

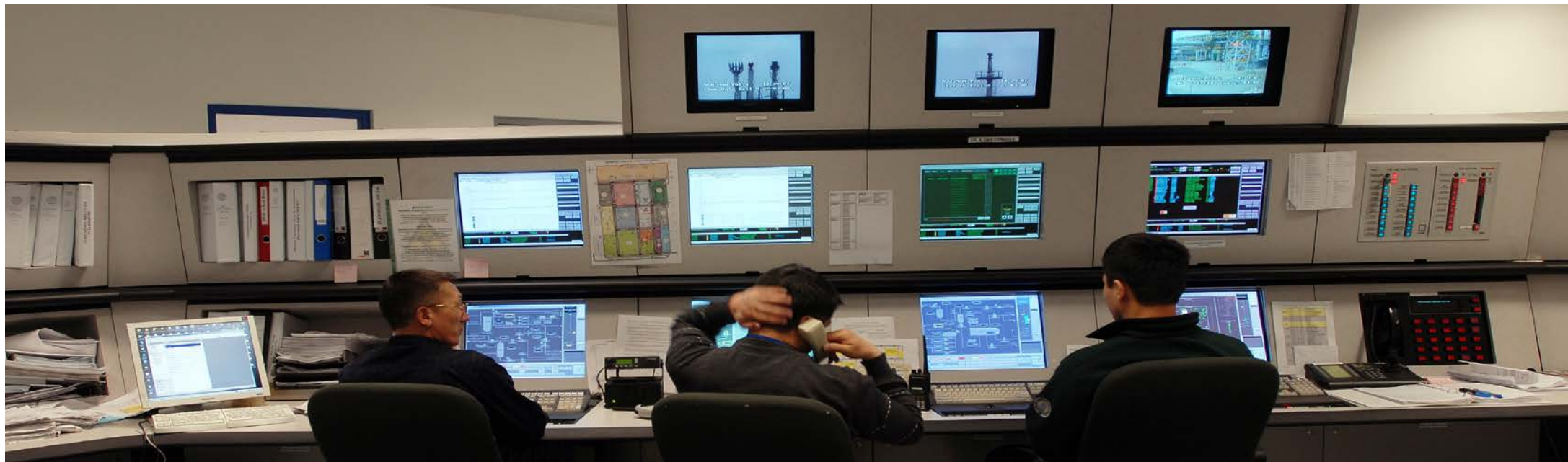
Using advanced process control to solve Butane quality issue while generating positive cash flow.



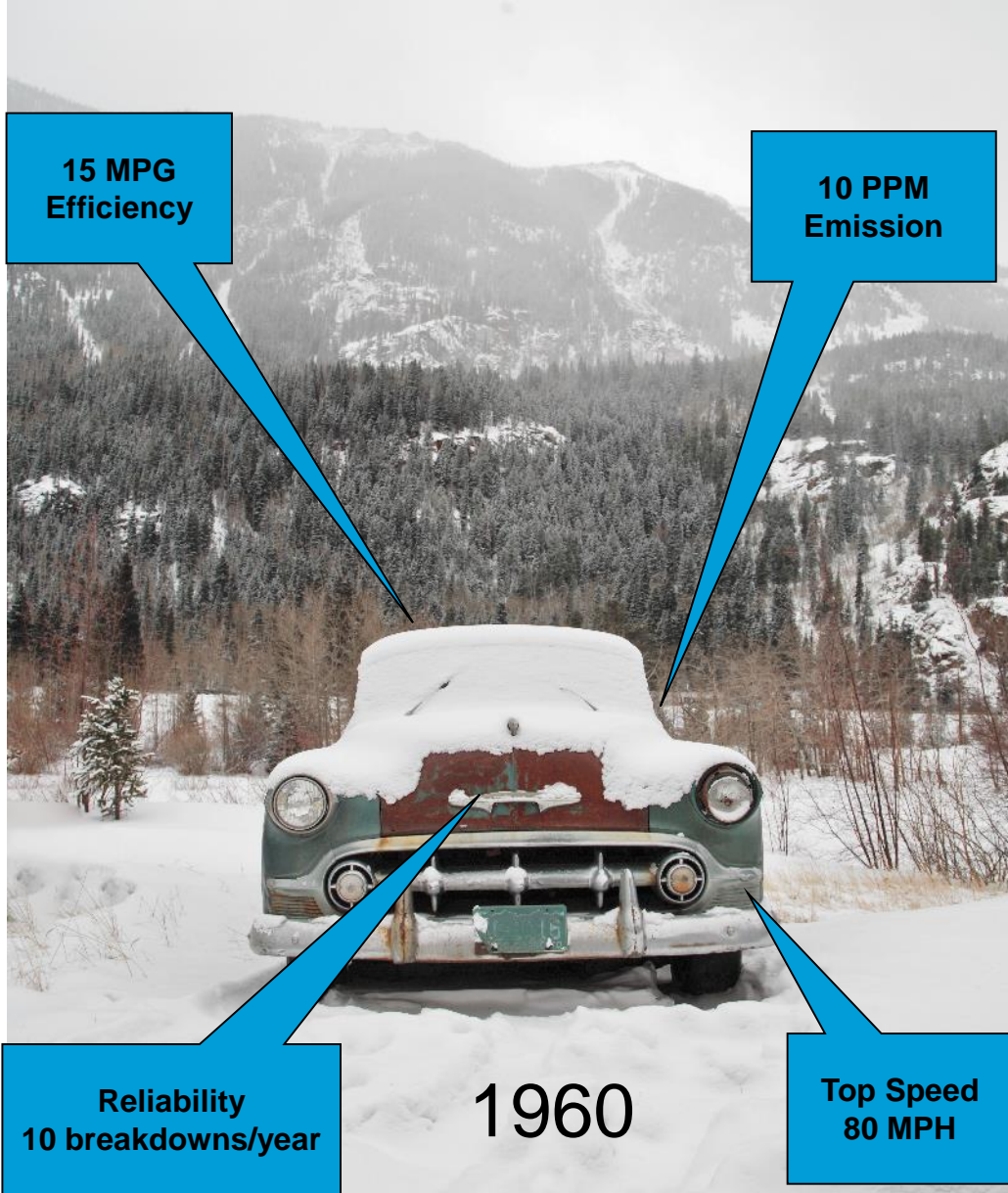
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Advanced Process Control (APC) Overview

