Drilling Plan Data Report

APD ID: 10400029978

Operator Name: LEGACY RESERVES OPERATING LP

Well Name: LEA UNIT

Well Type: OIL WELL

Submission Date: 05/22/2018

Well Number: 65H

Well Work Type: Drill

Highlighted data reflects the most recent changes

Show Final Text

Section 1 - Geologic Formations

Formation ID	Formation Name	Elevation	True Vertical Depth	Measured Depth	Lithologies	Mineral Resources	Producing Formation
1	MANZANITA	3663	0	0		USEABLE WATER	No
2	RUSTLER	1982	1680	1680		NONE	No
3	TOP SALT	1942	1720	1720		NONE	No
4	CAPITAN REEF	513	3150	3158		NONE	No
5	BOTTOM SALT	513	3150	3158		NONE	No
6	SAN ANDRES	-1047	4710	4734		NONE	No
7	CAPITAN REEF	-1047	4710	4734		NONE	No
8	QUEEN	-1056	4719	4743		NONE	No
9	CHERRY CANYON	-2801	6464	6488		NONE	No
10	BRUSHY CANYON	-3427	7090	7114		NONE	No
11	BONE SPRING	-4528	8191	8215		NONE	No
12	AVALON SAND	-5109	8772	8796		NONE	No
13	AVALON SAND	-5366	9029	9053		NONE	No
14	BONE SPRING 1ST	-5780	9443	9467		NONE	No
15	BONE SPRINGS	-5890	9553	9577		NONE	No
16	BONE SPRING 2ND	-6343	10006	10033		NONE	No
17	BONE SPRING 3RD	-6822	10485	10510		NONE	No
18	BONE SPRING 3RD	-7236	10899	13302		NATURAL GAS,OIL	No

Operator Name: LEGACY RESERVES OPERATING LP
Well Name: LEA UNIT   Well Number: 65H

Formation ID	Formation Name	Elevation	True Vertical Depth	Measured Depth	Lithologies	Mineral Resources	Producing Formation
19	WOLFCAMP	-7308	10971	18002		NATURAL GAS,OIL	No
20	STRAWN	-8379	12042	19537		NATURAL GAS,OIL	Yes

Section 2 - Blowout Prevention

Pressure Rating (PSI): 3M   **Rating Depth:** 5600

Equipment: A 3M BOP will be used to drill from the surface casing shoe (~1800') to the intermediate casing shoe (~5600'). The BOP will be a 5M system, however the "A" section wellhead will be a 3M wellhead (see attached BOP Diagram).
Requesting Variance? YES

Variance request: A variance to the requirement of a rigid steel line connecting to the choke manifold is requested. Specifications for the flex hose are provided with BOP schematic in exhibit section
Testing Procedure: The BOPs will be tested by an independent service company to 250 psi low and 3000 psi high.

Choke Diagram Attachment:

McVay_2_Choke_Manifold_Diagram_20180813141443.pdf

BOP Diagram Attachment:

Wellhead_Schematic_20180508124637.pdf

McVay_2_BOP_Diagram_20180808092813.pdf

Pressure Rating (PSI): 5M   **Rating Depth:** 10978

Equipment: Legacy Reserves plans to use a 13-5/8" 5000-psi working pressure BOP system consisting of a double ram BOP with one ram being pipe and one ram being blind, a 5000-psi annular type preventer, a 5000-psi choke manifold and 80 gallon accumulator with floor, five remote operating stations and an auxiliary power system. A rotating head will be utilized as needed. A drill string safety valve in the open position will be available on the rig floor. A mud gas separator will be available for use if needed. A 3M BOP will be used to drill from the surface casing shoe (~1800') to the intermediate casing shoe (~5600'). The BOP will be a 5M system, however the "A" section wellhead will be a 3M wellhead (see attached BOP Diagram). The BOP unit will be hydraulically operated. The BOP will be operated at least once per day while drilling and the blind rams will be operated when out of hole during trips. No abnormal pressure or temperature is expected while drilling.
Requesting Variance? YES

Variance request: A variance is requested to use a 10M BOP with 5M Annular Preventer. A variance to the requirement of a rigid steel line connecting to the choke manifold is requested. Specifications for the flex hose are provided with BOP schematic in exhibit section
Testing Procedure: The BOPs will be tested by an independent service company to 250 psi low and 5000 psi high.

Choke Diagram Attachment:

McVay_2_Choke_Manifold_Diagram_20180813141543.pdf

BOP Diagram Attachment:

Wellhead_Schematic_20180508125020.pdf

McVay_2_BOP_Diagram_20180813141552.pdf

Operator Name: LEGACY RESERVES OPERATING LP

Well Name: LEA UNIT
Well Number: 65H

Section 3 - Casing

Casing ID	String Type	Hole Size	Csg Size	Condition	Standard	Tapered String	Top Set MD	Bottom Set MD	Top Set TVD	Bottom Set TVD	Top Set MSL	Bottom Set MSL	Calculated casing length MD	Grade	Weight	Joint Type	Collapse SF	Burst SF	Joint SF Type	Joint SF	Body SF Type	Body SF
1	SURFACE	17.5	13.375	NEW	API	N	0	1800	0	1800	3689	1889	1800	J-55	54.5	STC	1.42	3.86	DRY	2.59	DRY	2.59
2	INTERMEDIATE	12.25	9.625	NEW	API	N	0	4000	0	3983	3689	-212	4000	J-55	40	LTC	1.97	1.43	DRY	2.99	DRY	2.99
3	INTERMEDIATE	8.5	7.0	NEW	API	N	0	5300	0	5276			5300	HCP-110	32	BUTT	2.45	1.26	DRY	2.49	DRY	2.49
4	INTERMEDIATE	12.25	9.625	NEW	API	N	0	5600	0	5576	-212	-1911	5600	HCK-55	40	LTC	1.97	1.43	DRY	2.99	DRY	2.99
5	LINER	8.5	7.0	NEW	API	N	5300	10000	0	9976			4700	HCP-110	32	BUTT	2.41	2.09	DRY	4.09	DRY	4.09
6	PRODUCTION	6	4.5	NEW	API	N	9500	18314	0	10978			8814	P-110	13.5	BUTT	1.94	1.25	DRY	1.91	DRY	1.91

Casing Attachments

Casing ID: 1 **String Type:** SURFACE

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

Lea_Unit_65H_Casing_Design_20180508141839.pdf

Lea_Unit_65H_Drilling_Plan_20180509125034.pdf

Casing Attachments

Casing ID: 2   **String Type:** INTERMEDIATE

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

Lea_Unit_65H_Casing_Design_20180508141849.pdf

Casing ID: 3   **String Type:** INTERMEDIATE

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

Lea_Unit_65H_Casing_Design_20180508141903.pdf

Casing ID: 4   **String Type:** INTERMEDIATE

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

Lea_Unit_65H_Casing_Design_20180508141915.pdf

Operator Name: LEGACY RESERVES OPERATING LP

Well Name: LEA UNIT   **Well Number:** 65H

Casing Attachments

Casing ID: 5   **String Type:** LINER

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

        Lea_Unit_65H_Casing_Design_20180508141931.pdf

Casing ID: 6   **String Type:** PRODUCTION

Inspection Document:

