Shell P&T - Wells Operated (Europe)

Standard Casing Design Document for Central North Sea Subsea Wells

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- Philip Imperiale (Production Technology Lead)
- David Reid (SME Well Design)

References

[1] Shell, "Casing and Tubing Design Manual; Volume 1 - Mandatory Requirements," February 2011.

[2] Shell, "TS03 Casing and Tubing Technical Standard," 2007.

[3] A. Oweh, A. Amike, D. Roberts and D. Moss, "Standard Wellcat File - R41 CNS Gen Option 1 shallow water - DM 3.wcd," 10 2013.

[4] J. Schreurs, "Subsurface temperatures from wireline BHT and production test data. Q21. 22. 29. Central North Sea," Shell Expro, UEX/35, June 1991.

[5] J. Edwards, "Cementing Manual WS 38.80.31.38-Gen".

[6] D. Moss, "Solids Drop Out Calculator".

[7] G. Thomson, "UIE Generic Casing Configuraion".

[8] D. R. a. Woulter, "NAM Generic Casing Design Documents".

[9] NAM, "QRA for Sweep Cemented Completions," 2012.

[10] D. Moss, "Standard Casing Design Cost Comparison," May 2013.

[11] D. Moss, "Standard CNS Casing Design Check Sheet," 2013.

Table of Contents

1. Executive Summary

This document describes the standard casing design to be applied for all wells to be drilled in the Central North Sea. The design complies with the Casing & Tubing Design Manual [1] and TS03 [2] . The design has been chosen to cover approximately 90% of all future CNS NPNT New Drill Production Wells. The standard design includes gas lifted wells. Water Injectors, Sidetracks and Northern Fields are not covered.

Because not all CNS wells will fit the standard design, a series of design checks are required by the design engineer to ensure the design fits the design envelope. These design checks also assist with certain material selection criteria (e.g. sour service or non sour service).

It is important to understand that this document does not drive the design and that instead the design is checked against this document. Any well that passes then does not require its own individual WellCat.

- Section 2 describes the standard well design

- Section 3 describes the design checks required by the design engineer to ensure the well fits within the WellCat design envelope

- Section 4 describes the key assumptions behind the design

2. Standard Well Design Architecture

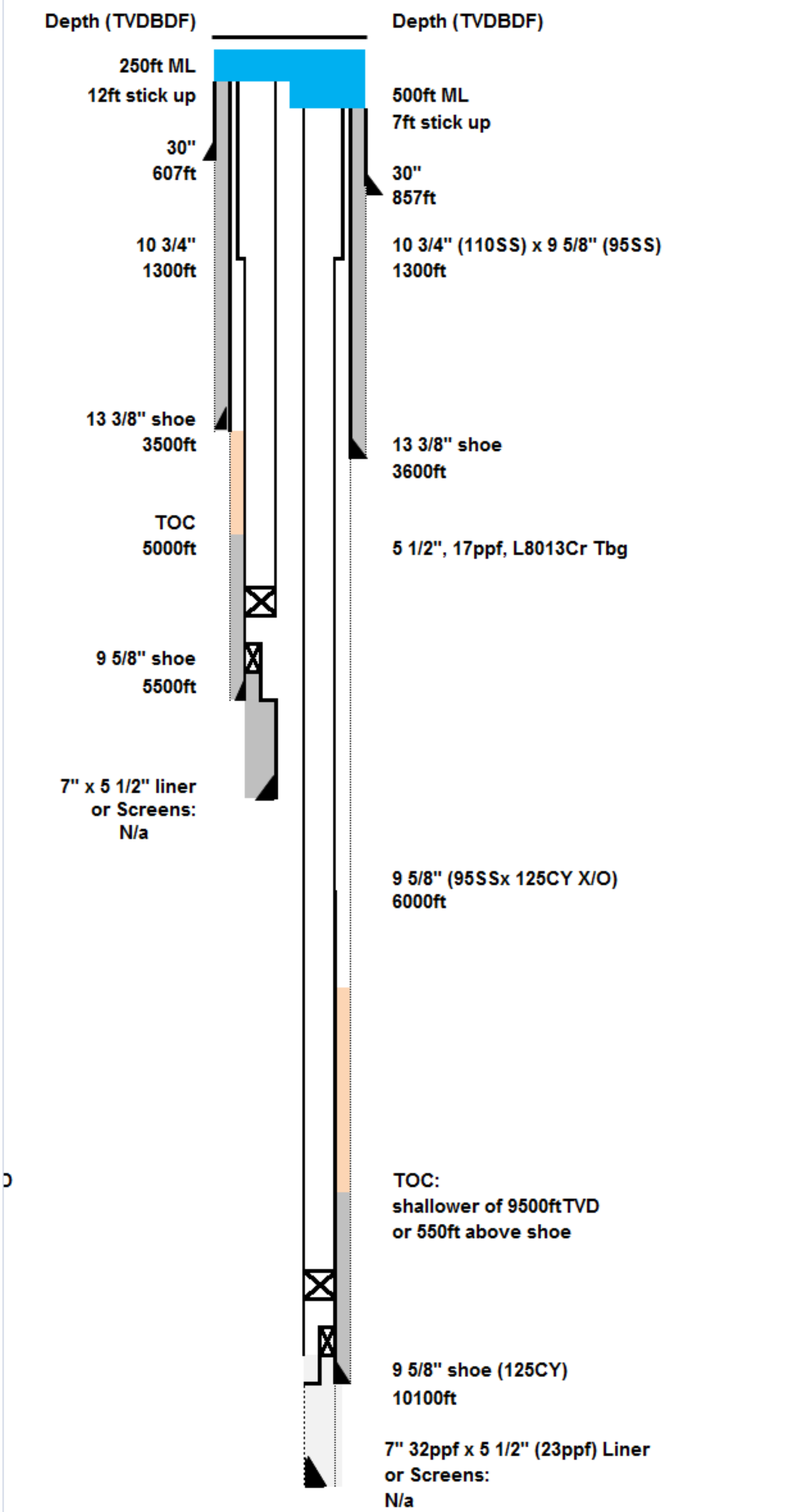
String	OD	weight	Grade	Connection	base depth (tvdbdf)
Conductor	35"x30"x20"	2"x1"	X56	Ht/HD90	607ft-857ft
Surface Casing	21"	1.25"	X56	weld	269ft-522ft
	20" Conn.	0.625"	X80	THM90	270ft-523ft
	13 3/8"	72ppf	P110	Vam Top	3500ft-3600ft
Production Casing	10 3/4"	55.5ppf	110SS	HP SC90	1300ft
	9 5/8"	53.5ppf	95SS	Vam Top	6000ft
	9 5/8"	53.5ppf	125CY	Vam Top	5500ft-10100ft
Production Liner	7"	32ppf	13Cr	Vam HT Bev	<10100ft
	5 1/2"	23ppf	13Cr	Vam HT Bev	<10100ft
Completion	5 1/2"	17ppf	13Cr	Vam Top HT	<10100ft

The Standard Well Design for CNS consists of 35”x30”x20” conductor, 21”x13 ⅜” surface casing to 3500ftTVDBDF, 10 ¾”x 9 ⅝” production casing and a either 7”x 5 ½” cemented liner or sand screens to TD.

In the figure below, the left hand side shows what the shallowest well looks like and the right hand side shows what the deepest well looks like.

The well design is mainly TVD dependent. Further details are shown in section 4.2.

The maximum AH length is 16500ft.



3. Well design envelope and checks

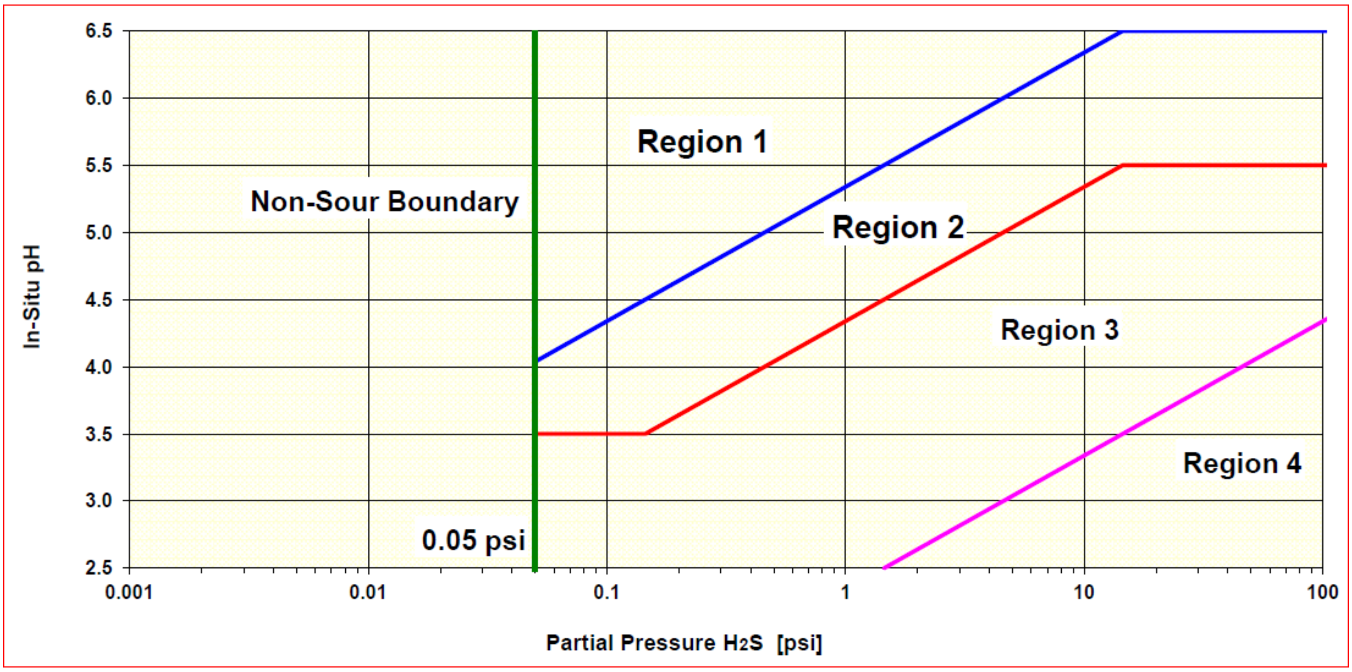
3.1. Introduction

The standard well design summarised in section 2 can be applied to any new drill production well in the Central North Sea. It does not apply to Water Injectors, or Sidetracks. Other requirements are listed below:

1. Max CITHP must be < 6-7ksi depending on THT as shown in the chart in section 3.3
2. Max BHT must be < 284 degF
3. Max THT depends on selection chart in section 3.3
4. Sour Service/CO2 Corrosion Criteria must be non sour or in Region 1 and Region 2

3.2. Material Selection for Sour Service & CO2 Corrosion Criteria

1. pH and H2S is provided by the PT and should be documented in the WFS.
2. Calculate the H2S Partial Pressure as per WFS using the below simple formula:
   Partial Pressure = BHP (psi) x H_2S (ppm) / $1x10^6$
3. Plot pH versus Partial Pressure on the below plot to determine if well is Non-Sour or in Region 1/2.

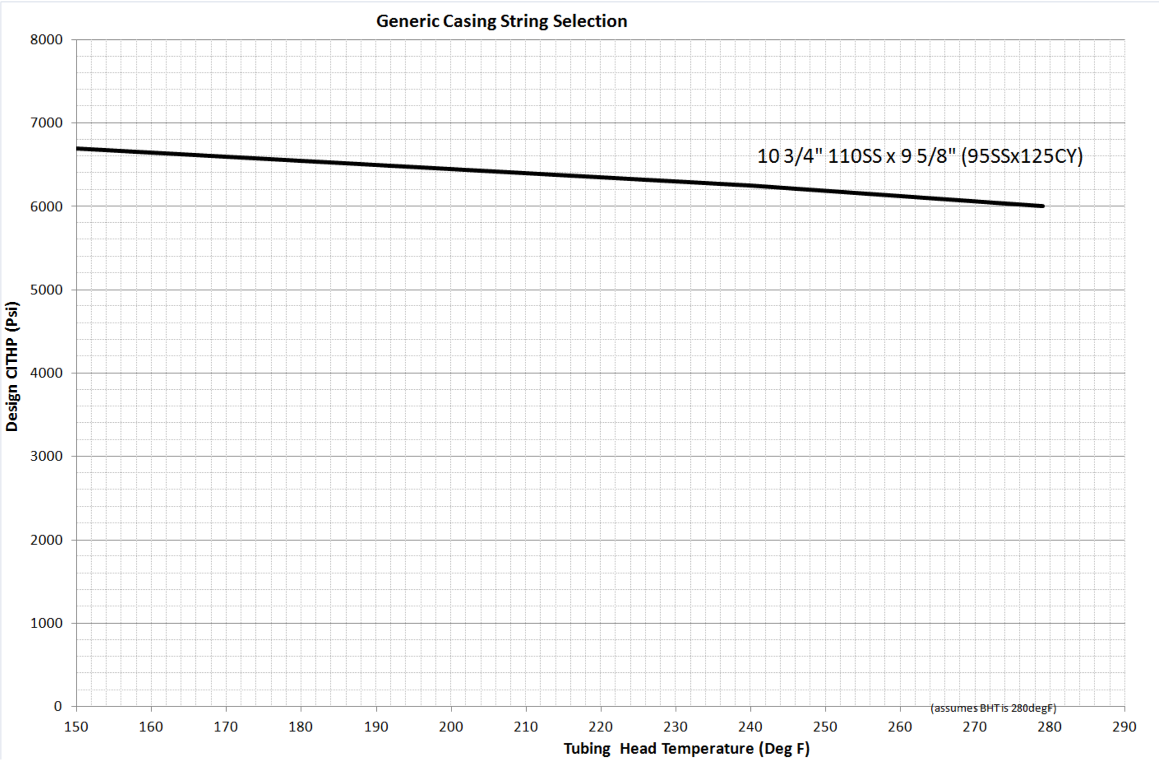


Further information on material selection criteria can be found in section 8 of the CTDM (Ref[1]) and in section 8 of Bridging document 1 referenced in the TS03 transition (Ref [2]) document.

3.3. Production Casing Selection based on CITHP and FTHT

The *hot bullhead annulus kill* (BHK) scenario is the driving burst case for the production casing in the standard well design. A range of production profiles have been tested to simulate the full range of temperatures that the well can see and the resultant material de-rating due to temperature. The max CITHP that will allow for a successful BHK immediately following any FTHT is described in the below chart. Steps are as follows

1. Obtain Design CITHP and FTHT from PT (this should be provided in the WFS)
2. Plot these on the chart below
3. If the design CITHP and FTHT lies below the line, then the production casing is good for this design



3.4. Production casing material selection matrix

Having defined the pressure/temperature suitability and the sour service requirement in sections 3.2 and 3.3, use the below selection matrix to determine the production casing design:

	CITHP<7ksi	LP Design (CITHP<TBC)
Non Sour (region 0)	10 ¾” P110 x 9 5/8” P110 x 9 5/8” 125CY $2.4m	For next Revision of standard casing design document 10 ¾” L80 x 9 5/8” L80 x 9 5/8” P110 $1.7m
Sour (region 1&2)	10 ¾” 110SS x 9 5/8” 95SS x 9 5/8” 125CY $3.3m	

3.5. Surface casing selection

The standard 13 3/8” 72ppf P110 surface casing c/w 21”x1.25”wt x THM90 wellhead connector will be suitable as per section 2 so long as the following criteria are met:

1. Section 3.3 and 3.4 of this document have been satisfied
2. Any gas lift design pressure is rated to less than 215bar (2900psi) as per section 4.16.
3. Refer to For FTHT more than 240degF (e.g. Pierce):
    a. If well is gas lifted then additional work will be required to ensure that surface casing is cemented to surface (or centralisation is in place) in order to prevent thermal buckling. No further work is required for non-gas lifted wells.
    b. Deep 13 3/8” casing with any dogleg severity will breach design criteria so either
        i. 13 3/8” shoe is to be set no deeper than 3000ft; or
        ii. 17 ½” hole is to be vertical to section TD (section TD<3600ft)

4. FTHT is less than 240degF
    a. TOC is not required to surface
    b. Shallow build with DLS of 1.5deg/100ft is allowable from 1000ft to 17 ½” section TD (section TD<3600ft)
    c. Refer to decision tree in Appendix 1 for guidance

5. The compression rating of the 13 3/8” Vam Top connection is assumed to be de-rated by 60% of tensile yield as per the ‘Geoff Thomson’ spec sheet (see Appendix 4). This is because there is currently no CUE available for 13 3/8” Vam Top connections at time of writing.

6. There is no 21” wellhead connector qualified as per the CTDM. A deviation, FSR against the CTDM may be required.

3.6. Tubing Selection

It is expected that 5 ½” 17ppf, L8013Cr, Vam Top HT tubing will be suitable for the standard well design but due to the diverse nature of CNS load cases ranging from hot water producing wells to cold gas producing wells, the specific WellCat ‘prod’ and ‘tube’ load cases capturing BHP, BHT complete with composition of producing fluids needs to be run through the Standard Casing Design WellCat file (ref[3]).

