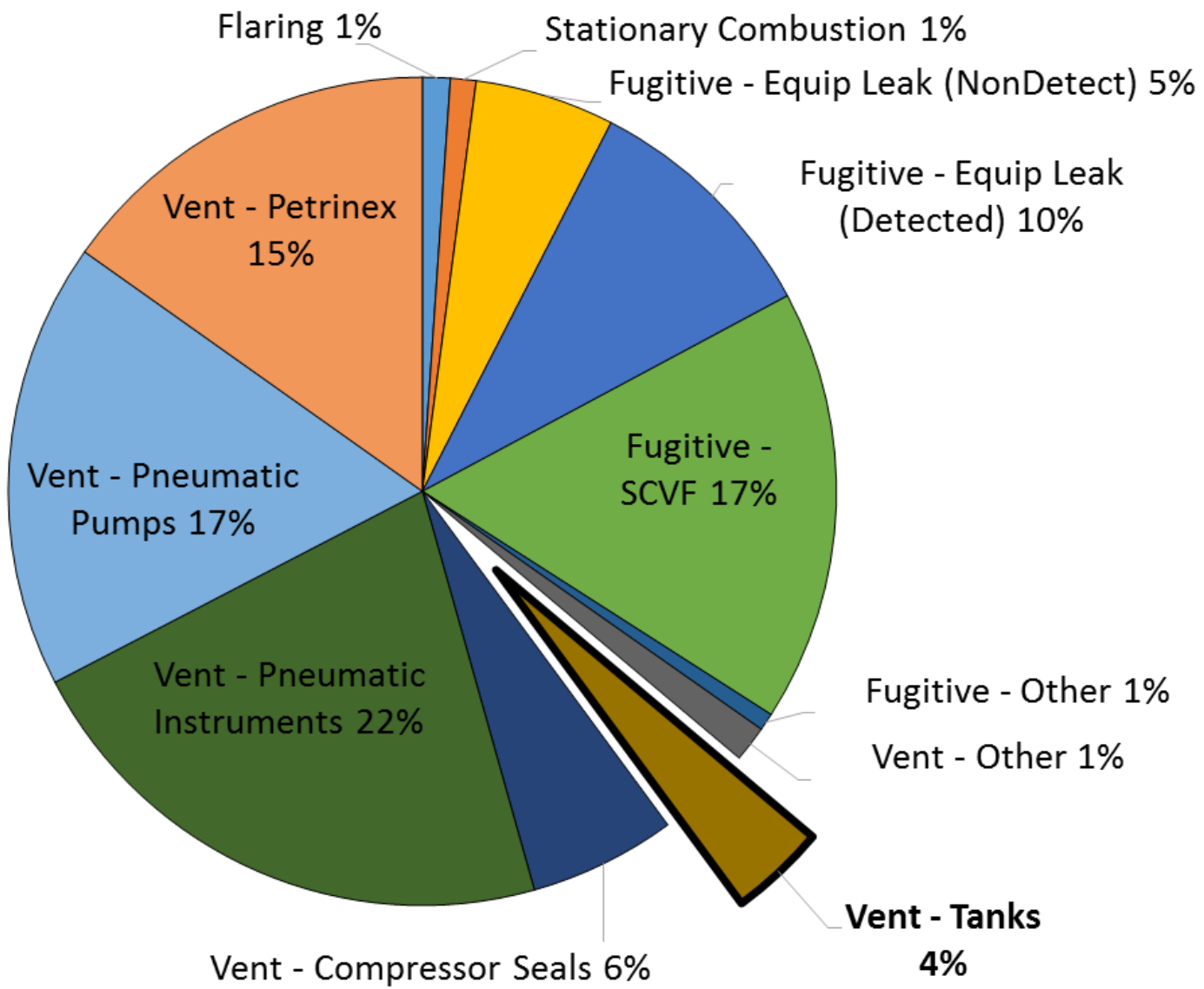
Investigation of Fugitives and Venting from Fixed-Roof Storage Tanks

Yori Jamin, P.Eng.

CLEARSTONE ENGINEERING

November 27, 2019

Upstream Oil & Gas CH_4 Emission Inventory



Bottom-up emission inventories may understate storage tank emissions.

