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October 26, 2010

NATIONAL COMMISSION ON THE
BP DEEPWATER HORIZON OIL SPILL AND OFFSHORE DRILLING
CEMENT TESTING RESULTS

MR. SAMBHAV N. "SAM" SANKAR

This report summarizes the results of the testing conducted in the cementing laboratory at Chevron's Briarpark facility at the request of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling.

We conducted these tests using samples of cement and additives supplied by Halliburton and sent to the Chevron laboratory at the request of the Commission. To our knowledge, these materials were supplied by Halliburton as representative of materials used on the Deepwater Horizon but are neither bulk plant samples nor rig samples from the actual job.

The mud sample used in the contamination testing described in this report was supplied by MI Swaco at the Commission's request. It is a sample of drilling fluid from an actual drilling operation (i.e. not laboratory-prepared nor taken from a freshly-built mud in a liquid mud plant). MI Swaco supplied an analysis (mud check) with the sample, and a similar suite of tests were run in the Chevron drilling fluids laboratory to confirm the fluid characteristics. Both the MI Swaco results and the Chevron results compare reasonably well with the field mud check #79 dated April 19, 2010. Copies of the mud reports are contained in the Appendix.

The testing was based on the Halliburton laboratory report dated April 12, 2010 and contained in Appendix J of the BP report *Deepwater Horizon Accident Investigation Report, September 8, 2010,* Appendix J. Most of the tests were conducted using multiple protocols. API and ISO cementing standards are, for the most part, technically identical standards which allow latitude in test procedures. The Halliburton report does not contain sufficient information to determine the exact test protocol used in the Halliburton lab in all cases. Halliburton elected not to provide additional information clarifying its testing protocols that was requested through the Commission. Therefore, a range of test procedures was selected to encompass a variety of test conditions.

Many of the test results were in reasonable agreement with those reported by Halliburton. However, we were unable to generate stable foam with any of the tests described in Section 9 of this report.

Craig Gardner

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Section 1: Thickening Time

Two test schedules were used:

(1) 135°F reached in 83 minutes with 14,458 psig

(2) 135°F reached in 230 minutes with 14,458 psig

Schedule (1) is taken from the Halliburton report. In schedule (2), the time-to-temperature is lengthened to correspond to the time-to-bottom from the Opticem simulation dated April 18, 2010.

Table 1: Thickening Time Test Results

Test Schedule	Laboratory	Test Identifier	30 B_c (hh:mm)	40 B_c (hh:mm)	50 B_c (hh:mm)	70 B_c (hh:mm)
1	**Halliburton**	**73909/2**	**07:25**	**07:34**	**07:36**	**07:37**
1	Chevron	100432-6	08:11	08:14	08:16	08:18
2	Chevron	100431-5	08:14	08:17	08:18	08:20

Section 2: Mud Balance

Density of the base slurry was confirmed with a pressurized fluid density balance using the method described in Clause 6 of API RP10B-2/ISO10426-2.

Table 2: Pressurized Mud Balance Results

Laboratory	Test Identifier	Slurry Density (lbm/gallon)
Halliburton	**811529**	**16.7**
Chevron	100431-5 foamed weigh up sheet	16.7

Section 3: Mixability

The slurry was prepared according to Clause 5 of API RP10B-2/ISO10426-2.

Halliburton's report rated the slurry mixability as a "4" on a scale of 1 to 5, with zero being assigned to a slurry which is deemed unmixable.

Chevron rated the slurry as mixable using a combination of factors:

The dry powder was incorporated into the mix fluid easily in 12-18 seconds depending on the particular test.
The blender consistently achieved 12,000 rpm and good slurry vortices were observed. However, sedimentation was noted in the blender bowl.
The initial consistency of the slurry was 13 - 18 B_c depending on the particular test. For context, Chevron uses an initial consistency value of 35 B_c (maximum) as a mixability "flag".

Section 4: Fluid Loss and Free Fluid Testing

Halliburton did not report these tests. They were included in the present testing program because un-foamed cap and shoe track slurries were pumped on the job.

The slurries were conditioned in a high-temperature, high-pressure consistometer according to the same test schedules used for the thickening time testing.

The fluid loss tests were conducted according to API RP10B-2/ISO 10426-2 Clause 10, using a "short cell" fluid loss apparatus.

The free-fluid tests were conducted according to API RP10B-2/ISO 10426-2 Clause 15.5, using the ambient temperature static period. The free-fluid tests were conducted with the 250-mL graduated cylinder inclined at 45 degrees and 90 degrees (vertical). The results are found in Table 3.

Table 3: Fluid Loss and Free Water Results

Test Schedule	Conditioning	Test Identifier	Fluid Loss (mL/30 min)	Free Fluid (90° vertical)	Free Fluid (45° angle)
1	HTHP	100432-6	578	1.6 percent	2 percent
2	HTHP	100431-5	456	zero	Channel present
1	Atmospheric	100432-6	Not Run	Settling[1]	8.8 percent

[1]Slurry sampled from the top of the graduate weighed 15.96 lbm/gal. Slurry sampled from the bottom of the graduate weighed 17.4 lbm/gal

Section 5: UCA Compressive Strength

The sonic compressive strength of the base slurry was measured according to Clause 8 of API RP10B-2/ISO10426-2, using an ultrasonic cement analyzer. Three testing schedules were used:

1) Heat to 135°F in 83 minutes with 14,458 psig (thickening time schedule), condition for a total elapsed time of 3 hours from initial application of temperature and pressure, remove from the consistometer and place in a pre-heated 135°F UCA and

heat from 135°F to 210°F in 4 hours with a confining pressure of 14,458 psig. Data are presented using both algorithm B and the foamed-cementing algorithm.

2) Heat to 135°F in 83 minutes with 14,458 psig (thickening time schedule), condition for a total elapsed time of 3 hours from initial application of temperature and pressure, remove from the consistometer and place in a pre-heated 135°F UCA and heat from 135°F to 180°F in 4 hours with a confining pressure of 14,458 psig (this procedure was intended to allow a comparison with the crushed foamed cube data). Data are presented using both algorithm B and the foamed-cementing algorithm.

3) The slurry was conditioned for 3 hours in an atmospheric consistometer at 135°F. Starting with a cold cup, place in the atmospheric consistometer and ramp temperature to 135°F as quickly as possible. Remove from the consistometer and place in a pre-heated 135°F UCA and heat 135°F to 210°F in 4 hours with a confining pressure of 14,458 psig. Data are presented using both algorithm B and the foamed-cementing algorithm.

The results are summarized in the Table 4. Copies of the test charts are found in the Appendix. The effect of drilling fluid contamination on sonic strength development is described in Section 11.

Table 4: UCA Compressive Strength Development

Laboratory	Schedule	Pressure	50 psi (hr:min)	500 psi (hr:min)	12 hour (psi)	24 hour (psi)	48 hour (psi)	Final (psi)
Halliburton	**Circulate 3 hours before pouring**	**14,458**	**08:12**	**08:40**	**2301**	**2966**	**3099**	**---**
Chevron	Protocol 1 (B algorithm)	14,458	05:57	06:24	2945	3550	3831	3918@108 hrs
Chevron	Protocol 1 (foam algorithm)	14,458	06:01	06:40	1040	1155	1206	1221@108 hrs
Chevron	Protocol 2 (B algorithm)	14,458	09:58	10:47	1302	3001	3541	3760@108 hrs
Chevron	Protocol 2 (foam algorithm)	14,458	10:03	11:25	643	1050	1153	1193 @ 108 hrs
Chevron	Protocol 3 (B algorithm)	14,458	06:31	06:59	3152	3976	4481	4575 @ 73 hrs
Chevron	Protocol 3 (foam algorithm)	14,458	06:35	07:15	1078	1232	---	1232 @ 24 hrs

Section 6: Crush Compressive Strength

The plan was to replicate the crushed cube compressive strength values reported in the Halliburton report with the test ID 806069.

A Humboldt Manufacturing Company Model 2820 3-gang, 2-inch brass mold was prepared according to API RP10B-4/ISO 10426-4. The molds were sealed with gasket material to allow curing in an atmospheric pressure water bath at 180°F.

After 48 hours curing, the samples were removed from the molds and were observed to have lost approximately one-half inch of their original two-inch height (photographs in Appendix). Therefore, no further tests were conducted.

Section 7: FYSA Viscosity Profile and Gel Strength

The Fann Yield Stress Adapter is a proprietary Halliburton test device that replaces the bob and sleeve in a Fann 35-type rotational viscometer. The device and test method are described in SPE 133050, *Techniques for the Study of Foamed Cement Rheology*, Olowolagba and Brenneis, 2010.

This test was not performed during the present study because a stable foam could not be obtained as described in the Section 9 on foamed stability testing. Table 5 contains only Halliburton-reported results.

Table 5: FYSA Viscosity Profile

Laboratory	Temperature	600 rpm	300 rpm	200 rpm	100 rpm	60 rpm	30 rpm	6 rpm	3 rpm
Halliburton (Test ID 806074)	**80°F**	**14**	**7**	**5**	**3**	**1**	**1**	**1**	**1**

6D=1, 3D=1

The FYSA viscosity profile is measured using a different instrument and procedure than the rotor-and-bob configuration described in API RP10B-2/ISO 10426-2, Clause 12. The FYSA viscosity profile cannot be compared with the rheological results that follow in Section 8, Table 6 because of the differences in test methodology and instruments.

Section 8: Rheological Profile Measurements

The rheological values reported in Table 6 were measured using a direct-reading rotational viscometer as described in API RP10B-2/ISO 10426-2, Clause 12. A variety of conditioning methods and measurement sequences were used.

Table 6: Rheological Profile Measurements

Laboratory	Test Conditions	600 rpm	300 rpm	200 rpm	100 rpm	60 rpm	30 rpm	20 rpm	10 rpm	6 rpm	3 rpm
Halliburton (ID 806075)	**Note 1**	**180**	**84**	**56**	**28**	**26**	**8**	**6**	**4**	**2**	**2**
Chevron	Note 2	164	78	52	26	16	8	6	4	2	2
Chevron	Note 2 (rerun)	180	80	58	26	16	8	6	4	2	2
Chevron	Note 3	136	69	45	25	16	10	8	6	6	4
Halliburton (ID 806075)	**Note 4**	**130**	**56**	**40**	**20**	**12**	**8**	**6**	**4**	**4**	**2**
Chevron	Note 5	124	57	38	23	16	11	9	8	6	4
Chevron	Note 6	176	92	64	36	24	14	12	8	6	4
Chevron	Note 7	120	76	56	32	22	14	12	10	8	6

[1]80°F – Slurry Conditioning Unknown
[2] 80°F – Slurry as mixed – no conditioning, measure and record 300 rpm to 3 rpm readings , then measure and record 600 rpm reading
[3] 80°F – Slurry as mixed – no conditioning, measure and record 3 rpm to 300 rpm to 3 rpm readings , then measure and record 600 rpm reading. Report the average values for the 3 rpm to 300 rpm readings. (RP10B-2/ISO 10426-2 Clause 12)
[4]135°F – Slurry Conditioning Unknown
[5]135°F Condition for 30 minutes in atmospheric consistometer. Take measurements from 3 rpm to 300 rpm to 3 rpm and average. Take 600 rpm reading last
[6]135°F Condition in an HTHP consistometer for 83-minute heat-up plus 30 minutes additional conditioning. Take measurements from 600 rpm to 3 rpm
[7]135°F Condition in HTHP consistometer for 230-minute heat-up. Take measurements from 600 to 3 rpm

Section 9: Foam Mixing and Stability

A series of nine tests were conducted under varying conditions as described below. Each test consisted of multiple measurements. API RP10B-4 and ISO 10426-4 are silent on the matter of slurry conditioning so several conditioning methods were used. None of the tests produced a stable foam. Foamed stability was assessed using several methods:

a) Visual inspection of the fluids: base slurry and foamed slurry
b) Density measurements of slurry sampled from the blender
c) Density measurement of slurry sampled from graduated cylinder after a 2-hour quiescent period according to API RP10B-4/ISO 10426-4 Clause 9.3.1.
d) Density measurement by Archimedes' Principle of samples cured in PVC molds at 180°F according to API RP10B-4/ISO 10426-4 Clause 9.3.3.

