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Any questions concerning the content of this manual, equipment operation, field maintenance, maintenance assistance and operation or maintenance training courses should be directed to:

MODEL:
QTIEG Field Installation

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1. QTIEG Gauge Overview

The QTIEG QUARTZ TUBING INSTALLED ELECTRONIC GAUGE is a proven design in permanent installations by Sercel-GRC. Pressure and temperature measurements are transmitted via conductor electric line, where a surface real-time interface or surface memory recorder gathers the data. The standard QTIEG gauge is an analog gauge. The newer QTIEG-4000 gauge is a digital gauge that allows multiple gauges to be used on a single TEC cable to significantly reduce well cost for the customer. These particular gauges are discussed further at the end of this document.

The QTIEG can record any type of production test, including buildups, drawdowns and variable rates. It greatly helps engineers optimize reservoir production by measuring data used to determine choke sizes, evaluate artificial lift needs, calculate gas-lift sizes, control gas-lift injection rates and properly size pumps.

With its rapid response to temperature and pressure changes, the QTIEG downhole monitoring system is vital for reservoir management. The superior permanent downhole gauge is uniquely designed to be mounted on a carrier for ruggedness and is integral with the production string.

2. QTIEG Specifications

<table>
<thead>
<tr>
<th>Transducer</th>
<th>Quartz</th>
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<tr>
<td>Pressure ranges</td>
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<tr>
<td>Pressure Accuracy</td>
<td>3.2 psi</td>
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<tr>
<td>Pressure Resolution</td>
<td>0.01 psi</td>
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<tr>
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<td>Housing Material</td>
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<td>Minimum Sample Rate</td>
<td>1 Second</td>
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</tbody>
</table>

3. Introduction

This document outlines the correct way to install a QTIEG gauge on a drilling or workover rig in a vertical or horizontal well. Please follow the steps precisely to ensure a successful installation. Any shortcuts taken will compromise the integrity of the installation and may affect the life span of the system. If the client representative has any questions about why the installation is taking place in a particular manner, please let him view this document or contact a Field Service Engineer at Sercel-GRC for further explanation.

4. Safety Meeting on Location

The following points should be made while conducting the safety meeting on location.

- The TEC cable is very fragile. You must mind its position at all times, especially in the Sheave Wheel.
- ALWAYS COVER THE HOLE WHEN INSTALLING BANDS OR CLAMPS.
- Make sure that any cabling connected from the Spooling Unit and Slip Ring is well marked so that personnel do not trip over it.
- Watch all pinch points while installing the bands and/or clamps.
- Wear the proper PPE (Personal Protection Equipment) for the job at all times.
- Anytime the cable is being cut, always wear hand gloves.
• When making the wire connections and crimp connections, do not wear hand gloves.
• Make sure that the location of all personnel is known at all times.
• Do not stand next to the cable or the spooling unit unless absolutely necessary. The tubing can part at any time causing the spool to turn rapidly and uncontrollably.
• The QTIEG should be connected to the proper SRO data acquisition system to check for proper operation before beginning installation procedure.

5. Rigging Up of Spooling Unit, TEC Sheave and Slip Ring

1. Upon arrival on location, check in with the client representative and introduce yourself and all members of your crew. Let him know what role each representative has in the installation.
2. Place the rope in the TEC sheave.
3. Hold both ends of the rope in one hand and allow the rig crew to install the sheave wheel in the Derrick as shown in Figure 1.

4. Locate the spooling unit so that the TEC sheave is in the center of the spool and the ends of the spool are parallel to the TEC sheave.
5. Connect the air lines from the spooling unit to the air supply on the rig.
6. Actuate the spooling unit in both directions fully to ensure proper functionality of the spooling unit. Make sure that the TEC is tied down properly so that it will not come off the reel.
7. Attach the rope to the TEC. Loop the rope around the TEC and use duct tape around the loops. Tape the end of the cable thoroughly so that the end of the cable slides through the sheave smoothly. Figure 2.
Figure 2. Attaching the rope to the TEC.

