Preventing Routine Tank Venting – A Transient Approach to the Design of Production Tank Battery Control Systems

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Overview

- The Problem: Routine Venting
- Causal Analyses: Transient Model
- Solutions and Benefits
- Case Studies
- Q&A

ROUTINE VENTING FROM CONTROLLED TANK BATTERIES

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Objective Hierarchy: Venting

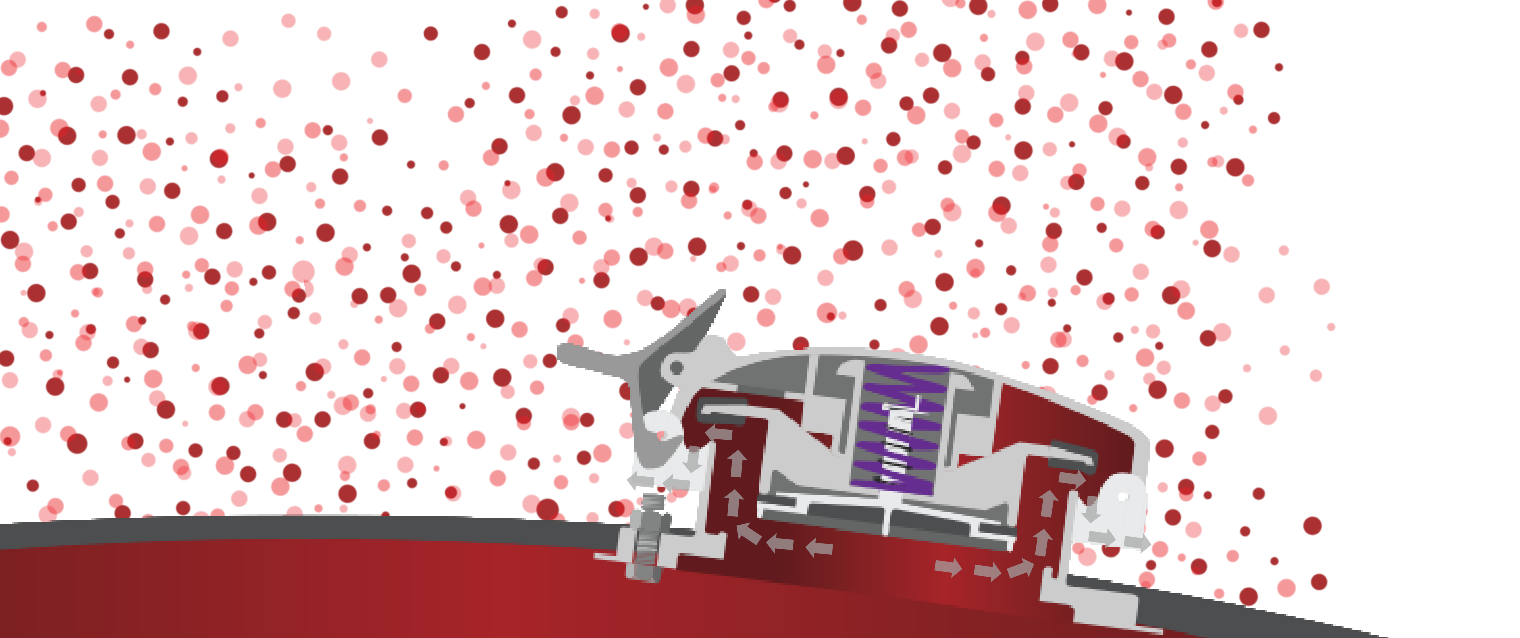
- Eliminate “routine venting” of unburned gases
- Reduce the volume of vented gas
  - planned and unplanned nonroutine venting (e.g. maintenance and repair)
- Improve efficiency of vent systems

Alberta Energy Regulator Directive 060, 2018

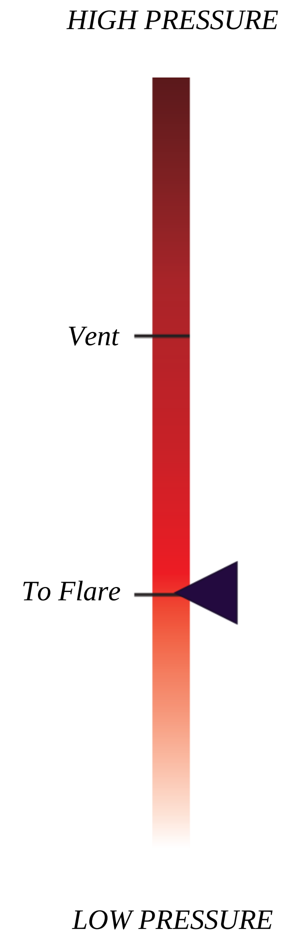
What is “Routine Venting?”