Spec Document:

Tapered String Spec:

Casing Design Assumptions and Worksheet(s):

        Lea_Unit_65H_Casing_Design_20180508141955.pdf

Section 4 - Cement

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
SURFACE	Lead		0	1566	1300	1.72	13.5	2236	75	Class C cement	4% bwoc bentonite II + 2% bwoc Calcium Chloride + 0.25 lbs/sack Cello Flake + 0.005% bwoc Static Free + 0.005 gps FP-6L
SURFACE	Tail		1566	1800	200	1.32	14.8	264	75	Class C cement	none
INTERMEDIATE	Lead		0	4984	1700	1.94	12.6	3298	80	Poz (fly ash) Class C	6% bwoc Bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder +

Operator Name: LEGACY RESERVES OPERATING LP

Well Name: LEA UNIT　　　　　　　　　　　**Well Number:** 65H

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
											0.4 pps Defoamer
INTERMEDIATE	Tail		4984	5600	200	1.18	15.6	236	80	Class H cement	none
INTERMEDIATE	Lead		0	5300	800	1.18	15.6	944	75	Class H cement	None

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
LINER	Lead		5300	10000	450	1.62	12.6	729	75	PVL	1.3% bwoc Salt + 5% bwoc Expanding Cement + 0.5% bwoc Fluidloss + 0.3% bwoc Retarder + 0.1% bwoc Anti-setting Agent + 0.4 pps Defoamer

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
INTERMEDIATE	Lead	11000	10200	11000	385	0.94	17.5	361.9	75	class H cement	0.2% bwoc Retarder + 0.5% bwoc Dispersant

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
INTERMEDIATE	Lead		11000	12200	450	1.18	15.6	531	75	class H cement	0.3% + bwoc Retarder

String Type	Lead/Tail	Stage Tool Depth	Top MD	Bottom MD	Quantity(sx)	Yield	Density	Cu Ft	Excess%	Cement type	Additives
PRODUCTION	Lead		9500	18500	700	1.34	14.2	938	75	poz (fly ash) class H cement	0.2% bwoc Retarder + 0.2% bwoc Dispersant + 0.4 pps Defoamer

Section 5 - Circulating Medium

Mud System Type: Closed

Will an air or gas system be Used? NO

Description of the equipment for the circulating system in accordance with Onshore Order #2:

Diagram of the equipment for the circulating system in accordance with Onshore Order #2:

Describe what will be on location to control well or mitigate other conditions: In the event that circulation is lost (> 50%) while drilling the 12-1/4" intermediate hole in the Capitan Reef at +/-4000', we will plan to install a DV tool and external casing packer within 200' of the top depth where lost circulation occurred and will pump a two-stage cement job with the potential to add an additional DV tool for a three-stage cement job. If there is no lost circulation a single stage cementing procedure will be followed. Legacy plans to cement to surface regardless of whether a single stage, 2-stage or 3-stage procedure is implemented.

Describe the mud monitoring system utilized: Mud logging program: 2 man unit from approximately 5600', after setting intermediate I casing. 6" vertical pilot hole to be drilled, with planned coring interval of ~11,000' TVD to ~12,000' TVD. Open-hole wireline logs will be ran after pilot-hole TD is reached at ~12,300' MD. In order to effectively run casing, the mud viscosity and fluid loss properties may be adjusted.

Circulating Medium Table

Top Depth	Bottom Depth	Mud Type	Min Weight (lbs/gal)	Max Weight (lbs/gal)	Density (lbs/cu ft)	Gel Strength (lbs/100 sqft)	PH	Viscosity (CP)	Salinity (ppm)	Filtration (cc)	Additional Characteristics
10000	18500	OIL-BASED MUD	9	9.5							
5600	10000	OTHER : Fresh water/brine	8.8	9.2							
1800	5600	OTHER : Brine water	10	10.2							
0	1800	SPUD MUD	8.4	9.2							
10000	12200	OTHER : Fresh water mud	9	12							

Section 6 - Test, Logging, Coring

List of production tests including testing procedures, equipment and safety measures:

Mud logging program: 2 man unit from approximately after setting intermediate casing.
Open-hole wireline logs will be ran after pilot-hole TD is reached at ~12,300' MD.

List of open and cased hole logs run in the well:

MUDLOG,OTH

Other log type(s):

Open-hole wireline logs will be ran after pilot-hole TD is reached at ~12,300' MD. 6" vertical pilot hole to be drilled, with planned coring interval of ~11,000' TVD to ~12,000' TVD.

Coring operation description for the well:

6" vertical pilot hole to be drilled, with planned coring interval of ~11,000' TVD to ~12,000' TVD.

Section 7 - Pressure

Anticipated Bottom Hole Pressure: 4700   **Anticipated Surface Pressure:** 2284.84

Anticipated Bottom Hole Temperature(F): 192

Anticipated abnormal pressures, temperatures, or potential geologic hazards? NO

Describe:

Contingency Plans geoharzards description:

Contingency Plans geohazards attachment:

Hydrogen Sulfide drilling operations plan required? YES

Hydrogen sulfide drilling operations plan:

Lea_Unit__65H_H2S_Briefing_Areas_and_Alarm_Locations_V_Door_East_20180509101237.pdf

Section 8 - Other Information

Proposed horizontal/directional/multi-lateral plan submission:

Lea_Unit_65H_Pilot_Hole_Planning_Report_Plan_2_20180509124647.pdf

Lea_Unit_65H_Sidetrack_Hole_Planning_Report_Plan_2_20180509124705.pdf

Other proposed operations facets description:

Other proposed operations facets attachment:

Lea_Unit_65H_Pilot_Hole_AC_Report_Plan_2_20180509124816.pdf
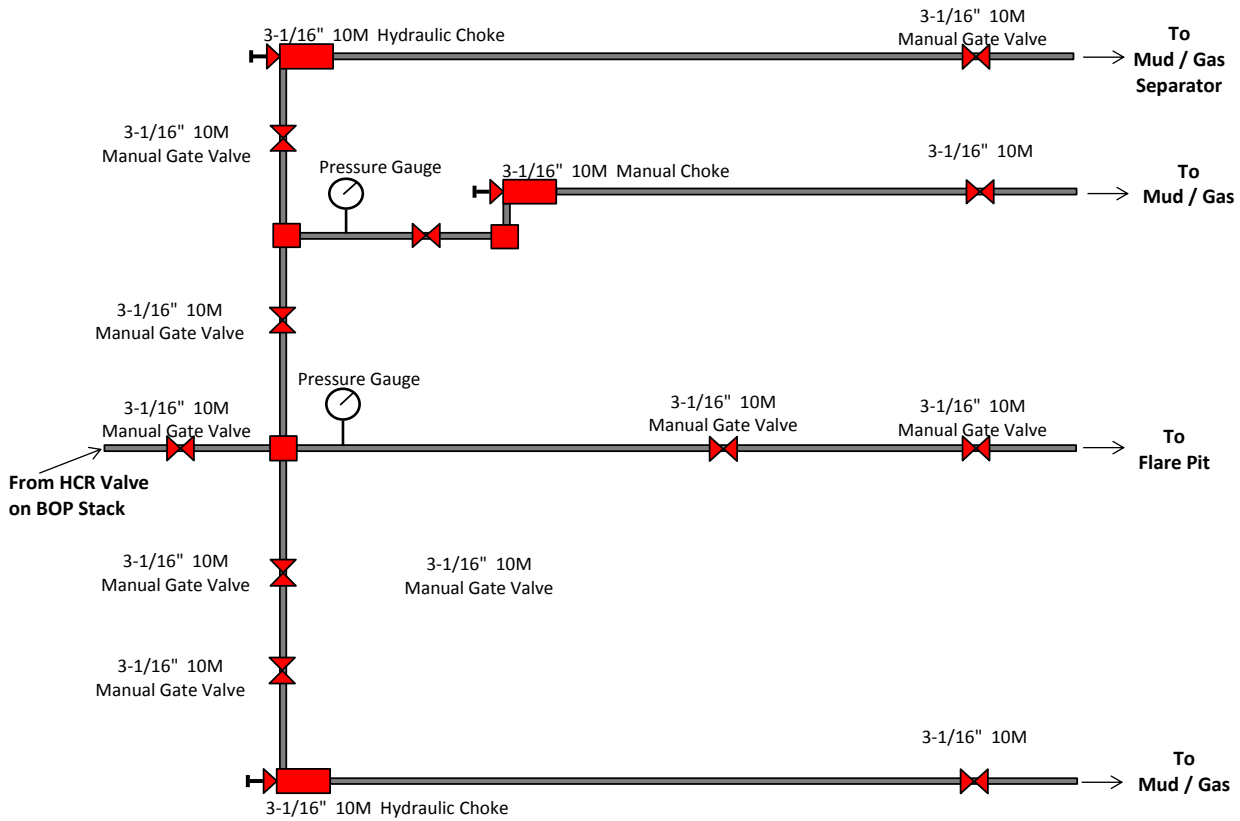
Lea_Unit_65H_Sidetrack_Hole_AC_Report_Plan_2_20180509124827.pdf

Lea_Unit_65H_Sidetrack_Hole_Plot_Plan_2_20180509124927.pdf

Other Variance attachment:

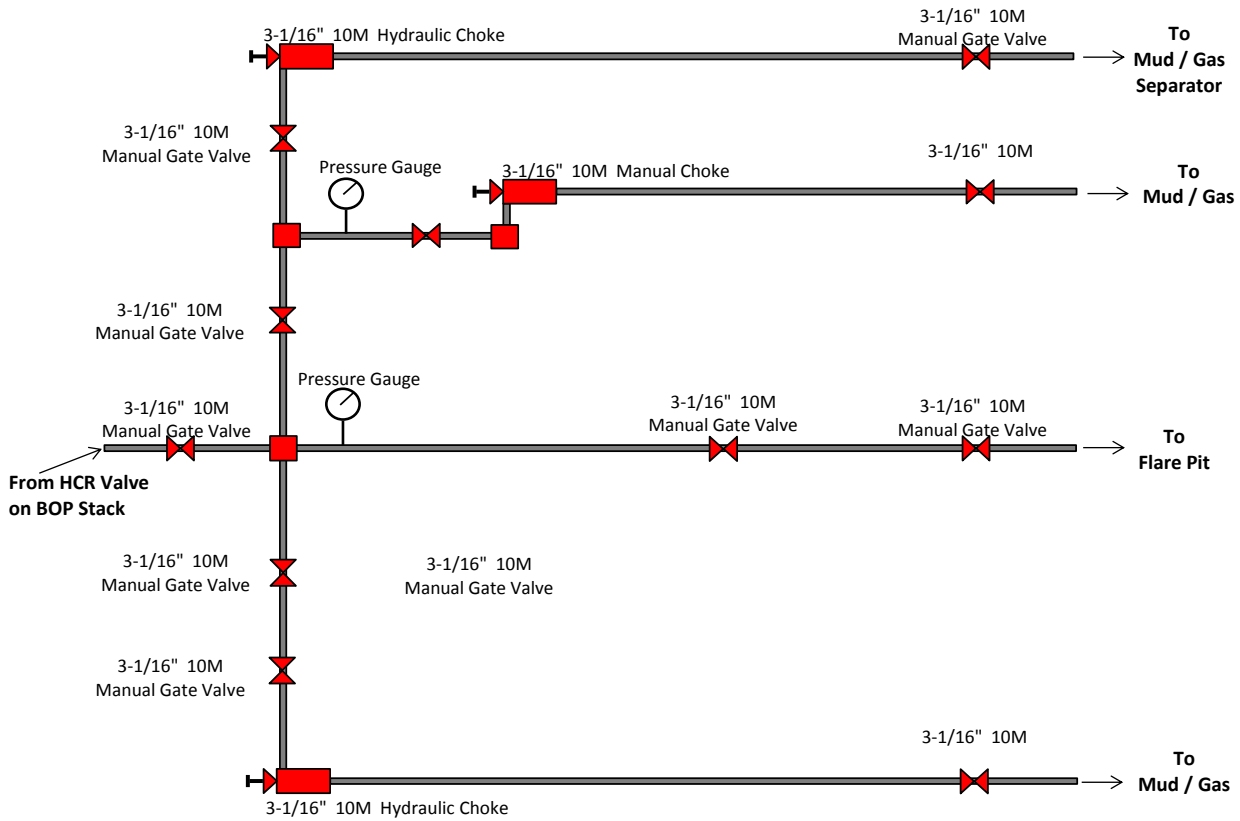Flex_Hose_Specs_20180509124725.pdf

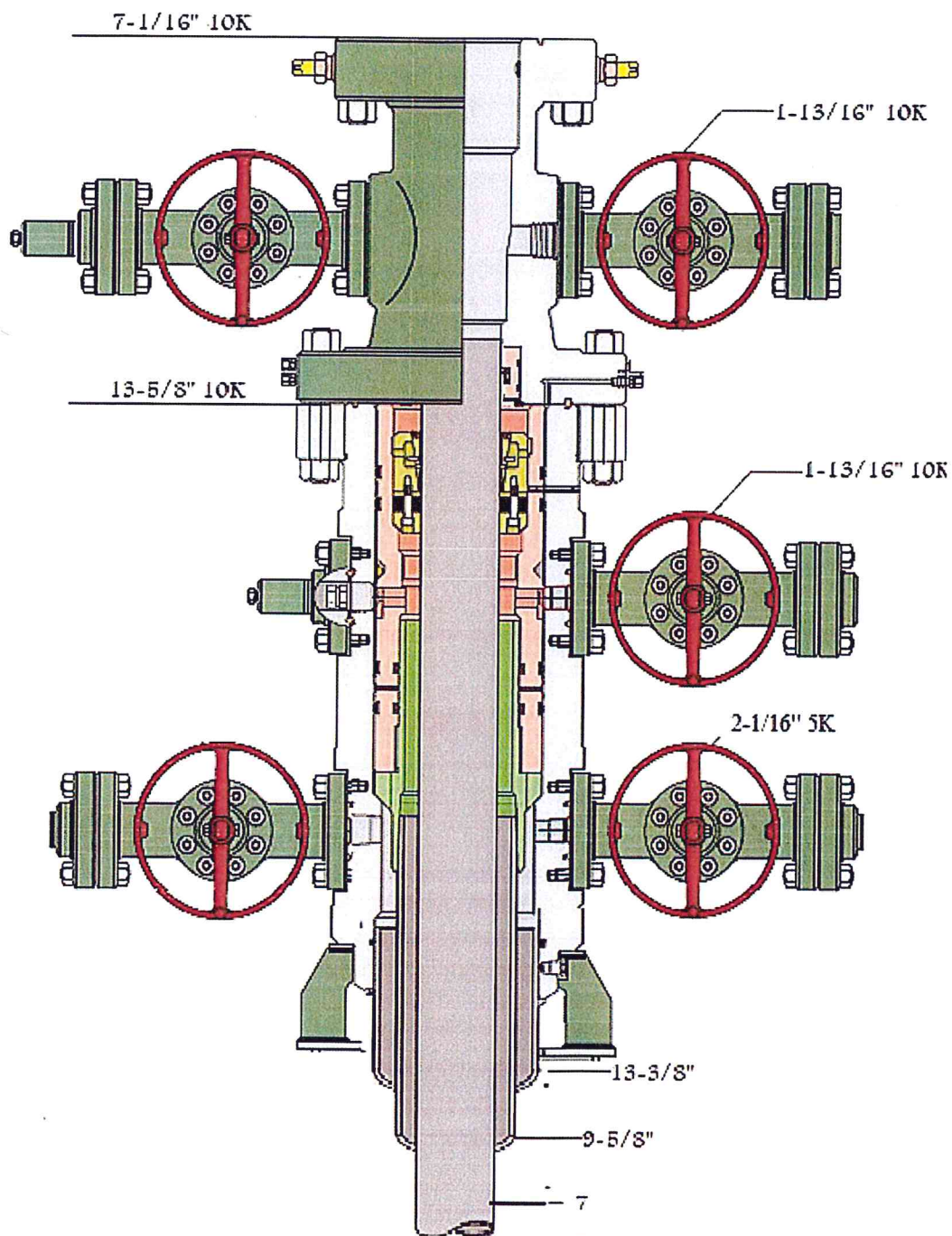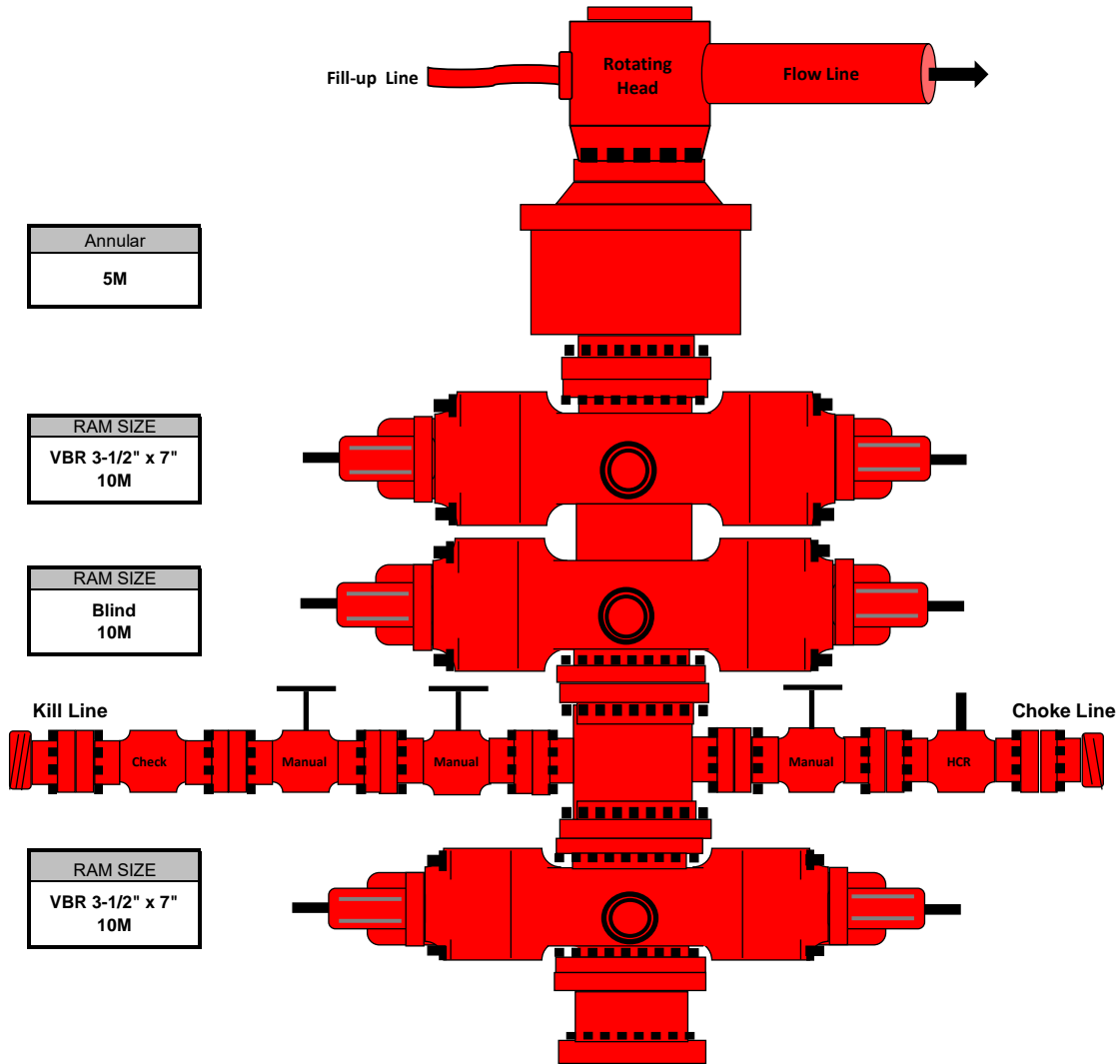# Choke Manifold (10M)

3-1/16" 10M Hydraulic Choke

3-1/16" 10M
Manual Gate Valve

To
Mud / Gas
Separator

3-1/16" 10M
Manual Gate Valve

Pressure Gauge

3-1/16" 10M Manual Choke

3-1/16" 10M

To
Mud / Gas

3-1/16" 10M
Manual Gate Valve

Pressure Gauge

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

To
Flare Pit

From HCR Valve
on BOP Stack

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M

To
Mud / Gas

3-1/16" 10M Hydraulic Choke

Choke Manifold (10M)