8. Connect the slip ring to the spooling unit. Figure 3.

- 8.1 Cut the end of the TEC and expose the conductor.
- 8.2 Place the TEC inside the metal junction box using an NPT to Swagelok fitting.
- 8.3 Connect the conductor wire on the slip ring to the conductor wire on the TEC cable, preferably using a terminal connection as shown in the picture above (red positive (+) and brown is negative (-)).
- 8.4 Connect the ground wire on the slip ring to a screw terminal that is conductive with the body of the metal junction box.
8.5 Test the conductive side of the connection and the ground side of the connection with an ohmmeter to ensure that the connection was made correctly.

8.6 Connect the SEMR to the slip ring.

6. QTIEG Cable Head Connection

1. Unpack the gauge and visually check to ensure that no damage has occurred.
2. Very carefully remove the top connector housings of the gauge.
3. It is suggested that the cable be run through the sheave at this time. Alternatively, develop a plan and verify the gauge can be run through the sheave after it.
4. Take a resistance check of the gauge with an ohm meter. Connect the positive lead to the pin connector of the gauge and ground the negative lead to the gauge housing at some point. Make a note of these resistances. The positive reading (forward) should not be lower than approximately 20K ohms and the negative (reverse) should be infinity.
5. Remove the Santoprene jacket from the tubing for approximately 15 inches. Make sure the 1/4" tubing is smooth, straight, and free of any nicks and/or scratches. Figure 4.

![Figure 4. Preparing the TEC for connection.](image)

6. Cut off approximately 2-1/2 inches of the 1/4 inch tubing and remove the filler. See Figure 5 for strip dimensions. Meg cable prior to installation of pin, if desired. Short inner and outer conductors to discharge cable before attaching pin to cable.

![Figure 5. Trimming the cable.](image)

7. Lightly grease the 1/4 inch tubing. Slide the connector housings over the 1/4 inch tubing. To do this, it may be necessary to loosen the nuts on the tubing fittings. Figure 6.
Figure 6. Installing the connector housing over the ¼ inch tubing.

Note: Once ferrules and nut are on the TEC cable, verify they are in the correct order. Make sure at least two set of eyes have verified orientation of ferrules. Figure 7 shows the correct orientation of the ferrules on a safety changer.

Figure 7. Correct orientation of ferrules as shown on Safety Changer.

8. Grease the wire insulation. Push some grease inside the seal boot. Slide the seal boot retainer and the seal boot over the insulation of the wire. Figure 8.

Figure 8. Installing the seal boot and the seal boot retainer.

9. Cut off approximately 3/8" of the wire insulation. Twist wires into a straight condition.

10. Crimp pin on wire. Figure 9.

Figure 9. Crimping the pin.

11. Slide the boot over the pin connector until it bottoms out and the O-ring seals properly. Figures 10 and 11.
12. Lightly grease the outside of the boot. Slide the seal boot retainer down over the boot and thread into position, slightly tightening. Figure 12.

13. Separate the lower portion of the upper connector housing. Before threading this cablehead onto the gauge, the metal-to-metal seal section of the cablehead and gauge should be absolutely clean. Slightly grease threads and metal to metal seal surfaces with the anti-seize lubricant. Slightly grease O-rings with Super O-lube. Tighten to torque specified on the housing (90 ft-lbs). Figure 12 and 13.

14. Hand tighten the tube fitting nut.
15. Verify that the gauge is reading through the TEC wire by powering on the SRO and checking the pressure and temperature readings. Make sure that the SRO is properly connected to the slip ring with the slip ring cable.

16. Power down the SRO and continue the steps below.

17. Further tighten nut with wrench 1-1/4 turns.

18. Prepare to install the second cablehead. Before threading this cablehead onto the gauge, the metal-to-metal seal section of the cablehead and gauge, should be absolutely clean. Slightly grease threads and metal to metal seal surfaces with the anti-seize lubricant. Slightly grease O-rings with Super O-lube. Tighten to torque specified on the housing (90 ft-lbs).


