

OVERVIEW OF PRODUCTION FACILITIES AND COMMINGLING



Matthew T. Scott, P.E.
September 30, 2015



Description of Acreage	Number of Acres
Freshwater Rivers (estimated)	1,000,000.000
Rivers, Creeks, Bayous (tidal)	8,676.710
Bays, Inlets, Coves	1,461,375.540
Gulf of Mexico	2,441,568.950
Surveyed School Lands	423,751.900
Lakes	68,601.330
Islands	18,051.840
Navigation Districts	89,132.730
Relinquishment Act Land (RAL) (mineral interest)	6,322,989.460
Free Royalty Land	818,880.680
Surface Sold and All or Part Minerals Reserved	362,817.420
Surface Acquired and All or Part Minerals Acquired	267,119.100
Small Tracts	0.320
Escheated Lands	162.270
Court Judgments	51,352.120
Gifts	19.730
Undivided Interest	7,514.140
State Real Property Inventory	1,559,615.300
Permanent University Fund (PUF)	2,109,190.870
Excess (estimated)	1,747,600.000
Veterans' Land Board (land contracts)	214,690.000
Total (estimated)	18,973,110.410

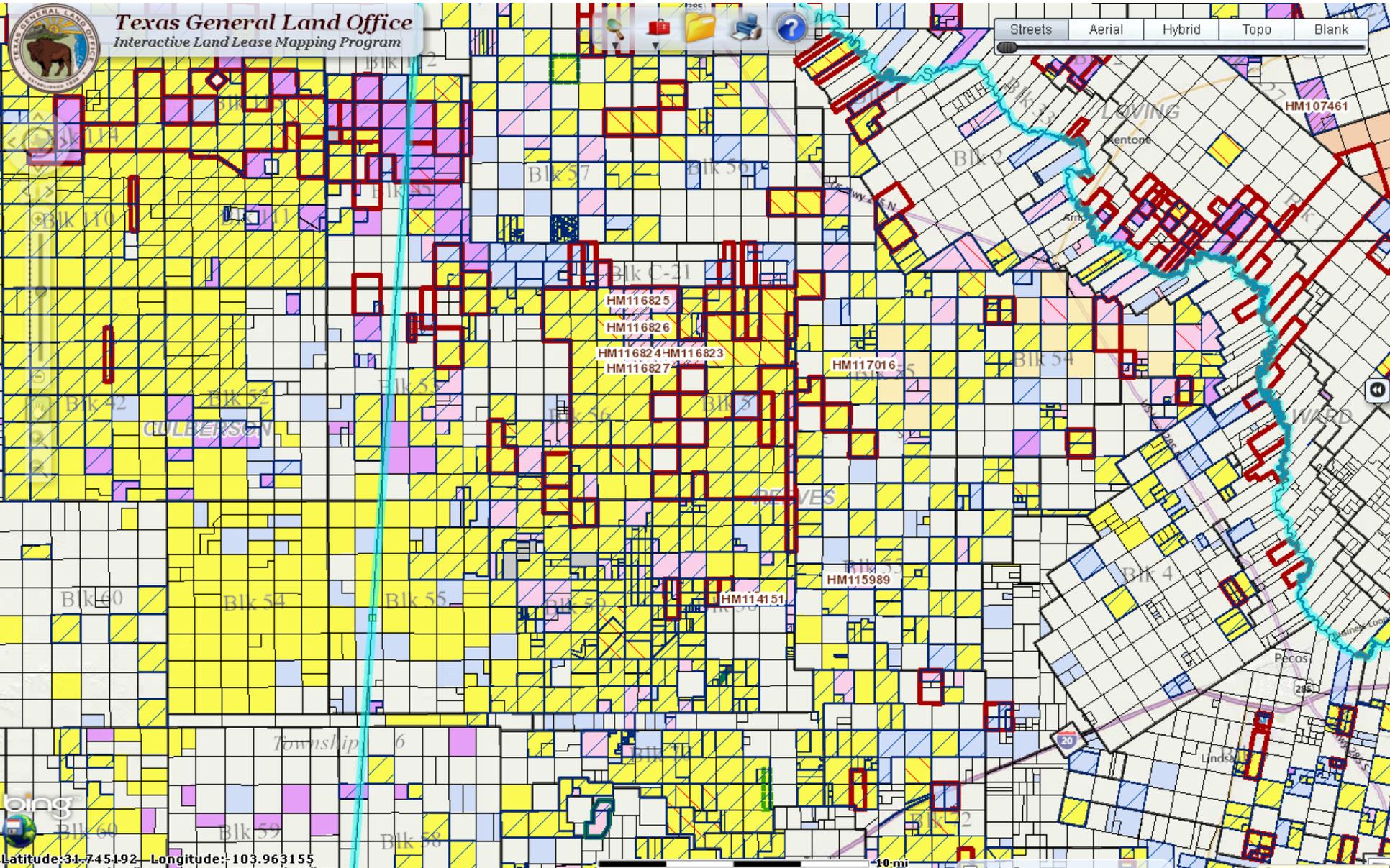
REEVES COUNTY
OUTLINED IN BLUE



GLO GIS WEB
APPLICATION

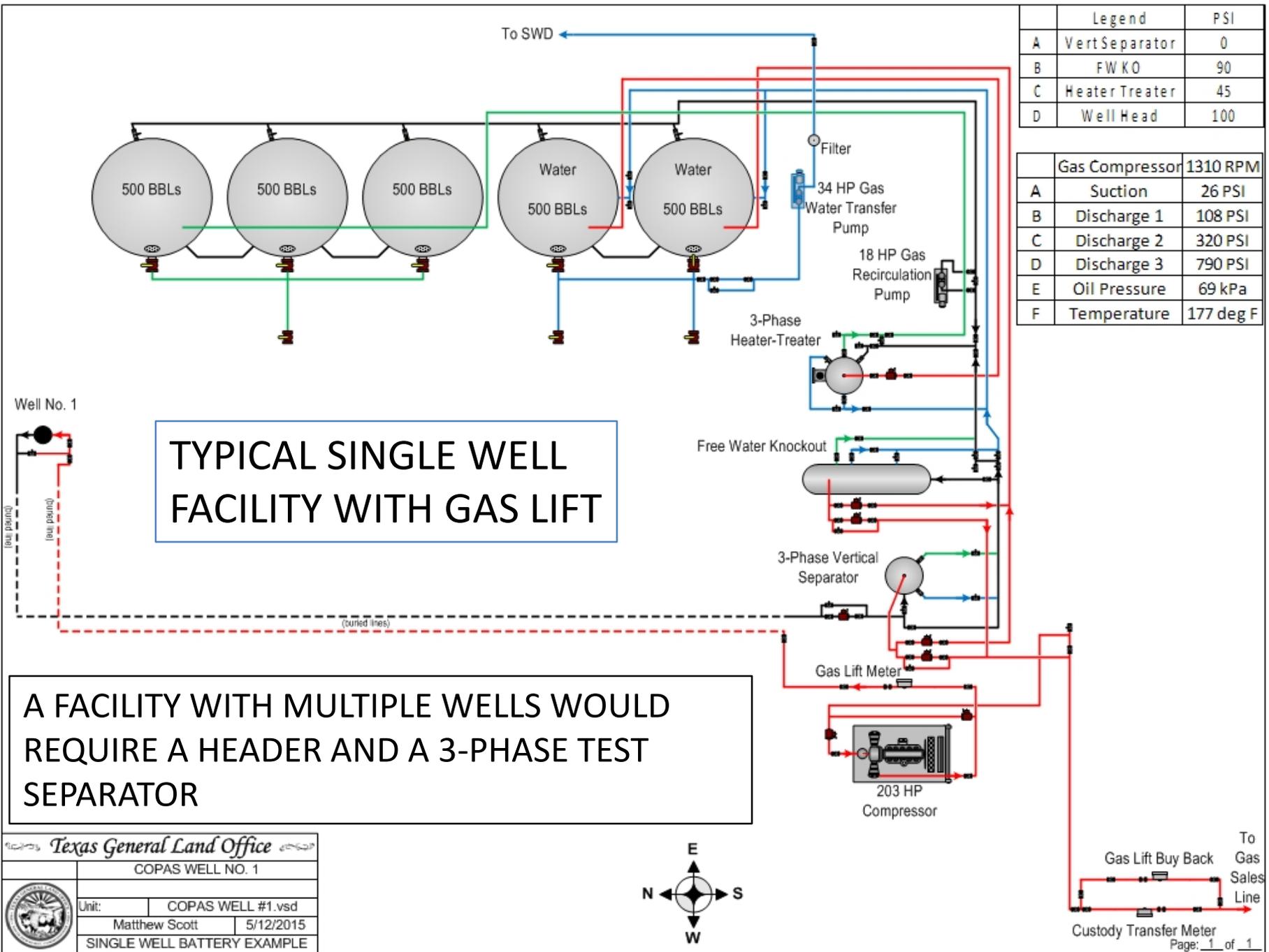


STATE LEASE TRACTS IN A PORTION OF REEVES COUNTY ARE THOSE IN COLOR.



