Natural Gas STAR Technology Transfer Pre-Conference Workshop

Roger Fernandez, U.S. EPA
Natural Gas STAR Program / Global Methane Initiative

September 24, 2013

SHALE INSIGHT™ 2013
A Marcellus Shale Coalition Conference
PENNSYLVANIA CONVENTION CENTER
PHILADELPHIA, PA
SEPTEMBER 25-26

NaturalGas
EPA POLLUTION PREVENTER

Natural Gas STAR Technology Transfer Pre-Conference Workshop

Methane Emissions Reduction Opportunities during Natural Gas Production

Leonard Nelms, Ph.D.

Principal Air Program Manager

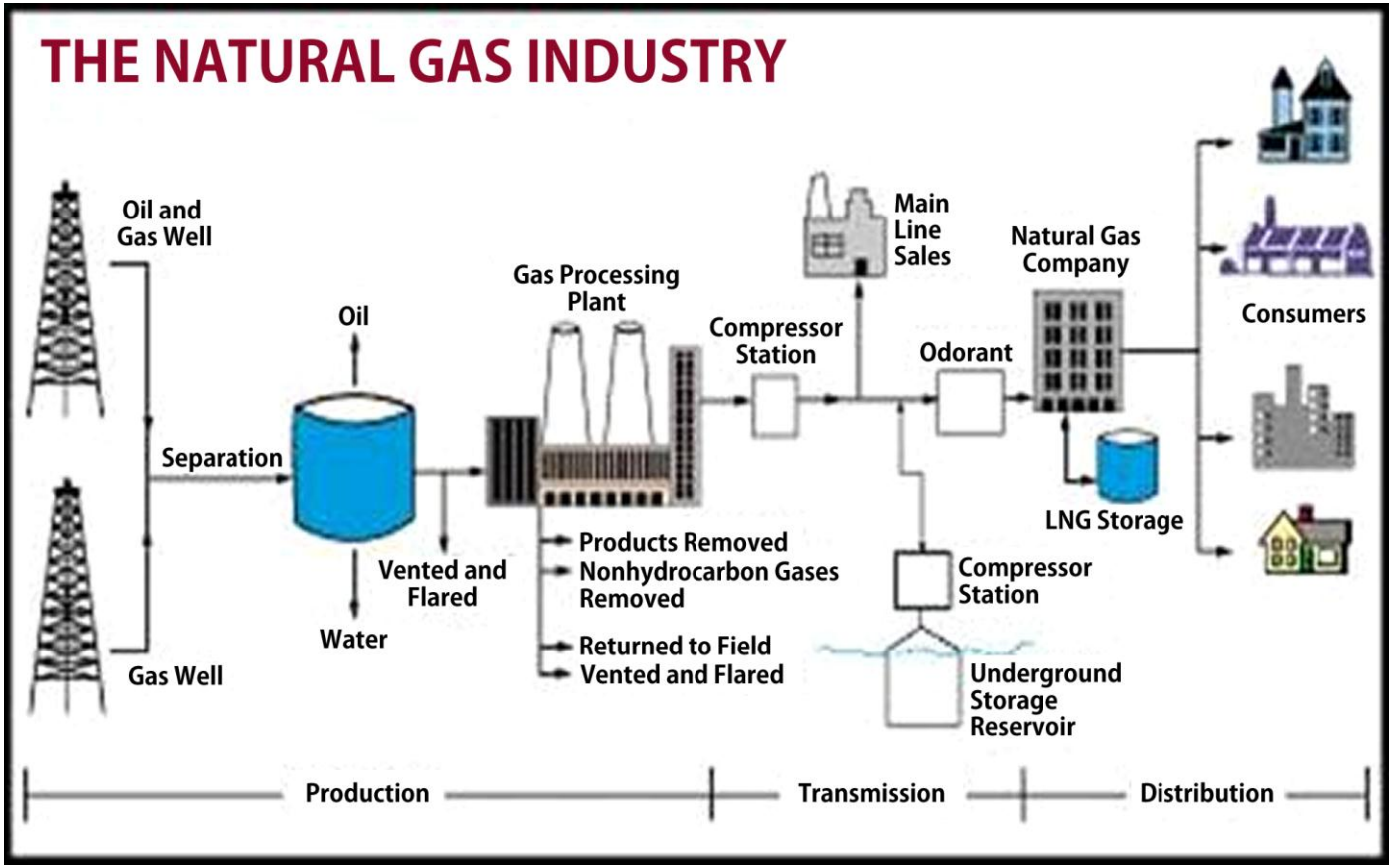
Tetra Tech, Inc.

