

Best Practices for Vapor Recovery Systems to Reduce Venting and Flaring

- Presented by : Jeff Voorhis, P.E. EMS-LA
- HY-BON Engineering

A blue-tinted photograph of an oil pumpjack in a desert landscape. The pumpjack is the central focus, with its long arm and counterweight visible. The background shows a flat, arid plain under a clear sky. The overall tone is professional and industrial.

What Does HY-BON Do ?

We take waste gas emissions and convert them into revenue, while keeping you in Safe and in Compliance.

Wasting resources and most importantly additional revenue!



Actual Measurement

- 530 tons per year VOC Emissions
- $55 \text{ MSCFD} \times \$4 / \text{MSCF} \times 2000 \text{ BTU}$
= \$132,000 revenue per year
- Project Cost: \$100,000 (VRU, VRT, VCU and install estimate)
- PAYOUT 9 Months!!!!!!

Why the current focus on tank battery emissions?

- Technology advancements to see and analyze these gas streams
- Realization that industry and nationwide inventories understated
- Dramatically higher volumes of VOC's & other contaminants
- Focus on reduction of greenhouse gases
- All resulted in heightened regulations & enforcement

EPA Amends Definition of Storage Vessel Affected Facility

- A single storage vessel located in the oil and natural gas production segment, natural gas processing segment or natural gas transmission and storage segment and has the potential for VOC emissions equal to or greater than 6 tpy MUST reduce the emissions by 95% taking into account requirements under a legally and practically enforceable limit in an operating permit or by other mechanism.

6 tons per year sounds like a lot, but is it

Threshold based on potential to emit VOCs - 6 tons per year or more

Daily equivalents could be as low as:

- 33 pounds emission
- About 1 mcf emission
- 1 barrel of condensate produced
- 20 barrels of oil produced
- 2000 barrels of water with 1% oil carryover processed

Emission Limitations

- The 6 tpy limit is on a per tank basis. Even if the tanks are manifolded together in a series the PTE needs to be looked at on a per tank basis. So if all of the flash is occurring in the first tank of the series, and as a result it's PTE is 10 tpy and the remaining tanks are only 1 tpy each, then the first tank is an affected source under OOOO and the others are not. Since the flash is occurring in that first tank, those emissions must be accounted for for that tank's PTE and cannot be averaged out to the other tanks in the series.

-

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Compliance Alert

September 2015

EPA Observes Air Emissions from Controlled Storage Vessels at Onshore Oil and Natural Gas Production Facilities

Purpose

The U.S. Environmental Protection Agency (EPA) is publishing this Compliance Alert because EPA and state investigations have identified Clean Air Act compliance concerns regarding significant emissions from storage vessels, such as tanks or containers, at onshore oil and natural gas production facilities. The Alert discusses certain engineering and maintenance practices causing the compliance concerns and potential emissions-reducing solutions. While this Alert provides information intended to help operators and state regulators identify and address compliance concerns, the Alert's engineering and maintenance practices do not equate to or guarantee compliance with federal and state regulations.

Compliance Concerns

This Alert aims to help operators assess whether their vapor control systems are properly designed, sized, operated, and maintained such that emissions from storage vessels may be controlled in compliance with applicable federal and state regulations. For purposes of this Alert, a "vapor control system" includes a closed-top storage vessel, all vent lines leading from the storage vessel, fittings and connectors in the vent lines, any liquid knock-out vessels in the vent lines, any pressure relief devices (PRDs) on the vessel or vent lines, and the control device used to combust gas or route gas into the sales line.

and natural gas is extracted from sub-surface formations through a wellhead and then flows into a separator at varying pressures. The separator divides material from the wellhead into various constituents, such as oil, water, hydrocarbon liquids and natural gas or comingled



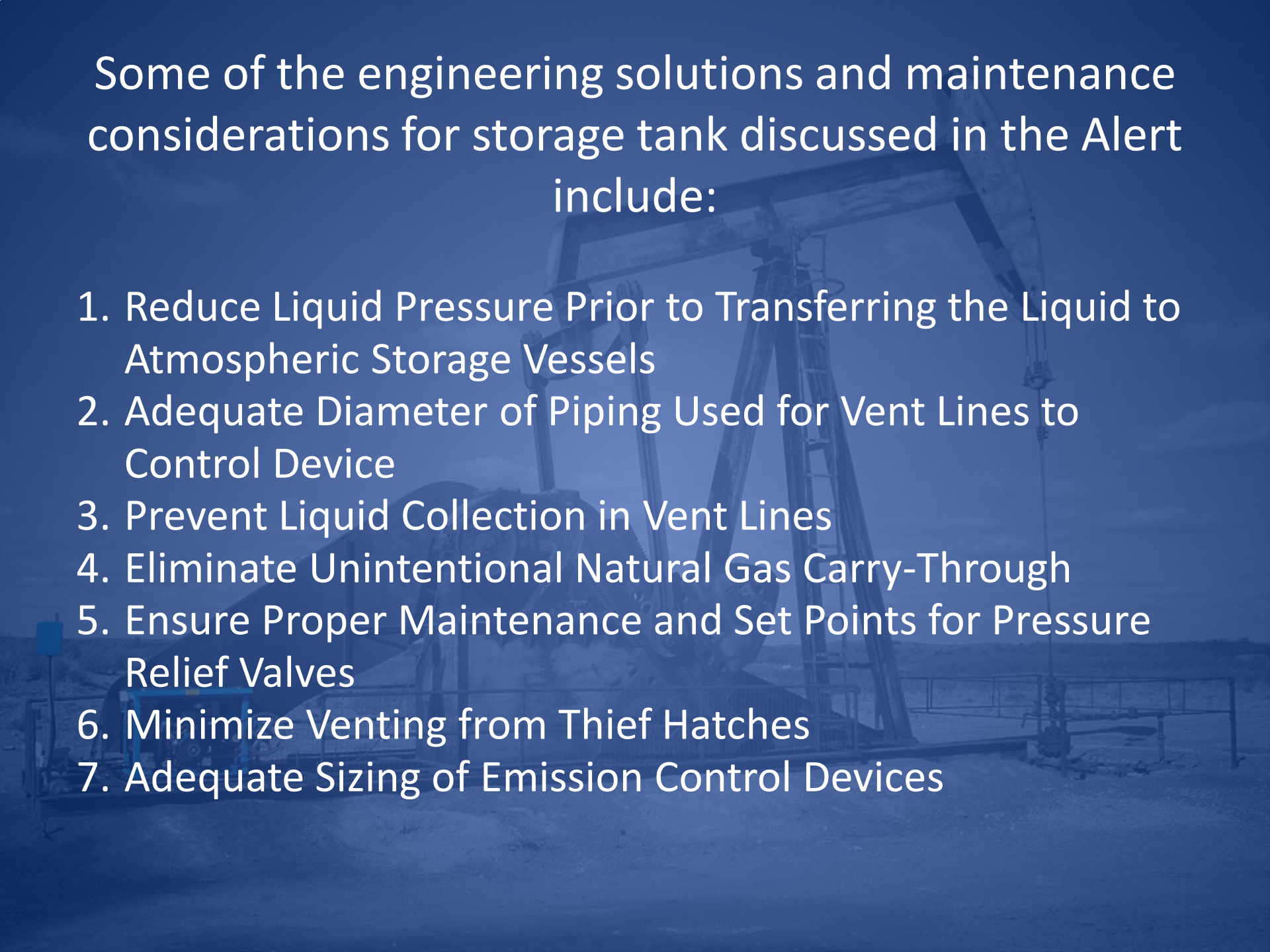
Storage vessels at an oil and gas production facility.

liquids and natural gas, depending on the characteristics of the well. The separator has a valve that opens to "dump" the pressurized liquid into a storage vessel.

While some storage vessels are designed to operate at pressures greater than atmospheric pressure, most storage vessels currently used for oil and natural gas production are atmospheric storage vessels, which are only designed to operate at or below atmospheric pressure.

Storage vessel emissions at onshore oil and natural gas production facilities are regulated because they contain: (1) large quantities of volatile organic compounds

EPA and state inspectors have observed emissions from storage vessel PRDs, such as closed thief hatches and pressure relief valves. Inadequately designed, sized, operated, and/or maintained vapor control systems may not effectively capture and control emissions.



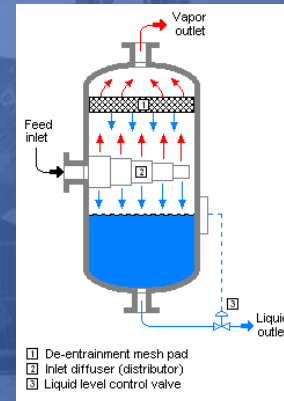
Some of the engineering solutions and maintenance considerations for storage tank discussed in the Alert include:

1. Reduce Liquid Pressure Prior to Transferring the Liquid to Atmospheric Storage Vessels
2. Adequate Diameter of Piping Used for Vent Lines to Control Device
3. Prevent Liquid Collection in Vent Lines
4. Eliminate Unintentional Natural Gas Carry-Through
5. Ensure Proper Maintenance and Set Points for Pressure Relief Valves
6. Minimize Venting from Thief Hatches
7. Adequate Sizing of Emission Control Devices

1. Crude Oil/Condensate/Produced Water Pressure Drop

To reduce flash gas volumes and peak flowrates of vent gas during separator dumps of oil/produced water to storage tanks, use multiple stages of separation. This allows the system to operate with a smaller pressure drop between the last stage of separation (low pressure separator/heater treater) and an atmospheric storage vessel. Of course, to reduce air emissions, the gas liberated by the intermediate stages of separation must be collected and sent to the system (fuel, sales pipeline) and not vented to the atmosphere.

HIGH DIFFERENTIAL PRESSURE EQUALS HIGH FLASH POTENTIAL



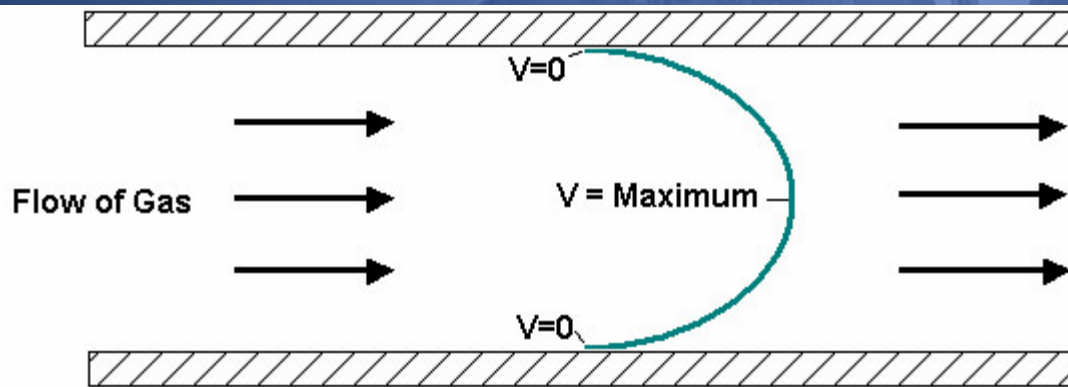
HY-BON's [IQR Emission Survey](#) includes an optional assessment of an oil and gas process to optimize pressure drops to atmospheric storage tanks and reduce flash emissions.



2. Adequate Diameter of Piping Used for Vent Lines to Control Device

Use vent piping between storage tanks and emission control devices that has a diameter designed to handle the potential instantaneous peak flow of vent gas including flash gas during separator dumps. If the piping is inadequate, then a portion of the gas will not be collected by the VRU and/or combustor. This will increase the chance of creating back pressure on the storage tank and result in venting to the atmosphere at the thief hatches and/or pressure relief valves (PRV).

