



## CRYSTAL GAUGE RECAP LOG DATA SHEET (C-7.b)

Project Mustang AFE/Work Order No. 5000268

Pipeline 6" Produced water DP409 1+00 27+00  
(Name) (Location)

Testing Contractor Wood

Pipe O.D. 2.25 Wall thickness. .875 Grade 750 MFG'R: Plat Steel

Test Fluid Water Additive none

Test Location: 6" PW Receiver Section No. 1+00 - 27+00

Instrumentation: Crystal Gauge 6" Produced water Receiver 27+00  
(Location)

Crystal Engineering 576537 2-18-19  
(Mfg'r) (S/N) (Date Calibrated)

chart recorder  
687923  
chart recorder  
642E-46924

Time	Pressure PSIG	Ambient Temp.
8:45	1061	36.99
9:15	1059	33.37
9:45	1057	33.59
10:15	1056	34.39
10:45	1055	32.37
11:15	1053	32.07
11:45	1052	36.62
12:15	1051	34.62
12:45	1050	35.60
1:15	1049	33.04
1:45	1048	31.64

Time	Pressure PSIG	Ambient Temp.
2:15	1047	27.63
2:45	1046	31.06
3:15	1047	29.58
3:45	1044	23.58
4:15	1043	24.90
4:45	1042	27.31
5:00	1041	28.99

Time	Pressure PSIG	Ambient Temp.

Test Started 8:45 AM/PM 3-21-19 Test Ended 5:00 AM/PM 3-22-19  
(Time) (Date) (Time) (Date)

Remarks:

Weather:

Testing Contractor's Representative Logan Longworth Tester Lambert 3-22-19  
(Name) (Title) (Signature) (Date)

Constr. Contractor's Representative Richard Mays Foran 3-22-19  
(Name) (Title) (Signature) (Date)

Company Representative STEVE PARANTO INSPECTOR Steve Paranto 3-22-19  
(Name) (Title) (Signature) (Date)

Construction Superintendent Chris Harrell QC Chris Harrell 3/22/19  
(Name) (Title) (Signature) (Date)

Project Name / No.: <u>Mogdang</u>		P&ID No. _____	
Test Package #: _____		_____	
System: <u>6" Produced water</u>			
Applicable Code: _____		Design Pressure: <u>740</u> PSIG	
<input checked="" type="checkbox"/> Above Ground Piping		<input checked="" type="checkbox"/> Below Ground Piping	
<input type="checkbox"/> Vessel/Other		_____	
Test Type: <input checked="" type="checkbox"/> Hydrostatic		<input type="checkbox"/> Pneumatic: <input type="checkbox"/> Leak <input type="checkbox"/> Service <input type="checkbox"/> Other _____	
Test Medium: <u>water</u>		Required Pressure: <u>1000</u> PSIG Actual Pressure: <u>1061</u> PSIG	
Required Test Pressure Hold Time: <u>8</u> Hours <u>0</u> Minutes		_____	
Ambient Temperature: <u>36</u> °F		Average Temperature: <u>34</u> °F	
Test Start Time: <u>8:45</u>		Test Finish Time: <u>5:00</u> Actual Test Hold Time: <u>8</u> Hour <u>15</u> Min.	
Allowable Leakage/Pressure Drop: <u>75 PSF</u>		Actual Leakage/Pressure Drop: <u>20 PSF</u>	
Test Acceptable: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		_____	
If Test Not Acceptable; State Why: _____			
<b>CALIBRATION DATA</b>			
Chart Recorder ID: <u>242E-46974</u>		Calibration Date: <u>2-13-19</u> Static Range: <u>0-3000</u>	
Chart Recorder ID: <u>11256336 8003</u>		Calibration Date: <u>3-4-19</u> Static Range: <u>0-3000</u>	
Pressure Gauge ID: <u>576537</u>		Calibration Date: <u>2-18-19</u> Gauge Range: <u>0-10 000</u>	
Pressure Gauge ID: _____		Calibration Date: _____ Gauge Range: _____	
Deadweight ID: _____		Calibration Date: _____ Weight Range: _____	
Lines Included: _____			
<b>TEST ACCEPTANCE</b>			
Test Performed By: <u>Logan Longworth</u>		Date: <u>3-22-19</u>	
Wood Superintendent: <u>[Signature]</u>		Date: <u>3-22-19</u>	
Client Representative: <u>Steve Rando</u>		Date: <u>3-22-19</u>	
Other: <u>QC</u> <u>[Signature]</u>		Date: <u>3/22/19</u>	