- Why is APC an improvement from traditional process control?
 - Multivariable – Control multiple objectives as single control solution
 - Model-Predictive – Uses empirical models to predict plant operation
 - Manages Constraints – Maintains plant within specification limits
 - Optimizer – Drive plant to most economic operating conditions...makes more oil!
- The APC tool used is a Model Based Predictive Controller, it uses Dynamic Models to predict constraints to drive operation to an economic optimum while honoring an ever changing set of constraints.



Process Control Evolution



15 MPG Efficiency

10 PPM Emission

Reliability
10 breakdowns/year

1960

Top Speed
80 MPH



1 PPM Emission

25 MPG Efficiency

Automation

Top Speed
120 MPH

2017

Reliability
1 breakdown/year

Advanced Computer Controls have improved Speed, Efficiency, Emissions and Reliability

Process Control Evolution

The image shows a refinery at night, split into two panels representing the years 2016 and 2017. The 2016 panel on the left has callout boxes for 'Some Sulfur in Butane product', 'Good RVP', 'Good Production Rates', and 'Reliability 3 plant upsets/year'. The 2017 panel on the right has callout boxes for 'Better RVP', 'Better Production Rates', 'Specific amount of Sulfur in Butane product', and 'Reliability 1 plant upset/year'. The word 'Automation' is written in large green letters across the center of the 2017 panel.

Advanced Computer Controls have improved Speed, Efficiency, Emissions and Reliability

Project Definition

Opportunity Statement

- Increase oil production by upgrading Butane into stabilized crude oil

Project Drivers

- Minimize impact of Mercaptans (Sulfur) issues post 2016 TA
- Increase Reid vapor pressure (RVP) in the stabilized crude

