



**November 21, 2014**

TO: Jim Hollar  
Cold Rivers Bridges, LLC  
FROM: DC Blakeman  
President, Becc Company Inc  
SUBJECT: Vibration Control Program (Vibration Monitoring Program)  
Rockingham BRF 0126(12)  
Rockingham, Vermont

The following Vibration Control Program is submitted, as required in Special Provisions: 55. Monitoring Criteria

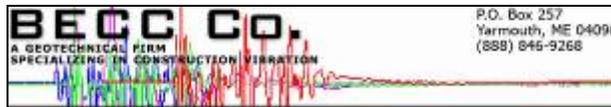
(b) VIBRATION MONITORING

**Monitoring Program Based on the  
Transportation- and Construction-Induced Vibration  
Guidance Manual**

**California Department of Transportation Environmental Program  
Environmental Engineering  
Noise, Vibration, and Hazardous Waste Management Office**

I. Instrumentation Used

- A. InstanTel Seismographs Series III and Series IV instruments; specifically –
- 1) Blast Mate III  
S/N BA7197
  - 2) MiniMate Plus (Series III)  
S/N BE6335  
S/N BE6468  
S/N BE6437
  - 3) Minimate Pro 4 (Series IV)  
S/N MP 12905  
S/N MP 12522
  - 4) **Micromate** (Series IV)  
S/N UM6043
- B. All of the instruments used will be calibrated within 6 months of the start of construction.
- C. The instruments used on this project will be the available instruments from the above 7 InstanTel Seismographs i.e. during the times monitoring is needed; the instruments will be dedicated to the project.
- D. These instruments will be coupled to the monitoring locations via: 1) weighted bags or glued to the surface of the structure and weighted bags or anchored via bolts as needed to collect the proper data.
- E. The locations of the monitoring instruments will be determined at the time of the construction vibration source. At that time the seismographs will be set at the closest structures i.e. bridge or building.



## II. Procedures

Upon notification by the State of Vermont AOT Contract Administrator the Vibration Consultant will dispatch a seismograph and Technician to monitor all vibration producing equipment and activities (i.e., blasting, vibration rollers, vibrating hammers etc).

## III. Vibration Control Program

### IV. Reference Special Provisions 55 (b)

- A) BECC Company will provide and have available 4 Seismographs that meet the standard set forth in Special Provisions at all times that we will be monitoring construction vibration activity. ( See the page 1)
- B) These seismographs will be placed at locations nearest buildings or structures closest to active construction to optimize evaluation and assessment of potential damage.
- C) Maximum Levels of Allowable Vibration:
  - 1) Maximum allowable vibrations for the Existing Structures should be no more than 2.00 inches per second with the vibration frequency at 30 Hz or higher, 1.00 in/sec at 4 Hz to 30 Hz and 0.79 in/sec below 4 Hz. The Maximum allowable “Air blast” should not exceed 150 dBl at any existing structure.

During construction operations the instruments will be set in Histogram Combo Record Mode.

#### **e. Histogram Combo Record Mode**

This mode creates a waveform during histogram recording if the signal exceeds the waveform trigger level. The waveform event is saved as a separate file while the histogram event file remains continuous. Up to 13 waveform events can be stored. The auxiliary trigger is disabled during histogram combo mode.

The maximum sample rates in this mode are as follows:

- a. 4 channels or less: 2048 samples per second
- b. more than 4 channels: 1024 samples per second

1. The level of detection for histogram collects all vibration data, the combo mode will be set at 0.050 in/sec (Maximum Geo Range – 10.0 in/sec)
2. The location of the monitor will be at the nearest structure on either side of the construction vibration source (i.e., building, bridge)
3. Trigger source will be transducer geophone only.

