# Methane Emissions and Mitigation Opportunities: 9 CCAC Sources, Other GMI Sources

**Oil & Gas Sector Workshop**
**Methane Mitigation Technologies and Practices**
**Hosted by Aramco, Global Methane Initiative and Climate & Clean Air Coalition**
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# Methane Emissions and Mitigation Opportunities: 9 CCAC Sources, Other GMI Sources Agenda

- Nine major upstream/midstream sources of methane emissions
- For each of the nine sources
  - What are uncontrolled methane emissions
  - What are “controlled” emissions
  - Brief description of control options
- Offshore platform and other sources

Following presentations will discuss:

- Methane Emissions Detection and Measurement Techniques, and
- Control/Reduction Project Evaluation and Implementation

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# CCAC Core Emissions Sources

- Nine sources in oil and gas production and processing account for half of total methane emissions from U.S. oil & gas operations

| Rank | Emissions Source | Total 2012 U.S. Oil & Gas Emissions (Bcf) | % of Total O&G Industry |
|---|---|---|---|
| 1 | Natural gas driven pneumatic controllers and pumps | 91.530 | 17.5% |
| 2 | Fugitive equipment and process leaks | 31.264 | 6.0% |
| 3 | Glycol dehydrators | 30.018 | 5.8% |
| 4 | Reciprocating compressors rod seal/packing vents | 27.609 | 5.3% |
| 5 | Hydrocarbon liquid storage tanks | 25.585 | 4.9% |
| 6 | Well venting for liquids unloading | 14.204 | 2.7% |
| 7 | Centrifugal compressors with “wet” (oil) seals | 12.343 | 2.4% |
| 8 | Well venting/flaring during well completion for hydraulically fractured wells | 11.274 | 2.2% |
| 9 | Casinghead gas venting | 0.739 | 0.1% |
| | **Total** | **244.567** | **46.9%** |
| | **Total U.S. Oil & Gas Industry** | **521.59** | |

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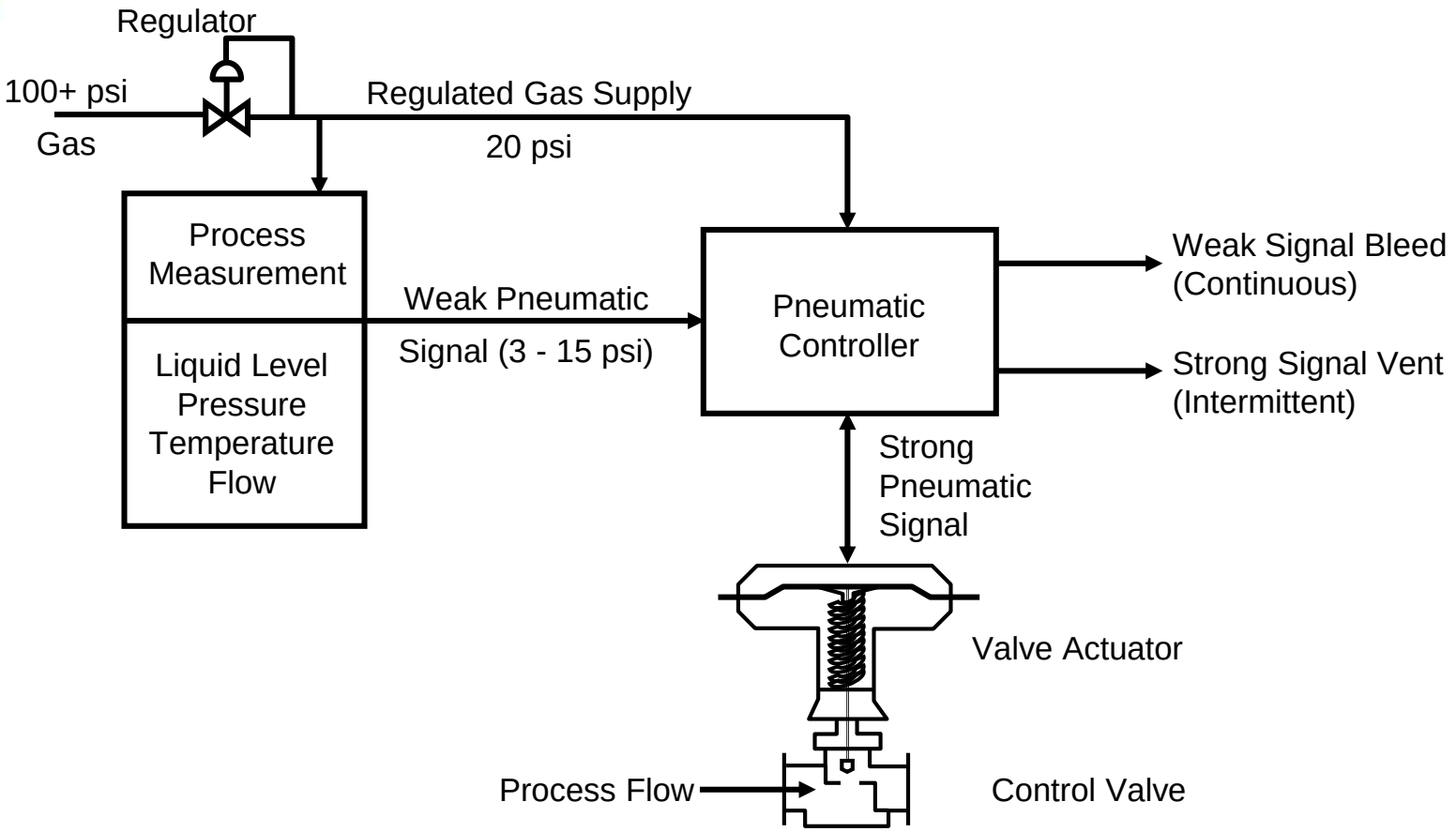
# Automated valve control loops