TYPICAL FACILITY EQUIPMENT





	Legend	PSI
A	Vert Separator	0
B	FW KO	90
C	Heater Treater	45
D	Well Head	100

	Gas Compressor	1310 RPM
A	Suction	26 PSI
B	Discharge 1	108 PSI
C	Discharge 2	320 PSI
D	Discharge 3	790 PSI
E	Oil Pressure	69 kPa
F	Temperature	177 deg F

TYPICAL SINGLE WELL FACILITY WITH GAS LIFT

A FACILITY WITH MULTIPLE WELLS WOULD REQUIRE A HEADER AND A 3-PHASE TEST SEPARATOR

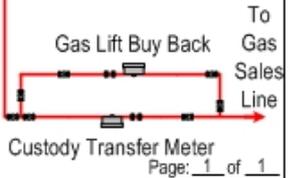
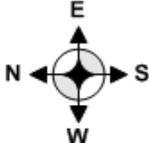
Texas General Land Office

COPAS WELL NO. 1

Unit: COPAS WELL #1.vsd

Matthew Scott 5/12/2015

SINGLE WELL BATTERY EXAMPLE

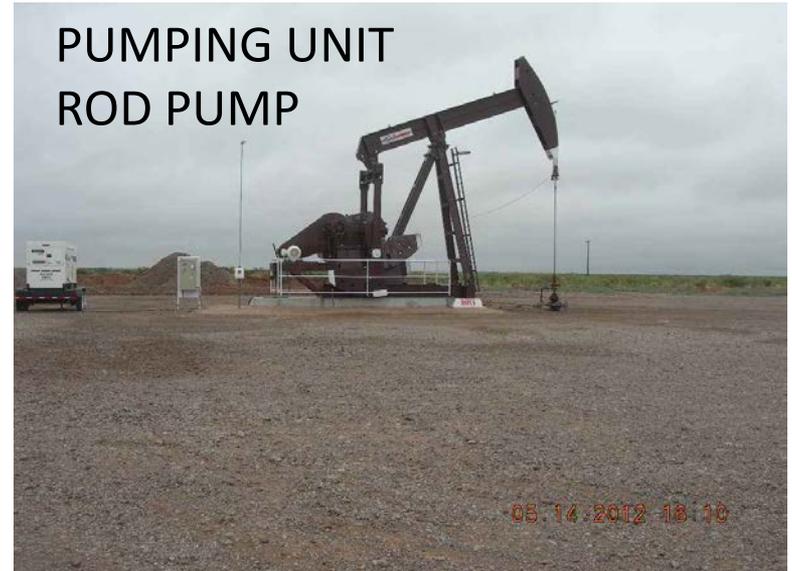


TYPICAL PRODUCTION METHODS AT THE WELLHEAD

FLOWING



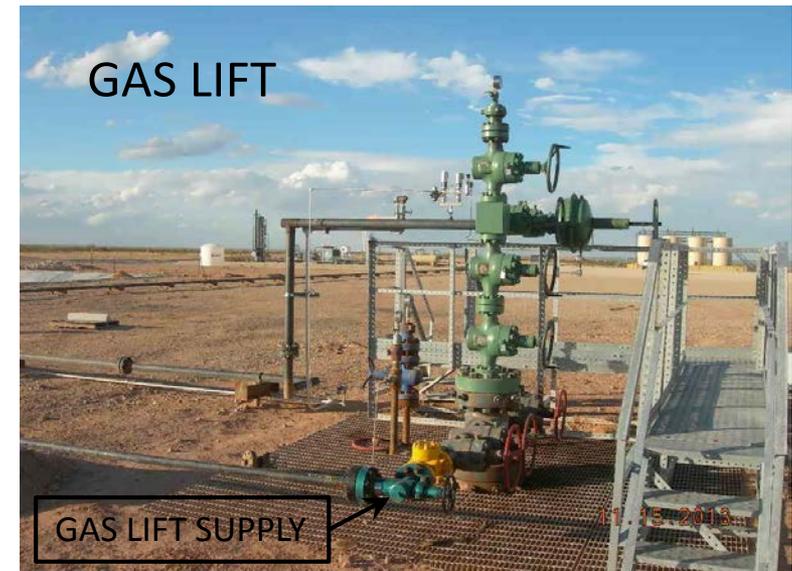
PUMPING UNIT
ROD PUMP



ARTIFICIAL LIFT METHODS:

- ROD PUMP (SUCKER RODS AND PUMP)
- GAS LIFT
- PLUNGER LIFT
- ELECTRIC SUBMERISBLE PUMP (ESP)
- PROGRESSIVE CAVITY PUMP
- HYDRAULIC JET PUMP
- HYDRAULIC RECIPROCATING PUMP
- MULTIPHASE FLOW PUMPS
- HYBRIDS (COMBINATIONS OF ABOVE)

GAS LIFT





PRODUCTION FROM EACH WELL
FLOWS THRU A DEDICATED FLOWLINE
TO A PRODUCTION HEADER.

AT THE HEADER THE FLOW IS DIRECTED
BY VALVES TO A PRODUCTION
SEPARATOR OR TEST SEPARATOR.



INDIVIDUAL WELL FLOWLINES

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05.07.2013



STEP 1
PRODUCTION
HEADER

STEP 1: PRODUCTION FROM EACH WELL FLOWS THROUGH A DEDICATED FLOWLINE TO THE PRODUCTION HEADER. AT THE HEADER THE PRODUCTION IS DIRECTED BY VALVES TO EITHER THE PRODUCTION HEADER, WHICH DIRECTS FLOW TO A 2-PHASE PRODUCTION SEPARATOR, OR THE TEST HEADER, WHICH DIRECTS FLOW TO A 3-PHASE TEST SEPARATOR .

STEP 2
2-PHASE PRODUCTION
SEPARATOR

2-PHASE: GAS IS SEPARATED
FROM THE FLUIDS (OIL &
WATER)

2-PHASE SEPARATOR HAS
ONLY ONE LIQUID LEVEL
CONTROL AND ONE DUMP
VALVE

STEP 1
HEADER

DUMP VALVE

STEP 2: PRODUCTION FROM THE HEADER THAT IS NOT ON TEST FLOWS THROUGH THE 2-PHASE SEPARATOR WHERE GAS IS SEPARATED FROM THE OIL AND WATER.



STEP 2
2-PHASE PRODUCTION
SEPARATOR

STEP 1
HEADER

STEP 3
FREE WATER KNOCKOUT
(FWKO)

STEP 3: OIL AND WATER FROM THE 2-PHASE SEPARATOR IS TRANSFERRED TO THE FWKO. THE FWKO IS WHERE FREE WATER IS REMOVED. THE FWKO PROVIDES ADDITIONAL RESIDENCE TIME TO ALLOW THE OIL DROPLETS TO COALESCE INTO THE OIL PHASE. THE FREE WATER RECOVERED IN THE FWKO IS DISCHARGED DIRECTLY INTO THE PRODUCED WATER TANK FOR DISPOSAL.

STEP 4 DIRECT FIRED 3-PHASE VERTICAL HEATER-TREATER

**STEP 2
2-PHASE PRODUCTION
SEPARATOR**

**STEP 1
HEADER**

**STEP 3
FREE WATER KNOCKOUT
(FWKO)**

STEP 4: THE REMAINING OIL AND WATER EMULSION IS DISCHARGED FROM THE FWKO TO THE DIRECT FIRED 3-PHASE HEATER-TREATER FOR FINAL SEPARATION OF THE OIL FROM THE WATER BEFORE STORAGE OF THE OIL AND WATER IN SEPARATE STORAGE (STOCK) TANKS.