INTERNAL GAS FLOW PIPE FRICTION CAUSES PROBLEMS: OVERSIZE IT



$$C_d = 0.5961 + 0.0261\beta^2 - 0.216\beta^8 + 0.000521\left(\frac{10^6\beta}{Re_D}\right)^{0.7} +$$

$$+ \left(0.0188 + 0.0063\left(\frac{19000\beta}{Re_D}\right)^{0.8}\right)\left(\frac{10^6}{Re_D}\right)^{0.3}\beta^{3.5} +$$

$$+ (0.043 + 0.08e^{-10L} - 0.123e^{-7L})\left(1 - 0.11\left(\frac{19000\beta}{Re_D}\right)^{0.8}\right)\frac{\beta^4}{1 - \beta^4} -$$

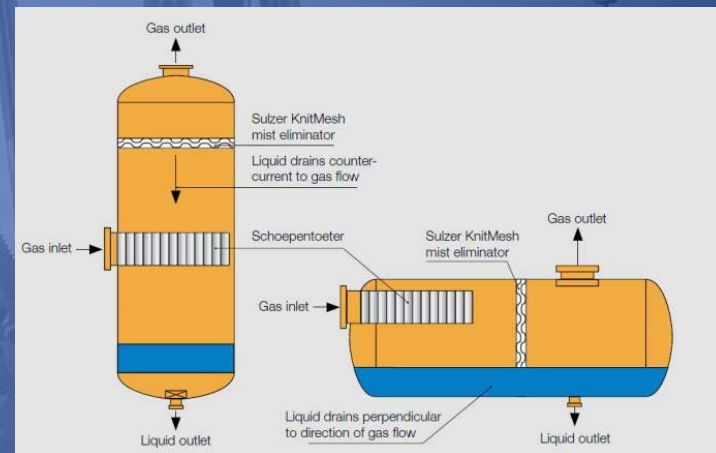
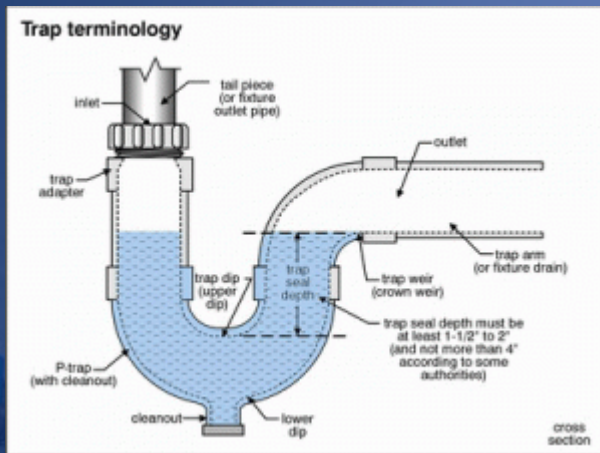
$$- 0.031\left(\frac{2L_2}{1 - \beta} - 0.8\left(\frac{2L_2}{1 - \beta}\right)^{1.1}\right)\beta^{1.3} + 0.011(0.75 - \beta)\left(2.8 - \frac{d_1}{0.0254}\right)$$

HY-BON includes this as a standard design criteria when sizing VRUs and combustors for a facility.

3. Prevent Liquid Collection in Vent Lines

The collection efficiency of vent gas control systems will be reduced if rich gas in the vent line between the storage tank and emission control device condenses and collect in vent lines – especially in low spots along the path.

NO LIQUID TRAPS TO GAS CONTROL DEVICES



In HY-BON's VRU and combustor lines, we recommend using a sloping piping of adequate inner diameter from the storage tank that is routed to a drip pot (i.e., scrubber) to ensure that liquids do not collect in the line creating a blockage. Also, the scrubber can remove liquids that can harm vapor recovery compressors and cause smoking conditions in enclosed combustors/flares.



4. Eliminate Unintentional Natural Gas Carry-Through

When storage tank pressure relief devices (PRD) are opening and venting gas on a regular basis due to pressure increase in storage vessel and this caused by unintentional natural gas carry-through, take corrective action to reduce/stop venting. This can be due to pressure increase during normal separator dump events and can also occur from separator dump valves stuck in open position (i.e., valve failed to reseal) and leaking gas into storage tanks.

If repeated PRD venting is not from unintentional natural gas carry-through, the following corrective actions are offered:

Increase the PRD pressure set points if there is sufficient margin between the set point and the rated pressure of the storage vessel to do so while continuing to safeguard storage vessel integrity-

Take steps to decrease the liquid's pressure drop experienced at the storage vessel

Replace the storage vessel with a storage vessel that is rated to a higher pressure and use higher pressure set points.

FIND THEM, DOCUMENT AND FIX THEM

HY-BON's design services will take into account production rates, operating pressures in sizing VRUs and combustors. Our IQR services include onsite inspections for carry-through of vent gas due to stuck dump valves.



5. Ensure Proper Maintenance and Set Points for Pressure Relief Valves

By design, pressure relief valves (PRVs) are safety devices that protect vessels from over-pressurization and should remain closed during normal operations. They are not process vents that should discharge during normal operations.

The EPA alert states that PRVs should have a pressure setting that is low enough to protect vessel structural integrity and avoid over-pressurization. Also, the pressure setting should be high enough to exceed storage vessel operating pressures during normal operation.

When a PRV is found to be venting to the atmosphere actions should be taken to verify proper valve reseating after opening.

CRITICAL TO ALL OPERATIONS OF VRU AND CONTROL DEVICES. CHECK MONITOR AND MAINTAIN TO STAY IN COMPLIANCE





Division now issuing Immediate Notice of Violation for visible emissions from a flare and/or open thief hatch.

“The Division has determined that improperly secured thief hatches, visible emissions from a flare, and audible emissions from a thief hatch or PRV are violations of Regulation No. 7. The Division has determined that the minimum fine for an open thief hatch, visible emissions from a flare or audible emissions from a thief hatch or PRV will be \$15,000 per day. The duration of each such violation will be at least one day, unless evidence gathered by the Division and/or provided by the source proves otherwise.” (emphasis in original).

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Air Quality Control Commission; REGULATION NUMBER 7 ; CONTROL OF OZONE VIA OZONE PRECURSORS

The background of the slide is a photograph of an oil pumpjack in a desert landscape. The pumpjack is a large mechanical structure used for extracting oil from a well. It consists of a long horizontal beam supported by a vertical post, with a counterweight and a walking beam. The pumpjack is set against a clear sky and a flat, arid ground. The entire image is overlaid with a semi-transparent blue filter.

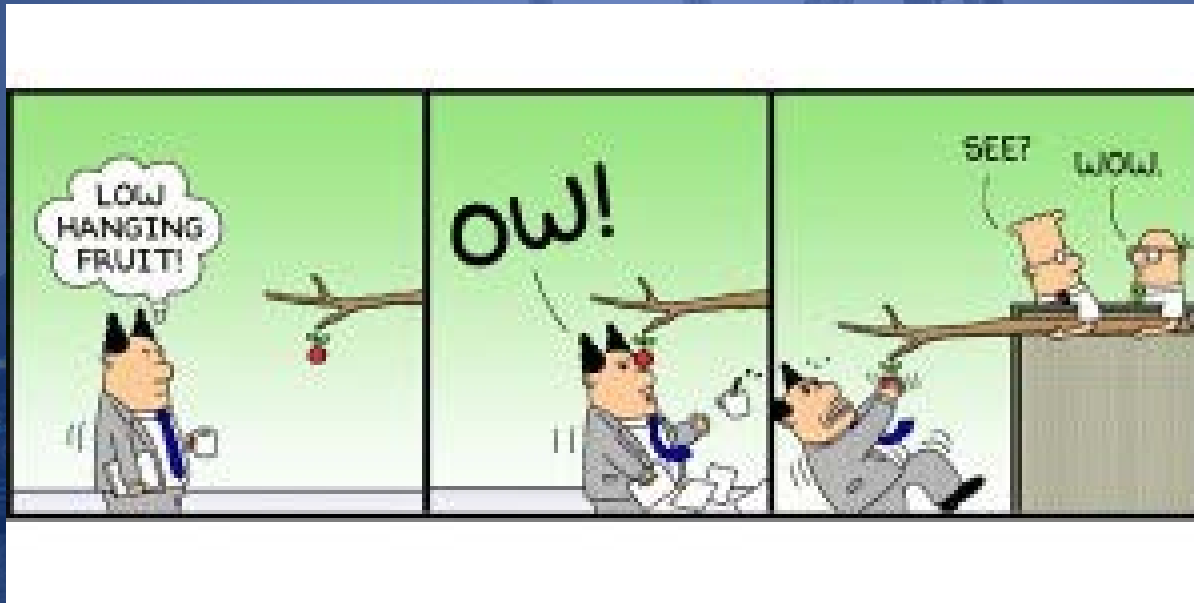
Noble Energy Reaches Agreement With Federal And State Regulators To Improve Air Emission Controls In DJ Basin Operations

The company will pay about \$13.5 million in civil penalties and \$60 Million to support environmental mitigation projects, according to the consent decree. Noble also agreed to upgrade its equipment in the DJ Basin to reduce emissions, with the work expected to be complete in 2019.

6. Minimize Venting from Thief Hatches

Inspect gauging/thief hatches and pressure relief devices regularly to ensure good seals. Install quality gaskets on thief hatches and regularly inspect those gaskets to ensure a tight seal. Implement procedures to ensure thief hatches are properly closed after vessel gauging, sampling and unloading.

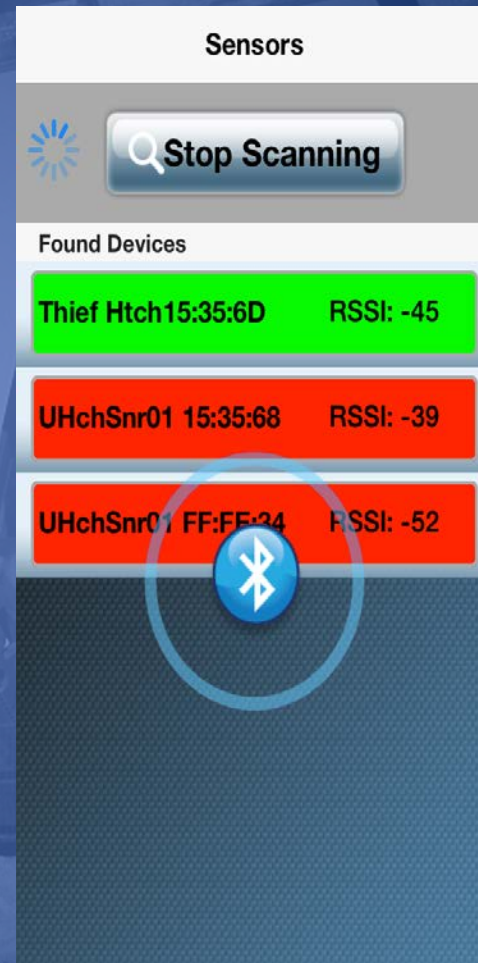
INSPECTORS GO AFTER LOW HANGING FRUIT ALWAYS, PICK AND FIX IT FIRST

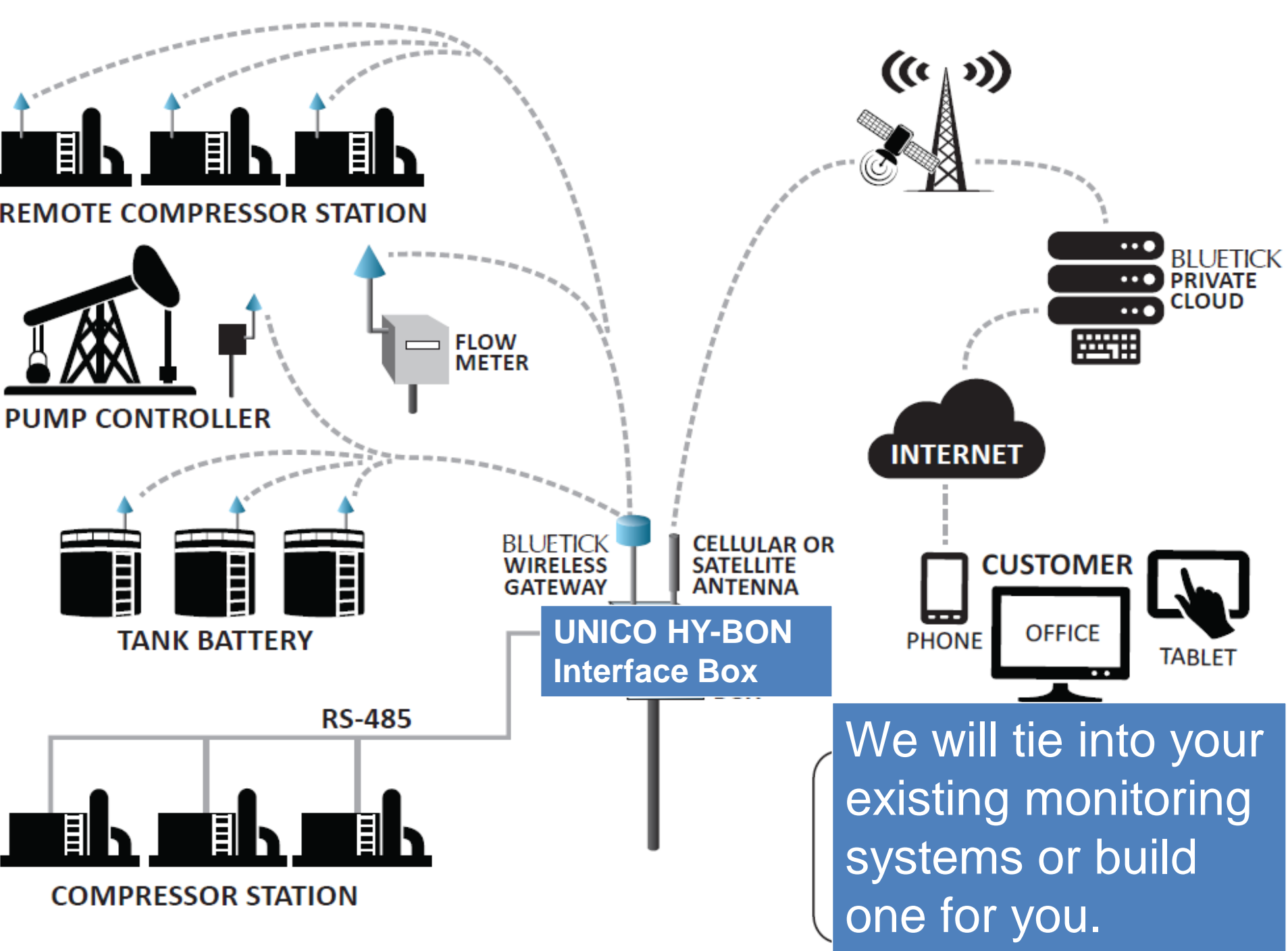


HY-BON routinely inspects and replaces gaskets for thief hatches and leaking pressure relief devices as a part of our [IQR services](#).



