Maine Drilling & Blasting

To: Mike Garn – Schultz Construction
From: Peter Marcotte, Maine Drilling & Blasting
Date: June 11, 2014
RE: Revised Rock bolt Testing Submittal for Bridge 16 - Rochester, VT

Mike,

This document covers the rock anchor testing tasks for the anchor described in the Installation submittal dated June 11 2014.

We have responded to the Review Comments, our response is in Bold

General Notes (from VHB Submittal review June 5 2014)

- VHB 5. The proposed testing method also includes only 1 dial gauge, rather than the 2 required by the Special Provision. Please provide 2 dial gauges.
    - **MD&B: We have revised the typical detail and commit to using 2 dial gauges. The can be placed redundantly or as directed by the Inspector.**

- VHB 6. The submittal requests a design load (DL) and any lock off loads. The design load and lock-off load shall be 7 kips as noted in the Contract Plans.
    - **MD&B: We have revised the Test Log section and provide room for notes for comments below.**

- VHB 7. Regarding the test load table, due to the relatively small design load required, we are hereby only requiring a test reading at 1.33 x DL (0.25, 0.5, 0.75, 1.0, and 1.2 x DL readings are not required for this project).
    - **MD&B: We have revised the Test log section. Elongation will be minimal with any 1" anchor or the Geobar we propose to use. To account for any Alignment loading that may be required to get an adequate test completed can VHB provide a maximum load which shall not be exceeded, we don't want to damage the bridge but do not want to be stuck in the field with a bad measurement because the load is very small. I am not concerned about our ability to control loading at this increment but we really don't have much room for alignment loading south of 7 kips. Alignment loading is essential to record elongations properly**

- VHB 8. Please provide cut sheets and calibration data for proposed Load Cell to be used.

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Maine 207.582.2338
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New York 518.632.9170
Pennsylvania 800.422.4927
Vermont 802.479.3341

- **MD&B: The cut sheets are provided with no change. The calibration information is sent with the unit and will be submitted upon arrival at least 5 days prior to use.**
- **We have selected a load cell based solely on the pass through ID. Load cells with a 1" ID are typically 100 kip units. Load cells with 2" ID are typically 200 kip units. The same goes for center hole jacks. The 7 kip anchor at 1"nominal is really a wild card, we have proposed a1.5" nominal diameter anchor. Either anchor would not fit in a 100 kip load cell. MD&B wants to ensure you have the load cell you have requested so we have reviewed with Geokon who manufactures and rents load cells and they have commented on the accuracy, I have attached their email beside the load cell cut sheets. This works out to 1 kip accuracy. MD&B can over stress as directed by the engineer to compensate for accuracy tolerance to ensure the capacity of the anchor is more than 7 kips.**

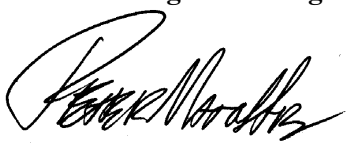
Index

- Procedure & Test Log
- Typical Detail
- Equipment Details

We look forward to working with your team. Please contact us with any questions.

Sincerely,

Maine Drilling & Blasting



Peter Marcotte
Project Engineer

Procedure & Test Log

- All Anchors will be Proof tested
- Deflections during the load test will be measured with a certified Starrett micrometer measuring to .001 inches.
- The anchors will be loaded with the center-hole jack, calibration report is enclosed.
- The load cell will be the primary load measurement; psi on the jack will be the secondary.
- We request a maximum test load so as to not exceed as described in the responses to the review on Page 1.

