



Wireless UT Sensors for Asset Integrity Monitoring & Remote Operations in a Post COVID19 World

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How Did COVID-19 Affect O&G

Reduction in oil utilization: 12.5mbpd (10/19-3/20) to 10.2mbpd (4/20-9/20) - **18% decline**

26 refineries globally closed, re-purposed, or idled in 2020 (with more coming)

32.1% overall reduction in O&G workforce (280,320 jobs) since April 2020

1.33 million O&G jobs eliminated over the last three 'crashes' (08-09, '15-'16, COVID)

Oil prices have **declined 44%** since April '11 ...

*Sources: Reuters, University of Houston, USDOE, Statista

A 20-Year Look at Historical O&G Prices

- 20-yr. High: \$145 ('08)
- 20-yr. Low: \$11 ('20)
- Avg Last 20-yr.: \$63
- Avg Last 10-yr.: \$75
- Avg Last 5-yr.: \$60

U.S. Oil Price Collapses To Lowest Level Since 1999

Daily price per barrel of WTI crude oil (dollars per barrel)*



* West Texas Intermediate (a benchmark for U.S. crude oil prices)

Source: U.S. Energy Information Administration



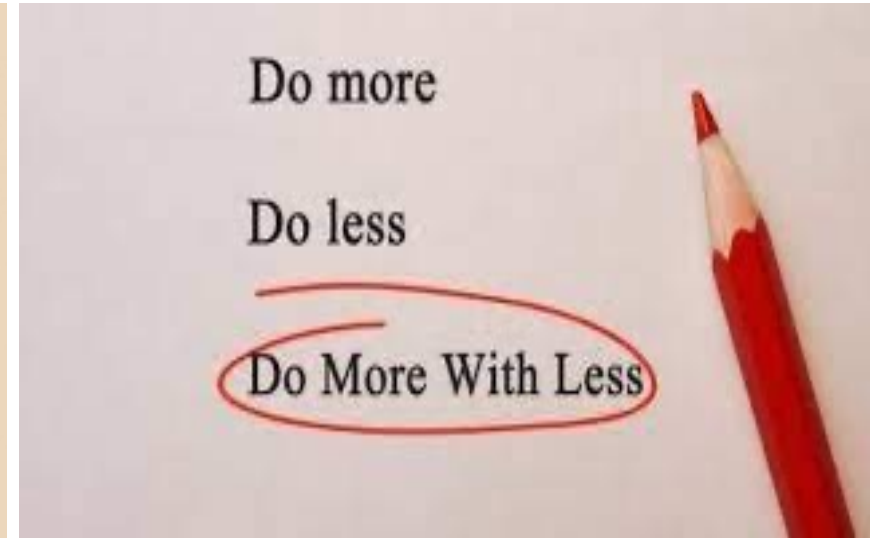
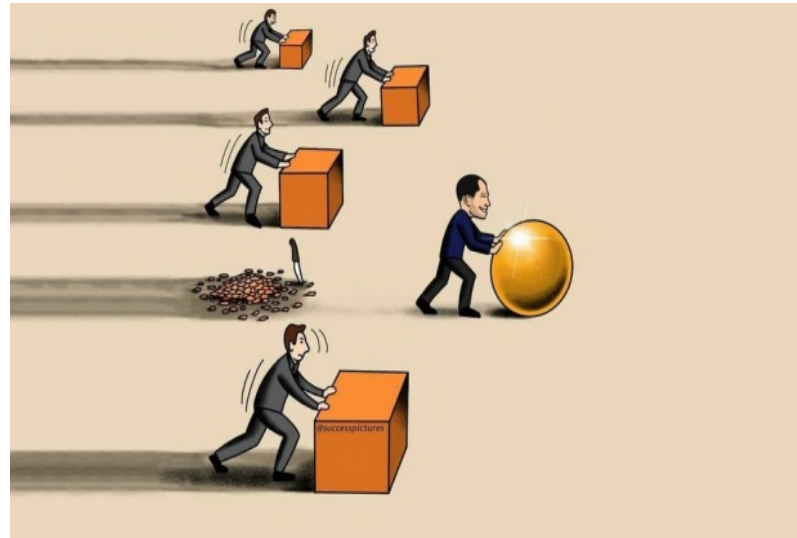
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Is it time to make some changes? I think so ...