3-1/16" 10M Hydraulic Choke

3-1/16" 10M
Manual Gate Valve

**To
Mud / Gas
Separator**

3-1/16" 10M
Manual Gate Valve

Pressure Gauge

3-1/16" 10M Manual Choke

3-1/16" 10M

**To
Mud / Gas**

3-1/16" 10M
Manual Gate Valve

Pressure Gauge

3-1/16" 10M
Manual Gate Valve

**From HCR Valve
on BOP Stack**

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

**To
Flare Pit**

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M
Manual Gate Valve

3-1/16" 10M

**To
Mud / Gas**

3-1/16" 10M Hydraulic Choke

7-1/16" 10K

1-13/16" 10K

13-5/8" 10K

1-13/16" 10K

2-1/16" 5K

13-3/8"

9-5/8"

7

LEGACY RESERVES
Matt Dickson
Well: Lea Unit 65h

CAMERON
A Schlumberger Company

| Name: | Date: | Working Pressure: | # | 1598854 |

13-5/8" BOP Stack (10M)

Fill-up Line

Rotating Head

Flow Line

Annular
5M

RAM SIZE
VBR 3-1/2" x 7"
10M

RAM SIZE
Blind
10M

Kill Line

Check

Manual

Manual

Manual

HCR

Choke Line

RAM SIZE
VBR 3-1/2" x 7"
10M

7-1/16" 10K

1-13/16" 10K

13-5/8" 10K

1-13/16" 10K

2-1/16" 5K

13-3/8"

9-5/8"

7

LEGACY RESERVES
Matt Dickson
Well: Lea Unit 65h

CAMERON
A Schlumberger Company

1598854

13-5/8" BOP Stack (10M)

Rotating Head

Fill-up Line

Flow Line

Annular
5M

RAM SIZE
VBR 3-1/2" x 7" **10M**

RAM SIZE
Blind **10M**

Kill Line

Choke Line

Check   Manual   Manual   Manual   HCR

RAM SIZE
VBR 3-1/2" x 7" **10M**

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

> Collapse Calculations: Collapse Rating / Collapse Force
>
> *Complete Evacuation:*
> 1,130psi / [(0.44psi/ft)(1,800')] = **1.42**
>
> *Cementing Operations:*
> 1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: DF_B = 1.25

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

> Burst Calculations: Internal Yield Rating / Internal Force
>
> *Casing Pressure Test:*
> 2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

> Tensile Calculations: Joint Strength / Axial Load
>
> *Overpull:*
> 514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

Intermediate I Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

Cementing Operations:
5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: DF_B = 1.25

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

Gas Kick at 7" liner shoe:
6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

Cementing Operations:
11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

Gas Kick at 7" liner shoe:
12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

Production Operations:
10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

Production Operations:
12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

  Collapse Calculations: Collapse Rating / Collapse Force

  Cementing Operations:
  11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

  Production Operations:
  11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

  Burst Calculations: Internal Yield Rating / Burst Force

  Frac Pressure:
  12,450psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(9,700'TVD)] = **1.26**

  Production Operations:
  12,450psi / [(0.5 psi/ft – 0.22 psi/ft)(9,700'TVD)] = **4.58**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

  Tensile Calculations: Joint Strength / Axial Load

  Overpull:
  1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

DRILLING PLAN
LEA UNIT 65H
LEGACY RESERVES OPERATING LP
SHL: UL M, Section 12
BHL: UL E, Section 24
T20S-R34E, Lea County, New Mexico

To satisfy requirements of Onshore Oil and Gas Order No. 1, Legacy Reserves Operating LP submits the following for your consideration:

1. **_Location:_**   SHL: 220' FSL & 785' FWL, Sec. 12, T20S-R34E (First Take: 330' FNL & 660' FWL, Sec. 13)

    BHL: 2310' FNL & 660' FWL, Sec. 24, T20S-R34E (Last Take Point)

2. **_Elevations:_**   3,654' GL

3. **_Geological Name of Surface Formation:_**   Quaternary alluvium deposits

4. **_Drilling Tools and Associated Equipment:_**   Rotary drilling rig using fluid as a means for removal of solid cuttings from the well.

5. **_Proposed Drilling Depth:_**

    Pilot-Hole : **+/-** 12,300' MD   12,200' TVD

    Horizontal: **+/-** 18,500' MD   10,980' TVD

6. **_Estimated Tops of Geological Markers:_**

Rustler	1,680'	Avalon Middle Shale	8,772'
Top Salt	1,720'	Middle Avalon Carb	9,029'
Bottom Salt	3,150'	1st Bone Spring	9,443'
Top of Capitan Reef	3,150'	1st BS M	9,553'
Capitan Reef Bottom	4,710'	2nd BS	10,006'
San Andres	4,710'	3rd BS Carb	10,485'
Queen	4,719'	3rd Bone Spring Sh	10,816'
Cherry Canyon	6,464'	3rd BS Sh Base	10,899'
Brushy Canyon	7,090'	Wolfcamp	10,971'
Bone Spring	8,191'	Strawn	12,042'

7. **_Possible mineral bearing formations:_**

    Primary: Wolfcamp (oil & gas)   Secondary: Bone Spring (oil); Delaware (oil), Avalon (oil), fresh water (~125')

8. **_Proposed Mud System:_**

Depth	Mud Wt.	Visc	Type Mud
0' - 1800'	8.4-9.2	28-40	Fresh Water/Gel Spud Mud
1800' - 5600'	10.0-10.2	28-30	Brine Water
5600' - 10,000'	8.8-9.2	28-30	Fresh Water/Brine
10,000' - 12,200'	9.0 -12.0	38-40	Fresh Water Mud
10,000' – 18,500'	9.0 -9.5	55-65	Oil-Base Mud (OBM)

*Sufficient mud materials will be kept on location at all times in order to combat lost circulation or unexpected kicks. A Pason PVT system will be rigged up prior to spudding this well. A volume monitoring system that measures, calculates and displays readings from the mud system on the rig to alert the rig crew of impending gas kicks and lost circulation. In order to effectively run open hole logs and casing, the mud viscosity and fluid loss properties may be adjusted.

9. ***Proposed Drilling Plan:***
   Set surface and intermediate casing and cement to surface. Drill 8-1/2" hole to ~10,000', set 7" intermediate liner. Drill 6" pilot hole and gather core through Wolfcamp interval, down to approximately 12,200' MD. Pump a cement isolation plug to the top of the Wolfcamp and spot a "kick-off" cement plug. Kick-off at approximately 10,200' MD and drill 6" hole to TD of ~18,500' MD. Set 4-1/2" liner from ~9,500' to TD (~18,500'). Cement 4-1/2" production liner back to the top of the expandable liner hanger at ~9,500' MD (500' overlap). Run a 7" tie-back string from surface to the top of the 7" liner at 5300', and circulate cement back to surface.