September 24, 2013

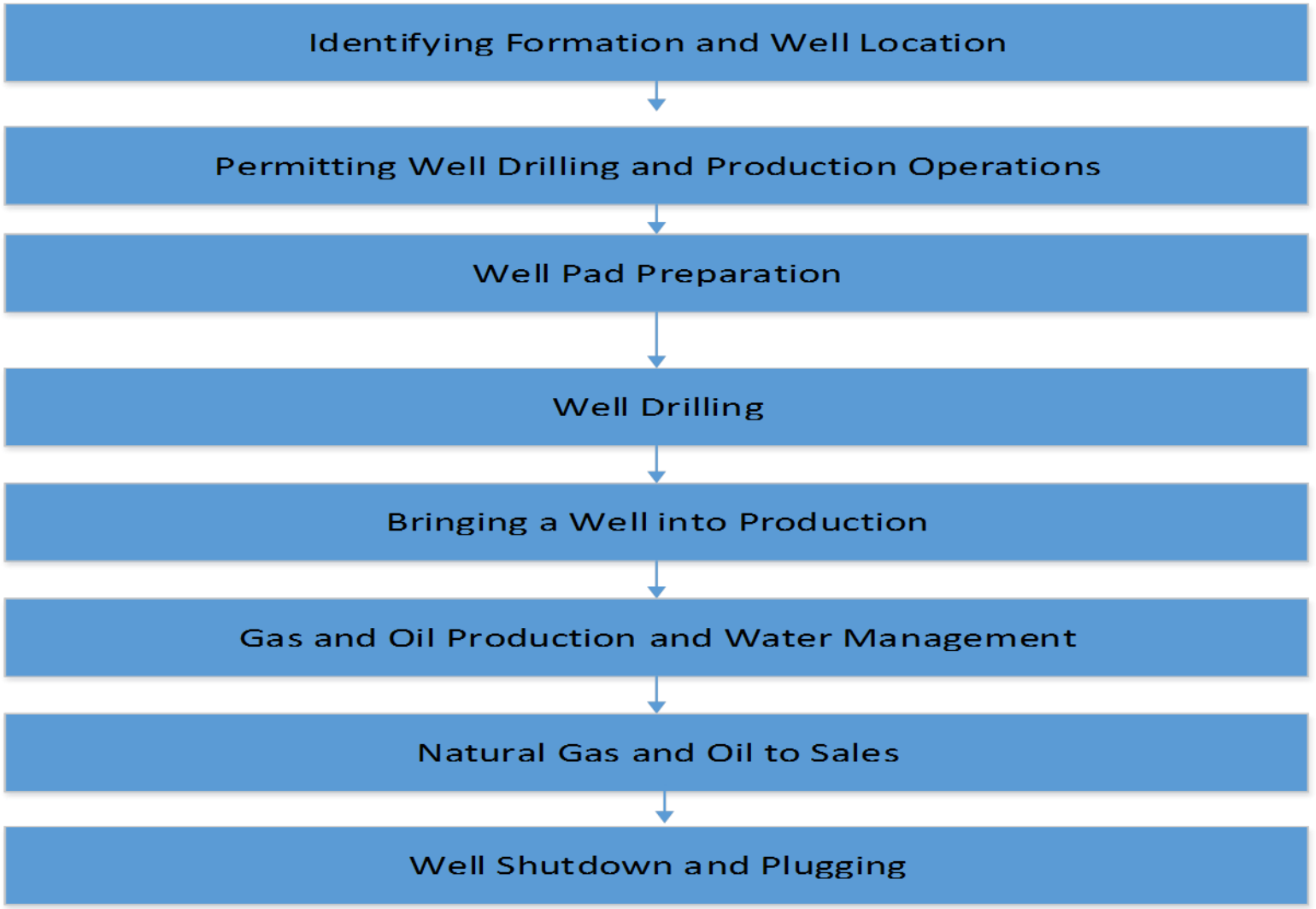
Introduction

- Overview of natural gas production process
- Drivers for implementing methane reduction measures
- Significant sources of methane (natural gas) releases
- Common emission control technologies employed
- Emission reduction successes
- Remaining challenges
- Summary

