quantiam technologies inc.

Q-Tough

Field Trial Testing of Q-Tough Wear Resistant Production Tubing

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Quantiam Technologies Inc.

Quantiam Technologies develops and commercializes disruptive new products based on Advanced Materials, Catalysts, Coatings and Surfaces

Petrochemical

- **CAMOL™:** Anti-Fouling Coatings for Olefins
- **SGX:** Super Coke Gasification
- **Inert-1300:** Inert at extreme temperatures

CleanTech & Alternative Energy

Green Chemistry

- Green H_2 (Water Splitting)
- Green Fuels (CO_2 Splitting)

Methanol+

- Captured Carbon Conversion

Oil & Gas and Oil Sands

Wear and Corrosion Resistant Coatings

- Internal tube surfaces
- External surfaces
- Complex Geometries

Aerospace & Defence

- High Temperature Wear & Corrosion Coatings for Weapon Barrels
- Ballistic Protection for Personnel and Vehicles

Applied R&D and Advanced Manufacturing

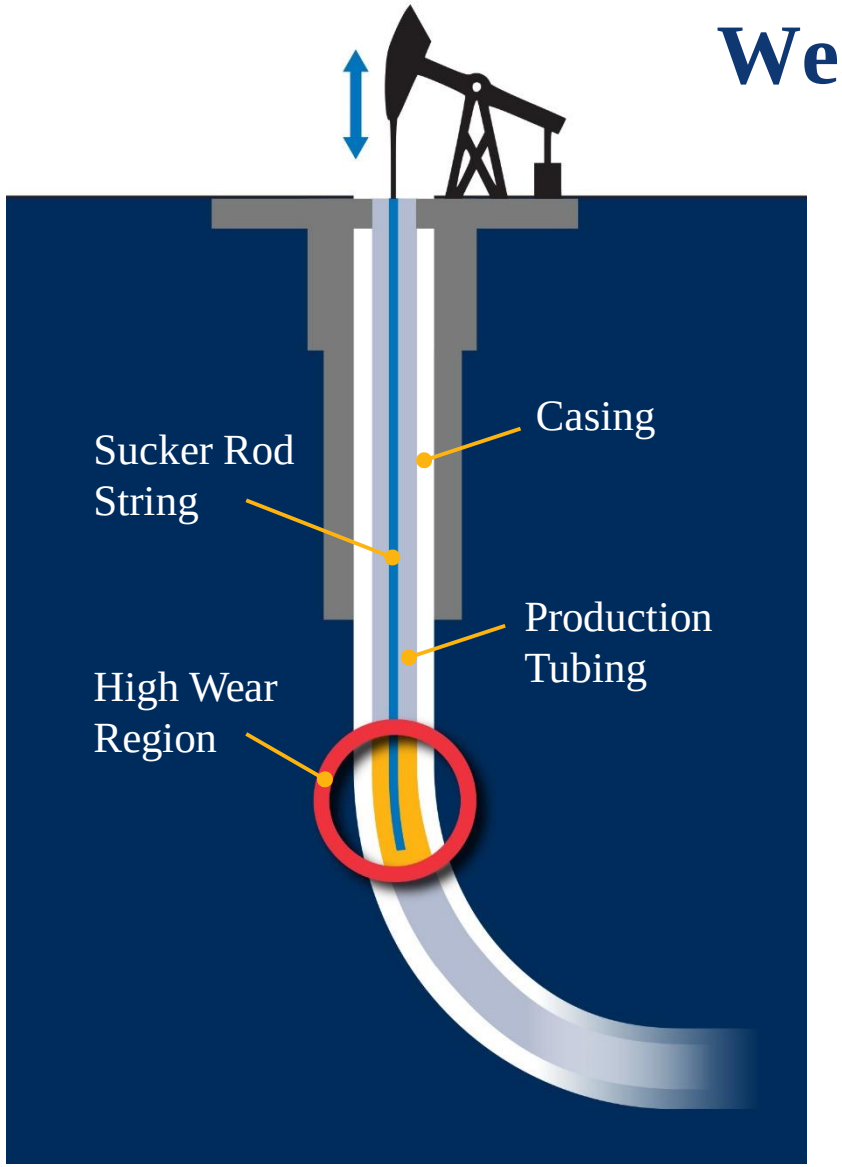
Quantiam has extensive in-house materials development, characterization and advanced manufacturing facilities

Manufacturing Technology Platform

Quantiam's cost-effective, proprietary coating manufacturing platform provides:

1. Non line-of-sight deposition (**internal, external or complex geometries)**
2. **Metallurgical bonding** for superior adhesion
3. Micro-composite structure for **excellent toughness and thermal shock resistance**
4. Macro coating thicknesses ranging from **50µm - 1mm (0.002″ - 0.040″)**
5. Part lengths up to 15 feet long
6. Compatibility with a wide variety of steels and other alloys
7. **Customizable**

Wear challenges in unconventional wells



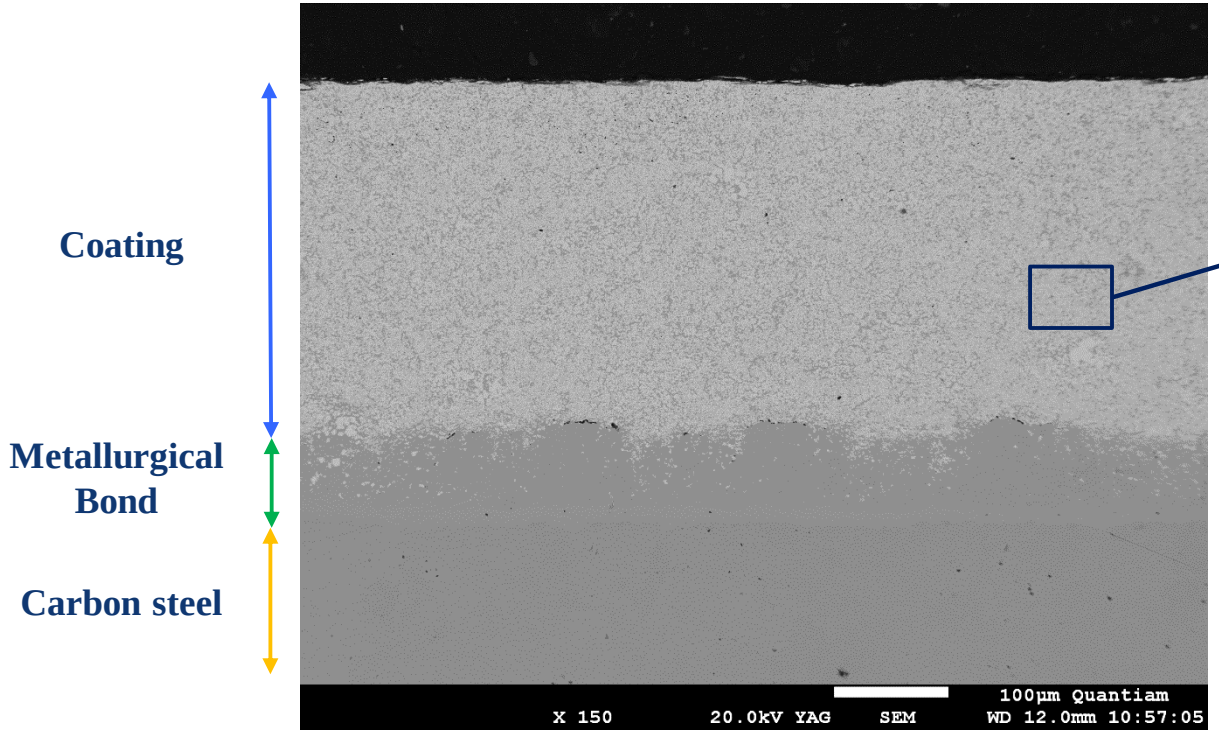
- High costs are driven by the frequency of wear-induced failures and the cost of workovers.
- Sliding wear between the sucker rod and the inside of production tubing is among the most common causes of failures.
- Q-Tough was developed to address this issue and has been successfully field trialed in the Bakken region of North Dakota.

