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Lean Methodology Improves Coiled Tubing Rig-up Time in High-Pressure Exploration Wells

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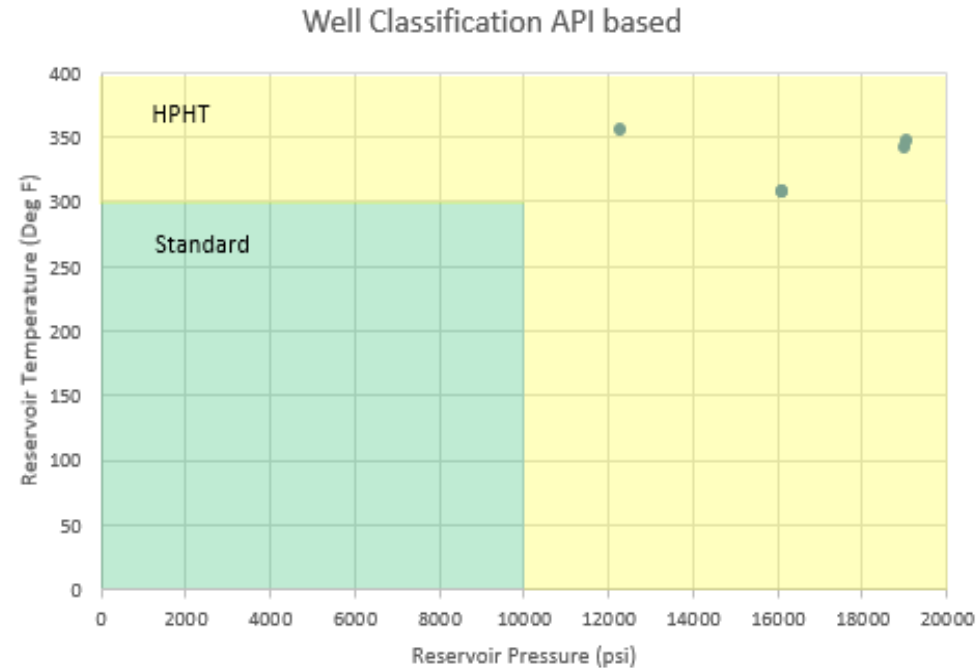
Well Intervention — Schlumberger
Offshore Mexico

Agenda

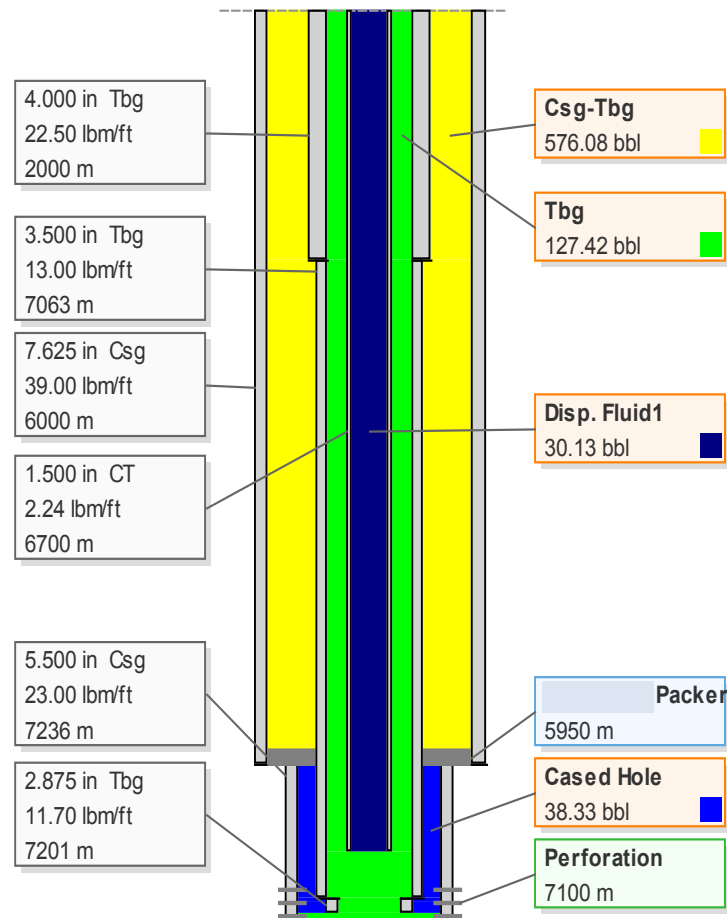
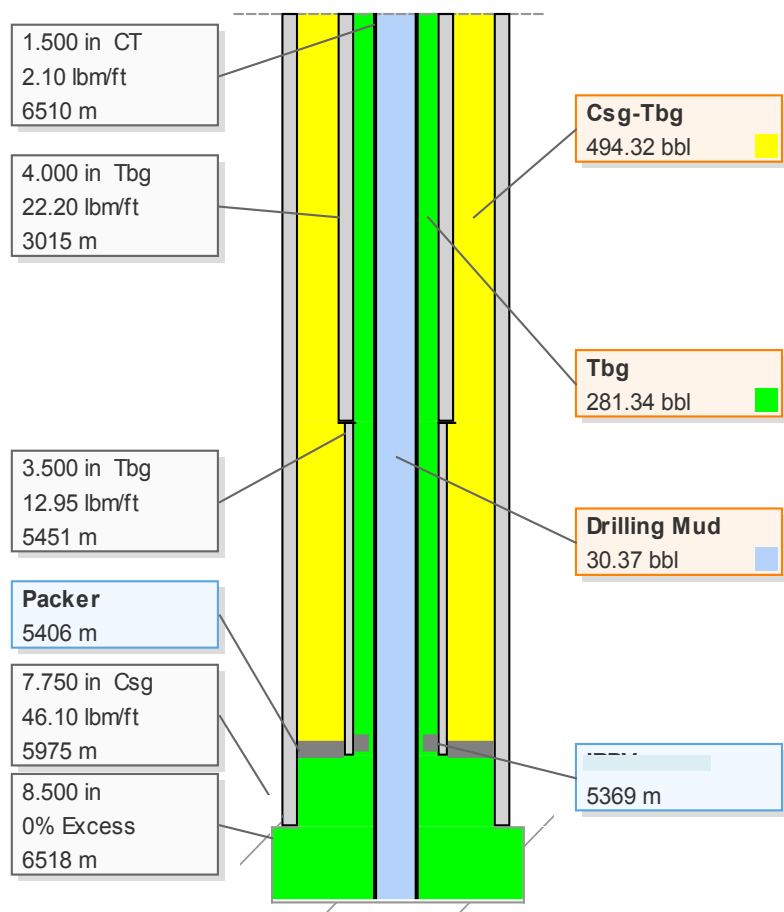
- Introduction to High-Pressure (HP) Coiled Tubing (CT) Operations
- 2015 Background
- Lean Tools
- 2016 – 2017 Results
- Conclusions

