This is the 2018 Errata Pack for the FPS version of the 14th Edition of the GPSA EDB.

Errata highlighted

To update your book, replace the pages in your Data Book with the pages in the enclosed errata pack as follows:

- Section 1: 2-sided page 17 and 18
- Section 1: 2-sided page 27 through 30
- Section 6: 2-sided page 17 through 20
- Section 7: 2-sided page 31 and 32
- Section 7: 2-sided page 41 and 42
- Section 13: 2-sided page 9 and 10
- Section 16: 2-sided page 19 and 20
- Entire Section 26

FIG. 1-12

Gaseous Composition of Air

Gas	Symbol	Molecular Weight	Volume %
Molecular Weight of Air = 28.9625			
Basic constituents			
Nitrogen	N_2	28.013	78.084 ± 0.004 %
Oxygen	O_2	32.0	20.946 ± 0.002 %
Argon	Ar	39.948	0.934 ± 0.001 %
Trace gases			
Neon	Ne	20.183	18.12 ± 0.04 ppm
Helium	He	4.003	5.239 ± 0.05 ppm
Krypton	Kr	83.80	1.14 ± 0.01 ppm
Xenon	Xe	131.30	0.087 ± 0.001 ppm
Hydrogen	H_2	2.016	0.5 ± 0.01 ppm
Impurities			
Water	H_2O	18.015	0.1 – 2.8 %
Carbon dioxide	CO_2	44.011	300 ± 30 ppm
Methane	CH_4	16.043	1.5 to 2.5 ppm
Carbon monoxide	CO	28.010	0.061 to 1.1 ppm
Sulphur dioxide	SO_2	64.06	1.1 ppm
Nitrous oxide	N_2O	44.012	0.5 ppm
Ozone	O_3	47.998	0.011 to 0.11
Nitrogen dioxide	NO_2	46.005	0.005 to 0.02 ppm
Radon	Rn	222	Trace
Nitric oxide	NO	30.006	Trace

Openshaw, D. and Cain, S., "Ultra-pure Cryogenic Nitrogen Generator," TCE, The Chemical Engineer, The Institution of Chemical Engineers, Rugby, England, UK., November 2002, p. 30.

Note that Fig. 1-12 is based on a fixed reference value of air (28.9625), and is no longer based upon the molar mass of air, which changes from time to time as the mole fractions of the components in dry air are updated. Refer to page 23-22 in Section 23 for additional information.

FIG. 1-13

Greek Alphabet

α A = Alpha	ι I = Iota	ρ P = Rho
β B = Beta	κ K = Kappa	σ Σ = Sigma
γ Γ = Gamma	λ Λ = Lambda	τ T = Tau
δ Δ = Delta	μ M = Mu	υ Y = Upsilon
ε E = Epsilon	ν N = Nu	ϕ Φ = Phi
ς Z = Zeta	ξ Ξ = Xi	χ X = Chi
η H = Eta	ο O = Omicron	ψ Ψ = Psi
θ Θ = Theta	π Π = Pi	ω Ω = Omega

GPA MIDSTREAM ASSOCIATION PUBLICATIONS

CORROSION DETECTION REPORT — A practical and convenient field guide to detecting, locating, and measuring common corrosion problems in gas processing plants and related equipment.

PLANT PROJECT AND DESIGN CHECK LIST — Prepared by Technical Section A to serve as a guide in planning and preparing job and equipment specifications using categories normally required for a processing plant.

ENERGY CONSERVATION CHECK LIST — Prepared by Technical Section A, and patterned after the earlier "Plant Project and Design Check List", it was developed to serve as a guide check list for energy conservation within various units of equipment.

SAFETY INSPECTION CHECK LIST — Prepared by the Safety Committee to show the plant and design engineer items of importance to check from the viewpoint of safety in design and operation. It consists of approximately 60 pages covering 15 areas in the gas processing plant.

GUIDE FOR PERFORMANCE TESTING OF PLANT EQUIPMENT — Prepared by Section A as a guide for checking the performance of various items of equipment within a plant. Over 200 pages divided into five major sections: A. Plant Acceptance and Performance Tests; B. Towers and Vessels; C. Engines and Turbines; D. Compressors, Pumps and Blowers; and E. Heating and Cooling.

NORTH AMERICAN STORAGE CAPACITY FOR LIGHT HYDROCARBONS AND U.S. LP-GAS IMPORT TERMINALS — A biennial report compiling the storage facilities for light hydrocarbons in the U.S. and the terminal facilities in the U.S. capable of receiving imported LP-gas. Excel Diskette available.

SALES OF NATURAL GAS LIQUIDS AND LIQUEFIED REFINERY GASES — A joint publication of API, GPA Midstream Association, PERC, and NPGA summarizes annual survey data on gas liquids sales — by product, by major market uses, and by state.

LP-GAS ODORIZATION SYMPOSIA PROCEEDINGS — Collection of papers presented at two symposia on LP-gas Odorization Technology in 1989 and 1990. Cosponsored by the National Propane Gas Association and the Propane Gas Association of Canada, these proceedings are a compilation of information on LP-gas odorants, odorization practices and equipment, and original research into the behavior of odorants in the LP-gas fuel system.

REPORT OF INVESTIGATIONS–ODORIZATION OF LP-GAS — A summary of research findings and studies conducted during 1986-1990 by a joint task force of representatives from GPA Midstream Association, the National Propane Gas Association and the Propane Gas Association of Canada. Includes task force recommendations for effective odorization of LP-gas.

OPERATIONS AND MAINTENANCE PRACTICES MANUAL — Prepared by Technical Section M, the intent of this publication is to provide a basic understanding of maintenance management practices and information on some of the tools available to assist in improving safety, environmental, and overall asset performance. These practices are representative of the current time and environment and should be periodically reviewed and updated for changes as is expected through continuous improvement.

REAPPLYING USED PLANTS AND EQUIPMENT — This monograph has been written to help those who may be interested in reapplying used equipment and/or plants in the gas processing industry. It is the result of many years of experiences of members of the GPA Midstream Association Technical Section A: Facilities Design, and of their fellow workers

ANNUAL CONVENTION PROCEEDINGS — Collection of all technical papers presented in the technical forums and general sessions of the GPA Midstream Association annual conventions.

STANDARDS AND BULLETINS

Specifications

GPA Standard 2108 — Fractionation Grade Product Specifications.

GPA Standard 2140 — Liquefied Petroleum Gas Specifications and Test Methods.

GPA Standard 3132 — Natural Gasoline Specifications and Test Methods.

Analytical Methods

AGA-GPA CODE 101 — Standard Compression and Charcoal Tests for Determining the Natural Gasoline Content of Natural Gas.

GPA Standard 2100 — Tentative Method for the Qualitative Determination of COS in Propane.

GPA Standard 2103- Tentative Method for the Analysis of Natural Gas Condensate Mixtures Containing Nitrogen and Carbon Dioxide by Gas Chromatography.

GPA Standard 2177 — Analysis of Natural Gas Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Gas Chromatography.

GPA Standard 2186 — Method for the Extended Analysis of Hydrocarbon Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Temperature Programmed Gas Chromatography.

GPA Standard 2187 — Tentative Method for the Determination of Ammonia in Liquid Propane.

GPA Standard 2l88 — Tentative Method for the Determination of Ethyl Mercaptan in LP-gas Using Length of Stain Tubes.

GPA Standard 2194 — Tentative Low Pressure Field Method for Determining Ethyl Mercaptan Odorant in LP-gas Using Length of Stain Tubes.

GPA Standard 2198 — Selection, Preparation, Validation, Care, and Storage of Natural Gas and Natural Gas Liquid Reference Standard Blends.

GPA Standard 2199 — The determination of Specific Sulfur Compounds by Capillary Gas Chromatography and Sulfur Chemiluminescence Detection.

RR-200 *Water Content of Sweet and Sour Gas Mixtures* — Matt Yarison, Kyoo Y. Song, Kenneth R. Cox, Dick Chronister, Walter G. Chapman. Rice University, Houston, Texas. Project 032. March, 2008

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TP-3 *A Model for the Precise Calculation of Liquefied Natural Gas Densities* — M. A. Albright, Phillips Petroleum Co., Bartlesville, Oklahoma.

TP-4 *Low-Temperature Data from Rice University for Vapor-Liquid and P-V-T Behavior* — R. Kobayashi, P.S. Chappelear and T. W. Leland, Rice University, Houston, Texas.

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TP-6 *Experimentally Based Thermodynamic Properties of Propane* — V. L. Bhirud and J. E. Powers, University of Michigan, Ann Arbor, Michigan.

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TP-18 *GPA Experimental Enthalpy Values Referred to Two Base Levels from Excess Enthalpy Data* — P.S. Chappelear, Houston, Texas.

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OTHER SOURCES OF INFORMATION

AFNOR **Association Francaise de Normalisation**
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AGA **American Gas Association**
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Fax: (202) 824-7115
www.aga.org

AIChE **American Institute of Chemical Engineers**
3 Park Ave.
New York, NY 10016
(212) 591-7338
www.aiche.org

AISC **American Institute of Steel Construction**
1 East Walker Dr., Ste 3100
Chicago, IL 60601
(312) 670-2400

AISI **American Iron and Steel Institute**
1101 17th St., N.W., Ste 1300
Washington, D.C. 20036
(202) 452-7100

ANSI **American National Standards Institute**
25 West 43rd St., 4th Floor
New York, NY 10036
(212) 642-4900

API **American Petroleum Institute**
1220 L. Street, N.W.
Washington, D.C. 20005
(202) 682-8000
www.api.org

ASHRAE **American Society of Heating, Refrigerating & Air-Conditioning Engineers**
1791 Tullie Circle, N.E.
Atlanta, GA 30329
(404) 636-8400
www.ashre.org

ASME **American Society of Mechanical Engineers**
United Engineering Center
3 Park Ave.
New York, NY 10016
(212) 591-7000
www.asme.org

ASTM **American Society for Testing and Materials**
100 Barr Harbor Dr.
West Conshohocken, PA 19428
(610) 832-9500
www.astm.org

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CGPA **Canadian Gas Processors Association**
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www.cgpsa.com

CTI **Cooling Tower Institute**
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Houston, TX 77068
(281) 583-4087
www.cti.org

GTI **Gas Technology Institute**
1700 S. Mount Prospect Road
Des Plaines, IL 60018
(773) 399-8100
www.gastechnology.org

IHS **Information Handling Services**
15 Inverness Way East
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Englewood, CO 80150-1154
(800) 241-7824
www.ihs.com

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445 Hoes Lane
Piscataway, NY 08854
(212) 419-7900
www.ieee.org

IP **Institute of Petroleum**
61 New Cavendish Street
London W1M 8AR, U.K.
Phone: 44 0207 467 7100
Fax: 44 0207 255 1472
Email: ip@petroleum.co.uk

ISA **Instrument Society of America**
67 Alexander Drive
Box 12277
Research Triangle Park, NC 27709
(919) 549-8411
www.isa.org

ISO **International Organization for Standardization**
Case postale 56
CH-211 Geneva, Switzerland
Phone: 4122 749 0111
Fax: 4122 733 3430

NACE **National Association of Corrosion Engineers**
P.O. Box 201009
Houston, TX 77216-1009
(281) 492-0535

NFPA **National Fire Protection Association**
1 Batterymarch Park
Quincy, MA 02269
(617) 770-3000
www.nfpa.org

NOAA **National Oceanic and Atmospheric Administration**
National Climatic Center
151 Patton Ave., Rm 120
Asheville, NC 28801-5001
Phone: (828) 271-4800
Fax: (828) 271-4876
www.ncdc.info@noaa.gov

NPGA **National Propane Gas Association**
1150 17th St. NW, Ste. 310
Washington, DC 20036
(202) 466-7200
www.npga.org

SPE **Society of Petroleum Engineers**
Box 833836
Richardson, TX 75083
(972) 952-9393
www.spe.org

TEMA **Tubular Exchanger Manufacturers Association**
25 North Broadway
Tarrytown, NY 10591
(914) 332-0040
www.tema.org

ment limits potential quantity of liquid and potential fire damage to equipment in the area.

Many codes, standards, and specifications regulate the location, design, and installation of storage tanks depending on their end use. Selecting the proper specification and providing adequate fire protection for the installation may allow lower insurance rates over the life of the installation. A partial list of applicable codes, standards, and specifications can be found at the end of this section. NFPA 30 applies for safe distances and spacing of storage tanks, as well as the design of the safety containment system.

Grounding

Metallic storage tanks used to store flammable liquids should be grounded to minimize the possibilities of an explosion or fire due to lightning or static electricity.

CATHODIC PROTECTION

Cathodic protection can be applied to control corrosion that is electrochemical in nature where direct current is discharged from the surface area of a metal (the anodic area) through an electrolyte. Cathodic protection reduces corrosion of a metal surface by using a direct current from an external source to oppose the discharge of metal immersed in a conducting medium or electrolyte such as soil, water, etc.

The bottom sides of most atmospheric tanks are not coated and presents a significant corrosion risk. Either sacrificial anodes buried beneath the tank or an impressed current system is required to prevent corrosion of the tank floor.

EMISSIONS

Vapor Losses

Vapors emitted from the vents and/or relief valves of a storage vessel are generated in four ways:

- Vapors that are forced out of the tank during filling operations (Displacement).
- Vapors that are generated by vaporization of the liquid stored in the tank (Flashing).
- Vapors that are generated in the system piping feeding the tank (high point elevations, or vapor carry-under from upstream vessels) (System).
- Vapors that are generated through ambient variations in temperature/pressure (Breathing).

A vapor recovery system should be sized to handle the total vapor from these sources.

Displacement losses — Vapors that are forced out of the tank are generally called displacement losses. A storage tank is generally not pumped completely dry when emptied. The vapor above the remaining liquid in the tank will expand to fill the void space at the vapor pressure of the liquid stored in the tank at storage temperature. As the tank is filled, the vapors are compressed into a smaller void space until the set pressure on the vent/relief system is reached. There are also some filling losses that are associated with the expansion of the liquid into the tank. Fig. 6-20 provides a graphical approach to estimating the filling losses as a percentage of the liquid being pumped into the tank.

Vaporization or flashing losses — This type of loss is characterized as the vapors generated by heat gain through the shell, bottom, and roof. The total heat input is the algebraic sum of the radiant, conductive, and convective heat transfer. This type of loss is especially prevalent where light hydrocarbon liquids are stored in full pressure or refrigerated storage. This is less prevalent but still quite common in crude oil and finished product storage tanks. These vapors may be recovered by the use of a vapor recovery system.

System losses — Quantifying the impacts of vapor formation upstream of the tank requires consideration of the detailed pressure profile in the piping to the tank. Often times, the control valve feeding the tank on a single circuit should be placed near the tank. At no point between the tank and the control valve shall the piping exceed an elevation of the low liquid level in the vessel where the static head could cause the fluid to go below the vapor pressure of the fluid.

Breathing losses — Usually due to ambient variations leading to either; flashing/condensation of the product itself or expansion / contraction of the vapor space above the fluid. This is usually only a consideration in large atmospheric tanks (API-650).

To calculate vaporization in tanks, sum up the effects of radiant, conductive, and convective heat inputs to the tank. Approximate vapor losses in lb/hr can then be calculated by dividing the total heat input by the latent heat of vaporization of the product at the fluid temperature.

EPA-AP42 provides a specific process to establish the vapor rate for regulated, atmospheric tanks storing toxic and hazardous air pollutants.

Liquid equivalents of tank vapors — The following procedure may be followed to calculate the liquid equivalent of vapor volumes above stored LP-gas liquids:

General Approach

Data Required:

1. Liquid product composition in mole % or mole fraction.
2. Temperature and pressure of the product from which the liquid sample was obtained.
3. Vapor-liquid equilibrium K values at an assumed 1,000 psia convergence pressure (see Section 25).

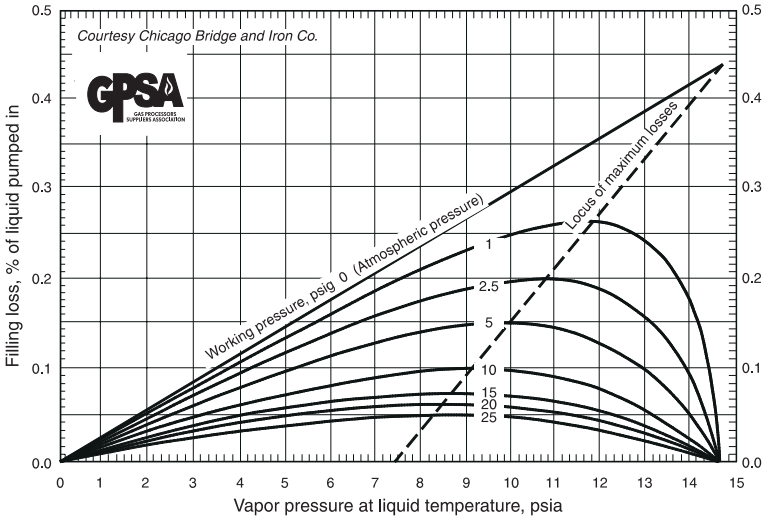
Calculation Procedure:

1. With the liquid product composition, calculate the bubble point pressures of the product at assumed temperatures: i.e., 60 °F, 80 °F. From the bubble point calculations, a vapor pressure chart can be made for this specific product composition.
2. From the bubble point calculation in (1), the product vapor composition can be obtained: i.e.,

$$\sum (y_i) = \sum (K_i x_i) = 1.0 \qquad \textbf{Eq 6-4}$$

3. Calculate the compressibility factor for the vapor by either (a) or (b).
    a. Compressibility factor charts, Section 23. Pseudocritical and pseudoreduced temperatures and pressures must be calculated to obtain a compressibility factor.

FIG. 6-20
Filling Losses from Storage Containers



b. Equations of state.

4. Calculate the total number of moles of vapor for volume V, by using the modified ideal-gas equation:

$PV = n_g ZRT$, $n_g = PV/ZRT$ = total moles vapor **Eq 6-5**

5. Calculate the gallons of liquid equivalent in the vapor phase by multiplying the total number of moles of vapor by the mole fraction of each component by the gal./mole factors for that component from Fig. 23-2.

$\sum [n_g(y_i)\ (\text{gal./mole})_i] = 60\ °F$ gallons in vapor phase **Eq 6-6**

Example 6-4 — Determine three points of data used to plot Fig. 6-20.

1. Calculate composition of vapor at the three data points.

	Liquid C^3 Composition	Bubble-point pressures					
		0 °F, 42 psia		60 °F, 114 psia		120 °F, 255 psia	
	x	K	y	K	y	K	y
C_2	0.03	4.35	0.1305	3.15	0.0945	2.55	0.0765
C_3	0.95	0.909	0.8633	0.945	0.8975	0.962	0.9136
iC_4	0.02	0.309	0.0062	0.398	0.0080	0.493	0.0099
	1.00		1.0000		1.0000		1.0000

2. Determine compressibility factor at the three points.

Vapor			
Average MW, $\sum (y_i MW_i)$,	42.353	42.884	43.163
Pseudo T_c, °R,	651	655	658
Pseudo P_c, psia	628	624	622
T_R	0.707	0.794	0.881
P_R	0.067	0.183	0.410
Z (Section 23)	0.913	0.855	0.730

3. Calculate moles of vapor per 1000 gal. of vapor.

$$n_g = \frac{PV}{ZRT} \quad \text{and } n_i = (n_g y_i)$$

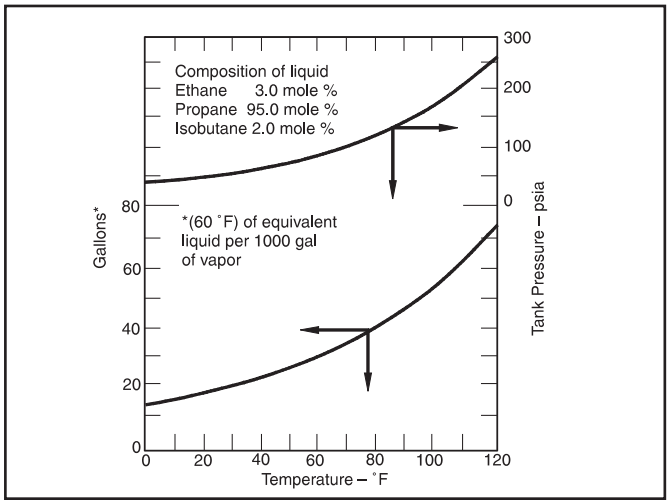
$$V = \frac{1{,}000}{7.48} = 133.7 \text{ cu ft}$$

$+n_i$, moles	C_2	0.1626	0.3019	0.5741
	C_3	1.0757	2.8673	6.8556
	iC_4	0.0077	0.0256	0.0743
	$n_g = \sum n_i$	1.2460	3.1948	7.5040

4. Calculate liquid equivalent gallons (60 °F) per 1000 gallons vapor.

	gal./mole			
C_2	10.126	1.646	3.057	5.813
C_3	10.433	11.223	29.915	71.524
iC_4	12.386	0.095	0.317	0.920
Liquid equivalent, gal.		12.964	33.289	78.257

FIG. 6-21
Liquid Equivalent of Tank Vapor



Suggested Simplified Approach

By using a typical product analysis, calculations can be made as outlined above, and from these calculations (see example 6-4) vapor pressure and gallon equivalent charts can be drawn as shown in Fig. 6-21. A convenient unit of vapor space volume should be used, such as 1,000 gal.