D. During continuous vibration activities such as vibrator rollers or pile driving activities the instrument will be set in Histogram (strip chart) Combo Record Mode. 1. The level of detection will be set at 10.00 in/sec (Geo Max Sensitivity)

*(Note: in the Histogram mode the instrument has no trigger source or level, the instrument records all vibrations and/or overpressure)*

2. The histogram interval will be set at 5 seconds (Note: the highest vibration level sensed every 5 seconds would be recorded).
3. The seismograph will be placed at the nearest structure to the vibration source.
4. The results of the vibration activities will be given to the Vermont AOT Engineer at the completion of the day’s monitoring. If, however, the vibration pattern approaches an “unsafe level” the Engineer and the operator will be notified immediately *(the safe level of vibration is based upon the latest publications – see list of publication at end of addendum-the safe level of operations as accepted by the industry is the USBM /USOSM STANDARD)*

IV. Reports

All recordings will be electronically sent and the Vibration Consultant will submit a hard copy after its analysis. An example of the hard copy description will appear later in this submission.

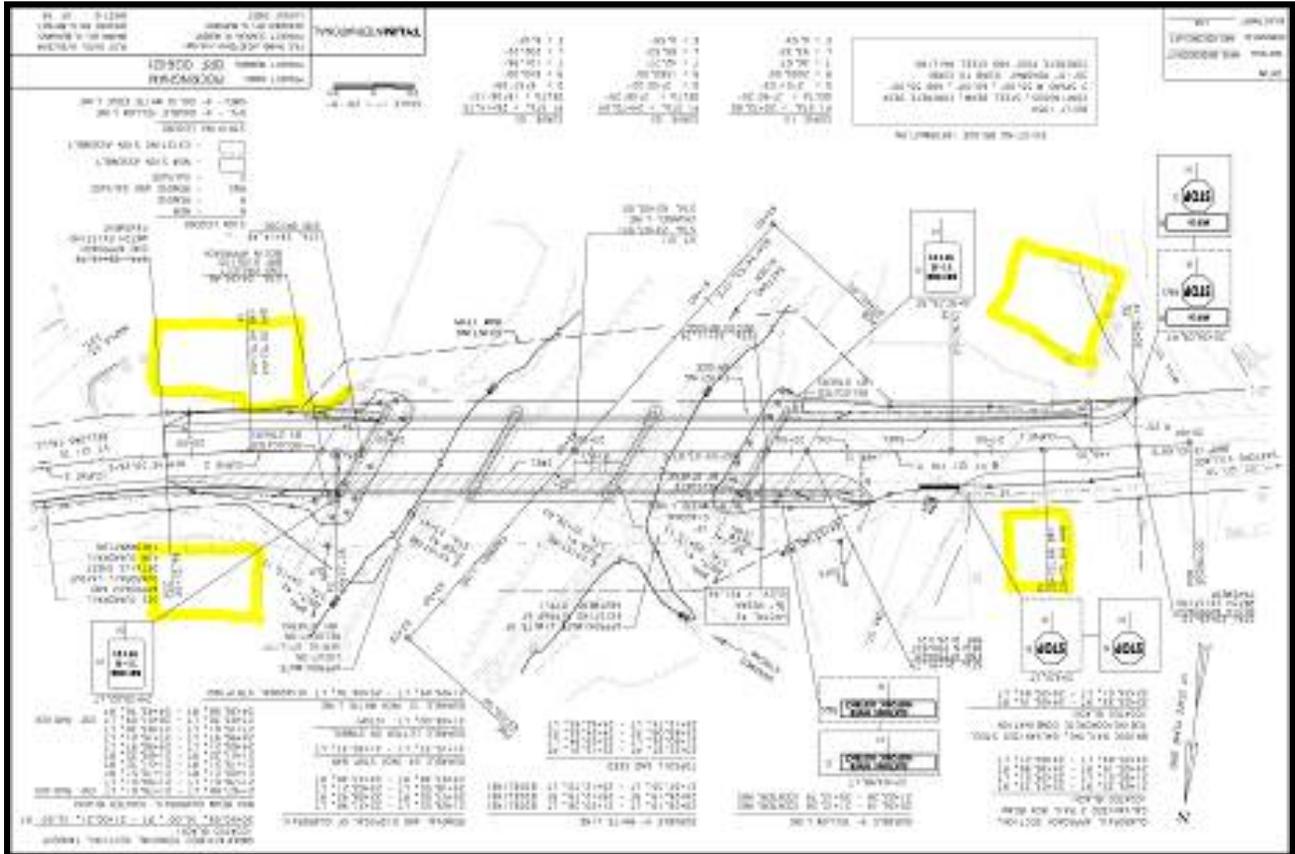
- 1) Data collection from each seismograph will be recorded at the end of each shift. An event log will be documented on an event log associated with each seismograph. (See sample event log on page 4) This log will be available to the resident engineer after each shift. A complete log will be recorded on the computer at the end of each day and sent to BECC Company and will be analyzed the next day. If in fact the field technician sees an event which exceeds or approaches a damage level, the resident engineer and construction company superintendent will be notified immediately. [56.(b)]
- 2) The Contingency plans for excessive wall or foundation movement will be determined by VOT engineers and Cold Rivers Bridges engineers. The “excessive wall or foundation movement” will coincide with the notification to the VOT engineers as a result of seismic monitoring and crack gauge monitoring.