3-PHASE TEST OR METERING
SEPARATOR

3-PHASE: OIL, WATER, AND GAS ARE
SEPARATED INTO INDIVIDUAL STREAMS

3-PHASE SEPARATOR HAS TWO LIQUID
LEVEL CONTROLS AND TWO DUMP
VALVES

STEP 1
HEADER

WHEN A WELL IS PLACED ON TEST THEN THE PRODUCTION FROM ONE WELL IS SWITCHED INTO THE TEST HEADER AND ROUTED TO THE INLET OF A 3-PHASE TEST SEPARATOR. THE OIL , WATER, AND GAS ARE SEPARATED AND THEN MEASURED. TYPICALLY, THE OIL AND WATER ARE RECOMBINED AND ROUTED TO THE HEATER-TREATER FOR FINAL TREATMENT AND THE GAS IS COLLECTED FOR SALE OR CUSTODY TRANSFER.

LEASE OIL AND WATER STOCK TANKS

WATER TANK
(FIBERGLASS CONSTRUCTION)

4 OIL STOCK TANKS (STEEL CONSTRUCTION) TANKS
STRAPPED AND GAUGED PER API MPMS.



TRUCK HAULED WATER CONNECTION

TRUCK HAULED OIL CONNECTION
OIL SALES VOLUME MEASURED AND
CALCULATED PER APPLICABLE AMERICAN
PETROLEUM INSTITUTE (API) MANUAL OF
PETROLEUM MEASUREMENT STANDARDS
(MPMS).

LEASE AUTOMATIC CUSTODY
TRANSFER (LACT) UNIT PER API
MPMS CH. 6.1

USED IN LIEU OF TRUCK HAUL
SALES.

AUTOMATES THE LEASE OIL SALES
OPERATION PER API MPMS.



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LEASE COMPRESSION

GAS ENGINE DRIVER MAY REQUIRE
LARGE VOLUMES OF LEASE GAS.

LEASE GAS COMPRESSION USED FOR SALES
AND/OR GAS LIFT SUPPLY



VAPOR RECOVERY UNIT (VRU)

RECOVERS GAS FLASHED INTO
STOCK TANKS AT LOW PRESSURE



LEASE FACILITY FLARES

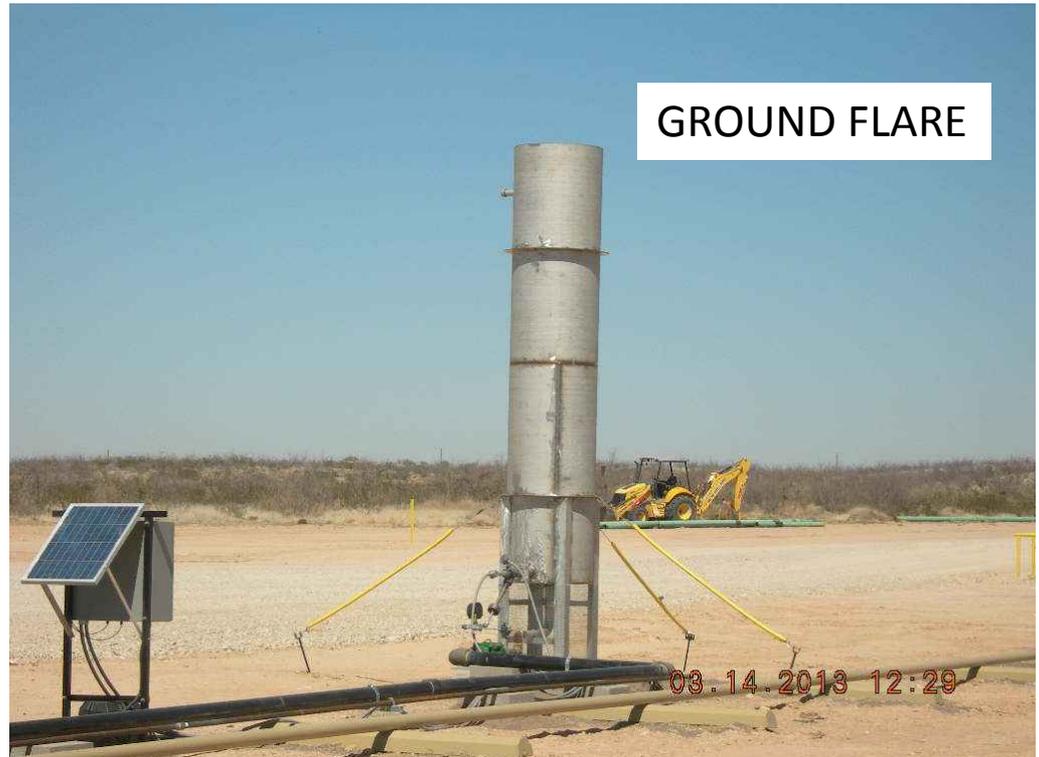
LEASE FLARES REQUIRED FOR EMERGENCY OPERATING CONDITIONS AND WHEN GAS GATHERING SYSTEM INFRASTRUCTURE NOT AVAILABLE.
SIGNIFICANT ROYALTY DUE AMOUNTS MAY BE ASSOCIATED WITH FLARES.

ELEVATED FLARE



FLARE SCRUBBER VESSEL

GROUND FLARE



VERTICAL 3-PHASE (OIL, WATER, & GAS) SEPARATOR

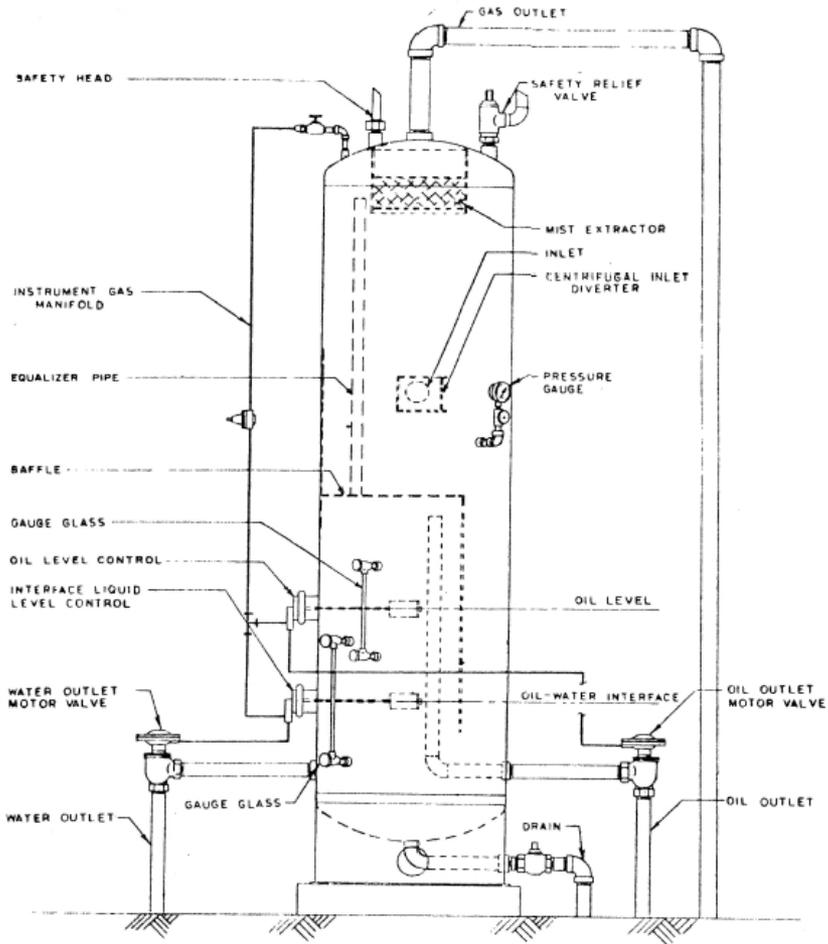


FIGURE COURTESY OF SIVALLS, INC.