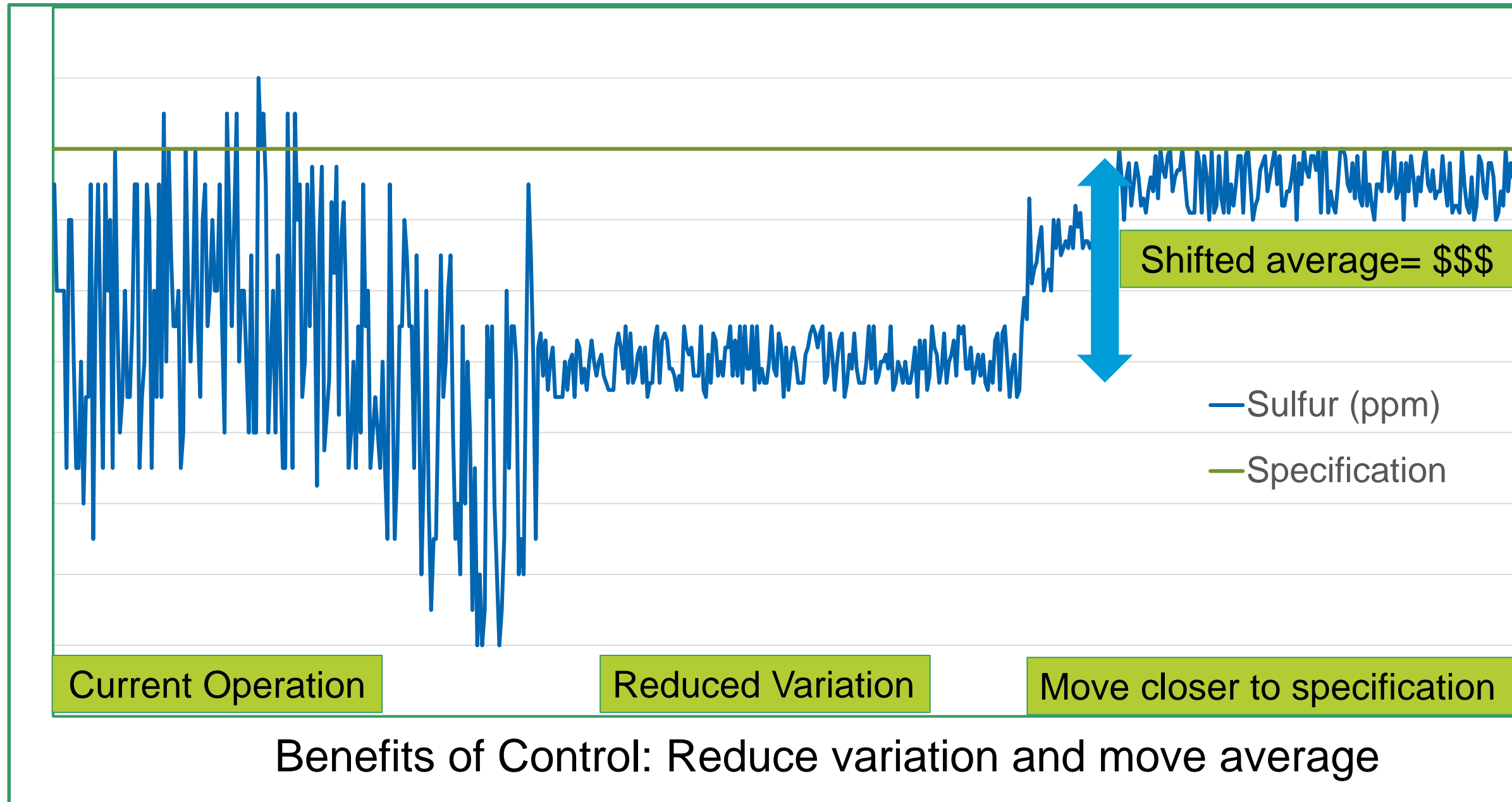
Desired State

- Produce more oil by shifting Butane into crude product while staying on Sulfur and RVP specifications
- Robust implementation



APC Features: Predictive and Optimizing Control.