# Natural Gas Driven Pneumatic Controllers and Pumps: Controlled vs Uncontrolled

| Configuration | Controlled or Uncontrolled |
|---|---|
| A high-bleed pneumatic controller continuously bleeds gas to the atmosphere | Uncontrolled |
| A chemical injection pump is pneumatically-powered and continuously vents methane to the atmosphere | |
| A gas-assisted glycol pump vents methane to the atmosphere entrained in the rich TEG sent to the glycol regenerator | |
| A high-bleed pneumatic gas controller is replaced with a low-/no-bleed controller to reduce gas emitted | Controlled (if confirmed to be functioning with low or no emissions) |
| A high-bleed pneumatic gas controller is retrofitted to convert it to low-bleed or intermittent bleed | |
| A chemical injection pump is replaced with a solar, electric, or instrument air pump | |
| A gas-assisted glycol pump is followed by a flash tank separator (with separated gas directed to a low-pressure usage) | |
| A gas-assisted glycol pump is replaced with an electric pump | |
| An instrument air system is installed for pneumatic gas supply/use for all facility controllers and pumps | |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 1: Natural gas pneumatic driven controllers and pumps

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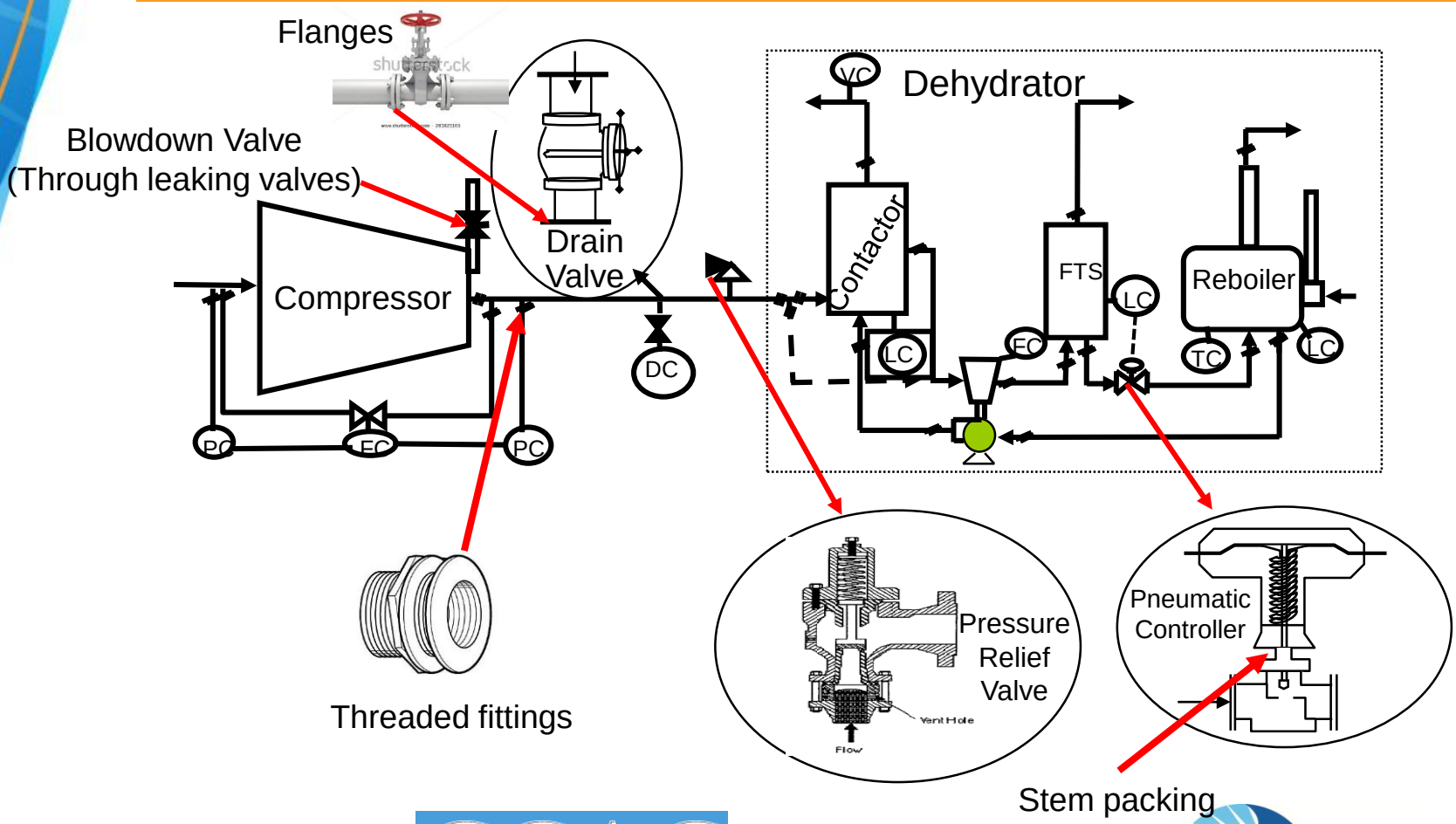
# Fugitive Equipment and Process Leaks: Schematic

