CASING DESIGN CALCULATIONS

A. BURST DESIGN

Drilling Conditon Criteria is the lesser of either the "FGASP" (Frac Gradient method Anticipated Surface Pressure) or the "BHPASP" (Bottom Hole Pressure method Anticip Surface Pressure).

Producing Condition Criteria for Casing Strings/Liners designed to be used for production: "BHPASP" is full BHP less gas gradient to surf

18 5/8" " Cond @ 0 to 1100 'MD; 0 to 1100 'TVD 94.50 ppf K-55 gr BTC conn

FGASP = (FG*TVD*0.052) - (GG*TVD)
FGASP = [(12.0) x (1100) x (0.052)] - [(0.10) x (1100)]
FGASP = 576 psi

BHPASP = (PP*TVD*0.052) - (GG*TVD*EVAC%) - (MW*TVD*0.052*(1-EVAC%))
BHPASP = [(9.5) x (4500) x (0.052)] - [(0.10) x (4500) x (0.70)] - [(10) x (4500) x (0.052) x (0.30)]
BHPASP = 1206 psi

Design Factor (SF): 2,420 / 576 = 4.20 Drilling condition

CASING TEST PRESSURE = 200 psi (diverter in use)

13 3/8 " Surf @ 0 to 5582 'MD; 0 to 4500 'TVD 68.00 ppf NT80-HE gr BTC conn

FGASP = (FG*TVD*0.052) - (GG*TVD)
FGASP = [(15.8) x (4500) x (0.052)] - [(0.10) x (4500)]
FGASP = 3247 psi

BHPASP = (PP*TVD*0.052) - (GG*TVD*EVAC%) - (MW*TVD*0.052*(1-EVAC%))
BHPASP = [(11.9) x (6500) x (0.052)] - [(0.10) x (6500) x (0.70)] - [(12.5) x (6500) x (0.052) x (0.30)]
BHPASP = 2300 psi

Design Factor (SF): 5310 / 2300 = 2.31 Drilling Condition

CASING TEST PRESSURE = [(Casing Burst) (.70)] - [(MW in casing during test - 9 ppg backup) (.052) (TVD)]
CASING TEST PRESSURE = [(5310) (0.70)] - [(10 - 9.0) (0.052) (4500)]
CASING TEST PRESSURE = 3483 psi

9 5/8 " Inter @ 0 to 8201 'MD; 0 to 6500 'TVD 47.00 ppf P110-HC gr LTC conn

FGASP = (FG*TVD*0.052) - (GG*TVD)
FGASP = [(17.1) x (6500) x (0.052)] - [(0.10) x (6500)] **NOTE: FG based on PP/FG plot worst case M&K method**
FGASP = 5130 psi

BHPASP = (PP*TVD*0.052) - (GG*TVD*EVAC%) - (MW*TVD*0.052*(1-EVAC%))
BHPASP = [(14.7) x (8500) x (0.052)] - [(0.10) x (8500) x (0.70)] - [(15.2) x (8500) x (0.052) x (0.30)]
BHPASP = 3887 psi

Design Factor (SF): 9440 / 3887 = 2.43 Drilling Condition

BHPASP = (PP*TVD*0.052) - (GG*TVD)
BHPASP = [(14.7) x (8500) x (0.052)] - [(0.10) x (8500)
BHPASP = 5647 psi

Design Factor (SF): 9440 / 5647 = 1.67 Producing Condition

CASING TEST PRESSURE = [(Casing Burst) (.70)] - [(MW in casing during test - 9 ppg backup) (.052) (TVD)]
CASING TEST PRESSURE = [(9440) (0.70)] - [(12.5 - 9.0) (0.052) (6500)]
CASING TEST PRESSURE = 5425 psi

5-1/2" " Prod Lin @ 7,801 to 10233 'MD; 6100 to 8500 'TVD 17.00 ppf P110-HC gr SLX conn

BHPASP = (PP*TVD*0.052) - (GG*TVD)
BHPASP = [(14.7) x (8500) x (0.052)] - [(0.10) x (8500)]
BHPASP = 5647 psi

Design Factor (SF): 10640 / 5647 = 1.88 Producing Condition

LINER TOP TEST PRESSURE =[(FG Prev Casing Shoe) (.052) (TVD Prev Casing Shoe) + 500 psi] - [(MW in casing during test) (.052) (TVD Prev Casing Shoe)]
LINER TOP TEST PRESSURE =[(17.1) (0.052) (6500) + 500] - [(15.2) (0.052) (6500)]
LINER TOP TEST PRESSURE = 1142 psi