WHY?

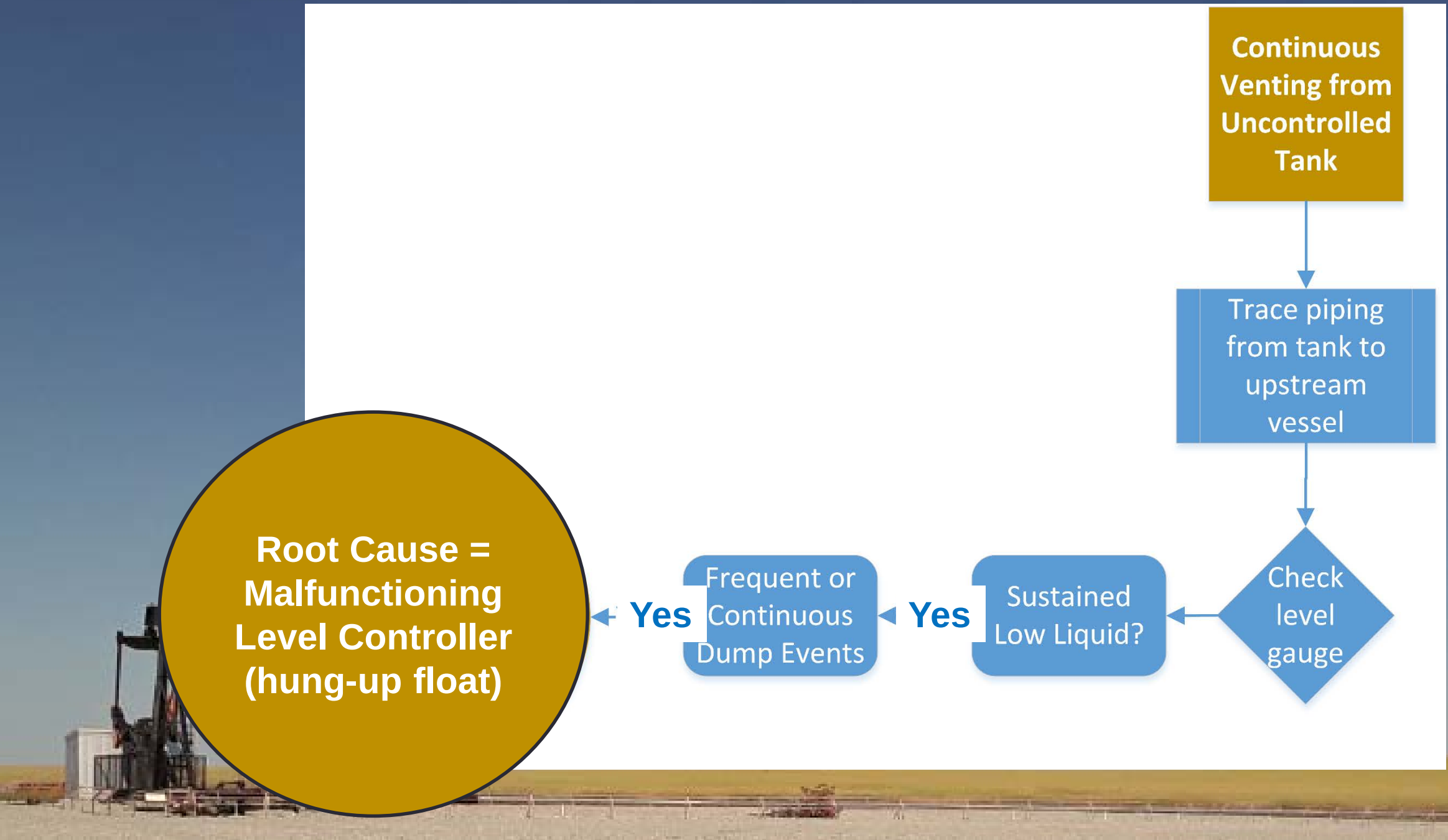
Investigate Root-Causes of Fugitives & Venting