7. Cable Head pressure test

1. Remove 1/8 “NPT” plug from cable head.

2. Connect hydraulic line from 5000 psi Hydraulic pump and Barton Recorder to the 1/8” NPT hole on the cable head.

3. Fill Cable head with fluid and purge air.

4. Pressure cable head to 1500 psi and hold for 3 min.

5. Pressure cable head to 5000 psi and hold for 15 min.

6. Remove Barton chart and present with field service report identifying the pressure and time.

7. Replace the 1/8 NPT plug. See Figure 14.

Figure 14. Pressure testing the cable head.
8. Installing the QTIEG in the Gauge Carrier

1. Use anti-seize lubricant on threads of gauge nut and carrier. Use Super O-lube on O-rings.
2. Place the QTIEG gauge into the gauge carrier by sliding the bottom end of the gauge carrier adapter into the port on the carrier.
3. Make sure that the collar on the QTIEG gauge is screwed all the way toward the top of the gauge.
4. Make sure that the gland nut (top locking nut) is loose.
5. Hand tighten the body (fastening nut) into the carrier.
6. Torque body to 55 ft-lbs.
7. Hand tighten the gland nut in place then further tighten 1-1/4 turns with a wrench. Figure 15 is an illustration of the carrier adapter with Sercel-GRC part numbers.

   **Note:** When tightening the anti-vibe gland nut, hold the collet body with a wrench to prevent the body from turning and over tightening. This will lock the collet against the tube. For subsequent retightening of the anti-vibration collet gland, use 3/4 turns past finger tight.

8. Verify communication on the QTIEG gauge and document the Pressure and Temperature.

9. Carrier Pressure Test

   1. Remove the 1/8 "NPT" plug from carrier.
   2. Connect the hydraulic line from the 5000 psi Hydraulic pump and Barton Recorder to the 1/8 "NPT" hole on the cable head.
   3. Fill the cable head with fluid and purge air.
   4. Pressure the cable head to 1500 psi and hold for 3 minutes.
   5. Pressure the cable head to 5000 psi and hold for 15 minutes.
6. Remove the Barton chart and present it with the field service report identifying the pressure and time.

7. Replace the 1/8 "NPT" plug in carrier. Figure 16.

10. RIH with the QTIEG and Production Tubing

1. Hold a pre-job safety meeting on the rig floor and make sure that all personnel are aware of the role that they will carry as the job is conducted.

2. Align the rotary table so that the groove on the bushing is oriented so that the TEC will pass through the groove.

3. Place and band on above and below the collar on top of the QTIEG carrier.

4. Once the tubing is lowered and the slips are set, pull and hold the TEC back out of the way so that the next tubing joint can be installed and the tubing tongs do not damage the cable.

5. As the tubing continues to be installed, place a band above each collar after and one band in the middle of the joint.

   **NOTE:** DO NOT PUT ANY BACK TENSION ON THE SPOOLING UNIT UNTIL AT LEAST 4 BANDS HAVE BEEN PLACE ON THE TUBING STRING.

6. Continue the steps above until the tubing hanger is reached.
11. TUBING WRAP PROCEDURE

1. Shut the air off at the spooling unit and bleed the pressure off so that the drum can spin freely.
2. Determine the length of cable needed outside the well head with a minimum length of 3 feet.
3. Multiply that number by 3.
4. Mark the cable at the tubing hanger or well head outlet.
5. Measure off a length of cable equal to the value of step 2.
6. Assemble the tubing hanger or well head flange onto the tubing.
7. Raise the tubing to a height equal to Step 2.
8. Place a band or clamp on the tubing string below where the wraps will be oriented.
9. Tightly wrap the cable around the tubing so that the length of cable is 2 times the step one measurement.
10. If there is a connection on the bottom of the tubing hanger or well head outlet, slide the compression fitting over the cable and double check the ferrule configuration.
11. Feed the cable through the well head outlet or tubing hanger.
12. Place a compression fitting or TEC to connect to a tubing hanger or place the compression fitting or well head outlet onto the TEC once the well head is landed.
13. Continue with nipple down procedure and prepare to terminate the well head outlet.
12. Cable Termination Feed-Thru at the Tubing Hanger

1. Stand next to the tubing and put your arm straight up in the air.
2. Have the driller lower the tubing hanger so that the bottom of the tubing hanger hits the top of your fingers.
3. Slide the correct size NPT to ¼ in Swagelok fittings over the TEC cable.

