Vapor Recovery Technology

Practical Applications & Case Studies

Presented by:
Larry S. Richards
Hy-Bon Engineering Co.

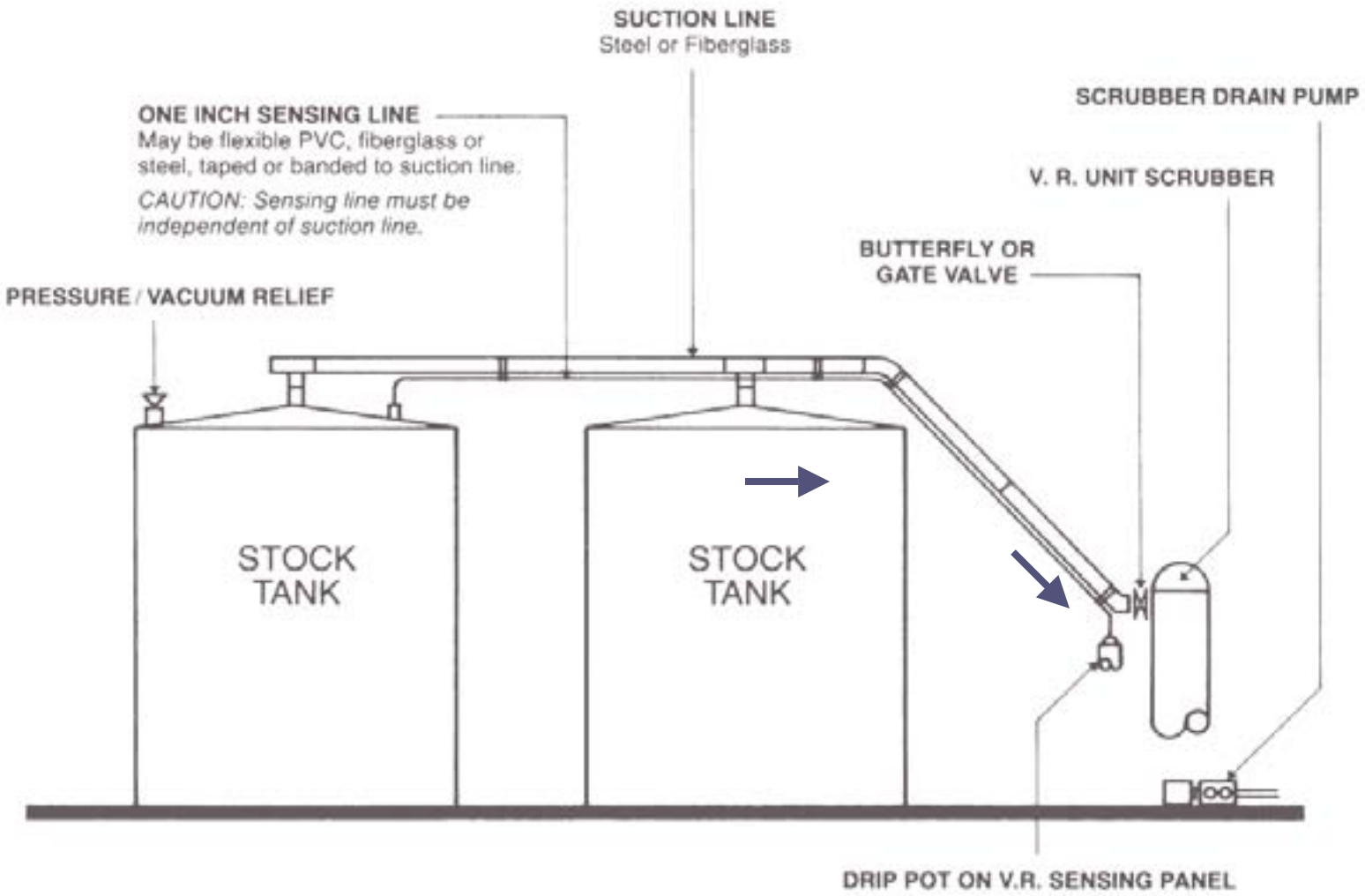
VAPOR RECOVERY SYSTEMS

VAPOR RECOVERY

Over 26.6 Billion cubic feet of natural gas escapes from oil field stock tanks in the United States every year.

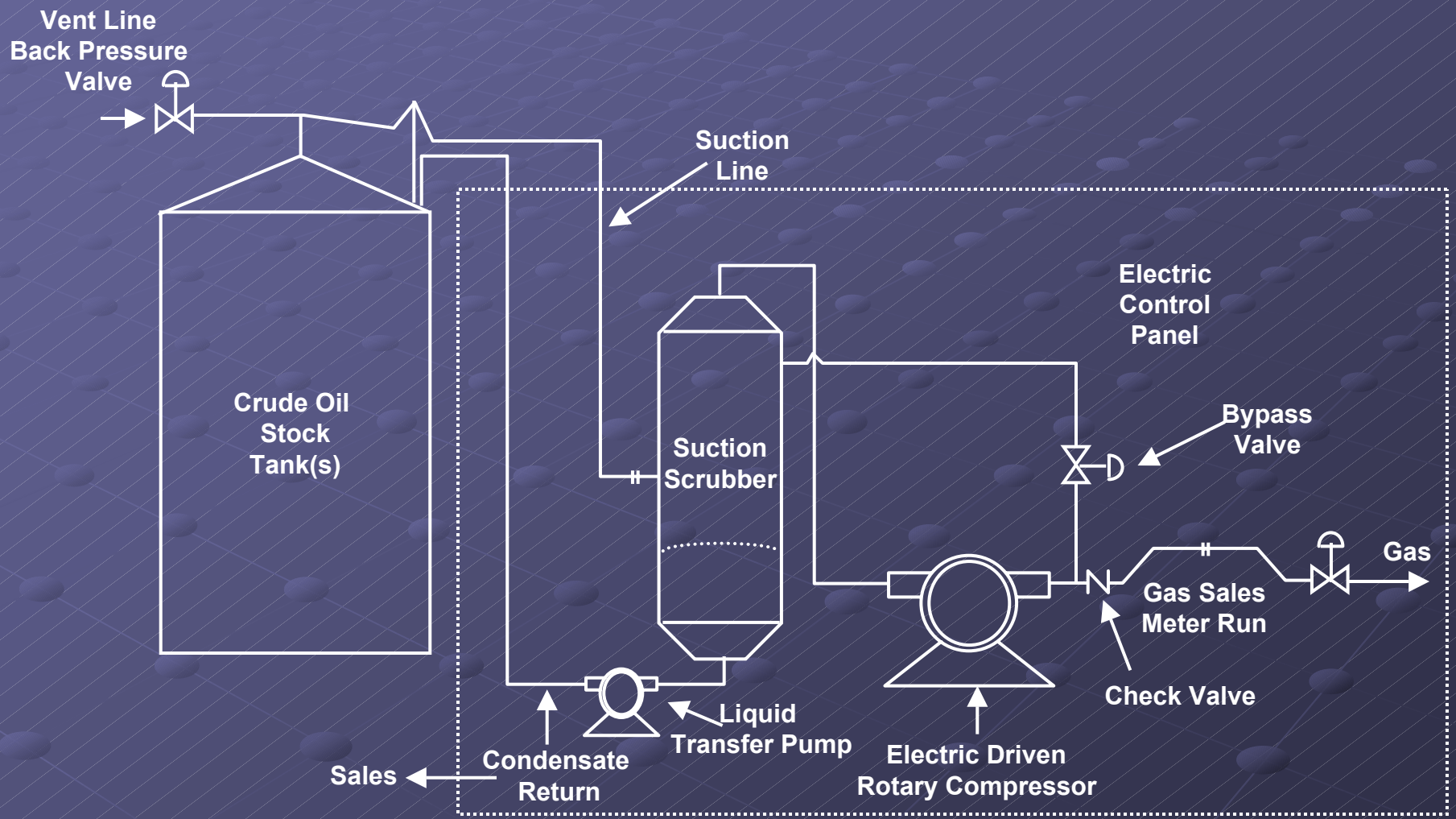
ENVIRONMENTAL HAZARDS

This flare in Venezuela was causing a variety of health and environmental concerns. Over 85 MMCFD of 2700 BTU tank vapors are now being captured in Eastern Venezuela that were previously flared.