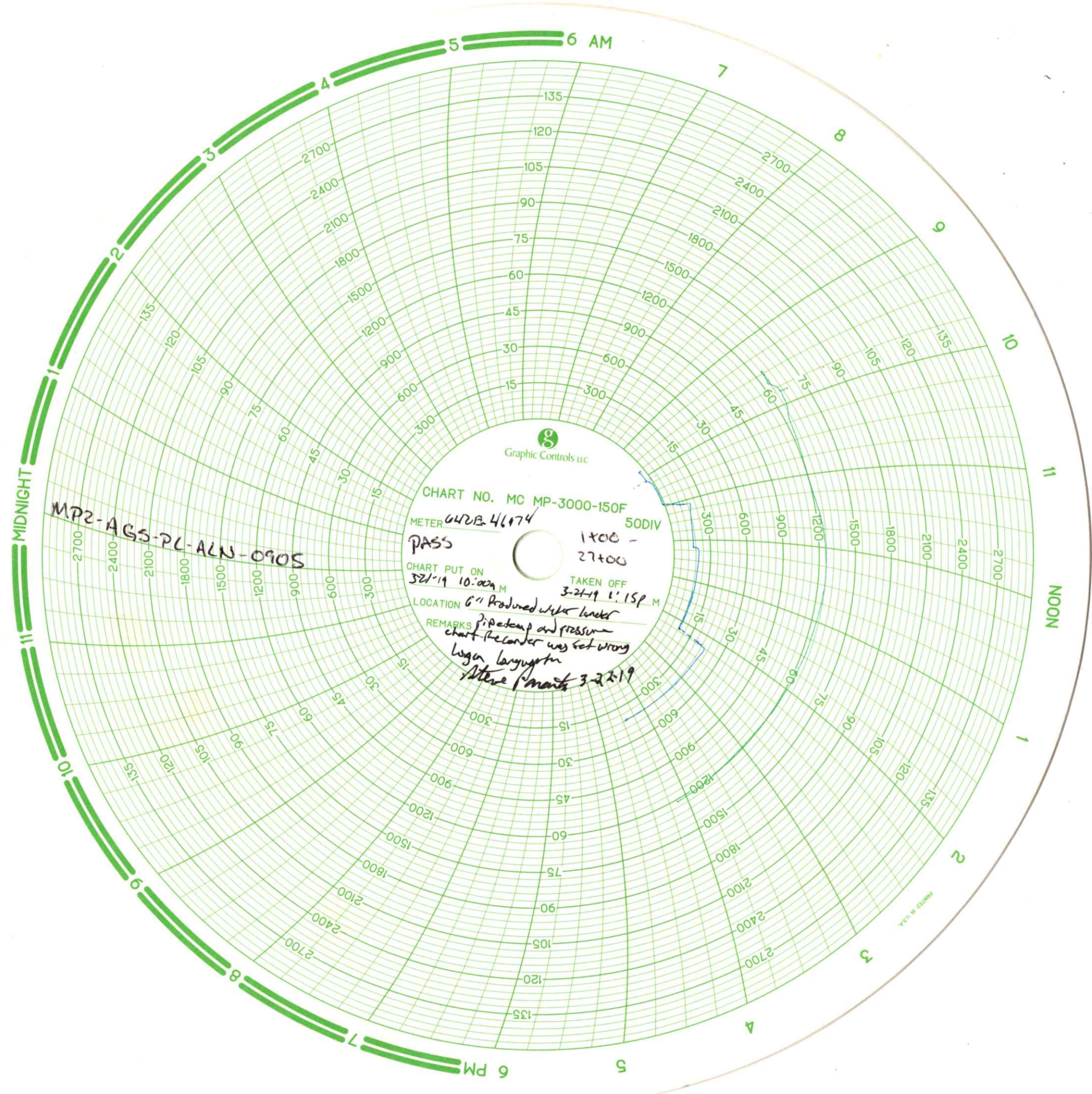




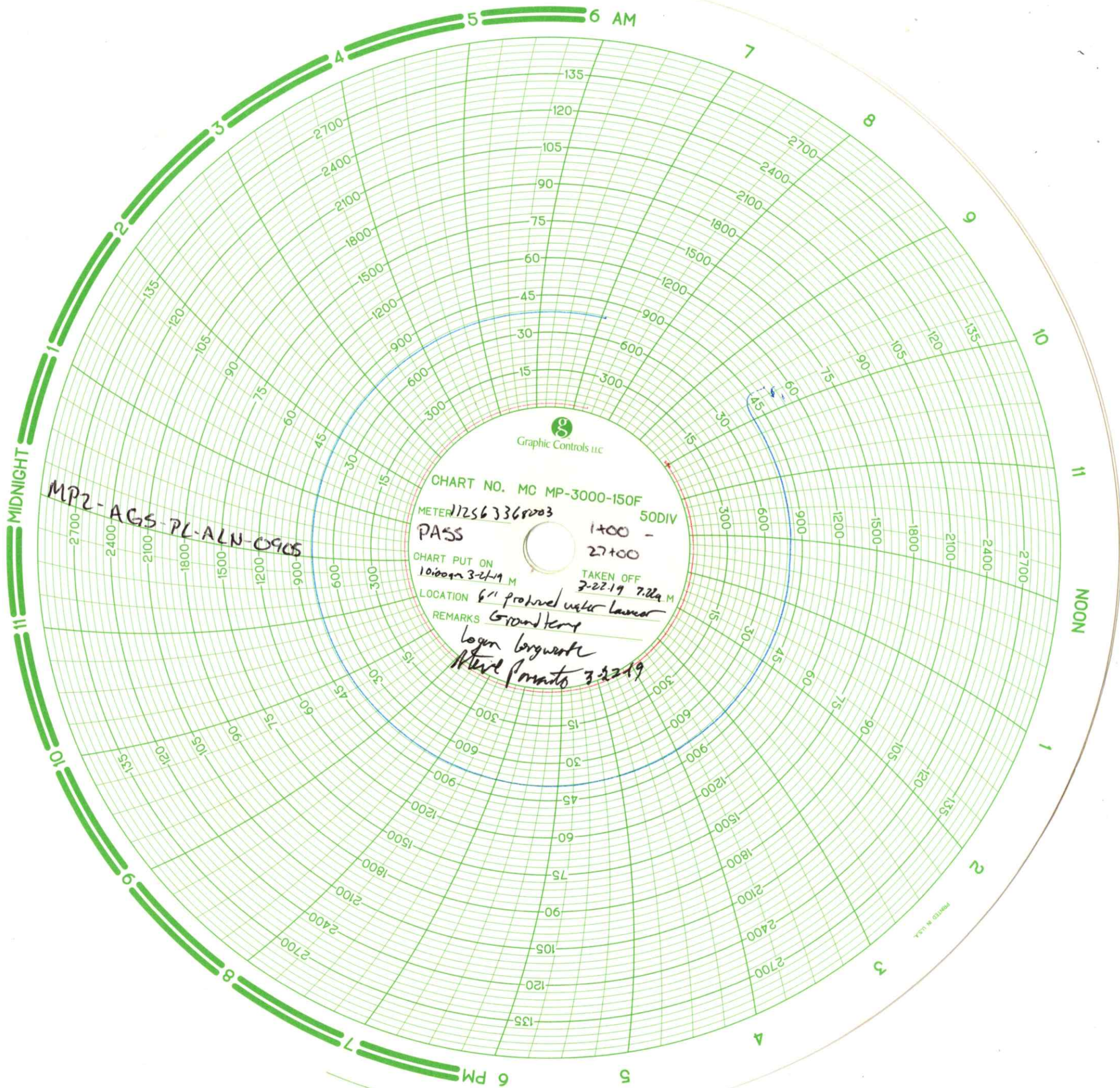
Form 15000-0029 Rev B  
Revision Date: March 2018



