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Silvia Murphy
Joint Investigation Team
Bureau of Ocean Energy Management, Regulation & Enforcement
Gulf of Mexico Region

Monday, August 1, 2011

JIT MACONDO WELL TESTING

Mrs. Silvia Murphy:

This report summarizes the results of the testing conducted in the cementing laboratory at Oilfield Testing & Consulting at your request.

A post-job evaluation of the given slurry designs, based on the cement design for the job performed on the Macando well, was to be performed with the specific outlined testing protocol given by you, the Joint Investigation Team. All testing was to be performed with cement, cement additives, spacer, base oil, and drilling fluid samples, representative of those used on the job for the Macando well in April 2010.

Except as specifically requested by you (and noted herein), all tests were conducted according to API Recommended Practice 10B-2 which is identical to ISO Document 10426-2 "Testing of Well Cements." Calibrations of all equipment have been performed according to API/ISO specifications and are attached in the Annex.

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SECTION 1. SAMPLE DESCRIPTION

Five 5-gallon buckets of Macaondo well samples were received Wednesday, June 22, 2011 from the U.S. Coast Guard. Among the samples received was one cement blend Lafarge cement sample, one Zonesealant 2000 sample, and three SCR-100L samples. A 1-gallon sample of Fourchon City water (6-22-11) was also received at this time. Four 5-gallon buckets of Lafarge Class H cement were received on Monday, June 27th, 2011. Some dry and wet additives were received from Halliburton, Friday, July 1, 2011, which included the following: SS1 (200-mesh) Silica flour, SS2 (100-mesh) Silica sand, SCR-100L retarder, ZoneSealant 2000 foam stabilizer, D-Air 3000 defoamer, SA-541 polysacharide, EZ-FLO flow enhancer, and KCL (Potassium Chloride) salt. A 1-gallon sample of Fourchon City water (from 6-8-11) was also received at this time. The materials to mix the spacer, Dual Spacer Surfactant A, Dual Surfactant B, Tuned Spacer III, SEM-8 emulsifier, and D-Air 3000L defoamer, were received Friday, July 8, 2011. Finally, one Rheliant base oil and one Rheliant drilling fluid (mud) sample was received from MI Swaco, Monday, July 11, 2011.

The slurry composition in the form of lab weights for a 600-mL portion of the 0.09 gps SCR-100L slurry was given as:

- Class H cement- 659.06 g
- SSA-1- 131-81 g
- SSA-2- 98.86 g
- KCL- 13.18 g
- D-Air 3000- 1.65 g
- SA-541- 1.32 g
- EZ-FLO- 0.46 g
- Fresh Water- 281.38 g
- SCR-100L- 6.10 g
- Zonesealant 2000- 6.85 g

Based on the above design, the wet phase of the 0.08 gps SCR-100L slurry was calculated as :

- Fresh Water- 282.06 g
- SCR-100L- 5.42 g
- Zonesealant 2000- 6.85 g

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SECTION 2. WATER ANALYSIS

Two Fourchon City water samples were received by OFTC. These samples were tested against Houston City water and a control sample of distilled water. The water analysis test results are as follows:

Water Sample Type	Sample Date	Sample ID	CL- (mg/L)	SO4 (mg/L)	Tannin Lignin (mg/L)	Total Hardness (as CaCO3) (ppm)	pH
Fresh	6-27-11	Houston City Water	65	< 50	0	25	7.7
Fresh	6-22-11	Fourchon City Water	30	75	0	250	7.0
Fresh	6-8-11	Fourchon City Water	35	75	0	250	7.3
Fresh	6-27-11	Distilled Water	10	< 50	0	25	7.5

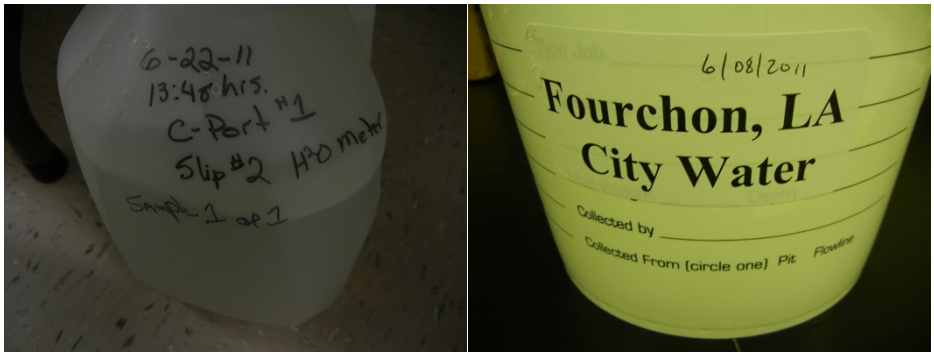

Figure #1. Fourchon City water samples.

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SECTION 3. MIXING AND BLENDING

All slurries were prepared as described in API RP 10B-2 Clause 5, or API RP 10B-4 Clause 7 (for foamed cement), as applicable.

- Both the cement and the water temperature were tested before beginning. All the samples were in the range of 71-75°F.
- The cement and the water were weighed in a clean dry container to an accuracy of 0.01 grams. The water was weighed immediately before use to prevent loss due to de-hydration.
- The mixer had a blade assembly with ≤ 10% wear on the blade and no obvious deformation.
- The dry cement was added to the water at a uniform rate in ≤ 15 seconds while the mixer maintained a speed of 4,000 rpm (±200 rpm).
- The mix was monitored for a clear vortex, and mixability is noted in the table below.
- The slurry was then mixed at 12,000 rpm (± 500 rpm) for 35 seconds, and an average speed under load for all slurries was documented.

Special mixing procedures for foamed cement:

The foam was achieved using a multi-blade assembly with a retro-fitted slurry cup that has a threaded cap, an o-ring, and a removable plug with a vent hole. The base slurry was prepared as described above, then the appropriate weight of slurry was placed in the cup which was then sealed. The mixer was turned to 12,000 rpm or the highest achievable rpm (and recorded) for 15 seconds.

Figure #2. Base slurry was mixable and a clear vortex was visable.

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SECTION 4. FLUID CONDITIONING

Fluids were conditioned in two different manners given by API RP 10B-2, Clause 12.4 (b,c). Depending on the test, the fluid was conditioned at either atmospheric pressure or in a pressurized vessel.

In both procedures, the consistometer cups were at room temperature when slurry was added to them. The slurry was mixed according to Section 1 mixing procedure, and then was immediately poured into the consistometer cup for test initiation. The test was increased to conditions in the individual manners described below, then allowed to stir for the designated conditioning time, as set by the JIT. Once the conditioning time was completed, every effort was made to prevent the slurry from remaining static for any period of time and was vigorously stirred with a spatula for 5 seconds immediately before removing the slurry from the vessel. At that time, the slurry was then prepared for prompt use.

Atmospheric Conditioning

Atmospheric conditioning was utilized for rheology and foam stability tests. The atmospheric consistometer was pre-heated to 80°F or 135°F, as required (refer to specific results in the appropriate sections). After adding the slurry to the vessel, the temperature was monitored until it reached the designated temperature. At that time, a timer was set to run for 30 minutes.

Pressurized Conditioning

In this series of tests, the pressurized method was used for all fluid loss tests, free fluid tests, BP settling tests, UCA tests, and Crush Strength Tests. The slurries were heated to 135°F and a pressure according to the test schedule for the cement application, using ramp times of 83 and 230 minutes. Specifically, before transferring to the appropriate vessels and/or starting the tests: the fluid loss tests were conditioned at 500 psi for a period of 30 minutes; the free fluid and BP settling tests were conditioned at 14,458 psi for 30 minutes; and the compressive strength tests were stirred at 14,458 psi for 3 hours. The time was closely monitored, and slurries treated promptly at the end of the designated period. The slurries were immediately and safely removed, and excess oil invaded from the consistometer was blotted from the top of the slurry just before the paddle was removed.

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SECTION 5. RHEOLOGY

The slurries noted below were prepared as described in Section 1 and tested for rheology and gel strength (10 second & 10 minute) according to API RP 10B-2 Clause 12.4 except as specifically noted in this document. An atmospheric viscometer was used with a standard rotor/bob/spring combination of R1/B1/F1. Measurements were made at rotational speeds of 3, 6, 30, 60, 100, 200, 300 & 600 rpm. The 600 RPM reading was observed after all other readings were recorded as illustrated in API RP 10B-2, Clause 12.4, item f. A heating assembly was used to maintain the temperature ±5°F during testing and to pre-heat the cup. Upon assembly, centralization of the rotor and bob was checked using a mirror.

After atmospheric conditioning as described in Section 2, for 30 minutes at the temperatures noted in the table below, the slurry was vigorously stirred for 5 seconds and immediately poured into a viscometer cup.

Procedure

The viscometer was initially rotating at 3 rpm as the cup was raised. Each reading was stabilized for 10 seconds before recording the dial reading. The temperature was taken before the first reading and after the final reading (before performing gel strength tests). Readings were taken first in ascending order followed by descending order and the ratio of the readings ascending to descending were calculated, as well as the average of the two readings and the difference between the two readings (no differences were greater than ±5°).

Gel strength at 3 rpm was measured immediately after taking the last temperature. The slurry in the cup was mixed at 300 rpm for 1 min to disperse the gel. The setting was then changed to 3 rpm, and the viscometer turned off for 10 seconds. Immediately upon turning the viscometer back on, the maximum dial reading was recorded as the "10 second gel strength." The viscometer was shut back off for 10 minutes and the process repeated for the "10 minute gel strength." A 3rd , final temperature was recorded.

Composition and Test Conditions Defined

#	COMPOSITION	Pre-condition	Gel Str.
Rh1	Base Slurry + 0.08 gps SCR-100	30 min @ 80°F	10s, 10m
Rh2	Base Slurry + 0.08 gps SCR-100	30 min @ 135°F	10s, 10m
Rh3	Base Slurry + 0.09 gps SCR-100	30 min @ 80°F	10s, 10m
Rh4	Base Slurry + 0.09 gps SCR-100	30 min @ 135°F	10s, 10m

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SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
Rh1	71.7	71.5	12198	0	Vortex visable
Rh2	70.6	71.4	12214	0	Vortex visable
Rh3	71.6	71.4	12207	0	Vortex visable
Rh4	71.3	72.9	12200	0	Vortex visable

RHEOLOGICAL RESULTS

#		600 rpm	300 rpm	200 rpm	100 rpm	60 rpm	30 rpm	6 rpm	3 rpm	10s GS	10m GS	Pv	Ty
Rh 1	Avg DR	105	47	30.5	16	9.5	5.5	1.5	1	1	2	46.5	0.50
	Ratio	1.00	1.00	1.10	1.13	1.11	1.20	2.00	1.00	--	--	--	--
Rh 2	Avg DR	99	44	29	15	10	5.5	2.5	1.5	2	8	43.5	0.50
	Ratio	1.00	1.00	1.07	1.14	1.22	1.20	1.50	2.00	--	--	--	--
Rh 3	Avg DR	62	28	20	9.5	5.5	3	1.5	1	1	3	27.8	0.25
	Ratio	1.00	1.00	1.10	1.38	1.20	1.00	2.00	1.00	--	--	--	--
Rh 4	Avg DR	84	36	22.5	12	7.5	4.5	1.5	1.5	2	6	36.0	0.00
	Ratio	1.00	1.00	1.04	1.00	1.14	1.25	2.00	2.00	--	--	--	--

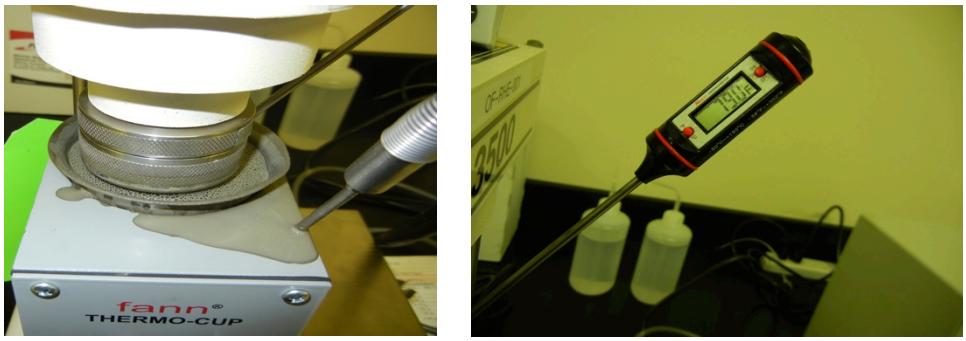

Figure #3. A heated cup was used for all rheology tests to regulate temperature and a thermometer was used to measure temperature.

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The following rheologies were performed at 135°F, as described above, with the exception of gel strengths, as part of the compatibility regimen. Slurries CR1-4 were mixed and conditioned several times to perform the ratio tests. For performing the ratio tests, the pure mixtures were prepared, then kept mixing at 135° while small aliquots were sequentially removed to prepare and test each of the five individual ratios required (i.e. two pure fluids were used to make each of the 5 ratios with no "dilutions" of previous mixtures). This procedure for determining compatibilities is further described in API RP 10B-2 Clause 16.

Composition and Test Conditions Defined

#	COMPOSITION	Ratio
CR1	Base Slurry + 0.09 gps SCR-100	100%
CR2	Spacer	100%
CR3	Base Oil	100%
CR4	Drilling Fluid	100%
CR5	Spacer CR2 : Base Oil CR3	95 : 5
CR6	CR5	75 : 25
CR7	CR5	50 : 50
CR8	CR5	25 : 75
CR9	CR5	5 : 95
CR10	Spacer CR2 : Slurry CR1	95 : 5
CR11	CR10	75 : 25
CR12	CR10	50 : 50
CR13	CR10	25 : 75
CR14	CR10	5 : 95
CR15	Base Oil CR3 : Slurry CR1	95 : 5
CR16	CR15	75 : 25
CR17	CR15	50 : 50
CR18	CR15	25 : 75
CR19	CR15	5 : 95
CR20	Drilling Fluid CR4 : Slurry CR1	95 : 5
CR21	CR20	75 : 25
CR22	CR20	50 : 50
CR23	CR20	25 : 75
CR24	CR20	5 : 95

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SPACER CR2:BASE OIL CR3 COMPATIBILITY RESULTS

Fluid Mixture (%)	Test Temp (°F)	Viscometer dial readings @ rpm (avg)							PV mPa·s (cps)	YP Pa (lbf/100 ft²)
		300	200	100	60	30	6	3		
100 % spacer	135	73	60.5	45.5	38.5	31.5	21.5	18	41.2	31.8
100% base oil	135	6	5	5	4.5	4	3.5	3	1.50	4.50
95 % spacer 5 % base oil	135	64	53	41.5	35	29.5	21	18	33.8	30.2
75 % spacer 25 % base oil	135	65	54	41	34	25.5	17.5	15.5	36.0	29.0
50 % spacer 50 % base oil	135	38	30	23	18.5	14.5	10.5	8.5	22.5	15.5
25 % spacer 75 % base oil	135	8	7	5	4.5	4	3.5	3	4.50	3.50
5 % spacer 95 % base oil	135	7	6.5	5	4	4	3	3	3.00	4.00

SPACER CR2:SLURRY CR1 COMPATIBILITY RESULTS

Fluid Mixture (%)	Test Temp (°F)	Viscometer dial readings @ rpm (avg)							PV mPa·s (cps)	YP Pa (lbf/100 ft²)
		300	200	100	60	30	6	3		
100 % spacer	135	73	60.5	45.5	38.5	31.5	21.5	18	41.25	31.75
100% slurry	135	27	19	11.5	8	6	4	4	23.2	3.75
95 % spacer 5 % slurry	135	173	149.5	119	99.5	90.5	82.5	79.5	81.0	92.0
75 % spacer 25 % slurry	135	170	143.5	112	97	82.5	72.5	68.5	87.0	83.0
50 % spacer 50 % slurry	135	149	119	87.5	73.5	61	43.5	39.5	92.2	56.8
25 % spacer 75 % slurry	135	110	82	51.5	38.5	27	15	11.5	87.8	22.2
5 % spacer 95 % slurry	135	28	19.5	12	9	7	4	3.5	24.0	4.00

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BASE OIL CR3:SLURRY CR1 COMPATIBILITY RESULTS

Fluid mixture %	Test temp (°F)	Viscometer dial readings @ rpm (avg)							PV mPa·s (cps)	YP Pa (lbf/100 ft2)
		300	200	100	60	30	6	3		
100 % base oil	135	6	5	5	4.5	4	3.5	3	1.50	4.50
100% slurry	135	27	19	11.5	8	6	4	4	23.2	3.80
95 % base oil 5 % slurry	135	6	5	4.5	4	4	4	3	2.25	3.75
75 % base oil 25 % slurry	135	6	5	4.5	4	4	3	3	2.25	3.75
50 % base oil 50 % slurry	135	50	36	22.5	16.5	12	7	6	41.2	8.75
25 % base oil 75 % slurry	135	83	58.5	34	24	15	7	5.5	73.5	9.50
5 % base oil 95 % slurry	135	30	20.5	12	9	7	4	4	27.0	3.00

DRILLING FLUID CR4:SLURRY CR1 COMPATIBILITY RESULTS

Fluid mixture %	Test temp (°F)	Viscometer dial readings @ rpm (avg)							PV mPa·s (cps)	YP Pa (lbf/100 ft²)
		300	200	100	60	30	6	3		
100 % drilling fluid	135	45	32.5	21	16	10.5	6.5	5	36.0	9.00
100% slurry	135	27	19	11.5	8	6	4	4	23.2	3.75
95 % drilling fluid 5 % slurry	135	47	36.5	23.5	17	12	7.5	5.5	35.2	11.8
75 % drilling fluid 25 % slurry	135	36	29	18	14.5	10.5	7	6	27.0	9.00
50 % drilling fluid 50 % slurry	135	30	22	13.5	10	7.5	4.5	3.5	24.8	5.25
25 % drilling fluid 75 % slurry	135	39	24.5	14.5	11	7.5	4.5	3.5	36.8	2.25
5 % drilling fluid 95 % slurry	135	60	40	23.5	16	10	4.5	3.5	54.8	5.25

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Figure #4. Compatibility between 50% base slurry and 50% base oil.

Figure #5. Compatibility between 25% base slurry and 75% drilling fluid.

The density of each fluid was verified before all compatibility tests were performed. The density measurements are as follows:

#	COMPOSITION	Density (ppg)
CR1	Base Slurry + 0.09 gps SCR-100	16.9
CR2	Spacer	15.1
CR3	Base Oil	6.60
CR4	Drilling Fluid	12.6

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SECTION 6. FREE FLUID and BP SETTLING

The slurries noted in the first table from the previous section (Section 3, Rh1-4) were re-mixed and re-conditioned (pressurized) as described in previous sections. They were tested for free fluid (with heated static period) and for sedimentation in a BP settling tube according to API RP 10B-2 Clause 15.4 and 15.6 .

Free Fluid at ≤190°F

A clear, graduated, glass, ASTM Class B, 250 mL cylinder was used with parafilm to reduce evaporation. The cylinder dimensions and exact slurry volume was documented for each test. A circulating water bath pre-heated to 135°F was used for the two hour static period. The four fluids were tested at both zero degree (vertical) and 45 degree angles with vibration minimized. At the end of two hours (from the moment of entering the cylinder), the clear or colored fluid on top of the cement slurry (free fluid) was measured to a precision of ± 0.2mL. The free fluid was documented as a percent of the original volume.

Sedimentation

Immediately after mixing and before conditioning, the slurry were tested for density with a pressurized mud balance. A BP Settling tube, greased inside and at joints, was utilized for the sedimentation test. The tube was filled to within ¾" from the top and then puddled (tamped) before completely filling the tube. A curing chamber heated to 210°F was used instead of a water bath. Each of the four samples was cured for 24 hours, before removing from the chamber. The chamber was then cooled to 190°F, the sample was removed and cooled to 80°F ±10°F using a water bath. The procedure for marking and measuring the density using Archimedes principle, described in API RP 10B-2 Clause 15.6 was used to find the density of each section with a scale of precision 0.001g.

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Composition and Test Conditions Defined

#	COMPOSITION	Ramp time	Angle
FF1	Base Slurry + 0.08 gps SCR-100	83 min	0°
FF2	Base Slurry + 0.08 gps SCR-100	83 min	45°
FF3	Base Slurry + 0.08 gps SCR-100	230 min	0°
FF4	Base Slurry + 0.08 gps SCR-100	230 min	45°
FF5	Base Slurry + 0.09 gps SCR-100	83 min	0°
FF6	Base Slurry + 0.09 gps SCR-100	83 min	45°
FF7	Base Slurry + 0.09 gps SCR-100	230 min	0°
FF8	Base Slurry + 0.09 gps SCR-100	230 min	45°
BP1	Base Slurry + 0.08 gps SCR-100	83 min	N/A
BP2	Base Slurry + 0.08 gps SCR-100	230 min	N/A
BP3	Base Slurry + 0.09 gps SCR-100	83 min	N/A
BP4	Base Slurry + 0.09 gps SCR-100	230 min	N/A

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
FF1	71.3	75.2	12214	0	Vortex visable
FF2	71.1	71.5	12198	0	Vortex visable
FF3	71.9	72.9	12207	0	Vortex visable
FF4	71.3	75.1	12231	0	Vortex visable
FF5	71.4	74.1	12217	0	Vortex visable
FF6	71.1	74.0	12223	0	Vortex visable
FF7	71.3	72.3	12226	0	Vortex visable
FF8	71.0	73.3	12254	0	Vortex visable
BP1	70.2	72.3	12226	0	Vortex visable
BP2	71.4	70.2	12210	0	Vortex visable
BP3	70.3	75.1	12214	0	Vortex visable
BP4	70.6	74.5	12207	0	Vortex visable

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FREE FLUID RESULTS

#	Ramp Time (min)	Static Test Temp (°F)	Static Period: Heated	Cylinder Ratio (H:W)	Angle	Total Volume (mL)	Free Fluid Volume (mL)	%FF	Settling?
FF1	83	135°F	Heat	6:1	0°	250	3.5	1.40	No
FF2	83	135°F	Heat	6:1	45°	250	8.5	3.40	Yes
FF3	230	135°F	Heat	6:1	0°	250	4.5	1.8	No
FF4	230	135°F	Heat	6:1	45°	250	18.6	7.44	Yes
FF5	83	135°F	Heat	6:1	0°	250	1.5	0.60	No
FF6	83	135°F	Heat	6:1	45°	250	12.0	4.80	Yes
FF7	230	135°F	Heat	6:1	0°	250	4.5	1.80	No
FF8	230	135°F	Heat	6:1	45°	250	13.0	5.20	Yes

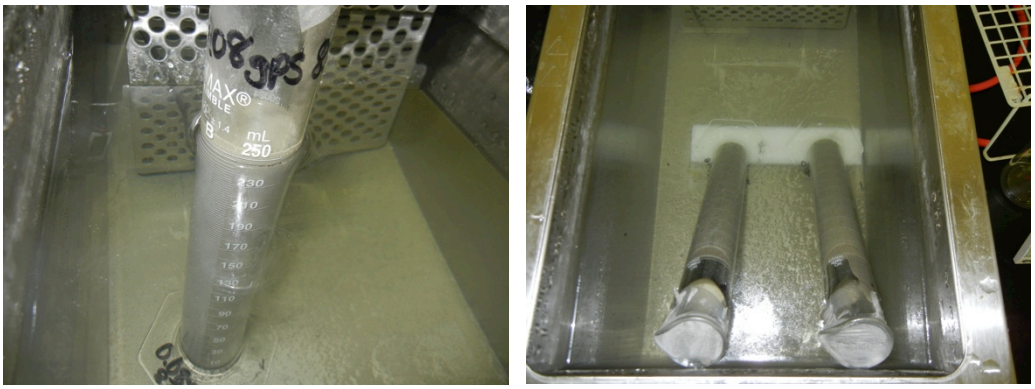

Figure #6. Heated Static Free Fluid tests in water bath at 0° and 45° inclination.

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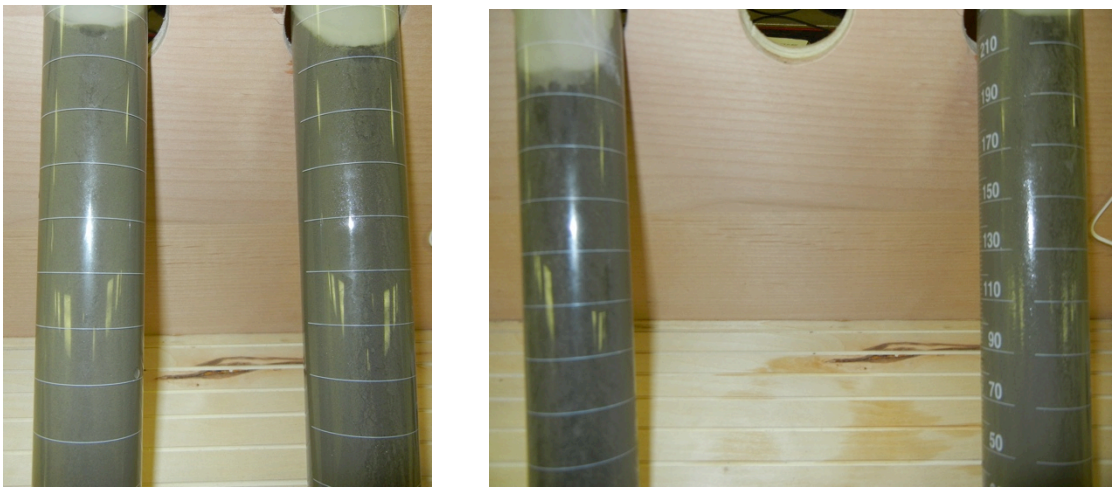

Figure #7. Picture on the left shows the 0.08 gps SCR-100 (l) and 0.09 (r) gps SCR-100 slurries that were pre-conditioned for 83 minutes and tested at a 45° angle for Free Fluid. Picture on the right shows the 0.08 gps (l) and 0.09 (r) gps slurries that were pre-conditioned for 230 minutes and tested at a 45° angle.

Figure #8. Picture on the left shows the 0.08 gps SCR-100 slurry that was pre-conditioned for 83 minutes and tested at a 0° angle for Free Fluid. Picture on the right shows the 0.09 gps SCR-100 slurry that was pre-conditioned for 83 minutes and tested at a 0° angle.

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BP SETTLING TEST RESULTS

Sample #	Weight of Sample (g)	Weight of Volume of Removed Water (g)	S.G. of Slurry (g/cm³)	Density of Slurry (ppg)	Volume of Sample (cm³)	Percent Difference
1 (Top)	12.28	6.05	2.03	16.94	89.47	0.25
2	30.73	14.85	2.07	17.27	79.02	2.21
3	28.27	13.67	2.07	17.26	64.76	2.14
4	23.21	11.29	2.06	17.16	52.28	1.54
5	25.72	12.43	2.07	17.27	40.42	2.20
6	33.59	16.15	2.08	17.36	26.13	2.73
7	15.66	7.51	2.09	17.41	14.30	2.99
8 (Bottom)	22.50	10.54	2.13	17.82	5.27	5.44

Average Density: **17.31**
Top and Bottom Difference: **0.88**
Measured Density of Slurry: **16.9**

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BP SETTLING TEST RESULTS

Sample #	Weight of Sample (g)	Weight of Volume of Removed Water (g)	S.G. of Slurry (g/cm^3)	Density of Slurry (ppg)	Volume of Sample (cm^3)	Percent Difference
1 (Top)	23.30	11.29	2.06	17.23	82.38	1.93
2	25.31	12.18	2.08	17.35	70.64	2.63
3	25.01	12.05	2.08	17.32	58.53	2.51
4	26.31	12.69	2.07	17.31	46.16	2.40
5	23.22	11.19	2.08	17.32	34.22	2.49
6	23.55	11.35	2.07	17.32	22.95	2.48
7	21.39	10.31	2.07	17.32	12.12	2.47
8 (Bottom)	14.70	6.96	2.11	17.63	3.48	4.32

Average Density: **17.35**
Top and Bottom Difference: **0.40**
Measured Density of Slurry: **16.9**

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BP SETTLING TEST RESULTS

Sample #	Weight of Sample (g)	Weight of Volume of Removed Water (g)	S.G. of Slurry (g/cm^3)	Density of Slurry (ppg)	Volume of Sample (cm^3)	Percent Difference
1 (Top)	21.23	10.82	1.96	16.38	90.87	3.09
2	24.96	12.13	2.06	17.18	79.40	1.63
3	27.01	13.06	2.07	17.26	66.80	2.15
4	26.04	12.62	2.06	17.22	53.96	1.91
5	25.92	12.55	2.07	17.24	41.38	2.01
6	25.64	12.53	2.05	17.08	28.84	1.07
7	33.23	16.04	2.07	17.29	14.55	2.32
8 (Bottom)	13.93	6.53	2.13	17.81	3.27	5.36

Average Density: **17.18**
Top and Bottom Difference: **1.43**
Measured Density of Slurry: **16.9**

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BP SETTLING TEST RESULTS

Sample #	Weight of Sample (g)	Weight of Volume of Removed Water (g)	S.G. of Slurry (g/cm³)	Density of Slurry (ppg)	Volume of Sample (cm³)	Percent Difference
1 (Top)	29.11	14.22	2.05	17.09	90.07	1.11
2	22.91	10.85	2.11	17.62	77.54	4.29
3	22.92	11.04	2.08	17.33	66.59	2.54
4	23.40	11.24	2.08	17.38	55.45	2.82
5	25.21	12.10	2.08	17.39	43.78	2.90
6	19.54	9.42	2.07	17.31	33.02	2.45
7	23.48	11.20	2.10	17.50	22.71	3.54
8 (Bottom)	36.27	17.11	2.12	17.69	8.56	4.70

Average Density: **17.41**
Top and Bottom Difference: **0.61**
Measured Density of Slurry: **16.9**

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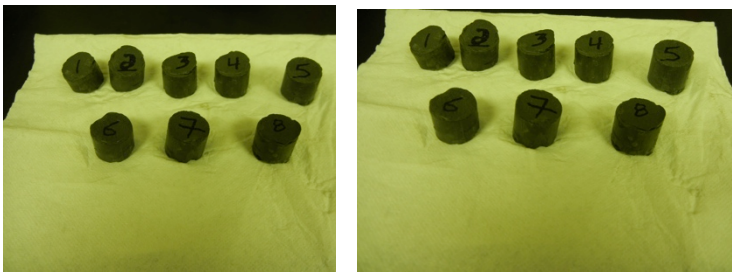

Figure #9. Picture on the left shows the 0.08 gps SCR-100 slurry that was pre-conditioned for 83 minutes and tested for the BP Settling Test. Picture on the right shows the 0.09 SCR-100 gps slurry that was pre-conditioned for 83 minutes and tested for BP Settling Test.

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SECTION 7. FLUID LOSS

The slurries noted below were prepared as described in Section 1 and tested for fluid loss according to API RP 10B-2 Clause 10. A stirred fluid loss apparatus was used to condition and perform all fluid loss tests. Pre-conditioning was performed for 30 min @ 135°F.