**NOTE: VERIFY WITH TWO SETS OF EYES THAT THE FERRULES ARE ORIENTED CORRECTLY**

4. Put a piece of black tape around the TEC cable below the hanger so that the fitting does not slide.
5. Slide the TEC Cable through the tubing hanger.
6. Slide the fitting up the TEC cable and screw it into the tubing hanger with the correct size spanner until tight. Make sure that Teflon tape is wrapped around the NPT side of the fitting.
7. Tighten the Swagelok fitting.
8. Slide the NPT fitting that is going to be installed on top of the hanger over the TEC
9. Repeat steps 15 and 16.
10. Using the Tubing Bender, bend the tubing 90 deg at the top tubing hanger fitting
11. Wrap the TEC around the top of the tubing hanger 5 times.
12. Cut the TEC Cable.
13. Reconnect the TEC cable to the SRO and record a reading on the gauge
14. Install a cap on the end of the TEC Cable.
15. Use wire ties to secure the TEC cable to the top of the hanger so that it can be lowered into the casing hanger.

13. Wellhead Outlet and Cable Termination

Several types of wellhead outlets and cable terminations can be used at this point. This procedure will explain the easiest method.

1. After the rig crew nipples down the BOP and riser, unwrap the TEC cable and straighten as much as possible.
2. Feed the TEC cable through the exit hole on the Christmas tree.
3. Slide the exit busing over the TEC cable and screw into the exit hole on the Christmas tree.
4. Verify that the nut and ferrule are correctly oriented.
5. Tighten the nut and ferrule onto the exit bushing.
6. Run the TEC cable to the junction box where the surface cable will be terminated.
7. Terminate the TEC cable at the junction box.
8. Reconnect the SRO to the surface cable and record the reading on the gauge.
14. Communicating with the OPTIM QTIEG Series Gauge

Please contact Sercel-GRC sales or customer service for any of the following OPTIM QTIEG series communication options best to suit your needs.

14.1 GIC-3000
The GIC-3000 is the most basic communications option offered by Sercel-GRC for the OPTIM QTIEG series gauge. It, like all the other communication options for the Optim QTIEG uses the GIC. The Gauge Interface Controller (GIC) is a micro-processor controlled device designed to operate GRC downhole gauges. The GIC can be configured with numerous options such as 4-20mA output current loop, Mux for running up to 4 gauges on 4 separate TEC lines, RS-422/485 Modbus network, Liquid Crystal Display (LCD), Memory Expansion for data storage, and battery operation. For information on installation and using the GIC-3000 consult Sercel-GRC manual part # 006-0195-00. Figure 17.

Figure 17. GIC-3000
14.2 Datalogger-3000 RTU
The Datalogger-3000 system is composed of the Remote Terminal Unit (RTU), and contains up to 4 GIC controllers for communication with Sercel-GRC’s wide range of pressure and temperature sensors. The system is available with several package options including NEMA 4 rated metal and nonmetallic enclosures and can also be packaged in a stainless steel NEMA 4X enclosure for more corrosive environments. The RTU board inputs and outputs and GIC gauge connections are pre-wired to terminal blocks inside the enclosure to allow for ease of field installation. The Datalogger uses SD card storage for user defined storage of pressure and temperature data along with any Modbus devices communicating with the Datalogger system. The user can define storage rates for the data in the Datalogger configuration software. The Datalogger system allows the operator to display user selected parameters on the panel display which can be selected using the Datalogger software. It also features a front panel AC power socket to allow for the use of a laptop during the installation procedure. The Datalogger-3000 is also available with optional radio communication modules to allow the customer to add remote monitoring capability. For information on installation and using the Datalogger-3000 consult Sercel-GRC manual part # 006-0193-00. Figure 18.

