

CAMERON TYPE U RAM BLOWOUT PREVENTER
REQUIRED SHEAR PRESSURE CALCULATION FORM

BY: R. M. Church, Jr.
 Richard M. Church, Jr. P.E.

CUSTOMER: Hercules Offshore, Inc.

RIG: Hercules 251

LOCATION: E.I. 290

DATE: 11-14-2011

OPERATOR: Walter Oil & Gas

BOP Size: 13-5/8" Pressure: 10,000 psi

Bonnet Type: LBT (Large Bore Shear with Boosters) Booster size: 11" Ram Type used: ISR

Pipe / Tubular to Shear: 5" 19.5 ppf S-135 (.362" wall thickness)

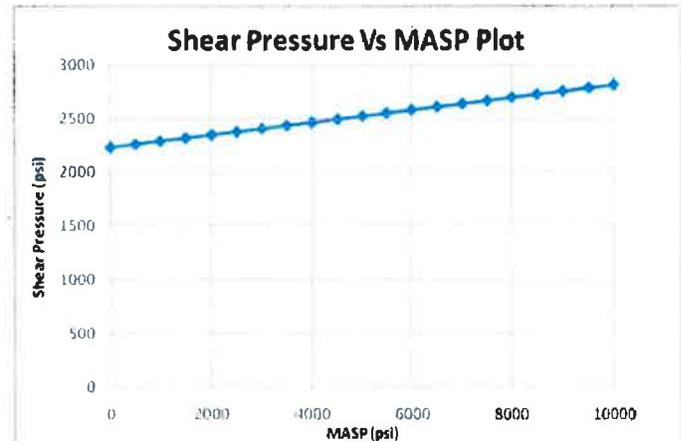
Maximum Allowable Operating Pressure of Bonnet: 3,000 psi

P_w (Wellbore Pressure at the time of the Shear): 9,135 psi

Is the pipe geometry acceptable per PD220-01, Section 5.0 and Cameron Engineering Bulletin EB 702 D? Yes

INPUT VARIABLES:

- C₁= 224 BOP / Bonnet constant corresponding to the piston closing area
- C₂= 13 BOP / Bonnet constant corresponding to the piston rod opening area
- C₃= .19 Shear ram type/ pipe grade constant
- ppf= 19.5 lbf/ft
- σ_{yield} = 135,000 Minimum Yield Strength of Pipe Material (psi)



Shear pressure, P_{Shear} is calculated using the following equation:

$$P_{\text{Shear}} = \left[\frac{(C_3)(ppf)(\sigma_{\text{yield}}) + (P_w)(C_2)}{C_1} \right]$$

P_{Shear} (Bonnet Shear Pressure) = 2,763 psi

Therefore, since P_{Shear} is less than the maximum allowable operator pressure, the BOP is acceptable for the shearing operation.

Hercules Offshore, Inc.
9 Greenway Plaza, Suite 2200
Houston, TX 77046

November 14, 2011

ATTENTION: Karl Callegan

RE: BOP shear ram verification for Hercules Offshore, Inc.

Shear testing of a 13-5/8" 10,000 psi W.P. Cameron Type U BOP equipped with large bore shear bonnets and shear boosters was conducted by Church Energy Services on 17th June 2010 (ref. ER 112B). The shear rams used were type ISR. The drill pipe used to shear was 5" 19.5 ppf S-135, .362" wall thickness. No wellbore pressure was used during the shearing operation. The calculated operating shear pressure was 2233 psi and the actual pressure required to shear the pipe was approximately 1000 psi (45 % of the calculated pressure). The maximum operating pressure of the BOP actuator was 3000 psi.

Church Energy Services also provided calculations to predict the pressure required to shear 5" 19.5 ppf S-135, .362" wall thickness drill pipe with wellbore pressure. The following information was utilized during calculations.

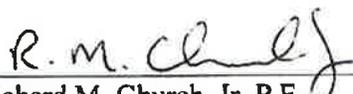
- Operator Name: Walter Oil & Gas
- Well Name: E.I. 290
- BOP Equipment: 13-5/8" 10,000 psi W.P. Type U BOP with large bore shear bonnets and shear boosters with ISR rams
- Drill Pipe: 5" 19.5 ppf S-135, .362" wall thickness
- MASP: 9135 psi

The calculated pressure required to shear the above drill pipe with the MASP shown is 2763 psi. After review of the test results and calculations, Church Energy Services hereby certifies that the BOP would shear the pipe based on the calculations and test results from actual pipe shear tests performed as stated above for Walter Oil & Gas's E.I. 290. The shear rams as identified will shear the 5" 19.5 ppf S-135, .362" wall thickness drill pipe.

Factors affecting shear ram operating pressures:

Many factors contribute to a wide range of shearing forces required to shear drill pipe and wellbore tubular. These may include the pipe material strength, toughness and dimensional differences used in the pipe manufacture. Other factors that can affect shearing performance include the BOP's internal dimensions, which include wear, corrosion and drill bit/tool damage to the ram cavities.

If we can be of any other assistance, please let us know.