HP CT Operations Environment

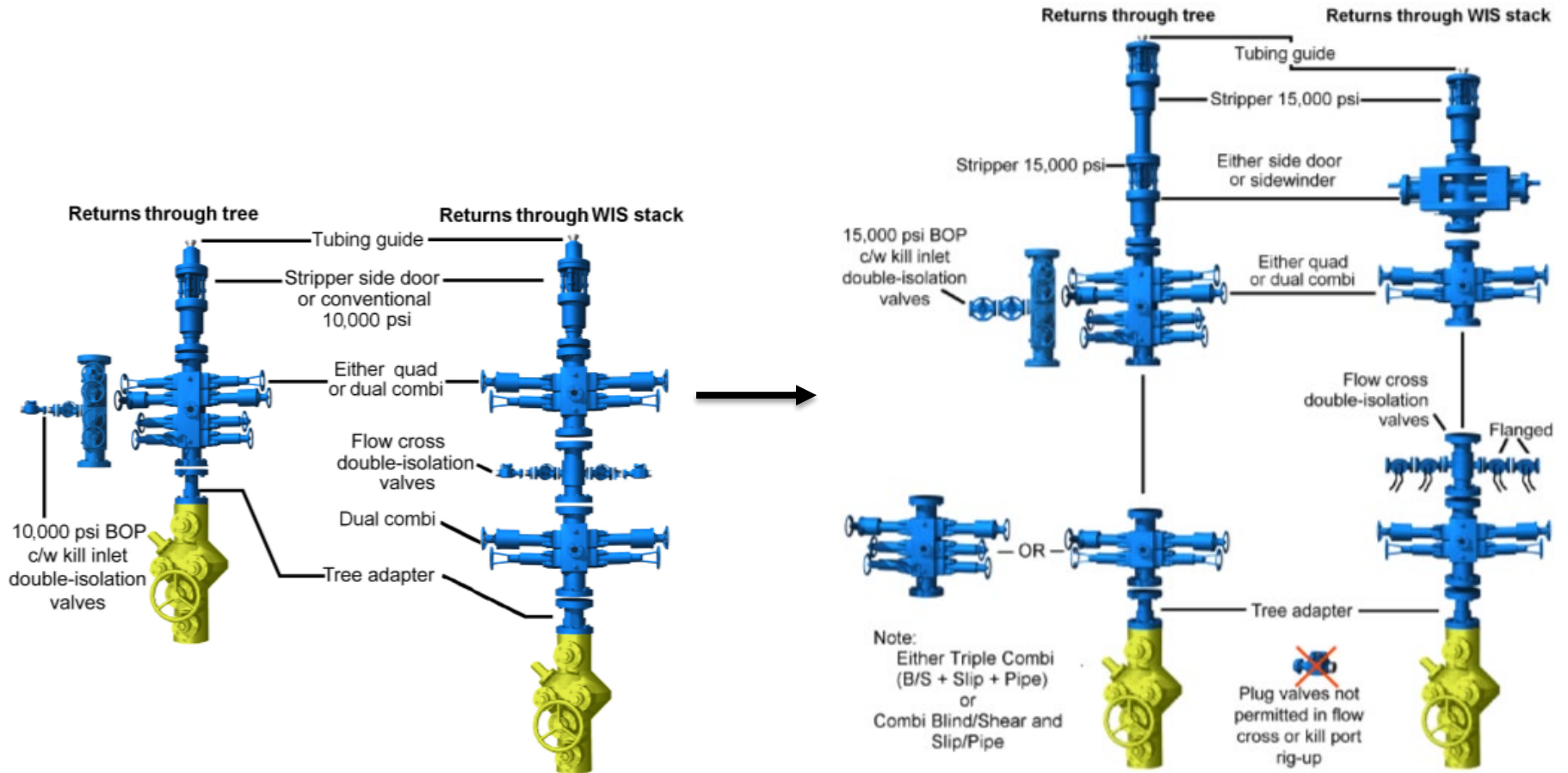
- Shallow water in offshore Mexico
- BHP: 10,000–20,000 psi
- BHT: 300–400°F
- Well testing of exploratory wells, which bottom-hole pressure and temperature are shown in the plot



