Strategic Petroleum Reserve
Crude Oil Assay Manual

3rd Edition
August 2008

U. S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Petroleum Reserves
Washington, DC

Table of Contents

TABLES

Page intentionally left blank

PREFACE

This booklet provides detailed information on the specifications for crude oils to be acquired for storage in the Strategic Petroleum Reserve (SPR), procedures used to assess quality of the stored petroleum during protracted storage, and methods used in developing assays of the various streams that may be sold. Assays of the eight SPR streams are provided. This edition supersedes the second edition, March 2002, as revised November 2002.

Any questions regarding sampling practices, analysis procedures, or the assays themselves should be addressed to Director, Operations and Readiness (FE-43), Office of Petroleum Reserves, Washington, DC 20585-0340, telephone +1 (202) 586-4691. This office should also be contacted for the latest edition of the SPR Crude Oil Specifications shown in Table I and a list of currently acceptable crude oils.

Page intentionally left blank

I. Acquisition and Storage of Crude Oils.

Specifications for acquisition of crude oil for storage in the Strategic Petroleum Reserve (SPR) were originally developed in 1976. At that time, six categories of crude oil were defined. These encompassed a large segment of crude oils being processed by U. S. refineries at that time – both domestic and foreign – and projections of future runs based on new fields being developed such as those on the Alaskan North Slope and in the North Sea.

These categories included one medium gravity, sour[1] crude oil of nominal Arabian Light quality; four medium gravity, sweet[1] categories, covering North and West African streams and production coming on-stream in the North Sea; and a heavy, sour category specific to Alaskan North Slope production. Later, a seventh category was added to allow for acquisition of Mexican Maya crude oil.

For practical reasons related to drawdown logistics, it was not possible to segregate all these various categories in storage and essentially four segregations evolved. The two largest of these in terms of volume were a medium gravity, sour of nominal Mexican Isthmus quality, and a medium gravity, sweet of nominal Ninian/Forties quality. Another segregation comprised Alaskan North Slope crude commingled with medium gravity, sour crude oils, and the fourth segregation was Mexican Maya. Due to technical considerations unrelated to crude oil quality or drawdown logistics, the Alaskan North Slope segregation formerly stored in the Weeks Island Mine has been relocated and commingled with medium gravity, sour crude oils. The Maya segregation has now been disposed of and replaced by other crude oils.

Today, only two specifications – one sweet and one sour, both of medium gravity – are used for acquiring crude oil for the SPR (Table I).

Member companies of the American Petroleum Institute, the National Petrochemical and Refiners Association, and other industry groups and petroleum companies have reviewed these specifications on several occasions. For the most part, these reviews have supported the specifications, and only relatively minor changes have been made. In their present form, these specifications allow for acquisition of a relatively broad slate of crude oils, both domestic and foreign.

Experience indicates that the crude oils known to conform to each category are compatible and reactions do not occur during long-term storage that will adversely affect quality of a mixture.

Currently, the SPR has a sweet and a sour segregation at each of its four sites. The approximate crude oil makeup of each of these eight segregations is summarized in Appendix A. Mexican Isthmus is the dominant crude oil comprising all four sour segregations, and U. K. Brent, Forties, and Ninian[2] are the dominant crude oils comprising three of the four sweet segregations. Girassol is the dominant crude oil comprising the Bayou Choctaw Sweet segregation.

[1] For the purposes of the SPR, sour crude oils are defined as those containing a maximum of 1.99 mass % total sulfur, and sweet crude oils are defined as those containing a maximum of 0.50 mass % total sulfur.
[2] Beginning in 1991, Ninian production was commingled with Brent and, since then, has not been a separate stream.

To maintain overall quality and minimize possible adverse reactions resulting from incompatibility, generally only crude oils of similar composition are commingled in storage. For example, North Sea crude oils such as U. K. Brent and U. K. Forties may be commingled, as would Arabian Light and Dubai. Arabian Light would not, however, be commingled with Brent or Forties, or other "sweet" crude oils. There are, however, several exceptions to this general rule. At both Bayou Choctaw and Big Hill, Alaskan North Slope has been commingled with medium gravity, sour crude oils following its transfer from the now abandoned Weeks Island Mine storage facility. And also at Bayou Choctaw and Big Hill, relatively small amounts of Maya are commingled in the sour crude oil segregations. Despite these exceptions, the composition of the crude oil mixture in the preponderance of SPR caverns conforms to one of the two specifications in Table I.

II. Crude Oil Quality Assessment Program.

Shortly after a storage cavern is initially filled with crude oil, a vertical series of samples is collected for laboratory analysis to determine quality of the mixture and provide a baseline for future quality assessments. Caverns are normally sampled again at approximately eight to twelve year intervals.

An inspection analysis (Table I) of each cavern sample is performed to ascertain if there is any stratification or differentiation of the crude oil mixture. If none is evident, a composite sample is made of the individual oil samples for comprehensive analysis in accordance with standard methods[3]. Should stratification or differentiation be apparent, each individual sample or a combination of samples will be analyzed separately using the same methods. On the basis of extensive studies of crude oil stockpiles in both the United States and Germany, it is evident that convective mixing induced by the natural geothermal gradient in the salt stock results in commingled crude oils becoming well mixed when stored in large underground caverns such as those of the SPR[4]. In most cases, little or no difference in quality will be present within 18 to 24 months following completion of cavern fill. While no deleterious changes in quality are known to occur to crude oil stored in solution-mined caverns in salt, a relatively small volume of dense, viscous, and waxy material containing emulsified water may accumulate in some caverns. This "sludge or rag layer" appears to be a natural phenomenon and not the result of incompatibility between various crude oils commingled in storage[5]. This layer is not removed from a cavern during a drawdown and does not become a component of the stream that is sold.

[3] *Manual on Significance of Tests for Petroleum Products* – 7th Edition, S. J. Rand, Editor. Chapter 5, "Crude Oils." ASTM, West Conshohocken, PA, 2002.
[4] "Stability of Refined Products and Crude Oil Stored in Large Caverns in Salt Deposits: Biogeochemical Aspects." H. N. Giles and others, *Energy & Fuels*, July 1991.
[5] "Microbial Aspects of Crude Oil Storage in Salt Dome Caverns." R. A. Neihof and H. N. Giles, *Biodeterioration and Biodegradation 8*, H. W. Rossmoore, Editor, Elsevier Applied Science, London, 1991.

III. Laboratory Procedures.

All crude oil samples are analyzed using ASTM standard test methods[6] to the maximum extent possible, following the scheme depicted in Table III. Distillation of the crude oil samples or composites is performed in accordance with ASTM D 2892 Standard Test Method for *Distillation of Crude Petroleum (15-Theoretical Plate Column)* at pressures of atmospheric to 0.266 kPa. Subsequent distillation of the residuum at a pressure of 0.13 kPa is performed using ASTM D 5236 Standard Test Method for *Distillation of Heavy Hydrocarbon Mixtures (Vacuum Potstill Method)*. Distillation is on a mass percent basis, with volume percent calculated using specific gravity of the fractions.

Detailed **P**araffin, **I**soparaffin, **A**romatic, **N**aphthene (PIAN) analysis of the naphtha fractions to 191°C (375°F) for C_1 through C_{12} hydrocarbons is performed using a modified version of ASTM D 5134 Standard Test Method for *Detailed Analysis of Petroleum Naphthas Through n-Nonane by Capillary Gas Chromatography*. This modified version provides for elution and identification of components up to a nominal *n*-C_{12} (216°C). Analyses of the distillation fractions also use standard ASTM test methods for the most part[3], with results reported in accordance with the respective test method's instructions.

High Temperature Simulated Distillation (HTSD) data reported with the other Gas Chromatographic data in the analyses were obtained in accordance with ASTM D 7169 Standard Test Method for *Boiling Point Distribution of Samples with Residues Such as Crude Oils and Atmospheric and Vacuum Residues by High Temperature Gas Chromatography*. Data obtained according to this method are permissible in conditionally accepting a crude oil for storage, but data obtained by ASTM D 2892 and D 5236 are still required for final certification of a crude oil's acceptability.

Hydrogen sulfide. The hydrogen sulfide values reported for the whole crude are for naturally occurring, dissolved (existent) gas, while the values reported for distillation fractions represent evolved (potential) gas resulting from decomposition of thermally unstable sulfur compounds. Due to the reactivity of dissolved hydrogen sulfide, a collection and handling procedure has been adopted that reasonably assures that little of the compound is lost between the time samples are collected and later analyzed (Appendix B). Efficacy of this procedure has been corroborated using a field test specific for hydrogen sulfide[7]. A modified version of UOP 163[8] *Hydrogen Sulfide and Mercaptan Sulfur in Liquid Hydrocarbons by Potentiometric Titration* is used for determination of hydrogen sulfide in the laboratory.

Organic Chlorides. To monitor for possible contamination, all shipments of crude oil received for storage in the reserve are now routinely analyzed for organic chlorides. ASTM D 4929 Test Method for *Determination of Organic Chloride Content in Crude Oil* is used for this determination.

---

[6] All references to ASTM test methods are to the latest edition of those published by ASTM International, West Conshohocken, PA.

[7] Neihof, Rex A. *Hydrogen Sulfide Analyzer With Protective Barrier*. U. S. Patent No. 5,529,841. U. S. Patent and Trademark Office, Washington, DC, June 25, 1996.

[8] Available from ASTM International, the exclusive, worldwide distributor of UOP laboratory test methods.