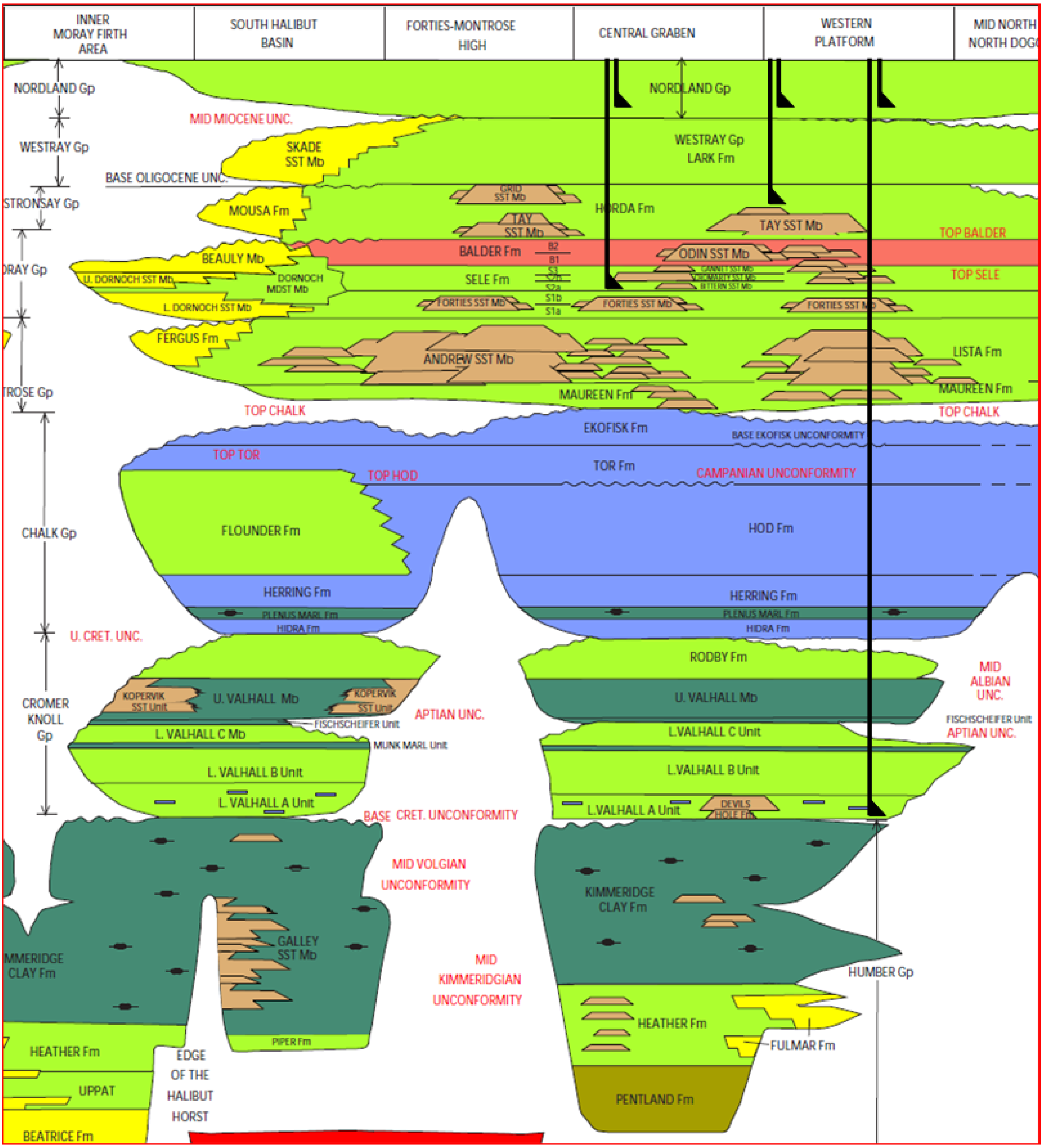
4. Assumptions

4.1. Formations

The three most common reservoir targets are the

- Tay/Odin Tertiary sandstones – 9 5/8” shoe set just above reservoir in Horda
- Forties/Andrew Tertiary sandstones– 9 5/8” shoe set just above reservoir in Sele
- Jurassic sands (Fulmar) – 9 5/8” shoe set above Kimmeridge

<u>Casing shoes</u>



The below table shows 1991 formation picks in 248 wells across NPNT fields in the Central North Sea which have been analysed to determine the deepest expected 9 5/8” casing depth required to cover 90% of the potential reservoir targets.

Formations	*P10 Depth ftTVDSS*	*P90 Depth ftTVDSS*	*Percentage of wells with these formations observed*	*P90 depth weighted by observations*
Lark Fm	3599	5059	61%	*4,932*
Horda Fm	5291	8433	74%	*8,186*
Tay Sst Mb	5585	8155	26%	*7,549*
Balder Fm	5712	9112	70%	*9,013*
Sele Fm	5761	9262	77%	*9,128*
Forties Sst Mb	5762	9411	56%	*9,009*
Lista Fm	6252	9388	63%	*9,246*
Andrew Sst Mb	6805	9977	20%	*8,710*
Maureen Fm	6354	9584	44%	*9,170*
Ekofisk Fm	6420	9854	45%	*9,528*
Tor Fm	7195	10134	33%	*9,450*
Hod Fm	6422	9986	32%	*9,148*
Valhall Fm	7072	11645	23%	*9,908*
Kimmeridge Clay Fm	7313	11685	39%	*10,302*
Heather Fm	7652	12061	17%	*9,714*
Fulmar	8022	12029	27%	*10,361*

Note 1: because the above table represents P90 depths, certain formations which are stratigraphically shallower than others may be shown in this table to appear deeper. This is due them being observed and recorded more frequently deeper than others. E.g. deep observations of Ekofisk have been recorded more frequently than deep observations of Tor so Ekofisk appears deeper.

Note 2: *P90 depth weighted by observations* should be used for shoe depths. This takes into account the fact that certain formations are not accessed frequently (e.g. Tay). It does not make sense for a standard well design to be robust for 90% of Tay observations. If 28% of wells see Tay, then a P50 depth will be robust for 14% of wells.

4.2. Shoe Depths

Temp	Water Depth (ftMSL)	Conductor (TVDBDF)	Surface Casing (TVDBDF)	Production Casing (TVDBDF)	Base Liner (TVDBDF)
Min	250ft	607ft	3500ft	5500ft**	N/A
Max	500ft*	857ft	3600ft	10100ft	10100ft

The above TVD envelope allows for 90% of CNS targets to be developed.
*This is based on the P90 water depth found in the CNS region. Water depth has a slight impact on the bullhead kill scenario. A sensitivity run between 250ft and 310ft water depth showed a SF impact of less than <0.01 with shallower water wells being more severe (see Appendix 2).
**shallowest casing shoe defined by TOC and barite sag accommodation (to be calculated – see Appendix 3).

4.3. Undisturbed Temperature Profile

	Temp versus ftTVDSS
Min	Above 4000ftTVDSS: T(°C) = 0.01137* Z + 6 Below 4000ftTVDSS: T(°C) = -14.51 + 0.0179 * Z - 3.5E-7 * Z^2
Max	BHT at Well TD < 280°F

Where z = TVDSS

- The standard well design is based on a geothermal/undisturbed temperature profile as above is based on Shell Geo chemical note GN91003 (see ref [4]).
- Minimum defines the sour service requirement of casing.
- Maximum defines the worst case flowing temperature profile in the well which causes design factors to be exceeded. The FTHT for the worst case temperature profile is captured in the selection chart in section 3.3

4.4. Pore Pressure behind 9 5/8" casing

	Pore Pressure (pptf)
Min	350pptf
Max	720pptf (above TOC)

Max PPP at shallowest cement to be tested but not expected to cause issues with CNS wells.

Pore pressure does not affect the burst or collapse load cases above production casing TOC and so for this reason all formations are assumed to be normally pressured for the purposes of the WellCat modelling. Below TOC pore pressure does have an impact on the casing design and this needs to be assessed on a case by case basis.

Mud weight has been assumed to drive External Load Lines (ELL).

4.5. Fracture Gradient

	EMW at 13 3/8" shoe
Min	710pptf
Max	860pptf

Fracture gradient is relevant for TITAP at the 13 3/8" surface casing shoe. As shown in the following chart, a review of key CNS leak off test data indicates that the P90 leak off at a 3,600ftTVDBDF 13 3/8" shoe is 860pptf. The WellCat model is therefore designed for this fracture gradient at the 13 3/8" shoe.

4.6. Mud Weights

	Mud Weight (pptf)
Min	350pptf (degraded)
Max	740pptf

A review of typical mud weights required in the standard CNS 12 ¼" section indicates that 740pptf is the highest mud weight that could be seen. These higher weights are typically driven by wellbore stability considerations in the Horda.

- ELL for collapse load cases is assumed to be driven by the worst case mud weight of 740pptf.

- ELL for burst load cases is assumed to be driven by degraded OBM mud at 350pptf

4.7. Top of Cement

Surface Casing

	Top of cement (ft)
Shallowest	To surface
Deepest	Minimum requirement as per cement manual (see ref [5]) = 500ft planned TOC above shoe.. Note, only for the case where there is gas lift and THT > 240degF then cement will be required to surface. For all cooler wells a TOC of 500ft above the shoe is sufficient.

1. Shallowest driven by mud line
2. Deepest driven by minimum requirement as per cement manual unless well is gas lifted
    a. If well is gas lifted and THT>240degF, cement will be required to surface in order to prevent compressive thermal loading which causes buckling inside large ID conductor.

Production Casing

	Top of cement (ft)
Shallowest	5000ftTVDBDF (need to model top of cement with barite sag)
Deepest	The shallower of 9500ftTVDBDF and 200ftAH above packer (550 ft above shoe)

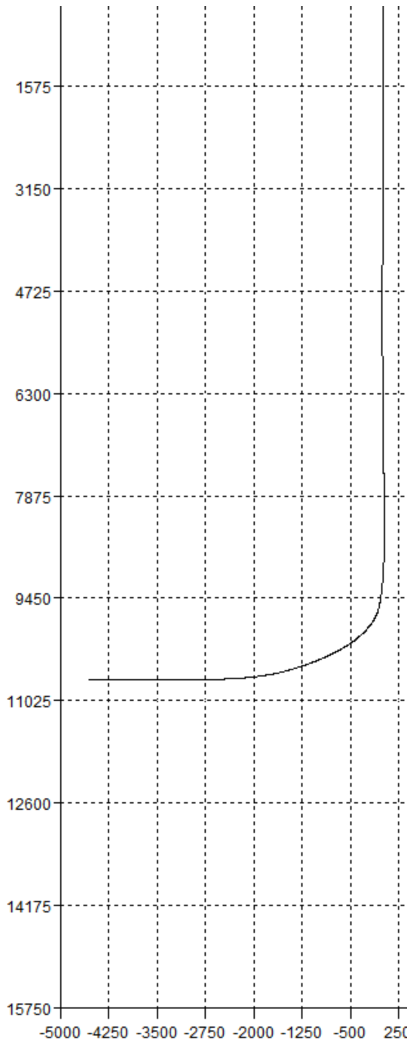
Shallowest driven by:
1. Protecting shoe from barite sag and resultant trapped annulus.

Deepest TOC is driven by:
1. Minimum requirements being 200ft above production packer and >500ft above the shoe as per cementing manual (300ft liner lap + 50ft for production packer = 550ft above shoe).
2. TITAP requires protection of deep casing against TITAP collapse loads (See Appendix 5)

4.8. Deviation

Min	0
Max	4000ft step out

As shown in the figure on the right



For the purposes of WellCat modelling, a deep well with a long horizontal reservoir section has been modelled. The deviation profile does impact heat transfer up the well but has little other impact on the standard well design.

4.9. Dog Leg Severity

If FTHT>240deg

TVDBDF	**DLS**	**DLS override**	**Total DLS**
<surface casing shoe	0deg/100ft	0deg/100ft	**0deg/100ft**
>surface casing shoe	<3deg/100ft	2deg/100ft	**5deg/100ft**

If FTHT<240deg:

TVDBDF	**DLS**	**DLS override**	**Total DLS**
<1000ft	0	0	**0deg/100ft**
1000ft - surface casing shoe	<1.5deg/100ft	2deg/100ft	**3.5deg/100ft**
>surface casing shoe	<3deg/100ft	2deg/100ft	**5deg/100ft**

Thermally induced compression of the surface casing causes high temperature wells (>240deg) with deep 13 3/8” surface casing to breach design criteria. High temperature wells therefore require a vertical surface casing section.

Any build/dogleg in the 17 ½” section is only permitted for wells where the FTHT is less than 240deg.

4.10. Reservoir Pressure

No assumptions on reservoir pressure have been made. A selection chart is provided in section 3.3 to allow the engineer to test if his or her well is robust against this standard WellCat design.

An offset review of planned wells shows a wide ranging absolute maximum pressure:

Well	Reservoir	Top Reservoir (TVD SS)	PP Abs Max (psi)
GF03	Forties	6,104	2,899
Gu P5	Fulmar	8,067	6,970
Gu South	Fulmar	8,430	6,160
Pierce A12	Forties	9,400	8,200
GB01 SIDETRACK	Tay + Forties (if present)	5942	3,072
Curlew DP3 SIDETRACK	Fulmar	10,680	7,402

4.11. Reservoir Temperature

Min	N/A
Max	282degF

Based on offset review, the standard WellCat model assumes a conservative reservoir temperature of 282deg.

Well	Reservoir	Top Reservoir (TVD SS)	Reservoir Temp (F)
GF03	Forties	6,104	187
Gu P5	Fulmar	8,067	219
Gu South	Fulmar	8,430	252
Pierce A12	Forties	9,400	272
GB01 SIDETRACK	Tay + Forties (if present)	5942	185
Curlew DP3 SIDETRACK	Fulmar	10,680	269

4.12. Tubing Head Temperature

Like pressure, tubing head temperature is not assumed fixed in this model. The engineer must compare his or her tubing head temperature with the casing selection chart in section 3.3.

4.13. Worst Case External Load Lines for 9 5/8”

Burst	350ppptf degraded mud above TOC, 450pptf formation pressure below TOC
Collapse	TITAP with 860pptf Leak Off and 740pptf mud above TOC, 450pptf formation pressure below TOC.

4.14. Worst Case Internal Load Line for 9 5/8”

Burst	Max CITHP + 500psi Bullhead Kill on top of ISW (base oil is possible but not limiting to this case).
Collapse	Fully Evacuated

4.15. Maximum Pressure Test Criteria

Casing	Green cement	Hard cement
Surface casing	4400psi	3500psi
Production casing	8000psi	6000psi
Production Liner	7000psi on 570pptf mud 8500psi on SW	7000psi on 570pptf mud 8500psi on 570pptf mud

4.16. Gas Lift Pressure

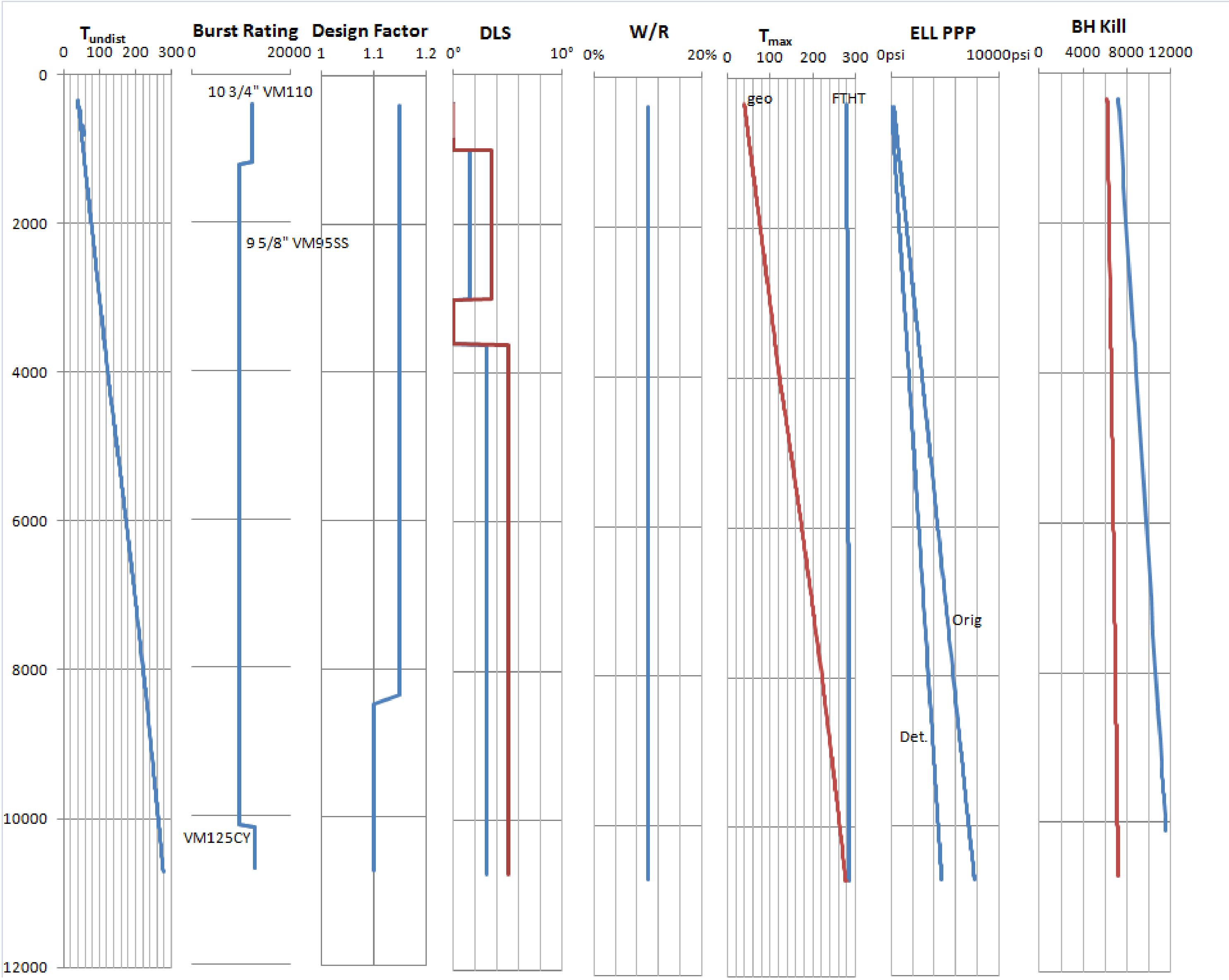
For B-Annulus (burst load case scenario from a production casing leak)

min	N/A
max	2,900psi 215bar

4.17. Packer Setting Depth

min	N/A
max	9950ftTVDBDF

5. Wellcat Casing Design Summary for Production Casing



These plots summarise the key design assumptions for the standard well design. The well engineer should check that the well functional specifications fall within these boundaries. All wells with a WFS within these barriers will satisfy all WellCat load cases as per the CTDM.

