FACULTY OF SCIENCE AND TECHNOLOGY

SUBJECT:	**PET100 DRILLING**
DATE:	**07.12.2018**
TIME:	**09:00 – 13:00 (4 HOURS)**
AID:	**Approved calculator**

Universitetet i Stavanger

THE EXAM CONSISTS OF TOTAL 15 PAGES: 6 PAGES WITH EXERCISES, 1 PAGE WITH FORMULAS, 7 PAGES WITH TABLES AND 1 PAGE WITH ANSWERSHEET FOR MULTIPLE-CHOICE QUESTIONS.

NB! ANSWERSHEET FOR MULTIPLE-CHOICE IS TO BE HANDED IN WITH THE REST OF THE ANSWERS.

NOTICE: All the 4 exercises is given equal weight, i.e each count 25%. Quickly read through all the exercises before you start. Use your time well, so that each part gets the necessary time. Make simple drawings and illustrate the case you are calculating.

EXERCISE 1 Axial load

A vertical well is to be drilled down to 3200m from a fixed platform. The mud used for drilling has a density of 1180 kg/m^3, and a viscosity of 12 cP. The drill pipe to be used is a 5", 25.60 lb/ft, premium grad E with NC50(XH) joints. We will have a 7.5" drillcollar of 250m, 181.7 kg/m with ID 3.00". We expect a reaction force from the formation (WOB) of 245 kN. The maximum torsional moment of the drill bit is expected to be 4.5 kNm.

a) Show that with ordinary safety margins the maximum expected nozzle force is about 7.4 kN (Use this value further).

b) **1.** Calculate the maximum axial load on the drill string when it hangs freely in the mud without mud circulation and no drilling.
2. Where do you find the maximum load on the drill string? Calculate the safety factor against yield.

c) The drill bit is most effective with a WOB between 180 kN and 250 kN. What drill collar length will be needed with these two values, and which one would you recommend to use in this case?

d) It is necessary with mud circulation while drilling. The pump pressure being used is maximum 300 bar gauge. The drill bit requires a torsional moment of 4.5 kNm. The combined safety factor should be at least 1.4 during the drilling operation. What is the maximum frictional moment allowed between the wellbore wall and the drill string?

Hint: use the combined safety factor formula.

e) The force acting on the fastline is given as 170.5kN, friction factor is $k_T = 1.04$, and the combined weight of the hoisting equipment is 2950 kg.

1. The drill string is to be tripped out of the well from a depth of 3200m. Calculate the number of sheaves needed (round off to the nearest number).
2. We wish to lift a stand (1 stand = 3 drill pipes, each 10m) in less than 45 seconds. How much power as minimum is required when you have a motor efficiency of 0.81?

Multiple-choice 1 Axial load

1. The tensile strength of the fastline is NOT dependent on?
   a) Friction factor
   b) Mud density
   c) Number of sheaves
   d) Reaction force from formation (WOB)

2. Where do we wish that the neutral point should be on the drill string?
   a) 2/3 h_v down from the top of the drillstring
   b) 2/3 h_v up from the bottom of the well
   c) 2/3 h_v down from the top of the drill collar
   d) 1/3 h_v up from the bottom of the well

3. If the mud density in exercise 1b)1. increases with 50 kg/m^3, what will happen to the axial load?
   a) ΔF_A increases
   b) ΔF_A is constant
   c) ΔF_A decreases
   d) ΔF_A starts to oscillate

4. What is the velocity of the dead-line?
   a) $v_D = C_D \sqrt{\frac{2 \cdot \Delta P_D}{\rho_m}}$
   b) $v_D = F_F \cdot \frac{k_T - 1}{1 - k_T^{-n}} \cdot W \cdot \Delta t$
   c) $v_D = 2 \square v_F$
   d) $v_D = 0$

EXERCISE 2 Fluids and pumps

For the drilling of the well in exercise 1 we want a circulation rate of 2200 liter/min. The frictional pressure drop from the mudpump to the top of the drill string is 0.7 bar, frictional pressure drop in annulus is 14 bar.
Well data: Vertical well, depth 3200m, drill collar length is 250m.
Mud data: density 1180 kg/m^3, viscosity 12 cP.

a) Calculate the frictional pressure drop from the top of the drillstring down to the nozzles, given that N_2 = 178 kPa/100m and N_3 = 590 kPa/100m?

b) During drilling we want a minimum pump pressure of 300 barg.
   1. Calculate the largest nozzle pressured drop, and show that this corresponds to about 63% of the total pump pressure. Is this acceptable?
   2. How large is then the nozzle force? (C_D = 0.96).
   3. There are 4 nozzles, each having the same diameter. What is then the diameter of each nozzle? (round up or down to nearest mm, and explain!)

From b) we want the mudpump to deliver at minimum 300 barg. We have been provided with Triplex mudpumps with the following data:

Stroke:	10" (inch)	Volume efficiency:	0.97
Power input:	1200 kW	Mechanical pump efficiency:	0.84
Topspeed:	120 revolution/min	Transmission efficiency:	0.79
Bushing:	4.5, 5, 5.5, 6 og 6.5"	Electric motor efficiency:	0.93

c) Which bushing do we have to choose in order to have high enough pump pressure?

d)
   1. What will be the maximum flowrate delivered from the mudpump using this bushing? Provide the answer in liters/min
   2. What will be the maximum pump pressure using this bushing?
   3. How many mud pumps are needed in order to get the desired flowrate of 2200 liter/min?

Multiple-choice 2 Fluid and pumps

1. What will happen if we use bigger bushing in the pump?
   a) Pump pressure increases, while the flowrate increases
   b) Pump pressure decreases, while the flowrate increases
   c) Pump pressure increases, while the flowrate decreases
   d) Pump pressure decreases, while the flowrate decreases

2. If the nozzle diamter decreases (while all other parameters is equal), what will this lead to?
   a) The frictional pressure drop in annulus will increase
   b) The frictional pressure drop in annulus will decrease
   c) The nozzle pressure drop will decrease
   d) The required pump pressure will increase

3. Which one of the following is a thumbrule regarding the mud velocity through the nozzles?
   a) Over 100 km/h
   b) Over 100 m/s
   c) 47% - 64% of the velocity in the drill string
   d) 47% - 64% of the nozzle pressure drop
4. Which one of the following is NOT a component in the *Circulation system*:
   a) Mud pump
   b) Drill bit
   c) Annulus
   d) Formation

EXERCISE 3 Casing

After drilling to a depth of 3000m below the wellhead (fixed platform) in a vertical well we will set a 13 3/8" casing. The formation pressure at 3000m was measured to 380 barg. We will continue with the same mud density (1180 kg/m^3), and it is estimated that the loss of mud to a possible low-pressure zone will empty maximum 40% of the casing. The required safety facotrs are 1.8 for tear-off, 1.5 against burst and 1.2 against collapse. Density of any gas in annulus is assumed to be 230 kg/m^3. When mud is still for a long period of time it can degenerate into a density of 1030 kg/m^3 (weight material falls out, but not salt).

a)
1. Make a sketch, and calculate the maximum burst pressure in case of possible gas kick situation.
2. At which depth is the strain (burst pressure) on the casing highest? Explain.
3. Make a sketch, and calculate the maximum collapse pressure in case of a possible fracture and loss of mud to the low-pressure zone.
4. At which depth is the strain (collapse pressure) on the casing highest? Explain.

For cementing a cement paste with a density of 1550 kg/m^3 is used. The fluid used to pump/push the cement down the casing has a density of 1050 kg/m^3 (mud to be used for further drilling). The casing is cemented up 300m below the wellhead. We assume «worst case» so the cement paste will fill up the casing completely bfore pump-down.

b)
1. Calculate the maximum burst pressure and maximum collapse pressure during cementing process. make a sketch of both scenarios.
2. At which depth is the strain on the casing biggest? Explain.

c)
1. What is now the dimensioning burst and collapse pressures?
2. Find the lightest casing that meets the loading requirements.
3. Calculate the safety factor against burst and collapse.

d)
1. Calculate the axial load, both for degeneraded mud and during cementing.
2. Calculate the safety factor against tear-off, both for degeneraded mud and during cementing.
3. What is the dimensioning axial load?