IF EQUIPPED WITH METERS IT BECOMES A 3-PHASE METERING SEPARATOR

HORIZONTAL 3-PHASE SEPARATOR



THIS IS AN EXAMPLE OF A HORIZONTAL 3-PHASE METERING SEPARATOR

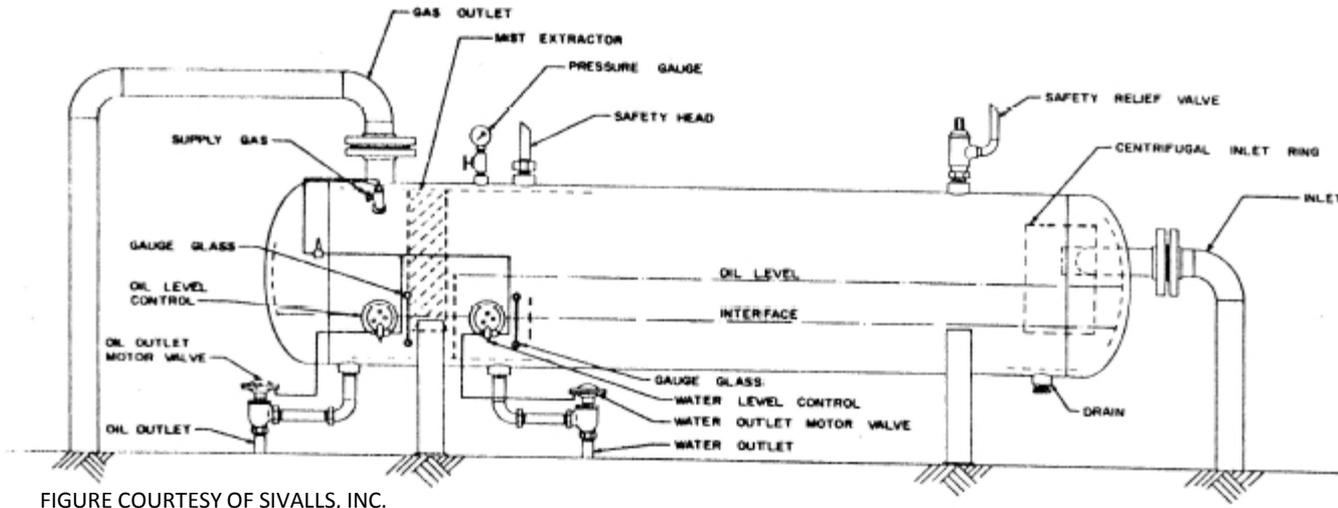


FIGURE COURTESY OF SIVALLS, INC.

3-PHASE VERTICAL TEST
SEPARATOR WITH OIL, WATER,
AND GAS METERS.

SEPARATES EACH STREAM /PHASE
(OIL, WATER, AND GAS)
TO ALLOW FOR MEASUREMENT
OF EACH STREAM BY A METER.

BURNER STACK

3-PHASE DIRECT FIRED
VERTICAL HEATER-TREATER

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TYPICAL PRODUCTION METERS USED ON 3-PHASE TEST SEPARATORS

GAS MEASURED BY AN ORIFICE METER EQUIPPED WITH
A FLOW COMPUTER, A TYPE OF FLOW RECORDER .

THIS IS ALSO KNOWN AS EFM (ELECTRONIC FLOW
MEASUREMENT).



OIL & WATER
TURBINE METERS



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TWO GAS FLOW RECORDER TYPES INSTALLED ON AN ORIFICE METER

TOTALFLOW EFM
FLOW COMPUTER



BARTON 202E
CHART
RECORDER



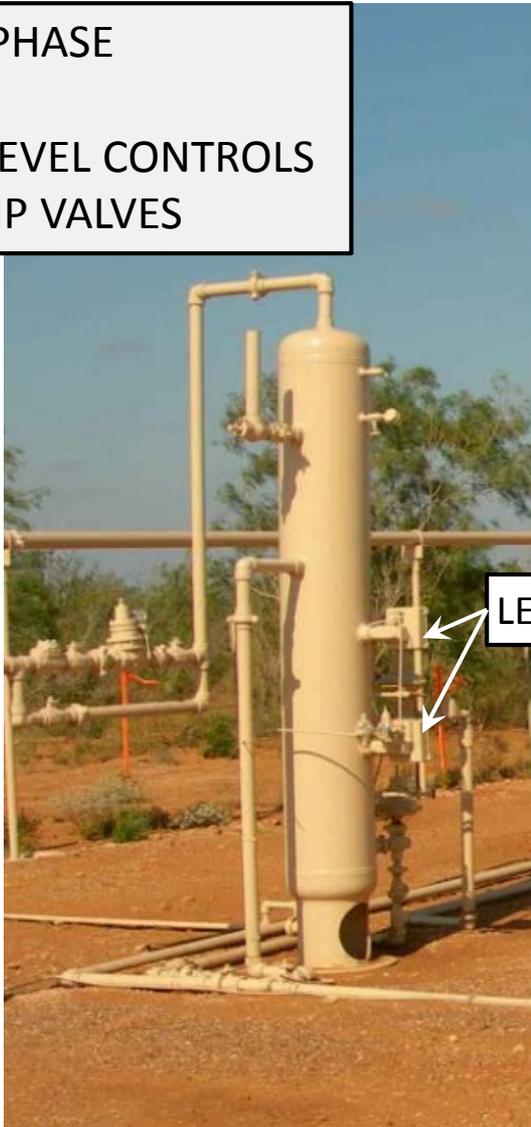
ORIFICE PLATE HOLDER AND METER TUBE

WHAT TYPE OF SEPARATORS ARE IN THE PICTURES BELOW?



WHAT TYPE OF SEPARATORS ARE IN THE PICTURES BELOW?

VERTICAL 3-PHASE
HINT: TWO LEVEL CONTROLS
& TWO DUMP VALVES



LEVEL CONTROLS



VERTICAL 2-PHASE
HINT: ONE LEVEL
CONTROL & ONE
DUMP VALVE

LEVEL CONTROL

DUMP VALVE

FREE WATER KNOCK OUT (FWKO)

PROVIDES RESIDENCE TIME TO ALLOW OIL DROPLETS TO FORM LARGER AND LARGER OIL DROPS THAT THEN FLOAT UP TO COALESCE WITH THE OIL PHASE (OIL IS LESS DENSE THAN WATER).

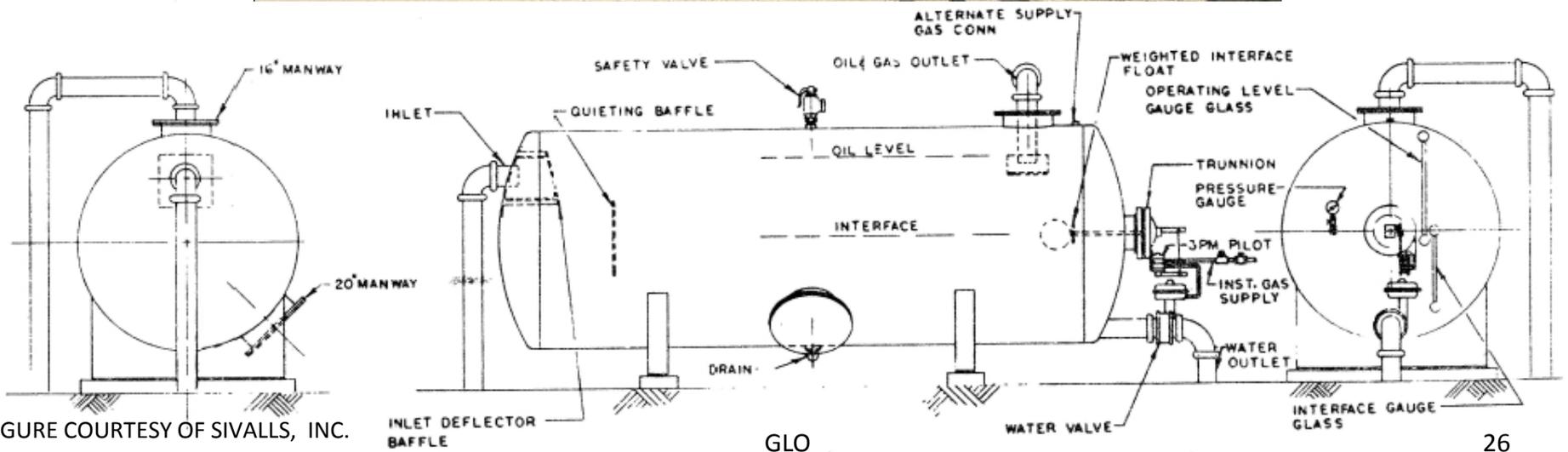
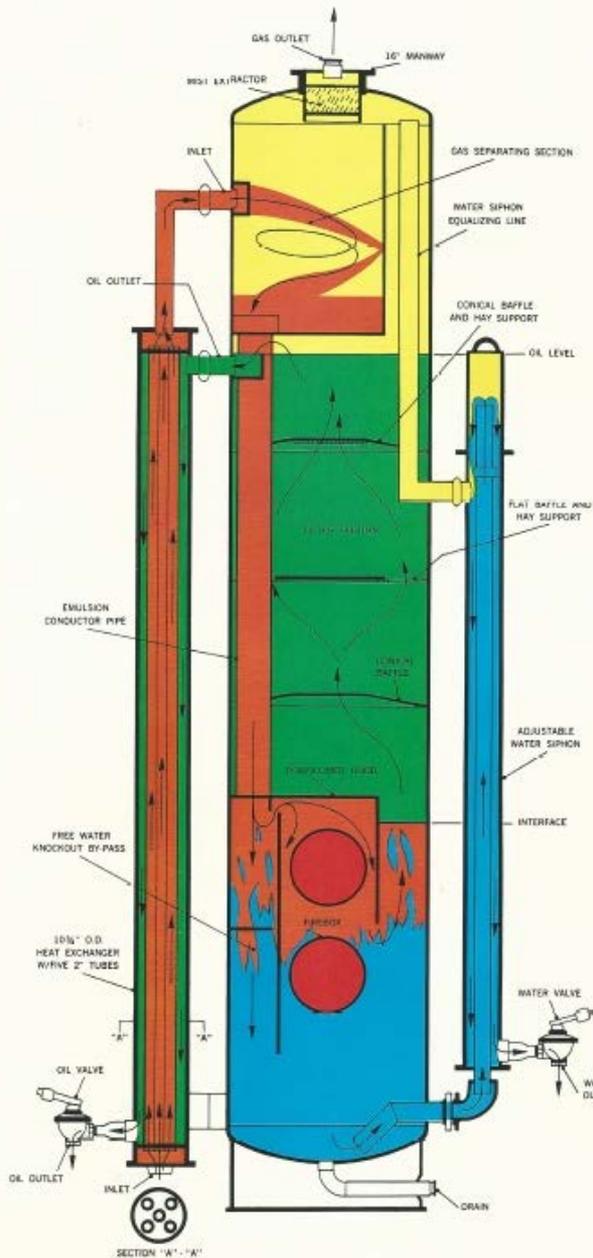