Overview of Natural Gas Production



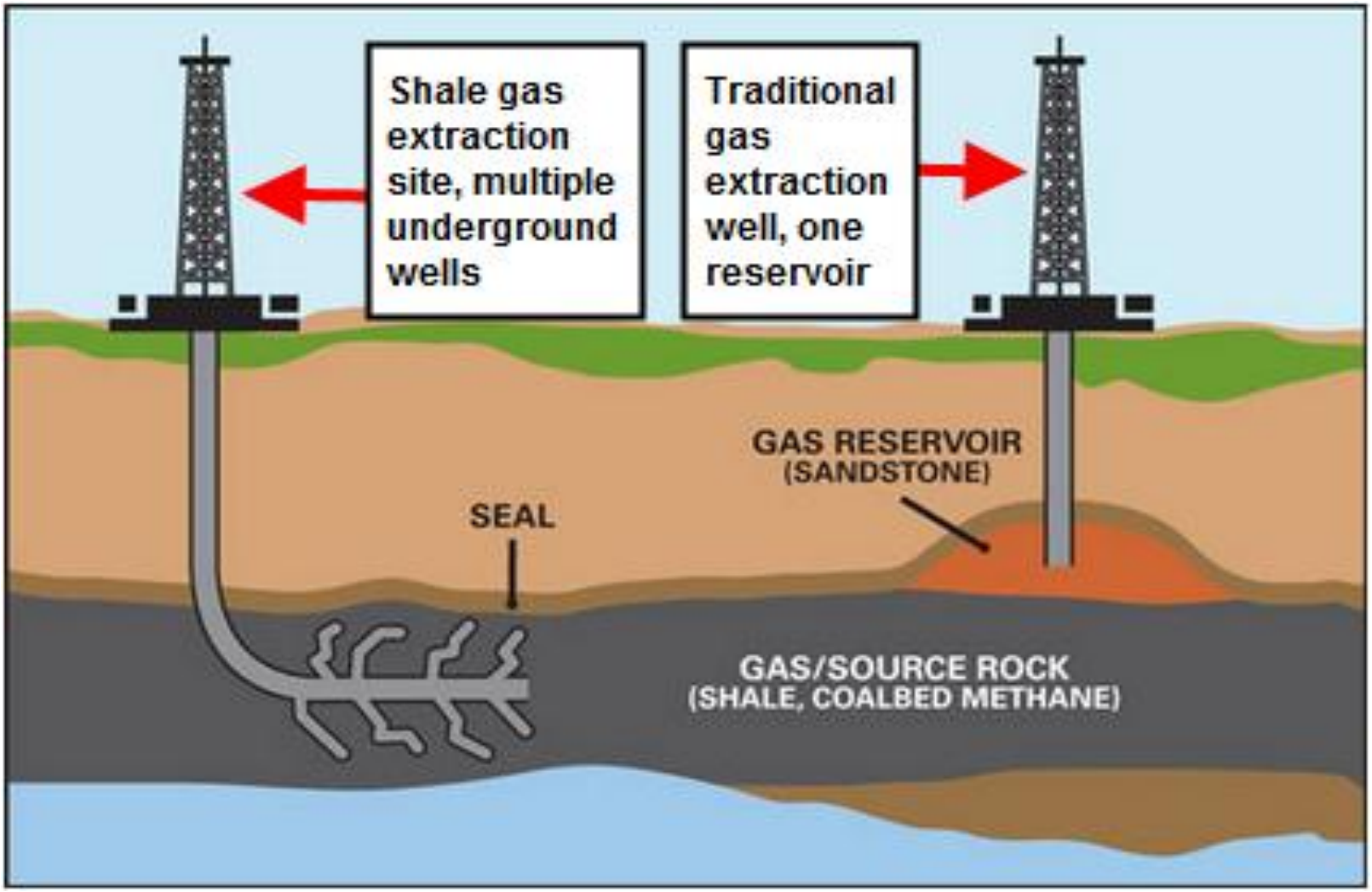
Life Cycle of an Oil and Gas Well



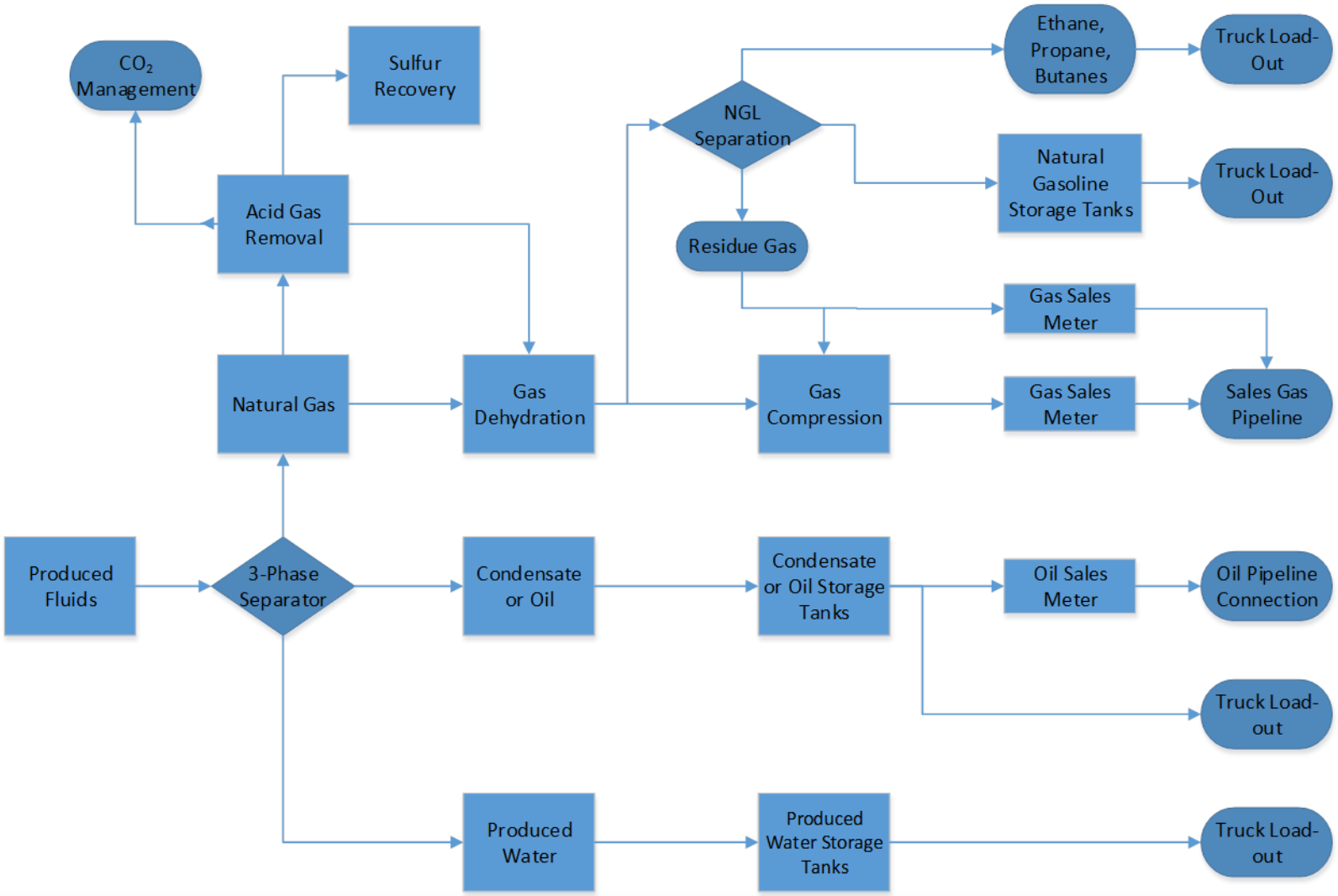
Drivers to Reduce U.S. Methane Emissions

- **Public perceptions and pressure**
- **Conservation of resources**
- **Improved profitability due to oil and condensate capture**
- **Regulatory changes**
  - EPA GHG reporting rules (40 CFR Part 98, Subpart W)
  - New NSPS rules for oil and gas production facilities
  - Revisions to EPA NAAQS for SO_2 and NO_x
- **New State Regulations**
  - Revisions to state minor source permitting requirements
  - Reductions in thresholds allowing exemption from permitting in some states
  - State-specific GHG reporting regulations
  - State requirements for royalty payment calculations

Gas Well Types



Oil and Gas Production Comprehensive Process Flow Diagram



Key Sources of Methane Emissions

- **Well drilling**
- **Well completion**
- **Fracking flow back**
- **Natural gas venting during processing**
  - Separation
  - Dehydration
  - Acid gas treatment
- **Storage tank flash gas emissions**
- **Gas compressor seal leaks**
- **Pneumatic controller bleed vents**
- **Pneumatic pump activation**
- **Fugitive leaks from valves, piping and other components**

