CLARK
Dynamic Test Laboratory, Inc.
A Division of Clark Testing Group

Qualification Test Report

Company	ZincFive
Address	220170 SW 112th Avenue Tualatin, OR 97062
Device	BC 2 Battery Cabinet
Model	ZF-38A__KB BC 2 Battery Cabinet
Report Number	JID 22-01199 Rev.1
Purchase Order	10591
Job Identification	JID 22-01199
Testing Date	12/08/2022
Issue Date	2/14/2023
Issued By	Clark Dynamic Test Laboratory Inc. 1801 Route 51 South Jefferson Hills, PA 15025

Prepared By:	Reviewed By:
	
Devon Lohr	Jacob Martin
General Manager	Mechanical Engineer
Clark Testing	Clark Testing

Amendments to Report

REV #	ISSUE DATE	PREPARED BY (CLARK)	SECTION	AMENDMENTS
0	1/30/2023	Devon Lohr	All	Initial Release
1	02/09/2023	Devon Lohr	Various	Addressed Rev.0 Customer Comments

Table of Contents

Table of Figures

List of Tables

Appendices

Conformance Statement

The testing performed on the equipment described herein conforms to the requirements set forth in the referenced procedure. Any deviations from these requirements are listed below and have been approved by the responsible supplier representative.

Customer Information:	ZincFive. 220170 SW 112th Avenue Tualatin, OR 97062
Customer Purchase Order No:	10591 **Revision:** 08/08/2022
Job Identification Number:	22-01199
Test Date:	12/08/2022
Test Item:	Battery Cabinet Model: ZF-38A___KB BC 2 Battery Cabinet Serial Number: DWFS-2022-47-000003
Quantity:	One (1)
Reference Procedure:	ICC AC156
Conducted Test:	Three (3) Sine Sweeps, Two (2) Seismic Earthquakes
Test Results:	Testing was conducted, for only the item listed above, in accordance with the above referenced procedure and/or specification.
Test Deviations:	None

The process and testing operations noted above have been performed within the requirements of the Clark Testing Management System Manual, dated January 2, 2019.

Prepared By:	Reviewed By:	Issue Date:
Devon Lohr General Manager	Michelle Felicetti Quality Manager	February 14, 2023

1. Summary

1.1. Purpose

The purpose of this document is to present the necessary information to verify testing was performed in accordance with the referenced test standard. A satisfactory test will meet the Criteria outlined in "ACCEPTANCE CRITERIA FOR SEISMIC CERTIFICATION BY SHAKE-TABLE TESTING OF NONSTRUCTURAL COMPONENTS", ICC AC156.

1.2. Applicable References, Standards, and Procedures

- ICC AC156 – "Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components"

1.3. Laboratory Equipment

1.3.1. Shake Table Specifications

The qualification program was conducted on an ANCO R6 Shake Table with the following specifications:

ANCO R-6 Triaxial Shake Table

- Three 38kips Hydraulic Actuators
- 50ips Velocity
- + / - 5" Peak Displacement
- 1Hz to 100Hz Frequency Capability
- 10ft Hexagonal Table, Measured Across the Flats (can be extended)
- 20,000lb max payload capacity

1.3.2. Instrumentation Calibration

Equipment and instrumentation were in calibration, traceable to the National Institute of Standards & Technology. The following figure lists the equipment used for the test program. The following list shows the Clark Testing Laboratory McBee identification number and the calibration due date.

CLARK TESTING

Job Number: JID 22-01199
Start Date: 12/08/22 - **End Date:** 12/08/22
Traceability Report for McBee Number(s): 4055, 4056, 4057, 4611, 4431, 4422, 4762, 4616, 4174, 4176, 4419

Cal. Due	Location	Instrument No.	McBee No.	Instrument	Model No.	Manfacturer	Serial No.
06/08/2024	Standards Lab	226	4055	Vibration Controller	8500	Vibration Research Corp.	1B87CE
06/08/2024	Standards Lab	227	4056	Vibration Controller	8500	Vibration Reasearch Corp.	1B8302
06/08/2024	Standards Lab	228	4057	Vibration Controller	8500	Vibraton Reseach Corp.	1B9028
03/07/2023	Seismic	1307	4611	Accelerometer	7596A-30	Endevco	32466
03/07/2023	Seismic	242	4431	Accelerometer	7596A-30	Endevco	32016
03/07/2023	Seismic	233	4422	Accelerometer	7596A-30	Endevco	32017
07/21/2023	Seismic	1490	4762	Torque Wrench	Computorq 3 2503CF3HA	CDI Torque Products (Snap On)	0215014880
10/27/2023	Standards Lab	1607	4616	Accelerometer	7596A-30	Endevco	33147
10/27/2023	Standards Lab	195	4174	Accelerometer	7596A-30	Endevco	31298
10/27/2023	Standards Lab	188	4176	Accelerometer	7596A-30	Endevco	31300
07/28/2023	Standards Lab	696	4419	Hanging Scale-Dock	5THB	Caston II	TH10204753

Figure 1: Calibration and Traceability Report

1.3.3. Location

Triaxial accelerometers (A1 FB, A2 SS and A3 V) were the controls used as a constant measure of table activity. The following tables provide the characteristics and location of the instrumentation used during testing.

Name	McBee #	mV/g	Calibration Due	Location
A1 FB	4611	66.05	03/07/2023	Control – Seismic Table
A2 SS	4431	66.25	03/07/2023	
A3 V	4422	66.20	03/07/2023	
A4 FB	4616	66.40	10/27/2023	Top, Right, Side, Front
A5 SS	4174	66.27	10/27/2023	
A6 V	4176	66.95	10/27/2023	

Table 1: Equipment Location

Figure 2: Placement of A4, A5, and A6

1.4. Observers

Testing was witnessed by ZincFive representative, Aaron Schott.

ZincFive
220170 SW 112th Avenue
Tualatin, OR 97062
Aaron Schott
aschott@zincfive.com
503-399-3517

Testing was performed at Clark Dynamic Test Laboratory Inc. under the guidance of Clark General Manager, Devon Lohr.

Clark Dynamic Test Laboratory Inc.
1801 Route 51 South
Jefferson Hills, PA 15025
Devon Lohr
dlohr@clarktesting.com
412-387-1026

1.5. Equipment to be Qualified

The following table describes the characteristics of the equipment. No damage was noted upon receipt inspection.

Name	Designation	Serial Number	Weight	Dimensions
BC 2 Battery Cabinet	UUT1	DWFS-2022-47-000003	1,841lbs.	36” L x 21” W x 82½” H

Table 2: Equipment Information

1.6. Seismic Parameters

1.6.1. Resonant Frequency Search

UUT1 was subjected to a single-axis sine sweep in each of the three orthogonal axes.

Frequency Range (Hz)	Sweep Rate (oct/min)	Acceleration Level (g)
1.3-33.3	2	0.07

Table 3: Resonant Frequency Search

1.6.2. Multi-frequency Seismic Simulation Tests

Prior to UUT mounting, the amplitude of each spectrum was independently adjusted in each of the three axes until the Test Response Spectra (TRS) enveloped each Required Response Spectra (RRS). The TRS were analyzed with 5% damping and plotted at ⅙ octave intervals. The RRS were based on the normalized response spectra shown in the figure below.

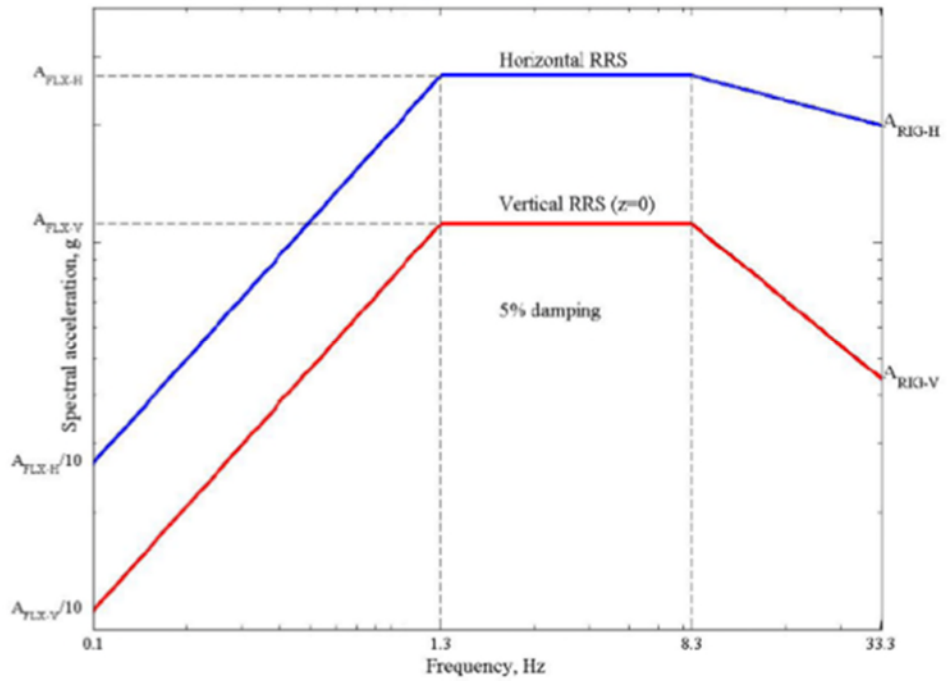

Figure 3: Normalized RRS

2. Execution and Results

2.1. UUT1

2.1.1. Mounting

UUT1 was mounted on the seismic table using four (4) ¾”-10 SAE grade 5 hex bolts with washers, and lock washers torqued to 150ft.-lbs. The table direction to UUT1 is shown in the diagram on page I-5 of Appendix I.