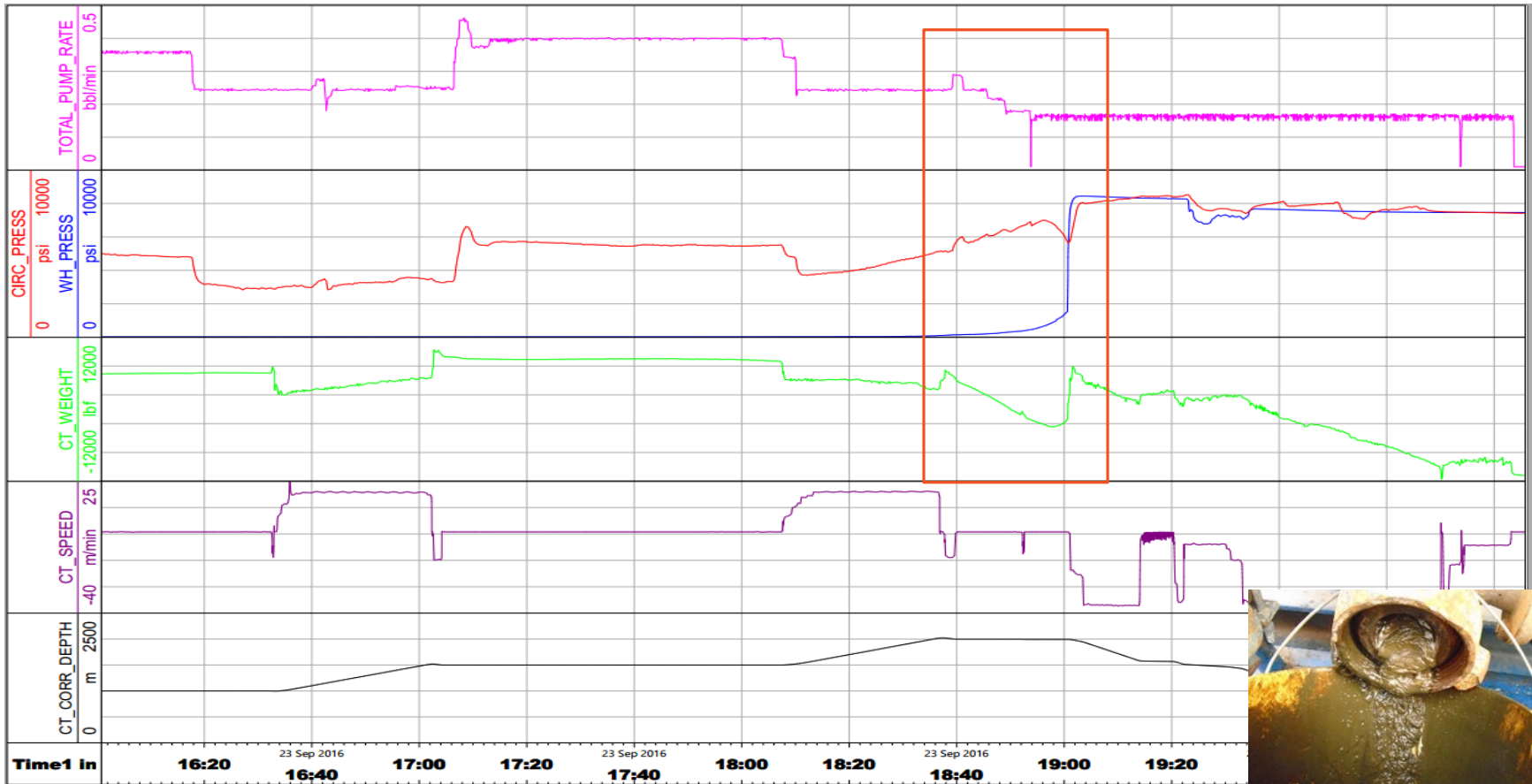
HP CT Operations Environment



HP CT Operations Environment



HP CT Operations Environment



Condition of the returning fluid

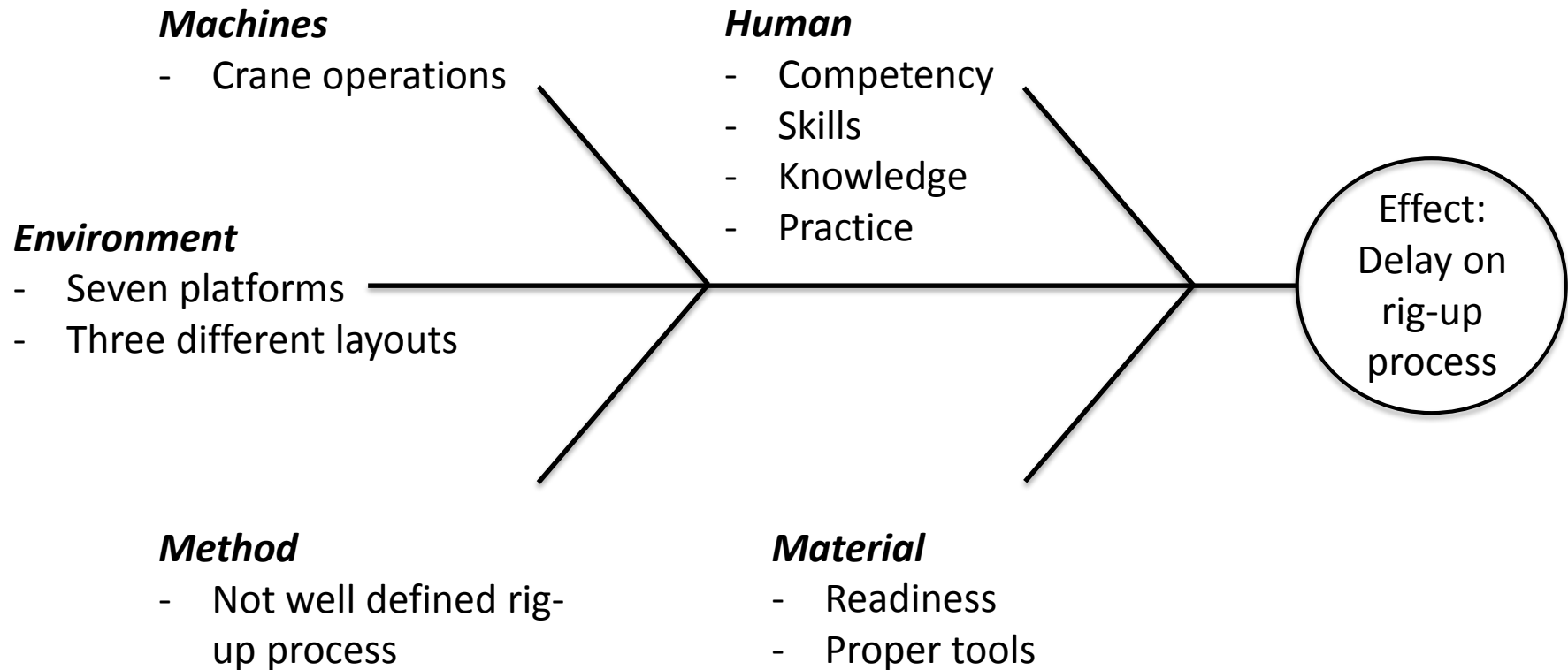
2015 Background

- Operator concerned due to long rig-up time and high standard deviation from plan
 - Average rig-up time: 27.8 hours
 - Standard deviation: ± 4.3 hours
- CT provider selected personnel based on availability
- Operational efficiency 95.5%

