Dynamic Properties of Stay Cables on the Bill Emerson Bridge

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FOREWORD

Cable-stayed bridges have become the design concept of choice over the past several decades for bridges in the medium- to long-span range. Nonetheless, in some cases, serviceability problems involving large-amplitude vibrations of stay cables under certain wind and wind/rain conditions have been observed. This study was conducted in response to State transportation departments' requests to develop improved design guidance for mitigation of excessive cable vibrations on cable-stayed bridges. The study included full-scale forced vibration tests on the cables of a new cable-stayed bridge to characterize cable dynamic behavior and evaluate effectiveness of mitigation details such as crossties. The results of this study will be made available to the Post-Tensioning Institute's DC-45 Cable-Stayed Bridge Committee for consideration during their periodic updates of its publication, *Recommendations for Stay Cable Design, Testing and Installation*.[1]

This report will be of interest to bridge engineers, wind engineers, and consultants involved in the design of cable-stayed bridges. It is the fifth in a series of reports addressing the subject of aerodynamic stability of bridge stay cables.[2–5]

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16. Abstract
Cable-stayed bridges have been recognized as the most efficient and cost-effective structural form for medium- to long-span bridges over the past several decades. With their widespread use, cases of serviceability problems associated with large amplitude vibration of stay cables have been reported.[2] Stay cables are laterally flexible structural members with very low inherent damping and thus are highly susceptible to environmental conditions such as wind and rain/wind combination.

Recognition of these problems led to the incorporation of different types of mitigation measures on many cable-stayed bridges around the world. These measures include surface modifications, cable crossties, and external dampers. Modification of cable surfaces has been widely accepted as a means to mitigate rain/wind vibrations. Recent studies have firmly established the formation of a water rivulet along the upper side of the stay and its interaction with wind flow as the main cause of rain/wind vibrations. Appropriate modification of exterior cable surface effectively disrupts the formation of a water rivulet.[6–9]

The objective of this study was to supplement the existing knowledge base on some of the outstanding issues of stay cable vibrations and develop technical recommendations that may be incorporated into design guidelines. Specifically, this project focused on identifying in-situ cable dynamic properties and performance of crossties on the Bill Emerson Bridge near Cape Girardeau, MO. Forced vibration tests were conducted on the stay cables during the latter stages of construction just prior to and following installation of grout as well as before and after installation of a single line of crossties. Cable properties, such as vibration frequencies and damping levels, were established and compared with design targets. The measured cable frequencies compared well with values calculated using standard formulas and numerical methods. The measured levels of inherent damping in the cables were low as expected, and the resulting low Scruton numbers confirmed the need for installation of cable crossties.

17. Key Words
Cable-stayed bridges, Cables, Vibrations, Wind, Rain, Crossties, Hazard mitigation

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviations

DOF	degree of freedom
EOM	equation of motion
FHWA	Federal Highway Administration
HDPE	high-density polyethylene
MoDOT	Missouri Department of Transportation
PSD	power spectral density

Symbols

A_n	Amplitude of in-plane displacement due to the *n*th mode of vibration
c	viscous damping coefficient per unit length
D	diameter of cable pipe
F_n	natural frequency of the *n*th mode of vibration
g	gravitational constant
H	pretension of string or cable
L	length of string or cable
L_1, L_2	chord length distance along cable to boxes 1 and 2
m	mass density per unit length
N	total number of modes
n	mode number
Sc	non-dimensional Scruton number
T_{dn}	damped natural period of the *n*th mode of vibration
t	time
u_n	time-dependent part of transverse displacement due to *n*th mode of vibration
$w(x,t)$	transverse displacement, w, at distance x and time, t
α_n	phase angle of time-dependent part of transverse in-plane displacement due to *n*th mode of vibration
δ	logarithmic decrement ratio
ζ	first-mode damping ratio
ζ_n	damping ratio of the *n*th mode of vibration
ρ	mass density of air

ω_n	natural angular frequency of the *n*th mode of vibration
ω_{dn}	damped natural angular frequency of the *n*th mode of vibration

CHAPTER 1. INTRODUCTION

Of particular importance to structural engineers and bridge owners is the dynamic behavior of a deck's supporting cables for cable-stayed bridges. These structurally critical components are often excited into several vibration modes by the ambient wind conditions. Studying the damped behavior of cables is fundamental to ensuring a safe and structurally sound system.

Stay cable vibration up to amplitudes of 6.5 ft (2 m) under conditions of moderate wind, sometimes in conjunction with light rain, has been observed with increasing frequency in recent years.(10) This problem is not new and has been studied extensively over a period of several decades; however, gaps remain in understanding the problem. With a growing inventory of cable-stayed bridges, reports of large amplitude cable vibrations have increased. Some structures have been retrofitted to mitigate these vibrations. Cable-stayed bridges under design and/or construction are currently incorporating dampers, crossties, and/or aerodynamic surface treatments into the cable system. While retrofits have been deployed to fix existing problems, and mitigation details have been evolving for new structural designs, few full-scale investigations have been conducted to either establish the detailed site/structure conditions or evaluate the effectiveness of mitigation measures. To fill the information gap, the Federal Highway Administration (FHWA) is performing long-term monitoring of cables on existing cable-stayed bridges and is conducting vibration tests on cables during various stages of construction on new bridges.

The Bill Emerson Bridge is a cable-stayed bridge near Cape Girardeau, MO. It carries four lanes of traffic across the Mississippi River and opened to the public on December 13, 2003. During construction, the Missouri Department of Transportation (MoDOT) and FHWA agreed to test the longer stay cables to determine their mode frequencies and damping ratio values both before and after the installation of crossties. A photo of the bridge taken from the riverbank is shown in figure 1.

Source: FHWA.

Figure 1. Photo. The Bill Emerson Bridge near Cape Girardeau, MO.

Four lines of crossties were installed in each cable fan based on specifications determined by the bridge designers. These short-term tests served to establish and benchmark cable properties such as vibration frequencies and inherent damping of each stay cable as well as the additional damping and stiffness provided by crossties installed on each cable. Information obtained in this study can be used, not only to assess if design objectives have been met, but also to catalog representative cable properties and for comparison with future measurements to determine if performance has changed, which could potentially require inspection and/or repairs.

CHAPTER 2. THEORETICAL BACKGROUND

VIBRATION OF TAUT STRING WITH DISTRIBUTED DAMPING

The transverse vibration of a taut string with uniformly distributed viscous damping can be described by the following equation in figure 2:[11]

$$m\frac{\partial^2 w}{\partial t^2} + c\frac{\partial w}{\partial t} = H\frac{\partial^2 w}{\partial x^2}$$

Figure 2. Equation. Equation of motion (EOM) for a string.

Where:

m = mass density per unit length.
$w(x,t)$ = transverse displacement, *w*, at distance, *x*, and time, *t*.
c = viscous damping coefficient per unit length.
H = pretension of the string.

For a string of length, *L*, fixed at both ends, $w(x,t)$ can be approximated by a finite degrees of freedom (DOF) system as defined in figure 3 as follows:

$$w(x,t) \cong \sum_{n=1}^{N} \sin\frac{n\pi x}{L} u_n(t)$$

Figure 3. Equation. General solution of EOM.

Where:

N = total number of modes.
n = mode number.
L = length of string or cable.
u_n = time-dependent part of transverse displacement due to *n*th mode of vibration.
t = time.

The sinusoidal spatial functions $\sin(n\pi x/L)$ in figure 3 represent the normal modes for a string where $c = 0$. Substituting $w(x,t)$ into the equation in figure 2 and rearranging yields the equation in figure 4 as follows:

$$\ddot{u}_n(t) + 2\zeta_n\omega_n\dot{u}_n + \omega_n^2 u_n = 0 \text{ where } \omega_n = \sqrt{\frac{H}{m}}\frac{n\pi}{L} \text{ and } \zeta_n = \frac{c}{2m\omega_n}$$

Figure 4. Equation. EOM for a string.

Where:

ζ_n = damping ratio of the *n*th mode of vibration.
ω_n = natural angular frequency of the *n*th mode of vibration.

The equation in figure 4 represents the equation of motion for the *n*th mode vibration of the string, ω_n and ζ_n , respectively, which denote the corresponding natural angular frequency and damping ratio of the mode. It is to be noted that the equations for this *N*-DOF system are fully decoupled, and each mode can be handled separately. Using the standard solution technique for a single DOF system, a general solution to the equation in figure 4 is shown in figure 5 as follows:(12)

$$u_n(t) = A_n e^{-\zeta_n \omega_n t} \cos(\omega_{dn} t - \alpha_n)$$

Figure 5. Equation. General solution to EOM.

Where:

A_n = amplitude of displacement due to the *n*th mode of vibration.
ω_{dn} = damped natural angular frequency of the *n*th mode of vibration.
α_n = phase angle of displacement due to *n*th mode of vibration.

This damped natural frequency is related to the natural frequency by the following equation shown in figure 6:

$$\omega_{dn} \equiv \omega_n \sqrt{1 - \zeta_n^2}$$

Figure 6. Equation. Damped natural frequency.

DETERMINATION OF DAMPING RATIOS

The damping ratio, or the fraction of critical damping, ζ_n, can be estimated experimentally. In the logarithmic decrement method, the damping ratio is found by measuring the amplitude of two consecutive peaks of damped free vibration and computing their ratio.(12) It can be shown that the ratio between the two consecutive peaks of the vibration is given by the following expression in figure 7:

$$\frac{u_n(t)}{u_n(t + T_{dn})} = \exp(\zeta_n \omega_n T_{dn}) = \exp(\frac{2\pi\zeta_n}{\sqrt{1 - \zeta_n^2}})$$

Figure 7. Equation. Ratio of two consecutive peaks.

Where T_{dn} is the damped natural period of the *n*th mode, equal to $2\pi / \omega_{dn}$. Selecting two consecutive peaks u_i and u_{i+1} and taking the natural logarithm of the equation in figure 7, the expression for the logarithmic decrement, δ, is defined by figure 8 as follows:

$$\delta \equiv \ln\left(\frac{u_i}{u_{i+1}}\right) = \frac{2\pi\zeta_n}{\sqrt{1 - \zeta_n^2}}$$

Figure 8. Equation. Logarithmic decrement.

For lightly damped systems ($\zeta_n < 0.2$), the equation in figure 8 can be simplified to $\delta \cong 2\pi\zeta_n$. This simplification is valid for inherent damping ratios of most stay cables, which are almost always below 0.01. From this simplification and the equation in figure 8, the damping ratio can be obtained by the equation in figure 9 as follows:

$$\zeta_n \cong \left(\frac{1}{2\pi}\right)\ln\left(\frac{u_i}{u_{i+1}}\right)$$

Figure 9. Equation. Damping ratio.

The equation in figure 9 is valid for both displacement and acceleration decay curves for lightly damped systems.

CHAPTER 3. EXPERIMENTAL PROCEDURES

THE TEST BRIDGE

The Bill Emerson Bridge is a cable-stayed bridge that carries four lanes of traffic across the Mississippi River near Cape Girardeau, MO. The bridge, which opened to the public on December 13, 2003, connects Missouri State Route 34 and Route 74 to Illinois State Route 146. A map of the bridge site and the surrounding area is shown in figure 10. The total length of the bridge is 3,956 ft (1,206 m), including a cable-stayed unit of 2,086 ft (636 m). The bridge, which took over 6 years to complete, replaced the Cape Girardeau Bridge, a continuous through truss structure originally built in 1928 and shown in figure 11.

Figure 10. Map. Bill Emerson Bridge site.[13]

Source: FHWA.

Figure 11. Photo. The old Cape Girardeau Bridge before it was demolished.

Prior to completion of construction of the Bill Emerson Bridge, FHWA was requested to test the stay cables and determine their natural frequencies and damping ratios before and after the installation of crossties. An overview of the bridge plan is shown in figure 12, while figure 13 shows a cross section of the deck. The span cross section consists of a 96-ft (29.26-m)-wide deck supported by a 10-ft (3.05-m)-deep system of steel edge girders and transverse floor beams. The 83-ft (25.30-m) roadway includes two 12-ft (3.65-m) lanes in each traffic direction flanked by a 10-ft (3.05-m) shoulder on the right and a 6-ft (1.83-m) shoulder on the left. The two traffic directions are separated by a 3-ft (0.91-m) concrete barrier in the median.

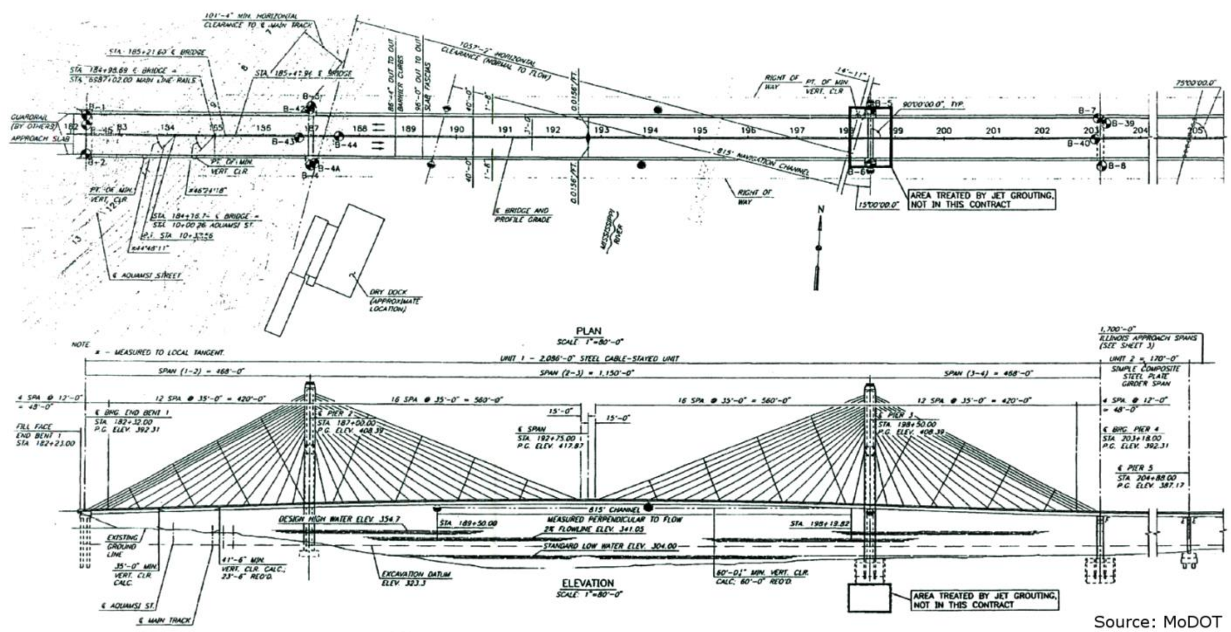


Figure 12. Illustration. Bridge plan and elevation.[14]

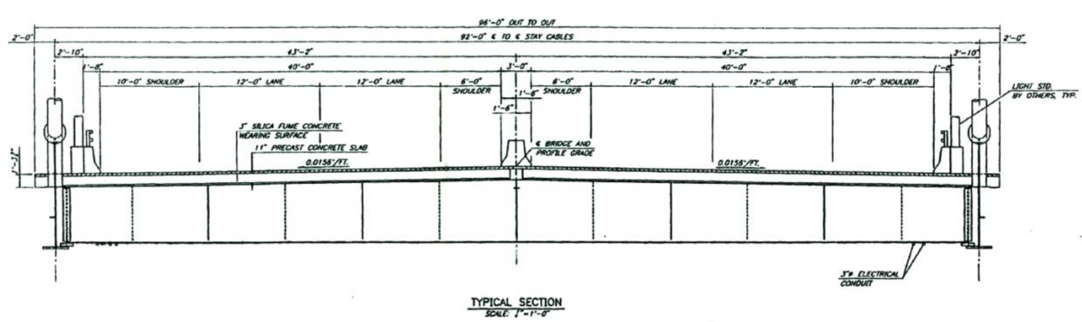
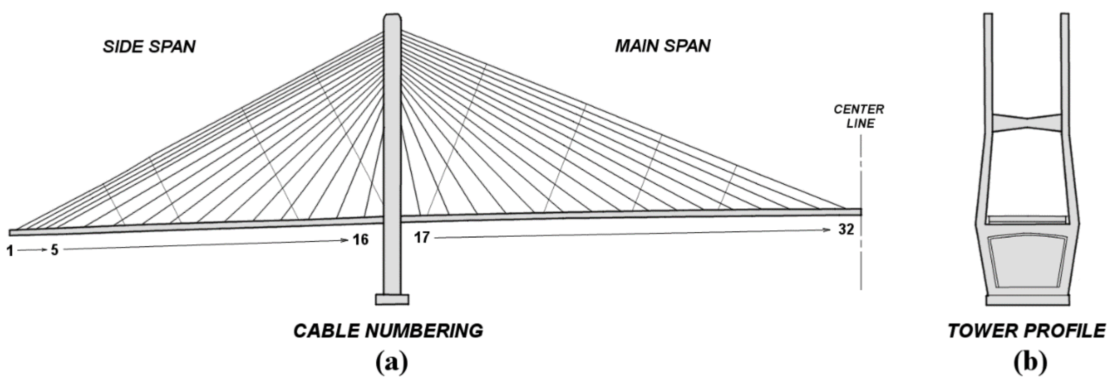


Figure 13. Illustration. Bridge main span cross section.[15]

The cable-stayed unit has two H-shaped towers (shown in figure 14) that are 348 ft (106 m) high with four fans of cables supporting the bridge deck. The four fans are symmetrical, each with 32 stay cables ranging in chord lengths from 133 to 588 ft (40.41 to 179.09 m) and with inclination angles ranging from 21.9 to 78.7 degrees. The five longest cables supporting the ends of the side spans are arranged in a parallel configuration, while the remaining cables are in a fan arrangement. A typical arrangement of stay cables in a quadrant of the bridge are shown schematically in figure 14 along with the numbering system used to identify each cable. Since the longitudinal axis of the bridge is essentially east to west, the two towers are characterized as either the east or west tower. Each tower supports a quadrant of cables on both the north and south edge of the bridge deck; therefore, the four fans are labeled NW, SW, NE, and SE. The cables are numbered from 1 to 32 in each fan, starting with 1 near the end of the cable-stayed unit and ending with 32 near the center. In this report, a cable is referenced by its fan and cable number (i.e., cable NW05). Cables 1 to 16 in each fan support the side spans of the bridge deck, while cables 17 to 32 in each fan support the main span of the bridge deck. Many figures in this report will reference the side span and main span of the cables.



Source: FHWA.

Figure 14. Illustrations. (a) A single fan of the Bill Emerson Bridge depicting the cable numbering system and (b) a profile of the tower.

The cables consisted of 19 to 54 steel wire strands surrounded by grout inside a high-density polyethylene (HDPE) pipe. At each end of the cables, there was a steel guide pipe with neoprene bushing. The HDPE pipe had four different outside diameters of 8.85, 7.87, 7.08, and 6.30 inches (225, 200, 180, and 160 mm) depending on the number of strands in the cable and had a double-helix spiral bead on the surface. Each 0.62-inch (15.7-mm)-diameter seven-wire strand was filled with grease and encased in an extruded HDPE sheath. It is worthwhile to note that the original design was for bare (i.e., uncovered) strands within the grouted stays; however, after the project was awarded, the state-of-practice on corrosion protection was shifting to the use of greased and sheathed strands without grout. Subsequently, the decision was made to switch to the greased and sheathed strands while still grouting the stays. Since the design had included the mass of the grout, and it had been bid in the contract, there was no compelling reason to eliminate it. A diagram of the numerous transitional elements of the stay cables is shown in figure 15. A steel anchor pipe, or guide pipe, extends from the steel anchorage assembly at the lower end of each stay cable. An HDPE overlap sleeve is used to make the transition from the guide pipe assembly to the primary HDPE pipe span, and the joint between steel and HDPE is sealed with a neoprene boot and steel bands. A neoprene damper, or bushing, was inserted inside each guide pipe to keep the steel strands properly spaced and to prevent the strands from contacting the pipe.

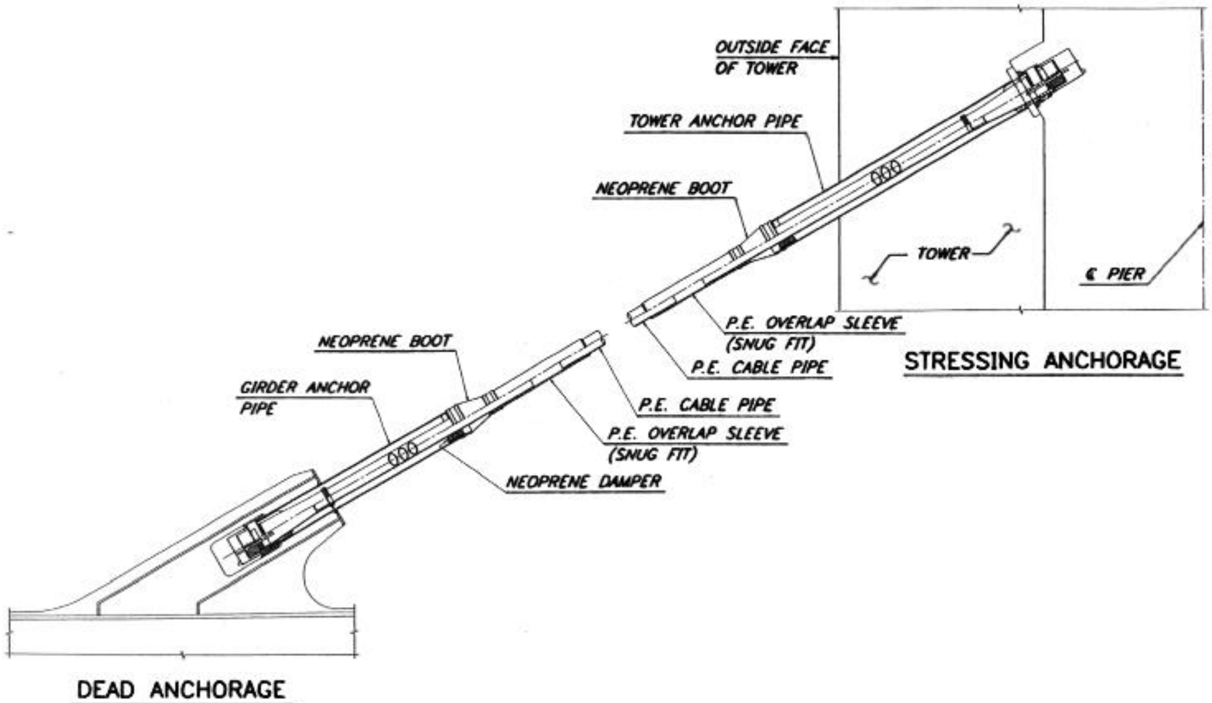
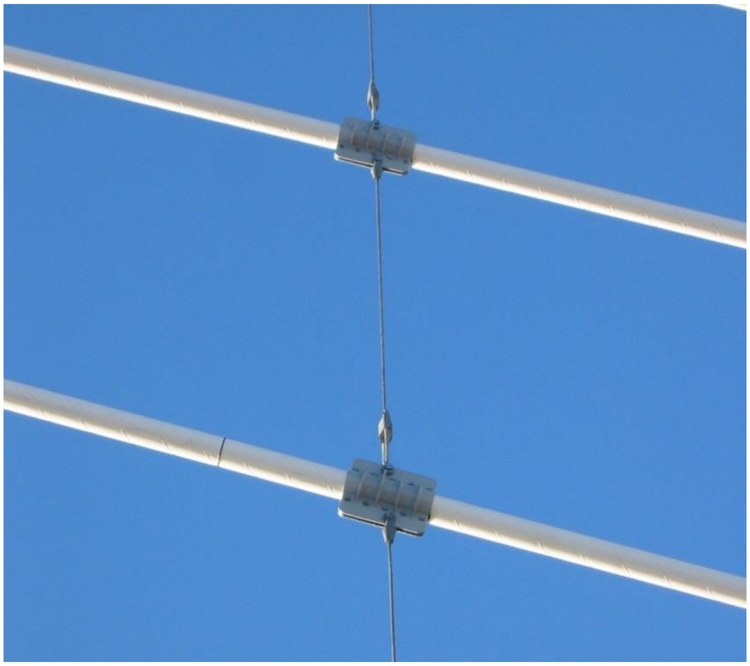


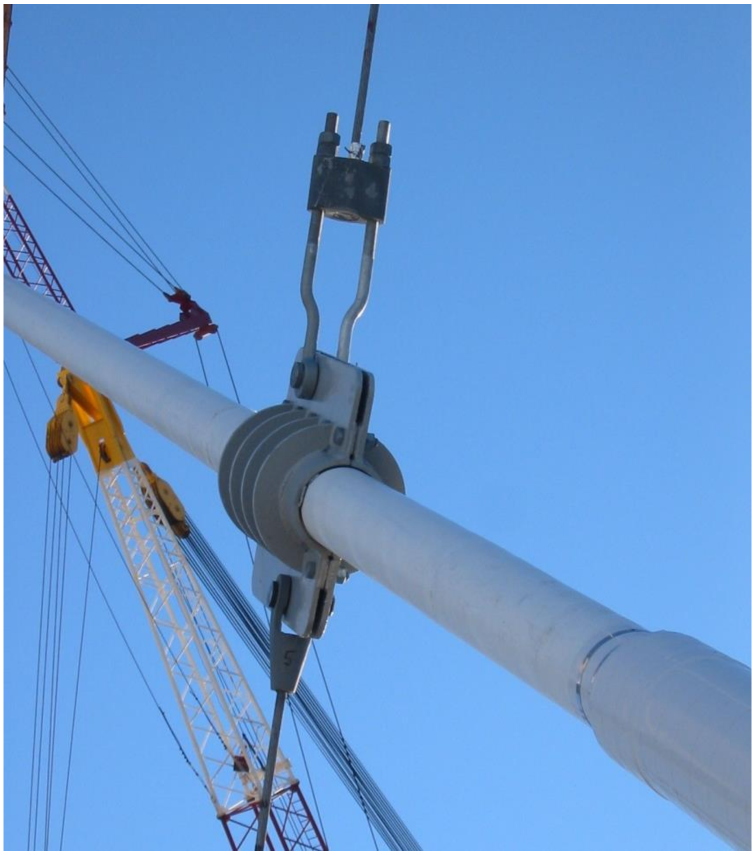
Figure 15. Illustration. Bridge stay cable assembly details.[16]

Eight lines of crossties were installed in each fan of cables with four lines on either side of the tower. A photo of a line of crossties connecting two stay cables is shown in figure 16. Each line was normal to the top stay and spaced along the cable, as shown in figure 14. Crosstie segments between stays consisted of 0.81-inch (2.06-cm)-diameter wire rope and were connected to each stay cable using a two-piece steel clamp. Each clamp was large enough to distribute transverse force on the HDPE pipe and had tie connections designed to minimize moment forces on the pipe. The segments contained an adjustable bolt assembly for introducing pretensions that range from 1.4 to 11.0 kip (6.23 to 48.93 kN). Details of the cable clamp and bolt assembly are shown in figure 17. Each line of crossties is anchored to the deck edge girder, as shown in figure 18.



Source: FHWA.

Figure 16. Photo. Crossties mounted on cables.



Source: FHWA.

Figure 17. Photo. Close-up view of the crosstie cable clamp and bolt assembly.

Source: FHWA.

Figure 18. Photo. Anchorage attaching the line of crossties to the deck.

SETUP AND PROCEDURES

Dynamic testing of the stay cables on the Bill Emerson Bridge was performed in three phases by staff from the FHWA Aerodynamics Lab. The first phase took place during the early stages of construction to establish the cable properties prior to installation of grout. The second phase was conducted about 1 month after the installation of grout was completed. The final phase was initiated after one line of crossties had been installed in several cable fans.

Data from the vibration testing were obtained by attaching dual tri-axial accelerometer boxes to each stay cable, the first box being 19 to 24 percent up the free length of the cable and the second being 9.5 to 11.5 percent up the length of the cable. The lower box, or enclosure, was positioned far enough away from the steel guide pipe to register significant oscillations, and the upper box was placed as high as possible on the cable and in a position that would avoid vibration nodes for the modes of interest. Figure 19 shows the accelerometers mounted on top of a stay cable, with the second one sitting further up the cable in the distance.

Source: FHWA.

Figure 19. Photo. Accelerometers mounted on cable with pull rope attached.

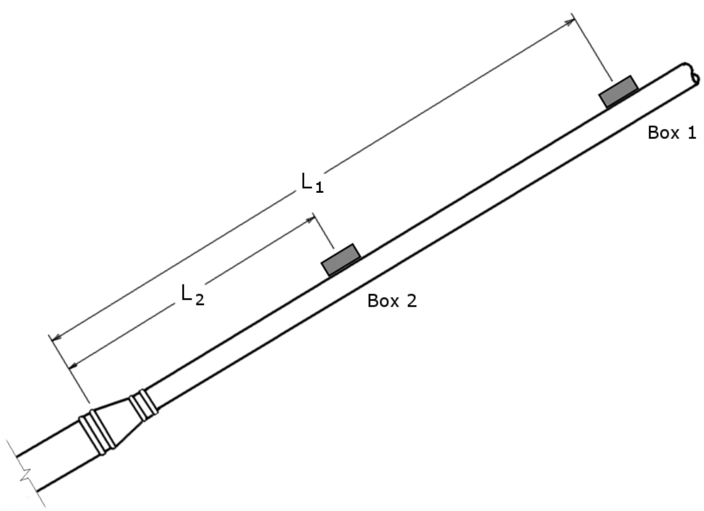
Multiple boxes ensured that useable data would be collected even in case of a malfunctioning sensor or if a sensor was inadvertently stationed at a frequency node. The accelerometers measured data from all three axes, although only data from the in-plane direction were required for analysis. The in-plane direction corresponds to the vertical plane of cables, which was measured as the z-direction on the accelerometer. Data from the accelerometers were recorded using a portable data acquisition system that was also connected to a vane-type anemometer to measure the wind direction and speed present during the test. In general, the anemometer was placed in the vicinity of the cables being tested and thus was moved about the bridge. The data acquisition system was connected to a generator for power and is shown in figure 20. The scan frequency used for both the accelerometers and the anemometer was 100 Hz.

Source: FHWA.

Figure 20. Photo. Data acquisition system.

The cables were manually excited in the vertical plane with a pull rope, while a spotter checked to make sure the proper amplitudes and modes were achieved. Positioned with a good view along the longitudinal axis of the cable under test, the spotter would signal the pullers to synchronize the pulling action with the cable motions. This approach enabled efficient excitation, vibrations primarily in the first vertical mode, and peak amplitudes of one cable diameter or more. When the cable reached a sufficient excitation, the rope was released, allowing the cable to freely oscillate and the vibrations to decay. The data acquisition system was triggered to start recording before the excitation was started and then continued recording until the decay subsided and only random traffic or wind-induced vibrations remained. Approximately 10 test runs were attempted on each cable.

In addition to the data recorded from the sensors, general test notes were taken regarding sensor locations, weather conditions, quality of the vibration modes achieved, traffic problems, interference from construction activities, and any difficulties encountered while exciting the cable. Figure 21 shows a diagram of a stay cable illustrating the distance each accelerometer was placed from the steel guide pipe, where L_1 and L_2 represent the distance along the cable to boxes 1 and 2, respectively. Table 1 contains a summary of the distances used during testing.



Source: FHWA.

Figure 21. Illustration. Location of accelerometers during testing.

Table 1. Summary of accelerometer locations.

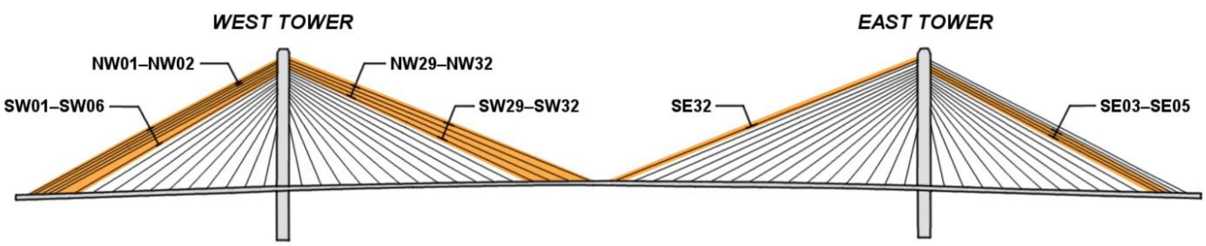
Cable	Phase 1		Phase 2		Phase 3	
	L_1 (ft)	L_2 (ft)	L_1 (ft)	L_2 (ft)	L_1 (ft)	L_2 (ft)
NW01	95.8	47.9	95.8	47.9	—	—
NW02	93.3	46.7	93.3	46.7	—	—
NW03	—	—	90.8	45.4	—	—
NW29	114.1	54.7	114.1	54.7	—	—
NW30	122.1	58.5	122.1	58.5	—	—
NW31	130.2	62.4	130.2	62.4	—	—
NW32	138.3	66.3	138.3	66.3	—	—
SW01	95.8	47.9	95.8	47.9	—	—
SW02	93.3	46.7	93.3	46.7	—	—
SW03	90.8	45.4	90.8	45.4	—	—
SW04	111.7	53.5	111.7	53.5	—	—
SW05	108.7	52.1	108.7	52.1	—	—
SW06	100.8	48.3	—	—	—	—
SW29	114.1	54.7	114.1	54.7	—	—
SW30	122.1	58.5	122.1	58.5	—	—
SW31	130.2	62.4	130.2	62.4	—	—
SW32	138.3	66.3	138.3	66.3	—	—
NE01	—	—	—	—	95.8	47.9
NE02	—	—	—	—	93.3	46.7
NE03	—	—	—	—	90.8	45.4
NE04	—	—	—	—	111.7	53.3
NE05	—	—	—	—	108.7	52.1
NE06	—	—	—	—	100.8	48.3
NE07	—	—	—	—	92.9	44.5
NE08	—	—	—	—	85.1	40.8
SE03	90.8	45.4	—	—	—	—
SE04	111.7	53.5	—	—	—	—
SE05	108.7	52.1	—	—	—	—
SE27	—	—	—	—	98.3	47.1
SE28	—	—	—	—	106.2	50.8
SE29	—	—	—	—	114.1	54.7
SE30	—	—	—	—	122.1	58.5
SE31	—	—	—	—	130.2	62.4
SE32	138.3	66.3	138.3	66.3	138.3	66.3

1 ft = 0.305 m.
—Indicates that no data are available.

CHAPTER 4. PHASE 1 INVESTIGATION

TESTING

Phase 1 testing of the stay cables on the Bill Emerson Bridge was conducted in 2003 in late September and early October before the installation of grout in the HDPE pipe. Measurements were taken on 20 of the longest stays located in 3 of the 4 fans. Construction logistics prevented a symmetrical sampling of cables. Testing began in the northwest quadrant of the bridge before moving to the southeast quadrant of the bridge and finally wrapping up in the southwest quadrant. For each quadrant, cables on the outer side span were tested first (1–16) before progressing to the inner cables of the main span of the bridge (17–32). Figure 22 shows the arrangement of the cables tested in phase 1 viewed from the south, with the north and south cables overlapping each other.



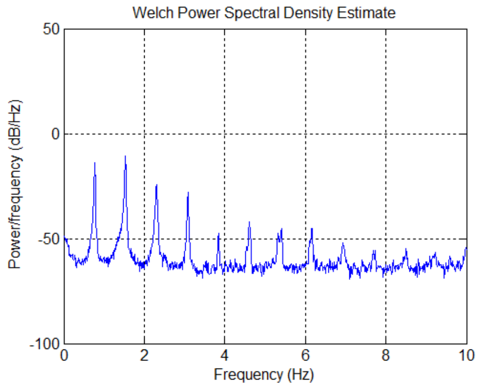
Source: FHWA.

Figure 22. Illustration. Arrangement of cables tested during phase 1.

ANALYSIS

Frequency Content

To determine the fundamental mode frequencies for each cable, an estimated power spectral density (PSD) analysis was performed on the time-history series for each individual run. The density was calculated in Matlab® using Welch's averaged modified periodogram method, which produces a one-sided density of frequency versus power per frequency with an acquisition frequency of 100 Hz.(17) The Welch function divides the input into eight segments with 50-percent overlap with each segment subjected to a Hamming window function. The average of the periodograms determines the PSD estimate. For these cable vibrations, the frequencies of interest were extremely low (i.e., in the single-digit Hz range). Appropriately, the density was graphed from 0 to 10 Hz, which contained the first 8 to 10 fundamental frequencies. Figure 23 shows a sample plot of the Welch spectral density plot.



Source: FHWA.

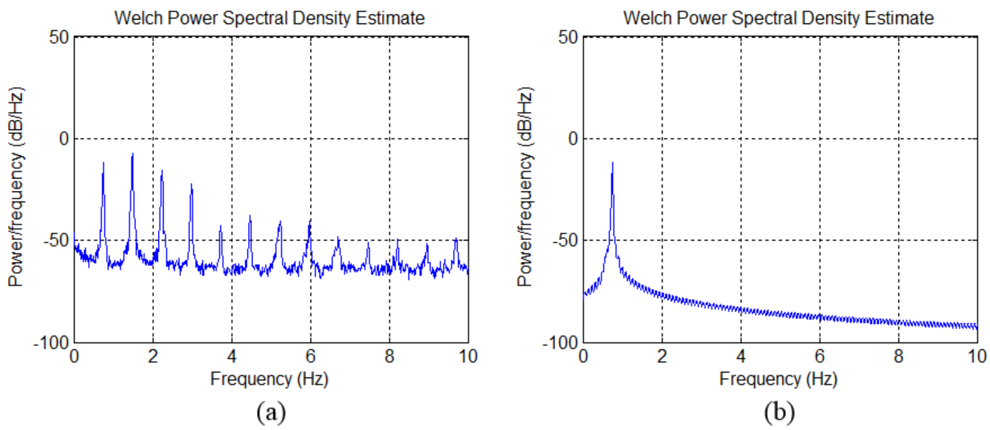
Figure 23. Graph. Phase 1 spectral density plot of cable SW02.

A cursor was placed on the plot and dragged along the points to determine the local maxima that corresponded to the natural frequencies. The frequencies were found with an accuracy of three decimal places for the first mode and two decimal places for the higher modes. The quality of the spectral density plots varied among the different runs. Some produced clear plots where each natural frequency could easily be recorded up to the 9th or 10th mode. Other plots were harder to interpret. Sometimes, the higher frequencies would lack distinct peaks, and other times, the energy would fall under a wider curve with multiple peaks. In these cases, some judgment was applied to determine which peaks were acceptable.

A table was compiled of the fundamental frequencies up to the seventh mode, if possible, for each time-series (see table 8 in appendix A). This was done for both accelerometer boxes. Usually, the frequencies were equivalent between the two boxes and across the separate runs for each individual cable, but they occasionally varied by a small percentage. At times, a judgment call was necessary when determining the average natural frequencies for a cable if it varied throughout the runs. If there were only a few outliers, the statistical mode was considered the average, but if there was greater variance among the runs, then the actual mean was calculated.

Damping Analysis

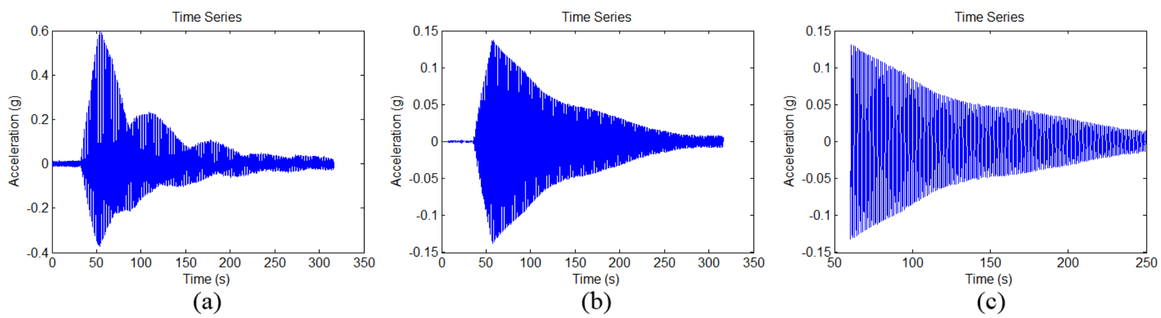
Once the fundamental frequencies were obtained for the first two modes, the damping ratios could then be calculated from the decay of the cable vibrations. Since the time-history for each run is the complex combination of numerous modes of vibration, a bandpass filter was used to isolate the decay associated with each mode. The bandpass frequencies were determined from the spectral density plot, choosing frequencies that closely encompassed the entire energy peak for the desired mode. A fourth-order elliptic filter was utilized on the signal twice to completely suppress the unwanted noise outside the band while effectively preserving the signal within the cutoff frequencies. An example of the elliptic filter’s effect on the spectral density plot of a data series is shown in figure 24.



Source: FHWA.

Figure 24. Graphs. The effect of the bandpass filter on the spectral density (a) before and (b) after for cable SW01.

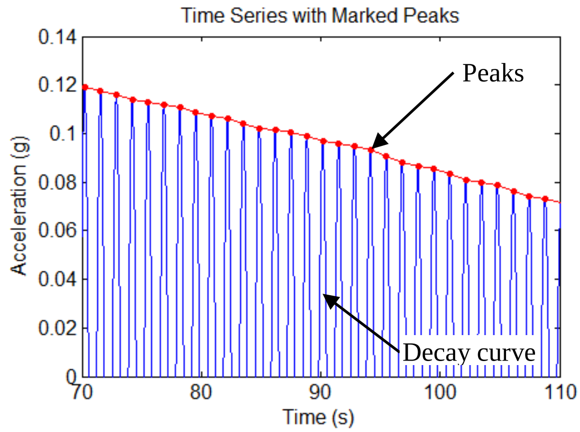
Once the bandpass filter had been applied, the time-series resembled a more consistent logarithmic decay. A time filter was also established to eliminate the data associated with the manual excitation at the beginning of the run and the random excitations prevalent after the decay had subsided. Figure 25 shows a comparison of the time-series before and after the bandpass and time filters were applied.



Source: FHWA.

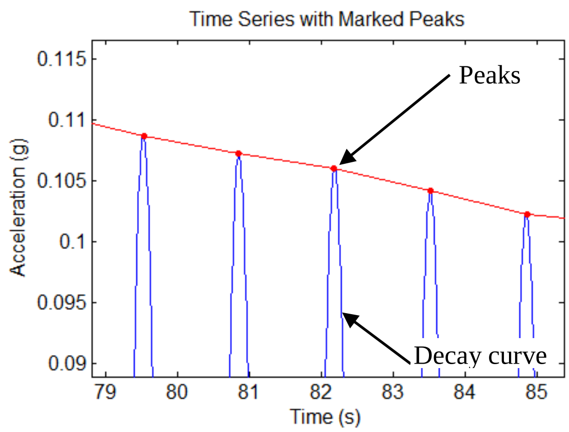
Figure 25. Graphs. Phase 1 plots comparing (a) the original time-series, (b) the bandpass filtered time-series, and (c) the truncated time-series.

After the logarithmic decay curve was revealed, the damping ratio could then be extracted using the equation from figure 9. Software created in Matlab® was used to mark both the positive and negative peaks along the sinusoidal curve and then take the natural log of the peaks.(17) Since damping was found from the ratio between two distinct, consecutive peaks, and that ratio varied throughout the run as the peaks varied, a regression line was fitted to the data to minimize random errors. An average damping ratio was then calculated from this best-fit line. A close-up of the software capturing the peaks from phase 1 testing of cable SW01 run 1 and the resulting regression line are shown in figure 26 through figure 29.



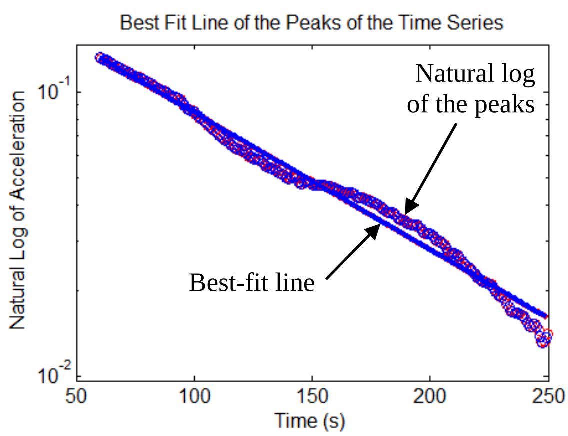
Source: FHWA.

Figure 26. Graph. Marked peaks of the decay curve.



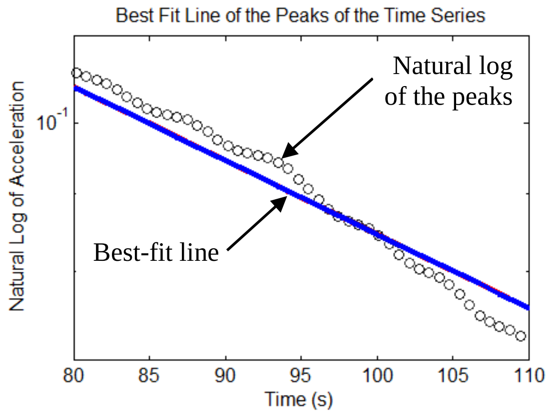
Source: FHWA.

Figure 27. Graph. Closer view of the marked peaks.



Source: FHWA.

Figure 28. Graph. Best-fit line of the natural log of the peaks.



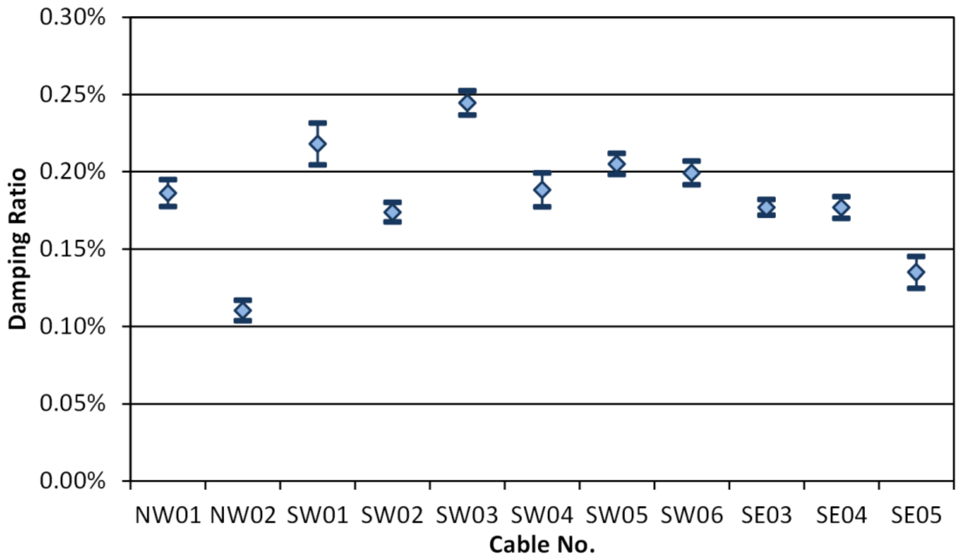
Source: FHWA.

Figure 29. Graph. Closer view of a 30-s interval of the best-fit line of the peaks.

To determine the effectiveness of the best-fit line, the correlation was noted between the regression line and the actual peak data points. In general, the correlation throughout the runs was extremely high, usually averaging over 0.990 for the first mode. In most cables, the average correlation was even higher, averaging between 0.994 and 0.997, although one cable's dataset only averaged 0.985. While that number still appears impressive, it was difficult to accurately fit a line with that much variability in the decay.

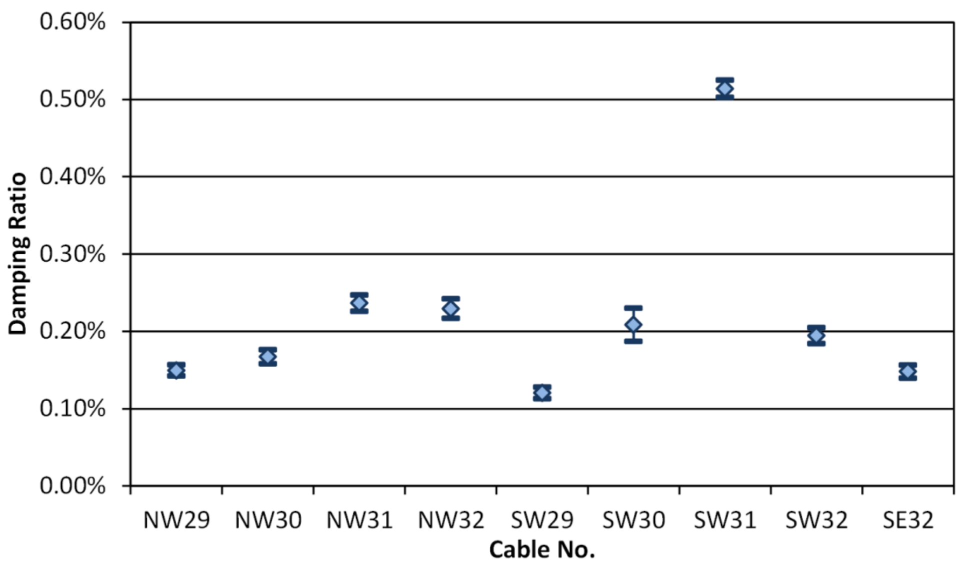
The correlation was also important because it helped determine the length of the sample. The length of the decay was chosen to extend for as long as possible before random vibrations affected the signal. The best-fit line and correlation numbers helped determine when the damping ended and when the logarithmic decay assumption was no longer valid. The length of the decay curve varied greatly among the runs, with the second frequency mode experiencing greater variability than the first. While the first frequency mode generally averaged around 100 to 260 s, the second frequency mode varied between 35 to 300 s.

After the best-fit line was established, the damping ratio could be identified for each cable. The number of runs performed for each cable varied between 9 and 10, although cable NW29 was only tested 5 times. Due to the small number of available sample datasets for each cable and the fact that the population mean and variance were both unknown, the Student-*t* test was used to find a 90 percent confidence interval on the mean.[18] This statistical process was performed for every cable for both the first and second modes, and graphs of the results are shown in figure 30 through figure 33. The results are grouped by the outer side span cables (1–16) and the inner main span cables (17–32). Table 2 contains a summary of the damping ratio, correlation, and frequencies for each cable.



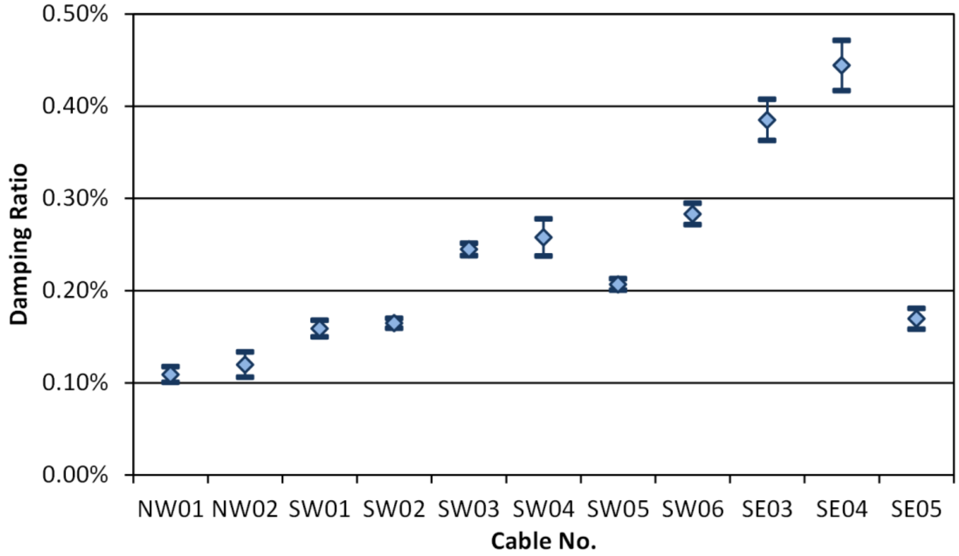
Source: FHWA.

Figure 30. Graph. Phase 1—first mode with 90-percent confidence interval on the mean for side span cables.



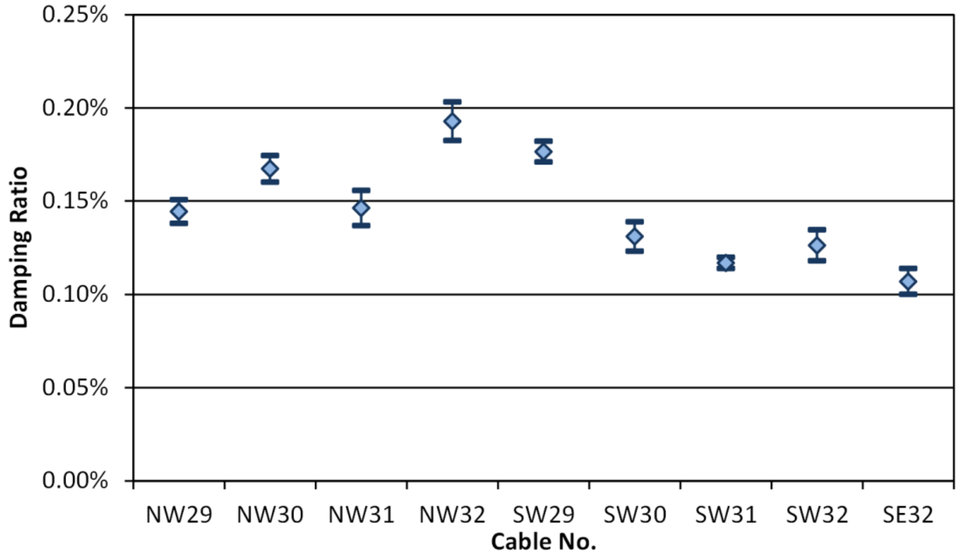
Source: FHWA.

Figure 31. Graph. Phase 1—first mode with 90-percent confidence interval on the mean for main span cables.



Source: FHWA.

Figure 32. Graph. Phase 1—second mode with 90-percent confidence interval on the mean for side span cables.



Source: FHWA.

Figure 33. Graph. Phase 1—second mode with 90-percent confidence interval on the mean for main span cables.

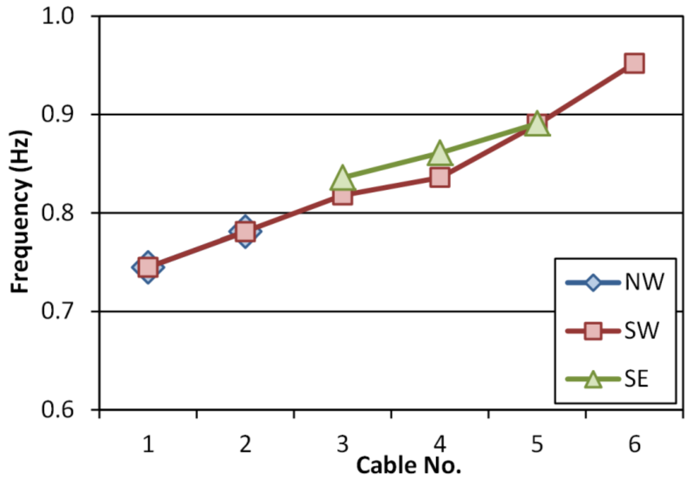
Table 2. Phase 1 summary of results.

Cable Number	First Mode			Second Mode		
	Average Damping Ratio (percent)	Correlation	Average Length of Time Sample (s)	Average Damping Ratio (percent)	Correlation	Average Length of Time Sample (s)
NW01	0.186	0.9934	159.4	0.109	0.9913	204.7
NW02	0.110	0.9976	231.8	0.120	0.8235	203.0
NW29	0.149	0.9944	259.0	0.144	0.9950	157.0
NW30	0.167	0.9957	203.5	0.167	0.9970	120.5
NW31	0.237	0.9596	176.0	0.146	0.9974	139.5
NW32	0.229	0.9914	91.0	0.193	0.9954	94.5
SW01	0.218	0.9909	96.5	0.159	0.9912	140.0
SW02	0.174	0.9973	222.5	0.165	0.9921	157.5
SW03	0.244	0.9971	137.0	0.244	0.9928	105.0
SW04	0.188	0.9938	176.1	0.257	0.9925	83.8
SW05	0.205	0.9947	167.5	0.207	0.9945	112.3
SW06	0.199	0.9972	173.0	0.283	0.9882	73.5
SW29	0.120	0.9967	256.5	0.176	0.9946	153.5
SW30	0.209	0.9852	100.8	0.131	0.9955	204.5
SW31	0.514	0.9929	68.0	0.117	0.9966	219.5
SW32	0.195	0.9931	98.3	0.126	0.9940	184.5
SE03	0.177	0.9975	210.6	0.385	0.9950	35.0
SE04	0.177	0.9974	206.8	0.444	0.9957	36.5
SE05	0.135	0.9970	228.8	0.169	0.9974	125.5
SE32	0.148	0.9963	265.0	0.107	0.9898	284.0

DISCUSSION

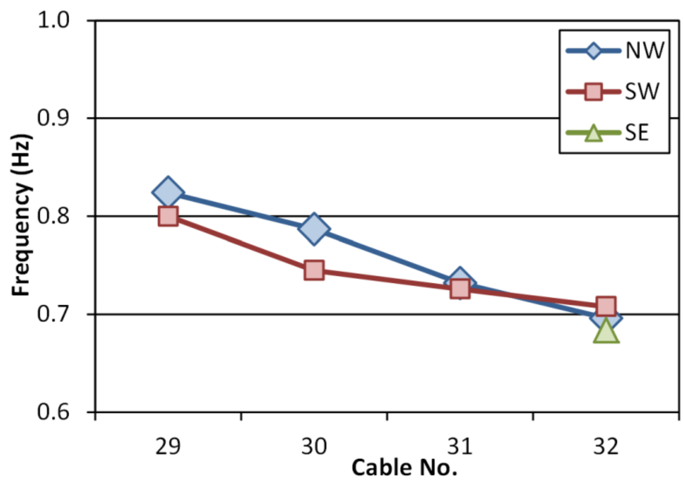
Frequency Content

The frequency trends obtained from the PSDs generally matched what would be expected. The fundamental frequencies increased as the length of the cable in each fan decreased. The longest cables supporting the main span of the bridge exhibited the lowest fundamental frequencies of all. First mode frequencies obtained from testing are shown in figure 34 and figure 35 for side and main span cables, respectively.



Source: FHWA.

Figure 34. Graph. First mode frequencies from phase 1 testing for side span cables.

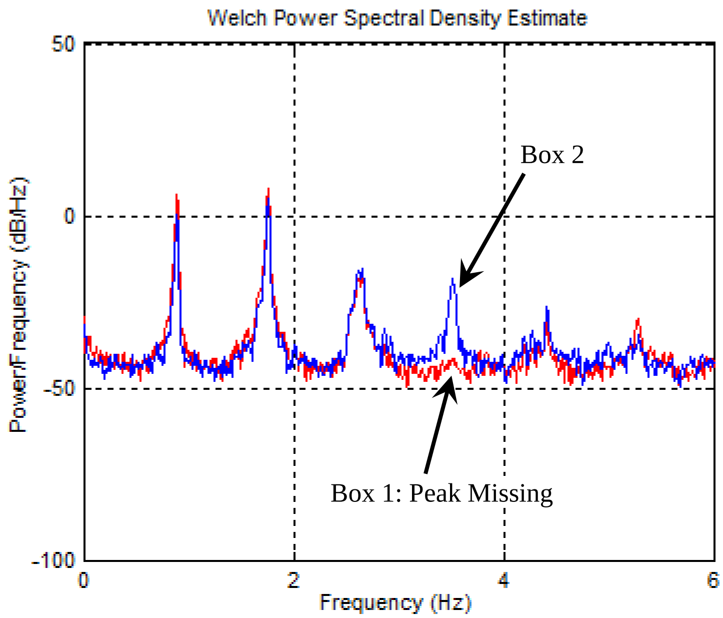


Source: FHWA.

Figure 35. Graph. First mode frequencies from phase 1 testing for main span cables.

Frequencies measured between the two accelerometers were usually in agreement although they occasionally varied by up to 2.5 percent. Similarly, the frequency measurements among the various runs for each cable were mainly consistent, with the maximum difference for any mode frequency for a cable in the range of 2 to 6 percent.

