# RRD-GAS-03

# OBSERVATION/RELIEF WELL (ORW)

# OPERATIONAL DATA

# RECOMMENDED REQUIREMENTS DOCUMENT

***Subject:*** **Observation/Relief Well (ORW) Operational Data**

## *1.0 Background*

The Blue Ribbon Commission (BRC) Gas Group has agreed to recommend that reducing and maintaining methane gas formation pressures in the Mississippi River Alluvial Aquifer (MRAA) to equal to or less than hydrostatic pressure across the Bayou Corne gas area is necessary in order to lift the mandatory evacuation order (**Figure 1**). This Recommended Requirements Document (RRD) defines the technical requirements for obtaining ORW operational data 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 upgrading the ORW operational data has been prepared with consideration of the following site conditions and existing ORW monitoring program:

- Limited available data indicated that formation gas pressure in the MRAA is slightly greater than hydrostatic pressure. For example, at ORW-02 where a contemporaneous wireline log confirmed that the water level was below the perforations, the shut-in wellhead pressure was 64 pounds per square inch (psi). Based on the top of perforations depth of 126 feet, the hydrostatic pressure at this location is slightly over 54 psi (assuming a water density of 1001.4 kilogram/cubic meter). At recently installed ORW-36, the wellhead pressure was 56 psi compared to a calculated hydrostatic pressure of 54 psi based on the top of perforations at 124 feet and an *assumption* that there was no water in the well above the perforations.
- Barton continuous chart recording gas flow meters are currently installed on 10 ORWs (**Table 1**). It is uncertain at present how these data are being managed or utilized.
- For the other ORWs, instantaneous flow rate data are currently being collected once per day and these data are extrapolated to obtain the daily cumulative daily flow total. These data are not sufficient to allow for the temporal analysis of flow rates resulting from changing site conditions or operational changes at nearby ORWs.
- There are Track-It pressure recording devices installed on the orifice plates of many of the ORWs. The records from the Track-it units have not been reported to Louisiana Department of Natural Resources (LDNR). It is uncertain if the accuracy of these instruments is adequate to record the differential pressures across the orifice plates attached to ORW vent lines. The accuracy of the Track-it instruments is ± 1% of full-scale range. For a 150 psi Track-It, this correlates to an accuracy of ±1.5 psi. Using a 0.5-inch orifice plate, this translates into a flow accuracy of ±7.5 MCF/D; using a 0.25 orifice plate, the accuracy would be ±2 MCF/D.
- Because the Track-It units have no external pressure display, it is not possible for LDNR inspectors to independently assess the reported flow rates.

- Wellhead pressures are currently being monitored using a pressure gauge with manual daily readings.
- Given that water levels are not collected in ORWs it is not possible to confirm that wellhead pressures are representative of gas formation pressures in the MRAA
- Some of the ORWs are configured as simple driven cased and perforated wells as shown on **Figure 2**. This was the design used as the initial configuration of all ORWs. The first five ORWs were installed using perforated standard driven casing that were subsequently cleaned out using coiled tubing units. Subsequently, the ORWs have been installed using sonic-vibrated casing and high pressure fluid to force the cuttings outside the casing into the surrounding formations.
- In January 2013, the plan proposed by Tetra Tech was to install self-controlling air auto-pumps inside of two-inch tubing to maintain a constant water level elevation in each ORW. With this well operational configuration, the wellhead pressures would always be equal to the formation pressures and thus it is not necessary to have water level or formation pressure monitoring instrumentation. Two-inch tubing with a sand pack in the annular space (**Figure 3**) has been installed in numerous wells (**Table 1**).
    - Auto-pumps were proposed in-lieu of the recommendation by LDNR to install pressure transducers in each ORW to provide for direct measurement of formation pressures.
    - LDNR agreed to this proposal.
    - The proposed auto-pumps are not installed in the ORWs but bladder pumps have been used in selected ORW wells to remove water. Based on field records, these pumps are operated manually to lower water levels in the wells on a periodic basis. Currently the volumes of water removed from each ORW have not been provided to LDNR.

This RRD is prepared as part of the overall GAS-05 BRC task. This BRC task addresses the need for improved flow and pressure monitoring data from the gas venting operations in MRAA and aquitard for use in quantitative evaluations of gas migration and mitigation. The quantitative evaluation requirements are addressed in other RRDs. This RRD establishes the procedures and equipment required for these data.

## *2.0 Objective and Requirements*

The objective of this RRD is to upgrade the gas flow-rate, wellhead pressure, and water level operational monitoring data from existing and any newly installed ORWs.

The requirements for obtaining ORW gas flow-rate, wellhead and formation pressure, and water level data consistent with this RRD are:

- Accurate and consistent gas flow-rate data at each ORW are necessary for assessing the daily and cumulative volume of gas recovered/flared from each well. Flow rate data should be recorded continuously (24-hours per day) at each well location.
- Wellhead pressure data are necessary at each ORW for proper operation of the well choke and to determine when maintenance is required. Shut-in pressures demonstrate overall

effectiveness of venting operations. Once the overall pressure reduction objective is achieved, the wellhead pressure in an area of successful venting should be zero as water completely displaces gas in the well. Flowing (well is venting/flaring gas) or static (well is shut-in) pressure measurements should be recorded on a frequency of at least once per day at each ORW.

- Formation pressures are required across the gas area to provide data necessary for mitigation design and evaluations, modeling, and determination of venting progress towards the overall goal of reducing and maintaining gas pressure to below hydrostatic. Pressure gage/pressure transducers should be selected to measure (gage) pressures up to 75 psi with an accuracy of 1% or less of full-scale range.
- Data generated as part of ORW operations should be documented and submitted to the LDNR on a daily basis.

These data are necessary for the following gas mitigation-related activities:

- Evaluating individual and overall ORW vent well performance in reducing gas pressure in the MRAA and overlying aquitard.
- Determining when maintenance of the wells is required
- Performing gas migration and mitigation modeling and quantitative assessments
- Evaluating when the pressure reduction overall objective has been met below the Bayou Corne and Grand Bayou communities.
- Determining gas formation pressures over time across the gas area.