- “Routine” applies to continuous or intermittent venting that occurs on a regular basis due to **normal operation**
- “Nonroutine” venting is intermittent and infrequent and may be planned or unplanned
- Normal operation generally means all periods of operation other than malfunction, maintenance and repair

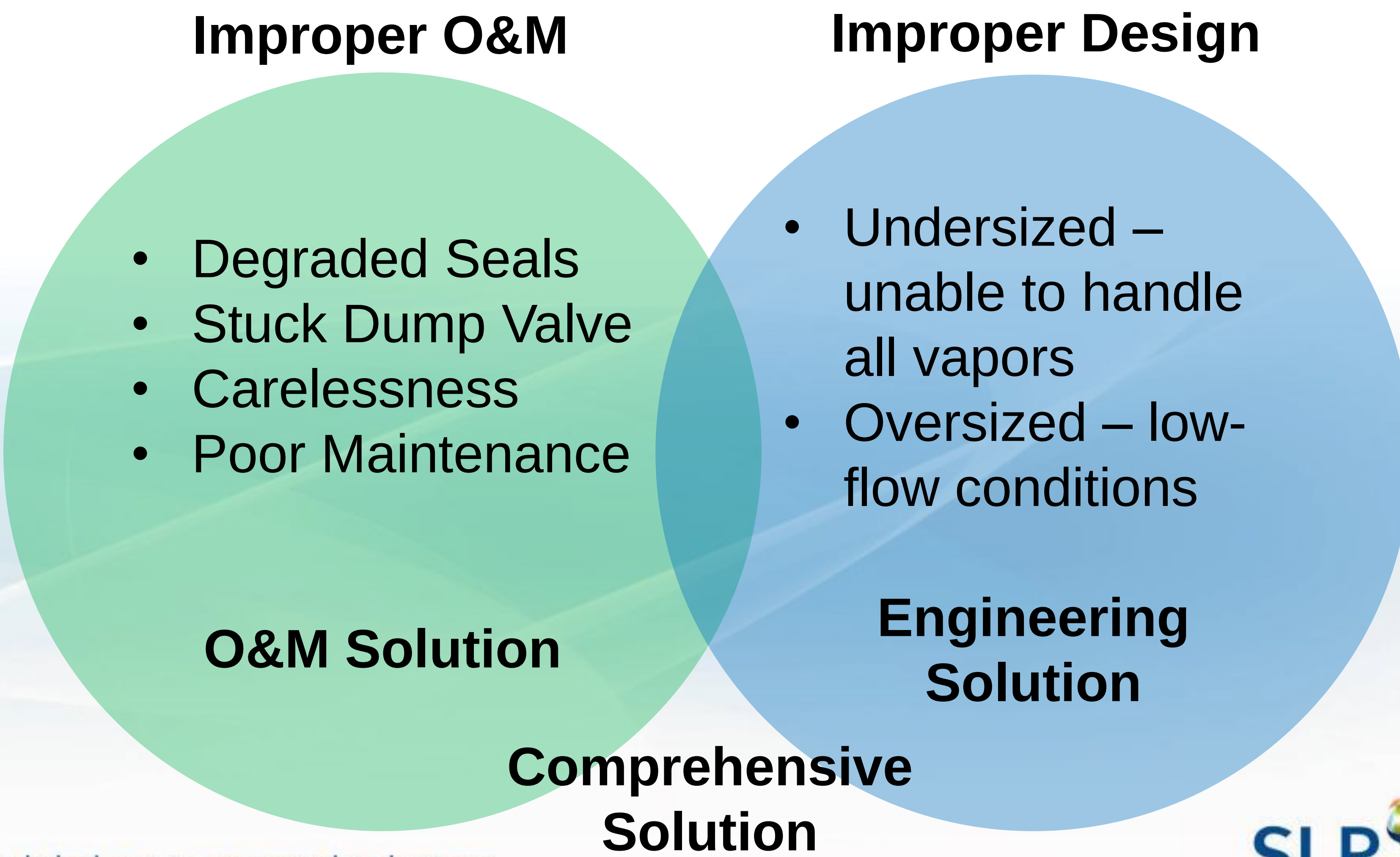
Routine Venting During Normal Operation?



