HALLIBURTON

NEMO FUND I LLC
12003 Pebble Hill
Houston, Tx., 77024

MAXWELL 24 1H

LEA County, NM, US
API/UWI 30-025-42670

Cementing Cost Estimate

Surface & Production Casing
Proposal 199596 - Version 1.0
January 26, 2016

Prepared for:
Dallas Frazier

Submitted by:
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HALLIBURTON

REVISED

FEB 19 2016

Contents

Halliburton appreciates the opportunity to present this cost estimate and looks forward to being of service to you.

1 Foreword

MIDLAND SALES OFFICE
1-800-844-8451

ODESSA DISTRICT
1-432-571-8600

CEMENTING:
Rene Lopez / Mike Kilgore
Steven Beckworth / Wayne Alger

STIMULATION:
Quincy Cole / Abraham Esparza / Emily Ratliff
John Gragg / Jared Salter

LOGGING & PERFORATING
Xavier Emiliano / Alvaro Martinez Alvernia

TOOLS & TESTING, PROD. SVCS., TCP, COMPL. PRODUCTS
Steve Engleman / Kevin Warren
Patrick Corder / Ryan Reynolds

BAROID
Dustin Pargmann / Joe Molina

SPERRY
Mike Halford / Garrett Young

HOBBS DISTRICT
1-575-492-5900

CEMENTING
Jaime Gonzales / Clay Erwin
Rodolfo Alvarado

DRILL BITS
Mike Washington

ARTIFICIAL LIFT
Phillip Bales

PREPARED BY: Phil Sheldon

_____
Mickie Hamilton, Account Representative

2 Surface Casing

2.1 *Job Information Surface Casing*

Job Criticality Status: GREEN
Well Name: MAXWELL 24 Well #: 1H

12-1/4" Hole	0 - 2400 ft (MD)
Inner Diameter	12.25 in
Excess Factor	100 %
Surface Casing	0 - 2400 ft (MD)
Outer Diameter	9.625 in
Inner Diameter	8.921 in
Linear Weight	36 lbm/ft
Casing Grade	J-55
Shoe Joint Length	40 ft
Thread Type	LTC

2.2 *Estimated Calculations Surface Casing*

Stage 1

CEMENT: (1072 ft fill)

1072 ft * 0.3132 ft3/ft * 100 %	= 671.47 ft3
ExtendaCem - CZ	= 671.47 ft3
	= 119.6 bbl
Total Lead	= 386.14 sack

CEMENT: (1328 ft fill)

1328 ft * 0.3132 ft3/ft * 100 %	= 831.83 ft3
HalCem - C	= 831.83 ft3
	= 148.1 bbl

Shoe Joint Volume: (40 ft fill)

40 ft * 0.4341 ft3/ft	= 17.36 ft3
	= 3.1 bbl

Tail plus shoe joint	= 848.93 ft3
	= 151.2 bbl
Total Tail	= 632.58 sack

Total Pipe Capacity:

2400 ft * 0.4341 ft3/ft	= 1041.76 ft3
	= 185.5 bbl

Displacement Volume to Shoe Joint:

Capacity of Pipe - Shoe Joint	= 185.5 bbl - 3.1 bbl
	= 182.5 bbl

2.3 *Job Volume Estimates Surface Casing*

Stage 1

Fluid 1: Water Based Spacer

Gel Spacer	Fluid Density:	8.4 lbm/gal
2.50 lbm/bbl CHEM,FDP-S1050-12, BULK BAG	**Volume:**	**20 bbl**

Fluid 2: Lead Slurry

EXTENDACEM (TM) SYSTEM	Fluid Weight:	13.5 lbm/gal
	Slurry Yield:	1.739 ft3/sack
	Total Mixing Fluid:	9.24 Gal/sack
	Volume:	**119.6 bbl**
	Top Of Fluid:	0 ft
	Calculated Fill:	1072 ft
	Calculated sack:	386.13 sack
	Proposed sack:	390 sack