The tests are described briefly below and the density measurements summarized in Table 7.

Test 1. Target design foamed density: 14.5 lbm/gal. The slurry was foamed immediately after mixing (no conditioning). The slurry was foamed with a multi-blade assembly (API RP10B-4/ISO 10426-4 Clause 5) for 15 seconds @ 12,000 rpm. A density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be below the designed density. Settling was noted in both the base slurry and the foam so the stability tests in the graduated cylinder and the PVC tubes were not performed. Density measurements were recorded from slurry sampled from the top, bottom and middle of the mixing blender. The results are reported in Table 7.

Test 2. Target design foamed density: 14.5 lbm/gal. Because of the instability noted in the base slurry and foamed slurry in Test 1, the test procedure was modified. Slurry quantities were adjusted to allow mixing and foaming in the same blender. This eliminated the need to transfer slurry from the mixing blender to the foaming blender thereby avoiding the effects of sedimentation in the base slurry. The slurry was foamed for 15 seconds @ 12,000 rpm using the single blade assembly (API RP10B-4/ISO 10426-4 Clause 5). A density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be below the designed density. Settling was again noted in both the base slurry and the foam, so the stability tests in the graduated cylinder and the PVC tubes were not performed. Density measurements were recorded from slurry sampled from the top, bottom and middle of the mixing blender. The results are reported in Table 7.

Test 3. This was a repeat of Test 1 except that the graduated-cylinder and PVC-mold stability tests were performed. Target design foamed density: 14.5 lbm/gal. The slurry was foamed with a multi-blade assembly (API RP10B-4/ISO 10426-4 Clause 5) for 15 seconds @ 12,000 rpm. A density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be below the designed density. The stability tests in the graduated cylinder and PVC molds were conducted. The results are shown in Table 7.

Test 4. This was the first test to include slurry conditioning. The target design density was 14.5 lbm/gal. The slurry was conditioned on an atmospheric consistometer for 20 minutes at 110°F (one of the schedules reported by Cementing Solution Inc. for their tests – Appendix K of the BP report). The slurry was foamed with a multi-blade assembly for 15 seconds @ 12,000 rpm. The density was found to be low. Settling was observed in the base and foamed slurry. The stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7.

Because the measured foam density continued to be low, the laboratory calculations and the density of the base slurry were verified. API RP10B-4/ISO 10426-4 Clause 7.2 describes a method for determining an "offset factor" if the foam density is less than the design density. In this case, the offset factor was 0.4 lbm/gal. In an attempt to attain a foam density of 14.5 lbm/gal, the target foam density was 14.9 lbm/gal in subsequent tests.

Test 5. This test was performed using the offset factor calculated during Test 4. In an attempt to attain a foam density of 14.5 lbm/gal, the target foam density was 14.9 lbm/gal. The slurry was foamed immediately after mixing without conditioning. A density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be 14.9 lbm/gal.

The density attained matched the calculated value (14.9 lbm/gal) but failed to exhibit the expected drop from the offset factor (14.5 lbm/gal was expected). API RP10B-4/ISO 10426-4 Clause 7.2 (j) recommends redesigning the base slurry if the offset factor does not give the desired result. It was decided to continue with the 14.9 lbm/gal foam density for future tests as this was the value reported in the Halliburton report (specific gravity = 1.8).

The stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7.

Test 6. This test began with conditioning the slurry on an atmospheric consistometer for three (3) hours at 135°F. The conditioning period matched the time reported in the Halliburton report. The offset factor density of 14.9 lbm/gal was used. The slurry was foamed with a multi-blade assembly for 15 seconds @ 12,000 rpm. Slight settling of the base slurry was noted. The density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be 14.7 lbm/gal. Stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7. The density measurements from the graduated-cylinder samples were unusually high so it was decided to re-run Test 6.

Test 7. This was a repeat of Test 6. The test began with conditioning the slurry on an atmospheric consistometer for three (3) hours at 135°F. The conditioning period matched the time reported in the Halliburton report. The offset factor density of 14.9 lbm/gal was used. The slurry was foamed with a multi-blade assembly for 15 seconds @ 12,000 rpm. Slight settling of the base slurry was noted. The density check of a sample of the foamed cement in a plastic cube of known volume again showed the density to be 14.7 lbm/gal. Stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7. The results of Test 7 are in reasonable agreement with those of Test 6.

Density measurements from the graduated-cylinder samples were again high but a careful examination of the volume in the graduated cylinder indicated an approximate 10 mL reduction at the end of the 2 hour quiescent period. This reduction alone would account for a density increase from the initial 14.7 lbm/gal to 15.3 lbm/gal.

Test 8. This was a repeat of Test 7 using a mill sample of Lafarge Class H cement obtained from the manufacturer rather than the cement sample from Halliburton. The additives supplied by Halliburton for the Commission testing were used so the only change was the cement sample.

The test began with conditioning the slurry on an atmospheric consistometer for three (3) hours at 135°F. The conditioning period matched the time reported in the Halliburton report. The offset factor density of 14.9 lbm/gal was used. The slurry was foamed with a multi-blade assembly for 15 seconds @ 12,000 rpm. The density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be 14.0 lbm/gal. Stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7. The performance was not improved by the change in cement sample.

Test 9. Test 9 was a repeat of Test 6 and Test 7 and achieved similar results. The test began with conditioning the slurry on an atmospheric consistometer for three (3) hours at 135°F. The conditioning period matched the time reported in the Halliburton report. The offset factor density of 14.9 lbm/gal was used. The slurry was foamed with a multi-blade assembly for 15 seconds @ 12,000 rpm. Slight settling of the base slurry was noted. The density check of a sample of the foamed cement in a plastic cube of known volume showed the density to be 14.64 lbm/gal. Stability tests in the graduated cylinder and PVC molds were conducted. The results are reported in Table 7. Tests 6, 7, and 9 are in reasonable agreement.

Table 7: Foamed Cement Stability Testing

Test Number	Density from Blender lbm/gal			Density from Graduated Cylinder lbm/gal			Density from PVC Molds lbm/gal			
	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Very Bottom[1]
1	12.77	13.38	14.06	NR	NR	NR	NR	NR	NR	NR
2	13.89	12.95	14.16	NR	NR	NR	NR	NR	NR	NR
3	NR[2]	NR	NR	10.23	12.21	13.34	11.7	13.30	14.10	NR
4	13.82	NR	14.13	13.67	14.14	14.41	11.96	11.84	11.80	12.13
5	14.95	NR	NR	13.70	14.22	14.98	13.97	13.82	13.96	14.73
6	14.66	NR	NR	15.85	16.09	16.30	12.80	12.86	13.07	12.51
7	14.71	NR	NR	14.99	16.11	16.43	12.16	13.15	13.79	13.70
8	14.04	NR	NR	9.80	15.84	16.83	14.05	18.27	19.14	19.87
9	14.64	NR	NR	15.75	16.25	16.51	12.91	13.39	14.17	14.63

[1]The notation "very bottom" refers to the portion of cement contained predominately in the end cap of the PVC fixture.
[2]NR = Not Run

Section 10: Effect of Mud Contamination on Un-foamed Slurry Sonic Strength Development

The effect of drilling-fluid contamination on unfoamed slurry sonic strength development was measured according to API RB10B-2/ISO 10426-2 Clause 16.5, using an ultrasonic cement analyzer (UCA) at 210°F and 14,458 psig. Drilling-fluid concentrations of 0%, 5%, 10%, 15%, 20%, 25%, and 30% by volume were used. Note that the dilutions are noted "by volume" but were prepared in the laboratory by mass for greater accuracy (rather than mixing by volume using beakers or similar containers). The final sonic strength decreased as drilling fluid contamination increased, but the time required to achieve 100 psig sonic strength was not greatly affected.

Table 8: Drilling Fluid Contamination of Base Slurry

Contamination %	50 psi (hr:min)	100 psi (hr:min)	500 psi (hr:min)	12 hour (psi)	24 hour (psi)	48 hour (psi)	Final (psi)
0	2:49	8:43	9:21	2584	3718	4414	4210
5	4:02	7:28	8:04	2170	2792	3090	3160
10	5:07	7:42	8:24	2089	2612	2763	2763
15	8:36	8:45	9:26	1203	1541	1649	1717
20	8:09	8:16	9:12	890	1071	1126	1117
25	8:04	8:12	---	271	322	343	345
30[1]	3:55	7:25	8:37	717	814	837	828

[1]The 30 percent contamination test was repeated 3 times because it was difficult to maintain a homogenous mixture of drilling fluid and cement slurry at this contamination level. The strength results did not follow the final strength trend.
[2]500 psi sonic strength was not obtained at this contamination level.

Section 11: Stability of Foamed Cement with Mud or Spacer Contamination

The original plan included evaluating the effect of drilling fluid or spacer contamination on foamed cement stability by two methods:

1) Stirring 5, 10, and 15 percent volume of drilling fluid or spacer into the foamed cement slurry in a manner similar to the CSI testing contained in the BP report.

2) Coating the interior of the 250-mL graduated cylinder used for the foam stability test with mud or spacer, then adding the foamed cement and evaluating the effect.

Neither test series was conducted due to the inability to generate stable foams.

Section 12: Static Gel Strength Development

The static gel strength of the base slurry was tested using two methods:

Static Gel Strength Analyzer (ultrasonic method). The slurry was conditioned in an HTHP consistometer. The slurry was heated to 135°F in 83 minutes with 14,458 psig as described in ISO 10426-6. Test conditions were maintained at 135°F and 14,458 psig for 162 minutes, for a total of 245 minutes (Job Placement Time). The slurry was then removed and placed in a 135°F pre-heated SGSA with 14,458 psig.

Multiple Analysis Cement Slurry (MACS II). The slurry was conditioned in the MACS II. The slurry was heated to 135°F in 83 minutes with 14,458 psig as described in API RP10B-6/ISO 10426-6. Test conditions were maintained at 135°F and 14,458 psig for 162 minutes, for a total of 245 minutes (Job Placement Time) before beginning the static gel strength development period.

Table 9: Static Gel Strength Development

Instrument	Time to 100 lbf/100 ft^2 gel strength	Time to 500 lbf/100 ft^2 gel strength	Transition Time
SGSA	2:17:30	3:44:00	1:26
MACS[1]	4:04:00	4:41:00	0:37

[1]The MACS data may not be correct due to the sedimentation exhibited by the base slurry.