MAINE DRILLING & BLASTING

PROOF TEST

DATE: _____

OPERATOR: _____

Provide Anchor Location Sketch w/ numbering

*Gauge PSI for Reference use Load Cell for Actual
*Design Load is 7,000 lbs

% LOAD	LOAD (lbs)	GAUGE (psi)*	STARRETT READING (Inches) Bolt 1	Bolt 2	Bolt 3	Bolt 4
AL	2,850	100				
1.33 DL	9,310	350				
Use the below space for any other elongation measurements, record the load and (inches)						
TBD	TBD	TBD				
TBD	TBD	TBD				
TBD	TBD	TBD				
TBD	TBD	TBD				
TBD	TBD	TBD				
CREEP TEST at 1.33 DL						
1 minute						
2 minutes						
3 minutes						
4 minutes						
5 minutes						
6 minutes						
10 minutes						
IF CHANGE FROM 1 TO 10 MIN > 0.040 INCH CONTINUED CREEP TEST						
20 minutes						
30 minutes						
40 minutes						
50 minutes						
60 minutes						
LOCK-OFF						
AL	2,850	100				
1.00 DL	7,000	250				
FINAL LIFT (psi)						

Typical Detail

CUSTOMER	
PROJECT	
LOCATION	DATE
SCALE	JOB#
	MANAGER

Maine Drilling & Blasting

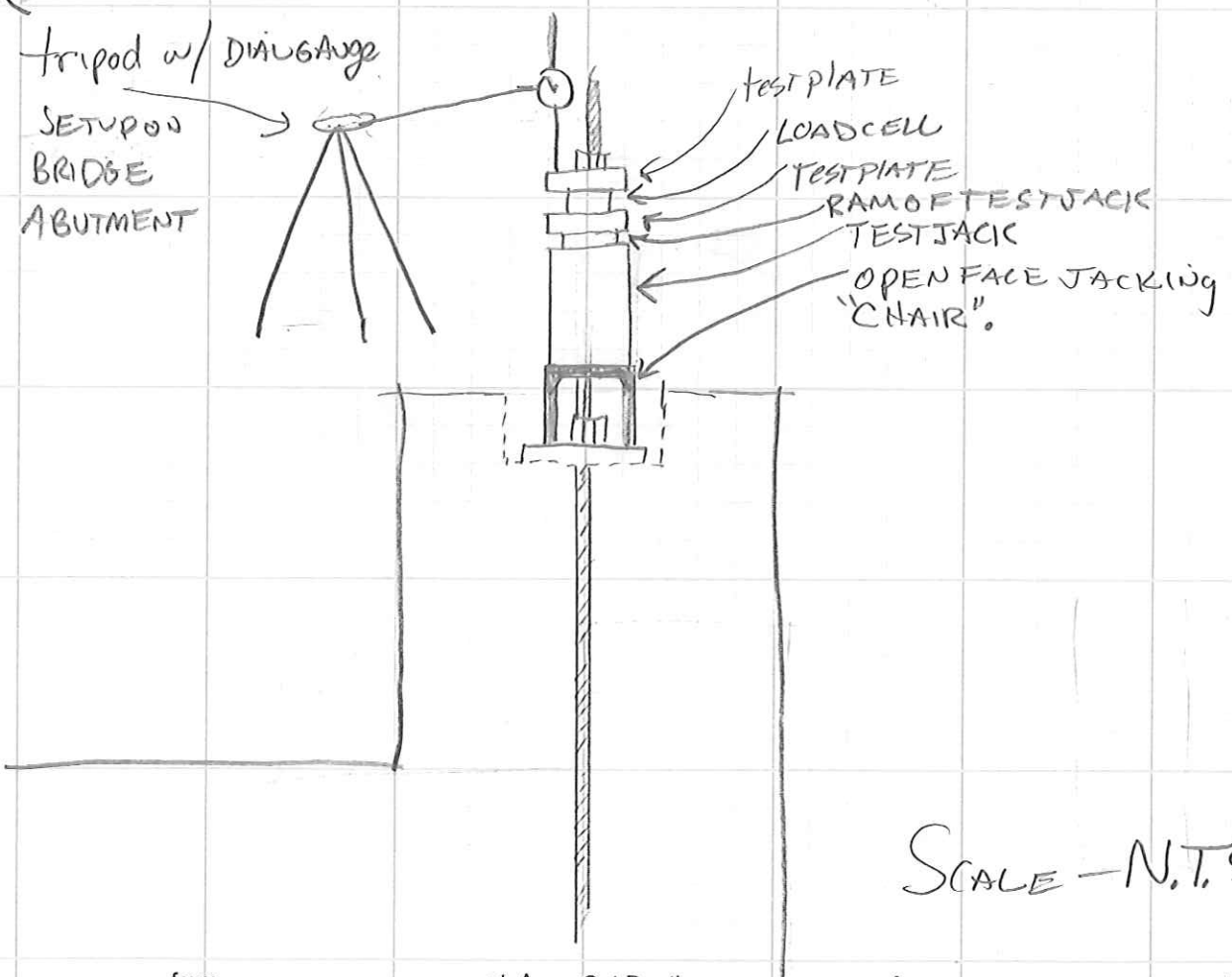
ATTACHMENT B

AGREED PLAN OF AREA TO BE BLASTED

TEST ANCHOR - DIAGRAM

ROCHESTER, VT - BRIDGE 16

(2 DIAL GAUGES WILL BE USED)



SCALE - N.T.S.

Cut Depth_____ from_____ at A

Cut Depth_____ from_____ at B

Cut Depth_____ from_____ at C

Cut Depth_____ from_____ at D

Cut Depth_____ from_____ at E

Cut Depth_____ from_____ at F

_____

Customer Signature

_____

Subcontractor Signature

Equipment Details

Pete Marcotte

From: Artie Patch <apatch@geokon.com>
Sent: Tuesday, June 10, 2014 3:49 PM
To: Pete Marcotte
Cc: Chris Brun
Subject: RE: Maine Drilling & Blasting quote

Dear Pete,

Geokon does not have a load cell for rental that is rated to a lower capacity than 200kips and that has an inner diameter of at least two inches. The model RS3000-200-2 would have an accuracy of ±1kips and a resolution of ±0.05kips.
We can calibrate the load cell for 0-14kips.

MD&B thinks this range is appropriate for 7 kip DL

Best regards,
Arthur Patch
Geokon Inc.
48 Spencer St.
Lebanon, NH 03766
Ph: 603-448-1562
Fax: 603-448-3216

From: Pete Marcotte [mailto:pmarcotte@mdandb.com]
Sent: Tuesday, June 10, 2014 1:29 PM
To: Artie Patch
Cc: Chris Brun
Subject: RE: Maine Drilling & Blasting quote