Asphaltenes. ASTM D 6560 Standard Test method for *Determination of Asphaltenes (Heptane Insolubles) in Crude Petroleum and Petroleum Products* is used for determining their content in the whole crude and in the atmospheric and vacuum residuum fractions. For whole crude, the determination is made on both untopped and topped samples in accordance with the instructions in Annex A1 of the test method. Slight differences in asphaltenes content are usually observed between topped and untopped samples.

Wax. A modified version of UOP 46 *Paraffin Wax Content of Petroleum Oils and Asphalts* is used for determining mass % wax content of the whole crude and the light and heavy vacuum gas oil (VGO) fractions.

Quality Assurance. The laboratory providing crude oil analytical services for the SPR participates in the ASTM Interlaboratory Crosscheck Program for crude oil. Results from this program provide assurance that the testing is being done to the precision and accuracy of the respective test methods used. Additionally, the laboratory has an established internal quality assurance program to ensure conformance to best industry laboratory practices and in meeting defined standards of quality with a stated level of confidence.

IV. Crude Oil Composition of SPR Streams.

Each SPR crude oil stream is comprised of crude oil stored in multiple caverns. The storage volume of individual caverns varies, with most being on the order of 10 million barrels (1.6 million m^3). Depending on the magnitude of a sale and drawdown of the SPR, one or more caverns comprising the segregation may be used to make up a delivery stream. The analyses provided in Appendix C in this manual are, essentially, an average of all of the caverns comprising a given SPR stream. For five of the eight streams, these composite assays are, nevertheless, clearly indicative of the quality generally available, although some minor deviation in quality of the crude oil delivered can be expected. Detailed laboratory analyses of the crude inventory in each cavern comprising these five streams confirm that there are no significant differences in quality among them.

For the other three streams, namely Bayou Choctaw Sour, Big Hill Sweet, and Big Hill Sour, there are minor differences in crude oil composition between the individual caverns used to constitute the stream (Appendix A). While the analysis published for these three streams is also an average, the delivered stream can be expected to exhibit some minor deviation in quality from the published analysis, depending on which caverns are commingled during a drawdown. To minimize variations in quality, a proportional drawdown of caverns comprising a given stream is practiced to the extent practicable.

As analytical data exist on the crude oil composition of each storage cavern and on the crude oil streams stored, assays can be generated using the Haverly Systems, Inc. H/CAMS Crude Assay Management System. This is an important capability in two respects. First, it allows a stream-specific assay to be developed for any combination of SPR caverns. Second, caverns are normally sampled only every eight to twelve years for the purpose of assessing quality. During

the interim between cavern samplings, changes in quality could result from the storage of additional crude oil. Again, H/CAMS allows an assay to be developed using existing analytical data for the cavern and the crude oil streams stored. The number of different crude oils commingled in storage is relatively limited which enhances the reliability of computer-generated assays. This is advantageous to both the SPR and those eventually purchasing the SPR streams in assessing their value and in determining refining characteristics and product slates.

The assays are available for downloading in Microsoft Excel format on the following Web site: www.spr.doe.gov/reports/crude_oil_assays.htm They are also available in CRU file format, generated by H/CAMS. Some properties, such as RON and MON are generated separately, and values calculated by H/CAMS from the CRU files may not exactly match the posted values. These CRU files are made available upon request by contacting the Director, Operations and Readiness, as directed in the Preface.

Page intentionally left blank

Table I. SPR CRUDE OIL SPECIFICATIONS[a] (SPRO 2008 JUL)[ε1]

CHARACTERISTIC	SOUR	SWEET	PRIMARY ASTM TEST METHOD[b]
API Gravity [°API]	30 – 45	30 - 45	D 1298 or D 5002
Total Sulfur [Mass %], max.	1.99	0.50	D 4294
Pour Point [°C], max.	10	10	D 97
Salt Content [Mass %], max.	0.050	0.050	D 6470
Viscosity [cSt @ 15.6°C], max.	32	32	D 445
[cSt @ 37.8°C], max.	13	13	
Reid Vapor Pressure [kPa @ 37.8°C], max.	76	76	D 323 or D 5191
Total Acid Number [mg KOH/g], max.	1.00	1.00	D 664
Water and Sediment [Vol. %], max.	1.0	1.0	D 473 & D 4006 or D4928
Yields [Vol. %]			D 2892 & D 5236[c]
Naphtha [28-191°C]	24 - 30	21 - 42	
Distillate [191-327°C]	17 - 31	19 - 45	
Gas Oil [327-566°C]	26 - 38	20 - 42	
Residuum [>566°C]	10 – 19	14 max.	

[ε!] This revision allows for the use of D 7169 data for conditionally accepting a crude oil stream (see footnote [c]).

[a]Marketable virgin crude petroleum suitable for normal refinery processing and free of foreign contaminants or chemicals including, but not limited to, pour point depressants, chlorinated and oxygenated hydrocarbons, and lead.

[b]Alternate methods may be used if approved by the contracting officer.

[c]D 7169 data may be provided in requesting conditional acceptance of a crude oil. Distillation data according to D 2892 and D 5236 will still be necessary for final qualification of a crude oil's acceptance.

NOTE 1: The Strategic Petroleum Reserve reserves the right to refuse to accept any crude oil which meets these specifications but is deemed to be incompatible with existing stocks, or which has the potential for adversely affecting handling.

Page intentionally left blank

Table II. TYPICAL SPR CAVERN SAMPLE INSPECTION ANALYSIS

Date Started 5/8/2008 Sample ID Example Cavern Date Reported 5/21/2008

Sample Log No.	Bottle Label Date Collected	Depth (ft.)	Relative Density D 5002 at 60/60° F	Gravity °API	Pour Pt. D 5853 °F	Nitrogen D 5762 (Mass %)	Sulfur D 4294 (Mass %)	Viscosity, cSt D 445 at 77° F	Viscosity, cSt D 445 at 100° F	Water D 4928 (Mass %)
2008SPR008	EX080501-011 5/1/08	2459	0.8533	34.3	25	0.103	0.418	8.189	5.556	0.02
2008SPR009	EX080501-010 5/1/08	2793	0.8533	34.3	25	0.103	0.413	8.148	5.599	0.02
2008SPR010	EX080501-009 5/1/08	3128	0.8532	34.3	20	0.102	0.429	8.083	5.551	0.02
2008SPR011	EX080501-008 5/1/08	3462	0.8533	34.3	30	0.101	0.421	7.991	5.581	0.02
2008SPR012	EX080501-007 5/1/08	3796	0.8532	34.3	25	0.101	0.413	8.103	5.653	0.02
2008SPR013	EX080430-006 4/30/08	4130	0.8533	34.3	30	0.099	0.431	8.154	5.530	0.02
2008SPR014	EX080430-005 4/30/08	4175	0.8533	34.3	15	0.100	0.435	8.172	5.572	0.02
2008SPR015	EX080430-004 4/30/08	4179	0.8533	34.3	20	0.099	0.421	8.166	5.587	0.02
2008SPR016	EX080430-003 4/30/08	4182	0.8532	34.3	20	0.104	0.420	8.195	5.577	0.02
2008SPR017	EX080430-002 4/30/08	4185	1.2038	--	--	--	Brine	--	--	--
2008SPR018	EX080429-001 4/29/08	4189	1.2045	--	--	--	Brine	--	--	--

Page intentionally left blank

Table III. SPR Crude Oil Comprehensive Assay Grid

Property	ASTM Representative Test Methods	Whole Crude	C_2-C_4 Gases	C_5-175°F Light Naphtha	175°-250°F Medium Naphtha	250-375°F Heavy Naphtha	375-530°F Kerosine	530-650°F Distillate Fuel Oil	650-850°F Light VGO	850-1050°F Heavy VGO	650°F + Atmospheric Residuum	1050°F + Vacuum Residuum
Volume and mass % yields	**D 2892 & D 5236**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
°API, density, specific gravity	**D 5002**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Sulfur, total, mass %	**D 4294**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Sediment, mass %	**D 473**	**X**										
Water, volume %	**D 4928**	**X**										
Salt, mass %	**D 6470**	**X**										
Nitrogen, total, mass %	**D 5762**	**X**					**X**	**X**	**X**	**X**	**X**	**X**
Micro. carbon residue, mass %	**D 4530**	**X**							**X**	**X**	**X**	**X**
Pour Point	**D 5853**	**X**					**X**	**X**	**X**	**X**	**X**	
Metals: Ni, V, Fe, Cu	**D 5708**	**X**								**X**	**X**	**X**
Organic chlorides, total, ppm	**D 4929**	**X**		**X**	**X**	**X**	**X**					
UOP "K" factor	**UOP 375**	**X**					**X**	**X**	**X**	**X**		**X**
Vapor Pressure, kPa@37.8°C	**D 323 or D 6377**	**X**										
Acid number, mg KOH/g	**D 664**	**X**					**X**	**X**	**X**	**X**	**X**	**X**
H_2S and mercaptans, ppm	**UOP 163**	**X**		**X**	**X**	**X**	**X**					
Paraffins, isoparaffins, aromatics, naphthenes (PIAN)	**D 5134 modified**	**B-T-E-X**	**X**	**X**	**X**	**X**						
Viscosity, cSt, @ 77°F	**D 445**	**X**					**X**					
100°F		**X**					**X**	**X**				
130°F								**X**	**X**	**X**	**X**	
180°F									**X**	**X**	**X**	**X**
210°F												**X**
High temp. sim. distillation	**D7169**	**X**										