The data from most cables produced clear spectral densities, easily allowing the recording of the first seven harmonic frequencies in at least one of each cable's experimental runs. Some of the cables had frequency spectrums that became weaker after the first three harmonic frequencies, although the peaks were still distinct enough to obtain a value. The tests had several instances where one of the accelerometers was located at a node point of one of the higher frequencies, thus demonstrating the significance of using multiple boxes on the cable to record data. Figure 36 shows an example from cable SE05 where an arrow points to where the fourth mode frequency is not visible in the spectrum produced from box 1 but is visible in spectrum produced from box 2.



Source: FHWA.

Figure 36. Graph. Comparison of spectral densities of both boxes for cable SE05.

Although the various cables tested in phase 1 produced different qualities of spectral densities, all of them contained the most power within the first two modes of vibration.

Damping Ratios

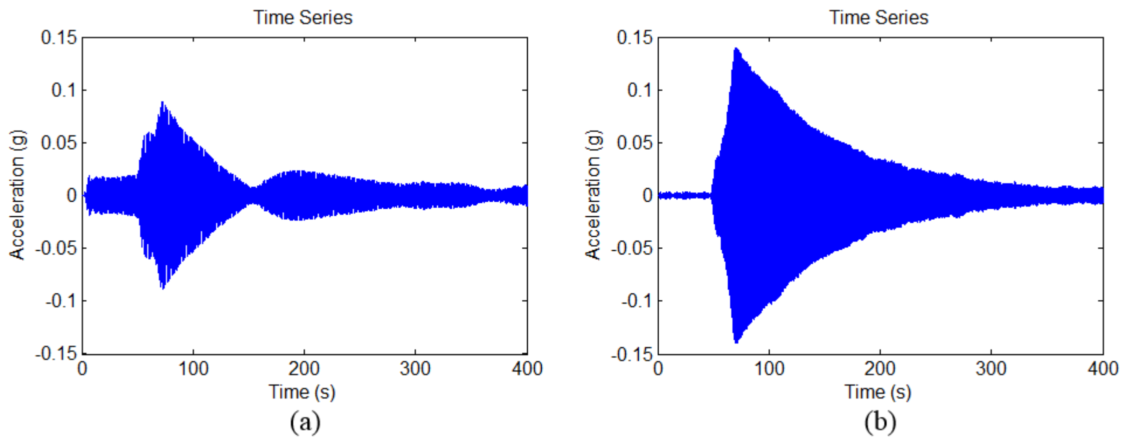
The damping ratios calculated for the stay cables experienced both a wide range of values and consistency. A handful of cables had very narrow confidence interval bands indicating extremely consistent decay in their time-series. Other cables did not contain equally uniform data, so their confidence bands stretched wider.

There was no correlation between damping ratio and cable length or other material properties. All but one of the mean damping ratios for the first mode were between 0.10 and 0.30 percent. Similarly, for the second mode, the majority of the mean damping ratios were also between 0.10 and 0.30 percent. All mean damping ratios calculated in phase 1 were under 0.55 percent.

Cable SW31 had the highest damping level in the first mode with a ratio of 0.51 percent. This particular cable also exhibited the shortest average length of a sample to calculate the ratio, with an average sample length of 68 s. As discussed previously, to most accurately determine the damping ratio, the longest length of the decay curve was used where the correlation remained over 0.990. By using these criteria, 75 percent of the average sample lengths were between 130 and 265 s.

The five cables that had shorter average sample lengths around 70 to 100 s all shared something in common. Even after applying the bandpass filter, they did not have a smooth decay curve for the first mode of damping. Each curve experienced a sinusoidal influence, indicating some sort of nonlinear behavior. For cable SW31, there was a sharp decay, after which vibrational amplitude increased with a bump after 70 s before flattening out with ambient vibrations.

However, for the second mode of damping, cable SW31 produced a smooth logarithmic decay that lasted almost 220 s with high correlation. Figure 37 compares the two damping curves from each mode. Not every one of these five cables produced such a strong similar decay in the second mode, but it trended that way. Similarly, the reverse could be true, with strong, smooth logarithmic decay in the first mode but choppy decay in the second mode that made it difficult to measure the appropriate damping curve.



Source: FHWA.

Figure 37. Graphs. (a) First mode and (b) second mode damping curves for cable SW31.

Scruton Number Analysis

Another widely used mass-damping parameter indicating the level of cable damping with respect to vibration mitigation is the Scruton number, *Sc*, defined by the equation in figure 38 as follows:

$$Sc = \frac{\zeta m}{\rho D^2}$$

Figure 38. Equation. Scruton number.

Where:

ζ = first-mode damping ratio.
m = mass density per unit length of cable.
ρ = mass density of air.
D = diameter of the cable pipe.(19)

The Scruton number is frequently used in developing a criterion for controlling rain/wind-induced vibration of stay cables. For instance, based on Irwin's suggestion, the Post-Tensioning Institute committee on cable-stayed bridges has suggested that rain/wind vibrations of stay cables can be avoided if the Scruton number is kept at a value of 10 or higher.(20,1) Additionally, a reduced Scruton number of five has been suggested if the cable has an aerodynamic surface treatment.(2)

Plugging the measured damping values presented in table 2 and the corresponding cable properties (found in appendix E) into the equation in figure 38 returns the following Scruton numbers shown in table 3. The Scruton numbers ranged from 1.2 to 6, far below the desired value of 10, indicating that the cable system under consideration was potentially vulnerable to rain/wind-induced (and perhaps wind-induced) vibrations. This would still be the case if a reduced Scruton number was used to account for the aerodynamic surface treatment. Based on these results, it was confirmed that an appropriate vibration mitigation measure, such as crossties, had to be incorporated into the cable system.

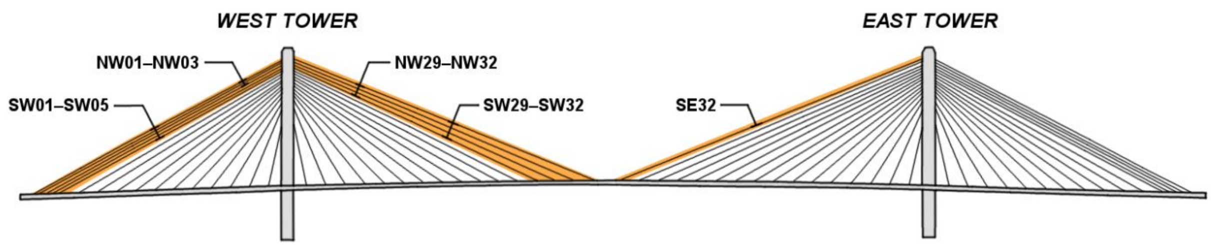
Table 3. Phase 1 Scruton number.

Cable Number	Scruton Number
NW01	2.2
NW02	1.3
NW29	1.5
NW30	1.8
NW31	2.8
NW32	2.7
SW01	2.6
SW02	2.0
SW03	2.7
SW04	1.9
SW05	2.0
SW06	1.9
SW29	1.2
SW30	2.2
SW31	6.0
SW32	2.3
SE03	1.9
SE04	1.8
SE05	1.3
SE32	1.7

CHAPTER 5. PHASE 2 INVESTIGATION

TESTING

Phase 2 testing of the stay cables on the Bill Emerson Bridge was conducted in 2003 in late October after the installation of grout in the HDPE pipe but before the installation of crossties. Although the original intent was to test the same cables as the previous phase, limitations presented by the ongoing construction resulted in some substitutions among the cables. Testing began in the northwest quadrant of the bridge, continuing with a single cable in the southeast quadrant, and then finishing in the southwest quadrant. Similar to the first phase, testing of the cables in a quadrant began in the outer side span first (cables 1–16) before progressing to the inner cables of the main span of the bridge (cables 17–32). Figure 39 shows the arrangement of the cables tested in phase 2.



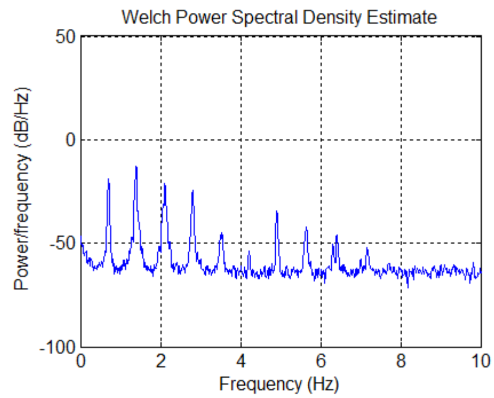
Source: FHWA.

Figure 39. Illustration. Arrangement of cables tested in phase 2.

ANALYSIS

Frequency Content

As in phase 1, spectral density analyses were used to determine the fundamental mode frequencies for each cable tested during phase 2. Once again, the spectral densities were calculated in Matlab® using Welch's averaged modified periodogram method and plotted on a scale from 0 to 10 Hz.[17] The mode frequencies were determined by tracing the peaks of the density plot. The data from phase 2 produced extremely clear spectrums, easily allowing frequencies up to the seventh mode to be recorded for each time-series. An example of the spectral density plot is shown in figure 40 for cable NW03. The complete table of frequency values for the testing done in phase 2 can be found in table 10 in appendix A.

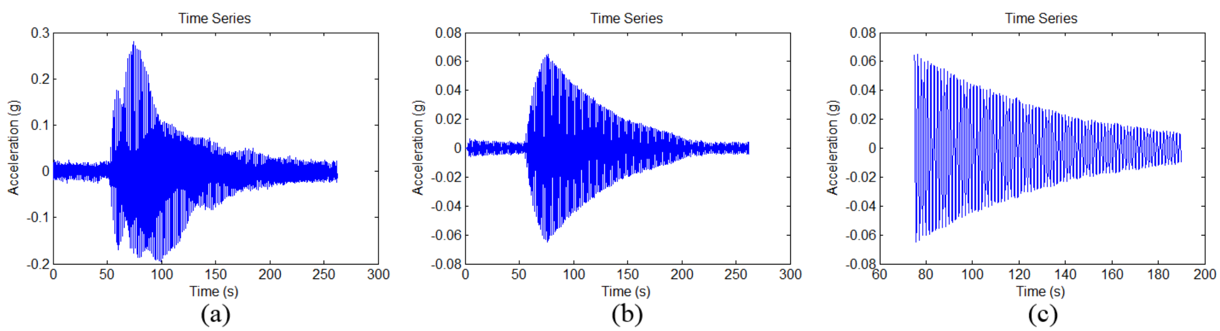


Source: FHWA.

Figure 40. Graph. Phase 2 spectral density plot of cable NW03.

Damping Analysis

The damping analysis for phase 2 testing utilized the same initial procedures outlined previously for phase 1. Figure 41 shows the effect of the bandpass and time filter on the newly grouted cable NW03.

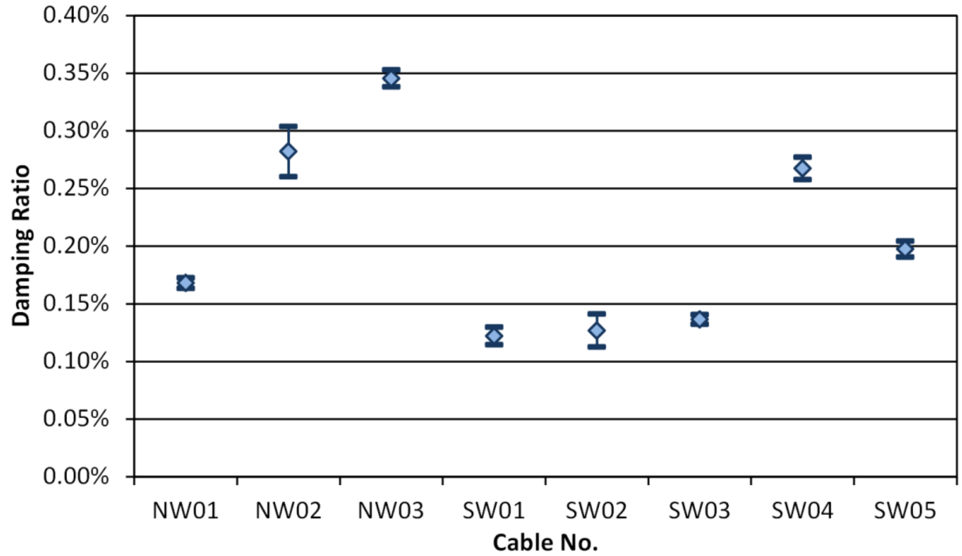


Source: FHWA.

Figure 41. Graphs. Phase 2 plots comparing (a) the original time-series, (b) the bandpass filtered time-series, and (c) the truncated time-series.

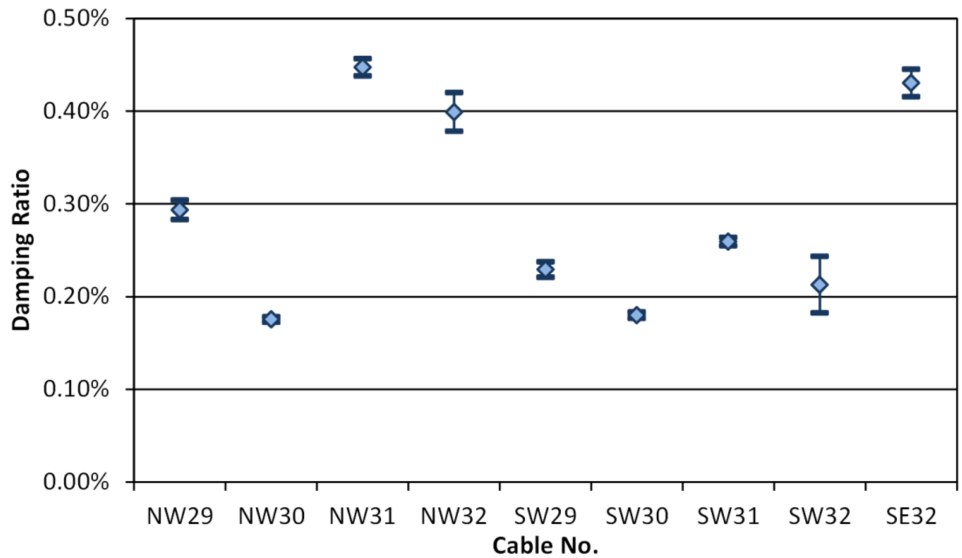
Once again, best-fit lines of the positive and negative peaks were used to determine the appropriate length of the decay curve. The correlation between the best-fit line and the peaks was kept above 0.990 by adjusting the length of the sample of the decay curve used. The length of the decay curves ranged between 75 and 260 s for testing done on the first mode and between 175 and 325 s for testing done on the second mode.

After best-fit lines were established for each cable run, the damping ratios could again be calculated and then averaged for each individual cable. During phase 2 testing, the number of runs performed for each cable was between 8 and 10 runs. Again, the Student-*t* test was utilized to find a 90 percent confidence on the mean of the damping ratio for each cable for both the first and second modes. Graphs of the results are shown in figure 42 through figure 45, while table 4 contains a summary of the damping ratio, correlation, and frequencies for each cable. The figures and table show the averaged data from the two boxes.



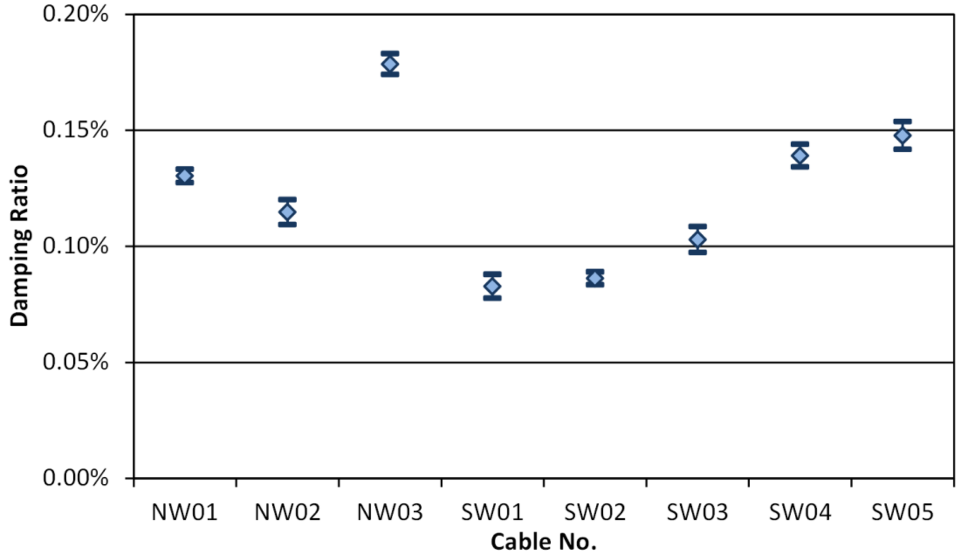
Source: FHWA.

Figure 42. Graph. Phase 2—first mode with 90-percent confidence interval on the mean for side span cables.



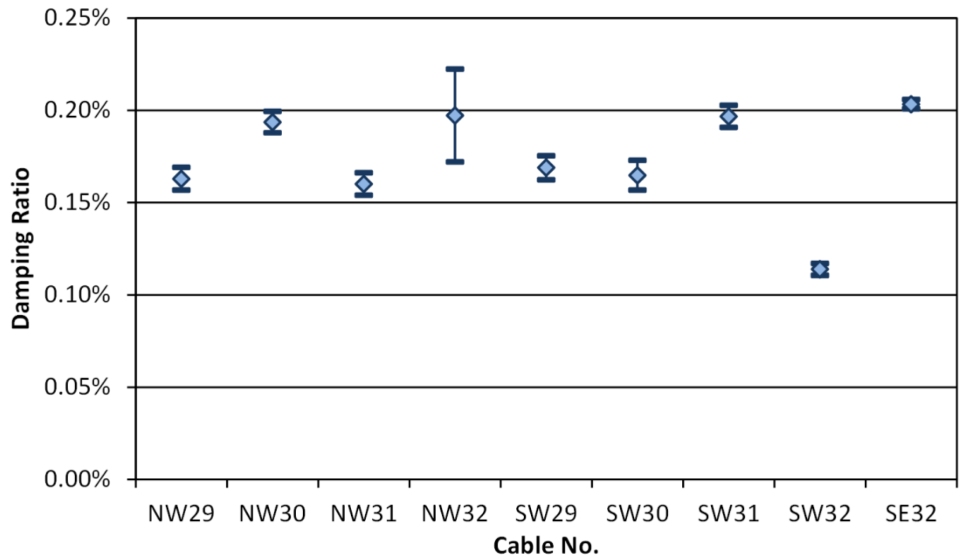
Source: FHWA.

Figure 43. Graph. Phase 2—first mode with 90-percent confidence interval on the mean for main span cables.



Source: FHWA.

Figure 44. Graph. Phase 2—second mode with 90-percent confidence interval on the mean for side span cables.



Source: FHWA.

Figure 45. Graph. Phase 2—second mode with 90-percent confidence interval on the mean for main span cables.

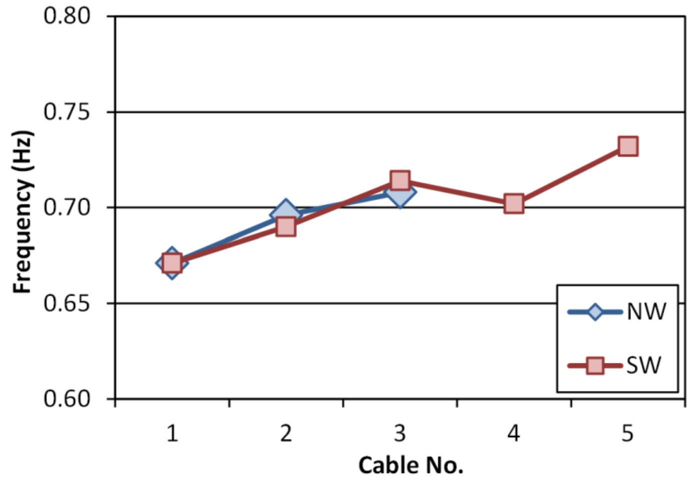
Table 4. Phase 2 summary of results data.

Cable Number	First Mode			Second Mode		
	Average Damping Ratio (percent)	Correlation	Average Length of Time Sample (s)	Average Damping Ratio (percent)	Correlation	Average Length of Time Sample (s)
NW01	0.168	0.9927	185.5	0.130	0.9973	235.0
NW02	0.282	0.9948	135.5	0.115	0.9976	241.5
NW03	0.345	0.9971	115.0	0.179	0.9983	157.5
NW29	0.293	0.9931	138.5	0.163	0.9969	177.0
NW30	0.175	0.9982	186.8	0.193	0.9909	150.0
NW31	0.447	0.9921	86.0	0.160	0.9966	194.5
NW32	0.399	0.9953	83.1	0.197	0.9783	171.3
SW01	0.122	0.9900	257.8	0.083	0.9977	325.0
SW02	0.127	0.9888	225.0	0.086	0.9961	311.0
SW03	0.136	0.9927	208.8	0.103	0.9981	238.1
SW04	0.267	0.9951	157.8	0.139	0.9980	226.8
SW05	0.197	0.9952	157.5	0.148	0.9978	187.5
SW29	0.229	0.9681	151.5	0.169	0.9929	158.5
SW30	0.180	0.9912	158.8	0.165	0.9960	168.0
SW31	0.259	0.9954	142.8	0.197	0.9965	161.0
SW32	0.213	0.9904	212.3	0.114	0.9979	264.5
SE32	0.430	0.9891	75.8	0.203	0.9983	176.1

DISCUSSION

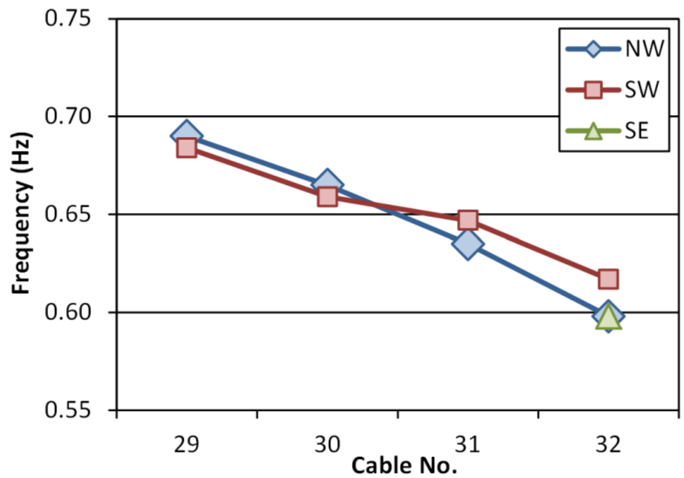
Frequency Content

Phase 2 testing also produced consistent results for frequency analysis. With the addition of grout, which both increased the mass and stabilized the cable by anchoring the steel strands within the HDPE pipe, the frequencies decreased slightly from phase 1 and produced clear spectrums into the higher frequencies. First mode frequencies obtained from testing are shown in figure 46 and figure 47 for side span and main span cables, respectively.



Source: FHWA.

Figure 46. Graph. First mode frequencies from phase 2 testing for side span cables.



Source: FHWA.

Figure 47. Graph. First mode frequencies from phase 2 testing for main span cables.

The frequencies measured between the two accelerometers were in agreement, with only one instance where the pair varied by more than 1 percent. Similarly, the frequency measurements among the various runs for each cable were mainly consistent, with the maximum difference for any mode frequency for a cable around 2 percent.

As mentioned previously, the accelerometer data obtained in phase 2 testing produced clear spectrums that easily allowed frequencies up to the seventh mode to be recorded. There were a few cases where one of the two accelerometer boxes was positioned at a node, and the energy peak was not measurable, as illustrated in figure 36. This occurred in both the SW02 and SW03 cables.

When viewing the spectral density plots, it is apparent that the most power is usually associated with the second mode of vibration, with both the first and usually the third modes showing strong peaks, as well.

Damping Ratios

Similar to phase 1, the damping ratios calculated during phase 2 testing experienced a wide range of values and consistency. Generally, the second mode damping values tended to be more consistent than the first mode values.

Once again, there did not appear to be any correlation between damping ratio and material properties or cable length. First mode damping ratios varied between 0.12 and just under 0.50 percent, while second mode damping ratios only varied from 0.08 to 0.20 percent.

The addition of grout to the cable not only increased the mass density and stabilized the steel strands from banging within the HDPE pipe, but it also seemed to have an effect on the damping curves. The sinusoidal effects that plagued damping ratio extraction for the phase 1 datasets were experienced less in phase 2, although a few cables still had this issue.

Second mode frequency peaks in the spectral density exhibited the most power, and the resulting second mode decay curves tended to be the easiest to extract damping ratios. Curves produced from the first mode were more likely to contain bumps or general variability in the vibrations. Despite the fact that the average sample size in the second mode was over 50 s longer, the average correlation among all the runs in the second mode was greater than the average correlation from the first mode.

Scruton Number Analysis

Damping values obtained during phase 2 testing were entered into the equation in figure 38 to calculate the resulting Scruton number. The results are shown in table 5. Although four of the cables had Scruton numbers over the desired reduced limit of five for cables with aerodynamic surface treatments, the rest of the tested cables had values between 2 and 5. Based on these results, it was confirmed that an appropriate vibration mitigation measure, such as crossties, had to be incorporated into the cable system.

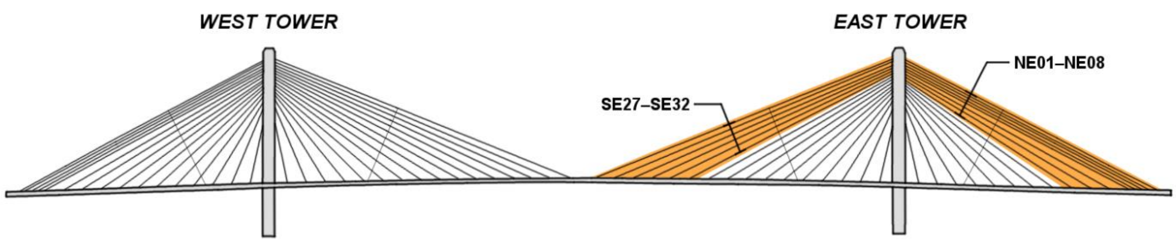
Table 5. Phase 2 Scruton number.

Cable Number	Scruton Number
NW01	2.8
NW02	4.8
NW03	5.7
NW29	4.7
NW30	2.9
NW31	7.6
NW32	6.8
SW01	2.1
SW02	2.1
SW03	2.3
SW04	4.3
SW05	3.1
SW29	3.7
SW30	2.9
SW31	4.4
SW32	3.6
SE32	7.3

CHAPTER 6. PHASE 3 INVESTIGATION

TESTING

Phase 3 testing of the stay cables on the Bill Emerson Bridge was conducted in 2003 in mid-November after both the installation of grout in the HDPE pipe and a single line of crossties. The final design called for four lines of crossties, but it was determined that the resulting complex network of cables would be too difficult to manually excite. As a result, testing a single line was chosen to explore its effects instead. Because of this limitation, only the northeast and southeast quadrants of the bridge were eligible for testing with a single line installed. Figure 48 shows the arrangement of cables tested in phase 3.



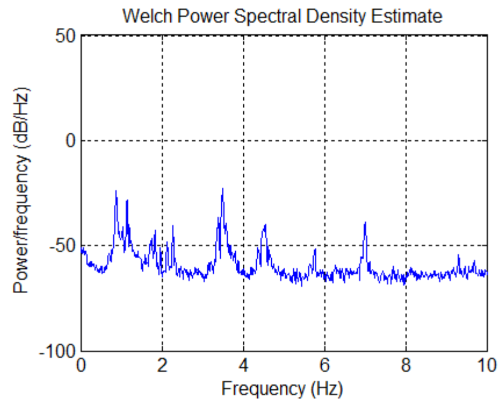
Source: FHWA.

Figure 48. Illustration. Arrangement of cables tested in phase 3.

ANALYSIS

Frequency Content

As in the first two phases, spectral density analyses were used to determine the fundamental mode frequencies for each cable tested during phase 3. The spectral densities were calculated in Matlab® using Welch's averaged modified periodogram method and plotted on a scale from 0 to 10 Hz.(17) The mode frequencies were determined by tracing the peaks of the density plot. Due to the single line of crossties now connecting the cables—thus creating a multi-DOF network of cables—the data from phase 3 produced complex spectrums containing both local and global modes. An example of the spectral density plot is shown in figure 49 for cable SE32. The complete table of frequency values for the testing done in phase 3 can be found in table 12 in appendix A.

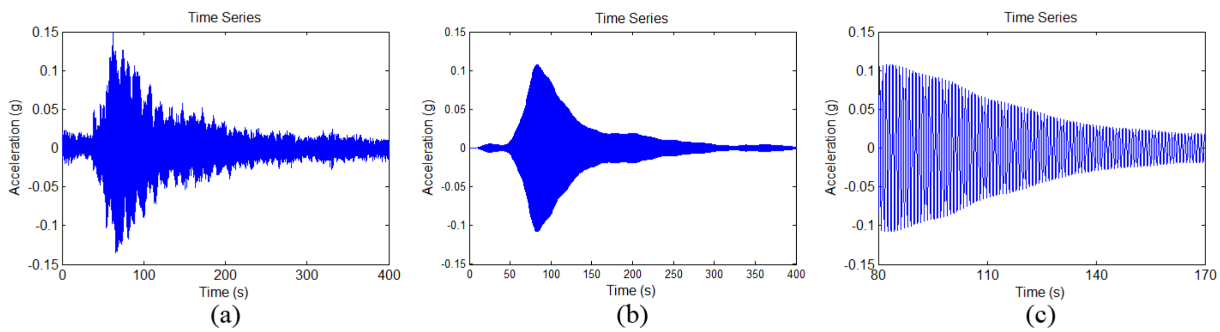


Source: FHWA.

Figure 49. Graph. Phase 3 spectral density plot of cable SE32.

Damping Analysis

The damping analysis for phase 3 testing utilized the same initial procedures outlined previously for phases 1 and 2. Figure 50 shows the effect of the bandpass and time filter on cable NE01, which is attached to a single line of crossties.



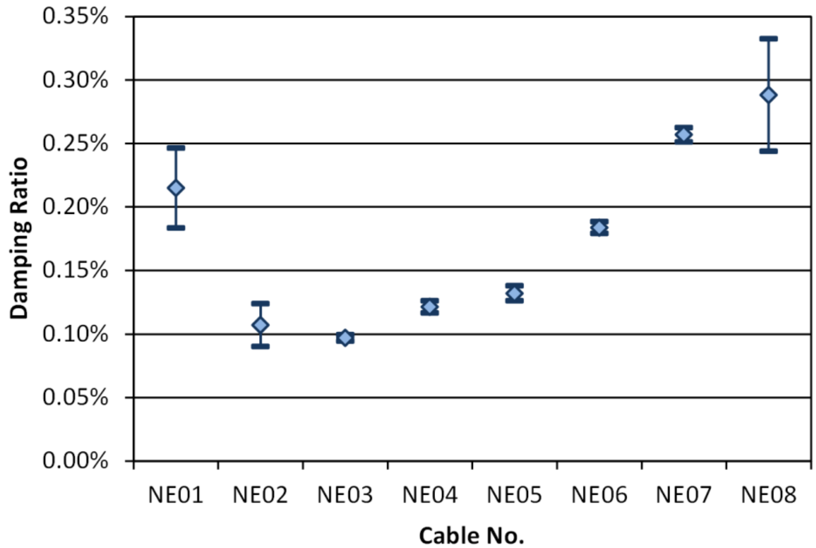
Source: FHWA.

Figure 50. Graphs. Phase 3 plots comparing (a) the original time-series, (b) the bandpass filtered time-series, and (c) the truncated time-series.

Once again, best-fit lines of the positive and negative peaks were used to determine the appropriate length of the decay curve. In the previous phases, the goal was to keep the correlation between the best-fit line and the peaks above 0.990; however, with the introduction of crossties, the decay data became extremely difficult to work with. There were only a few cases where correlation could be kept over the target value. For the first mode, 9 out of 14 cables tested had correlations under 0.990, and the second mode experienced even worse results. For the second mode, best-fit lines could not be established at all for two of the cables, and 9 of the remaining 12 cables had correlations below 0.990. For cables where best-fit lines could be established, the length of the decay curves ranged between 80 and 265 s for the first mode and between 25 and 185 s for the second mode.

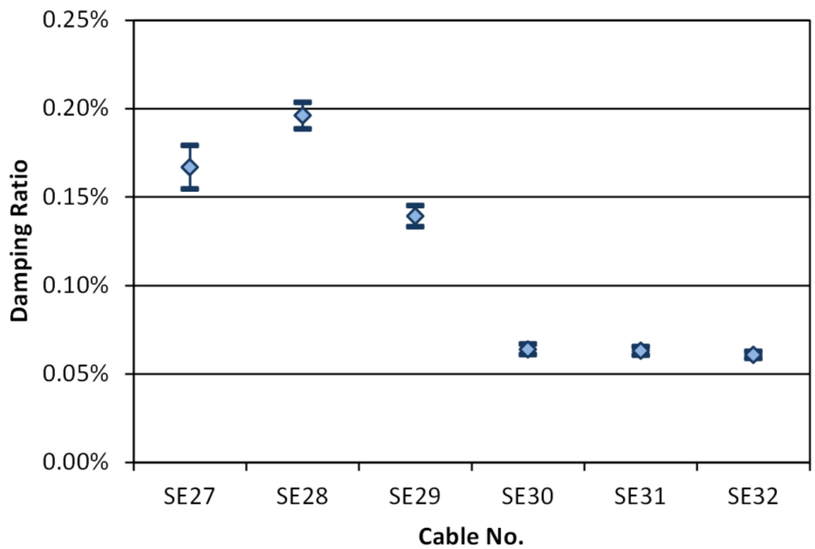
After best-fit lines were established for each cable run, the damping ratios could again be calculated and then averaged for each individual cable. During phase 3 testing, the number of runs performed for each cable was at least 10. Again, the Student-*t* test was utilized to find a

90 percent confidence on the mean of the damping ratio for each cable for both the first and second modes. Graphs of the results are shown in figure 51 through figure 54, while table 6 contains a summary of the damping ratio, correlation, and frequencies for each cable. The figures and table show the averaged data from the two boxes.



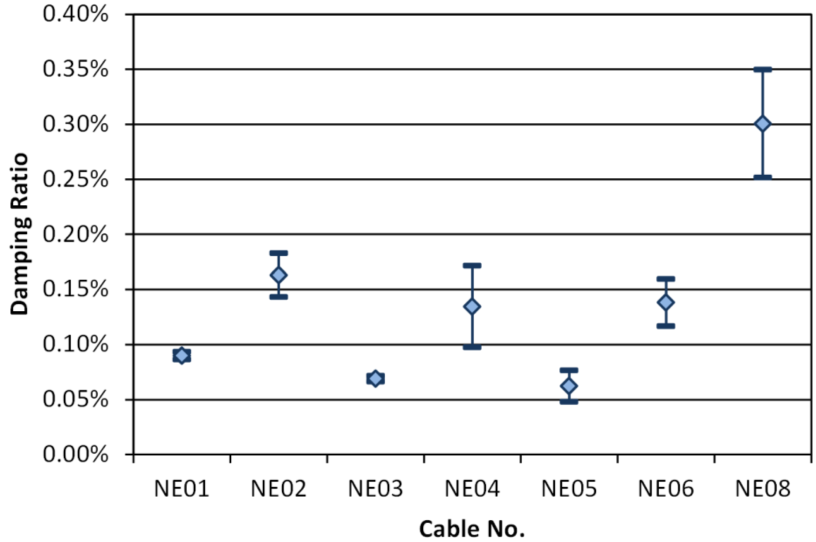
Source: FHWA.

Figure 51. Graph. Phase 3—first mode with 90 percent confidence interval on the mean for side span cables.



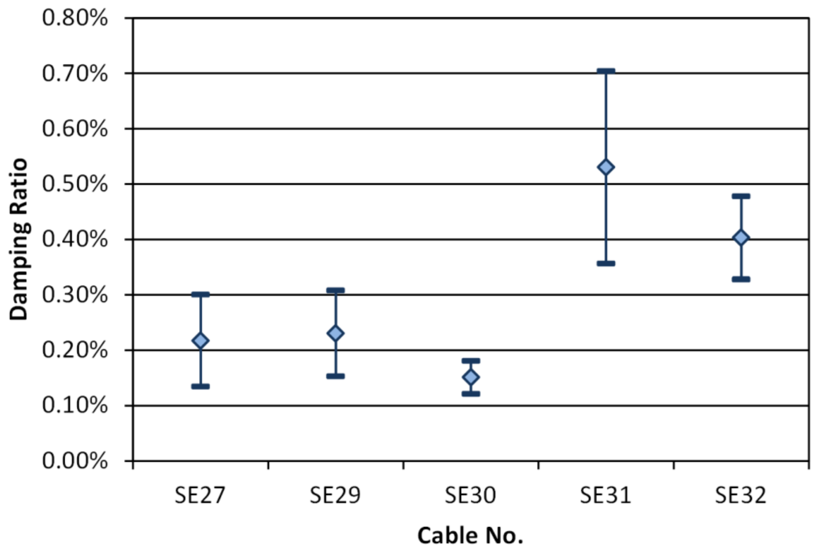
Source: FHWA.

Figure 52. Graph. Phase 3—first mode with 90 percent confidence interval on the mean for main span cables.



Source: FHWA.

Figure 53. Graph. Phase 3—second mode with 90 percent confidence interval on the mean for side span cables.



Source: FHWA.

Figure 54. Graph. Phase 3—second mode with 90 percent confidence interval on the mean for main span cables.

Table 6. Phase 3 summary of results data.

Cable Number	First Mode: Average Damping Ratio (percent)	First Mode: Correlation	First Mode: Average Length of Time Sample (s)	Second Mode: Average Damping Ratio (percent)	Second Mode: Correlation	Second Mode: Average Length of Time Sample (s)
SE27	0.167	0.9895	104.8	0.217	0.9742	36.3
SE28	0.196	0.9961	118.5	—	—	—
SE29	0.139	0.9852	164.0	0.230	0.9782	64.2
SE30	0.063	0.9804	191.3	0.151	0.9773	35.0
SE31	0.057	0.9567	148.0	0.530	0.9756	26.1
SE32	0.056	0.9567	154.0	0.403	0.9682	29.3
NE01	0.215	0.9912	155.5	0.090	0.9933	183.3
NE02	0.107	0.9892	192.2	0.163	0.9837	84.4
NE03	0.099	0.9923	172.5	0.069	0.9900	174.4
NE04	0.112	0.9865	207.8	0.134	0.9748	103.6
NE05	0.132	0.9841	266.8	0.062	0.9790	154.2
NE06	0.184	0.9982	180.5	0.138	0.9639	108.5
NE07	0.257	0.9910	86.5	—	—	—
NE08	0.288	0.9530	79.8	0.301	0.9914	25.0

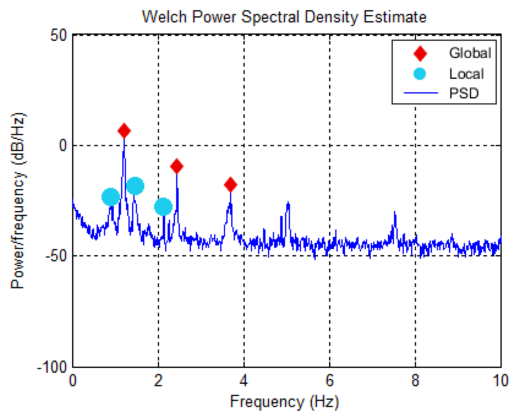
—Indicates no data are available.

DISCUSSION

Frequency Content

Phase 3 testing produced erratic results during the frequency analysis. After the installation of a single line of crossties, the cables no longer operated as a simple taut string but instead as a complex network of cables where both global and local modes would affect the vibration. For some cables, the frequencies were still easily determined from the PSD graphs, but other cables had extra peaks scattered throughout the spectrums, creating confusion about where to isolate the response to extract the decay curves.

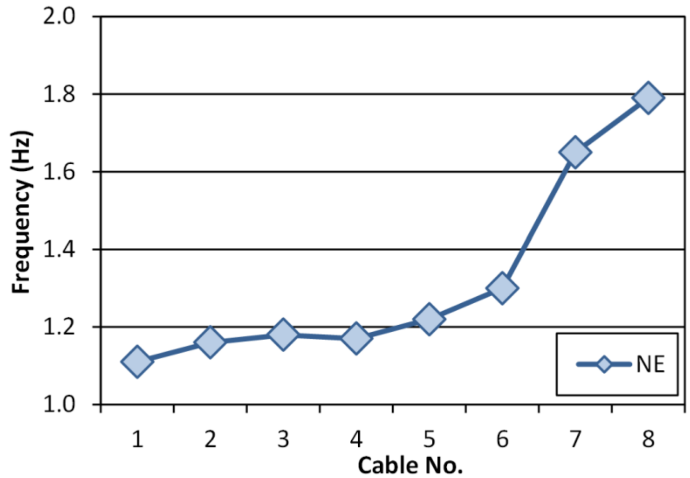
Figure 55 shows an example PSD for cable NE05 during phase 3 testing. While this particular cable was not tested in phase 2, cable SW05 was and has similar material properties. The spectrum shows strong peaks, of which the first three are highlighted by red diamonds. These peaks seem to represent the global modes of the network of cables. A closer inspection of the spectrum reveals smaller peaks around 1 to 2 Hz. These smaller peaks have been marked with light blue dots. The values for these smaller frequencies are 0.879, 1.44, and 2.15 Hz. Revisiting the phase 2 results, the first three frequencies for cable SW05 are similar and measured at 0.732, 1.44, and 2.18 Hz. These frequency peaks represent the local modes for the cable, which are now being dominated by the global modes in the spectrum.



Source: FHWA.

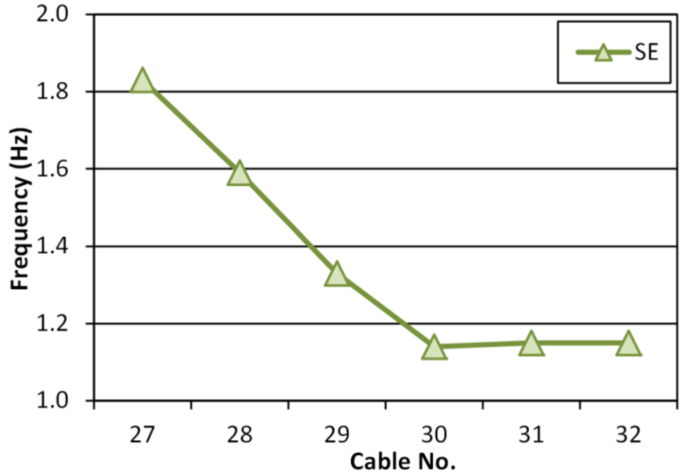
Figure 55. Graph. Global and local modes in the PSD.

Focusing on the stronger global modes, peaks were once again extracted up to the seventh mode when possible. There were many instances where peaks were not attainable for certain modes. Frequencies were higher than the previous two phases and contained wide peaks where the energy was distributed into nearby local modes. First mode frequencies obtained from testing are shown in figure 56 for the side span cables of the northeast fan and in figure 57 for the main span cables from the southeast fan, respectively.



Source: FHWA.

Figure 56. Graph. First mode frequencies from phase 3 testing for side span cables.



Source: FHWA.

Figure 57. Graph. First mode frequencies from phase 3 testing for main span cables.

As shown in these figures, the frequencies did not follow the same trends as in the previous two phases, where they were dominated by local modes established primarily by the physical cable properties and tension forces. With the crossties connecting the cables, their behavior became more complex. In figure 56, the first six cables had first mode frequencies in the range of 1.1–1.3 Hz before quickly increasing to over 1.6 Hz.

The main span cables showed a similar response, as seen in figure 57. The longest three cables all hovered at a first mode frequency around 1.15 Hz before increasing with the shorter cables as the stiffness of the network increased. It should be noted that the crossties were anchored to the deck, which helped increase the general stiffness of the cable network, especially in the shorter cables.

The frequencies measured between the two accelerometers were usually in agreement, although in rare cases, they varied up to 2 or 3 percent. However, the frequency measurements among the various runs for each cable were not as consistent, with differences for any mode frequency ranging between 0 and 5 percent and, in one case, by 12 percent.

Damping Ratios

As discussed in the frequency section, the peaks from the spectral density plots for phase 3 testing were wider and contained more distributed energy than similar plots for phases 1 and 2 that contained energy concentrated in distinct peaks. This resulted in greater difficulty in identifying the boundary frequencies for the bandpass filter to isolate a damping curve for a specific mode.

If frequencies were chosen too far apart, there was no clean damping curve, just random sinusoidal excitations that produced curves with extremely poor correlation. For several cables, the frequencies had to be brought very close together to isolate a narrow frequency band. These bands were sometimes less than 0.1 Hz wide. When the bandpass filter was that narrow, there could be bounce effects on either end of the filter, which therefore required careful adjustment of the filter by as little as 0.01 Hz to find an acceptable result. The boundaries in some cases were so delicate that it was discovered that after an upgrade to the Matlab® software that several cables had to have their bandpass frequencies readjusted to reproduce the decay plots to comparable numbers.[17]

It should be noted, however, that there were several cables during phase 3 testing that produced decent decay curves with strong correlation that would even have been considered acceptable in the previous two phases. Cable NE06 specifically had strong decay curves with correlations over 0.997.

Second mode damping numbers produced poor results overall. Although damping ratios were officially calculated for 12 of the 14 cables tested in phase 3, many of them were averaged from only a few runs for a particular cable. This was due to a lack of damping curves that simply could not be produced despite extensive tinkering with the bandpass frequency range surrounding the second mode peak. Compared to the previous phases, second mode damping ratios for phase 3 testing were extremely difficult to obtain, which was a notable effect of the crossties creating a complex cable network meant to suppress these high-energy vibrations.

Scruton Number Analysis

Damping values that were successfully obtained during phase 3 testing were entered into the equation in figure 38 to calculate the resulting Scruton number. The results are shown in table 7. All of the Scruton numbers were below the desired reduced limit of five for cables with aerodynamic surface treatments. Based on these results, an appropriate vibration mitigation measure, such as crossties, had to be incorporated into the cable system.

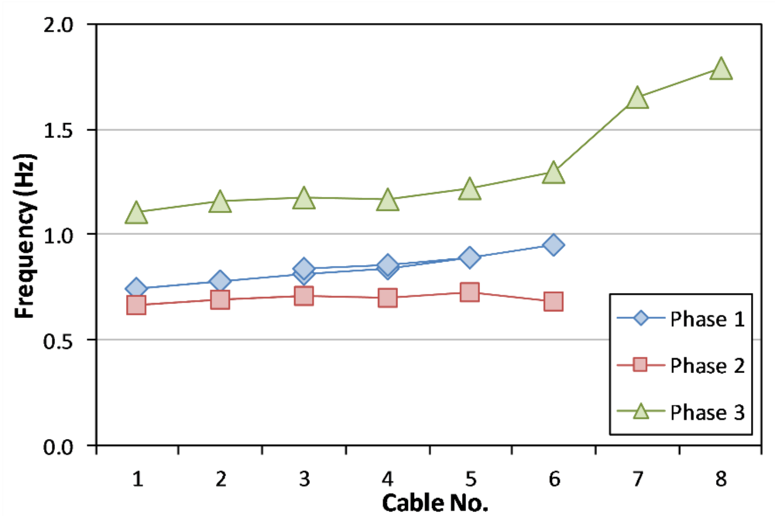
Table 7. Phase 3 Scruton number.

Cable Number	Scruton Number
SE27	2.6
SE28	3.1
SE29	2.2
SE30	1.0
SE31	1.1
SE32	1.0
NE01	3.6
NE02	1.8
NE03	1.6
NE04	2.0
NE05	2.1
NE06	2.9
NE07	4.2

CHAPTER 7. SUMMARY OF COMPARISONS

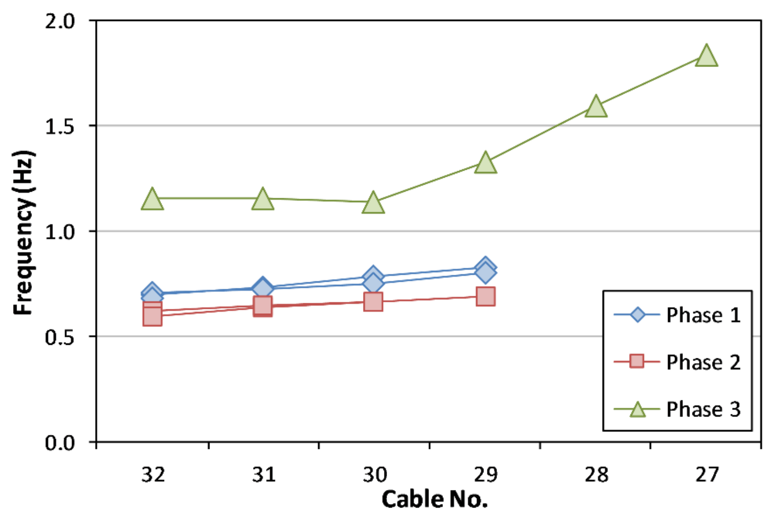
FREQUENCY

The frequencies obtained for similar cables from each quadrant of a fan were nearly equivalent for each phase of testing. After phase 1 testing, the frequencies for each cable decreased due to an increase in mass density from the addition of grout to the cables in phase 2. Then, in phase 3, the frequencies shifted upward dramatically after a single line of crossties was installed that stiffened the cable system. Figure 58 and figure 59 compare the first mode values across all phase stages for the side span and main span, respectively.



Source: FHWA.

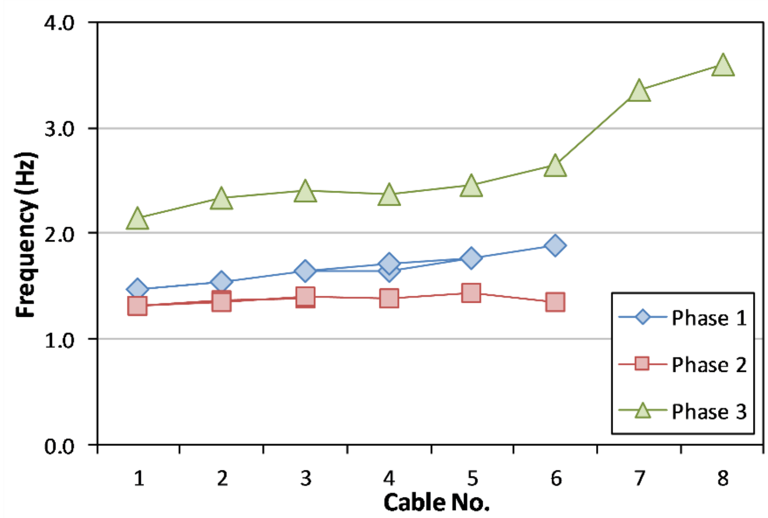
Figure 58. Graph. Comparison of first mode frequencies for side span cables.



Source: FHWA.

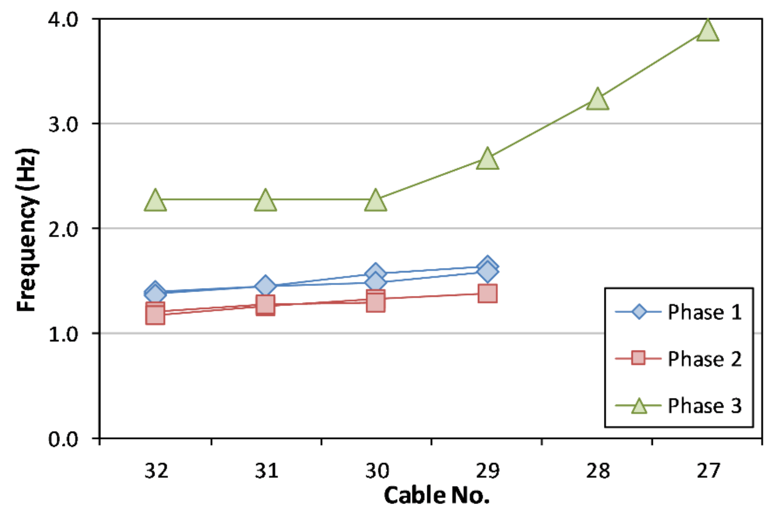
Figure 59. Graph. Comparison of first mode frequencies for main span cables.

Similarly, figure 60 and figure 61 compare the second mode values. The remaining graphs for modes 3 through 7 can be found in figure 82 through figure 91 in appendix B. On average, the frequencies match within 2 percent although some cables varied by up to 6 percent.



Source: FHWA.

Figure 60. Graph. Comparison of second mode frequencies for side span cables.

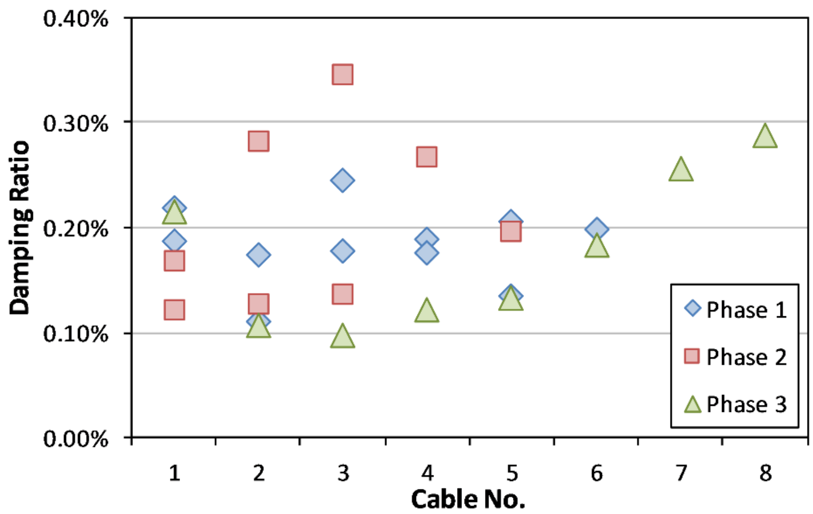


Source: FHWA.

Figure 61. Graph. Comparison of second mode frequencies for main span cables.

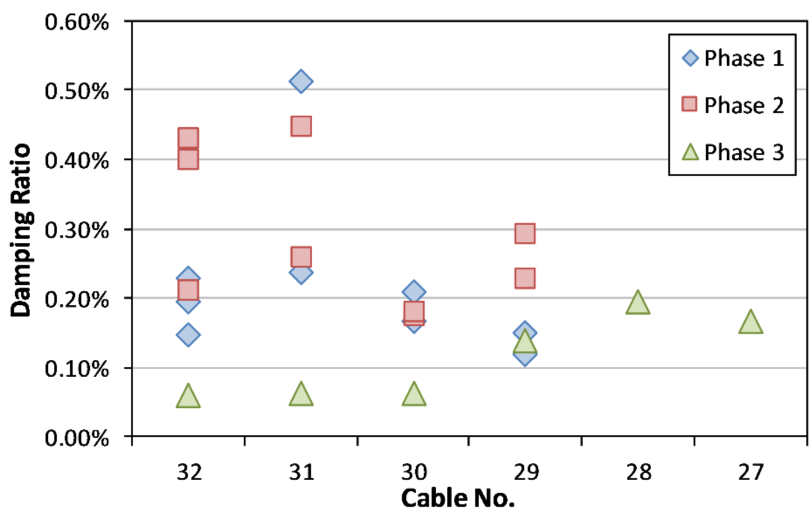
DAMPING

The damping ratios that were extracted for each cable from each phase of testing were plotted together, and the first mode results are shown in figure 62 and figure 63 for the side and main spans, respectively. Since no external viscous dampers were added during the construction of this bridge, it is not surprising to see that the damping ratio values did not vary among the different phases. There appears to be no correlation between any of the cables' properties and the resulting ratios, leading to scattered datasets. Damping ratios ranged between 0.10 and 0.25 percent for phase 1, 0.1 and 0.45 for phase 2, and 0.05 and 0.26 percent for phase 3.



Source: FHWA.

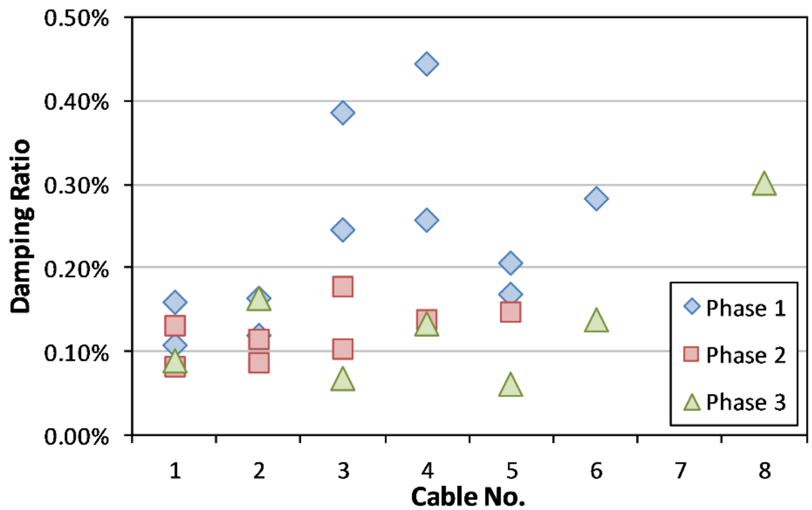
Figure 62. Graph. Comparison of first mode damping ratios for side span cables.



Source: FHWA.

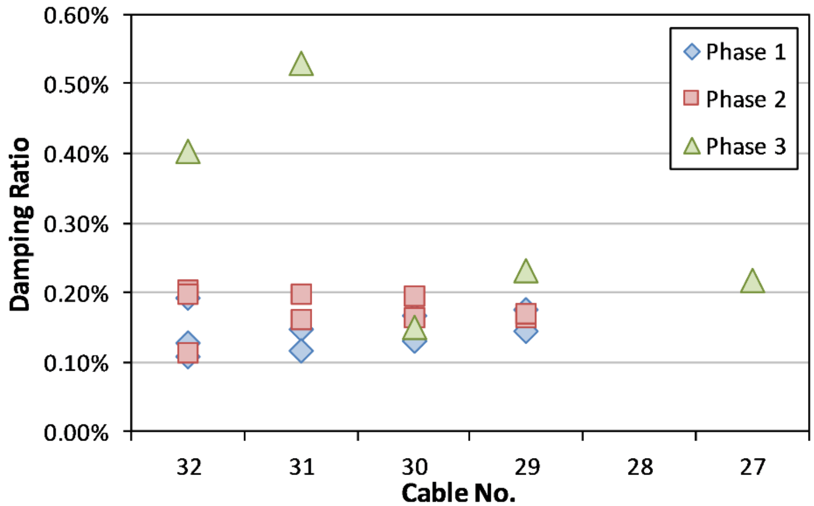
Figure 63. Graph. Comparison of first mode damping ratios for main span cables.

Damping ratios extracted from the second mode across all three phases of testing are plotted in figure 64 and figure 65 for the side and main spans, respectively. Similar to the first mode damping ratios, there were no trends among the different phases and cable types. The one similarity among all damping ratios for both modes and across all phases is that they were all below 0.6 percent, which is considered low and suggests that the cables were susceptible to prolonged vibration events. Second mode damping ratios ranged between 0.1 and 0.45 percent for phase 1, 0.1 to 0.2 percent for phase 2, and 0.05 and 0.5 percent for phase 3.



Source: FHWA.

Figure 64. Graph. Comparison of second mode damping ratios for side span cables.

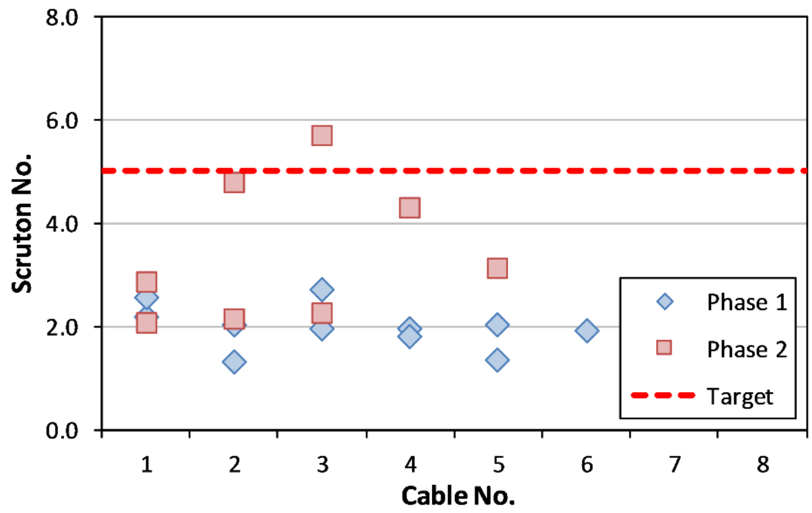


Source: FHWA.

