Case Study: Fan Acceptance Testing

Introduction

JetTech Mechanical was commissioned to perform acceptance testing for a 12-fan assembly unit. JetTech set up a temporary monitoring system using magnet mounted CTC TREA330 Triaxial Sensors.

They performed acceptance testing on four fans at a time, with sensor cabling run back from each set of four fans to the CTC TSB1000 Series Triaxial Switch Box. 252 readings were taken over the course of two hours of fan run time. Data was collected at each point at 20, 35, 40, 45, 50, 55, and 60 Hz.

Acceptance Criteria Used

ISO14692_2003

Machine Overview

The fan is classified as BV-3 because of motor size. The fan is also classified as rigid mounting because the frame/mount for the motors did not have a natural fundamental frequency lower than the lowest operating frequency.

Hardware Used

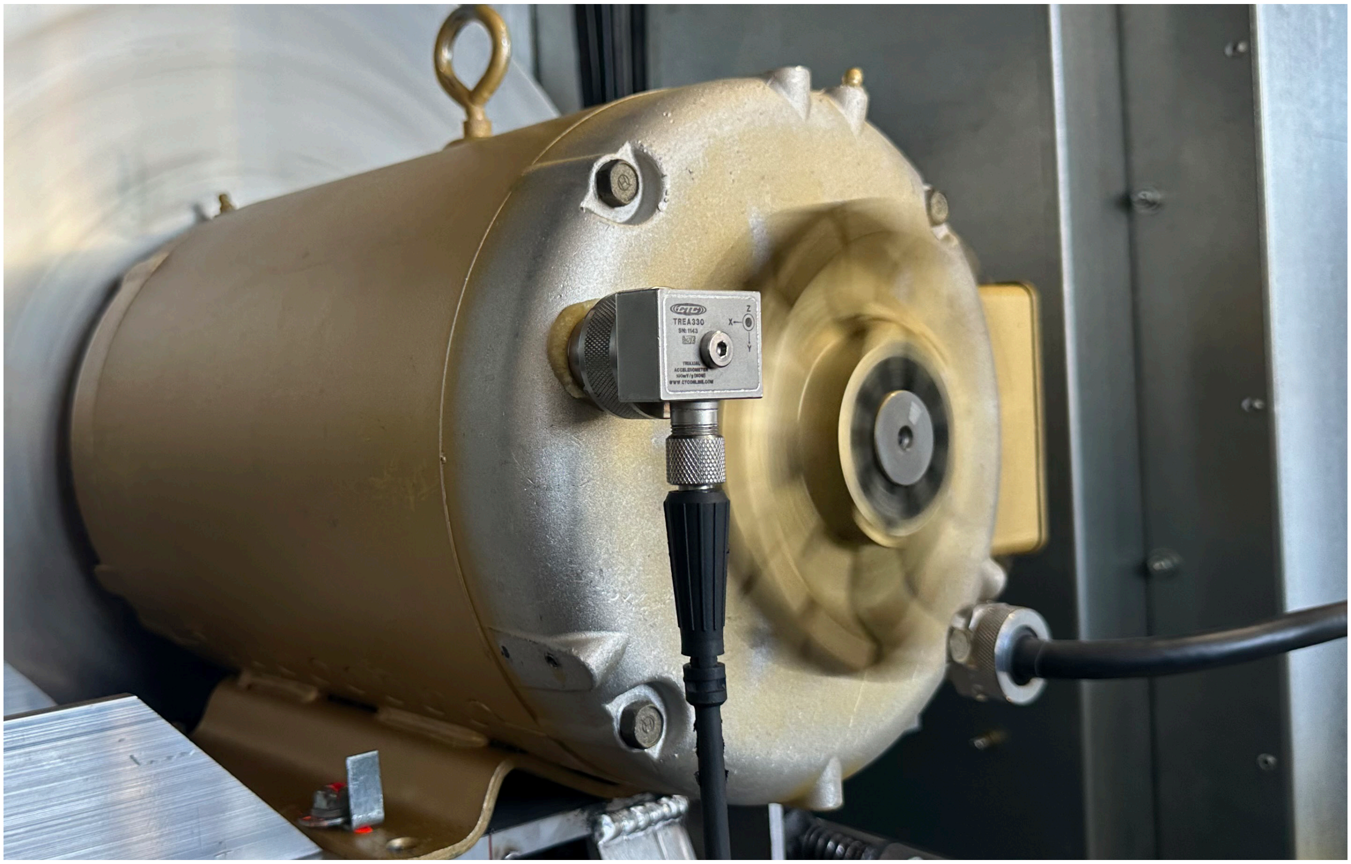
JetTech selected triaxial accelerometers for this project due to the number of vibration points requiring testing. Triaxial accelerometers allowed JetTech to collect data from hundreds of datapoints on 12 fans within a two-hour window, whereas single-axis sensors would significantly extend the time required. As a result, JetTech selected TREA330 Series Triaxial Accelerometers due to their premium frequency response capabilities.

TREA330
Premium Miniature Industrial Triaxial Accelerometer, Side Exit 4 Pin Mini-MIL Connector, Follows Cartesian Phase Coordinate System, 100 mV/g, ±5%

MH114-3T
Multipurpose 2 Rail Magnet Mounting Base with 1/4-28 Blind Tapped Hole and Triaxial Alignment Notch, 50 lbs. (23 kg) Pull Strength, 1.39 in. (35.31 mm) OD, 0.85 in. (21.59 mm) Height

CB105-J4C-020-F3D
4 Conductor, Shielded Cable with Black Polyurethane Jacket, 0.25 in. (6.4 mm) OD, 250 °F (121 °C) Maximum Temperature; Connector 1: 4 Socket Mini-MIL Connector with Rubber Bending Strain Relief, Polyurethane Molded; Connector 2: 3 Channel BNC Plug Connector, Polyurethane Molded