Property	ASTM Representative Test Methods	Whole Crude	C_2-C_4 Gases	C_5-175°F Light Naphtha	175°-250°F Medium Naphtha	250-375°F Heavy Naphtha	375-530°F Kerosine	530-650°F Distillate Fuel Oil	650-850°F Light VGO	850-1050°F Heavy VGO	650°F + Atmospheric Residuum	1050°F + Vacuum Residuum
Hydrogen and carbon, mass %	**D 5291**					**X**	**X**	**X**	**X**	**X**	**X**	**X**
Refractive Index @ 60°C	**D 1218**								**X**	**X**		
Research and Motor Octane Numbers	**Calculation from PIAN data**			**X**	**X**	**X**						
Asphaltenes, mass %	**D 6560**	**X**									**X**	**X**
Wax, mass %	**UOP 46, modified**	**X**							**X**	**X**		
Aniline Point	**D 611**					**X**	**X**	**X**	**X**	**X**		
Cetane Index	**D 976**						**X**	**X**	**X**			
Naphthalenes, volume %	**D 1840**					**X**	**X**	**X**				
Aromatics, volume %	**D 1319**						**X**					
Smoke Point, mm	**D 1322**					**X**	**X**	**X**				
Freezing Point	**D 2386**						**X**					
Cloud Point	**D 5773**						**X**	**X**	**X**	**X**		

Appendix A. Approximate Crude Oil Composition of SPR Streams[1,2]

Bayou Choctaw Sweet

Crude Oil	Volume %
Girassol	23
Ninian	16
Es Sider	11
Brent, LLS, & SLS	8 each
Cusiana and Forties	5 each
HLS, Kole, Oseberg, Qua Iboe, Sirtica, & Zarzaitine	<3 each

Bayou Choctaw Sour

Crude Oil	Volume %
Isthmus	35
Iranian Light	23
Alaskan North Slope	13
Maya	7
Arabian Light, Dubai, Gulf of Suez Blend, & Mars	4 each
Mandji, Mesa 30, Oman, & Upper Zakum	<2 each

Big Hill Sweet

Crude Oil	Volume %
Brent	29
Girassol, NPR CA Stevens Zone, & Zafiro	13 each
Oseberg	9
Es Sider, Kole, & Santa Barbara (Venezuela)	5 each
Forties	<3

[1]Quality of some crude oils changed significantly during the period they were received by the SPR. Among these are Ekofisk, Forties, Girassol, and Isthmus.

[2]Small quantities of crude oils other than those listed totaling less than 1 – 3% of overall volume may be present in a given stream. These, and rounding errors, may result to columns not adding to 100%.

Big Hill Sour

Crude Oil	Volume %
Isthmus	26
Alaskan North Slope & Urals	16 each
Arabian Light, Lagotreco, Mars, & Mesa 30	5 each
Dubai, Iranian Light, & Oman	3 each
Gulf of Suez Blend, Lagomedio, Mandji, & Maya	<2 each

Bryan Mound Sweet

Crude Oil	Volume %
Forties	38
Ninian	17
Brent and Es Sider	14 each
Bonny Light, Forcados, & Sirtica	4 each
Kole, Santa Barbara (Venezuela), & Zafiro	<2 each

Bryan Mound Sour

Crude Oil	Volume %
Ishtmus	76
Arabian Light, Dubai, Olmeca, & Oman	5 each
HOOPS Blend	<3

West Hackberry Sweet

Crude Oil	Volume %
Brent and Forties	22 each
Ninian	12
SLS	9
East Texas, Girassol, Kole, & Saharan Blend	5 each
Bonny Light, Ekofisk, Es Sider, & Escravos	<3 each

West Hackberry Sour

Crude Oil	Volume %
Isthmus	59
Mars	18
Arabian Light	9
Dubai, Iranian Light, & Oman	<5 each

Page intentionally left blank

Appendix B. Procedures for Collection of Samples for H_2S Determination

High Density Polyethylene (HDPE) bottles. Prepare the bottles by placing about 10 g (~2 tablespoons) of dry ice into each. Place the cap on the bottle and tighten loosely. Shake the bottle vigorously, and periodically loosen - but do not remove the cap - to relieve excess pressure. Continue this process until the dry ice has evaporated. Once the dry ice has evaporated, tighten the cap and wait until the bottle is needed for sampling. Do not overpressure the bottles. If the bottles are not relieved of pressure buildup, they may explode.

Bottles may be prepared up to two days in advance of when they will be needed. It is advisable to prepare at least one extra bottle in case one leaks.

When ready to collect the sample, remove the bottle cap. There must be an audible hiss indicating the presence of CO_2 overpressure. If not, use another bottle. Slowly fill the bottle using a Teflon® tube extending to the bottom. When the bottle is full to the top of the shoulder, i. e., just below the threads, squeeze the bottle at the center just enough to cause a small amount (a few drops) of oil to spill over the lip of the bottle. Screw the cap tightly onto the bottle and seal with plastic tape. Keep the bottle refrigerated at less than 4°C or on ice. If shipping is necessary, package samples with dry ice and in accordance with IATA regulations.

Samples collected in this manner and kept cold, may be used for determination of H_2S for up to 10 days following their collection.

Welker cylinders (Sulfinert®-treated). Prior to use, cylinders should have a back pressure at least 100 psi greater than that of the pipeline from which samples are to be collected. Argon should be used as back pressure gas, and not nitrogen or helium. No further preparation is necessary. Make connections to the pipeline with Sulfinert®-treated stainless steel or high pressure Teflon® tubing. Slowly open the valve nearest the pipeline and check for leaks. Next slowly open the bleed valve on the Welker cylinder and bleed at least 250 mL to waste to purge the system and displace air. Then, slowly open the third valve and gradually reduce the back pressure until it approaches that of the pipeline. Once the indicator rod begins to move, continue to slowly bleed the back pressure until the tip of the indicator rod is within approximately 1 cm of the red end cap. Several minutes should be allowed for this process in order to maintain a single phase in the cylinder. Tighten all valves, and then disconnect from the pipeline. Replace all plugs using Teflon tape.

Welker cylinders do not need to be refrigerated.

Prior to collecting either HDPE or Welker samples, thoroughly flush the sampling point and all connections.

Page intentionally left blank

Appendix C. SPR Crude Oil Assays

Page intentionally left blank

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Bryan Mound, Sweet

Sample No.: BM 2 (9%), BM 4 (28%), BM 106 (17%), BM 113 (8%), BM 114 (11%), BM 115 (13%), BM 116 (14%)

Laboratory No.: none

Date collected: 10/31/2006

Date results reported: 10/31/2006

Crude

Sediment by Extraction, mass %	0.03			Water, mass %	0.02	Salt, mass %	0.016
Relative Density, 60/60° F	0.8430	Ni, ppm	3.56	RVP, psi @ 100° F			5.47
API Gravity	36.4	V, ppm	5.32	Acid number, mg KOH/g			0.12
Sulfur, mass %	0.366	Fe, ppm	0.92	Mercaptan Sulfur, ppm			16
Nitrogen, mass %	0.101	Cu, ppm	0.23	H_2S Sulfur, ppm			9
Micro Car. Res., mass %	2.1	Org. Cl, ppm	0.3	Viscosity: 77° F	6.603	cSt	
Pour Point, °F	36	UOP "K" Factor*	12.0	100° F	4.303	cSt	
Wax, mass %	0.33	Asphaltenes, mass %	0.41				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	3.7	6.6	8.6	12.8	17.2	11.2	15.8	13.0	39.9	11.1
Vol. Sum %	3.7	10.3	18.9	31.8	49.0	60.1	75.9	88.9	100.0	100.0
mass %	2.6	5.2	7.5	11.9	16.9	11.4	16.7	14.5	44.4	13.3
mass Sum %	2.6	7.8	15.3	27.3	44.2	55.6	72.3	86.7	100.0	100.0
Relative Density, 60/60° F		0.6705	0.7372	0.7837	0.8284	0.8601	0.8928	0.9373	0.9395	1.009
API Gravity		79.5	60.4	49.1	39.3	33.0	27.0	19.5	19.1	8.8
Sulfur, mass %		0.0022	0.0024	0.0142	0.0952	0.290	0.453	0.689	0.753	1.20
Mercaptan Sulfur, ppm		8	10	20	14					
H_2S Sulfur, ppm		1	3	6	1					
Organic Cl, ppm		1.5	1.4	0.8	1.1					
Research Octane Number*		66.2	56.5							
Motor Octane Number*		64.1	54.4							
Acid Number, mg KOH/g					0.05	0.10	0.11	0.11	0.14	0.09
Cetane Index*					44.7	55.3	61.9			
Aromatics, Vol. %					20.4					
Naphthalenes, Vol. %				0.02	4.59	8.98				
Wax, mass %							5.13	7.88		
UOP "K" Factor*					11.7	11.8	11.9	11.9		11.7
Hydrogen, mass %				14.1	13.6	13.3	13.0	12.5	12.2	10.9
Carbon, mass %				85.2	86.2	86.5	86.6	86.5	86.6	86.7
Nitrogen, mass %					0.0010	0.0095	0.0539	0.175	0.223	0.489
Refractive Index, 60° C							1.4785	1.4973		
Viscosity, cSt 77° F					2.503					
100° F					1.977	5.298				
130° F						3.565	12.62	82.71	104.9	
180° F							4.822	39.30	30.95	3063
210° F										960.0
275° F										
Aniline Point, ° F				122.6	143.6	165.3	185.6	205.1		
Smoke point, mm				25.5	19.4	15.0				
Freezing Point, °F					-29					
Cloud Point, °F					-36	28	86	131		
Pour Point, °F					-41	21	81	126	91	
Ni, ppm								0.27	7.86	27.8
V, ppm								0.02	11.8	42.6
Fe, ppm									4.58	19.6
Cu, ppm									0.39	1.20
Micro Car. Res., mass %							0.01	0.66	4.64	14.91
Asphaltenes, mass %									0.89	4.26