10. ***Casing Information:***

String	Hole size	Depth	Casing OD	Collar	Weight	Grade
Surface	17-1/2"	1800' MD	New 13-3/8"	STC	54.5#	J-55
Intermediate I	12-1/4"	4000' MD	New 9-5/8"	LTC	40#	J-55
Intermediate II	12-1/4"	5600' MD	New 9-5/8"	LTC	40#	HCK-55
Intermediate Liner	8-1/2"	10000' MD	New 7"	BTC	32#	P-110HC
Production Liner	6"	18,314' MD	New 4-1/2"	BTC	13.5#	P-110
Intermediate Tie-Back	8-1/2"	5300' MD	New 7"	BTC	32#	P-110HC

13-3/8", 54.5#, J-55:

Collapse Factor:	1.42
Burst Factor:	3.86
Tension Factor:	2.59

9-5/8", 47#, HCL-80

Collapse Factor:	1.97
Burst Factor:	1.43
Tension Factor:	2.99

7", 32#, P-110HC Liner

Collapse Factor:	2.41
Burst Factor:	2.09
Tension Factor:	4.09

4-1/2", 13.5#, P-110

Collapse Factor:	1.94
Burst Factor:	1.25
Tension Factor:	1.91

7", 32#, P-110HC Tie-Back

Collapse Factor:	2.45
Burst Factor:	1.26
Tension Factor:	2.49

Cementing Information:

Surface Casing (0 - 1,800': 13-3/8", 54.5#)

Lead: 1300 sxs class C cement + 4% bwoc bentonite + 0.4 pps Defoamer + 0.125 pps Cellophane

(13.50 ppg, 1.72 cfps, 9.10 gps wtr).

Tail: 200 sxs class C Neat

(14.80 ppg, 1.32 cfps, 6.30 gps wtr).

Intermediate I Casing (0 - 5,600': 9-5/8", 40#)

In the event that circulation is lost (> 50%) while drilling the 12-1/4" intermediate hole in the Capitan Reef at +/-4000', we will plan to install a DV tool and external casing packer within 200' of the top depth where lost circulation occurred and will pump a two-stage cement job with the potential to add an additional DV tool for a three-stage cement job. If there is no lost circulation a single stage cementing procedure will be followed. Legacy plans to cement to surface regardless of whether a single stage, 2-stage or 3-stage procedure is implemented.

No DV tool   *(80% excess on lead & 80% excess on tail to design for cement top at surface)*

Lead: 1700 sx (35:65) poz (fly ash) Class C cement+ 6% bwoc Bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder + 0.4 pps Defoamer

(12.6 ppg, 1.94 cfps, 10.54 gps wtr)

Tail: 200 sx Class H cement

(15.6 ppg, 1.18 cfps, 5.22 gps wtr)

With (1) DV Tool *(100% excess on lead & 100% excess on tail to design for cement top at surface)*

Assuming DV tool set at 3950' but if the setting depth changes, cement volumes will be adjusted proportionately.

*Stage 1

Lead: 1700 sx (35:65) poz (fly ash) Class C cement+ 6% bwoc bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder + 0.4 pps Defoamer

(12.6 ppg, 1.94 cfps, 10.54 gps wtr)

Tail: 200 sx class H cement

(15.6 ppg, 1.18 cfps, 5.22 gps wtr)

*Stage 2

Lead: 1200 sx (35:65) poz (fly ash) Class C cement+ 6% bwoc bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder + 0.4 pps Defoamer

(12.6 ppg, 1.94 cfps, 10.54 gps wtr))

Tail: 200 sx class H cement

(15.6 ppg, 1.18 cfps, 5.22 gps wtr)

With (2) DV Tools *(100% excess on lead & 100% excess on tail to design for cement top at surface)*

Assuming one DV tool set at 3950' and one DV tool set at ~1900' but if the setting depths change, cement volumes will be adjusted proportionately.

*Stage 1

<u>Lead:</u>   1700 sx (35:65) poz (fly ash) Class C cement+ 6% bwoc bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder + 0.4 pps Defoamer
   (12.6 ppg, 1.94 cfps, 10.54 gps wtr)

<u>Tail:</u>   200 sx class H cement
   (15.6 ppg, 1.18 cfps, 5.22 gps wtr)

*Stage 2

<u>Lead:</u> 1200 sx (35:65) poz (fly ash) Class C cement+ 6% bwoc bentonite + 0.5% bwoc Fluidloss + 0.15% bwoc Retarder + 0.4 pps Defoamer
   (12.6 ppg, 1.94 cfps, 10.54 gps wtr))

<u>Tail:</u>   200 sx class H cement
   (15.6 ppg, 1.18 cfps, 5.22 gps wtr)

*Stage 3

<u>Tail:</u>   700 sxs class C Neat
   (14.80 ppg, 1.32 cfps, 6.30 gps wtr).

Intermediate Liner (5,300' – 10,000': 7", 32#)
<u>Tail:</u>   450 sx PVL + 1.3% bwoc Salt + 5% bwoc Expanding Cement + 0.5% bwoc Fluidloss + 0.3% bwoc Retarder + 0.1% bwoc Anti-settling Agent + 0.4 pps Defoamer
   (12.6 *ppg,* 1.62 cfps, 8.62 *gps* wtr)

Isolation Plug (12,200' – 11,000': 6" OH)
   450 sx class H cement + 0.3% bwoc Retarder
   (15.6 ppg, 1.18 cfps, 5.22 gps wtr)

Kick-off Plug (11,000' – 10,200': 6" OH)
   385 sx class H cement + 0.2% bwoc Retarder + 0.5% bwoc Dispersant
   (17.5 ppg, 0.94 cfps, 3.36 gps wtr)

Production Liner (9,500' – 18,500': 4-1/2", 13.5#)
<u>Tail:</u>   700 sxs (50:50) poz (fly ash) class H cement + 2% bwoc Bentonite + 5% bwow Salt + 0.5% bwoc Fluidloss + 0.2% bwoc Retarder + 0.2% bwoc Dispersant + 0.4 pps Defoamer
   (14.2 ppg, 1.34 cf/sx, 6.08 gps wtr).

Intermediate Tie-Back (0' – 5,300': 7", 32#)
<u>Tail:</u>   800 sx class H cement
   (15.6 ppg, 1.18 cfps, 6.3 gps wtr)

11. ***Pressure Control Eqpt/BOP:***

Legacy Reserves plans to use a 13-5/8" 5,000-psi working pressure BOP system consisting of a double ram BOP with one ram being pipe and one ram being blind, a 5,000-psi annular type preventer, a 5,000-psi choke manifold and 80 gallon accumulator with rig floor, five remote operating stations and an auxiliary power system. A rotating head will be utilized below surface interval. A drill string safety valve in the open position will be available on the rig floor. A mud gas separator will be available for use if needed.

A 3M BOP will be used to drill from the surface casing shoe (~1800') to the intermediate casing shoe (~5600'). The BOP will be a 5M system, however the "A" section wellhead will be a 3M wellhead (see attached BOP Diagram).