Composition and Test Conditions Defined

#	COMPOSITION	Ramp time
FL1	Base Slurry + 0.08 gps SCR-100	83 min
FL2	Base Slurry + 0.08 gps SCR-100	230 min
FL3	Base Slurry + 0.09 gps SCR-100	83 min
FL4	Base Slurry + 0.09 gps SCR-100	230 min
CL1	Slurry FL3 : Spacer at 95:5 ratio	83 min
CL2	Slurry FL3 : Spacer at 75:25 ratio	83 min
CL3	Slurry FL3 : Base Oil at 95:5 ratio	83 min
CL4	Slurry FL3 : Base Oil at 75:25 ratio	83 min

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
FL1	70.4	71.2	12194	0	Vortex visable
FL2	70.6	71.5	12220	0	Vortex visable
FL3	70.1	71.3	12219	0	Vortex visable
FL4	71.2	70.3	12285	0	Vortex visable
CL1	71.3	70.9	12216	0	Vortex visable
CL2	71.3	70.1	12134	0	Vortex visable
CL3	72.3	71.5	12219	0	Vortex visable
CL4	71.3	70.7	12219	0	Vortex visable

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FLUID LOSS RESULTS

#	FL Cell Type	Ramp Time (min)	Test Temp (°F)	Test Time (min:sec)	Final Volume (mL)	Calc. API FL (mL)	Filter Cake Condition
FL1	Stirred FL	83	135°F	15:17	101	285	Crumbly Powder
FL2	Stirred FL	230	135°F	2:55	81.0	519	Crumbly Powder
FL3	Stirred FL	83	135°F	13:01	100	303	Crumbly Powder
FL4	Stirred FL	230	135°F	2:21	62	443	Crumbly Powder
CL1	Stirred FL	83	135°F	3:39	79	452	4.25 inches
CL2	Stirred FL	83	135°F	5:41	54	248	3.25 inches
CL3	Stirred FL	83	135°F	5:08	79	382	3.75 inches
CL4	Stirred FL	83	135°F	30:00	42	84	2 inches

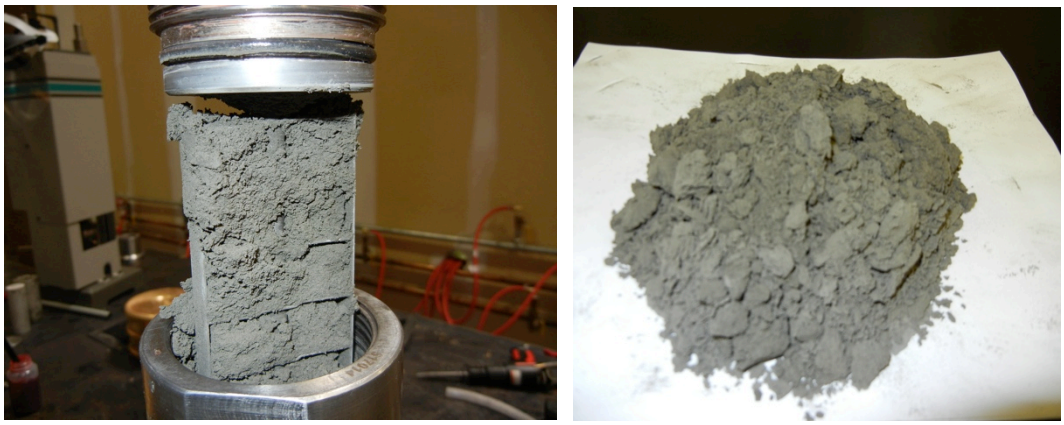

Figure #10. Fluid Loss specimen after test blew dry (0.08 gps SCR-100 system with 83 minute conditioning time).

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Figure #11. Fluid Loss test specimen after 30 minutes for the 75% 0.09 gps SCR-100 base slurry with 25% base oil contamination (with 83 minute conditioning time).

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SECTION 8. THICKENING TIME

All samples were tested for thickening time according to API RP 10B-2 Clause 9.

- The slurry cup was assembled before filling with the exception of the plug nut. Grease was applied to the threaded areas, only. While tapping on the side of the cup, the slurry was poured into the cup until it flowed out of the hole. Cement was wiped from the threads and capped. The cup was checked to ensure the paddle turned freely.
- Each test was initiated within 5 min ± 15 sec of mixing, with the exact time being recorded.

Composition and Test Conditions Defined

#	Composition	Test Temp (°F)	Test Pressure (psi)	Ramp Time (min)
TT1	Base Slurry + 0.08 gps SCR-100	135	14,458	83
TT2	Base Slurry + 0.08 gps SCR-100	135	14,458	230
TT3	Base Slurry + 0.09 gps SCR-100	135	14,458	83
TT4	Base Slurry + 0.09 gps SCR-100	135	14,458	230
CT1	Slurry TT3 : Spacer at 95:5 ratio	135	14,458	83
CT2	Slurry TT3 : Spacer at 75:25 ratio	135	14,458	83
CT3	Slurry TT3 : Base Oil at 95:5 ratio	135	14,458	83
CT4	Slurry TT3 : Base Oil at 75:25 ratio	135	14,458	83

Refer to Appendix A for thickening time graphs

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
TT1	71.7	73.4	12224	0	Vortex visable
TT2	71.7	73.4	12219	0	Vortex visable
TT3	74.1	72.4	12211	0	Vortex visable
TT4	71.2	73.7	12230	0	Vortex visable
CT1	70.6	73.5	12229	0	Vortex visable
CT2	71.1	75.4	12211	0	Vortex visable
CT3	71.3	71.9	12229	0	Vortex visable
CT4	70.5	70.0	12219	0	Vortex visable

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THICKENING TIME RESULTS

#	Test Temp (°F)	Batch Mix (min)*	Initial Bc	30 Bc at hh:mm	50 Bc at hh:mm	70 Bc at hh:mm	100 Bc at hh:mm
TT1	135	N/A	9	05:51	05:54	05:57	05:59
TT2	135	N/A	14	07:42	08:02	08:09	08:12
TT3	135	N/A	14	07:24	07:46	08:11	08:18
TT4	135	N/A	7	08:02	08:29	08:33	08:37
CT1	135	N/A	14	00:09	00:15	08:33	08:36
CT2	135	N/A	22	01:02	10:20	10:27	10:33
CT3	135	N/A	13	07:20	07:32	07:35	07:37
CT4	135	N/A	17	07:36	07:49	07:54	08:01

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SECTION 9. COMPRESSIVE STRENGTH

UCA Procedure

The slurries noted below were prepared as described in Section 1 and tested for compressive strength according to API RP 10B-2 Clause 8, except as specifically noted in this document. An alternate heat up schedule was used, as requested, as discussed in API RP 10B-2, clause 7.5.4 when simulating specific well conditions. The UCA cell was pre-heated to 135°F before accepting slurry. The test was initiated within 5 minutes of pre-conditioning. Each test was 48 hours, including ramp time, calculated from the initiation of temperature and pressure on the UCA cell. Pressure was maintained at 3000 psi throughout the UCA test. Pre-conditioning and the heat up schedule is outlined below and was utilized in testing the following slurry formulations:

Composition and Test Conditions Defined

#	COMPOSITION	Pre-condition
UCA1	Base Slurry + 0.08 gps SCR-100	3 hours @ 135°F (83 min ramp)
UCA1-B	Base Slurry + 0.08 gps SCR-100	3 hours @ 135°F (230 min ramp)
UCA2	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F(83 min ramp)
UCA2-B	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F (230 min ramp)
CU1	Slurry UCA2 : Spacer at 95:5 ratio	3 hours @ 135°F (83 min ramp)
CU1-B	Slurry UCA2 : Spacer at 95:5 ratio	3 hours @ 135°F (230 min ramp)
CU2	Slurry UCA2 : Spacer at 75:25 ratio	3 hours @ 135°F (83 min ramp)
CU2-B	Slurry UCA2 : Spacer at 75:25 ratio	3 hours @ 135°F (230 min ramp)
CU3	Slurry UCA2 : Base Oil at 95:5 ratio	3 hours @ 135°F (83 min ramp)
CU3-B	Slurry UCA2 : Base Oil at 95:5 ratio	3 hours @ 135°F (230 min ramp)
CU4	Slurry UCA2 : Base Oil at 75:25 ratio	3 hours @ 135°F (83 min ramp)
CU4-B	Slurry UCA2 : Base Oil at 75:25 ratio	3 hours @ 135°F (230 min ramp)

Pre-condition all samples for 3 hours at 135°F
Ramp from 135°F to 165°F in 4 hours
Ramp from 165°F to 185°F in 4 hours
Ramp from 185°F to 195°F in 4 hours
Ramp from 195°F to 210°F in 4 hours
Maintain 210°F for the remainder of the test period

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Crush Test Procedure

The slurries noted below were prepared as described in Section 1 and tested for compressive strength according to API RP 10B-2 Clause 7. The slurry was conditioned for 3 hours at 135°F and transferred to a pre-heated water bath at 180°F for 48 hours.

#	COMPOSITION	Pre-condition	Water Bath
ACS1	Base Slurry + 0.08 gps SCR-100	3 hours @ 135°F (83 min ramp)	180°F
ACS1-B	Base Slurry + 0.08 gps SCR-100	3 hours @ 135°F (230 min ramp)	180°F
ACS2	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F (83 min ramp)	180°F
ACS2-B	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F (83 min ramp)	180°F

The slurries noted below were prepared as described in Section 1 and tested for compressive strength according to API RP 10B-2 Clause 7. The slurry was conditioned according to the schedule listed below

#	COMPOSITION	Pre-condition	Weight	Foam Quality
ACS3	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F	14.5 ppg	13%
ACS4	Base Slurry + 0.09 gps SCR-100	3 hours @ 135°F	13.6 ppg	18.5%

Pre-condition samples for 3 hours at 135°F
Foam the slurry to the noted density and place in the water bath
Ramp from 135°F to 165°F in 4 hours
Ramp from 165°F to 180°F in 4 hours
Maintain 180°F for the remainder of the test period, total test time of 48 hours.

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SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
UCA1	70.2	73.7	12229	0	Vortex visable
UCA1-B	70.3	73.6	12224	0	Vortex visable
UCA2	70.9	75.4	12260	0	Vortex visable
UCA2-B	70.9	72.7	12267	0	Vortex visable
CU1	71.4	72.4	12220	0	Vortex visable
CU1-B	70.3	71.7	12218	0	Vortex visable
CU2	70.2	72.1	12203	0	Vortex visable
CU2-B	70.7	72.3	12224	0	Vortex visable
CU3	70.3	71.8	12235	0	Vortex visable
CU3-B	70.1	72.3	12204	0	Vortex visable
CU4	70.0	71.0	12217	0	Vortex visable
CU4-B	70.5	74.6	12205	0	Vortex visable
ACS1	70.8	70.6	12221	0	Vortex visable
ACS1-B	71.7	70.2	12210	0	Vortex visable
ACS2	71.4	75.9	12242	0	Vortex visable
ACS2-B	70.4	75.1	12224	0	Vortex visable
ACS3	71.3	72.2	12233	0	Vortex visable
ACS4	70.6	74.5	12198	0	Vortex visable

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UCA ("SONIC") COMPRESSIVE STRENGTH TEST RESULTS

#	Test Temp	Test Press.	50 psi at hh:mm	500 psi at hh:mm	psi at 12:00	psi at 24:00	psi at 48:00
UCA1	210°F	3000 psi	14:06	15:11	0	3006	3550
UCA1-B	210°F	3000 psi	16:24	17:20	0	2637	3551
UCA2	210°F	3000 psi	15:22	16:33	0	2762	3459
UCA2-B	210°F	3000 psi	16:32	17:42	0	2794	3958
CU1	210°F	3000 psi	15:26	16:33	0	2401	3042
CU1-B	210°F	3000 psi	16:51	17:56	0	2342	3137
CU2	210°F	3000 psi	16:58	19:50	0	846	1263
CU2-B	210°F	3000 psi	18:33	21:56	0	669	1183
CU3	210°F	3000 psi	16:43	19:43	0	1817	2596
CU3-B	210°F	3000 psi	15:51	17:57	0	2158	2692
CU4	210°F	3000 psi	20:52	34:50	0	322	557
CU4-B	210°F	3000 psi	20:27	24:13	0	486	852

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COMPRESSIVE STRENGTH TEST RESULTS

	Property	ACS1	ACS1-B	ACS2	ACS2-B
cube #1	Area (sq. in.)	3.99	4.20	3.99	4.72
	Force (lb_f)	16945	16388	18020	20066
	CS (psi)	4247	3902	4516	4251
cube #2	Area (sq. in.)	3.99	3.99	4.10	4.30
	Force (lb_f)	15561	15759	17201	22060
	CS (psi)	3900	3950	4195	5124
Average CS psi		4073	3926	4355	4688

COMPRESSIVE STRENGTH TEST RESULTS

	Property	ACS3	ACS4
cube #1	Area (sq. in.)	4.0	4.2
	Force (lb_f)	3953	3749
	CS (psi)	988.2	892.6
cube #2	Area (sq. in.)	4.6	4.2
	Force (lb_f)	6663	4782
	CS (psi)	1448	1139
cube #3	Area (sq. in.)	4.4	4.4
	Force (lb_f)	4456	3841
	CS (psi)	1012	873
Average CS psi		1150	968

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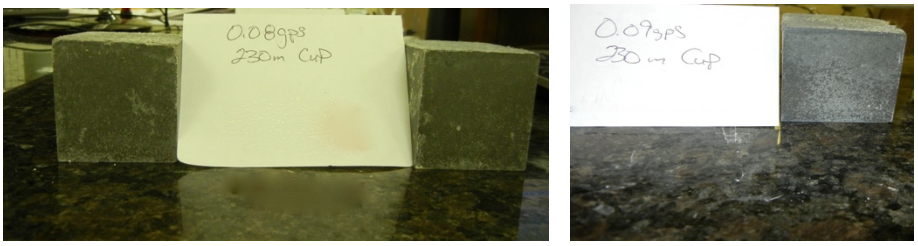

Figure #12. Picture on the left shows the 0.08 gps SCR-100 slurry that was pre-conditioned for 3 hours with a ramp of 230 minutes and tested for the Compressive Strength. Picture on the right shows the 0.09 SCR-100 gps slurry that was pre-conditioned for 3 hours with a ramp of 230 minutes and tested for Compressive Strength.

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SECTION 10. COMPATIBILITY TESTS

The sections listed below describe the testing that was done to determine compatibility:

- Section 5 – Rheology of tests CR1-CR24
- Section 8– Thickening Time of tests CT1-CT4
- Section 7 – Fluid Loss of tests CL1-CL4
- Section 9 – UCA Compressive Strength of tests CU1-CU4-B
- Section 11 – Foam Stability of CFM1-CFM4

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SECTION 11. FOAM STABILITY

The tests noted below were prepared as described below and tested for foam stability according to API RP 10B-4 Clauses 5 and 9. The stability was assessed using visual inspection (e.g. FF, settling, bubble conc.), as well as three density measurement methods, also described below. Foam stability tests were performed on a 14.5 ppg and a 13.6 ppg slurry prepared at atmospheric conditions to achieve approximately 13% and 18.5% gas, respectively. The base slurry was prepared and conditioned as described in Sections 1-2 for 90 minutes and 3 hours. The foam was achieved using a multi-blade assembly with a retro-fitted slurry cup that has a threaded cap, an o-ring, and a removable plug with a vent hole.

The total volume of the blender cup was measured on a scale with tap water prior to testing. The total volume measured was 1178.00 mL. This total volume was used to calculate the amount of base slurry and foamer required to generate 13% and 18.5% Foam Quality.

Density measurement of slurry sampled from the blender

Determined by the volume and weight of the slurry in the container.

Density measurement via graduated cylinder

The volume and weight of the slurry sampled from graduated cylinder after a 2-hour quiescent period according to API RP10B-4/ISO 10426-4 Clause 9.3.1.

Density measurement by Archimedes' Principle

The density of samples cured in PVC molds at 180°F according to API RP10B-4/ISO 10426-4 Clause 9.3.3.

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#	COMPOSITION	Pre-condition Time	Temp (°F)	ppg	% gas
FM1	Base Slurry + 0.08 gps SCR-100	1.5 hr	135	14.5	13
FM2	Base Slurry + 0.08 gps SCR-100	3.0 hr	135	14.5	13
FM3	Base Slurry + 0.09 gps SCR-100	1.5 hr	135	14.5	13
FM4	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	14.5	13
FM5	Base Slurry + 0.08 gps SCR-100	1.5 hr	135	13.6	18.5
FM6	Base Slurry + 0.08 gps SCR-100	3.0 hr	135	13.6	18.5
FM7	Base Slurry + 0.09 gps SCR-100	1.5 hr	135	13.6	18.5
FM8	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	13.6	18.5
CFM1	Base Slurry + 0.08 gps SCR-100 +10% Oil	3.0 hr	135	14.5	13
CFM2	Base Slurry + 0.08 gps SCR-100 + 20% Oil	3.0 hr	135	14.5	13
CFM3	Base Slurry + 0.09 gps SCR-100 +10% Oil	3.0 hr	135	14.5	13
CFM4	Base Slurry + 0.09 gps SCR-100 + 20% Oil	3.0 hr	135	14.5	13
MAC4	Macondo well Base Slurry + 0.09 gps SCR-100	3.0 hr	135	14.5	13

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
FM1	72.0	71.3	12262	0	Vortex visable
FM2	71.6	71.0	12204	0	Vortex visable
FM3	71.8	74.3	12235	0	Vortex visable
FM4	71.3	72.2	12233	0	Vortex visable
FM5	72.2	72.9	12221	0	Vortex visable
FM6	71.5	72.2	12226	0	Vortex visable
FM7	71.4	74.8	12228	0	Vortex visable
FM8	70.6	74.5	12198	0	Vortex visable
CFM1	71.3	71.8	12204	0	Vortex visable
CFM2	70.8	71.3	12201	0	Vortex visable
CFM3	71.3	74.5	12230	0	Vortex visable
CFM4	71.6	74.1	12209	0	Vortex visable
MAC4	71.7	72.5	12207	0	Vortex visable

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The following samples were conditioned and tested as described below. These samples were tested in conjunction with ACS3 and ACS4 as described in section 7 of this document. Testing all samples at the same time and water bath limited any variation in temperature exposure between the various samples.

#	COMPOSITION	Pre-condition Time	Temp (°F)	Weight (ppg)	Foam Quality
FM9	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	14.5	13%
FM10	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	13.6	18.5%

Pre-condition samples for 3 hours at 135°F
Foam the slurry to the noted density and place in the water bath
Ramp from 135°F to 165°F in 4 hours
Ramp from 165°F to 180°F in 4 hours
Maintain 180°F for the remainder of the test period, total test time of 48 hours.

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
FM9	71.3	72.2	12233	0	Vortex visable
FM10	70.6	74.5	12198	0	Vortex visable

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Stability of Unset Foamed Cement Slurry

#	Wt of Slurry in Blender (g)	Volume of Sample (mL)	S.G. (g/cm3)	Density of Slurry (ppg)
FM1	2057.86	1178.00	1.75	14.5
FM2	2057.86	1170.00	1.76	14.7
FM3	1931.08	1030.00	1.87	15.6
FM4	2057.86	1130.00	1.82	15.2
FM5	1931.09	1178.00	1.64	13.7
FM6	1931.09	1150.00	1.68	14.0
FM7	2057.86	1120.00	1.83	15.3
FM8	1931.08	1120.00	1.72	14.3
CFM1	1781.32	1100.00	1.62	13.5
CFM2	1708.03	1120.00	1.52	12.7
CFM3	1715.36	1000.00	1.71	14.2
CFM4	1569.35	980.00	1.60	13.3
FM9	2057.86	1130.00	1.82	15.2
FM10	1931.08	1120.00	1.72	14.3
MAC4	2057.86	1100.00	1.87	15.6

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Stability of Unset Foamed Cement Slurry

#	Wt of Graduated Cylinder (g)	Wt of Slurry/Grad. Cylinder (g)	Volume of Sample (mL)	S.G. (g/cm3)	Density of Slurry (ppg)	Bubble Break-out?	Settling ?	Free Fluid?
FM1	238.73	627.68	250.00	1.56	13.00	Yes	Yes	Yes
FM2	238.83	669.32	250.00	1.72	14.30	Yes	No	No
FM3	239.00	679.03	250.00	1.76	14.7	Yes	Yes	Yes
FM4	238.05	693.44	250.00	1.82	15.20	Yes	No	No
FM5	238.81	628.85	250.00	1.56	13.00	Yes	Yes	Yes
FM6	238.75	650.67	250.00	1.65	13.74	Yes	No	No
FM7	238.07	684.63	250.00	1.79	14.90	Yes	Yes	Yes
FM8	239.02	678.65	250.00	1.76	14.70	Yes	No	No
CFM1	238.38	649.63	250.00	1.64	13.70	Yes	No	No
CFM2	238.85	627.55	250.00	1.55	12.91	Yes	No	No
CFM3	238.80	658.27	250.00	1.68	14.00	Yes	No	No
CFM4	238.86	621.41	250.00	1.53	12.74	Yes	No	No
FM9	238.05	693.44	250.00	1.82	15.20	Yes	No	No
FM10	239.02	678.65	250.00	1.76	14.70	Yes	No	No
MAC4	238.51	686.42	250.00	1.79	14.90	Yes	No	No

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Stability of Set Foamed Cement Slurry

#	Wt of Top (g)	Wt of H20 Removed (g)	Density of Top (g)	Wt of Middle (g)	Wt of H20 Removed (g)	Density of Middle (g)	Wt of Bottom (g)	Wt of H20 Removed (g)	Density of Bottom (g)
FM1	61.68	39.90	12.88	77.40	43.15	14.94	63.77	32.20	16.50
FM2	76.84	55.05	11.63	78.06	58.20	11.17	80.31	47.97	13.95
FM3	79.81	50.80	13.09	66.02	40.15	13.70	59.07	34.66	14.20
FM4	73.56	44.25	13.85	67.59	39.18	14.37	80.39	45.25	14.80
FM5	67.57	43.22	13.02	48.33	27.60	14.59	74.78	40.17	15.51
FM6	84.00	62.23	11.07	73.15	49.17	12.39	69.18	44.53	12.94
FM7	70.31	45.62	12.84	61.86	36.57	14.09	50.44	27.51	15.27
FM8	67.33	47.82	11.73	67.65	43.75	12.88	78.98	49.95	13.26
CFM1	71.40	32.37	11.44	76.61	50.06	12.75	75.63	47.96	13.14
CFM2	67.43	49.19	11.42	78.49	53.65	12.19	62.80	41.40	12.64
CFM3	76.09	50.87	12.46	86.87	54.87	13.19	70.86	43.73	13.5
CFM4	49.15	33.52	12.21	66.84	43.32	12.85	72.51	45.92	13.15
FM9	73.56	44.25	13.85	67.59	39.18	14.37	80.39	45.25	14.8
FM10	67.33	47.82	11.73	67.65	43.75	12.88	78.98	49.95	13.26
MAC4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: MAC4 Macondo samples did not set hard during the 48 hour curing period, and, therefore, could not be tested for this particular part of the testing protocol.

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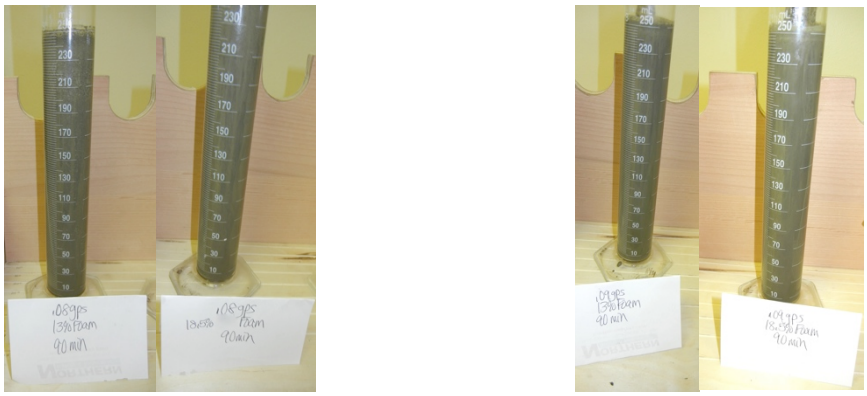

Figure #13. Pictures on the left show the 0.08 gps SCR-100 slurry that was pre-conditioned for 1.5 hours and tested for Foam Stability at 13% (l) and 18.5% (r) Foam Quality right after mixing. Pictures on the right show the 0.09 SCR-100 gps slurry that was pre-conditioned for 1.5 hours and tested for Foam Stability at 13% (l) nd 18.5% (r) Foam Quality right after mixing.

Figure #14. Pictures on the left show the 0.08 gps SCR-100 slurry that was pre-conditioned for 1.5 hours and tested for Foam Stability at 13% (l) and 18.5% (r) Foam Quality after 2-hour period. Pictures on the right show the 0.09 SCR-100 gps slurry that was pre-conditioned for 1.5 hours and tested for Foam Stability at 13% (l) nd 18.5% (r) Foam Quality after 2-hour period.

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Figure #15. Pictures on the left show the 0.08 gps SCR-100 slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% (l) and 18.5% (r) Foam Quality right after mixing. Pictures on the right show the 0.09 SCR-100 gps slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% (l) nd 18.5% (r) Foam Quality right after mixing.

Figure #16. Pictures on the left show the 0.08 gps SCR-100 slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% (l) and 18.5% (r) Foam Quality after 2-hour period. Pictures on the right show the 0.09 SCR-100 gps slurry that was pre-conditioned for 2 hours and tested for Foam Stability at 13% (l) nd 18.5% (r) Foam Quality after 2-hour period.

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Figure #17. Pictures above show the MAC4 Macondo cement 0.09 gps SCR-100 slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% Foam Quality right after mixing.

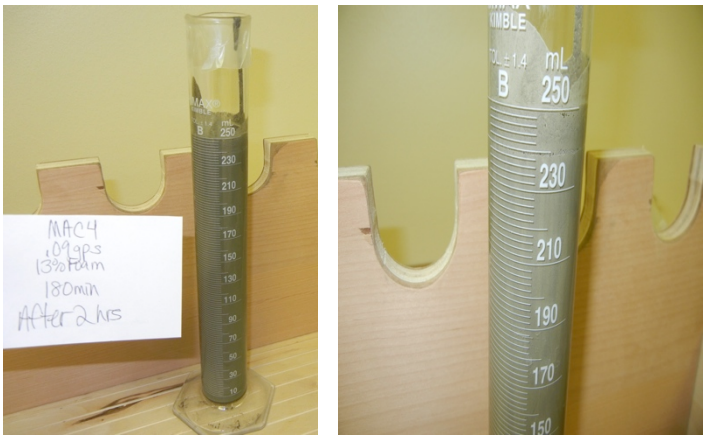

Figure #18. Pictures above show the MAC4 Macondo cement 0.09 gps SCR-100 slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% Foam Quality right after 2-hour period.

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Figure #19. Picture above shows the 0.09 gps SCR-100 slurry with 20% base oil contamination that was pre-conditioned for 3 hours and tested for Foam Stability at 13% Foam Quality. Cement cubes were not hard set after 48 hour curing period.

Figure #20. Picture above shows the MAC4 Macondo cement 0.09 gps SCR-100 slurry that was pre-conditioned for 3 hours and tested for Foam Stability at 13% Foam Quality. Cement cubes were not hard set after 48 hour curing period.

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APPENDIX A GRAPHS AND TABLES

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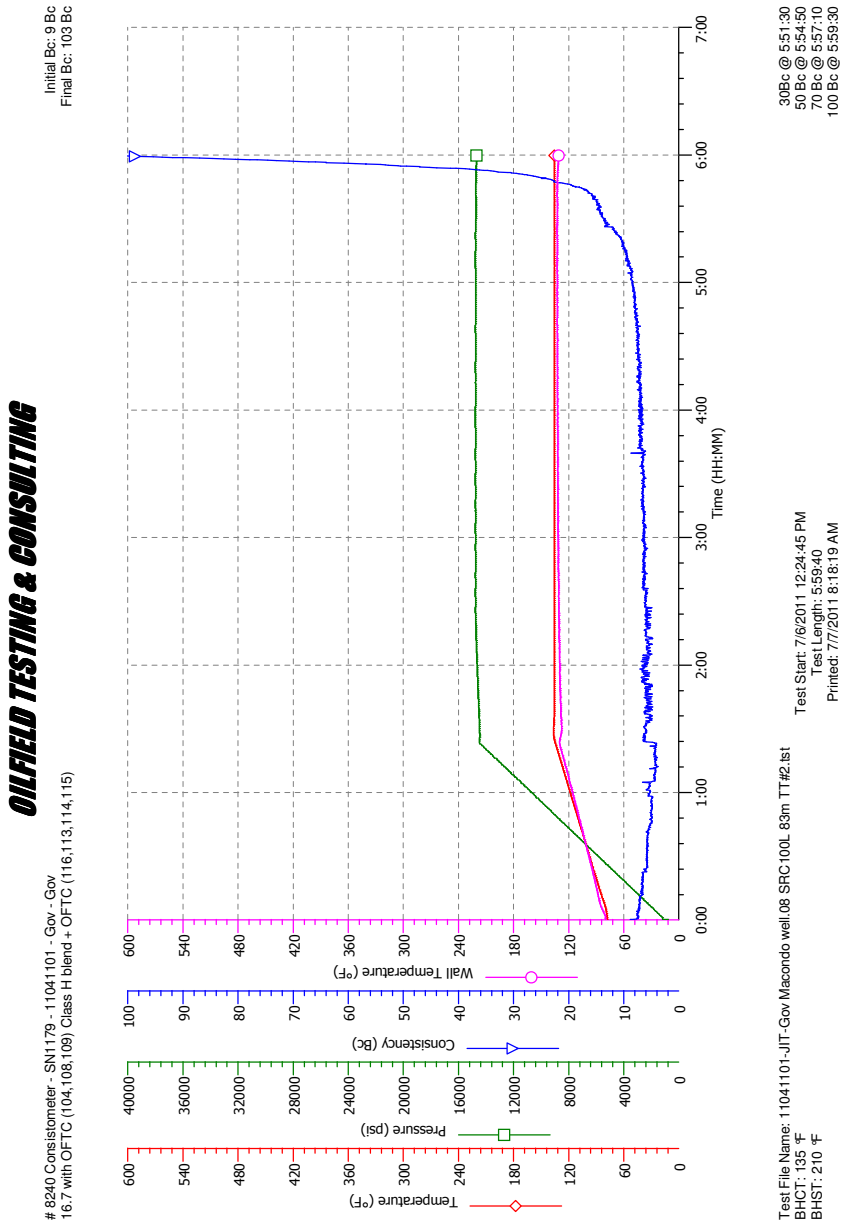

GRAPH #1. THICKENING TIME GRAPH FOR 0.08 GPS SYSTEM WITH 83 MIN RAMP.

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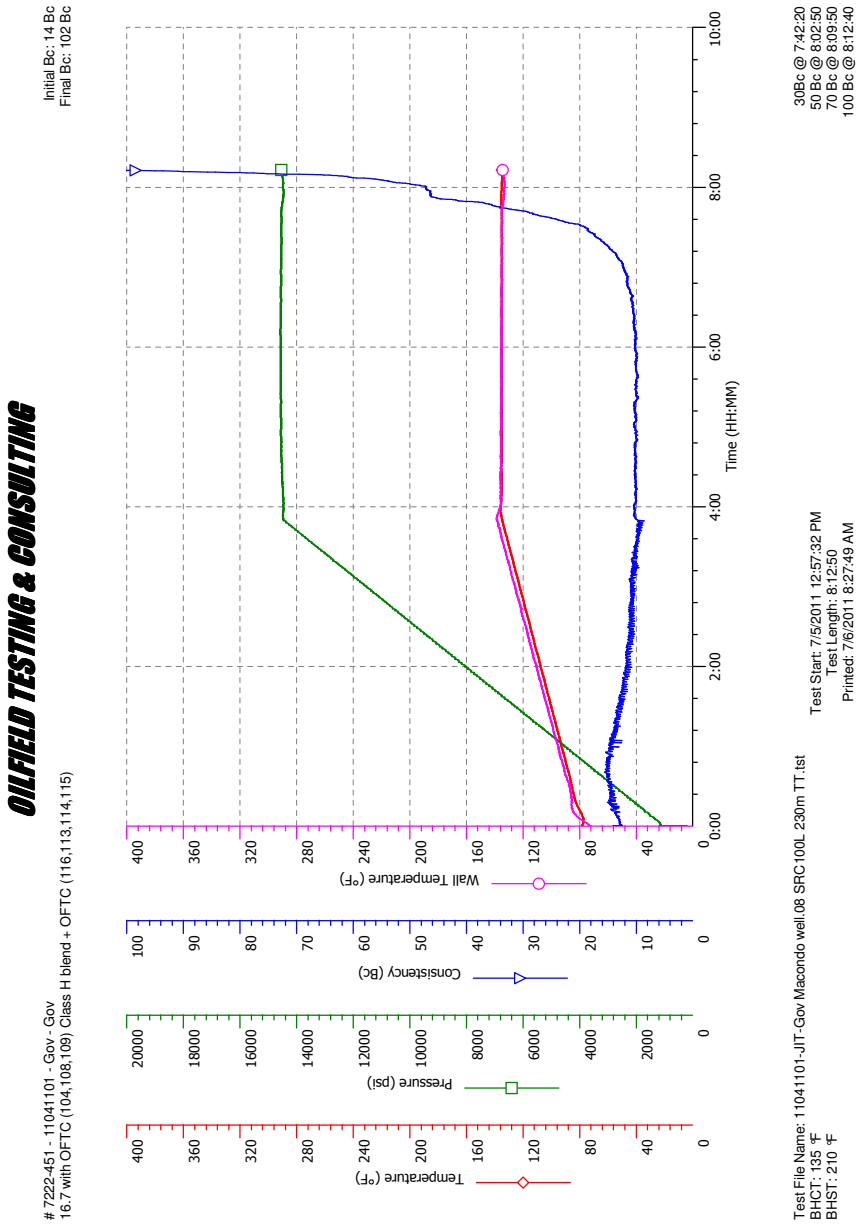

Graph #2. Thickening Time graph for 0.08 gps system with 230 min ramp.