Richard M. Church, Jr. P.E.
Vice President of Engineering and Quality



2810 Washington Drive
Houston, TX 77038-3319
Telephone: (281) 931-1400
Facsimile: (281) 931-8700
e-mail: sales@church-energy.com

ENGINEERING REPORT

REPORT NO.: ER112B
DATE: 06.24.10

TITLE: Test Report on Shear Ram performance performed at Church Energy Services facilities for a 13-5/8" 10000 psi W.P. Type U (Cameron) blowout preventer (BOP) equipped with large bore shear bonnets and shear boosters (LBT) with type ISR shear rams installed

DATE OF TEST: 17 June 2010

BACKGROUND: Church Energy Services was requested by Seahawk Drilling, Inc., Hercules Offshore, Inc. and Diamond Offshore to perform shear ram testing on 5" S-135 and 5" G-105 drill pipe used by both companies in their offshore drilling operations. This was initiated by a request from the United States MMS for verification of the equipment to perform its required function.

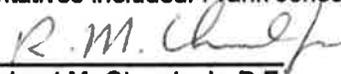
EQUIPMENT: A double ram Cameron Type U BOP was furnished by Seahawk Drilling in performing the shear tests. The BOP consisted of standard bonnets on the upper cavity and large bore shear bonnets on the lower cavity. Shear boosters were installed on the lower cavity. Shear rams and drill pipe were also furnished by Seahawk drilling. The rams were manufactured by Church Energy Services and the BOP had been recently remanufactured and re-certified by Church Energy Services. Hydrostatic test equipment and facilities were provided by Church Energy Services.

PROCEDURE: An 84" length of pipe was suspended into the BOP approximately midway across the shear rams. No attempt was made to center the pipe in the bore of the BOP. Strip chart recorders were used to monitor the closing pressure and bore pressures after shearing. No well bore pressure was used during the shearing operation. After shearing of the pipe, low pressure and the working pressure of the BOP were applied beneath the shear rams. A visual inspection of the shear rams was made between each shear test. After removal of the sheared pipe and shear rams, the rams were cleaned and surface NDE performed on the shearing blade surfaces.

SUMMARY: Church Energy Services supplied calculations for the predicted maximum operating shearing pressure of the 5" S-135 drill pipe to be approximately 2233 psi. The actual shearing operating pressure from the test was approximately 1000 psi (45% of calculated). The calculated maximum operating shearing pressure of the 5" G-105 drill pipe was to be approximately 2011 psi. The actual shearing operating pressure from the test was approximately 950 psi (47% of calculated). Visual inspection of the shear rams showed minor brinelling of the shear blade areas. Surface NDE showed no indications caused by the shear tests. The shear rams were dressed using emery paper by hand and were indistinguishable from a new set of shear rams.

ATTENDEES: The test was witnessed by numerous employees of Seahawk Drilling and Hercules Offshore along with other drilling contractor personnel and Church Energy employees.

Third Party representatives included: Frank Jones, Moduspec; I. M. Dobbie, ABS; Jarvis Outlaw, US MMS

PREPARED BY: 
Richard M. Church, Jr. P.E.

Attachments



2810 Washington Drive
Houston, TX 77038-3319
Telephone: 281-931-1400
www.church-energy.com

TYPE CAMERON U RAM BLOWOUT PREVENTER
SHEAR TEST DATA

CUSTOMER: SEAHAWK / HERCULES

DATE: 06-17-2010

BOP size: 13-5/8"

Pressure: 10,000 psi

UPPER RAM SN 720007-000-1

BOP type: DOUBLE

LOWER RAM SN 720008-000-1

Bonnet type: LBT (Large Bore Shear with Boosters)

Ram type: ISR

Pipe / Tubular to shear: 5" 19.5 ppf S-135

Maximum allowable operating pressure of bonnet: 3000 psi

Is the pipe geometry acceptable per the requirements of PD220-01, Section 5.0? YES

Shear pressure, P_{Shear} calculated using the equation in PD220-01, Section 6.0: 2233 psi

PROCEDURE:

1. Lower the pipe into the BOP and suspend it approximately 3" above the blind flange.

2. Close the shear rams and monitor the pressure to shear.

Pressure to shear: 1000 psi

3. Apply pressure below the rams and hold for 10 mins.

a. Low Pressure: 200-300 psi Accept: YES

b. High Pressure: 10,000 psi Accept: YES

4. Open shear rams and remove from bonnets.

5. Inspect ram cavities and rams for damage.

Data recorded by:

R. CHURCH / R. Church
Name / Signature

CHURCH ENERGY SERVICES
Company

06-17-2010
Date

Witness:

FRANK JONES
I. H. DOBBIE
Name / Signature

M. JONES
Company

17/6/2010
Date

A.B.S.
WITNESS
06/17/10



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TYPE CAMERON U RAM BLOWOUT PREVENTER

SHEAR TEST DATA

CUSTOMER: SEAHAWK / HERCULES

DATE: 06-17-2010

BOP size: 13-5/8"