V. Monitoring Activities

The majority of the monitoring activities will be concentrated on particular designated areas of concern that will be coordinated amongst the Vermont AOT personnel, the Vibration Consultant and the General Contractor. This will be done during the entire construction activity.

VI. Maximum Levels of Allowable Vibrations

Using four seismographs in the areas of highest sensitivities as designated by specifications and monitoring the vibration levels for a period of at least 60 hours will establish a basic line vibration. (see locations below)



## Sample Log

### VIBRATION MONITORING REPORT

#### Sample Log

Contractor  
**Cold River Bridges**  
Job Location  
**Rockingham BRF 0126(12)**

**BECC COMPANY**  
 28 Ledgewood Drive/Box 257  
 Yarmouth, ME 04096

Time	Activity
8:06	Set-Up
12:41	Take Down



SEISMOGRAPH UNIT: MiniMate  
 SERIAL# BE6468 CALIBRATED: 10/21/14  
 MODE/SETTINGS: Histogram-Combo

*VIBRATION CONSULTANT*

*[Signature]*

Time	PPV (in/sec)	Frequency (Hz)	dBl	Location	Distance
8:15	.072	23	112.8	Sample	115'
9:15	.007	8.8	115.9	"	"
10:16	.013	32	Out of range	"	"
11:10	.052	39	116.3	"	"
12:11	.012	5.2	Out of range	"	"

TECHNICIAN: Mike Sarrazin

JOB TIME AND TOTAL HOURS: 5

DATE: 10/22/10 WEATHER/COMMENTS: Cold, Clouds *(Please Note: American Excavating was hammering at the time)*



### Event Report

**Histogram Start Time** 9:42:48 AM January 4, 2012  
**Histogram Finish Time** 11:21:13 AM January 4, 2012  
**Number of Intervals** 393.00 at 15 seconds  
**Range** Geo: 1.25 in/s  
**Sample Rate** 1024sps

**Serial Number** BE6437 V 10.20-8.17 MiniMate Plus  
**Battery Level** 6.1 Volts  
**Unit Calibration** June 1, 2011 by Instantel  
**File Name** H437E3FE.ZC0