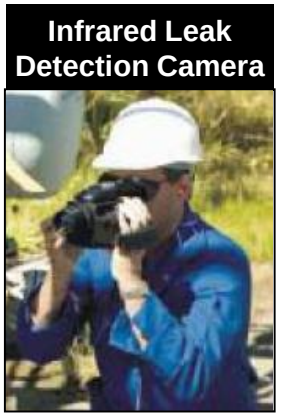


# Fugitive Equipment and Process Leaks: Controlled vs Uncontrolled

| Summary of Screening and Measurement Techniques | | |
|---|---|---|
| **Instrument/ Technique** | **Effectiveness** | **Approximate Capital Cost** |
| Soap Solution | ★★ | $ |
| Electronic Gas Detector | ★ | $$ |
| Acoustic Detector/ Ultrasound Detector | ★★ | $$$ |
| TVA (Flame Ionization Detector) | ★ | $$$ |
| Calibrated Bagging | ★ | $$ |
| High Volume Sampler | ★★★ | $$$ |
| Rotameter | ★★ | $$ |
| Infrared Leak Detection | ★★★ | $$$ |

Source: EPA's Lessons Learned

**Infrared Leak Detection**



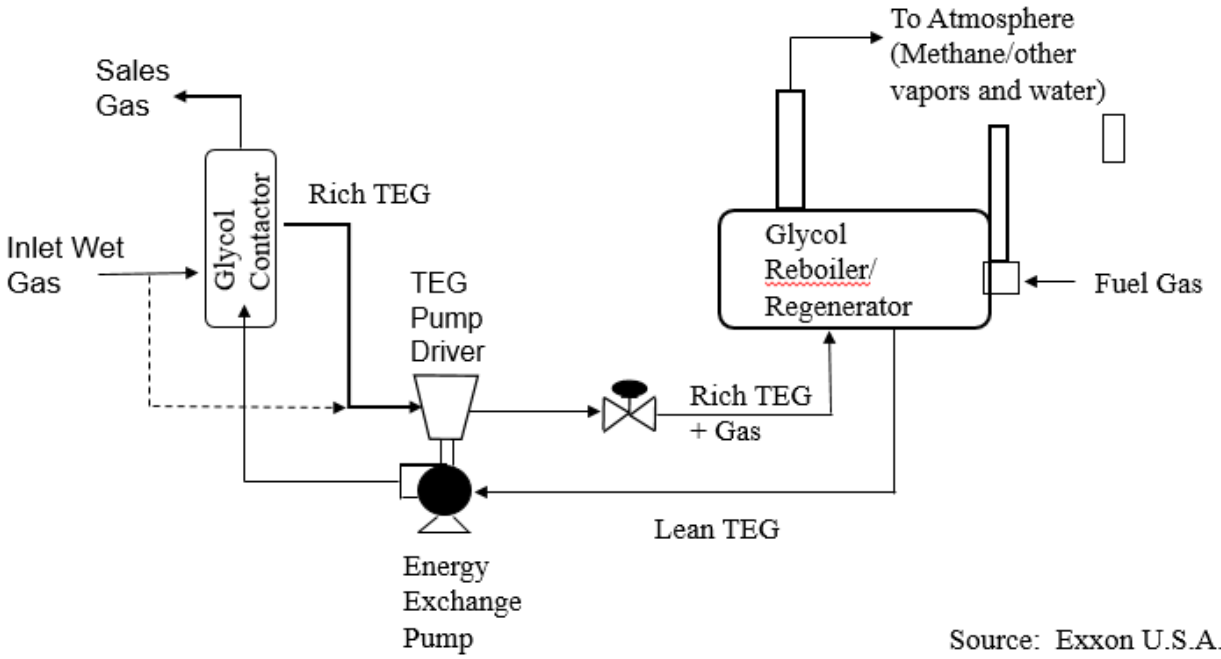

Source: Leak Surveys Inc.