T_{undist}: the geothermal gradient which defines depth of sour service casing requirement

Burst Rating: summarises casing design

Design Factor: Summarises required design factor as per CTDM requirement (temperature and SS dependent)

DLS: assumed dog leg severity. If FTHT>240deg, 13 3/8" casing must be vertical.

W/R: wall reduction assumed (10%)

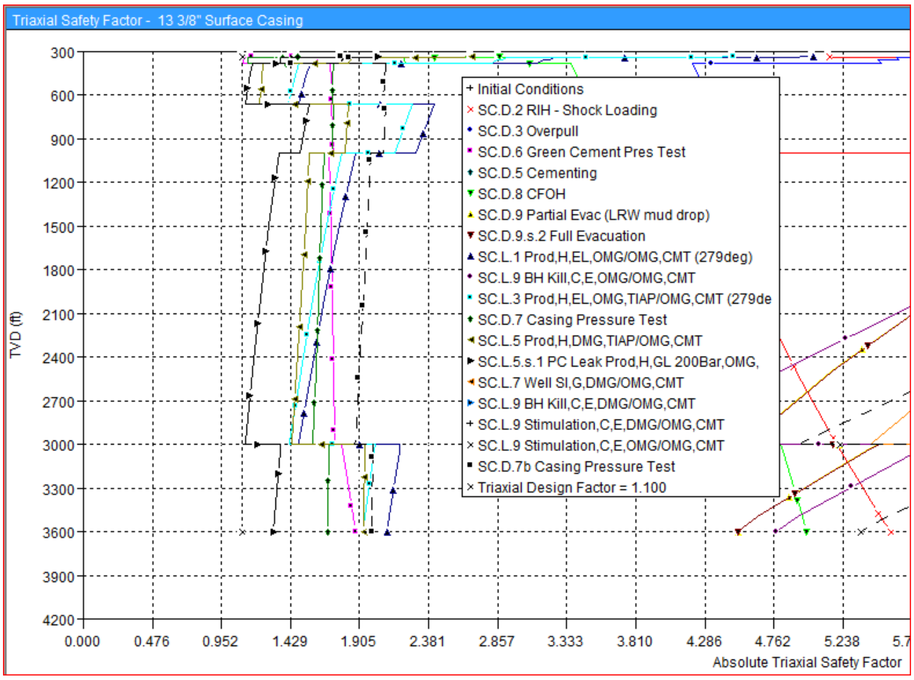
Tmax: max temperature profile in tubing

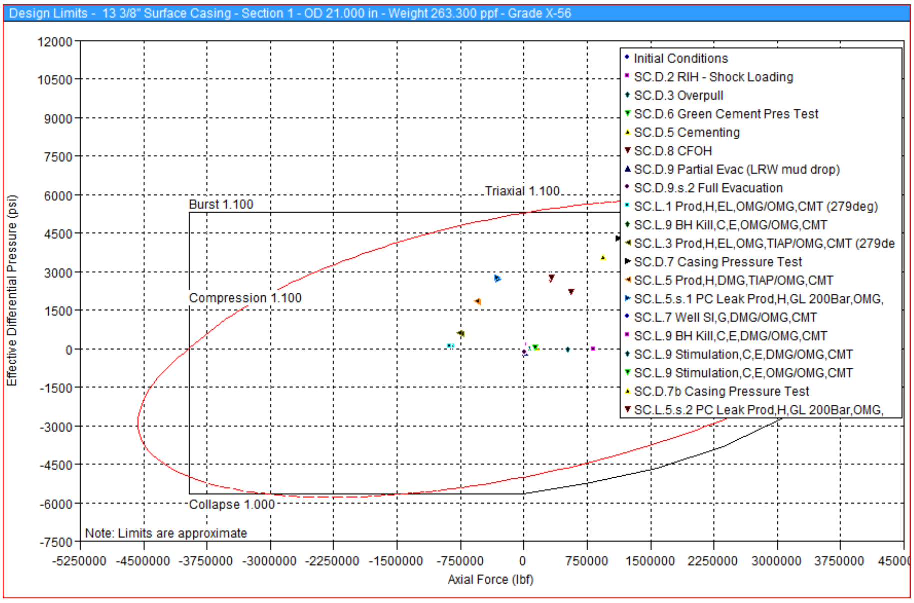
ELL PPP: best and worst case external load lines (degraded and undegraded mud)

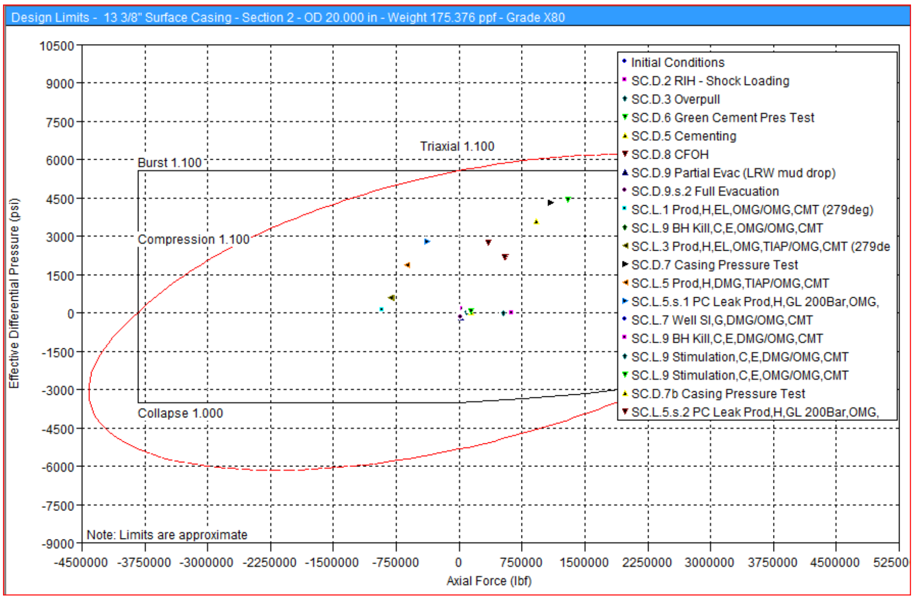
BH Kill: max design pressure inside tubing and max THP+500psi. This is also the worst case production casing burst ILL (annulus kill after tubing leak).

6. Wellcat load cases

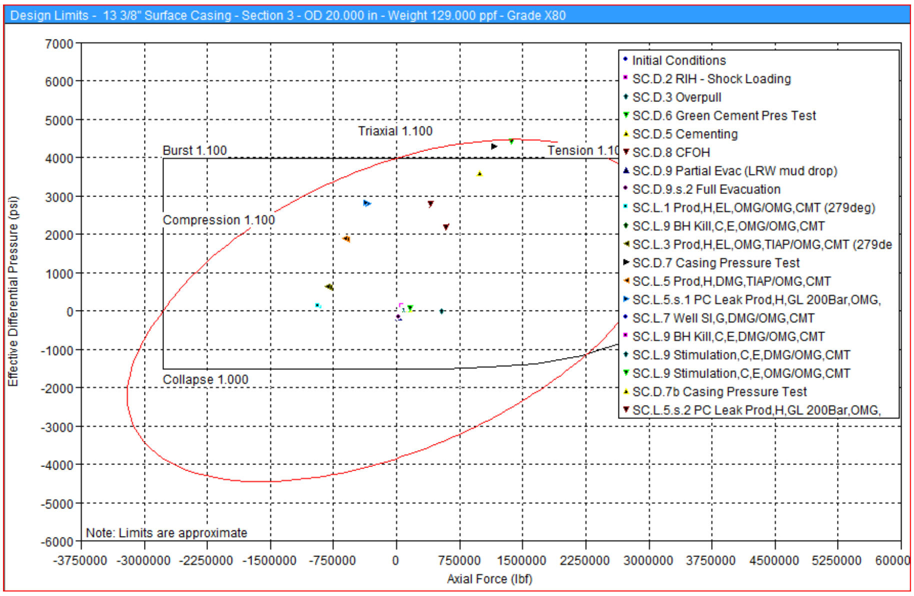
6.1. Surface Casing DLPs and Triaxial SF plots



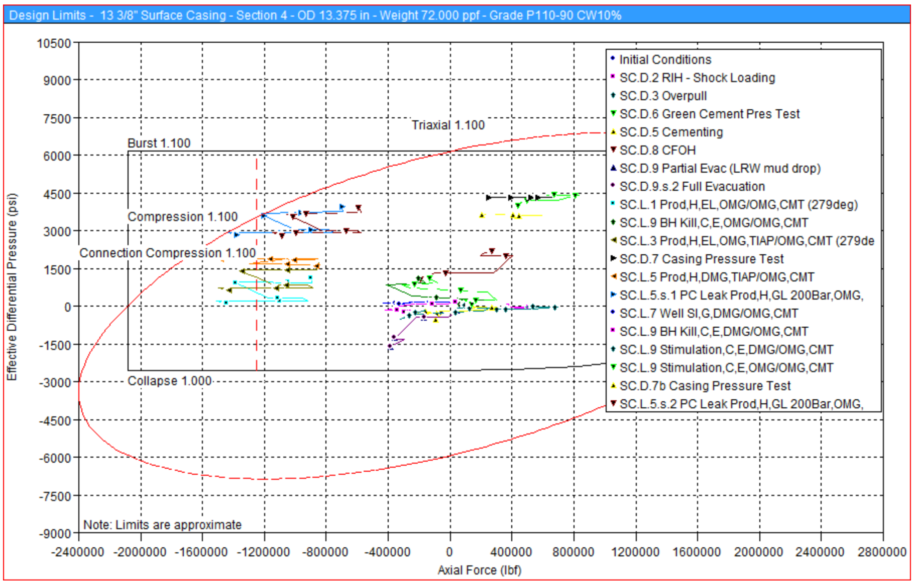




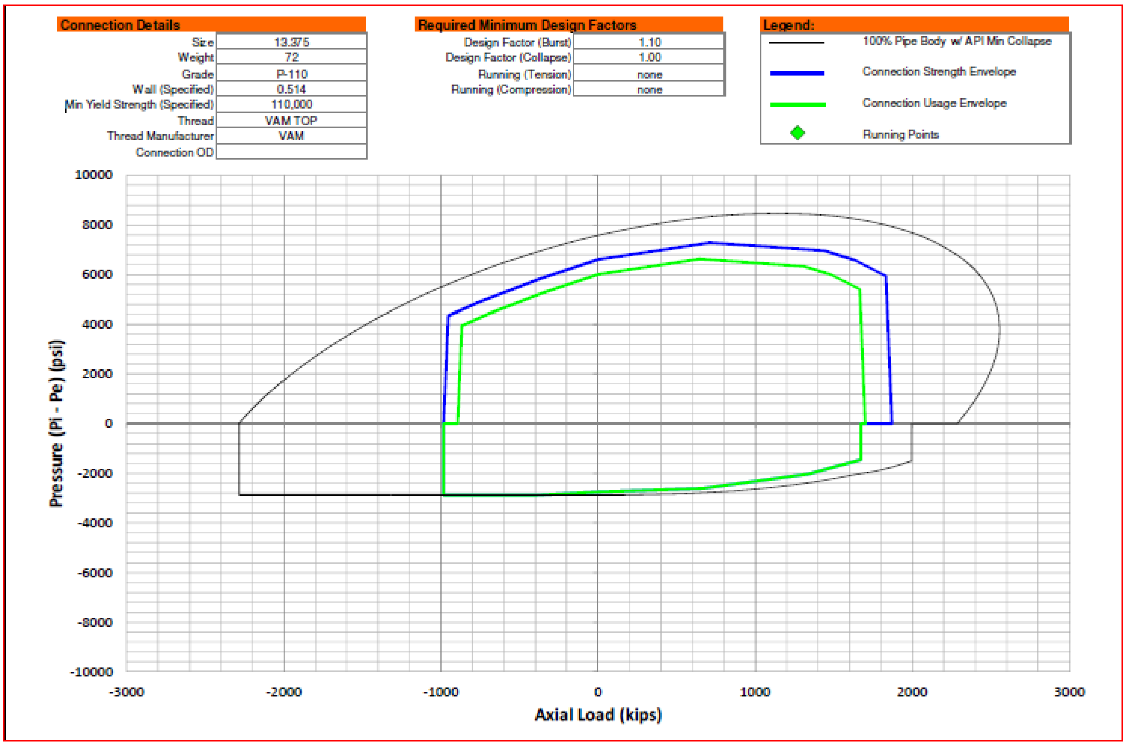
Design Limits - 13 3/8" Surface Casing - Section 2 - OD 20.000 in - Weight 175.376 ppf - Grade X80
Effective Differential Pressure (psi)
Axial Force (lbf)
Triaxial 1.100
Burst 1.100
Compression 1.100
Collapse 1.000
Note: Limits are approximate
Initial Conditions
SC.D.2 RIH - Shock Loading
SC.D.3 Overpull
SC.D.6 Green Cement Pres Test
SC.D.5 Cementing
SC.D.8 CFOH
SC.D.9 Partial Evac (LRW mud drop)
SC.D.9.s.2 Full Evacuation
SC.L.1 Prod,H,EL,OMG/OMG,CMT (279deg)
SC.L.9 BH Kill,C,E,OMG/OMG,CMT
SC.L.3 Prod,H,EL,OMG,TIAP/OMG,CMT (279de
SC.D.7 Casing Pressure Test
SC.L.5 Prod,H,DMG,TIAP/OMG,CMT
SC.L.5.s.1 PC Leak Prod,H,GL 200Bar,OMG,
SC.L.7 Well SI,G,DMG/OMG,CMT
SC.L.9 BH Kill,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,OMG/OMG,CMT
SC.D.7b Casing Pressure Test
SC.L.5.s.2 PC Leak Prod,H,GL 200Bar,OMG,



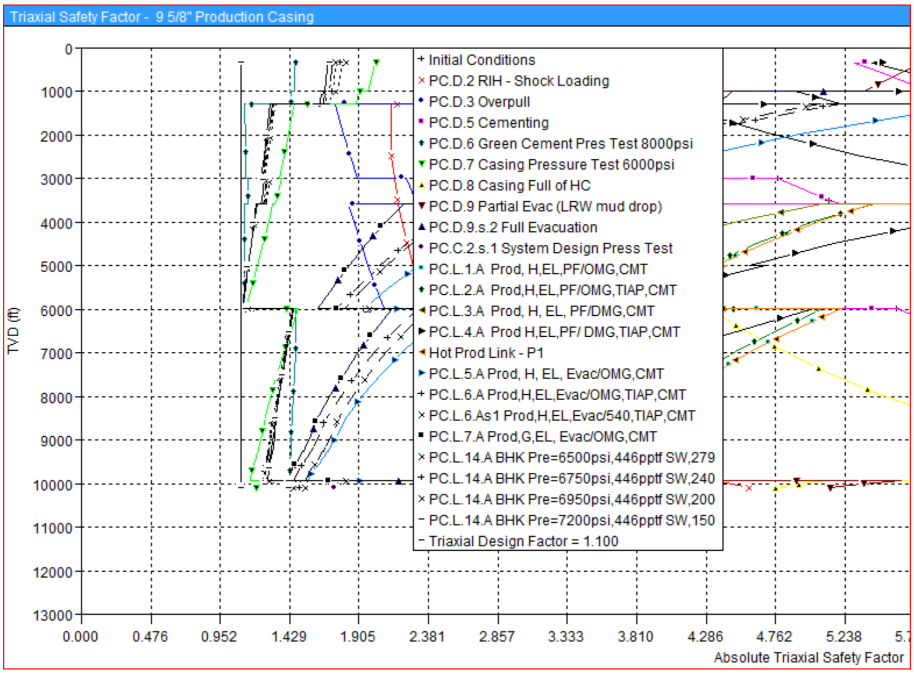
Design Limits - 13 3/8" Surface Casing - Section 3 - OD 20.000 in - Weight 129.000 ppf - Grade X80
Effective Differential Pressure (psi)
Axial Force (lbf)
Triaxial 1.100
Tension 1.10
Burst 1.100
Compression 1.100
Collapse 1.000
Note: Limits are approximate
Initial Conditions
SC.D.2 RIH - Shock Loading
SC.D.3 Overpull
SC.D.6 Green Cement Pres Test
SC.D.5 Cementing
SC.D.8 CFOH
SC.D.9 Partial Evac (LRW mud drop)
SC.D.9.s.2 Full Evacuation
SC.L.1 Prod,H,EL,OMG/OMG,CMT (279deg)
SC.L.9 BH Kill,C,E,OMG/OMG,CMT
SC.L.3 Prod,H,EL,OMG,TIAP/OMG,CMT (279de
SC.D.7 Casing Pressure Test
SC.L.5 Prod,H,DMG,TIAP/OMG,CMT
SC.L.5.s.1 PC Leak Prod,H,GL 200Bar,OMG,
SC.L.7 Well SI,G,DMG/OMG,CMT
SC.L.9 BH Kill,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,OMG/OMG,CMT
SC.D.7b Casing Pressure Test
SC.L.5.s.2 PC Leak Prod,H,GL 200Bar,OMG,