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Bryan Mound, Sweet
BM2 (9%), BM4 (28%), BM106 (17%), BM113 (8%), BM114 (11%), BM115 (13%), BM116 (14%)

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		43.50	23.13	20.00
Total **I**so-paraffins		34.10	29.91	31.57
Total **A**romatics		3.97	8.51	22.39
Total **N**aphthenes		18.42	38.43	24.10
Unknowns		0.00	0.00	1.93
Paraffins	C2	0.00	0.00	0.00
	C3	0.00	0.00	0.00
	C4	1.51	0.09	0.03
	C5	23.23	0.34	0.08
	C6	18.64	2.76	0.06
	C7	0.12	14.67	0.35
	C8	0.00	5.28	5.03
	C9	0.00	0.00	7.27
	C10	0.00	0.00	5.70
	C11	0.00	0.00	1.37
	C12	0.00	0.00	0.10
Iso-paraffins	C4	0.08	0.01	0.00
	C5	11.04	0.26	0.06
	C6	20.86	1.46	0.06
	C7	2.10	13.23	0.17
	C8	0.03	14.12	2.81
	C9	0.00	0.84	9.46
	C10	0.00	0.00	11.13
	C11	0.00	0.00	6.55
	C12	0.00	0.00	1.33
Aromatics	C6	3.26	0.82	0.03
	C7	0.71	7.16	0.91
	C8	0.00	0.53	9.34
	C9	0.00	0.00	5.41
	C10	0.00	0.00	6.30
	C11	0.00	0.00	0.36
	C12	0.00	0.00	0.03
Naphthenes	C5	3.05	0.10	0.01
	C6	14.49	7.01	0.14
	C7	0.89	24.61	1.34
	C8	0.00	6.64	6.01
	C9	0.00	0.06	10.39
	C10	0.00	0.00	4.98
	C11	0.00	0.00	1.23
	C12	0.00	0.00	0.01

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	0.65
Propane	23.55
i-Butane	13.71
n-Butane	48.91
2,2-dimethylpropane	0.12
i-Pentane	9.16
n-Pentane	3.83
C_6+	0.08

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.26
Toluene	0.68
Ethylbenzene	0.19
m-Xylene	0.40
p-Xylene	0.13
o-Xylene	0.24

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97
5%:	148.3
10%:	199.9
20%:	300.8
30%:	400.4
40%:	490.7
50%:	579.4
60%:	674.4
70%:	778.5
80%:	894.9
90%:	1047.7
95%:	1167.0
FBP	1362.8
Recovery at °F	Total, Wt.%
180	8.3
380	28.0
480	38.7
650	57.6
800	72.0
1050	90.0
1105	92.6
1328	99.0

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Bryan Mound, Sour Sample No.:

Laboratory No.: none Date collected: 11/27/2006 Date results reported: 11/27/2006

Crude

Sediment by Extraction, mass %	0.02			Water, mass %	0.03	Salt, mass %	0.0086
Relative Density, 60/60° F	0.8584	Ni, ppm	10.4	RVP, psi @ 100° F			4.02
API Gravity	33.3	V, ppm	47.5	Acid number, mg KOH/g			0.16
Sulfur, mass %	1.43	Fe, ppm	0.48	Mercaptan Sulfur, ppm			38
Nitrogen, mass %	0.123	Cu, ppm	0.11	H_2S Sulfur, ppm			76
Micro Car. Res., mass %	4.2	Org. Cl, ppm	0.3	Viscosity: 77° F	8.742	cSt	
Pour Point, °F	5	UOP "K" Factor*	11.9	100° F	5.846	cSt	
Wax, mass %	0.37	Asphaltenes, mass %	2.07				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	2.5	5.9	7.7	14.0	16.4	11.4	15.2	12.8	42.1	14.2
Vol. Sum %	2.5	8.3	16.1	30.1	46.5	57.9	73.1	85.8	100.0	100.0
mass %	1.7	4.5	6.5	12.6	15.7	11.5	16.0	14.2	47.6	17.4
mass Sum %	1.7	6.2	12.7	25.3	40.9	52.4	68.4	82.6	100.0	100.0
Relative Density, 60/60° F		0.6595	0.7227	0.7705	0.8215	0.8649	0.9054	0.9535	0.9714	1.058
API Gravity		83.1	64.3	52.1	40.7	32.1	24.8	16.9	14.2	2.2
Sulfur, mass %		0.0086	0.0106	0.0609	0.454	1.26	1.76	2.35	2.56	3.48
Mercaptan Sulfur, ppm		44	42	51	17					
H_2S Sulfur, ppm		10	23	36	7					
Organic Cl, ppm		0.9	0.6	0.7	1.8					
Research Octane Number*		60.7	57.1							
Motor Octane Number*		59.8	55.3							
Acid Number, mg KOH/g					0.05	0.07	0.08	0.08	0.10	0.10
Cetane Index*					47.6	53.3	56.0			
Aromatics, Vol. %					21.0					
Naphthalenes, Vol. %				0.02	3.95	10.51				
Wax, mass %							3.96	4.92		
UOP "K" Factor*					11.8	11.7	11.8	11.7		11.2
Hydrogen, mass %				14.3	13.8	13.1	12.6	12.0	11.5	10.1
Carbon, mass %				85.2	85.9	86.1	86.1	86.0	85.8	85.5
Nitrogen, mass %					0.0022	0.0215	0.0800	0.185	0.250	0.458
Refractive Index, 60° C							1.4863	1.5111		
Viscosity, cSt 77° F					2.406					
100° F					1.939	5.170				
130° F						3.570	13.34	106.6	237.6	
180° F							5.960	35.33	59.88	43300
210° F										10000
275° F										
Aniline Point, ° F				126.2	145.7	161.1	176.4	190.6		
Smoke point, mm				28.0	19.8	14.4				
Freezing Point, °F					-30					
Cloud Point, °F					-38	28	81	121		
Pour Point, °F					-44	18	74	117	49	
Ni, ppm								0.27	22.4	65.7
V, ppm								0.76	99.6	288.4
Fe, ppm									2.06	7.58
Cu, ppm									0.20	0.58
Micro Car. Res., mass %							0.01	1.28	8.78	23.50
Asphaltenes, mass %									4.16	15.33

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Bryan Mound, Sour

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		48.53	30.33	24.37
Total **I**so-paraffins		38.53	36.79	32.51
Total **A**romatics		2.48	9.08	24.35
Total **N**aphthenes		10.46	23.79	16.62
Unknowns		0.00	0.00	2.16
Paraffins	C2	0.00	0.00	0.00
	C3	0.04	0.00	0.00
	C4	1.81	0.12	0.03
	C5	23.73	0.53	0.07
	C6	22.68	4.28	0.11
	C7	0.27	19.03	0.61
	C8	0.00	6.37	6.05
	C9	0.00	0.01	8.59
	C10	0.00	0.00	6.78
	C11	0.00	0.00	2.03
	C12	0.00	0.00	0.09
Iso-paraffins	C4	0.15	0.01	0.00
	C5	12.23	0.34	0.06
	C6	23.27	2.23	0.08
	C7	2.88	16.57	0.34
	C8	0.01	16.84	4.16
	C9	0.00	0.80	12.62
	C10	0.00	0.00	11.34
	C11	0.00	0.00	3.89
	C12	0.00	0.00	0.02
Aromatics	C6	2.16	0.84	0.03
	C7	0.31	7.42	0.91
	C8	0.00	0.81	9.45
	C9	0.00	0.00	6.47
	C10	0.00	0.00	7.01
	C11	0.00	0.00	0.42
	C12	0.00	0.00	0.07
Naphthenes	C5	1.92	0.11	0.01
	C6	7.86	4.52	0.12
	C7	0.67	15.17	0.90
	C8	0.00	3.87	3.78
	C9	0.00	0.11	6.34
	C10	0.00	0.00	4.76
	C11	0.00	0.00	0.71
	C12	0.00	0.00	0.01

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	1.08
Propane	23.96
i-Butane	14.32
n-Butane	52.72
2,2-dimethylpropane	0.18
i-Pentane	5.85
n-Pentane	1.76
C_6+	0.18

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.17
Toluene	0.63
Ethylbenzene	0.23
m-Xylene	0.39
p-Xylene	0.17
o-Xylene	0.26

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97
5%:	155.3
10%:	222.2
20%:	325.7
30%:	423.2
40%:	518.1
50%:	611.6
60%:	712.3
70%:	819.7
80%:	940.7
90%:	1103.2
95%:	1221.3
FBP	1379.0
Recovery at °F	Total, Wt.%
180	7.2
380	25.6
480	35.8
650	54.1
800	68.3
1050	87.2
1105	90.0
1328	98.2

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: West Hackberry, Sweet Sample No.:

Laboratory No.: none Date collected: 11/27/2006 Date results reported: 11/27/2006

