NASA/TM–2015-218781/Volume II/Part 1
NESC-RP-12-00783

Empirical Model Development for Predicting Shock Response on Composite Materials Subjected to Pyroshock Loading

Appendices

Steven J. Gentz/NESC
Langley Research Center, Hampton, Virginia

David O. Ordway, David S. Parsons, Craig M. Garrison, C. Steven Rodgers, and Brian W. Collins
Marshall Space Flight Center, Huntsville, Alabama

July 2015

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  Mail Stop 148
  NASA Langley Research Center
  Hampton, VA 23681-2199

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National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

July 2015

Acknowledgments

The team would like to acknowledge the following for providing their expertise:

Dr. Curt Larsen/Johnson Space Center (JSC), of the NESC, for championing the Pyroshock Characterization of Composites task.

Mr. Ken Johnson/MSFC for his tireless support statistically analyzing the post-processed acceleration data.

Mr. Lee Allen/MSFC for supporting Ken Johnson in statistically analyzing the post-processed data

Ms. Barbara Breithaupt/MSFC for post-processing the pseudo-velocity data.

Mr. Justin Jackson/MSFC for providing his expertise in composite test panel fabrication.

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Empirical Model Development for Predicting Shock Response on Composite Materials Subjected to Pyroshock Loading

Volume II: Appendices

Part 1

April 16, 2015

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Technical Assessment Report Volume 2; Part 1

Appendix A. Composite Test Panel Fabrication

A1 Drawings

The following figures (Figure A1 through Figure A13) illustrate the Engineering drawings created to fabricate the pyroshock characterization of composite test panels and test support hardware.

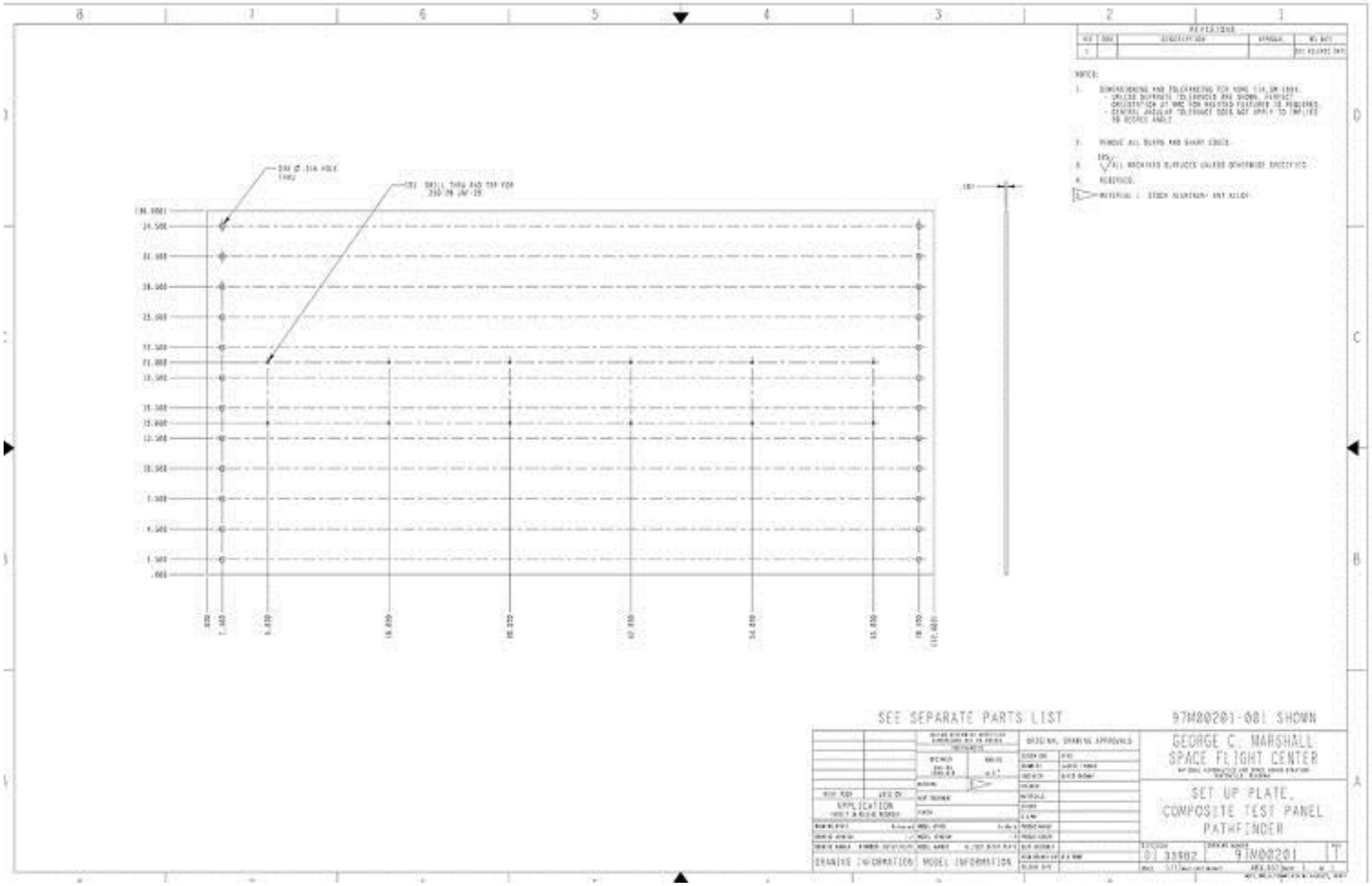
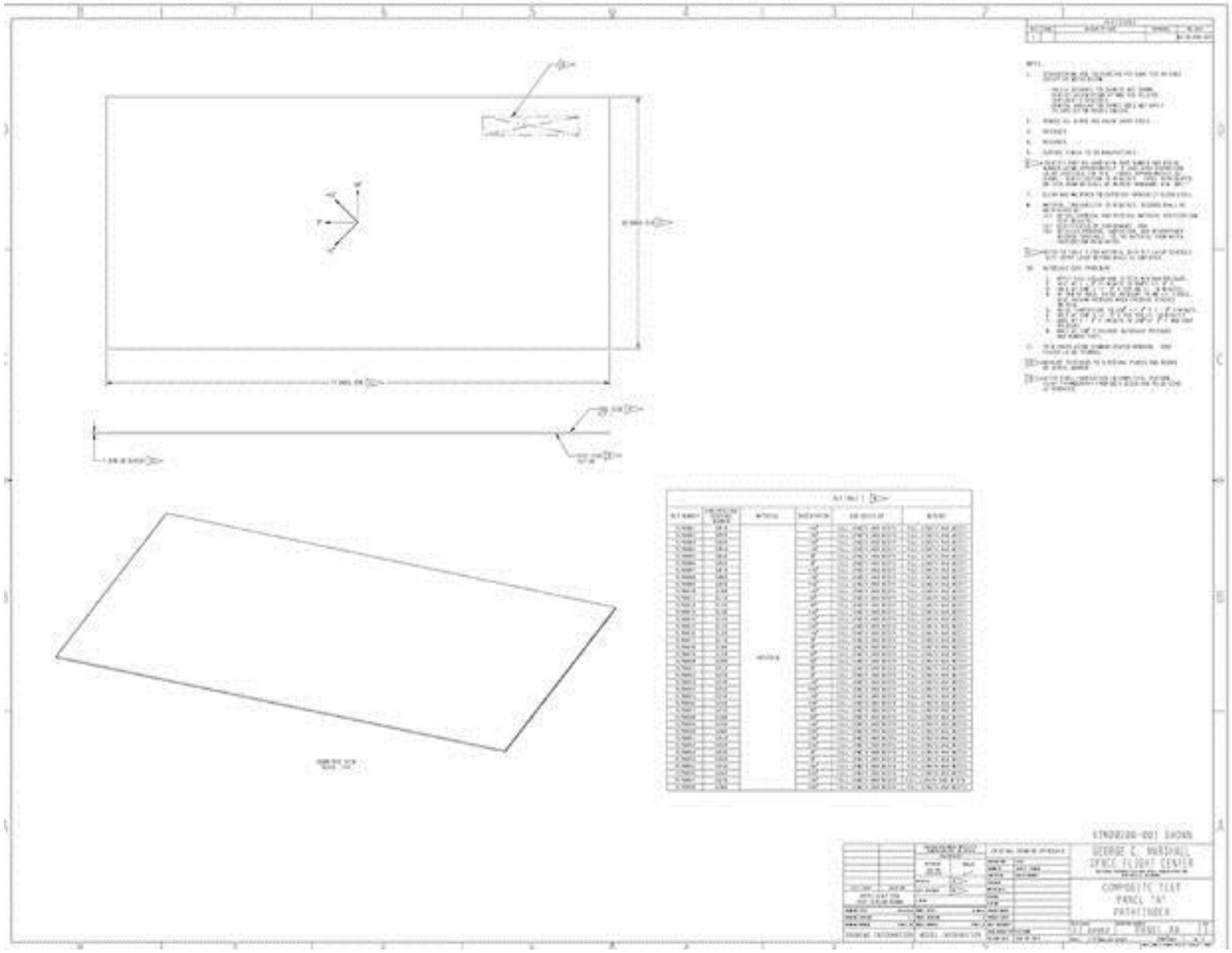
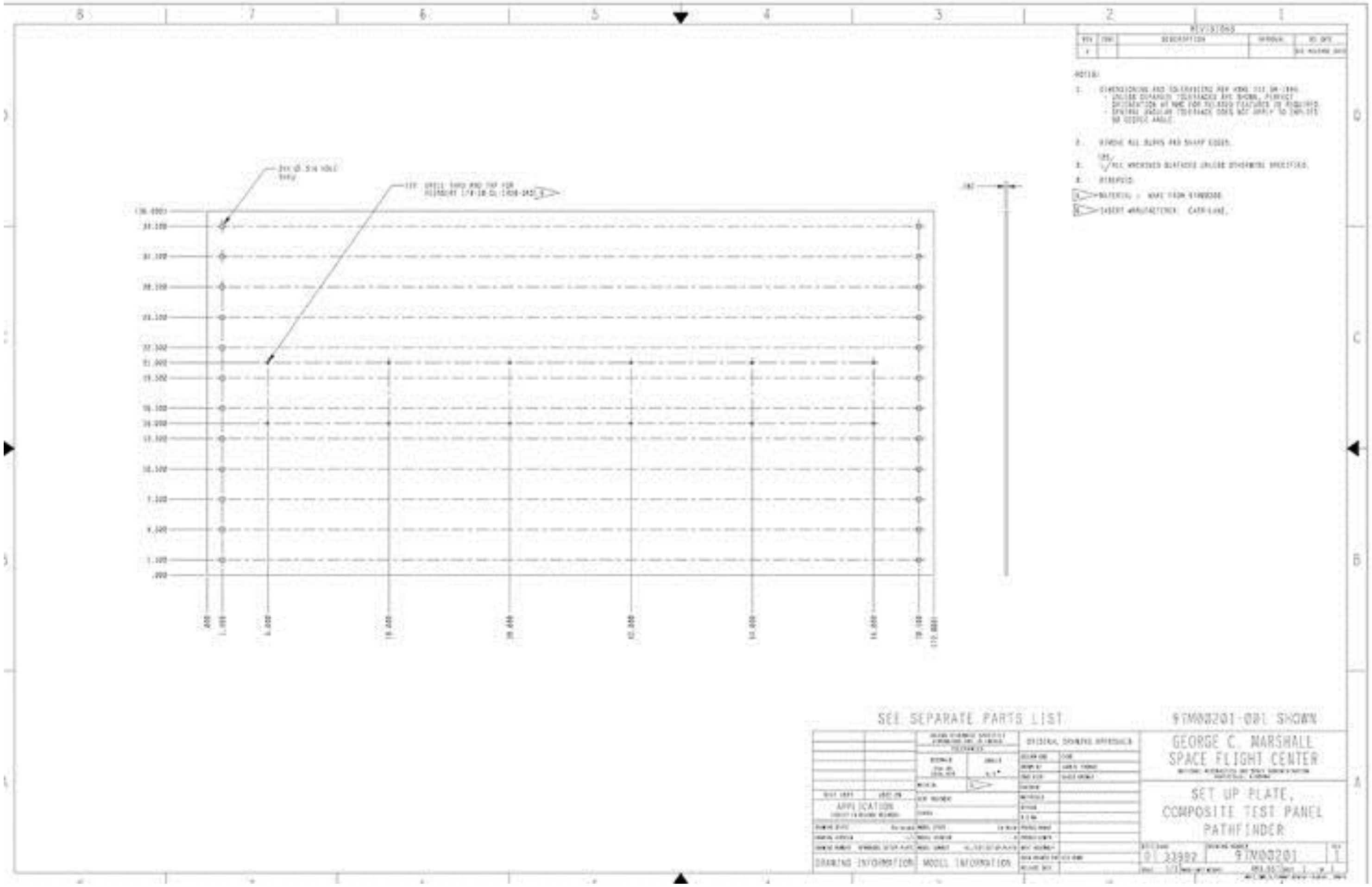


Figure A1. Al Pathfinder Panel


GEORGE C. MARSHALL
SPACE FLIGHT CENTER
COMPOSITE TEST
PANEL "A"
PATHFINDER
DRAWING INFORMATION
MODEL INFORMATION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ORIGINAL DRAWING APPROVALS
GEORGE C. MARSHALL
SPACE FLIGHT CENTER
SET UP PLATE,
COMPOSITE TEST PANEL
PATHFINDER
APPLICATION
DRAWING INFORMATION
MODEL INFORMATION
9TM00201
REVISIONS
NOTES:

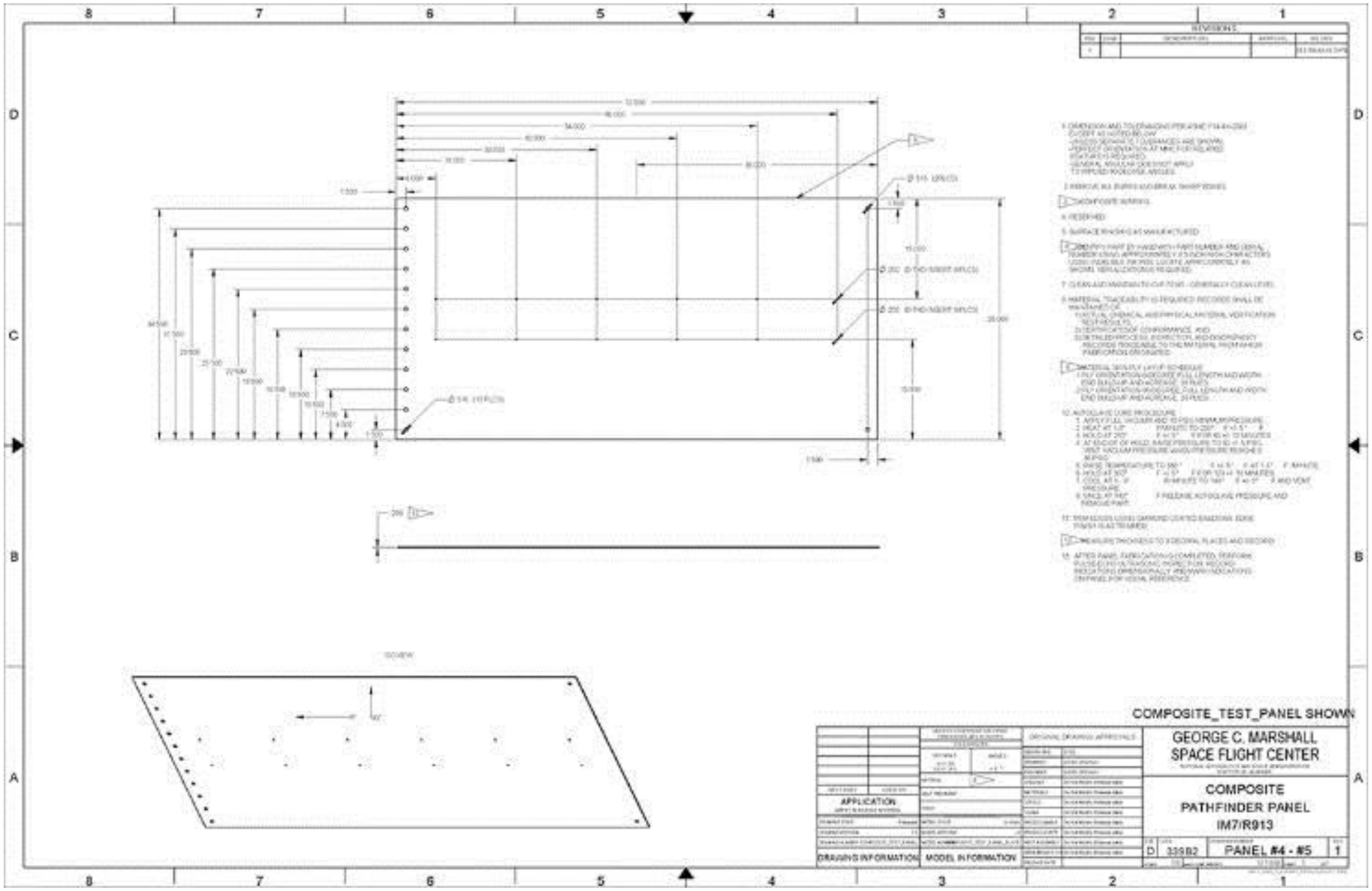


Figure A2. IM7/R913 Composite Pathfinder Panel

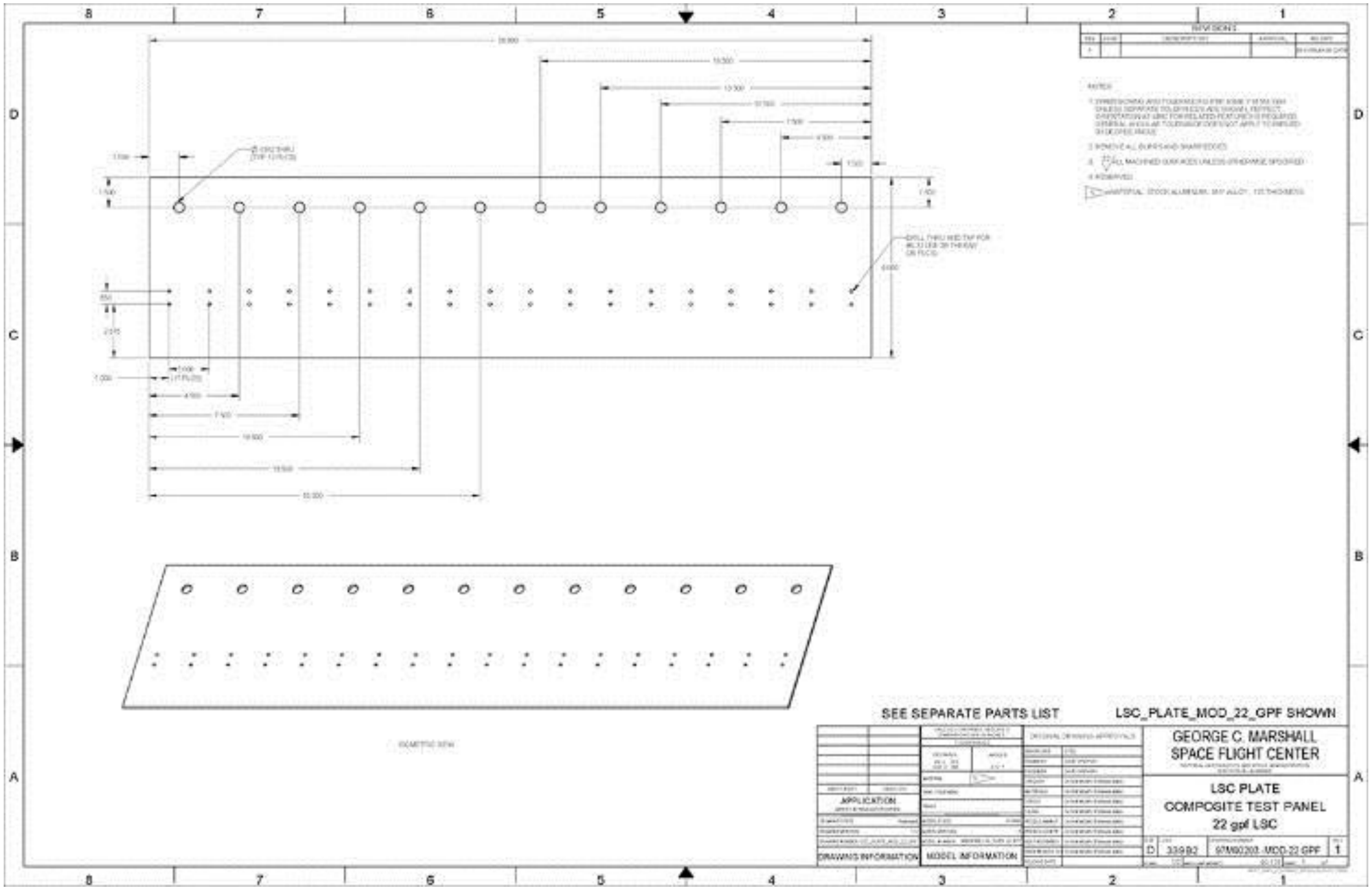


Figure A3. Al Linear Shaped Charge Plate

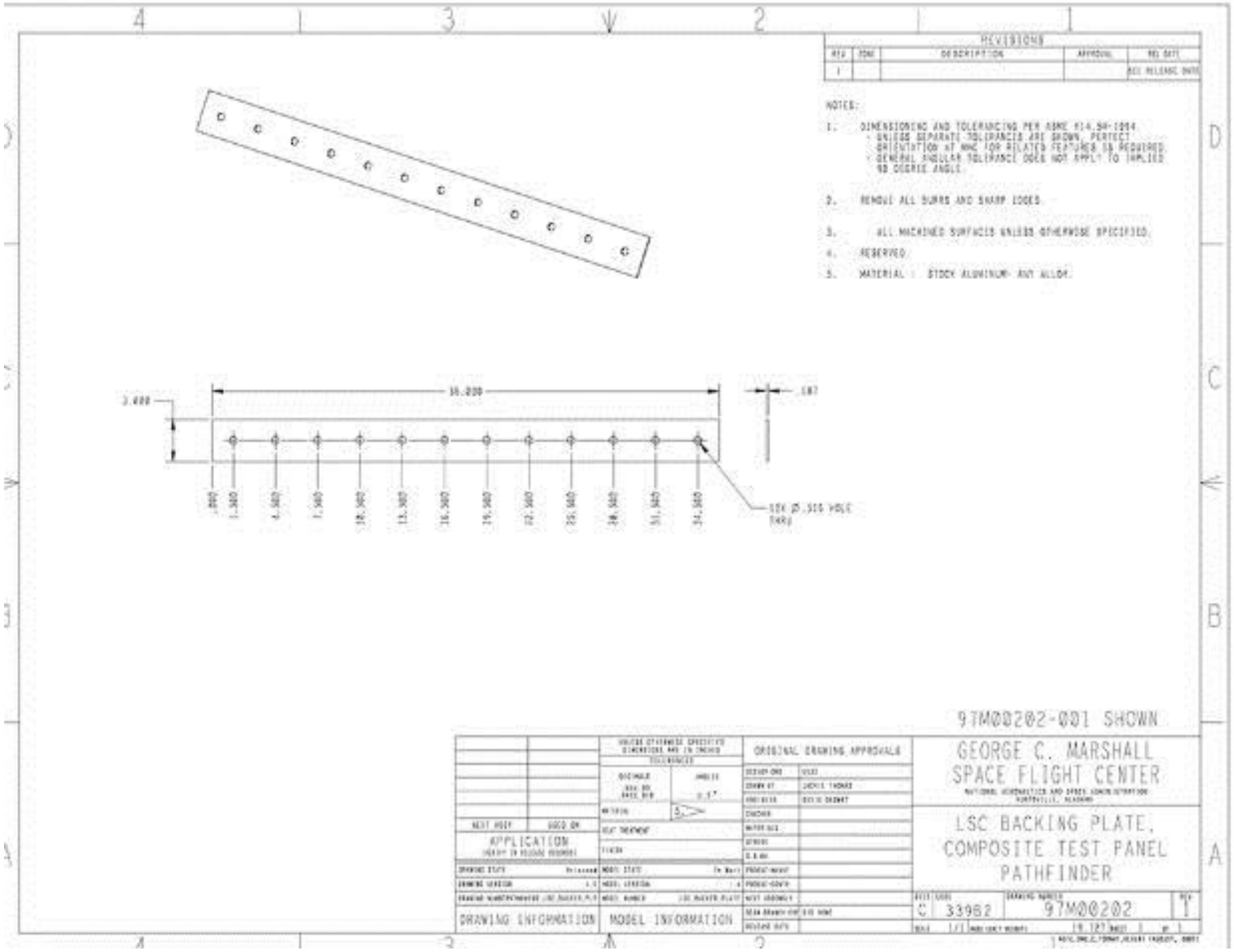


Figure A4. LSC Backing Plate

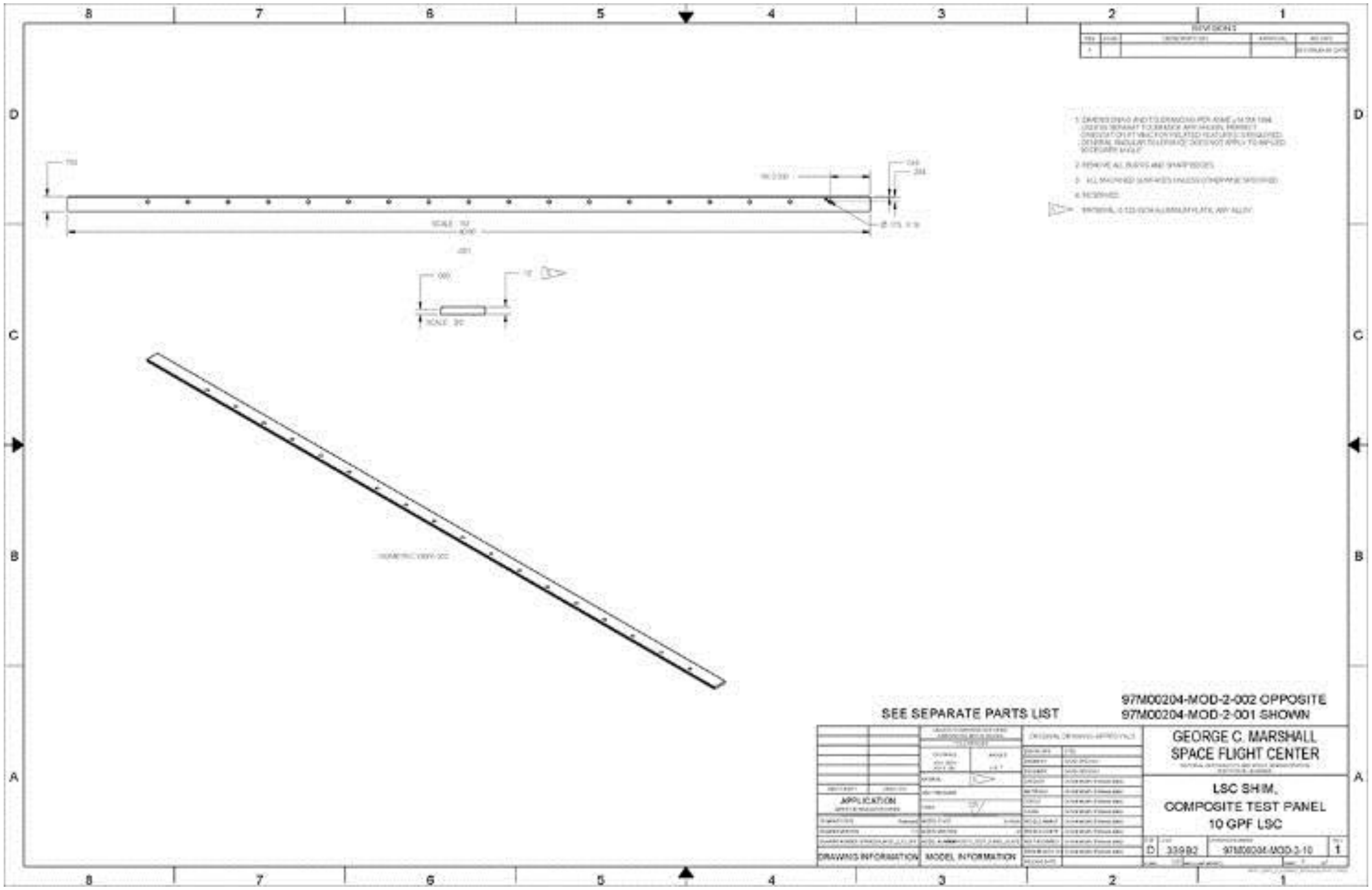


Figure A5. LSC Shim, 10 gpf

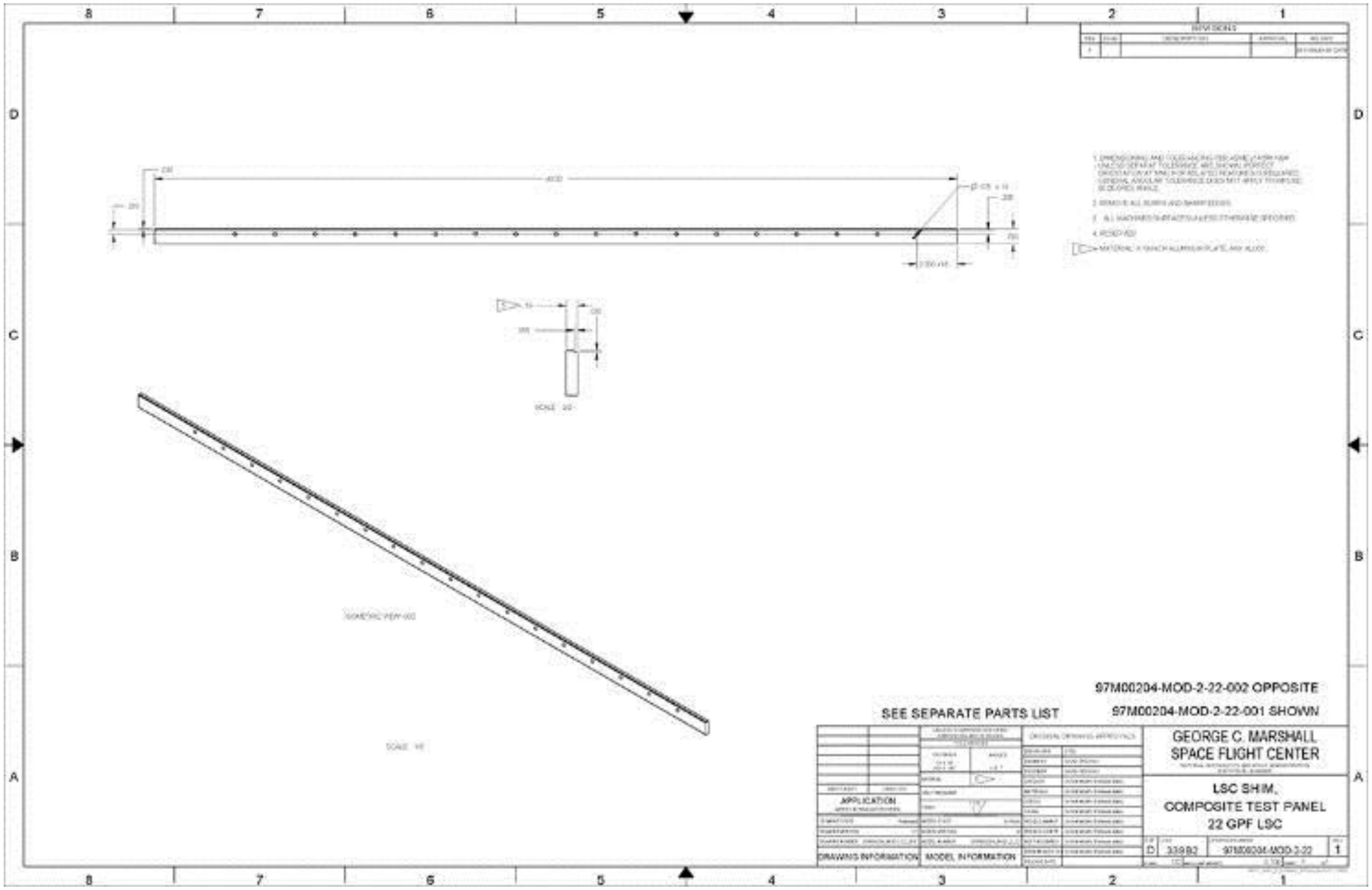
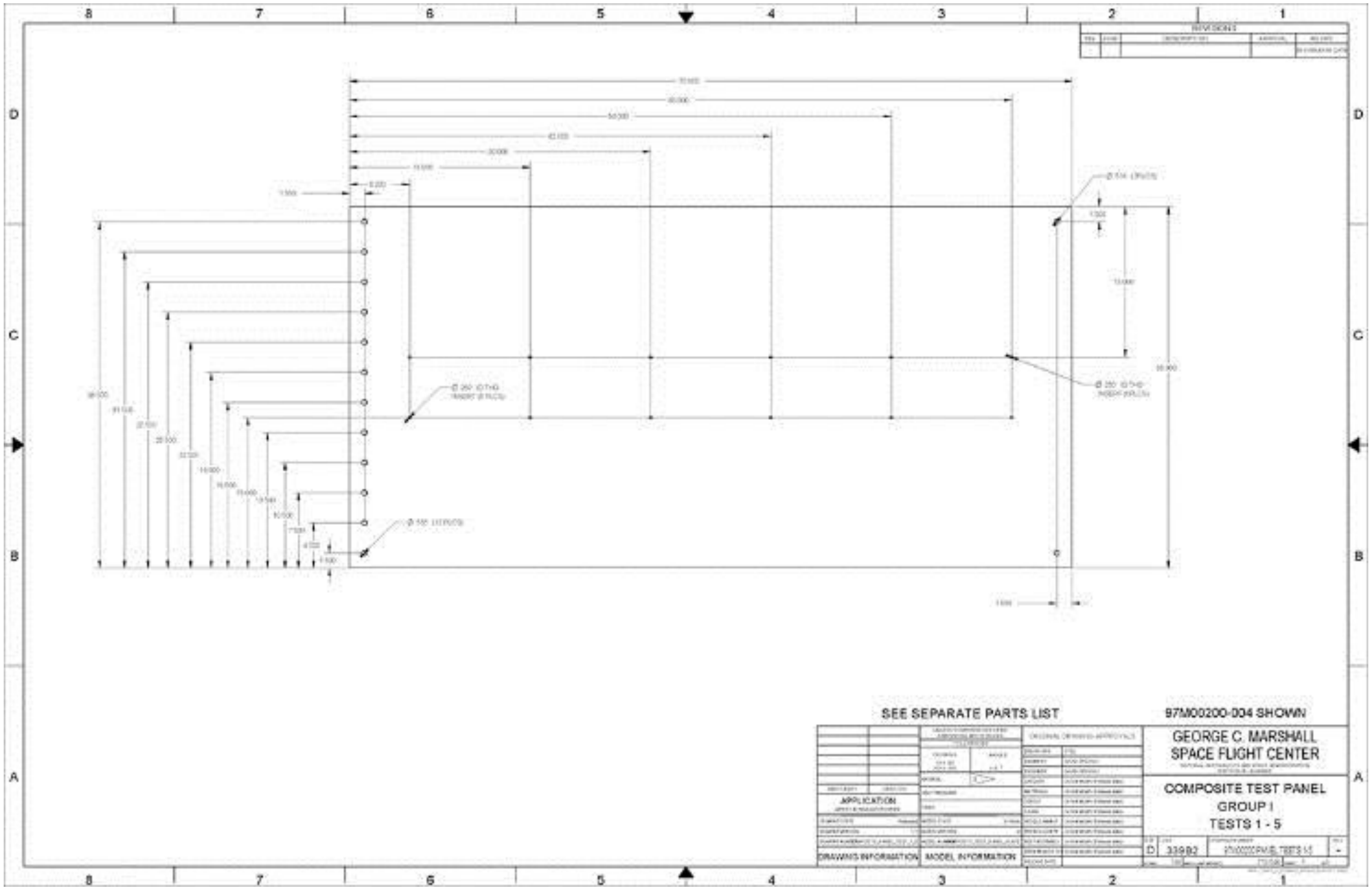


Figure A6. LSC Shim, 22 gpf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SPACE FLIGHT CENTER
COMPOSITE TEST PANEL
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TESTS 1 - 5
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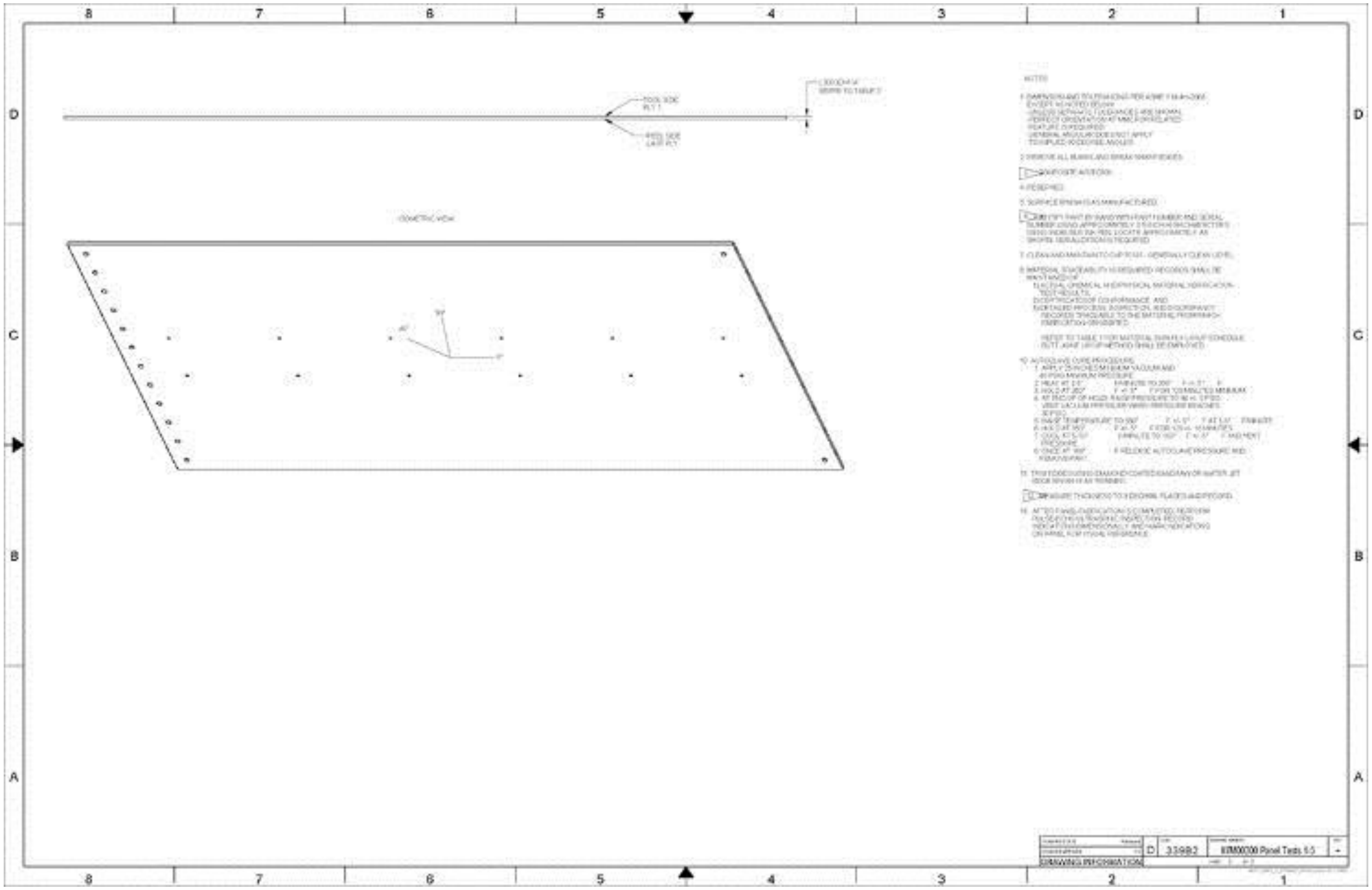
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Panel Tests 6.5
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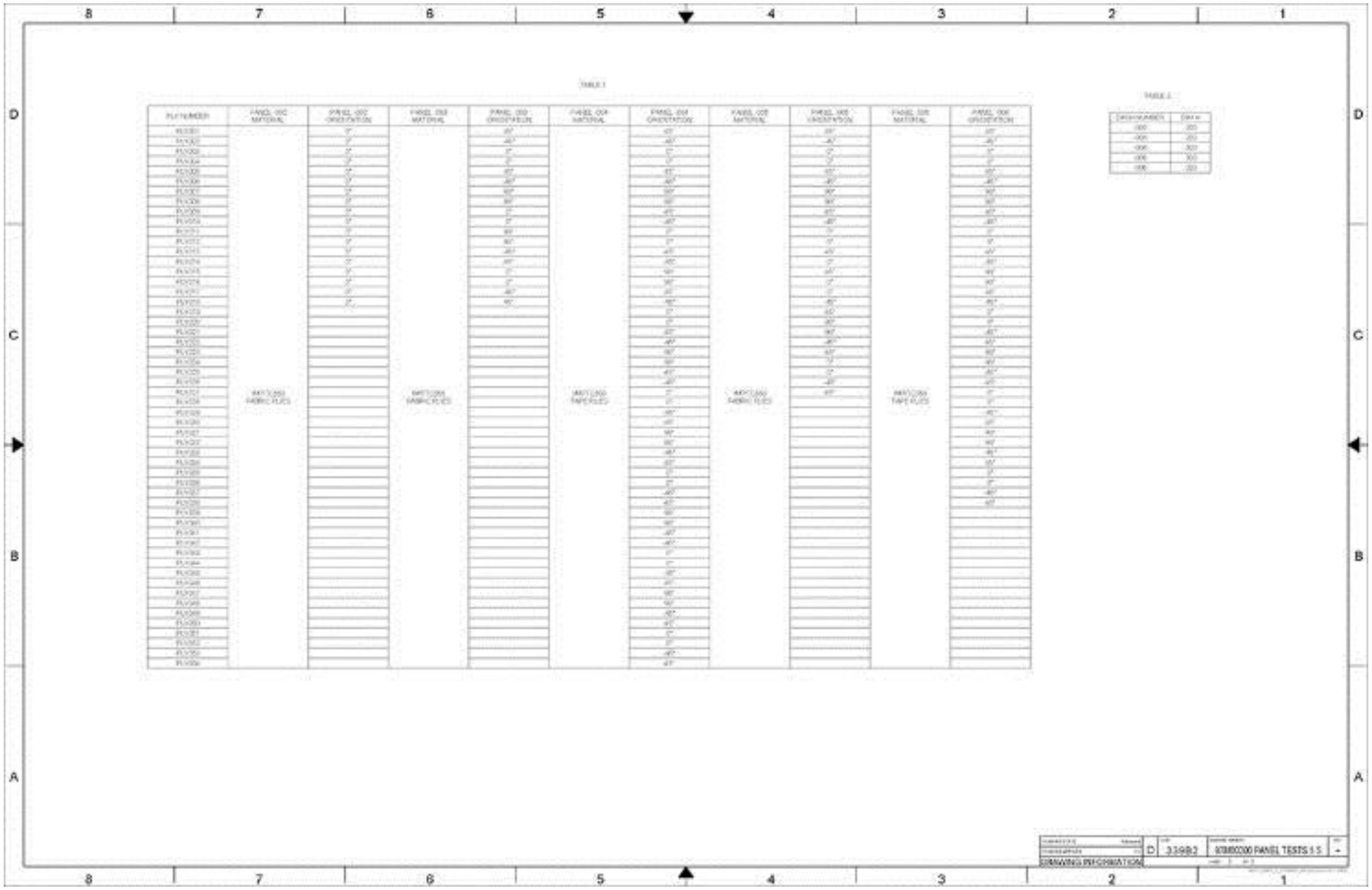
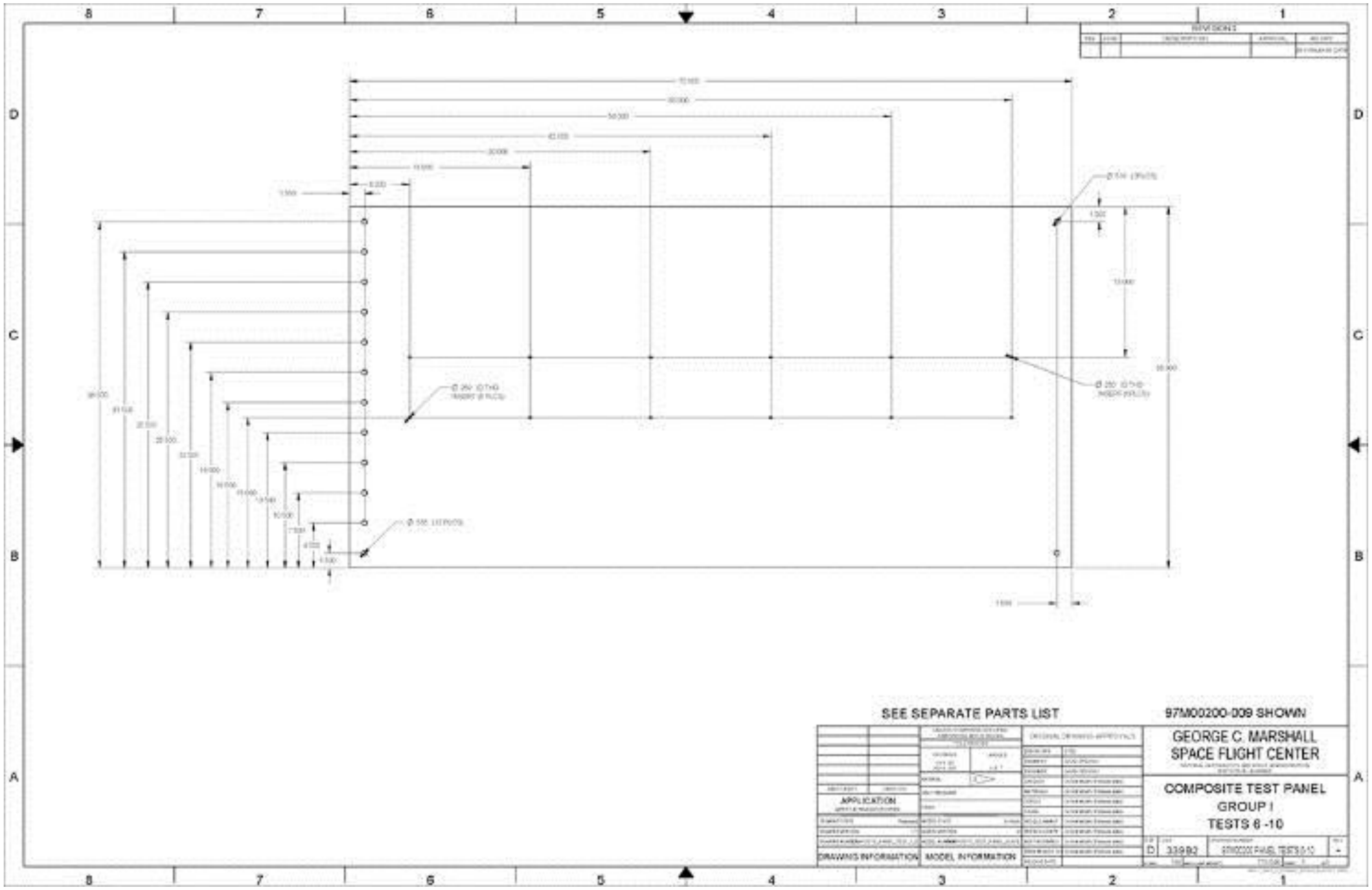


Figure A7. Monolithic Composite Test Panel, Tests 1 – 5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SPACE FLIGHT CENTER
COMPOSITE TEST PANEL
GROUP I
TESTS 6 -10
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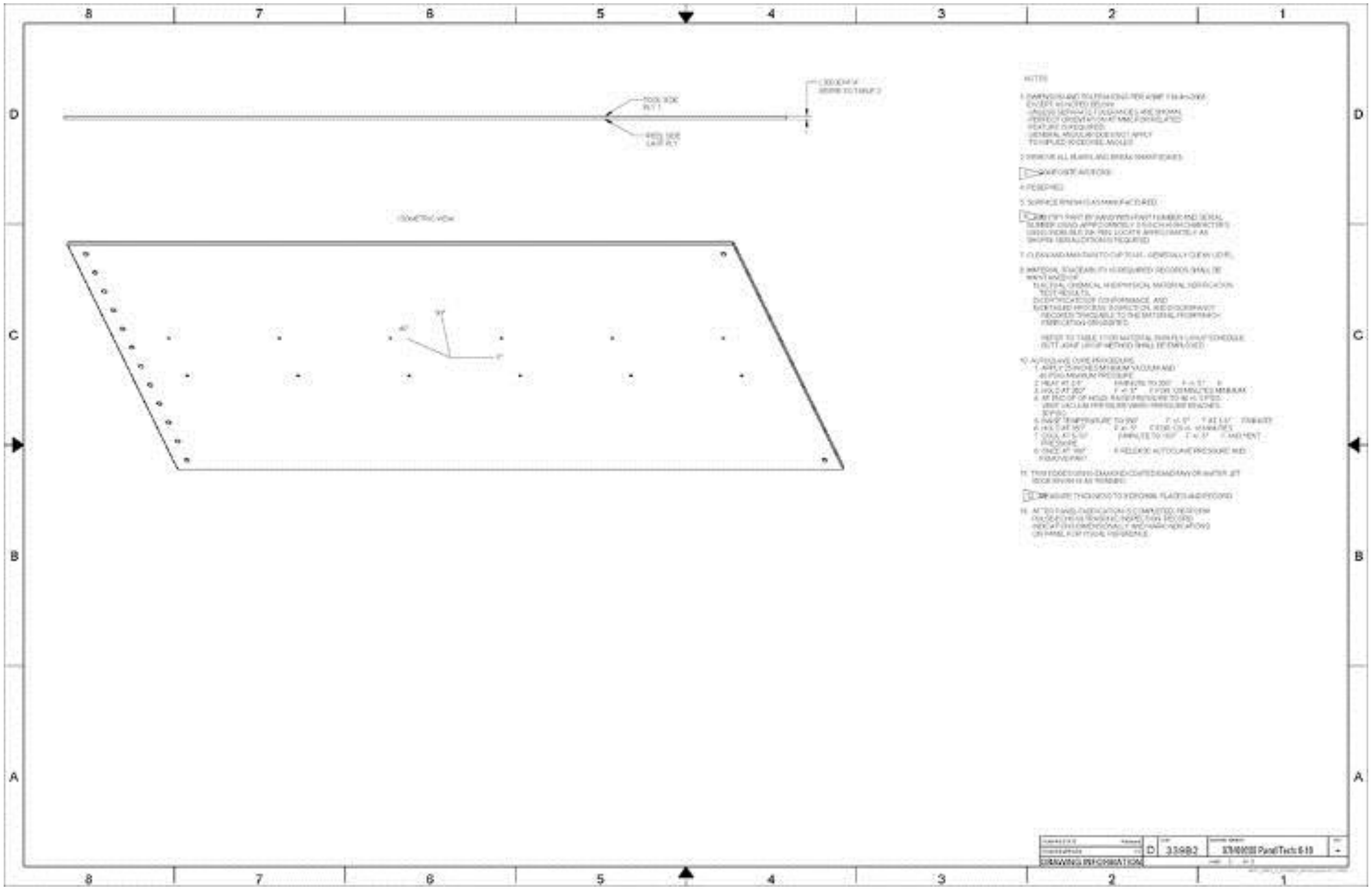
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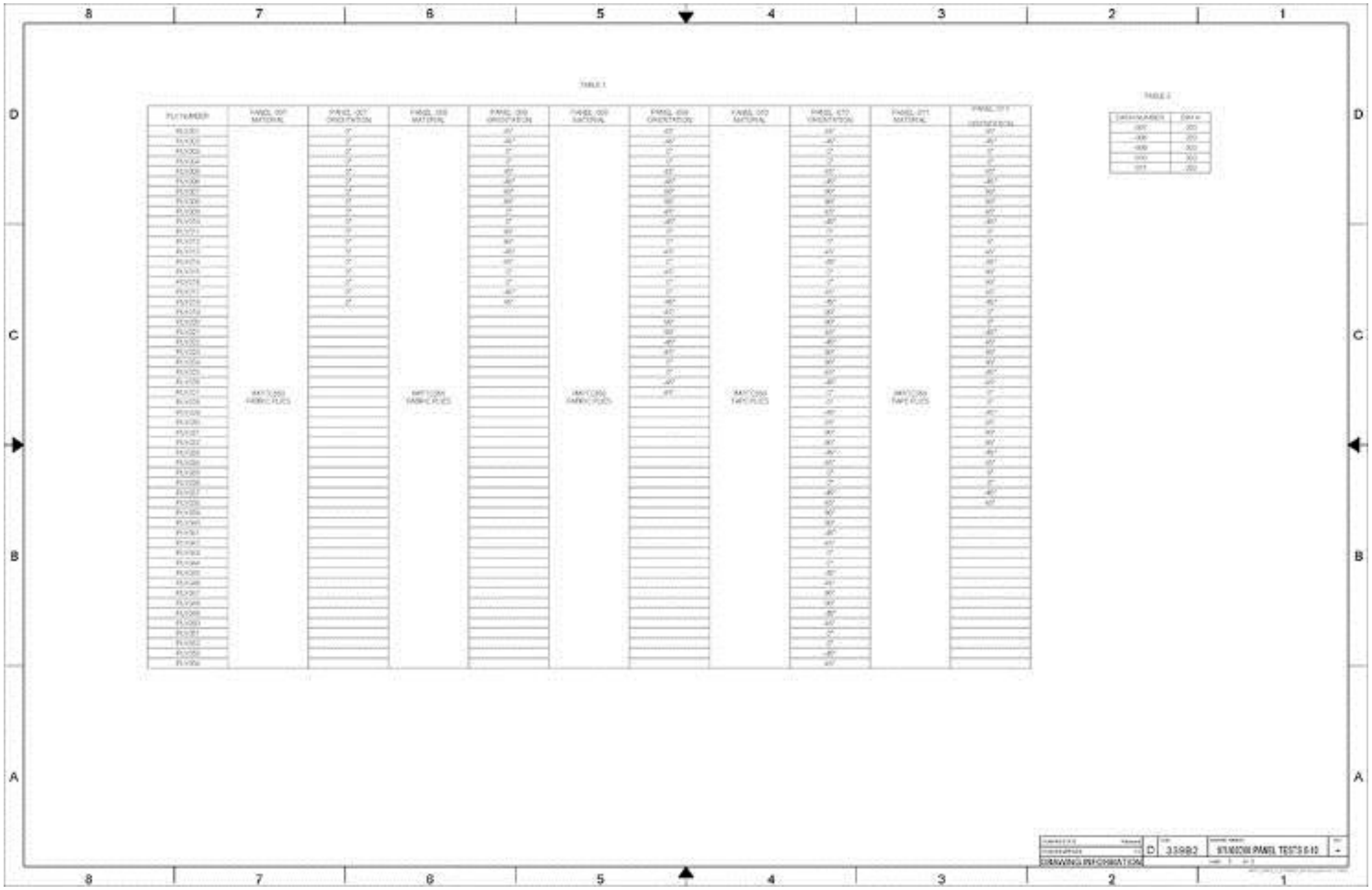
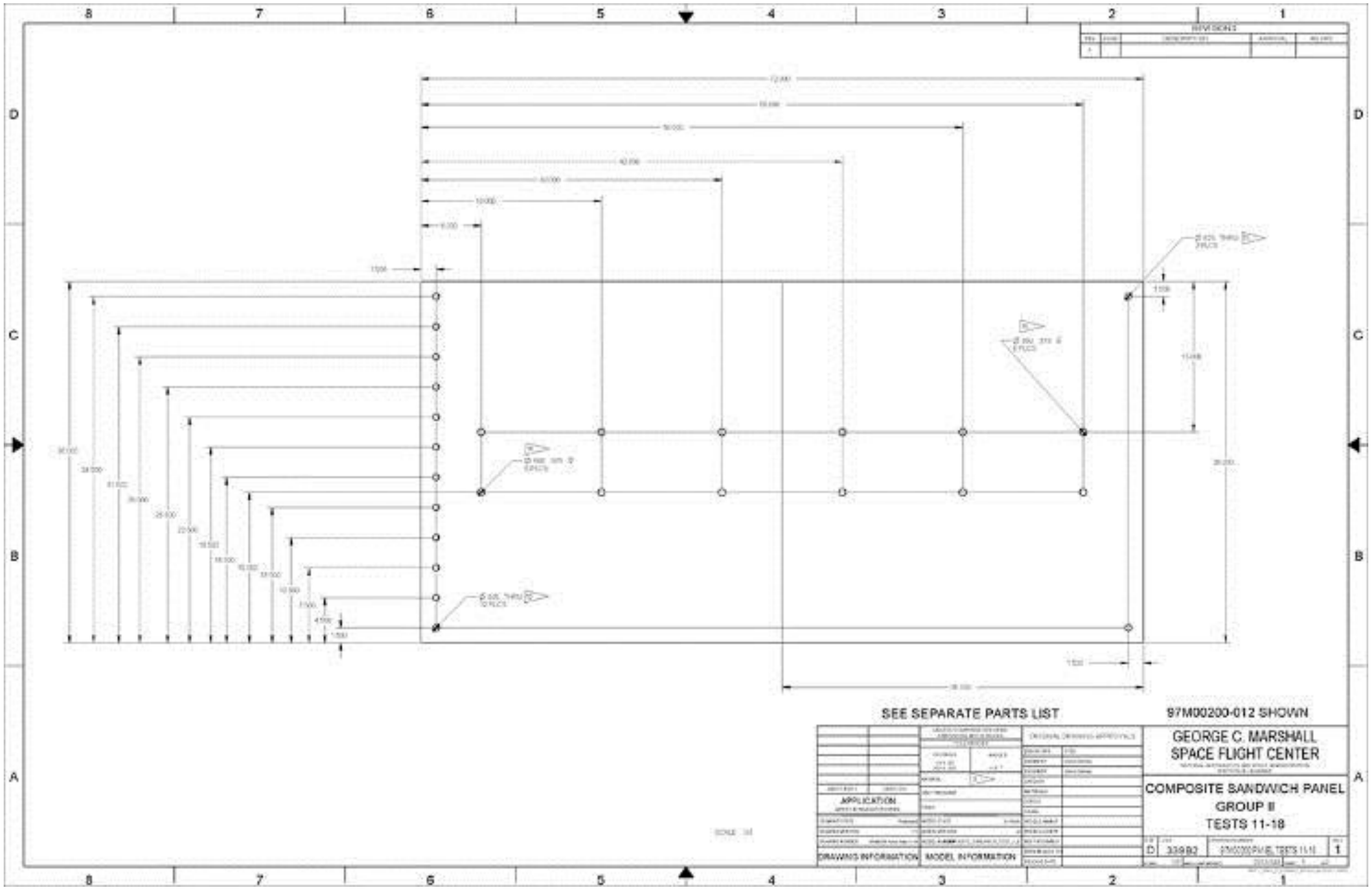


Figure A8. Monolithic Composite Test Panel, Tests 6 – 10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SPACE FLIGHT CENTER
COMPOSITE SANDWICH PANEL
GROUP II
TESTS 11-18
APPLICATION
DRAWING INFORMATION
MODEL INFORMATION
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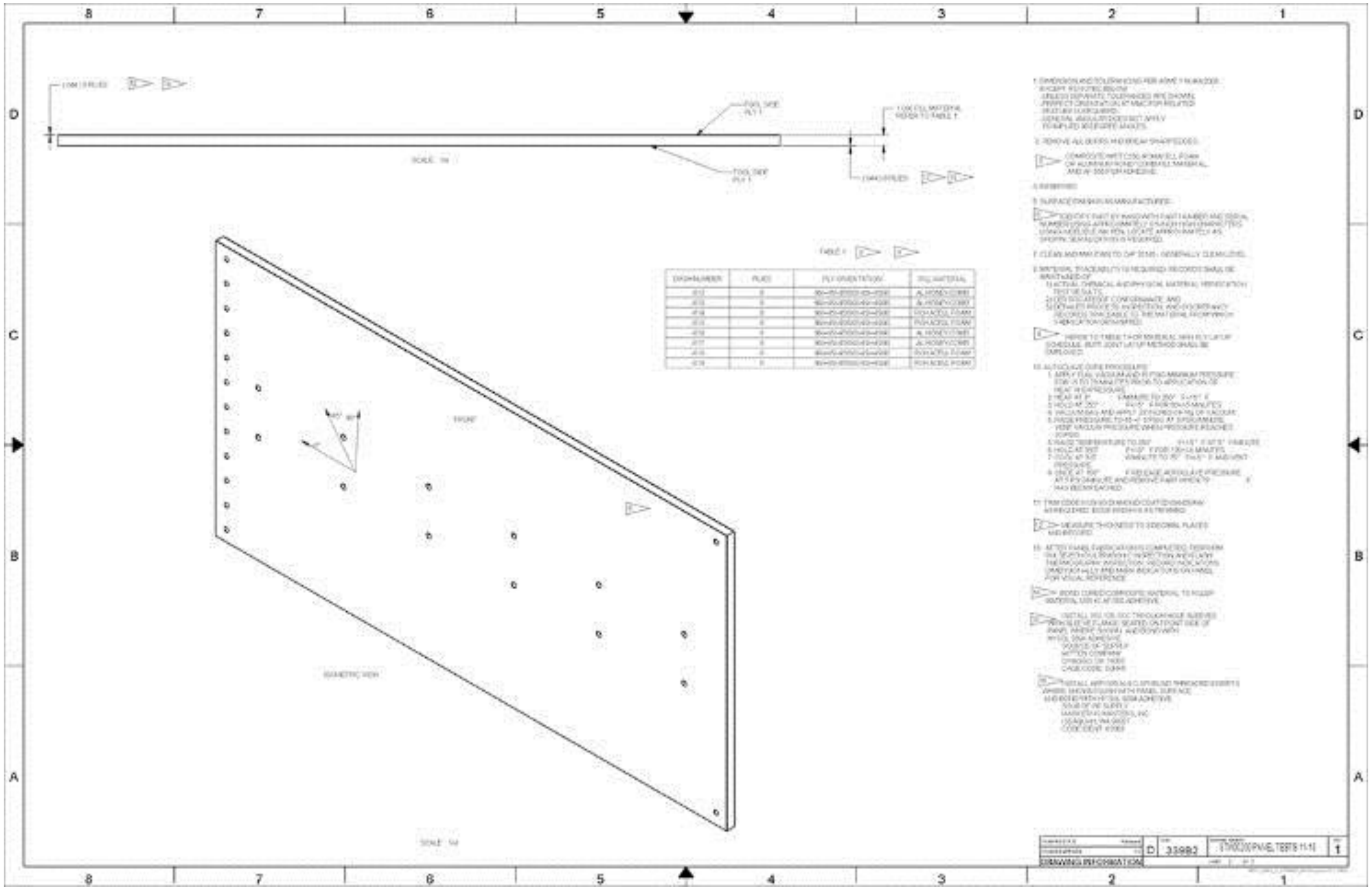
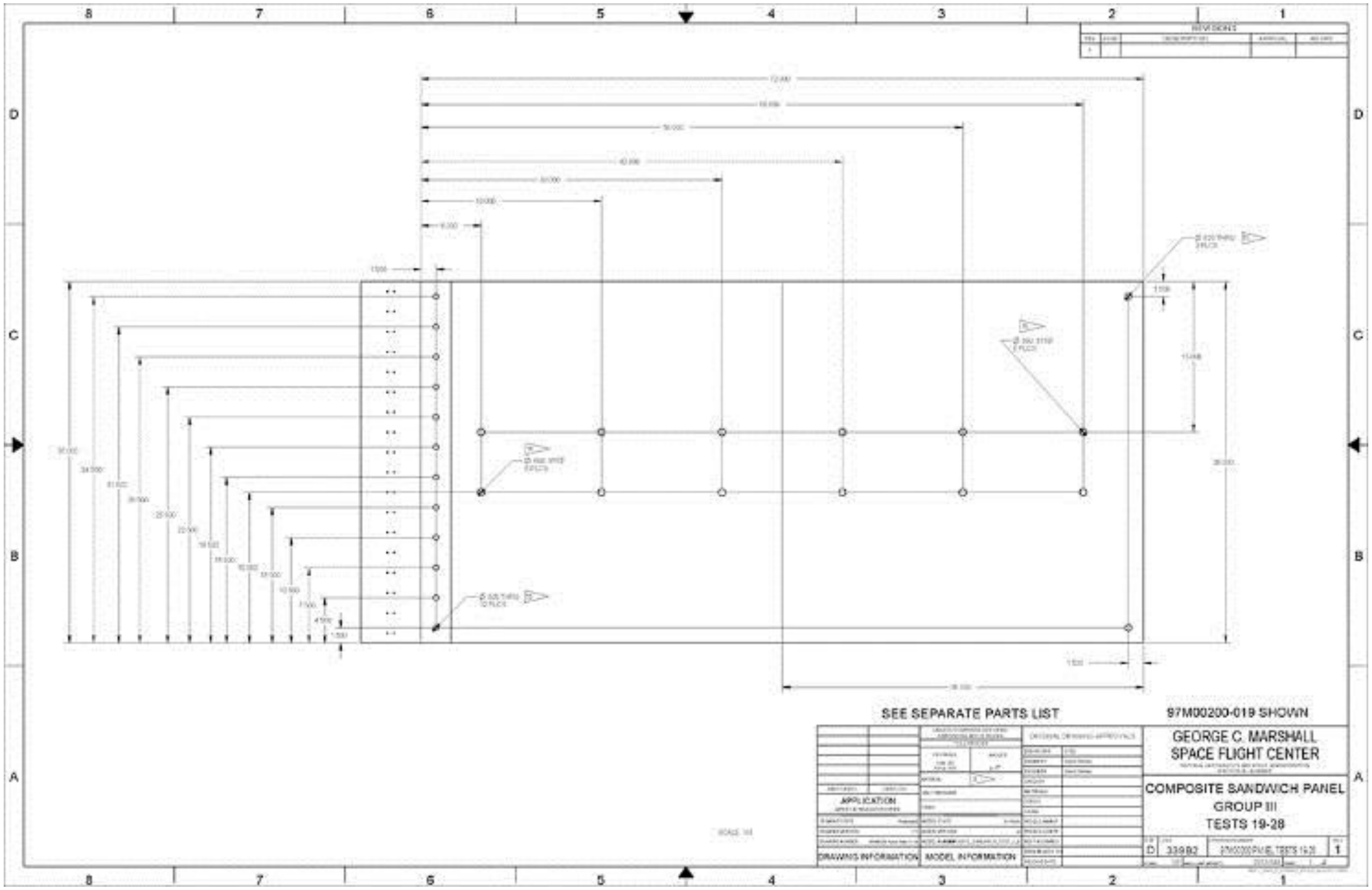


Figure A9. Sandwich Composite Test Panel, Group II



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GEORGE C. MARSHALL
SPACE FLIGHT CENTER
COMPOSITE SANDWICH PANEL
GROUP III
TESTS 19-28
APPLICATION
DRAWING INFORMATION
MODEL INFORMATION
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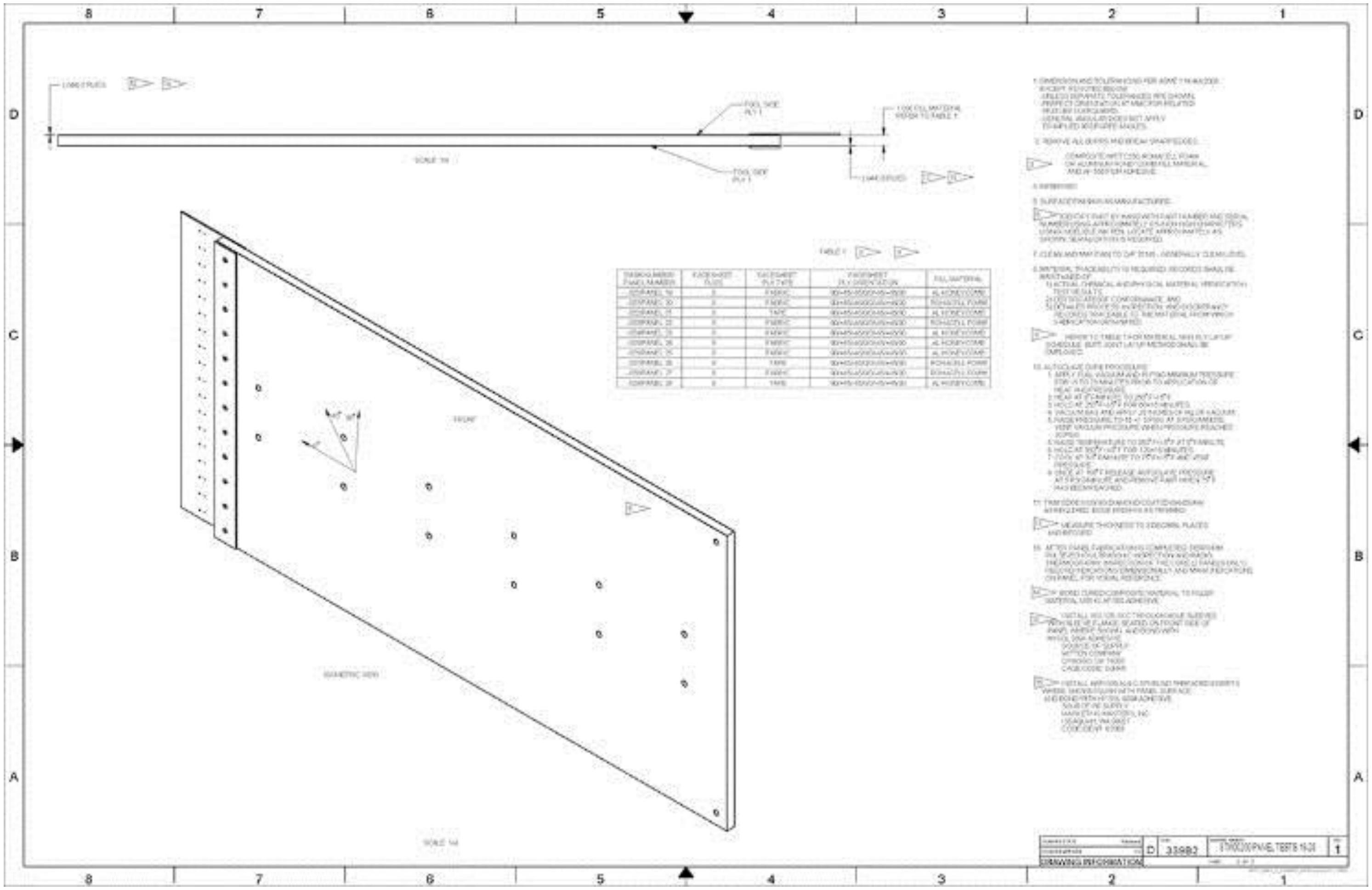


Figure A10. Sandwich Composite Test Panel, Group III

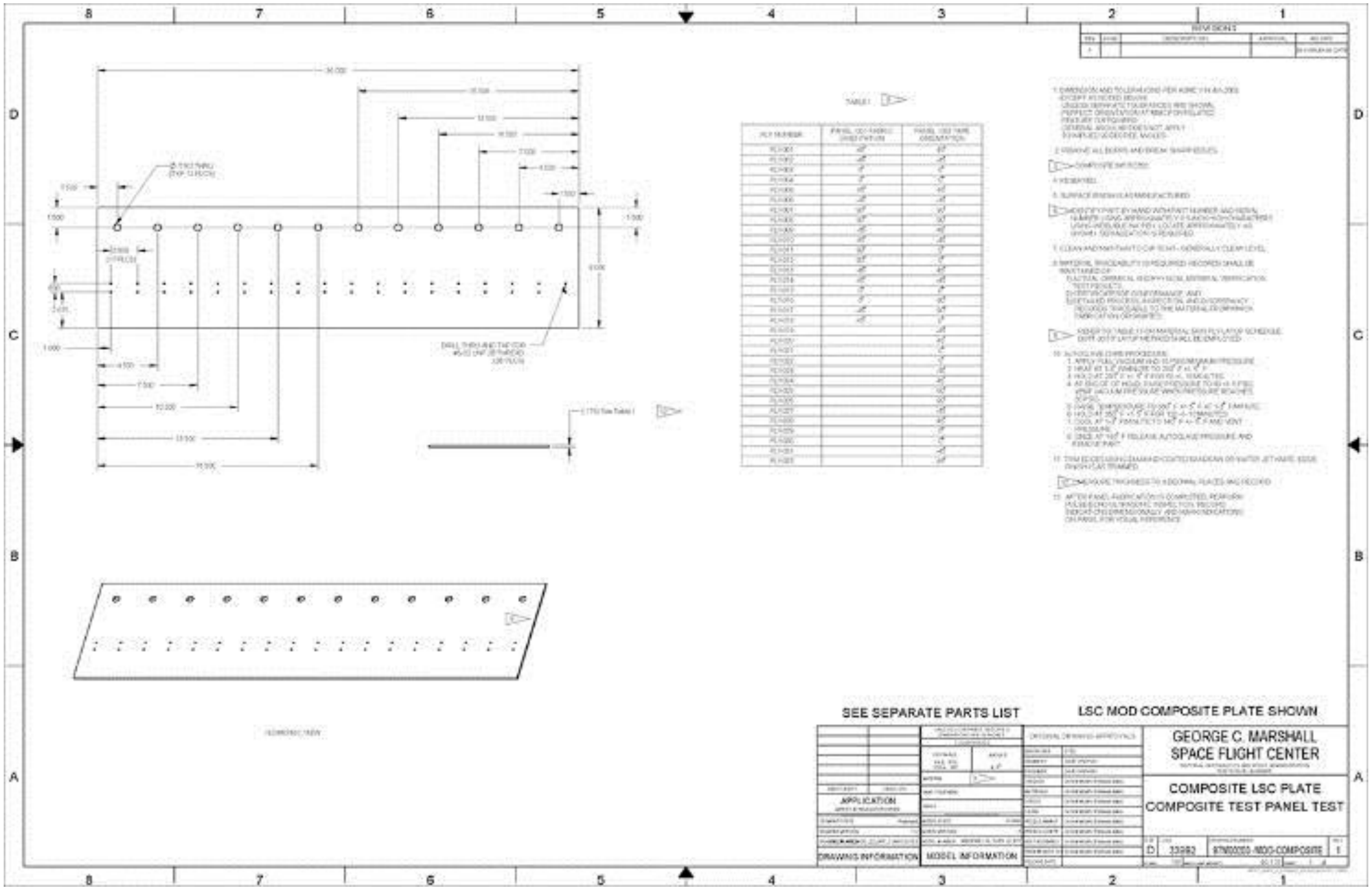


Figure A11. Composite LSC Test Plate

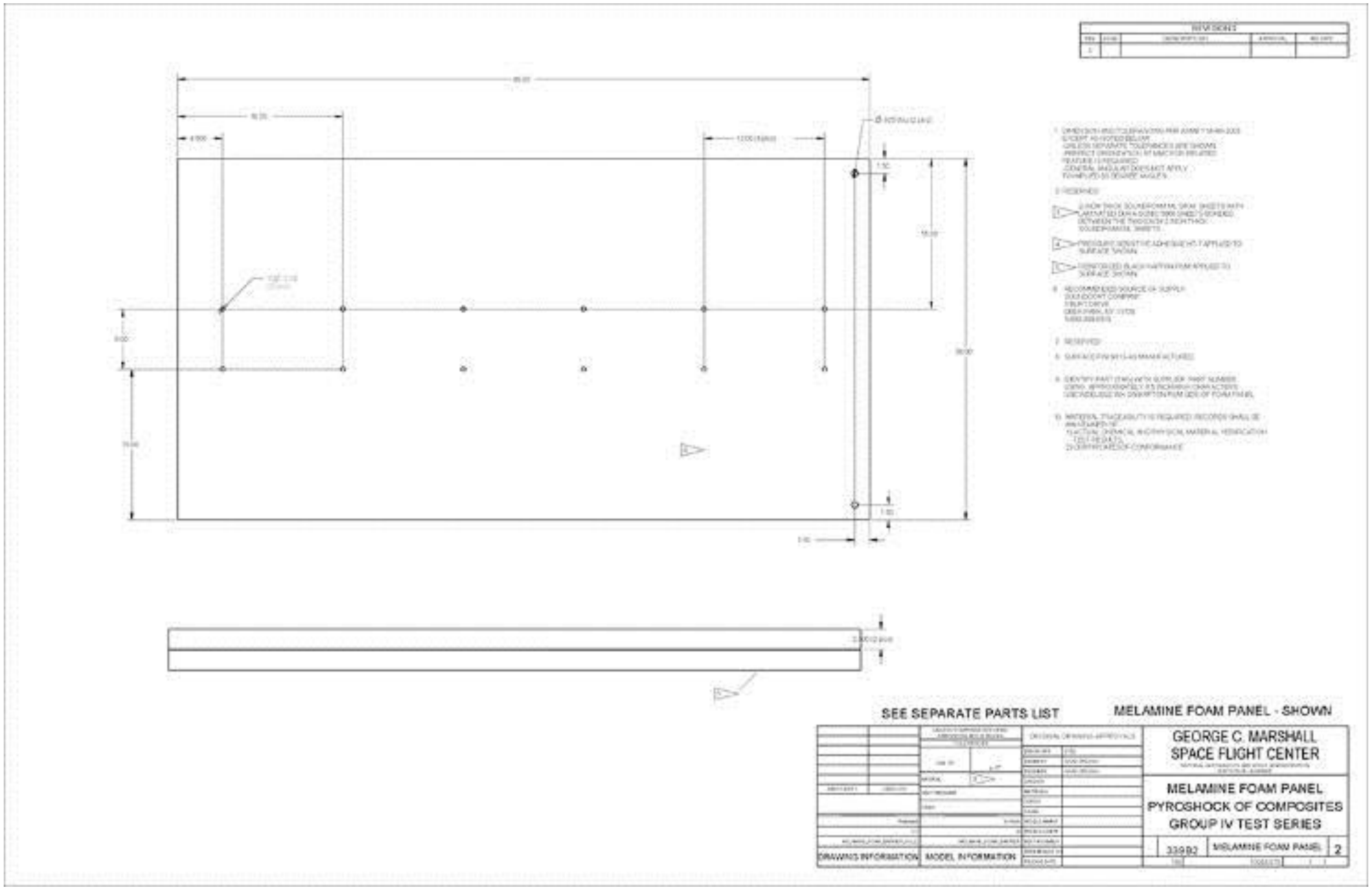
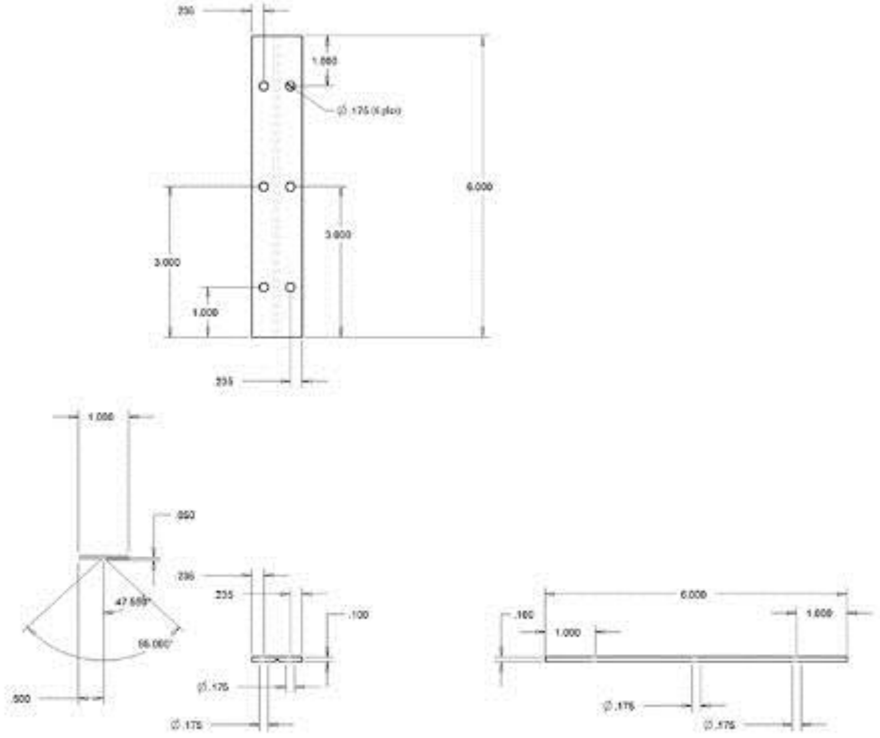


Figure A12. Melamine Acoustic Barrier Foam



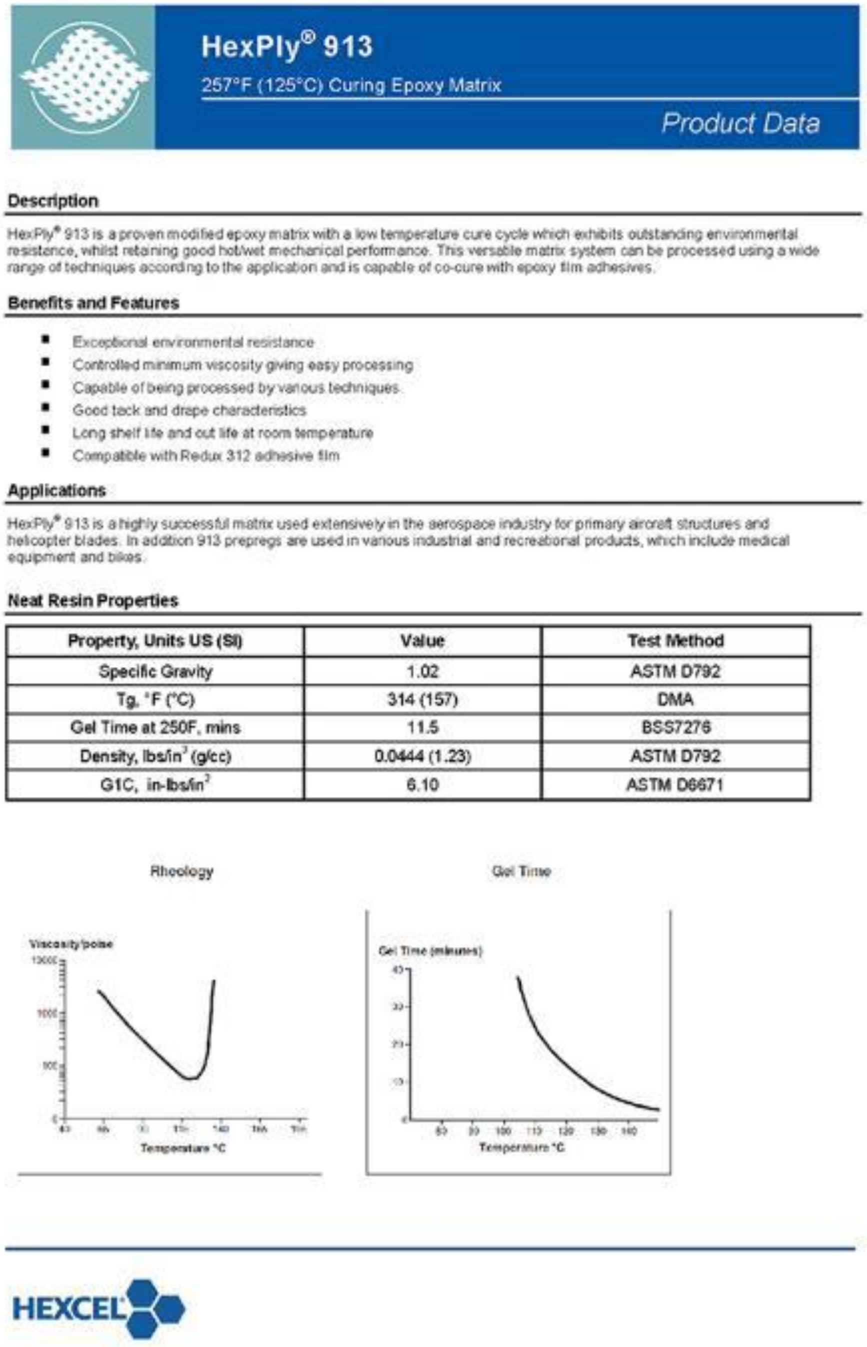
LSC SPLICE PLATE DRAWING
PYROSHOCK OF COMPOSITES
DAVID ORDWAY EV32
5/5/2014

Figure A13. LSC Splice Plate Drawing, 22 gpf LSC

A2 Composite Panel Materials

A2.1 Pathfinder Composite Panels

A series of five pathfinder tests, which were not included in the baseline T12-00783 task assessment plan (see Table 7.0-1). The objective for performing these tests was to validate the physical test setup and the DAS prior to embarking on the baseline tests. The first two tests utilized 5052 Al alloy plate with a thickness of 0.187 inches. The material properties for the IM7/R913 are shown in Figure A14.



HexPly® 913

257°F (125°C) Curing Epoxy Matrix

Product Data

Description

HexPly® 913 is a proven modified epoxy matrix with a low temperature cure cycle which exhibits outstanding environmental resistance, whilst retaining good hot/wet mechanical performance. This versatile matrix system can be processed using a wide range of techniques according to the application and is capable of co-cure with epoxy film adhesives.

Benefits and Features

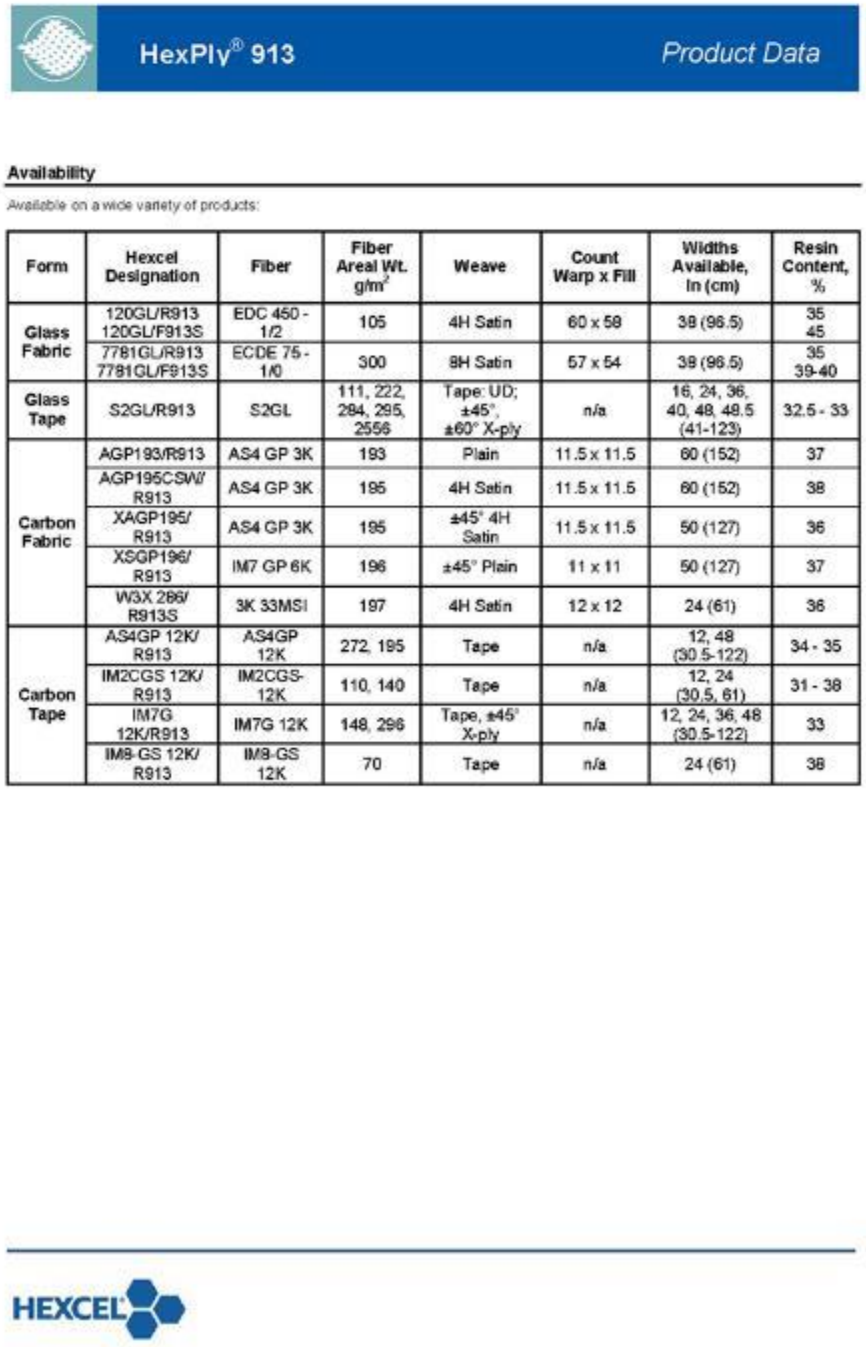
- Exceptional environmental resistance
- Controlled minimum viscosity giving easy processing
- Capable of being processed by various techniques
- Good tack and drape characteristics
- Long shelf life and out life at room temperature
- Compatible with Redux 312 adhesive film

Applications

HexPly® 913 is a highly successful matrix used extensively in the aerospace industry for primary aircraft structures and helicopter blades. In addition 913 prepregs are used in various industrial and recreational products, which include medical equipment and bikes.

Neat Resin Properties

Property, Units US (SI)	Value	Test Method
Specific Gravity	1.02	ASTM D792
Tg, °F (°C)	314 (157)	DMA
Gel Time at 250F, mins	11.5	BSS7276
Density, lbs/in^3 (g/cc)	0.0444 (1.23)	ASTM D792
G1C, in-lbs/in^2	6.10	ASTM D6671



HexPly® 913 *Product Data*

Availability

Available on a wide variety of products:

Form	Hexcel Designation	Fiber	Fiber Areal Wt. g/m^2	Weave	Count Warp x Fill	Widths Available, In (cm)	Resin Content, %
Glass Fabric	120GL/R913 120GL/F913S	EDC 450 - 1/2	105	4H Satin	60 x 58	38 (96.5)	35 45
	7781GL/R913 7781GL/F913S	ECDE 75 - 1/0	300	8H Satin	57 x 54	38 (96.5)	35 39-40
Glass Tape	S2GL/R913	S2GL	111, 222, 284, 295, 2556	Tape: UD; ±45°, ±60° X-ply	n/a	16, 24, 36, 40, 48, 48.5 (41-123)	32.5 - 33
Carbon Fabric	AGP193/R913	AS4 GP 3K	193	Plain	11.5 x 11.5	60 (152)	37
	AGP195CSW/ R913	AS4 GP 3K	195	4H Satin	11.5 x 11.5	60 (152)	38
	XAGP195/ R913	AS4 GP 3K	195	±45° 4H Satin	11.5 x 11.5	50 (127)	36
	XSGP196/ R913	IM7 GP 6K	196	±45° Plain	11 x 11	50 (127)	37
	W3X 286/ R913S	3K 33MSI	197	4H Satin	12 x 12	24 (61)	36
Carbon Tape	AS4GP 12K/ R913	AS4GP 12K	272, 195	Tape	n/a	12, 48 (30.5-122)	34 - 35
	IM2CGS 12K/ R913	IM2CGS-12K	110, 140	Tape	n/a	12, 24 (30.5, 61)	31 - 38
	IM7G 12K/R913	IM7G 12K	148, 296	Tape, ±45° X-ply	n/a	12, 24, 36, 48 (30.5-122)	33
	IM8-GS 12K/ R913	IM8-GS 12K	70	Tape	n/a	24 (61)	38

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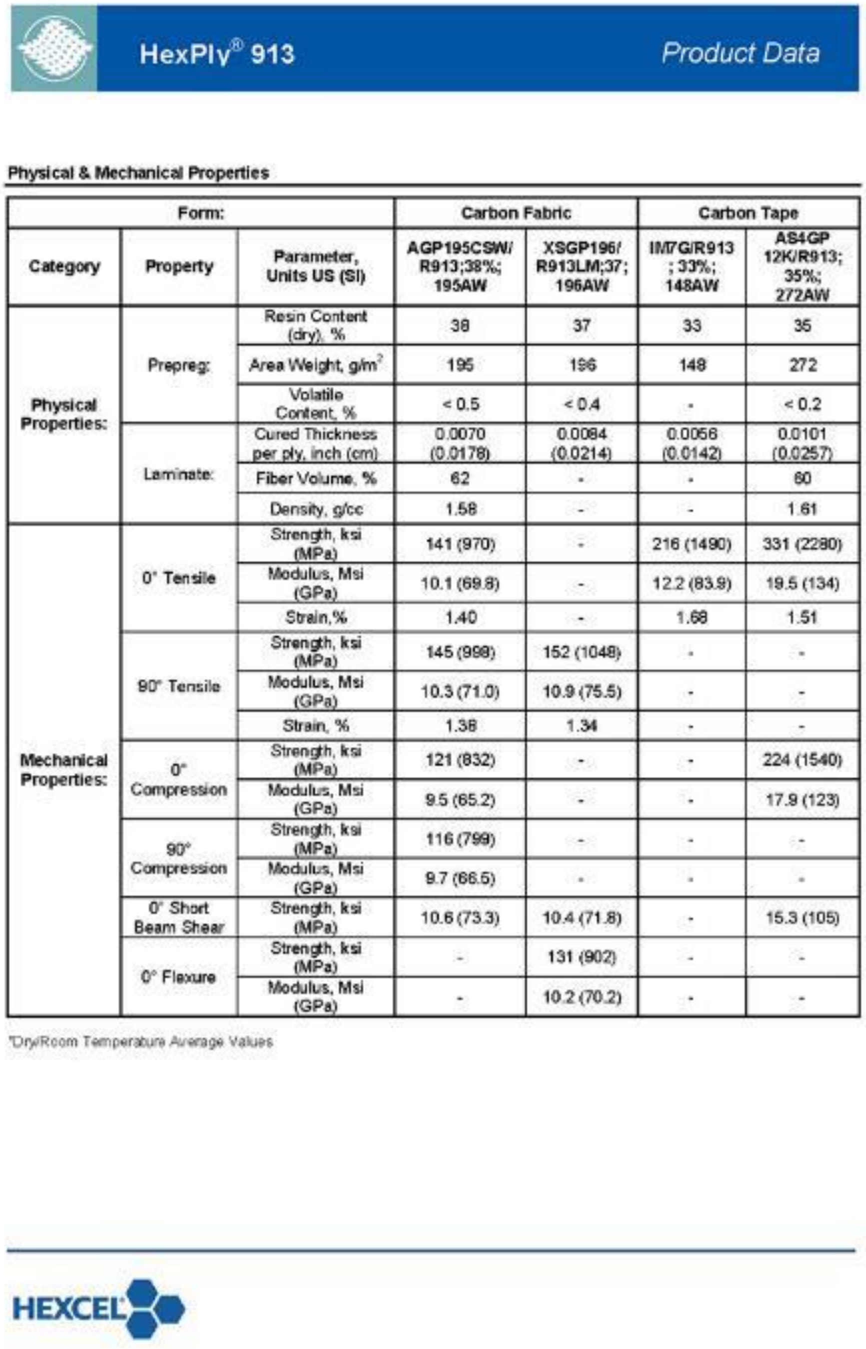


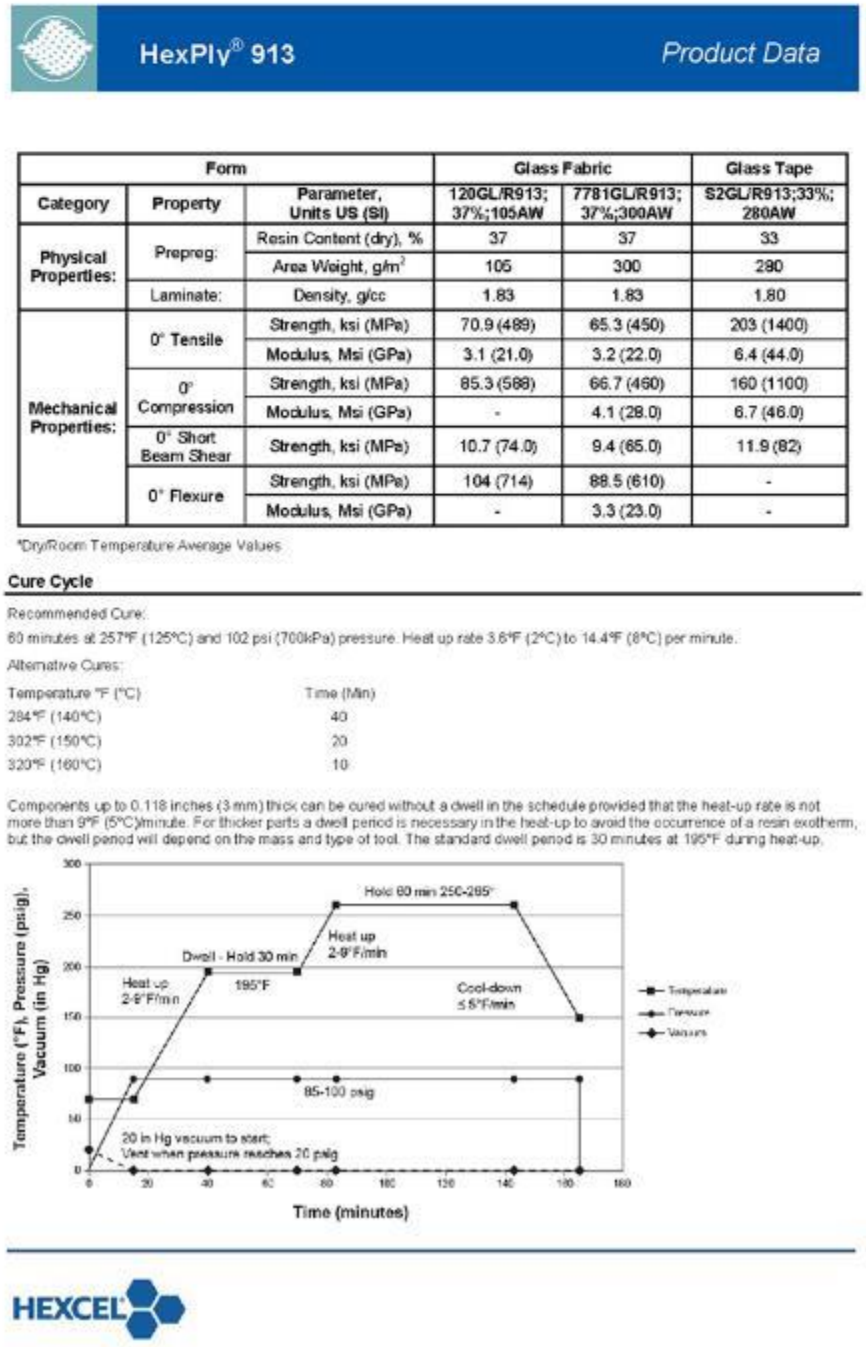
HexPly® 913 *Product Data*

Physical & Mechanical Properties

Form:			Carbon Fabric		Carbon Tape	
Category	**Property**	**Parameter, Units US (SI)**	**AGP195CSW/ R913;38%; 195AW**	**XSGP196/ R913LM;37; 196AW**	**IM7G/R913 ; 33%; 148AW**	**AS4GP 12K/R913; 35%; 272AW**
Physical Properties:	Prepreg:	Resin Content (dry), %	38	37	33	35
		Area Weight, g/m^2	195	196	148	272
		Volatile Content, %	< 0.5	< 0.4	-	< 0.2
	Laminate:	Cured Thickness per ply, inch (cm)	0.0070 (0.0178)	0.0084 (0.0214)	0.0056 (0.0142)	0.0101 (0.0257)
		Fiber Volume, %	62	-	-	60
		Density, g/cc	1.58	-	-	1.61
Mechanical Properties:	0° Tensile	Strength, ksi (MPa)	141 (970)	-	216 (1490)	331 (2280)
		Modulus, Msi (GPa)	10.1 (69.8)	-	12.2 (83.9)	19.5 (134)
		Strain,%	1.40	-	1.68	1.51
	90° Tensile	Strength, ksi (MPa)	145 (998)	152 (1048)	-	-
		Modulus, Msi (GPa)	10.3 (71.0)	10.9 (75.5)	-	-
		Strain, %	1.38	1.34	-	-
	0° Compression	Strength, ksi (MPa)	121 (832)	-	-	224 (1540)
		Modulus, Msi (GPa)	9.5 (65.2)	-	-	17.9 (123)
	90° Compression	Strength, ksi (MPa)	116 (799)	-	-	-
		Modulus, Msi (GPa)	9.7 (66.5)	-	-	-
	0° Short Beam Shear	Strength, ksi (MPa)	10.6 (73.3)	10.4 (71.8)	-	15.3 (105)
	0° Flexure	Strength, ksi (MPa)	-	131 (902)	-	-
		Modulus, Msi (GPa)	-	10.2 (70.2)	-	-

*Dry/Room Temperature Average Values

HEXCEL



HexPly® 913 Product Data

Form			Glass Fabric		Glass Tape
Category	Property	Parameter, Units US (SI)	120GL/R913; 37%;105AW	7781GL/R913; 37%;300AW	S2GL/R913;33%; 280AW
Physical Properties:	Prepreg:	Resin Content (dry), %	37	37	33
		Area Weight, g/m²	105	300	280
	Laminate:	Density, g/cc	1.83	1.83	1.80
Mechanical Properties:	0° Tensile	Strength, ksi (MPa)	70.9 (489)	65.3 (450)	203 (1400)
		Modulus, Msi (GPa)	3.1 (21.0)	3.2 (22.0)	6.4 (44.0)
	0° Compression	Strength, ksi (MPa)	85.3 (588)	66.7 (460)	160 (1100)
		Modulus, Msi (GPa)	-	4.1 (28.0)	6.7 (46.0)
	0° Short Beam Shear	Strength, ksi (MPa)	10.7 (74.0)	9.4 (65.0)	11.9 (82)
	0° Flexure	Strength, ksi (MPa)	104 (714)	88.5 (610)	-
		Modulus, Msi (GPa)	-	3.3 (23.0)	-

*Dry/Room Temperature Average Values

Cure Cycle

Recommended Cure:

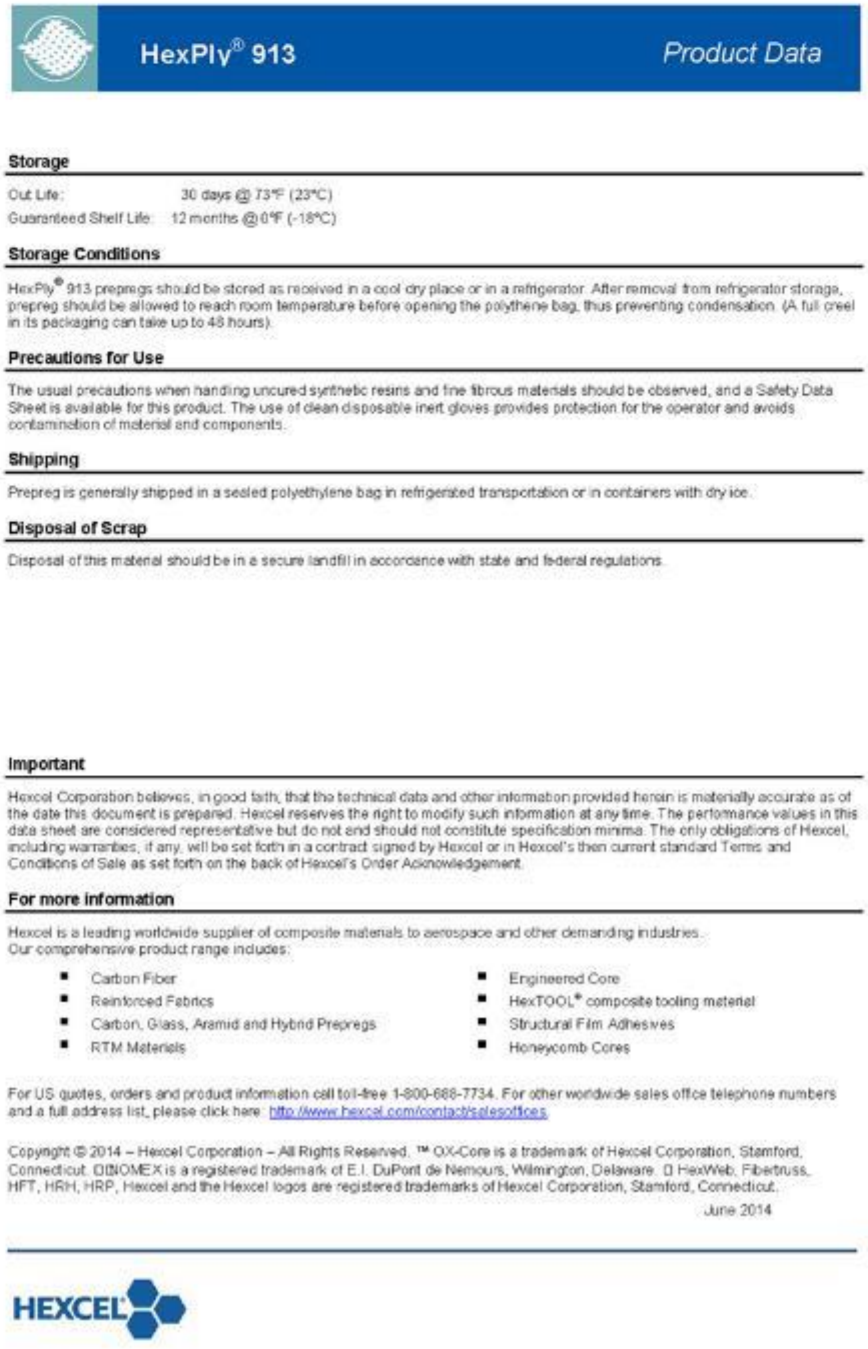
60 minutes at 257°F (125°C) and 102 psi (700kPa) pressure. Heat up rate 3.6°F (2°C) to 14.4°F (8°C) per minute.

Alternative Cures:

Temperature °F (°C)	Time (Min)
284°F (140°C)	40
302°F (150°C)	20
320°F (160°C)	10

Components up to 0.118 inches (3 mm) thick can be cured without a dwell in the schedule provided that the heat-up rate is not more than 9°F (5°C)/minute. For thicker parts a dwell period is necessary in the heat-up to avoid the occurrence of a resin exotherm, but the dwell period will depend on the mass and type of tool. The standard dwell period is 30 minutes at 195°F during heat-up.

HEXCEL



HexPly® 913

Product Data

Storage

Out Life: 30 days @ 73°F (23°C)
Guaranteed Shelf Life: 12 months @ 0°F (-18°C)

Storage Conditions

HexPly® 913 prepregs should be stored as received in a cool dry place or in a refrigerator. After removal from refrigerator storage, prepreg should be allowed to reach room temperature before opening the polythene bag, thus preventing condensation. (A full creel in its packaging can take up to 48 hours).

Precautions for Use

The usual precautions when handling uncured synthetic resins and fine fibrous materials should be observed, and a Safety Data Sheet is available for this product. The use of clean disposable inert gloves provides protection for the operator and avoids contamination of material and components.

Shipping

Prepreg is generally shipped in a sealed polyethylene bag in refrigerated transportation or in containers with dry ice.

Disposal of Scrap

Disposal of this material should be in a secure landfill in accordance with state and federal regulations.

Important

Hexcel Corporation believes, in good faith, that the technical data and other information provided herein is materially accurate as of the date this document is prepared. Hexcel reserves the right to modify such information at any time. The performance values in this data sheet are considered representative but do not and should not constitute specification minima. The only obligations of Hexcel, including warranties, if any, will be set forth in a contract signed by Hexcel or in Hexcel's then current standard Terms and Conditions of Sale as set forth on the back of Hexcel's Order Acknowledgement.

For more information

Hexcel is a leading worldwide supplier of composite materials to aerospace and other demanding industries.
Our comprehensive product range includes:

- Carbon Fiber
- Reinforced Fabrics
- Carbon, Glass, Aramid and Hybrid Prepregs
- RTM Materials
- Engineered Core
- HexTOOL® composite tooling material
- Structural Film Adhesives
- Honeycomb Cores

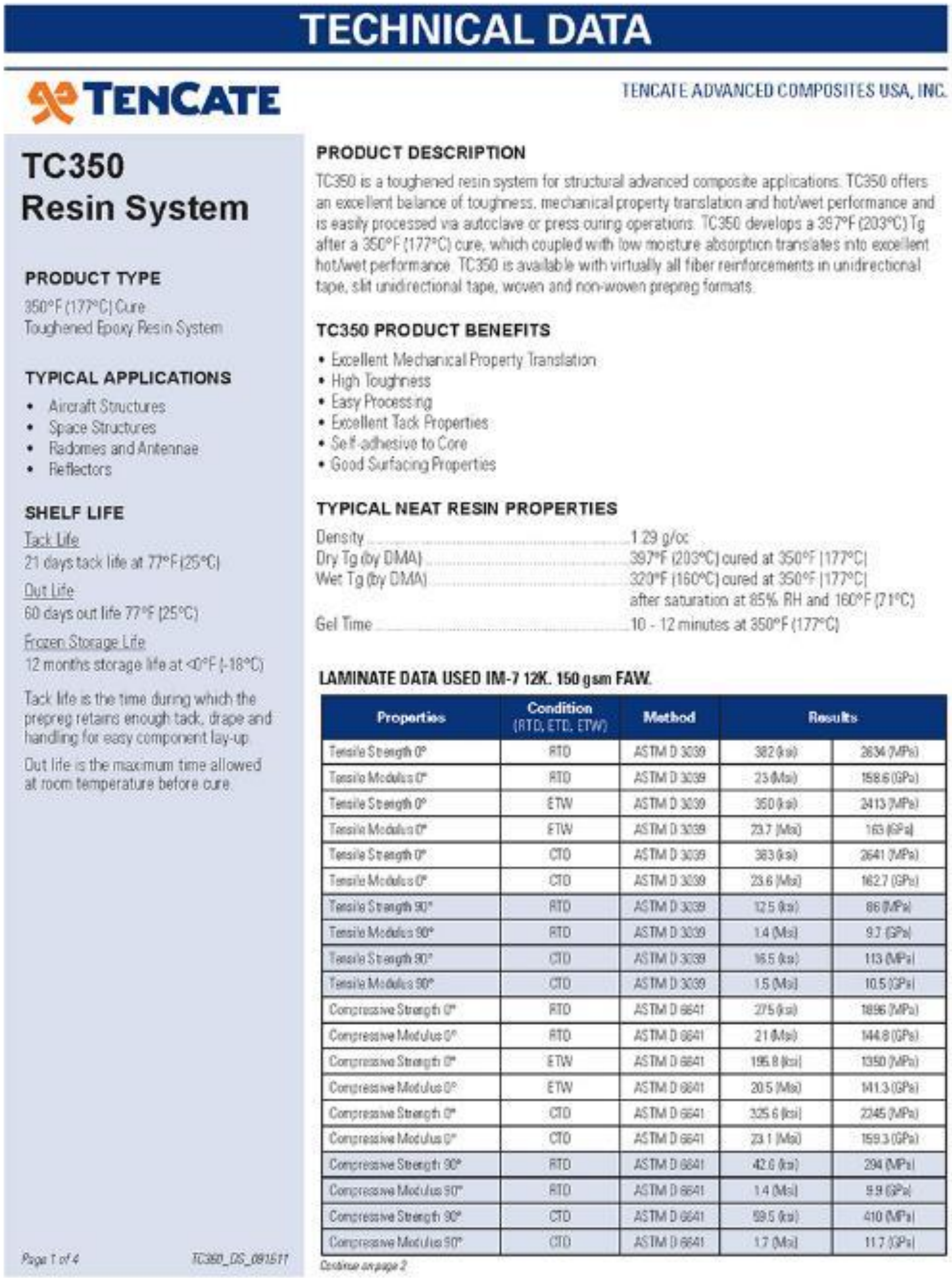
For US quotes, orders and product information call toll-free 1-800-688-7734. For other worldwide sales office telephone numbers and a full address list, please click here: http://www.hexcel.com/contact/salesoffices

June 2014

Figure A14. Hexcel IM7/R913 Material Properties

A2.2 Task Baseline Composite Panels

The IM7/TC350 composite material manufactured by TenCate Advanced Composites was chosen for fabrication of the task baseline composite test panels. The material is a 350°F toughened epoxy resin system for structural advanced composite applications, which include space structures. The composite is available in both tape and fabric prepreg formats. This material was chosen over the more commonly used IM7/977-3 composite material for aviation and aerospace applications primarily due to long lead time for procurement (29 weeks). The material properties of TC350 (shown in Figure A15) and 977-3 (provided herein for reference in Figure A16) are similar.