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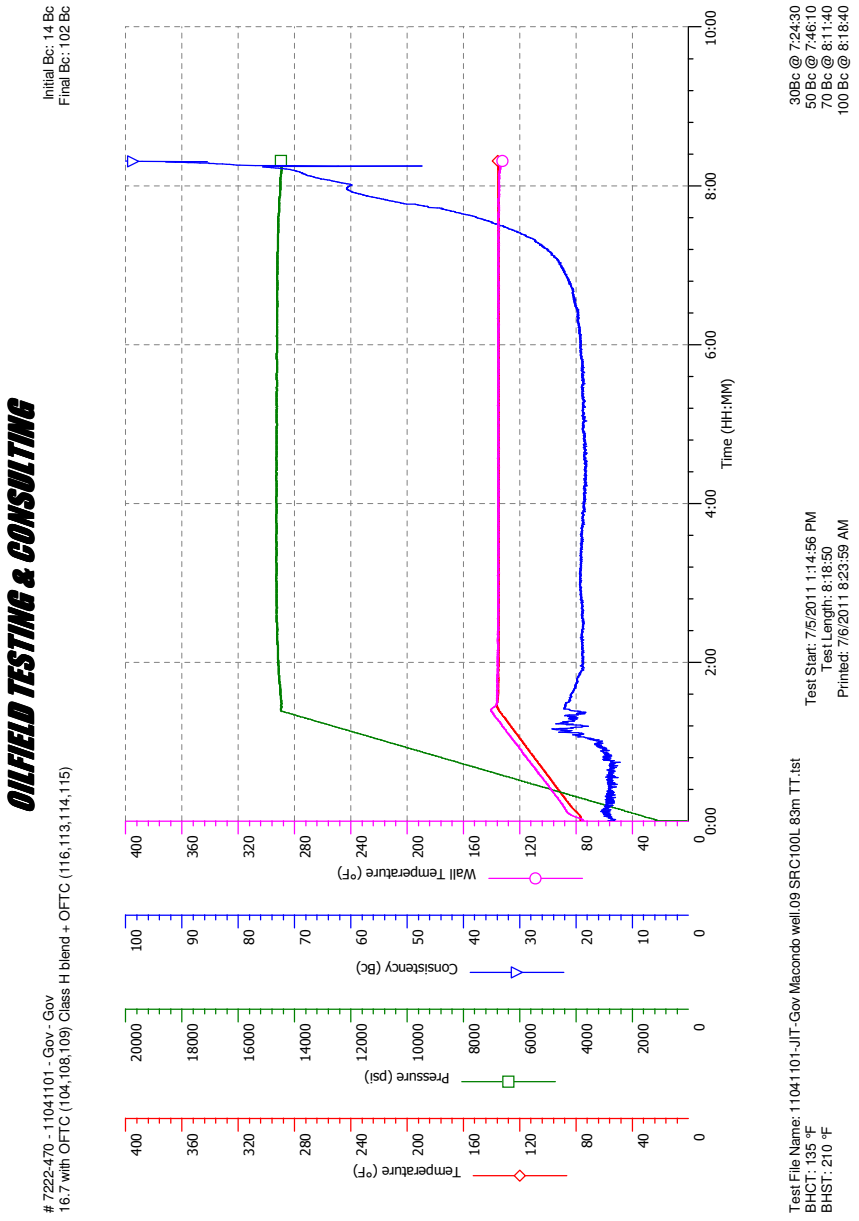

Graph #3. Thickening Time graph for 0.09 gps system with 83 min ramp.

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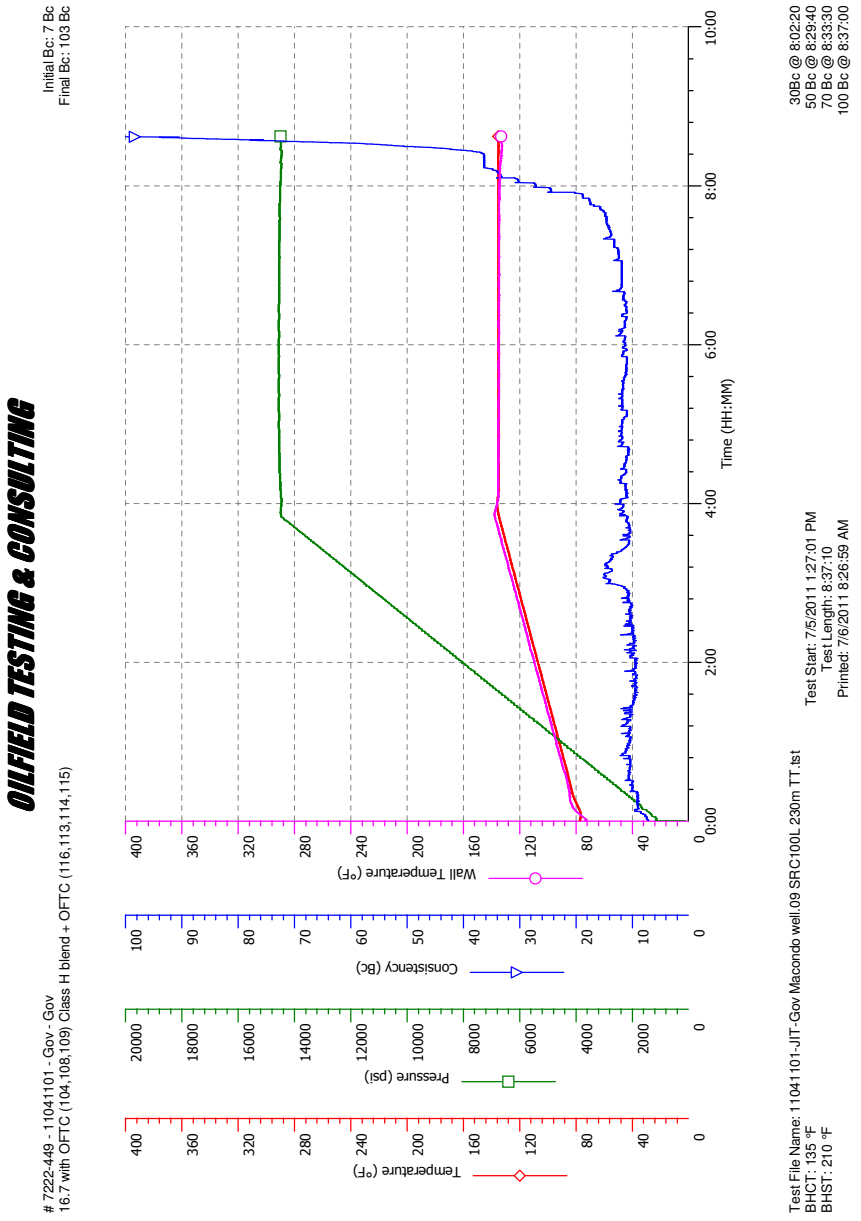

Graph #4. Thickening Time graph for 0.09 gps system with 230 min ramp.

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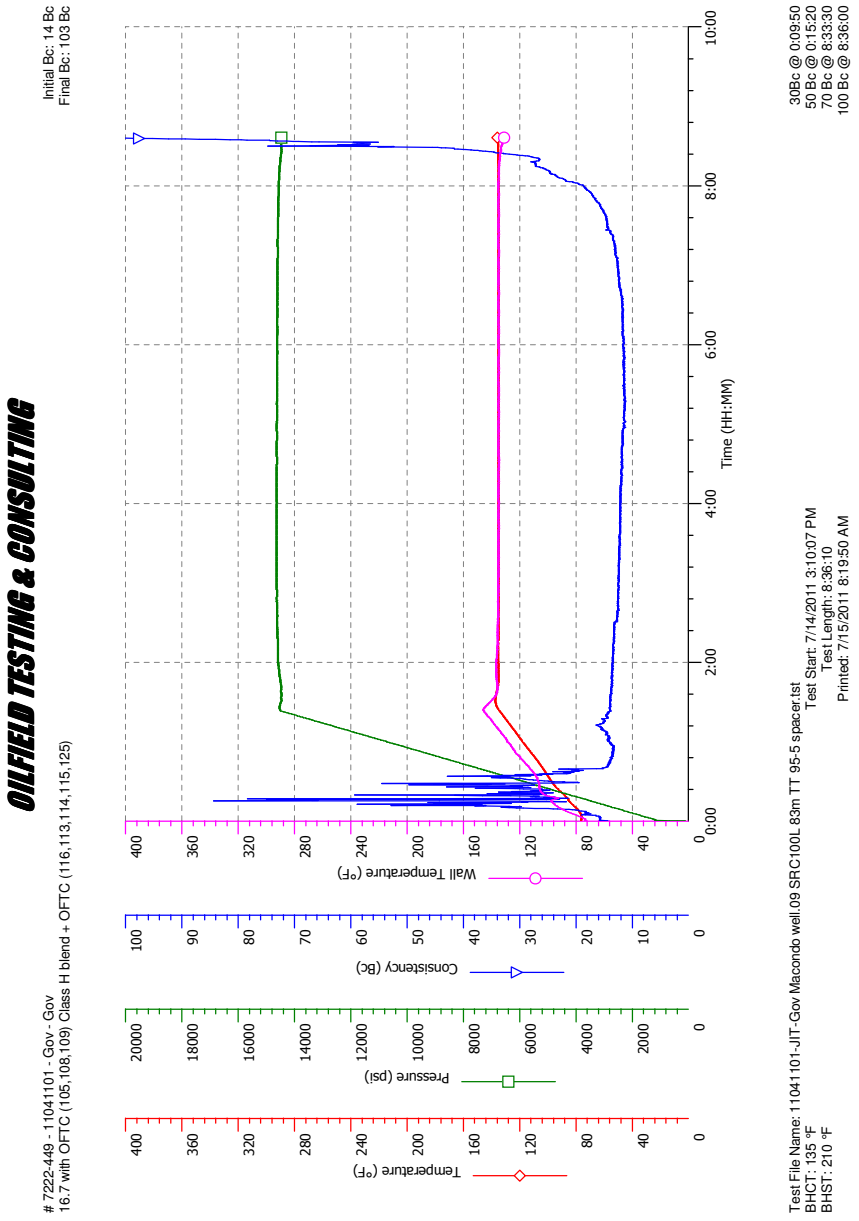

Graph #5. Thickening Time graph for 0.09 gps system 5% spacer.

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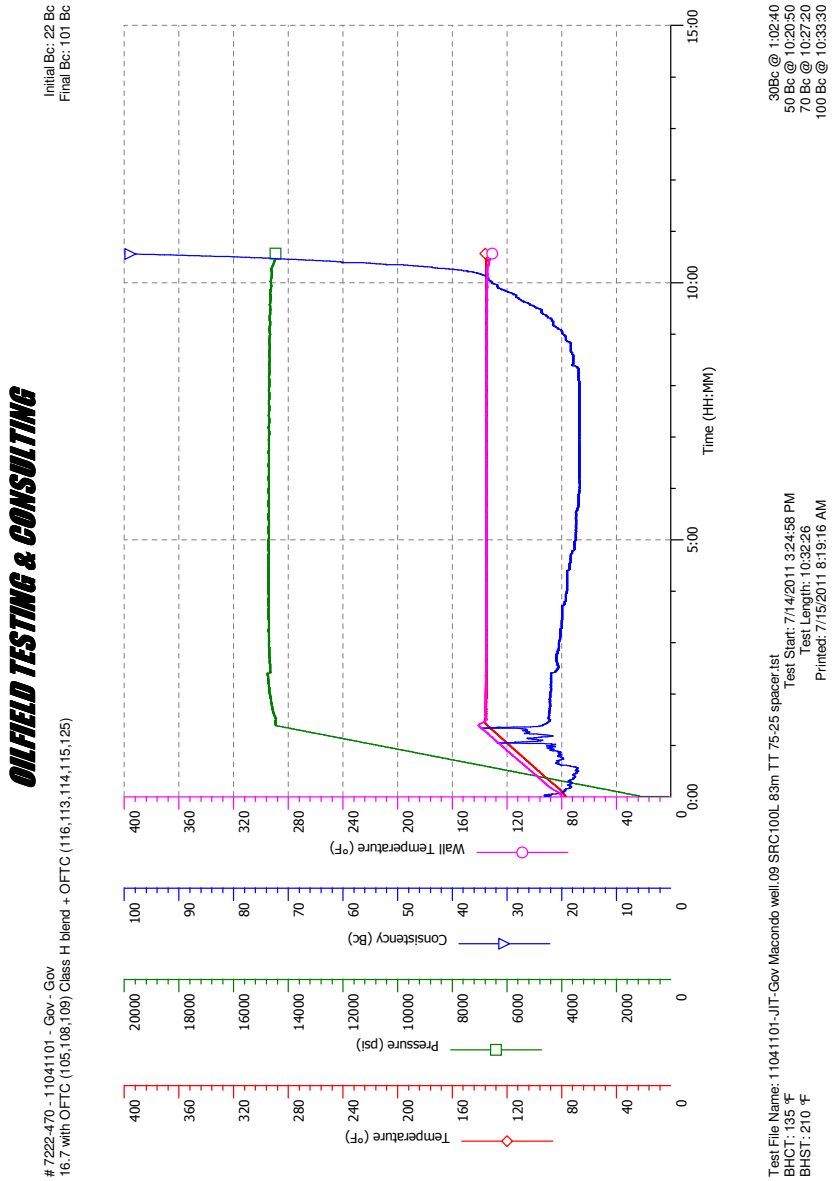

Graph #6. Thickening Time graph for 0.09 gps system 25% spacer.

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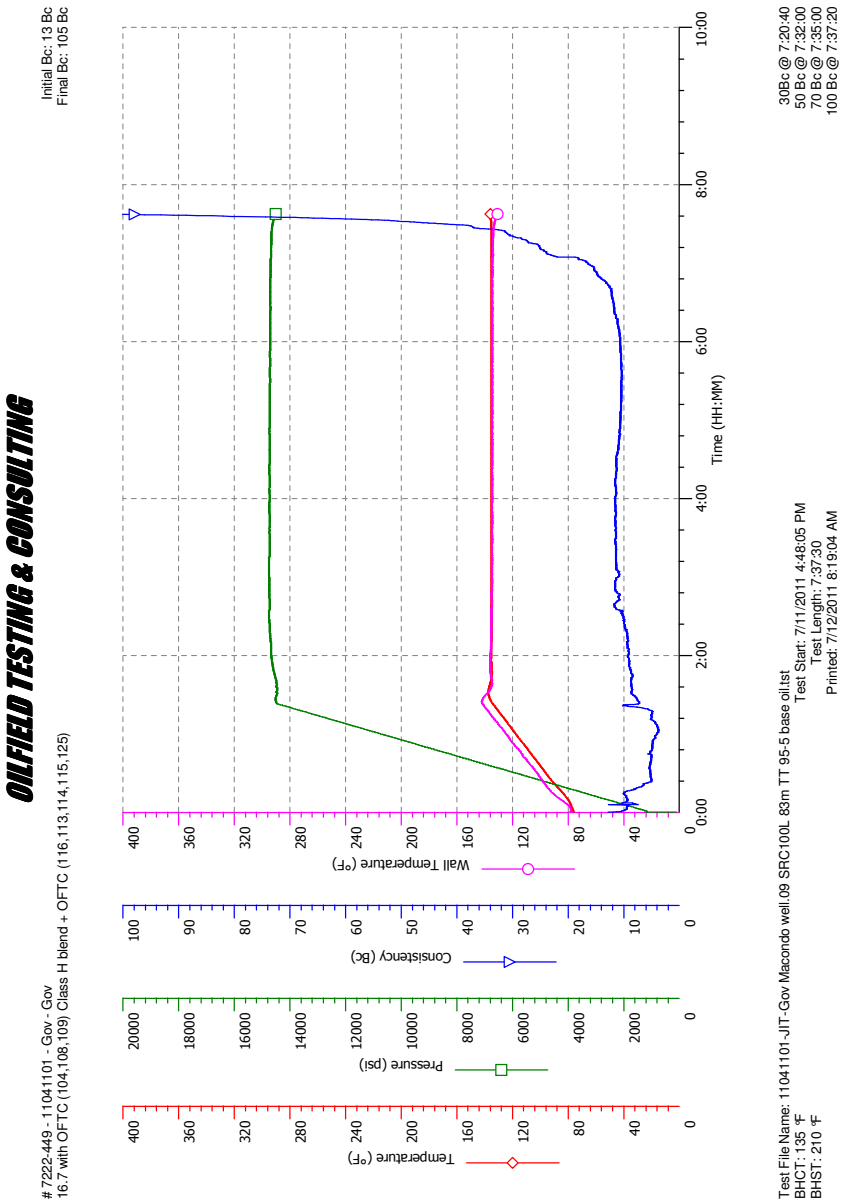

Graph #7. Thickening Time graph for 0.09 gps system 5% base oil.

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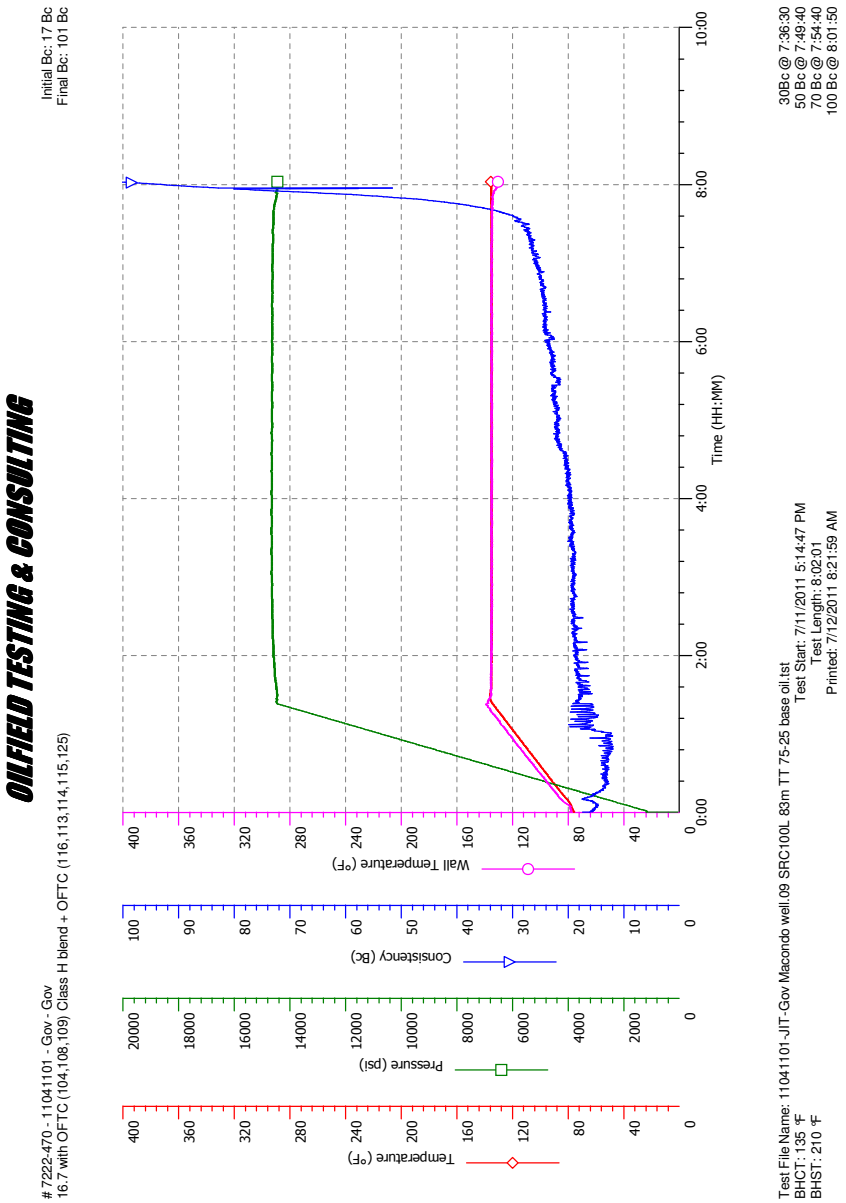

Graph #8. Thickening Time graph for 0.09 gps system 25% base oil.

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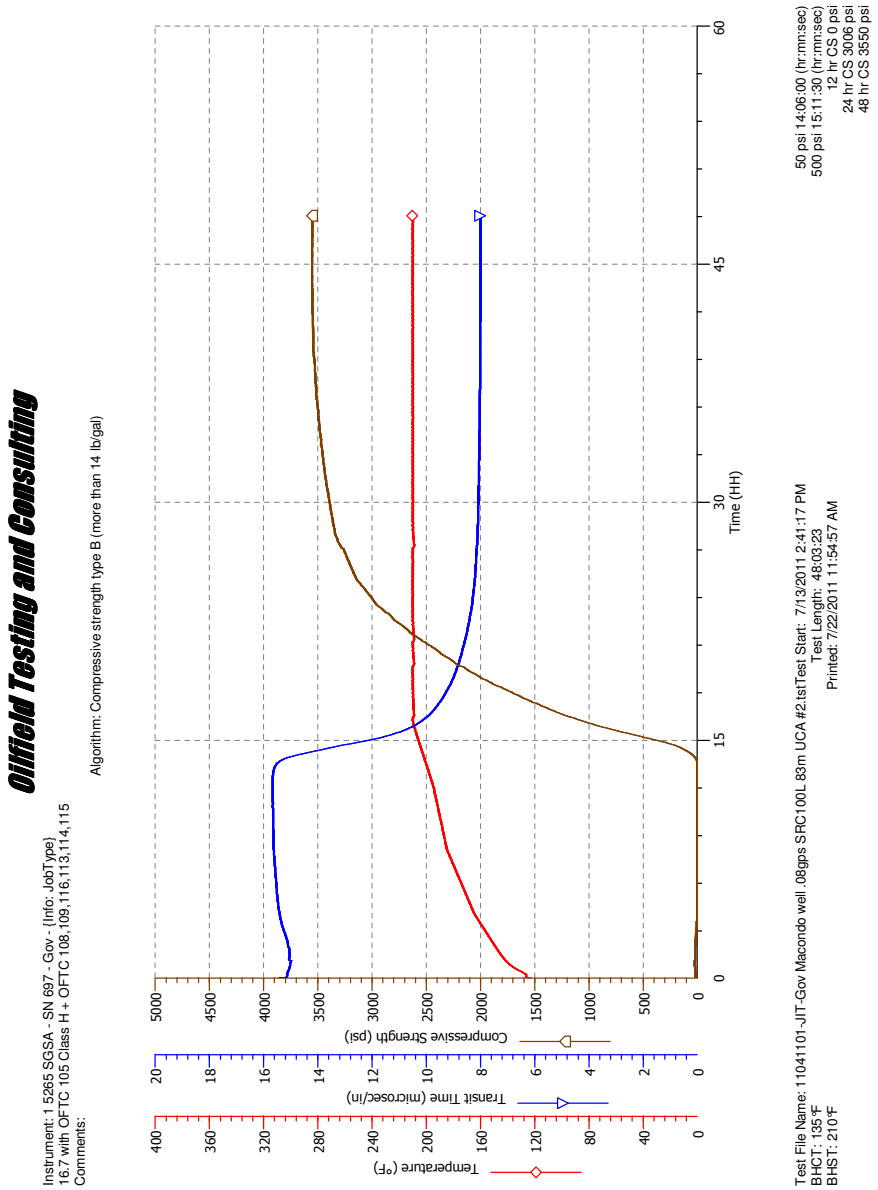

Graph #9. UCA graph for 0.08 gps system with 83 min ramp.

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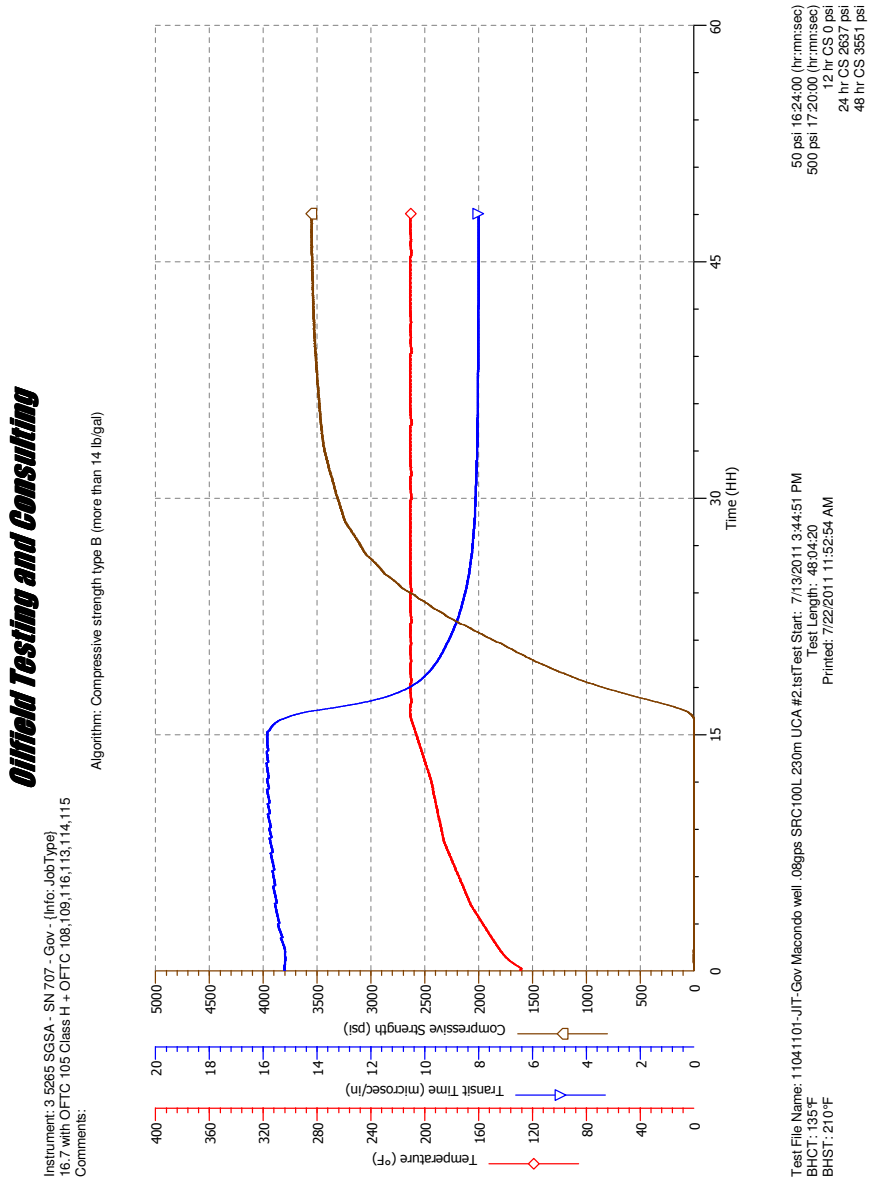

Graph #10. UCA graph for 0.08 gps system with 230 min ramp.

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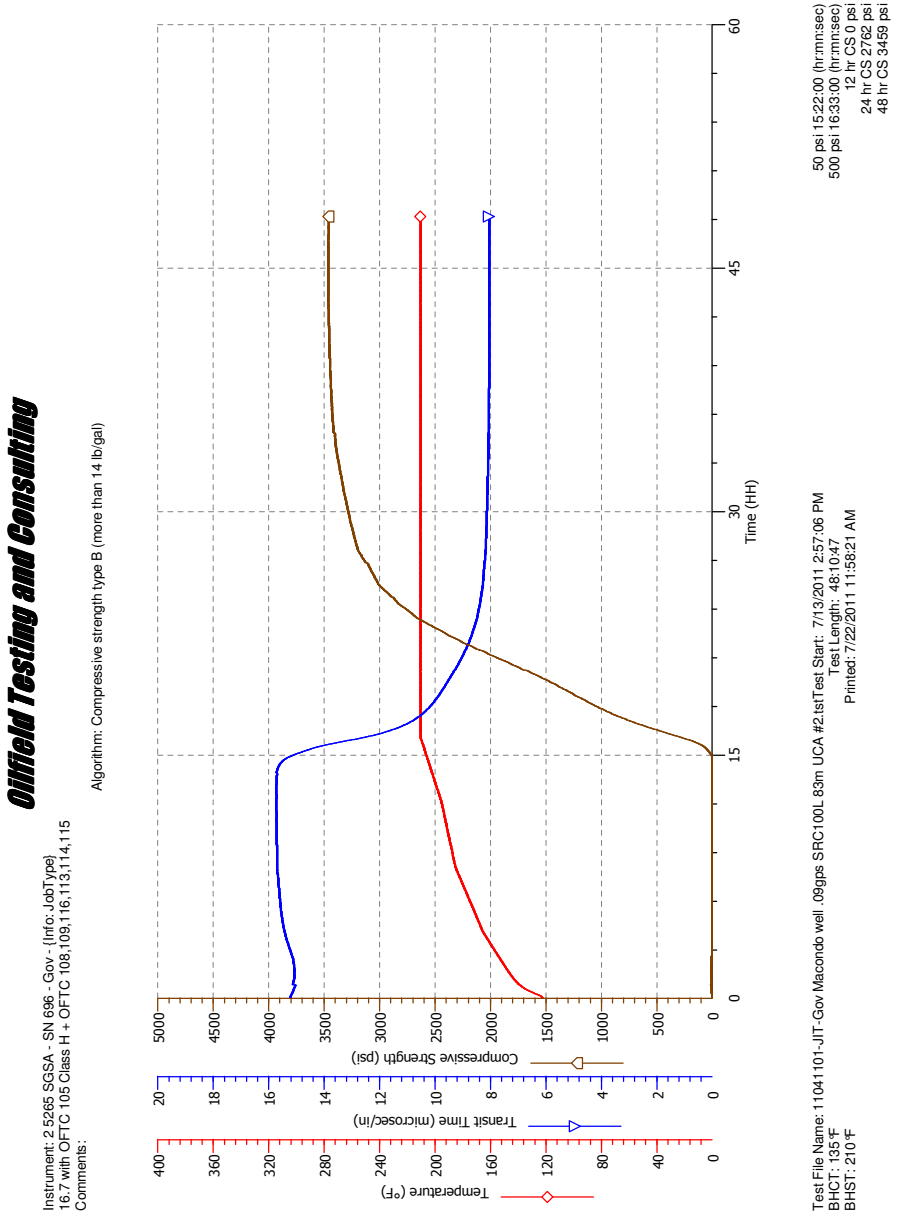

Graph #11. UCA graph for 0.09 gps system with 83 min ramp.