**High Volume Sampler**

Source: Heath Consultants

# Glycol Dehydrator Vent Emissions: Description

- Remove water from wet gas stream using, most commonly, triethylene glycol (TEG)
  - Vent from reboiler contains methane



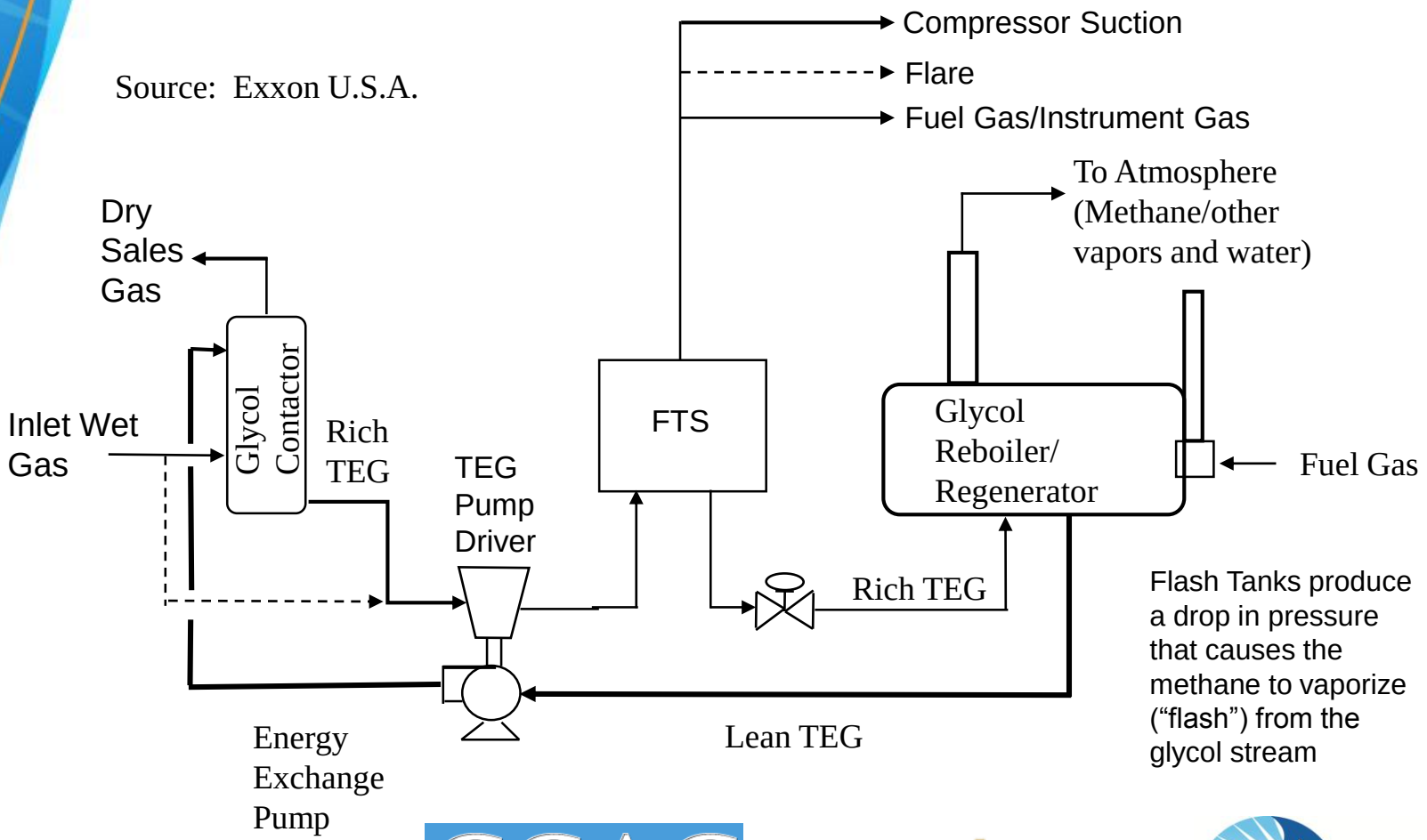

Source: Exxon U.S.A.

# Glycol Dehydrators: Controlled vs Uncontrolled

| Configuration | Controlled or Uncontrolled |
|---|---|
| Dehydrator does not have a flash tank separator, uses a gas assisted or electric pump, and reboiler vents are routed to the atmosphere | Uncontrolled |
| Dehydrator has a flash tank separator that vents to atmosphere , uses a gas or electric assisted pump, and reboiler vents are routed to the atmosphere | Uncontrolled |
| Dehydrator has a flash tank separator that directs gas to beneficial use (e.g. fuel gas, low pressure sales line, compressor suction) or flare, uses a gas assisted or electric pump, and reboiler vents are routed to the atmosphere | Controlled (if confirmed to be functioning with low or no methane emissions) |
| Dehydrator does not have a flash tank separator, uses a gas assisted or electric pump, and reboiler vents are routed to a flare, VRU, or other beneficial use | Controlled (if confirmed to be functioning with low or no methane emissions) |