- Proven tool for solving real world process control problems



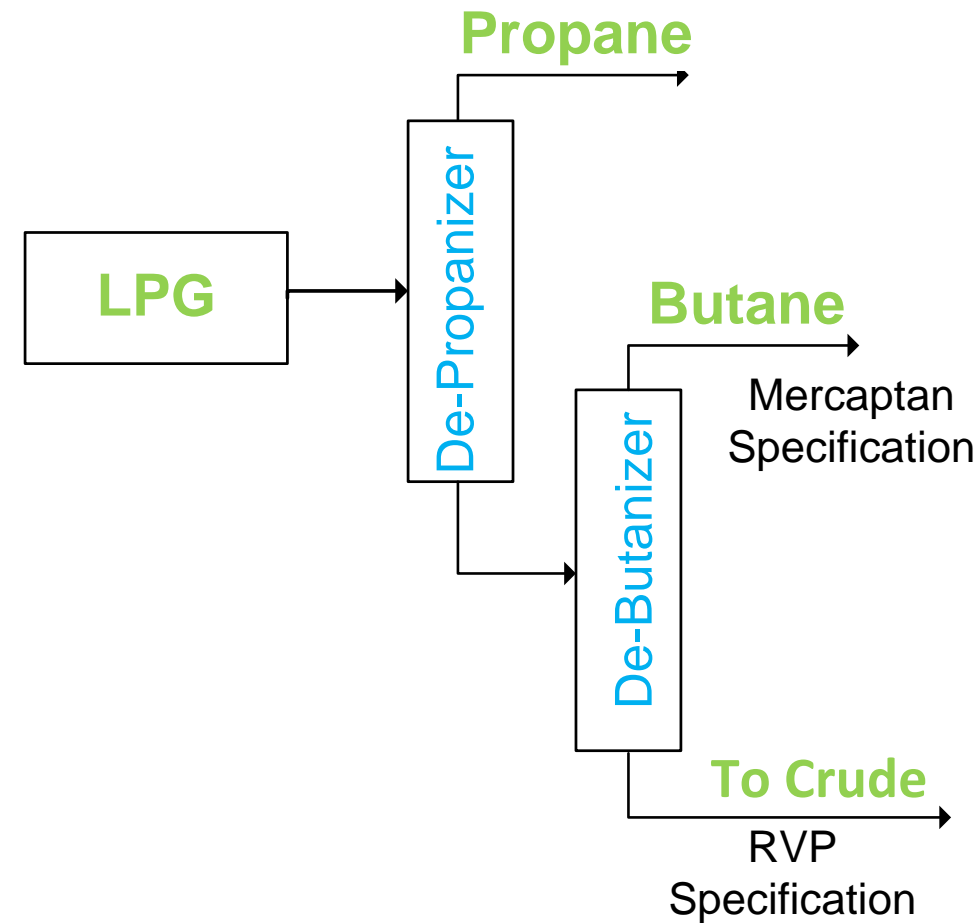
APC Project Scope and Objectives

Depropanizer:

- Optimize bottom & overhead temperatures for Propane/Butane split
- Control overhead product composition

Debutanizer:

- Optimize bottoms temperature to maximize Butane to crude
- Drive to RVP limits without exceeding Mercaptans in the overhead Butane
- Control overhead product composition



Produce more oil by shifting Butane into crude product while staying on RVP and mercaptan specifications

Insight to Depropanizer and Debutanizer

Reduced reflux rates

Reduces the sharpness of the split between the Iso and normal Butane

Provide less stripping gas to carry the methyl mercaptan into the overhead

Methyl mercaptan forms highly non-ideal solutions in the vapor phase

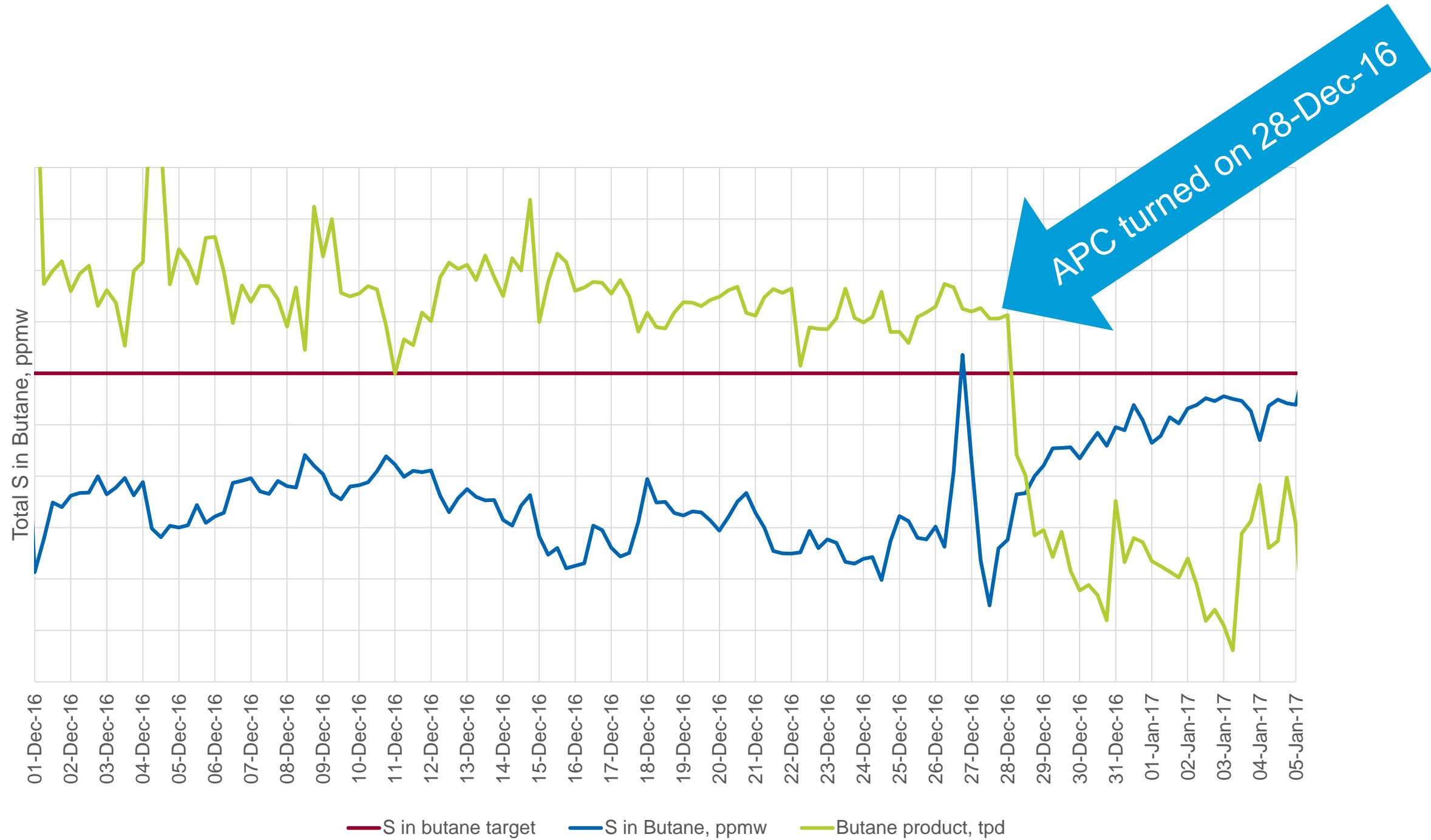
Reduced overall column temperature profile