BetaVib VibWorks Data Analyzer

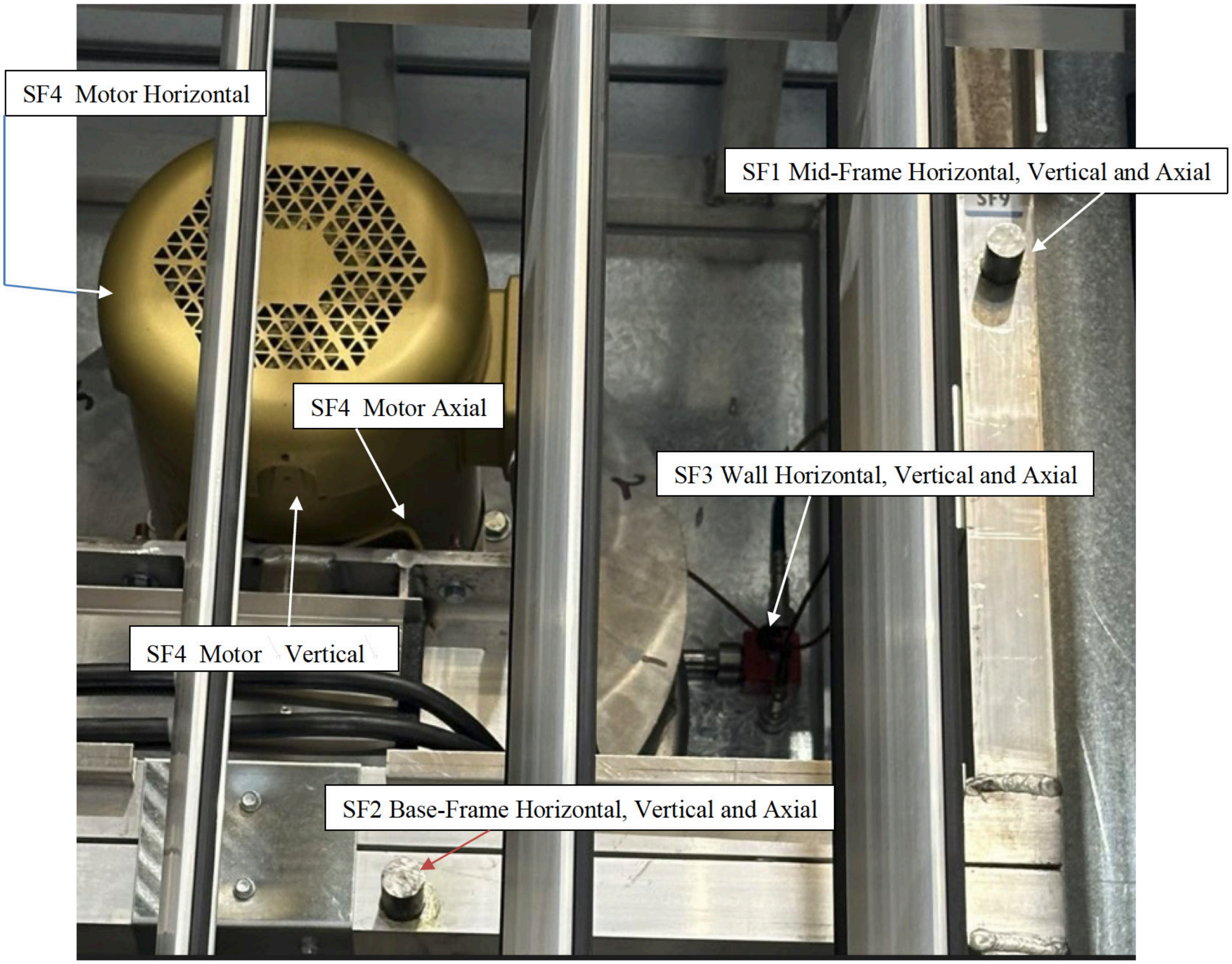



VibWorks

Analysis

The following table is the acceptance amplitudes permissible at any single axis. For this report, we are using inches/sec PEAK value of 0.346/s PEAK.

ISO 14694:2003 Table 5 - Seismic Vibration Limits for Tests Conducted in Situ					
Condition	Fan-Application Category	Rigid Mounting		Flexible Mounting	
		Peak / second	RMS / second	Peak / second	RMS / second
Startup	BV-1	14 mm / 0.551"	10 mm / 0.394"	15.2 mm / 0.598"	11.2 mm / 0.441"
	BV-2	7.6 mm / 0.299"	5.6 mm / 0.220"	12.7 mm / 0.500"	9.0 mm / 0.354"
	BV-3	6.4 mm / 0.252"	4.5 mm / 0.177"	8.8 mm / 0.346"	6.3 mm / 0.248"
	BV-4	4.1 mm / 0.161"	2.8 mm / 0.110"	6.4 mm / 0.252"	4.5 mm / 0.177"
	BV-5	2.5 mm / 0.098"	1.8 mm / 0.071"	4.1 mm / 0.161"	2.8 mm / 0.110"
Alarm	BV-1	15.2 mm / 0.598"	10.6 mm / 0.417"	19.1 mm / 0.752"	14.0 mm / 0.551"
	BV-2	12.7 mm / 0.500"	9.0 mm / 0.354"	19.1 mm / 0.752"	14.0 mm / 0.551"
	BV-3	10.2 mm / 0.402"	7.1 mm / 0.280"	16.6 mm / 0.654"	11.8 mm / 0.465"
	BV-4	6.4 mm / 0.252"	4.5 mm / 0.177"	10.2 mm / 0.402"	7.1 mm / 0.208"
	BV-5	5.7 mm / 0.224"	4.0 mm / 0.157"	7.6 mm / 0.299"	5.6 mm / 0.209"
Shutdown	BV-1	NOTE 1	NOTE 1	NOTE 1	NOTE 1
	BV-2	NOTE 1	NOTE 1	NOTE 1	NOTE 1
	BV-3	12.7 mm / 0.500"	9.0 mm / 0.354"	17.8 mm / 0.701"	12.5 mm / 0.492"
	BV-4	10.2 mm / 0.402"	7.1 mm / 0.280"	15.2 mm / 0.598"	11.2 mm / 0.441"
	BV-5	7.6 mm / 0.299"	5.6 mm / 0.220"	10.2 mm / 0402"	7.1 mm / 0.280"
NOTE 1: Shutdown levels for fan-application grades BV-1 and BV-2 should be established based on historical data NOTE 2: The RMS values given in this table are preferred. They are rounded to an R20 Series as specified in ISO10816-1. Peak values are widely used North America. Being made up of a number of sinusoidal wave-forms, these do not necessarily have an exact mathematical relationship with the RMS values. They also depend to some extent on the instrument used.					