Tank systems are designed to open to atmosphere during over-pressure or vacuum conditions to protect structural integrity



Causes of “Routine Venting”



Continuous Improvement Process – Tank VCS Design

Engineering Design or Redesign

Installation, Operation and Maintenance

Best Practices: Inspections/LDAR, Monitoring

Corrective Action: Repair or Replace

ENGINEERING DESIGN ASSESSMENT

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Design Assessment Objectives

1. Determine whether or not VCS capacity is of sufficient design and capacity to ensure that all gas/vapor emissions from the storage vessel are routed to the control device with no routine venting

Design Assessment Objectives

2. Establish boundary parameters within which battery VCS capacity is sufficient

3. Target bottlenecks and cost-effective engineering solutions to optimize system

Design Assessment – Steps

1. Quantify Vapor Into System

Potential Peak Instantaneous Vapor Flow Rate (PPIVFR)

2. Determine System Capacity

A transient approach includes accumulation in system

3. Compare PPIVFR and Capacity

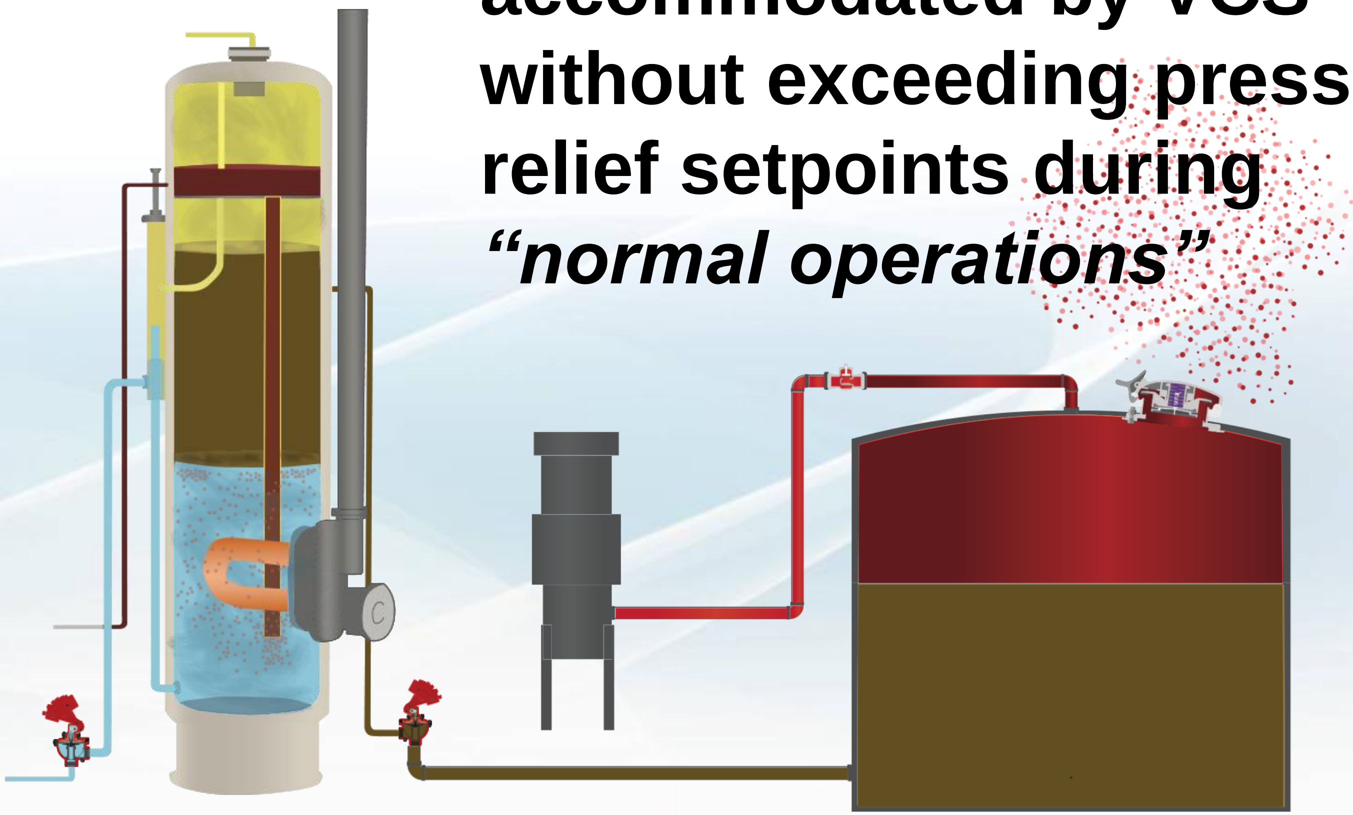
Can system accommodate PPIVFR with no venting?