TECHNICAL DATA

TENCATE

TENCATE ADVANCED COMPOSITES USA, INC.

TC350
Resin System

PRODUCT TYPE

350°F (177°C) Cure
Toughened Epoxy Resin System

TYPICAL APPLICATIONS

- Aircraft Structures
- Space Structures
- Radomes and Antennae
- Reflectors

SHELF LIFE

Tack Life
21 days tack life at 77°F (25°C)

Out Life
60 days out life 77°F (25°C)

Frozen Storage Life
12 months storage life at <0°F (-18°C)

Tack life is the time during which the prepreg retains enough tack, drape and handling for easy component lay-up.

Out life is the maximum time allowed at room temperature before cure.

PRODUCT DESCRIPTION

TC350 is a toughened resin system for structural advanced composite applications. TC350 offers an excellent balance of toughness, mechanical property translation and hot/wet performance and is easily processed via autoclave or press curing operations. TC350 develops a 397°F (203°C) Tg after a 350°F (177°C) cure, which coupled with low moisture absorption translates into excellent hot/wet performance. TC350 is available with virtually all fiber reinforcements in unidirectional tape, slit unidirectional tape, woven and non-woven prepreg formats.

TC350 PRODUCT BENEFITS

- Excellent Mechanical Property Translation
- High Toughness
- Easy Processing
- Excellent Tack Properties
- Self-adhesive to Core
- Good Surfacing Properties

TYPICAL NEAT RESIN PROPERTIES

Density	1.29 g/cc
Dry Tg (by DMA)	397°F (203°C) cured at 350°F (177°C)
Wet Tg (by DMA)	320°F (160°C) cured at 350°F (177°C) after saturation at 85% RH and 160°F (71°C)
Gel Time	10 - 12 minutes at 350°F (177°C)

LAMINATE DATA USED IM-7 12K. 150 gsm FAW.

Properties	Condition (RTD, ETD, ETW)	Method	Results	
Tensile Strength 0°	RTD	ASTM D 3039	382 (ksi)	2634 (MPa)
Tensile Modulus 0°	RTD	ASTM D 3039	23 (Msi)	158.6 (GPa)
Tensile Strength 0°	ETW	ASTM D 3039	350 (ksi)	2413 (MPa)
Tensile Modulus 0°	ETW	ASTM D 3039	23.7 (Msi)	163 (GPa)
Tensile Strength 0°	CTD	ASTM D 3039	383 (ksi)	2641 (MPa)
Tensile Modulus 0°	CTD	ASTM D 3039	23.6 (Msi)	162.7 (GPa)
Tensile Strength 90°	RTD	ASTM D 3039	12.5 (ksi)	86 (MPa)
Tensile Modulus 90°	RTD	ASTM D 3039	1.4 (Msi)	9.7 (GPa)
Tensile Strength 90°	CTD	ASTM D 3039	16.5 (ksi)	113 (MPa)
Tensile Modulus 90°	CTD	ASTM D 3039	1.5 (Msi)	10.5 (GPa)
Compressive Strength 0°	RTD	ASTM D 6641	275 (ksi)	1896 (MPa)
Compressive Modulus 0°	RTD	ASTM D 6641	21 (Msi)	144.8 (GPa)
Compressive Strength 0°	ETW	ASTM D 6641	195.8 (ksi)	1350 (MPa)
Compressive Modulus 0°	ETW	ASTM D 6641	20.5 (Msi)	141.3 (GPa)
Compressive Strength 0°	CTD	ASTM D 6641	325.6 (ksi)	2245 (MPa)
Compressive Modulus 0°	CTD	ASTM D 6641	23.1 (Msi)	159.3 (GPa)
Compressive Strength 90°	RTD	ASTM D 6641	42.6 (ksi)	294 (MPa)
Compressive Modulus 90°	RTD	ASTM D 6641	1.4 (Msi)	9.9 (GPa)
Compressive Strength 90°	CTD	ASTM D 6641	59.5 (ksi)	410 (MPa)
Compressive Modulus 90°	CTD	ASTM D 6641	1.7 (Msi)	11.7 (GPa)

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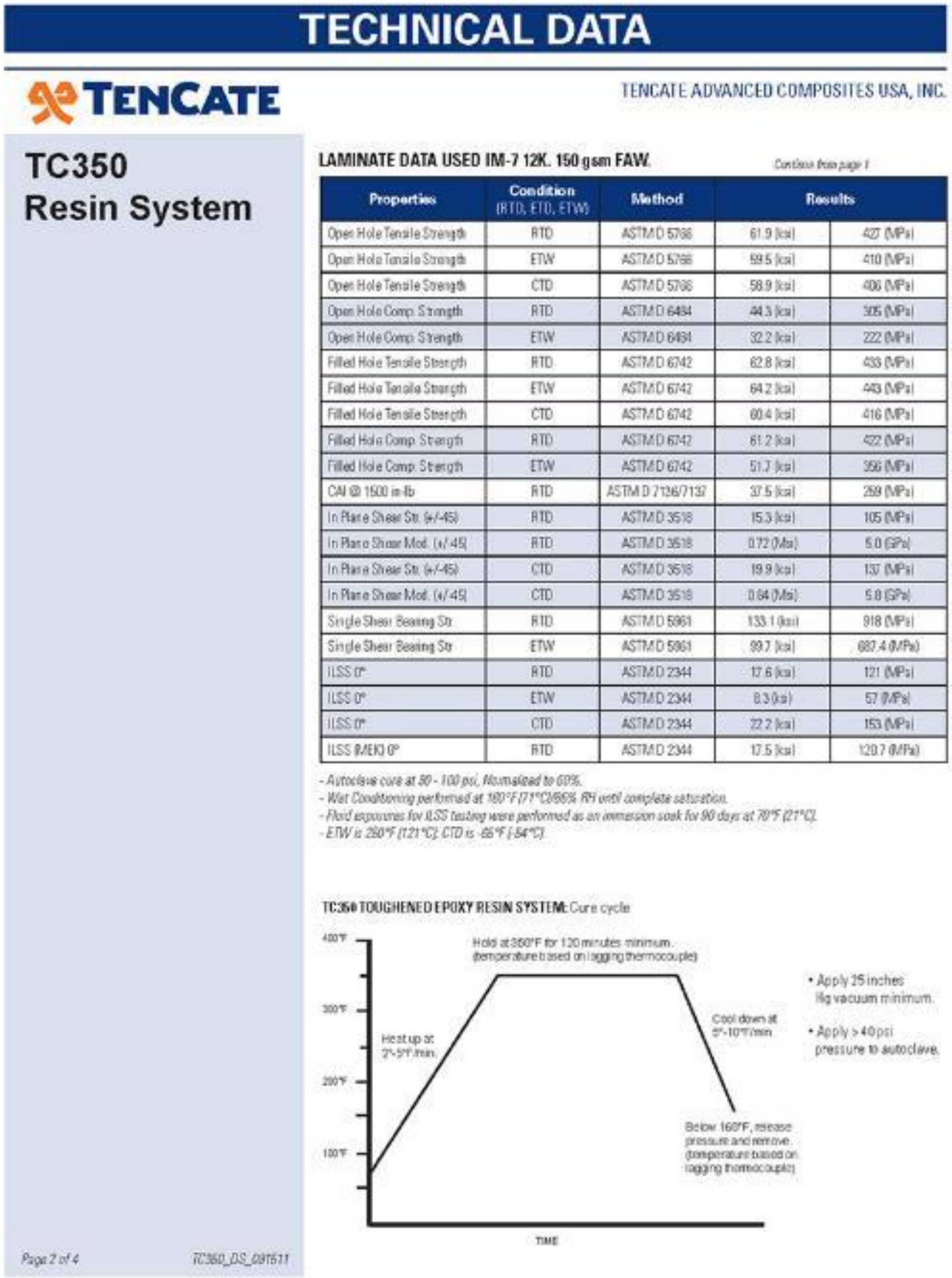
Continue on page 2



TECHNICAL DATA

TENCATE

TENCATE ADVANCED COMPOSITES USA, INC.

TC350
Resin System

LAMINATE DATA USED IM-7 12K. 150 gsm FAW.

Continue from page 1

Properties	Condition (RTD, ETD, ETW)	Method	Results	
Open Hole Tensile Strength	RTD	ASTM D 5766	61.9 (ksi)	427 (MPa)
Open Hole Tensile Strength	ETW	ASTM D 5766	59.5 (ksi)	410 (MPa)
Open Hole Tensile Strength	CTD	ASTM D 5766	58.9 (ksi)	406 (MPa)
Open Hole Comp. Strength	RTD	ASTM D 6484	44.3 (ksi)	305 (MPa)
Open Hole Comp. Strength	ETW	ASTM D 6484	32.2 (ksi)	222 (MPa)
Filled Hole Tensile Strength	RTD	ASTM D 6742	62.8 (ksi)	433 (MPa)
Filled Hole Tensile Strength	ETW	ASTM D 6742	64.2 (ksi)	443 (MPa)
Filled Hole Tensile Strength	CTD	ASTM D 6742	60.4 (ksi)	416 (MPa)
Filled Hole Comp. Strength	RTD	ASTM D 6742	61.2 (ksi)	422 (MPa)
Filled Hole Comp. Strength	ETW	ASTM D 6742	51.7 (ksi)	356 (MPa)
CAI @ 1500 in-lb	RTD	ASTM D 7136/7137	37.5 (ksi)	259 (MPa)
In Plane Shear Str. (+/-45)	RTD	ASTM D 3518	15.3 (ksi)	105 (MPa)
In Plane Shear Mod. (+/-45)	RTD	ASTM D 3518	0.72 (Msi)	5.0 (GPa)
In Plane Shear Str. (+/-45)	CTD	ASTM D 3518	19.9 (ksi)	137 (MPa)
In Plane Shear Mod. (+/-45)	CTD	ASTM D 3518	0.84 (Msi)	5.8 (GPa)
Single Shear Bearing Str	RTD	ASTM D 5961	133.1 (ksi)	918 (MPa)
Single Shear Bearing Str	ETW	ASTM D 5961	99.7 (ksi)	687.4 (MPa)
ILSS 0°	RTD	ASTM D 2344	17.6 (ksi)	121 (MPa)
ILSS 0°	ETW	ASTM D 2344	8.3 (ksi)	57 (MPa)
ILSS 0°	CTD	ASTM D 2344	22.2 (ksi)	153 (MPa)
ILSS (MEK) 0°	RTD	ASTM D 2344	17.5 (ksi)	120.7 (MPa)

- *Autoclave cure at 90 - 100 psi, Normalized to 60%.*
- *Wet Conditioning performed at 160°F (71°C)/85% RH until complete saturation.*
- *Fluid exposures for ILSS testing were performed as an immersion soak for 90 days at 70°F (21°C).*
- *ETW is 250°F (121°C); CTD is -65°F (-54°C).*

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle

- Apply 25 inches Hg vacuum minimum.
- Apply > 40 psi pressure to autoclave.

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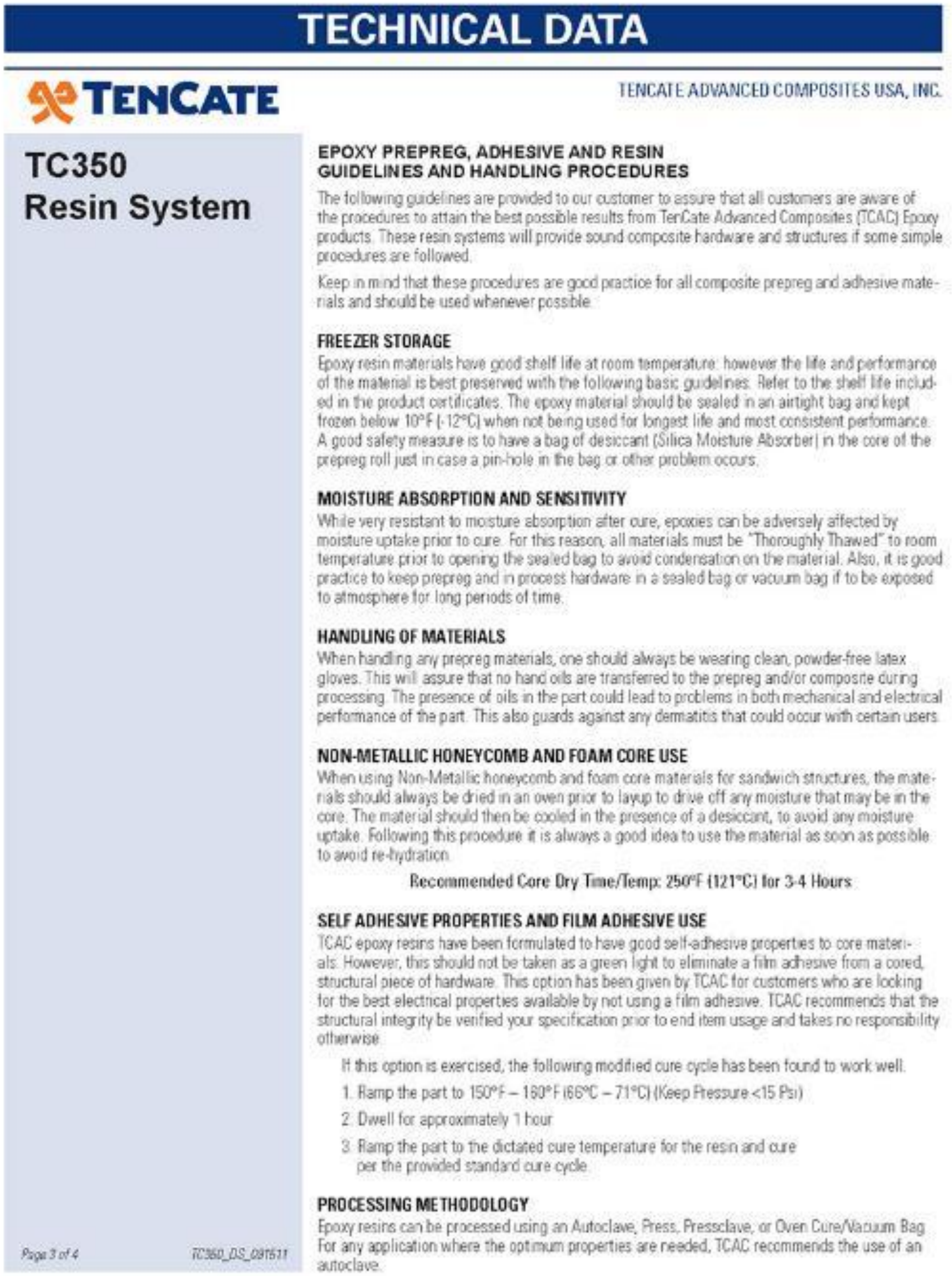

TECHNICAL DATA

TENCATE

TENCATE ADVANCED COMPOSITES USA, INC.

TC350
Resin System

EPOXY PREPREG, ADHESIVE AND RESIN GUIDELINES AND HANDLING PROCEDURES

The following guidelines are provided to our customer to assure that all customers are aware of the procedures to attain the best possible results from TenCate Advanced Composites (TCAC) Epoxy products. These resin systems will provide sound composite hardware and structures if some simple procedures are followed.

Keep in mind that these procedures are good practice for all composite prepreg and adhesive materials and should be used whenever possible.

FREEZER STORAGE

Epoxy resin materials have good shelf life at room temperature: however the life and performance of the material is best preserved with the following basic guidelines. Refer to the shelf life included in the product certificates. The epoxy material should be sealed in an airtight bag and kept frozen below 10°F (-12°C) when not being used for longest life and most consistent performance. A good safety measure is to have a bag of desiccant (Silica Moisture Absorber) in the core of the prepreg roll just in case a pin-hole in the bag or other problem occurs.

MOISTURE ABSORPTION AND SENSITIVITY

While very resistant to moisture absorption after cure, epoxies can be adversely affected by moisture uptake prior to cure. For this reason, all materials must be "Thoroughly Thawed" to room temperature prior to opening the sealed bag to avoid condensation on the material. Also, it is good practice to keep prepreg and in process hardware in a sealed bag or vacuum bag if to be exposed to atmosphere for long periods of time.

HANDLING OF MATERIALS

When handling any prepreg materials, one should always be wearing clean, powder-free latex gloves. This will assure that no hand oils are transferred to the prepreg and/or composite during processing. The presence of oils in the part could lead to problems in both mechanical and electrical performance of the part. This also guards against any dermatitis that could occur with certain users.

NON-METALLIC HONEYCOMB AND FOAM CORE USE

When using Non-Metallic honeycomb and foam core materials for sandwich structures, the materials should always be dried in an oven prior to layup to drive off any moisture that may be in the core. The material should then be cooled in the presence of a desiccant, to avoid any moisture uptake. Following this procedure it is always a good idea to use the material as soon as possible to avoid re-hydration.

Recommended Core Dry Time/Temp: 250°F (121°C) for 3-4 Hours

SELF ADHESIVE PROPERTIES AND FILM ADHESIVE USE

TCAC epoxy resins have been formulated to have good self-adhesive properties to core materials. However, this should not be taken as a green light to eliminate a film adhesive from a cored, structural piece of hardware. This option has been given by TCAC for customers who are looking for the best electrical properties available by not using a film adhesive. TCAC recommends that the structural integrity be verified your specification prior to end item usage and takes no responsibility otherwise.

If this option is exercised, the following modified cure cycle has been found to work well.

1. Ramp the part to 150°F – 160°F (66°C – 71°C) (Keep Pressure <15 Psi)
2. Dwell for approximately 1 hour
3. Ramp the part to the dictated cure temperature for the resin and cure per the provided standard cure cycle.

PROCESSING METHODOLOGY

Epoxy resins can be processed using an Autoclave, Press, Pressclave, or Oven Cure/Vacuum Bag. For any application where the optimum properties are needed, TCAC recommends the use of an autoclave.

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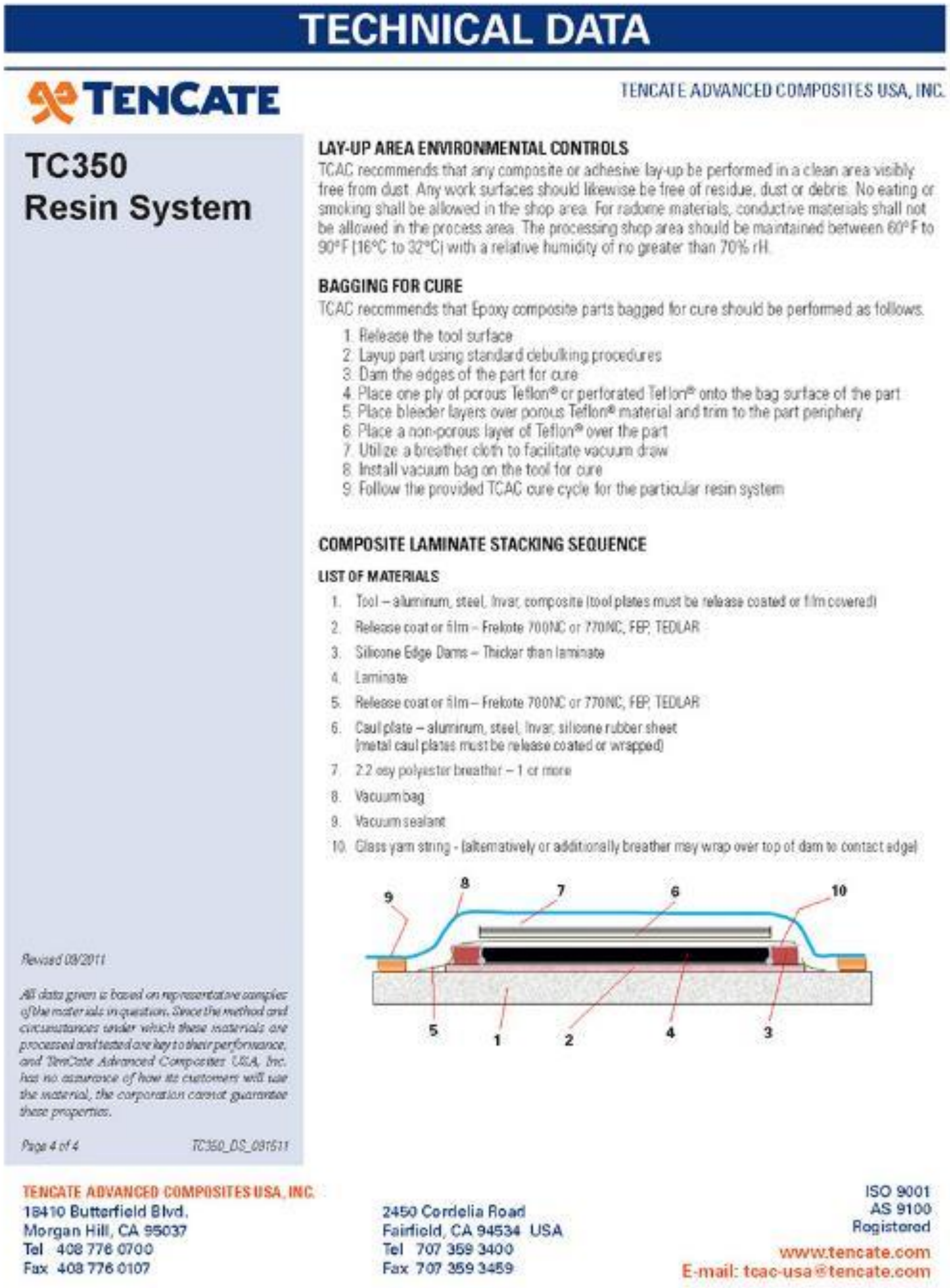

TECHNICAL DATA

TENCATE

TENCATE ADVANCED COMPOSITES USA, INC.

TC350 Resin System

LAY-UP AREA ENVIRONMENTAL CONTROLS

TCAC recommends that any composite or adhesive lay-up be performed in a clean area visibly free from dust. Any work surfaces should likewise be free of residue, dust or debris. No eating or smoking shall be allowed in the shop area. For radome materials, conductive materials shall not be allowed in the process area. The processing shop area should be maintained between 60°F to 90°F (16°C to 32°C) with a relative humidity of no greater than 70% rH.

BAGGING FOR CURE

TCAC recommends that Epoxy composite parts bagged for cure should be performed as follows.

1. Release the tool surface
2. Layup part using standard debulking procedures
3. Dam the edges of the part for cure
4. Place one ply of porous Teflon® or perforated Teflon® onto the bag surface of the part
5. Place bleeder layers over porous Teflon® material and trim to the part periphery
6. Place a non-porous layer of Teflon® over the part
7. Utilize a breather cloth to facilitate vacuum draw
8. Install vacuum bag on the tool for cure
9. Follow the provided TCAC cure cycle for the particular resin system

COMPOSITE LAMINATE STACKING SEQUENCE

LIST OF MATERIALS

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet
   (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string - (alternatively or additionally breather may wrap over top of dam to contact edge)

Revised 09/2011

All data given is based on representative samples of the materials in question. Since the method and circumstances under which these materials are processed and tested are key to their performance, and TenCate Advanced Composites USA, Inc. has no assurance of how its customers will use the material, the corporation cannot guarantee these properties.

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AS 9100
Registered

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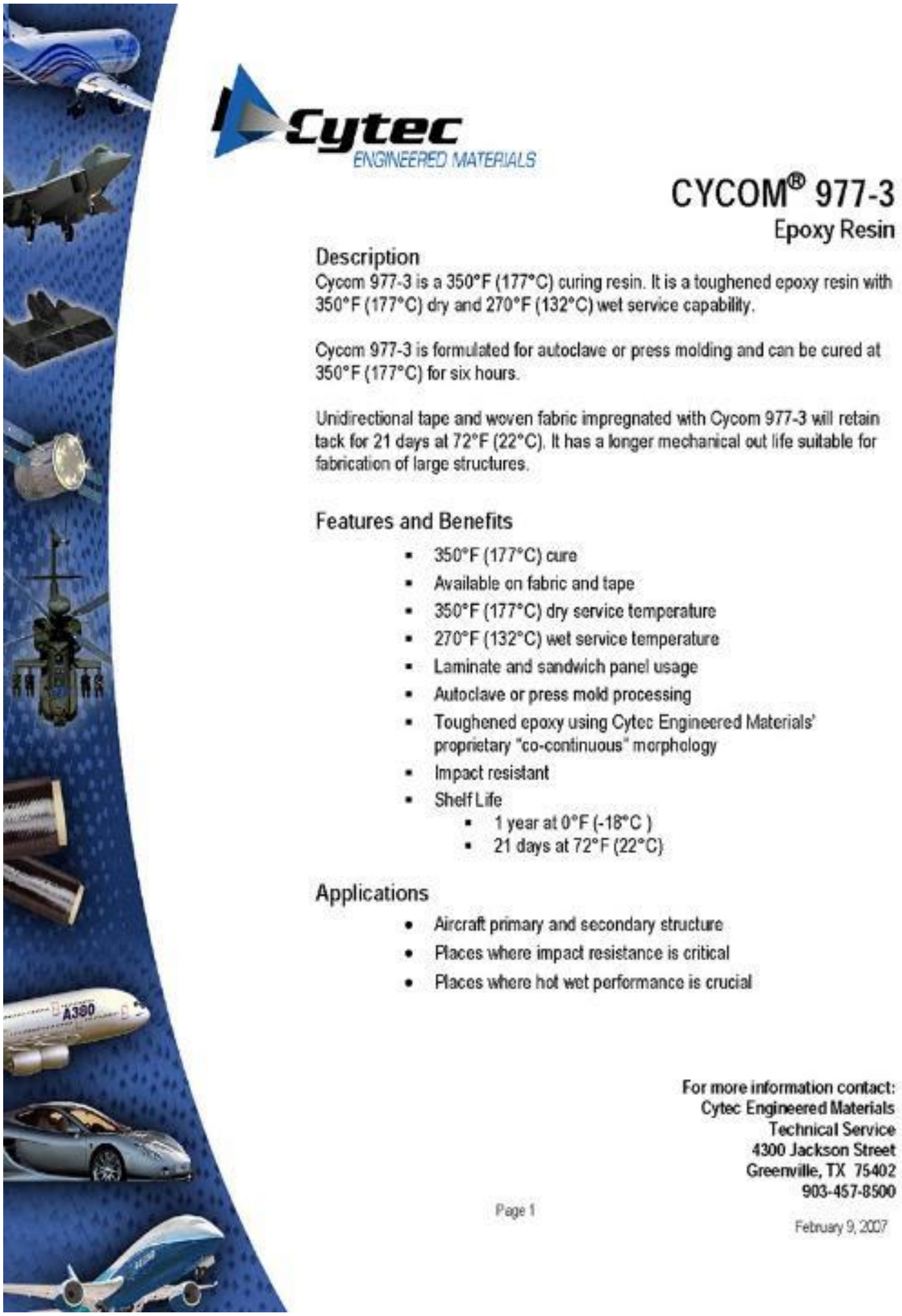
Figure A15. TenCate IM7/TC350 Material Properties



CYCOM® 977-3

Epoxy Resin

Description

Cycom 977-3 is a 350°F (177°C) curing resin. It is a toughened epoxy resin with 350°F (177°C) dry and 270°F (132°C) wet service capability.

Cycom 977-3 is formulated for autoclave or press molding and can be cured at 350°F (177°C) for six hours.

Unidirectional tape and woven fabric impregnated with Cycom 977-3 will retain tack for 21 days at 72°F (22°C). It has a longer mechanical out life suitable for fabrication of large structures.

Features and Benefits

- 350°F (177°C) cure
- Available on fabric and tape
- 350°F (177°C) dry service temperature
- 270°F (132°C) wet service temperature
- Laminate and sandwich panel usage
- Autoclave or press mold processing
- Toughened epoxy using Cytec Engineered Materials' proprietary "co-continuous" morphology
- Impact resistant
- Shelf Life
    - 1 year at 0°F (-18°C)
    - 21 days at 72°F (22°C)

Applications

- Aircraft primary and secondary structure
- Places where impact resistance is critical
- Places where hot wet performance is crucial

For more information contact:
Cytec Engineered Materials
Technical Service
4300 Jackson Street
Greenville, TX 75402
903-457-8500

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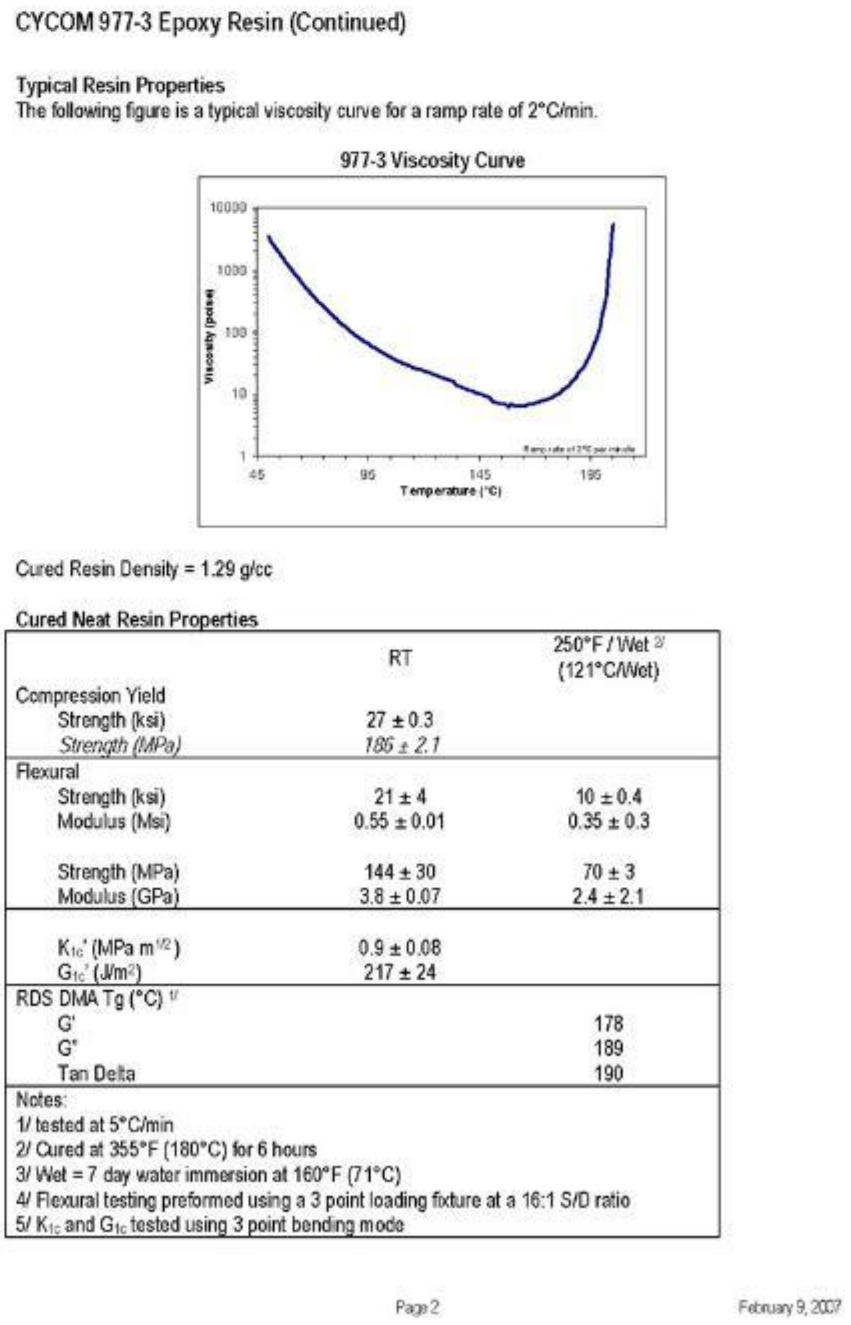

CYCOM 977-3 Epoxy Resin (Continued)

Typical Resin Properties
The following figure is a typical viscosity curve for a ramp rate of 2°C/min.

977-3 Viscosity Curve

Cured Resin Density = 1.29 g/cc

Cured Neat Resin Properties

	RT	250°F / Wet $^{3/}$ (121°C/Wet)
Compression Yield		
Strength (ksi)	27 ± 0.3	
Strength (MPa)	*186 ± 2.1*	
Flexural		
Strength (ksi)	21 ± 4	10 ± 0.4
Modulus (Msi)	0.55 ± 0.01	0.35 ± 0.3
Strength (MPa)	144 ± 30	70 ± 3
Modulus (GPa)	3.8 ± 0.07	2.4 ± 2.1
K_{1c}' (MPa m$^{1/2}$)	0.9 ± 0.08	
G_{1c}' (J/m^2)	217 ± 24	
RDS DMA Tg (°C) $^{1/}$		
G'		178
G"		189
Tan Delta		190

Notes:
1/ tested at 5°C/min
2/ Cured at 355°F (180°C) for 6 hours
3/ Wet = 7 day water immersion at 160°F (71°C)
4/ Flexural testing preformed using a 3 point loading fixture at a 16:1 S/D ratio
5/ K_{1c} and G_{1c} tested using 3 point bending mode

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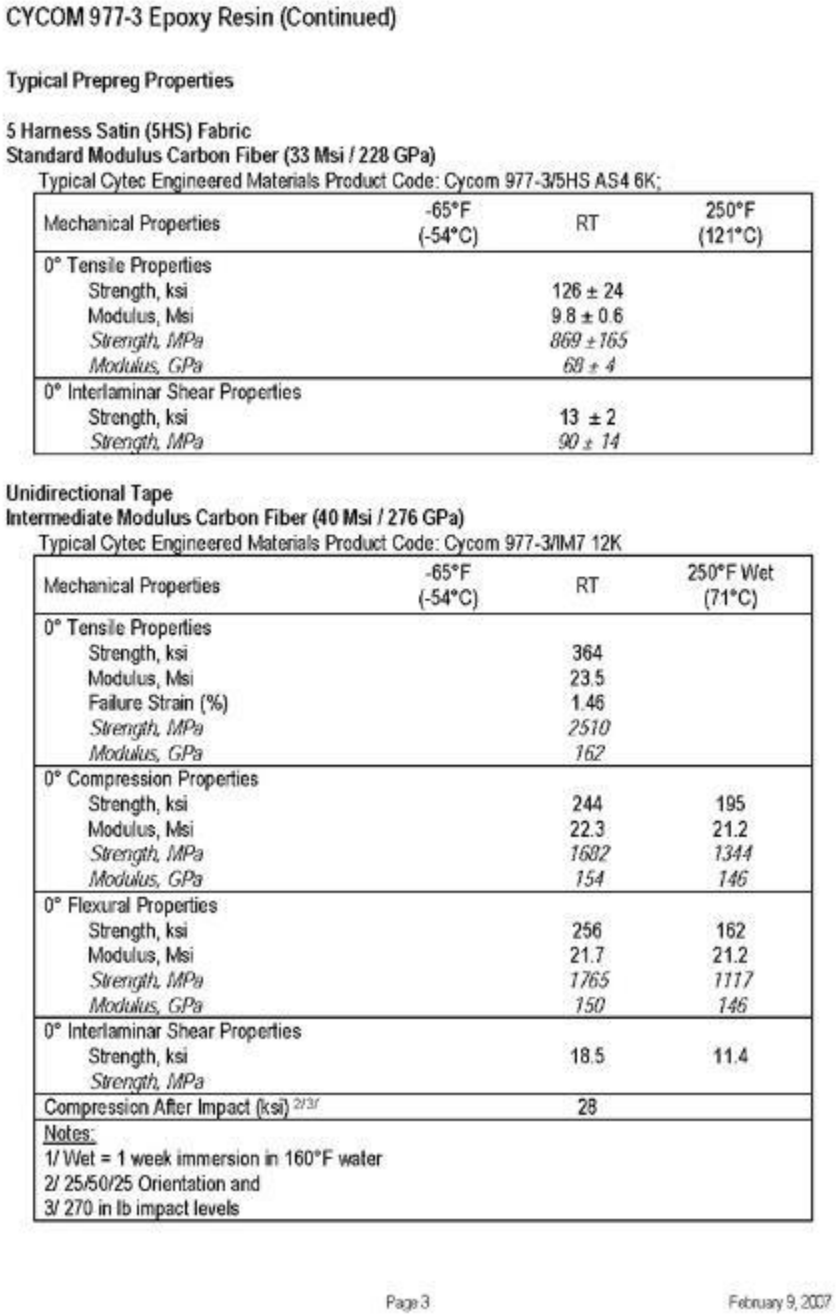


CYCOM 977-3 Epoxy Resin (Continued)

Typical Prepreg Properties

5 Harness Satin (5HS) Fabric
Standard Modulus Carbon Fiber (33 Msi / 228 GPa)
Typical Cytec Engineered Materials Product Code: Cycom 977-3/5HS AS4 6K;

Mechanical Properties	-65°F (-54°C)	RT	250°F (121°C)
0° Tensile Properties			
Strength, ksi		126 ± 24	
Modulus, Msi		9.8 ± 0.6	
Strength, MPa		*869 ± 165*	
Modulus, GPa		*68 ± 4*	
0° Interlaminar Shear Properties			
Strength, ksi		13 ± 2	
Strength, MPa		*90 ± 14*	

Unidirectional Tape
Intermediate Modulus Carbon Fiber (40 Msi / 276 GPa)
Typical Cytec Engineered Materials Product Code: Cycom 977-3/IM7 12K

Mechanical Properties	-65°F (-54°C)	RT	250°F Wet (71°C)
0° Tensile Properties			
Strength, ksi		364	
Modulus, Msi		23.5	
Failure Strain (%)		1.46	
Strength, MPa		*2510*	
Modulus, GPa		*162*	
0° Compression Properties			
Strength, ksi		244	195
Modulus, Msi		22.3	21.2
Strength, MPa		*1682*	*1344*
Modulus, GPa		*154*	*146*
0° Flexural Properties			
Strength, ksi		256	162
Modulus, Msi		21.7	21.2
Strength, MPa		*1765*	*1117*
Modulus, GPa		*150*	*146*
0° Interlaminar Shear Properties			
Strength, ksi		18.5	11.4
Strength, MPa			
Compression After Impact (ksi) 2/3/		28	
Notes: 1/ Wet = 1 week immersion in 160°F water 2/ 25/50/25 Orientation and 3/ 270 in lb impact levels			

CYCOM 977-3 Epoxy Resin (Continued)

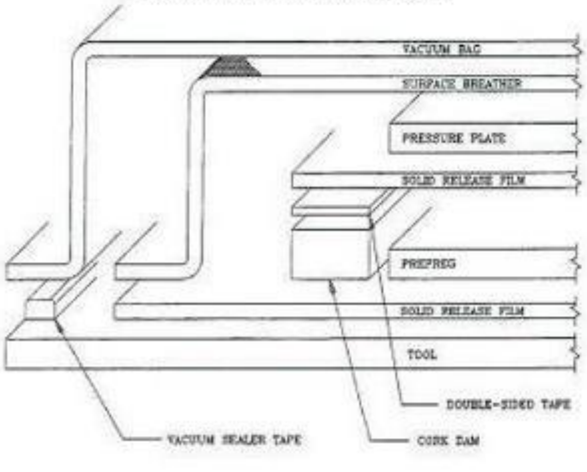
Preparation for Laminate Curing

Treat surfaces that lay-up will touch with a release agent. As each ply of material is positioned, work out any wrinkles or entrapped air with a paddle or roller before removing the backing. Take care not to distort the material during lay up. Insert a thermocouple into the lay-up near the center ply of the thickest edge section, outside the net trim line.

To eliminate porosity, keep the resin under pressure during cure with the use of compressible dam. Non-permeable fluorocarbon coated fabric should be placed over lay-up to protect the bag system in vacuum or autoclave cures.

Install a vacuum bag by standard techniques. Insert at least two vacuum ports through the bag, connecting one to a vacuum source and the other, at a point furthest away from the source, to a calibrated vacuum gage. Position part in oven or autoclave and draw vacuum to check for bag or system leaks. The following figure shows the recommended lay-up for CYCOM® 977-3 materials.

Cycom 977-3 Recommended Lay-up

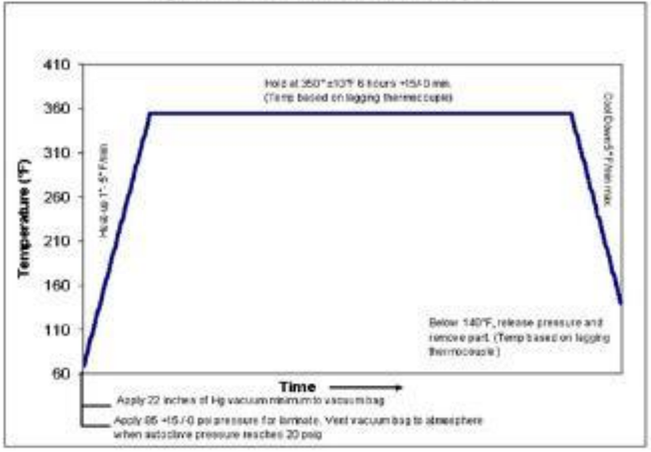


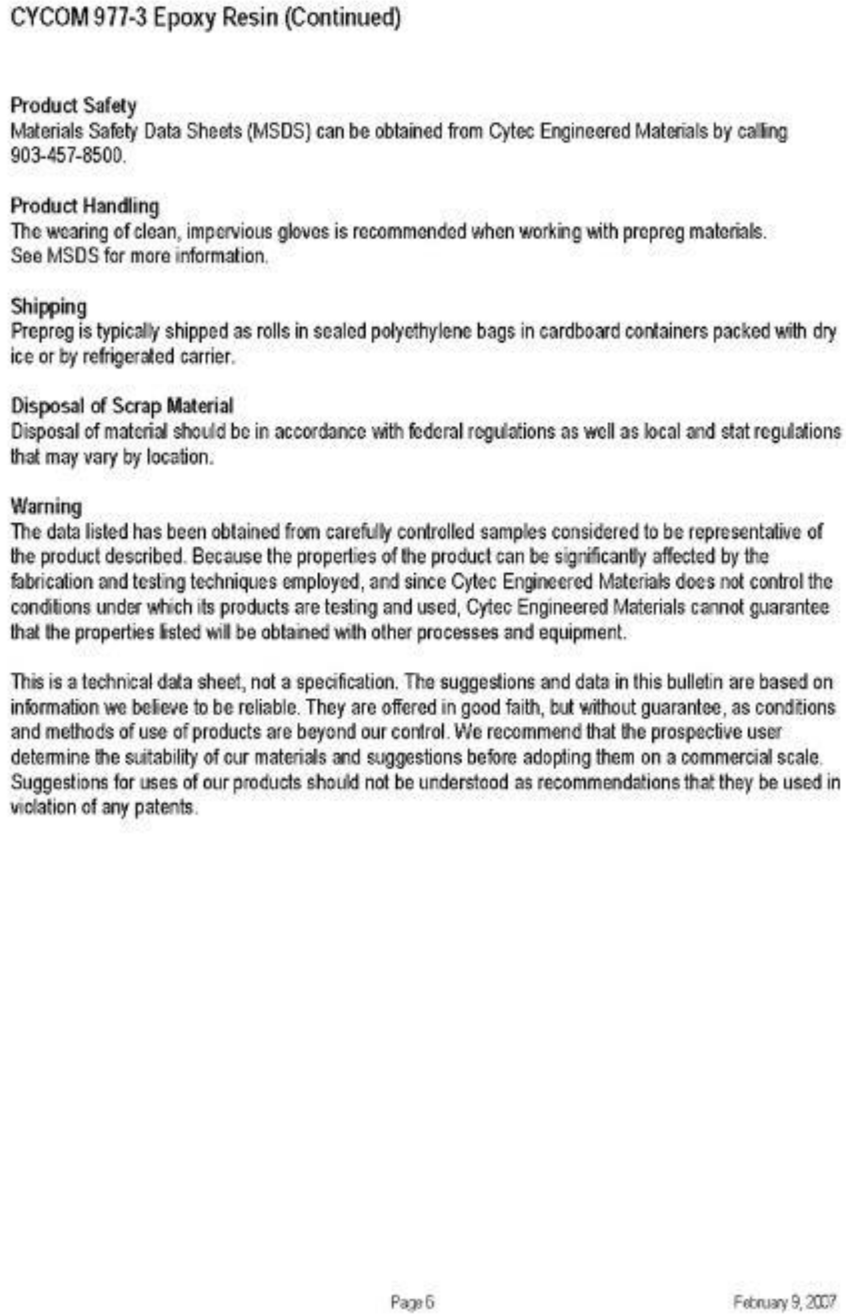
CYCOM 977-3 Epoxy Resin (Continued)

Recommended Cure Cycles

The following cure cycle is recommended for molding CYCOM® 977-3 materials. Cure cycles should be tailored based on application.

Cycom 977-3 Recommended Cure Cycle





CYCOM 977-3 Epoxy Resin (Continued)

Product Safety
Materials Safety Data Sheets (MSDS) can be obtained from Cytec Engineered Materials by calling 903-457-8500.

Product Handling
The wearing of clean, impervious gloves is recommended when working with prepreg materials. See MSDS for more information.

Shipping
Prepreg is typically shipped as rolls in sealed polyethylene bags in cardboard containers packed with dry ice or by refrigerated carrier.

Disposal of Scrap Material
Disposal of material should be in accordance with federal regulations as well as local and stat regulations that may vary by location.

Warning
The data listed has been obtained from carefully controlled samples considered to be representative of the product described. Because the properties of the product can be significantly affected by the fabrication and testing techniques employed, and since Cytec Engineered Materials does not control the conditions under which its products are testing and used, Cytec Engineered Materials cannot guarantee that the properties listed will be obtained with other processes and equipment.

This is a technical data sheet, not a specification. The suggestions and data in this bulletin are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use of products are beyond our control. We recommend that the prospective user determine the suitability of our materials and suggestions before adopting them on a commercial scale. Suggestions for uses of our products should not be understood as recommendations that they be used in violation of any patents.

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Figure A16. Cycom IM7/977-3 Material Properties

The Group I monolithic composite panels were fabricated using both tape ply and fabric ply in thicknesses of 0.20 inches and 0.30 inches. Depending upon the type of ply used (tape or fabric) and the desired panel thickness determines the number of plies required for composite layup. As a rule of thumb, the typical thickness for the tape ply is approximately 0.0055 inches and for the fabric ply, the typical thickness is approximately 0.011 inches. For the 0.20-inch-thick tape ply panel 38 plies were used and 54 tape plies were used for the 0.30-inch-thick tape ply panel. For the 0.20-inch-thick fabric ply panel 18 plies of fabric ply were used and for 0.30-inch-thick fabric ply panel 27 fabric plies were used. For the monolithic panels the ply layup was either unidirectional (0° (longitudinal with regard to the panel length)) or symmetrically quasi-isotropic (45°/-45°/0°/0°/45°/-45°/90°/90°)n.

For test Groups II and III, composite sandwich fill panels were fabricated. Two fill materials were chosen for the sandwich panels, which are typically used for aerospace applications; Al honeycomb and ROHACELL® foam. The fill thickness was held constant at 1.000 inch, regardless of the fill type. Eight-ply (either fabric or tape ply) IM7/TC350 composite face sheets were fabricated and bonded to both sides of the fill material with Cytec FM300 structural adhesive (reference Figure A17 for the FM300 adhesive material properties) and Scotch-Weld AF555M structural film adhesive (reference Figure A18 for the AF555M film adhesive properties) to make up the sandwich panels.

CYTEC

TECHNICAL DATA SHEET AEROSPACE MATERIALS

FM® 300 Epoxy Film Adhesive

DESCRIPTION

FM® 300 is a modified epoxy film adhesive available with three different moisture-resistant polyester carriers. It is designed for bonding metal-to-metal and sandwich composite structures. To achieve ultimate environmental resistance in bonding aluminum details, use pre-cured BR® 127 primer with FM 300 film adhesive.

Extensively used as a surface finished ply on composites material outside layers, FM 300 film adhesive has unique properties which drastically reduce, and in some cases virtually eliminate, time-consuming sanding and filling operations.

FM 300 film adhesive has high elongation and toughness with high ultimate shear strength. This makes it particularly suitable for redistributing the high shear stress concentrations of graphite epoxy- to-metal bonds, and allows it to accommodate the low interlaminar shear strength of the composite. It is particularly good in fatigue resistance in these joints. In properly designed and processed joints, the tight-knit tricot carrier provides a degree of electrical isolation between metal and graphite composites to reduce galvanic corrosion.

FEATURES & BENEFITS

- Superior metal-to-metal peel strength, composite-to-composite bonding and composite-to-metal joints
- Extensively used as surfacing ply for composite materials
- Service temperature from -67°F to 300°F (-55°C to 150°C)
- Excellent moisture and corrosion resistance in high humidity environments with no significant reduction in mechanical properties
- Allows x-ray inspection of assemblies due to natural opacity of adhesive formulations
- Available in a wide range of film thicknesses tailored to specific applications
- Industry wide acceptance

SUGGESTED APPLICATIONS

- Metal-to-metal bonding
- Composite-to-composite bonding
- Composite-to-metal bonding
- Composite surfacing

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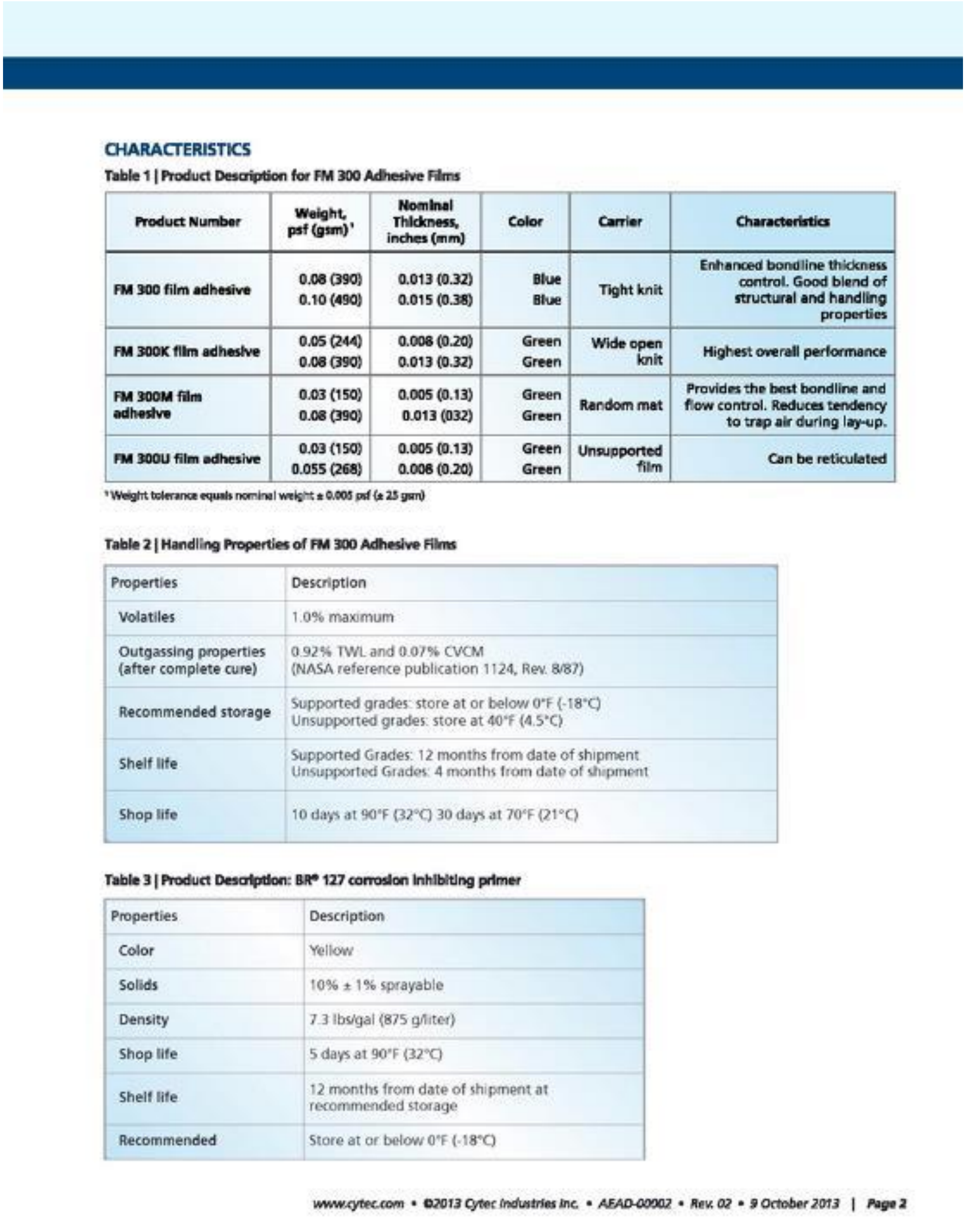


CHARACTERISTICS

Table 1 | Product Description for FM 300 Adhesive Films

Product Number	Weight, psf (gsm)[1]	Nominal Thickness, inches (mm)	Color	Carrier	Characteristics
FM 300 film adhesive	0.08 (390) 0.10 (490)	0.013 (0.32) 0.015 (0.38)	Blue Blue	Tight knit	Enhanced bondline thickness control. Good blend of structural and handling properties
FM 300K film adhesive	0.05 (244) 0.08 (390)	0.008 (0.20) 0.013 (0.32)	Green Green	Wide open knit	Highest overall performance
FM 300M film adhesive	0.03 (150) 0.08 (390)	0.005 (0.13) 0.013 (032)	Green Green	Random mat	Provides the best bondline and flow control. Reduces tendency to trap air during lay-up.
FM 300U film adhesive	0.03 (150) 0.055 (268)	0.005 (0.13) 0.008 (0.20)	Green Green	Unsupported film	Can be reticulated

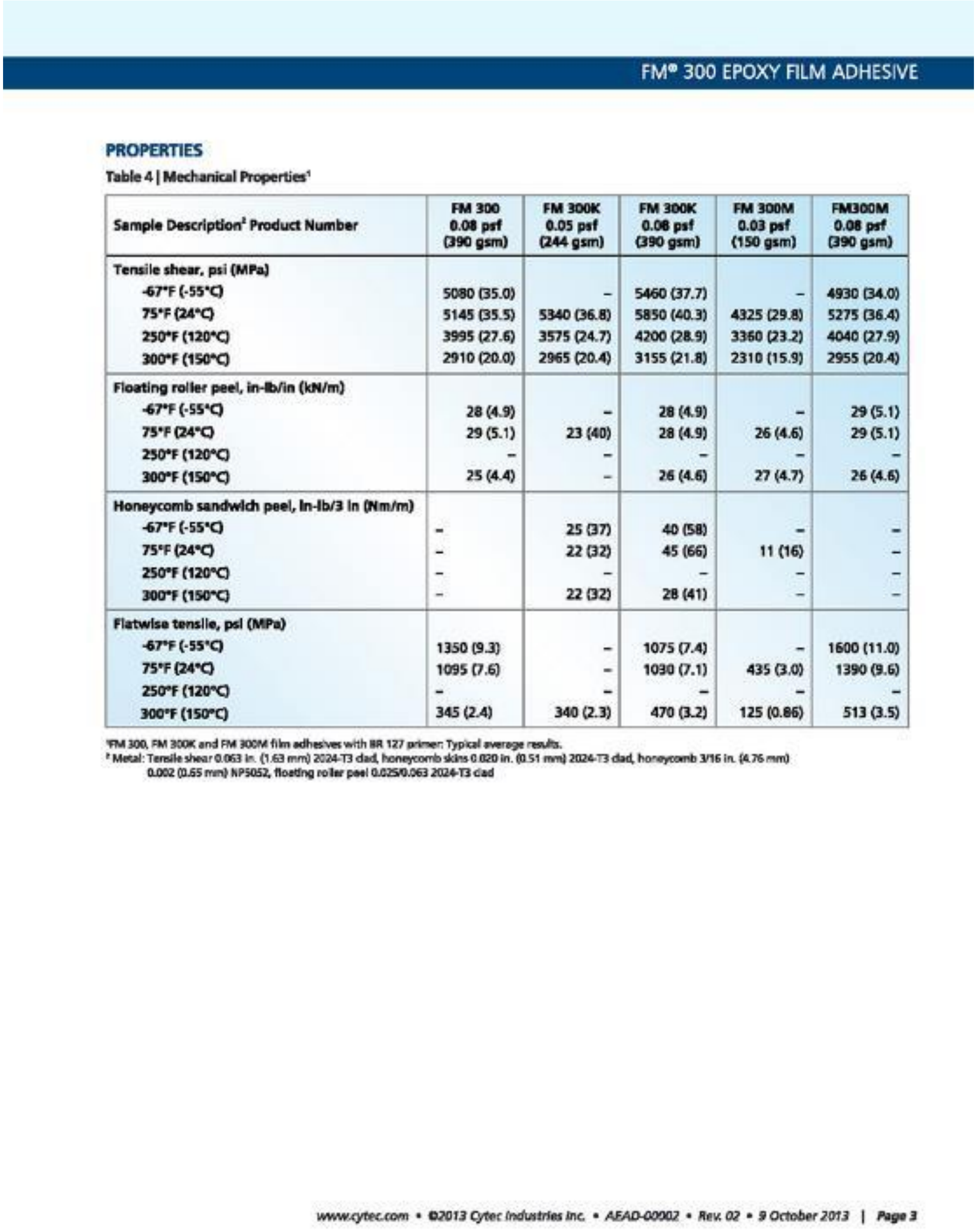
[1] Weight tolerance equals nominal weight ± 0.005 psf (± 25 gsm)

Table 2 | Handling Properties of FM 300 Adhesive Films

Properties	Description
Volatiles	1.0% maximum
Outgassing properties (after complete cure)	0.92% TWL and 0.07% CVCM (NASA reference publication 1124, Rev. 8/87)
Recommended storage	Supported grades: store at or below 0°F (-18°C) Unsupported grades: store at 40°F (4.5°C)
Shelf life	Supported Grades: 12 months from date of shipment Unsupported Grades: 4 months from date of shipment
Shop life	10 days at 90°F (32°C) 30 days at 70°F (21°C)

Table 3 | Product Description: BR® 127 corrosion inhibiting primer

Properties	Description
Color	Yellow
Solids	10% ± 1% sprayable
Density	7.3 lbs/gal (875 g/liter)
Shop life	5 days at 90°F (32°C)
Shelf life	12 months from date of shipment at recommended storage
Recommended	Store at or below 0°F (-18°C)



FM® 300 EPOXY FILM ADHESIVE

PROPERTIES

Table 4 | Mechanical Properties[1]

Sample Description[2] Product Number	FM 300 0.08 psf (390 gsm)	FM 300K 0.05 psf (244 gsm)	FM 300K 0.08 psf (390 gsm)	FM 300M 0.03 psf (150 gsm)	FM300M 0.08 psf (390 gsm)
Tensile shear, psi (MPa)					
-67°F (-55°C)	5080 (35.0)	–	5460 (37.7)	–	4930 (34.0)
75°F (24°C)	5145 (35.5)	5340 (36.8)	5850 (40.3)	4325 (29.8)	5275 (36.4)
250°F (120°C)	3995 (27.6)	3575 (24.7)	4200 (28.9)	3360 (23.2)	4040 (27.9)
300°F (150°C)	2910 (20.0)	2965 (20.4)	3155 (21.8)	2310 (15.9)	2955 (20.4)
Floating roller peel, in-lb/in (kN/m)					
-67°F (-55°C)	28 (4.9)	–	28 (4.9)	–	29 (5.1)
75°F (24°C)	29 (5.1)	23 (40)	28 (4.9)	26 (4.6)	29 (5.1)
250°F (120°C)	–	–	–	–	–
300°F (150°C)	25 (4.4)	–	26 (4.6)	27 (4.7)	26 (4.6)
Honeycomb sandwich peel, in-lb/3 in (Nm/m)					
-67°F (-55°C)	–	25 (37)	40 (58)	–	–
75°F (24°C)	–	22 (32)	45 (66)	11 (16)	–
250°F (120°C)	–	–	–	–	–
300°F (150°C)	–	22 (32)	28 (41)	–	–
Flatwise tensile, psi (MPa)					
-67°F (-55°C)	1350 (9.3)	–	1075 (7.4)	–	1600 (11.0)
75°F (24°C)	1095 (7.6)	–	1030 (7.1)	435 (3.0)	1390 (9.6)
250°F (120°C)	–	–	–	–	–
300°F (150°C)	345 (2.4)	340 (2.3)	470 (3.2)	125 (0.86)	513 (3.5)

[1] FM 300, FM 300K and FM 300M film adhesives with BR 127 primer: Typical average results.

[2] Metal: Tensile shear 0.063 in. (1.63 mm) 2024-T3 clad, honeycomb skins 0.020 in. (0.51 mm) 2024-T3 clad, honeycomb 3/16 in. (4.76 mm) 0.002 (0.65 mm) NP5052, floating roller peel 0.025/0.063 2024-T3 clad

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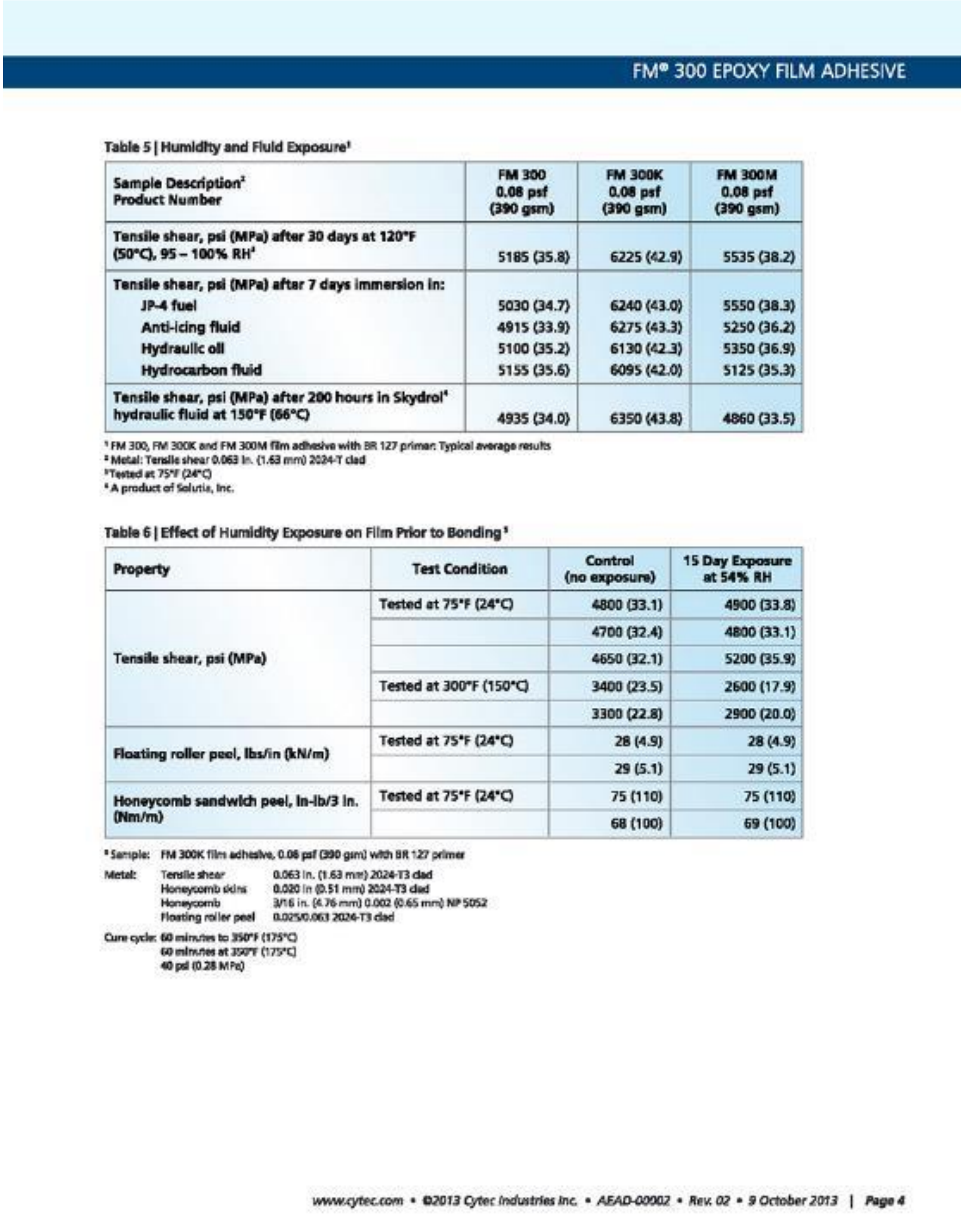


Table 5 | Humidity and Fluid Exposure[1]

Sample Description[2] Product Number	FM 300 0.08 psf (390 gsm)	FM 300K 0.08 psf (390 gsm)	FM 300M 0.08 psf (390 gsm)
Tensile shear, psi (MPa) after 30 days at 120°F (50°C), 95 – 100% RH[3]	5185 (35.8)	6225 (42.9)	5535 (38.2)
Tensile shear, psi (MPa) after 7 days immersion in:			
JP-4 fuel	5030 (34.7)	6240 (43.0)	5550 (38.3)
Anti-icing fluid	4915 (33.9)	6275 (43.3)	5250 (36.2)
Hydraulic oil	5100 (35.2)	6130 (42.3)	5350 (36.9)
Hydrocarbon fluid	5155 (35.6)	6095 (42.0)	5125 (35.3)
Tensile shear, psi (MPa) after 200 hours in Skydrol[4] hydraulic fluid at 150°F (66°C)	4935 (34.0)	6350 (43.8)	4860 (33.5)

[1] FM 300, FM 300K and FM 300M film adhesive with BR 127 primer. Typical average results
[2] Metal: Tensile shear 0.063 in. (1.63 mm) 2024-T clad
[3] Tested at 75°F (24°C)
[4] A product of Solutia, Inc.

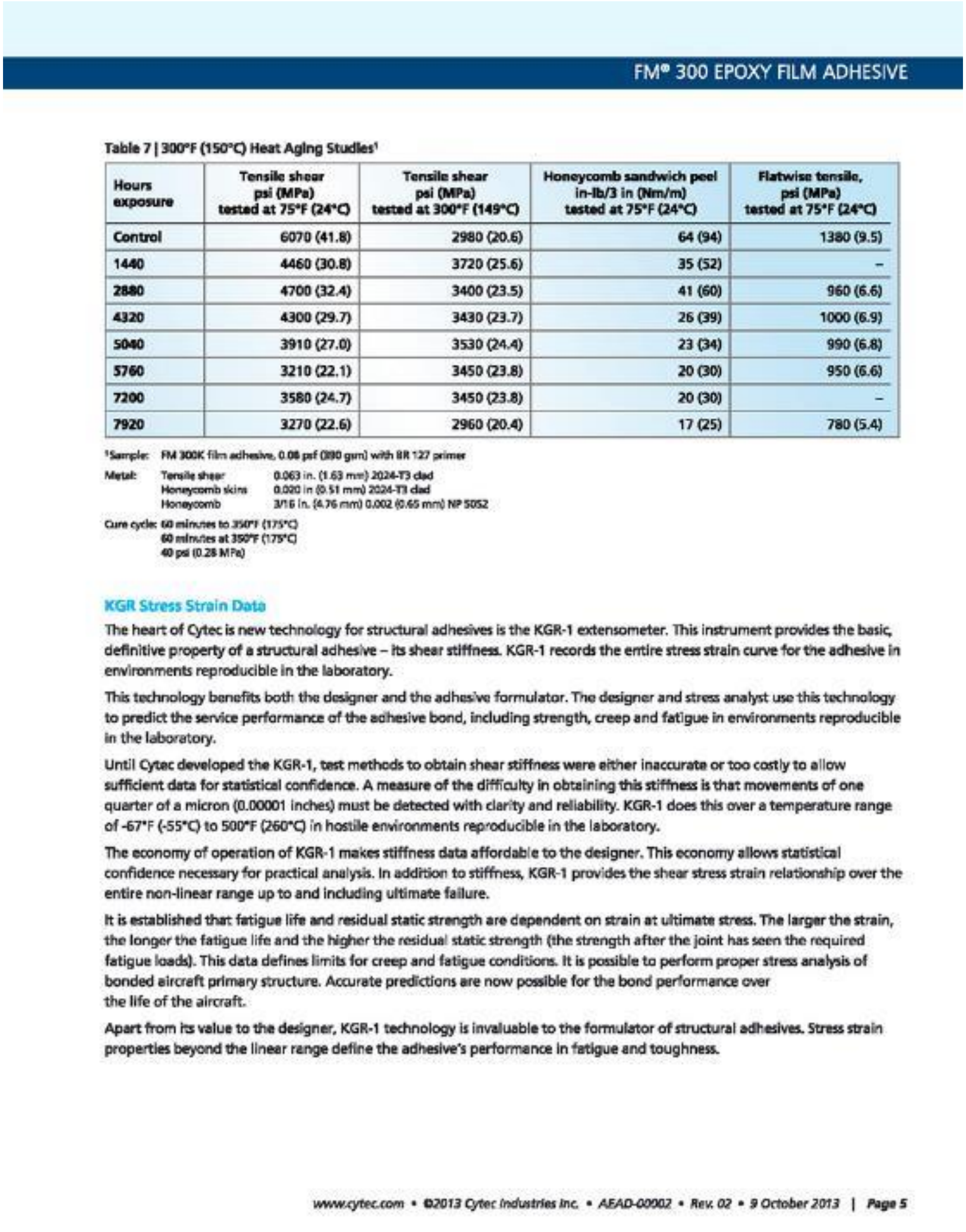
Table 6 | Effect of Humidity Exposure on Film Prior to Bonding[5]

Property	Test Condition	Control (no exposure)	15 Day Exposure at 54% RH
Tensile shear, psi (MPa)	Tested at 75°F (24°C)	4800 (33.1)	4900 (33.8)
		4700 (32.4)	4800 (33.1)
		4650 (32.1)	5200 (35.9)
	Tested at 300°F (150°C)	3400 (23.5)	2600 (17.9)
		3300 (22.8)	2900 (20.0)
Floating roller peel, lbs/in (kN/m)	Tested at 75°F (24°C)	28 (4.9)	28 (4.9)
		29 (5.1)	29 (5.1)
Honeycomb sandwich peel, in-lb/3 in. (Nm/m)	Tested at 75°F (24°C)	75 (110)	75 (110)
		68 (100)	69 (100)

[5] Sample: FM 300K film adhesive, 0.08 psf (390 gsm) with BR 127 primer

Metal:	Tensile shear	0.063 in. (1.63 mm) 2024-T3 clad
	Honeycomb skins	0.020 in (0.51 mm) 2024-T3 clad
	Honeycomb	3/16 in. (4.76 mm) 0.002 (0.65 mm) NP 5052
	Floating roller peel	0.025/0.063 2024-T3 clad

Cure cycle: 60 minutes to 350°F (175°C)
60 minutes at 350°F (175°C)
40 psi (0.28 MPa)



FM® 300 EPOXY FILM ADHESIVE

Table 7 | 300°F (150°C) Heat Aging Studies[1]

Hours exposure	Tensile shear psi (MPa) tested at 75°F (24°C)	Tensile shear psi (MPa) tested at 300°F (149°C)	Honeycomb sandwich peel in-lb/3 in (Nm/m) tested at 75°F (24°C)	Flatwise tensile, psi (MPa) tested at 75°F (24°C)
Control	6070 (41.8)	2980 (20.6)	64 (94)	1380 (9.5)
1440	4460 (30.8)	3720 (25.6)	35 (52)	–
2880	4700 (32.4)	3400 (23.5)	41 (60)	960 (6.6)
4320	4300 (29.7)	3430 (23.7)	26 (39)	1000 (6.9)
5040	3910 (27.0)	3530 (24.4)	23 (34)	990 (6.8)
5760	3210 (22.1)	3450 (23.8)	20 (30)	950 (6.6)
7200	3580 (24.7)	3450 (23.8)	20 (30)	–
7920	3270 (22.6)	2960 (20.4)	17 (25)	780 (5.4)

[1] Sample: FM 300K film adhesive, 0.08 psf (390 gsm) with BR 127 primer

Metal:	Tensile shear	0.063 in. (1.63 mm) 2024-T3 clad
	Honeycomb skins	0.020 in (0.51 mm) 2024-T3 clad
	Honeycomb	3/16 in. (4.76 mm) 0.002 (0.65 mm) NP 5052

Cure cycle: 60 minutes to 350°F (175°C)
60 minutes at 350°F (175°C)
40 psi (0.28 MPa)

KGR Stress Strain Data

The heart of Cytec is new technology for structural adhesives is the KGR-1 extensometer. This instrument provides the basic, definitive property of a structural adhesive – its shear stiffness. KGR-1 records the entire stress strain curve for the adhesive in environments reproducible in the laboratory.

This technology benefits both the designer and the adhesive formulator. The designer and stress analyst use this technology to predict the service performance of the adhesive bond, including strength, creep and fatigue in environments reproducible in the laboratory.

Until Cytec developed the KGR-1, test methods to obtain shear stiffness were either inaccurate or too costly to allow sufficient data for statistical confidence. A measure of the difficulty in obtaining this stiffness is that movements of one quarter of a micron (0.00001 inches) must be detected with clarity and reliability. KGR-1 does this over a temperature range of -67°F (-55°C) to 500°F (260°C) in hostile environments reproducible in the laboratory.

The economy of operation of KGR-1 makes stiffness data affordable to the designer. This economy allows statistical confidence necessary for practical analysis. In addition to stiffness, KGR-1 provides the shear stress strain relationship over the entire non-linear range up to and including ultimate failure.

It is established that fatigue life and residual static strength are dependent on strain at ultimate stress. The larger the strain, the longer the fatigue life and the higher the residual static strength (the strength after the joint has seen the required fatigue loads). This data defines limits for creep and fatigue conditions. It is possible to perform proper stress analysis of bonded aircraft primary structure. Accurate predictions are now possible for the bond performance over the life of the aircraft.

Apart from its value to the designer, KGR-1 technology is invaluable to the formulator of structural adhesives. Stress strain properties beyond the linear range define the adhesive's performance in fatigue and toughness.

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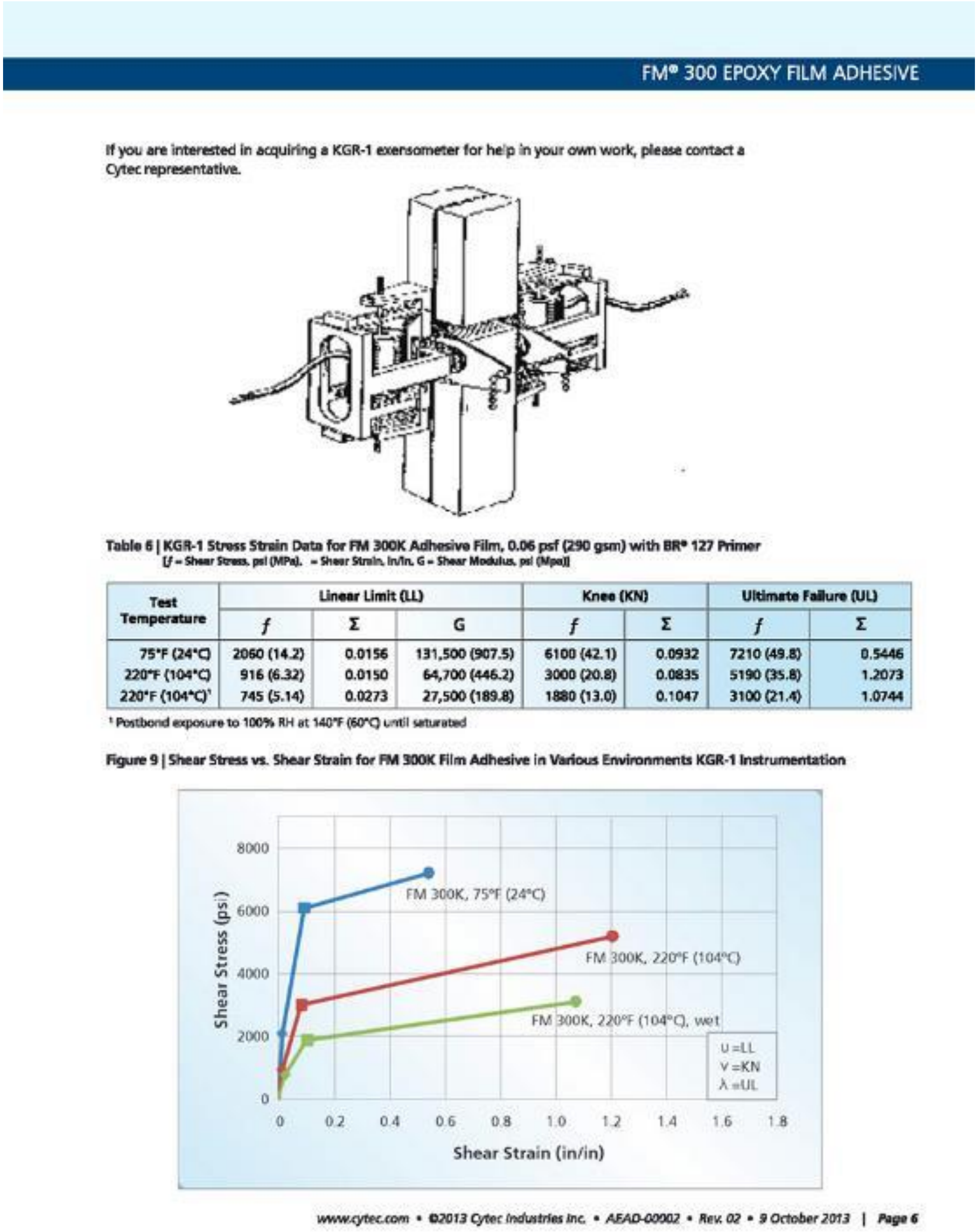

FM® 300 EPOXY FILM ADHESIVE

If you are interested in acquiring a KGR-1 exersometer for help in your own work, please contact a Cytec representative.

Table 6 | KGR-1 Stress Strain Data for FM 300K Adhesive Film, 0.06 psf (290 gsm) with BR® 127 Primer
[ƒ = Shear Stress, psi (MPa), = Shear Strain, in/in, G = Shear Modulus, psi (Mpa)]

Test Temperature	Linear Limit (LL)			Knee (KN)		Ultimate Failure (UL)	
	ƒ	Σ	G	ƒ	Σ	ƒ	Σ
75°F (24°C)	2060 (14.2)	0.0156	131,500 (907.5)	6100 (42.1)	0.0932	7210 (49.8)	0.5446
220°F (104°C)	916 (6.32)	0.0150	64,700 (446.2)	3000 (20.8)	0.0835	5190 (35.8)	1.2073
220°F (104°C)[1]	745 (5.14)	0.0273	27,500 (189.8)	1880 (13.0)	0.1047	3100 (21.4)	1.0744

[1] Postbond exposure to 100% RH at 140°F (60°C) until saturated

Figure 9 | Shear Stress vs. Shear Strain for FM 300K Film Adhesive in Various Environments KGR-1 Instrumentation

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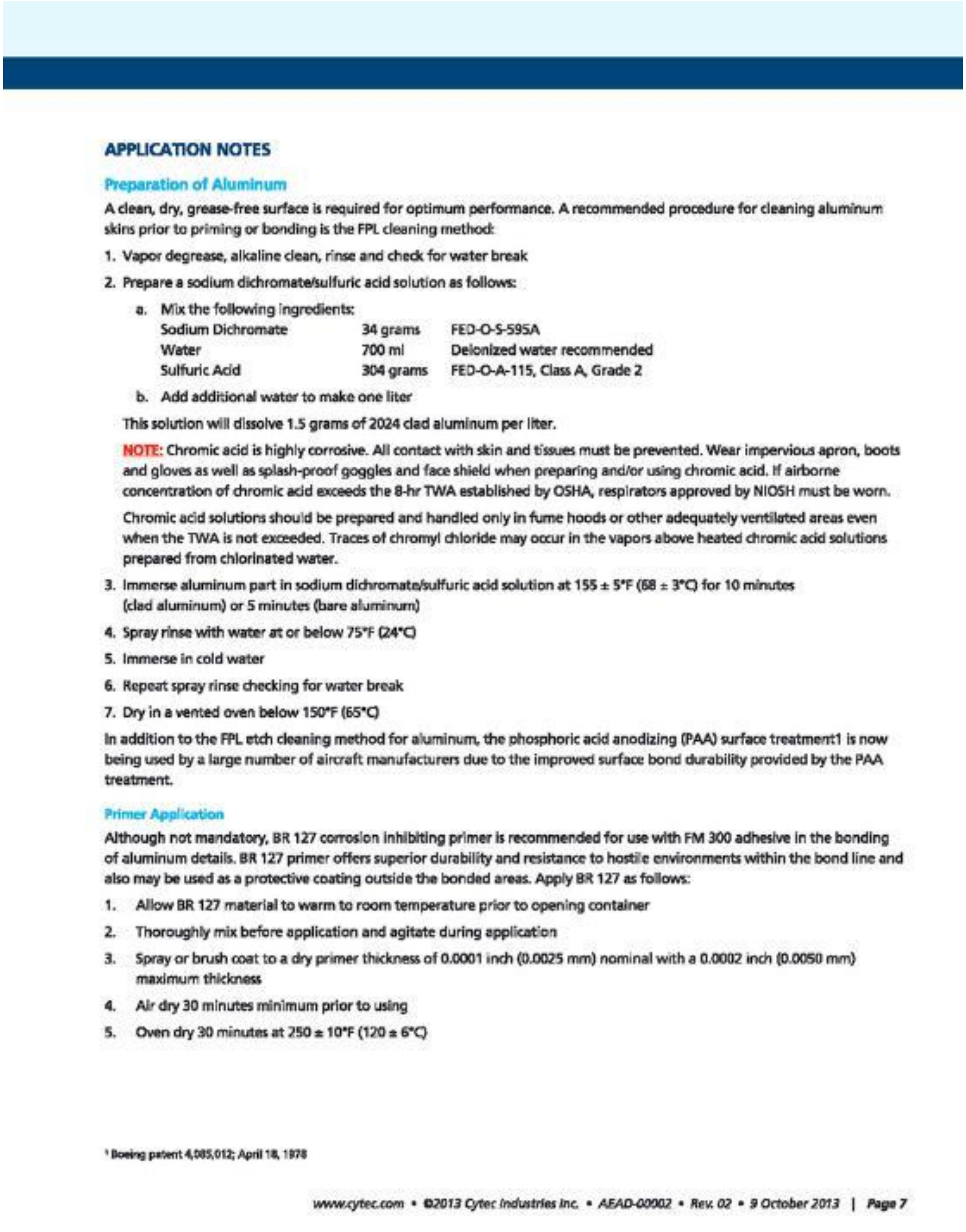

APPLICATION NOTES

Preparation of Aluminum

A clean, dry, grease-free surface is required for optimum performance. A recommended procedure for cleaning aluminum skins prior to priming or bonding is the FPL cleaning method:

1. Vapor degrease, alkaline clean, rinse and check for water break
2. Prepare a sodium dichromate/sulfuric acid solution as follows:
    a. Mix the following ingredients:

Sodium Dichromate	34 grams	FED-O-S-595A
Water	700 ml	Deionized water recommended
Sulfuric Acid	304 grams	FED-O-A-115, Class A, Grade 2

    b. Add additional water to make one liter

This solution will dissolve 1.5 grams of 2024 clad aluminum per liter.

NOTE: Chromic acid is highly corrosive. All contact with skin and tissues must be prevented. Wear impervious apron, boots and gloves as well as splash-proof goggles and face shield when preparing and/or using chromic acid. If airborne concentration of chromic acid exceeds the 8-hr TWA established by OSHA, respirators approved by NIOSH must be worn.

Chromic acid solutions should be prepared and handled only in fume hoods or other adequately ventilated areas even when the TWA is not exceeded. Traces of chromyl chloride may occur in the vapors above heated chromic acid solutions prepared from chlorinated water.

3. Immerse aluminum part in sodium dichromate/sulfuric acid solution at 155 ± 5°F (68 ± 3°C) for 10 minutes (clad aluminum) or 5 minutes (bare aluminum)
4. Spray rinse with water at or below 75°F (24°C)
5. Immerse in cold water
6. Repeat spray rinse checking for water break
7. Dry in a vented oven below 150°F (65°C)

In addition to the FPL etch cleaning method for aluminum, the phosphoric acid anodizing (PAA) surface treatment1 is now being used by a large number of aircraft manufacturers due to the improved surface bond durability provided by the PAA treatment.

Primer Application

Although not mandatory, BR 127 corrosion inhibiting primer is recommended for use with FM 300 adhesive in the bonding of aluminum details. BR 127 primer offers superior durability and resistance to hostile environments within the bond line and also may be used as a protective coating outside the bonded areas. Apply BR 127 as follows:

1. Allow BR 127 material to warm to room temperature prior to opening container
2. Thoroughly mix before application and agitate during application
3. Spray or brush coat to a dry primer thickness of 0.0001 inch (0.0025 mm) nominal with a 0.0002 inch (0.0050 mm) maximum thickness
4. Air dry 30 minutes minimum prior to using
5. Oven dry 30 minutes at 250 ± 10°F (120 ± 6°C)

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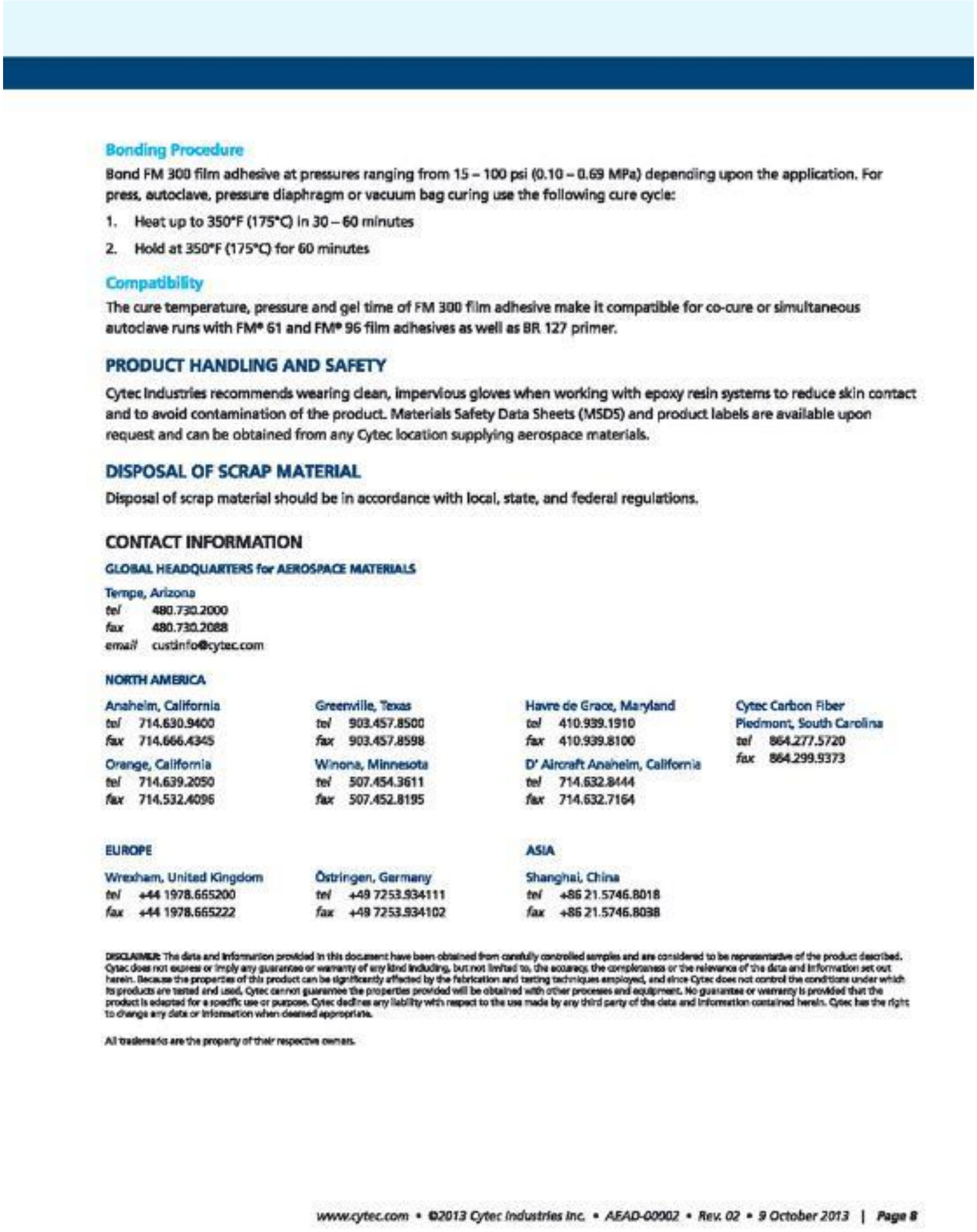
[1] Boeing patent 4,085,012; April 18, 1978



Bonding Procedure

Bond FM 300 film adhesive at pressures ranging from 15 – 100 psi (0.10 – 0.69 MPa) depending upon the application. For press, autoclave, pressure diaphragm or vacuum bag curing use the following cure cycle:

1. Heat up to 350°F (175°C) in 30 – 60 minutes
2. Hold at 350°F (175°C) for 60 minutes

Compatibility

The cure temperature, pressure and gel time of FM 300 film adhesive make it compatible for co-cure or simultaneous autoclave runs with FM® 61 and FM® 96 film adhesives as well as BR 127 primer.

PRODUCT HANDLING AND SAFETY

Cytec Industries recommends wearing clean, impervious gloves when working with epoxy resin systems to reduce skin contact and to avoid contamination of the product. Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec location supplying aerospace materials.

DISPOSAL OF SCRAP MATERIAL

Disposal of scrap material should be in accordance with local, state, and federal regulations.

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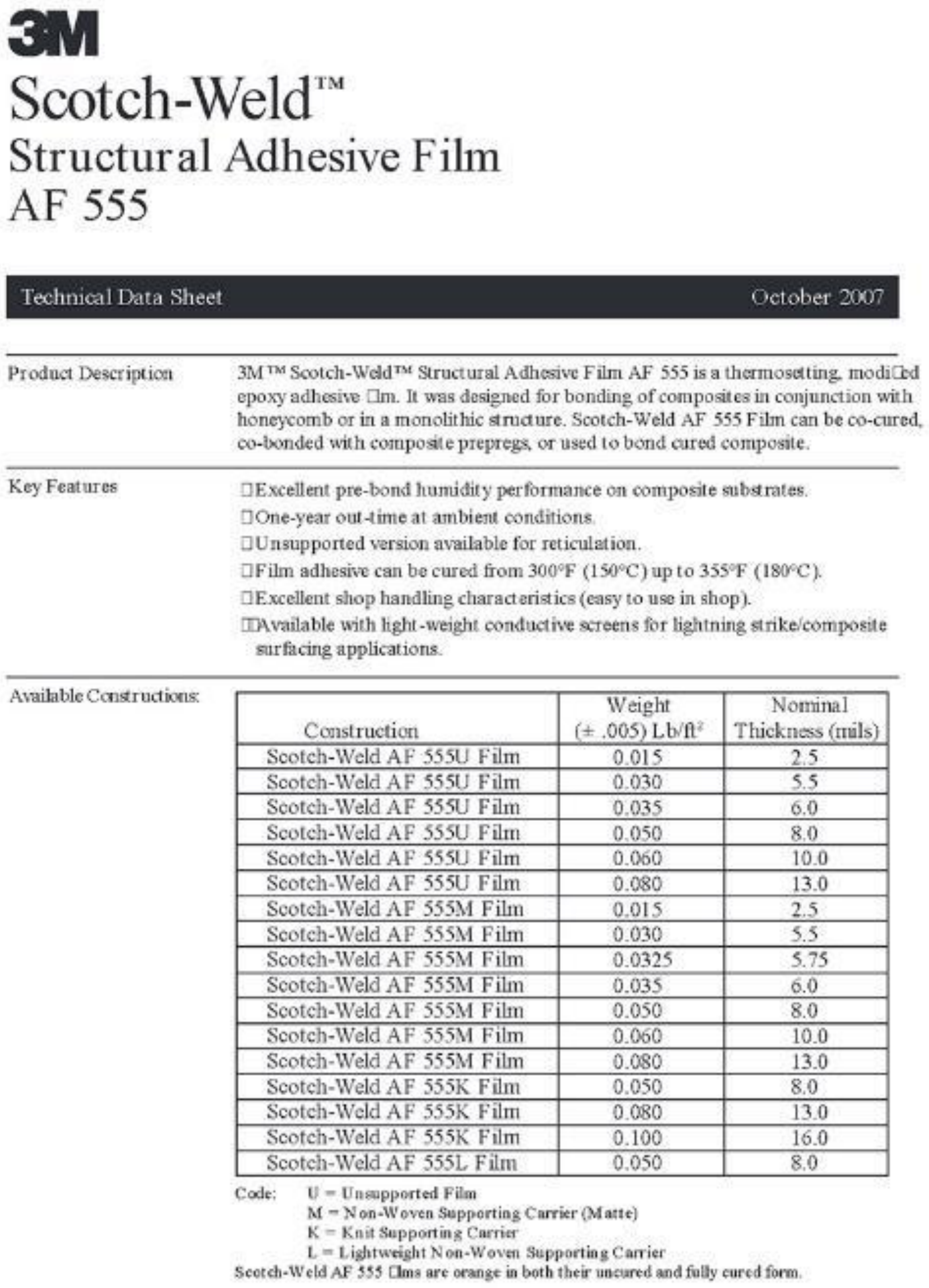
Figure A17. Cytec FM300 Adhesive Material Properties



3M

Scotch-Weld™
Structural Adhesive Film
AF 555

Technical Data Sheet October 2007

Product Description

3M™ Scotch-Weld™ Structural Adhesive Film AF 555 is a thermosetting, modified epoxy adhesive film. It was designed for bonding of composites in conjunction with honeycomb or in a monolithic structure. Scotch-Weld AF 555 Film can be co-cured, co-bonded with composite prepregs, or used to bond cured composite.

Key Features

- Excellent pre-bond humidity performance on composite substrates.
- One-year out-time at ambient conditions.
- Unsupported version available for reticulation.
- Film adhesive can be cured from 300°F (150°C) up to 355°F (180°C).
- Excellent shop handling characteristics (easy to use in shop).
- Available with light-weight conductive screens for lightning strike/composite surfacing applications.

Available Constructions:

Construction	Weight (± .005) Lb/ft²	Nominal Thickness (mils)
Scotch-Weld AF 555U Film	0.015	2.5
Scotch-Weld AF 555U Film	0.030	5.5
Scotch-Weld AF 555U Film	0.035	6.0
Scotch-Weld AF 555U Film	0.050	8.0
Scotch-Weld AF 555U Film	0.060	10.0
Scotch-Weld AF 555U Film	0.080	13.0
Scotch-Weld AF 555M Film	0.015	2.5
Scotch-Weld AF 555M Film	0.030	5.5
Scotch-Weld AF 555M Film	0.0325	5.75
Scotch-Weld AF 555M Film	0.035	6.0
Scotch-Weld AF 555M Film	0.050	8.0
Scotch-Weld AF 555M Film	0.060	10.0
Scotch-Weld AF 555M Film	0.080	13.0
Scotch-Weld AF 555K Film	0.050	8.0
Scotch-Weld AF 555K Film	0.080	13.0
Scotch-Weld AF 555K Film	0.100	16.0
Scotch-Weld AF 555L Film	0.050	8.0

Code: U = Unsupported Film
M = Non-Woven Supporting Carrier (Matte)
K = Knit Supporting Carrier
L = Lightweight Non-Woven Supporting Carrier

Scotch-Weld AF 555 films are orange in both their uncured and fully cured form.

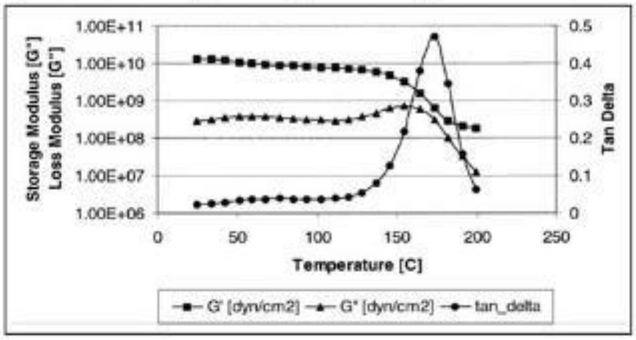
3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

I. Torsion RDA

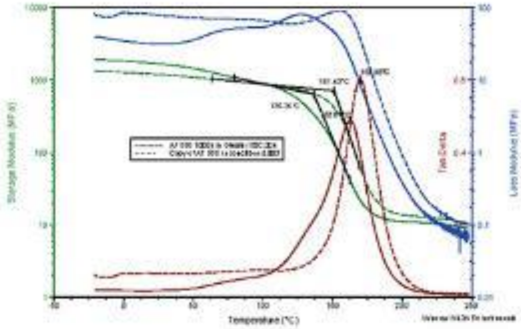
Test Equipment: Rheometric Dynamic Analyzer
3M™ Scotch-Weld™ Structural Adhesive AF 555 Film unsupported adhesive was cured under standard conditions. Specimen size: 33.848 (L) x 12.44 (W) x 1.94 mm (T).

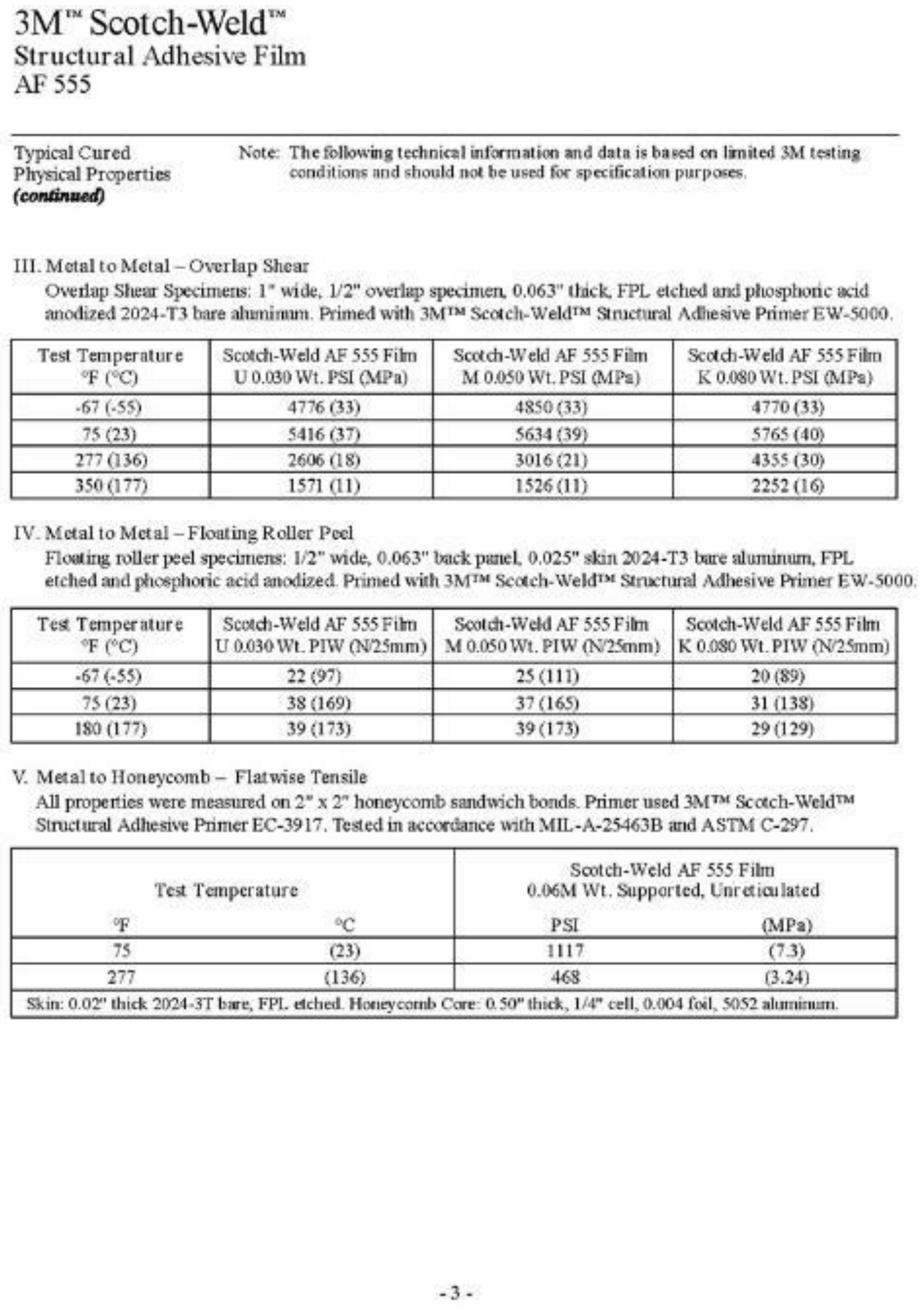


II. Dry / Wet Glass Transition Temperature

Cured Scotch-Weld AF 555 Film dry unconditioned vs. Scotch-Weld AF 555 Film aged in DI water for 1000 hours at 80°C.

	Onset Temp F [C]	Tan Delta Peak F [C]
Scotch-Weld AF 555 Film unconditioned	304 [151]	338 [170]
Scotch-Weld AF 555 Film aged in DI water for 1000 h @ 80°C	279 [137]	325 [163]





3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties ***(continued)***

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

III. Metal to Metal – Overlap Shear

Overlap Shear Specimens: 1" wide, 1/2" overlap specimen, 0.063" thick, FPL etched and phosphoric acid anodized 2024-T3 bare aluminum. Primed with 3M™ Scotch-Weld™ Structural Adhesive Primer EW-5000.

Test Temperature °F (°C)	Scotch-Weld AF 555 Film U 0.030 Wt. PSI (MPa)	Scotch-Weld AF 555 Film M 0.050 Wt. PSI (MPa)	Scotch-Weld AF 555 Film K 0.080 Wt. PSI (MPa)
-67 (-55)	4776 (33)	4850 (33)	4770 (33)
75 (23)	5416 (37)	5634 (39)	5765 (40)
277 (136)	2606 (18)	3016 (21)	4355 (30)
350 (177)	1571 (11)	1526 (11)	2252 (16)

IV. Metal to Metal – Floating Roller Peel

Floating roller peel specimens: 1/2" wide, 0.063" back panel, 0.025" skin 2024-T3 bare aluminum, FPL etched and phosphoric acid anodized. Primed with 3M™ Scotch-Weld™ Structural Adhesive Primer EW-5000.

Test Temperature °F (°C)	Scotch-Weld AF 555 Film U 0.030 Wt. PIW (N/25mm)	Scotch-Weld AF 555 Film M 0.050 Wt. PIW (N/25mm)	Scotch-Weld AF 555 Film K 0.080 Wt. PIW (N/25mm)
-67 (-55)	22 (97)	25 (111)	20 (89)
75 (23)	38 (169)	37 (165)	31 (138)
180 (177)	39 (173)	39 (173)	29 (129)

V. Metal to Honeycomb – Flatwise Tensile

All properties were measured on 2" x 2" honeycomb sandwich bonds. Primer used 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917. Tested in accordance with MIL-A-25463B and ASTM C-297.

Test Temperature		Scotch-Weld AF 555 Film 0.06M Wt. Supported, Unreticulated	
°F	°C	PSI	(MPa)
75	(23)	1117	(7.3)
277	(136)	468	(3.24)
Skin: 0.02" thick 2024-3T bare, FPL etched. Honeycomb Core: 0.50" thick, 1/4" cell, 0.004 foil, 5052 aluminum.			

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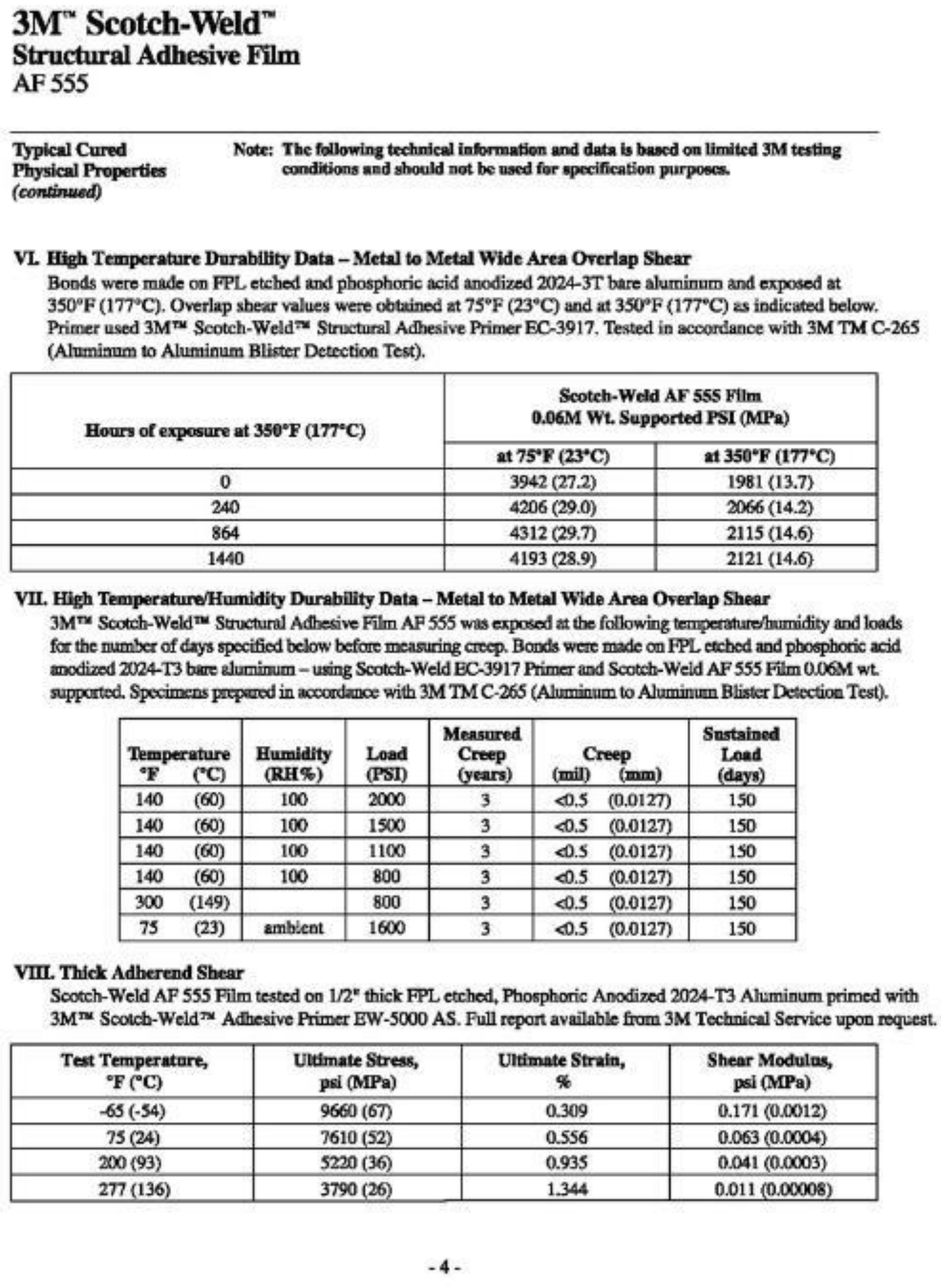

3M™ Scotch-Weld™

Structural Adhesive Film

AF 555

Typical Cured Physical Properties *(continued)*

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

VI. High Temperature Durability Data – Metal to Metal Wide Area Overlap Shear

Bonds were made on FPL etched and phosphoric acid anodized 2024-3T bare aluminum and exposed at 350°F (177°C). Overlap shear values were obtained at 75°F (23°C) and at 350°F (177°C) as indicated below. Primer used 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917. Tested in accordance with 3M TM C-265 (Aluminum to Aluminum Blister Detection Test).

Hours of exposure at 350°F (177°C)	Scotch-Weld AF 555 Film 0.06M Wt. Supported PSI (MPa)	
	at 75°F (23°C)	at 350°F (177°C)
0	3942 (27.2)	1981 (13.7)
240	4206 (29.0)	2066 (14.2)
864	4312 (29.7)	2115 (14.6)
1440	4193 (28.9)	2121 (14.6)

VII. High Temperature/Humidity Durability Data – Metal to Metal Wide Area Overlap Shear

3M™ Scotch-Weld™ Structural Adhesive Film AF 555 was exposed at the following temperature/humidity and loads for the number of days specified below before measuring creep. Bonds were made on FPL etched and phosphoric acid anodized 2024-T3 bare aluminum – using Scotch-Weld EC-3917 Primer and Scotch-Weld AF 555 Film 0.06M wt. supported. Specimens prepared in accordance with 3M TM C-265 (Aluminum to Aluminum Blister Detection Test).

Temperature °F	(°C)	Humidity (RH%)	Load (PSI)	Measured Creep (years)	Creep (mil)	(mm)	Sustained Load (days)
140	(60)	100	2000	3	<0.5	(0.0127)	150
140	(60)	100	1500	3	<0.5	(0.0127)	150
140	(60)	100	1100	3	<0.5	(0.0127)	150
140	(60)	100	800	3	<0.5	(0.0127)	150
300	(149)		800	3	<0.5	(0.0127)	150
75	(23)	ambient	1600	3	<0.5	(0.0127)	150

VIII. Thick Adherend Shear

Scotch-Weld AF 555 Film tested on 1/2" thick FPL etched, Phosphoric Anodized 2024-T3 Aluminum primed with 3M™ Scotch-Weld™ Adhesive Primer EW-5000 AS. Full report available from 3M Technical Service upon request.