Figure 4: UUT1 Pre-Test Condition

Figure 5: UUT1 Pre-Test Condition

Figure 6: UUT1 Pre-Test Condition

Figure 7: UUT1 Pre-Test Condition

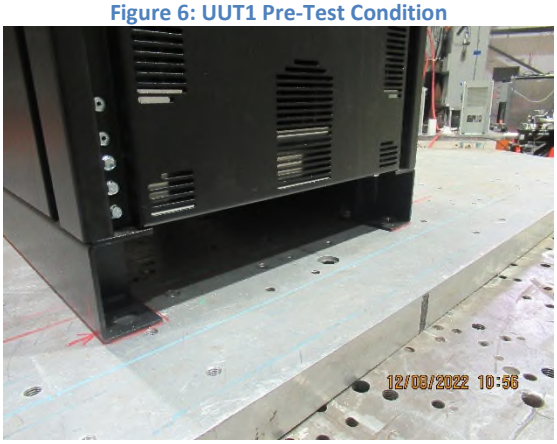

Figure 8: UUT1 Pre-Test Condition

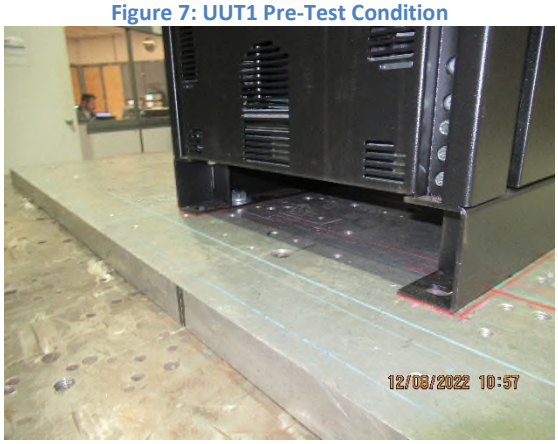

Figure 9: UUT1 Pre-Test Condition

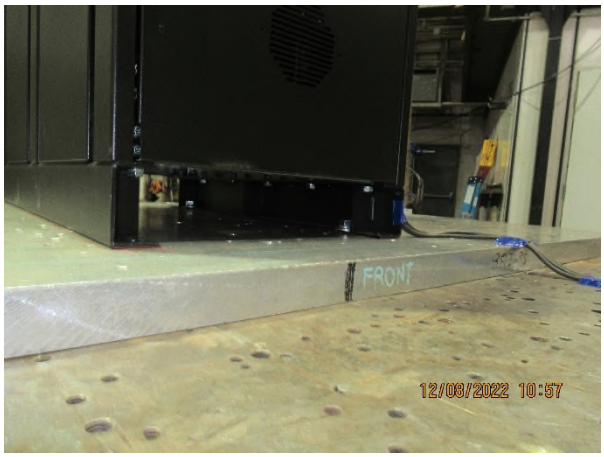

Figure 10: UUT1 Pre-Test Condition

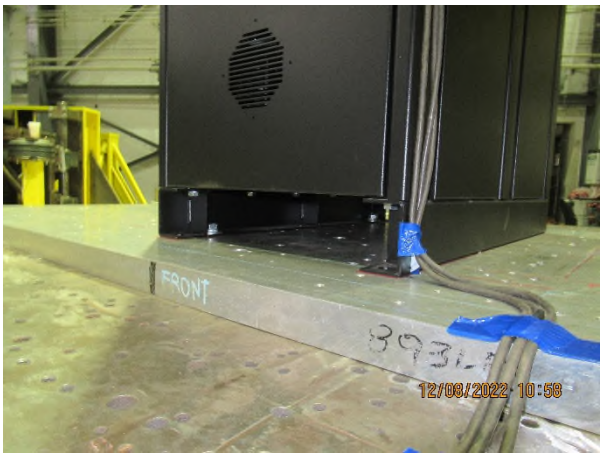

Figure 11: UUT1 Pre-Test Condition

2.1.2. Resonance Search

Clark Testing performed the resonance search as described in Section 1.6.1.

UUT	RESONANCE FREQUENCY (Hz)		
Identification	Front-to-Back	Side-to-Side	Vertical
UUT 1	12.28	10.07	N/A

Table 4: Resonance Frequency

2.1.3. Run 1 (Multi-frequency Seismic Simulation Test)

On 12/08/2022 Clark Testing performed run 1 in accordance with AC 156. The test was performed as described in Section 1.6.2., with the levels described in the following table.

Test Level	Test Criteria	Demand Level		Horizontal		Vertical	
		S_{DS}	z/h	A_{FLX-H}	A_{RIG-H}	A_{FLX-V}	A_{RIG-V}
1	AC156	1.5	1	2.4	1.8	1.01	.41

Table 5: Run 1 Seismic Parameters

Generated table input motion and test response spectrum were reviewed against criteria detailed in ICC AC156 section 6.5. The test met the acceptance criteria and was therefore determined acceptable. Plots of the run are available in Appendix II.

Damage noted after the test:

- No damage.

The minimum and maximum peak accelerations of run 1 are listed in the table below.

Channel	Minimum (-g)	Maximum (g)
A1 FB	2.06	1.98
A2 SS	1.88	1.69
A3 V	1.24	1.47
A4 FB	3.39	2.75
A5 SS	4.41	3.4
A6 V	1.49	1.48

Table 6: Run 1 Peak Accelerations

Figure 12: Run 1 Post-Test Condition

Figure 13: Run 1 Post-Test Condition

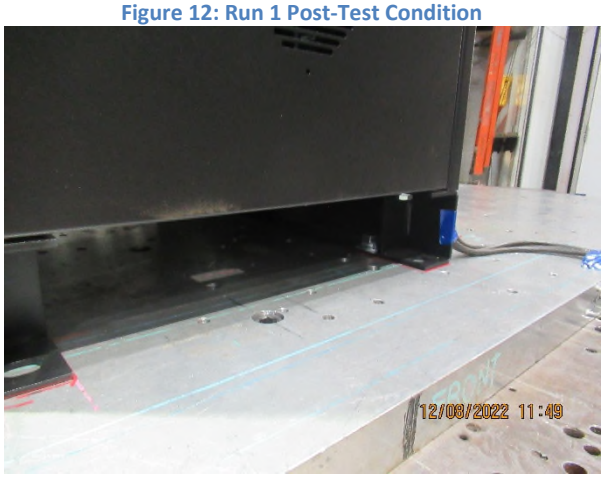

Figure 14: Run 1 Post-Test Condition

Figure 15: Run 1 Post-Test Condition

Figure 16: Run 1 Post-Test Condition

Figure 17: Run 1 Post-Test Condition

Figure 18: Run 1 Post-Test Condition

Figure 19: Run 1 Post-Test Condition

Figure 20: Run 1 Post-Test Condition

2.1.4. Post-Test Functional

The base mounting bolts were checked for torque. Proper torque value was confirmed. Aaron Schott, ZincFive representative, checked various hardware on UUT1.

2.1.5. Run 2 (Multi-frequency Seismic Simulation Test)

On 12/08/2022 Clark Testing performed run 2 in accordance with AC 156. The test was performed as described in Section 1.6.2., with the levels described in the following table.

Test Level	Test Criteria	Demand Level		Horizontal		Vertical	
		S_{DS}	z/h	A_{FLX-H}	A_{RIG-H}	A_{FLX-V}	A_{RIG-V}
1	AC156	2.29	1	3.66	2.75	1.53	.62

Table 7: Run 2 Seismic Parameters

Generated table input motion and test response spectrum were reviewed against criteria detailed in ICC AC156 section 6.5. The test met the acceptance criteria and was therefore determined acceptable. Plots of the run are available in Appendix II.

Damage noted after the test:

- The front, bottom seismic brace sheared the right cross brace mounting screw. The brace did not affect the structural ability of the cabinet, the security of the access panels/doors, and did not present any projectile hazard. Test was deemed a PASS.

The minimum and maximum peak accelerations of run 2 are listed in the table below.

Channel	Minimum (-g)	Maximum (g)
A1 FB	2.95	2.76
A2 SS	2.81	2.68
A3 V	2.03	1.98
A4 FB	5.66	5.79
A5 SS	6.77	6.81
A6 V	2.51	2.17

Table 8: Run 2 Peak Accelerations

Figure 21: Run 2 Post-Test Condition

Figure 22: Run 2 Post-Test Condition

Figure 23: Run 2 Post-Test Condition

Figure 24: Run 2 Post-Test Condition

Figure 25: Run 2 Post-Test Condition

Figure 26: Run 2 Post-Test Condition

Figure 27: Run 2 Post-Test Condition

Figure 28: Run 2 Post-Test Condition

Figure 29: Run 2 Post-Test Condition

2.1.6. Post-Test Functional

UUT1 was removed from the seismic table and prepared for shipping. This concluded testing on UUT1. The test program was completed.

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APPENDIX I

Clark Testing Laboratory Test Record Logbook

Logbook Page 1 of 6

Clark Testing Laboratory

Contract Number: JID 22-01199

Customer: Ometek (zinc five)

Test Specification: AC-156

Steps Completed: (3) Sine Sweeps FB, SS, V axis
(2) seismic earthquakes

Approved by Customer Representative: [signature] 12/8/22

Read and understood by - witness [signature] Date 1-31-23

Logbook Page 2 of 6

INSPECTION

UUT Number: UUT 1

Type of Unit: Battery Cabinet

Serial Number: DWFS-2022-47-000003

Model Number: ~~N/A~~ (MJ) 12-8-22 ZF-38A6SU022KB1CF

Weight of Unit: 1841 lb.

RECEIPT INSPECTION - Check for Damage and Photograph:

	Visual	Photograph
Top of UUT	✓	✓
Bottom of UUT	✓	✓
Sides of UUT (all)	✓	✓
Internal (if applicable)	N/A	N/A

POST TEST INSPECTION - Check for Damage and Photograph:

	Visual	Photograph
Top of UUT	✓	✓
Bottom of UUT	✓	✓
Sides of UUT (all)	✓	✓
Internal (if applicable)	N/A	N/A

Damage Noted: 36"L x 21"W x 82½"H
No apparent damage

Signature(s) person making entry: Mark Jacuinto Date 12-8-22

Read and understood by [illegible] Date 1-31-23

Logbook Page 3 of 6

EQUIPMENT LIST

McBee #	In Service Start Date (MI) 12-8-22	In Service Due Date	Equipment Name
4055	~~5-26-22~~ 6-8-22	~~5-~~ 6-8-24	VR8500 Box
4056	6-8-22	6-8-24	VR8500 Box
4057	6-8-22	6-8-24	VR8500 Box
4611	3-7-22	3-7-23	accelerometer
4431	3-7-22	3-7-23	accelerometer
4422	3-7-22	3-7-23	accelerometer
4762	7-21-22	7-21-23	torque wrench
4616	10-27-22	10-27-23	accelerometer
4174	10-27-22	10-27-23	accelerometer
4176	10-27-22	10-27-23	accelerometer
4419	7-28-22	7-28-23	overhead scale

Signature(s) person making entry: Mark Jacovino Date 12-8-22

Read and understood by: Joel Martin Date 1-31-23

Environmental: Temp: N/A Humidity: N/A

Logbook Page 4 of 6

Table Setup No. 1

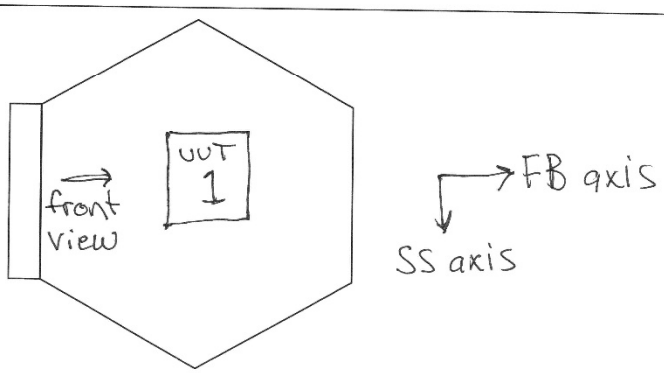
EUT Mounting Description

EUT:	UUT 1				
Number of Fasteners:	4				
Diameter and Thread:	3/4"-10	- Also washer, and lock washer			
Grade:	5				
Style:	Hex Head				
Torque:	150 ft-lbs				