Pressure: 10,000 psi

UPPER RAM SN 720007-000-1

BOP type: DOUBLE

LOWE RAM SN 720008-000-1

Bonnet type: LBT (Large Bore Shear with Boosters)

Ram type: ISR

Pipe / Tubular to shear: 5" 19.5 ppf G-105

Maximum allowable operating pressure of bonnet: 3000 psi

Is the pipe geometry acceptable per the requirements of PD220-01, Section 5.0? YES

Shear pressure, P_{Shear} calculated using the equation in PD220-01, Section 6.0: 2011 psi

PROCEDURE:

1. Lower the pipe into the BOP and suspend it approximately 3" above the blind flange.

2. Close the shear rams and monitor the pressure to shear.

Pressure to shear: 950 psi

3. Apply pressure below the rams and hold for 10 mins.

a. Low Pressure: 200-300 psi Accept: YES

b. High Pressure: 10,000 psi Accept: YES

4. Open shear rams and remove from bonnets.

5. Inspect ram cavities and rams for damage.

Data recorded by:

R. CHURCH / R. Church
Name / Signature

CHURCH ENERGY SERVICES
Company

06-17-2010
Date

Witness:

F. JONES / Frank Jones
Name / Signature
I.M. DOBBIE

M. DUBOIS
Company
A.B.S. WITNESS ONLY

17/6/2010
Date



2810 Washington Drive
Houston, TX 77038-3319
Telephone: 281-931-1400
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CAMERON TYPE U RAM BLOWOUT PREVENTER
REQUIRED SHEAR PRESSURE CALCULATION FORM

BY: R. M. Church
Richard M. Church, Jr. P.E.

CUSTOMER: Seahawk / Hercules

RIG: N/A

LOCATION: N/A

DATE: 09-10-2010

OPERATOR: N/A

BOP Size: 13-5/8" Pressure: 10,000 psi

Bonnet Type: LBT (Large Bore Shear with Boosters) Booster size: 11"

Ram Type used: ISR

Pipe / Tubular to Shear: 5" 19.5 ppf S-135 (0.362" wall thickness)

Maximum Allowable Operating Pressure of Bonnet: 3000 psi

P_w (Wellbore Pressure at the time of the Shear): 0 psi

Is the pipe geometry acceptable per the requirements of PD220-01, Section 5.0? YES

INPUT VARIABLES:

C₁ = 224 BOP / Bonnet constant corresponding to the piston closing area

C₂ = 13 BOP / Bonnet constant corresponding to the piston rod opening area

C₃ = 0.19 Shear ram type / pipe grade constant

ppf = 19.5 lbf/ft

σ_{yield} = 135,000 Minimum Yield Strength of Pipe Material (psi)

Shear pressure, P_{Shear} is calculated using the following equation:

$$P_{\text{Shear}} = \left[\frac{(C_3)(ppf)(\sigma_{\text{yield}}) + (P_w)(C_2)}{C_1} \right]$$

P_{Shear} (Bonnet Shear Pressure) = 2233 psi

Therefore, since P_{Shear} is less than the maximum allowable operator pressure, the BOP is acceptable for the shearing operation.



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BY: R. M. Church, Jr.
Richard M. Church, Jr. P.E.

CUSTOMER: Seahawk / Hercules

RIG: N/A

LOCATION: N/A

DATE: 09-10-2010

OPERATOR: N/A

BOP Size: 13-5/8" Pressure: 10,000 psi

Bonnet Type: LBT (Large Bore Shear with Boosters) Booster size: 11"

Ram Type used: ISR

Pipe / Tubular to Shear: 5" 19.5 ppf G-105 (0.362" wall thickness)

Maximum Allowable Operating Pressure of Bonnet: 3000 psi

P_w (Wellbore Pressure at the time of the Shear): 0 psi

Is the pipe geometry acceptable per the requirements of PD220-01, Section 5.0? YES

INPUT VARIABLES:

C₁ = 224 BOP / Bonnet constant corresponding to the piston closing area

C₂ = 13 BOP / Bonnet constant corresponding to the piston rod opening area

C₃ = 0.22 Shear ram type / pipe grade constant

ppf = 19.5 lbf/ft

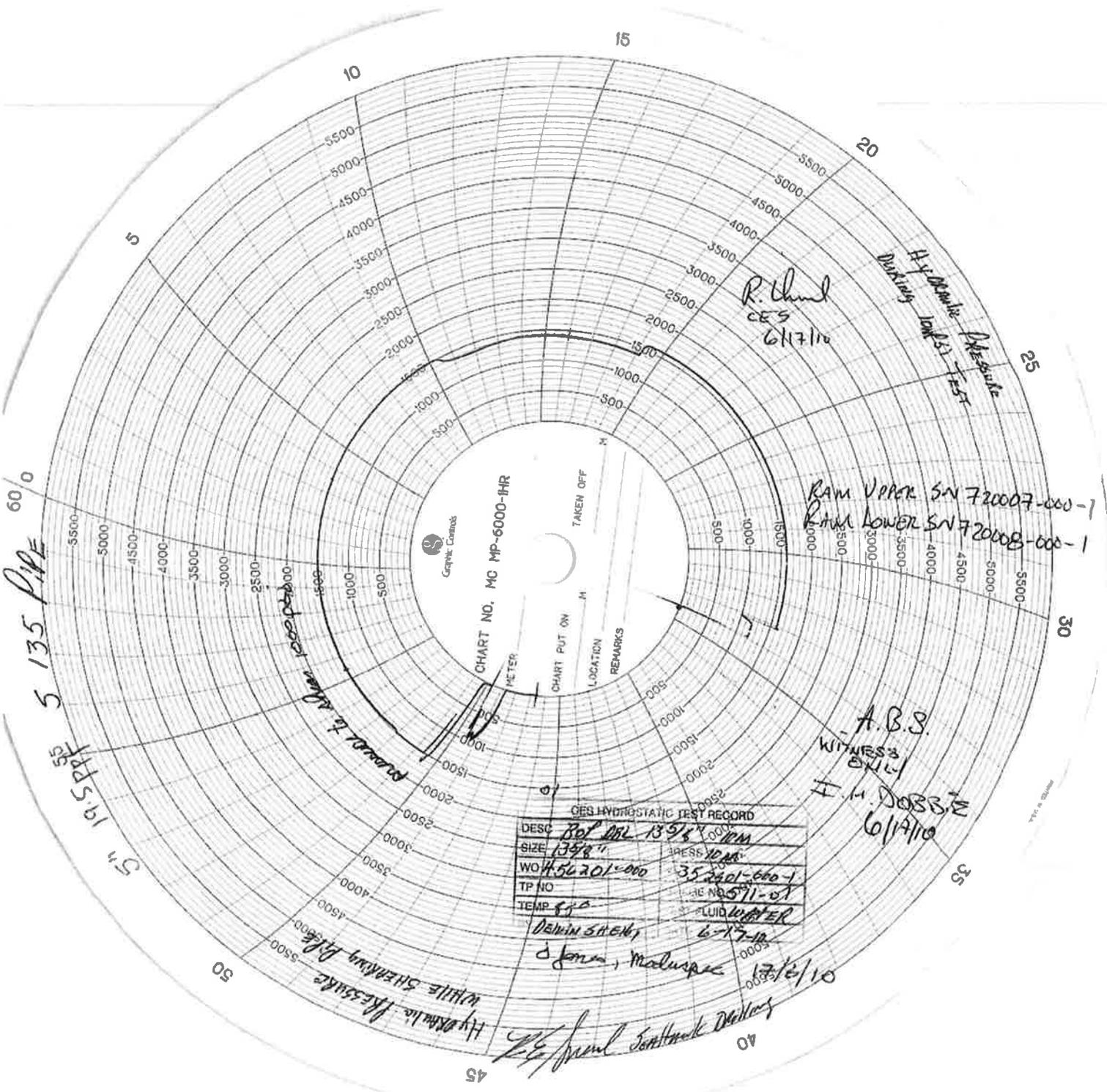
σ_{yield} = 105,000 Minimum Yield Strength of Pipe Material (psi)

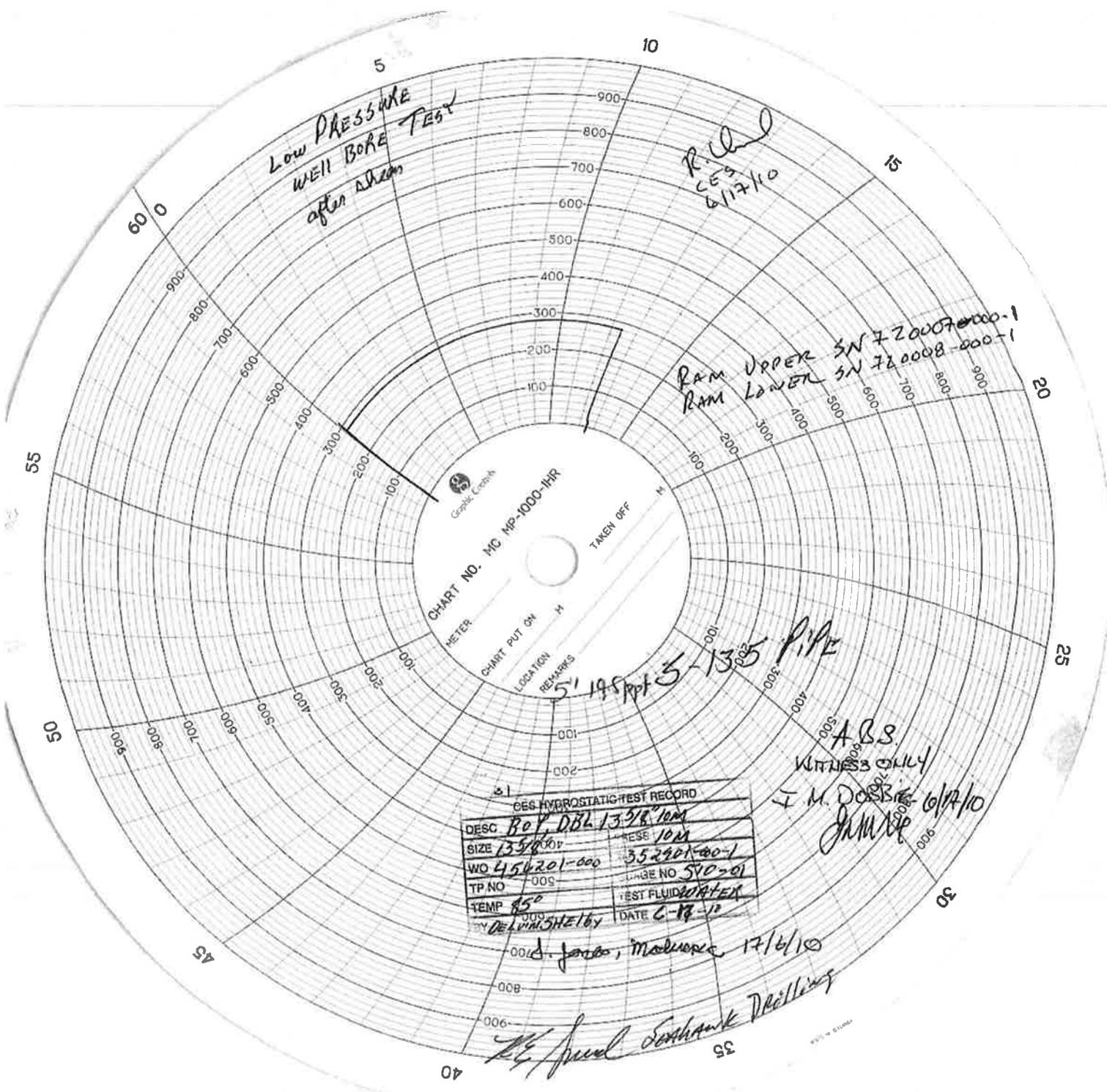
Shear pressure, P_{Shear} is calculated using the following equation:

$$P_{\text{Shear}} = \left[\frac{(C_3)(ppf)(\sigma_{\text{yield}}) + (P_w)(C_2)}{C_1} \right]$$

P_{Shear} (Bonnet Shear Pressure) = 2011 psi

Therefore, since P_{Shear} is less than the maximum allowable operator pressure, the BOP is acceptable for the shearing operation.





Low Pressure
Well Bore Test
after clean

R. [Signature]
6/17/10

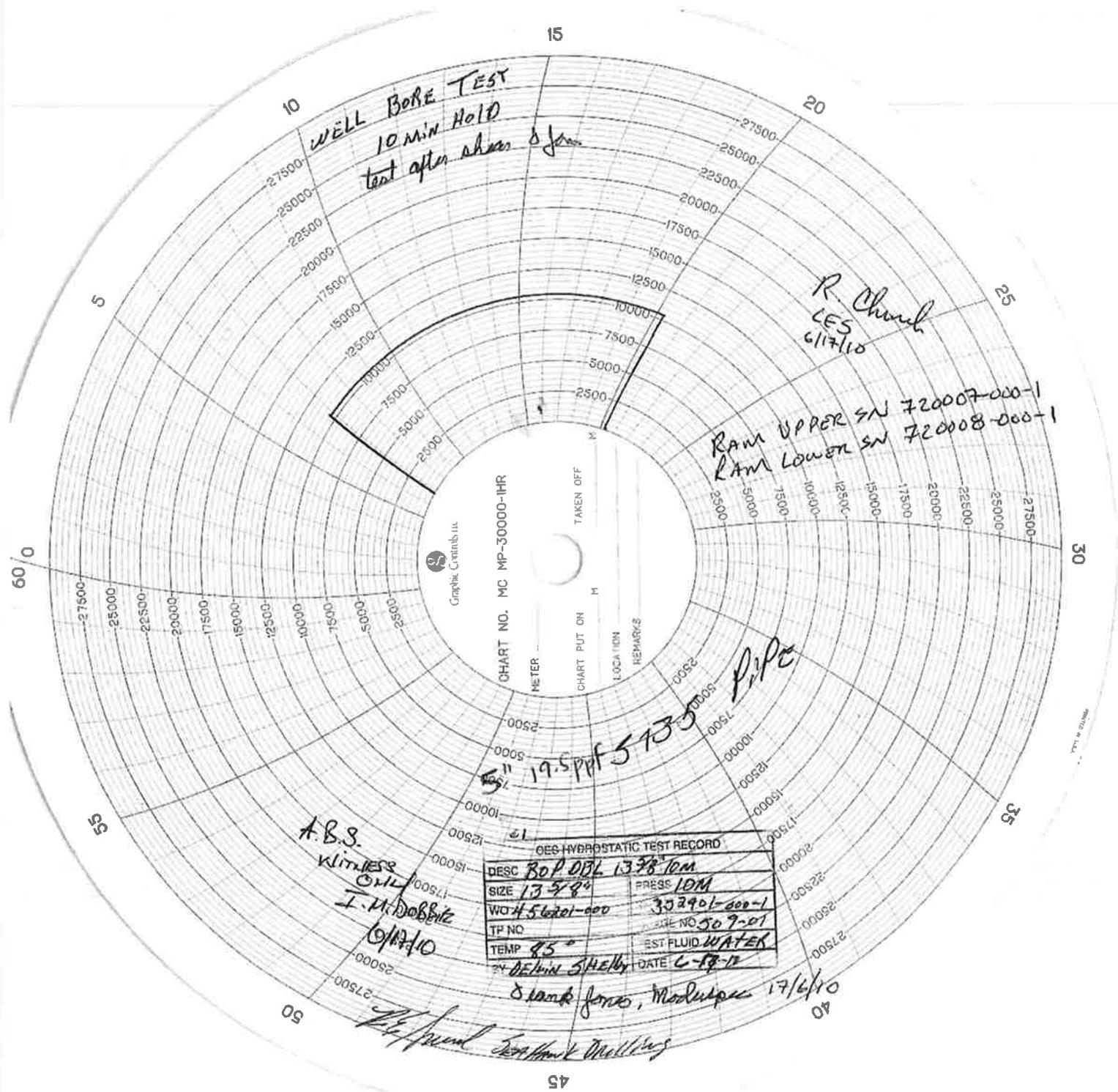
RAM UPPER SN 72007000-1
RAM LOWER SN 72008000-1