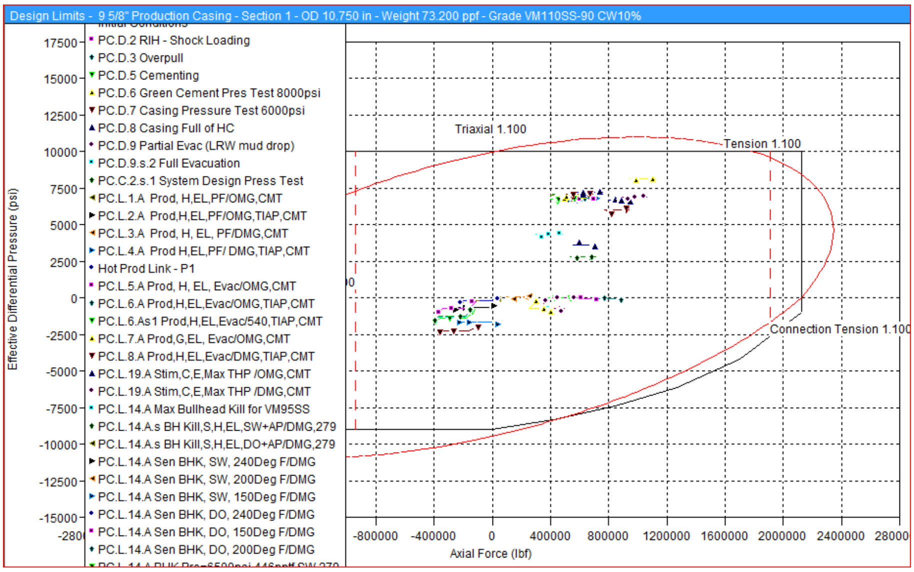


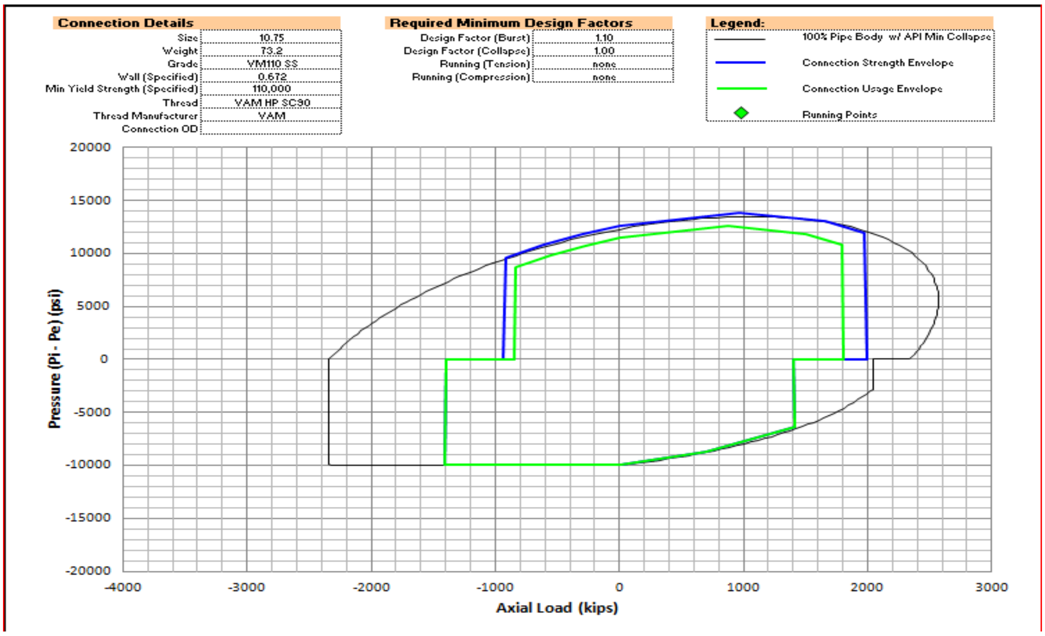
Design Limits - 13 3/8" Surface Casing - Section 4 - OD 13.375 in - Weight 72.000 ppf - Grade P110-90 CW10%
Effective Differential Pressure (psi)
Axial Force (lbf)
Triaxial 1.100
Burst 1.100
Compression 1.100
Connection Compression 1.100
Collapse 1.000
Note: Limits are approximate
Initial Conditions
SC.D.2 RIH - Shock Loading
SC.D.3 Overpull
SC.D.6 Green Cement Pres Test
SC.D.5 Cementing
SC.D.8 CFOH
SC.D.9 Partial Evac (LRW mud drop)
SC.D.9.s.2 Full Evacuation
SC.L.1 Prod,H,EL,OMG/OMG,CMT (279deg)
SC.L.9 BH Kill,C,E,OMG/OMG,CMT
SC.L.3 Prod,H,EL,OMG,TIAP/OMG,CMT (279de
SC.D.7 Casing Pressure Test
SC.L.5 Prod,H,DMG,TIAP/OMG,CMT
SC.L.5.s.1 PC Leak Prod,H,GL 200Bar,OMG,
SC.L.7 Well SI,G,DMG/OMG,CMT
SC.L.9 BH Kill,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,DMG/OMG,CMT
SC.L.9 Stimulation,C,E,OMG/OMG,CMT
SC.D.7b Casing Pressure Test
SC.L.5.s.2 PC Leak Prod,H,GL 200Bar,OMG,

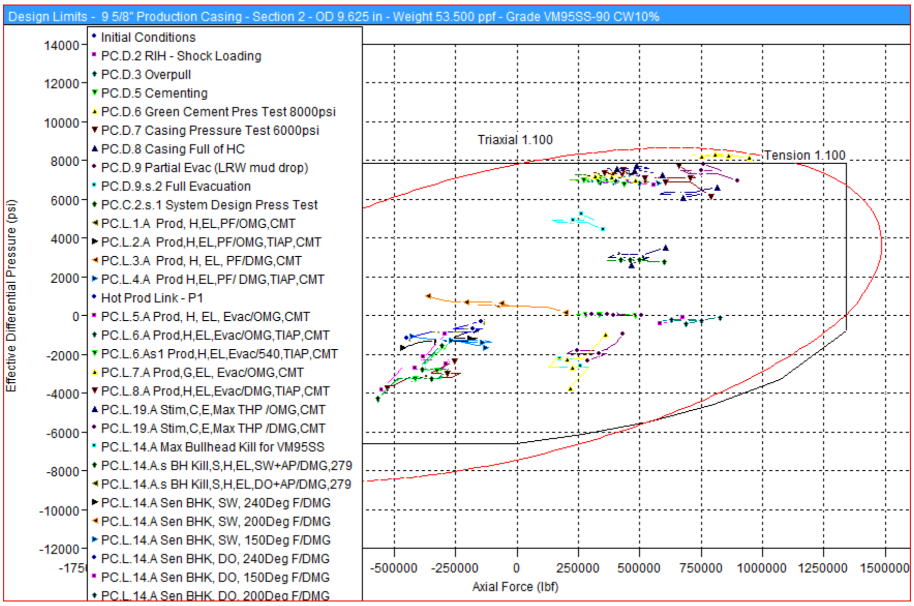


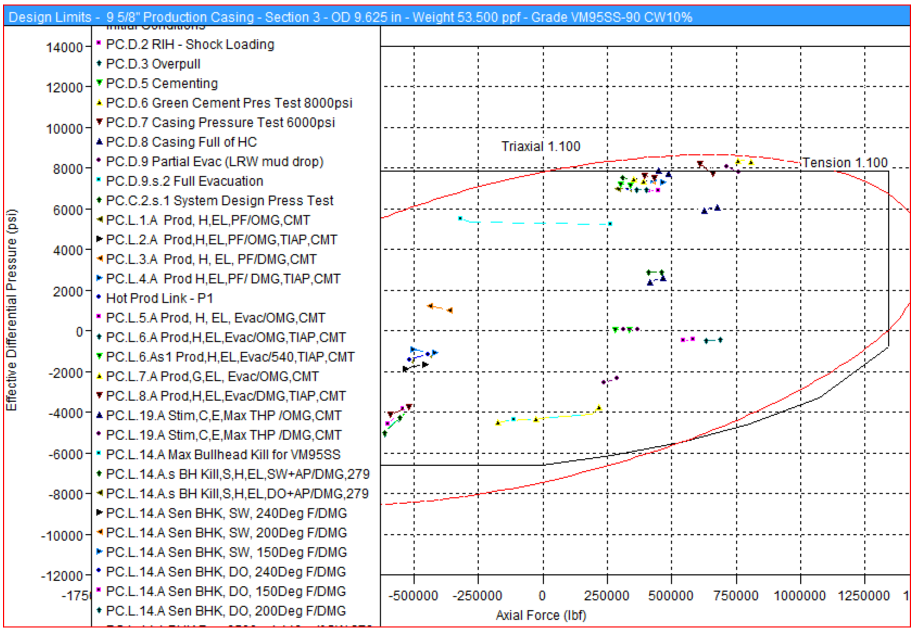
6.2. Production casing DLPs and Triaxial SF plots




Design Limits - 9 5/8" Production Casing - Section 1 - OD 10.750 in - Weight 73.200 ppf - Grade VM110SS-90 CW10%
PC.D.2 RIH - Shock Loading
PC.D.3 Overpull
PC.D.5 Cementing
PC.D.6 Green Cement Pres Test 8000psi
PC.D.7 Casing Pressure Test 6000psi
PC.D.8 Casing Full of HC
PC.D.9 Partial Evac (LRW mud drop)
PC.D.9.s.2 Full Evacuation
PC.C.2.s.1 System Design Press Test
PC.L.1.A Prod, H,EL,PF/OMG,CMT
PC.L.2.A Prod,H,EL,PF/OMG,TIAP,CMT
PC.L.3.A Prod, H, EL, PF/DMG,CMT
PC.L.4.A Prod H,EL,PF/ DMG,TIAP,CMT
Hot Prod Link - P1
PC.L.5.A Prod, H, EL, Evac/OMG,CMT
PC.L.6.A Prod,H,EL,Evac/OMG,TIAP,CMT
PC.L.6.As1 Prod,H,EL,Evac/540,TIAP,CMT
PC.L.7.A Prod,G,EL, Evac/OMG,CMT
PC.L.8.A Prod,H,EL,Evac/DMG,TIAP,CMT
PC.L.19.A Stim,C,E,Max THP /OMG,CMT
PC.L.19.A Stim,C,E,Max THP /DMG,CMT
PC.L.14.A Max Bullhead Kill for VM95SS
PC.L.14.A.s BH Kill,S,H,EL,SW+AP/DMG,279
PC.L.14.A.s BH Kill,S,H,EL,DO+AP/DMG,279
PC.L.14.A Sen BHK, SW, 240Deg F/DMG
PC.L.14.A Sen BHK, SW, 200Deg F/DMG
PC.L.14.A Sen BHK, SW, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 240Deg F/DMG
PC.L.14.A Sen BHK, DO, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 200Deg F/DMG
Triaxial 1.100
Tension 1.100
Connection Tension 1.100
Effective Differential Pressure (psi)
Axial Force (lbf)


Connection Details
Size 10.75
Weight 73.2
Grade VM110 SS
Wall (Specified) 0.672
Min Yield Strength (Specified) 110,000
Thread VAM HP SC90
Thread Manufacturer VAM
Connection OD
Required Minimum Design Factors
Design Factor (Burst) 1.10
Design Factor (Collapse) 1.00
Running (Tension) none
Running (Compression) none
Legend:
100% Pipe Body w/ API Min Collapse
Connection Strength Envelope
Connection Usage Envelope
Running Points
Pressure (Pi - Pe) (psi)
Axial Load (kips)

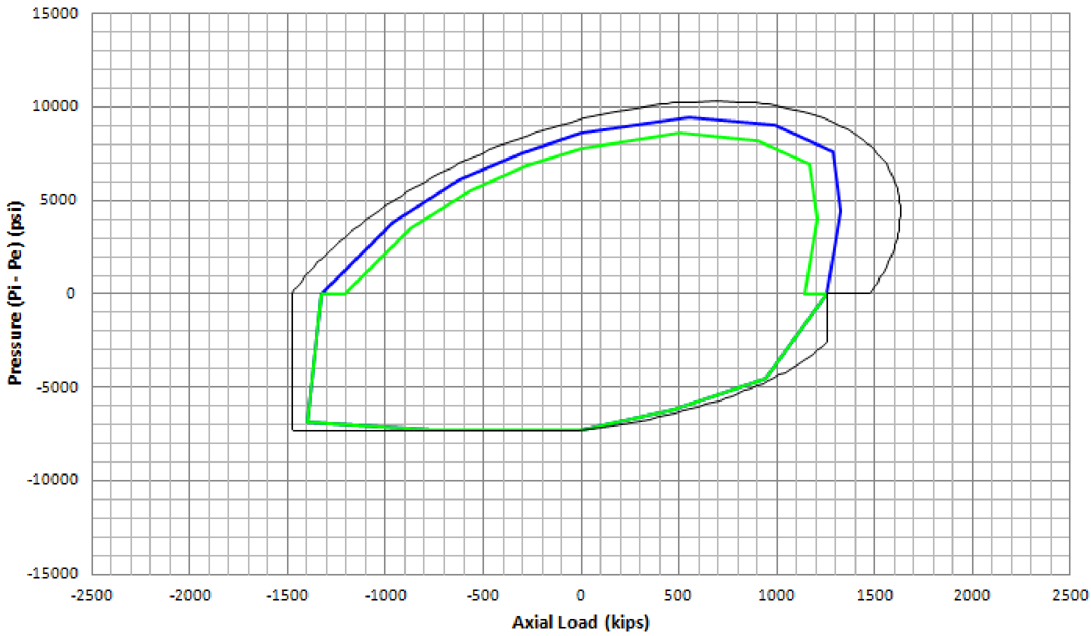

Design Limits - 9 5/8" Production Casing - Section 2 - OD 9.625 in - Weight 53.500 ppf - Grade VM95SS-90 CW10%
Initial Conditions
PC.D.2 RIH - Shock Loading
PC.D.3 Overpull
PC.D.5 Cementing
PC.D.6 Green Cement Pres Test 8000psi
PC.D.7 Casing Pressure Test 6000psi
PC.D.8 Casing Full of HC
PC.D.9 Partial Evac (LRW mud drop)
PC.D.9.s.2 Full Evacuation
PC.C.2.s.1 System Design Press Test
PC.L.1.A Prod, H,EL,PF/OMG,CMT
PC.L.2.A Prod,H,EL,PF/OMG,TIAP,CMT
PC.L.3.A Prod, H, EL, PF/DMG,CMT
PC.L.4.A Prod H,EL,PF/ DMG,TIAP,CMT
Hot Prod Link - P1
PC.L.5.A Prod, H, EL, Evac/OMG,CMT
PC.L.6.A Prod,H,EL,Evac/OMG,TIAP,CMT
PC.L.6.As1 Prod,H,EL,Evac/540,TIAP,CMT
PC.L.7.A Prod,G,EL, Evac/OMG,CMT
PC.L.8.A Prod,H,EL,Evac/DMG,TIAP,CMT
PC.L.19.A Stim,C,E,Max THP /OMG,CMT
PC.L.19.A Stim,C,E,Max THP /DMG,CMT
PC.L.14.A Max Bullhead Kill for VM95SS
PC.L.14.A.s BH Kill,S,H,EL,SW+AP/DMG,279
PC.L.14.A.s BH Kill,S,H,EL,DO+AP/DMG,279
PC.L.14.A Sen BHK, SW, 240Deg F/DMG
PC.L.14.A Sen BHK, SW, 200Deg F/DMG
PC.L.14.A Sen BHK, SW, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 240Deg F/DMG
PC.L.14.A Sen BHK, DO, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 200Deg F/DMG
Triaxial 1.100
Tension 1.100
Effective Differential Pressure (psi)
Axial Force (lbf)

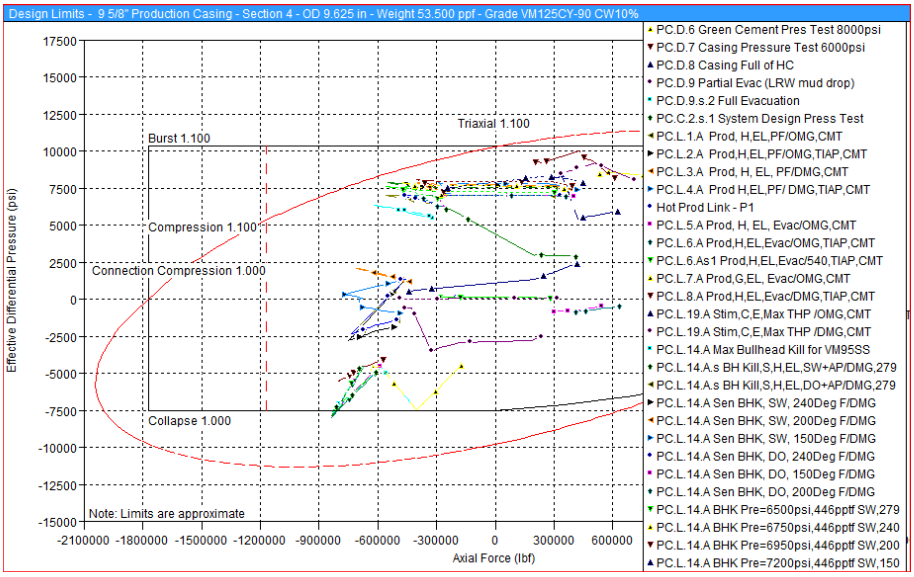


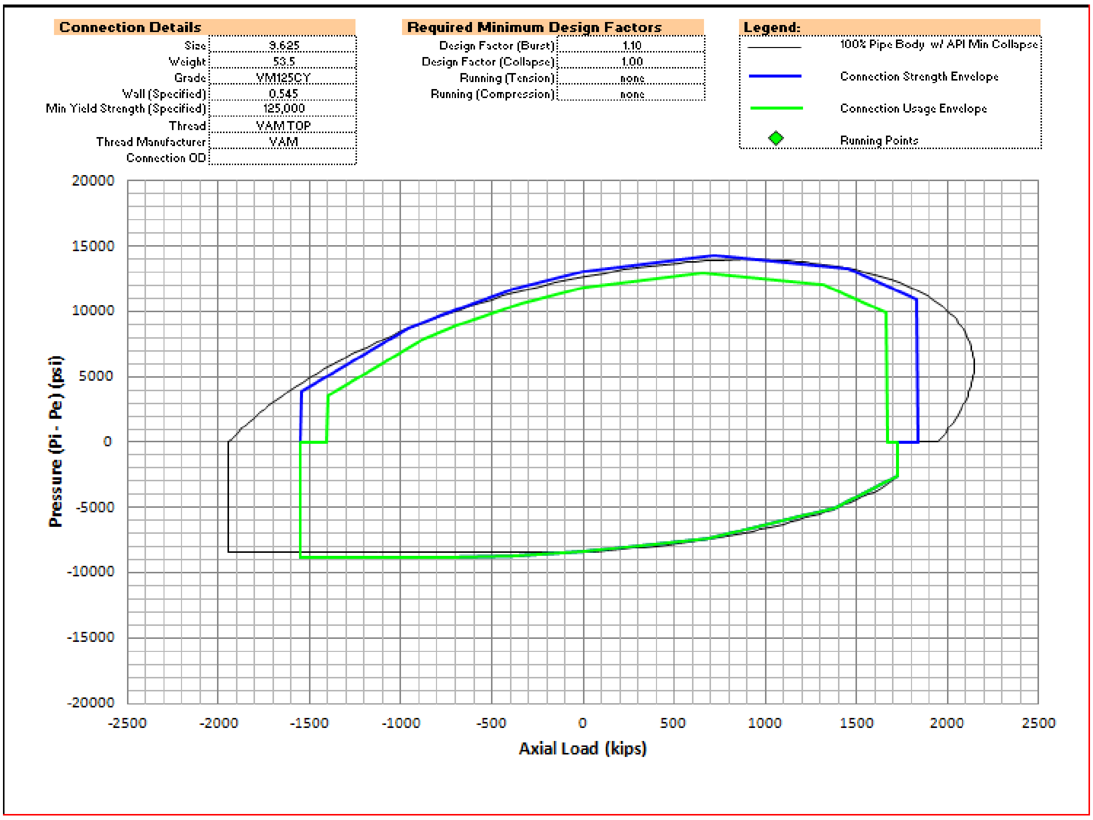
Connection Details	
Size	9.625
Weight	53.5
Grade	C/T-95
Wall (Specified)	0.545
Min Yield Strength (Specified)	95,000
Thread	VAM 21
Thread Manufacturer	VAM
Connection OD	