This will reduce the potential tendency for breakdown of DiSulfide Oil (DSO) in the debutanizer

The lower we pushed the overall temperature profile, the less dilution of the Butane product was required



Instant Benefits from APC



Improved Unit Operability

World Class Operations Acceptance

- Received personal congratulation and thank you from console operators
- Controller online over 99% of the time

Extreme Versatility

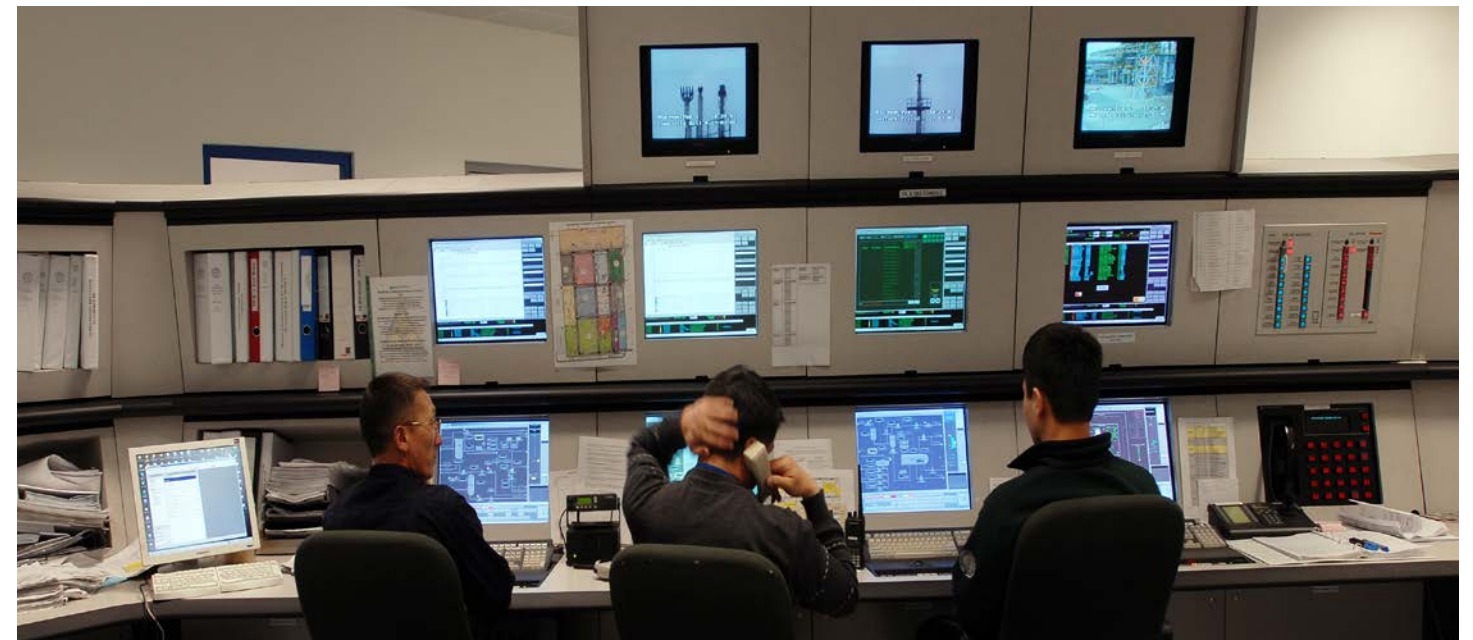
- The controller is robust
- Demonstrated the capability to ramp gas plant down to 50% rate and back up to 100%
- Proven to deliver value at any production rate