NOTES
All lines must be horizontal, or sloped down to V.R.U. suction as shown.
Scrubber fluid is piped back to tanks or to waste.
The system must be closed — no air entry.

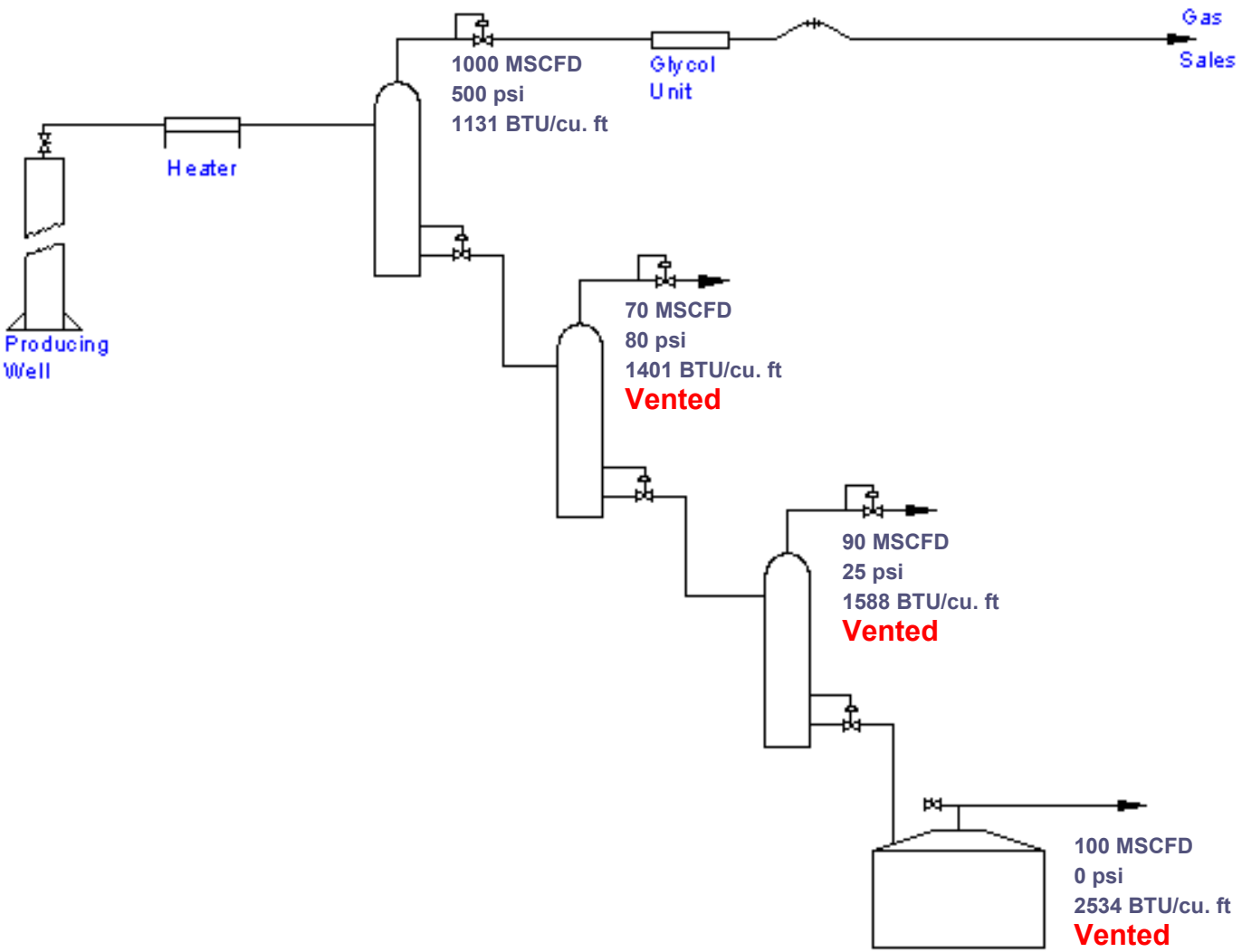
Standard Vapor Recovery Unit



Benefits of Vapor Recovery Units

- Capture up to 95 percent of hydrocarbon vapors that accumulate in tanks
- Recovered vapors have much higher Btu content than pipeline quality natural gas
- Recovered condensate can be extracted or sent back to the tanks to increase api gravity of the crude
- Major reduction in regulatory & liability exposure

CASE STUDIES



Gross Sales
Per Day

$5.00 x 1.13 x
1000 MSCFD = $5650

$5.00 x 0 MSCFD = $0

$5.00 x 0 MSCFD = $0

$5.00 x 0 MSCFD = $0

TOTAL GAS SALES = $5650

NOTE: Price based upon $5.00/MMBTU

THE SOLUTION

A system was designed to allow the customer to capture the vented gas from all phases of his separation process. A multi-stage unit was designed and built that took the gas from the tank vapors at atmospheric pressure, gathered the vent gas from the other separators and delivered the stream to the sales line at 500 psig.

Crude Oil Analysis

600 PSIG SEPARATION

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1703 West Industrial — P. O. Box 2150
MIDLAND, TEXAS 79701
(915) 683-3348

FRACTIONAL ANALYSIS REPORT

DATE RECEIVED 7-15-81

FILE NO. C-1902-G

LAB. NO. 45569

DATE SECURED 7-11-81

SECURED BY —

LE MARKED [illegible] Federal Well No. 1 (Strawn)

Oil sampled from H. Press., Sep. 600 psi

PLE FROM Estoril Producing Corporation

OF RUN 7-15-81

COMPONENT	MOL. %	G.P.M.	LIQUID VOL. %
ygen			
itrogen			
rbon Dioxide			
thane			3.44
hane			2.40
opane			2.93
Butane			1.35
-Butane			3.07
Pentane			2.29
-Pentane			2.50
exanes plus			82.02
eptanes & Heavier			
ydrogen Sulfide			
elium			
ydrogen			
arbon Monoxide			
OTALS			100.00

CONDENSATE VALUES, G.P.M.