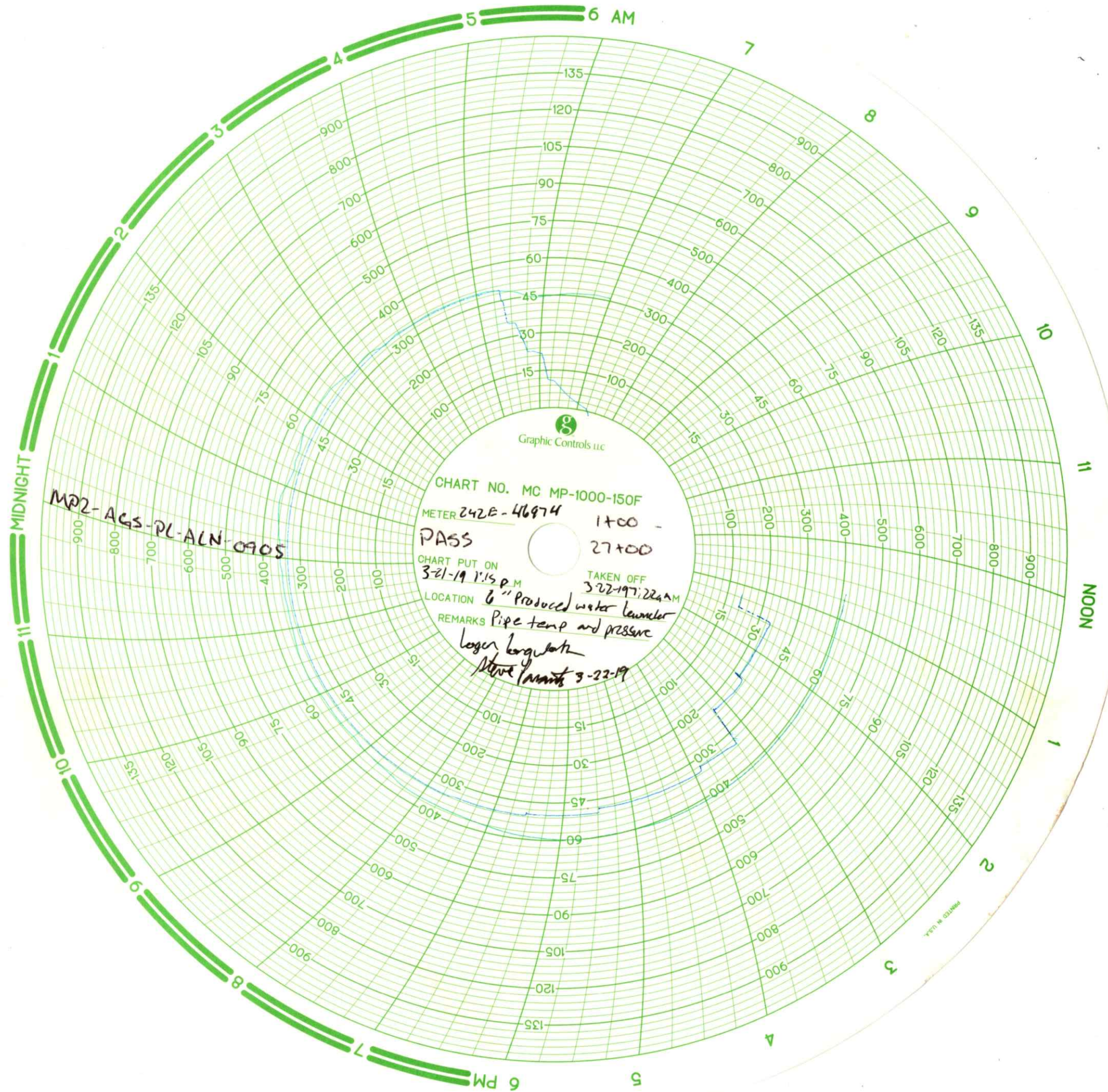












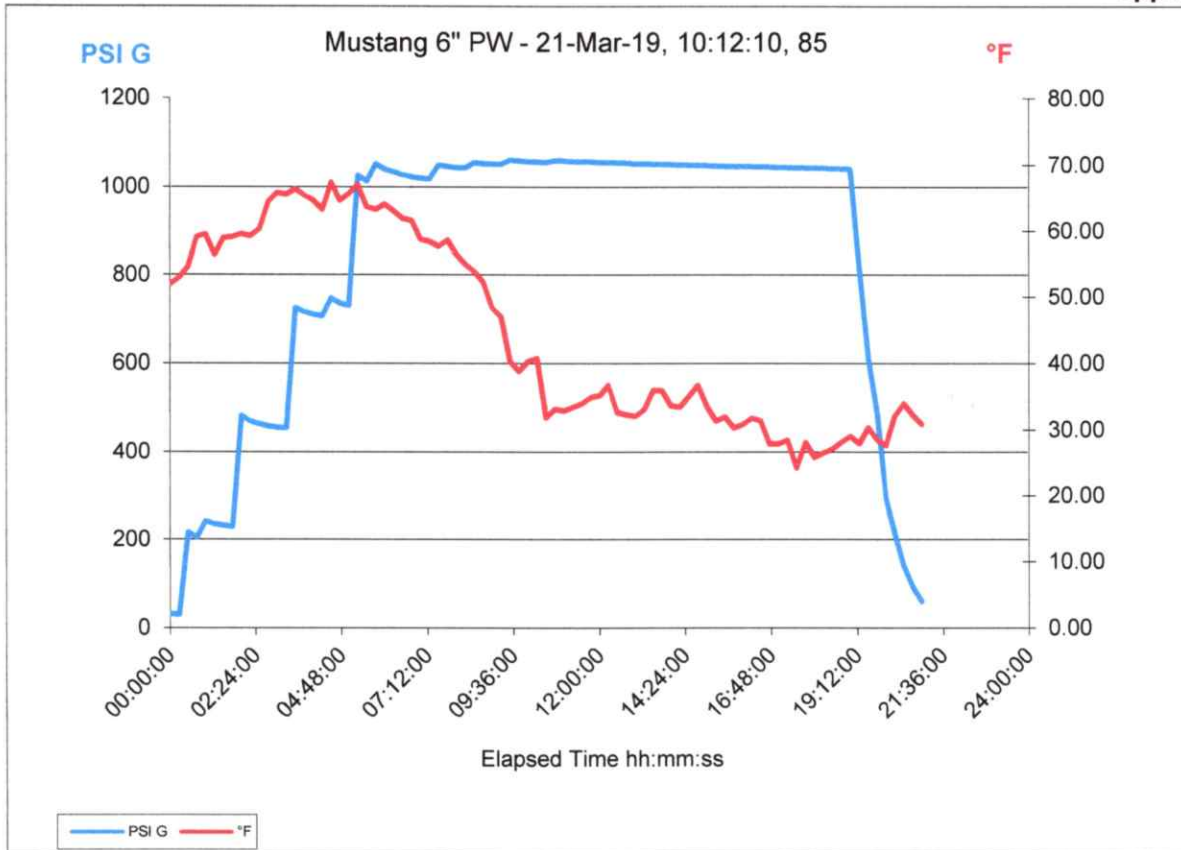


## Data Collection Report

	Chassis	Left Scale	Right Scale
Serial Number	683559	576537	687923
Datatype		Lower	Upper
Units		PSI G	°F

Lower

Upper



	Chassis	Lower Module	Upper Module	BARO Module	Left Scale	Right Scale
Serial Number	683559	576537	687923		576537	687923
Model	NV	10KPSI	RTD100			
Message Store						
Userspan		1.00000	1.00000			
Offset						
Datatype						
Units		PSI G	°F		Lower PSI G	Upper °F
Tare						
Average						
User Factor						
User Offset						
User Resolution						
Firmware Version	R080016	R090009	R100006			
Calibration Due		18-Feb-20	19-Feb-20			
Run Index	14					
Run Start Time			21-Mar-19/10:12:10			
Run Duration			21 hours			
Run Tag			Mustang 6" PW			
Logging Interval	900.0					

Data Points			
Point #	Time	Left - PSI G	Right - °F
1	00:00:00.0	32	51.88
2	00:15:00.0	30	52.92
3	00:30:00.0	216	54.56
4	00:45:00.0	204	59.07
5	01:00:00.0	242	59.50
6	01:15:00.0	235	56.35
7	01:30:00.0	232	58.92
8	01:45:00.0	229	59.07
9	02:00:00.0	483	59.54
10	02:15:00.0	469	59.22
11	02:30:00.0	463	60.26
12	02:45:00.0	459	64.46
13	03:00:00.0	456	65.79
14	03:15:00.0	454	65.51
15	03:30:00.0	725	66.34
16	03:45:00.0	716	65.37
17	04:00:00.0	710	64.67
18	04:15:00.0	706	63.20
19	04:30:00.0	747	67.39
20	04:45:00.0	735	64.61
21	05:00:00.0	730	65.61
22	05:15:00.0	1026	66.98
23	05:30:00.0	1013	63.61
24	05:45:00.0	1052	63.24
25	06:00:00.0	1040	64.05
26	06:15:00.0	1034	63.01
27	06:30:00.0	1027	61.89
28	06:45:00.0	1023	61.61
29	07:00:00.0	1020	58.71
30	07:15:00.0	1018	58.42
31	07:30:00.0	1049	57.64
32	07:45:00.0	1046	58.65
33	08:00:00.0	1044	56.41
34	08:15:00.0	1043	54.92
35	08:30:00.0	1055	53.89
36	08:45:00.0	1053	52.26
37	09:00:00.0	1052	48.41