4. Identify Cost-Effective Solutions

Increase capacity and/or decrease PPIVFR

What is VCS Capacity?

Volume of gas that can be accommodated by VCS without exceeding pressure relief setpoints during *“normal operations”*



Capacity Limitations

- Primary limiting factor – pressure
  - Physical volume of system vapor space
  - Losses in VCS piping/fittings, flame arrestor and combustor/flare
  - Pressure relief (thief hatches, PRDs) set points

Why A Transient Model?

- Oil and gas production facilities are dynamic systems
- Can account for accumulation (surge) capacity
- Trend pressure versus time
- Create optimal design and operating parameters

STED A Transient Model for Storage Tank VCS Systems

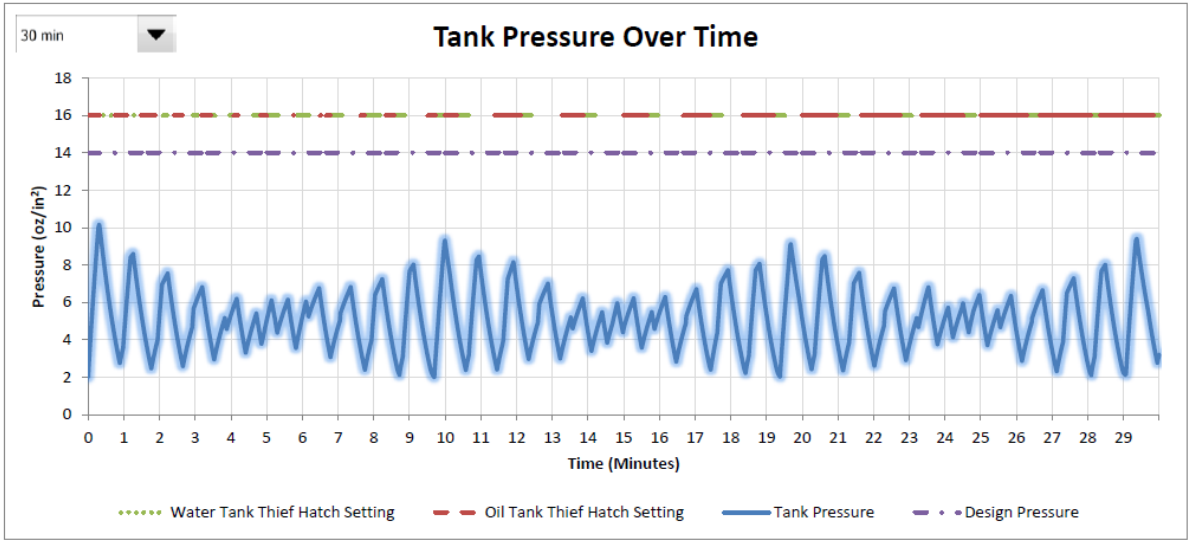
Storage Tank Emissions Design Model
Output

Site Name:	Example 1
Client Name:	XYZ Petroleum
Location:	Weld County Colorado

Peak Instantaneous Flow Rate	
Oil Tank Flash (scfh)	14,143
Water Tank Flash (scfh)	182
Working (scfh)	1,245
Breathing (scfh)	2
Other Sources (scfh)	0
Total (scfh)	15,572

System Capacity at Design Pressure	
Burner Capacity (scfh)	8,327
Vent Valve Capacity (scfh)	11,304
Surge Capacity (scfh)	13,166
Total (scfh)	21,494
Peak Tank Pressure (oz/in^2)	10.14

System Capacity at Relief Pressure	
Burner Capacity (scfh)	8,917
Vent Valve Capacity (scfh)	12,057
Surge Capacity (scfh)	15,647
Total (scfh)	24,564
Flow Out Thief Hatch (scfh)	0



