HOW YOUR TUBULAR STRING PROFILE COMPARES TO SURVEYS AND SOLUTIONS

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ABSTRACT

There is so much data being collected on each well site increasing the success to a company's maintenance program. When wellbore surveys identify hole deviations those specific areas can be targeted as potential premature failure points. These critical points down hole are many times found to be areas where problems initiate causing work-over shut downs. Nondestructive testing of tubing while pulling out of hole gives very essential sequential confirmation to the well's actual deviation situation. When correlating surveys to tubing profiles wear is an important element needed to analyze excessive rod on tubing wear making data very useful to assist with stroke control, rod guiding, reducing work-overs and decreasing well down times. The majority of wells, used tubing is not inspected it's just pulled and replaced when a well failure occurs. Nondestructive testing tubing in many ways provides valuable well information to know where leaks may have occurred.

INTRODUCTION

There are many artificial lift options being used with great designs and applications to optimize current production and ultimate recovery of the reserves. The sucker rod lifting process will be used for this paper and may not fit into all existing operating environments of each company. Operators in the mid 1980's requested the ability to know the approximate locations of tubing failures where rods wore away tube thickness until leaks occurred. The inspection (NDT) scanning of tubing while it is being "pulled out of hole" began in the attempt to locate the worst wear spots of tubing. The data collected is in sequential order of how the tubing is used downhole providing exact locations from top of well. Tubing inspection results are segregated into four common classification levels as per the API recommended practice 5C1 document identified by color bands. Inspected used tubing is painted by remaining wall thickness or referred to as wear, Yellow (0% to -15%), Blue (-16% to -30%), Green (-31% to -50%) and Red (-51% to -100%). The ability to correlate highest wear points of each length in the wellbore greatly increases the importance of visual tools, failure analysis, deviation surveys, and several other well aspects to recommend how to protect the tubing to last longer. An interactive computer program was developed in 1993 using a number of tools, like well plots, failure charts and side load charts all helping to identify and solve wear related problems by advising the proper tubing protection with empirical data in a rod guide advisory program. Well inspection results are stored per well name by lease and operator using very detailed graphs and charts showing the string profile with real-time data (snapshot) necessary to make accurate tubing and rod management decisions.

RECOMMENDATIONS

The artificial lift program known as Rod Guide Advisory Program (RGAP) is a rules based program using a long list of variables from well data, completions information, fluid properties and production targets in addition extra data such as SROD, RodStar and Deviation Surveys can be uploaded. Working with the applications engineer the recommendation will provide proper rod guide design, placement, and material selection which are all crucial to obtaining best overall performance for both beam and progressing cavity pump applications. Material recommendation uses several factors such as the presence of sands, xylene treatments, hot oil/water treatments, amount of paraffin and presence of corrosives CO2 and H2S to extend guide life. Tubing scans and caliper data of guides greatly improve the recommendation for a four (4) year run life goal that can be applied to the total well or specific zones and sections. Extending the recommendation to equipment would include a tubing rotator imperative to distribute eventual wear evenly protecting rods and tubing, sacrificing guides. Rod guide spacing, number per rod, guide design and placement of the guides in the rod string are very important for balance wear. The best rod guide design, identifies proper material, good placement, efficient number per rod, spacing of guides on each rod and tracking the results with future guide measuring and sequential tubing scans. RGAP has yielded greater results in highly deviated wells that were extremely difficult containing severe side loads and very short run times.

MEASURING

The measuring of rod guides while POOH is necessary to confirm and bridge results of provided recommendations. Knowing the amount of wear occurring to guides validates material and flow design. Compared with sideloads, stoke length contact in deviations allows for tweaking when required. Guide data in conjunction with tubing wear data from inspection and well deviation surveys really change how knowledge improves run times.

WELLBORE #1

In the first wellbore example used for this paper the guides were measured POOH and recorded identifying the amount of guide material loss in percentage by footage zones. At 1,250ft to 2,500ft there was an extreme amount wear measured more than 80% up to 100% of guide was worn protecting the tubing and reducing cost. At 2,500ft to 3,100ft no guide wear to only a minimum amount was measured, at 5,425ft to 7,000ft greater than 40% up to 100% of wear, at 7,400ft to 9,000ft measured greater than 80% to 100% guide wear. For the same well the Tubing scan of tube body wear results of the 328 total lengths were segregated into the four color groups of 189jts Yellow (58%) reusable, 52jts Blue (16%) typically not reused, 49 Green (15%)not used, 38 Red (12%) scrap, only yellow class tubing was returned into the wellbore. Noting all tubing failure locations and severe rod wear (wall loss) areas to correlate guide wear and well deviation survey.