Channel Assignment

Name	Mcbee	mV/g	Location
A1-FB	4611	66.05	} Seismic Table Control
A2-SS	4431	66.25	
A3-V	4422	66.20	
A4-FB	4616	66.40	} Top - Right side - front
A5-SS	4174	66.27	
A6-V	4176	66.95	

Top View of Table



Signature(s) person making entry: Mark Jacovino Date 12-8-22

Read and understood by: Mark Jacovino Date 1-31-23

Environmental: Temp: N/A Humidity: N/A Logbook Page 5 of 6

Table Setup No. 1

Performed Pre-Test Functional N/A

Performed Resonance Search

Performed FB, SS, and Vertical sine sweep from 1.3 Hz to 33.3 Hz at a constant .07 G-pk acceleration Oct/min. 2

Run No. 1

Performed shake test at the following level: AC-156 @ 1.5 sds Z/h=1

Horizontal		Vertical	
AFLX	ARIG	AFLX	ARIG
2.4	1.8	1.01	.41

Did the TRS meet or exceed the test requirements? Yes ✓ No

If No:

Post Test Visual Inspection

NO apparent damage

Post Test Functional/Customer Modifications

Base mounting bolts were checked for torque. Still good

Customer checked various hardware on UUT

Signature(s) person making entry: Mark Jacovino Date 12-8-22

Read and understood by: Joel Mont Date 1-31-23

Environmental: Temp: N/A Humidity: N/A Logbook Page 6 of 6

Table Setup No. 1

Performed Pre-Test Functional N/A

Performed Resonance Search N/A

Performed FB, SS, and Vertical sine sweep from____ Hz to____ Hz at a constant____ G-pk acceleration Oct/min.____

Run No. 2

Performed shake test at the following level: AC-156 @ 2.29 sds 2/h = 1

Horizontal		Vertical	
AFLX	ARIG	AFLX	ARIG
3.66	2.75	1.53	.62

Did the TRS meet or exceed the test requirements? Yes ✓ No____

If No:

Post Test Visual Inspection

1) front bottom seismic brace sheared the Right cross brace mounting screw. No other apparent damage

Post Test Functional/Customer Modifications

Removed from seismic table

Signature(s) person making entry: Mark Jacovino Date 12-8-22

Read and understood by: Joel Morris Date 1-31-23

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APPENDIX II

Seismic Data Plots

CLARK Dynamic Test Laboratory, Inc.
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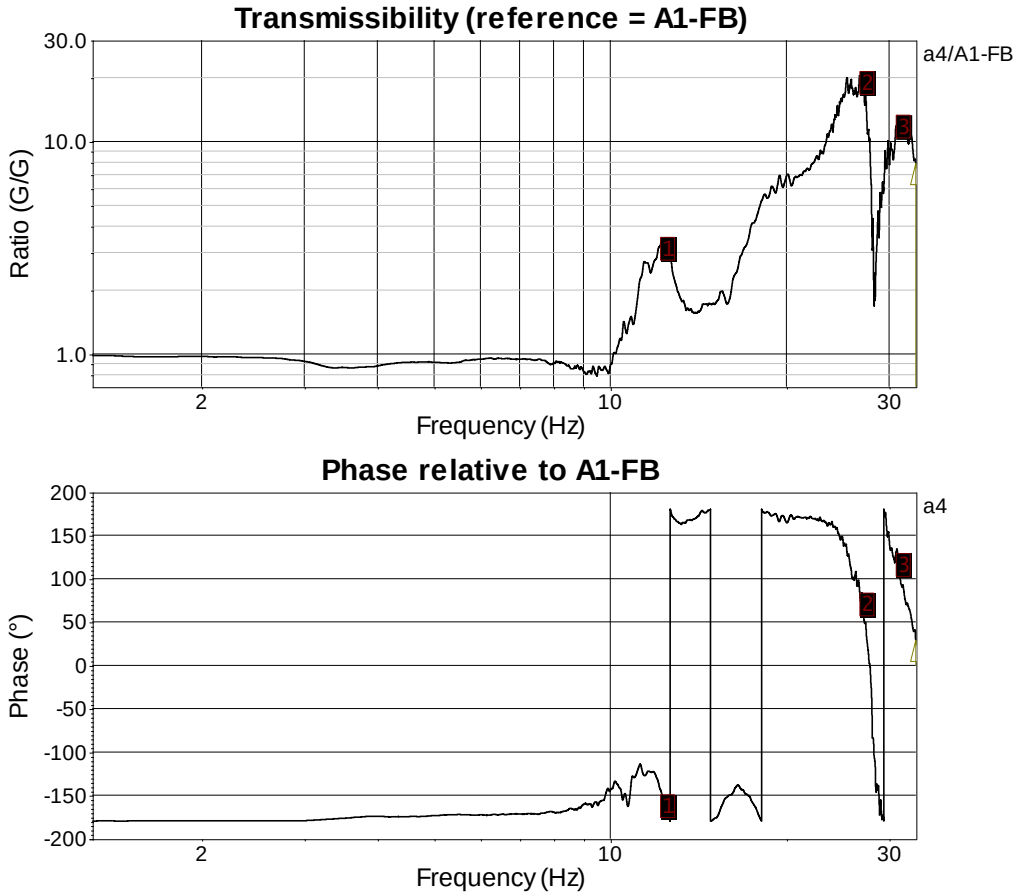
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:35:59
RUN NO.	Front to Back axis
SWEEP RATE	Sweep between 1.3 Hz and 33.3 Hz at 2 Oct/min
DURATION	0:02:21



Resonance Data			
INDEX	Frequency (Hz)	PHASE (Degree)	AMPLITUDE (G/G)
1	12.28	-151.4	3.5
2	26.89	81.4	20.9
3	31.07	126.7	13.1

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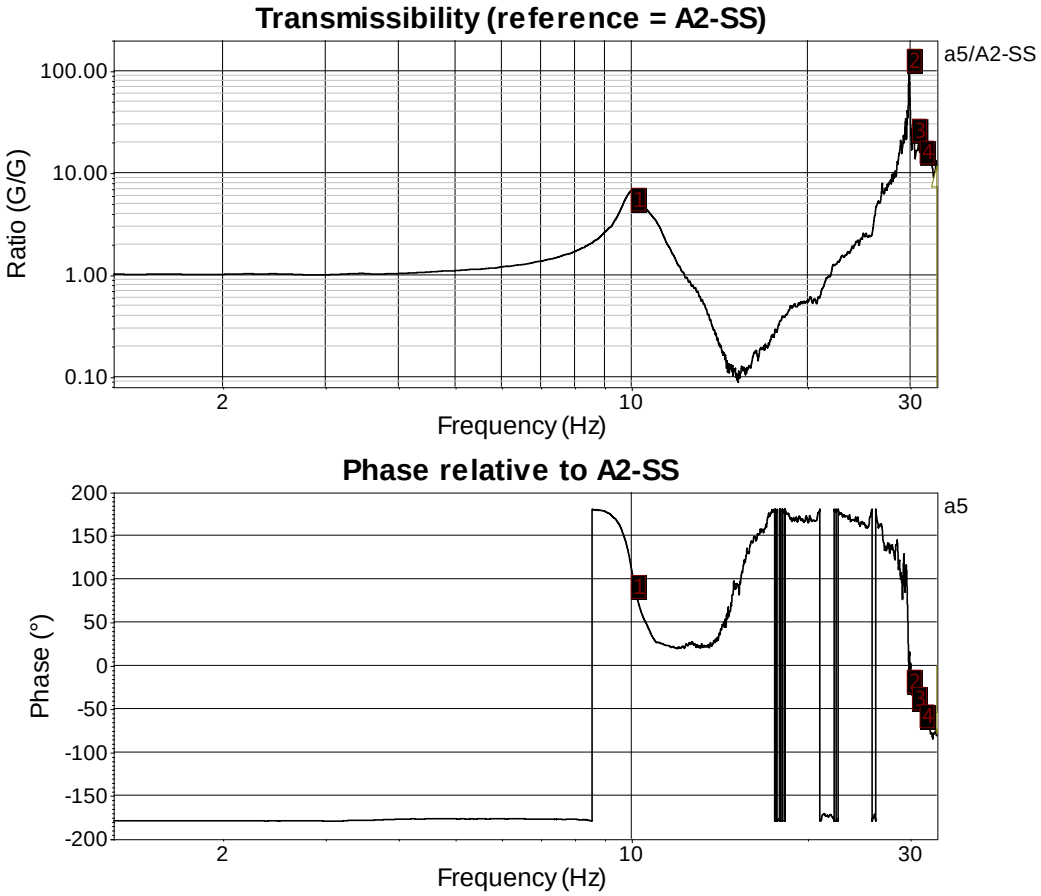
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:31:20
RUN NO.	Side to Side axis
SWEEP RATE	Sweep between 1.3 Hz and 33.3 Hz at 2 Oct/min
DURATION	0:02:21



Resonance Data			
INDEX	Frequency (Hz)	PHASE (Degree)	AMPLITUDE (G/G)
1	10.07	101.5	6.8
2	29.87	103.5	155.7
3	30.46	-27.5	32.0
4	31.41	-47.5	19.6