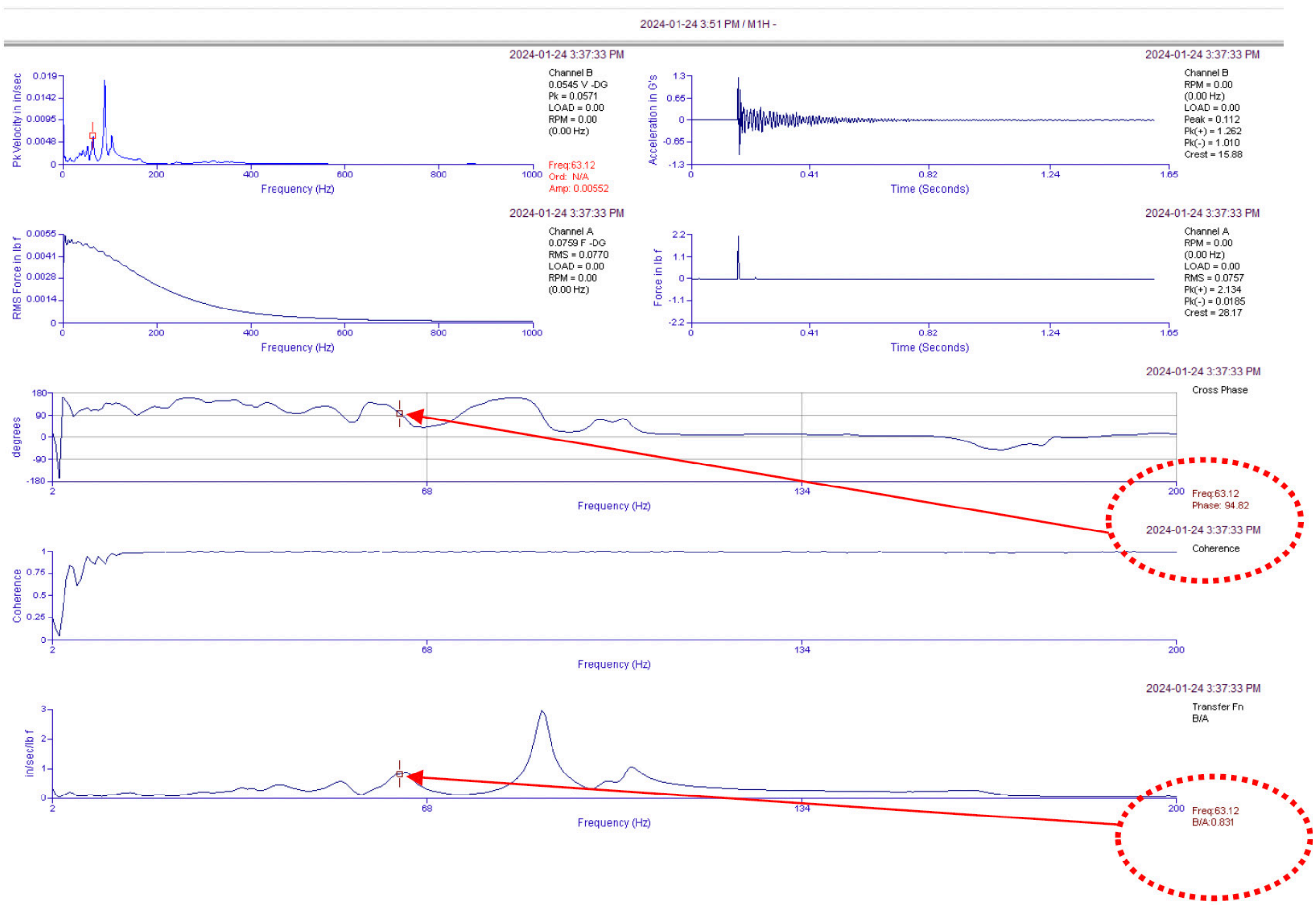
Actual Photo of Sensors and Positions

Impact Test Results - Overview

JetTech Mechanical performed calibrated impact testing on all 12 axis points in the above photo (M1 Motor H-V-A; F1 Mid Frame H-V-A; F2 Base-Frame H-V-A and FV3 Wall H-V-A).

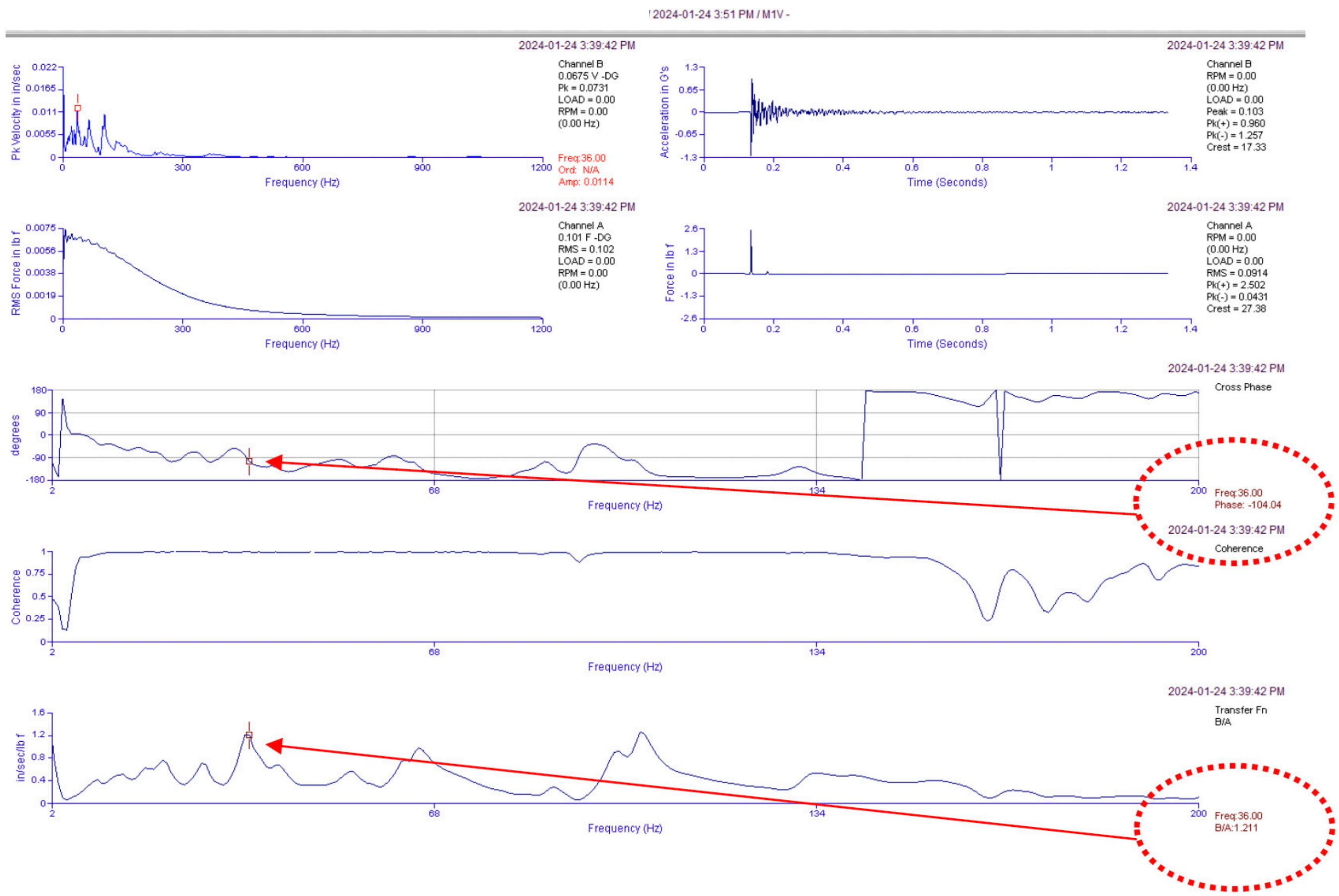
Motor Horizontal

We see a clear 63.12 Hz fundamental critical frequency with the confirming 90° phase shift.