**Notes**

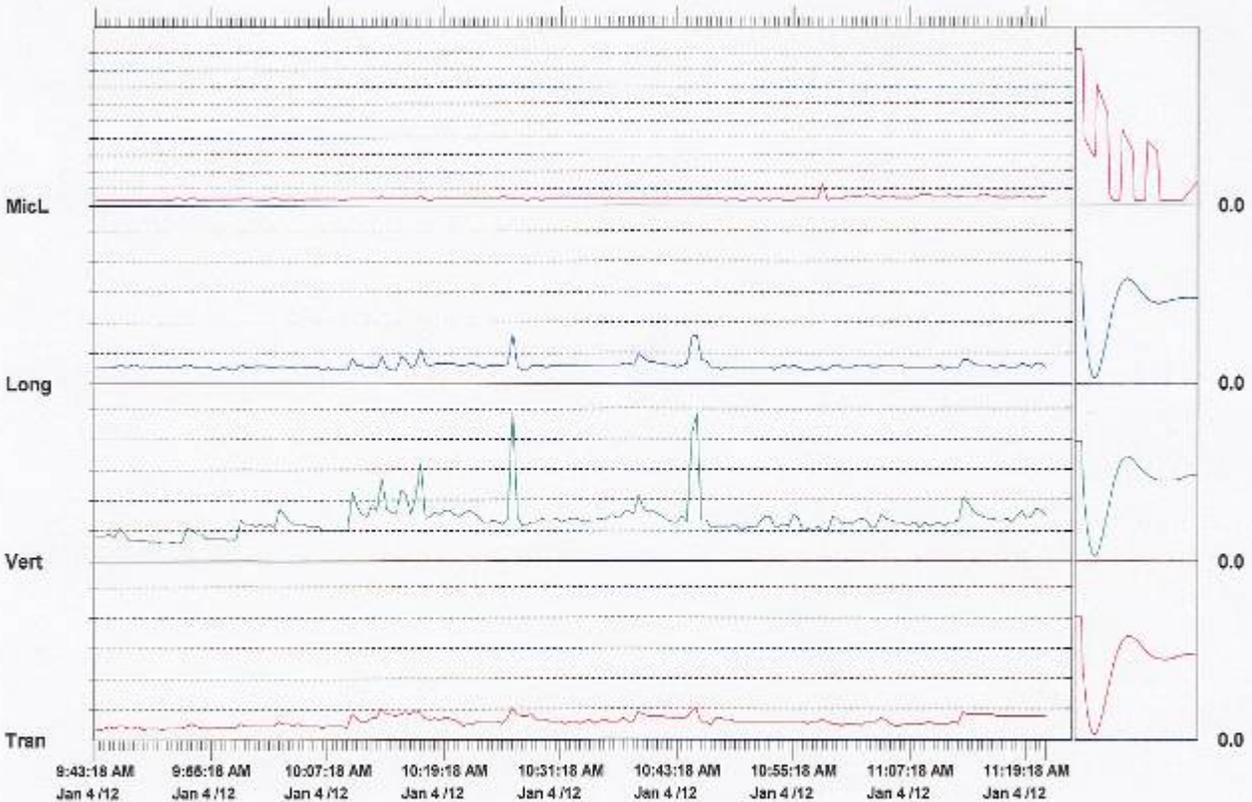
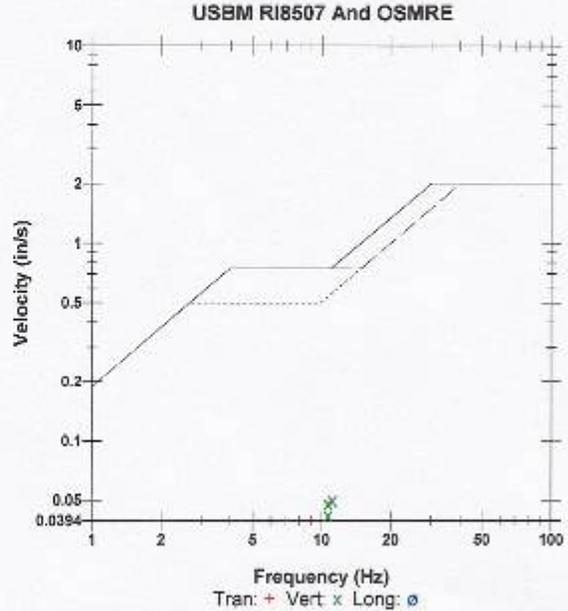
**Monitor Location:** 100ft NW Bridge Abutment  
**Client:** Cold River Bridges  
**Location:** Rockingham, VT  
**User Name:** BECC Company/Alex Gilbert