FIGURE COURTESY OF SIVALLS, INC.

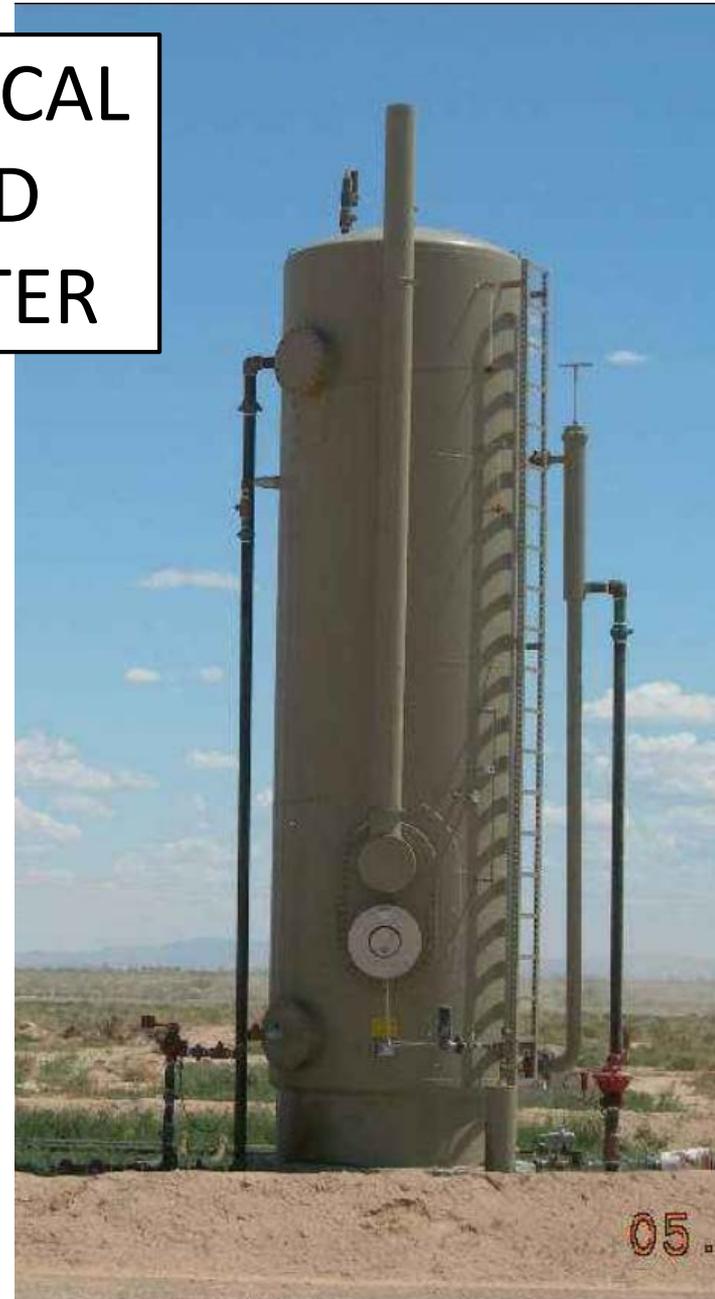
3-PHASE VERTICAL DIRECT FIRED HEATER TREATER



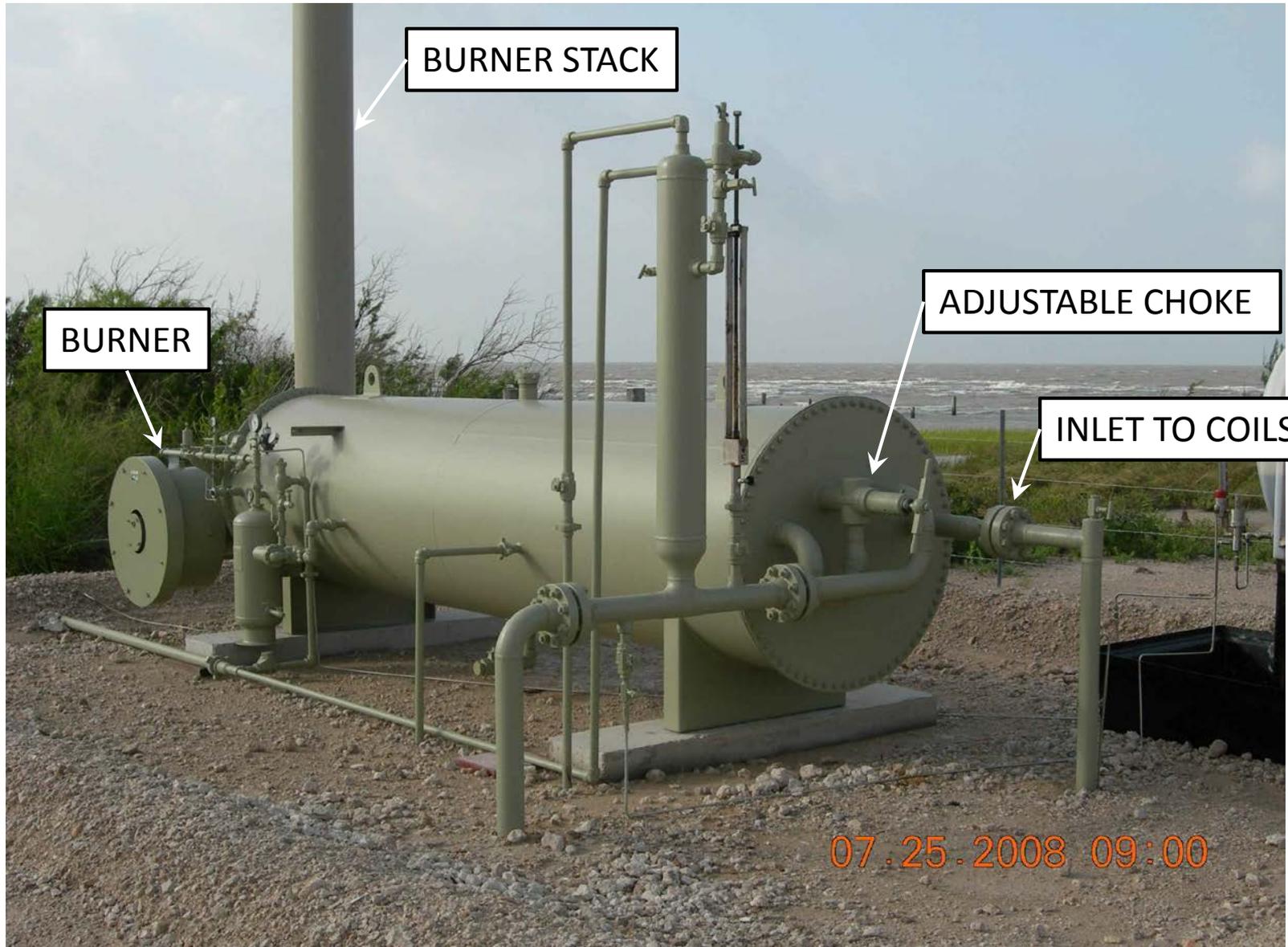
DIRECT FIRED MEANS THAT THE FIRE TUBE IS IN DIRECT CONTACT WITH THE FLUIDS THAT ARE HEATED.