Appendix

MI SWACO — bp — SYNTHETIC-BASED MUD REPORT No. 79

Operator :	BP Exploration	Field/Area :	MC 252 #1	Depth/TVD :	18360 ft / 18349 ft
Report For :	B.Kalhuza/D.Vidrine	Description :	OCS-G 32306	Date :	4/19/2010
Well Name :	MACONDO	Location :	MC 252 #1	Spud Date :	
Contractor:	Transocean	Water Depth :	4992 ft	Mud Type :	Rheliant
Report For :	J.Harrel	Rig Name :	Horizon	Activity :	Displace Cement

DRILLING ASSEMBLY	CASING (*TVD)
5068 ft, 6.625-in DP	22.-in @8001 ft (8001 TVD)
ft, -in	18.-in L @8969 ft (8969 TVD)
ft, -in	16.-in @11585 ft (11585 TVD)
ft, -in	13.625-in L @13145 ft (13134 TVD)
ft, -in	11.875-in L @15113 ft (15103 TVD)
ft, -in	9.875-in L @17173 ft (17162 TVD)
Nozzles 14x4 1/32"	7.-in L @18312 ft (18301 TVD)
Bit 8.5-in Hughs HC408XC	

MUD VOLUME (bbl)	
Hole	Active Pits
2538	1859
Total Circulating Volume	3647
Depth Drilled Last 24hr	ft
Volume Drilled Last 24hr	bbl

CIRCULATION DATA		
Pump Make	EMSCO 2200	EMSCO 2200
Pump Liner x Stk	6x15 in	6x15 in
Pump Capacity gal/stk	5.342	5.342
Pump stk/min	0@97%	0@97%
Flow Rate		gal/min
Pump Pressure		psi
Bottoms Up		
Total Circulation		

MUD PROPERTIES

Sample From		Active 21:00	Active 8:00	0:00	0:00
FlowLine Temp	°F	NA	NA		
Depth/TVD	ft	18360/18349	18360/18349	/	/
Mud Weight	lb/gal	14.0@80	14.0@78	.0@	.0@
Funnel Viscosity	s/qt	94	93		
Rheology Temp	°F	150	150		
R600/R300		71/43	70/42	/	/
R200/R100		32/20	32/21	/	/
R6/R3		10/9	10/9	/	/
PV	cP	28	28		
YP	lb/100ft²	15	14		
10s/10m/30m Gel	lb/100ft²	14/23/29	15/24/29	//	//
API Fluid Loss	cc/30min	–	–		
HTHP Fluid Loss	cc/30min	2.4@250	2.4@250	.0@	.0@
Cake APT/HT	1/32"	–/1	–/1	/	/
Unc Ret Solids	%Vol	27	27		
Correct Solids	%Vol	26.15	26.06		
Synthetic	%Vol	52.5	52.5		
Uncorr Water	%Vol	20.5	20.5		
Synthetic/Water Ratio		72/28	72/28	/	/
Alkal Mud (Psm)		0.9	0.8		
Cl- Whole Mud	mg/L	27000	26000		
Salt	%Wt	17.09	16.56		
Lime	lb/bbl	1.17	1.04		
Emul Stability		248	205		
Current Angle	degrees	–			
MWD Tool Temp	deg F	–			
PWD ECD	ppg	–			
Riser Boost	gpm	–			
LCS0/Lepto	Y/N	No/No			
Calib Scales	Y/N	Yes	Yes		
SST	ppb	21	21		
PPT	spurt/ml	.6/5.4	.6/5.4		
Reserve Volume	bbl	2011			

PRODUCTS USED Last 24 hr

Products	Size	Amount
ENGINEERING SERVICE	1. EA	4
NAFROC COMPLIANCE ENGINEERING	EA	1
SYNTHETIC B 2	1. GA	675

SOLIDS CONTROL EQUIPMENT Last 24 hr

Type	Model/Size	Hrs Used
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Brandt Shale Shaker	40/165/165	
Mud Cleaner		
5500 Centrifuge		
Verti g Dryer	24	
75 HP Vacuum Unit		

MUD PROPERTY SPECS		Actual
Weight	14	14.0
Viscosity	80-110	94
Filtrate	<4	2.4

REMARKS AND TREATMENT

MISwaco Man Hours: 60 Cumulative Man Hours: 4600 Start Cards: 1 Cumulative Start Cards: 99 Max bbls discharged per hour: 0 bbls No losses while running casing. No losses while landing casing. No losses while circulating. No losses while cementing. No losses while displacing cement. 1033 bbls left behind pipe.

REMARKS

Run casing with no losses and got on landing string. RIH. RIH to 18312' with no losses. Problems with converting floats. Pressure up to 3150 psi and convert floats. Circulate with no losses. Flush choke and kill lines. R/U and perform cement job with no losses. Displace cement with SBM with no losses.

TIME DISTRIBUTION Last 24 hrs	
Rig Up/Service	
Drilling	
Tripping	
Non-Productive Tim	
Running Casing	14
Condition Hole	3
Cementing	7

MUD VOL ACCTG (bbl)	
Synthetic Added	
Water Added	150
Mud Received	
Mud Returned	4260
Shakers	
Centrifuge	
Formation	
Left in Hole	
Adjustment	
Cuttings Retention	
Displacement	
Running Casing	
Cementing	
Left Behind Pipe	1033
Tripping	
Boat Tank Bottoms	52

SOLIDS ANALYSIS	
Salt Wt%	17.09
Salt Conc	14.8
Adjusted Solids	26.02
Synthetic/Water Ratio	72/28
Average SG Solids	3.9
Low Gravity %	4.6
Low Gravity Wt.	42.09
High Gravity %	21.4
High Gravity Wt.	314.3

RHEOLOGY & HYDRAULICS	
np/na	0.723/0.228
Kp/Ka	0.504/6.623
Bit Pressure Loss/%	/ 1.
Bit HHP/HSI	/ 1.
Jet Velocity	
Va Pipe	
Va Collars	
Cva Pipe	232
Cva Collars	295
ECD at Shoe	
ECD at TD	14

M-I ENGR / PHONE	RIG PHONE	WAREHOUSE PHONE	DAILY COST	CUMULATIVE COST
L.Lindner/B.Manuel 0 B. Hardy/G.Jones/J.Guibedaux	(281)366-7749	800-391-3147	[redacted]	[redacted]

Figure 1: Rig Drilling Fluid Report

MI SWACO
A Schlumberger Company

Technical Services Laboratory – Houston, Texas
Synthetic-Base Mud Report
ID Code No. 101011F.006
Lab Master No. 20103419

Operator: M-I SWACO
Well Name: N/A
Location: Pelican Island

Report Date: October 11, 2010
Depth: N/A
Mud Type: RHELIANT

Mud Properties	*Initial*		
Mud Weight, ppg	14.19		
Rheo Temp, °F	40	100	150
600 rpm	228	96	74
300 rpm	122	56	46
200 rpm	85	42	35
100 rpm	47	26	24
6 rpm	10	8	10
3 rpm	8	7	9
PV, cps	116	40	28
YP, lbs/100 ft²	16	16	18
10 Second Gel	12	13	15
10 Minute Gel	25	28	25
HTHP @ 250°F, ml	2.4		
E.S., Vts @ 120°F	88		
Excess Lime, ppb	2.98		
Solids, % by Vol	28.5		
Oil, % by Vol	50.5		
Water, % by Vol	21.0		
Syn/Water Ratio	70.6/29.4		
Corrected Solids, %	27.6		
LGS, %	6.21		
LGS, ppb	56.47		
HGS, %	21.4		
HGS, ppb	314.52		
SG Wt Material	4.2		
$CaCl_2$, % by wt	10.0		
NaCl, % by wt	6.0		
Cl^-, Whole Mud	25000		

Report by: Robert Christian
Reviewed by: Randy Ray
Copies to: Daryl Cullum, Ole Iacob Prebensen, Mike Freeman

Figure 2: Drilling Fluid Report Supplied by MI Swaco with Commission Mud Sample

NAF Mud Check

Project #:	S10140	**Date:**	10/13/2010
Rig:	Pelican Island Plant Sample	**Rec'd Date**	10/13/2010
Prospect:	Tank #7	**Sample date:**	10/11/2010
Well:		**Depth:**	
Lease:		NAF g/ml =	0.790

Properties	**80°F**	**120°F**	**150°F**
Density, g/ml	1.698		
Density, lb/gal	14.15		
Fann dial readings:			
600 RPM	123	102	75
300 RPM	70	60	46
200 RPM	51	44	35
100 RPM	30	28	23
6 RPM	8	9	9
3 RPM	7	8	8
Plastic viscosity, cps	53	42	29
Yield point, lb/100 ft²	17	18	17
Gel strengths, lb/100 ft²			
10 second	14	16	16
10 minute	31	31	27
HTHP filtrate : 500 psig, cm³/30 min	4.0	@ 250°F	
Water, cm³ (HPHT)	0.00		
HTHP filter cake thickness, 32nd in	3		
Retort analysis:			
Solids, vol%	31		
NAF, vol%	49		
Water, vol%	20		
NAF/water ratio	71 / 29		
NAF mud alkalinity, (POM)	2.49		
Whole mud chlorides, mg/l	23,450		
Whole mud calcium, mg/l **(Filtered)**	11,080		
Electrical stability (VB) @ 120°F	89		
Lime content, lb/bbl	3.2		
Sand Content %	-----		

Electrical stability (VB) @ 150°F 85

Permeability Plugging Test	
Disk Grade, micron	35
Test Temp, deg F	250°F
Diff. Pressure, psi	2,500
Spurt Volume, ml	0.40
PPT Value, ml	4.40
PPT Cake, 32nd	3

Solids Analysis

Retort QA (100 +/- 3 %)	**99.24%**	**lb/bbl**	**Volume %**
Corrected solids			29.54
Average specific gravity of solids		3.62	
Low gravity solids		98.0	10.77
High gravity solids		275.8	18.76
Chloride content, lb/bbl			
Calcium chloride		10.78	
Total sodium chloride		2.22	
Soluble sodium chloride		2.22	
Water phase salinity, ppm		156,636	

Diameter microns	**Cumulative less %**
6	**23.04**
44	**86.05**
74	**95.39**

Solids Analysis Constants	
barite g/ml	4.20
low grav g/ml	2.60
NAF g/ml	0.790

Figure 3: Chevron Analysis of MI Swaco Commission Sample

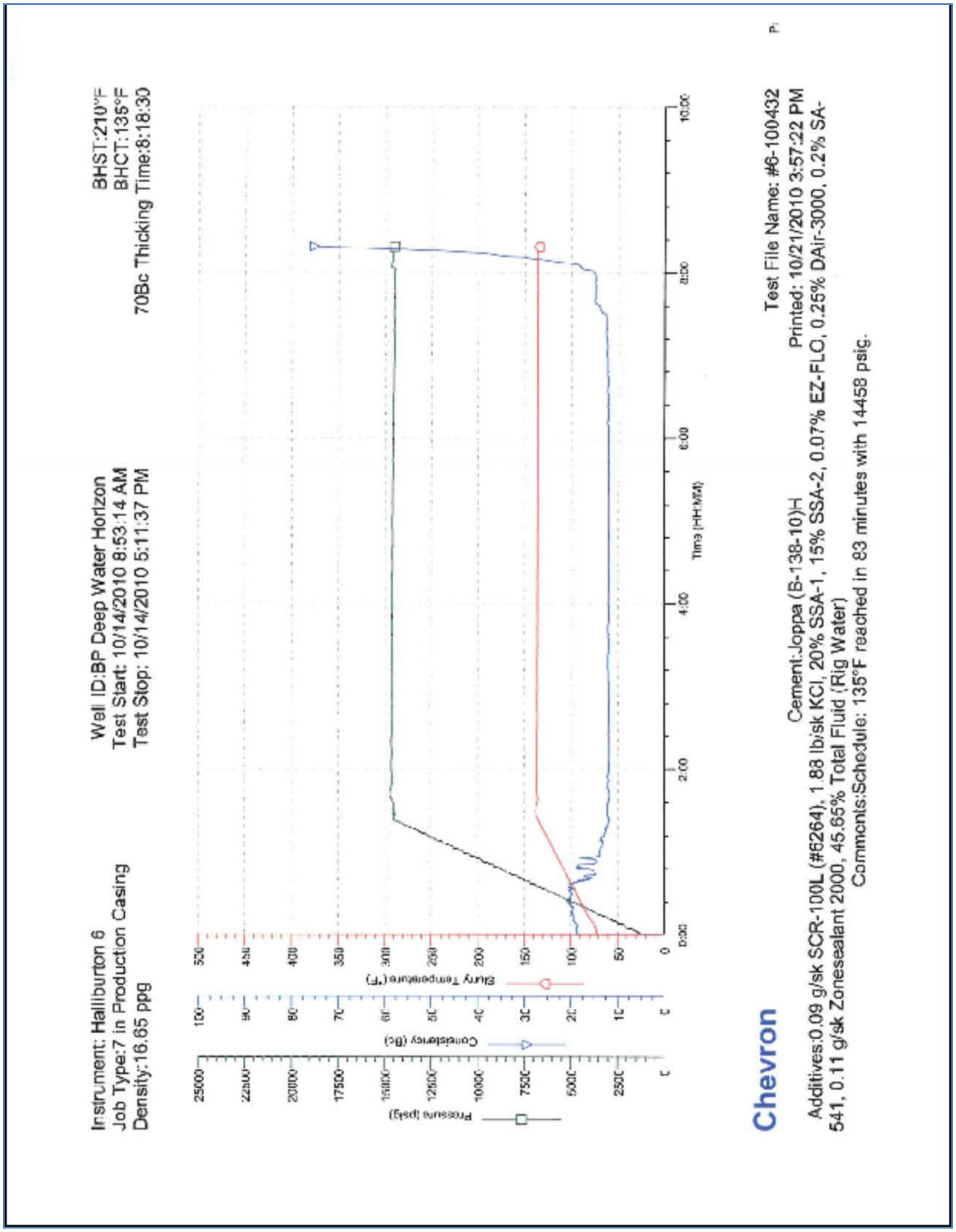

Figure 4: Thickening Time 100432-6 (82 minute heat-up)