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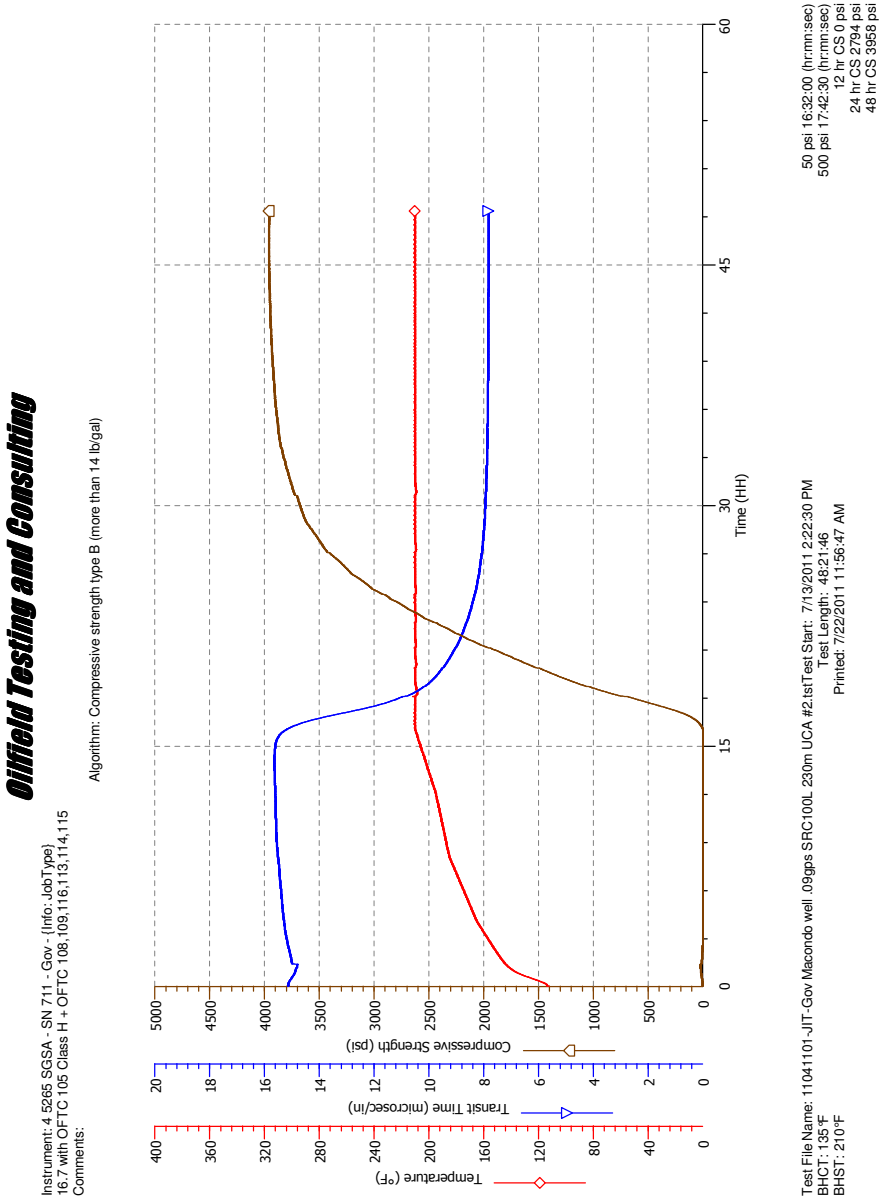

Graph #12. UCA graph for 0.09 gps system with 230 min ramp.

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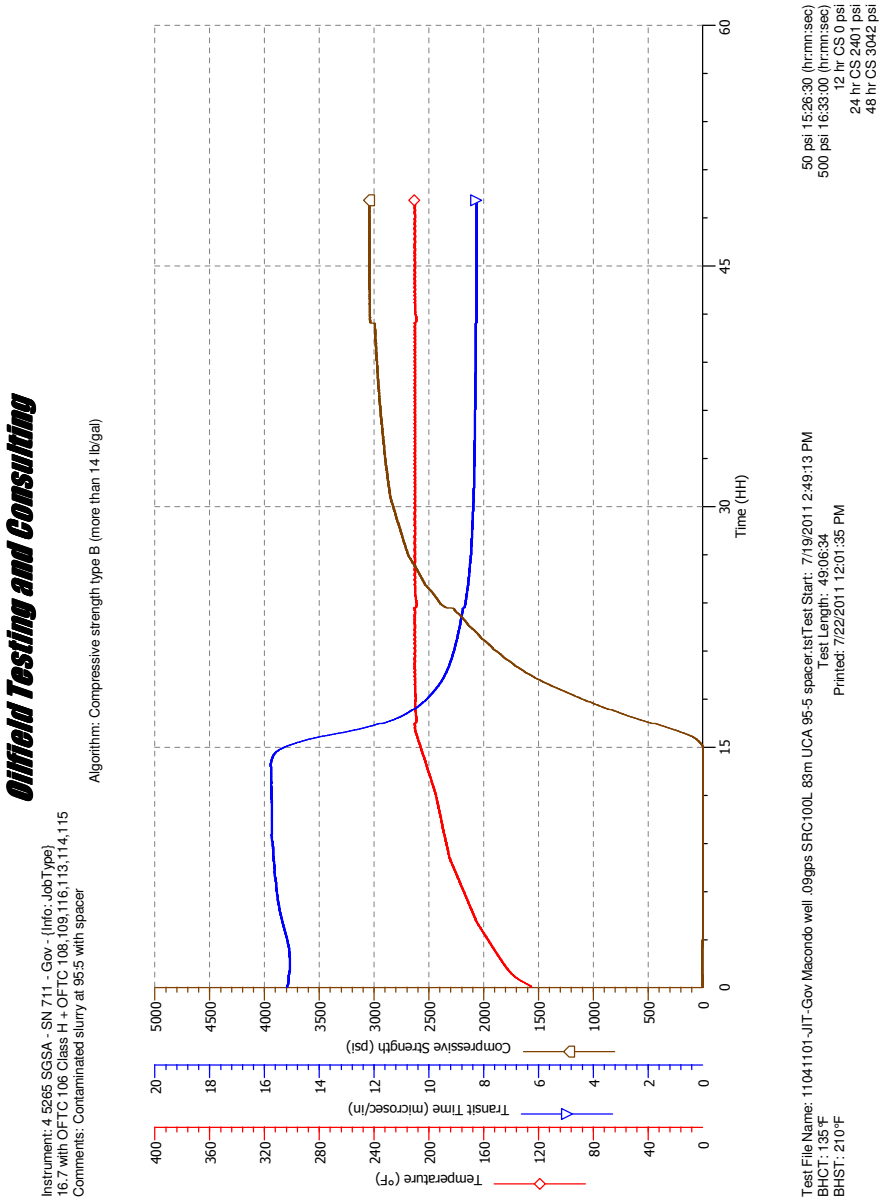

Graph #13. UCA graph for 0.09 gps system with 5% spacer with 83 min ramp.

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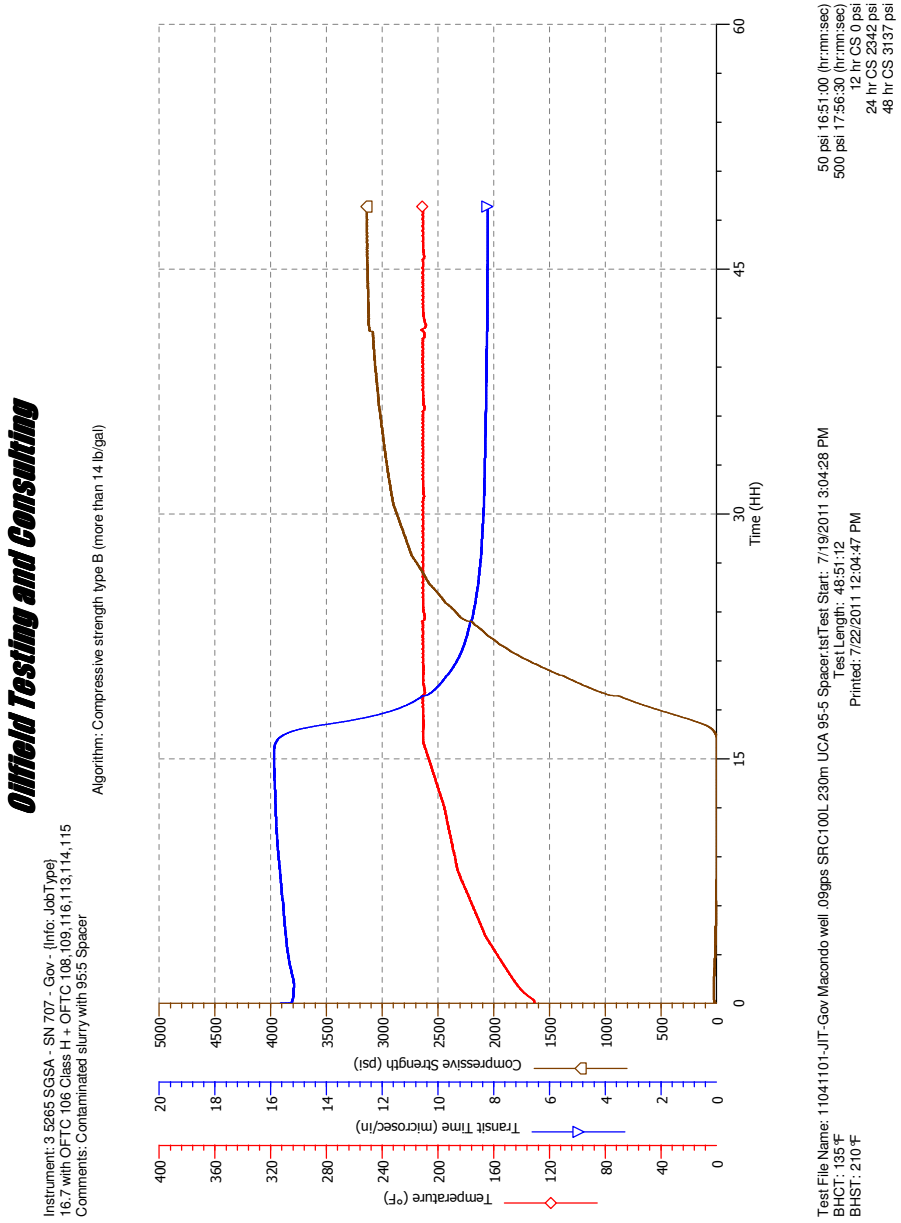

Graph #14. UCA graph for 0.09 gps system with 5% spacer with 230 min ramp.

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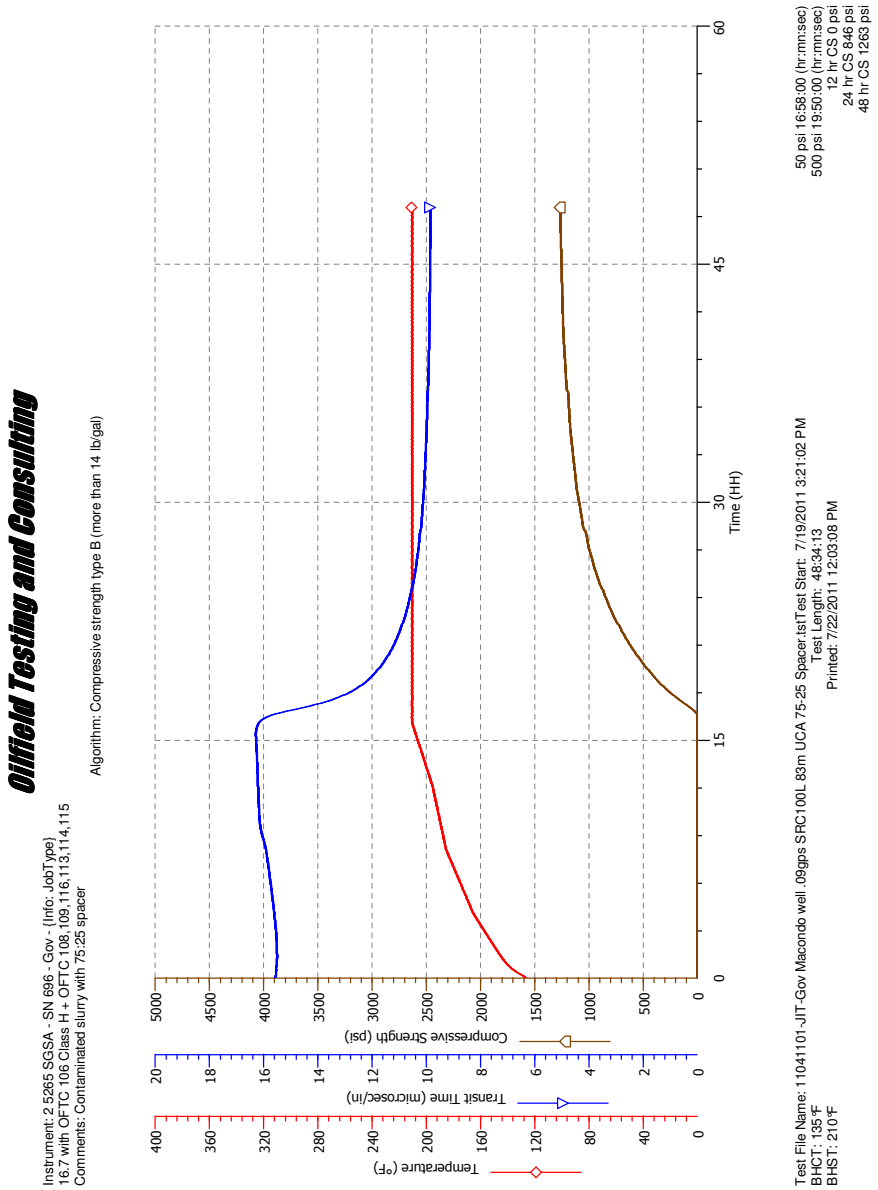

Graph #15. UCA graph for 0.09 gps system with 25% spacer with 83 min ramp.

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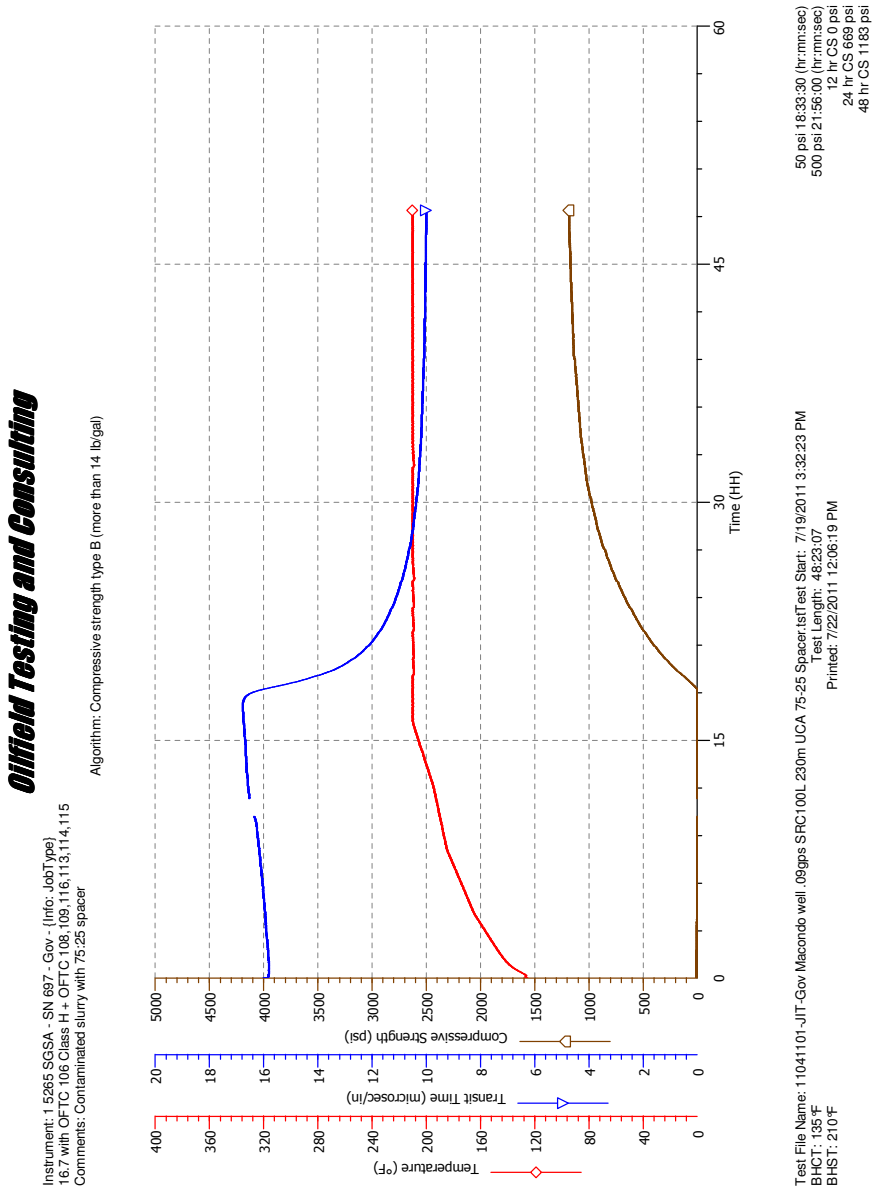

Graph #16. UCA graph for 0.09 gps system with 25% spacer with 230 min ramp.

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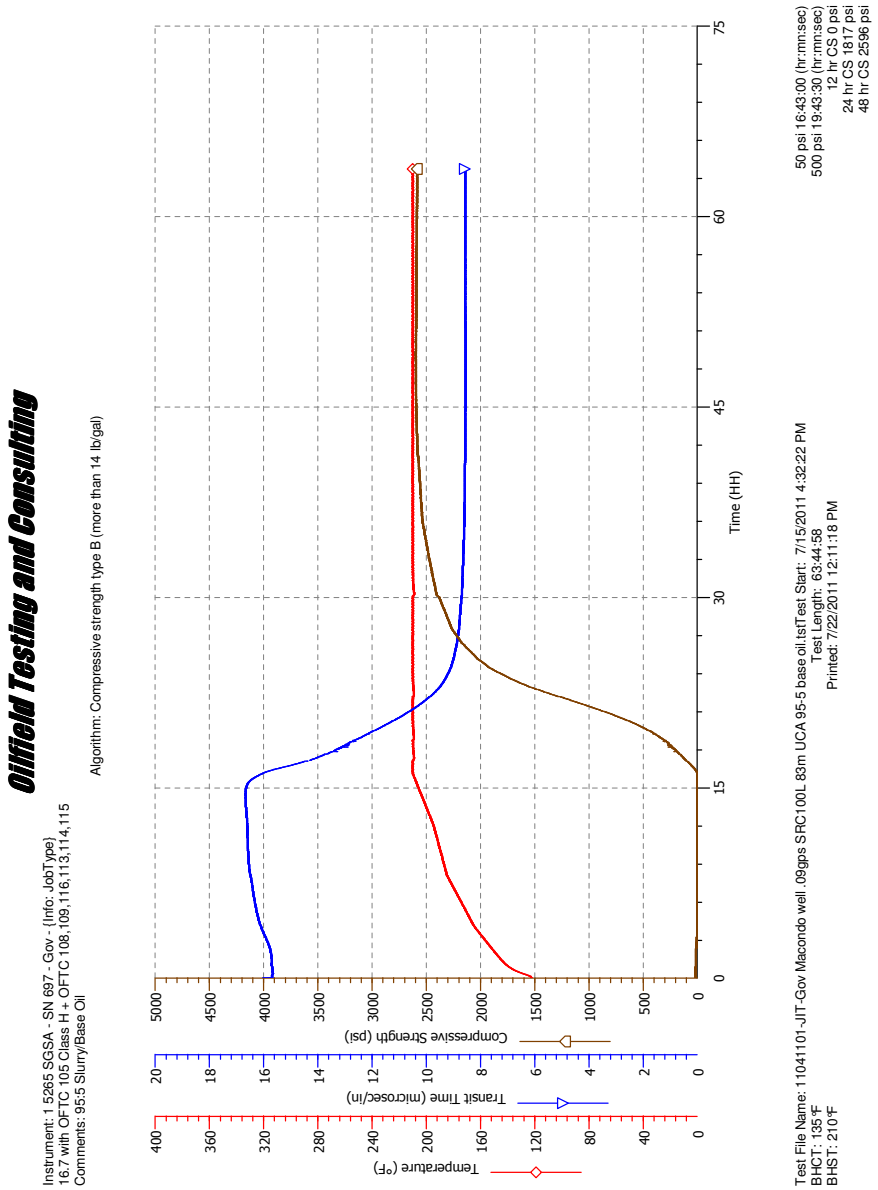

Graph #17. UCA graph for 0.09 gps system with 5% base oil with 83 min ramp.

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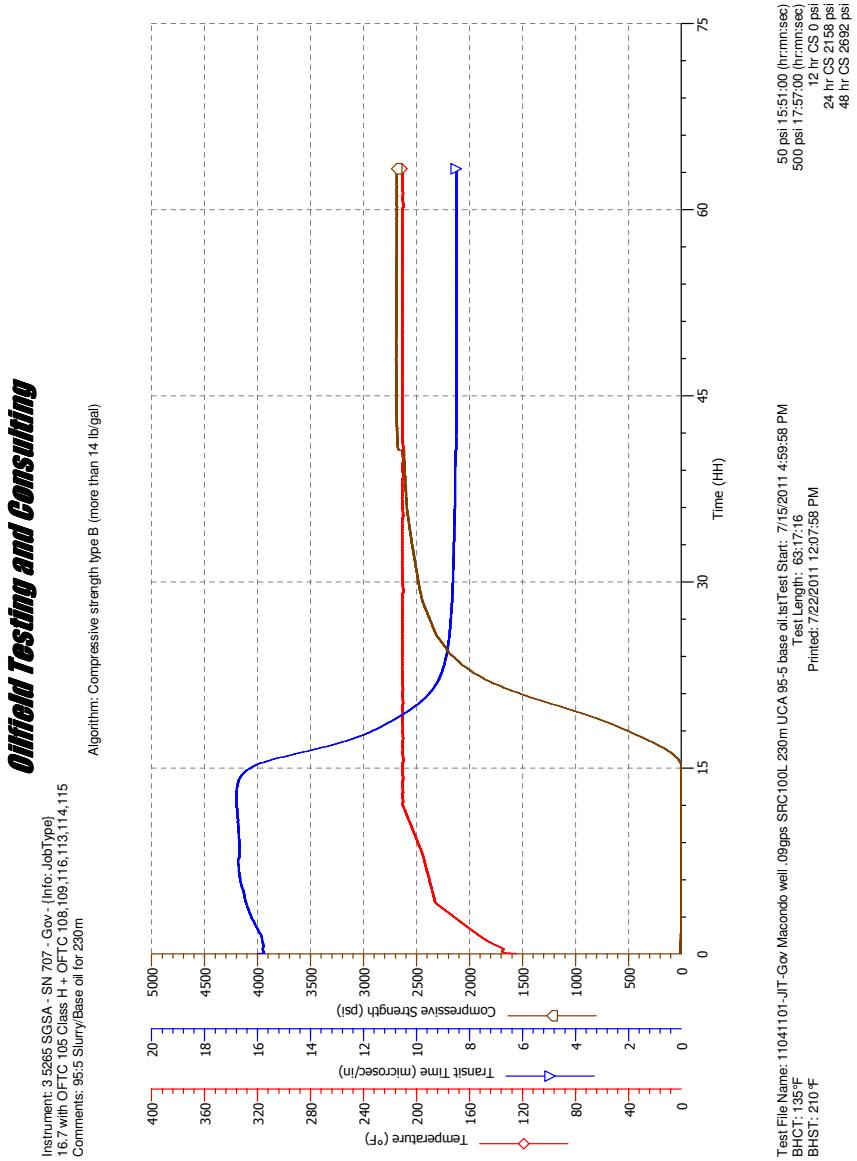

Graph #18. UCA graph for 0.09 gps system with 5% base oil with 230 min ramp.

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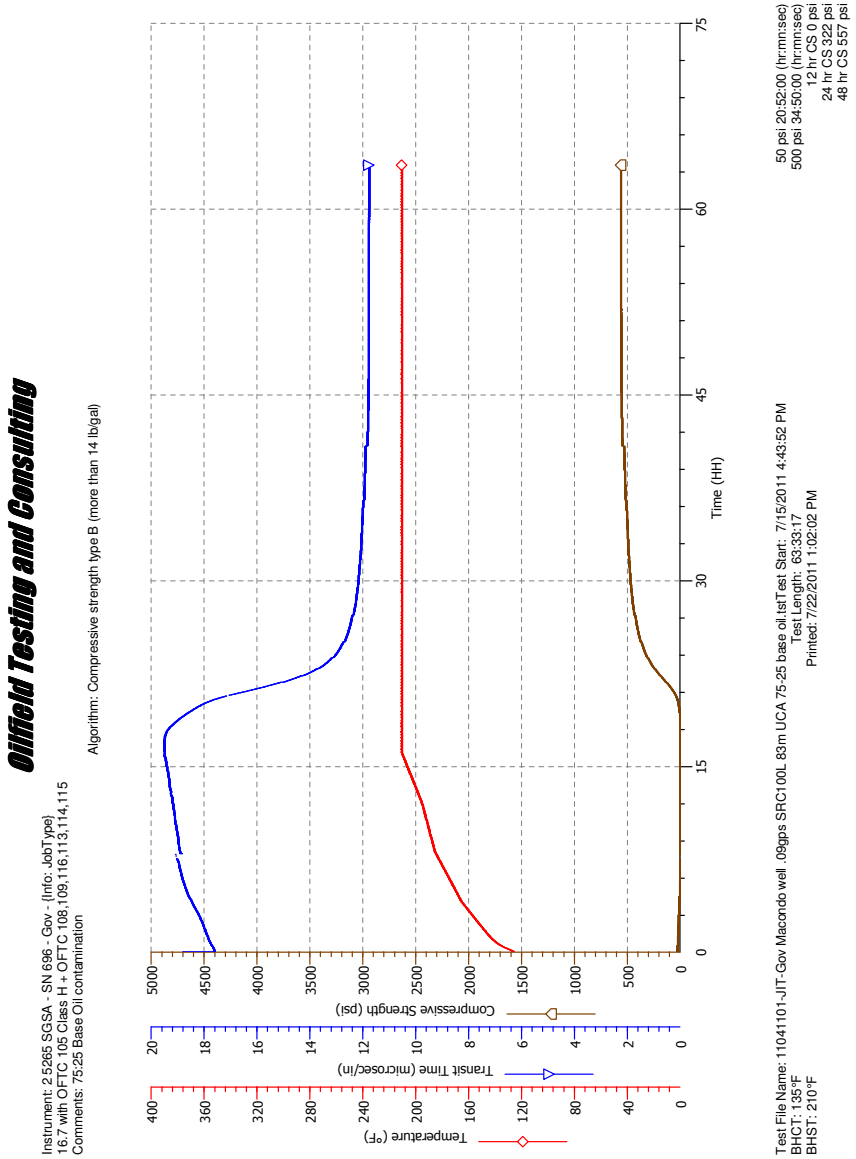

Graph #19. UCA graph for 0.09 gps system with 25% base oil with 83 min ramp.

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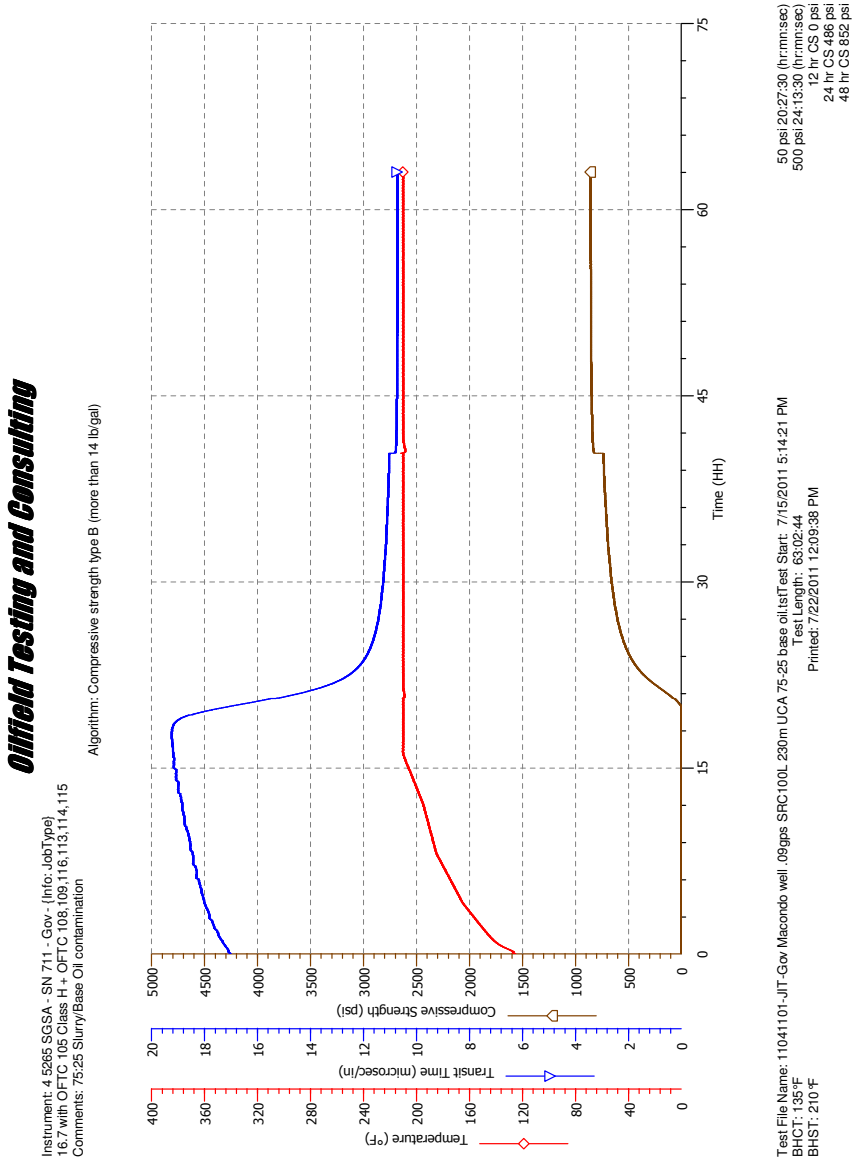

Graph #20. UCA graph for 0.09 gps system with 25% base oil with 230 min ramp.

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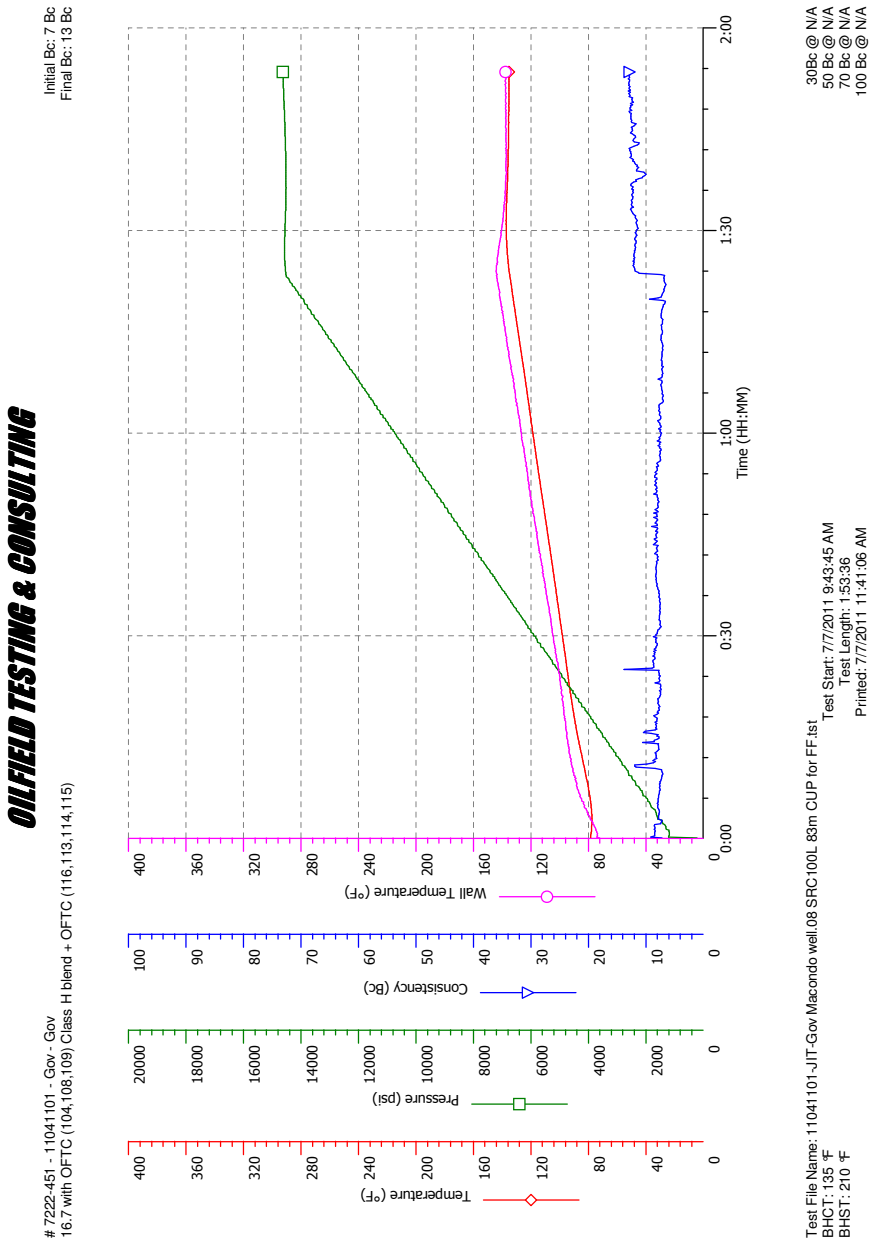

Graph #21. Graph for 0.08 gps system pressurized conditioning for 0° Free Fluid with 83 min ramp.

