

Performance of Special Sucker Rod (AlphaRod® CS) After 5 Years of Field Experiences Worldwide



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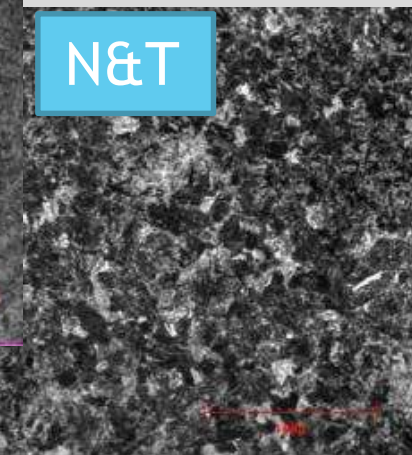
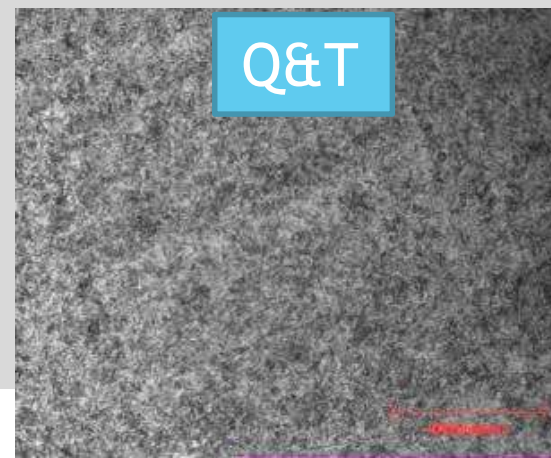
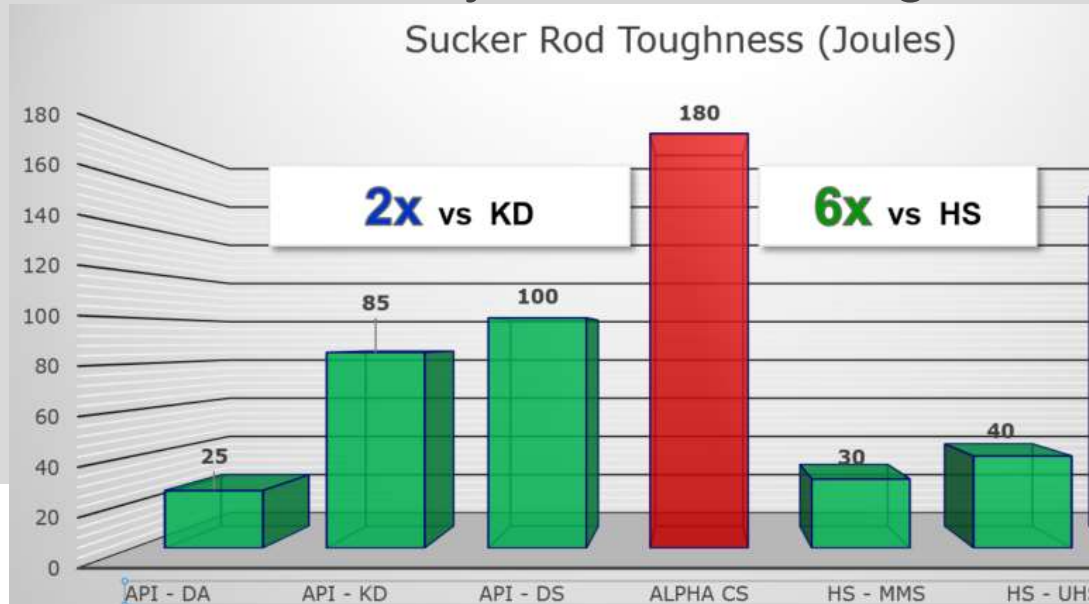
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Background



(2017) Paper #**SPE-184899-MS** • **Development of a Fatigue Corrosion for Sucker Rods**
M. Bühler, F. Camara Guillet, E. Lopez, M. Pereyra, Tenaris

- ▶ It was born as an R&D project in year 2014
- ▶ First installs in Argentina in 2015 and in the USA in 2016
- ▶ Unique alloy and heat treatment
- ▶ Strong market pull for a high % martensitic Q&T rod grade
- ▶ Value proposition focused on Corrosion Fatigue
- ▶ Dramatically increased toughness* compared to other grades:



* Toughness defined via the Charpy Impact Test – ASTM A370

Considerations

- Almost 250 wells furnished with AlphaRod in four countries: Argentina, USA, Canada and Romania
 1. Our rod alone
 2. Our rod taper combined with other grade taper (High Strength or API)
 3. Our rod taper with FiberGlass taper
- Main comparison parameters are loading, runlife and corrosion level
- Agree with operator on improvement goals. Most commonly a runlife multiplier
- Previous installs include API and non API grades: D, KD and HS4138

Load Level	Low	Med	High
% Goodman of Our rod CS SF 0.9	0-60	61-80	>81
Reference to D Grade Mod Goodman	0-90	91- 129	>130

- Wells were classified under corrosion criteria obtained from failures and fluid analysis expressed in terms of H_2S , CO_2 , bacteria content. Chlorides were included as corrosion accelerator.

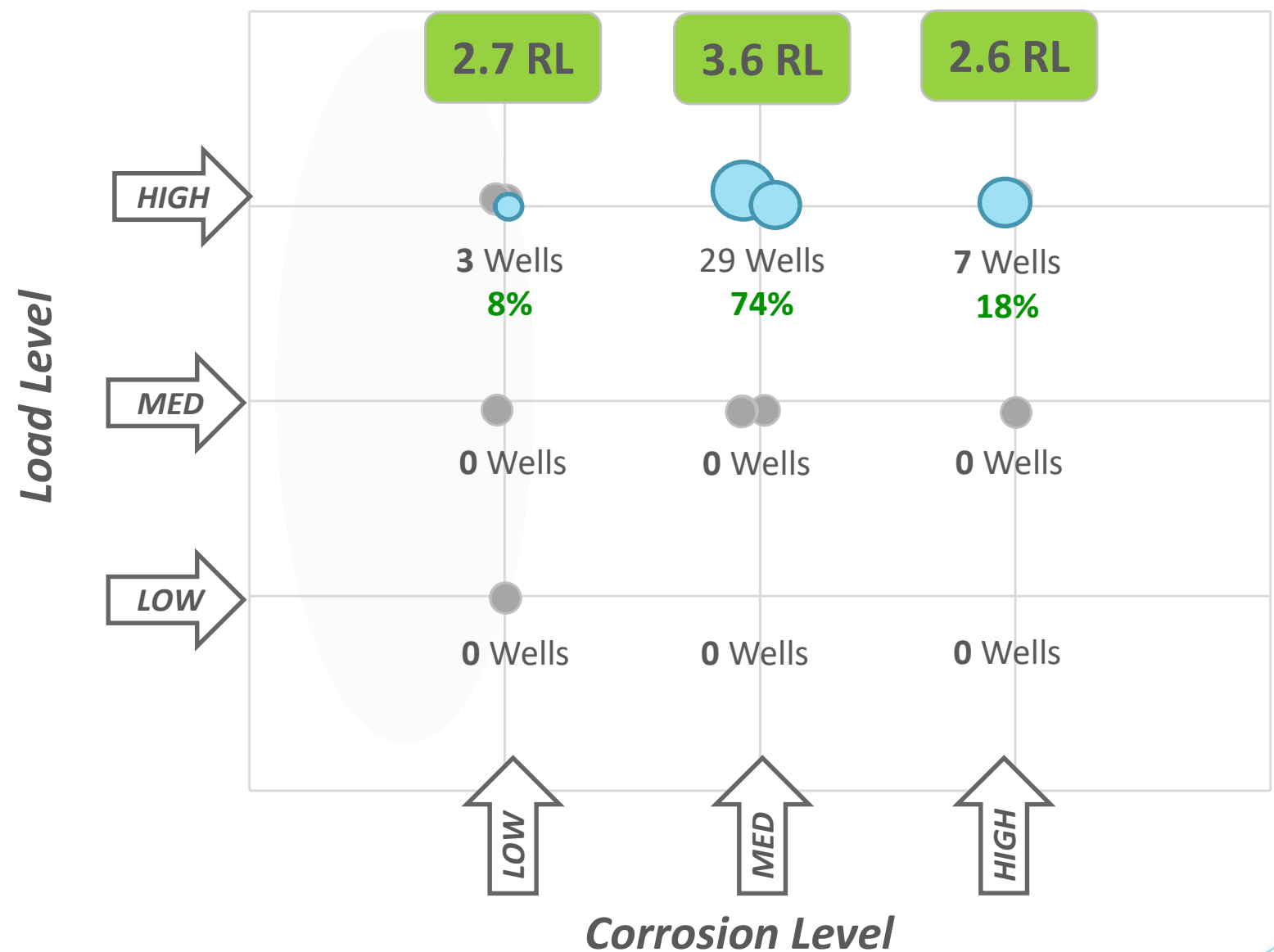
Our rod CS | USA

- ▶ Largest volume of AlphaRod dispatched in the world
- ▶ 250 direct installs and approx 150 through distributors
- ▶ Data analysis over 140 installs
- ▶ Previous installs were D, KD and HS4138
 - ▶ High occurrence of corrosion fatigue
- ▶ Customers targeting a runlife increase of at least double up

Application Profile	USA	
	Bakken	EF/ Permian
Oil Production Scheme	UR	UR
Depth [ft]	8,000- 10,000	5,700- 9,500
Production [bfpd]	150 - 300	200 - 420
Max Loads [lbs]	41,000	33,000
Previous Grade	HS4138	API D, KD, HS4138
Dominant Corrosion Level	Mid	High

Our rod CS | USA - BAKKEN

WELLS DISTRIBUTION – x RL Improvement



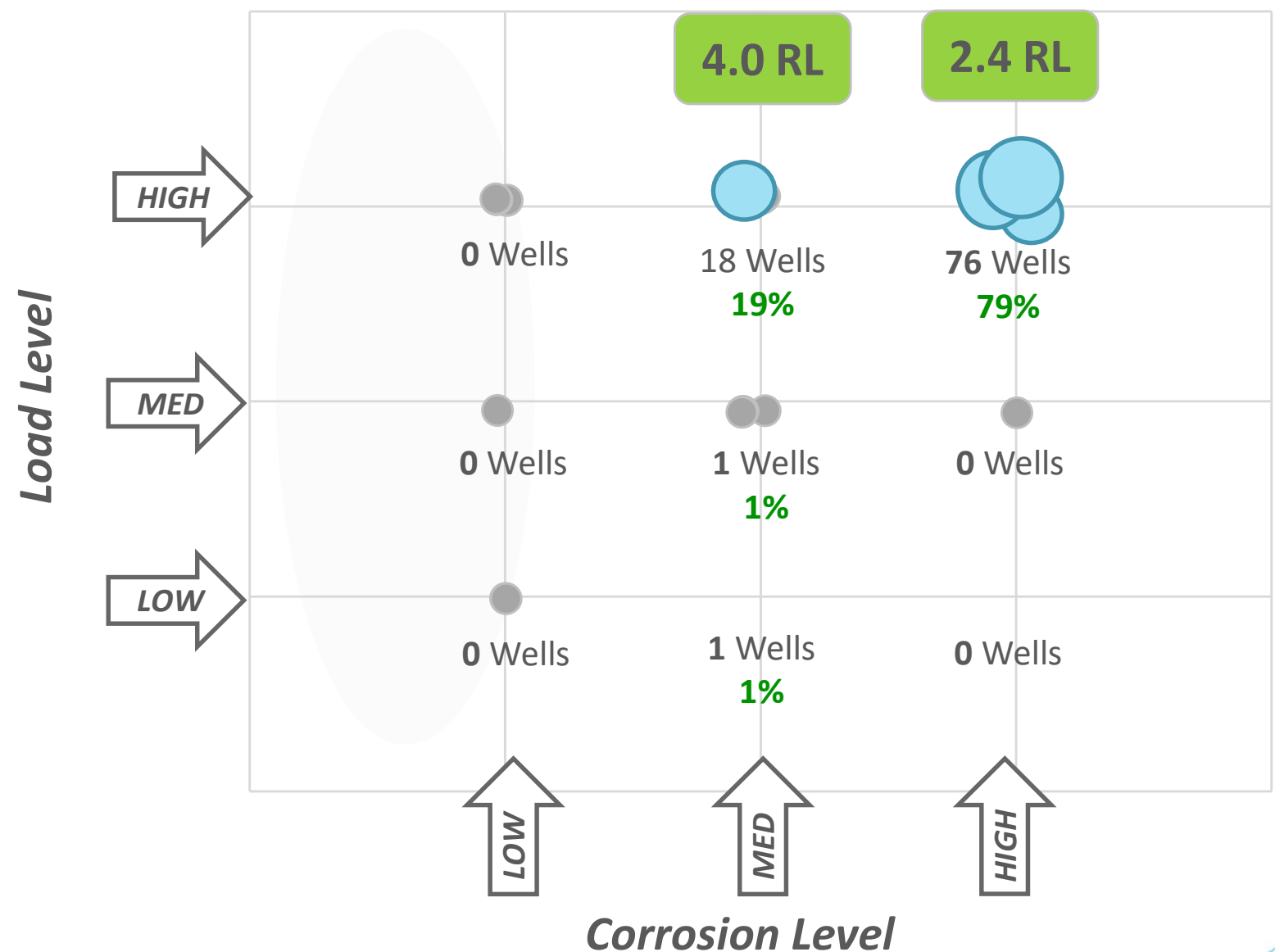
+ 92% of wells with medium-high corrosion level