Hatch Sense







7. Proper Sizing of Emission Controls

Ensure that vent gas control devices are properly designed/sized for the specific facility's operations. The design should be sized and operated to control for the full range of gas flowrates that are expected.

Key to ensuring proper sizing of emission controls is appropriate sampling, measurement and/or modeling to estimate potential maximum flow of vent gas from storage tanks.

YOU DON'T KNOW, WHAT YOU DON'T KNOW. GET GOOD DATA. Allows for Management Decisions based on fact.



HY-BON's engineers can run process simulation calculations to estimate the potential range of flowrates of vent gas for various operating scenarios. The assessment will take into account production rates, storage tanks used and operating pressures in sizing VRUs and combustors.

LOW BID COST MORE

After flyover of an oil and gas production site by the TCEQ using FLIR Camera, an O&G Operator observed visible vent gas emissions. TCEQ gave the operator the opportunity to correct the emissions without monetary penalty.



LOW BID COST MORE

The operator contacted HY-BON for an IQR measurement and bid for a vapor recovery unit (VRU). HY-BON engineered a system for the application and quoted a wet, flooded screw VRU and vapor recovery tower (VRT).

PAYBACK for HY-BON system estimated at 9 MONTHS.



LOW BID COST MORE

The operator decided to go with another vendor based on cost/low bid for a reciprocating compressor VRU (which was NOT designed for the wet gas service it would encounter.)

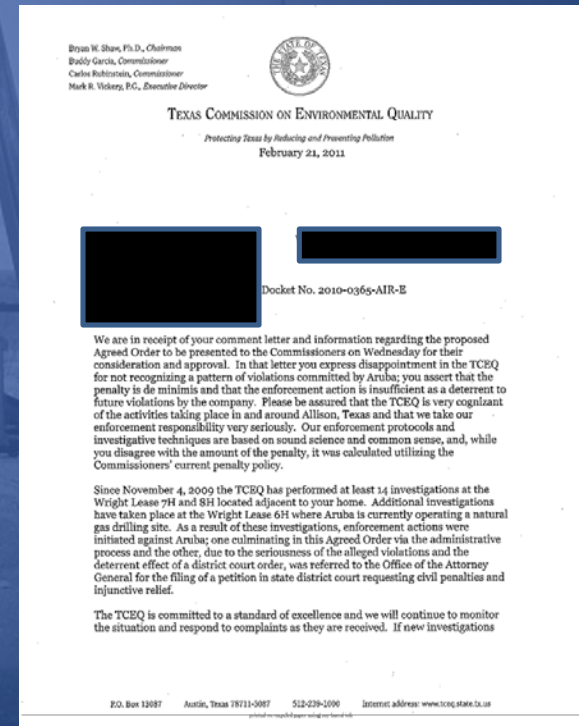
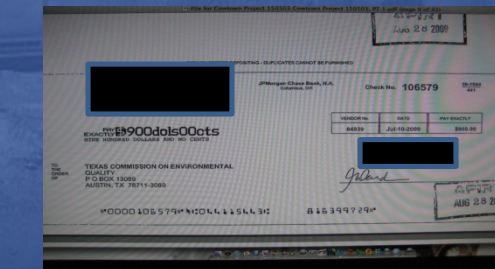
HY-BON gave a “HEADS UP” of possible failure using recip in wet gas service.



LOW BID COST MORE

TCEQ inspectors conducted a follow-up inspection for the production facility and found the site venting natural gas due to failure of the reciprocating VRU compressor.

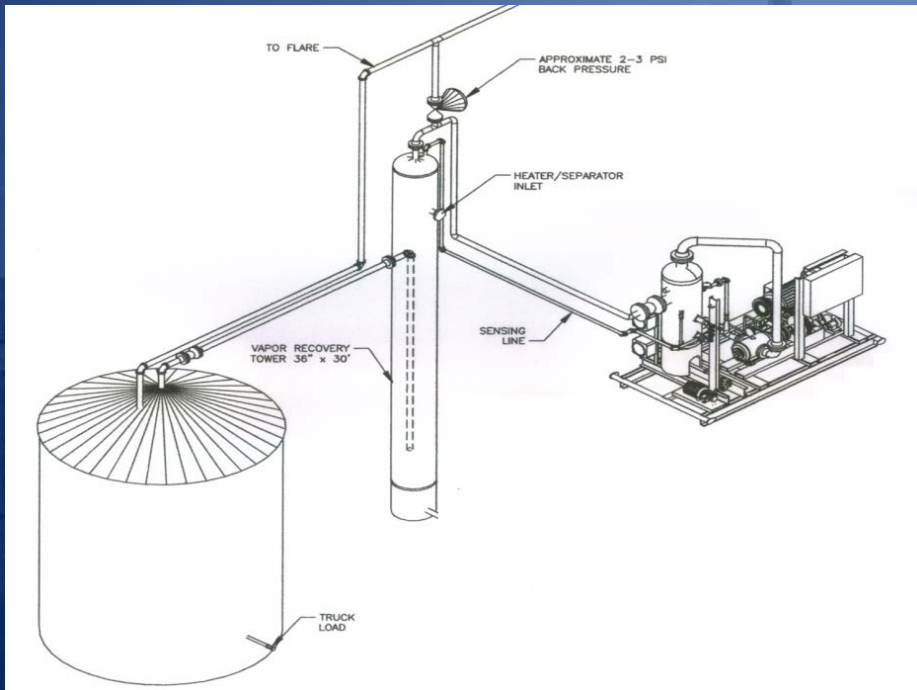
TCEQ issued a notice of violation and the company was fined \$300,000.



LOW BID COST MORE

The operator contact HY-BON to correct the low bid system that did not function properly.

HY-BON supplied the proper VRU design for the application. The production site is NOW producing and operating in compliance with TCEQ air quality regulations.



LOW BID COST MORE

Engineered designs have the lowest downtime and operating costs in the oil and gas industry.

DOING IT RIGHT THE FIRST TIME WILL MAKE YOUR COMPANY MONEY AND KEEP YOU IN COMPLIANCE.



HEADS UP: SECTION 114 LETTERS

- U.S. EPA has expansive authority under Clean Air Act (CAA) Section 114 to request any information it may reasonably require for developing regulations or determining compliance. Significant enforcement cases often begin with a Section 114 request.
- A Section 114 request is a formal, written request for information related to activities subject to the CAA, somewhat analogous to an IRS audit.
- As EPA discovers concerns with a company's operations as a result of a single or multiple facility inspection, broad authority under the Clean Air Act in Section 114 allows EPA to reach deep into a company's records for information that could uncover additional concerns. This broad authority has historically been used under other National Enforcement Initiatives (NEIs). EPA can request financial, capital expenditure, and maintenance expense records to help determine if projects should have been permitted or should have been considered subject to NSPS.

HEADS UP: SECTION 114 LETTERS

- If you do receive a Section 114 Request, remember the key is a good faith response to EPA. Act quickly and develop a plan of action to ensure your response is forthright and timely. First, don't panic; a planned approach is the best defense.





ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 60

[EPA-HQ-OAR-2010-0505; FRL-9929-75-OAR]

RIN 2060-AS30

**Oil and Natural Gas Sector: Emission
Standards for New and
Modified Sources**

AGENCY: Environmental Protection Agency
(EPA).

ACTION: Proposed rule.

SUMMARY OF PROPOSED ACTIONS

The proposed actions are:

- o Proposed updates to the agency's New Source Performance Standards that would set methane and VOC requirements for additional new and modified sources in the oil and gas industry;**
- o Draft guidelines for reducing VOC emissions from existing oil and gas sources in certain ozone nonattainment areas as well as in the mid-Atlantic and northeastern states in the Ozone Transport Region;**
- o Proposed updates to clarify the agency's air permitting rules as they apply to the oil and natural gas industry;**
- o A proposed Federal Implementation Plan to implement minor New Source Review permitting in Indian country.**



GasFindIR Camera

The invention of the FLIR Gas Find IR Camera's in 2004 allowed industry (and regulators) to see these gas streams for the first time



FLIR™ HI

MANUAL

WH



7/26/08 5:07:53PM

LOW



WHAT GETS SEEN, GETS MEASURED

**WHAT GETS MEASURED, GETS
CONTROLLED**

***WHAT GETS CONTROLLED, CAN MAKE
YOU MONEY***

PICARRO REAL TIME MEASUREMENT

Picarro Surveyor Mobile Platform



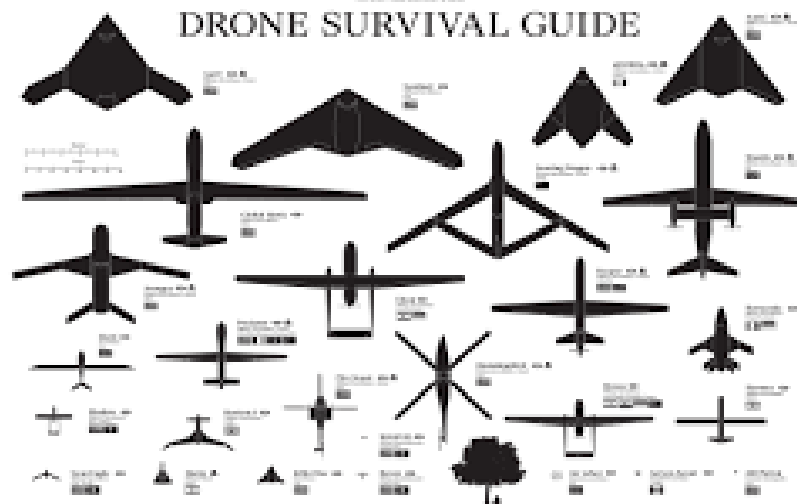
**See
greenhouse
emissions like
never before.**

Now anyone can measure and map emissions with CRDS precision and cloud-based algorithms. In seconds.

Methane emissions in Rodeo, CA.



DRONE SURVIVAL GUIDE



Total Safety gets approval to use drone in flare stack inspections. FAA: Feb 2015

- Company intends to make service available to Permian Basin clients
- Inspection by drone can be done for refineries, petrochemical plants, tank batteries, drilling rigs, completion sites or production facilities.
- More economical and efficient than traditional inspection methods.