HEATING THE OIL AND WATER REDUCES THE VISCOSITY, DENSITY, AND SURFACE TENSION OF THE OIL SO THAT IT WILL COALESCE EASIER INTO THE OIL PHASE.

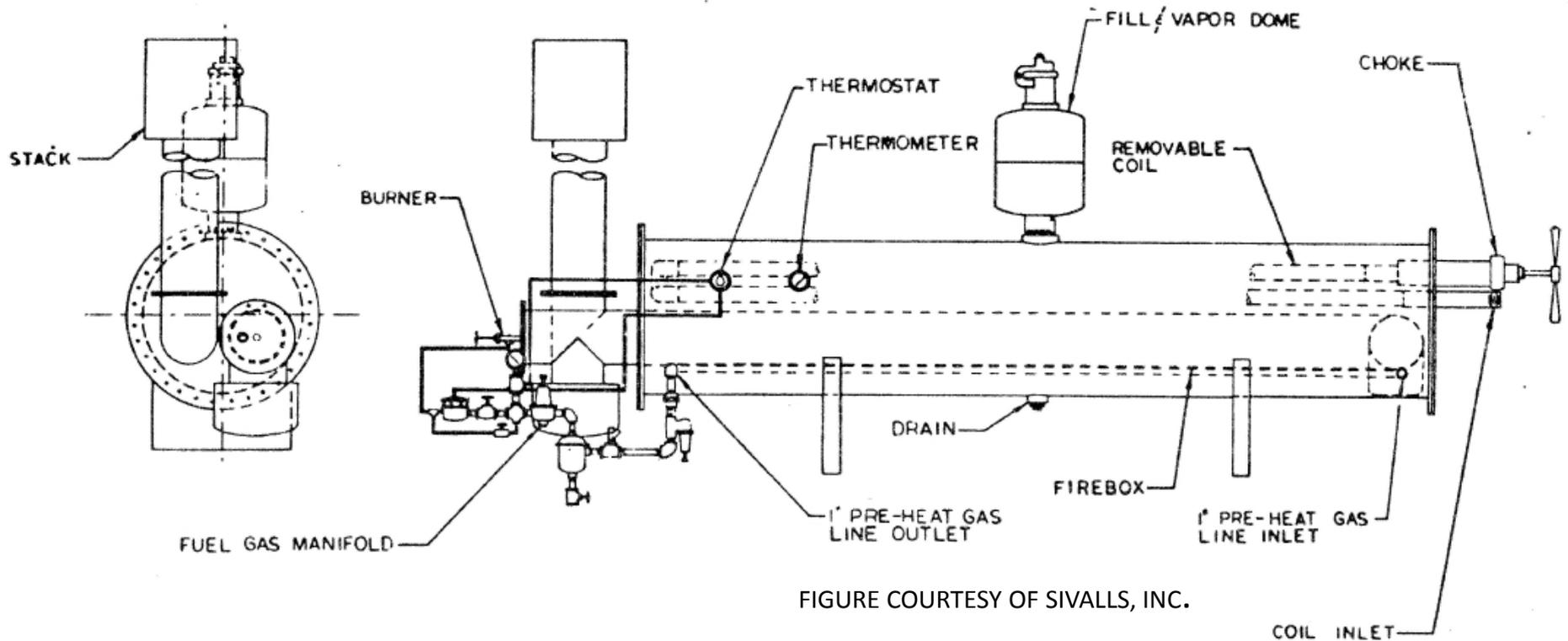
FIGURE COURTESY OF SIVALLS, INC.



HORIZONTAL INDIRECT FIRED HEATER TREATER



HORIZONTAL INDIRECT FIRED HEATER TREATER



TYPICALLY USED TO CONTROL HIGH PRESSURE GAS TO PREVENT HYDRATE FORMATION.

NO SEPARATION OCCURS SINCE THE OPERATOR IS TRYING TO PREVENT PLUGGING OF THE COILS WITH HYDRATES AFTER REDUCING THE PRESSURE WITH A CHOKE (RESTRICTION).

WATER AND GLYCOL IS HEATED BY CONTACT WITH THE FIRE TUBE. THE WATER AND GLYCOL THEN TRANSFER HEAT TO THE HIGH PRESSURE COILS WHICH INCLUDES A CHOKE FOR PRESSURE CONTROL OR PRESSURE REDUCTION.

HORIZONTAL DIRECT FIRED HEATER TREATER



OIL AND WATER EMULSION UNDER PRESSURE IS HEATED BY DIRECT CONTACT WITH THE FIRE TUBE. NOT SUITABLE FOR CORROSIVE FLUIDS OR HIGH PRESSURES.

HORIZONTAL DIRECT FIRED HEATER TREATER

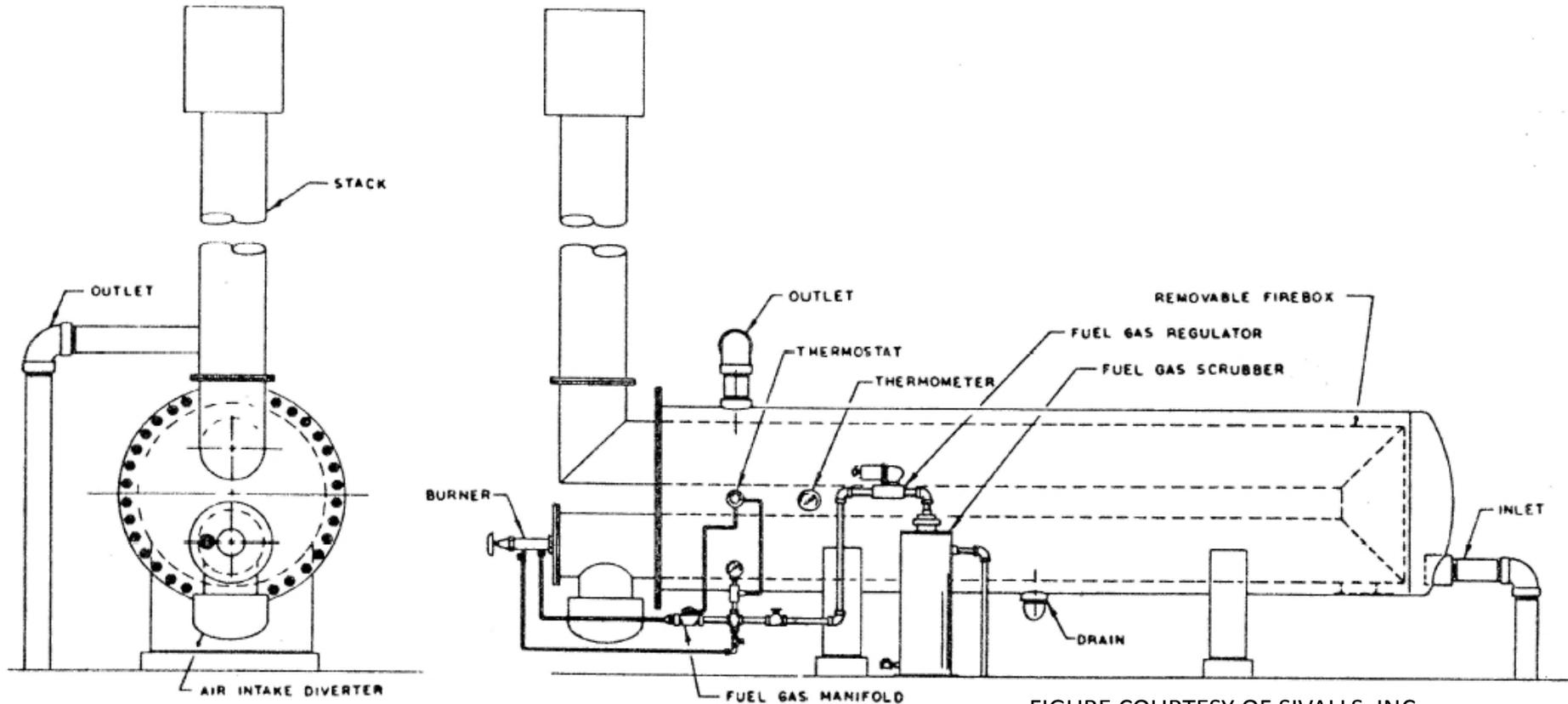


FIGURE COURTESY OF SIVALLS, INC.