**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 PROCEDURES

# 1.0 Introduction

This appendix 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 2.0 of the RRD. Key elements to meeting the objective are the installation.

# 2.0 Specialized Field Equipment

To obtain the necessary data, flow meters, pressure gauges, and water level monitoring devices or pressure transducers are required.

## 2.1 Flow Meters

Flow meters currently installed on numerous wells are Barton Flow Meters Model 202E, the specifications of which are included in **Attachments 1A and 1B**. These are differential pressure flow recorders that work in conjunction with a standard orifice plate installed in the flow line. The differential pressure is used with the orifice coefficient to determine gas flow rate. 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 plates. If the orifice plate differential pressure is too low for a given meter setup, then the setup should be modified so that accurate flow data can be obtained. Spring rates for the Barton meters range from 0 to 34 psi up to 0 to 7,200 psi. If these spring rates still will not yield accurate flow data, then a low-range water level column differential pressure recorder may be necessary for flow measurements.

Flow meters installed on the flowing ORW wells 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.

It is not necessary to install flow meters on shut-in ORWs if they are not being used for flaring operations.

## 2.2 Pressure Gauges

Pressure gauges are currently mounted on the wellhead at each well. These allow for daily pressure observation of wellhead pressures. The range of each pressure gauge should be recorded in the ORW operational data and reported the LDNR.

## 2.3 Water Level Measurement Devices

Water level measurement equipment is needed that can provide accurate and reliable depth to water in the wells on a continuous and/or periodic basis for calculating formation pressures. Traditional methods of measuring water level with a steel or electric tape cannot be used because of the gas pressures in the wells. During the startup of the ORW-01 through ORW-04 wells, wireline cable tension data were used

to determine water levels before and after water level removal operations. This is not a viable method for long-term monitoring because the expense and time required.

TBC has proposed using acoustic echo-sounders to monitor water levels in the ORWs but the recent comments on the gas venting radius of influence procedures indicate that the data from the echo sounds has been found to not be reliable. Pending the outcome of this analysis, these devices may be sufficient for calculating formation pressures providing they have sufficient water level accuracy and precision. One unresolved issue with the echo sounders is how they will be configured in wells under pressure.

The precision and accuracy of the echo-sounders needs to be established prior to full deployment. The reason is that acoustic water level devices may not be sufficiently accurate to reflect the small formation pressure changes that potentially may be occurring as a result of venting operations. The simplest way to document the precision and accuracy of the echo-sounder is to install a conventional recording pressure transducer in a well and comparing those results over a 48-hour period with the echo sounder results from the same well. The transducer and echo sounder should compare to within 0.05-foot or less over 48 hours (equivalent to 0.02 psi). The procedure for confirming the precision and accuracy of the echo-sounders should be documented in the TBC work plan.

Because the density of the MRAA groundwater is variable, if water level data are used to calculate formation pressures, water density data are also required.

### *2.4 Pressure Transducers*

Downhole recording pressure transducers eliminate the need for calculating formation pressures by directly measuring formation pressures in the well perforations. A transducer is installed at the same depth as the ORW perforations and records pressures of a predetermined schedule. For the ORW data, formation pressures on a 15-minute basis are probably sufficient but more frequent data may be necessary depending on the observed responses. **Attachment 2** presents examples of stand-alone downhole recording transducers and installation equipment for pressurized wells. Other vendors also provide similar recording transducers. Total pressure (non-vented) transducers are sufficient for this application as they are installed in a sealed system in the well not open to the atmosphere.

## *3.0 Definitions*

The following definitions are applicable to this appendix:

- *Formation pressure:* Pressure in the gas interval in the geologic horizon of interest. This can be measured directly in the well perforations or calculated from the wellhead pressure and the water level in a well.
- *Wellhead pressure:* Pressure at the wellhead. Wellhead pressure is a combination of gas pressure in the well and the water level in the well. In a given well, as the water level rises, the wellhead pressure will decline.

# 4.0 Procedure

The implementation of the measurement of the gas flow-rate, static and flowing well pressures, and depth to water in the operating ORW wells includes the following recommended procedures. For measurement of water levels, three separate methods are recommended.

## 4.1 Routine Data

On a daily basis, for the flowing wells, the flow meter charts need to be changed and processed to determine total daily gas flow rate. Wellhead pressures should be manually recorded once per day on all wells. It is preferable that water levels in the well be obtained at the same time and frequency as the wellhead pressure data. However, it is acknowledged that the current wellhead configuration may prevent measurement of water levels in the wells. If the auto-pumps originally proposed are installed and made operational, the wellhead pressure will be equal to the formation pressure. This potential formation pressure data gap is partially addressed by RRD-09-MRAA Pressure Monitoring.

Currently water removal from the ORWs is being conducted on manual, intermittent basis. It is important that the tubing water levels are reported before and after pumping and the volume pumped from each well for each pumping event should be reported. It is currently uncertain if these data can be used to determine formation pressures but the water levels and pumping data will allow for assessing the hydraulic communication between the tubing and the gas formation.

## 4.2 Water Level Data

As defined in Section 3, formation pressures are required for a variety of current and long-term purposes. The current well configuration limits the options available for obtaining these data. There are two basic options to determination of formation pressures. The first option it to measure pressured directly in the perforated interval using pressure transducers. The second option is to measure wellhead pressure and water level in the well and then calculate the formation pressure.

There are currently three configurations of ORWs at the site—1) wells that have gas wellhead pressure but do not have tubing installed (**Figure 2**), 2) wells that have no tubing installed but have no wellhead pressure, and 3) wells that have the two-inch tubing installed (**Figure 3**). Separate formation pressure monitoring procedures are required for each type of well configuration.