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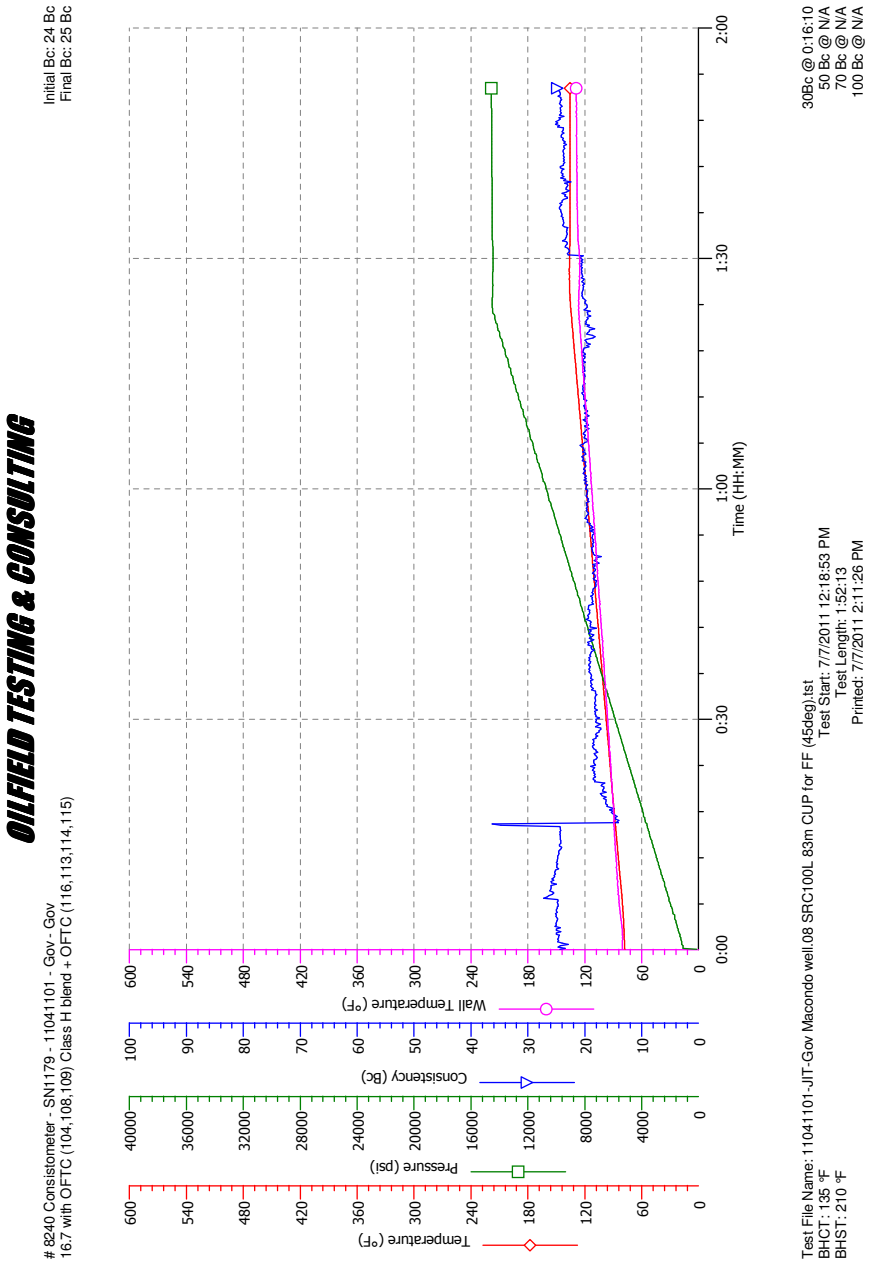

Graph #22. Graph for 0.08 gps system pressurized conditioning for 45° Free Fluid with 83 min ramp.

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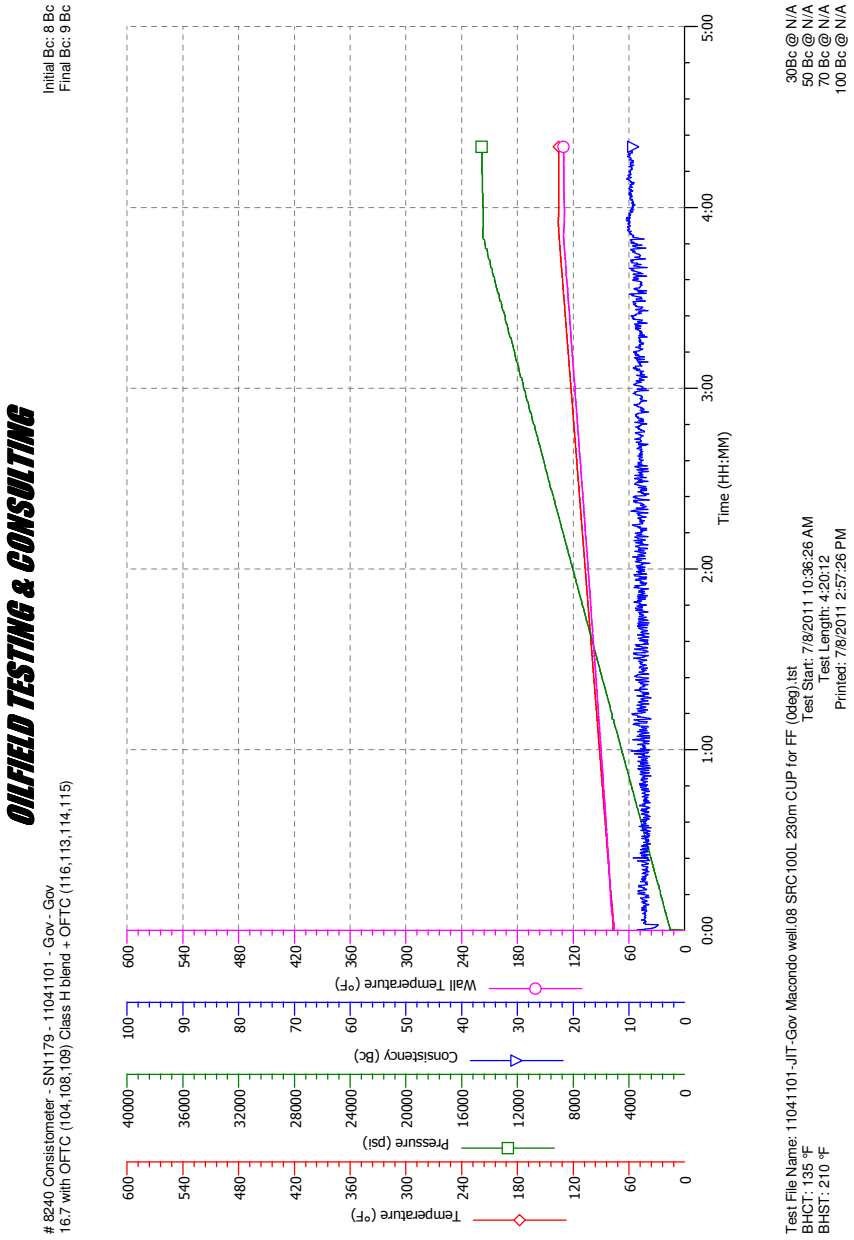

Graph #23. Graph for 0.08 gps system pressurized conditioning for 0° Free Fluid with 230 min ramp.

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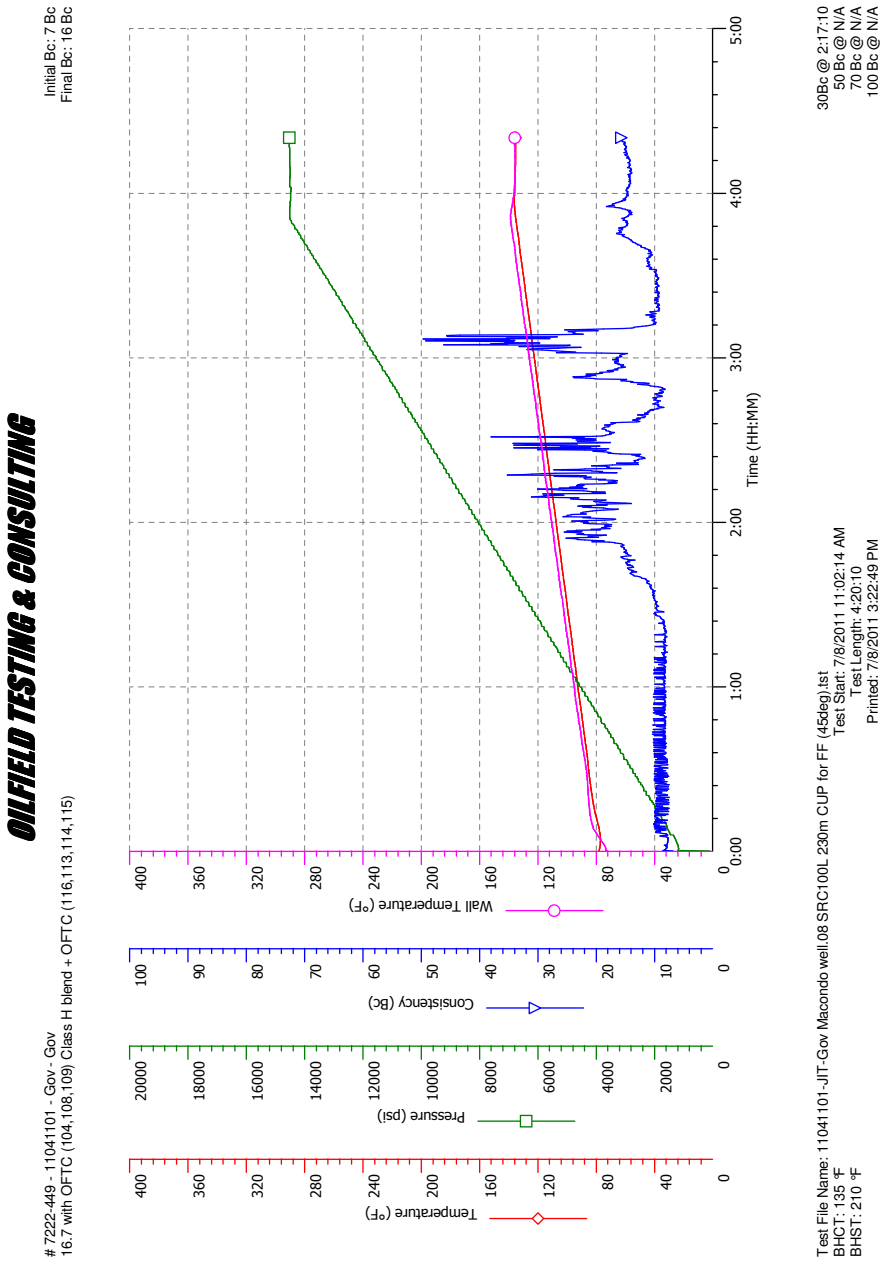

Graph #24. Graph for 0.08 gps system pressurized conditioning for 45° Free Fluid with 230 min ramp.

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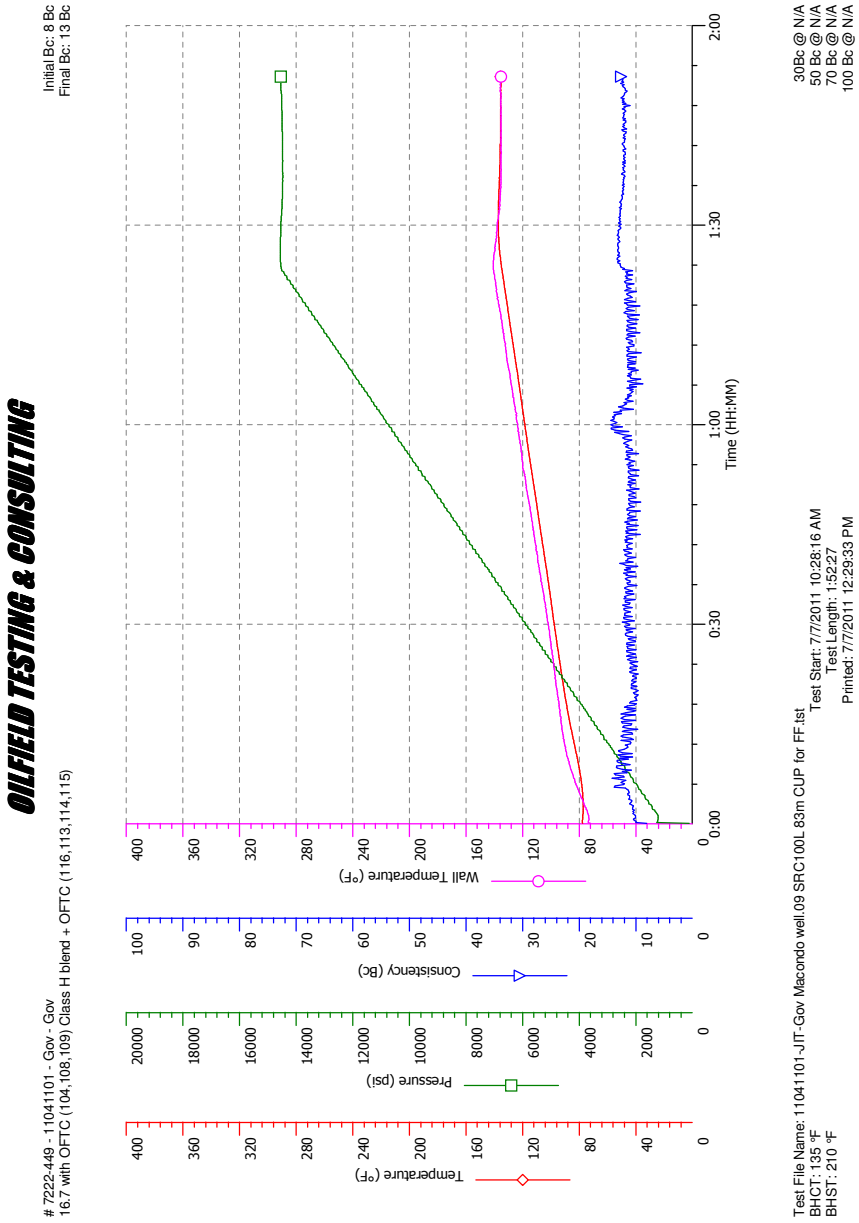

Graph #25. Graph for 0.09 gps system pressurized conditioning for 0° Free Fluid with 83 min ramp.

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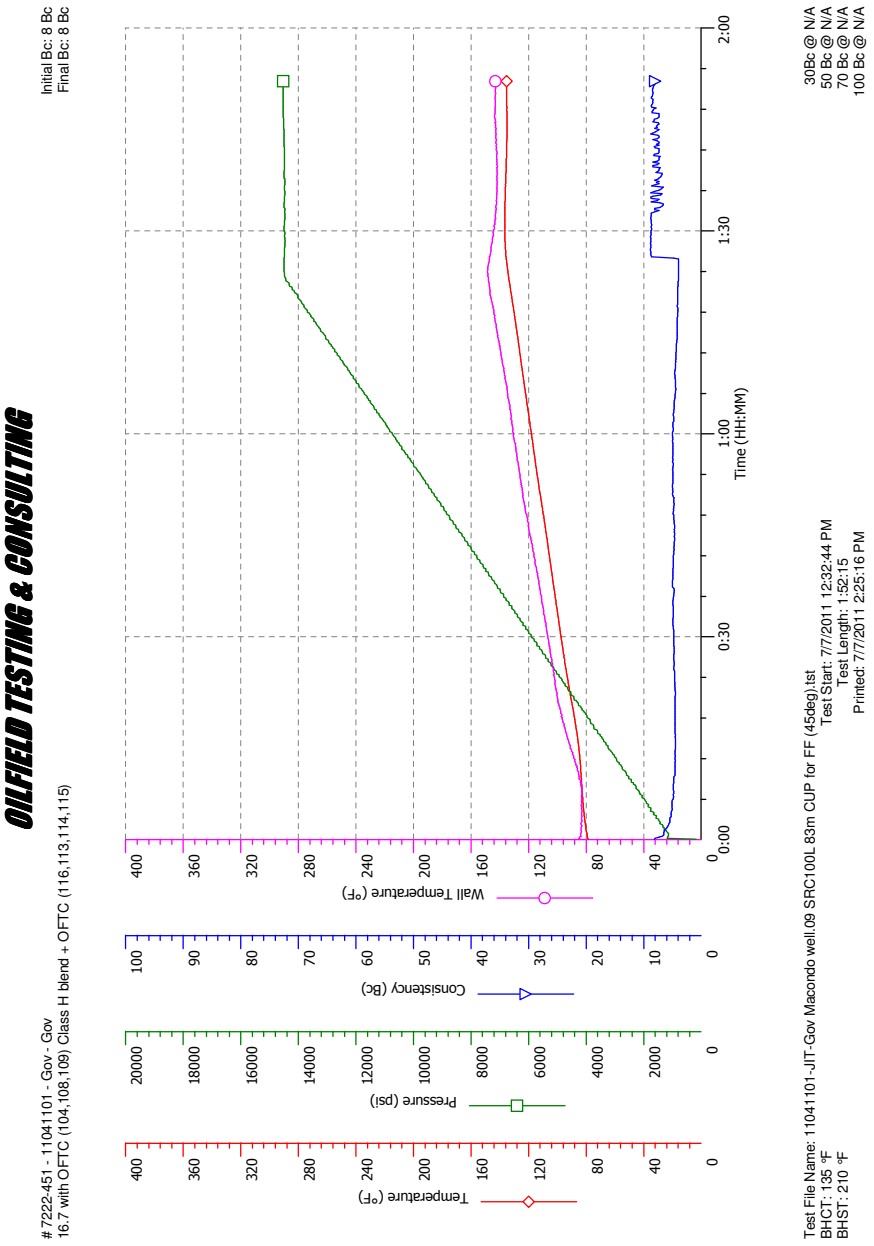

Graph #26. Graph for 0.08 gps system pressurized conditioning for 45° Free Fluid with 83 min ramp.

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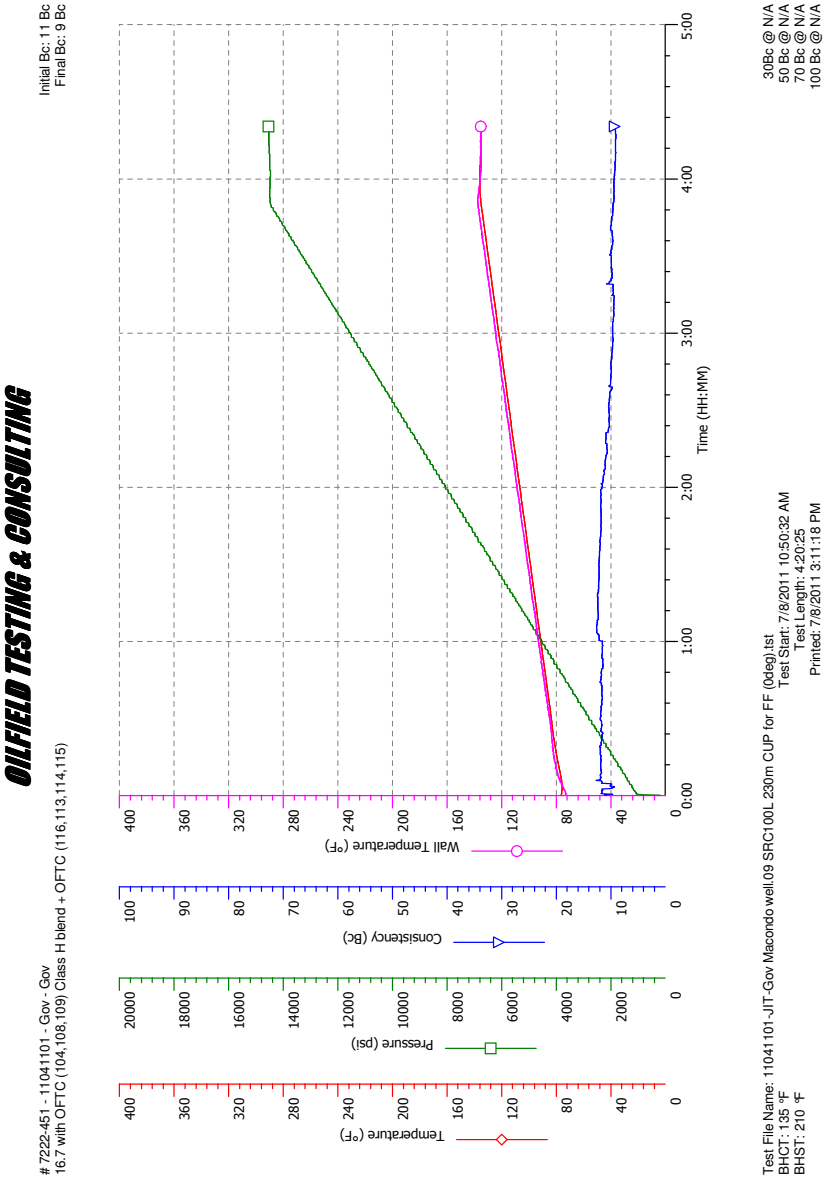

Graph #27. Graph for 0.09 gps system pressurized conditioning for 0° Free Fluid with 230 min ramp.

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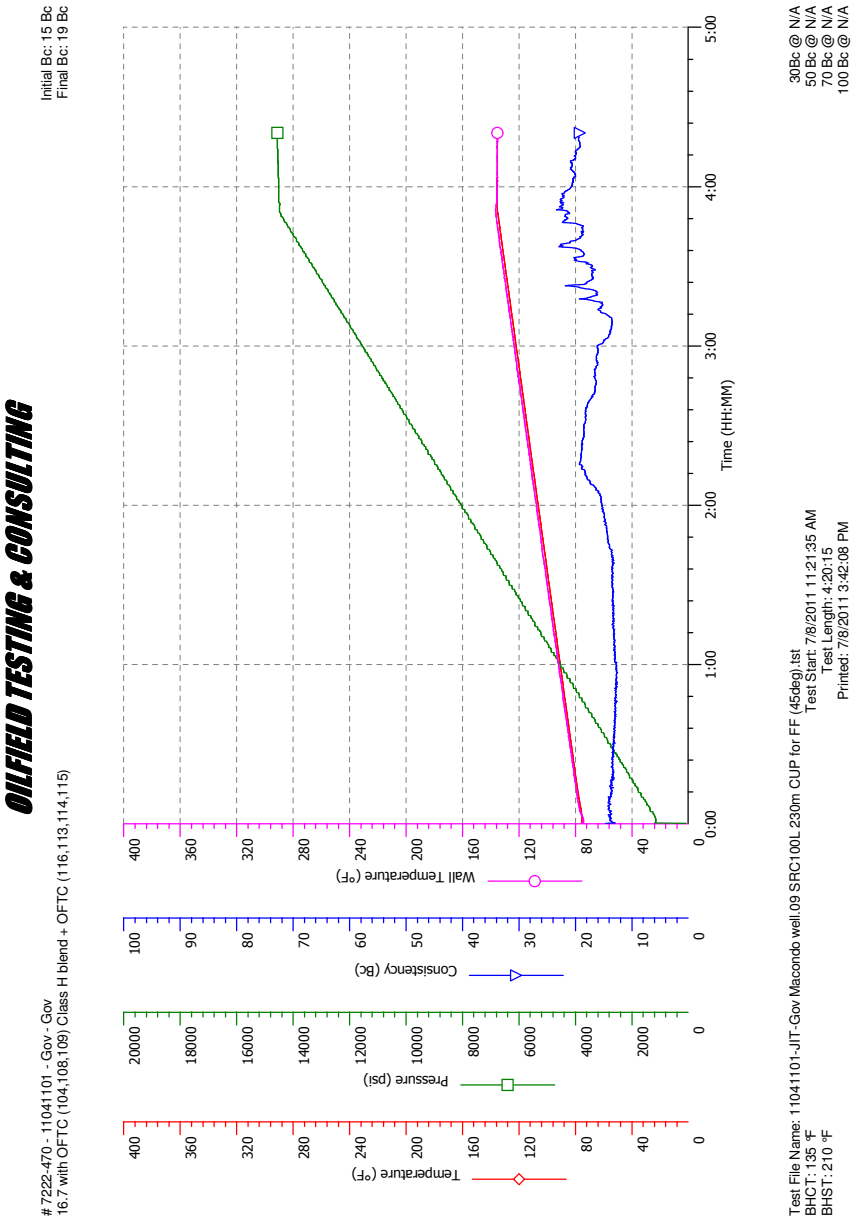

Graph #28. Graph for 0.09 gps system pressurized conditioning for 45° Free Fluid with 230 min ramp.

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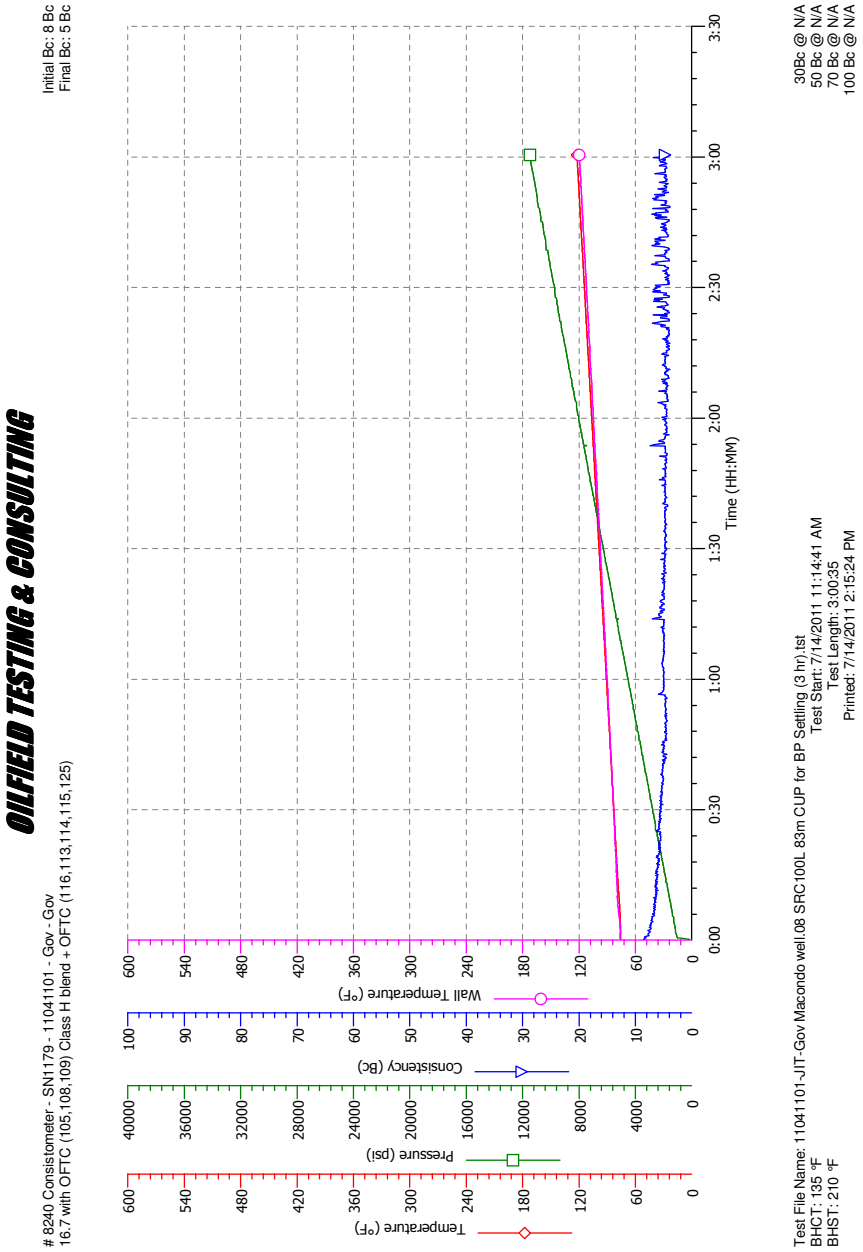

Graph #29. Graph for 0.08 gps system pressurized conditioning for BP Settling test with 83 min ramp.

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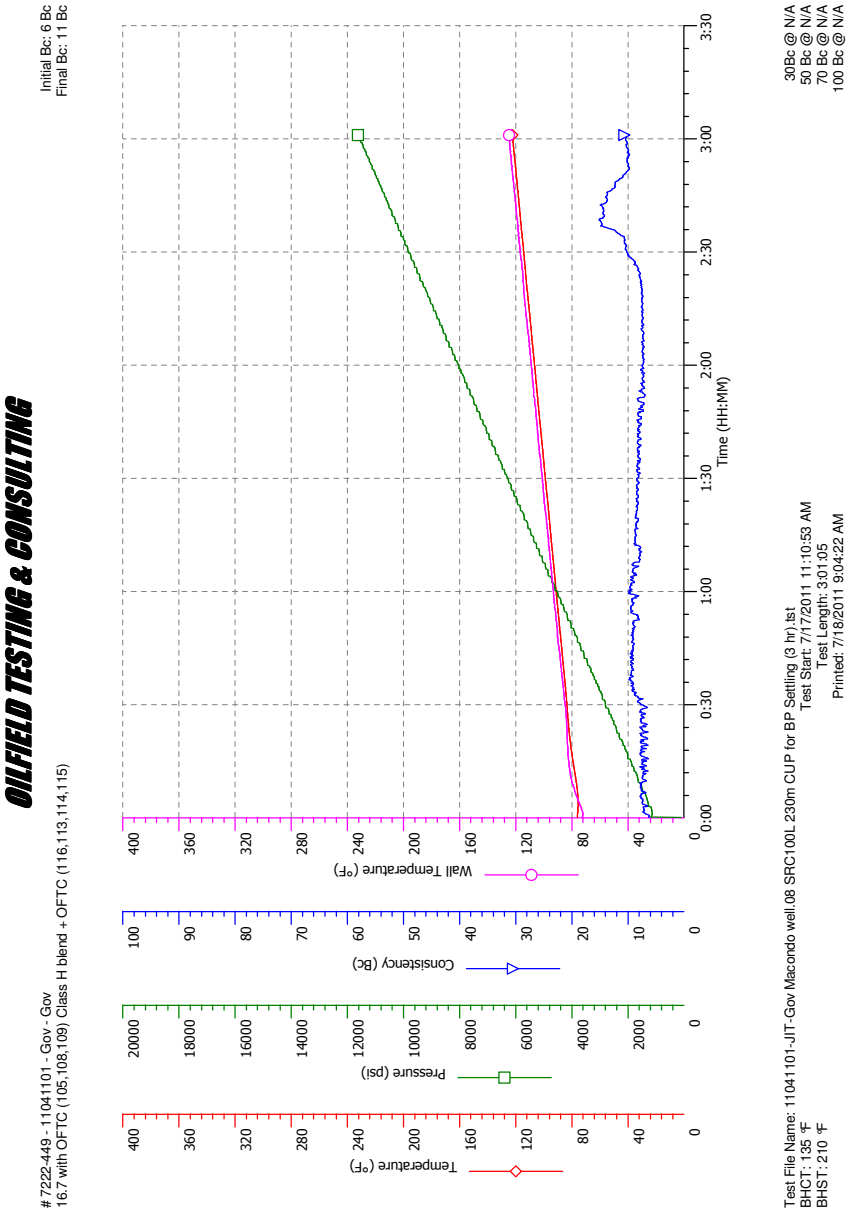

Graph #30. Graph for 0.08 gps system pressurized conditioning for BP Settling test with 230 min ramp.