Propane ____

Butane ____

Gasoline ____

HEATING VALUE, B.T.U. Per Cu. Ft.*

Calculated from % Composition ____

Calculated water saturated ____

SULPHUR CONTENT, Grains Per 100 Cu. Ft.*

Hydrogen Sulfide ____

Mercaptans ____

SPECIFIC GRAVITY*

Calculated from % Composition ____

*14.696 lbs./sq. in., 60° F

KS

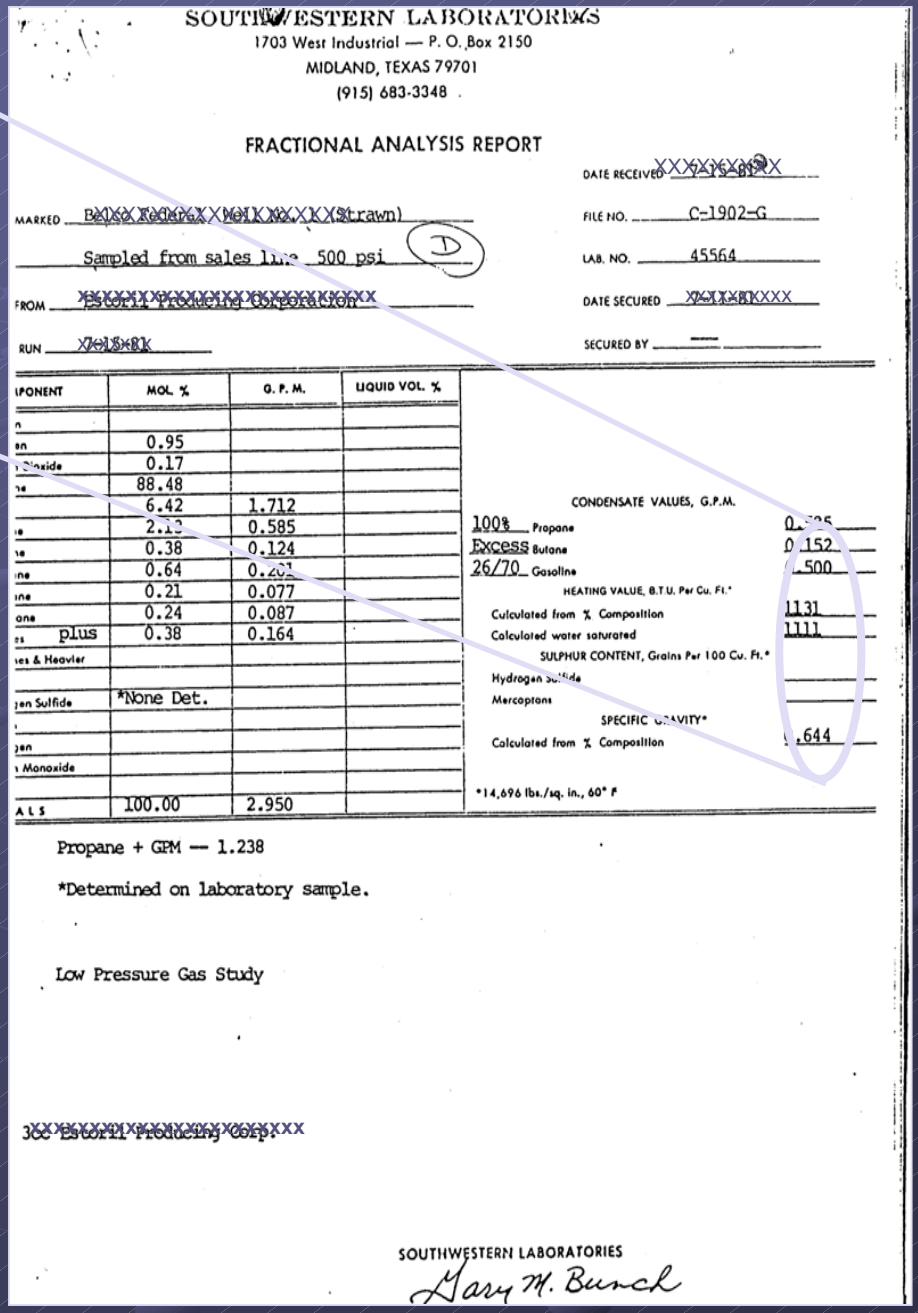
Low Pressure Gas Study

S: Cc: Estoril Producing Corp.

SOUTHWESTERN LABORATORIES

Mary M. Bunch

At 500 psig separation pressure the gas has a BTU content of 1131 BTU/cu. ft.



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FRACTIONAL ANALYSIS REPORT

DATE RECEIVED XXXXXXXX
MARKED [illegible] (Strawn)
Sampled from sales line 500 psi (D)
FILE NO. C-1902-G
LAB. NO. 45564
FROM [illegible] Estoril Producing Corporation
DATE SECURED XXXXXXX
RUN [illegible]
SECURED BY ——

PONENT	MOL %	G. P. M.	LIQUID VOL. %
n			
en	0.95		
Dioxide	0.17		
ne	88.48		
	6.42	1.712	
e	2.13	0.585	
e	0.38	0.124	
ne	0.64	0.201	
ne	0.21	0.077	
ane	0.24	0.087	
s plus	0.38	0.164	
es & Heavier			
gen Sulfide	*None Det.		
gen			
Monoxide			
ALS	100.00	2.950	

CONDENSATE VALUES, G.P.M.

100% Propane	0.[illegible]
Excess Butane	0.152
26/70 Gasoline	.500
HEATING VALUE, B.T.U. Per Cu. Ft.*	
Calculated from % Composition	1131
Calculated water saturated	1111
SULPHUR CONTENT, Grains Per 100 Cu. Ft.*	
Hydrogen Sulfide	
Mercaptans	
SPECIFIC GRAVITY*	
Calculated from % Composition	.644

*14,696 lbs./sq. in., 60° F

Propane + GPM — 1.238

*Determined on laboratory sample.

Low Pressure Gas Study

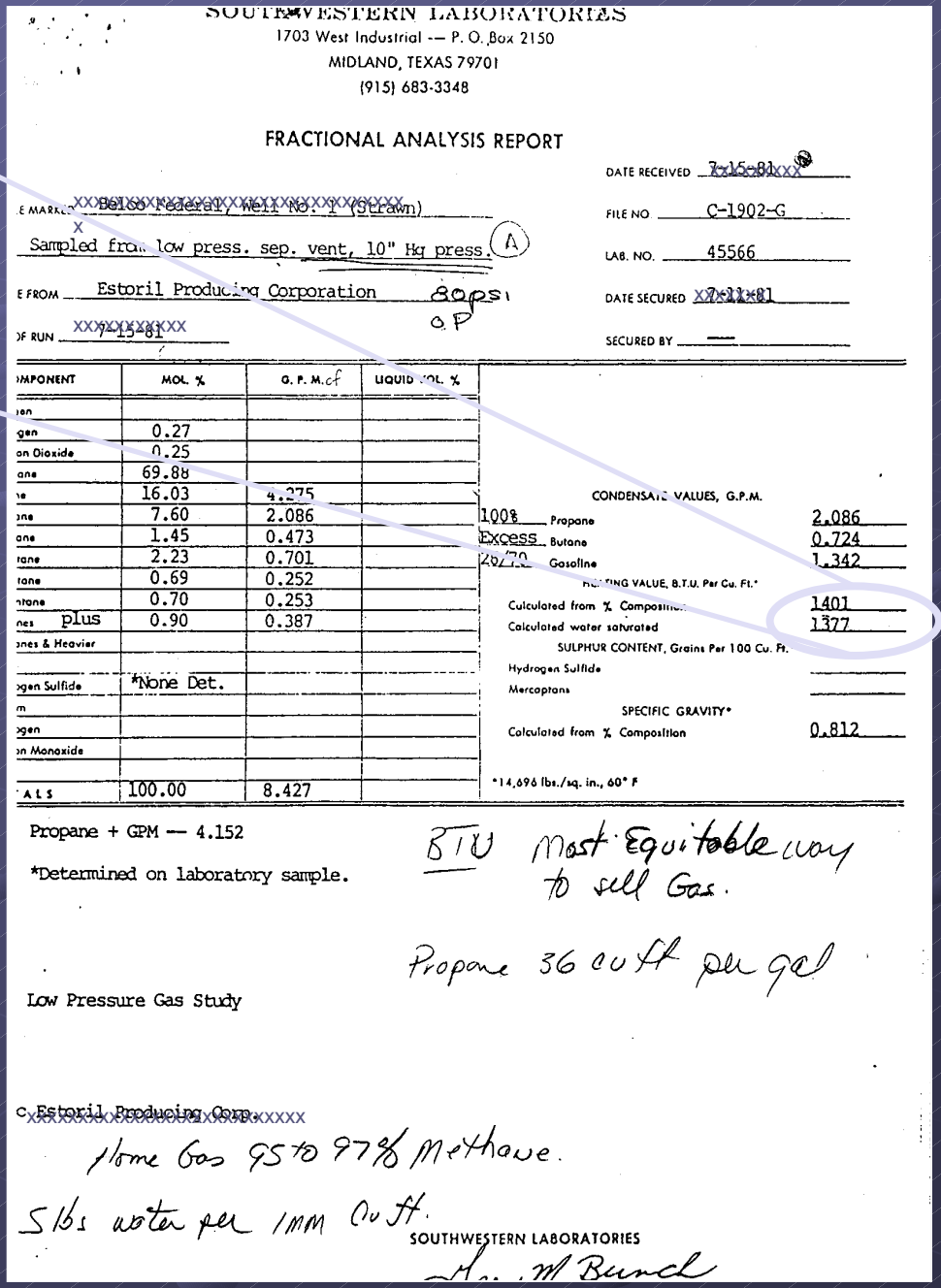
cc: Estoril Producing Corp.

