



Date: 21 February 2014 <Revised 4 April 2014>
To: Naval Goel, McMoRan
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Subject: Shear Calculations for 13-5/8" 25k EVO BOP

The purpose of this memo is to provide McMoRan with calculated shear pressures at MASP for shearing three different pipe sizes using Cameron's 13-5/8" 25k EVO BOP. Cameron document EB-702D was developed to assist users in defining the shearing requirements for drilling operations. Per the information supplied by McMoRan, shear calculations have been made for the following BOP with the pipe listed. (Note: All pipe shears are assumed to be made with DVS rams.)

- 13-5/8" 25k EVO BOP
 - 2-7/8" x 0.362" wall (ID= 2.151") V-150 pipe
 - 3-1/2" x 0.430" wall (ID=2.640") C22HS160 pipe
 - 1-3/4" x 0.203" wall (ID=1.344") QT1300 (w/ 146ksi yield strength)

Per EB-702D and the information supplied by McMoRan, the following data was used for the BOP.

- 13-5/8" 25k EVO BOP
 - C1= 327, C2= 36
 - MASP = 25,000 psi

For all three pipe materials (V-150, C22HS160 and QT1300) a C3 factor of 0.19 was used. (Note: Although QT1300 pipe has not been sheared and is therefore not directly mentioned in EB-702D, the C3 factor of 0.19 is used for S135, Z-140 and V-150 and the assumption is that QT1300 would be similar to these materials.)

Using the above information and the equations in EB-702D, shear pressures for the above BOP and pipe combinations at both zero and maximum wellbore pressure (MASP) are shown below:



13-5/8" 25k EVO BOP

- 2-7/8" x 0.362" wall V-150 pipe
 - At zero wellbore pressure, estimated shear pressure = **926** psi
 - At 25,000 psi wellbore pressure, estimated shear pressure = **3,678** psi
- 3-1/2" x 0.430" wall C22HS160 pipe
 - At zero wellbore pressure, estimated shear pressure = **1,433** psi
 - At 25,000 psi wellbore pressure, estimated shear pressure = **4,186** psi
- 1-3/4" x 0.203" wall QT1300 pipe (w/ 146k yield strength)
 - At zero wellbore pressure, estimated shear pressure = **311** psi
 - At 25,000 psi wellbore pressure, estimated shear pressure = **3,063** psi

I. Inputs :

$$D_1 := 2.875$$

$$D_2 := 3.500$$

$$D_3 := 1.750$$

$$w_1 := .362$$

$$w_2 := .430$$

$$w_3 := .203$$

$$C_1 := 327$$

$$C_2 := 36$$

$$C_3 := .19$$

$$Y_1 := 150000$$

$$Y_2 := 160000$$

$$Y_3 := 146000$$

$$P_1 := 25000$$

Outside diameter of the pipe

Outside diameter of the pipe

Outside diameter of the pipe

Wall thickness of the pipe

Wall thickness of the pipe

Wall thickness of the pipe

BOP/Operator constant Table 2 equivalent

BOP Operator constant Table 2 equivalent

Shear ram type/pipe grade constant

Material yeild strength of the pipe

Material yeild strength of the pipe

Material yeild strength of the pipe

Maximum Shearing Pressure in the wellbore

II. Calculations :

$$d_1 := D_1 - (2 \cdot w_1) \quad d_1 = 2.151$$

$$d_2 := D_2 - (2 \cdot w_2) \quad d_2 = 2.64$$

$$d_3 := D_3 - (2 \cdot w_3) \quad d_3 = 1.344$$

Inside diameter of the pipe

Inside diameter of the pipe

Inside diameter of the pipe

NO Wellbore pressure 2.875"X.362" wall

$$P_{\text{shear3}} := \left[\frac{[(C_3 \cdot Y_1) \cdot (D_1^2 - d_1^2) \cdot 2.92]}{C_1} \right] \quad P_{\text{shear3}} = 926$$

Required shear pressure to shear pipe with 0 wellbore pressure (psi)

FULL Wellbore pressure 2.875"X.362" wall

$$P_{\text{shear4}} := \left[\frac{[(C_3 \cdot Y_1) \cdot (D_1^2 - d_1^2) \cdot 2.92] + (P_1 \cdot C_2)}{C_1} \right] \quad P_{\text{shear4}} = 3678$$

Required shear pressure to shear pipe with 25000 wellbore pressure (psi)

NO Wellbore pressure 3.500"X.430" wall

$$P_{\text{shear3}} := \left[\frac{[(C_3 \cdot Y_2) \cdot (D_2^2 - d_2^2) \cdot 2.92]}{C_1} \right] \quad P_{\text{shear3}} = 1433$$

Required shear pressure to shear pipe with 0 wellbore pressure (psi)

FULL Wellbore pressure 2.875"X.362" wall

$$P_{\text{shear4}} := \left[\frac{[(C_3 \cdot Y_2) \cdot (D_2^2 - d_2^2) \cdot 2.92] + (P_1 \cdot C_2)}{C_1} \right] \quad P_{\text{shear4}} = 4186$$

Required shear pressure to shear pipe with 25000 wellbore pressure (psi)

NO Wellbore pressure 1.750"X.203" wall

$$P_{\text{shear3}} := \left[\frac{[(C_3 \cdot Y_3) \cdot (D_3^2 - d_3^2) \cdot 2.92]}{C_1} \right] \quad P_{\text{shear3}} = 311$$

Required shear pressure to shear pipe with 0 wellbore pressure (psi)

FULL Wellbore pressure 2.875"X.362" wall

$$P_{\text{shear4}} := \left[\frac{[(C_3 \cdot Y_3) \cdot (D_3^2 - d_3^2) \cdot 2.92] + (P_1 \cdot C_2)}{C_1} \right] \quad P_{\text{shear4}} = 3063$$

Required shear pressure to shear pipe with 25000 wellbore pressure (psi)