The BOP unit will be hydraulically operated. The BOP will be operated at least once per day while drilling and the blind rams will be operated when out of hole during trips. No abnormal pressure or temperature is expected while drilling.

The BOPs will be tested by an independent service company to 250 psi low and 5000 psi high.

12. ***Testing, Logging, and Coring Program:***
   A. Mud logging program: 2 man unit from approximately 5600', after setting intermediate I casing.
   B. 6" vertical pilot hole to be drilled, with planned coring interval of **~**11,000' TVD to **~**12,000' TVD
   C. Open-hole wireline logs will be ran after pilot-hole TD is reached at **~12,300' MD.**

13. ***Potential Hazards***

No abnormal pressures or temperatures are expected during the drilling of this well. If H2S is encountered the operator will comply with provisions of Onshore Order 6. Since there will be an H2S Safety package on location, attached is an "H2S Drilling Operations Plan". Adequate flare lines will be installed on the mud/gas separator so gas may be flared safely. All personnel will be familiar with all aspects of safe operations of equipment being used. Lost circulation may occur and a cement contingency plan is included in this plan along with mud materials to be kept on location at all times in order to combat lost circulation or unexpected kicks. Estimated BHP: 4700 psi, estimated BHT: 192°F.

14. ***Road and Location***

Road and location construction to expand the existing pad will begin after BLM approval of the APD. Drilling is expected to take 30-35 days and an additional 10 days for the completion.

15. ***Additional Requirements of Project:***

Completion: The targeted Bone Spring pay zone will be perforated and stimulated in multiple stages using acid and hydraulic fracturing treatments. Fresh water used in the drilling and completion of this well will be transferred from off-site via temporary flowlines and stored in frac tanks on the location.

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

        Complete Evacuation:
                1,130psi / [(0.44psi/ft)(1,800')] = **1.42**

        Cementing Operations:
                1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

    Burst Calculations: Internal Yield Rating / Internal Force

        Casing Pressure Test:
                2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

        Overpull:
                514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

<u>*Intermediate I Casing*</u>

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

> Collapse Calculations: Collapse Rating / Collapse Force

> > *Complete Evacuation:*
> > 5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

> > *Cementing Operations:*
> > 5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

> Burst Calculations: Internal Yield Rating / Burst Force

> > *Casing Pressure Test:*
> > 6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

> > *Gas Kick at 7" liner shoe:*
> > 6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

> Tensile Calculations: Joint Strength / Axial Load

> > *Overpull:*
> > 1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

   Collapse Calculations: Collapse Rating / Collapse Force

   Complete Evacuation:
   11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

   Cementing Operations:
   11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

   Burst Calculations: Internal Yield Rating / Burst Force

   Casing Pressure Test:
   12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

   Gas Kick at 7" liner shoe:
   12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

   Tensile Calculations: Joint Strength / Axial Load

   Overpull:
   1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

  Cementing Operations:
  10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

  Production Operations:
  10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

    Burst Calculations: Internal Yield Rating / Burst Force

  Frac Pressure:
  12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

  Production Operations:
  12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

  Overpull:
  422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

Production Operations:
11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,450psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(9,700'TVD)] = **1.26**

Production Operations:
12,450psi / [(0.5 psi/ft – 0.22 psi/ft)(9,700'TVD)] = **4.58**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

    Complete Evacuation:
        1,130psi / [(0.44psi/ft)(1,800')] = **1.42**

    Cementing Operations:
        1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: DF_B = 1.25

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

    Burst Calculations: Internal Yield Rating / Internal Force

    Casing Pressure Test:
        2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

    Overpull:
        514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

Intermediate I Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

Cementing Operations:
5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

Gas Kick at 7" liner shoe:
6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

   Collapse Calculations: Collapse Rating / Collapse Force

   Complete Evacuation:
   11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

   Cementing Operations:
   11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

   Burst Calculations: Internal Yield Rating / Burst Force

   Casing Pressure Test:
   12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

   Gas Kick at 7" liner shoe:
   12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

   Tensile Calculations: Joint Strength / Axial Load

   Overpull:
   1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

    Cementing Operations:
    10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

    Production Operations:
    10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

    Burst Calculations: Internal Yield Rating / Burst Force

    Frac Pressure:
    12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

    Production Operations:
    12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

    Overpull:
    422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

Production Operations:
11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: $DF_B = 1.25$

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,450psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(9,700'TVD)] = **1.26**

Production Operations:
12,450psi / [(0.5 psi/ft – 0.22 psi/ft)(9,700'TVD)] = **4.58**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
1,130psi / [(0.44psi/ft)(1,800')] = **1.42**

Cementing Operations:
1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

Burst Calculations: Internal Yield Rating / Internal Force

Casing Pressure Test:
2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

Intermediate I Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

> Collapse Calculations: Collapse Rating / Collapse Force

> *Complete Evacuation:*
> 5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

> *Cementing Operations:*
> 5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

> Burst Calculations: Internal Yield Rating / Burst Force

> *Casing Pressure Test:*
> 6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

> *Gas Kick at 7" liner shoe:*
> 6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

> Tensile Calculations: Joint Strength / Axial Load

> *Overpull:*
> 1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

Cementing Operations:
11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

Gas Kick at 7" liner shoe:
12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

Production Operations:
10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: $DF_B = 1.25$

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

Production Operations:
12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

Production Operations:
11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: $DF_B = 1.25$

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,450psi / [(9500 psi)+ (0.47 − 0.433psi/ft)(9,700'TVD)] = **1.26**

Production Operations:
12,450psi / [(0.5 psi/ft − 0.22 psi/ft)(9,700'TVD)] = **4.58**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

> Collapse Calculations: Collapse Rating / Collapse Force
>
> *Complete Evacuation:*
> 1,130psi / [(0.44psi/ft)(1,800')] = **1.42**
>
> *Cementing Operations:*
> 1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: DF_B = 1.25

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

> Burst Calculations: Internal Yield Rating / Internal Force
>
> *Casing Pressure Test:*
> 2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

> Tensile Calculations: Joint Strength / Axial Load
>
> *Overpull:*
> 514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

Intermediate I Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: $DF_C = 1.25$

Base Assumptions

- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

    Complete Evacuation:
    5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

    Cementing Operations:
    5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: $DF_B = 1.25$

Base Assumption

- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

    Burst Calculations: Internal Yield Rating / Burst Force

    Casing Pressure Test:
    6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

    Gas Kick at 7" liner shoe:
    6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: $DF_T = 1.6$

Base Assumption

- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

    Overpull:
    1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

Cementing Operations:
11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

Gas Kick at 7" liner shoe:
12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

Production Operations:
10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: $DF_B = 1.25$

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

Production Operations:
12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

Production Operations:
11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,450psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(9,700'TVD)] = **1.26**

Production Operations:
12,450psi / [(0.5 psi/ft – 0.22 psi/ft)(9,700'TVD)] = **4.58**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

Surface Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
13.375"	J-55	54.5	1130 psi	2730 psi	514 kips	BTC	1800'	98,100 lbs	8.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal force equivalent to the fresh water displacement fluid (0.433 psi/ft).