Vapor Recovery Systems

Vapor recovery systems are generally used to prevent pollution of the environment and to recover valuable product. EPA AP-42 may have additional specific requirements for pollutants (HAPs) to be considered under MTSA (Maritime Transportation Security Act 2002) and US 40 CFR 60, Subpart OOOO 154 — Facilities Transferring Oil or Hazardous Material in Bulk. In addition, there are emission limits on VOC, and BTEX (benzene, toulene, ethylbenzene, and xylene) compounds. Three basic types of vapor recovery systems may be encountered. One is designed to gather toxic wastes or a low value hydrocarbon stream (for example vapors from crude oil storage) that do not warrant full recovery. In this type system, the vapors are generally gathered and incinerated. If incineration will not meet government disposal standards, the vapors are generally compressed and condensed into a liquid and sent to a liquid disposal system.

The vapor recovery systems that are typically used with refrigerated storage tanks are generally integrated with the product refrigeration systems. In these types of systems, the vapors are generally compressed, condensed, and put back into the tank with the fill stream.

Vapor recovery systems on atmospheric pressure, ambient temperature storage tanks do not normally require a refrigeration system to condense the vapors. They are generally compressed through one stage of compression, condensed in either an air cooled or water cooled exchanger, and then put back into the tank. Fig. 6-22 provides the flow schematic of this system. In these systems the resulting natural gas stream is typically compressed and sent to a pipeline (or recycled in the facility depending upon location). If these options are not available, then the remaining vapor stream will be combusted or used for fuel.

A popular option to atmospheric storage tanks is an inclusion of a Vapor Recovery Tower (VRT) immediately upstream of the tanks, so that any vapor formed from the upstream equipment or within the piping, is captured before entering the tanks, and proceeds to a vapor recovery system or vapor collection header. This also prevents hydrocarbon vapors from entering the vapor space of the storage tanks and minimizes the potential for a hydrocarbon/air mixture in the tanks. This reduces the amount of vapor experienced through the actual storage tanks, and has the potential to reduce emissions and be in better compliance with environmental regulations than letting all the vapors continue to the tanks.

Tank Blanketing Systems

Tank blanketing may be required to prevent the ingress of air (and oxygen) into the stored products, such as the case with specialty chemicals such as amines. The use of steam, natural gas (methane) or nitrogen are common blanketing mediums that may be used depending on the process.

In some pressurized tank storage it may be necessary to provide a source of vapor to replace the displaced volume (during unloading) to maintain adequate vessel pressure and NPSH on the downstream pumping equipment.

Both vapor recovery and tank blanketing systems need to be designed with proper sizing to accommodate tank filling and pumpout operations, and must operate both:

- Efficiently, i.e., blanket gas systems are not creating undue load on the vapor recovery system
- Safely, i.e., vapor recovery and tank blanketing systems will not lead to an under or overpressure condition on the tank leading to rupture and loss of containment.

LIQUID STORAGE

Desirability of Large Units

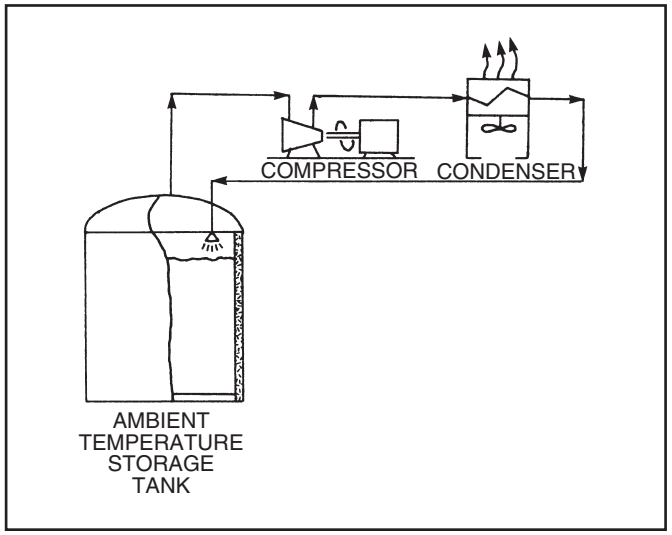
Depending upon the storage requirements of the facility, large storage units may be required. One option is to provide multiple storage bullets or tank batteries.

Detailed hydraulic evaluations should be conducted to ensure that symmetrical flow to each tank when multiple tanks or bullets in parallel are being filled. The main trunk line feeding all tanks should be larger than the individual lines to each tank. A good rule of thumb is that the pressure drop in the trunk line where full flow is experienced shall be about 1/10th of the pressure drop in the laterals to each tank. If this is not possible due to other limitations, inclusion of restriction orifices to regulate flow to each tank should be considered. An equalizing line on the back end of the tanks to other destinations is usually relied upon, but are often under-sized. The same considerations should be made for the liquid lines for emptying the vessel, if different piping connections are used for this purpose.

When filling bullets or tanks simultaneously in parallel, the consideration of vaporization in the piping before entering the tanks should be considered. For example, if filling horizontal bullets from an underground header, and a truck is off-loading higher vapor pressure material into the bullets than what is currently stored in the bullets, then vaporization in the header feeding the bullets can occur. If the header underground has a simple riser to each tank, then the vapors will preferentially to go to the first riser experienced in the piping network, and the vapors will flow primarily to the first tank being filled. There-

FIG. 6-22

Ambient Temperature Vapor Recovery Cycle



fore, design of the main header should consider horizontal or bottom-tees off the header to each tank to promote better distribution of the vapor/liquid mixture to tanks. Vapor equalizing lines between the tanks may be considered for unequal vapor flow to each tank. This may require oversizing the vapor lines as compared to the expected operation of the vessel receiving equal amounts of liquid and vapor.

Consideration in the layout of piping systems for tank farms with multiple products, will need to consider operational flexibility. For example a tank that is currently being used to store gasoline, may be needed to be taken out of service for extended maintenance, so a different tank will be required to handle that product during an interim period. This generates complex valve headers that must be properly isolated to prevent overfilling situations and product mixing. It is not uncommon to utilize double isolation valves, such as expanding gate, or expanding plug valves in critical specification applications.

The Hortonsphere vessel permits the storage of a large volume in one unit with only one set of pipe connections and fittings. This can be advantageous as compared to providing multiple vessels and piping connections. A battery of cylindrical tanks will generally occupy about four times more ground space than the same volume of storage in a Hortonsphere vessel. This factor is an important consideration in many locations where land values are high and space is at a premium.

The Hortonsphere vessel has less surface area for a given capacity than a container of any other shape. It is also true that the larger it is, the less its surface area per unit of volume. For these reasons, the liquid stored in a Hortonsphere vessel of large capacity changes temperature more slowly than in small vessels. Since the required operating pressure is a function of the temperature, the internal pressure in a large Hortonsphere vessel for liquid storage is less likely to exceed the setting of the relief valve during short periods of extremely hot weather. A large Hortonsphere vessel is, therefore, more efficient in preventing loss of vapors from a given volatile liquid than a smaller one designed for the same working pressure.

The larger units of storage are also more desirable because the cost per unit of capacity is less. Having less surface area, they provide a structure that is more economical to paint and maintain. The cost of insulation, when required, is also lower per barrel of capacity.

Hortonsphere vessels for liquid storage are commonly built in the capacities shown in Fig. 6-23. Intermediate or larger sizes and pressures can be supplied if desired.

Gauging Tables

A gauging table defines the non-linear relationship between level and contained volume. Tables can be furnished for any vessel to compensate for shape (Spheres and Bullets) and fabrication inconsistencies (Large crude tanks).

Gauging tables are of specific importance when performing custody measurements based on liquid level variations, in which case the gauging table is usually verified by a third party and “proving meter”.

PARTIAL VOLUMES IN STORAGE TANKS

The volume or size of a storage tank is determined by the configuration of the tank that is used (horizontal or vertical cylinder, sphere, rectangle). Each configuration uses different formulas for determining the total and partial volumes. Figs. 6-24 through 6-30 can be used to determine total and partial volumes in most common storage tanks.

FIG. 6-23

Hortonsphere Vessels for Liquid Storage

Nominal Capacity (Barrels)	Diameter (Ft-In)	ASME VIII Division 1 Pressure (psi)	ASME VIII Division 2 Pressure (psi)	Actual Volume (Ft^3)	Inside Surface Area (Ft^2)
1,000	22-3	380	532	5,768	1,555
1,500	25-6	327	456	8,682	2,043
2,000	28-0	306	432	11,494	2,463
2,500	30-3	282	399	14,494	2,875
3,000	32-0	266	377	17,157	3,217
4,000	35-3	240	341	22,934	3,904
5,000	38-0	222	315	28,731	4,536
6,000	40-6	207	295	34,783	5,153
7,500	43-6	191	273	43,099	5,945
10,000	48-0	171	246	57,906	7,238
12,000	51-0	160	230	69,456	8,171
15,000	54-9	147	213	85,931	9,417
20,000	60-6	131	190	115,948	11,499
25,000	65-0	120	175	143,793	13,273
30,000	69-0	111	163	172,007	14,957
40,000	76-0	98	145	229,847	18,146
50,000	81-10	89	132	286,939	21,038

H_4 (Nozzle) = 1.5 ft

H_5 (Nozzle Top to Demister Bottom) = 3 ft

H_6 (Demister Thickness) = 0.5 ft

(Demister to Outlet Nozzle) = 2.75 ft min (Fig. 7-40), Use 3.0 ft

H_7 (Demister to Top Tangent) = 1.0 ft (based on 2:1 elliptical head), Fig. 6-25

Total Vessel Length = 12 ft T-T

Sizing Methodology — Vertical Separator Without Internals

Refer to "Gas-Liquid Separation Fundamentals," presented earlier in this section. A vertical separator without mist eliminating internals can be sized in a similar manner to that used for separators with internals. For applications that are gas controlled, the diameter is based on a maximum allowable terminal gas velocity. The K value used should be selected to insure massive entrainment does not occur, and a reasonable separation efficiency is achieved. The design terminal velocity can be based on the appropriate Stokes' Law, and is based on a droplet size of 250-500 micron, the gas and liquid properties, and the calculated drag coefficient, plus a safety factor. An alternative approach which is common in the industry is to base the design on a K value of approximately 0.15 ft/sec. For fluids with low surface tension at high pressure, or in other circumstances where small droplets are expected, either the target droplet size, or the design K, depending on the approach used, should be further reduced. The maximum allowable velocity is then calculated via Equation 7-11 and the area (and then diameter) calculated via Equation 7-13. The liquid accumulation section and levels can be calculated as given in Fig. 7-43. The height above the inlet nozzle is calculated as given for dimension H_5 in Fig. 7-43.

For applications that are liquid controlled, the liquid surge time will determine the vessel dimensions (height and diameter) based on economics.

See "Flare K.O. Drums", later in this section, for sizing practices for vertical drums associated with flare systems.

Sizing Methodology — Two Phase Horizontal Separator with a Hanging Mesh

Horizontal separator drums with hanging mesh pads are sized so that the diameter and length are sufficient to provide the proper gas velocity through the vessel and mist eliminator and to provide the required liquid volume. The vapor space is a function of the gas flow area, and the settling length required to settle the majority of the droplets upstream of the mist eliminator (See Equation 7-14) and to minimize re-entrainment from the liquid surface (See Equations 7-9, 7-10, and Figs 7-9 and 7-37). The liquid volume required is determined by the sum of the surge volumes, and/or the required retention time, and/or a degassing criterion. The mist eliminator is sized based on the Souders–Brown equation with appropriate de-rating (See Equation 7-11). Adequate space must be provided above the mist eliminator, and between the HHLL and the mist eliminator to insure an even velocity profile through the mist eliminator. Other considerations that affect the required vessel diameter and length are the height required to install the feed inlet device above the liquid level, and the need for minimum space between the maximum level and the top of the vessel. In order to size the separator, the vessel diameter and length are adjusted to achieve an optimum (generally lowest weight but practical layout) which meets all of these criteria. Typically a length to diameter (L/D) ratio of three is used as the starting point, and the length to diameter ratio adjusted upward as required.

Example Problem — Two Phase Horizontal Separator with a Hanging Mesh

Example 7-3 — Determine the configuration and size of a separator vessel to provide surge upstream of a process unit and to separate liquids and gas. The stream is 25,000 bpd of condensate and 15 MMSCFD of gas (MW = 17.55). Process conditions are as follows:

Operating conditions —

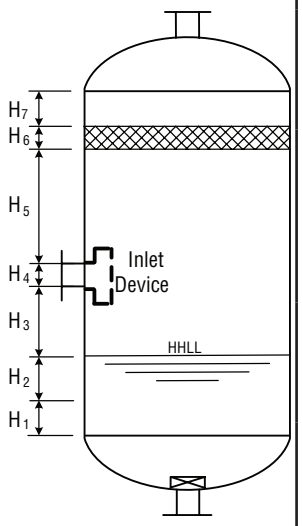
Operating temperature = 120 °F,
Operating pressure = 250 psig

Gas flowrate = 15 MMSCFD (28,910 lb/hr)

Liquid flowrate = 25,000 bpd (268,200 lb/hr)

FIG. 7-43
Level Distances for a Vertical Vessel

Dim	Section	Distance
H_1	Bottom Tangent to LLLL	12-18 in, can be lower depending on instrument mount
H_2	LLLL to HHLL	Per required surge time or retention time
H_3	HHLL to Feed Nozzle Bottom	1 ft - 2 ft for diffuser 0.25 D for all other inlet devices, with 2 ft minimum
H_4	Nozzle Diameter	Larger of piping size or velocity head criteria
H_5	Nozzle Top to Mist Eliminator Bottom	1 ft to 3 ft for diffuser 0.5D for all other inlet devices
H_6	Mist Eliminator	4 in to 6 in typical
H_7	Mist Eliminator to Top Tangent	6 in minimum or per Fig. 7-40



Physical properties —

ρ_g = 0.774 lb/ft^3, μ_g =0.012 cP, ρ_l = 44.58 lb/ft^3, μ_l = 0.573 cP, ρ_m = 6.87 lb/ft^3

Project surge times for this application —

LLLL to LLL = 1 min, LLL to HLL = 5 min, HLL to HHLL = 1 min

Configuration — Select a horizontal drum with a hanging mesh for this application due to high liquid rate, 5 minute surge time, and relatively small gas flow rate.

Preliminary vessel size — Calculate a preliminary vessel size as a starting point to calculate partially filled cylinder areas/volumes. Assume required liquid surge volume controls separator sizing (as opposed to gas flowrate):

- Use 70% full (typical maximum) to HHLL required total surge time of 7 minutes, with 3:1 L/D, and 18 in. LLLL
- Assume 10% of volume for min liquid level (LLLL) and ignore volume in heads, therefore 60% of volume is used for surge time

Total vessel volume:

$$\frac{\left(268{,}200\ \frac{\text{lb}}{\text{hr}} \cdot \frac{1\ \text{hr}}{60\ \text{min}} \cdot \frac{1\ \text{ft}}{44.58\ \text{lb}} \cdot 7\ \text{min}\right)}{0.60} = 1170\ \text{ft}^3$$

At 3:1 L/D:

$$\text{volume} = 1170\ \text{ft}^3 = 3 \cdot D \cdot \pi \left(\frac{D^2}{2}\right) \Rightarrow D = 7.9\ \text{ft}$$

Therefore preliminary size is 8 ft ID × 24 ft T/T

Liquid level calculation —

LLLL = 18 in. (per Fig. 6-26, interpolated fraction of cylinder volume at H/D = 1.5/8 = > 0.1298)

Surge volume (LLLL to HHLL) =

$$\left(750\ \frac{\text{gal}}{\text{min}} \cdot 7\ \text{min}\right) = 5{,}250\ \text{gal}$$

$$\text{Volume fraction at HHLL} = \frac{5250\ \text{gal}}{8750\ \text{gal}} + 0.1298 = 0.7298$$

From Fig. 6-26 @ vol. fraction = 0.7298, H/D ~ 0.685 (hence, 70% was an acceptable preliminary assumption)

Therefore H = HHLL = 5.48 ft, Use 5.5 ft

Volume fraction at NLL (assume as 3.5 min above LLLL) =

$$\frac{\left(750\frac{\text{gal}}{\text{min}}\right) \cdot 3.5\ \text{min}}{8750\ \text{gal}} + 0.1298 = 0.4298$$

From Fig. 6-26 @ vol. fraction = 0.4298, H/D ~ 0.445 = > NLL=3.56 ft or 3 ft 7 in

Check gas velocity @HHLL in gravity separation section —

$$A = (1 - 0.7298)\,\pi \left(\frac{8\ \text{ft}}{2}\right)^2 = 13.6\ \text{ft}^2$$

$$V = \frac{28{,}910\ \text{lb/hr}}{0.774\ \text{lb/ft}^3} \cdot \frac{1}{13.6\ \text{ft}^2} \cdot \frac{1\ \text{hr}}{3600\ \text{sec}} = 0.763\frac{\text{ft}}{\text{sec}}$$

Maximum vapor velocity =

$$0.40 \cdot \left(\frac{16\ \text{ft}}{10}\right)^{0.56} \cdot \sqrt{\frac{\frac{44.58\ \text{lb}}{\text{ft}^3} - \frac{0.774\ \text{lb}}{\text{ft}^3}}{\frac{0.774\ \text{lb}}{\text{ft}^3}}} = \frac{3.915\ \text{ft}}{\text{sec}} \quad \text{(Equation 7-11)}$$

2/3 of the vessel length (L) assumed for the gravity separation section. Since the maximum vapor velocity is greater than the actual vapor velocity, the gas area above HHLL is acceptable.

Check de-gassing —

At these surge times de-gassing is not an issue.

Calculate mesh pad area & height —

Utilizing Equation 7-11 for vertical flow through the hanging mesh:

$K = 0.35\ \frac{\text{ft}}{\text{sec}}$ for high efficiency mist eliminator

0.867 (derating factor) — interpolation for actual pressure (Fig. 7-38)

$$V_{max} = (0.35 \cdot 0.867)\sqrt{\frac{44.58 - 0.774}{0.774}} = 2.28\ \frac{\text{ft}}{\text{sec}} \quad \text{(Equation 7-11)}$$

$$A_{mesh} = \frac{\frac{28{,}910\ \frac{\text{lb}}{\text{hr}}}{0.774\ \frac{\text{lb}}{\text{ft}^3}} \cdot \frac{1\ \text{hr}}{3600\ \text{sec}}}{2.28\ \frac{\text{ft}}{\text{sec}}} = 4.55\ \text{ft}^2 \quad \text{(Equation 7-13)}$$

This is approximately a 26 in by 26 in square mesh pad.

Similar to Fig. 7-40, based on a 45° angle from the edge of the mesh pad to the edge of the outlet nozzle, the height above the mesh pad to the nozzle should be ½ of the mesh pad width minus ½ of the nozzle diameter. Use 1 ft height above mesh pad.