Artie,

Looking to clean this up today if we can. I need to talk to you about the following. See below for reference of our past emails on this rental.
The VTrans people are concerned that this unit will not be calibrated for their design load which is 7kips. Way smaller than I though. I still need 2" pass through. Will the load still be accurate? Can it be calibrated specifically for say a 0-14 kip load? Hopefully this is not a problem

What I will need from Geokon is:
A statement that says the unit you are providing is accurate for the load
A calibration will be send as soon as the unit is shipped.
The final load cell is...model

Once we work that out, can you send the rental agreement based on furnish for July 16 and we will return in 2 weeks. Thanks

Pete

Pete Marcotte | **Senior Project Engineer**

Calibration data will be submitted for the final selected unit at least 5 days prior to work start.

Load Cells

Applications

- Monitoring loads in tie-backs and rock bolts in the walls of excavations
- Monitoring long-term loads in concrete dam tie-downs
- Monitoring loads in steel arch tunnel supports
- Monitoring loads in cross lot struts
- Measurement of loads during pile testing

• *Model 3000 Load Cells with the Model GK-501 Readout Box.*

• *Model GK-403 Readout Box for use with the Model 4900 Load Cells.*

• *Model 4900 Vibrating Wire Load Cells.*

Operating Principle

The Geokon Model 4900 Load Cell consists of a cylinder of high-strength steel with 3-6 vibrating wire strain sensors arranged to measure the compression of the cylinder under load. The cylindrical shape allows the load cell to be used with tie-backs and rock bolts.

The readings from the individual sensors are averaged and used in conjunction with a calibration factor, supplied with the load cell, to calculate the applied loads.

The Model 3000 has the same annular design, using high-strength steel or aluminum, but uses electrical resistance strain gages cemented to the outside of the annulus and connected together in a Wheatstone Bridge Circuit so that there is a single mV/V output. Remote sensing techniques are used to minimize cable effects.