Fluid 3: Tail Slurry

HALCEM (TM) SYSTEM	Fluid Weight:	14.8 lbm/gal
1 % Calcium Chloride, Pellet	Slurry Yield:	1.342 ft3/sack
	Total Mixing Fluid:	6.43 Gal/sack
	Volume:	**151.2 bbl**
	Top Of Fluid:	1072 ft
	Calculated Fill:	1328 ft
	Calculated sack:	632.78 sack
	Proposed sack:	635 sack

2.4 *Volume Estimate Table Surface Casing*

Calculations are used for volume estimation. Well conditions will dictate final cement job design.
Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate	Downhole Volume
1	SPACER	Gel Spacer	8.4		20 bbl
2	CEMENT	ExtendaCem - CZ	13.5		390 sack
3	CEMENT	HalCem - C	14.8		635 sack

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.

2.5 Cost Estimate

Mtrl Nbr	Description	Qty	UOM	Unit Price	Gross Amt	Discount %	Net Amount
7521	**CMT SURFACE CASING BOM**	1.00	JOB	0.00	0.00		0.00
1	ZI-MILEAGE FROM NEAREST HES BASE,/UNIT Number of Units	120.00 2	MI	9.79	2,349.60	78.00	516.91
2	MILEAGE FOR CEMENTING CREW Number of Units	120.00 1	MI	5.76	691.20	78.00	152.06
11881	OVERWEIGHT PERMIT FEE-CEMENTING	1.00	EA	60.00	60.00		60.00
372867	Cmt PSL - DOT Vehicle Charge, CMT	4.00	EA	241.00	964.00		964.00
7	ENVIRONMENTAL CHARGE,/JOB,ZI	1.00	JOB	134.00	134.00		134.00
16091	ZI - PUMPING CHARGE FEET/METERS (FT/M) DEPTH	1.00 FT 2400	EA	7,095.00	7,095.00	78.00	1,560.90
141	RCM II W/ADC,/JOB,ZI ENTER FEET\METER\JOB\DAY NUMBER OF JOBS NUMBER OF UNITS	1.00 JOB 1 1	JOB	1,990.00	1,990.00	78.00	437.80
16115	FIELD STORAGE BIN ON SITE >8 HRS,DAY,ZI DAYS OR PARTIAL DAY(WHOLE NO.)	1.00 1	EA	1,344.00	1,344.00	78.00	295.68
74038	ZI PLUG CONTAINER RENTAL-1ST DAY HR/DAY/WEEK/MTH/YEAR/JOB/RUN DAYS OR FRACTION (MIN1)	1.00 DAY 1	EA	1,322.00	1,322.00	78.00	290.84
101214575	PLUG,CMTG,TOP,9 5/8,HWE,8.16 MIN/9.06 MA	1.00	EA	454.00	454.00	25.00	340.50
102175420	CHEM,FDP-S1050-12, BULK BAG *CHEM,FDP-S1050-12, BULK BAG*	50.00	LB	65.29	3,264.50	78.00	718.19
452981	CMT, ExtendaCem (TM) system	390.00	SK	0.00	24,076.35	78.00	5,296.80
452986	CMT, HalCem (TM) system	635.00	SK	0.00	35,382.20	78.00	7,784.08
101509387	CHEM, CALCIUM CHLORIDE-PELLET, 50 LB SK *Calcium Chloride, Pellet*	12.00	SK	180.30	2,163.60	78.00	475.99
76400	MILEAGE,CMT MTLS DEL/RET MIN NUMBER OF TONS	60.00 49.39	MI	3.35	9,927.39	78.00	2,184.03
3965	HANDLE&DUMP SVC CHRG, CMT&ADDITIVES,ZI Unit of Measurement NUMBER OF EACH	1,065.00 EA 1	CF	5.49	5,846.85	78.00	1,286.31
3997	BULK TANK CLEANING, EA/JOB, ZI ENTER FEET\METER\JOB\DAY NUMBER OF JOBS NUMBER OF UNITS	1.00 JOB 1 1	JOB	3,090.00	3,090.00	96.28	115.00
	Total Gross Amount						**100,154.69**
	Total Item Discounts						**77,541.60**
	Total Net Amount	**USD**					**22,613.09**