### 4.2.1 Configuration 1—Direct Formation Pressure Measurements in Wells with Wellhead Pressure and No Tubing

Recording pressure transducers can be installed in these ORWs to provide continuous direct formation pressure data. The transducers can be installed using a simple pressure pass-through fitting shown in **Attachment 2** that will serve as a stuffing box allowing the transducer and cable to be lowered into the well. The pass-through should be installed when the cables are assembled by the vendor. The pass-through is attached to a short lubricator-type assembly so that the transducer, cable, and fittings can be installed on the wellhead while the master valve is closed. Once the wellhead assembly is set up, the

master valve is opened and the transducer lowered into the perforations. For safety purposes, the flow valve should be open while the transducer is lowered into the well. This will reduce pressure on the transducer pass-through during installation. Because the transducer cable will need to pass through the master valve, the transducer will have to be pulled up into the lubricator-type assembly before closing the master valve.

### 4.2.2 Configuration 2—Formation Pressure Determination in Wells with No Wellhead Pressure

These are the easiest wells to use for formation pressure determination because the only data that are needed are the water level and the density profile of the water in the well. Because of the potential for different total dissolved solids concentrations in the various ORWs, it cannot be assumed that all wells have the same water density nor can it be assumed that the density is constant in individual wells.

Water levels can be measured manually and a specific conductance profile on the well from the water level down to the perforations will allow for an estimate of the fluid density profile from the water level down to the perforation combined with one fluid density sample collected from the perforated interval. Formation pressure is calculated using the water level and the density determined at different depths in the well:

**Equation 1. Formation pressure calculated in well with variable density fluid.**

$$P_f = P_{atmosphere} + g \sum_{i=i}^{n} \rho_i \Delta z_i$$

$where$
$P_f = formation\ pressure\ in\ perforations$
$g = gravitational\ constant$
$\rho_i = water\ density\ between\ point\ i\ and\ i + 1, if\ the\ well\ has\ uniform\ density, that\ density\ is\ used\ in\ the\ formula$
$\Delta z_i = depth\ interval\ between\ point\ i\ and\ i + 1, if\ the\ well\ has\ uniform\ density, \Delta z = depth\ to\ ptop\ perforation - water\ level$

In-lieu of a conductivity profile and density water sample, a one-time measurement of pressure in the perforations using a pressure transducer combined with a manual water level can be used as a calibration data point for subsequent water level measurements.

### 4.2.3 Configuration 3—Formation Pressure Determination in Wells with Tubing

In wells that have tubing installed to below the ORW perforations, the water level in the tubing will reflect the formation pressure. By measuring water level in the tubing, Equation 1 can be used to calculate formation pressure in a well.

There is some indication from the recent sampling event that some of the wells with tubing do not have good hydraulic connection to the MRAA. Therefore, it is recommended that pneumatic slug tests (ASTM, 2006; Butler, 1997) be performed on each well with tubing before the data are used for calculation of formation pressures. If the calculated hydraulic conductivity is less than approximately 1 foot/day, consideration needs to be made that the perforations are clogged and the water level in the well does not reflect formation pressure. A hydraulic conductivity of 1 foot/day is consistent with the fine-grained sand at the top of the MRAA at ORW-04 (Hecox and Saxton, 2013).

### 4.3 Operation and Maintenance

It is recommended that routine operation and maintenance (O&M) of the pressure, flow rate, and water level measurement equipment be performed to maintain continuous operation and provide for acquisition of the accurate and reliable data. Maintenance documentation should be reported in the quarterly report.

### 4.4 Data Submittal and Reporting

It is recommended that all data (e.g. flow rates, pressures, water levels, formation pressures, and operation and maintenance records) continue to be submitted to the LDNR in an organized format once per day or as specified by LDNR emergency order amendments and associated directives.

It is also recommended that TBC submit operational quarterly reports to LDNR on ORW performance including the flow rates and formation pressure changes during the quarter, maintenance performed on the recommended equipment, water produced, and any work-over activities performed on the ORWs. The quarterly reports should be submitted within 30 days after the end of a quarter.

## 5.0 Attachments

- ***Attachment 1***— Barton Differential Pressure Recorder Specifications Model 202E
- ***Attachment 2***—Examples recording pressure transducers and high-pressure pass-through fitting

## 6.0 Forms

No forms are provided but it is recommended that forms be developed (if not already developed) for documenting and submitting the information.

## 7.0 References

ASTM, 2006, Standard Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers, ASTM D7242-06, ASTM International, West Conshohocken, Pennsylvania.

Butler, J. J., 1997, The Design, Performance, and Analysis of Slug Tests, CRC Press, 262 p.:

Hecox, G. R., and Saxton, D. C., 2013, Bayou Corne Sinkhole Status Report to Blue Ribbon Commission, Baton Rouge, LA, CB&I, 121 plus appendices p.:

# TABLE

# Table 1. Observation/Relief Well (ORW) Well Status

| Well | Status Date | Tubing Installed | Bladder Pump Installed | Flow Meter Installed | Choke (1/64") | Orifice (Inch) | Diff. (Inch WC) | Gas Flow Rate (MCF/D) | Cumulative Gas Flared (MCF) | SIWHP (PSI) | FWHP (PSI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ORW-01 | 5/29/2013 | Yes | No | Yes | 3 | 0.25 | NA | 0.19 | 1,098 | | 27.3 |
| ORW-02 | 5/29/2013 | Yes | No | No | 0 | 0.25 | NA | 0.00 | 1,682 | 4 | 0.0 |
| ORW-04 | 5/29/2013 | No | No | Yes | 3 | 0.25 | 6.52 | 3.97 | 754 | | 45.0 |
| ORW-05 | 5/29/2013 | No | | No | 0 | 0.25 | 0.00 | 0.00 | 1,026 | 0 | 0.0 |
| ORW-06 | 5/29/2013 | No | No | Yes | 3 | 0.25 | 2.00 | 2.17 | 873 | | 31.9 |
| ORW-07 | 5/29/2013 | Yes | No | No | 0 | 0.25 | 0.00 | 0.00 | 58 | 0 | 0.0 |
| ORW-08 | 5/29/2013 | Yes | No | No | 0 | 0.25 | 0.00 | 0.00 | 151 | 12 | 0.0 |
| ORW-09 | 5/29/2013 | No | No | No | 0 | 0.25 | 0.00 | 0.00 | 1,020 | 51 | 0.0 |
| ORW-10 | 5/29/2013 | No | No | No | 7 | 0.25 | 3.04 | 2.68 | 459 | | 11.0 |
| ORW-11 | 5/29/2013 | Yes | Yes | No | 0 | 0.25 | 0.00 | 0.00 | 112 | 6 | 0.0 |
| ORW-12 | 5/29/2013 | Yes | Yes | No | 2 | 0.25 | 0.21 | 0.71 | 60 | | 23.8 |
| ORW-13 | 5/29/2013 | Yes | Yes | No | 0 | 0.25 | 0.00 | 0.0 | 0.4 | 35 | 0.0 |
| ORW-14 | 5/29/2013 | No | No | Yes | 8 | 0.25 | 6.50 | 3.90 | 1,110 | | 42.8 |
| ORW-15 | 5/29/2013 | No | No | Yes | 10.5 | 0.25 | 3.08 | 2.74 | 1,347 | | 8.1 |
| ORW-16 | 5/29/2013 | Yes | No | No | 2 | 0.25 | 0.02 | 0.1 | 199 | | 31.3 |
| ORW-17 | 5/29/2013 | Yes | Yes | No | 2 | 0.25 | 0.04 | 0.14 | 60 | | 36.2 |
| ORW-18 | 5/29/2013 | Yes | Yes | No | 1 | 0.13 | 0.54 | 0.18 | 7.40 | | 49.4 |
| ORW-19 | 5/29/2013 | Yes | Yes | Yes | 2 | 0.25 | 0.25 | 0.38 | 150 | | 25.3 |
| ORW-21 | 5/29/2013 | Yes | No | No | None | | | | | 0 | |
| ORW-22 | 5/29/2013 | No | No | Yes | 3 | 0.25 | 2.00 | 2.17 | 937 | | 10.1 |
| ORW-23 | 5/29/2013 | Yes | Yes | No | 1 | 0.13 | 0.13 | 0.10 | 102 | | 48.0 |
| ORW-24 | 5/29/2013 | Yes | Yes | No | 2 | 0.25 | 0.29 | 0.81 | 207 | | 36.0 |
| ORW-26 | 5/29/2013 | No | No | No | 0 | 0.25 | 0.00 | 0.00 | 170 | 19 | 0.0 |
| ORW-27 | 5/29/2013 | Yes | No | No | None | | | | | 0 | |

## Table 1. Observation/Relief Well (ORW) Well Status

| Well | Status Date | Tubing Installed | Bladder Pump Installed | Flow Meter Installed | Choke (1/64") | Orifice (Inch) | Diff. (Inch WC) | Gas Flow Rate (MCF/D) | Cumulative Gas Flared (MCF) | SIWHP (PSI) | FWHP (PSI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ORW-28 | 5/29/2013 | Yes | Yes | No | 0 | 0.25 | 0.00 | 0.00 | 26 | 30 | 0.0 |
| ORW-29 | 5/29/2013 | Yes | Yes | No | 0 | 0.25 | 0.00 | 0.00 | 58 | 32 | 0.0 |
| ORW-30 | 5/29/2013 | Yes | No | No | 2 | 0.25 | 0.20 | 0.7 | 29.4 | | 26.1 |
| ORW-31 | 5/29/2013 | | | No | 1 | 0.25 | 0.04 | 0.15 | 5 | | 40.2 |
| ORW-32 | 5/29/2013 | Yes | Yes | No | 0 | 0.25 | 0.00 | 0.00 | 90 | 16 | 0.0 |
| ORW-33 | 5/29/2013 | Yes | | | None | | | | | | |
| ORW-36 | 5/29/2013 | No | No | Yes | 3 | 0.25 | 4.00 | 3.1 | 47 | | 49.0 |
| ORW-37 | 5/29/2013 | No | No | Yes | 2 | 0.25 | 1.96 | 2.18 | 20.14 | | 30.0 |
| TBC-RW-1 | 5/29/2013 | Yes | No | Yes | 4 | 0.25 | 7.00 | 3.78 | 3,151 | | 55.0 |

*Notes:*

| | |
|---|---|
| " | Inch |
| FWHP | Flowing wellhead pressure |
| MCF | Thousands of cubic feet per day |
| MCF/D | Thousands of cubic feet |
| PSI | pounds per square inch |
| SIWHP | Shut-in wellhead pressure |
| WC | Water column |

# FIGURES

## Legend

- Sinkhole Location
- Surface bubble site
- Seismic shothole bubble site
- CPT
- Proposed CPT
- Flare
- Installed Observation/Relief Well
- Proposed Observation/Relief Well
- Borehole Seismic Station
- Microseismic Station
- Surface Seismic Station
- Proposed Geophone Well Alignment
- Industrial Water Well
- Geoprobe/Monitor Well
- Pressure Monitor Well
- MRAA Monitor Well
- Cavern Well
- Surface Water Site
- Berm
- Known Gas Area
- 1000' Top of Salt Contour Line
- Other Caverns
- Oxy #3
- Calculated Unstable Area
- Modeled Disturbed Rock Zone