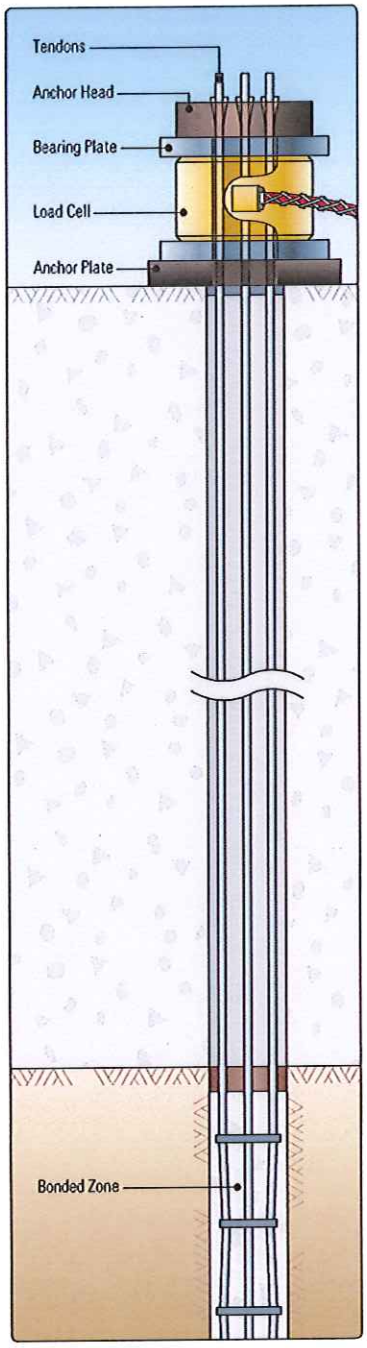
Advantages and Limitations

Vibrating wire load cells provide excellent long-term stability and can be used with long cables without adversely affecting the output frequency. They are water-proof and have low temperature coefficients. Vibrating wire load cells have also been used successfully in high radiation environments.

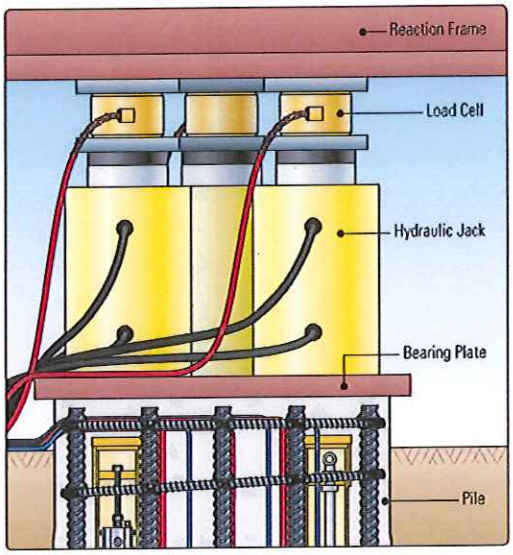
Eccentric loading is accounted for by averaging the readings from all the strain sensors.

Vibrating wire load cells are not able to measure dynamic loading and, although they are easily datalogged, the multiplicity of sensors requires a corresponding number of channels of the multiplexer. For dynamic applications it may be preferable to use the Model 3000 Load Cells.

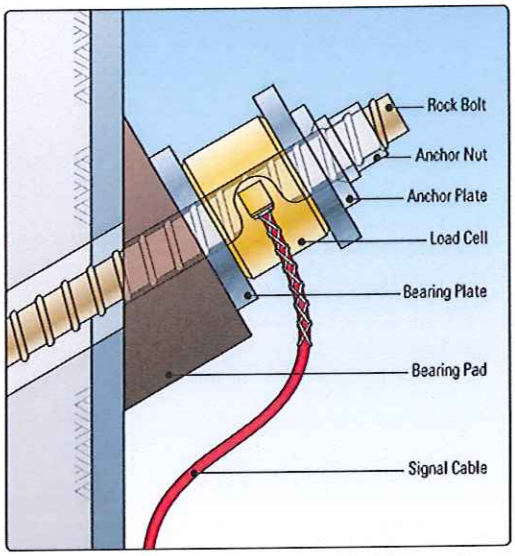
The calibration of annular shaped load cells is very dependent on the end loading conditions, i.e. on the flatness and thickness of the bearing surfaces and on any mismatch in size between the load cell and the hydraulic ram which could cause bearing plates to bend. Calibration variations of as much as 15% have been observed. For best accuracy, calibrations should be performed while duplicating or simulating actual field conditions.