Test Temperature, °F (°C)	Ultimate Stress, psi (MPa)	Ultimate Strain, %	Shear Modulus, psi (MPa)
-65 (-54)	9660 (67)	0.309	0.171 (0.0012)
75 (24)	7610 (52)	0.556	0.063 (0.0004)
200 (93)	5220 (36)	0.935	0.041 (0.0003)
277 (136)	3790 (26)	1.344	0.011 (0.00008)

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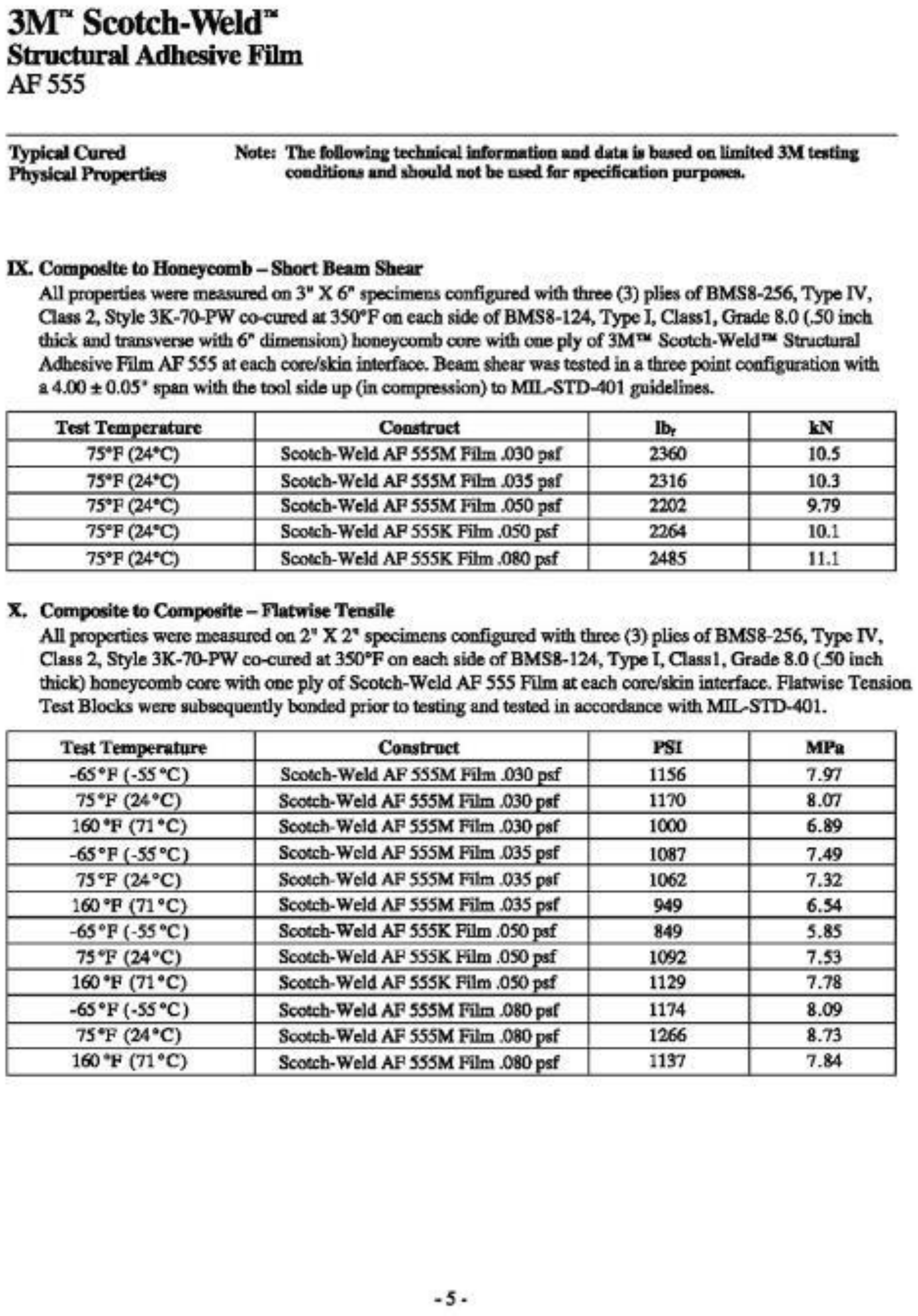

3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

IX. Composite to Honeycomb – Short Beam Shear

All properties were measured on 3" X 6" specimens configured with three (3) plies of BMS8-256, Type IV, Class 2, Style 3K-70-PW co-cured at 350°F on each side of BMS8-124, Type I, Class1, Grade 8.0 (.50 inch thick and transverse with 6" dimension) honeycomb core with one ply of 3M™ Scotch-Weld™ Structural Adhesive Film AF 555 at each core/skin interface. Beam shear was tested in a three point configuration with a 4.00 ± 0.05" span with the tool side up (in compression) to MIL-STD-401 guidelines.

Test Temperature	Construct	lb_f	kN
75°F (24°C)	Scotch-Weld AF 555M Film .030 psf	2360	10.5
75°F (24°C)	Scotch-Weld AF 555M Film .035 psf	2316	10.3
75°F (24°C)	Scotch-Weld AF 555M Film .050 psf	2202	9.79
75°F (24°C)	Scotch-Weld AF 555K Film .050 psf	2264	10.1
75°F (24°C)	Scotch-Weld AF 555K Film .080 psf	2485	11.1

X. Composite to Composite – Flatwise Tensile

All properties were measured on 2" X 2" specimens configured with three (3) plies of BMS8-256, Type IV, Class 2, Style 3K-70-PW co-cured at 350°F on each side of BMS8-124, Type I, Class1, Grade 8.0 (.50 inch thick) honeycomb core with one ply of Scotch-Weld AF 555 Film at each core/skin interface. Flatwise Tension Test Blocks were subsequently bonded prior to testing and tested in accordance with MIL-STD-401.

Test Temperature	Construct	PSI	MPa
-65°F (-55°C)	Scotch-Weld AF 555M Film .030 psf	1156	7.97
75°F (24°C)	Scotch-Weld AF 555M Film .030 psf	1170	8.07
160°F (71°C)	Scotch-Weld AF 555M Film .030 psf	1000	6.89
-65°F (-55°C)	Scotch-Weld AF 555M Film .035 psf	1087	7.49
75°F (24°C)	Scotch-Weld AF 555M Film .035 psf	1062	7.32
160°F (71°C)	Scotch-Weld AF 555M Film .035 psf	949	6.54
-65°F (-55°C)	Scotch-Weld AF 555K Film .050 psf	849	5.85
75°F (24°C)	Scotch-Weld AF 555K Film .050 psf	1092	7.53
160°F (71°C)	Scotch-Weld AF 555K Film .050 psf	1129	7.78
-65°F (-55°C)	Scotch-Weld AF 555M Film .080 psf	1174	8.09
75°F (24°C)	Scotch-Weld AF 555M Film .080 psf	1266	8.73
160°F (71°C)	Scotch-Weld AF 555M Film .080 psf	1137	7.84

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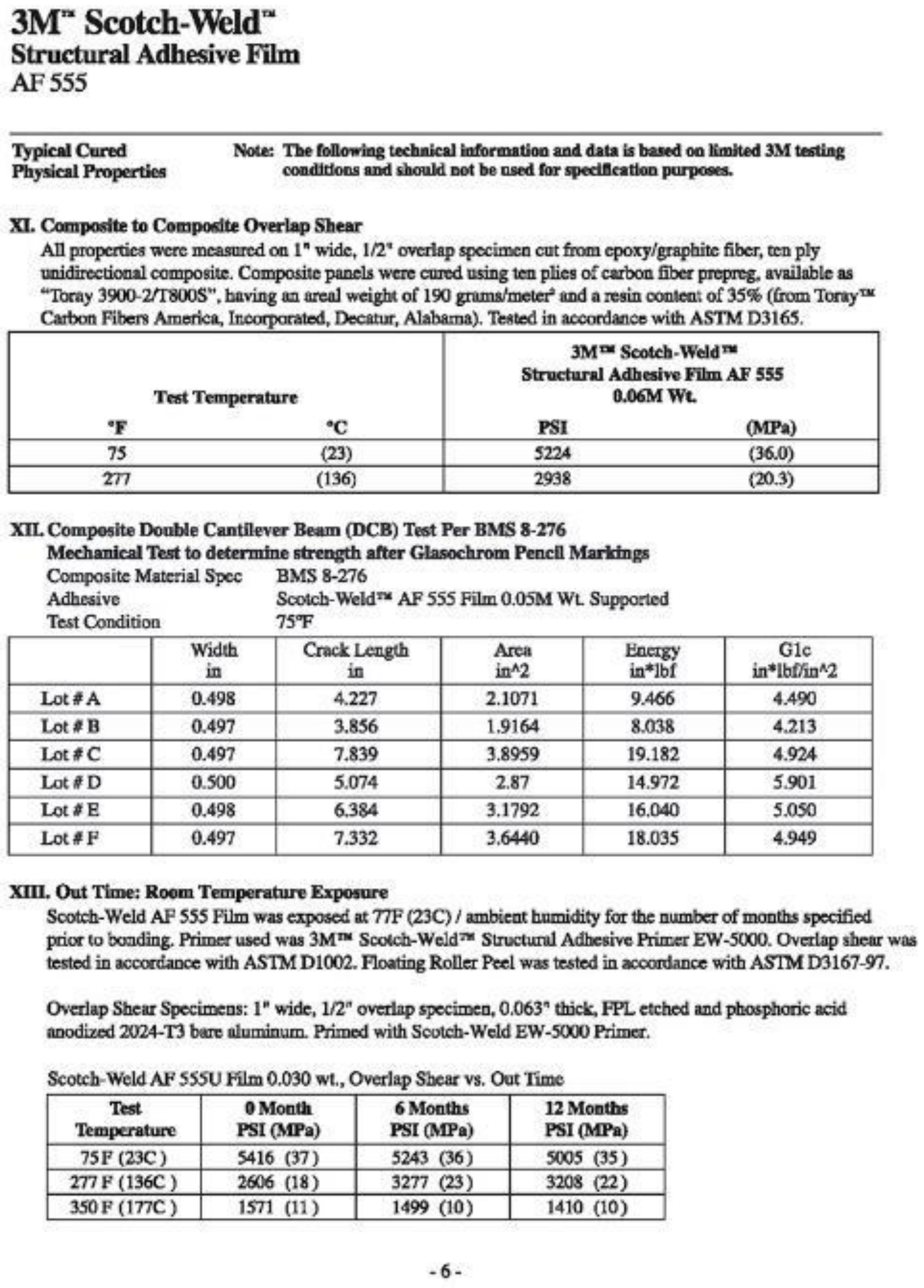


3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

XI. Composite to Composite Overlap Shear

All properties were measured on 1" wide, 1/2" overlap specimen cut from epoxy/graphite fiber, ten ply unidirectional composite. Composite panels were cured using ten plies of carbon fiber prepreg, available as "Toray 3900-2/T800S", having an areal weight of 190 grams/meter² and a resin content of 35% (from Toray™ Carbon Fibers America, Incorporated, Decatur, Alabama). Tested in accordance with ASTM D3165.

Test Temperature		**3M™ Scotch-Weld™ Structural Adhesive Film AF 555 0.06M Wt.**	
°F	**°C**	**PSI**	**(MPa)**
75	(23)	5224	(36.0)
277	(136)	2938	(20.3)

XII. Composite Double Cantilever Beam (DCB) Test Per BMS 8-276
Mechanical Test to determine strength after Glasochrom Pencil Markings

Composite Material Spec	BMS 8-276
Adhesive	Scotch-Weld™ AF 555 Film 0.05M Wt. Supported
Test Condition	75°F

	Width in	Crack Length in	Area in^2	Energy in*lbf	G1c in*lbf/in^2
Lot # A	0.498	4.227	2.1071	9.466	4.490
Lot # B	0.497	3.856	1.9164	8.038	4.213
Lot # C	0.497	7.839	3.8959	19.182	4.924
Lot # D	0.500	5.074	2.87	14.972	5.901
Lot # E	0.498	6.384	3.1792	16.040	5.050
Lot # F	0.497	7.332	3.6440	18.035	4.949

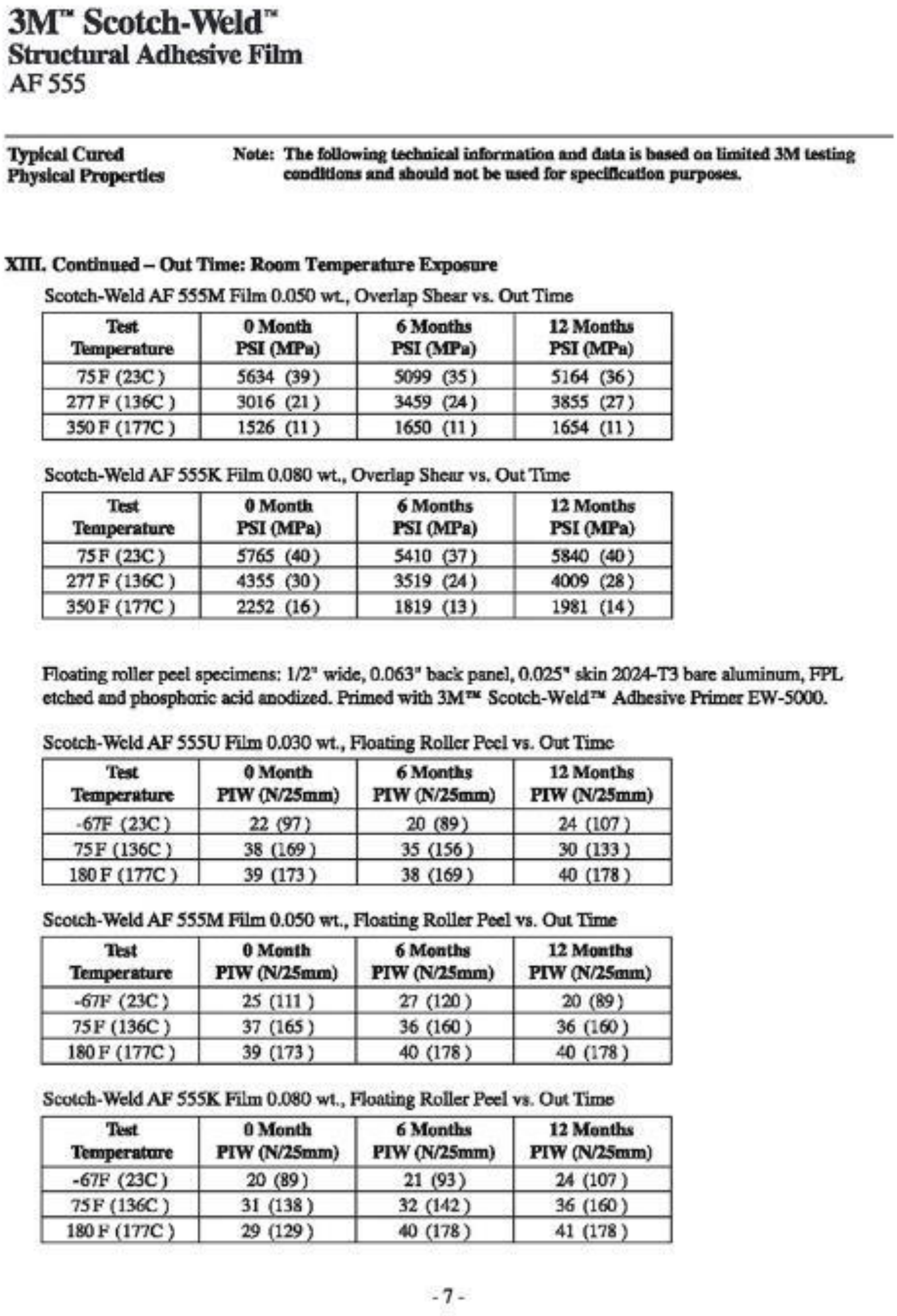
XIII. Out Time: Room Temperature Exposure

Scotch-Weld AF 555 Film was exposed at 77F (23C) / ambient humidity for the number of months specified prior to bonding. Primer used was 3M™ Scotch-Weld™ Structural Adhesive Primer EW-5000. Overlap shear was tested in accordance with ASTM D1002. Floating Roller Peel was tested in accordance with ASTM D3167-97.

Overlap Shear Specimens: 1" wide, 1/2" overlap specimen, 0.063" thick, FPL etched and phosphoric acid anodized 2024-T3 bare aluminum. Primed with Scotch-Weld EW-5000 Primer.

Scotch-Weld AF 555U Film 0.030 wt., Overlap Shear vs. Out Time

Test Temperature	**0 Month PSI (MPa)**	**6 Months PSI (MPa)**	**12 Months PSI (MPa)**
75F (23C)	5416 (37)	5243 (36)	5005 (35)
277 F (136C)	2606 (18)	3277 (23)	3208 (22)
350 F (177C)	1571 (11)	1499 (10)	1410 (10)



3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

XIII. Continued – Out Time: Room Temperature Exposure

Scotch-Weld AF 555M Film 0.050 wt., Overlap Shear vs. Out Time

Test Temperature	0 Month PSI (MPa)	6 Months PSI (MPa)	12 Months PSI (MPa)
75 F (23C)	5634 (39)	5099 (35)	5164 (36)
277 F (136C)	3016 (21)	3459 (24)	3855 (27)
350 F (177C)	1526 (11)	1650 (11)	1654 (11)

Scotch-Weld AF 555K Film 0.080 wt., Overlap Shear vs. Out Time

Test Temperature	0 Month PSI (MPa)	6 Months PSI (MPa)	12 Months PSI (MPa)
75 F (23C)	5765 (40)	5410 (37)	5840 (40)
277 F (136C)	4355 (30)	3519 (24)	4009 (28)
350 F (177C)	2252 (16)	1819 (13)	1981 (14)

Floating roller peel specimens: 1/2" wide, 0.063" back panel, 0.025" skin 2024-T3 bare aluminum, FPL etched and phosphoric acid anodized. Primed with 3M™ Scotch-Weld™ Adhesive Primer EW-5000.

Scotch-Weld AF 555U Film 0.030 wt., Floating Roller Peel vs. Out Time

Test Temperature	0 Month PIW (N/25mm)	6 Months PIW (N/25mm)	12 Months PIW (N/25mm)
-67F (23C)	22 (97)	20 (89)	24 (107)
75 F (136C)	38 (169)	35 (156)	30 (133)
180 F (177C)	39 (173)	38 (169)	40 (178)

Scotch-Weld AF 555M Film 0.050 wt., Floating Roller Peel vs. Out Time

Test Temperature	0 Month PIW (N/25mm)	6 Months PIW (N/25mm)	12 Months PIW (N/25mm)
-67F (23C)	25 (111)	27 (120)	20 (89)
75 F (136C)	37 (165)	36 (160)	36 (160)
180 F (177C)	39 (173)	40 (178)	40 (178)

Scotch-Weld AF 555K Film 0.080 wt., Floating Roller Peel vs. Out Time

Test Temperature	0 Month PIW (N/25mm)	6 Months PIW (N/25mm)	12 Months PIW (N/25mm)
-67F (23C)	20 (89)	21 (93)	24 (107)
75 F (136C)	31 (138)	32 (142)	36 (160)
180 F (177C)	29 (129)	40 (178)	41 (178)

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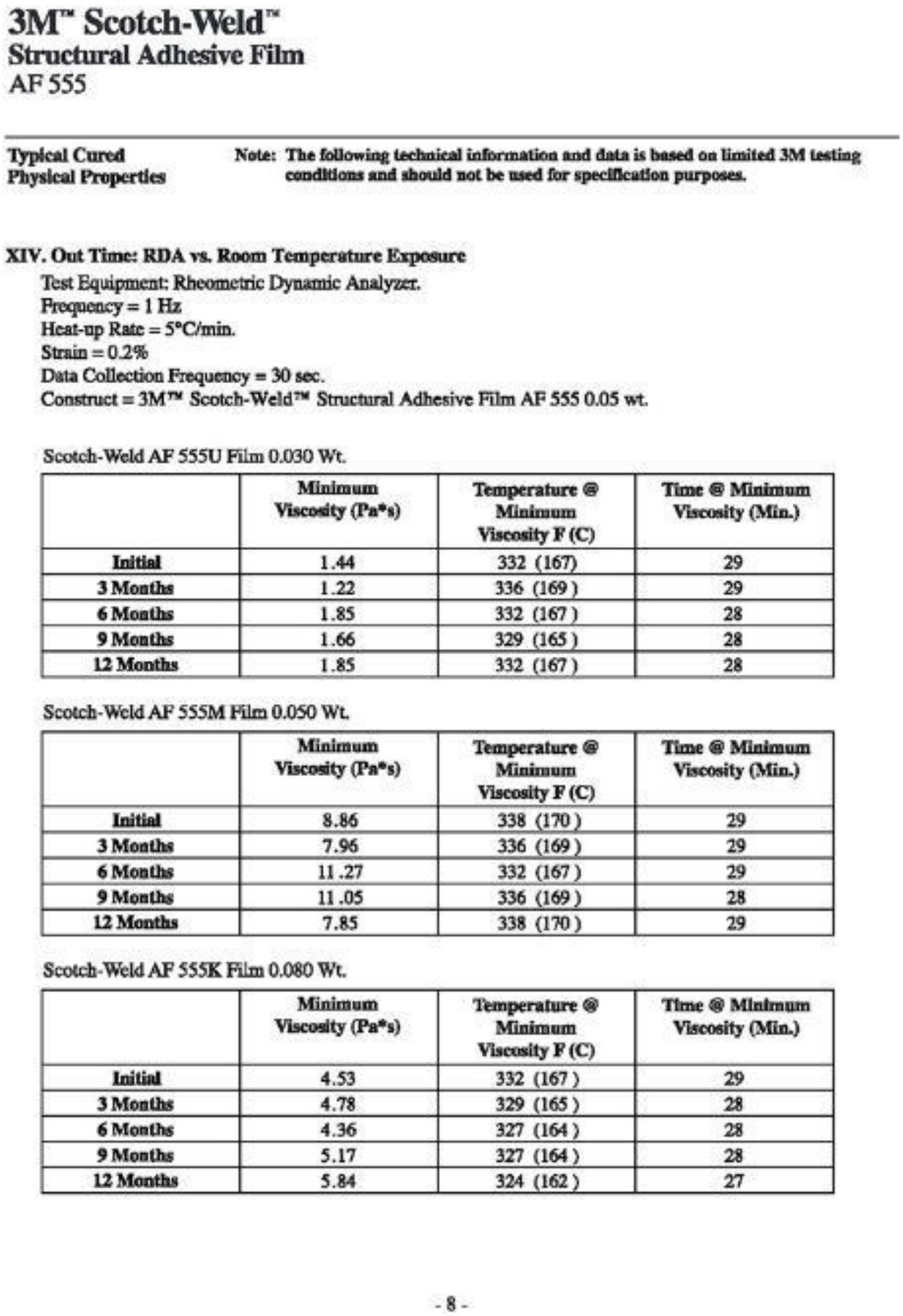


3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

XIV. Out Time: RDA vs. Room Temperature Exposure

Test Equipment: Rheometric Dynamic Analyzer.
Frequency = 1 Hz
Heat-up Rate = 5°C/min.
Strain = 0.2%
Data Collection Frequency = 30 sec.
Construct = 3M™ Scotch-Weld™ Structural Adhesive Film AF 555 0.05 wt.

Scotch-Weld AF 555U Film 0.030 Wt.

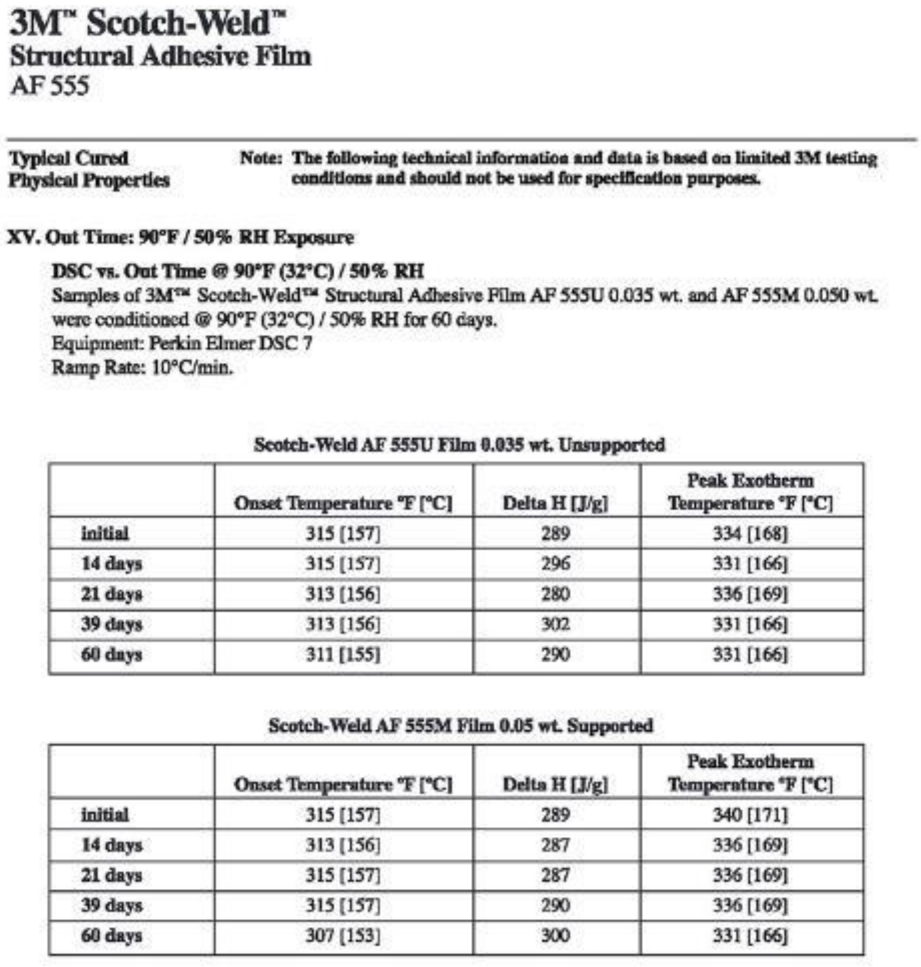
	Minimum Viscosity (Pa*s)	Temperature @ Minimum Viscosity F (C)	Time @ Minimum Viscosity (Min.)
Initial	1.44	332 (167)	29
3 Months	1.22	336 (169)	29
6 Months	1.85	332 (167)	28
9 Months	1.66	329 (165)	28
12 Months	1.85	332 (167)	28

Scotch-Weld AF 555M Film 0.050 Wt.

	Minimum Viscosity (Pa*s)	Temperature @ Minimum Viscosity F (C)	Time @ Minimum Viscosity (Min.)
Initial	8.86	338 (170)	29
3 Months	7.96	336 (169)	29
6 Months	11 .27	332 (167)	29
9 Months	11 .05	336 (169)	28
12 Months	7.85	338 (170)	29

Scotch-Weld AF 555K Film 0.080 Wt.

	Minimum Viscosity (Pa*s)	Temperature @ Minimum Viscosity F (C)	Time @ Minimum Viscosity (Min.)
Initial	4.53	332 (167)	29
3 Months	4.78	329 (165)	28
6 Months	4.36	327 (164)	28
9 Months	5.17	327 (164)	28
12 Months	5.84	324 (162)	27



3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

XV. Out Time: 90°F / 50% RH Exposure

DSC vs. Out Time @ 90°F (32°C) / 50% RH

Samples of 3M™ Scotch-Weld™ Structural Adhesive Film AF 555U 0.035 wt. and AF 555M 0.050 wt. were conditioned @ 90°F (32°C) / 50% RH for 60 days.
Equipment: Perkin Elmer DSC 7
Ramp Rate: 10°C/min.

Scotch-Weld AF 555U Film 0.035 wt. Unsupported

	Onset Temperature °F [°C]	Delta H [J/g]	Peak Exotherm Temperature °F [°C]
initial	315 [157]	289	334 [168]
14 days	315 [157]	296	331 [166]
21 days	313 [156]	280	336 [169]
39 days	313 [156]	302	331 [166]
60 days	311 [155]	290	331 [166]

Scotch-Weld AF 555M Film 0.05 wt. Supported

	Onset Temperature °F [°C]	Delta H [J/g]	Peak Exotherm Temperature °F [°C]
initial	315 [157]	289	340 [171]
14 days	313 [156]	287	336 [169]
21 days	315 [157]	287	336 [169]
39 days	315 [157]	290	336 [169]
60 days	307 [153]	300	331 [166]

3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Typical Cured Physical Properties

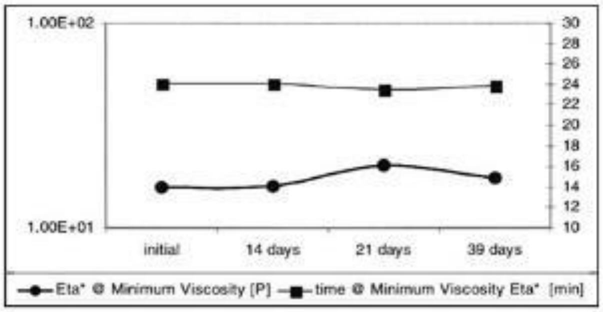
Note: The following technical information and data is based on limited 3M testing conditions and should not be used for specification purposes.

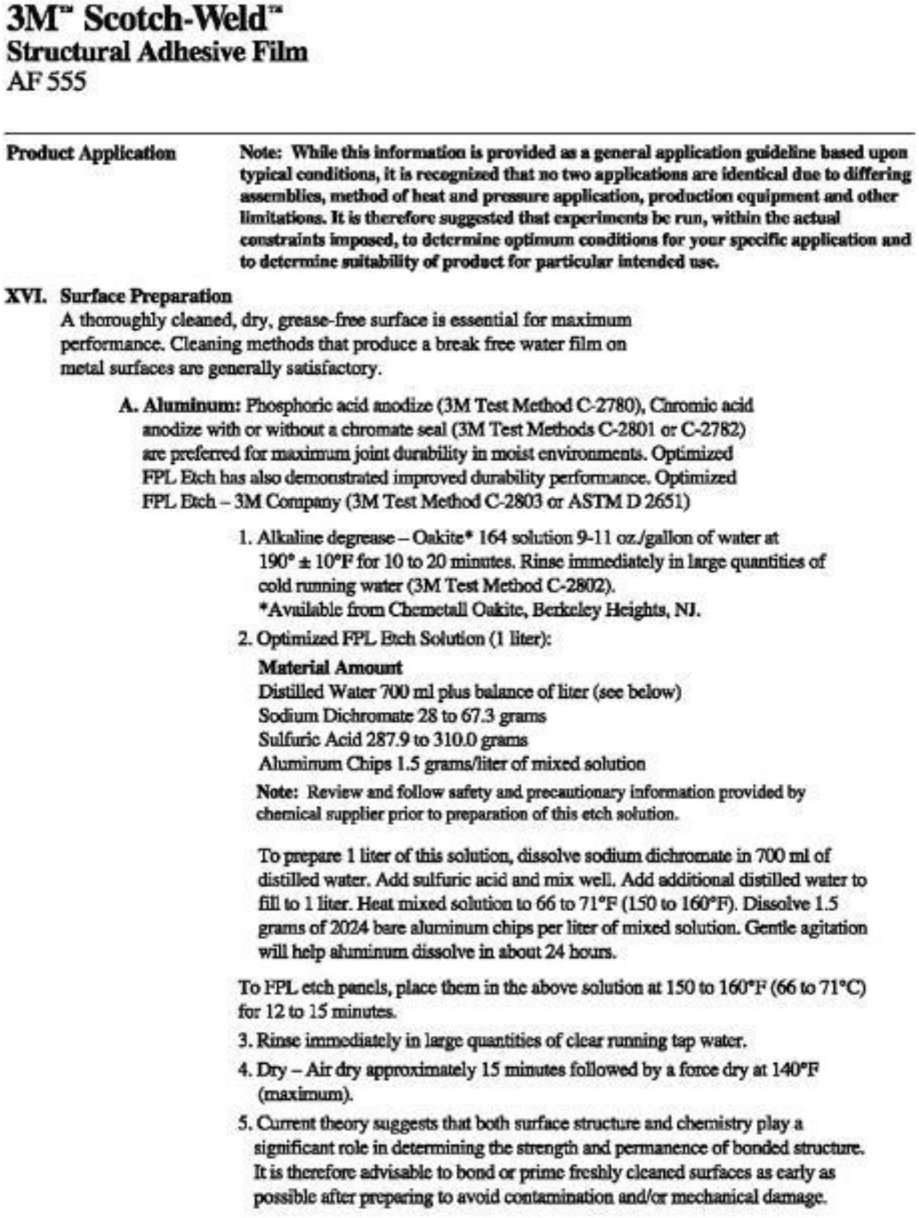
XV. Continued – Out Time: 90°F / 50% RH Exposure

Open Time Data – Minimum viscosity vs. out-time at 90°F (32°C)/50% RH

Test Equipment: Rheometric Dynamic Analyzer.
Frequency = 1 Hz
Heat-up Rate = 5°C/min.
Strain = 0.2%
Data Collection Frequency = 30 sec.
Construct = 3M™ Scotch-Weld™ Structural Adhesive Film AF 555 0.05 wt.

	Time to Minimum Viscosity (min)	Eta* @ Minimum Viscosity (P)
Initial	24.133	1.58E+01
14 days	24.133	1.60E+01
21 days	23.467	2.02E+01
39 days	23.9	1.75E+01





3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

Product Application

Note: While this information is provided as a general application guideline based upon typical conditions, it is recognized that no two applications are identical due to differing assemblies, method of heat and pressure application, production equipment and other limitations. It is therefore suggested that experiments be run, within the actual constraints imposed, to determine optimum conditions for your specific application and to determine suitability of product for particular intended use.

XVI. Surface Preparation

A thoroughly cleaned, dry, grease-free surface is essential for maximum performance. Cleaning methods that produce a break free water film on metal surfaces are generally satisfactory.

A. Aluminum: Phosphoric acid anodize (3M Test Method C-2780), Chromic acid anodize with or without a chromate seal (3M Test Methods C-2801 or C-2782) are preferred for maximum joint durability in moist environments. Optimized FPL Etch has also demonstrated improved durability performance. Optimized FPL Etch – 3M Company (3M Test Method C-2803 or ASTM D 2651)

1. Alkaline degrease – Oakite* 164 solution 9-11 oz./gallon of water at 190° ± 10°F for 10 to 20 minutes. Rinse immediately in large quantities of cold running water (3M Test Method C-2802).
*Available from Chemetall Oakite, Berkeley Heights, NJ.

2. Optimized FPL Etch Solution (1 liter):

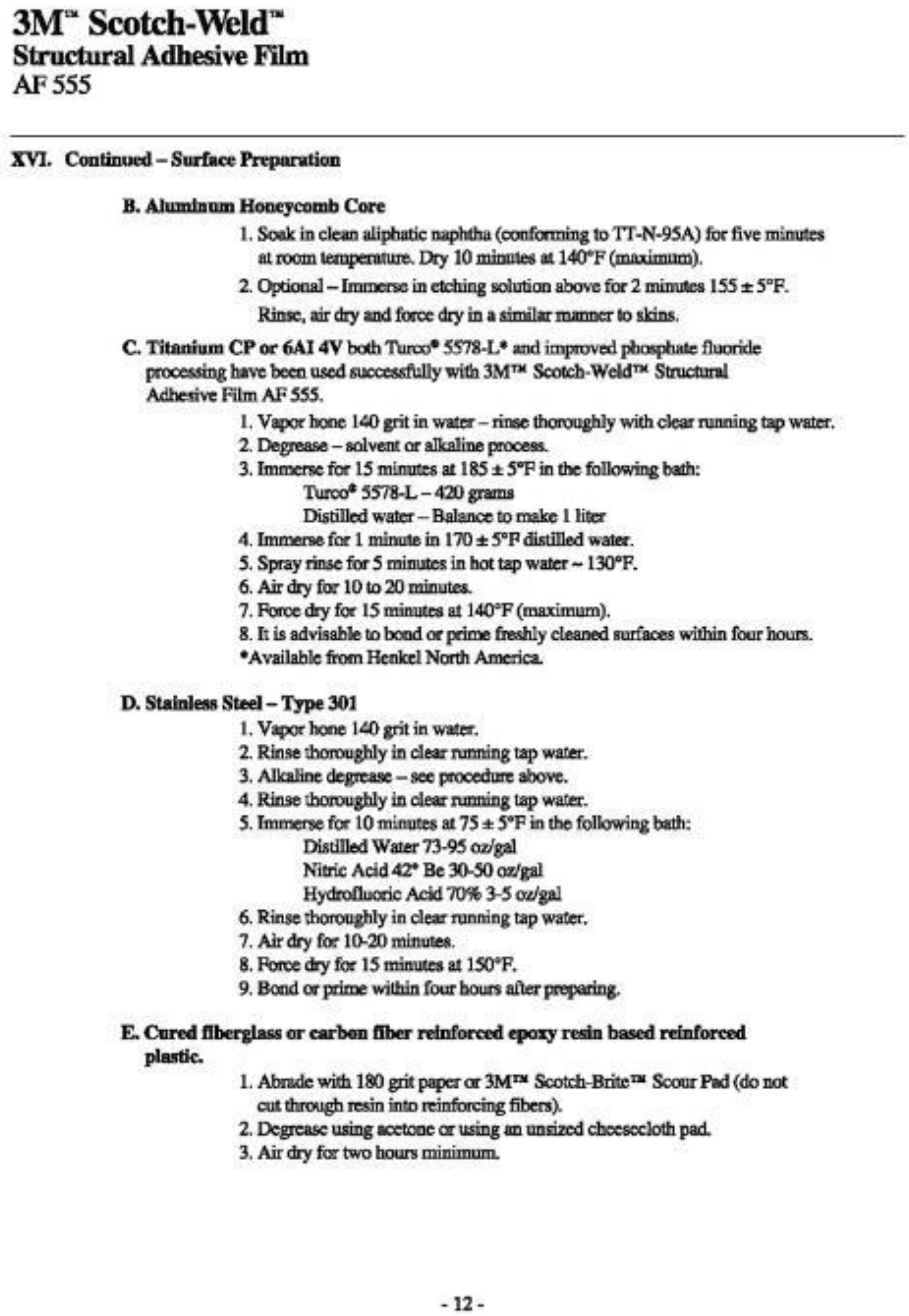
Material	Amount
Distilled Water	700 ml plus balance of liter (see below)
Sodium Dichromate	28 to 67.3 grams
Sulfuric Acid	287.9 to 310.0 grams
Aluminum Chips	1.5 grams/liter of mixed solution

Note: Review and follow safety and precautionary information provided by chemical supplier prior to preparation of this etch solution.

To prepare 1 liter of this solution, dissolve sodium dichromate in 700 ml of distilled water. Add sulfuric acid and mix well. Add additional distilled water to fill to 1 liter. Heat mixed solution to 66 to 71°F (150 to 160°F). Dissolve 1.5 grams of 2024 bare aluminum chips per liter of mixed solution. Gentle agitation will help aluminum dissolve in about 24 hours.

To FPL etch panels, place them in the above solution at 150 to 160°F (66 to 71°C) for 12 to 15 minutes.

3. Rinse immediately in large quantities of clear running tap water.
4. Dry – Air dry approximately 15 minutes followed by a force dry at 140°F (maximum).
5. Current theory suggests that both surface structure and chemistry play a significant role in determining the strength and permanence of bonded structure. It is therefore advisable to bond or prime freshly cleaned surfaces as early as possible after preparing to avoid contamination and/or mechanical damage.



3M™ Scotch-Weld™
Structural Adhesive Film
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XVI. Continued – Surface Preparation

B. Aluminum Honeycomb Core

1. Soak in clean aliphatic naphtha (conforming to TT-N-95A) for five minutes at room temperature. Dry 10 minutes at 140°F (maximum).
2. Optional – Immerse in etching solution above for 2 minutes 155 ± 5°F. Rinse, air dry and force dry in a similar manner to skins.

C. Titanium CP or 6Al 4V both Turco® 5578-L* and improved phosphate fluoride processing have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AF 555.

1. Vapor hone 140 grit in water – rinse thoroughly with clear running tap water.
2. Degrease – solvent or alkaline process.
3. Immerse for 15 minutes at 185 ± 5°F in the following bath:
    Turco® 5578-L – 420 grams
    Distilled water – Balance to make 1 liter
4. Immerse for 1 minute in 170 ± 5°F distilled water.
5. Spray rinse for 5 minutes in hot tap water ~ 130°F.
6. Air dry for 10 to 20 minutes.
7. Force dry for 15 minutes at 140°F (maximum).
8. It is advisable to bond or prime freshly cleaned surfaces within four hours.

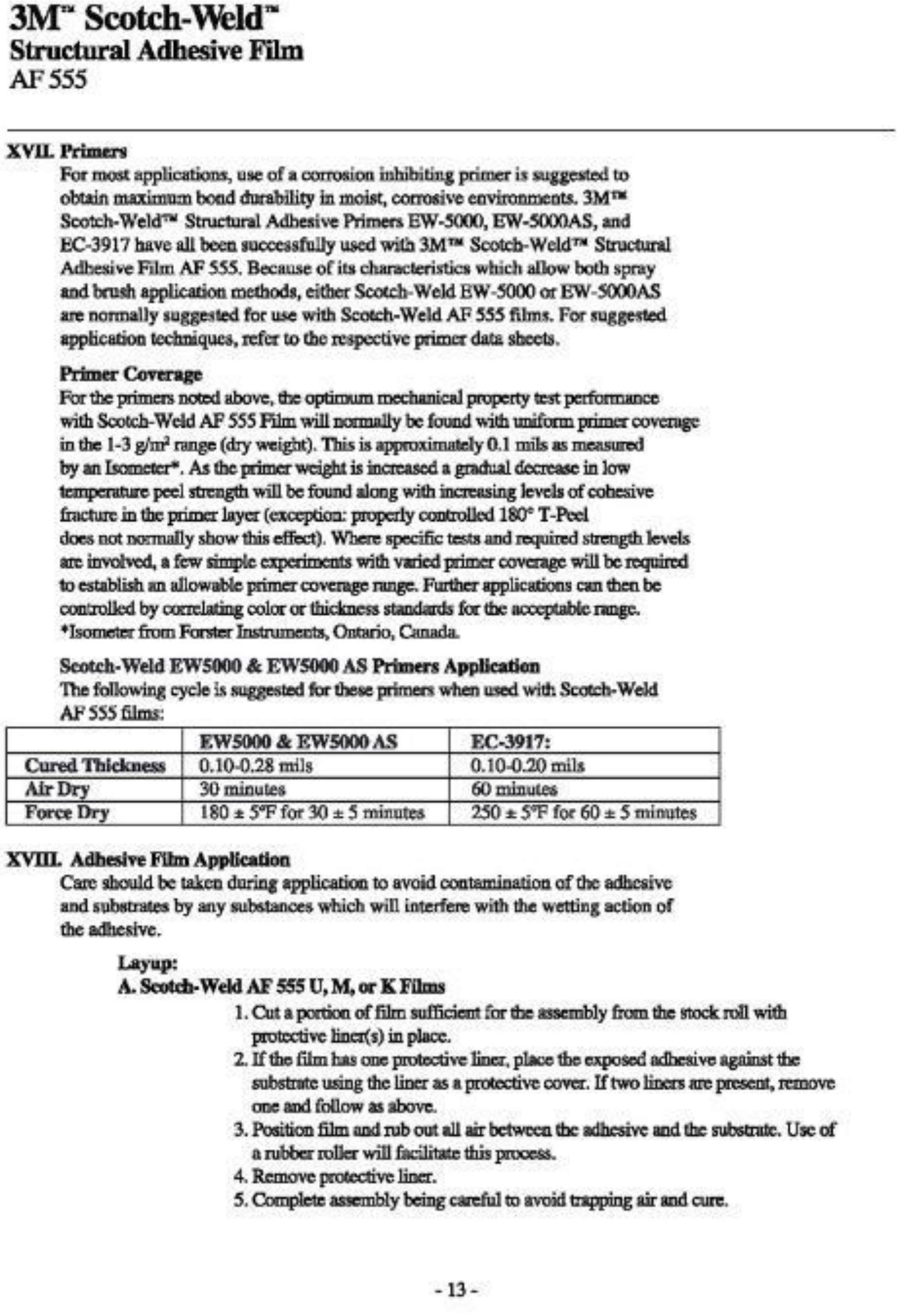
*Available from Henkel North America.

D. Stainless Steel – Type 301

1. Vapor hone 140 grit in water.
2. Rinse thoroughly in clear running tap water.
3. Alkaline degrease – see procedure above.
4. Rinse thoroughly in clear running tap water.
5. Immerse for 10 minutes at 75 ± 5°F in the following bath:
    Distilled Water 73-95 oz/gal
    Nitric Acid 42° Be 30-50 oz/gal
    Hydrofluoric Acid 70% 3-5 oz/gal
6. Rinse thoroughly in clear running tap water.
7. Air dry for 10-20 minutes.
8. Force dry for 15 minutes at 150°F.
9. Bond or prime within four hours after preparing.

E. Cured fiberglass or carbon fiber reinforced epoxy resin based reinforced plastic.

1. Abrade with 180 grit paper or 3M™ Scotch-Brite™ Scour Pad (do not cut through resin into reinforcing fibers).
2. Degrease using acetone or using an unsized cheesecloth pad.
3. Air dry for two hours minimum.



3M™ Scotch-Weld™
Structural Adhesive Film
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XVII. Primers

For most applications, use of a corrosion inhibiting primer is suggested to obtain maximum bond durability in moist, corrosive environments. 3M™ Scotch-Weld™ Structural Adhesive Primers EW-5000, EW-5000AS, and EC-3917 have all been successfully used with 3M™ Scotch-Weld™ Structural Adhesive Film AF 555. Because of its characteristics which allow both spray and brush application methods, either Scotch-Weld EW-5000 or EW-5000AS are normally suggested for use with Scotch-Weld AF 555 films. For suggested application techniques, refer to the respective primer data sheets.

Primer Coverage

For the primers noted above, the optimum mechanical property test performance with Scotch-Weld AF 555 Film will normally be found with uniform primer coverage in the 1-3 g/m² range (dry weight). This is approximately 0.1 mils as measured by an Isometer*. As the primer weight is increased a gradual decrease in low temperature peel strength will be found along with increasing levels of cohesive fracture in the primer layer (exception: properly controlled 180° T-Peel does not normally show this effect). Where specific tests and required strength levels are involved, a few simple experiments with varied primer coverage will be required to establish an allowable primer coverage range. Further applications can then be controlled by correlating color or thickness standards for the acceptable range.

*Isometer from Forster Instruments, Ontario, Canada.

Scotch-Weld EW5000 & EW5000 AS Primers Application

The following cycle is suggested for these primers when used with Scotch-Weld AF 555 films:

	EW5000 & EW5000 AS	EC-3917:
Cured Thickness	0.10-0.28 mils	0.10-0.20 mils
Air Dry	30 minutes	60 minutes
Force Dry	180 ± 5°F for 30 ± 5 minutes	250 ± 5°F for 60 ± 5 minutes

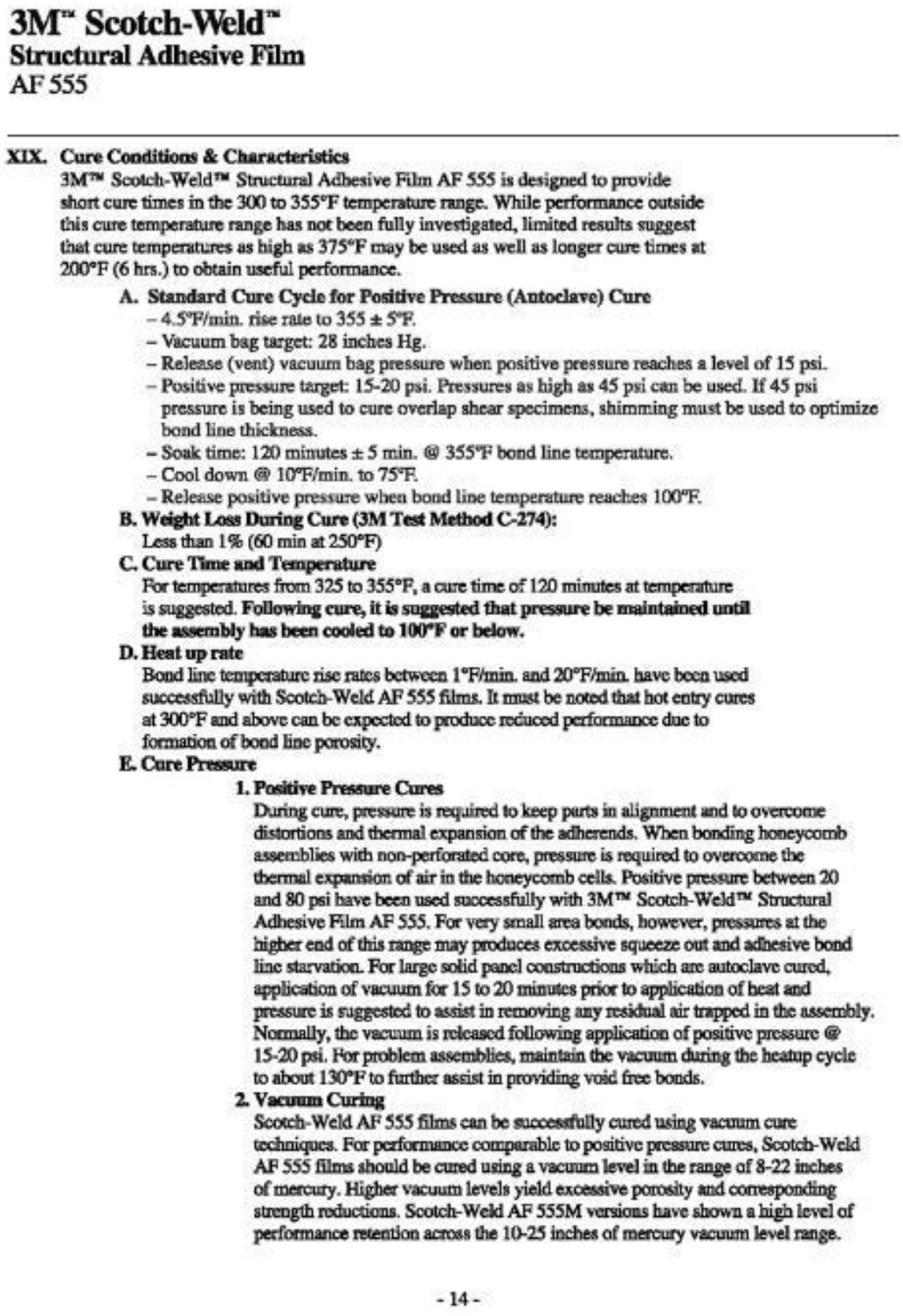
XVIII. Adhesive Film Application

Care should be taken during application to avoid contamination of the adhesive and substrates by any substances which will interfere with the wetting action of the adhesive.

Layup:

A. Scotch-Weld AF 555 U, M, or K Films

1. Cut a portion of film sufficient for the assembly from the stock roll with protective liner(s) in place.
2. If the film has one protective liner, place the exposed adhesive against the substrate using the liner as a protective cover. If two liners are present, remove one and follow as above.
3. Position film and rub out all air between the adhesive and the substrate. Use of a rubber roller will facilitate this process.
4. Remove protective liner.
5. Complete assembly being careful to avoid trapping air and cure.



3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

XIX. Cure Conditions & Characteristics

3M™ Scotch-Weld™ Structural Adhesive Film AF 555 is designed to provide short cure times in the 300 to 355°F temperature range. While performance outside this cure temperature range has not been fully investigated, limited results suggest that cure temperatures as high as 375°F may be used as well as longer cure times at 200°F (6 hrs.) to obtain useful performance.

A. Standard Cure Cycle for Positive Pressure (Autoclave) Cure

- 4.5°F/min. rise rate to 355 ± 5°F.
- Vacuum bag target: 28 inches Hg.
- Release (vent) vacuum bag pressure when positive pressure reaches a level of 15 psi.
- Positive pressure target: 15-20 psi. Pressures as high as 45 psi can be used. If 45 psi pressure is being used to cure overlap shear specimens, shimming must be used to optimize bond line thickness.
- Soak time: 120 minutes ± 5 min. @ 355°F bond line temperature.
- Cool down @ 10°F/min. to 75°F.
- Release positive pressure when bond line temperature reaches 100°F.

B. Weight Loss During Cure (3M Test Method C-274):

Less than 1% (60 min at 250°F)

C. Cure Time and Temperature

For temperatures from 325 to 355°F, a cure time of 120 minutes at temperature is suggested. **Following cure, it is suggested that pressure be maintained until the assembly has been cooled to 100°F or below.**

D. Heat up rate

Bond line temperature rise rates between 1°F/min. and 20°F/min. have been used successfully with Scotch-Weld AF 555 films. It must be noted that hot entry cures at 300°F and above can be expected to produce reduced performance due to formation of bond line porosity.

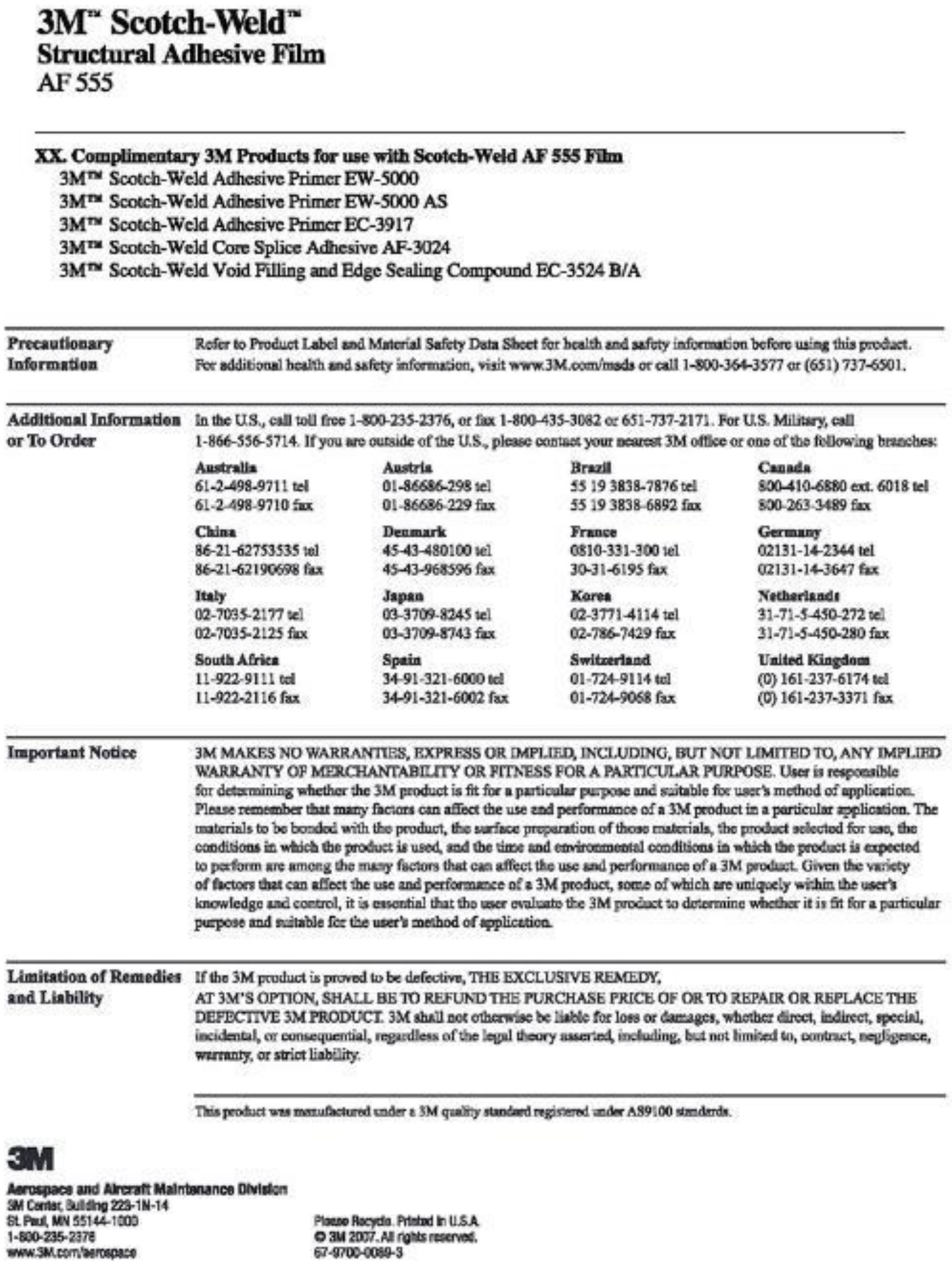
E. Cure Pressure

1. Positive Pressure Cures

During cure, pressure is required to keep parts in alignment and to overcome distortions and thermal expansion of the adherends. When bonding honeycomb assemblies with non-perforated core, pressure is required to overcome the thermal expansion of air in the honeycomb cells. Positive pressure between 20 and 80 psi have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AF 555. For very small area bonds, however, pressures at the higher end of this range may produce excessive squeeze out and adhesive bond line starvation. For large solid panel constructions which are autoclave cured, application of vacuum for 15 to 20 minutes prior to application of heat and pressure is suggested to assist in removing any residual air trapped in the assembly. Normally, the vacuum is released following application of positive pressure @ 15-20 psi. For problem assemblies, maintain the vacuum during the heatup cycle to about 130°F to further assist in providing void free bonds.

2. Vacuum Curing

Scotch-Weld AF 555 films can be successfully cured using vacuum cure techniques. For performance comparable to positive pressure cures, Scotch-Weld AF 555 films should be cured using a vacuum level in the range of 8-22 inches of mercury. Higher vacuum levels yield excessive porosity and corresponding strength reductions. Scotch-Weld AF 555M versions have shown a high level of performance retention across the 10-25 inches of mercury vacuum level range.



3M™ Scotch-Weld™
Structural Adhesive Film
AF 555

XX. Complimentary 3M Products for use with Scotch-Weld AF 555 Film

3M™ Scotch-Weld Adhesive Primer EW-5000
3M™ Scotch-Weld Adhesive Primer EW-5000 AS
3M™ Scotch-Weld Adhesive Primer EC-3917
3M™ Scotch-Weld Core Splice Adhesive AF-3024
3M™ Scotch-Weld Void Filling and Edge Sealing Compound EC-3524 B/A

Precautionary Information

Refer to Product Label and Material Safety Data Sheet for health and safety information before using this product. For additional health and safety information, visit www.3M.com/msds or call 1-800-364-3577 or (651) 737-6501.

Additional Information or To Order

In the U.S., call toll free 1-800-235-2376, or fax 1-800-435-3082 or 651-737-2171. For U.S. Military, call 1-866-556-5714. If you are outside of the U.S., please contact your nearest 3M office or one of the following branches:

Australia 61-2-498-9711 tel 61-2-498-9710 fax	**Austria** 01-86686-298 tel 01-86686-229 fax	**Brazil** 55 19 3838-7876 tel 55 19 3838-6892 fax	**Canada** 800-410-6880 ext. 6018 tel 800-263-3489 fax
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Italy 02-7035-2177 tel 02-7035-2125 fax	**Japan** 03-3709-8245 tel 03-3709-8743 fax	**Korea** 02-3771-4114 tel 02-786-7429 fax	**Netherlands** 31-71-5-450-272 tel 31-71-5-450-280 fax
South Africa 11-922-9111 tel 11-922-2116 fax	**Spain** 34-91-321-6000 tel 34-91-321-6002 fax	**Switzerland** 01-724-9114 tel 01-724-9068 fax	**United Kingdom** (0) 161-237-6174 tel (0) 161-237-3371 fax

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This product was manufactured under a 3M quality standard registered under AS9100 standards.

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67-9700-0089-3

Figure A18. Scotch-Weld AF555M Film Adhesive Material Properties

The Al honeycomb fill material used was procured from Texas Almet part number 3.1 1/8 .0007P 5052 (3.1 pcf), 1/8-inch hexagonal cell size, 0.0007-inch foil gauge, P = perforated, 5052 Al alloy). The ROHACELL® foam used was ROHACELL® 200 WF, which is a closed-cell rigid polymethacrylimade foam and was procured from Evonik Industries (reference Figure A19 for the ROHACELL® foam material properties).

EVONIK
INDUSTRIES

Product Information

ROHACELL® WF

Polymethacrylimide Foam

ROHACELL® WF is a closed-cell rigid foam based on polymethacrylimide (PMI) chemistry, which does not contain any CFC's.

ROHACELL® WF has been designed for use primarily in aerospace applications; in addition to conforming to our material specification sheet, it satisfies the usual industry requirements such as MIL and CMS specifications.

ROHACELL® WF rigid foam can be processed at pressures of up to 0.7 MPa and temperatures of up to 130°C. It is therefore highly suited for autoclave prepreg processing and all typical resin infusion processes.

After heat treatment, ROHACELL® WF can even tolerate curing temperatures of 180°C at a pressure of 0.7 MPa.

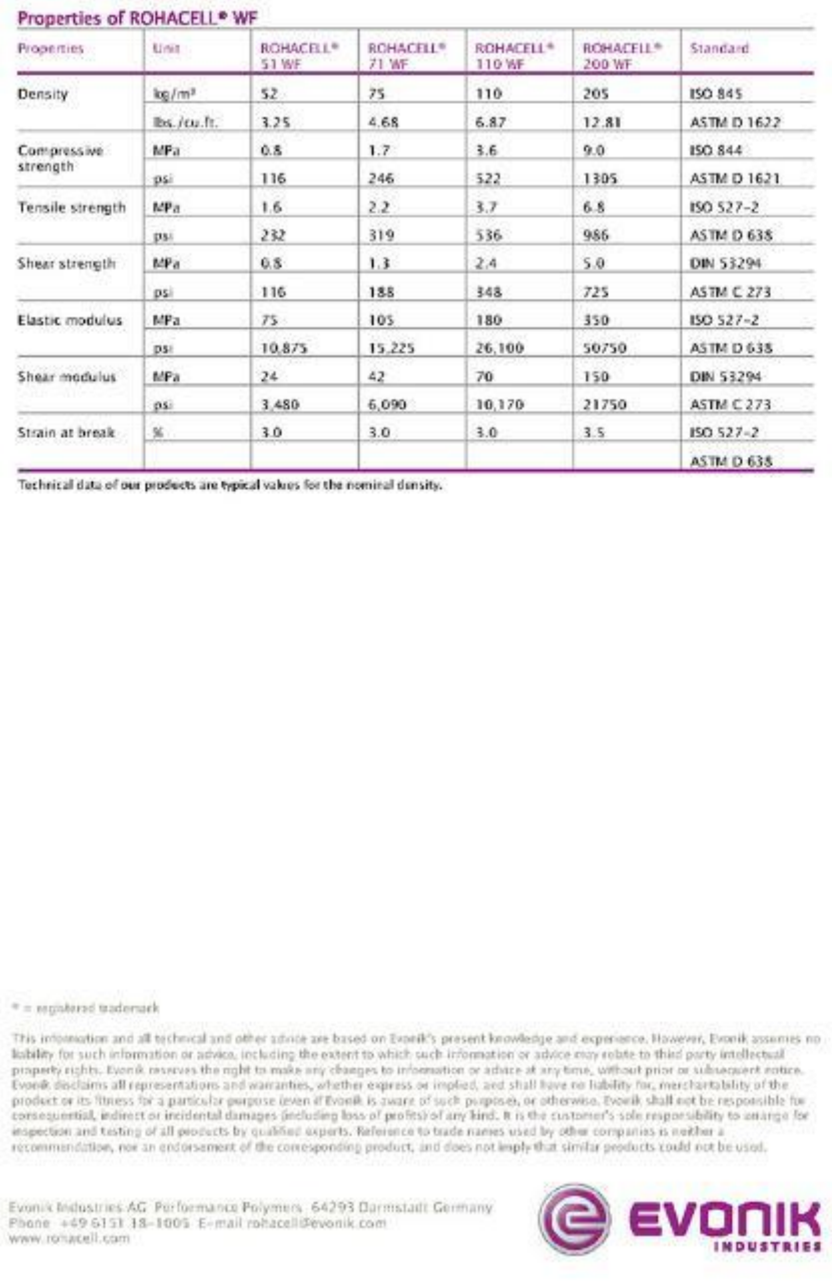
The thermo-formability of ROHACELL® provides a tremendous manufacturing advantage.

ROHACELL® WF is also easy to shape by machining.

For further information, please contact our experts by phone +49 6151 18 1005 or e-mail rohacell@evonik.com

ROHACELL® – registered trademark of the Evonik Rohm GmbH

January 2011



Properties of ROHACELL® WF

Properties	Unit	ROHACELL® 51 WF	ROHACELL® 71 WF	ROHACELL® 110 WF	ROHACELL® 200 WF	Standard
Density	kg/m³	52	75	110	205	ISO 845
	lbs./cu.ft.	3.25	4.68	6.87	12.81	ASTM D 1622
Compressive strength	MPa	0.8	1.7	3.6	9.0	ISO 844
	psi	116	246	522	1305	ASTM D 1621
Tensile strength	MPa	1.6	2.2	3.7	6.8	ISO 527-2
	psi	232	319	536	986	ASTM D 638
Shear strength	MPa	0.8	1.3	2.4	5.0	DIN 53294
	psi	116	188	348	725	ASTM C 273
Elastic modulus	MPa	75	105	180	350	ISO 527-2
	psi	10,875	15,225	26,100	50750	ASTM D 638
Shear modulus	MPa	24	42	70	150	DIN 53294
	psi	3,480	6,090	10,170	21750	ASTM C 273
Strain at break	%	3.0	3.0	3.0	3.5	ISO 527-2
						ASTM D 638

Technical data of our products are typical values for the nominal density.

® = registered trademark

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Evonik Industries AG Performance Polymers 64293 Darmstadt Germany
Phone +49 6151 18-1005 E-mail rohacell@evonik.com
www.rohacell.com

EVONIK
INDUSTRIES

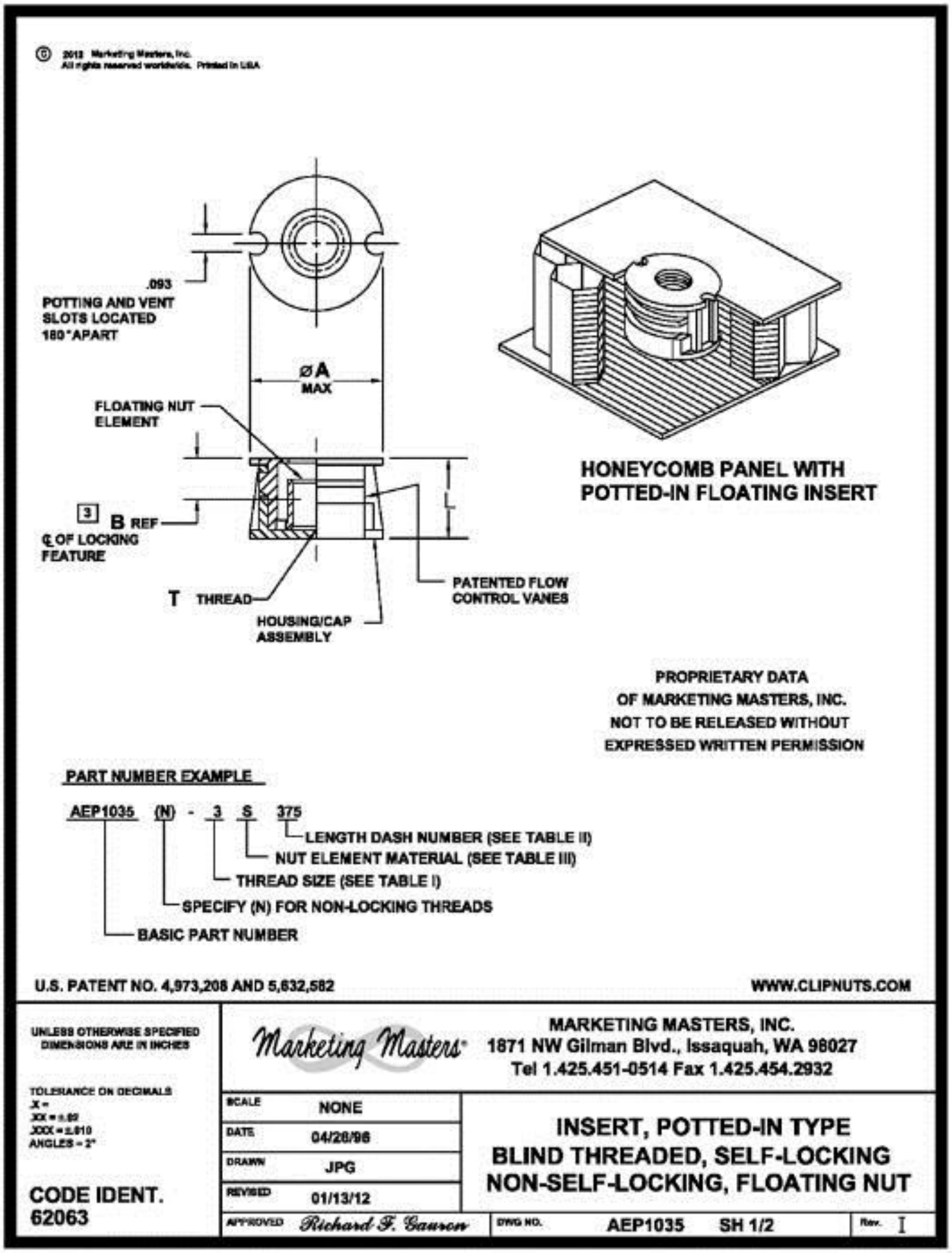
Figure A19. ROHACELL® Foam WF 200 Material Properties

A2.3 Test Support Hardware Materials

Mounting accelerometers to the test panels is critical for ensuring acquiring quality acceleration data. The accelerometers must be fully seated 360° for optimal response. For the initial pathfinder tests (using the 0.187-inch Al plate) the plate was drilled and tapped for 1/4-28 thread and the PCB350 accelerometers were mounted and torqued directly to the Al plate. With the monolithic composite panels it is not possible to mount the accelerometers directly to the test panel and ensure they will remain installed during the pyroshock event. The approach for mounting the accelerometers the monolithic panel was to drill and tap the composite panels with a 7/16-14 thread and to procure steel inserts with a 7/16-14 outer diameter thread and an inner diameter thread of 1/4-28. Figure A20 shows the threaded inserts that were used for all of the monolithic panel tests. The inserts were threaded into monolithic composite panels until flush with the front surface of the panel and bonded in place using Hysol® 9394 adhesive. The locking keys were not use and were removed after installation of the inserts.

Figure A20. Threaded Insert for Accelerometer Mounting

The composite sandwich panels produced new challenges for mounting the accelerometers to the Group II and Group III test specimen. The installation method chosen was to procure blind threaded inserts, which are potted in the sandwich panel such that the top of the insert is flush with the front facing composite face sheet. Mounting of the accelerometers consisted of threading into the insert and torque to specified torque value. Figure A21 shows the blind insert that was used to install the accelerometers to the composite sandwich panel. Figures A22 and A23 depict examples of the ROHACELL® Foam and Al honeycomb sandwich panels prior to insert installation, respectively.



PROPRIETARY DATA
OF MARKETING MASTERS, INC.
NOT TO BE RELEASED WITHOUT
EXPRESSED WRITTEN PERMISSION

PART NUMBER EXAMPLE

AEP1035 (N) - 3 S 375
- 375 — LENGTH DASH NUMBER (SEE TABLE II)
- S — NUT ELEMENT MATERIAL (SEE TABLE III)
- 3 — THREAD SIZE (SEE TABLE I)
- (N) — SPECIFY (N) FOR NON-LOCKING THREADS
- AEP1035 — BASIC PART NUMBER

U.S. PATENT NO. 4,973,208 AND 5,632,582

WWW.CLIPNUTS.COM

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCE ON DECIMALS
.X =
.XX = ±.02
.XXX = ±.010
ANGLES = 2°

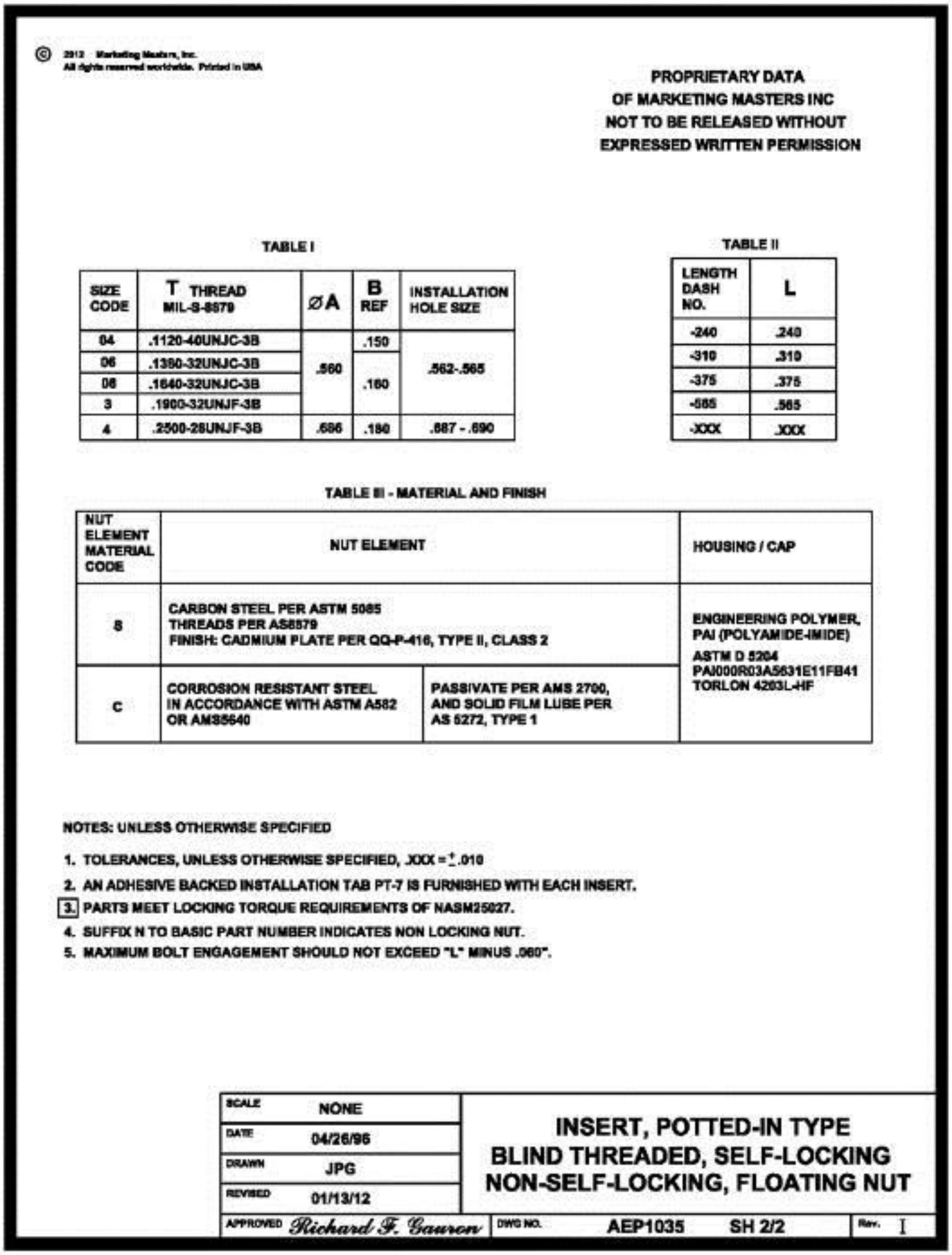
CODE IDENT.
62063

Marketing Masters®
MARKETING MASTERS, INC.
1871 NW Gilman Blvd., Issaquah, WA 98027
Tel 1.425.451-0514 Fax 1.425.454.2932

SCALE NONE
DATE 04/26/96
DRAWN JPG
REVISED 01/13/12
APPROVED Richard F. Gauron

INSERT, POTTED-IN TYPE
BLIND THREADED, SELF-LOCKING
NON-SELF-LOCKING, FLOATING NUT

DWG NO. AEP1035 SH 1/2
Rev. I



PROPRIETARY DATA
OF MARKETING MASTERS INC
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TABLE I

SIZE CODE	T THREAD MIL-S-8879	ØA	B REF	INSTALLATION HOLE SIZE
04	.1120-40UNJC-3B	.560	.150	.562-.565
06	.1380-32UNJC-3B		.160	
08	.1640-32UNJC-3B			
3	.1900-32UNJF-3B			
4	.2500-28UNJF-3B	.686	.180	.687 - .690

TABLE II

LENGTH DASH NO.	L
-240	.240
-310	.310
-375	.375
-565	.565
-XXX	.XXX

TABLE III - MATERIAL AND FINISH

NUT ELEMENT MATERIAL CODE	NUT ELEMENT		HOUSING / CAP
S	CARBON STEEL PER ASTM 5085 THREADS PER AS8879 FINISH: CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 2		ENGINEERING POLYMER, PAI (POLYAMIDE-IMIDE) ASTM D 5204 PAI000R03A5631E11FB41 TORLON 4203L-HF
C	CORROSION RESISTANT STEEL IN ACCORDANCE WITH ASTM A582 OR AMS5640	PASSIVATE PER AMS 2700, AND SOLID FILM LUBE PER AS 5272, TYPE 1	

NOTES: UNLESS OTHERWISE SPECIFIED

1. TOLERANCES, UNLESS OTHERWISE SPECIFIED, .XXX = ±.010
2. AN ADHESIVE BACKED INSTALLATION TAB PT-7 IS FURNISHED WITH EACH INSERT.
3. PARTS MEET LOCKING TORQUE REQUIREMENTS OF NASM25027.
4. SUFFIX N TO BASIC PART NUMBER INDICATES NON LOCKING NUT.
5. MAXIMUM BOLT ENGAGEMENT SHOULD NOT EXCEED "L" MINUS .060".

SCALE	NONE	INSERT, POTTED-IN TYPE BLIND THREADED, SELF-LOCKING NON-SELF-LOCKING, FLOATING NUT
DATE	04/26/96	
DRAWN	JPG	
REVISED	01/13/12	
APPROVED	Richard F. Gauron	DWG NO. AEP1035 SH 2/2 Rev. I

Figure A21. Clipnut Sandwich Panel Blind Insert for Accelerometer Mounting

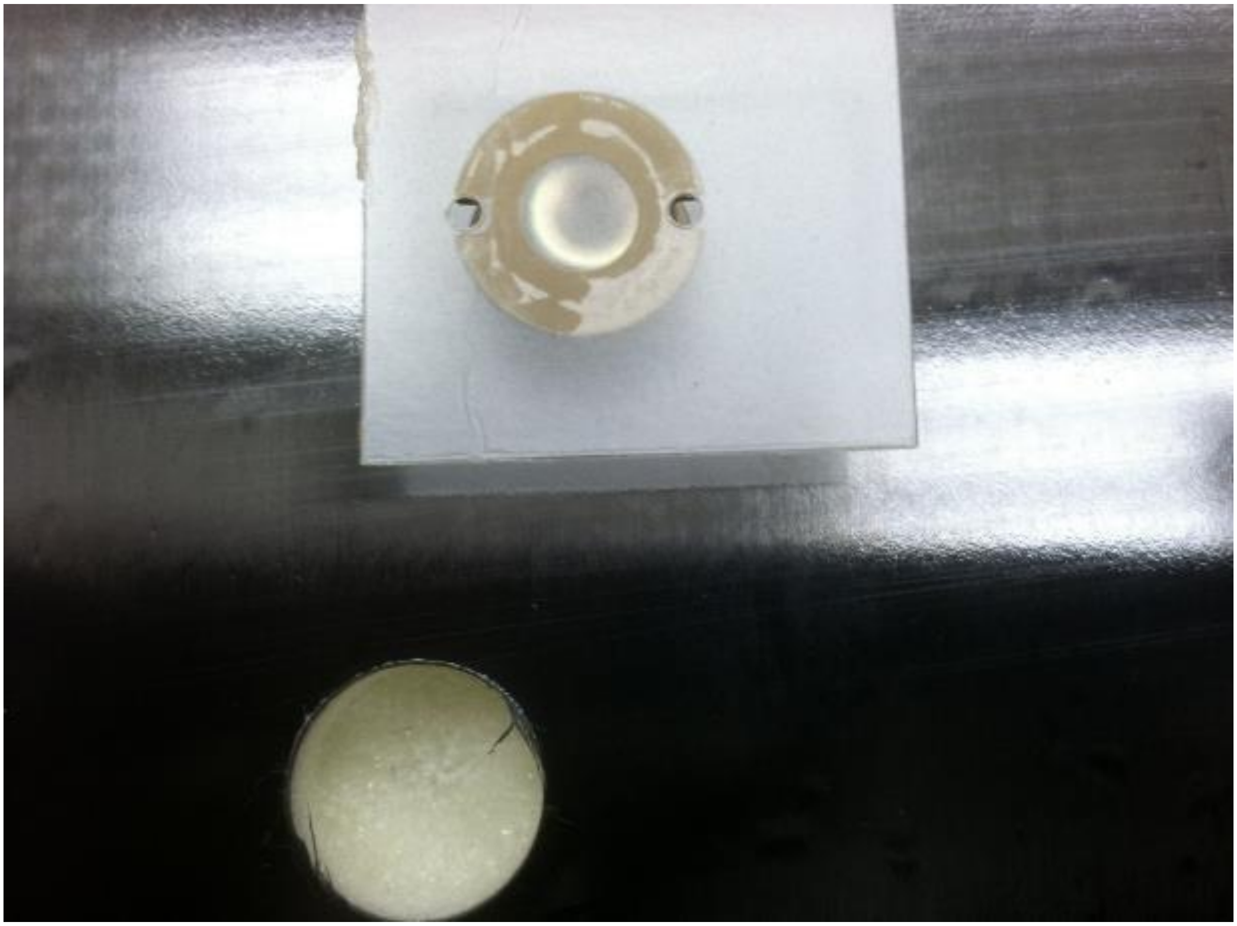


Figure A22. ROHACELL® Foam Sandwich Panel Prepped for Insert Installation

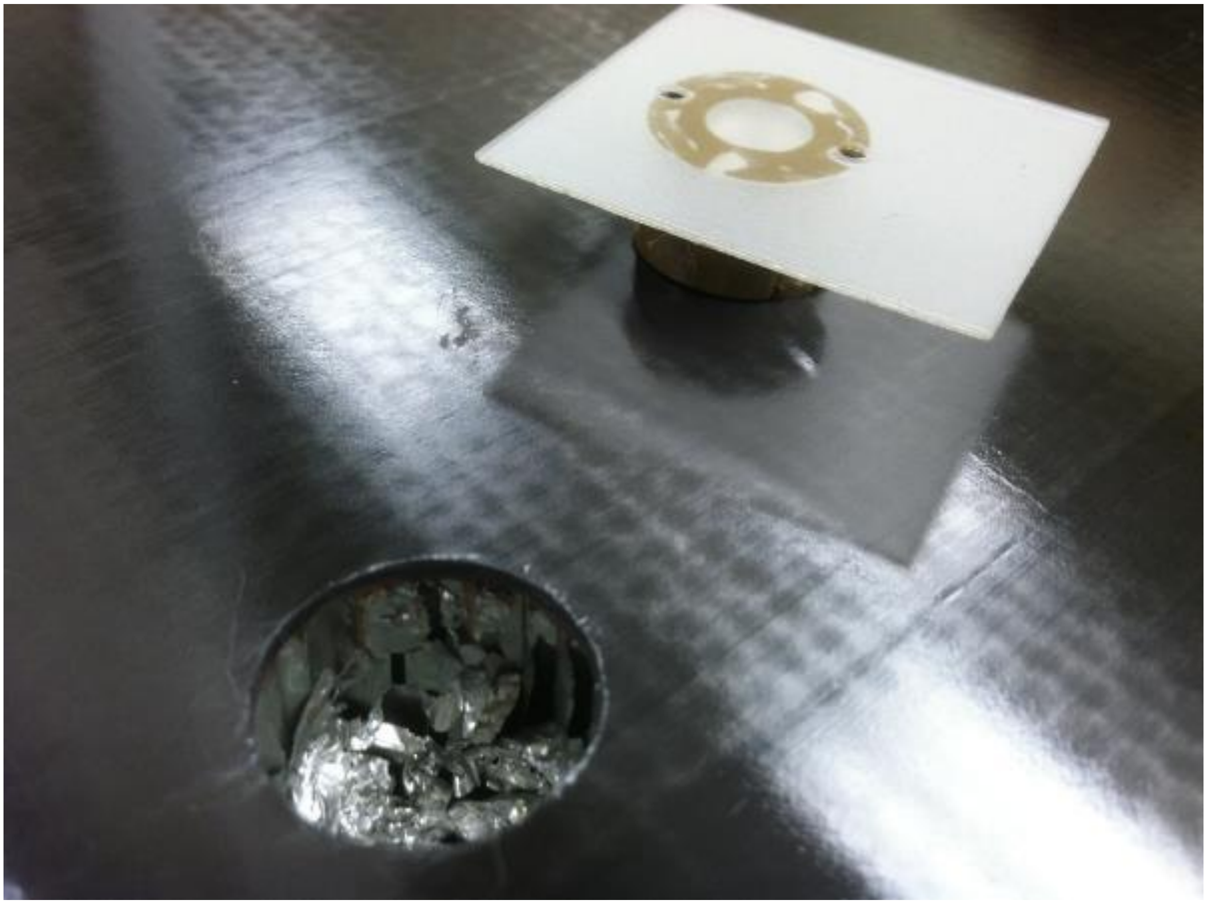
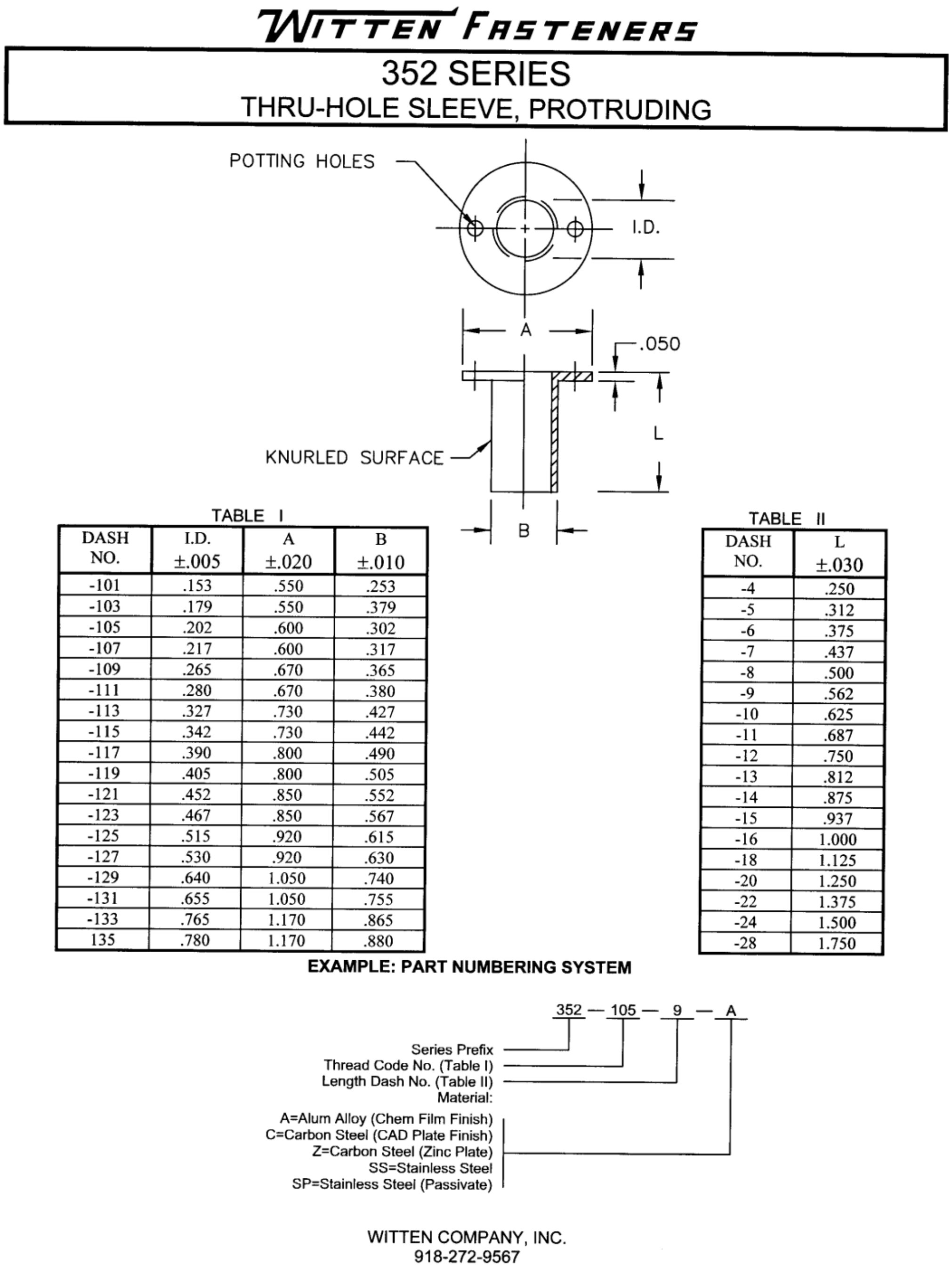


Figure A23. Al Honeycomb Sandwich Panel Prepped for Insert Installation

For subjection of the composite panels to test, the panels are suspended at the top two corners of the panels using straps and shackles, with 1/2-inch fasteners. Since the compressive strength of the composite sandwich panels is relatively low, it is not possible to torque the 1/-2 bolt and nut to 55 foot-pounds (ft-lb). To resolve this issue stainless steel sleeves were procured and machined to specific lengths so the sleeve would be just under flush with the backside composite face sheet to accommodate the fastener torque load. Initially, the sleeve with the flange was machined to length and bonded to the through hole machined in the sandwich panel. After the first panel was fabricated in this manner, it was decided to machine the sleeve to remove the flange and not bond them to the panel. The sleeves were inserted into the through holes in the panel during assembly of the panel into the test fixture. The sleeves were re-usable and sleeve pairs were machined in ~ 0.010-inch length increments from 1.070 inches up to 1.140 inches. Figure A24 provides detail on the stainless steel composite sandwich panel mounting sleeve.



WITTEN FASTENERS

352 SERIES
THRU-HOLE SLEEVE, PROTRUDING

TABLE I

DASH NO.	I.D. ±.005	A ±.020	B ±.010
-101	.153	.550	.253
-103	.179	.550	.379
-105	.202	.600	.302
-107	.217	.600	.317
-109	.265	.670	.365
-111	.280	.670	.380
-113	.327	.730	.427
-115	.342	.730	.442
-117	.390	.800	.490
-119	.405	.800	.505
-121	.452	.850	.552
-123	.467	.850	.567
-125	.515	.920	.615
-127	.530	.920	.630
-129	.640	1.050	.740
-131	.655	1.050	.755
-133	.765	1.170	.865
135	.780	1.170	.880

TABLE II

DASH NO.	L ±.030
-4	.250
-5	.312
-6	.375
-7	.437
-8	.500
-9	.562
-10	.625
-11	.687
-12	.750
-13	.812
-14	.875
-15	.937
-16	1.000
-18	1.125
-20	1.250
-22	1.375
-24	1.500
-28	1.750

EXAMPLE: PART NUMBERING SYSTEM

352 — 105 — 9 — A

Series Prefix
Thread Code No. (Table I)
Length Dash No. (Table II)
Material:
A=Alum Alloy (Chem Film Finish)
C=Carbon Steel (CAD Plate Finish)
Z=Carbon Steel (Zinc Plate)
SS=Stainless Steel
SP=Stainless Steel (Passivate)

WITTEN COMPANY, INC.
918-272-9567

Note: A dash number -125 with a length of -20 fabricated from passive stainless steel was used.

Figure A24. Witten Company, Through-Hole Sleeve for Mounting Sandwich Panels

In addition to the inserts and sleeves, the test support hardware for the pyroshock testing included the sacrificial LSC plate, the backing support plate, and the LSC standoff shims. The LSC plate and the LSC standoff shims were fabricated from 5052 Al alloy (except for the composite LSC plates as noted in Table 7.0-4 (test Group III)) and were expended in test, thus not re-usable. Two backing support plates were fabricated from 5052 Al alloy and were re-used through the entire test series.

A2.4 Melamine Acoustic Foam

The MAF tests were not included in the baseline task assessment plan and were added to the task assessment plan in the August 15, 2014, scope update to the assessment plan. The MAF used for these tests was procured from Soundcoat in accordance with the MSFC generated melamine foam drawing (reference Figure A12-2). The acoustic foam was configured with a thin layer of conductive Kapton® film covering both the front and backsides of the acoustic foam. Figure A25 provides the material properties of the MAF and Figure A26 provides information on the Kapton® film.

*Headquarters: 1 Burt Drive, Deer Park, NY 11729 * Tel. 800-394-8913 * Fax: 631-242-2246*
West Coast: 16901 Armstrong Avenue, Irvine, CA 92606 Tel. 949-955-9202 * Fax: 949-222-0834*

SOUNDCOAT *Technical Data Sheet*

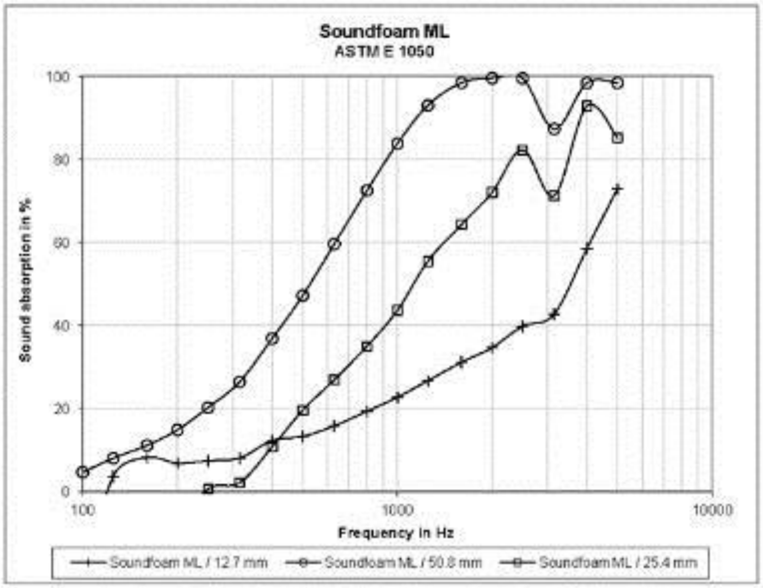
SOUNDFOAM® - ML

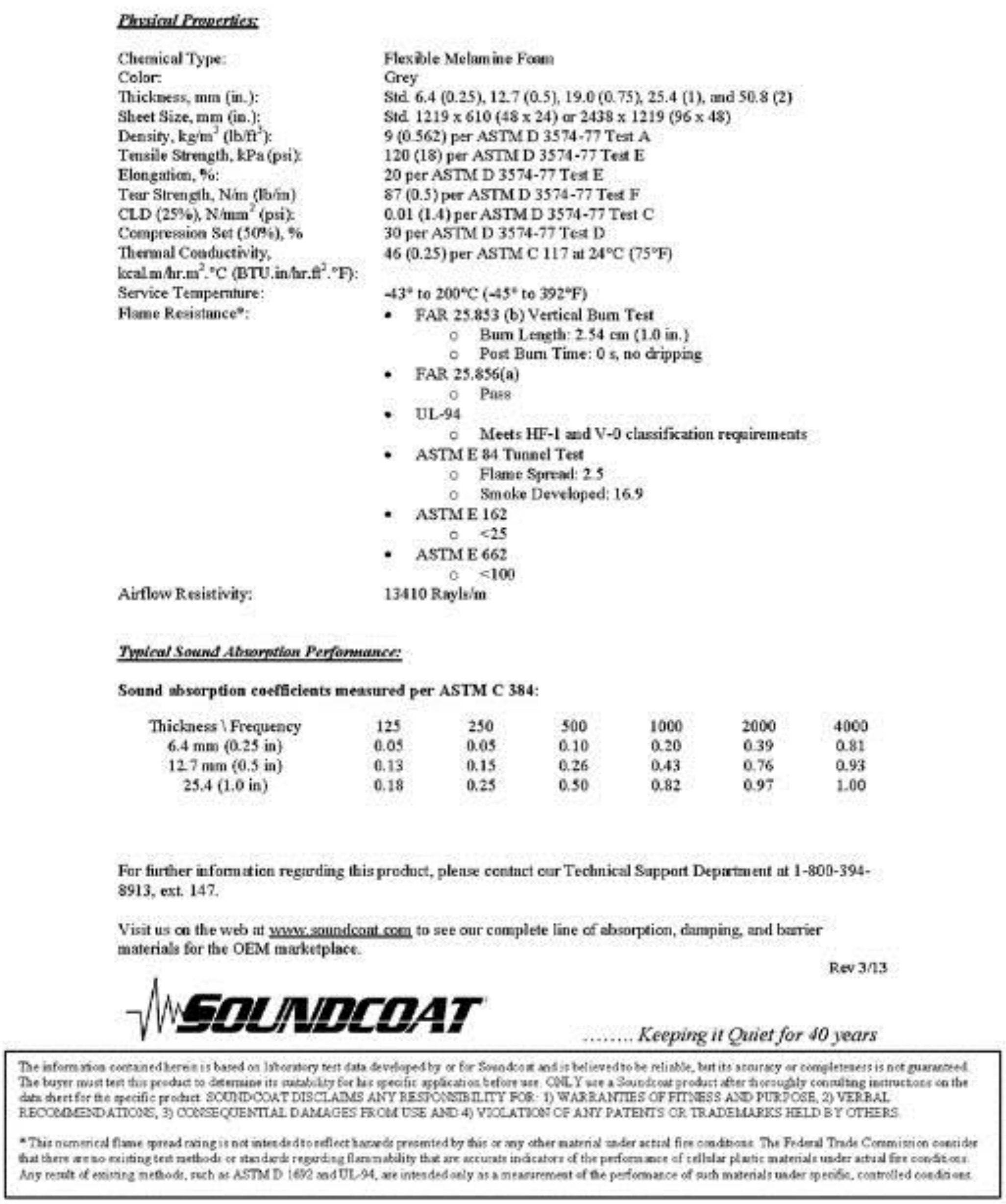
Product Description (w/ Features & Benefits):

SOUNDFOAM ML is a lightweight, flexible, open-cell, melamine based acoustic quality foam having excellent flame* and heat resistance. It exhibits a very low degree of flammability, does not drip upon ignition, ceases to burn after removal of ignition source, and produces a minimum amount of smoke. Compared with some glass-fiber based acoustical products, **SOUNDFOAM ML** has better strength, lower compression set, and higher resiliency. It is recommended for use as acoustic or thermal insulation in aerospace, marine, or ground units, etc., where light weight, heat resistance, and fire safety are of the utmost concern. It is available plain or with decorative and protective surface finishes of reinforced aluminized polyester film, Tedlar®, Nomex®, etc. For customer convenience, the foam is supplied with one of several high performance pressure-sensitive adhesives for ease of installation. Soundfoam ML is available in standard sheet sizes or in custom sheet sizes or as custom cut parts.

How It Works:

The sound absorption performance of elastic porous materials is determined mainly by the porosity and airflow resistance (air permeability) of the materials. Sound absorption data for various surface finishes are available upon request. Following are typical sound absorption curves.





Physical Properties:

Chemical Type:	Flexible Melamine Foam
Color:	Grey
Thickness, mm (in.):	Std. 6.4 (0.25), 12.7 (0.5), 19.0 (0.75), 25.4 (1), and 50.8 (2)
Sheet Size, mm (in.):	Std. 1219 x 610 (48 x 24) or 2438 x 1219 (96 x 48)
Density, kg/m^3 (lb/ft^3):	9 (0.562) per ASTM D 3574-77 Test A
Tensile Strength, kPa (psi):	120 (18) per ASTM D 3574-77 Test E
Elongation, %:	20 per ASTM D 3574-77 Test E
Tear Strength, N/m (lb/in)	87 (0.5) per ASTM D 3574-77 Test F
CLD (25%), N/mm^2 (psi):	0.01 (1.4) per ASTM D 3574-77 Test C
Compression Set (50%), %	30 per ASTM D 3574-77 Test D
Thermal Conductivity, kcal.m/hr.m^2.°C (BTU.in/hr.ft^2.°F):	46 (0.25) per ASTM C 117 at 24°C (75°F)
Service Temperature:	-43° to 200°C (-45° to 392°F)
Flame Resistance*:	• FAR 25.853 (b) Vertical Burn Test o Burn Length: 2.54 cm (1.0 in.) o Post Burn Time: 0 s, no dripping • FAR 25.856(a) o Pass • UL-94 o Meets HF-1 and V-0 classification requirements • ASTM E 84 Tunnel Test o Flame Spread: 2.5 o Smoke Developed: 16.9 • ASTM E 162 o <25 • ASTM E 662 o <100
Airflow Resistivity:	13410 Rayls/m

Typical Sound Absorption Performance:

Sound absorption coefficients measured per ASTM C 384:

Thickness \ Frequency	125	250	500	1000	2000	4000
6.4 mm (0.25 in)	0.05	0.05	0.10	0.20	0.39	0.81
12.7 mm (0.5 in)	0.13	0.15	0.26	0.43	0.76	0.93
25.4 (1.0 in)	0.18	0.25	0.50	0.82	0.97	1.00

For further information regarding this product, please contact our Technical Support Department at 1-800-394-8913, ext. 147.

Visit us on the web at www.soundcoat.com to see our complete line of absorption, damping, and barrier materials for the OEM marketplace.

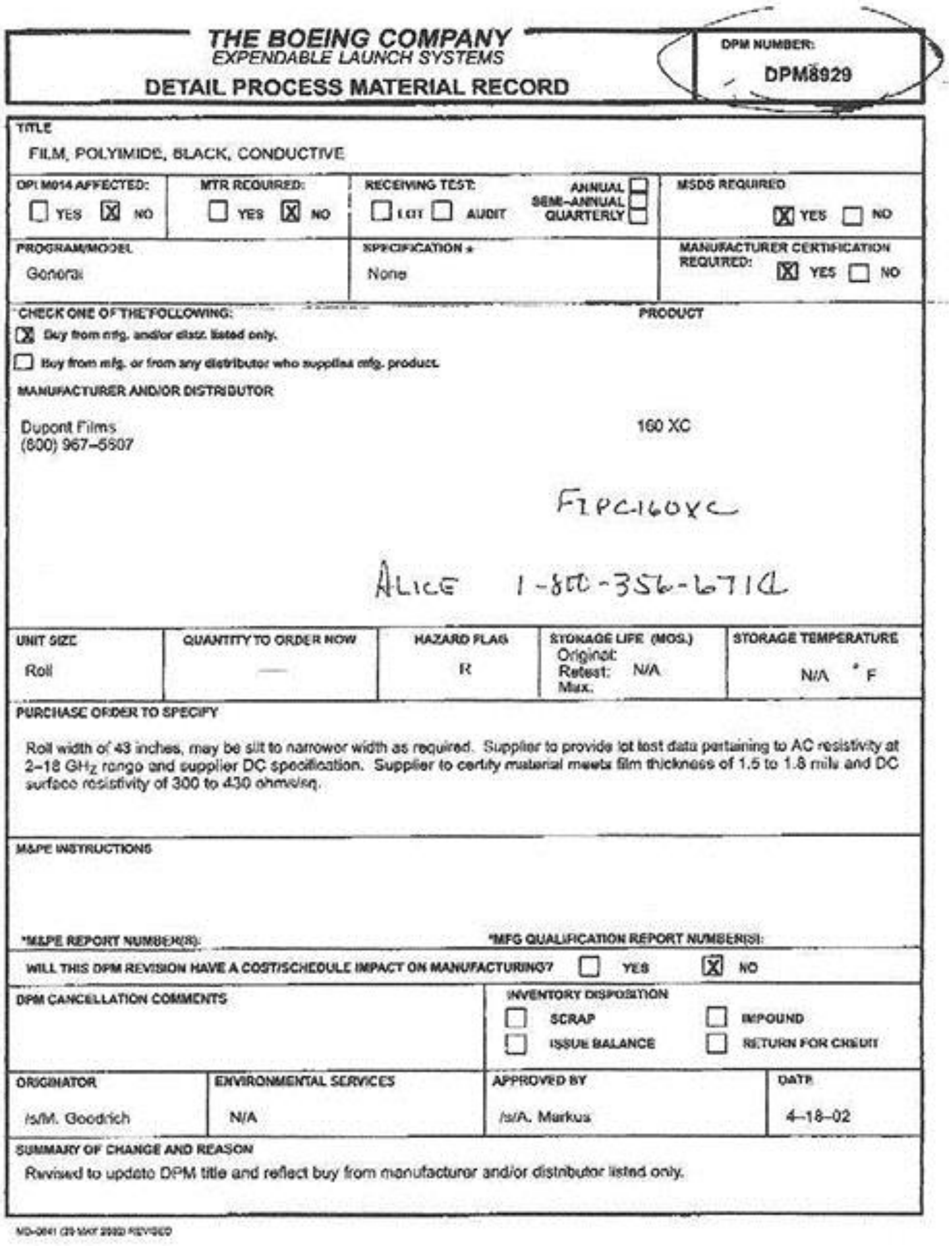
Rev 3/13

SOUNDCOAT .... *Keeping it Quiet for 40 years*

The information contained herein is based on laboratory test data developed by or for Soundcoat and is believed to be reliable, but its accuracy or completeness is not guaranteed. The buyer must test this product to determine its suitability for his specific application before use. ONLY use a Soundcoat product after thoroughly consulting instructions on the data sheet for the specific product. SOUNDCOAT DISCLAIMS ANY RESPONSIBILITY FOR: 1) WARRANTIES OF FITNESS AND PURPOSE, 2) VERBAL RECOMMENDATIONS, 3) CONSEQUENTIAL DAMAGES FROM USE AND 4) VIOLATION OF ANY PATENTS OR TRADEMARKS HELD BY OTHERS.

*This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions. The Federal Trade Commission consider that there are no existing test methods or standards regarding flammability that are accurate indicators of the performance of cellular plastic materials under actual fire conditions. Any result of existing methods, such as ASTM D 1692 and UL-94, are intended only as a measurement of the performance of such materials under specific, controlled conditions.

Figure A25. MAF Material Properties



THE BOEING COMPANY
EXPENDABLE LAUNCH SYSTEMS
DETAIL PROCESS MATERIAL RECORD

DPM NUMBER: DPM8929

TITLE
FILM, POLYIMIDE, BLACK, CONDUCTIVE

OPI M014 AFFECTED: ☐ YES ☒ NO

MTR REQUIRED: ☐ YES ☒ NO

RECEIVING TEST: ☐ LOT ☐ AUDIT ANNUAL ☐ SEMI-ANNUAL ☐ QUARTERLY ☐

MSDS REQUIRED ☒ YES ☐ NO

PROGRAM/MODEL: General

SPECIFICATION *: None

MANUFACTURER CERTIFICATION REQUIRED: ☒ YES ☐ NO

CHECK ONE OF THE FOLLOWING:
☒ Buy from mfg. and/or distr. listed only.
☐ Buy from mfg. or from any distributor who supplies mfg. product.

MANUFACTURER AND/OR DISTRIBUTOR
Dupont Films
(800) 967-5507

PRODUCT
160 XC

FIPC160XC

ALICE 1-800-356-671C

UNIT SIZE	QUANTITY TO ORDER NOW	HAZARD FLAG	STORAGE LIFE (MOS.)	STORAGE TEMPERATURE
Roll	—	R	Original: Retest: N/A Max.	N/A °F

PURCHASE ORDER TO SPECIFY
Roll width of 43 inches, may be slit to narrower width as required. Supplier to provide lot test data pertaining to AC resistivity at 2–18 $\mathrm{GH_Z}$ range and supplier DC specification. Supplier to certify material meets film thickness of 1.5 to 1.8 mils and DC surface resistivity of 300 to 430 ohms/sq.

M&PE INSTRUCTIONS

*M&PE REPORT NUMBER(S):

*MFG QUALIFICATION REPORT NUMBER(S):

WILL THIS DPM REVISION HAVE A COST/SCHEDULE IMPACT ON MANUFACTURING? ☐ YES ☒ NO

DPM CANCELLATION COMMENTS

INVENTORY DISPOSITION
☐ SCRAP ☐ IMPOUND
☐ ISSUE BALANCE ☐ RETURN FOR CREDIT

ORIGINATOR	ENVIRONMENTAL SERVICES	APPROVED BY	DATE
/s/M. Goodrich	N/A	/s/A. Markus	4–18–02

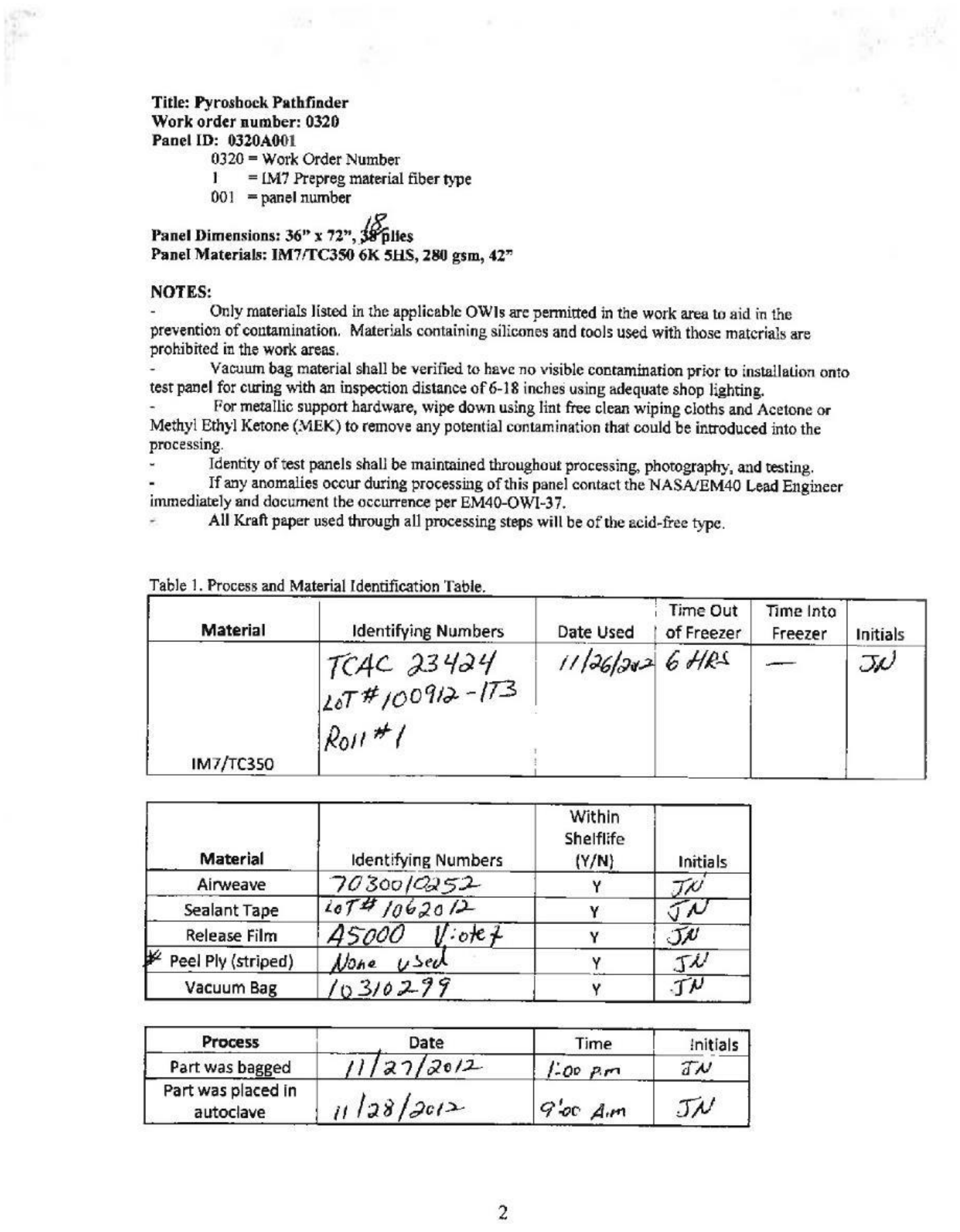
SUMMARY OF CHANGE AND REASON
Revised to update DPM title and reflect buy from manufacturer and/or distributor listed only.

MD-0041 (29 MAY 2002) REVISED

Figure A26. MAF Kapton® Film Data

A3 Fabrication

The EM42 personnel fabricated all of the composite panels at MSFC. The panels were fabricated per the steps listed in MSFC work orders approved by EM42 Engineering and the task assessment technical lead (see Figure A27, A28, and A29 for monolithic, sandwich, and MAF as typical examples). Figure A30 shows a pictorial overview for assembly of a ROHACELL® foam sandwich test panel.



Title: Pyroshock Pathfinder
Work order number: 0320
Panel ID: 0320A001
0320 = Work Order Number
1 = IM7 Prepreg material fiber type
001 = panel number

Panel Dimensions: 36" x 72", ~~38~~ 18 plies
Panel Materials: IM7/TC350 6K 5HS, 280 gsm, 42"

NOTES:

- Only materials listed in the applicable OWIs are permitted in the work area to aid in the prevention of contamination. Materials containing silicones and tools used with those materials are prohibited in the work areas.
- Vacuum bag material shall be verified to have no visible contamination prior to installation onto test panel for curing with an inspection distance of 6-18 inches using adequate shop lighting.
- For metallic support hardware, wipe down using lint free clean wiping cloths and Acetone or Methyl Ethyl Ketone (MEK) to remove any potential contamination that could be introduced into the processing.
- Identity of test panels shall be maintained throughout processing, photography, and testing.
- If any anomalies occur during processing of this panel contact the NASA/EM40 Lead Engineer immediately and document the occurrence per EM40-OWI-37.
- All Kraft paper used through all processing steps will be of the acid-free type.