RGAP #1 - Rod Guide Advisory Program

Rod Guide Advisory Program is a culmination of years of rod guide installations and inspection experience of guide failures. When designing a guided rod string focus must be on well conditions, work over histories, well deviations and knowledge of all considerations.

Start with wellbore deviations looking at inclination angles, dog leg severity in degrees and azimuth of hole. In this first wellbore example the maximum side load is 257lb @ 8693ft, maximum dog leg severity 1.69° @ 8693ft and maximum angle at 7.2° @ 8884ft these parameters are very important to formulate the proper recommendation to solve excessive calculates to receive the greatest amount of rod guides eight (8) per rod. Also very important is the guide's locations and spacing to maximize the rod support and tubing protection.

WELLBORE #2

In the second wellbore example used for this paper rod guides were used for total depth. All guides were measured POOH and recorded sequentially identifying the amount of guide material loss in percentage by footage zones. At 850ft to 3,100ft there were no guide wear to only a minimum amount measured, no wear to less than 25%, at 5,500ft to 6,900ft minimum guide wear up 40%, at 6,9005ft down to 10,100ft with heavy wear greater than 40% up to 100% wear saving the tube thickness. For the same well the Tubing scan of tube body wear results of the 318 total lengths were segregated into the four color groups of 279jts Yellow (88%) reusable, 37jts Blue (12%) typically not reused, 2 Green (1%) not used, 0 Red (0%) scrap, only yellow class tubing was returned into the wellbore. Noting all tubing wear was minimum with little to no rod wear (wall loss) areas.

RGAP #2 - Rod Guide Advisory Program

RGAP recommendation guided the entire well from the extreme variables of wellbore deviations looking at inclination angles, dog leg severity in degrees and azimuth of hole. In this second wellbore example the maximum side load is 533lb @ 9,200ft, maximum dog leg severity 3.24° @ 9200ft and maximum angle at 11.88° @ 7000ft these parameters are very important to formulate the proper recommendation to solve excessive tubing wear and premature work-overs. Specific number of guides were recommended with some zones to receive four (4) guides per rod and other zones used eight (8) guides per rod. This well shows how proper guide material, design, location and spacing are so very important to maximize the rod support and tubing protection, 88% of the string was reused with 12% lightly worn.

CONCLUSION

Wear prevention of tubing and sucker rods is very important since it can be as much as 85% of well maintenance cost not including rig time and loss production. The goal is to use the proper guide types for extended life with less drag and wide vanes for fluid flow protecting tubes and rods. Wellbore #1 had a very large amount of tubing lost in the zones of the well that had no guides for protection, 58% of tubing was reused with 42% of tubing loss and not reused due to excessive wear (wall loss). RGAP tweaked the recommendation using empirical data recorded and the follow-up scan showed 77% of tubing was saved and only 23% of tubing string was loss due to wall loss. Wellbore #2 was a more aggressive well with 533lbs of sideloads using rod guides for protection for the complete depth of well. A good amount of tubing stayed protected in the severe zones, 67% of tubing was reused with 33% of tubing was loss and not reused due to wear (wall loss). After RGAP recalculated values measured the recommendation was verified with the

follow-up scan showing 88% of the string was saved and only 12% of tubing string was loss. These are just two wellbore examples used for this paper with 1000s of wells that have been helped with protecting rods and tubing extending run times, reducing loss production and saving millions of dollars in good quality well maintenance programs. This is how your tubular string profile compares to surveys and solutions.