Primary Plant: Hobbs, NM, USA
Secondary Plant: Artesia, NM, USA
Price Book Ref: 27 - PERMIAN BASIN
Price Date: 1/25/2016

2.6 Optional Services

SAP Mtrl Number	Description	Quantity	Unit of Measure	Unit Price	Discount (%)	Net Price
	25% Discount					
3	DERRICK CHARGE	1	EA	$ 987.00	25%	$ 740.25
	Service Discount %					
16092	ADDITIONAL HOURS (PUMPING EQUIPMENT)	1	EA	$ 1,139.00	78%	$ 250.58
	HOURS	1				
802332	CEM STBY UNIT 8 HR OR FRACTION CASING JOB	1	UN	$ 10,000.00	78%	$ 2,200.00
803106	CEM STBY UNIT CSG JOB ADDL HR>8	1	EA	$ 1,139.00	78%	$ 250.58
	NUMBER OF HOURS	1				
	HR/DAY/WEEK/MTH/YEAR/JOB/RUN		H			
802333	CEM STBY UNIT 8 HR OR FRACTION MSC	1	UN	$ 10,000.00	78%	$ 2,200.00
803177	CEM STBY UNIT MULT STAGE ADDL HR>8	1	UN	$ 1,139.00	78%	$ 250.58
17	MSC ON SITE, ADD HR, ZI	1	H	$ 1,139.00	78%	$ 250.58
	NUMBER OF UNITS	1				
464256	ADDITIONAL HOURS - BULK TRUCK	1	EA	$ 196.00	78%	$ 43.12
	HOURS	1				
910253	CMT-ZI-100 BBL BLENDER, ADD HRS	1	EA	$ 1,139.00	78%	$ 250.58
775759	CEM RNTL BMXR 100 BBL 8 HR OR FRACTION	1	EA	$ 3,898.00	78%	$ 857.56
	NUMBER OF HOURS	8				
	UNIT OF MEASURE - HRS		H			
116	BOOSTER PUMP-SKID, /DAY	1	EA	$ 1,362.00	78%	$ 299.64
	NUMBER OF DAYS	1				
756211	LAB TEST PER HOUR, MIN 4 HR	4	EA	$ 309.00	78%	$ 67.98
356745	3rd Party Rental Pass Through, CMT	1	EA	$ 3,500.00	0%	$ 3,500.00

3 Production Casing

3.1 *Job Information Production Casing*

Job Criticality Status: YELLOW
Well Name: MAXWELL 24 Well #: 1H

Surface Casing	0 - 2400 ft (MD)
Outer Diameter	9.625 in
Inner Diameter	8.921 in
Linear Weight	36 lbm/ft
Casing Grade	J-55
Thread Type	LTC
8-3/4" Hole	2400 - 5300 ft (MD)
Inner Diameter	8.75 in
Excess Factor	100 %
Kick-off Point	- 4377 ft (MD)
8-3/4" Hole	5300 - 9650 ft (MD)
Inner Diameter	8.75 in
Excess Factor	25 %
Production Casing	0 - 4377 ft (MD)
Outer Diameter	7 in
Inner Diameter	6.184 in
Linear Weight	29 lbm/ft
Casing Grade	L-80
Thread Type	BTC
Production Casing	4377 - 9650 ft (MD)
Outer Diameter	5.5 in
Inner Diameter	4.778 in
Linear Weight	20 lbm/ft
Shoe Joint Length	80 ft

3.2 *Estimated Calculations Production Casing*

Stage 1

CEMENT: (4377 ft fill)

2400 ft * 0.1668 ft3/ft * 0 %	= 400.35 ft3
1977 ft * 0.1503 ft3/ft * 100 %	= 594.41 ft3
EconoCem - HLC	= 994.76 ft3
	= 177.2 bbl
Total Lead	= 507.35 sack

CEMENT: (4475 ft fill)