B. COLLAPSE DESIGN

18 5/8" " Cond @ 0 to 1100 'MD; 0 to 1100 'TVD 94.50 ppf K-55 gr BTC conn

Col = [(((0.45 psi/ft) (Mudline Depth)) + (0.052) x (MW Casing was Run in) x (Casing Setting Depth TVD)
Col = [((0.45) x (174)) + (0.052) x (9.1) x (1100) Assumes Full Evacuation of Conductor
Col = 599 psi

Design Factor (SF) : 780 / 599 = 1.30 Drilling Condition

13 3/8 " Surf @ 0 to 5582 'MD; 0 to 4500 'TVD 68.00 ppf NT80-HE gr BTC conn

Col = [(MW Casing was Run in) x (Casing Setting Depth TVD) x (0.052)
Col = [((10.00) x (4500)) + (0.052) Assumes Full Evacuation of Surface Casing
Col = 2340 psi

Design Factor (SF) : 3080 / 2340 = 1.32 Drilling Condition

Col = [((MW this casing run in) (TVD this csg shoe) (0.052) - (TVD this csg shoe) -(TVD next hole section x %Evac) x (MW in casing) x (0.052)
Col = [(10.0) x (4500) x (0.052) - (4500) - ((6500) x (33%)) X (12.5) x (0.052)
Col = 823 psi 2167 = ft evacuated

Design Factor (SF) : 3080 / 823 = 3.74 Drilling Condition

9 5/8 " Inter @ 0 to 8201 'MD; 0 to 6500 'TVD 47.00 ppf P110-HC gr LTC conn

Col = [((MW this casing run in) (TVD this csg shoe) (0.052) - (TVD this csg shoe) -(TVD next hole section x %Evac) x (MW in casing) x (0.052)
Col = [(12.5) x (6500) x (0.052) - (6500) - ((8500) x (33%)) X (15.2) x (0.052)
Col = 1325 psi 2831 = ft evacuated from Csg

Design Factor (SF) : 7100 / 1325 = 5.36 Drilling Condition

Col = (MW this casing run in*TVD*0.052) - (GG*TVD)
Col = [(12.5) x (6500) x (0.052)] - [(0.10) x (6500)]
Col = 3575 psi

Design Factor (SF) : 7100 / 3575 = 1.99 Producing Condition

5-1/2" " Prod Lin @ 7,801 to 10233 'MD; 6100 to 8500 'TVD 17.00 ppf P110-HC gr SLX conn

Col = (MW this casing run in*TVD*0.052) - (GG*TVD)
Col = [(15.2) x (8500) x (0.052)] - [(0.10) x (8500)]
Col = 5868 psi

Design Factor (SF) : 8730 / 5868 = 1.49 Producing Condition

C. TENSION DESIGN

18 5/8" " Cond @ 0 to 1100 'MD; 0 to 1100 'TVD 94.50 ppf K-55 gr BTC conn

Ten = [(ppf*MD*Bf)+50000] /(1000) MW = 9.1 ppg BF = 0.861
Ten = [(94.50) x (1100) x (0.861) + (50000)] / (1000)
Ten = 139.5

Design Factor (SF) = (Mfg JtSt or BdSt) / Ten = **1533 / 139.5 = 10.99**

13 3/8 " Surf @ 0 to 5582 'MD; 0 to 4500 'TVD 68.00 ppf NT80-HE gr BTC conn

Ten = [(ppf*MD*Bf)+50000] /(1000) MW = 10.0 ppg BF = 0.847
Ten = [(68.00) x (5582) x (0.847) + (50000)] / (1000)
Ten = 371.6

Design Factor (SF) = (Mfg JtSt or BdSt) / Ten = 1556 / 371.6 = 4.19

9 5/8 " Inter @ 0 to 8201 'MD; 0 to 6500 'TVD 47.00 ppf P110-HC gr LTC conn

Ten = [(ppf*MD*Bf)+50000] /(1000) MW = 12.5 ppg BF = 0.809
Ten = [(47.00) x (8201) x (0.809) + (50000)] / (1000)
Ten = 361.9