Introduction of Lean Tools

- Cause and effect diagram
- Work breakdown structure
- Critical path method
- Equipment layout
- Proper selection of workers

Lean Tool: Cause and Effect Diagram




Lean Tool: Work Breakdown Structure

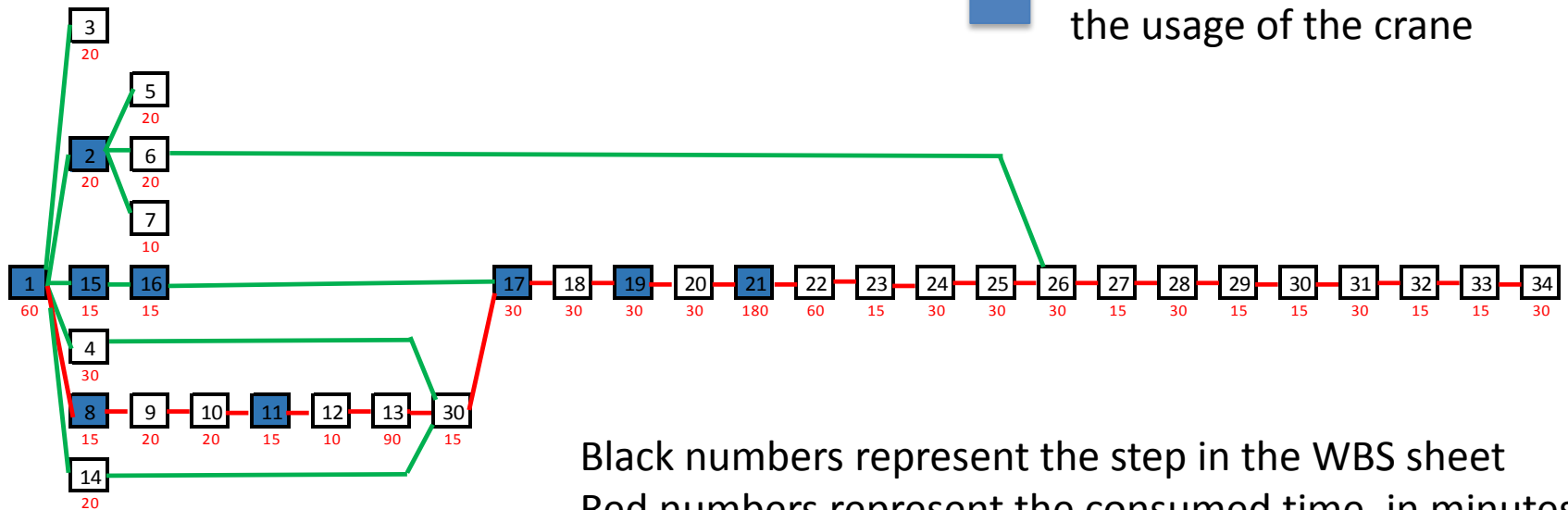
- Aided in defined the rig-up tasks and the consumed time
- Allowed the identification of resources needed to perform the task
- Enabled identification of waste time activities

No.	Activity	Resource					Time (hrs)
		Crane	Top Drive	Winch	Rig Personnel	Sib Personnel	
1	Align CT equipment, and N2 & Fluid pumps. (this is not consid	X			X	2	
2	Introduce DID on TRS	X			X	2	20
3	Install Internet Antena					2	30
4	Set supply hoses on displacement tanks on MPS				X	2	30
5	Rig-Up treating line from Fluid Pump to TRS					2	20
6	Rig-Up treating line from N2 Pump to TRS					2	20
7	Pull & connect hydraulic hoses from Power Pack to TRS					2	10
8	Move Well Control Equipment to drill floor	X			X	4	15
9	Install Wellhead Adapter			X	X	2	20
10	Install BOP		X		X	3	20
11	Pull & connect hydraulic hoses from Power Pack to BOP	X			X	4	15
12	Function Test BOP					2	10
13	Install risers/lubricators		X		X	3	90
14	Rig-Up treating line from Fluid Pump to BOP					2	40
15	Move Injector Head and Goose Neck to cantilever	X			X	2	15
16	Install Goose Neck on the Injector Head	X			X	2	15
17	Move Injector Head to Drill Floor	X			X	2	30
18	Secure Inhector Head with the Top Drive and Winchs		X	X	X	2	30
19	Pull & connect hydraulic hoses from Power Pack to Injector Head & Stripper	X			X	4	30
20	Function Test Injector Head					2	30
21	Stab CT on Injector Head	X		X	X	4	180
22	Rise Injector Head		X	X	X	1	60
23	Cut section of CT String		X			2	15
24	Install CT Connector		X			2	30
25	Perform Pull-Test		X			2	30
26	Fill CT String with water		X			1	30
27	Pressure Test CT Connector		X			3	15
28	Install BHA		X			2	30
29	Function Test BHA		X			3	15
30	Perform PT-1 (Swave V., well control equipment against BOP blind, & treating line)		X			3	15
31	Close Well Control Equipment		X		X	3	30
32	Perform PT-1 (Swave V., well control equipment against Stripper, CT String & treating line)		X			3	15
33	Perform pressure tes to check valves		X			3	15
34	Displace water on CT String with working fluid		X			3	30