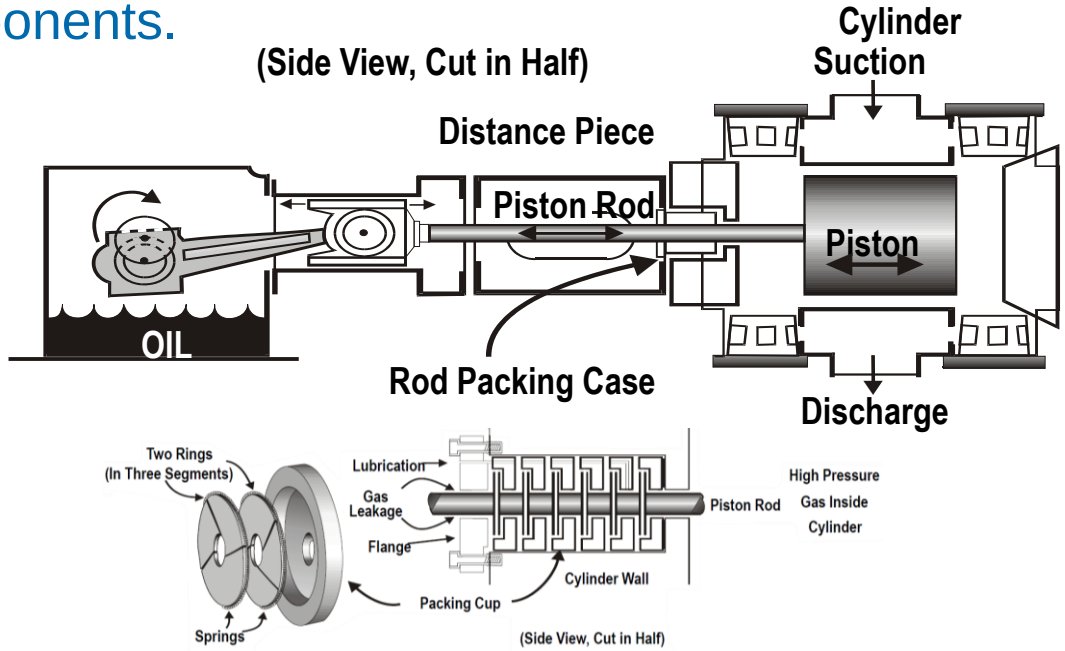
**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 3: Glycol dehydrators.

# Glycol Dehydrators: Schematic of Emissions Reductions



# Reciprocating Compressors Rod Seal/Packing Vents: Description

- Emit methane during normal operation
- Emissions can be vented from the rod packing and blowdowns or as fugitives from the various compressor components.



# Reciprocating Compressors Rod Seal/Packing Vents: Controlled vs Uncontrolled

- Maintenance of rod packing when gas leakage is more value than cost of ring replacement

| Configuration | Controlled or Uncontrolled |
|---|---|
| "Distance piece" or packing case vents (point where rod packing leakage exits the compressor) are vented to the atmosphere and rings are replaced only on a fixed schedule (e.g. during an engine overhaul (26,000 running hours)) | Uncontrolled |
| Rod packing is vented to the atmosphere and operator conducts periodic (annual) emissions measurement around each rod seal for excessive seal/packing leakage, and replaces rings/rods on seals/packing found to be excessively leaking | Controlled (if confirmed to be functioning with low or no emissions) |
| Each rod "distance piece" or packing case is equipped with a leak indicating device and rings/packing-cups/gaskets are replaced when the rod packing exhibit excessive leaking | |
| Reciprocating compressor "distance piece" or rod packing vents (point where rod packing leakage exits the compressor) are routed to recovery (e.g. VRU) or flare | |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 4: Reciprocating compressor rod seal/packing vents.

# Vent Emissions from Hydrocarbon Liquid Storage Tanks

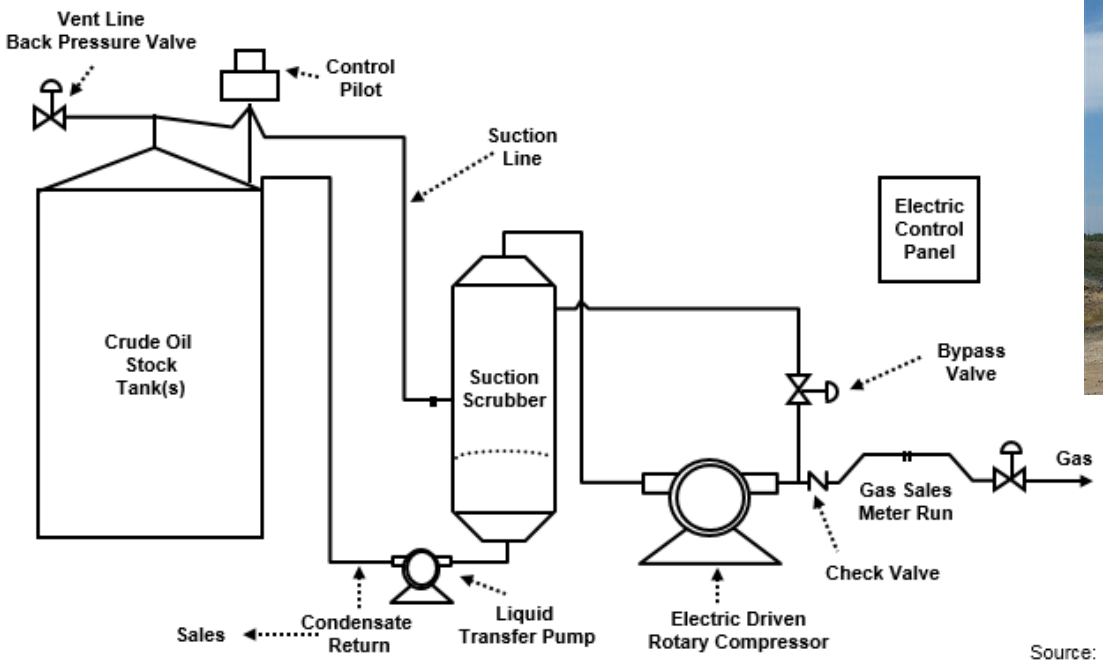
# Hydrocarbon Liquid Storage Tanks: Controlled vs Uncontrolled