Strong performance in spite of heavy loading

Mostly compared to HS4138 previous installs

Our rod CS | USA – EF/Permian

WELLS DISTRIBUTION – x RL Improvement

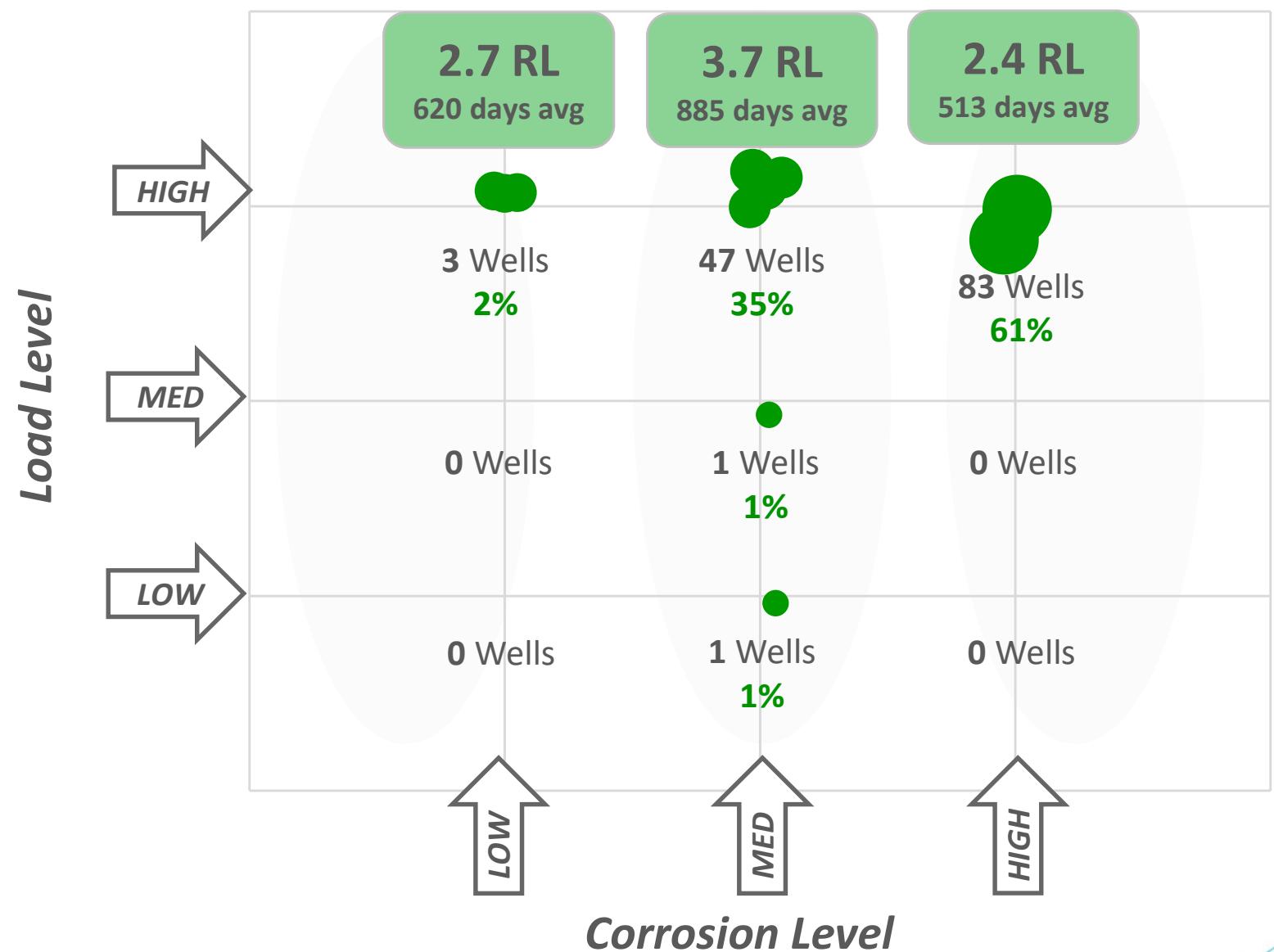


Strong performance in spite of heavy loading

Compared to D, KD and HS4138 previous installs

In some cases production increased and in other cases lightened the string from 86 to 76

