



EXTENDING THE LIFE OF WELLS

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FRANK'S INTERNATIONAL, USA, CONSIDER WAYS OF SAFEGUARDING WELL INTEGRITY.

Casing installation is one of the most crucial aspects of drilling operations, and the cost of repairing damaged casing can be exorbitant. Worse yet, removal and replacement of casing due to inevitable wear and tear can disrupt circulation within mud columns, in turn risking a blowout. With well integrity largely dependent on the condition of its foundational casing, today's well planning must include the anticipation of invariable casing wear and mitigating solutions. In response to certain contributing factors (including drillpipe reciprocation/rotation, dogleg severity and wellbore deviation) being unavoidable, several technologies to reduce cumulative casing wear and safeguard well integrity at nearly every stage of a drilling operation – from induction to production – have been developed.

Mitigating casing wear

Casing protection strategies should be implemented as early as possible in the drilling process. Given the highly corrosive environments and challenging lithological profiles that are inherent to certain regions, casing running tools can serve as a first line of defence in the prevention of pre-installation mechanical damage to the surface of casing that could potentially worsen downhole and result in premature tubular failure. One such preventive measure is higher slip crush capacity. The recent trend of increasingly deep offshore drilling wells has resulted in longer, heavier casing strings, which push the limits of existing tubular

tensile capacity and raise concerns about handling equipment possibly damaging casing due to excessive radial load (slip crush).

After conducting extensive research, Frank's International identified critical oversights in many long-standing industry practices that are used in the determination of slip crush and developed a new multi-faceted test approach that more accurately calculates composite load stress. Equipped with high quality data, the company was able to design a line of slips that feature a higher slip crush capacity than existing high capacity rotary slips currently on the market (Figure 1).

Another cause of pre-installation casing damage is gripping penetration. Inserts or dies that are common to most types of tubular handling equipment leave impressions on casing that, in wells with high concentrations of hydrogen sulfide, increase downhole tubular susceptibility to corrosion and sulfide stress cracking. Frank's solution is a fully non-marking handling system that consists of Fluid Grip® and Collar Load Support (CLS™) system technologies. In contrast to mechanical gripping devices with cam-activated jaws and dies, the Fluid Grip Tong utilises hydraulic fluid flow and pressure to inflate elastomeric bladders that effectively establish a gripping engagement between a rigid outer housing encasing the bladders and a tubular member. Additionally, unlike typical slip type elevators and spiders, the CLS system (Figure 2) allows for the running of threaded and



coupled tubulars without inflicting any damage due to its ability to support a casing joint exclusively by the load face, not by penetration.

Even if installed without damage, the casing must then be able to reliably endure high downhole internal pressure and

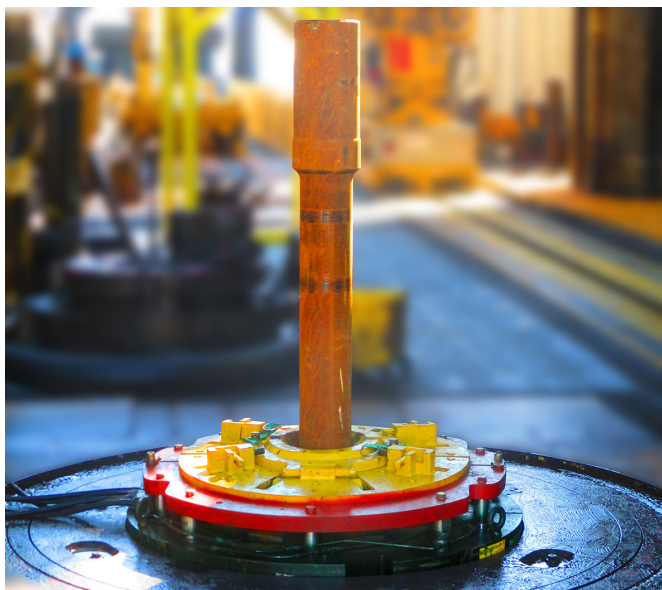


Figure 1. A 1500 t Landing String Spider equipped with high slip crush capacity slips.

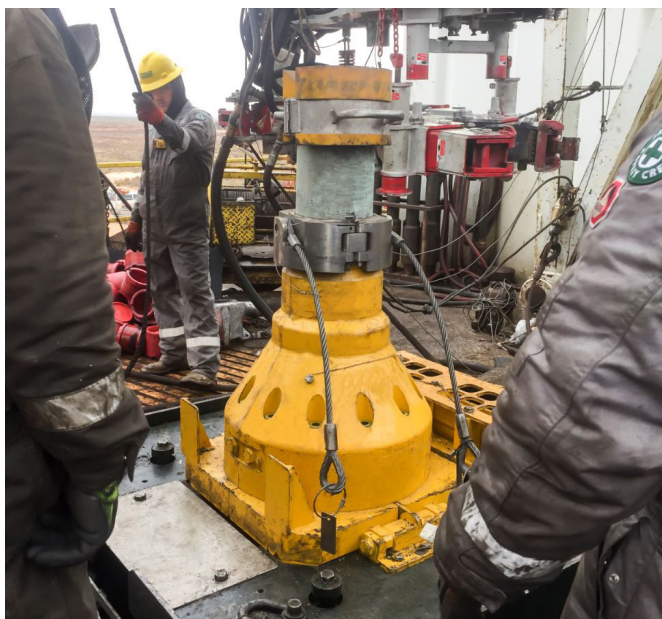


Figure 2. A CLS system.