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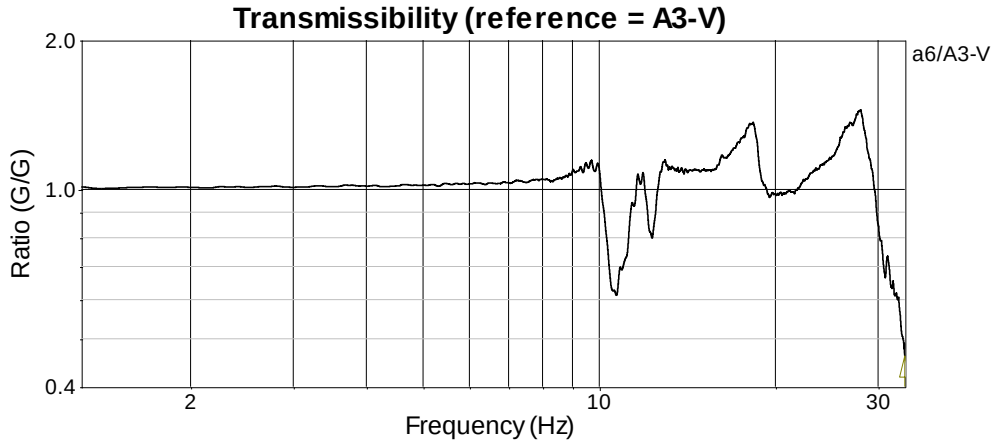
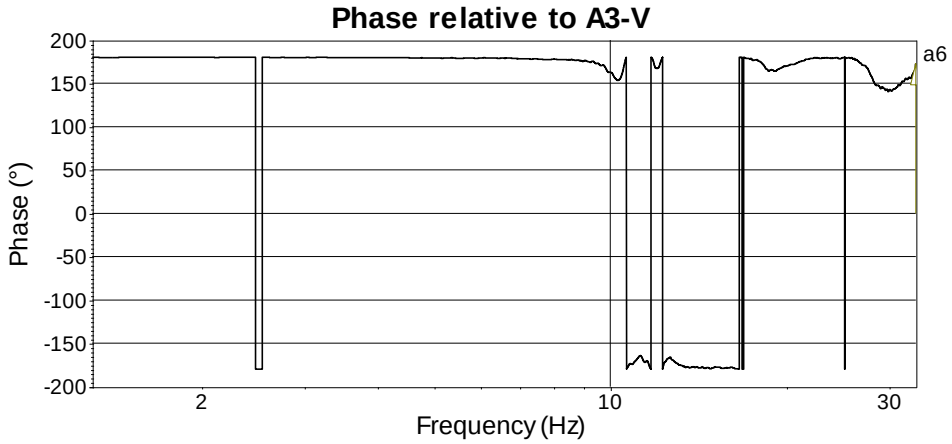
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:40:27
RUN NO.	Vertical axis
SWEEP RATE	Sweep between 1.3 Hz and 33.3 Hz at 2 Oct/min
DURATION	0:02:21





Resonance Data			
INDEX	Frequency (Hz)	PHASE (Degree)	AMPLITUDE (G/G)
1	n/a	n/a	n/a

CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 10:47:25
	RUN NO.	Run 1

CROSS CORRELATION FUNCTION PLOTS

CLARK Dynamic Test Laboratory, Inc.
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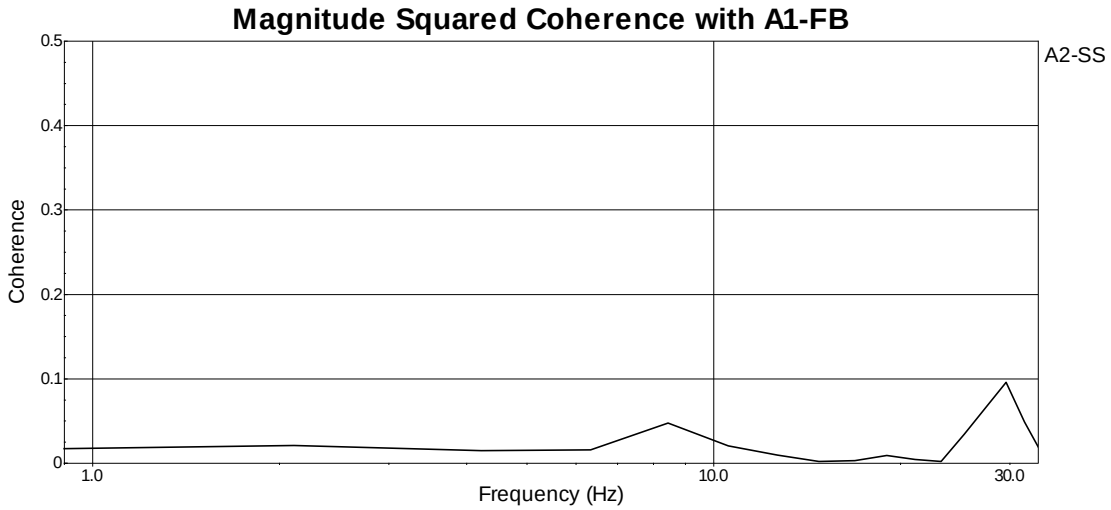
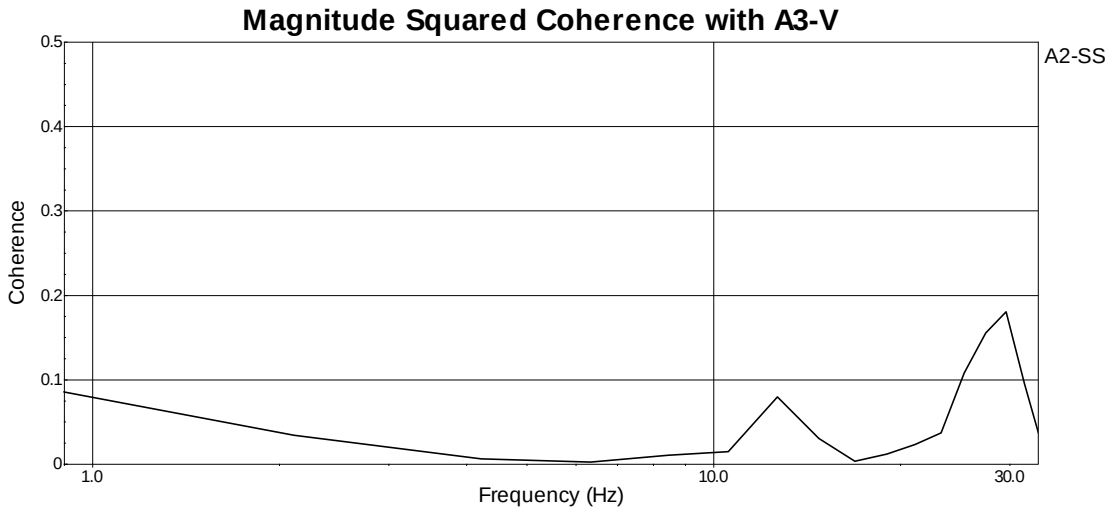
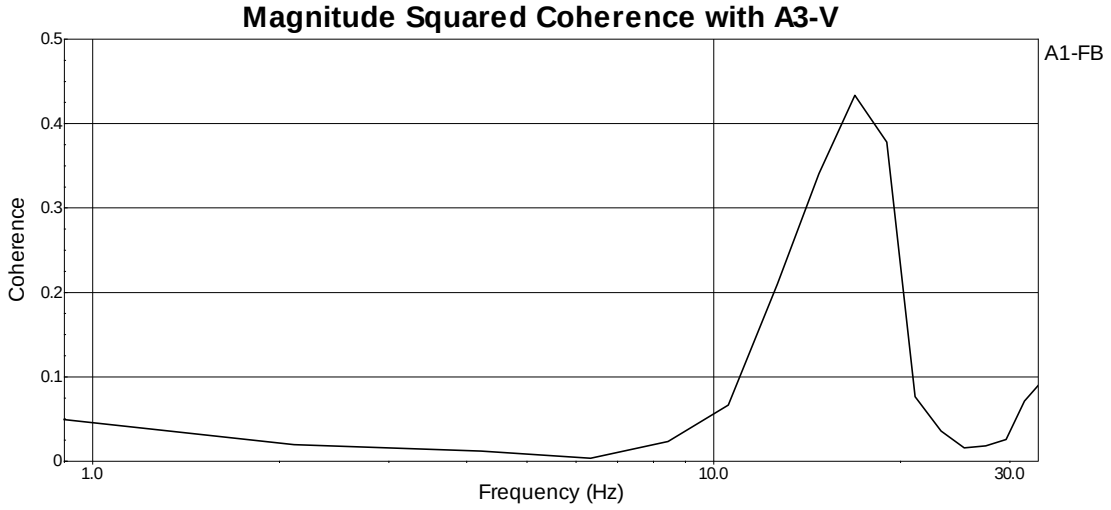
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:47:25
RUN NO.	Run 1







CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 10:47:25
	RUN NO.	Run 1

TABLE INPUTS

CLARK Dynamic Test Laboratory, Inc.
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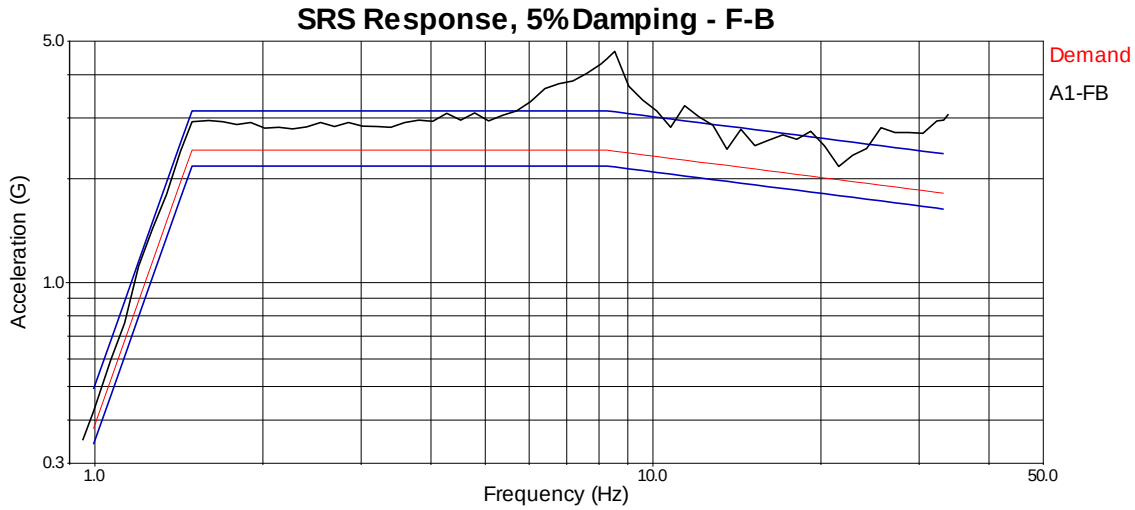
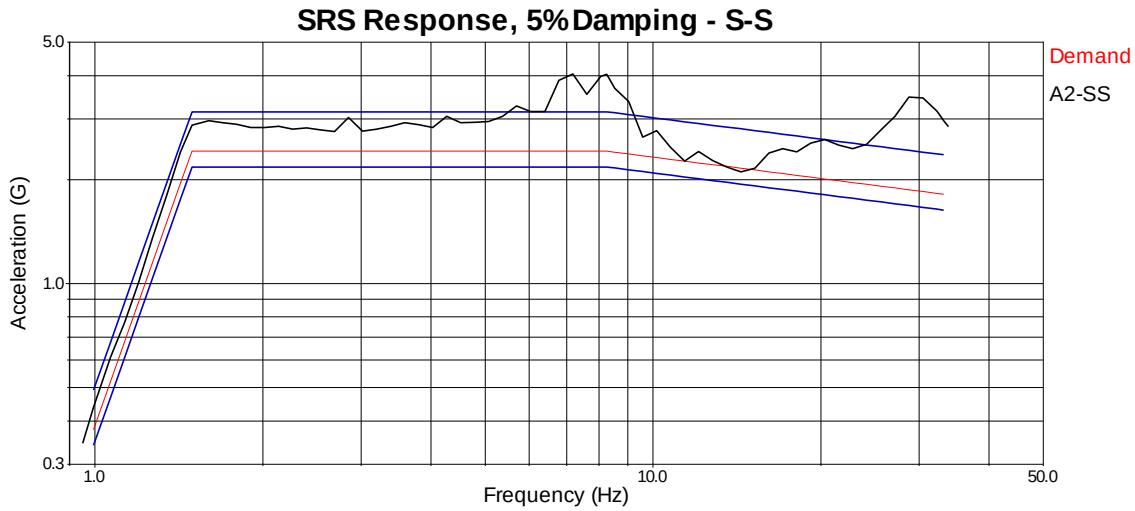
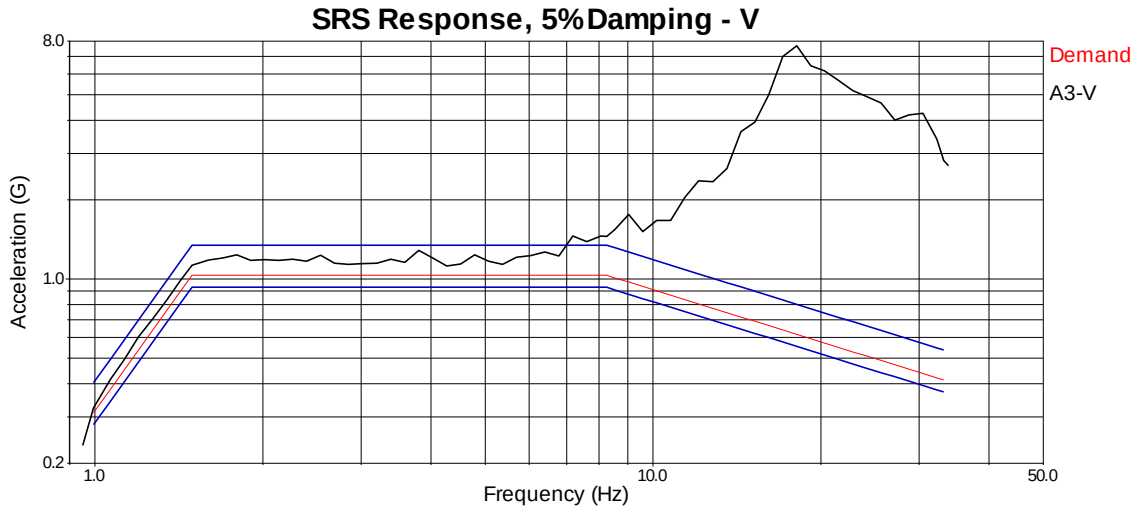
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:47:25
RUN NO.	Run 1







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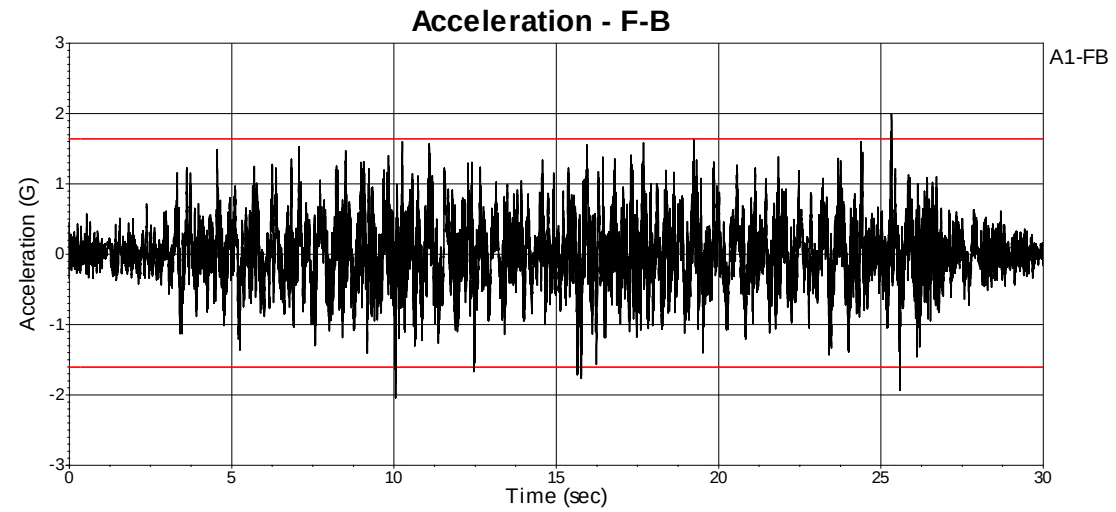
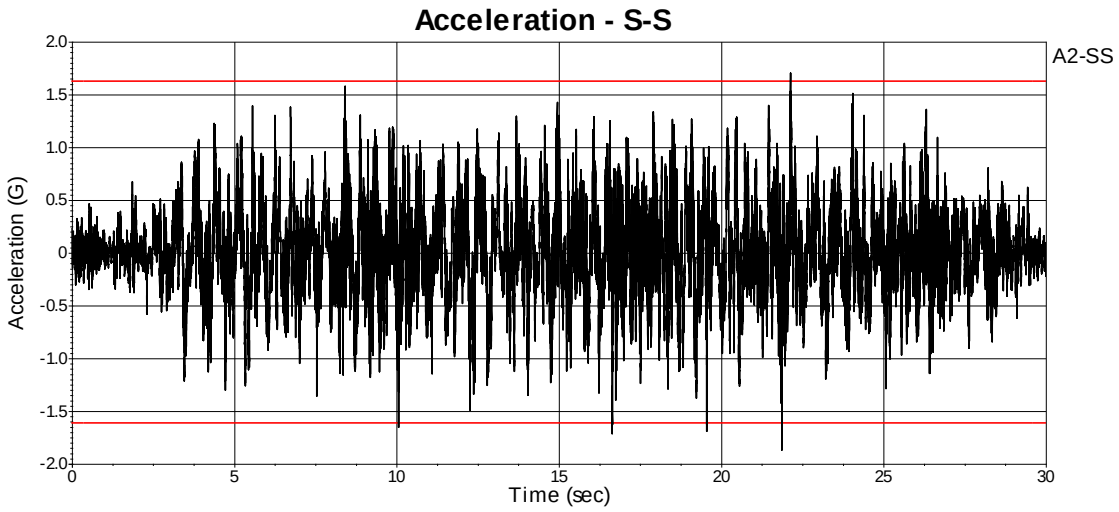
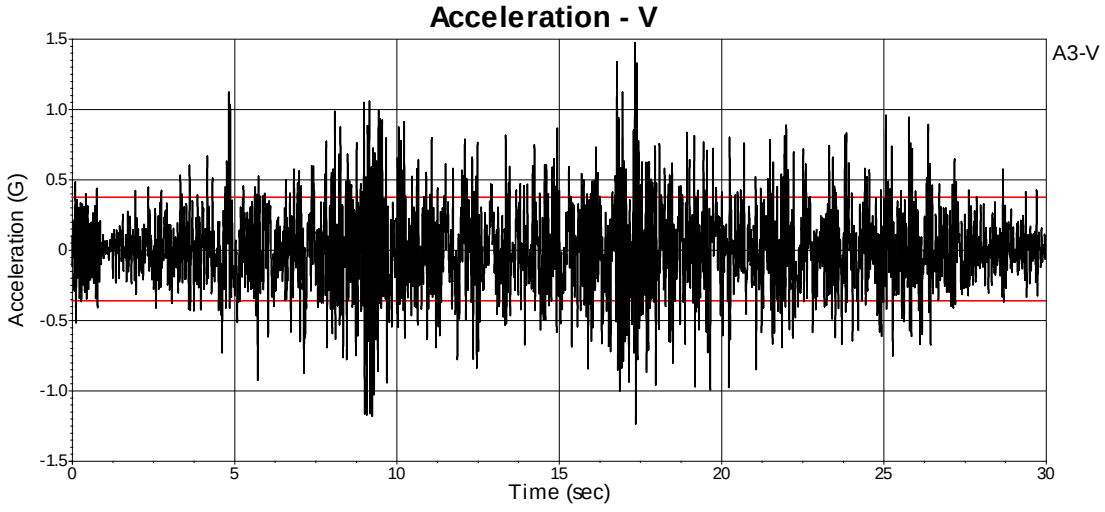
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:47:25
RUN NO.	Run 1





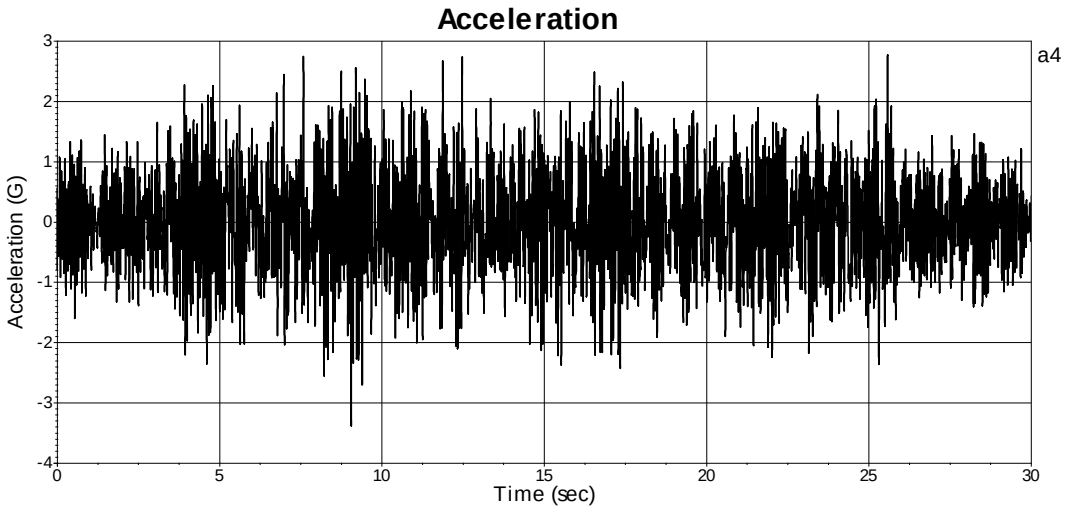


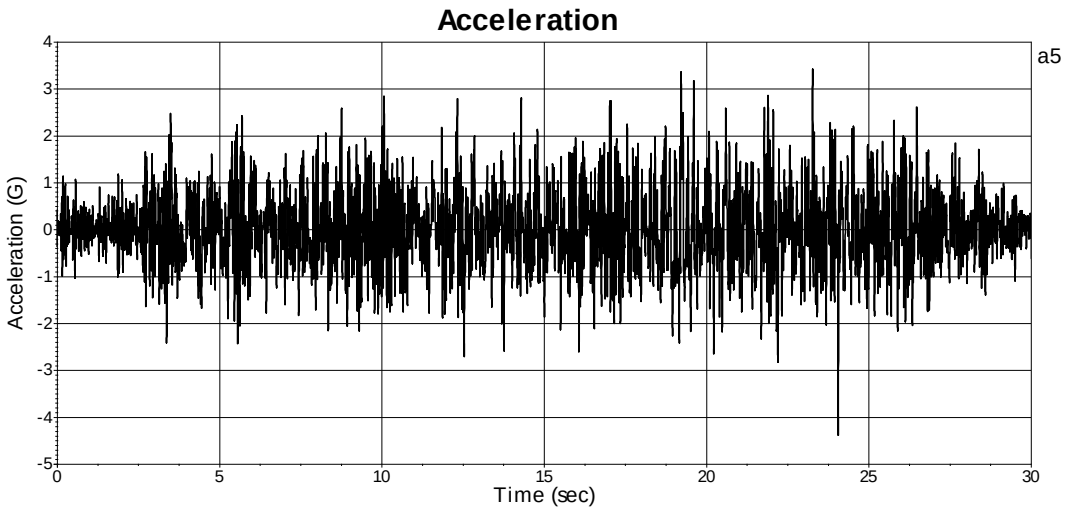
CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 10:47:25
	RUN NO.	Run 1