Innovate



Do MORE with LESS



Work SMART not HARD

Agenda

- Wireless UT Sensors – A technological walk down memory lane
- Conventional UT (Inspection) VS. Automated UT (monitoring)
- Overview of wireless UT technology – “What’s different, why now?”
- Enter COVID-19 ... a reset in asset integrity strategic thinking
- Case studies of deployments & outcomes up, mid, and downstream O&G
- Conclusion + Q&A

NDT Monitoring Over the Years ...



1980s: Installing sensors permanently

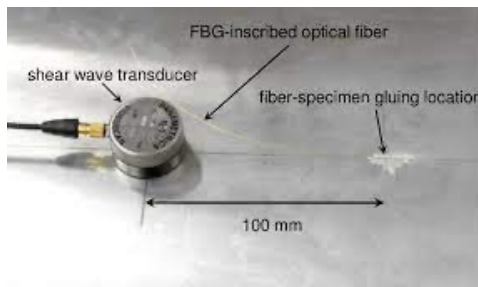


2000s: Wireless



2020s: Change & Scale

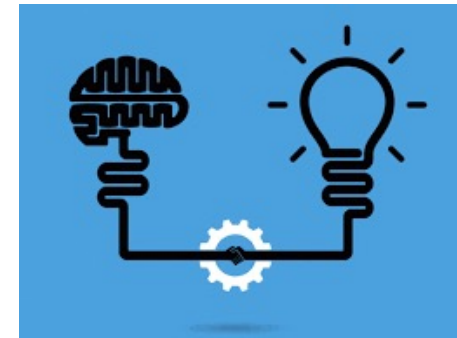
1970s: Remote Technicians



1990s: Digitizing & miniaturizing



2010s: Lower cost!



Inspection VS. Monitoring

	Installed UT	Manual UT
Data Quality	Precise	Variable
Data Quantity	Many	Few
Repeatable Corrosion Rate	Yes	No
Inspection Ability	No	Yes
Monitoring Ability	Yes	No
Human Error	Low	High
Cost Over Time	Low	High