38	09:15:00.0	1051	47.03
39	09:30:00.0	1061	40.31
40	09:45:00.0	1059	38.84
41	10:00:00.0	1058	40.33
42	10:15:00.0	1057	40.77
43	10:30:00.0	1056	31.83
44	10:45:00.0	1060	33.13
45	11:00:00.0	1059	32.92
46	11:15:00.0	1058	33.45
47	11:30:00.0	1057	33.98
48	11:45:00.0	1057	34.89
49	12:00:00.0	1056	35.17
50	12:15:00.0	1055	36.74
51	12:30:00.0	1055	32.65
52	12:45:00.0	1054	32.32
53	13:00:00.0	1053	32.08
54	13:15:00.0	1052	33.07
55	13:30:00.0	1052	35.93
56	13:45:00.0	1051	35.90
57	14:00:00.0	1051	33.66
58	14:15:00.0	1050	33.51
59	14:30:00.0	1050	35.05
60	14:45:00.0	1049	36.76
61	15:00:00.0	1049	33.52
62	15:15:00.0	1048	31.37
63	15:30:00.0	1048	31.98
64	15:45:00.0	1047	30.35
65	16:00:00.0	1047	30.89
66	16:15:00.0	1047	31.77
67	16:30:00.0	1046	31.41
68	16:45:00.0	1046	27.89
69	17:00:00.0	1045	27.90
70	17:15:00.0	1045	28.51
71	17:30:00.0	1044	24.27
72	17:45:00.0	1044	28.17
73	18:00:00.0	1043	25.89
74	18:15:00.0	1043	26.57
75	18:30:00.0	1042	27.11
76	18:45:00.0	1042	28.17
77	19:00:00.0	1041	29.06
78	19:15:00.0	821	27.96
79	19:30:00.0	612	30.38
80	19:45:00.0	489	28.50
81	20:00:00.0	293	27.61
82	20:15:00.0	214	32.15
83	20:30:00.0	142	34.00
84	20:45:00.0	93	32.28
85	21:00:00.0	60	30.88





7200 E. Dry Creek Rd, STE C-102, Centennial, CO 80112  
Ph. 303-804-0667 Cal.Lab@Apex-Instruments.com

# Calibration Certificate

**Certificate Number: 190896**

**Customer:**

Wood Group Ekhorn  
Greeley, CO

**Manufacturer:** Crystal Engineering  
**Model Number:** nVision 10,000 psi  
**Serial Number:** 576537  
**Description:** Pressure Module  
**Procedure:** CI-001  
**Calibrated To:** Manufacturer's Specifications  
**Technician:** Austin Molyneux

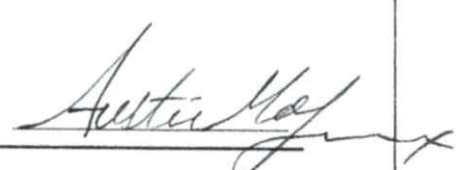
**Calibration Date:** 2/18/2019  
**Due Date:** 2/18/2020  
**As Found:** In Tolerance  
**As Left:** As Found  
**Temperature:** 69.8 F  
**Humidity:** 18.8 %

**Tolerance Specs:**

0 to 30% of FS: +/- 0.015% of FS  
30% to 110% of FS: +/- 0.05% of Rdg

**Technician Notes:**

As Left Userspan: 1.00000

Approved Signatory: 

Apex Instruments certifies that the instrument listed above meets the specifications of the manufacturer at the completion of its calibration. Standards used are traceable to the National Institute of Standards and Technology (NIST), or have been derived from accepted values, natural physical constants, or through the use of the ratio method of self-calibration techniques.

Methods used are in accordance with the procedure listed above. This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

Unless otherwise contractually specified, a binary decision rule, utilizing simple acceptance, and simple rejection criteria will be used for the determination of compliance. When compliance statements are present, they are reported without factoring in the effects of uncertainty and the limits are defined by the manufacturer's stated accuracy.

This certificate does not guarantee the continued performance of the instrument listed above. Any modifications or services performed hereafter may void this certificate.

This certificate is not to be reproduced other than in full, except with prior written approval from Apex Instruments Inc.



APX01014



## Standards Used

Description	Model Number	Serial Number	Calibration Date	Due Date	ID
Electronic Deadweight Tester	RPM4-E-DWT A100M/A10M	1709	11/19/2018	11/19/2019	APX00024
Temp / RH Datalogger	UX100-011	20369499	8/28/2018	8/28/2019	APX04795

## Compass Import

10000PSI

Test Description	Nominal	As Found - As Left		UUT Error	Status	Pass
		Test Results	Tolerance (+/-)			
0	0.00 psi	0.0 psi	1.5 psi	0.0 psi	Pass	
2000	2000.09 psi	2000.5 psi	1.5 psi	0.4 psi	Pass	
4000	4000.60 psi	4001.0 psi	2.0 psi	0.4 psi	Pass	
6000	5999.37 psi	6000.0 psi	3.0 psi	0.6 psi	Pass	
8000	8000.03 psi	8000.5 psi	4.0 psi	0.5 psi	Pass	
10000	10001.83 psi	10002.2 psi	5.0 psi	0.4 psi	Pass	
8000	7998.44 psi	7999.0 psi	4.0 psi	0.6 psi	Pass	
6000	6001.52 psi	6002.0 psi	3.0 psi	0.5 psi	Pass	
4000	3998.91 psi	3999.8 psi	2.0 psi	0.9 psi	Pass	
2000	2001.03 psi	2002.0 psi	1.5 psi	1.0 psi	Pass	
0	-0.10 psi	0.0 psi	1.5 psi	0.1 psi	Pass	

-- End of measurement results--



APX01014



# P-SS-SS-COMPANIES



9700 E. 104<sup>TH</sup> AVE, UNIT F- HENDERSON, CO 80640 - Phone (303)857-7986 - Fax (303)389-4945

## CALIBRATION CERTIFICATE

CERTIFICATE NUMBER: CO

Details +/-: 1.0% ACCURACY

**DATE CALIBRATED:** 03/04/2019

**DUE DATE:** 03/04/2020

**INDICATED TEMPERATURE RANGE:** # 0 – 150°F

**INDICATED PRESSURE RANGE:** #0 – 3000 PSI

**SERIAL NO:** 11256368003 **ID NO:** 006980

**MANUFACTURER:** BARTON/ 12" RECORDER

**TYPE OF INSTRUMENT CALIBRATED:** TEMPERATURE / PRESSURE RECORDER

**INSTRUMENT FINDINGS/STATUS:** UNIT IS IN TOLERANCE/ INSTRUMENT MEETS OR EXCEEDS SPECIFICATIONS.

**BASED ON INTERNATIONAL STANDARDS OF GRAVITY:** (980.665 cm./sq.).

**TYPE OF STANDARD USED TO CALIBRATE:** REFINERY DEADWEIGHT TEST UNIT SPT. (35225-3) SERIAL No. 5268: KESSLER TEST THERMOMETERS; SERIAL NO. CALIBRATION

**ALL STANDARD DIRECTLY TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGIES TEST NO:** (N.I.S.T.) 2.6/172490 & 6.6/139577.