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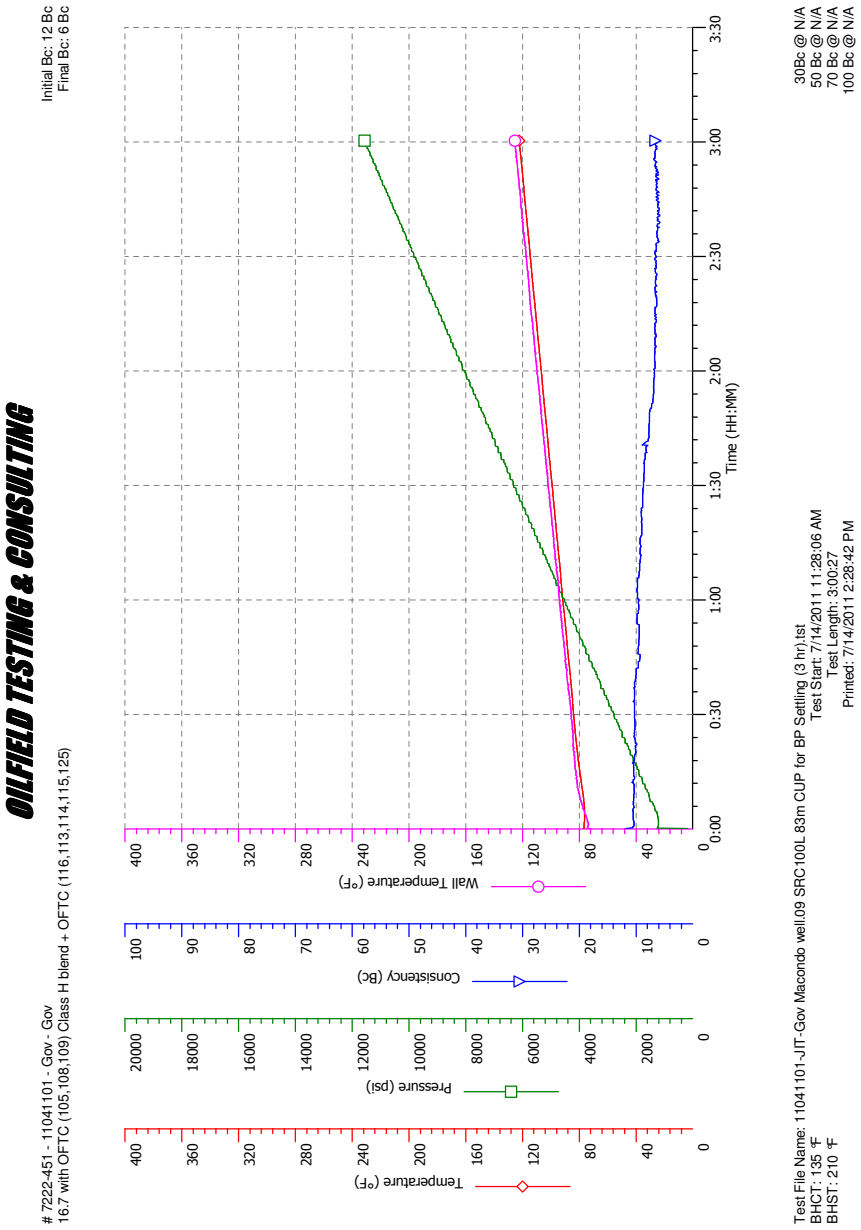

Graph #31. Graph for 0.09 gps system pressurized conditioning for BP Settling test with 83 min ramp.

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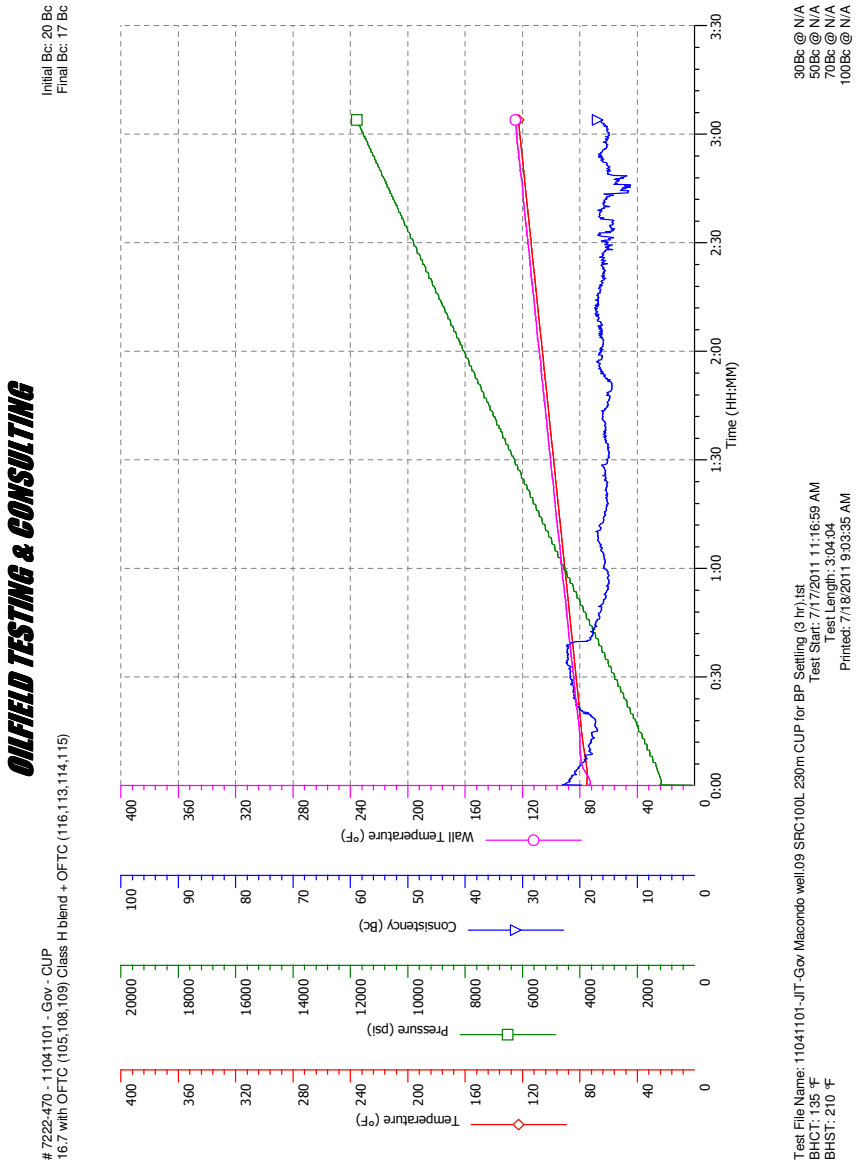

Graph #32. Graph for 0.09 gps system pressurized conditioning for BP Settling test with 230 min ramp.

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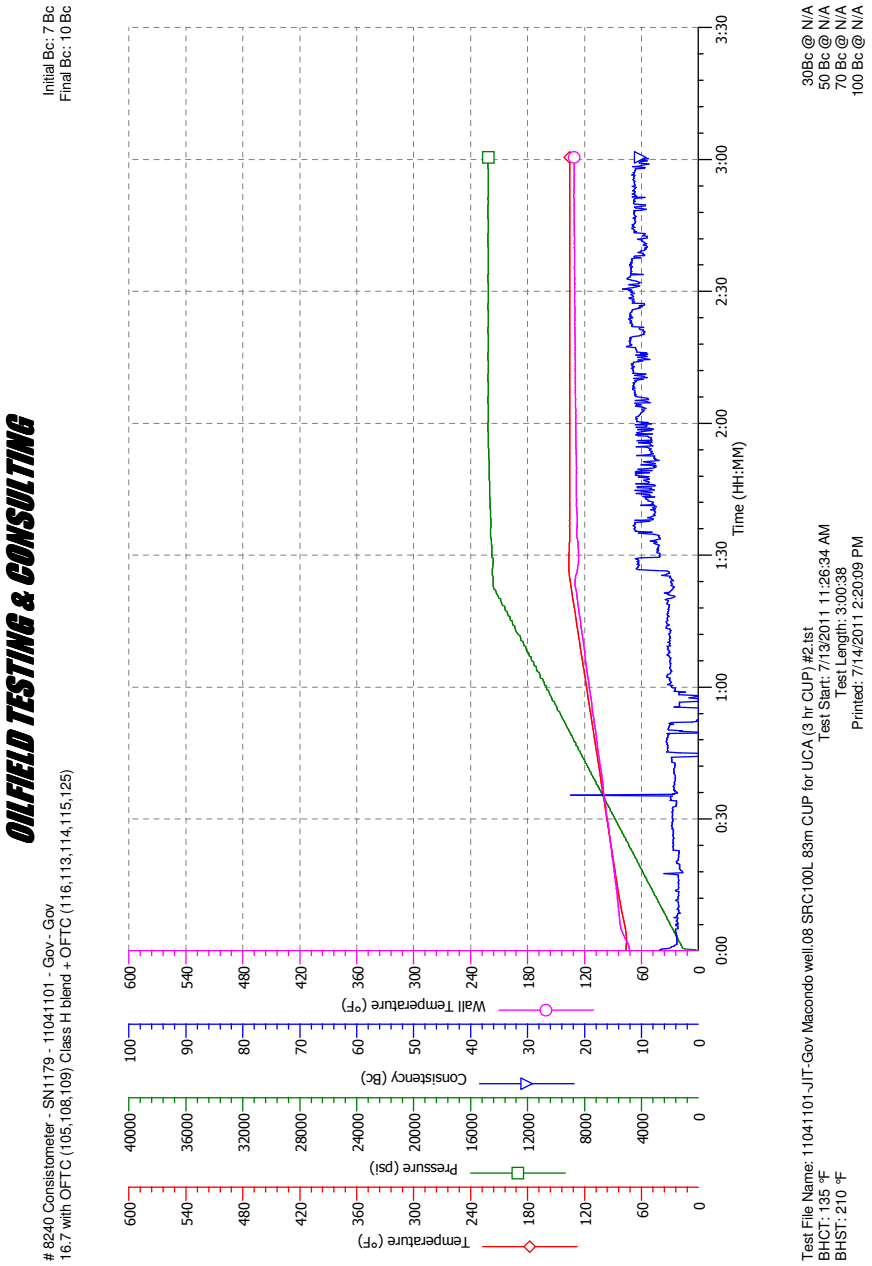

Graph #33. Graph for 0.08 gps system pressurized conditioning for UCA test with 83 min ramp.

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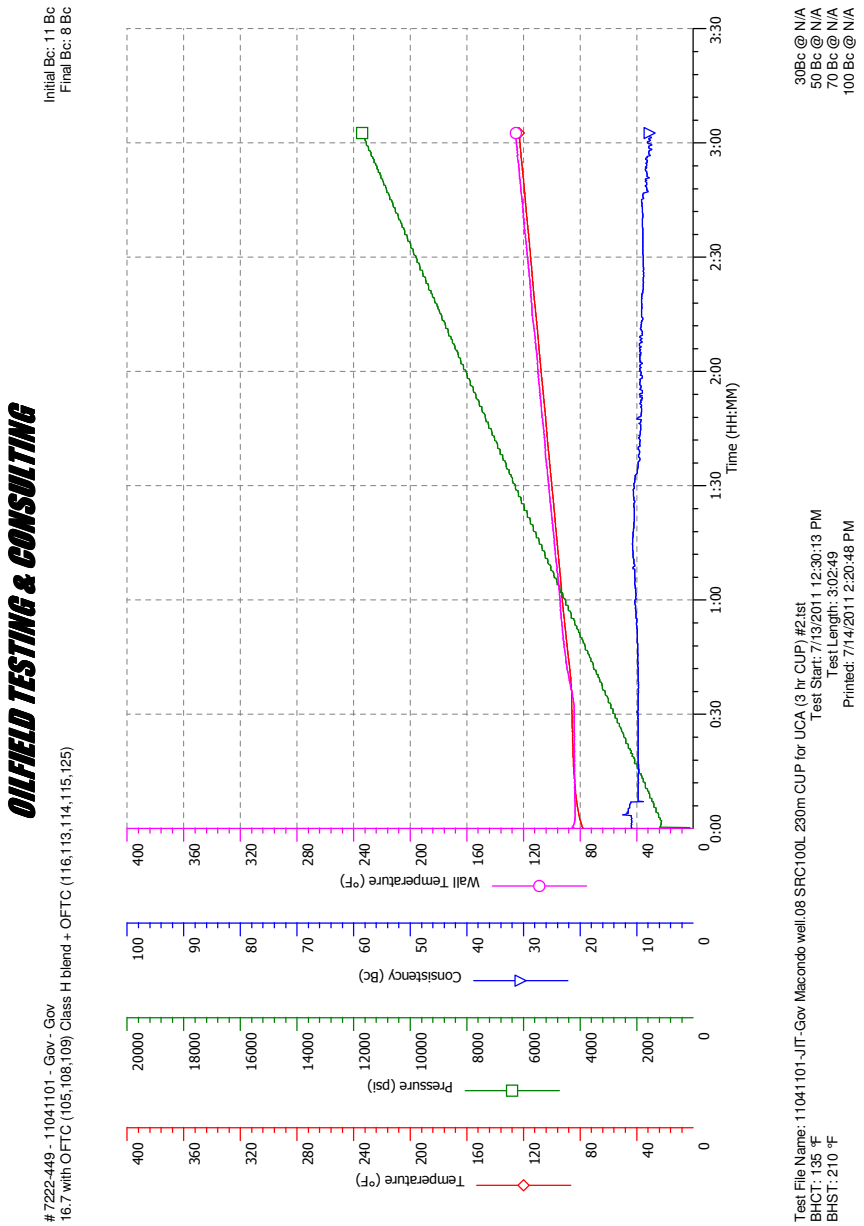

Graph #34. Graph for 0.08 gps system pressurized conditioning for UCA test with 230 min ramp.

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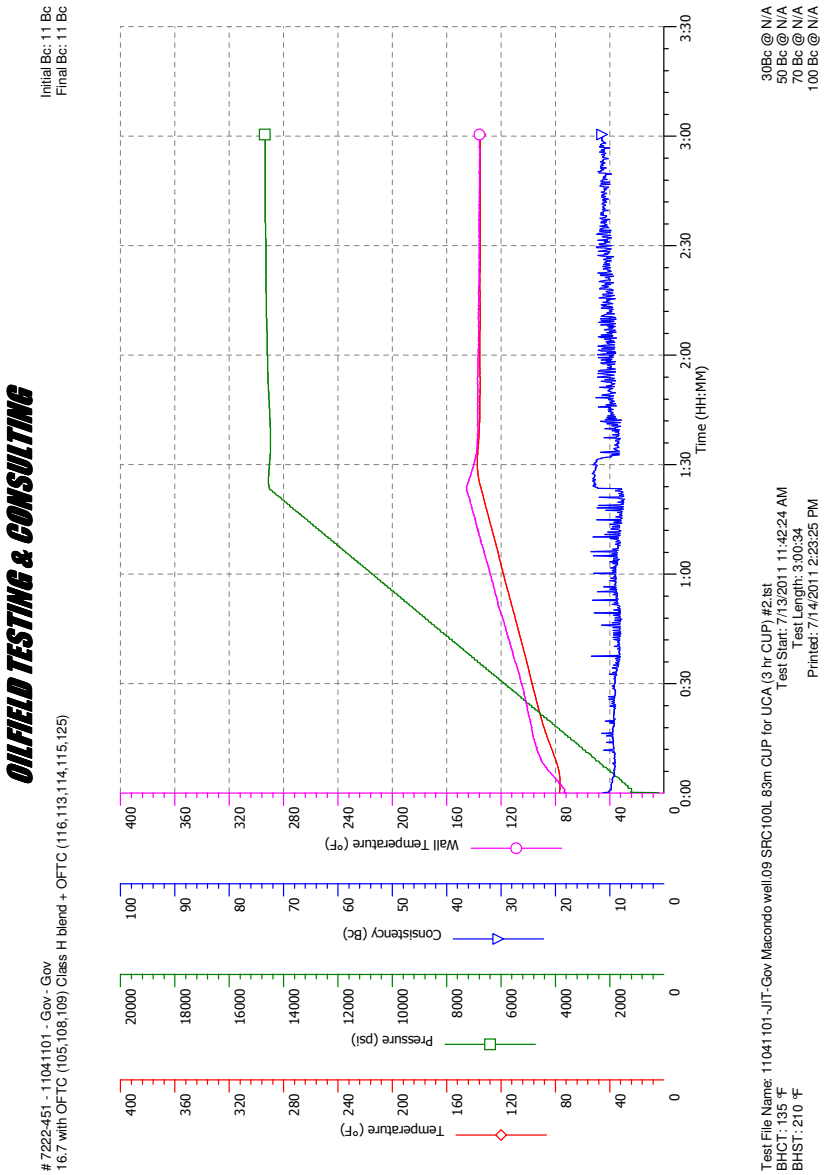

Graph #35. Graph for 0.09 gps system pressurized conditioning for UCA test with 83 min ramp.

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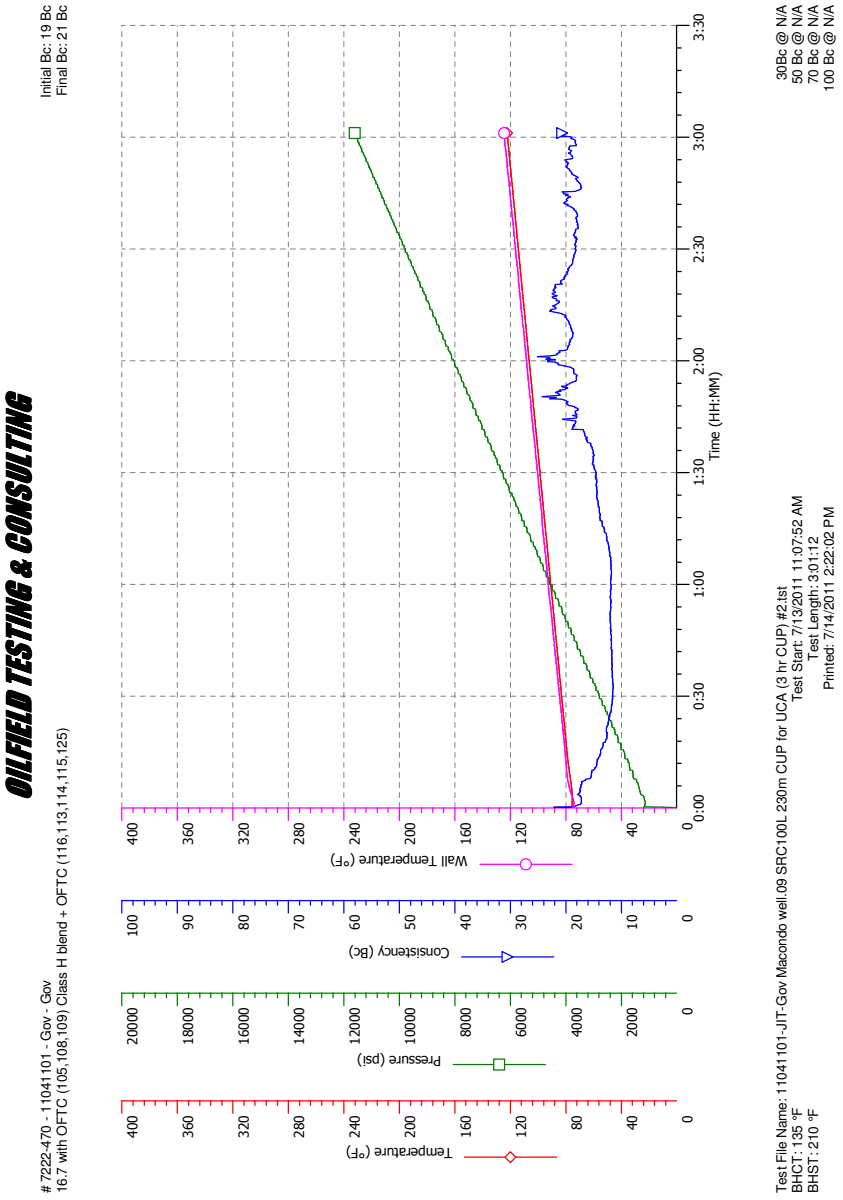

Graph #36. Graph for 0.09 gps system pressurized conditioning for UCA test with 230 min ramp.

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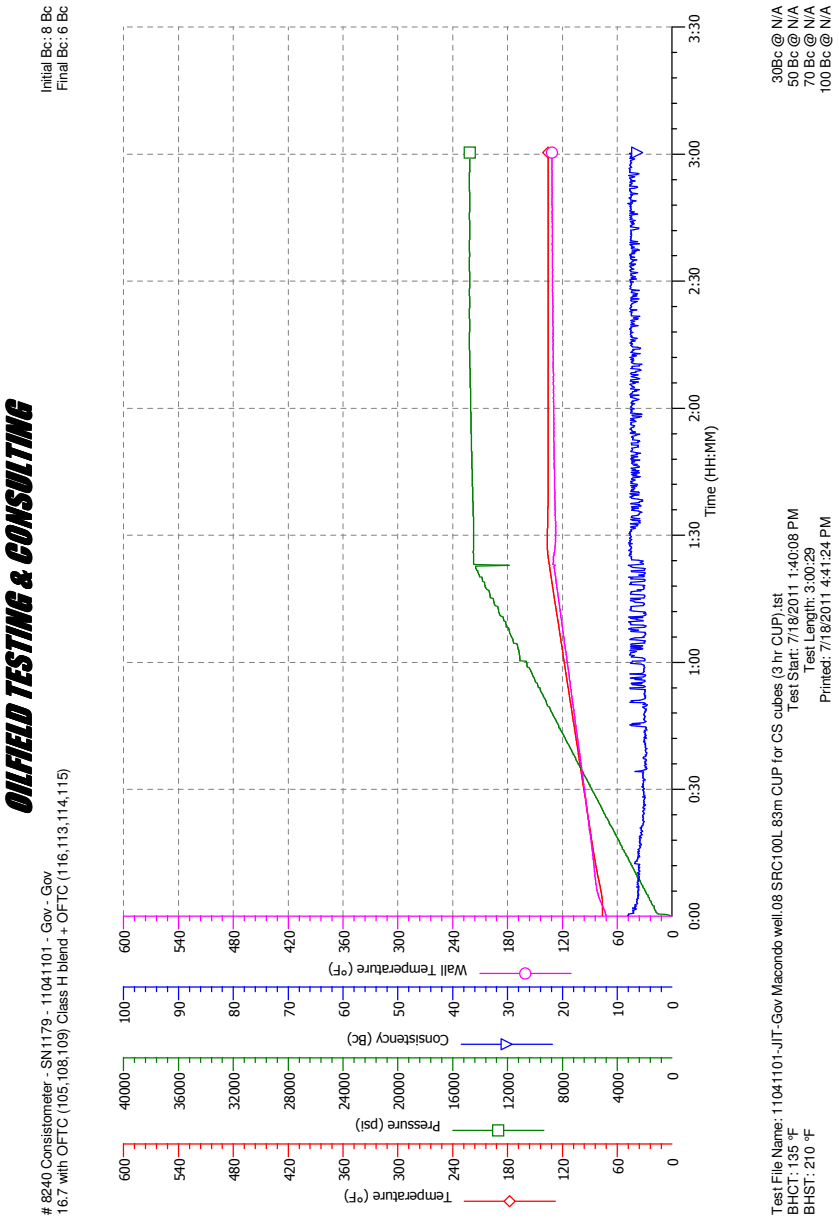

Graph #37. Graph for 0.08 gps system pressurized conditioning for Compressive Strength Crush test with 83 min ramp.

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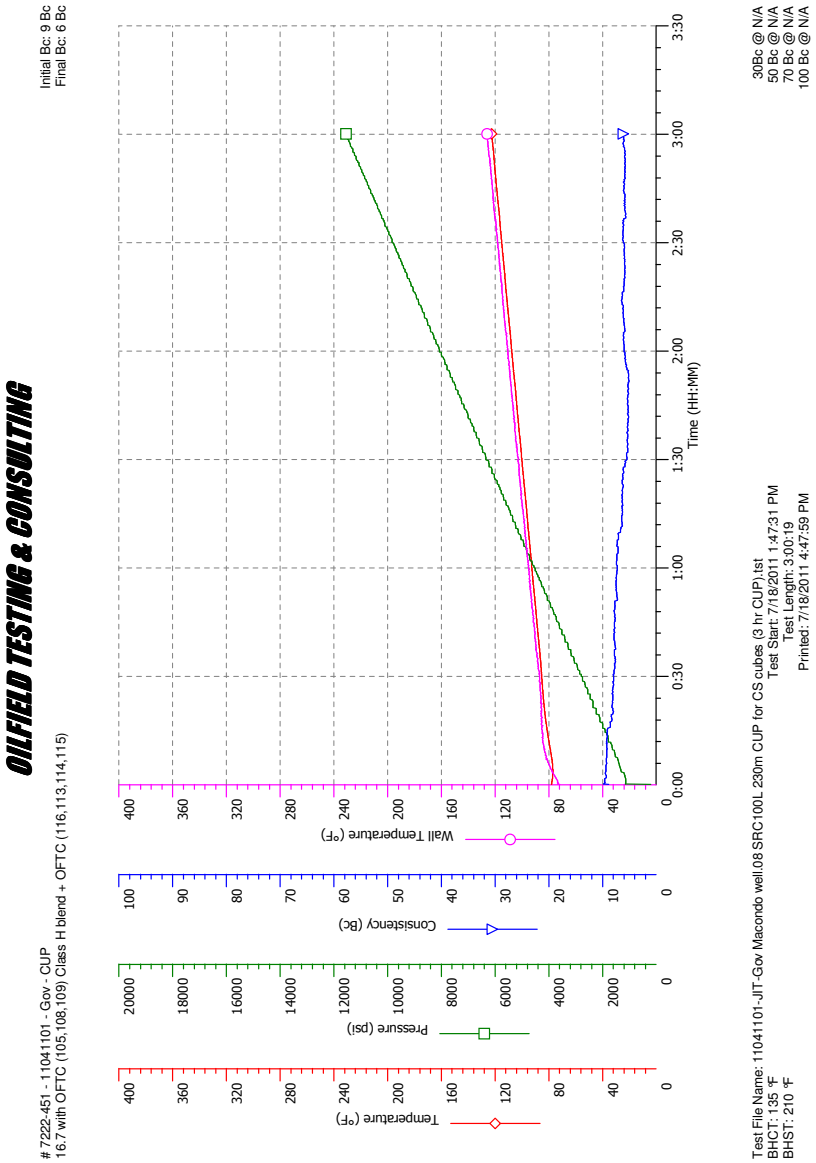

Graph #38. Graph for 0.08 gps system pressurized conditioning for Compressive Strength Crush test with 230 min ramp.

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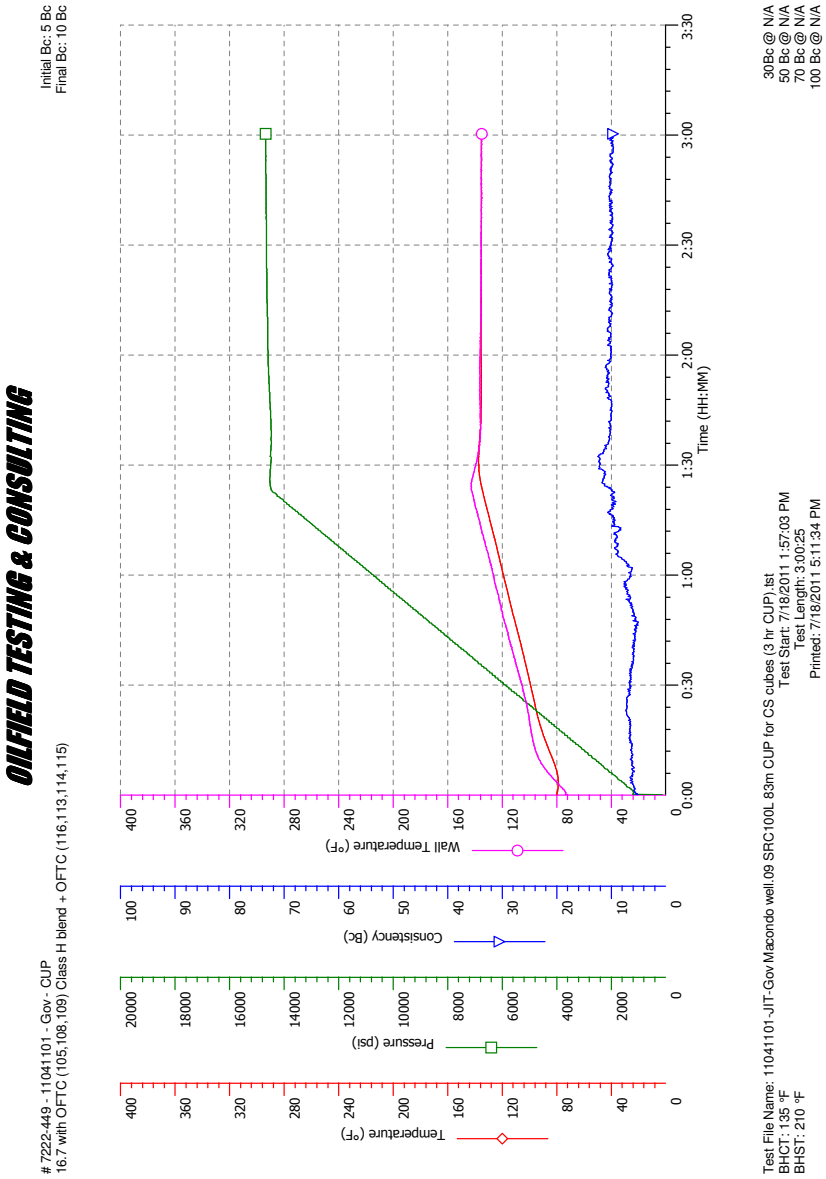

Graph #39. Graph for 0.09 gps system pressurized conditioning for Compressive Strength Crush test with 83 min ramp.

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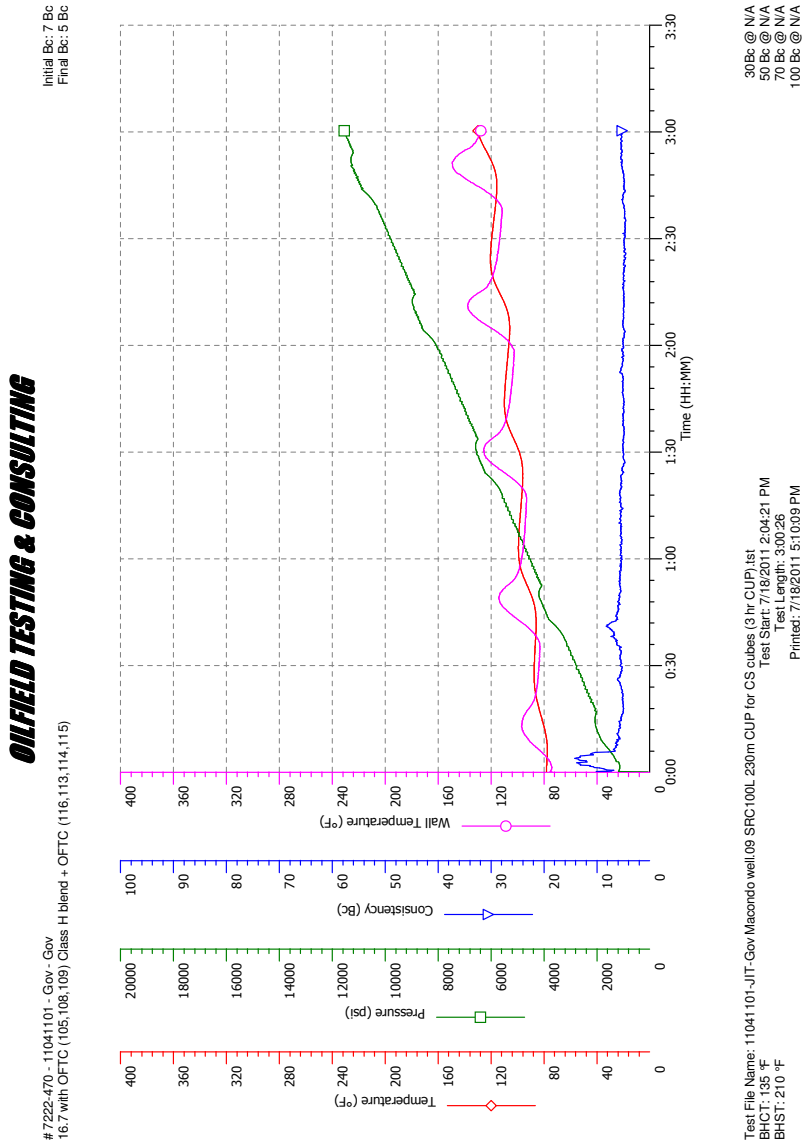

Graph #40. Graph for 0.09 gps system pressurized conditioning for Compressive Strength Crush test with 230 min ramp.