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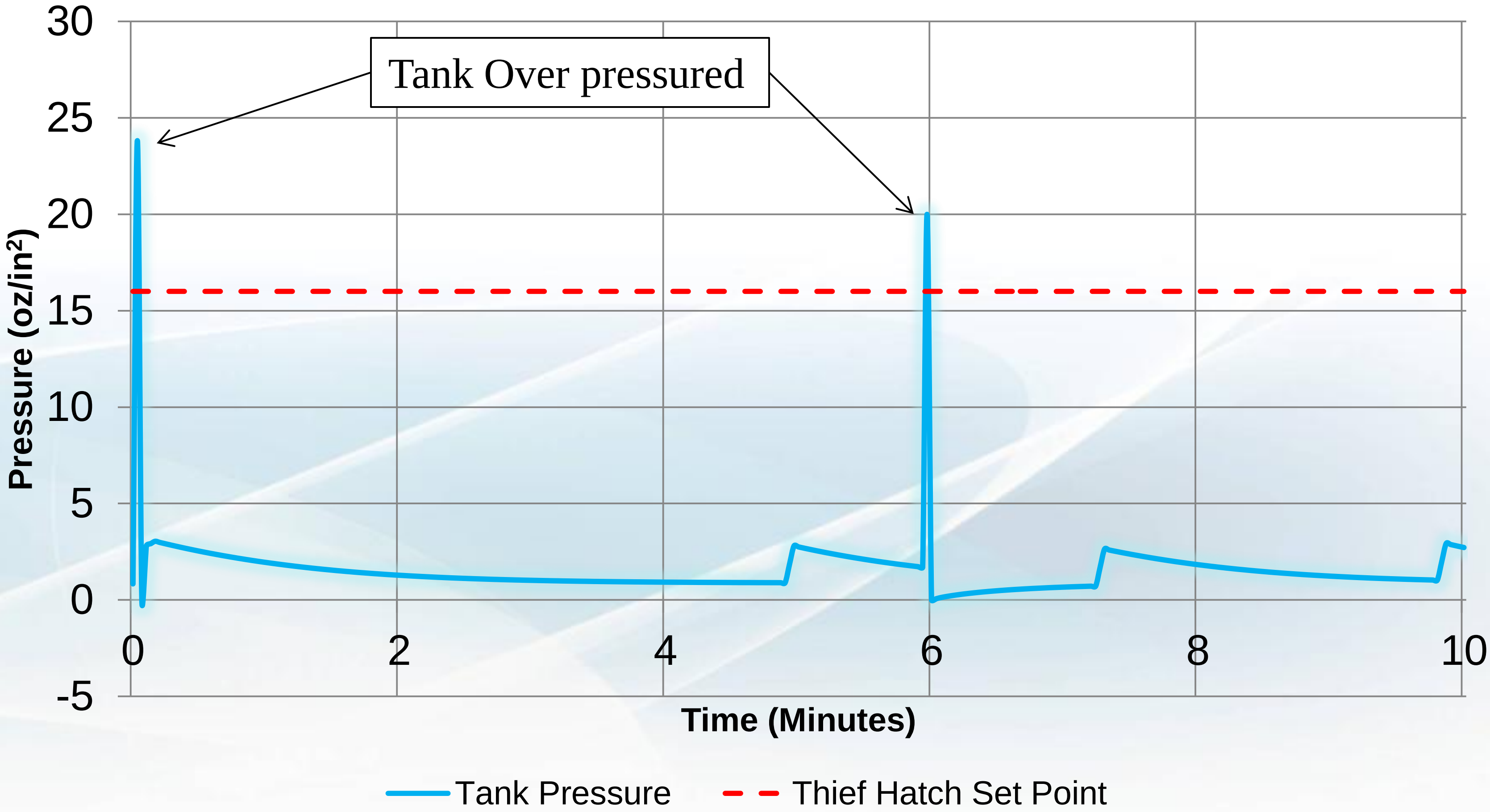