SOUTHWESTERN LABORATORIES
Gary M. Bunch

500 PSIG SEPARATION

At 80 psig separation pressure the gas has reached a BTU value of 1401 BTU/ cu. ft.

80 PSIG SEPARATION



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FRACTIONAL ANALYSIS REPORT

DATE RECEIVED 7-15-81
FILE NO. C-1902-G
LAB. NO. 45566
DATE SECURED 7-11-81
SECURED BY —

E MARKED Belco Federal, well No. 1 (Strawn)
Sampled from low press. sep. vent, 10" Hg press. (A)
E FROM Estoril Producing Corporation 80psi
OF RUN 7-15-81

COMPONENT	MOL %	G. P. M. cf	LIQUID VOL. %
gen	0.27		
on Dioxide	0.25		
ane	69.88		
ne	16.03	4.275	
ane	7.60	2.086	
ane	1.45	0.473	
tane	2.23	0.701	
tane	0.69	0.252	
ntane	0.70	0.253	
nes plus	0.90	0.387	
nes & Heavier			
gen Sulfide	*None Det.		
n			
gen			
on Monoxide			
TALS	100.00	8.427	

CONDENSATE VALUES, G.P.M.

100%	Propane	2.086
Excess	Butane	0.724
20/70	Gasoline	1.342

HEATING VALUE, B.T.U. Per Cu. Ft.*

Calculated from % Composition	1401
Calculated water saturated	1377

SULPHUR CONTENT, Grains Per 100 Cu. Ft.

Hydrogen Sulfide	
Mercaptans	

SPECIFIC GRAVITY*

Calculated from % Composition	0.812

*14.696 lbs./sq. in., 60° F

Propane + GPM — 4.152

*Determined on laboratory sample.

BTU Most Equitable way to sell Gas.

Propane 36 cu ft per gal

Low Pressure Gas Study

c Estoril Producing Corp.

Home Gas 95 to 97% Methane.

5 lbs water per 1MM Cu ft.

SOUTHWESTERN LABORATORIES

Jas. M Bunch

At 25 psig separation, the gas stream is at its richest point yet, with a BTU value of 1588 BTU/cu. ft.

25 PSIG SEPARATION

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FRACTIONAL ANALYSIS REPORT

DATE RECEIVED 7-15-81
FILE NO. C-1902-G
LAB. NO. 45567
DATE SECURED 7-14-81
SECURED BY —

MARKED Belco Federal Well No. 1 (Strawn)
Sampled from Heater-Treater Vent - 2" Hg (B)
FROM Estoril Producing Corporation 25 psi OP
RUN 7-15-81

COMPONENT	MOL %	G. P. M.	LIQUID VOL. %
n	5.17		
Dioxide	0.31		
e	48.04		
	23.49	6.264	
	13.10	3.596	
e	2.60	0.848	
ne	3.96	1.245	
ne	1.23	0.449	
ne	1.08	0.390	
plus	1.02	0.439	
es & Heavier			
en Sulfide	*None Det.		
en			
Monoxide			
TALS	100.00	13.231	

CONDENSATE VALUES, G.P.M.

100%	Propane	3.596
Excess	Butane	1.496
26/70	Gasoline	1.875

HEATING VALUE, B.T.U. Per Cu. Ft.*

Calculated from % Composition	1588
Calculated water saturated	1560

SULPHUR CONTENT, Grains Per 100 Cu. Ft.*

Hydrogen Sulfide	
Mercaptans	

SPECIFIC GRAVITY*

Calculated from % Composition	0.985

*14.696 lbs./sq. in., 60° F

Propane + GPM — 6.967

*Determined on laboratory sample.