Crude

Sediment by Extraction, mass %	0.02			Water, mass %	0.06	Salt, mass %	0.0034
Relative Density, 60/60° F	0.8402	Ni, ppm	3.86	RVP, psi @ 100° F			5.47
API Gravity	36.9	V, ppm	4.53	Acid number, mg KOH/g			0.21
Sulfur, mass %	0.321	Fe, ppm	2.12	Mercaptan Sulfur, ppm			7
Nitrogen, mass %	0.105	Cu, ppm	0.87	H_2S Sulfur, ppm			5
Micro Car. Res., mass %	1.8	Org. Cl, ppm	0.3	Viscosity: 77° F	5.680	cSt	
Pour Point, °F	28	UOP "K" Factor*	12.0	100° F	3.901	cSt	
Wax, mass %	0.29	Asphaltenes, mass %	0.37				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	3.7	7.4	9.0	13.3	16.7	11.6	15.8	12.4	38.3	10.2
Vol. Sum %	3.7	11.1	20.1	33.5	50.1	61.7	77.4	89.8	100.0	100.0
mass %	2.6	5.9	7.9	12.5	16.5	11.8	16.7	13.8	42.9	12.3
mass Sum %	2.6	8.5	16.4	28.9	45.3	57.2	73.9	87.7	100.0	100.0
Relative Density, 60/60° F		0.6701	0.7394	0.7873	0.8297	0.8599	0.8933	0.9388	0.9392	1.011
API Gravity		79.7	59.9	48.2	39.0	33.1	26.9	19.2	19.2	8.5
Sulfur, mass %		0.0016	0.0016	0.0100	0.0868	0.264	0.421	0.647	0.662	1.01
Mercaptan Sulfur, ppm		6	8	11	6					
H_2S Sulfur, ppm		0	1	3	1					
Organic Cl, ppm		1.8	0.7	0.8	2.2					
Research Octane Number*		67.1	58.2							
Motor Octane Number*		65.1	55.8							
Acid Number, mg KOH/g					0.08	0.15	0.19	0.20	0.22	0.08
Cetane Index*					44.2	55.5	61.5			
Aromatics, Vol. %					20.7					
Naphthalenes, Vol. %					4.70	9.23				
Wax, mass %							4.60	7.38		
UOP "K" Factor*					11.6	11.8	11.8	11.8		11.7
Hydrogen, mass %				14.4	13.8	13.5	13.2	12.7	12.4	11.1
Carbon, mass %				85.6	86.2	86.6	86.8	86.8	86.9	87.0
Nitrogen, mass %					0.0011	0.0103	0.0608	0.197	0.245	0.548
Refractive Index, 60° C							1.4782	1.4973		
Viscosity, cSt 77° F					2.474					
100° F					1.958	5.129				
130° F						3.485	12.74	80.96	95.49	
180° F							4.200	49.39	28.65	3468
210° F										1141
275° F										
Aniline Point, ° F				120.7	142.7	163.9	184.3	203.2		
Smoke point, mm				24.6	19.6	15.3				
Freezing Point, °F					-30					
Cloud Point, °F					-38	25	87	132		
Pour Point, °F					-43	18	82	129	90	
Ni, ppm								0.31	8.32	30.5
V, ppm								0.09	10.2	37.7
Fe, ppm									8.01	28.9
Cu, ppm									2.04	4.54
Micro Car. Res., mass %							<0.01	0.61	4.17	16.08
Asphaltenes, mass %									0.84	4.05

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: West Hackberry, Sweet

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		42.28	20.90	20.65
Total **I**so-paraffins		33.61	27.29	29.99
Total **A**romatics		4.46	10.49	23.29
Total **N**aphthenes		19.56	41.32	24.04
Unknowns		0.00	0.00	2.03
Paraffins	C2	0.00	0.00	0.00
	C3	0.10	0.01	0.01
	C4	2.00	0.17	0.04
	C5	21.44	0.47	0.10
	C6	18.47	2.32	0.08
	C7	0.27	13.60	0.33
	C8	0.00	4.32	5.59
	C9	0.00	0.00	7.09
	C10	0.00	0.00	5.82
	C11	0.00	0.00	1.58
	C12	0.00	0.00	0.01
Iso-paraffins	C4	0.18	0.02	0.01
	C5	10.93	0.31	0.06
	C6	20.01	1.17	0.07
	C7	2.30	11.84	0.19
	C8	0.19	13.28	3.47
	C9	0.00	0.67	11.07
	C10	0.00	0.00	11.34
	C11	0.00	0.00	3.75
	C12	0.00	0.00	0.03
Aromatics	C6	4.09	1.08	0.04
	C7	0.37	8.89	0.89
	C8	0.00	0.52	9.74
	C9	0.00	0.00	5.61
	C10	0.00	0.00	6.62
	C11	0.00	0.00	0.35
	C12	0.00	0.00	0.03
Naphthenes	C5	2.95	0.11	0.01
	C6	15.33	7.48	0.17
	C7	1.24	26.52	1.20
	C8	0.04	7.12	6.58
	C9	0.00	0.10	9.70
	C10	0.00	0.00	5.20
	C11	0.00	0.00	1.18
	C12	0.00	0.00	0.00

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	0.85
Propane	23.80
i-Butane	14.10
n-Butane	52.68
2,2-dimethylpropane	0.95
i-Pentane	6.13
n-Pentane	1.45
C_6+	0.05

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.30
Toluene	0.79
Ethylbenzene	0.19
m-Xylene	0.40
p-Xylene	0.14
o-Xylene	0.25

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97.0
5%:	142.4
10%:	205.4
20%:	299.3
30%:	398.6
40%:	490.9
50%:	579.2
60%:	676.0
70%:	783.1
80%:	900.1
90%:	1070.8
95%:	1221.1
FBP	1372.7
Recovery at °F	Total, Wt.%
180	7.7
380	28.1
480	38.7
650	57.4
800	71.6
1050	89.1
1105	91.5
1328	97.6

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: West Hackberry, Sour Sample No.:

Laboratory No.: none Date collected: 11/28/2006 Date results reported: 11/28/2006

Crude

Sediment by Extraction, mass %	0.02			Water, mass %	0.03	Salt, mass %	0.0030
Relative Density, 60/60° F	0.8575	Ni, ppm	8.28	RVP, psi @ 100° F			4.20
API Gravity	33.5	V, ppm	36.0	Acid number, mg KOH/g			0.18
Sulfur, mass %	1.41	Fe, ppm	0.53	Mercaptan Sulfur, ppm			40
Nitrogen, mass %	0.122	Cu, ppm	0.16	H_2S Sulfur, ppm			82
Micro Car. Res., mass %	4.0	Org. Cl, ppm	0.3	Viscosity: 77° F	8.274	cSt	
Pour Point, °F	-4	UOP "K" Factor*	11.8	100° F	5.584	cSt	
Wax, mass %	0.10	Asphaltenes, mass %	1.63				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	2.9	6.1	7.7	14.0	16.1	10.8	15.1	12.9	42.4	14.4
Vol. Sum %	2.9	9.0	16.7	30.7	46.8	57.6	72.7	85.6	100.0	100.0
mass %	2.0	4.7	6.5	12.6	15.4	10.9	15.9	14.4	48.0	17.8
mass Sum %	2.0	6.7	13.2	25.8	41.2	52.0	67.9	82.3	100.0	100.0
Relative Density, 60/60° F		0.6612	0.7237	0.7708	0.8211	0.8632	0.9034	0.9566	0.9709	1.054
API Gravity		82.5	64.0	52.1	40.8	32.4	25.1	16.4	14.2	2.7
Sulfur, mass %		0.0092	0.0172	0.0723	0.454	1.25	1.68	2.31	2.53	3.46
Mercaptan Sulfur, ppm		45	71	109	35					
H_2S Sulfur, ppm		7	30	45	9					
Organic Cl, ppm		0.8	0.7	0.8	1.5					
Research Octane Number*		62.0	48.8							
Motor Octane Number*		60.9	47.4							
Acid Number, mg KOH/g					0.05	0.08	0.13	0.10	0.15	0.13
Cetane Index*					47.7	54.0	57.0			
Aromatics, Vol. %					21.5					
Naphthalenes, Vol. %				0.01	3.93	10.95				
Wax, mass %							3.30	4.09		
UOP "K" Factor*					11.8	11.7	11.7	11.6		11.5
Hydrogen, mass %				14.4	13.8	13.2	12.7	11.9	11.5	10.2
Carbon, mass %				85.5	86.0	86.1	86.0	85.8	85.7	85.3
Nitrogen, mass %					0.0019	0.0190	0.0756	0.189	0.252	0.460
Refractive Index, 60° C							1.4862	1.5105		
Viscosity, cSt 77° F					2.363					
100° F					1.871	5.061				
130° F						3.437	13.09	101.9	204.7	
180° F							5.854	35.82	53.60	10890
210° F										4438
275° F										
Aniline Point, ° F				126.0	145.2	160.7	175.7	191.3		
Smoke point, mm				28.5	20.3	15.2				
Freezing Point, °F					-28					
Cloud Point, °F					-36	24	80	124		
Pour Point, °F					-40	18	75	119	55	
Ni, ppm								0.26	17.3	50.4
V, ppm								0.45	73.8	216.8
Fe, ppm									1.91	10.7
Cu, ppm									0.33	0.88
Micro Car. Res., mass %							0.00	1.17	8.26	23.09
Asphaltenes, mass %									3.24	13.12