| Configuration | Controlled or Uncontrolled |
|---|---|
| Tank vapors are emitted to the atmosphere via routing through an open vent, unlit flare, and/or through openings in the fixed roof of an oil or condensate production tank (e.g., open/unsealed thief hatch, cracks/corrosion in tank roof, ENARDO pressure/vacuum relief valve) | Uncontrolled |
| Tank vapors are recovered by routing to a Vapor Recovery Unit (VRU) system and directing to productive use (e.g., fuel gas, compressor suction, gas lift) | Controlled (if confirmed to be functioning with low or no emissions) |
| Tank vapors are emitted to the atmosphere via routing through an open vent, unlit flare, and/or through openings in the fixed roof of an oil or condensate production tank, but are minimized by having reduced the differential pressure between the last gas/oil separation step prior to the tank to near atmospheric pressure to reduce the amount of gas emitted from the tank(s) | |
| Stabilization towers are installed ahead of tanks to reduce the amount of entrained gas and flash gas emitted from the tank(s) | |
| Tank vapors are routed to a flare/combustion device | |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 5: Hydrocarbon liquid storage tanks.

# Hydrocarbon Liquid Storage Tanks: Emissions Reductions – Vapor Recovery Unit

- Capturing low pressure, wet gas from oil storage tanks requires a special designed vapor recovery system

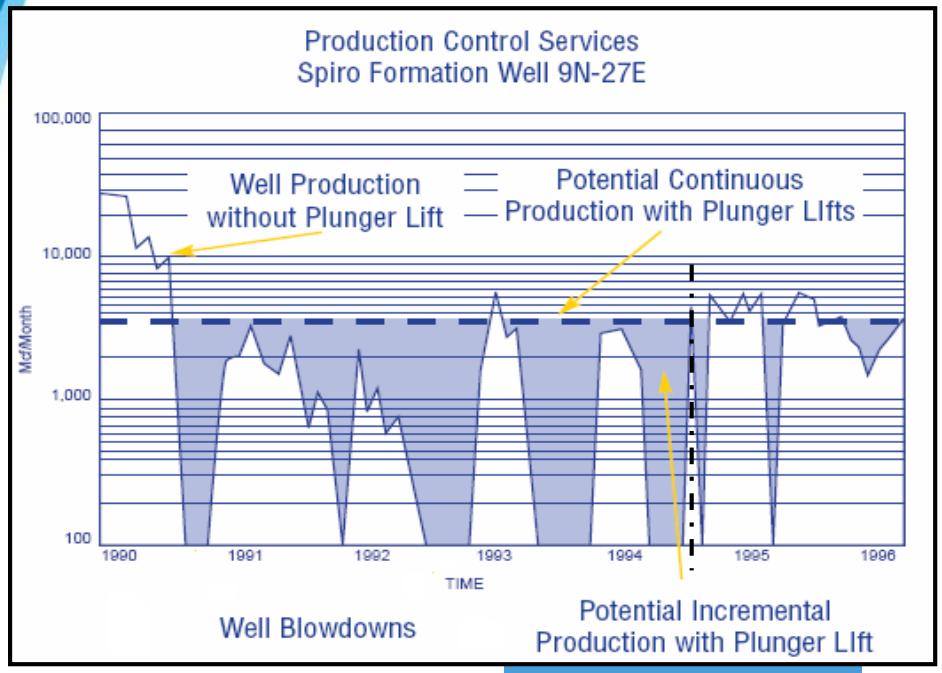



Source: Evans & Nelson (1968)

Courtesy of Anadarko

# Well Venting for Liquids Unloading: Description

- Liquids (water) accumulation in the tubing of a mature gas well slows and stops production
  - The quick fix is to blow the well to the atmosphere to blow out water
  - Vents significant methane




Taken by Arlington Fire Department

From Star-Telegram article

# Well Venting for Liquids Unloading: Controlled vs Uncontrolled

| Configuration | Controlled or Uncontrolled |
|---|---|
| Well is vented directly to the atmosphere. | Uncontrolled |
| Well is equipped with a plunger lift and is vented to the atmosphere during the plunger cycle. | |
| Well is equipped with artificial lift (e.g., a plunger lift, downhole pump) that reduces the frequency of well venting to maintain productivity and may be tied directly into the sales line through a gas/liquid separator (when cycling the plunger). | Controlled (if confirmed to be functioning with low or no methane emissions) |
| Well is equipped with other liquids removal techniques (e.g., foaming agents, velocity tubing). | |
| Well is horizontal and uses gas lift, a downhole pump in a "rat hole," sequential lift, or another form of artificial lift to remove liquids. | |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 6: Well venting for liquids unloading.

