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CBM for Hydraulic Hoses on Oil & Gas Rigs

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Status Quo

Hydraulic hose failures on Oil & Gas rigs are sudden, hard to detect in advance, and costly when they occur. Because hoses differ in material, construction, and installation, and because they often fail without observable trends in existing sensors, NOV does not yet have a reliable way to predict or pre-identify degradation. This is a known challenge with clear operational and financial impact.

The Challenge: Existing condition monitoring approaches struggle with hydraulic hoses because:

- Failures happen suddenly without clear warning signs in traditional sensor data
- Hose construction varies widely (material, design, installation)
- The roughneck environment is harsh and constantly moving
- Adding sensors directly to hoses is not practical
- Visual inspection is limited and time-consuming

This gap creates significant operational risk and cost. A single hose failure can stop operations for several hours, typically costing between 100,000 and 300,000 USD per event depending on the rig's day rate and timing of the incident. Unnecessary scheduled teardowns also add cost even when hoses are still healthy.

Goal

This project explores a practical, low-risk path toward condition-based maintenance for hydraulic hoses without adding sensors to hoses, redesigning hardware, or introducing significant operational overhead.

The goal of this first phase is to identify one or two realistic ways to detect early hose degradation that work with the constraints of the roughneck environment and NOV's existing equipment.

🔍 **Failure Signature Analysis**

Identify observable symptoms of early degradation including vibration patterns, oscillations, deformation, stiffening, and motion irregularities.

Non-Intrusive Detection

Evaluate remote sensing methods, particularly camera-based motion amplification, that don't require attaching sensors to hoses.

Operational Integration

Design inspection routines that fit seamlessly into existing drilling workflows without adding operator burden.

Clear Roadmap

Deliver a viable detection principle with accuracy assessment, integration options, and pilot/prototype outline.

Proposed Solution

Understanding Failure Signatures

We start by clarifying what early degradation actually looks like and which symptoms are observable. This includes:

- Vibration patterns and small oscillations
- Deformation under partial load
- Stiffening and delayed rebound
- Motion irregularities and abnormal behavior
- Typical failure locations and field patterns

Requirements: Photos or short videos of the roughneck area, plus notes or summaries of previous internal experiments.

Camera-Based Motion Amplification

The most promising approach is non-intrusive, remote sensing using modern high-frame-rate cameras. Motion amplification technology allows micro-movements to be magnified and analyzed, making deviations from normal hose behavior detectable long before failure.

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Key Technical Considerations:

- How much the roughneck system itself moves
- Compensation for system movement
- Inspection timing during stable workflow moments
- Camera positioning (fixed vs. robotic mount)
- Processing requirements and algorithm complexity

Alternative Approaches: Depth sensing, thermal patterns, and machine-learning-based optical flow analysis will also be evaluated, but priority remains on approaches that don't interfere with hose construction or require major hardware changes.

Operational Integration

Any solution must fit seamlessly into the drilling workflow. We design a simple inspection routine that can run during an existing process step:

Proposed Inspection Workflow:

1. Trigger after certain number of cycles or hours
2. 20-30 second inspection window during stationary moment
3. System captures short sequence
4. Algorithm compares hose behavior to baseline
5. Simple recommendation: continue, inspect at downtime, or replace

This approach:

- Avoids false alarms

- Minimizes operator burden
- Integrates into NOV's current CBM structure
- Provides actionable insights without disruption

Approach

We propose a phased exploration to validate technical feasibility and business value before committing to full development.

❶ Failure Mode Analysis & Data Collection

Understand what degradation looks like and gather baseline data from NOV's existing operations and test facilities.

Deliverables:

- Comprehensive analysis of hydraulic hose failure modes specific to roughneck operations
- Documentation of observable early degradation symptoms
- Baseline data from field observations and previous experiments
- Prioritized list of detectable failure signatures
- Requirements specification for sensing and detection methods

Activities:

- Review historical failure data and maintenance records
- Conduct field visits to capture video of roughneck operations
- Interview NOV engineers and field technicians
- Document typical failure locations and patterns
- Identify stable inspection windows in workflow

❷ Detection Method Evaluation

Evaluate and prototype the most promising detection approaches, with focus on camera-based motion amplification.

Deliverables:

- Technical assessment of camera-based motion amplification feasibility
- Evaluation of alternative sensing methods (depth, thermal, ML-based)
- Prototype algorithm for motion analysis and deviation detection

- Assessment of system movement compensation requirements
- Camera positioning and mounting recommendations
- Processing requirements and hardware specifications

Activities:

- Develop motion amplification algorithms
- Test with existing roughneck video footage
- Evaluate signal-to-noise ratio and detection sensitivity
- Assess alternative sensing technologies
- Define baseline behavior models
- Determine optimal camera specifications

❸ Integration Concept & Pilot Plan

Design how the detection method integrates into NOV operations and outline the path to pilot testing.

Deliverables:

- Integration concept for existing CBM infrastructure
- Inspection workflow design with timing and trigger logic
- Simple recommendation system (continue/inspect/replace)
- Processing architecture (edge vs. cloud)
- Pilot test plan for controlled environment validation
- Cost-benefit analysis and expected accuracy assessment
- Risk mitigation strategy and limitations documentation

Activities:

- Design inspection routine that fits drilling workflow
- Define integration points with NOV systems
- Develop recommendation algorithm and thresholds
- Plan pilot testing approach
- Assess hardware and software requirements
- Calculate expected detection accuracy and false alarm rates

Business Value and ROI

Downtime on an offshore rig quickly becomes expensive. A single hose failure can stop operations for several hours, typically costing between 100,000 and 300,000 USD per event depending on the rig's day rate and the timing of the incident. Unnecessary scheduled teardowns also add cost even when hoses are still healthy.

Conservative ROI Scenario

Annual customer benefit from preventing:

Event Type	Count	Cost per Event	Annual Savings
Hose failure events	2	$200,000	$400,000
Unnecessary teardowns	1	$50,000	$50,000
Total Annual Benefit			**$450,000**

A condition-based maintenance capability that prevents even a small number of hose failures per year has a meaningful financial effect. Even with modest deployment costs, payback would occur in well under a year.

Strategic Benefits:

- Scales across entire rig fleet
- Strengthens NOV's CBM offering portfolio
- Competitive advantage in value-share contracts
- Reduces total-cost-of-ownership for customers
- Enhances NOV's predictive maintenance capabilities

Expected Outcomes

This exploration phase will deliver clear, actionable insights for NOV's hydraulic hose CBM strategy:

Technical Validation: Clear description of the most viable detection principle, including how and where it could be applied, expected accuracy, and technical limitations.

Risk Reduction: Validate feasibility early to avoid unnecessary engineering effort on impractical approaches.

Integration Roadmap: Processing requirements, integration options with existing NOV systems, and deployment considerations.

Pilot Foundation: Outline for potential pilot or prototype testing in controlled environment before field deployment.

Business Case: Cost-benefit analysis and ROI projections to support investment decisions.

Clear Decision Point: Sound technical and business basis for any follow-on development steps.