Deployed Using Chevron Methodology

- Long term maintainability
- Best in class technology

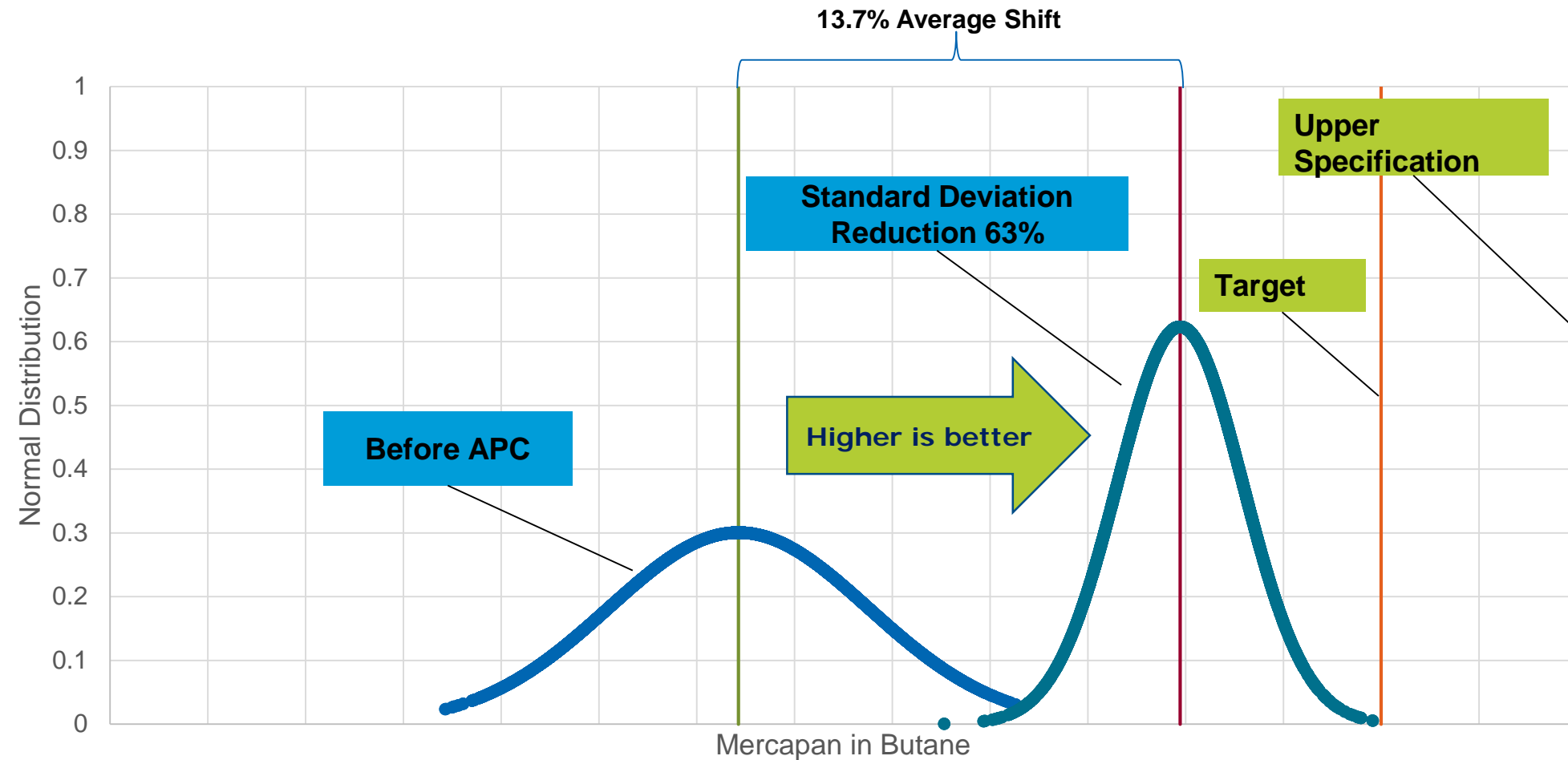
New Production Records Achieved 37 times

- New Daily MAX record achieved 3 Times
 - New 7 day SMPP record achieved 4 Times
 - New 30 day BRA record achieved 22 Times
 - New 90 day BRA record achieved 8 Times
- SMPP: Structural Maximum Production Potential
– BRA: Best Rolling Average