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: West Hackberry, Sour

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		47.72	29.06	24.74
Total **I**so-paraffins		38.47	35.97	31.75
Total **A**romatics		2.70	9.48	24.34
Total **N**aphthenes		11.12	25.49	16.82
Unknowns		0.00	0.00	2.36
Paraffins	C2	0.00	0.00	0.00
	C3	0.01	0.01	0.00
	C4	1.61	0.20	0.05
	C5	21.80	0.55	0.09
	C6	21.94	3.68	0.09
	C7	2.29	18.75	0.53
	C8	0.07	5.85	5.75
	C9	0.00	0.02	8.43
	C10	0.00	0.00	7.31
	C11	0.00	0.00	2.37
	C12	0.00	0.00	0.11
Iso-paraffins	C4	0.16	0.02	0.01
	C5	11.41	0.32	0.06
	C6	23.76	1.82	0.07
	C7	2.87	15.71	0.26
	C8	0.27	17.38	3.78
	C9	0.00	0.72	11.20
	C10	0.00	0.00	11.98
	C11	0.00	0.00	4.35
	C12	0.00	0.00	0.05
Aromatics	C6	2.44	0.80	0.02
	C7	0.26	7.78	0.83
	C8	0.00	0.90	8.97
	C9	0.00	0.00	6.54
	C10	0.00	0.00	7.33
	C11	0.00	0.00	0.55
	C12	0.00	0.00	0.10
Naphthenes	C5	2.04	0.10	0.01
	C6	8.36	4.40	0.10
	C7	0.72	15.62	0.81
	C8	0.00	5.23	4.12
	C9	0.00	0.14	6.28
	C10	0.00	0.00	4.77
	C11	0.00	0.00	0.72
	C12	0.00	0.00	0.02

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	2.46
Propane	23.70
i-Butane	14.09
n-Butane	49.25
2,2-dimethylpropane	0.24
i-Pentane	6.89
n-Pentane	3.18
C_6+	0.20

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.17
Toluene	0.63
Ethylbenzene	0.25
m-Xylene	0.38
p-Xylene	0.16
o-Xylene	0.27

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97.0
5%:	152.1
10%:	232.7
20%:	334.6
30%:	434.6
40%:	533.4
50%:	629.3
60%:	734.3
70%:	846.2
80%:	946.9
90%:	1141.6
95%:	1280.6
FBP	1372.0
Recovery at °F	Total, Wt.%
180	6.5
380	24.5
480	34.5
650	52.1
800	66.2
1050	85.2
1105	88.3
1328	96.7

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Bayou Choctaw Blend (84%-cavern 18, 16%-cavern 20) | Sample No.: Bayou Choctaw Sweet

Laboratory No.: | Date collected: | Date results reported: 10/9/2006

Crude

Sediment by Extraction, mass %	0.01			Water, mass %	0.03	Salt, mass %	0.0072
Relative Density, 60/60° F	0.8410	Ni, ppm	3.00	RVP, psi @ 100° F			4.82
API Gravity	36.8	V, ppm	5.05	Acid number, mg KOH/g			0.15
Sulfur, mass %	0.402	Fe, ppm	1.17	Mercaptan Sulfur, ppm			14
Nitrogen, mass %	0.103	Cu, ppm	0.02	H_2S Sulfur, ppm			0
Micro Car. Res., mass %	2.0	Org. Cl, ppm	0.1	Viscosity: 77° F	5.934	cSt	
Pour Point, °F	37	UOP "K" Factor*	12.0	100° F	4.206	cSt	
Wax, mass %	0.96	Asphaltenes, mass %	0.41				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	3.8	6.2	9.0	13.3	17.0	12.7	15.1	12.1	38.0	10.8
Vol. Sum %	3.8	10.0	19.0	32.3	49.3	62.0	77.1	89.2	100.0	100.0
mass %	2.6	4.9	7.9	12.3	16.7	13.0	16.1	13.4	42.6	13.1
mass Sum %	2.6	7.5	15.4	27.7	44.4	57.4	73.5	86.9	100.0	100.0
Relative Density, 60/60° F		0.6678	0.7358	0.7783	0.8263	0.8615	0.8962	0.9333	0.9429	1.019
API Gravity		80.4	60.8	50.3	39.7	32.7	26.4	20.1	18.6	7.4
Sulfur, mass %		0.0016	0.0024	0.0122	0.0836	0.281	0.472	0.712	0.819	1.36
Mercaptan Sulfur, ppm		9	6	11	10					
H_2S Sulfur, ppm		0	5	9	2					
Organic Cl, ppm		0.5	0.2	0.4	0.8					
Research Octane Number*		66.6	56.9							
Motor Octane Number*		64.3	54.9							
Acid Number, mg KOH/g					0.07	0.13	0.18	0.20	0.21	0.11
Cetane Index*					45.7	54.9	59.8			
Aromatics, Vol. %					19.3					
Naphthalenes, Vol. %				0.00	4.18	8.33				
Wax, mass %							5.09	7.48		
UOP "K" Factor*					11.7	11.7	11.8	11.9		11.6
Hydrogen, mass %				14.3	13.9	13.5	13.1	12.7	12.4	11.1
Carbon, mass %				85.7	86.3	86.4	86.5	86.6	86.6	86.6
Nitrogen, mass %					0.0014	0.0092	0.0606	0.164	0.220	0.473
Refractive Index, 60° C							1.4774	1.4963		
Viscosity, cSt 77° F					2.448					
100° F					1.944	5.298				
130° F						3.567	13.05	81.24	103.5	
180° F							5.908	28.71	30.91	3589
210° F										1086
275° F										
Aniline Point, ° F				121.8	144.6	165.7	186.5	198.7		
Smoke point, mm				26.7	20.0	15.9				
Freezing Point, °F					-32					
Cloud Point, °F					-41	29	87	123		
Pour Point, °F					-47	19	81	117	99	
Ni, ppm								0.25	7.29	26.0
V, ppm								0.05	11.7	42.3
Fe, ppm									3.03	8.46
Cu, ppm									0.02	0.16
Micro Car. Res., mass %							<0.01	0.55	4.43	13.76
Asphaltenes, mass %									0.81	4.05

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Bayou Choctaw, sweet
Blend, 84% Bayou Choctaw Cavern 18, 16% Bayou Choctaw Cavern 20

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		40.61	21.89	20.13
Total **I**so-paraffins		33.82	28.54	32.54
Total **A**romatics		5.85	9.86	24.03
Total **N**aphthenes		19.73	39.72	21.32
Unknowns			0.00	1.95
Paraffins	C2	0.00	0.00	0.00
	C3	0.00	0.00	0.00
	C4	1.43	0.08	0.01
	C5	18.84	0.39	0.05
	C6	20.33	2.54	0.04
	C7	0.01	13.48	0.41
	C8	0.00	5.40	4.31
	C9	0.00	0.00	7.09
	C10	0.00	0.00	6.21
	C11	0.00	0.00	2.00
	C12	0.00	0.00	0.00
Iso-paraffins	C4	0.13	0.00	0.00
	C5	9.33	0.29	0.04
	C6	21.66	1.42	0.03
	C7	2.69	12.34	0.20
	C8	0.00	13.26	4.07
	C9	0.00	1.23	12.07
	C10	0.00	0.00	12.46
	C11	0.00	0.00	3.64
	C12	0.00	0.00	0.03
Aromatics	C6	4.21	1.16	0.02
	C7	1.64	8.11	0.96
	C8	0.00	0.59	8.84
	C9	0.00	0.00	6.50
	C10	0.00	0.00	7.40
	C11	0.00	0.00	0.29
	C12	0.00	0.00	0.02
Naphthenes	C5	2.56	0.11	0.00
	C6	16.17	7.05	0.13
	C7	1.00	25.20	1.43
	C8	0.00	7.30	3.94
	C9	0.00	0.05	9.47
	C10	0.00	0.00	4.80
	C11	0.00	0.00	1.55
	C12	0.00	0.00	0.00

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	1.06
Propane	28.19
i-Butane	15.69
n-Butane	48.15
2,2-dimethylpropane	0.15
i-Pentane	5.65
n-Pentane	1.07
C_6+	0.04

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.28
Toluene	0.72
Ethylbenzene	0.18
m-Xylene	0.43
p-Xylene	0.13
o-Xylene	0.25

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97
5%:	159.7
10%:	218.2
20%:	315.8
30%:	417.7
40%:	502.6
50%:	585.9
60%:	678.0
70%:	780.9
80%:	890.4
90%:	1048.7
95%:	1172.6
FBP	1366.6
Recovery at °F	Total, Wt.%
180	6.5
380	26.1
480	37.3
650	57.1
800	72.0
1050	90.1
1105	92.5
1328	98.8

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Bayou Choctaw, Sour

Sample No.: BC 15 (31%), BC 17 (22%), BC 19 (23%), BC 101 (24%)

Laboratory No.: none

Date collected: 10/17/2006

Date results reported: 10/17/2006

Crude

Sediment by Extraction, mass %	0.02			Water, mass %	0.04
Salt, mass %	0.0039				
Relative Density, 60/60° F	0.8631	Ni, ppm	10.7	RVP, psi @ 100° F	3.68
API Gravity	32.4	V, ppm	37.5	Acid number, mg KOH/g	0.16
Sulfur, mass %	1.46	Fe, ppm	1.16	Mercaptan Sulfur, ppm	28
Nitrogen, mass %	0.157	Cu, ppm	0.02	H_2S Sulfur, ppm	17
Micro Car. Res., mass %	3.9	Org. Cl, ppm	0.4	Viscosity: 77° F	9.354 cSt
Pour Point, °F	20	UOP "K" Factor*	11.9	100° F	6.356 cSt
Wax, mass %	0.12	Asphaltenes, mass %	1.28		