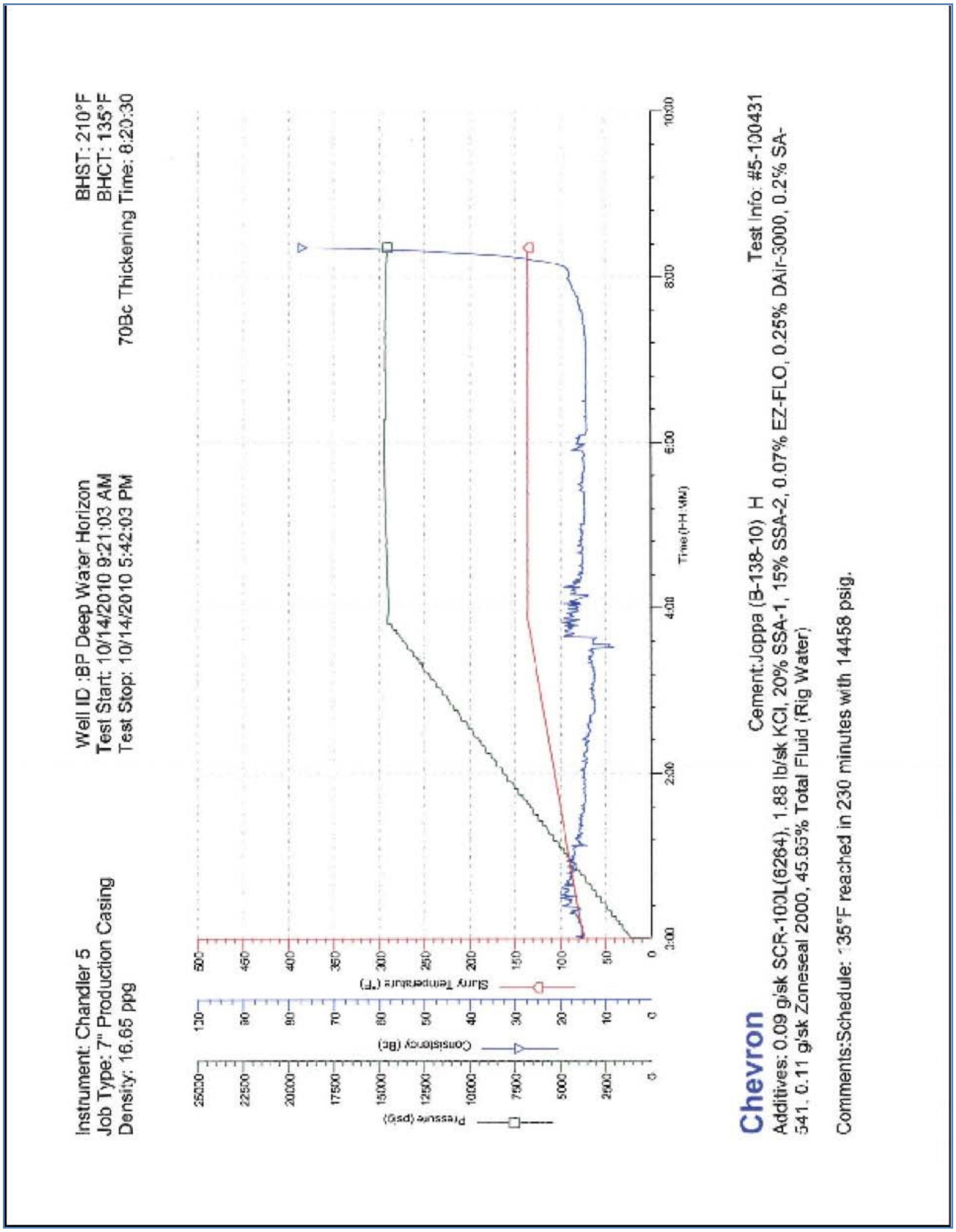

Figure 5: Thickening Time (230 minute heat-up)

Figure 6: Free Fluid - Protocol 1 HTHP - 90 degree

Figure 7: Free Fluid - Protocol 1 HTHP - 45 degree

Figure 8: Free Fluid - Protocol 2 HTHP - 90 degree

Figure 9: Free Fluid - Protocol 2 HTHP - 45 degree

Figure 10: Free Fluid - Protocol 1 Atmospheric - 90 degree

Figure 11: Free Fluid - Protocol 1 Atmospheric - 45 degree

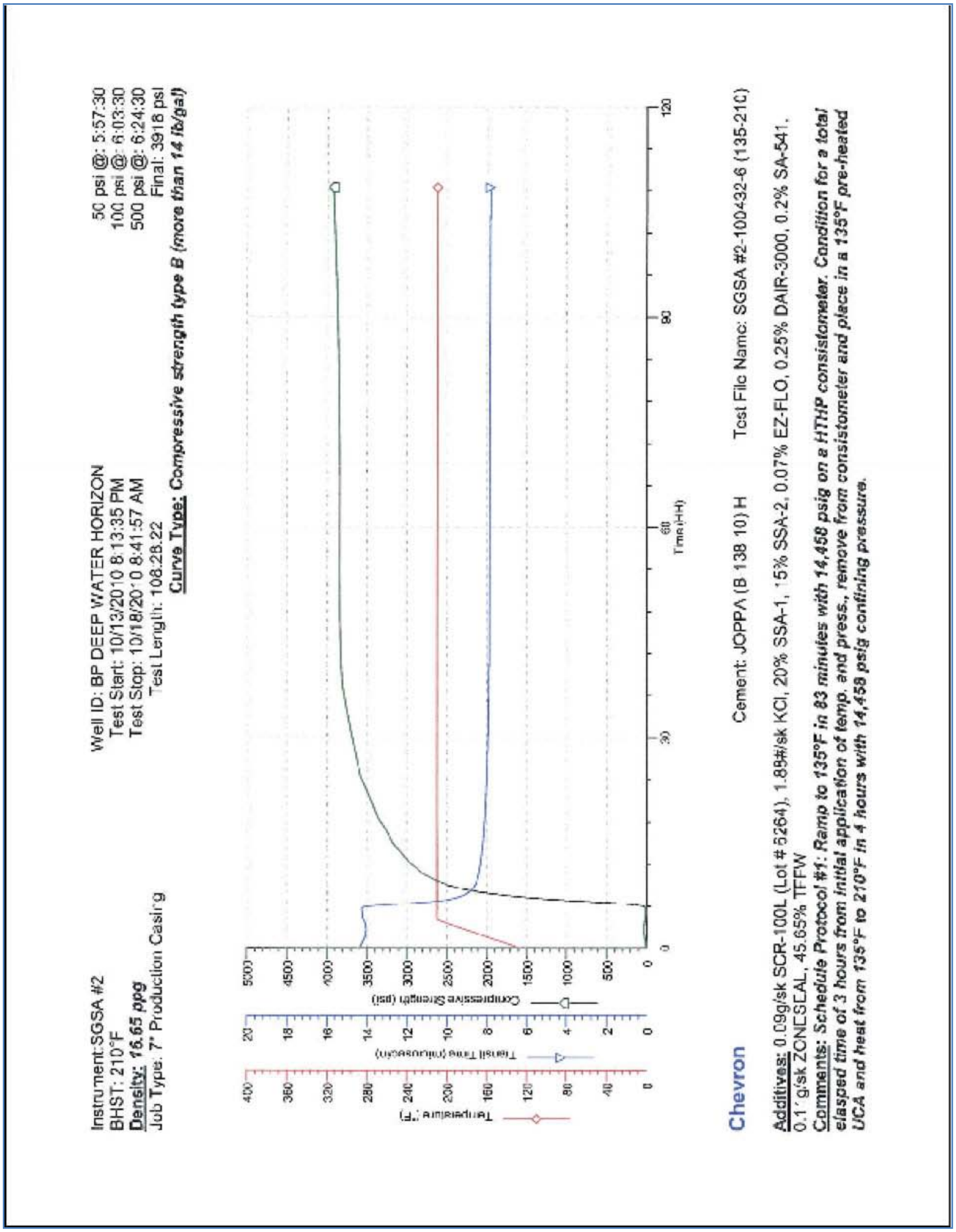

Figure 12: UCA Testing - Protocol 1 - Algorithm B (un-foamed)