(Hint: Internal volume can be calculated from the table using value of the inner diameter, or from the capacity, which in the table is defined as liters per meter).

Multiple-choice 3 Casing

1. What is true ?
   a) Production casing is set before the liner
   b) Surface casing is set before conductor casing
   c) Intermediate casing is set after conductor casing
   d) Surface casing is set before intermediate casing

2. What happens to the burst pressure in 3a1) if the gas density increases by 60 kg/m^3?
   a) ΔP_b decreases
   b) ΔP_b is unchanged
   c) ΔP_b increases
   d) The formation at well bottom fractures

3. What is the main advantage of using liners to secure the well?
   a) It is very cost effective compared to casing
   b) It can withstand greates pressures
   c) It makes the well cleaner
   d) None of the above

4. Which of the following phenomena decreases the axial load compared to the axial load in mud?
   a) Overpull when casing is stuck
   b) Plug bumping pressure
   c) Lost circulation
   d) Higher mudweight

EXERCISE 4 Kick calculations

During drilling of the vertical well in exercise 1 to a depth of 3200m below the wellhead the mud level in the return tank increased more than expected. We stoped drilling, shut off the pump and seal off the BOP, 86 seconds after we assume the kick started. (Mud data: 2200 liter/min, 1180 kg/m^3, 12 cP). We measured an increase of volume in the return tank (mudpit) of 14.7 m3. The pressure at the top of annulus, just beneath the BOP, was measured to be 32 bar. The formation pressure at 3200m was measured to be 400 barg.

Length of drill collar:	250 m
Inner area of drill pipe:	0.01105 m^2
Inner area of drill collar:	0.00456 m^2
Annulus area outside drill pipe:	0.06192 m^2
Annulus area outside drill collar:	0.04064 m^2

a)

1. What is the shut-in drill pipe pressure (SIDPP)?
2. The killmud should give a safety margin of 5 bar at the bottom of the well. What density should our killmud have?
3. What is the hydrostatic pressure of the killmud at the bottom of the well?

b)

1. How high up in the well is there reservoir fluid?
2. What is the density of the influx fluid?

We want to use «driller´s method» to kill the well. During these type of situations we want a lower pump rate and we choose a pump rate of 650 liter/min. The viscosity of the kill mud is 26 cP.

c) Calculate
  1. The time needed to displace the drillstring volume.
  2. The time needed to displace the annulus volume.
  3. The time needed to kill the well using this method (total time).

d) **1.** What is the frictional pressure drop in the drillstring under mud circulation with the old mud?
  2. What is the nozzle pressure drop during circulation with old mud?
  3. What is the frictional pressure drop in the drillstring during mud circulation with kill mud in the entire drillstring?
  4. What is the nozzle pressure drop during circulation with kill mud?
  5. Draw a graph showing the standpipe pressure during the entire process (use calculated numerical values).

Multiple-choice 4   Kick calculations

1. On this platform, where is the BOP located?
    a) On the drillfloor
    b) On the seafloor
    c) On the pump floor
    d) In the bottom of the well

2. What is true about "engineer´s method" compared to "driller´s method"?
    a) Takes less time, uses old mud to circulate out the kick
    b) Takes more time, uses old mud to circulate out the kick
    c) Takes less time, uses kill mud to circulate out the kick
    d) Takes more time, uses kill mud to circulate out the kick

3. What does BOP stand for?
    a. Bleed Out Preventer
    b. Blow Out Power
    c. Blow Out Preventer
    d. Black Oil Pressuriser

4. Which of the following statements are correct?
    a) BOP works as storage unit for drillpipe during harsh weather conditions.
    b) The Blowout preventer prevent kicks from occurring.
    c) The hydraulic power package produces the main pump pressure during kick circulation.
    d) The kill line provides a means of pumping fluids downhole when the drillstring is absent.

EQUATIONS GIVEN ON THE EXAM:

0.0254 m = 1"
g = 9.81 m/s^2
$\rho_s = 7850\ kg/m^3$

- ***Tension in the fastline (deadline)***: $F_F = F_d = \frac{k_T - 1}{1 - k_T^{-n}} \cdot W$
- ***Frictional pressure drop in a circular pipe***: $\Delta P_F = \frac{Q^{1.8} \cdot \rho^{0.8} \cdot \mu_p^{0.2}}{90163 \cdot D^{4.8}} \cdot \Delta L$
- ***Frictional pressure drop in an annular space***: $\Delta P_F = \frac{Q^{1.8} \cdot \rho^{0.8} \cdot \mu_p^{0.2}}{70696 \cdot (D+d)^{1.8}(D-d)^3} \cdot \Delta L$

Units for ΔP_F [bar]: Q [liter/min], ΔL [m], D & d [inch], density and viscosity relative to water

- ***Nozzle formulas***: $v = C_D \sqrt{\frac{2 \cdot \Delta P_D}{\rho}}$ (C_D = 0.95) /// $F_D = \dot{m} \cdot v = \rho \cdot Q \cdot v = \frac{\rho \cdot Q^2}{A_D}$
- ***Relative Drillstring Frictional Pressure Drop***: $\Delta P_{F2} = \frac{Q_2^{1.8} \cdot \rho_2^{0.8} \cdot \mu_2^{0.2}}{Q_1^{1.8} \cdot \rho_1^{0.8} \cdot \mu_1^{0.2}} \cdot \Delta P_{F1}$
- ***Relative Nozzle Pressure Drop***: $\Delta P_{D2} = \frac{Q_2^2 \cdot \rho_2}{Q_1^2 \cdot \rho_1} \cdot \Delta P_{D1}$
- ***Initial Drillstring Pressure Loss with Kill Rate***: $P_{c1} = \Delta P_{F,m,2} + \Delta P_{D,m,2} + \Delta P_s$
- ***Final Drillstring Pressure Loss with Kill Rate***: $P_{c2} = \Delta P_{F,km} + \Delta P_{D,km}$
- ***Length of Kick 1 (V_k>$V_{ann,dc}$)***: $L_K = L_{dc} + \frac{V_i + Q_m \Delta t - A_{ann,dc} L_{dc}}{A_{ann,dp}}$
- ***Length of Kick 2 (V_k=<$V_{ann,dc}$)***: $L_K = \frac{V_i + Q_m \Delta t}{A_{ann,dc}}$
- ***Mass Balance***: $\rho_1 \cdot V_1 + \rho_2 \cdot V_2 = \rho_m \cdot V_m$
- ***Combined Safety Factor during Drilling***: $\frac{1}{SF} = \sqrt{\left(\frac{P_i - P_o}{P_Y}\right)^2 + \left(\frac{F_E}{F_Y}\right)^2 + \left(\frac{M_R + M_F}{M_Y}\right)^2}$
- ***Safety Factor under Tension***: $SF = \frac{F_Y}{F_A}$

GEOMETRIC CHARACTERISTICS OF DRILL PIPES
(New pipe bodies and tool joints) (continued)