Inlet device selection —

Inlet device can be diffuser, half open pipe, or elbow at these liquid/gas rates. Diffuser is preferred.

Nozzle sizing —

Inlet Piping = 10 in Sch. 40 (ID = 10.02 in), based on acceptable line sizing criteria, and inlet nozzle size equals pipe size.

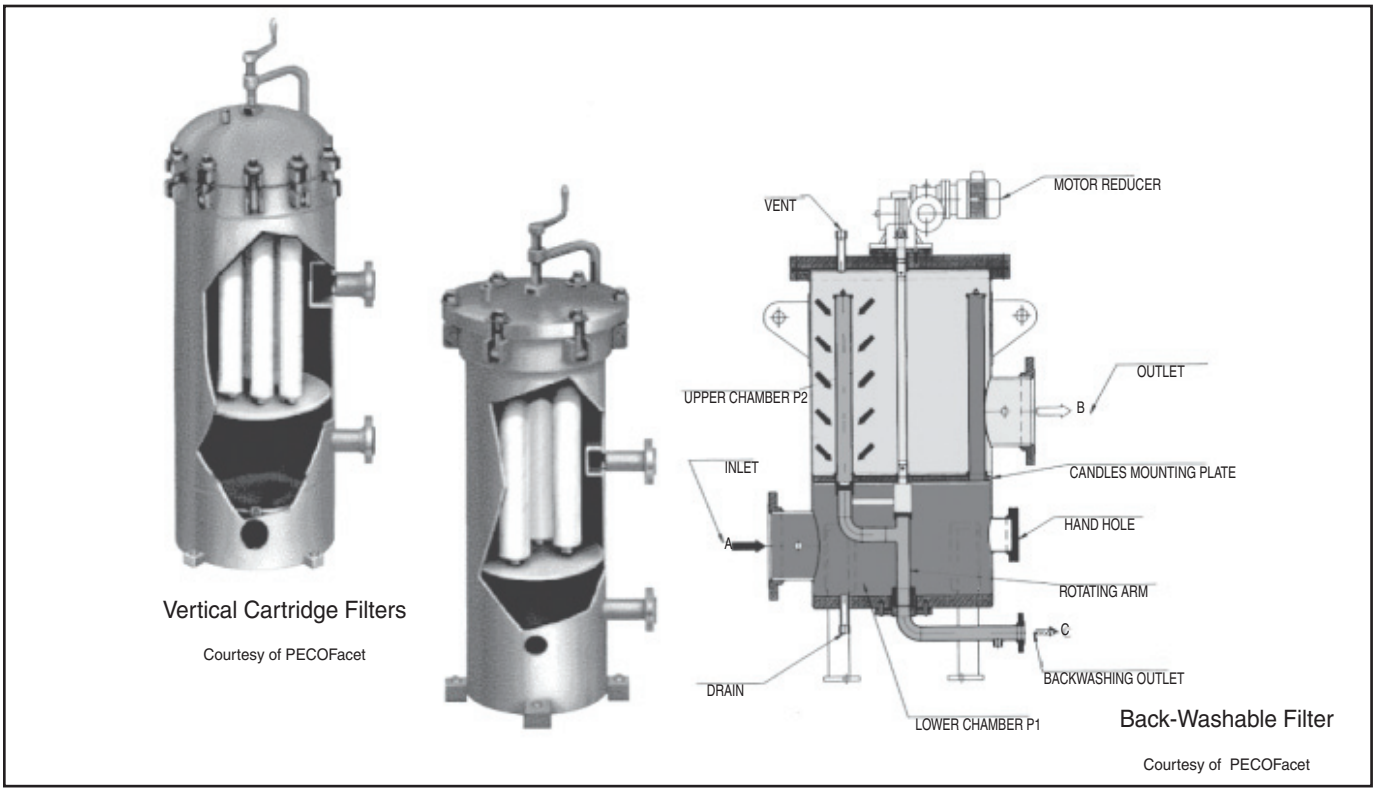
Check inlet velocity head —

$$V = \left(\frac{(268{,}200 + 28{,}910)\frac{\text{lb}}{\text{hr}} \cdot 144\ \text{in}^2 \cdot 1\ \text{hr}}{6.87\ \frac{\text{lb}}{\text{ft}^3} \cdot 1\ \text{ft}^2\,\pi\left(\frac{10.02}{2}\right)^2\ \text{in}^2 \cdot 3600\ \text{sec}}\right) = 21.9\ \frac{\text{ft}}{\text{sec}}$$

Using Equation 7-15:

$$J = (\rho_m V^2) = (6.87 \cdot 21.9^2) = 3307\ \frac{\text{lb}}{\text{ft} \cdot \text{sec}^2} < 6000\ \frac{\text{lb}}{\text{ft} \cdot \text{sec}^2}$$

FIG. 7-51
Cartridge Filters



the filtration of solids and liquids from hydrocarbon vapors and the filtration of solids from air intakes of engines and turbine combustion chambers. See Fig. 7-51 for a typical filter housing. These cartridges come in generally two types: pleated and depth. Pleated cartridges are generally better when removing hard particles. Depth filters generally work better with deformable and shear sensitive contaminants. Traditionally the filter cartridges have been 2.5 to 3 in OD. There are currently a large variety of element configurations offered from 6 in OD and down. Some filters are arranged to flow through the elements from outside to inside and some flow inside to outside.

Metal filter cartridges are also offered. These come in three types: wedge wire, woven mesh and sintered metal. These are generally used in extreme conditions (either from temperature or chemical compatibility) or in a cleanable form. Some may be cleaned in process through backwashing and some may be cleaned by removing the elements from service and cleaning. Back washable filters come in many types. One type is shown in Fig. 7-51.

Pre-coat filters find use some use in the gas processing industry; however, they are complicated and require considerable attention. Most frequent use is in larger amine plants where frequent replacement of cartridge elements is considerably more expensive than the additional attention required by pre-coat filters. The pre-coat filter consists of a coarse filter medium over which a coating has been deposited. In many applications, the coating is one of the various grades of diatomaceous earth that is mixed in a slurry and deposited on the filter medium. During operation, additional coating material is often added continuously to the liquid feed. When the pressure drop across the filter reaches a specified maximum, the filter is taken offline and backwashed to remove the spent coating and accumulated solids. Applications for pre-coat filters include water treatment for water facilities as well as amine filtration to reduce foaming. Typical designs for amine plants use 1-2 gpm flow per square foot of filter surface area. Sizes range upward from 10-20% of the full stream rates.

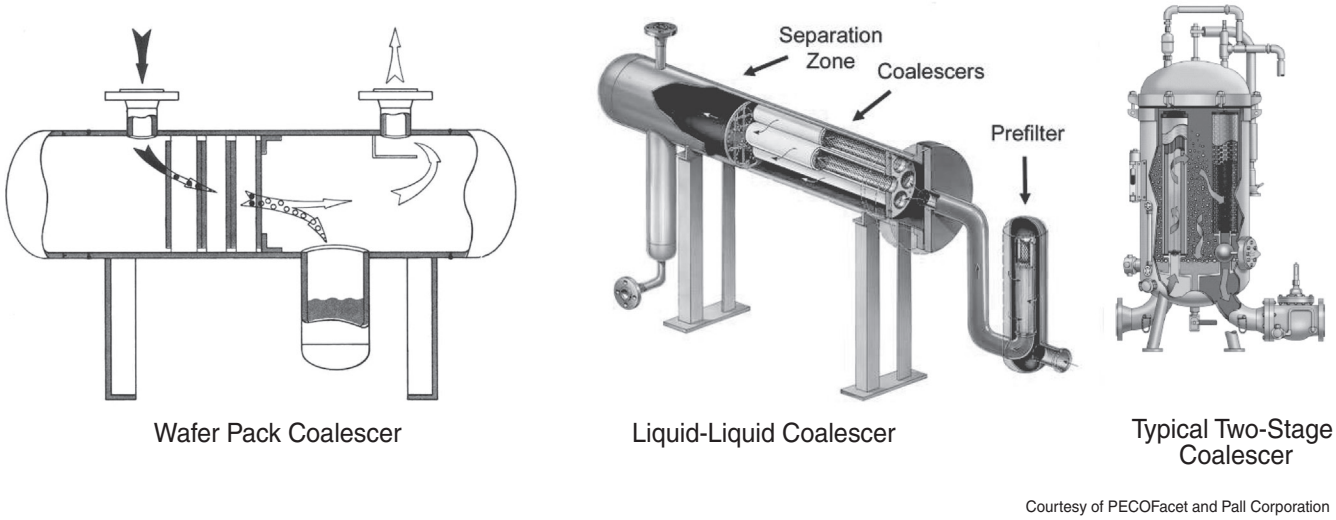
Filtration Equipment Removal Ratings

There is no commonly accepted standard for rating filter cartridges. Some common tests for rating filters are listed in the Filter Testing Standards on page 7-47.

Manufacturer's specified removal ratings generally fall into two categories: nominal rating and absolute rating. Generally a nominal rating means that the filter will remove approximately 90% of the contaminants above a specified size (e.g. 10 μm). (Nominal ratings can vary from 50% to 95% depending upon manufacturer and filter type.) With a nominally rated filter it is possible to have particles much larger than the nominal size in the effluent (e.g. 30 μm to 100 μm).

Absolute ratings can be determined by the NFPA standard as to the largest hard particle that will pass through the filter, or by one of the other test methods referred to above. The rating can be stated in two ways: filter efficiency or Beta Ratio. These two terms are related. Efficiency rating is the number of particles (or number of particles by weight) removed by the filter above a specified size. Beta Ratio, ß, is the number of particles in the influent of the filter at or above the specified micron size divided by the number of particles in the effluent of the filter

FIG. 7-52
Liquid-Liquid Coalescers



at or above the same micron size. This results in the following equation for relating the ß value to removal efficiency:

$$\% \text{ removal} = \frac{(\beta - 1)}{\beta \cdot 100} \qquad \text{Eq 7-22}$$

Most "absolute" filters typically have a β of 5,000 (99.98% removal) or 10,000 (99.99% removal). However, some manufacturers will provide absolute ratings based upon a efficiency of 99% and above (β greater than 100).

When comparing and evaluating filter ratings it is important to realize the filters are rated using standard test methods using a hard test dirt or beads. While these methods should give a good indication of actual performance in a process, the actual contaminant in the process may not be similar to the test contaminant.

Liquid/Liquid Coalescer Separators — Supplier Design

Liquid / Liquid coalescers are mechanical devices used primarily for purifying hydrocarbon products by removing emulsified water and solids. The phase separator removes free water. The dissolved water, which is in solution, remains in the hydrocarbon product. This is an important point to remember in the design and application of liquid / liquid coalescers. Interfacial tension (IFT), density, viscosity and temperature are important factors in phase separation. The basics of liquid / liquid separation have been covered earlier in this section.

The basic premise of all liquid / liquid coalescers is to take an emulsion or fine droplets and break the emulsion and grow these droplets to sufficient size that the discontinuous phase will separate from the continuous phase by gravity. In order to accomplish this, the coalescer media first breaks the emulsion and then agglomerates the discontinuous liquid into large droplets. Once these large droplets form, gravity causes the heavier phase to settle to the bottom and the lighter phase to float to the top. If the discontinuous phase is heavier than the continuous phase (water being removed from hydrocarbon for example), the droplets will settle into the vessel sump for removal. If the discontinuous phase is lighter than the continuous phase (hydrocarbon being removed from water for example), the droplets will float to the top of the vessel for removal. If high efficiency separation is not required, the coalescing can be performed using a packed bed or wafer pack. Fig. 7-52 shows a wafer pack coalescer. The vessels are horizontal. The wafer pack may typically be excelsior, fiberglass, synthetic media, or stainless steel.

High efficiency separation of water from hydrocarbons is generally accomplished using coalescer elements. In some cases two stage vessels designed like the EI 1581 Aviation Fuel coalescers will be used. These can be either vertical or horizontal. Both configurations are shown in Fig. 7-52. The fluid to be coalesced enters the vessel and passes through the coalescing elements first. The flow through this element is from inside to outside. The emulsion is broken and the fine liquid droplets of the immiscible water phase are coalesced into large droplets that are separated by settling. Because of small pores in this element it will also filter out solid particles. The filtered and coalesced liquid then flows outside to inside through the second stage separation element. This further separates the immiscible phase. The separation element, being selectively wetted by the continuous hydrocarbon phase is hydrophobic and impervious to the flow of water. Water droplets literally "bounce off" the element. These separator elements are generally made from silicone impregnated cellulose, fluorocarbon, or some other synthetic hydrophobic media. After flowing through the second stage element, only clean liquid, free of suspended water and solids, exits the unit.

Because of the cost of the coalescing elements and the fact that they are not optimally designed to remove particulates, if there is a significant load of solid particles (greater than 0.5 ppm) it is advisable to use a pre-filter. Fig. 7-52 shows a liquid / liquid coalescer with a prefilter.

One method for accounting for suction and discharge valve losses is to reduce the volumetric efficiency by an arbitrary amount, typically 4%, thus modifying Equation 13-14 as follows:

$$VE = 96 - r - C\left[\frac{Z_s}{Z_d}\ (r^{1/k}) - 1\right] \qquad \textbf{Eq 13-15}$$

When a non-lubricated compressor is used, the volumetric efficiency should be corrected by subtracting an additional 5% for slippage of gas. This is a capacity correction only and, as a first approximation, would not be considered when calculating compressor horsepower. The energy of compression is used by the gas even though the gas slips by the rings and is not discharged from the cylinder.

If the compressor is in propane, or similar heavy gas service, an additional 4% should be subtracted from the volumetric efficiency. These deductions for non-lubricated and propane performance are both approximate and, if both apply, cumulative.

Volumetric efficiencies for "high speed" separable compressors in the past have tended to be slightly lower than estimated from Equation 13-14. Recent information suggests that this modification is not necessary for all models of high speed compressors.

In evaluating efficiency, horsepower, volumetric efficiency, etc., the user should consider past experience with different speeds and models. Larger valve area for a given swept volume will generally lead to higher compression efficiencies.

Equivalent Capacity

The net capacity for a compressor, in cubic feet per day at 14.4 psia and suction temperature, may be calculated by Equation 13-16a which is shown in dimensioned form:

$$MMcfd = \frac{\left[PD\ \frac{ft^3}{min}\right] \cdot 1440\ \frac{min}{d} \cdot \left[\frac{VE\%}{100}\right] \cdot P_s\ \frac{lb}{in^2} \cdot 10^{-6}\ \frac{MMft^3}{ft^3} \cdot Z_{14.4}}{14.4\ \frac{lb}{in^2} \cdot Z_s} \qquad \textbf{Eq 13-16a}$$

which can be simplified to Equation 13-16b when $Z_{14.4}$ is assumed to equal 1.0.

$$MMcfd = \frac{PD \cdot VE \cdot P_s \cdot 10^{-6}}{Z_s} \qquad \textbf{Eq 13-16b}$$

For example, a compressor with 200 cu ft/min piston displacement, a volumetric efficiency of 80%, a suction pressure of 75 psia, and suction compressibility of 0.9 would have a capacity of 1.33 MMcfd at 14.4 psia. If compressibility is not used as a divisor in calculating cu ft/min, then the statement "not corrected for compressibility" should be added.

In many instances the gas sales contract or regulation will specify some other measurement standard for gas volume. To convert volumes calculated using Equation 13-16 (i.e. at 14.4 psia and suction temperature) to a P_L and T_L basis, Equation 13-17 would be used:

$$MMscfd\ at\ P_L, T_L = (MMcfd\ from\ Eq\ 13\text{-}16)\ \left(\frac{14.4}{P_L}\right)\left(\frac{T_L}{T_s}\right)\left(\frac{Z_L}{Z_s}\right) \qquad \textbf{Eq 13-17}$$

Discharge Temperature

The temperature of the gas discharged from the cylinder can be estimated from Equation 13-18, which is commonly used but not recommended. (Note: the temperatures are in absolute units, °R or K.) Equation 13-32 gives better results.

$$T_d = T_s\ (r^{(k-1)/k}) \qquad \textbf{Eq 13-18}$$

The discharge temperature determined from Equation 13-18 is the theoretical value. It neglects heat from friction, irreversibility effects, etc., and is therefore too low,

Rod Loading

Each compressor frame has definite limitations as to maximum load-carrying capacity. The load-carrying of a compressor involves two primary considerations: rod loading and horsepower.

The horsepower rating of a compressor frame is an indicator of the supporting structure and crankshaft to withstand the torque (turning force) and the loads. Rod loads are established to limit the static and dynamic loads on the frame, crankshaft, connecting rod, frame, crosshead, piston rod, bolting, and projected bearing surfaces.

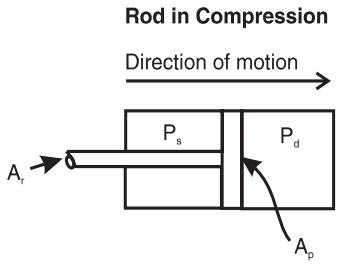
Rod loads are calculated differently based upon the compressor manufacturer. Some manufacturers use flange-to-flange pressures while others use internal pressures and others may use combined rod loads (gas load plus inertia load).

Many manufacturers also require a load reversal of the load at the crosshead pin. This load reversal is required so that lube oil can lubricate and cool the crosshead pin and bushings.

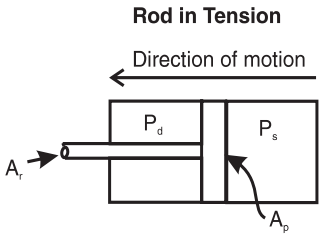
Gas rod loadings may be calculated by the use of Equations 13-19 and 13-20.

$$\text{Load in compression} = P_d A_p - P_s (A_p - A_r) = (P_d - P_s) A_p + P_s A_r \qquad \textbf{Eq 13-19}$$

$$\text{Load in tension} = P_d (A_p - A_r) - P_s A_p = (P_d - P_s) A_p - P_d A_r \qquad \textbf{Eq 13-20}$$



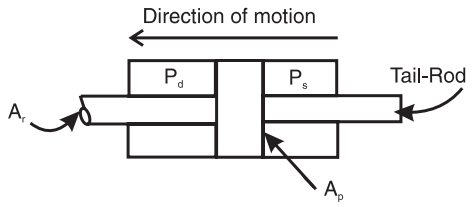
Using Equations 13-19 and 13-20, a plus value for the load in both compression and tension indicates a reversal of loads based on gas pressure only. Inertial effects will tend to increase the degree of reversal.



The true rod loads would be those calculated using internal cylinder pressures after allowance for valve losses. Normally, the operator will know only line pressures, and because of this, manufacturers generally rate their compressors based on line-pressure calculations.

A further refinement in the rod-loading calculation would be to include inertial forces. While the manufacturer may consider inertial forces when rating compressors, useful data on this point is seldom available in the field. Except in special cases, inertial forces are ignored.

A tail-rod cylinder would require consideration of rod cross-section area on both sides of the piston instead of on only one side of the piston, as in Equations 13-19 and 13-20.



Detailed Horsepower Calculation

A more detailed calculation of reciprocating compressor power requirements can be performed using the following equation:

$$\text{BHP/stage} = 3.03 \cdot Z_{avg} \cdot [Q_g T_s/E] \cdot (k/(k\text{-}1)) \cdot \left(\frac{P_L}{T_L}\right) \cdot [(P_d/P_s)^{((k-1)/k)} - 1] \qquad \textbf{Eq 13-21}$$

The total horsepower for the compressor is the sum of the horsepower required for each of the stages that are utilized. For multistage machines an allowance should be made for the interstage pressure drop associated with piping, cooler, scrubber, etc., typically 5–10 psi.

Procedure

1. Calculate overall compression ratio ($r_t = P_{dfinal}/P_s$).
2. Calculate the compression ratio per stage, r, by taking the s root of r_t, where s is the number of compression stages. The number of stages, s, should be increased until the ratio per stage, r, is < ~ 4. This should generally result in stage discharge temperatures of < 300 °F depending on the interstage cooler outlet temperature assumed.
3. Multiplying r by the absolute suction pressure of the stage being considered will give you discharge pressure of the stage.
4. Calculate the horsepower required for the stage using Equation 13-21.
5. Subtract the assumed interstage pressure loss from the discharge pressure of the preceding stage to obtain the suction pressure for the next stage.
6. Repeat steps 4 and 5 until all stages have been calculated.
7. Sum the stage horsepowers to obtain the total compressor power required.