Design Factor (SF) = (Mfg JtSt or BdSt) / Ten = 1500 / 361.9 = 4.14

5-1/2" " Prod Lin @ 7,801 to 10233 'MD; 6100 to 8500 'TVD 17.00 ppf P110-HC gr SLX conn

Ten = [(ppf*MD*Bf)+50000] /(1000) MW = 15.2 ppg BF = 0.768
Ten = [(17.00) x (2432) x (0.768) + (50000)] / (1000)
Ten = 81.7

Design Factor (SF) = (Mfg JtSt or BdSt) / Ten = 393 / 81.7 = 4.81

CASING DESIGN CRITERIA

BURST DESIGN CONDITIONS

A. DRILLING CONDITIONS

CALCULATION OF MAXIMUM ANTICIPATED SURFACE PRESSURE (MASP)

For drilling conditions, the BSEE accepts the lesser of two calculations for Maximum Anticipated Surface Pressure. The equations are known as "FGASP" and "BHPASP".
This spread sheet calculates the MASP by both methods.

MASP = Maximum Anticipated Surface Pressure = Lesser of FGASP or BHPASP

FGASP = Frac Gradient method Anticipated Surface Pressure = Maximum possible surface pressure based on casing shoe fracture pressure less gas gradient.

BHPASP = Bottom Hole Pressure method Anticipated Surface Pressure = Maximum anticipated surface pressure based on pore pressure at next casing point (or TD - as appropriate), expected mud density, and relevant % evacuation of mud in wellbore, with gas gradient in evacuated section.

B. PRODUCING CONDITIONS

MASP = Based on reservoir pressure or pore pressure at TD, less gas gradient to surface.

CASING TEST PRESSURES

For full casing strings, the BSEE requires that the casing be tested to 70% of rated burst, adjusted for the weight of the mud in the casing during the test and a 9.0 ppg minimum backup.

For liners, the BSEE requires that the liner be tested to a pressure equivalent to the frac gradient at the previous casing/liner lap + 500 psi, adjusted for the mud weight in the hole during the test.

COLLAPSE DESIGN CRITERIA

A. DRILLING CONDITIONS

1. Conductor - Complete evacuation, internal pressure inside the casing is zero.
   Surface - Complete evacuation, internal pressure inside the casing is zero.
   Surface - Partial evacuation of casing can be used. Base case assumes 33.33% (1/3rd) of next hol
   Intermediate - Partial evacuation of casing can be used. Base case assumes 33.33% (1/3rd) of ne
   Intermediate - Lost Circulation where the fluid column inside the casing drops to a height such that the casing balances the formation pressure of the theif zone should be considered as a design cas known depleated sands:
   [(Max MW next hole section - PP at zone of interest) (TVD this csg shoe) (MW this casing ru MW next hole section]

2. External pressure equal to the hydrostatic pressure exerted by the mud density that the casing will be run in.

B. PRODUCING CONDITIONS

1. Internal pressure equal to pressure exerted by a full column of gas (100% evacuation).

2. External pressure equal to the hyrostatic pressure exerted by the mud that the casing will be run in.

3. The detrimental effect of tension on collapse ratings accounted for at casing weight/grqade changeover points, if any.

TENSION DESIGN CRITERIA

Tensile loads are based on the buoyant weight of casing due to the mud density the casing will be run in, plus 50,000# overpull.

MP 207 #A-3

CASING DESIGN SUMMARY

Rig:	
RKB - MSL =	**100**
Water Depth =	**174**
RKB - ML =	**274**
RKB - MLH =	**N/A**

CASING DATA :

Casing	Size	Weight	Grade	Conn.	Int Yield	Col	Jt.Strength	Body Yield	ID	Drift	Conn ID	Conn OD
	OD in.	ppf			psi	psi	Kips	Kips	in.	in.	Bored, in.	in.
Drive Pipe	24	0.5 WT	Grade B	Welded					23.000	24.000		
Conductor	18 5/8"	94.50	K-55	BTC	2420	780	1533	1469	17.689	17.501		
Surface	13 3/8	68.00	NT80-HE	BTC	5310	3080	1585	1556	12.415	12.299		14.375
Intermediate	9 5/8	47.00	P110-HC	LTC	9440	7100	1500	1493	8.681	8.525		
Production Liner	5-1/2"	17.00	P110-HC	SLX	10640	8730	393	546	4.892	4.767	4.812	5.598