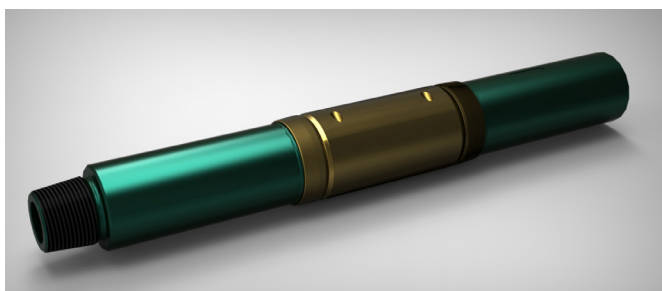


Figure 3. A DST sub.

temperatures, resist corrosion via sour gases and withstand the inevitable wear and tear that is incurred from drillpipe rotation and/or dogleg severity. As such, connection integrity becomes key to overall well integrity.

Today's ultra-deepwater wells require increasingly robust connections, the secure make-up of which necessitates levels of torque incapable of being sustained by conventional casing tongs. In response to this challenge, Frank's 18 in. High Torque Tong can achieve up to 175 000 lb-ft of torque and maintain output while imparting minimal stress to tubulars. The tool's gripping system entails three sliding jaws. Enabled by a dual-plane rotary gear and overlapping cam profiles, that configuration allows for a wide range of tubular coverage with only negligible penetration levels.

Having covered available measures to prevent or mitigate damage to casing while handling and installing, the next phase in protecting overall casing integrity and pressure rating is by limiting cumulative wear effects originating from contact with the drillstring.

Casing wear has long been an industry concern and subject of study. When viewed from an abrasive wear standpoint, it is typically controlled and minimised by fluid and solid lubrication means, using drilling fluid lubricity additives and consumable or sacrificial wear coatings.

Another effective way of mitigating casing wear and tear is the Drill String Torque Reducer (DSTR™) sub, an integral drillstring component consisting of a mandrel fitted with a bearing-supported, non-rotating sleeve (Figure 3). Originally designed to reduce torque-and-drag, the DSTR is now seeing a major new area of application due to the industry adopting a more critical perspective of casing wear to maximise well asset utilisation. The one-piece mandrel is made up to the drillpipe and has mechanical properties that exceed the specifications of the drillpipe, while the dual sleeve retention mechanism offers downhole reliability. The tool is designed to allow for high side loads to occur across the tool without compromising the supporting bearings between the rotating parts. Excessive side loads are carried by the rollers, and the angular contact ball bearings provide the primary means of axially locating the sleeve and limiting the end float. The sheer functionality of the roller bearing load-carrying capability and its low/near-zero friction signature provides a significant advantage over fluid/solid lubrication means. Further, the seals act as restrictors in their ability to reduce the amount of mud invasion into the bearing area.

In the Gulf of Mexico, DSTRs have frequently been used to prevent casing wear in upperhole sections, where deviations have created shallow doglegs. These hindrances can be introduced while jetting in the conductor, and, as such, are located immediately below the wellhead. Shallow doglegs may remain even when later installing additional 'nested' or telescoping casing strings, which imposes localised casing wear zones, the negative impact of which will permeate throughout the entire life of the well. Additionally, riser deflection due to rig positioning, wave currents and other factors may create further 'kinks' in the wellbore, thereby increasing localised side forces in an area that is already prone to aggravated casing wear.

There has been an increase in the observance of extensive side forces that have rendered fluid or solid lubrication completely ineffective and fail to provide the desired degree of protection. In fact, one operator went as far as to select the densest possible placement routine (i.e., three DSTRs per stand or one DSTR per joint) to maximise the attainable level of casing wear protection.

Even in this specific configuration, side force modelling revealed more than 10 000 lb-ft, which significantly exceeds the effectiveness of fluid or solid lubrication methods.

Frank's employs analytical software packages to identify points of drillstring contact and locations of higher side forces. For a given deviation profile, the applications programme assists in maximising the tool's performance by determining deployment in the critical sections of the borehole. For optimum effectiveness, the tool is best deployed in the build-up section of the deviated hole, which helps to extend the envelope of rotary drilling and provide for greater reductions in drilling torque than anywhere else in the hole. As indicated in Figure 4, Frank's provides simulations both with and without DSTRs made up in the string to show reductions in torque and casing wear.