• *Model 4900 used in concrete dam tie-down.*



• *Load cells used in pile test.*



• *Load cell used to monitor performance of tie-back in excavation.*

System Components

Signals from the load cell are transmitted to the readout location by means of a multi-conductor shielded cable, which may be armored for extra protection. Kellems grips prevent the cable from being pulled from the load cell. Larger size load cells are supplied with lifting lugs.

Readout of the Model 4900 Load Cells is by Model GK-401, GK-403 or Micro-10 Datalogger. Manual readout can be facilitated using a multi-channel switch box connected to the end of the cable. In the case of the GK-403 Readout Box, there is the option to use the Model GK-403-5 multiplexer which allows the GK-403 to automatically scan through all the vibrating wire sensors, average the readings, apply the calibration constant and display the load in engineering units. Readout of the Model 3000 Load Cells is by means of the Model GK-501 Readout Box.

To minimize eccentric and uneven loading, the use of the thick machined-flat bearing plates and centralizer bushings (where necessary) are recommended.

Bearing plates should be machined flat and large enough to totally cover the load bearing surface of the load cell. The thickness is related to the load cell/hydraulic jack size mismatch: the greater the size disparity the thicker the bearing plate. Typical thickness ranges from 25 to 75 mm.

If the size of the tie-back or rock bolt is more than 30 mm smaller than the internal diameter of the load cell, then centralizer bushings are recommended.

Technical Specifications

	3000	4900
Rated Capacities[1]	100 to 10,000 kN	100 to 10,000 kN
Over Range[2]	150% F.S.	150% F.S.
Resolution	0.025% F.S.	0.025% F.S.
Accuracy[3]	±0.5% F.S.	±0.5% F.S.
Output	1.5 to 2.5 mV/V @ F.S.	1200-2800 Hz
Temperature Range	–20°C to +80°C	–20°C to +80°C
Cables	Multi-conductor shielded pairs with PVC outer jacket	
Internal Diameters[1]	solid, 25, 50, 75, 100, 125, 150, 200, 250 mm	

[1]*Other capacities and diameters available on request. Calibrations that exceed Geokon's NIST traceable capacity of approximately 4500 kN are subcontracted to an accredited testing laboratory.*
[2]*With no calibration shift.*
[3]*Established under laboratory conditions. System accuracy depends on end loading conditions.*

GEOKON
The World Leader in Vibrating Wire Technology™

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Load Cell Readout Box

Applications

The Model GK-502 Load Cell Readout Box is designed to read Geokon's Model 3000 full bridge resistance strain gage type load cells. The rugged and reliable, user-friendly GK-502 features the following...

- Easy-to-use control panel
- Output displayed in engineering units
- 16×2 LCD display
- 10-pin load cell connector
- USB communications port
- Internal real-time clock
- Non-volatile memory
- Rechargeable battery
- Data storage capability
- Cold weather operation

• *Model GK-502 Load Cell Readout Box.*

• *Close-up of the Model GK-502 Load Cell Readout Box control panel.*

Operating Principle

The Model GK-502 Load Cell Readout Box is a portable battery powered instrument designed to read all full bridge resistance strain gage type load cells, including the Geokon Model 3000 Load Cells.

The readout incorporates a 12 Volt, 1.4 Ahr Sealed Lead Acid (SLA) battery, 16×2 graphic liquid crystal display (LCD) with backlight, membrane keypad, and battery charger circuit. Two side-mounted 10-pin, military style Bendix® connectors are provided; the first is used to connect the load cell, and the second is used for communications, via a USB connection (COM port), and for charging of the battery, via the battery charger.

The GK-502 supplies a precision 2.048 VDC excitation to the full bridge Load Cell and displays the output in Digits, mV, mV/V, or by entering a Gage Factor and Zero Reading, in engineering units (lbs, kg, kips, Tons, etc.).

