RRD-STA-18

TBC - GEOPHONE 1 WELL PRESSURE AND RELATED DATA

RECOMMENDED REQUIREMENTS DOCUMENT

Subject: **TBC-Geophone 1 Well Pressure and Related Data**

1.0 Background

The Blue Ribbon Commission (BRC) Stability Group has agreed to recommend that subsidence, seismic (both shallow and at depth), cavern pressure, and nearby cavern shape/size monitoring, were deemed suitable ongoing metrics for evaluation of current and future stability of the impacted area near Bayou Corne. This Recommended Requirements Document (RRD) defines the technical requirements for obtaining data from the Geophone 1 micro-seismic well to address this overall objective. The intent of this RRD is to provide recommended requirements for use by the appropriate state agencies when directing the development of a comprehensive work plan for addressing the RRD objective.

This RRD for collecting data from the Geophone 1 Well has been prepared with consideration of the following site conditions as reported by the Louisiana Department of Natural Resources field drilling inspector and from the various geophysical logs run on the borehole and well:

- Drilling for the Geophone 1 Well was initiated on May 24, 2013 and completed on June 9, 2013. The borehole was directionally drilled to a depth of approximately 3,192 feet (measured depth) and the borehole was cased through the overlying sedimentary units including the cap rock to a depth of 902 feet measured depth. The bottom of this casing is within the salt.

- Below the surface casing the well was drilled to the total depth using salt drilling methods. Three 60-foot core samples were collected from three different depths in the borehole for geomechanical testing.

- Upon completion of drilling and logging, the borehole was filled with 10-pound saturated brine with standard control valves at the surface.

- Numerous electric logs were completed by Baker-Hughes on the borehole and well casing, including Hexagonal Caliper Log; Gamma Ray Log, DSL Composite, Geo XMAC Composite Log , X-Multipole Array Acoustilog; Compensated Z-Densilog; Compensated Neutron Log, Digital Spectralog, and Diplog, and Segmented Bond Log.

- Following installation of the wellhead, a pressure gauge was installed on the well for monitoring wellhead pressure. An initial wellhead pressure of 200 pounds per square inch (psi) was recorded on June 18, 2013 at which time an unknown volume of gas was bled off down to a wellhead pressure of 0 psi. According to Texas Brine Corporation (TBC) field manager, the gas flow rate and flow volume were not recorded during this venting event. By 10:00 AM on June 20 the wellhead pressure increased to 270 psi and continued to increase to 380 psi on June 25. At

9:30 AM on June 26 the pressure was 375 psi and by 2:30 PM the pressure had dropped to 290 psi. The most recent pressure as of the writing of this document was 350 psi measured on June 28, 2013.

- On Tuesday, July 2, 2013, the well was again vented to the atmosphere but gas flow rate and volume were not recorded. Then TBC field inspector did report that the venting took approximately 30 minutes through the needle valve mounted on the wellhead. The verbal field report was that the venting was all gas with no brine produced. The well was vented down to zero psi wellhead pressure. As of July 7, 2103 at 0900, the wellhead pressure had recovered 215 psi.

- A sample of gas vented from the well on June 27, 2013 was collected for laboratory analyses for TO-15 (volatile organics) plus tentatively identified compound (TICs), Light Hydrocarbon Gas and Sulfur, NG-3 Analysis (gas composition and isotopes). This data should provide information concerning the source of the gas that is accumulating in the well.

- Initially, TBC indicated the well was experiencing pressure due to closing of the well bore (salt creep) and that the occurrence of pressure in the well was not unexpected. The BRC Commissioners were informed of the measured wellhead pressures to provide feedback on the well conditions and potential concern related to the well conditions. Based on the BRC's feedback, it was agreed that additional data was needed to monitor and evaluate the Geophone 1 Well conditions with respect to the intended use of the well for the pending installation of the geophone seismic array.

This RRD has been prepared as part of the overall STA-04 BRC task. This BRC task addresses the need for additional data to assess the potential concerns related to the installation and operation of the geophone due to the elevated pressure and presence of gas in the well. This RRD establishes the procedures and equipment required to collect these data.