Figure 65. Graph. Comparison of second mode damping ratios for main span cables.

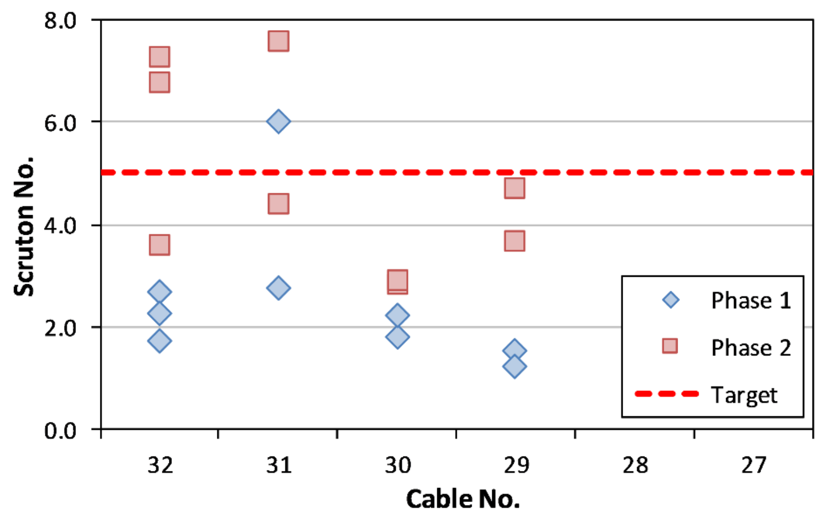
SCRUTON NUMBERS

Scruton numbers from the first two phases are compared in figure 66 and figure 67 for the side span and main span, respectively. They were all lower than the recommended minimum value of 10 for controlling rain/wind-induced vibrations and, in many cases, fell below the alternative reduced value of 5 for cables with an aerodynamic surface treatment. Scruton numbers increased slightly from phase 1 to phase 2 testing due to the increased mass of the cable after the installation of grout. They ranged between 1.3 and 6.0 in phase 1 and between 2.1 and 7.6 in phase 2. These results confirm that an effective cable vibration mitigation technique, in this case crossties, was required.



Source: FHWA.

Figure 66. Graph. Comparison of Scruton numbers for side span cables.



Source: FHWA.

Figure 67. Graph. Comparison of Scruton numbers for main span cables.

CHAPTER 8. THEORETICAL FREQUENCIES AND COMPUTER MODELING

COMPUTATIONAL METHODS

In addition to simply comparing the field data across each phase of testing, the frequency values were compared against theoretical frequencies calculated using string theory and computer analysis using SAP2000® (SAP®) finite element modeling software.(21)

First mode theoretical frequencies were calculated for each cable using the string theory equation presented in figure 4. The formula requires three cable properties, including length, tension force, and mass density. Cable coordinates and initial tension forces were obtained from construction drawings from the bridge designer. Since the bridge was under construction during field testing, the weight of certain dead loads that had not been completed, such as railings, concrete barriers, and asphalt overlays, were estimated and subtracted from the initial tension force. The length of the cable was calculated from the geometry of the cable coordinates; however, it was assumed that the effective length of the cable should be calculated from the end of the guide pipe, not the total length of the cable, since the stiff pipe hinders the free movement of the cable. The length, or chord length, used in the theoretical calculations did not account for sag in the cable. The final input of the formula, the mass density of the cable, was obtained from worksheets from the cable manufacturer, which neatly tabulated the properties of the various components of the cable, including the weight and size of the steel strands, sheathing, grout, grease, and the outer HDPE pipe. For phases 2 and 3, it was assumed that the mass density of the cable was the total value from the table; however, for phase 1 calculations, the weight of the grout was removed before entering it into the formula.

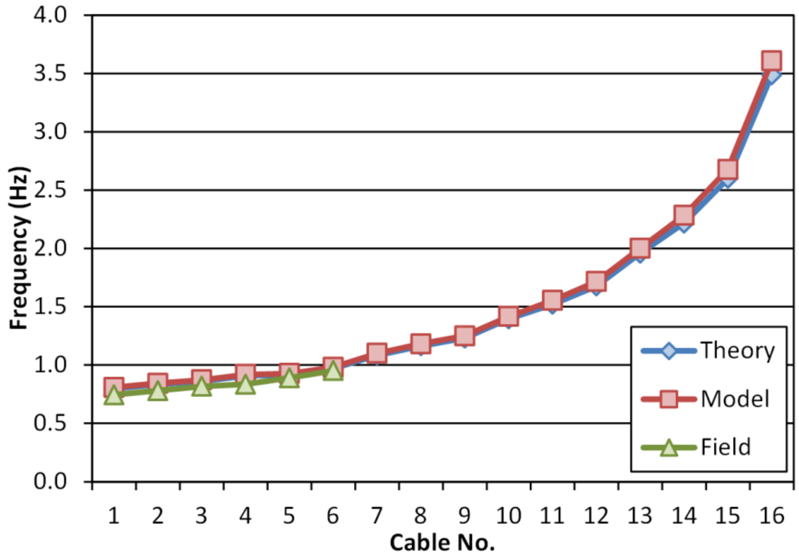
The physical cable properties used to calculate theoretical frequencies with string theory were also entered into SAP® finite element modeling software to model an entire quadrant of the bridge.(21) Split independently into the side and main spans, both groups contained 16 cables accurately positioned using the coordinates provided by the designer. The biggest advantage to using finite element modeling was that crossties could be added and the effects of their behavior explored. The model was tested with no crossties (similar to phases 1 and 2), one line of crossties (similar to phase 3), and four lines of crossties, which was the final configuration of the bridge.

In SAP®, the cables were modeled as consecutive beam elements with varying element lengths and node points whose numbers depended on the length of the cable.(21) The beam elements were modeled as steel material using an equivalent diameter based on the unit weight values given by the manufacturer. This equivalent diameter was calculated to have the same unit weight as the entire material of the pipe, including the HDPE pipe, sheathing, grease, and grout. The beam elements used the elasticity modulus of steel for the entire mass and a flexural stiffness of zero. A flexural stiffness of zero could not actually be programmed into the modeling software, so instead, a very small decimal value was used to produce the same effect. Tension forces were applied to each cable using the *p*-delta analysis method.

The four lines of crossties were positioned on the model so that they were properly spaced on the longest cable, splitting it into five subspans. Each line of crossties extended perpendicular from the longest cable, connecting each consecutive cable until it reached the simulated bridge deck where they attached to anchor points whose coordinates were measured during construction. This was done for both the main and side spans. For the modeling tests where only one line of crossties was used, that line was the third line up from the deck, which was equivalent to the field condition during phase 3 testing.

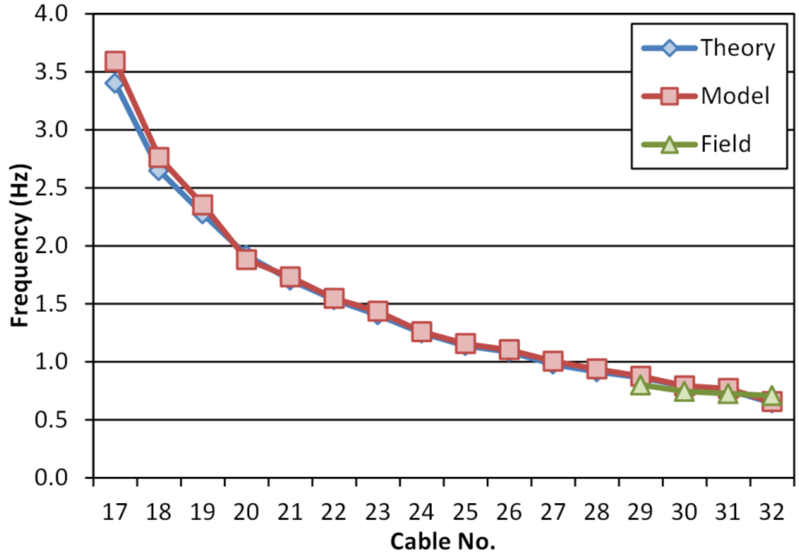
FREQUENCY COMPARISONS

The first mode frequencies calculated from string theory were plotted against the results obtained from SAP® modeling and the data obtained from the SW fan during field testing.[21] Figure 68 and figure 69 contain the frequency data from phase 1 testing for the main and side spans, respectively. As seen in the plots, the theoretical first mode frequencies match the field data quite closely, with the theoretical values being slightly higher. For the majority of cables, the two theoretical methods matched within a few percent, but for the shortest cables in the fan, the SAP® model produced first mode frequencies that were up to 5 percent higher.[21]



Source: FHWA.

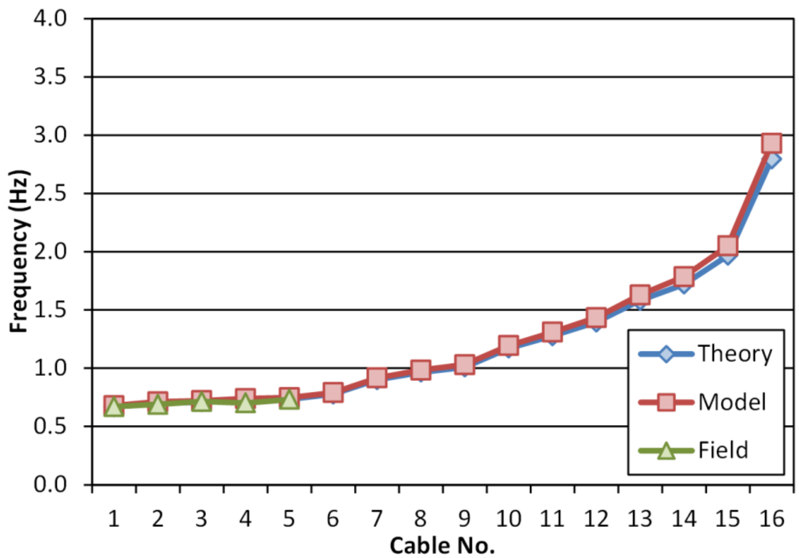
Figure 68. Graph. First mode frequency comparison for phase 1 conditions for side span cables.



Source: FHWA.

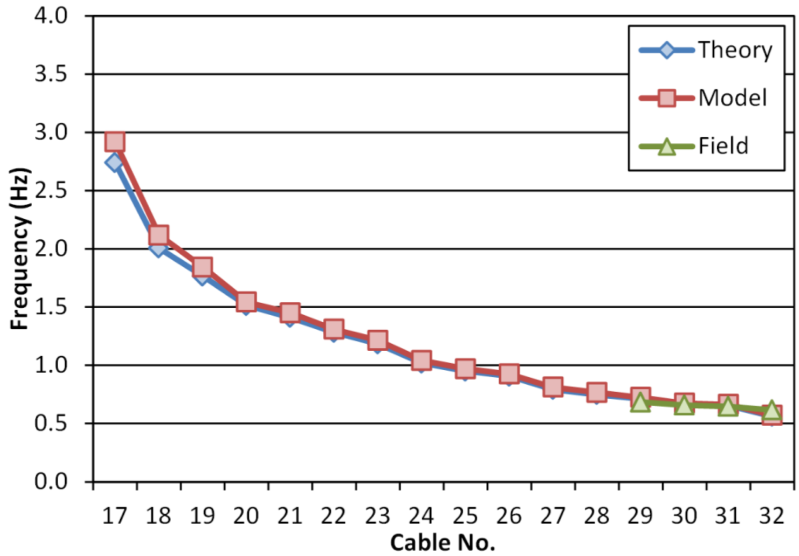
Figure 69. Graph. First mode frequency comparison for phase 1 conditions for main span cables.

Similarly, figure 70 and figure 71 contain the frequency data from phase 2 testing for the side and main spans, respectively. In phase 2 testing, the increased mass density lowered the natural frequencies of the cables. This was reflected in all three of the methods. Once again, the field data matched the theoretical methods quite well but was generally slightly lower. The theoretical methods themselves overall were nearly equivalent, usually within a few percent, but in the shortest cables, the SAP® model produced frequencies that were up to 6 percent higher.(21)



Source: FHWA.

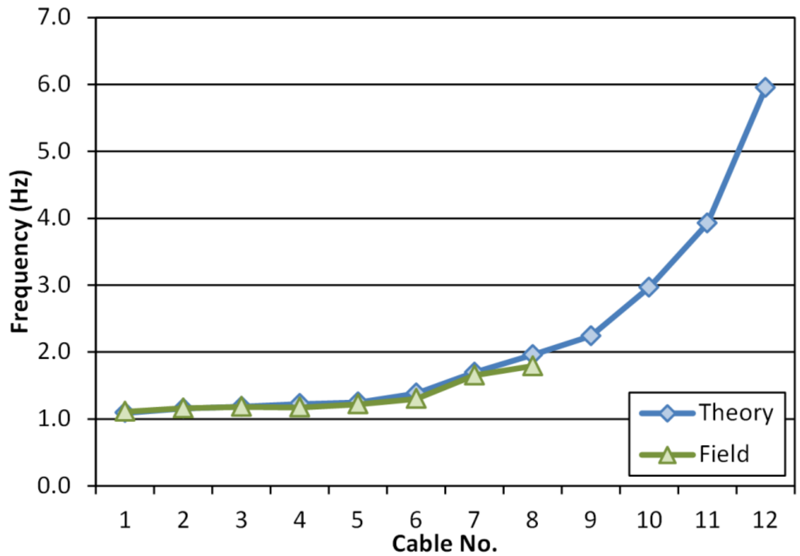
Figure 70. Graph. First mode frequency comparison for phase 2 conditions for side span cables.



Source: FHWA.

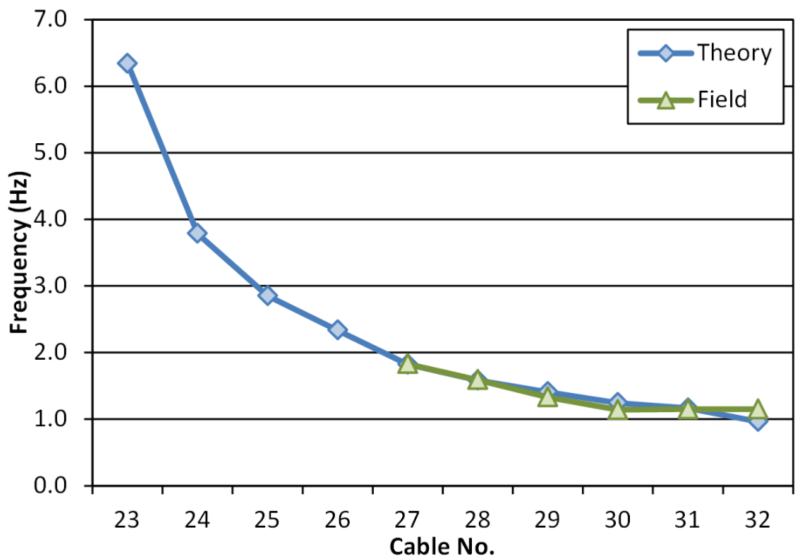
Figure 71. Graph. First mode frequency comparison for phase 2 conditions for main span cables.

As mentioned previously in this section, the cable fans were modeled in SAP® with a single line of crossties to simulate the behavior during phase 3 testing. While SAP® could easily produce a table of eigenvalues and frequencies for the global network cable system, it was not possible to isolate each individual cable to plot their first mode frequencies as done in figure 68 through figure 71.[(21)] However, a decision was made to still plot the field data from phase 3 testing against string theory, plugging in a new effective length for each cable as the distance between the guide pipe to the crosstie. The results are shown in figure 72 and figure 73 for side and main spans, respectively. The installed line of crossties did not intersect the three shortest cables, so those were not included in the plot. Additionally, the next shortest cable was left off the plot as well because its theoretical frequency of 15 Hz skewed the scale of the axes.



Source: FHWA.

Figure 72. Graph. First mode frequency comparison for phase 3 conditions for side span cables.



Source: FHWA.

Figure 73. Graph. First mode frequency comparison for phase 3 conditions for main span cables.

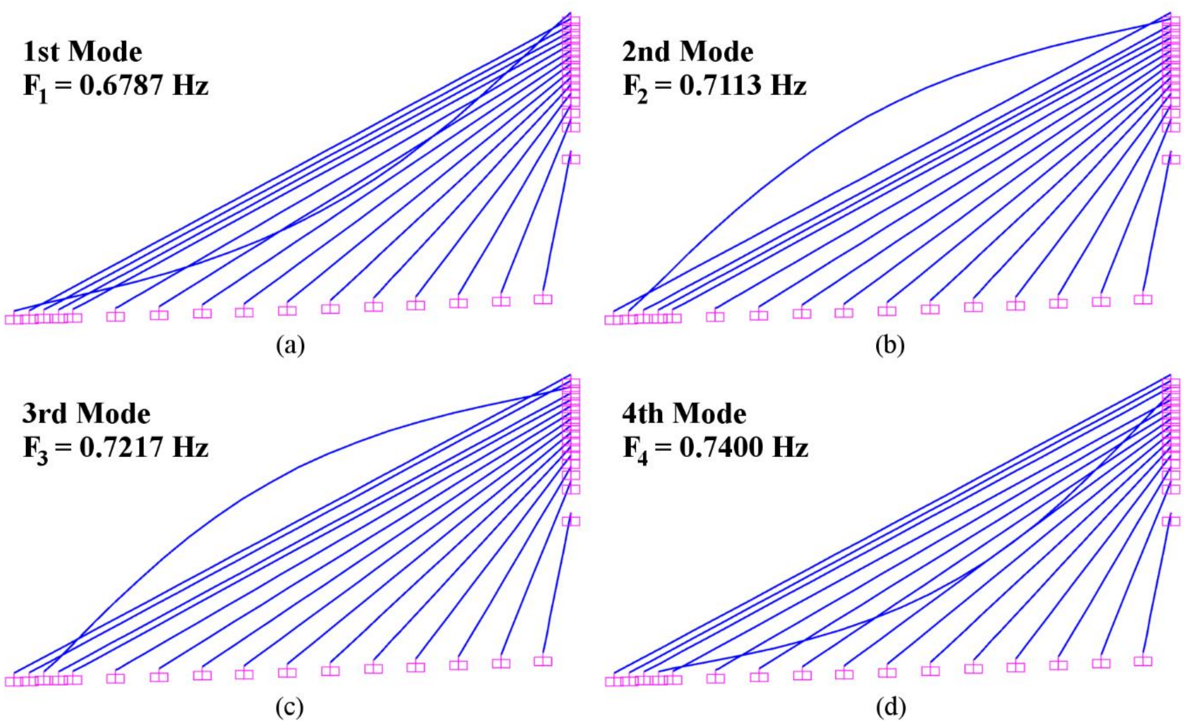
Interestingly, the comparison between the field and theory matched extremely well, within a few percent in most cases, indicating that the higher frequencies obtained during phase 3 testing are actually a result of the crossties producing shorter effective cable lengths. It also explains the behavior in the spectral density plots where it seemed multiple sets of natural frequencies were observed. The more powerful frequencies were the results of the shorter effective cable lengths, while the weaker natural frequencies came from the entire length of the cable still resonating.

These figures imply that as more crossties are added, the effective lengths of the cables are quickly diminished in size, therefore raising the natural frequencies of the cable system. These higher frequencies require more power for major cable excitations, proving that crossties are an effective technique for cable vibration mitigation. Although some of the original frequencies associated with the full length of the cable still exist, they are greatly weakened.

CROSSTIE ANALYSIS

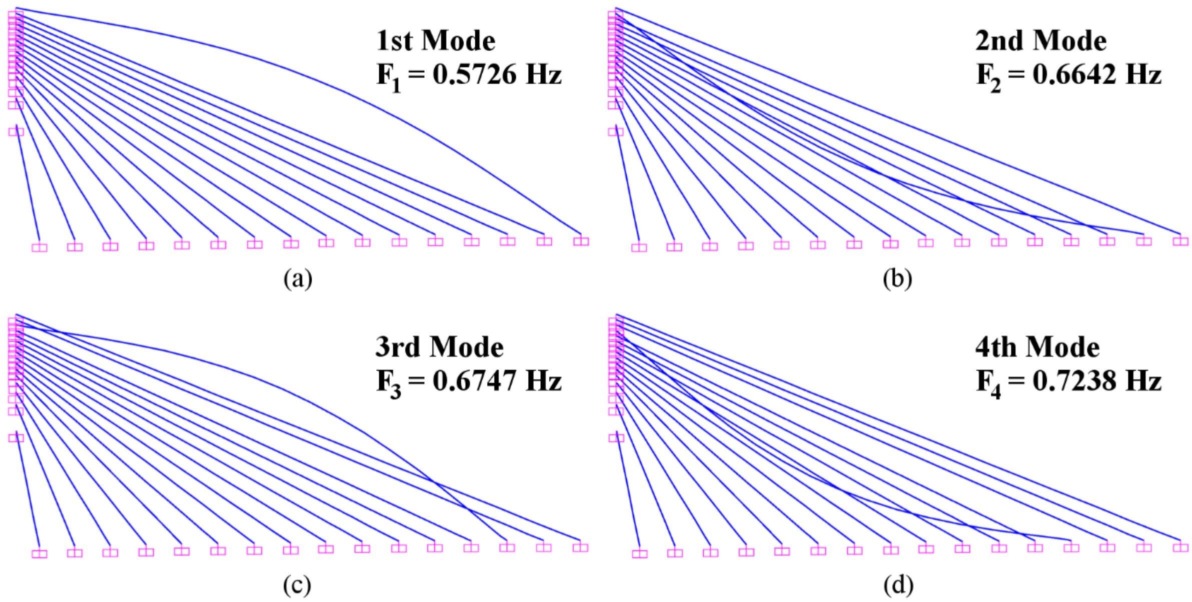
Visualization of the mode shapes was an additional benefit of modeling the cable networks and crossties in SAP®.(21) The simulations were a useful tool for identifying how the behavior of the system changed as crossties were added. Figure 74 shows the first four mode shapes for the side span of the bridge with no crossties attached, which is equivalent to phase 2 testing; where F_n is the natural frequency of the *n*th mode of vibration. Similarly, figure 75 shows the first four mode shapes for the main span with no crossties.

Since there were no crossties installed during phase 2 testing, the mode shapes of the cable network system correspond to the natural modes of the individual cables. It should be noted, though, that around the 12th mode, the higher modes of the longer cables started to merge with the first mode of the shorter cables. From there, the mode frequency values for the cable system were intertwined among the cables.



Source: FHWA.

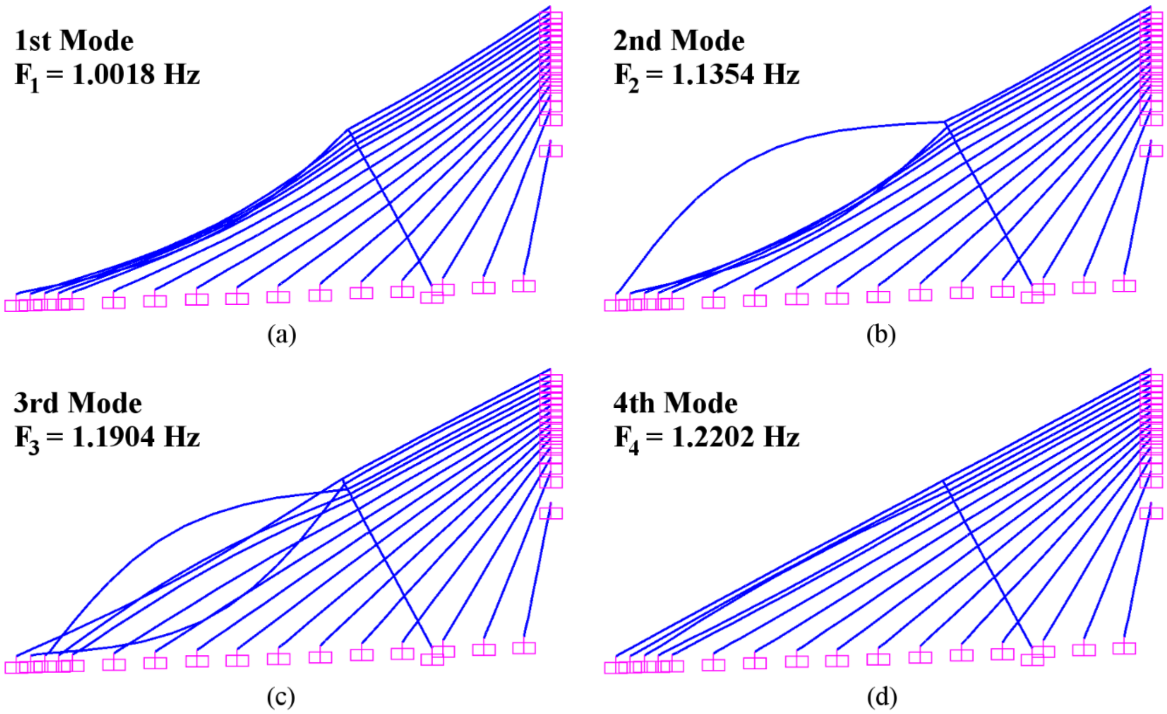
Figure 74. Images. Vibration mode shapes of the side span with no crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.



Source: FHWA.

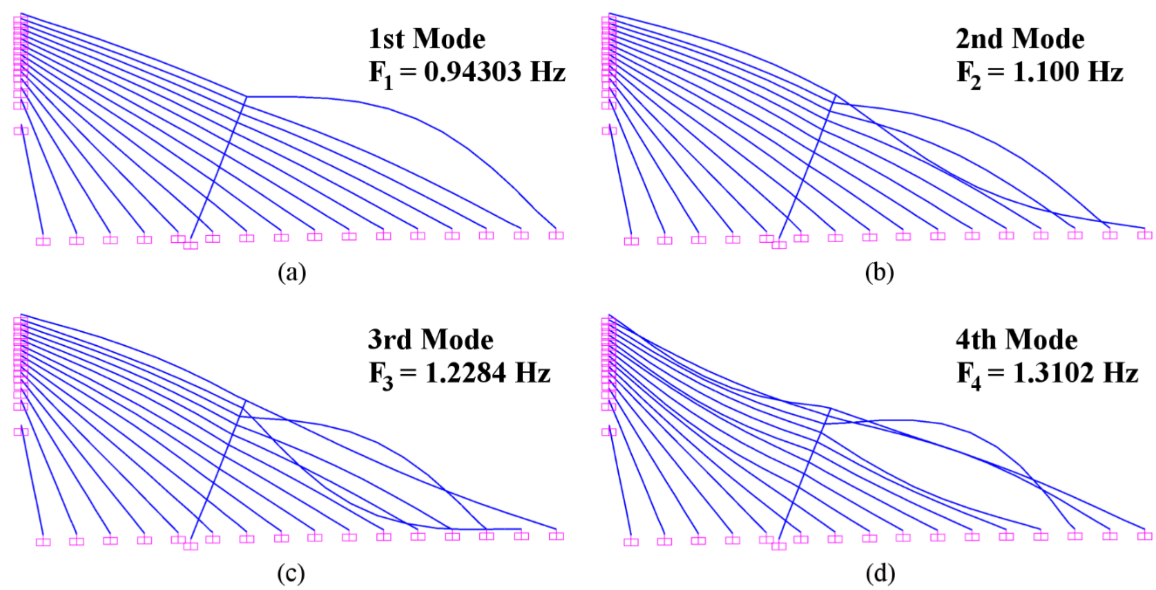
Figure 75. Images. Vibration mode shapes of the main span with no crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.

A single line of crossties was added to the model, producing an identical setup to the configuration present during phase 3 testing. Figure 76 shows the first four mode shapes for the side span with a single line of crossties, while figure 77 shows the same results for the main span. There was a noticeable increase in frequencies compared to the unconstrained system by 50 percent or more. These images show that the first few vibration modes tended to be local in nature, affecting only the longest segments of the longest cables.



Source: FHWA.

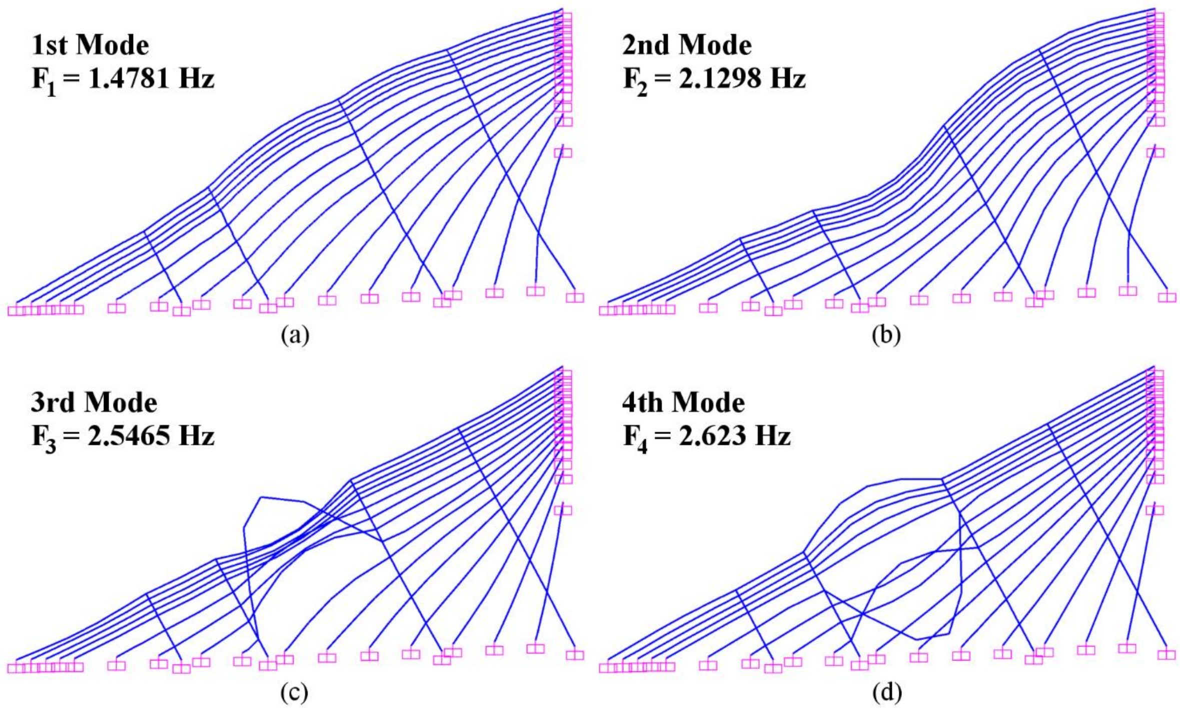
Figure 76. Images. Vibration mode shapes of the side span with a single line of crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.



Source: FHWA.

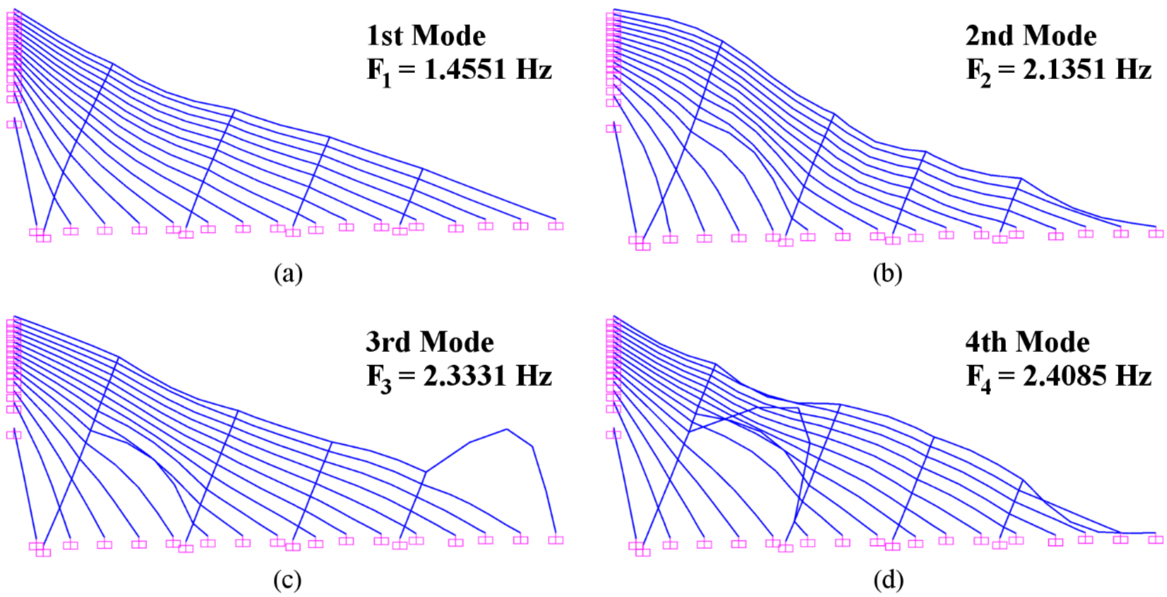
Figure 77. Images. Vibration mode shapes of the main span with a single line of crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.

Finally, the cable system was modeled with four lines of crossties, which was the final configuration of the cable network after construction. This configuration was not physically tested in the field. Figure 78 shows the first four mode shapes for the side span with four lines of crossties, while figure 79 shows the same results for the main span. Once again, there was a large increase in frequencies by an additional 50 percent or more as the cable network was further stiffened. The figures show that the vibrational modes were global in nature, affecting all segments of each cable in the lowest modes.



Source: FHWA.

Figure 78. Images. Vibration mode shapes of the side span with four lines of crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.



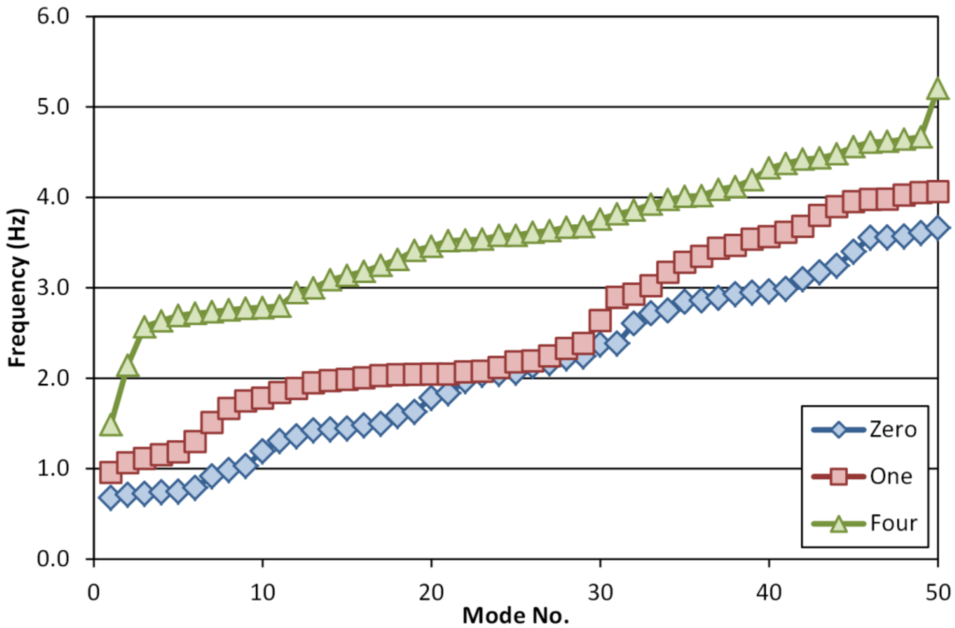
Source: FHWA.

Figure 79. Images. Vibration mode shapes of the main span with four lines of crossties for (a) first mode, (b) second mode, (c) third mode, and (d) fourth mode.

MODE FREQUENCY EVOLUTION

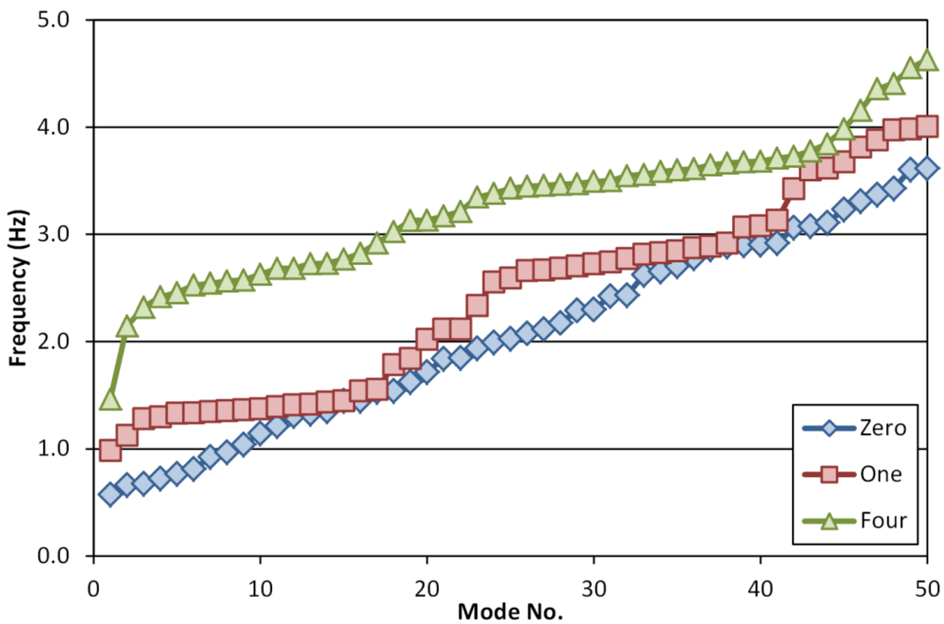
Mode frequency evolution of the three crosstie configurations for both spans of the bridge are presented in figure 80 and figure 81. A similar approach has been used by Abdel-Ghaffar and Khalifa (1991) and Caracoglia and Jones (2005) and was studied extensively in an earlier report from FHWA, which compared numerous different configurations of crossties and their effects on mode frequency.(3,22,23)

For such plots of networked cables, it is common to observe a sequence of global modes followed by a plateau of densely populated local modes, which is then followed by a second set of global modes, etc. Such behavior is clearly evident in the results from the four-line network configuration studied. For the single line configuration, the switch or transition from global to local modes is less obvious but still evident. Without any crossties, the system modes are the natural modes of the individual cables.



Source: FHWA.

Figure 80. Graph. Mode frequency evolution comparing crosstie configurations for the side span.



Source: FHWA.

Figure 81. Graph. Mode frequency evolution comparing crosstie configurations for the main span.

CHAPTER 9. CONCLUSIONS

Vibration testing was performed on the stay cables of the Bill Emerson Bridge located near Cape Girardeau, MO, by manually exciting the stay cables and measuring the decay with accelerometers and a portable data acquisition system. The vibration data underwent post-processing using various filters. Natural frequencies and damping ratios were extracted for the tested stay cables. Confidence intervals on the mean were found for the cables in both the first and second modes of damping.

For phase 1 testing, measured first mode frequencies for side span cables varied from 0.75 to 0.95 Hz, while those for the longer main span cables varied from 0.68 to 0.82 Hz. Following the addition of grout to the cables in phase 2 testing, the frequencies decreased due to the added mass with a new range from 0.67 to 0.73 Hz for the side span cables and from 0.60 to 0.69 Hz for the main span cables. After the installation of a single line of crossties in phase 3 testing, the cable networks were stiffened, which increased the range of first mode frequencies from 1.11 to 1.79 Hz for the side span cables and from 1.14 to 1.83 Hz for the main span cables. Similar cables tested in different quadrants around the bridge compared favorably during each phase of testing. Measured frequencies compared well with theoretical values based on the string theory and computer modeling simulations.

For phase 1 testing, damping ratios for all cables tested varied from 0.11 to 0.51 percent for the first mode and from 0.11 to 0.44 percent for the second mode. For phase 2 testing, damping ratios remained similar, varying from 0.12 to 0.45 percent for the first mode and from 0.08 to 0.20 percent for the second mode. Damping ratios were more difficult to calculate from phase 3 test data due to complications in extracting bandpass filter frequencies from the spectral density plots. Damping ratios that were obtained ranged from 0.06 to 0.29 percent for the first mode and from 0.06 to 0.53 for the second mode.

The Scruton numbers, which were used as a criterion to determine effective cable vibration mitigation, were calculated for the first two phases of testing only. They ranged from 1.2 to 6.0 for phase 1 testing and from 2.1 to 7.6 for phase 2 testing. For phase 2 testing, over three-fourths of the cables tested had values below the target value of 5 for cables with aerodynamic surface treatments, such as a helical fillet. These results show that the cable system was vulnerable to rain/wind induced vibrations and required further mitigation techniques, in this case crossties.

Further investigation into the first mode frequencies obtained during phase 3 testing showed that they matched up well when plotted against theoretical frequencies calculated with string theory using a shorter effective length equal to the distance from the bridge deck to the crosstie. This confirms that the crossties helped stiffen the system by shortening the effective length of each cable segment. With the final installation of four crossties, the cable network was stiffened even further, protecting it from rain/wind-induced vibrations.

APPENDIX A. MODE FREQUENCY TABLES

Table 8. Phase 1 mode frequencies (Hz).

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
NW01	1	0.745	1.47	2.20	2.93	3.67	4.41	5.15	0.745	1.47	2.20	2.93	3.67	4.41	5.15
NW01	2	0.745	1.47	2.21	2.93	3.67	4.41	5.14	0.745	1.47	2.21	2.93	3.65	4.41	5.14
NW01	3	0.745	1.47	2.21	2.93	3.69	4.37	5.15	0.745	1.47	2.21	2.93	3.64	4.37	5.10
NW01	4	0.745	1.48	2.21	2.94	3.69	4.42	5.16	0.745	1.48	2.21	2.94	3.69	4.43	5.16
NW01	5	0.745	1.47	2.21	2.93	—	4.41	5.14	0.745	1.47	2.21	2.93	3.69	4.41	5.19
NW01	6	0.745	1.47	2.21	2.93	3.67	4.37	5.13	0.745	1.47	2.21	2.93	3.66	4.37	5.13
NW01	7	0.745	1.47	2.21	2.94	3.69	4.40	5.12	0.745	1.48	2.21	2.94	3.65	4.41	5.12
NW01	8	0.745	1.48	2.22	2.94	—	4.41	5.14	0.745	1.48	2.22	2.94	3.70	4.41	5.14
NW01	9	0.745	1.48	2.21	2.94	3.69	4.42	5.16	0.745	1.48	2.21	2.94	3.69	4.42	5.16
NW02	1	0.781	1.55	2.33	3.11	3.89	4.65	5.41	0.781	1.55	2.33	3.11	3.87	4.65	5.41
NW02	2	0.781	1.54	2.33	3.11	3.88	4.65	5.44	0.781	1.54	2.33	3.11	3.88	4.65	5.43
NW02	3	0.781	1.54	2.33	3.10	3.88	4.63	5.41	0.781	1.54	2.33	3.10	3.88	4.66	5.41
NW02	4	0.781	1.54	2.32	3.10	3.88	4.64	5.42	0.781	1.54	2.32	3.10	3.88	4.64	5.42
NW02	5	0.781	1.56	2.33	3.11	3.88	4.67	5.45	0.781	1.54	2.33	3.11	3.88	4.67	5.45
NW02	6	0.781	1.55	2.32	3.10	3.88	4.64	5.41	0.781	1.55	2.32	3.10	3.88	4.64	5.42
NW02	7	0.781	1.55	2.33	3.11	3.89	4.65	5.43	0.781	1.55	2.33	3.11	3.89	4.65	5.43
NW02	8	0.781	1.54	2.32	3.10	3.88	4.64	5.41	0.781	1.54	2.32	3.10	3.88	4.64	5.41
NW02	9	0.781	1.54	2.32	3.10	3.88	4.64	5.41	0.781	1.54	2.32	3.10	3.88	4.64	5.41
NW02	10	0.781	1.54	2.32	3.10	3.88	4.64	5.42	0.781	1.54	2.32	3.10	3.87	4.64	5.52
NW29	1	0.824	1.63	2.45	—	4.08	4.93	5.72	0.824	1.63	2.45	3.27	4.08	4.88	5.71
NW29	2	0.830	1.64	2.47	—	4.05	4.94	5.69	0.830	1.64	2.47	3.26	3.92	4.70	—
NW29	3	0.824	1.63	2.46	—	4.09	4.97	5.70	0.824	1.64	2.46	3.26	4.09	4.80	—
NW29	4	0.824	1.64	2.45	3.28	4.09	4.93	5.72	0.824	1.64	2.45	3.28	4.09	4.83	—
NW29	5	0.824	1.64	2.48	3.28	4.09	4.93	5.74	0.824	1.64	2.48	3.28	4.10	4.93	5.74
NW30	1	0.787	1.56	2.33	3.12	3.89	4.66	5.44	0.787	1.56	2.33	3.11	3.89	4.66	5.44
NW30	2	0.787	1.56	2.33	3.12	3.88	4.66	5.40	0.787	1.56	2.33	3.12	3.88	4.66	5.43

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
NW30	3	0.787	1.56	2.33	3.12	3.88	4.65	5.46	0.781	1.56	2.33	3.11	3.88	4.65	5.46
NW30	4	0.781	1.55	2.33	3.13	3.87	4.65	5.42	0.781	1.55	2.33	3.11	3.87	4.65	5.42
NW30	5	0.787	1.56	2.33	3.13	3.88	4.67	5.44	0.787	1.56	2.33	3.11	3.88	4.67	5.44
NW30	6	0.787	1.56	2.33	3.13	3.88	4.66	5.43	0.787	1.56	2.33	3.13	3.88	4.66	5.46
NW30	7	0.781	1.55	2.32	3.11	3.87	4.65	5.45	0.781	1.55	2.32	3.11	3.87	4.65	5.44
NW30	8	0.781	1.55	2.38	3.11	3.88	4.64	5.46	0.781	1.55	2.38	3.10	3.88	4.64	5.46
NW30	9	0.781	1.55	2.32	3.11	3.87	4.65	5.41	0.781	1.55	2.32	3.11	3.87	4.65	5.41
NW30	10	0.781	1.55	2.32	3.10	3.86	4.64	5.43	0.781	1.55	2.32	3.10	3.86	4.64	5.43
NW31	1	0.732	1.45	2.20	2.91	3.63	4.32	5.08	0.732	1.45	2.18	2.90	3.63	4.36	5.08
NW31	2	0.732	1.45	2.16	2.91	3.65	4.32	5.05	0.732	1.45	2.16	2.91	3.64	4.32	5.04
NW31	3	0.732	1.45	2.19	2.91	3.64	4.35	5.09	0.732	1.45	2.19	2.91	3.64	4.35	5.08
NW31	4	0.732	1.45	2.17	2.91	3.64	4.35	5.09	0.732	1.45	2.17	2.91	3.64	4.35	5.09
NW31	5	0.732	1.45	2.16	2.92	3.63	4.31	5.09	0.732	1.45	2.16	2.92	3.63	4.31	5.09
NW31	6	0.732	1.45	2.17	2.92	3.64	4.32	5.10	0.732	1.45	2.17	2.91	3.64	4.32	5.10
NW31	7	0.732	1.45	2.17	2.91	3.64	4.36	5.09	0.732	1.45	2.17	2.91	3.64	4.35	5.09
NW31	8	0.732	1.45	2.17	2.91	3.64	4.37	5.08	0.732	1.45	2.17	2.91	3.64	4.37	5.09
NW31	9	0.732	1.45	2.16	2.91	3.64	4.33	5.05	0.732	1.45	2.16	2.91	3.67	4.33	5.05
NW31	10	0.732	1.45	2.19	2.91	3.65	4.36	5.10	0.732	1.45	2.19	2.91	3.65	4.33	5.10
NW32	1	0.696	1.38	2.06	2.77	3.44	4.14	4.82	0.696	1.37	2.06	2.75	3.44	4.14	4.80
NW32	2	0.696	1.38	2.06	2.77	3.43	4.11	4.81	0.696	1.37	2.06	2.75	3.43	4.11	4.81
NW32	3	0.696	1.37	2.06	2.77	3.44	4.11	4.81	0.696	1.37	2.06	2.75	3.44	4.11	4.77
NW32	4	0.696	1.38	2.06	2.77	3.45	4.12	4.82	0.696	1.38	2.06	2.75	3.45	4.12	4.82
NW32	5	0.696	1.37	2.06	2.77	3.44	4.11	4.81	0.696	1.37	2.06	2.75	3.44	4.12	4.80
NW32	6	0.696	1.38	2.07	—	3.45	4.12	4.80	0.696	1.38	2.07	2.75	3.46	4.12	4.85
NW32	7	0.696	1.37	2.06	2.77	3.44	4.13	4.82	0.696	1.37	2.06	2.75	3.44	4.13	4.82
NW32	8	0.696	1.37	2.06	2.76	3.43	4.11	4.80	0.696	1.37	2.06	2.76	3.43	4.11	4.80
NW32	9	0.696	1.38	2.06	—	3.44	4.14	4.83	0.696	1.38	2.06	2.77	3.44	4.14	4.83
NW32	10	0.696	1.37	2.06	2.77	3.43	4.11	4.82	0.696	1.37	2.06	2.75	3.43	4.11	4.79
SW01	1	0.759	1.49	2.23	2.99	3.72	4.48	5.25	0.759	1.49	2.23	2.99	3.72	4.48	5.25
SW01	2	0.745	1.48	2.23	2.98	3.71	4.46	5.19	0.745	1.48	2.23	2.98	3.71	4.46	5.19

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SW01	3	0.745	1.48	2.22	2.98	3.72	4.46	5.21	0.745	1.48	2.22	2.98	3.71	4.46	5.21
SW01	4	0.745	1.48	2.22	2.98	3.71	4.46	5.21	0.745	1.48	2.22	2.98	3.71	4.46	5.21
SW01	5	0.745	1.48	2.22	2.98	3.71	4.44	5.19	0.745	1.48	2.22	2.98	3.71	4.44	5.20
SW01	6	0.745	1.48	2.22	2.98	3.70	4.44	5.21	0.745	1.48	2.22	2.98	3.71	4.44	5.21
SW01	7	0.745	1.48	2.22	2.98	3.71	4.44	5.21	0.745	1.48	2.22	2.98	3.71	4.44	5.14
SW01	8	0.745	1.48	2.22	2.97	3.70	4.44	5.19	0.745	1.48	2.22	2.97	3.70	4.44	5.19
SW01	9	0.745	1.48	2.22	2.97	—	4.44	5.14	0.745	1.48	2.22	2.97	3.70	4.44	5.14
SW01	10	0.745	1.48	2.22	2.97	3.70	4.44	5.16	0.745	1.48	2.22	2.97	3.70	4.44	5.16
SW02	1	0.781	1.54	2.31	3.09	3.85	4.61	5.41	0.781	1.54	2.31	3.09	3.85	4.61	5.41
SW02	2	0.781	1.54	2.31	3.09	3.85	4.63	5.41	0.781	1.54	2.31	3.09	3.86	4.63	5.41
SW02	3	0.781	1.54	2.32	3.10	3.86	4.60	5.36	0.781	1.54	2.32	3.10	3.87	4.59	5.36
SW02	4	0.781	1.54	2.30	3.09	3.85	4.60	5.37	0.781	1.54	2.30	3.09	3.85	4.60	5.37
SW02	5	0.781	1.54	2.31	3.09	3.85	4.60	5.36	0.781	1.54	2.31	3.09	3.85	4.60	5.36
SW02	6	0.781	1.54	2.31	3.09	3.85	4.63	5.37	0.781	1.54	2.31	3.09	3.83	4.63	5.37
SW02	7	0.781	1.54	2.31	3.09	3.85	4.61	5.40	0.781	1.54	2.31	3.09	3.85	4.61	5.40
SW02	8	0.781	1.54	2.31	3.09	3.85	4.60	5.33	0.781	1.54	2.31	3.09	3.83	4.60	5.33
SW02	9	0.781	1.54	2.30	3.09	3.85	4.60	5.35	0.781	1.54	2.30	3.09	3.85	4.60	5.40
SW02	10	0.781	1.54	2.31	3.09	3.85	4.60	5.37	0.781	1.54	2.31	3.09	3.83	4.60	5.37
SW03	1	0.830	1.64	2.45	3.28	4.08	4.91	5.68	0.830	1.64	2.45	3.28	4.08	4.91	5.74
SW03	2	0.818	1.64	2.45	3.28	4.09	4.91	5.68	0.818	1.64	2.45	3.28	4.09	4.91	5.68
SW03	3	0.830	1.64	2.47	3.28	4.09	4.93	5.69	0.830	1.64	2.47	3.28	4.10	4.93	5.69
SW03	4	0.830	1.64	2.47	3.28	4.08	4.92	5.69	0.830	1.64	2.47	3.28	4.10	4.92	5.76
SW03	5	0.830	1.64	2.45	3.27	4.07	4.90	5.70	0.830	1.64	2.45	3.27	4.08	4.90	5.70
SW03	6	0.818	1.64	2.45	3.28	4.09	4.90	5.69	0.818	1.64	2.45	3.28	4.09	4.90	5.69
SW03	7	0.818	1.64	2.45	3.28	4.08	4.90	5.69	0.818	1.64	2.45	3.27	4.08	4.91	5.69
SW03	8	0.818	1.64	2.44	3.28	4.09	4.90	5.73	0.830	1.64	2.44	3.28	4.10	4.91	5.73
SW03	9	0.818	1.62	2.41	3.28	4.09	4.93	5.65	0.818	1.62	2.41	3.28	4.09	4.93	5.66
SW03	10	0.818	1.64	2.47	3.27	4.09	4.93	5.69	0.818	1.64	2.47	3.28	4.09	4.93	5.69
SW04	1	0.830	1.66	2.49	3.31	4.13	4.91	5.80	0.830	1.66	2.49	3.30	4.13	4.96	5.80
SW04	2	0.836	1.65	2.50	3.33	4.09	4.99	5.78	0.836	1.65	2.50	3.29	4.09	4.91	—

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
SW04	3	0.836	1.65	2.52	3.33	4.08	4.88	5.79	0.836	1.65	2.52	3.33	4.08	4.89	—
SW04	4	0.836	1.65	2.48	3.31	4.07	4.85	5.73	0.836	1.65	2.48	3.31	4.07	4.85	—
SW04	5	0.830	1.65	2.49	3.32	4.13	4.96	5.81	0.830	1.65	2.49	3.32	4.14	4.96	5.80
SW04	6	0.836	1.65	2.49	3.32	4.08	4.90	5.79	0.836	1.65	2.49	3.32	4.09	4.90	5.79
SW04	7	0.836	1.65	2.50	3.31	4.11	4.91	5.75	0.836	1.65	2.50	3.30	4.11	4.91	5.79
SW04	8	0.830	1.65	2.50	3.32	4.11	4.90	5.73	0.830	1.65	2.50	3.30	4.13	4.90	5.79
SW04	9*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SW04	10	0.830	1.65	2.50	3.31	4.10	4.90	5.79	0.830	1.65	2.50	3.30	4.13	4.90	5.79
SW04	11	0.830	1.65	2.49	3.30	4.09	4.88	5.79	0.830	1.65	2.50	3.27	4.00	4.88	5.70
SW05	1	0.836	1.76	2.64	—	4.38	5.27	5.94	0.836	1.76	2.64	3.53	4.39	5.26	—
SW05	2	0.891	1.76	2.64	3.50	4.41	5.29	6.19	0.891	1.76	2.65	3.53	4.41	5.29	6.08
SW05	3	0.890	1.76	2.64	3.53	4.41	5.27	6.09	0.890	1.76	2.65	3.53	4.41	5.27	6.09
SW05	4	0.891	1.76	2.66	3.52	4.43	5.32	6.14	0.891	1.76	2.66	3.54	4.43	5.20	—
SW05	5	0.891	1.76	2.66	3.54	4.42	5.31	6.04	0.891	1.76	2.66	3.54	4.42	5.30	6.10
SW05	6	0.885	1.76	2.64	3.52	4.41	5.27	6.17	0.885	1.76	2.64	3.53	4.41	5.27	6.18
SW05	7	0.891	1.76	2.65	3.53	4.41	5.27	6.15	0.891	1.76	2.65	3.53	4.41	5.27	6.07
SW05	8	0.885	1.76	2.66	3.52	4.38	5.28	6.13	0.885	1.76	2.64	3.53	4.39	5.28	6.12
SW05	9	0.891	1.76	2.64	3.52	4.36	5.27	6.08	0.891	1.76	2.64	3.52	4.36	5.27	6.15
SW05	10	0.885	1.76	2.65	3.52	4.38	5.27	6.13	0.885	1.76	2.65	3.53	4.38	5.27	—
SW06	1	0.952	1.89	2.86	3.73	4.74	5.67	—	0.952	1.89	2.86	3.73	4.75	5.69	—
SW06	2	0.952	1.89	2.82	3.78	4.74	5.69	—	0.952	1.89	2.82	3.80	4.75	5.69	—
SW06	3	0.952	1.89	2.83	3.78	4.67	5.68	—	0.952	1.89	2.83	3.80	4.76	5.68	—
SW06	4	0.952	1.89	2.86	3.78	4.74	5.68	6.64	0.952	1.89	2.84	3.78	4.74	5.68	6.63
SW06	5	0.952	1.89	2.86	3.80	4.75	5.69	6.64	0.952	1.89	2.83	3.78	4.75	5.69	6.64
SW06	6	0.952	1.89	2.83	3.78	4.74	5.68	—	0.952	1.89	2.83	3.78	4.74	5.68	—
SW06	7	0.952	1.89	2.83	3.78	4.74	5.68	6.64	0.952	1.89	2.83	3.78	4.74	5.68	6.64
SW06	8	0.952	1.89	2.83	3.79	4.74	5.68	6.64	0.952	1.89	2.83	3.77	4.75	5.68	6.66
SW06	9	0.952	1.89	2.83	3.79	4.74	5.69	6.64	0.952	1.89	2.83	3.76	4.74	5.69	6.64
SW06	10	0.952	1.89	2.83	3.78	4.74	5.68	6.64	0.952	1.89	2.83	3.78	4.75	5.69	6.64
SW29	1	0.800	1.58	2.33	3.13	3.93	4.65	5.51	0.800	1.58	2.33	3.16	3.88	4.74	5.51