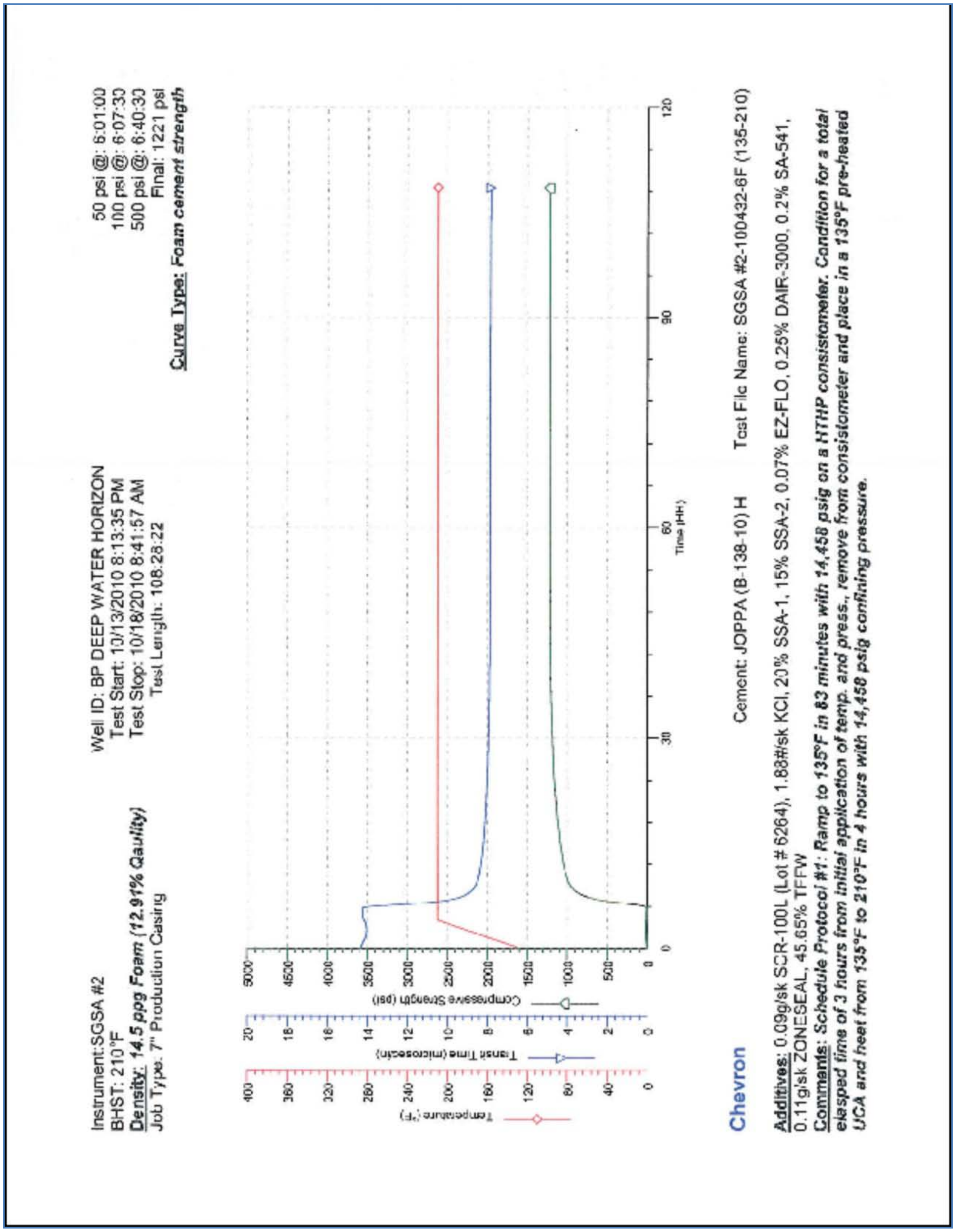

Figure 13: UCA Testing - Protocol 1 - Foamed Cement Algorithm

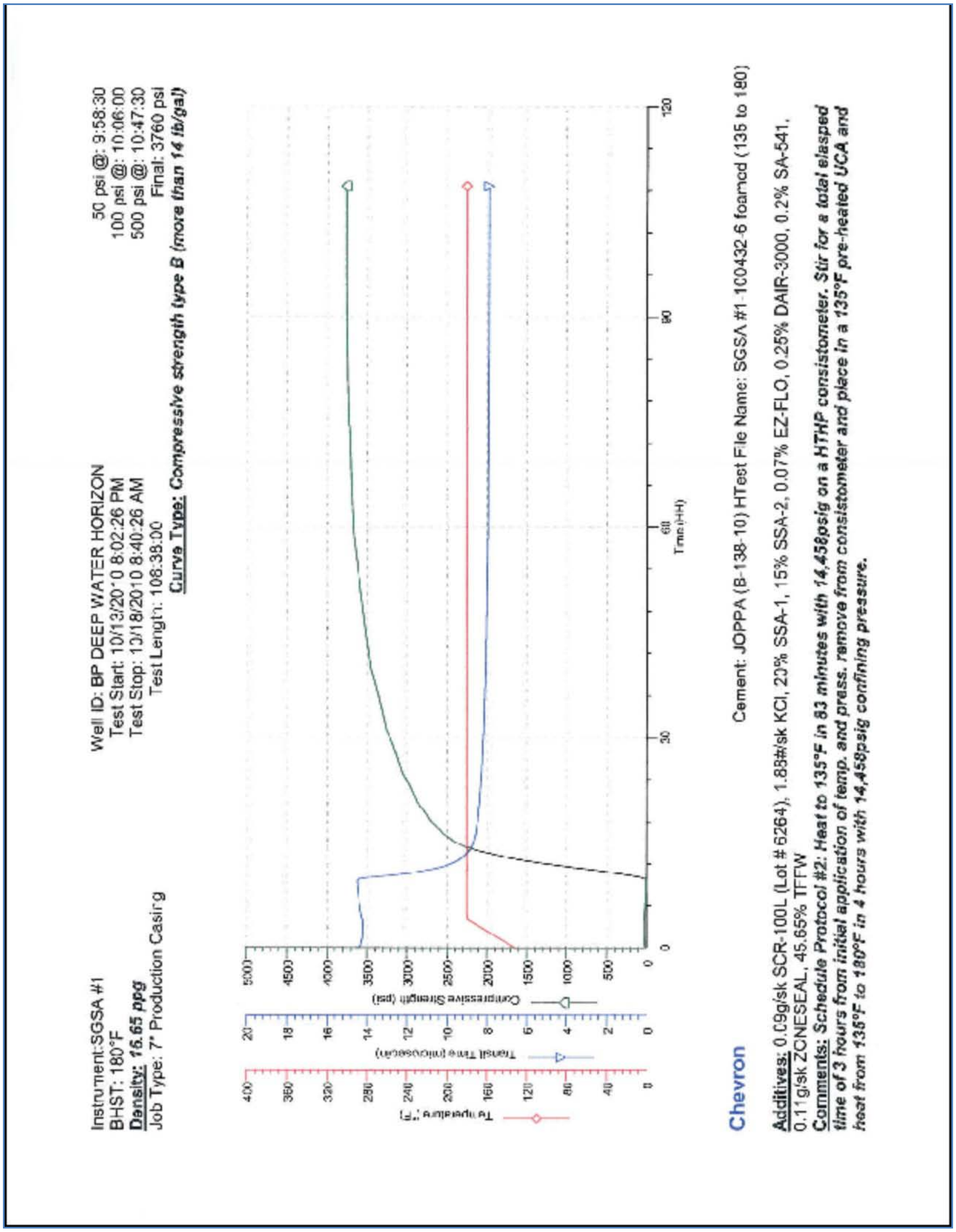

Figure 14: UCA Testing - Protocol 2 - Algorithm B (un-foamed)

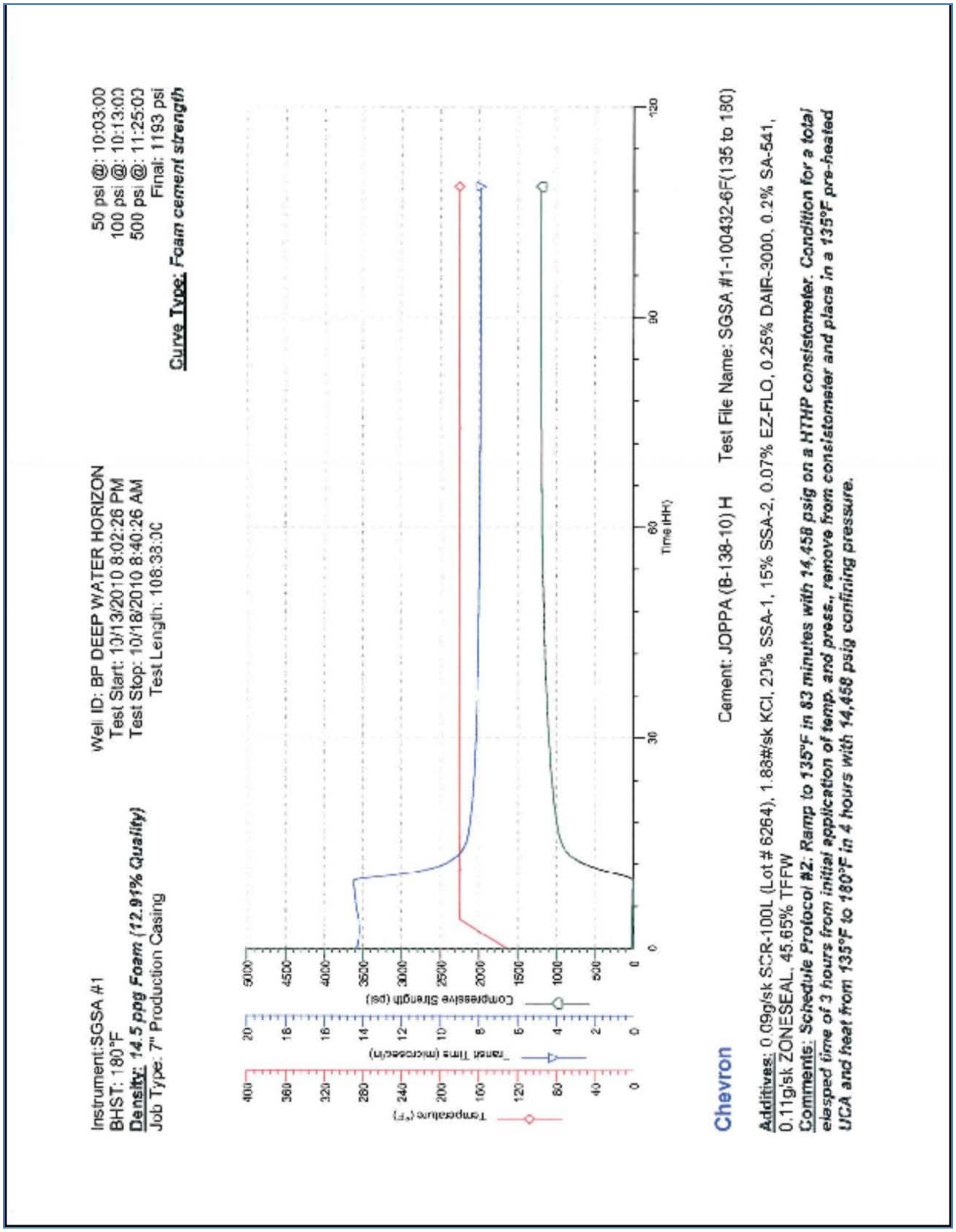

Figure 15: UCA Testing - Protocol 2 - Foamed Cement Algorithm

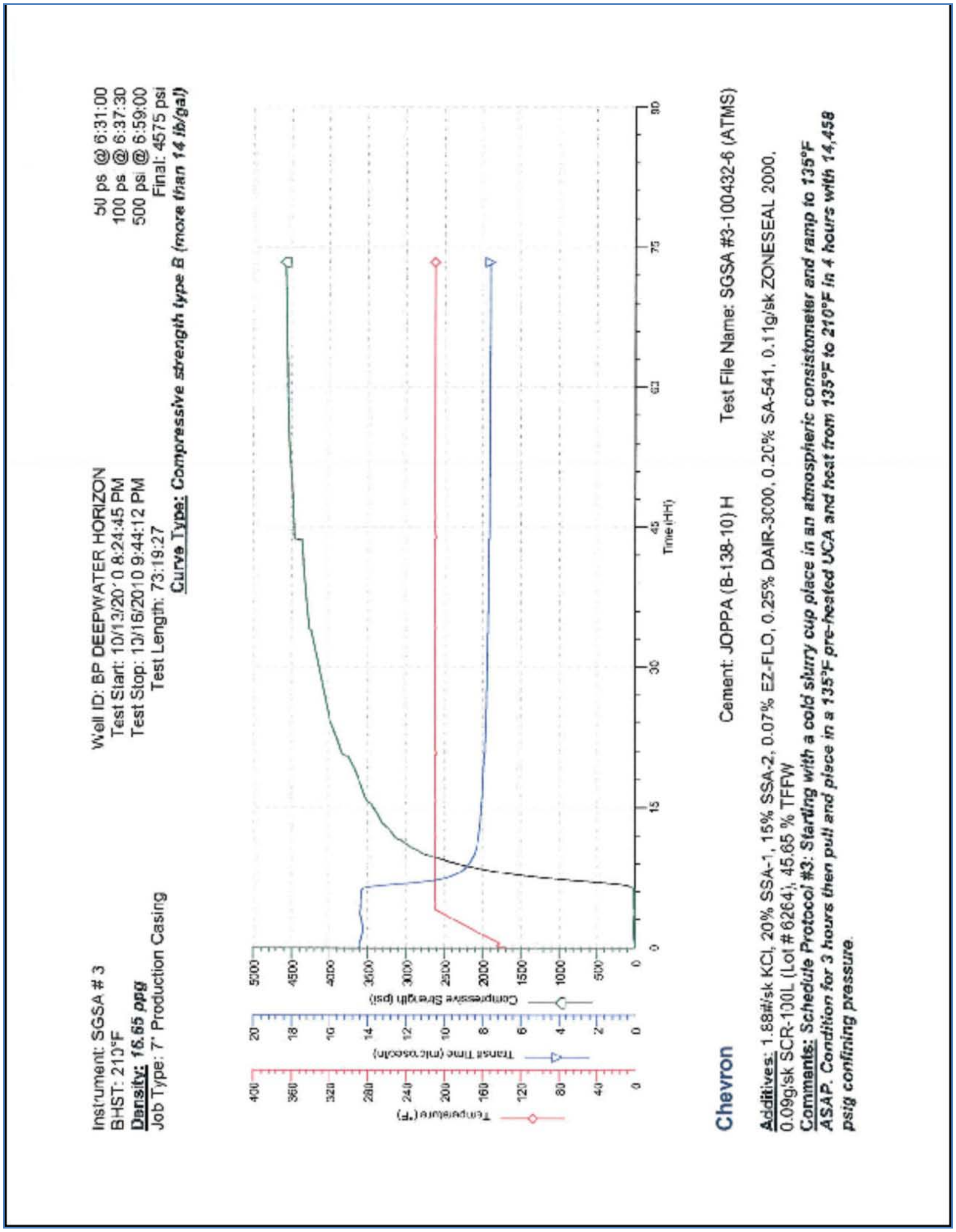

Figure 16: UCA Testing - Protocol 3 - Algorithm B (un-foamed)