DSTRs can also be a solution for heat-checking issues, a casing wear mechanism also known as surface fatigue. For a deepwater GoM application, Frank's utilised customer well data and provided torque and drag modelling and casing wear simulations for placement recommendations. Frank's dispatched a total of 99 6 5/8 in. DSTR subs to the customer's rig to aid in the prevention of heat checking. The tools, installed one sub per stand, were used on two 12 1/4 in. x 14 in. runs for a total of 3791 ft drilled. The tools prevented hazardous heat-checking, thereby eliminating the potential for compromised structural well integrity and saving the operator millions of dollars in non-productive time. This was proven by the customer performing a cut-and-pull

and ultrasonically testing the 14 in. casing, particularly where the DSTR subs had been utilised. The inspection showed no appreciable heat checking. In fact, as indicated in Table 1, nearly all of the 379 joints showed that at least 95% of the casing wall remained.

Tracking systems

In addition to embracing casing wear protection measures, the industry is attempting to adopt more active analytical tracking systems to prove and monitor their overall effectiveness. The equipment has been used successfully many times. However, if the given state of casing wear is not routinely checked, it becomes almost impossible to properly quantify the benefits of casing wear protection measures.

One must also consider the possibility of no casing wear protection plan being implemented or accounted for during the planning phase of the well construction process. For cases when unprotected casing suffers critical levels of damage, operators may require alternative solutions. In the process of drilling and completing a well for production, it is often necessary to isolate sections of formation and casing. Retrievable tools offer versatile and economical means to isolate portions of the well to perform remedial repairs that are, in some cases, due to casing wear. The Brute™ Packer (Figure 5a) from Blackhawk Specialty Tools offers these capabilities and is designed for general purpose high pressure and high tensile service work. The hydraulically-operated upper hold-down buttons anchor the packer with differential pressures from below, and the mechanical slips anchor the packer with differential pressures from above.

Incorporated with the Brute Packer is its Brute Heavy Duty Unloader Circulating Valve (Figure 5b), which is a locked-open/locked-closed valve that serves as both a circulating valve and bypass with the ability to withstand severe operating conditions. The large ports of the Brute Unloader provide a means of equalising the work string and annulus pressures, as well as a flow path above the Brute Packer. Multiple operations can be executed with the Brute Unloader Valve, including circulating or spotting fluids, circulating well debris, high pressure casing tests and reducing the surging/swabbing effect when running in tight tolerance applications.

When casing integrity becomes an issue within the wellbore, the Brute Packer and Unloader Valve can be set multiple times to identify the leak path. Once the leak path has been identified, the assembly can be picked up above the remedial zone. Remediation with a cement slurry can be performed to isolate the potential leak path. While the packer and unloader valves are in the set position above the remedial zone, circulation can be performed to place the cement slurry above the unloader valve prior to pumping below. Once the cement slurry is near the unloader, the valve is closed and the cement slurry is pumped into the wellbore below the Brute Packer, isolating the identified leak path. After cementing operations are complete and thickening time has been allotted, a casing pressure test can be conducted, ensuring casing integrity meets well design containment pressures.

Conclusion

From well planning through production, by implementing a range of well integrity safeguards as described, operators can reduce casing wear and help preserve and extend the life of the well, potentially resulting in lower maintenance costs and improved project economics. ■

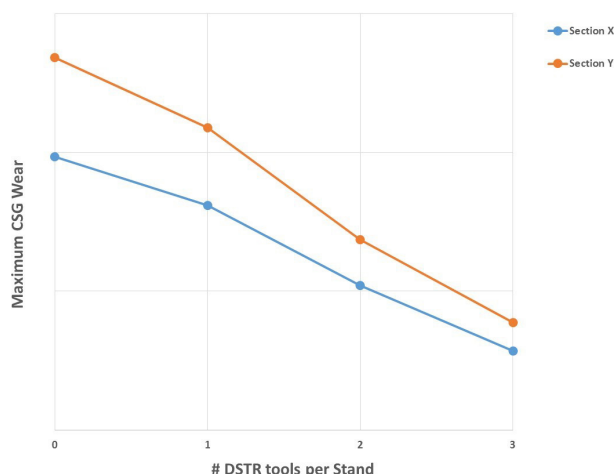


Figure 4. An example of Frank's simulation software.

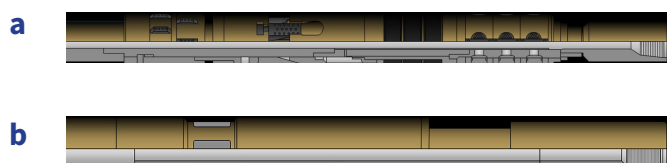


Figure 5. (a) A Blackhawk Brute Packer, and (b) a Heavy Duty Unloader Circulating Valve.

Table 1 - Casing wall thickness readings with DSTR subs

| Number of joints | Percentage of remaining body wall (RBW) |
|------------------|---|
| 373 | > 95 |
| 5 | 90 - 95 |
| 1 | 84.5 (inside diameter pitting) |