N

0 1,000 2,000

Feet

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

BAYOU CORNE/NAPOLEONVILLE SALT DOME EMERGENCY RESPONSE

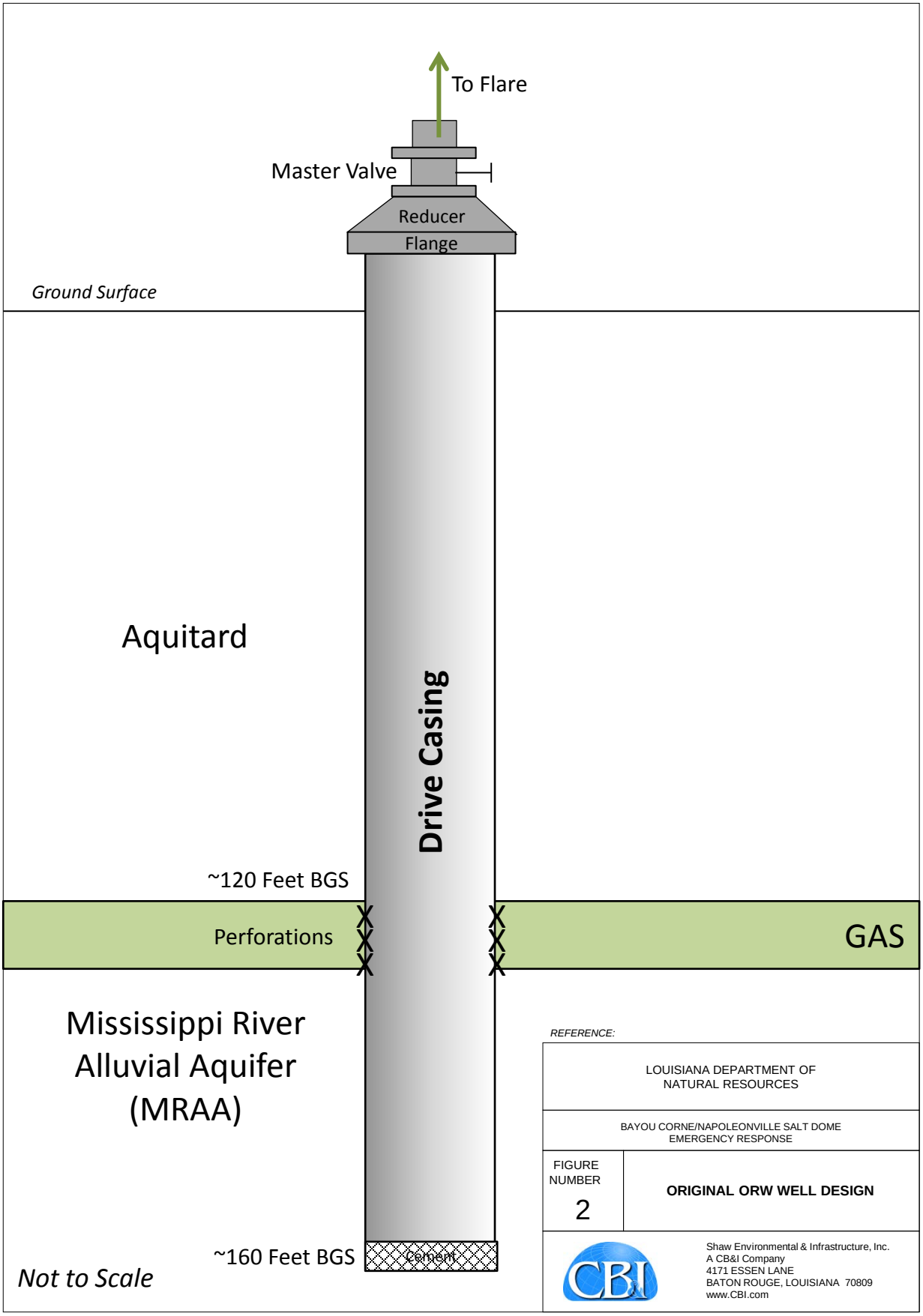
FIGURE NUMBER 1

**ACTIVE SITES**

Shaw Environmental & Infrastructure, Inc.
A CB&I Company
4171 ESSEN LANE
BATON ROUGE, LOUISIANA 70809
www.CBI.com

Service Layer Credits:

G:\LDNR_Bayou_Corne\GIS_Documents\Project_Maps\BRC_Maps\BRC_RRD_003_Active_Sites.mxd; Analyst: ben.holt; Date: 6/8/2013 3:48:40 PM




REFERENCE:

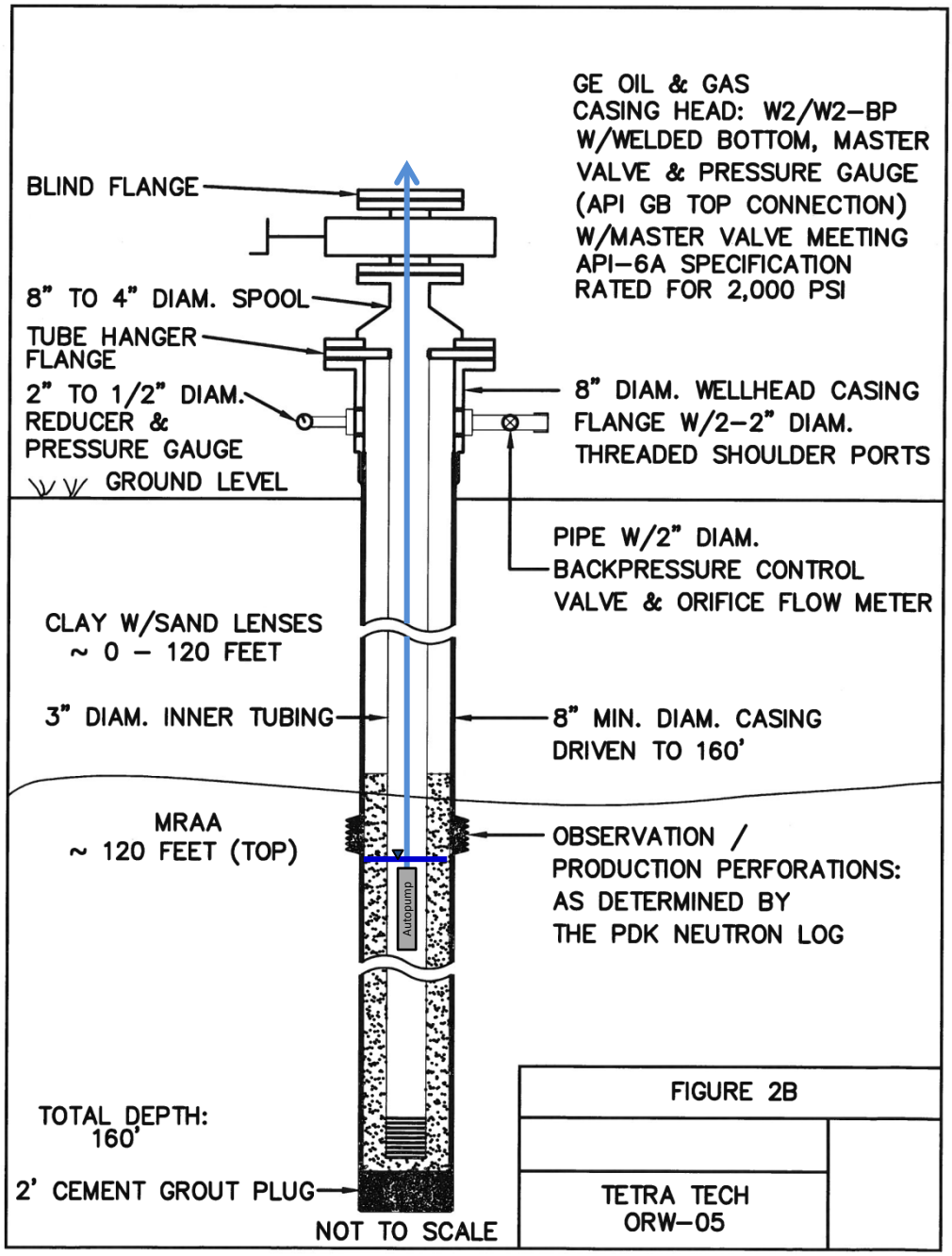
LOUISIANA DEPARTMENT OF
NATURAL RESOURCES