Example 13-2 — Compress 2 MMscfd of gas measured at 14.65 psia and 60 °F. Intake pressure is 100 psia, and intake temperature is 100 °F. Discharge pressure is 900 psia. The gas has a specific gravity of 0.80 (23 MW). What is the required brake horsepower, assuming a high speed compressor?

Assume E = 0.82

1. Compression ratio is

   $$\frac{900 \text{ psia}}{100 \text{ psia}} = 9$$

   This would be a two-stage compressor; therefore, the ratio per stage is $\sqrt{9}$ or 3.

2. 100 psia x 3 = 300 psia (1st stage discharge pressure). Suction pressure to second stage is given by

   300 psia – 5 = 295 psia

   Where the 5 psi represents the pressure drop between first stage discharge and second stage suction.

   $$\frac{900 \text{ psia}}{295 \text{ psia}} = 3.05 \text{ (compression ratio for 2nd stage)}$$

   It may be desirable to recalculate the interstage pressure to balance the ratios. For this sample problem, however, the first ratios determined will be used.

3. From Fig. 13-8 a gas with specific gravity of 0.8 at 150 °F would have an approximate k of 1.21. For most compression applications, the 150 °F curve will be adequate. This should be checked after determining the average cylinder temperature.

4. Discharge temperature for the 1st stage may be obtained by using Fig. 13-32 or solving Equation 13-18. For a compression ratio of 3, discharge temperature = approximately 220 °F. Average cylinder temperature = 160 °F.

5. In the same manner, discharge temperature for the second stage (with r = 3.05 and assuming interstage cooling to 120 °F) equals approximately 244 °F. Average cylinder temperature = 182 °F.

6. From the physical properties section (Section 23), estimate the compressibility factors at suction and discharge pressure and temperature of each stage.

   1st stage: $Z_s = 0.98$, $Z_d = 0.97$, $Z_{avg} = 0.975$

   2nd stage: $Z_s = 0.94$, $Z_d = 0.92$, $Z_{avg} = 0.93$

7. Calculate the horsepower required for the first and second stages from Equation 13-21:

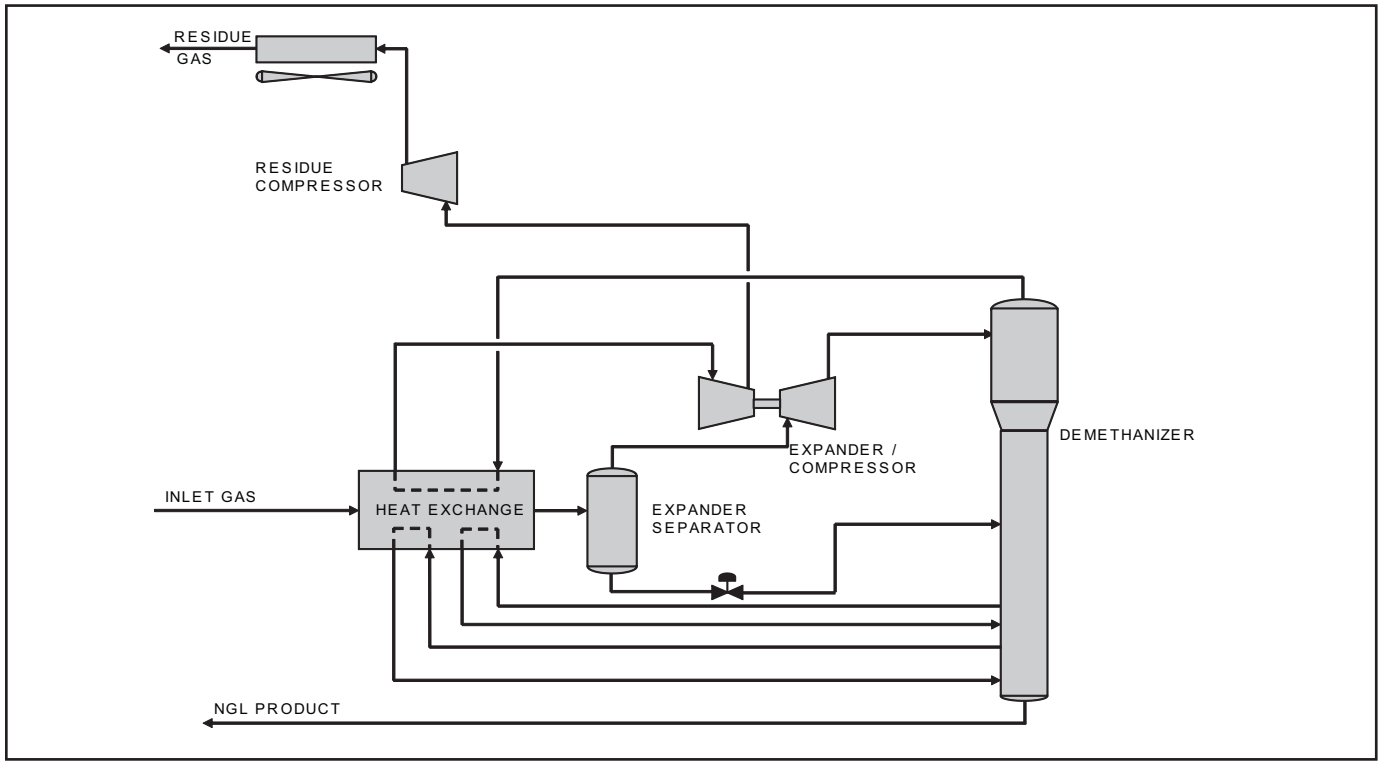
$$\text{BHP for 1st stage} = 3.03 \cdot (0.975) \cdot [2 \cdot 560/0.82] \cdot [1.21/(1.21-1)] \cdot \left(\frac{14.65}{520}\right) \cdot [(300/100)^{((1.21-1)/1.21)} - 1] = 137.6$$

$$\text{BHP for 2nd stage} = 3.03 \cdot (0.93) \cdot [2 \cdot 580/0.82] \cdot [1.21/(1.21-1)] \cdot \left(\frac{14.65}{520}\right) \cdot [(900/295)^{((1.21-1)/1.21)} - 1] = 138.2$$

Total BHP required = 137.6 + 138.2 = 275.8

FIG. 16-23

Simple Turboexpander Process for Ethane Recovery



The expander feed is sent to the tower several stages below the top of the column. Vapor rising from the expander feed will contain a significant amount of ethane, which is condensed by the colder reflux stream.

In this process the column overhead is warmed up and the column pressure is increased significantly without sacrificing liquid recovery, due to the subcooled reflux. The cold separator now operates at a much warmer temperature, well away from the system critical. The flow rate through the expander is less than in a non-refluxed design, but the vapor is much warmer, so the expander actually produces more horsepower for the GSP design than for a non-refluxed design. The residue compression power is much less at a given ethane recovery level than for the non-refluxed design so the non-refluxed design is no longer used.

Example Comparison of Ethane Recovery Designs

The hypothetical example presented earlier for propane recovery is presented in Fig. 16-25, but for ethane recovery to demonstrate the differences in ethane recovery for several ethane recovery designs. The design basis assumptions from the propane plus recovery comparison are used here with the additional constraint of 2.0% max methane/ethane ratio for the bottoms product. For ethane recovery, only the J-T, simple turboexpander, and GSP options are tabulated since the other processes discussed are propane recovery designs.

RSV High Ethane Recovery Process

The maximum ethane recovery for the GSP design is limited by the ethane content of the reflux. As the reflux has the same composition as the cold separator vapor it contains some ethane. A portion of this ethane will flash, thus generally limiting the ethane recovery to around 93%, regardless of the residue compressor power. A leaner reflux stream is needed to achieve higher recovery.

One method to obtain lean reflux is to recycle a portion of the residue gas, after recompression, back through the inlet heat exchange, subcool it and flash to the top of the column. The expander outlet stream is then sent a few trays down the column. This residue reflux design can effectively achieve very high ethane recoveries. Ortloff combined this successful and proven approach and the GSP design in the Recycle Split Vapor (RSV) process, shown in Fig. 16-26. Up to 99% ethane recovery can be achieved efficiently by optimizing the recycle flow so as to capture the ethane from the equilibrium losses at the GSP reflux feed point. Tolerance to CO_2 is higher than with the GSP design.

STANDARD NGL RECOVERY PLANTS

Several companies offer complete pre-engineered modular NGL recovery plants in the form of package units. Proven designs are used, based on open art technology, licensed technology or the supplier's own process technology. Plant performance is assessed for the range of feed gas conditions to choose the best "standard" design for the specific project requirements.

The pre-engineered modular approach is especially applicable to smaller-scale plants, that can be more easily modularized and transported, and when revenue earned from earlier start-up and production justifies any reduction in NGL recovery by using a "standard" design compared to a customized design.

By using a "standard" package plant, engineering is greatly reduced so equipment orders can be placed much earlier, changes to equipment layout are avoided or minimized and module fabrication can commence. Plant modules are built in fabrication shops providing clean conditions and high quality control, and transported to the plant site. On-site construction activity and time can be much less than with "stick-built" construction.

Modular plants are especially appropriate for remote sites, where construction costs are high, such as for shale gas developments, and for plant expansion for future gas supplies.

FIG. 16-24
GSP Process for Ethane Recovery

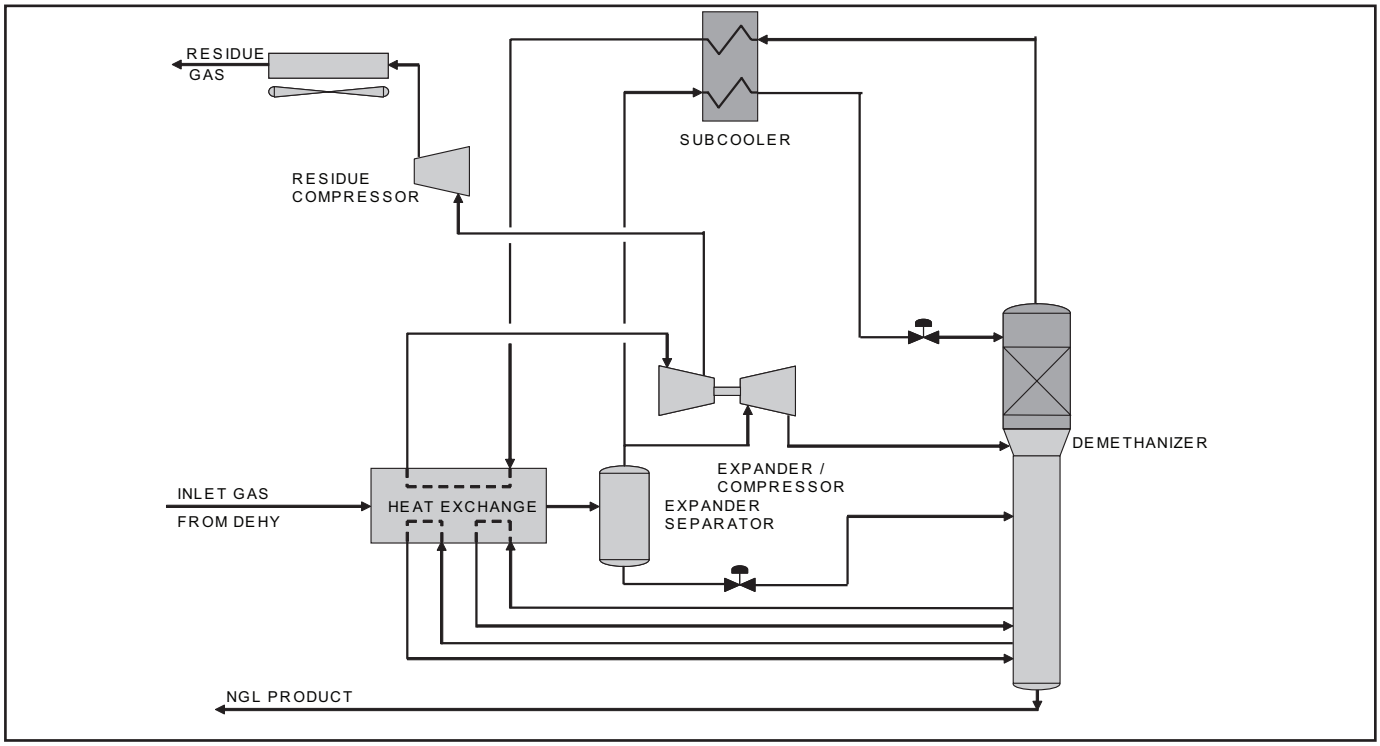


FIG. 16-25
Process Design Comparison for Ethane Recovery

		A	B	C
Process Design		**J-T**	**SIMPLE**	**GSP**
Calculated Ethane Recovery	%	8.1%	59.3%	84.0%
Calculated Propane Recovery	%	27.1%	93.8%	98.7%
Calculated Butanes Recovery	%	56.5%	99.2%	99.8%
Total Liquids Recovered	BPD	7,148	17,316	20,149
Expander Power	HP	0	4,150	3,780
Column Overhead Temperature	°F	–20	–118	–138
Column Bottoms Temperature	°F	236	94	85
Column Reboiler Duty	MMBTU / hr	7.0	7.3	6.3
Residue Gas Flow Rate	MMSCFD	241	225	221

Notes:

1. C_2/C_3 Ratio set at 2.0 mol% all designs
2. Inlet Gas Flow 250 MMSCFD, 6.6% Ethane, 2.8% Propane, 110 °F, 1000 PSIG
3. Residue Delivery 120 °F, 1000 PSIG
4. Residue Compressor Power set at 12,900 HP

SECTION 26

Members

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The following is a listing of the members of GPSA. Please contact them directly for further information. Behind this listing of members, the GPSA companies are classified by the type of services and supplies that they provide to the industry. Services begin on page 26-13; Supplies begin on page 26-25.

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Accurate Gas Products, LLC 116 Board Road Lafayette, LA 70508 http://www.accurategasllc.com	337-269-1217
Accurate Lab Audits, LLC 302 N. Coreil Street - P.O. Box 248 Ville Platte, LA 70586 http://www.accuratelabaudits.com	337-280-1003
AECOM 6200 S. Quebec Street Greenwood Village, CO 80111 http://www.aecom.com	303-694-2770
Aeon PEC 505 Aero Drive Shreveport, LA 71107 http://www.aeonPEC.com	318-221-0122
AF Global 945 Bunker Hill Road, Suite 500 Houston, TX 77024 http://www.afglobalcorp.com	713-393-4200
Afton Pumps, Inc. 7335 Ave. North Houston, TX 77011 http://www.aftonpumps.com	713-923-9731
Airgas 9810 Bay Area Boulevard Pasadena, TX 77507 http://www.airgas.com	866-935-3370
Alfa Laval Niagara 91 Sawyer Avenue Tonawanda, NY 14150 http://www.niagarablower.com	716-875-2000

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Alliance Source Testing 5530 Marshall Street Arvada, CO 80002 http://www.stacktest.net	303-420-5949
Alpine Site Services 10875 Dover Street, Unit 1100 Westminister, CO 80021 http://www.alpinesites.com	303-420-0048
AMACS Process Tower Internals 14211 Industry Street Houston, TX 77053 http://www.amacs.com	713-434-0934
Ampeva Midstream, LLC 5507 Bright Timber Landing Drive Spring, TX 77386 http://www.ampeva.com	903-238-1488
Analytical Systems Keco 9515 Windfern Road Houston, TX 77064 http://www.liquidgasanalyzers.com	281-516-3950
Anguil Environmental Systems 8855 N. 55th Street Milwaukee, WI 53223 http://www.anguil.com	414-365-6400
Anvil Corporation 1675 W. Bakerview Road Bellingham, WA 98226 http://www.anvilcorp.com	360-937-0550
Aqseptence Group, Inc. 1950 Old Hwy 8 NorthWest New Brighton, MN 55112 http://www.aqseptence.com	651-636-3900
ARC Energy Equipment 308 N. Fieldspan Road Scott, LA 70583 http://www.arcenergyequipment.com	337-852-1105

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Baker Hughes, a GE company 16250 Port Northwest Drive Houston, TX 77077 http://www.engagerecip.com	844-732-4743
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Barr Engineering Co. 4300 MarketPointe Drive, Suite 200 Minneapolis, MN 55435 http://www.barr.com	800-922-4400
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Bartlett Equipment Co. 4951 S Mingo Road Tulsa, OK 74146 http://www.bartlettequipment.com	918-627-7040
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BCCK Holding 2500 N. Big Spring Midland, TX 79705 http://www.bcck.com	432-685-6095
Bennett Construction, Inc. P.O. Box 1377 Beaver, OK 73932 http://www.bennettconstruction.net	580-651-5413
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Black & Veatch Corp. 4400 Post Oak Parkway, Suite 1200 Houston, TX 77027 http://www.bv.com/oil-gas	713-961-1100
Boardman, LLC 1135 S. McKinley Avenue Oklahoma City, OK 73108 http://www.boardmaninc.com	405-634-5434
Bold Production Services, LLC 10880-A Alcott Drive Houston, TX 77043 http://www.bps-llc.com	832-320-2629
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CAM Integrated Solutions 11757 Katy Fwy, Suite 1120 Houston, TX 77079 http://www.camintegrated.com	832-533-8202
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Catalytic Combustion Corporation 311 Riggs Street Bloomer, WI 54724 http://www.catalyticcombustion.com	715-568-2882

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Catamount Constructors 1527 Cole Boulevard, Suite 100 Lakewood, CO 80401 http://www.catamountinc.com	303-679-0087
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CECA Molecular Sieves/Arkema, Inc. 900 First Avenue King of Prussia, PA 19406 http://www.arkema.com	410-424-0220
CECO-Compressor Engineering Corp. 5440 Alder Drive Houston, TX 77081 http://tryceco.com	800-879-2326
Champion Process, Inc. 5171 Ashley Court Houston, TX 77041 http://championprocess.com	281-953-9010
Charbonneau Industries, Inc. 1619 E. Richey Road Houston, TX 77073 http://www.ciactuation.com	281-209-3800
Chart Industries 8665 New Trails Drive, Suite 100 The Woodlands, TX 77381 http://www.chart-ec.com	281-364-8700
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Chiyoda Corp. Minatomirai Grand Central Tower 4-6-2, Minatomirai, Nishi-ku Yokohama, JP https://www.chiyoda-corp.com/en/	81-45-225-7601 Ext 2
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Dearing Compressor & Pump Co. 3974 Simon Road Youngstown, OH 44512 http://www.dearingcomp.com	330-599-5720
Dew Point Control, LLC P.O. Box 18887 Sugar Land, TX 77496 http://www.dewpointcontrol.com	281-265-0101
Diablo Analytical, Inc. 5141 Lone Tree Way Antioch, CA 94531 http://www.diabloanalytical.com	925-755-1005
Dickson Process Systems, Ltd. P.O. Box 60478 Midland, TX 79711 http://www.dicksonprocess.com	432-561-8594
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EnerSys Corporation 7979 S. Sam Houston Parkway West Houston, TX 77085 http://www.EnerSysCorp.com	281-598-7100
EnFlex Group 10497 Town & Country Way, Suite 700 Houston, TX 77024 http://www.enflexgroup.com	713-493-1658
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eSimulation, Inc. 17625 El Camino Real, Suite 200 Houston, TX 77058 http://www.esimulation.com	713-962-3107
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Facility & Plant Consulting, LLC 42 Edgemire Place Spring, TX 77381 http://www.facility-plant.com	936-827-0661
Federal Services, LLC 120 E. Main Street Oklahoma City, OK 73104 http://www.federalservicesllc.com	405-239-7301
FESCO, Ltd. 1100 FESCO Avenue Alice, TX 78332 http://www.fescoinc.com	361-661-7015
FES-Southwest, Inc. 19221 IH-45 South, Suite 340 Conroe, TX 77385 http://www.fessw.com	281-296-7920
Field Industries LLC 6620 Dixie Drive Houston, TX 77087 http://www.fieldindustries.com	832-736-1839
Files and Associates 11927 S. 85 East Avenue Bixby, OK 74008 http://www.filesassoc.com	918-630-3717
Fives Cryo, Inc. Willowbrook I 17314 State Hwy 249, #108 Houston, TX 77064 http://www.fivesgroup.com	346-333-6320
Flatrock Engineering and Environmental 18615 Tuscany Stone, Suite 200 San Antonio, TX 78258 http://flatrockenergy.net	210-568-1707
Flow-Cal, Inc. 2525 Bay Area Boulevard, Suite 500 Houston, TX 77058 http://www.flowcal.com	281-282-0865
Fluid Flow Products, Inc. 7255 E 46th Street Tulsa, OK 74145 http://www.fluidflow.com	918-663-5310
Fluor Enterprises, Inc. 3 Polaris Way Aliso Viejo, CA 92698 http://www.fluor.com	949-349-2231
Forum Energy Technologies 10344 Sam Houston Park Drive, # 300 Houston, TX 77064 http://www.f-e-t.com	281-994-3463
Freeman and Curiel Engineers, LLP 13101 Northwest Freeway, Suite 320 Houston, TX 77040 http://www.fcengr.com	713-895-8668
Freese and Nichols, Inc. 4055 International Plaza, Suite 200 Fort Worth, TX 76109 http://www.freese.com	817-735-7300
FW Murphy Production Controls P.O. Box 470248 Tulsa, OK 74147 http://www.fwmurphy.com	918-317-4100