Lean Tool: Critical Path Method

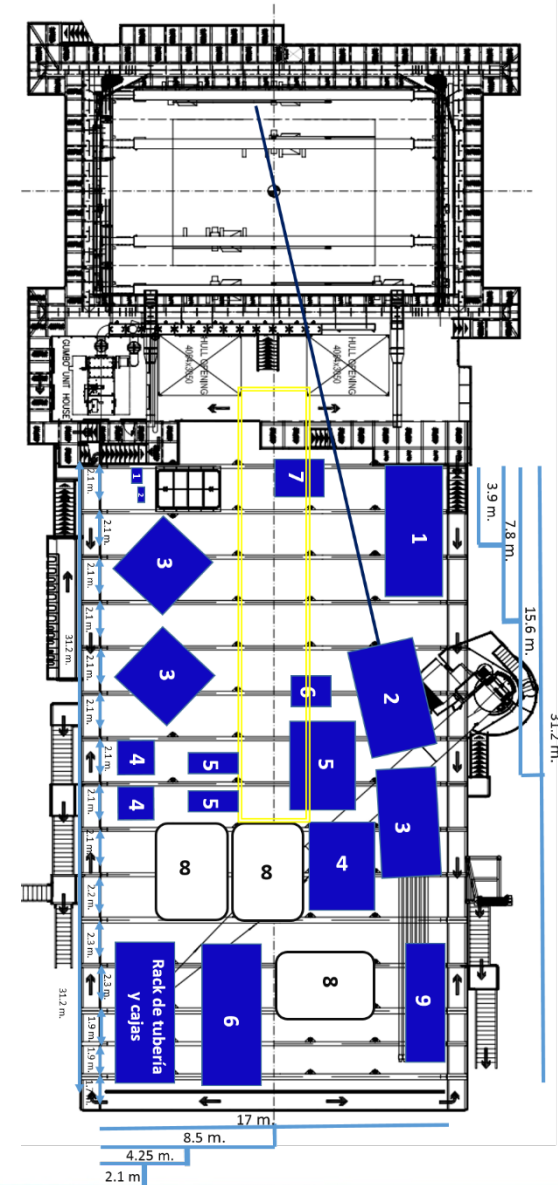
- Helped to define the logical sequence of project activities that form the longest chain in terms of time