Q-Tough

Q-Tough was developed to solve wear challenges in production tubing

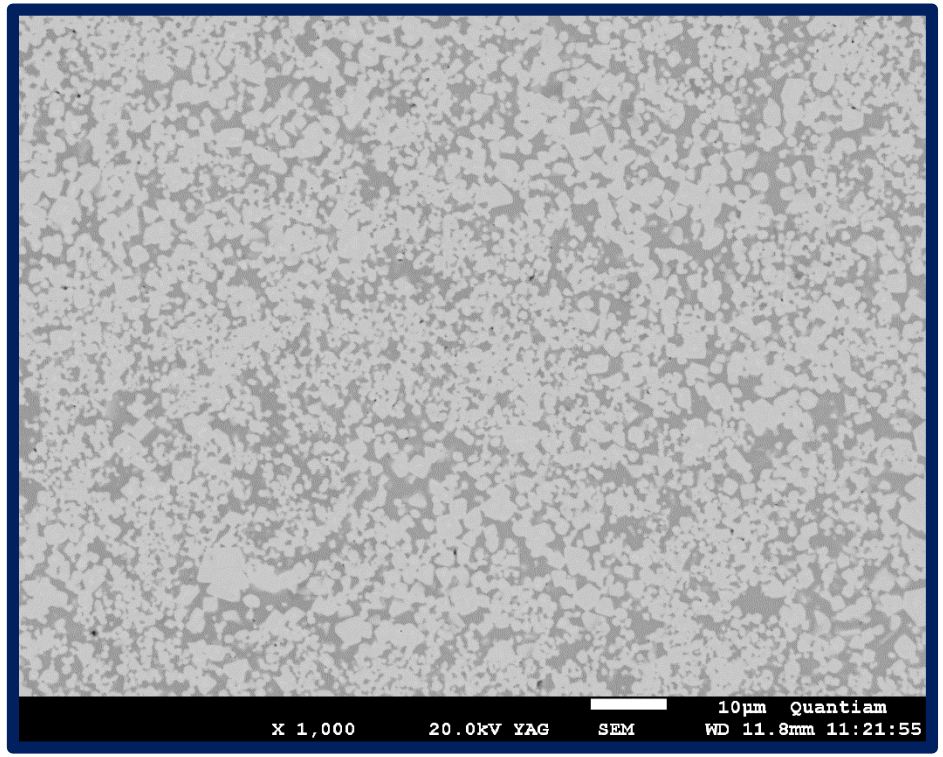
- Cost-effective **non-line-of-sight** deposition process
- **High toughness** eliminates special handling
- **Smooth surface finish** and **unique composition** enables long runtimes **without accelerating wear of other components**
- Lab and field trial testing validates performance

Q-Tough



Metallurgical bonding

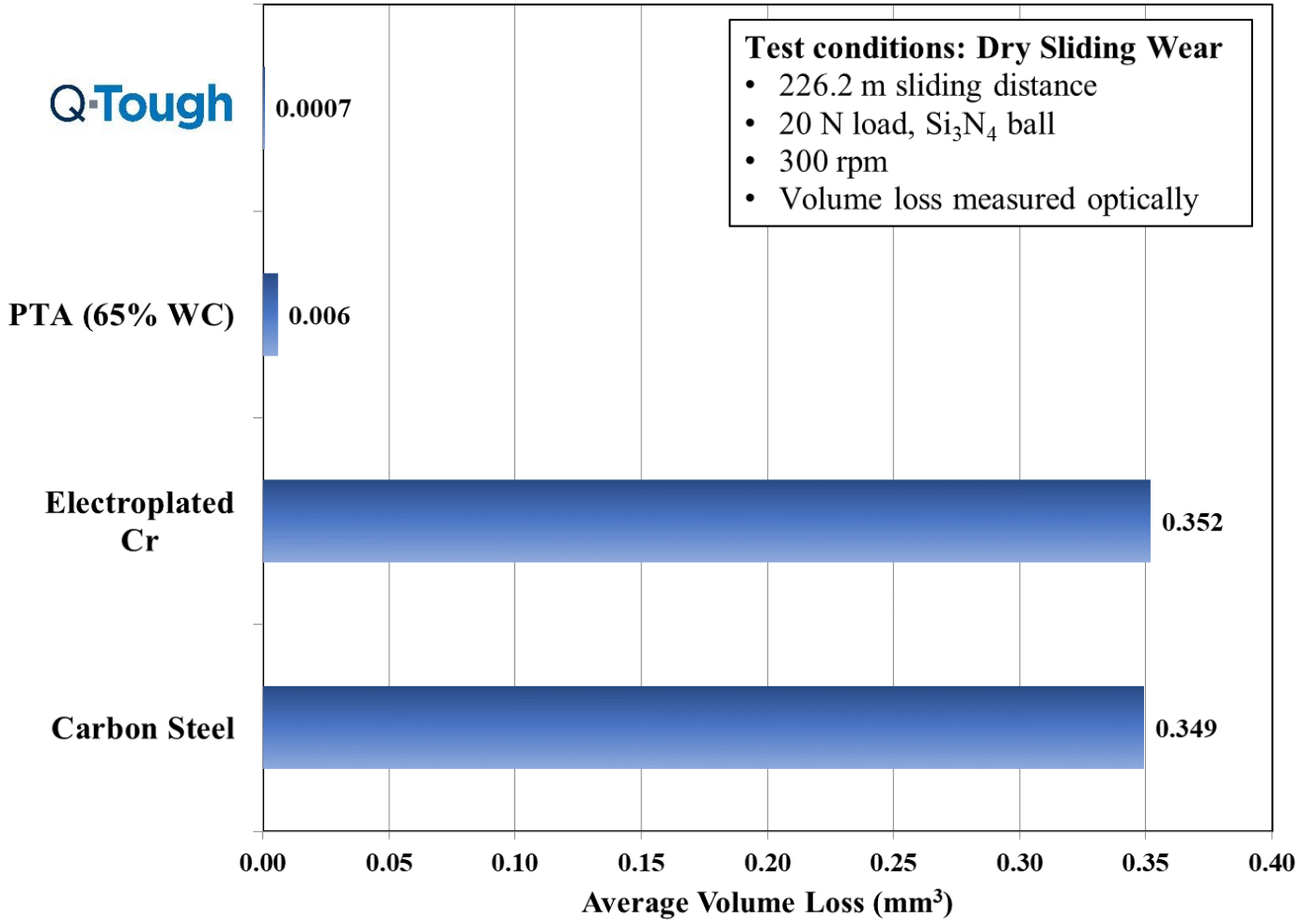
- No special handling requirements
- Eliminates delamination



Microcomposite structure

- Well dispersed hard particles (light grey)
- Ductile, corrosion resistant metallic matrix (grey)

Pin-on-Disk Wear Testing (ASTM G99)