GHG Emissions - Petroleum and Natural Gas Sector

GHG MRR Data for 2011

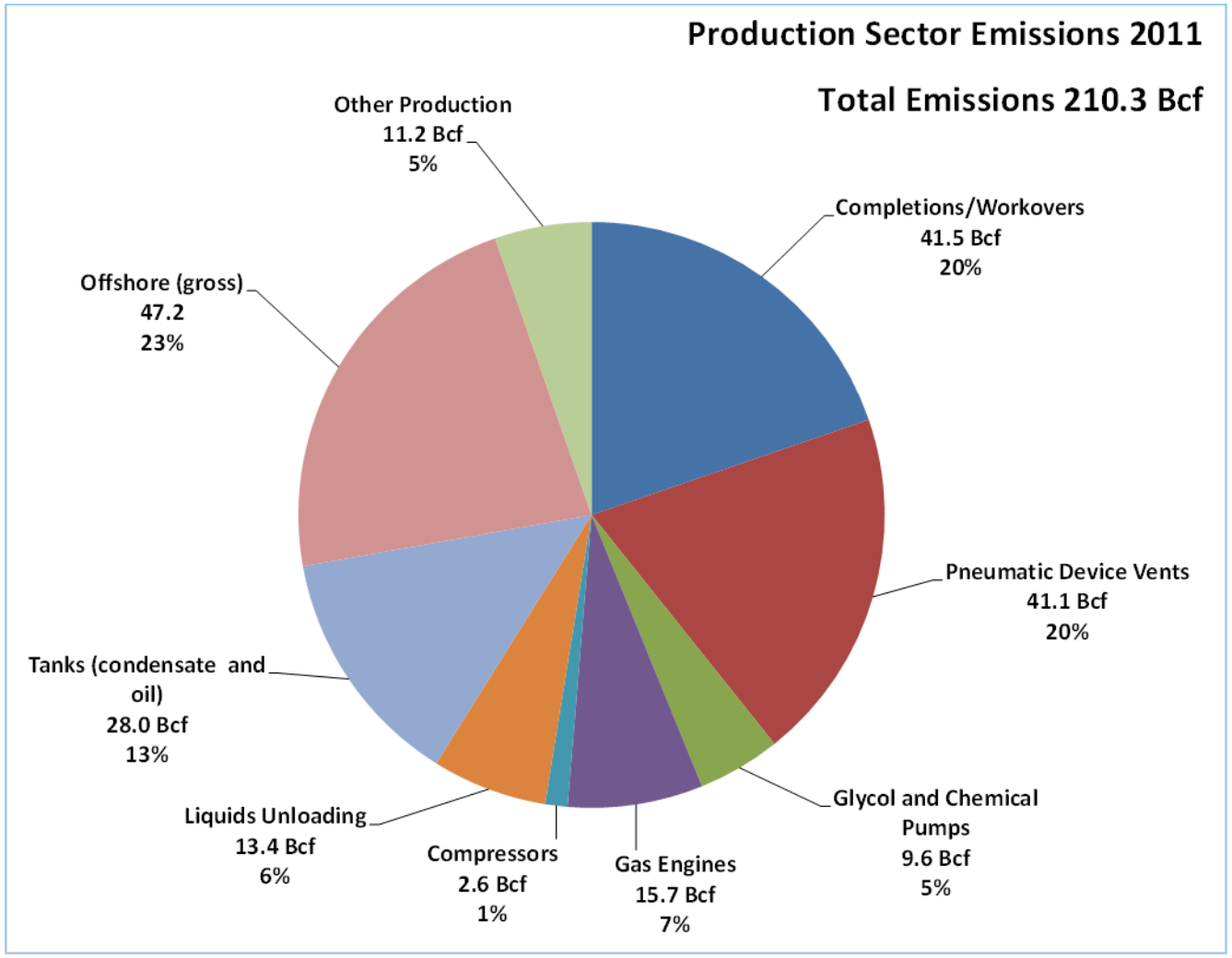
Number of facilities	1,880

Emissions	Million Mg
Total GHGs (CO_2e)	225

Emissions by GHG (CO_2e)	
Carbon dioxide (CO_2)	142
Methane (CH_4)	83
Nitrous oxide (N_2O)	1

Emissions by industry segment (CO_2e) (Million Mg)	
Onshore Petroleum & Natural Gas Production	94
Offshore Petroleum & Natural Gas Production	6
Natural Gas Processing	62
Natural Gas Transmission/Compression	24
Underground Natural Gas Storage	1
Natural Gas Local Distribution Companies	14
Liquefied Natural Gas Storage	<0.5
Liquefied Natural Gas Imp./Exp. Equipment	0.07
Other Petroleum and Natural Gas Systems	23

U.S. Petroleum and Natural Gas Production Methane Emissions



Source: U.S. EPA Breakdown of Sector Emissions, http://www.epa.gov/gasstar/basic-information/

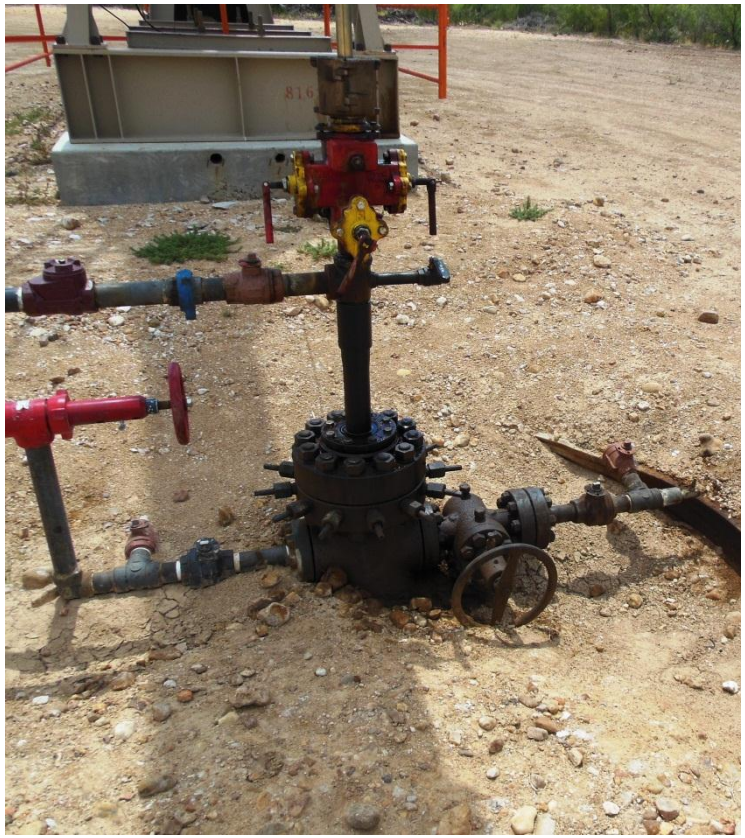
Well Drilling Activities

Drilling Rig (Typical)