FLIR™

HI

MANUAL

WH



1/18/08 2:42:47PM



Understanding this gas stream

- **3 Phase separation – as pressure is reduced on the liquid, heavier hydrocarbon gases are released.**
- **Methane versus ethane, butane & propane**
- **Higher levels of contaminants & H₂S**
- **Some is heavier than air, so exposure to employees and community is higher**
- **Higher BTU, so more valuable**
 - **2,000 to 3,000 BTU vs. 1,000 BTU typical pipeline gas**
 - **Sells for 2.5X normal NYMEX gas prices**

GAS COMING OUT OF SOLUTION



Challenges in Compression

- Analogy is compressing steam versus air
- Heavier, wetter gas stream to compress
- Liquids fall out in piping from tanks
- Dew point can cause the gas to return to liquid form at higher discharge pressures (based on compression ratios)
- H₂S and CO₂ (often with water vapor) cause higher levels of corrosion
- Volume of gas spikes & drops during separator dumps; and over life of battery
- Low pressure system must NEVER pull in oxygen into the pipeline

“Best in Class” Solutions for Effective Capture & Control

Requires a Total Solutions Approach

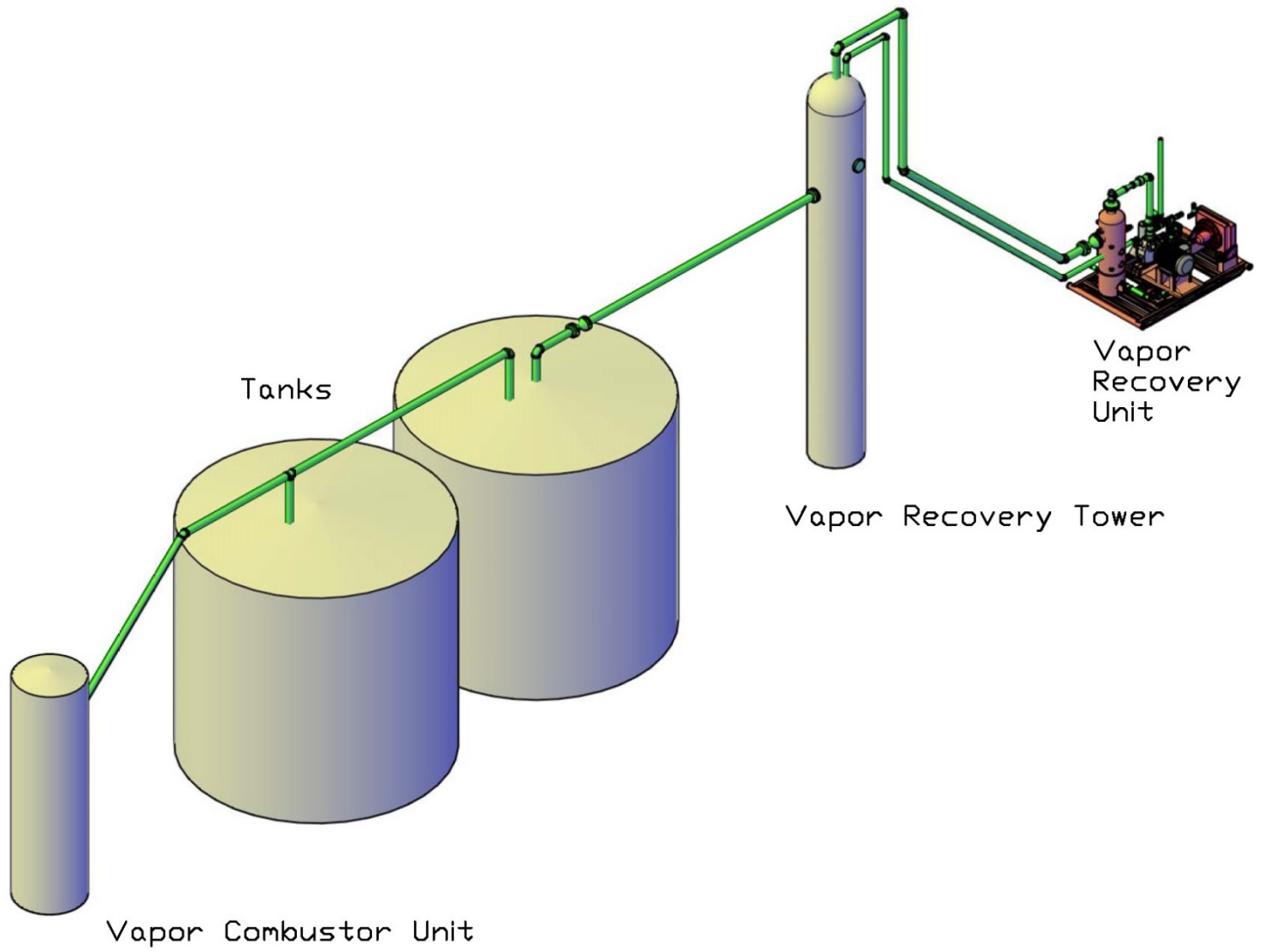
Emission Surveys to Accurately determine volumes, gas analysis & pressures

Vapor Recovery Towers

“Real” Vapor Recovery Units

Enclosed Combusters

Maintenance & Tracking program



Vapor Recovery Tower




What is a VRT?

- A *vapor recovery tower* is a tall pressure vessel which is installed between the production separator(s) and the liquid storage tanks
- “Best in Class” VRT’s are engineered for proper retention time to allow gas to separate from the liquid, and have no potential for liquid traps in gas vapor piping to VRU.
 - Although VRT’s are normally rated for pressures between 50 and 175 psig, they typically gravity feed to the liquid storage tanks at very low pressure (~1 psig)
 - In most installations, the flash gas from the liquids in the VRT flow to a vapor recovery unit for compression

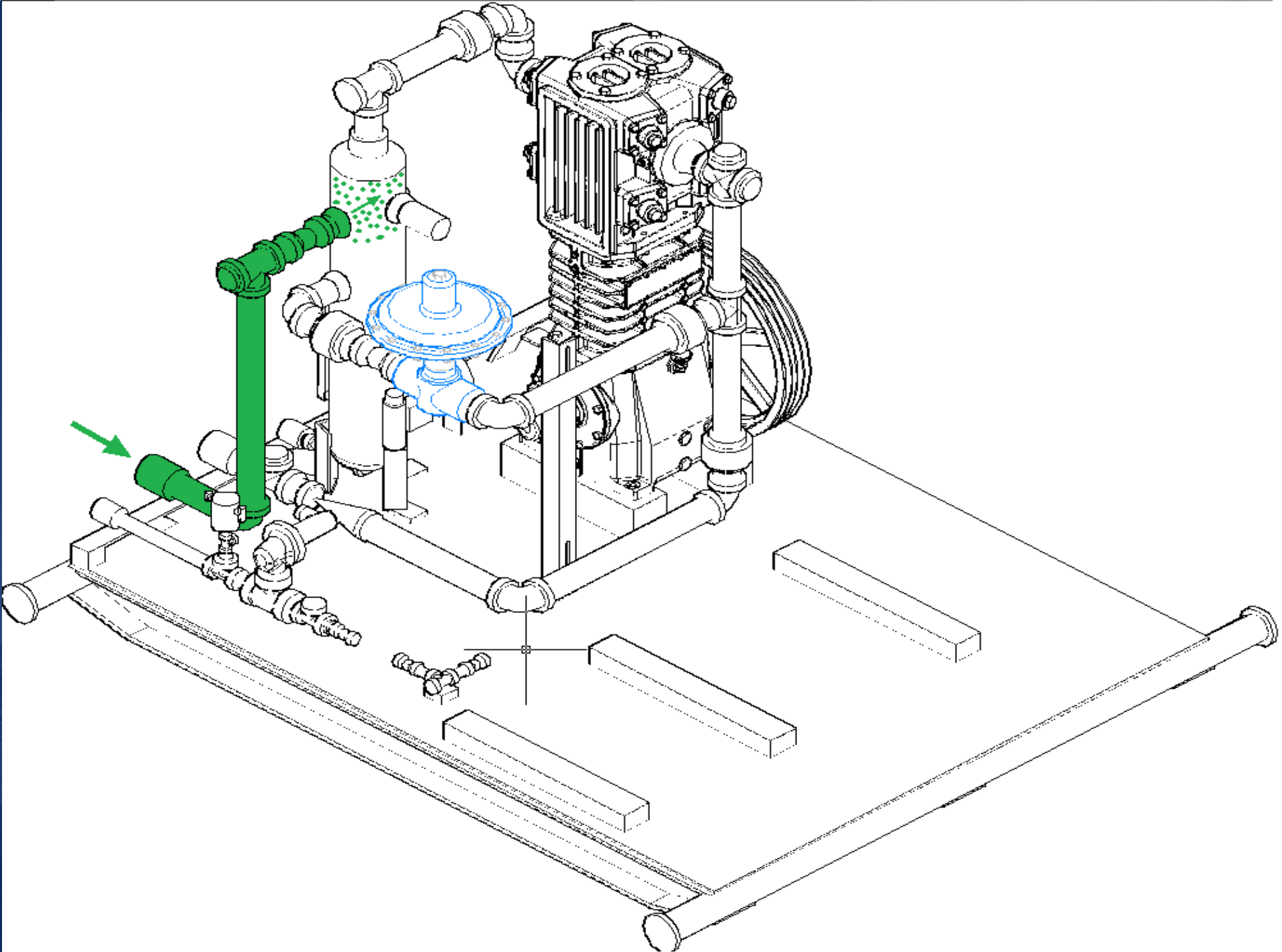


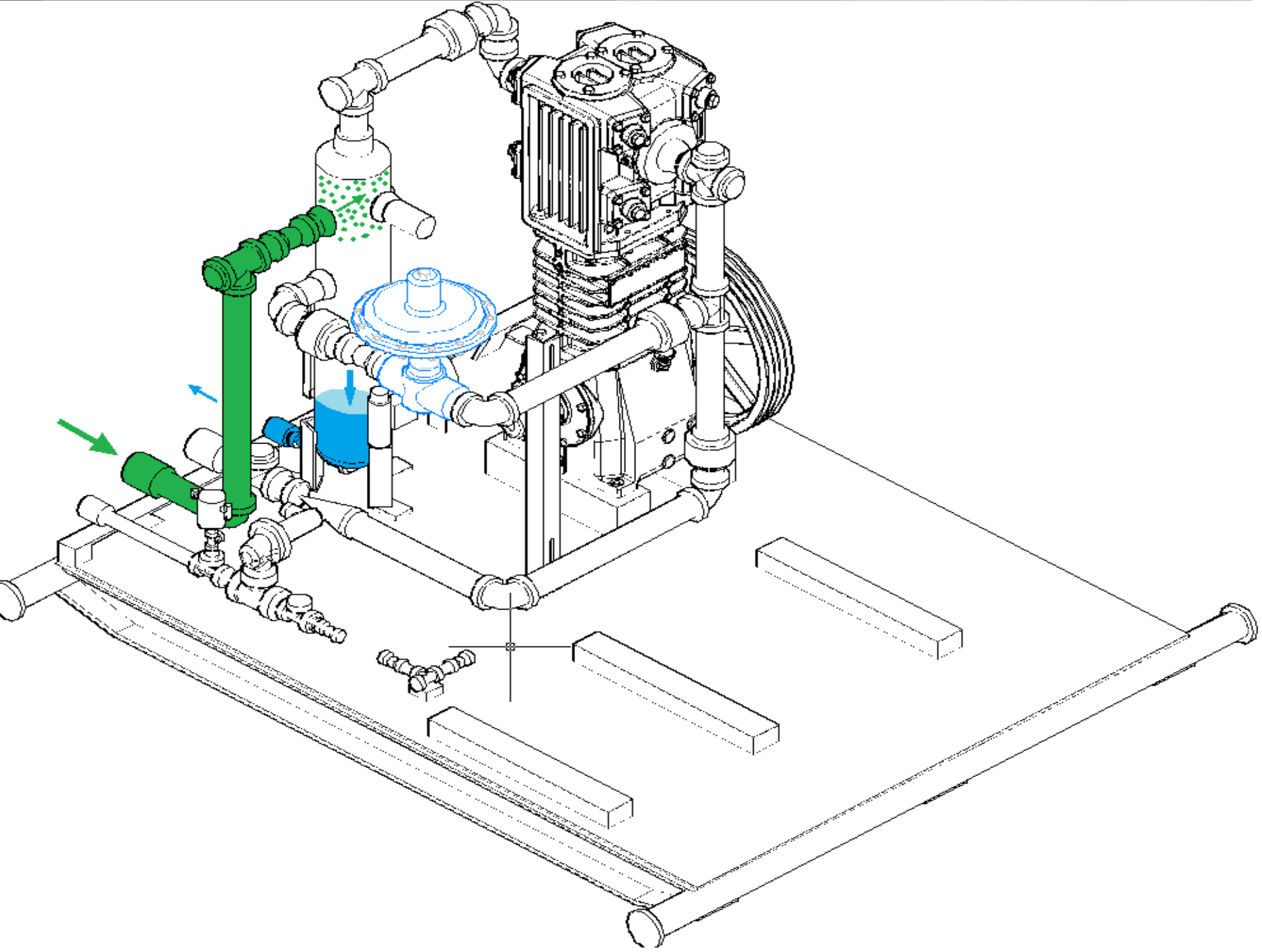
What is a VRU?