Nominal diameter (in)	Nominal weight (lb/ft)	Wall thickness (mm)	ID (in)	ID (mm)	Cross-section (mm²)	Polar moment of inertia (mm⁴)	Polar modulus (mm³)	Upset and grade		Type of tool joint	Tool joint OD (mm)	Tool joint ID (mm)	Approximate weight including tool joint (kg/m)	Approximate weight including tool joint (lb/ft)
4 (101.60 mm)	14.00	8.38	3.340	84.84	2 454	5 374 730	105 802	EU	G	NC46 (IF)	152.4	82.6	24.10	16.19
								IU	G	NC40(FH)	139.7	61.9	23.59	15.85
								IU	G	H90	139.7	71.4	23.22	15.60
								EU	S	NC46 (IF)	152.4	76.2	24.44	16.42
								IU	S	NC40(FH)	139.7	50.8	24.00	16.13
								IU	S	H90	139.7	71.4	23.22	15.60
4 1/2 (114.30 mm)	13.75	6.88	3.958	100.54	2 322	6 725 300	117 678	EU	E	NC50 (IF)	161.9	95.3	22.91	15.39
								EU	E	NC50 (WO)	155.6	98.4	22.03	14.80
								EU	E	OH	146.1	100.8	20.98	14.10
								IU	E	H90	152.4	82.6	22.62	15.20
	16.60	8.56	3.826	97.18	2 844	8 000 523	139 992	EU	E	NC50 (IF)	161.9	95.3	26.78	18.00
								EU	E	NC50 (IF)	168.3	95.3	27.49	18.47
								EU	E	OH	149.2	95.3	25.45	17.10
								IEU	E	NC46 (XH)	158.8	82.6	27.34	18.37
								IEU	E	FH	152.4	76.2	27.00	18.14
								IEU	E	H90	152.4	82.6	26.64	17.90
								IEU	E	NC38 (SH)	127.0	68.3	25.00	16.80
								EU	X	NC50 (IF)	161.9	95.3	27.33	18.36
								EU	X	NC50 (IF)	168.3	95.3	28.05	18.85
								IEU	X	NC46 (XH)	158.8	76.2	27.71	18.62
								IEU	X	FH	152.4	76.2	27.02	18.16
								IEU	X	H90	152.4	82.6	26.79	18.00
								EU	G	NC50 (IF)	161.9	95.3	27.33	18.36
								EU	G	NC50 (IF)	168.3	95.3	28.05	18.85
								IEU	G	NC46 (XH)	158.8	76.2	27.71	18.62
								IEU	G	FH	152.4	76.2	27.02	18.16
								IEU	G	H90	152.4	82.6	26.79	18.00
								EU	S	NC50 (IF)	161.9	88.9	27.72	18.63
								EU	S	NC50 (IF)	168.3	88.9	28.44	19.11
								IEU	S	NC46 (XH)	158.8	69.9	28.02	18.83
								IEU	S	FH	158.8	63.5	28.31	19.02
								IEU	S	H90	152.4	76.2	27.02	18.16

mm × 0.0394 = in $mm^2 \times 0.00155 = in^2$ $mm^3 \times 6.10\ 10^{-5} = in^3$ $mm^4 \times 2.40\ 10^{-6} = in^4$

GEOMETRIC CHARACTERISTICS OF DRILL PIPES
(New pipe bodies and tool joints) (continued)

Nominal diameter (in)	Nominal weight (lb/ft)	Wall thickness (mm)	ID (in)	ID (mm)	Cross-section (mm²)	Polar moment of inertia (mm⁴)	Polar modulus (mm³)	Upset and grade		Type of tool joint	Tool joint OD (mm)	Tool joint ID (mm)	Approximate weight including tool joint (kg/m)	Approximate weight including tool joint (lb/ft)
4 1/2 (114.30 mm)	20.00	10.92	3.640	92.46	3 547	9 581 665	167 658	EU	E	NC50 (IF)	161.9	92.1	32.19	21.63
								EU	E	NC50 (IF)	168.3	92.1	32.91	22.11
								IEU	E	NC46 (XH)	158.8	76.2	32.92	22.12
								IEU	E	FH	152.4	76.2	32.24	21.66
								IEU	E	H90	152.4	76.2	32.24	21.66
								EU	X	NC50 (IF)	161.9	88.9	32.88	22.09
								EU	X	NC50 (IF)	168.3	88.9	33.60	22.58
								IEU	X	NC46 (XH)	158.8	69.9	33.66	22.62
								IEU	X	FH	152.4	63.5	33.26	22.35
								IEU	X	H90	152.4	82.6	32.29	21.70
								EU	G	NC50 (IF)	161.9	88.9	32.88	22.09
								EU	G	NC50 (IF)	168.3	88.9	33.60	22.58
								IEU	G	NC46 (XH)	158.8	63.5	33.95	22.81
								IEU	G	FH	152.4	63.5	33.26	22.35
								IEU	G	H90	152.4	76.2	32.59	21.90
								EU	S	NC50 (IF)	168.3	76.2	34.31	23.06
								IEU	S	NC46 (XH)	158.8	57.2	34.20	22.98
5 (127 mm)	19.50	9.19	4.276	108.62	3 401	11 873 714	186 988	IEU	E	NC50 (XH)	161.9	95.3	31.06	20.87
								IEU	E	NC50 (XH)	168.3	95.3	31.77	21.35
								IEU	E	5 1/2 FH	177.8	95.3	33.19	22.30
								IEU	X	NC50 (XH)	161.9	88.9	31.84	21.40
								IEU	X	NC50 (XH)	168.3	88.9	32.55	21.87
								IEU	X	5 1/2 FH	177.8	95.3	33.58	22.56
								IEU	G	NC50 (XH)	165.1	82.6	32.55	21.87
								IEU	G	NC50 (XH)	168.3	82.6	32.92	22.12
								IEU	G	5 1/2 FH	177.8	95.3	33.58	22.56
								IEU	S	NC50 (XH)	168.3	69.9	33.57	22.56
								IEU	S	5 1/2 FH	184.2	88.9	34.86	23.42
	25.60	12.70	4.000	101.60	4 560	15 078 604	237 458	IEU	E	NC50 (XH)	161.9	95.3	40.00	26.88
								IEU	E	NC50 (IF)	168.3	88.9	40.70	27.35
								IEU	E	5 1/2 FH	177.8	95.3	42.12	28.30

mm × 0.0394 = in $mm^2 \times 0.00155 = in^2$ $mm^3 \times 6.10\ 10^{-5} = in^3$ $mm^4 \times 2.40\ 10^{-6} = in^4$

GEOMETRIC CHARACTERISTICS OF DRILL PIPES
(New pipe bodies and tool joints) (continued)

Nominal diameter	Nominal weight	Wall thickness	ID		Cross-section	Polar moment of inertia	Polar modulus	Upset and grade		Type of tool joint	Tool joint OD	Tool joint ID	Approximate weight including tool joint	
(in)	(lb/ft)	(mm)	(in)	(mm)	(mm^2)	(mm^4)	(mm^3)				(mm)	(mm)	(kg/m)	(lb/ft)
5 (127 mm)	25.60	12.70	4.000	101.60	4 560	15 078 604	237 458	**IEU**	**X**	**NC50 (XH)**	**165.1**	**76.2**	**41.40**	**27.82**
								IEU	X	NC50 (IF)	168.3	73.2	41.77	28.07
								IEU	X	5 1/2 FH	177.8	88.9	42.48	28.55
								IEU	**G**	**NC50 (XH)**	**168.3**	**69.9**	**42.08**	**28.28**
								IEU	G	5 1/2 FH	184.2	88.9	43.32	29.11
								IEU	S	5 1/2 FH	184.2	82.6	43.73	29.39
5 1/2 (139.70 mm)	21.90	9.17	4.778	121.36	3 760	16 096 385	230 442	**IEU**	**E**	**FH**	**177.8**	**101.6**	**35.41**	**23.79**
								IEU	**X**	**FH**	**177.8**	**95.3**	**36.33**	**24.41**
								IEU	**G**	**FH**	**184.2**	**88.9**	**37.59**	**25.26**
								IEU	**S**	**FH**	**190.5**	**76.2**	**39.25**	**26.37**
	24.70	10.54	4.670	118.62	4 277	17 955 483	257 058	**IEU**	**E**	**FH**	**177.8**	**101.6**	**39.16**	**26.31**
								IEU	**X**	**FH**	**184.2**	**88.9**	**41.29**	**27.75**
								IEU	**G**	**FH**	**184.2**	**88.9**	**41.29**	**27.75**
								IEU	**S**	**FH**	**190.5**	**76.2**	**42.94**	**28.85**
6 5/8 (168.28 mm)	25.20	8.38	5.965	151.52	4 210	26 981 773	320 677	**IEU**	**E**	**FH**	**203.2**	**127.0**	**41.00**	**27.55**
								IEU	**X**	**FH**	**203.2**	**127.0**	**41.00**	**27.55**
								IEU	**G**	**FH**	**209.6**	**120.7**	**42.57**	**28.61**
								IEU	**S**	**FH**	**215.9**	**107.9**	**44.70**	**30.04**
	27.70	9.19	5.901	149.90	4 593	29 159 551	346 560	**IEU**	**E**	**FH**	**203.2**	**127.0**	**43.76**	**29.41**
								IEU	**X**	**FH**	**209.6**	**120.7**	**45.32**	**30.45**
								IEU	**G**	**FH**	**209.6**	**120.7**	**45.32**	**30.45**
								IEU	**S**	**FH**	**215.9**	**107.9**	**47.44**	**31.88**

mm × 0.0394 = in $mm^2 \times 0.00155 = in^2$ $mm^3 \times 6.10\ 10^{-5} = in^3$ $mm^4 \times 2.40\ 10^{-6} = in^4$