Wellhead Blowout Preventer

Typical Gas Well Surface Installations

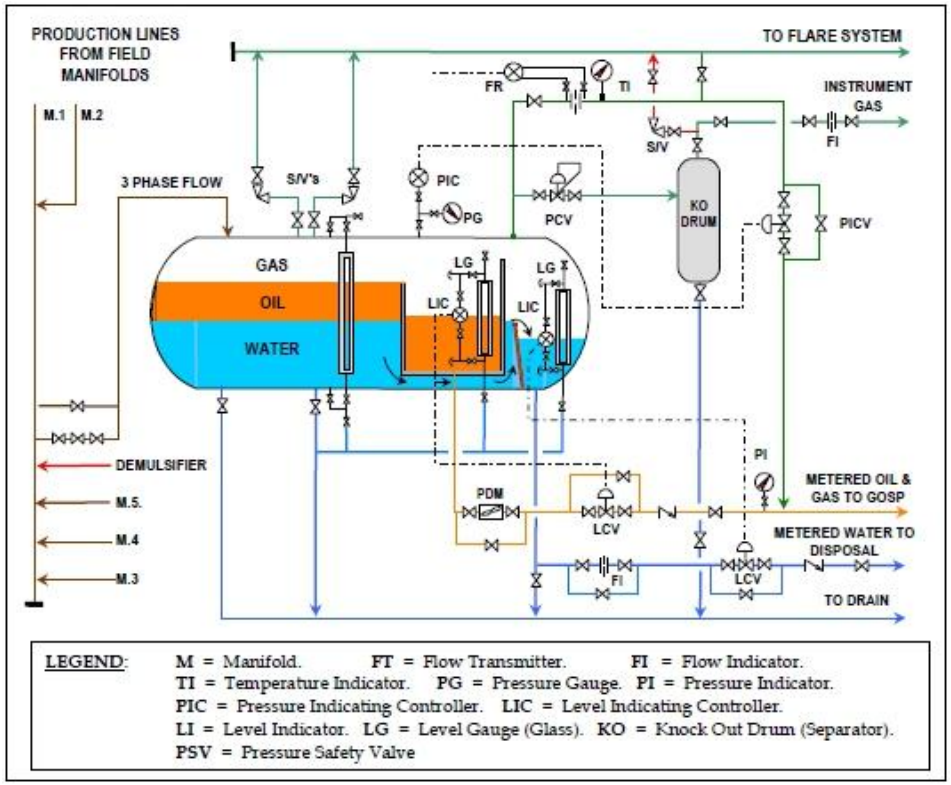
Wellhead in Production Mode



Wellhead Rigged for Fracking

Gas-Liquids Separation

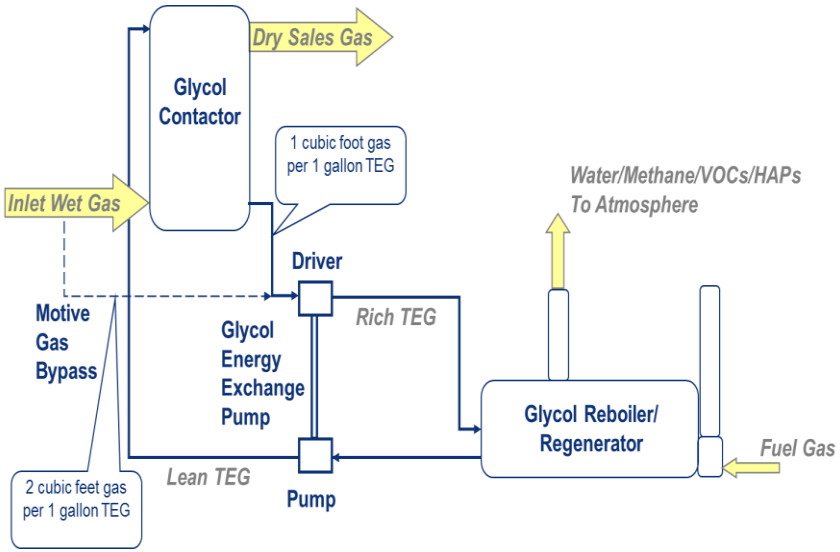
Horizontal Separator Flow Diagram



Vertical Separator Installation

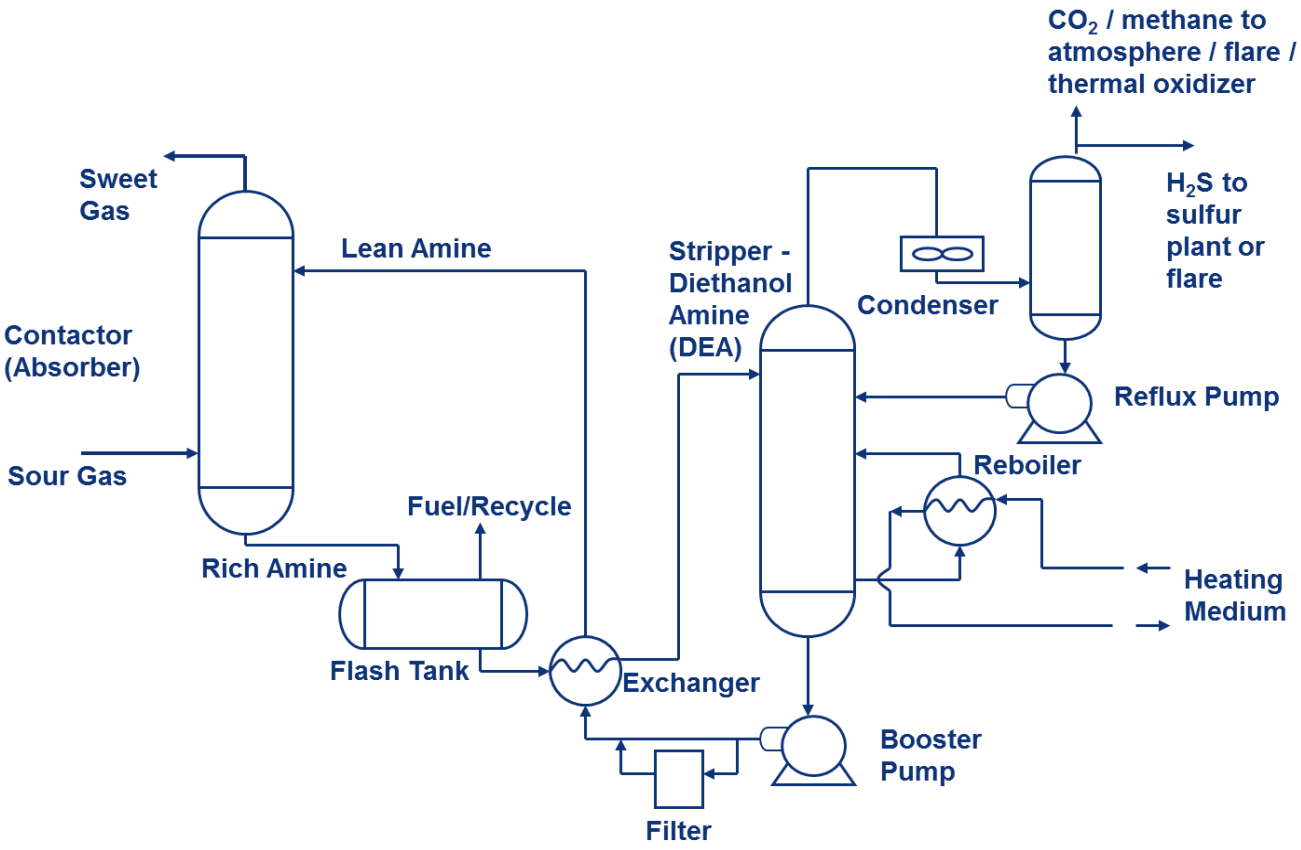
Glycol Dehydrator Unit for Moisture Removal