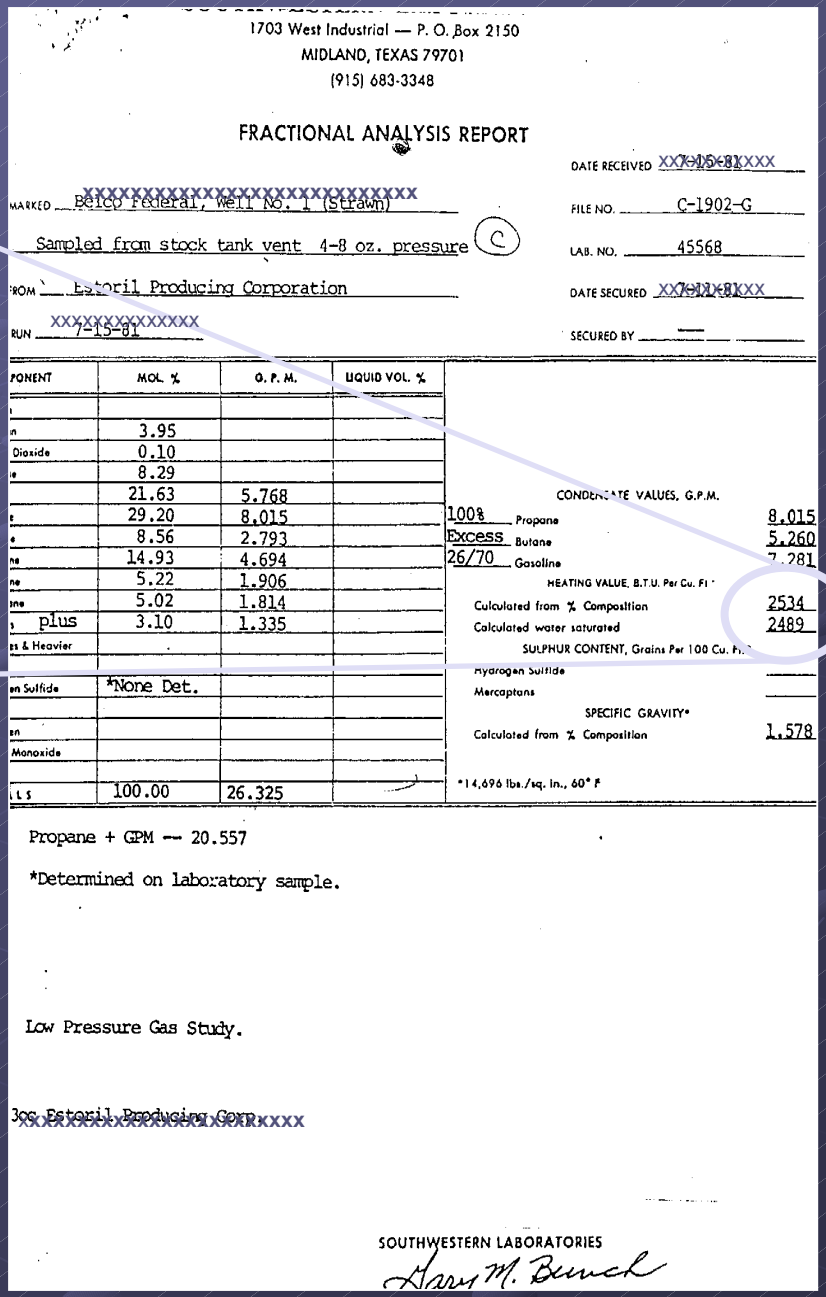
Low Pressure Gas Study

Doc: Estoril Producing Corp

SOUTHWESTERN LABORATORIES
Harris M. Bunch

This gas stream reaches its most valuable point during storage in the oil tank. This gas has a BTU value of 2514 BTU/ cu. Ft. Obviously, this gas is worth capturing!

OIL TANK STORAGE



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FRACTIONAL ANALYSIS REPORT

DATE RECEIVED XXXXXXXXXXXX

MARKED xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx Belco Federal, Well No. 1 (Strawn)

FILE NO. C-1902-G

Sampled from stock tank vent 4-8 oz. pressure (C)

LAB. NO. 45568

FROM Estoril Producing Corporation

DATE SECURED XXXXXXXXXXXX

RUN xxxxxxxxxxxxx 7-15-81

SECURED BY

PONENT	MOL. %	G. P. M.	LIQUID VOL. %
n	3.95		
Dioxide	0.10		
e	8.29		
	21.63	5.768	
e	29.20	8.015	
e	8.56	2.793	
ne	14.93	4.694	
ne	5.22	1.906	
ne	5.02	1.814	
plus	3.10	1.335	
s & Heavier			
en Sulfide	*None Det.		
en			
Monoxide			
LS	100.00	26.325	

CONDENSATE VALUES, G.P.M.

100%	Propane	8.015
Excess	Butane	5.260
26/70	Gasoline	7.281

HEATING VALUE, B.T.U. Per Cu. Ft.*

Calculated from % Composition	2534
Calculated water saturated	2489

SULPHUR CONTENT, Grains Per 100 Cu. Ft.*

Hydrogen Sulfide	
Mercaptans	

SPECIFIC GRAVITY*

Calculated from % Composition	1.578

*14.696 lbs./sq. in., 60° F

Propane + GPM — 20.557

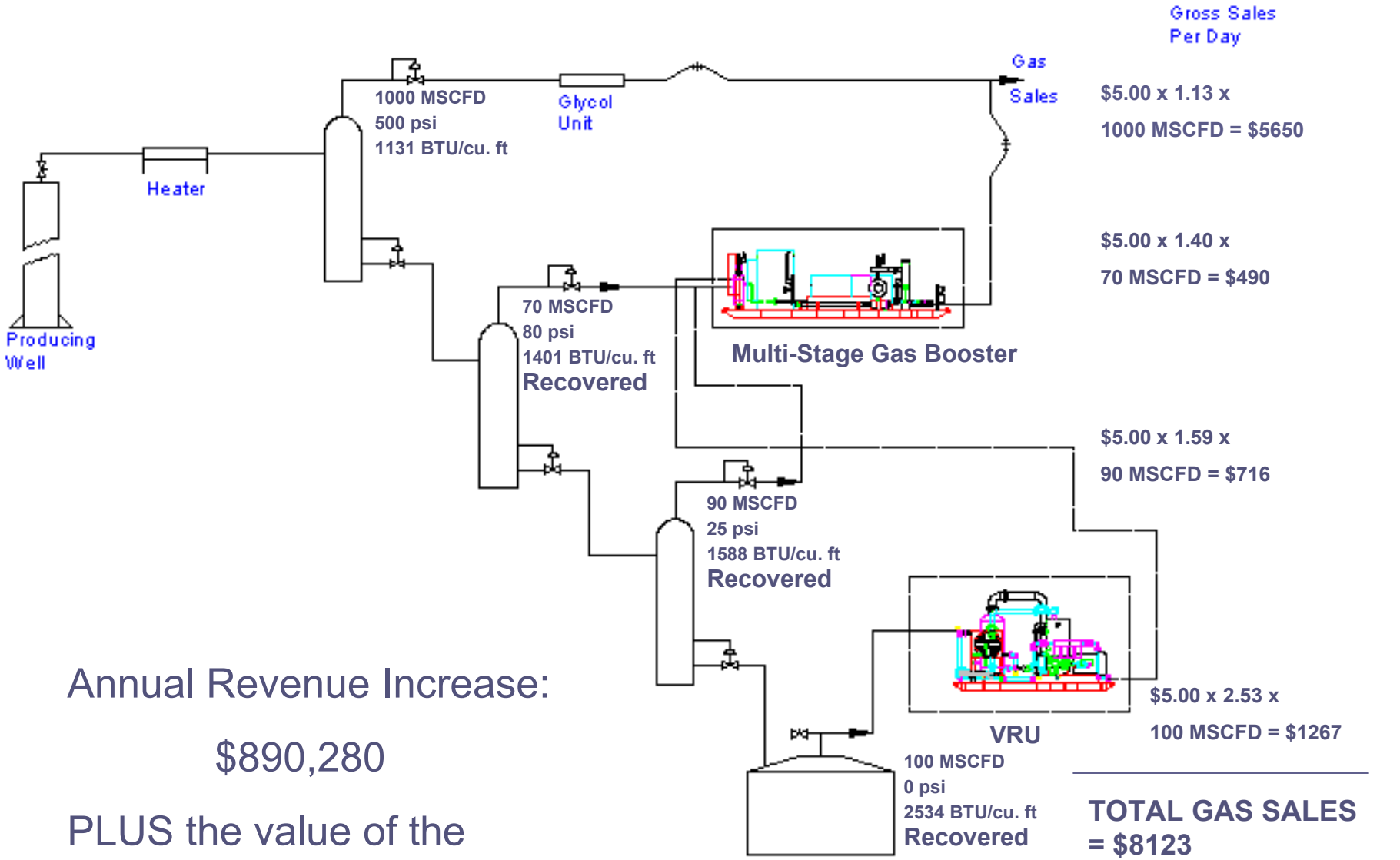
*Determined on laboratory sample.

Low Pressure Gas Study.