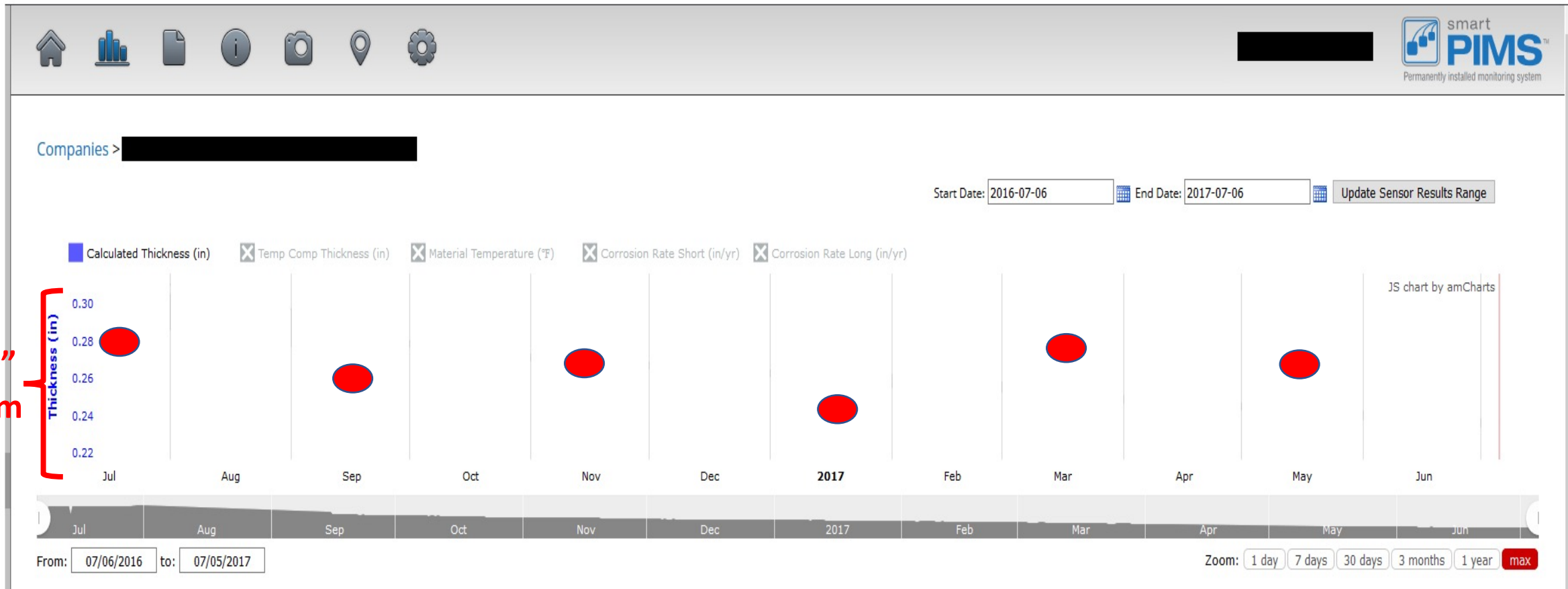
Inspection



Monitoring

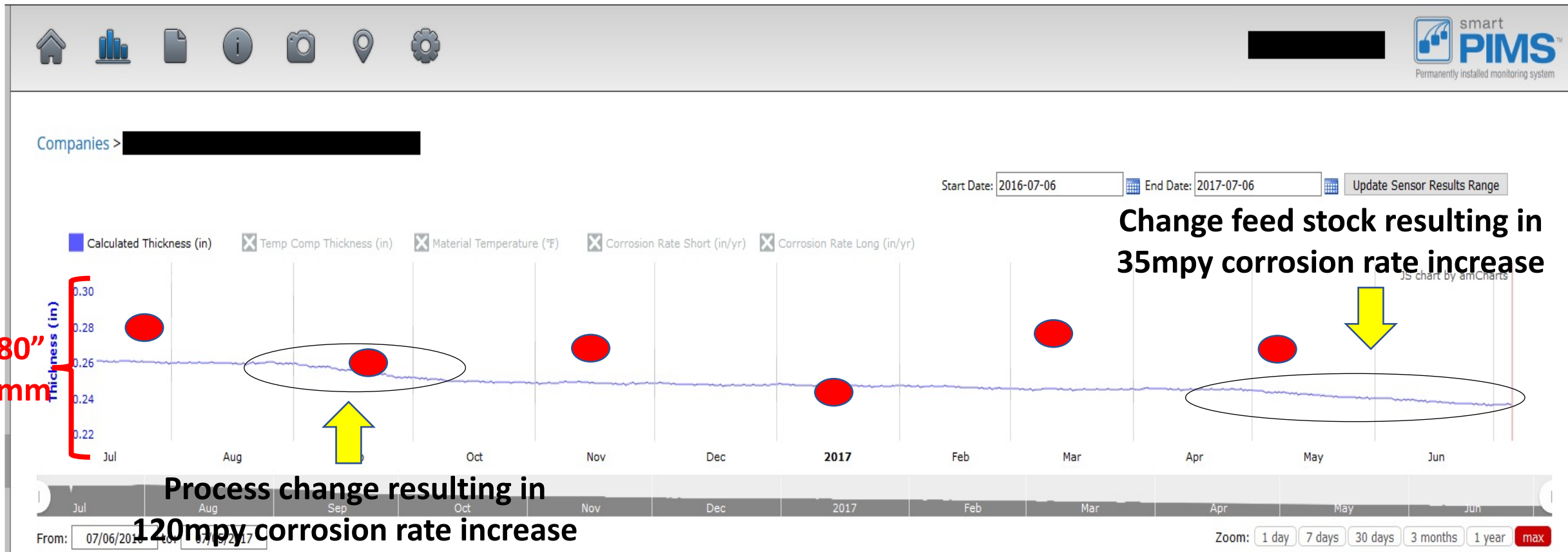
Inspection.

● Manually taken thickness measurement



Monitoring.

● Manually taken thickness measurement



What's New? Why Now?

System Design & Flexibility

Industrial Wireless – 900MHz

Ease of Deployment & Scalability

Sensor Cost & Battery Life

Business Models are Changing

Savings:

- Safety
- Efficiency
- Operations



System Design & Flexibility

Wired **OR** Wireless

Ultra high (950F/500C) **OR** Ultra low (-40F/C) temp ranges

Above ground **OR** buried

Single point **OR** multi-point **OR** area monitoring

Permanently **OR** temporarily installed



Industrial Wireless – 900MHz

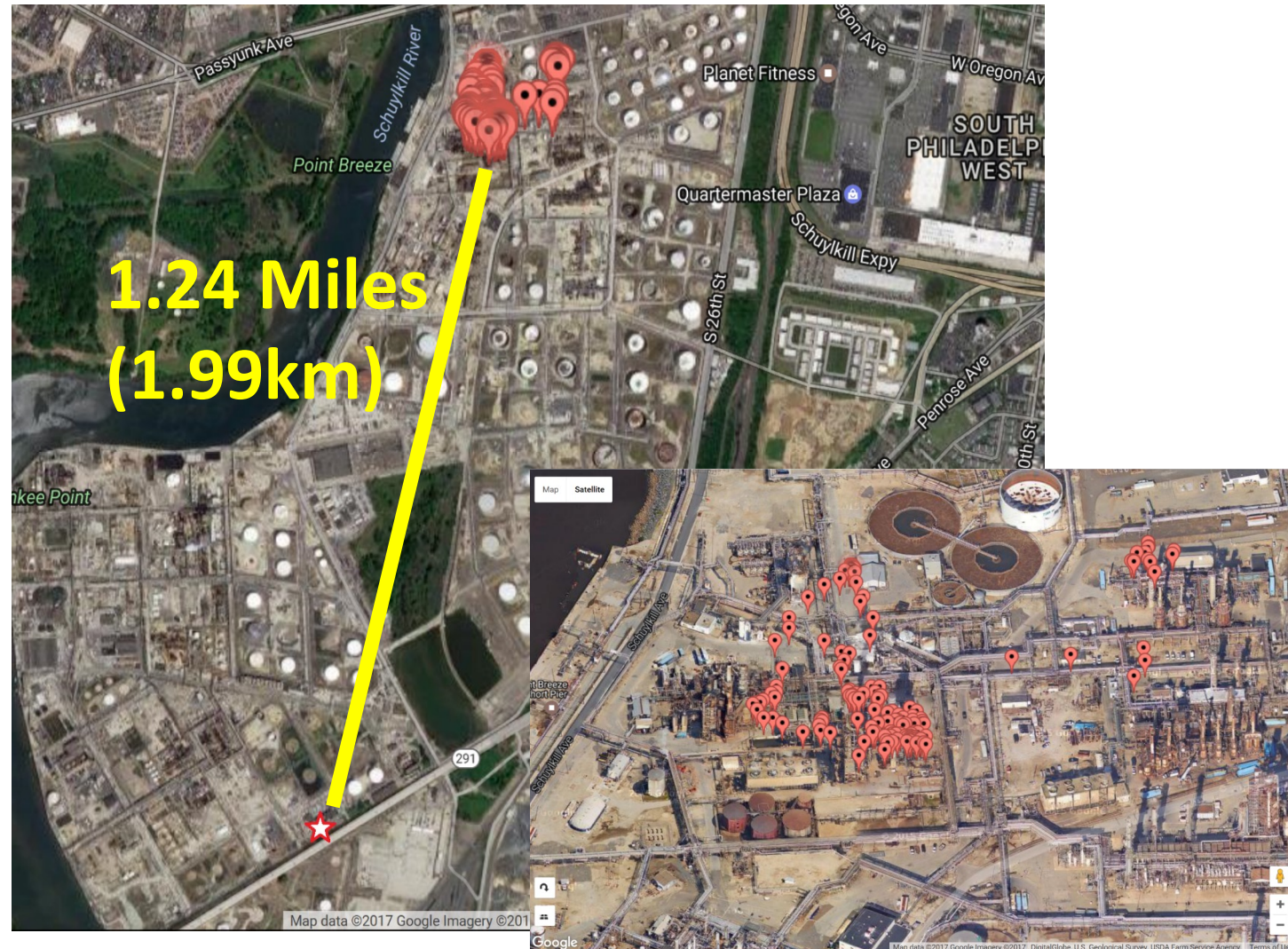
Wireless Protocol: LoRaWAN STAR network from sensor to gateway

Gateway & Antennae: ~1-mile (1.6km) range with no repeaters needed*

Gateway Capacity: ~5,000 sensors

Data Backhaul: Cellular/Ethernet to cloud OR on-premise server

Sensor Battery Life: 10+ years on 1 reading per day



Scale & Deployment in 15 Mins.



Sensor Cost & Battery Life

<u>Year(s)</u>	<u>Sensor Cost</u>	<u>Battery Life</u>
2000	\$12K+/sensor (system)	Wired only
2010	\$7.5K/sensor	3-5 yrs
2020	\$4K/sensor	5-10 yrs
Next 5? ... 10?	\$1.5K-\$3K/sensor	11-20 yrs



“Technology is always evolving, those who **not only embrace it**, but **put it into practice** will elevate themselves to a level far beyond their colleagues and competitors” – Bill Gates

Business Models are Changing

CAPEX to OPEX

Software as a Service (SAAS) models

Subscription models ... Don't buy the hardware, buy the data

More data analysts, less technicians

Data management ... who's going to take the lead?