3552 ft * 0.2526 ft3/ft * 25 %	= 1121.55 ft3
923 ft * 0.2526 ft3/ft * 100 %	= 466.29 ft3
VersaCem - H	= 1587.84 ft3
	= 282.8 bbl
Total Lead	= 1294.05 sack

CEMENT: (798 ft fill)

798 ft * 0.2526 ft3/ft * 25 %	= 251.94 ft3
SoluCem - H	= 251.94 ft3
	= 44.8 bbl

Shoe Joint Volume: (80 ft fill)

80 ft * 0.1245 ft3/ft	= 9.96 ft3
	= 1.8 bbl

Tail plus shoe joint = 261.64 ft3
= 46.6 bbl

Total Tail = 99.90 sack

Total Pipe Capacity:

4350 ft * 0.1245 ft3/ft	= 541.64 ft3
2400 ft * 0.2086 ft3/ft	= 500.58 ft3
1977 ft * 0.2086 ft3/ft	= 412.36 ft3
923 ft * 0.1245 ft3/ft	= 114.93 ft3
	= 279.5 bbl

Displacement Volume to Shoe Joint:

Capacity of Pipe - Shoe Joint	= 279.5 bbl - 1.8 bbl
	= 277.8 bbl

3.3 *Job Volume Estimates Production Casing*

Stage 1

Fluid 1: Water Based Spacer

Gel Spacer	Fluid Density:	8.4 lbm/gal
2.50 lbm/bbl CHEM,FDP-S1050-12, BULK BAG	**Volume:**	**20 bbl**

Fluid 2: Lead Slurry

ECONOCEM (TM) SYSTEM	Fluid Weight:	12.5 lbm/gal
0.25 lbm/sk D-AIR 5000	Slurry Yield:	1.961 ft3/sack
	Total Mixing Fluid:	10.91 Gal/sack
	Volume:	**177.2 bbl**
	Top Of Fluid:	0 ft
	Calculated Fill:	4377 ft
	Calculated sack:	507.27 sack
	Proposed sack:	510 sack

Fluid 3: Tail Slurry

VERSACEM (TM) SYSTEM	Fluid Weight:	14.5 lbm/gal
0.50 % LAP-1	Slurry Yield:	1.227 ft3/sack
0.30 % CFR-3	Total Mixing Fluid:	5.58 Gal/sack
0.10 % FWCA	**Volume:**	**282.8 bbl**
0.25 lbm/sk D-AIR 5000	Top Of Fluid:	4377 ft
	Calculated Fill:	4475 ft
	Calculated sack:	1294.08 sack
	Proposed sack:	1295 sack

Fluid 4: Gas Migration Control

SOLUCEM (TM) CEMENT	Fluid Weight:	15 lbm/gal
0.25 lbm/sk D-AIR 5000	Slurry Yield:	2.619 ft3/sack
0.40 % HR-601	Total Mixing Fluid:	11.36 Gal/sack
	Volume:	**46.6 bbl**
	Top Of Fluid:	8852 ft
	Calculated Fill:	798 ft
	Calculated sack:	100 sack
	Proposed sack:	100 sack

3.4 *Volume Estimate Table Production Casing*

Calculations are used for volume estimation. Well conditions will dictate final cement job design.
Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate	Downhole Volume
1	SPACER	Gel Spacer	8.4		20 bbl
2	CEMENT	EconoCem - HLC	12.5		510 sack
3	CEMENT	VersaCem - H	14.5		1295 sack
4	CEMENT	SoluCem - H	15		100 sack

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.