**CALCULATED USING MASS VALUES, AREA, AO, AND STATED GRAVITY.**  
**ROOM TEMPERATURE/HUMIDITY (AT TIME OF TEST):** 66°F / 25%.

**CALIBRATED BY:** NICK BEDFORD



# Cross Country Pipeline Supply CO. Inc

Sales and Service

2251 Rifle Street - Aurora, Colorado 80011

Phone 303.361.6797 Fax 303.361.6836

## NIST CALIBRATION DATA

Model Number	Serial Number	Customer	Range	Accuracy
Barton	242E-46974	WOOD	3000# - 150F	1/2%

Work Performed:	Calibration: Output/Reading	Results: Pressure
Calibrate to Mfg. Spec.	0 PSI	0 PSI
	600 PSI	600 PSI
	1200 PSI	1200 PSI
	1800 PSI	1800 PSI
	2400 PSI	2400 PSI
	3000 PSI	3000 PSI
	33 Deg	33 DEG
	56 DEG	56 DEG
	115 DEG	115 DEG
	147 DEG	147 DEG

PO Number	Sales Order Number	Date of Test
Recalibrated	Recerted	2/13/2019 5:26:30 PM

Remarks: ALL CALIBRATIONS ARE GOOD FOR ONE YEAR FROM DATE OF TEST

--

### Standard Used:

Manufacturer	Model	Instrument	Calibration Date	Certification #
Perma-Cal	101FTM15B21	Pressure Gauge	08/08/2018	17-043
Tech Instrumentation	TM99A	Thermometer	08/18/2018	59448

Don F.

Signature

*Don Erick* 2-13-19









## Mustang Gathering System

Noble Midstream Partners

### Hydrostatic Pressure Test Procedure for Produced Water FlexSteel Pipelines

MP2-JAC-PI-RPT-0002 | 0

October 18, 2018





## Mustang Gathering System

Project No: 704161  
Document Title: Hydrostatic Pressure Test Procedure for Produced Water FlexSteel Pipelines  
Document No.: MP2-JAC-PI-RPT-0002  
Revision: 0  
Date: October 18, 2018  
Client Name: Noble Midstream Partners  
Project Manager: Blake Evans  
Author: Shawn Heath  
File Name: MP2-JAC-PI-RPT-0002

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### Document history and status

Revision	Date	Description	By	Review	Approved
0	10/18/18	Issued for Construction	SH	BE	BE

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## Appendix A. Site Specific Testing Information



## EXECUTIVE SUMMARY

This general procedure defines the minimum requirements for hydrostatic pressure testing of FlexSteel pipelines. This document is intended to be used in conjunction with site-specific testing information to be provided in Appendix A.

## 1. REFERENCES

Testing procedures shall comply with the latest editions of the following industry standards:

- Title 49 CFR DOT Part 195 – Transportation of Hazardous Liquids by Pipeline
- API RP 1110 – Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids or Carbon Dioxide
- ASME B31.4 – Pipeline Transportation Systems for Liquids and Slurries
- ASME B16.5 – Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard
- FlexSteel Technical manual
- FlexSteel Commissioning Field Notes

## 2. PRE-TEST PRECAUTIONS

### 2.1 SAFETY PRECAUTIONS

This safety information is in addition to the safety information in other sections of this document.

Always take precautions to eliminate hazards to persons near lines being tested. For the entire duration of the procedure, including filling, initial pressurization, time at test pressure, and depressurization, only persons conducting the test or inspecting the system should be allowed near the section under test. These persons should be fully informed of the hazards of field pressure testing. All other persons should be kept a safe distance away. The test section must be supervised at all times. Failure may result in sudden, violent, uncontrolled, and dangerous movement of system piping, or components, or parts of components.

### 2.2 TEST PRESSURE AND DURATION

#### 2.2.1 TEST PRESSURE

Pipelines shall be tested at a minimum test pressure of 125% of the internal design pressure.

A site-specific pressure test range calculated based on pipeline elevation, pipeline material, corrosion allowance, and minimum code requirements for each test section shall be included in Appendix A of this procedure.

#### 2.2.2 TEST DURATION

The hydrostatic test pressure shall be maintained for 8 hours after final test pressure has stabilized, and the pipe has been conditioned properly in the field. With pipe conditioning accounted for, the test commonly takes 16 –

20 hours. This is dependent on how well the pipe responds to the conditioning procedure (times up to 24 hours may be required).

The test pressure shall be considered stabilized after 5 minutes without fluctuation.

## **2.3 TEST EQUIPMENT AND MATERIALS**

Pressure test equipment shall be selected to meet the hydrostatic test conditions and shall be in working order. The measurement equipment shall be designed for the pressures expected during the pressure test.

### **2.3.1 FILL PUMP**

The pump used to fill the line shall be a high-volume pump which provides adequate pressure to overcome static head and maintains sufficient velocity to move pigs, spheres, and any debris in the pipeline.

The fill pump or associated discharge piping shall be equipped with a flow measurement device capable of maintaining a specified fill rate.

### **2.3.2 SUPPLY WATER FILTER**

The pump discharge piping shall be equipped with an in-line filter capable of capturing debris greater than 1 mm.

### **2.3.3 PRESSURIZATION PUMP**

The pressurization pump shall be a variable speed, positive displacement pump that pressurizes the line to the specified test pressure. The pump shall have a known volume per stroke and shall be equipped with a stroke counter.

A constant-speed pump with a variable flowrate control may be used in lieu of the above pump if the liquid test medium injected into the pipeline is measured during pressurization.

### **2.3.4 CALIBRATION DEVICES**

#### **2.3.4.1 PRESSURE CALIBRATION DEVICE**

A deadweight tester or an equivalent pressure sensing device that is capable of measuring in increments of less than or equal to one (1) psig shall be used. The device shall have a certificate of calibration that is not more than one year old at the start of testing.

#### **2.3.4.2 TEMPERATURE CALIBRATION DEVICE**

A certified thermometer shall be provided. The device shall have a certificate of calibration that is not more than one year old at the start of testing.

### **2.3.5 RECORDING DEVICES**

#### **2.3.5.1 PRESSURE RECORDING**

This procedure refers to the recording device used during the test duration as a chart recorder. A digital recorder may be used in lieu of the more traditional chart recorder.

Pressure recording equipment shall be provided and qualified as follows:



- A continuous-recording pressure measurement device that provides a permanent record of pressure versus time. This device should be calibrated immediately before each use with the deadweight tester.
- Electronic pressure/temperature monitoring and recording systems that assist in the analysis of test data. Such systems can be used in lieu of the components listed above provided that the individual pressure sensors included in the systems have a level of sensitivity and can be field calibrated in a manner similar to those instruments listed above.