5 1/4" 13.5" PIPE

ABS
WITNESS ONLY
I. M. [Signature] 6/17/10

| GCS HYDROSTATIC TEST RECORD | |
|-----------------------------|--------------------|
| DESC | BOY, DBL 13.5" 10M |
| SIZE | 13.5" 10M |
| WO | 454201-000 |
| TP NO | 005 |
| TEMP | 85° |
| TEST FLUID | WATER |
| DATE | 6-18-10 |

A. Jones, Malvern 17/6/10
S. Paul, Southank Drilling



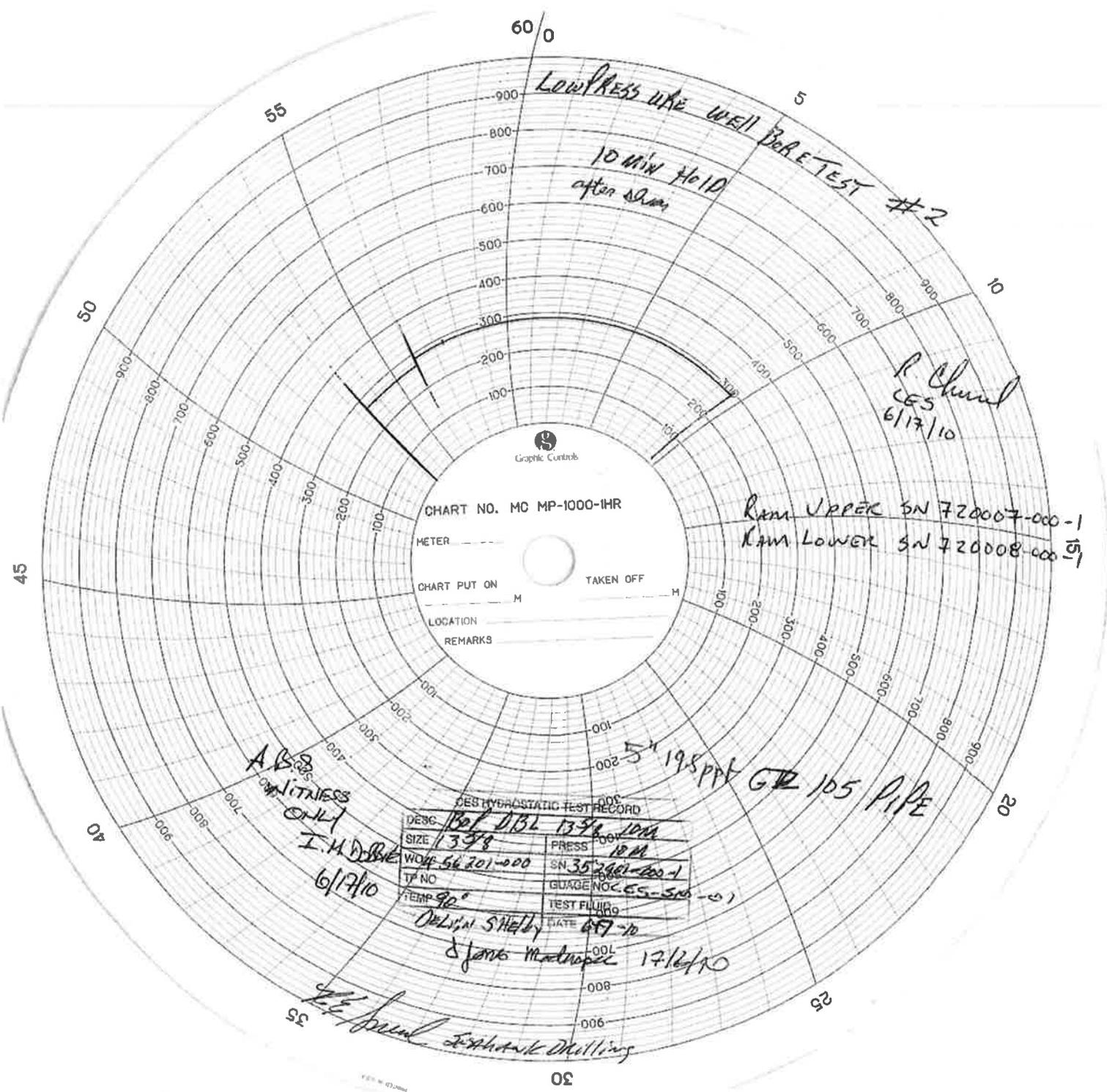


CHART NO. MC MP-1000-1HR

METER _____

CHART PUT ON _____ M

TAKEN OFF _____ M

LOCATION _____

REMARKS _____

DESIGN HYDROSTATIC TEST RECORD

| | |
|--------------|-----------------------------|
| DESC | 100' DBL 13 5/8" 10M |
| SIZE | 13 5/8" PRESS 10M |
| WOL | 56 201-000 SN 35 2401-000-1 |
| TP NO | GAUGE NO. CES-510-01 |
| TEMP | 90° TEST FILLING |
| DATE 6/17/10 | |