GAS DEHYDRATION (WATER REMOVAL) USING A GLYCOL DEHYDRATION UNIT



TYPICAL GLYCOL DEHYDRATION UNIT EQUIPMENT

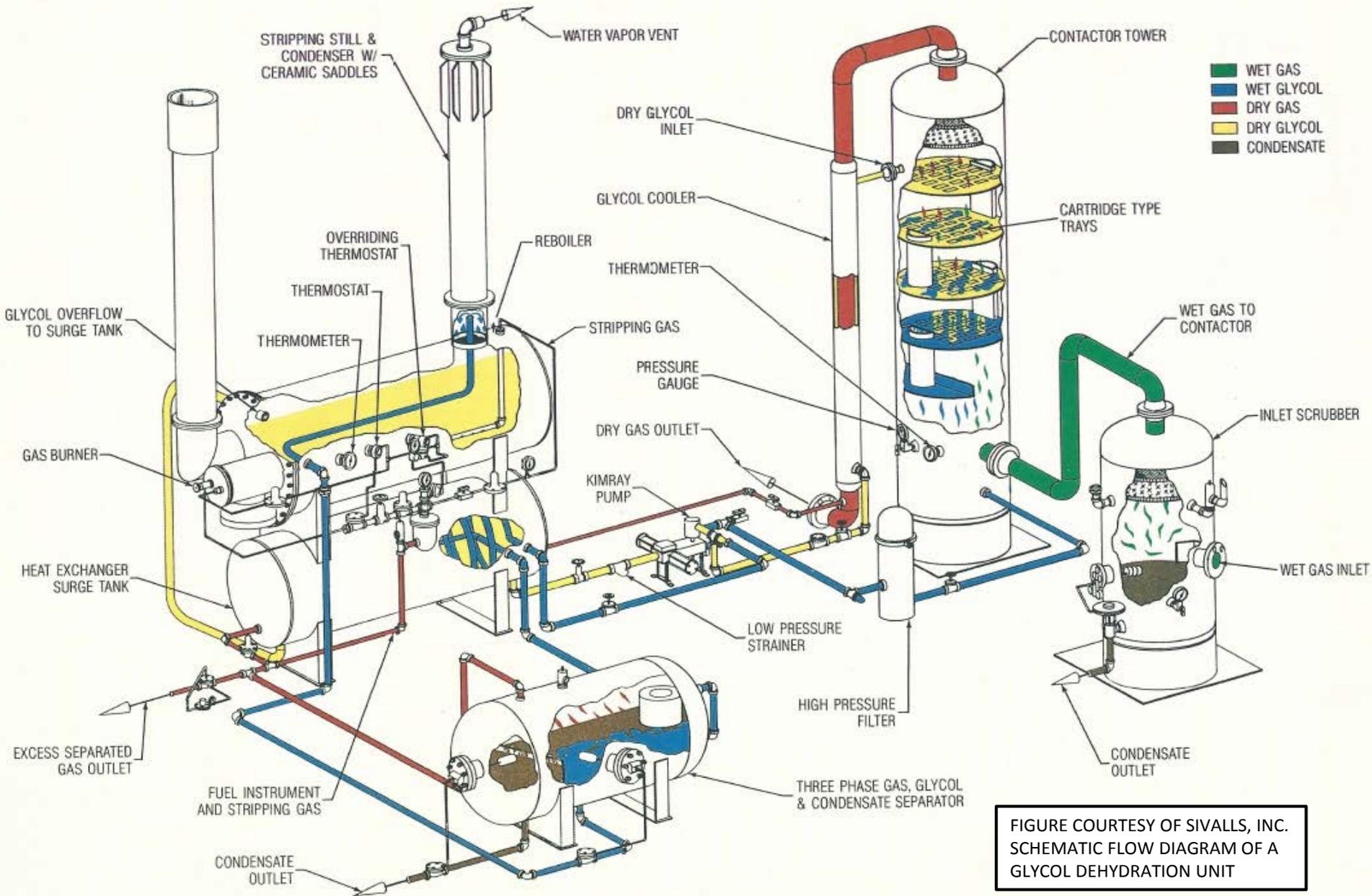


FIGURE COURTESY OF SIVALLS, INC.
SCHEMATIC FLOW DIAGRAM OF A
GLYCOL DEHYDRATION UNIT

COMMINGLED FACILITIES

- COMMINGLING OCCURS WHEN THE PRODUCTION FROM TWO OR MORE TX RAILROAD COMMISSION (RRC) LEASES IS COMMINGLED INTO A COMMON MANIFOLD, SEPARATION, AND/OR STORAGE.
- REGULATORY AUTHORITY TO COMMINGLE RRC LEASES IS REQUIRED FROM THE RRC PER STATE WIDE RULES (SWR) 26 AND 27 FOR OIL AND GAS. A FORM P-17 PERMIT APPLICATION IS FILED WITH THE RRC.
- AUTHORITY FROM THE STATE (GLO) IS REQUIRED PER TEXAS ADMINISTRATIVE CODE (TAC) RULE 9.35 (PURSUANT TO THE STATE LEASE) IF THE PRODUCTION FROM A STATE LEASE IS COMMINGLED WITH A PRIVATE LEASE OR ANOTHER STATE LEASE.

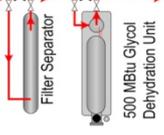
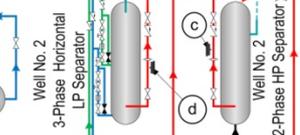
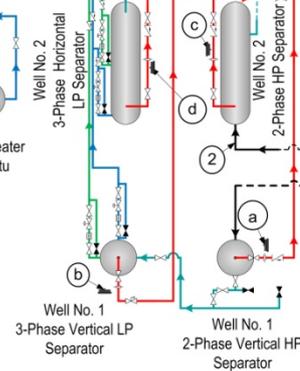
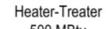
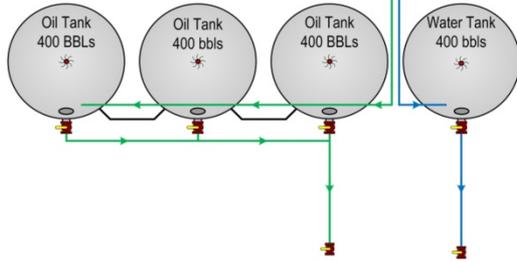
COMMINGLED FACILITIES

- OPERATORS COMMINGLE LEASES TO REDUCE PRODUCTION FACILITY CAPITAL INVESTMENTS AND OPERATING EXPENSES.
- THE BASIS USED TO ALLOCATE OIL AND GAS PRODUCTION VOLUMES AFFECTS THE ROYALTY PAID TO THE ROYALTY AND WORKING INTEREST OWNERS. COMMINGLING INCREASES ALLOCATION AND METERING COMPLEXITIES AS WELL AS FINANCIAL RISK.
- GAS VOLUME AND ENERGY CONTENT CALCULATIONS (MMBTU) BY LEASE OR WELL BECOME IMPORTANT DUE TO VOLUME, WATER CONTENT, AND GAS COMPOSITION DIFFERENCES.
- LEASE USE (NON-SALES DISPOSITIONS) SUCH AS FUEL GAS, VENT GAS, AND FLARE GAS WILL HAVE TO BE ACCURATELY REPORTED AND ACCOUNTED FOR PURSUANT TO THE TERMS OF EACH LEASE.
- A STATE LEASE TYPICALLY DOES NOT ALLOW DEDUCTIONS FOR LEASE USE (BY STATUTE) WHILE A PRIVATE LEASE MAY ALLOW FOR LEASE USE.

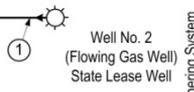
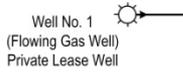
TYPICAL ALLOCATION BASIS IN ORDER OF INCREASING FINANCIAL RISK

- **BY SEPARATION AND MEASUREMENT OF THE PRODUCTION FROM EACH LEASE TRACT.**
- **BY PERIODIC WELL TEST. IF AGREED TO BY ALL PARTIES; BY MONTHLY OIL WELL TEST, AND FOR GAS WELLS, PER THE RRC G-10 WELL TEST FREQUENCY, OR SOME OTHER MUTUALLY AGREED TO TEST FREQUENCY.**
- **BY MEASUREMENT OF THE FULL WELL STREAM (FWS) PRODUCTION OF EACH COMMINGLED GAS WELL.**

Gas Meter Information				
a	#1 H.P. Separator	H.P.Sep#1	chart	1.941" 0.750"
b	#1 L.P. Separator	L.P.Sep#1	chart	1.941" 1.500"
c	#2 H.P. Separator	H.P.Sep#2	chart	2.824" 1.750"
d	#2 L.P. Separator	H.P.Sep#2	chart	1.941" 0.625"
e	Flash Gas to Compressor	Flash c + d	chart	1.941" 0.875"
f	Master Meter	Sales	chart	3.825" 0.875"



OIL PRODUCTION COMMINGLED INTO COMMON STORAGE.
 GAS COMMINGLED THRU COMMON CUSTODY TRANSFER METER.