Table 1. Process and Material Identification Table.

Material	Identifying Numbers	Date Used	Time Out of Freezer	Time Into Freezer	Initials
IM7/TC350	TCAC 23424 LOT # 100912-IT3 Roll #1	11/26/2012	6 HRS	—	JN

Material	Identifying Numbers	Within Shelflife (Y/N)	Initials
Airweave	7030010252	Y	JN
Sealant Tape	LOT # 1062012	Y	JN
Release Film	A5000 Violet	Y	JN
* Peel Ply (striped)	None used	Y	JN
Vacuum Bag	10310299	Y	JN

Process	Date	Time	Initials
Part was bagged	11/27/2012	1:00 p.m	JN
Part was placed in autoclave	11/28/2012	9:00 A.m	JN

2

Prepreg/Adhesive Preparation

1. Place lint and powder free latex gloves on when handling prepreg at all times.

INITIALS JN

2. Record out time on NMIH label when removing any frozen material, If label is full, attach another label adjacent to the previous one. Weigh prepreg/adhesive rolls and jot number next to out time also fill out this info in table 1.

3. Allow 4 hours to thaw for large prepreg rolls. Return material to freezer immediately after cutting for your panel to minimize out time.

4. Record ambient temperature and humidity below.

Temperature 72°F

Humidity 45% RH

Laminate Construction

1. Environment requirements for temperature and humidity for all steps of lay-up shall be maintained during the operation per the following:

Temperature = 70 +/- 5°F

Humidity = 40 – 55%

INITIALS: JN

2. Cut a piece of solid release film that is larger than the cut plies. Label the film with the panel ID along with the 0°, 45° and the 90° ply directional rosette on the edge of the film. Placement of rosette should be placed as seen below. Place the release film on top of the baseplate tool shown in Figure 3.

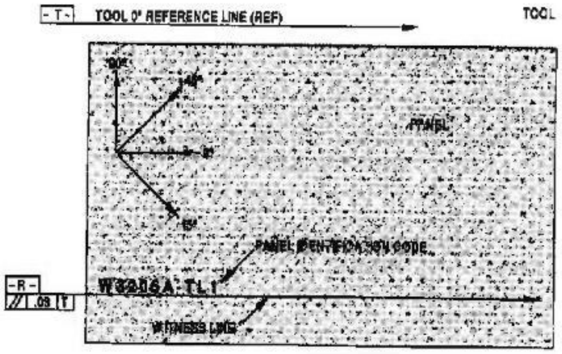
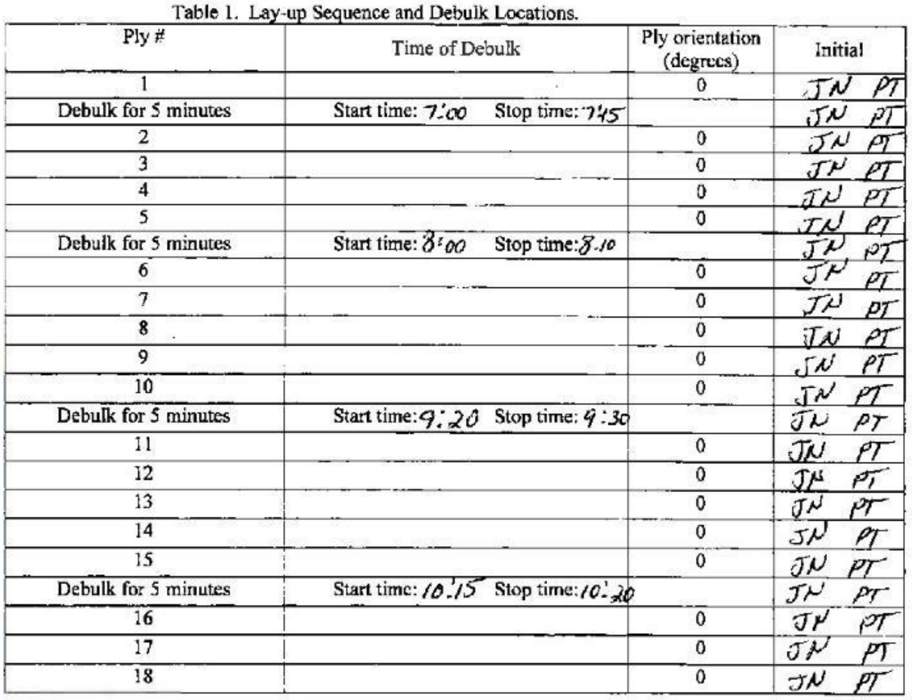


Figure 1. Rosette Location

3. Lay up plies of IM7/TC350 prepreg placed in the sequence listed in table 1. A vacuum debulk should always be performed after the 1st ply and at 5 ply intervals thereafter. After final debulk, repeat process for the second face sheet.

INITIALS: JN

Table 1. Lay-up Sequence and Debulk Locations.



Ply #	Time of Debulk	Ply orientation (degrees)	Initial
1		0	JN PT
Debulk for 5 minutes	Start time: 7:00 Stop time: 745		JN PT
2		0	JN PT
3		0	JN PT
4		0	JN PT
5		0	JN PT
Debulk for 5 minutes	Start time: 8:00 Stop time: 8.10		JN PT
6		0	JN PT
7		0	JN PT
8		0	JN PT
9		0	JN PT
10		0	JN PT
Debulk for 5 minutes	Start time: 9:20 Stop time: 9:30		JN PT
11		0	JN PT
12		0	JN PT
13		0	JN PT
14		0	JN PT
15		0	JN PT
Debulk for 5 minutes	Start time: 10:15 Stop time: 10:20		JN PT
16		0	JN PT
17		0	JN PT
18		0	JN PT

Lay-Up & Bagging

Bagging Sequence for Cure:

List of materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone/Rubber Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string - (alternatively or additionally breather may wrap over top of dam to contact edge)

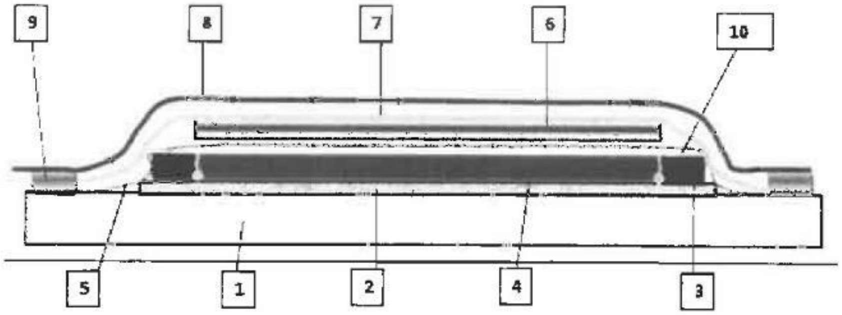


Figure 3. Lay Up

1. Follow Figure 3 as a guide to panel lay up materials and layer sequence. Ensure curing plate has been solvent wiped to remove potential contaminants using MEK or acetone and clean lint free wipes. Wipe in a linear motion to prevent recontamination.
INITIALS: JN

2. Install thermocouple to monitor the temperature of the part during cure. Bag part per Figure 3. Before bagging an EM40 engineer must check and sign off.
INITIALS: JN EM40 ENGINEER INTIALS: BwC

3. Encompass lay up in vacuum bag in preparation for cure cycle. Pull vacuum at 25 inHg minimum. Leak check vacuum bag by disconnecting the vacuum line and installing a vacuum gauge. Ensure that the leak rate does not exceed 1.0 inHg after five minutes. If leak is detected completely replace vacuum bag and repeat process.

4. Keep track of which thermocouple wire number is assigned to this panel during the cure by noting here:
#4 Rear of clave between Lay-up Table and Panel.
#5 Front of clave between Kaul Plate and panel.

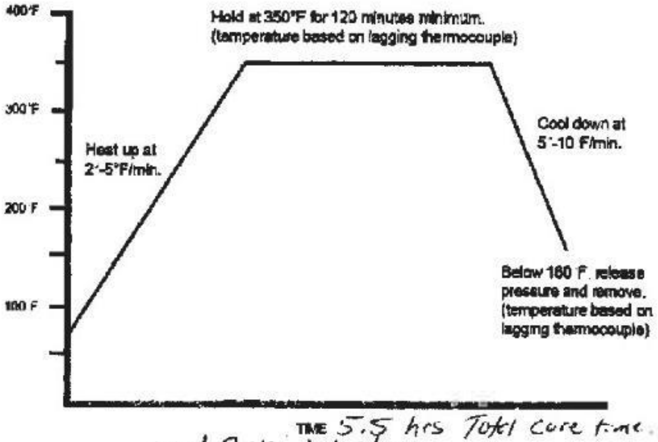
5. Cure times and temperature shall be recorded using the autoclave data recorder for traceability. Print the recorded cure cycle profile and attach it to the Shop Traveler. Cure the panel using the autoclave per the following cure cycle:

- 75° to 350° @ 3°/min ~= 1 hour 30 min
- 350° hold ~= 2 hour 0 min
- 350° to 75° @ 5°/min ~= 60 min

Pathfinder Panel Cure Cycle

· **Autoclave cure at 90 - 100 psi**

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle



5.5 hrs Total cure time.
used 9x12 Autoclave.

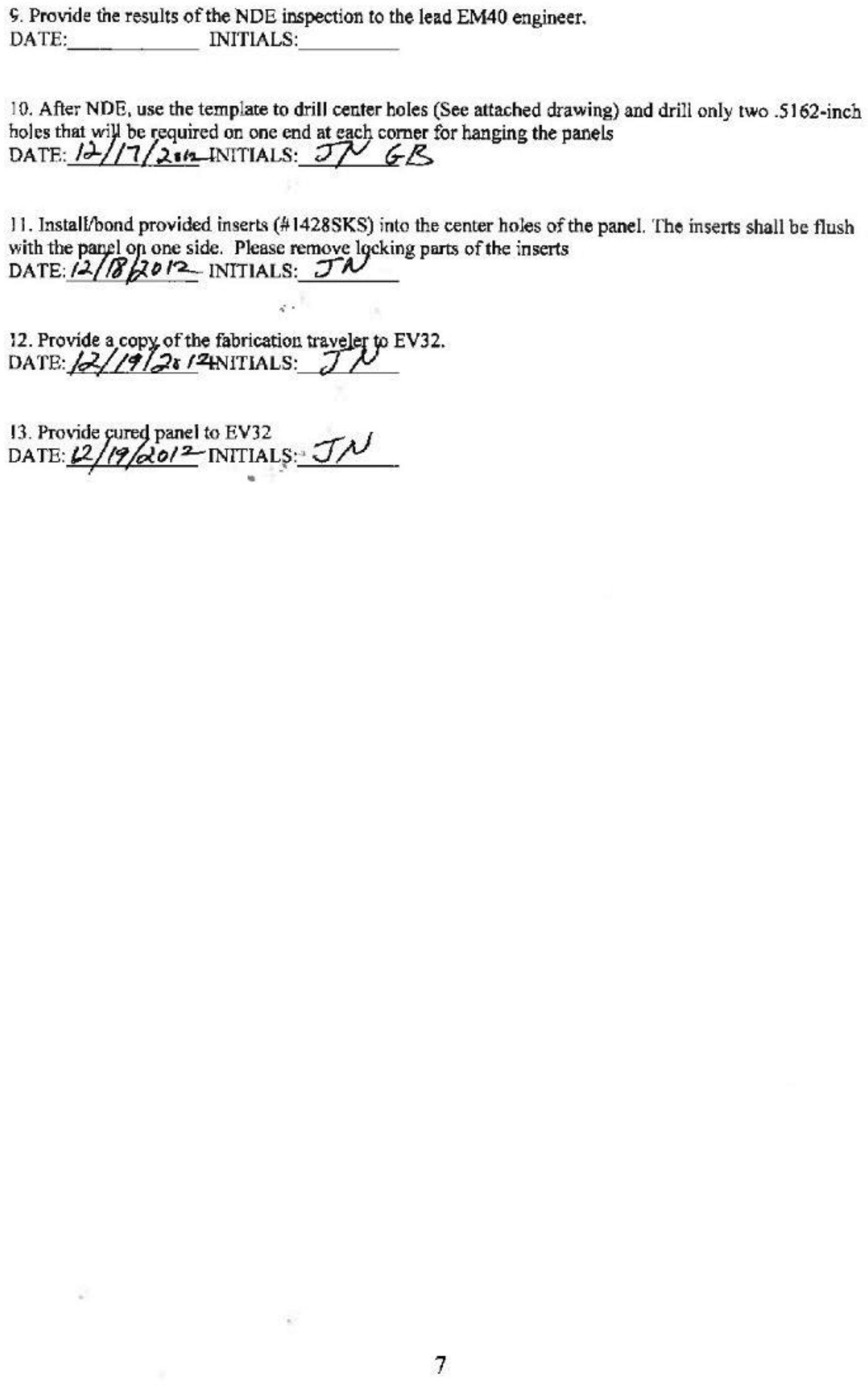
6. Remove all sharp edges from the as-cured panels using a file, rasp, or abrasive paper. Mark with panel identification, core ribbon direction, 0° orientation, 1.0" from the edge of the panel using a paint pen.

7. Record all anomalies or process deviations below and coordinate with EM40 Lead Engineer:
None

DATE: 11/28/2012 INITIALS: JN

8. Deliver cured panel to EM20 for NDE inspection. Attach results of inspection to the end of this Work Traveller.
DATE: 11/28/2012 INITIALS: JN

6



9. Provide the results of the NDE inspection to the lead EM40 engineer.
DATE:_____________ INITIALS:__________

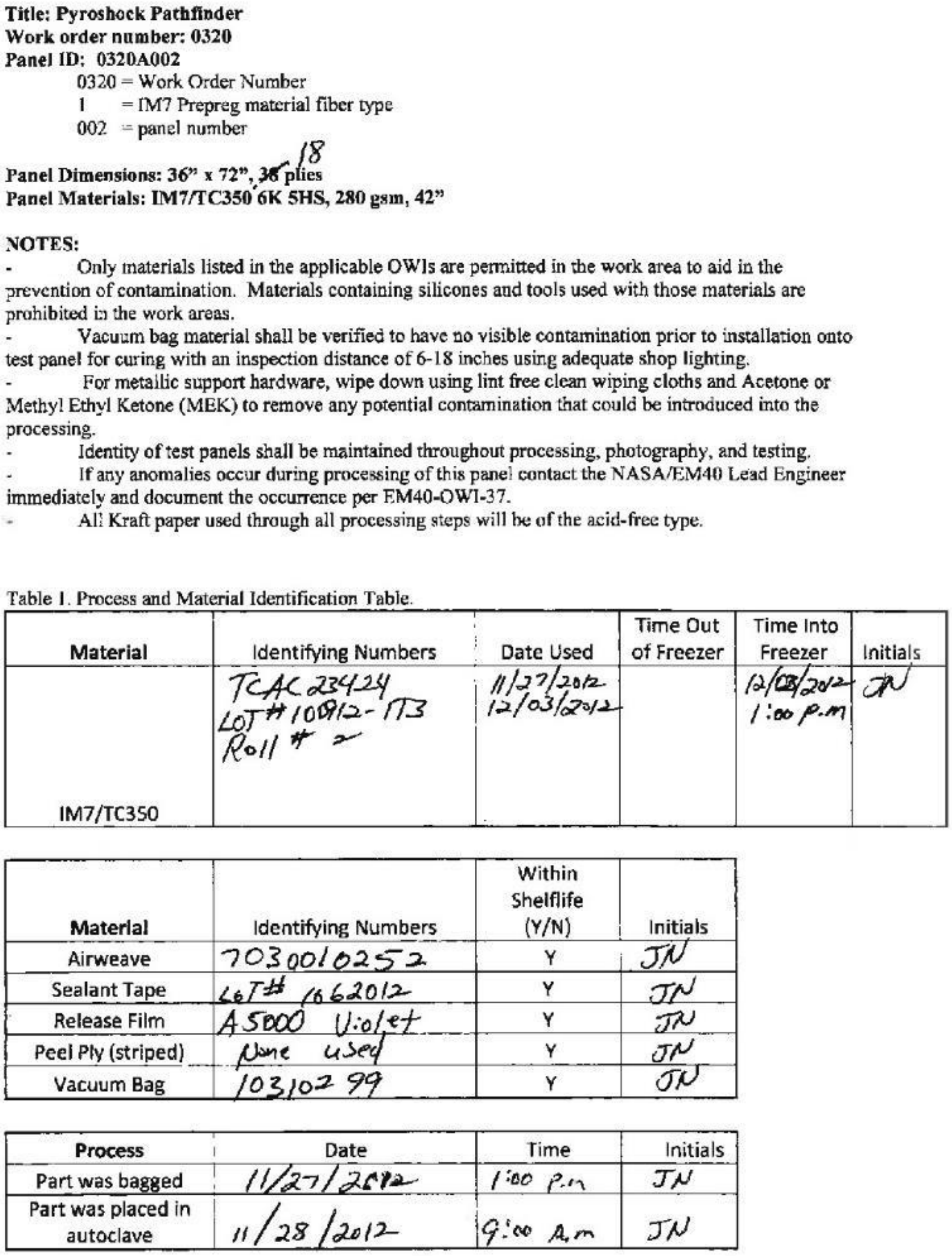
10. After NDE, use the template to drill center holes (See attached drawing) and drill only two .5162-inch holes that will be required on one end at each corner for hanging the panels
DATE: 12/17/2012 INITIALS: JN GB

11. Install/bond provided inserts (#1428SKS) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts
DATE: 12/18/2012 INITIALS: JN

12. Provide a copy of the fabrication traveler to EV32.
DATE: 12/19/2012 INITIALS: JN

13. Provide cured panel to EV32
DATE: 12/19/2012 INITIALS: JN

7



Title: Pyroshock Pathfinder
Work order number: 0320
Panel ID: 0320A002
0320 = Work Order Number
1 = IM7 Prepreg material fiber type
002 = panel number

Panel Dimensions: 36" x 72", ~~38~~ 18 plies
Panel Materials: IM7/TC350 6K 5HS, 280 gsm, 42"

NOTES:

- Only materials listed in the applicable OWIs are permitted in the work area to aid in the prevention of contamination. Materials containing silicones and tools used with those materials are prohibited in the work areas.
- Vacuum bag material shall be verified to have no visible contamination prior to installation onto test panel for curing with an inspection distance of 6-18 inches using adequate shop lighting.
- For metallic support hardware, wipe down using lint free clean wiping cloths and Acetone or Methyl Ethyl Ketone (MEK) to remove any potential contamination that could be introduced into the processing.
- Identity of test panels shall be maintained throughout processing, photography, and testing.
- If any anomalies occur during processing of this panel contact the NASA/EM40 Lead Engineer immediately and document the occurrence per EM40-OWI-37.
- All Kraft paper used through all processing steps will be of the acid-free type.

Table 1. Process and Material Identification Table.

Material	Identifying Numbers	Date Used	Time Out of Freezer	Time Into Freezer	Initials
IM7/TC350	TCAC 23424 LOT# 100912-1T3 Roll # 2	11/27/2012 12/03/2012		12/03/2012 1:00 p.m	JN

Material	Identifying Numbers	Within Shelflife (Y/N)	Initials
Airweave	7030010252	Y	JN
Sealant Tape	LOT# 1062012	Y	JN
Release Film	A5000 Violet	Y	JN
Peel Ply (striped)	None used	Y	JN
Vacuum Bag	10310299	Y	JN

Process	Date	Time	Initials
Part was bagged	11/27/2012	1:00 p.m	JN
Part was placed in autoclave	11/28/2012	9:00 A.m	JN

Prepreg/Adhesive Preparation

1. Place lint and powder free latex gloves on when handling prepreg at all times.
INITIALS JN

2. Record out time on NMIH label when removing any frozen material, If label is full, attach another label adjacent to the previous one. Weigh prepreg/adhesive rolls and jot number next to out time also fill out this info in table 1.

3. Allow 4 hours to thaw for large prepreg rolls. Return material to freezer immediately after cutting for your panel to minimize out time.

4. Record ambient temperature and humidity below.
Temperature 72 °F
Humidity 45 %RH

Laminate Construction

1. Environment requirements for temperature and humidity for all steps of lay-up shall be maintained during the operation per the following:

Temperature = 70 +/- 5°F
Humidity = 40 – 55%
INITIALS: JN

2. Cut a piece of solid release film that is larger than the cut plies. Label the film with the panel ID along with the 0°, 45° and the 90° ply directional rosette on the edge of the film. Placement of rosette should be placed as seen below. Place the release film on top of the baseplate tool shown in Figure 3.

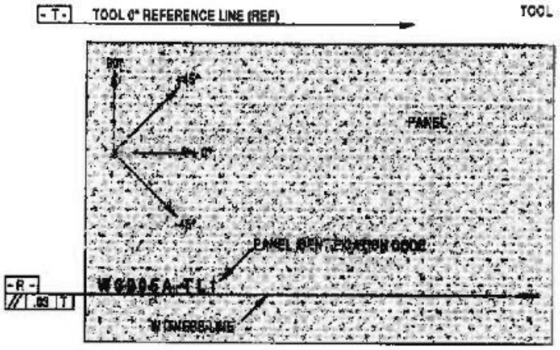


Figure 1. Rosette Location

3. Lay up plies of IM7/TC350 prepreg placed in the sequence listed in table 1. A vacuum debulk should always be performed after the 1st ply and at 5 ply intervals thereafter. After final debulk, repeat process for the second face sheet.
INITIALS: JN

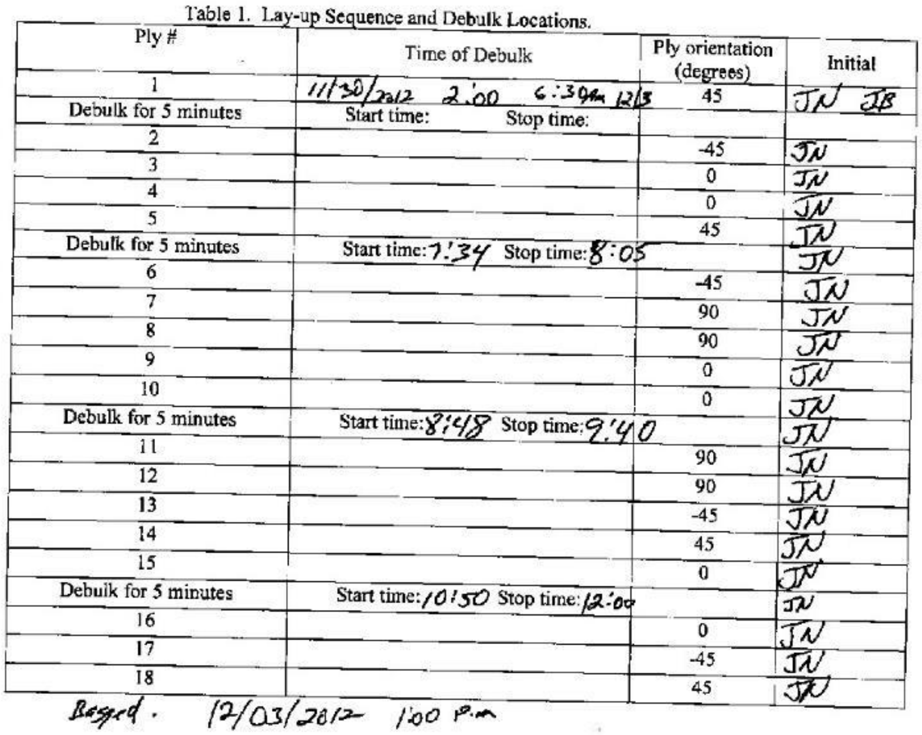
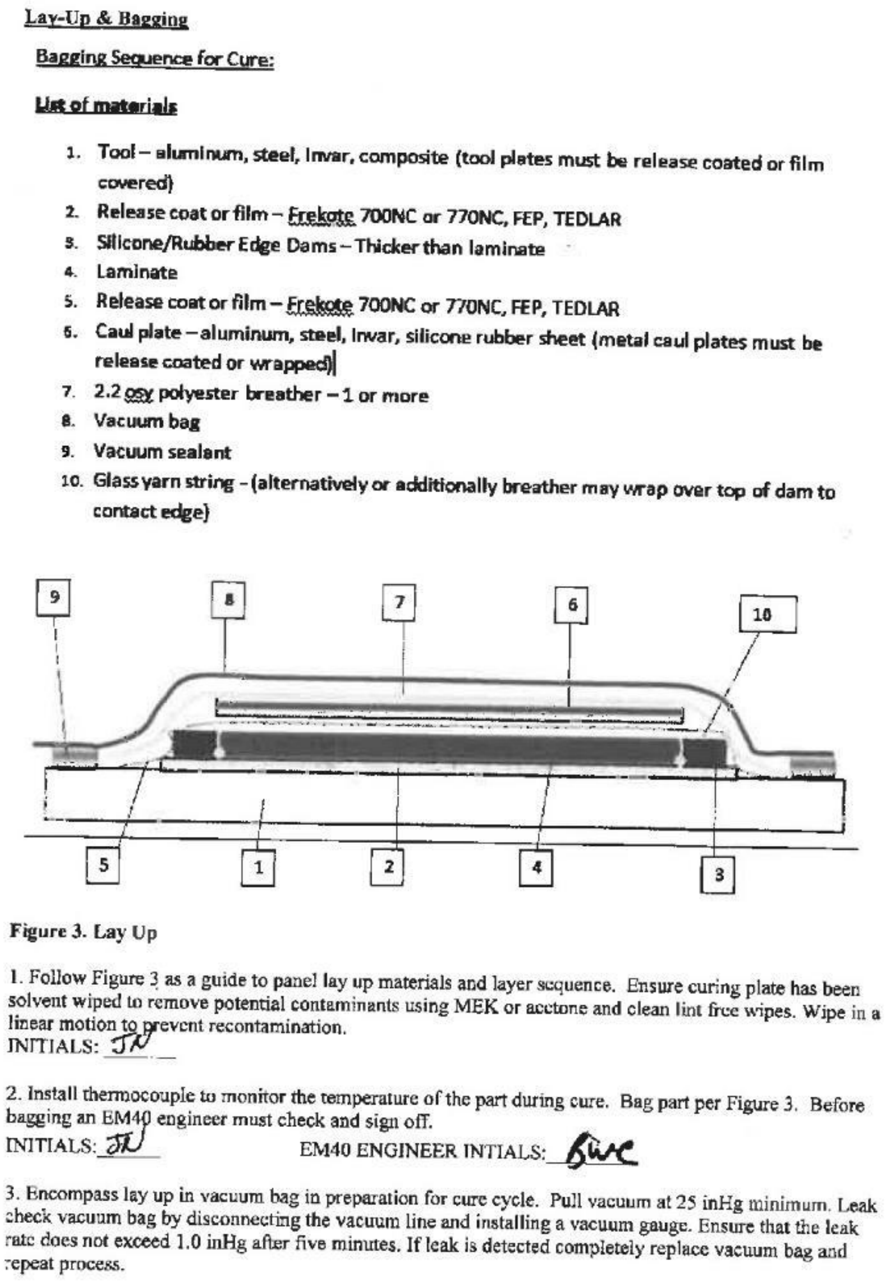


Table 1. Lay-up Sequence and Debulk Locations.

Ply #	Time of Debulk	Ply orientation (degrees)	Initial
1	11/30/2012 2:00 6:30am 12/3	45	JN JB
Debulk for 5 minutes	Start time: Stop time:		
2		-45	JN
3		0	JN
4		0	JN
5		45	JN
Debulk for 5 minutes	Start time: 7:34 Stop time: 8:05		JN
6		-45	JN
7		90	JN
8		90	JN
9		0	JN
10		0	JN
Debulk for 5 minutes	Start time: 8:48 Stop time: 9:40		JN
11		90	JN
12		90	JN
13		-45	JN
14		45	JN
15		0	JN
Debulk for 5 minutes	Start time: 10:50 Stop time: 12:00		JN
16		0	JN
17		-45	JN
18		45	JN

Bagged. 12/03/2012 1:00 P.m



Lay-Up & Bagging

Bagging Sequence for Cure:

List of materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone/Rubber Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string – (alternatively or additionally breather may wrap over top of dam to contact edge)

Figure 3. Lay Up

1. Follow Figure 3 as a guide to panel lay up materials and layer sequence. Ensure curing plate has been solvent wiped to remove potential contaminants using MEK or acetone and clean lint free wipes. Wipe in a linear motion to prevent recontamination.
INITIALS: JN

2. Install thermocouple to monitor the temperature of the part during cure. Bag part per Figure 3. Before bagging an EM40 engineer must check and sign off.
INITIALS: JN EM40 ENGINEER INTIALS: Bwc

3. Encompass lay up in vacuum bag in preparation for cure cycle. Pull vacuum at 25 inHg minimum. Leak check vacuum bag by disconnecting the vacuum line and installing a vacuum gauge. Ensure that the leak rate does not exceed 1.0 inHg after five minutes. If leak is detected completely replace vacuum bag and repeat process.

4. Keep track of which thermocouple wire number is assigned to this panel during the cure by noting here:
#_#4 Tool
#5 Panel

5. Cure times and temperature shall be recorded using the autoclave data recorder for traceability. Print the recorded cure cycle profile and attach it to the Shop Traveler. Cure the panel using the autoclave per the following cure cycle:

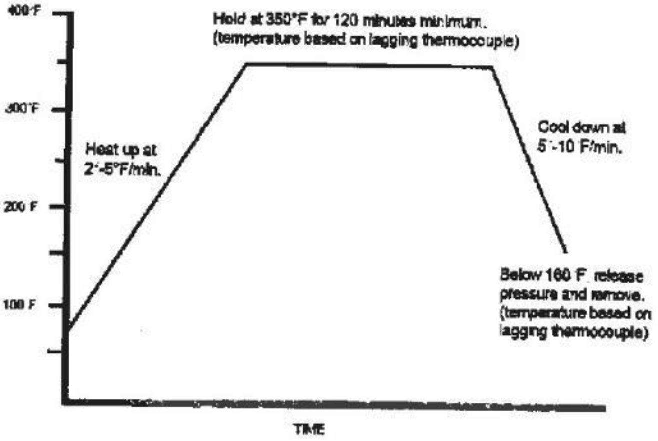
- 75° to 350° @ 3°/min ~= 1 hour 30 min
- 350° hold ~= 2 hour 0 min
- 350° to 75° @ 5°/min ~= 60 min

Pathfinder Panel Cure Cycle

· **Autoclave cure at 90 - 100 psi**

File Name: Pyroshock Pathfinder 0320A002.CSV

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle



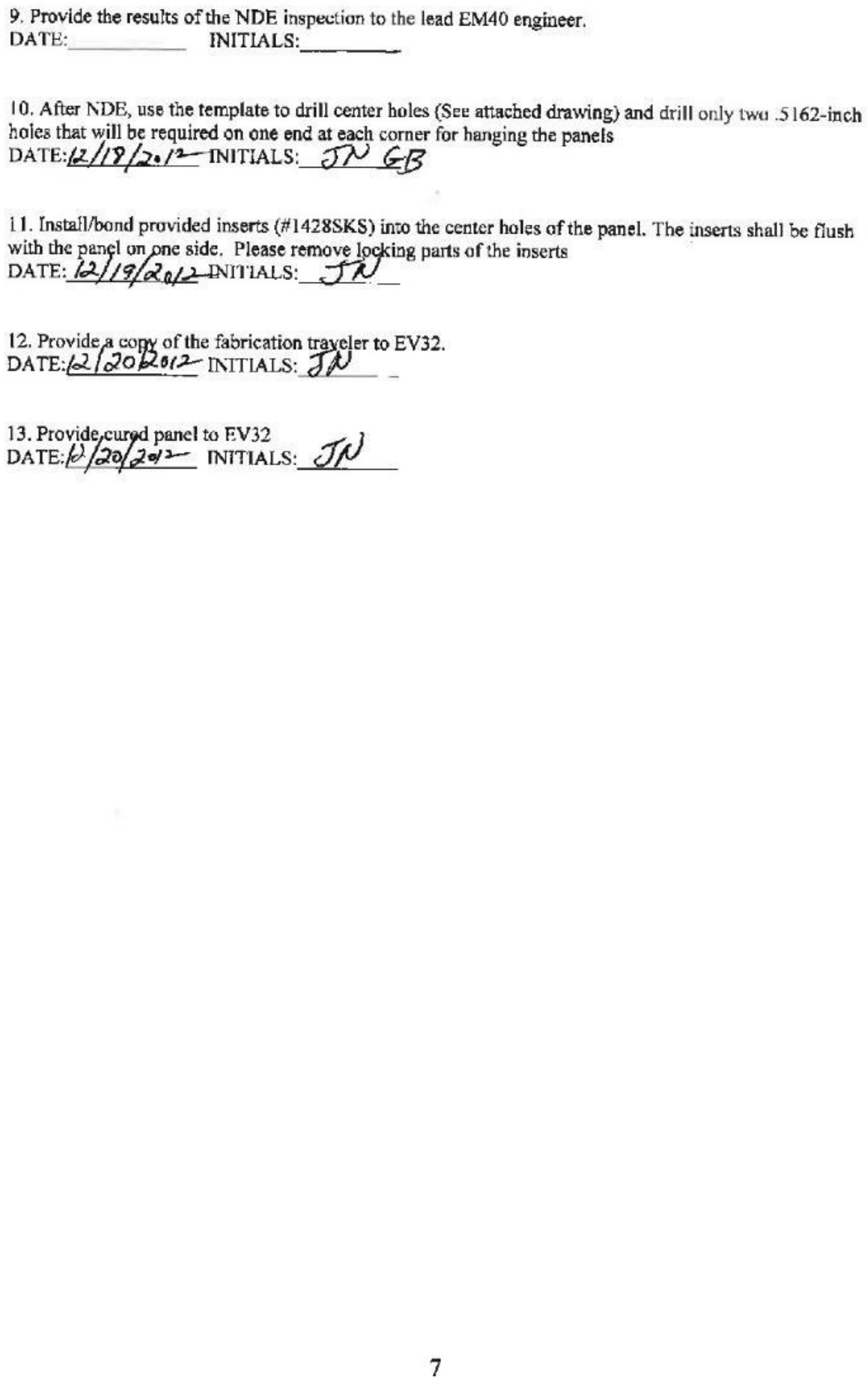
6. Remove all sharp edges from the as-cured panels using a file, rasp, or abrasive paper. Mark with panel identification, core ribbon direction, 0° orientation, 1.0" from the edge of the panel using a paint pen.

7. Record all anomalies or process deviations below and coordinate with EM40 Lead Engineer:

None

DATE: 12/04/2012 INITIALS: JN

8. Deliver cured panel to EM20 for NDE inspection. Attach results of inspection to the end of this Work Traveller.
DATE: 12/05/2012 INITIALS: JN



9. Provide the results of the NDE inspection to the lead EM40 engineer.
DATE:__________ INITIALS:__________

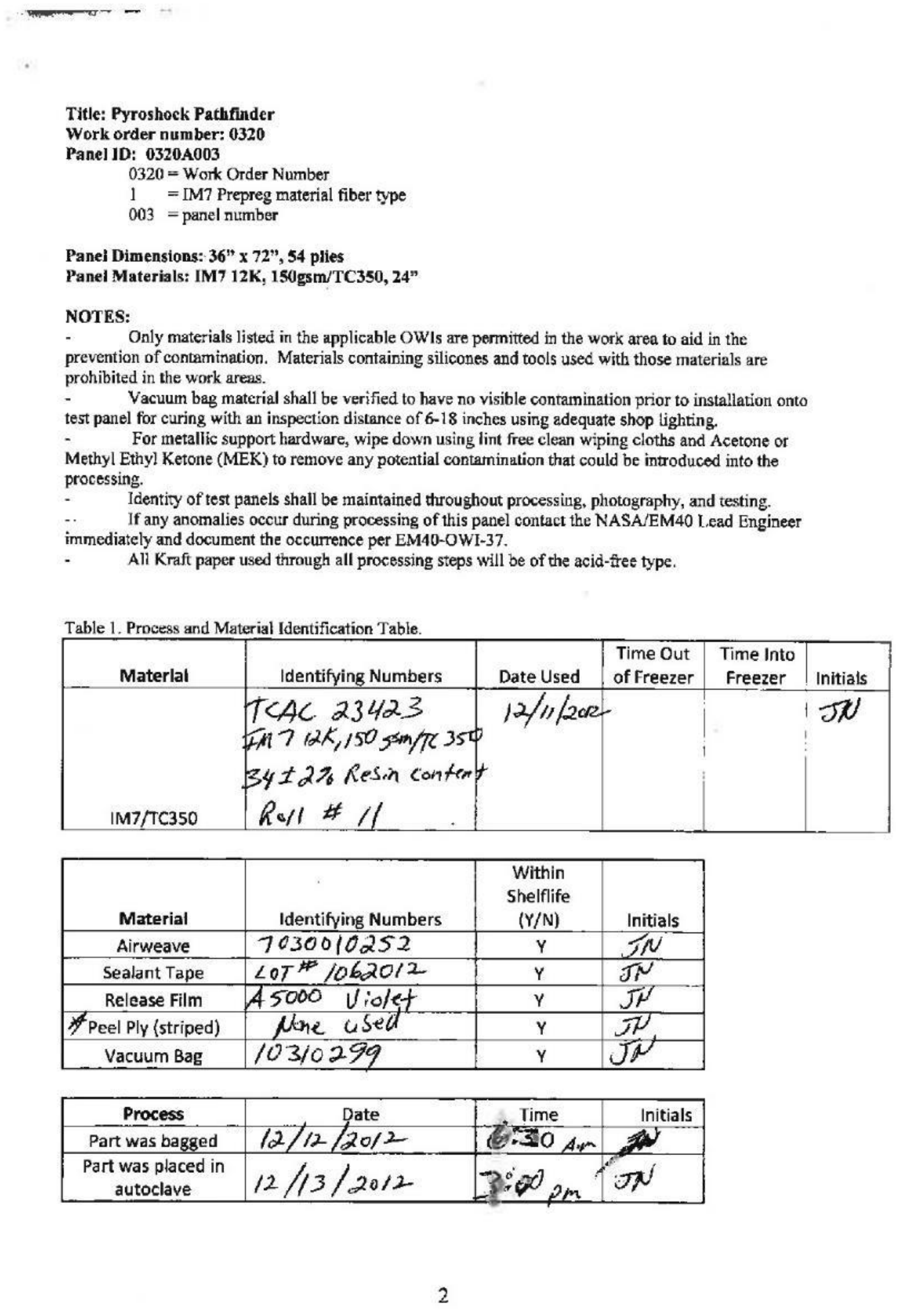
10. After NDE, use the template to drill center holes (See attached drawing) and drill only two .5162-inch holes that will be required on one end at each corner for hanging the panels
DATE: 12/18/2012 INITIALS: JN GB

11. Install/bond provided inserts (#1428SKS) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts
DATE: 12/19/2012 INITIALS: JN

12. Provide a copy of the fabrication traveler to EV32.
DATE: 12/20/2012 INITIALS: JN

13. Provide cured panel to EV32
DATE: 12/20/2012 INITIALS: JN

7



Title: Pyroshock Pathfinder
Work order number: 0320
Panel ID: 0320A003
0320 = Work Order Number
1 = IM7 Prepreg material fiber type
003 = panel number

Panel Dimensions: 36" x 72", 54 plies
Panel Materials: IM7 12K, 150gsm/TC350, 24"

NOTES:

- Only materials listed in the applicable OWIs are permitted in the work area to aid in the prevention of contamination. Materials containing silicones and tools used with those materials are prohibited in the work areas.
- Vacuum bag material shall be verified to have no visible contamination prior to installation onto test panel for curing with an inspection distance of 6-18 inches using adequate shop lighting.
- For metallic support hardware, wipe down using lint free clean wiping cloths and Acetone or Methyl Ethyl Ketone (MEK) to remove any potential contamination that could be introduced into the processing.
- Identity of test panels shall be maintained throughout processing, photography, and testing.
- If any anomalies occur during processing of this panel contact the NASA/EM40 Lead Engineer immediately and document the occurrence per EM40-OWI-37.
- All Kraft paper used through all processing steps will be of the acid-free type.

Table 1. Process and Material Identification Table.

Material	Identifying Numbers	Date Used	Time Out of Freezer	Time Into Freezer	Initials
IM7/TC350	TCAC 23423 IM7 12K, 150 gsm/TC 350 34 ± 2% Resin content Roll # 11	12/11/2012			JN

Material	Identifying Numbers	Within Shelflife (Y/N)	Initials
Airweave	7030010252	Y	JN
Sealant Tape	LOT # 1062012	Y	JN
Release Film	A5000 Violet	Y	JN
# Peel Ply (striped)	None used	Y	JN
Vacuum Bag	10310299	Y	JN

Process	Date	Time	Initials
Part was bagged	12/12/2012	6:30 Am	JN
Part was placed in autoclave	12/13/2012	3:00 pm	JN

2

Prepreg/Adhesive Preparation

1. Place lint and powder free latex gloves on when handling prepreg at all times.
INITIALS JN

2. Record out time on NMIH label when removing any frozen material, If label is full, attach another label adjacent to the previous one. Weigh prepreg/adhesive rolls and jot number next to out time also fill out this info in table 1.

3. Allow 4 hours to thaw for large prepreg rolls. Return material to freezer immediately after cutting for your panel to minimize out time.

4. Record ambient temperature and humidity below.
Temperature 73°F
Humidity 50% RH

Laminate Construction

1. Environment requirements for temperature and humidity for all steps of lay-up shall be maintained during the operation per the following:

Temperature = 70 +/- 5°F
Humidity = 40 – 55%
INITIALS: JN

2. Cut a piece of solid release film that is larger than the cut plies. Label the film with the panel ID along with the 0°, 45° and the 90° ply directional rosette on the edge of the film. Placement of rosette should be placed as seen below. Place the release film on top of the baseplate tool shown in Figure 3.

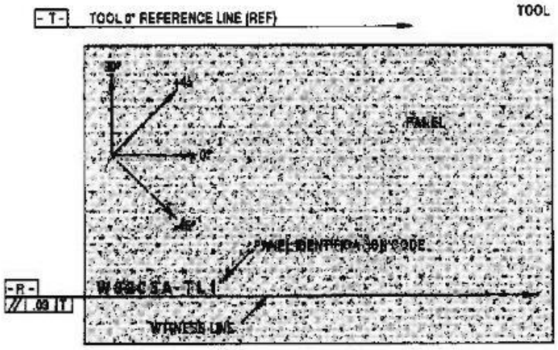


Figure 1. Rosette Location

3. Lay up plies of the material placed in the sequence listed in table 1. A vacuum debulk should always be performed after the 1st ply and at 5 ply intervals thereafter. After final debulk, repeat process for the second face sheet.
INITIALS: JN TT

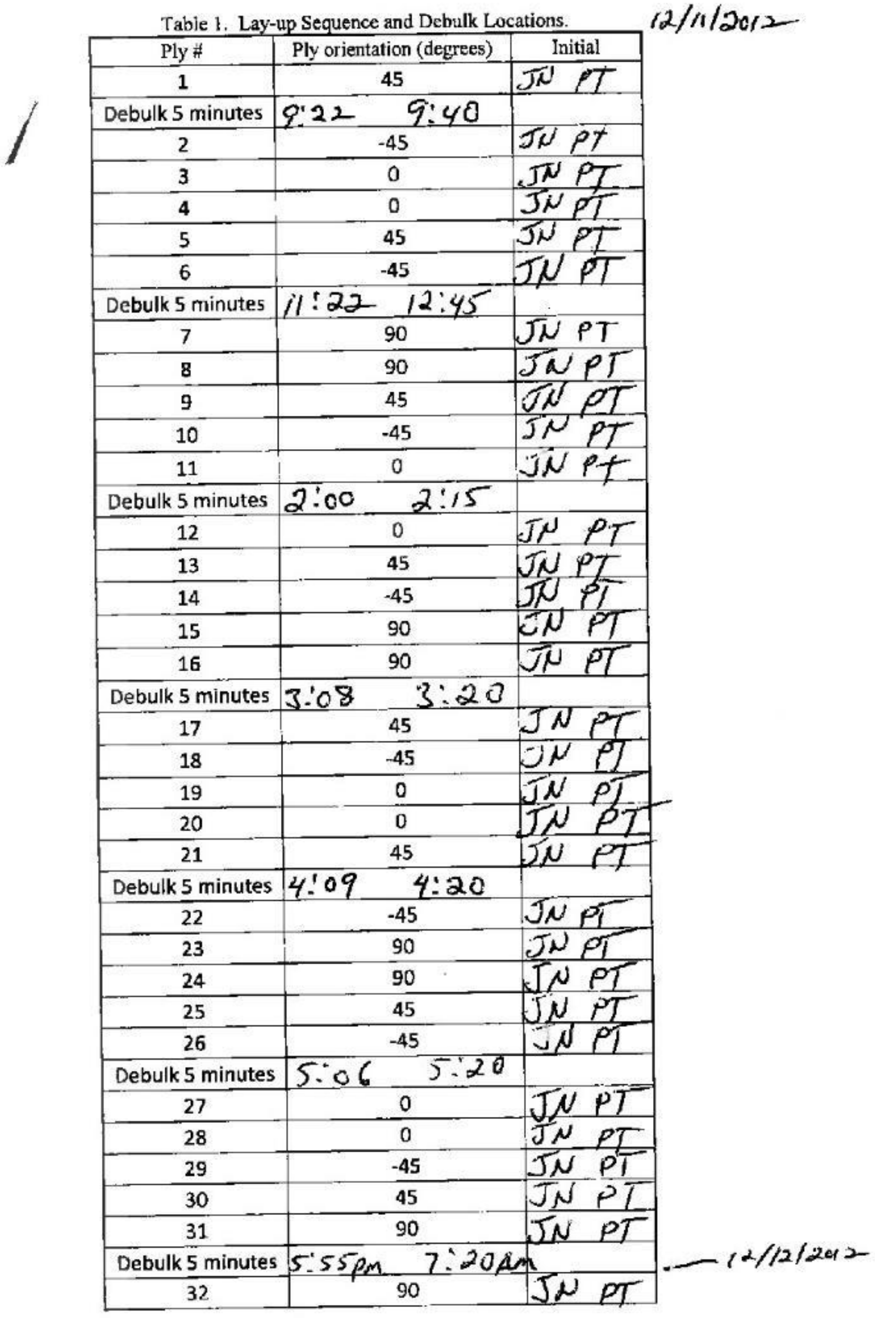
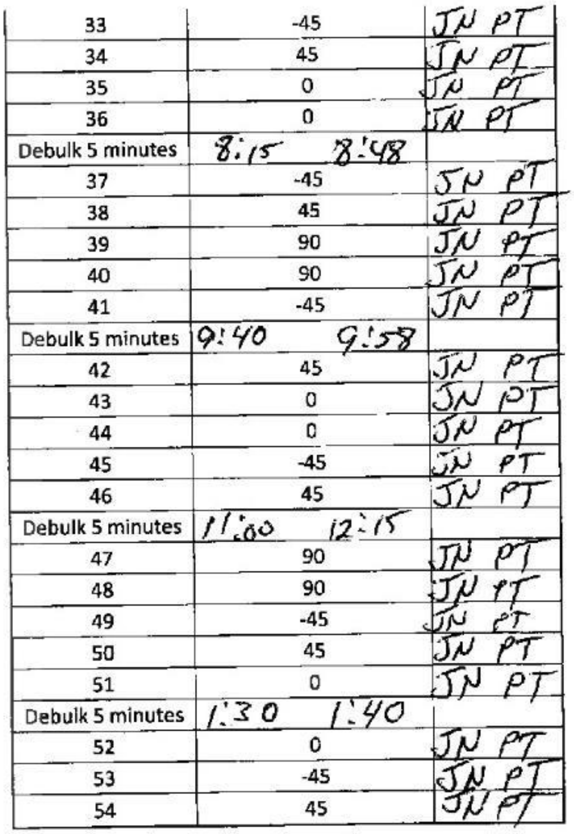


Table 1. Lay-up Sequence and Debulk Locations. 12/11/2012

Ply #	Ply orientation (degrees)	Initial
1	45	JN PT
Debulk 5 minutes	9:22 9:40	
2	-45	JN PT
3	0	JN PT
4	0	JN PT
5	45	JN PT
6	-45	JN PT
Debulk 5 minutes	11:22 12:45	
7	90	JN PT
8	90	JN PT
9	45	JN PT
10	-45	JN PT
11	0	JN PT
Debulk 5 minutes	2:00 2:15	
12	0	JN PT
13	45	JN PT
14	-45	JN PT
15	90	JN PT
16	90	JN PT
Debulk 5 minutes	3:08 3:20	
17	45	JN PT
18	-45	JN PT
19	0	JN PT
20	0	JN PT
21	45	JN PT
Debulk 5 minutes	4:09 4:20	
22	-45	JN PT
23	90	JN PT
24	90	JN PT
25	45	JN PT
26	-45	JN PT
Debulk 5 minutes	5:06 5:20	
27	0	JN PT
28	0	JN PT
29	-45	JN PT
30	45	JN PT
31	90	JN PT
Debulk 5 minutes	5:55pm 7:20AM	
32	90	JN PT

12/12/2012



33	-45	JN PT
34	45	JN PT
35	0	JN PT
36	0	JN PT
Debulk 5 minutes	8:15 8:48	
37	-45	JN PT
38	45	JN PT
39	90	JN PT
40	90	JN PT
41	-45	JN PT
Debulk 5 minutes	9:40 9:58	
42	45	JN PT
43	0	JN PT
44	0	JN PT
45	-45	JN PT
46	45	JN PT
Debulk 5 minutes	11:00 12:15	
47	90	JN PT
48	90	JN PT
49	-45	JN PT
50	45	JN PT
51	0	JN PT
Debulk 5 minutes	1:30 1:40	
52	0	JN PT
53	-45	JN PT
54	45	JN PT

5

Lay-Up & Bagging

Bagging Sequence for Cure:

List of materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone/Rubber Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string - (alternatively or additionally breather may wrap over top of dam to contact edge)

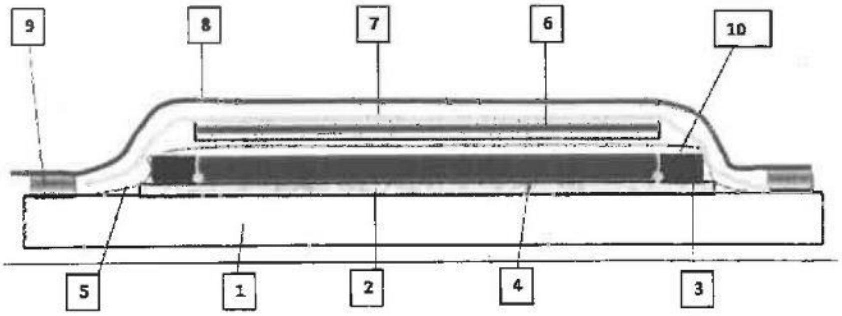
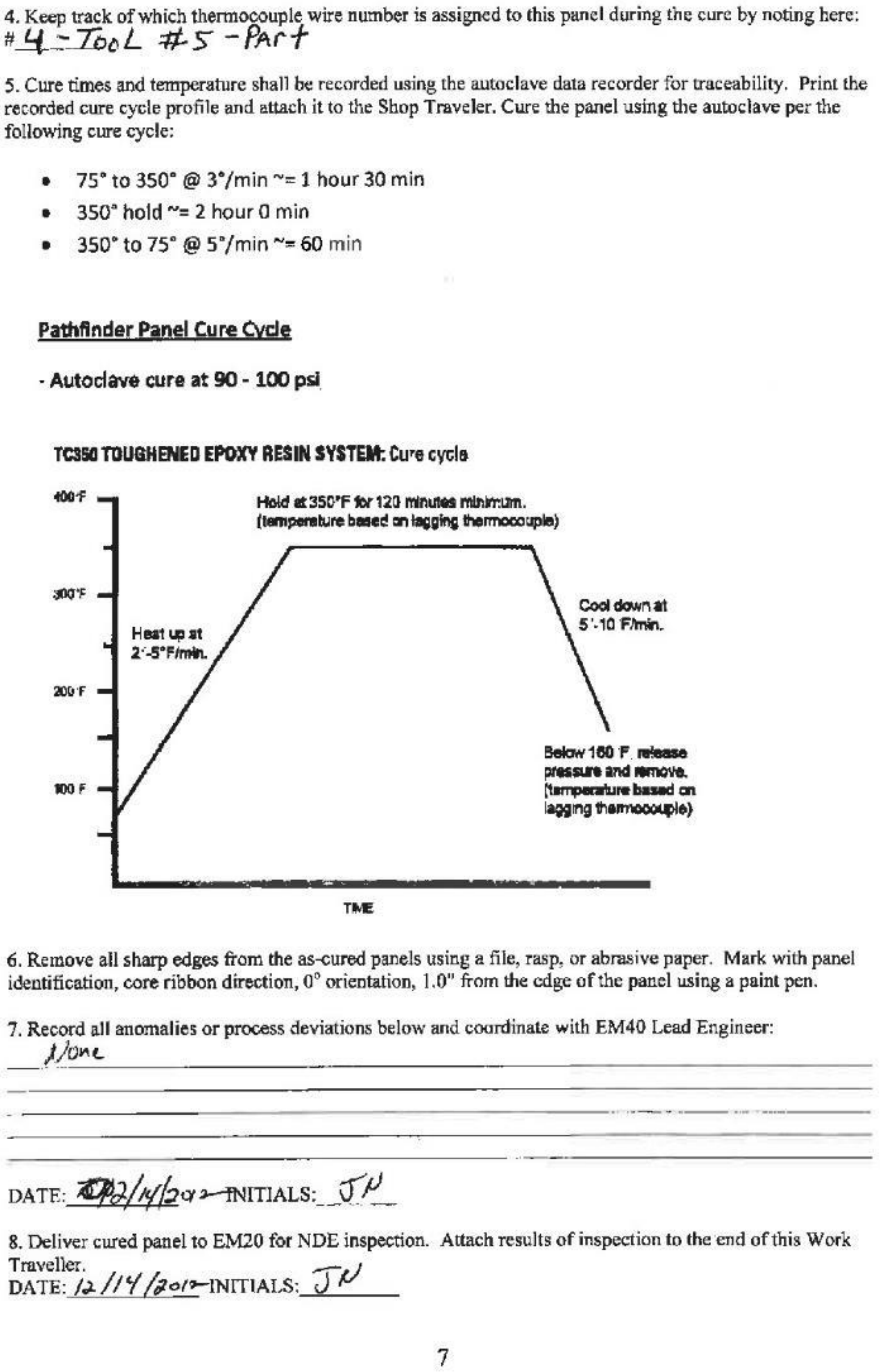


Figure 3. Lay Up

1. Follow Figure 3 as a guide to panel lay up materials and layer sequence. Ensure curing plate has been solvent wiped to remove potential contaminants using MEK or acetone and clean lint free wipes. Wipe in a linear motion to prevent recontamination.
INITIALS: JN PT

2. Install thermocouple to monitor the temperature of the part during cure. Bag part per Figure 3. Before bagging an EM40 engineer must check and sign off.
INITIALS: JNPT EM40 ENGINEER INTIALS: BWC

3. Encompass lay up in vacuum bag in preparation for cure cycle. Pull vacuum at 25 inHg minimum. Leak check vacuum bag by disconnecting the vacuum line and installing a vacuum gauge. Ensure that the leak rate does not exceed 1.0 inHg after five minutes. If leak is detected completely replace vacuum bag and repeat process.



4. Keep track of which thermocouple wire number is assigned to this panel during the cure by noting here:
#4 - Tool #5 - Part

5. Cure times and temperature shall be recorded using the autoclave data recorder for traceability. Print the recorded cure cycle profile and attach it to the Shop Traveler. Cure the panel using the autoclave per the following cure cycle:

- 75° to 350° @ 3°/min ~= 1 hour 30 min
- 350° hold ~= 2 hour 0 min
- 350° to 75° @ 5°/min ~= 60 min

Pathfinder Panel Cure Cycle

- Autoclave cure at 90 - 100 psi

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle

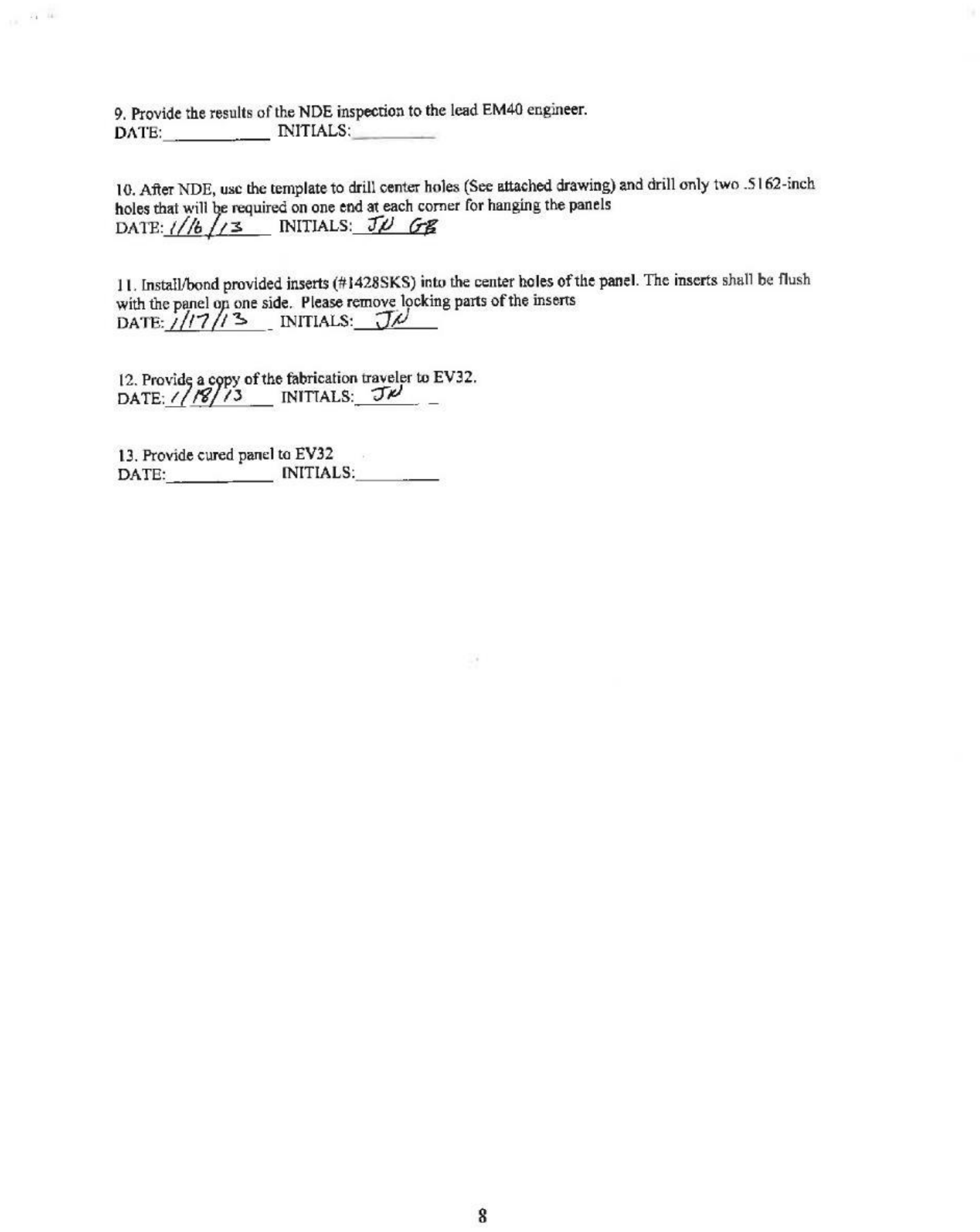
6. Remove all sharp edges from the as-cured panels using a file, rasp, or abrasive paper. Mark with panel identification, core ribbon direction, 0° orientation, 1.0" from the edge of the panel using a paint pen.

7. Record all anomalies or process deviations below and coordinate with EM40 Lead Engineer:
None

DATE: 12/14/2012 INITIALS: JN

8. Deliver cured panel to EM20 for NDE inspection. Attach results of inspection to the end of this Work Traveller.
DATE: 12/14/2012 INITIALS: JN

7



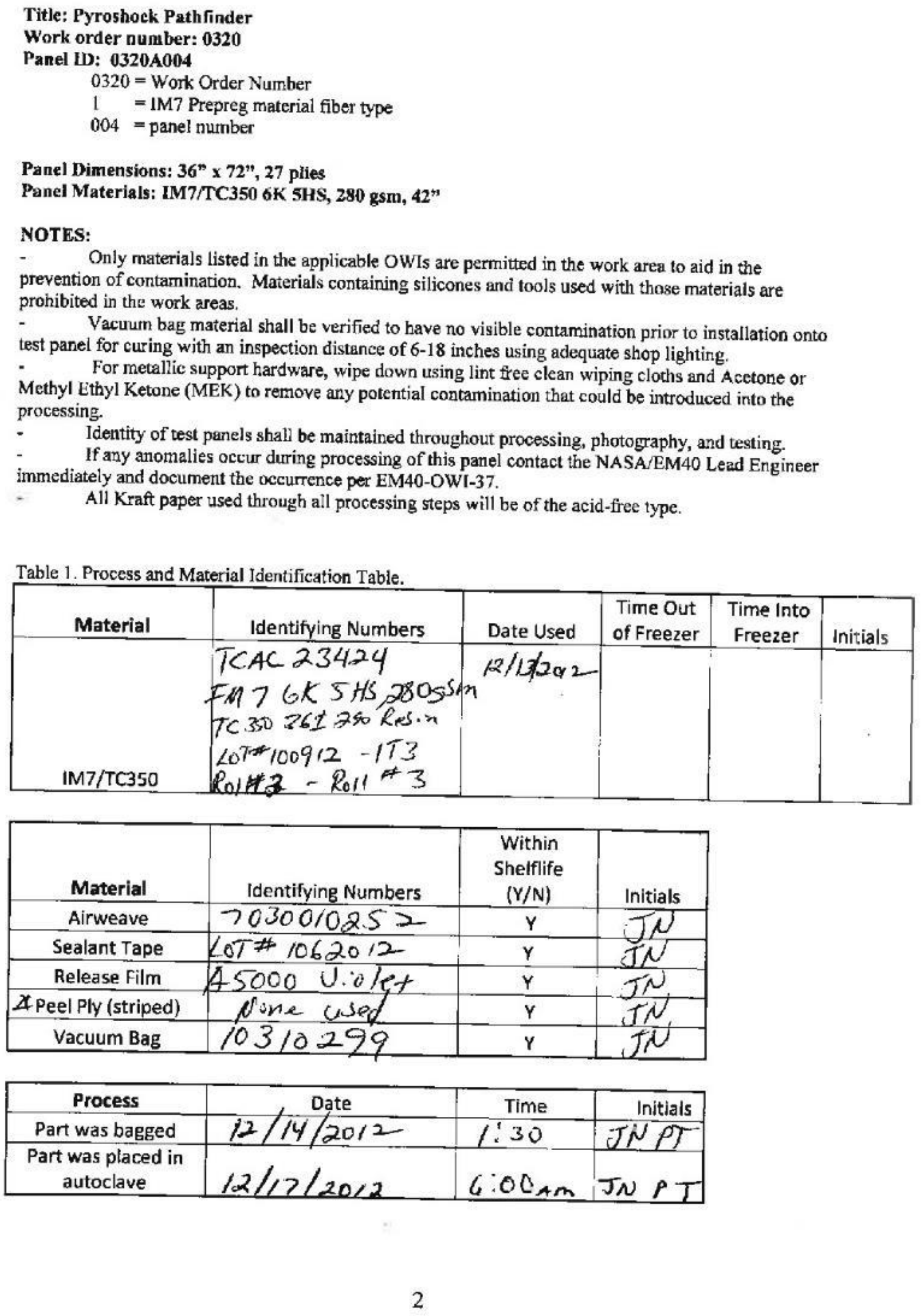
9. Provide the results of the NDE inspection to the lead EM40 engineer.
DATE:__________ INITIALS:__________

10. After NDE, use the template to drill center holes (See attached drawing) and drill only two .5162-inch holes that will be required on one end at each corner for hanging the panels
DATE: 1/16/13 INITIALS: JN GB

11. Install/bond provided inserts (#1428SKS) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts
DATE: 1/17/13 INITIALS: JN

12. Provide a copy of the fabrication traveler to EV32.
DATE: 1/18/13 INITIALS: JN

13. Provide cured panel to EV32
DATE:__________ INITIALS:__________



Title: Pyroshock Pathfinder
Work order number: 0320
Panel ID: 0320A004
0320 = Work Order Number
1 = IM7 Prepreg material fiber type
004 = panel number

Panel Dimensions: 36" x 72", 27 plies
Panel Materials: IM7/TC350 6K 5HS, 280 gsm, 42"

NOTES:

- Only materials listed in the applicable OWIs are permitted in the work area to aid in the prevention of contamination. Materials containing silicones and tools used with those materials are prohibited in the work areas.
- Vacuum bag material shall be verified to have no visible contamination prior to installation onto test panel for curing with an inspection distance of 6-18 inches using adequate shop lighting.
- For metallic support hardware, wipe down using lint free clean wiping cloths and Acetone or Methyl Ethyl Ketone (MEK) to remove any potential contamination that could be introduced into the processing.
- Identity of test panels shall be maintained throughout processing, photography, and testing.
- If any anomalies occur during processing of this panel contact the NASA/EM40 Lead Engineer immediately and document the occurrence per EM40-OWI-37.
- All Kraft paper used through all processing steps will be of the acid-free type.

Table 1. Process and Material Identification Table.

Material	Identifying Numbers	Date Used	Time Out of Freezer	Time Into Freezer	Initials
IM7/TC350	TCAC 23424 IM 7 6K 5HS, 280gsm TC350 261 250 Resin LOT#100912 -1T3 Roll#2 - Roll #3	12/13/2012			

Material	Identifying Numbers	Within Shelflife (Y/N)	Initials
Airweave	70300/0252	Y	JN
Sealant Tape	LOT# 1062012	Y	JN
Release Film	A5000 Violet	Y	JN
4 Peel Ply (striped)	None used	Y	JN
Vacuum Bag	10310299	Y	JN

Process	Date	Time	Initials
Part was bagged	12/14/2012	1:30	JN PT
Part was placed in autoclave	12/17/2012	6:00AM	JN PT

Prepreg/Adhesive Preparation

1. Place lint and powder free latex gloves on when handling prepreg at all times.
INITIALS JN

2. Record out time on NMIH label when removing any frozen material, If label is full, attach another label adjacent to the previous one. Weigh prepreg/adhesive rolls and jot number next to out time also fill out this info in table 1.

3. Allow 4 hours to thaw for large prepreg rolls. Return material to freezer immediately after cutting for your panel to minimize out time.

4. Record ambient temperature and humidity below.
Temperature 73 °F
Humidity 41% RH

Laminate Construction

1. Environment requirements for temperature and humidity for all steps of lay-up shall be maintained during the operation per the following:

Temperature = 70 +/- 5°F
Humidity = 40 – 55%
INITIALS: JN

2. Cut a piece of solid release film that is larger than the cut plies. Label the film with the panel ID along with the 0°, 45° and the 90° ply directional rosette on the edge of the film. Placement of rosette should be placed as seen below. Place the release film on top of the baseplate tool shown in Figure 3.

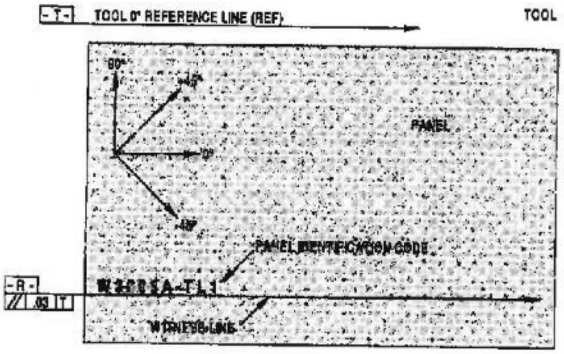


Figure 1. Rosette Location

3. Lay up plies of the material placed in the sequence listed in table 1. A vacuum debulk should always be performed after the 1st ply and at 5 ply intervals thereafter. After final debulk, repeat process for the second face sheet.
INITIALS: JN RT

3

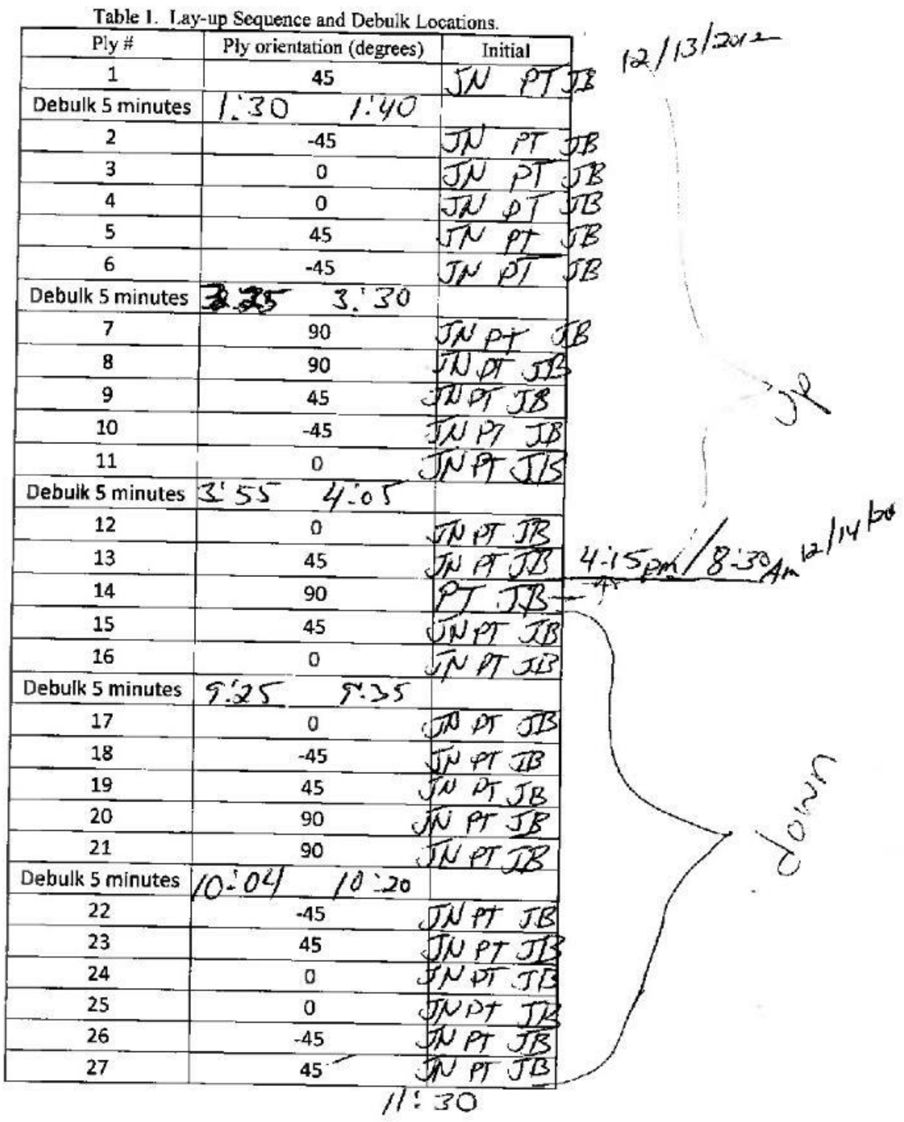


Table 1. Lay-up Sequence and Debulk Locations.

Ply #	Ply orientation (degrees)	Initial
1	45	JN PT JB
Debulk 5 minutes	1:30 1:40	
2	-45	JN PT JB
3	0	JN PT JB
4	0	JN PT JB
5	45	JN PT JB
6	-45	JN PT JB
Debulk 5 minutes	3:25 3:30	
7	90	JN PT JB
8	90	JN PT JB
9	45	JN PT JB
10	-45	JN PT JB
11	0	JN PT JB
Debulk 5 minutes	3:55 4:05	
12	0	JN PT JB
13	45	JN PT JB
14	90	PT JB
15	45	JN PT JB
16	0	JN PT JB
Debulk 5 minutes	9:25 9:35	
17	0	JN PT JB
18	-45	JN PT JB
19	45	JN PT JB
20	90	JN PT JB
21	90	JN PT JB
Debulk 5 minutes	10:04 10:20	
22	-45	JN PT JB
23	45	JN PT JB
24	0	JN PT JB
25	0	JN PT JB
26	-45	JN PT JB
27	45	JN PT JB

11:30

12/13/2012

up

4:15pm/8:30Am 12/14/20

down

Lay-Up & Bagging

Bagging Sequence for Cure:

List of materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone/Rubber Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string - (alternatively or additionally breather may wrap over top of dam to contact edge)

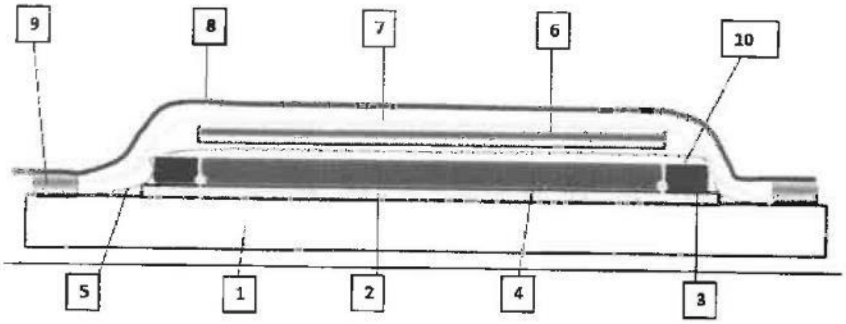


Figure 3. Lay Up

1. Follow Figure 3 as a guide to panel lay up materials and layer sequence. Ensure curing plate has been solvent wiped to remove potential contaminants using MEK or acetone and clean lint free wipes. Wipe in a linear motion to prevent recontamination.
INITIALS: JP

2. Install thermocouple to monitor the temperature of the part during cure. Bag part per Figure 3. Before bagging an EM40 engineer must check and sign off.
INITIALS: JP EM40 ENGINEER INTIALS:_______

3. Encompass lay up in vacuum bag in preparation for cure cycle. Pull vacuum at 25 inHg minimum. Leak check vacuum bag by disconnecting the vacuum line and installing a vacuum gauge. Ensure that the leak rate does not exceed 1.0 inHg after five minutes. If leak is detected completely replace vacuum bag and repeat process.

4. Keep track of which thermocouple wire number is assigned to this panel during the cure by noting here: #4-TOOL#5-Part

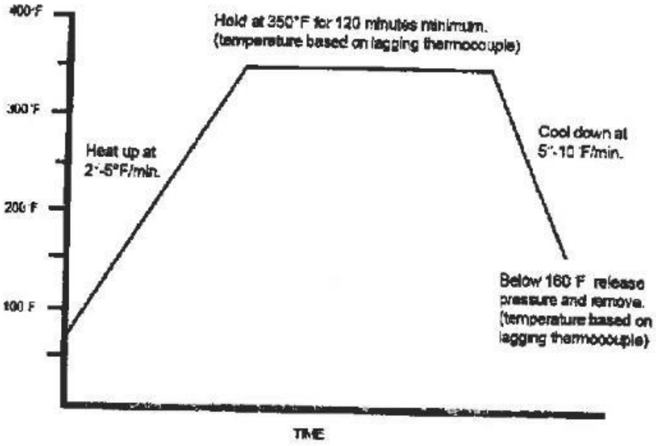
5. Cure times and temperature shall be recorded using the autoclave data recorder for traceability. Print the recorded cure cycle profile and attach it to the Shop Traveler. Cure the panel using the autoclave per the following cure cycle:

- 75° to 350° @ 3°/min ~= 1 hour 30 min
- 350° hold ~= 2 hour 0 min
- 350° to 75° @ 5°/min ~= 60 min

Pathfinder Panel Cure Cycle

· Autoclave cure at 90 - 100 psi

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle

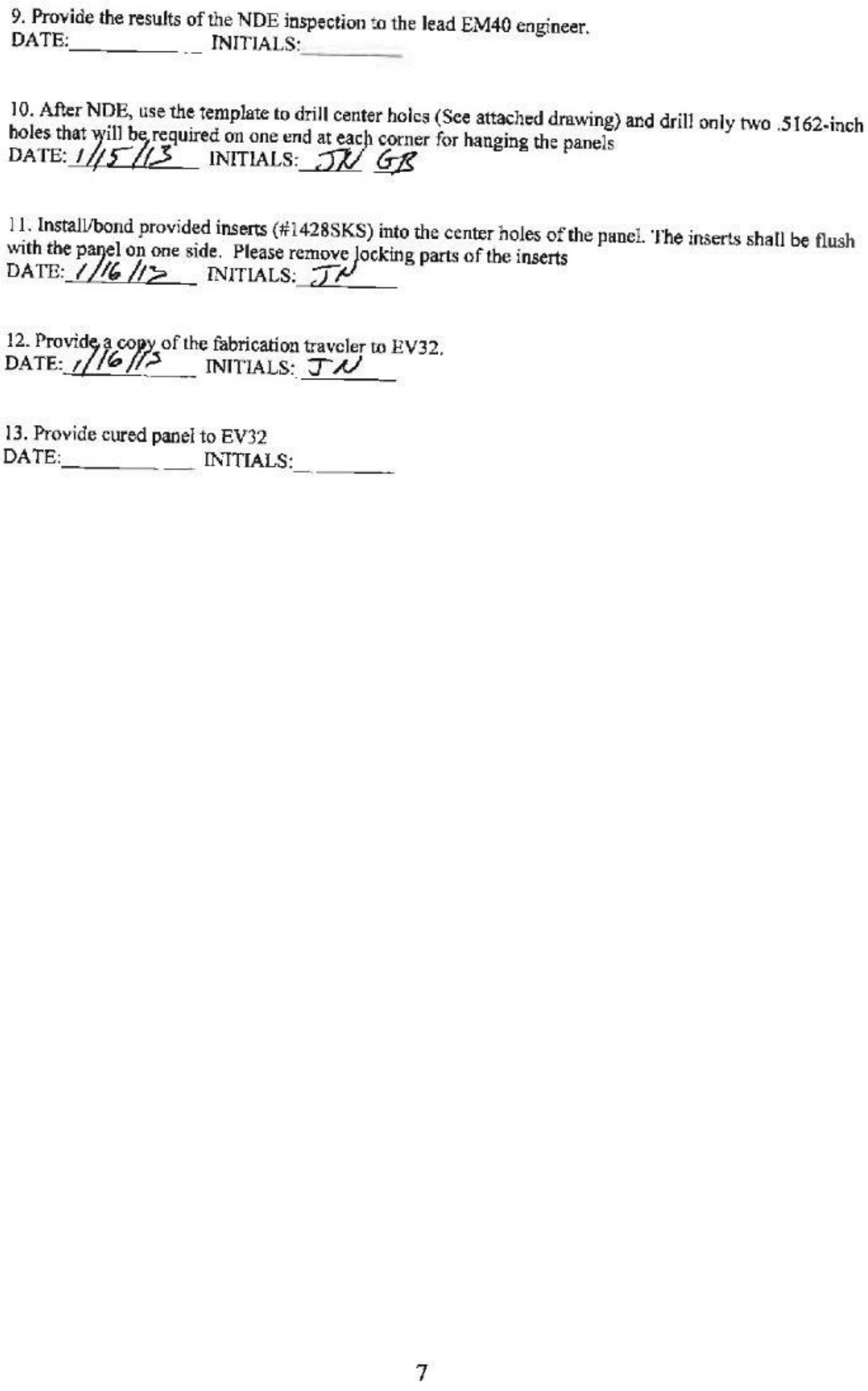


6. Remove all sharp edges from the as-cured panels using a file, rasp, or abrasive paper. Mark with panel identification, core ribbon direction, 0° orientation, 1.0" from the edge of the panel using a paint pen.

7. Record all anomalies or process deviations below and coordinate with EM40 Lead Engineer:

DATE: 12/17/12 INITIALS: P.T

8. Deliver cured panel to EM20 for NDE inspection. Attach results of inspection to the end of this Work Traveller.
DATE: 12/17/12 INITIALS: JN



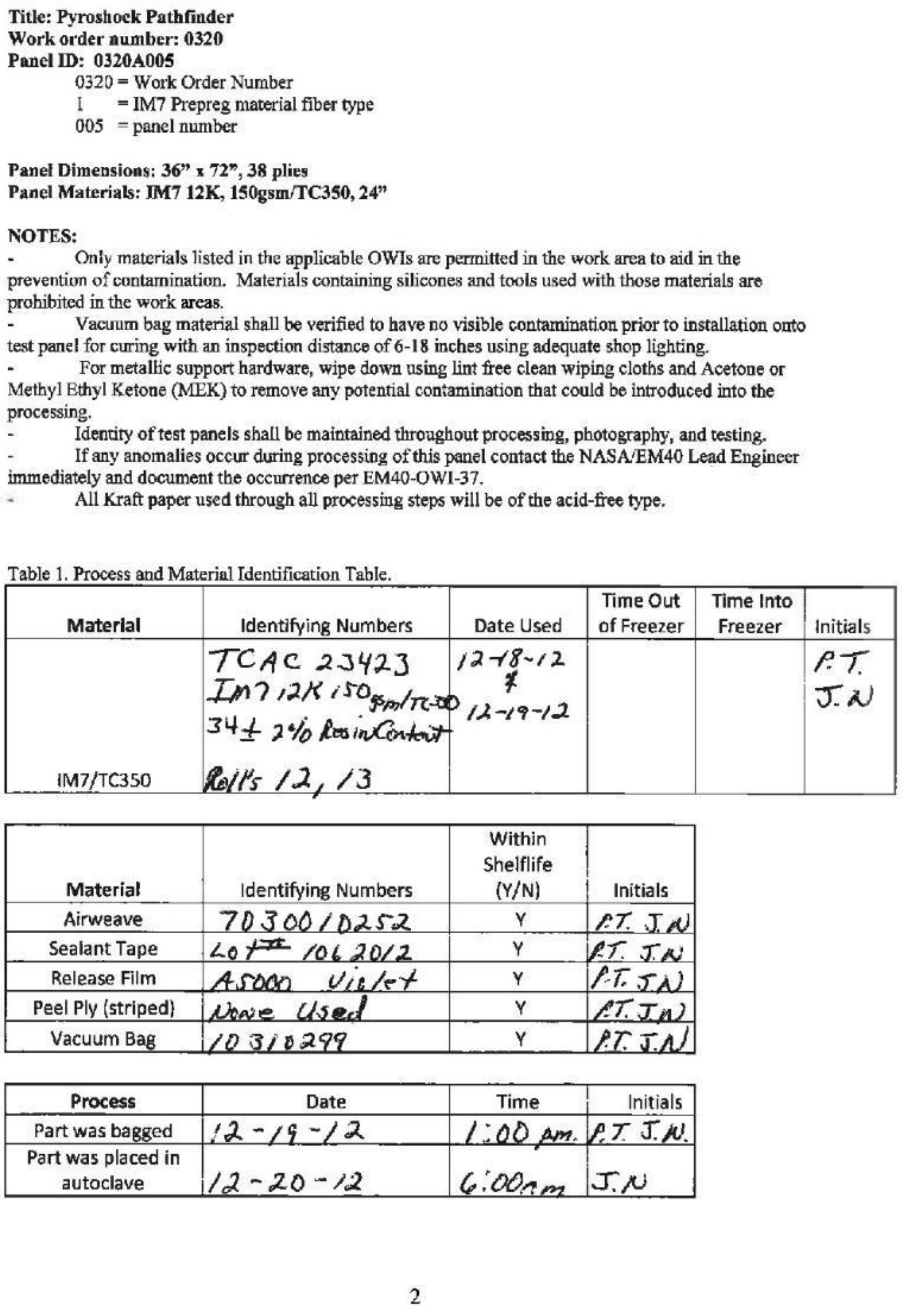
9. Provide the results of the NDE inspection to the lead EM40 engineer.
DATE:__________ INITIALS:__________

10. After NDE, use the template to drill center holes (See attached drawing) and drill only two .5162-inch holes that will be required on one end at each corner for hanging the panels
DATE: 1/15/13 INITIALS: JN GB

11. Install/bond provided inserts (#1428SKS) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts
DATE: 1/16/13 INITIALS: JN

12. Provide a copy of the fabrication traveler to EV32.
DATE: 1/16/13 INITIALS: JN

13. Provide cured panel to EV32
DATE:__________ INITIALS:__________



Title: Pyroshock Pathfinder
Work order number: 0320
Panel ID: 0320A005
0320 = Work Order Number
I = IM7 Prepreg material fiber type
005 = panel number

Panel Dimensions: 36" x 72", 38 plies
Panel Materials: IM7 12K, 150gsm/TC350, 24"

NOTES:

- Only materials listed in the applicable OWIs are permitted in the work area to aid in the prevention of contamination. Materials containing silicones and tools used with those materials are prohibited in the work areas.
- Vacuum bag material shall be verified to have no visible contamination prior to installation onto test panel for curing with an inspection distance of 6-18 inches using adequate shop lighting.
- For metallic support hardware, wipe down using lint free clean wiping cloths and Acetone or Methyl Ethyl Ketone (MEK) to remove any potential contamination that could be introduced into the processing.
- Identity of test panels shall be maintained throughout processing, photography, and testing.
- If any anomalies occur during processing of this panel contact the NASA/EM40 Lead Engineer immediately and document the occurrence per EM40-OWI-37.
- All Kraft paper used through all processing steps will be of the acid-free type.

Table 1. Process and Material Identification Table.

Material	Identifying Numbers	Date Used	Time Out of Freezer	Time Into Freezer	Initials
IM7/TC350	TCAC 23423 IM7 12K 150gsm/TC350 34± 2% Resin Content Roll's 12, 13	12-18-12 & 12-19-12			P.T. J.N

Material	Identifying Numbers	Within Shelflife (Y/N)	Initials
Airweave	70300/D252	Y	P.T. J.N
Sealant Tape	Lot # 1062012	Y	P.T. J.N
Release Film	A5000 Violet	Y	P.T. J.N
Peel Ply (striped)	None Used	Y	P.T. J.N
Vacuum Bag	10310299	Y	P.T. J.N

Process	Date	Time	Initials
Part was bagged	12-19-12	1:00 pm.	P.T. J.N.
Part was placed in autoclave	12-20-12	6:00am	J.N

2

Prepreg/Adhesive Preparation

1. Place lint and powder free latex gloves on when handling prepreg at all times.
INITIALS P.T.

2. Record out time on NMIH label when removing any frozen material, If label is full, attach another label adjacent to the previous one. Weigh prepreg/adhesive rolls and jot number next to out time also fill out this info in table 1.

3. Allow 4 hours to thaw for large prepreg rolls. Return material to freezer immediately after cutting for your panel to minimize out time.

4. Record ambient temperature and humidity below.
Temperature 71
Humidity 42

Laminate Construction

1. Environment requirements for temperature and humidity for all steps of lay-up shall be maintained during the operation per the following:

Temperature = 70 +/- 5°F
Humidity = 40 – 55%
INITIALS: P.T.

2. Cut a piece of solid release film that is larger than the cut plies. Label the film with the panel ID along with the 0°, 45° and the 90° ply directional rosette on the edge of the film. Placement of rosette should be placed as seen below. Place the release film on top of the baseplate tool shown in Figure 3.

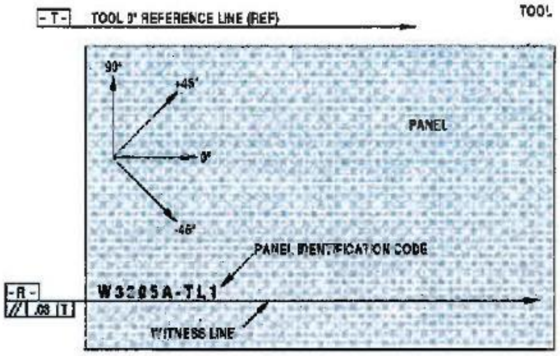


Figure 1. Rosette Location

3. Lay up plies of the material placed in the sequence listed in table 1. A vacuum debulk should always be performed after the 1st ply and at 5 ply intervals thereafter. After final debulk, repeat process for the second face sheet.
INITIALS: P.T

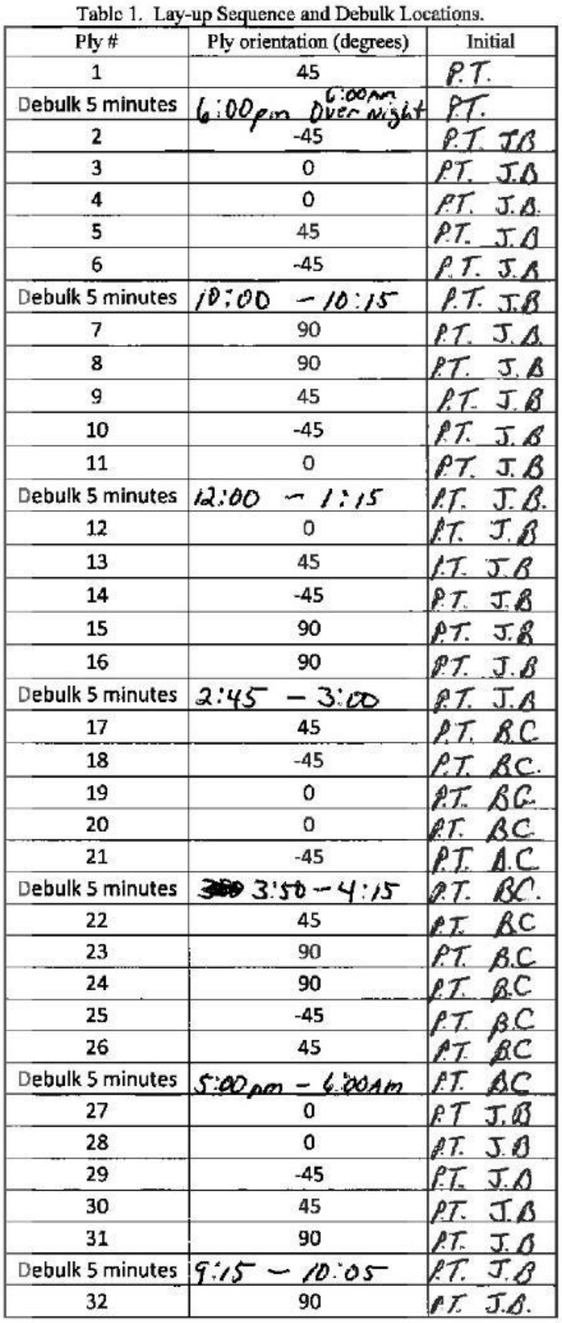
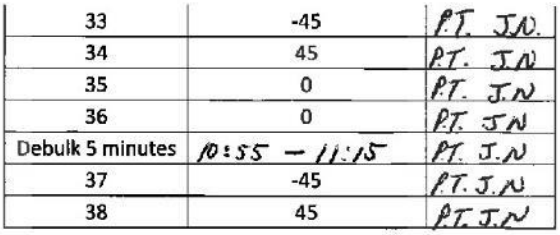


Table 1. Lay-up Sequence and Debulk Locations.

Ply #	Ply orientation (degrees)	Initial
1	45	P.T.
Debulk 5 minutes	6:00pm Over night 6:00Am	P.T.
2	-45	P.T. J.B
3	0	P.T. J.B
4	0	P.T. J.B.
5	45	P.T. J.B
6	-45	P.T. J.B
Debulk 5 minutes	10:00 – 10:15	P.T. J.B
7	90	P.T. J.B
8	90	P.T. J.B
9	45	P.T. J.B
10	-45	P.T. J.B
11	0	P.T. J.B
Debulk 5 minutes	12:00 – 1:15	P.T. J.B.
12	0	P.T. J.B
13	45	P.T. J.B
14	-45	P.T. J.B
15	90	P.T. J.B
16	90	P.T. J.B
Debulk 5 minutes	2:45 – 3:00	P.T. J.B
17	45	P.T. B.C
18	-45	P.T. B.C.
19	0	P.T. B.C
20	0	P.T. B.C
21	-45	P.T. B.C
Debulk 5 minutes	3:50 – 4:15	P.T. B.C.
22	45	P.T. B.C
23	90	P.T. B.C
24	90	P.T. B.C
25	-45	P.T. B.C
26	45	P.T. B.C
Debulk 5 minutes	5:00pm – 6:00Am	P.T. B.C
27	0	P.T. J.B
28	0	P.T. J.B
29	-45	P.T. J.B
30	45	P.T. J.B
31	90	P.T. J.B
Debulk 5 minutes	9:15 – 10:05	P.T. J.B
32	90	P.T. J.B.



33	-45	P.T. J.N.
34	45	P.T. J.N
35	0	P.T. J.N
36	0	P.T. J.N
Debulk 5 minutes	10:55 – 11:15	P.T. J.N
37	-45	P.T. J.N
38	45	P.T. J.N

Lay-Up & Bagging

Bagging Sequence for Cure:

List of materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered)
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone/Rubber Edge Dams – Thicker than laminate
4. Laminate
5. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate – aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 osy polyester breather – 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string - (alternatively or additionally breather may wrap over top of dam to contact edge)

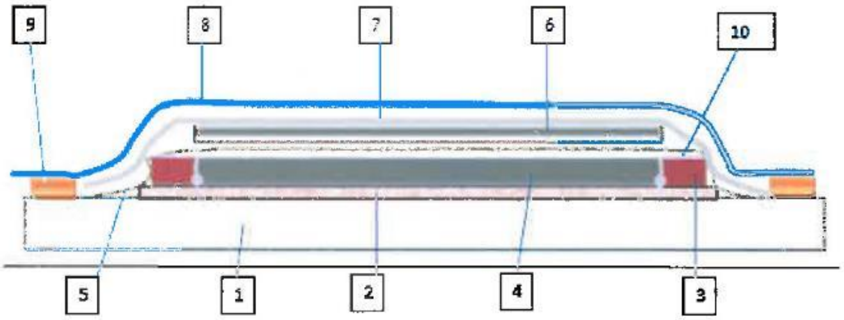


Figure 3. Lay Up

1. Follow Figure 3 as a guide to panel lay up materials and layer sequence. Ensure curing plate has been solvent wiped to remove potential contaminants using MEK or acetone and clean lint free wipes. Wipe in a linear motion to prevent recontamination.
INITIALS: P.T. J.N.

2. Install thermocouple to monitor the temperature of the part during cure. Bag part per Figure 3. Before bagging an EM40 engineer must check and sign off.
INITIALS: P.T. EM40 ENGINEER INTIALS:_________

3. Encompass lay up in vacuum bag in preparation for cure cycle. Pull vacuum at 25 inHg minimum. Leak check vacuum bag by disconnecting the vacuum line and installing a vacuum gauge. Ensure that the leak rate does not exceed 1.0 inHg after five minutes. If leak is detected completely replace vacuum bag and repeat process.

4. Keep track of which thermocouple wire number is assigned to this panel during the cure by noting here:
#4-Tool. #5-Part

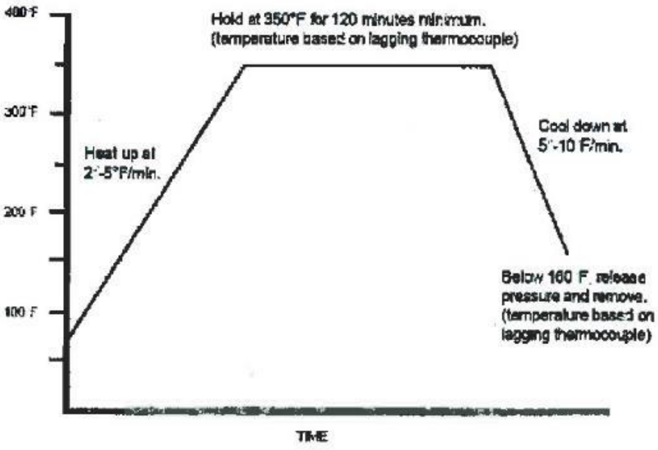
5. Cure times and temperature shall be recorded using the autoclave data recorder for traceability. Print the recorded cure cycle profile and attach it to the Shop Traveler. Cure the panel using the autoclave per the following cure cycle:

- 75° to 350° @ 3°/min ~= 1 hour 30 min
- 350° hold ~= 2 hour 0 min
- 350° to 75° @ 5°/min ~= 60 min

Pathfinder Panel Cure Cycle

· Autoclave cure at 90 - 100 psi

TC350 TOUGHENED EPOXY RESIN SYSTEM: Cure cycle

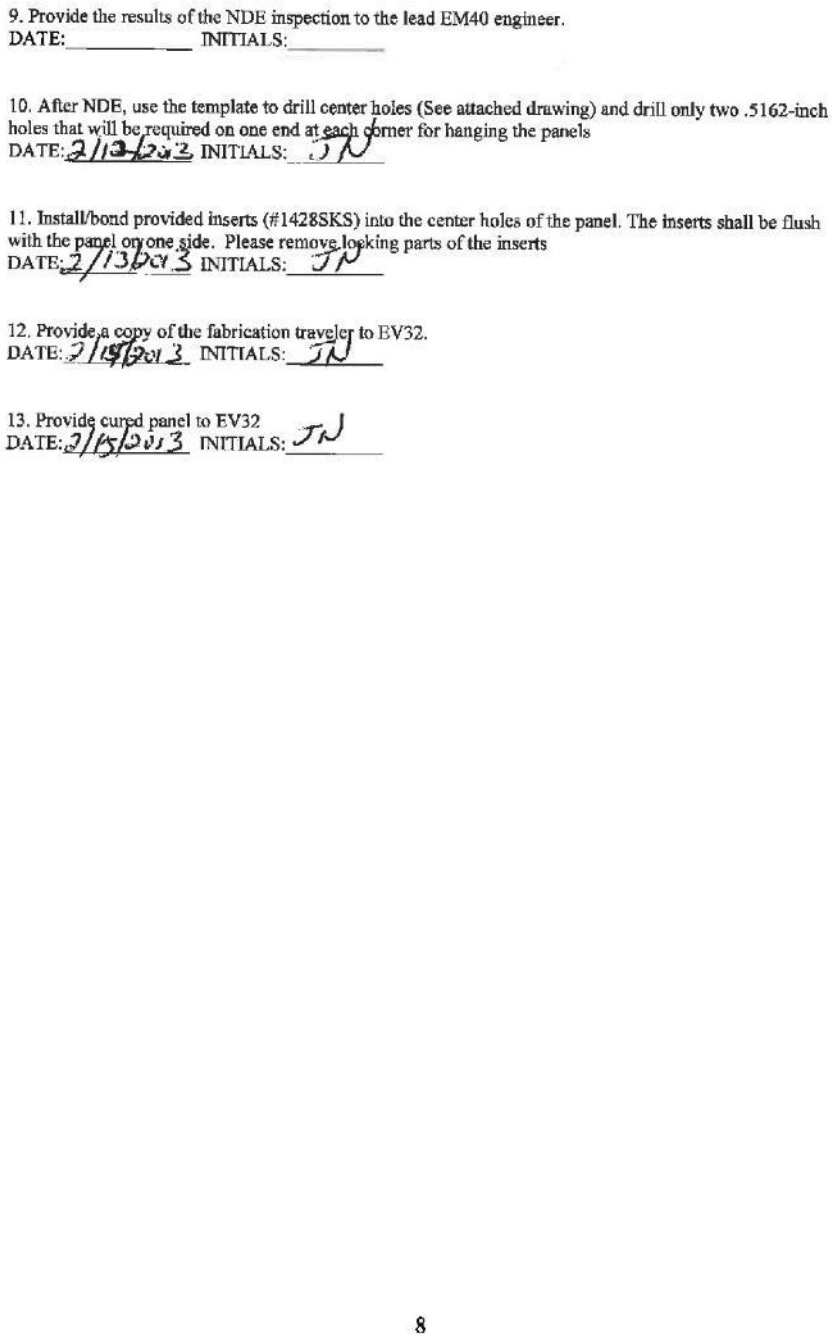


6. Remove all sharp edges from the as-cured panels using a file, rasp, or abrasive paper. Mark with panel identification, core ribbon direction, 0° orientation, 1.0" from the edge of the panel using a paint pen.

7. Record all anomalies or process deviations below and coordinate with EM40 Lead Engineer:

DATE: 12-20-12 INITIALS: RT

8. Deliver cured panel to EM20 for NDE inspection. Attach results of inspection to the end of this Work Traveller.
DATE: 12-21-2012 INITIALS: JN



9. Provide the results of the NDE inspection to the lead EM40 engineer.
DATE:__________ INITIALS:__________

10. After NDE, use the template to drill center holes (See attached drawing) and drill only two .5162-inch holes that will be required on one end at each corner for hanging the panels
DATE: 2/13/2013 INITIALS: JN

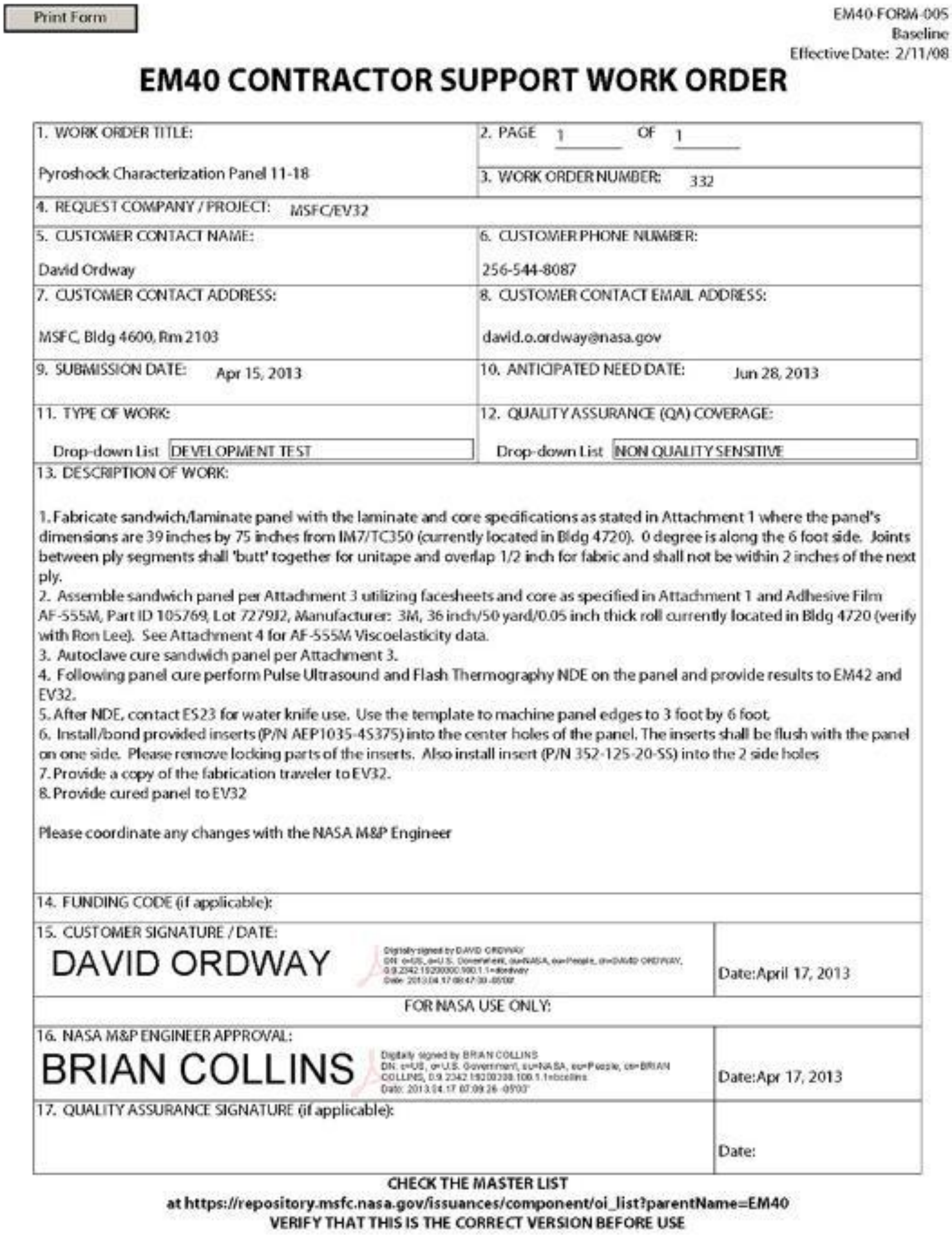
11. Install/bond provided inserts (#1428SKS) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts
DATE: 2/13/2013 INITIALS: JN

12. Provide a copy of the fabrication traveler to EV32.
DATE: 2/15/2013 INITIALS: JN

13. Provide cured panel to EV32
DATE: 2/15/2013 INITIALS: JN

8

Figure A27. Monolithic Composite Panels #1 - #5 Fabrication Work Order



Print Form

EM40-FORM-005
Baseline
Effective Date: 2/11/08

EM40 CONTRACTOR SUPPORT WORK ORDER

1. WORK ORDER TITLE: Pyroshock Characterization Panel 11-18

2. PAGE 1 OF 1

3. WORK ORDER NUMBER: 332

4. REQUEST COMPANY / PROJECT: MSFC/EV32

5. CUSTOMER CONTACT NAME: David Ordway

6. CUSTOMER PHONE NUMBER: 256-544-8087

7. CUSTOMER CONTACT ADDRESS: MSFC, Bldg 4600, Rm 2103

8. CUSTOMER CONTACT EMAIL ADDRESS: david.o.ordway@nasa.gov

9. SUBMISSION DATE: Apr 15, 2013

10. ANTICIPATED NEED DATE: Jun 28, 2013

11. TYPE OF WORK: Drop-down List DEVELOPMENT TEST

12. QUALITY ASSURANCE (QA) COVERAGE: Drop-down List NON QUALITY SENSITIVE

13. DESCRIPTION OF WORK:

1. Fabricate sandwich/laminate panel with the laminate and core specifications as stated in Attachment 1 where the panel's dimensions are 39 inches by 75 inches from IM7/TC350 (currently located in Bldg 4720). 0 degree is along the 6 foot side. Joints between ply segments shall 'butt' together for unitape and overlap 1/2 inch for fabric and shall not be within 2 inches of the next ply.
2. Assemble sandwich panel per Attachment 3 utilizing facesheets and core as specified in Attachment 1 and Adhesive Film AF-555M, Part ID 105769, Lot 727932, Manufacturer: 3M, 36 inch/50 yard/0.05 inch thick roll currently located in Bldg 4720 (verify with Ron Lee). See Attachment 4 for AF-555M Viscoelasticity data.
3. Autoclave cure sandwich panel per Attachment 3.
4. Following panel cure perform Pulse Ultrasound and Flash Thermography NDE on the panel and provide results to EM42 and EV32.
5. After NDE, contact ES23 for water knife use. Use the template to machine panel edges to 3 foot by 6 foot.
6. Install/bond provided inserts (P/N AEP1035-4S375) into the center holes of the panel. The inserts shall be flush with the panel on one side. Please remove locking parts of the inserts. Also install insert (P/N 352-125-20-SS) into the 2 side holes
7. Provide a copy of the fabrication traveler to EV32.
8. Provide cured panel to EV32

Please coordinate any changes with the NASA M&P Engineer

14. FUNDING CODE (if applicable):

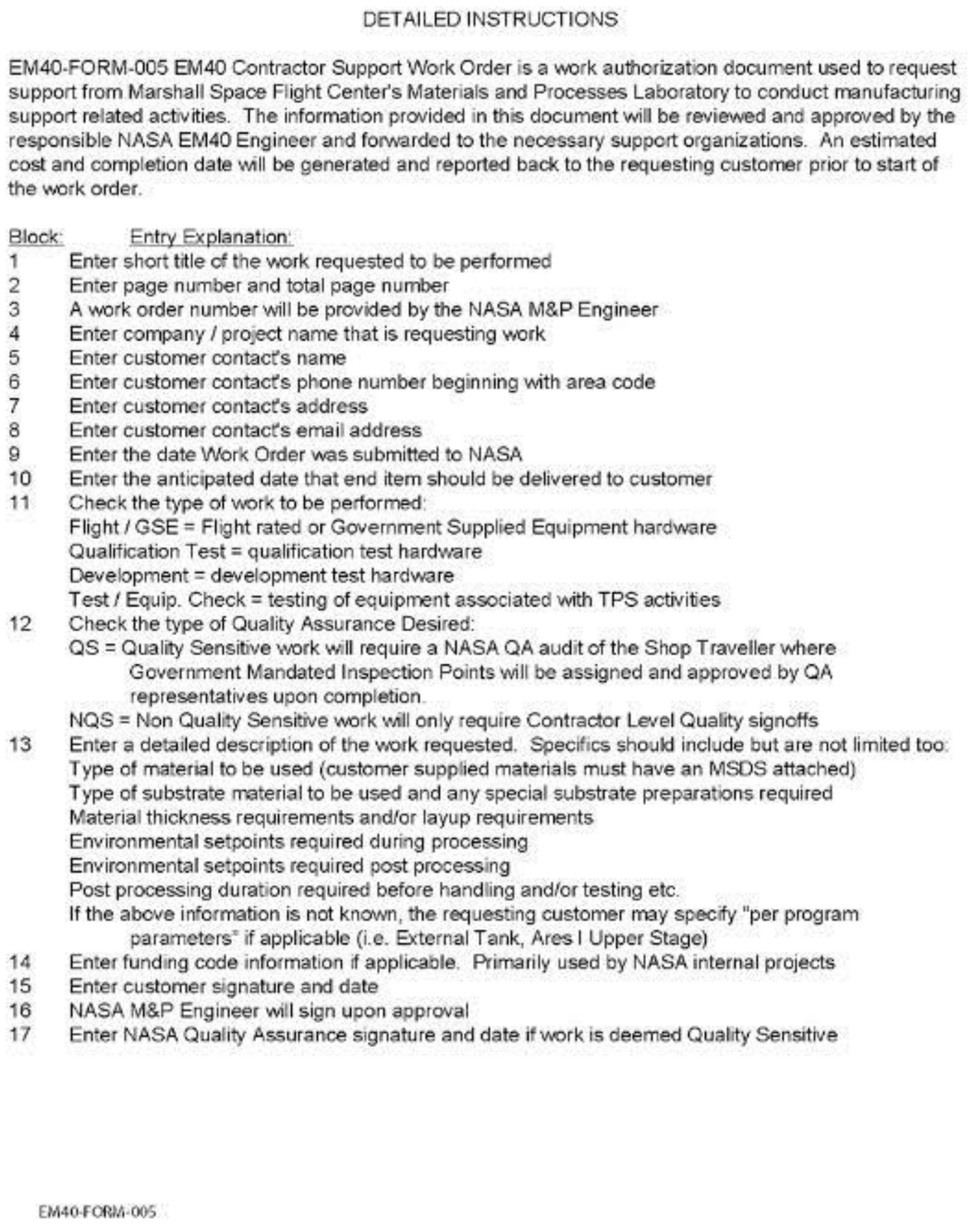
15. CUSTOMER SIGNATURE / DATE: DAVID ORDWAY
Digitally signed by DAVID ORDWAY
DN: c=US, o=U.S. Government, ou=NASA, ou=People, cn=DAVID ORDWAY, 0.9.2342.19200300.100.1.1=dordway
Date: 2013.04.17 08:47:30 -05'00'
Date: April 17, 2013

FOR NASA USE ONLY:

16. NASA M&P ENGINEER APPROVAL: BRIAN COLLINS
Digitally signed by BRIAN COLLINS
DN: c=US, o=U.S. Government, ou=NASA, ou=People, cn=BRIAN COLLINS, 0.9.2342.19200300.100.1.1=bcollins
Date: 2013.04.17 07:09:26 -05'00'
Date: Apr 17, 2013

17. QUALITY ASSURANCE SIGNATURE (if applicable):
Date:

CHECK THE MASTER LIST
at https://repository.msfc.nasa.gov/issuances/component/oi_list?parentName=EM40
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE



DETAILED INSTRUCTIONS

EM40-FORM-005 EM40 Contractor Support Work Order is a work authorization document used to request support from Marshall Space Flight Center's Materials and Processes Laboratory to conduct manufacturing support related activities. The information provided in this document will be reviewed and approved by the responsible NASA EM40 Engineer and forwarded to the necessary support organizations. An estimated cost and completion date will be generated and reported back to the requesting customer prior to start of the work order.