ACKNOWLEDGEMENTS

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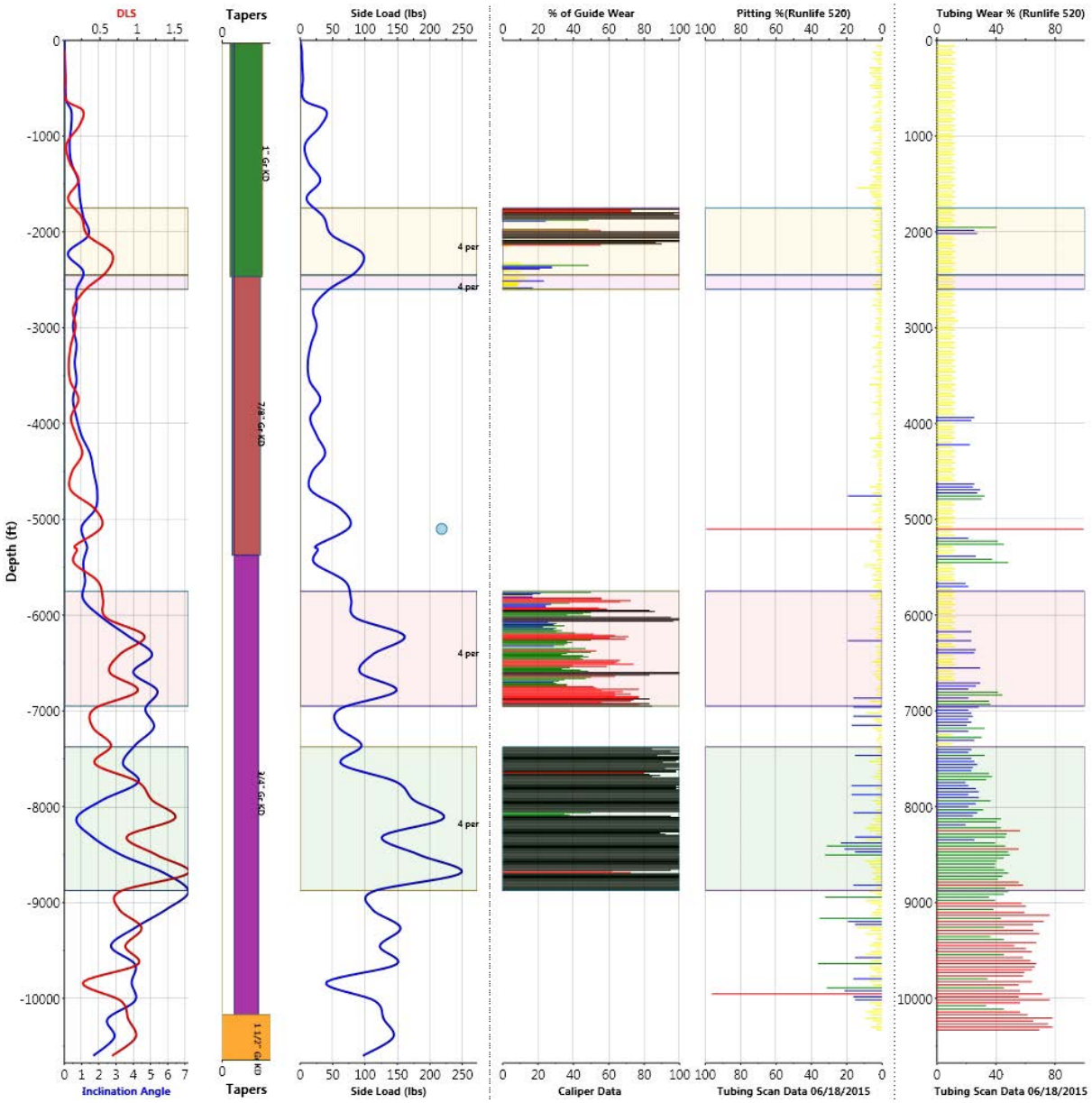
REFERENCES