An internal Real-Time Clock/Calendar (RTCC) and non-volatile memory allows storage for up to 999 time-stamped readings, which can be displayed via the LCD display, or downloaded to a computer via the COM port for further analysis.

The GK-502 is designed to read both 4-wire and 6-wire remote-sense full bridge load cells.

Power consumption of the GK-502 is very low (300 mW), and will allow continuous operation for up to 48 hours under normal conditions. Continuous battery monitoring is included to warn the user when the battery is low and requires recharging.

• *Model GK-502 Load Cell Readout Box, showing load cell and communication connectors.*

• *Model GK-502 Load Cell Readout Box shown with the Model 3000 Electrical Resistance Load Cell.*

Advantages and Limitations

The Model GK-502 is designed to be user-friendly with push button operation for all functions.

The display shows digits, mV, mV/V or engineering units.

Readings, including reading number, date and time, can be stored by pressing the "STORE" button.

To power off the GK-502, press the "ON/OFF" switch. Alternatively, the GK-502 will automatically shut off after five minutes of remaining idle.

Load cells are easily connected via the side-mounted 10-pin connector, or via the supplied patch cord with alligator clips.

Remote sense capabilities for added accuracy with long cable lengths.

Stored data can be downloaded through the 10-pin USB port for use in spreadsheet applications.

System Components

The Model GK-502 is supplied complete with battery charger, USB cable, USB driver (CD format), patch cord with alligator clips, for connection to load cell cables without 10-pin connectors, and manual.

Technical Specifications

Display Resolution	1 uV (mV, mV/V); 1 digit (Dg); 1 lb (lbs.); 1 kg (kg); 0.01 kip (kips); 0.01 ton (tons); 0.01 metric ton (metric tons); 0.01 kN (kilonewton)
Accuracy	0.015% F.S. (max)
Range (S+S–)	±16 mV (±31,250 digits)
ADC	Differential 24 bit Sigma Delta
ADC Resolution	1.9 nV
Excitation Voltage/ ADC Reference	2.048 V (± 0.001 V) 3 ppm/°C
Display	16 × 2 graphic LCD with backlight
Connectors	*Bulkhead:* Bendix PTO2A-12-10S *Mating:* Bendix PY06A-12-10P(SR)
Operating Temperature	–30 to +50°C
Power Requirements	12 VDC @ 22 mA (operation) 12 VDC @ 16 µA (off)
AC Adaptor	120/230 VAC: 50-60 Hz, 18 VDC, 1.66 A
Battery	*(type)* Lead acid 12 volt, 1.4 Ahr *(operating time)* 48 hours
Materials	Aluminum case and lid
Weight	2.3 kg
L × W × H	165 × 102 × 216 mm

GEOKON

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gives the same reading as the GK-501. Alternatively the P3 can be set up to readout directly in engineering units – ponds, tons, kips, etc,