Block: Entry Explanation:
1 Enter short title of the work requested to be performed
2 Enter page number and total page number
3 A work order number will be provided by the NASA M&P Engineer
4 Enter company / project name that is requesting work
5 Enter customer contact's name
6 Enter customer contact's phone number beginning with area code
7 Enter customer contact's address
8 Enter customer contact's email address
9 Enter the date Work Order was submitted to NASA
10 Enter the anticipated date that end item should be delivered to customer
11 Check the type of work to be performed:
Flight / GSE = Flight rated or Government Supplied Equipment hardware
Qualification Test = qualification test hardware
Development = development test hardware
Test / Equip. Check = testing of equipment associated with TPS activities
12 Check the type of Quality Assurance Desired:
QS = Quality Sensitive work will require a NASA QA audit of the Shop Traveller where Government Mandated Inspection Points will be assigned and approved by QA representatives upon completion.
NQS = Non Quality Sensitive work will only require Contractor Level Quality signoffs
13 Enter a detailed description of the work requested. Specifics should include but are not limited too:
Type of material to be used (customer supplied materials must have an MSDS attached)
Type of substrate material to be used and any special substrate preparations required
Material thickness requirements and/or layup requirements
Environmental setpoints required during processing
Environmental setpoints required post processing
Post processing duration required before handling and/or testing etc.
If the above information is not known, the requesting customer may specify "per program parameters" if applicable (i.e. External Tank, Ares I Upper Stage)
14 Enter funding code information if applicable. Primarily used by NASA internal projects
15 Enter customer signature and date
16 NASA M&P Engineer will sign upon approval
17 Enter NASA Quality Assurance signature and date if work is deemed Quality Sensitive

EM40-FORM-005

Figure A28. Composite Sandwich Panel #11-#18 Fabrication Work Order

Print Form

EM40-FORM-005
Baseline
Effective Date: 2/11/08

EM40 CONTRACTOR SUPPORT WORK ORDER

1. WORK ORDER TITLE: Pyroshock Characterization Melamine Panels

2. PAGE 1 OF 1

3. WORK ORDER NUMBER: 382

4. REQUEST COMPANY / PROJECT: MSFC/EV32

5. CUSTOMER CONTACT NAME: David Ordway

6. CUSTOMER PHONE NUMBER: 256-544-8087

7. CUSTOMER CONTACT ADDRESS: MSFC, Bldg 4600, Rm 2103

8. CUSTOMER CONTACT EMAIL ADDRESS: david.o.ordway@nasa.gov

9. SUBMISSION DATE: 06/18/2014

10. ANTICIPATED NEED DATE: 07/30/14

11. TYPE OF WORK: Drop-down List DEVELOPMENT TEST

12. QUALITY ASSURANCE (QA) COVERAGE: Drop-down List NON QUALITY SENSITIVE

13. DESCRIPTION OF WORK:

1. Bond the melamine foam panels to the aluminum or composite panels as specified in the Attachments utilizing the self adhesive.
2. Deliver panel to customer
3. Provide a copy of the fabrication traveler to customer
4. Stainless steel sleeves are to be fabricated from provided steel tube. Dimensions are 0.625-inch in diameter and a length of ~5.25 inches, with a clearance for a ½-20 UNF bolt, i.e. 0.515-inch.

Please coordinate any changes with the NASA M&P Engineer

14. FUNDING CODE (if applicable):

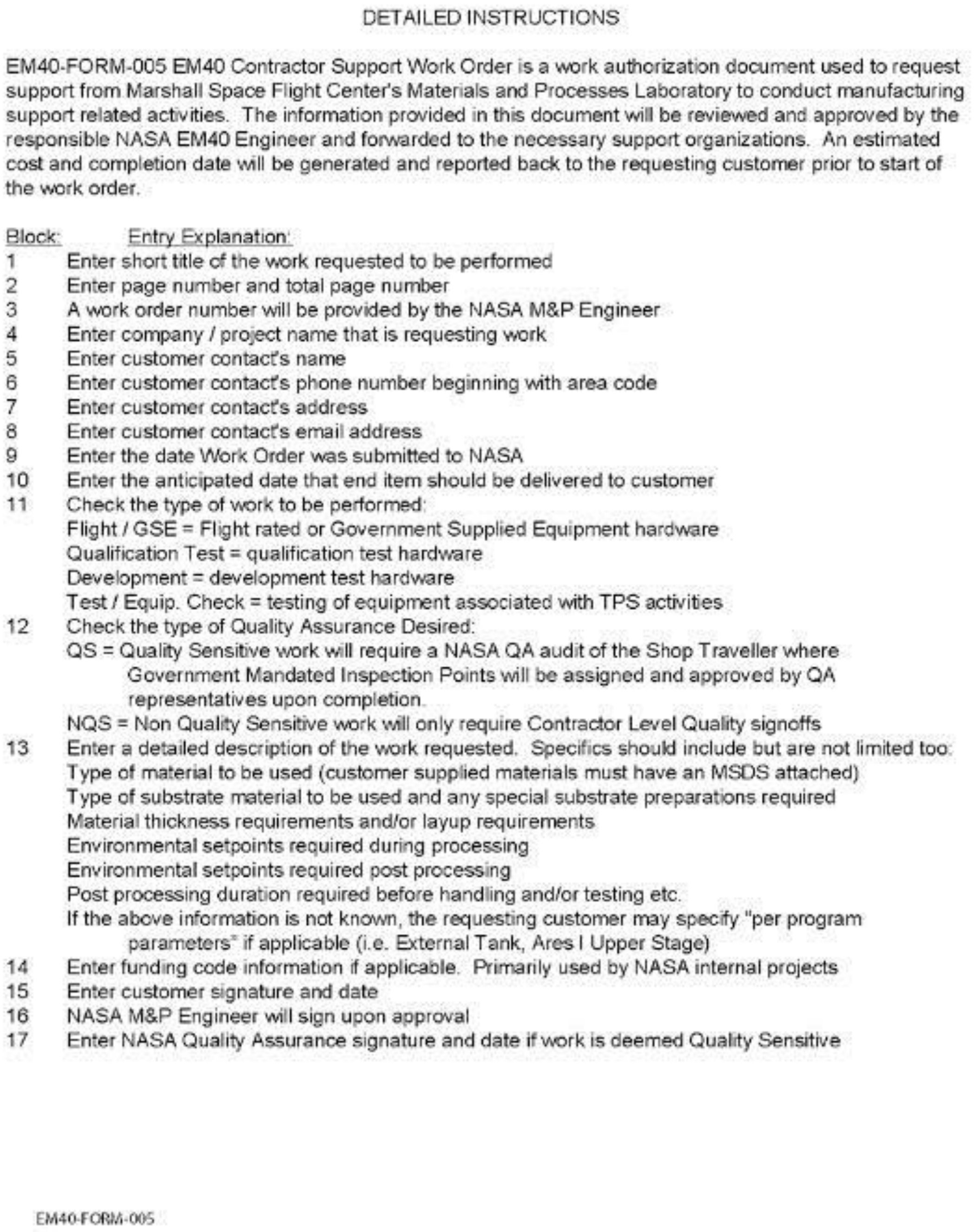
15. CUSTOMER SIGNATURE / DATE: DAVID ORDWAY Date: 06/18/2014

FOR NASA USE ONLY:

16. NASA M&P ENGINEER APPROVAL: Date: 02/19/2013

17. QUALITY ASSURANCE SIGNATURE (if applicable): Date:

CHECK THE MASTER LIST
at https://repository.msfc.nasa.gov/issuances/component/oi_list?parentName=EM40
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE



DETAILED INSTRUCTIONS

EM40-FORM-005 EM40 Contractor Support Work Order is a work authorization document used to request support from Marshall Space Flight Center's Materials and Processes Laboratory to conduct manufacturing support related activities. The information provided in this document will be reviewed and approved by the responsible NASA EM40 Engineer and forwarded to the necessary support organizations. An estimated cost and completion date will be generated and reported back to the requesting customer prior to start of the work order.

Block: Entry Explanation:
1 Enter short title of the work requested to be performed
2 Enter page number and total page number
3 A work order number will be provided by the NASA M&P Engineer
4 Enter company / project name that is requesting work
5 Enter customer contact's name
6 Enter customer contact's phone number beginning with area code
7 Enter customer contact's address
8 Enter customer contact's email address
9 Enter the date Work Order was submitted to NASA
10 Enter the anticipated date that end item should be delivered to customer
11 Check the type of work to be performed:
Flight / GSE = Flight rated or Government Supplied Equipment hardware
Qualification Test = qualification test hardware
Development = development test hardware
Test / Equip. Check = testing of equipment associated with TPS activities
12 Check the type of Quality Assurance Desired:
QS = Quality Sensitive work will require a NASA QA audit of the Shop Traveller where Government Mandated Inspection Points will be assigned and approved by QA representatives upon completion.
NQS = Non Quality Sensitive work will only require Contractor Level Quality signoffs
13 Enter a detailed description of the work requested. Specifics should include but are not limited too:
Type of material to be used (customer supplied materials must have an MSDS attached)
Type of substrate material to be used and any special substrate preparations required
Material thickness requirements and/or layup requirements
Environmental setpoints required during processing
Environmental setpoints required post processing
Post processing duration required before handling and/or testing etc.
If the above information is not known, the requesting customer may specify "per program parameters" if applicable (i.e. External Tank, Ares I Upper Stage)
14 Enter funding code information if applicable. Primarily used by NASA internal projects
15 Enter customer signature and date
16 NASA M&P Engineer will sign upon approval
17 Enter NASA Quality Assurance signature and date if work is deemed Quality Sensitive

EM40-FORM-005

Figure A29. MAF Panel Fabrication Work Order

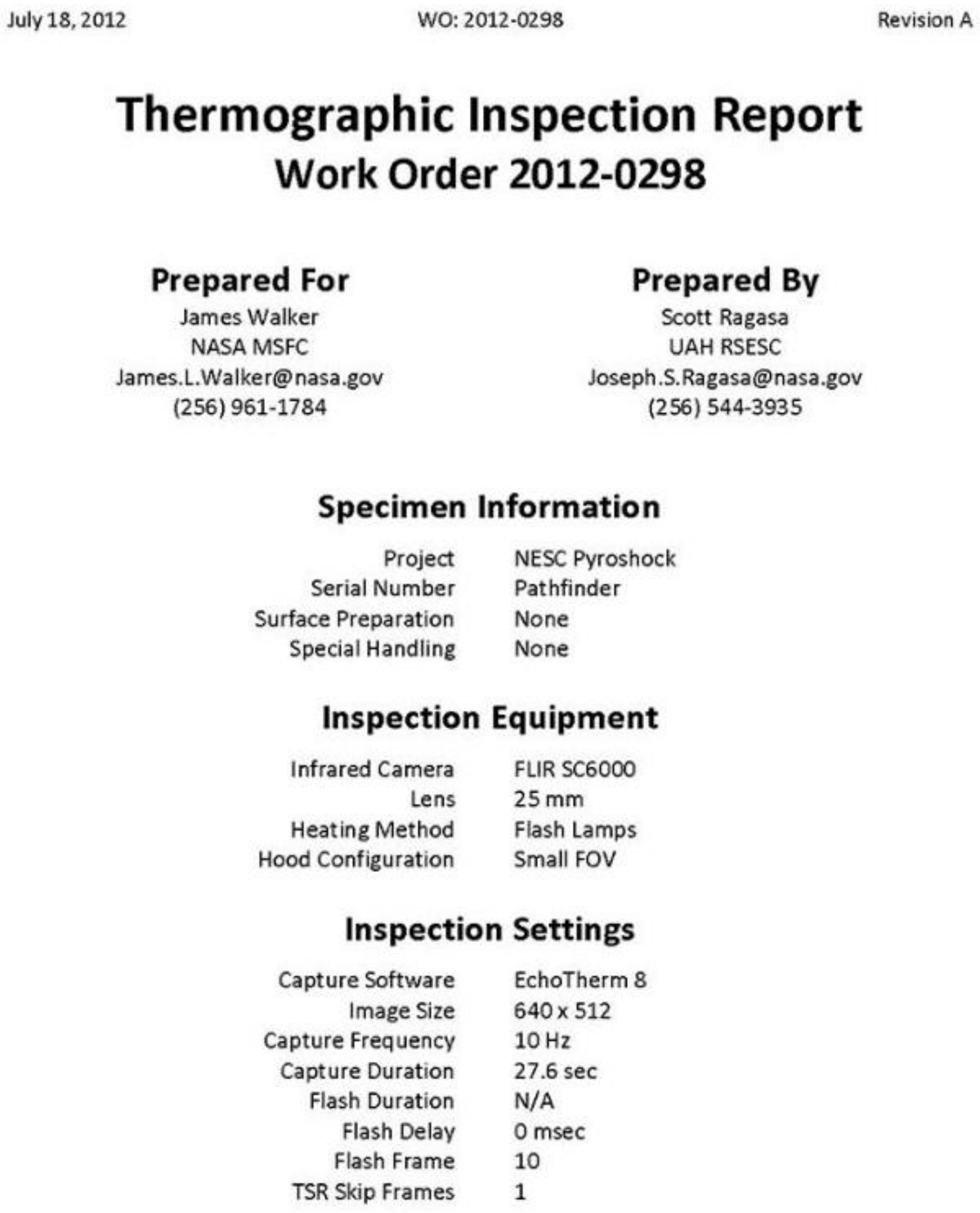

SO-LOW
WT: 215 LBS


SO-LOW
JANICKI P/N
901-09834-021

Figure A30. Composite Sandwich Panel Fabrication – Pictorial Presentation

A3.1 Post-Panel Fabrication NDE

Two methodologies are commonly used for NDE of composites, phased array ultrasound (PAUT) and flash infrared thermography. Both of these methodologies were used for the IM7/R913 composite pathfinder panels. The pathfinder composite panels were 0.20 inch thick, which is approaching the maximum thickness for infrared thermography inspection. It was determined from inspection of the composite pathfinder panels the surface texture and overall panel thickness reduced the detection capability of infrared thermography. Based on the test results only the phased array ultrasound inspection methodology was used for the task baseline IM7/TC350 composite panel NDE, which was not limited in resolution by the panel surface texture or thickness. Figure A31 shows the IR thermography results and Figure A32 documents the phased array ultrasound results for the composite pathfinder panels.



July 18, 2012 WO: 2012-0298 Revision A

Thermographic Inspection Report

Work Order 2012-0298

Prepared For

James Walker
NASA MSFC
James.L.Walker@nasa.gov
(256) 961-1784

Prepared By

Scott Ragasa
UAH RSESC
Joseph.S.Ragasa@nasa.gov
(256) 544-3935

Specimen Information

Project	NESC Pyroshock
Serial Number	Pathfinder
Surface Preparation	None
Special Handling	None

Inspection Equipment

Infrared Camera	FLIR SC6000
Lens	25 mm
Heating Method	Flash Lamps
Hood Configuration	Small FOV

Inspection Settings

Capture Software	EchoTherm 8
Image Size	640 x 512
Capture Frequency	10 Hz
Capture Duration	27.6 sec
Flash Duration	N/A
Flash Delay	0 msec
Flash Frame	10
TSR Skip Frames	1

July 18, 2012 WO: 2012-0298 Revision A

Overview

The panel was subdivided into four quadrants according to Figure 1.

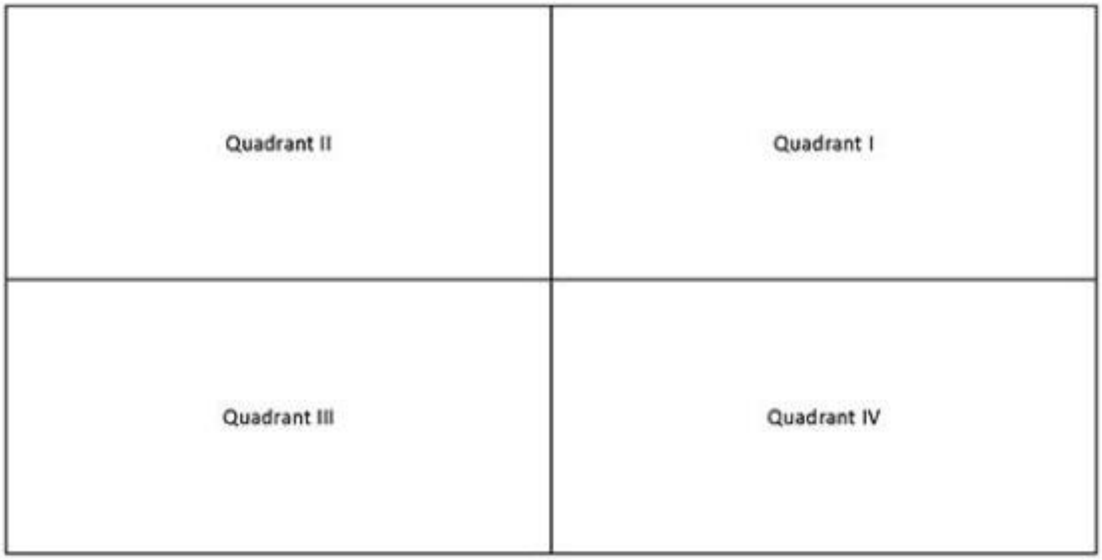


Figure 1

The thickness of the panel is approaching the maximum that can be inspected by flash thermography. A reduced acquisition rate of 10 frames per second was used to achieve the best compromise of detectability and interrogation depth.

Figure 2 shows the logarithmic time versus temperature curve over a nominal area of the panel. Note the slight upward trend when the panel back wall is reached.

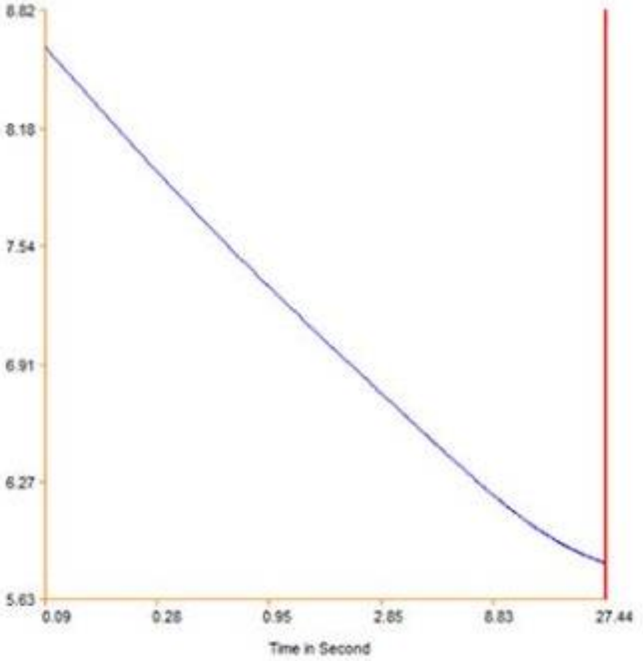
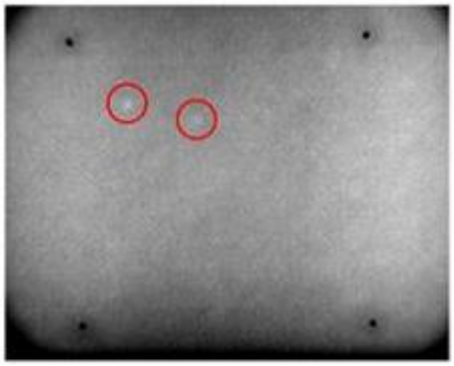
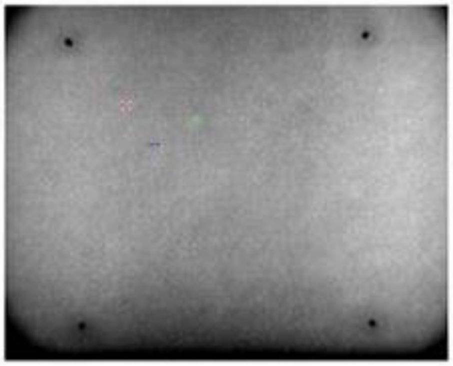
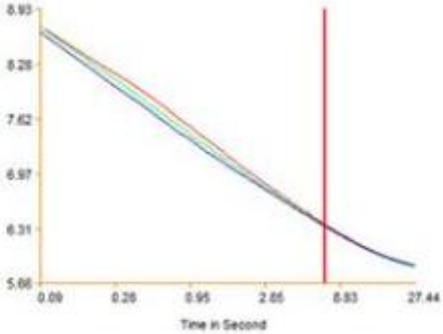


Figure 2

Indication: D3







Two indications, approximately 0.25" by 0.25", were found in inspection location D3 and denoted by the red circles. Time-temperature cursors, shown in red and green, were placed on each indication and measured the average intensity value of the local 3 by 3 pixel area. A blue reference time-temperature cursor was placed over a nominal area for comparison. Plotting the data from the two indications and the reference point shows that both indications deviate from the behavior of nominal areas of the panel.

In addition to infrared thermography, phased array ultrasound (PAUT) was used to inspection the panel. PAUT did not detect any anomalies at grid location D3, and as a result, it is believed the indications present in the thermographic data are the result of a surface condition.

Comments

The surface texture of the panel also influenced the acquired data. As shown in Figure 3 the raw, first derivative, and second derivative images (a, b, and c, respectively) exhibit a mottled texture in the infrared images.

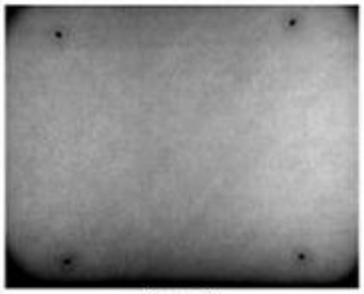


Figure 3a

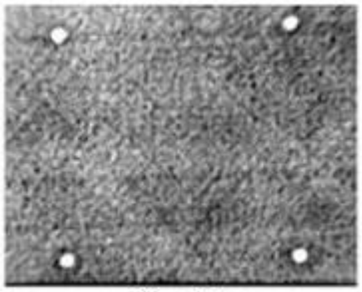


Figure 3b

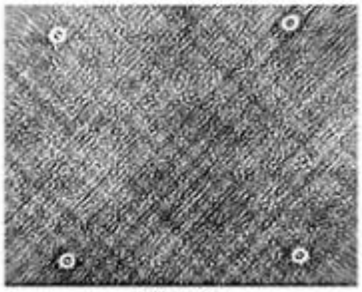


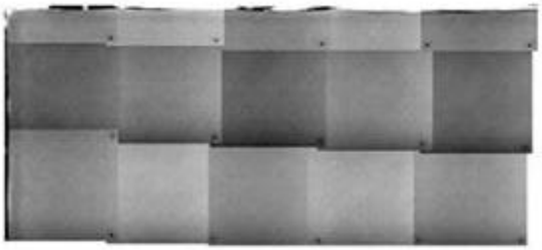
Figure 3c

The combination of infrared thermography and phased array ultrasound nondestructive inspection techniques provided a thorough interrogation of the panel. The surface texture and overall panel thickness reduced the detection capability of infrared thermography.

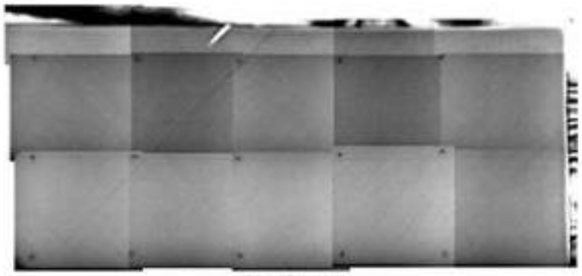
Appendix

Overview and Full-Size Quadrant Mosaics

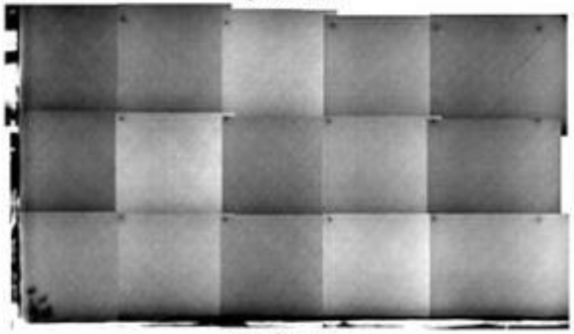
Raw Data – Overview



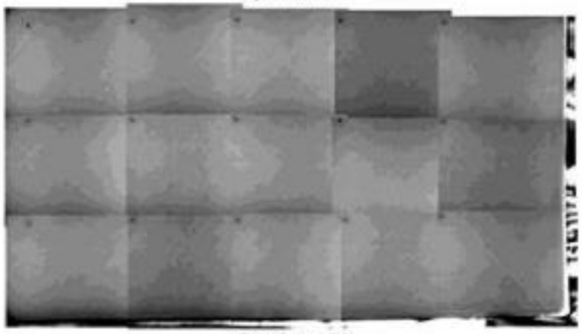
Quadrant II



Quadrant I

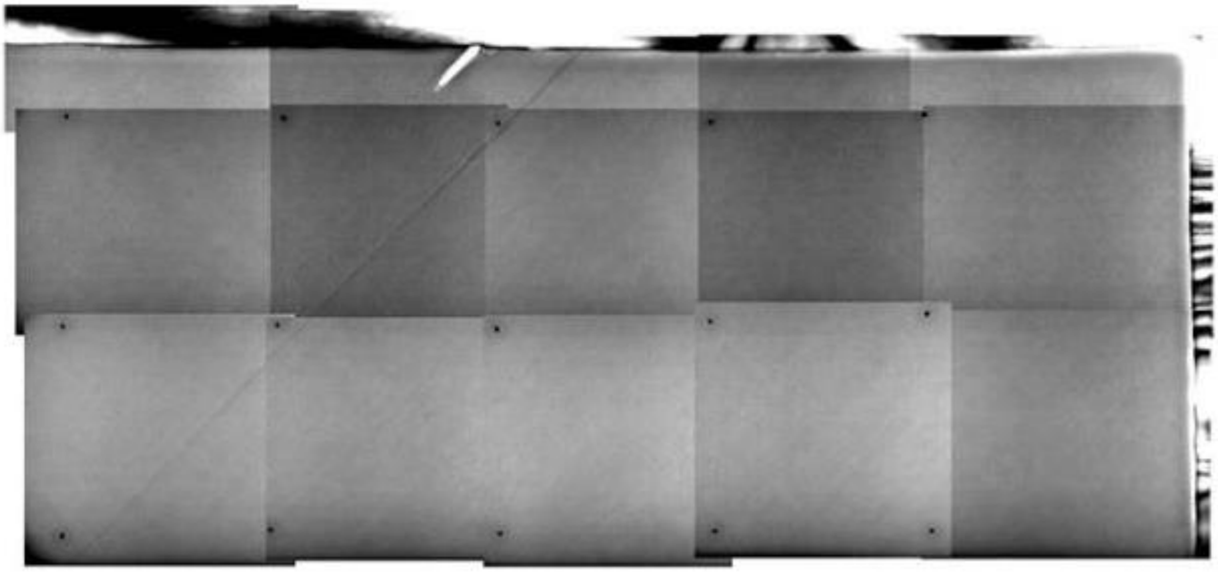


Quadrant III

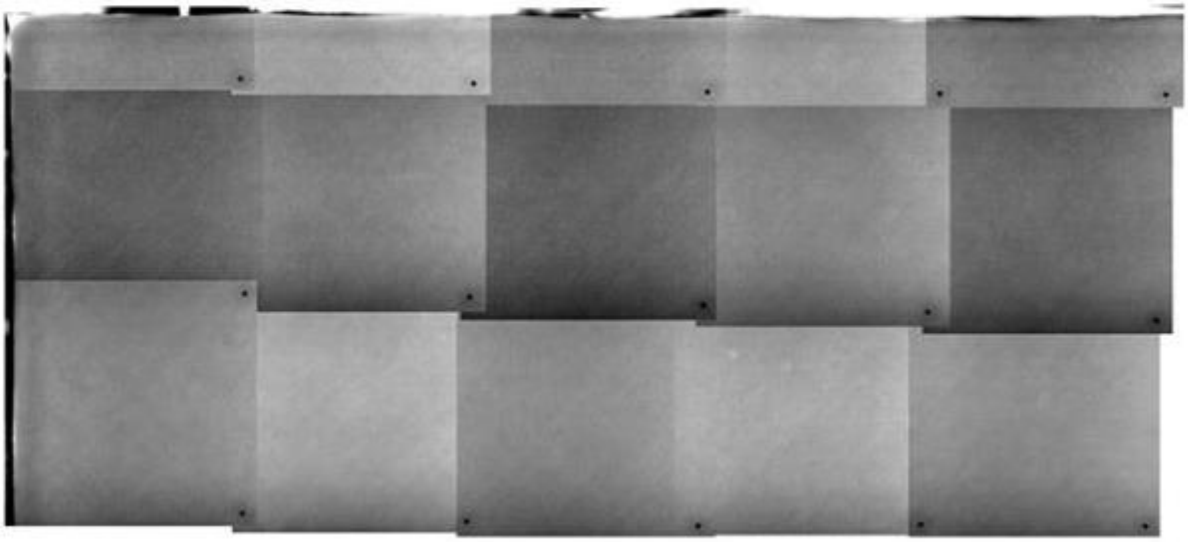


Quadrant IV

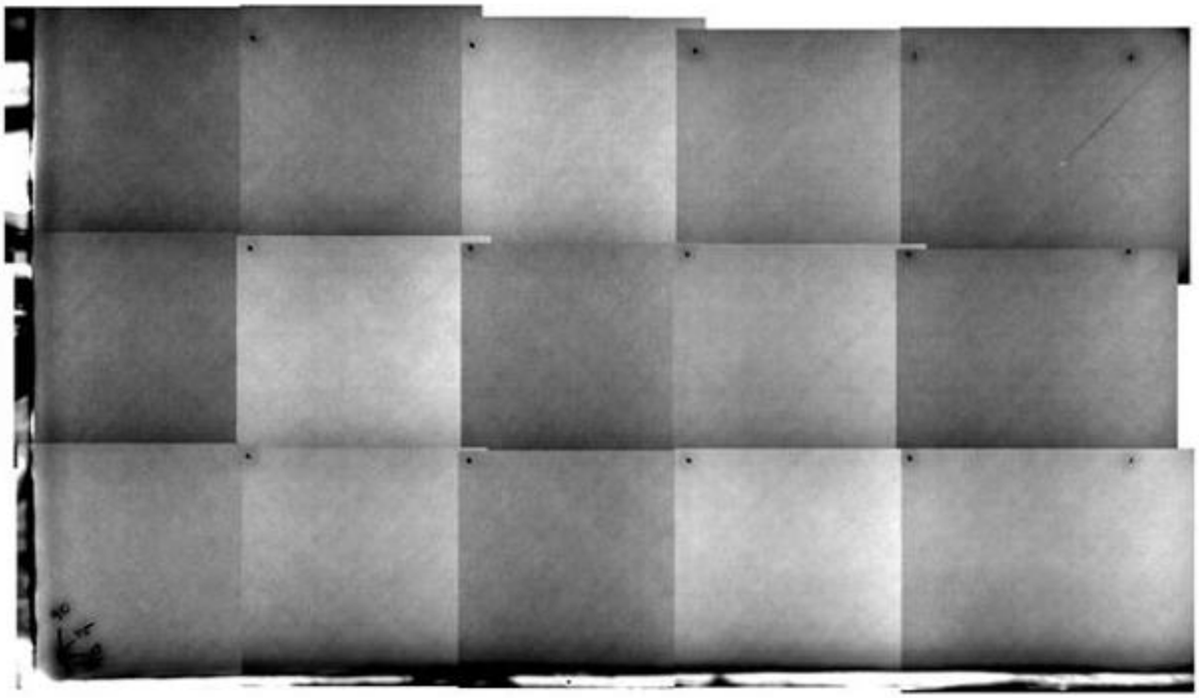
Raw Data – Quadrant I



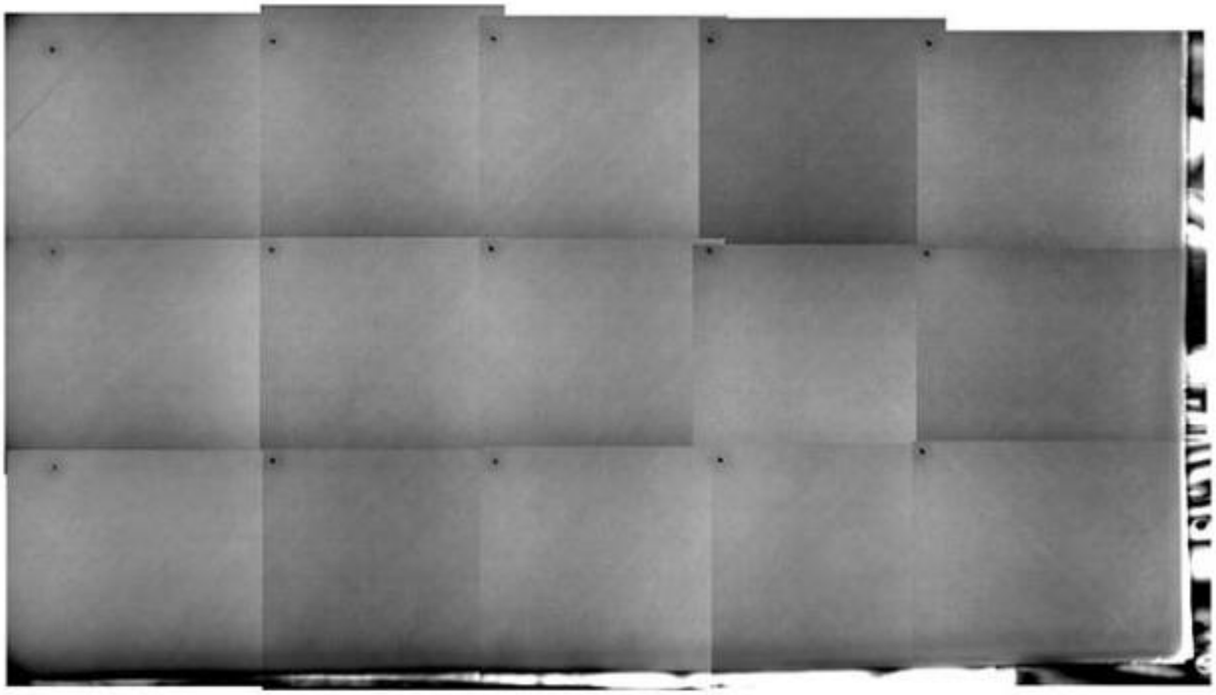
Raw Data – Quadrant II



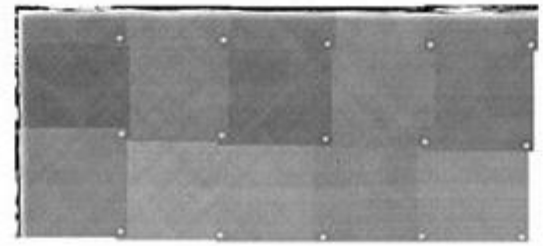
Raw Data – Quadrant III



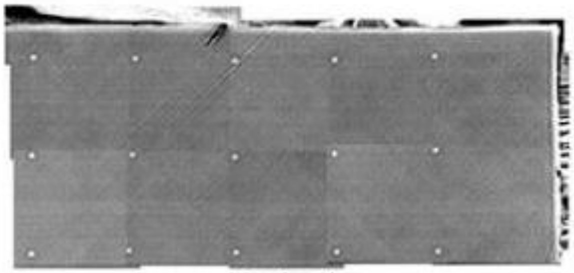
Raw Data – Quadrant IV



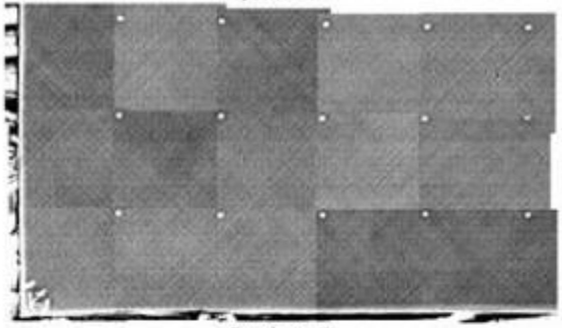
First Derivative – Overview



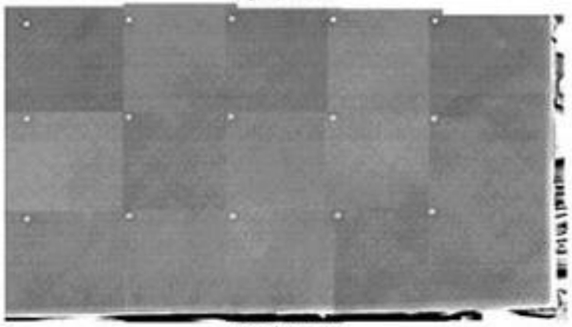
Quadrant II



Quadrant I

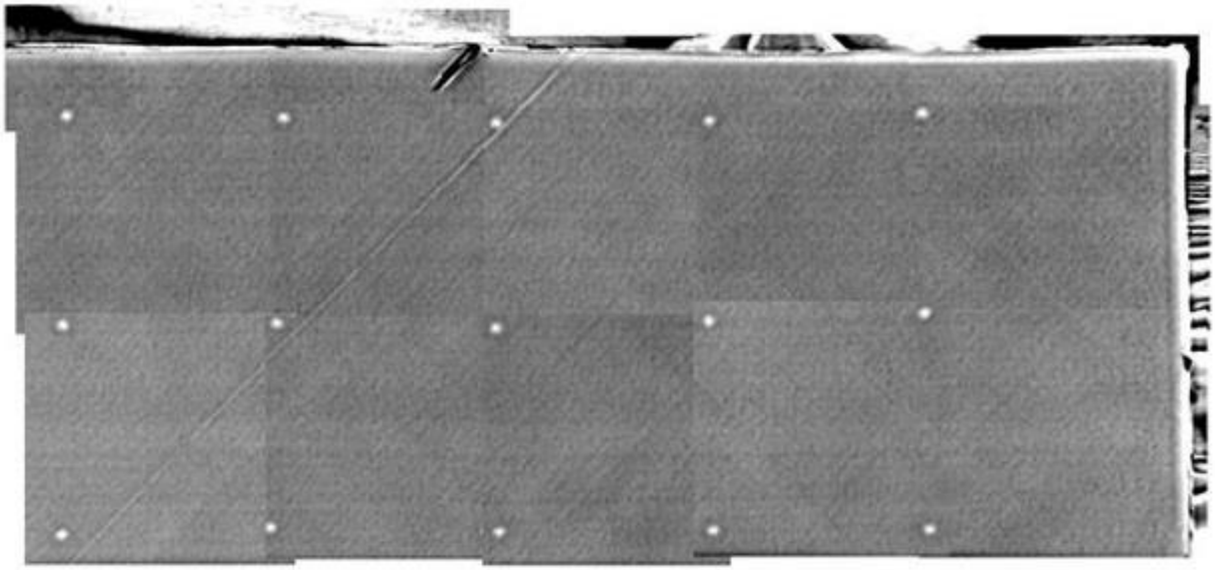


Quadrant III

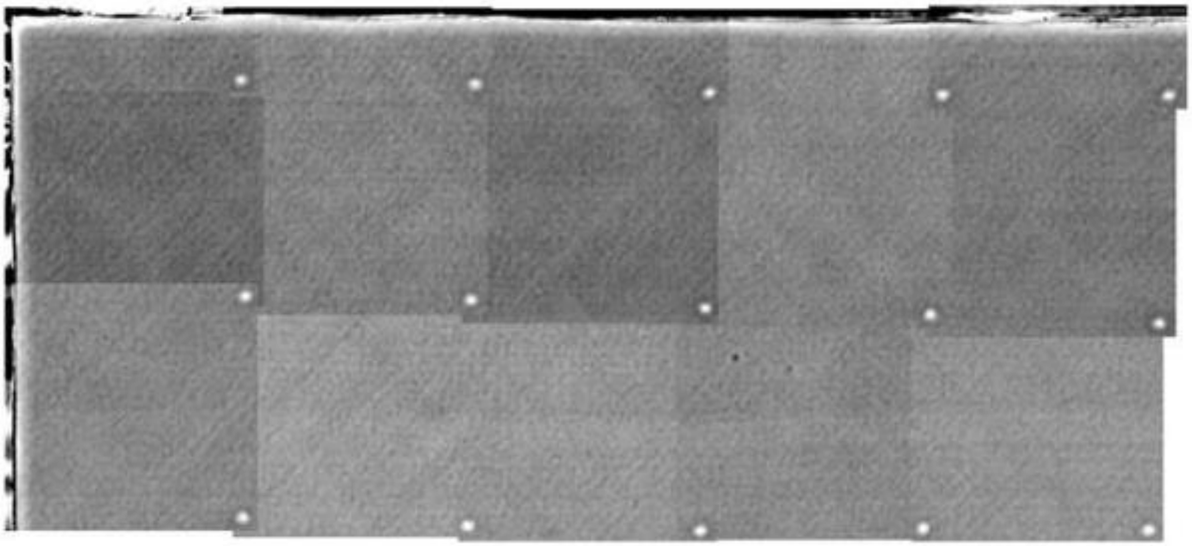


Quadrant IV

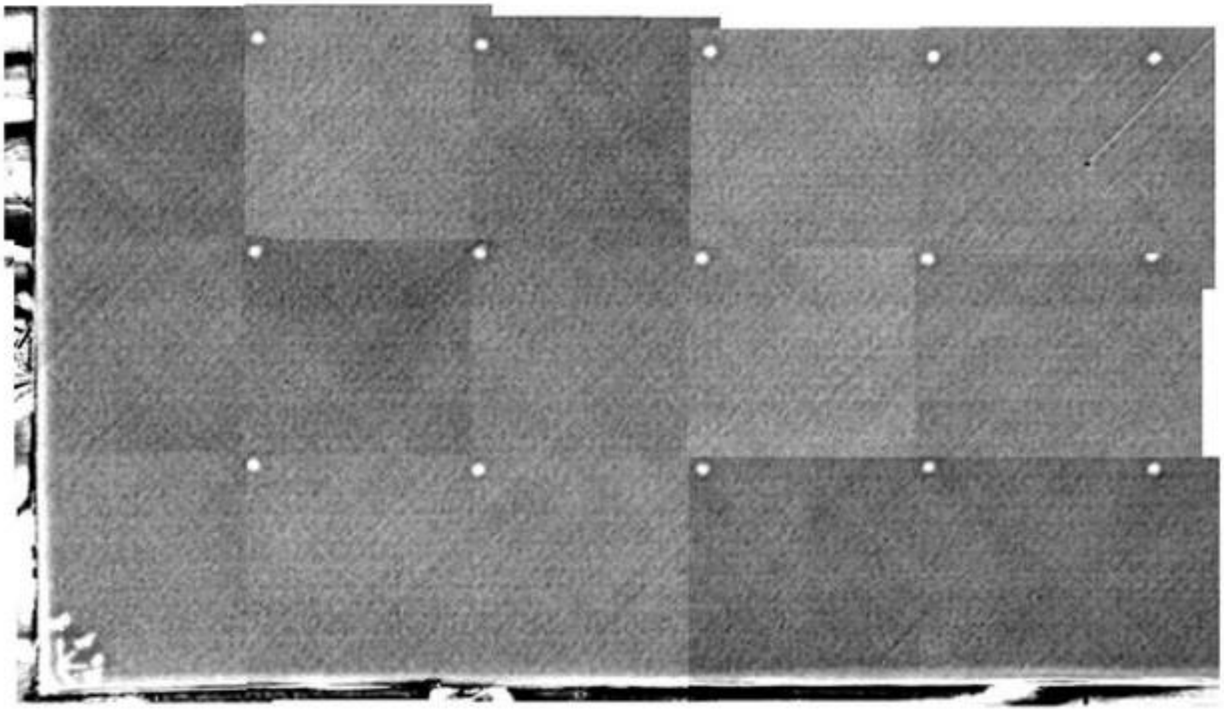
First Derivative – Quadrant I



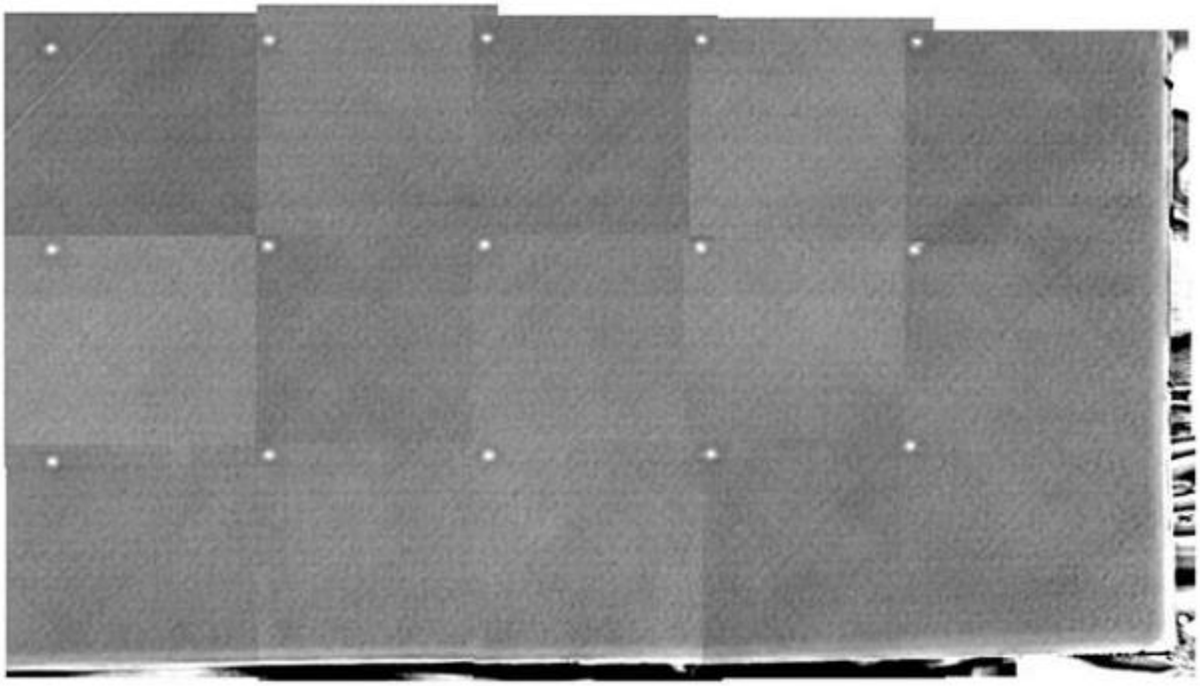
First Derivative – Quadrant II



First Derivative – Quadrant III

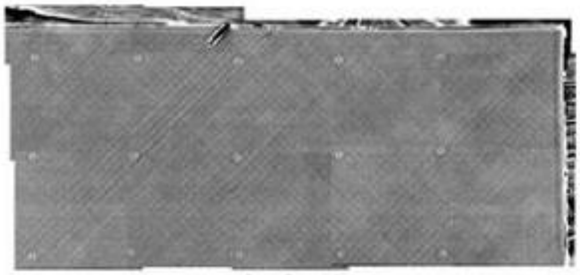


First Derivative – Quadrant IV

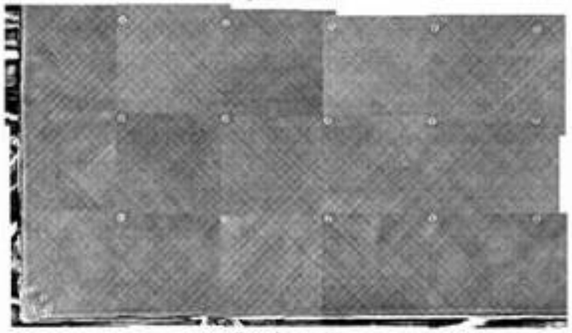


Second Derivative – Overview

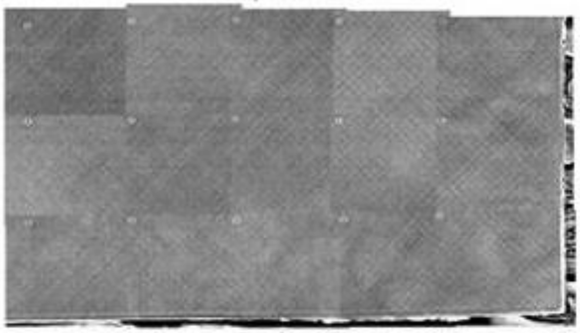
Quadrant II



Quadrant I

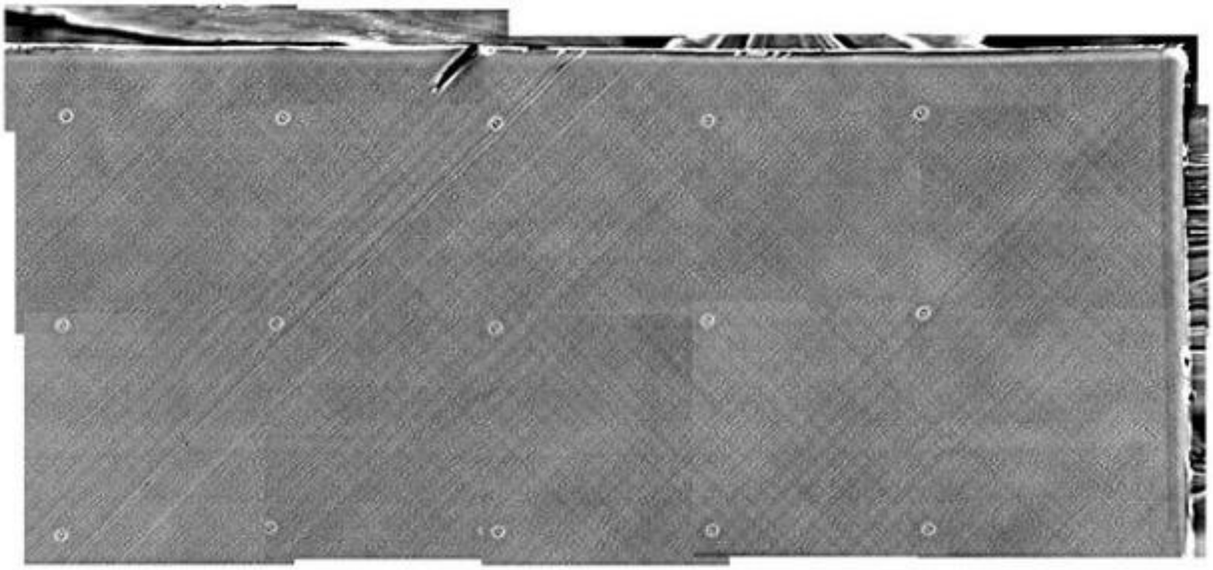


Quadrant III

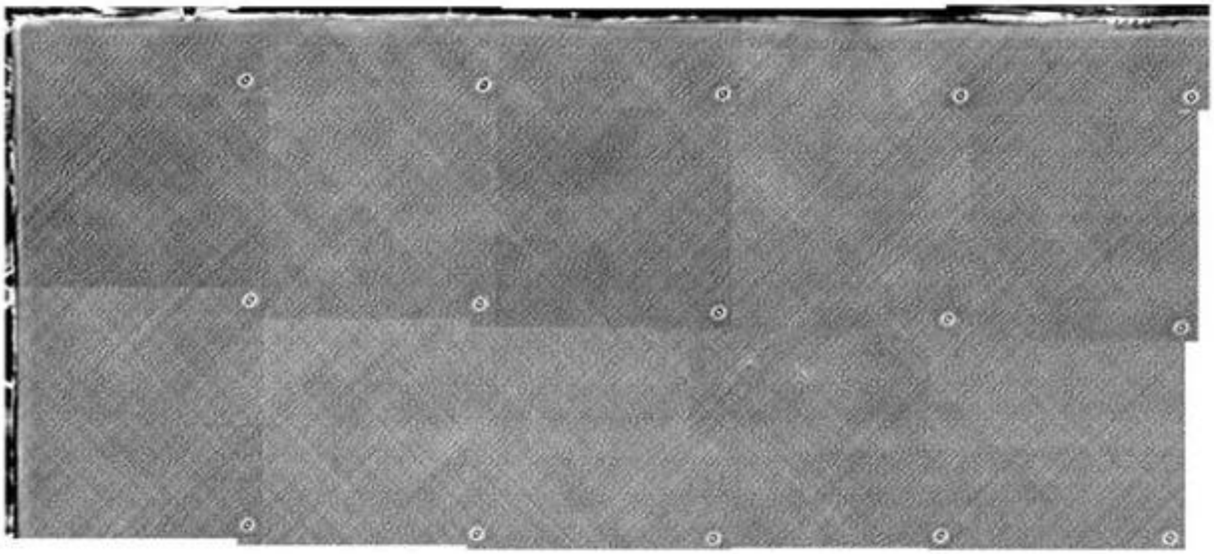


Quadrant IV

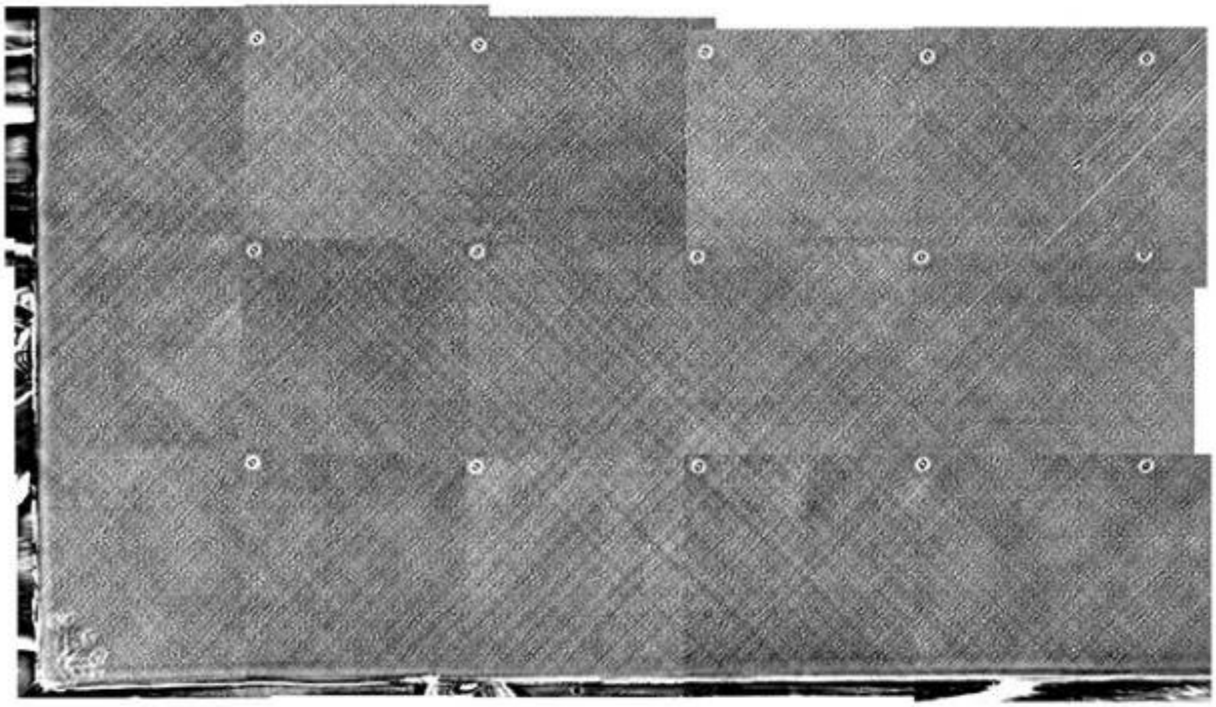
Second Derivative – Quadrant I

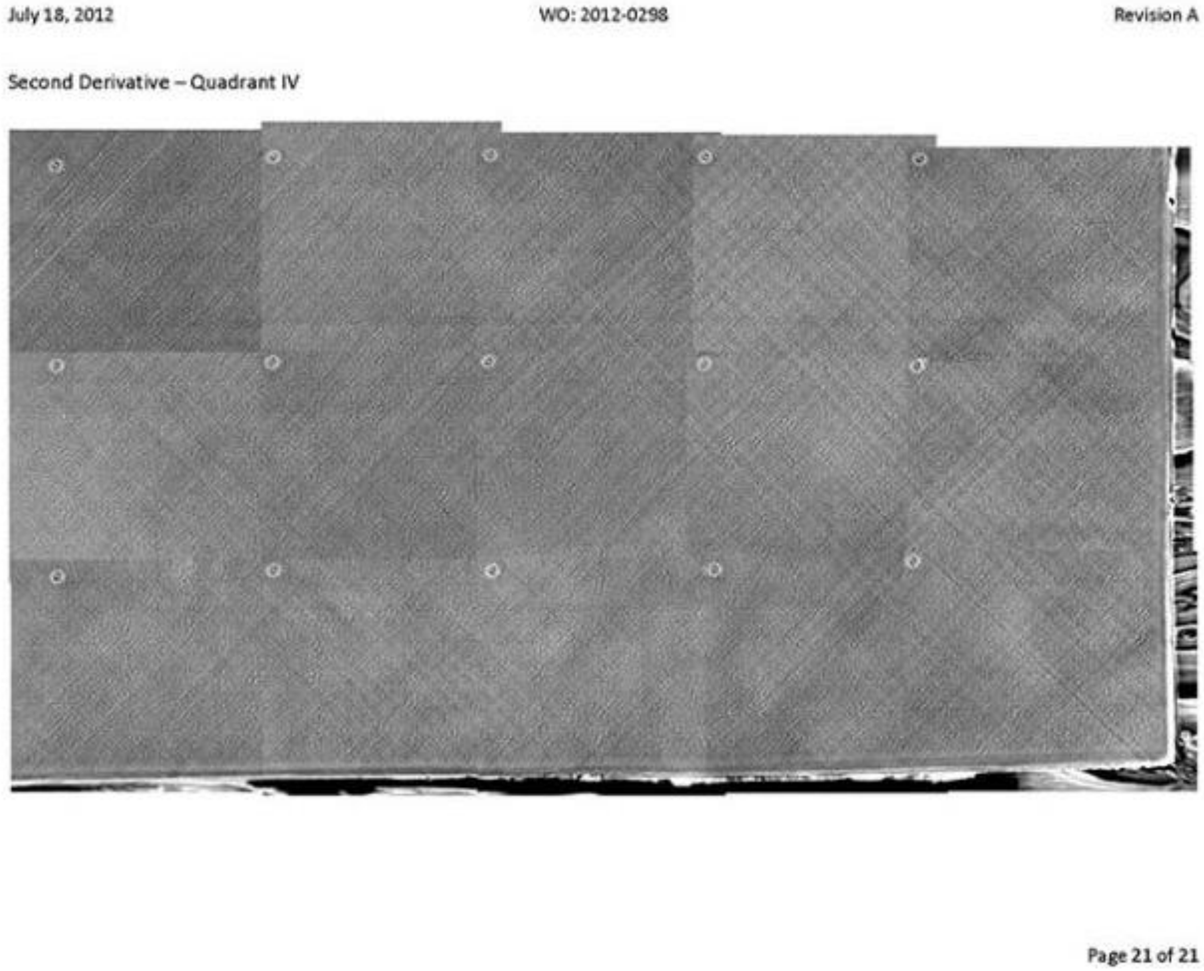


Second Derivative – Quadrant II



Second Derivative – Quadrant III





July 18, 2012 WO: 2012-0298 Revision A

Second Derivative – Quadrant IV

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Figure A31. Pathfinder Composite Flash Infrared Thermography Inspection Results

Ultrasonic Inspection Report

EV32 Pyroshock Pathfinder Panel
Work Order 2012-0298

18 July 2012

Prepared By

Matthew R. McDougal
EM20 Nondestructive Evaluation Team
NASA Marshall Space Flight Center
(256) 544-7783
matthew.mcdougal@nasa.gov

Specimen Information

Description	36" x 72" composite panel
Part Numbers	120298001

Inspection Equipment

Instrument	Olympus TomoScan Focus LT, SN FLT-1190
Software	Olympus TomoView 2.9R13
Scanner	Amdata Catamaran
Probe	Olympus 2.25L64-A2 MHz Phased Array, SN G0120
Wedge	Olympus SA2-0L-IHC

Inspection Settings

Mode	Pulse Echo
Frequency	2.25 MHz
Law Configuration	0° linear scan, 8 aperture, approx 0.1" focus
Acquisition Range	16.8 µsec
Filter	None
Gain	15 dB
Compression	5 samples
Scanning Rate	0.6 in./sec
Scan Resolution	0.0295" x 0.0394"
Couplant	Submerged in water
Orientation	Scanned from back surface in 3 columns with edge with writing at the bottom. Images oriented to front view.
Notes	None

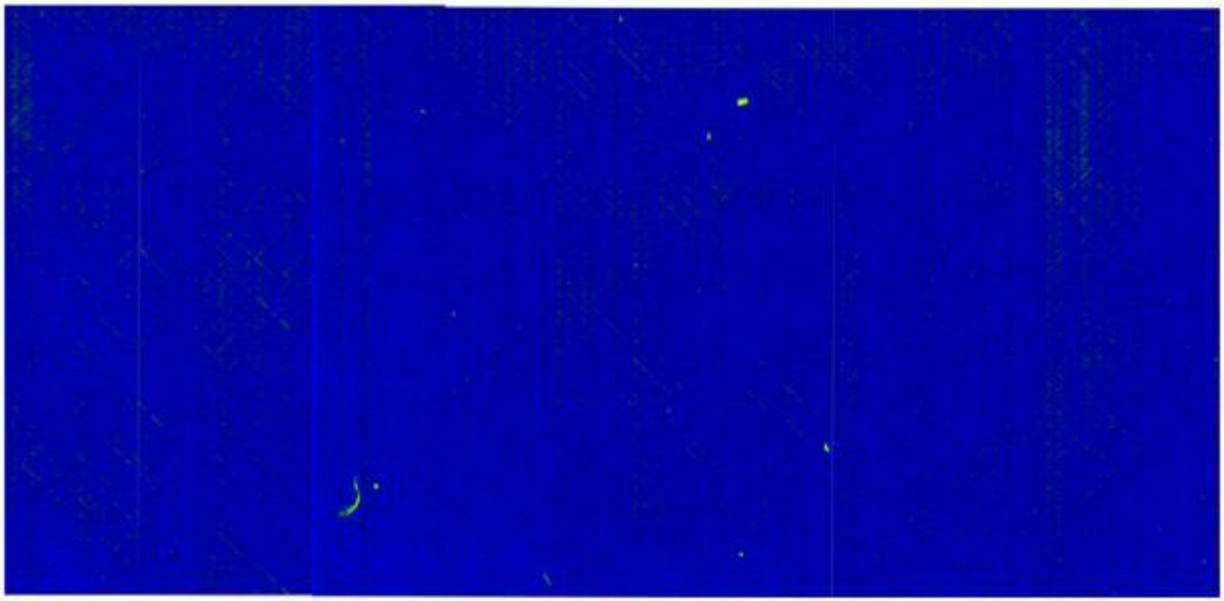
Panel Overview

Page 2 of 5

Photo of panel, oriented to match other imagery

Panel Overview

Page 3 of 5

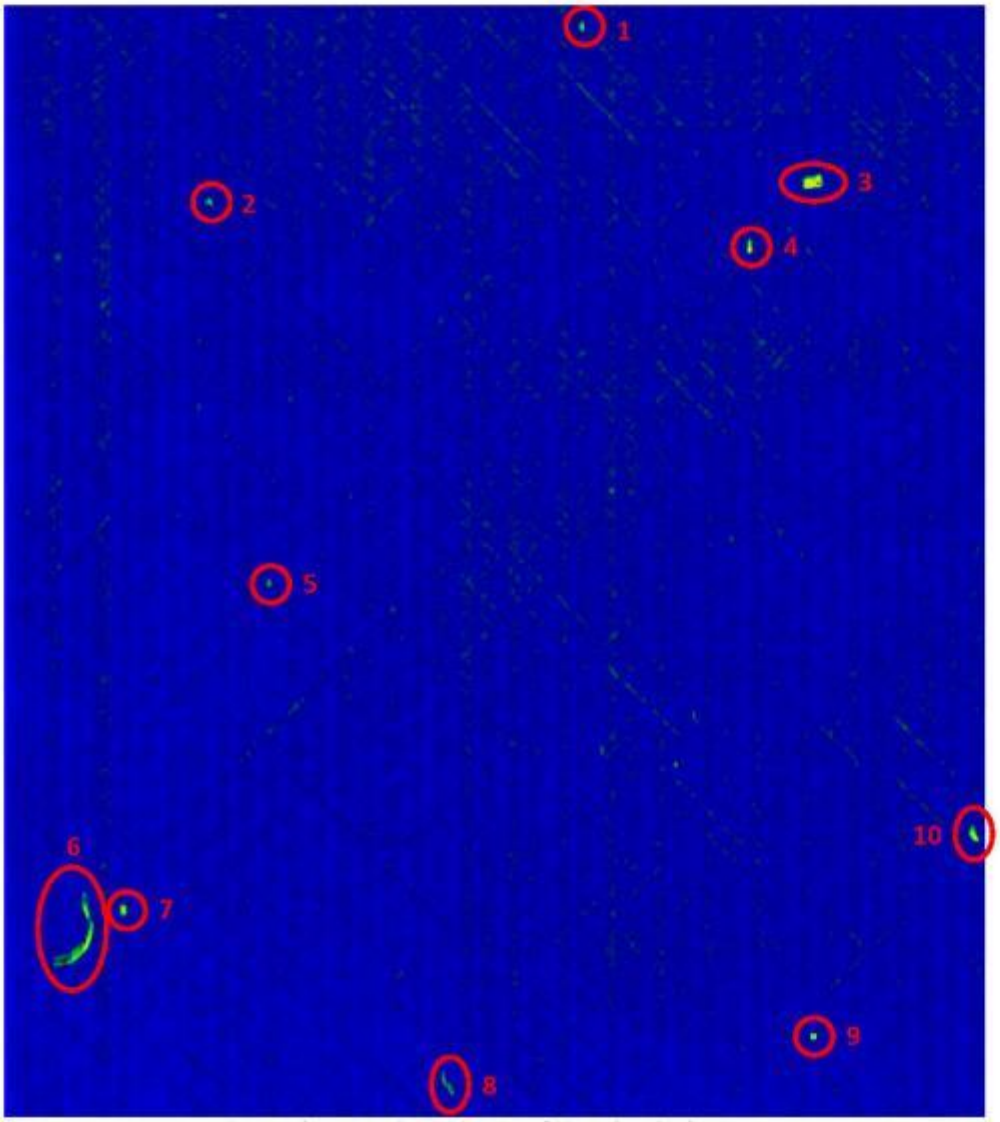


Overview composite image of data from all three scans.

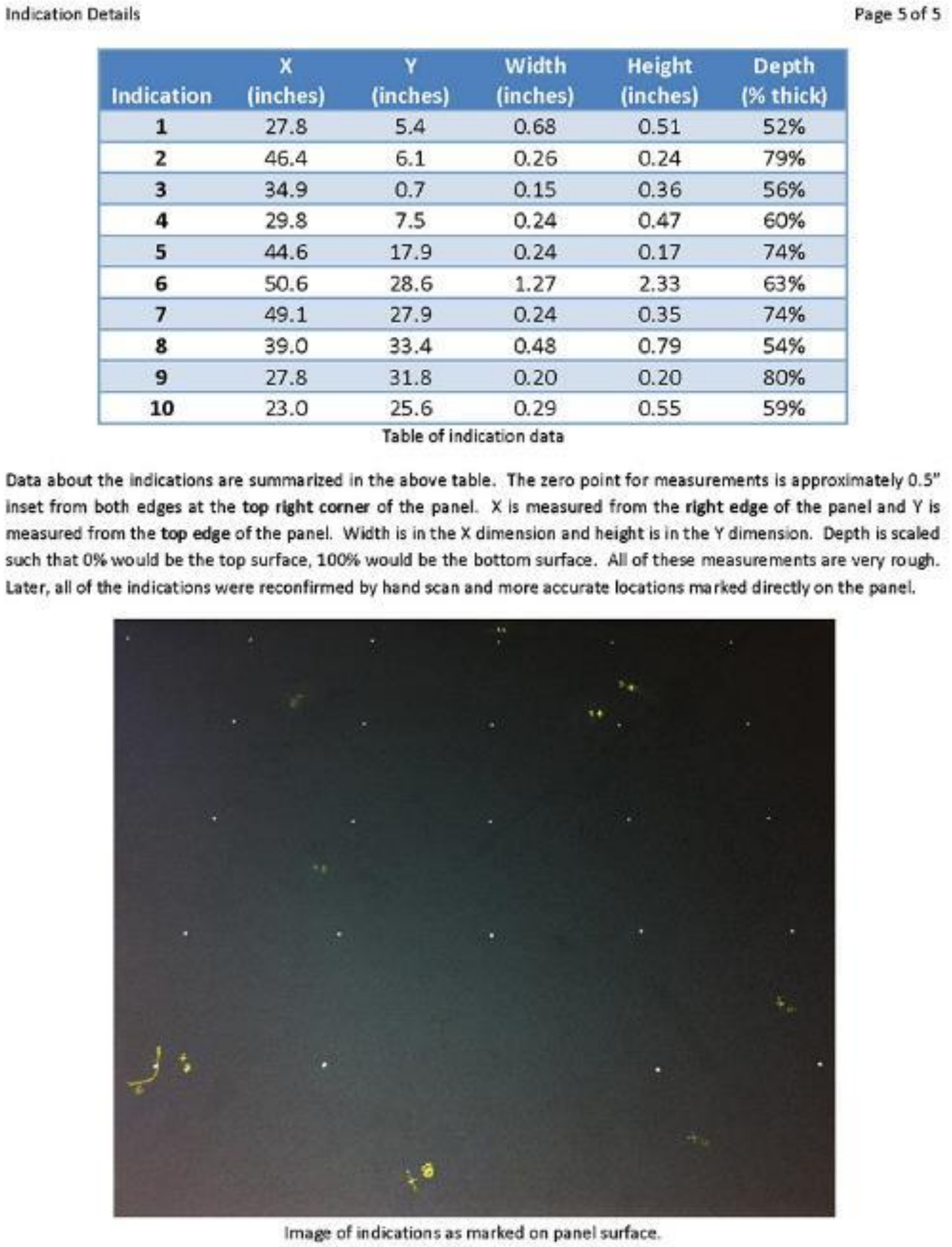
Ten indications were noted on this panel. Seven of the ten indications were corroborated by being seen in 2 separate scans. Sizes vary and most of the indications appear to be approximately midway through the panel thickness. There are also several indeterminate areas with scattered small reflections. Notably, none of the indications appear to correlate with indentions and markings visible on the rear surface of the panel.

Indication Details

Page 4 of 5



Center column scan showing location of 10 numbered indications.



Indication Details

Page 5 of 5

Indication	X (inches)	Y (inches)	Width (inches)	Height (inches)	Depth (% thick)
1	27.8	5.4	0.68	0.51	52%
2	46.4	6.1	0.26	0.24	79%
3	34.9	0.7	0.15	0.36	56%
4	29.8	7.5	0.24	0.47	60%
5	44.6	17.9	0.24	0.17	74%
6	50.6	28.6	1.27	2.33	63%
7	49.1	27.9	0.24	0.35	74%
8	39.0	33.4	0.48	0.79	54%
9	27.8	31.8	0.20	0.20	80%
10	23.0	25.6	0.29	0.55	59%

Table of indication data

Data about the indications are summarized in the above table. The zero point for measurements is approximately 0.5" inset from both edges at the **top right corner** of the panel. X is measured from the **right edge** of the panel and Y is measured from the **top edge** of the panel. Width is in the X dimension and height is in the Y dimension. Depth is scaled such that 0% would be the top surface, 100% would be the bottom surface. All of these measurements are very rough. Later, all of the indications were reconfirmed by hand scan and more accurate locations marked directly on the panel.

Image of indications as marked on panel surface.

Figure A32. Pathfinder Composite Phased Array Ultrasound Inspection Results

Figure A33 illustrates typical ultrasound inspection data of the monolithic IM7/TC350 composite panels and the high-level assembly quality of the panels (no significant indications were found in any of the TC350 composite panels).

Ultrasonic Inspection Report

Pyroshock Panels
Work Order 2012-0620

14 December 2012

Prepared By

Matthew R. McDougal
EM20 Nondestructive Evaluation Team
NASA Marshall Space Flight Center
(256) 544-7783
matthew.mcdougal@nasa.gov

Specimen Information

Description	~ 36" x 72" composite panels, 0.2" thick, qty. 2
Part Numbers	0320A001 and 0320A002

Inspection Equipment

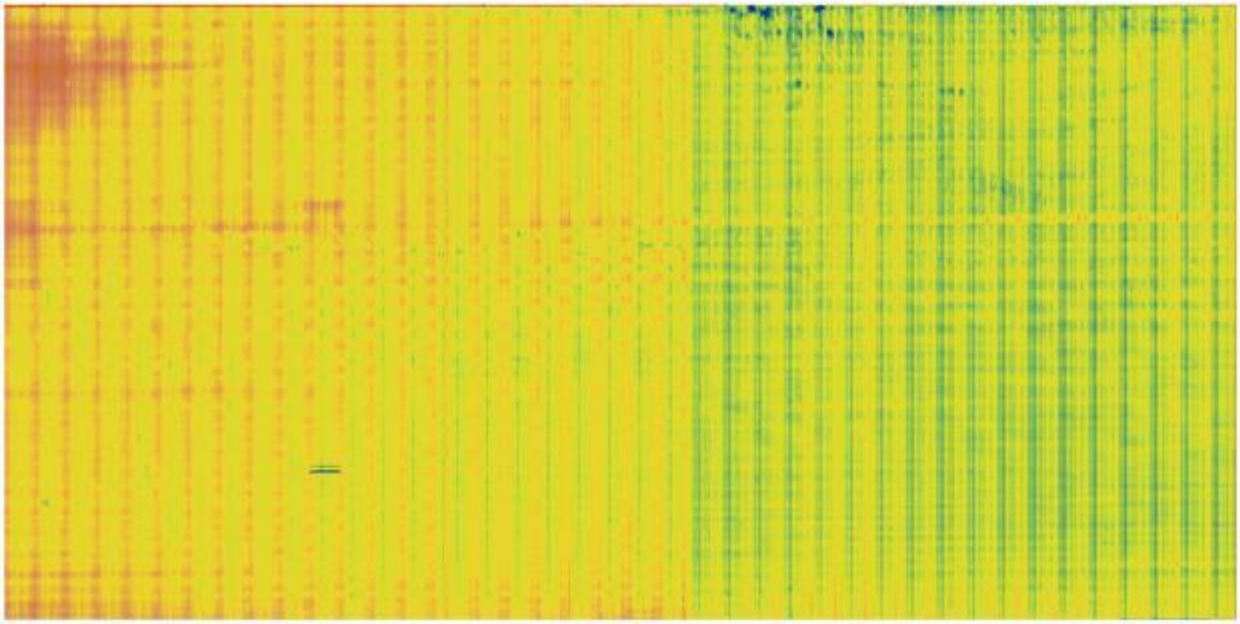
Instrument	Olympus Tomoscan Focus LT, SN FLT-1190
Scanner	Amdata Catamaran
Probe	Olympus 2.25L64-A2 Phased Array, SN G0120
Wedge	Olympus SA2-0L-IHC

Inspection Settings

Mode	Pulse Echo
Frequency	2.25 MHz
Law Configuration	0° linear scan, 8 aperture, approx. 0.1" focus
Acquisition Range	16.8 µsec
Filter	None
Gain	13.5 dB
Compression	5 samples
Scanning Rate	0.7 in./sec
Scan Resolution	0.0295" x 0.0394"
Couplant	Submerged in water
Orientation	Scanned in 3 columns, min. 5" overlap. Panel text at bottom left.
Notes	None

Panel 0320A001

Page 2 of 7

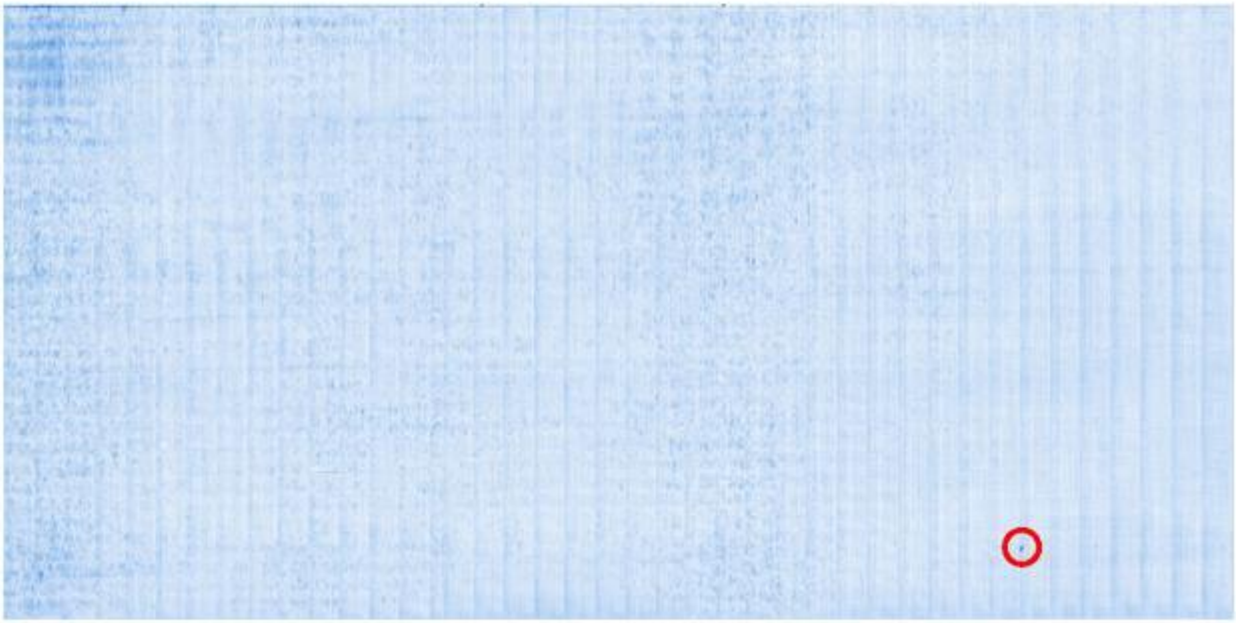


Gated for front surface

No indications noted.

Panel 0320A001

Page 3 of 7

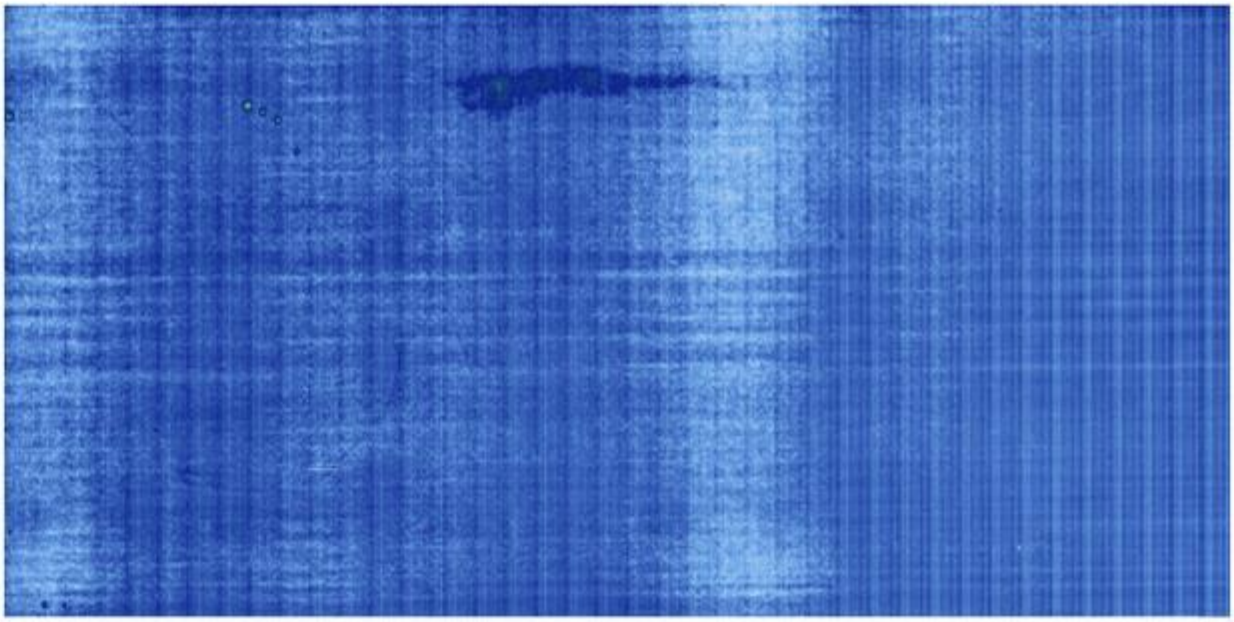


Gated for through-thickness.

One tiny indication.

Panel 0320A001

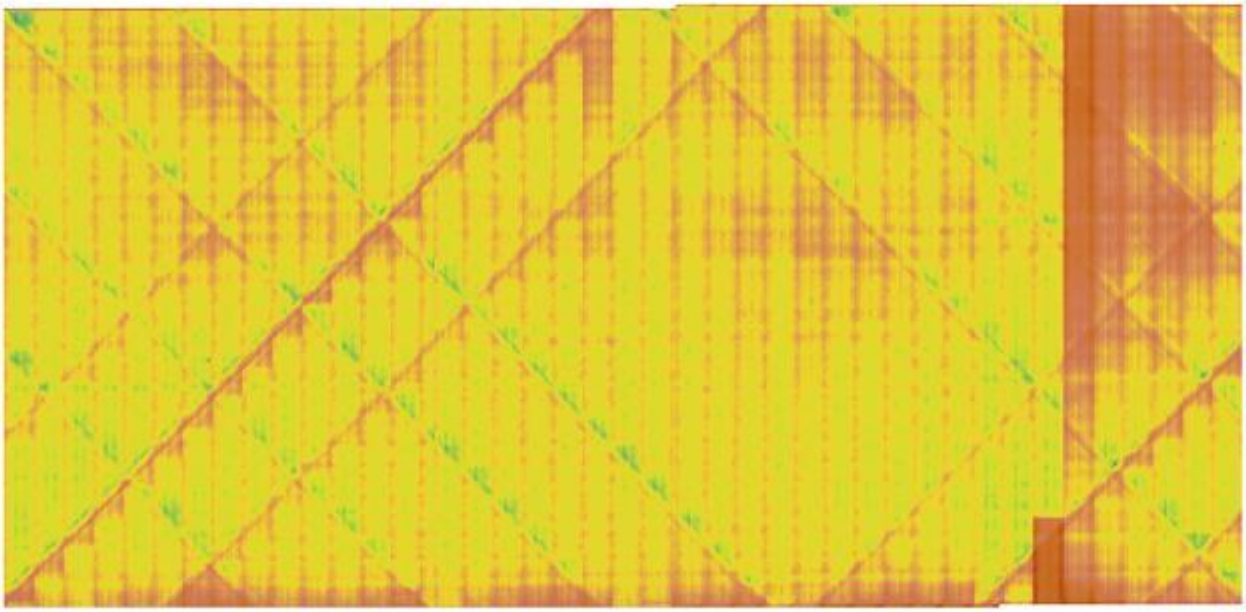
Page 4 of 7



Gated for back surface.

No indications noted. Patterns are due to air bubbles trapped under panel during scan.

Panel 0320A002

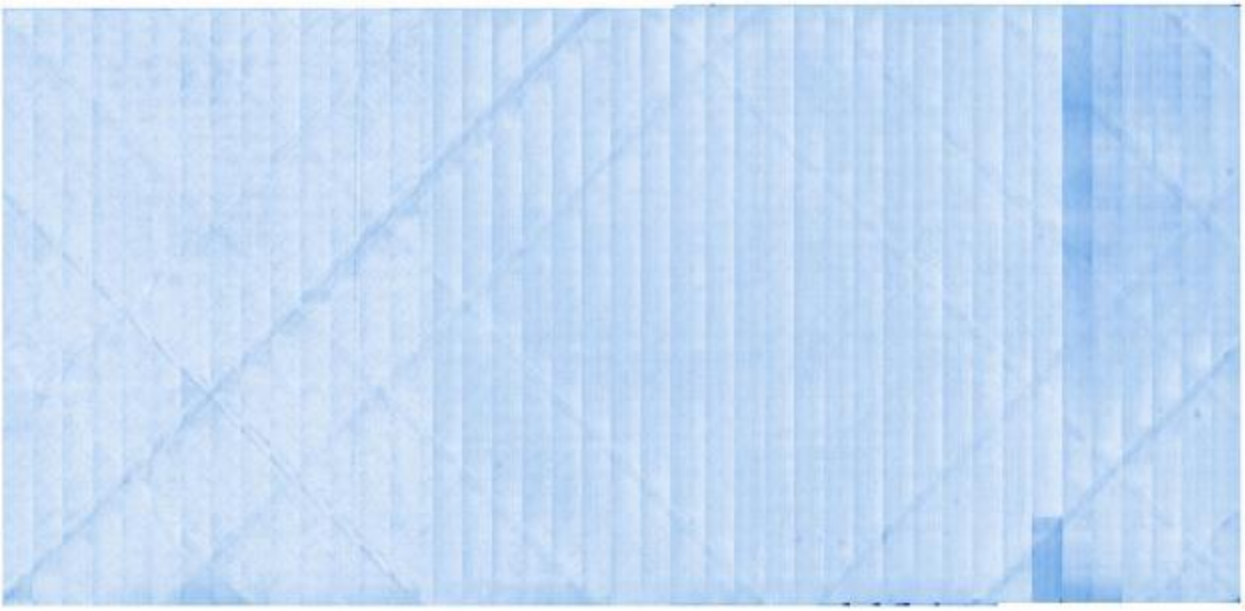


Gated for front surface.

No indications noted.

Panel 0320A002

Page 6 of 7



Gated for through-thickness.

No indications noted.

Panel 0320A002

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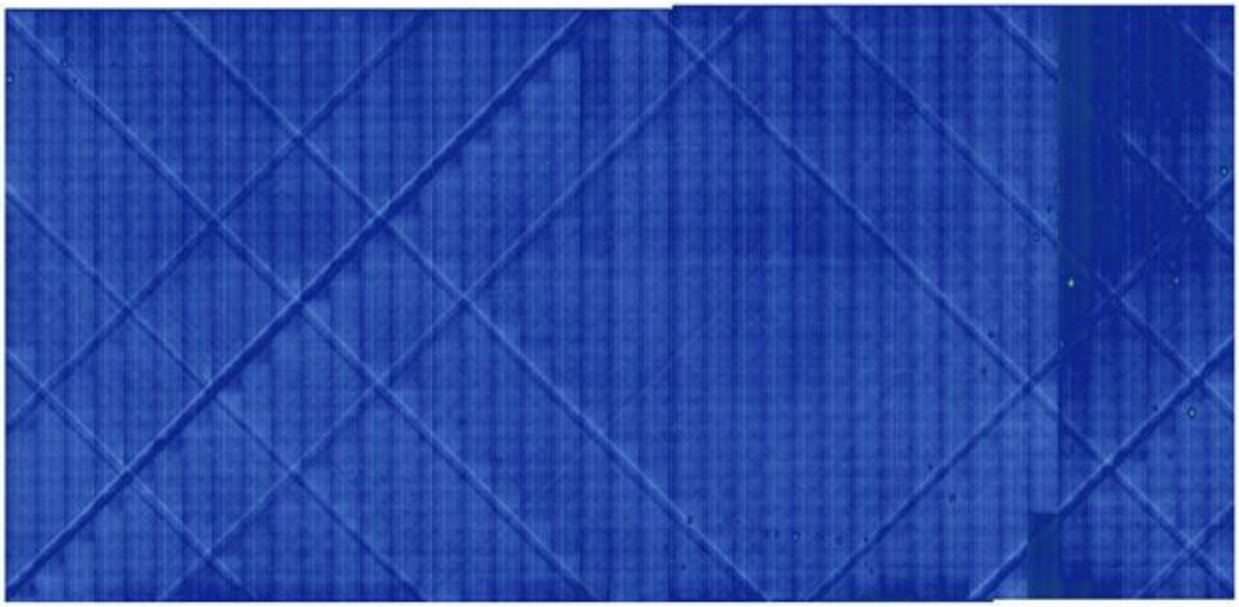
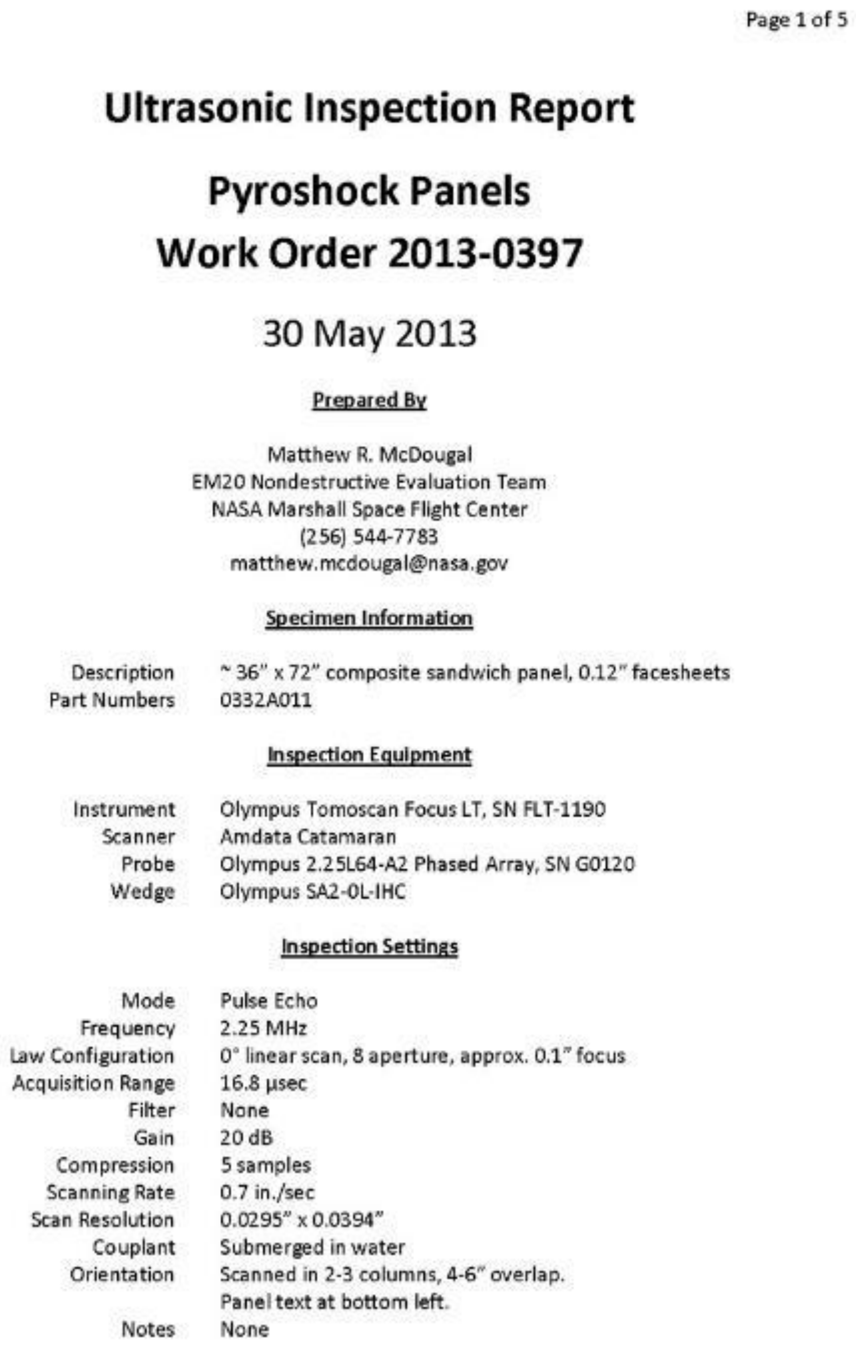


Gated for back surface.

No indications noted. Spots are from air bubbles trapped under panel during scan.

Figure A33. Ultrasound Inspection Results of Monolithic Test Panel #1 and #2

Phased array ultrasound (also referred herein as pulse echo ultrasound) was also used for NDE of the composite sandwich panels. The technique used was entirely acceptable for the through thickness of the composite face sheets and the bond line between the face sheets and the fill core material. Results from the pulse echo ultrasound for composite sandwich panels #11 through #18 are documented in Figure A34. Ultrasound inspection, however, is not a suitable NDE method for evaluating flaws in the foam filler core material. A study was undertaken to evaluate an acceptable NDE methodology for resolving a flaw (crack) in the ROHACELL® foam. Two methods were evaluated; digital radiography (DR) and computed tomography (CT). The results of the study are documented in Figure A35, which show only the CT method was able to detect flaws in the foam filler material.



Ultrasonic Inspection Report

Pyroshock Panels
Work Order 2013-0397

30 May 2013

Prepared By

Matthew R. McDougal
EM20 Nondestructive Evaluation Team
NASA Marshall Space Flight Center
(256) 544-7783
matthew.mcdougal@nasa.gov

Specimen Information

Description	~ 36" x 72" composite sandwich panel, 0.12" facesheets
Part Numbers	0332A011

Inspection Equipment

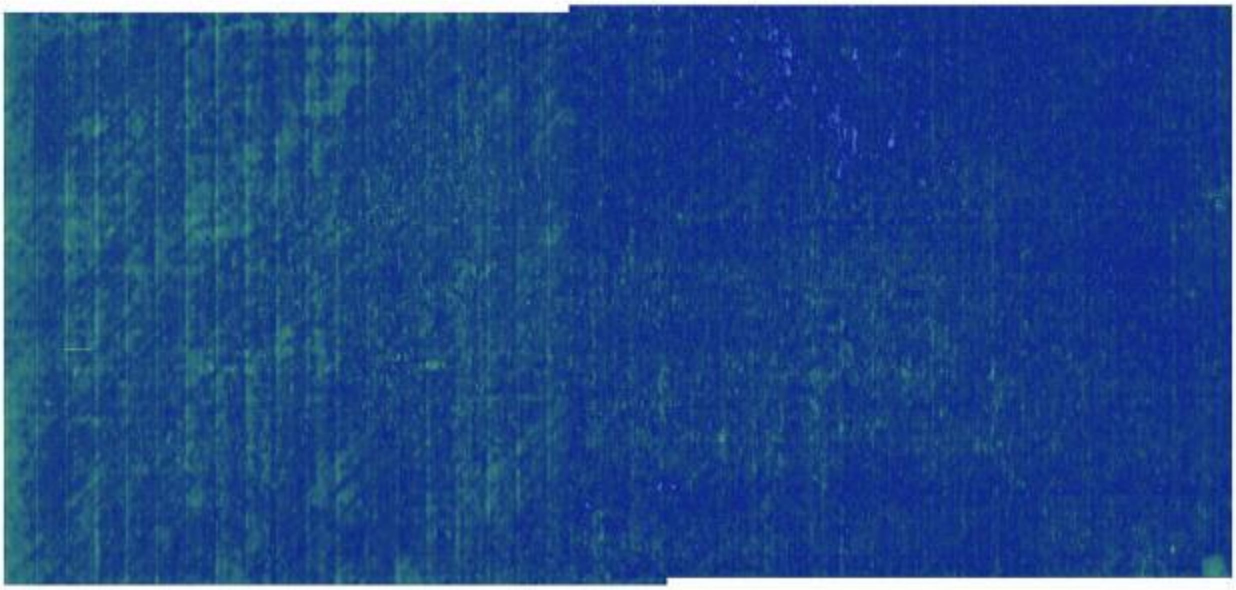
Instrument	Olympus Tomoscan Focus LT, SN FLT-1190
Scanner	Amdata Catamaran
Probe	Olympus 2.25L64-A2 Phased Array, SN G0120
Wedge	Olympus SA2-0L-IHC

Inspection Settings

Mode	Pulse Echo
Frequency	2.25 MHz
Law Configuration	0° linear scan, 8 aperture, approx. 0.1" focus
Acquisition Range	16.8 µsec
Filter	None
Gain	20 dB
Compression	5 samples
Scanning Rate	0.7 in./sec
Scan Resolution	0.0295" x 0.0394"
Couplant	Submerged in water
Orientation	Scanned in 2-3 columns, 4-6" overlap. Panel text at bottom left.
Notes	None

Panel 0332A011 Front

Page 2 of 5

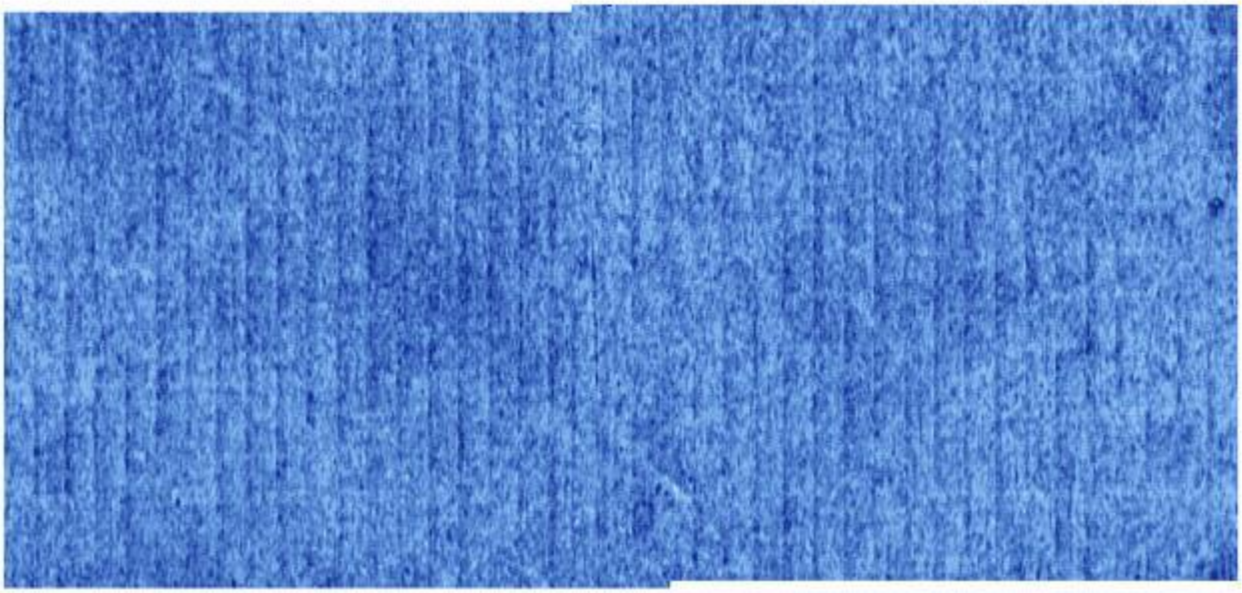


Front side, gated for facesheet thickness.

No indications noted.

Panel 0332A011 Front

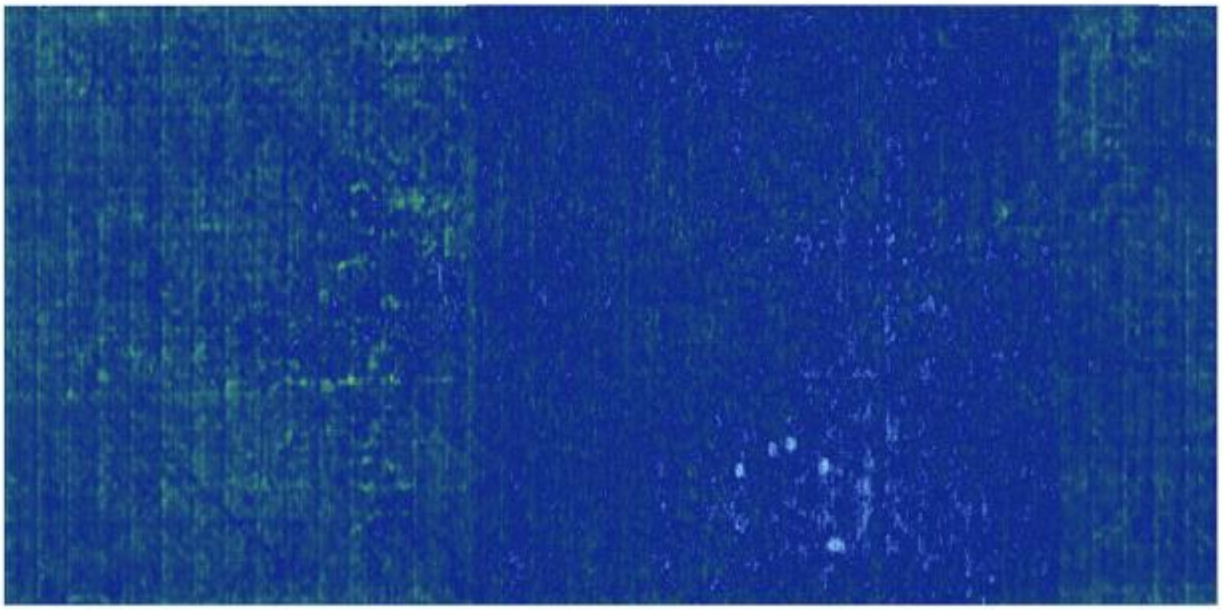
Page 3 of 5



Front side, gated for bondline.

No indications noted.

Panel 0332A011 Back

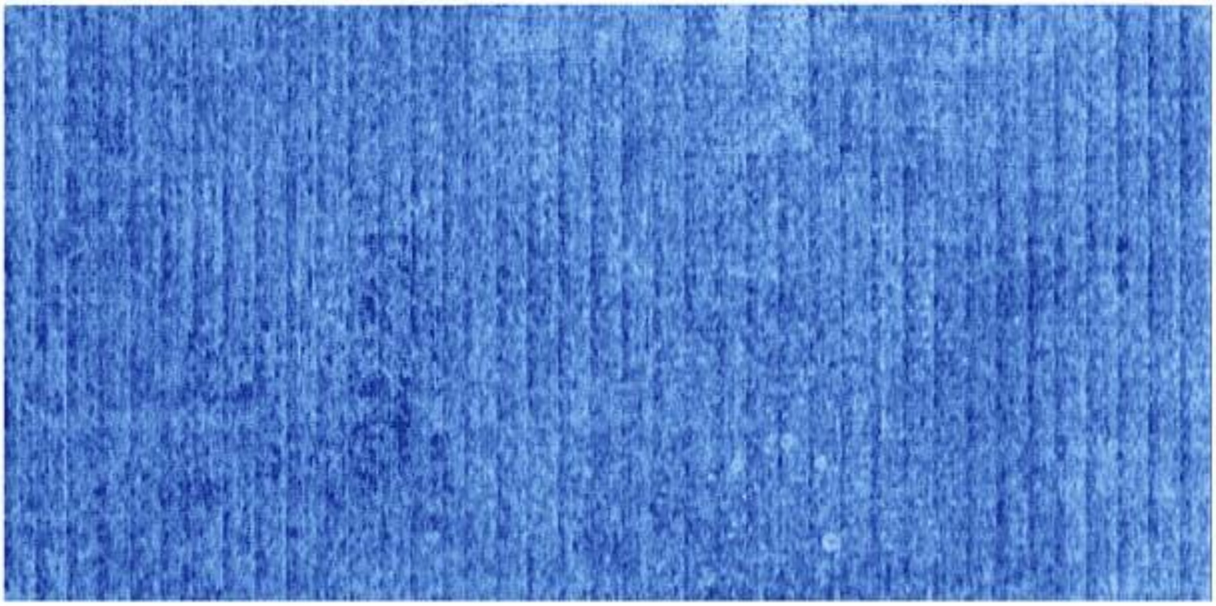


Back side, gated for facesheet thickness.

No indications noted.

Panel 0332A011 Back

Page 5 of 5



Back side, gated for bondline.

No indications noted.

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Ultrasonic Inspection Report

Pyroshock Panels

Work Order 2013-0397, Part II

14 June 2013

Prepared By

Matthew R. McDougal
EM20 Nondestructive Evaluation Team
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Scott Ragasa
University of Alabama in Huntsville
(256) 544-3935
joseph.s.ragasa@nasa.gov

Specimen Information

Description	~ 36" x 72" composite sandwich panel, 0.12" facesheets
Part Numbers	0332A014

Inspection Equipment

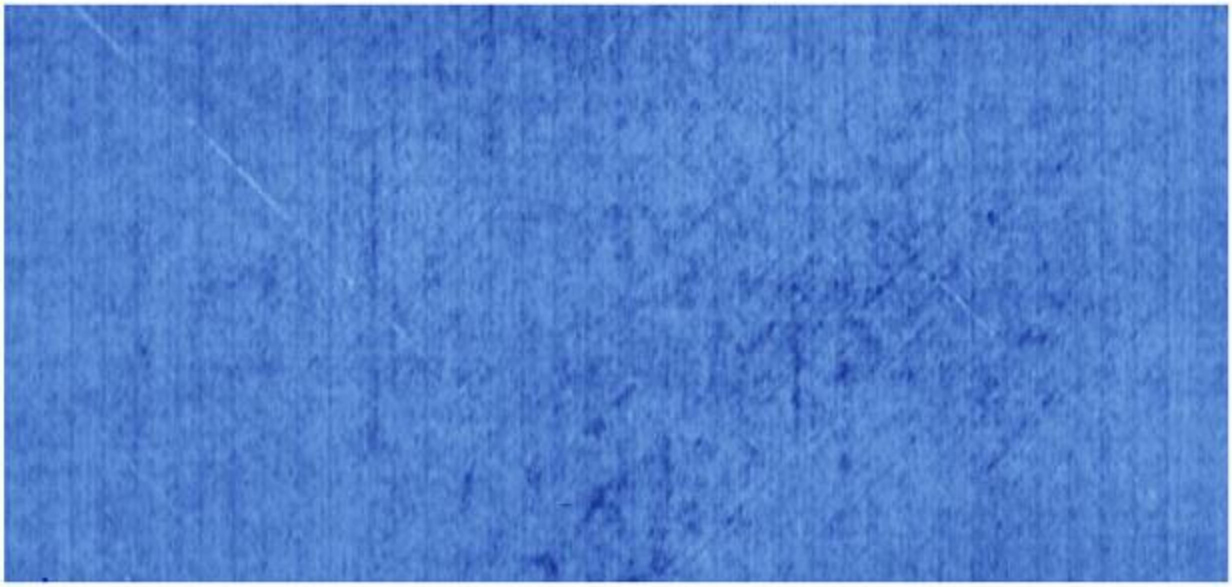
Instrument	Olympus Tomoscan Focus LT, SN FLT-1190
Scanner	Amdata Catamaran
Probe	Olympus 2.25L64-A2 Phased Array, SN G0120
Wedge	Olympus SA2-0L-IHC

Inspection Settings

Mode	Pulse Echo
Frequency	2.25 MHz
Law Configuration	0° linear scan, 8 aperture, approx. 0.1" focus
Acquisition Range	16.8 μsec
Filter	None
Gain	20 dB
Compression	5 samples
Scanning Rate	0.7 in./sec
Scan Resolution	0.0295" x 0.0394"
Couplant	Submerged in water
Orientation	Scanned in 2 columns, 4-6" overlap. Panel text at bottom left.
Notes	None

Panel 0332A014 Front

Page 2 of 5

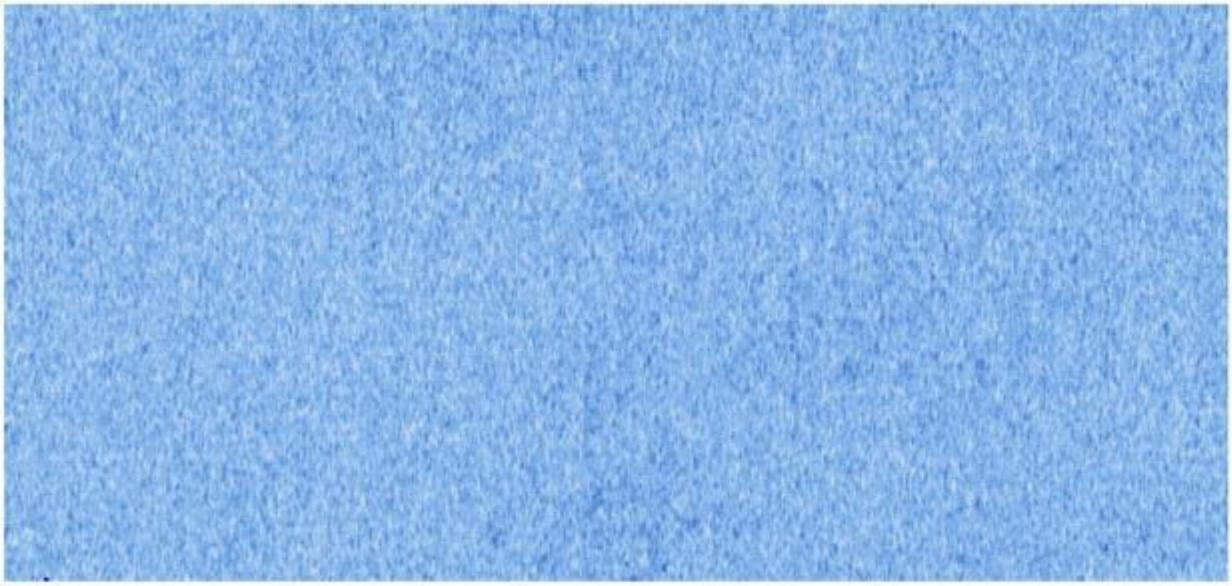


Front side, gated for facesheet thickness.

No indications noted.

Panel 0332A014 Front

Page 3 of 5

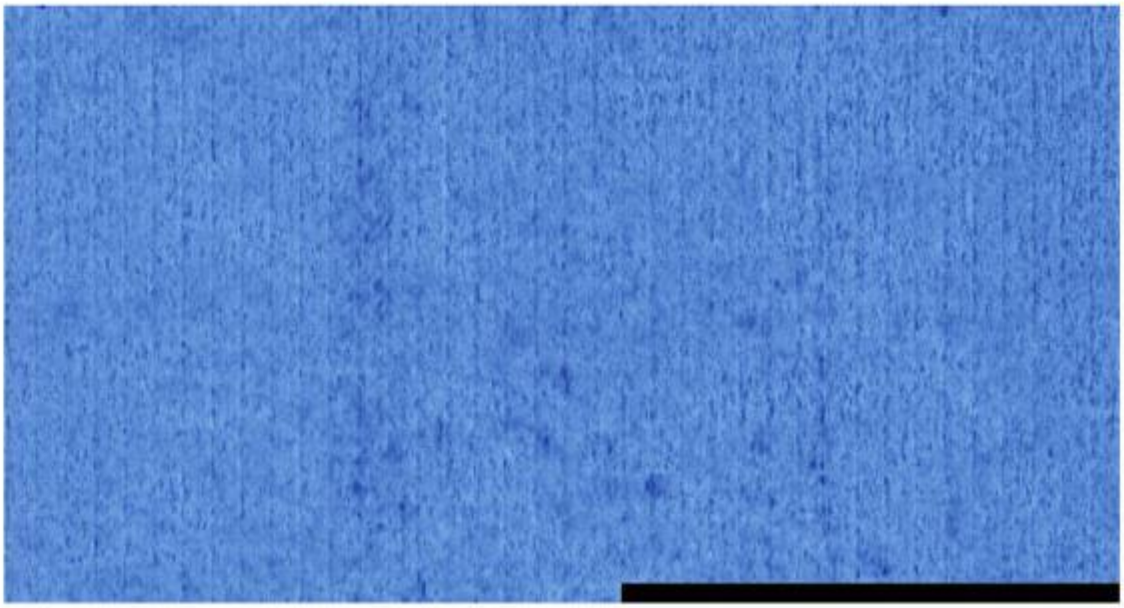


Front side, gated for bondline.

No indications noted.