Company & Address	Phone
Gas Analytical Services 1408 Alpine Boulevard Bossier City, LA 71111 http://www.gasana.com	318-746-2404
Gas Equipment Co., Inc. 11616 Harry Hines Boulevard Dallas, TX 75229 http://www.gasequipment.com	972-280-8430
Gas Technology Corp. 1425 Greenway Drive, Suite 450 Irving, TX 75038 http://www.gastech.net	972-255-7800
Gas Treatment Services B.V. Timmerbabriekstraat 12, Bergambacht 2861 GV, NL http://www.gtsbv.com	31 182 621890
GasTech Engineering, LLC 2110 Industrial Road Sapulpa, OK 74066 http://www.gastecheng.com	918-663-8383
GC2 Specialty Construction, LP 2620 S. Sam Houston Parkway West Houston, TX 77047 http://www.gc-2.com	979-373-8313
GE Distributed Power, Inc. 1101 W. Saint Paul Avenue Waukesha, WI 53188 https://www.ge.com/power/gas/reciprocating-engines/waukesha	262-547-3311
GEA Refrigeration North America, Inc. 3475 Board Road York, PA 17406 http://www.gea.com	717-487-7577
Gemstar, Inc. P.O. Box 12376 Odessa, TX 79768 http://www.gemstarfab.com	432-362-2315
Geolex, Inc. 500 Marquette Avenue NorthWest, #1350 Albuquerque, NM 87102 http://www.geolex.com	505-842-8000
GHD Services, Inc. 1755 Wittington Place, Suite 500 Dallas, TX 75234 http://www.ghd.com	972-331-8500
Global Compressor, LP 13415 Emmett Road Houston, TX 77041 http://www.globalcompressorparts.com	713-983-8773
Graves Analytical Services, LLC 3875 Hammer Ranch Road Colorado Springs, CO 80929 http://www.gaspeak.com	719-683-4000
Great Western Valve, Inc. 14247 Bandera Street Cypress, TX 77015 http://www.gwvalve.com	713-455-9400
GTC Vorro 900 Threadneedle Street, Suite 800 Houston, TX 77079 http://www.gtcvorro.com	541-601-2347

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GTUIT 2924 Millennium Circle Billings, MT 59102 http://www.gtuit.com	406-867-6700
Gulf Coast Chemical, LLC 220 Jacqulyn Street Abbeville, LA 70510 http://www.gulfcoastchemical.com	337-898-0213
Gulf Publishing Co. 2 Greenway Plaza, Suite 1020 Houston, TX 77046 http://www.gasprocessingnews.com	713-520-4443
H.J. Baker, PE 1511 Rock Ridge Drive Cleveland, OK 74020	918-853-9186
H2W United, LLC 8450 E. Crescent Parkway, Suite 420 Greenwood Village, CO 80111 http://www.h2wunited.com	303-501-1994
Halff TriTex, Inc. 1201 North Bowser Road Richardson, TX 75081 http://www.halfftritex.com	214-217-6509
Hargrove Engineers + Constructors 16300 Katy Freeway, Suite 300 Houston, TX 77094 http://www.hargrove-epc.com	832-916-3551
Heat Transfer Specialists, Inc. 9550 Max Conrad Drive Spring, TX 77379 http://htstx.com	281-820-9002
Heatec, Inc. 5200 Wilson Road Chattanooga, TN 37410 http://www.heatec.com	423-821-5200
Heath Consultants Incorporated 9030 Monroe Road Houston, TX 77061 http://www.heathus.com	713-844-1300
Holloman Corporation 333 N. Sam Houston Parkway, Suite 600 Houston, TX 77060 http://www.hollomancorp.com	281-878-2600
Honeywell UOP 7050 S Yale, Suite 210 Tulsa, OK 74136 http://www.honeywell.com	918-481-5682
Howard Energy Partners 16211 La Cantera Parkway, Suite 202 San Antonio, TX 78256 http://www.howardep.com	210-298-2222
HTS Rocky Mountains 9550 Max Conrad Drive Spring, TX 77379 http://htsrm.com	918-557-7499
Hunt, Guillot & Associates 603 Reynolds Drive Ruston, LA 71270 http://www.hga-llc.com	318-255-6825
Hunter Buildings 14935 Jacintoport Boulevard Houston, TX 77015 http://www.hunterbuildings.com	713-632-5979

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Huntsman Corp. 10003 Woodloch Forest Dr The Woodlands, TX 77380 http://www.huntsman.com	281-719-6000
I & S Technical Resources, Inc. 248 Twin Lakes Blvd West Columbia, TX 77486	832-476-5473
Industrial Distributors, Inc. 4920 Nome Street, Unit A Denver, CO 80239 http://www.idiprocess.com	303-375-9070
INEOS GAS/SPEC Technology Group 2600 S. Shore Boulevard, Suite 400 League City, TX 77573 http://www.ineos.com	281-535-4353
Interra Global Corp. 800 Busse Highway Park Ridge, IL 60068 http://www.interraglobal.com	847-292-8600
Interstate Treating, Inc. 7141 Club Drive Odessa, TX 79762 http://www.intertreat.com	432-362-9291
ISTI Plant Services 1437 S. Boulder, Suite 1500 Tulsa, OK 74119 http://www.istips.com	918-592-1133
J. H. Foglietta Consulting, LLC 5827 Fairdale Lane Houston, TX 77057 http://fogliettaconsulting.com	713-962-0470
J.S. James Co. 10814 S. Erie Avenue Tulsa, OK 74137 http://www.jsjames.net	918-299-1804
Jacobs 5995 Rogerdale Road Houston, TX 77072 http://www.jacobs.com	832-351-7397
Jasper Ventures, Inc. 101 Glenda Street Whitehouse, TX 75791 http://www.jasperventuresinc.com	903-939-1555
JEM Resources & Engineering, Inc. 1008 Shell Avenue Midland, TX 79705 http://www.jemres-eng.com	432-352-0802
JFE Engineering Corporation 2-1 Suehiro-cho, Tsurumi-Ku, Yokohama, 230-8611, JP http://www.jfe-eng.com	81 45 505 07772
Johnson Matthey P.O. Box 1, Belasis Avenue Billingham, Cleveland, TS23 1LB, GB http://www.matthey.com	01-64-252-3773
Johnson Petrotech Services, Inc. 6320 Buffalo Speedway Houston, TX 77005	281-636-1422
Jonell, Inc. 11607 E. 43rd Street North Tulsa, OK 74116 http://www.jonellinc.com	918-984-6038

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Joule Processing, LLC 3800 Buffalo Speedway, Suite 525 Houston, TX 77098 http://www.jouleprocessing.com	713-481-1864
JP3 Measurement 4109 Todd Lane, Suite 200 Austin, TX 78744 http://www.jp3measurement.com	512-837-8450
Kahuna Ventures 11400 Westmoor Circle, Suite 325 Westminster, CO 80021 http://www.kahunaventures.com	303-451-7374
Kane Environmental Engineering 8816 Big View Drive Austin, TX 78730	281-370-6580
KBR 601 Jefferson Street, Suite KT3398B Houston, TX 77002 http://www.kbr.com	713-753-5201
Kimley-Horn 11700 Katy Freeway, Suite 800 Houston, TX 77079 http://www.kimley-horn.com	346-888-3890
Knighten Industries, Inc. 3323 NC Rd. West Odessa, TX 79764 http://www.knind.com	432-362-0468
Koch-Glitsch LP 4111 East 37th Street North Wichita, KS 67220 http://www.kochglitsch.com	316-828-6439
KP Engineering, LP 5555 Old Jacksonville Highway Tyler, TX 75703 http://www.kpe.com	903-534-9155
L.A. Turbine 28557 Industry Drive Valencia, CA 91355 http://www.laturbine.com	661-294-8290
LCM Industries, Inc. 1605 S. Marlin Drive Odessa, TX 79763 http://www.lcmindustries.com	432-332-5516
Lexicon, Inc. 8900 Fourche Dam Pike Little Rock, AR 72206 http://www.lexicon-inc.com	501-490-4200
Linde Engineering North America Inc. 6100 S. Yale, Suite 1200 Tulsa, OK 74136 https://www.leamericas.com	918-477-1200
Lindsayca Solutions 1602 Peach Leaf Strett Houston, TX 77039 http://www.Indsol.com	713-870-8351
M J & H Fabrication 2120 Hall Boulevard Ponca City, OK 74601 http://www.mjhfab.com	580-749-5339
Mangan, Inc. 1650 Highway 6 South, Suite 200 Sugar Land, TX 77478 http://www.manganinc.com	281-795-8103

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Master Corporation 1330 East 8th Street, Suite 105 Odessa, TX 79761 http://www.mastercorporation.com	432-580-0600
Matrix PDM Engineering 5100 E. Skelly Drive, Suite 100 Tulsa, OK 74135 http://devcousa.com	918-496-4400
McCartney Gas Advisors, LLC P.O. Box 27089 Shawnee Mission, KS 66225	913-593-3912
McDaniel Technical Services, Inc. P.O. Box 2557 Broken Arrow, OK 74013 http://www.mcdanieltsi.com	918-294-1628
Metal Goods Manufacturing Co. Inc. P.O. Box 2096 Bartlesville, OK 74005 http://www.metalgoodsmfg.com	918-336-4282
Midstream Energy Group, Inc. 2002 Rosalyn Court Sugar Land, TX 77478 http://www.midstreamenergygroup.com	713-582-2579
MIRATECH Group, LLC. 420 S 145th East Avenue Tulsa, OK 74108 http://www.miratechcorp.com	918-622-7077
Mitsubishi Heavy Industries Compressor International 14888 Kirby Drive Houston, TX 77047 http://www.mhicompressor.com/en	832-710-4700
MODEC International, Inc. 15011 Katy Freeway, Suite 500 Houston, TX 77094 http://www.modec.com	281-529-8100
Monico Monitoring, Inc. 18530 Klein Church Road Spring, TX 77379 http://www.monicoinc.com	281-350-8751
Moore Control Systems, Inc. 1435 Katy-Flewellen Katy, TX 77494 http://www.moore-control.com	281-392-7747
Morrow Energy P.O. Box 61447 Midland, TX 79711 http://www.morrowenergy.com	432-570-4200
Movilab, S.A. de C.V. Paseo de Francia 163 Pisol Naucalpan, Estado de, 53120, MX http://www.movilab.com	5225-553- 442121 x102
Neuman & Esser USA, Inc. 1502 East Summitry Circle Katy, TX 77449 http://www.neuman-esser.com	281-497-5113
Neumann Consulting 4126 Luong Field Court Katy, TX 77494	713-806-6042
New Industries, LLC 6032 Railroad Avenue Morgan City, LA 70380 http://www.newindustries.com	985-385-6789

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New Tech Global Ventures 202 Madison Square Colleyville, TX 76034 http://www.ntglobal.com	817-821-8107
Nexo Solutions 25003 Pitkin Road, Suite A100 The Woodlands, TX 77386 http://www.nexosolutions.com	832-510-8191
Nicholas Consulting Group, Inc. 600 N. Marienfeld, Suite 300 Midland, TX 79701 http://www.thencg.com	435-570-8093
Nitro-Lift Technologies LLC 6742 Industrial Road Beaumont, TX 77705 http://www.nitrolift.com	580-371-3700
North Shore Steel 1566 Miles Street Houston, TX 77015 http://www.nssco.com	713-453-3533
NorthStar Energy Services, Inc. 15025 East Freeway Channelview, TX 77530 http://www.nses.com	281-452-2355
Norwood S&S, LLC 6415 Calle Lozano Drive Houston, TX 77041 http://www.NorwoodSS.com	281-558-2946
NTACT Operations, LLC 12615 West County Road 91 Midland, TX 79707 http://ntactops.com	817-680-0253
Oil-GasTech, Inc. 4200 Maple Odessa, TX 79762 http://www.Oil-GasTech.com	432-561-5481
OK Leasing Latin America Energy, LLC 6811 Gant Road Houston, TX 77066	281-678-1260
Oliver Equipment Co. 4620 Brittmoore Road Houston, TX 77041 http://www.oliverequip.com	713-856-9206
Omni Flow Computers, Inc. 12320 Cardinal Meadow Dr, Suite 180 Sugar Land, TX 77478 http://www.omniflow.com	281-240-6161
Optimized Gas Treating, Inc. 12337 Jones Road, Suite 432 Houston, TX 77070 http://www.ogtrt.com	580-428-3535
Optimized Process Designs 25610 Clay Road Katy, TX 77493 http://www.opdepc.com	281-371-5909
Optimized Process Furnaces 3995 S. Santa Fe Chanute, KS 66720 http://www.firedheater.com	620-431-1260
Pantechs Laboratories, Inc. 5915 50th Street Lubbock, TX 79424 http://www.pantechs.com	806-797-4325

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Paratherm - Heat Transfer Fluids 2009 Renaissance Boulevard King of Prussia, PA 19406 http://www.paratherm.com	610-941-4900
Parker IPF (PECO) Parker Hannifin Corp. 118 Washington Avenue Mineral Wells, TX 76067 http://www.parker.com	940-327-6311
Pasadyn, Inc. 3311 El Dorado Boulevard Missouri City, TX 77459 http://www.pasadyn.net	713-907-0711
Payne-Huber Engineering, Inc. 8211 E. Regal Place, Suite 104 Tulsa, OK 74133 http://www.payne-huber.com	918-906-0936
Peak AI Solutions 2825 Wilcrest Drive, Suite 530 Houston, TX 77042 http://www.peak-ai.com	832-581-3910
PERC Engineering, LLC 1880 S Dairy Ashford Road, Suite 606 Houston, TX 77077 http://www.perc-eng.com	281-937-4468
Petral Consulting Co. P.O. Box 42586 Houston, TX 77242 http://www.petral.com	713-977-0144
Petron Asia Energy PTE Ltd. 531A Upper Cross Street, Hong Lim #04-95 Singapore 51531 http://www.petronasia.com	65-9882-9875
PetroSkills/John M. Campbell 1215 Crossroads Blvd. Norman, OK 73072 http://www.petroskills.com	918-828-2500
Pine River Energy Services, LLC 836 Ludwig Drive Bayfield, CO 81122 http://www.pineriverenergysvcsllc.com	970-799-1971
PLC Construction Inc. 1320 N. Main Street, Suite F Liberty, TX 77575 http://www.plcconstruction.com	936-336-5652
Precise Engineering, Inc. 9752-B Whithorn Drive Houston, TX 77095 http://www.precise-engineering.net	281-855-7333
Prime Controls, LP 1725 Lakepointe Drive Lewisville, TX 75057 http://www.prime-controls.com	972-221-4849
Process Vision, Inc. 12320 Barker Cypress, Suite 600 # 157 Cypress, TX 77429 http://www.processvision.com	281-709-6160
PSI (Process Solutions Integration) 6654-A Canyon Drive Amarillo, TX 79109 http://www.psi-technology.com	806-356-9800
Q.B. Johnson Manufacturing, Inc. 9000 S. Sunnylane Road Oklahoma City, OK 73165 http://www.qbjohnson.com	405-677-6676

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QPS Engineering 4500 S. Garnett Road, Suite 700 Tulsa, OK 74146 http://www.qpse.com	918-858-7620
QuantityWare GmbH Zeiloch 1b Bruchsal, 76646 DE http://www.quantityware.com	49 7251 982 3003
R & R Engineering Co., Inc. PO Box 700005 Tulsa, OK 74170	918-252-2571
R&H Technical Sales, Inc. PO Box 7331 The Woodlands, TX 77387 http://www.rhtechnical.com	281-681-9955
Ranger Plant Constructional Co. Inc. 5851 E. Interstate 20 Abilene, TX 79601 http://www.rpccinc.com	325-677-2888
Red Ball Technical Gas Services 609 N. Market Street Shreveport, LA 71107 http://www.redball oxygen.com	318-425-3211
Redd Ridge Consulting, LLC PO Box 339 Glenpool, OK 74033 http://www.reddridgeconsulting.com	918-237-6098
Ref-Chem LP 1128 S. Grandview Avenue Odessa, TX 79761 http://www.ref-chem.com	432-332-8531
Regard Resources Co., Inc. 555 Aero Drive Shreveport, LA 71107 http://www.regardresources.com	318-425-2533
Relevant Solutions 1423 E. Richey Road Houston, TX 77073 http://www.relevantsolutions.com	713-688-8834
Reset Energy P.O. Box 8601 Midland, TX 79708 http://www.resetenergy.com	432-682-2020
Rhine Ruhr Pty, Ltd. Unit 1, 10-30 West Circuit, Sunshine West Melbourne, Vi 3020 http://www.rhineruhr.com.au	61 3 9300 5000
River City Engineering 4830 Bob Billings Parkway, Suite 100B Lawrence, KS 66049 http://www.rivercityeng.com	785-842-4783
Robert R. Reis, Attorney-Mediator, P.C. 2287 E. 39th Street Tulsa, OK 74105	918-742-2028
Ross Engineering, LLC 510 E. 2nd Street Tulsa, OK 74120 http://www.rossengr.com	405-264-2200
Rotor-Tech, Inc. 10613 Stebbins Circle Houston, TX 77379 http://www.rotor-tech.com	713-984-8900

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Royal Filter Mfg. Co., Inc. 4327 S. 4th Chickasha, OK 73018 http://www.royalfilter.com	405-224-0229
RT Technical Solutions 4484 Hodgson Road Nederland, TX 77627 http://www.rttechnicalsolutions.com	409-344-2701
S & B Engineers and Constructors, Ltd. 7825 Park Place Boulevard Houston, TX 77087 http://www.sbec.com	713-845-7850
Samuel Engineering, Inc. 8450 E. Crescent Parkway, Suite 2300 Greenwood Village, CO 80111 http://www.samuelengineering.com	303-714-4840
Saulsbury Industries, Inc. 2951 E. Interstate 20 Odessa, TX 79766 http://www.saulsbury.com	432-438-6436
Scelerin Heaters, LLC 7633 E. 63rd Place, Suite 270 Tulsa, OK 74133 http://www.scelerin.com	918-499-2700
Schultz Process Services, Inc. 12515 Cypress N. Houston Road Cypress, TX 77429 http://www.spshouston.com	281-894-2100
Scott Measurement Service, Inc. P.O. Box 5247 Granbury, TX 76049 http://www.scottmeasurement.com	817-573-0036
SEC Energy Products & Services, LP 9523 Fairbanks N Houston Houston, TX 77064 http://www.sec-ep.com	281-890-9977
Select Engineering, Inc. 1437 S. Boulder Avenue, Suite 1500 Tulsa, OK 74119 http://www.select-engineering.com	918-592-1133
Selective Adsorption Associates, Inc. 41 University Drive, Suite 400 Newtown, PA 18940 http://www.mercuryadsorbents.com	215-702-0323
Sepra-Chem Corp. 10975 Spur 248 Tyler, TX 75707 http://www.sepra-chem.com	903-566-1015
SERO PumpSystems, Inc. 3727 Greenbriar Drive, Suite 105 Stafford, TX 77477 http://www.seropumps.com	281-242-8080
Shamrock Gas Analysis 1100 South Madden Street Shamrock, TX 79097 http://www.sgalab.com	806-256-3249
Shawcor 5875 N. Sam Houston Parkway West, Suite 200 Houston, TX 77086 http://www.shawcor.com	832-426-3852