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
SW29	2	0.800	1.58	2.37	3.15	3.95	4.76	5.55	0.800	1.58	2.37	3.17	3.95	4.76	—
SW29	3	0.800	1.58	2.37	3.16	3.93	4.76	5.53	0.800	1.58	2.38	3.15	3.93	4.76	—
SW29	4	0.800	1.58	2.37	3.17	3.93	4.76	5.51	0.800	1.58	2.38	3.15	3.93	4.76	5.52
SW29	5	0.800	1.58	2.37	3.15	3.91	4.72	5.49	0.800	1.58	2.37	3.15	3.91	4.72	5.50
SW29	6	0.800	1.58	2.35	3.14	3.94	4.72	5.50	0.800	1.58	2.35	3.17	3.94	4.72	5.51
SW29	7	0.800	1.58	2.37	3.14	3.94	4.66	5.49	0.800	1.58	2.38	3.15	3.94	4.73	5.49
SW29	8	0.800	1.58	2.33	3.14	3.83	4.69	5.52	0.800	1.58	2.33	3.17	3.92	4.62	—
SW29	9	0.800	1.58	2.37	3.14	3.94	4.71	5.49	0.800	1.58	2.37	3.16	3.94	4.71	5.49
SW29	10	0.800	1.58	2.34	3.14	3.94	4.72	5.50	0.800	1.58	2.33	3.15	3.94	4.72	5.50
SW30	1	0.745	1.48	2.20	2.97	3.70	4.41	5.19	0.745	1.48	2.20	2.97	3.70	4.41	5.20
SW30	2	0.745	1.48	2.21	2.97	3.70	4.45	5.19	0.745	1.48	2.21	2.97	3.70	4.45	5.19
SW30	3	0.745	1.48	2.21	2.96	3.69	4.39	5.18	0.745	1.48	2.21	2.96	3.69	4.39	5.18
SW30	4	0.745	1.48	2.20	2.97	3.69	4.37	5.18	0.745	1.48	2.20	2.96	3.69	4.37	5.18
SW30	5	0.745	1.48	2.20	2.97	3.70	4.38	5.13	0.745	1.48	2.20	2.97	3.70	4.42	5.13
SW30	6	0.745	1.48	2.21	2.96	3.69	4.38	5.18	0.745	1.48	2.21	2.96	3.69	4.38	5.19
SW30	7	0.745	1.48	2.20	2.96	3.69	4.42	5.16	0.745	1.48	2.20	2.96	3.69	4.43	—
SW30	8	0.745	1.48	2.20	2.96	3.69	4.38	5.10	0.745	1.48	2.20	2.96	3.69	4.38	—
SW30	9	0.745	1.48	2.21	2.97	3.70	4.37	5.09	0.745	1.48	2.21	2.95	3.70	4.36	5.12
SW30	10	0.745	1.48	2.21	2.96	3.69	4.40	5.18	0.745	1.48	2.21	2.96	3.69	4.40	5.13
SW31	1	0.726	1.45	2.17	2.90	3.62	4.34	5.05	0.726	1.45	2.17	2.89	3.62	4.32	5.05
SW31	2	0.726	1.45	2.17	—	3.62	4.34	5.05	0.726	1.45	2.17	2.89	3.62	4.34	5.06
SW31	3	0.732	1.45	2.17	2.91	3.59	4.32	5.04	0.732	1.45	2.16	2.91	3.59	4.32	5.05
SW31	4	0.726	1.45	2.17	—	3.62	4.33	5.05	0.726	1.45	2.17	2.90	3.61	4.33	5.05
SW31	5	0.726	1.45	2.17	—	3.61	4.33	5.04	0.726	1.45	2.17	2.89	3.61	4.33	5.04
SW31	6	0.726	1.45	2.16	—	3.62	4.31	5.05	0.726	1.45	2.16	2.89	3.62	4.31	5.05
SW31	7	0.726	1.45	2.17	—	3.61	4.34	5.04	0.726	1.45	2.17	2.91	3.61	4.34	5.05
SW31	8	0.732	1.45	2.17	—	3.61	4.33	5.05	0.732	1.45	2.17	2.89	3.62	4.33	5.06
SW31	9	0.732	1.44	2.17	2.91	3.61	4.33	5.04	0.732	1.44	2.16	2.89	3.61	4.33	5.05
SW31	10	0.726	1.45	2.17	—	3.59	4.33	5.04	0.726	1.45	2.17	2.90	3.59	4.33	5.04
SW32	1	0.702	1.39	2.09	2.80	3.46	4.15	4.90	0.702	1.39	2.09	2.80	3.49	4.16	4.90

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
SW32	2	0.702	1.40	2.09	2.80	3.49	4.15	4.91	0.702	1.40	2.09	2.80	3.49	4.15	4.87
SW32	3	0.708	1.39	2.09	2.80	3.49	4.18	4.91	0.708	1.39	2.09	2.81	3.49	4.18	4.91
SW32	4	0.708	1.39	2.09	—	3.50	4.15	4.91	0.708	1.39	2.09	2.78	3.50	4.16	—
SW32	5	0.702	1.40	2.09	2.80	3.49	4.19	4.89	0.702	1.40	2.09	2.80	3.49	4.18	4.90
SW32	6	0.708	1.39	2.09	2.80	3.50	4.19	4.91	0.708	1.39	2.09	2.80	3.50	4.19	—
SW32	7	0.708	1.39	2.09	—	3.50	4.15	4.91	0.708	1.39	2.09	2.80	3.50	4.19	4.91
SW32	8	0.708	1.40	2.09	—	3.50	4.15	4.92	0.708	1.40	2.09	2.81	3.50	4.15	—
SW32	9	0.708	1.39	2.09	—	3.50	4.14	4.91	0.708	1.39	2.09	2.80	3.50	4.14	—
SW32	10	0.702	1.40	2.09	—	3.50	4.19	4.87	0.702	1.40	2.09	2.80	3.50	4.19	4.90
SE03	1	0.836	1.65	2.48	3.31	4.15	4.96	5.80	0.836	1.65	2.48	3.31	4.15	4.96	5.80
SE03	2	0.836	1.65	2.48	3.32	4.15	4.96	5.80	0.836	1.65	2.48	3.32	4.15	4.97	5.80
SE03	3	0.830	1.65	2.48	3.32	—	4.96	5.79	0.830	1.65	2.48	3.32	4.14	4.96	5.79
SE03	4	0.830	1.65	2.48	3.31	4.15	4.96	5.73	0.830	1.65	2.48	3.31	4.14	4.96	5.70
SE03	5	0.836	1.65	2.48	3.32	4.15	4.96	5.77	0.836	1.65	2.48	3.32	4.14	4.96	5.80
SE03	6	0.830	1.65	2.48	3.31	4.13	4.96	5.79	0.830	1.65	2.48	3.31	4.11	4.96	5.79
SE03	7	0.830	1.65	2.48	3.31	4.12	4.96	5.76	0.830	1.65	2.48	3.31	4.11	4.96	5.76
SE03	8	0.830	1.65	2.49	3.32	—	4.97	5.80	0.830	1.65	2.49	3.32	4.14	4.97	5.80
SE03	9	0.836	1.65	2.50	3.33	4.13	4.99	5.81	0.836	1.65	2.50	3.33	4.13	4.99	5.81
SE03	10	0.842	1.66	2.49	3.33	4.18	4.99	5.84	0.842	1.66	2.49	3.33	4.13	4.99	5.81
SE04	1	0.867	1.71	2.59	—	4.24	5.08	5.92	0.867	1.71	2.59	3.41	4.24	—	—
SE04	2	0.861	1.70	2.56	3.41	4.26	5.08	5.96	0.861	1.70	2.56	3.42	4.26	5.14	—
SE04	3	0.867	1.71	2.53	—	4.24	5.07	5.81	0.867	1.71	2.54	3.42	4.24	—	—
SE04	4	0.861	1.71	2.53	3.42	4.30	5.12	5.87	0.861	1.71	2.53	3.44	4.30	5.11	—
SE04	5	0.867	1.72	2.59	—	4.28	5.10	—	0.867	1.72	2.59	3.44	4.28	5.10	—
SE04	6	0.861	1.71	2.58	3.44	4.29	5.15	6.03	0.861	1.71	2.58	3.44	4.29	5.15	6.03
SE04	7	0.867	1.71	2.57	3.42	4.29	5.12	6.01	0.867	1.71	2.57	3.44	4.29	—	—
SE04	8	0.861	1.71	2.58	3.42	4.29	5.12	6.00	0.861	1.71	2.58	3.43	4.29	5.14	5.99
SE04	9	0.861	1.70	2.50	3.43	4.28	5.10	6.01	0.861	1.70	2.50	3.42	4.27	—	—
SE04	10	0.856	1.70	2.56	3.42	4.27	5.10	5.99	0.856	1.70	2.58	3.42	4.27	—	—
SE04	11	0.861	1.70	2.56	3.42	4.27	5.05	6.01	0.861	1.70	2.56	3.42	4.27	5.05	6.01

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SE05	1	0.891	1.76	2.65	—	4.42	5.30	—	0.891	1.76	2.65	3.52	4.42	5.23	—
SE05	2	0.891	1.76	2.65	—	4.41	5.30	6.19	0.891	1.76	2.66	3.52	4.41	5.30	—
SE05	3	0.891	1.76	2.65	—	4.42	5.29	6.18	0.891	1.76	2.66	3.52	4.41	5.29	6.18
SE05	4	0.891	1.76	2.65	3.53	4.42	5.29	6.18	0.891	1.76	2.65	3.52	4.42	5.30	6.19
SE05	5	0.891	1.76	2.70	—	4.41	5.30	6.18	0.891	1.76	2.64	3.54	4.41	—	—
SE05	6	0.891	1.76	2.66	—	4.41	5.31	6.20	0.891	1.76	2.66	3.54	4.41	5.31	6.20
SE05	7	0.891	1.76	2.66	—	4.42	5.31	6.15	0.891	1.76	2.66	3.54	4.42	5.33	6.19
SE05	8	0.891	1.76	2.65	—	4.40	5.30	—	0.891	1.76	2.65	3.54	4.42	5.29	6.20
SE05	9	0.891	1.76	2.65	—	4.40	5.30	6.19	0.891	1.76	2.65	3.54	4.41	5.24	6.19
SE05	10	0.891	1.76	2.66	—	4.41	5.31	6.20	0.891	1.76	2.66	3.55	4.41	5.31	6.21
SE32	1	0.684	1.36	2.03	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.72	3.39	4.07	4.74
SE32	2	0.684	1.36	2.03	2.72	3.40	4.07	4.73	0.684	1.36	2.03	2.72	3.40	4.07	4.72
SE32	3	0.684	1.36	2.03	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.72	3.39	4.07	4.75
SE32	4	0.684	1.36	2.03	2.72	3.39	4.05	4.74	0.684	1.36	2.03	2.72	3.39	4.05	4.74
SE32	5	0.684	1.36	2.04	2.72	3.39	4.07	4.74	0.684	1.36	2.04	2.71	3.39	4.07	4.74
SE32	6	0.684	1.36	2.03	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.71	3.39	4.07	4.74
SE32	7	0.684	1.36	2.03	2.72	3.39	4.07	4.76	0.684	1.36	2.03	2.72	3.39	4.07	4.76
SE32	8	0.684	1.36	2.03	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.71	3.39	4.07	4.74
SE32	9	0.684	1.36	2.04	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.72	3.39	4.07	4.75
SE32	10	0.684	1.36	2.03	2.72	3.39	4.07	4.74	0.684	1.36	2.03	2.72	3.39	4.07	4.74

*No excitation.

—Indicates no data are available.

Table 9. Phase 1 averaged mode frequencies (Hz).

Cable	1	2	3	4	5	6	7
NW01	0.745	1.47	2.21	2.93	3.67	4.40	5.14
NW02	0.781	1.54	2.33	3.10	3.88	4.65	5.43
NW29	0.824	1.63	2.46	3.26	4.08	4.94	5.70
NW30	0.787	1.56	2.33	3.12	3.88	4.66	5.44
NW31	0.732	1.45	2.17	2.91	3.64	4.33	5.07
NW32	0.696	1.37	2.06	2.75	3.44	4.12	4.81
SW01	0.745	1.48	2.22	2.98	3.71	4.44	5.19
SW02	0.781	1.54	2.31	3.09	3.85	4.60	5.37
SW03	0.818	1.64	2.45	3.28	4.09	4.91	5.69
SW04	0.836	1.65	2.50	3.33	4.13	4.91	5.79
SW05	0.890	1.76	2.64	3.53	4.41	5.27	6.09
SW06	0.952	1.89	2.83	3.78	4.75	5.68	—
SW29	0.800	1.58	2.37	3.15	3.94	4.72	5.51
SW30	0.745	1.48	2.21	2.97	3.69	4.40	5.18
SW31	0.726	1.45	2.17	2.90	3.61	4.33	5.05
SW32	0.708	1.39	2.09	2.80	3.50	4.15	4.91
SE03	0.836	1.65	2.48	3.32	4.15	4.96	5.80
SE04	0.861	1.71	2.53	3.42	4.26	5.12	5.87
SE05	0.891	1.76	2.65	3.52	4.42	5.30	6.18
SE32	0.684	1.36	2.03	2.72	3.39	4.07	4.74

—Indicates no data are available.

Table 10. Phase 2 mode frequencies (Hz).

		Box 1							Box 2						
Cable	**Run**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
NW01	1	0.665	1.31	1.99	2.64	3.30	3.97	4.61	0.665	1.31	1.99	2.64	3.30	3.97	4.61
NW01	2	0.671	1.31	1.99	2.64	3.33	3.97	4.61	0.671	1.31	1.99	2.64	3.33	3.97	4.61
NW01	3	0.671	1.32	1.99	2.64	3.35	3.97	4.61	0.671	1.32	1.99	2.64	3.35	3.97	4.61
NW01	4	0.671	1.32	1.99	2.64	3.30	3.97	4.61	0.671	1.32	1.99	2.64	3.30	3.97	4.61
NW01	5	0.671	1.32	1.99	2.64	3.33	3.97	4.61	0.671	1.32	1.99	2.64	3.33	3.97	4.61
NW01	6	0.671	1.32	1.99	2.64	3.31	3.97	4.61	0.671	1.32	1.99	2.64	3.31	3.97	4.61
NW01	7	0.671	1.32	1.99	2.65	3.33	3.97	4.61	0.671	1.32	1.99	2.65	3.33	3.97	4.61
NW01	8	0.671	1.32	1.99	2.64	3.33	3.97	4.61	0.671	1.32	1.99	2.64	3.33	3.97	4.61
NW01	9	0.671	1.32	1.99	2.64	3.33	3.97	4.61	0.671	1.32	1.99	2.64	3.30	3.97	4.61
NW01	10	0.671	1.31	1.99	2.65	3.33	3.97	4.61	0.671	1.31	1.99	2.65	3.33	3.97	4.61
NW02	1	0.690	1.37	2.06	2.73	3.47	4.12	4.80	0.690	1.37	2.06	2.73	3.47	4.13	4.80
NW02	2	0.696	1.37	2.06	2.73	3.47	4.13	4.80	0.696	1.37	2.06	2.73	3.47	4.13	4.80
NW02	3	0.696	1.37	2.08	2.75	3.47	4.14	4.80	0.696	1.37	2.08	2.75	3.47	4.14	4.80
NW02	4	0.696	1.37	2.08	2.73	3.47	4.13	4.80	0.696	1.37	2.06	2.73	3.47	4.13	4.80
NW02	5	0.696	1.37	2.08	2.75	3.49	4.14	4.81	0.696	1.37	2.08	2.75	3.49	4.14	4.81
NW02	6	0.696	1.37	2.08	2.75	3.48	4.14	4.81	0.696	1.37	2.08	2.75	3.48	4.14	4.81
NW02	7	0.696	1.37	2.08	2.75	3.48	4.14	4.81	0.696	1.37	2.08	2.75	3.48	4.14	4.81
NW02	8	0.696	1.38	2.08	2.76	3.49	4.15	4.82	0.696	1.38	2.08	2.76	3.49	4.15	4.82
NW02	9	0.696	1.37	2.08	2.75	3.48	4.14	4.81	0.696	1.37	2.08	2.75	3.48	4.14	4.81
NW02	10	0.696	1.37	2.05	2.73	3.46	4.10	4.77	0.696	1.37	2.05	2.73	3.46	4.10	4.77
NW03	1	0.708	1.40	2.11	2.81	3.50	4.23	4.91	0.708	1.40	2.11	2.81	3.50	4.22	4.91
NW03	2	0.708	1.39	2.11	2.81	3.54	4.22	4.91	0.708	1.39	2.11	2.81	3.54	4.22	4.91
NW03	3	0.708	1.39	2.11	2.81	3.54	4.22	4.91	0.708	1.39	2.11	2.81	3.54	4.22	4.91
NW03	4	0.708	1.39	2.11	2.81	3.50	4.21	4.91	0.708	1.39	2.11	2.81	3.50	4.22	4.91
NW03	5	0.708	1.39	2.12	2.81	3.55	4.22	4.92	0.708	1.39	2.12	2.81	3.55	4.24	4.92
NW03	6	0.708	1.39	2.11	2.81	3.55	4.22	4.91	0.708	1.39	2.11	2.81	3.55	4.22	4.91
NW03	7	0.708	1.39	2.11	2.80	3.49	4.21	4.91	0.708	1.39	2.11	2.80	3.49	4.21	4.91
NW03	8	0.708	1.39	2.11	2.80	3.54	4.21	4.91	0.708	1.39	2.11	2.80	3.54	4.21	4.91

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
NW03	9	0.708	1.39	2.11	2.80	3.49	4.21	4.90	0.708	1.39	2.11	2.80	3.49	4.21	4.90
NW03	10	0.708	1.39	2.11	2.80	3.49	4.21	4.90	0.708	1.39	2.11	2.80	3.49	4.21	4.90
NW29	1	0.690	1.37	2.05	2.75	3.38	4.12	4.80	0.690	1.37	2.05	2.75	3.38	4.12	4.80
NW29	2	0.696	1.37	2.05	2.75	3.38	4.13	4.80	0.696	1.37	2.05	2.75	3.38	4.13	4.80
NW29	3	0.690	1.37	2.05	2.74	3.38	4.12	4.80	0.690	1.37	2.05	2.74	3.38	4.12	4.80
NW29	4	0.690	1.37	2.05	2.75	3.38	4.10	4.80	0.690	1.37	2.05	2.74	3.38	4.13	4.80
NW29	5	0.696	1.37	2.05	2.75	3.38	4.13	4.80	0.696	1.37	2.05	2.75	3.38	4.13	4.80
NW29	6	0.696	1.37	2.05	2.75	3.38	4.13	4.80	0.696	1.37	2.05	2.75	3.38	4.10	4.80
NW29	7	0.696	1.37	2.05	2.75	3.38	4.13	4.81	0.696	1.37	2.05	2.75	3.38	4.13	4.81
NW29	8	0.696	1.37	2.05	2.75	3.39	4.13	4.82	0.696	1.37	2.05	2.75	3.42	4.14	4.82
NW29	9	0.696	1.37	2.05	2.75	3.39	4.13	4.81	0.696	1.37	2.05	2.75	3.39	4.13	4.81
NW29	10	0.696	1.37	2.05	2.76	3.39	4.14	4.81	0.696	1.37	2.05	2.75	3.39	4.14	4.81
NW30	1	0.665	1.32	1.97	2.63	3.30	3.99	4.64	0.665	1.32	1.97	2.63	3.30	3.99	4.64
NW30	2	0.665	1.32	1.97	2.63	3.30	4.00	4.63	0.665	1.32	1.97	2.63	3.30	4.00	4.63
NW30	3	0.665	1.32	1.97	2.63	3.30	3.99	4.63	0.665	1.32	1.97	2.63	3.30	3.99	4.63
NW30	4	0.665	1.32	1.97	2.63	3.30	3.99	4.64	0.665	1.32	1.97	2.63	3.30	3.99	4.64
NW30	5	0.665	1.32	1.97	2.63	3.30	3.99	4.63	0.665	1.32	1.97	2.63	3.30	3.96	4.64
NW30	6	0.665	1.32	1.97	2.63	3.30	3.96	4.64	0.665	1.32	1.97	2.63	3.30	3.96	4.64
NW30	7	0.665	1.32	1.97	2.63	3.30	3.97	4.64	0.665	1.32	1.97	2.63	3.30	3.98	4.64
NW30	8	0.665	1.32	1.97	2.63	3.30	3.99	4.64	0.665	1.32	1.97	2.63	3.30	3.99	4.64
NW30	9	0.665	1.32	1.97	2.63	3.30	4.00	4.64	0.665	1.32	1.97	2.63	3.30	4.00	4.64
NW30	10	0.665	1.32	1.97	2.63	3.30	3.99	4.64	0.665	1.32	1.97	2.63	3.30	3.99	4.64
NW31	1	0.635	1.26	1.87	2.52	3.18	3.79	4.42	0.635	1.26	1.89	2.52	3.18	3.79	4.42
NW31	2	0.635	1.26	1.89	2.53	3.19	3.80	4.43	0.635	1.26	1.88	2.53	3.19	3.80	4.43
NW31	3	0.635	1.26	1.89	2.53	3.19	3.80	4.43	0.635	1.26	1.89	2.53	3.19	3.80	4.43
NW31	4	0.635	1.26	1.89	2.52	3.19	3.80	4.43	0.635	1.26	1.89	2.52	3.19	3.80	4.43
NW31	5	0.635	1.26	1.89	2.52	3.19	3.78	4.43	0.635	1.26	1.89	2.52	3.19	3.78	4.43
NW31	6	0.635	1.27	1.89	2.53	3.19	3.80	4.44	0.635	1.27	1.89	2.53	3.19	3.80	4.44
NW31	7	0.635	1.26	1.88	2.53	3.19	3.80	4.43	0.635	1.26	1.88	2.53	3.19	3.80	4.43
NW31	8	0.635	1.26	1.89	2.52	3.20	3.80	4.44	0.635	1.26	1.89	2.53	3.20	3.80	4.43

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
NW31	9	0.635	1.26	1.89	2.52	3.19	3.78	4.43	0.635	1.26	1.89	2.53	3.19	3.78	4.43
NW31	10	0.635	1.26	1.89	—	3.19	3.80	4.44	0.635	1.26	1.89	2.53	3.19	3.80	4.44
NW32	1	0.592	1.18	1.76	2.37	2.97	3.50	4.16	0.592	1.18	1.76	2.37	2.97	3.50	4.16
NW32	2	0.598	1.17	1.77	2.36	2.95	3.50	4.16	0.598	1.17	1.77	2.36	2.97	3.50	4.16
NW32	3	0.598	1.17	1.77	2.36	2.97	3.53	4.13	0.598	1.17	1.77	2.36	2.97	3.52	4.13
NW32	4	0.592	1.18	1.76	2.36	2.97	3.50	4.14	0.592	1.18	1.76	2.36	2.97	3.50	4.14
NW32	5	0.598	1.17	1.77	2.36	2.97	3.50	4.13	0.598	1.17	1.77	2.36	2.97	3.50	4.13
NW32	6	0.598	1.17	1.77	2.36	2.98	3.50	4.16	0.598	1.17	1.77	2.36	2.98	3.50	4.16
NW32	7	0.598	1.17	1.77	2.36	2.98	3.50	4.18	0.598	1.17	1.77	2.36	2.95	3.50	4.18
NW32	8	0.598	1.17	1.77	2.36	2.97	3.50	4.14	0.598	1.17	1.77	2.36	2.97	3.50	4.14
SW01	1	0.671	1.32	1.99	2.64	3.36	—	4.61	0.671	1.32	1.99	2.64	3.36	3.98	4.61
SW01	2	0.671	1.31	1.98	2.65	3.29	3.97	4.60	0.671	1.31	1.98	2.65	3.29	3.98	4.61
SW01	3	0.671	1.31	1.98	2.64	3.35	3.97	4.61	0.671	1.31	1.98	2.64	3.35	3.97	4.61
SW01	4	0.665	1.31	1.98	2.64	3.35	3.97	4.60	0.665	1.31	1.98	2.64	3.35	3.97	4.61
SW01	5	0.671	1.31	1.98	2.64	3.3	3.97	4.61	0.671	1.31	1.98	2.64	3.30	3.97	4.61
SW01	6	0.671	1.31	1.98	2.64	3.3	3.97	4.61	0.671	1.31	1.98	2.64	3.30	3.97	4.61
SW01	7	0.671	1.31	1.98	2.65	3.3	3.97	4.61	0.671	1.31	1.98	2.64	3.30	3.97	4.61
SW01	8	0.665	1.31	1.98	2.64	3.3	3.96	4.60	0.665	1.31	1.98	2.64	3.30	3.97	4.60
SW01	9	0.665	1.31	1.98	2.64	3.29	3.96	4.60	0.665	1.31	1.98	2.64	3.29	3.96	4.60
SW01	10	0.671	1.31	1.98	2.64	3.35	3.97	4.60	0.671	1.31	1.98	2.64	3.35	3.97	4.60
SW02	1	0.69	1.36	2.05	2.74	—	4.10	4.77	0.69	1.36	2.05	2.73	3.47	4.10	4.77
SW02	2	0.69	1.36	2.05	2.74	—	4.13	4.77	0.69	1.36	2.05	2.74	3.47	4.13	4.77
SW02	3	0.69	1.36	2.06	2.74	—	4.10	4.78	0.69	1.36	2.06	2.73	3.41	4.11	4.78
SW02	4	0.69	1.36	2.05	2.74	3.41	4.07	4.77	0.69	1.36	2.05	2.74	3.41	4.13	4.77
SW02	5	0.69	1.36	2.05	2.73	3.41	4.13	4.76	0.69	1.36	2.05	2.73	3.41	4.13	4.76
SW02	6	0.69	1.36	2.05	2.73	—	4.08	4.77	0.69	1.36	2.05	2.73	3.40	4.13	4.77
SW02	7	0.69	1.36	2.05	2.72	—	4.10	4.77	0.69	1.36	2.05	2.72	3.47	4.13	4.77
SW02	8	0.690	1.36	2.05	2.73	—	4.13	4.77	0.690	1.36	2.05	2.73	3.41	4.13	4.77
SW02	9	0.690	1.36	2.05	2.73	—	4.10	4.77	0.690	1.36	2.05	2.73	3.47	4.13	4.77
SW02	10	0.690	1.36	2.05	2.73	3.39	4.08	4.76	0.690	1.36	2.05	2.73	3.4	4.12	4.46

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SW03	1	0.714	1.40	2.12	2.83	3.60	4.29	4.94	0.714	1.40	2.12	2.83	3.53	4.29	4.94
SW03	2	0.714	1.40	2.12	2.83	—	4.24	4.94	0.714	1.40	2.12	2.82	3.52	4.24	4.94
SW03	3	0.714	1.40	2.12	2.82	—	4.29	4.93	0.714	1.40	2.12	2.82	3.53	4.29	4.93
SW03	4	0.714	1.40	2.12	2.83	—	4.29	4.93	0.714	1.40	2.12	2.83	3.52	4.29	4.96
SW03	5	0.708	1.40	2.11	2.83	—	4.29	4.94	0.708	1.40	2.11	2.83	3.53	4.29	4.94
SW03	6	0.708	1.40	2.12	2.83	—	4.26	4.94	0.708	1.40	2.12	2.83	3.59	4.26	4.94
SW03	7	0.708	1.40	2.11	2.83	—	4.27	4.92	0.708	1.40	2.11	2.83	3.52	4.27	4.92
SW03	8	0.708	1.39	2.12	2.81	—	4.22	4.93	0.708	1.40	2.11	2.82	3.52	4.24	4.92
SW04	1	0.702	1.38	2.09	2.79	3.53	4.22	4.91	0.702	1.38	2.09	2.79	3.53	4.22	4.91
SW04	2	0.708	1.38	2.09	2.78	3.53	4.22	4.9	0.708	1.38	2.09	2.78	3.53	4.22	4.90
SW04	3	0.702	1.38	2.08	2.78	3.53	4.23	4.90	0.702	1.38	2.08	2.78	3.53	4.23	4.90
SW04	4	0.708	1.38	2.09	2.78	3.53	4.24	4.91	0.708	1.38	2.09	2.78	3.53	4.24	4.91
SW04	5	0.708	1.38	2.09	2.78	3.52	4.22	4.90	0.708	1.38	2.09	2.78	3.52	4.22	4.90
SW04	6	0.708	1.38	2.08	2.78	3.53	4.22	4.91	0.708	1.38	2.08	2.78	3.53	4.22	4.91
SW04	7	0.708	1.38	2.08	2.78	3.53	4.22	4.90	0.708	1.38	2.08	2.78	3.53	4.22	4.91
SW04	8	0.708	1.38	2.09	2.78	3.53	4.21	4.88	0.708	1.38	2.09	2.78	3.53	4.21	4.88
SW04	9	0.708	1.38	2.08	2.78	3.52	4.20	4.88	0.708	1.38	2.08	2.77	3.52	4.20	4.88
SW04	10	0.696	1.38	2.08	2.78	3.53	4.22	4.90	0.696	1.38	2.08	2.78	3.53	4.22	4.90
SW05	1	0.739	1.45	2.18	2.91	3.69	4.42	5.18	0.739	1.45	2.18	2.91	3.70	4.42	5.18
SW05	2	0.732	1.44	2.19	2.92	3.69	4.42	5.18	0.732	1.44	2.19	2.92	3.69	4.42	5.18
SW05	3	0.732	1.44	2.17	2.92	3.69	4.42	5.16	0.732	1.44	2.17	2.92	3.69	4.42	5.16
SW05	4	0.732	1.44	2.17	2.92	3.69	4.42	5.18	0.732	1.44	2.19	2.92	3.69	4.42	5.18
SW05	5	0.732	1.44	2.19	2.92	3.69	4.42	5.16	0.732	1.44	2.19	2.92	3.69	4.42	5.16
SW05	6	0.732	1.44	2.19	2.92	3.70	4.42	5.16	0.732	1.44	2.19	2.92	3.70	4.42	5.16
SW05	7	0.732	1.44	2.17	2.92	3.70	4.42	5.18	0.732	1.44	2.17	2.92	3.70	4.42	5.18
SW05	8	0.732	1.44	2.19	2.92	3.69	4.42	5.16	0.732	1.44	2.17	2.92	3.69	4.42	5.16
SW05	9	0.732	1.44	2.19	2.92	3.69	4.42	5.15	0.732	1.44	2.19	2.92	3.69	4.42	5.19
SW05	10	0.732	1.44	2.19	—	3.69	4.42	5.18	0.732	1.44	2.19	2.92	3.69	4.42	5.18
SW29	1	0.684	1.35	2.02	2.72	3.34	4.06	4.72	0.684	1.35	2.02	2.70	3.34	4.06	4.72
SW29	2	0.684	1.34	2.01	2.71	3.35	4.07	4.72	0.684	1.34	2.01	2.71	3.35	4.07	4.72

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SW29	3	0.684	1.35	2.02	—	3.33	4.05	4.72	0.684	1.35	2.02	2.71	3.33	4.06	4.72
SW29	4	0.684	1.34	2.01	2.71	3.33	4.05	4.72	0.684	1.34	2.01	2.71	3.33	4.07	4.72
SW29	5	0.684	1.34	2.01	—	3.33	4.05	4.72	0.684	1.34	2.01	2.71	3.33	4.05	4.72
SW29	6	0.684	1.34	2.01	—	—	—	—	0.684	1.34	2.01	2.71	3.33	4.03	4.69
SW29	7	0.684	1.33	2.00	2.70	3.33	4.04	4.69	0.684	1.33	2.00	2.70	3.33	4.04	4.69
SW29	8	0.684	1.34	2.00	2.70	3.33	4.04	4.69	0.684	1.34	2.00	2.70	3.33	4.04	4.69
SW29	9	0.684	1.34	2.00	2.70	3.33	4.04	4.69	0.684	1.34	2.00	2.70	3.33	4.04	4.69
SW29	10	0.684	1.33	2.00	2.70	3.33	4.04	4.69	0.684	1.33	2.00	2.70	3.33	4.04	4.69
SW30	1	0.659	1.29	1.93	2.58	3.24	3.93	4.55	0.659	1.29	1.93	2.58	3.24	3.93	4.55
SW30	2	0.659	1.29	1.93	2.56	3.24	3.92	4.55	0.659	1.29	1.93	2.58	3.24	3.92	4.55
SW30	3	0.659	1.29	1.93	2.56	3.24	3.92	4.54	0.659	1.29	1.93	2.56	3.24	3.92	4.54
SW30	4	0.659	1.29	1.93	2.56	3.24	3.92	4.55	0.659	1.29	1.93	2.56	3.24	3.92	4.55
SW30	5	0.659	1.29	1.93	2.56	3.24	3.92	4.55	0.659	1.29	1.93	2.58	3.24	3.92	4.55
SW30	6	0.659	1.29	1.93	2.58	3.24	3.92	4.55	0.659	1.29	1.93	2.58	3.24	3.92	4.55
SW30	7	0.653	1.29	1.93	2.58	3.24	3.93	4.55	0.653	1.29	1.93	2.58	3.24	3.93	4.55
SW30	8	0.659	1.29	1.93	2.58	3.24	3.92	4.55	0.659	1.29	1.93	2.58	3.24	3.92	4.55
SW30	9	0.659	1.29	1.93	2.58	3.24	3.92	4.55	0.659	1.29	1.94	2.58	3.24	3.92	4.55
SW30	10	0.659	1.29	1.93	2.56	3.22	3.92	4.55	0.659	1.29	1.93	2.58	3.22	3.92	4.55
SW31	1	0.647	1.28	1.93	2.56	3.25	3.85	4.52	0.647	1.28	1.93	2.56	3.25	3.85	4.52
SW31	2	0.647	1.28	1.93	2.56	3.25	3.86	4.50	0.647	1.28	1.93	2.56	3.25	3.86	4.52
SW31	3	0.647	1.28	1.93	2.57	3.22	3.86	4.51	0.647	1.28	1.93	2.56	3.25	3.86	4.51
SW31	4	0.647	1.28	1.93	2.56	3.22	3.85	4.50	0.647	1.28	1.93	2.56	3.22	3.85	4.50
SW31	5	0.647	1.28	1.93	2.56	3.21	3.86	4.50	0.647	1.28	1.93	2.56	3.22	3.86	4.50
SW31	6	0.647	1.28	1.93	2.58	3.25	3.86	4.52	0.647	1.28	1.93	2.56	3.25	3.86	4.52
SW31	7	0.647	1.28	1.93	2.56	3.26	3.85	4.52	0.647	1.28	1.93	2.56	3.26	3.85	4.52
SW31	8	0.647	1.28	1.93	2.56	3.25	3.85	4.52	0.647	1.28	1.93	2.56	3.25	3.85	4.52
SW31	9	0.647	1.28	1.93	2.56	3.25	3.85	4.52	0.647	1.28	1.93	2.56	3.25	3.85	4.52
SW31	10	0.647	1.28	1.93	2.56	3.25	3.86	4.52	0.647	1.28	1.93	2.56	3.25	3.86	4.52
SW32	1	0.617	1.21	1.83	2.43	3.06	3.61	4.29	0.617	1.21	1.83	2.42	3.06	2.62	4.30
SW32	2	0.617	1.21	1.83	2.43	3.06	3.61	4.29	0.617	1.21	1.83	2.42	3.06	3.61	4.29

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SW32	3	0.617	1.21	1.82	2.43	3.05	3.61	4.28	0.617	1.21	1.82	2.42	3.05	3.61	4.28
SW32	4	0.617	1.21	1.83	2.43	3.06	3.61	4.29	0.617	1.21	1.83	2.43	3.06	3.61	4.29
SW32	5	0.610	1.21	1.82	2.43	3.05	3.61	4.29	0.610	1.21	1.82	2.43	3.05	3.61	4.29
SW32	6	0.617	1.21	1.82	2.43	3.05	3.61	4.28	0.617	1.21	1.82	2.42	3.05	3.61	4.27
SW32	7	0.610	1.21	1.82	2.43	3.05	3.61	4.30	0.610	1.21	1.82	2.43	3.05	3.61	4.30
SW32	8	0.610	1.21	1.82	2.43	3.05	3.61	4.29	0.610	1.21	1.82	2.43	3.05	3.61	4.29
SW32	9	0.610	1.21	1.82	2.43	3.04	3.60	4.30	0.610	1.21	1.82	2.43	3.04	3.60	4.30
SW32	10	0.610	1.21	1.82	2.43	3.05	3.61	4.29	0.610	1.21	1.82	2.43	3.05	3.61	4.27
SE32	1	0.592	1.17	1.76	2.35	2.97	3.50	4.14	0.592	1.17	1.76	2.36	2.97	3.50	4.14
SE32	2	0.598	1.17	1.76	2.36	2.97	3.50	4.15	0.598	1.17	1.76	2.36	2.97	3.50	4.15
SE32	3	0.598	1.17	1.76	2.36	2.97	3.50	4.14	0.598	1.17	1.76	2.36	2.97	3.50	4.14
SE32	4	0.598	1.17	1.76	2.36	2.97	3.50	4.15	0.598	1.17	1.76	2.36	2.97	3.50	4.15
SE32	5	0.598	1.17	1.76	2.36	2.97	3.50	4.11	0.598	1.17	1.76	2.36	2.97	3.50	4.11
SE32	6	0.598	1.17	1.76	2.36	2.98	3.50	4.15	0.598	1.17	1.76	2.36	2.98	3.50	4.15
SE32	7	0.598	1.17	1.76	2.36	2.97	3.50	4.11	0.598	1.17	1.76	2.36	2.97	3.50	4.10
SE32	8	0.598	1.17	1.76	2.36	2.97	3.52	4.14	0.598	1.17	1.76	2.36	2.97	3.52	4.14
SE32	9	0.598	1.17	1.76	2.36	2.97	3.52	4.13	0.598	1.17	1.76	2.36	2.97	3.52	4.13

—Indicates no data are available.

Table 11. Phase 2 averaged mode frequencies (Hz).

Cable	1	2	3	4	5	6	7
NW01	0.671	1.31	1.99	2.64	3.33	3.97	4.61
NW02	0.696	1.37	2.06	2.73	3.47	4.13	4.80
NW03	0.708	1.39	2.11	2.81	3.54	4.22	4.91
NW29	0.69	1.37	2.05	2.75	3.38	4.12	4.80
NW30	0.665	1.32	1.97	2.63	3.30	3.99	4.63
NW31	0.635	1.26	1.89	2.53	3.19	3.80	4.43
NW32	0.598	1.17	1.77	2.36	2.97	3.50	4.16
SW01	0.671	1.31	1.98	2.64	3.35	3.97	4.61
SW02	0.69	1.36	2.05	2.74	3.47	4.11	4.77
SW03	0.714	1.40	2.12	2.83	3.53	4.29	4.94
SW04	0.702	1.38	2.09	2.78	3.53	4.22	4.90
SW05	0.732	1.44	2.18	2.92	3.69	4.42	5.18
SW06	0.684	1.35	2.02	2.71	3.34	4.06	4.72
SW30	0.659	1.29	1.93	2.58	3.24	3.92	4.55
SW31	0.647	1.28	1.93	2.56	3.25	3.86	4.52
SW32	0.617	1.21	1.83	2.43	3.06	3.61	4.29
SE32	0.598	1.17	1.76	2.36	2.97	3.50	4.14

Table 12. Phase 3 mode frequencies (Hz).

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
SE27	1	1.83	3.89	5.66	7.85	—	—	—	1.83	3.89	5.66	—	—	—	—
SE27	2	1.84	3.89	5.74	7.83	—	—	—	1.84	3.89	5.75	—	—	—	—
SE27	3	1.83	3.89	5.69	7.84	—	—	—	1.83	3.89	5.76	—	—	—	—
SE27	4	1.84	3.89	5.73	7.85	—	—	—	1.84	3.89	5.74	—	—	—	—
SE27	5	1.83	3.89	5.76	7.85	9.71	11.74	13.89	1.84	3.89	5.76	7.84	9.69	11.76	13.89
SE27	6	1.84	3.89	5.75	7.84	9.85	11.77	13.89	1.84	3.89	5.75	7.84	9.85	11.77	13.89
SE27	7	1.84	3.91	5.77	7.84	9.71	11.77	13.89	1.84	3.91	5.77	—	9.71	11.77	—
SE27	8	1.84	3.89	5.77	7.84	9.77	11.74	—	1.84	3.89	5.77	—	9.77	11.76	—
SE27	9	1.86	3.91	5.75	7.85	—	11.77	—	1.86	3.89	5.75	—	9.86	11.77	—
SE27	10	1.84	3.89	5.76	7.84	—	11.73	—	1.84	3.89	5.76	—	9.71	11.73	—
SE28	1	1.59	—	4.77	—	8.09	—	—	1.59	3.23	4.77	6.43	8.09	—	—
SE28	2	1.59	—	4.76	—	8.09	—	—	1.59	3.24	4.76	—	8.09	—	—
SE28	3	1.59	—	4.77	—	8.18	—	—	1.59	3.24	4.77	—	8.09	—	—
SE28	4	1.59	—	4.77	—	8.09	—	—	1.59	3.24	4.77	6.42	—	—	—
SE28	5	1.59	—	4.76	6.60	8.08	9.84	11.45	1.59	3.24	4.76	6.42	8.07	9.84	11.45
SE28	6	1.59	—	4.76	6.63	8.09	9.79	11.52	1.59	3.22	4.76	—	8.09	9.89	—
SE28	7	1.59	—	4.76	6.60	8.23	9.97	11.46	1.59	3.24	4.76	—	8.23	9.78	11.65
SE28	8	1.59	—	4.76	6.65	8.08	9.99	11.62	1.59	3.25	4.76	—	8.08	9.85	11.62
SE28	9	1.60	—	4.79	6.65	8.12	—	—	1.60	3.25	4.79	—	8.25	9.92	—
SE28	10	1.60	—	4.79	6.64	8.11	—	—	1.60	3.25	4.79	—	8.11	9.85	—
SE28	11*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SE29	1	1.33	2.67	3.97	5.35	6.89	8.17	9.63	1.33	2.67	3.97	5.36	6.88	8.16	9.63
SE29	2	1.33	2.67	3.99	5.35	6.87	8.14	9.62	1.33	2.67	3.99	5.34	6.87	8.14	—
SE29	3	1.32	2.67	3.99	5.35	6.87	8.15	9.61	1.33	2.67	3.99	5.35	6.87	8.15	9.61
SE29	4	1.33	2.67	3.99	5.35	6.87	—	9.62	1.33	2.67	3.99	5.35	6.87	8.14	9.62
SE29	5	1.33	2.66	3.98	5.36	6.87	8.07	9.61	1.33	2.66	3.98	5.36	6.87	8.07	9.62
SE29	6	1.32	2.67	3.99	5.35	6.88	8.16	9.63	1.32	2.67	3.99	5.35	6.88	8.13	9.63
SE29	7	1.33	2.67	3.99	5.36	6.89	8.15	9.62	1.33	2.67	3.99	5.35	6.87	8.15	9.61
SE29	8	1.33	2.66	3.98	5.35	6.87	8.13	9.62	1.33	2.66	3.98	5.35	6.87	8.13	9.61
SE29	9	1.33	2.67	3.98	5.36	6.81	8.14	9.61	1.33	2.66	3.98	5.36	6.81	8.13	9.61
SE29	10	1.33	2.66	3.98	5.36	6.86	8.15	9.62	1.33	2.66	3.98	5.36	6.86	8.15	9.62

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
SE30	1	1.14	2.28	3.49	4.61	5.79	7.04	—	1.14	2.28	3.49	4.61	—	—	—
SE30	2	1.14	2.27	3.49	4.61	5.79	7.02	—	1.14	2.27	3.49	4.61	—	—	—
SE30	3	1.15	2.27	3.49	4.61	5.77	—	—	1.15	2.27	3.49	4.61	—	—	—
SE30	4	1.14	2.28	3.49	4.61	5.79	7.02	—	1.14	2.28	3.49	4.61	5.79	7.02	—
SE30	5	1.15	2.28	3.49	4.61	5.79	7.04	8.20	1.15	2.28	3.49	4.61	—	7.12	8.20
SE30	6	1.15	2.28	3.49	4.61	5.79	7.10	8.20	1.15	2.28	3.49	4.61	—	7.03	8.20
SE30	7	1.14	2.28	3.49	4.61	5.79	7.01	8.20	1.14	2.28	3.49	4.61	5.77	7.12	8.20
SE30	8	1.14	2.28	3.49	4.61	5.79	7.06	8.20	1.14	2.28	3.49	4.61	—	7.06	8.20
SE30	9	1.14	2.28	3.49	4.61	5.79	7.06	—	1.14	2.28	3.49	4.61	—	7.13	8.24
SE30	10	1.15	2.27	3.49	4.61	5.79	7.06	—	1.15	2.27	3.49	4.61	5.79	7.06	8.23
SE31	1	1.15	2.26	3.50	4.52	5.76	7.02	—	1.15	2.27	3.50	4.52	—	7.03	—
SE31	2	1.15	2.27	3.49	4.55	5.77	7.01	—	1.15	2.27	3.49	4.55	—	7.01	—
SE31	3	1.15	2.27	3.49	4.52	5.76	7.03	—	1.15	2.27	3.49	4.51	—	7.03	—
SE31	4	1.15	2.28	3.49	4.50	5.75	7.02	—	1.15	2.27	3.49	4.50	—	7.02	—
SE31	5	1.15	2.28	3.49	4.50	5.76	7.03	—	1.15	2.28	3.49	4.50	—	7.03	8.08
SE31	6	1.15	2.27	3.5	4.50	5.76	7.03	—	1.15	2.27	3.50	4.50	—	7.03	8.15
SE31	7	1.15	2.27	3.49	4.50	5.76	7.03	—	1.15	2.27	3.49	4.50	—	7.03	8.09
SE31	8	1.15	2.28	3.49	4.50	5.76	7.03	—	1.15	2.28	3.49	4.50	—	7.03	8.07
SE31	9	1.15	2.27	3.49	4.52	5.76	7.13	—	1.15	2.27	3.49	4.52	—	7.02	8.09
SE31	10	1.15	2.28	3.49	4.50	5.76	7.02	—	1.15	2.28	3.49	4.50	—	7.02	8.08
SE32	1	1.15	2.26	3.38	4.52	5.76	7.02	—	1.15	2.26	3.38	4.52	—	7.03	—
SE32	2	1.15	2.27	3.49	4.55	5.77	7.01	—	1.15	2.27	3.50	4.55	—	7.01	—
SE32	3	1.15	2.27	3.49	4.52	5.76	7.03	—	1.15	2.27	3.49	4.51	—	7.03	—
SE32	4	1.15	2.28	3.49	4.50	5.75	7.02	—	1.15	2.27	3.49	4.50	—	7.02	—
SE32	5	1.15	2.28	3.49	4.50	5.76	7.03	—	1.15	2.28	3.49	4.50	—	7.03	—
SE32	6	1.15	2.27	3.50	4.50	5.76	7.03	—	1.15	2.27	3.50	4.50	—	7.03	—
SE32	7	1.15	2.27	3.49	4.50	5.76	7.03	—	1.15	2.27	3.49	4.50	—	7.03	—
SE32	8	1.15	2.28	3.49	4.50	5.76	7.03	—	1.15	2.28	3.49	4.50	—	7.03	—
SE32	9	1.15	2.27	3.49	4.52	5.76	7.13	—	1.15	2.27	3.49	4.52	—	7.02	8.09
SE32	10	1.15	2.28	3.49	4.51	5.76	7.02	—	1.15	2.28	3.49	4.50	—	7.02	8.08
NE01	1	1.11	2.14	3.31	4.32	5.54	6.55	—	1.11	2.14	3.31	4.32	5.54	—	—
NE01	2	1.11	2.14	3.30	4.32	5.53	6.56	7.74	1.11	2.14	3.30	4.32	5.53	6.56	7.74
NE01	3	1.1	2.15	3.31	4.32	5.54	6.55	7.74	1.10	2.15	3.31	4.32	5.54	—	7.74

Cable	Run	Box 1							Box 2						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
NE01	4	1.11	2.15	3.31	4.32	5.55	6.56	7.75	1.11	2.15	3.31	4.32	5.55	—	—
NE01	5	1.11	2.14	3.31	4.32	5.54	6.56	7.74	1.11	2.14	3.31	4.32	5.54	—	—
NE01	6	1.11	2.15	3.31	4.32	5.53	6.56	7.75	1.11	2.15	3.31	4.32	5.53	—	—
NE01	7	1.11	2.14	3.31	4.32	5.55	6.55	—	1.11	2.14	3.31	4.32	5.55	—	—
NE01	8	1.11	2.15	3.31	4.22	5.54	6.55	7.74	1.11	2.15	3.31	4.22	5.54	—	—
NE01	9	1.11	2.15	3.31	4.32	5.54	6.57	7.74	1.11	2.15	3.31	4.32	5.54	—	—
NE01	10	1.11	2.15	3.31	4.32	5.55	6.57	7.74	1.11	2.15	3.31	4.32	5.55	6.57	—
NE02	1	1.1	2.33	3.52	4.70	5.85	7.07	8.35	1.10	2.33	3.52	4.70	5.85	—	—
NE02	2	1.16	2.26	—	4.61	5.93	7.07	—	1.16	2.26	3.52	4.61	5.93	7.07	—
NE02	3	1.16	2.33	3.52	4.69	5.93	7.07	8.26	1.16	2.33	3.52	4.67	5.92	7.07	—
NE02	4	1.16	2.33	3.52	4.69	5.85	7.06	8.33	1.16	2.33	3.52	4.69	5.85	—	—
NE02	5	1.16	2.33	3.50	4.69	—	7.08	8.34	1.16	2.33	3.50	4.69	—	—	—
NE02	6	1.16	2.26	—	4.47	5.92	—	—	1.16	2.26	3.52	4.47	5.92	—	—
NE02	7	1.16	2.32	3.50	4.70	5.92	—	—	1.16	2.33	3.52	4.70	5.92	—	—
NE02	8	1.16	2.26	—	4.7	5.92	7.07	—	1.16	2.26	3.49	4.70	5.92	—	—
NE02	9	1.16	2.33	3.50	4.69	5.92	7.07	8.33	1.16	2.33	3.48	4.69	5.92	7.07	—
NE02	10	1.16	2.26	—	4.67	5.92	7.06	—	1.16	2.26	3.52	4.69	5.92	7.06	—
NE03	1	1.18	2.1	3.64	4.89	6.02	7.32	8.65	1.18	2.41	3.64	4.89	—	—	—
NE03	2	1.18	2.4	3.64	4.88	6.02	7.36	8.66	1.18	2.40	3.64	4.88	6.02	—	—
NE03	3	1.18	2.41	3.64	4.88	6.02	7.34	8.64	1.18	2.41	3.64	4.88	6.02	—	—
NE03	4	1.18	2.41	3.64	4.88	6.02	7.35	—	1.18	2.41	3.64	4.88	6.02	—	—
NE03	5	1.18	2.41	—	4.88	6.02	—	8.66	1.18	2.41	3.64	4.88	6.02	—	—
NE03	6	1.18	2.41	—	4.80	6.02	7.35	8.56	1.18	2.41	3.64	4.80	6.02	7.35	8.56
NE03	7	1.18	2.39	—	4.87	6.02	—	8.63	1.18	2.39	3.64	4.87	6.02	—	—
NE03	8	1.18	2.39	3.63	4.87	6.02	7.34	—	1.18	2.39	3.63	4.87	6.02	—	—
NE03	9	1.18	2.39	3.64	4.87	6.01	—	—	1.18	2.39	3.63	4.87	5.99	—	—
NE03	10	1.18	2.39	3.64	4.87	6.02	—	—	1.18	2.39	3.64	4.87	6.02	—	—
NE04	1	1.17	2.37	3.55	4.83	5.95	7.21	8.58	1.17	2.37	3.55	4.83	5.95	7.21	8.55
NE04	2	1.17	2.37	3.55	4.82	6.05	7.31	—	1.17	2.37	3.55	4.82	—	—	—
NE04	3	1.17	2.36	3.55	4.81	5.93	7.32	—	1.17	2.36	3.55	4.81	—	7.32	8.54
NE04	4*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NE04	5	1.17	2.36	3.55	4.81	—	7.21	—	1.17	2.36	3.55	4.81	—	—	8.53
NE04	6	1.17	2.37	3.55	4.81	—	7.20	8.54	1.17	2.37	3.55	4.81	—	7.21	8.53

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
NE04	7	1.16	2.37	3.54	4.82	—	7.31	8.55	1.16	2.37	3.54	4.82	—	—	8.55
NE04	8	1.16	2.37	3.55	4.81	—	7.21	—	1.16	2.37	3.55	4.81	—	—	8.55
NE04	9	1.16	2.37	3.55	4.82	—	7.31	—	1.16	2.36	3.55	4.81	—	—	8.53
NE04	10	1.17	2.36	3.56	4.81	—	7.20	—	1.17	2.36	3.56	4.81	—	—	8.53
NE05	1	1.22	2.46	3.71	5.05	—	7.53	—	1.22	2.46	3.71	5.05	—	—	—
NE05	2	1.22	2.46	3.69	5.05	6.16	7.53	8.88	1.22	2.46	3.69	5.05	—	—	—
NE05	3	1.22	2.46	3.69	5.06	—	7.54	—	1.22	2.46	3.69	5.06	—	—	—
NE05	4	1.22	2.46	3.71	5.01	6.16	7.47	8.88	1.22	2.46	3.71	5.01	—	—	—
NE05	5	1.22	2.45	3.69	5.05	—	7.53	—	1.22	2.45	3.69	5.05	—	—	8.89
NE05	6	1.21	2.47	3.69	5.05	—	7.54	—	1.21	2.47	3.69	5.05	—	—	—
NE05	7	1.22	2.45	3.71	5.05	—	7.53	—	1.22	2.45	3.71	5.05	—	—	—
NE05	8	1.22	2.45	3.69	5.07	—	7.53	—	1.22	2.45	3.69	5.07	—	—	—
NE05	9	1.22	2.46	3.69	5.06	—	7.56	—	1.22	2.46	3.69	5.06	—	—	—
NE05	10	1.22	2.45	3.69	5.05	—	7.53	—	1.22	2.45	3.69	5.02	—	—	—
NE06	1	1.30	2.64	3.92	5.40	6.82	8.27	—	1.30	2.64	3.92	5.40	—	8.35	—
NE06	2	1.30	2.64	3.92	5.41	6.84	8.26	—	1.30	2.64	3.92	5.41	—	8.23	—
NE06	3	1.29	2.64	3.93	5.47	6.82	8.26	—	1.29	2.64	3.93	5.47	—	—	—
NE06	4	1.30	2.64	3.91	5.48	6.85	8.26	—	1.31	2.64	3.93	5.41	—	8.26	—
NE06	5	1.31	2.65	3.93	5.41	6.82	8.25	—	1.31	2.64	3.93	5.41	—	8.25	9.56
NE06	6	1.31	2.64	3.92	5.41	6.84	8.26	—	1.31	2.64	3.92	5.41	—	8.26	9.57
NE06	7	1.31	2.64	3.93	5.47	6.84	8.26	—	1.31	2.64	3.93	5.47	—	8.26	9.53
NE06	8	1.31	2.64	3.93	5.40	6.81	8.26	—	1.31	2.64	3.93	5.40	—	8.26	9.62
NE06	9	1.31	2.65	3.96	5.41	6.85	8.33	—	1.31	2.65	3.96	5.41	—	8.33	9.53
NE06	10	1.31	2.64	3.96	5.40	6.82	8.24	—	1.31	2.64	3.96	5.40	—	8.25	9.55
NE07	1	1.63	3.35	5.01	6.55	8.41	9.84	—	1.63	3.35	5.01	6.65	8.41	9.92	11.71
NE07	2	1.65	3.35	4.99	6.54	8.41	9.83	11.69	1.65	3.35	4.99	6.54	8.41	9.92	11.69
NE07	3	1.65	3.35	5.00	6.54	8.39	9.83	11.71	1.66	3.35	5.00	6.54	8.39	9.92	11.71
NE07	4	1.65	3.35	4.99	6.56	8.39	9.83	11.72	1.65	3.35	4.99	6.56	8.40	9.83	11.71
NE07	5	1.65	3.35	5.02	6.53	8.40	9.83	11.72	1.65	3.35	5.02	6.65	8.40	9.91	11.72
NE07	6	1.65	3.35	4.99	6.54	8.37	9.83	11.71	1.65	3.35	4.99	6.54	8.37	9.83	11.71
NE07	7	1.66	3.35	5.01	6.54	8.40	9.84	11.72	1.66	3.35	5.01	6.54	8.40	9.91	11.72
NE07	8	1.65	3.35	5.02	6.54	8.40	9.81	11.71	1.65	3.35	5.02	6.54	8.40	9.92	11.71
NE07	9	1.65	3.35	5.01	6.54	8.33	9.81	11.71	1.65	3.35	5.01	6.54	8.40	9.81	11.71

Cable	Run	Box 1							Box 2						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
NE07	10	1.65	3.31	5.01	6.54	8.40	9.84	11.72	1.65	3.31	5.01	6.54	8.40	9.92	11.72
NE08	1	1.84	3.59	5.47	7.57	9.23	11.01	13.21	1.84	3.59	5.46	7.39	9.22	11.00	13.48
NE08	2	1.84	3.59	5.47	7.54	9.31	11.01	13.23	1.84	3.59	5.47	7.39	9.31	11.01	13.49
NE08	3	1.79	3.59	5.58	7.56	9.22	11.01	13.22	1.79	3.59	5.58	7.39	9.22	11.01	13.48
NE08	4	1.79	3.59	5.47	7.52	9.23	11.01	13.23	1.79	3.59	5.57	7.39	9.22	11.01	13.23
NE08	5	1.84	3.59	5.47	7.57	9.23	11.01	13.23	1.84	3.59	5.47	7.39	9.23	11.01	13.23
NE08	6	1.79	3.58	5.47	7.52	9.23	11.02	13.24	1.79	3.58	5.47	7.36	9.23	11.01	13.23
NE08	7	1.79	3.59	5.47	7.57	9.23	11.02	13.23	1.79	3.59	5.47	7.41	9.31	11.02	13.23
NE08	8	1.79	3.59	5.47	7.54	9.22	11.02	13.23	1.79	3.59	5.47	7.39	9.22	11.02	13.23
NE08	9	1.79	3.58	5.47	7.53	9.24	11.02	13.21	1.79	3.58	5.47	7.39	9.20	11.02	13.21
NE08	10	1.79	3.59	5.47	7.58	9.2	11.02	13.23	1.79	3.59	5.47	7.39	9.24	11.02	13.23
NE08	11	1.79	3.59	5.47	7.53	9.22	10.96	13.22	1.79	3.59	5.47	7.39	9.22	10.97	13.22

*No excitation.

—Indicates no data are available.

Table 13. Phase 3 averaged mode frequencies (Hz).

Cable	1	2	3	4	5	6	7
SE27	1.83	3.89	5.74	7.85	—	—	—
SE28	1.59	3.24	4.77	6.43	8.09	—	—
SE29	1.33	2.67	3.99	5.35	6.87	8.15	9.62
SE30	1.14	2.28	3.49	4.61	5.79	7.02	—
SE31	1.15	2.27	3.49	4.52	5.76	7.02	—
SE32	1.15	2.27	3.49	4.52	5.76	7.02	—
NE01	1.11	2.14	3.31	4.32	5.54	6.56	7.74
NE02	1.16	2.33	3.52	4.69	5.85	7.07	8.33
NE03	1.18	2.41	3.64	4.88	6.02	7.34	8.65
NE04	1.17	2.37	3.55	4.81	5.95	7.31	8.55
NE05	1.22	2.46	3.71	5.05	6.16	7.53	8.88
NE06	1.30	2.64	3.92	5.41	6.82	8.26	—
NE07	1.65	3.35	5.00	6.54	8.40	9.84	11.71
NE08	1.79	3.59	5.47	7.52	9.22	11.01	13.23

—Indicates no data are available.

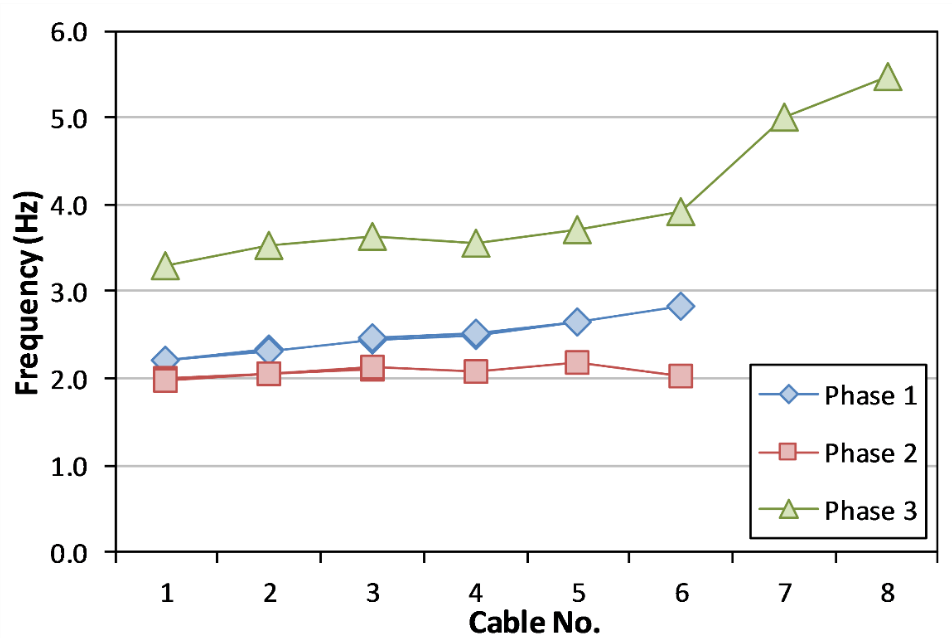
Table 14. Theoretical and computational model first mode frequencies compared to field measurements (Hz).