3.5 Cost Estimate

Mtrl Nbr	Description	Qty	UOM	Unit Price	Gross Amt	Discount %	Net Amount
7523	**CMT PRODUCTION CASING BOM**	1.00	JOB	0.00	0.00		0.00
1	ZI-MILEAGE FROM NEAREST HES BASE,/UNIT Number of Units	120.00 3	MI	9.79	3,524.40	78.00	775.37
2	MILEAGE FOR CEMENTING CREW Number of Units	120.00 1	MI	5.76	691.20	78.00	152.06
11881	OVERWEIGHT PERMIT FEE-CEMENTING	1.00	EA	60.00	60.00		60.00
372867	Cmt PSL - DOT Vehicle Charge, CMT	8.00	EA	241.00	1,928.00		1,928.00
7	ENVIRONMENTAL CHARGE,/JOB,ZI	1.00	JOB	134.00	134.00		134.00
16091	ZI - PUMPING CHARGE FEET/METERS (FT/M) DEPTH	1.00 FT 9650	EA	13,534.00	13,534.00	78.00	2,977.48
141	RCM II W/ADC,/JOB,ZI ENTER FEET\METER\JOB\DAY NUMBER OF JOBS NUMBER OF UNITS	1.00 JOB 1 1	JOB	1,990.00	1,990.00	78.00	437.80
16115	FIELD STORAGE BIN ON SITE >8 HRS,DAY,ZI DAYS OR PARTIAL DAY(WHOLE NO.)	2.00 1	EA	1,344.00	2,688.00	78.00	591.36
74038	ZI PLUG CONTAINER RENTAL-1ST DAY HR/DAY/WEEK/MTH/YEAR/JOB/RUN DAYS OR FRACTION (MIN1)	1.00 DAY 1	EA	1,322.00	1,322.00	78.00	290.84
100003129	PLUG,CMTG,TOP,5-1/2 X 7 IN,COMB	1.00	EA	1,077.00	1,077.00	25.00	807.75
102175420	CHEM,FDP-S1050-12, BULK BAG *CHEM,FDP-S1050-12, BULK BAG*	50.00	LB	65.29	3,264.50	78.00	718.19
452992	CMT, EconoCem (TM) system	310.00	SK	0.00	24,603.88	78.00	5,412.86
102068797	CHEM, D-AIR 5000, 50 LB SACK *D-AIR 5000*	128.00	LB	11.92	1,525.76	78.00	335.67
452010	CMT, VersaCem (TM) system	1,295.00	SK	0.00	57,022.84	78.00	12,545.03
100012766	CHEM, LAP-1 *LAP-1*	544.00	LB	27.18	14,785.92	78.00	3,252.90
100003653	CHEM, CFR-3, 50 LB SACK *CFR-3*	327.00	LB	14.69	4,803.63	78.00	1,056.80
100003714	CHEM, FWCA, 50 LB BAG *FWCA*	109.00	LB	65.29	7,116.61	78.00	1,565.65
102068797	CHEM, D-AIR 5000, 50 LB SACK *D-AIR 5000*	324.00	LB	11.92	3,862.08	78.00	849.66
502297	CMT, SoluCem (TM) cement	100.00	SK	0.00	21,518.55	78.00	4,734.08
102068797	CHEM, D-AIR 5000, 50 LB SACK *D-AIR 5000*	25.00	LB	11.92	298.00	78.00	65.56
101328348	Chem - HR-601 - 50 Lb Bag *HR-601*	38.00	LB	23.11	878.18	78.00	193.20
76400	MILEAGE,CMT MTLS DEL/RET MIN NUMBER OF TONS	60.00 89.673	MI	3.35	18,024.27	78.00	3,965.34
3965	HANDLE&DUMP SVC CHRG, CMT&ADDITIVES,ZI Unit of Measurement NUMBER OF EACH	2,187.00 EA 1	CF	5.49	12,006.63	78.00	2,641.46
3997	BULK TANK CLEANING, EA/JOB, ZI ENTER FEET\METER\JOB\DAY NUMBER OF JOBS NUMBER OF UNITS	1.00 JOB 1 1	JOB	3,090.00	3,090.00	96.28	115.00
	Total Gross Amount						**199,749.45**
	Total Item Discounts						**154,143.39**
	Total Net Amount	**USD**					**45,606.06**

Primary Plant:	Hobbs, NM, USA	**Price Book Ref:**	27 - PERMIAN BASIN
Secondary Plant:	Artesia, NM, USA	**Price Date:**	1/26/2016