    Collapse Calculations: Collapse Rating / Collapse Force

        Complete Evacuation:
            1,130psi / [(0.44psi/ft)(1,800')] = **1.42**

        Cementing Operations:
            1,130psi / [(0.77psi/ft – 0.433psi/ft)(1800')] = **1.86**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an external force equivalent to the mud gradient (0.44 psi/ft) in which the casing will be ran.

    Burst Calculations: Internal Yield Rating / Internal Force

        Casing Pressure Test:
            2,730psi / [(1500psi)-(0.44 psi/ft)(1,800')] = **3.86**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight without considering the effects of buoyancy.

    Tensile Calculations: Joint Strength / Axial Load

        Overpull:
            514 kips / (100,000 lbs. + 98,100 lbs.) = **2.59**

Intermediate I Casing

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
9.625"	HCL-80	47	5740 psi	6870 psi	1086 kips	BTC	5600'	263,200 lb	10.0 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
5,740psi / [(0.52psi/ft)(5,600')] = **1.97**

Cementing Operations:
5,740 psi / [(0.77psi/ft – 0.433psi/ft)(5600')] = **3.04**

Burst: $DF_B = 1.25$

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg and external force equivalent to 8.4 ppg.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
6,870 psi / [(1500psi +2504 psi) - (2446psi)] = **4.41**

Gas Kick at 7" liner shoe:
6,870 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4000')] = **1.43**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1086 kips / (100,000 lbs. + 263,200 lbs.) = **2.99**

Intermediate Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	4,700'	150,400 lb	9.2 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Complete internal evacuation of the casing, utilizing a collapse force equivalent to the mud gradient (0.52 psi/ft) in which the casing will be ran.
- Cementing operations in which, utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Complete Evacuation:
11,890psi / [(0.494psi/ft)(10,000')] = **2.41**

Cementing Operations:
11,890 psi / [(0.77psi/ft – 0.433psi/ft)(10,000')] = **3.53**

Burst: DF_B = 1.25

Base Assumption
- Casing pressure test as per Onshore Oil and Gas Order No. 2 (0.22 psi/ft or 1500 psi), utilizing an internal force equivalent to the displacement fluid of 8.6 ppg, with complete evacuation of the casing annular.
- Gas kick at the 7" liner shoe, in which a 0.7 psi/ft shoe test is assumed, and 0.22 psi/ft gas gradient is assumed, along with complete evacuation of the casing annular.

Burst Calculations: Internal Yield Rating / Burst Force

Casing Pressure Test:
12,450 psi / (1500psi) + [(0.45)(5600')]= **3.1**

Gas Kick at 7" liner shoe:
12,450 psi / [(0.7psi/ft)(10,000')-(0.22psi/ft)(4700')] = **2.09**

Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
1025 kips / (100,000 lbs. + 150,400 lbs.) = **4.09**

Production Liner

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
4.5"	P-110	13.5	10690 psi	12420 psi	422 kips	BTC	9,000'	121,500 lb	9.5 ppg

Collapse: $DF_C = 1.25$

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and an internal back-up force equivalent to the fresh water displacement fluid (0.433 psi/ft).
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

Collapse Calculations: Collapse Rating / Collapse Force

Cementing Operations:
10,690psi / [(0.77 psi/ft-0.433 psi/ft)(11,000'TVD)] = **2.89**

Production Operations:
10,690psi / (11,000' TVD)(0.5 psi/ft) = **1.94**

Burst: $DF_B = 1.25$

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft.

Burst Calculations: Internal Yield Rating / Burst Force

Frac Pressure:
12,420psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(11,000'TVD)] = **1.25**

Production Operations:
12,420psi / [(0.5 psi/ft – 0.22 psi/ft)(11,000'TVD)] = **4.03**

Tensile: $DF_T = 1.6$

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string and without considering the effects of buoyancy.

Tensile Calculations: Joint Strength / Axial Load

Overpull:
422,000 lbs /[(100,000 lbs.) + (121,500 lbs.)] = **1.91**

7" Liner Tie-Back

Size	Grade	#/ft	Collapse	Burst (Internal Yield)	Tensile	Coupling	Length	Dry Weight	Mud Weight
7"	P-110HC	32	11890 psi	12450 psi	1025 kips	BTC	9,700'	310,400 lb	9.5 ppg

Collapse: DF_C = 1.25

Base Assumptions
- Cementing operations in which utilizes a collapse force equivalent to the gradient of the planned cement slurry (0.77 psi/ft) and pipe completely evacuated.
- Production operations in which the pipe is completely evacuated with an external force equivalent to the pore pressure gradient (0.5 psi/ft).

>   Collapse Calculations: Collapse Rating / Collapse Force

> *Cementing Operations:*
> 11,890 psi / [(0.77 psi/ft)(5,300'TVD)] = **2.92**

> *Production Operations:*
> 11,890psi / (9,700' TVD)(0.5 psi/ft) = **2.45**

Burst: DF_B = 1.25

Base Assumption
- Frac pressure utilizing a surface pressure of 9500 psi along with a frac fluid gradient equivalent to 0.47 psi/ft and an external force equal to the minimum fluid gradient (0.433 psi/ft) in which the casing will be cemented.
- Production operations in which the casing is completely filled with a gas equivalent gradient of 0.22 psi/ft and an external force equivalent to pore pressure of 0.5 psi/ft, with top of production liner at 9700'

>   Burst Calculations: Internal Yield Rating / Burst Force

> *Frac Pressure:*
> 12,450psi / [(9500 psi)+ (0.47 – 0.433psi/ft)(9,700'TVD)] = **1.26**

> *Production Operations:*
> 12,450psi / [(0.5 psi/ft – 0.22 psi/ft)(9,700'TVD)] = **4.58**
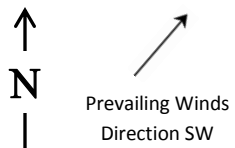
Tensile: DF_T = 1.6

Base Assumption
- A downward force of 100,000 lb. overpull is applied at the base of the casing along with the weight of the string without considering the effects of buoyancy.

>   Tensile Calculations: Joint Strength / Axial Load

> *Overpull:*
>   1025 kips / (100,000 lbs. + 310,400 lbs.) = **2.49**

H2S Briefing Areas and Alarm Locations

N

Prevailing Winds
Direction SW

155 ft.

Flare line 150 ft. from wellbore

Mudhouse

Closed Loop System

Steel Pit   Steel Pit

Pumps

Catwalk

150 ft.

340 ft.

Rig

Generator House

Water Tank

Water Tank

Fuel Tank

Parts House

250 ft.

Legend

Wellhead

Wind Indicator

Safe Briefing Area

Self-Contained Breathing Apparatus (SCBA)

H_2S Sensors

H_2S Alarm

H_2S Briefing Area

Housing   Housing   Housing   Housing

Alternate H_2S Briefing Area

Access Road

Secondary Egress