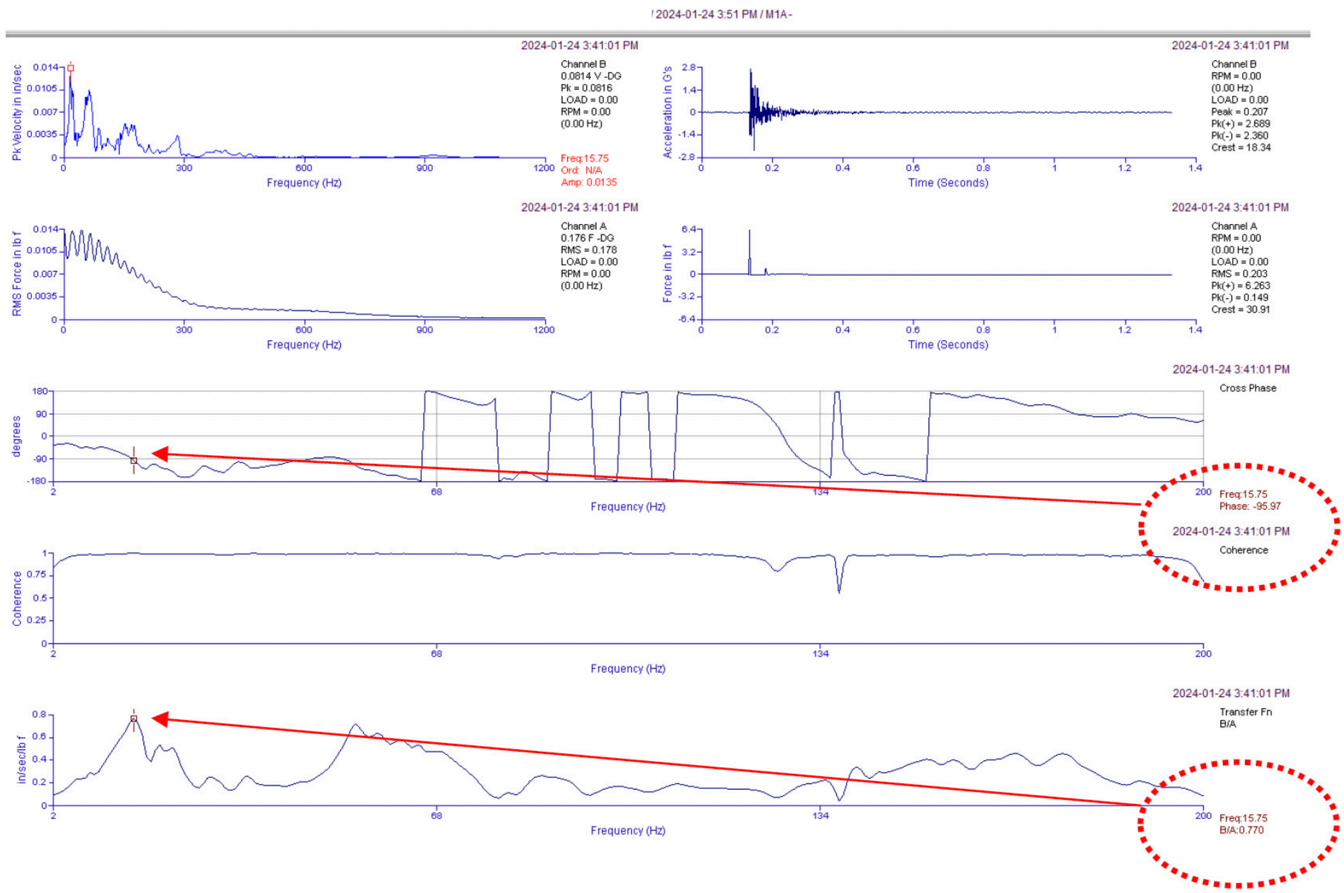
Motor Vertical

We see a clear 36 Hz critical frequency with the confirming 90° phase shift.



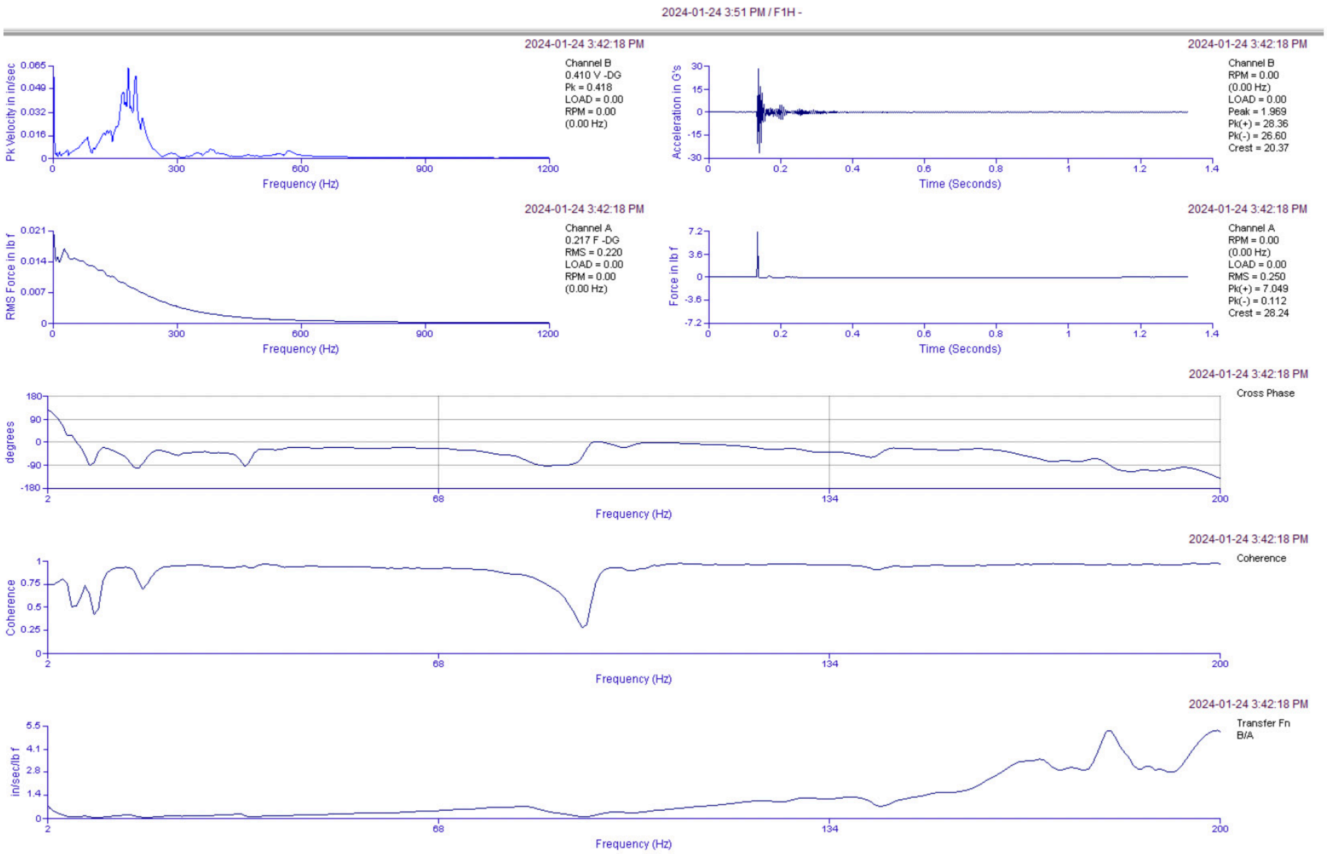
Motor Axial

We see a clear 15.75 Hz critical frequencies with the confirming 90° phase shift.