DELVIN SHELBY
 & JAMES MADRUPAC 17/6/10

A.B.S.
 WITNESS ONLY
 I.H. DRILL
 6/17/10

James
 & James
 Drilling

Rim UPPER SN 720007-000-1
 Rim LOWER SN 720008-000-1

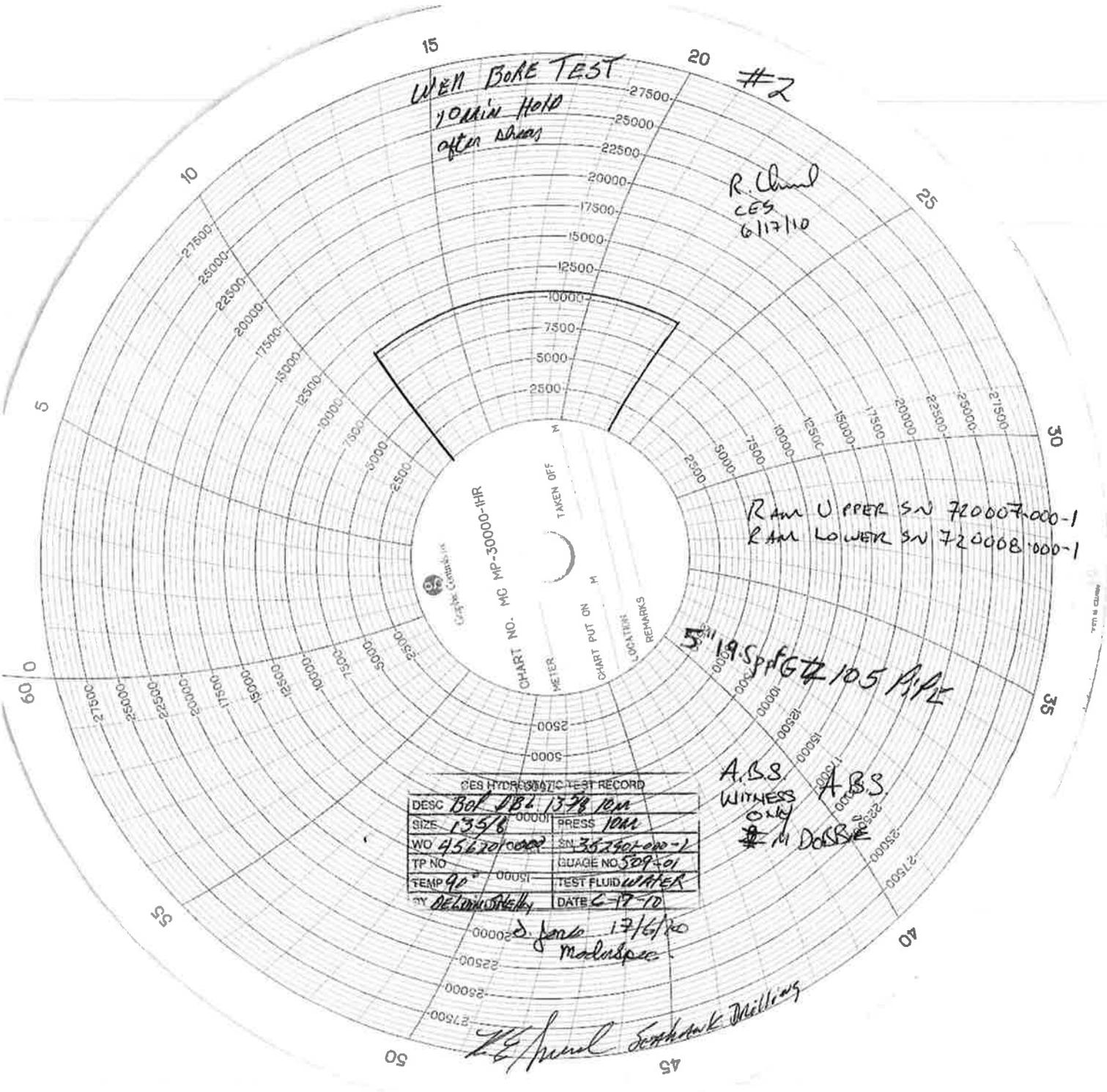
R. Chumal
 CES
 6/17/10

10 MIN HOLD
 after show

LOW PRESSURE WELL BORE TEST #2

WEM BORE TEST
 10min Hold
 after stress

#2
 R. Chind
 CES
 6/17/10



RAM UPPER SN 720007-000-1
 RAM LOWER SN 720008-000-1

5" 19 SpFG #105 PIPE

A.B.S.
 WITNESS
 ONLY
 M. DORRIS

CES HYDROSTATIC TEST RECORD

| | |
|-------|---------------------------|
| DESC | Bolt JBL 1378 10M |
| SIZE | 1 3/8" PRESS 10M |
| WO | 45670/0000 |
| SN | 35790-000-1 |
| TP NO | GUAGE NO 509-01 |
| TEMP | 90° TEST FLUID WATER |
| BY | Debra Stelby DATE 6-17-10 |

J. Jones 12/6/10
 Malinspec

R. Chind
 Joseph K. Millings



L.L.P

P.O. Box 802404 ♦ Houston, TX 77280-2404 ♦ Telephone (713) 460-3655 ♦ FAX (713) 460-3695

Report Date: 06/21/10
Report No: 465984.0
Rev.: A
Cust Acct: CHU038

To: Church Energy Services, Ltd.
2810 Washington Drive
Houston, TX 77038-3319

Ordered By: Paul Burkhardt PO#: 1110662
Material: S135 5"OD x 4-1/4"ID x 8"LG Test PC
ID/Heat: WO:456201 000 997000
Job Info:

Tensile Test Results

| No./Location | Size (in.) | Area (in^2) | Ult. Load (lbs.) | Yield (psi) | Tensile (psi) | Elong. (%) | R. of A. (%) | Hardness |
|--------------|------------|-------------|------------------|-------------|---------------|------------|--------------|----------|
| 1 | .249 | | | 158,500 | 170,000 | 17.0 | 60.0 | |

Unless otherwise stated, yield stress is 0.2% offset, gage length is 2 in. for 1/2 in. bars or 1 in. for 1/4 in. bars.

Charpy Test Results

| | Temp | Location | Foot-Pounds | % Shear | Mils Lat Exp |
|---|-------|----------|-------------|-------------|--------------|
| 1 | +72°F | LCVN | 49-42-48 | 100-100-100 | 46-43-47 |