Cable	Phase 1			Phase 2			Phase 3[b]	
	Theory	Modeling	Field[a]	Theory	Modeling	Field[a]	Theory	Field[a]
1	0.797	0.808	0.745	0.668	0.679	0.671	1.091	1.11
2	0.833	0.844	0.781	0.701	0.711	0.690	1.154	1.16
3	0.862	0.873	0.818	0.711	0.722	0.714	1.182	1.18
4	0.908	0.919	0.836	0.729	0.740	0.702	1.223	1.17
5	0.916	0.927	0.890	0.736	0.747	0.732	1.247	1.22
6	0.969	0.981	0.952	0.777	0.790	—	1.381	1.30
7	1.084	1.101	—	0.901	0.917	—	1.695	1.65
8	1.164	1.181	—	0.966	0.984	—	1.956	1.79
9	1.231	1.250	—	1.010	1.030	—	2.239	—
10	1.395	1.416	—	1.172	1.194	—	2.964	—
11	1.521	1.553	—	1.277	1.309	—	3.922	—
12	1.677	1.715	—	1.396	1.435	—	5.950	—
13	1.958	2.001	—	1.582	1.629	—	13.968	—
14	2.217	2.283	—	1.721	1.786	—	—	—
15	2.599	2.678	—	1.968	2.050	—	—	—
16	3.487	3.607	—	2.795	2.930	—	—	—
17	3.400	3.588	—	2.739	2.919	—	—	—
18	2.648	2.760	—	2.006	2.117	—	—	—
19	2.273	2.352	—	1.766	1.843	—	—	—
20	1.917	1.880	—	1.513	1.542	—	—	—
21	1.704	1.730	—	1.410	1.451	—	—	—
22	1.535	1.546	—	1.283	1.309	—	15.916	—
23	1.404	1.435	—	1.184	1.215	—	6.337	—
24	1.248	1.259	—	1.020	1.041	—	3.786	—
25	1.139	1.156	—	0.951	0.970	—	2.851	—
26	1.087	1.103	—	0.907	0.924	—	2.335	—
27	0.979	1.005	—	0.793	0.812	—	1.821	1.83
28	0.914	0.938	—	0.749	0.767	—	1.582	1.59
29	0.865	0.875	0.800	0.713	0.724	0.684	1.406	1.33
30	0.790	0.793	0.745	0.666	0.675	0.659	1.243	1.14
31	0.759	0.769	0.726	0.654	0.664	0.647	1.165	1.15
32	0.646	0.656	0.708	0.563	0.573	0.617	0.963	1.15

[a]Field data were from the SW fan for phases 1 and 2 but from the NE and SE fans for phase 3.
[b]First mode frequencies could not be extracted for individual cables during SAP® modeling after the introduction of a crosstie.
—Indicates no data are available.

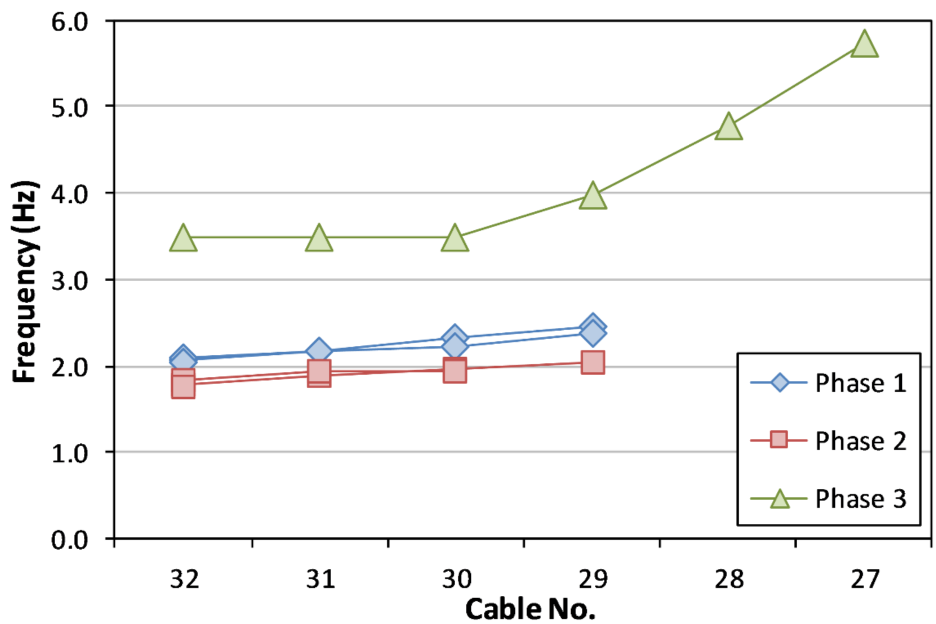
APPENDIX B. MODE FREQUENCY PLOTS

To view the comparison of first mode frequencies for side and main span cables, please refer to figure 58 and figure 59 in chapter 7, respectively. To view the comparison of second mode frequencies for side and main span cables, please refer to figure 60 and figure 61.



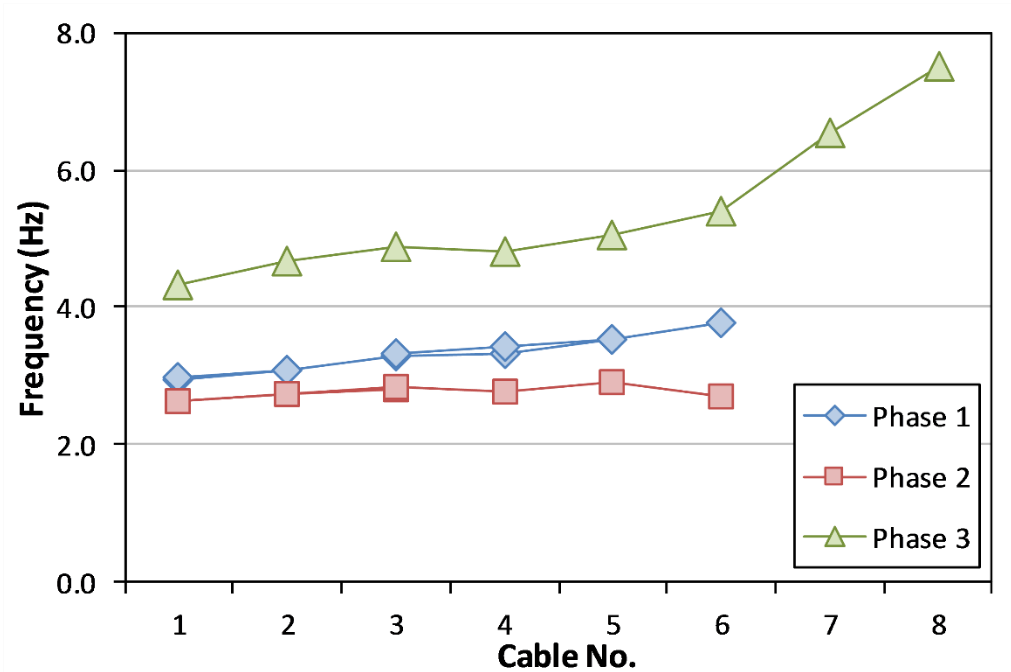
Source: FHWA.

Figure 82. Graph. Comparison of third mode frequencies for side span cables.



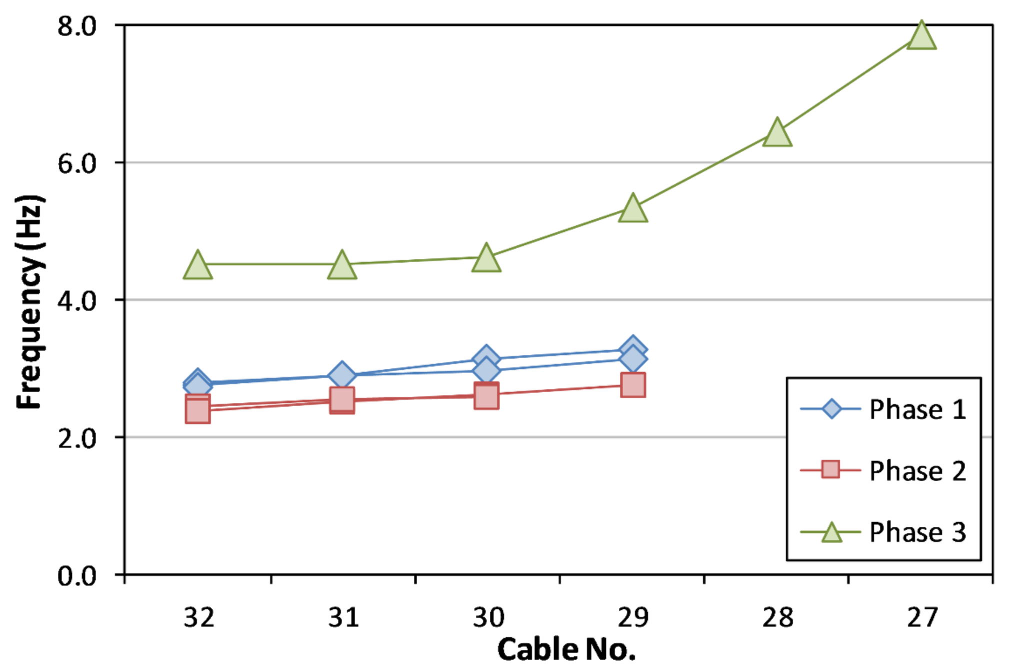
Source: FHWA.

Figure 83. Graph. Comparison of third mode frequencies for main span cables.



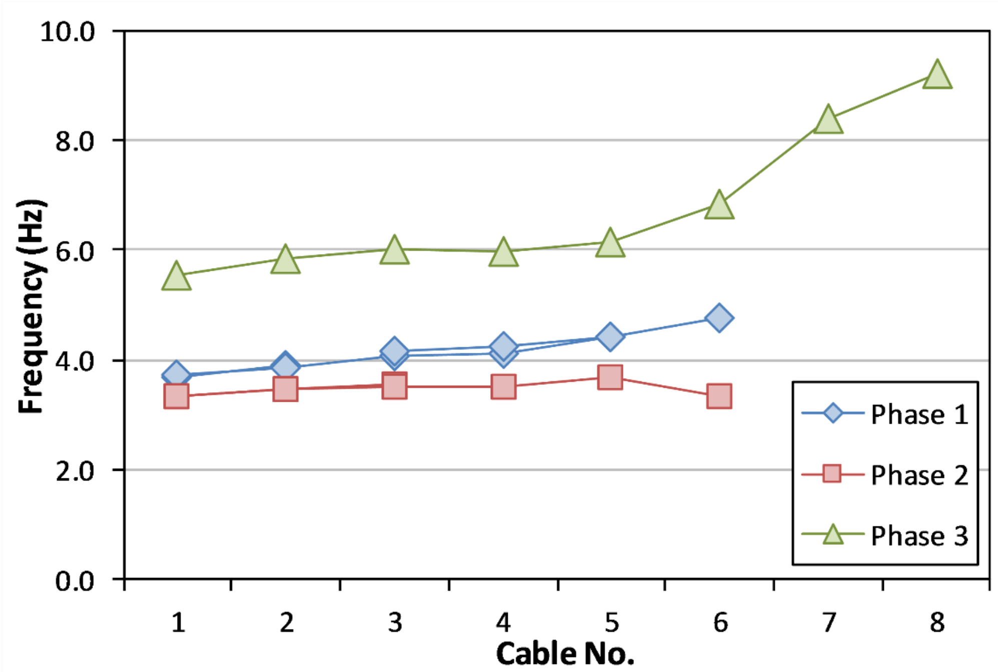
Source: FHWA.

Figure 84. Graph. Comparison of fourth mode frequencies for side span cables.



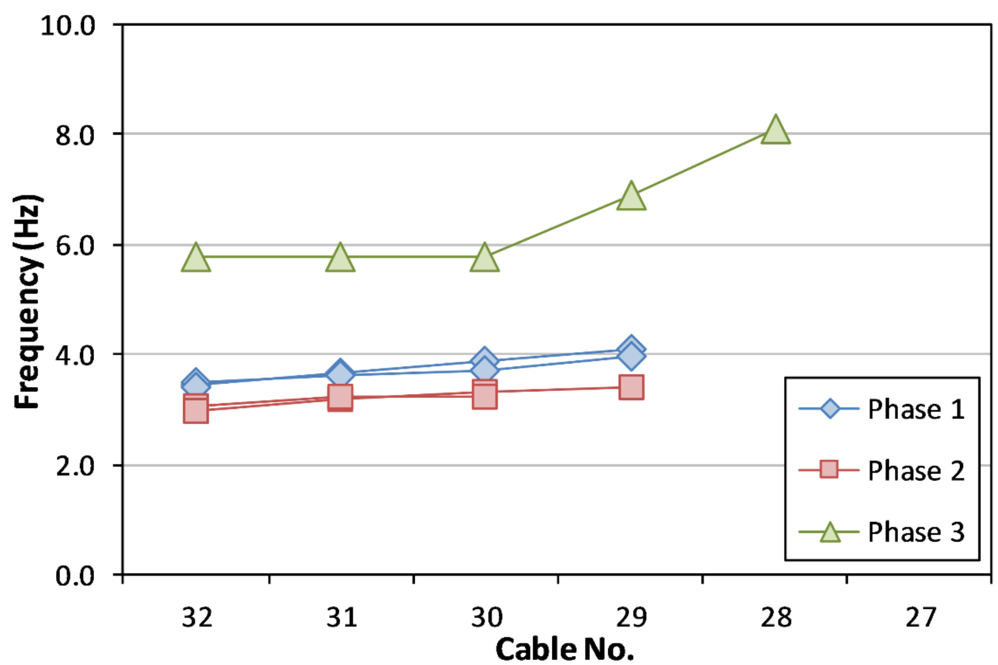
Source: FHWA.

Figure 85. Graph. Comparison of fourth mode frequencies for main span cables.



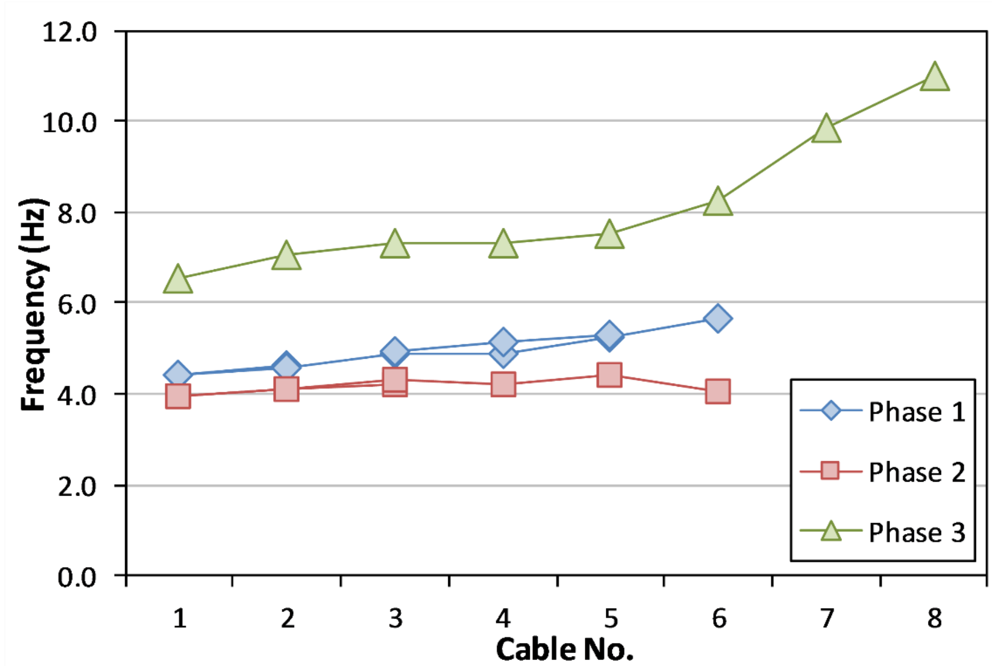
Source: FHWA.

Figure 86. Graph. Comparison of fifth mode frequencies for side span cables.



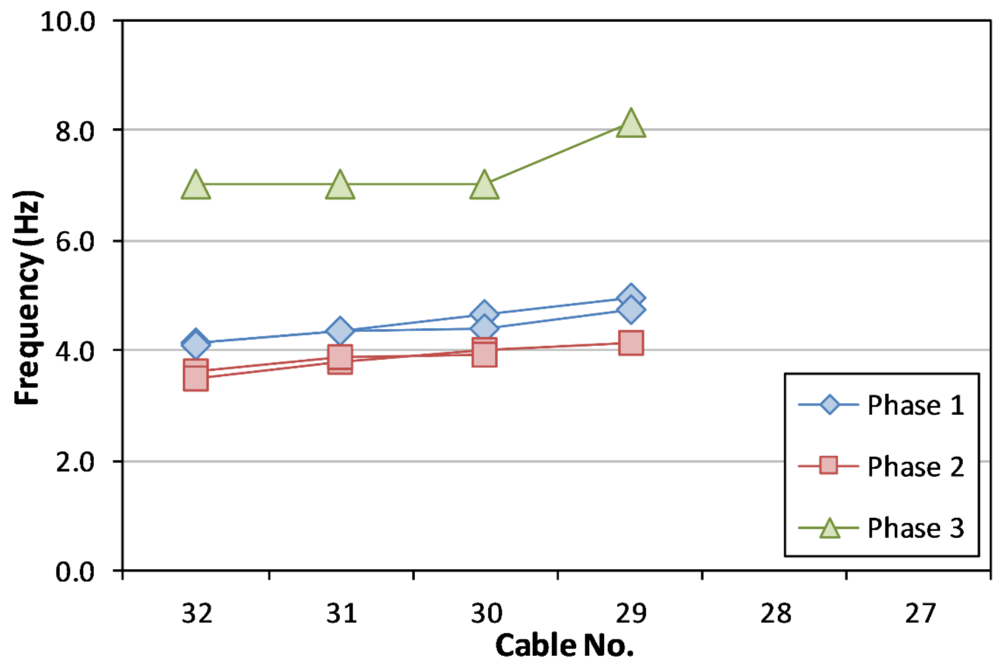
Source: FHWA.

Figure 87. Graph. Comparison of fifth mode frequencies for main span cables.



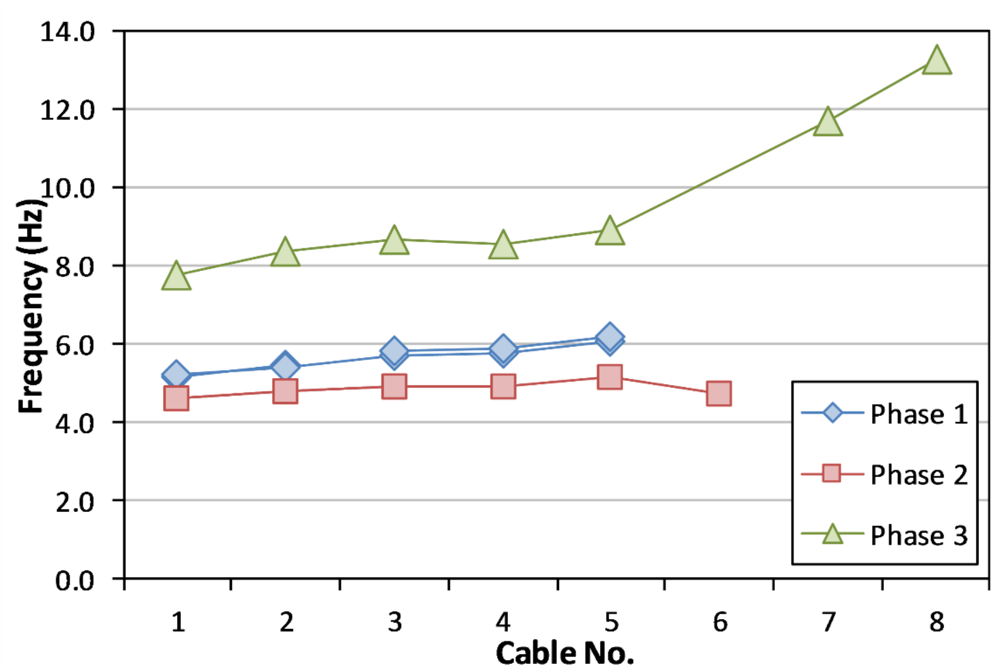
Source: FHWA.

Figure 88. Graph. Comparison of sixth mode frequencies for side span cables.



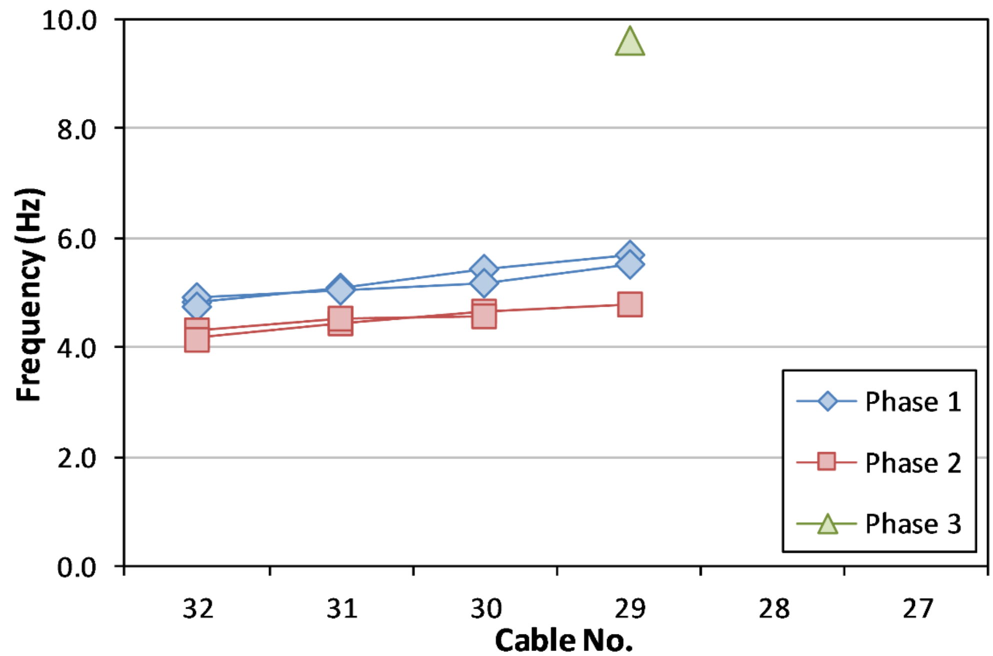
Source: FHWA.

Figure 89. Graph. Comparison of sixth mode frequencies for main span cables.



Source: FHWA.

Figure 90. Graph. Comparison of seventh mode frequencies for side span cables.



Source: FHWA.

Figure 91. Graph. Comparison of seventh mode frequencies for main span cables.

APPENDIX C. DAMPING RATIO TABLES

Table 15. Phase 1—box 1 first mode damping data.

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW01	1	0.60	0.85	30	180	0.182	0.9929	0.182	0.9930
NW01	2	0.55	0.90	70	350	0.154	0.9920	0.155	0.9921
NW01	3	0.60	0.85	55	200	0.187	0.9922	0.188	0.9924
NW01	4	0.60	0.85	45	200	0.181	0.9950	0.181	0.9949
NW01	5	0.55	0.90	75	200	0.174	0.9918	0.175	0.9918
NW01	6	0.55	0.90	45	160	0.213	0.9975	0.213	0.9974
NW01	7	0.55	0.90	70	300	0.201	0.9972	0.201	0.9972
NW01	8	0.55	0.90	60	160	0.160	0.9935	0.160	0.9937
NW01	9	0.55	0.90	90	220	0.220	0.9945	0.220	0.9945
NW02	1	0.60	0.90	30	200	0.082	0.9971	0.082	0.9970
NW02	2	0.60	0.90	75	300	0.106	0.9987	0.106	0.9987
NW02	3	0.60	0.90	70	250	0.098	0.9970	0.098	0.9970
NW02	4	0.60	0.90	50	250	0.104	0.9986	0.104	0.9986
NW02	5	0.60	0.90	50	300	0.101	0.9992	0.101	0.9992
NW02	6	0.60	0.90	60	300	0.104	0.9982	0.103	0.9982
NW02	7	0.60	0.90	50	300	0.126	0.9991	0.126	0.9991
NW02	8	0.60	0.90	65	250	0.118	0.9979	0.118	0.9979
NW02	9	0.60	0.90	50	200	0.145	0.9969	0.145	0.9968
NW02	10	0.60	1.00	50	250	0.133	0.9986	0.133	0.9986
NW29	1	0.60	1.00	55	300	0.146	0.9989	0.146	0.9989
NW29	2	0.50	1.10	125	280	0.159	0.9919	0.159	0.9919
NW29	3	0.60	1.00	90	350	0.139	0.9954	0.140	0.9955
NW29	4	0.60	1.00	115	380	0.168	0.9981	0.167	0.9981
NW29	5	0.60	1.00	30	400	0.137	0.9971	0.137	0.9971
NW30	1	0.55	0.90	165	450	0.148	0.9981	0.148	0.9981

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW30	2	0.55	1.00	85	250	0.188	0.9979	0.188	0.9978
NW30	3	0.55	1.00	100	250	0.148	0.9977	0.148	0.9977
NW30	4	0.55	1.00	90	300	0.188	0.9972	0.188	0.9971
NW30	5	0.55	1.00	130	300	0.138	0.9928	0.138	0.9929
NW30	6	0.55	1.00	115	260	0.198	0.9986	0.198	0.9986
NW30	7	0.55	1.00	75	300	0.149	0.9979	0.149	0.9979
NW30	8	0.55	1.00	115	280	0.142	0.9928	0.141	0.9930
NW30	9	0.55	1.00	195	450	0.196	0.9992	0.196	0.9992
NW30	10	0.55	1.00	65	330	0.173	0.9942	0.173	0.9941
NW31	1	0.45	0.90	110	270	0.278	0.9586	0.276	0.9580
NW31	2	0.50	0.90	55	220	0.226	0.9778	0.225	0.9784
NW31	3	0.50	0.90	80	240	0.258	0.9806	0.256	0.9811
NW31	4	0.50	0.90	65	230	0.256	0.9720	0.257	0.9714
NW31	5	0.55	0.87	90	250	0.239	0.9298	0.240	0.9316
NW31	6	0.50	0.90	85	270	0.249	0.9628	0.248	0.9634
NW31	7	0.55	0.90	80	250	0.182	0.9542	0.183	0.9539
NW31	8	0.50	0.90	75	240	0.209	0.9572	0.207	0.9582
NW31	9	0.45	0.90	90	300	0.233	0.9724	0.233	0.9724
NW31	10	0.50	0.90	100	320	0.246	0.9539	0.248	0.9537
NW32	1	0.50	0.90	130	250	0.301	0.9929	0.301	0.9927
NW32	2	0.50	0.90	85	190	0.274	0.9947	0.272	0.9954
NW32	3	0.50	0.90	115	200	0.219	0.9930	0.217	0.9937
NW32	4	0.50	0.90	80	160	0.220	0.9972	0.219	0.9973
NW32	5	0.50	0.90	75	160	0.217	0.9974	0.216	0.9977
NW32	6	0.50	0.90	70	160	0.223	0.9910	0.223	0.9908
NW32	7	0.50	0.90	90	180	0.235	0.9963	0.237	0.9962
NW32	8	0.50	0.90	80	180	0.200	0.9907	0.201	0.9909
NW32	9	0.50	0.90	95	155	0.210	0.9860	0.207	0.9859
NW32	10	0.50	0.90	55	150	0.181	0.9922	0.181	0.9923

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW01	1	0.55	0.90	60	250	0.235	0.9916	0.235	0.9917
SW01	2	0.55	0.90	50	120	0.239	0.9964	0.240	0.9965
SW01	3	0.55	0.90	55	150	0.230	0.9915	0.229	0.9908
SW01	4	0.55	0.90	55	140	0.234	0.9925	0.233	0.9924
SW01	5	0.55	0.90	60	120	0.217	0.9977	0.217	0.9977
SW01	6	0.55	0.90	65	130	0.249	0.9942	0.251	0.9946
SW01	7	0.55	0.90	55	140	0.225	0.9937	0.227	0.9941
SW01	8	0.55	0.90	60	140	0.192	0.9927	0.192	0.9929
SW01	9	0.55	0.90	40	190	0.126	0.9778	0.126	0.9773
SW01	10	0.55	0.90	50	140	0.224	0.9911	0.223	0.9905
SW02	1	0.55	0.90	80	350	0.164	0.9990	0.164	0.9990
SW02	2	0.55	0.90	45	320	0.149	0.9984	0.148	0.9984
SW02	3	0.55	0.90	70	260	0.158	0.9981	0.158	0.9981
SW02	4	0.55	0.90	65	290	0.185	0.9978	0.185	0.9978
SW02	5	0.55	0.90	60	320	0.173	0.9983	0.173	0.9983
SW02	6	0.55	0.90	60	290	0.174	0.9980	0.174	0.9980
SW02	7	0.55	0.90	50	230	0.170	0.9975	0.170	0.9975
SW02	8	0.55	0.90	35	210	0.202	0.9978	0.202	0.9978
SW02	9	0.55	0.90	50	260	0.193	0.9982	0.193	0.9982
SW02	10	0.55	0.90	40	250	0.166	0.9986	0.166	0.9986
SW03	1	0.60	1.00	90	220	0.232	0.9985	0.232	0.9986
SW03	2	0.60	1.00	70	200	0.222	0.9969	0.222	0.9969
SW03	3	0.60	1.00	50	200	0.249	0.9987	0.249	0.9987
SW03	4	0.60	1.00	70	200	0.266	0.9989	0.266	0.9989
SW03	5	0.55	1.00	90	230	0.221	0.9981	0.221	0.9980
SW03	6	0.60	1.00	55	200	0.251	0.9974	0.251	0.9975
SW03	7	0.60	1.00	50	180	0.248	0.9990	0.248	0.9991
SW03	8	0.60	1.00	95	230	0.239	0.9991	0.239	0.9991
SW03	9	0.60	1.00	55	190	0.229	0.9982	0.229	0.9982

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW03	10	0.60	1.00	55	190	0.291	0.9973	0.290	0.9973
SW04	1	0.50	1.10	80	200	0.230	0.9963	0.230	0.9961
SW04	2	0.50	1.10	65	300	0.153	0.9972	0.153	0.9972
SW04	3	0.50	1.10	90	250	0.217	0.9952	0.217	0.9952
SW04	4	0.60	1.00	80	260	0.192	0.9963	0.191	0.9963
SW04	5	0.50	1.00	50	250	0.201	0.9962	0.201	0.9961
SW04	6	0.60	1.00	90	300	0.187	0.9965	0.187	0.9965
SW04	7	0.60	1.00	100	300	0.181	0.9938	0.181	0.9938
SW04	8	0.60	1.10	195	250	0.257	0.9974	0.258	0.9974
SW04	9*	—	—	—	—	—	—	—	—
SW04	10	0.50	1.00	120	250	0.192	0.9934	0.192	0.9933
SW04	11	0.60	1.00	95	250	0.146	0.9974	0.146	0.9973
SW05	1	0.50	1.20	160	250	0.197	0.9801	0.198	0.9799
SW05	2	0.50	1.20	80	250	0.208	0.9975	0.208	0.9975
SW05	3	0.50	1.20	155	350	0.187	0.9991	0.187	0.9991
SW05	4	0.50	1.20	85	230	0.197	0.9981	0.197	0.9981
SW05	5	0.50	1.20	90	300	0.189	0.9990	0.189	0.9991
SW05	6	0.50	1.20	50	250	0.190	0.9987	0.190	0.9987
SW05	7	0.50	1.20	45	220	0.198	0.9989	0.198	0.9989
SW05	8	0.50	1.20	75	230	0.241	0.9991	0.241	0.9991
SW05	9	0.50	1.20	85	220	0.224	0.9969	0.224	0.9969
SW05	10	0.50	1.20	75	250	0.219	0.9980	0.219	0.9980
SW06	1	0.50	1.20	95	230	0.204	0.9985	0.204	0.9985
SW06	2	0.50	1.20	45	220	0.197	0.9984	0.198	0.9984
SW06	3	0.50	1.20	100	300	0.154	0.9954	0.154	0.9954
SW06	4	0.50	1.20	100	320	0.185	0.9976	0.185	0.9976
SW06	5	0.50	1.20	60	240	0.212	0.9987	0.212	0.9987
SW06	6	0.50	1.20	60	200	0.230	0.9966	0.230	0.9966
SW06	7	0.50	1.20	70	250	0.205	0.9989	0.205	0.9990

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW06	8	0.50	1.20	85	220	0.215	0.9980	0.215	0.9980
SW06	9	0.50	1.20	85	250	0.204	0.9992	0.204	0.9992
SW06	10	0.50	1.20	60	260	0.186	0.9991	0.186	0.9991
SW29	1	0.50	1.00	90	400	0.157	0.9967	0.157	0.9967
SW29	2	0.60	1.00	105	350	0.111	0.9992	0.111	0.9992
SW29	3	0.60	1.00	80	350	0.115	0.9968	0.115	0.9968
SW29	4	0.60	1.00	75	300	0.114	0.9989	0.115	0.9990
SW29	5	0.60	1.00	80	350	0.155	0.9989	0.155	0.9989
SW29	6	0.50	1.00	170	500	0.105	0.9988	0.105	0.9988
SW29	7	0.50	1.00	80	300	0.112	0.9962	0.112	0.9962
SW29	8	0.60	1.00	70	300	0.101	0.9964	0.101	0.9963
SW29	9	0.50	1.00	75	300	0.120	0.9979	0.120	0.9979
SW29	10	0.60	1.00	90	330	0.114	0.9958	0.114	0.9958
SW30	1	0.55	0.90	85	160	0.227	0.9932	0.227	0.9928
SW30	2	0.55	0.90	80	140	0.212	0.9861	0.210	0.9858
SW30	3	0.55	0.90	95	200	0.146	0.9713	0.144	0.9714
SW30	4	0.55	0.90	65	200	0.162	0.9785	0.161	0.9785
SW30	5	0.50	0.90	80	200	0.169	0.9800	0.169	0.9804
SW30	6	0.55	0.90	100	220	0.144	0.9805	0.145	0.9804
SW30	7	0.55	0.90	110	220	0.208	0.9768	0.207	0.9772
SW30	8	0.55	0.90	135	200	0.286	0.9935	0.287	0.9934
SW30	9	0.55	0.90	60	140	0.315	0.9993	0.315	0.9993
SW30	10	0.55	0.90	60	200	0.227	0.9916	0.227	0.9917
SW31	1	0.55	0.90	95	160	0.486	0.9954	0.489	0.9946
SW31	2	0.55	0.90	75	140	0.526	0.9920	0.528	0.9918
SW31	3	0.40	0.90	60	130	0.520	0.9938	0.520	0.9935
SW31	4	0.50	0.90	75	140	0.566	0.9870	0.568	0.9869
SW31	5	0.50	0.90	70	140	0.510	0.9919	0.517	0.9916
SW31	6	0.50	0.90	70	140	0.532	0.9964	0.537	0.9964

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW31	7	0.50	0.90	90	160	0.542	0.9956	0.538	0.9953
SW31	8	0.50	0.90	70	140	0.479	0.9947	0.484	0.9939
SW31	9	0.55	0.90	65	130	0.486	0.9955	0.484	0.9960
SW31	10	0.55	0.90	60	130	0.506	0.9938	0.512	0.9935
SW32	1	0.60	0.85	180	330	0.197	0.9960	0.197	0.9961
SW32	2	0.55	0.90	50	130	0.194	0.9941	0.195	0.9938
SW32	3	0.55	0.90	60	160	0.183	0.9913	0.183	0.9915
SW32	4	0.50	0.90	50	150	0.176	0.9927	0.176	0.9929
SW32	5	0.50	0.90	110	200	0.201	0.9966	0.203	0.9963
SW32	6	0.50	0.90	65	140	0.179	0.9926	0.179	0.9929
SW32	7	0.55	0.90	70	170	0.185	0.9918	0.184	0.9918
SW32	8	0.55	0.90	85	170	0.190	0.9974	0.191	0.9972
SW32	9	0.40	0.90	100	200	0.170	0.9947	0.170	0.9948
SW32	10	0.50	0.90	120	220	0.269	0.9954	0.270	0.9950
SE03	1	0.50	1.10	90	300	0.187	0.9990	0.187	0.9990
SE03	2	0.60	1.10	60	300	0.169	0.9993	0.169	0.9993
SE03	3	0.50	1.10	60	220	0.178	0.9977	0.178	0.9977
SE03	4	0.50	1.10	50	300	0.168	0.9992	0.168	0.9992
SE03	5	0.60	1.00	45	300	0.152	0.9987	0.152	0.9988
SE03	6	0.60	1.00	75	300	0.195	0.9980	0.195	0.9980
SE03	7	0.50	1.00	120	320	0.189	0.9973	0.189	0.9974
SE03	8	0.50	1.10	80	250	0.175	0.9977	0.175	0.9977
SE03	9	0.60	1.00	65	250	0.180	0.9985	0.180	0.9986
SE04	1	0.60	1.10	85	220	0.137	0.9940	0.138	0.9940
SE04	2	0.50	1.10	50	250	0.165	0.9989	0.164	0.9990
SE04	3	0.50	1.10	90	250	0.199	0.9972	0.199	0.9972
SE04	4	0.50	1.10	85	270	0.194	0.9989	0.194	0.9989
SE04	5	0.50	1.10	80	300	0.160	0.9982	0.160	0.9982
SE04	6	0.50	1.10	75	300	0.178	0.9983	0.178	0.9983

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE04	7	0.50	1.10	70	300	0.160	0.9974	0.160	0.9974
SE04	8	0.50	1.10	80	300	0.159	0.9981	0.159	0.9981
SE04	9	0.50	1.10	70	250	0.185	0.9976	0.185	0.9976
SE04	10	0.50	1.10	75	250	0.206	0.9988	0.206	0.9988
SE04	11	0.50	1.10	75	350	0.158	0.9951	0.158	0.9951
SE05	1	0.60	1.10	110	350	0.078	0.9937	0.078	0.9937
SE05	2	0.60	1.10	120	350	0.133	0.9989	0.133	0.9989
SE05	3	0.60	1.10	75	300	0.139	0.9977	0.138	0.9977
SE05	4	0.60	1.10	60	300	0.135	0.9978	0.135	0.9978
SE05	5	0.60	1.10	50	270	0.161	0.9990	0.161	0.9990
SE05	6	0.60	1.10	75	350	0.101	0.9980	0.101	0.9980
SE05	7	0.60	1.10	70	270	0.164	0.9991	0.164	0.9991
SE05	8	0.60	1.10	65	260	0.155	0.9987	0.155	0.9986
SE05	9	0.60	1.10	55	250	0.151	0.9990	0.151	0.9989
SE05	10	0.60	1.10	65	340	0.132	0.9950	0.132	0.9950
SE32	1	0.50	0.85	90	350	0.145	0.9970	0.145	0.9970
SE32	2	0.50	0.90	70	450	0.121	0.9958	0.121	0.9958
SE32	3	0.50	0.90	65	390	0.126	0.9961	0.126	0.9962
SE32	4	0.50	0.90	50	400	0.126	0.9978	0.126	0.9977
SE32	5	0.50	0.90	65	250	0.136	0.9975	0.136	0.9976
SE32	6	0.50	0.90	75	240	0.185	0.9985	0.186	0.9984
SE32	7	0.50	0.90	60	250	0.141	0.9946	0.141	0.9946
SE32	8	0.50	0.90	70	300	0.172	0.9959	0.172	0.9959
SE32	9	0.50	0.90	50	290	0.174	0.9983	0.174	0.9982
SE32	10	0.50	0.90	45	370	0.153	0.9983	0.153	0.9983

*No excitation.

—Indicates no data are available.

Table 16. Phase 1—box 2 first mode damping data.

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW01	1	0.60	0.85	30	180	0.179	0.9903	0.179	0.9903
NW01	2	0.55	0.90	70	350	0.152	0.9887	0.152	0.9889
NW01	3	0.60	0.85	55	200	0.186	0.9915	0.187	0.9918
NW01	4	0.60	0.85	45	200	0.184	0.9949	0.183	0.9948
NW01	5	0.55	0.90	75	200	0.178	0.9924	0.179	0.9927
NW01	6	0.55	0.90	45	160	0.211	0.9947	0.211	0.9946
NW01	7	0.55	0.90	70	300	0.199	0.9965	0.199	0.9963
NW01	8	0.55	0.90	50	160	0.166	0.9900	0.165	0.9900
NW01	9	0.55	0.90	90	220	0.221	0.9957	0.221	0.9957
NW02	1	0.60	0.90	30	200	0.082	0.9950	0.082	0.9949
NW02	2	0.60	0.90	75	300	0.105	0.9979	0.105	0.9980
NW02	3	0.60	0.90	70	250	0.098	0.9960	0.098	0.9960
NW02	4	0.60	0.90	25	350	0.101	0.9978	0.101	0.9978
NW02	5	0.60	0.90	30	380	0.100	0.9987	0.100	0.9987
NW02	6	0.60	0.90	35	350	0.102	0.9975	0.102	0.9976
NW02	7	0.60	0.90	40	300	0.125	0.9977	0.125	0.9977
NW02	8	0.60	0.90	45	320	0.113	0.9968	0.113	0.9969
NW02	9	0.60	0.90	50	280	0.132	0.9951	0.132	0.9950
NW02	10	0.60	0.90	45	300	0.132	0.9980	0.132	0.9979
NW29	1	0.60	1.00	55	300	0.145	0.9975	0.145	0.9974
NW29	2	0.60	1.00	125	280	0.156	0.9792	0.156	0.9790
NW29	3	0.60	1.00	90	350	0.138	0.9935	0.139	0.9936
NW29	4	0.60	1.00	115	380	0.169	0.9970	0.169	0.9969
NW29	5	0.60	1.00	30	400	0.137	0.9956	0.136	0.9956
NW30	1	0.55	0.95	165	450	0.150	0.9939	0.150	0.9939
NW30	2	0.55	1.00	85	250	0.190	0.9970	0.189	0.9970
NW30	3	0.55	1.00	100	250	0.149	0.9969	0.149	0.9969
NW30	4	0.55	1.00	90	300	0.191	0.9960	0.191	0.9958

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW30	5	0.55	1.00	130	300	0.137	0.9887	0.137	0.9888
NW30	6	0.55	1.00	115	260	0.196	0.9974	0.196	0.9973
NW30	7	0.55	1.00	75	300	0.150	0.9969	0.150	0.9970
NW30	8	0.55	1.00	115	280	0.144	0.9899	0.144	0.9899
NW30	9	0.55	1.00	195	450	0.197	0.9979	0.197	0.9978
NW30	10	0.55	0.95	65	330	0.174	0.9930	0.174	0.9929
NW31	1	0.50	0.90	110	270	0.280	0.9502	0.282	0.9512
NW31	2	0.55	0.90	55	220	0.219	0.9723	0.219	0.9726
NW31	3	0.50	0.90	80	240	0.258	0.9786	0.257	0.9786
NW31	4	0.55	0.90	65	230	0.253	0.9683	0.254	0.9669
NW31	5	0.50	0.90	90	250	0.237	0.9146	0.238	0.9169
NW31	6	0.50	0.90	85	270	0.247	0.9602	0.246	0.9605
NW31	7	0.55	0.90	80	250	0.181	0.9414	0.182	0.9409
NW31	8	0.55	0.90	75	240	0.205	0.9617	0.204	0.9624
NW31	9	0.55	0.90	90	300	0.230	0.9718	0.230	0.9717
NW31	10	0.50	0.90	100	320	0.247	0.9541	0.248	0.9545
NW32	1	0.50	0.90	130	250	0.297	0.9942	0.297	0.9940
NW32	2	0.50	0.90	85	190	0.270	0.9940	0.268	0.9947
NW32	3	0.50	0.90	115	200	0.219	0.9910	0.218	0.9913
NW32	4	0.50	0.90	80	160	0.225	0.9936	0.224	0.9936
NW32	5	0.50	0.90	75	160	0.221	0.9939	0.219	0.9942
NW32	6	0.50	0.90	70	160	0.232	0.9871	0.233	0.9870
NW32	7	0.50	0.90	90	180	0.234	0.9917	0.234	0.9918
NW32	8	0.50	0.90	80	180	0.197	0.9863	0.198	0.9867
NW32	9	0.50	0.90	95	155	0.230	0.9776	0.226	0.9763
NW32	10	0.50	0.90	55	150	0.186	0.9876	0.184	0.9879
SW01	1	0.55	0.90	60	250	0.233	0.9911	0.232	0.9915
SW01	2	0.55	0.90	50	120	0.239	0.9958	0.240	0.9959
SW01	3	0.55	0.90	55	140	0.244	0.9953	0.245	0.9955

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW01	4	0.55	0.90	55	140	0.233	0.9922	0.233	0.9922
SW01	5	0.55	0.90	60	120	0.221	0.9934	0.221	0.9933
SW01	6	0.55	0.90	65	130	0.252	0.9968	0.254	0.9970
SW01	7	0.55	0.90	55	140	0.226	0.9895	0.228	0.9897
SW01	8	0.55	0.90	60	140	0.186	0.9885	0.186	0.9886
SW01	9	0.55	0.90	40	190	0.127	0.9642	0.126	0.9635
SW01	10	0.55	0.90	50	140	0.226	0.9916	0.225	0.9914
SW02	1	0.55	0.90	80	350	0.167	0.9977	0.167	0.9976
SW02	2	0.55	0.90	45	320	0.147	0.9980	0.147	0.9980
SW02	3	0.55	0.90	70	260	0.158	0.9966	0.158	0.9965
SW02	4	0.55	0.90	65	290	0.190	0.9953	0.190	0.9952
SW02	5	0.55	0.90	60	320	0.175	0.9968	0.175	0.9968
SW02	6	0.55	0.90	60	290	0.171	0.9963	0.171	0.9963
SW02	7	0.55	0.90	50	230	0.172	0.9966	0.172	0.9966
SW02	8	0.55	0.90	35	210	0.201	0.9949	0.201	0.9949
SW02	9	0.55	0.90	50	260	0.196	0.9959	0.195	0.9959
SW02	10	0.55	0.90	40	250	0.164	0.9971	0.164	0.9971
SW03	1	0.60	1.00	90	220	0.232	0.9960	0.232	0.9960
SW03	2	0.60	1.00	70	200	0.224	0.9957	0.224	0.9956
SW03	3	0.60	1.00	50	200	0.249	0.9947	0.249	0.9948
SW03	4	0.60	1.00	70	200	0.265	0.9978	0.266	0.9978
SW03	5	0.60	1.00	90	230	0.221	0.9976	0.221	0.9976
SW03	6	0.60	1.00	60	200	0.247	0.9928	0.247	0.9926
SW03	7	0.60	1.00	50	200	0.248	0.9971	0.248	0.9972
SW03	8	0.60	1.00	95	230	0.241	0.9987	0.241	0.9987
SW03	9	0.60	1.00	50	190	0.228	0.9949	0.227	0.9949
SW03	10	0.60	1.00	55	190	0.286	0.9953	0.285	0.9950
SW04	1	0.50	1.00	80	200	0.230	0.9953	0.230	0.9951
SW04	2	0.50	1.00	65	300	0.151	0.9921	0.151	0.9924

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	Run	Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW04	3	0.50	1.00	90	250	0.218	0.9906	0.218	0.9907
SW04	4	0.50	1.00	80	260	0.188	0.9914	0.189	0.9917
SW04	5	0.60	1.00	55	250	0.199	0.9944	0.198	0.9942
SW04	6	0.60	1.00	90	300	0.185	0.9942	0.185	0.9942
SW04	7	0.60	1.00	100	300	0.182	0.9870	0.182	0.9870
SW04	8	0.60	1.10	195	250	0.251	0.9907	0.252	0.9905
SW04	9*	—	—	—	—	—	—	—	—
SW04	10	0.60	1.00	120	250	0.193	0.9908	0.192	0.9909
SW04	11	0.60	1.00	100	250	0.143	0.9898	0.143	0.9900
SW05	1	0.60	1.10	160	250	0.200	0.9598	0.201	0.9600
SW05	2	0.60	1.10	80	250	0.210	0.9942	0.211	0.9942
SW05	3	0.60	1.10	160	350	0.190	0.9981	0.190	0.9981
SW05	4	0.60	1.10	90	300	0.191	0.9935	0.191	0.9936
SW05	5	0.60	1.10	90	300	0.188	0.9979	0.188	0.9979
SW05	6	0.60	1.10	50	250	0.189	0.9976	0.189	0.9976
SW05	7	0.60	1.10	45	220	0.197	0.9980	0.197	0.9980
SW05	8	0.60	1.10	80	230	0.242	0.9979	0.241	0.9977
SW05	9	0.60	1.10	85	220	0.224	0.9954	0.224	0.9954
SW05	10	0.60	1.10	80	250	0.218	0.9953	0.218	0.9953
SW06	1	0.60	1.20	95	230	0.204	0.9964	0.204	0.9965
SW06	2	0.60	1.20	45	220	0.198	0.9967	0.198	0.9967
SW06	3	0.60	1.20	100	300	0.154	0.9918	0.153	0.9917
SW06	4	0.60	1.20	100	320	0.187	0.9967	0.187	0.9965
SW06	5	0.60	1.20	60	240	0.212	0.9979	0.213	0.9979
SW06	6	0.60	1.20	60	200	0.229	0.9938	0.228	0.9937
SW06	7	0.60	1.20	70	250	0.206	0.9981	0.206	0.9982
SW06	8	0.60	1.20	85	220	0.213	0.9958	0.213	0.9958
SW06	9	0.60	1.20	85	250	0.201	0.9983	0.201	0.9983
SW06	10	0.60	1.20	60	260	0.187	0.9983	0.186	0.9982

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW29	1	0.50	1.00	90	400	0.158	0.9915	0.159	0.9915
SW29	2	0.60	0.95	105	350	0.110	0.9988	0.110	0.9988
SW29	3	0.60	0.95	80	350	0.115	0.9958	0.115	0.9958
SW29	4	0.60	0.95	75	300	0.114	0.9984	0.114	0.9985
SW29	5	0.60	0.95	80	350	0.155	0.9981	0.155	0.9981
SW29	6	0.55	1.00	170	500	0.105	0.9975	0.105	0.9975
SW29	7	0.55	1.00	80	300	0.112	0.9939	0.112	0.9941
SW29	8	0.60	0.95	70	300	0.100	0.9940	0.100	0.9941
SW29	9	0.60	1.00	75	300	0.120	0.9973	0.120	0.9973
SW29	10	0.60	0.95	90	330	0.114	0.9942	0.114	0.9943
SW30	1	0.55	0.90	85	160	0.230	0.9944	0.230	0.9945
SW30	2	0.55	0.90	80	140	0.199	0.9858	0.198	0.9857
SW30	3	0.55	0.90	95	200	0.141	0.9684	0.140	0.9680
SW30	4	0.55	0.90	65	200	0.166	0.9769	0.166	0.9766
SW30	5	0.55	0.90	85	200	0.165	0.9818	0.166	0.9819
SW30	6	0.55	0.90	100	220	0.144	0.9828	0.145	0.9827
SW30	7	0.55	0.90	110	220	0.209	0.9800	0.209	0.9803
SW30	8	0.55	0.90	135	200	0.279	0.9952	0.279	0.9950
SW30	9	0.55	0.90	60	140	0.317	0.9960	0.317	0.9961
SW30	10	0.55	0.90	60	200	0.228	0.9909	0.228	0.9908
SW31	1	0.55	0.90	95	160	0.489	0.9945	0.491	0.9942
SW31	2	0.55	0.90	75	140	0.544	0.9872	0.543	0.9876
SW31	3	0.55	0.90	60	130	0.506	0.9924	0.512	0.9925
SW31	4	0.55	0.90	75	140	0.562	0.9879	0.566	0.9869
SW31	5	0.55	0.90	70	140	0.501	0.9888	0.509	0.9886
SW31	6	0.55	0.90	70	140	0.510	0.9961	0.515	0.9965
SW31	7	0.55	0.90	90	160	0.551	0.9930	0.546	0.9923
SW31	8	0.55	0.90	70	140	0.474	0.9912	0.479	0.9905
SW31	9	0.55	0.90	65	130	0.471	0.9956	0.469	0.9958

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW31	10	0.55	0.90	60	130	0.512	0.9941	0.516	0.9944
SW32	1	0.60	0.85	180	330	0.198	0.9951	0.197	0.9952
SW32	2	0.60	0.85	50	130	0.195	0.9931	0.197	0.9932
SW32	3	0.55	0.85	60	160	0.182	0.9923	0.182	0.9928
SW32	4	0.55	0.85	45	150	0.176	0.9904	0.176	0.9905
SW32	5	0.55	0.85	110	200	0.197	0.9956	0.199	0.9954
SW32	6	0.50	0.90	65	140	0.189	0.9876	0.189	0.9881
SW32	7	0.55	0.85	70	170	0.188	0.9898	0.188	0.9894
SW32	8	0.60	0.85	85	170	0.187	0.9963	0.188	0.9960
SW32	9	0.50	0.85	100	200	0.165	0.9889	0.163	0.9895
SW32	10	0.50	0.85	120	220	0.269	0.9913	0.270	0.9912
SE03	1	0.60	1.00	90	300	0.189	0.9981	0.189	0.9981
SE03	2	0.60	1.00	60	300	0.168	0.9988	0.168	0.9988
SE03	3	0.60	1.00	60	220	0.176	0.9949	0.175	0.9948
SE03	4	0.60	1.00	50	300	0.166	0.9982	0.166	0.9982
SE03	5	0.60	1.00	45	300	0.154	0.9954	0.155	0.9954
SE03	6	0.60	1.00	75	300	0.194	0.9952	0.194	0.9953
SE03	7	0.60	1.00	120	320	0.186	0.9958	0.187	0.9958
SE03	8	0.60	1.00	80	250	0.176	0.9968	0.176	0.9969
SE03	9	0.60	1.00	65	250	0.179	0.9968	0.179	0.9968
SE04	1	0.60	1.10	85	220	0.138	0.9889	0.138	0.9890
SE04	2	0.55	1.00	50	250	0.167	0.9975	0.167	0.9975
SE04	3	0.55	1.00	90	250	0.198	0.9947	0.198	0.9948
SE04	4	0.55	1.00	85	270	0.195	0.9983	0.195	0.9983
SE04	5	0.60	1.00	80	300	0.160	0.9957	0.160	0.9958
SE04	6	0.60	1.00	75	300	0.180	0.9982	0.180	0.9982
SE04	7	0.60	1.00	70	300	0.161	0.9973	0.161	0.9973
SE04	8	0.60	1.00	85	300	0.158	0.9973	0.158	0.9973
SE04	9	0.60	1.00	70	250	0.187	0.9972	0.187	0.9972

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE04	10	0.60	1.00	75	250	0.207	0.9984	0.208	0.9984
SE04	11	0.60	1.00	75	350	0.160	0.9950	0.160	0.9950
SE05	1	0.60	1.00	110	350	0.076	0.9910	0.076	0.9910
SE05	2	0.60	1.00	120	350	0.133	0.9985	0.133	0.9985
SE05	3	0.60	1.00	75	300	0.139	0.9962	0.139	0.9962
SE05	4	0.60	1.00	60	300	0.135	0.9956	0.135	0.9957
SE05	5	0.60	1.00	50	260	0.160	0.9974	0.160	0.9973
SE05	6	0.60	1.00	75	350	0.101	0.9973	0.101	0.9973
SE05	7	0.60	1.00	70	270	0.164	0.9985	0.164	0.9985
SE05	8	0.60	1.00	65	260	0.155	0.9974	0.155	0.9974
SE05	9	0.60	1.00	60	250	0.154	0.9976	0.153	0.9976
SE05	10	0.65	1.05	65	340	0.131	0.9943	0.131	0.9943
SE32	1	0.50	0.85	90	350	0.147	0.9950	0.147	0.9950
SE32	2	0.50	0.90	70	450	0.122	0.9945	0.122	0.9945
SE32	3	0.50	0.90	65	390	0.126	0.9953	0.126	0.9954
SE32	4	0.50	0.90	50	400	0.126	0.9959	0.126	0.9959
SE32	5	0.50	0.90	65	250	0.135	0.9956	0.135	0.9956
SE32	6	0.50	0.90	75	240	0.186	0.9975	0.186	0.9975
SE32	7	0.50	0.90	60	250	0.139	0.9937	0.140	0.9936
SE32	8	0.50	0.90	70	300	0.173	0.9946	0.173	0.9946
SE32	9	0.50	0.90	50	290	0.176	0.9974	0.176	0.9974
SE32	10	0.50	0.90	45	370	0.152	0.9975	0.152	0.9976

*No excitation.

—Indicates no data are available.

Table 17. Phase 1—box 1 second mode damping data.