1. Hilton Prejean "Your Tubular String – Know Its Fit for Service with NDT Techniques" SWPSC 2014-041

Example Wellbore #1 - Comparison Page



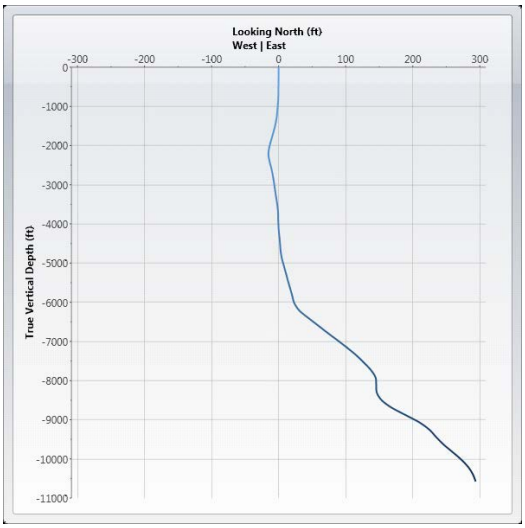
ZONE FACTS

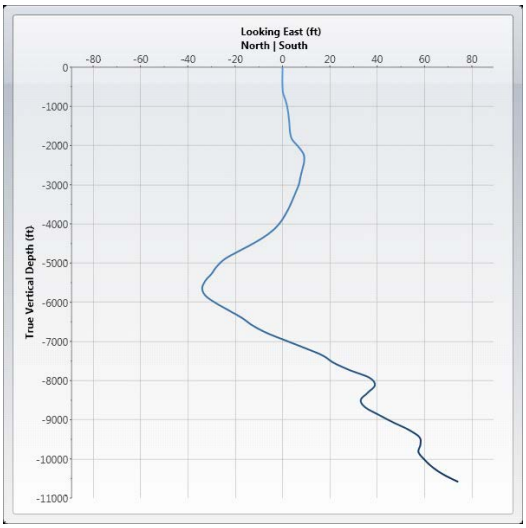
Max Values

Max SideLoad	257 lb @ 8693 ft
Max Angle	7.2° @ 8884 ft
Max DogLeg	1.69 @ 8693 ft

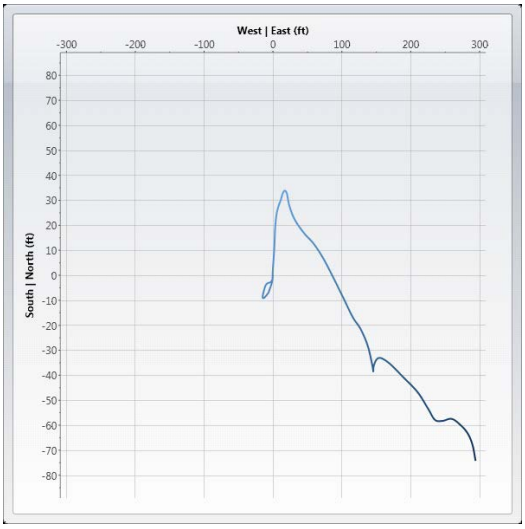
Tubing

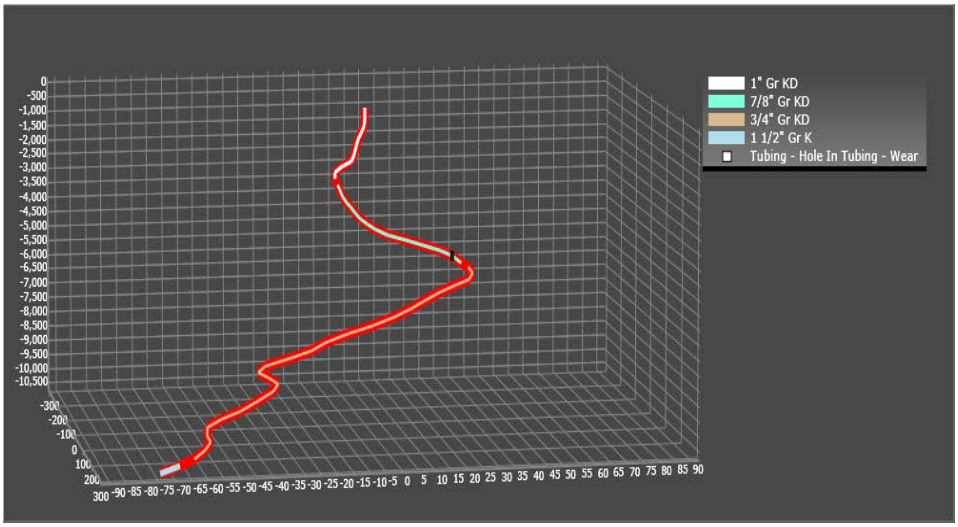
Example Wellbore #1





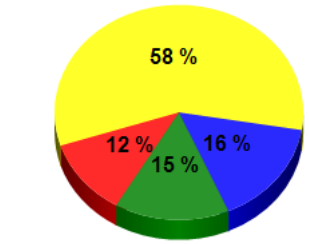
Top View



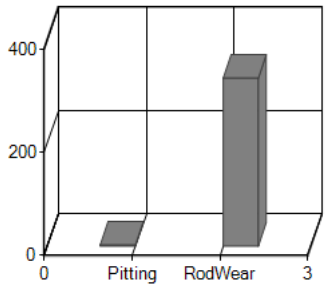


Example Wellbore #1

Tubing Scan Results – June 2015 (First)