Xxx Estoril Producing Corp. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

SOUTHWESTERN LABORATORIES

Harry M. Bunch



Annual Revenue Increase:

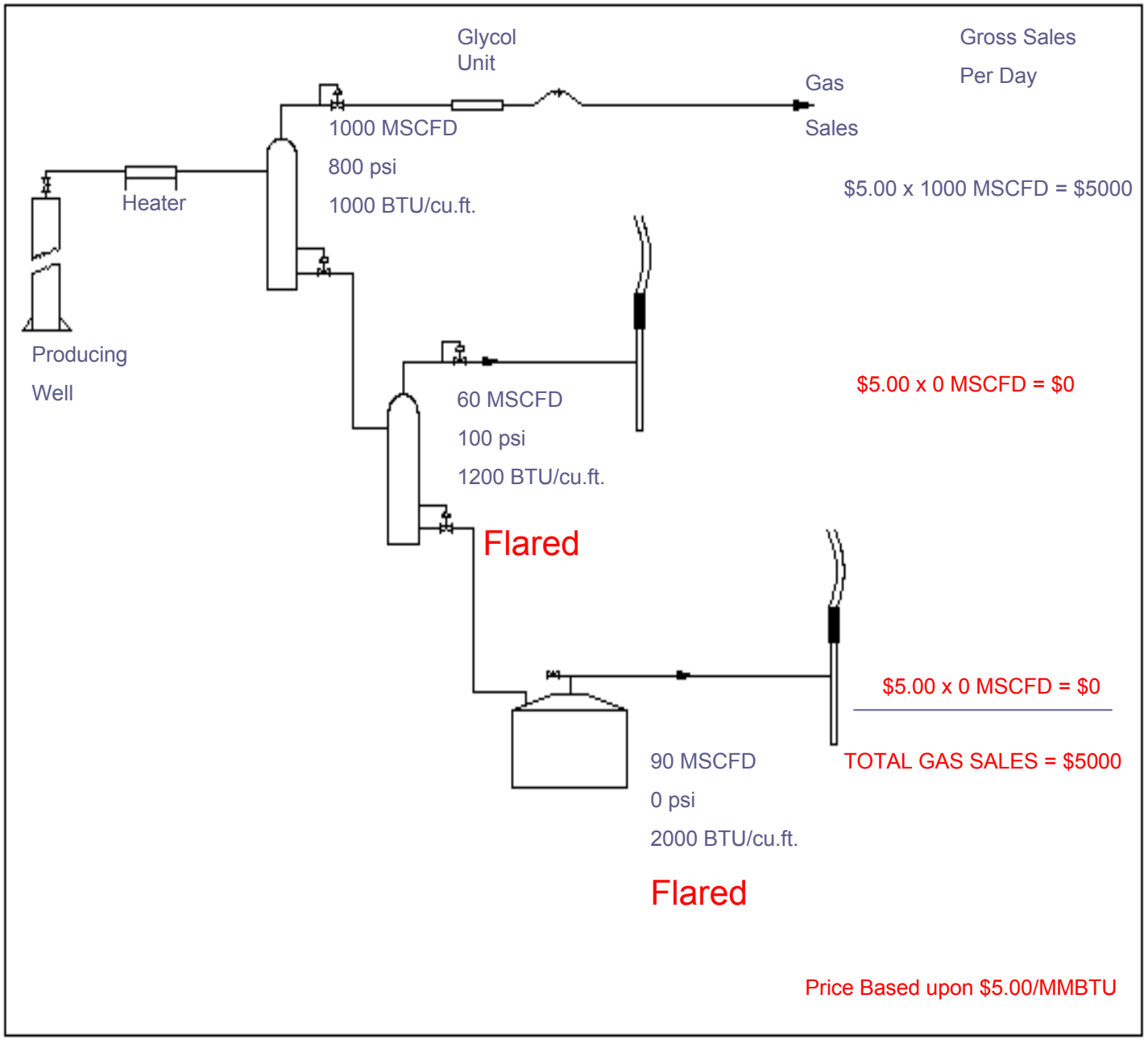
$890,280

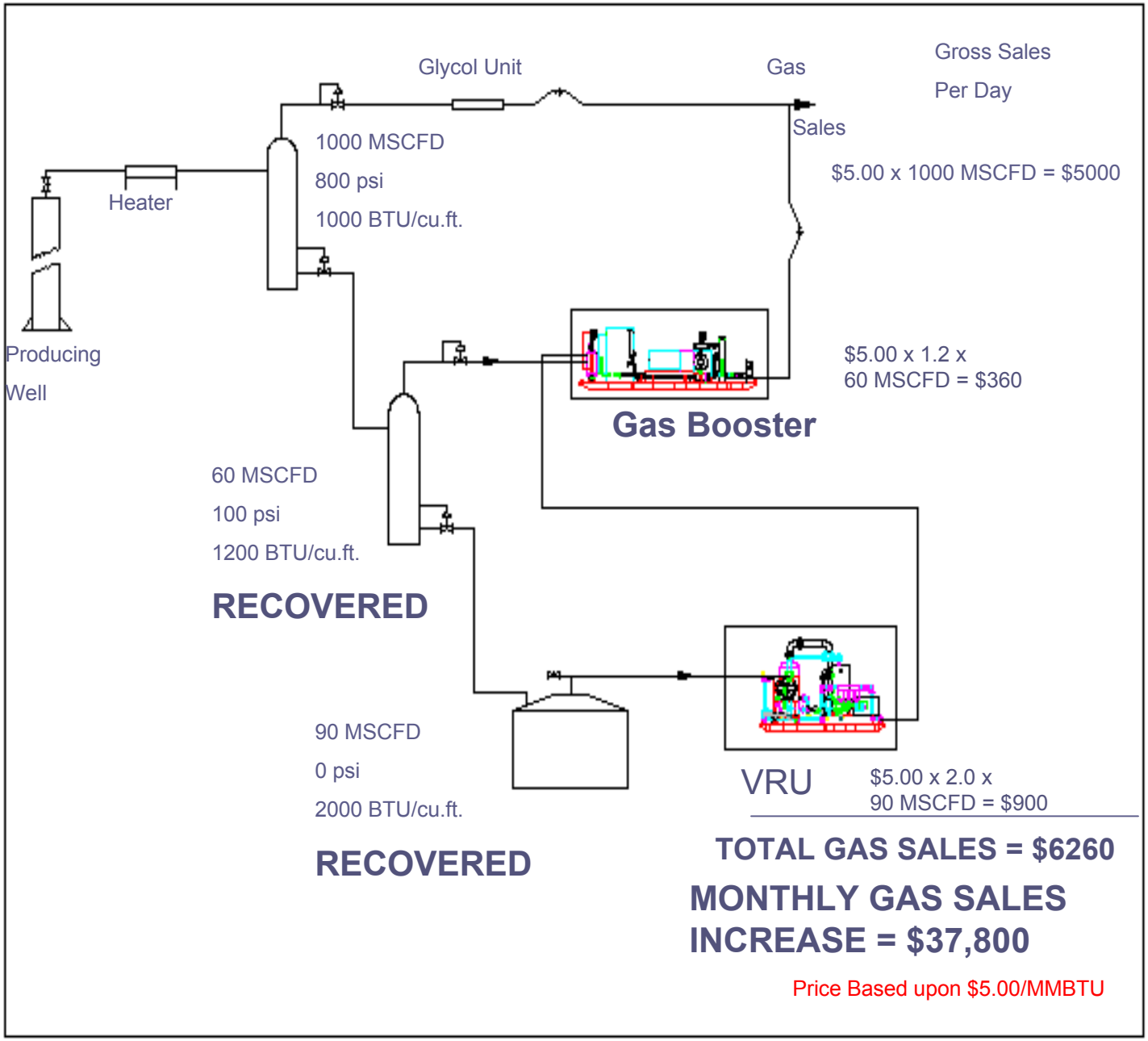
PLUS the value of the captured condensates (not metered by the operator)

MONTHLY GAS SALES INCREASE

= $74,190

NOTE: Price based upon $5.00/MMBTU


Glycol
Unit
Gross Sales
Per Day
Gas
Sales
1000 MSCFD
800 psi
1000 BTU/cu.ft.
$5.00 x 1000 MSCFD = $5000
Heater
Producing
Well
60 MSCFD
100 psi
1200 BTU/cu.ft.
$5.00 x 0 MSCFD = $0
Flared
$5.00 x 0 MSCFD = $0
90 MSCFD
0 psi
2000 BTU/cu.ft.
TOTAL GAS SALES = $5000
Flared
Price Based upon $5.00/MMBTU



Annual Revenue Increase:

$ 453,600

Case Study – Chevron

- Chevron installed eight VRUs at crude oil stock tanks in 1996

Project Economics – Chevron				
Methane Loss Reduction (Mcf/unit/yr)	Approximate Savings per Unit[1]	Total Savings	Total Capital and Installation Costs	Payback
21,900	$43,800	$350,400	$240,000	<1 yr
[1] Assumes a $2 per Mcf gas price; excludes value of recovered NGLs. Refer to the *Lessons Learned* for more information.				