Process Flow Diagram



Glycol Dehydrator at Well Pad

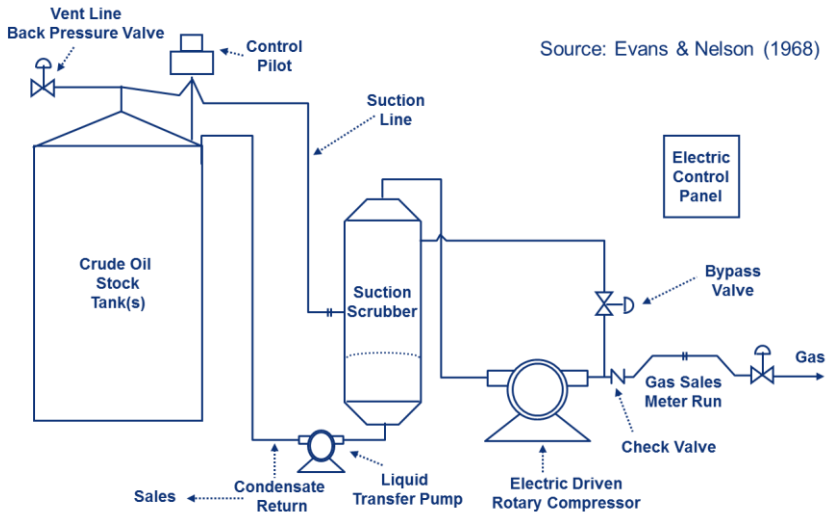
Acid Gas Treatment System



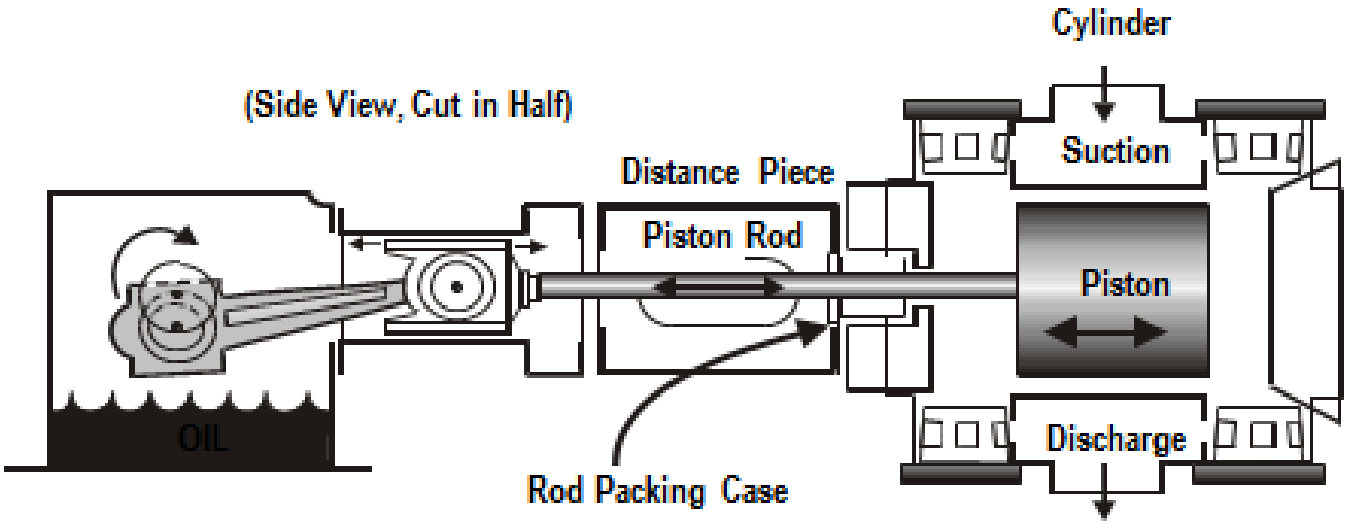
Stock Tank Configurations

Storage Tanks with Venting

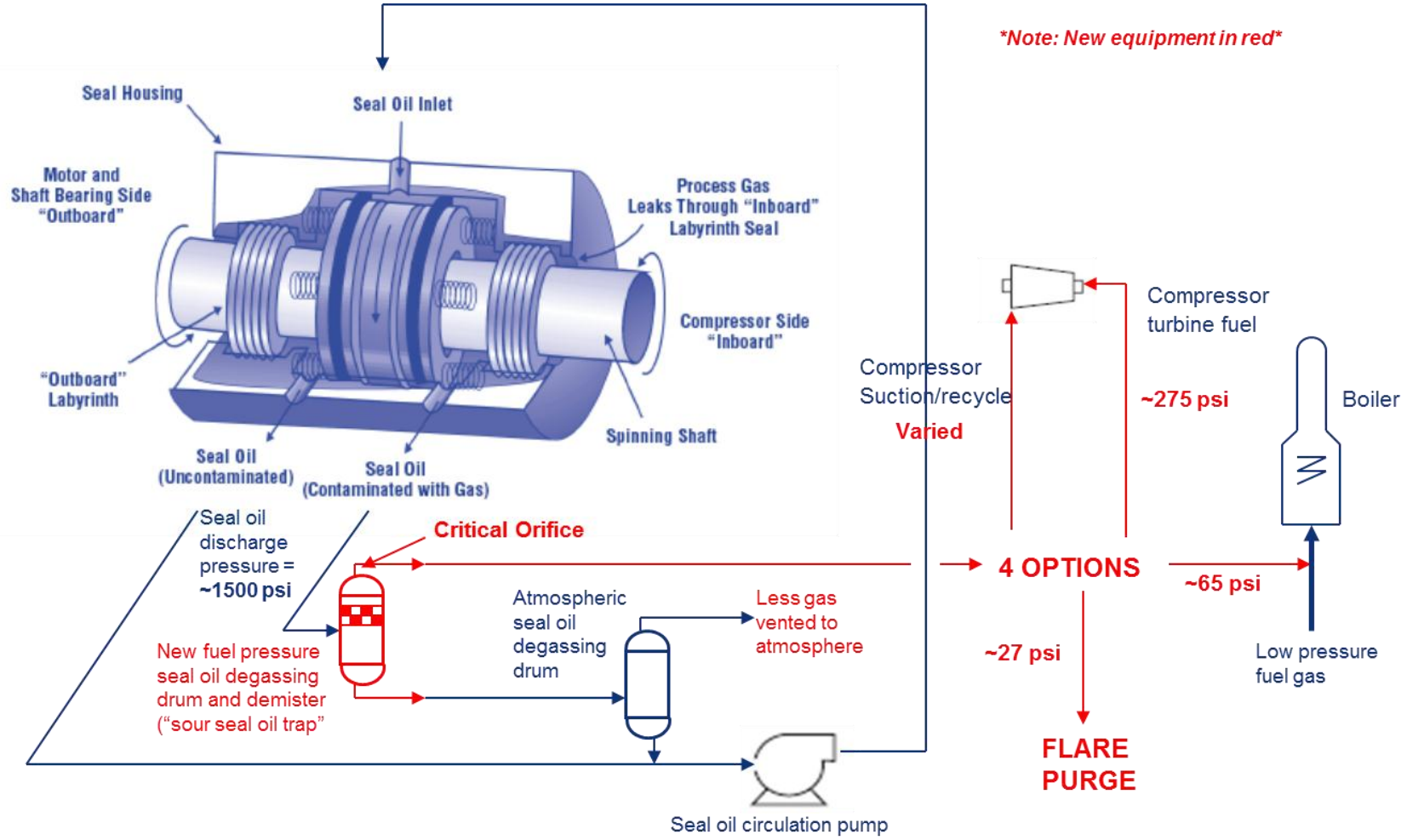
Storage Tank with Vapor Recovery



Typical Reciprocating Compressor Design



Centrifugal Compressor Wet Seal Design



Typical Component Counts for Gas Production Emission Estimates

Equipment/Process	Connectors	Valves	Open-Ended Lines	Compressor Seals	Pressure Relief Valves
Wellheads	60	16	3		
Header Piping	105	26	4		
Heaters	147	22	4		2
Separators	160	30	5		3
Dehydrators	155	31	5		
Compressors	195	31	5	2	
Vapor Recovery Units	78	10	3		
Scrubbers	120	24	2		2
Flares	221	71	1		
Miscellaneous	177	32	5		2
TOTAL COMPONENTS	1418	293	37	2	9

Data Sources:

Canadian Association of Petroleum Producers (CAPP) *Calculating Greenhouse Gas Emissions*, Guide (April 2003), based on American Petroleum Institute (API), *Fugitive Hydrocarbon Emissions from Oil and Gas Production Operations* (December 1993)

Reducing Methane Emissions during Liquids Unloading

- Liquids unloading operations at some gas wells are a normal process performed to reduce head pressure and increase gas production.
- Historically, liquids unloading has required opening up the well tubing to remove collected oil, condensate and/or water from the well bore
- This process is sometimes called “blowing the well” because the liquids and associated gas were allowed to vent to the atmosphere, releasing methane and other hydrocarbons
- Recent developments in equipment and controls have allowed an improved approach to removing liquids from gas and oil wells

New Techniques and Operating Approaches for Liquids Unloading

- Plunger lifts are a proven means for removing well liquids
- Several types of plungers can be used, ranging from the traditional pump jacks to much smaller mechanical or gas operated units.
- Manual operation of plunger lifts is being replaced by automated systems that are customized to a specific well
- Well liquids removal can be continuous periodic to optimize production and energy use
- Well liquids removed are routed into the production stream where the components can be recovered
- Natural gas venting during liquids unloading is reduced or eliminated