2.0 Objective and Requirements

The objective of this RRD is to provide additional data from the Geophone 1 Well for:

- Assessing, monitoring, and evaluating conditions for the pending installation of the geophone seismic array.
- Identifying potential issues that could interfere with short and long term operation and maintenance of the geophone seismic array.
- Identifying potential mitigating measures for the identified issues to allow for the proper installation and operation of the seismic array based on the well conditions.
- Provide critical deep data on the stability of the Napoleonville Salt Dome in this area.

3.0 Requirements

The requirements for obtaining additional data from the Geophone 1 Well are:

1. Monitoring continuous wellhead pressure and bottom-hole pressure in the well.
2. Measuring the volume of gas that is accumulating in and vented from the well.
3. In the event that the pressure in the well is reduced to zero wellhead pressure, the well should be filled with 10 pound brine to the surface. The volume of 10 pound brine pumped int the well should be recorded.
4. Sampling the gas to determine composition with respect to the source of the gas.
5. Perform additional geophysical logging or processing of the borehole to determine borehole conditions and evaluate reasons for the pressure increases.

Appendix 1 presents suggested procedures for data collection to meet the above objective and requirements. These procedures can be modified or replaced as appropriate to meet the objectives and requirements.

APPENDIX 1

SUGGESTED GEOPHONE-01 MONITORING PROCEDURES

1.0 Introduction

This **Appendix 1** is intended for use as a procedural reference for obtaining the data required in the RRD. The procedures in this section have been used by one or more Blue Ribbon Commissioners to obtain or generate the data specified in Section 3.0 of the RRD. In preparing the work plan to address this RRD, other procedures can be used provided the objectives and data requirements in Sections 2 and 3 are met.

2.0 Contract Services

2.1 Geophysical Logging

A geophysical logging contractor will be required to obtain the borehole data recommended in this RRD. All logging activities should be completed in accordance with standard industry practices and comply with the applicable regulations.

2.2 Analytical Services

Laboratory analytical services will be necessary to provide analyses of gas samples for gas constituent concentrations, composition, and isotopic characteristics.

3.0 Specialized Field Equipment

3.1 Gas Flow Meter

A gas flow meter should be installed on the vent line from Geophone-01 so that cumulative gas flow total can be determined for each flaring event. To obtain data on gas inflow in the well, the venting should occur once per week.

For measuring the volume of gas vented form the Geophone 1 Well, a flow meter or proper recording differential pressure gauge can be placed across an orifice plate or a temporary mass flow meter can also be used. Flow meters currently installed on numerous wells at the site are Barton Flow Meters Model 202E, the specifications of which are included in **Attachment 1**. The selected flow meter should be appropriate for that range of differential pressures being measured across the orifice plate. The accuracy of the Barton meters is ±0.5% of the full-scale differential pressure range. The flow meter should be equipped with a 24-hour clock to provide continuous pressure readings (or at a minimum of every 10 seconds).

These are differential pressure flow recorders that work in conjunction with a standard orifice plate installed in the flow line. It is important that the Barton meter springs and other settings be set up for the range of differential pressures being monitored across the orifice plate. Spring rates for the Barton meters range from 0 to 34 psi up to 0 to 7,200 psi differential pressure.

3.2 Wellhead Pressure Instrumentation

A pressure gauge is currently mounted on the wellhead of the Geophone 1 Well to allow for periodic pressure observation of wellhead pressures. A pressure recording instrument should be installed on the

wellhead to provide continuous readings based on the pressures observed or expected in the well. A pressure transmitter similar to what is installed on OG-3A is adequate. Wellhead pressures should be recorded at a 10 second frequency.

3.3 Down-hole Pressure Transducer

A down-hole quartz or similar high-pressure transducer should be installed at the bottom of the well to provide direct measurements of the bottom-hole pressure. For the bottom-hole pressure data, pressures should be recorded on a 10-second basis but more frequent data may be necessary depending on the observed responses. Based on estimated pressure at the bottom of the borehole, the range of the transducer should be a minimum of 0 to 3,000 psi.

3.4 Geophysical Logging and Processing

A number of geophysical logs have been run on Geophone 1 Well. It is recommended that these logs be processed by a qualified petrophysicist to identify potential fracturing and anomalous zones in the salt that may explain the gas pressures being observed. At a minimum, it is recommended that a fluid density-pressure-caliper log be run on the borehole to identify the depth of the gas-brine interface, the existing fluid density in the borehole and to determine if there has been any observable changes in borehole diameter that could account for the pressure build up.