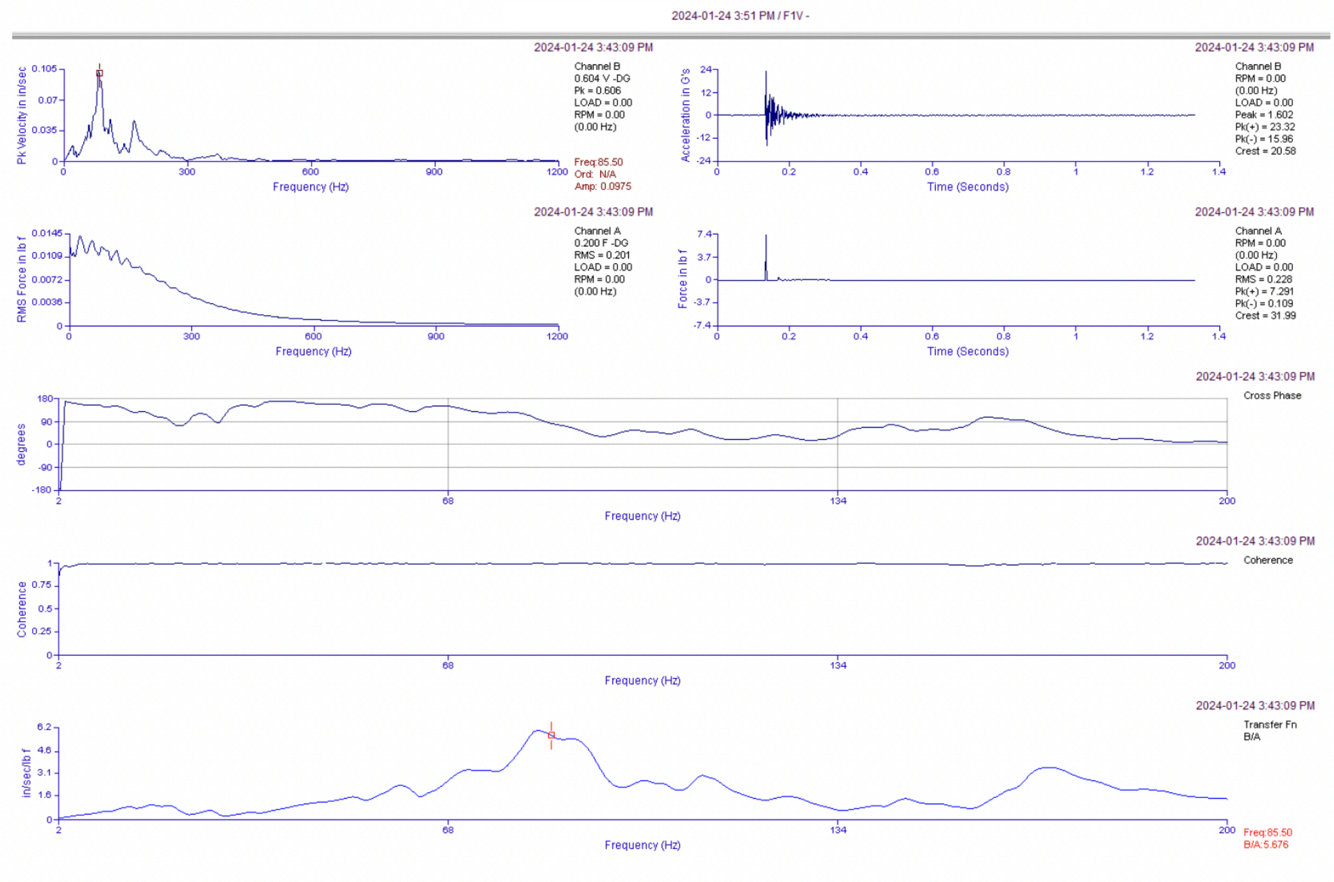
Frame Midpoint Horizontal

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



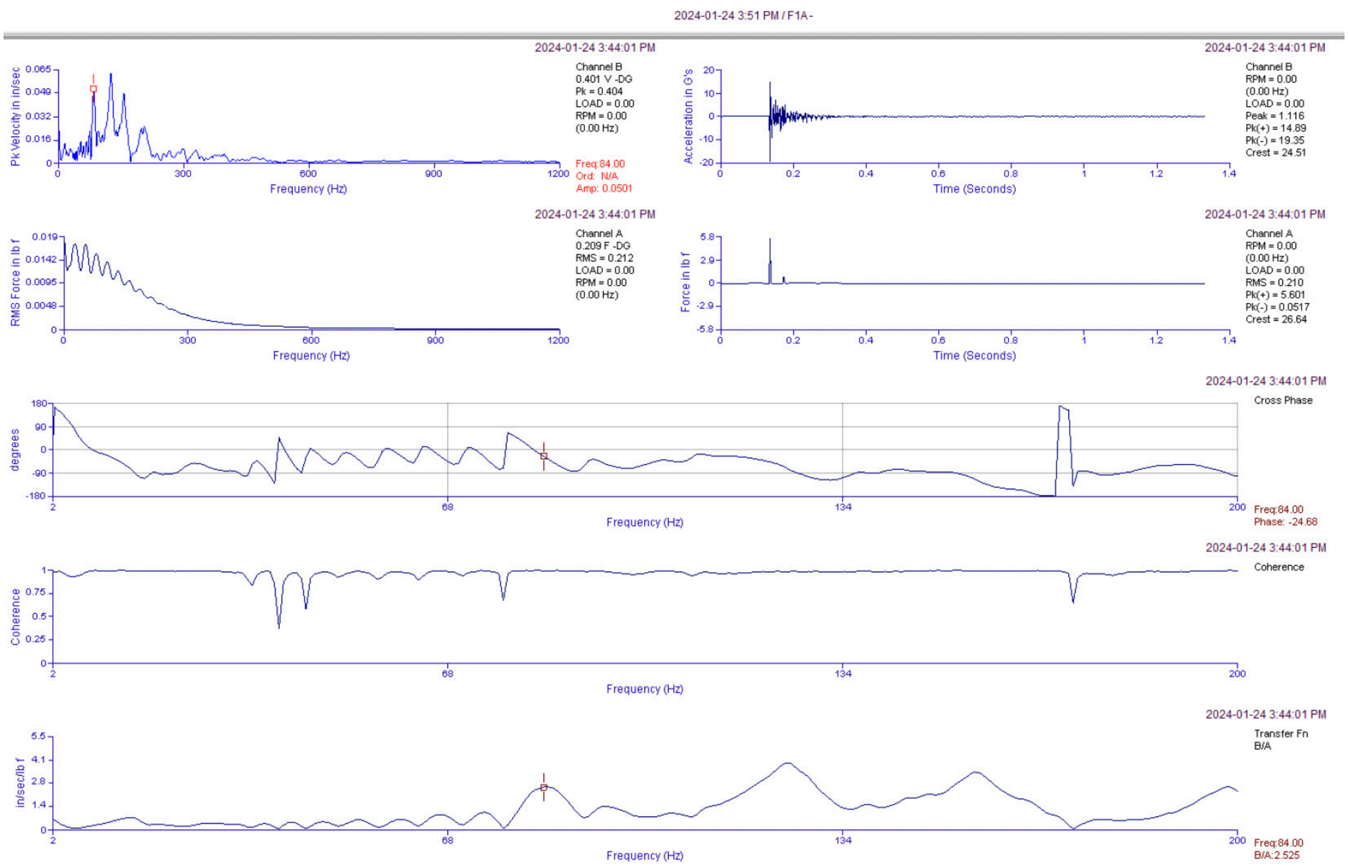
Frame Midpoint Vertical

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



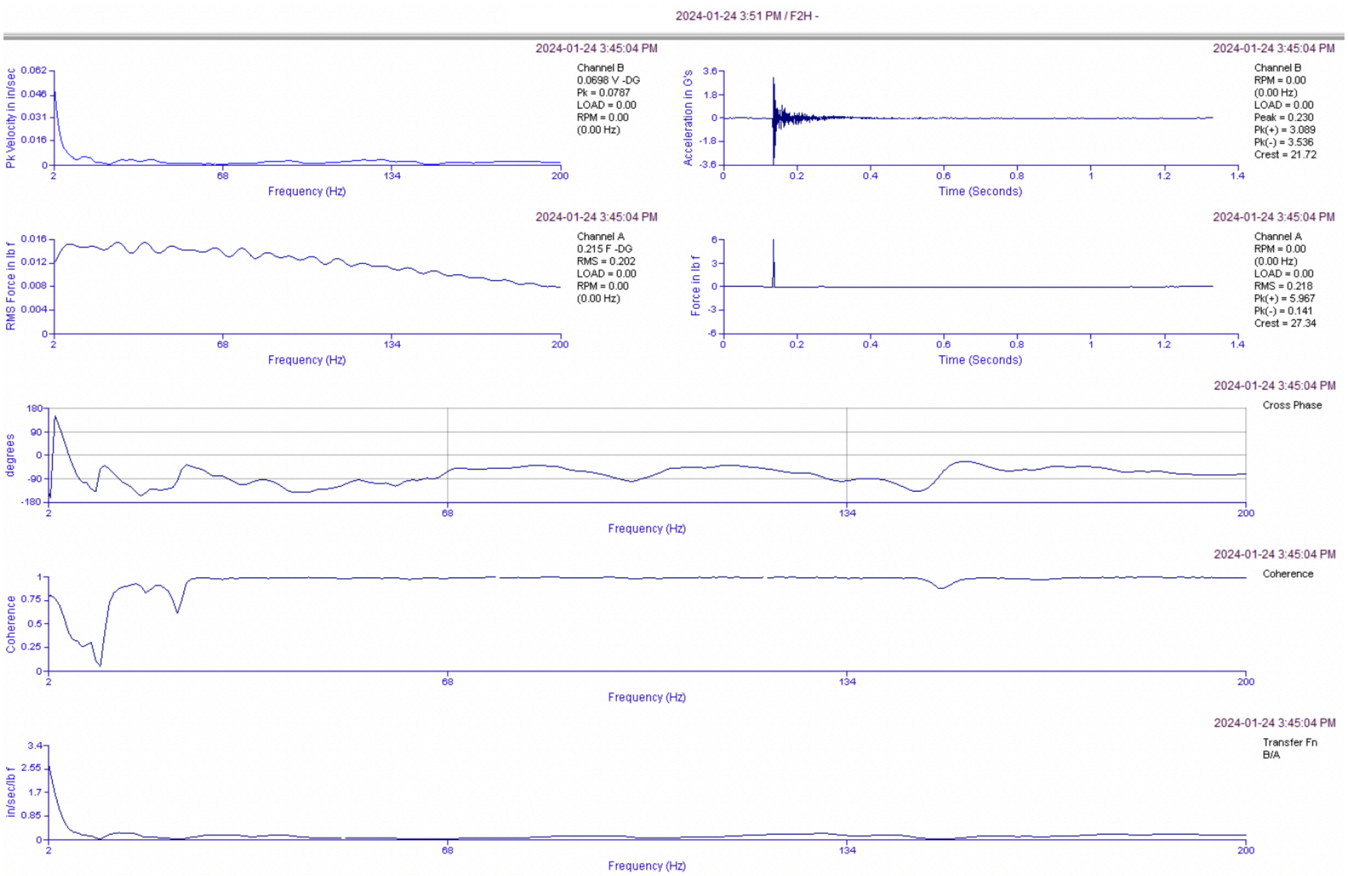