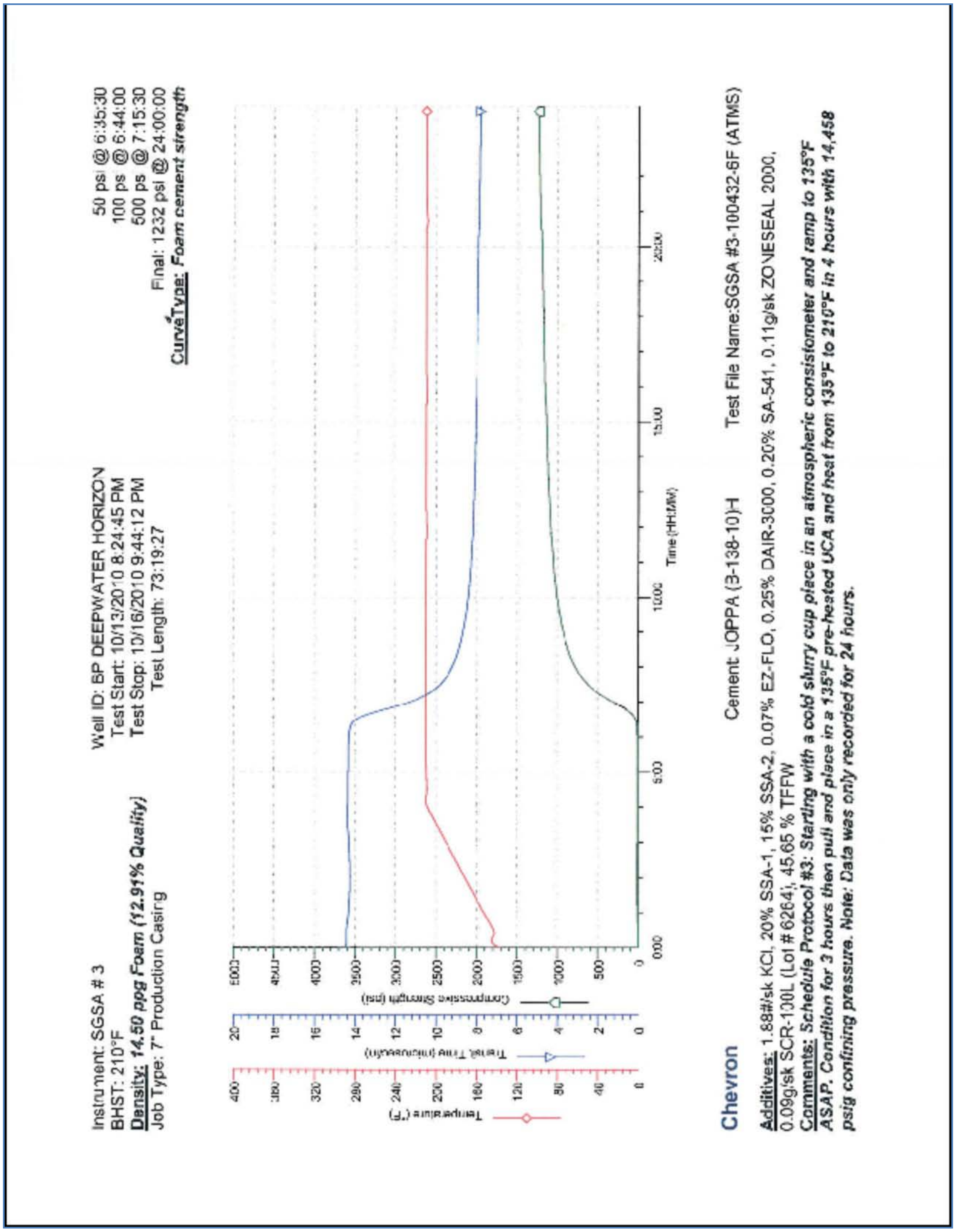

Figure 17: UCA Testing - Protocol 3 - Foamed Cement Algorithm

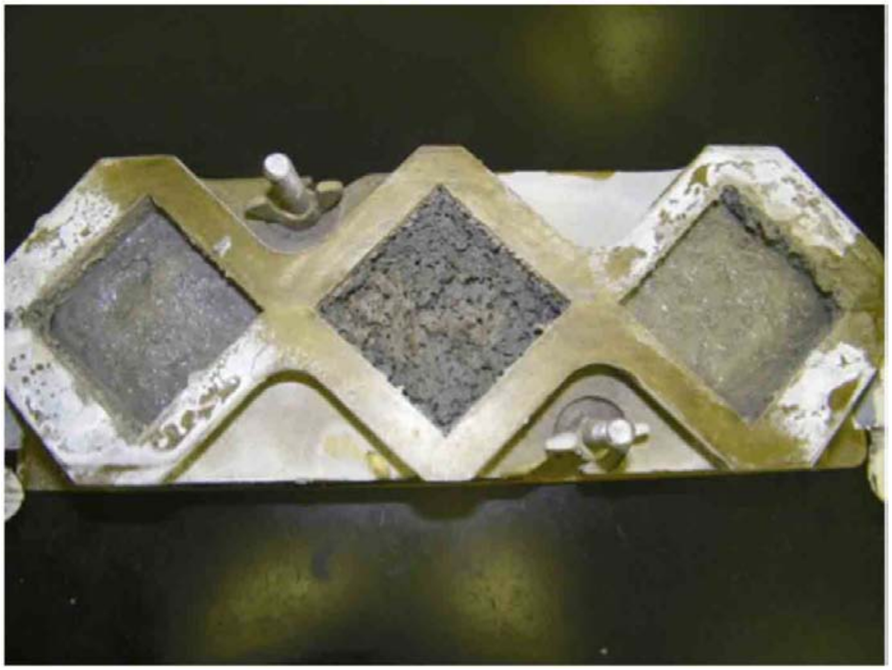

Figure 18: 48 hour Cubes in Mold

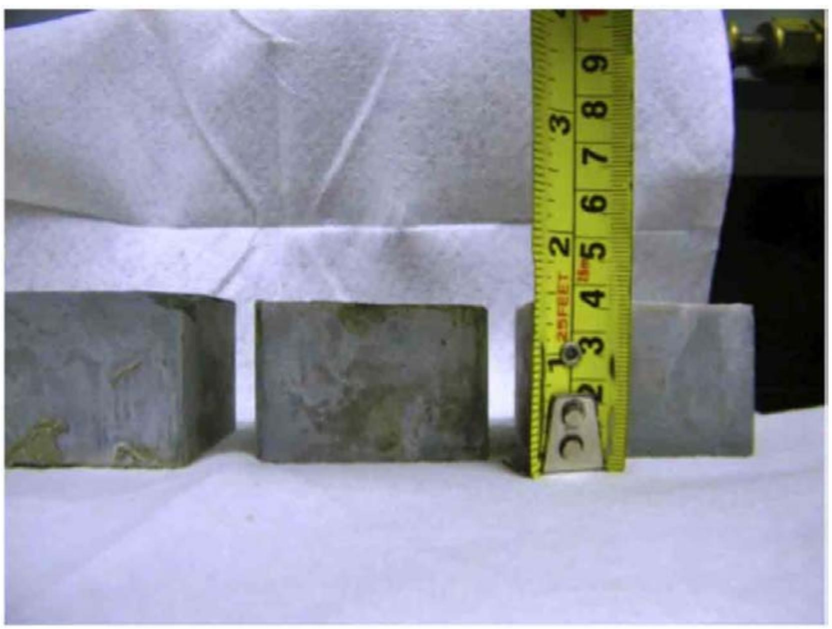

Figure 19: 48 hour Cubes Removed from Mold