#### **2.3.5.2 TEMPERATURE RECORDING**

Temperature recording equipment shall be provided and qualified as follows:

- A test medium temperature sensing and display instrument that is properly calibrated to a range suitable for anticipated test temperatures. Temperature instrument accuracy should be within 1 °F of actual temperature. Temperature instrument sensitivity should be within 0.1 °F.
- A continuous-recording temperature measurement device that provides a permanent record of test medium temperature versus time. This device should be calibrated immediately before each use with a certified thermometer.
- An ambient temperature sensing and display instrument that is properly calibrated to a range suitable for anticipated ambient temperatures. Temperature instrument accuracy should be within 1 °F of actual temperature. Temperature instrument sensitivity should be within 0.1 °F.
- A continuous-recording temperature measurement device that provides a permanent record of ambient temperature versus time. This device should be calibrated immediately before each use with a certified thermometer.

#### **2.3.6 SAFETY RELIEF VALVE**

The hydrostatic test fill pump and pressurization pump or associated discharge piping shall be equipped with a pressure relief valve. The pressure relief valve shall be set to relieve at the site-specific calculated maximum testing pressure to be provided in Appendix A.

### **2.4 QUALIFICATION OF CONTRACTOR AND OPERATOR PERSONNEL**

Qualifications of contractor and operator personnel for conducting pressure tests will be based on certification requirements by 49 CFR Part 192/195, Code, or Noble standards and procedures.

Noble personnel and contractors involved with designing, planning, conducting, or approval of a pressure test should be qualified by both training and experience. Noble is responsible for establishing these qualifications. The following factors to determine qualifications are recommended per API RP 1110:

- Performance of applicable calculations and interpretation of test data and results.
- Knowledge of code requirements and regulations.
- Qualification requirements of governing authority to conduct or witness testing.
- Governmental or operator requirements to certify test results.
- Familiarity with equipment and pressure test set-up.

- Familiarity with test procedures.

## **2.5 PERMIT TO WORK**

Prior to commencing work, work permits shall be obtained. At a minimum, the below documents shall be provided by the contractor for submittal:

- Operator Qualification records for each person performing tasks.
- Test equipment certifications.
- Water source.
- Biocide injection plan (If Applicable).
- Biocide Safety Data Sheets (SDS) (If Applicable).
- Leak monitoring plan.
- Depressurization plan.
- Water disposal plan.
- Drying plan (If Applicable).

## **3. TEST PROCEDURE**

As part of the work permit, a hydrostatic test plan for each section of pipe shall be developed by the contractor and submitted to the appointed Noble representative prior to commencing work. The test plan shall, at a minimum, address the requirements specified in this procedure.

### **3.1 SOURCE WATER**

The quality and source of the test water shall be determined prior to the permitting process. Non-potable water shall be treated with biocide prior to entering the pipeline. The SDS sheets and injection rate for the Biocide shall be submitted and approved by a Noble representative prior to work permit issuance. Biocide treatment may not always be required.

Water shall be filtered prior to entering the pipeline. The maximum allowable particle size is 1 mm.

### **3.2 EQUIPMENT INSTALLATION**

If possible, excavated segments shall be backfilled prior to the initial pressurization.

Temporary piping shall be properly anchored and adequately secured from movement. Pipe couplings shall have safety devices or restraints to limit movement due to unexpected piping separation.

A flow meter shall be placed in the line to monitor and maintain the planned design rate of fill.

The sensor on each temperature recording device shall be installed so that it is in contact with the pipeline at a point where it has normal cover. Additionally, it shall be at a distance far enough from the injection point so that



the effects of the exposed piping and make-up injection(s) on temperature is minimized. The backfill around the temperature recording device sensor shall be tamped.

Insulation, if appropriate, shall be used on the capillary lines to the temperature recorder and the temperature recorder should be installed in an insulated box. Large centrifugal pumps and storage tanks will affect the temperature of the test medium.

Per the *FlexSteel Commissioning Field Notes*, FlexSteel recommends that the vent valves on all end fittings be removed during hydrostatic test and replaced thereafter.

### **3.3 LINE FILL**

The line fill water volume shall be calculated for each test section and be included in Appendix A of this procedure.

All temporary piping and test heads shall be adequately secured before the line fill process is started.

If pigs or spheres are used in the filling process, they shall be equipped with trackers for monitoring location and speed during the line fill process. Per the *FlexSteel Commissioning Field Notes*, only polyurethane pigs are allowed to be used with FlexSteel.

The fill pump shall be sized for the pigs to travel at a speed that will maintain a seal with the pipeline. This will reduce the risk of introducing air behind the pigs. A travel speed of 2 – 3 mph shall be maintained.

High velocities may cause excessive wearing of the pigs and may cause the displaced air to mix with the test medium. As pigs travel down the line and down a slope, unless backpressure is applied during the line fill, the weight of the column of fluid could cause the pig to travel faster than the specified speed and introduce air behind the pig.

Air shall be bled during the filling process to minimize the time for line pressure stabilization. The total amount of residual air shall be less than 0.2% of the volume of the test section. If it is determined that air is trapped in the pipeline, vents or traps at high elevation points may be installed to bleed the air from the pipeline. Any equipment added to the pipeline shall be removed after the pipeline has been dewatered.

The temperature, pressure, and flow rate of the test medium during line fill shall be recorded. All applicable conditions shall be monitored to prevent over-pressurization during line fill.

### **3.4 INITIAL PRESSURIZATION**

A pipe maintained at high pressure is potentially dangerous. Established safety guidelines in accordance with the work permit shall be followed at all times.

The amount of water required to increase the pressure from the initial fill to the final test pressure shall be calculated prior to the pressure test and made available to test personnel.

The initial pressurization of the segment of pipe to be tested begins once the segment is full of fluid and the appropriate measures have been taken to bleed all air.

Personnel conducting the test shall maintain continuous surveillance over the operation to ensure that it is carefully controlled. Test personnel should be located at a safe distance from the test section.

Pipe connections shall be periodically checked for leaks during the pressurization process.

The flowrate shall be monitored and logged for the preparation of a pressure-volume plot.

A pressure-volume plot shall be initiated at the start of the pressurization process and continue until the test pressure is reached. The lower end of the pressure-volume plot can be used to determine the total amount of residual air in the test section. The upper end of the pressure-volume plot can be used to determine if any pipe in the test segment may have reached its elastic limit.

Pressurization up to 75% of the final test pressure shall occur at a rate of 10 PSIG/MIN.

Once 25% of the final test pressure is reached, the pressure must be allowed to stabilize for a minimum of 15 minutes. The pressure shall be considered stabilized after 5 minutes without fluctuation.

This process should be repeated for pressurizing the pipe to 50% of the final test pressure. Once the pressure has stabilized for 15 minutes, the pipe should be pressurized to 75% of the final test pressure at which point the pressure should be allowed to stabilize for 1 hour.

After the pressure has stabilized to 75% of the final test pressure, pressurization at a rate of 5 PSIG/MIN shall be used to complete the pressurization process up to the final test pressure. The final test pressure shall be considered stabilized after 5 minutes without fluctuation.

When the final test pressure is reached and has stabilized, pressurization shall cease and all valves and connections to the line shall be inspected for leakage.