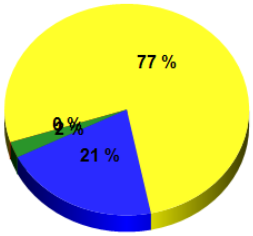


58 % 189 of 328
16 % 52 of 328
15 % 49 of 328
12 % 38 of 328

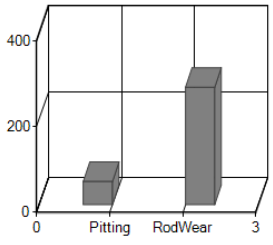


Pitting 2 of 328 (0.61%)
Rodwear 326 of 328 (99.39%)

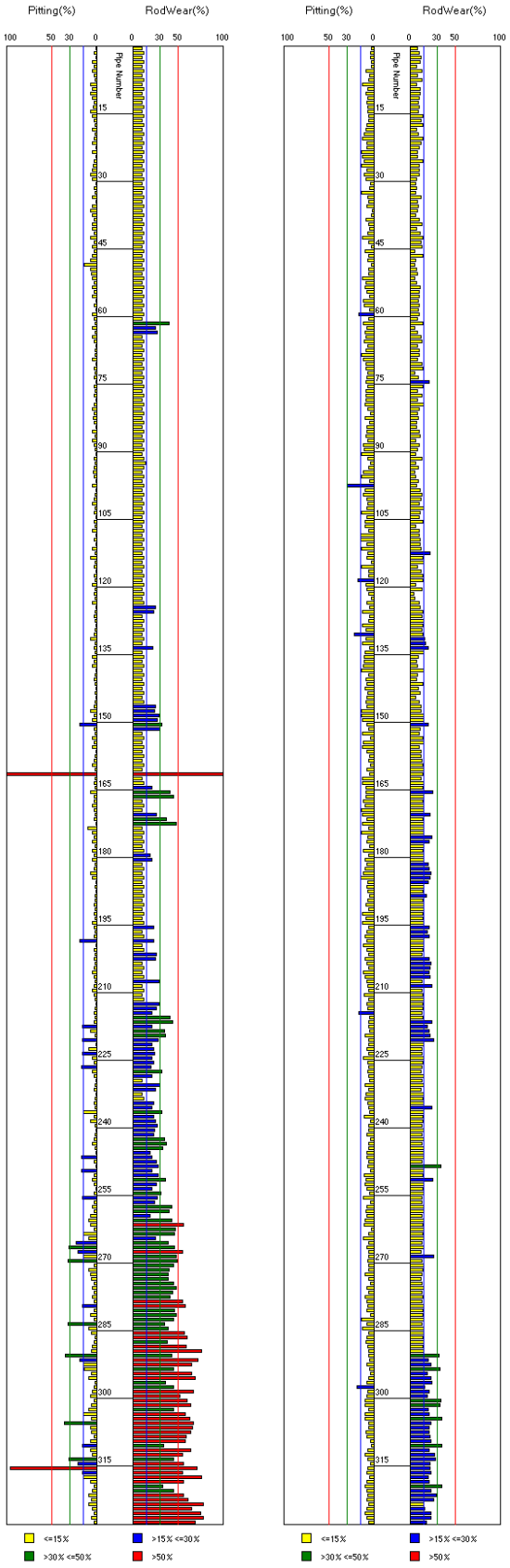
Tubing Scan Results – October 2015 (Follow-up)