4.0 Definitions

The following definitions are applicable to this appendix:

- *Wellhead pressure:* Pressure at the wellhead, which can be affected by the presence of a gas column in the brine-filled well.
- *Bottom-hole pressure:* Pressure at the bottom of the well, which will represent the true bottom-hole pressure with or without the potential presence of a gas column in the well.

5.0 Procedure

The recommended pressure monitoring, gas volume measurements, gas composition analyses, and borehole geophysical logging should be performed consistent with the following recommendations. The data recommended below should be collected until the permanent micro-seismic geophone array is installed and cemented into the borehole.

5.1 Monitoring of Wellhead and Bottom-Hole Pressures

Wellhead pressure instrumentation should be installed such that it is equipped with continuous reading capability (at a minimum frequency of every 10 seconds) and can provide accurate readings based on the actual pressure ranges observed or expected at the well. Additionally, a pressure transducer should be installed to the bottom of the well to record bottom-hole pressure measurements at a frequency of every 10 seconds.

5.2 Measurement of Gas Volume

As gas is vented from the well weekly, the volume of gas vented should be measured during each venting event with the flow meter or differential pressure gauge placed across the orifice plate. Daily and cumulative total gas volume vented should be recorded and reported.

5.3 Replacement Brine

If the pressure in the well is reduced to zero psi wellhead pressure, the well should be filled with 10 pound brine to the surface. The volume of 10 pound brine pumped into the well should be recorded and reported to DNR..

5.4 Gas Composition Analyses

Gas vented from the wellhead of Geophone 1 Well was sampled on June 27, 2013 for laboratory analyses for: TO-15 (volatile organics) plus TICs, Light Hydrocarbon Gas and Sulfur, NG-3 Analysis (Gas composition and Isotopes). Additional gas samples should be collected every 2 weeks until the geophone array is installed. Standard and proper gas sampling techniques should be used for the collection of representative gas samples from the well on an as needed basis.

5.5 Borehole Geophysical Logging

A caliper/pressure/density geophysical log should be completed every 2 weeks to monitor the borehole for changes. Logging procedures should be completed in accordance with standard industry practices.

5.6 Submittal of Data

All pressure monitoring, gas volume measurements, gas composition analyses, and borehole geophysical logging should be documented and reported to LDNR in an electronic format once per week or as specified by LDNR directives. All data, as applicable, should be submitted in PDF and Excel or similar electronic data transfer format.

6.0 Attachments

- ***Attachment 1***— Barton Differential Pressure Recorder Specifications Model 202E

ATTACHMENT 1

BARTON MODEL 202E SPECIFICATIONS

BARTON®

Chart Recorders

Models 202E, 202N, 242E, and J8A

Barton chart recorders are the industry standard for accurate, reliable measurement and recording of pressure, differential pressure, and temperature in a wide variety of applications. In addition, DP models utilize Barton's rupture-proof bellows DPU as the actuating unit – with features like overrange protection and pulsation dampening (on some models).