3.6 Optional Services

SAP Mtrl Number	Description	Quantity	Unit of Measure	Unit Price	Discount (%)	Net Price
	25% Discount					
3	DERRICK CHARGE	1	EA	$ 987.00	25%	$ 740.25
	Service Discount %					
16092	ADDITIONAL HOURS (PUMPING EQUIPMENT)	1	EA	$ 1,139.00	78%	$ 250.58
	HOURS	1				
802332	CEM STBY UNIT 8 HR OR FRACTION CASING JOB	1	UN	$ 10,000.00	78%	$ 2,200.00
803106	CEM STBY UNIT CSG JOB ADDL HR>8	1	EA	$ 1,139.00	78%	$ 250.58
	NUMBER OF HOURS	1				
	HR/DAY/WEEK/MTH/YEAR/JOB/RUN		H			
802333	CEM STBY UNIT 8 HR OR FRACTION MSC	1	UN	$ 10,000.00	78%	$ 2,200.00
803177	CEM STBY UNIT MULT STAGE ADDL HR>8	1	UN	$ 1,139.00	78%	$ 250.58
17	MSC ON SITE, ADD HR,ZI	1	H	$ 1,139.00	78%	$ 250.58
	NUMBER OF UNITS	1				
464256	ADDITIONAL HOURS - BULK TRUCK	1	EA	$ 196.00	78%	$ 43.12
	HOURS	1				
910253	CMT-ZI-100 BBL BLENDER, ADD HRS	1	EA	$ 1,139.00	78%	$ 250.58
775759	CEM RNTL BMXR 100 BBL 8HR OR FRACTION	1	EA	$ 3,898.00	78%	$ 857.56
	NUMBER OF HOURS	8				
	UNIT OF MEASURE - HRS		H			
116	BOOSTER PUMP-SKID,/DAY	1	EA	$ 1,362.00	78%	$ 299.64
	NUMBER OF DAYS	1				
756211	LAB TEST PER HOUR,MIN 4 HR	4	EA	$ 309.00	78%	$ 67.98
356745	3rd Party Rental Pass Through, CMT	1	EA	$ 3,500.00	0%	$ 3,500.00

4 Conditions

The cost in this analysis is good for the materials and/or services outlined within and shall be valid for 30 days from the date of this proposal. In order to meet your needs under this proposal with a high quality of service and responsive timing, Halliburton will be allocating limited resources and committing valuable equipment and materials to your area of operations. Accordingly, the discounts reflected in this proposal are available only for materials and services awarded on a first-call basis. Alternate pricing may apply in the event that Halliburton is awarded work on any basis other than as a first-call provider.

The unit prices stated in the proposal are based on our current published prices. The projected equipment, personnel, and material needs are only estimates based on information about the work presently available to us. At the time the work is actually performed, conditions then existing may require an increase or decrease in the equipment, personnel, and/or material needs. Charges will be based upon unit prices in effect at the time the work is performed and the amount of equipment, personnel, and/or material actually utilized in the work. Taxes, if any, are not included. Applicable taxes, if any, will be added to the actual invoice.

It is understood and agreed between the parties that with the exception of the subject discounts, all services performed and equipment and materials sold are provided subject to Halliburton's General Terms and Conditions contained in our current price list, (which include LIMITATION OF LIABILITY and WARRANTY provisions), and pursuant to the applicable Halliburton Work Order Contract (whether or not executed by you), unless a Master Service and/or Sales Contract applicable to the services, equipment, or materials supplied exists between your company and Halliburton, in which case the negotiated Master Contract shall govern the relationship between the parties. A copy of the latest version of our General Terms and Conditions is available from your Halliburton representative or at: http://www.halliburton.com/terms for your convenient review, and we would appreciate receiving any questions you may have about them. Should your company be interested in negotiating a Master Contract with Halliburton, our Law Department would be pleased to work with you to finalize a mutually agreeable contract. In this connection, it is also understood and agreed that Customer will continue to execute Halliburton usual field work orders and/or tickets customarily required by Halliburton in connection with the furnishing of said services, equipment, and materials.