NEW (N), PREMIUM CLASS (P) AND CLASS 2 (2) DRILL PIPE, TORSIONAL AND TENSILE DATA
(API RP 7G, 16th edition, August 1998)

Size OD	Nominal weight	Class	Torsional yield strength[1]								Tensile yield strength							
			E		95		105		135		E		95		105		135	
(in)	(lb/ft)		(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)
2 3/8	4.85	N	4 763	645	6 033	817	6 668	904	8 574	1 162	97 817	43.5	123 902	55.1	136 944	60.9	176 071	78.3
		P	3 725	505	4 719	639	5 215	707	6 705	909	76 893	34.2	97 398	43.3	107 650	47.8	138 407	61.5
		2	3 224	437	4 083	553	4 513	612	5 802	786	66 686	29.6	84 469	37.5	93 360	41.5	120 035	53.3
	6.65	N	6 250	847	7 917	1 073	8 751	1 186	11 251	1 525	138 214	61.4	175 072	77.8	193 500	86.0	248 786	110.6
		P	4 811	652	6 093	826	6 735	913	8 659	1 173	107 616	47.8	136 313	60.6	150 662	67.0	193 709	86.1
		2	4 130	560	5 232	709	5 782	783	7 434	1 007	92 871	41.3	117 636	52.3	130 019	57.8	167 167	74.3
2 7/8	6.85	N	8 083	1 095	10 238	1 387	11 316	1 533	14 549	1 971	135 902	60.4	172 143	76.5	190 263	84.6	244 624	108.7
		P	6 332	858	8 020	1 087	8 865	1 201	11 397	1 544	106 946	47.5	135 465	60.2	149 725	66.5	192 503	85.6
		2	5 484	743	6 946	941	7 677	1 040	9 871	1 338	92 801	41.2	117 549	52.2	129 922	57.7	167 043	74.2
	10.40	N	11 554	1 566	14 635	1 983	16 176	2 192	20 798	2 818	214 344	95.3	271 503	120.7	300 082	133.4	385 820	171.5
		P	8 858	1 200	11 220	1 520	12 401	1 680	15 945	2 161	166 535	74.0	210 945	93.8	233 149	103.6	299 764	133.2
		2	7 591	1 029	9 615	1 303	10 627	1 440	13 663	1 851	143 557	63.8	181 839	80.8	200 980	89.3	258 403	114.8
3 1/2	9.50	N	14 146	1 917	17 918	2 428	19 805	2 684	25 463	3 450	194 264	86.3	246 068	109.4	271 970	120.9	349 676	155.4
		P	11 094	1 503	14 052	1 904	15 531	2 104	19 968	2 706	152 979	68.0	193 774	86.1	214 171	95.2	275 363	122.4
		2	9 612	1 302	12 176	1 650	13 457	1 823	17 302	2 344	132 793	59.0	168 204	74.8	185 910	82.6	239 027	106.2
	13.30	N	18 551	2 514	23 498	3 184	25 972	3 519	33 392	4 525	271 569	120.7	343 988	152.9	380 197	169.0	488 825	217.3
		P	14 361	1 946	18 191	2 465	20 106	2 724	25 850	3 503	212 150	94.3	268 723	119.4	297 010	132.0	381 870	169.7
		2	12 365	1 675	15 663	2 122	17 312	2 346	22 258	3 016	183 398	81.5	232 304	103.2	256 757	114.1	330 116	146.7
	15.50	N	21 086	2 857	26 708	3 619	29 520	4 000	37 954	5 143	322 775	143.5	408 848	181.7	451 885	200.8	580 995	258.2
		P	16 146	2 188	20 452	2 771	22 605	3 063	29 063	3 938	250 620	111.4	317 452	141.1	350 868	155.9	451 115	200.5
		2	13 828	1 874	17 515	2 373	19 359	2 623	24 890	3 373	215 967	96.0	273 558	121.6	302 354	134.4	388 741	172.8

(1) N: Based on the shear strength equal to 57.7% of minimum yield strength and nominal thickness.
P: Based on the shear strength equal to 57.7% of minimum yield strength and torsional data based on 20% of uniform wear on outside diameter and tensile data based on 20% uniform wear on outside diameter.
2: Based on the shear strength equal to 57.7% of minimum yield strength and torsional data based on 30% of uniform wear on outside diameter and tensile data based on 30% uniform wear on outside diameter

NEW (N), PREMIUM CLASS (P) AND CLASS 2 (2) DRILL PIPE, TORSIONAL AND TENSILE DATA (continued)
(API RP 7G, 16th edition, August 1998)

Size OD	Nominal weight	Class	Torsional yield strength[1]								Tensile yield strength							
			E		95		105		135		E		95		105		135	
(in)	(lb/ft)		(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)
4	11.85	N	19 474	2 639	24 668	3 343	27 264	3 694	35 054	4 750	230 755	102.6	292 290	129.9	323 057	143.6	415 360	184.6
		P	15 310	2 075	19 392	2 628	21 433	2 904	27 557	3 734	182 016	80.9	230 554	102.5	254 823	113.3	327 630	145.6
		2	13 281	1 800	16 823	2 280	18 594	2 520	23 907	3 239	158 132	70.3	200 301	89.0	221 385	98.4	284 638	126.5
	14.00	N	23 288	3 156	29 498	3 997	32 603	4 418	41 918	5 680	285 359	126.8	361 454	160.6	399 502	177.6	513 646	228.3
		P	18 196	2 466	23 048	3 123	25 474	3 452	32 752	4 438	224 182	99.6	283 963	126.2	313 854	139.5	403 527	179.3
		2	15 738	2 133	19 935	2 701	22 034	2 986	28 329	3 839	194 363	86.4	246 193	109.4	272 108	120.9	349 852	155.5
	15.70	N	25 810	3 497	32 692	4 430	36 134	4 896	46 458	6 295	324 118	144.1	410 550	182.5	453 765	201.7	583 413	259.3
		P	20 067	2 719	25 418	3 444	28 094	3 807	36 120	4 894	253 851	112.8	321 544	142.9	355 391	158.0	456 931	203.1
		2	17 315	2 346	21 932	2 972	24 241	3 285	31 166	4 223	219 738	97.7	278 335	123.7	307 633	136.7	395 528	175.8
4 1/2	13.75	N	25 907	3 510	32 816	4 447	36 270	4 915	46 633	6 319	270 034	120.0	342 043	152.0	378 047	168.0	486 061	216.0
		P	20 403	2 765	25 844	3 502	28 564	3 870	36 725	4 976	213 258	94.8	270 127	120.1	298 561	132.7	383 864	170.6
		2	17 715	2 400	22 439	3 041	24 801	3 361	31 887	4 321	185 389	82.4	234 827	104.4	259 545	115.4	333 701	148.3
	16.60	N	30 807	4 174	39 022	5 288	43 130	5 844	55 453	7 514	330 558	146.9	418 707	186.1	462 781	205.7	595 004	264.4
		P	24 139	3 271	30 576	4 143	33 795	4 579	43 450	5 888	260 165	115.6	329 542	146.5	364 231	161.9	468 297	208.1
		2	20 908	2 833	26 483	3 588	29 271	3 966	37 634	5 099	225 771	100.3	285 977	127.1	316 080	140.5	406 388	180.6
	20.00	N	36 901	5 000	46 741	6 333	51 661	7 000	66 421	9 000	412 358	183.3	522 320	232.1	577 301	256.6	742 244	329.9
		P	28 683	3 887	36 332	4 923	40 157	5 441	51 630	6 996	322 916	143.5	409 026	181.8	452 082	200.9	581 248	258.3
		2	24 747	3 353	31 346	4 247	34 645	4 694	44 544	6 036	279 502	124.2	354 035	157.3	391 302	173.9	503 103	223.6
	22.82	N	40 912	5 544	51 821	7 022	57 276	7 761	73 641	9 978	471 239	209.4	596 903	265.3	659 734	293.2	848 230	377.0
		P	31 587	4 280	40 010	5 421	44 222	5 992	56 856	7 704	367 566	163.4	465 584	206.9	514 593	228.7	661 620	294.1
		2	27 161	3 680	34 404	4 662	38 026	5 153	48 890	6 625	317 497	141.1	402 163	178.7	444 496	197.6	571 495	254.0

(1) See note B 13.