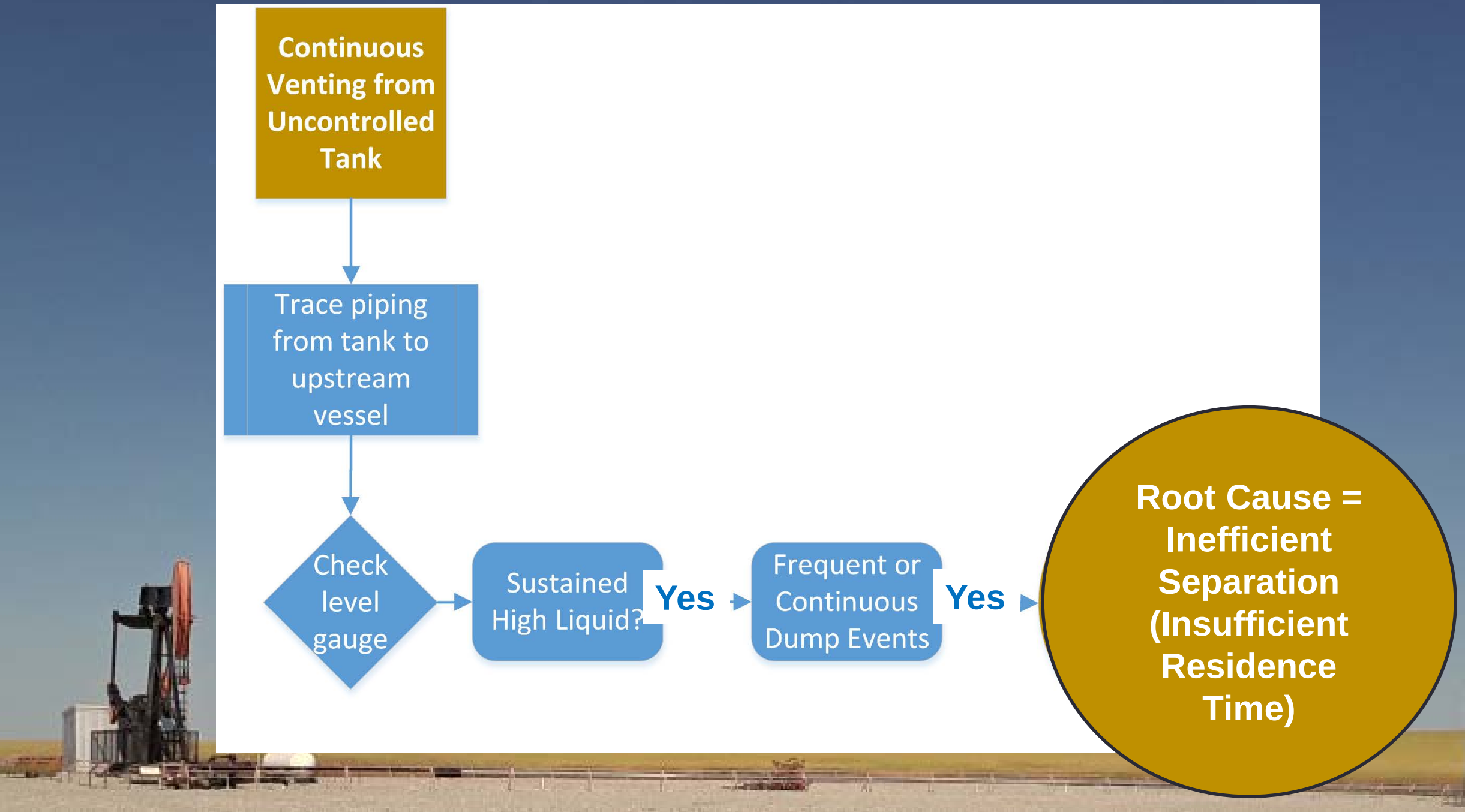
- Desk-top review of field data from 2018 & 2019 campaigns:
  - Energy Efficiency **Alberta** Baseline Opportunity Assessments (38 AB tanks).
  - **British Columbia** Climate Action Secretariat & ECCC Methane Field Study (9 tanks).
- IR camera videos identified ‘excessive’ tank emissions.
- 9 companies volunteered data & investigated possible root-causes.
- Observed three tank emission categories:

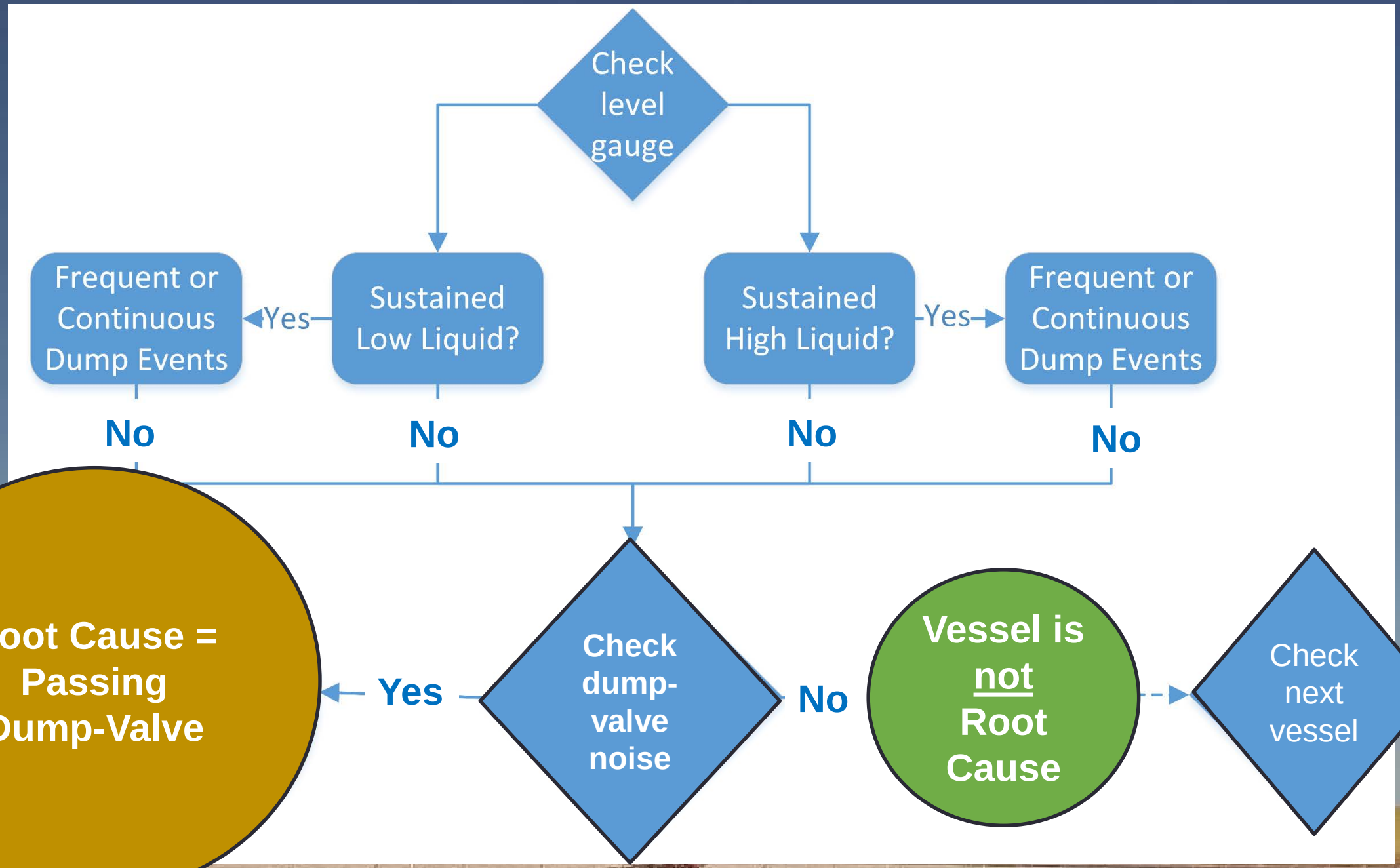
1. **Volatile liquid flashing (venting)**
2. **Tank-top equipment component leak (fugitive)**
3. **Unintentional gas carry-through (fugitive missing from bottom-up inventory)**

Propose Field Troubleshooting Decision Tree

- Incorporate into Fugitive Emission Management Programs (FEMP).
- Systematic first attempt at root-cause identification.
- Used during LDAR surveys.
- Relevant to:
  - **Uncontrolled** storage tanks (controlled tanks source of component leaks).
  - **Water** and **Hydrocarbon** storage tanks.
  - **Continuous** venting (intermittent vent indicator of normal operation).