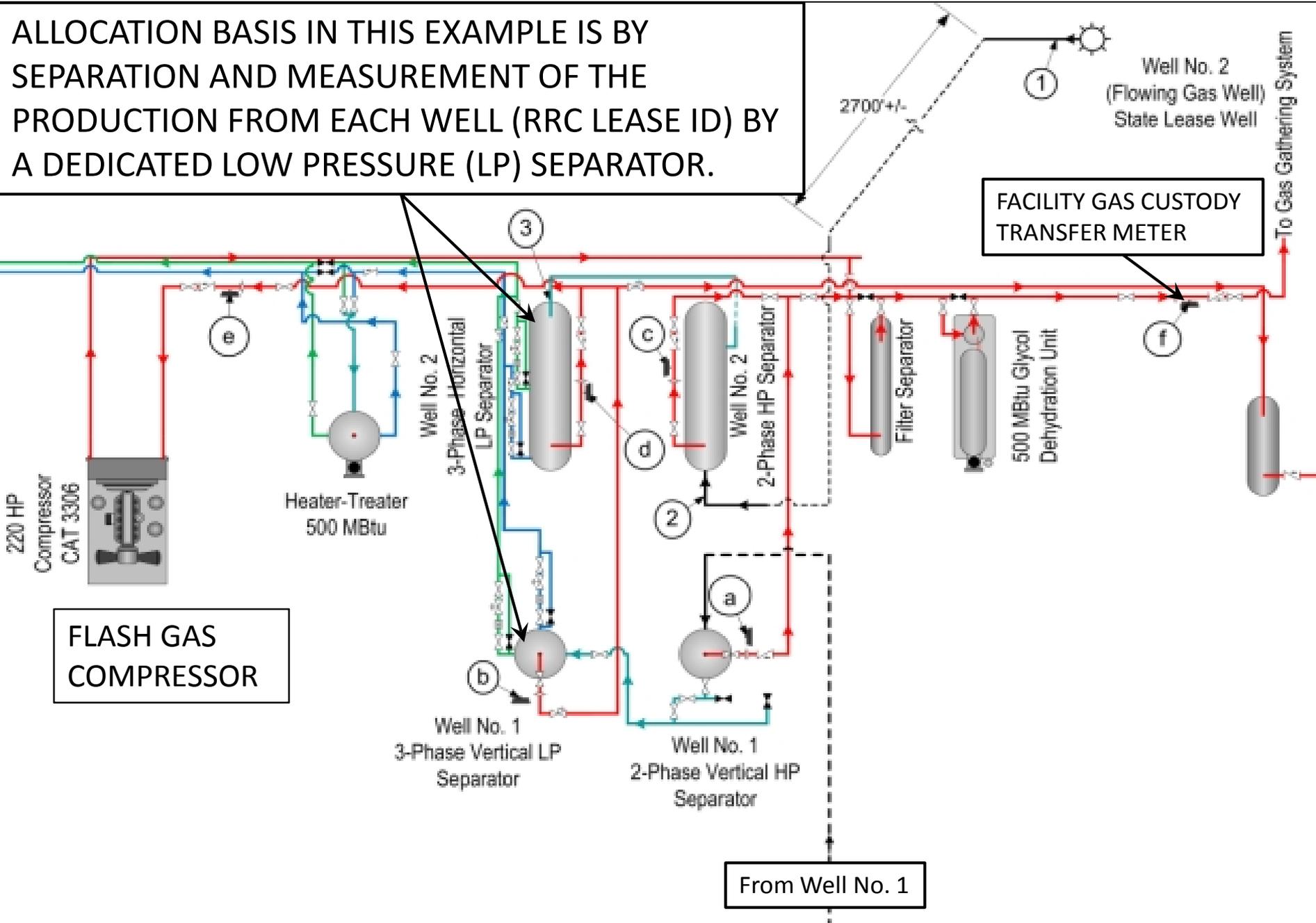


LEGEND

1	Well Head Tubing	610psi
2	2ph HP Separator	600psi
3	3ph LP Separator	65psi

Texas General Land Office
 COPAS COMMINGLED WELLS
 Unit: Commingled.vsd
 Matthew Scott 5/12/2015
 EXAMPLE OF COMMINGLED LEASES

ALLOCATION BASIS IN THIS EXAMPLE IS BY SEPARATION AND MEASUREMENT OF THE PRODUCTION FROM EACH WELL (RRC LEASE ID) BY A DEDICATED LOW PRESSURE (LP) SEPARATOR.



OIL & GAS METERS (CASH REGISTER\$)

- INSTALLATION PER API MPMS OR OTHER APPLICABLE INDUSTRY STANDARDS
- CALIBRATE AND PROVE ON A REGULAR BASIS
- HAVE TO BE PROPERLY MAINTAINED
- MUST MAINTAIN VOLUME AND FLOW COMPUTER AUDIT RECORDS PER API MPMS
- TYPE OF METER SHOULD BE THE SAME FOR ALL LEASES FOR THE FLUID BEING MEASURED
- CORRECTION OF METER VOLUME PER APPLICABLE API MPMS AND AGA STANDARDS

OIL & GAS VOLUME CALCULATIONS

- OIL METER INDICATED VOLUME CORRECTED TO STOCK TANK CONDITIONS PER API MPMS.
- GAS VOLUME CALCULATED PER AGA/API MPMS METHODS ALSO REQUIRES CORRECTION FOR WATER CONTENT AND APPLICATION OF THE CORRECT BTU CONTENT, IN BTU/SCF, AS DRY, AS-DELIVERED, OR FULLY SATURATED (WET).
- REVENUE AND PRODUCTION ACCOUNTANTS TEND TO OVER-SIMPLIFY THE ALLOCATION PROCESS, WHICH IN REALITY IS AN INVENTORY CONTROL PROBLEM.
- ERRORS MADE IN THE CALCULATION OF THE TOTAL ENERGY CONTENT, IN MMBTUS, OF A GAS CAN BE COSTLY IF THE VOLUME & BTU CONTENT ARE NOT ON THE SAME BASIS (I.E. DRY GAS VOL * DRY BTU).

LEASE USE (FUEL, VENT, & FLARE) ALLOCATION

- ALLOCATION OF LEASE USE DEPENDS ON WHAT IS BEING HANDLED OR PROCESSED THRU A PIECE OF EQUIPMENT OR WHAT WAS THE SOURCE OF THE FLUID SUCH AS FLASH GAS DERIVED FROM OIL.
- A FLASH GAS COMPRESSOR AND A VRU IS ALLOCATED ON THE BASIS OF THE FLASH GAS VOLUME EVOLVED FROM THE OIL PRODUCED FROM EACH LEASE.
- A FIRED HEATER TREATER HANDLES FLUIDS (OIL AND WATER) THUS ALLOCATION IS BASED ON LIQUIDS.
- FLARE AND VENT VOLUMES ARE TYPICALLY BASED ON THE FLASH GAS VOLUME ASSOCIATED WITH THE OIL PRODUCED FROM EACH LEASE UNLESS THERE IS AN UPSET.
- THE BTU CONTENT OF TANK VENT GAS > LOW PRESSURE SEPARATOR FLASH GAS BTU AND > HIGH PRESSURE SEPARATOR BTU CONTENT.

WHEN A LEASE IS COMMINGLED WITH OTHER LEASES, THE CALCULATION OF PRODUCED VOLUMES AND ROYALTY BECOMES MORE COMPLEX.

- METER SELECTION, APPLICATION, CALIBRATION, AND VOLUME CORRECTION METHODS
- ALLOCATION BASIS
- LEASE USE REPORTING AND ACCOUNTING
- QUANTIFYING THE PROCESS PLANT INLET VOLUME BY ACCOUNTING FOR WATER CONTENT AND GAS COMPOSITION DIFFERENCES

THE END

ANY QUESTIONS?

Matthew T. Scott, P.E.
Petroleum Engineer
Texas General Land Office
P. O. Box 12873
Austin, Texas 78711-2873

Email: Matthew.Scott@glo.texas.gov
Office: 512-475-2230