NEW (N), PREMIUM CLASS (P) AND CLASS 2 (2) DRILL PIPE, TORSIONAL AND TENSILE DATA (continued)
(API RP 7G, 16th edition, August 1998)

Size OD	Nominal weight	Class	Torsional yield strength[1]								Tensile yield strength							
			E		95		105		135		E		95		105		135	
(in)	(lb/ft)		(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(ft.lb)	(daN.m)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)	(lb)	(10^3 daN)
5	16.25	N	35 044	4 749	44 389	6 015	49 062	6 648	63 079	8 547	328 073	145.8	415 559	184.7	459 302	204.1	590 531	262.5
		P	27 607	3 741	34 969	4 738	38 650	5 237	49 693	6 733	259 155	115.2	328 263	145.9	362 817	161.3	466 479	207.3
		2	23 974	3 249	30 368	4 115	33 564	4 548	43 154	5 847	225 316	100.1	285 400	126.8	315 442	140.2	405 568	180.3
	19.50	N	41 167	5 578	52 144	7 066	57 633	7 809	74 100	10 041	395 595	175.8	501 087	222.7	553 833	246.1	712 070	316.5
		P	32 285	4 375	40 895	5 541	45 199	6 125	58 113	7 874	311 535	138.5	394 612	175.4	436 150	193.8	560 764	249.2
		2	27 976	3 791	35 436	4 802	39 166	5 307	50 356	6 823	270 432	120.2	342 548	152.2	378 605	168.3	486 778	216.3
	25.60	N	52 257	7 081	66 192	8 969	73 159	9 913	94 062	12 746	530 144	235.6	671 515	298.5	742 201	329.9	954 259	424.1
		P	40 544	5 494	51 356	6 959	56 762	7 691	72 979	9 889	414 690	184.3	525 274	233.5	580 566	258.0	746 443	331.8
		2	34 947	4 735	44 267	5 998	48 926	6 630	62 905	8 524	358 731	159.4	454 392	202.0	502 223	223.2	645 715	287.0
5 1/2	19.20	N	44 074	5 972	55 826	7 564	61 703	8 361	79 332	10 750	372 181	165.4	471 429	209.5	521 053	231.6	669 925	297.7
		P	34 764	4 711	44 035	5 967	48 670	6 595	62 575	8 479	294 260	130.8	372 730	165.7	411 965	183.1	529 669	235.4
		2	30 208	4 093	38 263	5 185	42 291	5 730	54 374	7 368	255 954	113.8	324 208	144.1	358 335	159.3	460 717	204.8
	21.90	N	50 710	6 871	64 233	8 704	70 994	9 620	91 278	12 368	437 116	194.3	553 681	246.1	611 963	272.0	786 809	349.7
		P	39 863	5 401	50 494	6 842	55 809	7 562	71 754	9 723	344 780	153.2	436 721	194.1	482 692	214.5	620 604	275.8
		2	34 582	4 686	43 804	5 936	48 414	6 560	62 247	8 435	299 533	133.1	379 409	168.6	419 346	186.4	539 160	239.6
	24.70	N	56 574	7 666	71 660	9 710	79 204	10 732	101 833	13 799	497 222	221.0	629 814	279.9	696 111	309.4	894 999	397.8
		P	44 320	6 005	56 139	7 607	62 048	8 408	79 776	10 810	391 285	173.9	495 627	220.3	547 799	243.5	704 313	313.0
		2	38 383	5 201	48 619	6 588	53 737	7 281	69 090	9 362	339 533	150.9	430 076	191.1	475 347	211.3	611 160	271.6
6 5/8	25.20	N	70 580	9 564	89 402	12 114	98 812	13 389	127 044	17 215	489 464	217.5	619 988	275.6	685 250	304.6	881 035	391.6
		P	55 766	7 556	71 522	9 691	79 050	10 711	101 635	13 772	387 466	172.2	490 790	218.1	542 452	241.1	697 438	310.0
		2	48 497	6 571	61 430	8 324	67 896	9 200	87 295	11 829	337 236	149.9	427 166	189.9	472 131	209.8	607 026	269.8
	27.70	N	76 295	10 338	96 640	13 095	106 813	14 473	137 330	18 608	534 199	237.4	676 651	300.7	747 877	332.4	961 556	427.4
		P	60 192	8 156	77 312	10 476	85 450	11 579	109 864	14 887	422 419	187.7	535 064	237.8	591 387	262.8	760 354	337.9
		2	52 308	7 088	66 257	8 978	73 231	9 923	94 155	12 758	367 455	163.3	465 443	206.9	514 437	228.6	661 419	294.0

(1) See note B 13.

NEW (N), PREMIUM CLASS (P) AND CLASS 2 (2) DRILL PIPE, COLLAPSE AND BURST PRESSURE DATA (continued)
(API RP 7G, 16th edition, August 1998)

Size OD	Nominal weight	Class	Collapse pressure E		Collapse pressure 95		Collapse pressure 105		Collapse pressure 135		Burst pressure E		Burst pressure 95		Burst pressure 105		Burst pressure 135	
in	(lb/ft)		(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)	(psi)	(MPa)
5	16.25	N	6 938	47.8	8 108	55.9	8 616	59.4	9 831	67.8	7 770	53.6	9 842	67.9	10 878	75.0	13 986	96.4
		P	4 490	31.0	4 935	34.0	5 067	34.9	5 661	39.0	7 104	49.0	8 998	62.0	9 946	68.6	12 787	88.2
		2	3 275	22.6	3 696	25.5	3 850	26.5	4 065	28.0	6 216	42.9	7 874	54.3	8 702	60.0	11 189	77.1
	19.50	N	9 962	68.7	12 026	82.9	12 999	89.6	15 672	108.1	9 503	65.5	12 037	83.0	13 304	91.7	17 105	117.9
		P	7 041	48.5	8 241	56.8	8 765	60.4	10 029	69.1	8 688	59.9	11 005	75.9	12 163	83.9	15 638	107.8
		2	5 514	38.0	6 262	43.2	6 552	45.2	7 079	48.8	7 602	52.4	9 629	66.4	10 643	73.4	13 684	94.3
	25.60	N	13 500	93.1	17 100	117.9	18 900	130.3	24 300	167.5	13 125	90.5	16 625	114.6	18 375	126.7	23 625	162.9
		P	11 458	79.0	14 514	100.1	16 042	110.6	20 510	141.4	12 000	82.7	15 200	104.8	16 800	115.8	21 600	148.9
		2	10 338	71.3	12 640	87.1	13 685	94.4	16 587	114.4	10 500	72.4	13 300	91.7	14 700	101.4	18 900	130.3
5 1/2	19.20	N	6 039	41.6	6 942	47.9	7 313	50.4	8 093	55.8	7 255	50.0	9 189	63.4	10 156	70.0	13 058	90.0
		P	3 736	25.8	4 130	28.5	4 336	29.9	4 714	32.5	6 633	45.7	8 401	57.9	9 286	64.0	11 939	82.3
		2	2 835	19.5	3 128	21.6	3 215	22.2	3 265	22.5	5 804	40.0	7 351	50.7	8 125	56.0	10 447	72.0
	21.90	N	8 413	58.0	10 019	69.1	10 753	74.1	12 679	87.4	8 615	59.4	10 912	75.2	12 061	83.2	15 507	106.9
		P	5 730	39.5	6 542	45.1	6 865	47.3	7 496	51.7	7 876	54.3	9 977	68.8	11 027	76.0	14 177	97.7
		2	4 334	29.9	4 733	32.6	4 899	33.8	5 464	37.7	6 892	47.5	8 730	60.2	9 649	66.5	12 405	85.5
	24.70	N	10 464	72.1	12 933	89.2	14 013	96.6	17 023	117.4	9 903	68.3	12 544	86.5	13 865	95.6	17 826	122.9
		P	7 635	52.6	9 011	62.1	9 626	66.4	11 177	77.1	9 055	62.4	11 469	79.1	12 676	87.4	16 298	112.4
		2	6 050	41.7	6 957	48.0	7 329	50.5	8 115	56.0	7 923	54.6	10 035	69.2	11 092	76.5	14 261	98.3
6 5/8	25.20	N	4 788	33.0	5 321	36.7	5 500	37.9	6 036	41.6	6 538	45.1	8 281	57.1	9 153	63.1	11 768	81.1
		P	2 931	20.2	3 252	22.4	3 353	23.1	3 429	23.6	5 977	41.2	7 571	52.2	8 368	57.7	10 759	74.2
		2	2 227	15.4	2 343	16.2	2 346	16.2	2 346	16.2	5 230	36.1	6 625	45.7	7 322	50.5	9 414	64.9
	27.70	N	5 894	40.6	6 755	46.6	7 103	49.0	7 813	53.9	7 172	49.4	9 084	62.6	10 040	69.2	12 909	89.0
		P	3 615	24.9	4 029	27.8	4 222	29.1	4 562	31.5	6 557	45.2	8 306	57.3	9 180	63.3	11 803	81.4
		2	2 765	19.1	3 037	20.9	3 113	21.5	3 148	21.7	5 737	39.6	7 267	50.1	8 032	55.4	10 327	71.2