Continuous Venting from Uncontrolled Tank
Trace piping from tank to upstream vessel
Check level gauge
Sustained Low Liquid?
Yes
Frequent or Continuous Dump Events
Yes
Root Cause = Malfunctioning Level Controller (hung-up float)


Continuous Venting from Uncontrolled Tank
Trace piping from tank to upstream vessel
Check level gauge
Sustained High Liquid?
Yes
Frequent or Continuous Dump Events
Yes
Root Cause = Inefficient Separation (Insufficient Residence Time)

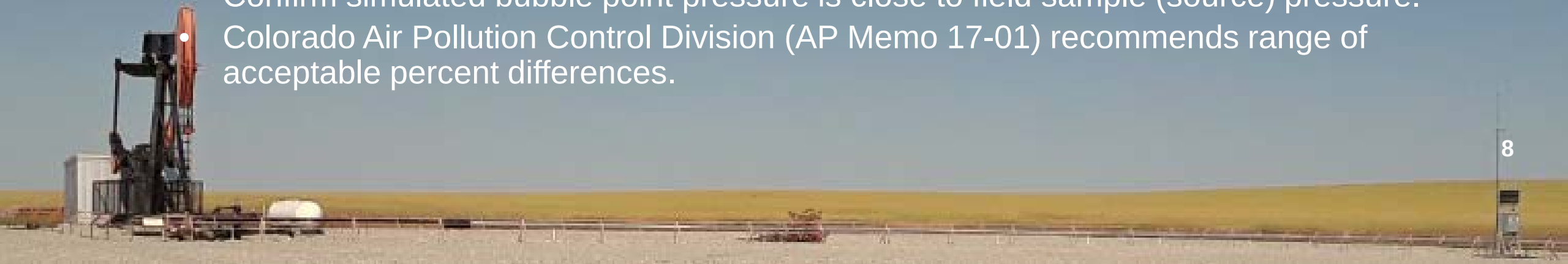

Check level gauge
Sustained Low Liquid?
Yes
Frequent or Continuous Dump Events
Sustained High Liquid?
Yes
Frequent or Continuous Dump Events
No
No
No
No
Check dump-valve noise
Yes
Root Cause = Passing Dump-Valve
No
Vessel is not Root Cause
Check next vessel

Volatile Liquid Flashing

- If no equipment malfunctioning, tank emissions entirely from volatile liquid flashing. Confirm compliance with regulated methane venting limits.
- Quantify flashing using Gas-to-Oil Ratio (GOR) according to D017:
  - Direct measurement of gas and oil produced over 24 hour test period.
  - Pressurized sample and pressure-volume-temperature (PVT) analysis by laboratory.
  - Pressurized sample, compositional analysis by laboratory and simulation program.

VaporSIM

- Validate pressurized sample integrity for reliable GOR:
  - Confirm simulated bubble point pressure is close to field sample (source) pressure.
  - Colorado Air Pollution Control Division (AP Memo 17-01) recommends range of acceptable percent differences.