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW01	1	1.25	1.65	40	250	0.109	0.9923	0.109	0.9923
NW01	2	1.10	1.70	95	350	0.060	0.9802	0.060	0.9802
NW01	3	1.10	1.80	50	275	0.106	0.9957	0.106	0.9957
NW01	4	1.10	1.80	35	250	0.127	0.9944	0.127	0.9943
NW01	5	1.10	1.80	70	250	0.106	0.9928	0.106	0.9929
NW01	6	1.10	1.80	45	310	0.111	0.9914	0.111	0.9913
NW01	7	1.10	1.80	65	240	0.127	0.9956	0.127	0.9956
NW01	8	1.10	1.80	60	280	0.096	0.9961	0.096	0.9961
NW01	9	1.10	1.80	125	275	0.127	0.9914	0.127	0.9914
NW02	1	1.20	1.80	25	250	0.075	0.7023	0.075	0.7009
NW02	2	1.20	1.80	50	300	0.099	0.7951	0.099	0.7954
NW02	3	1.20	1.80	40	275	0.101	0.8845	0.101	0.8846
NW02	4	1.20	1.80	20	250	0.090	0.8322	0.090	0.8323
NW02	5	1.20	1.80	30	250	0.082	0.7822	0.082	0.7841
NW02	6	1.20	1.80	30	250	0.105	0.8091	0.106	0.8106
NW02	7	1.20	1.80	30	200	0.154	0.8249	0.154	0.8233
NW02	8	1.20	1.80	40	250	0.139	0.8674	0.139	0.8685
NW02	9	1.20	1.80	45	180	0.161	0.8711	0.161	0.8716
NW02	10	1.20	1.80	40	190	0.177	0.8788	0.176	0.8772
NW29	1	1.20	1.90	50	220	0.139	0.9972	0.139	0.9973
NW29	2	1.10	2.00	140	230	0.151	0.9927	0.151	0.9928
NW29	3	1.20	1.90	85	240	0.148	0.9963	0.148	0.9963
NW29	4	1.20	2.00	110	260	0.158	0.9978	0.159	0.9978
NW29	5	1.20	1.90	30	250	0.128	0.9934	0.128	0.9934
NW30	1	1.20	1.90	165	270	0.159	0.9989	0.159	0.9990
NW30	2	1.20	1.90	80	220	0.162	0.9967	0.162	0.9966
NW30	3	1.20	1.90	100	200	0.164	0.9993	0.164	0.9993
NW30	4	1.20	1.90	90	220	0.173	0.9960	0. 173	0.9961

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW30	5	1.20	1.90	130	200	0.126	0.9916	0.125	0.9912
NW30	6	1.20	1.90	110	290	0.165	0.9944	0.165	0.9945
NW30	7	1.20	1.90	75	190	0.185	0.9990	0.185	0.9991
NW30	8	1.20	1.90	115	190	0.149	0.9973	0.149	0.9973
NW30	9	1.10	1.90	195	320	0.192	0.9992	0.192	0.9992
NW30	10	1.20	1.90	60	230	0.187	0.9979	0.187	0.9979
NW31	1	1.10	1.80	105	210	0.149	0.9986	0.149	0.9986
NW31	2	1.10	1.80	55	170	0.161	0.9990	0.161	0.9990
NW31	3	1.10	1.80	80	210	0.171	0.9973	0.171	0.9972
NW31	4	1.10	1.80	60	160	0.153	0.9996	0.153	0.9996
NW31	5	1.10	1.80	85	180	0.138	0.9957	0.137	0.9955
NW31	6	1.10	1.80	85	200	0.141	0.9989	0.141	0.9989
NW31	7	1.10	1.80	80	350	0.100	0.9943	0.100	0.9943
NW31	8	1.10	1.80	70	300	0.112	0.9980	0.112	0.9980
NW31	9	1.10	1.80	90	210	0.186	0.9991	0.186	0.9991
NW31	10	1.10	1.80	95	300	0.129	0.9952	0.129	0.9951
NW32	1	1.10	1.70	125	195	0.254	0.9967	0.254	0.9969
NW32	2	1.10	1.70	80	190	0.206	0.9917	0.207	0.9916
NW32	3	1.10	1.70	115	220	0.196	0.9934	0.196	0.9934
NW32	4	1.10	1.70	75	150	0.198	0.9972	0.198	0.9970
NW32	5	1.10	1.70	75	150	0.181	0.9959	0.180	0.9957
NW32	6	1.10	1.70	70	200	0.167	0.9949	0.167	0.9949
NW32	7	1.10	1.70	90	160	0.164	0.9952	0.164	0.9949
NW32	8	1.10	1.70	75	145	0.203	0.9967	0.202	0.9964
NW32	9	1.10	1.70	90	220	0.155	0.9959	0.155	0.9959
NW32	10	1.10	1.70	50	160	0.196	0.9952	0.196	0.9952
SW01	1	1.20	1.80	55	220	0.151	0.9905	0.151	0.9906
SW01	2	1.10	1.80	45	220	0.143	0.9913	0.143	0.9913
SW01	3	1.20	1.80	55	160	0.168	0.9907	0.168	0.9906

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW01	4	1.20	1.80	50	250	0.111	0.9856	0.111	0.9856
SW01	5	1.20	1.80	60	150	0.185	0.9904	0.184	0.9902
SW01	6	1.20	1.80	60	200	0.192	0.9917	0.192	0.9917
SW01	7	1.20	1.80	50	200	0.170	0.9928	0.170	0.9928
SW01	8	1.20	1.80	55	200	0.181	0.9937	0.181	0.9936
SW01	9	1.10	1.80	35	150	0.141	0.9913	0.142	0.9914
SW01	10	1.20	1.80	45	160	0.164	0.9946	0.165	0.9947
SW02	1	1.10	1.80	75	210	0.157	0.9957	0.157	0.9957
SW02	2	1.20	1.80	40	280	0.171	0.9866	0.171	0.9865
SW02	3	1.20	1.80	60	210	0.156	0.9878	0.156	0.9879
SW02	4	1.20	1.80	60	280	0.160	0.9922	0.160	0.9922
SW02	5	1.20	1.80	55	200	0.178	0.9942	0.179	0.9942
SW02	6	1.20	1.80	55	140	0.193	0.9944	0.193	0.9943
SW02	7	1.20	1.80	45	220	0.146	0.9943	0.146	0.9943
SW02	8	1.20	1.80	35	200	0.159	0.9929	0.159	0.9929
SW02	9	1.20	1.80	50	200	0.159	0.9928	0.159	0.9928
SW02	10	1.20	1.80	40	200	0.161	0.9971	0.161	0.9971
SW03	1	1.20	1.90	90	200	0.234	0.9933	0.235	0.9934
SW03	2	1.20	1.90	65	180	0.234	0.9857	0.234	0.9858
SW03	3	1.20	1.90	45	160	0.249	0.9908	0.249	0.9908
SW03	4	1.20	1.90	70	180	0.264	0.9966	0.264	0.9965
SW03	5	1.20	2.00	90	210	0.240	0.9945	0.239	0.9945
SW03	6	1.20	1.90	55	160	0.236	0.9902	0.237	0.9904
SW03	7	1.20	1.90	50	160	0.249	0.9962	0.249	0.9962
SW03	8	1.20	1.90	95	210	0.235	0.9974	0.235	0.9975
SW03	9	1.20	1.90	50	160	0.213	0.9926	0.213	0.9925
SW03	10	1.20	1.90	55	140	0.272	0.9963	0.273	0.9962
SW04	1	1.10	1.90	80	210	0.190	0.9931	0.190	0.9931
SW04	2	1.20	2.00	65	200	0.176	0.9938	0.176	0.9938

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW04	3	1.20	2.00	90	180	0.265	0.9950	0.266	0.9948
SW04	4	1.20	2.00	75	160	0.229	0.9917	0.229	0.9916
SW04	5	1.20	2.00	50	120	0.320	0.9974	0.320	0.9974
SW04	6	1.20	2.00	85	180	0.264	0.9950	0.265	0.9951
SW04	7	1.30	1.90	100	160	0.336	0.9908	0.335	0.9908
SW04	8	1.20	2.00	195	260	0.283	0.9863	0.282	0.9865
SW04	9*	—	—	—	—	—	—	—	—
SW04	10	1.20	2.00	115	190	0.293	0.9848	0.294	0.9849
SW04	11	1.10	2.00	100	180	0.194	0.9977	0.195	0.9973
SW05	1	1.20	2.20	160	260	0.177	0.9957	0.177	0.9956
SW05	2	1.20	2.20	80	200	0.195	0.9968	0.196	0.9967
SW05	3	1.20	2.20	155	300	0.205	0.9944	0.205	0.9945
SW05	4	1.20	2.20	85	170	0.212	0.9930	0.212	0.9929
SW05	5	1.20	2.10	90	250	0.197	0.9925	0.197	0.9926
SW05	6	1.20	2.10	50	150	0.220	0.9916	0.220	0.9915
SW05	7	1.20	2.10	45	160	0.203	0.9973	0.203	0.9973
SW05	8	1.40	2.10	75	150	0.238	0.9959	0.238	0.9959
SW05	9	1.30	2.10	85	200	0.223	0.9965	0.223	0.9965
SW05	10	1.30	2.10	75	210	0.199	0.9968	0.199	0.9968
SW06	1	1.30	2.30	90	155	0.295	0.9894	0.295	0.9895
SW06	2	1.30	2.30	45	120	0.294	0.9920	0.294	0.9921
SW06	3	1.30	2.30	95	170	0.239	0.9912	0.238	0.9910
SW06	4	1.30	2.30	100	170	0.278	0.9950	0.278	0.9950
SW06	5	1.30	2.30	55	125	0.313	0.9965	0.312	0.9965
SW06	6	1.30	2.30	60	140	0.323	0.9921	0.323	0.9921
SW06	7	1.40	2.30	70	140	0.266	0.9910	0.266	0.9910
SW06	8	1.30	2.30	80	180	0.227	0.9564	0.227	0.9558
SW06	9	1.30	2.30	85	150	0.313	0.9905	0.313	0.9904
SW06	10	1.30	2.30	60	130	0.288	0.9961	0.288	0.9961

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW29	1	1.20	1.90	85	250	0.162	0.9920	0.162	0.9920
SW29	2	1.20	1.90	100	280	0.172	0.9903	0.172	0.9906
SW29	3	1.30	1.90	80	220	0.200	0.9915	0.200	0.9913
SW29	4	1.20	1.90	75	200	0.197	0.9954	0.197	0.9954
SW29	5	1.20	1.90	80	260	0.157	0.9950	0.157	0.9950
SW29	6	1.10	1.90	170	340	0.178	0.9956	0.179	0.9956
SW29	7	1.20	1.90	75	200	0.184	0.9957	0.184	0.9957
SW29	8	1.20	1.90	65	220	0.161	0.9960	0.161	0.9960
SW29	9	1.20	1.90	75	220	0.174	0.9947	0.174	0.9947
SW29	10	1.20	1.90	85	260	0.165	0.9970	0.165	0.9970
SW30	1	1.10	1.80	85	310	0.127	0.9960	0.128	0.9960
SW30	2	1.10	1.80	80	300	0.106	0.9961	0.106	0.9961
SW30	3	1.10	1.80	90	350	0.108	0.9978	0.108	0.9978
SW30	4	1.10	1.80	65	350	0.104	0.9928	0.104	0.9928
SW30	5	1.10	1.80	80	260	0.136	0.9982	0.136	0.9982
SW30	6	1.10	1.80	90	300	0.141	0.9930	0.141	0.9931
SW30	7	1.10	1.80	110	340	0.148	0.9972	0.148	0.9972
SW30	8	1.10	1.80	130	270	0.162	0.9957	0.162	0.9957
SW30	9	1.10	1.80	55	210	0.129	0.9965	0.129	0.9965
SW30	10	1.10	1.80	55	250	0.150	0.9960	0.150	0.9960
SW31	1	1.10	1.80	95	300	0.124	0.9986	0.124	0.9986
SW31	2	1.10	1.80	70	380	0.111	0.9968	0.111	0.9967
SW31	3	1.10	1.80	60	270	0.109	0.9970	0.109	0.9969
SW31	4	1.10	1.80	75	300	0.121	0.9953	0.121	0.9953
SW31	5	1.10	1.80	70	350	0.109	0.9966	0.109	0.9966
SW31	6	1.10	1.80	70	300	0.130	0.9962	0.130	0.9962
SW31	7	1.10	1.80	90	350	0.124	0.9981	0.124	0.9981
SW31	8	1.20	1.80	70	250	0.112	0.9977	0.112	0.9977
SW31	9	1.10	1.80	65	220	0.111	0.9969	0.111	0.9969

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW31	10	1.10	1.80	60	260	0.121	0.9979	0.121	0.9979
SW32	1	1.20	1.70	175	400	0.133	0.9808	0.133	0.9809
SW32	2	1.10	1.70	50	210	0.123	0.9896	0.123	0.9895
SW32	3	1.10	1.70	60	280	0.117	0.9984	0.117	0.9984
SW32	4	1.10	1.70	50	180	0.118	0.9930	0.118	0.9929
SW32	5	1.10	1.70	110	320	0.132	0.9987	0.133	0.9987
SW32	6	1.10	1.70	65	260	0.113	0.9935	0.113	0.9936
SW32	7	1.10	1.70	65	230	0.133	0.9962	0.133	0.9962
SW32	8	1.10	1.70	80	360	0.089	0.9968	0.089	0.9968
SW32	9	1.00	1.70	95	320	0.108	0.9964	0.108	0.9964
SW32	10	1.10	1.70	115	320	0.154	0.9962	0.154	0.9962
SE03	1	1.30	2.00	85	125	0.468	0.9938	0.466	0.9936
SE03	2	1.30	2.00	55	90	0.489	0.9868	0.493	0.9873
SE03	3	1.30	2.00	55	90	0.337	0.9987	0.337	0.9987
SE03	4	1.30	2.00	50	85	0.418	0.9952	0.419	0.9952
SE03	5	1.30	2.00	40	75	0.320	0.9968	0.321	0.9972
SE03	6	1.30	2.00	70	100	0.387	0.9959	0.389	0.9963
SE03	7	1.30	2.00	120	150	0.358	0.9977	0.359	0.9978
SE03	8	1.30	2.00	80	115	0.362	0.9936	0.364	0.9940
SE03	9	1.30	2.00	65	105	0.368	0.9946	0.366	0.9941
SE04	1	1.30	2.10	80	150	0.268	0.9899	0.267	0.9899
SE04	2	1.30	2.00	50	85	0.440	0.9955	0.438	0.9953
SE04	3	1.30	2.10	90	130	0.282	0.9942	0.281	0.9937
SE04	4	1.30	2.10	80	115	0.486	0.9975	0.486	0.9974
SE04	5	1.30	2.10	75	115	0.382	0.9962	0.384	0.9964
SE04	6	1.30	2.10	70	110	0.541	0.9937	0.542	0.9939
SE04	7	1.20	2.10	65	105	0.436	0.9963	0.439	0.9966
SE04	8	1.20	2.10	80	115	0.441	0.9983	0.443	0.9985
SE04	9	1.20	2.10	70	100	0.511	0.9960	0.511	0.9960

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SE04	10	1.20	2.10	75	110	0.489	0.9943	0.490	0.9945
SE04	11	1.30	2.10	75	110	0.461	0.9967	0.464	0.9968
SE05	1	1.30	2.20	110	220	0.113	0.9964	0.113	0.9964
SE05	2	1.30	2.20	115	260	0.159	0.9982	0.159	0.9982
SE05	3	1.30	2.20	70	170	0.190	0.9991	0.190	0.9990
SE05	4	1.30	2.10	55	140	0.141	0.9992	0.141	0.9992
SE05	5	1.20	2.20	50	200	0.186	0.9963	0.186	0.9963
SE05	6	1.30	2.20	75	200	0.169	0.9948	0.169	0.9948
SE05	7	1.30	2.20	70	200	0.213	0.9971	0.213	0.9971
SE05	8	1.20	2.20	60	180	0.190	0.9969	0.190	0.9969
SE05	9	1.30	2.20	55	200	0.190	0.9982	0.190	0.9982
SE05	10	1.30	2.20	65	240	0.145	0.9978	0.145	0.9978
SE32	1	1.00	1.70	85	450	0.100	0.9956	0.100	0.9956
SE32	2	1.00	1.70	80	440	0.083	0.9700	0.083	0.9699
SE32	3	1.00	1.70	65	380	0.086	0.9940	0.086	0.9940
SE32	4	1.00	1.70	50	400	0.094	0.9912	0.094	0.9912
SE32	5	1.00	1.70	70	340	0.085	0.9841	0.085	0.9843
SE32	6	1.00	1.70	70	310	0.131	0.9930	0.131	0.9929
SE32	7	1.00	1.70	60	380	0.105	0.9924	0.105	0.9924
SE32	8	1.00	1.70	70	330	0.125	0.9946	0.125	0.9946
SE32	9	1.00	1.70	50	290	0.126	0.9956	0.126	0.9956
SE32	10	1.00	1.70	45	370	0.112	0.9948	0.112	0.9948

*No excitation.

—Indicates no data are available.

Table 18. Phase 1—box 2 second mode damping data.

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW01	1	1.30	1.70	40	250	0.111	0.9916	0.111	0.9915
NW01	2	1.10	1.70	95	350	0.062	0.9757	0.062	0.9758
NW01	3	1.20	1.70	50	275	0.107	0.9956	0.107	0.9956
NW01	4	1.20	1.70	35	250	0.126	0.9939	0.126	0.9939
NW01	5	1.10	1.70	70	250	0.108	0.9920	0.108	0.9920
NW01	6	1.20	1.70	45	250	0.123	0.9927	0.123	0.9927
NW01	7	1.20	1.80	65	240	0.128	0.9951	0.128	0.9951
NW01	8	1.10	1.80	60	290	0.096	0.9949	0.096	0.9949
NW01	9	1.10	1.80	125	220	0.131	0.9813	0.131	0.9812
NW02	1	1.30	1.70	30	250	0.076	0.6903	0.075	0.6884
NW02	2	1.20	1.80	50	300	0.101	0.7816	0.101	0.7820
NW02	3	1.20	1.80	40	250	0.094	0.8326	0.094	0.8323
NW02	4	1.30	1.70	20	250	0.094	0.8242	0.094	0.8258
NW02	5	1.40	1.80	30	250	0.087	0.8007	0.087	0.7988
NW02	6	1.30	1.80	30	250	0.111	0.7969	0.111	0.7966
NW02	7	1.30	1.80	30	200	0.161	0.8274	0.161	0.8261
NW02	8	1.40	1.80	40	250	0.145	0.8930	0.145	0.8930
NW02	9	1.30	1.80	45	180	0.165	0.8824	0.165	0.8829
NW02	10	1.30	1.80	40	190	0.176	0.8928	0.176	0.8931
NW29	1	1.20	1.90	50	220	0.140	0.9963	0.140	0.9963
NW29	2	1.10	2.00	140	230	0.147	0.9910	0.147	0.9910
NW29	3	1.20	1.90	85	240	0.148	0.9960	0.148	0.9960
NW29	4	1.20	2.00	110	260	0.158	0.9969	0.158	0.9969
NW29	5	1.20	2.00	30	250	0.127	0.9923	0.127	0.9922
NW30	1	1.20	1.90	165	270	0.158	0.9978	0.159	0.9978
NW30	2	1.20	1.90	80	220	0.162	0.9955	0.162	0.9955
NW30	3	1.20	1.90	100	200	0.165	0.9989	0.165	0.9989
NW30	4	1.20	1.90	90	220	0.175	0.9960	0.175	0.9960

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW30	5	1.20	1.90	130	190	0.138	0.9952	0.138	0.9952
NW30	6	1.20	1.90	110	290	0.164	0.9935	0.164	0.9936
NW30	7	1.20	1.90	75	190	0.188	0.9989	0.188	0.9988
NW30	8	1.20	1.90	115	190	0.150	0.9965	0.150	0.9964
NW30	9	1.10	1.90	195	320	0.194	0.9990	0.194	0.9990
NW30	10	1.20	1.90	60	230	0.188	0.9974	0.188	0.9975
NW31	1	1.10	1.80	105	210	0.148	0.9979	0.148	0.9979
NW31	2	1.10	1.80	55	170	0.161	0.9981	0.161	0.9982
NW31	3	1.10	1.80	80	180	0.183	0.9983	0.183	0.9983
NW31	4	1.10	1.80	60	160	0.154	0.9992	0.154	0.9993
NW31	5	1.10	1.80	85	180	0.138	0.9956	0.138	0.9956
NW31	6	1.10	1.80	85	200	0.142	0.9984	0.142	0.9984
NW31	7	1.10	1.80	80	200	0.129	0.9944	0.128	0.9943
NW31	8	1.10	1.80	70	300	0.112	0.9965	0.112	0.9965
NW31	9	1.10	1.80	90	210	0.187	0.9989	0.187	0.9989
NW31	10	1.10	1.80	95	300	0.128	0.9942	0.128	0.9941
NW32	1	1.10	1.70	125	195	0.251	0.9969	0.251	0.9971
NW32	2	1.10	1.70	80	190	0.211	0.9927	0.211	0.9926
NW32	3	1.10	1.70	115	220	0.199	0.9938	0.199	0.9938
NW32	4	1.10	1.70	75	150	0.198	0.9976	0.198	0.9975
NW32	5	1.10	1.70	75	150	0.182	0.9959	0.181	0.9957
NW32	6	1.10	1.70	70	200	0.168	0.9951	0.168	0.9951
NW32	7	1.10	1.70	90	160	0.167	0.9964	0.167	0.9963
NW32	8	1.10	1.70	75	145	0.203	0.9967	0.202	0.9963
NW32	9	1.10	1.70	90	220	0.157	0.9952	0.157	0.9952
NW32	10	1.10	1.70	50	160	0.199	0.9946	0.199	0.9946
SW01	1	1.20	1.80	55	220	0.148	0.9908	0.148	0.9909
SW01	2	1.20	1.80	45	220	0.142	0.9920	0.143	0.9921
SW01	3	1.20	1.80	55	160	0.163	0.9908	0.163	0.9906

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW01	4	1.20	1.80	50	250	0.109	0.9866	0.109	0.9867
SW01	5	1.20	1.80	60	150	0.175	0.9914	0.175	0.9913
SW01	6	1.20	1.80	60	200	0.188	0.9918	0.188	0.9918
SW01	7	1.20	1.80	50	200	0.166	0.9927	0.166	0.9927
SW01	8	1.20	1.80	55	200	0.177	0.9937	0.177	0.9938
SW01	9	1.10	1.80	35	150	0.139	0.9869	0.139	0.9870
SW01	10	1.20	1.80	45	160	0.162	0.9950	0.162	0.9950
SW02	1	1.10	1.80	75	210	0.155	0.9948	0.155	0.9948
SW02	2	1.20	1.80	40	180	0.182	0.9816	0.182	0.9813
SW02	3	1.20	1.80	60	210	0.157	0.9855	0.157	0.9856
SW02	4	1.20	1.80	60	280	0.161	0.9902	0.161	0.9901
SW02	5	1.20	1.80	55	200	0.178	0.9934	0.178	0.9934
SW02	6	1.20	1.80	55	140	0.192	0.9939	0.192	0.9939
SW02	7	1.20	1.80	45	220	0.145	0.9934	0.145	0.9933
SW02	8	1.20	1.80	35	200	0.162	0.9929	0.161	0.9930
SW02	9	1.20	1.80	50	200	0.158	0.9929	0.158	0.9930
SW02	10	1.20	1.80	40	200	0.161	0.9963	0.161	0.9963
SW03	1	1.20	1.90	90	200	0.236	0.9917	0.236	0.9917
SW03	2	1.20	1.90	65	180	0.234	0.9829	0.234	0.9829
SW03	3	1.20	1.90	45	160	0.253	0.9898	0.253	0.9898
SW03	4	1.20	1.90	70	180	0.261	0.9953	0.261	0.9953
SW03	5	1.20	2.00	90	210	0.243	0.9901	0.242	0.9902
SW03	6	1.20	1.90	55	120	0.267	0.9917	0.267	0.9916
SW03	7	1.20	1.90	50	160	0.250	0.9947	0.250	0.9948
SW03	8	1.20	1.90	95	210	0.236	0.9954	0.236	0.9954
SW03	9	1.20	1.90	50	110	0.209	0.9959	0.208	0.9962
SW03	10	1.20	1.90	55	140	0.275	0.9958	0.275	0.9957
SW04	1	1.30	1.90	80	160	0.218	0.9950	0.218	0.9950
SW04	2	1.20	1.90	65	160	0.191	0.9930	0.191	0.9930

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW04	3	1.20	1.90	90	180	0.266	0.9958	0.266	0.9958
SW04	4	1.20	1.90	75	160	0.228	0.9918	0.229	0.9918
SW04	5	1.20	1.90	50	120	0.325	0.9964	0.324	0.9964
SW04	6	1.20	1.90	85	180	0.269	0.9946	0.269	0.9947
SW04	7	1.20	1.90	100	160	0.344	0.9886	0.342	0.9886
SW04	8	1.20	2.00	195	255	0.268	0.9875	0.269	0.9876
SW04	9*	—	—	—	—	—	—	—	—
SW04	10	1.20	2.00	115	190	0.290	0.9850	0.291	0.9850
SW04	11	1.10	2.00	100	180	0.197	0.9957	0.198	0.9951
SW05	1	1.20	2.20	160	260	0.178	0.9919	0.178	0.9919
SW05	2	1.20	2.20	80	200	0.197	0.9953	0.197	0.9953
SW05	3	1.20	2.20	155	250	0.198	0.9937	0.198	0.9940
SW05	4	1.20	2.20	85	165	0.211	0.9917	0.211	0.9915
SW05	5	1.30	2.10	90	250	0.198	0.9914	0.198	0.9914
SW05	6	1.30	2.10	50	150	0.217	0.9919	0.217	0.9919
SW05	7	1.30	2.10	45	160	0.203	0.9965	0.202	0.9965
SW05	8	1.30	2.10	75	150	0.237	0.9965	0.237	0.9964
SW05	9	1.30	2.10	85	200	0.223	0.9949	0.223	0.9948
SW05	10	1.30	2.10	75	210	0.201	0.9961	0.202	0.9961
SW06	1	1.30	2.30	90	155	0.297	0.9841	0.296	0.9843
SW06	2	1.30	2.30	45	120	0.294	0.9915	0.294	0.9916
SW06	3	1.30	2.30	95	170	0.238	0.9883	0.237	0.9883
SW06	4	1.40	2.30	100	170	0.275	0.9955	0.275	0.9955
SW06	5	1.40	2.30	60	130	0.314	0.9950	0.313	0.9946
SW06	6	1.40	2.30	60	130	0.310	0.9894	0.310	0.9895
SW06	7	1.40	2.30	70	140	0.269	0.9900	0.269	0.9899
SW06	8	1.40	2.30	80	180	0.227	0.9557	0.226	0.9551
SW06	9	1.40	2.30	85	150	0.310	0.9889	0.309	0.9889
SW06	10	1.40	2.30	60	130	0.286	0.9952	0.287	0.9952

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW29	1	1.20	1.90	85	240	0.169	0.9939	0.169	0.9939
SW29	2	1.20	1.90	100	260	0.171	0.9929	0.171	0.9930
SW29	3	1.30	1.90	80	220	0.203	0.9938	0.203	0.9937
SW29	4	1.20	1.90	75	200	0.198	0.9959	0.198	0.9959
SW29	5	1.20	1.90	80	240	0.162	0.9940	0.162	0.9940
SW29	6	1.10	1.90	170	340	0.183	0.9955	0.183	0.9955
SW29	7	1.20	1.90	75	200	0.185	0.9958	0.185	0.9958
SW29	8	1.20	1.90	65	220	0.164	0.9957	0.164	0.9957
SW29	9	1.20	1.90	75	220	0.176	0.9949	0.176	0.9949
SW29	10	1.20	1.90	85	260	0.168	0.9962	0.168	0.9962
SW30	1	1.10	1.80	85	290	0.126	0.9952	0.126	0.9952
SW30	2	1.10	1.80	80	300	0.106	0.9953	0.106	0.9954
SW30	3	1.10	1.80	90	350	0.108	0.9963	0.108	0.9964
SW30	4	1.10	1.80	65	260	0.096	0.9911	0.096	0.9911
SW30	5	1.10	1.80	80	260	0.136	0.9965	0.136	0.9965
SW30	6	1.10	1.80	90	300	0.141	0.9930	0.141	0.9931
SW30	7	1.10	1.80	110	340	0.150	0.9954	0.150	0.9953
SW30	8	1.10	1.80	130	270	0.162	0.9950	0.161	0.9950
SW30	9	1.10	1.80	55	210	0.130	0.9960	0.130	0.9960
SW30	10	1.10	1.80	55	250	0.152	0.9959	0.152	0.9959
SW31	1	1.10	1.80	95	300	0.123	0.9976	0.123	0.9976
SW31	2	1.10	1.80	70	380	0.110	0.9950	0.110	0.9950
SW31	3	1.10	1.80	60	270	0.108	0.9961	0.108	0.9960
SW31	4	1.10	1.80	75	240	0.109	0.9960	0.109	0.9959
SW31	5	1.10	1.80	70	350	0.109	0.9952	0.109	0.9952
SW31	6	1.10	1.70	70	300	0.131	0.9951	0.131	0.9951
SW31	7	1.10	1.80	90	290	0.125	0.9966	0.125	0.9966
SW31	8	1.10	1.80	70	250	0.111	0.9963	0.111	0.9962
SW31	9	1.10	1.80	65	220	0.113	0.9961	0.113	0.9961

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW31	10	1.10	1.80	60	260	0.121	0.9973	0.121	0.9973
SW32	1	1.20	1.70	175	300	0.179	0.9963	0.179	0.9964
SW32	2	1.10	1.70	50	130	0.154	0.9862	0.154	0.9862
SW32	3	1.10	1.70	60	280	0.118	0.9975	0.118	0.9975
SW32	4	1.10	1.70	50	180	0.119	0.9895	0.119	0.9894
SW32	5	1.10	1.70	110	320	0.134	0.9981	0.134	0.9982
SW32	6	1.10	1.70	65	260	0.113	0.9906	0.113	0.9907
SW32	7	1.10	1.70	65	230	0.133	0.9956	0.133	0.9956
SW32	8	1.10	1.70	80	260	0.096	0.9976	0.096	0.9976
SW32	9	1.00	1.70	95	290	0.110	0.9946	0.109	0.9946
SW32	10	1.10	1.70	115	290	0.150	0.9952	0.150	0.9952
SE03	1	1.30	2.00	85	125	0.458	0.9949	0.456	0.9945
SE03	2	1.30	2.00	55	90	0.470	0.9894	0.474	0.9897
SE03	3	1.30	2.00	55	90	0.335	0.9978	0.336	0.9979
SE03	4	1.30	2.00	50	85	0.404	0.9956	0.405	0.9956
SE03	5	1.30	2.00	40	75	0.312	0.9968	0.314	0.9972
SE03	6	1.30	2.00	70	100	0.378	0.9962	0.381	0.9965
SE03	7	1.30	2.00	120	150	0.347	0.9968	0.348	0.9971
SE03	8	1.30	2.00	80	115	0.354	0.9942	0.357	0.9946
SE03	9	1.30	2.00	65	105	0.362	0.9953	0.361	0.9950
SE04	1	1.30	2.10	80	130	0.277	0.9836	0.276	0.9836
SE04	2	1.30	2.00	50	85	0.435	0.9963	0.434	0.9961
SE04	3	1.30	2.10	90	130	0.277	0.9909	0.277	0.9908
SE04	4	1.30	2.10	80	115	0.486	0.9972	0.485	0.9969
SE04	5	1.30	2.10	75	115	0.380	0.9945	0.381	0.9945
SE04	6	1.30	2.10	70	110	0.533	0.9934	0.534	0.9936
SE04	7	1.30	2.10	65	105	0.431	0.9960	0.433	0.9962
SE04	8	1.20	2.10	80	115	0.434	0.9976	0.436	0.9976
SE04	9	1.20	2.10	70	100	0.500	0.9964	0.500	0.9963

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE04	10	1.20	2.10	75	110	0.481	0.9962	0.482	0.9965
SE04	11	1.20	2.10	75	110	0.454	0.9963	0.456	0.9965
SE05	1	1.30	2.20	110	220	0.113	0.9948	0.113	0.9949
SE05	2	1.30	2.20	115	220	0.155	0.9985	0.155	0.9985
SE05	3	1.30	2.20	70	170	0.193	0.9986	0.193	0.9986
SE05	4	1.30	2.20	55	140	0.142	0.9987	0.142	0.9988
SE05	5	1.30	2.20	50	190	0.181	0.9975	0.181	0.9975
SE05	6	1.30	2.20	75	200	0.170	0.9951	0.170	0.9951
SE05	7	1.30	2.20	70	200	0.215	0.9974	0.215	0.9974
SE05	8	1.30	2.20	60	170	0.187	0.9981	0.187	0.9980
SE05	9	1.30	2.20	55	200	0.191	0.9977	0.191	0.9977
SE05	10	1.30	2.20	65	240	0.145	0.9976	0.145	0.9976
SE32	1	1.00	1.70	85	240	0.123	0.9937	0.123	0.9937
SE32	2	1.10	1.60	80	420	0.085	0.9619	0.085	0.9619
SE32	3	1.00	1.70	65	380	0.087	0.9937	0.087	0.9937
SE32	4	1.00	1.70	50	250	0.107	0.9907	0.107	0.9906
SE32	5	1.00	1.70	70	340	0.085	0.9818	0.085	0.9820
SE32	6	1.00	1.70	70	310	0.133	0.9925	0.133	0.9925
SE32	7	1.00	1.70	60	380	0.106	0.9924	0.106	0.9924
SE32	8	1.00	1.70	70	330	0.124	0.9937	0.124	0.9937
SE32	9	1.00	1.70	50	290	0.126	0.9950	0.126	0.9950
SE32	10	1.00	1.70	45	340	0.116	0.9949	0.116	0.9949

*No excitation.

—Indicates no data are available.

Table 19. Phase 1 summary of average damping values.

Cable	Mode	Average Damping Value (percent)	Maximum Damping Value[a] (percent)	Minimum Damping Value[a] (percent)	Correlation	Average Length of Time Sample (s)
NW01	1	0.186	0.195	0.177	0.9934	159.4
NW02	1	0.110	0.117	0.104	0.9976	231.8
NW29	1	0.149	0.157	0.142	0.9944	259.0
NW30	1	0.167	0.176	0.158	0.9957	203.5
NW31	1	0.237	0.247	0.226	0.9596	176.0
NW32	1	0.229	0.242	0.217	0.9914	91.0
SW01	1	0.218	0.232	0.204	0.9909	96.5
SW02	1	0.174	0.180	0.168	0.9973	222.5
SW03	1	0.244	0.252	0.237	0.9971	137.0
SW04	1	0.188	0.199	0.177	0.9938	176.1
SW05	1	0.205	0.212	0.198	0.9947	167.5
SW06	1	0.199	0.207	0.191	0.9972	173.0
SW29	1	0.120	0.128	0.113	0.9967	256.5
SW30	1	0.209	0.230	0.187	0.9852	100.8
SW31	1	0.514	0.525	0.503	0.9929	68.0
SW32	1	0.195	0.205	0.184	0.9931	98.3
SE03	1	0.177	0.182	0.172	0.9975	210.6
SE04	1	0.177	0.184	0.170	0.9974	206.8
SE05	1	0.135	0.145	0.125	0.9970	228.8
SE32	1	0.148	0.157	0.139	0.9963	265.0
NW01	2	0.109	0.117	0.100	0.9913	204.7
NW02	2	0.120	0.133	0.106	0.8235	203.0
NW29	2	0.144	0.151	0.138	0.9950	157.0
NW30	2	0.167	0.174	0.160	0.9970	120.5
NW31	2	0.146	0.156	0.137	0.9974	139.5
NW32	2	0.193	0.203	0.182	0.9954	94.5
SW01	2	0.159	0.168	0.150	0.9912	140.0
SW02	2	0.165	0.170	0.159	0.9921	157.5

Cable	Mode	Average Damping Value (percent)	Maximum Damping Value[a] (percent)	Minimum Damping Value[a] (percent)	Correlation	Average Length of Time Sample (s)
SW03	2	0.244	0.251	0.238	0.9928	105.0
SW04	2	0.257	0.278	0.237	0.9925	83.8
SW05	2	0.207	0.213	0.200	0.9945	112.3
SW06	2	0.283	0.294	0.271	0.9882	73.5
SW29	2	0.176	0.182	0.171	0.9946	153.5
SW30	2	0.131	0.139	0.123	0.9955	204.5
SW31	2	0.117	0.120	0.114	0.9966	219.5
SW32	2	0.126	0.134	0.118	0.9940	184.5
SE03	2	0.385	0.407	0.362	0.9950	35.0
SE04	2	0.444	0.471	0.417	0.9957	36.5
SE05	2	0.169	0.181	0.158	0.9974	125.5
SE32	2	0.107	0.114	0.100	0.9898	284.0

[a]Maximum and minimum values are for the 90 percent confidence interval on the mean.

Table 20. Phase 2—box 1 first mode damping data.

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW01	1	0.45	0.90	90	300	0.166	0.9978	0.166	0.9978
NW01	2	0.45	0.90	40	250	0.160	0.9943	0.160	0.9943
NW01	3	0.45	0.90	70	250	0.181	0.9965	0.181	0.9965
NW01	4	0.45	0.90	80	270	0.184	0.9955	0.183	0.9955
NW01	5	0.45	0.90	70	250	0.176	0.9960	0.176	0.9960
NW01	6	0.45	0.90	70	250	0.174	0.9932	0.174	0.9930
NW01	7	0.45	0.90	65	250	0.178	0.9970	0.178	0.9970
NW01	8	0.45	0.90	45	200	0.158	0.9960	0.158	0.9960
NW01	9	0.45	0.90	60	250	0.144	0.9898	0.144	0.9897
NW01	10	0.45	0.90	45	220	0.164	0.9959	0.164	0.9960
NW02	1	0.50	0.90	105	240	0.223	0.9940	0.222	0.9939
NW02	2	0.50	0.90	55	200	0.238	0.9984	0.239	0.9984
NW02	3	0.45	0.90	55	210	0.232	0.9972	0.231	0.9974
NW02	4	0.45	0.90	55	200	0.233	0.9944	0.233	0.9945
NW02	5	0.45	0.90	65	200	0.331	0.9965	0.330	0.9966
NW02	6	0.45	0.90	50	180	0.311	0.9973	0.310	0.9972
NW02	7	0.45	0.90	50	210	0.284	0.9952	0.283	0.9950
NW02	8	0.45	0.90	60	180	0.399	0.9947	0.398	0.9946
NW02	9	0.45	0.90	45	150	0.327	0.9966	0.328	0.9967
NW02	10	0.45	0.90	55	180	0.237	0.9980	0.237	0.9980
NW03	1	0.45	0.90	150	220	0.307	0.9984	0.307	0.9985
NW03	2	0.45	0.90	75	190	0.364	0.9987	0.364	0.9987
NW03	3	0.45	0.90	50	170	0.333	0.9982	0.334	0.9981
NW03	4	0.45	0.90	50	170	0.341	0.9976	0.341	0.9978
NW03	5	0.45	0.90	60	200	0.337	0.9964	0.337	0.9964
NW03	6	0.45	0.90	50	170	0.385	0.9974	0.385	0.9973

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW03	7	0.45	0.90	50	160	0.348	0.9988	0.348	0.9988
NW03	8	0.45	0.90	55	170	0.356	0.9987	0.356	0.9987
NW03	9	0.45	0.90	55	170	0.330	0.9985	0.330	0.9986
NW03	10	0.45	0.90	65	180	0.349	0.9988	0.349	0.9988
NW29	1	0.40	0.90	255	410	0.267	0.9982	0.267	0.9982
NW29	2	0.40	0.90	80	220	0.273	0.9988	0.273	0.9988
NW29	3	0.40	0.90	120	270	0.262	0.9988	0.262	0.9988
NW29	4	0.40	0.90	90	200	0.261	0.9921	0.259	0.9929
NW29	5	0.40	0.90	60	200	0.274	0.9980	0.275	0.9979
NW29	6	0.40	0.90	95	260	0.291	0.9977	0.290	0.9977
NW29	7	0.40	0.90	50	200	0.338	0.9968	0.337	0.9969
NW29	8	0.40	0.90	60	200	0.317	0.9971	0.318	0.9971
NW29	9	0.40	0.90	55	180	0.326	0.9964	0.327	0.9963
NW29	10	0.40	0.90	50	170	0.304	0.9974	0.306	0.9975
NW30	1	0.40	0.90	100	300	0.175	0.9976	0.175	0.9977
NW30	2	0.40	0.90	65	250	0.171	0.9986	0.171	0.9986
NW30	3	0.40	0.90	70	250	0.181	0.9988	0.181	0.9988
NW30	4	0.40	0.90	80	300	0.177	0.9984	0.177	0.9984
NW30	5	0.40	0.90	70	240	0.171	0.9994	0.171	0.9994
NW30	6	0.40	0.90	70	250	0.162	0.9980	0.162	0.9979
NW30	7	0.40	0.90	70	240	0.171	0.9979	0.171	0.9980
NW30	8	0.40	0.90	70	240	0.177	0.9992	0.177	0.9992
NW30	9	0.40	0.90	70	240	0.193	0.9990	0.194	0.9990
NW30	10	0.40	0.90	85	330	0.178	0.9984	0.178	0.9984
NW31	1	0.40	0.90	105	180	0.457	0.9902	0.462	0.9899
NW31	2	0.40	0.90	65	140	0.445	0.9952	0.445	0.9951
NW31	3	0.40	0.90	45	120	0.430	0.9915	0.434	0.9915
NW31	4	0.40	0.90	35	120	0.441	0.9908	0.440	0.9911
NW31	5	0.40	0.90	45	120	0.461	0.9938	0.458	0.9935

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW31	6	0.40	0.90	40	140	0.413	0.9982	0.414	0.9982
NW31	7	0.40	0.90	65	130	0.466	0.9960	0.466	0.9963
NW31	8	0.40	0.90	45	150	0.465	0.9884	0.466	0.9889
NW31	9	0.40	0.90	45	140	0.495	0.9964	0.494	0.9962
NW31	10	0.40	0.90	45	160	0.433	0.9967	0.435	0.9969
NW32	1	0.45	0.90	140	200	0.432	0.9946	0.426	0.9943
NW32	2	0.40	0.85	80	140	0.368	0.9963	0.368	0.9961
NW32	3	0.40	0.85	75	140	0.438	0.9960	0.438	0.9961
NW32	4	0.40	0.85	55	180	0.330	0.9978	0.330	0.9977
NW32	5	0.40	0.85	70	200	0.461	0.9988	0.459	0.9987
NW32	6	0.40	0.85	125	190	0.475	0.9967	0.474	0.9969
NW32	7	0.40	0.85	55	120	0.367	0.9956	0.363	0.9960
NW32	8	0.40	0.85	55	150	0.396	0.9942	0.396	0.9940
SW01	1*	—	—	—	—	—	—	—	—
SW01	2	0.40	0.90	100	200	0.153	0.9903	0.152	0.9899
SW01	3	0.40	0.90	75	140	0.105	0.9899	0.105	0.9892
SW01	4	0.40	0.90	60	450	0.109	0.9911	0.109	0.9911
SW01	5	0.40	0.90	105	450	0.143	0.9831	0.144	0.9830
SW01	6	0.40	0.90	65	350	0.142	0.9929	0.142	0.9929
SW01	7	0.40	0.90	60	420	0.120	0.9927	0.120	0.9926
SW01	8	0.40	0.90	60	200	0.114	0.9928	0.113	0.9926
SW01	9	0.40	0.90	50	400	0.103	0.9921	0.103	0.9921
SW01	10	0.40	0.90	55	340	0.110	0.9912	0.110	0.9914
SW02	1	0.50	0.90	100	160	0.162	0.9912	0.161	0.9910
SW02	2	0.40	0.90	65	300	0.109	0.9917	0.109	0.9915
SW02	3	0.40	0.90	75	140	0.183	0.9922	0.183	0.9923
SW02	4	0.40	0.90	65	130	0.231	0.9910	0.231	0.9912
SW02	5	0.40	0.90	70	140	0.150	0.9898	0.149	0.9894
SW02	6	0.50	0.85	75	400	0.087	0.9759	0.087	0.9760

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW02	7	0.50	0.85	75	150	0.160	0.9898	0.160	0.9903
SW02	8	0.50	0.85	90	400	0.095	0.9911	0.095	0.9912
SW02	9	0.50	0.85	70	420	0.098	0.9925	0.098	0.9926
SW02	10	0.40	0.90	65	390	0.120	0.9963	0.120	0.9963
SW03	1	0.40	0.90	190	450	0.132	0.9942	0.132	0.9942
SW03	2	0.50	0.90	95	430	0.135	0.9933	0.135	0.9933
SW03	3	0.50	0.90	75	300	0.132	0.9946	0.132	0.9946
SW03	4	0.50	0.90	70	310	0.135	0.9931	0.135	0.9931
SW03	5	0.50	0.90	75	300	0.121	0.9940	0.121	0.9939
SW03	6	0.50	0.90	60	250	0.132	0.9943	0.131	0.9943
SW03	7	0.50	0.90	85	230	0.158	0.9960	0.157	0.9960
SW03	8	0.50	0.90	80	140	0.130	0.9769	0.127	0.9775
SW04	1	0.50	0.90	245	400	0.268	0.9955	0.268	0.9955
SW04	2	0.50	0.90	60	210	0.289	0.9985	0.289	0.9985
SW04	3	0.50	0.90	110	260	0.242	0.9956	0.243	0.9956
SW04	4	0.50	0.90	80	220	0.264	0.9938	0.264	0.9938
SW04	5	0.40	0.90	50	240	0.229	0.9952	0.229	0.9952
SW04	6	0.40	0.90	70	250	0.253	0.9965	0.253	0.9964
SW04	7	0.40	0.90	65	200	0.256	0.9959	0.257	0.9959
SW04	8	0.40	0.90	70	180	0.304	0.9974	0.304	0.9974
SW04	9	0.40	0.90	60	260	0.281	0.9965	0.282	0.9965
SW04	10	0.40	0.90	50	220	0.310	0.9961	0.310	0.9960
SW05	1	0.40	0.90	205	320	0.201	0.9949	0.202	0.9951
SW05	2	0.40	0.90	90	310	0.190	0.9960	0.190	0.9960
SW05	3	0.40	0.90	60	220	0.190	0.9972	0.190	0.9971
SW05	4	0.40	0.90	75	250	0.157	0.9968	0.157	0.9968
SW05	5	0.40	1.10	70	180	0.205	0.9928	0.205	0.9917
SW05	6	0.40	1.00	80	220	0.209	0.9974	0.209	0.9975
SW05	7	0.40	1.00	65	170	0. 213	0.9930	0.213	0.9933

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW05	8	0.40	1.00	95	310	0.208	0.9951	0.208	0.9950
SW05	9	0.50	0.90	60	230	0.179	0.9954	0.178	0.9953
SW05	10	0.50	0.90	55	220	0.220	0.9867	0.219	0.9864
SW29	1	0.50	0.85	125	350	0.199	0.9828	0.198	0.9832
SW29	2	0.50	0.85	80	230	0.247	0.9972	0.247	0.9972
SW29	3	0.50	0.85	100	200	0.209	0.9069	0.209	0.9064
SW29	4	0.50	0.85	65	250	0.227	0.9955	0.227	0.9955
SW29	5	0.50	0.85	90	330	0.221	0.9829	0.221	0.9829
SW29	6	0.50	0.85	60	150	0.217	0.9080	0.222	0.9052
SW29	7	0.50	0.85	65	270	0.277	0.9957	0.277	0.9957
SW29	8	0.50	0.85	65	180	0.230	0.9962	0.230	0.9962
SW29	9	0.50	0.85	60	170	0.244	0.9893	0.244	0.9893
SW29	10	0.50	0.85	65	160	0.218	0.9904	0.218	0.9901
SW30	1	0.30	0.90	75	200	0.173	0.9861	0.172	0.9862
SW30	2	0.40	0.90	55	150	0.184	0.9914	0.183	0.9912
SW30	3	0.40	0.90	85	210	0.203	0.9948	0.203	0.9948
SW30	4	0.40	0.90	70	250	0.171	0.9921	0.171	0.9918
SW30	5	0.40	0.90	70	260	0.173	0.9941	0.174	0.9942
SW30	6	0.40	0.90	85	240	0.183	0.9931	0.183	0.9928
SW30	7	0.40	0.90	70	260	0.176	0.9932	0.176	0.9931
SW30	8	0.40	0.90	75	260	0.183	0.9952	0.184	0.9952
SW30	9	0.40	0.90	60	250	0.176	0.9906	0.175	0.9906
SW30	10	0.40	0.90	55	210	0.177	0.9945	0.177	0.9944
SW31	1	0.40	0.90	350	500	0.244	0.9969	0.243	0.9967
SW31	2	0.40	0.90	75	220	0.263	0.9970	0.263	0.9969
SW31	3	0.40	0.90	100	250	0.244	0.9925	0.245	0.9926
SW31	4	0.40	0.90	60	200	0.258	0.9961	0.258	0.9961
SW31	5	0.40	0.90	75	200	0.270	0.9961	0.270	0.9960
SW31	6	0.40	0.90	65	200	0.262	0.9961	0.262	0.9961

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW31	7	0.40	0.90	70	220	0.253	0.9943	0.254	0.9945
SW31	8	0.40	0.90	60	220	0.280	0.9978	0.279	0.9978
SW31	9	0.40	0.90	65	220	0.269	0.9982	0.269	0.9982
SW31	10	0.40	0.90	70	200	0.249	0.9962	0.249	0.9962
SW32	1	0.40	0.90	195	550	0.116	0.9915	0.116	0.9916
SW32	2	0.40	0.90	145	520	0.142	0.9937	0.142	0.9938
SW32	3	0.40	0.90	95	250	0.143	0.9860	0.143	0.9867
SW32	4	0.40	0.90	85	400	0.129	0.9841	0.129	0.9841
SW32	5	0.40	0.90	85	250	0.173	0.9928	0.173	0.9933
SW32	6	0.40	0.90	60	220	0.230	0.9912	0.230	0.9914
SW32	7	0.40	0.90	75	230	0.280	0.9967	0.280	0.9969
SW32	8	0.40	0.90	80	220	0.300	0.9963	0.300	0.9964
SW32	9	0.40	0.90	70	220	0.281	0.9962	0.280	0.9961
SW32	10	0.40	0.90	65	220	0.322	0.9972	0.322	0.9971
SE32	1	0.40	0.90	170	250	0.402	0.9939	0.401	0.9931
SE32	2	0.40	0.90	80	170	0.435	0.9931	0.437	0.9925
SE32	3	0.40	0.90	70	160	0.460	0.9970	0.458	0.9959
SE32	4	0.40	0.90	70	160	0.431	0.9966	0.430	0.9966
SE32	5	0.40	0.90	65	130	0.486	0.9905	0.477	0.9897
SE32	6	0.40	0.90	65	130	0.380	0.9904	0.383	0.9877
SE32	7	0.40	0.90	55	110	0.412	0.9951	0.401	0.9945
SE32	8	0.40	0.90	55	150	0.472	0.9929	0.472	0.9921
SE32	9	0.40	0.90	60	120	0.465	0.9844	0.471	0.9805

*Excitation too small for analysis.
—Indicates no data are available.

Table 21. Phase 2—box 2 first mode damping data.

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	Run	Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW01	1	0.45	0.90	90	300	0.168	0.9955	0.168	0.9954
NW01	2	0.45	0.90	40	250	0.163	0.9855	0.162	0.9853
NW01	3	0.45	0.80	70	250	0.178	0.9905	0.179	0.9904
NW01	4	0.45	0.80	80	270	0.181	0.9924	0.181	0.9925
NW01	5	0.45	0.80	70	250	0.173	0.9920	0.174	0.9919
NW01	6	0.45	0.80	70	250	0.177	0.9866	0.177	0.9865
NW01	7	0.45	0.80	65	250	0.176	0.9930	0.176	0.9932
NW01	8	0.45	0.80	45	200	0.155	0.9921	0.154	0.9920
NW01	9	0.45	0.80	60	250	0.145	0.9826	0.145	0.9825
NW01	10	0.45	0.80	45	220	0.159	0.9912	0.159	0.9914
NW02	1	0.50	0.85	105	240	0.227	0.9898	0.227	0.9896
NW02	2	0.50	0.85	55	200	0.238	0.9963	0.238	0.9964
NW02	3	0.50	0.85	55	210	0.245	0.9863	0.244	0.9863
NW02	4	0.50	0.85	55	200	0.230	0.9916	0.230	0.9915
NW02	5	0.50	0.85	65	200	0.338	0.9930	0.338	0.9930
NW02	6	0.50	0.85	50	180	0.307	0.9962	0.308	0.9961
NW02	7	0.50	0.85	50	210	0.290	0.9958	0.291	0.9958
NW02	8	0.50	0.85	60	180	0.389	0.9925	0.388	0.9924
NW02	9	0.50	0.85	45	150	0.326	0.9950	0.327	0.9951
NW02	10	0.50	0.85	55	180	0.232	0.9970	0.232	0.9971
NW03	1	0.50	0.85	150	220	0.317	0.9949	0.316	0.9952
NW03	2	0.50	0.85	75	190	0.349	0.9971	0.348	0.9973
NW03	3	0.50	0.85	50	170	0.332	0.9957	0.332	0.9957
NW03	4	0.50	0.85	50	170	0.343	0.9970	0.342	0.9970
NW03	5	0.50	0.85	60	200	0.339	0.9928	0.339	0.9929
NW03	6	0.50	0.85	50	170	0.381	0.9959	0.380	0.9958
NW03	7	0.50	0.85	50	180	0.359	0.9955	0.360	0.9956
NW03	8	0.50	0.85	55	170	0.351	0.9965	0.351	0.9966

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW03	9	0.50	0.85	55	170	0.329	0.9971	0.330	0.9971
NW03	10	0.50	0.85	65	180	0.354	0.9972	0.353	0.9973
NW29	1	0.55	0.80	260	410	0.264	0.9954	0.264	0.9954
NW29	2	0.50	0.85	85	220	0.293	0.9954	0.293	0.9953
NW29	3	0.50	0.85	120	270	0.270	0.9951	0.270	0.9950
NW29	4	0.50	0.85	90	200	0.278	0.9610	0.278	0.9610
NW29	5	0.55	0.85	60	200	0.269	0.9679	0.268	0.9686
NW29	6	0.55	0.85	95	260	0.283	0.9935	0.283	0.9935
NW29	7	0.50	0.90	50	200	0.344	0.9959	0.342	0.9960
NW29	8	0.50	0.90	65	200	0.324	0.9944	0.324	0.9941
NW29	9	0.50	0.90	55	180	0.325	0.9956	0.325	0.9957
NW29	10	0.50	0.90	55	170	0.306	0.9971	0.306	0.9971
NW30	1	0.50	0.80	100	300	0.176	0.9975	0.176	0.9976
NW30	2	0.50	0.80	70	250	0.171	0.9978	0.171	0.9977
NW30	3	0.50	0.80	75	250	0.181	0.9983	0.181	0.9983
NW30	4	0.50	0.80	80	300	0.174	0.9975	0.174	0.9975
NW30	5	0.50	0.80	75	240	0.173	0.9987	0.172	0.9987
NW30	6	0.50	0.80	70	250	0.163	0.9977	0.164	0.9976
NW30	7	0.50	0.80	75	240	0.171	0.9975	0.171	0.9975
NW30	8	0.50	0.80	75	240	0.176	0.9990	0.176	0.9990
NW30	9	0.50	0.80	75	240	0.190	0.9978	0.190	0.9978
NW30	10	0.50	0.80	90	320	0.177	0.9967	0.177	0.9967
NW31	1	0.45	0.80	105	180	0.451	0.9899	0.456	0.9898
NW31	2	0.45	0.80	65	140	0.441	0.9932	0.440	0.9929
NW31	3	0.45	0.80	45	120	0.422	0.9872	0.428	0.9860
NW31	4	0.45	0.80	35	120	0.426	0.9888	0.425	0.9898
NW31	5	0.45	0.80	45	120	0.442	0.9927	0.438	0.9923
NW31	6	0.45	0.80	40	140	0.407	0.9936	0.407	0.9936
NW31	7	0.45	0.80	65	130	0.452	0.9930	0.458	0.9934

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW31	8	0.45	0.80	45	140	0.478	0.9807	0.480	0.9810
NW31	9	0.45	0.80	45	140	0.489	0.9942	0.489	0.9941
NW31	10	0.45	0.80	45	160	0.430	0.9920	0.432	0.9920
NW32	1	0.45	0.80	140	200	0.412	0.9918	0.412	0.9918
NW32	2	0.45	0.80	80	140	0.348	0.9939	0.349	0.9933
NW32	3	0.45	0.80	75	140	0.418	0.9944	0.418	0.9944
NW32	4	0.45	0.80	55	180	0.332	0.9959	0.332	0.9958
NW32	5	0.45	0.80	70	200	0.443	0.9963	0.442	0.9963
NW32	6	0.45	0.80	125	190	0.444	0.9960	0.444	0.9964
NW32	7	0.45	0.80	55	120	0.343	0.9943	0.341	0.9941
NW32	8	0.45	0.80	55	150	0.380	0.9929	0.379	0.9925
SW01	1*	—	—	—	—	—	—	—	—
SW01	2	0.50	0.80	100	200	0.156	0.9899	0.155	0.9898
SW01	3	0.50	0.80	75	140	0.105	0.9884	0.104	0.9883
SW01	4	0.50	0.80	60	450	0.109	0.9897	0.109	0.9897
SW01	5	0.50	0.80	105	450	0.144	0.9842	0.144	0.9844
SW01	6	0.50	0.80	65	350	0.141	0.9916	0.141	0.9915
SW01	7	0.50	0.80	60	420	0.120	0.9917	0.119	0.9916
SW01	8	0.50	0.80	60	200	0.112	0.9908	0.112	0.9907
SW01	9	0.50	0.80	50	400	0.104	0.9889	0.104	0.9890
SW01	10	0.50	0.80	55	340	0.109	0.9891	0.109	0.9891
SW02	1	0.50	0.85	100	160	0.167	0.9809	0.165	0.9815
SW02	2	0.50	0.85	65	300	0.110	0.9890	0.110	0.9889
SW02	3	0.50	0.85	75	300	0.118	0.9805	0.118	0.9809
SW02	4	0.50	0.85	65	400	0.111	0.9864	0.111	0.9864
SW02	5	0.50	0.85	70	350	0.107	0.9939	0.107	0.9940
SW02	6	0.50	0.85	65	320	0.105	0.9846	0.105	0.9845
SW02	7	0.50	0.85	75	290	0.102	0.9801	0.102	0.9802
SW02	8	0.50	0.85	85	450	0.096	0.9933	0.096	0.9933

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW02	9	0.50	0.85	65	390	0.103	0.9905	0.103	0.9906
SW02	10	0.50	0.85	65	390	0.122	0.9945	0.122	0.9945
SW03	1	0.50	0.90	190	350	0.144	0.9900	0.144	0.9900
SW03	2	0.50	0.90	95	350	0.130	0.9917	0.130	0.9916
SW03	3	0.50	0.90	75	300	0.138	0.9941	0.138	0.9940
SW03	4	0.50	0.90	70	310	0.142	0.9933	0.142	0.9932
SW03	5	0.50	0.90	75	300	0.126	0.9928	0.126	0.9927
SW03	6	0.50	0.90	60	250	0.132	0.9944	0.132	0.9943
SW03	7	0.50	0.90	85	230	0.150	0.9958	0.150	0.9959
SW03	8	0.50	0.90	80	300	0.148	0.9954	0.148	0.9954
SW04	1	0.50	0.90	245	400	0.255	0.9931	0.255	0.9931
SW04	2	0.50	0.90	60	210	0.249	0.9955	0.250	0.9954
SW04	3	0.50	0.90	110	260	0.250	0.9953	0.250	0.9953
SW04	4	0.50	0.90	80	220	0.265	0.9918	0.264	0.9916
SW04	5	0.50	0.90	50	240	0.231	0.9940	0.231	0.9939
SW04	6	0.50	0.90	70	250	0.255	0.9941	0.255	0.9939
SW04	7	0.50	0.90	65	200	0.257	0.9939	0.257	0.9939
SW04	8	0.50	0.90	70	180	0.299	0.9958	0.302	0.9965
SW04	9	0.50	0.90	60	260	0.271	0.9950	0.271	0.9949
SW04	10	0.50	0.90	55	220	0.313	0.9918	0.313	0.9921
SW05	1	0.50	0.90	205	320	0.202	0.9962	0.202	0.9959
SW05	2	0.50	0.90	90	310	0.192	0.9969	0.192	0.9969
SW05	3	0.50	0.90	60	220	0.189	0.9963	0.189	0.9963
SW05	4	0.50	0.90	75	250	0.157	0.9974	0.157	0.9974
SW05	5	0.40	0.90	70	180	0.207	0.9952	0.206	0.9947
SW05	6	0.50	0.90	80	220	0.212	0.9954	0.212	0.9954
SW05	7	0.50	0.90	65	170	0.207	0.9938	0.208	0.9939
SW05	8	0.50	0.90	95	310	0.211	0.9979	0.211	0.9979
SW05	9	0.50	1.00	60	230	0.178	0.9968	0.178	0.9967

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SW05	10	0.50	0.90	55	220	0.218	0.9919	0.218	0.9919
SW29	1	0.50	0.85	125	350	0.197	0.9731	0.197	0.9735
SW29	2	0.50	0.85	80	230	0.246	0.9958	0.247	0.9959
SW29	3	0.50	0.85	100	200	0.211	0.8681	0.209	0.8657
SW29	4	0.50	0.85	65	250	0.226	0.9935	0.226	0.9936
SW29	5	0.50	0.85	90	330	0.227	0.9751	0.226	0.9753
SW29	6	0.50	0.85	60	150	0.216	0.8529	0.220	0.8529
SW29	7	0.50	0.85	65	270	0.274	0.9928	0.274	0.9930
SW29	8	0.50	0.85	65	180	0.232	0.9934	0.231	0.9935
SW29	9	0.50	0.85	60	170	0.239	0.9830	0.239	0.9830
SW29	10	0.50	0.85	65	160	0.222	0.9892	0.223	0.9889
SW30	1	0.45	0.80	75	200	0.181	0.9787	0.180	0.9788
SW30	2	0.45	0.80	55	150	0.184	0.9911	0.183	0.9912
SW30	3	0.45	0.80	85	210	0.201	0.9939	0.201	0.9939
SW30	4	0.40	0.80	70	250	0.172	0.9881	0.172	0.9881
SW30	5	0.45	0.80	75	260	0.171	0.9932	0.172	0.9933
SW30	6	0.45	0.80	85	240	0.182	0.9894	0.182	0.9893
SW30	7	0.45	0.80	70	260	0.174	0.9877	0.174	0.9877
SW30	8	0.45	0.80	75	260	0.183	0.9941	0.183	0.9941
SW30	9	0.45	0.80	60	250	0.177	0.9895	0.176	0.9895
SW30	10	0.45	0.80	55	210	0.179	0.9943	0.180	0.9945
SW31	1	0.50	0.80	355	500	0.243	0.9970	0.243	0.9969
SW31	2	0.40	0.80	75	220	0.266	0.9943	0.265	0.9940
SW31	3	0.45	0.80	100	250	0.241	0.9902	0.242	0.9904
SW31	4	0.45	0.80	65	200	0.258	0.9968	0.258	0.9968
SW31	5	0.45	0.80	75	200	0.261	0.9955	0.262	0.9956
SW31	6	0.45	0.80	65	200	0.267	0.9924	0.267	0.9923
SW31	7	0.45	0.80	75	220	0.255	0.9939	0.255	0.9940
SW31	8	0.45	0.80	60	220	0.277	0.9956	0.277	0.9957

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW31	9	0.45	0.80	70	220	0.270	0.9964	0.270	0.9965
SW31	10	0.45	0.80	75	200	0.250	0.9951	0.250	0.9953
SW32	1	0.45	0.75	195	550	0.119	0.9885	0.119	0.9884
SW32	2	0.45	0.75	150	520	0.140	0.9903	0.140	0.9902
SW32	3	0.45	0.75	95	250	0.141	0.9756	0.141	0.9751
SW32	4	0.45	0.80	85	400	0.130	0.9792	0.130	0.9792
SW32	5	0.45	0.80	85	250	0.173	0.9861	0.173	0.9864
SW32	6	0.45	0.80	60	220	0.236	0.9890	0.237	0.9890
SW32	7	0.45	0.80	75	230	0.288	0.9940	0.289	0.9938
SW32	8	0.45	0.80	80	220	0.305	0.9926	0.305	0.9926
SW32	9	0.40	0.80	70	220	0.288	0.9936	0.287	0.9934
SW32	10	0.40	0.80	65	220	0.323	0.9937	0.325	0.9939
SE32	1	0.45	0.75	170	250	0.391	0.9900	0.388	0.9900
SE32	2	0.45	0.75	85	170	0.401	0.9800	0.403	0.9805
SE32	3	0.45	0.75	70	160	0.450	0.9907	0.448	0.9909
SE32	4	0.45	0.75	70	160	0.419	0.9956	0.420	0.9957
SE32	5	0.40	0.75	70	130	0.448	0.9869	0.451	0.9874
SE32	6	0.45	0.75	70	130	0.346	0.9820	0.353	0.9815
SE32	7	0.45	0.75	60	120	0.440	0.9782	0.448	0.9777
SE32	8	0.45	0.75	60	150	0.463	0.9849	0.464	0.9842
SE32	9	0.40	0.75	60	120	0.445	0.9823	0.439	0.9827

*Excitation too small for analysis.
—Indicates no data are available.