Sulfur In Butane Product Control Improvement

7 days before and after APC implementation

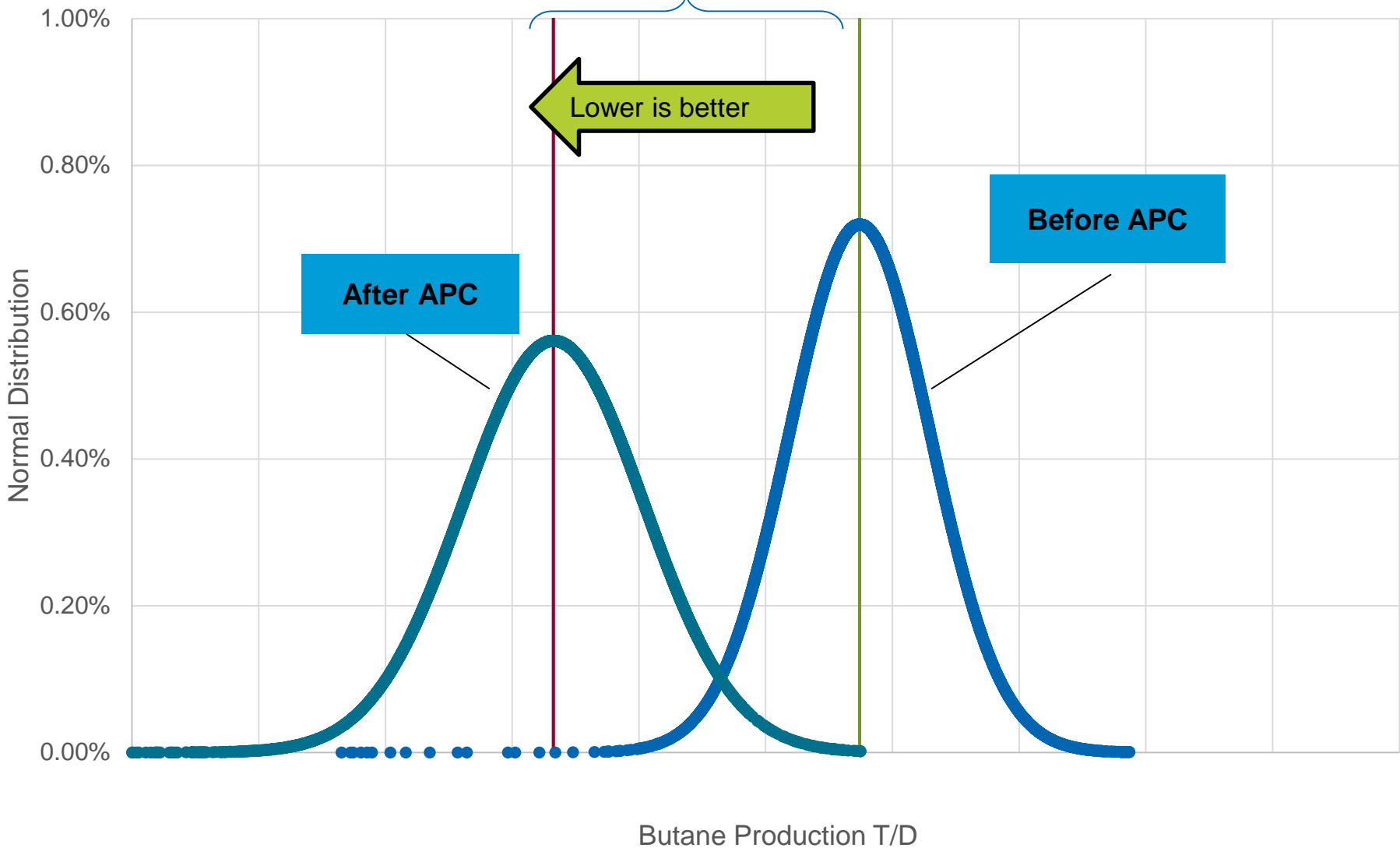


Reducing the variation in Butane product quality by 63% allows us to shift average 13% closer to specification