 Activity that demands the usage of the crane



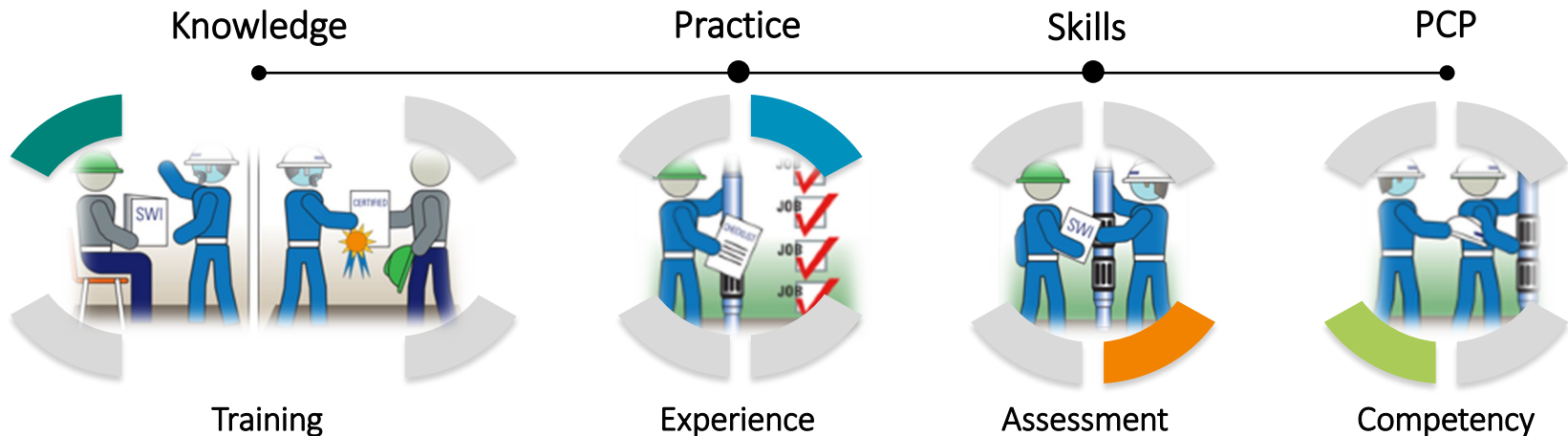
Lean Tool: Process Layout

- Seven drilling rigs visited (Three different models)
- Defined and standardized equipment layouts for well testing and CT operations in each rig, based on platform distribution
- Coordinated effort among operator, rig manager, well testing and CT representatives



Lean Tool: Proper Selection of Workers

- Competency assurance tool allowed the identification of experienced HP CT field specialists