Source: Natural Gas Star Partners

Case Study

Mid Size Independent in Hobbs, NM area March ‘04

Installation of 2 VRU’s on 2 stock tank batteries, each emitting approximately 90 MSCFD of 2500 btu tank vapors / 45 psig sales line

Previous gas sales revenue: $0 (venting)

Monthly gas revenue: $5 X 2.5 X 90 MSCFD X 30 days
x 2 tanks = $ 67,500

Capital expense: $24,000 X 2 units = $48,000

Payback: 21 DAYS

Case Study

Large Independent in North Texas June ‘04

Installation of 1 VRU on a stock tank battery emitting approximately 190 MSCFD of 2400 btu tank vapors / 50 psig sales line

Previous gas sales revenue: $0 (venting)

Monthly gas revenue: $5 X 2.4 X 190 MSCFD X 30 days

= $ 68,400

Capital expense: $32,000

Payback: 14 DAYS

CO_2 Recapture

Pulling stock tank vapors for a Major in Snyder, Texas. Flooded screw compressor for volumes to 1.5 MMSCFD. Pressure to 250 psig.

Other Costs to Consider

- Regulatory Liability Exposure
- Public Relations Exposure
  - Positive or Negative
- Litigation Exposure

Producing a clean energy source (natural gas) and simultaneously improving air quality in the community – with an economic payback of usually less than 3 months

VAPOR RECOVERY

So why aren't more companies taking advantage of this technology to generate revenue?

- Considered an “Environmental Issue”

- Haven’t run the economics since gas was $1.50 / mcf and internal afe’s based on $.75 gas.

- Few companies actually meter the volume of captured gas or condensate

- Because “the field guys” don’t like them

So Why Does the Field Push Back?

- “Our bonuses are based on oil increases, not gas”
- “They are not high on the radar screen – not on the morning report or monthly report”
- “The air permits ask if there is a vru on location, it doesn’t ask if there is a ***working*** vru on location”
- “It broke down a year ago and nobody started screaming about it”
- “It’s just another piece of equipment to take care of – and we don’t get any credit if it captures a lot of gas”
- “They let oxygen into the lines, and the pipeline company will shut us off”
- “They are a pain in the ass, I had a little Quincy once and I was replacing valves every other week”

VRUs are not a COMMODITY

Proper Tank Configuration

+

Proper Compressor Selection

+

Proper Package Design

+

Minimal Preventive Maintenance

=

Success

Vapor Recovery

Properly designed vapor recovery units average between 95% and 97% Run Time consistently – and DO NOT allow oxygen into the pipeline.

Electric drive vapor recovery units require very minimal (but necessary) preventive maintenance.

Units require pressure sensors and transmitters, sophisticated control systems, a bypass system, the correct compressor style (compatible with wet gas streams) and the proper tank configuration in order to operate effectively.

EXAMPLES OF APPLICATIONS

VAPOR RECOVERY

Dual VRU bound for Venezuela… one of 17 units capturing gas currently for Petroleos de Venezuela. Flooded screw compressor for volumes to 5.0 MMSCFD; up to 200 psig.

VAPOR RECOVERY

At this installation, three dual compressor packages were set in tandem to move 15 MMSCFD of 2500-2600 BTU/cu ft. tank vapors.

VAPOR RECOVERY

Two large rotary screw VRU systems manufactured in 2003 for ENI –designed to move 1.4 MMcfd of gas at pressures to 230 psig.

VAPOR RECOVERY

A 2004 installation for Amerada Hess for service in Algeria. This unit is a dual rotary vane system capable of moving 4MMCFD at pressures from 0 to 40 psig.

OFFSHORE VRUs - Examples

A rotary vane compressor package on an El Paso platform handles 500 MSCFD from 0 to 55 psig.

A high-spec offshore screw compressor VRU package designed for Kerr-McGee (Gulf region) handles 600 MSCFD to 120 psig.

A 2004 installation for Hunt will move 300 MSCFD at a discharge pressure of 70 psig.

Technological Advancements

Low Pressure Gas Management Systems

Sensing Technology

Pressure sensing can be achieved with diaphragm actuated mechanical device / set pressures achieved by manually setting counter weights in conjunction with proximity switch.

High sensitivity electronic transmitters are now commercially viable for low pressure applications. Transmitters are highly accurate to extremely minute pressures – and do not require a highly trained technician to calibrate.