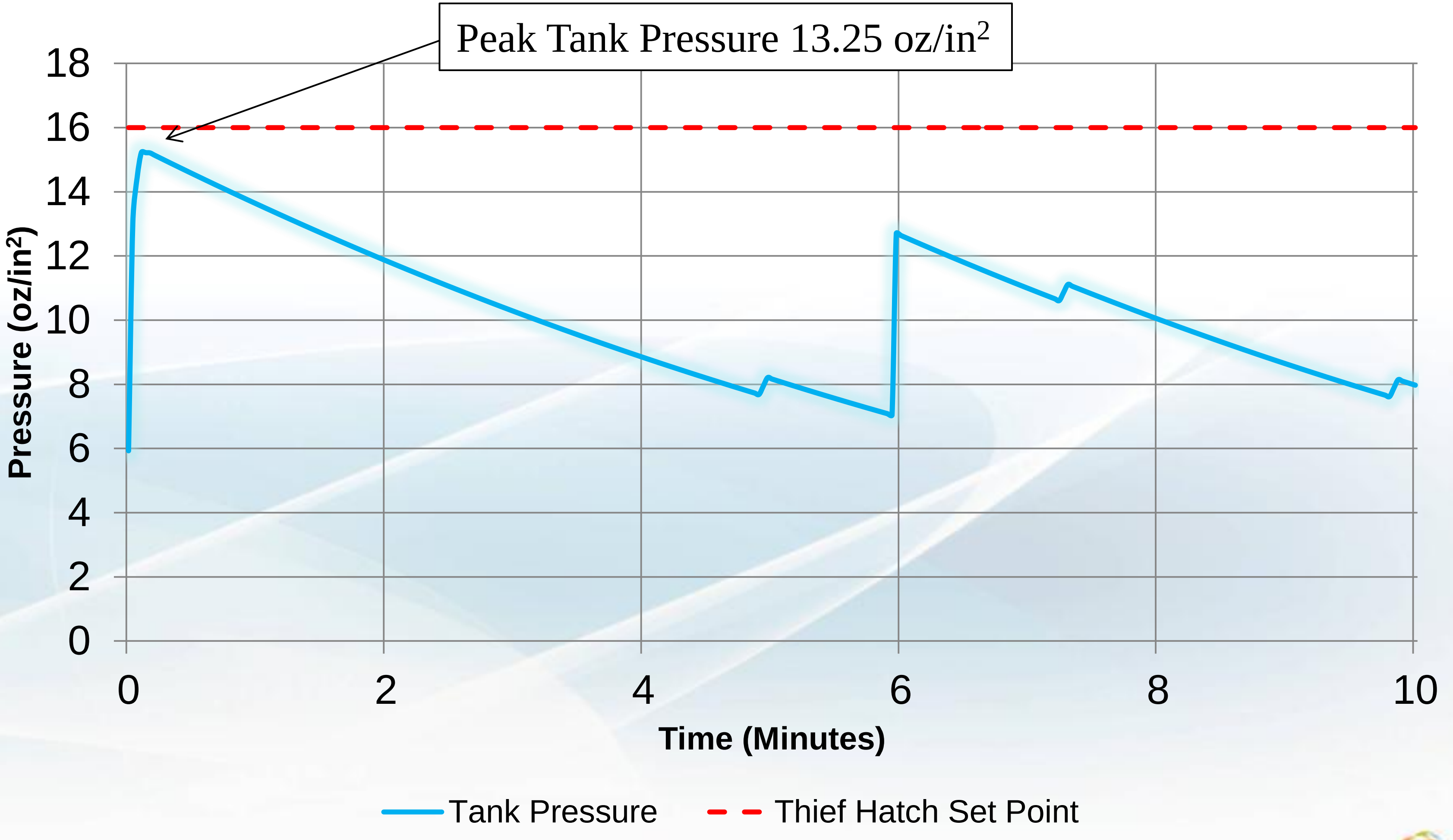
Example 1: Inadequate Design