Unless otherwise stated, Charpy Impact specimens are V-notch 10 x 10 mm.

Notes:

Size: .295" X .394"

Chemical Analysis Results

1 C: 0.26 Mn: 1.35 P: 0.008 S: 0.009 Si: 0.28 Cr: 0.74 Mo: 0.19 Ni: 0.02 Cu: 0.01
Al: 0.024

Chemical analysis results are reported in percent by weight.

Signed:

Erica Budzisz

Erica Budzisz

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P.O. Box 802404 ♦ Houston, TX 77280-2404 ♦ Telephone (713) 460-3655 ♦ FAX (713) 460-3695

Report Date: 06/21/10
Report No: 465983.0
Rev.: A
Cust Acct: CHU038

To: Church Energy Services, Ltd.
2810 Washington Drive
Houston, TX 77038-3319

Ordered By: Paul Burkhardt PO#: 1110662
Material: G105 5"OD x 4-1/4"ID x 8"LG Test PC
ID/Heat: WO:456201 000 997000
Job Info:

Tensile Test Results

| No./Location | Size (in.) | Area (in ²) | Ult. Load (lbs.) | Yield (psi) | Tensile (psi) | Elong. (%) | R. of A. (%) | Hardness |
|--------------|------------|-------------------------|------------------|-------------|---------------|------------|--------------|----------|
| 1 | .248 | | | 128,000 | 141,100 | 20.0 | 69.0 | |

Unless otherwise stated, yield stress is 0.2% offset, gage length is 2 in. for 1/2 in. bars or 1 in. for 1/4 in. bars.

Charpy Test Results

| | Temp | Location | Foot-Pounds | % Shear | Mils Lat Exp |
|---|-------|----------|-------------|-------------|--------------|
| 1 | +72°F | LCVN | 90-77-82 | 100-100-100 | 80-70-75 |

Unless otherwise stated, Charpy Impact specimens are V-notch 10 x 10 mm.

Notes:

Size: .295" X .394"

Chemical Analysis Results

| | |
|---|--|
| 1 | C: 0.26 Mn: 1.38 P: 0.009 S: 0.003 Si: 0.28 Cr: 0.79 Mo: 0.18 Ni: 0.04 Cu: 0.07 Al: 0.032 |
|---|--|

Chemical analysis results are reported in percent by weight.

Signed: _____

Erica Budzisz

Erica Budzisz

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