APPENDIX C

Stress Calcualtions for Well Tubulars

Geostock Sandia

APPENDIX C
Lapis Energy
Project Blue Site
Injection Well(s)
Tubular Design Calculations

Water String:

The greatest burst, collapse and tension stresses induced over the life of the water string occur during its installation.

A. **Burst**: The burst pressure of the casing is governed by conditions present at the casing shoe. Two scenarios are considered. The first scenario assumes that the formation will fracture before the casing ruptures. A second scenario is considered using the highest burst pressure expected occurring during cementing operations. The greater of the two anticipated pressures will dictate the required burst strength of the casing.

$$P_{shoe} = P_{test} + (FG + SF) \times 0.052 \times D_{csg} - MW \times 0.052 \times D_{csg}$$

and

$$P_{shoe} = MW_{lead} \times 0.052 \times H_{lead} + MW_{tail} \times 0.052 \times H_{tail} - MW \times 0.052 \times L_{csg} + MASP_{cmt}$$

Where:

P_{shoe}	=	Maximum anticipated shoe pressure, psi
P_{test}	=	Maximum anticipated casing test pressure, psi
FG	=	Estimated fracture pressure at shoe, lb/gal
SF	=	Burst loading safety factor, (1.5 lb/gal)
D_{csg}	=	Casing setting depth, feet
MW	=	Mud Weight of drilling fluid, lb/gal
0.052	=	Conversion factor, psi-gal/ft-lb
MW_{lead}	=	Mud Weight of Lead Cement, lb/gal
H_{lead}	=	Height of lead cement, feet
MW_{tail}	=	Mud Weight of Tail Cement, lb/gal
H_{tail}	=	Height of tail cement, feet
MW	=	Mud Weight of drilling fluid, lb/gal

L_{csg} = Affected length of casing, feet

Cap_{csg} = Casing capacity (.2222 bbl/ft)

V_{lead} = Volume of lead cement from cementing recommendation

V_{tail} = Volume of tail cement from cementing recommendation

Scenario 1:

P_{shoe} = 1,000 psi + (12.2 + 1.5) x 0.052 x 900 – 9.0 x 0.052 x 900

P_{shoe} = 1,220 psi

Scenario 2:

This scenario assumes that lost circulation occurs, and the float equipment plugs up with all the cement inside the casing. Water is used as a backup to be conservative, and the maximum allowable surface pressure during this operation is 700 psig. Using the cementing recommendation, the lead cement volume is 115 bbl and the density is 11.5 lb/gal. The tail cement volume is 135 bbl and the density is 13.2 lb/gal.

H_{lead} = Volume of lead cement from cementing recommendation/Casing capacity

$$H_{lead} = 115/.2222$$

$$H_{lead} = 518 \text{ feet}$$

H_{tail} = Volume of tail cement from cementing recommendation/Casing capacity

$$H_{tail} = 135/.2222$$

$$H_{tail} = 608 \text{ feet}$$

Since the casing length is 900 feet, the affected length of casing is the total length of the tail and part of the lead cements (608 + 292), or 900 feet. Inserting these values into the master equation:

$$P_{shoe} = (11.5 \times 0.052 \times 608) + 13.2 \times 0.052 \times 292 - 8.33 \times 0.052 \times 900 + 700$$

$$P_{shoe} = 874 \text{ psi}$$

For Injection Well (and Contingency Well)

The burst pressure rating of the 16-inch O.D., 75 lb/ft, Grade J-55 water string is 2,630 psi, which results in a safety factor of 2.16 (2,630/1,220).

B. **Collapse**: The collapse pressure of the casing is governed by conditions present at the shoe during cementing of the casing. The scenario assumes that the casing is void of fluids inside. The anticipated pressure will dictate the required collapse strength of the casing.

$$P_{shoe} = (MW_{lead} \times 0.052 \times D_{lead}) + (MW_{tail} \times 0.052 \times L_{tail})$$

Where:

P_{shoe}	=	Maximum anticipated external shoe pressure, psi
MW_{lead}	=	Mud Weight of lead cement, lb/gal
D_{lead}	=	Depth of Lead Cement, feet
L_{tail}	=	Height of tail slurry, feet
0.052	=	Conversion factor, psi-gal/ft-lb

P_{shoe} = (11.5 x 0.052 x 400) + (13.2 x 0.052 x 500)

P_{shoe} = 582 psi

For Injection and Contingency Well:

The collapse pressure rating of the 16-inch O.D., 75 lb/ft, Grade J-55 water string is 1,020 psi, which results in a safety factor of 1.75 (1,020/582).

C. Tension: The tensile strength of the casing is governed by the unit tubular weight and buoyancy effects.

$$W_{\max} = W_{csg} \times D_{csg} - MW \times A_{csg} \times 0.052 \times D_{csg}$$

Where:

W_{max}	=	Maximum tensile weight at worst case, lbs
W_{csg}	=	Unit casing weight, lb/ft

D_{csg}	=	Casing setting depth, feet
MW	=	Weight of fresh water, (8.33) lb/gal
A_{csg}	=	Cross-sectional area of casing, (21.41 sq. in.)
0.052	=	Conversion factor, psi-gal/ft-lb

For Injection and Contingency Well:

W_{max} = 75 x 900 – 8.33 x 21.41 x 0.052 x 900
W_{max} = 59,153 lbs

The tensile rating of the 16-inch O.D., 75 lb/ft, Grade J-55 water string is 1,178,000 lbs, which results in a safety factor of 19.91 (1,178,000/59,153).

The tensile rating of the STC on the 16-inch O.D., 75 lb/ft, Grade J-55 water string is 710,000 lbs, which results in a safety factor of 12.00 (710,000/59,153).

Surface Casing:

The greatest burst, collapse and tension stresses induced over the life of the surface casing occur during its installation.

A. **Burst**: The burst pressure of the casing is governed by conditions present at the casing shoe. Two scenarios are considered. The first scenario assumes that the formation will fracture before the casing ruptures. A second scenario is considered using the highest burst pressure expected occurring during cementing operations. The greater of the two anticipated pressures will dictate the required burst strength of the casing.

$$P_{shoe} = P_{test} + (FG + SF) \times 0.052 \times D_{csg} - MW \times 0.052 \times D_{csg}$$

and

$$P_{shoe} = MW_{lead} \times 0.052 \times H_{lead} + MW_{tail} \times 0.052 \times H_{tail} - MW \times 0.052 \times L_{csg} + MASP_{cmt}$$

Where:

P_{shoe}	=	Maximum anticipated shoe pressure, psi
P_{test}	=	Maximum anticipated casing test pressure, psi
FG	=	Estimated fracture pressure at shoe, lb/gal
SF	=	Burst loading safety factor, (1.5 lb/gal)
D_{csg}	=	Casing setting depth, feet
MW	=	Mud Weight of drilling fluid, lb/gal
0.052	=	Conversion factor, psi-gal/ft-lb
MW_{lead}	=	Mud Weight of Lead Cement, lb/gal
H_{lead}	=	Height of lead cement, feet
MW_{tail}	=	Mud Weight of Tail Cement, lb/gal
H_{tail}	=	Height of tail cement, feet
MW	=	Mud Weight of drilling fluid, lb/gal
L_{csg}	=	Affected length of casing, feet
Cap_{csg}	=	Casing capacity (.0962 bbl/ft)
V_{lead}	=	Volume of lead cement from cementing recommendation
V_{tail}	=	Volume of tail cement from cementing recommendation

Scenario 1:

P_{shoe} = 1,000 psi + (12.2 + 1.5) x 0.052 x 3250 – 9.0 x 0.052 x 3250

P_{shoe} = 1,391 psi

Scenario 2:

This scenario assumes that lost circulation occurs, and the float equipment plugs up with all the cement inside the casing. Water is used as a backup to be conservative, and the maximum allowable surface pressure during this operation is 700 psig. Using the cementing recommendation, the lead cement volume is 196 bbl and the density is 11 lb/gal. The tail cement volume is 73 bbl and the density is 14.2 lb/gal.

H_{lead} = Volume of lead cement from cementing recommendation/Casing capacity

$$H_{lead} = 196/.0962$$

$$H_{lead} = 2{,}037 \text{ feet}$$

H_{tail} = Volume of tail cement from cementing recommendation/Casing capacity

$$H_{tail} = 73/.0962$$

$$H_{tail} = 759 \text{ feet}$$

Since the casing length is 3,250 feet, the cement will be followed by 9.0 lb/gal drilling mud. Inserting these values into the master equation:

$$P_{shoe} = 11 \times 0.052 \times 2037 + 14.2 \times 0.052 \times 759 + 9.0 \times 0.052 \times 454 - 8.33 \times 0.052 \times 3250 + 700$$

$$P_{shoe} = 1{,}230 \text{ psi}$$

For Injection Well (and Contingency Well)

The burst pressure rating of the 10-3/4-inch O.D., 45.5 lb/ft, Grade J-55 surface casing is 3,580 psi, which results in a safety factor of 2.91 (3,580/1,230).

B. **Collapse**: The collapse pressure of the casing is governed by conditions present at the shoe during cementing of the casing. This scenario assumes that the casing contains a column of fresh water inside to be more conservative and to counteract the external hydrostatic force from the cement slurries. As the cementing operation is planned as a two-stage event, a calculation is performed for each stage. A worst-case scenario is assumed with a perfect hole and no losses for the first or second stages.

$$P_{shoe} = MW_{lead} \times 0.052 \times H_{lead} + MW_{tail} \times 0.052 \times H_{tail} - MW \times 0.052 \times (D_{csg})$$

Where:

P_{shoe}	=	Maximum anticipated shoe pressure, psi
MW_{lead}	=	Mud Weight of lead cement, lb/gal
MW_{tail}	=	Mud Weight of tail cement lb/gal
H_{tail}	=	Height of tail slurry, feet
H_{lead}	=	Height of lead slurry, feet
MW	=	Weight of fresh water, (8.33 lb/gal)
D_{csg}	=	Affected casing depth, feet
0.052	=	Conversion factor, psi-gal/ft-lb

$$Capacity\ between\ 14\frac{3}{4}"\ hole\ and\ 10\frac{3}{4}"\ casing\ =\ 0.0991\ bbl/ft$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 1\ Tail =\ 73\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 1\ Tail\ = \frac{73}{0.0991} = 737\ feet$$

$$Top\ of\ Stage\ 1\ Cement\ Tail = 3{,}250 - 737 = 2{,}513\ feet$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 1\ Lead =\ 196\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 1\ Lead = \frac{196}{0.0991} = 1{,}978\ feet$$

$$Top\ of\ Stage\ 1\ Lead\ Cement\ =\ 2{,}513 - 1{,}978 = 535\ feet$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 2\ Tail =\ 16\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 2\ Tail\ = \frac{16}{0.0991} = 161\ feet$$

$$Top\ of\ Stage\ 2\ Cement\ Tail = 1{,}500 - 161 = 1{,}339\ feet$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 2\ Lead = 318\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 2\ Lead\ = \frac{318}{0.0991} = 3{,}209\ feet$$

$$Stage\ 2\ Lead\ Cement\ =\ 1{,}339\ feet*$$

**Note: Stage tool is at 1,500 feet*

Injection and Contingency Well:

Stage 1: Using the cementing volume recommendation for Stage 1, the calculated top of lead cement is at 535 feet and the density is 11 lb/gal, and the calculated top of tail cement is at 2,513 feet and the density is 14.8 lb/gal.

$$P_{shoe(S1)} = (11 \times 0.052 \times 1{,}978) + (14.2 \times 0.052 \times 737) + (9.0\ x\ 0.052\ x\ 535) - 8.33 \times 0.052 \times 3{,}250$$

$$P_{shoe(S1)} = 518 \text{ psi}$$

Stage 2: Using the cementing volume recommendation for Stage 2, the top of lead cement is at surface and the density is 11 lb/gal, and the calculated top of tail cement is at 1,339 feet and the density is 14.2 lb/gal.

$$P_{shoe(S2)} = (14.2 \times 0.052 \times 1{,}339) + (11 \times 0.052 \times 161) - 8.33 \times 0.052 \times 1{,}500$$

$$P_{shoe(S2)} = 431 \text{ psi}$$

The collapse pressure rating of the 10-3/4-inch O.D., 45.5 lb/ft, Grade J-55 surface casing is 2,090 psi, which results in a design safety factor of 4.03 (2,090/518).

C. Tension: The tensile strength of the casing is governed by the unit tubular weight and buoyancy effects.

$$W_{\max} = W_{csg} \times D_{csg} - MW \times A_{csg} \times 0.052 \times D_{csg}$$

Where:

W_{max}	=	Maximum tensile weight at worst case, lbs
W_{csg}	=	Unit casing weight, lb/ft
D_{csg}	=	Casing setting depth, feet
MW	=	Weight of fresh water, (8.33) lb/gal
A_{csg}	=	Cross-sectional area of casing, (13.01 sq. in.)
0.052	=	Conversion factor, psi-gal/ft-lb

For Injection and Contingency Well:

W_{max} = 45.5 x 3250 – 8.33 x 13.01 x 0.052 x 3250
W_{max} = 129,560 lbs

The tensile rating of the 10-3/4-inch O.D., 45.5 lb/ft, Grade J-55 surface casing is 715,000 lbs, which results in a safety factor of 5.52 (715,000/129,560).

The tensile rating of the STC on the 10-3/4-inch O.D., 45.5 lb/ft, Grade J-55 surface casing is 493,000 lbs, which results in a safety factor of 3.81 (493,000/129,560).

Protection Casing:

The greatest burst, collapse and tension stresses induced over the life of the protection casing occur during its installation.

A. **Burst**: The greatest rupture stresses induced over the life of the protection casing occur during the casing pressure test after cementing of the casing string with a surface test pressure of 1,500 psi. This scenario assumes that the fluid in the casing is a mud weight of 9.0 ppg and there isn't any external pressure supporting the casing.

$$P_{max} = P_{\max an} + (0.433\ x\ MW\ x\ D)$$

Where:

P_{max}	=	Maximum internal pressure, psi
$P_{max\ csg}$	=	Maximum casing pressure, psi
0.052	=	Conversion factor
MW	=	Mud weight of the fluid in the casing, ppg
D	=	Depth of casing, feet GL

For Injection and Contingency Well:

7-inch, 26 lb/ft, Grade L-80 at 3,000 feet

$P_{max} = 1500 + (0.052\ x\ 9.0\ x\ 3{,}000)$

$P_{max} = 2{,}904$ psi

7-inch, 26 lb/ft, P110 Grade 2550 or G3 Casing at 6,350 ft

$P_{max} = 1500 + (0.052\ x\ 9.0\ x\ 6{,}350)$

$P_{max} = 4{,}472$ psi

The burst pressure rating of the 7-inch O.D., 26 lb/ft, Grade L-80 protection casing is 7,240 psi, which results in a design safety factor of 2.49 (7,240/2,904).

The burst pressure rating of the 7-inch O.D., 26 lb/ft, P110 Grade 2550 or G3 protection casing is 9,960 psi, which results in a design safety factor of 2.23 (9,960/4,472).

C. **Collapse**: The collapse pressure of the casing is governed by conditions present at the shoe during cementing of the casing. This scenario assumes that the casing contains a column of fresh water inside to be more conservative and to counteract the external hydrostatic force from the cement slurries. As the cementing operation is planned as a two-stage event, a calculation is performed for each stage. A worst-case scenario is assumed with a perfect hole and no losses for the first stage as well as for the tail cement in the second stage.

$$P_{shoe} = MW_{lead} \times 0.052 \times H_{lead} + MW_{tail} \times 0.052 \times H_{tail} - MW \times 0.052 \times (D_{csg})$$

Where:

P_{shoe}	=	Maximum anticipated shoe pressure, psi
MW_{lead}	=	Mud Weight of lead cement, lb/gal
MW_{tail}	=	Mud Weight of tail cement lb/gal
H_{tail}	=	Height of tail slurry, feet
H_{lead}	=	Height of lead slurry, feet
MW	=	Weight of fresh water, (8.33 lb/gal)
D_{csg}	=	Affected casing depth, feet
0.052	=	Conversion factor, psi-gal/ft-lb

$$Capacity\ between\ 9-7/8"\ hole\ and\ 7"\ casing\ =\ 0.0471\ bbl/ft$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 1\ =\ 194\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 1\ = \frac{194}{0.0471} = 4{,}119\ feet$$

$$Top\ of\ Stage\ 1\ Cement\ =\ 6{,}350 - 4{,}119 = 2{,}231\ feet$$

$$Volume\ of\ Proposed\ Cement\ for\ Stage\ 2\ Tail\ = 17\ bbl$$

$$Height\ of\ Proposed\ Cement\ for\ Stage\ 2\ Tail\ = \frac{17}{0.0471} = 360\ feet$$

$$Stage\ 2\ Lead\ Cement\ =\ 3{,}000 - 360 = 2{,}640\ feet$$

Injection and Contingency Well:

Stage 1: Using the cementing volume recommendation for Stage 1, the calculated top of tail cement is at 2,231 feet and the density is 14.8 lb/gal.

$$P_{shoe(S1)} = (14.8 \times 0.052 \times 4{,}119) + (9.0\ x\ 0.052\ x\ 2{,}231) - 8.33 \times 0.052 \times 6{,}300$$
$$P_{shoe(S1)} = 1{,}485 \text{ psi}$$

Stage 2: Using the cementing volume recommendation for Stage 2, the top of lead cement is at surface and the density is 12.5 lb/gal, and the calculated top of tail cement is at 2,640 feet and the density is 15.6 lb/gal.

$$P_{shoe(S2)} = (15.6 \times 0.052 \times 360) + (12.5 \times 0.052 \times 2{,}640) - 8.33 \times 0.052 \times 2{,}875$$
$$P_{shoe(S2)} = 763 \text{ psi}$$

The collapse pressure rating of the 7-inch O.D., 26 lb/ft, Grade L-80 protection casing is 5,410 psi, which results in a design safety factor of 7.09 (5,410/763) at 3,000 feet.

The collapse pressure rating of the 7-inch O.D., 26 lb/ft, P110 Grade 2550 or G3 protection casing is 6,230 psi, which results in a design safety factor of 4.20 (6,230/1,485) at the 7-inch casing shoe.

C. **Tension**: The tensile strength of the casing is governed by the unit tubular weight and buoyancy effects or the maximum overpull designed for the pipe during installation (100,000 lbs), whichever is greater.

$$W_{\max} = W_{csg} \times D_{csg} - MW \times A_{csg} \times 0.052 \times D_{csg}$$

Where:

W_{max}	=	Maximum tensile weight at worst case, lbs
W_{csg}	=	Unit weight of casing, lb/ft
D_{csg}	=	Setting depth of casing, feet
MW	=	Weight of fresh water, (8.33 lb/gal)
A_{csg}	=	Cross-sectional area of casing (7.55 sq. in.)
D_{csg}	=	Casing setting depth, feet
0.052	=	Conversion factor, psi-gal/ft-lb

For Injection and Contingency Well:

Casing String

W_{max} = (26 x 6350) – (8.33 x 7.55 x .052 x 6350)

W_{max} = 144,333 lbs.

P110 Grade 2550 or G3 casing (3,350 feet)

W_{max} = (26 x 3350) – (8.33 x 7.55 x .052 x 3,350)

W_{max} = 76,144 lbs.

The tensile rating of the 7-inch O.D., 26 lb/ft, Grade L-80 Protection casing is 604,000 lbs, which results in a safety factor of 4.18 (604,000/144,333).

The tensile rating of the 7-inch O.D., 26 lb/ft, P110 Grade 2550 or G3 Protection casing is 830,000 lbs, which results in a safety factor of 10.90 (830,000/76,144).

The tensile rating of the LTC connection on the 7-inch O.D., 26 lb/ft, Grade L-80 Protection casing is 511,000 lbs, which results in a safety factor of 3.54 (511,000/144,333).

The tensile rating of the premium gas tight connection on the 7-inch O.D., 26 lb/ft, P110 Grade 2550 or G3 Protection casing is 520,000 lbs, which results in a safety factor of 6.83 (520,000/76,144).