Casing	Size	Setting Depth, MD Feet			TVD Feet		PP	MW	FG	Evac	Gas Grad
	OD in.	from	to	ft	from	to	ppg	ppg	ppg	%	psi/ft
Drive Pipe	24	0	500	500	0	500					
Conductor	18 5/8"	0	1100	1100	0	1100	8.6	9.1	12.0	70%	0.10
Surface	13 3/8	0	5582	5582	0	4500	9.5	10.0	15.8	70%	0.10
Intermediate	9 5/8	0	8201	8201	0	6500	11.9	12.5	17.1	70%	0.10
Production Liner	5-1/2"	7801	10233	2432	6100	8500	14.7	15.2	17.9	70%	0.10

				DESIGN FACTORS BASED ON DRILLING LOADS								
				Burst		Collapse			Tension	MASP	MASP	Casing
Casing	Size	Weight	Grade	Drlg	Prod	Drlg	Prod			Drlg	Prod	Test Press
	OD in.	ppf		DFb	DFb	DFc	DFc	**	DFt	psi	psi	psi
Drive Pipe	24	0.5 WT	Grade B									
Conductor	18 5/8"	94.5	K-55	4.20		1.30			10.99	576		200
Surface	13 3/8	68.00	NT80-HE	2.31		1.32			4.19	2300		3483
Intermediate	9 5/8	47.00	P110-HC	2.43	1.67	5.36	1.99	gg	4.14	3887	5647	5425
Production Liner	5-1/2"	17.00	P110-HC		1.88		1.49	gg	4.81		5647	1142

**gg = full column of gas

Tana Exploration
OCS-G 22802 #A-3
Main Pass Block 207

Rig: Hercules

RKB - MSL =	100
Water Depth =	174
RKB - ML =	274
RKB - MLH =	NA

Cement Volume Calculations

Cement Volume Requirements:
Conductor Casing - Cement To Mudline.
Surface Casing - Cement To Surface.
Intermediate Casing - 1500' of fill.

18-5/8" 87.5# Conductor Casing @ 1100' MD / TVD; 24" 0.5" Wt Drive Pipe @ 500' (226' BML)
Cement To Mudline

Conductor Casing		Drive Pipe	Open Hole	18-5/8" Csg	18-5/8" x 24" Csg	22" x 18-5/8" OH
OD	ID	ID	Size	Int Cap	Ann Cap	Ann Cap
in.	in.	in.	in.	cfpf	cfpf	cfpf
18.625	17.689	23.000	22.000	1.7066	0.9933	0.7478
Note: Assumes DP is washed out to 23" ID				bpf	bpf	bpf
				0.3040	0.1769	0.1332

Cmt Cover	Cement Interval		Footage	Vol, cf	Cum Vol, cf	BOEMRE APD
18-5/8" x 23" Csg	274	500	226	224.48	224.48	
28" x 49-1/4" Csg	0	0	0	0.00	224.48	
22" x 18-5/8" OH	500	1,100	600	448.70	673.18	
18-5/8" Shoe			40	68.27	741.44	
				0.00	741.44	
			TOT CF	741.44		742

OH From, MD ft	OH To, MD ft	Tot OH Ftg, ft	Drill Bit Size, in	Theo OH Cap, bpf	Theo OH Vol,bbls	Theo OH Vol, cf
500	1,100	600	22.000	0.4702	282.11	1583.91
	Actual OH Vol From Log, cf		OH Size From Log Vol, in		Theo Hole Size vs Act Log Size, % Inc	

13-3/8" 68# Surface Casing @ 5582' MD
Cement To Surface

Surface Casing		18-5/8" Csg	Open Hole	13-3/8" Csg	18-5/8" x 13-3/8" Csg	17-1/2" OH
OD	ID	ID	Size	Int Cap	Ann Cap	Ann Cap
in	in	in	in	cfpf	cfpf	cfpf
13.375	12.415	17.689	17.500	0.8407	0.7309	0.6946
Note:				bpf	bpf	bpf
				0.1497	0.1302	0.1237