![Figure 18. Datalogger-3000.](image-url)
14.3 ADDN/SEMR-2000

Sercel-GRC has many options for acquiring data from the OPTIM QTIEG series gauge including the ADDN/SEMR-2000 battery-powered data recorder. The ADDN/SEMR-2000 contains the GIC-2000 “engine”, is battery operated, can be connected to a solar cell for unattended use, is portable, easy to transport and very flexible. It can be configured with numerous options such as 4-20mA output current loop, RS422/485 Modbus network, Multiplexor interface, Liquid Crystal Display (LCD), and Memory Expansion for data storage. It’s designed to be used with GRC Electronic Pressure Gauges totally unattended at remote sites or inconvenient well locations. SEMR-2000 is connected to the gauge by a single conductor cable, which also supplies power, eliminating the need for grid power or a generator at the site. It operates on an internal lead-acid battery for up to 7 days, which can be recharged by a common truck battery. The ADDN/SEMR-2000 is capable of operating for an infinite period of time on a small solar generator. The ADDN/SEMR-2000 can be located up to 25,000 feet (4.73 miles) from the gauge. The ADDN is also available in an explosion proof enclosure. For information on installation and using the ADDN/SEMR2000 consult Sercel-GRC manual part # 006-0185-00. Figure 19.
The following information is specific to the QTIEG-4000 Gauge.

15. Communicating with the QTIEG-4000

15.1 FIC-4000
The FIC-4000 surface controller is used to communicate with Sercel-GRC QTIEG gauges using FSK communication. The information provided here is for reference purposes only. For complete operations instruction please consult the FIC-4000 operations manual Sercel-GRC part # 006-0199-00. The system contains an FSK surface controller powered by a 100-240 VAC power supply. For more information on the operation of the FSK surface board see the FSK Surface Board Technical Reference Manual, Sercel-GRC part number 006-0196-00.

One FSK interface board can communicate with a maximum of 6 QTIEG-4000s (6 FSK channels) on the same TEC line. The standard FIC-4000 is equipped with one FSK card but can support two if requested. The FSK interface card relays data from downhole tool(s) via Modbus to a VSD or SCADA system. The FIC-4000 makes connection to Modbus equipment simple and flexible. The Modbus data is transmitted using RS-485 protocol and has been pre-wired as a factory default. Figure 20.

Figure 20. FIC-4000
15.2 Datalogger 4000

The Sercel-GRC Datalogger-4000™ is a high performance Remote Terminal Unit (RTU) designed to interface with the GRC suite of FSK pressure and temperature sensing products. It is capable of acquiring data from virtually any third party device that supports an analog, digital or Modbus connection (hard wired or wireless). Data may be stored using removable SD data cards (2 megs) in ASCII coded text files that can be addressed by any Excel or similar program. Data can also be transmitted to other remote devices using Modbus protocol. Support for an onboard or remote display for all remote and locally connected signals allows for easy data display and control entry. The Sercel-GRC Datalogger-4000™ may be configured using the keypad and LCD, a local PC via a built-in USB, RS-232 or RS-485 ports, serial link, or a radio connection. The Sercel-GRC Datalogger-4000™ can use virtually any commercial radio modem connected via RS-232 or RS-485. All digital & analog signals are acquired, processed and output at a minimum resolution of 16 bits and Modbus support includes acquiring 32 bit resolution data from other devices. The 8 analog outputs may be driven by any local or remote signal source, and the flexible scaling scheme covers virtually any field application. Nine relays on the board may also be driven by multiple sources, such as adjustable tank controls and control of oil field pumps dependent upon wellbore pressures. The Sercel-GRC Datalogger-4000™ is a very powerful recorder that can be configured for almost any data gathering and recording task. Figure 21.
15.3 Datalogger 4200
The Sercel-GRC Datalogger-4200™ is a high performance surface monitoring and automation system designed to interface with Sercel-GRC’s suite of digital downhole sensors. Device control is provided to allow alarm signaling using (2) high current relays. External devices may be monitored and controlled using one of the (3) analog inputs, and (2) analog outputs. USB and TCP/IP are provided for additional interface for data collection and downhole monitoring. Remote control and data collection communication is via Modbus, RS-232, and RS-485. Data is also recorded on a removable SD memory card. Data may be stored using removable SD data cards (2 megs) in ASCII coded text files that can be addressed by any Excel or similar program. Data can also be transmitted to other remote devices using MODBUS protocol. Protection from the environment is provided by a NEMA enclosure. The Sercel-GRC Datalogger-4200™ is a very powerful recorder that can be configured for almost any data gathering and recording task. Figure 22.
Appendix 1 – ACC – 104 QTIEG Spare Cable Heads & Accessory Kit