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	2.3	5.5	7.2	13.2	16.2	11.9	14.9	13.8	43.6	14.9
Vol. Sum %	2.3	7.8	15.1	28.3	44.5	56.4	71.3	85.1	100.0	100.0
mass %	1.6	4.2	6.1	11.9	15.5	11.9	15.6	15.2	48.8	18.0
mass Sum %	1.6	5.8	11.9	23.7	39.2	51.2	66.8	82.0	100.0	100.0
Relative Density, 60/60° F		0.6615	0.7270	0.7714	0.8250	0.8671	0.9061	0.9486	0.9679	1.048
API Gravity		82.4	63.1	51.9	40.0	31.7	24.7	17.7	14.7	3.6
Sulfur, mass %		0.0109	0.0134	0.0597	0.377	1.10	1.65	2.27	2.59	3.66
Mercaptan Sulfur, ppm		55	52	63	14					
H_2S Sulfur, ppm		6	16	29	6					
Organic Cl, ppm		1.2	1.3	2.3	2.3					
Research Octane Number*		63.3	59.5							
Motor Octane Number*		62.1	57.6							
Acid Number, mg KOH/g					0.08	0.09	0.10	0.08	0.15	0.08
Cetane Index*					46.2	52.3	55.7			
Aromatics, Vol. %					22.0					
Naphthalenes, Vol. %				0.00	4.17	10.90				
Wax, mass %							3.53	5.14		
UOP "K" Factor*					11.7	11.7	11.7	11.7		11.4
Hydrogen, mass %				14.2	13.8	13.3	12.8	12.1	11.6	10.3
Carbon, mass %				85.3	86.0	86.2	86.2	85.9	85.8	85.5
Nitrogen, mass %					0.0016	0.0168	0.0867	0.217	0.317	0.600
Refractive Index, 60° C							1.4857	1.5099		
Viscosity, cSt 77° F					2.393					
100° F					1.900	5.229				
130° F						3.524	13.12	107.2	234.8	
180° F							5.873	33.81	58.14	22790
210° F										4813
275° F										
Aniline Point, ° F				124.1	142.9	159.0	174.8	186.0		
Smoke point, mm				27.8	19.1	14.4				
Freezing Point, °F					-31					
Cloud Point, °F					-40	26	80	126		
Pour Point, °F					-45	19	75	112	71	
Ni, ppm								0.26	22.3	68.4
V, ppm								0.68	75.8	229.45
Fe, ppm									3.61	11.5
Cu, ppm									0.02	0.08
Micro Car. Res., mass %							<0.01	1.13	7.20	18.40
Asphaltenes, mass %									2.66	10.29

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Bayou Choctaw, Sour
BC 15 (31%), BC 17 (22%), BC 19 (23%), BC 101 (24%)

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		46.42	27.67	22.08
Total **I**so-paraffins		37.82	35.94	33.01
Total **A**romatics		3.59	8.94	24.53
Total **N**aphthenes		12.17	27.45	18.54
Unknowns		0.00	0.00	1.84
Paraffins	C2	0.00	0.00	0.00
	C3	0.00	0.00	0.00
	C4	1.68	0.12	0.04
	C5	22.98	0.41	0.07
	C6	21.69	3.65	0.10
	C7	0.08	17.72	0.74
	C8	0.00	5.77	6.70
	C9	0.00	0.00	7.87
	C10	0.00	0.00	4.98
	C11	0.00	0.00	1.57
	C12	0.00	0.00	0.00
Iso-paraffins	C4	0.11	0.01	0.00
	C5	11.91	0.34	0.06
	C6	23.71	1.66	0.06
	C7	2.09	17.39	0.41
	C8	0.00	15.60	5.58
	C9	0.00	0.93	14.10
	C10	0.00	0.00	9.88
	C11	0.00	0.00	2.91
	C12	0.00	0.00	0.01
Aromatics	C6	2.74	0.93	0.04
	C7	0.84	7.37	1.32
	C8	0.00	0.63	11.00
	C9	0.00	0.00	5.84
	C10	0.00	0.00	6.06
	C11	0.00	0.00	0.28
	C12	0.00	0.00	0.00
Naphthenes	C5	2.30	0.06	0.00
	C6	9.39	5.53	0.16
	C7	0.49	18.02	1.39
	C8	0.00	3.81	4.18
	C9	0.00	0.03	7.92
	C10	0.00	0.00	4.06
	C11	0.00	0.00	0.83
	C12	0.00	0.00	0.00

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	1.01
Propane	24.40
i-Butane	15.66
n-Butane	51.36
2,2-dimethylpropane	0.17
i-Pentane	6.03
n-Pentane	1.31
C_6+	0.07

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.18
Toluene	0.57
Ethylbenzene	0.20
m-Xylene	0.37
p-Xylene	0.14
o-Xylene	0.23

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97
5%:	165.0
10%:	232.5
20%:	337.5
30%:	438.6
40%:	532.9
50%:	624.9
60%:	725.8
70%:	830.3
80%:	948.8
90%:	1110.8
95%:	1221.8
FBP	1366.4
Recovery at °F	Total, Wt.%
180	6.0
380	23.9
480	34.2
650	52.6
800	67.2
1050	86.6
1105	89.7
1328	98.4

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Big Hill Blend, Sweet

Sample No.: BH 101 (17%), BH 102 (16%), BH 103 (16%), BH 104 (17%), BH 105 (17%), BH 114 (17%)+

Laboratory No.: none

Date collected: 10/26/2006

Date results reported: 10/26/2006

Sediment by Extraction, mass %: 0.01 | **Crude** | Water, mass %: 0.04 | Salt, mass %: 0.013

Relative Density, 60/60° F	0.8476	Ni, ppm	9.16	RVP, psi @ 100° F	4.69
API Gravity	35.4	V, ppm	8.60	Acid number, mg KOH/g	0.28
Sulfur, mass %	0.413	Fe, ppm	5.13	Mercaptan Sulfur, ppm	7
Nitrogen, mass %	0.134	Cu, ppm	0.02	H_2S Sulfur, ppm	5
Micro Car. Res., mass %	2.3	Org. Cl, ppm	0.4	Viscosity: 77° F 6.117 cSt	
Pour Point, °F	26	UOP "K" Factor*	11.9	100° F 4.417 cSt	
Wax, mass %	0.52	Asphaltenes, mass %	0.48		

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	3.1	6.8	8.9	13.8	16.6	12.7	15.2	11.9	38.2	11.1
Vol. Sum %	3.1	9.9	18.8	32.5	49.1	61.8	77.0	88.9	100.0	100.0
mass %	2.2	5.4	7.8	12.8	16.2	13.0	16.2	13.2	42.8	13.4
mass Sum %	2.2	7.5	15.3	28.0	44.3	57.2	73.4	86.6	100.0	100.0
Relative Density, 60/60° F		0.6723	0.7406	0.7856	0.8307	0.8659	0.9016	0.9409	0.9488	1.022
API Gravity		79.0	59.6	48.6	38.8	31.9	25.4	18.9	17.6	7.0
Sulfur, mass %		0.0025	0.0036	0.0167	0.104	0.315	0.502	0.758	0.827	1.29
Mercaptan Sulfur, ppm		9	12	12	5					
H_2S Sulfur, ppm		2	5	7	1					
Organic Cl, ppm		1.0	0.6	0.7	2.1					
Research Octane Number*		69.3	59.5							
Motor Octane Number*		66.9	57.5							
Acid Number, mg KOH/g					0.14	0.33	0.46	0.46	0.42	0.09
Cetane Index*					43.8	53.0	57.3			
Aromatics, Vol. %					20.5					
Naphthalenes, Vol. %				0.01	4.09	8.61				
Wax, mass %							6.51	7.41		
UOP "K" Factor*					11.6	11.7	11.7	11.8		11.7
Hydrogen, mass %				13.9	13.5	13.2	12.8	12.3	11.9	10.5
Carbon, mass %				85.5	86.2	86.4	86.5	86.6	86.5	86.5
Nitrogen, mass %					0.0031	0.0215	0.0904	0.226	0.299	0.622
Refractive Index, 60° C							1.4827	1.5036		
Viscosity, cSt 77° F					2.553					
100° F					2.041	5.353				
130° F						3.747	15.34	144.8	156.7	
180° F							6.588	36.67	42.92	17910
210° F										4915
275° F										
Aniline Point, ° F				121.0	142.0	163.4	182.6	197.1		
Smoke point, mm				25.7	19.2	15.5				
Freezing Point, °F					-27					
Cloud Point, °F					-41	25	85	125		
Pour Point, °F					-57	13	78	118	88	
Ni, ppm								0.60	22.7	80.4
V, ppm								0.02	19.9	72.7
Fe, ppm									15.7	38.4
Cu, ppm									0.02	0.11
Micro Car. Res., mass %							<0.01	0.76	5.43	16.49
Asphaltenes, mass %									1.12	5.65

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Big Hill, sweet
BH101 (17%), BH102 (16%), BH103 (16%), BH104 (17%), BH105 (17%), BH114 (17%)