Cmt Cover	Cement Interval		Footage	Vol, cf	Cum Vol, cf	BOEMRE APD
13-3/8" x 18-5/8" Csg	0	1,100	1,100	804.02	804.02	
	0	0	0	0.00	804.02	
17-1/2" OH	1,100	5,582	4,482	3113.42	3917.43	
13-3/8" Shoe			80	67.25	3984.69	
				0.00	3984.69	
			TOT CF	3984.69		4000

OH From, MD ft	OH To, MD ft	Tot OH Ftg, ft	Drill Bit Size, in	Theo OH Cap, bpf	Theo OH Vol,bbls	Theo OH Vol, cf
1,100	5,582	4,482	17.500	0.2975	1333.41	7486.57
	Actual OH Vol From Log, cf		OH Size From Log Vol, in		Theo Hole Size vs Act Log Size, % Inc	

9-5/8" 47# Intermediate Casing @ 8,201' MD
1500' of Fill Cement

Intermediate Casing		13-3/8" Csg	Open Hole	9-5/8" Csg	9-5/8" x 13-3/8" Csg	9-5/8" x 12-1/4" OH
OD	ID	ID	Size	Int Cap	Ann Cap	Ann Cap
in	in	in	in	cfpf	cfpf	cfpf
9.625	8.681	12.415	12.250	0.4110	0.3354	0.3132
				bpf	bpf	bpf
				0.0732	0.0597	0.0558

Cmt Cover	Cement Interval		Footage	Vol, cf	Cum Vol, cf	BOEMRE APD
	0	0	0	0.00	0.00	
	0	0	0	0.00	0.00	
9-5/8" x 12-1/4" OH	6,701	8,201	1,500	469.79	469.79	
9-5/8" Shoe			80	32.88	502.67	
			TOT CF	502.67		503

OH From, MD ft	OH To, MD ft	Tot OH Ftg, ft	Drill Bit Size, in	Theo OH Cap, bpf	Theo OH Vol,bbls	Theo OH Vol, cf
6,701	8,201	1,500	12.250	0.1458	218.66	1227.72
	Actual OH Vol From Log, cf		OH Size From Log Vol, in		Theo Hole Size vs Act Log Size, % Inc	

Tana Exploration
OCS-G 22802 #A-3
Main Pass Block 207

Rig: Hercules
RKB - MSL = 100
Water Depth = 174
RKB - ML = 274
RKB - MLH = NA

Cement Volume Calculations

Cement Volume Requirements:
Production Liner - Top of Liner

5-1/2" 17# Production Liner @ 10233' MD; 9-5/8" Intermediate Casing @ 8,201' MD						
Cement to Top of Liner						
Drilling Liner		9-5/8" Csg	Open Hole	9-5/8" Csg	5-1/2" x 9-5/8" Csg	5-1/2" x 8.5" OH
OD	ID	ID	Size	Int Cap	Ann Cap	Ann Cap
in.	in.	in.	in.	cfpf	cfpf	cfpf
5.500	4.892	8.681	8.500	0.1305	0.2460	0.2291
				bpf	bpf	bpf
				0.0232	0.0438	0.0408

Cmt Cover	Cement Interval		Footage	Vol, cf	Cum Vol, cf	BOEMRE APD
5-1/2" x 9-5/8" Csg	7,801	8,201	400	98.42	98.42	
5-1/2" x 9-5/8" Csg	0	0	0	0.00	98.42	
5-1/2"" x 8-1/2" OH	7,801	10,233	2,432	557.12	655.53	
5-1/2" Shoe			80	10.44	665.98	
Cmnt on top of liner				0.00	665.98	
			TOT CF	665.98		666

OH From, MD ft	OH To, MD ft	Tot OH Ftg, ft	Drill Bit Size, in	Theo OH Cap, bpf	Theo OH Vol,bbls	Theo OH Vol, cf
7,801	10,233	2,432	8.500	0.0702	170.69	958.38
	Actual OH Vol From Log, cf		OH Size From Log Vol, in		Theo Hole Size vs Act Log Size, % Inc	