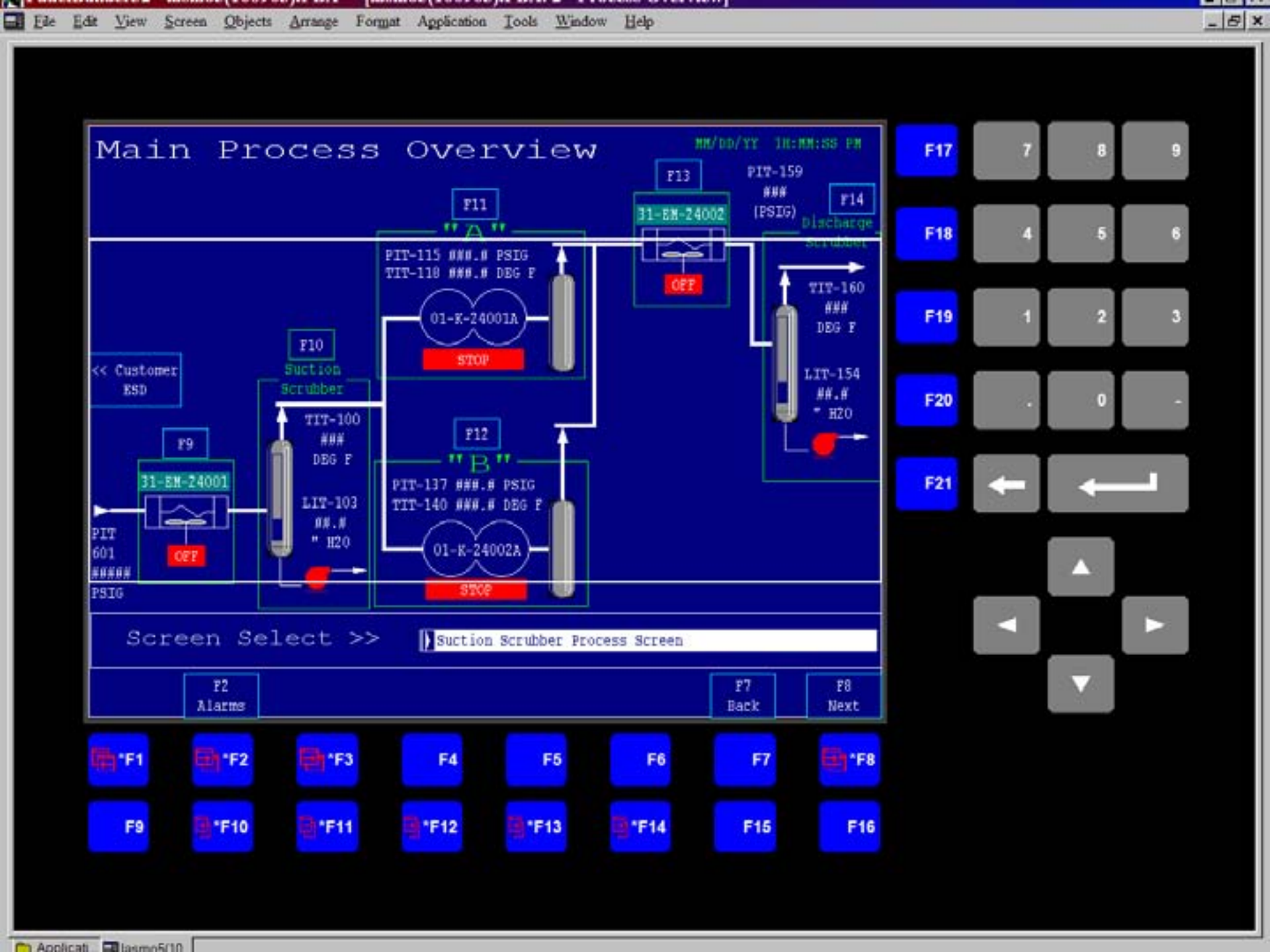
Lubrication Systems

Advancements in lubrication systems monitoring and control have dramatically increased bearing life.

Lubrication requirements are precisely monitored and detailed reporting capabilities are easily downloaded into handheld “palm” devices or directly into Excel format.

Control Systems

PLC driven auto ignition for natural gas drive engines reduce compressor downtime and pumper requirements.


File Edit View Screen Objects Arrange Format Application Tools Window Help
Main Process Overview
MM/DD/YY HH:MM:SS PM
F11
"A"
PIT-115 ###.# PSIG
TIT-110 ###.# DEG F
01-K-24001A
STOP
F13
31-EM-24002
OFF
PIT-159
###
(PSIG)
F14
Discharge
Scrubber
TIT-160
###
DEG F
LIT-154
##.#
" H2O
F10
Suction
Scrubber
<< Customer
ESD
TIT-100
###
DEG F
LIT-103
##.#
" H2O
F9
31-EM-24001
OFF
PIT
601
#####
PSIG
F12
"B"
PIT-137 ###.# PSIG
TIT-140 ###.# DEG F
01-K-24002A
STOP
Screen Select >>
Suction Scrubber Process Screen
F2
Alarms
F7
Back
F8
Next
F17
F18
F19
F20
F21
7
8
9
4
5
6
1
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*F3
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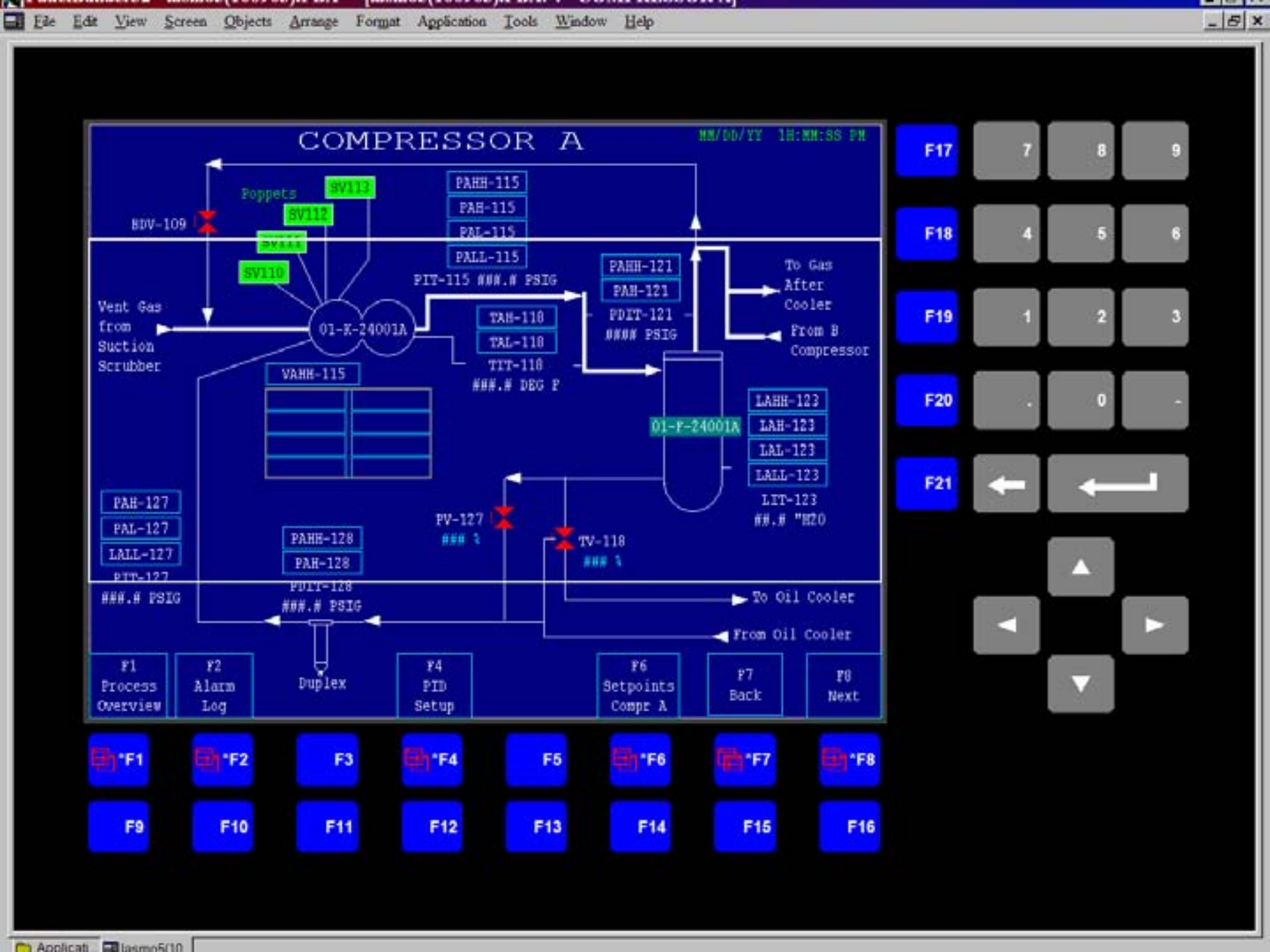
File Edit View Screen Objects Arrange Format Application Tools Window Help
COMPRESSOR A
MM/DD/YY 1H:MM:SS PM
Poppets
SV113
SV112
SV111
SV110
BDV-109
PAHH-115
PAH-115
PAL-115
PALL-115
PIT-115 ###.# PSIG
PAHH-121
PAH-121
PDIT-121
PSIG
To Gas After Cooler
From B Compressor
Vent Gas from Suction Scrubber
01-K-24001A
TAH-110
TAL-110
TIT-110
###.# DEG F
VAHH-115
01-F-24001A
LAHH-123
LAH-123
LAL-123
LALL-123
LIT-123
##.# "H2O
PAH-127
PAL-127
LALL-127
PIT-127
###.# PSIG
PV-127
%
TV-110
%
PAHH-128
PAH-128
PDIT-128
###.# PSIG
To Oil Cooler
From Oil Cooler
Duplex
F1 Process Overview
F2 Alarm Log
F4 PID Setup
F6 Setpoints Compr A
F7 Back
F8 Next
F17
F18
F19
F20
F21
7
8
9
4
5
6
1
2
3
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0
-
*F1
*F2
F3
*F4
F5
*F6
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F14
F15
F16

HY-BON ENGINEERING COMPANY, INC.

Setting a New Standard!!