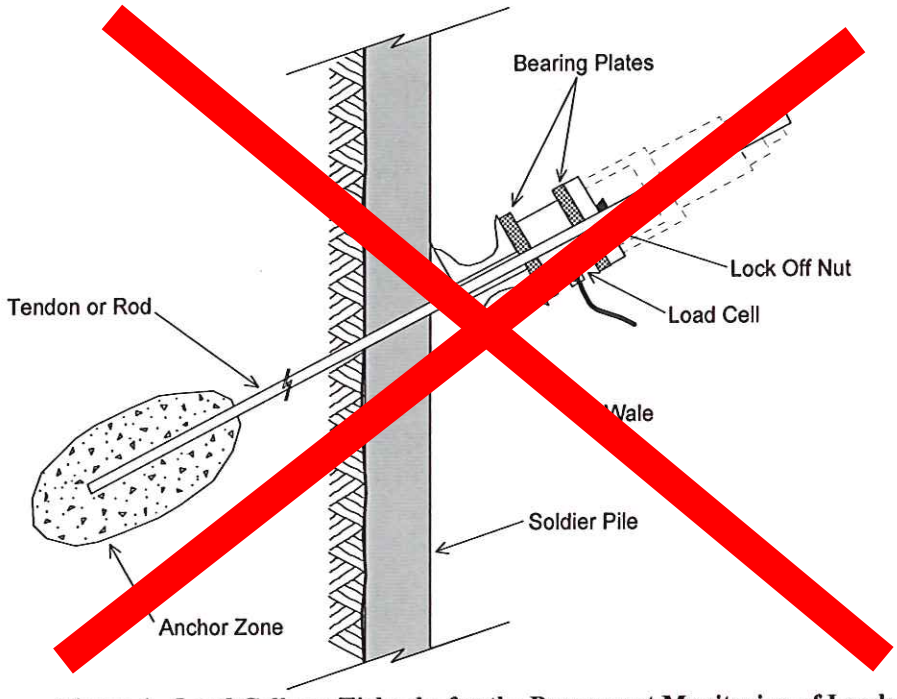

Figure 1 - Load Cells on Tiebacks for the Permanent Monitoring of Loads

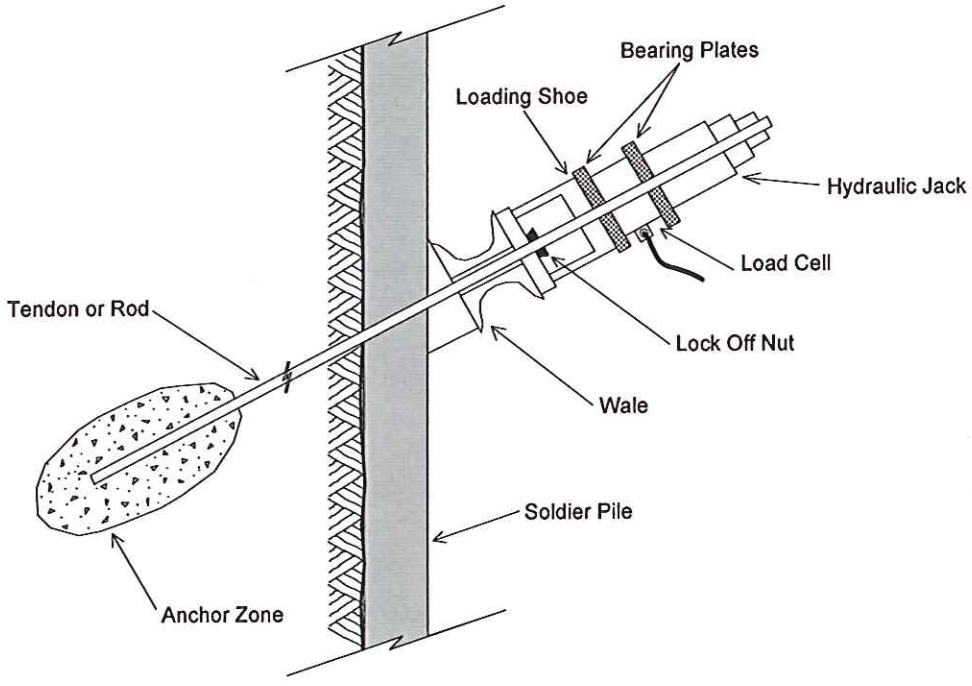

Figure 2 - Load Cells On Tiebacks For Proof Testing Only

A similar calibration report will be furnished

Load Cell Calibration Report

Model Number: 3000-400-3

Calibration Date: July 12, 2013

Serial Number: 2539

Calibration Instruction: CI-3000

Max. Range (lbs): 400000

Cable Length: 25 feet

Technician:

Initial Cycling Data

Load (lbs):	0	0	400000	0
Reading:	-110	-112	19518	-115

Calibration

Applied Load in lbs	Readings from GK-501 or GK-502 readout box				Linearity % Max Load	Polynomial Error (%FS)
	Cycle 1	Cycle 2	Average	Change		
0	-115	-118	-117		-0.88	-0.08
40000	1947	1929	1938	2055	-0.37	0.06
80000	3938	3943	3941	2003	-0.13	0.01
120000	5919	5921	5920	1979	-0.01	-0.09
160000	7923	7910	7917	1997	0.20	-0.02
200000	9885	9872	9879	1962	0.24	-0.05
240000	11856	11840	11848	1969	0.31	0.03
280000	13766	13790	13778	1930	0.18	-0.03
320000	15731	15723	15727	1949	0.15	0.09
360000	17659	17639	17649	1922	-0.02	0.13
400000	19502	19494	19498	1849	-0.57	-0.15
0	-115	-112	-114			