Required Minimum Design Factors	
Design Factor (Burst)	1.10
Design Factor (Collapse)	1.00
Running (Tension)	none
Running (Compression)	none

Legend:
100% Pipe Body w/ API Min Collapse
Connection Strength Envelope
Connection Usage Envelope
Running Points

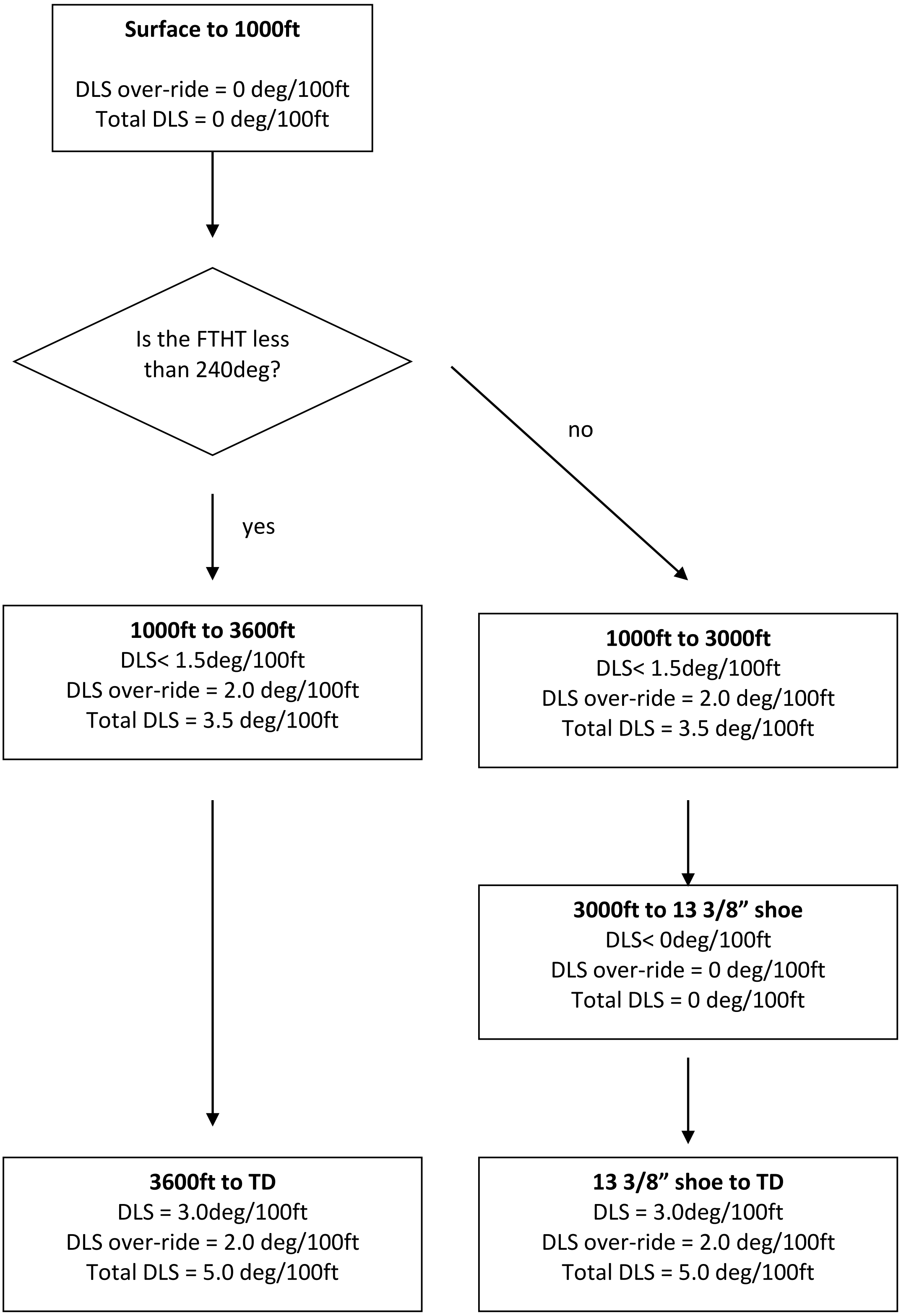



Design Limits - 9 5/8" Production Casing - Section 4 - OD 9.625 in - Weight 53.500 ppf - Grade VM125CY-90 CW10%
Effective Differential Pressure (psi)
Axial Force (lbf)
Triaxial 1.100
Burst 1.100
Compression 1.100
Connection Compression 1.000
Collapse 1.000
Note: Limits are approximate
PC.D.6 Green Cement Pres Test 8000psi
PC.D.7 Casing Pressure Test 6000psi
PC.D.8 Casing Full of HC
PC.D.9 Partial Evac (LRW mud drop)
PC.D.9.s.2 Full Evacuation
PC.C.2.s.1 System Design Press Test
PC.L.1.A Prod, H,EL,PF/OMG,CMT
PC.L.2.A Prod,H,EL,PF/OMG,TIAP,CMT
PC.L.3.A Prod, H, EL, PF/DMG,CMT
PC.L.4.A Prod H,EL,PF/ DMG,TIAP,CMT
Hot Prod Link - P1
PC.L.5.A Prod, H, EL, Evac/OMG,CMT
PC.L.6.A Prod,H,EL,Evac/OMG,TIAP,CMT
PC.L.6.As1 Prod,H,EL,Evac/540,TIAP,CMT
PC.L.7.A Prod,G,EL, Evac/OMG,CMT
PC.L.8.A Prod,H,EL,Evac/DMG,TIAP,CMT
PC.L.19.A Stim,C,E,Max THP /OMG,CMT
PC.L.19.A Stim,C,E,Max THP /DMG,CMT
PC.L.14.A Max Bullhead Kill for VM95SS
PC.L.14.A.s BH Kill,S,H,EL,SW+AP/DMG,279
PC.L.14.A.s BH Kill,S,H,EL,DO+AP/DMG,279
PC.L.14.A Sen BHK, SW, 240Deg F/DMG
PC.L.14.A Sen BHK, SW, 200Deg F/DMG
PC.L.14.A Sen BHK, SW, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 240Deg F/DMG
PC.L.14.A Sen BHK, DO, 150Deg F/DMG
PC.L.14.A Sen BHK, DO, 200Deg F/DMG
PC.L.14.A BHK Pre=6500psi,446pptf SW,279
PC.L.14.A BHK Pre=6750psi,446pptf SW,240
PC.L.14.A BHK Pre=6950psi,446pptf SW,200
PC.L.14.A BHK Pre=7200psi,446pptf SW,150

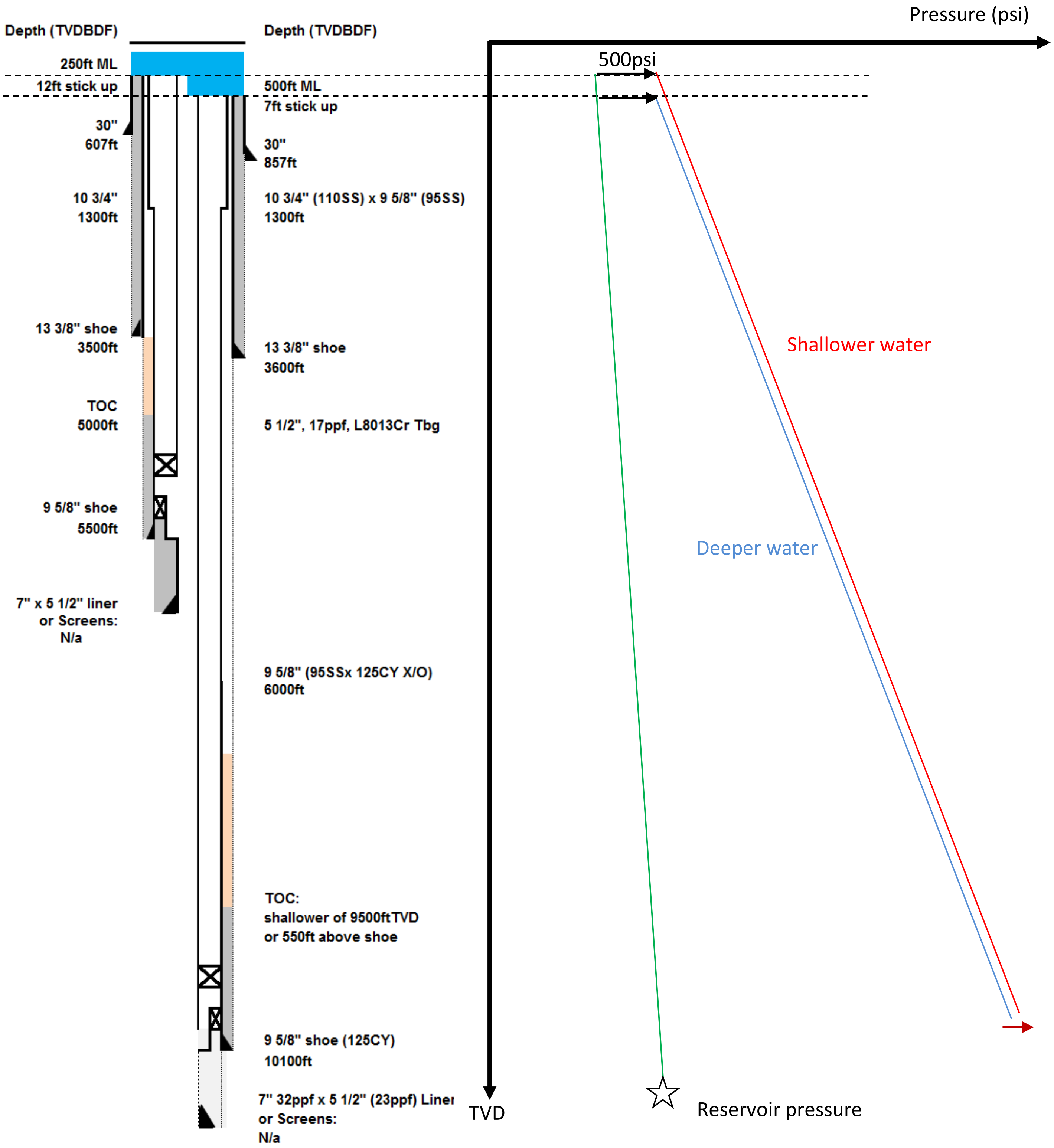

Connection Details
Size 9.625
Weight 53.5
Grade VM125CY
Wall (Specified) 0.545
Min Yield Strength (Specified) 125,000
Thread VAM TOP
Thread Manufacturer VAM
Connection OD
Required Minimum Design Factors
Design Factor (Burst) 1.10
Design Factor (Collapse) 1.00
Running (Tension) none
Running (Compression) none
Legend:
100% Pipe Body w/ API Min Collapse
Connection Strength Envelope
Connection Usage Envelope
Running Points
Pressure (Pi - Pe) (psi)
Axial Load (kips)

7. Appendices

Appendix 1. Dog Leg Severity Rules



Appendix 2. Water-depth sensitivity check



As can be seen in the above schematic. Water depth makes a very small difference to the effect of the driving bullhead kill load case. As shallower water depth results in a slightly higher pressure burst load line due to the additional kill fluid height from tubing head to TD.

Appendix 3. Solids Drop Out Calculator

double click below to edit. Original calculator can also be found in Ref [6]

Solids Drop Out Calculation (21 June 2013)

casing capacities (input)
well depths (input)
mud properties & volumes (input)
calculated values

casing capacities

9.625" Casing x OH Ann Cap	0.0558	bbls/ft
9.625" Casing x 13.375" Casing Cap	0.0581	bbls/ft
10.75" Casing x 13.375" Casing Cap	0.0358	bbls/ft

well design

cmt volume	188.1	bbls
13 3/8" shoe	3500	ft
Wellhead	374	ft
Base 10 3/4"	1305	ft
9 5/8" shoe	7402	ft
TOC 20%xs	4672	ft
TOC (in gauge)	4030	ft

top of solids

chemical wash ahead	70	bbls
bbls of mud above TOC	190	bbls
solids volume per bbl mud	0.19	bbls/bbl
porosity of solids plug	20%	p/c
solids volume	29	bbls
length of solids plug	525	ft
Top of Solids	**3505**	**ft**

Solids Content in Mud (barrels per barrel of mud)

	ppb	sg	bbls/bbl
bentone	6.5	1.6	0.01
versatrol M	4	1.04	0.01
versaclean vb	6	n/a	n/a
versaclean fl	6	n/a	n/a
lime	10	2.2	n/a
M-I BAR UFG	200	4.2	0.14
Safecarb 40	35	2.8	0.04
cuttings?			
		total	**0.19**

Appendix 4. Casing Spec Sheets

35", 2.0"Nom.WT (705#), X52 c/w Swedge to 30", 1.0"Nom.WT, X52 c/w DQ 30", 1.0"Nom.WT, HD/HT-90/QS (x8 Anti-Rotation Lugs) Box Down Weld On Connector, PSL1+

Item Rev. No. B
Primary Uses: Housing Extension for Conductor in Subsea Applications
Other Uses: None
Notes: Replacing Vetco equivalent
Manufacturing Specification: API5L Latest Revision and Shell EPE x DQ Manufacturing Specification & Quality Plan Latest Revision, PSL1+
Shell EPE SAP Blue Print No. See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions				Pipe Performances	
Nominal OD	35.000 *ins*	Max OD (API)	35.350 *ins*	Weight	705.00 *lbf/ft*
Thickness	2.000 *ins*	Min Thk (API)	1.750 *ins*		
Nominal ID	31.000 *ins*			Pipe Body Yield Strength	10,782,000 *lbf*
				Internal Yield Pressure	NA *psi*
Drift Type	NA			Collapse Pressure	NA *psi*
Drift Diameter	NA *ins*			Bending	7,015,000 *ft lbs*
Drift Length	NA *ins*			Mill Hydrotest Pressure	NA *psi*

Swedge Body Dimensions & Performance Properties:

Swedge Dimensions				Swedge Performances	
Nominal OD	35 x 30 *ins*	Max OD (API)	35.350 *ins*	Weight	NA *lbf/ft*
Thickness	2 x 1 *ins*	Min Thk (API)	NA *ins*		
Nominal ID	31 x 28 *ins*			Pipe Body Yield Strength	4,738,000 *lbf*
				Internal Yield Pressure	NA *psi*
Drift Type	Steel			Collapse Pressure	NA *psi*
Drift Diameter	26.154 *ins*			Bending	2,770,000 *ft lbs*
Drift Length	12 *ins*			Mill Hydrotest Pressure	NA *psi*

Pipe Body Material Properties:

Material Grade	X52			
Yield Strength	52,000 *psi* Minimum	77,000 *psi* Maximum		
UTS	66,000 *psi* Minimum			
Hardness	NA *HRc max.*			
Suitability for SSC	NACE MR01-75: Up to 0.05psi p/p			
Toughness	Per PSL2 *Joules (10 x 10) @ -20 Deg.C.*			
Young's Modulus	31.175 *E-06 psi*		Poisson's Ratio	0.28
Temperature Derating	0.045% per Deg.F. above 60Deg.F.		Anisotropy	
Thermal Exp. Coef.	6.90 *E-06/deg F*		Longitudinal	100 %
Thermal Conductivity	*Btu/hr-ft-deg F*		Transverse	100 %
Heat Capacity	*Btu/lbm-deg F*		Hoop	100 %

Connector Dimensions & Performance Properties:

Drawing

Connector Dimensions		Connector Performances	
Nom inal OD	33.000 *ins*	Tensile Yield Load	4,220,000 *lbf*
Max OD	NA *ins*	Internal Integrity - Liquid	NA *psi*
Min OD	NA *ins*	External Integrity - Liquid	NA *psi*
Bevel	NA *deg.*	Bending	2,970,000 *ft lbs*
Nominal ID (Pipe End/Cplg)	26.500 *ins*	Compression	NA *lbf*
Max ID (Pipe End/Cplg)	NA *ins*	Torque	1,500,000 *ft.lbs*
Min ID (Pipe End/Cplg)	NA *ins*		
Pin int'l chamfer	NA *deg*		
Cpl'g Length	NA *ins*		
Make-up Loss	14.063 *ins*		

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA

Field End Make Up Torque (except Rotating Liner)
Min / Opt / Max *(lbf.ft)* NA

Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA

Colour Codes, Protections & Coatings

Upper Connector	Upper Pipe Set	Pipe Centre	Lower Pipe Set	Lower Connector
35" x 2" BWP	Band 1: Blue	Green	Band 1: Yellow	30" x 1" HD/HT-90/QS Box
	Band 2: Green			