WELLS DISTRIBUTION – x RL Improvement



+ 98% of wells with medium-high corrosion level

Higher working loads vs all other regions

Our rod CS | Argentina

- ▶ 2nd largest volume of AlphaRod dispatched in the world
- ▶ More than 100 installs
- ▶ Data analysis over 40 installs
- ▶ Previous installs were D and HS4138
 - ▶ High occurrence of corrosion fatigue
 - ▶ Avg 2 fail/yr
- ▶ Goal was improving standard rod performance and offer an increased reliability in aggressive environments

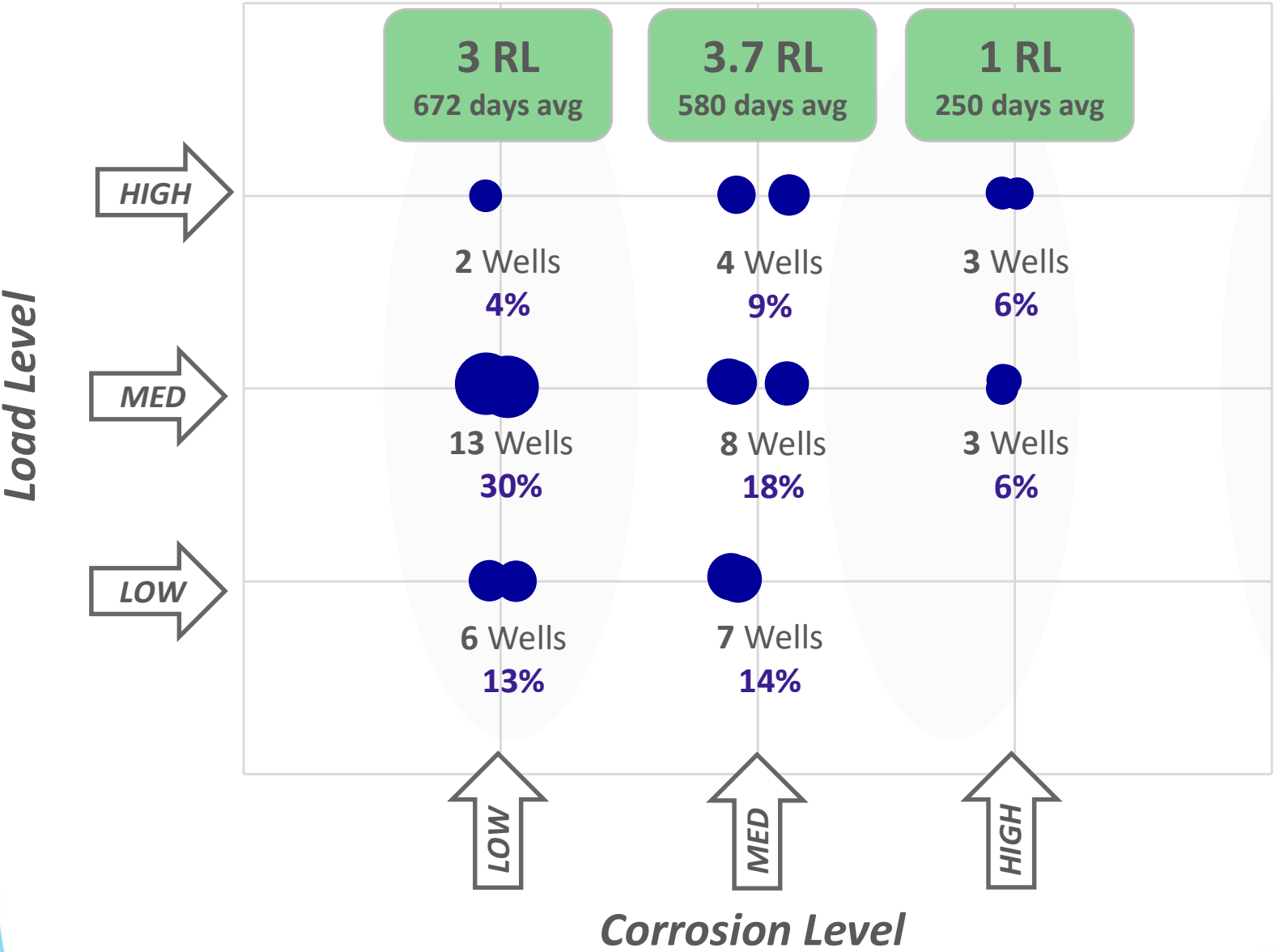
Artificial Lift
R&D Council



	Argentina
Application Profile	Cerro Dragón/El Trebol
Oil Production Scheme	Conventional/Secondary
Depth [ft]	6,000-8,000
Production [bfpd]	230 - 350
Max Loads [lbs]	25,000
Previous Grade	API D/HS4138
Dominant Corrosion Level	Mid

Our rod CS | Argentina

WELLS DISTRIBUTION – x RL Improvement



High Corrosion level Wells didn't show improvement on runlife

Premature failures occurred in the High Corr level in presence of bacterial activity and CO₂

Our rod CS | Canada

- ▶ Data analysis over 40 installs
- ▶ Previous installs were D and HS4138
- ▶ Goal was improving D grade performance and offer an increased reliability in high load applications

Artificial Lift
R&D Council



Application Profile	Canada
	Bakken
Oil Production Scheme	UR
Depth [ft]	5,500-6,000
Production [bfpd]	250-400
Max Loads [lbs]	39,000
Previous Grade	D, HS4138
Dominant Corrosion Level	Mid