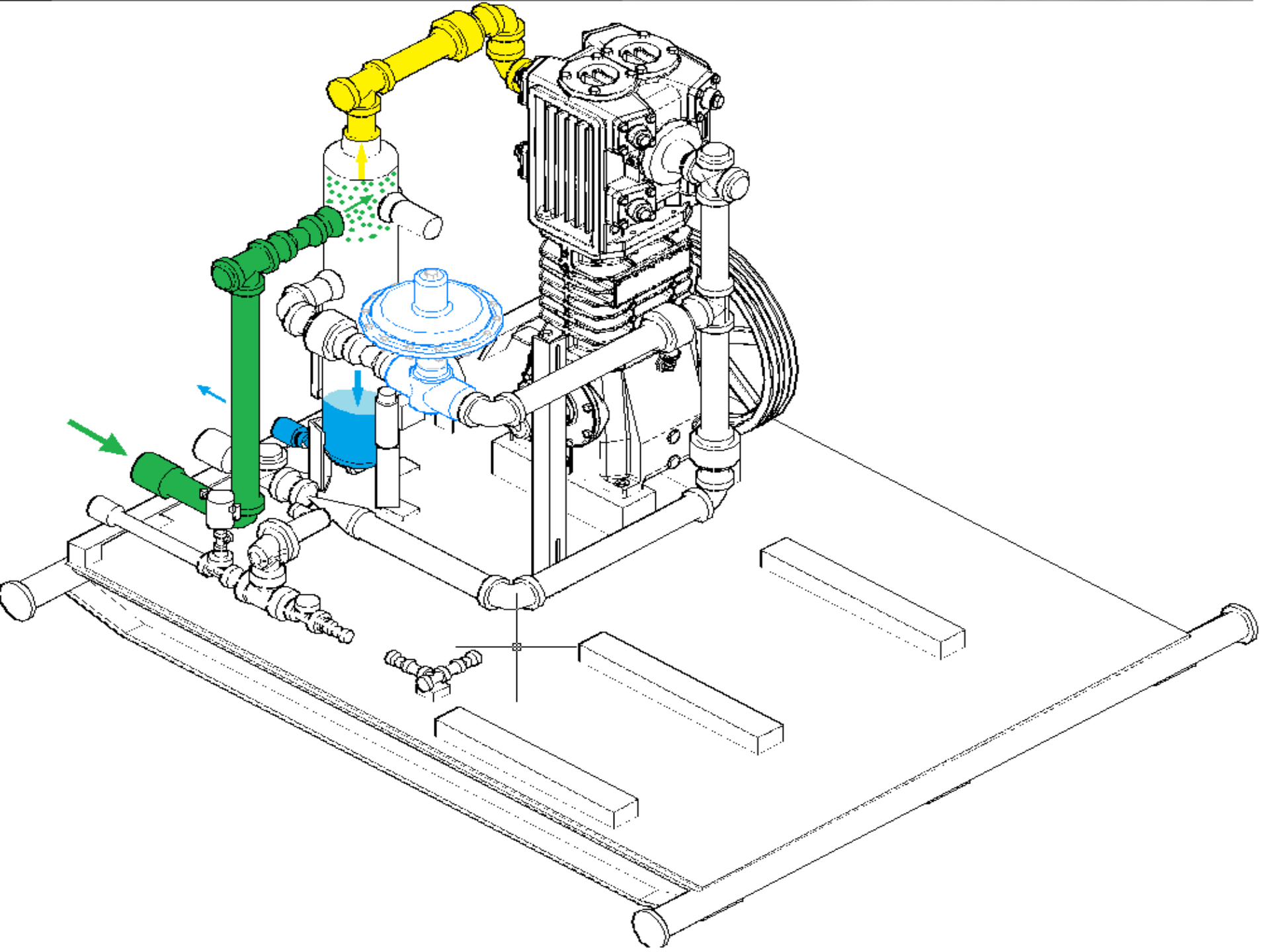
- *A vapor recovery unit is a specialized compression package designed specifically to capture low pressure, wet gas streams from oil and condensate storage tanks*
- A Vapor Recovery Unit meets the following technical definition of a VRU as defined by the Natural Gas STAR Program, the EPA, and multiple state regulatory agencies:
 - Correct compressor selection (for wet gas streams) including rotary vane, rotary screw, vapor jet, or eductor/venturi jet / Recips are not recommended
 - Pressure sensing devices off the tanks or tower
 - An automated bypass system
 - Ability to vary the speed of the compressor based on changing volumes of the gas.
- VRU's are automated systems which start, stop and bypass automatically as pressure is increased in the tanks or tower. Variable frequency drives are recommended.
- "Best in Class" VRU's incorporate Variable frequency drives for changing volumes, automation packages to document compliance, and versatile designs for long term changes in tank battery oil volumes and corrosive gas streams