Panel 0332A014 Back

Page 4 of 5

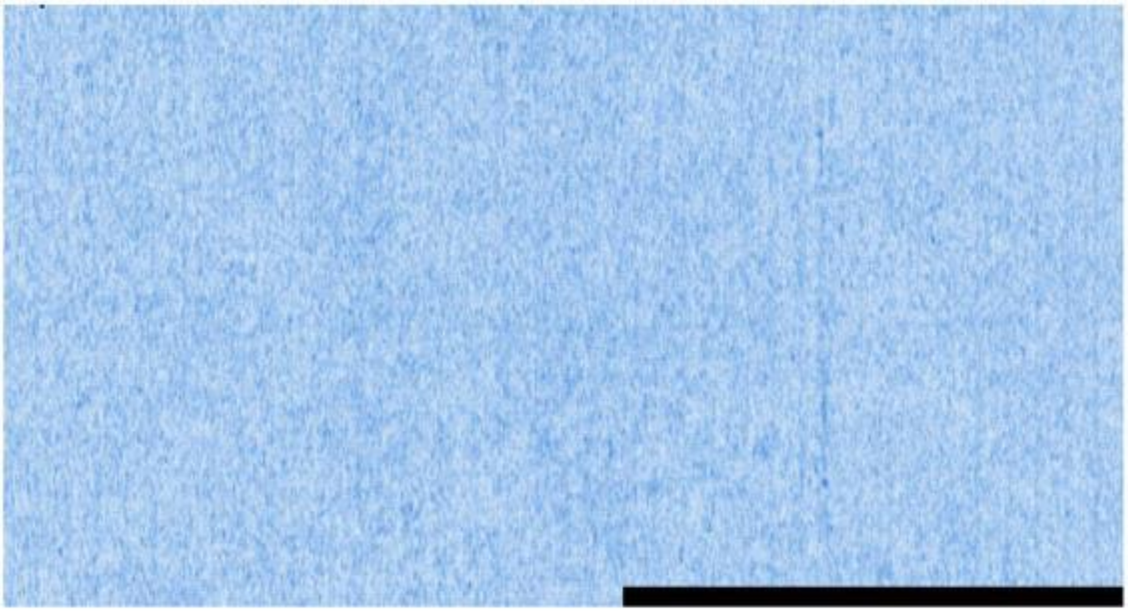


Back side, gated for facesheet thickness.

No indications noted.

Panel 0332A014 Back

Page 5 of 5



[redacted]

Back side, gated for bondline.

No indications noted.

Ultrasonic Inspection Report

Pyroshock Panels

Work Order 2013-0397, Part III

9 July 2013

Prepared By

Matthew R. McDougal
EM20 Nondestructive Evaluation Team
NASA Marshall Space Flight Center
(256) 544-7783
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Scott Ragasa
University of Alabama in Huntsville
(256) 544-3935
joseph.s.ragasa@nasa.gov

Specimen Information

Description	~ 36" x 72" composite sandwich panels, qty. 6
Part Numbers	0332A012, 0332A013, 0332A015, 0332A016, 0332A017, 0332A018

Inspection Equipment

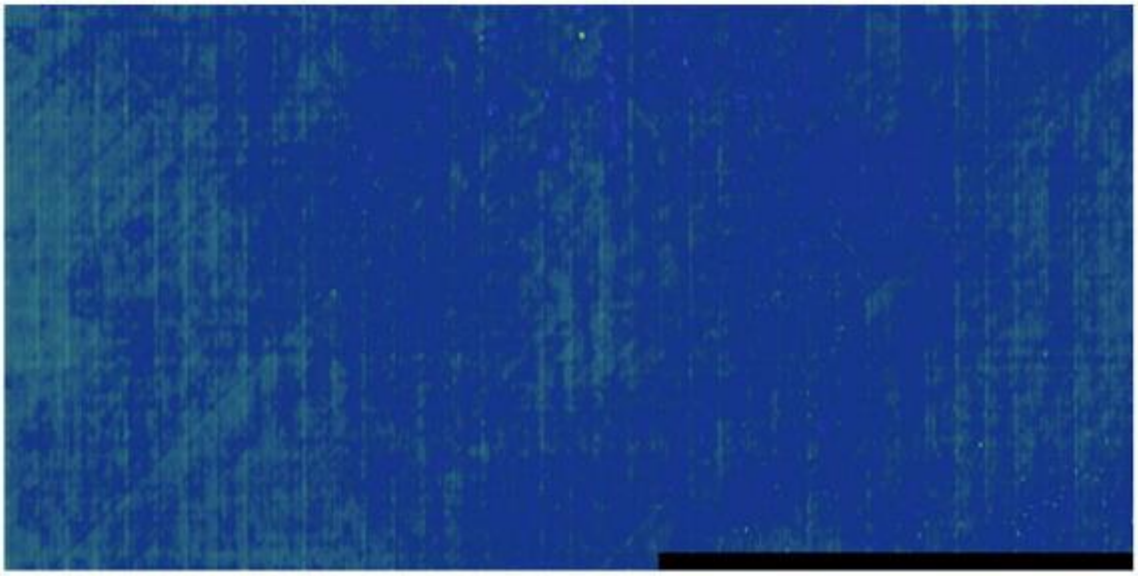
Instrument	Olympus Tomoscan Focus LT, SN FLT-1190
Scanner	Amdata Catamaran
Probe	Olympus 2.25L64-A2 Phased Array, SN G0120
Wedge	Olympus SA2-0L-IHC

Inspection Settings

Mode	Pulse Echo
Frequency	2.25 MHz
Law Configuration	0° linear scan, 8 aperture, approx. 0.1" focus
Acquisition Range	16.8 µsec
Filter	None
Gain	20 dB
Compression	5 samples
Scanning Rate	0.7 in./sec
Scan Resolution	0.0295" x 0.0394"
Couplant	Submerged in water
Orientation	Scanned in 2 columns, 4-6" overlap. Panel text at bottom left.
Notes	None

Panel 0332A012 Front

Page 2 of 25

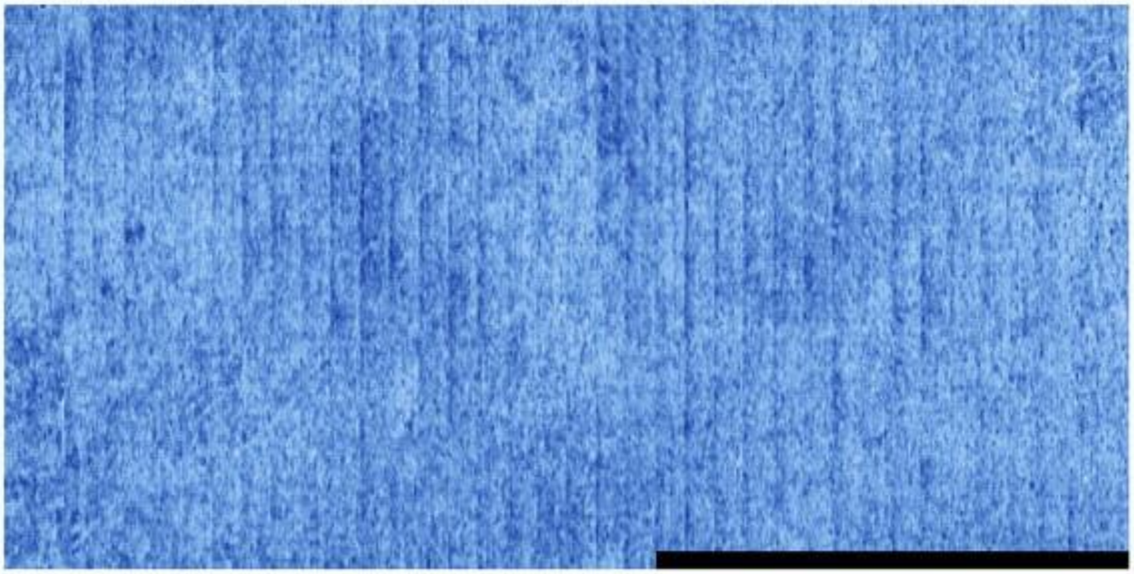


Front side, gated for facesheet thickness.

No indications noted.

Panel 0332A012 Front

Page 3 of 25

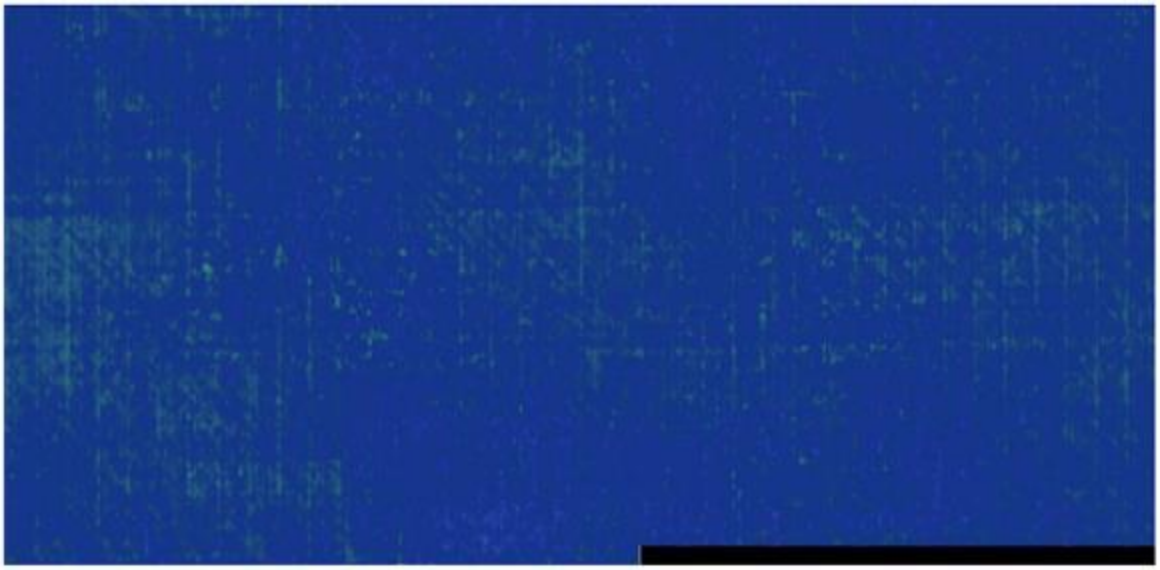


Front side, gated for bondline.

No indications noted.

Panel 0332A012 Back

Page 4 of 25

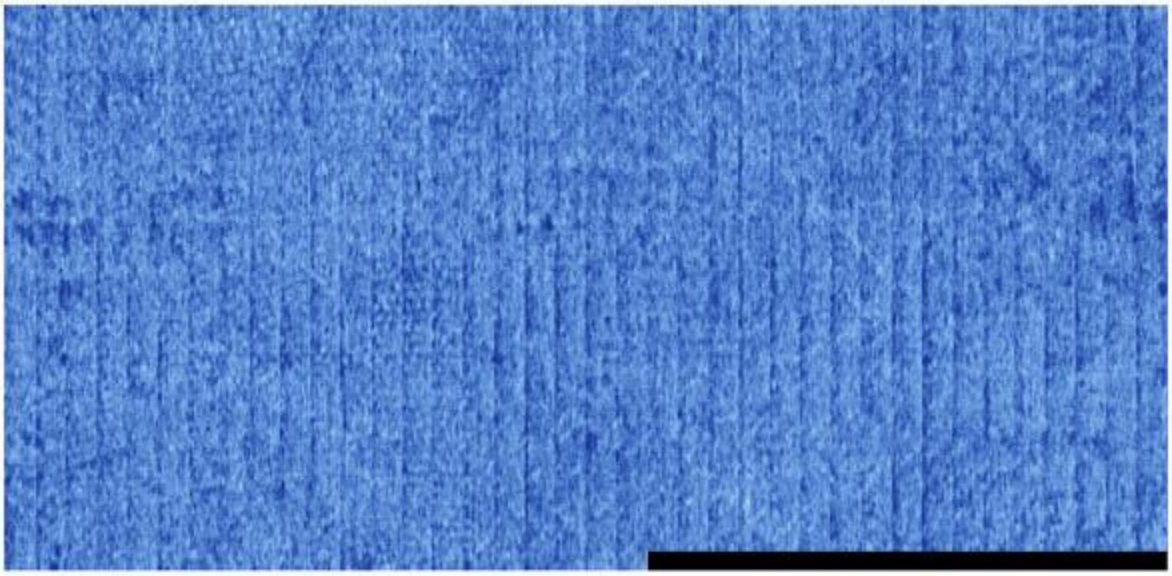


Back side, gated for facesheet thickness.

No indications noted.

Panel 0332A012 Back

Page 5 of 25

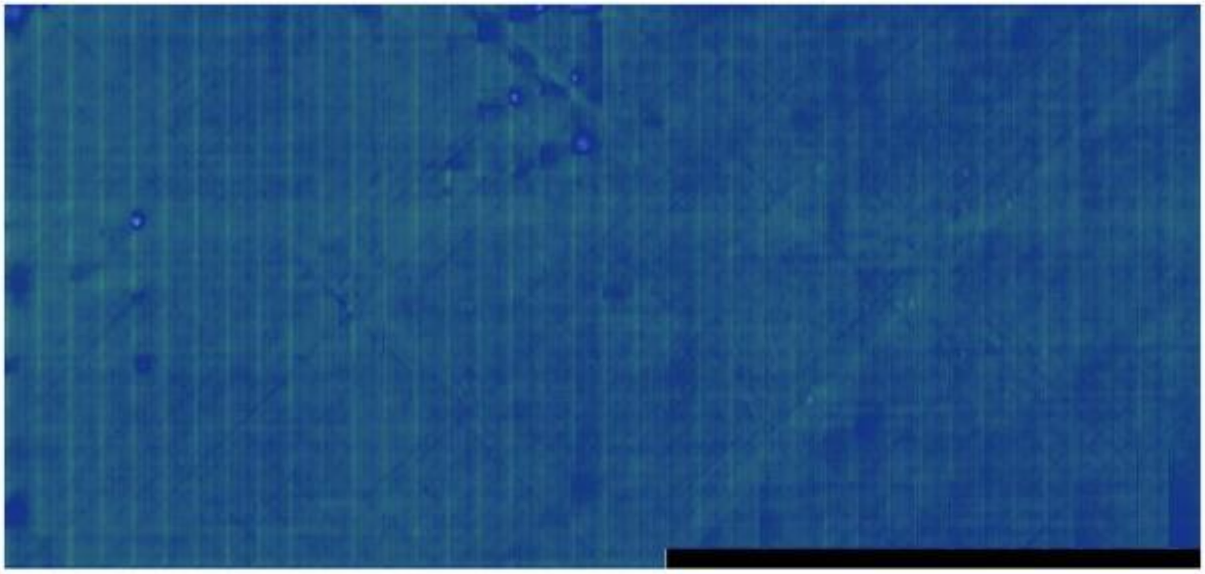


Back side, gated for bondline.

No indications noted.

Panel 0332A013 Front

Page 6 of 25

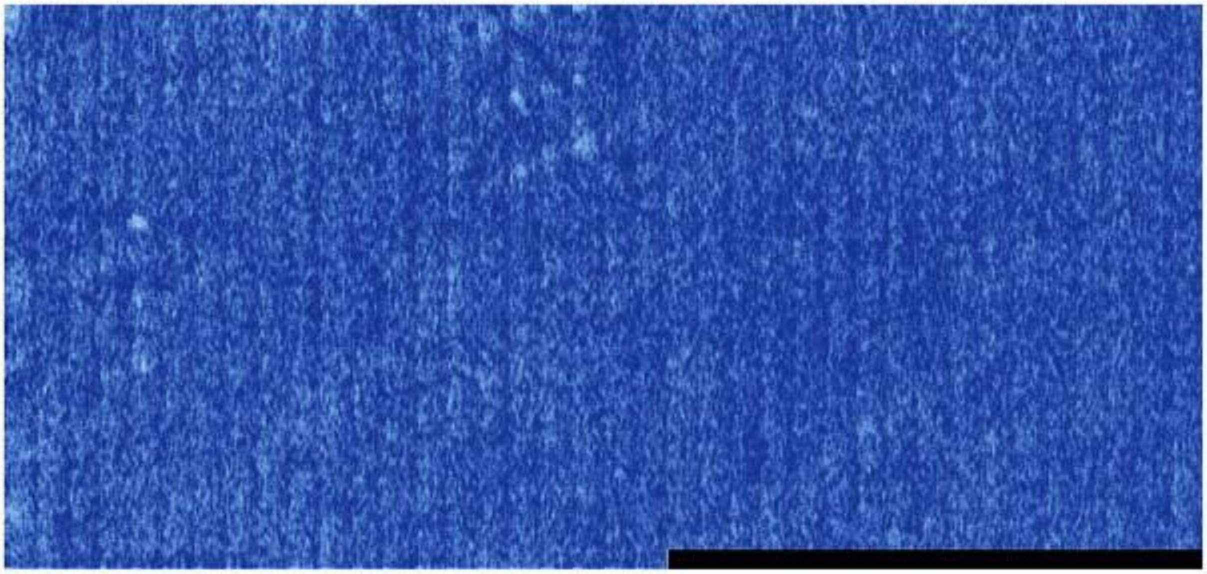


Front side, gated for facesheet thickness.

No indications noted. Patterns are due to surface features and wrinkles.

Panel 0332A013 Front

Page 7 of 25

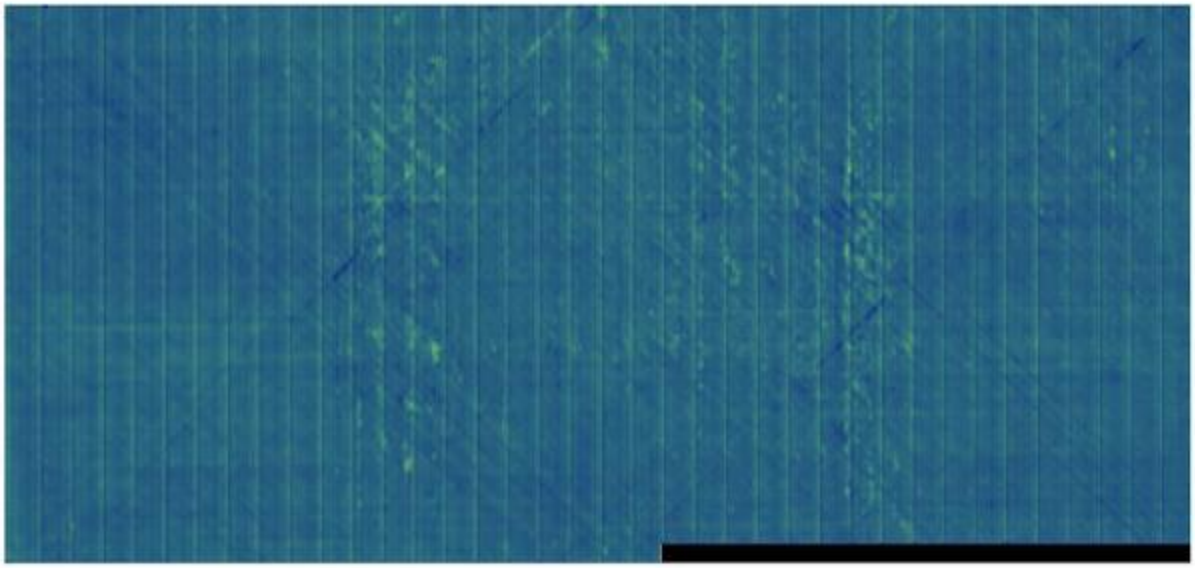


Front side, gated for bondline.

No indications noted. Patterns are due to surface features and wrinkles.

Panel 0332A013 Back

Page 8 of 25

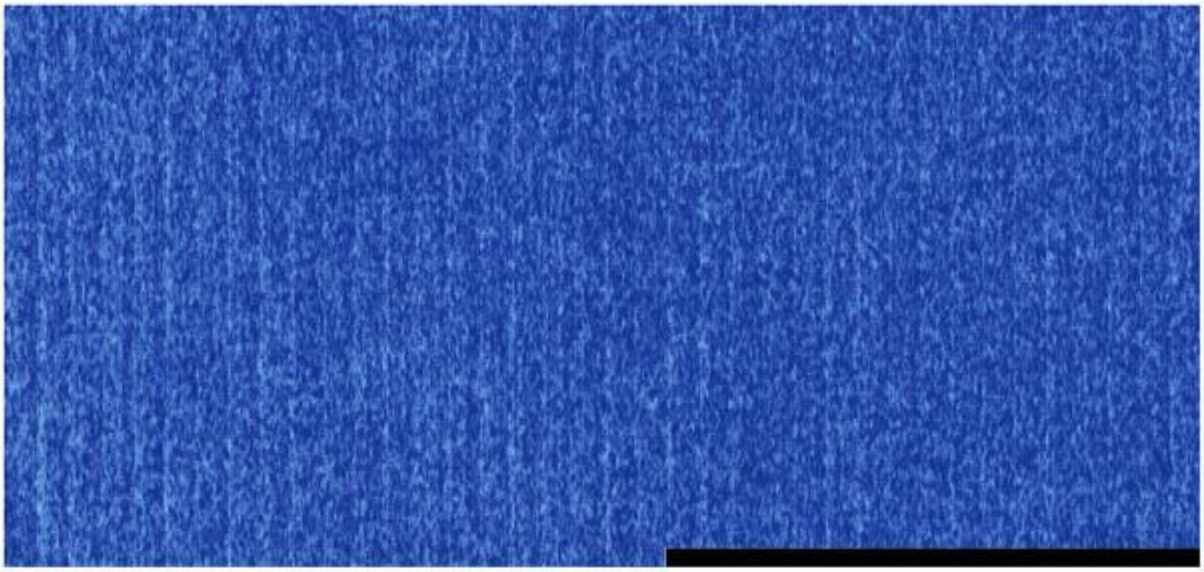


Back side, gated for facesheet thickness.

No indications noted.

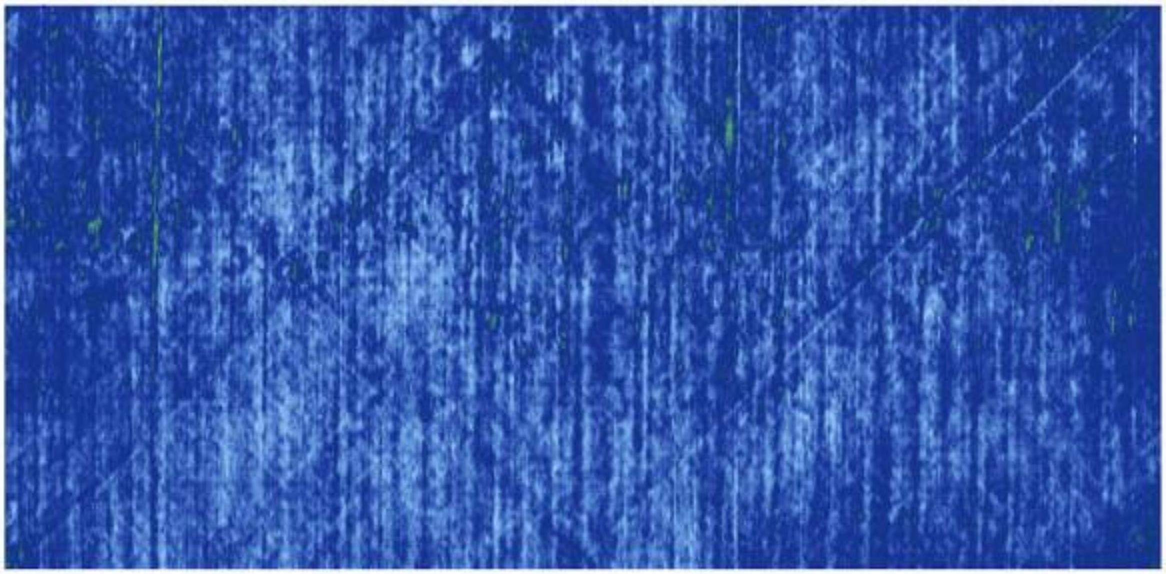
Panel 0332A013 Back

Page 9 of 25



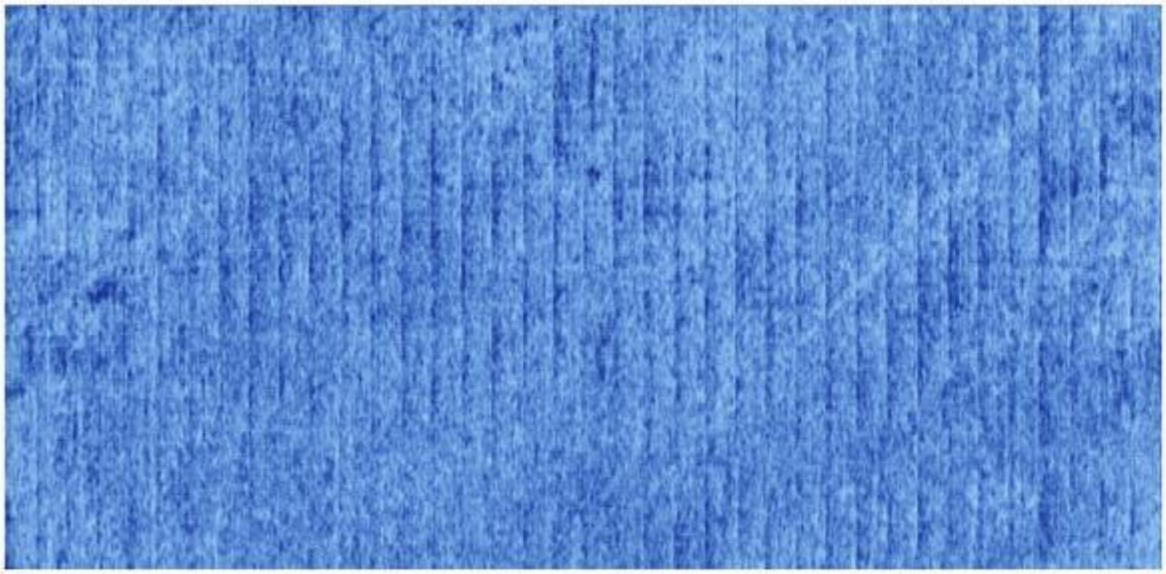
Back side, gated for bondline.

No indications noted.



Front side, gated for facesheet thickness.

No indications noted.



Front side, gated for bondline.

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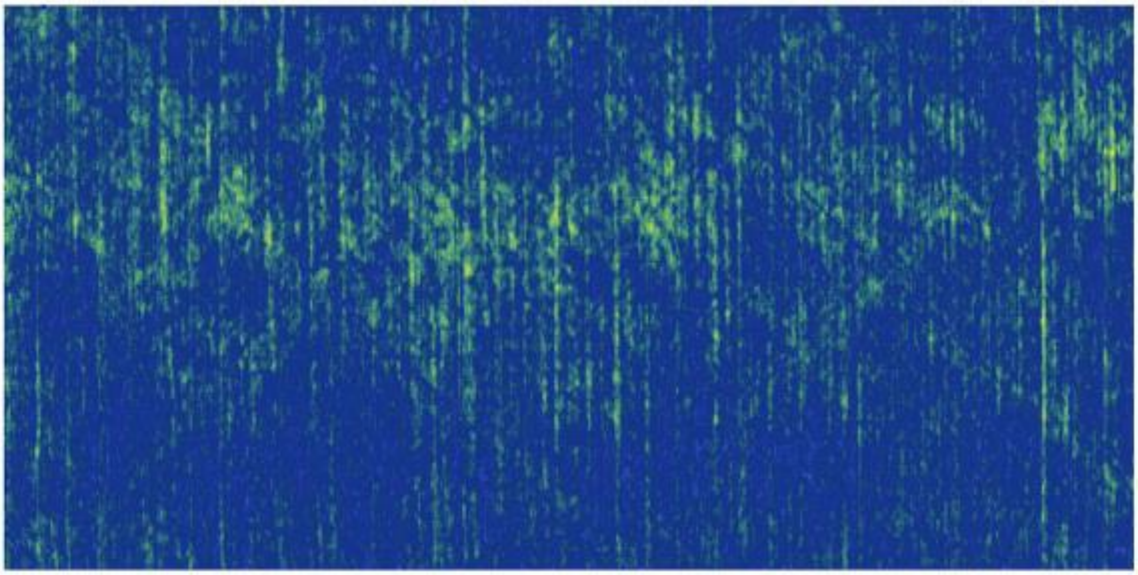
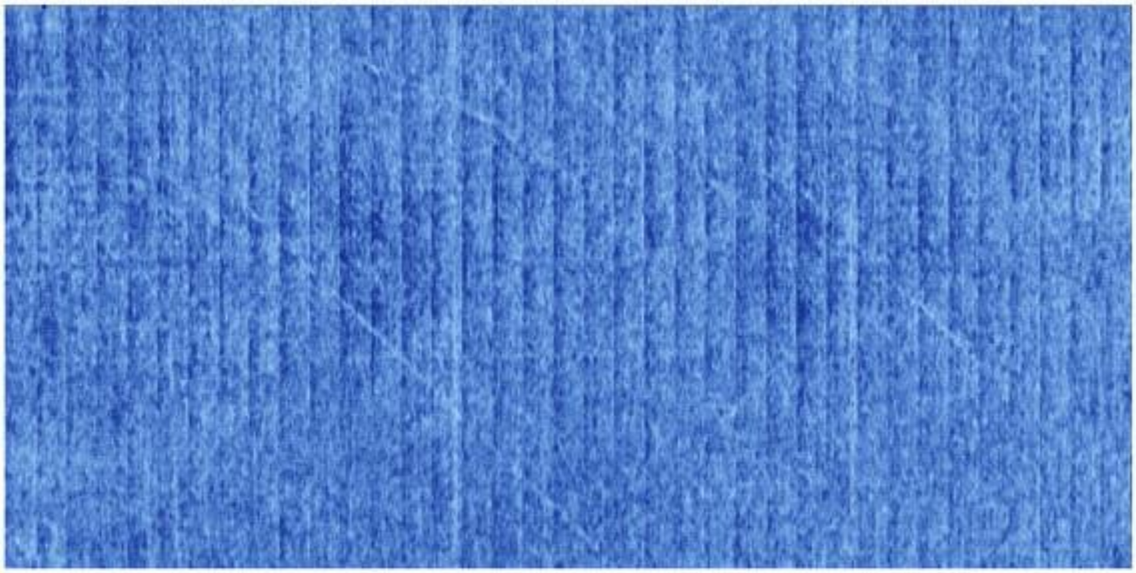


Back side, gated for facesheet thickness.

No indications noted.



Back side, gated for bondline.

No indications noted.

Panel 0332A016 Front

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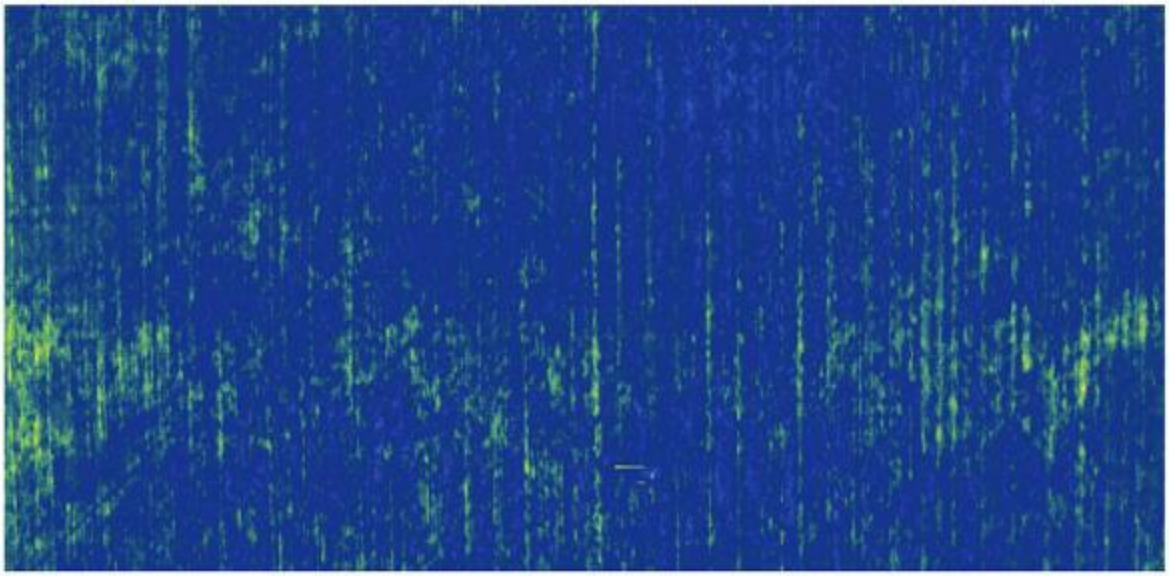
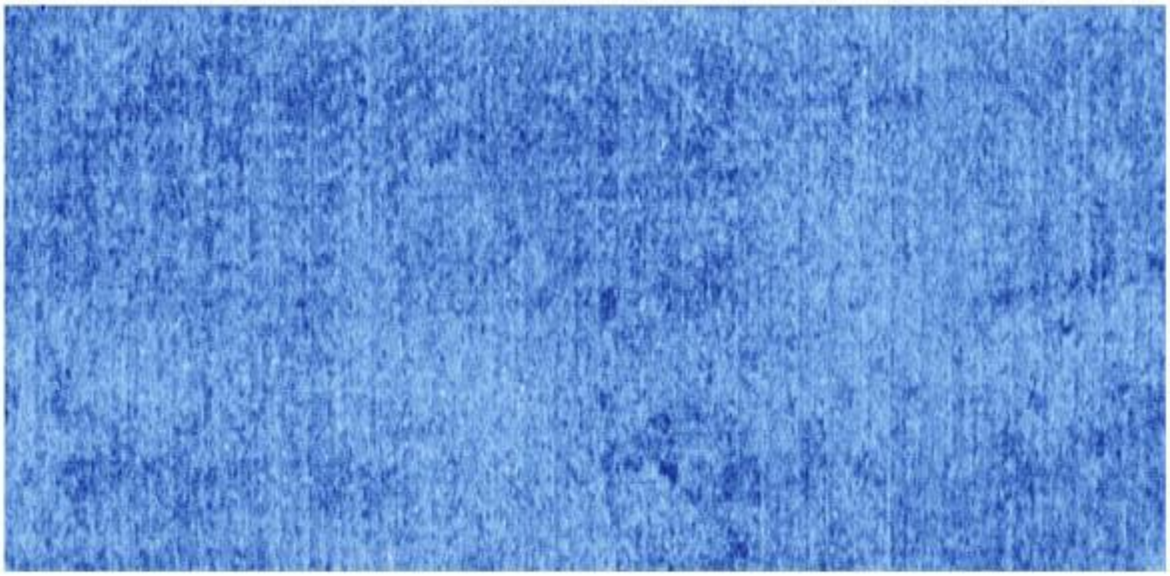


Front side, gated for facesheet thickness.

No indications noted.

Panel 0332A016 Front

Page 15 of 25



Front side, gated for bondline.

No indications noted.

Panel 0332A016 Back

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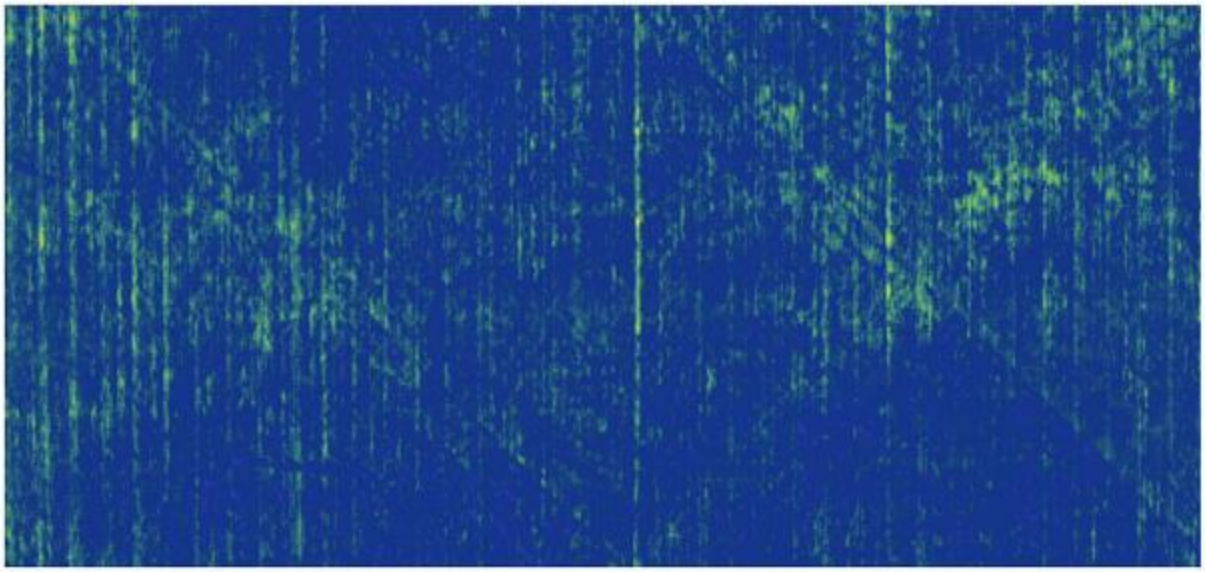
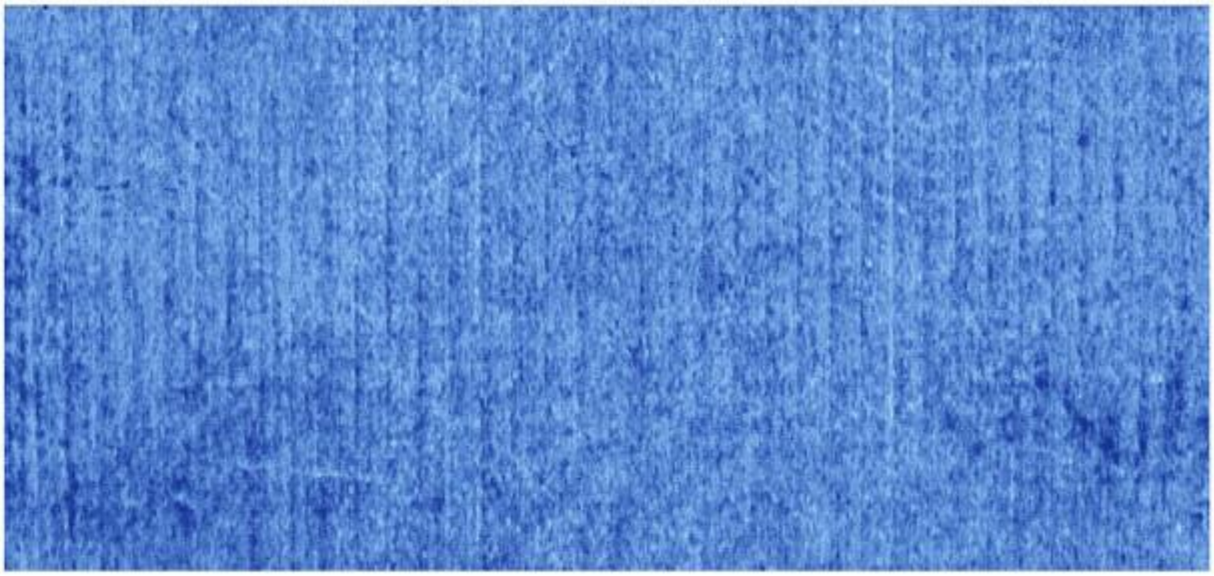


Back side, gated for facesheet thickness.

No indications noted.

Panel 0332A016 Back

Page 17 of 25

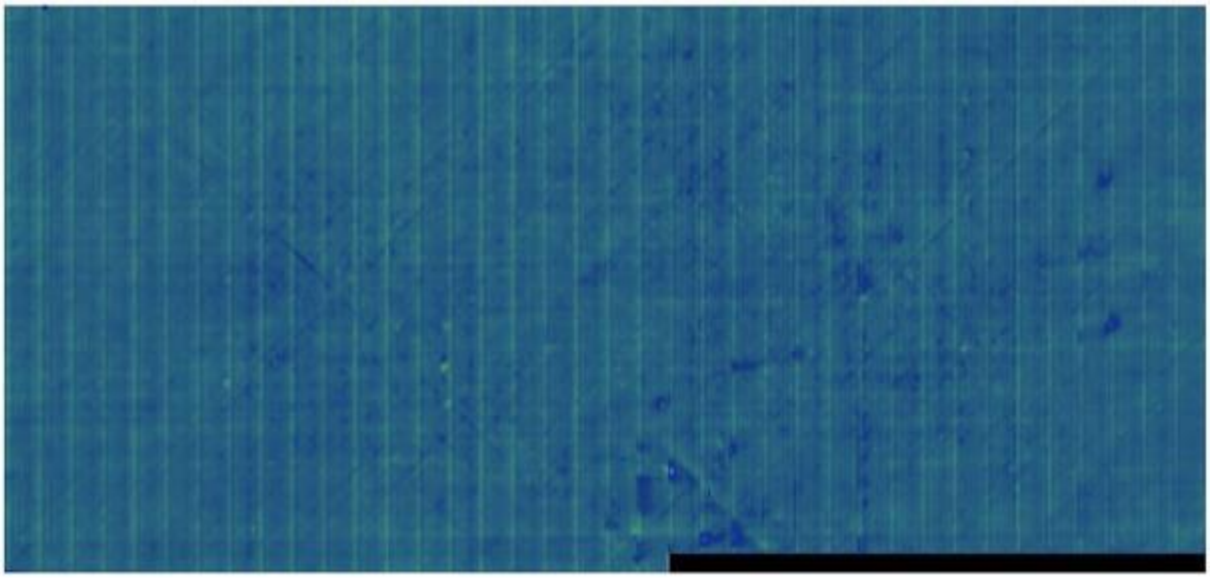


Back side, gated for bondline.

No indications noted.

Panel 0332A017 Front

Page 18 of 25



Front side, gated for facesheet thickness.

No indications noted. Patterns are due to surface features and wrinkles.

Panel 0332A017 Front

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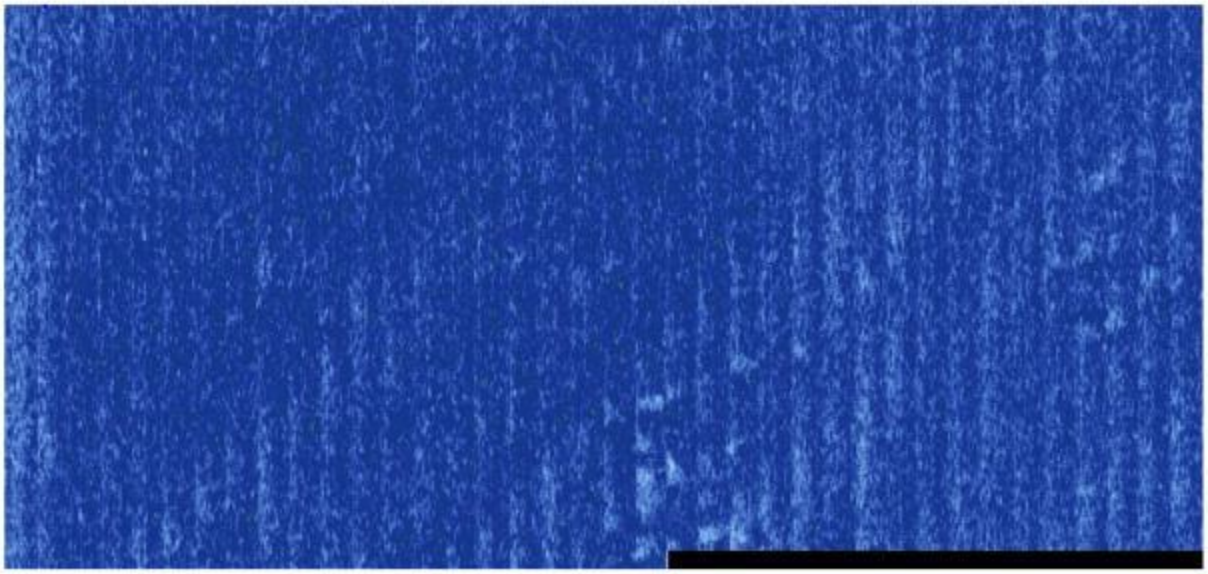

Front side, gated for bondline.

No indications noted.

Panel 0332A017 Back

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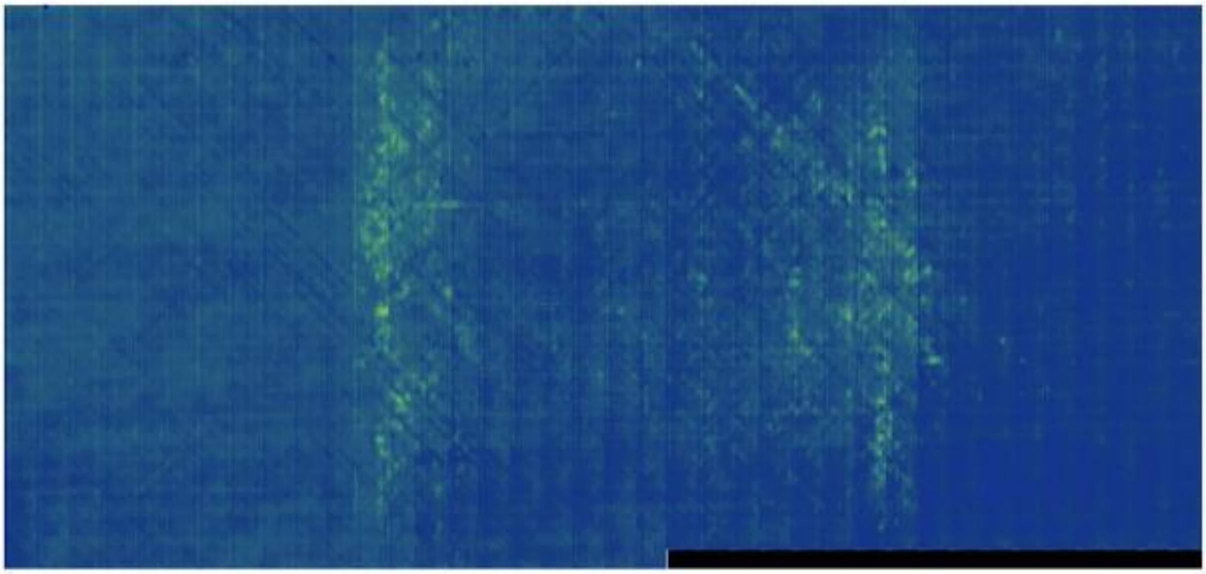

Back side, gated for facesheet thickness.

No indications noted.

Panel 0332A017 Back

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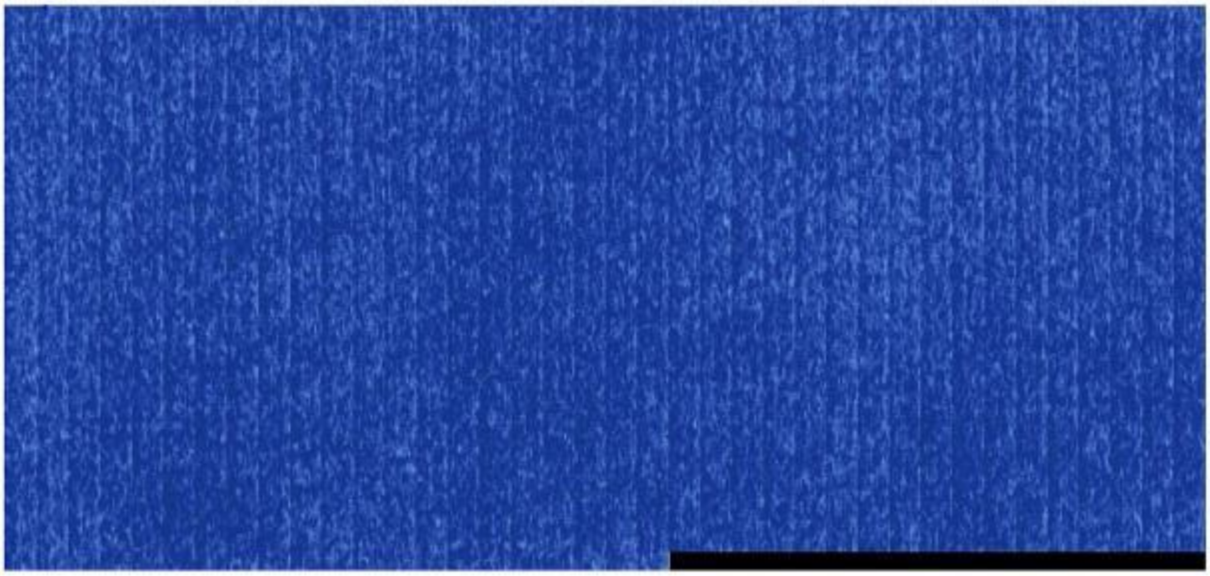

Back side, gated for bondline.

No indications noted.

Panel 0332A018 Front

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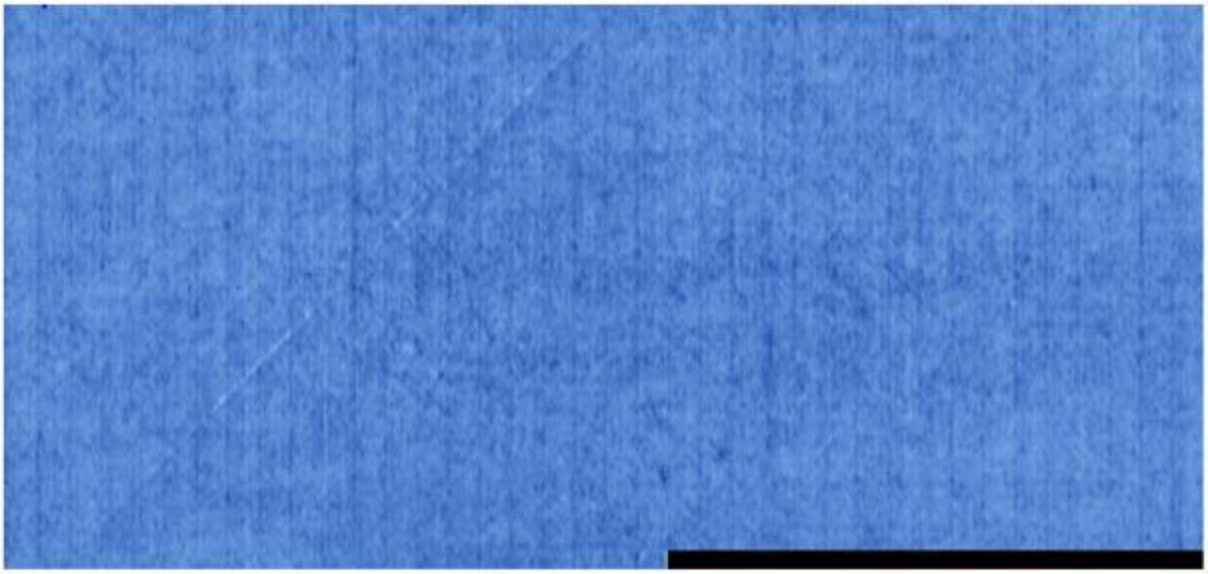

Front side, gated for facesheet thickness.

No indications noted.

Panel 0332A018 Front

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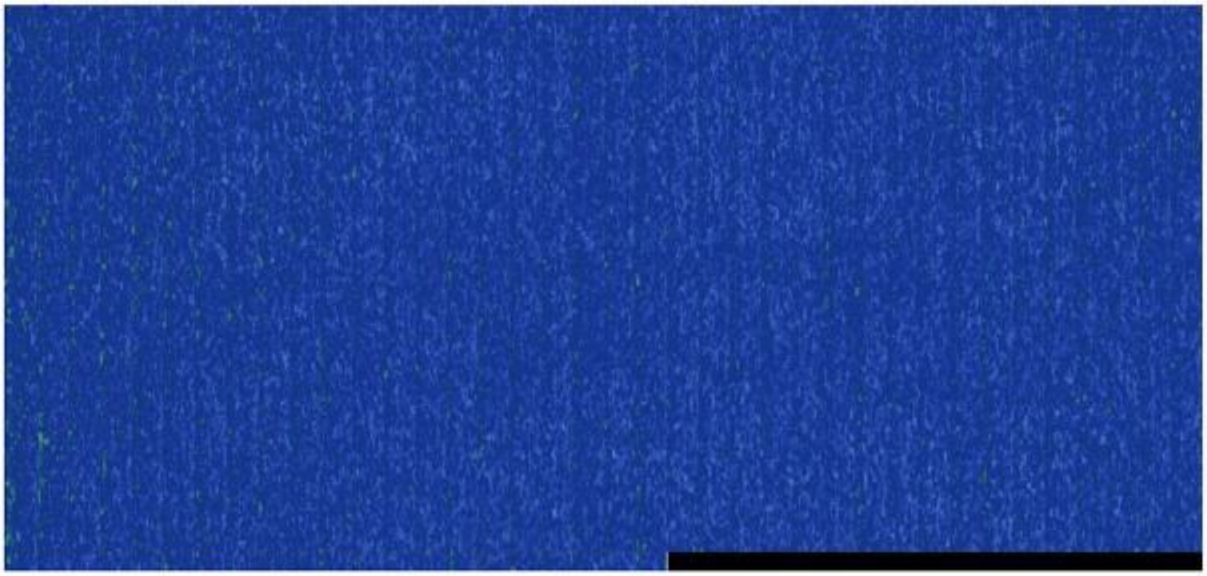

Front side, gated for bondline.

No indications noted.

Panel 0332A018 Back

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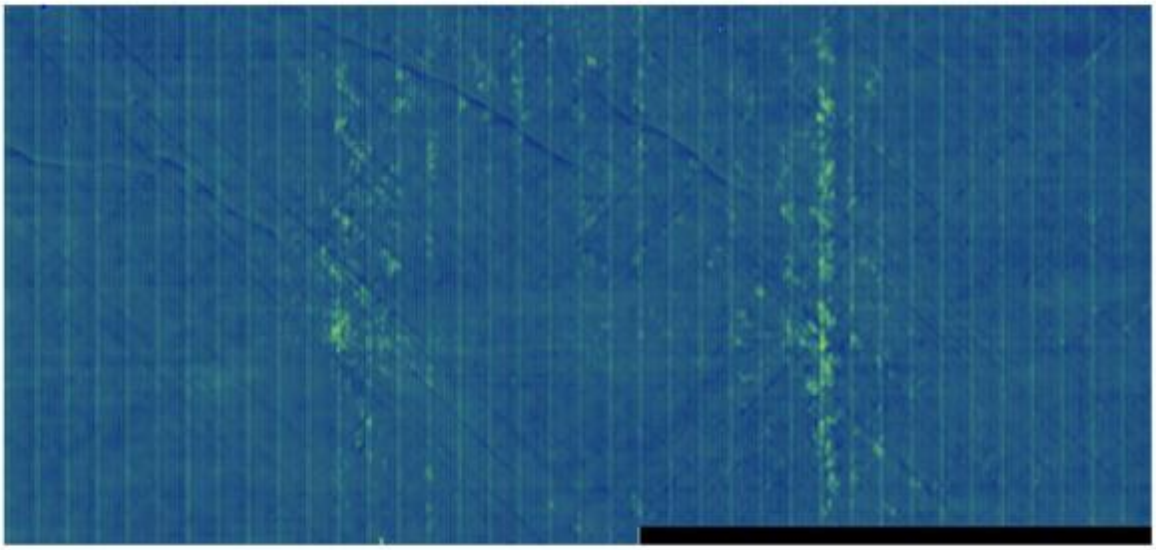

Back side, gated for facesheet thickness.

No indications noted. Patterns are due to surface features and wrinkles.

Panel 0332A018 Back

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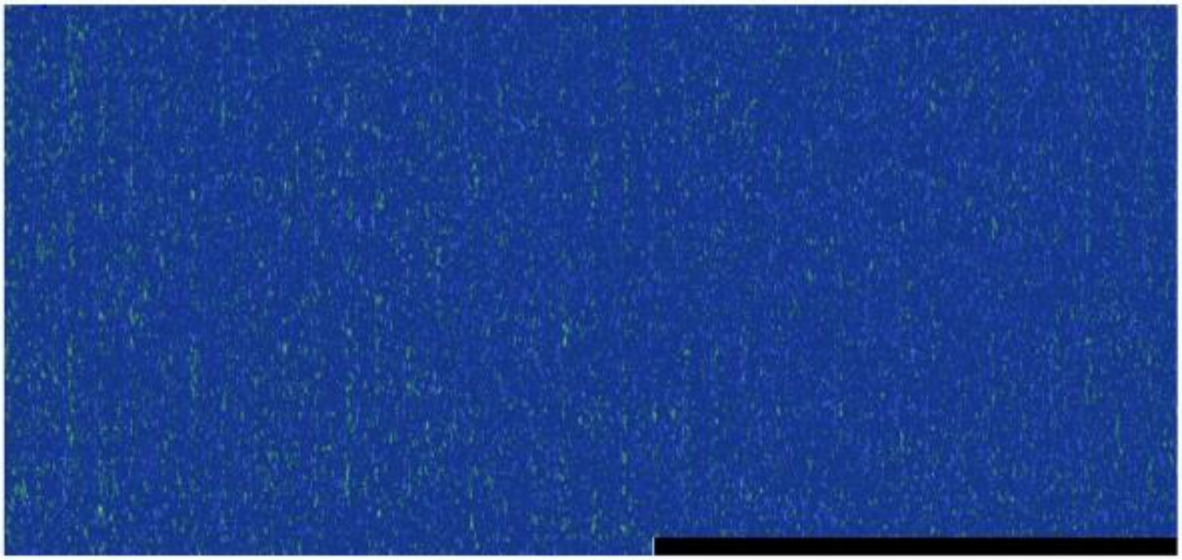

Back side, gated for bondline.

No indications noted.

Figure A34. NDE Ultrasonic Inspection Results of Composite Sandwich Panels #11 - #18.

Data Sheet for MSFC ACTIS Scanning

Date:6/4/2013	**Work order #:2013-V-0397**

Notes: Pyroshock Char-Comp Materials. Perform DR on test sample to attempt to resolve crack in foam.

Record system verification checks (date/time, otherwise n/a):			
	1	2	3
Offset: Gain: Find Geometry:	9/4/2013 | 0813 9/4/2013 | 0814 n/a	9/4/2013 | 0822 9/4/2013 | 0823 n/a	

Foam sample on CT table.

CHECK THE MASTER LIST – VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE
http://em20.msfc.nasa.gov/oi.htm

EM20-NDE-FM-002
09-21-2009

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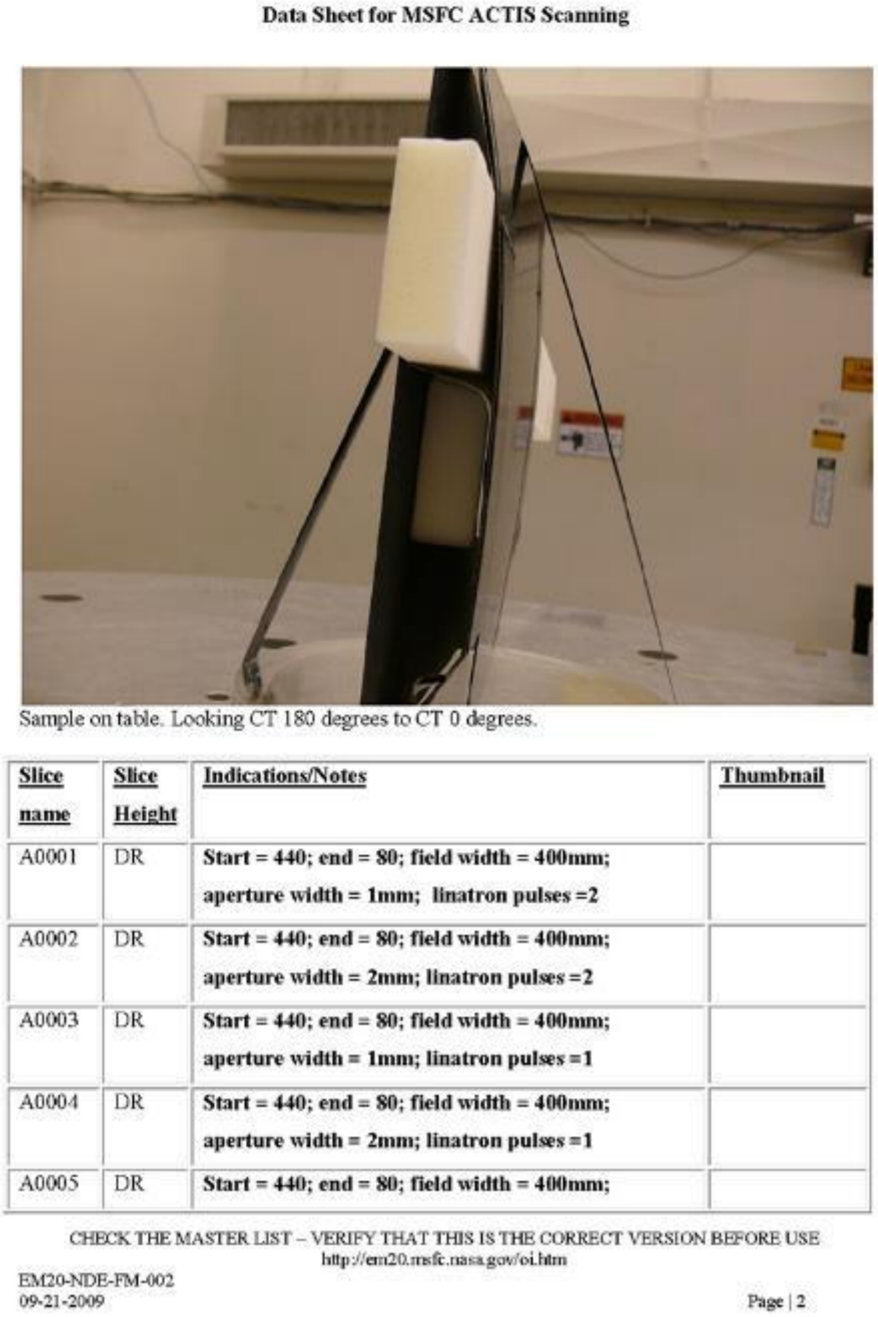

Data Sheet for MSFC ACTIS Scanning

Sample on table. Looking CT 180 degrees to CT 0 degrees.

Slice name	Slice Height	Indications/Notes	Thumbnail
A0001	DR	**Start = 440; end = 80; field width = 400mm; aperture width = 1mm; linatron pulses =2**	
A0002	DR	**Start = 440; end = 80; field width = 400mm; aperture width = 2mm; linatron pulses =2**	
A0003	DR	**Start = 440; end = 80; field width = 400mm; aperture width = 1mm; linatron pulses =1**	
A0004	DR	**Start = 440; end = 80; field width = 400mm; aperture width = 2mm; linatron pulses =1**	
A0005	DR	**Start = 440; end = 80; field width = 400mm;**	

CHECK THE MASTER LIST – VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE
http://em20.msfc.nasa.gov/oi.htm

EM20-NDE-FM-002
09-21-2009

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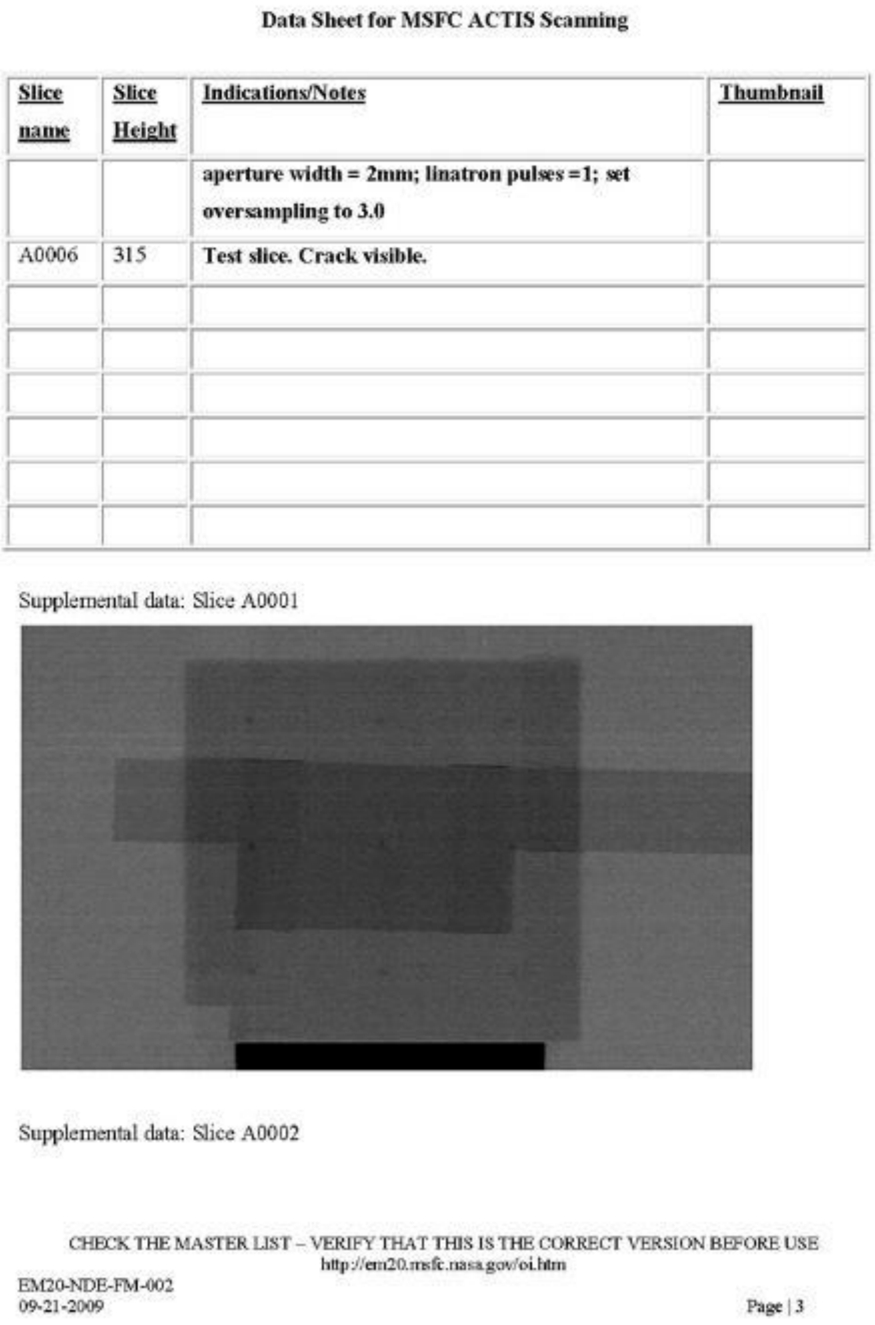

Data Sheet for MSFC ACTIS Scanning

Slice name	**Slice Height**	**Indications/Notes**	**Thumbnail**
		aperture width = 2mm; linatron pulses =1; set oversampling to 3.0	
A0006	315	**Test slice. Crack visible.**	

Supplemental data: Slice A0001

Supplemental data: Slice A0002

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http://em20.msfc.nasa.gov/oi.htm

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09-21-2009

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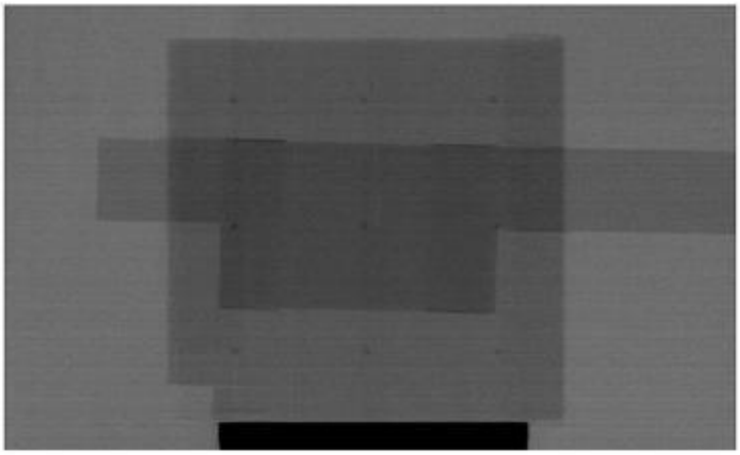
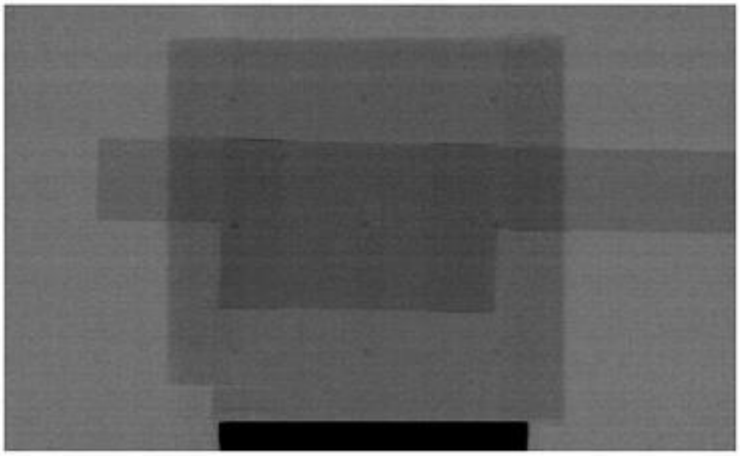
Data Sheet for MSFC ACTIS Scanning

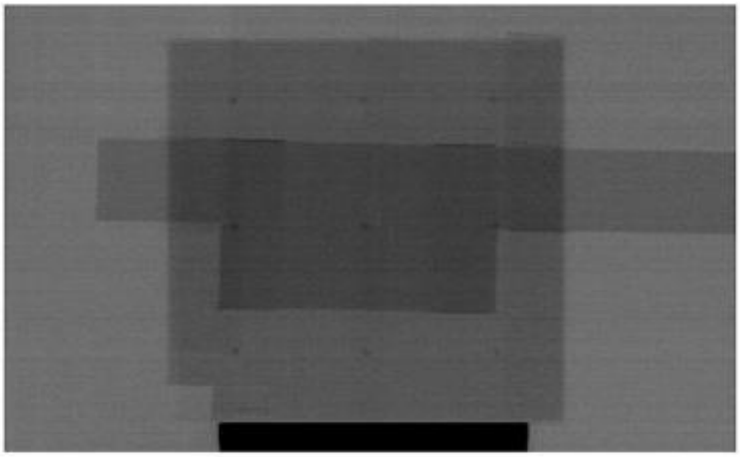


Supplemental data: Slice A0003

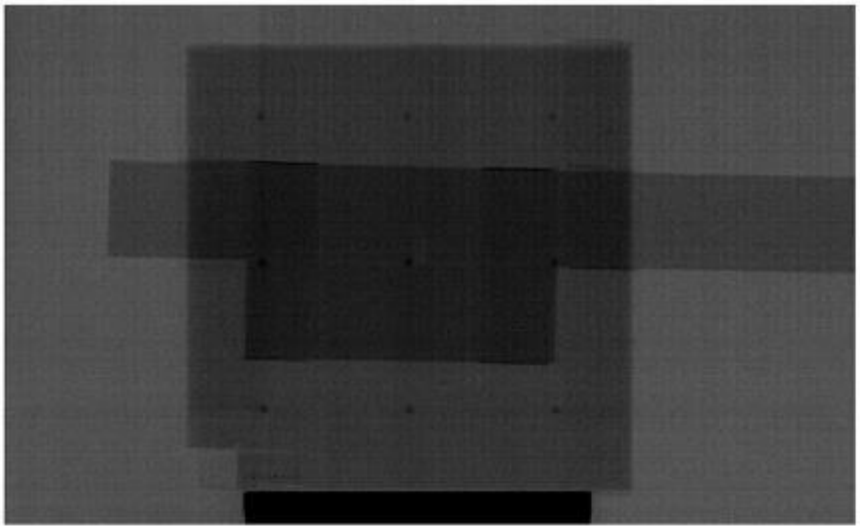


Supplemental data: Slice A0004

Data Sheet for MSFC ACTIS Scanning



Supplemental data: Slice A0005



Supplemental data: Slice A0006

CHECK THE MASTER LIST – VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE
http://em20.msfc.nasa.gov/oi.htm

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09-21-2009

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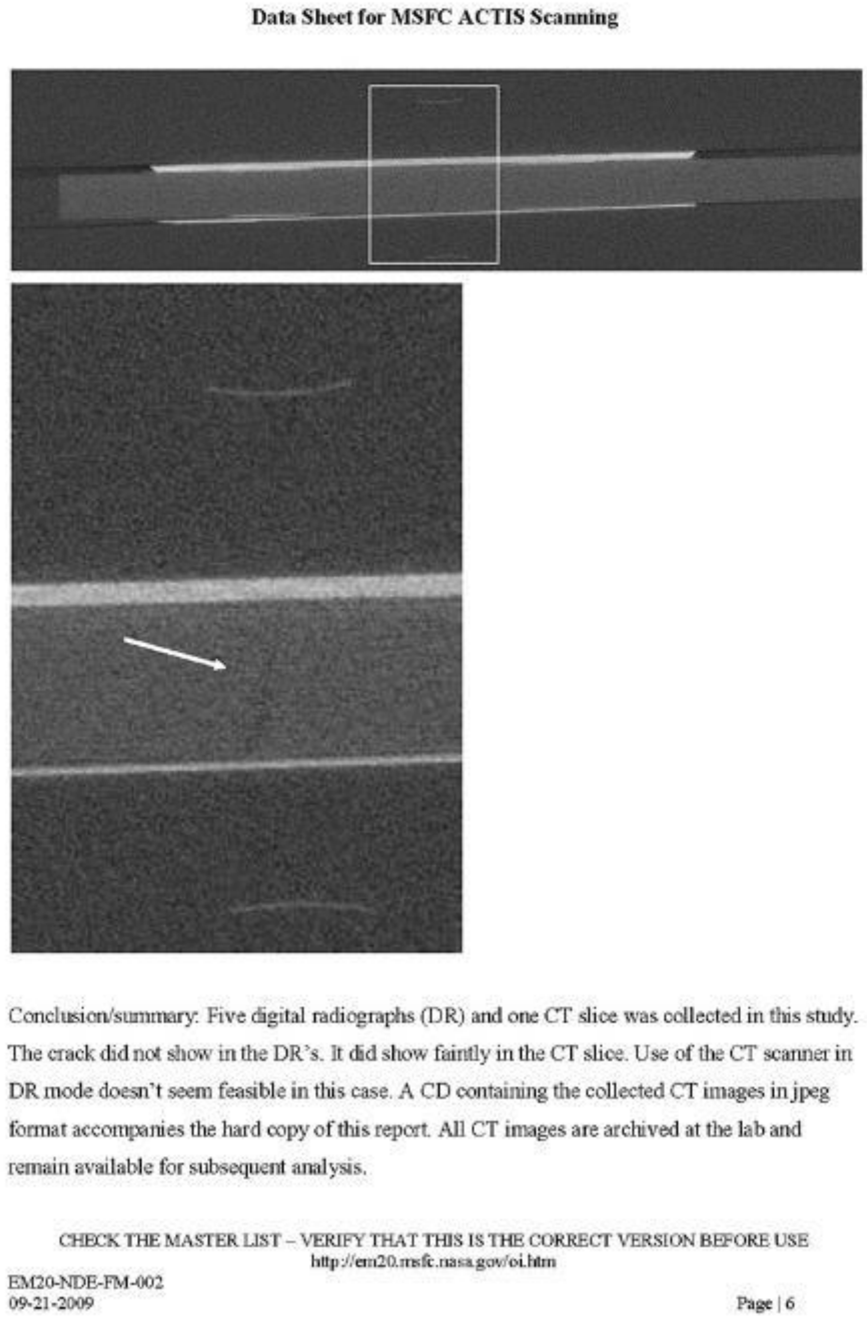

Data Sheet for MSFC ACTIS Scanning

Conclusion/summary: Five digital radiographs (DR) and one CT slice was collected in this study. The crack did not show in the DR's. It did show faintly in the CT slice. Use of the CT scanner in DR mode doesn't seem feasible in this case. A CD containing the collected CT images in jpeg format accompanies the hard copy of this report. All CT images are archived at the lab and remain available for subsequent analysis.

CHECK THE MASTER LIST – VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE
http://em20.msfc.nasa.gov/oi.htm

EM20-NDE-FM-002
09-21-2009

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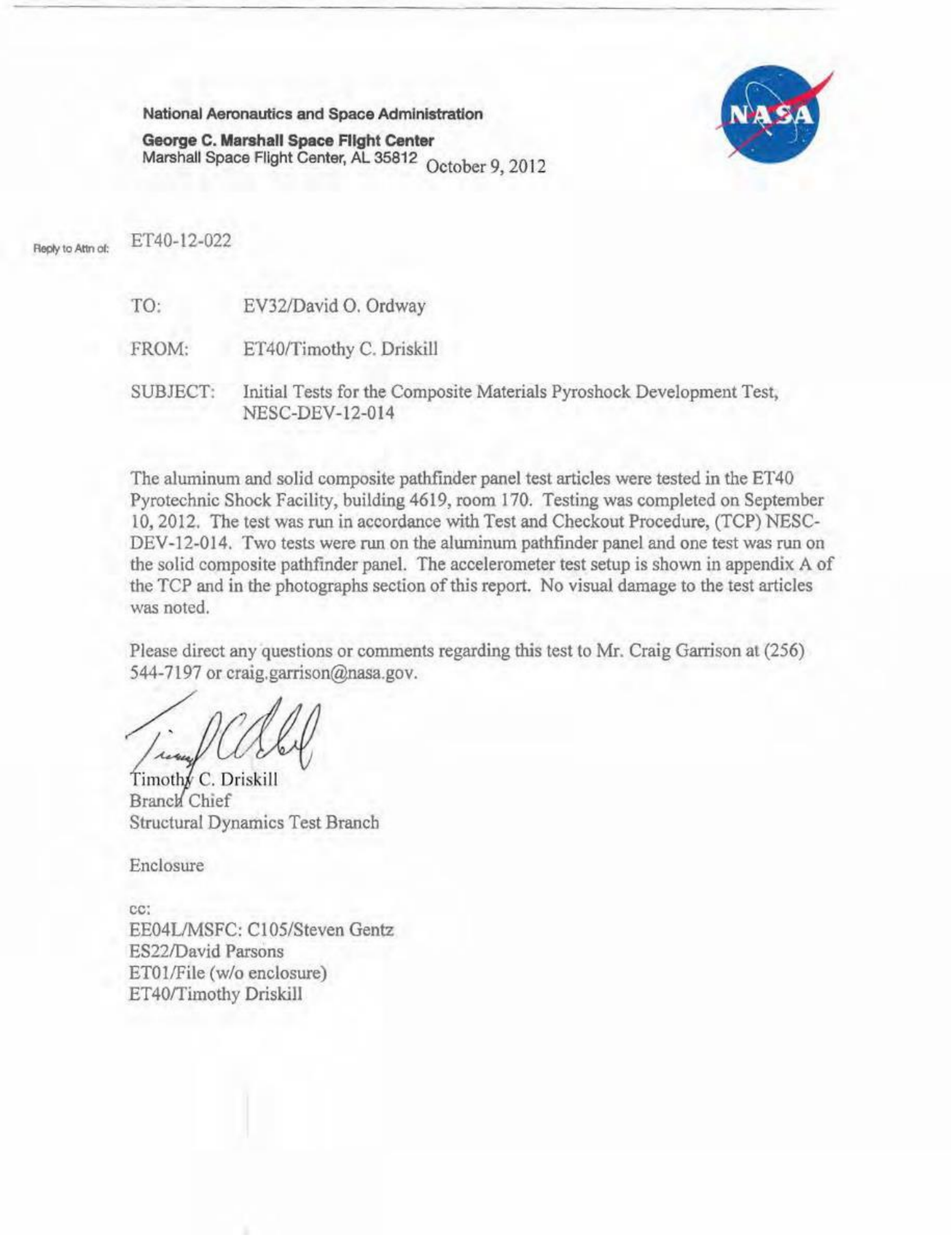
Figure A35. DR and CT Evaluation of Core Filler Material after Assembly

Appendix B. Pyroshock Test Reports

B1. Pathfinder Tests

The test report documenting the test results from pathfinder test group, tests 1 through 3 is documented in the attachment below.



National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

October 9, 2012

Reply to Attn of: ET40-12-022

TO: EV32/David O. Ordway

FROM: ET40/Timothy C. Driskill

SUBJECT: Initial Tests for the Composite Materials Pyroshock Development Test, NESC-DEV-12-014

The aluminum and solid composite pathfinder panel test articles were tested in the ET40 Pyrotechnic Shock Facility, building 4619, room 170. Testing was completed on September 10, 2012. The test was run in accordance with Test and Checkout Procedure, (TCP) NESC-DEV-12-014. Two tests were run on the aluminum pathfinder panel and one test was run on the solid composite pathfinder panel. The accelerometer test setup is shown in appendix A of the TCP and in the photographs section of this report. No visual damage to the test articles was noted.

Please direct any questions or comments regarding this test to Mr. Craig Garrison at (256) 544-7197 or craig.garrison@nasa.gov.

Timothy C. Driskill
Branch Chief
Structural Dynamics Test Branch

Enclosure

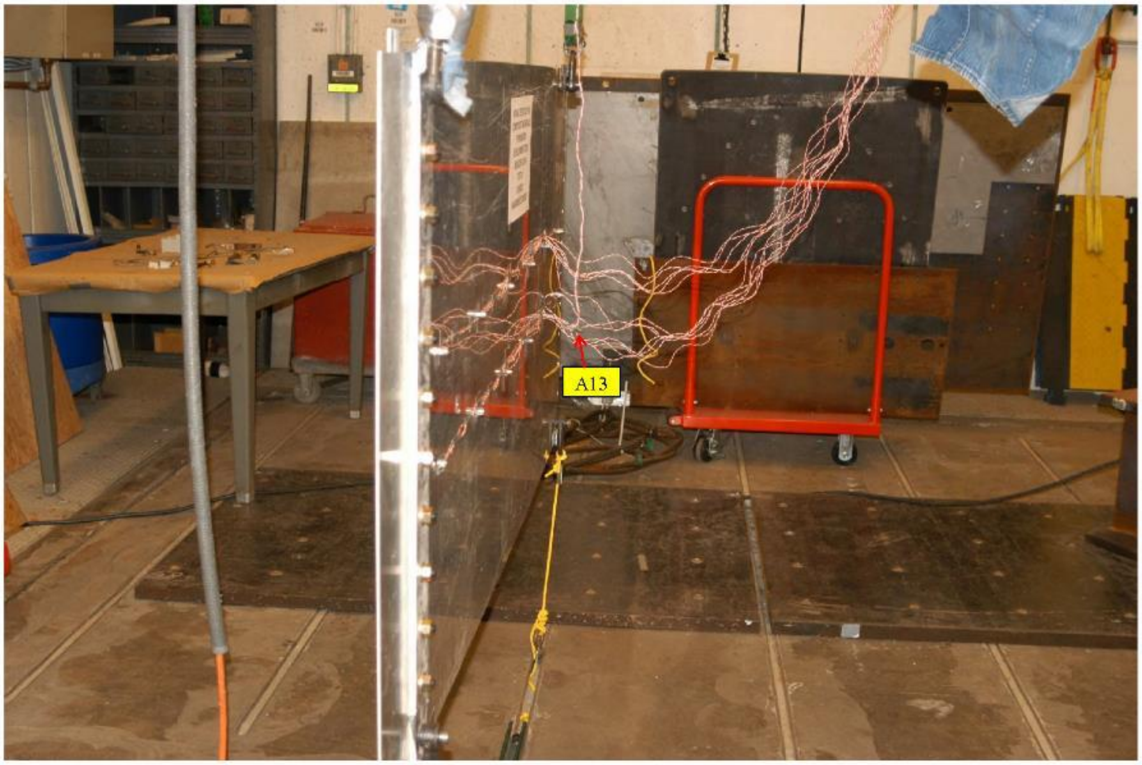
cc:
EE04L/MSFC: C105/Steven Gentz
ES22/David Parsons
ET01/File (w/o enclosure)
ET40/Timothy Driskill

Table of Contents

Photographs

Overall Setup, Test T01

Accelerometer Locations, Test T01

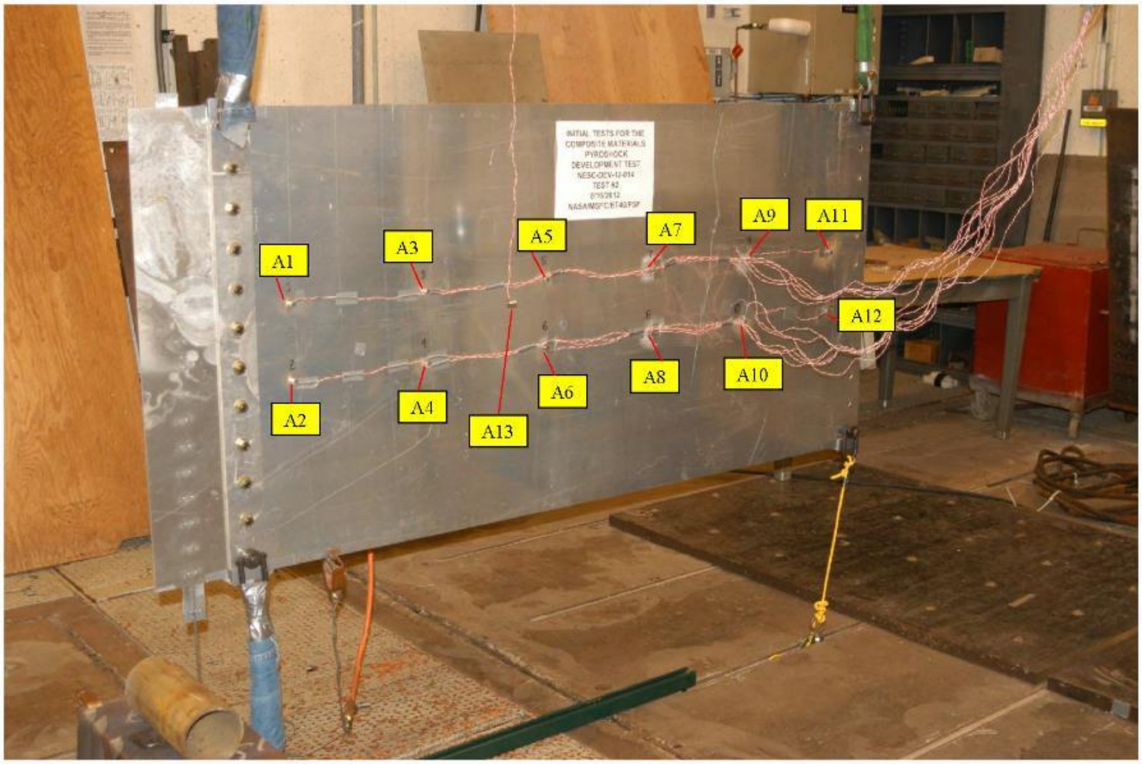


Side View, Test T01

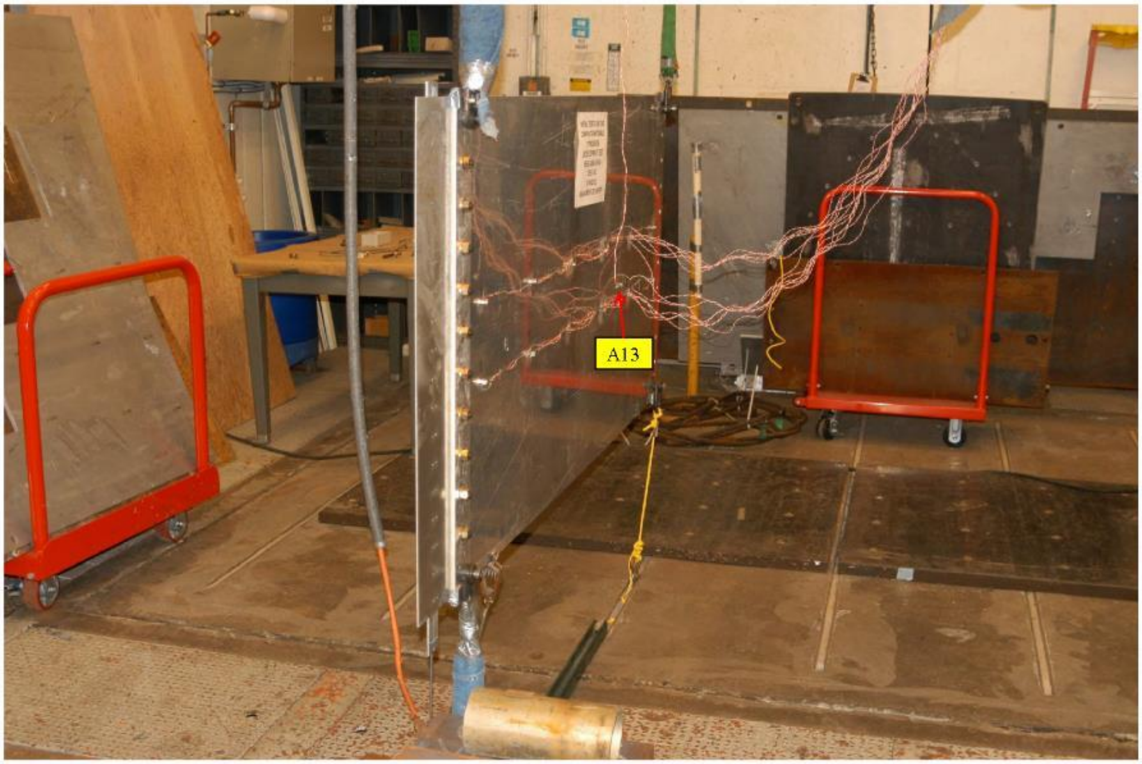
Explosives Location, Test T01

Explosives Location, Post-Test, Test T01

LSC Plate Close-up, Post-Test, Test T01



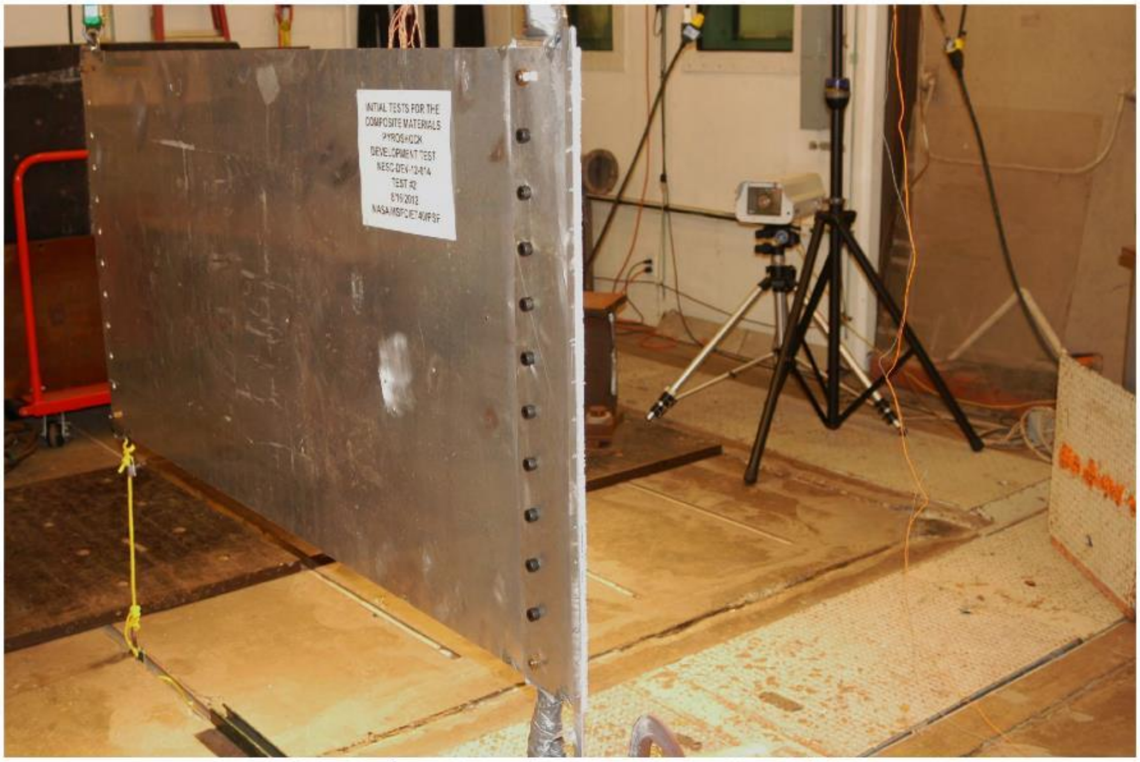
Accelerometer Locations, Test T02



Side View, Test T02

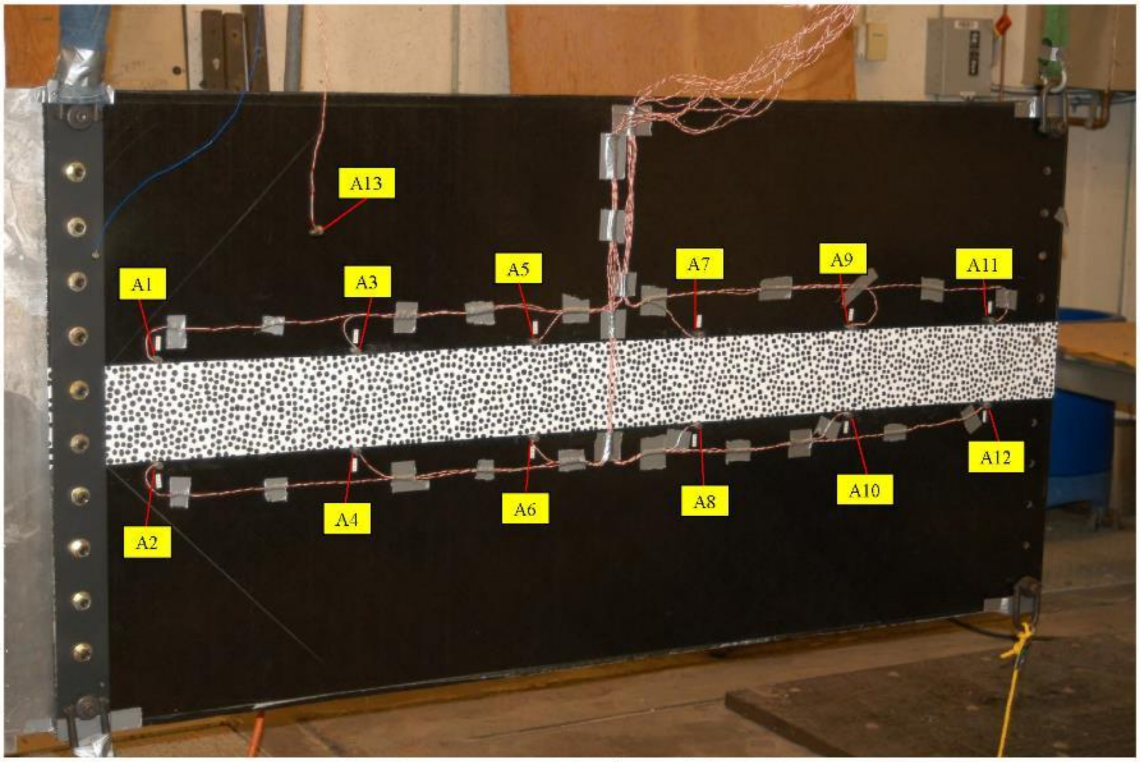
22 gpf, FLSC, CH-6, Aluminum

Explosives Location, Test T02

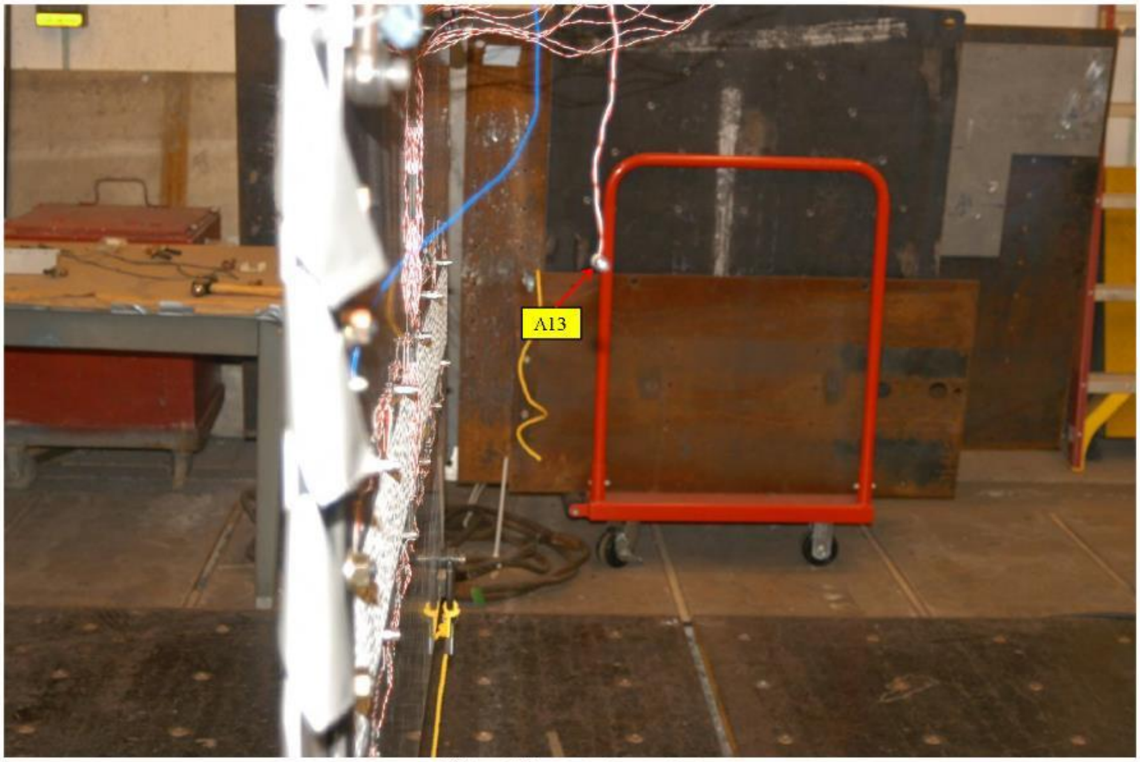


Explosives Location, Post-Test, Test T02

LSC Plate Close-up, Post-test, Test T02



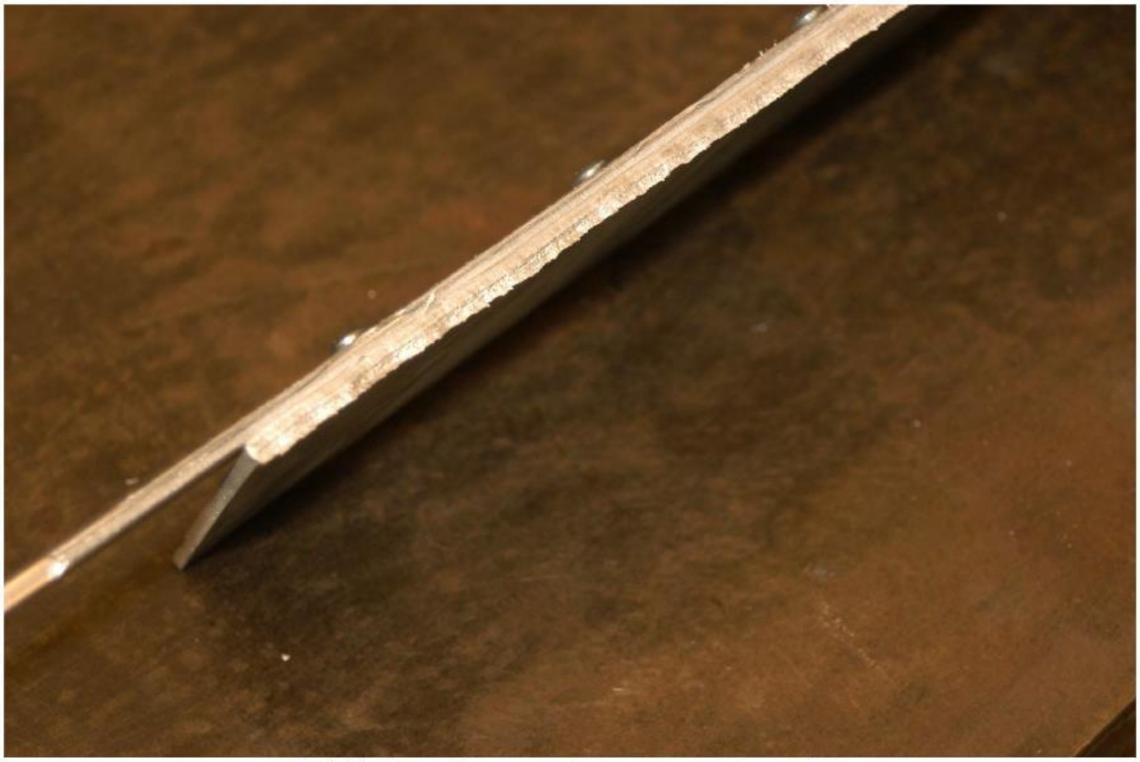
Accelerometer Locations, Test T03



Side View, Test T03

Explosives Location, Test T03

Explosives Location, Post-Test, Test T03



LSC Plate Close-up, Post-Test, Test T03

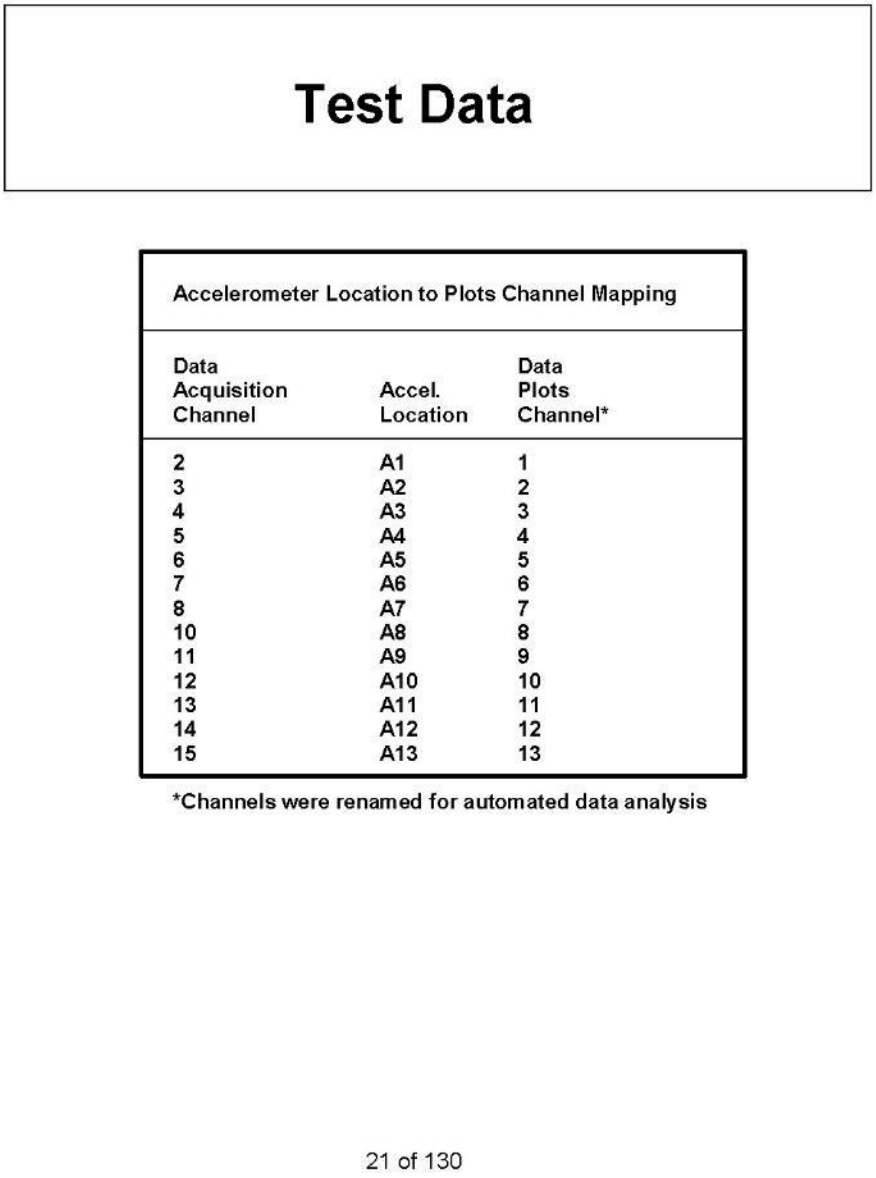
Test Data

Initial Tests for the Composite Materials Pyroshock Development Test

Accelerometer Location to Plot Channel Mapping

SRS
Test T01
Test T02
Test T03

Time History
Test T01
Test T02
Test T03



Test Data

Accelerometer Location to Plots Channel Mapping

Data Acquisition Channel	Accel. Location	Data Plots Channel*
2	A1	1
3	A2	2
4	A3	3
5	A4	4
6	A5	5
7	A6	6
8	A7	7
10	A8	8
11	A9	9
12	A10	10
13	A11	11
14	A12	12
15	A13	13

*Channels were renamed for automated data analysis

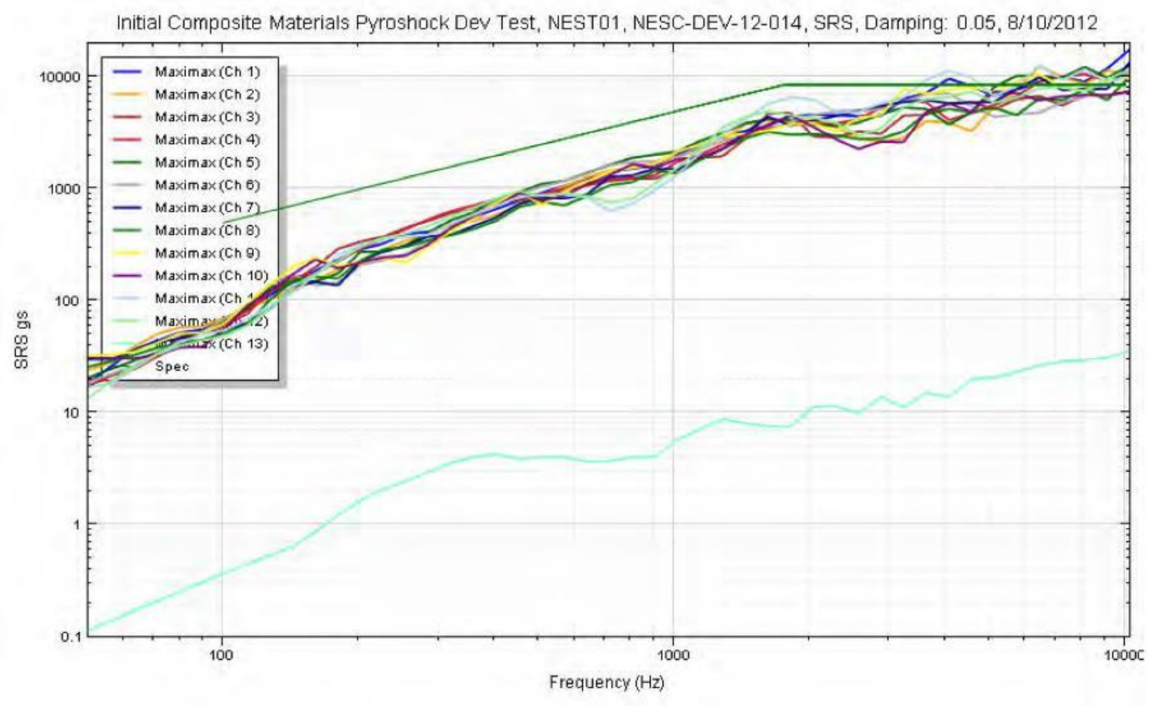
Test Data

SRS
Test T01

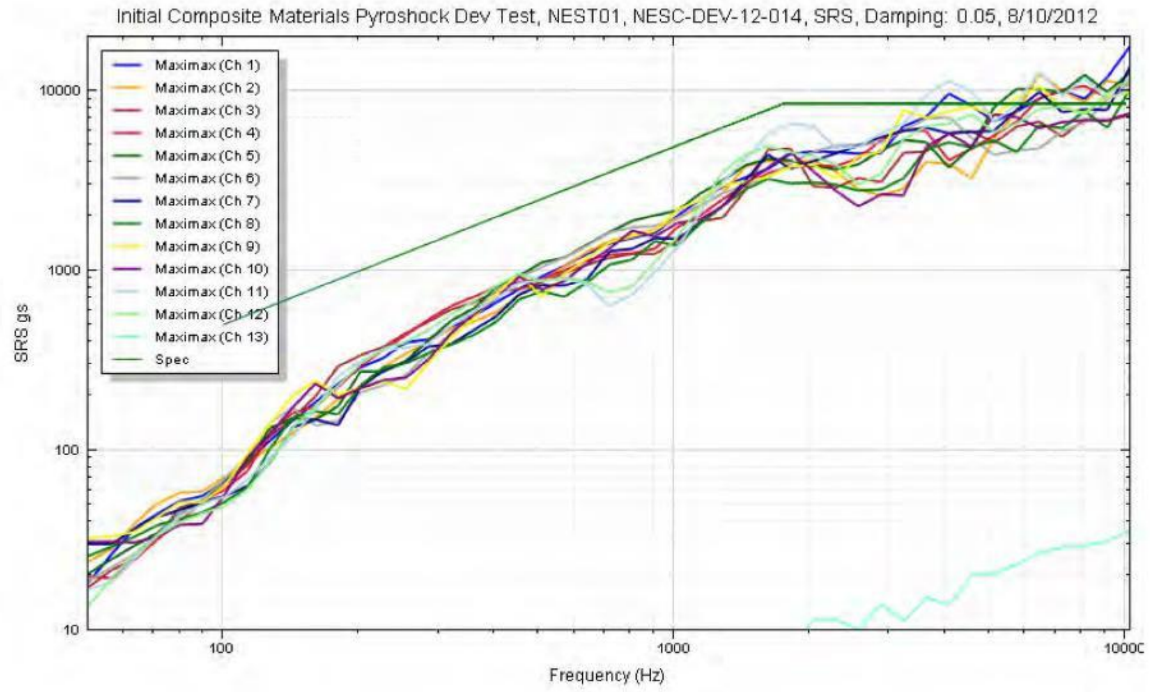
Aluminum Pathfinder Panel
10 gpf, FLSC

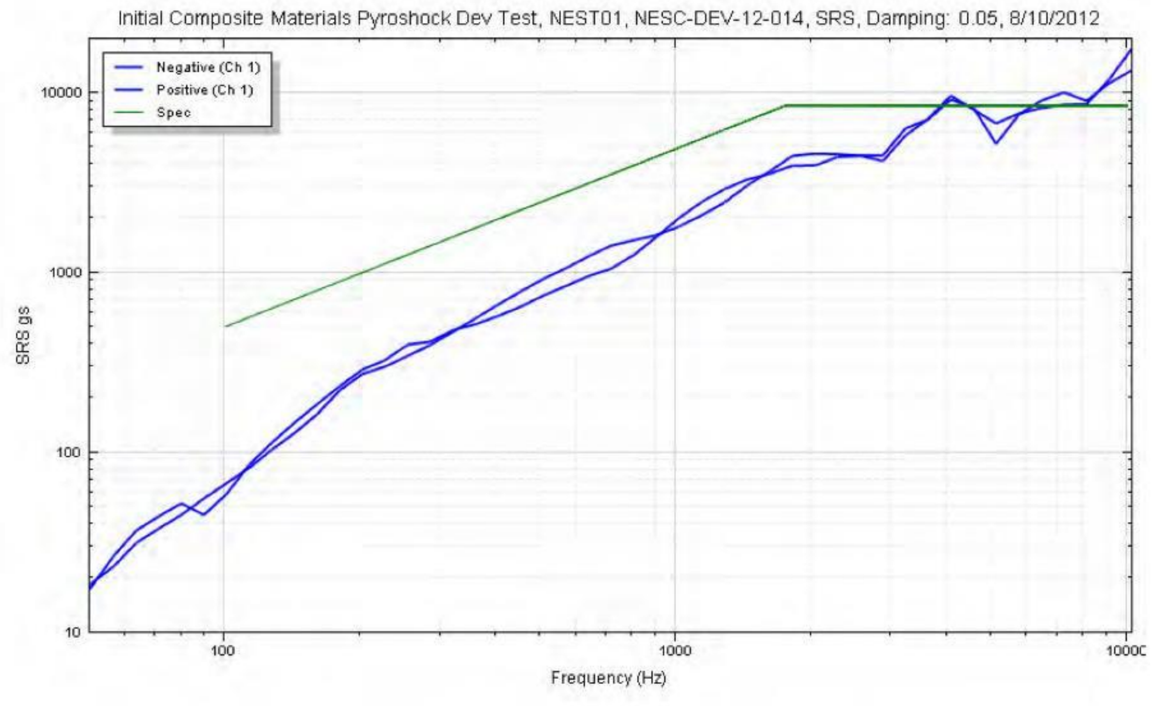
The Spec. line for Test T01 is the Estimated Source Shock