**Extended Notes**

**Microphone** Linear Weighting  
**PSPL** 108.5 dB(L) on January 4, 2012 at 10:58:03 AM  
**ZC Freq** >100 Hz  
**Channel Test** Passed (Freq = 19.7 Hz Amp = 689 mv)

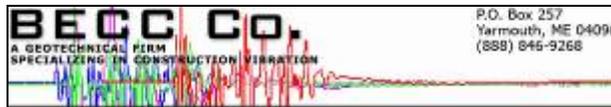
	Tran	Vert	Long	
PPV	0.01000	0.0500	0.0162	in/s
ZC Freq	12	11	12	Hz
Date	Jan 4 /12	Jan 4 /12	Jan 4 /12	
Time	10:12:33 AM	10:26:18 AM	10:26:18 AM	
<b>Sensor Check</b>	Passed	Passed	Passed	
Frequency	7.3	7.5	7.5	Hz
Overswing Ratio	4.2	4.0	4.1	

**Peak Vector Sum** 0.0501 in/s on January 4, 2012 at 10:26:18 AM



**Time Scale:** 30 seconds /div **Amplitude Scale:** Geo: 0.01000 in/s/div Mic: 0.00050 psi(L)/div

Sensor Check



### Levels of Comparison

In the following table a very basic comparison of vibration response as compared with everyday activities. (Note: this is a blasting vibration comparison)

Loading Phenomena	Site (a)	Micro strain Induced by Phenomena (uin/in)	Corresponding Blast Level (b)	
			(in/sec)	(mm/sec)
Daily Environmental changes	K1	149	1.2	30.0
	K2	385	3.0	76.0
Household Activity				
Walking	S2	9.1	0.03	0.8
Heel drops	S2	16.0	0.03	0.8
Jumping	S2	37.3	0.28	7.1
Door Slams	S1	48.8	0.50	12.7
Pounding Nails	S12	88.7	0.88	22.4

- (a) K1 & K2 were placed across a taped joint between two sheets of gypsum wallboard
- (b) Blast equivalent based on envelope line of strain versus ground vibration.

### Dynamic Crack Monitoring Plan [55 (i)]

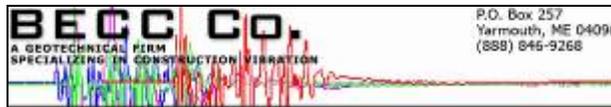
During the “Pre-Construction Building Inspections”, coordinated with the State Engineer the crack displacement monitoring gages locations will be determined.

The digital crack gauge is a valuable tool for measuring the movement of a cosmetic or structural crack during vibration causing events. Using Avongard crack gauge systems BECC Company working with the Vermont Field Engineers we will determine which cracks will be monitored. These crack gauge systems will yield both comprehensive dynamic and environmental information on crack displacement. Dynamic data (recorded during a vibratory event) is essential for determining a crack's activity during excitation. Our crack gauge systems, which can measure crack movement with a resolution of 0.000004 inch, show if there is any correlation between crack movement and other vibration producing activities.

In conjunction with seismographic monitoring any movement will be photographed before each construction activity and at the completion of each day photograph each system. By reviewing the seismic activity one can determine if the movement is related to construction activity.

Early crack monitor methods could falsely confirm that a crack was inactive, unless drastic shifts occurred. Environmental factors are constantly exerting a significant and measurable force on structures. While these forces are small, their effects are cumulative and add up to visible crack movement over time. Research shows that environmental movement from temperature and relative humidity changes typically exceed movement from most vibratory sources by a large margin.

The accuracy of crack gauge system also gives it value as a public relations tool. Concepts like particle velocity and air overpressures are often hard to explain to people without industry expertise. Digital crack gauges take some of the mystery out of crack movement, providing clear, easy-to-understand answers to the question, "Did the crack get bigger or not?"