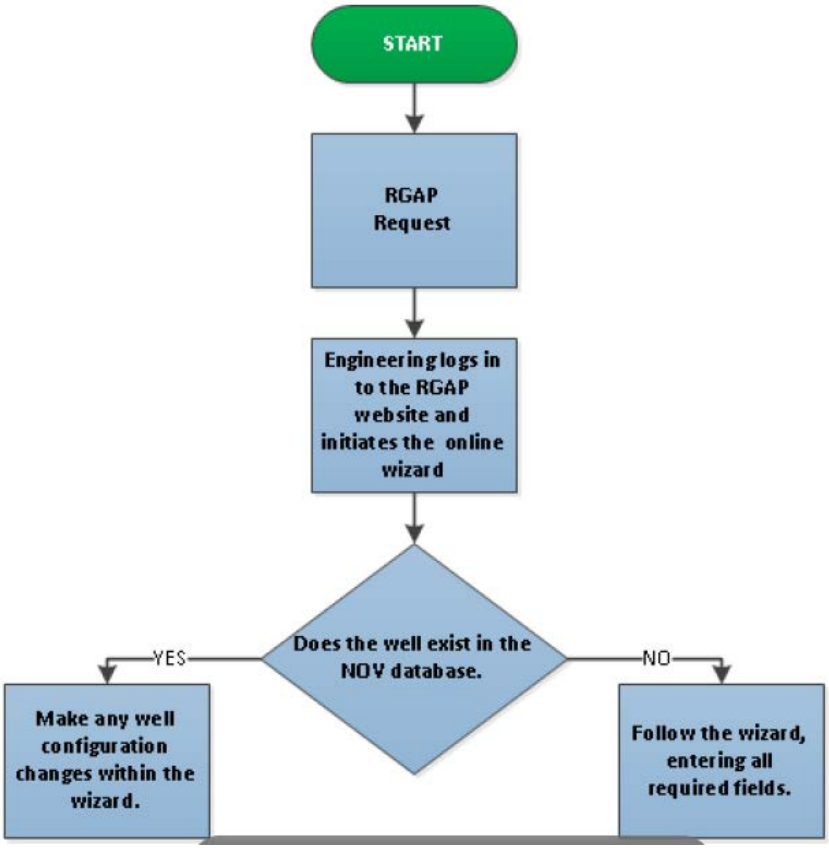
77 % 252 of 328
21 % 68 of 328
2 % 8 of 328
0 % 0 of 328



Pitting 54 of 328 (16.46%)
Rodwear 274 of 328 (83.54%)



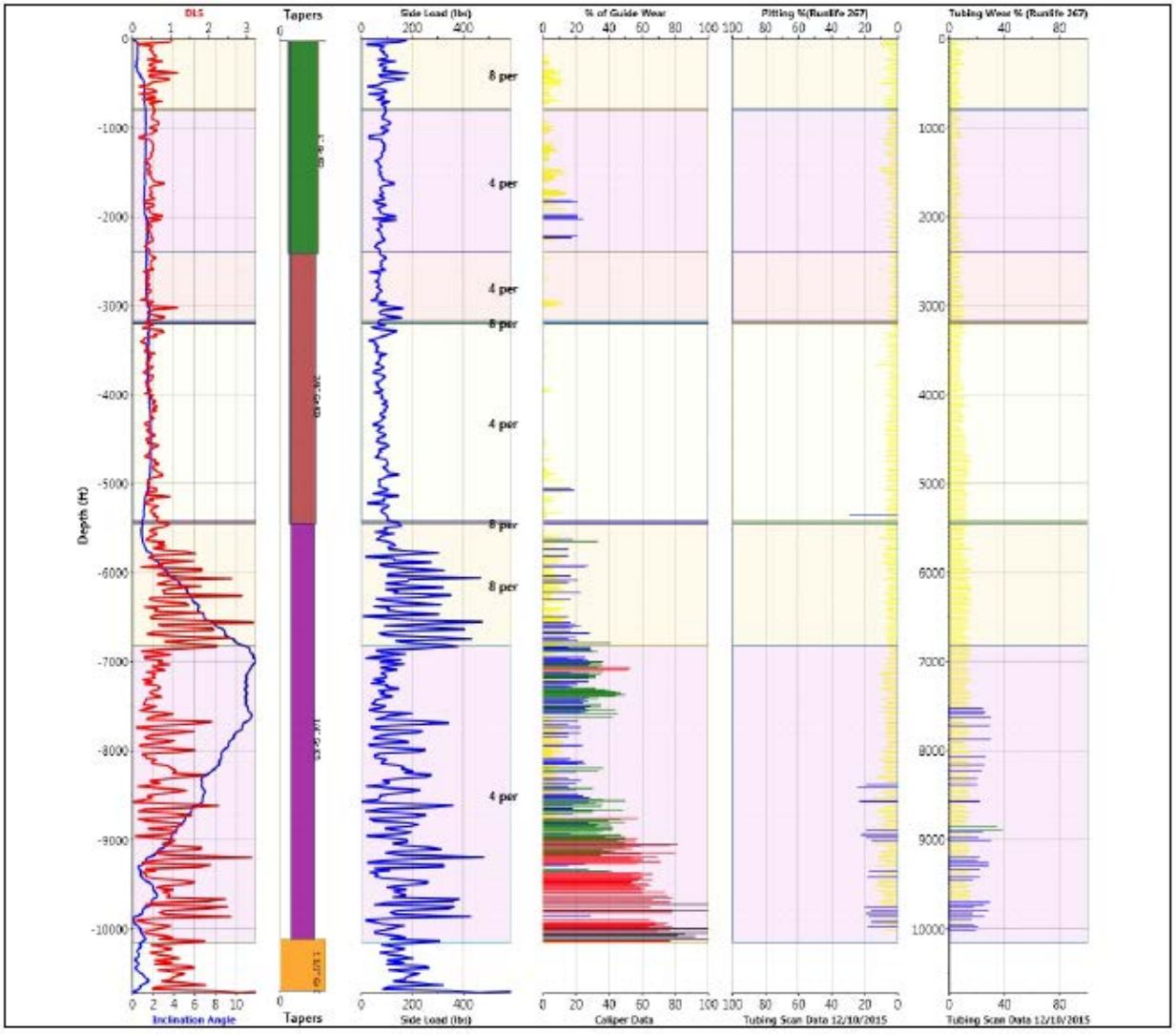
RGAP - Rod Guide Advisery Program
Work Flow