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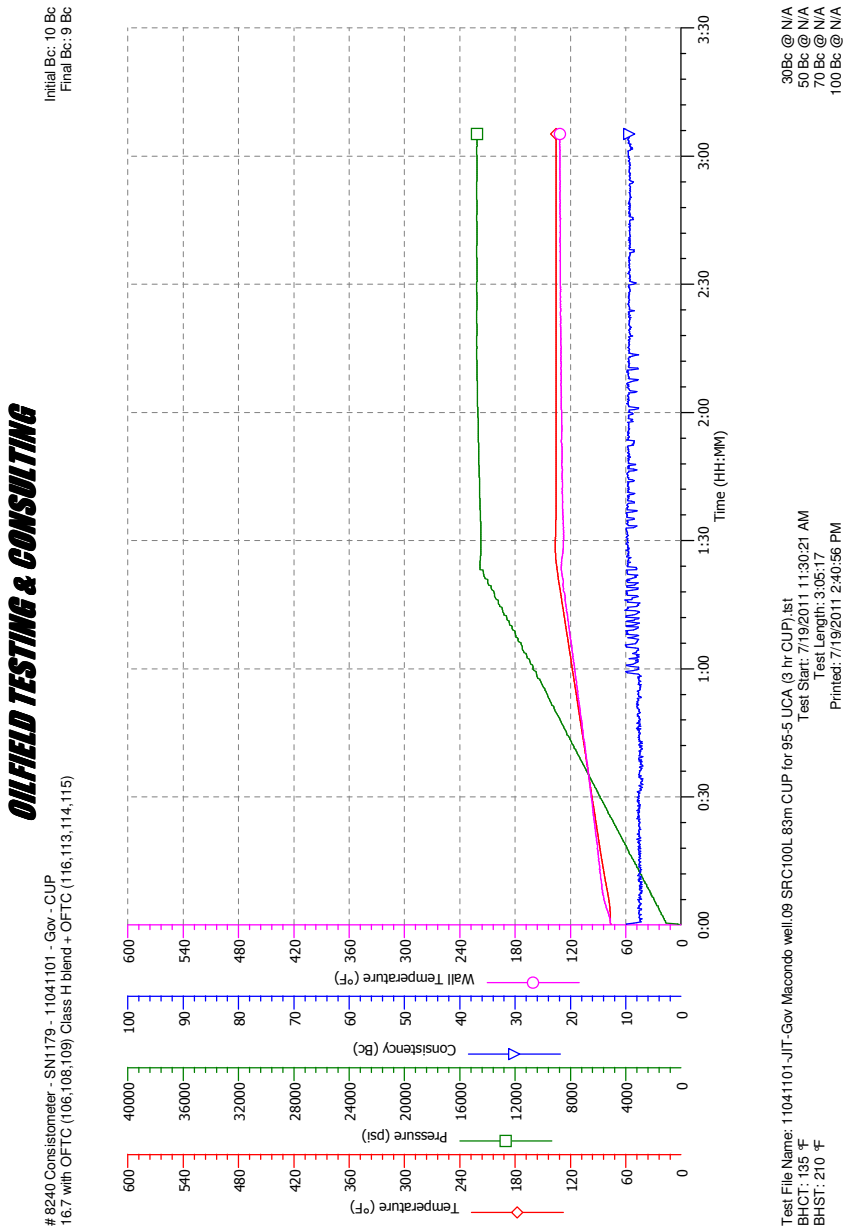

Graph #41. Graph for 0.09 gps system pressurized conditioning for UCA test with 5% spacer with 83 min ramp.

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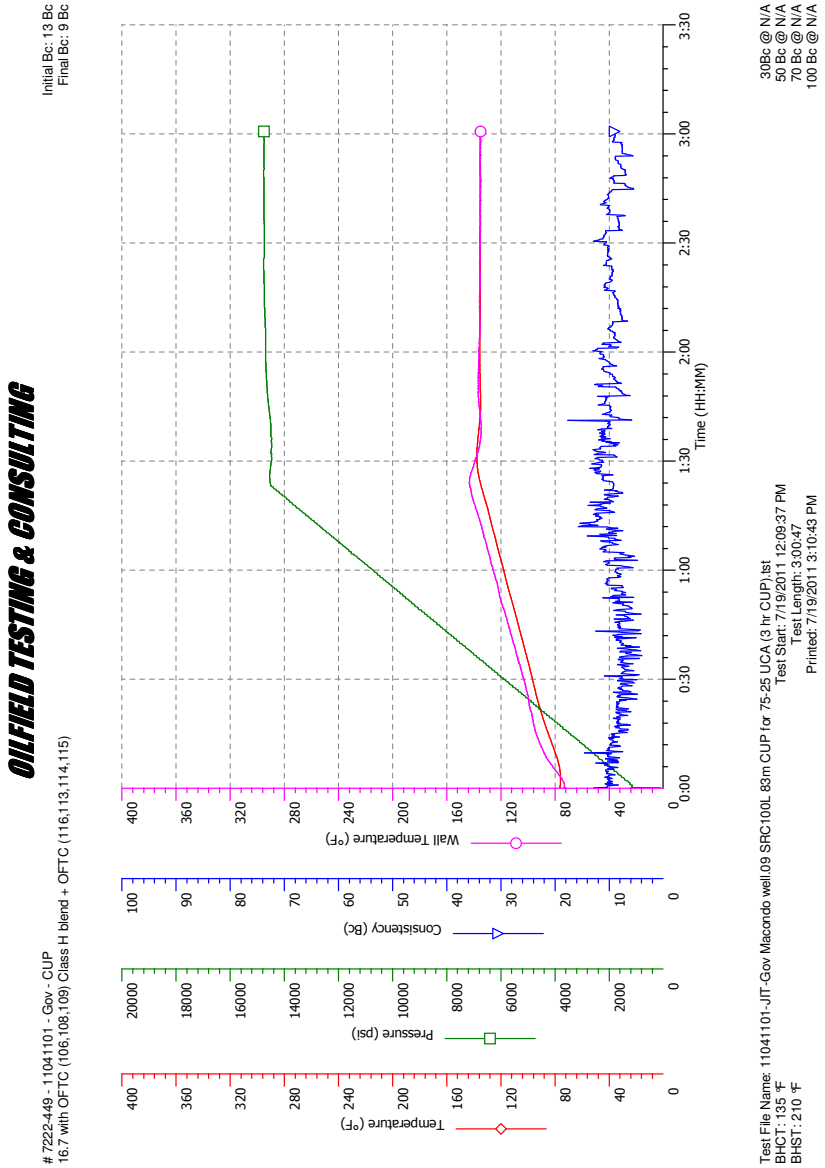

Graph #42. Graph for 0.09 gps system pressurized conditioning for UCA test with 25% spacer with 83 min ramp.

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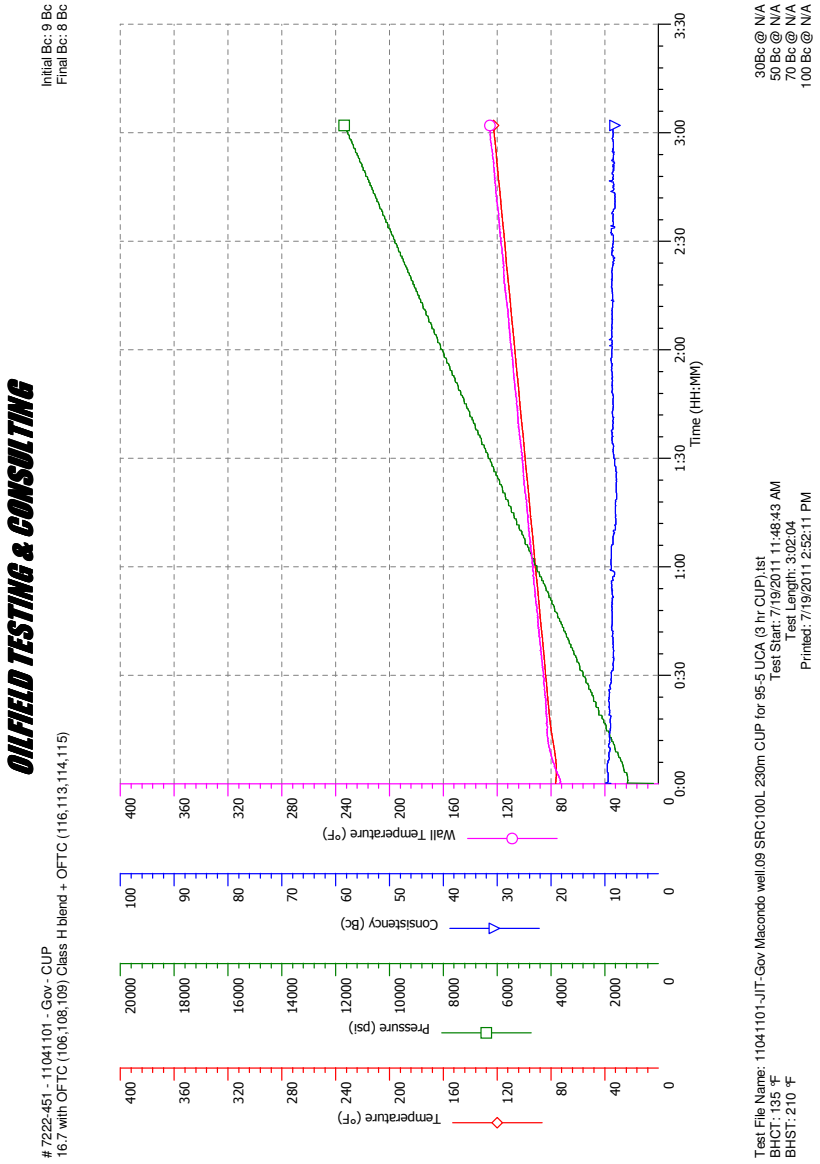

Graph #43. Graph for 0.09 gps system pressurized conditioning for UCA test with 5% spacer with 230 min ramp.

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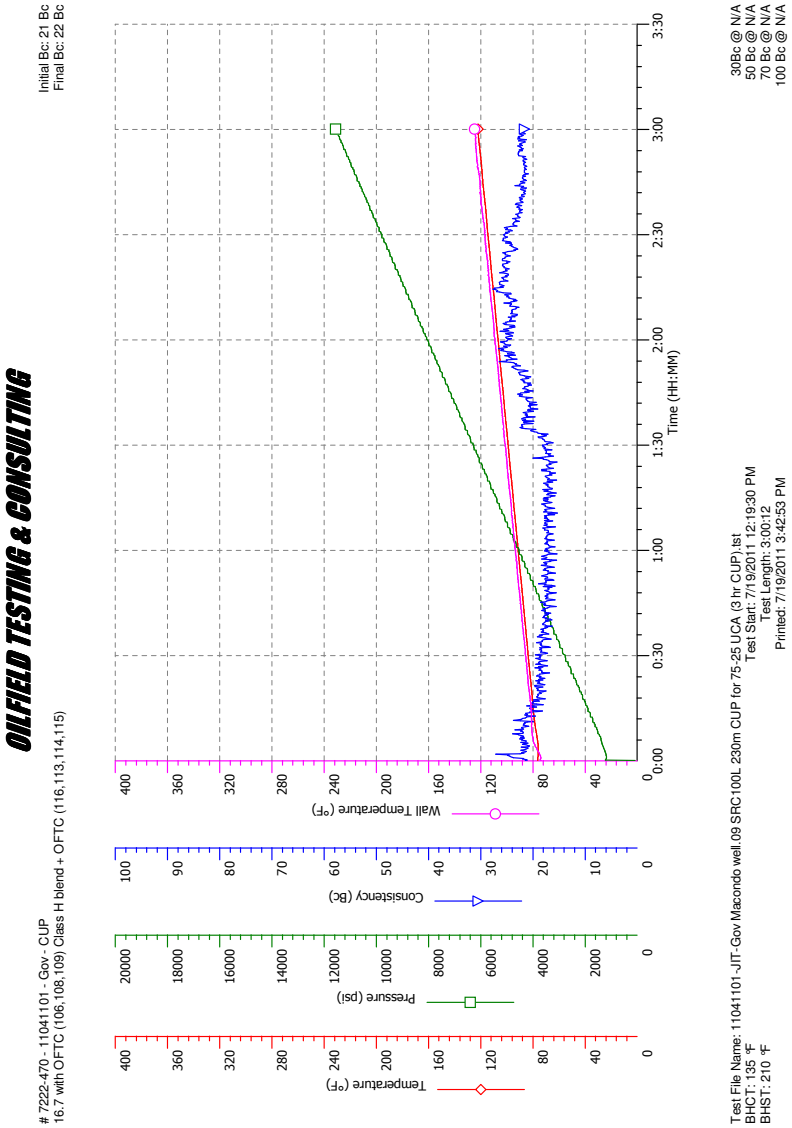

Graph #44. Graph for 0.09 gps system pressurized conditioning for UCA test with 25% spacer with 230 min ramp.

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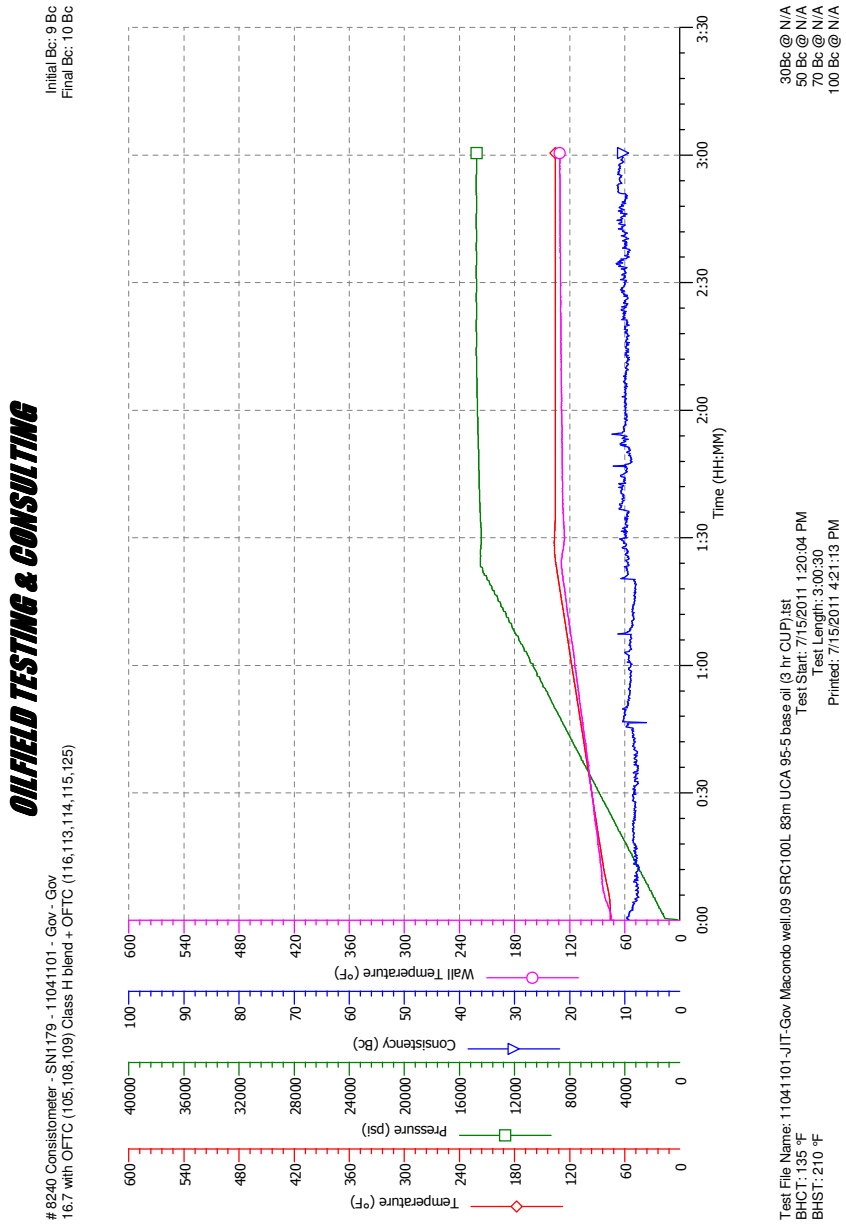

Graph #45. Graph for 0.09 gps system pressurized conditioning for UCA test with 5% base oil with 83 min ramp.

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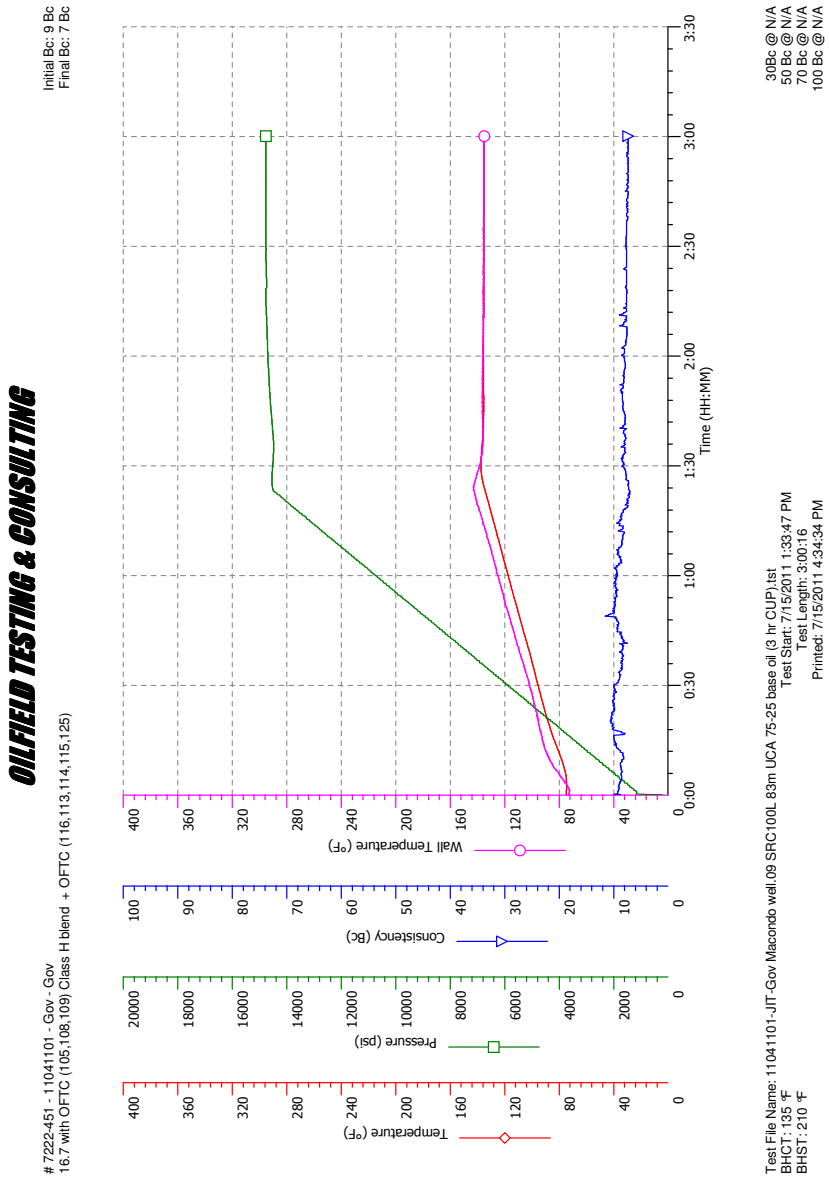

Graph #46. Graph for 0.09 gps system pressurized conditioning for UCA test with 25% base oil with 83 min ramp.

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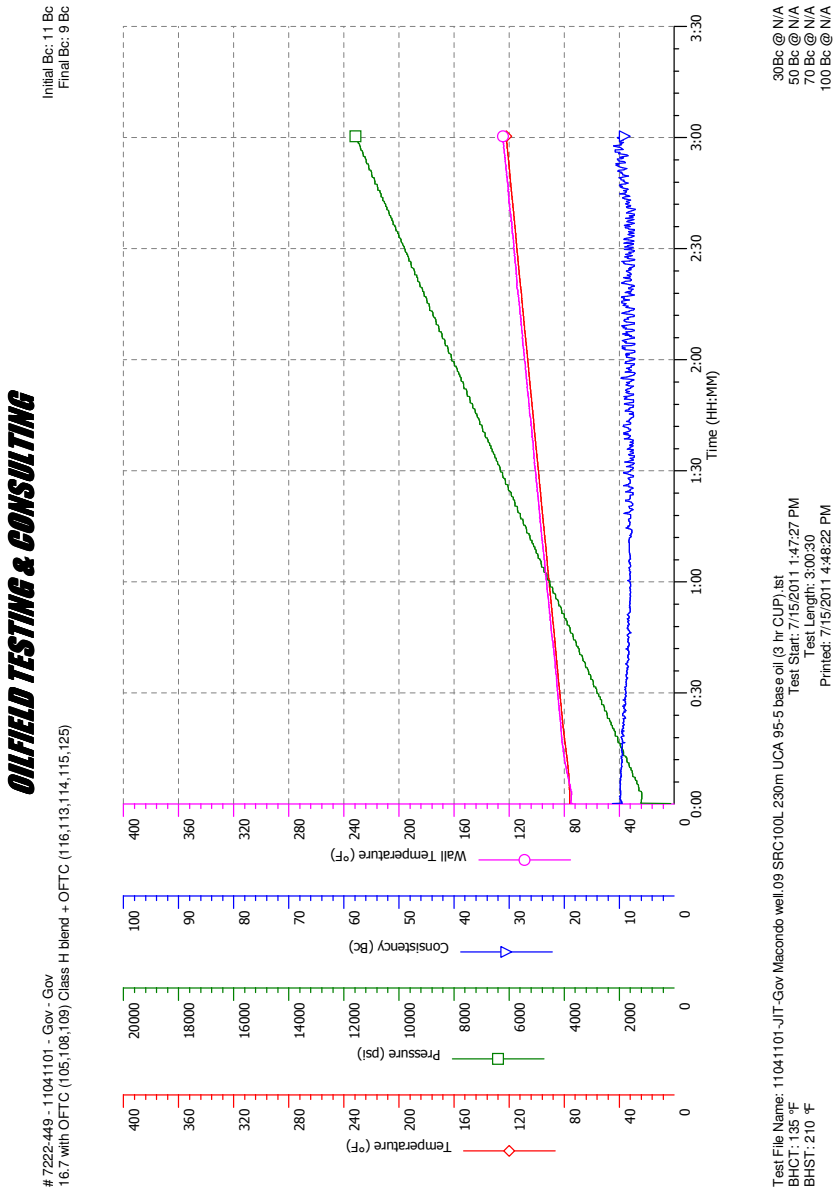

Graph #47. Graph for 0.09 gps system pressurized conditioning for UCA test with 5% base oil with 230 min ramp.

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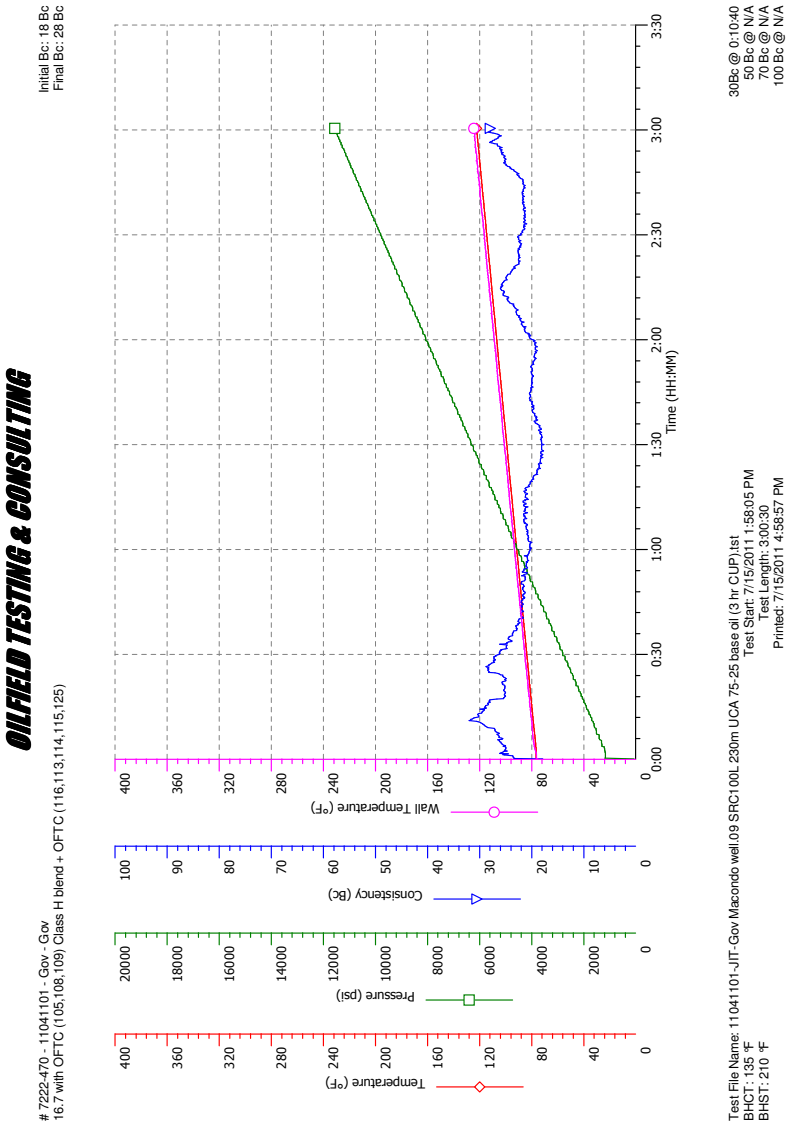

Graph #48. Graph for 0.09 gps system pressurized conditioning for UCA test with 25% base oil with 230 min ramp.

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APPENDIX B ORIGINAL FOAM STABILITY DATA

Note:
The original test calculations for the foam stability tests were based upon a blender cup volume of 1000 ml (1L). This data is illustrated here in Appendix B. It was later discovered the calibrated volume of the blender cup is 1178 ml. Therefore, the tests were repeated using the correct volume, and the data is presented in the main document (Section 11). The theoretical foam qualities in Appendix B are 15.3% and 21.8%, instead of the targeted values of 13% and 18.5%.

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Composition and Test Conditions Defined

#	COMPOSITION	Pre-condition Time	Temp (°F)	ppg	% gas (target)
FM1	Base Slurry + 0.08 gps SCR-100	1.5 hr	135	14.5	13
FM2	Base Slurry + 0.08 gps SCR-100	3.0 hr	135	14.5	13
FM3	Base Slurry + 0.09 gps SCR-100	1.5 hr	135	14.5	13
FM4	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	14.5	13
FM5	Base Slurry + 0.08 gps SCR-100	1.5 hr	135	13.6	18.5
FM6	Base Slurry + 0.08 gps SCR-100	3.0 hr	135	13.6	18.5
FM7	Base Slurry + 0.09 gps SCR-100	1.5 hr	135	13.6	18.5
FM8	Base Slurry + 0.09 gps SCR-100	3.0 hr	135	13.6	18.5
CFM1	Base Slurry + 0.08 gps SCR-100 +10% Oil	3.0 hr	135	14.5	13
CFM2	Base Slurry + 0.08 gps SCR-100 + 20% Oil	3.0 hr	135	14.5	13
CFM3	Base Slurry + 0.09 gps SCR-100 +10% Oil	3.0 hr	135	14.5	13
CFM4	Base Slurry + 0.09 gps SCR-100 + 20% Oil	3.0 hr	135	14.5	13

SLURRY PREPARATION DATA

#	Cement °F (avg)	Water °F (avg)	Load Rpm (avg)	Add'l seconds	Vortex & Mixability notes
FM1	70.8	71.0	12181	0	Vortex visable
FM2	70.4	70.7	12117	0	Vortex visable
FM3	71.8	70.5	12121	0	Vortex visable
FM4	71.2	70.7	12121	0	Vortex visable
FM5	70.5	70.7	12221	0	Vortex visable
FM6	70.6	70.8	12117	0	Vortex visable
FM7	71.2	70.7	12113	0	Vortex visable
FM8	71.4	70.7	12127	0	Vortex visable
CFM1	71.7	71.0	12123	0	Vortex visable
CFM2	71.9	71.0	12130	0	Vortex visable
CFM3	71.3	70.9	12123	0	Vortex visable
CFM4	71.4	70.6	12121	0	Vortex visable

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Stability of Unset Foamed Cement Slurry

#	Wt of Slurry in Blender (g)	Volume of Sample (mL)	S.G. (g/cm3)	Density of Slurry (ppg)
FM1	1746.91	994.0	1.76	14.7
FM2	1746.91	1000.00	1.75	14.6
FM3	1746.91	950.00	1.83	15.2
FM4	1746.91	960.00	1.82	15.2
FM5	1639.30	990.00	1.66	13.8
FM6	1639.30	960.00	1.70	14.2
FM7	1639.30	850.00	1.93	16.1
FM8	1639.30	950.00	1.72	14.3
CFM1	1482.94	910.00	1.63	13.6
CFM2	1427.57	930.00	1.53	12.7
CFM3	1415.90	820.00	1.73	14.4
CFM4	1288.41	790.00	1.63	13.6

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Stability of Unset Foamed Cement Slurry

#	Wt of Graduated Cylinder (g)	Wt of Slurry/Grad. Cylinder (g)	Volume of Sample (mL)	S.G. (g/cm3)	Density of Slurry (ppg)	Bubble Break-out?	Settling?	Free Fluid?
FM1	238.56	605.94	250.00	1.47	12.2	Yes	Yes	Yes
FM2	238.18	630.62	250.00	1.57	13.10	Yes	No	No
FM3	238.00	541.25	250.00	1.33	11.10	Yes	Yes	Yes
FM4	238.03	693.44	250.00	1.82	15.20	Yes	Yes	No
FM5	238.96	593.64	250.00	1.53	12.70	Yes	Yes	Yes
FM6	238.77	617.62	250.00	1.51	12.60	Yes	No	No
FM7	238.74	567.10	250.00	1.31	10.90	Yes	Yes	Yes
FM8	238.84	591.95	250.00	1.41	11.70	Yes	Yes	Yes
CFM1	238.18	623.77	250.00	1.54	12.80	Yes	No	Yes
CFM2	238.73	617.23	250.00	1.51	12.60	Yes	No	No
CFM3	238.54	622.99	250.00	1.54	12.80	Yes	No	Yes
CFM4	238.94	603.39	250.00	1.46	12.20	Yes	No	Yes

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Stability of Set Foamed Cement Slurry

#	Wt of Top (g)	Wt of H20 Removed (g)	Density of Top (g)	Wt of Middle (g)	Wt of H20 Removed (g)	Density of Middle (g)	Wt of Bottom (g)	Wt of H20 Removed (g)	Density of Bottom (g)
FM1	67.10	38.54	14.50	49.50	27.18	15.17	37.27	19.34	16.05
FM2	58.22	55.31	8.77	46.86	42.45	9.20	60.82	53.54	9.46
FM3	38.99	27.40	11.85	49.32	26.68	15.40	53.54	26.36	16.92
FM4	42.47	28.51	12.41	53.84	31.50	14.24	46.53	25.01	15.50
FM5	48.43	41.39	9.75	61.42	47.83	10.70	60.85	40.83	12.41
FM6	58.55	47.76	10.21	51.75	45.91	9.39	55.29	47.52	9.69
FM7	5.54	3.62	12.75	50.56	26.58	15.85	59.98	29.02	17.22
FM8	59.09	51.96	9.47	46.39	38.83	9.95	65.02	44.73	12.11
CFM1	35.43	21.43	14.16	52.88	29.41	14.98	68.53	35.75	15.97
CFM2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CFM3	57.09	36.29	13.10	76.41	46.06	13.82	49.05	26.73	15.29
CFM4	54.85	34.78	13.14	58.21	35.79	13.55	47.67	28.38	13.99

Note: CFM2 0.08 gps SCR-100L with 20 % base oil samples did not set hard during the 48 hour curing period, and, therefore, could not be tested for this particular part of the testing protocol.