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Shermco Industries 2425 E. Pioneer Drive Irving, TX 75061 http://www.shermco.com	972-793-5523
Sigma Thermal, Inc. 4875 Deen Road Marietta, GA 30066 http://www.sigmathermal.com	770-427-5770
Simplified Rail Logistics 1301 E. Zion Fayetteville, AR 72703 http://www.simplifiedraillogistics.com	479-225-6352
Single Buoy Moorings 5 Route de Fribourg Marly 1723, CH http://www.sbmoffshore.com	281-848-6326
Smithco Engineering, Inc. 7718 E. 91st Street, Suite 200 Tulsa, OK 74133 http://www.smithco-eng.com	918-446-4406
SNC-Lavalin 919 Milam, Suite 1000 Houston, TX 77002 http://www.snclavalin.com/en/market-services/oil-gas/processing-treating/	713-744-6100
Solar Turbines, Inc. 2200 Pacific Coast Highway San Diego, CA 92186 http://www.solarturbines.com	800-416-5024
Solomon Associates One Lincoln Centre - 5400 LBJ Freeway, Suite 1400 Dallas, TX 75240 http://www.solomononline.com	972-672-7933
Spartan Energy Partners 9595 Six Pines Drive, Suite 4000 The Woodlands, Texas, TX 77380 http://www.spartanep.com	281-466-3310
SpectraSensors an Endress+Hauser Co. 4333 W. Sam Houston Parkway North, Suite 100 Houston, TX 77043 http://www.spectrasensors.com	713-300-2719
Spitzer Industries 12141 Wickchester Lane, Suite 750 Houston, TX 77079 http://www.spitzerind.com	832-783-7000
SPL, Inc. 8880 Interchange Drive Houston, TX 77054 http://www.spl-inc.com	713-660-0901
Stantec 500 Jefferson Street, Suite 1670 Houston, TX 77002 http://www.stantec.com	832-509-4342
Strategic Automation Services, LLC 16203 Park Row Road, Suite 140 Houston, TX 77084 http://SAS-web.com	281-945-8900
STS Consulting Services P.O. Box 9005 Longview, TX 75608 http://ststx.com	903-247-1787

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STV Energy Services, Inc. 205 W. Welsh Drive Douglassville, PA 19518 http://www.stvinc.com	610-385-8200
SULPETRO, Inc. #600, 600-6th Avenue Calgary, AB, CA http://www.sulpetro.com	403-233-9337
Sulzer Chemtech 8505 E. North Belt Drive Humble, TX 77396 http://www.sulzer.com	281-441-5804
Superior Energy Systems, Ltd. 13660 Station Road Columbia Station, OH 44028 http://www.superiornrg.com	440-236-6711
T.F. Hudgins, Inc. 4405 Directors Row Houston, TX 77092 http://www.tfhudgins.com	
Taylor Forge Engineered Systems 208 N. Iron Street Paola, KS 66071 http://www.tfes.com	913-294-5331
Texas Turbine, Inc. 624 Profit St Azle, TX 76020 http://www.txturbine.com	817-444-5528
The Gateway Companies 80 E 5th Street, Suite 400 Edmond, OK 73034 http://www.gatewayok.com	405-285-2884
TM-EMS, LLC 1428 N. Banks Pampa, TX 79066 http://www.tm-ems.com	806-665-5700
Tomcej Engineering Inc. P.O. Box 1274 Station Main Edmonton, Al 0 http://www.tomcej.com	780-483-0248
TorcSill Foundations 204 N. Robinson, Suite 2400 Oklahoma City, OK 73102 http://www.torcsill.com	405-693-8460
Torrent Energy Services 800 Gessner Road, Suite 1000 Houston, TX 77024 http://www.torrentenergyservices.com	281-450-4000
Total Energy Corp. 2 Hardscrabble Road North Salem, NY 10560 http://www.totalenergy.com	405-253-4728
Total Equipment Co. 400 5th Avenue Coraopolis, PA 15108 http://www.totalequipment.com	412-269-0999
Total Valve & Equipment PO Box 131464 Spring, TX 77393 http://www.total-valve.com	713-855-1486

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TransTech Energy P.O. Box 8197 Rocky Mount, NC 27804 http://www.transtechenergy.com	252-801-1879
TransTex Treating 1707 Â½ Post Oak Boulevard, #479 Houston, TX 77056 http://www.transtextreating.com	713-654-4440
TRC Companies, Inc. 10550 Richmond Avenue, Suite 210 Houston, TX 77042 http://www.trcsolutions.com	713-244-1000
Trimeric Corp. P.O. Box 826 Buda, TX 78610 http://www.trimeric.com	512-295-8118
Trinity Containers, LLC 2525 Stemmons Freeway, Suite 520 Dallas, TX 75207 http://www.trinitycontainers.com	888-558-8529
Tri-Point Oil & Gas Production Systems 5555 San Felipe, Suite 1250 Houston, TX 77056 http://www.tri-pointllc.com	281-615-2072
Tryer Process Equipment 1730 City View Drive Wichita Falls, TX 76306 http://www.tryerpe.com	940-432-0130
Tulco Oils 5240 E. Pine Street Tulsa, OK 74115 http://www.tulco.com	918-230-4653
Tulsa Heaters Midstream 1215 S. Boulder, Suite 1040 Tulsa, OK 74119 http://www.tulsaheatersmidstream.com	918-392-8000
UEC, LLC 9461 Willow Court Henderson, CO 80640 http://www.uecompression.com	303-515-8588
Unison Industrial Solutions 1218 W. Webster Street Houston, TX 77019 http://www.unisongrp.com	832-496-3004
Univar 19450 State Highway 249, 3rd Floor Houston, TX 77070 http://www.univar.com	281-949-9120
UniversalPegasus International 4848 Loop Central Drive Suite 137 Houston, TX 77081 http://www.universalpegasus.com	713-425-6000
Upstream Development and Engineering, Inc. 230 Jay Street, Unit 2F Brooklyn, NY 11201 http://www.upstreamdne.com	281-752-7754

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Vapor Point 1306 West F Street La Porte, TX 77571 http://www.vaporpoint.net	
Vavco, LLC 101 Mahood Road Butler, PA 16001 http://www.vavcollc.com	724-285-6684
VGas, LLC 12221 FM 529 Road Houston, TX 77070 http://www.vgasllc.com	713-896-8531
Vinson Process Controls 2747 Highpoint Oaks Drive Lewisville, TX 75067 http://www.vinsonprocess.com	972-459-8200
Virtual Materials Group Alastair Ross Technology Centre #300, 3553 - 31 Street NW Calgary, AB, CA http://www.virtualmaterials.com	281-944-9902
VME 3733 Shiloh Road Tyler, TX 75707 http://www.vmecompanies.com	903-561-4082
VUV Analytics, Inc. 715 Discovery Boulevard, Suite 502 Cedar Park, TX 78717 http://vuvanalytics.com	512-961-3834
Wagner Power Systems 4000 Osuna Road NorthEast Albuquerque, NM 87109 http://www.wagnerpower.com	505-345-8411
Wasson-ECE 101 Rome Court Ft. Collins, CO 80524 http://www.wasson-ece.com	970-221-9179
Western Filter Co., Inc. 10702 E. 11th Street Tulsa, OK 74128 http://www.westernfilterco.com	918-949-4455

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WinSim Inc. 8653 FM 2759 Road Richmond, TX 77469 http://www.winsim.com	281-545-9200
Wood 17325 Park Row Drive Houston, TX 77084 http://www.woodPLC.com	832-809-8000
Worldwide Exchangers, LLC 601 W 136th Street North Skiatook, OK 74070 http://worldwideexchanger.com	918-396-7200
WorleyParsons 15721 Park Row Houston, TX 77084 http://www.worleyparsons.com	713-797-2733
WSP 16200 Park Row Boulevard, Suite 200 Houston, TX 77084 http://www.wsp-pb.com/en/wsp-usa/what-we-do-usa/industrial-and-energy/markets/underground-energy-storage/	281-589-5800
York Process Systems 100 CV Avenue Waynesboro, PA 17268 http://www.jci.com/yps	717-765-2510
Zachry 3411 Northfield Drive Midland, TX 79707 http://www.zachrygroup.com	281-864-7656
ZAP Engineering & Construction Services, Inc. 333 S. Allison Parkway, Suite 100 Lakewood, CO 80226 http://www.zapecs.com	303-565-5533
Zedi US 2881 S. 31st Avenue, Unit 6 Greeley, CO 80631 http://www.zedi.us	970-460-0055
Zeochem 1600 West Hill Street Louisville, KY 40210 http://www.zeochem.com	502-693-0325

Services

GPSA

Sixty Sixty American Plaza, Suite 700
Tulsa, Oklahoma 74135
Phone: 918-493-3872
Fax: 918-493-3875
Email: DataBook@GPSAmidstream suppliers.org
http://GPSAmidstream suppliers.org

The following is a listing of GPSA member companies classified by the type of services that they provide to the industry.

COMPLIANCE — AUDITING

Ampeva Midstream, LLC
Audubon
Barr Engineering Co.
Black & Veatch Corp.
C3 Resources, LLC
Contek Solutions, LLC
EnerSys Corporation
Environex
Flatrock Engineering and Environmental
Graves Analytical Services, LLC
Halff TriTex, Inc.
Jacobs
Joule Processing, LLC
Kahuna Ventures
QuantityWare GmbH
Ross Engineering, LLC
Spitzer Industries
SPL, Inc.
STS Consulting Services
TM-EMS, LLC
TRC Companies, Inc.
Wood
Zedi US

COMPLIANCE — CRITICAL INCIDENT/EMERGENCY RESPONSE

Contek Solutions, LLC
Flatrock Engineering and Environmental
GHD Services, Inc.
Halff TriTex, Inc.
QuantityWare GmbH
TRC Companies, Inc.

COMPLIANCE — EMISSIONS TESTING

Anguil Environmental Systems
Archrock, Inc.
Barr Engineering Co.
Black & Veatch Corp.
CECO-Compressor Engineering Corp.
CSI Compressco LP
Enerflex
Environex
Federal Services, LLC
FESCO, Ltd.
Flatrock Engineering and Environmental
GHD Services, Inc.
Graves Analytical Services, LLC
Heath Consultants Incorporated
Johnson Petrotech Services, Inc.
SPL, Inc.
TRC Companies, Inc.

COMPLIANCE — ENVIRONMENTAL SERVICES

AECOM
Anguil Environmental Systems
Audubon
Barr Engineering Co.
BGE, Inc.
Black & Veatch Corp.
Catalytic Combustion Corporation
Contek Solutions, LLC
CSI Compressco LP
Environex
Flatrock Engineering and Environmental
Freese and Nichols, Inc.
Geolex, Inc.
GHD Services, Inc.
Halff TriTex, Inc.
Heath Consultants Incorporated
Jacobs
Johnson Petrotech Services, Inc.
Kahuna Ventures
Kimley-Horn
MIRATECH Group, LLC.
Pantechs Laboratories, Inc.

QPS Engineering
SPL, Inc.
TRC Companies, Inc.
Trimeric Corp.
Vapor Point
Wood

COMPLIANCE — LEAK DETECTION SERVICES

Contek Solutions, LLC
EnerSys Corporation
Flatrock Engineering and Environmental
GHD Services, Inc.
Heath Consultants Incorporated
Johnson Petrotech Services, Inc.
SPL, Inc.
TM-EMS, LLC
UniversalPegasus International

COMPLIANCE — LEGAL SERVICES

ENGlobal U.S. Inc.
Environex
Johnson Petrotech Services, Inc.
Robert R. Reis, Attorney-Mediator, P.C.
SPL, Inc.

COMPLIANCE — SAFETY CONSULTANT

Ampeva Midstream, LLC
Audubon
Barr Engineering Co.
C3 Resources, LLC
Contek Solutions, LLC
EPIC
Federal Services, LLC
Flatrock Engineering and Environmental
GHD Services, Inc.
H.J. Baker, PE
Halff TriTex, Inc.
Kahuna Ventures
Mangan, Inc.
STS Consulting Services
Trimeric Corp.
Wood

COMPLIANCE — SECURITY

Black & Veatch Corp.
TRC Companies, Inc.

CONSULTING — COMPUTER SYSTEMS

Barry D. Payne & Associates, Inc.
Black & Veatch Corp.
Federal Services, LLC
GHD Services, Inc.
Halff TriTex, Inc.
J.S. James Co.
Mangan, Inc.
Puffer Sweiven
QuantityWare GmbH
Strategic Automation Services, LLC
UniversalPegasus International

CONSULTING — EXPERT WITNESS

Barr Engineering Co.
Black & Veatch Corp.
Coastal Flow Measurement, Inc.
Contek Solutions, LLC
Emerson
Environex
Flatrock Engineering and Environmental
Geolex, Inc.
GHD Services, Inc.
Graves Analytical Services, LLC
Halff TriTex, Inc.
J. H. Foglietta Consulting, LLC
Johnson Petrotech Services, Inc.
Optimized Gas Treating, Inc.
Pasadyn, Inc.
Robert R. Reis, Attorney-Mediator, P.C.
Samuel Engineering, Inc.
Selective Adsorption Associates, Inc.
SPL, Inc.
TM-EMS, LLC
TRC Companies, Inc.
Trimeric Corp.
WSP

CONSULTING — FORENSIC ENGINEERING

Baker Hughes, a GE company
GHD Services, Inc.
Pasadyn, Inc.

CONSULTING — CORROSION

Barr Engineering Co.
Coastal Chemical Co., LLC
Contek Solutions, LLC
Federal Services, LLC
Flatrock Engineering and Environmental
GHD Services, Inc.
Gulf Coast Chemical, LLC
Heath Consultants Incorporated
Johnson Petrotech Services, Inc.
Pasadyn, Inc.
Shawcor
TM-EMS, LLC
TRC Companies, Inc.
Trimeric Corp.
Wood

CONSULTING — STRATEGY PLANNING

ARC Energy Equipment
Audubon
Bartlett & West
BGE, Inc.
Black & Veatch Corp.
Calibrate Capital Partners LLC
CAM Integrated Solutions

Contek Solutions, LLC
Dollahon PR
EPIC
Geolex, Inc.
GHD Services, Inc.
Halff TriTex, Inc.
J. H. Foglietta Consulting, LLC
Johnson Petrotech Services, Inc.
Kahuna Ventures
Moore Control Systems, Inc.
Pasadyn, Inc.
Petral Consulting Co.
QPS Engineering
QuantityWare GmbH
STS Consulting Services
TRC Companies, Inc.
UniversalPegasus International
Wood

DISMANTLE, SURPLUS EQUIPMENT

ARC Energy Equipment
Baker Hughes, a GE company
Enerflex
Gas Technology Corp.
Interstate Treating, Inc.
Nicholas Consulting Group, Inc.
Ref-Chem LP
Ross Engineering, LLC
Wood

ENGINEERING — PROCUREMENT AND CONSTRUCTION

AECOM
Anvil Corporation
ARC Energy Equipment
Archrock, Inc.
Audubon
Azota Ltd.
Barr Engineering Co.
Barry D. Payne & Associates, Inc.
Bartlett & West
Bilfinger Westcon, Inc.
Black & Veatch Corp.
Bowden Construction Co. Ltd.
CAM Integrated Solutions
Catamount Constructors
Chiyoda Corp.
CryoSys
Echo Group, Ltd.
EDG, Inc.
EMD, Inc.
Emerson
Enerflex
ENGlobal U.S. Inc.
EXTERRAN
Forum Energy Technologies
Freeman and Curiel Engineers, LLP
Freese and Nichols, Inc.
GasTech Engineering, LLC
GHD Services, Inc.
Holloman Corporation
Honeywell UOP
Hunt, Guillot & Associates
Interstate Treating, Inc.
ISTI Plant Services
Jacobs
Jasper Ventures, Inc.
Joule Processing, LLC
Kahuna Ventures
KBR
KP Engineering, LP
Lexicon, Inc.
Linde Engineering North America Inc.
Mangan, Inc.
Master Corporation
Matrix PDM Engineering
MIRATECH Group, LLC.
MODEC International, Inc.
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Nicholas Consulting Group, Inc.
NorthStar Energy Services, Inc.
Oil-GasTech, Inc.
Optimized Process Designs
PLC Construction Inc.
QPS Engineering
Ref-Chem LP
Regard Resources Co., Inc.
Ross Engineering, LLC
Samuel Engineering, Inc.
Saulsbury Industries, Inc.
SEC Energy Products & Services, LP
Select Engineering, Inc.
Single Buoy Moorings
SNC-Lavalin
Spartan Energy Partners
STS Consulting Services
TRC Companies, Inc.
UniversalPegasus International
Upstream Development and Engineering, Inc.
Vavco, LLC
VGas, LLC
Wanzek Construction, Inc.
Wood
WSP

ENGINEERING — DRAFTING

AECOM
Anvil Corporation
Aqseptence Group, Inc.
ARC Energy Equipment
Audubon
Azota Ltd.
Barr Engineering Co.
Bartlett & West
Black & Veatch Corp.
CAM Integrated Solutions
EDG, Inc.
EMD, Inc.

Enerflex
ENGlobal U.S. Inc.
EXTERRAN
Forum Energy Technologies
Freeman and Curiel Engineers, LLP
Freese and Nichols, Inc.
Gas Technology Corp.
GasTech Engineering, LLC
GHD Services, Inc.
Halff TriTex, Inc.
Honeywell UOP
Hunt, Guillot & Associates
Jacobs
Joule Processing, LLC
Kahuna Ventures
Kimley-Horn
KP Engineering, LP
Linde Engineering North America Inc.
Master Corporation
Matrix PDM Engineering
MIRATECH Group, LLC.
Moore Control Systems, Inc.
Nicholas Consulting Group, Inc.
NorthStar Energy Services, Inc.
Oil-GasTech, Inc.
Optimized Process Designs
PERC Engineering, LLC
PLC Construction Inc.
QPS Engineering
Ref-Chem LP
Ross Engineering, LLC
Samuel Engineering, Inc.
Saulsbury Industries, Inc.
SEC Energy Products & Services, LP
Select Engineering, Inc.
Spartan Energy Partners
STS Consulting Services
TM-EMS, LLC
TRC Companies, Inc.
UniversalPegasus International
Upstream Development and Engineering, Inc.
Vavco, LLC
VGas, LLC
Wood
WSP
ZAP Engineering & Construction Services, Inc.

Engineering — Pipeline

AECOM
Audubon
Barr Engineering Co.
Bartlett & West
Black & Veatch Corp.
CAM Integrated Solutions
EDG, Inc.
EMD, Inc.
Enerflex
EXTERRAN
Flatrock Engineering and Environmental
Forum Energy Technologies
Freeman and Curiel Engineers, LLP
Freese and Nichols, Inc.
GasTech Engineering, LLC
GHD Services, Inc.
Halff TriTex, Inc.
Hunt, Guillot & Associates
Jacobs
Joule Processing, LLC
Kahuna Ventures
KBR
Kimley-Horn
Master Corporation
Matrix PDM Engineering
Nicholas Consulting Group, Inc.
NorthStar Energy Services, Inc.
PERC Engineering, LLC
PLC Construction Inc.
QPS Engineering
Ross Engineering, LLC
Samuel Engineering, Inc.
Select Engineering, Inc.
Spartan Energy Partners
STS Consulting Services
TRC Companies, Inc.
Trimeric Corp.
UniversalPegasus International
Vavco, LLC
Wood
WSP
ZAP Engineering & Construction Services, Inc.