Rules of RGAP

Side Load	Abrasives
Inclination	Corrosion
Azimuth	Paraffin
Dog Leg Severity	Treating Chemicals
Wear Related Failures	Fiberglass Rods
TAC Buckling Depth / Setting	Coated/Lined Tubing
Rod Neutral Point	Tubing Scan
Rod Buckling	Rod Guide Caliper Report
Fluid Properties	Previous String Design
Temperature (MAX)	Coupling Size/EWV

Example Wellbore #2



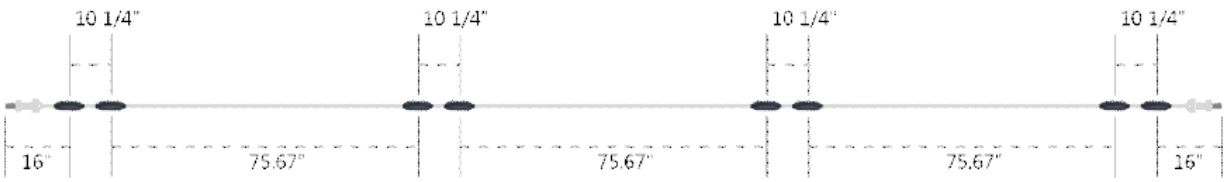
ZONE FACTS

Max Values

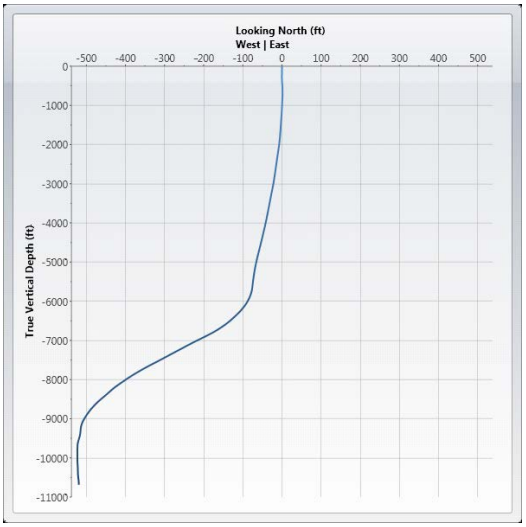
Max SideLoad	533 lb @ 9200 ft
Max Angle	11.88° @ 7000 ft
Max DogLeg	3.24 @ 9200 ft