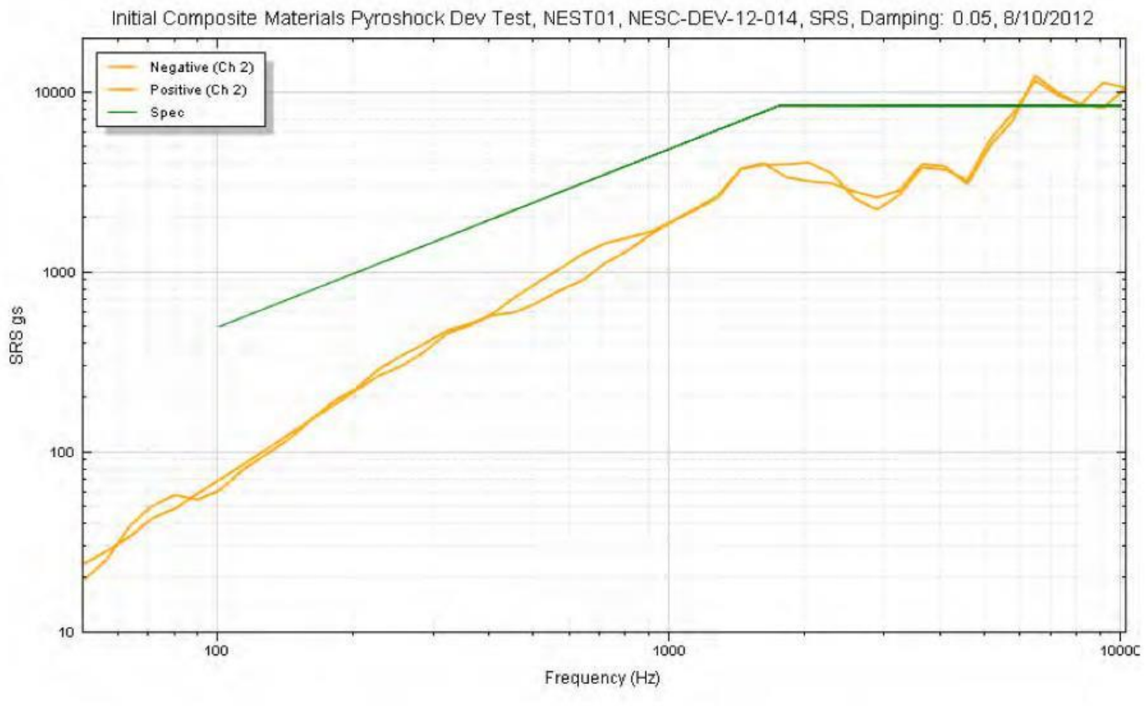
Hz.	SRS g's
100	500
1750	8500
10k	8500

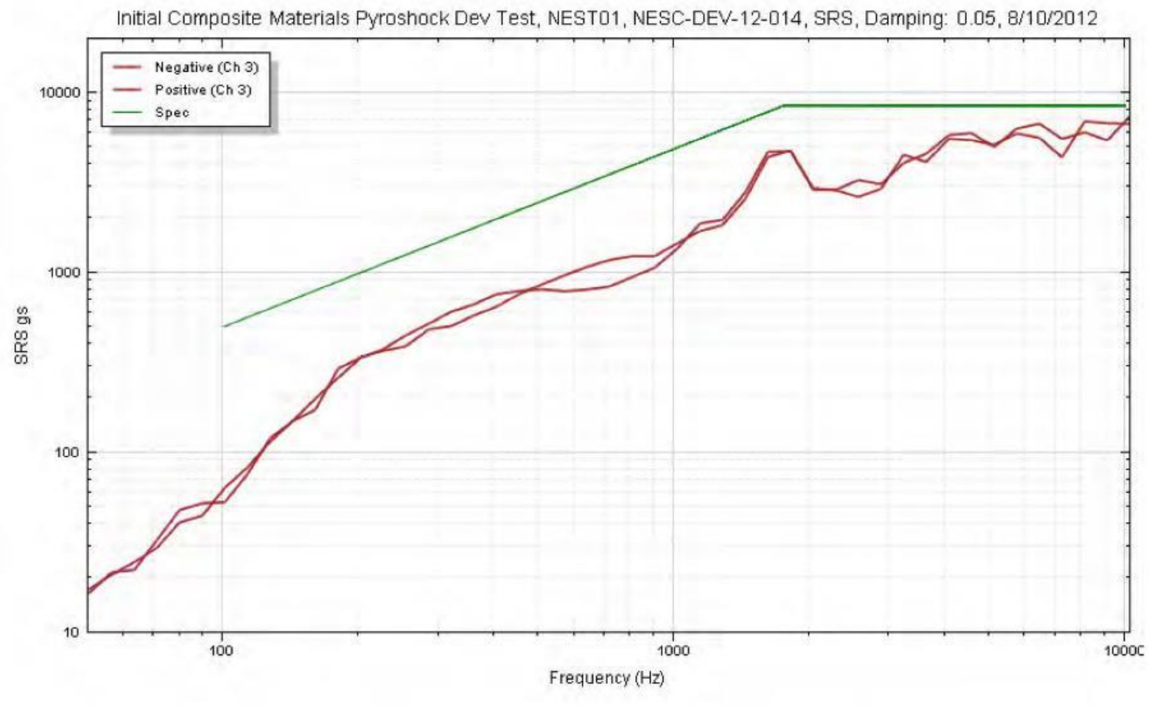


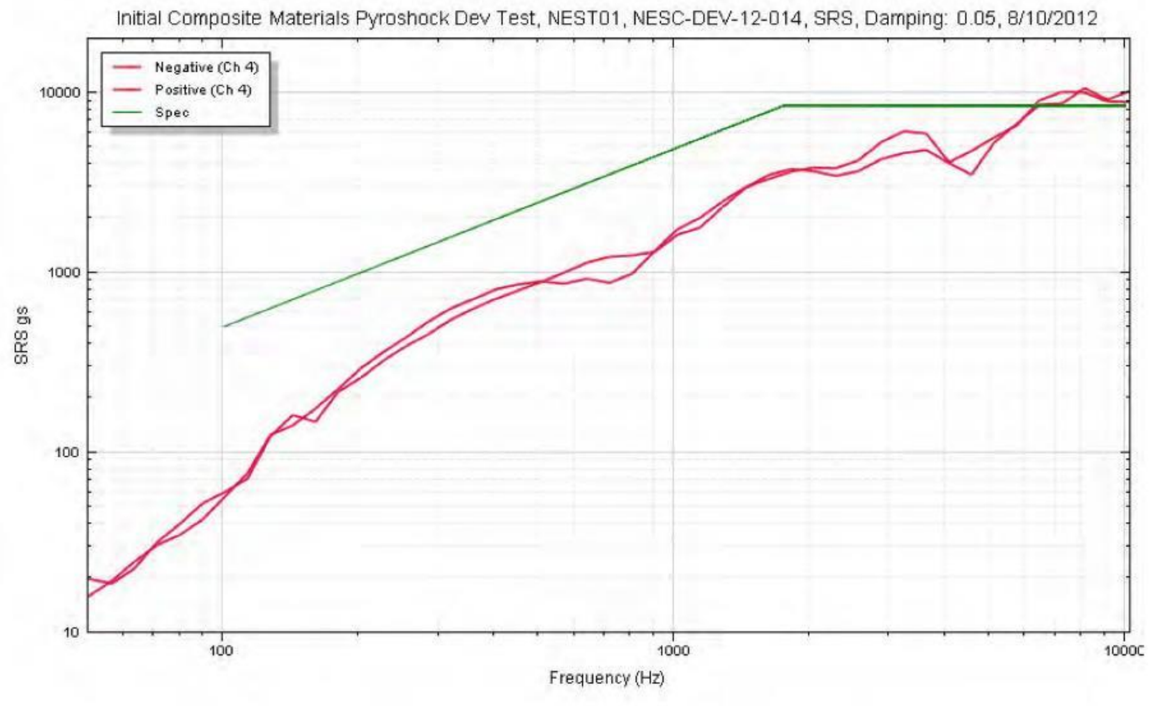
Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 1
Maxima 2)
x (Ch 13)
Spec
SRS gs
10000
1000
100
10
1
0.1
100
1000
10000
Frequency (Hz)

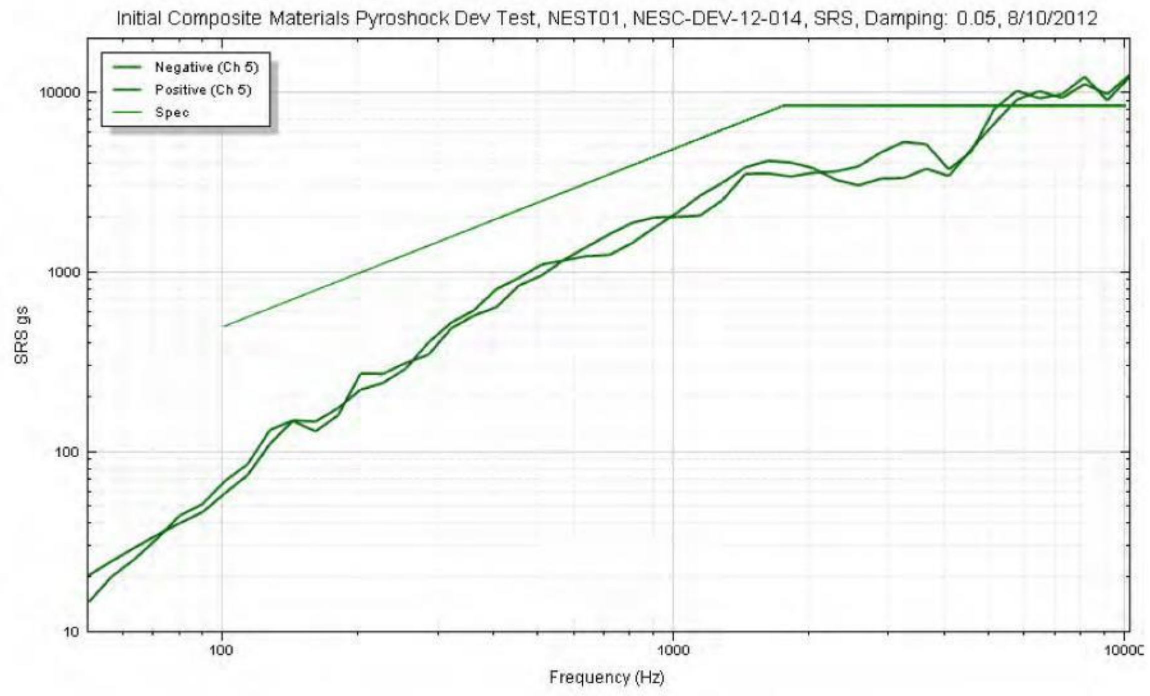

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 11)
Maximax (Ch 12)
Maximax (Ch 13)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

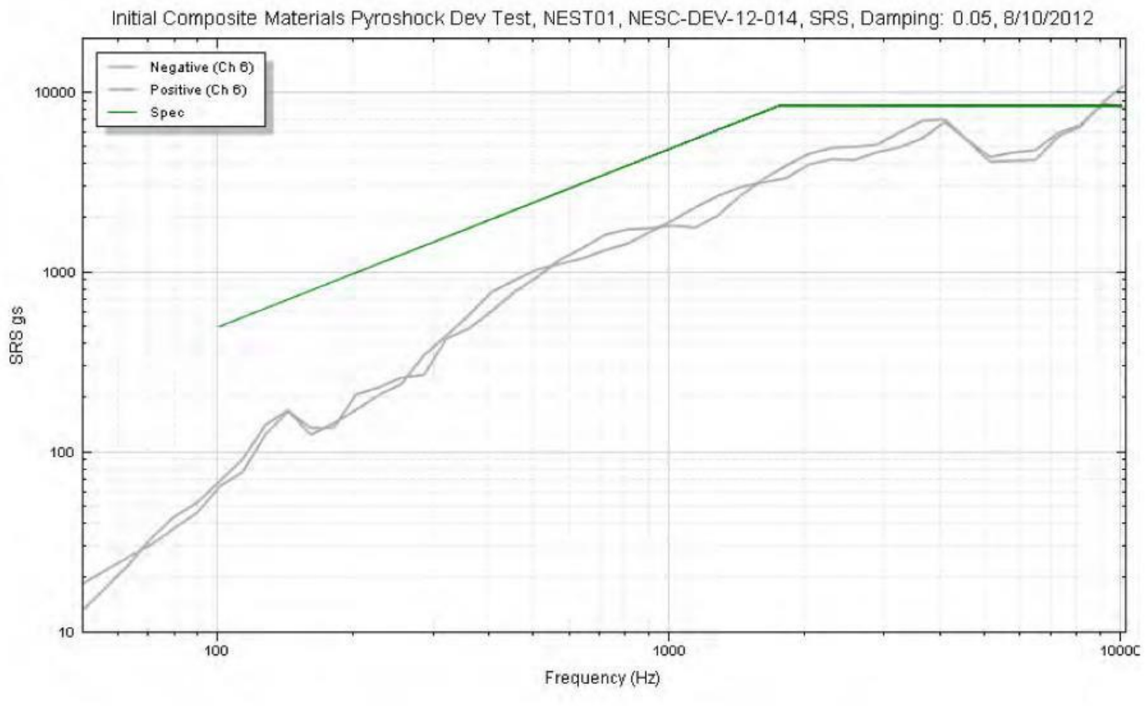

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 1)
Positive (Ch 1)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

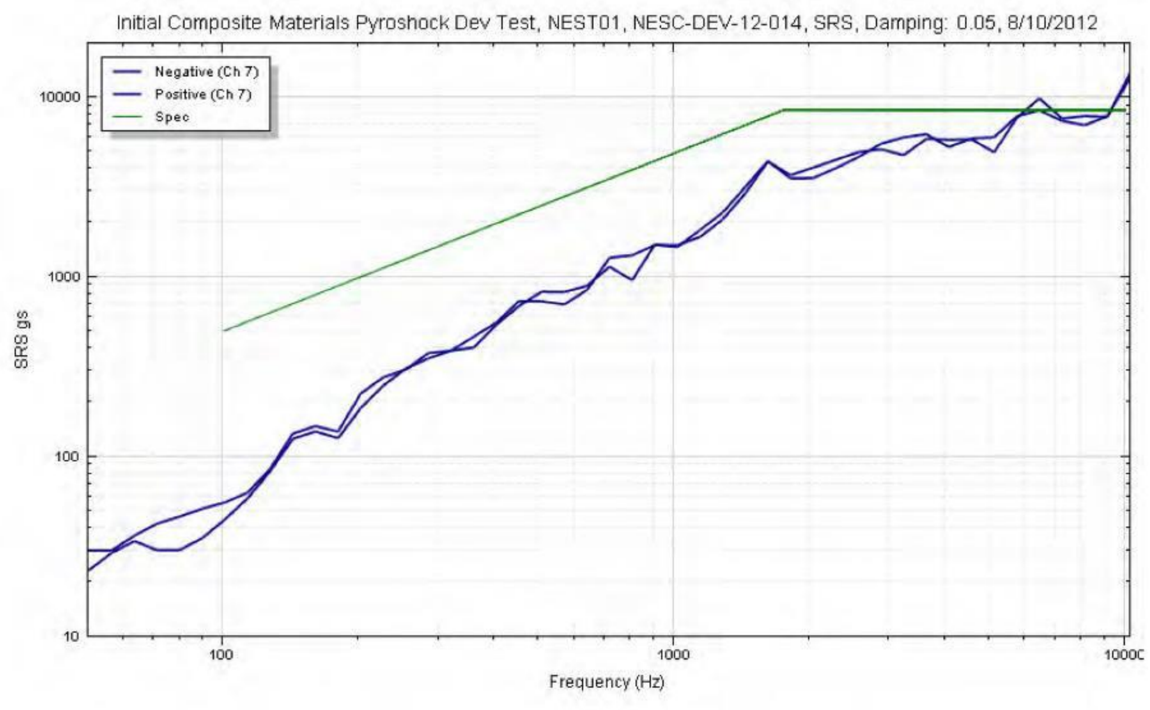

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 2)
Positive (Ch 2)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

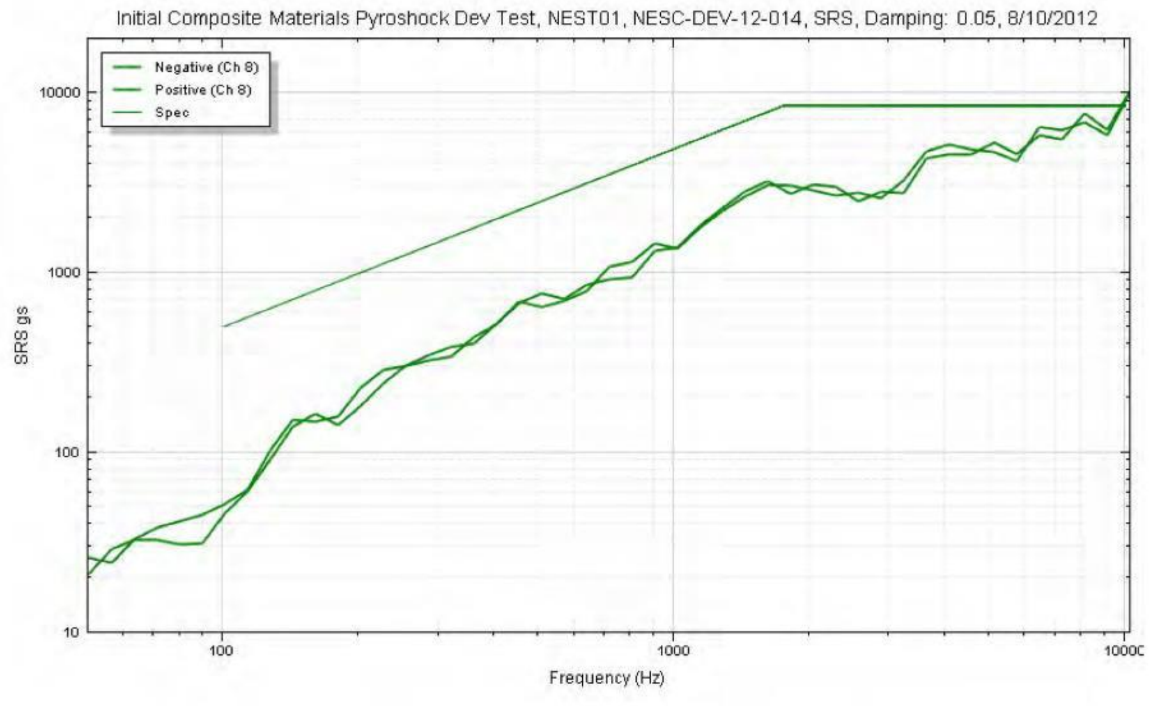

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 3)
Positive (Ch 3)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

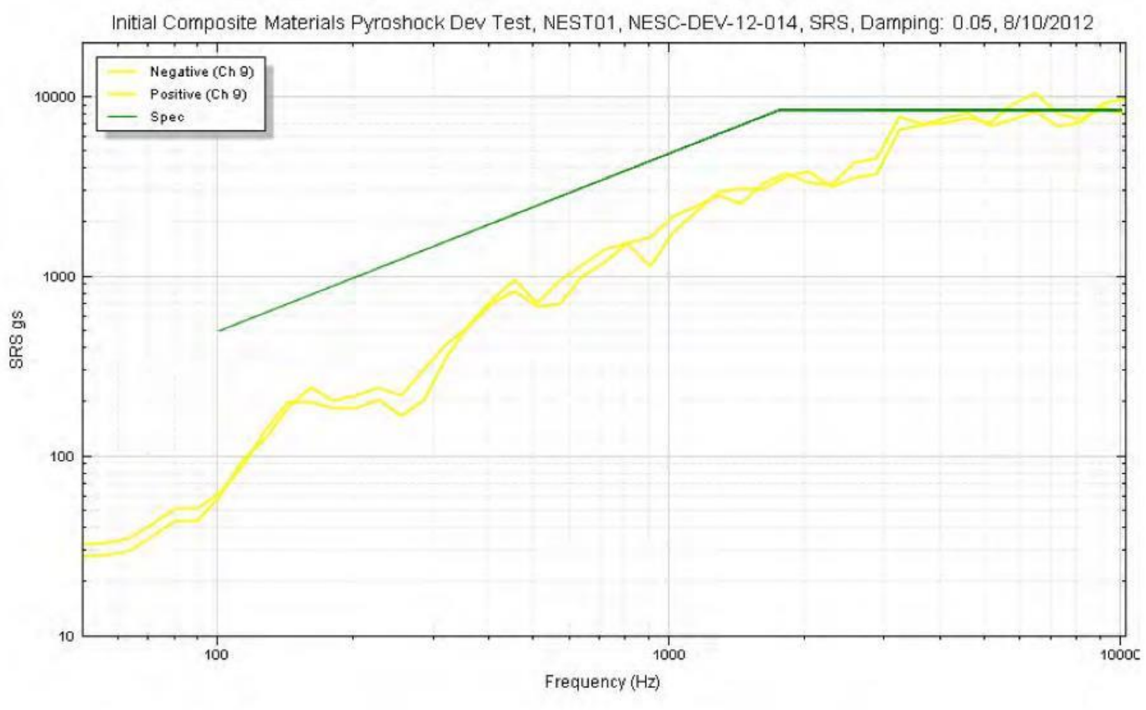

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 4)
Positive (Ch 4)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

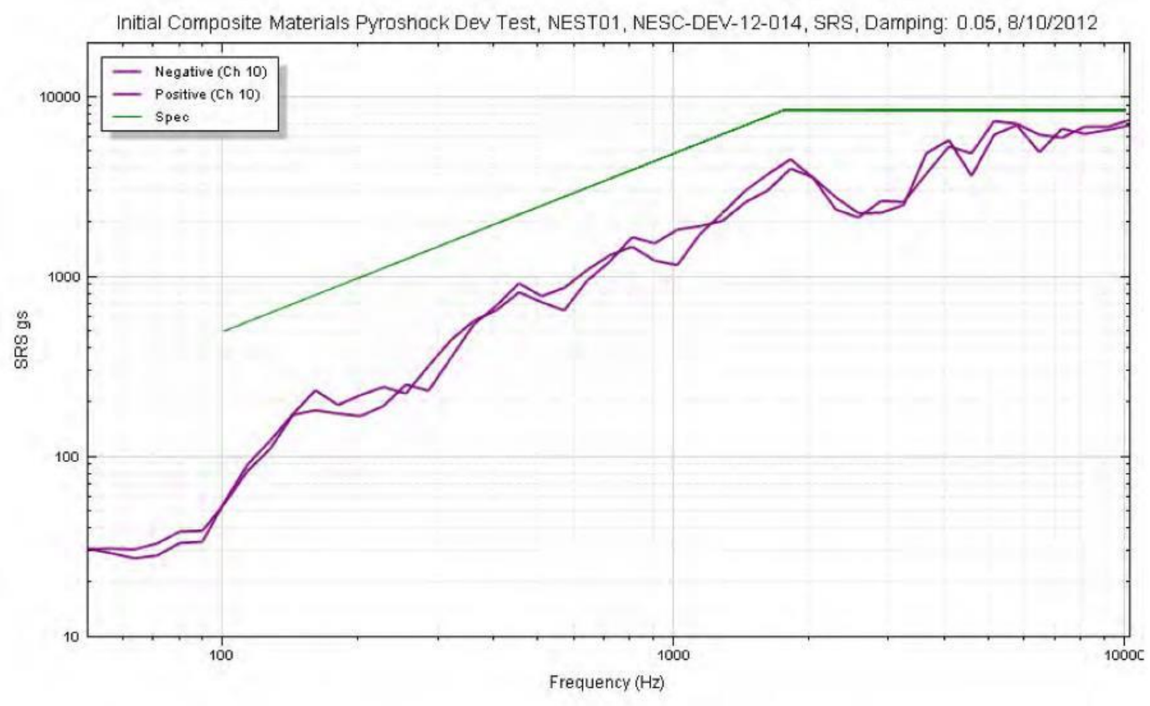

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 5)
Positive (Ch 5)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

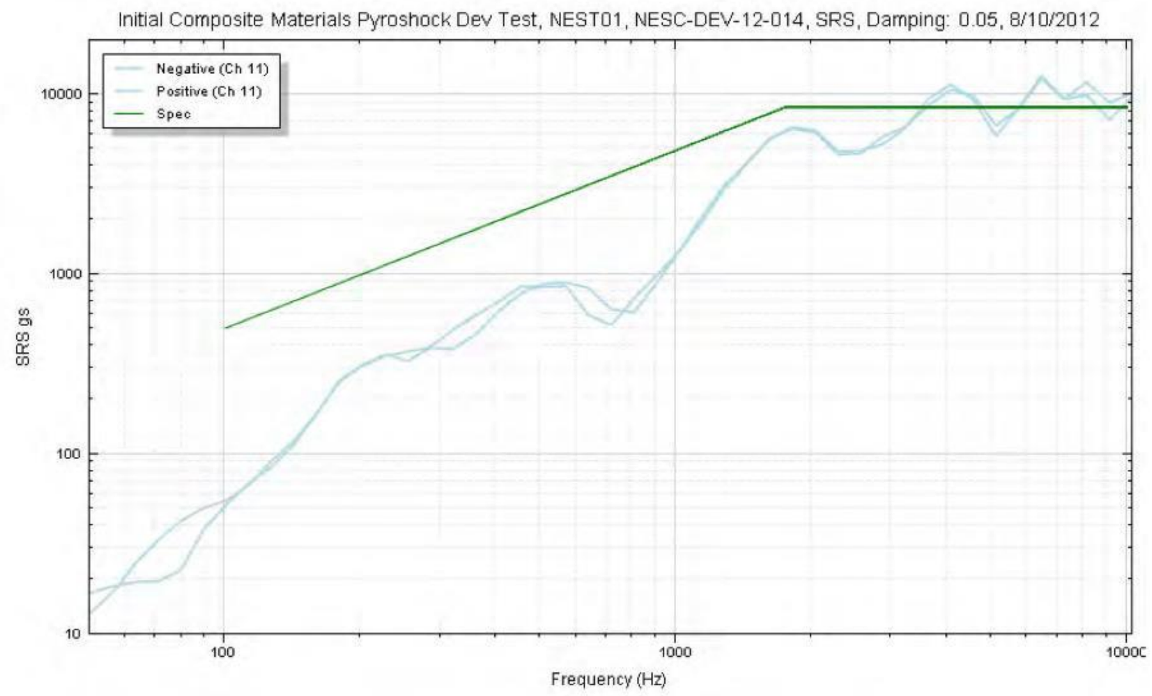

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 6)
Positive (Ch 6)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

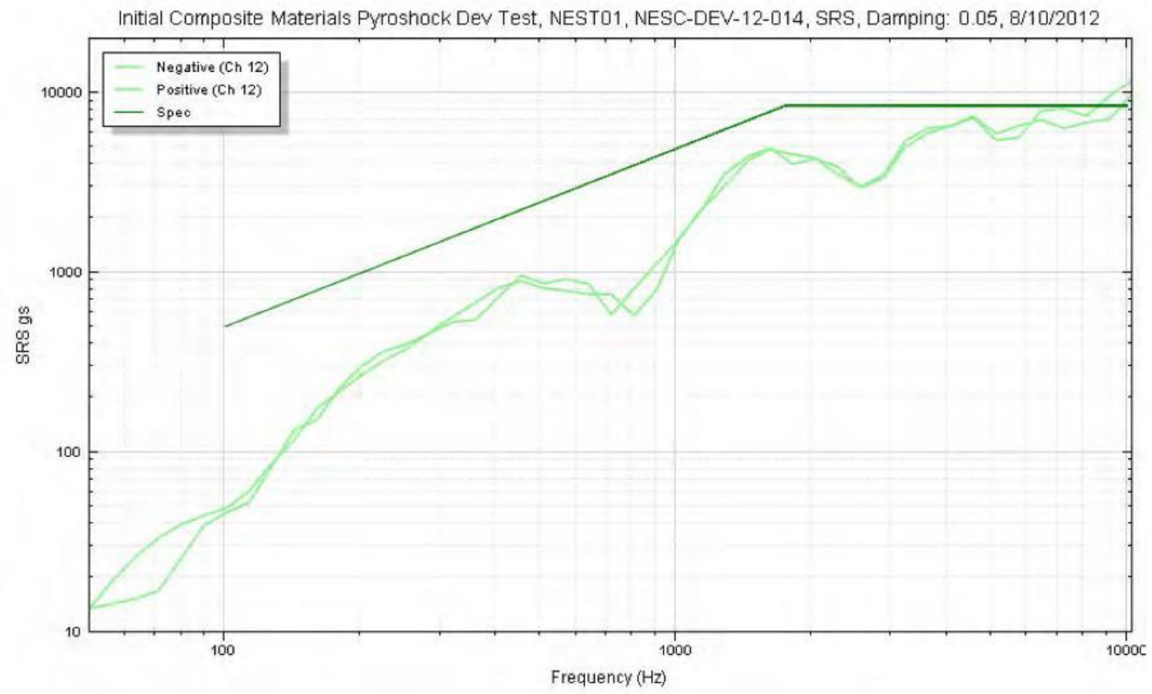

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 7)
Positive (Ch 7)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

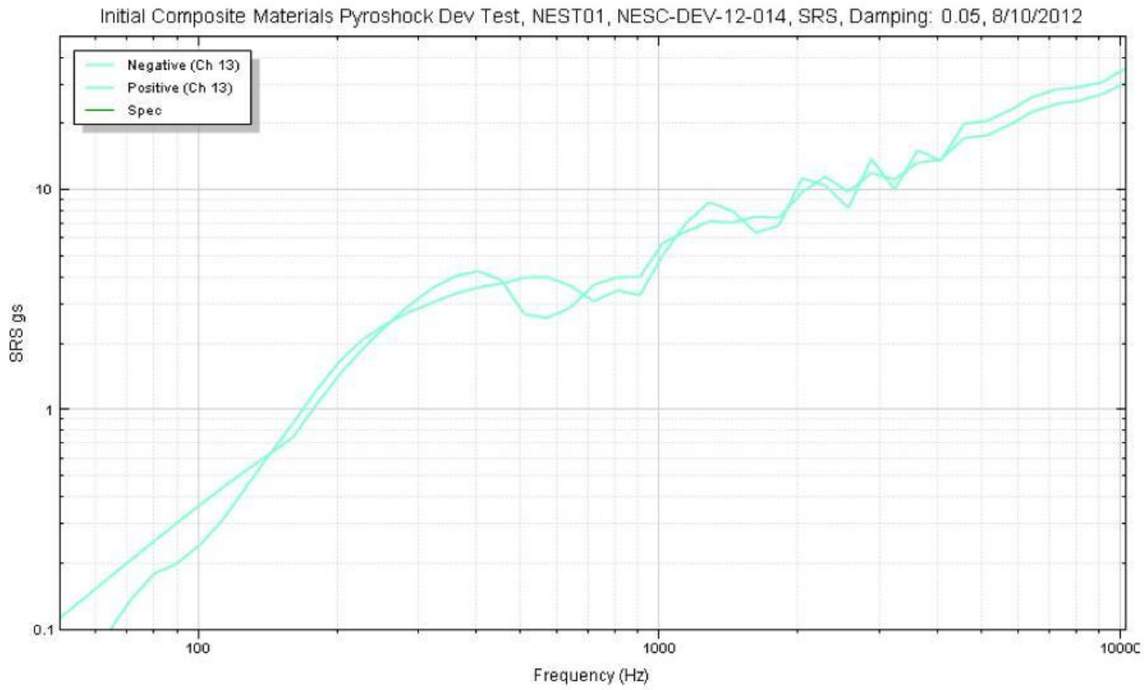

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 8)
Positive (Ch 8)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 9)
Positive (Ch 9)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 10)
Positive (Ch 10)
Spec
10000
1000
100
10
SRS gs
100
1000
1000C
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 11)
Positive (Ch 11)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 12)
Positive (Ch 12)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, SRS, Damping: 0.05, 8/10/2012
Negative (Ch 13)
Positive (Ch 13)
Spec
SRS gs
10
1
0.1
100
1000
10000
Frequency (Hz)

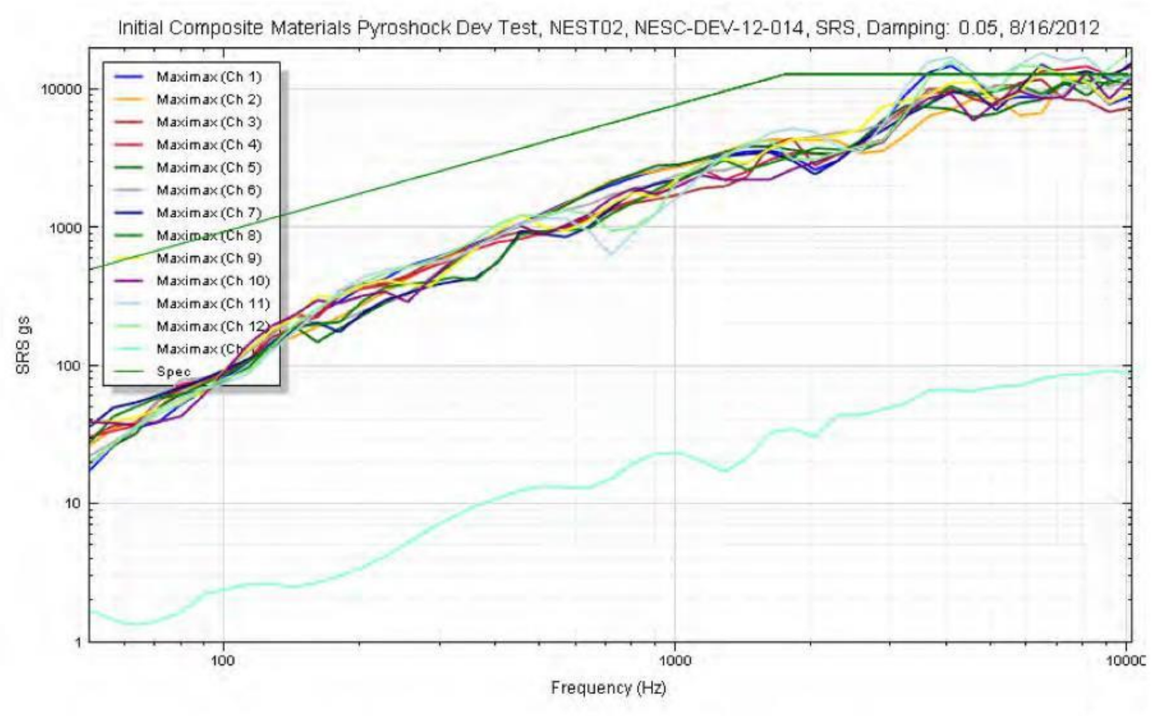
Test Data

SRS
Test T02

Aluminum Pathfinder Panel
22 gpf, FLSC

The Spec. line for Test T02 is the Estimated Source Shock

Hz.	SRS g's
50	500
1750	13,000
10k	13,000


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 11)
Maximax (Ch 12)
Maximax (Ch
Spec
SRS gs
10000
1000
100
10
1
100
1000
10000
Frequency (Hz)

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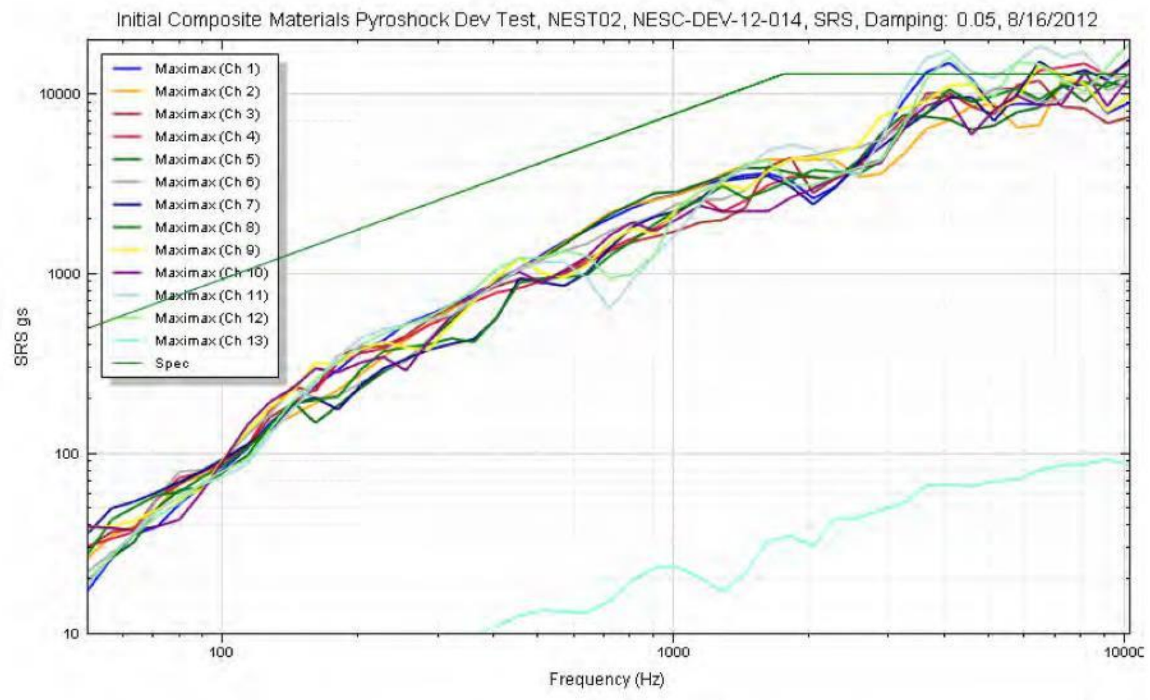
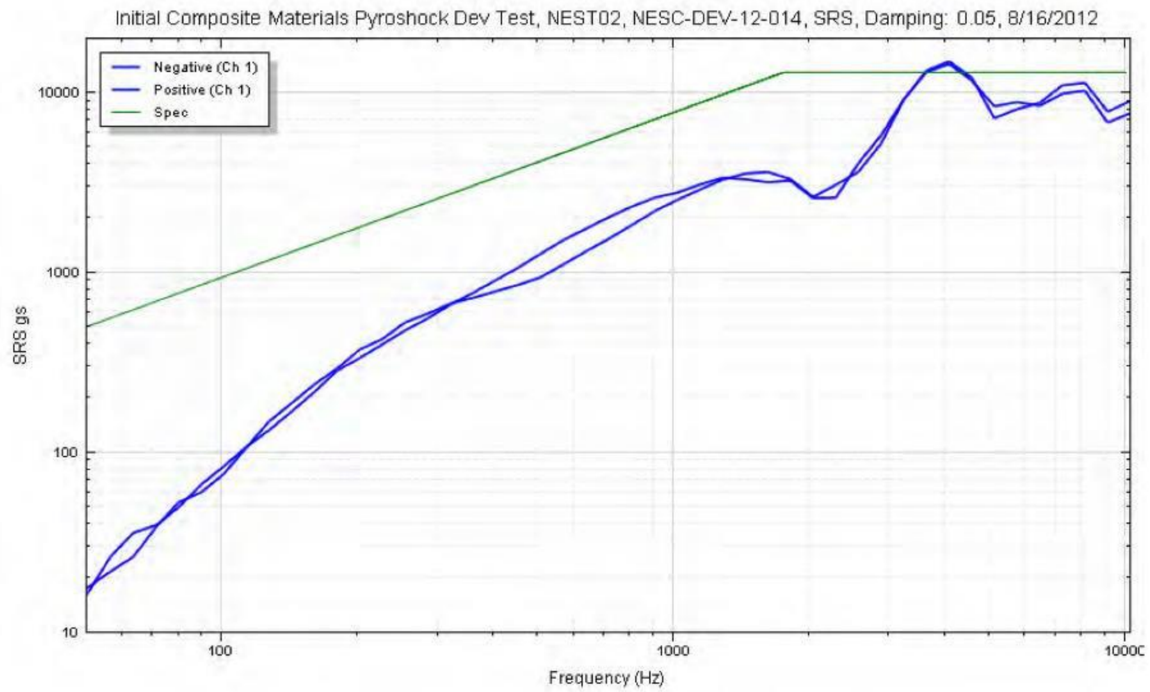
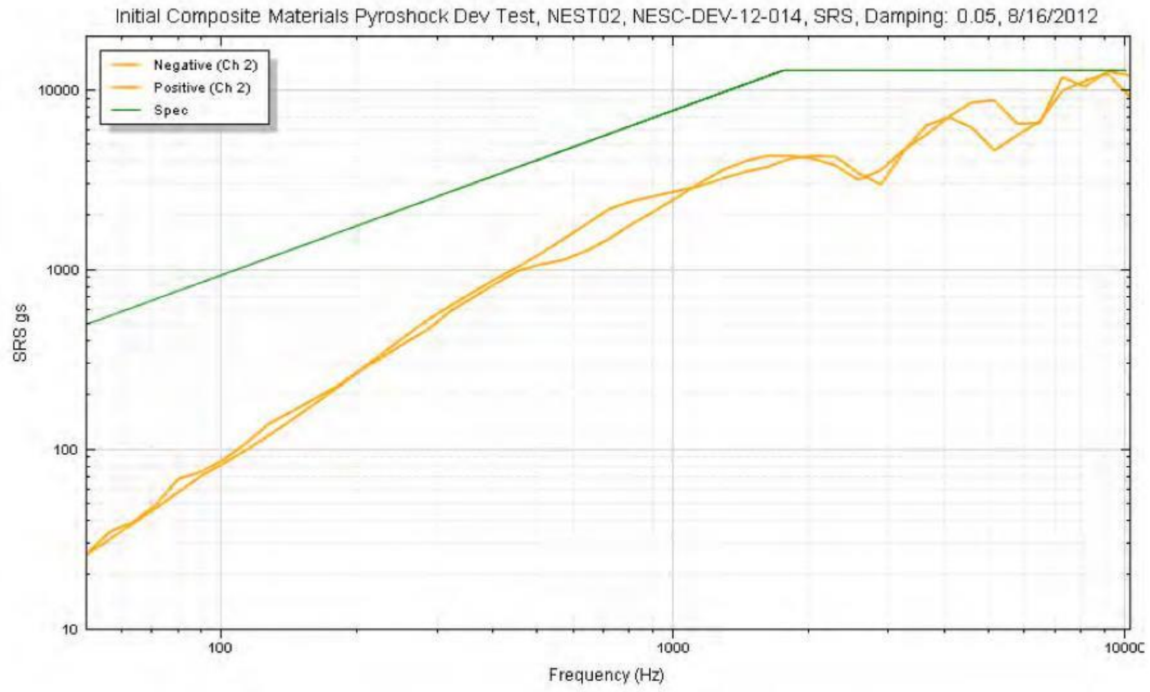
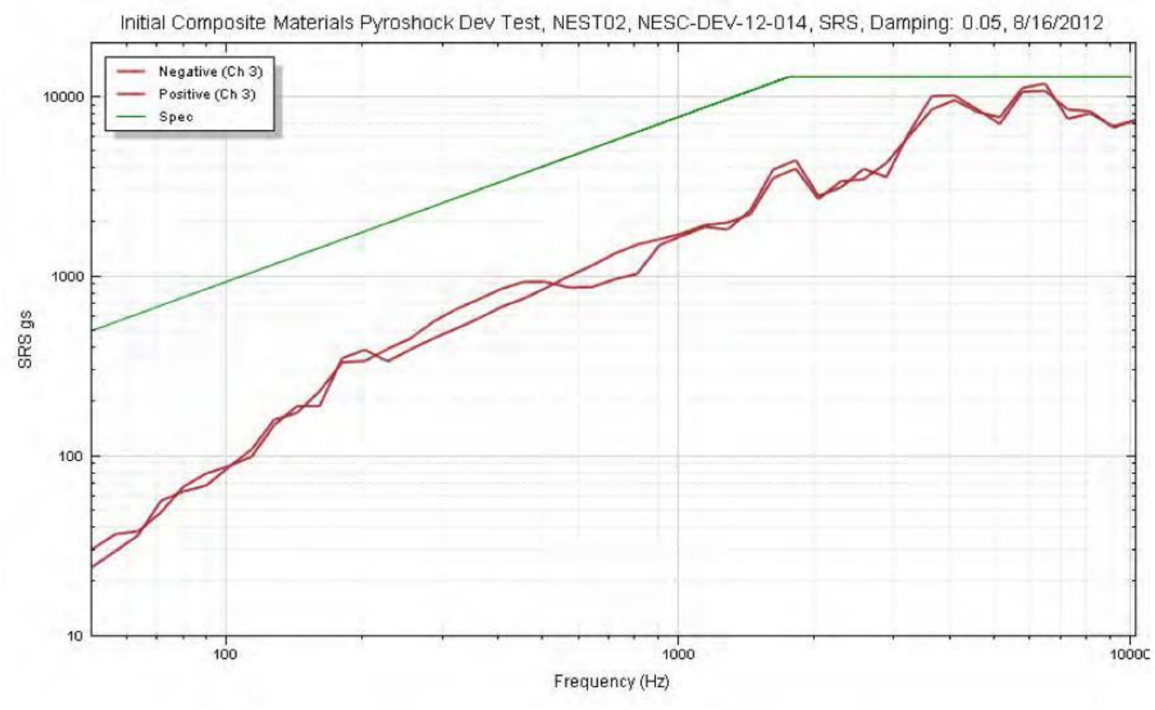
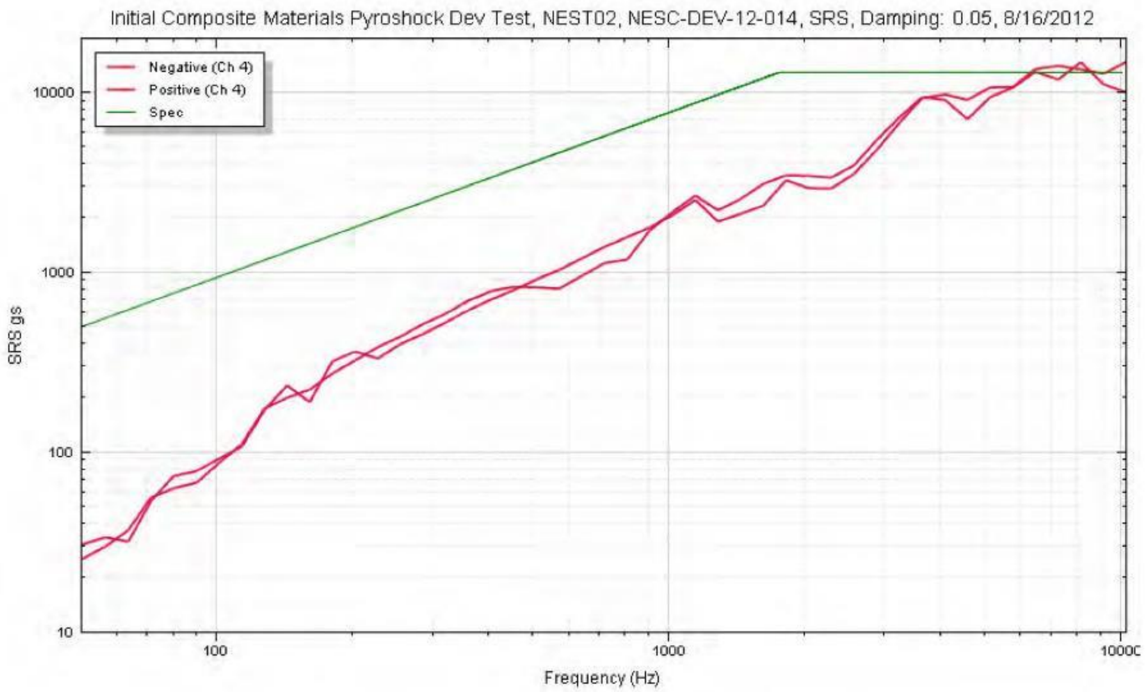
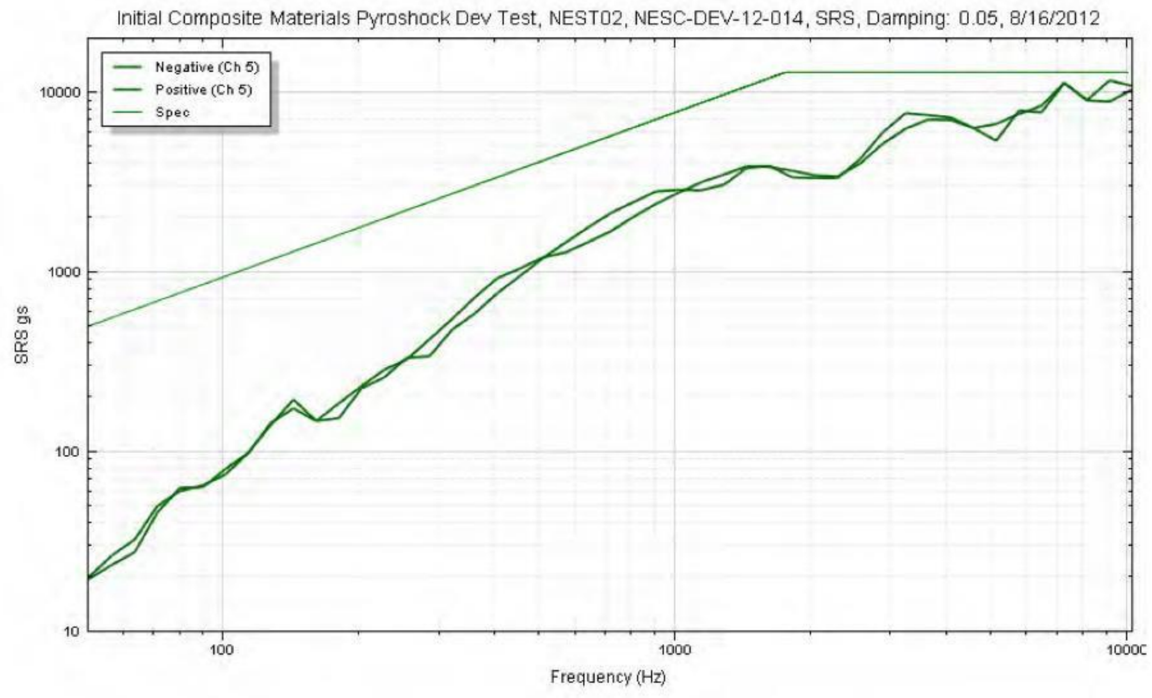

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 11)
Maximax (Ch 12)
Maximax (Ch 13)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

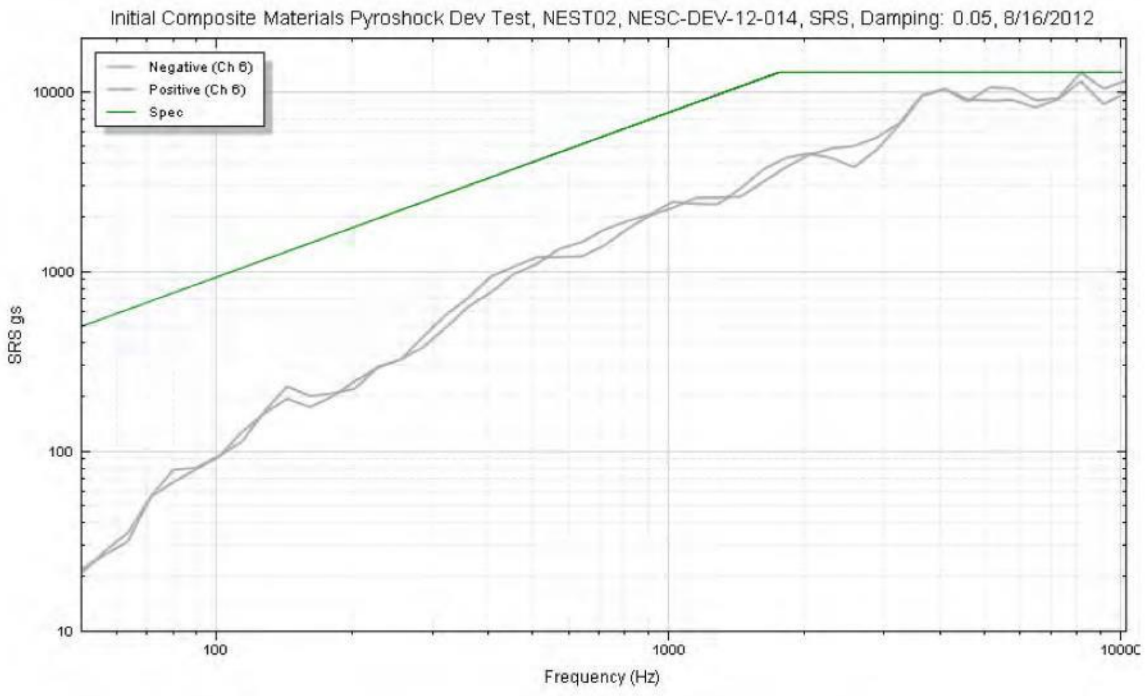

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 1)
Positive (Ch 1)
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

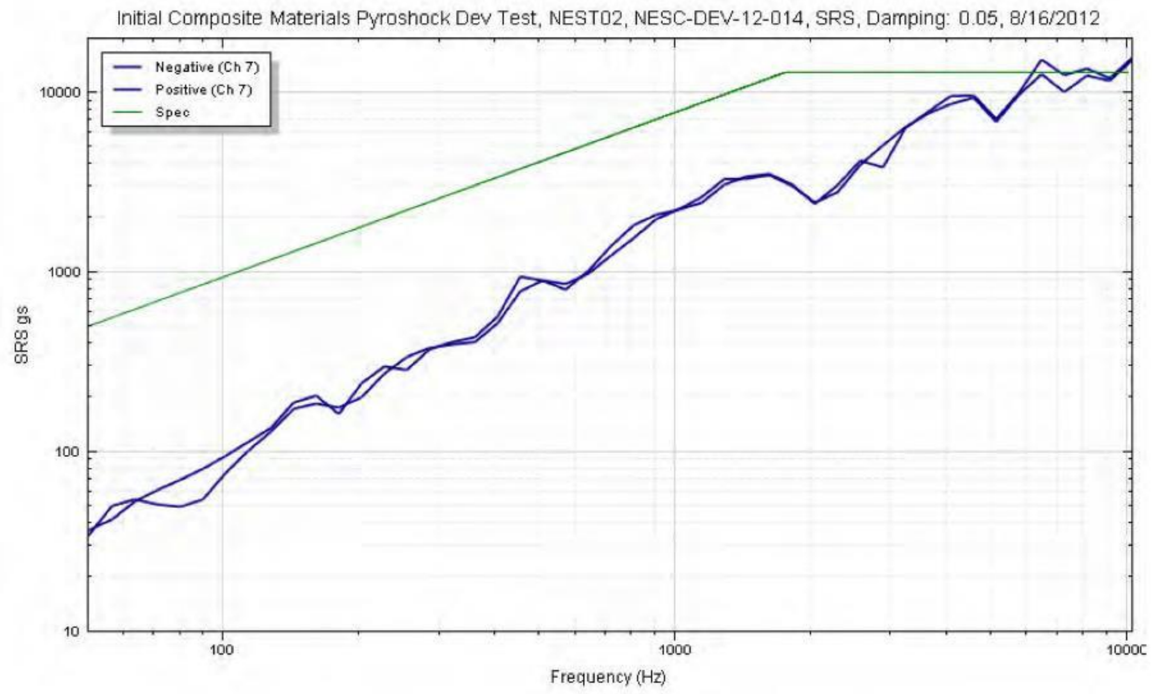

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 2)
Positive (Ch 2)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

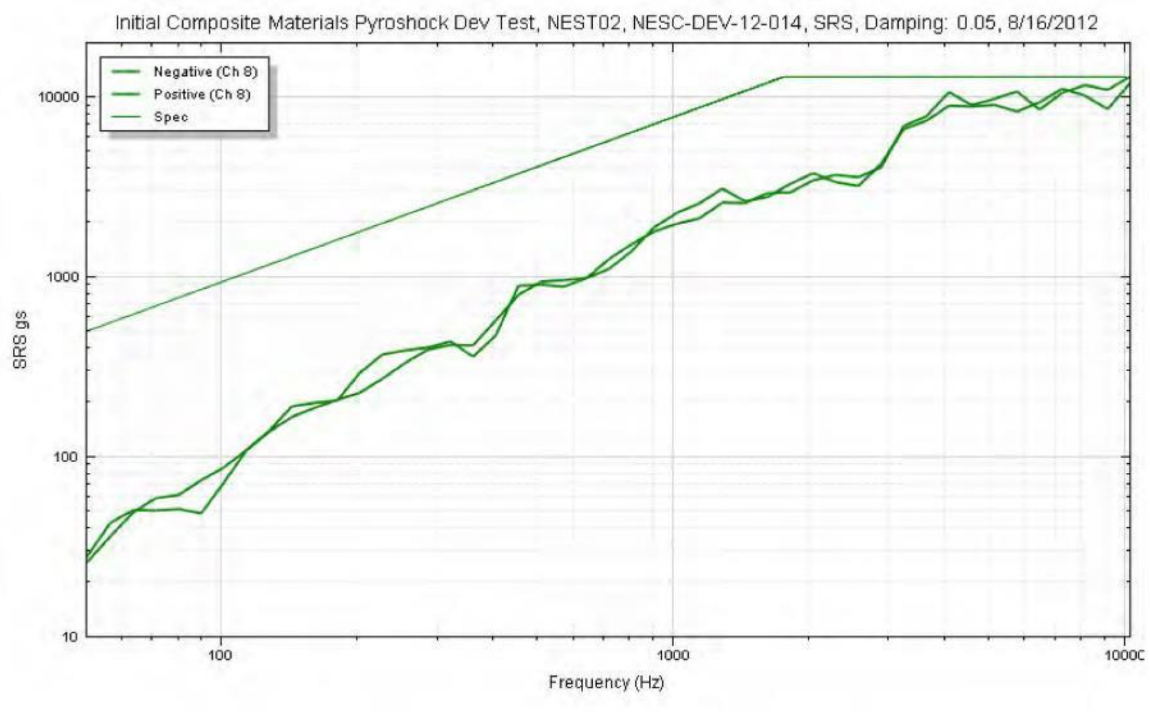

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 3)
Positive (Ch 3)
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 4)
Positive (Ch 4)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

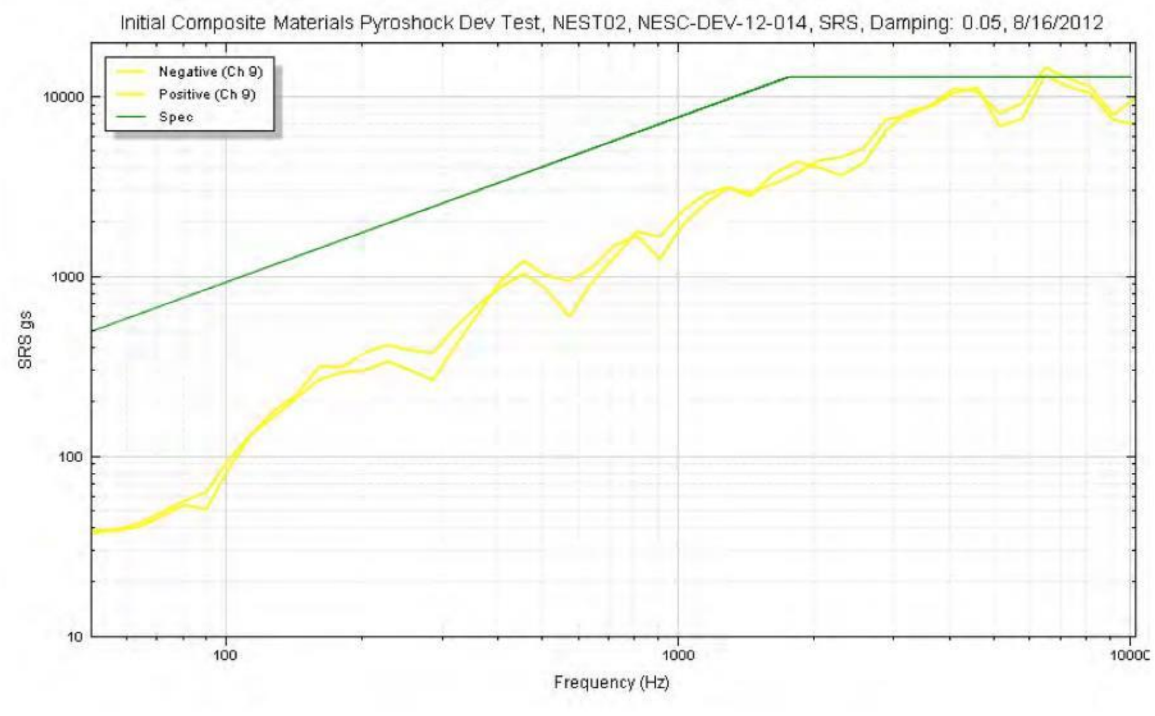

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 5)
Positive (Ch 5)
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

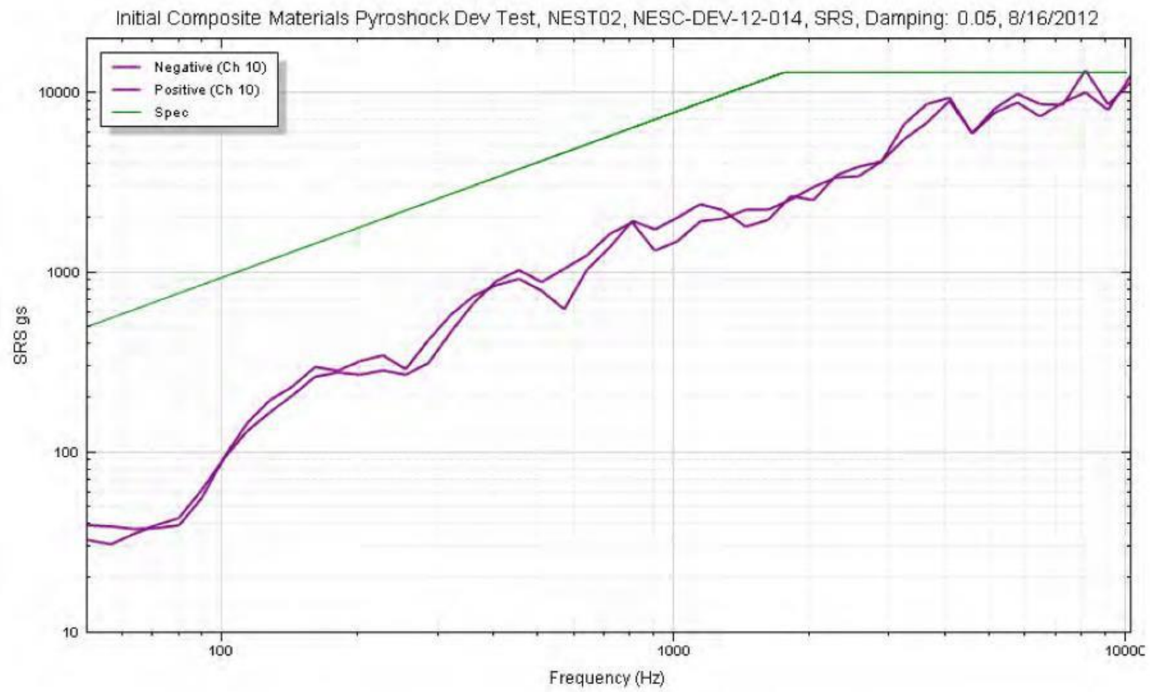

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 6)
Positive (Ch 6)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

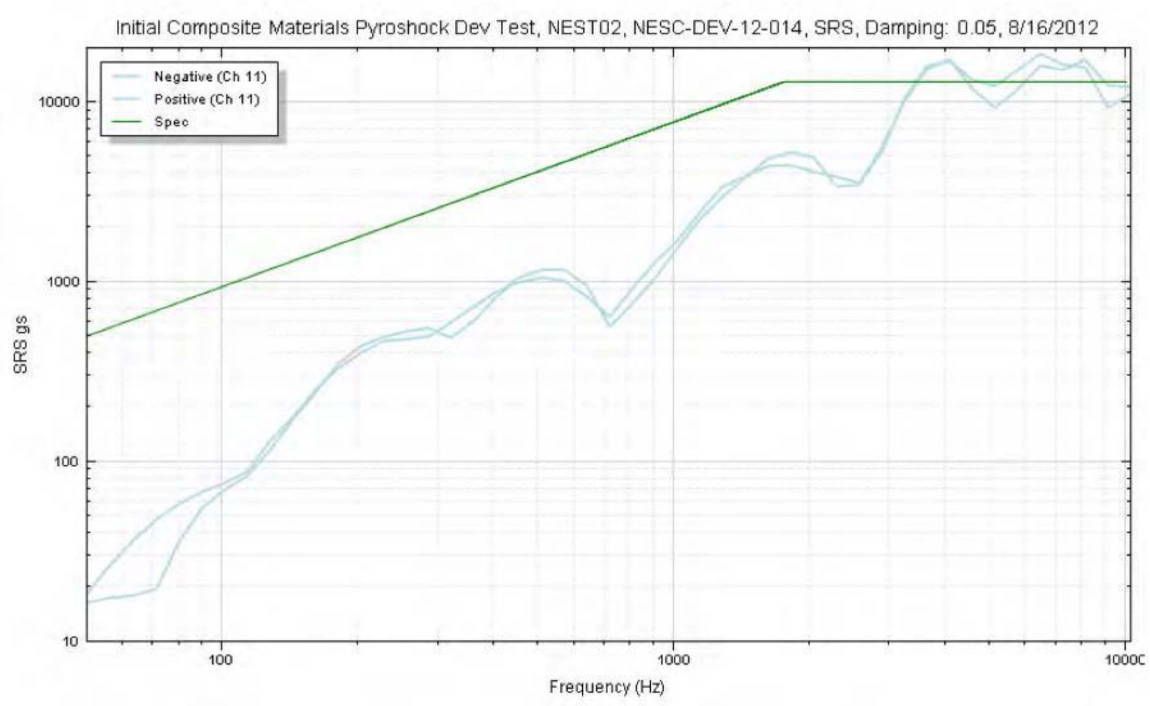

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 7)
Positive (Ch 7)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)



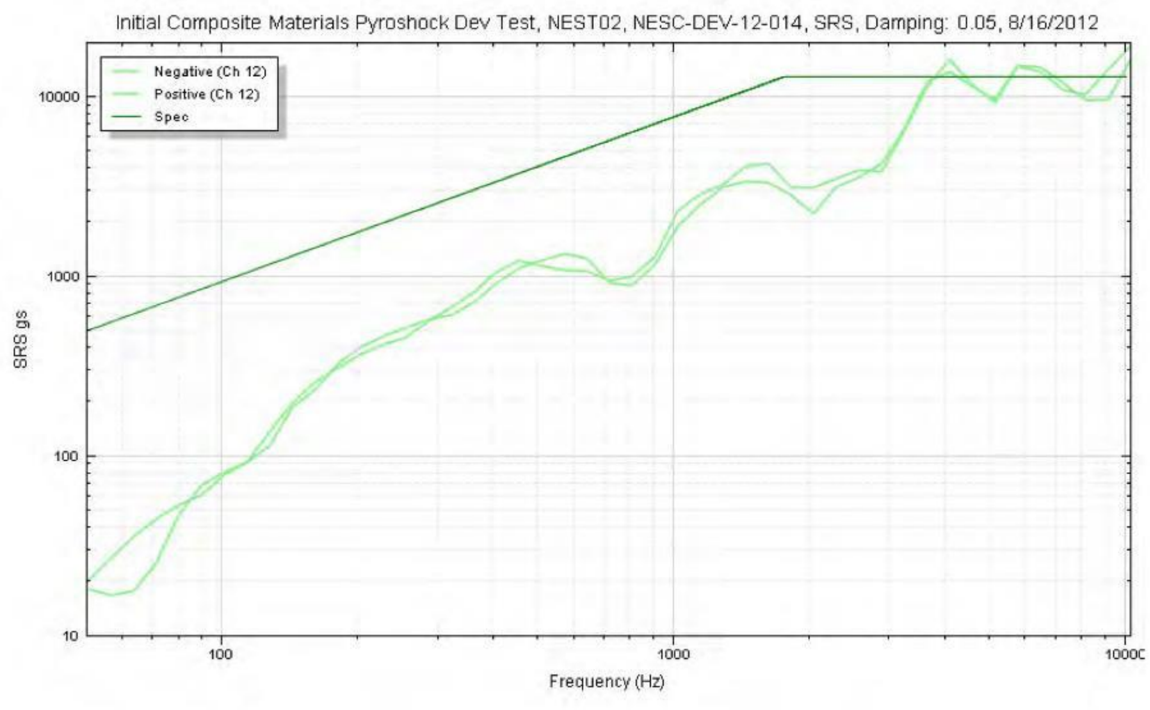
Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 8)
Positive (Ch 8)
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 9)
Positive (Ch 9)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 10)
Positive (Ch 10)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)



Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 11)
Positive (Ch 11)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 12)
Positive (Ch 12)
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
1000C

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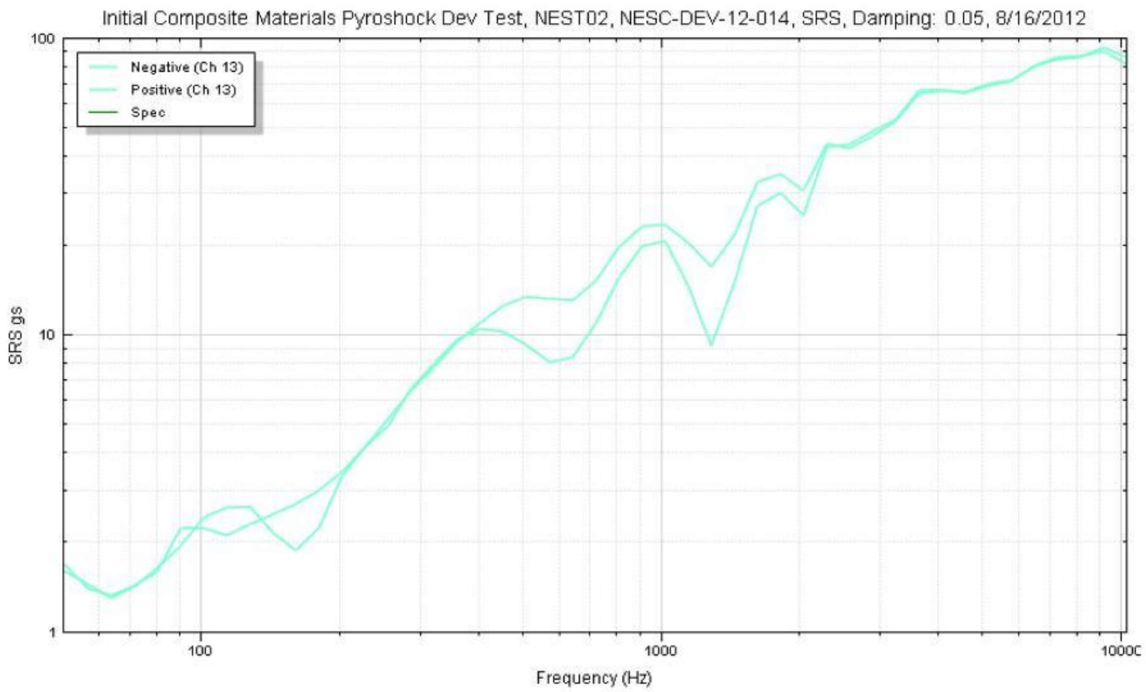

Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, SRS, Damping: 0.05, 8/16/2012
Negative (Ch 13)
Positive (Ch 13)
Spec
SRS gs
100
10
1
100
1000
10000
Frequency (Hz)

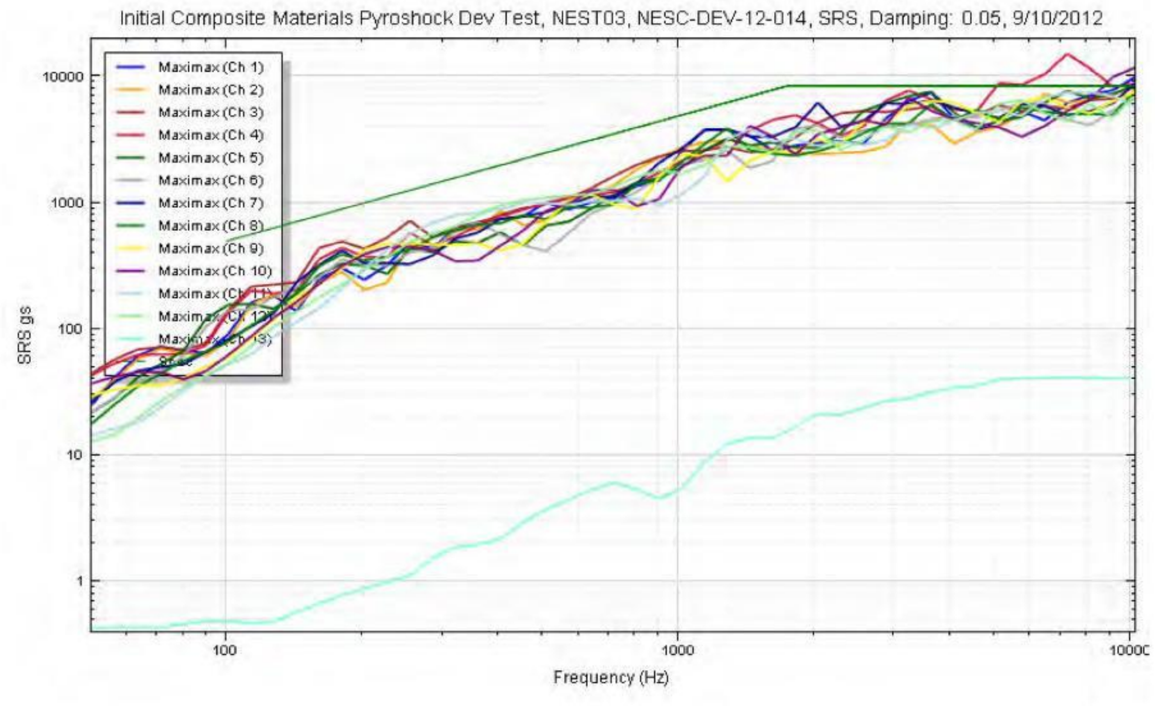
Test Data

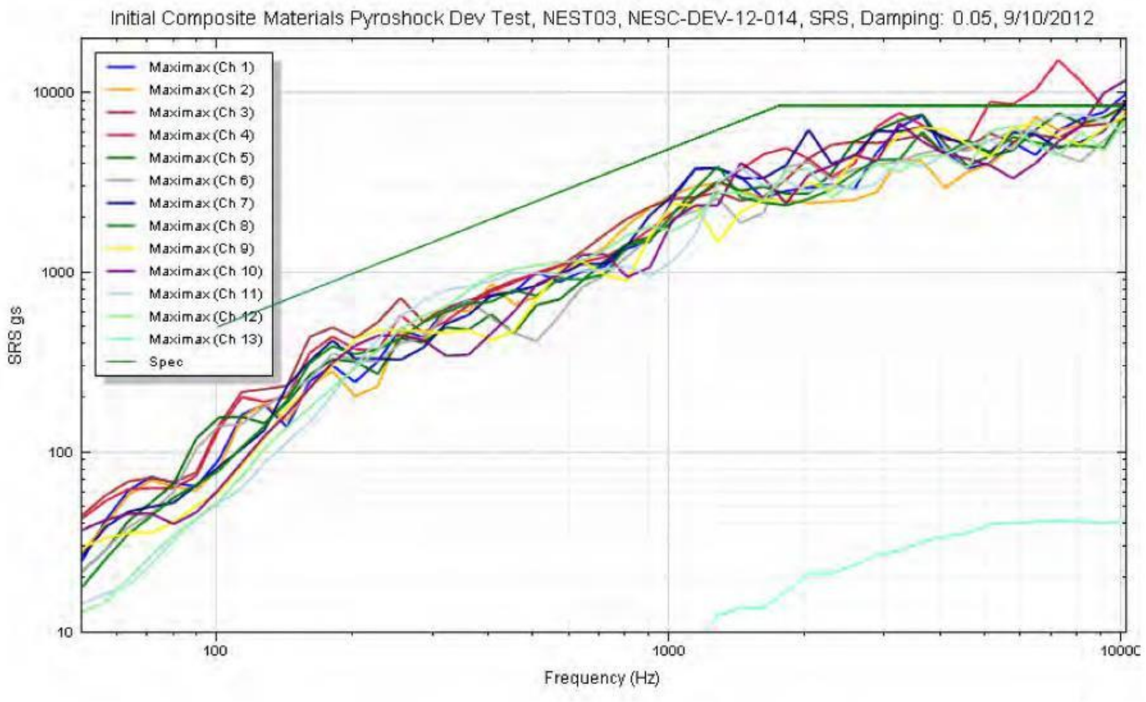
SRS
Test T03

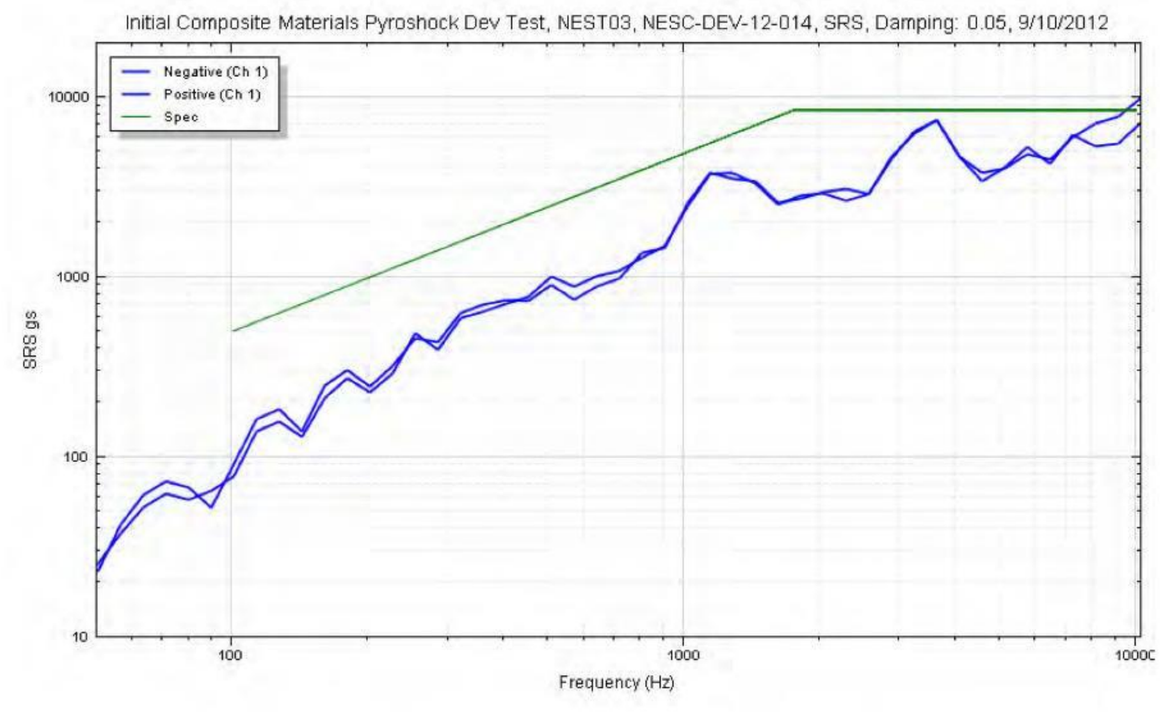
Solid Composite Pathfinder Panel
10 gpf, FLSC

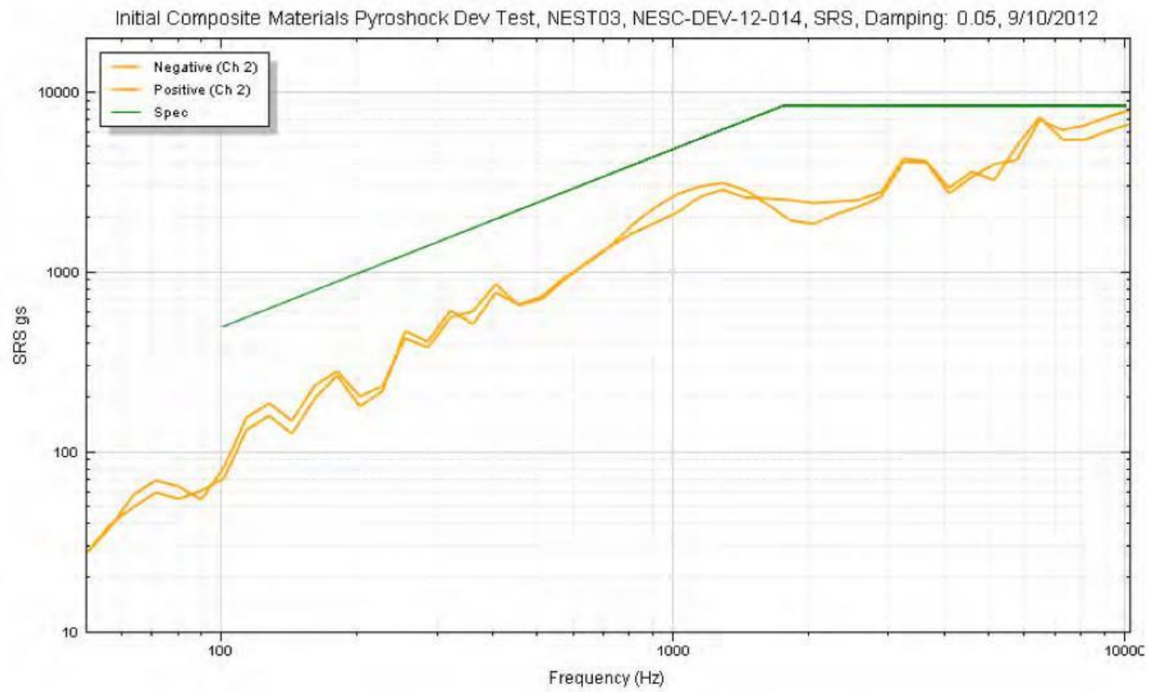
The Spec. line for Test T03 is the Estimated Source Shock

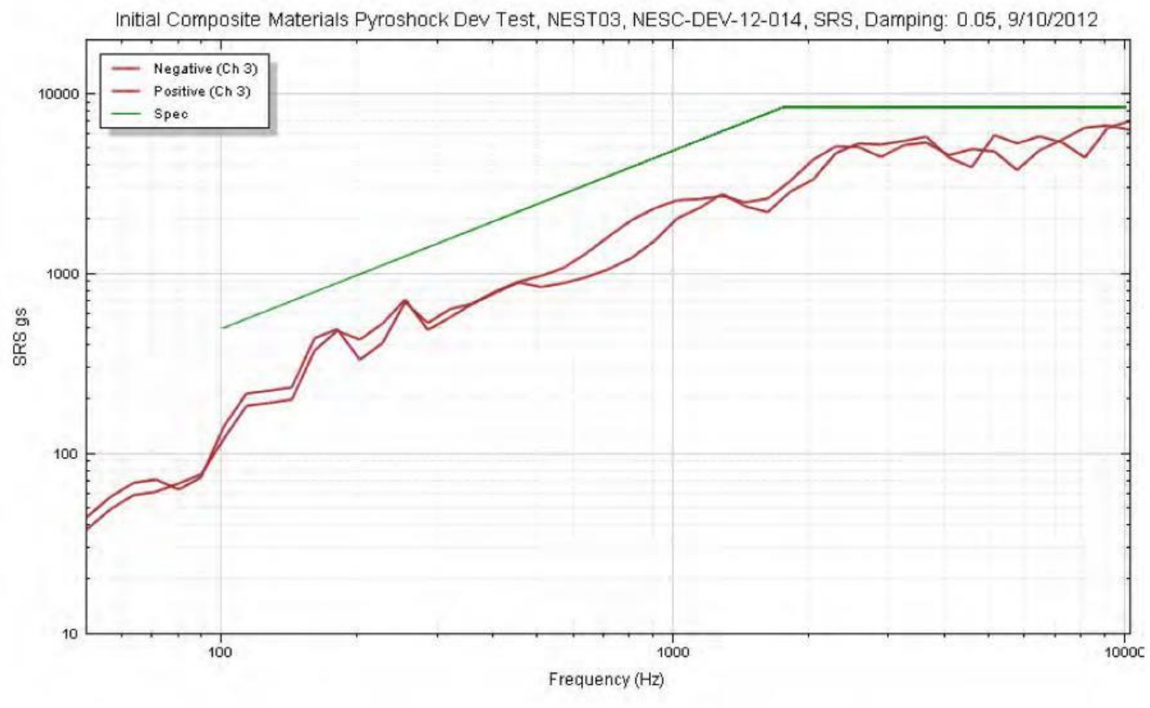
Hz.	SRS g's
100	500
1750	8500
10k	8500

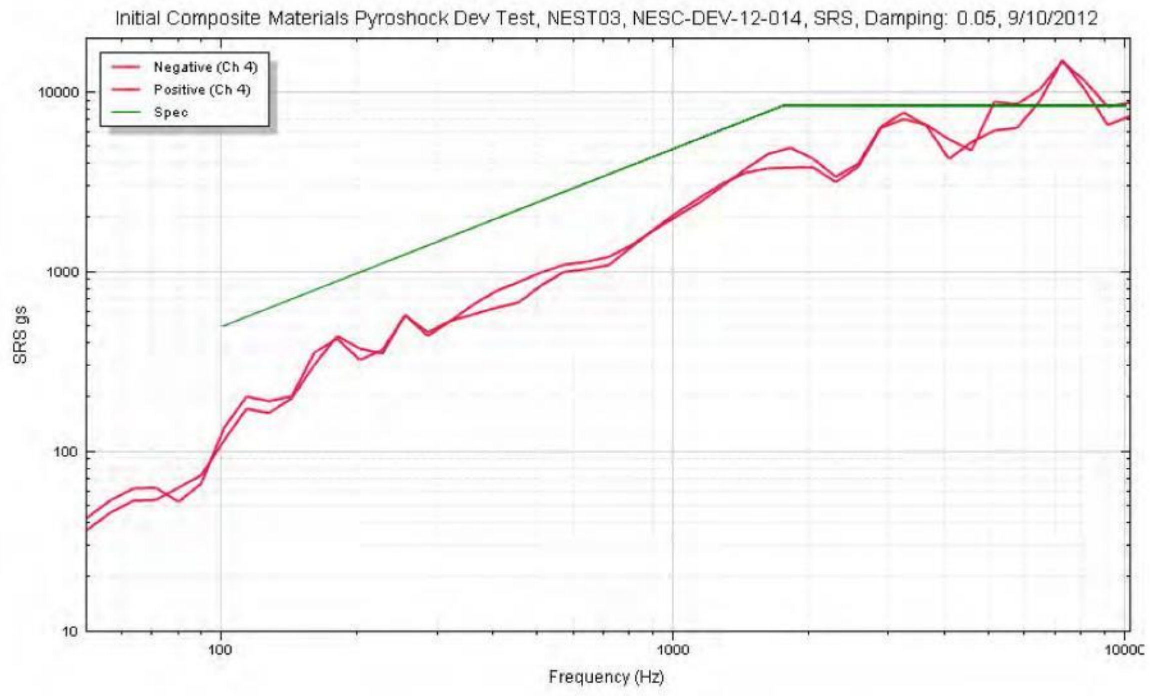

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 11)
Maximax (Ch 12)
Maximax (Ch 13)
Spec
SRS gs
10000
1000
100
10
1
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Maximax (Ch 1)
Maximax (Ch 2)
Maximax (Ch 3)
Maximax (Ch 4)
Maximax (Ch 5)
Maximax (Ch 6)
Maximax (Ch 7)
Maximax (Ch 8)
Maximax (Ch 9)
Maximax (Ch 10)
Maximax (Ch 11)
Maximax (Ch 12)
Maximax (Ch 13)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 1)
Positive (Ch 1)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

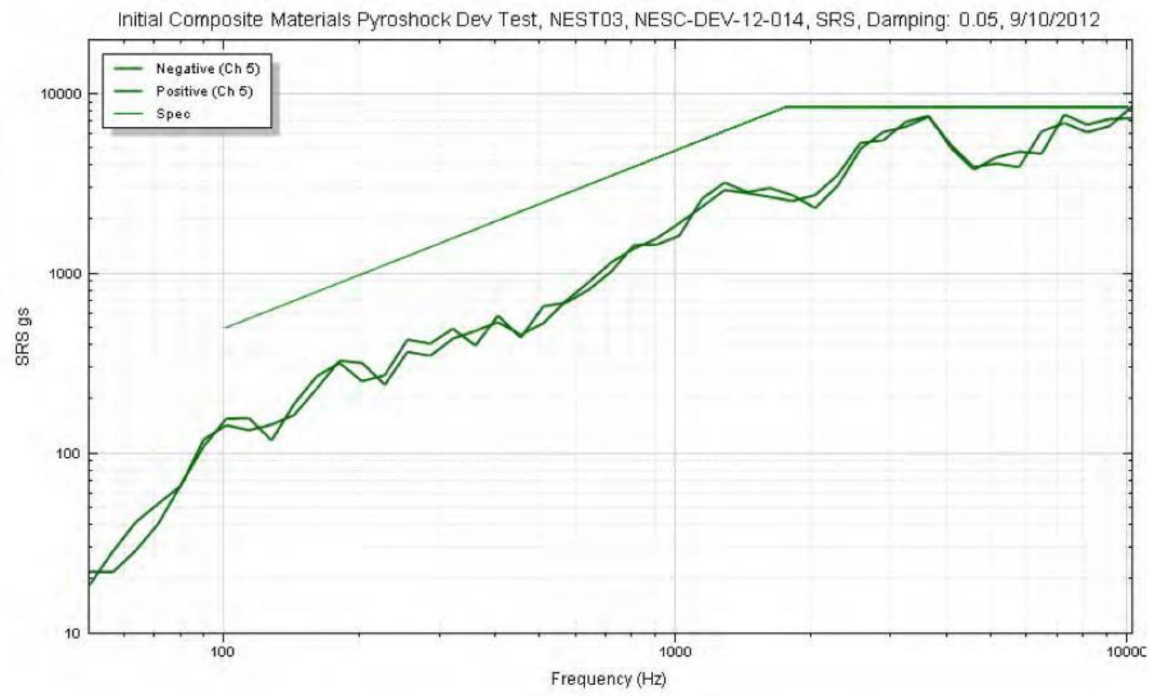

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 2)
Positive (Ch 2)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

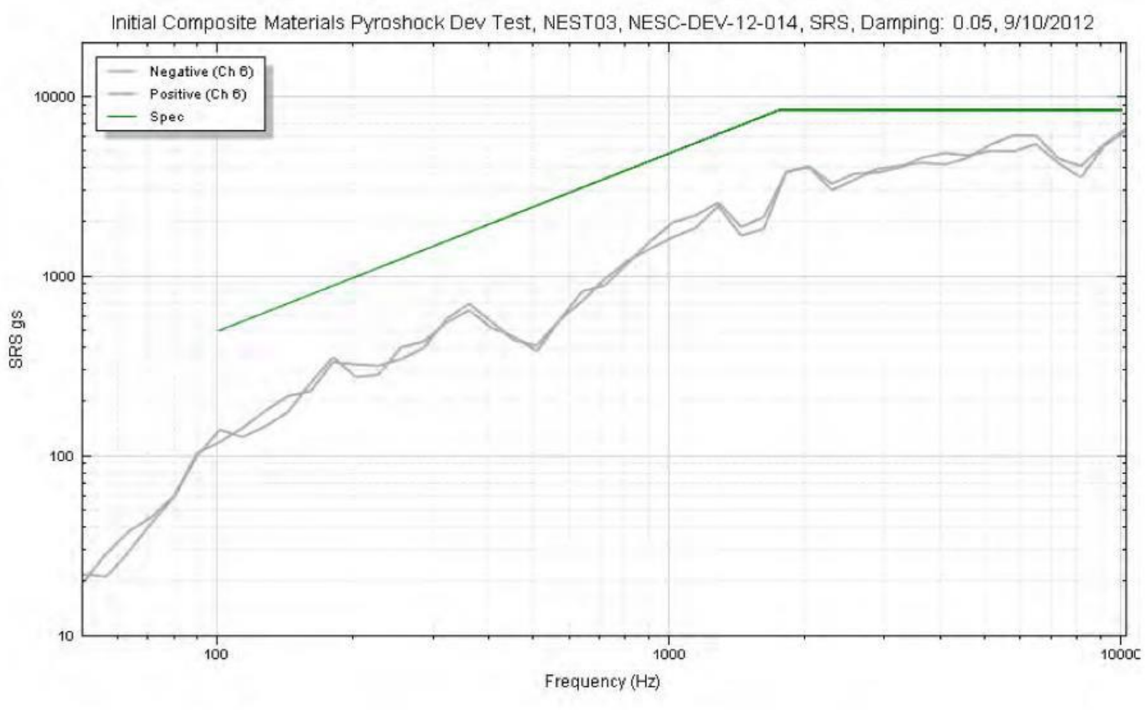

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 3)
Positive (Ch 3)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

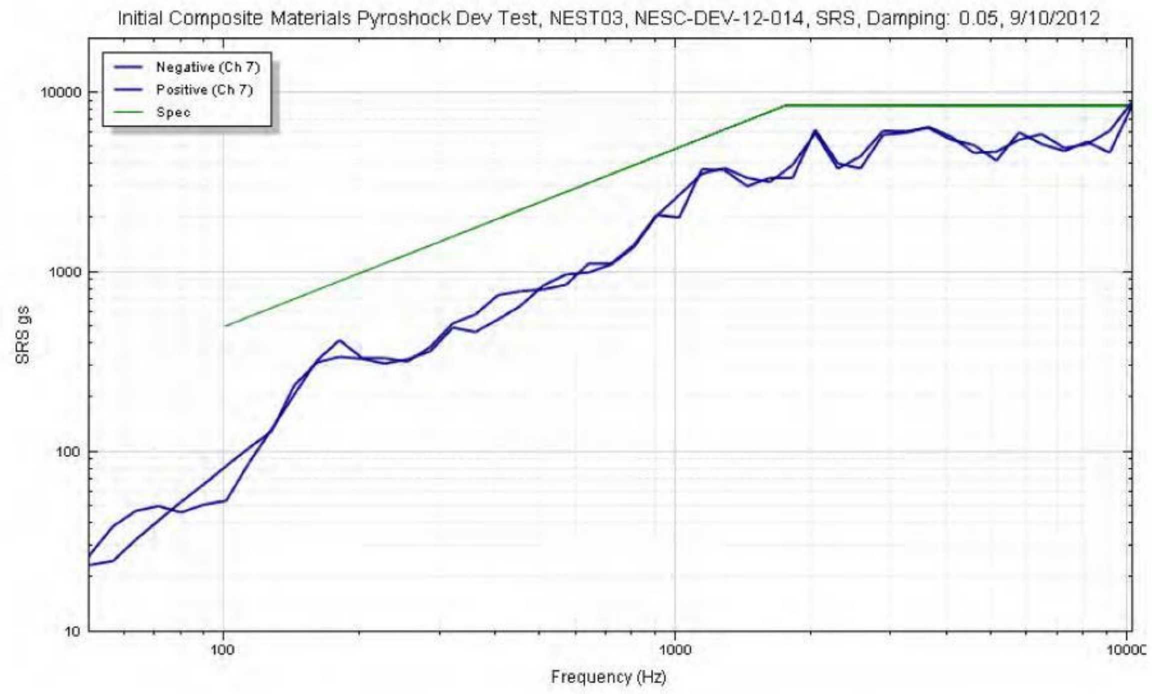


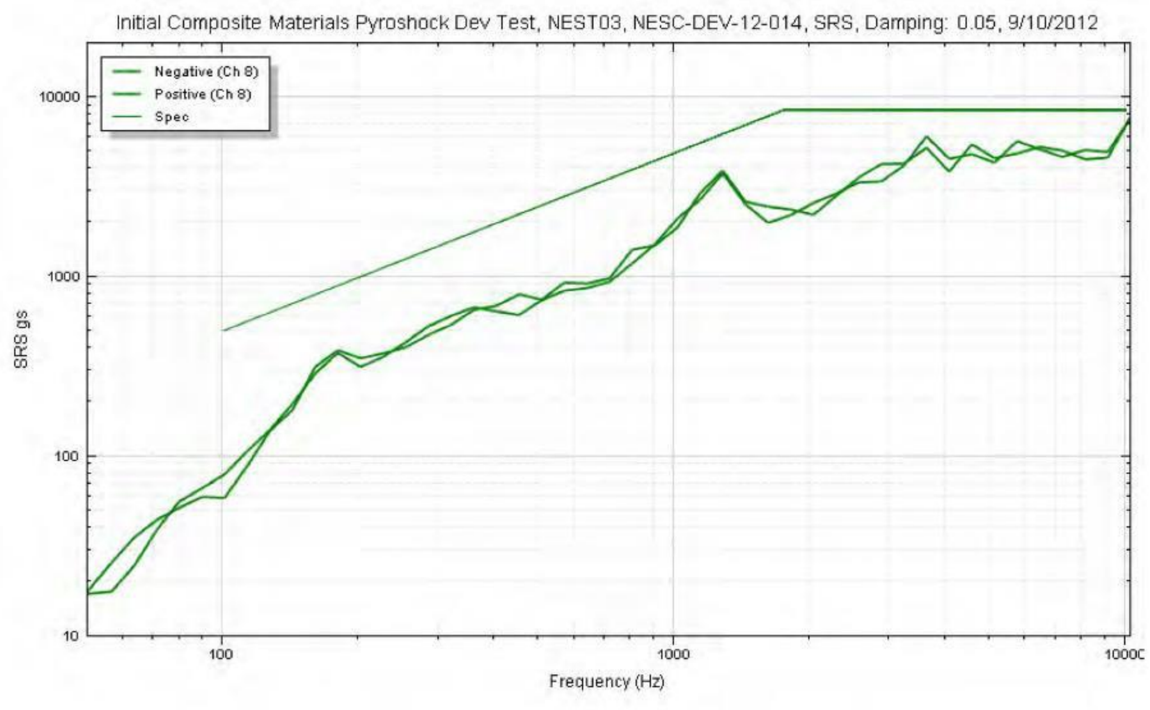
Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 4)
Positive (Ch 4)
Spec
10000
1000
100
10
SRS gs
100
1000
1000C
Frequency (Hz)

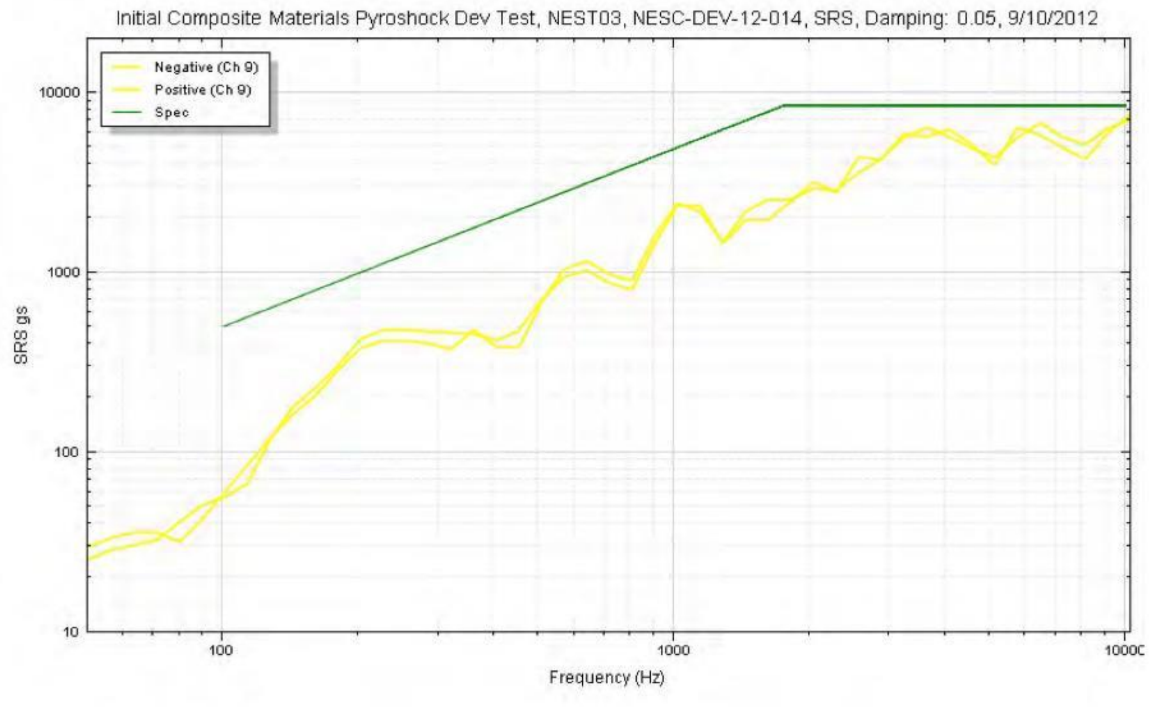
60 of 130

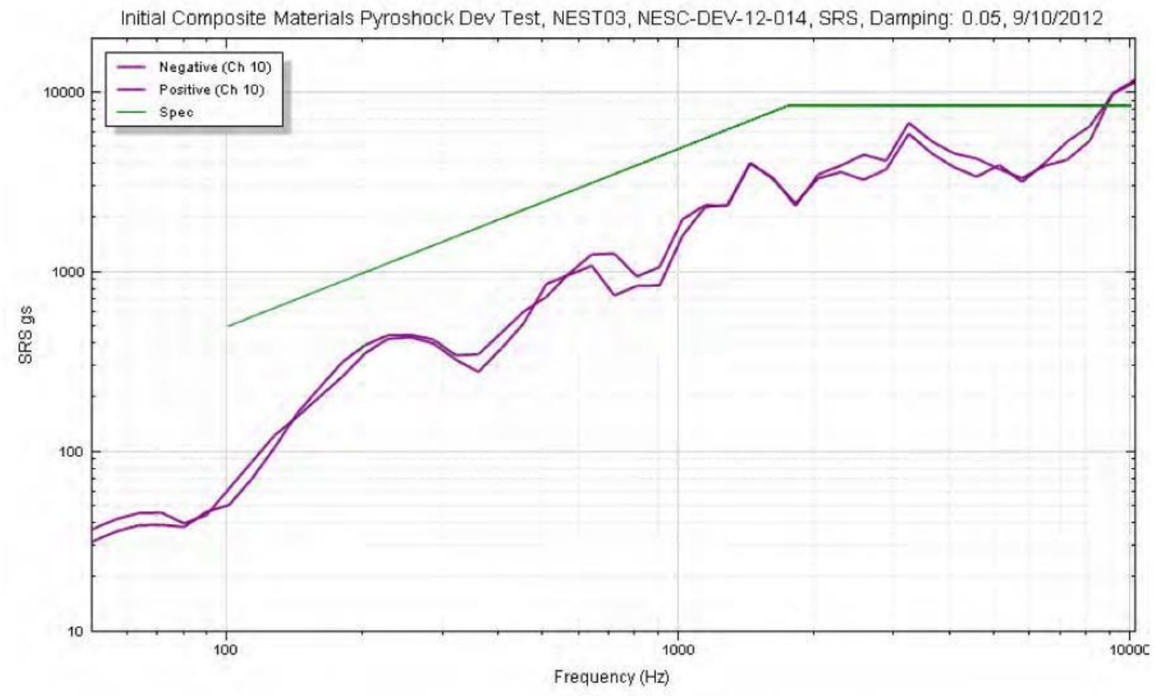

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 5)
Positive (Ch 5)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

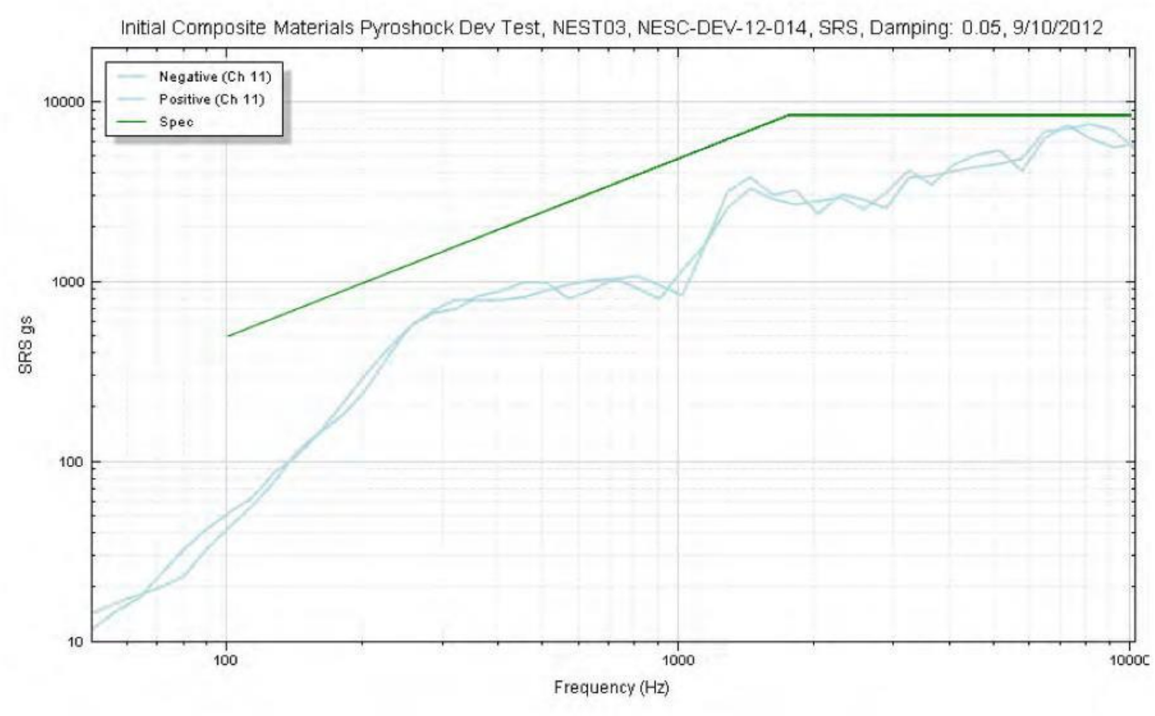

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 6)
Positive (Ch 6)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

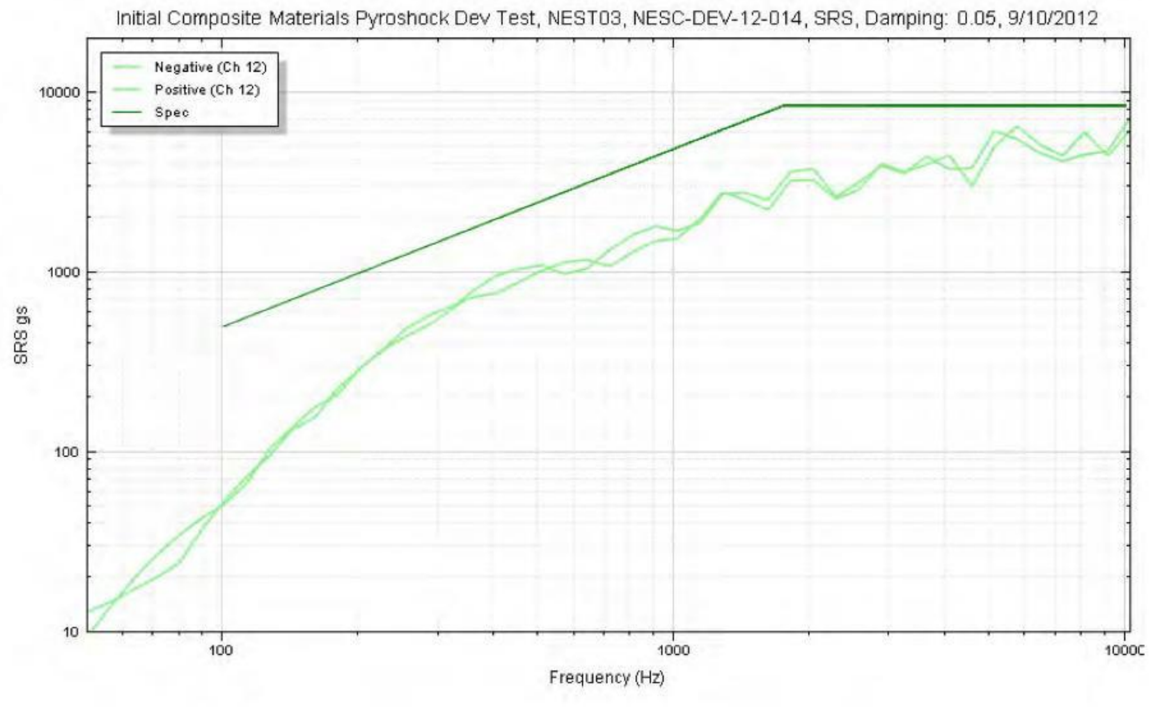

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 7)
Positive (Ch 7)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

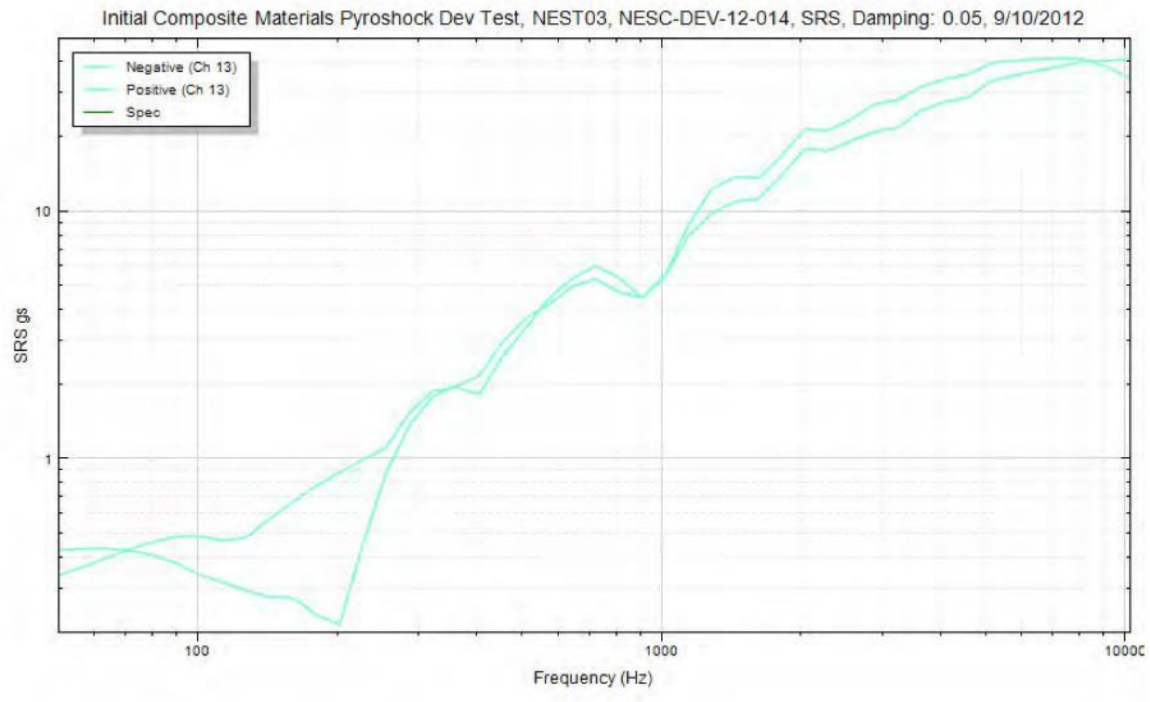

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 8)
Positive (Ch 8)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 9)
Positive (Ch 9)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 10)
Positive (Ch 10)
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 11)
Positive (Ch 11)
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