Publications:

**Construction Vibrations**; Charles H Dowding  
**Shock and Vibration Handbook, Fourth Edition**; Cyril M Harris

**Blasters' Handbook, Seventeenth Edition; ISEE**  
**Effects of Repeated Blasting on a Wood-Frame House**; Mark S Stagg, David E Siskind, Michael G Stevens and Charles H Dowding

**California Department of Transportation**  
**Noise, Vibration, and Hazardous Waste Management Office 1120 N Street, Room**  
**4301 (MS27)**  
**Sacramento, CA 94274 Contact: Jim Andrews**  
**Prepared by:**  
**Jones & Stokes 2600 V Street**  
**Sacramento, CA 95818 Contact: David Buehler, P.E.**

The qualifications for BECC COMPANY will be attached with this submittal.

Mr. D. C. Blakeman will oversee and analyze all vibration results based on past 35 years of experience.

The two field technicians how will be on the project monitoring will be:

- 1) Dwayne West; BECC's Senior Field Technician; 10 years of vibration monitoring on at least 80 projects.
- 2) Taylor LaPierre; BECC's Field Technician; 5 years of vibration monitoring on at least 30 projects.
  - A) All three of the above employees of BECC Company have been qualified by Maine Department of Transportation, New Hampshire Department of Transportation, Army Corp of Engineers and NOAA.

**Visit: [WWW.becccompany.com](http://WWW.becccompany.com)**

FEDERAL ID NUMBER 01-0380695

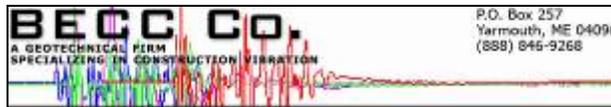
BECC Company, Inc. was organized and incorporated in 1981. The primary objective of the corporation is to complement the construction industry with general safety and Geotechnical expertise.

Since its inception BECC has performed Geotechnical and Construction Safety tasks for General Contractors, Subcontractors, Blasting Contractors, The Insurance Industry, Engineering Firms, Governmental Community and The Legal Community with expertise.

In 1985 BECC organized a Geotechnical, Seismographic, and Construction Vibration department. Our staff is associated with the U.S. Bureau of Mines, The World Construction Vibration Group, and the Civil Engineering Department at Northwestern University. BECC Company is an authorized INSTANTEL™ dealer for the Northeast and Mountain States since 1991. We maintain clients in Maine, New Hampshire, Vermont, Massachusetts, South Dakota, Montana, Wyoming and Colorado.

Additional information is available for specific corporation references.

Becc Company Inc.  
28 LedgeWood Drive  
PO Box 257  
Yarmouth ME 04096  
Phone: 207-846-9268  
888-846-9268  
Fax: 207-846-1405



**References:**

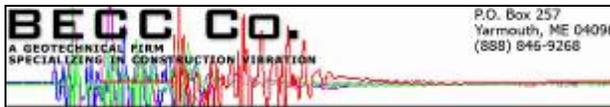
- Bechtel Company, Otis Eastern Service Inc, Welded Construction, Portland Natural Gas Transmission System (Portland Natural Gas Pipeline Construction Project)
- BIW Expansion Project (Atkinson Construction, Inner Space Services Inc)
- 3 sewer contracts City of Berlin (SCI, Paragon)
- 4 sewer contracts City of Manchester NH (S.E. MacMillan Company, Park Construction Company)
- 5 sewer contracts City of South Portland ME (each contract had a different Prime, Breascia Construction, S. E. MacMillian, R.D. Grondin and Sons, Cianbro Company, & Methuen Construction)
- Henniker Bridge-NH (Moores Marine Construction)
- Enfield Bridge Reconstruction (Miller Construction)
- Haley & Aldrich, GZA GeoEnvironmental
- Reed & Reed, Inc.
- Sanford Maine Sewer Department

(Contractors)