ENGINEERING — PROCESS

AECOM
Anvil Corporation
Aqseptence Group, Inc.
ARC Energy Equipment
Atlas Copco Gas and Process
Audubon
Azota Ltd.
Barr Engineering Co.
Black & Veatch Corp.
CAM Integrated Solutions
Champion Process, Inc.
Chiyoda Corp.
Contek Solutions, LLC
CryoSys
Dickson Process Systems, Ltd.
EDG, Inc.
EMD, Inc.
Emerson
Enerflex
EnerSys Corporation
ENGlobal U.S. Inc.
EXTERRAN
Forum Energy Technologies
Freeman and Curiel Engineers, LLP
Freese and Nichols, Inc.
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
GHD Services, Inc.

Halff TriTex, Inc.
Honeywell UOP
Hunt, Guillot & Associates
Interstate Treating, Inc.
J. H. Foglietta Consulting, LLC
Jacobs
Jasper Ventures, Inc.
JEM Resources & Engineering, Inc.
Johnson Matthey
Jonell, Inc.
Joule Processing, LLC
Kahuna Ventures
KBR
KP Engineering, LP
Linde Engineering North America Inc.
Master Corporation
Matrix PDM Engineering
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Nexo Solutions
Nicholas Consulting Group, Inc.
NorthStar Energy Services, Inc.
Oil-GasTech, Inc.
Optimized Process Designs
Paratherm — Heat Transfer Fluids
Pasadyn, Inc.
PERC Engineering, LLC
Petron Asia Energy PTE Ltd.
PLC Construction Inc.
Prime Controls, LP
QPS Engineering
Ref-Chem LP
Regard Resources Co., Inc.
Rhine Ruhr Pty, Ltd.
River City Engineering
Ross Engineering, LLC
Samuel Engineering, Inc.
Saulsbury Industries, Inc.
Schultz Process Services, Inc.
Select Engineering, Inc.
Selective Adsorption Associates, Inc.
Single Buoy Moorings
SNC-Lavalin
Spartan Energy Partners
Strategic Automation Services, LLC
STS Consulting Services
Tomcej Engineering Inc.
TRC Companies, Inc.
Trimeric Corp.
UniversalPegasus International
Upstream Development and Engineering, Inc.
Vavco, LLC
Wasson-ECE
WinSim Inc.
Wood
WSP
York Process Systems
ZAP Engineering & Construction Services, Inc.
Zeochem

FACILITIES, EQUIPMENT

AECOM
Alfa Laval Niagara
Aqseptence Group, Inc.
ARC Energy Equipment
Audubon
Azota Ltd.
Barr Engineering Co.
Black & Veatch Corp.
Cameron, A Schlumberger Company
ColdStream Energy
Contek Solutions, LLC
CryoSys
CSI Compressco LP
Dew Point Control, LLC
Dickson Process Systems, Ltd.
DistributionNow
Echo Group, Ltd.
EDG, Inc.
EMD, Inc.
Enerflex
EXTERRAN
Freeman and Curiel Engineers, LLP
Gas Equipment Co., Inc.
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Global Compressor, LP
Halff TriTex, Inc.
Honeywell UOP
Interstate Treating, Inc.
Jacobs
Joule Processing, LLC
KP Engineering, LP
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nexo Solutions
Nicholas Consulting Group, Inc.
Oil-GasTech, Inc.
Optimized Process Furnaces
Pasadyn, Inc.
PLC Construction Inc.
R&H Technical Sales, Inc.
Ref-Chem LP
Regard Resources Co., Inc.
Relevant Solutions
River City Engineering
Rotor-Tech, Inc.
Samuel Engineering, Inc.
Schultz Process Services, Inc.
SEC Energy Products & Services, LP
Select Engineering, Inc.
Sepra-Chem Corp.
SERO PumpSystems, Inc.
Smithco Engineering, Inc.
SNC-Lavalin
Solar Turbines, Inc.
Spartan Energy Partners
Spitzer Industries
SPL, Inc.

Texas Turbine, Inc.
TM-EMS, LLC
TRC Companies, Inc.
Trimeric Corp.
Tri-Point Oil & Gas Production Systems
UniversalPegasus International
Upstream Development and Engineering, Inc.
USA Compression
VGas, LLC
VME
Wagner Power Systems
Wanzek Construction, Inc.
Wood
WSP

GAS COMPRESSION — LEASING

Archrock, Inc.
CSI Compressco LP
Enerflex
EXTERRAN
Gas Technology Corp.
MODEC International, Inc.
Neuman & Esser USA, Inc.
Relevant Solutions
SEC Energy Products & Services, LP
SNC-Lavalin
Solar Turbines, Inc.
USA Compression

GAS COMPRESSION — REPAIR

Archrock, Inc.
Baker Hughes, a GE company
Cameron, A Schlumberger Company
CECO-Compressor Engineering Corp.
CSI Compressco LP
Dearing Compressor & Pump Co.
Enerflex
Gas Technology Corp.
GEA Refrigeration North America, Inc.
Global Compressor, LP
L.A. Turbine
Mitsubishi Heavy Industries Compressor International
Neuman & Esser USA, Inc.
Relevant Solutions
SEC Energy Products & Services, LP
SNC-Lavalin
Solar Turbines, Inc.
UEC, LLC
Wagner Power Systems
Wood
York Process Systems

GAS COMPRESSION — SALES

ARC Energy Equipment
Archrock, Inc.
Baker Hughes, a GE company
CAID Industries
Cameron, A Schlumberger Company
CSI Compressco LP
Dearing Compressor & Pump Co.
Enerflex
EXTERRAN
FES-Southwest, Inc.
Gas Technology Corp.
GEA Refrigeration North America, Inc.
Global Compressor, LP
L.A. Turbine
Linde Engineering North America Inc.
MIRATECH Group, LLC.
Mitsubishi Heavy Industries Compressor International
Neuman & Esser USA, Inc.
Relevant Solutions
Reset Energy
SEC Energy Products & Services, LP
SNC-Lavalin
Solar Turbines, Inc.
Spartan Energy Partners
UEC, LLC
Wagner Power Systems
York Process Systems

INSPECTIONS, TESTING, ANALYSIS — GAS CONTAMINATION TESTING

Barr Engineering Co.
GHD Services, Inc.
Graves Analytical Services, LLC
Johnson Petrotech Services, Inc.
Nexo Solutions
Nitro-Lift Technologies LLC
Pantechs Laboratories, Inc.
Parker IPF (PECO) Parker Hannifin Corp.
Scott Measurement Service, Inc.
SPL, Inc.
TM-EMS, LLC
Wasson-ECE

INSPECTIONS, TESTING, ANALYSIS — GENERAL

AECOM
Aqseptence Group, Inc.
Audubon
Barr Engineering Co.
Bartlett & West
Black & Veatch Corp.
CAM Integrated Solutions
Charbonneau Industries, Inc.
Environex
Gas Analytical Services
GEA Refrigeration North America, Inc.
Geolex, Inc.
GHD Services, Inc.
Graves Analytical Services, LLC
Hunt, Guillot & Associates
Johnson Petrotech Services, Inc.
Kahuna Ventures

McDaniel Technical Services, Inc.
Monico Monitoring, Inc.
Nexo Solutions
Nitro-Lift Technologies LLC
Pantechs Laboratories, Inc.
PERC Engineering, LLC
PLC Construction Inc.
Scott Measurement Service, Inc.
Shawcor
SPL, Inc.
Texas Turbine, Inc.
TM-EMS, LLC
TRC Companies, Inc.
Trimeric Corp.
UniversalPegasus International
Wasson-ECE
Wood
Zedi US
Zeochem

INSPECTIONS, TESTING, ANALYSIS — PIPELINE

Audubon
Barr Engineering Co.
Bartlett & West
CAM Integrated Solutions
CECO-Compressor Engineering Corp.
Charbonneau Industries, Inc.
Coastal Chemical Co., LLC
FESCO, Ltd.
Gas Analytical Services
GHD Services, Inc.
Graves Analytical Services, LLC
Hunt, Guillot & Associates
Johnson Petrotech Services, Inc.
Kahuna Ventures
McDaniel Technical Services, Inc.
Nitro-Lift Technologies LLC
NorthStar Energy Services, Inc.
PERC Engineering, LLC
PLC Construction Inc.
Shawcor
SPL, Inc.
STS Consulting Services
TM-EMS, LLC
TRC Companies, Inc.
UniversalPegasus International
Wood
Zedi US

OPERATION, MAINTENANCE, RELIABILITY — ANALYTICAL LABORATORIES

Diablo Analytical, Inc.
Environex
EXTERRAN
FESCO, Ltd.
Gas Analytical Services
Graves Analytical Services, LLC
Johnson Petrotech Services, Inc.
Nexo Solutions
Pantechs Laboratories, Inc.
Scott Measurement Service, Inc.
Shamrock Gas Analysis
SPL, Inc.
TM-EMS, LLC
Zedi US

OPERATION, MAINTENANCE, RELIABILITY — FAILURE ANALYSIS

Baker Hughes, a GE company
Charbonneau Industries, Inc.
Emerson
Environex
Gas Technology Corp.
GHD Services, Inc.
Linde Engineering North America Inc.
Monico Monitoring, Inc.
Neuman & Esser USA, Inc.
Samuel Engineering, Inc.
Texas Turbine, Inc.
Wood
Worldwide Exchangers, LLC

OPERATION, MAINTENANCE, RELIABILITY — INSPECTIONS

Audubon
Charbonneau Industries, Inc.
GHD Services, Inc.
Hunt, Guillot & Associates
L.A. Turbine
Linde Engineering North America Inc.
Neuman & Esser USA, Inc.
Nitro-Lift Technologies LLC
Ref-Chem LP
Samuel Engineering, Inc.
Shawcor
STS Consulting Services
TRC Companies, Inc.
Vavco, LLC
Wood

OPERATION, MAINTENANCE, RELIABILITY — INSULATION, PAINTING

Gas Technology Corp.
ISTI Plant Services
Oil-GasTech, Inc.
Saulsbury Industries, Inc.
Wood

OPERATION, MAINTENANCE, RELIABILITY — MACHINING AND REPAIR

Atlas Copco Gas and Process
Baker Hughes, a GE company
CECO-Compressor Engineering Corp.
Charbonneau Industries, Inc.
CSI Compressco LP
Emerson

Enerflex
Gas Technology Corp.
Great Western Valve, Inc.
Neuman & Esser USA, Inc.
SPL, Inc.
Wagner Power Systems
Wood
Worldwide Exchangers, LLC

OPERATION, MAINTENANCE, RELIABILITY — MEASUREMENT

Cameron, A Schlumberger Company
Coastal Flow Measurement, Inc.
Diablo Analytical, Inc.
Emerson
Graves Analytical Services, LLC
Mangan, Inc.
Neuman & Esser USA, Inc.
Omni Flow Computers, Inc.
Samuel Engineering, Inc.
SPL, Inc.
TM-EMS, LLC
TRC Companies, Inc.
Wood

OPERATION, MAINTENANCE, RELIABILITY — PERFORMANCE ANALYSIS

Baker Hughes, a GE company
Black & Veatch Corp.
Charbonneau Industries, Inc.
EMD, Inc.
Emerson
Environex
Gas Technology Corp.
Graves Analytical Services, LLC
Halff TriTex, Inc.
JEM Resources & Engineering, Inc.
L.A. Turbine
Linde Engineering North America Inc.
Monico Monitoring, Inc.
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Nexo Solutions
Nicholas Consulting Group, Inc.
Pantechs Laboratories, Inc.
Pasadyn, Inc.
Petron Asia Energy PTE Ltd.
River City Engineering
Ross Engineering, LLC
Samuel Engineering, Inc.
Texas Turbine, Inc.
TRC Companies, Inc.
Trimeric Corp.
UniversalPegasus International
Vavco, LLC
Wood

OPERATION, MAINTENANCE, RELIABILITY — SERVICES

AECOM
Anguil Environmental Systems
Archrock, Inc.
Atlas Copco Gas and Process
Baker Hughes, a GE company
Bilfinger Westcon, Inc.
Black & Veatch Corp.
Cameron, A Schlumberger Company
CECO-Compressor Engineering Corp.
Charbonneau Industries, Inc.
Chiyoda Corp.
CSI Compressco LP
EMD, Inc.
Emerson
Enerflex
Environex
Federal Services, LLC
Gas Technology Corp.
GasTech Engineering, LLC
Graves Analytical Services, LLC
Jacobs
KBR
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Nexo Solutions
Nitro-Lift Technologies LLC
Oil-GasTech, Inc.
Saulsbury Industries, Inc.
Shamrock Gas Analysis
SNC-Lavalin
Spartan Energy Partners
STS Consulting Services
TM-EMS, LLC
TRC Companies, Inc.
Vavco, LLC
Wood
Worldwide Exchangers, LLC

PROCESS CONTROLS — INSTRUMENT AND ELECTRICAL CONSTRUCTION

Anvil Corporation
Audubon
Barr Engineering Co.
Barry D. Payne & Associates, Inc.
Bilfinger Westcon, Inc.
Black & Veatch Corp.
Buffalo Gap Instrumentation & Electrical
Coastal Flow Measurement, Inc.
Dave Allert Co.
EMD, Inc.
Emerson
EnerSys Corporation
ENGlobal U.S. Inc.
FW Murphy Production Controls
Gas Technology Corp.
GasTech Engineering, LLC

GEA Refrigeration North America, Inc.
GHD Services, Inc.
Honeywell UOP
J.S. James Co.
LCM Industries, Inc.
Linde Engineering North America Inc.
Mangan, Inc.
Master Corporation
Moore Control Systems, Inc.
Nicholas Consulting Group, Inc.
NorthStar Energy Services, Inc.
Oil-GasTech, Inc.
Optimized Process Designs
PLC Construction Inc.
Prime Controls, LP
Relevant Solutions
Reset Energy
Ross Engineering, LLC
Samuel Engineering, Inc.
Saulsbury Industries, Inc.
Select Engineering, Inc.
Sigma Thermal, Inc.
SPL, Inc.
Strategic Automation Services, LLC
TRC Companies, Inc.
UniversalPegasus International
Vavco, LLC
Vinson Process Controls
Wanzek Construction, Inc.
Wood

PROCESS CONTROLS — LICENSED PROCESSES

Barry D. Payne & Associates, Inc.
Black & Veatch Corp.
Dave Allert Co.
EMD, Inc.
Emerson
EXTERRAN
GEA Refrigeration North America, Inc.
GHD Services, Inc.
Huntsman Corp.
KBR
PLC Construction Inc.
Prime Controls, LP
Vinson Process Controls

TECHNOLOGY — LNG PROCESSES

AECOM
Atlas Copco Gas and Process
Audubon
Azota Ltd.
Black & Veatch Corp.
Cameron, A Schlumberger Company
Chart Industries
CryoSys
Emerson
EXTERRAN
Gas Technology Corp.
GasTech Engineering, LLC
J. H. Foglietta Consulting, LLC
Johnson Petrotech Services, Inc.
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nexo Solutions
Pasadyn, Inc.
Pentair
Petron Asia Energy PTE Ltd.
Ross Engineering, LLC
Wood
Zeochem

TECHNOLOGY — NITROGEN REJECTION

AECOM
Azota Ltd.
Black & Veatch Corp.
Chart Industries
CryoSys
Emerson
Honeywell UOP
J. H. Foglietta Consulting, LLC
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nitro-Lift Technologies LLC
Pasadyn, Inc.
Petron Asia Energy PTE Ltd.
Ross Engineering, LLC
Wood
Zeochem

TECHNOLOGY — OFFGAS RECOVERY

AECOM
Anguil Environmental Systems
Azota Ltd.
Black & Veatch Corp.
CryoSys
Dickson Process Systems, Ltd.
Emerson
Gas Technology Corp.
GEA Refrigeration North America, Inc.
Interstate Treating, Inc.
J. H. Foglietta Consulting, LLC
Linde Engineering North America Inc.
Neuman & Esser USA, Inc.
Pasadyn, Inc.
Pentair
Petron Asia Energy PTE Ltd.
Ross Engineering, LLC
SNC-Lavalin
Trimeric Corp.
UniversalPegasus International
Vavco, LLC
Wood
Zeochem

TRAINING, PUBLICATIONS — PIPELINE MAPS & DATA

Barr Engineering Co.
COMPRESSORtech
SULPETRO, Inc.

TRAINING, PUBLICATIONS — PROCESS

Black & Veatch Corp.
COMPRESSORtech
Dickson Process Systems, Ltd.
Federal Services, LLC
Gulf Publishing Co.
Halff TriTex, Inc.
J. H. Foglietta Consulting, LLC
Nexo Solutions
Optimized Gas Treating, Inc.
Pasadyn, Inc.
QuantityWare GmbH
River City Engineering
Selective Adsorption Associates, Inc.
SULPETRO, Inc.
Trimeric Corp.
Vavco, LLC

TREATING — GAS

AECOM
Anguil Environmental Systems
ARC Energy Equipment
Audubon
Bartlett Equipment Co.
Black & Veatch Corp.
CAID Industries
Coastal Chemical Co., LLC
ColdStream Energy
CryoSys
Dickson Process Systems, Ltd.
Enerflex
EXTERRAN
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gulf Coast Chemical, LLC
Halff TriTex, Inc.
Honeywell UOP
Huntsman Corp.
Industrial Distributors, Inc.
INEOS GAS/SPEC Technology Group
Interra Global Corp.
Interstate Treating, Inc.
Jasper Ventures, Inc.
Johnson Matthey
Johnson Petrotech Services, Inc.
Joule Processing, LLC
Kahuna Ventures
KP Engineering, LP
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nexo Solutions
Optimized Process Designs
Pasadyn, Inc.
Pentair
PLC Construction Inc.
Q.B. Johnson Manufacturing, Inc.
Reset Energy
Ross Engineering, LLC
Samuel Engineering, Inc.
Select Engineering, Inc.
Selective Adsorption Associates, Inc.
Sepra-Chem Corp.
SNC-Lavalin
Spartan Energy Partners
Spitzer Industries
STS Consulting Services
Tomcej Engineering Inc.
Trimeric Corp.
Tryer Process Equipment
Univar
UniversalPegasus International
USA Compression
Vapor Point
Wanzek Construction, Inc.
Wood
Zeochem

TREATING — LIQUID

AECOM
Anguil Environmental Systems
ARC Energy Equipment
Audubon
Black & Veatch Corp.
CAID Industries
Coastal Chemical Co., LLC
Enerflex
EXTERRAN
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gulf Coast Chemical, LLC
Halff TriTex, Inc.
Honeywell UOP
Huntsman Corp.
Industrial Distributors, Inc.
INEOS GAS/SPEC Technology Group
Interra Global Corp.
Interstate Treating, Inc.
Johnson Matthey
Johnson Petrotech Services, Inc.
Joule Processing, LLC
Kahuna Ventures
KP Engineering, LP
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nexo Solutions
Optimized Process Designs
Pasadyn, Inc.

Pentair
PLC Construction Inc.
Q.B. Johnson Manufacturing, Inc.
Reset Energy
Ross Engineering, LLC
Samuel Engineering, Inc.
Select Engineering, Inc.
Selective Adsorption Associates, Inc.
Sepra-Chem Corp.
SNC-Lavalin
Spartan Energy Partners
STS Consulting Services
Tomcej Engineering Inc.
Trimeric Corp.
Univar
UniversalPegasus International
Wanzek Construction, Inc.
Wood
Zeochem

Supplies

GPSA

Sixty Sixty American Plaza, Suite 700
Tulsa, Oklahoma 74135
Phone: 918-493-3872
Fax: 918-493-3875
Email: DataBook@GPSAmidstream suppliers.org
http://GPSAmidstream suppliers.org

The following is a listing of GPSA member companies classified by the type of services that they provide to the industry.