Common Components

- **Case** – is made of rugged, lightweight die-cast aluminum that features a built-in rain-shield. It is finished in polyurethane electrostatic powder paint that has a high resistance to weathering, scratches, and industrial fumes. aircraft-type door hinge (made of 302 SST) provides excellent resistance to salt spray and H_2S. A closed neoprene gasket, non-absorbent to fluids and resistant to oils and most solvents, provides the seal between the door and the case.
  - Optional "S" versions use a stainless steel case or a corrosion resistant "offshore coating" for harsh saltwater environments.
- **Chart Drive** – Available in battery and spring-wound versions with a wide variety of chart speeds. All chart drives, with simple positive chart lock hub, are interchangeable.
- **NuFlo™ Charts** – are made from "woodfree" paper – a special low shrinkage high quality product that eliminate eccentric and elliptical errors. Charts are shrink wrapped to help maintain the factory default size until it is opened by the user. Once a box of charts is opened, it can be stored in the supplied plastic re-sealable storage bag.
- **Recording Mechanism** – All parts are stainless steel for long life. The pen mount is exceptionally rugged and pen shafts are fitted with ball pivots to minimize friction. All links are adjustable, with micrometer adjustments for accurate calibration. All adjustments have screwdriver slots to simplify calibration. Disposable pens are standard.
- **Pressure Elements** – Used in Models 202E, 242E, and J8A are precision wound helical-type available in a variety of materials – pressure ranges from 0-30-in. mercury vacuum (0 - 14.7 psi/1 bar) to 0 - 30,000 psi (0 - 2,068 bar). The Model 202N uses a K-Monel element – pressure ranges from 0 - 250 psi (0 - 17 bar) to 0 - 6,000 psi (0 - 414 bar). Connections available in 1/4-in. NPT for ranges less than 10,000 psi (689 bar). Ranges greater than 10,000 psi (689 bar) utilize an Aminco 9/16–18 (1/4-in. ODT) female connection.
- **Thermal Systems** – Consist of a bourdon tube, a capillary with stainless steel armor, and a bulb with a bendable extension. All parts are stainless steel. Systems are available in Class V (mercury fill with an 11/16-in. OD bulb) or Class I (hydrocarbon fill w/ a 3/8-in. OD bulb). Temperature ranges for each design are listed below. A thermal system must have a span of more than 50°F (27°C) and the high temperature limit must be greater than 95°F (35°C).
  - **Class VA** (fully compensated) -40° to 600°F (-40° to 315°C)
  - **Class VB** (case compensated): -40° to 600°F (-40° to 315°C)
  - **Class IA** (fully compensated) – temperature range varies with fill material
    - ethyl-benzene, -125° to 350°F (-87° to 177°C)
    - kerosene, -20° to 500°F (-29° to 260°C)
    - alcohol, -200° to 150°F (-129° to 66°C)
  - **Class IB** (case compensated) - temperature range varies with fill material
    - ethyl-benzene, -125° to 350°F (-87° to 177°C)
    - kerosene, -20° to 500°F (-29° to 260°C)
    - alcohol, -200° to 150°F (-129° to 66°C)
  - **Accuracy**: +/- 1.0% of F.S.
  - **Hardware**: Capillary standard length is 10 ft. (additional lengths available)

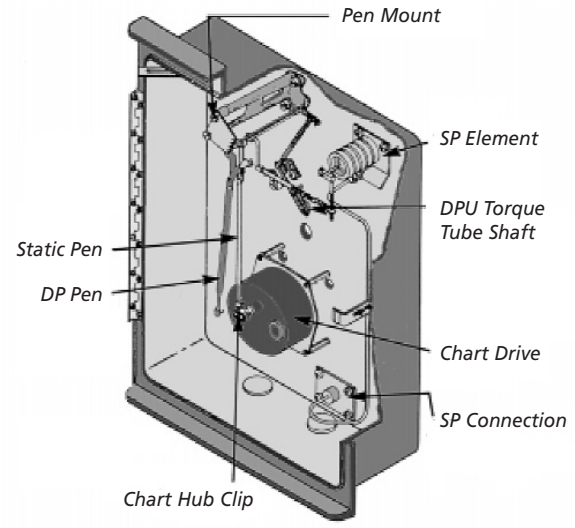
Models 202E (DP)

The 202E is a 12-in. chart recorder that has been widely used in gas transmission and distribution fields – accurate calibration, even under extreme variations in static pressure and ambient temperatures.

The 202E is available in 1 to 4 pen configurations (DP+3 additional pens). The additional pens can be used to record temperature and supplemental pressure data.

The unit is actuated by a Barton Model 199 DPU, with standard and NACE units available (up to 4,500 PSI/310 bar SWP) – see DPU bulletin #21700 for details. Static pressure and temperature pens are actuated by precision wound elements (see page 1).

Main Components



Specifications

Safe Working Pressure:	up to 6,000 PSI (414 bar)
DP Ranges	0-10-in. w.c. to 0-100 PSID (0-25 mbar to 0-6.9 bar)
Accuracy	+/- 0.5% F.S.
Temperature Limits	-40°F/°C to +180°F (+82°C)

Model 202N (DP) (NACE)

The 202N is a 12-in. chart recorder designed to measure flow, static pressure, and temperature in sour gas applications. The 202N meets all NACE requirements for H2S environments, per MR-01-75 (1991 Revision) – SWP up to 2,000 PSI (138 bar).