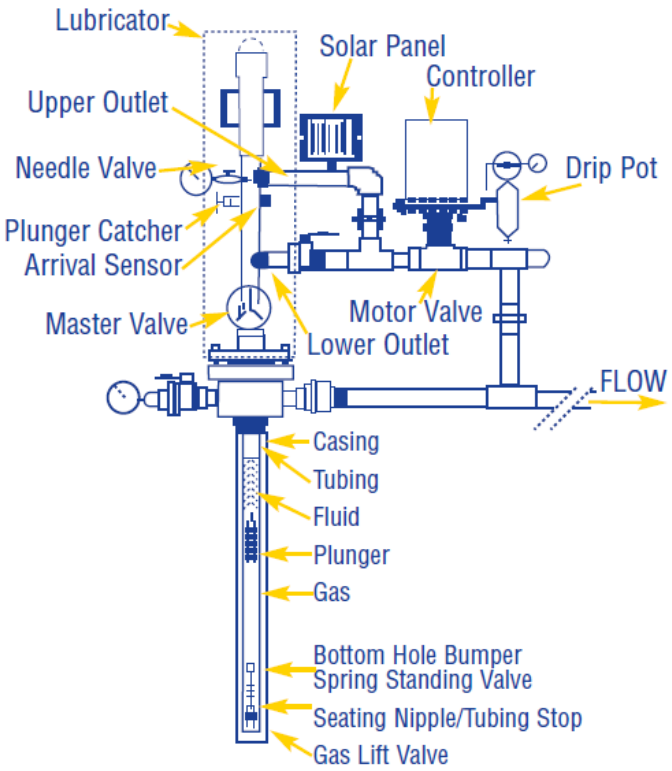
Liquids Unloading with Pump Jacks

Traditional Pump Jack System

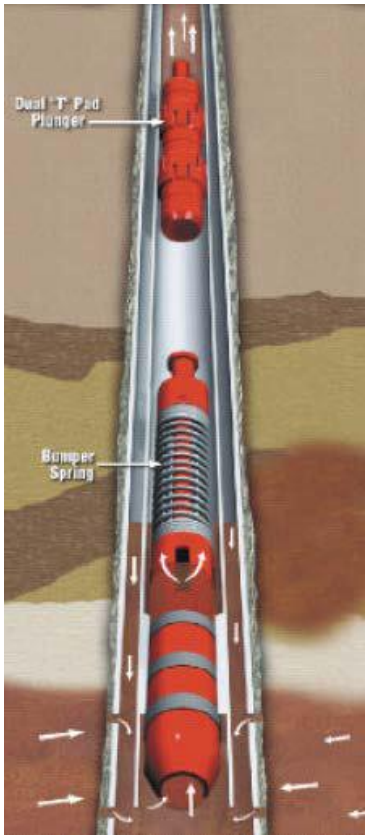
Wellhead with Pump Jack Unit

Modern Plunger Lift Systems

Process Flow Diagram

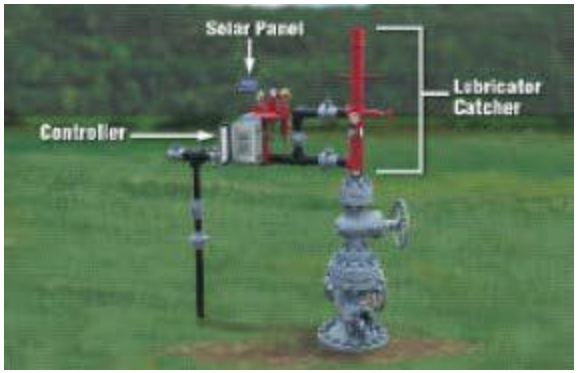


Plunger Lift System (Weatherford)



Plunger Lift Installations

Typical Solar-Powered Plunger Lift Installations



Impacts of GHG Reporting Rules (40 CFR Part 98 Subpart W)

- **Require collection of data and calculation of emissions of methane and other GHGs for most production processes**
- **Establish procedures and data quality objectives for GHG reporting**
- **Specify methods for determining GHG emissions from units**
- **Address major sources of methane releases, including:**
  - Gas venting from well completions, fracking, and work-overs
  - Natural gas releases from pneumatic controller bleed vents and activation of pneumatic pumps and valves
  - Gas venting from uncontrolled separator, glycol dehydrator, and acid gas removal unit process vents
  - Flash gas venting from flash tanks or liquid storage (stock) tanks
  - Gas vented from equipment during maintenance and shutdowns
  - Fugitive emissions from valves, connectors, compressor seals, etc.

NSPS Crude Oil and Natural Gas Production (40 CFR 60, Subpart OOOO)

- Establishes VOC control standards for oil and gas facilities constructed, modified, or reconstructed after August 23, 2011.
- Applies to each gas well; certain centrifugal and reciprocating gas compressors; high-bleed pneumatic controllers; storage vessels; and all other process units, except compressors at new oil and gas wells.
- Also include requirements that apply to certain existing gas wells that are re-fracked after October 15, 2012.
- Mandate use of low- or no-bleed pneumatic controllers
- Establish operating and maintenance practices for gas compressor seals and rod packings
- Require installation of VOC emission controls on storage tanks with uncontrolled emission rates of >6 tons/year on a schedule not yet published in the Federal Register
- Require, under the general duty clause, capture and beneficial use of produced hydrocarbons where technically feasible.

Common Technologies Used to Reduce Methane Emissions

- Capture and control natural gas released from well completions, workovers, process vents, and storage tanks
- Replace high-bleed pneumatic controllers with low- or no-bleed devices, compressed air units, or electric actuators
- Utilize "Green Completion" methods to capture natural gas during well completions, fracking, workovers, and liquids unloading
- Replace plunger lift vented to the atmosphere with sealed systems
- Route captured natural gas to sales gas stream to minimize flaring, where practical
- Utilize advanced screening and measurement tools to improve leak detection and repair programs

Emission Reduction Successes

- **Some states already requiring using "Green Completion" technology in advance of the NSPS OOOO 2015 deadline by:**
  - Routing well flow back to enclosed tanks with gas capture systems
  - Venting casing head gas to capture systems during completions and workovers
  - Reducing time between first production and sales gas pipeline connection
- **Replacement of high-bleed pneumatic controllers with lower emission alternatives has reduced methane emissions**
- **Increased use of central tank batteries for separation and gas processing improves natural gas capture because:**
  - Combined control systems are more economical
  - Centralized equipment improves maintenance and repair activities
  - Sales pipeline interconnection is simplified at a centralized facility

Challenges Going Forward

- **Current low value of natural gas negatively impacts cost recovery**
- **Lack of pipeline infrastructure or unwillingness to install increased capacity in some major gas producing areas limits the opportunity to route produced natural gas to sales markets**
- **Some resource recovery opportunities are limited by other constraints, e.g. lack of power grids to accept electric generation from waste gas**
- **Resistance to change may slow down voluntary implementation**

Summary

- **The impacts of various drivers on reducing methane emissions from oil and gas production are already positive**
- **Regulatory and social mandate to produce pressures are driving oil and gas operators to modify traditional operating practices by reducing natural gas venting during oil and gas production**
- **Technology developments are allowing these operators to implement changes and capture and sell more natural gas**
- **Current oil and natural gas prices are driving production more toward liquids (oil and condensate) rather than gas**
- **As natural gas use and prices increase, the economics of capturing more gas for sales will become increasingly favorable**

QUESTIONS?

Contact Information

Leonard H. Nelms
Tetra Tech, Inc.
2901 Wilcrest Drive, Suite 410
Houston, TX 77042

(832) 251-5171 (voice)
(832) 251-5170 (FAX)

www.tetratech.com
Len.nelms@tetratech.com