Thread Protector	Open End Non-Liftable
Thread Storage Dope	Jet Lube ALCO EP ECF
Make-Up Dope - Mill End	NA
Make-Up Dope - Field End	Jet Lube ALCO EP ECF
Pipe OD Coating	Bare or Varnish or Paint
Bore Finish	None
Pipe Bore Coating	None

30", 1.0"Nom.WT (310#), X52 c/w DQ 30", 1.0"Nom.WT, HD/HT-90/QS (x8 Anti-Rotation Lugs) Pin Up x Box Down Weld On Connectors, PSL1+

Item Rev. No. B
Primary Uses: Conductor in Subsea Applications
Other Uses: None
Notes: Replacing Vetco equivalent
Manufacturing Specification: API5L Latest Revision and Shell EPE x DQ Manufacturing Specification & Quality Plan Latest Revision, PSL1+
Shell EPE SAP Blue Print No. See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions				**Pipe Performances**	
Nominal OD	30.000 *ins*	Max OD (API)	30.300 *ins*	Weight	310.00 *lbf/ft*
Thickness	1.000 *ins*	Min Thk (API)	0.875 *ins*		
Nominal ID	28.000 *ins*			Pipe Body Yield Strength	4,738,000 *lbf*
				Internal Yield Pressure	NA *psi*
Drift Type	Steel			Collapse Pressure	NA *psi*
Drift Diameter	26.154 *ins*			Bending	2,770,000 *ft lbs*
Drift Length	12 *ins*			Mill Hydrotest Pressure	NA *psi*

Pipe Body Material Properties:

Material Grade	X52				
Yield Strength	52,000 *psi* Minimum	77,000 *psi* Maximum			
UTS	66,000 *psi* Minimum				
Hardness	NA *HRc max.*				
Suitability for SSC	NACE MR01-75: Up to 0.05psi p/p				
Toughness	Per PSL2 *Joules (10 x 10) @ -20 Deg.C.*				
Young's Modulus	31.175 *E-06 psi*		Poisson's Ratio	0.28	
Temperature Derating	0.045% per Deg.F. above 60Deg.F.		Anisotropy		
Thermal Exp. Coef.	6.90 *E-06/deg F*		Longitudinal	100	%
Thermal Conductivity	*Btu/hr-ft-deg F*		Transverse	100	%
Heat Capacity	*Btu/lbm-deg F*		Hoop	100	%

Connector Dimensions & Performance Properties:

Drawing

Connector Dimensions		**Connector Performances**	
Nom inal OD	33.000 *ins*	Tensile Yield Load	4,220,000 *lbf*
Max OD	NA *ins*	Internal Integrity - Liquid	NA *psi*
Min OD	NA *ins*	External Integrity - Liquid	NA *psi*
Bevel	NA *deg*	Bending	2,970,000 *ft lbs*
Nominal ID (Pipe End/Cplg)	26.500 *ins * Note: < Pipe ID*	Compression	NA *lbf*
Max ID (Pipe End/Cplg)	NA *ins*	Torque	1,500,000 *ft lbs*
Min ID (Pipe End/Cplg)	NA *ins*		
Pin int'l chamfer	NA *deg*		
Cpl'g Length	NA *ins*		
Make-up Loss	14.063 *ins*		

30", 1.0"Nom.WT (310#), X52 c/w DQ 30", 1.0"Nom.WT, SL-60/QS Box Up x Pin Down Weld On Connectors, PSL1+

Item Rev. No. B
Primary Uses: Conductor in Subsea Applications
Other Uses: None
Notes: Replacing Vetco equivalent
Manufacturing Specification: API5L Latest Revision and Shell EPE x DQ Manufacturing Specification & Quality Plan Latest Revision, PSL1+
Shell EPE SAP Blue Print No. See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions				**Pipe Performances**	
Nominal OD	30.000 *ins*	Max OD (API)	30.300 *ins*	Weight	310.00 *lbf/ft*
Thickness	1.000 *ins*	Min Thk (API)	0.875 *ins*		
Nominal ID	28.000 *ins*			Pipe Body Yield Strength	4,738,000 *lbf*
				Internal Yield Pressure	NA *psi*
Drift Type	Steel			Collapse Pressure	NA *psi*
Drift Diameter	26.154 *ins*			Bending	2,770,000 *ft lbs*
Drift Length	12 *ins*			Mill Hydrotest Pressure	NA *psi*

Pipe Body Material Properties:

Material Grade	X52				
Yield Strength	52,000 *psi* Minimum	77,000 *psi* Maximum			
UTS	66,000 *psi* Minimum				
Hardness	NA *HRc max.*				
Suitability for SSC	NACE MR01-75: Up to 0.05psi p/p				
Toughness	Per PSL2 *Joules (10 x 10) @ -20 Deg.C.*				
Young's Modulus	31.175 *E-06 psi*		Poisson's Ratio	0.28	
Temperature Derating	0.045% per Deg.F. above 60Deg.F.		Anisotropy		
Thermal Exp. Coef.	6.90 *E-06/deg F*		Longitudinal	100	%
Thermal Conductivity	*Btu/hr-ft-deg F*		Transverse	100	%
Heat Capacity	*Btu/lbm-deg F*		Hoop	100	%

Connector Dimensions & Performance Properties:

Drawing

Connector Dimensions		**Connector Performances**	
Nom inal OD	32.000 *ins*	Tensile Yield Load	2,080,000 *lbf*
Max OD	NA *ins*	Internal Integrity - Liquid	NA *psi*
Min OD	NA *ins*	External Integrity - Liquid	NA *psi*
Bevel	NA *deg*	Bending	1,470,000 *ft lbs*
Nominal ID (Pipe End/Cplg)	27.000 *ins * Note: < Pipe ID*	Compression	NA *lbf*
Max ID (Pipe End/Cplg)	NA *ins*		
Min ID (Pipe End/Cplg)	NA *ins*		
Pin int'l chamfer	NA *deg*		
Cpl'g Length	NA *ins*		
Make-up Loss	10.000 *ins*		

21", 1.25"Nom.WT, X56 c/w Swedge to 20", 0.875"Nom.WT, X80 c/w DQ 20"Nom., 0.625"Nom.WT, THM-90/MT Weld On Connector, PSL1+

Item Rev. No.	E
Primary Uses:	Wellhead Housing Extension & X-Over for Surface Casing in Subsea Applications
Other Uses:	None
Notes:	Suitable for **Drilling Phase** "Gas" Service (Well Control / Gas Kick / Displacement) & Gas Lift **Secondary** Barrier up to 4500psi IP differential.
Manufacturing Specification:	API5L Latest Revision and Shell EPE x DQ Manufacturing Specification & Quality Plan Latest Revision, PSL1+
Shell EPE SAP Blue Print No.	See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions, Material Properaties & Performance Properties:

Dimensions				**Performances**	
Nominal OD	21.000 *ins*	Max OD (API)	21.210 *ins*	Weight	NA *lbf/ft*
Thickness	1.250 *ins*	Min Thk (API)	1.094 *ins*	Pipe Body Yield Strength	4,343,000 *lbf*
Nominal ID	18.500 *ins*			Internal Yield Pressure	5,830 *psi*
Drift Type	Steel			Collapse Pressure	5,686 *psi*
Drift Diameter	17.570 *ins*			Bending	1,680,000 *ft lbs*
Drift Length	12 *ins*			Mill Hydrotest Pressure	NA *psi*
Material Grade	X56				
Yield Strength	56,000 *psi* Minimum		79,000 *psi* Maximum		
UTS	71,000 *psi* Minimum				
Hardness	NA *HRc max.*				
Suitability for SSC	NACE MR01-75: Up to 0.05psi p/p			Temp Derating: 0.03% per Deg.F. above 60Deg.F.	
Toughness	PSL1+ *Joules (10 x 10) @ -20 Deg.C.*			Thermal Exp. Coef.	6.90 *E-06/deg F*
Young's Modulus	30.00 *E* [06] *psi - New info. ex-SIEP*			Poisson's Ratio	0.30 - *New info. ex-SIEP*

Swedge Body Dimensions & Performance Properties:

Swedge Dimensions				**Swedge Performances**	
Nominal OD	21 x 20 *ins*	Max OD (API)	21.210 *ins*	Weight	NA *lbf/ft*
Thickness	1.25 x 0.875 *ins*	Min Thk (API)	NA *ins*	Pipe Body Yield Strength	4,205,800 *lbf*
Nominal ID	18.5 x 18.25 *ins*			Internal Yield Pressure	6,125 *psi*
Drift Type	Steel			Collapse Pressure	3,520 *psi*
Drift Diameter	17.570 *ins*			Bending	1,610,000 *ft lbs*
Drift Length	12 *ins*			Mill Hydrotest Pressure	NA *psi*
Material Grade	X80				
Yield Strength	80,000 *psi* Minimum		TBA *psi* Maximum		
UTS	TBA *psi* Minimum				
Hardness	NA *HRc max.*				
Suitability for SSC	NACE MR01-75: Up to 0.05psi p/p			Temp Derating: 0.03% per Deg.F. above 60Deg.F.	
Toughness	PSL1+ *Joules (10 x 10) @ -20 Deg.C.*			Thermal Exp. Coef.	6.90 *E-06/deg F*
Young's Modulus	30.00 *E* [06] *psi - New info. ex-SIEP*			Poisson's Ratio	0.30 - *New info. ex-SIEP*

Connector Dimensions & Performance Properties:

Connector Dimensions	
Nom inal OD	23.250 *ins*
Max OD	*ins*
Min OD	*ins*
Bevel	NA *deg.*
Nominal ID (Pipe End/Cplg)	18.250 *ins*
Max ID (Pipe End/Cplg)	*ins*
Min ID (Pipe End/Cplg)	*ins*
Pin int'l chamfer	NA *deg*
Cpl'g Length	*ins*
Make-up Loss	7.500 *ins*
Upper Weld Prep	20"OD x 0.875"
Lower Weld Prep	20"OD x 0.625"
Body Yield Strength	90000.000 *psi Minimum*

Connector Performances

20", 0.625"wt THM-90/MT Connector and Upper 20"x0.875"wt Weld Prep Interface Welded to Swedge (above):

Tensile Yield Load	3,180,000 *lbf*
Internal Integrity - Liquid	6,075 *psi*
Internal Integrity - Gas: Drilling Phase and Gas Lift Secondary Barrier **ONLY**	5,000 *psi*
External Integrity	1,925 *psi*
Bending	1,410,000 *ft lbs*
Compression	3,080,000 *lbf*

Lower 20"x0.625"WT Weld Prep Interface Welded to the following Surface Casings:

	20"x0.625", X65 Surface Casing	20"x0.625", X80 Surface Casing	X-Over Swedge, X80, 20"x0.625" to 13.3/8" or 13.5/8" Surface Casings
Tensile Yield Load	2,473,000 *lbs*	3,043,000 *lbs*	3,043,000 *lbf*
Internal Integrity	3,555 *psi*	4,375 *psi*	4,375 *psi*
External Integrity	1,510 *psi*	1,525 *psi*	1,525 *psi*
Bending	968,000 *ft lbs*	1,191,000 *ft lbs*	1,191,000 *ft lbs*
Compression	2,473,000 *lbs*	3,043,000 *lbs*	3,043,000 *lbf*

Connector Torques

Mill End Make Up Torque	
Min / Opt / Max *(lbf.ft)*	NA
Field End Make Up Torque	
Min / Opt / Max *(lbf.ft)*	40,000 / 45,000 / 50,000ft lbs plus Energisation of x12 Socket Set Screws

Colour Codes, Protections & Coatings

Upper Connector	**Upper Pipe Set**	**Pipe Centre**	**Lower Pipe Set**	**Lower Connector**		
21" x 1.25" BWP	Band 1: Blue	Blue	Band 1: Yellow	20" x 0.625" THM-90/MT Pin	Thread Protector	Open End Non-Liftable
	Band 2: Silver				Thread Storage Dope	Jet Lube ALCO EP ECF
					Make-Up Dope - Mill End	NA
					Make-Up Dope - Field End	Jet Lube ALCO EP ECF
					Pipe OD Coating	Bare or Varnish or Paint
					Bore Finish	None
					Pipe Bore Coating	None

13.3/8", 72# (90%Min.WT), P110, Vam Top, Alternative 12.25" Drift, PSL1+

DATA SHEET FOR SMI (SUMITOMO) SUPPLIED TUBULAR. FOR THIS TUBULAR, SMI ARE THE "DEFAULT" SUPPLIER WITH VMOG (SEE SEPARATE DATA SHEET) AS THE "BACK-UP" SUPPLIER

Item Rev. No.	D
Primary Uses:	Intermediate Casing ONLY (DO NOT use as Production Casing without first discussing application)
Other Uses:	None
Notes:	See comment above
Manufacturing Specification:	ISO11960 / API5CT Latest Revision and Shell EPE x SMI MPS TSP-2239 & 2623 Latest Revision, PSL1+
Shell EPE SAP Blue Print No.	R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	13.375 *ins*	Max OD (API)	13.509 *ins*	
Thickness	0.514 *ins*	Min Thk (90%)	0.463 *ins*	
Nominal ID	12.347 *ins*			
Drift Type	Steel			
Drift Diameter (Alternative)	12.250 *ins*			
Drift Length	12 *ins*			

Pipe Performances

Weight	72.00 *lbf/ft*
Pipe Body Yield Strength	2,285,000 *lbf*
Internal Yield Pressure	7,610 *psi*
Collapse Pressure	2,880 *psi*
Mill Hydrotest Pressure	6,900 *psi*

Pipe Body and Connection Material Properties:

Material Grade	P110
Yield Strength	110,000 *psi* Minimum; 140,000 *psi* Maximum
UTS	125,000 *psi* Minimum
Hardness	NA *HRc max.*
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 3 - *Updated Info.* Shell DEP 39.01.10.12-Gen.: Table 1 - *Updated Info.* ISO15156-2: All Temperatures above 175Deg.F. - *Updated Info.*
Toughness	SR16 *at 0 Deg.C*
Young's Modulus	30.00 *E* ^{06} *psi - New info. ex-SIEP*
Temperature Derating	0.03% *per Deg.F. above 60Deg.F. - New info. ex-SIEP*
Thermal Exp. Coef.	6.90 *E-06/deg F - New info. ex-SIEP*
Thermal Conductivity	26.20 *Btu/hr-ft-deg F. - New info. ex-SIEP*
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*

Poisson's Ratio	0.30 - *New info. ex-SIEP*	
Anisotropy		
Longitudinal	100	%
Transverse	100	%
Hoop	100	%

Connection Dimensions & Performance Properties:

Drawing ST-D 7521

Connection Dimensions

Nominal OD	14.236 *ins*
Max OD	14.291 *ins*
Min OD	14.236 *ins*
Bevel	NA *deg.*
Nominal ID (Pipe End/Cplg)	12.563 *ins*
Max ID (Pipe End/Cplg)	12.563 *ins*
Min ID (Pipe End/Cplg)	12.543 *ins*
Pin int'l chamfer	6 *deg*
C'pl'g Length	13.386 *ins*
Make-up Loss	5.698 *ins*
Nom. Bending Rating	30 *Deg/100ft*

Connection Performances

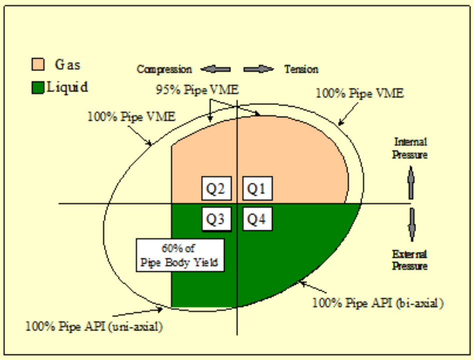
Tensile Yield Load	2,285,000 *lbf*
Internal Integrity - Gas	7,610 *psi*
External Integrity - Liquid	2,880 *psi*
Compression Limit Q2	1,371,000 *lbf*
Comp/Pipe Q2	60%
Compression Limit Q3	1,371,000 *lbf*
Comp/Pipe Q3	60%
Load on Cplg Face	1,364,000 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 23,150 / 25,450 (Make-up as close to Max. as possible

Field End Make Up Torque (except Rotating Liner)
Min / Opt / Max *(lbf.ft)* 20,850 / 23,150 / 25,450

Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA

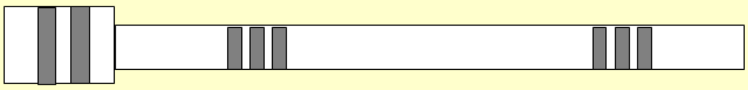


Connection Service Envelope

Make-up Notes
Connection expected to shoulder between 5% and 70% of Optimum

Based on: Extrapolation from Physical Testing of 13.3/8", 72#, L80 & C95 Vam Top and 13.3/8" Vam Top in various Weight/Grade Combinations. Note: Check status of latest Connection Testing as original test was to 50% Compression but subsequently some testing was performed to both 80% & 95% Compression - see restrictions on applications under "Primary Uses", above

Colour Codes, Protections & Coatings



Coupling	Pipe Set 1	Pipe Set 2
White	Band 1 Yellow	Band 1 Green
	Band 2 Brown	Band 2 Blank
	Band 3 Blank	Band 3 Silver

Thread Protectors:	CE Liftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL API HP Modified
~Mill End M/Up ex-Refurb:	JL API HP Modified
~Field End M/Up:	
:<140Deg.C. Well Ops Temp	JL Seal Guard ECF
:>140Deg.C. Well Ops Temp	JL API HP Modified
Pipe OD Coat ex-Mill:	Mill Varnish or Paint
Pipe OD Coat ex-Refurb:	Mill Varnish or Paint
Bore Finish ex-Mill:	None
Bore Finish ex-Refurb:	Iron Blasted SA2 or Water Blast
Pipe Bore Coat ex-Mill:	None
Pipe Bore Coat ex-Refurb:	None

10.3/4", 73.2# (90%Min.WT), VM110SS, Vam HP SC90 Special Clearance 11.470"Nom. OD Coupling, Special 9.33" Drift, PSL2+

DATA SHEET FOR VMOG (VAM) SUPPLIED TUBULAR.