### **3.5 PIPE CONDITIONING**

FlexSteel must be conditioned prior to commencing a “hold” or test period in order to allow the polymer liner in the FlexSteel to creep to bed into the tensile elements in the FlexSteel. (*FlexSteel Technical Manual*)

After the test pressure has stabilized in the Initial Pressurization phase, the pipe should be blocked in. The pressure drop in the pipe should be monitored and recorded continuously, or at least every fifteen (15) minutes for 1 hour. After that, the pipe should be re-pressurized to the test pressure, blocked in, and have its pressure monitored and recorded continuously, or at least every fifteen (15) minutes for 1 hour. (*FlexSteel Technical Manual*)

The two recorded pressure drops should be compared. If the rate of pressure drop is smaller for the second run, the pipe is conditioning and not leaking. (*FlexSteel Technical Manual*)

However, if the pressure drop rate does not decrease, there is a possibility that leak exists in the pressure boundary system. These leaks are usually in the test equipment or flanges rather than the pipe. If this occurs, testing should continue for two (2) additional cycles to verify that the pressure drop rate is still not changing. If the pressure drop rate remains constant, or increases, the test fittings and flange connections should be checked for leakage. Following this, if there is still no decline in the rate of pressure drop, the pipe is leaking. A leak in the pipe is rare, and if it occurs, it could result from a faulty end fitting or end fitting installation. Thus, the end fittings should be carefully inspected and/or replaced to determine if the leak occurred at an end fitting. (*FlexSteel Technical Manual*)

If the rate of pressure drop did decrease without any issues, the cycle of pressurizing to the test pressure, blocking the pipe in, and monitoring and recording the test pressure for an hour should continue a few more times to get more data and demonstrate that the rate of pressure drop is decreasing with each cycle. If an issue arises, then the steps mentioned above to determine if a leak is present should be followed.

Otherwise, the anticipated 24-hour test pressure drop shall be calculated by assuming the most recent pressure drop rate is maintained over a 24-hour test. If the predicted pressure is less than the calculated minimum test



pressure, then more conditioning cycles are needed. After each cycle, the predicted pressure drop shall be calculated for a 24-hour test to see if the pressure will always stay above the minimum test pressure. Once this has been confirmed, the pipe has been properly conditioned. The pipe should be re-pressurized to the test pressure, blocked in, and The Test Period shall start. (*FlexSteel Technical Manual*)

Conditioning may occur during the evening and/or in cold weather situations and precautions must be taken to eliminate the possibility of freezing in the appurtenances, such precautions may include the use of thermal blankets and heaters.

The conditioning process can take several hours (8 – 12). It may be the case that the pipe needs to be pressurized up to the final test pressure a few times to finalize the conditioning before being blocked in and starting the test period. It is also recommended that all personnel be at least 50 feet away from the pipe during the pressure test. (*FlexSteel Commissioning Field Notes*)

### **3.6 TEST PERIOD**

The test period shall begin after the temperature of the test medium, pipe temperature, and ground temperature have stabilized. When this stabilization process is complete, the pressurization pump should be isolated from the test section.

After inspecting for leakage, test personnel shall verify that the specified test pressure is being maintained.

Pressure and temperature shall be continuously monitored during the test. Data shall be recorded every half hour throughout the duration of the test.

Weather changes, such as the development of rain or clouds, which could affect the pressure and temperature of the pipe and test medium shall be documented on the test log.

The volume of any added or subtracted test medium shall be documented on the test log as well as its temperature and pressure at that time and be accounted for in the assessment of the results of the pressure test. For any pressure test of piping that cannot be 100% visually checked for leaks, it is mandatory that the volume of any test medium added or removed be accounted for to determine if the pressure test has been completed without evidence of leakage.

### **3.7 SEARCHING FOR LEAKS**

Prior to commencing work, the method(s) for locating leaks or failures shall be approved by the Noble representative. The operator may choose to fly, drive and/or walk the pipeline right-of-way to visually check for evidence of leaks during the pressure test. The operator should develop contingency plans for locating large and small leaks in areas of difficult terrain or in the event of inclement weather.

Acceptable methods for finding leaks during a pressure test are listed as follows:

- Sectioning or segmenting the pipeline and monitoring the pressure of each section. Closing mainline block valves will isolate the pipeline into smaller segments. Freeze plugs may also be used to isolate sections of the pipeline for evaluation.
- Acoustical monitoring equipment may be employed to narrow the search area.
- Odorants or tracers introduced into the test medium during the filling process will allow the operator to detect leaks with sensing equipment.

### **3.8 PRESSURE TEST FAILURES**

All leaks and test failures shall be reported to the Noble representative immediately.

Any pipeline leaks or failures shall be documented in the test report.

If a rupture or a substantial leak occurs, the test shall be stopped and the pipeline depressurized. The cause of failure shall be understood, test procedures shall be reevaluated, and approval from the Noble representative shall be obtained before proceeding with repairs and starting a new hydrostatic test.

Pipe, valves, fittings, and test components that fail during a pressure test shall be investigated to determine the cause of failure and to minimize the possibility of a recurrence.

Pipe or other failed components shall be preserved for further examination and failure analysis.

If a small leak occurs, the pressure should be reduced to 80% of the final test pressure while locating the leak. After repairs are completed and authorization from the Noble representative has been obtained, the test can be restarted per the initial pressurization steps above.

Pressure excursions outside of the site-specific maximum and minimum test pressures as defined in Appendix A are considered test failures.

### **3.9 DEPRESSURIZATION, DISPLACEMENT, AND DISPOSAL OF TEST WATER**

Prior to commencing work, a depressurization, displacement, and disposal plan shall be submitted to and approved by the Noble representative.

Depressurization activities shall not commence without authorization from the Noble representative. Once authorization is received, depressurization should commence at a rate of 10 PSIG/MIN in increments of 25% of the final test pressure. The pressure should be allowed to stabilize for 15 minutes between increments.

Displacement and disposal activities shall not commence prior to Noble engineering acceptance of the hydrostatic test results.

A disposal plan for the test medium must be developed and the Noble representative shall review and approve the disposal plan.

Pigs or spheres used in the dewatering process shall be equipped with trackers for monitoring location and speed during the dewatering process.

The travel speed for the dewatering pigs shall be maintained at 2 – 3 MPH.

### **3.10 DRYING OPERATIONS**

If the pipeline will not be placed into service within seven (7) days of dewatering, drying operations are required.

Prior to commencing work, a drying plan shall be submitted to and approved by the Noble representative.

Upon completion of drying, a 5 psig nitrogen blanket shall be maintained on the pipeline until commissioned.



## 4. RECORDS

After the hydrostatic test has been completed, the following records shall be submitted as part of the Final Test Report, which must be reviewed and accepted by an authorized Noble representative. These records must be retained for as long as the pipeline is in use.