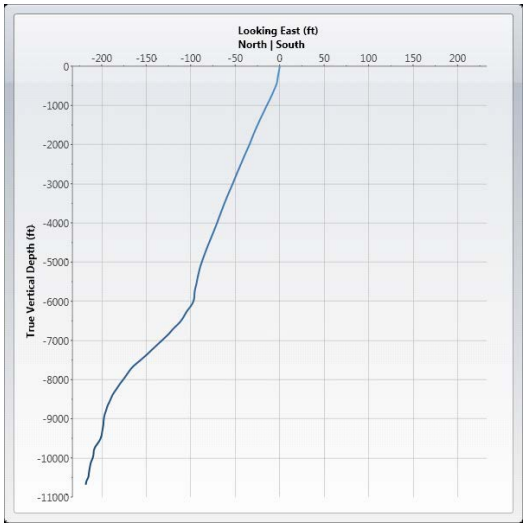
Tubing

Tubing	2 7/8", 6.4 lb/ft

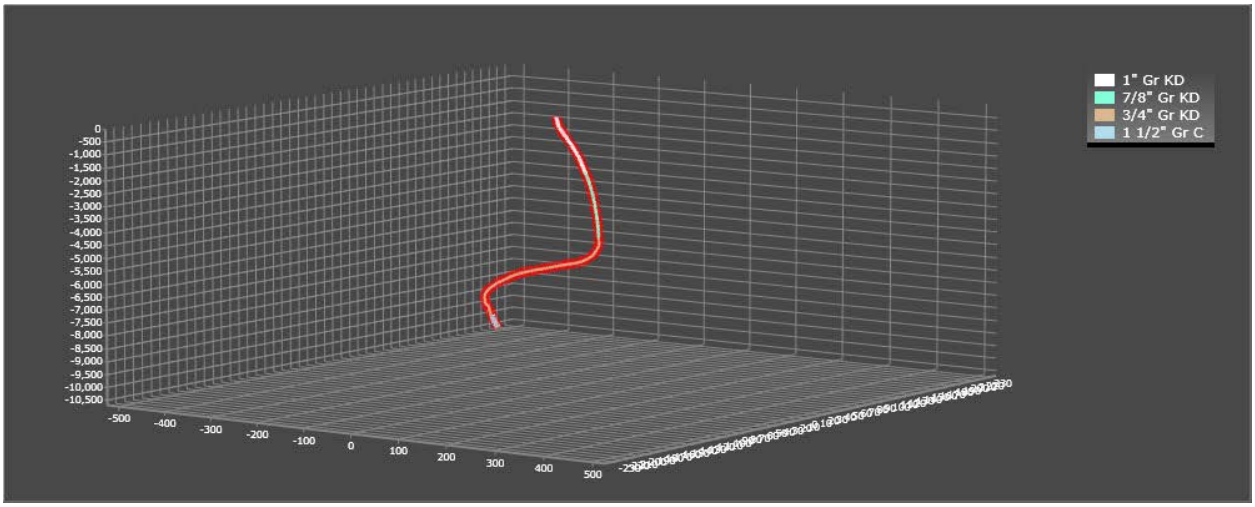


Example Wellbore #2



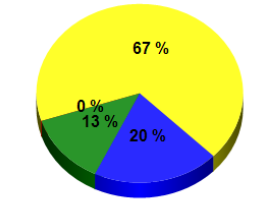


Top View

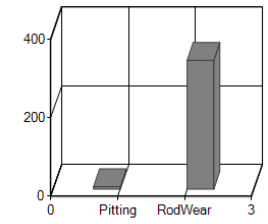


Example Wellbore #2

Tubing Scan Results – April 2014 (First)

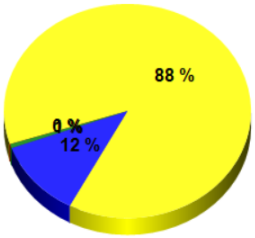


67 % 225 of 334
0 % 0 of 334
20 % 66 of 334
13 % 43 of 334

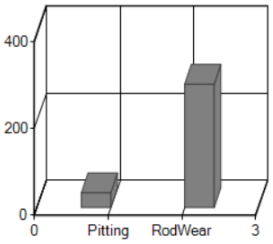


Pitting 6 of 334 (1.8%)
Rodwear 328 of 334 (98.2%)

Tubing Scan Results – December2015 (Follow-up)



88 % 279 of 318
1 % 2 of 318
12 % 37 of 318
0 % 0 of 318



Pitting 34 of 318 (10.69%)
Rodwear 284 of 318 (89.31%)