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		39.63	18.59	17.50
Total **I**so-paraffins		35.23	29.36	35.97
Total **A**romatics		4.24	10.14	24.11
Total **N**aphthenes		20.90	41.91	20.36
Unknowns		0.00	0.00	2.05
Paraffins	C2	0.00	0.00	0.00
	C3	0.00	0.00	0.00
	C4	0.97	0.04	0.02
	C5	20.80	0.34	0.12
	C6	17.62	1.91	0.13
	C7	0.24	11.74	0.41
	C8	0.00	4.56	4.96
	C9	0.00	0.00	5.98
	C10	0.00	0.00	4.73
	C11	0.00	0.00	1.14
	C12	0.00	0.00	0.00
Iso-paraffins	C4	0.06	0.00	0.00
	C5	11.56	0.27	0.09
	C6	20.89	1.12	0.12
	C7	2.73	10.82	0.31
	C8	0.00	16.16	3.57
	C9	0.00	0.99	16.96
	C10	0.00	0.00	11.36
	C11	0.00	0.00	3.54
	C12	0.00	0.00	0.02
Aromatics	C6	3.89	0.95	0.07
	C7	0.35	8.76	0.99
	C8	0.00	0.42	10.23
	C9	0.00	0.00	7.01
	C10	0.00	0.00	5.64
	C11	0.00	0.00	0.17
	C12	0.00	0.00	0.01
Naphthenes	C5	2.83	0.07	0.02
	C6	16.29	6.18	0.28
	C7	1.75	27.26	1.53
	C8	0.03	8.33	5.34
	C9	0.00	0.07	8.79
	C10	0.00	0.00	3.81
	C11	0.00	0.00	0.60
	C12	0.00	0.00	0.00

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	1.40
Propane	28.09
i-Butane	15.25
n-Butane	50.32
2,2-dimethylpropane	0.14
i-Pentane	4.05
n-Pentane	0.72
C_6+	0.02

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.31
Toluene	0.76
Ethylbenzene	0.17
m-Xylene	0.44
p-Xylene	0.13
o-Xylene	0.25

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97.0
5%:	150.0
10%:	212.5
20%:	307.9
30%:	406.2
40%:	496.0
50%:	585.2
60%:	683.4
70%:	790.0
80%:	910.3
90%:	1088.5
95%:	1253.7
FBP	1377.3
Recovery at °F	Total, Wt.%
180	7.1
380	27.6
480	39.2
650	56.9
800	71.0
1050	88.4
1105	90.7
1328	96.9

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).

SPR CRUDE OIL COMPREHENSIVE ANALYSIS

Sample ID: Big Hill, Sour

Sample No.: BH 106 (13%), BH 107 (12%), BH 108 (11%), BH 109 (13%), BH 110 (12%), BH 111 (13%), BH 112 (13%), BH 113 (13%)

Laboratory No.: none

Date collected: 10/30/2006

Date results reported: 10/30/2006

Crude

Sediment by Extraction, mass %	0.02			Water, mass %	0.04	Salt, mass %	0.0075
Relative Density, 60/60° F	0.8723	Ni, ppm	14.0	RVP, psi @ 100° F			3.45
API Gravity	30.7	V, ppm	51.8	Acid number, mg KOH/g			0.15
Sulfur, mass %	1.46	Fe, ppm	1.52	Mercaptan Sulfur, ppm			22
Nitrogen, mass %	0.150	Cu, ppm	0.68	H_2S Sulfur, ppm			42
Micro Car. Res., mass %	4.6	Org. Cl, ppm	0.4	Viscosity: 77° F	12.46	cSt	
Pour Point, °F	17	UOP "K" Factor*	11.8	100° F	8.368	cSt	
Wax, mass %	0.17	Asphaltenes, mass %	1.8				

Fraction	Gas	1	2	3	4	5	6	7	Residuum	Residuum
Cut Temp.	C_2 - C_4	C5 - 175° F	175° - 250° F	250° - 375° F	375° - 530° F	530° - 650° F	650° - 850° F	850° - 1050° F	650° F+	1050° F+
Vol. %	2.0	5.3	6.5	12.1	15.4	12.3	15.7	14.7	46.4	16.0
Vol. Sum %	2.0	7.4	13.9	26.0	41.4	53.7	69.4	84.0	100.0	100.0
mass %	1.4	4.1	5.4	10.8	14.6	12.2	16.4	16.1	51.6	19.2
mass Sum %	1.4	5.4	10.9	21.7	36.2	48.4	64.8	80.8	100.0	100.0
Relative Density, 60/60° F		0.6641	0.7290	0.7760	0.8265	0.8689	0.9095	0.9541	0.9711	1.047
API Gravity		81.6	62.6	50.8	39.7	31.3	24.1	16.8	14.2	3.6
Sulfur, mass %		0.0064	0.0090	0.0665	0.415	1.07	1.61	2.20	2.45	3.37
Mercaptan Sulfur, ppm		32	45	52	13					
H_2S Sulfur, ppm		3	7	11	3					
Organic Cl, ppm		1.3	0.7	0.6	1.4					
Research Octane Number*		64.9	53.8							
Motor Octane Number*		63.5	52.2							
Acid Number, mg KOH/g					0.09	0.13	0.14	0.13	0.12	0.05
Cetane Index*					45.6	51.6	54.3			
Aromatics, Vol. %					22.5					
Naphthalenes, Vol. %				0.02	4.33	11.11				
Wax, mass %							4.75	5.02		
UOP "K" Factor*					11.7	11.6	11.6	11.6		11.4
Hydrogen, mass %				14.0	13.4	12.8	12.3	11.6	11.2	9.9
Carbon, mass %				85.5	85.9	85.8	85.7	85.4	85.4	85.2
Nitrogen, mass %					0.0016	0.0173	0.0707	0.181	0.278	0.537
Refractive Index, 60° C							1.4884	1.5120		
Viscosity, cSt 77° F					2.443					
100° F					1.911	5.505				
130° F						3.720	14.45	122.9	295.1	
180° F							5.968	40.35	74.30	35660
210° F										8450
275° F										
Aniline Point, ° F				124.4	143.8	159.5	173.6	186.0		
Smoke point, mm				25.6	18.9	13.9				
Freezing Point, °F					-33					
Cloud Point, °F					-37	26	78	114		
Pour Point, °F					-51	15	73	111	65	
Ni, ppm								0.38	27.3	74.0
V, ppm								0.61	99.9	263.9
Fe, ppm									4.26	12.7
Cu, ppm									1.03	2.30
Micro Car. Res., mass %							<0.01	1.08	8.62	22.30
Asphaltenes, mass %									3.41	10.65

* Data are calculated

SPR GAS CHROMATOGRAPHIC ANALYSES
Sample ID: Big Hill, Sour

		Distillate fractions, ASTM D2892		
		C_5-175° F	175-250° F	250-375° F
		Wt. %	Wt. %	Wt. %
* Total **P**araffins		45.64	26.02	22.31
Total **I**so-paraffins		36.31	33.40	32.14
Total **A**romatics		4.00	9.74	24.94
Total **N**aphthenes		14.05	30.58	17.79
Unknowns		0.00	0.00	2.79
Paraffins	C2	0.00	0.00	0.00
	C3	0.18	0.04	0.03
	C4	2.68	0.16	0.08
	C5	21.23	0.70	0.20
	C6	21.05	3.62	0.25
	C7	0.50	15.84	0.79
	C8	0.00	5.67	5.46
	C9	0.00	0.01	7.31
	C10	0.00	0.00	5.82
	C11	0.00	0.00	2.09
	C12	0.00	0.00	0.27
Iso-paraffins	C4	0.41	0.06	0.02
	C5	9.62	0.47	0.11
	C6	22.89	3.51	0.20
	C7	3.40	14.68	0.56
	C8	0.00	14.13	3.69
	C9	0.00	0.55	15.49
	C10	0.00	0.00	7.98
	C11	0.00	0.00	4.07
	C12	0.00	0.00	0.03
Aromatics	C6	2.86	1.10	0.09
	C7	1.13	8.10	1.38
	C8	0.00	0.54	10.17
	C9	0.00	0.00	8.07
	C10	0.00	0.00	5.02
	C11	0.00	0.00	0.17
	C12	0.00	0.00	0.05
Naphthenes	C5	2.25	0.15	0.02
	C6	10.50	5.46	0.27
	C7	1.26	18.62	1.13
	C8	0.04	6.06	3.44
	C9	0.00	0.30	6.67
	C10	0.00	0.00	5.47
	C11	0.00	0.00	0.78
	C12	0.00	0.00	0.01

Debutanization Fraction	
Component	Wt. %
Methane	0.00
Ethane	1.60
Propane	32.02
i-Butane	13.90
n-Butane	41.21
2,2-dimethylpropane	0.17
i-Pentane	7.95
n-Pentane	2.95
C_6+	0.21

From PIANO analysis of whole crude	
Component	Wt. % of crude
Benzene	0.19
Toluene	0.54
Ethylbenzene	0.18
m-Xylene	0.30
p-Xylene	0.12
o-Xylene	0.21

High Temp. Sim. Dist.	
Recovery, Wt. %	°F
IBP:	<97
5%:	182.8
10%:	251.3
20%:	360.9
30%:	465.1
40%:	561.7
50%:	653.6
60%:	754.5
70%:	860.1
80%:	984.6
90%:	1154.8
95%:	1218.7
FBP	1334.2
Recovery at °F	Total, Wt.%
180	4.9
380	21.8
480	31.5
650	49.6
800	64.5
1050	84.4
1105	87.7
1328	---

* The modified D 5134 gas chromatographic PIAN method used provides for elution and identification of components up to a nominal n-C_{12} (420° F).