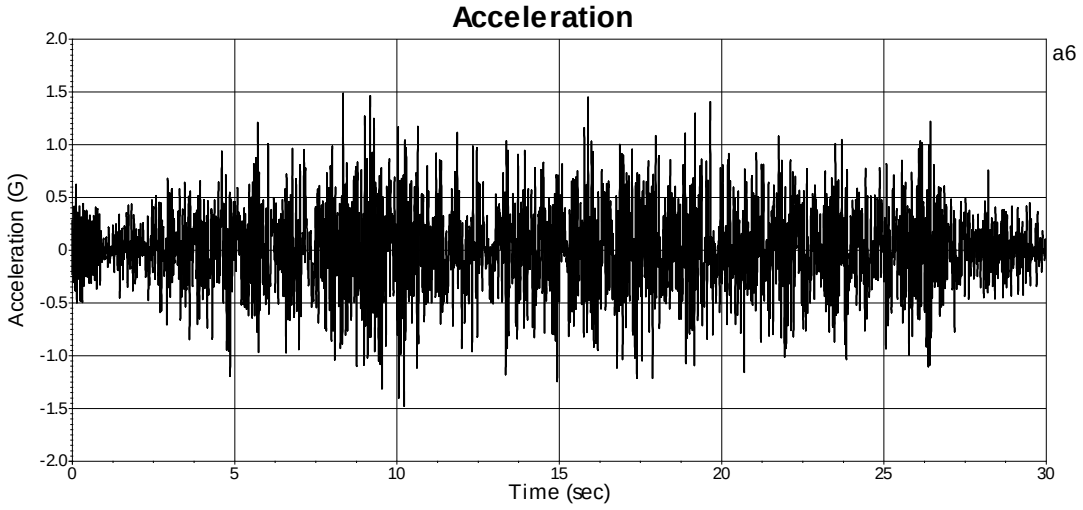
TIME HISTORY PLOTS

CLARK Dynamic Test Laboratory, Inc.
A Division of Clark Testing Group

CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:47:25
RUN NO.	Run 1







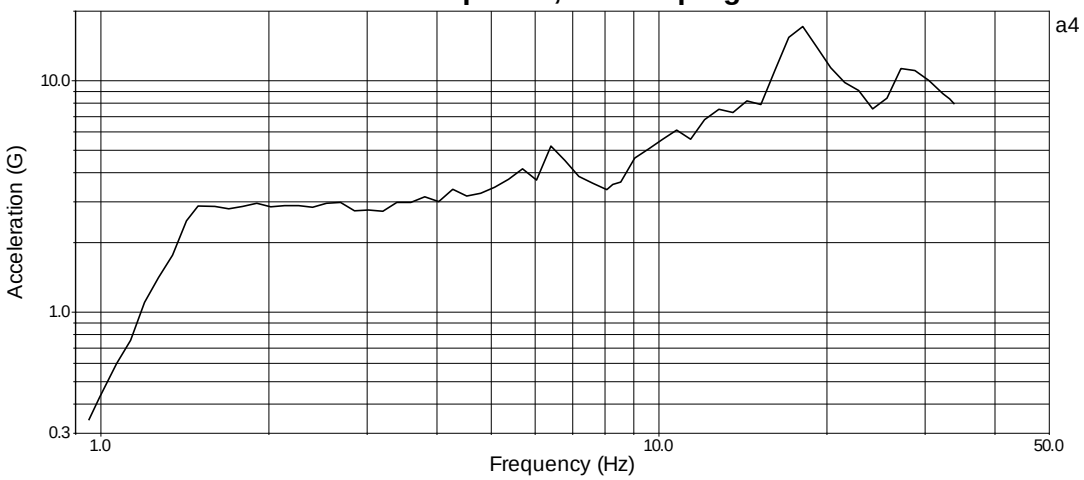
CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 10:47:25
	RUN NO.	Run 1

RESPONSE SPECTRUM PLOTS

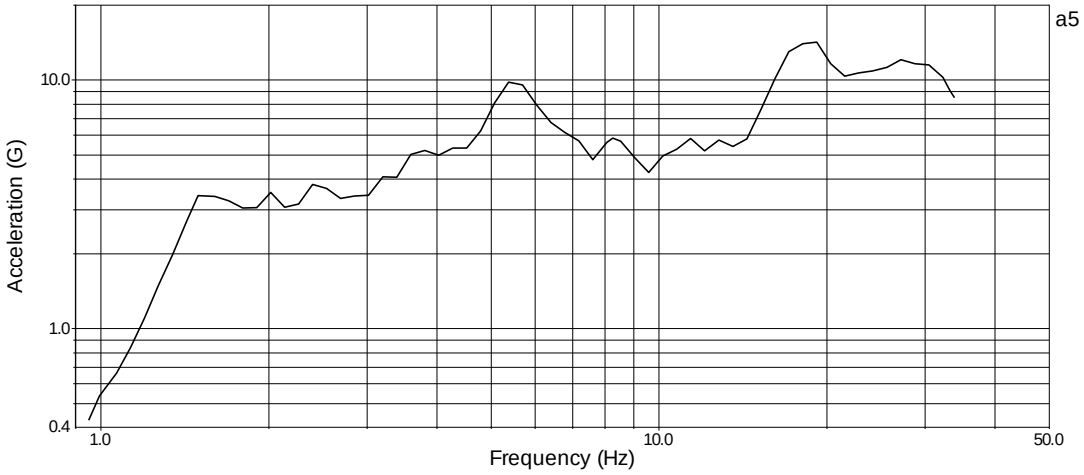
CLARK Dynamic Test Laboratory, Inc.
A Division of Clark Testing Group

CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 10:47:25
RUN NO.	Run 1

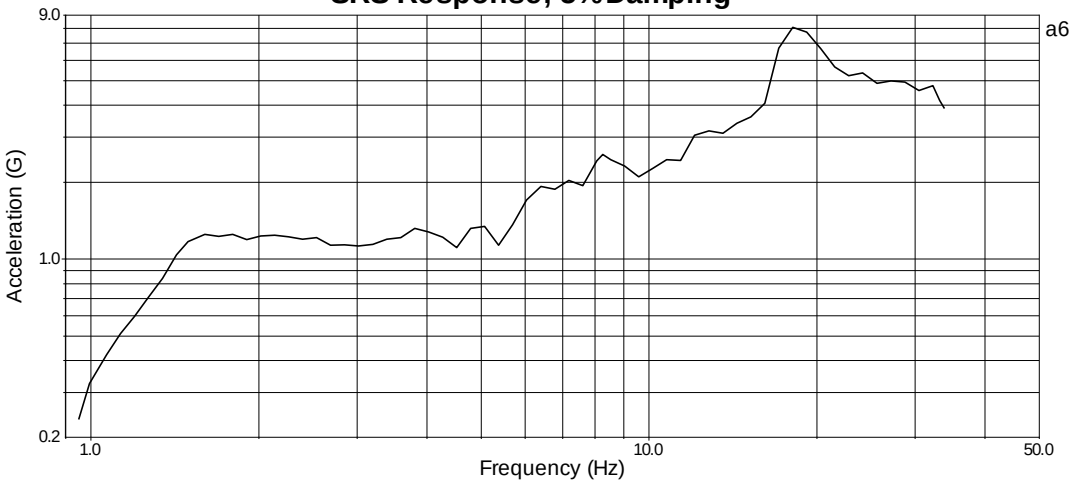
SRS Response, 5% Damping



SRS Response, 5% Damping



SRS Response, 5% Damping

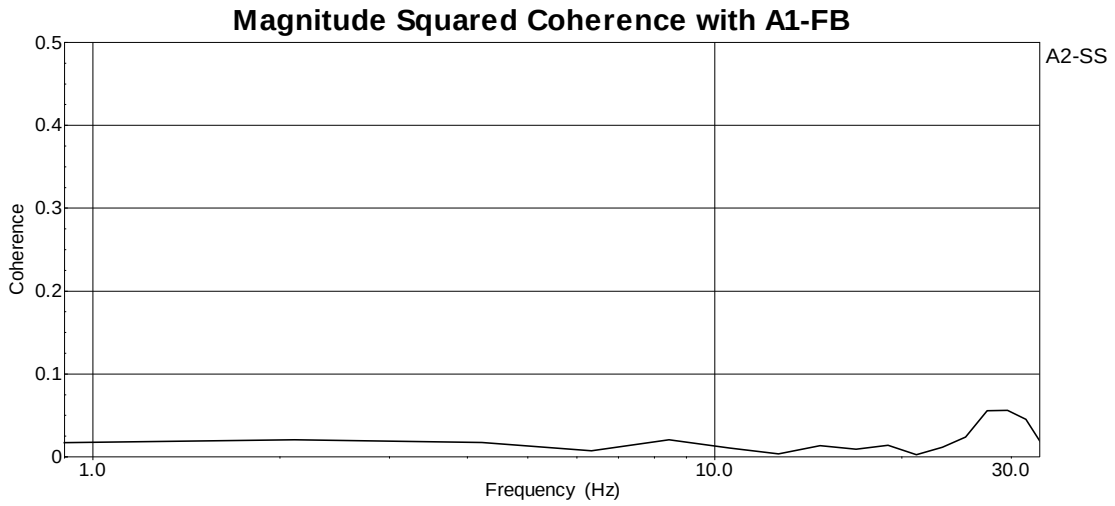


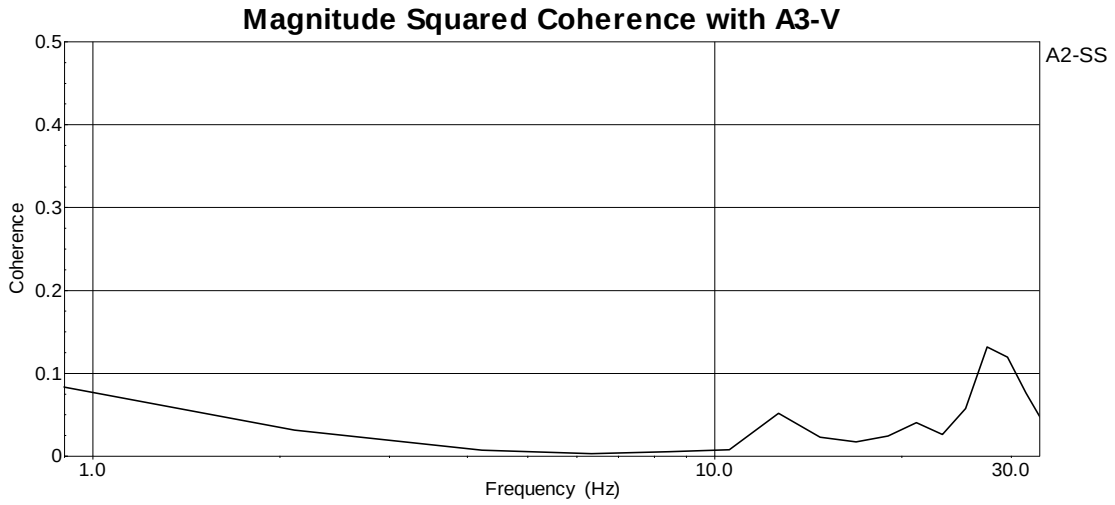
CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 11:27:46
	RUN NO.	Run 2

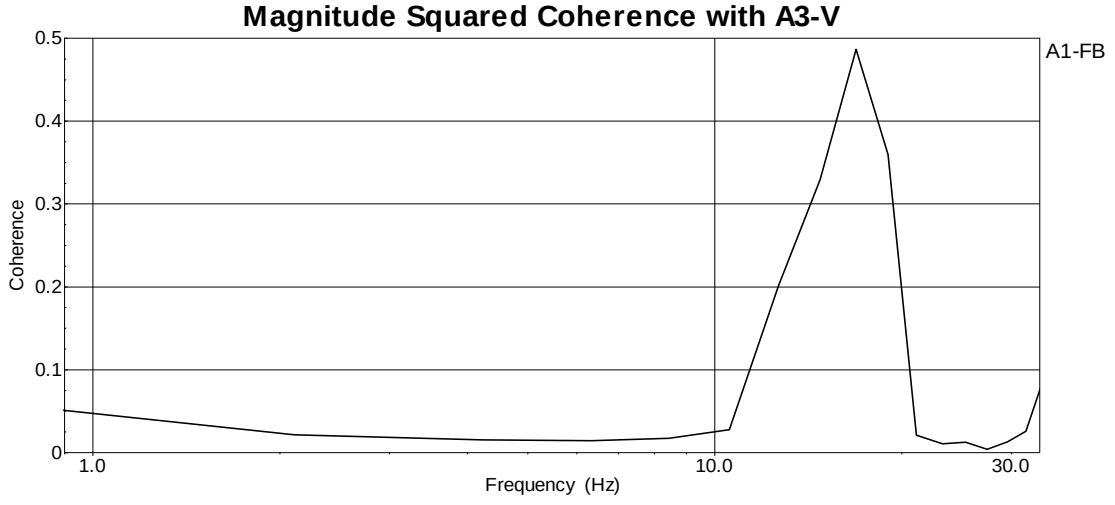
CROSS CORRELATION FUNCTION PLOTS

CLARK Dynamic Test Laboratory, Inc.
A Division of Clark Testing Group

CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 11:27:46
RUN NO.	Run 2





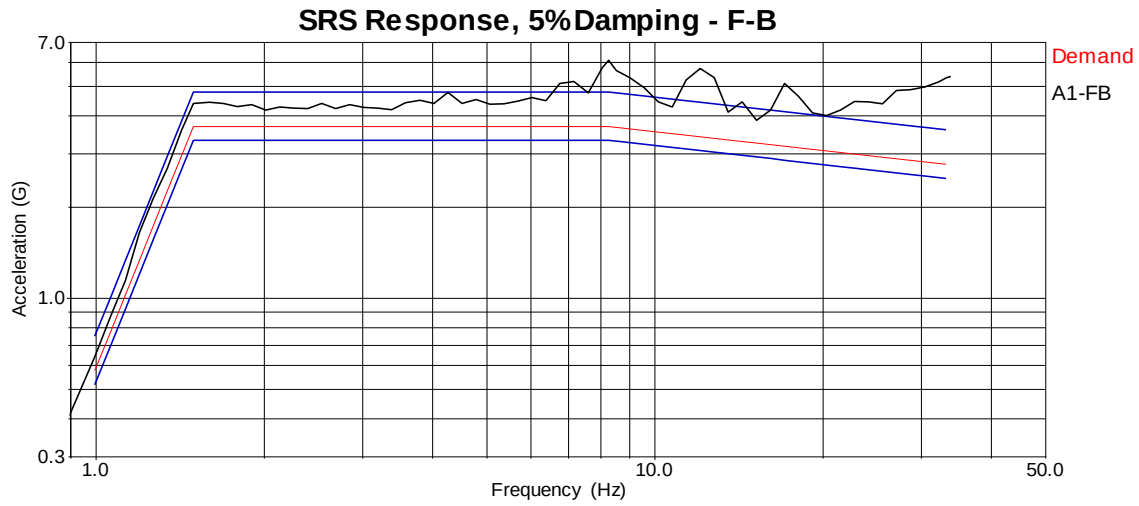


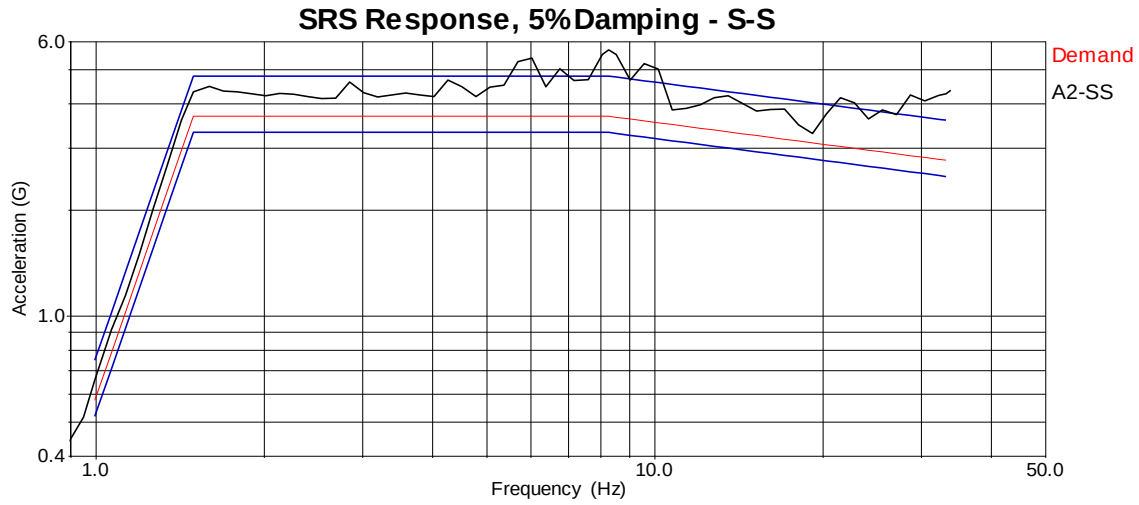
CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 11:27:46
	RUN NO.	Run 2