Any terms and conditions contained in purchase orders or other documents issued by the customer shall be of no effect except to confirm the type and quantity of services, equipment, and materials to be supplied to the customer.

If customer does not have an approved open account with Halliburton or a mutually executed written contract with Halliburton, which dictates payment terms different than those set forth in this clause, all sums due are payable in cash at the time of performance of services or delivery of equipment, products, or materials. If customer has an approved open account, invoices are payable on the twentieth day after date of invoice.

Customer agrees to pay interest on any unpaid balance from the date payable until paid at the highest lawful contract rate applicable, but never to exceed 18% per annum. In the event Halliburton employs an attorney for collection of any account, customer agrees to pay attorney fees of 20% of the unpaid account, plus all collection and court costs.

5 Cementing Best Practices

Cementing Best Practices

1. **Cement quality and weight:** You must choose cement slurry that is designed to solve the problems specific to each string of pipe.

2. **Waiting time:** You must hold the cement slurry in place and under pressure until it hardens. A cement slurry is a time-dependent liquid and must be allowed to undergo a hydration reaction to produce a competent cement sheath. A fresh cement slurry can be worked (thickening or pump time) as long as it is plastic, and the initial set of cement occurs during the rapid reaction stage. If the cement is not allowed to hydrate; it will be subject to changes in density, dilution, settling, water separation, and gas cutting that can lead to lack of zonal isolation with resultant bridging in the annulus.

3. **Pipe movement**: Pipe movement may be one of the single most influential factors in mud removal. Reciprocation and/or rotation mechanically breaks up gelled mud and constantly changes the flow patterns in the annulus for better cement bonding.

4. **Mud properties:** Plastic viscosity (PV) should be less than 15 centipoise (cp), and less than 10 cp, if possible, yield point (YP) should be less than 10 pound/100-square feet (lb/100ft²) decreasing down to about 5 lb/100 ft².

5. **Mud gel strength**: A nonthixotropic mud is desirable for good mud removal. Mud left in the hole prior to running casing should have 10-second/10-minute/30-minute gel strength such that the 10-minute is less than double the 10-second and the 30-minute is less than 20 lb/100 ft²). Sufficient shear strength may not be achieved on a primary cement job to remove mud left in the hole should the mud develop more than 25 lb/100 ft².

6. **Mud fluid loss:** Decreasing the filtrate loss into a permeable zone enhances the creation of a thin filter cake. This increases the fluid mud in the hole, which is more easily removed. Generally, an API fluid loss of 7 or 8 milliliter (ml) is sufficient with high-temperature/high-pressure fluid loss (HTHP) no more than double this amount.

7. **Circulation:** Circulate bottoms up twice, or until well conditioned mud is being returned to the surface. There should be no cutting in the mud returns. An annular velocity of 260 feet per minute is optimum (SPE/IADC 18617), if possible.

8. **Flow rate:** Turbulent flow is more desirable flow regime for mud removal. If turbulence cannot be achieved, better mud removal is found when maximum flow energy is used. The maximum pump rate should be determined to obtain the best flow regime.

9. **Hole size:** The optimum hole size recommended for good mud removal is 1.5 to 2 inches larger than the casing or liner size. Hole sizes larger than 2 inches annular space can be dealt with, but those that are smaller than 1.5 inches present difficult problems.

10. **Pipe Centralization:** This helps to create a uniform flow area perpendicular to flow direction. Cement will take the path of least resistance so that centralization is important in keeping the pipe off the walls of the hole. At least a 70 percent standoff should be achieved for centralization.

11. **Rat hole:** When applicable, a weighted viscous pill in the rat hole prevents cement from swapping with lighter weight mud when displacement stops.

    Shoe joint: A shoe joint is recommended on all primary casings and liners. The length of the shoe joint will vary, although the absolute minimum length is one joint of pipe. If conditions exist, such as not running a bottom plus, two joints should be the minimum lengths.