Item Rev. No.	S
Primary Uses:	Production Casing
Other Uses:	None
Notes:	Has replaced 10.3/4", 73.2# (90%Min.WT), AC110SS, NK HW-SC S/C, Special 9.33" Drift
Manufacturing Specification:	ISO11960 / API5CT Latest Revision and Shell EPE x VMOG QP/BLC-SPE-02 Latest Revision, PSL2+
Shell EPE SAP Blue Print No.	R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	10.750 *ins*	Max OD (Special)	10.884 *ins*
Thickness	0.672 *ins*	Min Thk (90%)	0.605 *ins*
Nominal ID	9.406 *ins*		
Drift Type	Steel		
Drift Diameter (Special)	9.330 *ins*		
Drift Length	12 *ins*		

Pipe Performances

Weight	73.20 *lbf/ft*
Pipe Body Yield Strength	2,339,000 *lbf*
Internal Yield Pressure	12,375 *psi*
Collapse Pressure	10,010 *psi*
Mill Hydrotest Pressure	10000(11300) *psi*

Pipe Body and Connection Material Properties:

Material Grade	VM110SS	
Yield Strength	110,000 *psi* Minimum	120,000 *psi* Maximum
UTS	120,000 *psi* Minimum	

Hardness	29.0 *HRc max.*
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 10.4 - *Updated Info.*
	Well Specific Testing 1): @ 1psi p/p H2S @ pH4.0 @ 90%SMYS per NACE TM01-77, Test Method "A"
	Well Specific Testing 2): K1SSC; Ave. > 37MPa[m^0.5] / Min > 37MPa[m^0.5] using 1psi p/p H2S @ pH4.0 per NACE TM01-77, Test Method "D"
	Well Specific Testing 3): @ 14.5psi p/p H2S @ pH2.6-2.8 @ 85%SMYS per NACE TM01-77, Test Method "A"
Toughness	62 *Joules (10 x 10) @ 0 Deg.C.*
Young's Modulus	30.00 *E* [06] *psi - New info. ex-SIEP*
Temperature Derating	0.03% *per Deg.F. above 60Deg.F. - New info. ex-SIEP*
Thermal Exp. Coef.	6.90 *E-06/deg F - New info. ex-SIEP*
Thermal Conductivity	26.20 *Btu/hr-ft-deg F. - New info. ex-SIEP*
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*

Poisson's Ratio	0.30 - *New info. ex-SIEP*	
Anisotropy		
Longitudinal	100	*%*
Transverse	100	*%*
Hoop	100	*%*

Connection Dimensions & Performance Properties:

Drawing SI - PD 100075

Connection Dimensions

Nom inal OD	11.470 *ins*
Max OD	11.500 *ins*
Min OD	11.470 *ins*
Bevel	NA *deg.*
Nominal ID (Pipe End/Cplg)	9.616 *ins*
Max ID (Pipe End/Cplg)	9.626 *ins*
Min ID (Pipe End/Cplg)	9.606 *ins*
Pin int'l chamfer	6 *deg*
C'pl'g Length	17.047 *ins*
Make-up Loss	7.535 *ins*
Nom. Bending Rating	20 *Deg/100ft*

Connection Performances

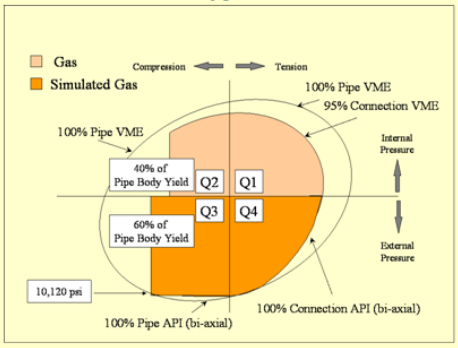
Tensile Yield Load	2,105,000 *lbf*
Internal Integrity - Gas	12,375 *psi*
Ext. Integrity - Gas / Liquid	10010 / 10010 *psi*
Compression Limit Q2	935,600 *lbf*
Comp/Pipe Q2	40%
Compression Limit Q3	1,403,400 *lbf*
Comp/Pipe Q3	60%
Load on Cplg Face	1,216,424 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 43,000 / 47,300 (Make-up as close to Max as possible)

Field End Make Up Torque (except Rotating Liner)
Min / Opt / Max *(lbf.ft)* 38,700 / 43,000 / 47,300

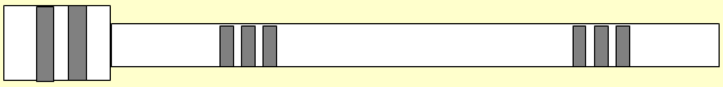
Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA



Make-up Notes
Connection expected to shoulder between 5% and 70% of Optimum

Connection Service Envelope
Based on: Physical Testing of 10.3/4", 73.2#, VM110SS, Vam HP SC90.

Colour Codes, Protections & Coatings



Thread Protectors:	OE Liftable/Driftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL API HP Modified
~Mill End M/Up ex-Refurb:	JL API HP Modified
~Field End M/Up:	
:<140Deg.C. Well Ops Temp	JL Seal Guard ECF
:>140Deg.C. Well Ops Temp	JL API HP Modified
Pipe OD Coat ex-Mill:	Mill Varnish or Paint
Pipe OD Coat ex-Refurb:	Mill Varnish or Paint
Bore Finish ex-Mill:	None
Bore Finish ex-Refurb:	Iron Blasted SA2 or Water Blast
Pipe Bore Coat ex-Mill:	None
Pipe Bore Coat ex-Refurb:	None

Coupling	Pipe Set 1	Pipe Set 2
White with x2 Orange Bands	Band 1 Purple	Band 1 Green
S/C Black Band	Band 2 Purple	Band 2 Note below
	Band 3 Orange	Band 3 Silver
	Band 4 None	

Note. Blue: Class 1 wt, >95%. Orange: Class 2 wt, 92.5<->95%. Purple: Class 3 wt, 90<->92.5%

9.5/8", 53.5# (90%Min.WT), VM95SS (ex-ST95), Vam Top, Alternative 8.5" Drift, PSL2+

DATA SHEET FOR VMOG (VAM) SUPPLIED TUBULAR.

Item Rev. No. M
Primary Uses: Production Casing
Other Uses: None
Notes: None
Manufacturing Specification: ISO11960 / API5CT Latest Revision and Shell EPE x VMOG QP/BLC-SPE-02 Latest Revision, PSL2+
Shell EPE SAP Blue Print No. R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	9.625 *ins*	Max OD (API)	9.721 *ins*
Thickness	0.545 *ins*	Min Thk (90%)	0.491 *ins*
Nominal ID	8.535 *ins*		
Drift Type	Steel		
Drift Diameter (Alternative)	8.500 *ins*		
Drift Length	12 *ins*		

Pipe Performances

Weight	53.50 *lbf/ft*
Pipe Body Yield Strength	1,477,000 *lbf*
Internal Yield Pressure	9,680 *psi*
Collapse Pressure	7,340 *psi*
Mill Hydrotest Pressure	8,800 *psi*

Pipe Body and Connection Material Properties:

Material Grade	VM95SS (ex-ST95)
Yield Strength	95,000 *psi* Minimum 110,000 *psi* Maximum
UTS	105,000 *psi* Minimum
Hardness	25.0 *HRc max.*
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 10.4 - *Updated Info.* Shell DEP 39.01.10.12-Gen.: Table 1 - *Updated Info.* ISO15156-2: All Temperatures - *Updated Info.*
Toughness	Ref. VM95SS *at 0 Deg.C*
Young's Modulus	30.00 *E* ^{06} *psi - New info. ex-SIEP*
Temperature Derating	0.03% *per Deg.F. above 60Deg.F. - New info. ex-SIEP*
Thermal Exp. Coef.	6.90 *E-06/deg F - New info. ex-SIEP*
Thermal Conductivity	26.20 *Btu/hr-ft-deg F. - New info. ex-SIEP*
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*

Poisson's Ratio	0.30 - *New info. ex-SIEP*	
Anisotropy		
Longitudinal	100	%
Transverse	100	%
Hoop	100	%

Connection Dimensions & Performance Properties:

Drawing ST-D 7517

Connection Dimensions

Nominal OD	10.520 *ins*
Max OD	10.575 *ins*
Min OD	10.520 *ins*
Bevel	NA *deg.*
Nominal ID (Pipe End/Cplg)	8.726 *ins*
Max ID (Pipe End/Cplg)	8.726 *ins*
Min ID (Pipe End/Cplg)	8.707 *ins*
Pin int'l chamfer	6 *deg*
C'pl'g Length	13.189 *ins*
Make-up Loss	5.589 *ins*
Nom. Bending Rating	30 *Deg/100ft*

Connection Performances

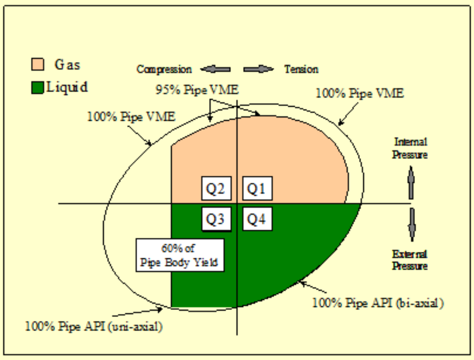
Tensile Yield Load	1,477,000 *lbf*
Internal Integrity - Gas	9,680 *psi*
External Integrity - Liquid	7,340 *psi*
Compression Limit Q2	886,200 *lbf*
Comp/Pipe Q2	60%
Compression Limit Q3	886,200 *lbf*
Comp/Pipe Q3	60%
Load on Cplg Face	903,000 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 23,150 / 25,450 (Make-up as close to Max as possible)

Field End Make Up Torque (except Rotating Liner)
Min / Opt / Max *(lbf.ft)* 20,850 / 23,150 / 25,450

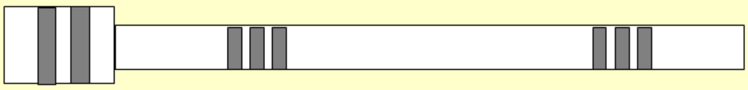
Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA



Make-up Notes
Connection expected to shoulder between 5% and 70% of Optimum

Connection Service Envelope
Based on: Interpolation from Physical Testing of 9.5/8", 53.5#, L80, Vam Top and 9.5/8", 53.5#, VM125CY(ex-QR125), Vam Top. Note: Check status of latest Connection Testing as original test was to 60% Compression but subsequently some testing was performed to 80% Compression

Colour Codes, Protections & Coatings



Coupling	Pipe Set 1	Pipe Set 2
Old: Purple with Brown Band	Band 1 Yellow	Band 1 Green
New: Brown with x2 Orange Bands	Band 2 Blue	Band 2 Blank
	Band 3 Blank	Band 3 Silver

Thread Protectors:	OE Liftable/Driftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL API HP Modified
~Mill End M/Up ex-Refurb:	JL API HP Modified
~Field End M/Up:	
:<140Deg.C. Well Ops Temp	JL Seal Guard ECF
:>140Deg.C. Well Ops Temp	JL API HP Modified
Pipe OD Coat ex-Mill:	Mill Varnish or Paint
Pipe OD Coat ex-Refurb:	Mill Varnish or Paint
Bore Finish ex-Mill:	None
Bore Finish ex-Refurb:	Iron Blasted SA2 or Water Blast
Pipe Bore Coat ex-Mill:	None
Pipe Bore Coat ex-Refurb:	None

9.5/8", 53.5# (90%Min.WT), VM125CY (ex-QR125), Vam Top, Alternative 8.5" Drift, PSL2+

DATA SHEET FOR VMOG (VAM) SUPPLIED TUBULAR.

Item Rev. No. N
Primary Uses: Production Casing
Other Uses: None
Notes: None
Manufacturing Specification: ISO11960 / API5CT Latest Revision and Shell EPE x VMOG QP/BLC-SPE-02 Latest Revision, PSL2+
Shell EPE SAP Blue Print No. R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	9.625 *ins*	Max OD (API)	9.721 *ins*
Thickness	0.545 *ins*	Min Thk (90%)	0.491 *ins*
Nominal ID	8.535 *ins*		
Drift Type	Steel		
Drift Diameter (Alternative)	8.500 *ins*		
Drift Length	12 *ins*		

Pipe Performances

Weight	53.50 *lbf/ft*
Pipe Body Yield Strength	1,943,000 *lbf*
Internal Yield Pressure	12,740 *psi*
Collapse Pressure	8,440 *psi*
Mill Hydrotest Pressure	10000(11600) *psi*

Pipe Body and Connection Material Properties:

Material Grade	VM125CY (ex-QR125)	
Yield Strength	125,000 *psi* Minimum	140,000 *psi* Maximum
UTS	135,000 *psi* Minimum	
Hardness	35.0 *HRc max.*	
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 3 - *Updated Info.* Shell DEP 39.01.10.12-Gen.: Table 1 - *Updated Info.* ISO15156-2: All Temperatures above 175Deg.F. - *Updated Info.*	
Toughness	SR16 *at 0 Deg.C*	
Young's Modulus	30.00 *E ^{06} psi - New info. ex-SIEP*	
Temperature Derating	0.03% *per Deg.F. above 60Deg.F. - New info. ex-SIEP*	
Thermal Exp. Coef.	6.90 *E-06/deg F - New info. ex-SIEP*	
Thermal Conductivity	26.20 *Btu/hr-ft-deg F. - New info. ex-SIEP*	
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*	

Poisson's Ratio	0.30 - *New info. ex-SIEP*	
Anisotropy		
Longitudinal	100	%
Transverse	100	%
Hoop	100	%

Connection Dimensions & Performance Properties:

Drawing ST-D 7517

Connection Dimensions

Nom inal OD	10.520 *ins*
Max OD	10.575 *ins*
Min OD	10.520 *ins*
Bevel	NA *deg.*
Nominal ID (Pipe End/Cplg)	8.726 *ins*
Max ID (Pipe End/Cplg)	8.726 *ins*
Min ID (Pipe End/Cplg)	8.707 *ins*
Pin int'l chamfer	6 *deg*
Cpl'g Length	13.189 *ins*
Make-up Loss	5.589 *ins*
Nom. Bending Rating	30 *Deg/100ft*

Connection Performances

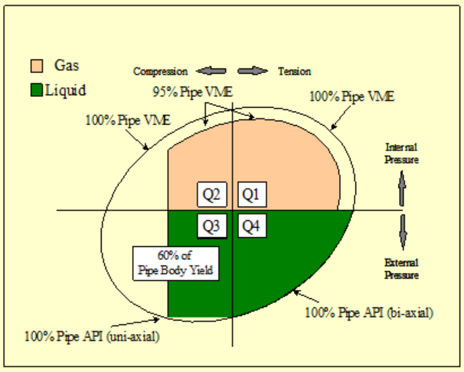
Tensile Yield Load	1,943,000 *lbf*
Internal Integrity - Gas	12,740 *psi*
External Integrity - Liquid	8,440 *psi*
Compression Limit Q2	1,165,800 *lbf*
Comp/Pipe Q2	60%
Compression Limit Q3	1,165,800 *lbf*
Comp/Pipe Q3	60%
Load on Cplg Face	1,188,000 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 23,150 / 25,450 (Make-up as close to Max as possible)

Field End Make Up Torque (except Rotating Liner)
Min / Opt / Max *(lbf.ft)* 20,850 / 23,150 / 25,450

Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA

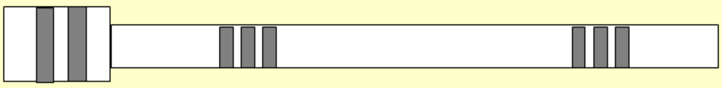


Connection Service Envelope

Make-up Notes
Connection expected to shoulder between 5% and 70% of Optimum

Based on: Physical Testing of 9.5/8", 53.5#, VM125CY(ex-QR125), Vam Top. Note: Check status of latest Connection Testing as original test was to 60% Compression but subsequently some testing was performed to 80% Compression

Colour Codes, Protections & Coatings



Coupling	Pipe Set 1	Pipe Set 2
Old: Orange with White Band	Band 1 Yellow	Band 1 Green
New: Orange with Brown Band	Band 2 Blue	Band 2 Blank
	Band 3 Blank	Band 3 Silver

Thread Protectors:	OE Liftable/Driftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL API HP Modified
~Mill End M/Up ex-Refurb:	JL API HP Modified
~Field End M/Up:	
:<140Deg.C. Well Ops Temp	JL Seal Guard ECF
:>140Deg.C. Well Ops Temp	JL API HP Modified
Pipe OD Coat ex-Mill:	Mill Varnish or Paint
Pipe OD Coat ex-Refurb:	Mill Varnish or Paint
Bore Finish ex-Mill:	None
Bore Finish ex-Refurb:	Iron Blasted SA2 or Water Blast
Pipe Bore Coat ex-Mill:	None
Pipe Bore Coat ex-Refurb:	None

7", 32#, L80 / 13%Cr, Vam Top HT Bev., Alternative 6.0" Drift, PSL1+

DATA SHEET FOR SMI (SUMITOMO) SUPPLIED TUBULAR. FOR THIS TUBULAR, SMI ARE THE "DEFAULT" SUPPLIER WITH VMOG (SEE SEPARATE DATA SHEET) AS THE "BACK-UP" SUPPLIER

Item Rev. No.	G
Primary Uses:	Production Tubing, Production Casing and Production Rotating Liner
Other Uses:	None
Notes:	Has replaced 7" 32# L80 / 13Cr TS-3SB (ex-NK3SB), Alt 6.0" Drift, Bev., PSL2+
Manufacturing Specification:	ISO11960 / API5CT Latest Revision and Shell EPE x SMI MPS TSP-2356 & 2589 Latest Revision, PSL1+
Shell EPE SAP Blue Print No.	R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	7.000 *ins*	Max OD (API)	7.070 *ins*
Thickness	0.453 *ins*	Min Thk (API)	0.396 *ins*
Nominal ID	6.094 *ins*		
Drift Type	Alum/Teflon		
Drift Diameter (Alternative)	6.000 *ins*		
Drift Length	42 *ins*		