Blasting & General

Drilling & Blasting Rock Specialists  
 RD Edmunds  
 Allen Drilling & Blasting  
 Hill Drilling & Blasting  
 SCI Construction  
 American Explosives  
 Dyno New England  
 Sigler Drilling & Blasting  
 Dynamite Drilling & Blasting  
 Cianbro Corp  
 Frank Whitcomb Corp  
 Moores Marine  
 Abbot Brothers

Manter Company  
 Daniels Drilling & Blasting  
 Jamco  
 Procon Construction  
 Paragon Construction  
 J Parker & Daughters  
 Northeast Blasting  
 PDK Drilling & Blasting  
 McGoldrick Bros. Blasting  
 Sargent Corp  
 SUR  
 Miller Construction  
 Iby Drilling & Blasting



Dwight C. Blakeman  
 President Becc Co.  
 Supervising Administrator

**EDUCATION**

University of Maine	Orono, Maine	1973
BS: Forestry - Wood Science and Technology		
Minor: Civil, Structural Engineering, Business Law		
Casper College	Casper, Wyoming	1970
AS: Engineering/Geology		
St. John's Academy	Winfield, Kansas	1963
College Prep		

**BUSINESS EXPERIENCE**

**BECC Co., Inc. Yarmouth, Maine 1981-present**

President & Owner Organized and Incorporated BECC as a Geotechnical and safety organization.

- \* Handle all CEO responsibilities.
- \* Chief Consultant.
- \* More than 35 years in related construction industry.
- \* Over 40 years dealing with construction law and insurance.
- \* Organize and implement Pre-Construction safety consulting and expert Witness. (Court testified in MA, RI, NH, and ME.)

**The Dunlap Agency Auburn, Maine 1980-1981**

General Manager of Loss Control and Claims Administration Dunlap is an insurance agency that services Northern New England.

- \* Established and organized both the Loss Control and Claims Departments.
- \* Designed and implemented uniform reporting system.
- \* Wrote and coordinated comprehensive loss control and safety programs for Four firms. (Largest program implemented was L.L. Bean's.)
- \* Established liaison between large agency accounts and insurance company Claims manager.

**Blue Rock Industries Westbrook, Maine 1977-1980**

Director of Safety and EEO

- \* Personnel, safety, loss prevention, and EEO were the major responsibilities.
- \* Established and implemented complete safety - EEO - loss control program For company. Program produced a marked reduction of one truck Accidents. 30% reduction of each of 3 years as director of program.
- \* Wrote and implemented a program to satisfy all government regulation Changes, which included a complete EEO - Affirmation Action Program. Program enabled Blue Rock Industries to accept \$26 million in contracts.
- \* Worked with controller to reduce overall insurance cost by 15%.

**BUSINESS EXPERIENCE (continued)**

**U.S.F. & G. Portland, Maine 1973-1977**

Safety Engineer and Premium Auditor

- \* Responsible for general safety, loss control, and fire safety for all clients in NH and Southern Maine. Audited clients in Western and Northern NH.
- \* Had largest reduction percentage in New England (U.S.F. & G. insured) during last two years.

**Construction Worker 1968-1970**

Various companies

**U.S. NAVY 1964-1968**

Naval Air Crewman and Air Intelligence Operations



**EDUCATIONAL CERTIFICATES**

OSHA 500 course (qualified OSHA Regs Instructor)	1991
Revised Trenching - OSHA Seminar	1991
R&S - White - Blasting & Seismographic Institute	1987-1991
U.S. Department of Labor Professional Safety Seminar	1981-1989
DDC Instruction Massachusetts Safety Council	1981
Defensive Driver's Instructor Class	1981
Continuous OSHA Approved First Aid	1979-1981
Professional Safety Seminar - OSHA U.S. Department of Labor	1979
U.S.A. Mine Safety & Health Administration Instructor of Education	1978
American National Red Cross	1977-1980, 1983-1986
AGC Multimedia to Injured	
Graduated of Industrial Hygiene Course	1976
Graduate of Insurance Institute of America General Insurance Courses	1974