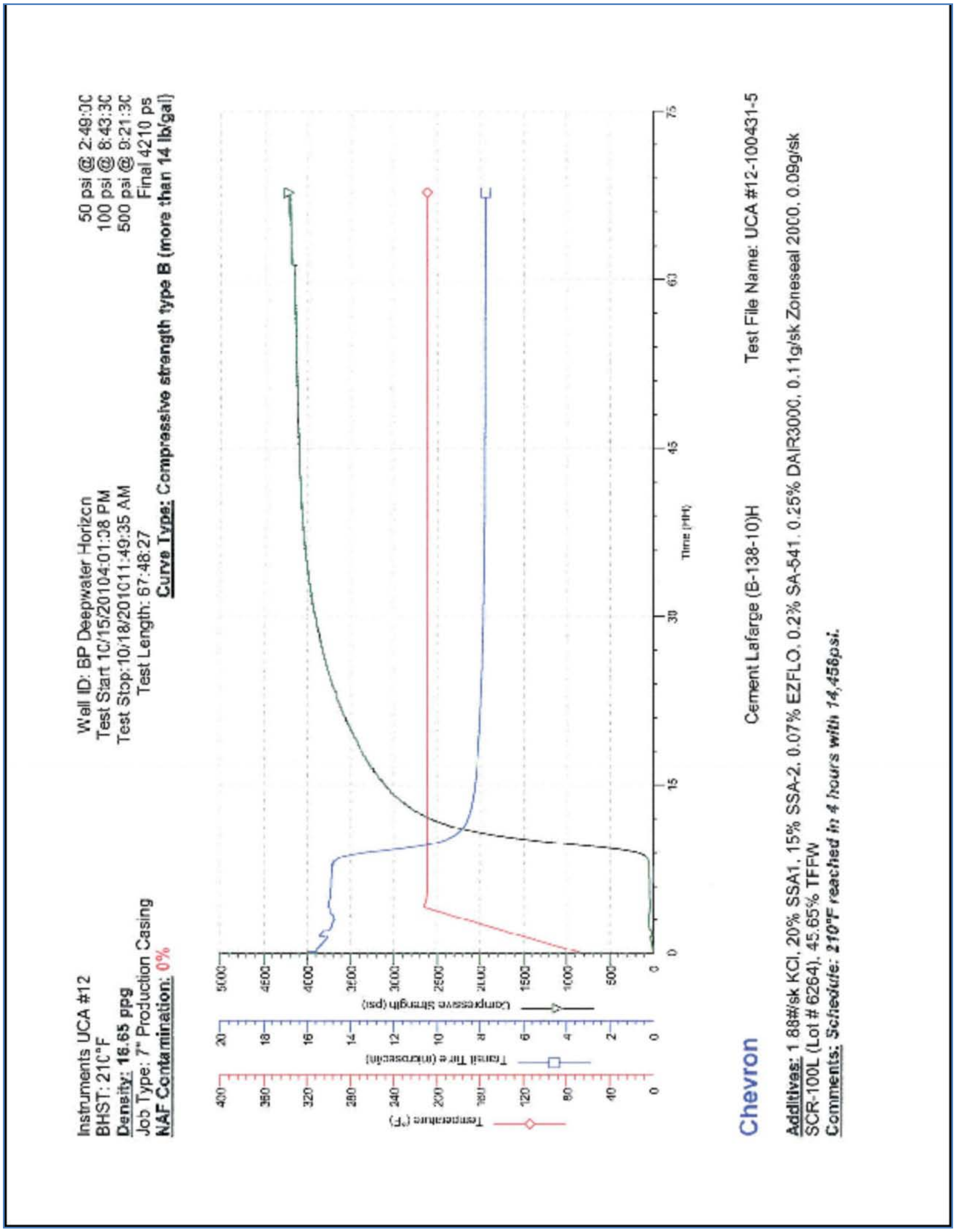

Figure 20: Zero Percent NAF Contamination

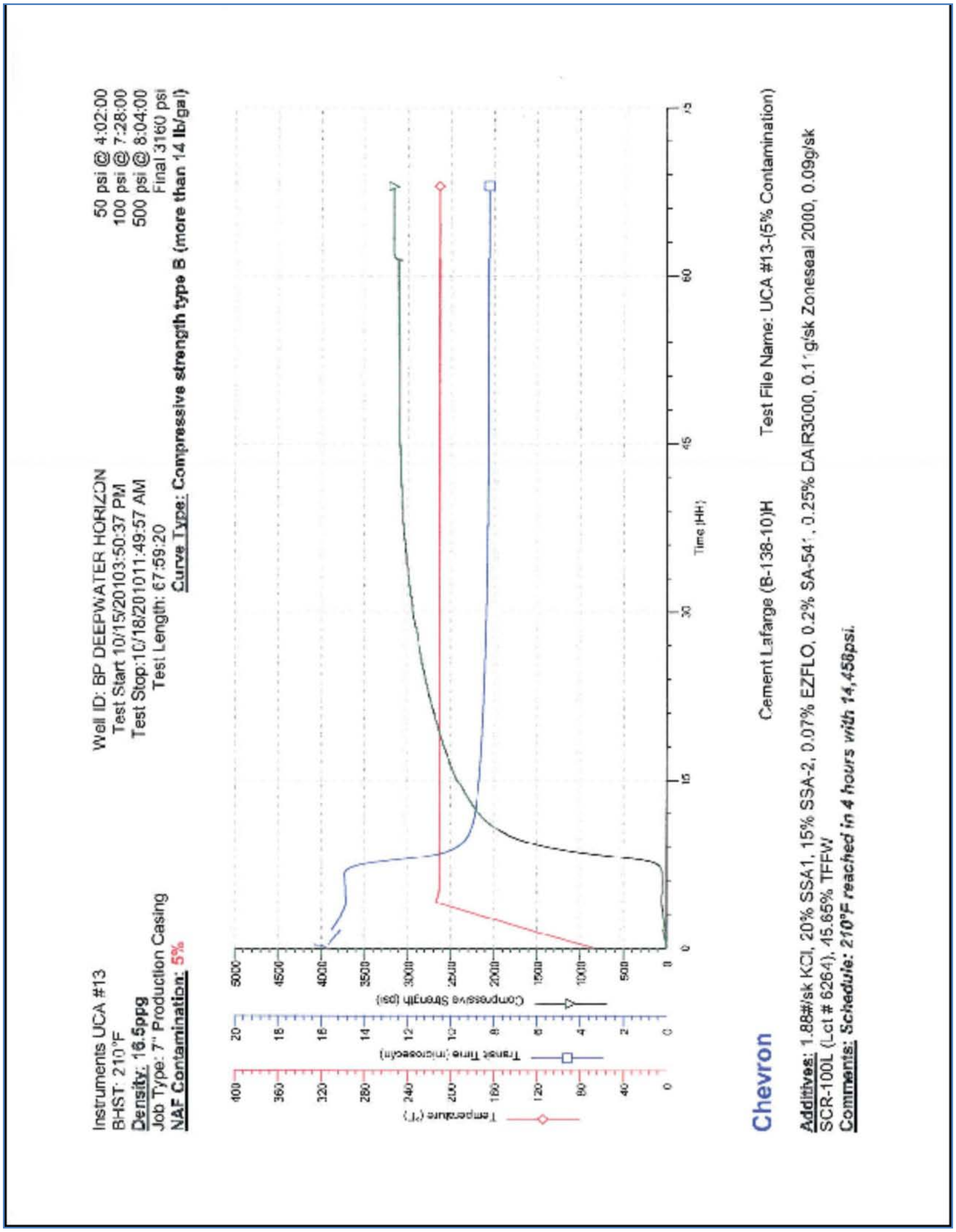

Figure 21: 5 Percent NAF Contamination

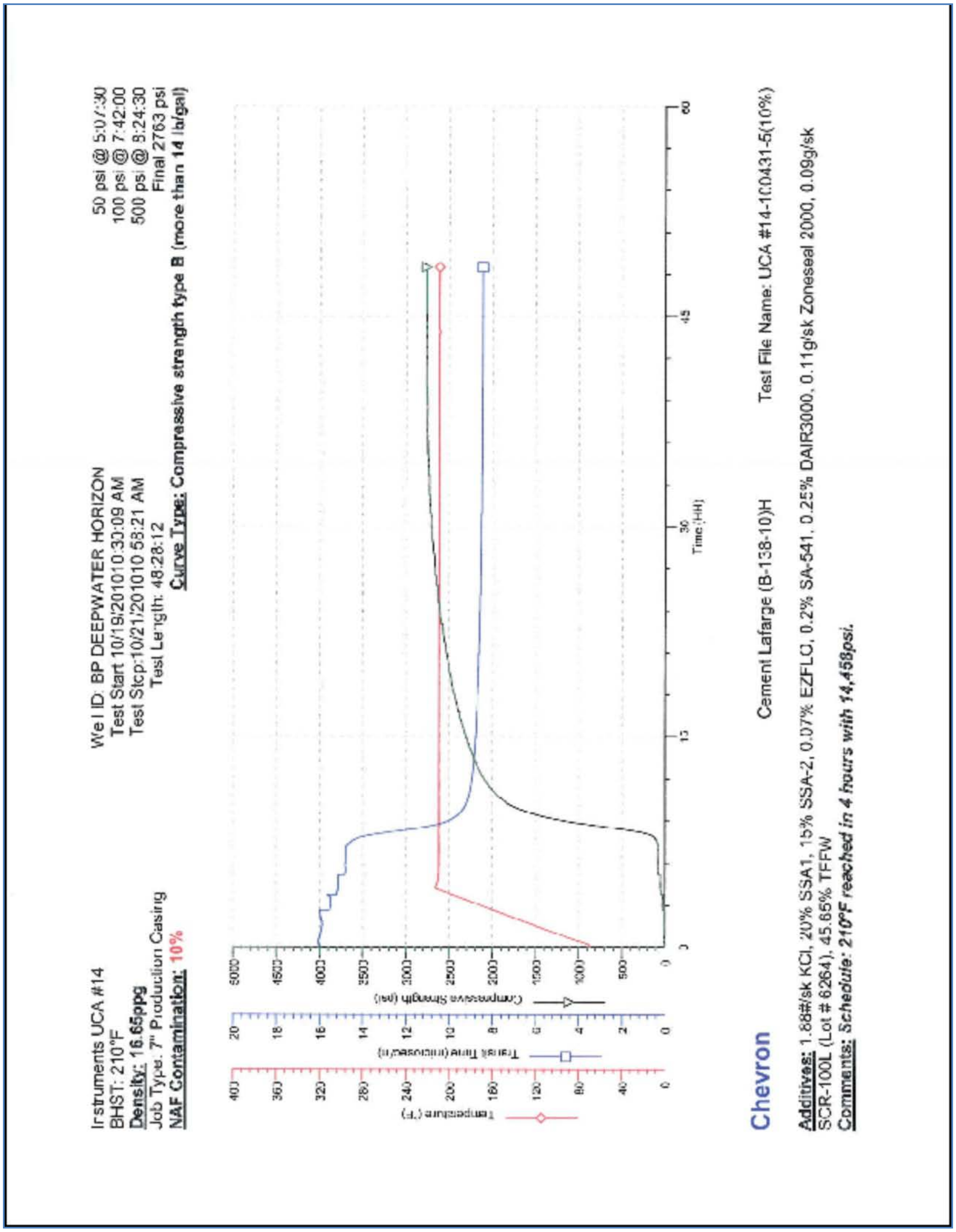

Figure 22: 10 percent NAF Contamination

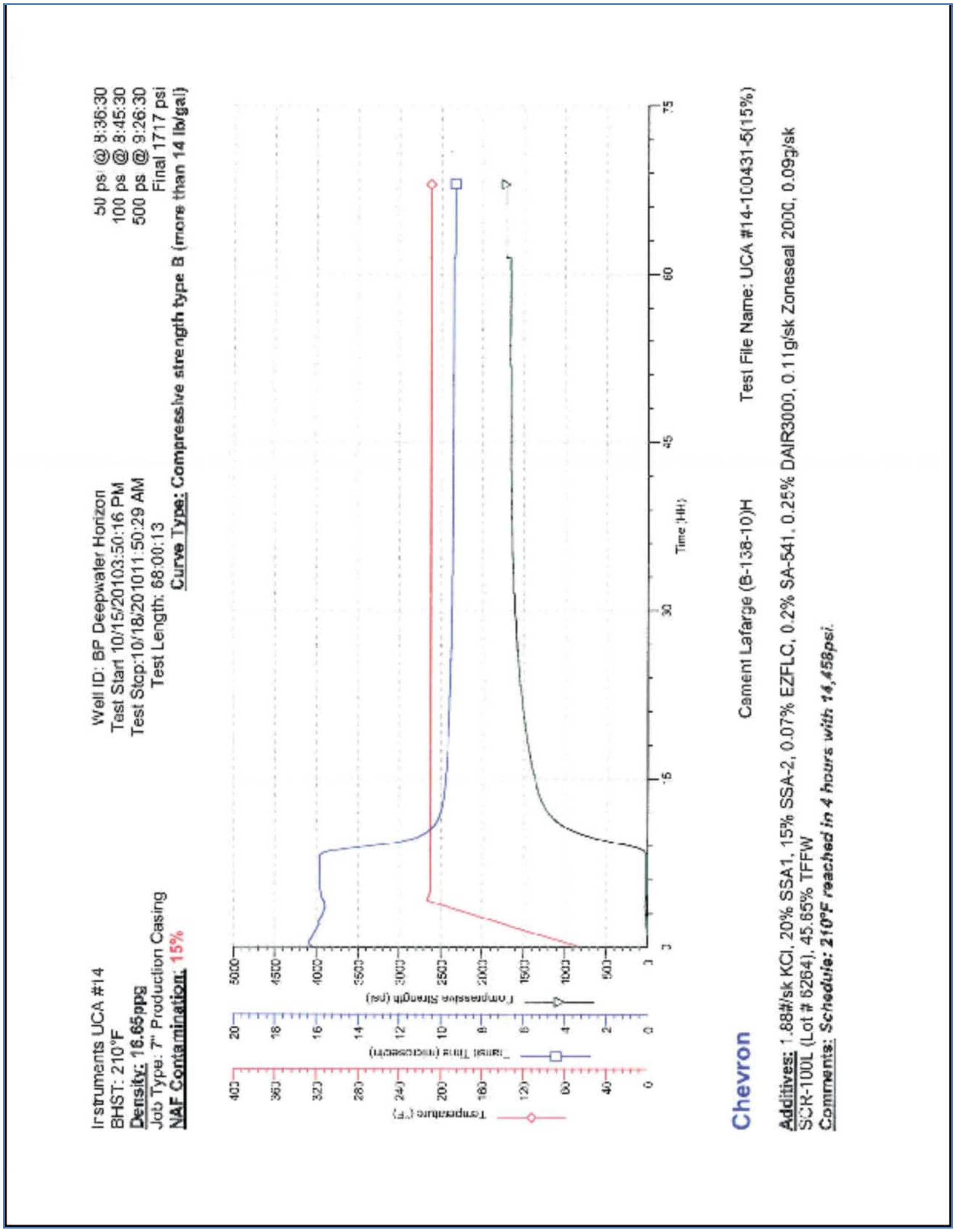