Example 2: Adequate Design



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Solutions

Objective	Solution
Increase VCS Capacity	Increase vapor surge capacity (empty space) – e.g., "bottom out" tanks or engineered tank liquid height limits *-Repurpose surplus tanks from over-designed systems*
	Increase pressure relief device (PRD) set points
	Eliminate liquid accumulation in VCS piping *-aboveground piping optimal*
	Increase pipe/fittings diameter, remove unnecessary fittings and bottlenecks
	Additional or larger flares/burners, burner management systems
Decrease PPIVFR	Staged separation or VRT to reduce flash in tanks *-Repurpose surplus vessels from over-designed systems*
	Reduce dump valve body and/or valve trim size

Additional Benefits

- Eliminate routine venting, subject to proper O&M
- No production curtailment
- Little or no CAPEX($)
- Standardize design for future surface sites
- Optimize existing operations
- Reduce pad footprint for overdesigned systems
- Improved public relations

Transcient Engineering Design Evaluation

CASE STUDIES

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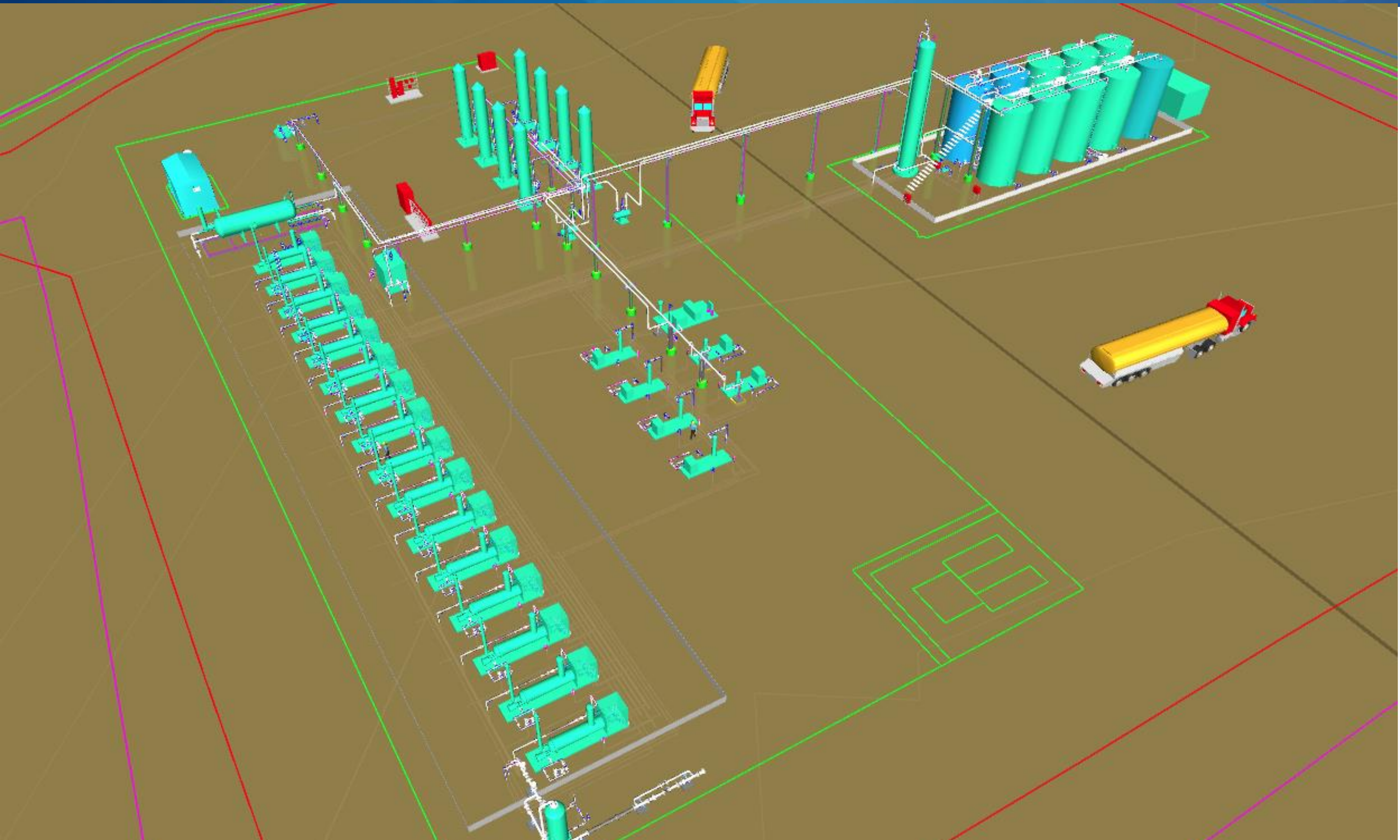
Case 1: Field-Wide Optimization



Case 1: Field-Wide Optimization

- 288 geographically dispersed multi-well batteries in Denver-Julesburg Basin
- Conventional and unconventional wells
- Gathered field-verified VCS parameters
- Developed model inputs and engineering boundary parameters
- Transient process modeling
- Targeted optimization measures

Case 1: Modeling

Transient Engineering Analysis to Identify Each Tank System VCS that was

- Adequately- or over-designed
  - Peak Tank Pressure < Relief/Design Pressure
- Under-designed
  - Peak Tank Pressure ≥ Relief/Design Pressure