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COMPRESSIVE STRENGTH TEST RESULTS

	Property	ACS3	ACS4
cube #1	Area (sq. in.)	3.15	3.36
	Force (lb_f)	5708	6498
	CS (psi)	1812	1934
cube #2	Area (sq. in.)	3.36	4.20
	Force (lb_f)	7306	2777
	CS (psi)	2174	661
cube #3	Area (sq. in.)	3.15	5.04
	Force (lb_f)	7475	2231
	CS (psi)	2373	443
Average CS psi		2120	1012

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Figure #21. Pictures show 0.09 gps SCR-100 slurry testing for Foam Stability and Foam Quality after a 2-hour quiescent period, pre-conditioned for 1.5 hours (left set) and 3 hours (right set). In each pair of cylinders, the targeted 13% foam quality (15.3% true) is on the left and the targeted 18.5% (21.8% true) is on the right.

ANNEX: CALIBRATIONS & CERTIFICATIONS

EQUIPMENT TYPE	SERIAL NUMBER	FACTORY CALIBRATION	OTC ROUTINE CAL CHECK	CERTIFIED CALIBRATION

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		DATE RANGE	DATE	DATE
BALANCE (±0.01g)	G0581121031791	03/28/11 - 11/28/11	NEW	03/28/11
BALANCE (±0.0001g)	38670	03/28/11 - 11/28/11	NEW	03/28/11
CONSTANT SPD MIXER	1704	01/10/11 – 05/10/11	06/16/11	01/10/11
VISCOMETER	1251	04/11/11 – 07/11/11	NEW	04/11/11
VISC TEMP CONTROL	11-343	03/31/11 - 07/22/11	06/16/11	03/31/11
PRESS.CONSISTOMETER	449	01/10/11 – 05/10/11	07/13/11	01/10/11
PRESS. CONSISTOMETER	451	01/08/11 – 05/08/11	07/13/11	01/08/11
PRESS.CONSISTOMETER	470	04/29/11 – 06/30/11	07/13/11	04/29/11
PRESS.CONSISTOMETER	1179	04/14/11 – 06/30/11	07/13/11	04/14/11
STIRRED FLUID LOSS	337	01/04/11 – 05/04 2011	06/15/11	01/04/11
STAT FL TEMP CONTROL	11-344	03/31/11 - 07/22/1	06/16/11	03/31/11
CURING CHAMBER	611	04/19/11 – 06/30/11	07/12/11	04/19/11
AUTOMATED PRESS	345684	1/14/2011 – 1/26/2012	NEW	01/14/2011
SGSA	696	01/04/11 – 05/04/11	07/13/11	01/04/11
SGSA	697	01/04/11 – 05/04/11	07/13/11	01/04/11
SGSA	707	04/19/11 – 06/30/11	07/13/11	04/19/11
SGSA	711	04/25/11 – 06/30/11	07/13/11	04/25/11
ATM. CONSISTOMETER	1090	01/05/11 – 05/05/11	07/13/11	01/05/11
ATM. CONSISTOMETER	1106	04/07/11 – 1/31/12	07/13/11	04/07/11
ATM CONS. THERM.	NOT REC'D	NOT YET REC'D	NOT YET REC'D	NOT YET REC'D
WATER BATH THERM.	21615	03/02/11 - 03/02/12	NEW	03/02/11
AIR THERMOMETER	101861696	08/03/10 – 08/03/12	NEW	08/03/10
STICK THERM. (21467, 21468, 21470, 21476)		02/16/11 – 02/16/12	NEW	02/16/11
TIMERS (SET A: 102151418/102151455; SET B 101978797/10198778)		A: 12/10-12/12 B: 09/10-09/12	NEW	A: 12/10/11 B: 09/10/11
WEIGHT SET CERTIFICATION ±0.1g (2393: 11/23/2010, 2407/2409: 01/10/2011)				
SIEVE CERTIFICATION (E44073, #20)				
DAC 5270 CERTIFICATION				

*Timer & Stick Thermometer calibration certificates available upon request

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BALANCE CALIBRATION REPORT

Customer: Oilfield Testing & Consulting, LLC **City:** Houston
Mfr/Model: Mettler/AE50 **Serial #:** 38670 **Unit ID:**
Capacity: 55 g **Readability:** 0.1 mg **Location:** Lab
Date of Service: 3/28/2011 **Previous Service:** - **Next Service:** 03/2012
Temperature: 23° C **Humidity:** 49%

CALIBRATION DATA

Test Points	As Found	As Left	Error As Left
500mg	0.4996g	0.5000g	0
1g	0.9993	1.0000	0
10	9.9927	10.0000	0
20	19.9854	20.0000	0
50	49.9642	50.0000	0

As found Cornerload (within ± 3 counts): Yes **As left Cornerload (within ± 3 counts):** Yes
As found Linearity (within ± 3 counts): Yes **As left Linearity (within ± 3 counts):** Yes

WEIGHT TRACEABILITY

The weight set(s) below, utilized in this calibration have been tested and certified by an accredited calibration laboratory and are directly traceable to the National Institute for Standards and Technology, (NIST) through the Cal Lab Cert. #.

Weight Set No.	Cal Lab Cert. #	Exp. Date
005	579521-1	11/18/2011

SERVICES PERFORMED

Inspections and adjustments have been performed in accordance to Allometrics work instruction 5-4WI03 in compliance with ISO/IEC 17025, ANSI/NCSL Z540-1 and the principles of ISO 9001-2008. Reported measurements are within the accredited scope of Allometrics Inc.

Service Technician: Brian Burtzlaff

Comments:

ACCREDITED
Calibration Cert. #2039.01

REPORT NO. 02003281101

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BALANCE CALIBRATION REPORT

Customer: Oilfield Testing & Consulting, LLC **City:** Houston
Mfr/Model: Ohaus/EOB120 **Serial #:** G0581121031791 **Unit ID:**
Capacity: 2100 g **Readability:** 0.01 g **Location:** Lab
Date of Service: 3/28/2011 **Previous Service:** - **Next Service:** 03/2012
Temperature: 23° C **Humidity:** 49%

CALIBRATION DATA

Test Points	As Found	As Left	Error As Left
100g	99.98g	100.00g	0
200	199.96	200.00	0
500	499.91	500.00	0
1kg	999.82	1000.00	0
2	1999.65	2000.00	0

As found Cornerload (within ± 3 counts): Yes **As left Cornerload (within ± 3 counts):** Yes
As found Linearity (within ± 3 counts): Yes **As left Linearity (within ± 3 counts):** Yes

WEIGHT TRACEABILITY

The weight set(s) below, utilized in this calibration have been tested and certified by an accredited calibration laboratory and are directly traceable to the National Institute for Standards and Technology, (NIST) through the Cal Lab Cert. #.

Weight Set No.	Cal Lab Cert. #	Exp. Date
005	579521-1	11/18/2011

SERVICES PERFORMED

Inspections and adjustments have been performed in accordance to Allometrics work instruction 5-4WI03 in compliance with ISO/IEC 17025, ANSI/NCSL Z540-1 and the principles of ISO 9001-2008. Reported measurements are within the accredited scope of Allometrics Inc.

Service Technician: Brian Burtzlaff

Comments:

ACCREDITED
Calibration Cert. #2039.01

REPORT NO. 02003281100

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ilac-MRA ACCREDITED Calibration Certificate No. 1750.01

Calibration complies with ISO 9001
ISO/IEC 17025 AND ANSI/NCSL Z540-1

Cert. No.: 4105-3088841

Traceable® Certificate of Calibration for Thermometer/Time/Date Max/Min

Instrument Identification:

Model: 4105 S/N: 101861696 Manufacturer : Control Company

Standards/Equipment:

Description	Serial Number	Due Date	NIST Traceable Reference
Temperature Calibration Bath TC-231	A79341		
Temperature Probe	3039	12/10/10	A9B23080-1
Thermistor Module	A17118	11/19/10	A9B21010
Temperature Calibration Bath TC-218	A73332		
Thermistor Module	A27129	8/09/10	1000264338
Temperature Probe	5202	3/11/11	B0310050

Certificate Information:

Technician: 68 Procedure: CAL-03 Cal Date: 8/03/10 **Cal Due: 8/03/12**
Test Conditions: 22.0°C 45.0 %RH 1018 mBar

Calibration Data: (New Instrument)

Unit(s)	Nominal	As Found	In Tol	Nominal	As Left	In Tol	Min	Max	±U	TUR
°C		N.A.		0.000	0.5	Y	-1.5	1.5	0.310	>4:1
°C		N.A.		50.000	50.0	Y	48.5	51.5	0.580	2.6:1

This Instrument was calibrated using Instruments Traceable to National Institute of Standards and Technology.

A Test Uncertainty Ratio of at least 4:1 is maintained unless otherwise stated and is calculated using the expanded measurement uncertainty. Uncertainty evaluation includes the instrument under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM). The uncertainty represents an expanded uncertainty using a coverage factor k=2 to approximate a 95% confidence level. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement. The results contained herein relate only to the item calibrated. This certificate shall not be reproduced except in full, without written approval of Control Company.

Nominal=Standard's Reading; As Left=Instrument's Reading; In Tol=In Tolerance; Min/Max=Acceptance Range; ±U=Expanded Measurement Uncertainty; TUR=Test Uncertainty Ratio; Accuracy=±(Max-Min)/2; Min = Nominal(Rounded) - Tolerance; Max = Nominal(Rounded) + Tolerance; Date=MM/DD/YY

Nicol Rodriguez, Quality Manager

Wallace Berry, Technical Manager

Maintaining Accuracy:

In our opinion once calibrated your Thermometer/Time/Date Max/Min should maintain its accuracy. There is no exact way to determine how long calibration will be maintained. Thermometer/Time/Date Max/Mins change little, if any at all, but can be affected by aging, temperature, shock, and contamination.

Recalibration:

For factory calibration and re-certification traceable to National Institute of Standards and Technology contact Control Company.

CONTROL COMPANY 4455 Rex Road Friendswood, TX 77546 USA
Phone 281 482-1714 Fax 281 482-9448 service@control3.com www.control3.com

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NIST TRACEABLE CALIBRATION CERTIFICATE

INSTRUMENT CATALOG No. ACC895DIG

INSTRUMENT SERIAL NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
21615	MAR 0 2 2011	MAR 0 2 2012

TEST REFERENCE

ASTM E-77 Standard Test Method for Inspection and Verification of Thermometers
NIST Publication 250-22 Platinum Resistance Thermometer Calibration.

PHYSICAL EXAMINATION ✓

The physical integrity of the thermometer was verified and inspected for any malfunctions of the digital readout and any defects to the thermometer's structure. Upon completion, it was determined the thermometer was suitable for calibration.

CALIBRATION RESULTS ✓

NIST TRACEABLE INSTRUMENT	NIST CALIBRATION REPORT NUMBER
Hart Model 850C S/N A12356	S163521
Burns IPRT Probe S/N 757140	S163521

Calibrated Temperature for:

Freezer	- 20.0 C
Refrigerator	+ 4.0 C
Incubator	+ 37.0 C
Water Bath ✓	+ 37.0 C
Block Heater	+ 37.0 C
Thermometer only	+ 50.0 C

The NIST traceable calibration instruments listed above were used to calibrate the thermometer listed by the comparison method noted in the above publications. The indications were found to be within +/- 0.5 C. The liquid bath was maintained at +/-0.05 C during calibration.

CALIBRATION APPROVED BY: J. Saucedo

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www.ThermcoProductsInc.com

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CHANDLER ENGINEERING

ISO 9001

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 3060

Serial Number: 1704
Date Calibrated: 01/10/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-201	Multimeter	81480264	6/7/2010	6/30/2011
620-200	Temperature Calibrator	7968103	1/11/2010	1/31/2011
620-530	Temperature Calibrator	9234019	6/7/2010	6/30/2011
7030850	Tachometer	7030850	1/11/2010	1/31/2011
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-203	Pressure Reference (40K)	926312	2/18/2010	2/28/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
N/A	N/A	N/A

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
N/A	N/A	N/A	N/A

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	N/A

Timer (minutes)	Display
2	2:00:16
4	4:00:13

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: Steve Carlow

Date: 01/10/11

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CHANDLER ENGINEERING

ISO 9001

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 7222

Serial Number: 449
Date Calibrated: 01/18/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-201	Multimeter	81480264	6/7/2010	6/30/2011
620-200	Temperature Calibrator	7968103	1/11/2010	1/31/2011
620-530	Temperature Calibrator	9234019	6/7/2010	6/30/2011
7030850	Tachometer	7030850	1/11/2010	1/31/2011
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-203	Pressure Reference (40K)	926312	2/18/2010	2/28/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
50	50	50.4
100	100	100.2
200	200	200.2
300	300	300.7
400	400	400.0

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
5000	5.0	5.0	5000
10000	10.0	10.0	10000
15000	15.0	15.0	15000
20000	20.0	20.0	20000
22000	22.0	22.0	22000

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	150.1

Timer (minutes)	Display
2	2:00:09
4	4:00:10

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: General Gillespie G. G.

Date: 01/18/11

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CHANDLER ENGINEERING

ISO 9001

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 7222

Serial Number: 451
Date Calibrated: 01/14/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-201	Multimeter	81480264	6/7/2010	6/30/2011
620-200	Temperature Calibrator	7968103	1/11/2010	1/31/2011
620-530	Temperature Calibrator	9234019	6/7/2010	6/30/2011
7030850	Tachometer	7030850	1/11/2010	1/31/2011
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-203	Pressure Reference (40K)	926312	2/18/2010	2/28/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
50	50	50.0
100	100	100.0
200	200	200.0
300	300	300.0
400	400	400.0

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
5000	5.0	5.0	5000
10000	10.0	10.0	10000
15000	15.0	15.0	15000
20000	20.0	20.0	20000
22000	22.0	22.0	22000

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	150.9

Timer (minutes)	Display
2	2:00:02
4	4:00:10

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: General Gillespie G. G.

Date: 01/14/11

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CHANDLER ENGINEERING ISO 9001

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 7222

Serial Number: 470
Date Calibrated: 04/29/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-200	Temperature Calibrator	7968103	1/24/2011	1/31/2012
7030850	Tachometer	7030850	1/24/2011	1/31/2012
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
50	50	50.0
100	100	100.0
200	200	200.0
400	400	400.0

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
5000	5.0	5.0	5000
10000	10.0	10.0	10000
15000	15.0	15.0	15000
20000	20.0	20.0	20000
22000	22.0	22.0	22000

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	150.4

Timer (minutes)	Display
2	2:00:12
4	4:00:11

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: General Gillespie G. G.

Date: 04/29/11

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CHANDLER ENGINEERING **ISO 9001**

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 8240

Serial Number: 1179
Date Calibrated: 04/14/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-200	Temperature Calibrator	7968103	24/01/11	1/31/2012
7030850	Tachometer	7030850	1/24/2011	1/31/2012
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
50	50	50.0
100	100	100.0
200	200	200.0
400	400	400.0
600	600	600.1

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
5000	5.0	5.0	5000
10000	10.0	10.0	10000
15000	15.0	15.0	15000
20000	20.0	20.0	20000
30000	30.0	30.0	30000
40000	40.0	40.0	40000

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	150.4

Timer (minutes)	Display
2	2:00:12
4	4:00:08

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: General Gillespie G. G. Date: 04/14/11

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CHANDLER ENGINEERING **ISO 9001**

CALIBRATION CERTIFICATE

Manufacturer: Chandler Eng.
Model: 1200

Serial Number: 1090
Date Calibrated: 01/05/11

This certificate attests that this instrument has been calibrated under the standard conditions with standards traceable to the National Institute of Standards and Technology (NIST). Evidence of traceablity is maintained on file.

Identification Number	Description	Serial Number	Calibration Date	Calibration Due Date
620-201	Multimeter	81480264	6/7/2010	6/30/2011
620-200	Temperature Calibrator	7968103	1/11/2010	1/31/2011
620-530	Temperature Calibrator	9234019	6/7/2010	6/30/2011
7030850	Tachometer	7030850	1/11/2010	1/31/2011
620-207	Pressure Reference (60K)	1005406	6/29/2010	6/30/2011
620-203	Pressure Reference (40K)	926312	2/18/2010	2/28/2011
620-202	Stopwatch	91280889	12/9/2009	12/9/2011

Temperature Reference (°F)	Controller	Chart Recorder
50	50	N/A
100	100	
150	150	
200	200	

Tolerance per API Spec 10 (± 3.0°F / 1.7°C)

Pressure Reference (PSI)	Controller	Chart Recorder	Gauge
N/A	N/A	N/A	N/A

Tolerance per API Spec 10 (0.25% of full range at a minimum 25%,50% & 75% of full scale)

Motor Speed (RPM)	Tachometer
Tolerance per API Spec 10 (150 ± 15 rpm)	150.4

Timer (minutes)	Display-L	Display-R
2	2:00:03	2:00:09
4	4:00:00	4:00:04

Tolerance per API Spec 10 (± 30 sec/hour)

Calibrated By: General Gillespie G. G. Date: 01/05/11

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SIN E 44073

Testing Equipment for Construction Materials
HUMBOLDT

Certificate of Compliance

to specifications of
ASTM — American Society for Testing and Materials
ANSI — American National Standards Institute
ISO — International Standards Organization

This is to certify that the openings in the wire cloth of this test sieve have been checked through advanced optical technology to ensure conformity to ASTM Specification E-11. The dimensions of the test sieve frame have also been checked with precision gauges to ensure conformity to these same specifications.

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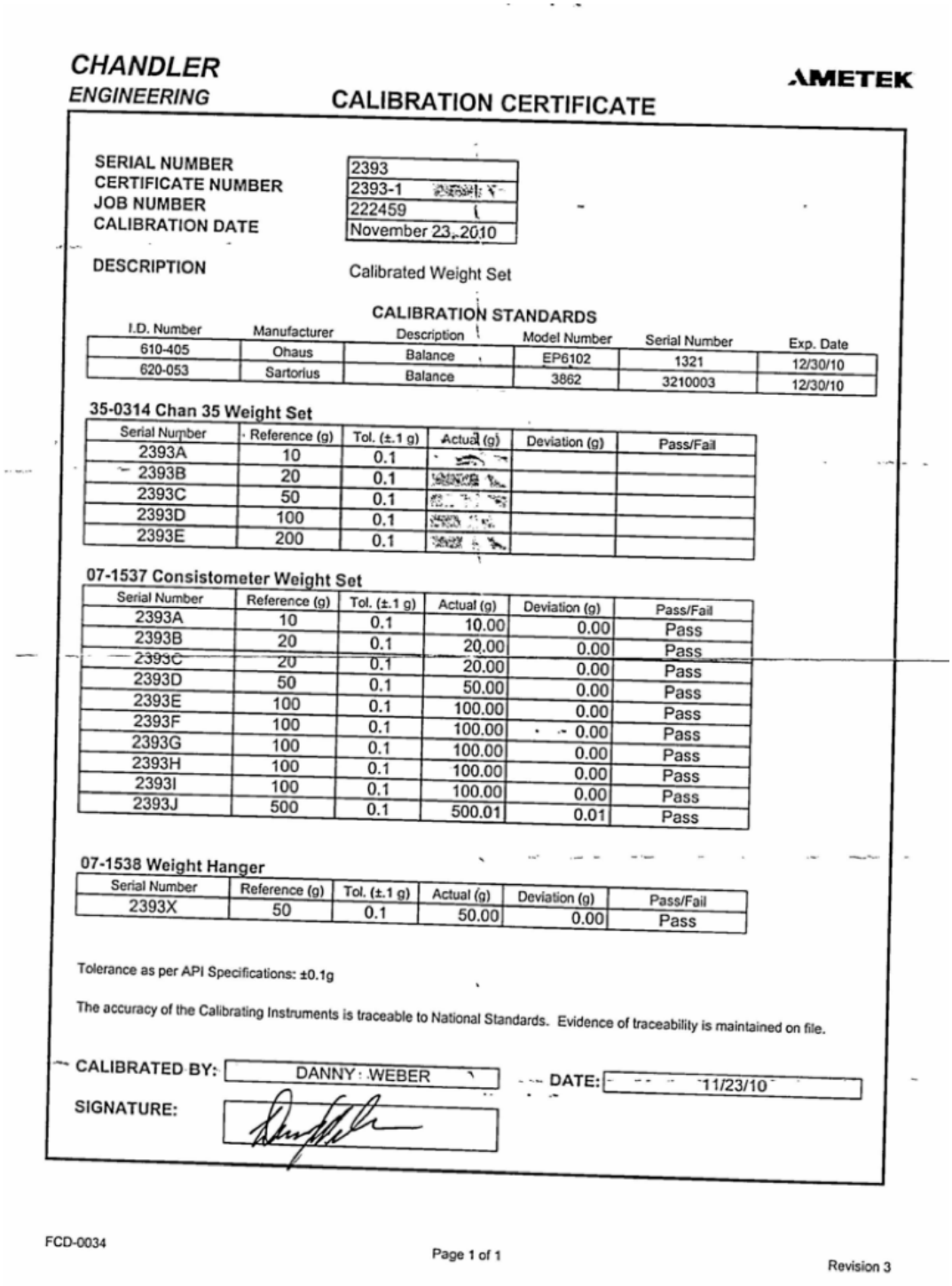

CHANDLER ENGINEERING

AMETEK

CALIBRATION CERTIFICATE

SERIAL NUMBER	2393
CERTIFICATE NUMBER	2393-1
JOB NUMBER	222459
CALIBRATION DATE	November 23, 2010

DESCRIPTION: Calibrated Weight Set

CALIBRATION STANDARDS

I.D. Number	Manufacturer	Description	Model Number	Serial Number	Exp. Date
610-405	Ohaus	Balance	EP6102	1321	12/30/10
620-053	Sartorius	Balance	3862	3210003	12/30/10

35-0314 Chan 35 Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2393A	10	0.1			
2393B	20	0.1			
2393C	50	0.1			
2393D	100	0.1			
2393E	200	0.1			

07-1537 Consistometer Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2393A	10	0.1	10.00	0.00	Pass
2393B	20	0.1	20.00	0.00	Pass
2393C	20	0.1	20.00	0.00	Pass
2393D	50	0.1	50.00	0.00	Pass
2393E	100	0.1	100.00	0.00	Pass
2393F	100	0.1	100.00	0.00	Pass
2393G	100	0.1	100.00	0.00	Pass
2393H	100	0.1	100.00	0.00	Pass
2393I	100	0.1	100.00	0.00	Pass
2393J	500	0.1	500.01	0.01	Pass

07-1538 Weight Hanger

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2393X	50	0.1	50.00	0.00	Pass

Tolerance as per API Specifications: ±0.1g

The accuracy of the Calibrating Instruments is traceable to National Standards. Evidence of traceability is maintained on file.

CALIBRATED BY: DANNY WEBER DATE: 11/23/10

SIGNATURE:

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15730 Park Row, Ste 400
Houston, TX 77084
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CHANDLER ENGINEERING AMETEK

CALIBRATION CERTIFICATE

SERIAL NUMBER	2407
CERTIFICATE NUMBER	2407-1
JOB NUMBER	222459
CALIBRATION DATE	January 10, 2011

DESCRIPTION Calibrated Weight Set

CALIBRATION STANDARDS

I.D. Number	Manufacturer	Description	Model Number	Serial Number	Exp. Date
610-405	Ohaus	Balance	EP6102	1321	06/30/11
620-053	Sartorius	Balance	3862	3210003	06/30/11

35-0314 Chan 35 Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2407A	10	0.1			
2407B	20	0.1			
2407C	50	0.1			
2407D	100	0.1			
2407E	200	0.1			

07-1537 Consistometer Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2407A	10	0.1	10.00	0.00	Pass
2407B	20	0.1	20.00	0.00	Pass
2407C	20	0.1	20.00	0.00	Pass
2407D	50	0.1	50.00	0.00	Pass
2407E	100	0.1	100.07	0.07	Pass
2407F	100	0.1	100.00	0.00	Pass
2407G	100	0.1	100.00	0.00	Pass
2407H	100	0.1	100.02	0.02	Pass
2407I	100	0.1	100.02	0.02	Pass
2407J	500	0.1	500.04	0.04	Pass

07-1538 Weight Hanger

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2407X	50	0.1	50.00	0.00	Pass

Tolerance as per API Specifications: ±0.1g

The accuracy of the Calibrating Instruments is traceable to National Standards. Evidence of traceability is maintained on file.

CALIBRATED BY: DANNY .WEBER DATE: 01/10/11

SIGNATURE:

FCD-0034 Page 1 of 1 Revision 3

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CHANDLER ENGINEERING

AMETEK

CALIBRATION CERTIFICATE

SERIAL NUMBER	2409
CERTIFICATE NUMBER	2409-1
JOB NUMBER	222459
CALIBRATION DATE	January 10, 2011

DESCRIPTION: Calibrated Weight Set

CALIBRATION STANDARDS

I.D. Number	Manufacturer	Description	Model Number	Serial Number	Exp. Date
610-405	Ohaus	Balance	EP6102	1321	06/30/11
620-053	Sartorius	Balance	3862	3210003	06/30/11

35-0314.Chan 35 Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2409A	10	0.1			
2409B	20	0.1			
2409C	50	0.1			
2409D	100	0.1			
2409E	200	0.1			

07-1537 Consistometer Weight Set

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2409A	10	0.1	10.00	0.00	Pass
2409B	20	0.1	20.00	0.00	Pass
2409C	20	0.1	20.00	0.00	Pass
2409D	50	0.1	50.00	0.00	Pass
2409E	100	0.1	99.98	-0.02	Pass
2409F	100	0.1	100.03	0.03	Pass
2409G	100	0.1	100.05	0.05	Pass
2409H	100	0.1	100.06	0.06	Pass
2409I	100	0.1	100.05	0.05	Pass
2409J	500	0.1	500.02	0.02	Pass

07-1538 Weight Hanger

Serial Number	Reference (g)	Tol. (±.1 g)	Actual (g)	Deviation (g)	Pass/Fail
2409X	50	0.1	50.00	0.00	Pass

Tolerance as per API Specifications: ±0.1g

The accuracy of the Calibrating Instruments is traceable to National Standards. Evidence of traceability is maintained on file.

CALIBRATED BY: DANNY WEBER DATE: 01/10/11

SIGNATURE:

FCD-0034 Page 1 of 1 Revision 3

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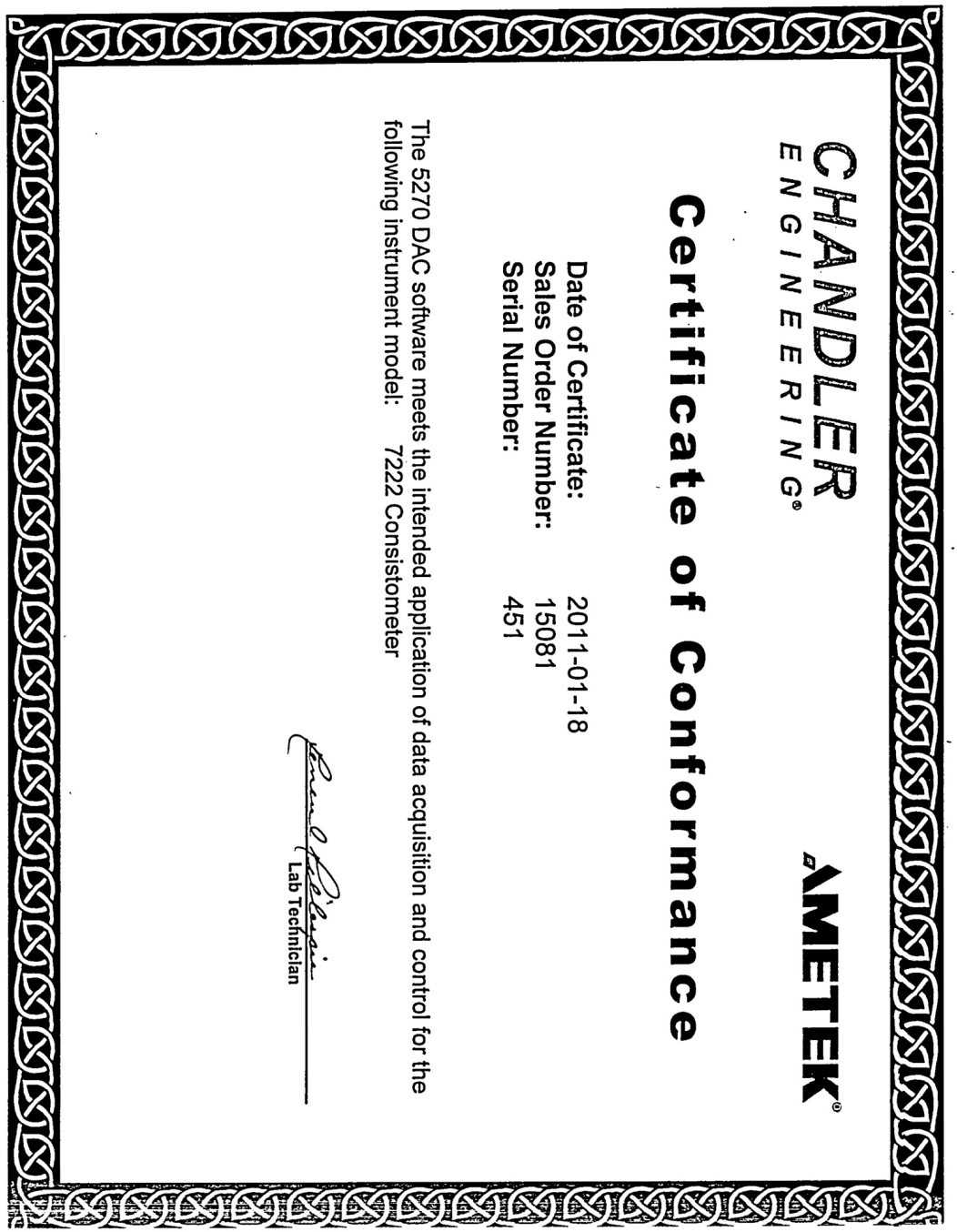

CHANDLER ENGINEERING®

AMETEK®

Certificate of Conformance

Date of Certificate: 2011-01-18
Sales Order Number: 15081
Serial Number: 451

The 5270 DAC software meets the intended application of data acquisition and control for the following instrument model: 7222 Consistometer

Lab Technician

Oilfield Testing & Consulting

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COOPER INSTRUMENTS & SYSTEMS

Tel: 540-349-4746
www.cooperinstruments.com

CERTIFICATE OF CALIBRATION

Transducer Model:	LKCP 410		
Serial Number:	345684		
Capacity:	50000	LBS	
Calibration Date:	1/14/2011		
Excitation:	10	VDC	
Calibration Factor:	2.1252	MV/V	Compression
Input Resistance:	353	Ohms	
Output Resistance:	353	Ohms	
Temperature Range:	60-160	Degrees F	

An output of **1.4666** **MV/V** is induced when
A shunt resistor of 60K ohms is applied across (-) Excitation and (-) Signal.

Special Instructions:

Wiring Code	RED	**(+)Excitation**
	BLACK	**(-) Excitation**
	WHITE	**(+)Signal**
	GREEN	**(-) Signal**

This is to certify that the following instrument was calibrated using loading equipment traceable to NIST through one or more of standards. The unit was found to meet or exceed all published sales literature accuracy specifications.

Date of Shipment: 1/26/2011 Re-Calibration Date: 1 year after Shipment Date

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Fax: 281-579-1975
www.oftesting.com

SSI SMART SENSORS INC.

CERTIFICATE OF CONFORMANCE

Date:	March 30, 2011
Customer:	Chandler Engineering
Purchase Order#:	BT13090
Serial #:	24970-4-3
Item #:	4
SSI Job#	24970

This is to certify that the material supplied on this purchase order meets all the requirements of the order. 100% Quality Assurance was performed on each piece for compliance to standard specification. This type J thermocouple is per ANSI MC96.1 special limits of error +/- 1 degree C (+/- 2 degrees F) up to 277 degrees C (530 degrees F). Pressure testing was performed at the following rates:

Per 07-0437-02 REV. D– pressure tested to 60,000 psig @ ambient temperature.

Dave Adkins

Temperature Measurement...The Right Way!

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