Pipe Performances

Weight	32.00 *lbf/ft*
Pipe Body Yield Strength	745,000 *lbf*
Internal Yield Pressure	9,060 *psi*
Collapse Pressure	8,610 *psi*
Mill Hydrotest Pressure	8,300 *psi*

Pipe Body and Connection Material Properties:

Material Grade	L80 / 13%Cr
Yield Strength	80,000 *psi* Minimum — 95,000 *psi* Maximum
UTS	95,000 *psi* Minimum
Hardness	23.0 *HRc max.*
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 10.5 - *Updated Info.* Shell DEP 39.01.10.12-Gen.: Table 1 - *Updated Info.* ISO15156-3: All Temperatures, up to 1.5psi p/p H2S @ pH ≥ 3.5 - *Updated Info.*
Toughness	SR16 *at 0 Deg.C*
Young's Modulus	31.29 *E* ^{06} *psi - New info. ex-SIEP*
Temperature Derating	0.033% *per Deg.F. above 75Deg.F. - New info. ex-SIEP*
Thermal Exp. Coef.	6.10 *E-06/deg F - New info. ex-SIEP*
Thermal Conductivity	15.00 *Btu/hr-ft-deg F. - New info. ex-SIEP*
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*

Poisson's Ratio	*0.27 - New info. ex-SIEP*
Anisotropy	
Longitudinal	100 %
Transverse	100 %
Hoop	100 %

Connection Dimensions & Performance Properties:

Drawing SI-PD 100528 & ST-D-7595

Connection Dimensions

Nominal OD	7.717 *ins*
Max OD	7.772 *ins*
Min OD	7.717 *ins*
Bevel	20 *deg. Shell Special*
Nominal ID (Pipe End/Cplg)	6.059 *ins*
Max ID (Pipe End/Cplg)	6.059 *ins*
Min ID (Pipe End/Cplg)	6.039 *ins*
Pin int'l chamfer	3 *deg*
C'pl'g Length	11.535 *ins*
Make-up Loss	4.776 *ins*
Nom. Bending Rating	30 *Deg/100ft*

Connection Performances

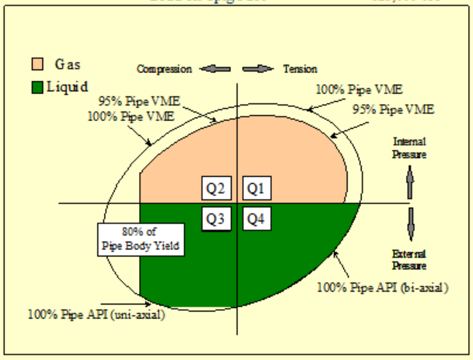
Tensile Yield Load	745,000 *lbf*
Internal Integrity - Gas	9,060 *psi*
External Integrity - Liquid	8,610 *psi*
Compression Limit Q2	596,000 *lbf*
Comp/Pipe Q2	80%
Compression Limit Q3	596,000 *lbf*
Comp/Pipe Q3	80%
Load on Cplg Face	125,000 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 25,450 / 28,000 (Make-up as close to Max as possible)

Field End Make Up Torque for Tubing (& Non-Rotating Liner) applications
Min / Opt / Max *(lbf.ft)* 14,050 / 15,550 / 17,050

Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA / 23,130 / 25,450

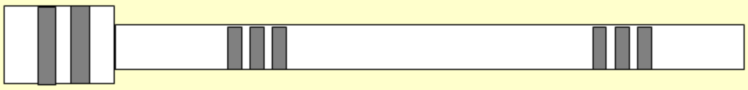


Make-up Notes
Connection expected to shoulder between 5% and 70% of "Tubing" Opt. Torque

Connection Service Envelope

Based on: **At Vam Top HT Liner Torques:**
Interpolation from Physical Testing of 7", 32#, SM13CrM-110, Vam Top HT.
At Vam Top HT Tubing Torques (= Vam Top HC):
Interpolation from Physical Testing of 7", 32#, SM13CrM-110, Vam Top HC

Colour Codes, Protections & Coatings



Coupling	Pipe Set 1	Pipe Set 2
Blank with Yellow Band	Band 1 Yellow	Band 1 Yellow
	Band 2 Blue	Band 2 Blank
	Band 3 Blank	Band 3 Silver

Thread Protectors:	CE Liftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL Seal Guard ECF
~Mill End M/Up ex-Refurb:	JL Seal Guard ECF
~Field End M/Up:	JL Seal Guard ECF
Pipe OD Coat ex-Mill:	Mill Varnish
Pipe OD Coat ex-Refurb:	Mill Varnish or Agma 501
Bore Finish ex-Mill:	Sand Blast SA2.5
Bore Finish ex-Refurb:	Sand Blast SA2.5 or Water Blast
Pipe Bore Coat ex-Mill:	Light Oil, Anticorit DFW90 or Vincit120
Pipe Bore Coat ex-Refurb:	Anticorit DFW90 or Vincit120

5.1/2", 23#, L80 / 13%Cr, Vam Top HT Bev., PSL1+

DATA SHEET FOR SMI (SUMITOMO) SUPPLIED TUBULAR. FOR THIS TUBULAR, SMI ARE THE "DEFAULT" SUPPLIER WITH VMOG (SEE SEPARATE DATA SHEET) AS THE "BACK-UP" SUPPLIER

Item Rev. No.	F
Primary Uses:	Production Tubing and Production Rotating Liner
Other Uses:	None
Notes:	Has replaced 5.1/2" 23# L80 / 13Cr TS-3SB (ex-NK3SB), Bev., PSL2+
Manufacturing Specification:	ISO11960 / API5CT Latest Revision and Shell EPE x SMI MPS TSP-2356 & 2589 Latest Revision, PSL1+
Shell EPE SAP Blue Print No.	R3, Pups and Couplings: See Latest Revision of Summary Sheet Listing

Pipe Body Dimensions & Performance Properties:

Pipe Dimensions

Nominal OD	5.500 *ins*	Max OD (API)	5.555 *ins*
Thickness	0.415 *ins*	Min Thk (API)	0.363 *ins*
Nominal ID	4.670 *ins*		
Drift Type	Alum/Teflon		
Drift Diameter	4.545 *ins*		
Drift Length	42 *ins*		

Pipe Performances

Weight	23.00 *lbf/ft*
Pipe Body Yield Strength	530,000 *lbf*
Internal Yield Pressure	10,560 *psi*
Collapse Pressure	11,160 *psi*
Mill Hydrotest Pressure	9,700 *psi*

Pipe Body and Connection Material Properties:

Material Grade	L80 / 13%Cr	
Yield Strength	80,000 *psi* Minimum	95,000 *psi* Maximum
UTS	95,000 *psi* Minimum	
Hardness	23.0 *HRc max.*	
Suitability for SSC	Shell Casing and Tubing Design Manual Volume 1: Chapter 10.5 - *Updated Info.* Shell DEP 39.01.10.12-Gen.: Table 1 - *Updated Info.* ISO15156-3: All Temperatures, up to 1.5psi p/p H2S @ pH ≥ 3.5 - *Updated Info.*	
Toughness	SR16 *at 0 Deg.C*	
Young's Modulus	31.29 *E [06] psi - New info. ex-SIEP*	
Temperature Derating	*0.033% per Deg.F. above 75Deg.F. - New info. ex-SIEP*	
Thermal Exp. Coef.	6.10 *E-06/deg F - New info. ex-SIEP*	
Thermal Conductivity	15.00 *Btu/hr-ft-deg F. - New info. ex-SIEP*	
Heat Capacity	1.1x10[-1] *Btu/lbm-deg F. - New info. ex-SIEP*	

Poisson's Ratio	*0.27 - New info. ex-SIEP*
Anisotropy	
Longitudinal	100 %
Transverse	100 %
Hoop	100 %

Connection Dimensions & Performance Properties:

Drawing SI-PD 100526 & ST-D-7595

Connection Dimensions

Nominal OD	6.156 *ins*
Max OD	6.211 *ins*
Min OD	6.156 *ins*
Bevel	20 *deg. Shell Special*
Nominal ID (Pipe End/Cplg)	4.607 *ins*
Max ID (Pipe End/Cplg)	4.607 *ins*
Min ID (Pipe End/Cplg)	4.588 *ins*
Pin int'l chamfer	3 *deg*
Cpl'g Length	10.748 *ins*
Make-up Loss	4.382 *ins*
Nom. Bending Rating	30 *Deg/100ft*

Connection Performances

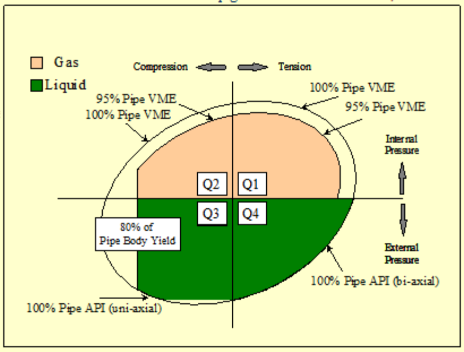
Tensile Yield Load	530,000 *lbf*
Internal Integrity - Gas	10,560 *psi*
External Integrity - Liquid	11,160 *psi*
Compression Limit Q2	424,000 *lbf*
Comp/Pipe Q2	80%
Compression Limit Q3	424,000 *lbf*
Comp/Pipe Q3	80%
Load on Cplg Face	99,000 *lbs*

Torques

Mill End Make Up Torque
Min / Opt / Max *(lbf.ft)* NA / 15,200 / 16,700 (Make-Up as close to Max. as possible

Field End Make Up Torque for Tubing (& Non-Rotating Liner) applications
Min / Opt / Max *(lbf.ft)* 9,850 / 10,850 / 11,850

Field End Make Up Torque for Rotating Liner
Min / Opt / Max *(lbf.ft)* NA / 13,820 / 15,200

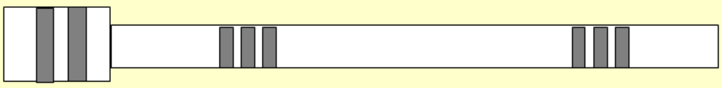


Connection Service Envelope

Make-up Notes
Connection expected to shoulder between 5% and 70% of **"Tubing"** Opt. Torque Based on:

At Vam Top HT Liner Torques:
Interpolation from Physical Testing of 5.1/2", 23# & 26#, 25%Cr-125 Super Duplex, Vam Top HT.
At Vam Top HT Tubing Torques (= Vam Top HC):
Interpolation from Physical Testing of 5.1/2", 23#, SM2535-110, Vam Top HC

Colour Codes, Protections & Coatings

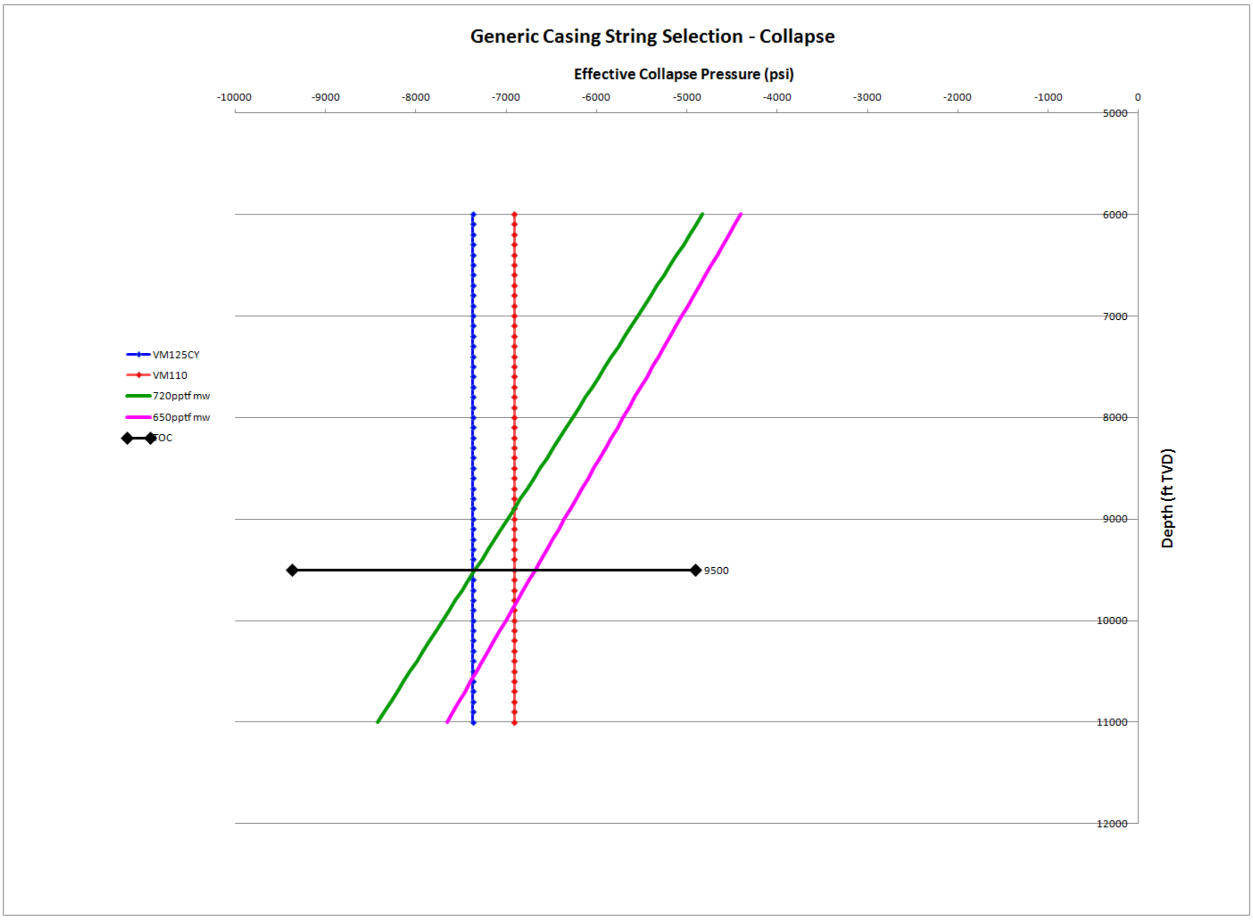


Coupling	Pipe Set 1	Pipe Set 2
Blank with Yellow Band	Band 1 Yellow	Band 1 Yellow
	Band 2 Brown	Band 2 Blank
	Band 3 Blank	Band 3 Silver

Thread Protectors:	CE Liftable
Thread Dopes:	
~Storage ex-Mill:	JL Seal Guard ECF
~Storage ex-Refurb:	JL Seal Guard ECF
~Mill End M/Up ex-Mill:	JL Seal Guard ECF
~Mill End M/Up ex-Refurb:	JL Seal Guard ECF
~Field End M/Up:	JL Seal Guard ECF
Pipe OD Coat ex-Mill:	Mill Varnish
Pipe OD Coat ex-Refurb:	Mill Varnish or Agma 501
Bore Finish ex-Mill:	Sand Blast SA2.5
Bore Finish ex-Refurb:	Sand Blast SA2.5 or Water Blast
Pipe Bore Coat ex-Mill:	Light Oil, Anticorit DFW90 or Vincit120
Pipe Bore Coat ex-Refurb:	Anticorit DFW90 or Vincit120

Appendix 5. TITAP Collapse Pressure on production casing

This schematic shows that with an 860pptf leak off at the 13 3/8” shoe, and heavy 720pptf mud (reactive Horda or drilling through Kimmeridge) in 12 ¼” section and therefore left in the B annulus a 9500ft TOC is required to protect VM125CY casing deeper down from collapse. If the drilling mud used is a more common 650pptf (typical against Lark) then a much deeper TOC is acceptable.



Appendix 6. Required minimum design factors for use in the design (As per TS03 [2])

Description	Label	Pipe Body	Conn: Tested	Conn: Legacy
Running & Pulling: Axial				
Running Compression: Static/Dynamic: Torque & Drag	RC	1.10	1.10	1.25
Running Tension: Torque & Drag	RT1	1.40	1.40	1.55
Pulling Tension: Static: Overpull (string stuck)	RT2	1.20	1.20	1.35
Running Tension: Dynamic shock loading	**RT3**	**1.30**	**1.30**	**1.50**
Collapse (Combined Load Q3 & Q4):	C	1.00	1.00	1.20
Burst – Triaxial (VME Q1 & VME Q2):				
Environment: Up to Non-Sour Boundary(CTDM Figure 4):				
All Tubing & Casing, no SR16, no SR2	B1	1.25	1.25	1.40
All Tubing & Casing, SR16 & SR2	B2	**1.10**	**1.10**	1.30
Environment: 'Mild (M)' Sour Region 1&2 (CTDM Figure 4) (and bordered by <1psi p/p H2S):				
Sour Spec. Tubing < 150Deg. F	B3(M)	**1.20**	**1.20**	**1.40**
Sour Spec. Casing < 150Deg.F	B4(M)	**1.15**	**1.15**	**1.35**
Sour Spec. Tubing & Casing > 150Deg.F	B5(M)	**1.10**	**1.10**	**1.30**
Non-Sour Spec. Tubing & Casing, SR16 & SR2 > Sour Threshold Temp.	**B7**(M)	**1.10**	**1.10**	**1.30**
Environment: 'Full (F)' Sour Region 3&4 (CTDM Figure 4):				
Sour Spec. Tubing < 150Deg.F	B3(F)	1.25	1.25	1.40
Sour Spec. Casing < 150Deg.F	B4(F)	1.20	1.20	1.35
Sour Spec. Tubing & Casing > 150Deg.F	B5(F)	1.15	1.15	1.30
Non-Sour Spec. Tubing & Casing, SR16 & SR2 > Sour Threshold Temp.	**B7**(F)	**1.15**	**1.15**	**1.30**
Injectors : Injection (injection, hydraulic fracturing and pressure testing) Load Case. All Tubing & Casing, SR16 & SR2	B6	1.10	1.10	1.25
Axial:				
Tension under Burst (VME Q1)		**As Burst**	**As Burst**	**1.60**
Tension under Collapse (VME Q4)		**1.00**	**1.00**	**1.60**
Compression under Burst (VME Q2)		**As Burst**	**As Burst**	**1.30**
Compression under Collapse (VME Q3)		**1.00**	**1.00**	**1.30**