The following replacement parts and accessories may be purchased from Sercel-GRC Customer Service. They may be purchased individually or as a kit.

Accessory Kit part number: ACC-104

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<tr>
<th>Component Part</th>
<th>Description</th>
<th>Quantity</th>
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<td>037-0047-04</td>
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<td>037-0132-01</td>
<td>CONTACT, #16 AWG CRIMP/SOLDER</td>
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<td>067-0067-03</td>
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Appendix 2 – ACC-106 QTIEG Accessory Kit

The following replacement parts and accessories may be purchased from Sercel-GRC Customer Service. They may be purchased individually or as a kit.

Accessory Kit part number: ACC-106

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<td>PLUG,1/8&quot;304SS HEX SKT.HD.PIPE</td>
<td>4</td>
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<td>089-0239-00</td>
<td>FITTING, SAFETY CHANGER NUT&amp;FER</td>
<td>1</td>
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<tr>
<td>135-0026-00</td>
<td>CMPND, 0.5 OZ., ANTI-SEIZE &amp; LUBR.</td>
<td>2</td>
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<tr>
<td>140-0010-00</td>
<td>TAPE, TEFLON SEALANT</td>
<td>1</td>
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<tr>
<td>65A901</td>
<td>INSTRUCT, TIEG GAUGE/CABLE ASSY</td>
<td>1</td>
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<tr>
<td>140-0112-00</td>
<td>SUPER O-LUBE, 0.5 OZ.</td>
<td>1</td>
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</table>
Appendix 3 – ACC-105 Anti-Vibration Collet Accessory Kit

The following replacement parts and accessories may be purchased from Sercel-GRC Customer Service. They may be purchased individually or as a kit.

Accessory Kit part number: ACC-105

<table>
<thead>
<tr>
<th>Component Part</th>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>089-0240-00</td>
<td>COLLET, 9/16 316SS SLOT</td>
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<tr>
<td>089-0242-00</td>
<td>COLLAR, 9/16&quot; 316SS</td>
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<td>65A320</td>
<td>COLLET, MODIFIED</td>
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<tr>
<td>65A322</td>
<td>NUT, MODIFIED GLAND</td>
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</tr>
</tbody>
</table>

Appendix 4 – 99B1150 Cable Splice Kit
Appendix 5 – Optim QTIEG Gauge Dimensions

Appendix 6 – Cable Head Assembly Drawing Instructions
Appendix 7 - Gauge Carrier Dimensions

NOTE: THE FOLLOWING DRAWINGS ARE FOR REFERENCE ONLY. PLEASE CONTACT SERCEL-GRC CUSTOMER SERVICE FOR SPECIFIC PART NUMBERS AND SPECIFICATIONS.

65D1215 2-3/8” Welded Annulus

65D1220 2-7/8” Welded Annulus
65D272 3½” Machined

Optim QTIEG Gauge Installed in Carrier

65B1205 Gauge Carrier
Sercel-GRC Corp. is a worldwide leader in downhole data acquisition and the leader in proprietary technology for measuring, recording and delivering reliable and accurate well data with extremely high resolutions. Sercel-GRC provides gauges and surface readout tools for permanent, memory, mechanical and artificial lift applications and is the manufacturer of the Amerada® mechanical gauge used for over 80 years in the oil and gas industry.

For more information on this product or any of the quality monitoring and data acquisition solutions Sercel-GRC offers, contact us.