the defined stability region
- Displays the COG position on the HMI
- Issues warnings or protective actions if limits are exceeded

Because the system reacts immediately to load changes, operators can see developing instability early. The Stability Monitoring System automatically includes the effects of lateral wind loading in the jack-reaction values shown on the HMI. Wind acting on the mast and any suspended equipment creates a sideways overturning moment, and this is reflected directly in the real-time load readings. Operators therefore see the true stability state of the rig, inclusive of wind effects, without needing to make separate wind adjustments.

The Stability Monitoring System continuously evaluates not only the magnitude of jack reactions but also the rate of change of the rig's lateral centre of gravity (COG). Rapid COG movement is treated as a leading indicator of developing instability, such as sudden ground subsidence, uncontrolled lateral loading, or dynamic pipe movement. When the system detects a COG shift that exceeds predefined acceleration thresholds, the PLC initiates an automatic protective sequence. This sequence engages the slips and commands the drawworks to stop and lower, transferring the tubular load back into the slips and removing the destabilising mass from the mast. By unloading the mast and reducing the overturning moment acting on the grillage beam, the system aims to arrest further ground movement and restore stability.

During well control equipment handling, the rig may be operated with the work floor hydraulically packed up and the mast luffed to its maximum rated angle 97° for the XDR 75 to lift the BOP vertically from the wellhead and position it onto the BOP transport skid along the longitudinal axis of the rig. This operation falls within the rig's certified stability calculations, as the primary load path remains aligned with the mast and substructure. Other lateral effects such as wind influence, natural pendulum motion of the suspended BOP, or small positional adjustments made during controlled handling are expected and are accounted for by the Stability Monitoring System. Operators must ensure that ground conditions, load distribution platform configuration, and jack reactions remain within allowable limits throughout the lift, and must monitor the Stability System for any unexpected or accelerating COG movement. This longitudinal BOP handling method is the approved configuration for removing or installing the BOP using the rig's lifting system.

This behaviour aligns with the system's design intent to provide "automatic protective actions when limits are exceeded" and to give operators early audible warning of developing instability. As this protective function has not yet undergone field validation, its thresholds, timing, and operational behaviour remain subject to controlled testing and may be refined as operational data becomes available

3. Key Safety Benefits

- Early detection of instability caused by side pulls, pipe movement, wind gusts, and ground subsidence
- Real time COG tracking for continuous situational awareness
- Clear visual guidance using a moving COG marker on the HMI operating screens
- Defined safety boundaries including normal, caution, and "do not go further" zones
- Automatic protective actions when limits are exceeded

In addition to real-time stability monitoring, the system is integrated with XDR's Xenon telemetry platform, which provides continuous data capture, remote visibility, and post-event analysis capability. Xenon includes an onboard "black box" recorder that logs jack reactions, COG movement, mast loading, drawworks activity, and operator inputs. This data has already proven critical in reconstructing the sequence of events during a rig rollover, enabling XDR to supply objective information to the contractor, well owner, and relevant government authorities. The same telemetry framework also supports real-time maintenance monitoring, allowing early detection of developing mechanical issues and improving overall rig reliability.

4. Operator Interface Overview

The HMI is designed to be simple and intuitive.

Load Display

Each rear jack leg shows its current load (e.g., 44.0 t and 33.0 t).

COG Slider

A horizontal slider represents the lateral stability zone. An orange ball shows the real time COG position. As load changes, the ball moves left or right.

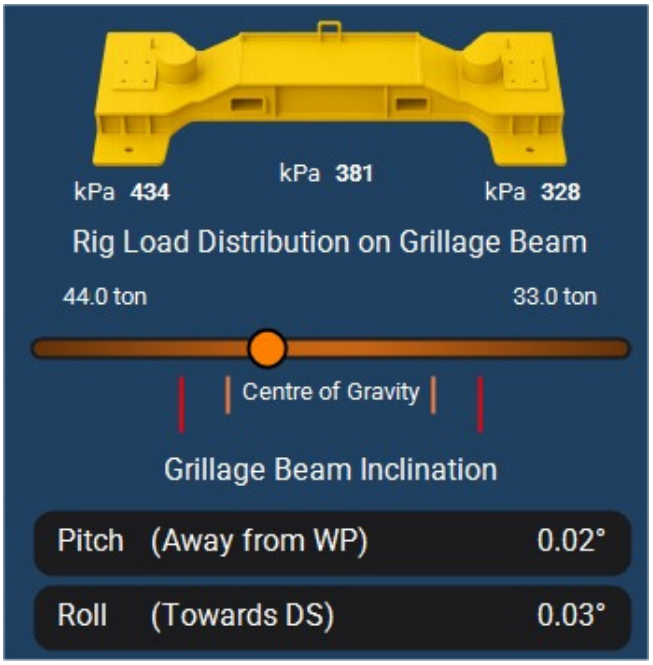
Stability Markers

- Normal Operating Zone — safe
- Caution Zone — approaching limits
- Do Not Go Further Marker — unsafe boundary