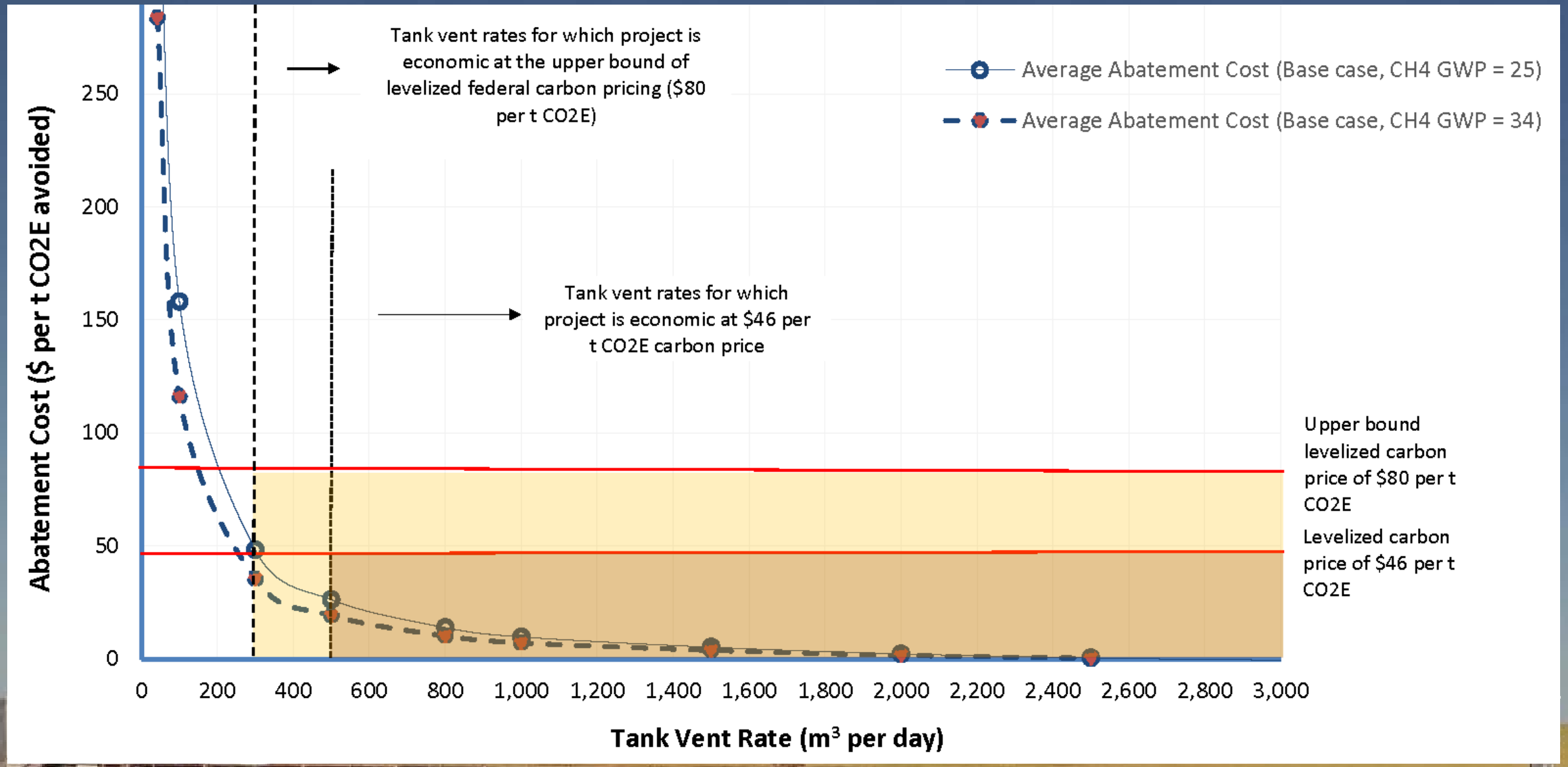
Volatile Liquid Flashing

- When site-specific details are not available (e.g., emission inventories), use simple correlations to estimate GOR.
- Valko and McCain (2003) recommended for stock tank oil with API gravity between 6.0^{o} and 56.8^{o}.
- Vasquez & Beggs (1980) or D017 ‘Rule of Thumb’ recommended for condensates with API gravity greater than 56.8^{o}.

Techno-Economic Assessment of Mitigation Options

- Design memorandums developed by VANGUARD ENGINEERING INC
  - Relevant venting range of 42 to ~3000 m^3/day (i.e., regulated methane limits).
  - 10 mitigation options investigated. Applicability depends on site features.
    - Capture vapours off tank top versus a flash vessel.
    - Conservation versus flaring.
  - Process flow diagrams.
  - Total Installed Capital Cost (TICC) estimates.
- Used for economic assessment (net present value and abatement cost curves).

Case #9: Tank Top to VRU for Gas Sales



THANK YOU

Alberta Upstream Petroleum Research

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA