A NEW APPROACH TO SAFELY LOCKING OUT PUMPING UNITS USING A HYDRAULIC SHEAVE LOCK VERSUS TRADITIONAL METHODS

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INTRODUCTION

Each day in oil producing regions around the world, beam pumping units are shut down to perform a wide range of preventative or routine maintenance on the pumping unit or at the well head including recommended quarterly and semi-annual inspections, stroke and counterweight adjustments, belt replacements, stuffing box packing changes, brake cable replacements, rod string adjustments, horse head realignment, repair and routine service rig and flushby operations.

Pumping units are mechanical equipment with rotating parts with counterweights weighing several tons, the hazards associated with shutting down a beam pumping unit, even for a short period of time, expose operations personnel to significant risk of injury or death. Unfortunately, many people who work in the industry have a personal knowledge of someone who was injured by pumping units when working at the well site. As a result, many oil producers have reduced their liability and risk by requiring a third party to perform routine pumping unit maintenance. The risk remains but is now incurred by the third-party service companies and their employees. The cost to perform routine maintenance is increased. Unintentional impacts may also include lower well productivity and increased downtime due to wells and beam pumping units not being properly optimized due to the time and cost to manage third party service providers.

PROBLEM/ ISSUE

Identify a new method to reduce hazard exposure and improve operational efficiency for personnel working around beam pumping units to optimize safety, reduce third party service and equipment costs and minimize pumping unit downtime.

SITUATIONAL ANALYSIS

Traditional methods of lockout/ tagout and shutting down pumping units require operations personnel follow pumping unit manufacturer's recommendations. Lockout/Tagout (LOTO) is defined as the process in which the equipment is shut down and all energy sources are isolated to prevent the release of potentially hazardous energy or motion while work is being performed.

The amount of time required to follow proper lock out/ tagout procedures results in short cuts being taken in the field. This happens in situations where third party service providers are incurring standby charges while the pumping unit is safely shut down/ locked out. It also occurs in the case where personnel are working alone and *"only"* need to do a simple rod string adjustment or brief visual inspection of the pumpjack or well head equipment. As a result, personnel are inadvertently putting themselves and their coworkers at risk by relying on uncertified chains, brake cables which are subject to wear and breakage or a worn or damaged pawl. This risk has become acceptable because alternatives were unavailable and have become a common practice that occurs hundreds of times per day in oil producing regions around the world. Risk is further elevated when during an uptick in activity at the field level and more inexperienced new employees enter the industry.

According to beam pumping unit manufacturers and ANSI Standard 244.1 proper lockout procedures are required every time a pumping unit is shut down. This recommendation is not always followed for the reasons previously outlined.

In addition to the elevated risk profile, the incremental costs associated with traditional lock out methods include damage to the sheave because of over torquing the chains, third party equipment costs, additional labor/ personnel costs, delayed preventive maintenance due to time and risk involved in locking out the pumping unit, increased traffic at the well site resulting in increased road wear & an increased carbon footprint.

Regularly Occurring Lock/Unlock Pumping Unit Events:

- scheduled visual inspections & maintenance (greasing, belt inspection or replacement)
- packing changes
- counterweight adjustments
-stroke length adjustments
-rod string adjustments
-flush by operations
-workover rig work (e.g., rod string/rod pump repair)
-brake maintenance/replacement
-bridle cable inspection/ replacement
-horse head removal/ install/ alignment
-beam pumping unit repair

HISTORY OF HYDRAULIC SHEAVE LOCK APPROACH

A new approach to safely lock out pumping units using an engineered hydraulic sheave lock was developed in the field by two individuals who had personal experience with loss & injury. This had a profound impact on them and was the key driver that determined there must be a better way to keep people safe. Most professionals who work in the industry around pumping units have similar personal experiences or first-person stories about injuries related to brake failures/ counterweight struck-by incidents.

They envisioned a sheave lock device that would eliminate the ability of the counterweights to move in the event of a brake cable or pawl failure, while also enabling the counterweights to be easily locked in a variety of positions to accommodate field maintenance needs and reduce the need for third party cranes.

They filed a patent in 2013, developed prototypes and installed 21 units over the next 6 years with a variety of producers to validate concept and fine tune the design in the field. The original design was effective but needed modifications to accommodate commercialization and scalability. This process was completed, and the redesigned 2nd gen unit was installed in June 2020 with a major producer.

HYDRAULIC SHEAVE LOCK METHOD

How the hydraulic sheave lock operates:

- Simple, but robust design is engineered to prevent crank movement, even if the brake is released and power is engaged.
- Hydraulic hand pump engages/ releases the hydraulic sheave lock from **outside the swing area** to avoid any hazard exposure from counterweights. Locks can then be applied directly to the locking rail on the pump box.
- Simple field installation uses existing mounting brackets.
- Minimize downtime and optimize operational maintenance efficiency versus traditional approach

- Brackets for most common beam pumping units can be accommodated. Locking hardware is standardized for most units.
- The hydraulic sheave lock has been designed to meet the requirement of ANSI/ASSP Z244.1-2016 (R2020) The Control of Hazardous Energy Lockout, Tagout and Alternative Methods or CSA Z460:20 (Control of Hazardous Energy – Lockout and other methods).