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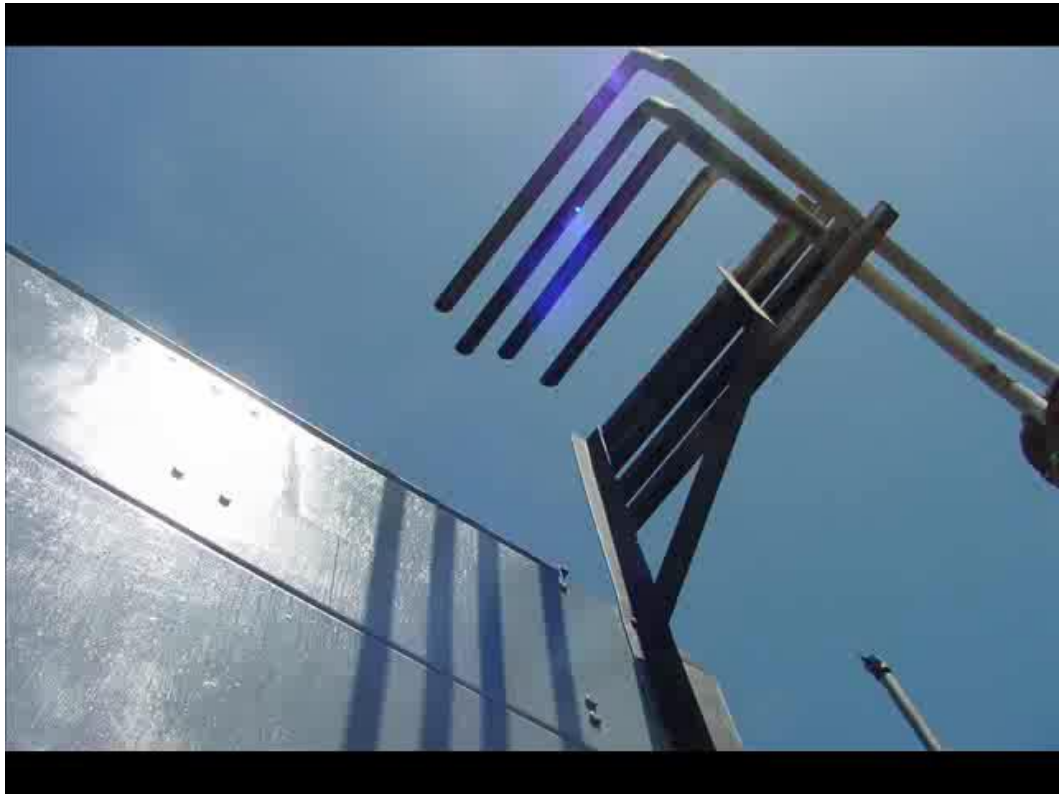
# Vent Emissions from Wet Seal Centrifugal Compressors



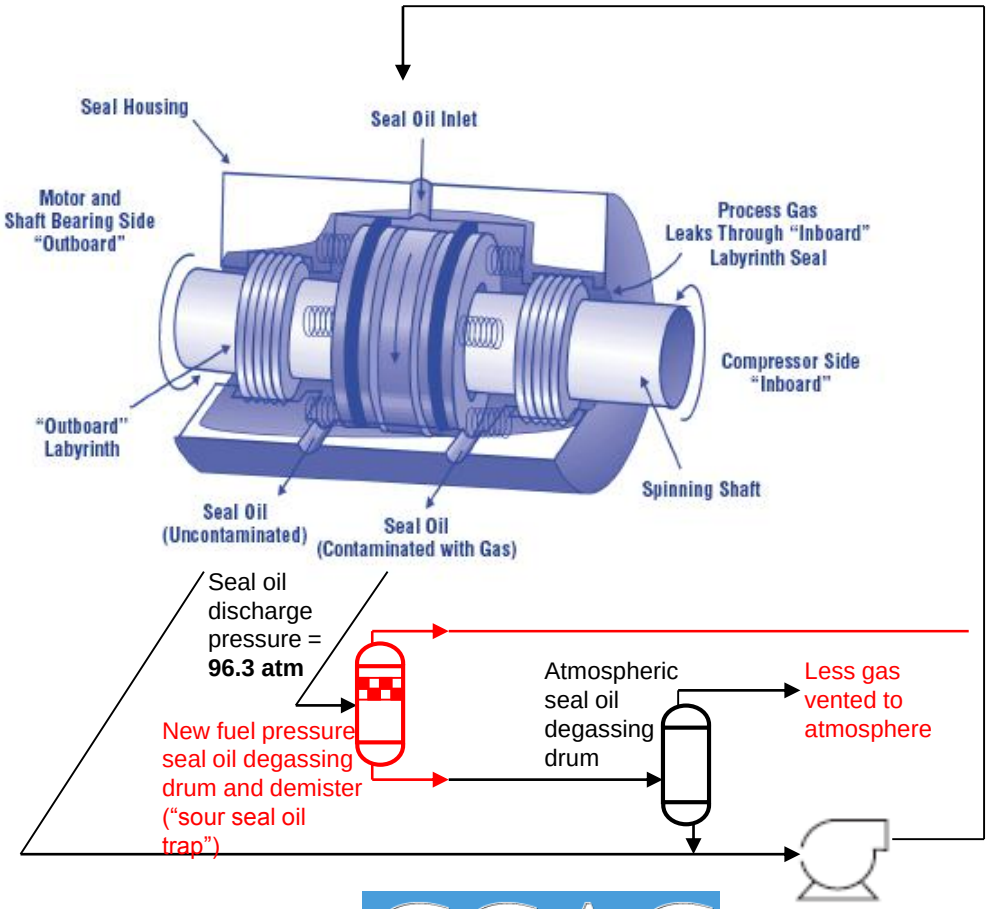
# Centrifugal Compressors with "Wet" (Oil) Seals: Controlled vs Uncontrolled