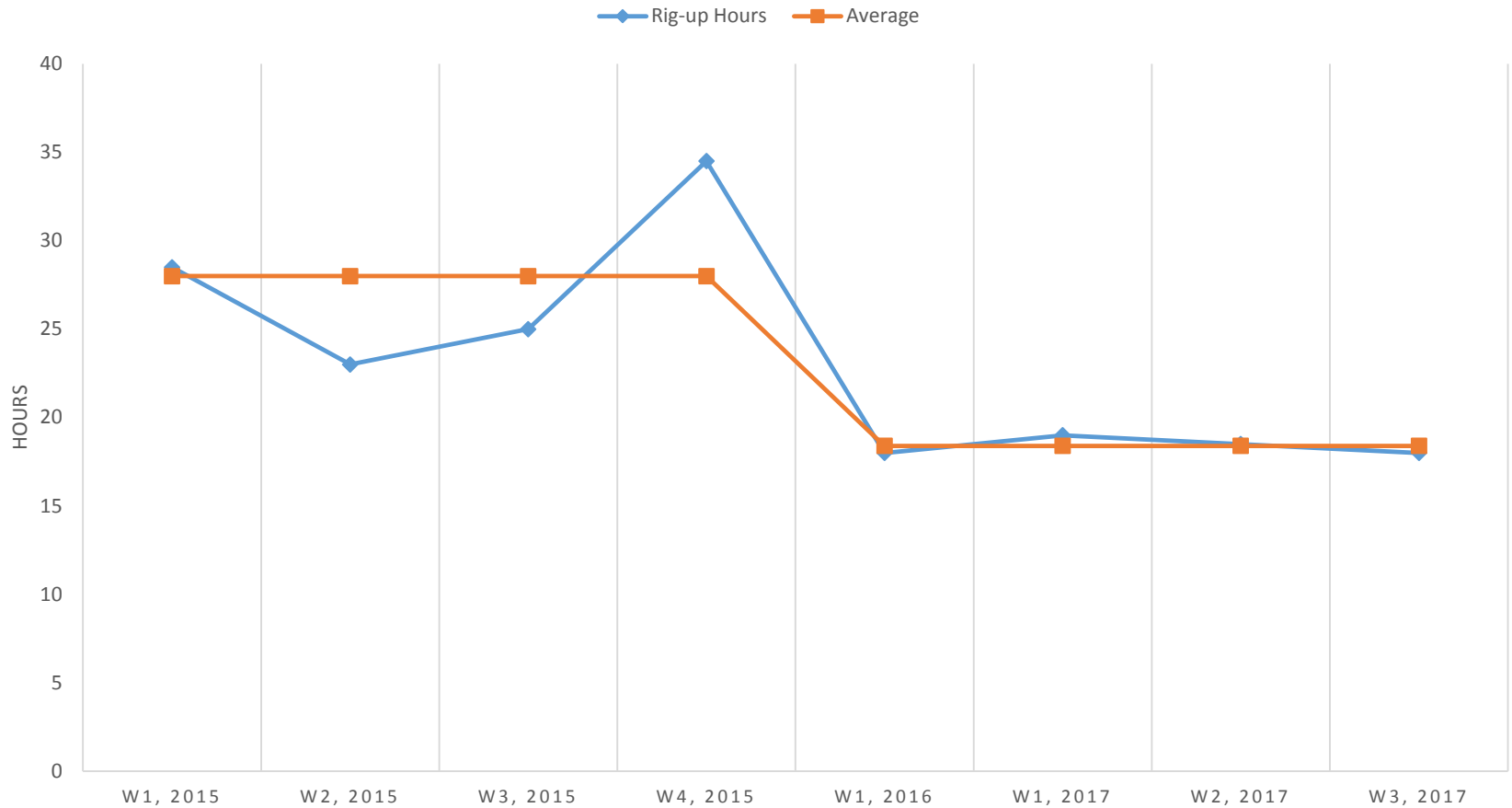


- Employee involvement in organizing work

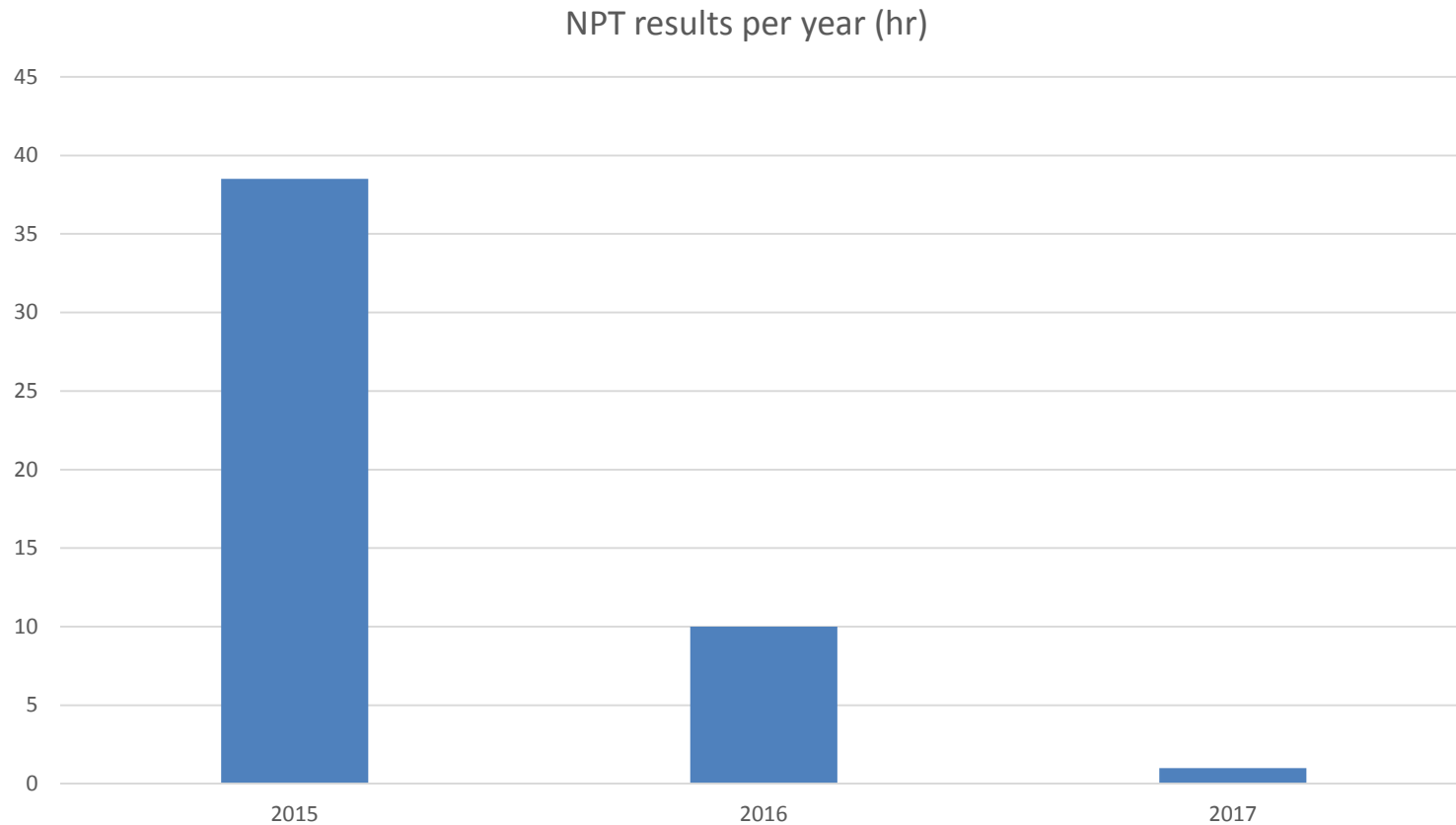
2016–2017 Results

Average rig-up time: 18.4 hr
Standard deviation: ± 0.3 hr

RIG-UP TIME OPTIMIZATION



NPT Results



- Operational efficiency increased to 99.8%

Conclusions

With Lean methodology, CT service company

- Increased its operational efficiency
 - By means of consistent NPT reduction
 - 74% in the first year (2016 vs 2015)
 - 90% in the second year (2017 vs 2016)
- Reduced the non-added-value during rig-up by 33%
- Reduced rig-up standard deviation by 90%