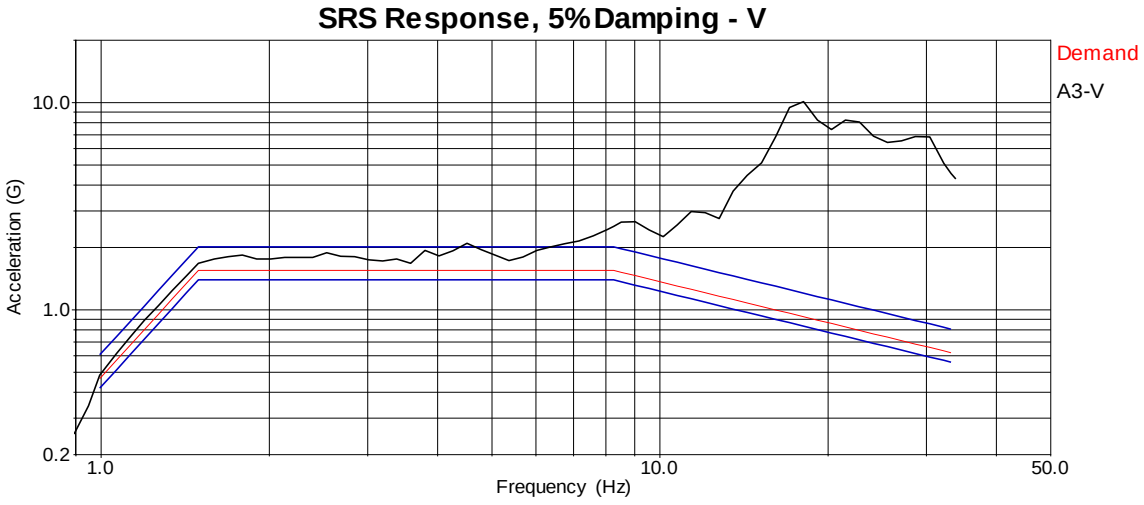
TABLE INPUTS

CLARK Dynamic Test Laboratory, Inc.
A Division of Clark Testing Group

CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 11:27:46
RUN NO.	Run 2







CLARK Dynamic Test Laboratory, Inc.
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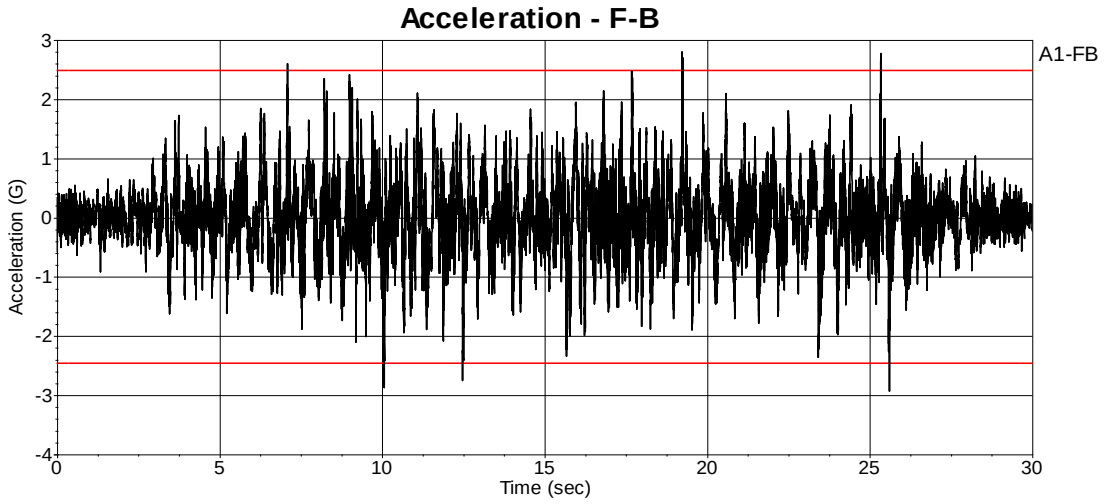
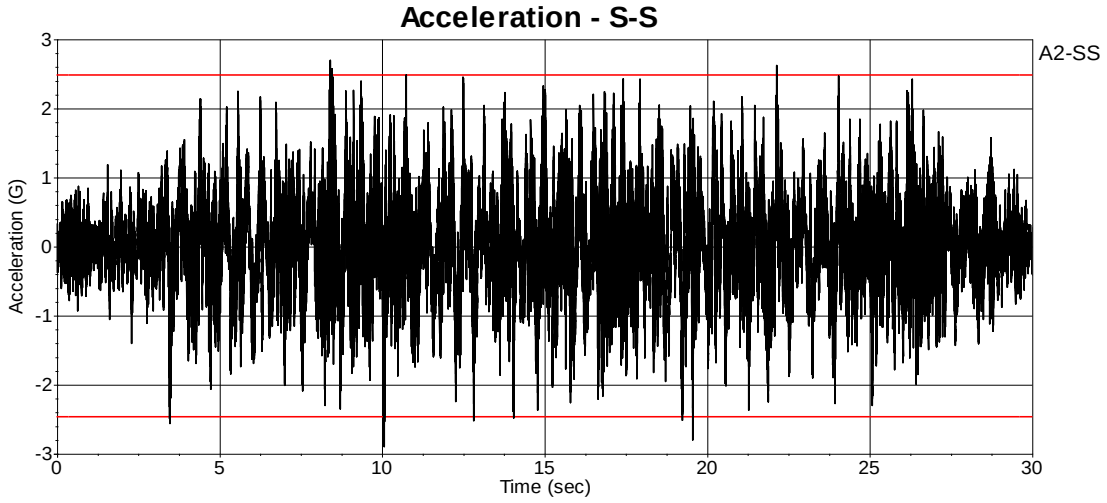
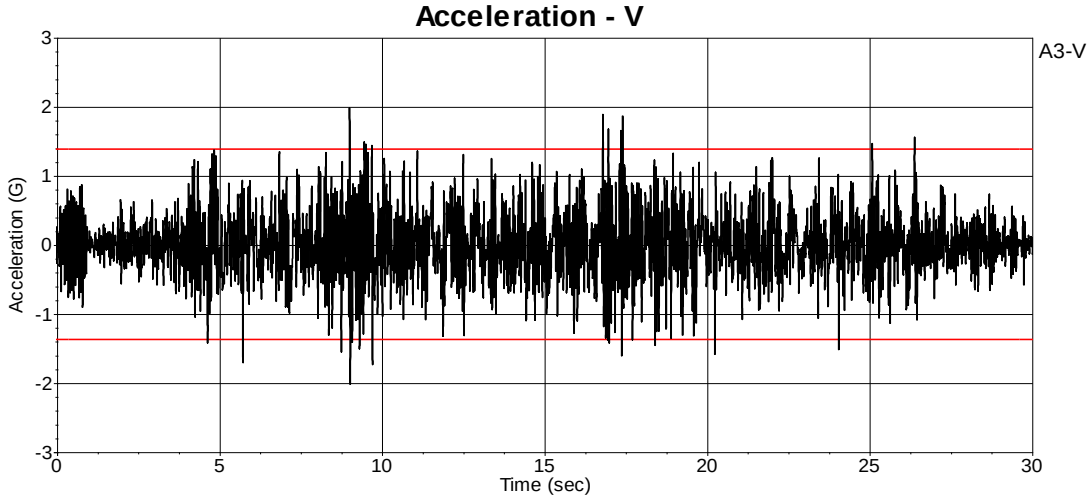
CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 11:27:46
RUN NO.	Run 2







CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group	**CUSTOMER**	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 11:27:46
	RUN NO.	Run 2

TIME HISTORY PLOTS

CLARK Dynamic Test Laboratory, Inc.
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CUSTOMER	ZincFive
JID	Battery Cabinet
TIME	Dec 08, 2022 11:27:46
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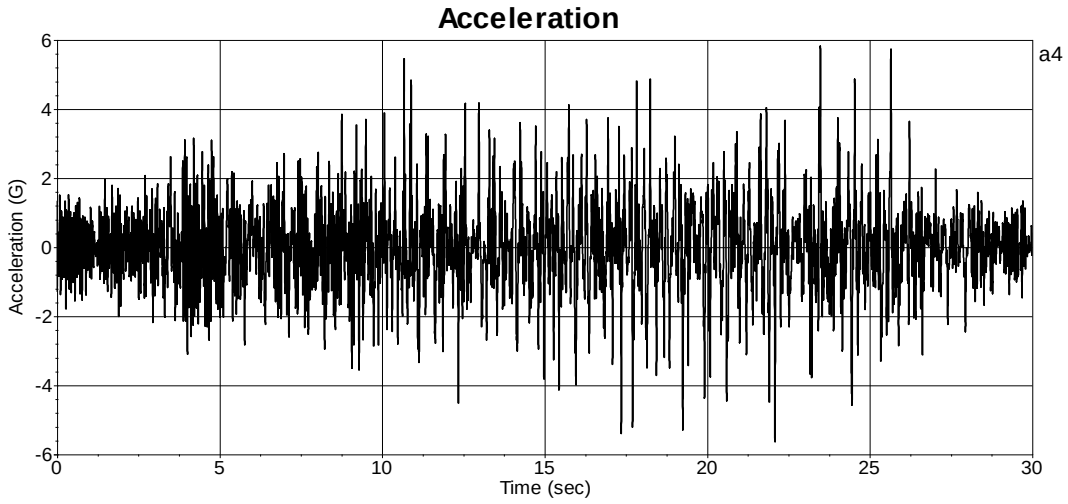

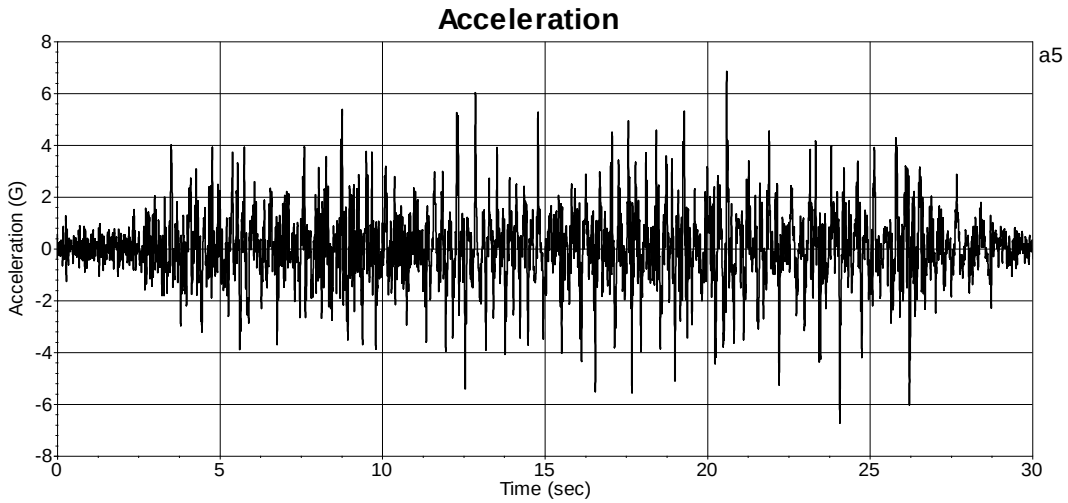

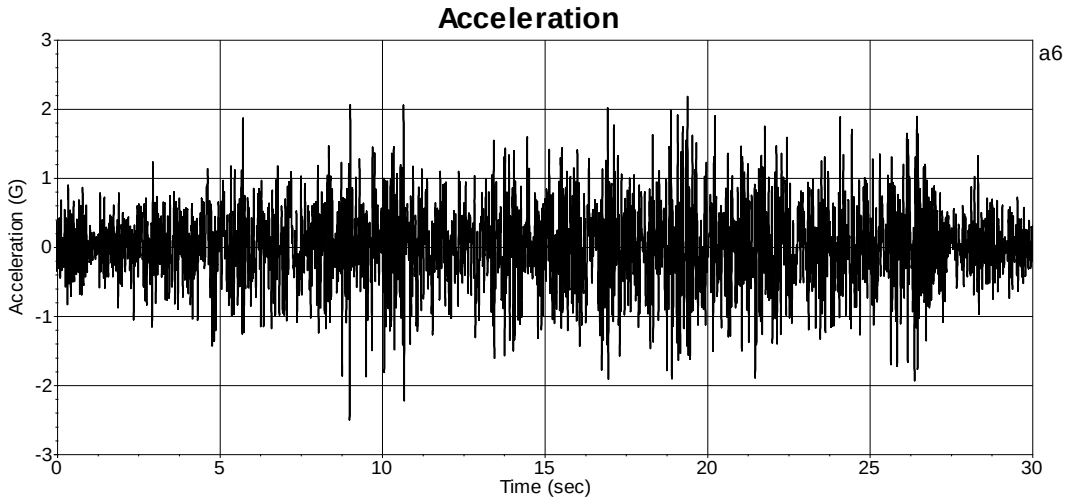

CLARK Dynamic Test Laboratory, Inc. A Division of Clark Testing Group		
	CUSTOMER	ZincFive
	JID	Battery Cabinet
	TIME	Dec 08, 2022 11:27:46
	RUN NO.	Run 2

RESPONSE SPECTRUM PLOTS

CLARK Dynamic Test Laboratory, Inc.
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CUSTOMER	ZincFive
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TIME	Dec 08, 2022 11:27:46
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