- Pressure / Volume Plot
- Pressure Recording Chart / Plot
- Calibration Records
  - Deadweight Tester
  - Chart Recorder
  - Temperature Recorders
  - Certified Thermometer
- Title 49 CFR Part 195 Operator Qualifications
  - Operator
  - Person responsible for making the test
  - Test company used, if any
- Hydrostatic Test Log, including:
  - Date and time of the test
  - Minimum test pressure
  - Test medium
  - Description of the pipeline tested and the test apparatus
- Leak Reports
- Failure Reports
- Site-specific hydrostatic test plan including:
  - Elevation profile of the pipeline
  - Locations of test sites over the entire length of the pipeline
- Temperature Chart / Plot

## **APPENDIX A. SITE SPECIFIC TESTING INFORMATION**



Hydrotest Summary Page - FlexSteel

Project: Mustang DP409  
Client: Noble Midstream Partners  
Location: Weld County, CO

		Start of Line				End of Line					
	Test Segment	Process Fluid	Test Medium	Test Duration (hrs)	MOP (psig)	Min Test Pressure (psig)	Max Test Pressure (psig)	Min Test Pressure (psig)	Max Test Pressure (psig)	Max % Burst Pressure (psig)	Est. Water Volume (gal)
1	PL-0903 to PR-0903	Produced Water	Water	8	740	930	1123	930	1124	75.0%	3,272
2	PL-0906 to PR-0906	Produced Water	Water	8	740	930	1125	925	1120	75.0%	12,020

Notes:

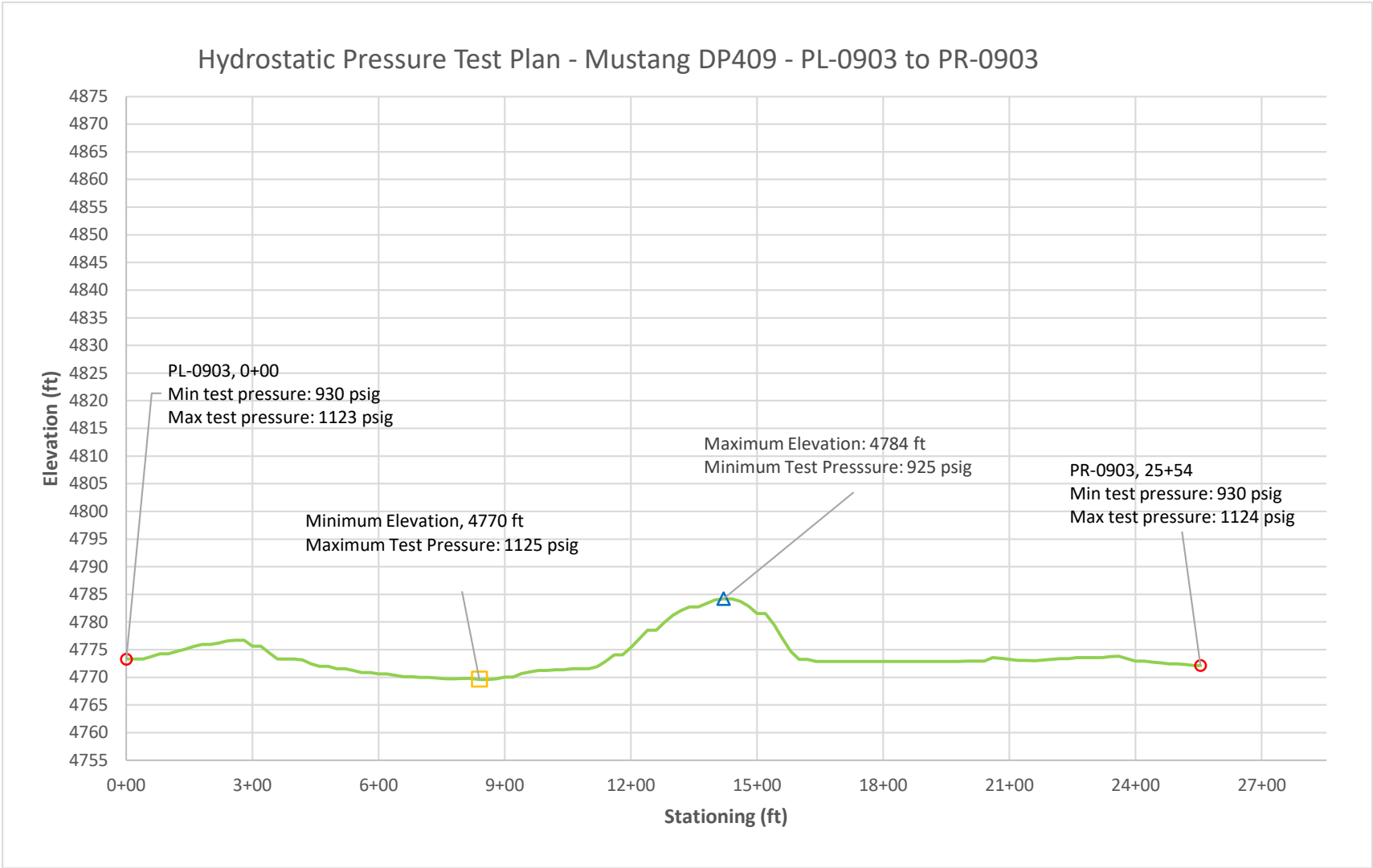
1.) See attached calculations for specific information on each test section.

Hydrostatic Pressure Test Plan - FlexSteel

Project:	Mustang DP409	By: SH
Client:	Noble Midstream Partners	Checked By: BE
Location:	Weld County, CO	Date: 12/12/2018
Segment:	PL-0903 to PR-0903	Revision: A

Design Criteria		Calculated values	
PW	Process Fluid	6.93	Outside Pipe Diameter (in)
750	FlexSteel Rating (psig)	5.60	Inside Pipe Diameter (in)
6	Pipe Nominal Diameter (in)	0.66	Wall Thickness (in)
740	MAOP (psig)	925	Min Test Pressure (psig)
1.25	Hydrotest design factor	1125	Max Allowable Test Pressure (psig)
300	ANSI Fitting Rating	1500	Burst Pressure (psig)
Water	Test Medium	1.281	Water volume, gal/ft
8	Test Duration (hours)	2,554	Test section length (ft)
		3,272	Water volume (gal)

Test Pressure Summary						
	Station	Elevation	Minimum (Allowable)		Maximum (Allowable)	
			psig	% burst	psig	% burst
Begin	0+00	4773.29	930	62%	1123	75%
High	14+20	4784	925	62%	1119	75%
Low	8+40	4770	931	62%	1125	75%
End	25+54	4772.13	930	62%	1124	75%



# Hydrostatic Pressure Test Plan - FlexSteel

Project: **Mustang DP409**  
 Client: **Noble Midstream Partners**  
 Location: **Weld County, CO**  
 Segment: **PL-0906 to PR-0906**

By: SH  
 Checked By: BE  
 Date: 12/12/2018  
 Revision: A

Design Criteria		Calculated values	
PW	Process Fluid	9.12	Outside Pipe Diameter (in)
750	FlexSteel Rating (psig)	7.63	Inside Pipe Diameter (in)
8	Pipe Nominal Diameter (in)	0.75	Wall Thickness (in)
740	MAOP (psig)	925	Min Test Pressure (psig)
1.25	Hydrotest design factor	1125	Max Allowable Test Pressure (psig)
300	ANSI Fitting Rating	1500	Burst Pressure (psig)
Water	Test Medium	2.372	Water volume, gal/ft
8	Test Duration (hours)	5,067	Test section length (ft)
		12,020	Water volume (gal)

Test Pressure Summary						
	Station	Elevation	Minimum (Allowable)		Maximum (Allowable)	
			psig	% burst	psig	% burst
Begin	0+00	4772.20	930	62%	1125	75%
High	50+00	4783	925	62%	1120	75%
Low	8+80	4771	930	62%	1125	75%
End	50+67	4783.44	925	62%	1120	75%