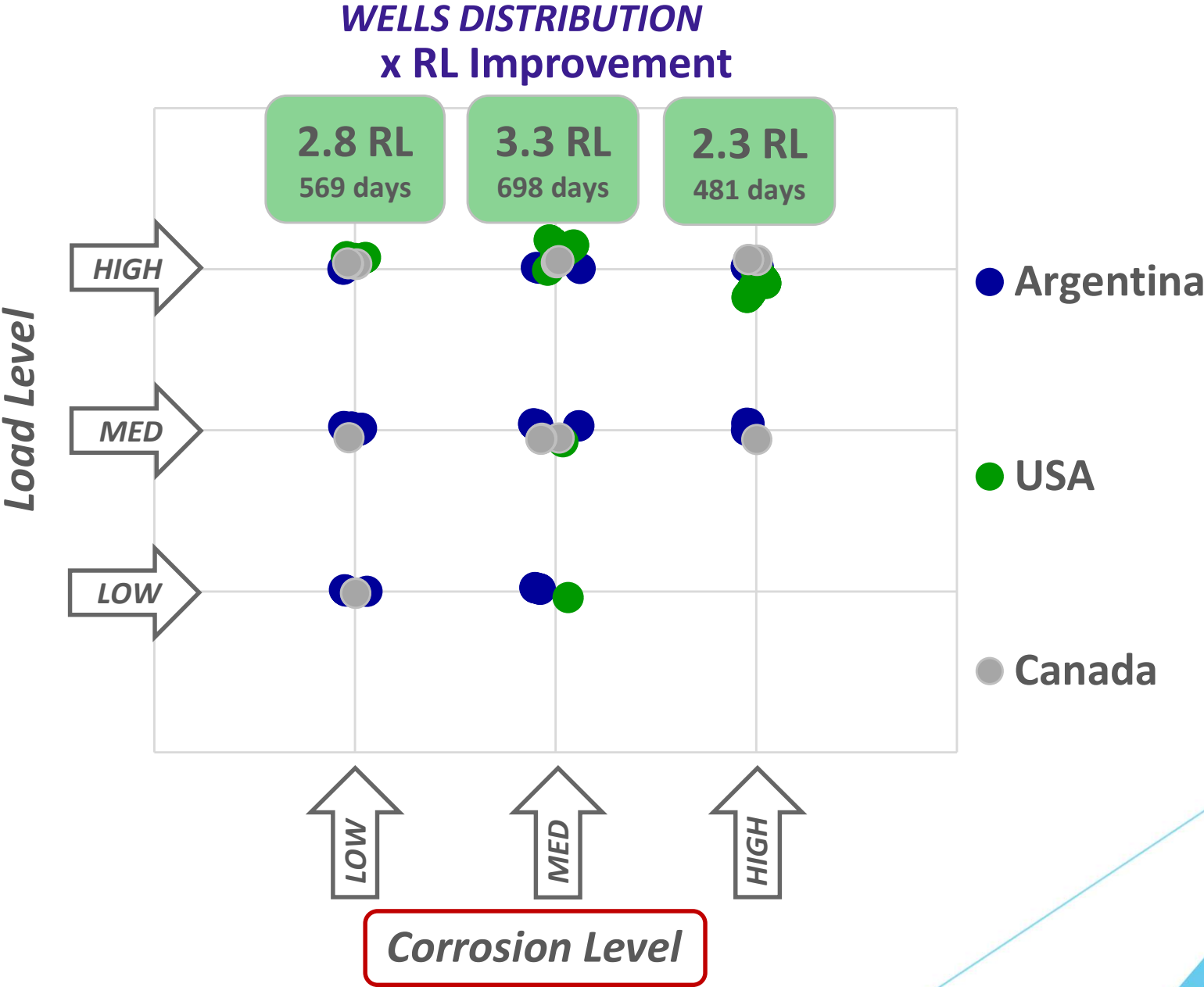
WELLS DISTRIBUTION – x RL Improvement



+ 95% of wells with low-mid corrosion level

100% of failures occurred on body, and +60% of these were located on the upset/near-upset.

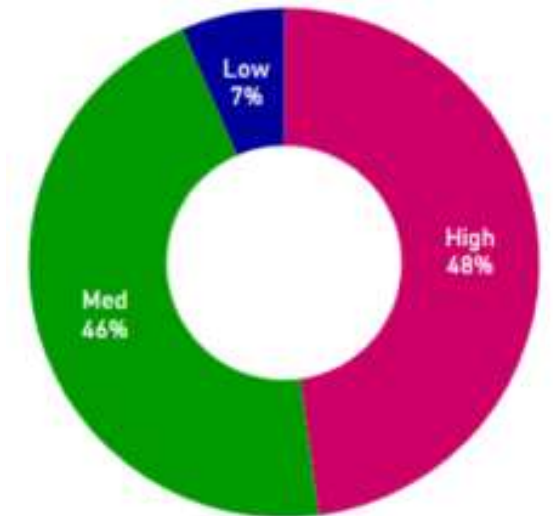
Our rod CS | Worldwide



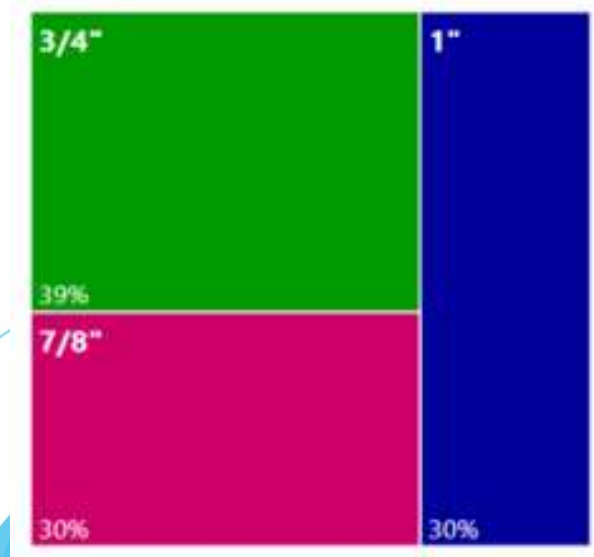
Our rod CS | Failures Highlights

- ▶ Analysis of events where $RL_x < 1$
- ▶ >90% are Mid-Hi corrosion level
- ▶ Interestingly, a high % in the $\frac{3}{4}$ " taper
- ▶ Several events of Corrosion Assisted Fatigue due to erosion washout in guided rods
- ▶ Corrosion Assisted Fatigue in wells where operator attempted to reduce or eliminate corrosion inhibition program