Frame Midpoint Axial

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



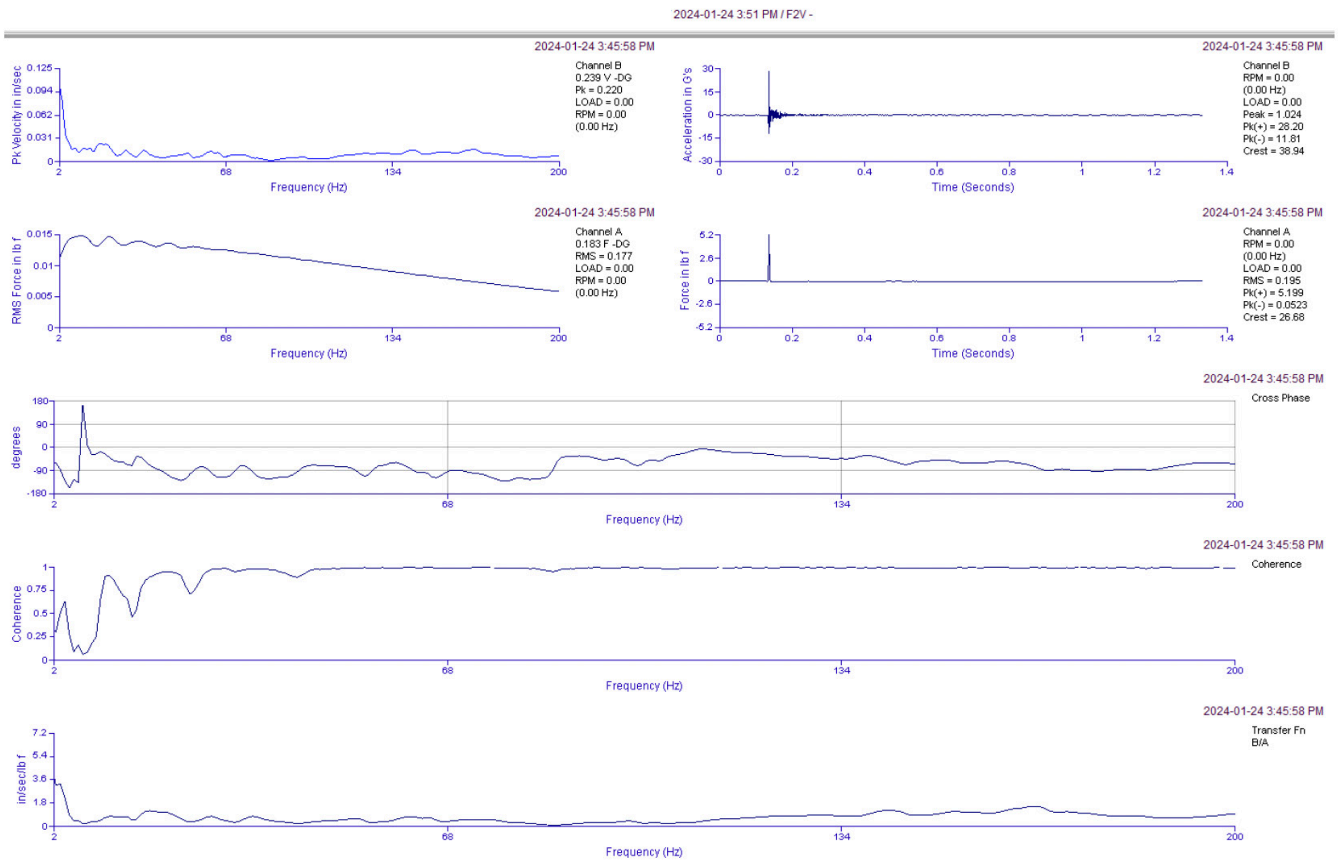
Frame Base Horizontal

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



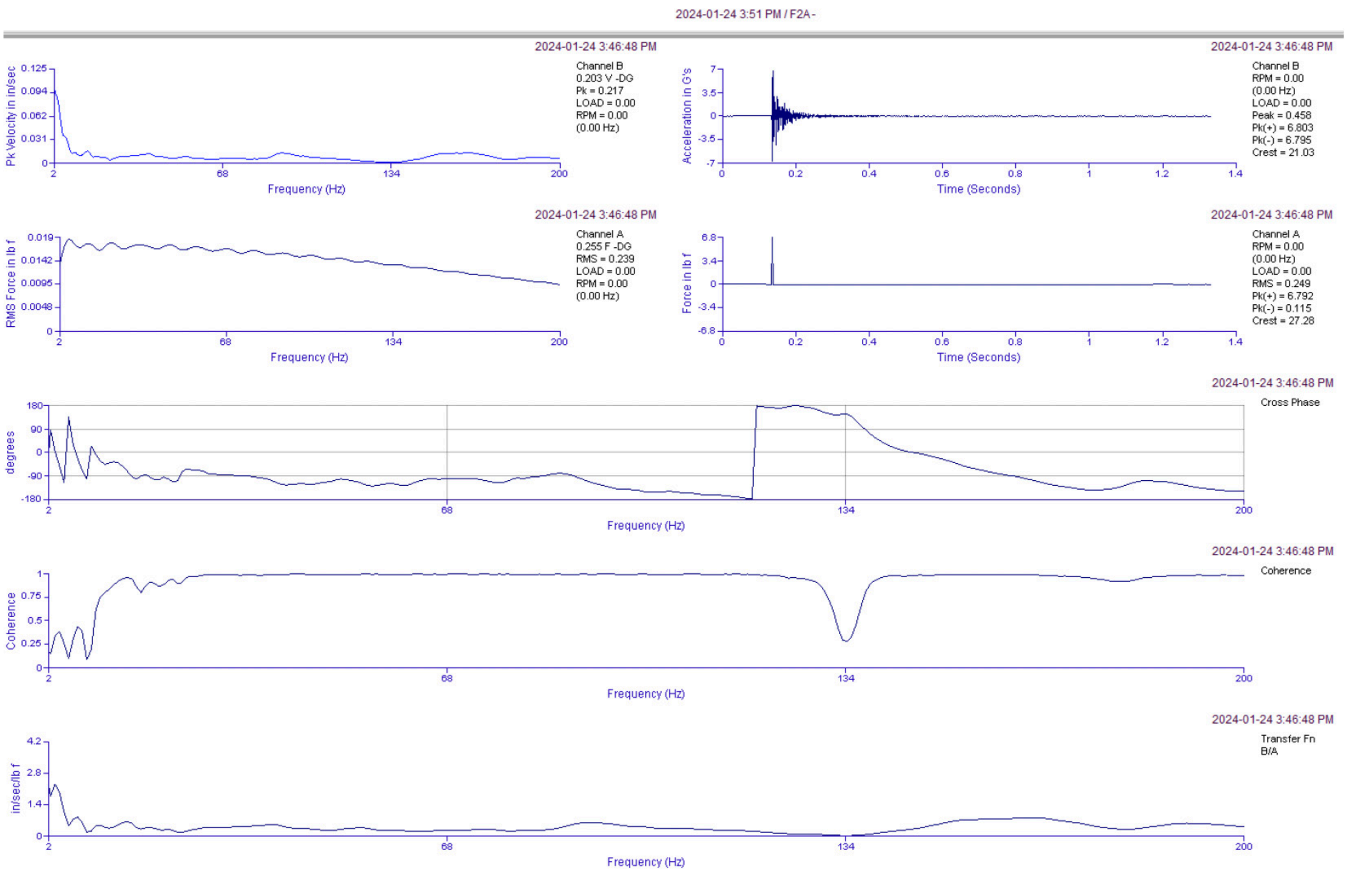
Frame Base Vertical