**PROFESSIONAL AFFILIATIONS**

Professional Member International Society of Explosive Engineers	1991 - Present
Member Maine Safety Council	1974 - Present
American Society of Safety Engineers (Professional Member)	1975 - Present
Member National Safety Council	1975 - Present
Member AGC's Safety Committee (Note: Chairman 1979 - 1981)	1977 - Present
Member Holmes Safety Council (Note: President)	1978 - Present
Member ASSE Construction Division	1984 - Present
Member Associated General Contractors	1977 - Present
Maine Insurance Adjuster Association	1980 - 1984

**PROFESSIONAL SEMINAR MODERATOR/LECTURER**

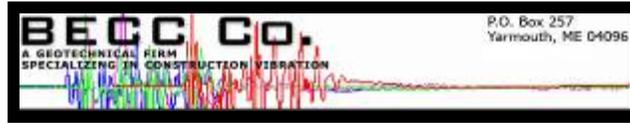
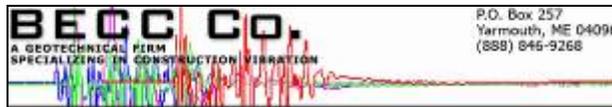
Associated General Contractors of Maine  
 Maine State Department of Labor - Safety Division  
 New Hampshire Department of Public Works  
 Maine Safety Congress  
 ASSE "Construction Safety"

**PROFESSIONAL RECOGNITION**

DuPonts Safe Blasting Award  
 U.S.F. & G. Safe Professional Award  
 AGS Safety Contribution Award

**BLASTING RELATED ACTIVITIES**

20 years of field related pre- post blast structural condition serves  
 18 years of blast monitoring and consultation  
 10 years as distributor of INSTANTEL™ blasting seismographs.  
 15 years of Geotechnical consultation for public and private blasting projects.



In addition to the enclosed CV I would like to add the following qualifications specifically concerning blasting safety as well as seismology.

During my tenure at U.S.F. & G. Companies the Loss Control Supervisor was an expert at Blasting and Blasting Safety. I enjoyed four year's of personal training and received invaluable field and technical claims experience regarding blasting and seismology. We were one of the first insurance companies in the Northeast to use seismographs regularly in the field. I took two formal courses on Blasting and Blasting Safety and Field Seismograph/Instrumentation Usage while employed at USF&G.

I carried that experience to Blue Rock Industries, where I worked with the Bureau of Mines, their insurance company, Dupont, MSHA and our Blaster to reduce blasting vibration damage. We did a great deal of blasting in quarries and in our trenching operations.

I attended two programs on Blasting and Blasting Safety at The Bureau of Mines training facility in Pittsburgh, PA during my employment at Blue Rock. My formal seismology training began shortly thereafter, first with the Department of Interior then later with Bureau of Mines.

I have since given training programs on Blasting and Blasting Safety for the State of Maine Safety Inspectors, AGC of ME and the State of Maine Safety Conference. Through Tufts University and Northwestern University I have associated with Professors in Seismology and Ph.D. that are presently practicing in the private arena.

In 1981 I organized Becc Co., Inc. and we have worked directly with construction companies blasting companies, engineering companies and insurance companies completing pre-blast surveys, setting up blasting programs, investigating blasting claims reviewing seismograph data and advising them on blasting claims. I have continued my education the blasting and seismographic fields and have gone to Chicago to meet with Prof. Dowding and to San Francisco to inspect the effects of various sizes of earth tremors.

A partial list of the companies that we have dealt with in the past is included in the enclosed materials. Specifically, in New Hampshire, we have worked with the Testing Department at NHDOT (the department that handles seismographs), City of Manchester, City of Berlin, City of Portsmouth, City of Laconia and several smaller towns through out the State. We have been qualified as seismologists in each of these towns.

The State of Maine as well as NOAA has qualified BECC Company to monitor for Fish Sound Disruption by Construction Vibration Companies.