ADSORBENTS, CATALYSTS, MOLESIEVES

Anguil Environmental Systems
Catalytic Combustion Corporation
CECA Molecular Sieves/Arkema, Inc.
Chemical Products Industries, Inc.
Coastal Chemical Co., LLC
Enerflex
EXTERRAN
Forum Energy Technologies
GasTech Engineering, LLC
Gulf Coast Chemical, LLC
Industrial Distributors, Inc.
Interra Global Corp.
Johnson Matthey
MIRATECH Group, LLC.
Selective Adsorption Associates, Inc.
Western Filter Co., Inc.
Zeochem

ANALYZERS, SAMPLING SYSTEMS

Accurate Lab Audits, LLC
Analytical Systems Keco
Cameron, A Schlumberger Company
Dave Allert Co.
Diablo Analytical, Inc.
Emerson
ENGlobal U.S. Inc.
FESCO, Ltd.
Gas Analytical Services
Graves Analytical Services, LLC
Heath Consultants Incorporated
JP3 Measurement
Metal Goods Manufacturing Co. Inc.
Moore Control Systems, Inc.
Relevant Solutions
SpectraSensors an Endress+Hauser Co.
SPL, Inc.
TM-EMS, LLC
Wasson-ECE

AUTOMATION, INSTRUMENTS, PROCESS CONTROLS

Aeon PEC
ARC Energy Equipment
Barry D. Payne & Associates, Inc.
Bartlett Equipment Co.
Buffalo Gap Instrumentation & Electrical
CAID Industries
Catalytic Combustion Corporation
Charbonneau Industries, Inc.
Coastal Flow Measurement, Inc.
Dave Allert Co.
Diablo Analytical, Inc.
DistributionNow
EMD, Inc.
Emerson
Enerflex
Federal Services, LLC
FW Murphy Production Controls
GasTech Engineering, LLC
JP3 Measurement
Kahuna Ventures
LCM Industries, Inc.
Mangan, Inc.
Monico Monitoring, Inc.
Moore Control Systems, Inc.
PLC Construction Inc.
Prime Controls, LP
Puffer Sweiven
Relevant Solutions
Reset Energy
SEC Energy Products & Services, LP
Select Engineering, Inc.
Sigma Thermal, Inc.
SPL, Inc.
Strategic Automation Services, LLC
Texas Turbine, Inc.
TM-EMS, LLC
TRC Companies, Inc.

Vavco, LLC
Vinson Process Controls
Wasson-ECE

BUILDINGS

Dave Allert Co.
Enerflex
ENGlobal U.S. Inc.
Moore Control Systems, Inc.
TM-EMS, LLC
Wasson-ECE
Wood

CHEMICALS

Chemical Products Industries, Inc.
Coastal Chemical Co., LLC
Eastman Therminol
Gulf Coast Chemical, LLC
Huntsman Corp.
INEOS GAS/SPEC Technology Group
Nexo Solutions
Paratherm - Heat Transfer Fluids
Univar
Wasson-ECE

COMPLIANCE (CONTINGENCY PLANS, EMISSION CONTROLS, SAFETY EQUIPMENT)

Anguil Environmental Systems
Catalytic Combustion Corporation
Contek Solutions, LLC
Environex
Flatrock Engineering and Environmental
FW Murphy Production Controls
Heath Consultants Incorporated
Johnson Petrotech Services, Inc.
MIRATECH Group, LLC.
Monico Monitoring, Inc.
Robert R. Reis, Attorney-Mediator, P.C.
TRC Companies, Inc.
Tri-Point Oil & Gas Production Systems
Vapor Point
Western Filter Co., Inc.

COMPRESSORS (AND PARTS)

ARC Energy Equipment
Archrock, Inc.
Ariel Corporation
Atlas Copco Gas and Process
Baker Hughes, a GE company
Baker Hughes, a GE company
Cameron, A Schlumberger Company
CECO-Compressor Engineering Corp.
CSI Compressco LP
Dave Allert Co.
Dearing Compressor & Pump Co.
Enerflex
FES-Southwest, Inc.
Gas Equipment Co., Inc.
GEA Refrigeration North America, Inc.
Global Compressor, LP
L.A. Turbine
Mitsubishi Heavy Industries Compressor International
Monico Monitoring, Inc.
Neuman & Esser USA, Inc.
Petron Asia Energy PTE Ltd.
Relevant Solutions
SEC Energy Products & Services, LP
SNC-Lavalin
Solar Turbines, Inc.
Texas Turbine, Inc.
UEC, LLC
Western Filter Co., Inc.
York Process Systems

ELECTRIC MOTORS (AND SUPPLIES)

Baker Hughes, a GE company
Baker Hughes, a GE company
Buffalo Gap Instrumentation & Electrical
CSI Compressco LP
Dave Allert Co.
EMD, Inc.
Enerflex
Gas Equipment Co., Inc.
Neuman & Esser USA, Inc.
Rotor-Tech, Inc.
SEC Energy Products & Services, LP
UEC, LLC
Wagner Power Systems

ENGINES (AND PARTS)

ARC Energy Equipment
Archrock, Inc.
Baker Hughes, a GE company
Baker Hughes, a GE company
CSI Compressco LP
Cummins, Inc.
Enerflex
GE Distributed Power, Inc.
Global Compressor, LP
Monico Monitoring, Inc.
Neuman & Esser USA, Inc.
SNC-Lavalin
Solar Turbines, Inc.
UEC, LLC
Wagner Power Systems
Western Filter Co., Inc.

FILTERS

Aeon PEC
ARC Energy Equipment
Bartlett Equipment Co.
CAID Industries
Champion Process, Inc.
Fluid Flow Products, Inc.
Forum Energy Technologies

Freeman and Curiel Engineers, LLP
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Global Compressor, LP
Industrial Distributors, Inc.
Jonell, Inc.
MIRATECH Group, LLC.
Nexo Solutions
Parker IPF (PECO) Parker Hannifin Corp.
PSI (Process Solutions Integration)
Q.B. Johnson Manufacturing, Inc.
R&H Technical Sales, Inc.
Relevant Solutions
Rotor-Tech, Inc.
Royal Filter Mfg. Co., Inc.
Schultz Process Services, Inc.
SEC Energy Products & Services, LP
Sepra-Chem Corp.
Solar Turbines, Inc.
Western Filter Co., Inc.

FIRED EQUIP (BOILERS, FLARES, HEATERS)

Aeon PEC
Anguil Environmental Systems
ARC Energy Equipment
Bartlett Equipment Co.
Catalytic Combustion Corporation
Enerflex
Files and Associates
Fluid Flow Products, Inc.
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
Heat Transfer Specialists, Inc.
Heatec, Inc.
Linde Engineering North America Inc.
Matrix PDM Engineering
Optimized Process Furnaces
Q.B. Johnson Manufacturing, Inc.
Relevant Solutions
Reset Energy
Scelerin Heaters, LLC
Sigma Thermal, Inc.
Spitzer Industries
Tri-Point Oil & Gas Production Systems

INDUSTRIAL AND SPECIALTY GASES

Accurate Gas Products, LLC
Airgas
Lampton Welding Supply Co., Inc.
Red Ball Technical Gas Services

MEMBRANES

ARC Energy Equipment
Fluid Flow Products, Inc.
Industrial Distributors, Inc.
Nitro-Lift Technologies LLC
Relevant Solutions

ODORIZATION, ODOR CONTROL

Anguil Environmental Systems
Catalytic Combustion Corporation
Heath Consultants Incorporated
Schultz Process Services, Inc.
Vapor Point

PACKAGED SYSTEMS

AECOM
Aeon PEC
Anguil Environmental Systems
ARC Energy Equipment
Atlas Copco Gas and Process
Baker Hughes, a GE company
Baker Hughes, a GE company
CAID Industries
Catalytic Combustion Corporation
Champion Process, Inc.
Charbonneau Industries, Inc.
CSI Compressco LP
Dave Allert Co.
Dearing Compressor & Pump Co.
Dickson Process Systems, Ltd.
DistributionNow
Emerson
Enerflex
EXTERRAN
Federal Services, LLC
FES-Southwest, Inc.
Files and Associates
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Heatec, Inc.
Holloman Corporation
Hunt, Guillot & Associates
Jasper Ventures, Inc.
Joule Processing, LLC
Koch-Glitsch LP
KP Engineering, LP
Linde Engineering North America Inc.
Matrix PDM Engineering
MIRATECH Group, LLC.
MODEC International, Inc.
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Nexo Solutions
Q.B. Johnson Manufacturing, Inc.
R&H Technical Sales, Inc.
Regard Resources Co., Inc.
Relevant Solutions
Reset Energy
Schultz Process Services, Inc.
Selective Adsorption Associates, Inc.
Sigma Thermal, Inc.
SNC-Lavalin
Solar Turbines, Inc.
Spartan Energy Partners
Spitzer Industries

SPL, Inc.
Taylor Forge Engineered Systems
Texas Turbine, Inc.
TM-EMS, LLC
Tri-Point Oil & Gas Production Systems
Tryer Process Equipment
UEC, LLC
VGas, LLC
VME
Wagner Power Systems
York Process Systems

PIPE, VALVES, FITTINGS, REGULATORS

Accurate Gas Products, LLC
Aeon PEC
ARC Energy Equipment
Bartlett Equipment Co.
Cameron, A Schlumberger Company
Charbonneau Industries, Inc.
Corpac Steel Products Corp.
DistributionNow
Emerson
Federal Services, LLC
FESCO, Ltd.
Field Industries LLC
FW Murphy Production Controls
Gas Equipment Co., Inc.
Gas Technology Corp.
GasTech Engineering, LLC
Joule Processing, LLC
LCM Industries, Inc.
Metal Goods Manufacturing Co. Inc.
PSI (Process Solutions Integration)
Scott Measurement Service, Inc.
SPL, Inc.
Taylor Forge Engineered Systems
TM-EMS, LLC
Tri-Point Oil & Gas Production Systems
Vinson Process Controls

PIPELINE EQUIPMENT (INSTALLATION, PIGGING, REPAIR)

Baker Hughes, a GE company
Champion Process, Inc.
Forum Energy Technologies
GasTech Engineering, LLC
Moore Control Systems, Inc.
R&H Technical Sales, Inc.
Saulsbury Industries, Inc.
Schultz Process Services, Inc.
Taylor Forge Engineered Systems
TM-EMS, LLC
TRC Companies, Inc.
Western Filter Co., Inc.
Wood

PROCESS EQUIPMENT — AIR COOLERS

Aeon PEC
Alfa Laval Niagara
ARC Energy Equipment
Bartlett Equipment Co.
Chart Industries
CSI Compressco LP
Enerflex
EXTERRAN
Fabsco Shell & Tube, LLC
Files and Associates
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Heat Transfer Specialists, Inc.
Joule Processing, LLC
Petron Asia Energy PTE Ltd.
Ref-Chem LP
Relevant Solutions
Reset Energy
Smithco Engineering, Inc.
Spartan Energy Partners
Wood
Worldwide Exchangers, LLC

PROCESS EQUIPMENT — DEHYDRATION

AECOM
Aeon PEC
Aqseptence Group, Inc.
ARC Energy Equipment
BWFS Industries, LLC
CAID Industries
Charbonneau Industries, Inc.
CryoSys
CSI Compressco LP
Dickson Process Systems, Ltd.
Enerflex
EXTERRAN
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gemstar, Inc.
Heatec, Inc.
Honeywell UOP
Interstate Treating, Inc.
Joule Processing, LLC
Koch-Glitsch LP
KP Engineering, LP
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Nexo Solutions
Norwood S&S, LLC
Q.B. Johnson Manufacturing, Inc.
Ref-Chem LP
Regard Resources Co., Inc.
Relevant Solutions
Reset Energy
Rhine Ruhr Pty, Ltd.

Rotor-Tech, Inc.
Schultz Process Services, Inc.
SEC Energy Products & Services, LP
Select Engineering, Inc.
SNC-Lavalin
Spartan Energy Partners
Spitzer Industries
Tri-Point Oil & Gas Production Systems
Tryer Process Equipment
VGas, LLC
VME
Wood
York Process Systems

PROCESS EQUIPMENT — MEASUREMENT

AECOM
Analytical Systems Keco
ARC Energy Equipment
CAID Industries
Cameron, A Schlumberger Company
Charbonneau Industries, Inc.
Dave Allert Co.
DistributionNow
EMD, Inc.
Emerson
Enerflex
Federal Services, LLC
FESCO, Ltd.
Forum Energy Technologies
Gas Analytical Services
GEA Refrigeration North America, Inc.
Graves Analytical Services, LLC
JP3 Measurement
L.A. Turbine
Moore Control Systems, Inc.
Omni Flow Computers, Inc.
R&H Technical Sales, Inc.
Relevant Solutions
Schultz Process Services, Inc.
Select Engineering, Inc.
SNC-Lavalin
Spitzer Industries
SPL, Inc.
TM-EMS, LLC
VME
Wasson-ECE
Wood
Zedi US

PROCESS EQUIPMENT — TURBOEXPANDERS

ARC Energy Equipment
Atlas Copco Gas and Process
Bartlett Equipment Co.
CAID Industries
Enerflex
Honeywell UOP
Joule Processing, LLC
KP Engineering, LP
L.A. Turbine
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Petron Asia Energy PTE Ltd.
Q.B. Johnson Manufacturing, Inc.
Texas Turbine, Inc.
Wood

PROCESS EQUIPMENT — VAPOR RECOVERY UNITS

ARC Energy Equipment
CAID Industries
Catalytic Combustion Corporation
CSI Compressco LP
Dearing Compressor & Pump Co.
Dew Point Control, LLC
Emerson
Enerflex
EXTERRAN
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Heat Transfer Specialists, Inc.
Joule Processing, LLC
Linde Engineering North America Inc.
Moore Control Systems, Inc.
Norwood S&S, LLC
Q.B. Johnson Manufacturing, Inc.
Ref-Chem LP
Reset Energy
Select Engineering, Inc.
SNC-Lavalin
Spartan Energy Partners
Texas Turbine, Inc.
Vapor Point
VGas, LLC
Wood
York Process Systems

PROCESS EQUIPMENT — VESSELS, TANKS

AECOM
Aeon PEC
Aqseptence Group, Inc.
ARC Energy Equipment
BWFS Industries, LLC
CAID Industries
Champion Process, Inc.
Chart Industries
Dearing Compressor & Pump Co.
Dew Point Control, LLC
Dickson Process Systems, Ltd.
Echo Group, Ltd.
Enerflex
Files and Associates
Forum Energy Technologies
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gemstar, Inc.
Heatec, Inc.

Industrial Distributors, Inc.
Interstate Treating, Inc.
Joule Processing, LLC
Koch-Glitsch LP
Matrix PDM Engineering
Moore Control Systems, Inc.
Nitro-Lift Technologies LLC
Norwood S&S, LLC
Parker IPF (PECO) Parker Hannifin Corp.
PSI (Process Solutions Integration)
R&H Technical Sales, Inc.
Regard Resources Co., Inc.
Relevant Solutions
Rhine Ruhr Pty, Ltd.
Schultz Process Services, Inc.
SEC Energy Products & Services, LP
Select Engineering, Inc.
SNC-Lavalin
Spitzer Industries
Taylor Forge Engineered Systems
Trinity Containers, LLC
Tri-Point Oil & Gas Production Systems
Tryer Process Equipment
VGas, LLC
VME
Western Filter Co., Inc.
Wood
Worldwide Exchangers, LLC

PROCESS EQUIPMENT — WASTE HEAT RECOVERY

Aeon PEC
Anguil Environmental Systems
ARC Energy Equipment
Atlas Copco Gas and Process
Bartlett Equipment Co.
CAID Industries
Enerflex
EXTERRAN
Files and Associates
Gas Technology Corp.
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Heat Transfer Specialists, Inc.
Heatec, Inc.
Joule Processing, LLC
Linde Engineering North America Inc.
Matrix PDM Engineering
MIRATECH Group, LLC.
Optimized Process Furnaces
Petron Asia Energy PTE Ltd.
R&H Technical Sales, Inc.
Relevant Solutions
Scelerin Heaters, LLC
Sigma Thermal, Inc.
Spartan Energy Partners
Texas Turbine, Inc.
Wood

PROCESS EQUIPMENT — CRYOGENIC

ARC Energy Equipment
Atlas Copco Gas and Process
BWFS Industries, LLC
CAID Industries
Charbonneau Industries, Inc.
Chart Industries
CryoSys
Emerson
Enerflex
EXTERRAN
Files and Associates
Forum Energy Technologies
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gemstar, Inc.
Heatec, Inc.
Honeywell UOP
Jasper Ventures, Inc.
Joule Processing, LLC
Koch-Glitsch LP
KP Engineering, LP
L.A. Turbine
Linde Engineering North America Inc.
Metal Goods Manufacturing Co. Inc.
Moore Control Systems, Inc.
Norwood S&S, LLC
Petron Asia Energy PTE Ltd.
R&H Technical Sales, Inc.
Relevant Solutions
Select Engineering, Inc.
SNC-Lavalin
Spitzer Industries
Texas Turbine, Inc.
VGas, LLC

PROCESS EQUIPMENT — EXCHANGERS

Aeon PEC
Anguil Environmental Systems
ARC Energy Equipment
Atlas Copco Gas and Process
AXH Air-Coolers
Bartlett Equipment Co.
CAID Industries
Chart Industries
Dew Point Control, LLC
Echo Group, Ltd.
Enerflex
EXTERRAN
Fabsco Shell & Tube, LLC
Federal Services, LLC
FES-Southwest, Inc.
Files and Associates
Forum Energy Technologies
Gas Technology Corp.
GEA Refrigeration North America, Inc.
Heat Transfer Specialists, Inc.
Joule Processing, LLC
L.A. Turbine
Linde Engineering North America Inc.

Petron Asia Energy PTE Ltd.
R&H Technical Sales, Inc.
Ref-Chem LP
Regard Resources Co., Inc.
Relevant Solutions
Spartan Energy Partners
Taylor Forge Engineered Systems
Tri-Point Oil & Gas Production Systems
Worldwide Exchangers, LLC
York Process Systems

PROCESS EQUIPMENT — LNG

ARC Energy Equipment
Atlas Copco Gas and Process
CAID Industries
Champion Process, Inc.
Charbonneau Industries, Inc.
Chart Industries
CryoSys
CSI Compressco LP
Emerson
Enerflex
EXTERRAN
Files and Associates
GasTech Engineering, LLC
GEA Refrigeration North America, Inc.
Gemstar, Inc.
Heatec, Inc.
Koch-Glitsch LP
L.A. Turbine
Linde Engineering North America Inc.
Metal Goods Manufacturing Co. Inc.
Moore Control Systems, Inc.
Norwood S&S, LLC
Petron Asia Energy PTE Ltd.
R&H Technical Sales, Inc.
Ref-Chem LP
Relevant Solutions
Reset Energy
Schultz Process Services, Inc.
Sigma Thermal, Inc.
Spartan Energy Partners
Texas Turbine, Inc.
VGas, LLC
York Process Systems

PUMPS

ARC Energy Equipment
Bartlett Equipment Co.
CAID Industries
Champion Process, Inc.
CSI Compressco LP
Dearing Compressor & Pump Co.
Enerflex
Federal Services, LLC
Gas Equipment Co., Inc.
Gas Technology Corp.
Joule Processing, LLC
Petron Asia Energy PTE Ltd.
Puffer Sweiven
Rotor-Tech, Inc.
Select Engineering, Inc.
SERO PumpSystems, Inc.
SNC-Lavalin
Solar Turbines, Inc.
Wagner Power Systems
Western Filter Co., Inc.

RECONDITIONED, SURPLUS EQUIPMENT

Aeon PEC
ARC Energy Equipment
Archrock, Inc.
Cameron, A Schlumberger Company
Charbonneau Industries, Inc.
Emerson
Enerflex
Gas Technology Corp.
Interstate Treating, Inc.
Joule Processing, LLC
Moore Control Systems, Inc.
Neuman & Esser USA, Inc.
Regard Resources Co., Inc.
Reset Energy
SEC Energy Products & Services, LP
Solar Turbines, Inc.
TM-EMS, LLC
Tri-Point Oil & Gas Production Systems
Vinson Process Controls

SOFTWARE

Atlas Copco Gas and Process
Bryan Research & Engineering, LLC
Dave Allert Co.
Diablo Analytical, Inc.
EMD, Inc.
ENGlobal U.S. Inc.
Gas Analytical Services
Joule Processing, LLC
JP3 Measurement
Mangan, Inc.
Monico Monitoring, Inc.
Nexo Solutions
Prime Controls, LP
Virtual Materials Group
Wasson-ECE
WinSim Inc.