GK-501 or GK-502 Readout

Linear Gage Factor (G): 20.46 lbs/digit

Regression Zero (R_0):* 56

Polynomial Gage Factors: **A: 0.00003728** **B: 19.66** **C: 1992**

Polynomial, $L = AR_1^2 + BR_1 + C$

Full Scale mV/ V: 4.904 mV/ V

Calculate C by setting L=0 and R_1 = initial field zero reading in the polynomial equation

* Note: The above calibration uses a linear regression method. The Regression Zero Reading shown is ideal for straight line computation and does not usually agree with the actual no-load reading.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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Richard Dudgeon, Inc.

1565 Railroad Avenue Bridgeport, CT 06605
Tel (203) 336-4459 Fax (203) 333-8417

JACK CALIBRATION REPORT

Cylinder 150 Tons Capacity, 8 " Stroke, Serial No. S11308
Gauge 10,000 PSI Rating, 6 " Dial Dia., Serial No. Z7005W4

Notice: Calibration reports prepared by Richard Dudgeon, Inc. are submitted on a confidential basis and the data contained therein is our customer's proprietary information. Such reports may or may not be used by others without the express written consent of Richard Dudgeon, Inc. and it's customers.

Dudgeon Order No. S13791 Order Date 7/19/13 Test Date 7/19/13
Customer Maine Drilling + Blasting Purchase Order No. VERBAL
Test Performed By W. Nold In 760 Ton Load Frame, S/N 760TLF-1. Output Measured by 190 Ton Loadcell S/N 50141375, with Strain Indicator Model P3500, S/N 0140334, Test No. 2.667, Zero Set +/-0000.

Test Method: Cylinder pressure increased in even increments at slow rate by hydraulic pump. Output force of cylinder measured by calibrated Loadcell (within a tolerance of one percent) between 20 and 190 tons traceable to the Nat'l Institute of Standards and Technology (formerly the Nat'l Bureau of Standards).

LOAD ON CYLINDER (~~KIPS~~/TONS)	GAUGE READING IN PSI AT RAM EXTENSIONS OF			AVERAGE PRESSURE (PSI)	MD+B Average PSI	S/N
	2 INCHES	4 INCHES	6 INCHES			
20	1400	1400	1400	1400	1400	28,5714
40	2725	2775	2750	2725	2733	29.2683
60	4050	4075	4075	4025	4067	29.5082
80	5400	5400	5405	5400	5408	29.5840
100	6700	6750	6725	6725	6725	29.7398
120	8050	8075	8075	8075	8067	29.7521
					ave	
					29.40	

File:JKCAL1G.FRM, 12/21/99 Temperature at time of test _____ Deg. F

RICHARD DUDGEON, INC.
1565 RAILROAD AVE. BRIDGEPORT, CT. 06605 TEL:203-336-4459 FAX:203-333-8417

PRESSURE GAUGE CERTIFICATION

CUSTOMER: MAINE DRILLING & BLASTING INC.

CUSTOMER'S ORDER NO	DUDGEON ORDER NO.	ORDER DATE
VERBAL,PETE	S13791	07/19/12

GAUGE SERIAL NO.	CAPACITY
Z7005W4	6" DIA x 10,000 PSI

WE HEREBY CERTIFY THE ABOVE HYDRAULIC GAUGE HAVE BEEN TESTED AGAINST OUR HEISE DIGITAL PRESSURE INDICATOR, SERIAL NO. S7-9400 AND FOUND TO BE WITHIN A STANDARD ACCURACY (PLUS OR MINUS 1/2%) OF FULL SCALE. OUR TEST EQUIPMENT IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

REFERENCE PRESSURE (PSI)	GAUGE READING (PSI)
0	50
1000	1000
2000	2000
3000	3000
4000	4000
5000	4975
6000	5975
7000	6950
8000	7950
9000	8950
10000	X

RICHARD DUDGEON, INC.

W. Dudgeon

DATE: 7/19/12

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