Figure 23: 15 Percent NAF Contamination

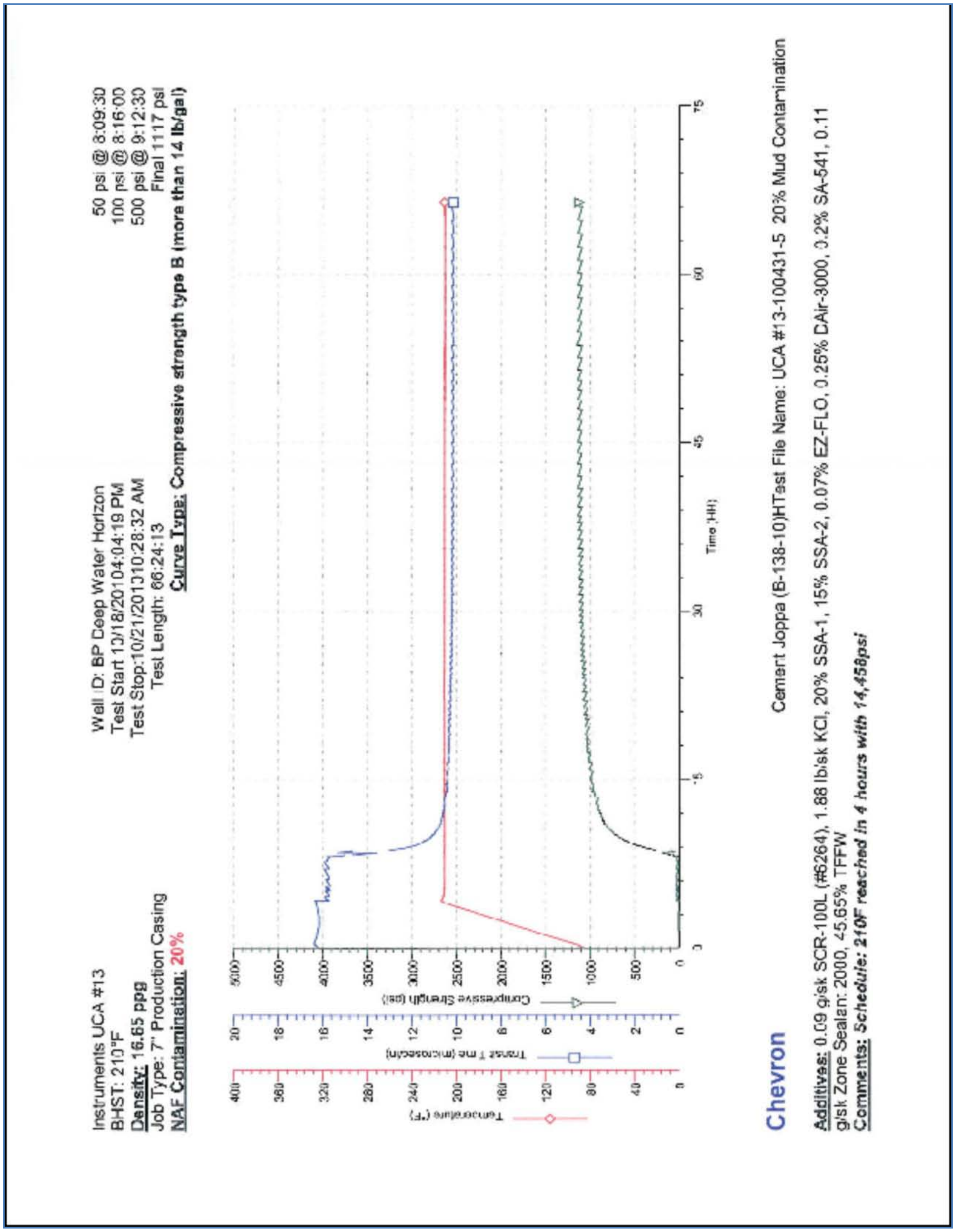

Figure 24: 20 Percent NAF Contamination

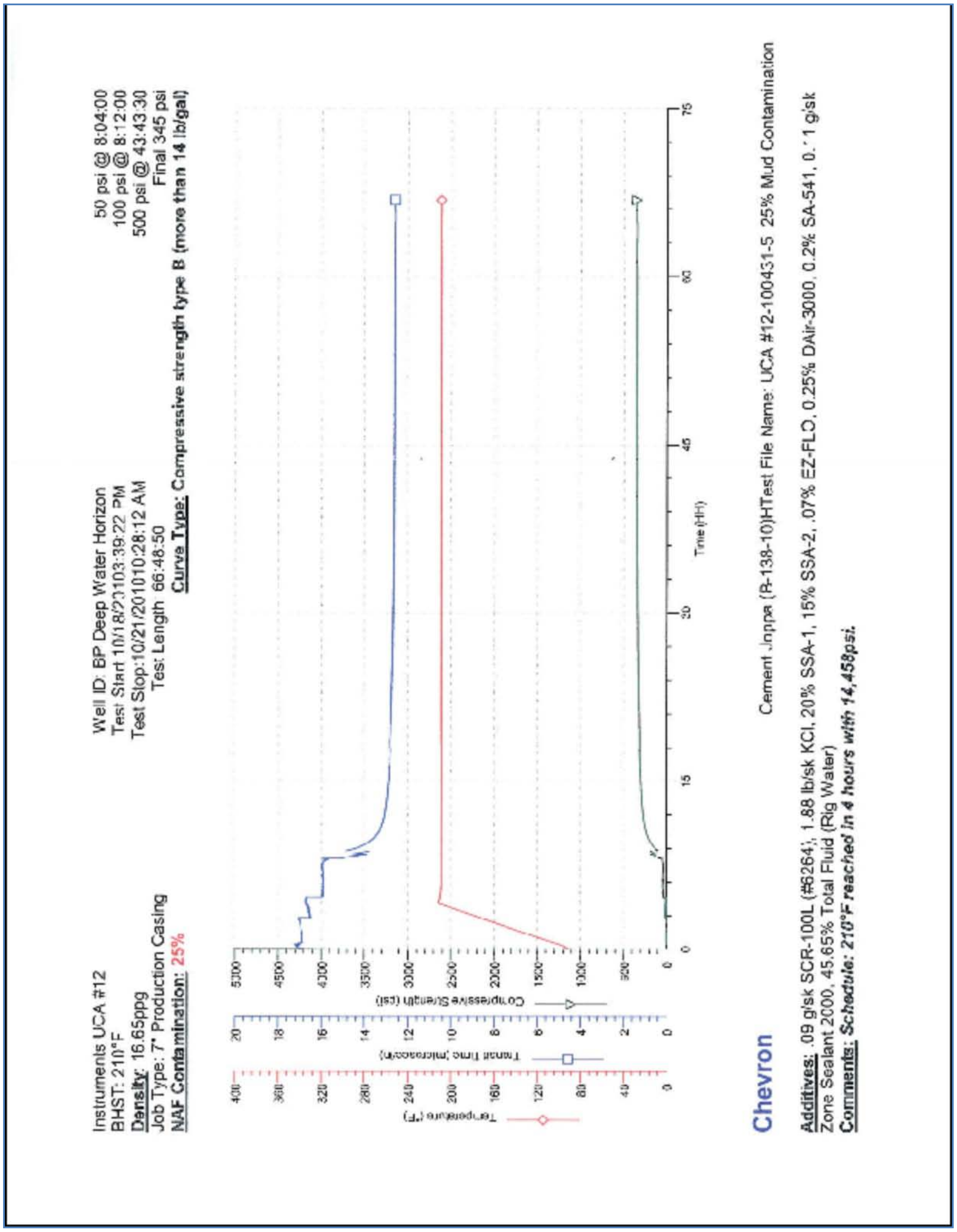

Figure 25: 25 percent NAF Contamination

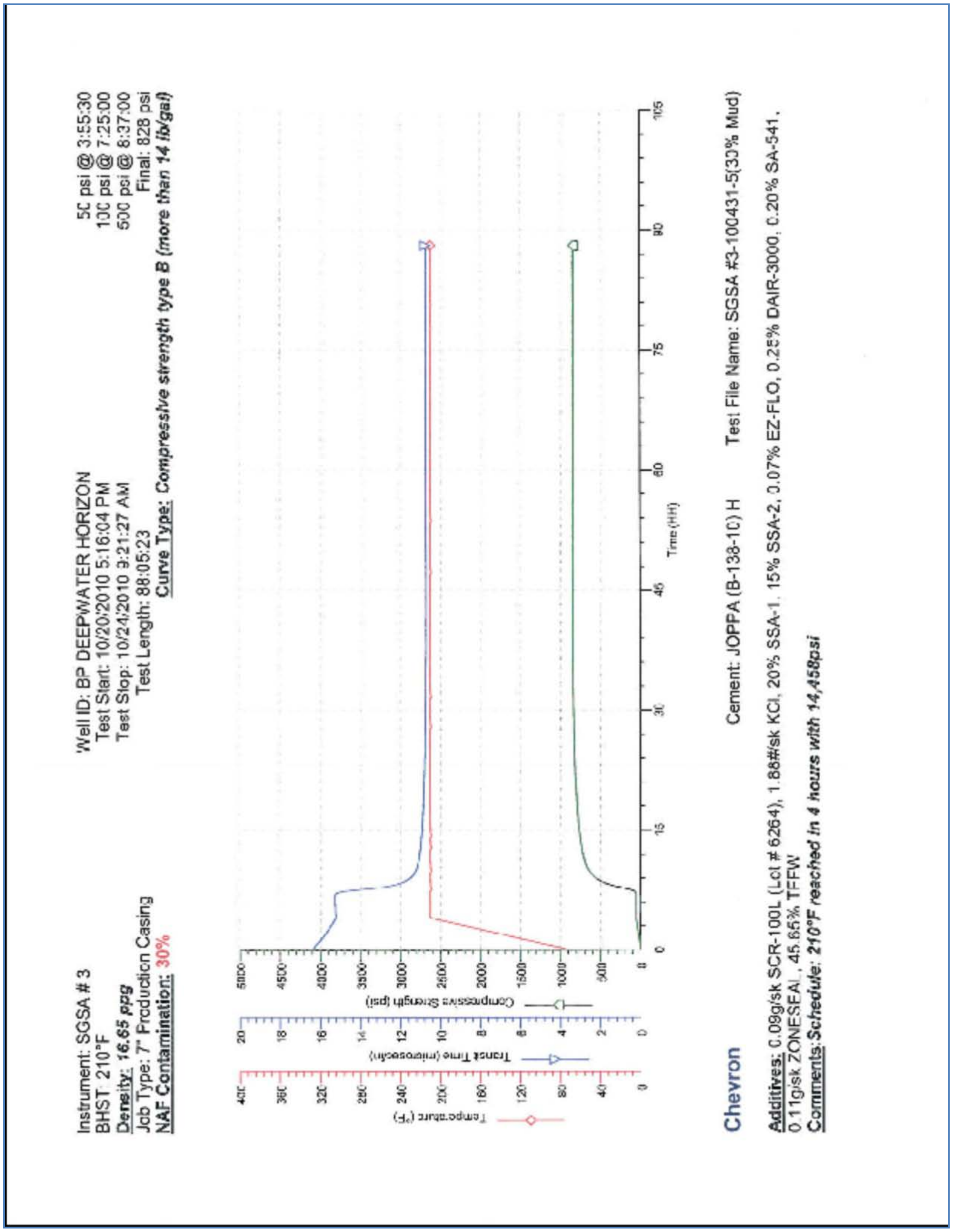

Figure 26: 30 Percent NAF Contamination