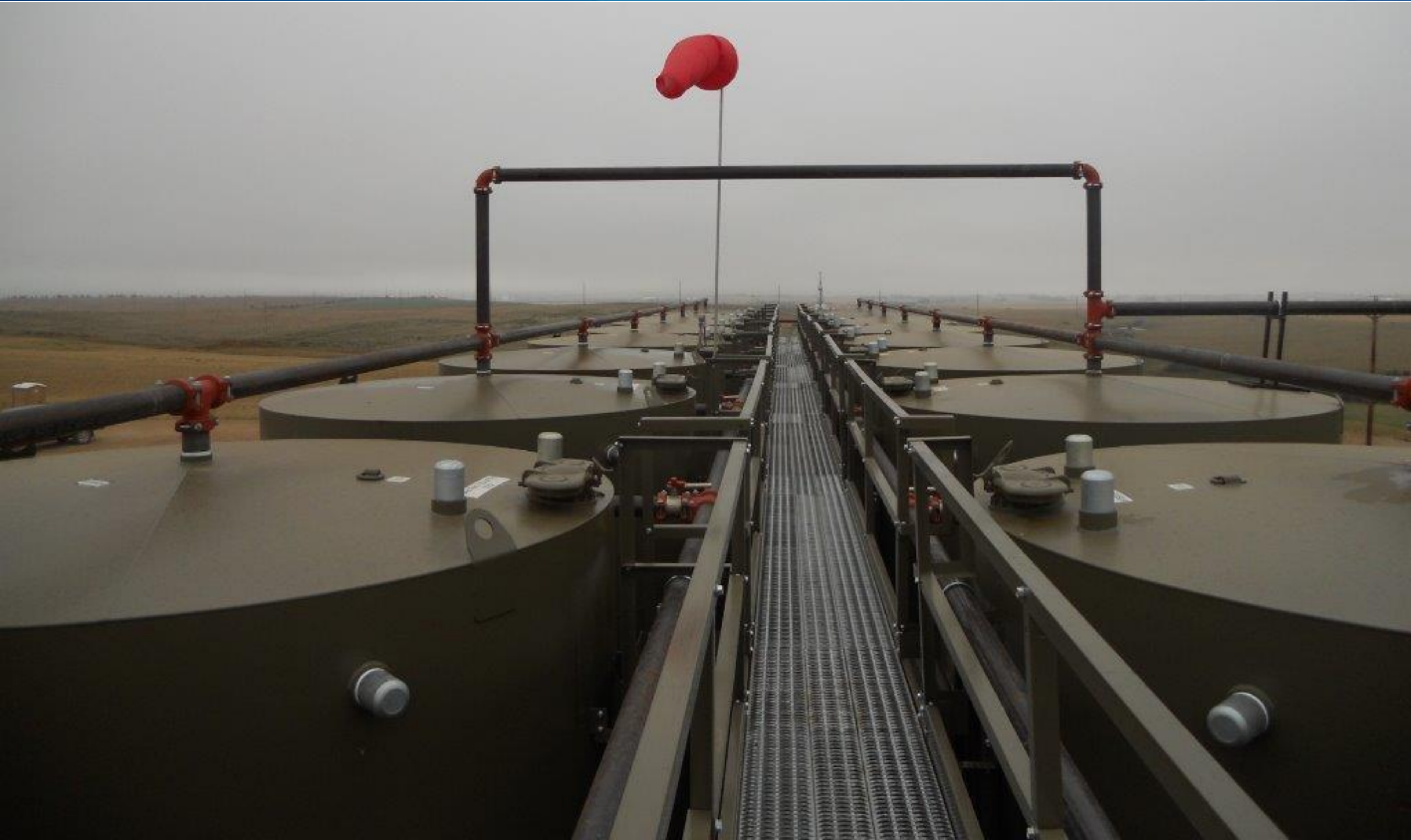
Case 1: Solutions

- Increase Vapor Accumulation (Surge) Capacity
  - "Bottom Out" tank(s) (isolate from liquid service)
  - Relocate tank(s) from over-designed sites
- Decrease Vapor Flow into System
  - Relocate Vapor Recovery Tower(s) from over-designed sites to reduce solution gas
- Increase Combustor Capacity
  - Burner management systems for low-flow
  - Relocate combustor(s) from over-designed sites

Case 1: Results

- Eliminate routine venting resulting from inadequate design
- No complete re-design, no curtailment of production
- Asset-wide cost savings >$2M USD so far
- Reduced pad footprint for downsized sites
- Field operations awareness and engagement culture
- Regulator and public stakeholder relations

Case 2: Asset-Wide Design Analysis



Case 2: Asset-Wide Design Analysis

- U.S. EPA Settlement
- 170 oil and gas well pads in Williston Basin
- Developed Engineering Modeling Guideline
  - Determine PPIVFR
- Grouped similar Tank Systems
- Developed Engineering Design Standards for each Tank System group
  - Tank Systems meeting boundary criteria presumed to be adequately sized

Case 2: Results

EPA estimates system upgrades

"will reduce the emission of at least 11,700 tons of VOCs, 400 tons of hazardous air pollutants, primarily benzene, toluene, ethylbenzene and xylenes, and 2,600 tons of methane annually."

To Learn More

Colorado Air Pollution Control Division

Storage tank and vapor control system guidelines

https://www.colorado.gov/cdphe/air-oilandgas-storagetankguidelines

Questions?

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