Shift in Butane Production

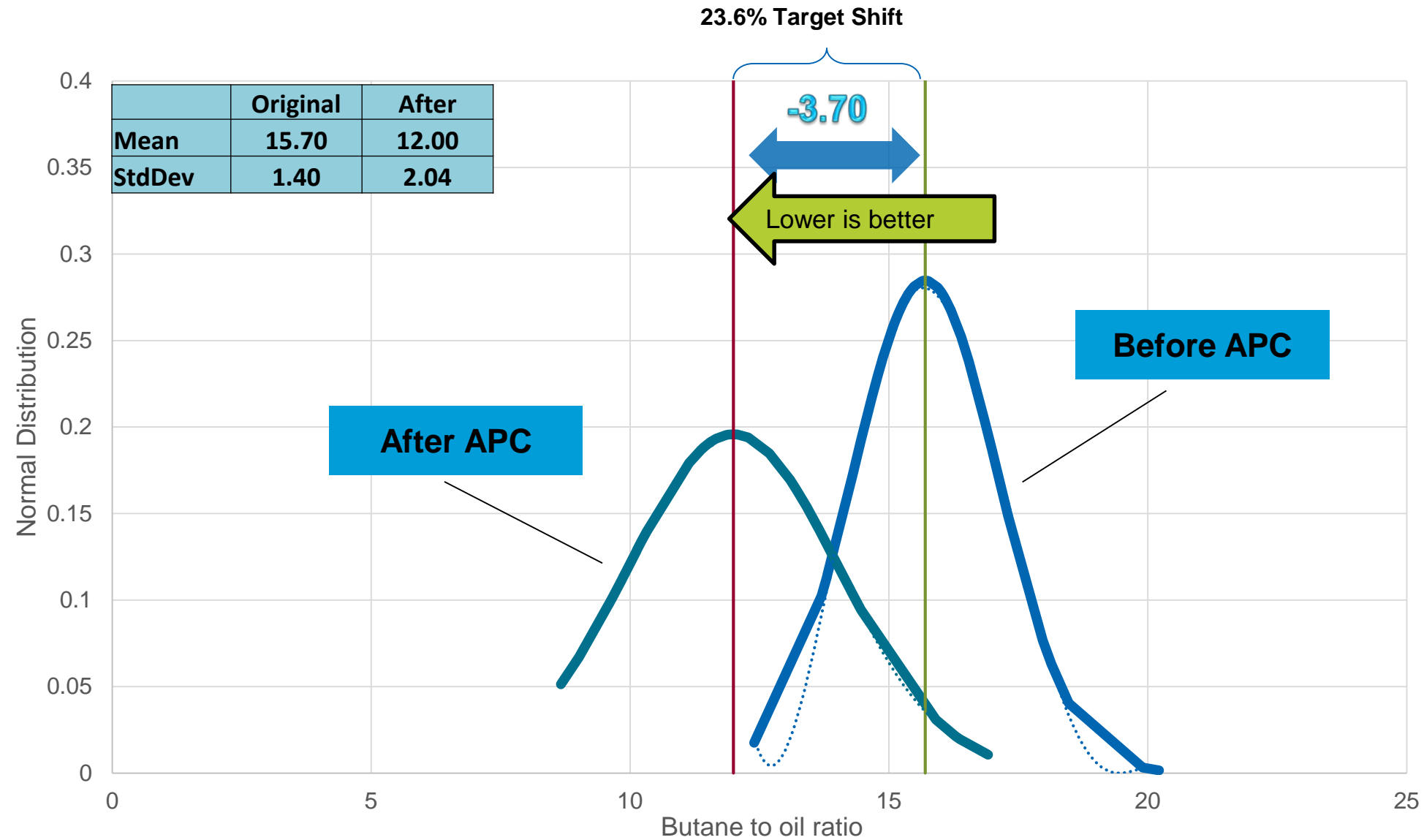
7 days before and after APC implementation

33.3% Average Shift



The result of shifting Butane quality is less Butane production. Excess Butane can now be dropped into produced oil stream

Shift of Butane to Oil Ratio



The Butane to oil ratio is measurement of how much additional Butane is sold as crude

APC Benefit Calculations

Before APC	15.7	
After APC	12	
	3.7	Change in Butane to Oil Ratio
Increased Oil	>1200	BPD
Annualized Value	\$\$\$\$\$	\$/year



High Performance Behaviors

Credits and appreciation

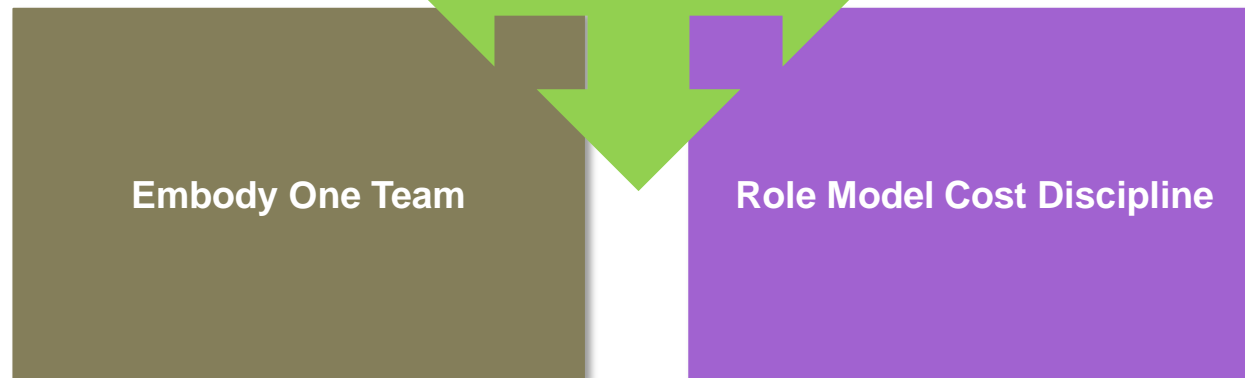
- Great assistance from Lead Board Engineers
- Great assistance from Analyzer Reliability Team
- Great assistance from Central Laboratory

Prioritize High Value work



Demonstrated sense of urgency Management was seeking input from all disciplines

Operations
Automation
Engineering
Laboratory
Analyzer Team



Chevron already has rights to the software. No additional CAPEX or OPEX costs

Questions