See note B 16.

RECOMMENDED MINIMUM OD* AND MAKE-UP TORQUE OF WELD-ON TYPE TOOL JOINTS BASED ON TORSIONAL STRENGTH OF BOX AND DRILL PIPE
(API RP 7G, 16th edition, August 1998)

Drill pipe: Nominal size	Drill pipe: Nominal weight	Drill pipe: Type upset and grade	New tool joint data: Connection	New OD		New ID		Make-up torque[6]		Premium class: Minimum OD tool joint		Premium class: Minimum box shoulder with eccentric wear		Premium class: Make-up torque for minimum OD tool joint		Class 2: Minimum OD tool joint		Class 2: Minimum box shoulder with eccentric wear		Class 2: Make-up torque for minimum OD tool joint	
(in)	(lb/ft)			(in)	(mm)	(in)	(mm)	(ft.lb)	(daN.m)	(in)	(mm)	(in)	(mm)	(ft.lb)	(daN.m)	(in)	(mm)	(in)	(mm)	(ft.lb)	(daN.m)
2 3/8	4.85	EU 75	NC26	3 3/8	85.7	1 3/4	44.5	4 125 B	**559**	3 1/8	79.4	3/64	1.2	1 945	**264**	3 3/32	78.6	1/32	0.8	1 689	**229**
	4.85	EU 75	WO	3 3/8	85.7	2	50.8	2 541 P	**344**	3 1/16	77.8	1/16	1.6	1 994	**270**	3 1/32	77.0	3/64	1.2	1 746	**237**
	4.85	EU 75	2 3/8 OHLW	3 1/8	79.4	2	50.8	2 716 P	**368**	3	76.2	1/16	1.6	1 723	**233**	2 31/32	75.4	3/64	1.2	1 481	**201**
	4.85	EU 75	2 3/8 SL-H90	3 1/4	82.6	2	50.8	3 042 P	**412**	2 31/32	75.4	1/16	1.6	1 996	**270**	2 15/16	74.6	3/64	1.2	1 726	**234**
2 3/8	6.65	IU 75	2 3/8 PAC[2]	2 7/8	73.0	1 3/8	34.9	2 803 P	**380**	2 25/32	70.6	9/64	3.6	2 455	**333**	2 23/32	69.1	7/64	2.8	2 055	**278**
	6.65	EU 75	NC26	3 3/8	85.7	1 3/4	44.5	4 125 B	**559**	3 3/16	81.0	5/64	2.0	2 467	**334**	3 5/32	80.2	1/16	1.6	2 204	**299**
	6.65	EU 75	2 3/8 SL-H90	3 1/4	82.6	2	50.8	3 042 P	**412**	3 1/32	77.0	3/32	2.4	2 549	**345**	2 31/32	75.4	1/16	1.6	1 996	**270**
	6.65	EU 75	2 3/8 OHSW	3 1/4	82.6	1 3/4	44.5	3 783 B	**513**	3 1/16	77.8	3/32	2.4	2 216	**300**	3 1/32	77.0	5/64	2.0	1 967	**267**
2 3/8	6.65	EU 95	NC26	3 3/8	85.7	1 3/4	44.5	4 125 B	**559**	3 1/4	82.6	7/64	2.8	3 005	**407**	3 7/32	81.8	3/32	2.4	2 734	**370**
2 3/8	6.65	EU 105	NC26[2]	3 3/8	85.7	1 3/4	44.5	4 125 B	**559**	3 9/32	83.3	1/8	3.2	3 279	**444**	3 1/4	82.6	7/64	2.8	3 005	**407**
2 7/8	6.85	EU 75	NC31	4 1/8	104.8	2 1/8	54.0	7 074 P	**959**	3 11/16	93.7	5/64	2.0	3 154	**427**	3 21/32	92.9	1/16	1.6	2 804	**380**
	6.85	EU 75	2 7/8 WO	4 1/8	104.8	2 7/16	61.9	4 209 P	**570**	3 5/8	92.1	5/64	2.0	3 216	**436**	3 19/32	91.3	1/16	1.6	2 876	**390**
	6.85	EU 75	2 7/8 OHLW[2]	3 3/4	95.3	2 7/16	61.9	3 290 P	**446**	3 1/2	88.9	7/64	2.8	3 297	**447**	3 7/16	87.3	5/64	2.0	2 804	**380**
	6.85	EU 75	2 7/8 SL-H90	3 7/8	98.4	2 7/16	61.9	4 504 P	**610**	3 1/2	88.9	3/32	2.4	3 397	**460**	3 7/16	87.3	1/16	1.6	2 666	**361**
2 7/8	10.40	EU 75	NC31	4 1/8	104.8	2 1/8	54.0	7 074 P	**959**	3 13/16	96.8	9/64	3.6	4 597	**623**	3 3/4	95.3	7/64	2.8	3 867	**524**
	10.40	IU 75	2 7/8 XH	4 1/4	108.0	1 7/8	47.6	7 853 P	**1 064**	3 23/32	94.5	9/64	3.6	4 357	**590**	3 21/32	92.9	7/64	2.8	3 664	**496**
	10.40	IU 75	NC26[2]	3 3/8	85.7	1 3/4	44.5	4 125 B	**559**	3 3/8	85.7	11/64	4.4	4 125	**559**	3 11/32	84.9	5/32	4.0	3 839	**520**
	10.40	EU 75	2 7/8 OHSW[2]	3 7/8	98.4	2 5/32	54.8	5 194 P	**704**	3 19/32	91.3	5/32	4.0	4 411	**598**	3 9/16	90.5	7/64	2.8	3 941	**534**
	10.40	EU 75	2 7/8 SL-H90	3 7/8	98.4	2 5/32	54.8	6 732 P	**912**	3 19/32	91.3	9/64	3.6	4 529	**614**	3 17/32	89.7	7/64	2.8	3 770	**511**
	10.40	IU 75	2 7/8 PAC[2]	3 1/8	79.4	1 1/2	38.1	3 424 P	**464**	3 1/8	79.4	15/64	6.0	3 424	**464**	3 1/8	79.4	15/64	6.0	3 439	**466**
2 7/8	10.40	EU 95	NC31	4 1/8	104.8	2	50.8	7 895 P	**1 070**	3 29/32	99.2	3/16	4.8	5 726	**776**	3 27/32	97.6	5/32	4.0	4 969	**673**
	10.40	EU 95	2 7/8 SL-H90[2]	3 7/8	98.4	2 5/32	54.8	6 732 P	**912**	3 11/16	93.7	3/16	4.8	5 702	**773**	3 5/8	92.1	5/32	4.0	4 915	**666**
2 7/8	10.40	EU 105	NC31	4 1/8	104.8	2	50.8	7 895 P	**1 070**	3 15/16	100.0	13/64	5.2	6 110	**828**	3 7/8	98.4	11/64	4.4	5 345	**724**
2 7/8	10.40	EU 135	NC31	4 3/8	111.1	1 5/8	41.3	10 086 P	**1 367**	4 1/16	103.2	17/64	6.7	7 694	**1 043**	4	101.6	15/64	6.0	6 893	**934**
3 1/2	9.50	EU 75	NC38	4 3/4	120.7	3	76.2	7 595 P	**1 029**	4 13/32	111.9	1/8	3.2	5 773	**782**	4 11/32	110.3	3/32	2.4	4 797	**650**
	9.50	EU 75	NC38	4 3/4	120.7	2 11/16	68.3	10 843 P	**1 469**	4 13/32	111.9	1/8	3.2	5 773	**782**	4 11/32	110.3	3/32	2.4	4 797	**650**
	9.50	EU 75	3 1/2 OHLW	4 3/4	120.7	3	76.2	7 082 P	**960**	4 9/32	108.7	1/8	3.2	6 340	**724**	4 1/4	108.0	7/64	2.8	4 868	**660**
	9.50	EU 75	3 1/2 SL-H90	4 5/8	117.5	3	76.2	7 469 P	**1 012**	4 3/16	106.4	7/64	2.8	5 521	**748**	4 5/32	105.6	3/32	2.4	5 003	**678**