HOW THE HYDRAULIC SHEAVE LOCK IS ENGAGED

A simple hand pump engages and disengages the hydraulic sheave Lock from outside the danger area. With the hydraulic fork engaged, there is zero crank movement - even with no brake and full power applied to the unit. The hydraulic cylinder utilizes a 100% non-toxic and environmentally friendly fluid is in a closed loop system.

HYDRAULIC SHEAVE LOCK APPROACH TO LOTO:

1) Select Pumpjack to be worked on
2) De-energize pumpjack including disconnection of Presco switch
3) Actuate hydraulic sheave lock as per manufacturer's instructions.
4) Install personal locks on hydraulic sheave locking rail on pump box.
5) Complete necessary documentation that pumpjack is locked out
6) Perform subsequent task as required
7) Once task is completed de-actuate hydraulic sheave lock as per manufacturer's instructions.
8) Remove locks from lockbox and complete documentation
9) Inform operations that work is complete

TRADITIONAL APPROACH TO LOTO:

1) Select Pumpjack to be worked on
2) Witness customer representative perform loaded brake check (If carrier bar is not already disconnected) and/or receive verification that the brake check has taken place
3) De-energize pumpjack including disconnection of Presco switch
4) Customer representative to perform bump test on pump jack verify power to pump jack has been de-energized
5) All workers must place their personal lock on the associated breaker in the MCC building for the pump jack to be worked on.
6) Remove cages from around pumpjack
7) Enter cage area and install chain on flywheel and chain back to frame
8) Install boomer on chain and tighten
9) Complete necessary documentation that pumpjack is locked out
10) Perform subsequent task as required
11) Once task is completed, enter caged area to loosen chain and remove from flywheel
12) Put fences back in position to protect workers from swing path of weights
13) Pull locks from breaker and complete lockout documentation
14) Inform operations that work is complete

HOW THE HYDRAULIC SHEAVE LOCK APPROACH DIFFERS FROM TRADITIONAL APPROACH: (see Table 1)

-engineered safety factor of 3:1 eliminates risk of struck by or crush incidents due to unanticipated counterweight movement due to improper LOTO procedures or failed brake cables
-damage to the sheave flywheel is reduced due to over-torqued chains during traditional LOTO practices
-time to LOTO with hydraulic sheave lock method is reduced to 1.5 minutes from an average of 20 to 25 minutes for traditional methods
-third party equipment (cranes) requirements are reduced reducing standby and equipment costs

-non-productive time and labor costs are reduced
-Current acceptable methods of locking out include using chains which are rated at 125% of their capacity. The hydraulic sheave lock is designed and engineered with a minimum 3-1 safety factor for forces that can be produced by the flywheel, so the prospect of failure is nominal.

HYDRAULIC SHEAVE LOCK COST/ BENEFIT ANALYSIS:

An analysis based on survey of oil producers about the frequency of lock/ unlock events at the beam pumping unit and the potential impact on improved productivity, reduced downtime, lower third party equipment and standby charges, but did not include the impact of optimization of the pumping unit on production volumes.

It yielded a return on investment of 12 to 18 months, not including the savings related to reduced insurance and liability costs incurred because of the improved safety at the well site.

CONCLUSION:

ADAPTING CURRENT PRACTICES TO INCORPORATE ENGINEERED HYDRAULIC SHEAVE LOCK

Readers/audience members are invited to consider and reflect on their own field experiences to further validate current field practices to assess the risk associated with struck by and crush incidents related to on pumping units. In the past, the risk was considered acceptable in the absence of options that were safer, faster and easy to implement. How will availability of a safe and effective alternative method to safely shutting down a pumping unit affect field practices? Are field personnel more likely to use a new tool if it more efficient and safer than what they do currently? How will operators re-evaluate risk and accepted field practices to incorporate availability of an alternative method? How will inertia to current practices affect the rate of adoption and what impact will this have on operations and ability to attract labor? In addition to safety, how does the ability of the new approach to deliver a compelling return on investment by generating time savings, increasing production due to enhanced uptime, reduction of labor and third-party costs, reducing insurance liability risk and improving environmental impact by reducing traffic at the well site?

The hydraulic sheave lock approach is entering field demonstration pilot stage in the US, which will incorporate data reflecting common basin practices to provide an analysis of safety, environmental and financial benefits of the new approach to pumping unit lock out / shut down practices.

Table 1 – Traditional Methods of Pumping Unit Lockout Versus Engineered Safety Lock Method

Elements of Lockout Procedure	Hydraulic Sheave Lock Method	Traditional Pumping Unit Manufacturer's Method
Risk of struck-by or crush injuries eliminated	Eliminated	Present
Damage to sheave flywheel due to over torqued chains or failed brake cables	Reduced	Present
Time Required to SAFELY Lock out a beam pumping unit	1.5 minutes	20 – 25 minutes
Third party Standby/Service or Equipment Costs	Reduced	Static/ Present
Carbon footprint due to traffic at well site	Reduced	Static/ Present
Non-Productive Time	Reduced	Static
Labor Costs	Reduced	Static