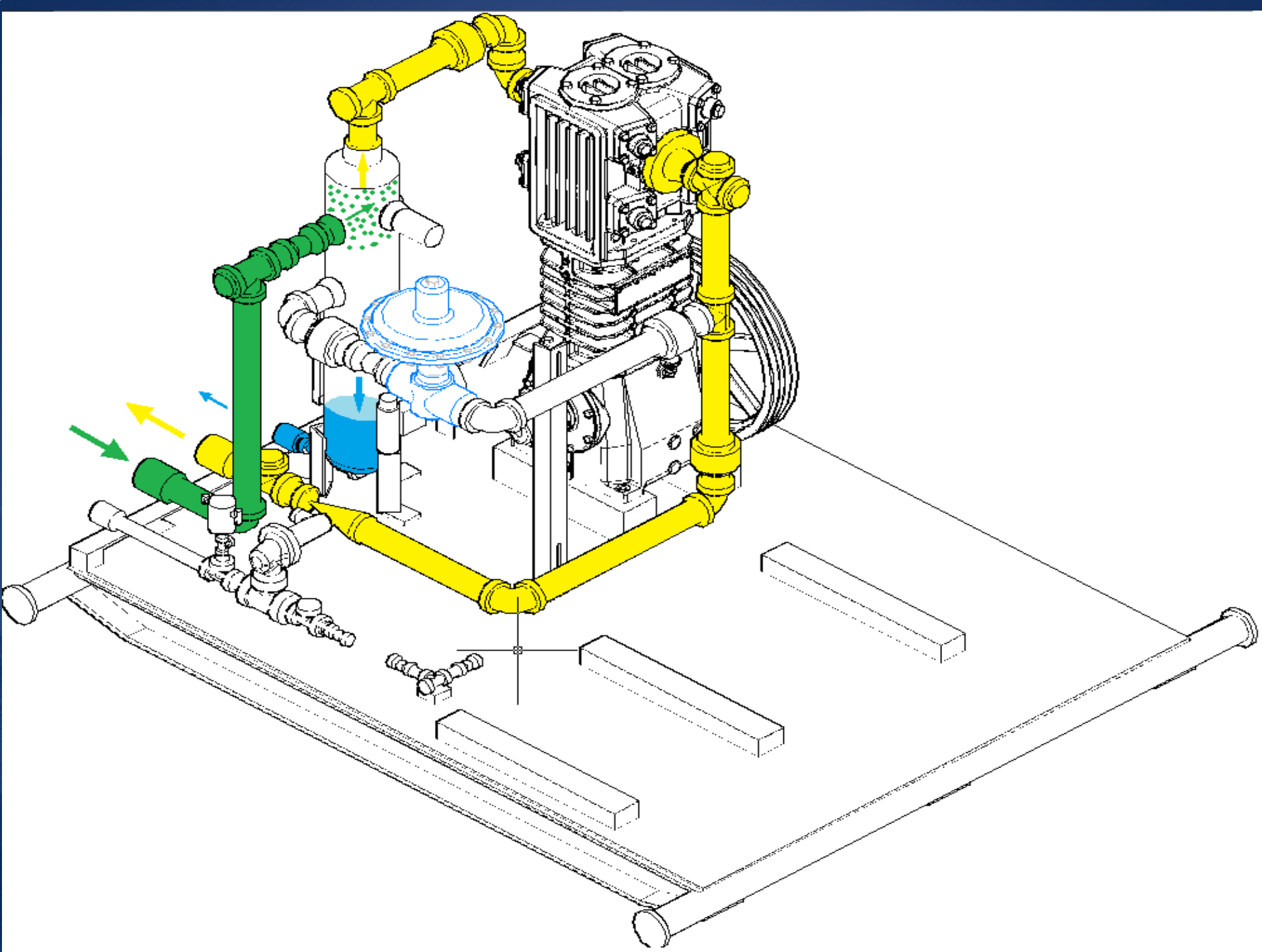


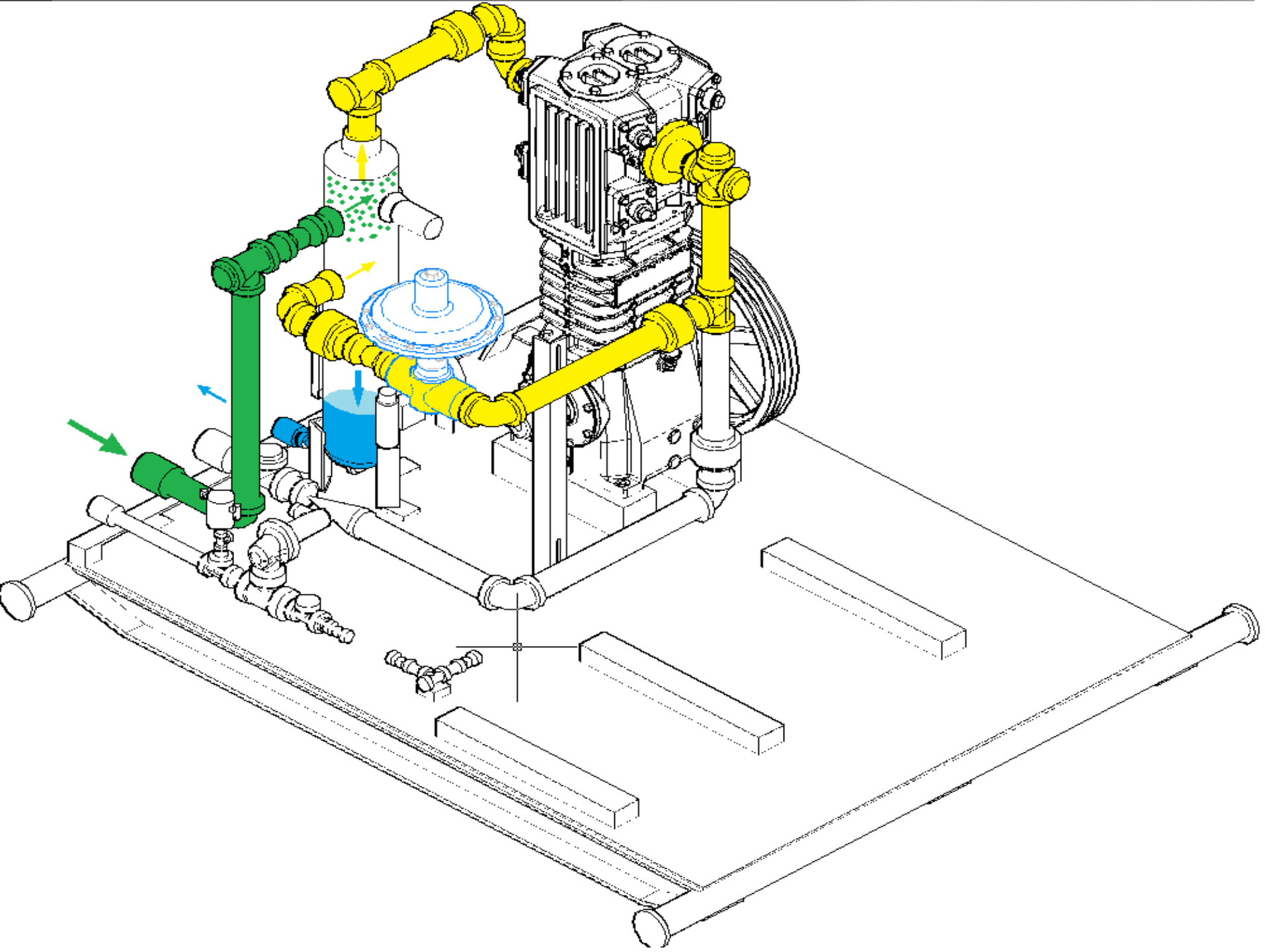
Compressor Fundamentals

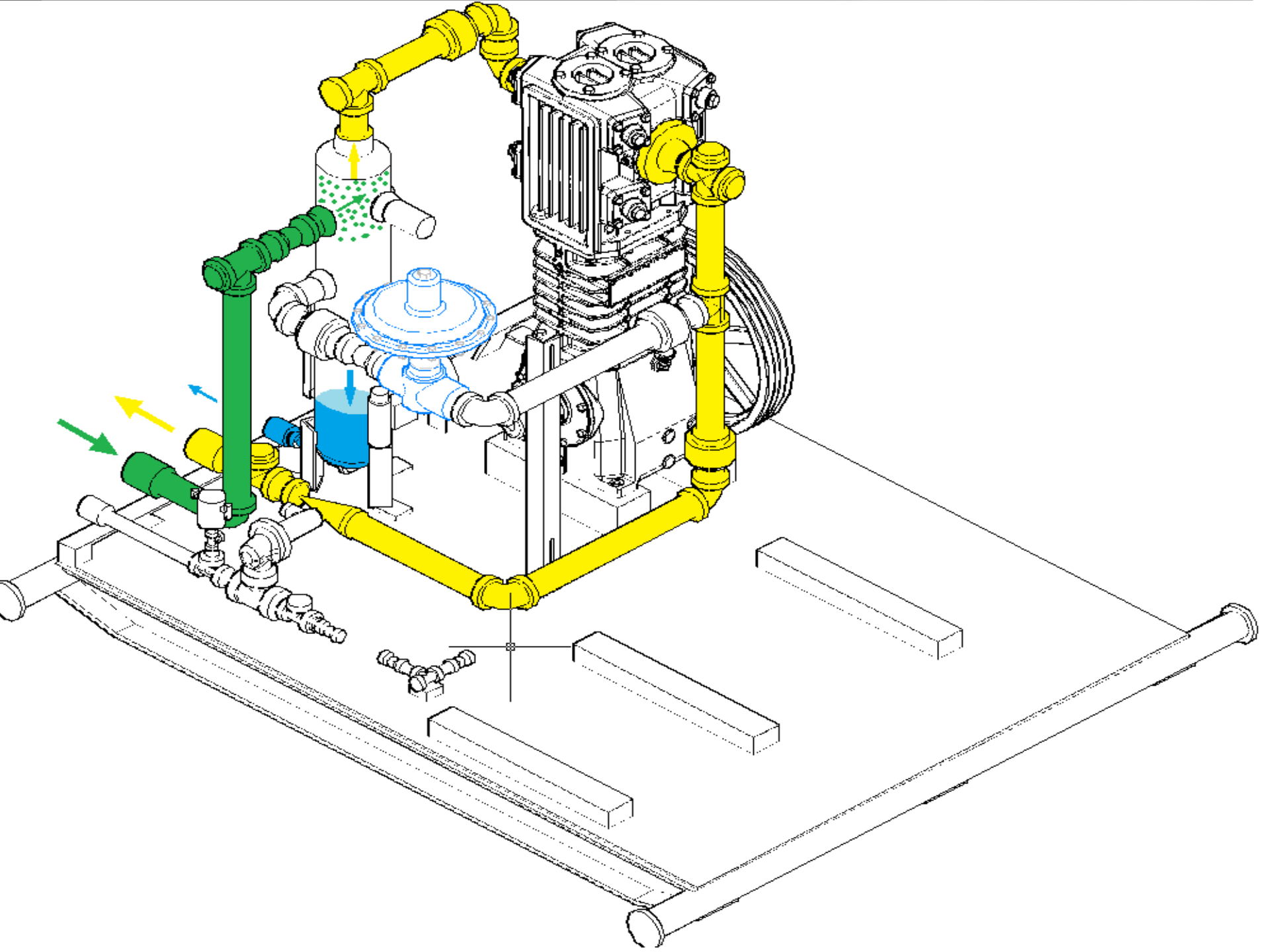














Industry Experience: ConocoPhillips



- Vapor recovery units installed in Baker, MT
- Anticipated multiple sites, so detailed technical review of options was conducted
- Volumes per site ranged from 30 mcf/d to 400 mcf/d
- Pipeline pressure ranged from 20 to 40 psig
- Captures vapors from
 - Crude oil storage tanks
 - Produced Water tanks
 - All manifolded together in closed loop system
 - Gas blanket system used to backfill tanks



















HY-BON
432-697-2292
CAUTION
THIS EQUIPMENT MAY
START AUTOMATICALLY
AT ANY TIME
CONTROL CAUTION CAUTION

HY-BON



RAYMOND
15C-294Z

EDN

PAIRS 123-4051-001

DANGER
HOT

DANGER
REMOVING
STARTER MOTOR
AUTOMATICALLY

CAUTION
HEARING
PROTECTION
REQUIRED

DANGER
THE BATTERY
EXPLODES IF OPEN
TO FLAME!

CAUTION
HEARING
PROTECTION
REQUIRED

DA

Industry Experience: ConocoPhillips

- Payback Economics – Project for 9 Tank Batteries

– Purchase Price for 9 VRU's	\$475,000
– Estimate Install Cost	\$ 237,500
– Total Capital Costs	\$ 712,500

- Approx Gas Revenue

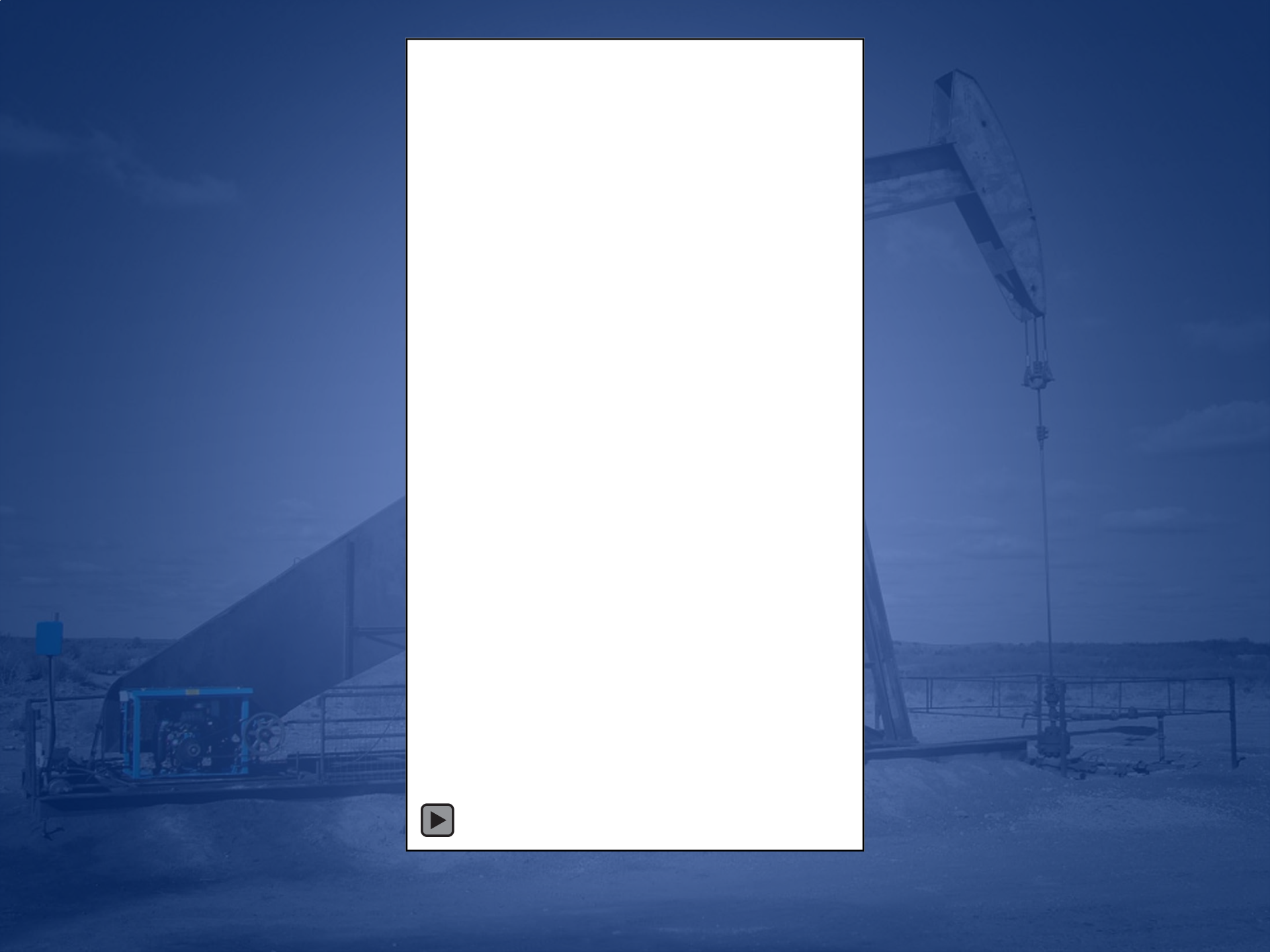
- $1,490 \text{ mcf/d} \times \$6/\text{mcf} \times 30 \text{ days} = \$268,200/\text{mo}$

- Payback on Capital Investment < 3 months

What is an Enclosed Combuster?

- An enclosed combuster is a form of gas flare that burns or “combusts” the gas at a much higher combustion efficiency than a typical open flare design
- The enclosed design eliminates visibility of the flame from the road or community – it appears like a piece of production equipment
- “Best in Class” enclosed combusters maintain 99% + control efficiency – which largely eliminates smoke trails and soot emissions (black carbon)
- New regulations (EPA Quad O) require data logging to document control requirements are being met.
- Testing ports for emissions testing are highly recommended for pending regulations





“Best in Class” Solution

- Conduct emission surveys to get accurate field data on gas analysis, 24 hour volumes and required discharge pressures.
- Use of Vapor Recovery Towers to eliminate oxygen ingress potential, especially in truck loaded batteries
- Use of “real” Vapor Recovery Units to capture gas volume off the towers or tanks. Document run times & volumes. Can be used straight off tanks, or off VRTs.
- When volumes off tanks are below 10 to 20 mcf (company specific payback threshold), consider utilizing an enclosed combustor to burn residual gas in a prudent and compliant manner
- Install a maintenance program on the equipment and track / document run times and compliance

1500TPY 125MSCFD



Opportunity to Learn Something New



Gas Conservation Filter (GCF) for Oil Production Tanks and Waste Water Storage Tanks

The GCF works on the same absorption principle as the smaller plunger pump and compressor counter parts.

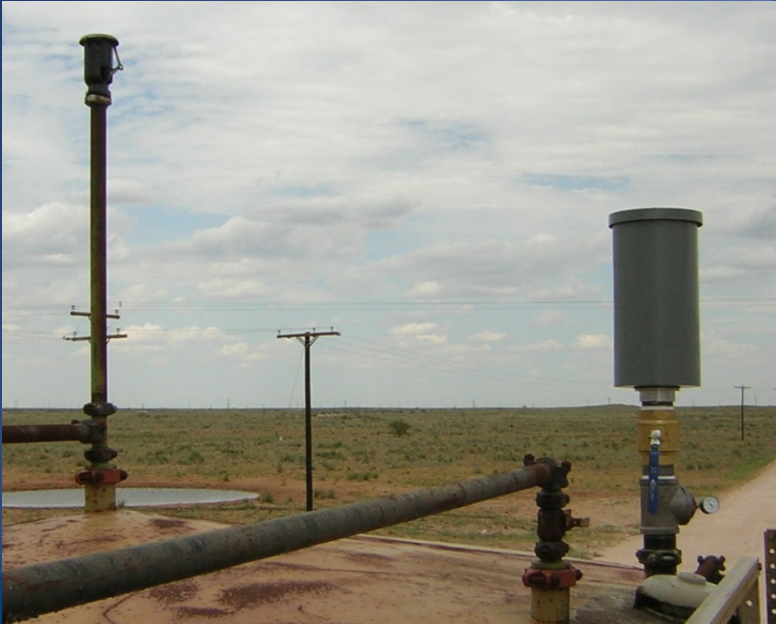
These filters are much larger and are filled with the same stripping agent to reduce VOC's and GHG Emissions



Gas Conservation Filter for Oil Production Tanks and Waste Water Storage Tanks

Safety

The GCF installed as shown here does not compromise the integrity or safety of the storage tanks.



Connection

The GCF canister can be a 4 inch thread connection, Victaulic or Flanged connection. Installation of the filter will be installed or supervised by HY-BON personnel.



Vent gas will follow the least path of resistance and we are using this theory to flow the gas through the GCF.