Table 22. Phase 2—box 1 second mode damping data.

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW01	1	1.00	1.60	85	350	0.128	0.9991	0.128	0.9991
NW01	2	1.00	1.60	40	250	0.147	0.9943	0.147	0.9943
NW01	3	1.00	1.60	70	320	0.133	0.9986	0.133	0.9986
NW01	4	0.90	1.60	75	330	0.137	0.9990	0.137	0.9990
NW01	5	0.90	1.60	65	300	0.137	0.9986	0.137	0.9986
NW01	6	0.90	1.60	65	320	0.133	0.9987	0.133	0.9987
NW01	7	0.90	1.60	60	310	0.125	0.9987	0.124	0.9987
NW01	8	1.00	1.60	50	290	0.120	0.9987	0.120	0.9987
NW01	9	0.90	1.60	55	280	0.129	0.9982	0.129	0.9981
NW01	10	0.90	1.60	50	250	0.119	0.9989	0.119	0.9989
NW02	1	1.00	1.70	105	490	0.083	0.9959	0.083	0.9959
NW02	2	1.00	1.70	55	340	0.100	0.9969	0.100	0.9969
NW02	3	1.00	1.70	55	300	0.106	0.9986	0.106	0.9986
NW02	4	1.00	1.70	55	320	0.107	0.9980	0.107	0.9980
NW02	5	1.00	1.70	65	310	0.117	0.9977	0.117	0.9977
NW02	6	1.00	1.70	50	310	0.125	0.9992	0.125	0.9992
NW02	7	1.00	1.70	50	270	0.116	0.9980	0.115	0.9980
NW02	8	1.00	1.70	60	300	0.118	0.9991	0.118	0.9991
NW02	9	1.00	1.70	45	250	0.134	0.9988	0.134	0.9988
NW02	10	1.00	1.70	55	290	0.128	0.9994	0.128	0.9994
NW03	1	1.00	1.70	150	370	0.150	0.9969	0.150	0.9968
NW03	2	1.00	1.70	75	260	0.163	0.9975	0.163	0.9976
NW03	3	1.00	1.70	45	210	0.173	0.9991	0.173	0.9991
NW03	4	1.00	1.70	50	270	0.171	0.9991	0.171	0.9991
NW03	5	1.00	1.70	60	220	0.184	0.9989	0.184	0.9989
NW03	6	1.00	1.70	50	240	0.176	0.9981	0.176	0.9981
NW03	7	1.00	1.70	45	230	0.186	0.9991	0.186	0.9991
NW03	8	1.00	1.70	55	190	0.178	0.9988	0.178	0.9988

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NW03	9	1.00	1.70	55	230	0.188	0.9990	0.188	0.9990
NW03	10	1.00	1.70	65	240	0.188	0.9986	0.188	0.9986
NW29	1	1.10	1.70	255	400	0.165	0.9990	0.165	0.9990
NW29	2	1.00	1.70	80	310	0.145	0.9950	0.144	0.9949
NW29	3	1.00	1.70	120	280	0.146	0.9987	0.146	0.9987
NW29	4	1.10	1.70	85	300	0.140	0.9981	0.140	0.9981
NW29	5	1.10	1.70	60	240	0.158	0.9983	0.158	0.9983
NW29	6	1.10	1.70	95	260	0.167	0.9991	0.167	0.9991
NW29	7	1.10	1.70	50	250	0.170	0.9982	0.170	0.9982
NW29	8	1.10	1.70	60	240	0.165	0.9976	0.165	0.9976
NW29	9	1.10	1.70	55	240	0.167	0.9977	0.168	0.9978
NW29	10	1.10	1.70	50	210	0.198	0.9987	0.199	0.9988
NW30	1	1.00	1.60	95	200	0.199	0.9774	0.198	0.9775
NW30	2	1.00	1.60	65	200	0.211	0.9916	0.210	0.9916
NW30	3	1.00	1.60	70	200	0.205	0.9901	0.206	0.9901
NW30	4	1.00	1.60	75	200	0.208	0.9919	0.208	0.9920
NW30	5	1.00	1.60	70	250	0.180	0.9945	0.180	0.9944
NW30	6	1.00	1.60	70	210	0.211	0.9938	0.211	0.9939
NW30	7	1.00	1.60	70	260	0.174	0.9956	0.175	0.9956
NW30	8	1.00	1.60	70	240	0.172	0.9952	0.172	0.9952
NW30	9	1.00	1.60	70	210	0.186	0.9927	0.187	0.9926
NW30	10	1.00	1.60	85	300	0.183	0.9956	0.183	0.9957
NW31	1	0.90	1.60	100	380	0.130	0.9986	0.130	0.9986
NW31	2	0.90	1.60	65	260	0.168	0.9992	0.168	0.9993
NW31	3	1.00	1.60	45	210	0.181	0.9988	0.181	0.9988
NW31	4	1.00	1.60	35	270	0.143	0.9975	0.143	0.9976
NW31	5	1.00	1.60	45	310	0.155	0.9989	0.154	0.9989
NW31	6	1.00	1.60	40	210	0.151	0.9983	0.151	0.9983
NW31	7	1.00	1.60	65	290	0.179	0.9992	0.179	0.9992

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NW31	8	0.90	1.60	60	220	0.173	0.9972	0.173	0.9971
NW31	9	0.90	1.60	45	260	0.156	0.9971	0.156	0.9971
NW31	10	1.00	1.60	55	210	0.162	0.9940	0.162	0.9939
NW32	1	0.90	1.50	140	300	0.144	0.9777	0.143	0.9775
NW32	2	0.90	1.50	80	260	0.198	0.9928	0.198	0.9929
NW32	3	0.90	1.50	75	290	0.163	0.9646	0.163	0.9650
NW32	4	0.90	1.50	55	300	0.154	0.9889	0.154	0.9889
NW32	5	0.80	1.50	70	290	0.191	0.9601	0.191	0.9597
NW32	6	0.90	1.50	125	340	0.170	0.9718	0.170	0.9715
NW32	7	0.90	1.50	55	130	0.288	0.9943	0.289	0.9943
NW32	8	0.90	1.50	50	135	0.284	0.9911	0.284	0.9909
SW01	1	0.90	1.60	70	190	0.054	0.9926	0.054	0.9926
SW01	2	0.90	1.60	100	550	0.076	0.9993	0.076	0.9993
SW01	3	0.90	1.60	75	460	0.089	0.9997	0.089	0.9997
SW01	4	0.90	1.60	60	450	0.082	0.9992	0.082	0.9992
SW01	5	0.90	1.60	105	480	0.084	0.9995	0.084	0.9995
SW01	6	0.90	1.60	65	360	0.087	0.9996	0.087	0.9996
SW01	7	0.90	1.60	55	330	0.085	0.9995	0.085	0.9995
SW01	8	0.90	1.60	55	360	0.110	0.9943	0.110	0.9943
SW01	9	0.90	1.60	50	400	0.079	0.9997	0.079	0.9997
SW01	10	0.90	1.60	55	360	0.081	0.9992	0.081	0.9992
SW02	1	1.00	1.70	95	360	0.082	0.9974	0.082	0.9974
SW02	2	1.00	1.70	65	380	0.084	0.9972	0.084	0.9972
SW02	3	1.00	1.70	75	300	0.086	0.9939	0.086	0.9938
SW02	4	1.00	1.70	65	500	0.087	0.9953	0.087	0.9953
SW02	5	1.00	1.70	70	360	0.094	0.9966	0.094	0.9966
SW02	6	1.00	1.70	70	410	0.090	0.9965	0.090	0.9966
SW02	7	1.00	1.70	75	340	0.090	0.9974	0.090	0.9974
SW02	8	1.00	1.70	80	380	0.094	0.9959	0.094	0.9959

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SW02	9	1.00	1.70	65	420	0.088	0.9981	0.088	0.9980
SW02	10	1.00	1.70	65	390	0.070	0.9904	0.070	0.9903
SW03	1	1.00	1.70	190	490	0.086	0.9975	0.086	0.9975
SW03	2	1.00	1.70	95	310	0.106	0.9991	0.106	0.9991
SW03	3	1.00	1.70	75	290	0.100	0.9960	0.100	0.9960
SW03	4	1.00	1.70	70	420	0.081	0.9986	0.082	0.9986
SW03	5	1.00	1.70	75	320	0.111	0.9975	0.111	0.9975
SW03	6	1.00	1.70	60	260	0.109	0.9994	0.109	0.9994
SW03	7	1.00	1.70	85	360	0.109	0.9973	0.109	0.9973
SW03	8	1.20	1.60	80	185	0.120	0.9992	0.120	0.9992
SW04	1	1.00	1.70	250	560	0.113	0.9954	0.113	0.9954
SW04	2	1.00	1.70	60	300	0.128	0.9975	0.128	0.9975
SW04	3	1.00	1.70	110	410	0.127	0.9982	0.127	0.9982
SW04	4	1.00	1.70	80	310	0.144	0.9982	0.144	0.9982
SW04	5	1.00	1.70	50	280	0.132	0.9986	0.132	0.9986
SW04	6	1.00	1.70	70	280	0.145	0.9987	0.145	0.9987
SW04	7	1.00	1.70	65	320	0.132	0.9980	0.132	0.9980
SW04	8	1.00	1.70	75	300	0.150	0.9975	0.150	0.9975
SW04	9	1.00	1.70	60	270	0.158	0.9990	0.158	0.9990
SW04	10	1.00	1.70	50	230	0.151	0.9983	0.151	0.9983
SW05	1	1.10	1.70	205	400	0.148	0.9991	0.148	0.9991
SW05	2	1.10	1.70	90	310	0.139	0.9990	0.139	0.9990
SW05	3	1.10	1.70	60	300	0.134	0.9978	0.134	0.9977
SW05	4	1.10	1.70	75	290	0.132	0.9979	0.132	0.9980
SW05	5	1.10	1.70	70	210	0.168	0.9985	0.168	0.9985
SW05	6	1.10	1.70	80	240	0.170	0.9991	0.170	0.9990
SW05	7	1.10	1.70	65	230	0.151	0.9968	0.151	0.9968
SW05	8	1.10	1.70	95	310	0.141	0.9981	0.142	0.9982
SW05	9	1.10	1.70	60	220	0.128	0.9973	0.128	0.9972

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW05	10	1.10	1.70	55	220	0.167	0.9946	0.167	0.9946
SW29	1	1.10	1.60	120	270	0.143	0.9969	0.143	0.9968
SW29	2	1.00	1.60	80	310	0.156	0.9920	0.156	0.9919
SW29	3	1.10	1.60	95	180	0.150	0.9713	0.151	0.9717
SW29	4	1.10	1.60	60	270	0.157	0.9988	0.157	0.9988
SW29	5	1.10	1.60	90	300	0.150	0.9951	0.150	0.9950
SW29	6	1.20	1.50	65	180	0.187	0.9802	0.187	0.9802
SW29	7	1.00	1.60	65	240	0.183	0.9989	0.183	0.9989
SW29	8	1.00	1.60	65	200	0.180	0.9984	0.180	0.9983
SW29	9	1.00	1.60	60	270	0.183	0.9973	0.183	0.9973
SW29	10	1.00	1.60	60	190	0.182	0.9975	0.182	0.9975
SW30	1	0.90	1.60	70	180	0.150	0.9928	0.149	0.9927
SW30	2	0.90	1.60	55	250	0.128	0.9947	0.128	0.9947
SW30	3	0.90	1.60	85	320	0.148	0.9950	0.148	0.9950
SW30	4	0.90	1.60	60	280	0.143	0.9972	0.143	0.9972
SW30	5	0.90	1.60	70	220	0.195	0.9965	0.194	0.9965
SW30	6	0.90	1.60	85	260	0.182	0.9978	0.182	0.9978
SW30	7	0.90	1.60	65	240	0.166	0.9984	0.166	0.9983
SW30	8	0.90	1.60	75	220	0.181	0.9983	0.181	0.9983
SW30	9	0.90	1.60	60	210	0.178	0.9986	0.178	0.9986
SW30	10	0.90	1.60	55	180	0.179	0.9969	0.178	0.9969
SW31	1	1.00	1.60	350	500	0.189	0.9975	0.189	0.9975
SW31	2	0.90	1.60	75	210	0.204	0.9967	0.204	0.9968
SW31	3	0.90	1.60	95	260	0.207	0.9983	0.207	0.9983
SW31	4	0.90	1.60	60	250	0.213	0.9961	0.213	0.9961
SW31	5	0.90	1.60	75	260	0.208	0.9971	0.208	0.9971
SW31	6	0.90	1.60	60	210	0.180	0.9956	0.180	0.9956
SW31	7	0.90	1.60	70	240	0.210	0.9967	0.210	0.9967
SW31	8	0.90	1.60	55	240	0.171	0.9958	0.171	0.9958

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SW31	9	0.90	1.60	65	240	0.189	0.9976	0.189	0.9976
SW31	10	0.90	1.60	70	240	0.190	0.9981	0.190	0.9980
SW32	1	0.90	1.60	190	500	0.126	0.9983	0.126	0.9984
SW32	2	0.90	1.50	145	430	0.104	0.9974	0.104	0.9974
SW32	3	0.90	1.50	95	390	0.102	0.9977	0.102	0.9977
SW32	4	0.90	1.50	90	340	0.114	0.9984	0.114	0.9983
SW32	5	0.90	1.50	85	350	0.118	0.9986	0.118	0.9986
SW32	6	0.90	1.50	60	350	0.115	0.9989	0.115	0.9989
SW32	7	0.90	1.50	75	340	0.117	0.9977	0.117	0.9977
SW32	8	0.90	1.50	80	320	0.107	0.9988	0.107	0.9988
SW32	9	0.90	1.50	70	340	0.102	0.9978	0.102	0.9977
SW32	10	0.90	1.50	65	300	0.125	0.9986	0.125	0.9986
SE32	1	0.90	1.50	170	340	0.210	0.9974	0.210	0.9974
SE32	2	0.90	1.50	80	240	0.197	0.9981	0.197	0.9981
SE32	3	0.90	1.50	65	260	0.202	0.9986	0.202	0.9986
SE32	4	0.90	1.50	65	250	0.211	0.9987	0.211	0.9987
SE32	5	0.90	1.50	65	240	0.204	0.9986	0.204	0.9986
SE32	6	0.90	1.50	70	240	0.196	0.9993	0.196	0.9993
SE32	7	0.90	1.50	55	240	0.194	0.9995	0.194	0.9995
SE32	8	0.90	1.50	55	240	0.205	0.9995	0.206	0.9995
SE32	9	0.90	1.50	60	220	0.203	0.9994	0.203	0.9994

Table 23. Phase 2—box 2 second mode damping data.

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (%)	Positive Peaks Correlation	Negative Peaks Damping (%)	Negative Peaks Correlation
NW01	1	1.00	1.60	85	350	0.129	0.9981	0.129	0.9981
NW01	2	1.00	1.60	40	180	0.137	0.9926	0.137	0.9926
NW01	3	1.00	1.60	70	320	0.134	0.9960	0.133	0.9960
NW01	4	1.00	1.60	75	330	0.137	0.9978	0.137	0.9978
NW01	5	1.00	1.60	65	300	0.136	0.9966	0.136	0.9966
NW01	6	1.00	1.60	65	320	0.133	0.9965	0.133	0.9966
NW01	7	1.00	1.60	60	310	0.125	0.9962	0.125	0.9964
NW01	8	1.00	1.60	50	290	0.119	0.9970	0.119	0.9970
NW01	9	0.90	1.60	55	280	0.129	0.9963	0.129	0.9963
NW01	10	0.90	1.60	50	250	0.120	0.9957	0.120	0.9958
NW02	1	1.00	1.70	105	340	0.093	0.9968	0.093	0.9968
NW02	2	1.00	1.70	55	340	0.101	0.9958	0.101	0.9958
NW02	3	1.00	1.70	55	180	0.113	0.9964	0.112	0.9963
NW02	4	1.00	1.70	55	320	0.107	0.9966	0.107	0.9965
NW02	5	1.00	1.70	65	240	0.125	0.9971	0.125	0.9971
NW02	6	1.00	1.70	50	310	0.124	0.9977	0.124	0.9978
NW02	7	1.00	1.70	50	270	0.115	0.9958	0.115	0.9958
NW02	8	1.00	1.70	60	300	0.118	0.9978	0.118	0.9978
NW02	9	1.00	1.70	45	250	0.136	0.9978	0.136	0.9978
NW02	10	1.00	1.70	55	290	0.129	0.9987	0.129	0.9987
NW03	1	1.00	1.70	150	310	0.162	0.9988	0.162	0.9988
NW03	2	1.00	1.70	75	220	0.172	0.9984	0.172	0.9984
NW03	3	1.00	1.70	45	210	0.171	0.9976	0.171	0.9976
NW03	4	1.00	1.70	50	180	0.176	0.9989	0.176	0.9989
NW03	5	1.00	1.70	60	180	0.183	0.9979	0.183	0.9979
NW03	6	1.00	1.70	50	150	0.193	0.9979	0.193	0.9979
NW03	7	1.00	1.70	45	170	0.195	0.9988	0.195	0.9988
NW03	8	1.00	1.70	55	140	0.184	0.9969	0.183	0.9969

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (%)	Correlation	Damping (%)	Correlation
NW03	9	1.00	1.70	55	190	0.189	0.9987	0.189	0.9987
NW03	10	1.00	1.70	65	240	0.190	0.9980	0.190	0.9981
NW29	1	1.00	1.60	255	400	0.165	0.9974	0.165	0.9974
NW29	2	1.10	1.70	80	210	0.162	0.9972	0.162	0.9971
NW29	3	1.10	1.70	120	280	0.146	0.9972	0.146	0.9973
NW29	4	1.10	1.70	85	300	0.138	0.9902	0.138	0.9901
NW29	5	1.10	1.70	60	240	0.156	0.9917	0.156	0.9916
NW29	6	1.10	1.70	95	260	0.165	0.9967	0.165	0.9968
NW29	7	1.10	1.70	50	250	0.171	0.9969	0.172	0.9969
NW29	8	1.10	1.70	60	240	0.166	0.9963	0.166	0.9963
NW29	9	1.10	1.70	55	240	0.167	0.9968	0.167	0.9969
NW29	10	1.10	1.70	50	210	0.198	0.9981	0.198	0.9980
NW30	1	1.00	1.60	95	200	0.200	0.9742	0.199	0.9743
NW30	2	1.00	1.60	65	200	0.211	0.9884	0.210	0.9886
NW30	3	1.00	1.60	70	200	0.206	0.9878	0.207	0.9878
NW30	4	1.00	1.60	75	200	0.207	0.9886	0.207	0.9887
NW30	5	1.00	1.60	70	250	0.181	0.9922	0.181	0.9922
NW30	6	1.00	1.60	70	210	0.214	0.9919	0.214	0.9920
NW30	7	1.00	1.60	70	260	0.176	0.9947	0.176	0.9947
NW30	8	1.00	1.60	70	240	0.170	0.9948	0.170	0.9947
NW30	9	1.00	1.60	70	210	0.185	0.9924	0.185	0.9924
NW30	10	1.00	1.60	85	240	0.190	0.9939	0.190	0.9939
NW31	1	0.90	1.60	100	310	0.134	0.9969	0.134	0.9969
NW31	2	0.90	1.60	65	260	0.168	0.9978	0.168	0.9978
NW31	3	0.90	1.60	45	210	0.181	0.9981	0.181	0.9981
NW31	4	0.90	1.60	35	270	0.143	0.9971	0.143	0.9971
NW31	5	0.90	1.60	45	240	0.152	0.9980	0.152	0.9980
NW31	6	0.90	1.60	40	210	0.148	0.9940	0.148	0.9941
NW31	7	1.00	1.60	65	240	0.183	0.9986	0.183	0.9986

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (%)	Positive Peaks Correlation	Negative Peaks Damping (%)	Negative Peaks Correlation
NW31	8	0.90	1.60	60	170	0.172	0.9948	0.172	0.9948
NW31	9	1.00	1.60	45	260	0.157	0.9960	0.157	0.9961
NW31	10	1.00	1.60	55	210	0.163	0.9810	0.163	0.9812
NW32	1	0.90	1.50	140	300	0.144	0.9761	0.143	0.9758
NW32	2	0.90	1.50	80	260	0.197	0.9924	0.197	0.9925
NW32	3	0.90	1.50	75	290	0.164	0.9618	0.164	0.9623
NW32	4	0.90	1.50	55	300	0.153	0.9868	0.153	0.9868
NW32	5	0.90	1.50	70	240	0.148	0.9398	0.148	0.9390
NW32	6	0.90	1.50	125	340	0.170	0.9708	0.171	0.9705
NW32	7	0.90	1.50	55	130	0.295	0.9934	0.296	0.9934
NW32	8	0.90	1.50	50	135	0.288	0.9906	0.287	0.9904
SW01	1	0.90	1.60	70	190	0.056	0.9859	0.056	0.9860
SW01	2	1.00	1.70	100	550	0.076	0.9985	0.076	0.9985
SW01	3	1.00	1.70	75	460	0.089	0.9993	0.089	0.9993
SW01	4	1.00	1.70	60	450	0.082	0.9984	0.082	0.9984
SW01	5	1.00	1.70	105	480	0.084	0.9989	0.084	0.9989
SW01	6	1.00	1.70	65	360	0.087	0.9993	0.087	0.9993
SW01	7	1.00	1.70	55	330	0.085	0.9993	0.085	0.9993
SW01	8	1.00	1.70	55	360	0.111	0.9940	0.111	0.9939
SW01	9	1.00	1.70	50	400	0.079	0.9993	0.079	0.9993
SW01	10	1.00	1.70	55	360	0.081	0.9982	0.081	0.9982
SW02	1	1.00	1.70	95	360	0.082	0.9971	0.082	0.9971
SW02	2	1.00	1.70	65	380	0.084	0.9969	0.084	0.9969
SW02	3	1.00	1.70	75	300	0.086	0.9934	0.086	0.9933
SW02	4	1.00	1.70	65	500	0.086	0.9953	0.086	0.9953
SW02	5	1.00	1.70	70	360	0.094	0.9967	0.094	0.9968
SW02	6	1.00	1.70	65	410	0.090	0.9969	0.090	0.9969
SW02	7	1.00	1.70	75	340	0.090	0.9978	0.090	0.9978
SW02	8	1.00	1.70	80	380	0.094	0.9962	0.094	0.9962

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (%)	Correlation	Damping (%)	Correlation
SW02	9	1.00	1.70	65	420	0.088	0.9974	0.088	0.9974
SW02	10	1.00	1.70	80	390	0.068	0.9952	0.068	0.9952
SW03	1	1.00	1.70	190	490	0.086	0.9971	0.086	0.9971
SW03	2	1.00	1.70	95	310	0.106	0.9992	0.106	0.9992
SW03	3	1.00	1.70	75	290	0.100	0.9964	0.100	0.9964
SW03	4	1.00	1.70	70	420	0.081	0.9983	0.081	0.9983
SW03	5	1.00	1.70	75	320	0.112	0.9977	0.112	0.9977
SW03	6	1.00	1.70	60	260	0.109	0.9991	0.109	0.9991
SW03	7	1.00	1.70	85	360	0.109	0.9974	0.109	0.9974
SW03	8	1.00	1.70	80	185	0.121	0.9993	0.121	0.9993
SW04	1	1.00	1.70	245	430	0.127	0.9974	0.127	0.9974
SW04	2	1.00	1.70	60	300	0.127	0.9980	0.127	0.9980
SW04	3	1.00	1.70	110	290	0.130	0.9981	0.130	0.9981
SW04	4	1.00	1.70	80	310	0.146	0.9982	0.146	0.9982
SW04	5	1.00	1.70	50	280	0.131	0.9986	0.131	0.9987
SW04	6	1.00	1.70	70	280	0.146	0.9985	0.146	0.9985
SW04	7	1.00	1.70	65	320	0.132	0.9973	0.132	0.9973
SW04	8	1.00	1.70	75	300	0.151	0.9974	0.151	0.9974
SW04	9	1.00	1.70	60	270	0.159	0.9989	0.159	0.9989
SW04	10	1.00	1.70	50	230	0.152	0.9982	0.152	0.9982
SW05	1	1.10	1.70	205	400	0.148	0.9990	0.148	0.9990
SW05	2	1.00	1.80	90	310	0.139	0.9983	0.139	0.9983
SW05	3	1.10	1.70	60	300	0.134	0.9976	0.134	0.9976
SW05	4	1.10	1.70	75	290	0.131	0.9976	0.131	0.9977
SW05	5	1.10	1.70	70	210	0.168	0.9981	0.168	0.9981
SW05	6	1.10	1.70	80	240	0.170	0.9989	0.170	0.9989
SW05	7	1.10	1.70	65	230	0.152	0.9968	0.152	0.9968
SW05	8	1.10	1.70	95	310	0.140	0.9978	0.140	0.9979
SW05	9	1.10	1.80	60	220	0.128	0.9987	0.128	0.9987

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (%)**	**Correlation**	**Damping (%)**	**Correlation**
SW05	10	1.10	1.80	55	220	0.166	0.9951	0.166	0.9952
SW29	1	1.10	1.60	120	270	0.144	0.9967	0.144	0.9967
SW29	2	1.00	1.60	80	210	0.185	0.9970	0.185	0.9970
SW29	3	1.10	1.50	95	180	0.151	0.9832	0.151	0.9834
SW29	4	1.00	1.70	60	270	0.158	0.9980	0.158	0.9981
SW29	5	1.10	1.60	90	310	0.150	0.9946	0.150	0.9946
SW29	6	1.10	1.50	65	180	0.191	0.9687	0.191	0.9689
SW29	7	1.00	1.60	65	240	0.181	0.9985	0.181	0.9985
SW29	8	1.00	1.60	65	170	0.176	0.9993	0.176	0.9993
SW29	9	1.00	1.60	60	270	0.184	0.9970	0.185	0.9969
SW29	10	1.00	1.60	60	180	0.182	0.9979	0.182	0.9979
SW30	1	0.90	1.60	70	180	0.148	0.9905	0.147	0.9905
SW30	2	0.90	1.60	55	250	0.128	0.9937	0.128	0.9936
SW30	3	0.90	1.60	85	320	0.150	0.9948	0.150	0.9948
SW30	4	0.90	1.60	60	280	0.141	0.9944	0.141	0.9944
SW30	5	0.90	1.60	70	220	0.194	0.9967	0.193	0.9967
SW30	6	0.90	1.60	85	260	0.181	0.9971	0.182	0.9971
SW30	7	0.90	1.60	65	240	0.167	0.9970	0.167	0.9970
SW30	8	0.90	1.60	75	220	0.181	0.9972	0.181	0.9972
SW30	9	0.90	1.60	60	210	0.177	0.9962	0.177	0.9963
SW30	10	0.90	1.60	55	180	0.179	0.9961	0.179	0.9960
SW31	1	0.90	1.60	350	500	0.187	0.9960	0.187	0.9961
SW31	2	0.90	1.60	75	210	0.203	0.9955	0.203	0.9954
SW31	3	0.90	1.60	95	220	0.205	0.9972	0.205	0.9972
SW31	4	0.90	1.60	60	190	0.223	0.9946	0.223	0.9946
SW31	5	0.90	1.60	75	260	0.207	0.9966	0.207	0.9966
SW31	6	0.90	1.60	60	210	0.177	0.9942	0.177	0.9941
SW31	7	0.90	1.60	70	210	0.219	0.9977	0.219	0.9976
SW31	8	0.90	1.60	55	240	0.170	0.9944	0.170	0.9944

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (%)	Correlation	Damping (%)	Correlation
SW31	9	0.90	1.60	65	240	0.189	0.9968	0.189	0.9968
SW31	10	0.90	1.60	70	240	0.191	0.9983	0.190	0.9982
SW32	1	0.90	1.50	195	500	0.126	0.9975	0.126	0.9975
SW32	2	0.90	1.50	145	430	0.104	0.9971	0.104	0.9971
SW32	3	0.90	1.50	95	310	0.106	0.9971	0.106	0.9971
SW32	4	0.90	1.50	85	300	0.118	0.9983	0.118	0.9983
SW32	5	0.90	1.50	85	350	0.120	0.9978	0.120	0.9978
SW32	6	0.90	1.50	60	350	0.115	0.9983	0.115	0.9983
SW32	7	0.90	1.50	75	340	0.118	0.9966	0.118	0.9966
SW32	8	0.90	1.50	80	320	0.108	0.9982	0.108	0.9982
SW32	9	0.90	1.50	70	340	0.103	0.9970	0.103	0.9970
SW32	10	0.90	1.50	65	300	0.125	0.9978	0.125	0.9978
SE32	1	0.90	1.50	170	340	0.213	0.9953	0.213	0.9953
SE32	2	0.90	1.50	80	240	0.196	0.9973	0.196	0.9973
SE32	3	0.90	1.50	65	260	0.205	0.9959	0.205	0.9959
SE32	4	0.90	1.50	65	250	0.213	0.9982	0.213	0.9982
SE32	5	0.90	1.50	65	240	0.204	0.9982	0.204	0.9981
SE32	6	0.90	1.50	70	240	0.200	0.9984	0.200	0.9984
SE32	7	0.90	1.50	55	240	0.194	0.9993	0.194	0.9994
SE32	8	0.90	1.50	55	240	0.206	0.9988	0.206	0.9988
SE32	9	0.80	1.50	60	220	0.204	0.9986	0.204	0.9986

Table 24. Phase 2 summary of average damping values.

Cable	Mode	Average Damping Value (percent)	Maximum Damping Value[a] (percent)	Minimum Damping Value[a] (percent)	Correlation	Average Length of Time Sample (s)
NW01	1	0.168	0.173	0.164	0.9927	185.5
NW02	1	0.282	0.304	0.260	0.9948	135.5
NW03	1	0.345	0.353	0.338	0.9971	115.0
NW29	1	0.293	0.304	0.283	0.9931	138.5
NW30	1	0.175	0.178	0.173	0.9982	186.8
NW31	1	0.447	0.456	0.438	0.9921	86.0
NW32	1	0.399	0.420	0.378	0.9953	83.1
SW01	1	0.122	0.130	0.114	0.9900	257.8
SW02	1	0.127	0.141	0.113	0.9888	225.0
SW03	1	0.136	0.141	0.132	0.9927	208.8
SW04	1	0.267	0.277	0.258	0.9951	157.8
SW05	1	0.197	0.204	0.190	0.9952	157.5
SW29	1	0.229	0.237	0.221	0.9681	151.5
SW30	1	0.180	0.183	0.177	0.9912	158.8
SW31	1	0.259	0.263	0.255	0.9954	142.8
SW32	1	0.213	0.243	0.183	0.9904	212.3
SE32	1	0.430	0.445	0.415	0.9891	75.8
NW01	2	0.130	0.133	0.127	0.9973	235.0
NW02	2	0.115	0.120	0.109	0.9976	241.5
NW03	2	0.179	0.183	0.174	0.9983	157.5
NW29	2	0.163	0.169	0.157	0.9969	177.0
NW30	2	0.193	0.199	0.188	0.9909	150.0
NW31	2	0.160	0.166	0.154	0.9966	194.5
NW32	2	0.197	0.222	0.172	0.9783	171.3
SW01	2	0.083	0.088	0.078	0.9977	325.0
SW02	2	0.086	0.089	0.084	0.9961	311.0
SW03	2	0.103	0.108	0.097	0.9981	238.1
SW04	2	0.139	0.144	0.134	0.9980	226.8
SW05	2	0.148	0.154	0.142	0.9978	187.5
SW29	2	0.169	0.175	0.162	0.9929	158.5
SW30	2	0.165	0.173	0.157	0.9960	168.0
SW31	2	0.197	0.203	0.191	0.9965	161.0
SW32	2	0.114	0.117	0.110	0.9979	264.5
SE32	2	0.203	0.206	0.201	0.9983	176.1

[a]Maximum and minimum values are for the 90 percent confidence interval on the mean.

Table 25. Phase 3—box 1 first mode damping data.

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE27	1	1.80	1.89	155	250	0.177	0.9943	0.177	0.9942
SE27	2	1.78	1.86	120	220	0.149	0.9859	0.149	0.9859
SE27	3	1.80	1.95	170	240	0.188	0.9945	0.188	0.9946
SE27	4	1.79	1.94	70	200	0.191	0.9854	0.191	0.9853
SE27	5	1.71	1.94	70	210	0.141	0.9972	0.141	0.9972
SE27	6	1.75	1.94	65	140	0.190	0.9926	0.190	0.9923
SE27	7	1.78	1.90	90	190	0.156	0.9921	0.156	0.9918
SE27	8	1.78	1.95	60	190	0.124	0.9968	0.124	0.9968
SE27	9	1.78	1.94	100	190	0.225	0.9778	0.225	0.9778
SE27	10	1.78	1.94	75	180	0.127	0.9906	0.127	0.9906
SE28	1	1.52	1.67	155	270	0.207	0.9989	0.207	0.9989
SE28	2	1.54	1.64	105	240	0.209	0.9958	0.209	0.9959
SE28	3	1.53	1.65	115	200	0.202	0.9926	0.202	0.9926
SE28	4	1.45	1.65	75	200	0.209	0.9984	0.209	0.9984
SE28	5	1.45	1.65	85	180	0.204	0.9930	0.204	0.9929
SE28	6	1.51	1.67	125	190	0.224	0.9954	0.224	0.9955
SE28	7	1.43	1.63	85	250	0.172	0.9991	0.172	0.9991
SE28	8	1.49	1.66	90	240	0.155	0.9929	0.155	0.9929
SE28	9	1.44	1.65	75	210	0.183	0.9974	0.183	0.9974
SE28	10	1.42	1.66	75	190	0.205	0.9978	0.205	0.9977
SE28	11*	—	—	—	—	—	—	—	—
SE29	1	1.28	1.38	210	450	0.107	0.9650	0.107	0.9650
SE29	2	1.22	1.43	70	400	0.143	0.9949	0.143	0.9949
SE29	3	1.26	1.37	80	150	0.158	0.9889	0.158	0.9887
SE29	4	1.26	1.37	85	250	0.149	0.9917	0.149	0.9917
SE29	5	1.26	1.37	75	150	0.141	0.9914	0.141	0.9913
SE29	6	1.26	1.37	75	160	0.160	0.9899	0.159	0.9901

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SE29	7	1.26	1.37	110	220	0.118	0.9531	0.118	0.9541
SE29	8	1.23	1.38	75	280	0.133	0.9954	0.133	0.9954
SE29	9	1.24	1.37	80	260	0.131	0.9916	0.131	0.9917
SE29	10	1.24	1.38	70	250	0.140	0.9983	0.141	0.9983
SE30	1	1.09	1.17	120	280	0.048	0.9620	0.048	0.9622
SE30	2	1.09	1.19	125	320	0.054	0.9862	0.054	0.9862
SE30	3	1.07	1.18	75	300	0.061	0.9925	0.061	0.9926
SE30	4	1.08	1.17	70	240	0.063	0.9899	0.062	0.9900
SE30	5	1.07	1.18	80	250	0.079	0.9775	0.079	0.9772
SE30	6	1.09	1.17	105	220	0.048	0.9508	0.048	0.9515
SE30	7	1.10	1.19	100	350	0.069	0.9988	0.069	0.9988
SE30	8	1.08	1.17	85	260	0.066	0.9889	0.066	0.9889
SE30	9	1.10	1.19	100	310	0.073	0.9980	0.073	0.9980
SE30	10	1.09	1.19	65	310	0.065	0.9972	0.065	0.9972
SE31	1	1.10	1.19	130	310	0.049	0.9869	0.049	0.9871
SE31	2	1.10	1.19	130	320	0.052	0.9868	0.052	0.9867
SE31	3	1.10	1.19	95	180	0.044	0.8727	0.045	0.8774
SE31	4	1.11	1.18	130	280	0.061	0.9692	0.061	0.9698
SE31	5	1.10	1.19	105	260	0.060	0.9861	0.060	0.9860
SE31	6	1.10	1.19	150	320	0.054	0.9825	0.053	0.9822
SE31	7	1.08	1.17	80	220	0.076	0.9713	0.076	0.9713
SE31	8	1.09	1.19	100	280	0.061	0.9590	0.061	0.9585
SE31	9	1.10	1.19	120	270	0.051	0.9607	0.051	0.9604
SE31	10	1.10	1.19	100	180	0.056	0.9612	0.055	0.9592
SE32	1	1.10	1.19	135	310	0.049	0.9859	0.049	0.9859
SE32	2	1.10	1.19	130	320	0.052	0.9868	0.052	0.9867
SE32	3	1.10	1.19	95	180	0.044	0.8727	0.045	0.8774
SE32	4	1.10	1.19	95	300	0.052	0.9785	0.052	0.9784
SE32	5	1.10	1.19	100	260	0.060	0.9863	0.060	0.9866

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE32	6	1.09	1.19	130	320	0.057	0.9761	0.057	0.9761
SE32	7	1.10	1.19	90	220	0.074	0.9857	0.074	0.9857
SE32	8	1.09	1.19	100	280	0.061	0.9590	0.061	0.9585
SE32	9	1.10	1.19	125	270	0.051	0.9565	0.051	0.9562
SE32	10	1.10	1.19	100	180	0.056	0.9612	0.055	0.9592
NE01	1	1.06	1.14	160	220	0.323	0.9916	0.323	0.9915
NE01	2	1.04	1.14	80	170	0.318	0.9953	0.319	0.9955
NE01	3	1.01	1.14	80	150	0.293	0.9942	0.292	0.9942
NE01	4	1.06	1.16	110	350	0.130	0.9922	0.129	0.9922
NE01	5	1.01	1.16	105	350	0.158	0.9941	0.158	0.9941
NE01	6	1.02	1.16	80	300	0.142	0.9893	0.141	0.9894
NE01	7	1.04	1.14	75	140	0.305	0.9909	0.305	0.9908
NE01	8	1.04	1.17	95	310	0.161	0.9911	0.161	0.9910
NE01	9	1.03	1.19	75	250	0.157	0.9909	0.157	0.9907
NE01	10	1.00	1.19	60	230	0.155	0.9913	0.155	0.9913
NE02	1	1.01	1.13	190	280	0.211	0.9905	0.211	0.9903
NE02	2	1.13	1.22	95	310	0.108	0.9914	0.108	0.9915
NE02	3	1.13	1.22	105	340	0.108	0.9896	0.108	0.9896
NE02	4	1.12	1.31	80	260	0.119	0.9776	0.119	0.9776
NE02	5	1.11	1.24	80	310	0.091	0.9904	0.091	0.9903
NE02	6	1.14	1.23	125	280	0.079	0.9843	0.079	0.9843
NE02	7	1.10	1.30	120	300	0.075	0.9280	0.075	0.9282
NE02	8	1.14	1.25	80	270	0.076	0.9892	0.076	0.9893
NE02	9	1.13	1.24	85	360	0.084	0.9940	0.084	0.9941
NE02	10	1.13	1.22	95	270	0.081	0.9952	0.081	0.9952
NE03	1	1.11	1.20	200	370	0.095	0.9816	0.095	0.9814
NE03	2	1.14	1.23	140	390	0.086	0.9951	0.086	0.9952
NE03	3	1.14	1.23	110	320	0.103	0.9984	0.103	0.9984
NE03	4	1.14	1.23	110	260	0.099	0.9963	0.099	0.9963

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
NE03	5	1.14	1.23	110	290	0.101	0.9963	0.101	0.9963
NE03	6	1.14	1.23	110	270	0.109	0.9979	0.109	0.9979
NE03	7	1.14	1.23	100	270	0.102	0.9943	0.102	0.9943
NE03	8	1.14	1.23	135	235	0.088	0.9705	0.088	0.9700
NE03	9	1.14	1.23	110	320	0.091	0.9953	0.091	0.9953
NE03	10	1.14	1.23	115	250	0.107	0.9930	0.107	0.9931
NE04	1	1.13	1.20	250	470	0.128	0.9901	0.128	0.9903
NE04	2	1.13	1.20	120	370	0.125	0.9885	0.125	0.9886
NE04	3	1.13	1.20	140	440	0.126	0.9943	0.126	0.9942
NE04	4*	—	—	—	—	—	—	—	—
NE04	5	1.13	1.20	180	420	0.102	0.9959	0.101	0.9959
NE04	6	1.13	1.20	110	230	0.061	0.9586	0.060	0.9590
NE04	7	1.13	1.20	160	320	0.096	0.9939	0.096	0.9939
NE04	8	1.13	1.20	150	320	0.097	0.9854	0.097	0.9852
NE04	9	1.13	1.20	160	380	0.088	0.9921	0.088	0.9922
NE04	10	1.13	1.20	180	370	0.114	0.9954	0.114	0.9953
NE05	1	1.14	1.29	105	420	0.115	0.9841	0.115	0.9842
NE05	2	1.14	1.28	75	380	0.122	0.9888	0.122	0.9887
NE05	3	1.12	1.28	65	360	0.134	0.9832	0.134	0.9832
NE05	4	1.14	1.25	85	350	0.172	0.9701	0.172	0.9699
NE05	5	1.14	1.28	75	340	0.131	0.9940	0.131	0.9940
NE05	6	1.12	1.28	80	330	0.132	0.9803	0.132	0.9802
NE05	7	1.12	1.25	65	340	0.118	0.9815	0.118	0.9817
NE05	8	1.14	1.28	70	350	0.136	0.9858	0.136	0.9858
NE05	9	1.16	1.29	95	370	0.141	0.9884	0.142	0.9884
NE05	10	1.16	1.27	75	300	0.130	0.9911	0.130	0.9911
NE06	1	1.22	1.37	65	250	0.199	0.9978	0.199	0.9978
NE06	2	1.22	1.37	80	300	0.173	0.9984	0.173	0.9984
NE06	3	1.22	1.37	95	300	0.186	0.9982	0.186	0.9982

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NE06	4	1.22	1.37	100	290	0.166	0.9993	0.166	0.9993
NE06	5	1.22	1.37	75	240	0.206	0.9974	0.206	0.9973
NE06	6	1.22	1.37	70	220	0.178	0.9972	0.177	0.9973
NE06	7	1.22	1.37	85	270	0.177	0.9992	0.177	0.9992
NE06	8	1.22	1.37	65	230	0.177	0.9994	0.177	0.9994
NE06	9	1.22	1.37	60	220	0.189	0.9987	0.189	0.9987
NE06	10	1.22	1.37	70	250	0.187	0.9983	0.187	0.9984
NE07	1	1.49	1.83	80	150	0.269	0.9882	0.269	0.9882
NE07	2	1.49	1.83	105	170	0.264	0.9895	0.264	0.9897
NE07	3	1.49	1.83	70	160	0.261	0.9951	0.262	0.9951
NE07	4	1.49	1.83	140	250	0.255	0.9977	0.255	0.9977
NE07	5	1.49	1.83	85	210	0.243	0.9957	0.243	0.9957
NE07	6	1.49	1.83	65	170	0.236	0.9950	0.236	0.9951
NE07	7	1.49	1.83	70	140	0.264	0.9664	0.265	0.9658
NE07	8	1.49	1.83	100	180	0.263	0.9939	0.263	0.9939
NE07	9	1.49	1.83	115	200	0.230	0.9984	0.230	0.9984
NE07	10	1.49	1.83	85	150	0.264	0.9942	0.265	0.9942
NE08	1	1.84	1.92	380	510	0.103	0.7885	0.102	0.7874
NE08	2	1.83	1.93	145	290	0.189	0.9922	0.189	0.9924
NE08	3	1.83	1.93	80	240	0.189	0.9878	0.189	0.9879
NE08	4	1.63	1.81	145	180	0.404	0.9770	0.410	0.9767
NE08	5	1.80	1.93	95	230	0.117	0.7673	0.117	0.7680
NE08	6	1.65	1.81	80	120	0.471	0.9707	0.476	0.9715
NE08	7	1.65	1.81	95	135	0.371	0.9796	0.372	0.9793
NE08	8	1.65	1.81	95	140	0.368	0.9845	0.369	0.9846
NE08	9	1.65	1.81	85	125	0.413	0.9810	0.413	0.9813
NE08	10	1.65	1.81	80	125	0.361	0.9759	0.361	0.9755
NE08	11	1.65	1.81	85	140	0.313	0.9535	0.314	0.9541

*No excitation.

—Indicates no data are available.

Table 26. Phase 3—box 2 first mode damping data.

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
SE27	1	1.80	1.89	155	250	0.180	0.9925	0.179	0.9926
SE27	2	1.78	1.86	120	220	0.147	0.9870	0.147	0.9871
SE27	3	1.80	1.95	170	240	0.188	0.9940	0.188	0.9940
SE27	4	1.79	1.94	70	200	0.188	0.9861	0.188	0.9860
SE27	5	1.71	1.94	65	210	0.141	0.9960	0.140	0.9961
SE27	6	1.75	1.94	60	140	0.190	0.9909	0.190	0.9907
SE27	7	1.78	1.90	85	190	0.156	0.9912	0.157	0.9910
SE27	8	1.78	1.95	55	190	0.124	0.9968	0.124	0.9968
SE27	9	1.73	1.94	100	190	0.227	0.9601	0.227	0.9594
SE27	10	1.78	1.94	70	180	0.130	0.9887	0.129	0.9888
SE28	1	1.45	1.68	135	270	0.204	0.9983	0.204	0.9984
SE28	2	1.45	1.68	100	230	0.206	0.9958	0.206	0.9958
SE28	3	1.52	1.67	110	200	0.201	0.9934	0.201	0.9935
SE28	4	1.45	1.68	70	200	0.211	0.9986	0.211	0.9986
SE28	5	1.45	1.68	80	180	0.205	0.9922	0.205	0.9922
SE28	6	1.45	1.68	120	190	0.218	0.9957	0.218	0.9957
SE28	7	1.45	1.67	80	250	0.170	0.9986	0.170	0.9986
SE28	8	1.45	1.67	100	220	0.157	0.9936	0.157	0.9934
SE28	9	1.45	1.67	75	210	0.180	0.9980	0.180	0.9979
SE28	10	1.45	1.67	75	180	0.198	0.9968	0.198	0.9968
SE28	11*	—	—	—	—	—	—	—	—
SE29	1	1.28	1.38	210	450	0.109	0.9604	0.109	0.9602
SE29	2	1.22	1.43	70	400	0.144	0.9943	0.144	0.9943
SE29	3	1.26	1.37	80	150	0.159	0.9910	0.159	0.9909
SE29	4	1.26	1.37	85	250	0.152	0.9913	0.151	0.9913
SE29	5	1.26	1.37	75	150	0.140	0.9914	0.139	0.9913
SE29	6	1.26	1.37	75	160	0.161	0.9904	0.160	0.9906
SE29	7	1.26	1.37	110	220	0.124	0.9412	0.125	0.9433

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE29	8	1.23	1.38	75	280	0.134	0.9945	0.134	0.9945
SE29	9	1.24	1.37	80	260	0.131	0.9915	0.131	0.9916
SE29	10	1.24	1.38	70	250	0.141	0.9977	0.141	0.9978
SE30	1	1.09	1.17	120	280	0.049	0.9654	0.049	0.9657
SE30	2	1.09	1.19	125	320	0.054	0.9898	0.054	0.9898
SE30	3	1.07	1.18	75	300	0.061	0.9907	0.061	0.9908
SE30	4	1.08	1.17	70	240	0.064	0.9749	0.063	0.9746
SE30	5	1.07	1.18	80	250	0.077	0.9685	0.076	0.9682
SE30	6	1.09	1.17	110	220	0.055	0.9000	0.055	0.9035
SE30	7	1.10	1.19	100	350	0.063	0.9986	0.063	0.9986
SE30	8	1.08	1.17	85	260	0.070	0.9880	0.070	0.9880
SE30	9	1.10	1.19	100	310	0.070	0.9966	0.070	0.9967
SE30	10	1.09	1.19	65	310	0.066	0.9937	0.066	0.9937
SE31	1	1.10	1.19	130	310	0.054	0.9905	0.054	0.9904
SE31	2	1.10	1.19	130	320	0.057	0.9894	0.057	0.9893
SE31	3	1.10	1.19	95	180	0.041	0.7819	0.041	0.7843
SE31	4	1.11	1.18	130	280	0.061	0.9847	0.061	0.9845
SE31	5	1.10	1.19	105	260	0.061	0.9928	0.061	0.9928
SE31	6	1.10	1.19	150	320	0.061	0.9867	0.061	0.9865
SE31	7	1.08	1.17	80	220	0.065	0.9480	0.065	0.9480
SE31	8	1.09	1.19	100	280	0.055	0.9157	0.055	0.9146
SE31	9	1.10	1.19	120	270	0.058	0.9689	0.058	0.9693
SE31	10	1.10	1.19	100	180	0.059	0.9396	0.059	0.9368
SE32	1	1.10	1.19	135	310	0.054	0.9903	0.055	0.9902
SE32	2	1.10	1.19	130	320	0.057	0.9894	0.057	0.9893
SE32	3	1.10	1.19	95	180	0.041	0.7819	0.041	0.7843
SE32	4	1.10	1.19	95	300	0.054	0.9690	0.054	0.9689
SE32	5	1.10	1.19	100	260	0.060	0.9923	0.060	0.9926
SE32	6	1.09	1.19	130	320	0.061	0.9669	0.061	0.9672

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE32	7	1.10	1.19	90	220	0.066	0.9727	0.066	0.9722
SE32	8	1.09	1.19	100	280	0.055	0.9157	0.055	0.9146
SE32	9	1.10	1.19	125	270	0.059	0.9678	0.059	0.9683
SE32	10	1.10	1.19	100	180	0.059	0.9396	0.059	0.9368
NE01	1	1.06	1.14	160	220	0.319	0.9862	0.320	0.9859
NE01	2	1.04	1.14	80	170	0.328	0.9948	0.329	0.9951
NE01	3	1.04	1.14	85	150	0.302	0.9949	0.302	0.9950
NE01	4	1.04	1.14	90	350	0.132	0.9910	0.132	0.9910
NE01	5	1.04	1.16	105	330	0.152	0.9905	0.153	0.9905
NE01	6	1.02	1.16	70	300	0.147	0.9886	0.146	0.9886
NE01	7	1.02	1.18	70	140	0.303	0.9880	0.302	0.9877
NE01	8	1.02	1.19	95	310	0.160	0.9902	0.159	0.9902
NE01	9	1.02	1.19	75	250	0.160	0.9902	0.160	0.9900
NE01	10	1.02	1.19	60	230	0.153	0.9885	0.153	0.9885
NE02	1	1.01	1.13	185	280	0.215	0.9821	0.214	0.9819
NE02	2	1.13	1.21	100	310	0.108	0.9910	0.108	0.9911
NE02	3	1.13	1.21	130	340	0.116	0.9945	0.116	0.9945
NE02	4	1.13	1.21	100	260	0.109	0.9921	0.110	0.9922
NE02	5	1.11	1.24	75	310	0.093	0.9911	0.093	0.9912
NE02	6	1.14	1.23	115	280	0.086	0.9804	0.086	0.9801
NE02	7	1.00	1.30	120	300	0.076	0.9260	0.076	0.9261
NE02	8	1.14	1.25	80	270	0.076	0.9848	0.076	0.9848
NE02	9	1.13	1.24	85	360	0.085	0.9925	0.085	0.9925
NE02	10	1.13	1.22	95	270	0.081	0.9953	0.081	0.9954
NE03	1	1.14	1.23	220	370	0.095	0.9936	0.095	0.9937
NE03	2	1.14	1.23	140	390	0.087	0.9975	0.087	0.9975
NE03	3	1.14	1.23	110	320	0.108	0.9974	0.108	0.9974
NE03	4	1.14	1.23	110	260	0.110	0.9976	0.110	0.9976
NE03	5	1.14	1.23	110	290	0.105	0.9955	0.105	0.9954

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NE03	6	1.14	1.23	110	270	0.108	0.9960	0.108	0.9960
NE03	7	1.14	1.23	100	270	0.104	0.9946	0.104	0.9947
NE03	8	1.14	1.23	135	235	0.086	0.9653	0.086	0.9645
NE03	9	1.14	1.23	110	320	0.092	0.9950	0.092	0.9951
NE03	10	1.14	1.23	115	250	0.106	0.9956	0.106	0.9956
NE04	1	1.13	1.20	250	470	0.130	0.9875	0.130	0.9875
NE04	2	1.13	1.20	120	370	0.121	0.9812	0.122	0.9814
NE04	3	1.13	1.20	140	440	0.129	0.9940	0.129	0.9940
NE04	4*	—	—	—	—	—	—	—	—
NE04	5	1.13	1.20	180	420	0.103	0.9973	0.103	0.9972
NE04	6	1.13	1.20	110	230	0.066	0.9646	0.065	0.9644
NE04	7	1.13	1.20	160	320	0.096	0.9921	0.096	0.9920
NE04	8	1.13	1.20	150	320	0.092	0.9825	0.092	0.9822
NE04	9	1.13	1.20	160	380	0.099	0.9979	0.099	0.9980
NE04	10	1.13	1.20	180	370	0.102	0.9906	0.102	0.9905
NE05	1	1.14	1.29	100	380	0.109	0.9805	0.109	0.9805
NE05	2	1.14	1.29	75	380	0.123	0.9868	0.123	0.9868
NE05	3	1.14	1.29	65	330	0.132	0.9804	0.132	0.9805
NE05	4	1.14	1.29	85	240	0.165	0.9703	0.165	0.9706
NE05	5	1.14	1.29	75	340	0.131	0.9937	0.131	0.9939
NE05	6	1.14	1.29	80	330	0.130	0.9788	0.130	0.9789
NE05	7	1.12	1.25	65	340	0.118	0.9830	0.119	0.9831
NE05	8	1.14	1.28	70	350	0.137	0.9853	0.137	0.9853
NE05	9	1.13	1.29	90	370	0.138	0.9828	0.138	0.9829
NE05	10	1.13	1.27	70	300	0.128	0.9928	0.128	0.9929
NE06	1	1.22	1.37	65	250	0.199	0.9973	0.200	0.9971
NE06	2	1.22	1.37	80	300	0.170	0.9971	0.170	0.9971
NE06	3	1.22	1.37	95	300	0.185	0.9984	0.185	0.9984
NE06	4	1.22	1.37	100	290	0.168	0.9990	0.168	0.9990

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NE06	5	1.22	1.37	75	240	0.206	0.9968	0.206	0.9968
NE06	6	1.22	1.37	70	220	0.176	0.9975	0.175	0.9976
NE06	7	1.22	1.37	85	270	0.178	0.9991	0.178	0.9991
NE06	8	1.22	1.37	65	230	0.176	0.9985	0.176	0.9985
NE06	9	1.22	1.37	60	220	0.191	0.9982	0.191	0.9982
NE06	10	1.22	1.37	70	250	0.188	0.9982	0.188	0.9982
NE07	1	1.49	1.83	80	150	0.270	0.9891	0.270	0.9889
NE07	2	1.49	1.83	105	170	0.269	0.9852	0.269	0.9855
NE07	3	1.49	1.83	70	160	0.263	0.9931	0.264	0.9929
NE07	4	1.49	1.83	140	250	0.257	0.9969	0.257	0.9968
NE07	5	1.49	1.83	85	210	0.243	0.9969	0.243	0.9969
NE07	6	1.49	1.83	65	170	0.237	0.9945	0.237	0.9946
NE07	7	1.49	1.83	70	140	0.277	0.9687	0.277	0.9687
NE07	8	1.49	1.83	100	180	0.270	0.9901	0.270	0.9902
NE07	9	1.49	1.83	115	200	0.230	0.9982	0.230	0.9981
NE07	10	1.49	1.83	85	150	0.269	0.9927	0.270	0.9926
NE08	1	1.84	1.96	395	510	0.116	0.8911	0.116	0.8897
NE08	2	1.83	1.93	145	290	0.194	0.9911	0.193	0.9913
NE08	3	1.83	1.93	80	240	0.192	0.9905	0.192	0.9905
NE08	4	1.83	1.93	155	230	0.148	0.9609	0.148	0.9616
NE08	5	1.83	1.93	110	230	0.142	0.9313	0.141	0.9307
NE08	6	1.65	1.81	75	120	0.425	0.9625	0.430	0.9631
NE08	7	1.65	1.81	95	135	0.372	0.9820	0.372	0.9819
NE08	8	1.65	1.81	95	140	0.368	0.9856	0.369	0.9857
NE08	9	1.65	1.81	85	125	0.412	0.9823	0.412	0.9826
NE08	10	1.65	1.81	80	125	0.358	0.9795	0.358	0.9793
NE08	11	1.65	1.81	85	140	0.315	0.9506	0.316	0.9512

*No excitation.

—Indicates no data are available.

Table 27. Phase 3—box 1 second mode damping data.