See notes at the end of B 23.

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GEOMETRICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF CASING (continued)

Pipe body	1	Nominal size (OD)	8.625 in	219.1 mm	8.625 in	219.1 mm
	2	Nominal weight	49.00 lb/ft	71.5 daN/m	52.00 lb/ft	75.9 daN/m
	3	Wall thickness	0.557 in	14.1 mm	0.595 in	15.1 mm
	4	Inside diameter	7.511 in	190.8 mm	7.435 in	188.8 mm
	5	Steel cross-section	14.12 in²	9108 mm²	15.01 in²	9684 mm²
	6	Capacity	2.30 gal/ft	28.59 l/m	2.26 gal/ft	28.01 l/m
	7	Displacement (1)	3.04 gal/ft	37.69 l/m	3.04 gal/ft	37.69 l/m

			K55	L80	N80	C90	RT95	CP110	Q125	K55	L80	N80	C90	RT95	CP110	Q125
Pipe body	8	Grade	K55	L80	N80	C90	RT95	CP110	Q125	K55	L80	N80	C90	RT95	CP110	Q125
	9	Collapse resistance (MPa)	44.4	59.1	59.1	64.4	66.9	74.0	80.4	48.7	66.6	66.6	72.9	75.9	84.6	92.7
	10	Internal yield pressure (MPa)	42.9	62.3	62.3	70.1	74.0	85.7	97.4	45.8	66.6	66.6	74.9	79.1	91.6	104.0
	11	Pipe body yield strength (1000 daN)	345	502	502	565	597	691	785	367	534	534	601	634	734	835
Tensile strength (10^3 daN)	12	Buttress Standard	474	525	544	564	593	700	769	504	558	578	600	631	744	817
	13	Buttress Special Clearance	373	373	393	393	412	491	530	373	373	393	393	412	491	530
	14	API STC	302	391	396	432	455	531	595	324	419	425	463	488	570	639
	15	API LTC	339	437	444	483	509	594	665	364	469	476	518	546	637	714

			49.00 lb/ft	52.00 lb/ft
Connection efficiency	16	Grant Prideco TCII		
	17	Grant Prideco STL	59.1	
	18	Hydril LX	100.0	100.0
	19	Hydril 563	100.0	100.0
	20	Hydril 511		
	21	Hydril 521		
	22	Vallourec & Mannesmann New VAM		
	23	Vallourec & Mannesmann VAM ACE	100.0	100.0
	24	Vallourec & Mannesmann VAM PRO		
	25	Vallourec & Mannesmann VAM TOP		
	26	Vallourec & Mannesmann FJL	77.8	78.6

			Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)	Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)
			55ksi	75-80ksi	90-95ksi	110ksi	125ksi				55ksi	75-80ksi	90-95ksi	110ksi	125ksi			
Connection characteristics	27	Buttress Standard						244.5		187.6						244.5		185.7
	28	Buttress Special Clearance						231.8		187.6						231.8		185.7
	29	API STC																
	30	API LTC		1342	1551	1810	2028	244.5		187.6								
	31	Grant Prideco TCII																
	32	Grant Prideco STL	807	1017	1017	1017	1017	219.1	190.8	187.6								
	33	Hydril LX	2360	2731	2875	3076	3250	244.5	191.4	187.6	2518	2915	3074	3295	3484	244.5	190.4	185.7
	34	Hydril 563	3252	3252	3252	3252	3252	244.5	190.8	187.6	3388	3388	3388	3388	3388	244.5	188.8	185.7
	35	Hydril 511																
	36	Hydril 521																
	37	Vallourec & Mannesmann New VAM																
	38	Vallourec & Mannesmann VAM ACE	2260	2840	3040	3140	3140	242.0	195.5	187.6	2550	3140	3140	3140	3140	243.5	193.8	185.7
	39	Vallourec & Mannesmann VAM PRO																
	40	Vallourec & Mannesmann VAM TOP																
	41	Vallourec & Mannesmann FJL		2750	3000	3190	3430	224.9	189.4	187.6		3020	3190	3430	3680	225.6	187.4	185.7

MPa x 145 = psi daN x 2.25 = lb daN.m x 7.38 = lb.ft mm x 0.0394 = in

(1) The closed-end displacement does not account for couplings.

GEOMETRICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF CASING (continued)

1	13.375 in	339.7 mm	13.375 in	339.7 mm
2	54.50 lb/ft	79.5 daN/m	61.00 lb/ft	89.0 daN/m
3	0.380 in	9.7 mm	0.430 in	10.9 mm
4	12.615 in	320.4 mm	12.515 in	317.9 mm
5	15.51 in²	10 009 mm²	17.49 in²	11 282 mm²
6	6.49 gal/ft	80.64 l/m	6.39 gal/ft	79.36 l/m
7	7.30 gal/ft	90.65 l/m	7.30 gal/ft	90.65 l/m

8	K55	L80	N80	C90	RT95	CP110	Q125	K55	L80	N80	C90	RT95	CP110	Q125
9	7.8	7.9	7.9	7.9	7.9	7.9	7.9	10.6	11.5	11.5	11.5	11.5	11.5	11.5
10	18.9	27.4	27.4	30.9	32.6	37.7	42.9	21.3	31.0	31.0	34.9	36.9	42.7	48.5
11	380	552	552	621	656	759	863	428	622	622	700	739	856	972
12	462	548	563	597	629	738	818	520	618	634	673	709	832	923
13														
14	243	322	326	358	377	439	494	282	373	377	414	437	509	572
15														

16	100.0	100.0
17	59.9	59.9
18	100.0	100.0
19	100.0	100.0
20		
21	61.0	65.0
22		
23		100.0
24		
25		
26		

	Make-up torque (daN.m) 55ksi	75-80ksi	90-95ksi	110ksi	125ksi	OD (mm)	ID (mm)	Drift API (mm)	Make-up torque (daN.m) 55ksi	75-80ksi	90-95ksi	110ksi	125ksi	OD (mm)	ID (mm)	Drift API (mm)
27						365.1		316.5						365.1		313.9
28																
29	742					365.1		316.5	858					365.1		313.9
30																
31		2657	2657	2657	2657	354.3	318.0	316.5		2874	2874	2874	2874	356.5	317.9	313.9
32	942	1193	1193	1193	1193	339.7	320.1	316.5	1071	1349	1349	1349	1349	339.7	317.9	313.9
33	3292	3391	3391	3391	3391	360.0	318.0	316.5	3704	3803	3803	3803	3803	360.0	316.0	313.9
34	2846	2846	2846	2846	2846	365.1	318.5	316.5	3252	3252	3252	3252	3252	365.1	316.0	313.9
35																
36	3794	3794	3794	3794	3794	343.7	318.5	316.5	4201	4201	4201	4201	4201	345.9	316.0	313.9
37																
38									1770	2260	2550	2840	3140	357.8	323.0	313.9
39																
40																
41																