For ranges between 2,000 PSI (138 bar) and 4,500 PSI (310 bar), see optional NACE version of M202E.

The 202N is actuated by Barton's M199 NACE DPU. Static pressure measurements are provided by precision wound K-Monel helical-type elements.

- All other features and benefits are the same as the 202E.

Specifications

Safe Working Pressure:	up to 2,000 PSI (138 bar)
DP Ranges	0-10-in. w.c. to 0-100 PSID (0-25 mbar to 0-6.9 bar)
Accuracy	+/- 0.5% F.S.
Temperature Limits	-40°F/°C to +180°F (+82°C)

Model 242E (Temperature/Pressure)

The 242E is a 12-in. chart temperature and pressure recorder designed for general pressure applications.

Specifications

Pressure Element Range	up to 30,000 PSI (138 bar)
Accuracy	+/- 1.0% F.S.
Temperature Limits	-40°F/°C to +180°F (+82°C)

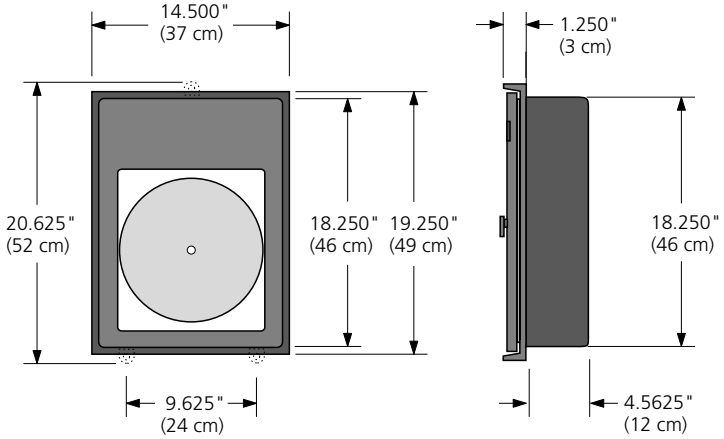
Model J8A (Temperature/Pressure)

The J8A is a compact 8-in. chart Temperature and Pressure Recorder designed for general pressure applications. Available as a single or dual pen unit, it can use any combination of pressure measuring helical elements or temperature measuring thermal systems.

- **Pressure Elements** – Same as those supplied for 12-in. recorders, with pressure ranges from 0-30-in. Hg to 30,000 psi (0-14.7 psi/1 bar to 2,068 bar).
- **Case** – A smaller version of the 242E, the J8A case is 3/16-in. thick, with a closed cell neoprene gasket. The standard door comes with an 8-in. square piece of glass, Plexiglas (Lexan), or 16-gauge steel plate for solid door applications.
- **Overall dimensions of standard unit** – 10.5-in. wide x 13.75-in. tall x 4 5/8-in. deep.

Recorder Dimensions

Overall case dimensions for Models 202 and 242:



Recorder Weights

	202E / 202N					
	Forged Steel			Forged SST		
Ind. Model	2500	4500	6000	1000	3000	6000
Safe Working Pressure (psi)	68 (31)	69 (31)	71 (32)	59 (27)	69 (31)	71(32)

The M242E or J8A gross weight is approx. 25 lbs (11 kg). For SST "S" versions, add 10 lbs (6 kg) to standard weights.

Mounting Options

- Panel
- Wall
- Pipe mount, slip-on, non-thread (1-1/2-in. or 2-in. std. pipe)
- Portable stand, with handle
- Wall shock-mounting kit

Ordering

When ordering recorder, please specify the following items:

- Model Number
- Housing Pressure Rating (SWP) (DPU models)
- Housing and Bellows Materials (DPU models)
- Process Material Contacting Bellows (DPU models)
- Differential Pressure Range (DPU models)
- Pressure Elements (range, material)
- Pens (disposable)
- Chart Drive (type and rotation)
- Thermal Systems (range, capillary length, class)
- Mounting (pipe, wall, flush panel, portable or shock mount)
- Charts

MEASUREMENT SYSTEMS

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