Failures by Corrosion Level



Failures by Rod Diameter



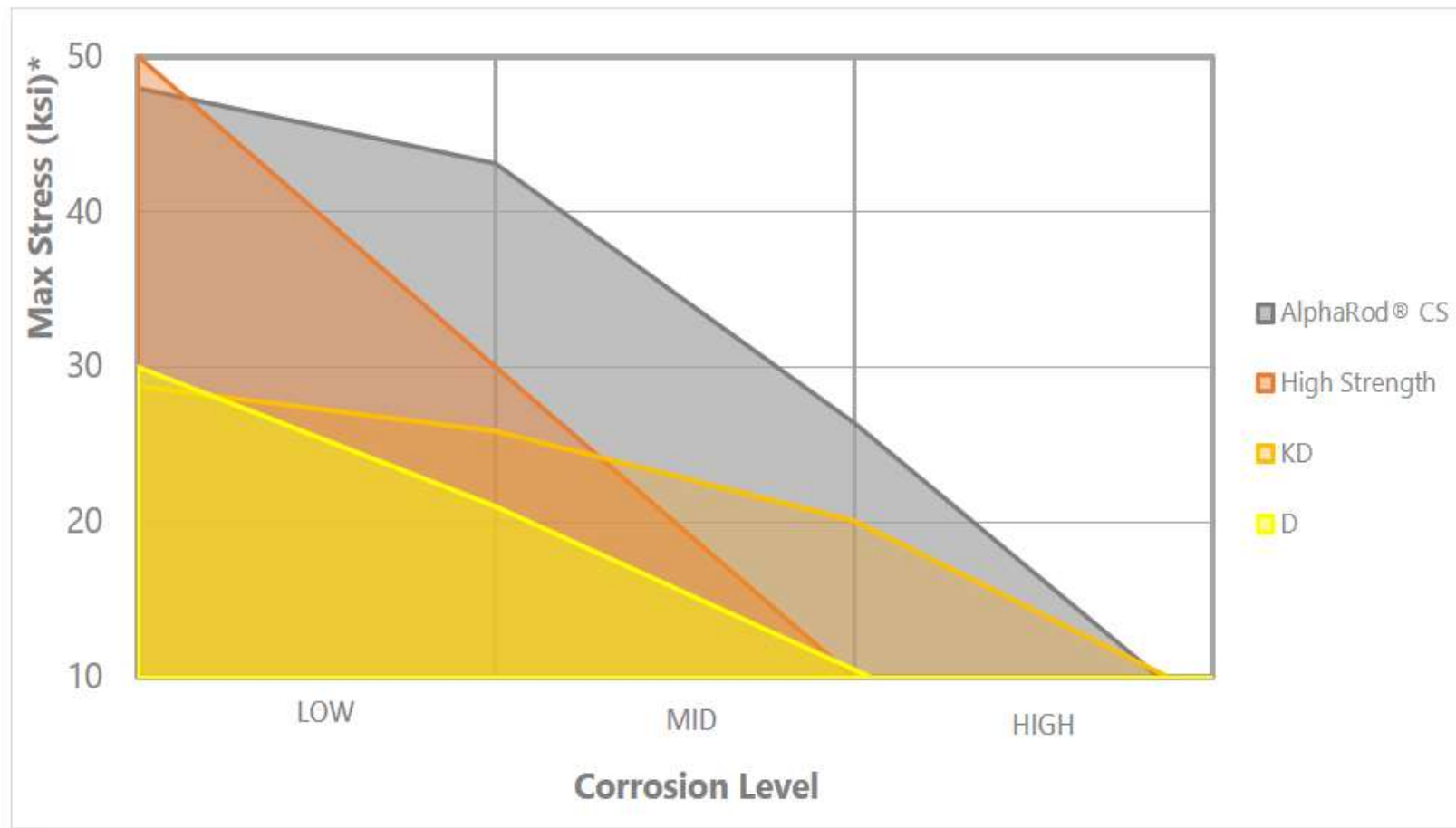
Our rod CS | Conclusions



- ▶ USA experience showed that we can push Our rod CS up to 80% of High Strength Goodman
- ▶ Our rod is capable of replacing D, KD and HS4138 rod grades in low, medium and high corrosive level wells, and create value by:
 - ▶ Increasing rod reliability
 - ▶ Reducing rod string weight
 - ▶ Reduce OPEX and production losses in remote or seasonal access locations (Canada)
- ▶ Runlife increase differs mainly between the USA vs all other countries:
 - ▶ Need to further understand the differences of the HIGH level corrosive environments between those regions
 - ▶ What are the corrosion inhibition practices in each one of those regions?
- ▶ Corrosion inhibition programs must be properly designed and cannot be eliminated upon the incorporation of Our rodCS

Our rod CS | Conclusions (cont)

- ▶ As we learn from the increased installation base, we can move forward into more accurate application guidelines:



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Q&A