IQR Inspection

Engineering Company, Inc.
2404 COMMERCE MIDLAND, TEXAS 79703

IQR Job # **Bio Filter Lease**

Service **Direct Measurement**

Company Name **Biofilter Installation**

Location/Lease **A Battery**

Inspected By **Kevin McGinnis**

Requested By / Ph# **Allen W.**

Local Contact / Ph# **Chad C.**

Date Tested **October 13, 2012**

County / State **Andrews Tx**

Purchase Order #

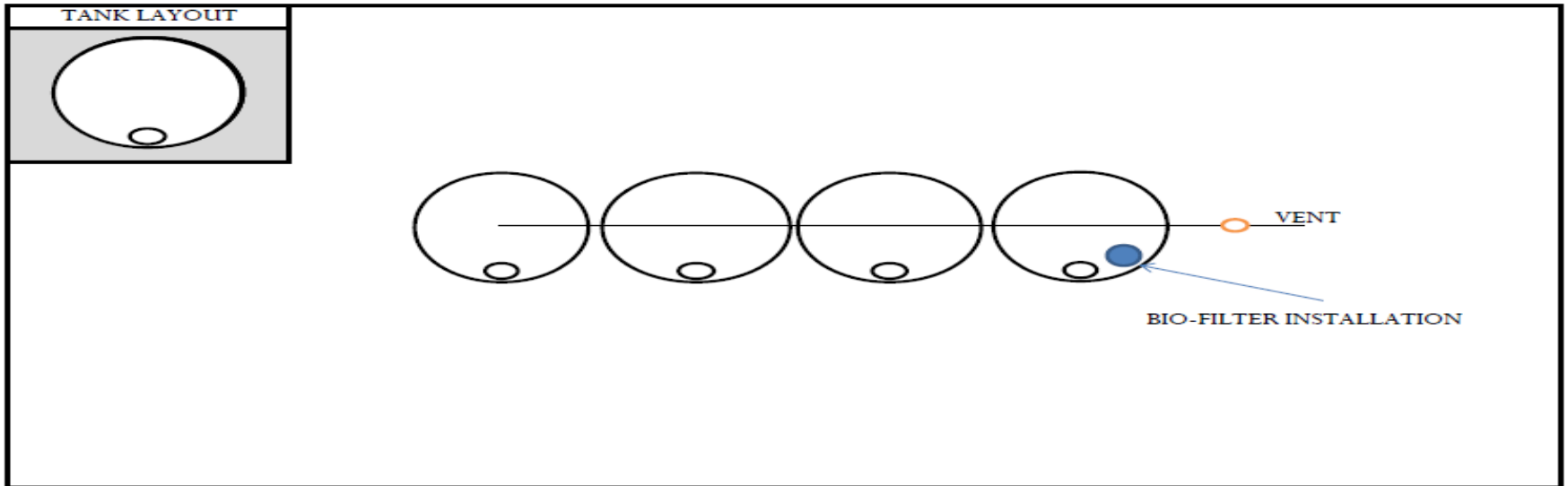
Work Order #

Task #

Directions:

Tank # / Description	Equipment	Brand	Model	Size	Gasket Type	Condition
Oil Tank	Hatch	Enardo	660	8"	Viton	Good
Oil Tank	Hatch	Enardo	660	8"	Viton	Good
Water Tank	Hatch	Enardo	660	8"	Viton	Good
Water Tank	Hatch	Enardo	660	8"	Viton	Good
	Vent Valve	Enardo	330	3"	Butyl	Good

Comments



Biofilter Installation

A Battery Andrews Tx



*Hy-Bon Engineering
IQR Survey Services*

Survey Date:

10/13/12

Surveyed By:

Kevin McGinnis

Base Input Parameters

	Initial Test 10-31-12	Post Filter 11-15-12	Post Filter 3-20-12	Measurement 4	Measurement 5	Measurement 6
Measured Volume	7.40	7.40	3.10			
Atmospheric Press	30.30	30.30	30.30			
Tank Vapor Temp.	65.00	65.00	65.00			
Tank Vapor MW	31.80	28.01	30.32			
Tank Vapor % VOC	35.58%	0.00%	11.48%			
Tank Vapor % HAP	0.811386425	0	0.47200178			

EMISSIONS CALCULATIONS / VOC's ton/yr

Site	Measured Volume	Corrected Volume	Tank Vapor MW	Total Emissions	Tank Vapor VOC	Tank Vapor HAP	VOC Emissions	
	V_{ACT} [ACFD]	V_{STD} [MSCFD]	MW_{TV} [lb/lb-mole]	E_{tot} [ton/yr]	X_{VOC} [lb/lb]	X_{HAP} [lb/lb]	E_{VOC} [tpy]	E_{HAP} [tpy]
1 <i>Measurement 1</i>	7.400	7.45	31.80	113.71	35.58%	0.81%	40.46	0.92
2 <i>Measurement 2</i>	7.400	7.45	28.01	100.18	0.00%	0.00%	0.00	0.00
3 <i>Measurement 3</i>	3.100	3.12	30.32	45.43	11.48%	0.47%	5.22	0.21
4	0.000	0.00	0.00	0.00	0.00%	0.00%	0.00	0.00
5	0.000	0.00	0.00	0.00	0.00%	0.00%	0.00	0.00
6	0.000	0.00	0.00	0.00	0.00%	0.00%	0.00	0.00

Reductions

87.11%

76.76%

STATE CONCURRENCE



Based on the data provided and discussions from the meeting we have agreed to allow tanks in low flow service where conditions are acceptable to the installation and operation of the Tank Gas Conservation Filter a baseline collection of 80%. If a company wishes to authorize a higher collection efficiency then direct measurement of the tank emissions with the filter in place is necessary. The measurement results would need to be submitted with the application registration for any claims over 80%.

Best,

Joe Shine

Team Leader, Rule Registrations Section

Air Permits Division

joe.shine@tceq.texas.gov

(512) 239-6595

STATE CONCURRENCE



NORTH DAKOTA
DEPARTMENT of HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov



April 10, 2015

Jeff Voorhis, P.E., EMS-LA
Corporate Sales Austin
2404 Commerce
Midland, TX 79703

Re: State Concurrence

Dear Mr. Voorhis:

The North Dakota Department of Health (Department) appreciates the presentation conducted on March 12, 2015 by Hy-Bon Engineering on new emerging control technologies for the oil and gas industry. Based on the information contained in your presentation, it appears the equipment described should be considered for control/monitoring of emissions at well sites. The gas concentration filter may provide adequate emission control from tanks in certain applications (i.e. low flow).

The Department will...

STATE CONCURRENCE



Department of Environmental Quality

*To protect, conserve and enhance the quality of Wyoming's
environment for the benefit of current and future generations.*



Matthew H. Moad, Governor

Todd Parfitt, Director

April 8, 2015

Mr. Jeff Voorhis, P.E., EMS-LA
Corporate Sales Austin
2404 Commerce
Midland, TX 79703

Dear Mr. Voorhis:

I want to thank you for taking time on March 10, 2015, to present HY-BON™ products for the oil and gas industry. During our meeting you requested a letter acknowledging that the Wyoming Department of Environmental Quality (DEQ) was aware of the bio-filter technology and how it might be used in Wyoming.

Wyoming DEQ does not certify control equipment. Instead, control equipment is evaluated on a case-by-case basis for each permitting action. Performance requirements are established, when appropriate, for controls and operators are expected to meet them. For example, oil and gas operators who install and operate a vapor combustor to control volatile organic compound emissions are required to meet a 98% destruction efficiency.

Based on the information you provided, I can see how the bio-filter could be used to control emissions from tanks in certain cases. Wyoming DEQ would certainly allow the use of such equipment on a trial basis to determine its effectiveness on sources in Wyoming. I encourage any company wishing to test these filters to contact NSR for approval; such requests will be approved on a case-by-case basis.

If you have any questions, please let me know at (307) 777-7391.

Sincerely,

A handwritten signature in black ink, appearing to read "Cole Anderson".

Cole Anderson
NSR Program Manager
Wyoming DEQ

STATE CONCURRENCE

The Pennsylvania Department of Environmental Protection (the Department) has examined **the technology of gas conservation filters which may be included in required best available technology (BAT) determinations for low-flow, high-concentration VOC storage tanks.** BAT is determined on a case-by-case basis by the Department at the time of issuance of a Plan Approval. BAT is an evolving standard and is defined as equipment, devices, methods, or techniques as determined by the Department which will prevent, reduce, or control emissions of air contaminants to the maximum degree possible and which are available or may be made available.

Charles Boritz | Air Quality Engineering Specialist

Department of Environmental Protection | Technical Support Section

400 Market St. | Hbg PA 17101

Phone: 717.772.3977 | Fax: 717.772.2303

www.depweb.state.pa.us

STATE CONCURRENCE

The WVDEP is aware of HY-BON's "Biofilter" for reducing VOC emissions from hydrocarbon and produced water storage tanks and WV will evaluate these on a case-by-case basis. HY-BON stated the filter is designed for tank vent gas volumes that are less than 5,000 ft³/day. HY-BON's proposal of quarterly VOC emission monitoring to check the status of the gas conservation filter could be incorporated as a condition in a Rule 13 air quality permits. Currently, WV's General permit (G70-A) does not accommodate the use of this device, but companies are able to obtain Rule 13 permits for this device.

Robert Keatley, PE

Senior Engineer

Supervisor, Compliance and Enforcement

Division of Air Quality

601 57th Street, SE

Charleston, WV 25304

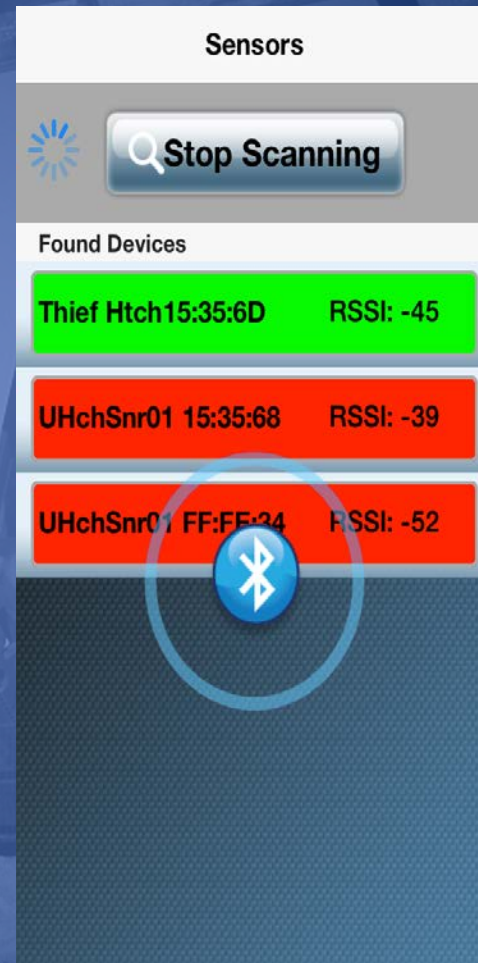
Direct (304) 926-0499 ext. 1695 | **Fax** (304) 926-0479

e-mail: Robert.L.Keatley@wv.gov

West Virginia department of environmental protection

"Promoting a healthy environment"

Hatch Sense



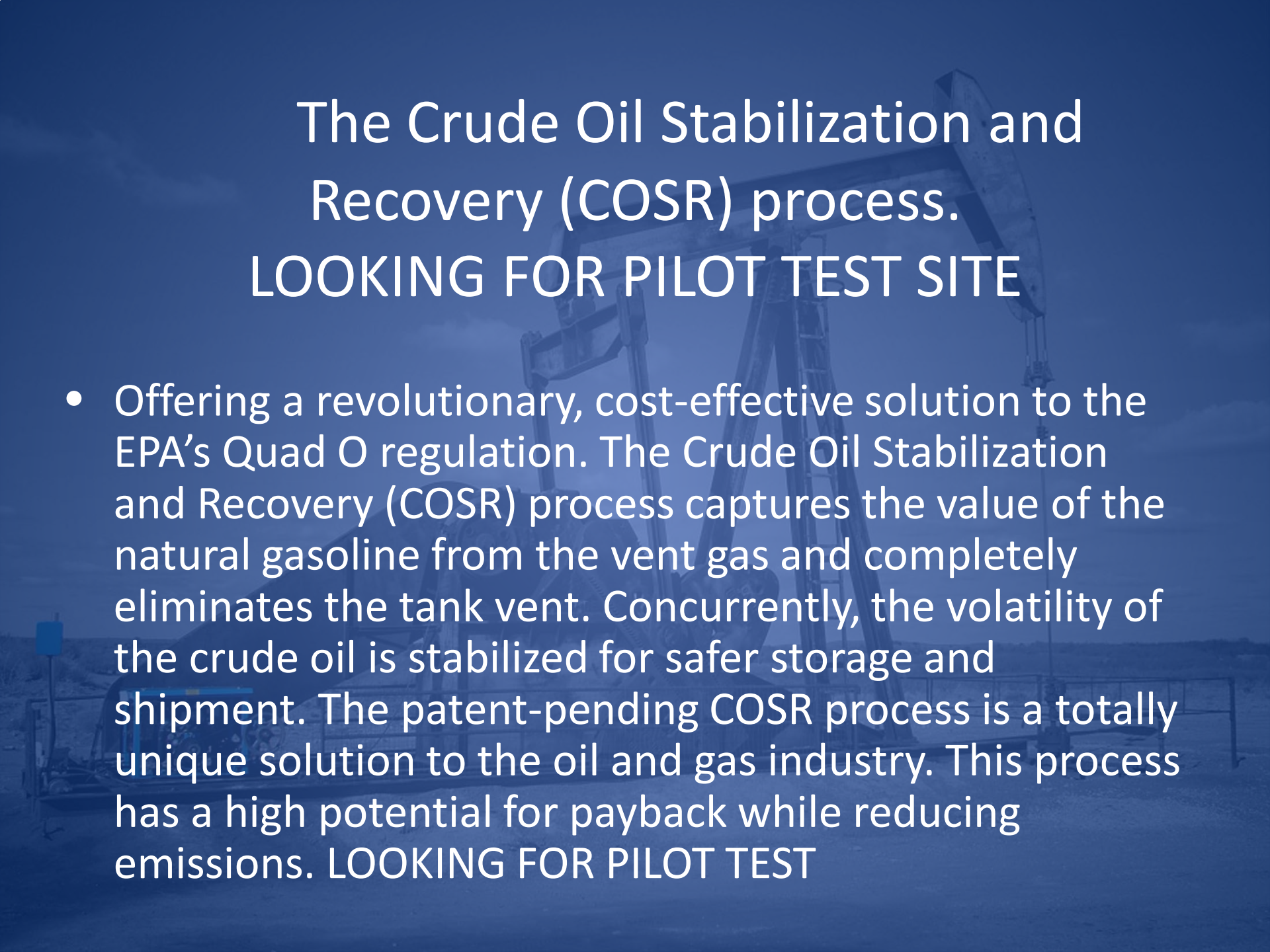
Optional Volume Measurement



- Specifically designed to monitor vent gas.
- Can be permanently mounted or used as a portable device
- No moving parts, non-clogging
- Handles gases and liquids
- For use in tubing & piping up to 6" diameter
- Superior low flow sensing (0-100 fps)
- No cavities or dead legs
- Simple, screw-in installation
- Self-contained unit
- **Does not require calibration in the field**
- **Meets EPA Greenhouse Gases Reporting Rule Subpart 'W' requirements**