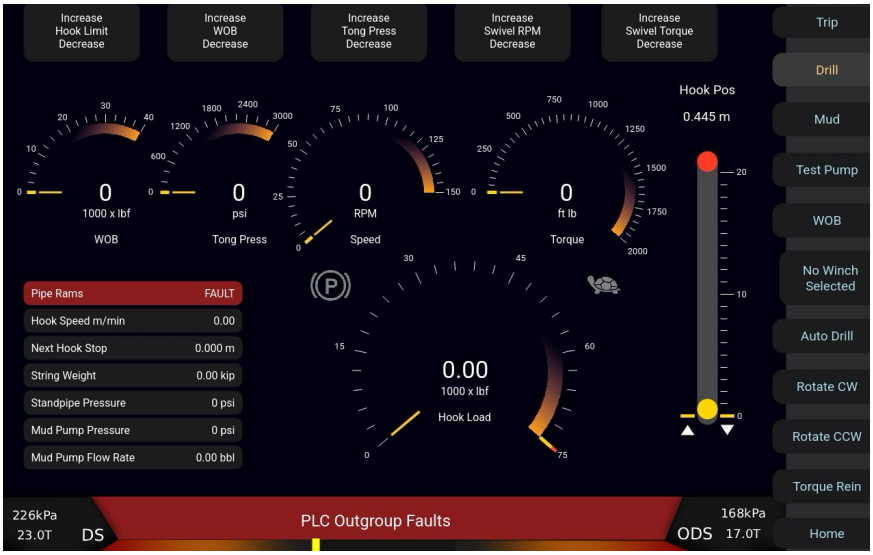
Operator Interpretation

- Ball centred → stable
- Ball drifting → caution
- Ball crossing boundary → unsafe

This visualisation allows operators to react early and confidently.



The HMI includes an independent inclinometer showing the pitch and roll of the grillage beam before the rig is set up. On the HMI, roll represents the side-to-side inclination of the beam from left to right across the screen, and pitch represents the front-to-back inclination from the bottom to the top of the screen. These measurements confirm whether the grillage beam is level prior to loading and form the baseline for accurate centre-of-gravity (COG) calculations. Although the rig is equipped with its own onboard inclinometers, the grillage-mounted inclinometer provides an additional layer of safety by verifying that the support foundation is level and stable before jacking commences. If the grillage beam is not within the specified pitch and roll tolerances, operators must not commence setup. An out-of-level beam can distort load distribution, shift the calculated COG, and significantly reduce lateral stability.



The lower section of the main drilling screen functions as the system's alert bar, displaying interlocks, system faults, and operational warnings in real time.

This same bar also acts as a graphical representation of the grillage beam, using a red–orange-black gradient on the DS and ODS sides to illustrate relative loading across the beam. Above each end of the gradient, the HMI shows the live rear jack-leg reaction loads (t) and the corresponding ground pressure beneath the grillage beam (kPa). A small yellow COG marker is positioned on the beam graphic and moves laterally as the calculated centre of gravity shifts, mirroring the behaviour of the orange COG ball on the dedicated stability slider. This combined display gives operators an immediate, intuitive view of both ground loading and lateral stability during drilling operations.

5. The load distribution platform system under the grillage beam, must provide a stable, level, and structurally adequate support surface capable of sustaining the maximum jack reactions without exceeding the allowable ground bearing pressure of 100 kPa. The stability assessment does not rely on friction between the grillage beam and the distribution platform, as the grillage beam is positively restrained against sliding, by securing the grillage beam to the distribution platform. Selection, configuration, and verification of the load distribution platform system including its material type, thickness, stiffness, and the certified depth of competent ground beneath it remain the responsibility of the operator, who must ensure that the chosen support arrangement can safely distribute loads into the ground under all expected operating conditions.

6. The supporting ground beneath the load distribution platform system must consist of a certified depth of competent material capable of sustaining the required 100 kPa bearing capacity. This bearing capacity must be verified through the full depth of the competent layer, not just at the surface, to ensure that the load distribution plsatform and grillage system can safely transfer loads into the ground without overstressing any weaker underlying strata. Verification of ground conditions, including depth, strength, and uniformity, is the responsibility of the operator or site geotechnical personnel.

7. The Stability Monitoring System brings a new level of transparency and control to workover rig operations. By giving operators real-time visibility of load distribution, centre-of-gravity movement, and ground pressure, the system helps crews recognise developing instability long before it becomes hazardous. When combined with correct load distribution platform configuration and verified ground conditions, the system supports safer decision-making, reduces the likelihood of unexpected load transfer, and provides a clear operational picture that was previously unavailable. This enhanced situational awareness strengthens overall rig stability, shows if side loading is occurring, and contributes to a safer, more predictable operating environment.

The Stability Monitoring System represents a major step forward in workover rig safety. By combining real-time load monitoring, intuitive operator guidance, and integrated telemetry, it gives contractors and well owners a clearer picture of rig behaviour than ever before. This increased visibility supports safer operations, reduces unplanned downtime, and strengthens confidence in the rig's performance. It is a practical, data-driven tool that helps crews work more safely and efficiently every day.

For any queries or further information please contact XDR.

Exploration Drill Rig Pty Ltd. 27 General Macarthur Place, Redbank, 4301
+61 7 3381 5363
Ross@xdr.com.au

XDR
Engineered For Safety