Shorter bars indicate higher wear resistance

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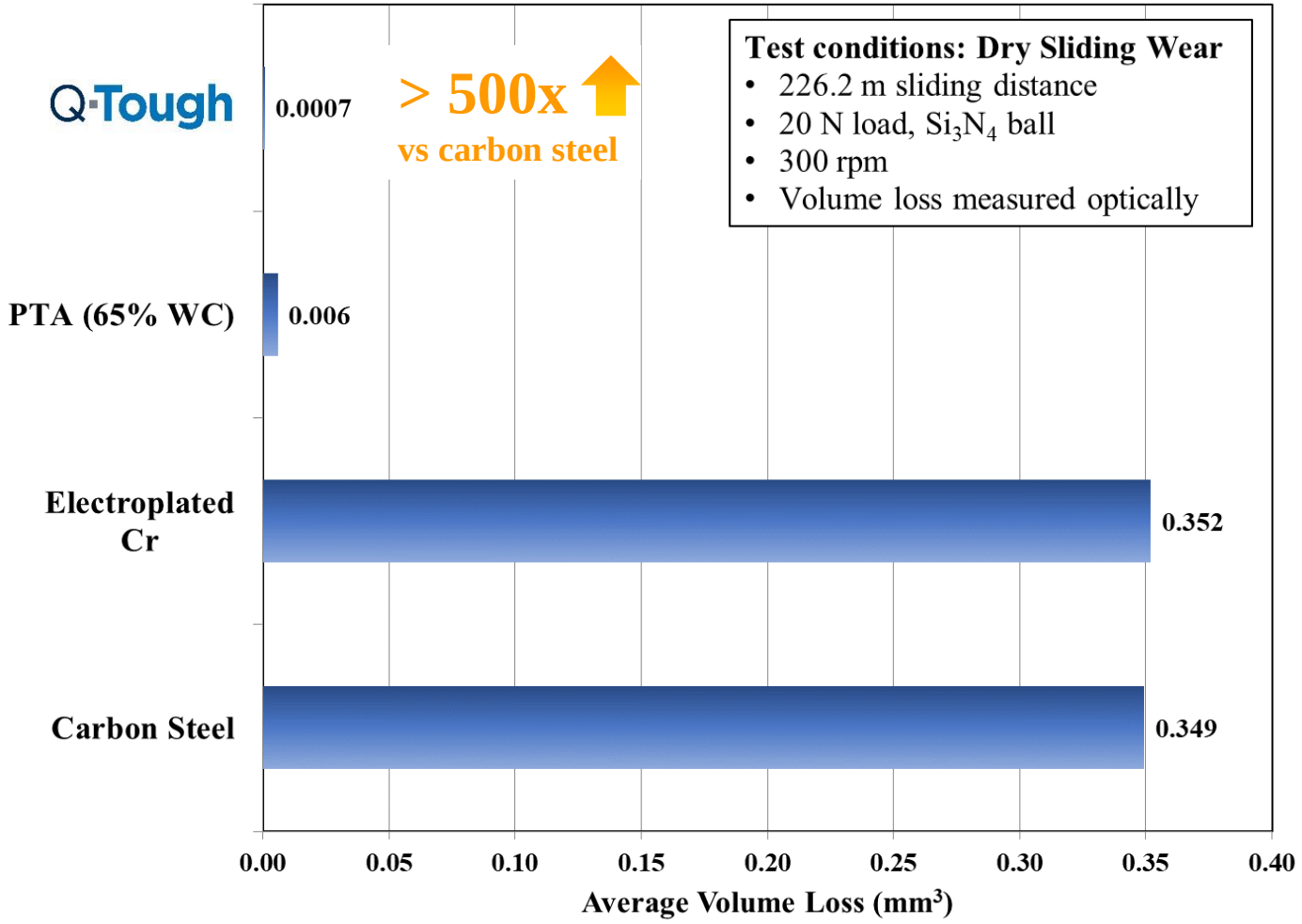

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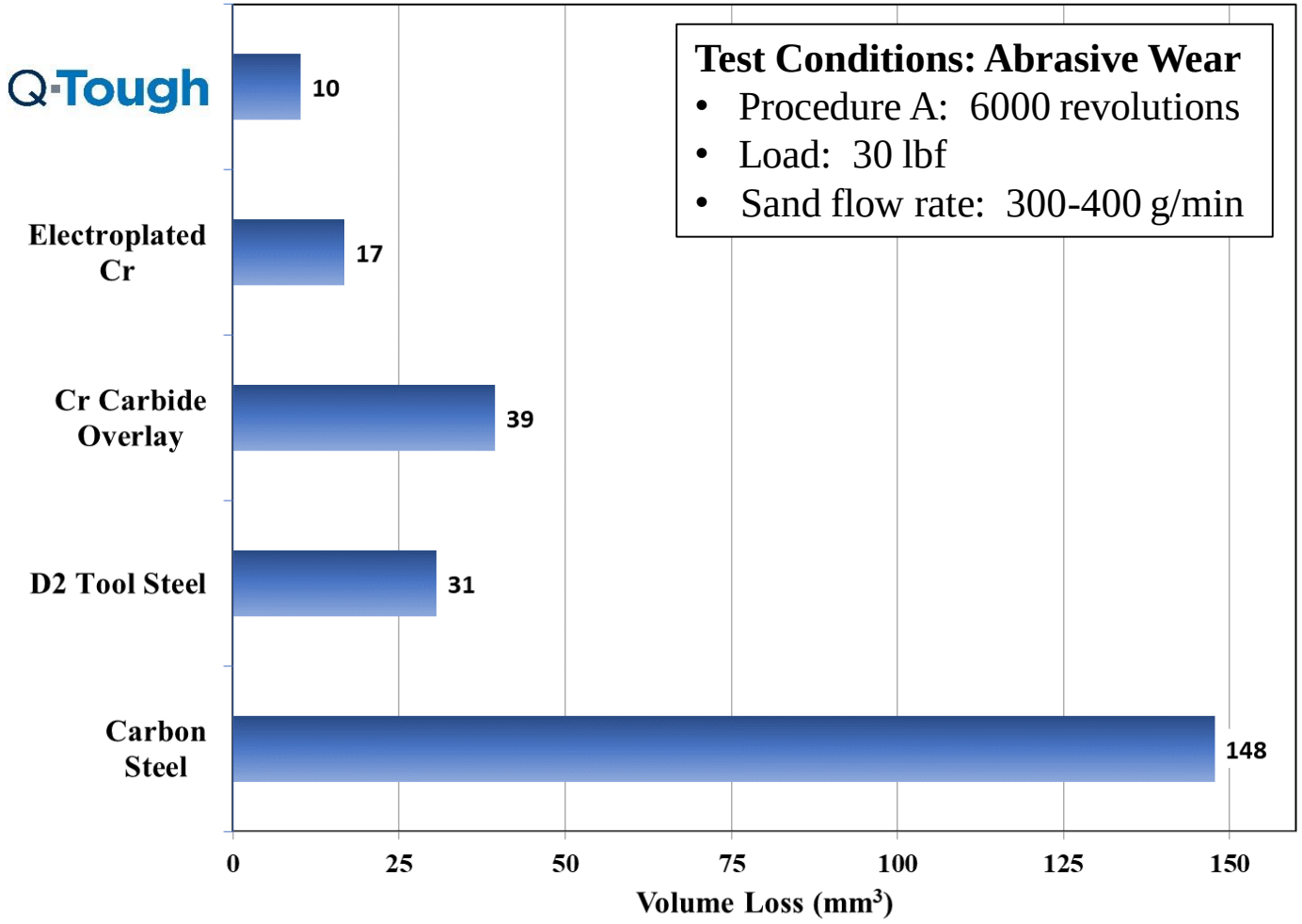
Sand Abrasion Wear Testing (ASTM G65)



Test Conditions: Abrasive Wear

- Procedure A: 6000 revolutions
- Load: 30 lbf
- Sand flow rate: 300-400 g/min

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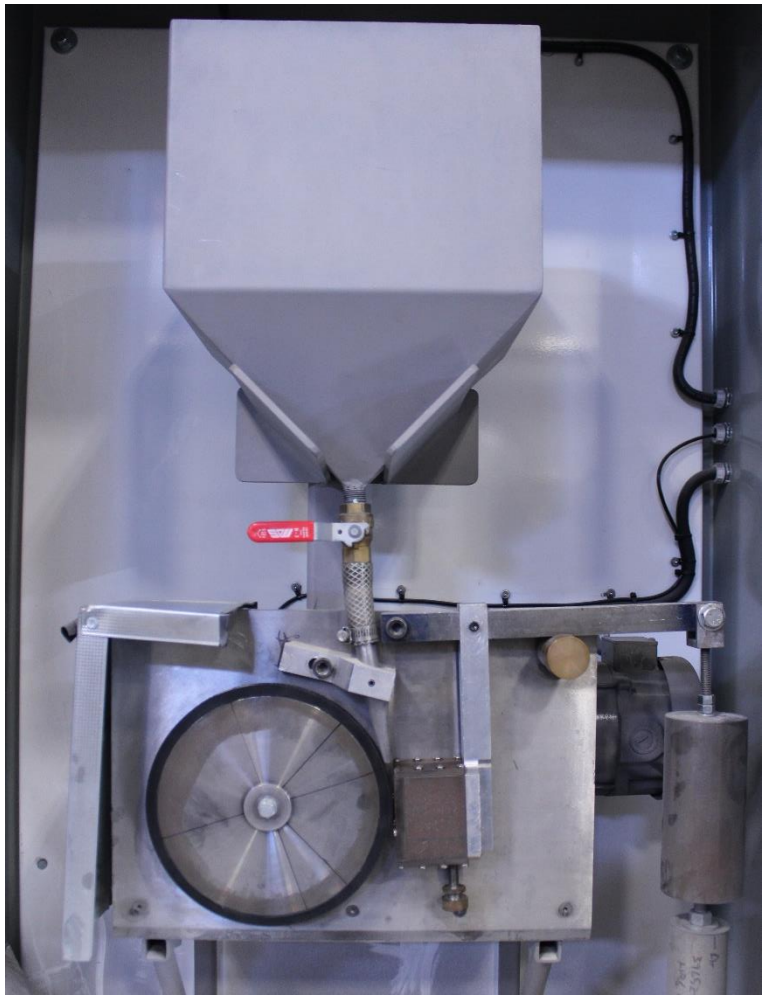

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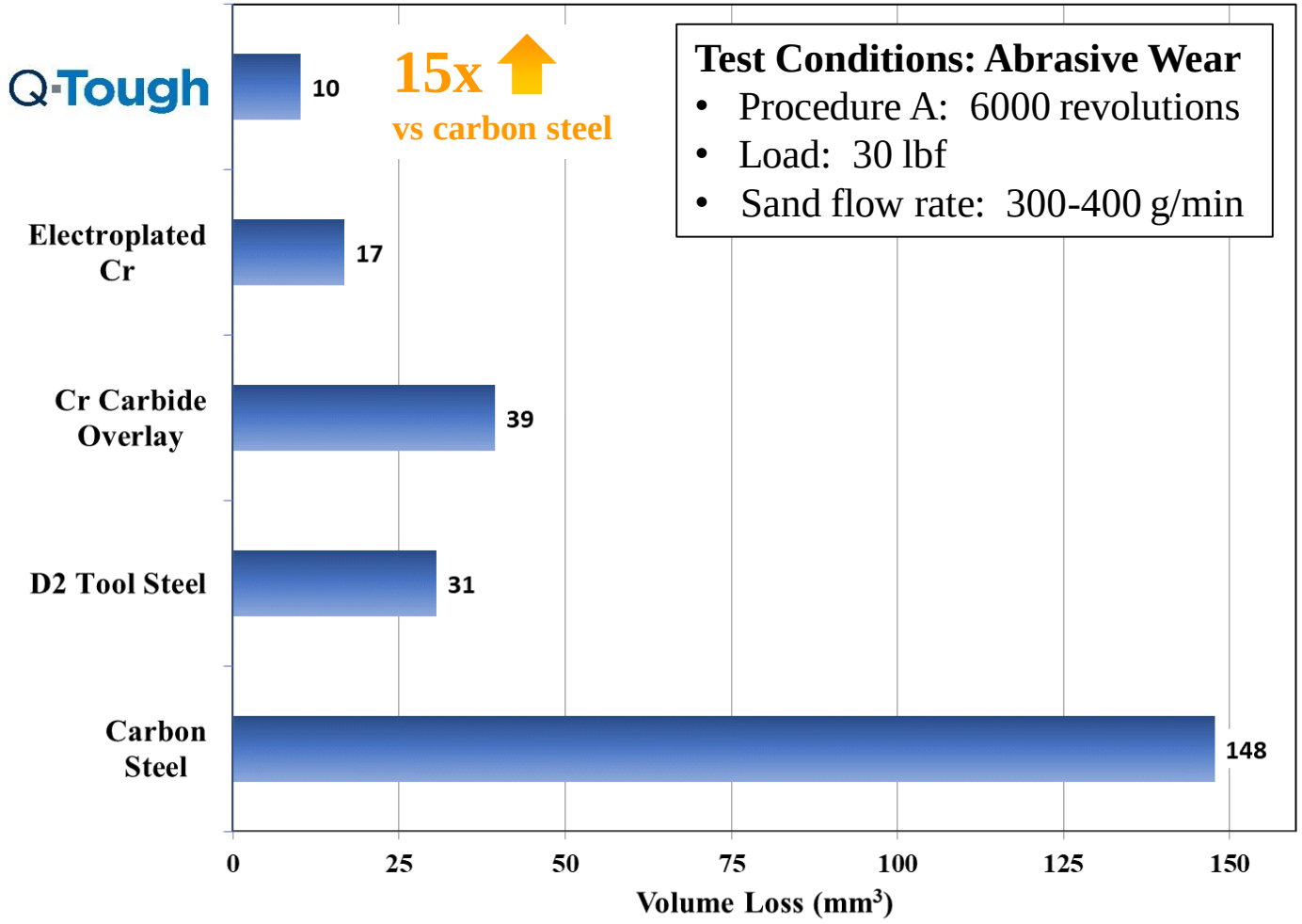

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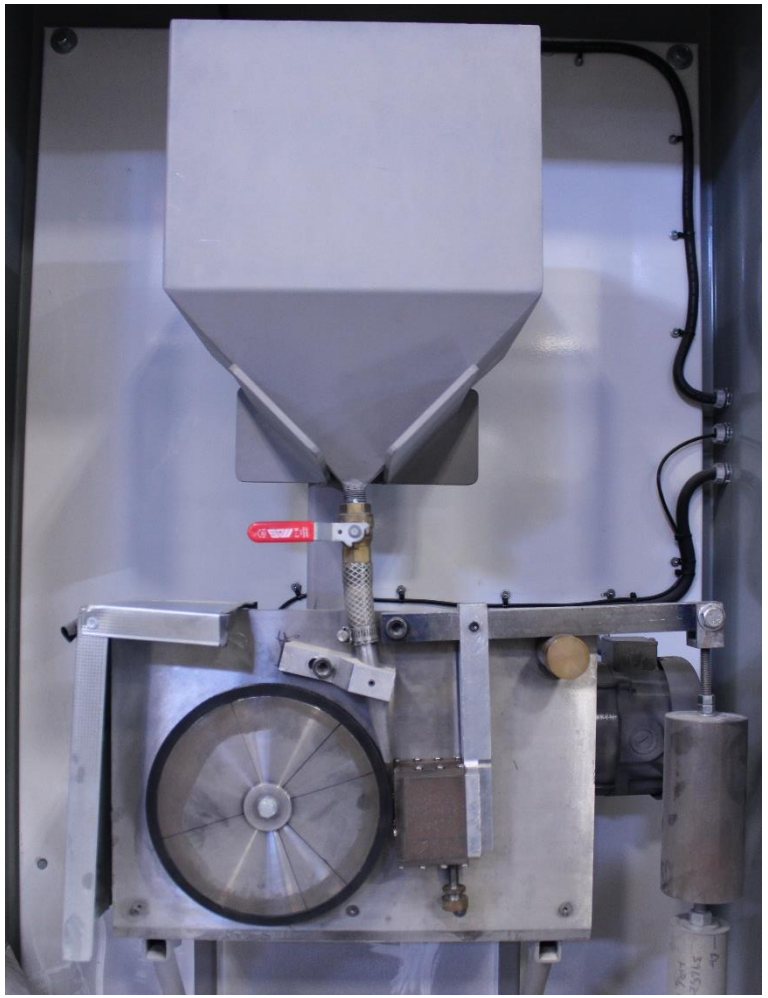

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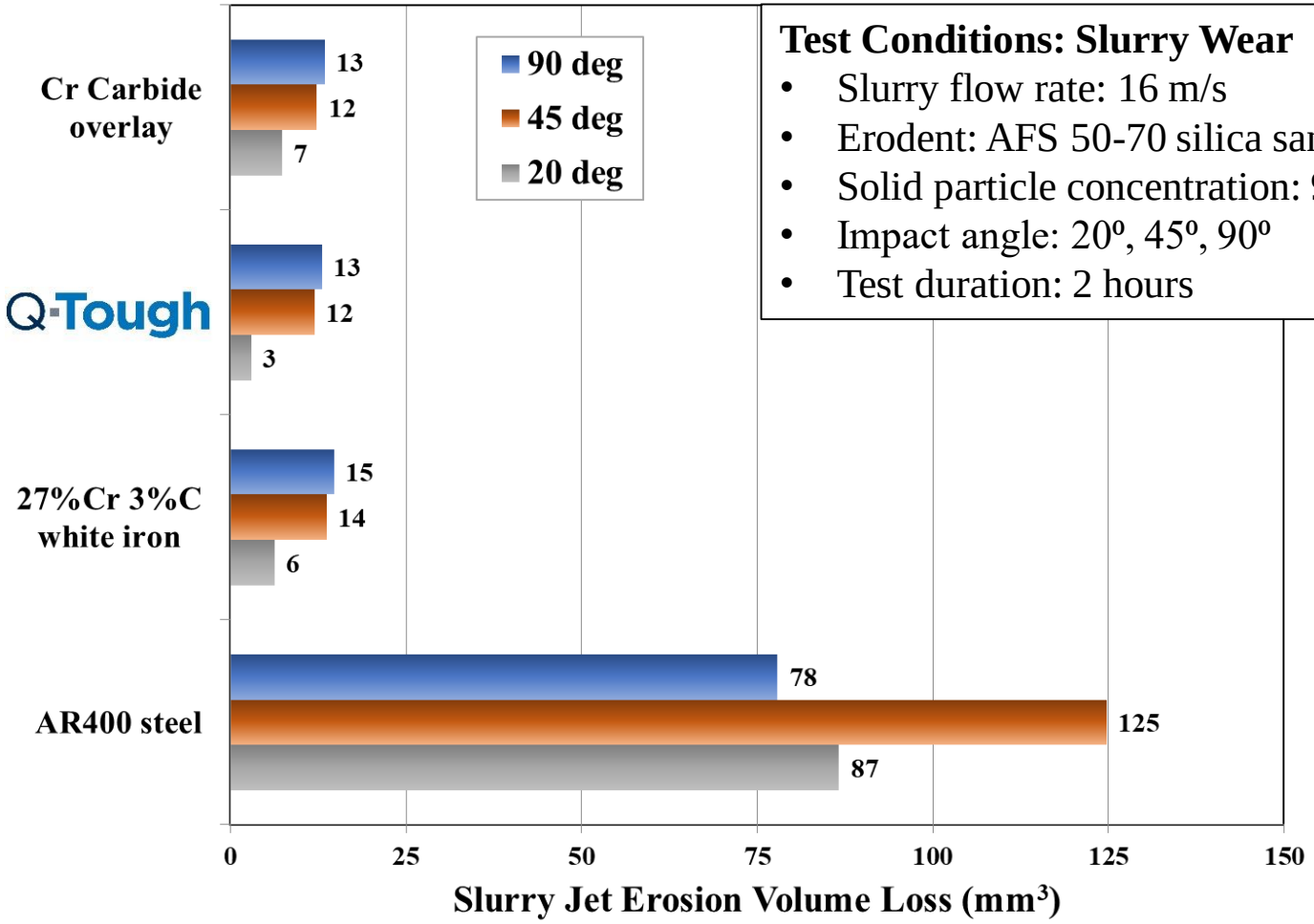
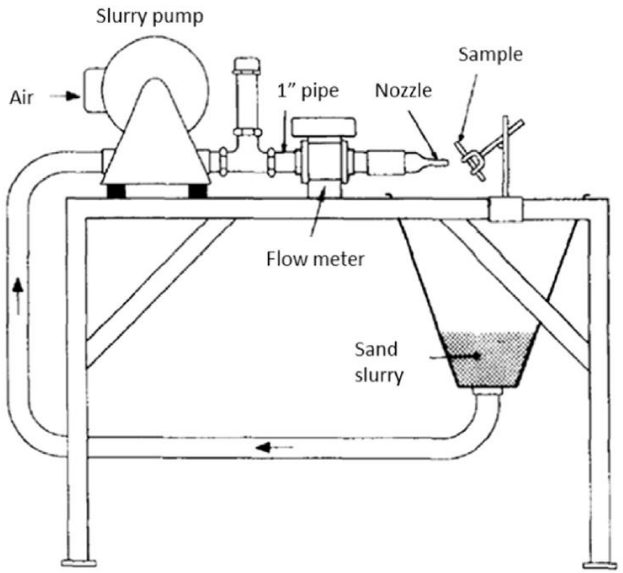
Slurry Jet Erosion Testing



Test Conditions: Slurry Wear

- Slurry flow rate: 16 m/s
- Erodent: AFS 50-70 silica sand
- Solid particle concentration: 9.1 wt%
- Impact angle: 20º, 45º, 90º
- Test duration: 2 hours



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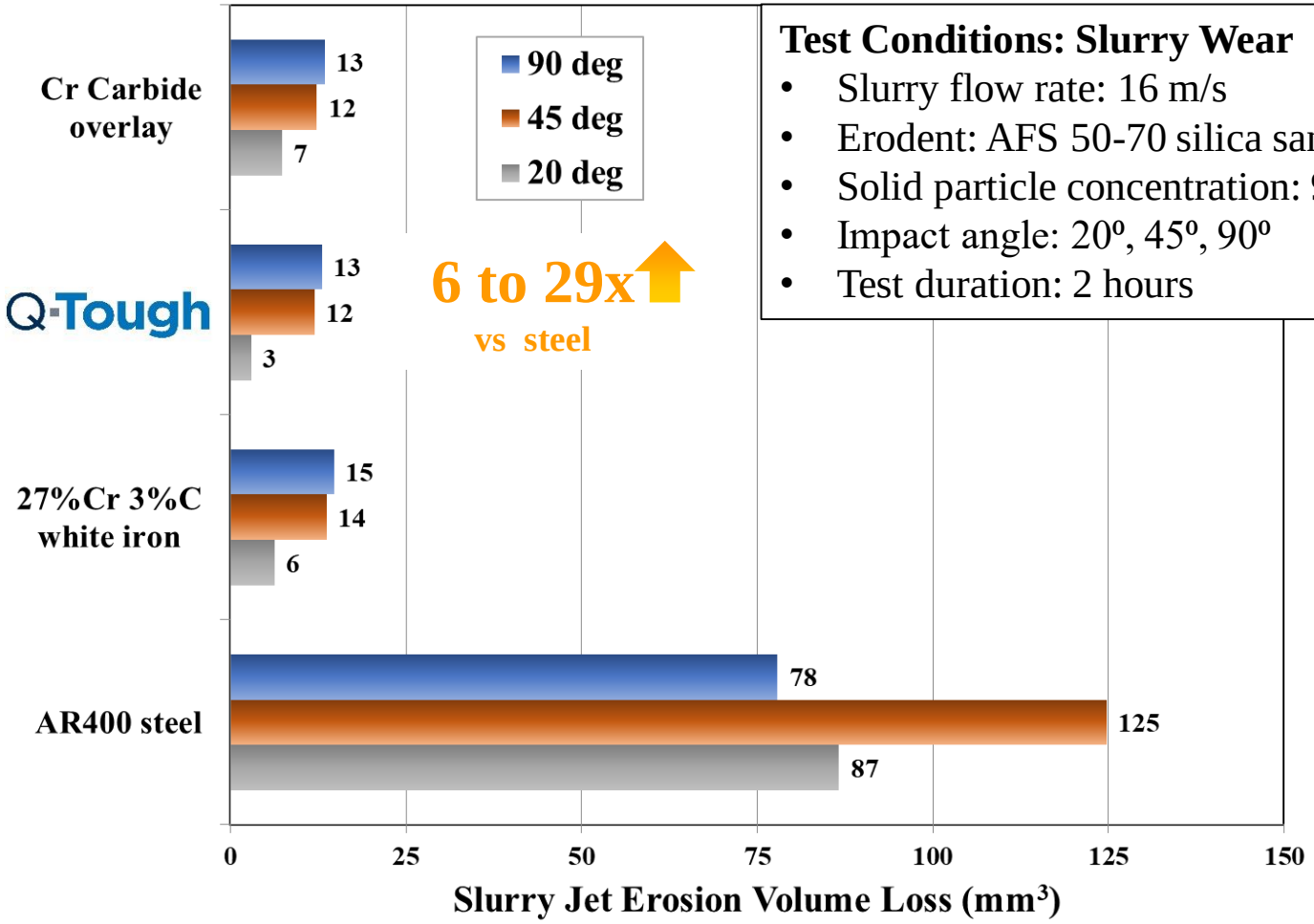

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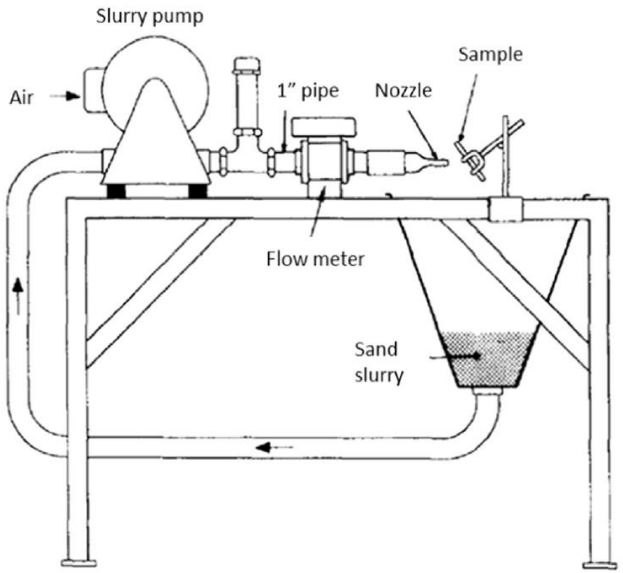
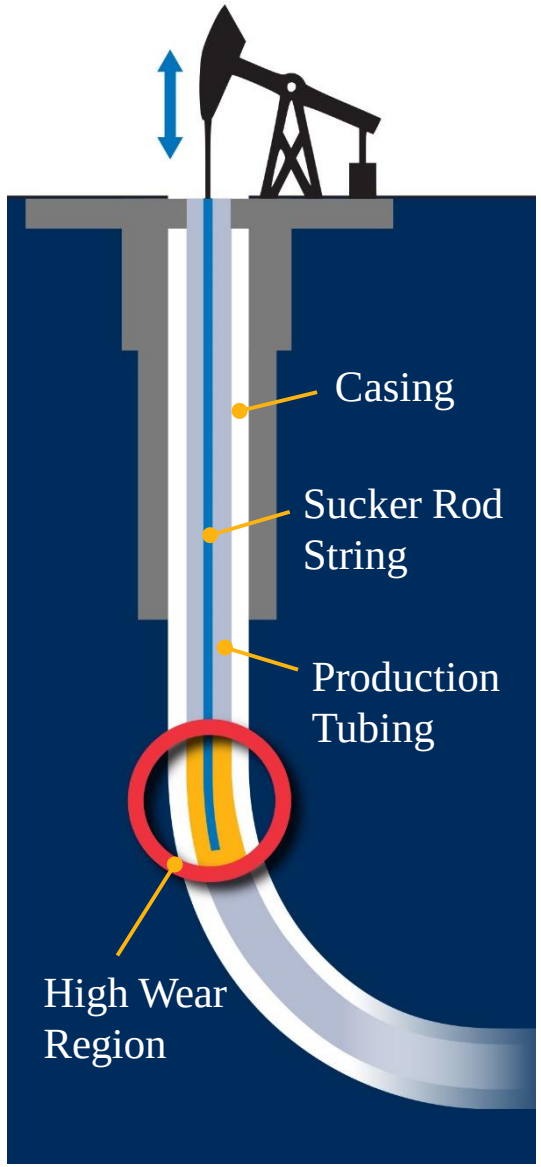
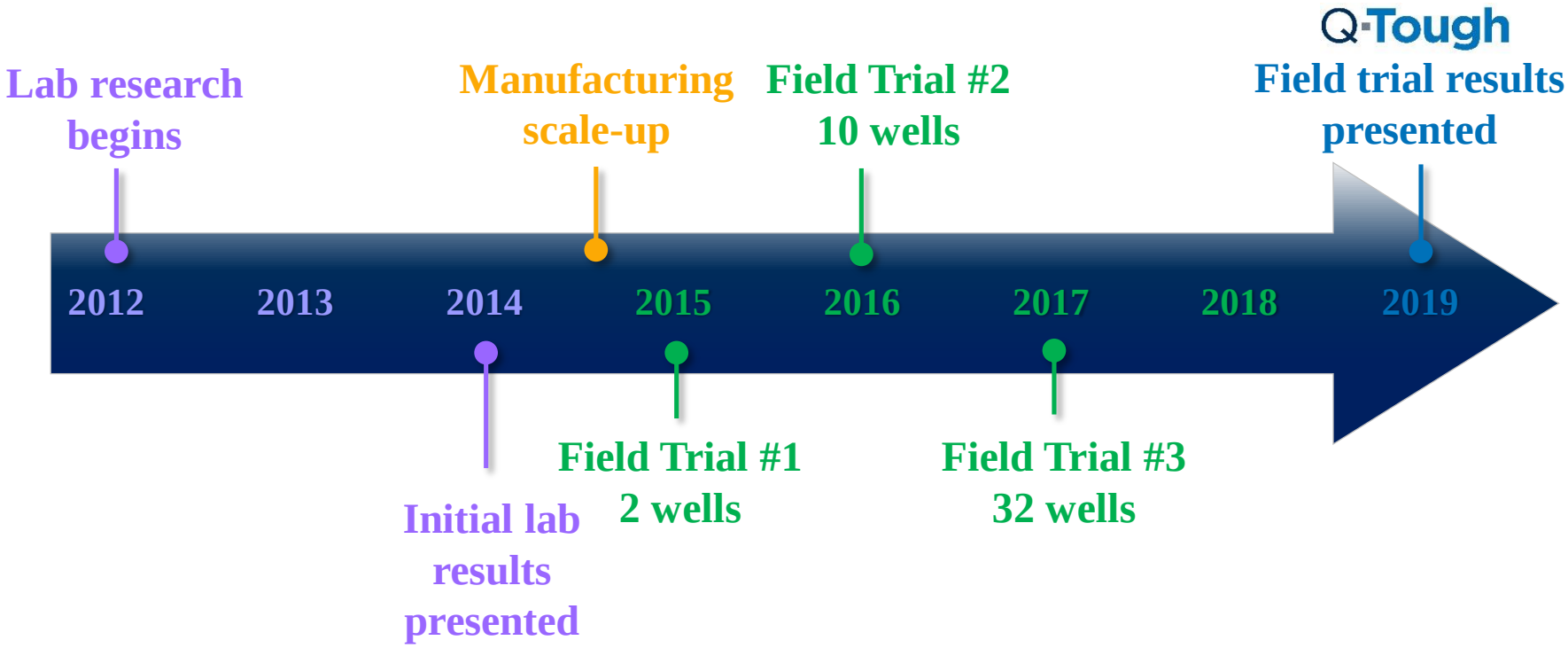


Q-Tough Field Trials

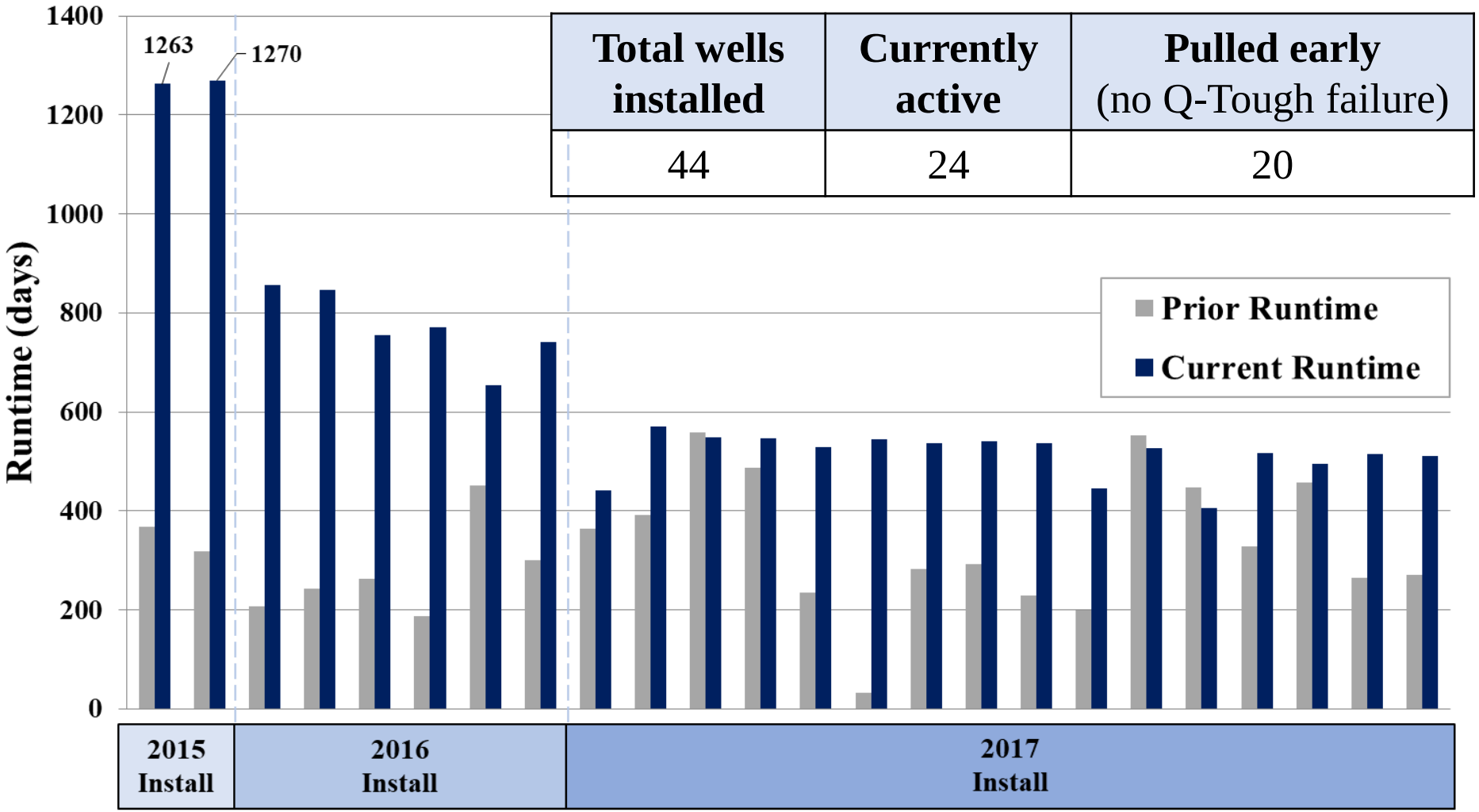
GOAL: To extend runtimes by installing coated tubes in known problem areas of the well

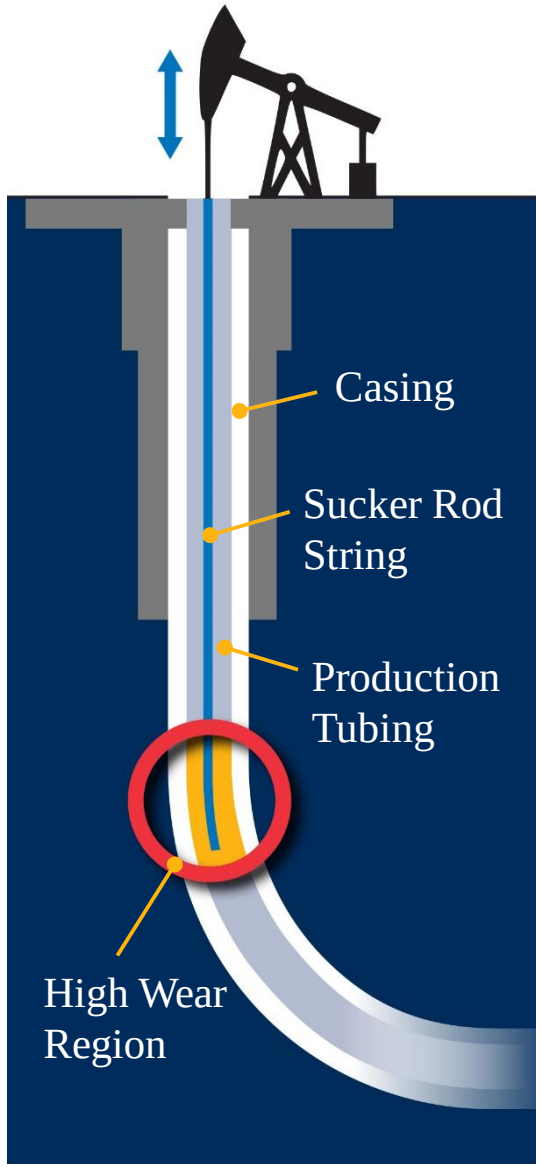




Q-Tough Field Trial Installations (44 wells)

Total wells installed	Currently active	Pulled early (no Q-Tough failure)
44	24	20





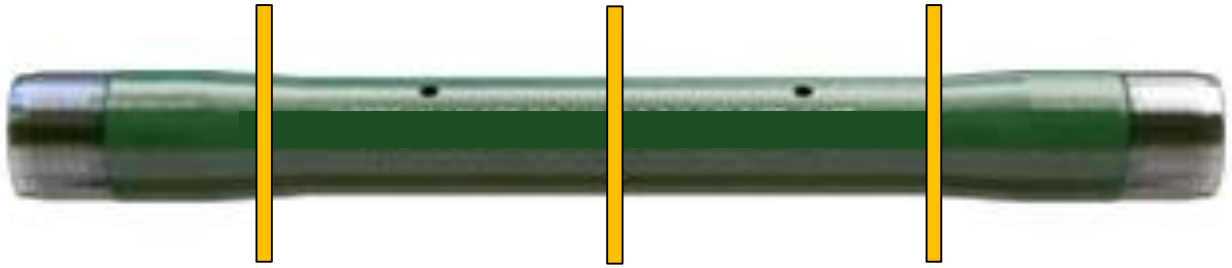
Q-Tough Field Trial Results

- **3x - 4x increase in runtime** (and counting)
- Earliest installations more than 4 years in service
- **No coating related failures** to date
- Benefits achieved by installing **coated tubes in 60 to 100 ft** in problematic areas of well
- No adverse effects on other components

Evaluation of field trial Q-Tough tubing

- Four Q-Tough coated tubes were removed early from one well during a workover to get an early snap-shot of coating degradation
- Well was worked over to replace a corroded pump plunger
- Well operated for 506 days before the workover
- This represents a **1.4x increase in runtime** compared to the well's previous runtime

Evaluation of field trial Q-Tough tubing
Borescope and cross-sectional coating analysis



Area 1
2 feet from end

Area 2
(Middle)

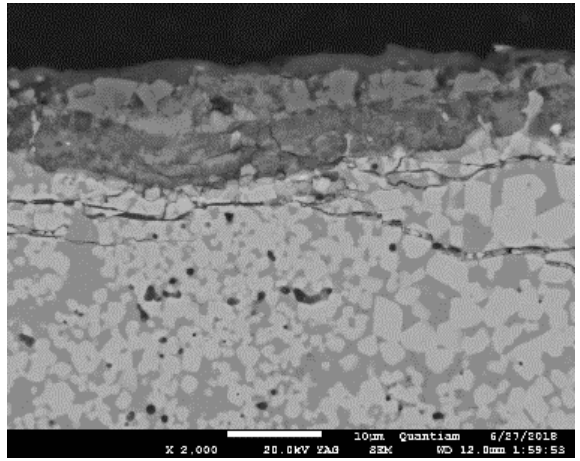
Area 3
2 feet from end

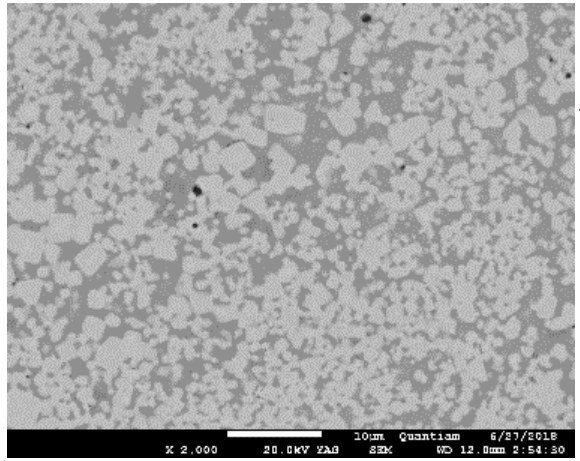
- All four tubes were non-destructively inspected with a borescope
- **No damaged areas were observed**

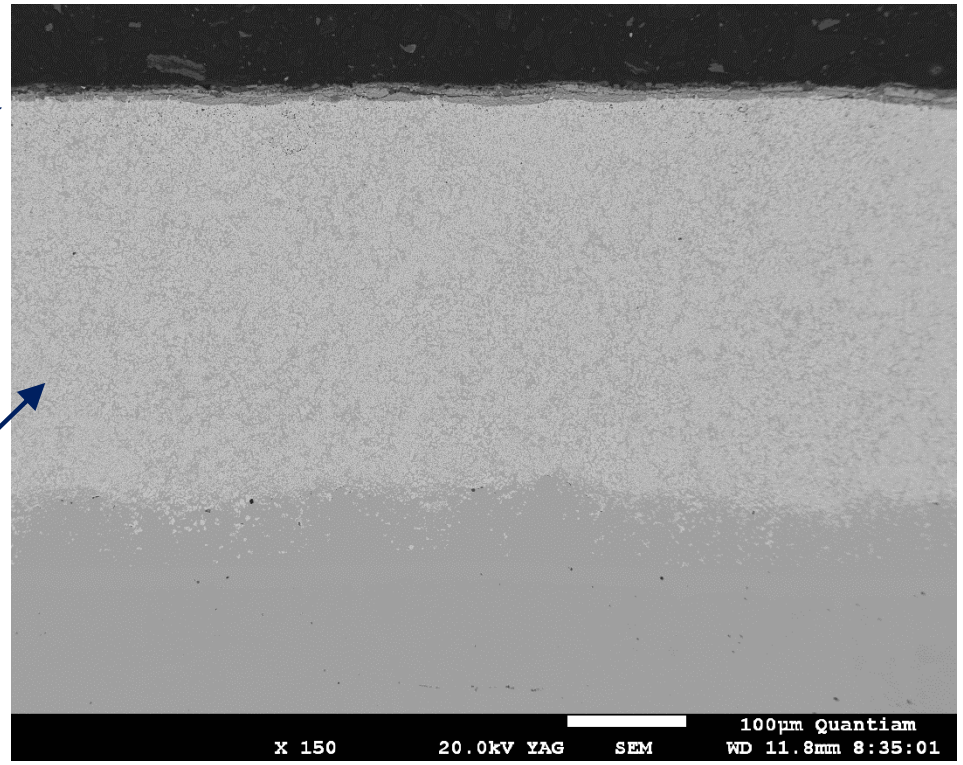
- Cross sectional samples were taken from the middle and ends of each tube
- Coating damage assessed with scanning electron microscopy (SEM)

Typical Field Trial Q-Tough Coating Microstructure

(506 days of operation downhole, 1.4x typical runtime)







Damaged coating
<25 µm thick
(<1.0 thou)

Undamaged coating
~350 µm thick
(~14 thou)

Metallurgical bond

Carbon steel

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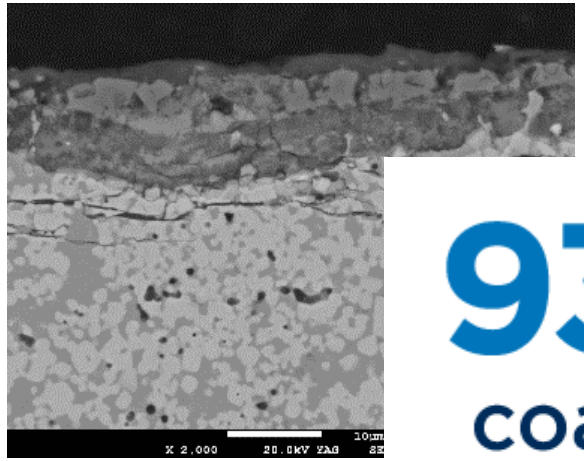
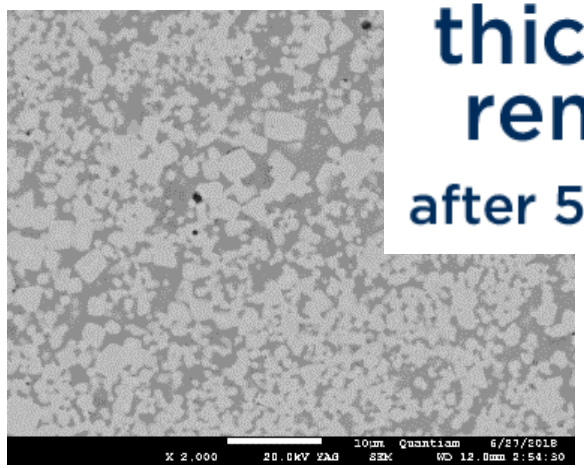
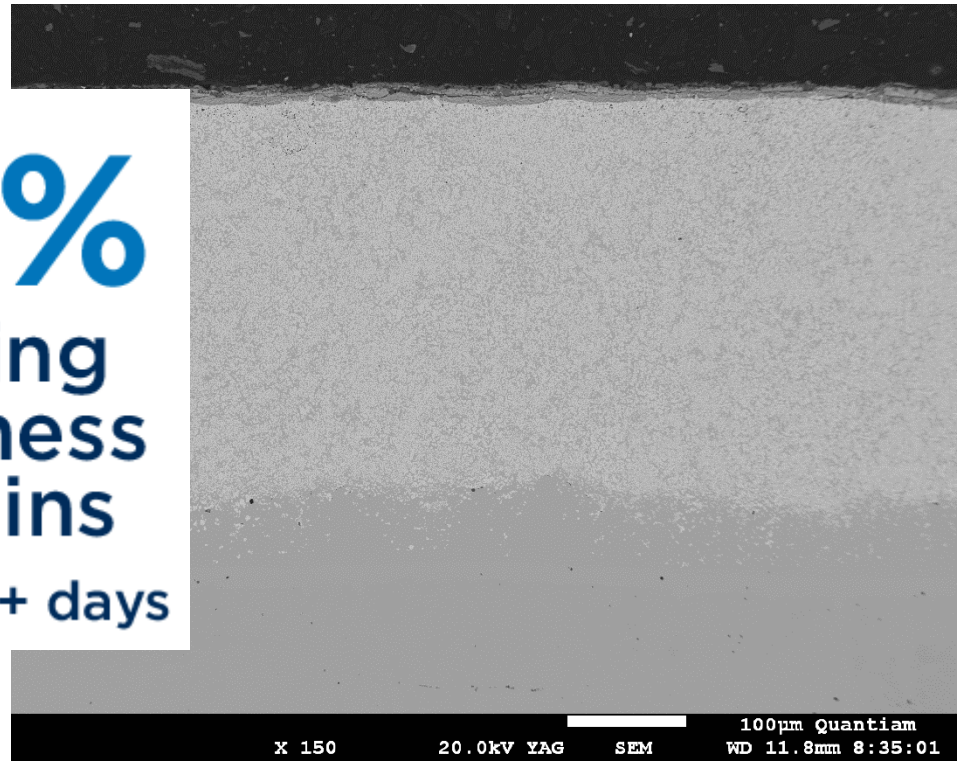




93%

coating thickness remains

after 500+ days



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(<1.0 thou)

Undamaged coating
~350 µm thick
(~14 thou)

Metallurgical bond

Carbon steel

Q-Tough coatings were developed to address wear challenges in production tubing

- **Q-Tough coatings have**:
  - Composite microstructures
  - Metallurgical bonding
  - Cost-effective non-line-of-sight manufacturing
  - Smooth surface finish and unique composition = long runtimes without accelerated wear of components

- **Field trials** of Q-Tough coatings have been installed in 44 wells in the Bakken region of North Dakota
- In 4 years operation no coating related failures have occurred
- Early stage evaluation of field trial coating observed that 93% of the coating remains undamaged after >500 days downhole

Coating Property Summary

	Property
Sliding Wear Resistance (ASTM G99)	>500x better compared to uncoated J55 carbon steel
Sand Abrasion Wear Resistance (ASTM G65)	15x better compared to uncoated J55 carbon steel
Slurry Jet Erosion Resistance	Comparable to CrC overlays and white cast irons
Substrate Compatibility	Carbon and alloy steel, stainless steel, Ni-based alloys
Part Sizes and Geometries	Internal and External surfaces Tubular and complex geometries Lengths up to 15' long
Average Microhardness	~800 Hv (63 HRC)
Coating Thickness	50-1000 µm (0.002" -0.040")
Substrate-Coating Bond Strength	Excellent due to Metallurgical Bond
Coating Porosity	Minimal
Appearance	Smooth as coated finish Coating applied as Light Grey Finishes to a high metallic lustre when polished