Also stand alone Measurement



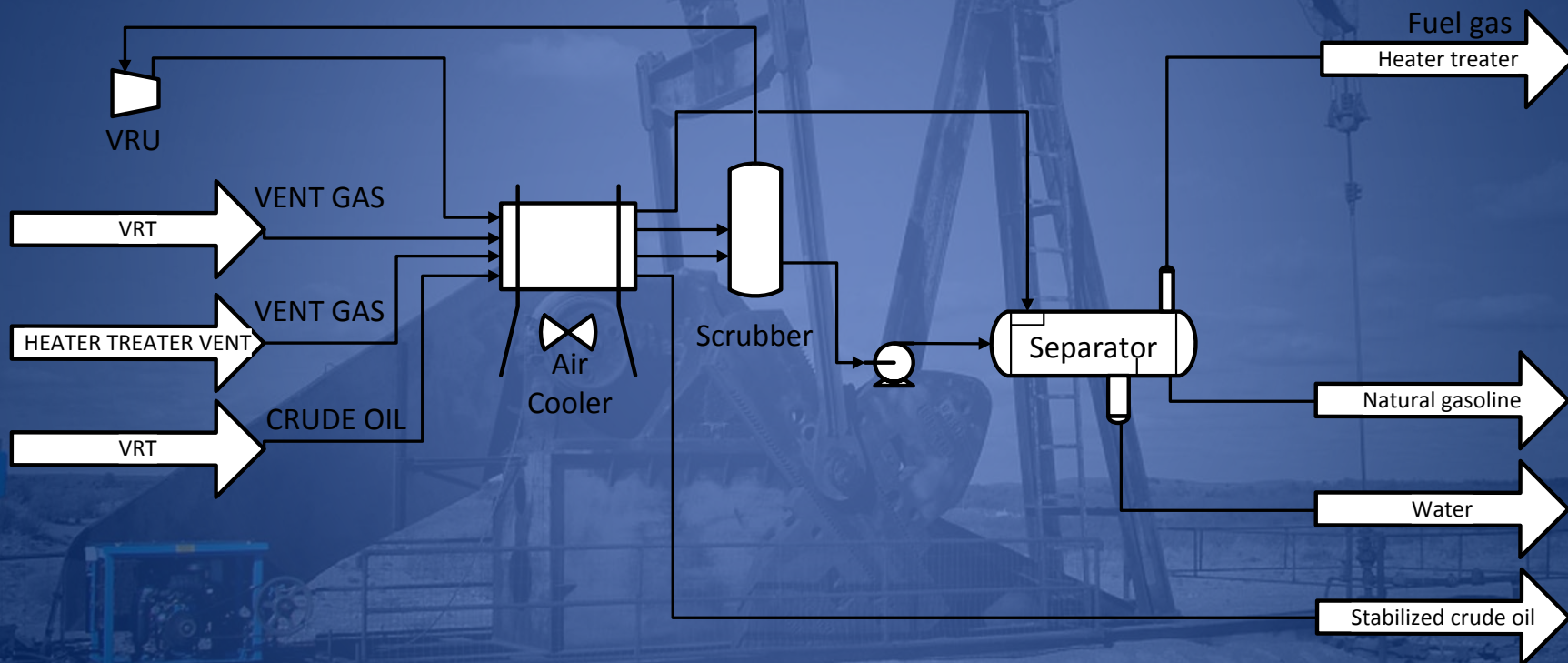


The Crude Oil Stabilization and Recovery (COSR) process.

LOOKING FOR PILOT TEST SITE

- Offering a revolutionary, cost-effective solution to the EPA's Quad O regulation. The Crude Oil Stabilization and Recovery (COSR) process captures the value of the natural gasoline from the vent gas and completely eliminates the tank vent. Concurrently, the volatility of the crude oil is stabilized for safer storage and shipment. The patent-pending COSR process is a totally unique solution to the oil and gas industry. This process has a high potential for payback while reducing emissions. LOOKING FOR PILOT TEST

The Crude Oil Stabilization and Recovery (COSR) process



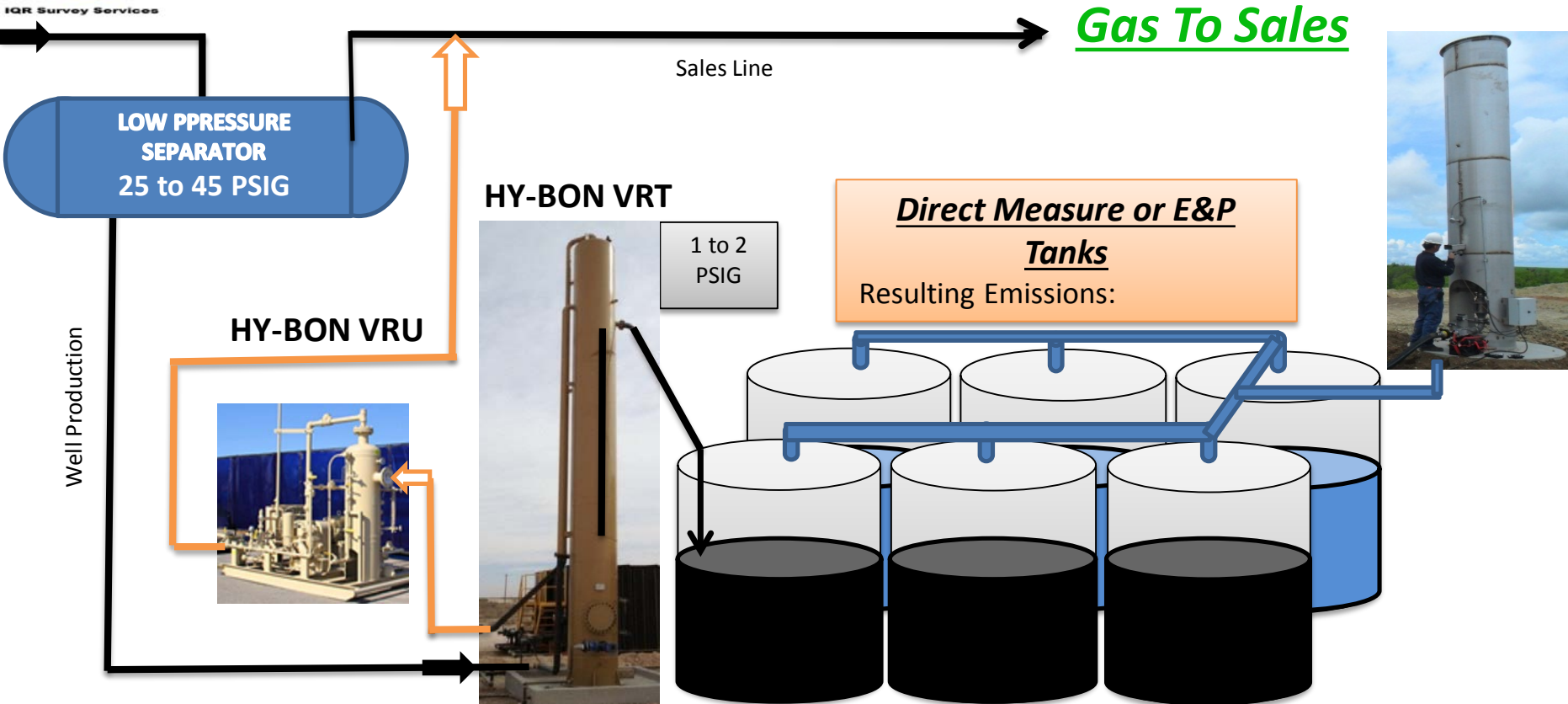
The Crude Oil Stabilization and Recovery (COSR) process

Six Bakken crude oil wells, each producing 400 barrels of oil per day of oil, with an uncontrolled Reid vapor pressure of 17, are gathered to feed a single heater treater at 50 psig. The Reid vapor pressure is reduced to 7.6 psi. Concurrently, the tank vent is completely recovered without the need for a flare.

	COSR	Uncontrolled
Vent recovery	100%	0%
Crude oil Reid vapor pressure, psia	7.6	17.2
Max storage temp., °F	113	44
Recovered vent value, \$/month	\$ 161,241	\$0



**SHOW
ME THE
MONEY!**



Economic Payback

6.65

Months

Operational Data		Qty	Project Installed Cost			\$145,400.00
Flow Volume MSCFD	100		IQR Field Survey Cost			\$1,600
Operating Days	350		UNIT SELECTION			
BTU of GAS	2100	1	HB-NK100-40-36D	Op Range	PSI	41,900
Gas Price	\$3.57	1	HY-BON(VRT)	5 - 75	1 - 2	20,500
		1	HY-BON Combustor (SM)	.7MTF	4 oz	9,500
Annualized Revenue	\$262,395.00	0	NONE	0	0	0
			Install Cost %	100%	Installation Cost	71,900

XYZ Energy

Vent Gas Management Recommendations

Program Approach on 30 Sites

									**Est	Total	Survey	Total
	# of	Total	Gas \$ per day						Instal	Installed	Cost Avg	Program
	Sites	mcf/d	@ \$4 per mcf	Gas \$ per year	Solution	Cost	Qty	Total Cost	Costs	Costs	\$1,550 ea	Cost
Tier 3 Sites	6	460	\$1,840	\$671,600	VRU - NK 100	\$41,097	6	\$246,582	\$86,304	\$332,886	\$9,300	\$342,186
Tier 4 Sites	20	469	\$1,876	\$684,740	VRU - NK 60	\$33,255	20	\$665,100	\$232,785	\$897,885	\$31,000	\$928,885
Tier 5 Sites	3	11	\$0	\$0	BioFilters *	\$6,600	3	\$19,800		\$19,800	\$4,650	\$24,450
Under 25 tons	1	1									\$1,550	\$1,550
Totals	30	929 mcf/d		\$1,356,340	<i>per year</i>		29	\$931,482	\$319,089	\$1,250,571	\$46,500	\$1,297,071
			(Captured Gas)	\$113,028	<i>per month</i>							
Tier 1 Site		Over 300 mcf	Case by Case design									
Tier 2 Site		120-300 mcf	Q225 VRU									
Tier 3 Site		60-120 mcf	NK100 VRU									
Tier 4 Site		5-60 mcf	NK60 VRU									
Tier 5 Site		2 - 5 mcf	BioFilter									

Payback Analysis: < 12 months

(Not including OPEX)

WHAT GETS SEEN, GETS MEASURED

WHAT GETS MEASURED, GETS
CONTROLLED

***WHAT GETS CONTROLLED, CAN MAKE
YOU MONEY***

Keys to Success

“TOTAL SOLUTIONS APPROACH”

Using Standardized VRU Designs Engineered to cost effectively capture the gas analysis from your field or basin with maximum run times

Recommendation:

A Pilot Program –
Evaluate 10 Sites in one
Basin

*Allows for management decisions based on
fact*



HY-BON Engineering Company



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Electronic Design for Industry



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