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	Run	Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE27	1	3.84	3.98	195	210	0.256	0.9857	0.257	0.9862
SE27	2	3.84	3.98	115	155	0.233	0.9819	0.232	0.9821
SE27	3[a]	—	—	—	—	—	—	—	—
SE27	4[a]	—	—	—	—	—	—	—	—
SE27	5[a]	—	—	—	—	—	—	—	—
SE27	6[a]	—	—	—	—	—	—	—	—
SE27	7[a]	—	—	—	—	—	—	—	—
SE27	8[a]	—	—	—	—	—	—	—	—
SE27	9[a]	—	—	—	—	—	—	—	—
SE27	10[a]	—	—	—	—	—	—	—	—
SE28	1[a]	—	—	—	—	—	—	—	—
SE28	2[a]	—	—	—	—	—	—	—	—
SE28	3[a]	—	—	—	—	—	—	—	—
SE28	4[a]	—	—	—	—	—	—	—	—
SE28	5[a]	—	—	—	—	—	—	—	—
SE28	6[a]	—	—	—	—	—	—	—	—
SE28	7[a]	—	—	—	—	—	—	—	—
SE28	8[a]	—	—	—	—	—	—	—	—
SE28	9[a]	—	—	—	—	—	—	—	—
SE28	10[a]	—	—	—	—	—	—	—	—
SE28	11[b]	—	—	—	—	—	—	—	—
SE29	1	2.60	2.70	170	230	0.161	0.9581	0.161	0.9579
SE29	2	2.64	2.68	170	230	0.149	0.9892	0.149	0.9891
SE29	3	2.64	2.71	215	235	0.272	0.9976	0.271	0.9975
SE29	4[a]	—	—	—	—	—	—	—	—
SE29	5	2.62	2.71	70	85	0.280	0.9859	0.282	0.9875
SE29	6[a]	—	—	—	—	—	—	—	—
SE29	7	2.60	2.72	150	170	0.446	0.9833	0.451	0.9842

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE29	8[a]	—	—	—	—	—	—	—	—
SE29	9	2.63	2.70	215	240	0.394	0.9822	0.392	0.9814
SE29	10[a]	—	—	—	—	—	—	—	—
SE30	1	2.22	2.32	90	125	0.156	0.9721	0.156	0.9720
SE30	2[a]	—	—	—	—	—	—	—	—
SE30	3[a]	—	—	—	—	—	—	—	—
SE30	4[a]	—	—	—	—	—	—	—	—
SE30	5[a]	—	—	—	—	—	—	—	—
SE30	6[a]	—	—	—	—	—	—	—	—
SE30	7[a]	—	—	—	—	—	—	—	—
SE30	8[a]	—	—	—	—	—	—	—	—
SE30	9[a]	—	—	—	—	—	—	—	—
SE30	10[a]	—	—	—	—	—	—	—	—
SE31	1	2.22	2.33	115	150	0.186	0.9884	0.187	0.9893
SE31	2	2.22	2.31	105	125	0.553	0.9708	0.552	0.9729
SE31	3[a]	—	—	—	—	—	—	—	—
SE31	4	2.22	2.34	50	67	0.649	0.9913	0.649	0.9912
SE31	5	2.22	2.32	65	75	1.222	0.9873	1.236	0.9891
SE31	6	2.21	2.33	125	155	0.379	0.9410	0.381	0.9394
SE31	7[a]	—	—	—	—	—	—	—	—
SE31	8	2.22	2.31	85	100	0.398	0.9910	0.399	0.9912
SE31	9	2.22	2.32	80	110	0.541	0.9645	0.542	0.9650
SE31	10	2.22	2.33	60	100	0.497	0.9694	0.496	0.9692
SE32	1	2.22	2.33	115	145	0.201	0.9956	0.201	0.9956
SE32	2	2.23	2.32	105	125	0.591	0.9835	0.591	0.9821
SE32	3[a]	—	—	—	—	—	—	—	—
SE32	4	2.23	2.34	50	70	0.624	0.9780	0.630	0.9735
SE32	5[a]	—	—	—	—	—	—	—	—
SE32	6	2.21	2.30	130	160	0.370	0.9806	0.371	0.9810

		Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
Cable	**Run**	**Low (Hz)**	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
SE32	7[a]	—	—	—	—	—	—	—	—
SE32	8	2.22	2.32	85	120	0.249	0.8930	0.245	0.8967
SE32	9	2.22	2.32	80	115	0.473	0.9560	0.476	0.9555
SE32	10	2.22	2.32	60	90	0.343	0.9645	0.350	0.9623
NE01	1	2.04	2.20	160	330	0.082	0.9812	0.082	0.9812
NE01	2	2.08	2.17	95	300	0.081	0.9951	0.081	0.9950
NE01	3	2.09	2.20	85	300	0.077	0.9941	0.077	0.9941
NE01	4	2.09	2.20	100	350	0.096	0.9977	0.096	0.9977
NE01	5	2.10	2.22	100	300	0.099	0.9979	0.099	0.9979
NE01	6	2.10	2.22	85	270	0.089	0.9960	0.089	0.9960
NE01	7	2.10	2.20	80	270	0.086	0.9993	0.086	0.9993
NE01	8	2.11	2.22	95	180	0.107	0.9919	0.107	0.9919
NE01	9	2.09	2.22	75	220	0.086	0.9946	0.086	0.9946
NE01	10	2.09	2.22	55	230	0.092	0.9954	0.092	0.9953
NE02	1	2.16	2.29	150	270	0.106	0.9874	0.106	0.9873
NE02	2	2.17	2.29	80	160	0.149	0.9969	0.149	0.9969
NE02	3	2.20	2.28	100	160	0.148	0.9950	0.148	0.9952
NE02	4	2.17	2.27	70	140	0.168	0.9740	0.167	0.9742
NE02	5	2.19	2.29	65	200	0.121	0.9891	0.121	0.9891
NE02	6	2.17	2.29	105	200	0.118	0.9878	0.118	0.9880
NE02	7	2.17	2.29	90	200	0.085	0.9158	0.085	0.9147
NE02	8	2.17	2.29	60	130	0.164	0.9873	0.164	0.9872
NE02	9	2.17	2.29	75	125	0.249	0.9855	0.249	0.9856
NE02	10	2.17	2.29	75	150	0.230	0.9855	0.230	0.9853
NE03	1[a]	—	—	—	—	—	—	—	—
NE03	2	2.28	2.44	100	300	0.064	0.9890	0.064	0.9890
NE03	3	2.37	2.43	95	270	0.076	0.9923	0.076	0.9924
NE03	4	2.37	2.43	90	250	0.070	0.9958	0.070	0.9958
NE03	5[a]	—	—	—	—	—	—	—	—

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NE03	6	2.30	2.44	70	250	0.067	0.9962	0.067	0.9962
NE03	7	2.30	2.44	60	250	0.070	0.9884	0.070	0.9884
NE03	8	2.30	2.43	100	230	0.068	0.9933	0.068	0.9934
NE03	9	2.30	2.44	65	230	0.069	0.9957	0.069	0.9957
NE03	10	2.30	2.44	75	225	0.078	0.9915	0.078	0.9914
NE04	1	2.33	2.39	215	300	0.152	0.9899	0.151	0.9899
NE04	2	2.30	2.39	80	165	0.184	0.9711	0.183	0.9710
NE04	3	2.30	2.39	105	165	0.271	0.9933	0.270	0.9933
NE04	4[b]	—	—	—	—	—	—	—	—
NE04	5[a]	—	—	—	—	—	—	—	—
NE04	6	2.31	2.39	145	230	0.069	0.9799	0.069	0.9797
NE04	7	2.31	2.39	95	300	0.079	0.9742	0.079	0.9742
NE04	8	2.30	2.39	80	210	0.071	0.9744	0.071	0.9741
NE04	9[a]	—	—	—	—	—	—	—	—
NE04	10	2.30	2.39	90	230	0.071	0.9419	0.071	0.9419
NE05	1[a]	—	—	—	—	—	—	—	—
NE05	2	2.35	2.50	90	200	0.076	0.9724	0.076	0.9721
NE05	3	2.42	2.51	80	145	0.103	0.9718	0.103	0.9717
NE05	4[a]	—	—	—	—	—	—	—	—
NE05	5[a]	—	—	—	—	—	—	—	—
NE05	6	2.42	2.50	95	280	0.049	0.9919	0.049	0.9920
NE05	7	2.43	2.50	85	310	0.026	0.9769	0.026	0.9768
NE05	8	2.43	2.50	90	225	0.083	0.9876	0.083	0.9876
NE05	9	2.43	2.55	100	310	0.040	0.9855	0.040	0.9856
NE05	10[a]	—	—	—	—	—	—	—	—
NE06	1[a]	—	—	—	—	—	—	—	—
NE06	2[a]	—	—	—	—	—	—	—	—
NE06	3	2.54	2.72	95	220	0.101	0.9452	0.101	0.9449
NE06	4	2.54	2.67	100	180	0.155	0.9698	0.155	0.9703

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
NE06	5[a]	—	—	—	—	—	—	—	—
NE06	6	2.55	2.70	70	200	0.101	0.9784	0.101	0.9784
NE06	7	2.57	2.68	90	195	0.146	0.9510	0.146	0.9507
NE06	8	2.57	2.68	70	180	0.156	0.9737	0.156	0.9737
NE06	9[a]	—	—	—	—	—	—	—	—
NE06	10[a]	—	—	—	—	—	—	—	—
NE07	1[a]	—	—	—	—	—	—	—	—
NE07	2[a]	—	—	—	—	—	—	—	—
NE07	3[a]	—	—	—	—	—	—	—	—
NE07	4[a]	—	—	—	—	—	—	—	—
NE07	5[a]	—	—	—	—	—	—	—	—
NE07	6[a]	—	—	—	—	—	—	—	—
NE07	7[a]	—	—	—	—	—	—	—	—
NE07	8[a]	—	—	—	—	—	—	—	—
NE07	9[a]	—	—	—	—	—	—	—	—
NE07	10[a]	—	—	—	—	—	—	—	—
NE08	1[a]	—	—	—	—	—	—	—	—
NE08	2[a]	—	—	—	—	—	—	—	—
NE08	3[a]	—	—	—	—	—	—	—	—
NE08	4[a]	—	—	—	—	—	—	—	—
NE08	5[a]	—	—	—	—	—	—	—	—
NE08	6[a]	—	—	—	—	—	—	—	—
NE08	7	3.45	3.66	90	120	0.259	0.9878	0.259	0.9875
NE08	8[a]	—	—	—	—	—	—	—	—
NE08	9[a]	—	—	—	—	—	—	—	—
NE08	10	3.45	3.66	80	100	0.344	0.9972	0.344	0.9971
NE08	11[a]	—	—	—	—	—	—	—	—

[a]No measurable damping curve.
[b]No excitation.
—Indicates no data are available.

Table 28. Phase 3—box 2 second mode damping data.

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE27	1[a]	—	—	—	—	—	—	—	—
SE27	2	3.84	3.98	100	145	0.162	0.9550	0.162	0.9550
SE27	3[a]	—	—	—	—	—	—	—	—
SE27	4[a]	—	—	—	—	—	—	—	—
SE27	5[a]	—	—	—	—	—	—	—	—
SE27	6[a]	—	—	—	—	—	—	—	—
SE27	7[a]	—	—	—	—	—	—	—	—
SE27	8[a]	—	—	—	—	—	—	—	—
SE27	9[a]	—	—	—	—	—	—	—	—
SE27	10[a]	—	—	—	—	—	—	—	—
SE28	1[a]	—	—	—	—	—	—	—	—
SE28	2[a]	—	—	—	—	—	—	—	—
SE28	3[a]	—	—	—	—	—	—	—	—
SE28	4[a]	—	—	—	—	—	—	—	—
SE28	5[a]	—	—	—	—	—	—	—	—
SE28	6[a]	—	—	—	—	—	—	—	—
SE28	7[a]	—	—	—	—	—	—	—	—
SE28	8[a]	—	—	—	—	—	—	—	—
SE28	9[a]	—	—	—	—	—	—	—	—
SE28	10[a]	—	—	—	—	—	—	—	—
SE28	11[b]	—	—	—	—	—	—	—	—
SE29	1	2.60	2.70	170	230	0.158	0.9705	0.158	0.9704
SE29	2	2.62	2.70	130	190	0.121	0.9700	0.121	0.9703
SE29	3[a]	—	—	—	—	—	—	—	—
SE29	4[a]	—	—	—	—	—	—	—	—
SE29	5[a]	—	—	—	—	—	—	—	—
SE29	6[a]	—	—	—	—	—	—	—	—
SE29	7[a]	—	—	—	—	—	—	—	—

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE29	8[a]	—	—	—	—	—	—	—	—
SE29	9[a]	—	—	—	—	—	—	—	—
SE29	10	2.60	2.71	85	250	0.094	0.9670	0.094	0.9672
SE30	1	2.22	2.32	90	125	0.146	0.9825	0.145	0.9823
SE30	2[a]	—	—	—	—	—	—	—	—
SE30	3[a]	—	—	—	—	—	—	—	—
SE30	4[a]	—	—	—	—	—	—	—	—
SE30	5[a]	—	—	—	—	—	—	—	—
SE30	6[a]	—	—	—	—	—	—	—	—
SE30	7[a]	—	—	—	—	—	—	—	—
SE30	8[a]	—	—	—	—	—	—	—	—
SE30	9[a]	—	—	—	—	—	—	—	—
SE30	10[a]	—	—	—	—	—	—	—	—
SE31	1	2.22	2.33	115	150	0.174	0.9849	0.175	0.9851
SE31	2	2.22	2.33	105	125	0.702	0.9679	0.691	0.9661
SE31	3[a]	—	—	—	—	—	—	—	—
SE31	4[a]	—	—	—	—	—	—	—	—
SE31	5[a]	—	—	—	—	—	—	—	—
SE31	6[a]	—	—	—	—	—	—	—	—
SE31	7[a]	—	—	—	—	—	—	—	—
SE31	8[a]	—	—	—	—	—	—	—	—
SE31	9[a]	—	—	—	—	—	—	—	—
SE31	10[a]	—	—	—	—	—	—	—	—
SE32	1	2.22	2.33	115	145	0.186	0.9855	0.186	0.9854
SE32	2	2.23	2.32	105	125	0.552	0.9929	0.544	0.9932
SE32	3[a]	—	—	—	—	—	—	—	—
SE32	4[a]	—	—	—	—	—	—	—	—
SE32	5[a]	—	—	—	—	—	—	—	—
SE32	6[a]	—	—	—	—	—	—	—	—

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	High (Hz)	Start (s)	End (s)	Damping (percent)	Correlation	Damping (percent)	Correlation
SE32	7[a]	—	—	—	—	—	—	—	—
SE32	8	2.22	2.32	85	120	0.404	0.9652	0.403	0.9651
SE32	9	2.22	2.32	80	115	0.442	0.9813	0.442	0.9819
SE32	10	2.22	2.32	60	90	0.397	0.9422	0.408	0.9398
NE01	1	2.04	2.20	160	330	0.084	0.9763	0.084	0.9763
NE01	2	2.04	2.20	75	300	0.082	0.9935	0.082	0.9934
NE01	3	2.04	2.20	80	300	0.077	0.9935	0.077	0.9935
NE01	4	2.04	2.20	90	350	0.096	0.9978	0.096	0.9978
NE01	5	2.04	2.20	105	300	0.100	0.9976	0.100	0.9976
NE01	6	2.04	2.20	80	260	0.089	0.9968	0.089	0.9968
NE01	7	2.04	2.20	75	270	0.085	0.9984	0.085	0.9984
NE01	8	2.10	2.20	95	180	0.110	0.9803	0.109	0.9809
NE01	9	2.10	2.20	80	220	0.087	0.9907	0.087	0.9908
NE01	10	2.00	2.20	55	230	0.092	0.9974	0.092	0.9974
NE02	1	2.16	2.29	150	270	0.113	0.9854	0.113	0.9852
NE02	2	2.16	2.29	80	160	0.152	0.9842	0.152	0.9842
NE02	3	2.20	2.29	85	160	0.165	0.9653	0.165	0.9653
NE02	4	2.17	2.28	70	140	0.141	0.9601	0.140	0.9602
NE02	5	2.17	2.28	65	200	0.127	0.9862	0.127	0.9863
NE02	6	2.17	2.28	105	200	0.125	0.9858	0.125	0.9857
NE02	7	2.17	2.29	90	180	0.103	0.9389	0.103	0.9384
NE02	8	2.17	2.28	60	130	0.164	0.9809	0.165	0.9807
NE02	9	2.17	2.28	75	125	0.263	0.9908	0.263	0.9907
NE02	10	2.17	2.28	80	150	0.231	0.9789	0.232	0.9787
NE03	1	2.28	2.44	180	400	0.052	0.9772	0.052	0.9771
NE03	2	2.28	2.44	100	300	0.066	0.9911	0.066	0.9912
NE03	3	2.28	2.44	75	270	0.076	0.9822	0.076	0.9823
NE03	4	2.28	2.44	65	250	0.065	0.9871	0.065	0.9870
NE03	5[a]	—	—	—	—	—	—	—	—

Cable	Run	Bandpass Filter Low (Hz)	Bandpass Filter High (Hz)	Time Filter Start (s)	Time Filter End (s)	Positive Peaks Damping (percent)	Positive Peaks Correlation	Negative Peaks Damping (percent)	Negative Peaks Correlation
NE03	6	2.28	2.44	65	250	0.069	0.9948	0.069	0.9948
NE03	7	2.28	2.44	55	250	0.069	0.9855	0.069	0.9856
NE03	8	2.28	2.43	100	230	0.066	0.9865	0.066	0.9866
NE03	9	2.28	2.44	70	230	0.069	0.9950	0.069	0.9950
NE03	10	2.28	2.43	75	225	0.078	0.9890	0.078	0.9890
NE04	1	2.33	2.39	215	300	0.149	0.9844	0.149	0.9842
NE04	2	2.30	2.39	85	165	0.189	0.9664	0.188	0.9663
NE04	3	2.33	2.39	105	165	0.302	0.9818	0.302	0.9815
NE04	4[b]	—	—	—	—	—	—	—	—
NE04	5	2.33	2.39	155	240	0.111	0.9950	0.111	0.9949
NE04	6[a]	—	—	—	—	—	—	—	—
NE04	7	2.31	2.39	95	250	0.060	0.9721	0.060	0.9719
NE04	8	2.31	2.39	85	210	0.073	0.9755	0.073	0.9753
NE04	9[a]	—	—	—	—	—	—	—	—
NE04	10	2.30	2.39	120	190	0.101	0.9474	0.101	0.9466
NE05	1[a]	—	—	—	—	—	—	—	—
NE05	2	2.35	2.50	90	200	0.074	0.9674	0.074	0.9672
NE05	3	2.42	2.51	80	145	0.102	0.9627	0.102	0.9627
NE05	4[a]	—	—	—	—	—	—	—	—
NE05	5[a]	—	—	—	—	—	—	—	—
NE05	6	2.42	2.50	95	280	0.047	0.9877	0.047	0.9876
NE05	7	2.43	2.50	85	310	0.028	0.9664	0.028	0.9662
NE05	8	2.43	2.50	90	225	0.080	0.9885	0.080	0.9886
NE05	9	2.43	2.50	110	310	0.039	0.9895	0.039	0.9895
NE05	10[a]	—	—	—	—	—	—	—	—
NE06	1[a]	—	—	—	—	—	—	—	—
NE06	2	2.54	2.72	75	170	0.154	0.9706	0.155	0.9709
NE06	3	2.54	2.72	95	220	0.101	0.9524	0.101	0.9523
NE06	4	2.54	2.67	100	180	0.216	0.9516	0.215	0.9517

Cable	Run	Bandpass Filter		Time Filter		Positive Peaks		Negative Peaks	
		Low (Hz)	**High (Hz)**	**Start (s)**	**End (s)**	**Damping (percent)**	**Correlation**	**Damping (percent)**	**Correlation**
NE06	5[a]	—	—	—	—	—	—	—	—
NE06	6	2.55	2.70	70	200	0.106	0.9826	0.106	0.9826
NE06	7	2.55	2.70	90	195	0.144	0.9637	0.144	0.9634
NE06	8[a]	—	—	—	—	—	—	—	—
NE06	9[a]	—	—	—	—	—	—	—	—
NE06	10[a]	—	—	—	—	—	—	—	—
NE07	1[a]	—	—	—	—	—	—	—	—
NE07	2[a]	—	—	—	—	—	—	—	—
NE07	3[a]	—	—	—	—	—	—	—	—
NE07	4[a]	—	—	—	—	—	—	—	—
NE07	5[a]	—	—	—	—	—	—	—	—
NE07	6[a]	—	—	—	—	—	—	—	—
NE07	7[a]	—	—	—	—	—	—	—	—
NE07	8[a]	—	—	—	—	—	—	—	—
NE07	9[a]	—	—	—	—	—	—	—	—
NE07	10[a]	—	—	—	—	—	—	—	—
NE08	1[a]	—	—	—	—	—	—	—	—
NE08	2[a]	—	—	—	—	—	—	—	—
NE08	3[a]	—	—	—	—	—	—	—	—
NE08	4[a]	—	—	—	—	—	—	—	—
NE08	5[a]	—	—	—	—	—	—	—	—
NE08	6[a]	—	—	—	—	—	—	—	—
NE08	7	3.45	3.66	90	120	0.271	0.9886	0.272	0.9891
NE08	8[a]	—	—	—	—	—	—	—	—
NE08	9[a]	—	—	—	—	—	—	—	—
NE08	10	3.45	3.66	80	100	0.328	0.9919	0.329	0.9921
NE08	11[a]	—	—	—	—	—	—	—	—

[a]No measurable damping curve.
[b]No excitation.
—Indicates no data are available.

Table 29. Phase 3 summary of average damping values.

Cable	Mode	Average Damping Value (percent)	Maximum Damping Value[a] (percent)	Minimum Damping Value[a] (percent)	Correlation	Average Length of Time Sample (s)
SE27	1	0.167	0.179	0.155	0.9895	104.8
SE28	1	0.196	0.204	0.189	0.9961	118.5
SE29	1	0.139	0.145	0.133	0.9852	164.0
SE30	1	0.063	0.067	0.061	0.9804	191.3
SE31	1	0.057	0.066	0.061	0.9567	148.0
SE32	1	0.056	0.063	0.059	0.9567	154.0
NE01	1	0.215	0.246	0.183	0.9912	155.5
NE02	1	0.107	0.124	0.090	0.9892	192.2
NE03	1	0.099	0.100	0.094	0.9923	172.5
NE04	1	0.112	0.126	0.117	0.9865	207.8
NE05	1	0.132	0.138	0.126	0.9841	266.8
NE06	1	0.184	0.188	0.179	0.9982	180.5
NE07	1	0.257	0.263	0.251	0.9910	86.5
NE08	1	0.288	0.332	0.244	0.9530	79.8
SE27	2	0.217	0.300	0.134	0.9742	36.3
SE28	2[b]	—	—	—	—	—
SE29	2	0.230	0.308	0.153	0.9782	64.2
SE30	2	0.151	0.181	0.121	0.9773	35.0
SE31	2	0.530	0.704	0.356	0.9756	26.1
SE32	2	0.403	0.478	0.328	0.9682	29.3
NE01	2	0.090	0.093	0.086	0.9933	183.3
NE02	2	0.163	0.183	0.143	0.9837	84.4
NE03	2	0.069	0.072	0.066	0.9900	174.4
NE04	2	0.134	0.171	0.098	0.9748	103.6
NE05	2	0.062	0.077	0.048	0.9790	154.2
NE06	2	0.138	0.159	0.117	0.9639	108.5
NE07	2[b]	—	—	—	—	—
NE08	2	0.301	0.350	0.252	0.9914	25.0

[a]Maximum and minimum values are for the 90 percent confidence interval on the mean.
[b]No measurable damping curve.
—Indicates no data are available.

APPENDIX D. ANEMOMETER DATA

Table 30. Phase 1 anemometer data.

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NW01	1	4.97	273.6	12.25	1.16	11.77	265.0
NW01	2	5.35	307.7	13.66	0.66	12.93	292.2
NW01	3	4.12	282.3	11.00	0.71	10.86	259.8
NW01	4	7.38	284.6	12.75	4.32	12.51	274.0
NW01	5	4.89	312.3	12.60	1.61	12.26	327.4
NW01	6	7.94	304.3	15.01	2.11	14.36	326.7
NW01	7	9.59	308.6	13.81	4.92	13.27	315.2
NW01	8	5.49	303.0	11.60	1.86	11.22	312.3
NW01	9	7.03	293.6	12.00	3.87	11.27	277.7
NW02	1	1.00	326.2	1.16	0.91	1.05	322.0
NW02	2	0.64	60.7	1.76	0.00	1.58	48.7
NW02	3	0.58	26.0	1.31	0.00	1.14	33.5
NW02	4	0.71	63.4	1.96	0.00	1.80	79.6
NW02	5	1.56	75.2	3.07	0.21	3.04	57.1
NW02	6	2.19	70.6	4.17	0.16	3.99	63.5
NW02	7	2.68	54.4	4.82	0.01	4.72	47.2
NW02	8	1.80	50.1	4.37	0.01	4.22	48.7
NW02	9	3.67	53.5	7.23	0.86	6.93	49.0
NW02	10	3.32	38.9	7.23	0.86	7.14	43.6
NW29	1	8.47	28.0	12.75	4.82	12.26	9.4
NW29	2	10.23	28.0	14.06	7.48	13.67	19.7
NW29	3	8.37	28.6	15.81	3.72	15.22	22.2
NW29	4	9.59	34.2	14.06	6.78	13.52	23.9
NW29	5	7.86	29.0	12.30	4.12	12.07	12.8
NW30	1	8.07	37.5	13.15	2.62	12.84	75.2
NW30	2	8.95	36.0	12.75	3.67	12.48	29.1
NW30	3	6.95	56.3	12.50	2.16	11.60	33.5
NW30	4	9.70	34.4	13.81	5.88	13.44	29.3
NW30	5	6.33	24.8	11.85	1.06	11.74	27.7
NW30	6	7.31	32.2	12.75	4.57	12.56	20.7
NW30	7	7.58	61.2	11.00	3.07	10.74	27.3
NW30	8	5.53	32.3	9.69	1.51	9.50	80.6
NW30	9	8.40	29.4	13.15	2.62	12.94	21.3
NW30	10	7.59	30.0	11.00	3.72	10.82	25.8
NW31	1	9.30	22.5	12.70	5.22	12.39	22.7
NW31	2	8.48	27.8	12.05	4.12	11.66	19.5
NW31	3	9.73	22.0	14.66	5.88	14.13	14.4
NW31	4	9.48	29.9	14.01	5.63	13.63	29.4

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NW31	5	8.57	56.5	13.61	4.77	13.11	45.6
NW31	6	9.07	45.6	14.46	4.77	13.85	44.4
NW31	7	8.28	56.0	13.35	2.57	12.98	46.0
NW31	8	9.11	24.9	13.81	4.12	13.35	16.6
NW31	9	9.73	18.6	13.61	6.33	13.28	8.9
NW31	10	10.07	34.1	15.36	5.88	14.59	21.8
NW32	1	7.76	38.8	10.54	5.02	10.06	25.1
NW32	2	8.10	37.1	11.00	5.68	10.73	27.4
NW32	3	6.59	39.2	9.44	3.92	9.19	31.0
NW32	4	5.86	42.3	8.09	3.92	8.01	20.0
NW32	5	6.41	42.1	10.09	3.27	9.92	33.9
NW32	6[a]	—	—	—	—	—	—
NW32	7	6.86	39.6	10.29	4.57	10.08	40.2
NW32	8	6.36	50.0	9.24	3.52	9.06	35.4
NW32	9	6.26	31.7	10.34	3.07	10.02	20.4
NW32	10	7.56	35.2	10.34	5.02	10.01	48.4
SE03	1	3.68	332.1	7.88	0.00	7.73	331.3
SE03	2	3.52	330.1	6.78	0.76	6.50	340.3
SE03	3	3.74	331.8	8.34	0.00	8.08	329.7
SE03	4	4.55	344.1	8.14	1.31	7.89	346.7
SE03	5	3.72	332.8	8.59	0.00	8.11	329.8
SE03	6	5.91	342.8	11.00	1.51	10.22	331.3
SE03	7	6.37	333.8	13.81	0.31	13.44	320.1
SE03	8	7.29	334.8	14.51	0.66	14.39	339.6
SE03	9	6.91	332.3	14.06	0.01	13.07	338.8
SE04	1	5.55	337.8	9.69	0.21	9.45	318.3
SE04	2	7.55	297.4	14.76	3.07	14.03	300.0
SE04	3	7.28	304.5	15.36	1.11	14.99	308.6
SE04	4	8.67	312.6	16.47	3.27	15.80	309.1
SE04	5	9.34	307.6	15.81	2.87	15.42	297.7
SE04	6	6.95	323.5	13.40	3.07	13.02	326.6
SE04	7	4.98	325.9	10.59	0.01	10.40	309.1
SE04	8	6.92	313.0	13.20	2.67	12.87	315.9
SE04	9	5.91	311.1	11.90	0.66	11.49	311.3
SE04	10	6.83	318.8	13.66	1.76	12.95	318.7
SE04	11	7.58	305.3	13.66	2.67	13.10	318.0
SE05	1	5.83	315.0	11.45	0.01	11.22	305.2
SE05	2	6.22	334.1	12.35	0.46	12.01	316.3
SE05	3	7.49	323.8	13.20	0.81	12.83	317.6
SE05	4	5.57	353.6	10.79	0.01	10.25	12.2
SE05	5	7.20	340.1	13.20	0.01	12.51	333.3
SE05	6	4.04	340.1	7.08	0.01	7.04	344.2

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SE05	7	8.13	325.7	14.51	0.81	13.83	323.4
SE05	8	5.81	359.7	12.55	0.01	12.13	9.0
SE05	9	6.42	331.0	13.86	0.01	13.33	328.1
SE05	10	5.96	329.8	13.86	0.06	13.02	317.6
SE32	1	6.93	46.2	11.65	0.01	11.17	58.9
SE32	2	5.75	52.9	9.89	1.96	9.26	67.8
SE32	3	5.66	57.8	9.44	2.82	9.12	78.1
SE32	4	7.33	62.1	11.20	2.62	10.60	57.3
SE32	5	4.65	46.2	8.59	0.00	8.55	37.0
SE32	6	7.28	21.4	10.54	3.27	10.30	18.7
SE32	7	6.23	49.2	9.24	2.82	9.06	48.1
SE32	8	6.90	25.8	11.85	2.16	11.67	33.6
SE32	9	5.80	28.7	9.64	1.31	9.35	25.9
SE32	10	5.98	39.1	9.24	1.06	8.91	39.1
SW01	1	5.40	77.4	9.39	2.47	8.74	73.9
SW01	2	4.22	68.3	8.14	2.21	7.45	64.6
SW01	3	4.17	60.9	6.58	1.31	6.12	49.3
SW01	4	3.99	56.7	6.53	1.51	6.24	48.1
SW01	5	3.70	56.4	5.93	1.56	5.75	68.3
SW01	6	2.93	64.1	5.02	1.11	4.74	77.8
SW01	7	3.30	76.1	6.83	1.56	6.55	49.3
SW01	8	2.55	83.4	4.92	1.11	4.48	89.2
SW01	9	3.09	82.3	5.17	1.56	4.92	87.9
SW01	10	4.60	63.7	8.29	1.76	8.04	51.1
SW02	1	4.01	39.9	7.28	0.66	7.19	60.2
SW02	2	3.86	35.9	7.68	1.51	7.17	38.6
SW02	3	4.17	35.5	7.93	1.31	7.53	20.6
SW02	4	5.31	32.6	10.54	1.51	9.72	25.1
SW02	5	4.50	359.3	10.34	0.86	9.14	309.1
SW02	6	6.01	343.4	13.61	1.56	12.42	347.8
SW02	7	6.44	345.0	13.20	1.81	12.57	350.2
SW02	8	6.59	358.9	12.75	1.76	11.60	334.8
SW02	9	4.24	359.8	9.89	0.86	9.37	334.6
SW02	10	5.09	7.6	9.24	0.81	8.56	342.1
SW03	1	4.18	20.4	8.54	0.86	8.02	358.8
SW03	2	3.63	37.3	10.95	0.06	10.22	42.6
SW03	3	5.22	37.3	12.95	0.06	12.69	50.2
SW03	4	4.15	33.6	12.50	0.31	11.46	42.6
SW03	5	4.88	357.6	11.20	1.26	11.02	11.6
SW03	6	5.12	351.1	11.85	0.06	11.00	348.9
SW03	7	4.05	25.6	7.03	1.71	6.49	18.2
SW03	8	5.11	7.5	16.67	1.51	15.98	52.4

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SW03	9	3.70	29.0	7.68	0.31	7.30	48.7
SW03	10	6.57	36.5	12.70	1.96	12.33	40.9
SW03	11	6.16	10.8	11.65	2.67	10.94	50.2
SW04	1	6.30	185.9	10.29	3.22	9.97	174.0
SW04	2	5.71	199.4	9.64	1.46	9.16	186.1
SW04	3	6.79	203.4	11.60	3.22	11.06	198.4
SW04	4	6.42	212.0	8.99	4.12	8.67	206.9
SW04	5	6.90	211.3	11.40	3.02	10.99	208.6
SW04	6	6.40	195.1	10.29	2.16	9.98	210.1
SW04	7	7.30	185.0	10.95	3.47	10.64	194.5
SW04	8	7.52	189.9	10.95	4.77	10.63	180.3
SW04	9[a]	—	—	—	—	—	—
SW04	10	6.65	192.3	10.95	3.67	10.63	180.3
SW04	11	6.78	208.1	10.09	3.02	9.69	220.2
SW05	1	7.82	206.3	12.50	3.92	12.32	216.4
SW05	2	10.62	205.1	18.42	4.12	18.18	207.8
SW05	3	8.34	204.7	13.81	1.96	13.56	199.7
SW05	4	12.95	210.7	18.17	8.09	17.96	211.5
SW05	5	9.94	226.5	16.21	3.27	15.83	242.7
SW05	6	9.33	223.4	13.81	4.12	13.57	236.4
SW05	7	10.04	225.3	18.22	4.57	17.96	240.8
SW05	8	13.71	214.3	19.53	5.68	19.13	221.6
SW05	9	11.65	219.5	17.97	5.02	17.38	237.1
SW05	10	9.66	217.9	16.47	4.82	15.26	221.0
SW06	1	10.95	216.2	16.26	6.13	15.79	225.5
SW06	2	10.73	210.7	16.67	6.58	14.53	212.6
SW06	3	8.55	206.5	12.95	3.27	12.58	203.2
SW06	4	10.76	205.4	17.77	5.48	17.00	199.6
SW06	5	12.27	211.4	19.73	6.33	18.84	220.3
SW06	6	13.37	213.3	19.33	6.98	18.35	224.8
SW06	7	11.38	213.0	19.07	5.68	17.75	200.3
SW06	8	13.21	204.1	20.63	6.13	20.17	218.8
SW06	9	12.36	220.5	23.04	5.28	21.85	213.5
SW06	10	10.59	231.5	21.28	1.96	19.51	227.5
SW29	1	6.11	350.2	12.10	0.21	11.76	3.2
SW29	2	2.02	352.0	7.48	0.01	7.16	322.9
SW29	3	2.92	51.3	7.03	0.66	6.73	15.5
SW29	4	3.57	318.6	7.68	0.01	7.61	286.9
SW29	5	4.28	310.9	9.49	0.01	9.16	318.8
SW29	6	2.57	296.4	6.18	0.71	6.00	307.2
SW29	7	2.69	307.7	6.38	0.01	6.23	304.5
SW29	8	3.65	341.7	6.63	1.51	6.58	349.1

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SW29	9	2.01	301.8	4.62	0.16	4.47	295.2
SW29	10	3.42	263.8	6.83	0.86	6.66	295.9
SW30	1	3.63	288.8	13.76	1.66	12.17	243.6
SW30	2	4.59	309.9	7.38	1.66	6.88	324.6
SW30	3	3.75	319.8	6.73	1.51	6.38	325.1
SW30	4	3.95	288.6	9.19	1.51	8.86	282.1
SW30	5	3.73	289.6	14.01	1.01	13.83	266.0
SW30	6	3.57	34.6	14.01	0.01	13.83	46.7
SW30	7	2.22	44.3	4.77	0.11	4.69	18.1
SW30	8	2.64	33.5	4.77	0.16	4.64	41.3
SW30	9	2.79	17.9	4.77	0.56	4.70	11.1
SW30	10	2.31	37.7	5.68	0.11	5.50	24.2
SW31	1	1.96	237.4	4.12	0.41	4.05	233.1
SW31	2	3.04	244.5	6.58	0.01	6.32	212.8
SW31	3	4.38	225.2	6.98	1.46	6.83	212.3
SW31	4	5.32	213.2	8.54	1.06	8.21	186.2
SW31	5	5.66	222.9	9.39	1.26	9.38	214.5
SW31	6	3.21	241.5	6.13	0.56	5.95	259.8
SW31	7	4.14	229.0	7.23	1.06	7.05	188.6
SW31	8	3.39	208.6	7.23	0.86	7.06	194.4
SW31	9	5.07	214.4	8.09	1.46	7.86	242.9
SW31	10	2.89	272.4	6.38	0.01	6.19	260.2
SW32	1	3.13	270.9	6.13	0.00	5.90	257.6
SW32	2	3.81	233.1	7.48	0.46	7.37	234.2
SW32	3	3.21	232.9	6.58	0.56	6.43	219.7
SW32	4	4.36	282.2	8.14	1.96	7.89	269.3
SW32	5	4.06	278.3	7.68	0.66	7.45	276.6
SW32	6	3.31	334.5	7.23	0.06	7.16	327.7
SW32	7	4.75	303.6	12.05	1.96	11.31	275.8
SW32	8	2.56	284.3	7.03	0.00	6.86	284.1
SW32	9	3.31	317.0	7.23	0.16	7.01	323.0
SW32	10	5.82	336.5	11.40	1.76	10.81	340.4

1 mi/h = 1.61 km/h

[a]Unreadable data.

—Indicates no data are available.

Table 31. Phase 2 anemometer data.

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NW01	1	6.12	120.1	10.74	2.82	10.04	132.6
NW01	2	6.45	115.1	10.09	3.72	9.63	123.9
NW01	3	5.60	121.7	11.40	0.81	11.08	125.4
NW01	4	5.88	124.9	8.54	2.41	8.46	123.3
NW01	5	6.34	118.6	10.74	2.82	10.50	124.0
NW01	6	6.85	119.9	10.09	3.67	9.69	113.7
NW01	7	5.47	127.8	8.54	2.62	8.25	145.0
NW01	8	4.60	123.9	8.14	2.62	7.86	132.9
NW01	9	4.23	120.2	8.34	1.51	8.16	125.8
NW01	10	4.32	128.6	6.78	1.76	6.43	136.2
NW02	1	4.62	126.6	8.59	1.31	8.17	126.8
NW02	2	4.42	131.7	8.14	0.00	7.82	120.9
NW02	3	5.27	118.1	10.54	2.16	10.30	129.6
NW02	4	5.75	116.5	10.74	3.27	9.86	99.3
NW02	5	7.45	122.7	12.30	3.07	11.92	123.2
NW02	6	5.87	137.5	9.19	1.96	8.42	141.2
NW02	7	5.53	139.7	9.04	2.87	8.78	136.8
NW02	8	5.36	125.6	9.44	0.16	8.92	154.6
NW02	9	6.44	128.6	10.14	2.87	9.73	117.8
NW02	10	7.12	128.3	13.20	3.32	12.28	135.2
NW03	1	6.74	113.9	11.90	1.31	10.68	99.1
NW03	2	5.39	132.7	10.59	0.00	10.10	125.9
NW03	3	6.15	135.5	11.25	1.76	10.99	142.9
NW03	4	7.15	123.4	11.90	1.36	11.57	118.8
NW03	5	5.41	131.6	12.10	0.16	11.05	114.9
NW03	6	6.11	148.1	12.55	1.31	12.07	153.0
NW03	7	8.02	128.5	13.00	3.77	12.23	121.7
NW03	8	3.29	142.9	9.49	0.00	7.81	151.5
NW03	9	5.22	152.9	11.70	0.41	10.77	145.4
NW03	10	6.23	149.7	12.95	0.86	11.86	160.4
NW29	1	9.04	8.9	13.20	4.62	13.01	1.2
NW29	2	8.05	352.9	10.54	3.97	10.54	352.2
NW29	3	7.27	3.1	9.69	5.02	9.53	348.3
NW29	4	7.42	356.0	11.00	4.22	10.91	358.6
NW29	5	8.06	358.2	11.00	5.93	10.84	7.1
NW29	6	8.93	352.4	13.61	5.28	13.39	329.4
NW29	7	8.30	350.4	12.75	4.62	12.50	347.8
NW29	8	9.76	352.6	13.00	6.78	12.75	354.6
NW29	9	7.74	358.2	12.10	4.17	11.56	4.8
NW29	10	9.32	4.3	14.06	4.82	13.89	14.8
NW30	1	2.85	259.5	5.28	0.81	5.16	260.7
NW30	1	2.85	259.5	5.28	0.81	5.16	260.7
NW30	3	2.82	267.4	4.37	1.71	4.23	258.2
NW30	4	3.87	259.1	6.18	2.21	5.99	261.0

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NW30	5	3.31	290.5	7.03	0.86	7.02	285.2
NW30	6	1.47	289.0	5.53	0.00	4.99	296.7
NW30	7	3.71	310.4	7.93	1.06	7.67	342.2
NW30	8	3.76	338.7	7.03	0.61	6.96	351.2
NW30	9	5.05	349.2	8.79	2.16	8.41	332.7
NW30	10	6.69	359.3	10.34	3.52	10.16	353.2
NW31	1	6.12	143.8	10.19	2.06	9.56	122.2
NW31	2	9.22	177.1	14.41	2.06	14.10	178.2
NW31	3	9.76	161.3	16.72	3.52	15.95	172.9
NW31	4	7.82	156.7	12.65	0.86	12.23	166.4
NW31	5	7.92	169.9	13.66	1.11	13.17	155.8
NW31	6	10.48	159.9	16.06	4.82	15.92	162.5
NW31	7	10.72	164.0	17.82	3.52	16.08	181.2
NW31	8	8.87	160.1	15.41	0.61	15.29	157.8
NW31	9	8.33	165.0	13.00	2.87	12.37	169.6
NW31	10	9.32	164.3	19.58	0.86	18.50	160.3
NW32	1	6.46	139.7	9.89	1.51	9.56	130.0
NW32	2	7.20	140.4	12.50	0.16	12.49	154.3
NW32	3	7.88	142.3	12.95	2.21	12.72	144.4
NW32	4	7.26	147.6	14.51	0.16	14.02	158.1
NW32	5	9.59	167.6	14.71	3.07	13.81	158.8
NW32	6	7.20	170.8	12.10	0.00	11.39	189.6
NW32	7	5.30	159.5	11.00	0.00	10.68	156.6
NW32	8	6.20	130.8	11.45	0.61	11.03	140.7
SE32	1	15.48	219.5	22.64	9.59	20.83	222.4
SE32	2	15.94	235.7	23.49	9.74	21.79	222.2
SE32	3	13.76	205.5	20.28	7.93	19.03	203.5
SE32	4	18.50	209.0	26.55	10.49	23.46	208.1
SE32	5[a]	—	—	—	—	—	—
SE32	6[a]	—	—	—	—	—	—
SE32	7[a]	—	—	—	—	—	—
SE32	8	15.61	211.0	22.19	0.00	20.57	220.1
SE32	9	14.28	207.2	20.23	9.64	16.82	210.7
SW01	1	3.56	135.9	5.53	2.47	4.33	112.7
SW01	2	2.40	126.7	4.87	0.26	4.02	92.9
SW01	3	2.09	169.8	4.17	0.00	3.25	171.2
SW01	4	3.87	208.3	7.38	0.06	6.15	226.4
SW01	5	6.57	199.8	10.19	2.52	9.04	199.8
SW01	6	5.59	215.5	8.49	2.92	6.78	196.9
SW01	7	5.23	262.6	8.69	0.00	6.89	248.4
SW01	8	6.13	244.8	11.30	2.21	10.86	256.7
SW01	9	7.06	208.3	10.90	4.22	9.21	231.2
SW01	10	6.46	186.0	10.44	3.67	8.94	198.0
SW02	1	9.51	174.7	12.15	0.00	11.01	174.7
SW02	2	8.45	153.2	11.55	0.00	10.01	161.3
SW02	3	7.48	163.6	10.79	-0.65	9.59	63.5

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SW02	4	7.40	117.8	10.90	0.00	9.73	137.5
SW02	5	8.95	150.6	10.95	1.71	10.35	183.5
SW02	6	8.23	121.5	11.45	0.00	9.91	108.2
SW02	7	9.04	121.8	12.65	0.00	11.03	127.4
SW02	8	8.23	141.8	12.15	0.00	10.98	182.7
SW02	9	6.70	130.6	11.30	0.00	10.04	145.2
SW02	10	6.64	151.9	9.49	3.52	8.57	151.4
SW03	1	9.39	155.6	13.00	0.00	11.69	150.7
SW03	2	9.39	166.2	12.65	5.73	11.22	168.4
SW03	3	9.08	160.1	12.80	5.58	11.13	212.7
SW03	4	9.24	158.9	12.55	5.43	11.05	147.2
SW03	5	9.09	167.4	12.00	5.07	10.96	167.6
SW03	6	8.84	181.2	12.35	4.87	10.76	198.6
SW03	7	7.36	156.7	10.39	3.67	9.19	153.8
SW03	8[a]	—	—	—	—	—	—
SW04	1	11.72	145.5	18.07	0.31	16.35	150.9
SW04	2	10.85	160.6	16.47	0.00	14.03	164.9
SW04	3	9.41	157.3	14.86	3.42	14.40	148.5
SW04	4	10.46	166.0	15.16	6.48	13.55	149.2
SW04	5	9.08	161.6	14.26	5.68	12.40	158.3
SW04	6	8.86	167.1	13.55	3.57	12.70	159.0
SW04	7	9.28	158.4	17.32	4.42	15.15	158.7
SW04	8	11.69	157.0	17.92	5.58	17.13	147.5
SW04	9	11.86	156.9	17.92	0.00	16.60	152.8
SW04	10	12.46	183.5	18.77	6.53	15.81	193.8
SW05	1	16.27	168.0	24.39	0.56	22.04	161.0
SW05	2	14.85	169.2	24.09	6.03	21.25	146.3
SW05	3	15.04	177.2	24.39	8.54	21.35	171.2
SW05	4	15.19	194.0	23.54	4.72	21.00	206.3
SW05	5	14.61	168.2	22.39	2.11	20.12	184.8
SW05	6	14.81	144.2	22.44	1.26	19.66	150.5
SW05	7	14.59	131.2	20.73	0.36	18.63	127.1
SW05	8	12.80	128.8	23.04	0.00	20.25	158.0
SW05	9[a]	—	—	—	—	—	—
SW05	10[a]	—	—	—	—	—	—
SW29	1[a]	—	—	—	—	—	—
SW29	2[a]	—	—	—	—	—	—
SW29	3[a]	—	—	—	—	—	—
SW29	4[a]	—	—	—	—	—	—
SW29	5[a]	—	—	—	—	—	—
SW29	6[a]	—	—	—	—	—	—
SW29	7[a]	—	—	—	—	—	—
SW29	8[a]	—	—	—	—	—	—
SW29	9[a]	—	—	—	—	—	—
SW29	10[a]	—	—	—	—	—	—
SW30	1	5.57	174.6	10.79	0.16	10.50	182.6

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SW30	2	7.26	175.9	12.25	3.77	11.31	167.2
SW30	3	8.41	191.8	12.60	4.67	10.97	194.6
SW30	4	8.31	195.5	14.21	4.47	13.13	169.1
SW30	5	8.58	166.9	12.50	4.87	11.48	158.2
SW30	6	13.00	217.2	18.82	6.03	17.13	212.7
SW30	7	12.43	218.8	17.72	6.13	16.50	212.1
SW30	8	12.05	192.9	17.57	6.03	15.91	200.9
SW30	9	12.03	202.9	15.61	6.73	14.32	203.9
SW30	10	12.22	191.6	17.67	7.38	16.18	191.3
SW31	1	6.35	182.1	11.10	2.77	9.87	197.1
SW31	2	8.27	197.4	11.65	4.47	10.96	180.4
SW31	3	7.84	194.0	11.10	4.57	10.34	209.4
SW31	4	8.00	189.7	11.20	4.12	10.02	190.7
SW31	5	8.04	201.3	11.40	3.82	10.33	177.8
SW31	6	7.73	182.6	14.81	3.72	13.44	164.0
SW31	7	8.49	192.7	10.95	6.33	10.19	178.3
SW31	8	3.81	178.6	7.58	0.86	6.87	217.1
SW31	9	6.90	169.1	13.00	2.77	11.87	171.1
SW31	10	7.66	148.3	10.79	3.72	10.05	167.5
SW32	1	7.94	185.5	10.95	3.17	9.96	182.4
SW32	2	9.29	190.4	13.20	5.58	12.04	193.8
SW32	3	9.75	181.5	13.50	5.58	12.22	174.1
SW32	4	8.85	165.5	11.80	5.17	10.62	183.8
SW32	5	7.56	157.2	10.54	4.77	9.40	167.5
SW32	6	7.81	171.2	11.70	4.77	10.50	191.4
SW32	7	6.56	177.2	10.85	3.82	9.66	185.9
SW32	8	8.16	167.2	12.30	3.42	10.92	166.7
SW32	9	10.19	171.2	13.61	6.48	12.48	174.6
SW32	10	10.27	189.7	13.91	6.73	12.45	166.2

1 mi/h = 1.61 km/h
[a]Unreadable data.
—Indicates no data are available.

Table 32. Phase 3 anemometer data.

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NE01	1	8.56	310.3	14.26	3.52	14.02	298.0
NE01	2	6.28	288.3	11.00	2.41	10.44	288.6
NE01	3	5.55	289.3	10.09	0.71	9.80	264.2
NE01	4	4.16	300.2	8.59	1.06	8.56	314.2
NE01	5	6.84	301.3	12.30	1.11	11.92	301.4
NE01	6	7.21	288.4	12.30	1.96	12.14	294.8
NE01	7	7.35	309.1	13.40	1.31	12.93	321.0
NE01	8	7.30	285.1	11.65	4.17	11.31	270.4
NE01	9	7.47	283.0	12.75	2.41	12.35	288.3
NE01	10	6.06	269.6	10.74	1.76	10.37	251.7
NE02	1	6.24	282.4	11.65	3.07	11.32	291.8
NE02	2	4.93	274.8	8.34	1.06	7.60	249.2
NE02	3	5.04	269.9	9.89	2.41	9.64	260.4
NE02	4	6.60	270.2	10.54	2.87	10.37	269.2
NE02	5	6.77	279.6	11.20	2.16	10.74	287.9
NE02	6	4.70	280.0	7.93	2.62	7.59	283.0
NE02	7	4.91	283.2	8.14	2.62	7.61	299.0
NE02	8	5.87	275.8	8.99	1.01	8.35	275.0
NE02	9	5.46	271.7	9.14	2.67	8.84	276.2
NE02	10	5.85	261.2	8.89	3.17	8.56	233.9
NE03	1	8.82	240.8	13.91	3.72	13.52	230.9
NE03	2	7.84	243.7	11.85	3.37	11.62	235.7
NE03	3	9.00	237.0	12.75	4.62	12.51	239.7
NE03	4	8.77	238.8	12.10	5.53	11.84	247.1
NE03	5	7.12	236.5	10.59	3.92	10.39	238.2
NE03	6	6.40	242.6	9.29	3.72	8.87	241.6
NE03	7	6.27	242.8	8.49	3.37	8.27	235.1
NE03	8	7.38	245.0	11.45	4.52	11.32	239.9
NE03	9	7.10	246.5	10.04	4.12	9.66	238.3
NE03	10	7.72	245.1	10.49	4.52	10.09	241.5
NE04	1	5.38	220.5	9.19	2.11	8.71	208.3
NE04	2	7.11	214.7	11.05	1.56	10.41	214.6
NE04	3	6.22	215.7	10.49	1.31	9.79	212.7
NE04	4	5.98	221.3	8.94	3.72	8.28	214.5
NE04	5	6.49	226.9	10.29	2.87	9.16	218.4
NE04	6	6.03	230.9	8.39	3.82	7.95	233.6
NE04	7	4.84	223.1	7.53	2.01	7.23	234.4
NE04	8	5.19	222.2	7.38	2.97	6.68	216.8
NE04	9	5.48	215.6	7.98	3.17	7.75	213.7
NE04	10	5.49	209.1	8.14	2.36	7.78	204.1

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
NE04	11	4.86	209.1	7.43	2.36	7.33	213.3
NE05	1	5.69	226.0	8.49	3.72	7.73	220.0
NE05	2	6.58	220.5	9.49	3.47	9.23	219.7
NE05	3	7.44	223.7	11.50	4.47	10.91	219.8
NE05	4	8.46	223.7	13.45	4.42	12.93	221.7
NE05	5	6.04	217.3	9.24	3.17	8.69	225.0
NE05	6	5.80	215.4	8.89	2.47	8.63	220.2
NE05	7	5.68	214.7	8.04	3.17	7.56	215.0
NE05	8	6.40	214.8	9.74	2.57	9.40	208.4
NE05	9	6.28	201.2	9.49	3.32	9.41	202.7
NE05	10	5.98	197.3	8.39	2.82	8.27	190.3
NE06	1	7.93	212.2	12.75	4.42	11.74	216.9
NE06	2	8.88	204.3	12.75	4.32	12.37	202.2
NE06	3	8.26	213.5	13.15	3.57	12.67	205.6
NE06	4	8.61	215.6	12.35	4.97	11.94	210.0
NE06	5	8.26	213.0	12.10	3.32	11.62	219.7
NE06	6	8.54	211.4	13.45	4.12	13.18	201.9
NE06	7	8.37	206.7	12.35	3.97	12.01	200.2
NE06	8	8.85	215.5	14.36	3.97	13.67	209.8
NE06	9	9.92	220.7	13.61	6.23	13.08	223.1
NE06	10	10.24	227.1	14.46	6.43	13.74	236.7
NE07	1	11.96	224.4	17.32	6.78	16.33	222.6
NE07	2	13.22	231.7	17.87	8.34	17.69	220.7
NE07	3	12.73	231.7	20.18	6.78	19.81	220.9
NE07	4	12.41	230.8	18.27	5.58	17.64	235.3
NE07	5	11.02	228.4	15.91	6.48	15.13	220.1
NE07	6	12.06	221.7	17.22	6.03	16.40	220.0
NE07	7	11.72	220.3	17.17	6.63	16.36	219.5
NE07	8	13.60	220.9	19.07	7.43	18.60	218.5
NE07	9	12.01	214.6	18.62	5.02	16.36	218.3
NE07	10	13.07	216.7	19.98	7.43	19.02	220.5
NE08	1	10.93	218.0	18.02	5.48	17.60	222.7
NE08	2	14.15	214.3	21.48	5.22	19.86	222.7
NE08	3	15.02	220.0	22.39	7.88	21.33	218.8
NE08	4	14.38	223.1	21.93	7.43	21.24	220.1
NE08	5	13.59	222.7	21.73	7.88	20.38	220.5
NE08	6	13.90	224.0	20.43	7.63	19.51	221.1
NE08	7	13.03	216.2	20.38	5.48	19.25	211.8
NE08	8	12.26	217.0	21.53	5.02	21.39	213.7
NE08	9	13.89	215.6	19.98	7.23	19.81	229.1
NE08	10	14.10	220.9	22.39	7.03	21.26	223.2
NE08	11	15.09	219.4	23.49	5.48	22.41	222.9

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SE27	1	9.51	350.9	16.01	4.17	15.86	351.7
SE27	2	9.29	346.1	14.51	3.47	14.15	340.3
SE27	3	8.77	338.9	14.71	2.41	14.09	351.0
SE27	4	9.97	340.5	17.77	1.51	16.85	341.5
SE27	5	10.98	324.4	16.67	1.31	16.06	327.8
SE27	6	7.26	337.2	13.15	0.01	12.92	344.1
SE27	7	9.77	345.1	16.26	3.72	15.12	345.4
SE27	8	7.75	310.8	14.46	0.01	14.08	317.3
SE27	9	10.52	325.3	17.12	4.37	16.07	324.6
SE27	10	7.57	320.8	12.95	2.16	12.47	329.6
SE28	1	9.28	343.4	20.18	1.31	19.66	341.5
SE28	2	9.32	339.5	15.61	1.31	14.61	331.1
SE28	3	7.80	345.3	16.92	1.96	15.93	339.5
SE28	4	7.54	337.4	13.61	2.62	12.69	340.8
SE28	5	7.99	348.0	17.37	2.62	17.02	343.3
SE28	6	7.86	337.5	14.71	2.62	14.18	326.3
SE28	7	7.50	341.1	14.06	2.41	13.66	355.8
SE28	8	8.37	332.5	15.61	2.16	15.27	331.0
SE28	9	7.47	344.4	14.51	1.11	14.12	341.7
SE28	10	7.41	345.0	14.26	1.51	13.88	345.5
SE28	11[a]	—	—	—	—	—	—
SE29	1	6.63	158.6	9.89	3.52	9.65	165.4
SE29	2	7.00	160.4	11.00	4.17	10.96	137.7
SE29	3	8.45	157.9	13.61	5.22	13.16	150.6
SE29	4	7.80	155.3	11.65	4.62	11.25	159.1
SE29	5	7.52	156.1	12.10	2.41	11.84	136.4
SE29	6	8.05	151.8	12.50	4.62	12.27	153.0
SE29	7	7.28	160.1	11.65	4.17	11.26	154.4
SE29	8	7.89	158.2	11.85	3.52	10.96	163.7
SE29	9	8.11	160.9	12.75	4.17	12.35	157.5
SE29	10	8.82	159.4	14.31	5.48	14.10	149.1
SE30	1	6.67	158.9	9.44	4.17	9.21	163.9
SE30	2	5.83	155.7	8.79	3.07	8.70	163.7
SE30	3	6.23	167.6	12.30	3.27	11.83	175.7
SE30	4	7.63	162.4	11.85	5.48	11.62	137.3
SE30	5	8.97	169.7	12.10	5.68	11.75	172.5
SE30	6	7.14	165.6	10.09	3.27	9.87	174.2
SE30	7	6.77	160.4	11.40	3.07	11.17	169.8
SE30	8	8.02	154.1	9.89	6.33	9.79	145.3
SE30	9	7.41	159.7	12.75	4.37	12.49	133.1
SE30	10	7.20	160.5	12.30	3.72	11.90	152.2
SE31	1	4.12	137.0	6.58	1.76	6.35	162.8

Cable	Run	Mean Speed (mi/h)	Mean Direction (degrees)	Maximum Speed (mi/h)	Minimum Speed (mi/h)	3-s Gust (mi/h)	3-s Gust Direction (degrees)
SE31	2	6.76	135.9	10.54	3.72	10.30	123.2
SE31	3	5.63	131.5	9.24	3.27	8.90	122.9
SE31	4	7.29	134.4	11.00	3.52	10.66	126.1
SE31	5	8.77	148.2	13.40	4.17	13.07	159.0
SE31	6	8.44	154.6	12.30	4.82	11.98	172.3
SE31	7	7.70	155.9	11.40	4.17	11.17	155.8
SE31	8	7.73	161.2	12.50	4.17	11.99	151.9
SE31	9	6.97	171.9	10.34	4.82	10.17	174.2
SE31	10	7.08	153.7	10.74	4.17	10.22	165.9
SE32	1	4.12	137.0	6.58	1.76	6.35	162.8
SE32	2	6.76	135.9	10.54	3.72	10.30	123.2
SE32	3	5.63	131.5	9.24	3.27	8.90	122.9
SE32	4	7.29	134.4	11.00	3.52	10.66	126.1
SE32	5	8.77	148.2	13.40	4.17	13.07	159.0
SE32	6	8.44	154.6	12.30	4.82	11.98	172.3
SE32	7	7.70	155.9	11.40	4.17	11.17	155.8
SE32	8	7.73	161.2	12.50	4.17	11.99	151.9
SE32	9	6.97	171.9	10.34	4.82	10.17	174.2
SE32	10	7.08	153.7	10.74	4.17	10.22	165.9

1 mi/h = 1.61 km/h
[a]Unreadable data.
—Indicates no data are available.

APPENDIX E. CABLE PROPERTIES

Table 33. General properties of tested cables.

Cable	Strand Count	Unit Weight Ungrouted (lb/ft)	Unit Weight Grouted (lb/ft)	Diameter (inches)	Length (ft)
1	54	51.3	74.0	8.85	516.4
2	54	51.3	74.0	8.85	503.2
3	50	47.9	71.9	8.85	490.1
4	45	43.7	69.3	8.85	476.9
5	43	42.0	68.3	8.85	464.3
6	41	40.3	67.2	8.85	431.2
7	37	35.7	55.5	7.87	398.3
8	37	35.7	55.5	7.87	365.8
9	35	34.0	54.5	7.87	334.2
10	31	29.8	45.5	7.08	303.2
11	31	29.8	45.5	7.08	273.1
12	30	29.0	45.0	7.08	243.8
13	27	26.4	43.4	7.08	216.3
14	23	23.1	41.3	7.08	190.3
15	21	21.4	40.3	7.08	162.7
16	19	18.9	33.1	6.30	134.7
17	19	18.9	33.1	6.30	132.6
18	21	21.4	40.3	7.08	158.6
19	23	23.1	41.3	7.08	184.6
20	24	23.9	41.9	7.08	209.3
21	29	28.1	44.5	7.08	235.8
22	30	29.0	45.0	7.08	264.5
23	31	29.8	45.5	7.08	293.9
24	34	33.2	54.0	7.87	324.5
25	37	35.7	55.5	7.87	355.7
26	37	35.7	55.5	7.87	387.7
27	42	41.1	67.7	8.85	420.4
28	44	42.8	68.8	8.85	453.5
29	45	43.7	69.3	8.85	486.7
30	49	47.1	71.4	8.85	519.7
31	54	51.3	74.0	8.85	553.6
32	54	51.3	74.0	8.85	587.6

1 lb/ft = 14.6 N/m.
1 inch = 25.4 mm.
1 ft = 0.305 m.

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