- Centrifugal compressors with dry seals are controlled

| Configuration | Controlled or Uncontrolled |
|---|---|
| Seal oil is degassed at atmospheric pressure and the gas is routed to an open vent stack | Uncontrolled |
| Seal oil is degassed at intermediate pressure and intermediate pressure gas is routed to an open vent stack; seal oil is degassed again at atmospheric pressure, venting the small portion of gas remaining in the oil to the atmosphere | Uncontrolled |
| Seal oil is degassed at intermediate pressure and intermediate pressure gas is routed to productive use (e.g. compressor suction, fuel gas) or routed to flare ; seal oil is degassed again at atmospheric pressure, and there is typically a smaller volume of gas vented to the atmosphere | Controlled (if confirmed to be functioning with low or no emissions) |
| Seal oil is degassed at atmospheric pressure and the gas is recovered and used (e.g., routed to a vapor recovery unit (VRU) or other destination and not vented) or flared | Controlled (if confirmed to be functioning with low or no emissions) |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 7: Centrifugal compressors with "wet" (oil) seals.

# Routing Wet Seal Degassing Emissions: 4 Options

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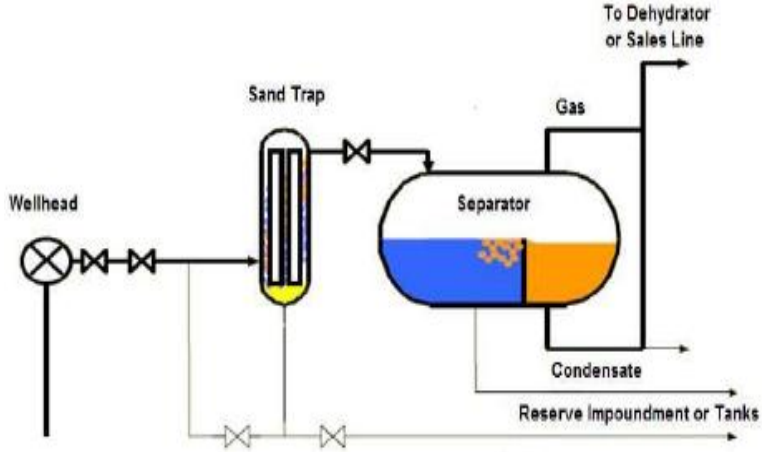
# Well Venting/Flaring during Well Completions for Hydraulically Fractured Wells

| Configuration | Controlled or Uncontrolled |
|---|---|
| During completion of hydraulically fractured gas well, well is produced to a pit or tanks where water, hydrocarbon liquids and sand are captured and slugs of gas vented to the atmosphere | Uncontrolled |
| During completion of hydraulically fractured gas well, reduced emission (green) completion is implemented, using speciality flow-back equipment if necessary, and flow-back gas is routed to sales or flare rather than vent to the atmosphere | Controlled (if confirmed to be functioning with low or no methane emissions) |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 8: Well Venting/Flaring During Well Completion for Hydraulically Fractured Gas Wells.

Source: Newfield

## Reduced emissions completions



# Casinghead Gas Venting: Description

- Low pressure oil reservoirs must be pumped
  - To avoid vapor locking downhole beam or electric submergence pump, gas is vented to the atmosphere from the casing

| Configuration | Controlled or Uncontrolled |
|---|---|
| Casinghead gas is vented directly to the atmosphere, either continuously or periodically to relieve pressure build-up | Uncontrolled |
| Casinghead gas is recovered by a wellhead compressor/vapor recovery unit (VRU) and routed to sales or for on-site use | Controlled (if confirmed to be functioning with low or no emissions) |
| Casinghead gas is routed to tanks with new or existing VRU systems and routed to sales or for on-site use | |
| Casinghead gas is routed to a flare | |

**Source:** CCAC O&G Methane Partnership – DRAFT Technical Guidance Document Number 9: Casinghead venting.

# Casinghead Gas Vapor Recovery Unit

- Casinghead gas can be captured with vapor recovery unit
  - The benefits are gas recovery, increased oil production and methane emissions reduction

**Casinghead Pressure Reduction Unit**

Source: Hy-Bon and Natural Gas STAR

# Offshore Platform and Other Sources

- Storage Tank Venting
  - Install vapor recovery unit
  - Scrubber dump valve repair
- Reciprocating Compressor
  - Economic replacement of rod packing
- Glycol Dehydrator
  - Route non-condensable gas from condenser vent to vapor recovery unit
- Fugitive Emissions
  - Leak detection, quantification and repair
- Platform Cold Vents
  - Route individual vented emissions sources to vapor recovery unit (including pig launcher venting)
  - Route routine compressor blowdowns to fuel gas system
- Centrifugal Compressor Wet Seals
  - Replace centrifugal compressor wet seals with dry seals
  - Route centrifugal compressor wet seal oil vent to fuel
- Produced Water Tank Vents
  - Manifold water tanks with oil tanks to vapor recovery units

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