- Service company?
- Asset owner?
- Equipment manufacturer?
- Other?



COVID-19 a 'Reset Button' for Asset Integrity

Facility access ... 90% reduction in personnel

Do more with less

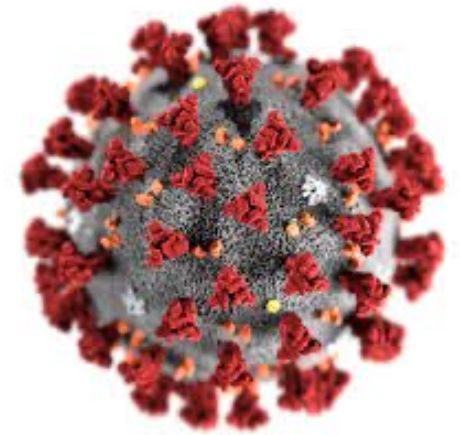
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Safety pressures versus time constraints

Reduce costs due to oil prices/demand

How can we work remotely and still know our assets are operating:

- At all?
- Properly?
- Optimally?



Case Study: Upstream

Problem: Newly producing well operating at 3X maximum allowable operating pressure (MAOP). Asset owner wants to know how long they can run until failure.

What are they doing today: Sending an NDT technician to drive ~4 hours round trip to take four (4) UT readings at eight (8) critical ware locations (32 total readings) every three (3) days (or more frequently) for 12 weeks.

Outcome:

- Assets are approved to continue running ... or not
- Cost ~\$40K

Case Study: Upstream

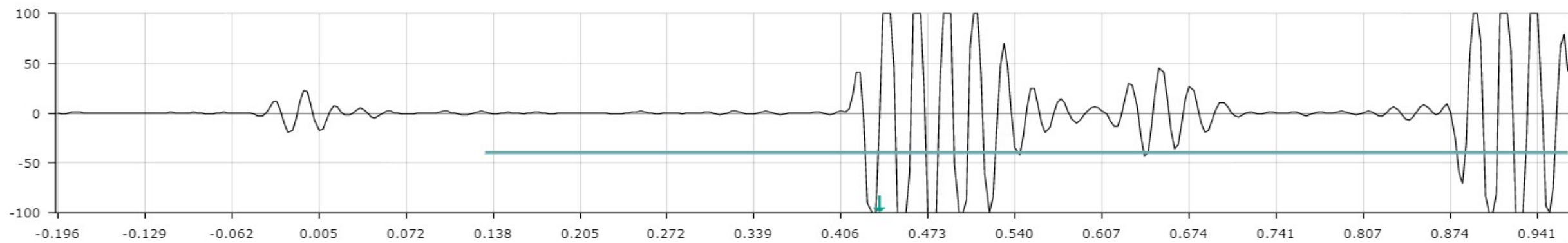
New Solution: Install four (4), eight-sensor systems using cellular connectivity to monitor each of the 32 locations daily

Outcome:

- Client received an erosion rate
- Optimized the well head/critical assets flow to maximize throughput vs. wall loss
- Can now predict when failures will occur
- No longer run to failure & can schedule maintenance during non-productive time
- Estimated savings: \$685K/location
- Cost \$60K



Case Study: Upstream



Case Study: Midstream

Problem: <20 yr. old pipeline showed signs of wall loss comparing old ILI inspection data to most recent. Pipe was not deemed at a critical level to warrant a repair, but asset owner wanted to monitor/mitigate the issue AND maintain their normal ILI interval.

What they would have done: Take asset offline, to then cut, fix, sleeve, or repair affected areas.

Outcome:

- No information on corrosion activity, no way of knowing when/why/how
- Cost: \$1.24M (downtime, equipment, time, material)
- Able to keep normal ILI interval

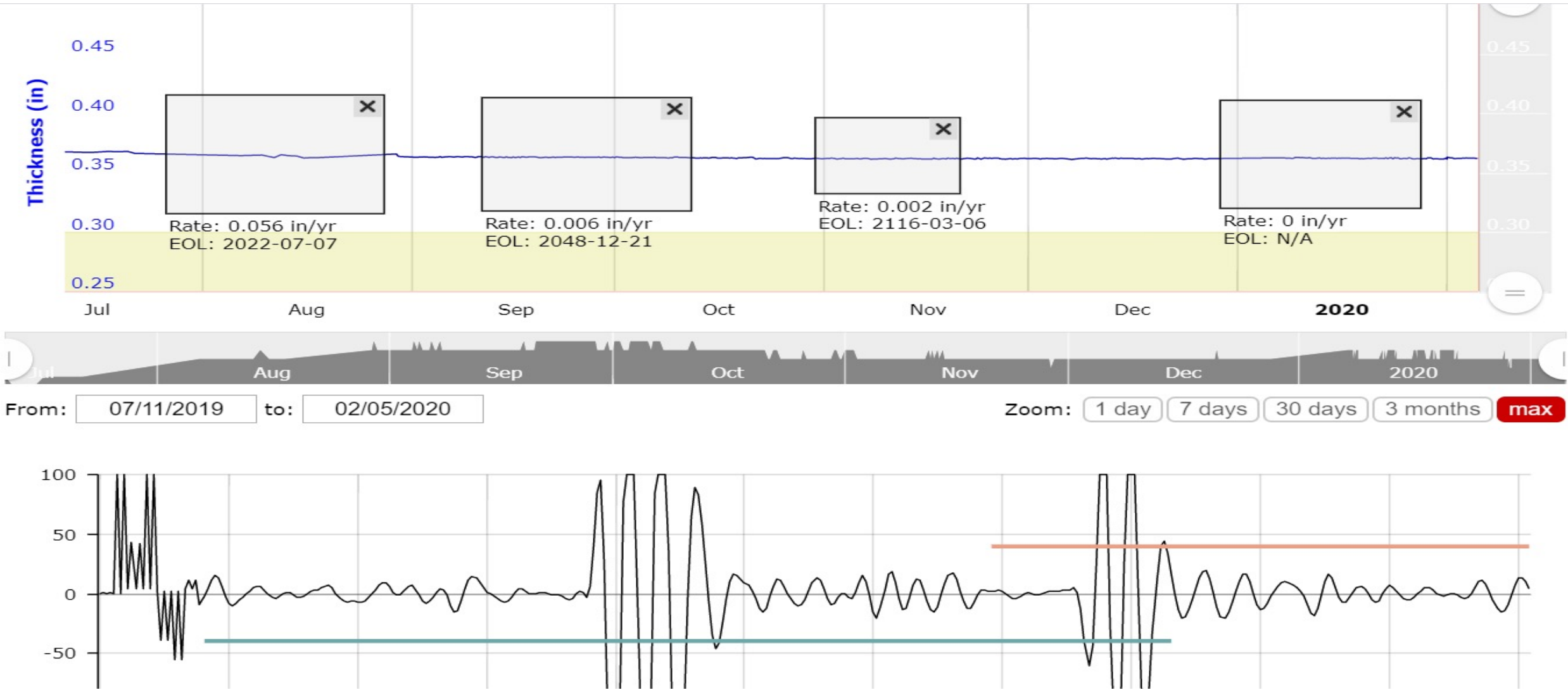
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Outcome:

- Client received corrosion rates for all locations
- Able to measure effectiveness of cleaning pigs & inhibitors used (and timing)
- Maintain normal ILI interval AND maintain PHMSA/DOT MegaRule compliance
- Estimated savings: \$6MM over lifetime of asset
- Cost \$35K



Case Study: Midstream



Case Study: Downstream

Problem: Refiner's Sulfur Recovery Unit (SRU) had a history of varied (manually taken) 'corrosion rates' at six (6) easy-to-access locations.

What they were doing: Sending a UT technician to take monthly readings

Outcome:

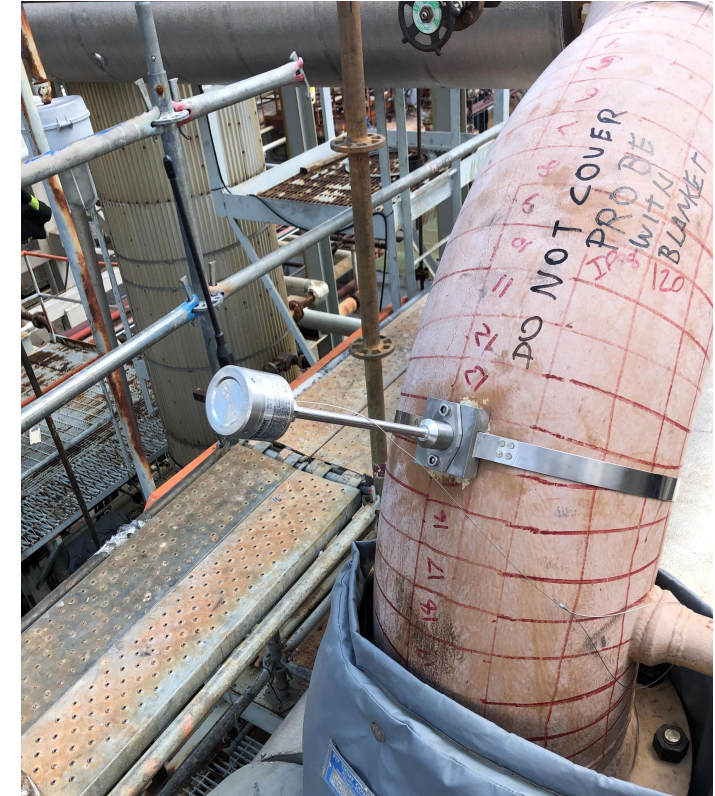
- Varied corrosion rates ... average was 20 mpy (.020"/yr. or .5mm/yr.)
- Unit was taken out of service for maintenance every 5 years, regardless
- Cost: ~\$1,000/yr

Case Study: Downstream

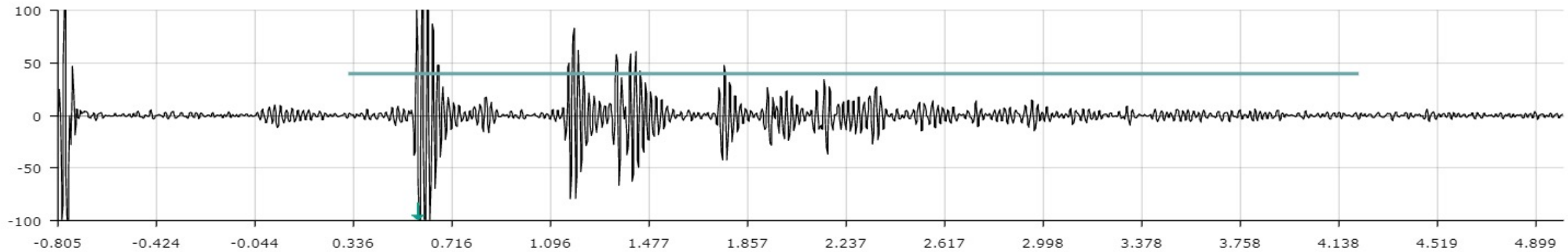
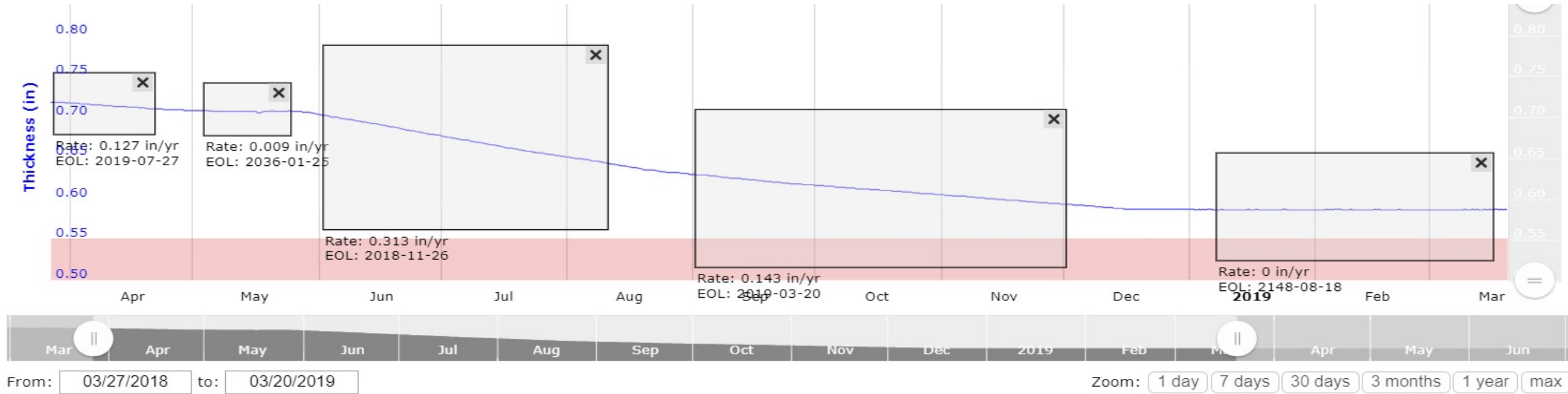
New Solution: Asset owner installed six (6) single point fully wireless UT sensors to take readings every eight (8) hours to monitor corrosion activity

Outcome:

- Corrosion rate changed SIGNIFICANTLY based on IOW, process parameters, and changes
- Corrosion rate accuracy/repeatability of .001"
- Tweak process operations to minimize corrosion
- Unit was extended to 7-yr maintenance cycle
- Estimate Savings: ~\$4.2M
- Cost: \$50K



Case Study: Downstream



Case Study: Chemical

Problem: Chemical mfr. Had a few locations along his furnace piping which he suspected was suffering from unknown corrosion activity (over the course of the last 10 yrs)

What they did: Installed wireless UT sensors to take *temperature adjusted* thickness readings each day

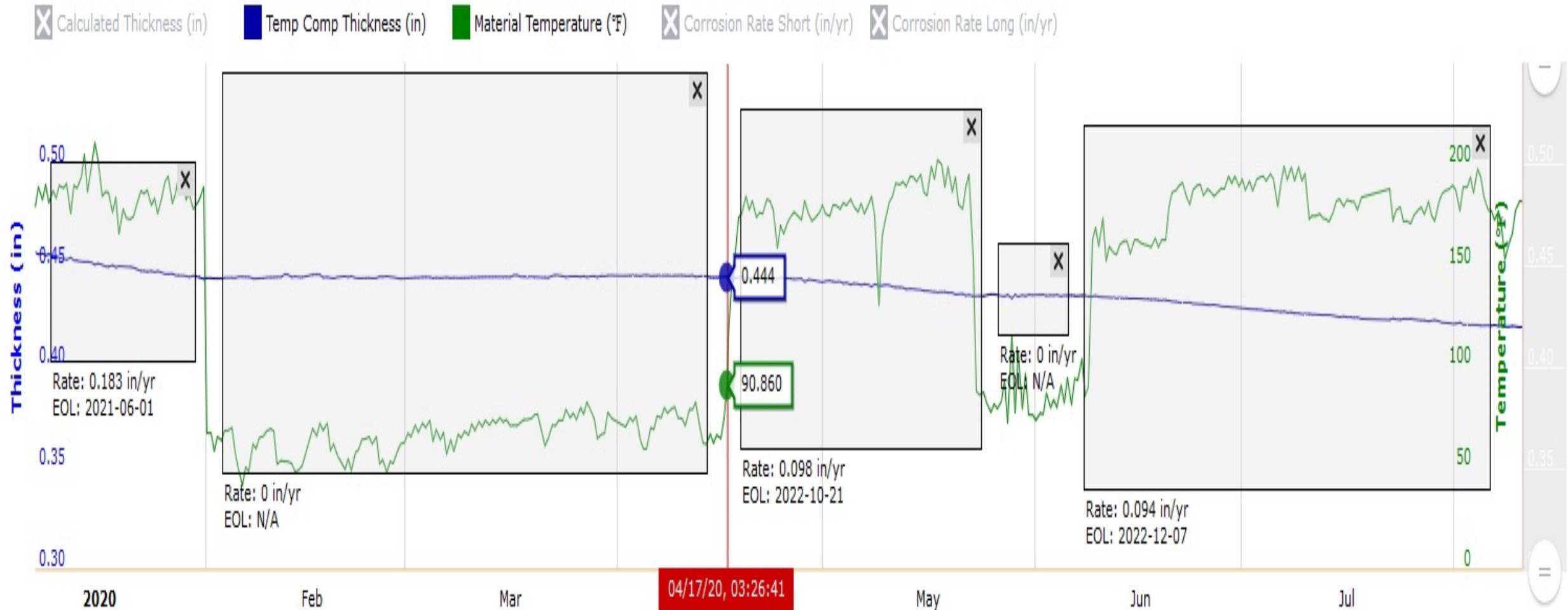
Outcome:

- Optimized operational temperature of the unit vs. corrosion
- “We never really knew when/why/how we were corroding doing it the old fashioned way (infrequent manual inspections)”

Cost: \$75K



Case Study: Chemical



Conclusion

Navigating COVID-19 has been a challenge, but was an opportunity for many to think differently about their businesses

Real people just like you are thinking about things differently and becoming advocates and leaders of change ... and it's making a difference!

Change can seem like a lot of work ... but then again, it may just be a change in mindset



THANK YOU



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