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



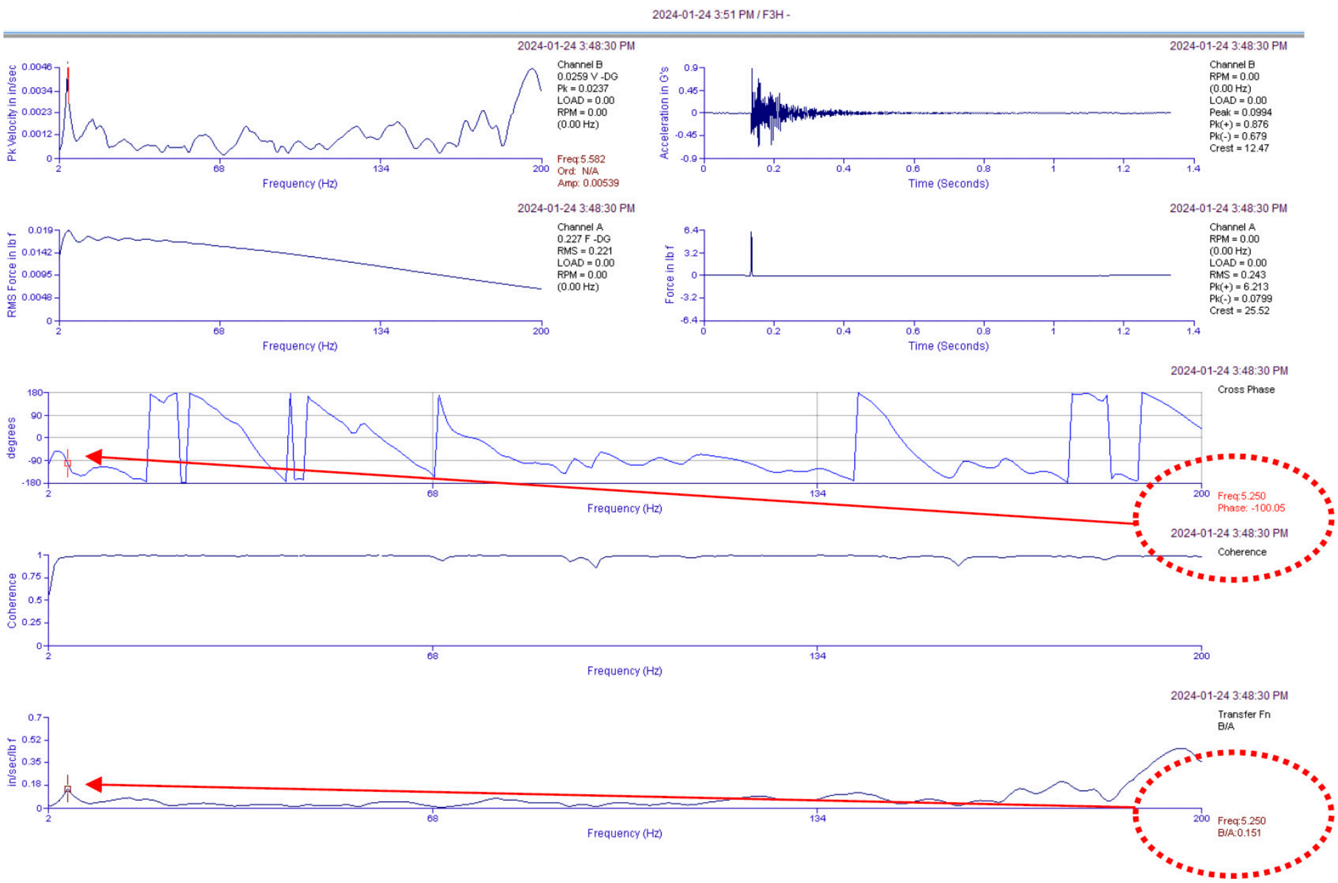
Frame Base Axial

No appreciable critical frequencies in this axis in the operating range of 17 - 34.5 Hz.



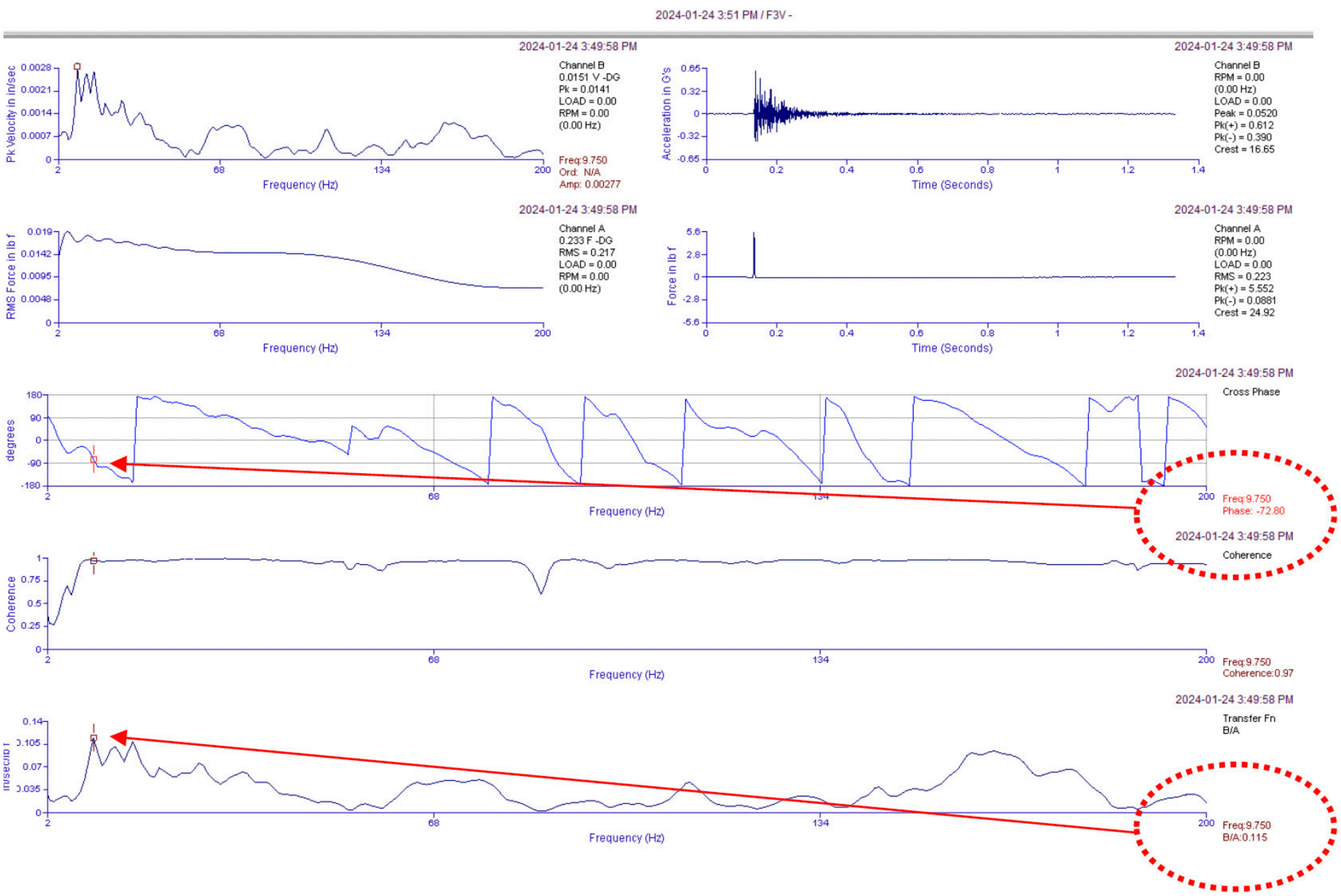
Wall Horizontal

We see a clear 5.35 Hz critical frequency with the confirming 90° phase shift.



Wall Vertical

We see a clear 9.75 Hz critical frequency with the confirming 90° phase shift.



Wall Axial

We see a clear fundamental critical frequency of 15 Hz with the confirming 90° phase shift.