MPa × 145 = psi daN × 2.25 = lb daN.m × 7.38 = lb.ft mm × 0.0394 = in

GEOMETRICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF CASING (continued)

1	13.375 in	339.7 mm	13.375 in	339.7 mm
2	68.00 lb/ft	99.2 daN/m	72.00 lb/ft	105.1 daN/m
3	0.480 in	12.2 mm	0.514 in	13.1 mm
4	12.415 in	315.3 mm	12.347 in	313.6 mm
5	19.45 in²	12 545 mm²	20.77 in²	13 398 mm²
6	6.29 gal/ft	78.10 l/m	6.22 gal/ft	77.25 l/m
7	7.30 gal/ft	90.65 l/m	7.30 gal/ft	90.65 l/m

8	K55	L80	N80	C90	T95	P110	Q125	K55	L80	N80	C90	T95	P110	Q125
9	13.4	15.6	15.6	16.0	16.1	16.1	16.1	15.4	18.4	18.4	19.2	19.5	19.9	19.9
10	23.8	34.6	34.6	39.0	41.1	47.6	54.1	25.5	37.1	37.1	41.7	44.1	51.0	58.0
11	476	692	692	778	822	951	1081	508	739	739	831	878	1016	1155
12	578	687	705	749	788	925	1026	618	734	753	800	842	988	1096
13														
14	320	424	428	470	496	577	649	345	458	463	508	535	623	701
15														

16		
17	59.9	69.0
18	72.1	73.6
19	92.2	92.7
20		
21	68.2	70.0
22	127.9	119.8
23	126.0	118.0
24		
25	102.1	102.1
26		

	Make-up torque (daN.m) K55	LN80	C90/95	P110	Q125	OD (mm)	ID (mm)	Drift API (mm)	Make-up torque (daN.m) K55	LN80	C90/95	P110	Q125	OD (mm)	ID (mm)	Drift API (mm)
27						365.1		311.4								
28														365.1		309.6
29	973	1298	1510	1758		365.1		311.4								
30										1403	1632	1900	2138	365.1		309.6
31		3539	3539	3539	3539	358.8	316.3	311.4		3762	3762	3762	3762	360.3	316.1	309.6
32	1180	1505	1505	1505	1505	339.7	316.8	311.4	1478	1674	1674	1674	1674	339.7	313.4	309.6
33	2779	3457	3932	4339	4813	344.5	312.5	311.4	2847	3593	4000	4474	4881	345.5	312.3	309.6
34	2847	2847	2847	2847	2847	365.1		311.4	3118	3118	3118	3118	3118	365.1		309.6
35																
36	3932	3932	3932	3932	3932	348.2	313.4	311.4	4204	4204	4204	4204	4204	349.7	312.9	309.6
37	2156	2156	2156	2156	2156	365.7		311.4	2156	2156	2156	2156	2156	365.7		309.6
38	2156	2156	2156	2156	2156	365.1		311.4	2156	2156	2156	2156	2156	365.1		309.6
39																
40	2549	3139	3139	3139	3139	360.0		311.4	2942	3139	3139	3139	3139	361.6		309.6
41																

MPa × 145 = psi daN × 2.25 = lb daN.m × 7.38 = lb.ft mm × 0.0394 = in

C 73

GEOMETRICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF CASING (continued)

1	13.375 in			339.7 mm				13.375 in			339.7 mm			
2	77.00 lb/ft			112.4 daN/m				80.70 lb/ft			117.8 daN/m			
3	0.550 in			14.0 mm				0.580 in			14.7 mm			
4	12.275 in			311.8 mm				12.215 in			310.3 mm			
5	22.16 in²			14 297 mm²				23.31 in²			15 041 mm²			
6	6.15 gal/ft			76.35 l/m				6.09 gal/ft			75.60 l/m			
7	7.30 gal/ft			90.65 l/m				7.30 gal/ft			90.65 l/m			
8	K55	L80	N80	C90	T95	P110	Q125	K55	L80	N80	C90	T95	P110	Q125
9	17.8	21.4	21.4	22.5	23.0	24.1	24.5	20.4	23.8	23.8	25.4	26.0	27.6	28.5
10	27.3	39.7	39.7	44.7	47.1	54.6	62.0	28.8	41.9	41.9	47.1	49.7	57.6	65.4
11	542	789	789	887	936	1084	1232	570	830	830	933	985	1141	1296
12	659	783	804	853	898	1054	1169	694	824	845	898	945	1109	1230
13														
14	372	493	499	548	577	672	756	395	523	529	580	612	713	802
15														
16														
17				59.9										
18				75.7							75.9			
19				90.6							91.1			
20														
21				70.3										
22				112.3							106.7			
23				110.6							105.1			
24														
25				102.1							102.0			
26														

	Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)	Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)
	K55	LN80	C90/95	P110	Q125				K55	LN80	C90/95	P110	Q125			
27						365.1		307.8						365.1		306.3
28																
29																
30																
31		4528	4528	4528	4528	361.9	313.2	307.8		4969	4969	4969	4969	363.2	311.9	306.3
32	1356	1708	1708	1708	1708	339.7	314.4	307.8								
33	3118	3864	4339	4745	4882	345.7	309.8	307.8	3322	4271	4813	5355	5898	345.8	308.3	306.3
34	4610	4610	4610	4610	4610	365.1	309.9	307.8	4881	4881	4881	4881	4881	365.1	308.4	306.3
35																
36	5424	5424	5424	5424	5424	347.6	309.9	307.8								
37	2156	2156	2156	2156	2156	365.7		307.8	2156	2156	2156	2156	2156	365.7		306.3
38	2156	2156	2156	2156	2156	365.1		307.8	2156	2156	2156	2156	2156	365.1		306.3
39																
40	3139	3139	3139	3139	3139	363.2		307.8	3139	3139	3139	3139	3139	364.5		306.3
41																

MPa × 145 = psi daN × 2.25 = lb daN.m × 7.38 = lb.ft mm × 0.0394 = in

C 74

GEOMETRICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF CASING (continued)

1	13.625 in			346.1 mm				14.000 in			355.6 mm			
2	88.20 lb/ft			128.7 daN/m				82.50 lb/ft			120.4 daN/m			
3	0.625 in			15.9 mm				0.562 in			14.3 mm			
4	12.375 in			314.3 mm				12.876 in			327.1 mm			
5	25.53 in²			16 468 mm²				23.73 in²			15 307 mm²			
6	6.25 gal/ft			77.60 l/m				6.76 gal/ft			84.01 l/m			
7	7.57 gal/ft			94.07 l/m				8.00 gal/ft			99.31 l/m			
8	K55	L80	N80	C90	T95	P110	Q125	K55	L80	N80	C90	T95	P110	Q125
9	23.2	27.4	27.4	28.5	29.3	31.5	33.1	16.7	20.3	20.3	21.3	21.7	22.6	22.7
10	30.4	44.3	44.3	49.8	52.6	60.9	69.2	26.6	38.7	38.7	43.6	46.0	53.3	60.5
11	624	908	908	1022	1079	1249	1419	580	844	844	950	1003	1161	1319
12														
13														
14														
15														
16														
17				70.7										
18														
19				91.7										
20														
21				73.3										
22				100.0										
23														
24														
25														
26														

	Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)	Make-up torque (daN.m)					OD (mm)	ID (mm)	Drift API (mm)
	K55	LN80	C90/95	P110	Q125				K55	LN80	C90/95	P110	Q125			
27																
28																
29																
30																
31																
32	1844	2346	2346	2346	2346	346.1	312.3	309.6								
33																
34	5017	5017	5017	5017	5017	371.5		309.6								
35																
36	6238	6238	6238	6238	6238	354.1	312.5	309.6								
37	2156	2156	2156	2156	2156	365.7		309.6								
38																
39																
40																
41																

MPa × 145 = psi daN × 2.25 = lb daN.m × 7.38 = lb.ft mm × 0.0394 = in