BAYOU CORNE/NAPOLEONVILLE SALT DOME
EMERGENCY RESPONSE

FIGURE NUMBER 2

**ORIGINAL ORW WELL DESIGN**

Shaw Environmental & Infrastructure, Inc.
A CB&I Company
4171 ESSEN LANE
BATON ROUGE, LOUISIANA 70809
www.CBI.com




*REFERENCE: TETRA TECH WORK PLAN*
*ADDITIONAL GROUNDWATER OBSERVATION/VENT WELLS*

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

BAYOU CORNE/NAPOLEONVILLE SALT DOME EMERGENCY RESPONSE

| FIGURE NUMBER | TETRA TECH MODIFIED OBSERVATION RELIEF WELL DESIGN |
|---|---|
| 3 | |

Shaw Environmental & Infrastructure, Inc.
A CB&I Company
4171 ESSEN LANE
BATON ROUGE, LOUISIANA 70809
www.CBI.com

# ATTACHMENT 1

# BARTON DIFFERENTIAL PRESSURE RECORDER SPECIFICATIONS MODEL 202E

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)

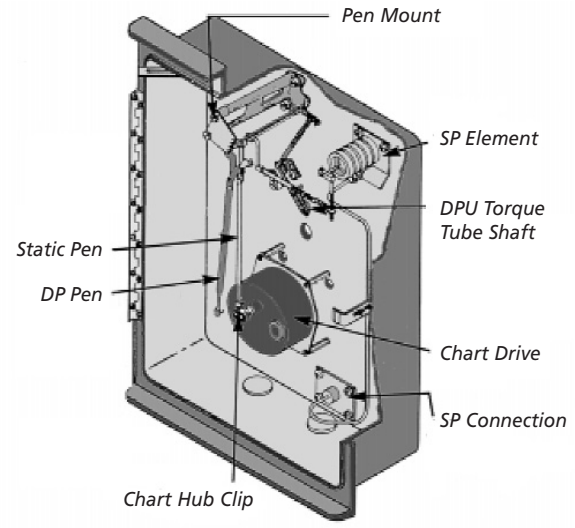
## Models 202E (DP)

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<br>(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<br>(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) |

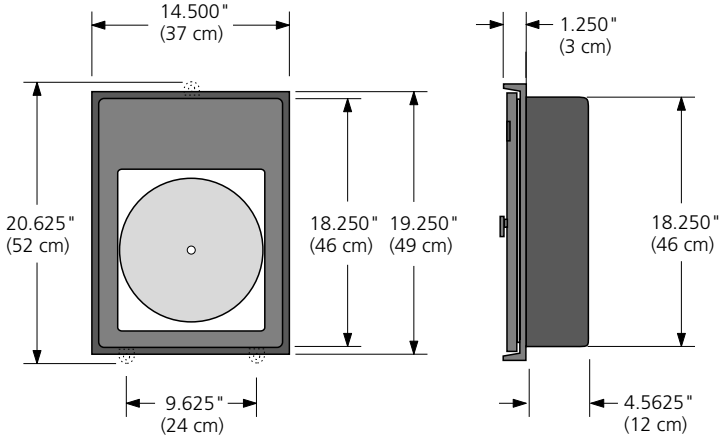
## Model J8A (Temperature/Pressure)


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

HOUSTON HEAD OFFICE | 281.582.9500
NORTH AMERICA | 1.800.654.3760 | ms-us@c-a-m.com
ASIA PACIFIC | +603.5569.0501 | ms-kl@c-a-m.com
EUROPE, MIDDLE EAST & AFRICA | +44.1243.826741 | ms-uk@c-a-m.com

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www.c-a-m.com/flo

# •ATTACHMENT 2

# EXAMPLES RECORDING PRESSURE TRANSDUCERS AND HIGH-PRESSURE PASS-THROUGH FITTING

In-Situ Inc.