Injection Tubing

A. **Burst**: The greatest rupture stresses induced over the life of the injection tubing occur during injection operations. This scenario assumes that the maximum injection pressure is realized while injecting waste fluids at the maximum permitted specific gravity. The annular fluid is used as a backup. The required minimum annulus pressure isn't included to increase the safety factor for this calculation. This would only occur with a sudden failure of the annulus system and a complete loss of the annulus pressure applied on surface.

$$P_{max} = P_{max\ inj} + (0.433 \times SG_{infl} \times D) - (0.433 \times SG_{aflI} \times D)$$

Where:

P_{max}	=	Maximum internal pressure, psia
$P_{max\ inj}$	=	Maximum injection pressure, psia
SG_{injfl}	=	Maximum specific gravity of injection fluid (0.86)
D	=	Depth of tubing, feet
0.433	=	Pressure gradient, psi/ft
SG_{afl}	=	Specific gravity of annular fluid (1.02)

For Injection and Contingency Well:

Surface with Wellhead Injection Pressure of 2,400 psi

$$P_{max} = 2{,}400 + (0.433 \times 0.86 \times 0) - (0.433 \times 1.02 \times 0)$$

$$P_{max} = 2{,}400 \text{ psi}$$

Packer at 5,500 feet

$$P_{max} = 2{,}400 + (0.433 \times 0.86 \times 5{,}500) - (0.433 \times 1.02 \times 5{,}500)$$

$$P_{max} = 2{,}019 \text{ psi}$$

The burst pressure rating of the 4-1/2-inch O.D., 11.6 lb/ft, 13CR80 tubing is 7,780 psi, which results in a design safety factor of 3.85 (7780/2019) at the packer and 3.24 (7780/2400) at surface.

B. **Collapse**: The maximum loading condition for collapse pressure of the injection tubing is governed by conditions present during annular pressure testing of the well. This scenario assumes that the waste fluid inside the tubing is at its minimum specific gravity and the surface injection pressure is zero.

$$P_{max} = P_{maxan} + (0.433 \text{ x } SG_{afl} \text{ x } D) - (0.433 \text{ x } SG_{infl} \text{ x } D)$$

Where:

P_{max}	=	Maximum external pressure, psi
P_{maxan}	=	Maximum annular pressure, psi
SG_{afl}	=	Specific gravity of annular fluid (1.02)
D	=	Depth of tubing, feet
0.433	=	Pressure gradient, psi/ft
SG_{injfl}	=	Minimum specific gravity of injection fluid (0.84)

For Injection and Contingency Well:

$$P_{max} = 2{,}500 + (0.433 \text{ x } 1.02 \text{ x } 5{,}500) - (0.433 \text{ x } 0.84 \text{ x } 5{,}500)$$

$$P_{max} = 2{,}929 \text{ psi}$$

The collapse pressure rating of the 4-1/2-inch O.D., 11.6 lb/ft, 13CR80 tubing is 6,360 psi, which results in a design safety factor of 2.17 (6360/2929).

C. **Tension:** The tensile strength of the injection tubing is governed by the unit tubular weight, with effects from buoyancy included. The maximum tensile weight will be just prior to setting the tubing into the packer. Calculations assume the well is filled with 1.02 specific gravity annular fluid prior to setting each tubing string.

$$W_{max} = W_{ta} \times D \times K_b$$

Where:

W_{max}	=	Maximum tensile weight at worst case, lbs
W_{ta}	=	Unit weight of injection tubing, lb/ft
D	=	Depth of tubing, feet
K_b	=	Bouyancy Factor

and,

$$K_b = \left(1 - \frac{SG_{afl} * 8.33}{65.44}\right)$$

Where:

SG_{afl}	=	Specific gravity of annular fluid (1.02)
8.33	=	Conversion Factor
65.44	=	Conversion Factor

For Injection and Contingency Well:

W_{max} = (13.5 x 5,500) x (1 – (1.02 x 8.33)/65.44)

W_{max} = 64,610 lbs.

The tensile rating of the body of the 4-1/2-inch O.D., 11.6 lb/ft, 13CR80 injection tubing is 267,000 lbs, which results in a safety factor of 4.13 (267,000 /64,610).

The tensile rating of the Premium connection on the 4-1/2-inch O.D., 11.6 lb/ft, 13CR80 injection tubing is 141,000 lbs, which results in a safety factor of 1.91 (141,000 /74,007).