Innovations in Water Monitoring

# Level TROLL® Instruments

## Water Level Instruments for Every Application & Budget


### Level TROLL® 700 Instrument

- Optimized for aquifer characterization
- Gauged (vented) and absolute (non-vented) instruments
- Linear, fast linear, linear average, event, step linear, and true logarithmic logging modes
- Rugged titanium probe and sensor (OD: 1.83 cm; 0.72 in)

### Level TROLL® 500 Instrument

- Ideal for groundwater and surface-water monitoring
- Gauged and absolute instruments
- Linear, fast linear, and event logging modes
- Durable titanium probe and sensor (OD: 1.83 cm; 0.72 in)

### Level TROLL® 300 Instrument

- Suitable for fresh water and industrial monitoring
- Absolute instrument
- Linear, fast linear, and event logging modes
- Stainless steel probe and sensor (OD: 2.08 cm; 0.82 in)

### Powerful, Accurate, Reliable Performance

- **Superior accuracy**—For guaranteed accuracy under all operating conditions, instruments undergo extensive calibration procedures for pressure and temperature. Each instrument includes a serialized calibration report.
- **Telemetry and SCADA integration**—Access data when you need it. No adapters or confusing proprietary protocols are required. Outputs include standard Modbus/RS485, SDI-12, and 4-20 mA.
- **Low power consumption**—Batteries have a typical life of 10 years or 2 million readings. 8-36 VDC input is compatible with external batteries and solar power.
- **Intuitive interface**—Win-Situ® 5 and Win-Situ® Mobile Software simplify data collection and management. Software features setup wizards, fast data download rates, multiple water level reference options, and more.

### Applications

- Aquifer characterization
- Coastal deployments—tide/harbor levels, storm surge systems, and wetlands research
- Construction and mine dewatering
- River, lake, and reservoir monitoring
- Stormwater management

# Level TROLL® 300, 500 & 700 Instruments

| General | Level TROLL 300 | Level TROLL 500 | Level TROLL 700 | BaroTROLL |
|---|---|---|---|---|
| **Temperature ranges**[1] | Operational: -20-80° C (-4-176° F)<br>Storage: -40-80° C (-40-176° F)<br>Calibrated: -5-50° C (23-122° F) | Operational: -20-80° C (-4-176° F)<br>Storage: -40-80° C (-40-176° F)<br>Calibrated: -5-50° C (23-122° F) | Operational: -20-80° C (-4-176° F)<br>Storage: -40-80° C (-40-176° F)<br>Calibrated: -5-50° C (23-122° F) | Operational: -20-80° C (-4-176° F)<br>Storage: -40-80° C (-40-176° F)<br>Calibrated: -5-50° C (23-122° F) |
| **Diameter** | 2.08 cm (0.82 in) | 1.83 cm (0.72 in) | 1.83 cm (0.72 in) | 1.83 cm (0.72 in) |
| **Length** | 22.9 cm (9.0 in) | 21.6 cm (8.5 in) | 21.6 cm (8.5 in) | 21.6 cm (8.5 in) |
| **Weight** | 245 g (0.54 lb) | 197 g (0.43 lb) | 197 g (0.43 lb) | 197 g (0.43 lb) |
| **Materials** | Stainless steel body; Delrin® nose cone | Titanium body; Delrin nose cone | Titanium body; Delrin nose cone | Titanium body; Delrin nose cone |
| **Output options** | Modbus/RS485, SDI-12, 4-20 mA | Modbus/RS485, SDI-12, 4-20 mA | Modbus/RS485, SDI-12, 4-20 mA | Modbus/RS485, SDI-12, 4-20 mA |
| **Battery type & life**[2] | 3.6V lithium; 10 years or 2M readings | 3.6V lithium; 10 years or 2M readings | 3.6V lithium; 10 years or 2M readings | 3.6V lithium; 10 years or 2M readings |
| **External power** | 8-36 VDC | 8-36 VDC | 8-36 VDC | 8-36 VDC |
| **Memory**<br>**Data records**[3]<br>**Data logs** | 1.0 MB<br>65,000<br>2 | 2.0 MB<br>130,000<br>50 | 4.0 MB<br>260,000<br>50 | 1.0 MB<br>65,000<br>2 |
| **Log types** | Linear, Fast Linear, and Event | Linear, Fast Linear, and Event | Linear, Fast Linear, Linear Average, Event, Step Linear, True Logarithmic | Linear |
| **Fastest logging rate & Modbus rate** | 2 per second | 2 per second | 4 per second | 1 per minute |
| **Fastest SDI-12 & 4-20 mA output rate** | 1 per second | 1 per second | 1 per second | 1 per second |
| **Real-time clock** | Accurate to 1 second/24-hr period | Accurate to 1 second/24-hr period | Accurate to 1 second/24-hr period | Accurate to 1 second/24-hr period |
| ***Sensor Type/Material*** | Piezoresistive; stainless steel | Piezoresistive; titanium | Piezoresistive; titanium | Piezoresistive; titanium |
| **Range** | *Absolute (non-vented)*<br>30 psia: 10.9 m (35.8 ft)<br>100 psia: 60.1 m (197.3 ft)<br>300 psia: 200.7 m (658.7 ft) | *Absolute (non-vented)*<br>30 psia: 10.9 m (35.8 ft)<br>100 psia: 60.1 m (197.3 ft)<br>300 psia: 200.7 m (658.7 ft)<br>500 psia: 341.3 m (1120 ft)<br><br>*Gauged (vented)*<br>5 psig: 3.5 m (11.5 ft)<br>15 psig: 11 m (35 ft)<br>30 psig: 21 m (69 ft)<br>100 psig: 70 m (231 ft)<br>300 psig: 210 m (692 ft)<br>500 psig: 351 m (1153 ft) | *Absolute (non-vented)*<br>30 psia: 10.9 m (35.8 ft)<br>100 psia: 60.1 m (197.3 ft)<br>300 psia: 200.7 m (658.7 ft)<br>500 psia: 341.3 m (1120 ft)<br>1000 psia: 703 m (2306.4 ft)<br>*Gauged (vented)*<br>5 psig: 3.5 m (11.5 ft)<br>15 psig: 11 m (35 ft)<br>30 psig: 21 m (69 ft)<br>100 psig: 70 m (231 ft)<br>300 psig: 210 m (692 ft)<br>500 psig: 351 m (1153 ft) | 0 to 16.5 psi; 0 to 1.14 bar |
| **Burst pressure** | Max. 2x range; burst > 3x range | Max. 2x range; burst > 3x range | Max. 2x range; burst > 3x range | Vaccum/over-pressure above 16.5 psi damages sensor |
| **Accuracy @ 15° C**[4] | ±0.1% full scale (FS) | ±0.05% FS | ±0.05% FS | ±0.1% FS |
| **Accuracy (FS)**[5] | ±0.2% FS | ±0.1% FS | ±0.1% FS | ±0.2% FS |
| **Resolution** | ±0.01% FS or better | ±0.005% FS or better | ±0.005% FS or better | ±0.005% FS or better |
| **Units of measure** | Pressure: psi, kPa, bar, mbar, mmHg, inHg, $cmH_2O$, $inH_2O$<br>Level: in, ft, mm, cm, m | Pressure: psi, kPa, bar, mbar, mmHg, inHg, $cmH_2O$, $inH_2O$<br>Level: in, ft, mm, cm, m | Pressure: psi, kPa, bar, mbar, mmHg, inHg, $cmH_2O$, $inH_2O$<br>Level: in, ft, mm, cm, m | Pressure: psi, kPa, bar, mbar, mmHg, inHg, $cmH_2O$, $inH_2O$ |
| ***Temperature Sensor*** | | | | |
| **Accuracy & resolution** | ±0.1° C; 0.01° C or better | ±0.1° C; 0.01° C or better | ±0.1° C; 0.01° C or better | ±0.1° C; 0.01° C or better |
| **Units of measure** | Celsius or Fahrenheit | Celsius or Fahrenheit | Celsius or Fahrenheit | Celsius or Fahrenheit |
| ***Warranty*** | 1 year | 2 years | 2 years | 2 years |
| | Up to 5-year extended warranties are available for all instruments—call for details | | | |

## BaroTROLL® Instrument

The titanium BaroTROLL measures and logs barometric pressure and temperature. Use the BaroTROLL in conjunction with Level TROLL Instruments.

Win-Situ® Baro Merge™ Software simplifies post-correction of water level data. Barometric readings are automatically subtracted from data collected by an absolute Level TROLL to compensate for changes in pressure due to barometric fluctuations.

## 24/7 Support

In-Situ technical support specialists assist with instrument setup, application support, and troubleshooting. Call for free technical support.

[1] Temperature range for non-freezing liquids
[2] Typical battery life when used within the factory-calibrated temperature range.
[3] 1 data record = date/time plus 2 parameters logged (no wrapping) from device within the factory-calibrated temperature range
[4] Across factory-calibrated pressure range
[5] Across factory-calibrated pressure and temperature ranges
Specifications are subject to change without notice.
Delrin is a registered trademark of E.I. du Pont de Nemours and Company.

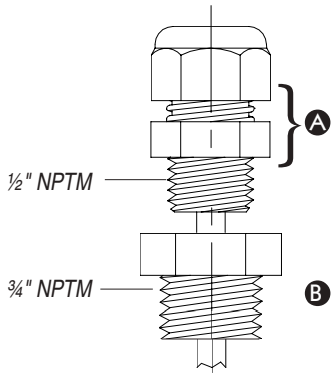
CE FC

In-Situ Inc.®

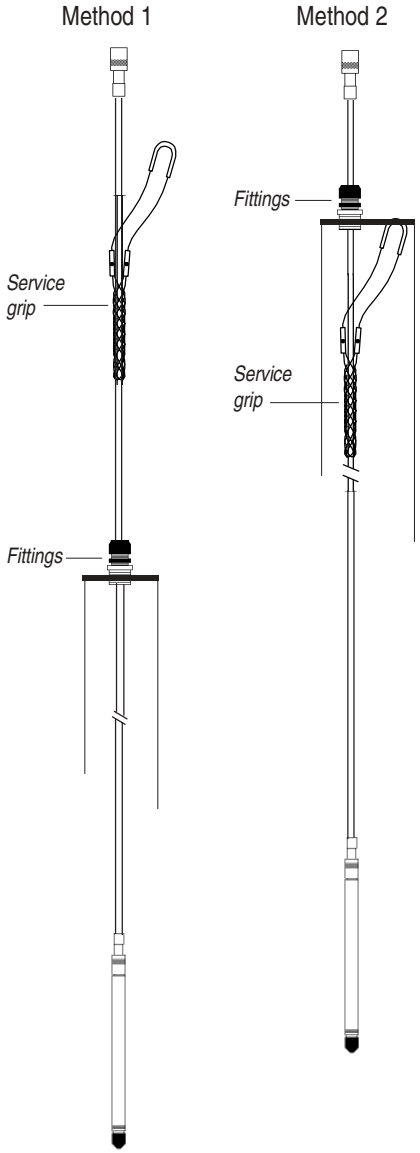
**Call to purchase or rent—www.in-situ.com**
221 East Lincoln Avenue, Fort Collins, Colorado, U.S.A. 80524
1-800-446-7488 (toll-free in U.S.A. and Canada)
1-970-498-1500 (U.S.A. and international)

In-Situ Inc.

***Information Sheet***




# ARTESIAN WELL CABLE OPTION
## (SEALED WELL APPLICATIONS)




### APPLICATION

Permits installation of a Level TROLL® or miniTROLL® into a sealed well where the seal is made around the cable. Allows easy removal from a ¾" NPT application. Includes a black dome compression fitting that makes a water- and air-tight seal around the cable.

Components are factory-installed on the Level TROLL RuggedCable™ or miniTROLL Quick-Connect cable

### COMPONENTS

Ⓐ Black two-piece dome connector with ½" male threads (NPTM)

Ⓑ White PVC adapter that accepts connector A (interior threads are ½" female, NPTF) and mates with ¾" NPT threads

### INSTALLATION

1. Loosen halves of connector A and slide to desired position on cable.
2. Tighten the compression fitting firmly around the cable and screw into PVC adapter B for installation into ¾" NPT fitting.

Additional adapter(s) may be added for installation into 1" or other size NPT fitting.

***TIP:*** *Cable may be ordered with the sealing fittings **below** the service grip (Method 1) or **above** the service grip (Method 2), depending on well configuration.*

**1 800 446 7488**
**(toll-free, US and Canada) or 970 498 1500** **www.in-situ.com**



0027772 rev. 002 07/07

# In-Situ High Pressure Transducer Cable Pass-Through Fitting