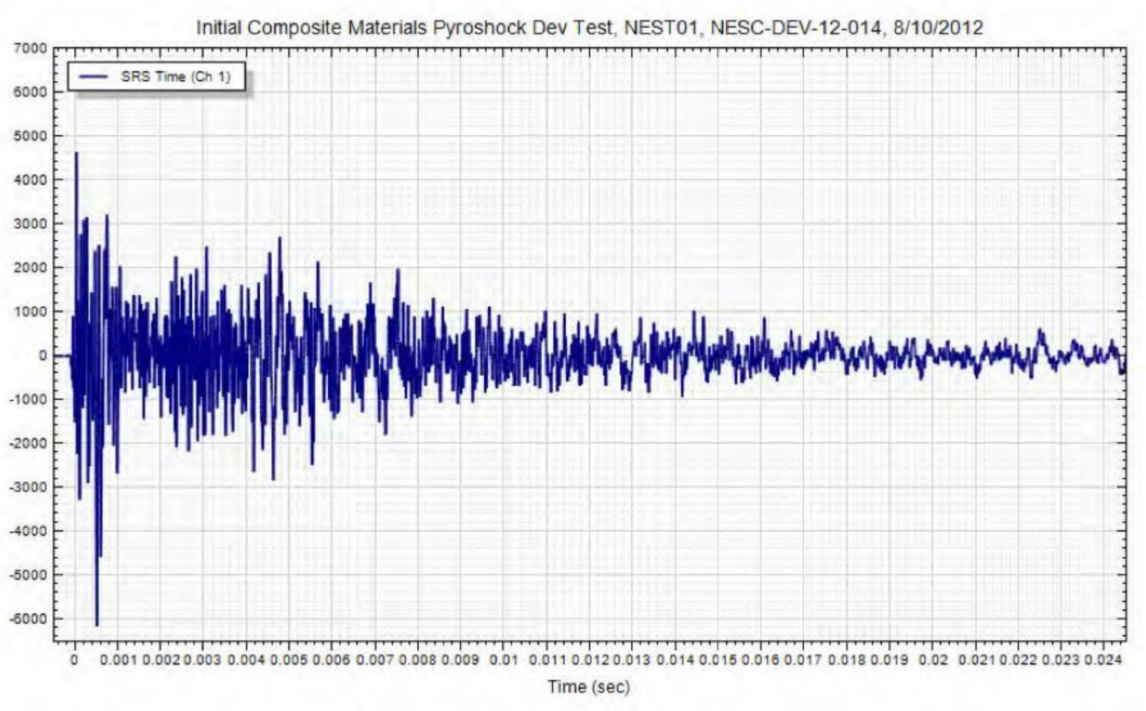

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 12)
Positive (Ch 12)
Spec
SRS gs
10000
1000
100
10
100
1000
1000C
Frequency (Hz)

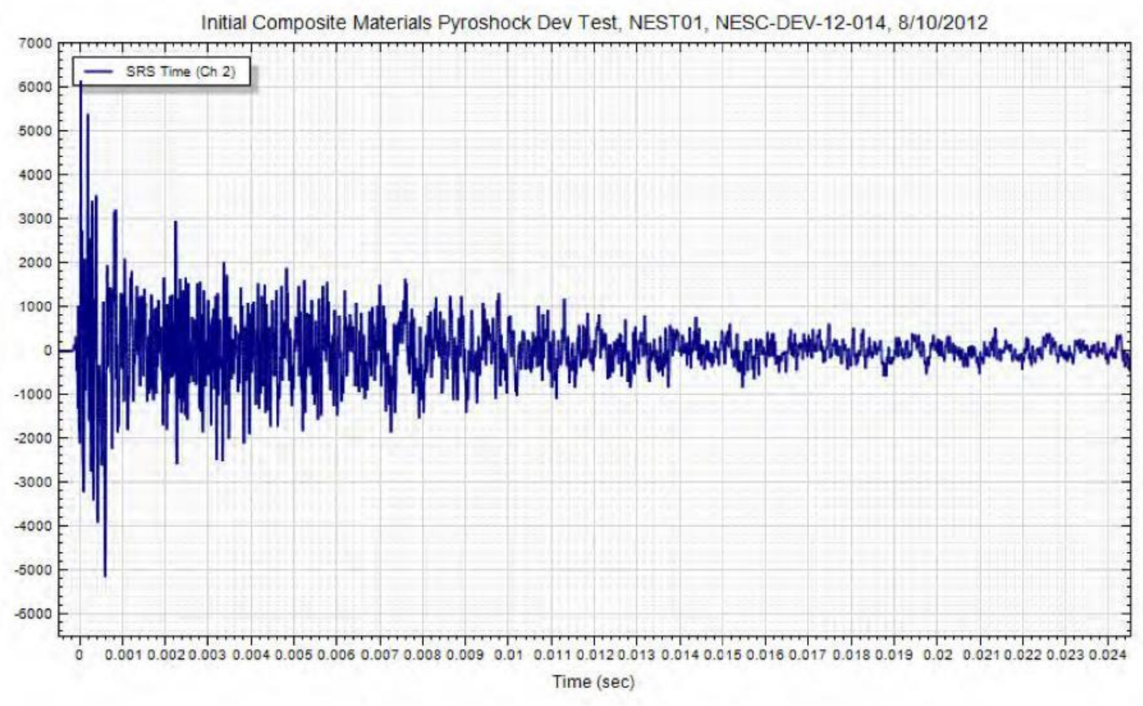

Initial Composite Materials Pyroshock Dev Test, NEST03, NESC-DEV-12-014, SRS, Damping: 0.05, 9/10/2012
Negative (Ch 13)
Positive (Ch 13)
Spec
SRS gs
10
1
100
1000
10000
Frequency (Hz)

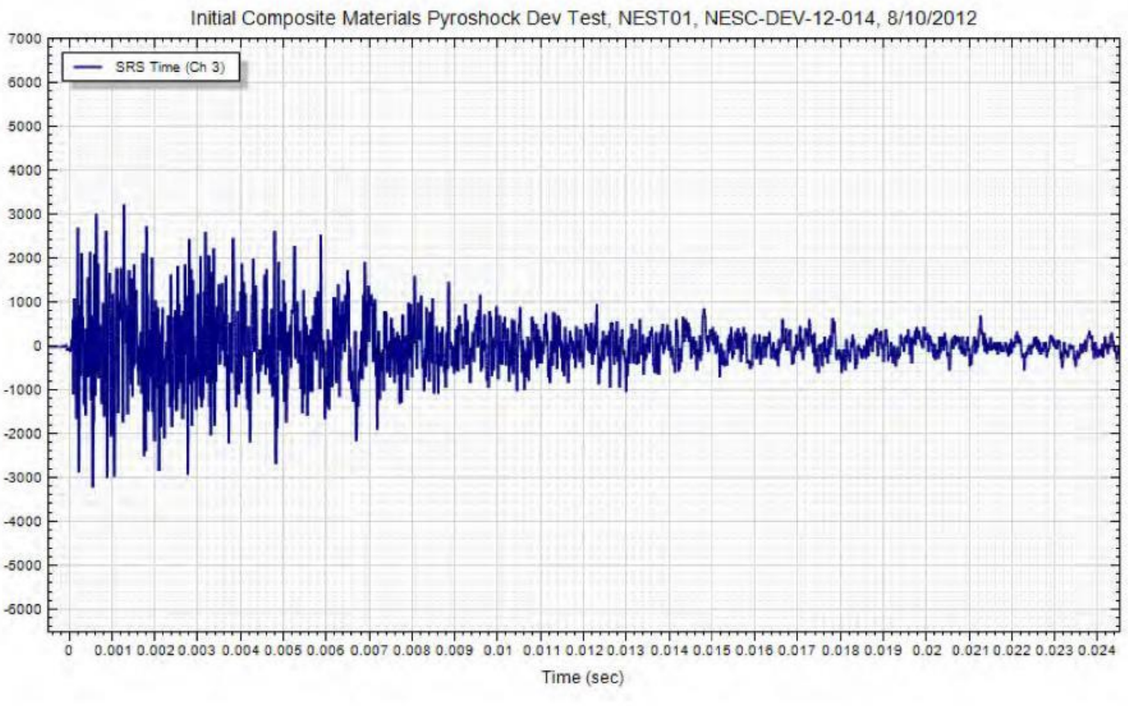
Test Data

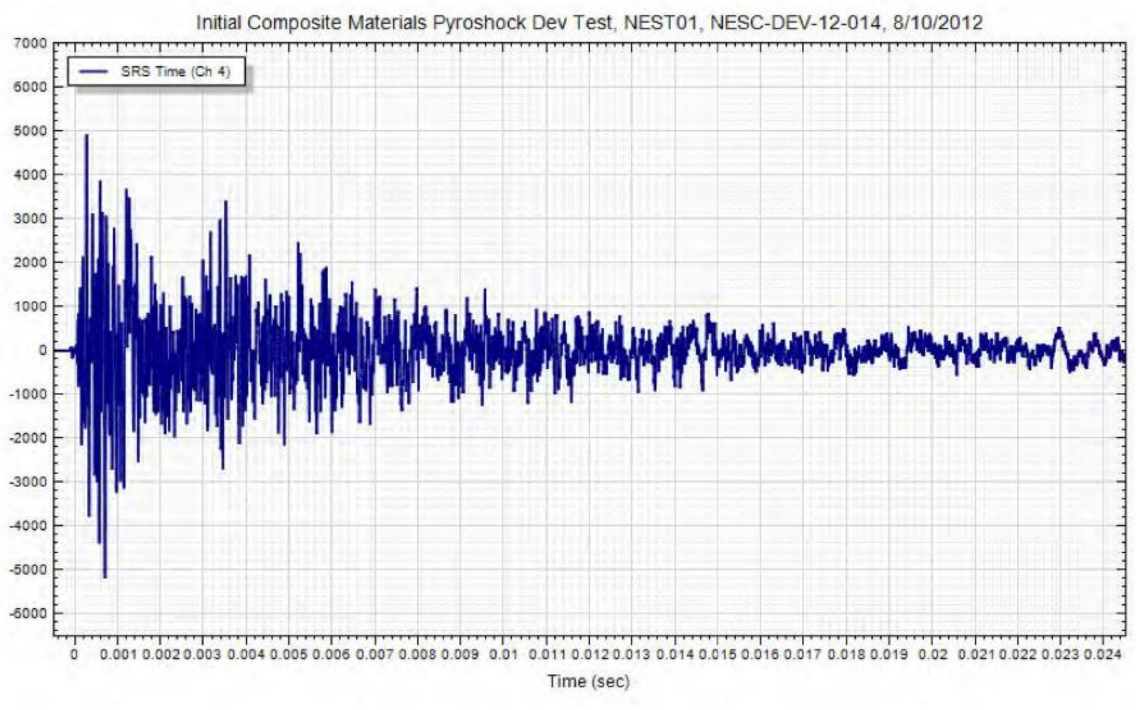
Time History
Test T01

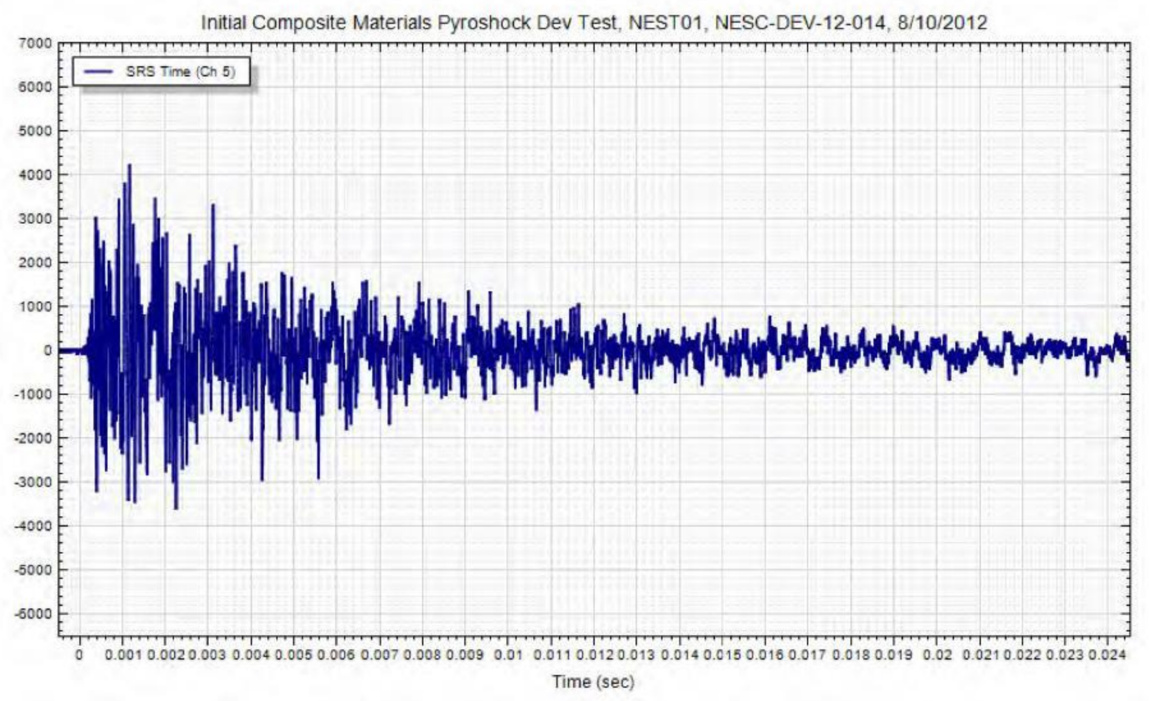
Aluminum Pathfinder Panel
10 gpf, FLSC

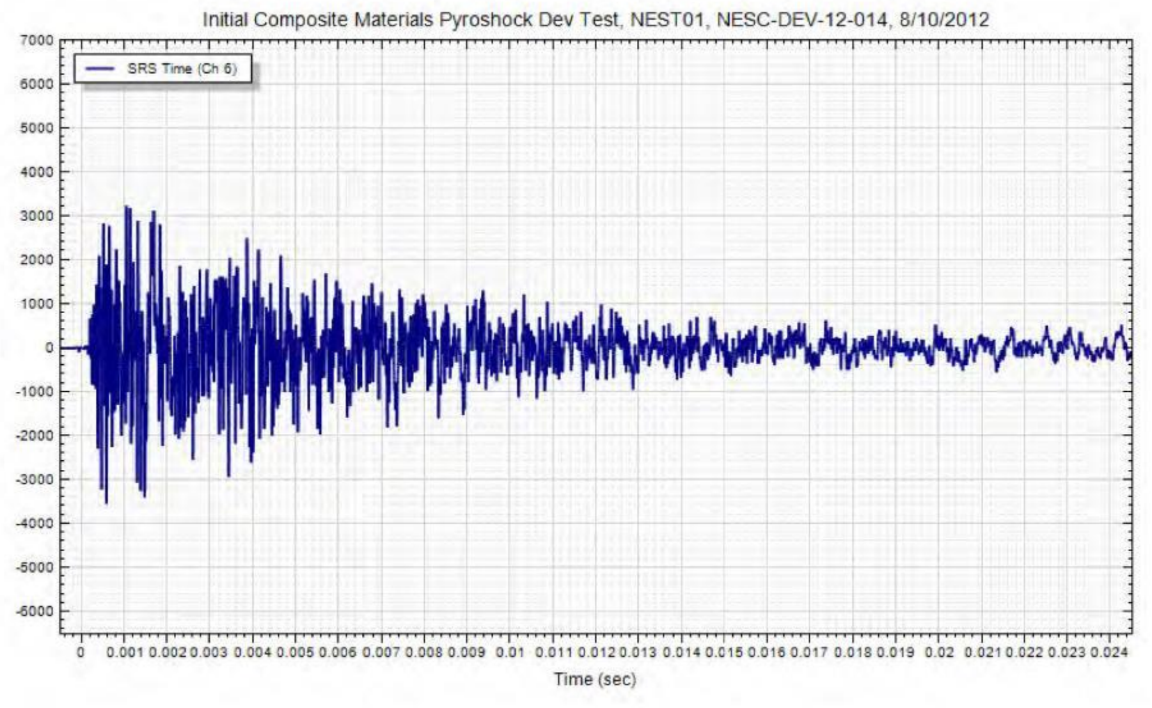

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 1)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

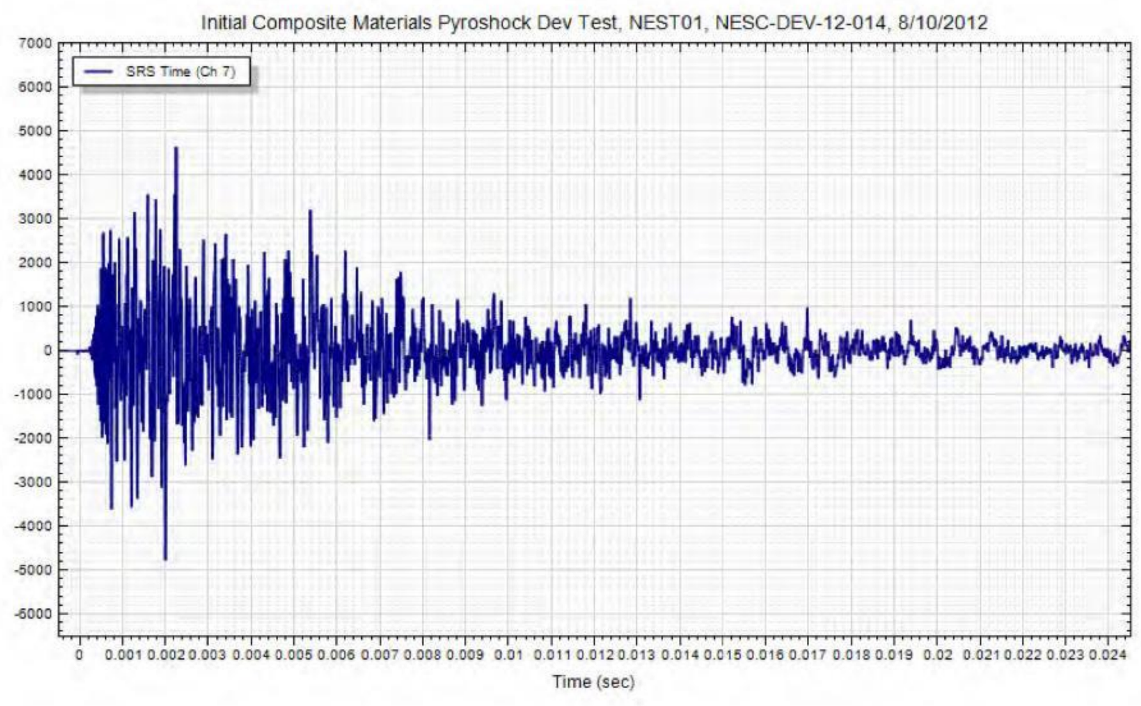

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 2)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

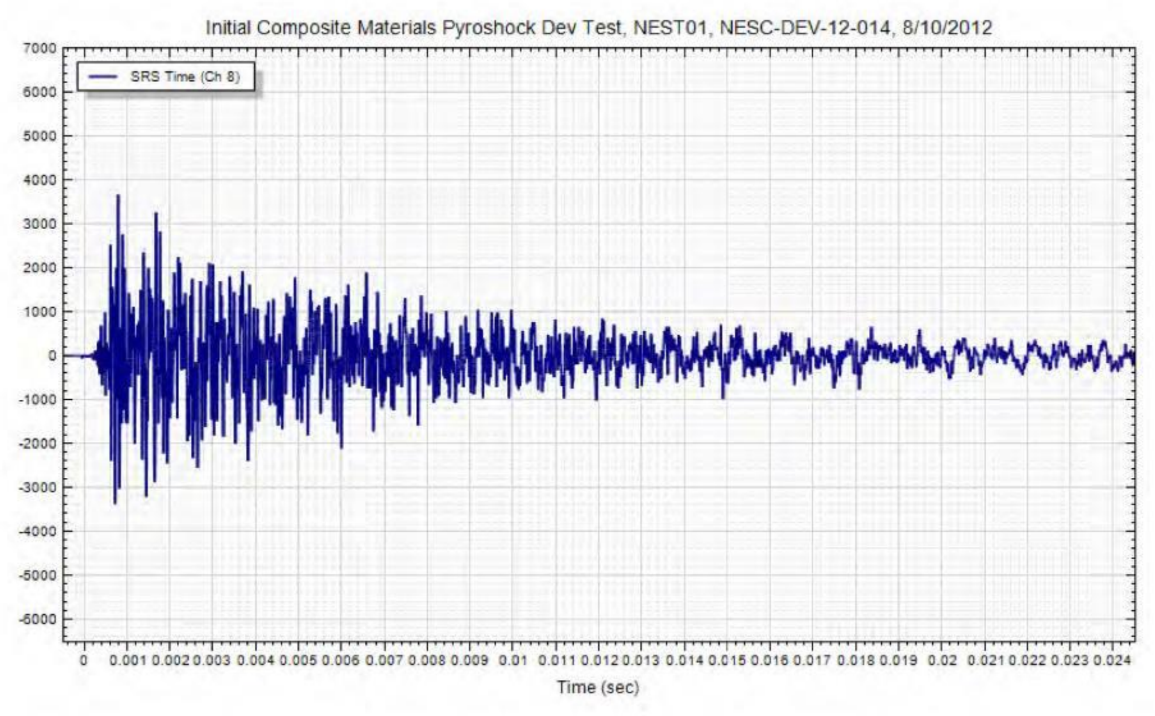

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 3)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

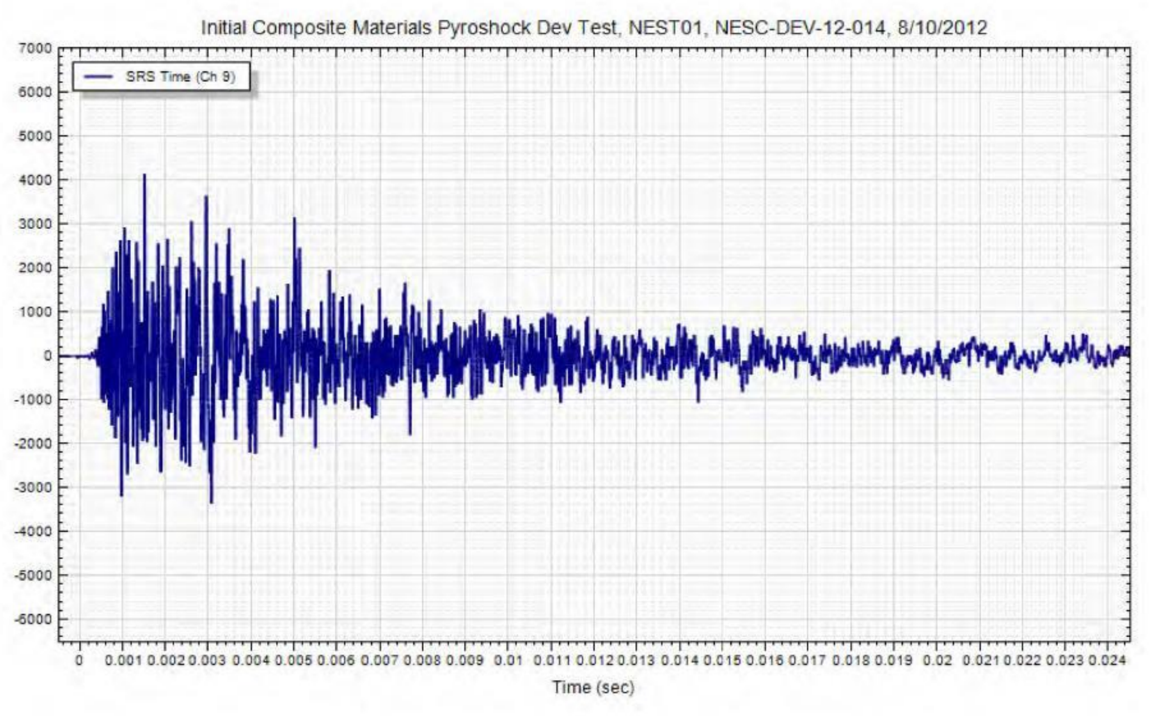

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 4)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

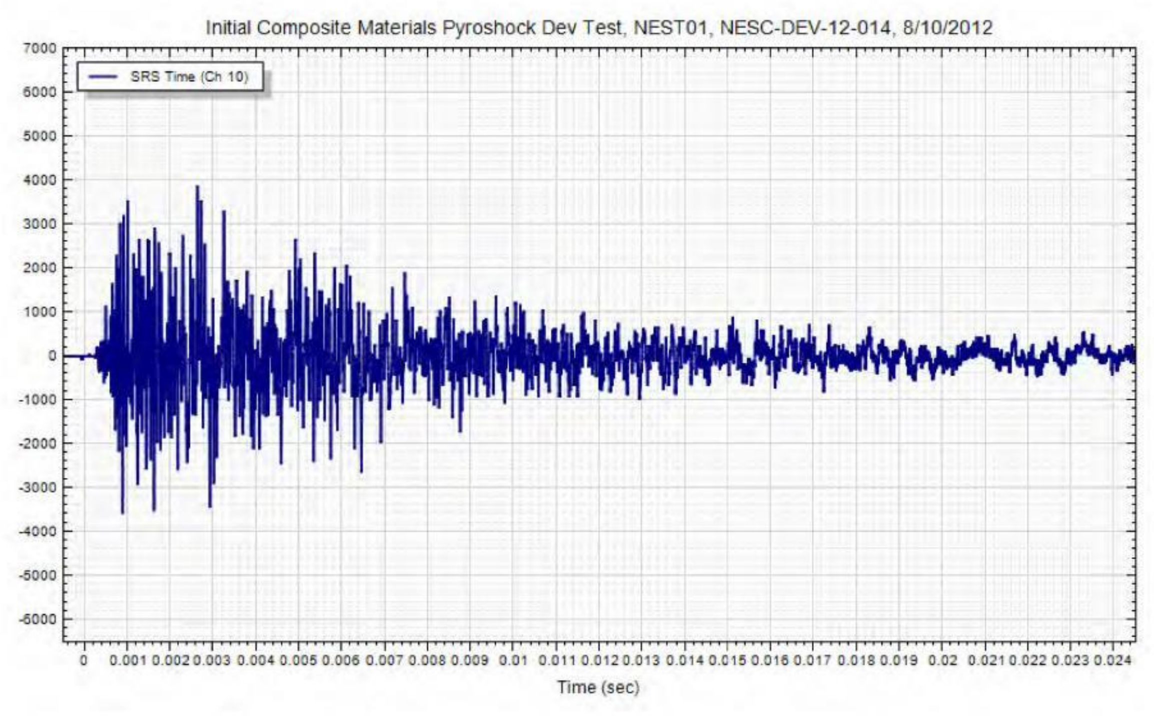

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 5)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

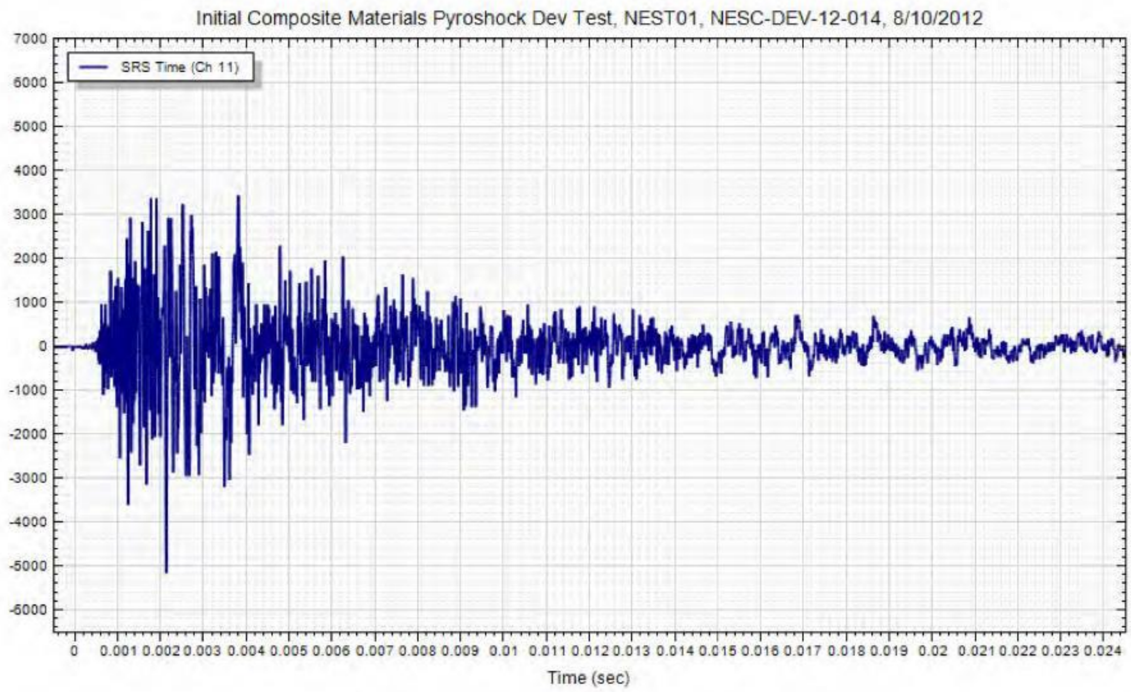

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 6)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

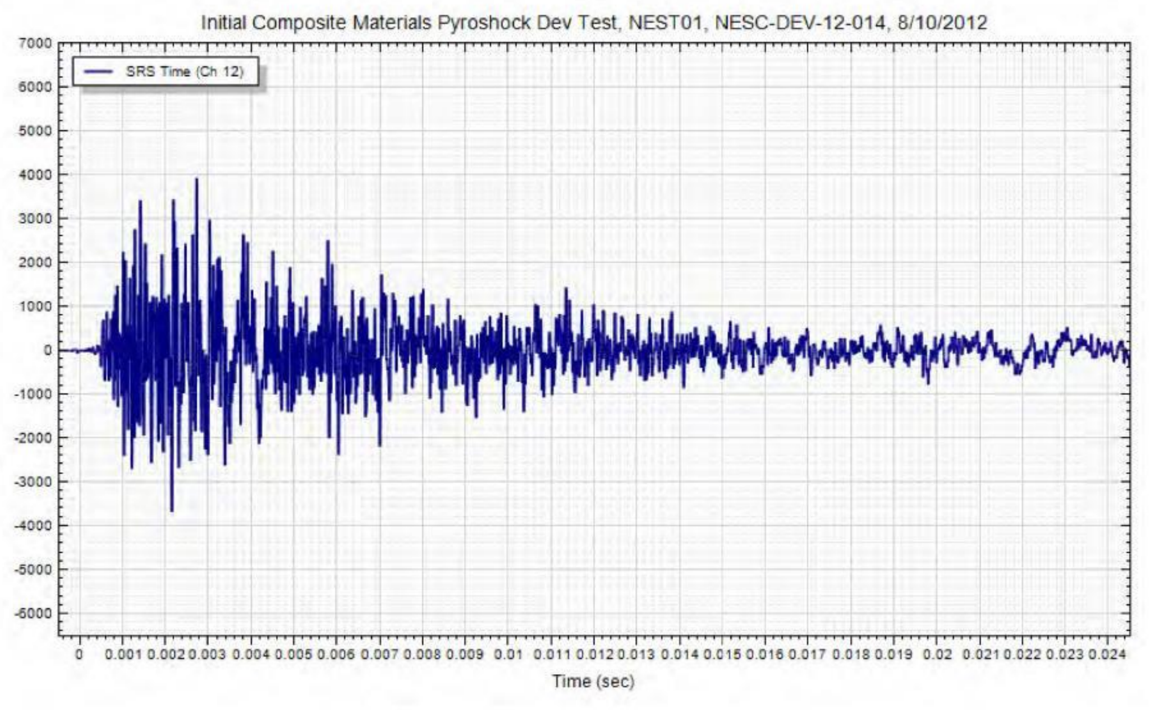

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 7)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

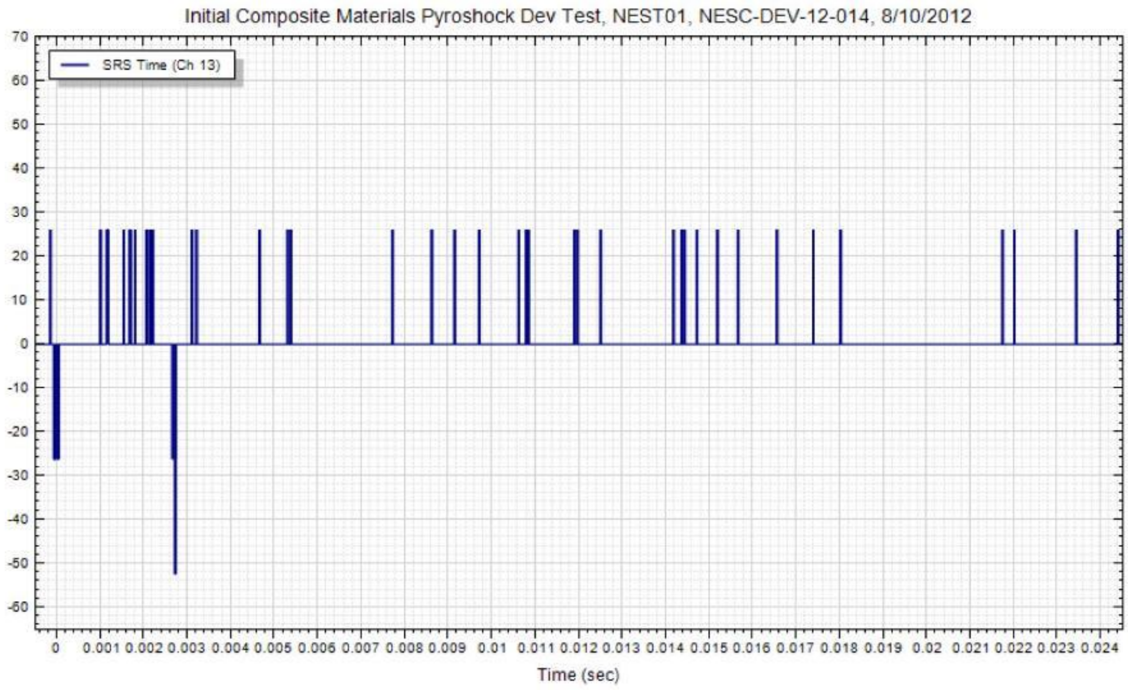

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 8)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 9)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 10)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 11)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

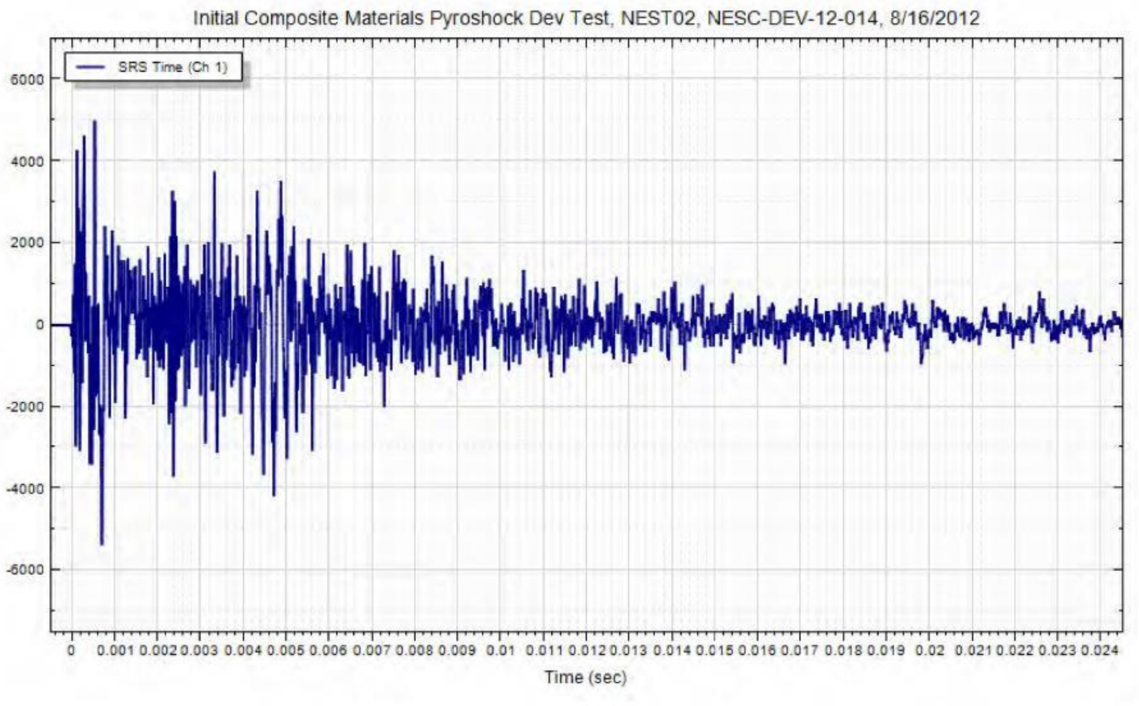

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 12)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

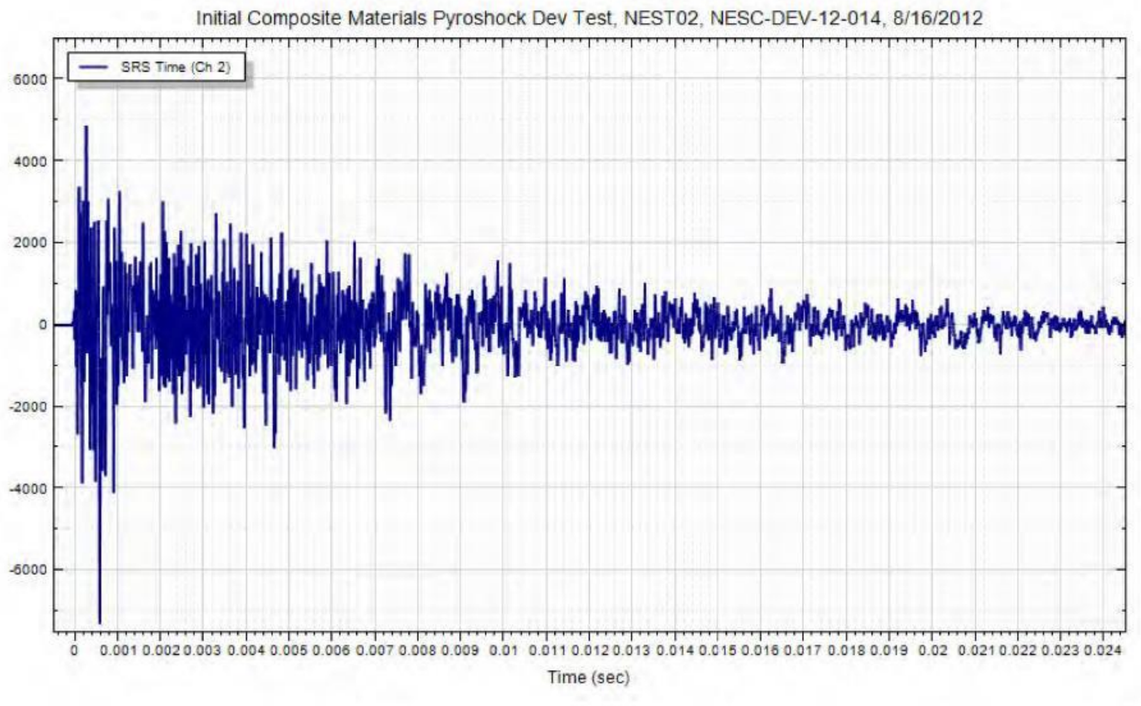

Initial Composite Materials Pyroshock Dev Test, NEST01, NESC-DEV-12-014, 8/10/2012
SRS Time (Ch 13)
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)

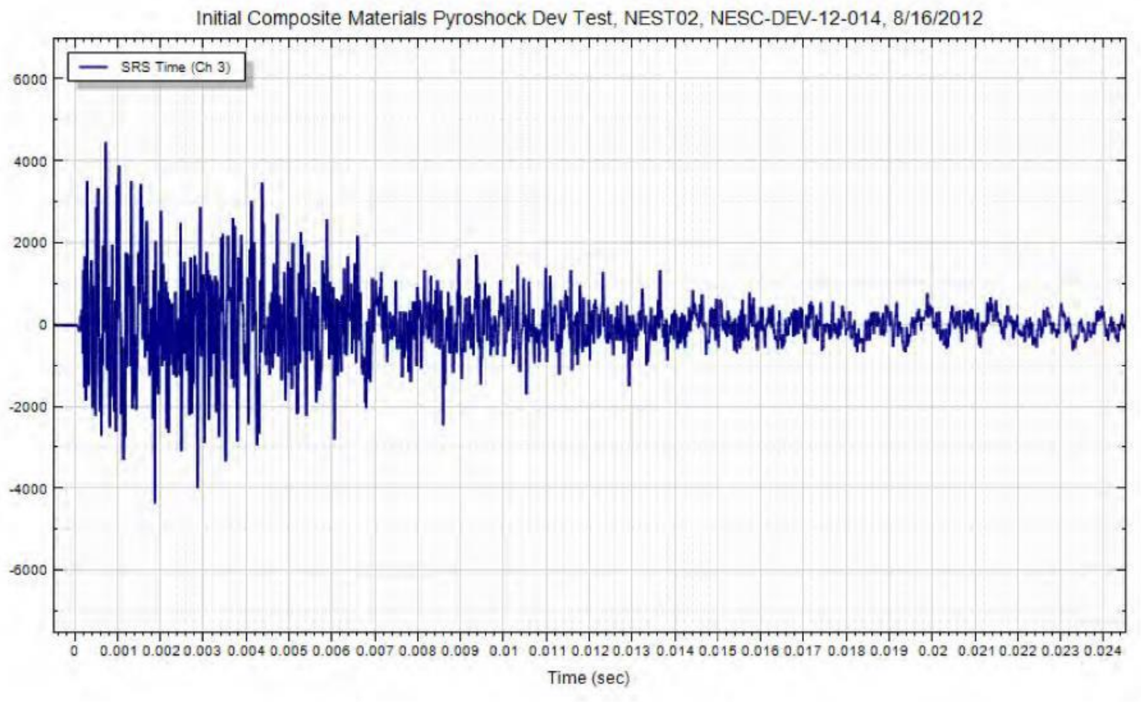
Test Data

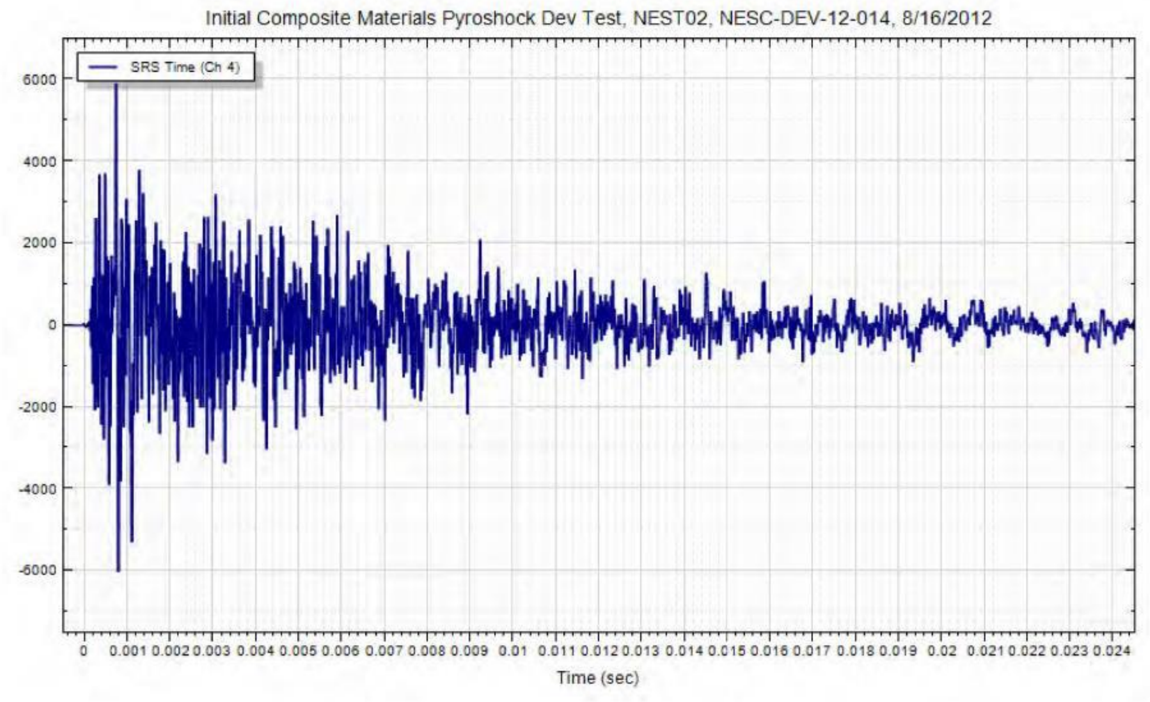
Time History
Test T02

Aluminum Pathfinder Panel
22 gpf, FLSC


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, 8/16/2012
SRS Time (Ch 1)
6000
4000
2000
0
-2000
-4000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, 8/16/2012
SRS Time (Ch 2)
6000
4000
2000
0
-2000
-4000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, 8/16/2012
SRS Time (Ch 3)
6000
4000
2000
0
-2000
-4000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
0.021
0.022
0.023
0.024
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, 8/16/2012
SRS Time (Ch 4)
6000
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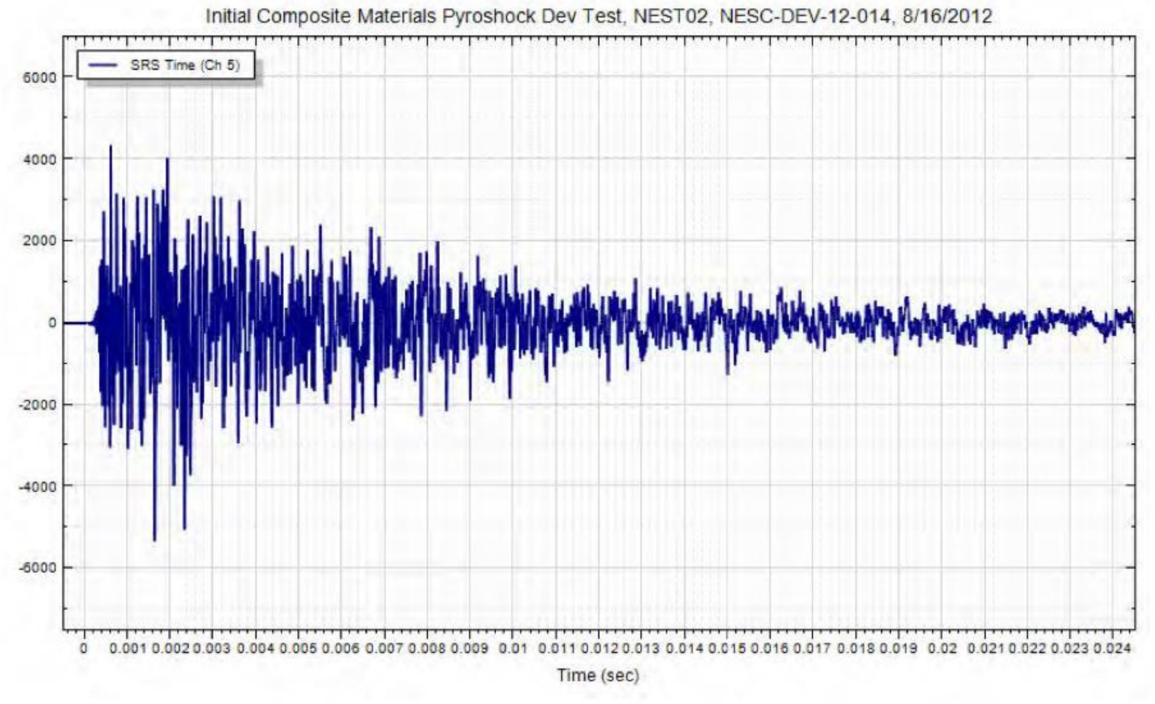
Time (sec)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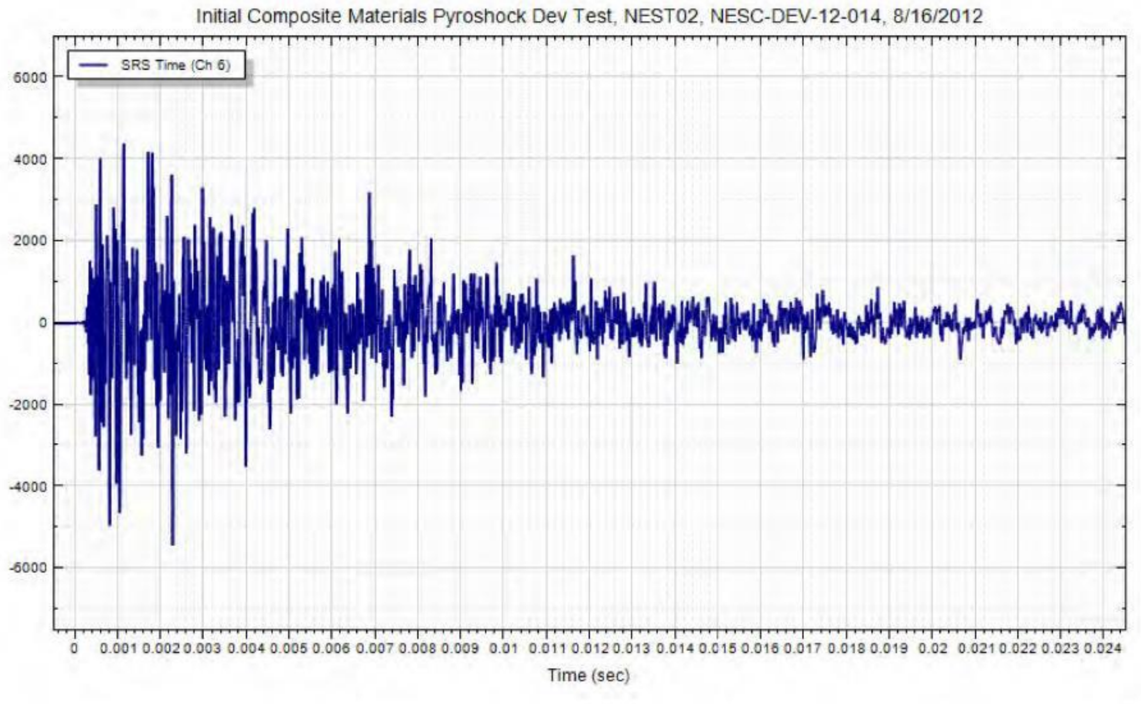
Time (sec)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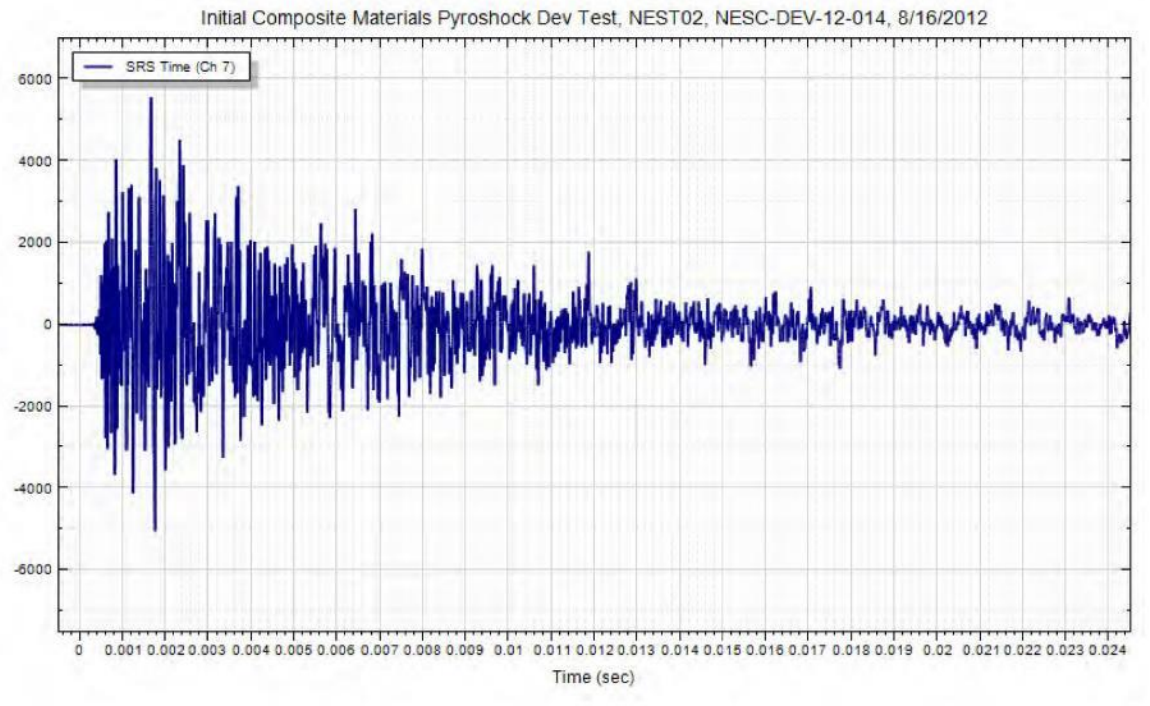
Time (sec)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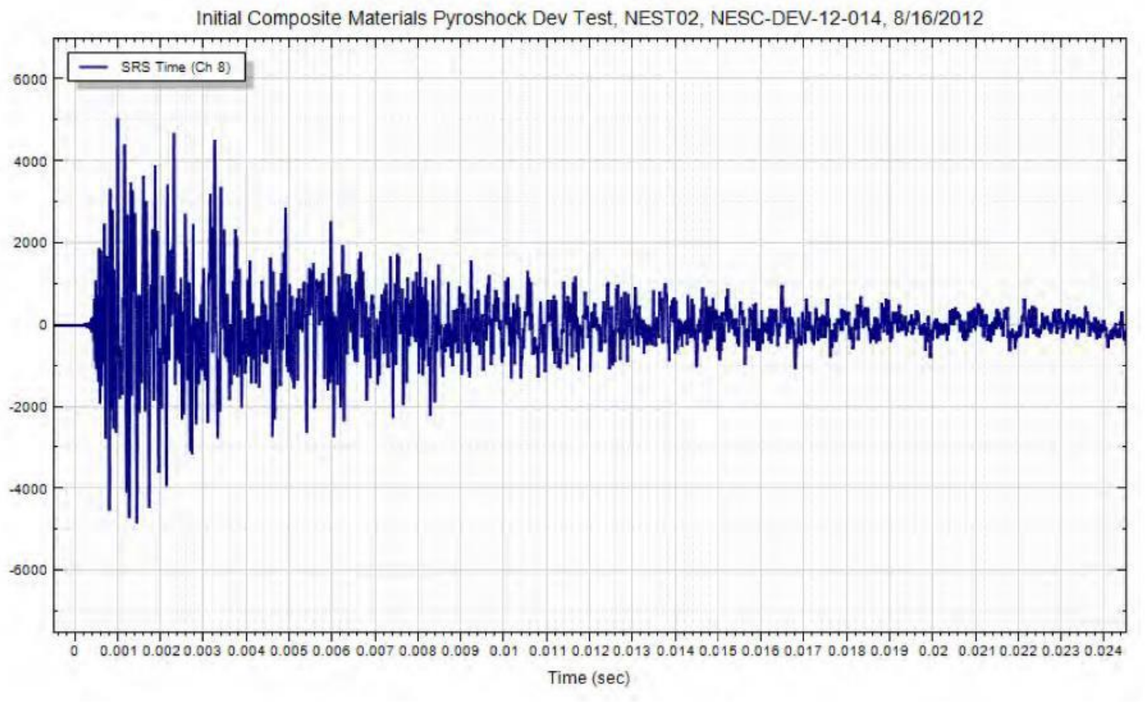
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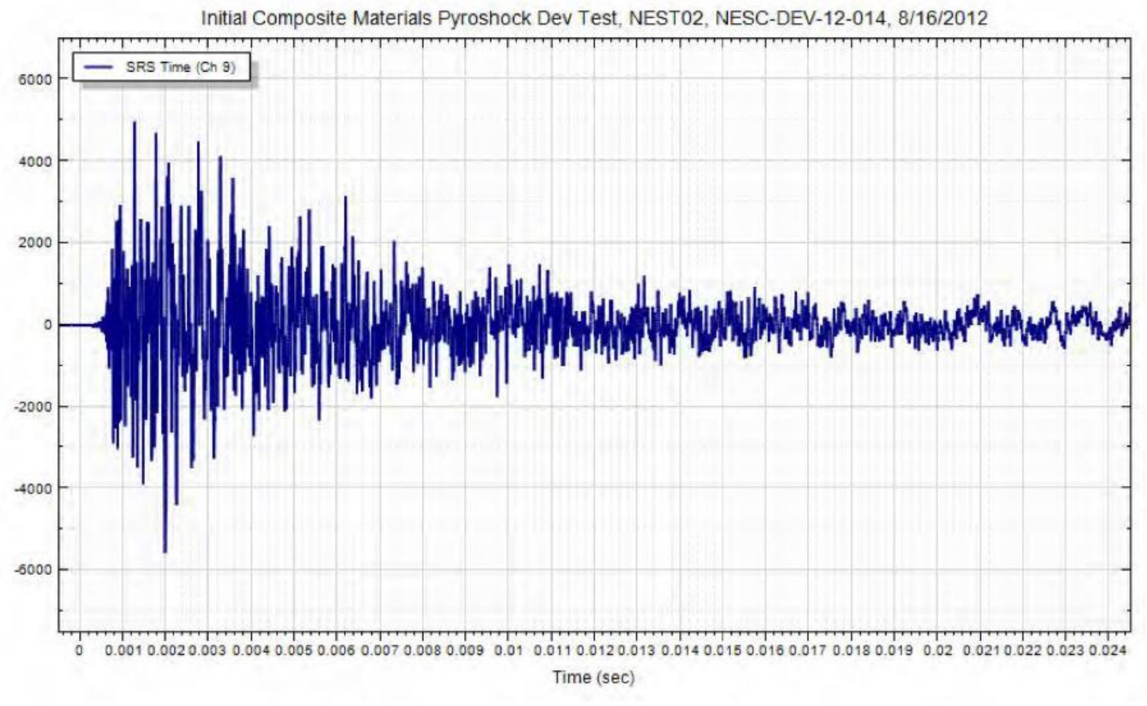
Time (sec)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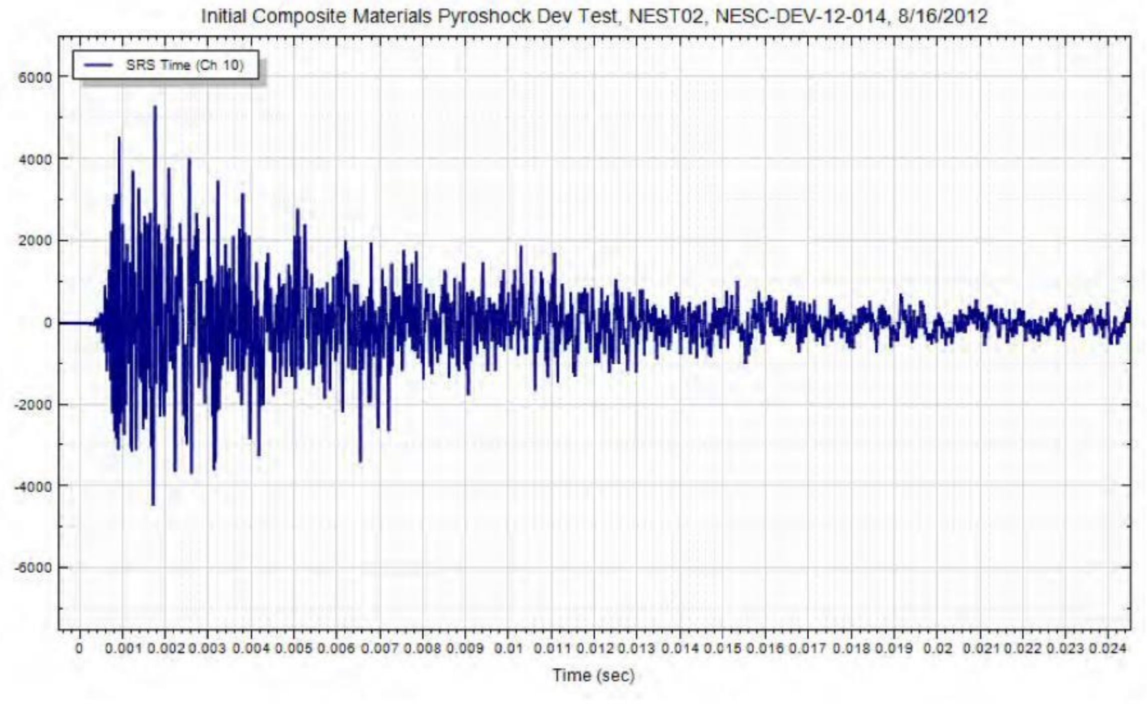
Time (sec)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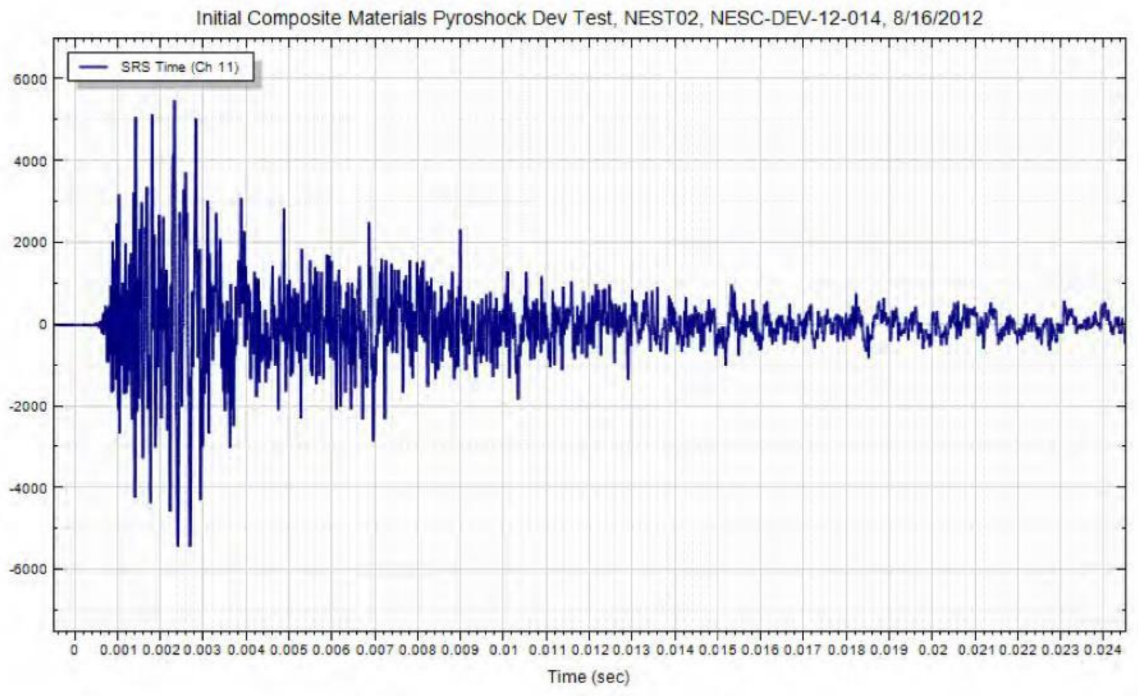
Time (sec)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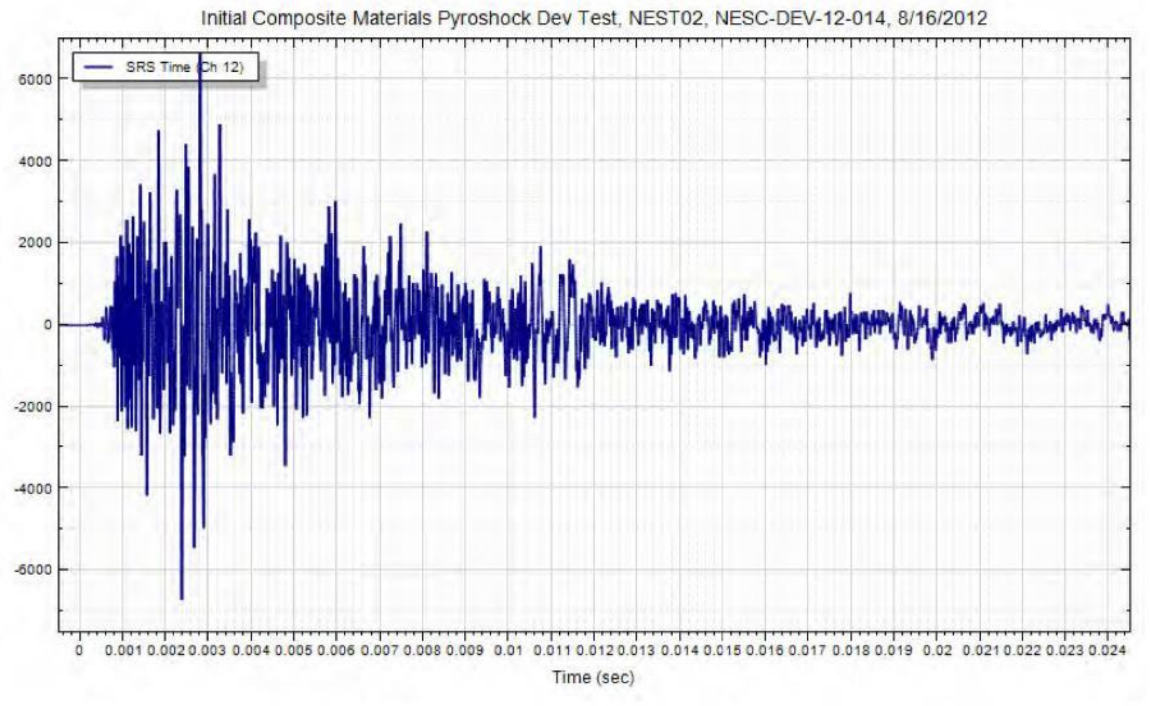
Time (sec)


Initial Composite Materials Pyroshock Dev Test, NEST02, NESC-DEV-12-014, 8/16/2012
SRS Time (Ch 12)
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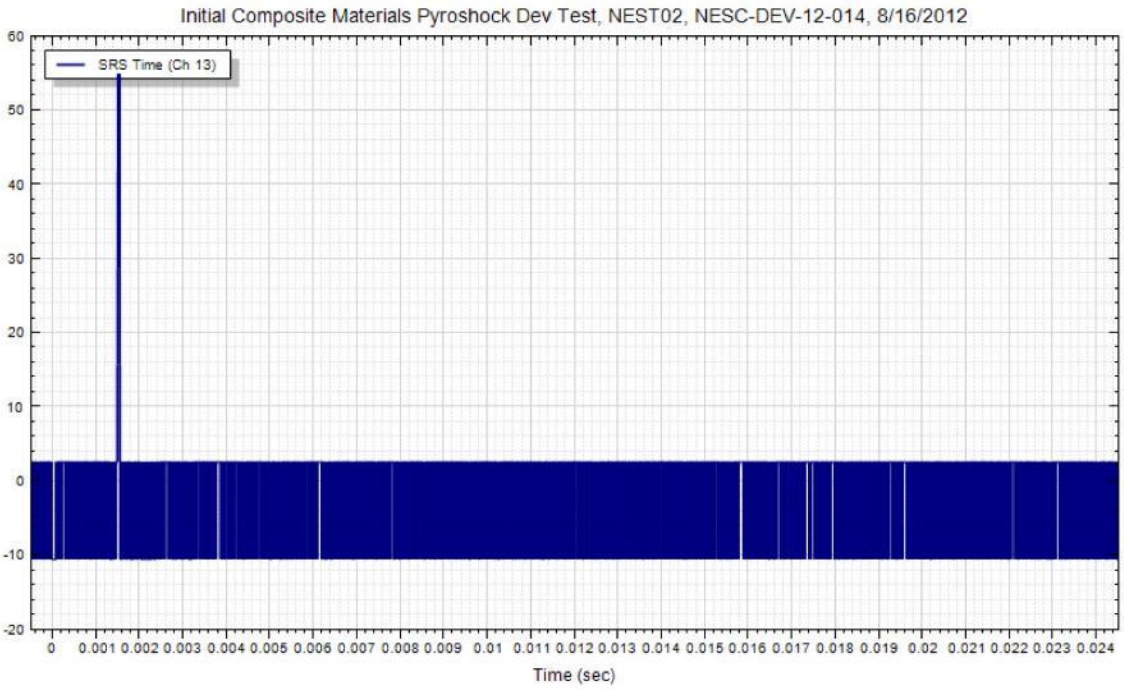
Time (sec)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SRS Time (Ch 13)
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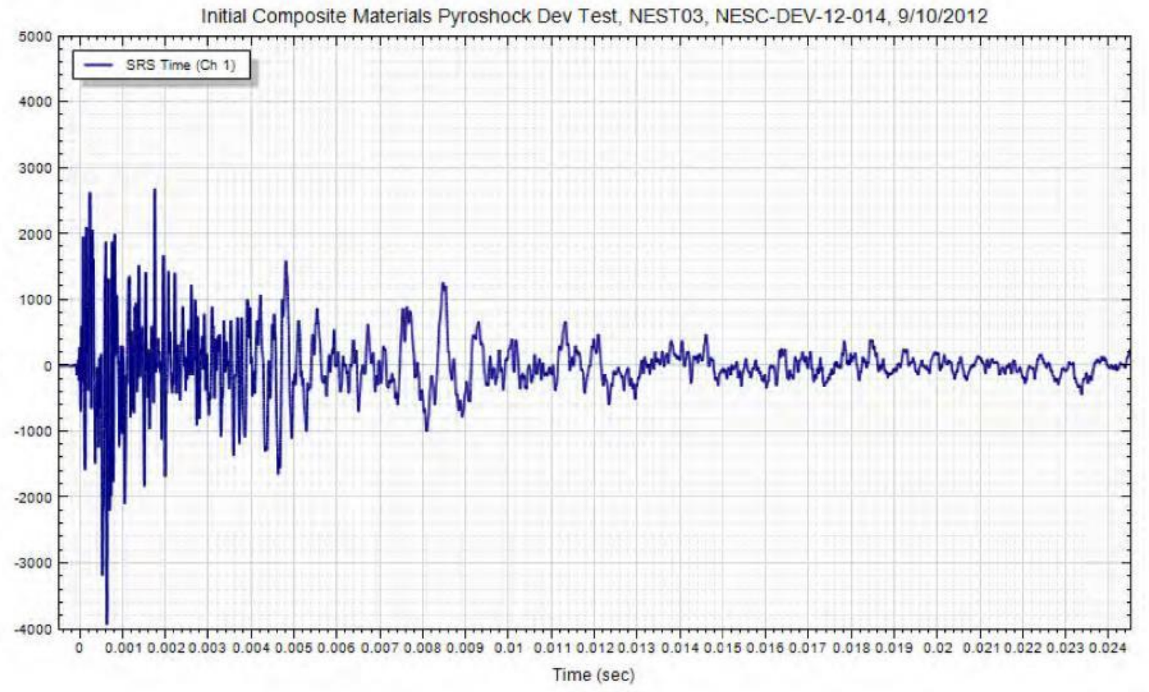
Time (sec)

Test Data

Time History
Test T03

Solid Composite Pathfinder Panel
10 gpf, FLSC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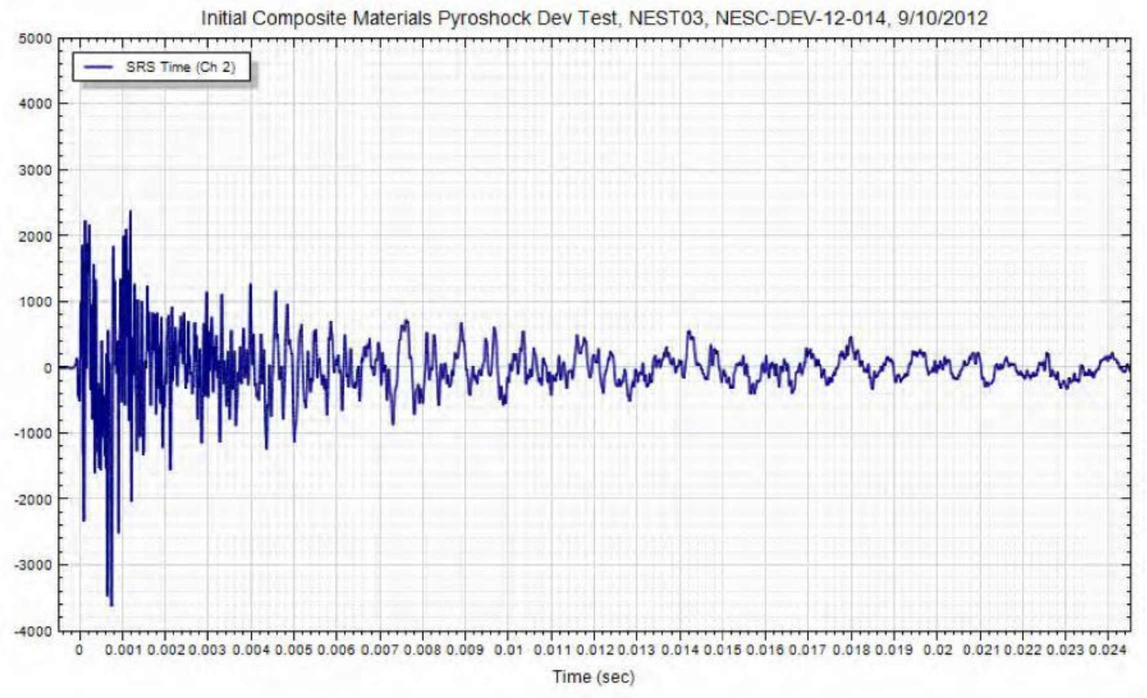
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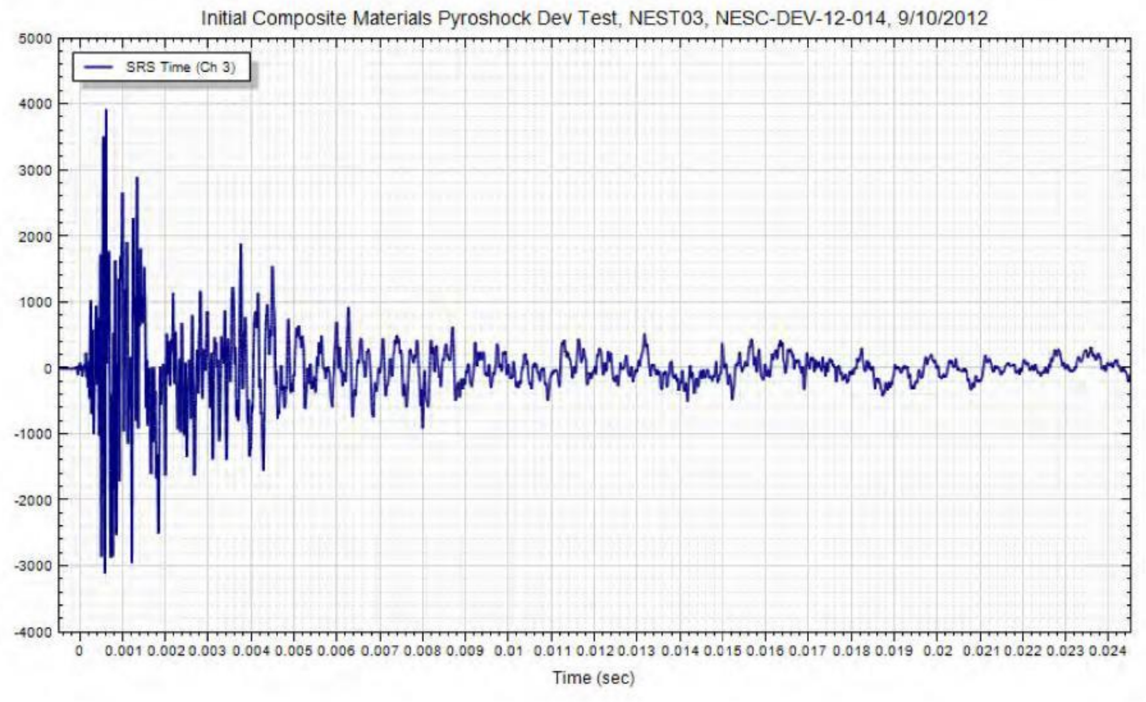
Time (sec)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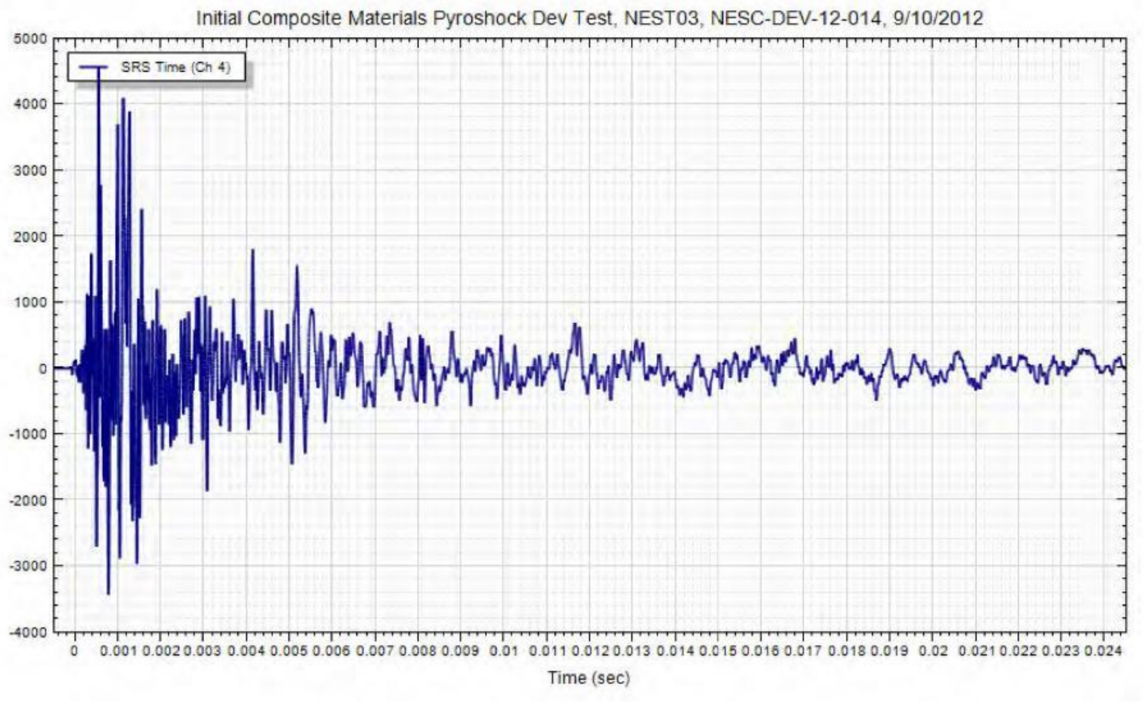
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SRS Time (Ch 4)
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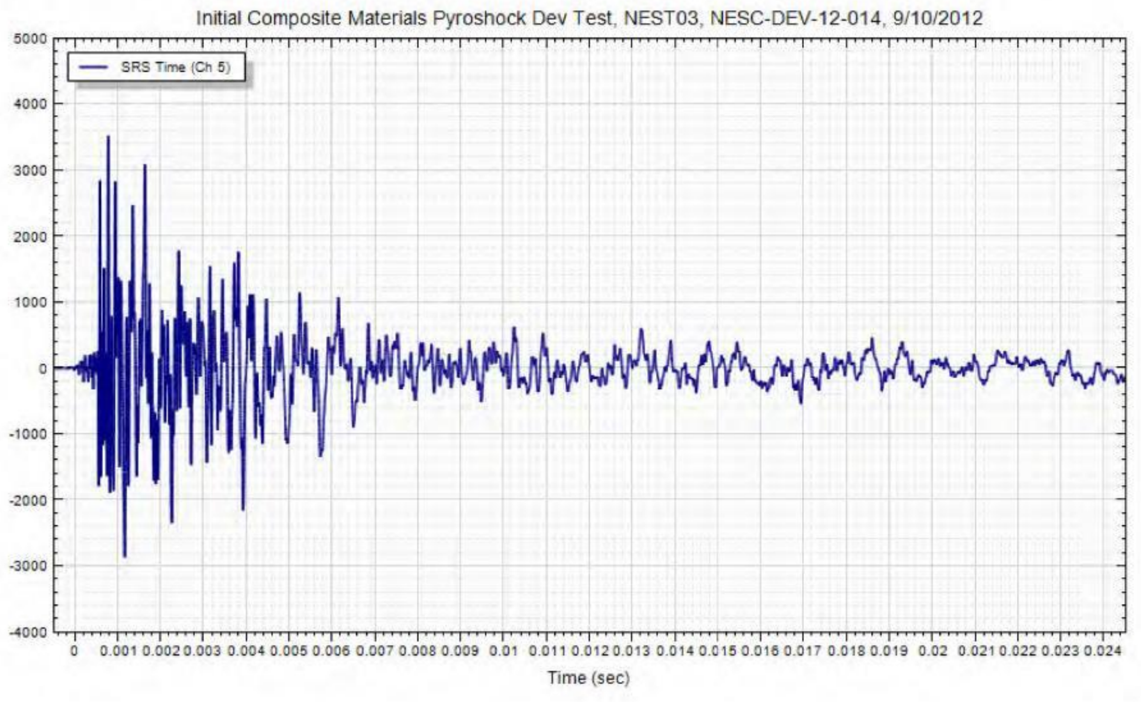
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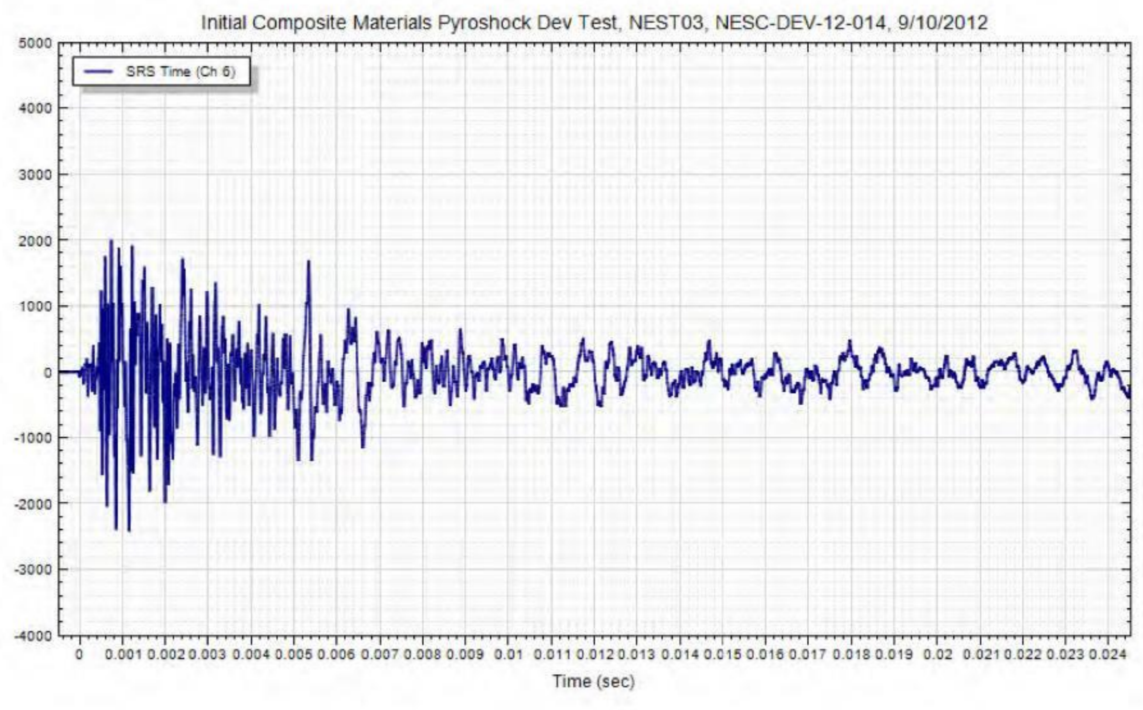
Time (sec)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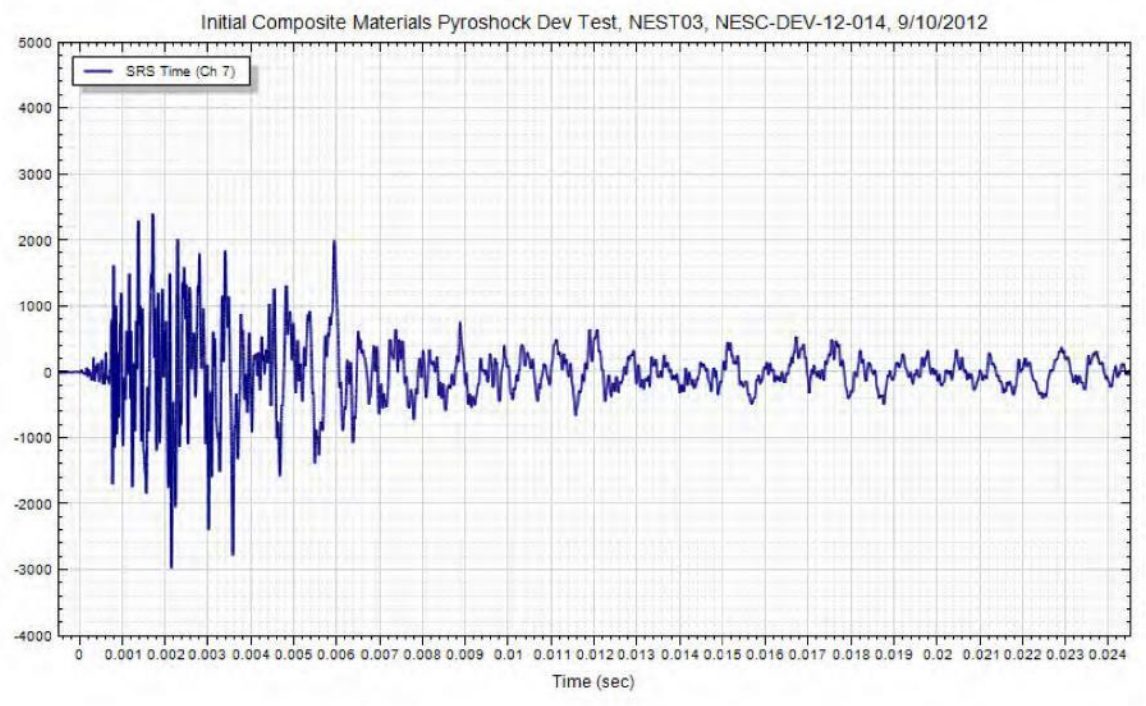
Time (sec)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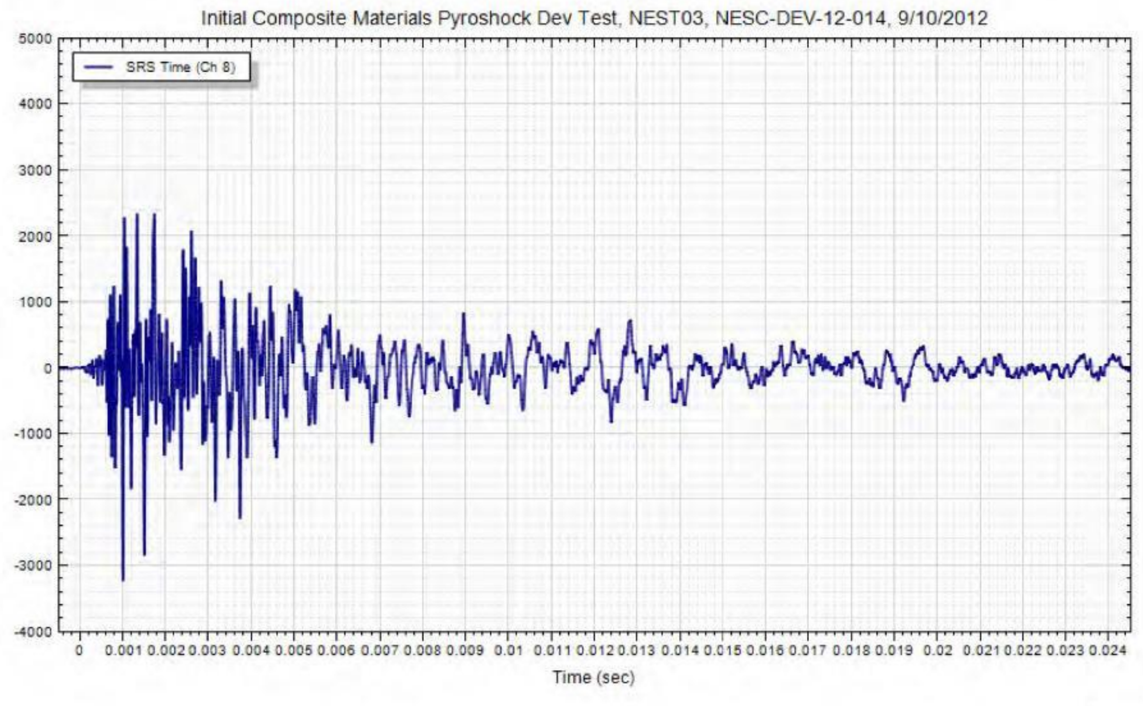
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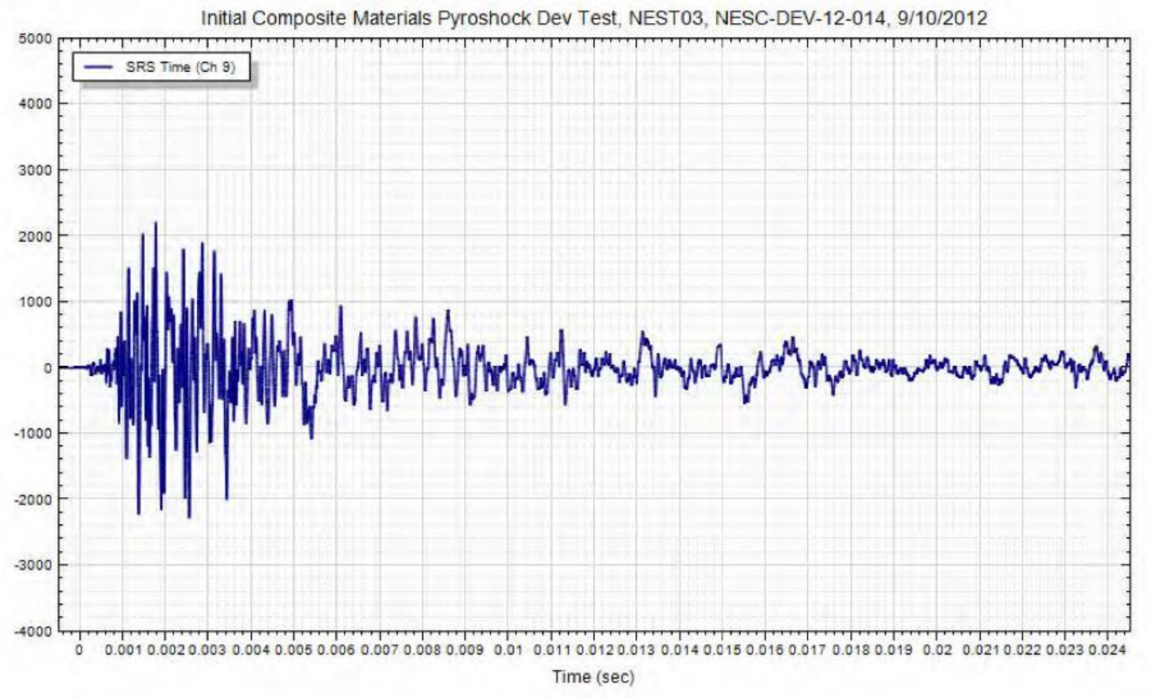
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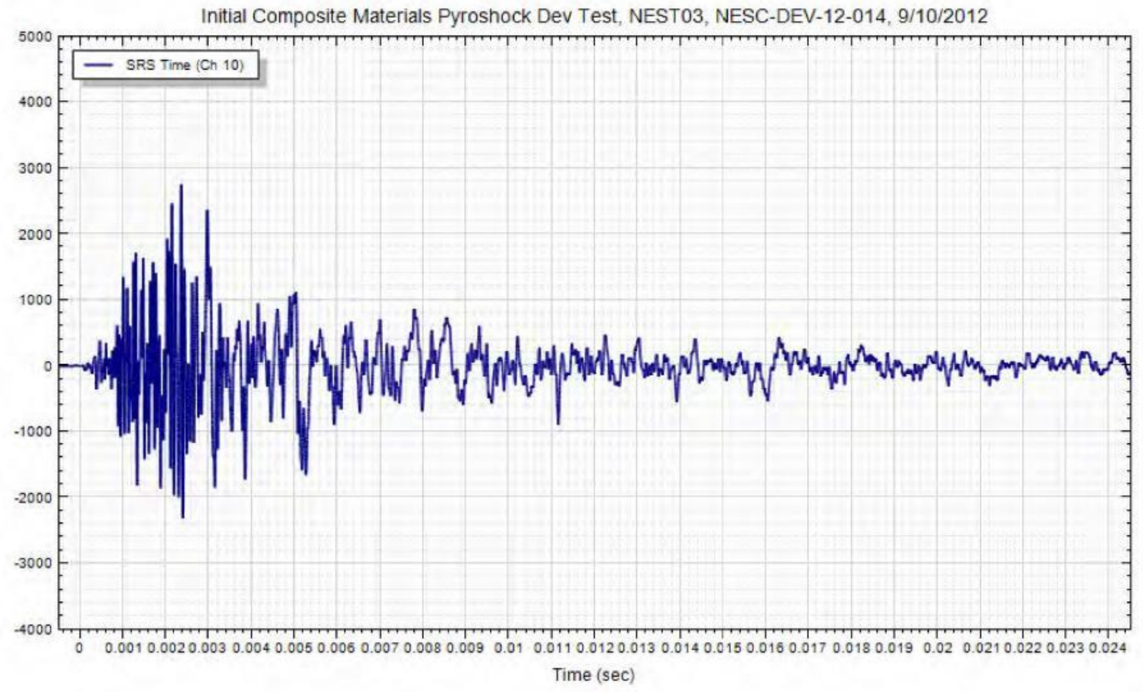
Time (sec)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SRS Time (Ch 10)
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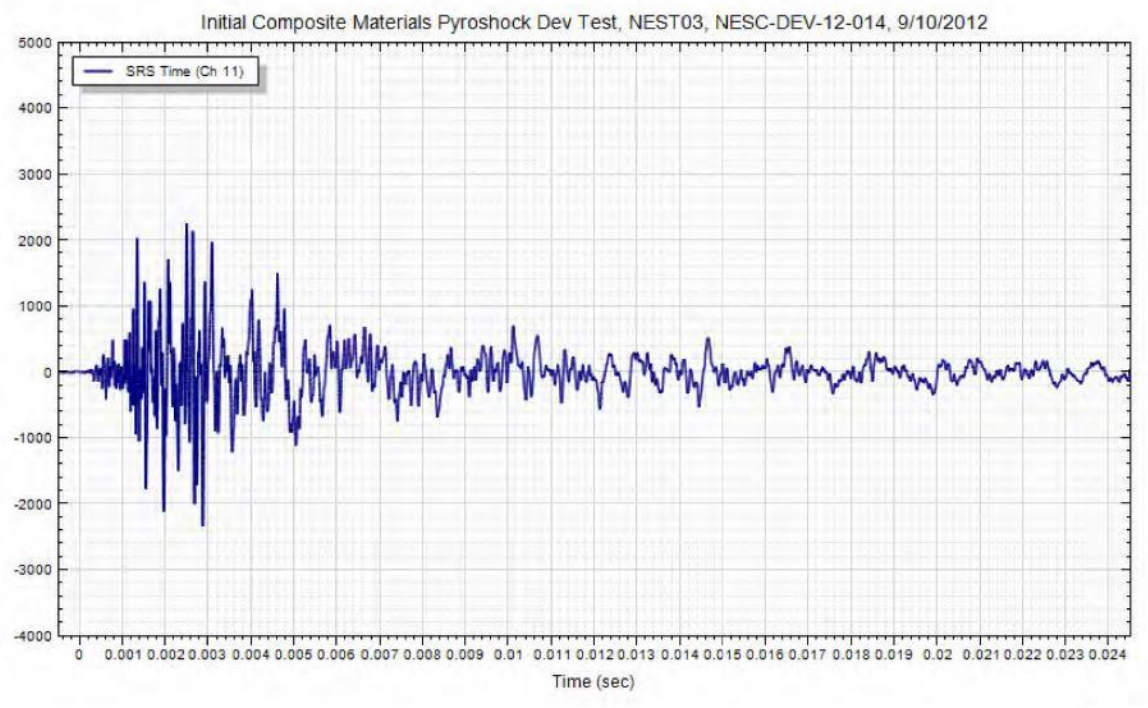
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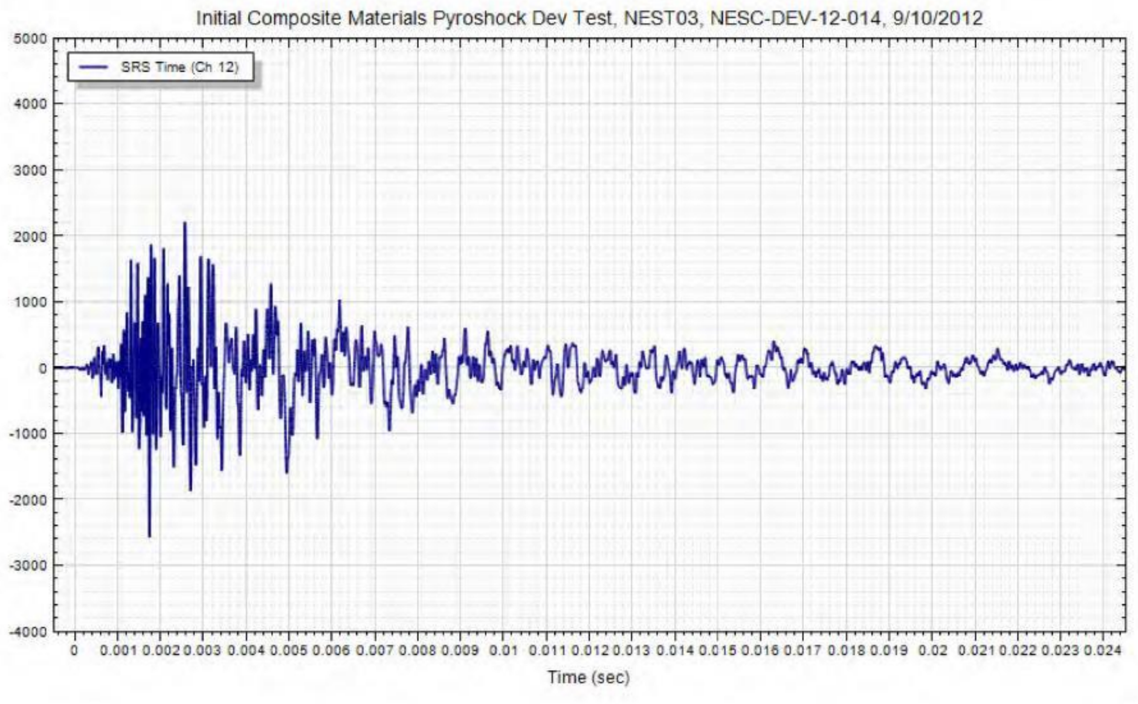
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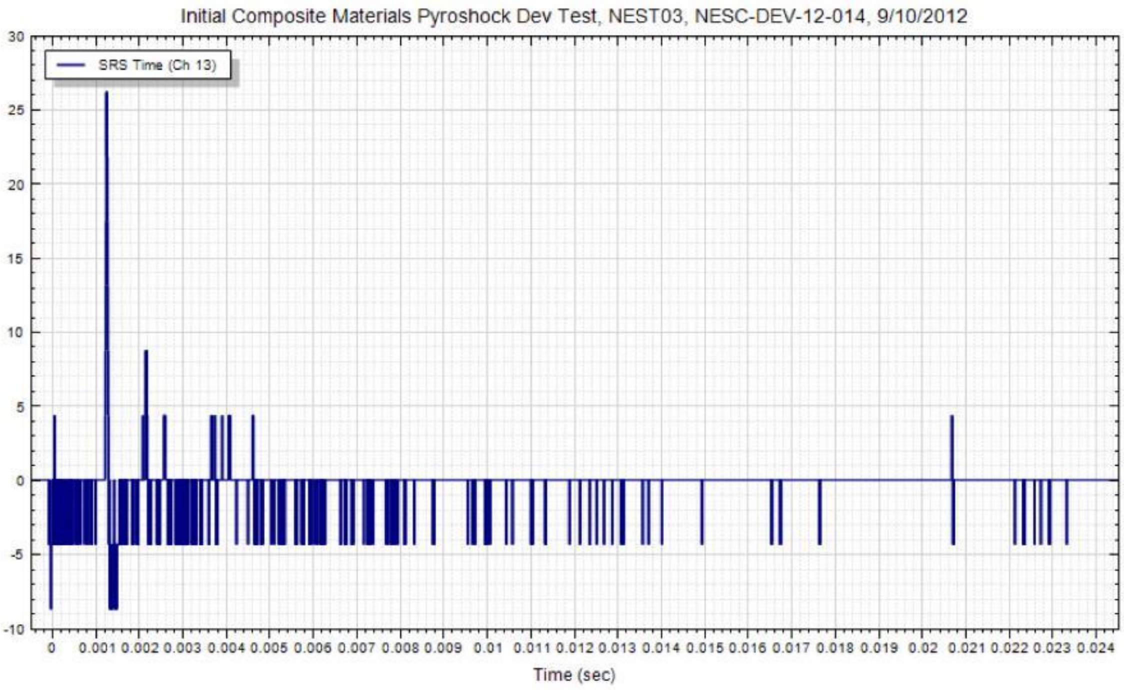
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SRS Time (Ch 13)
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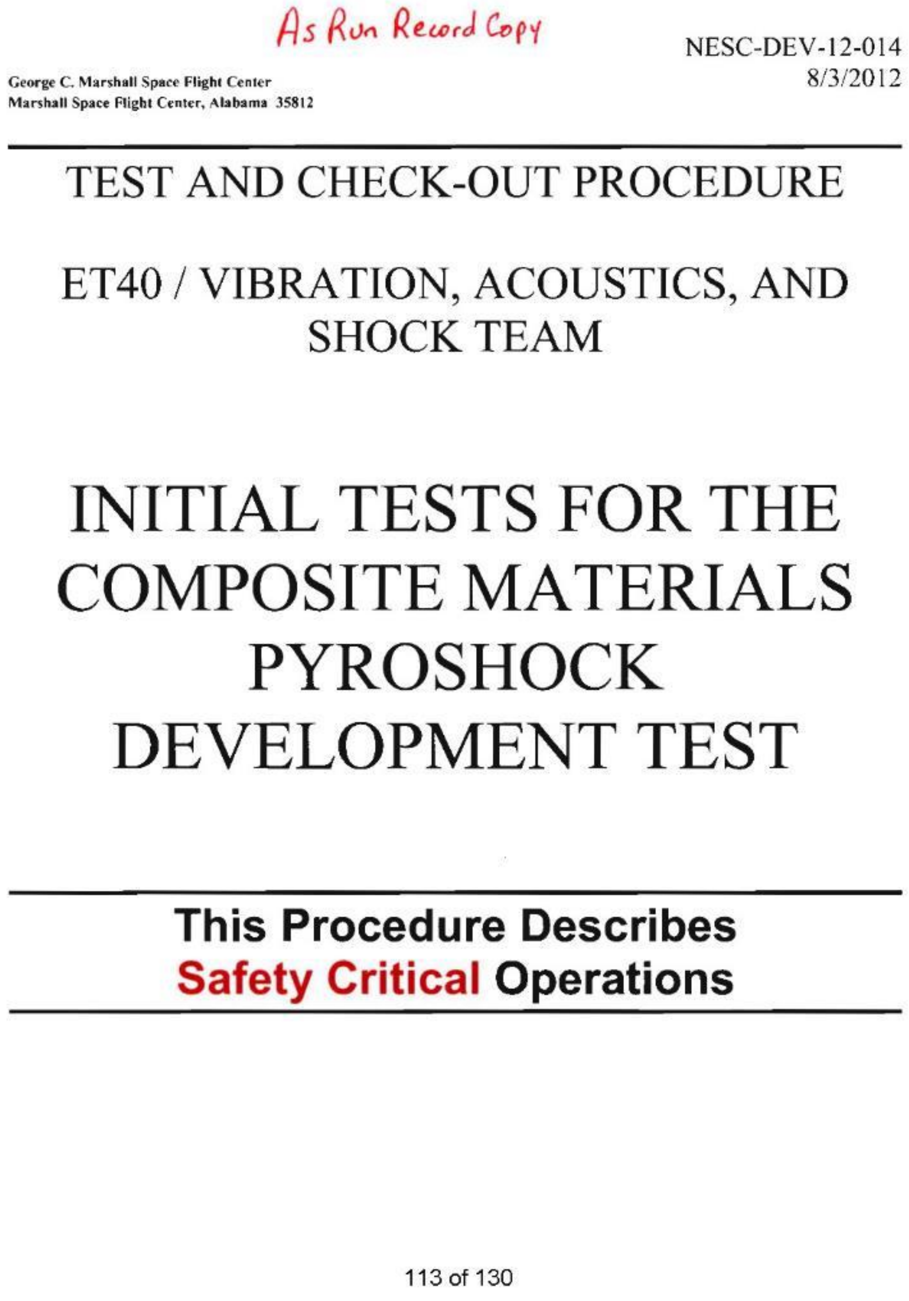
Time (sec)

Test and Checkout Procedure

NESC-DEV-12-014

"As Run"



As Run Record Copy

NESC-DEV-12-014
8/3/2012

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

TEST AND CHECK-OUT PROCEDURE

ET40 / VIBRATION, ACOUSTICS, AND SHOCK TEAM

INITIAL TESTS FOR THE COMPOSITE MATERIALS PYROSHOCK DEVELOPMENT TEST

This Procedure Describes Safety Critical Operations

113 of 130

ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	**NESC-DEV-12-014** **Date: 8/3/2012**	**Revision:** **Page 1 of 11**

PREPARED BY: John Craig Garrison 8/6/2012

John Craig Garrison / ET40
Test Engineer

Date

APPROVED BY: Kathy Owen 8/6/12

Kathy L. Owen / ET40
Deputy Branch Chief
Structural Dynamics Test Branch

Date

APPROVED BY: David Ordway 8/6/12

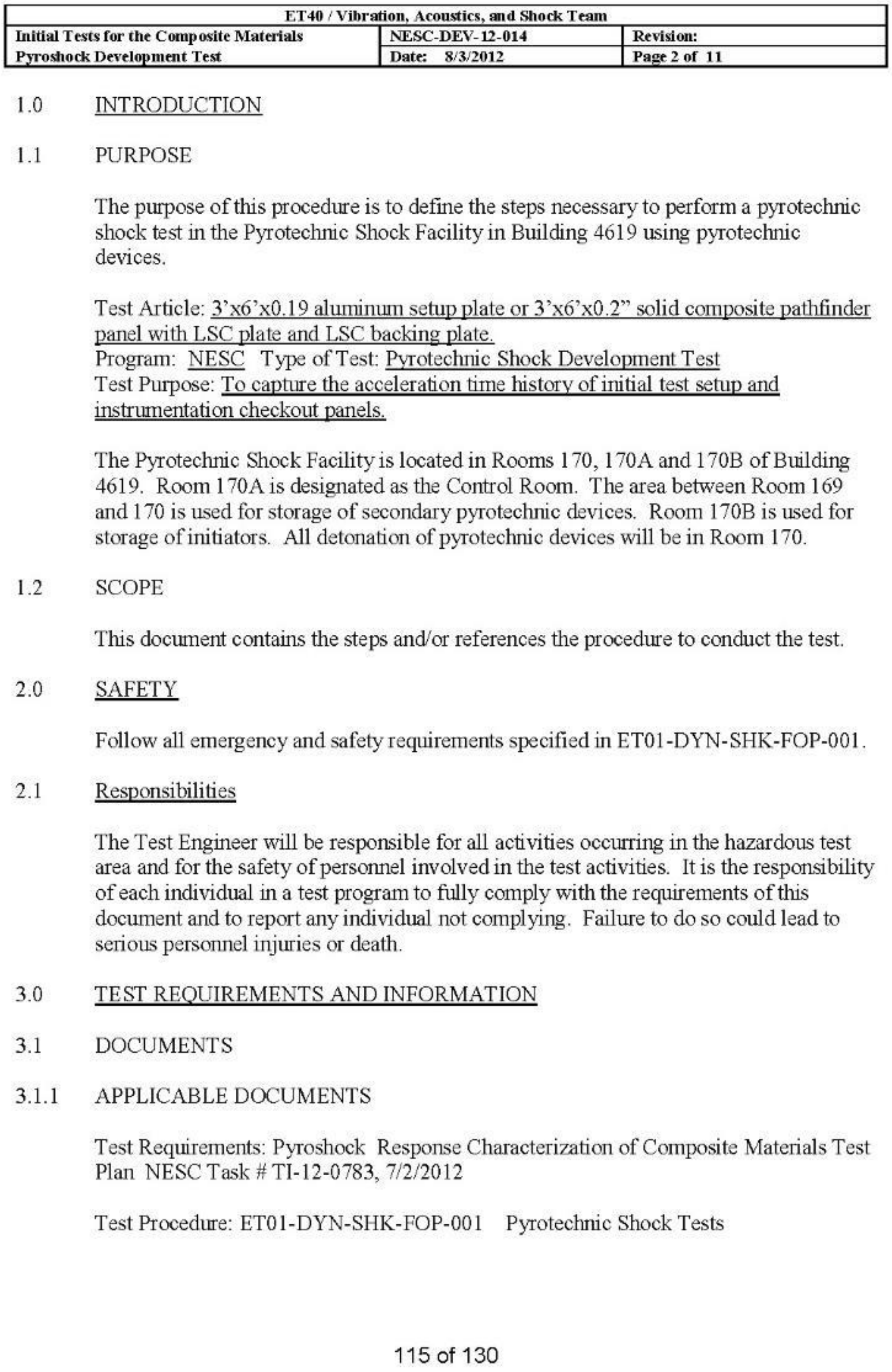
David Ordway / EV32
Aerospace Engineer, Pyrotechnics
Structural & Mechanical Design Branch
Test Requester

Date

APPROVED BY: David Parsons 8/6/12

David Parsons / ES22
Structural Dynamics
Mechanical, Thermal and Life Support Branch

Date



ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	**NESC-DEV-12-014**	**Revision:**
	Date: 8/3/2012	**Page 2 of 11**

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this procedure is to define the steps necessary to perform a pyrotechnic shock test in the Pyrotechnic Shock Facility in Building 4619 using pyrotechnic devices.

Test Article: 3’x6’x0.19 aluminum setup plate or 3’x6’x0.2” solid composite pathfinder panel with LSC plate and LSC backing plate.
Program: NESC Type of Test: Pyrotechnic Shock Development Test
Test Purpose: To capture the acceleration time history of initial test setup and instrumentation checkout panels.

The Pyrotechnic Shock Facility is located in Rooms 170, 170A and 170B of Building 4619. Room 170A is designated as the Control Room. The area between Room 169 and 170 is used for storage of secondary pyrotechnic devices. Room 170B is used for storage of initiators. All detonation of pyrotechnic devices will be in Room 170.

1.2 SCOPE

This document contains the steps and/or references the procedure to conduct the test.

2.0 SAFETY

Follow all emergency and safety requirements specified in ET01-DYN-SHK-FOP-001.

2.1 Responsibilities

The Test Engineer will be responsible for all activities occurring in the hazardous test area and for the safety of personnel involved in the test activities. It is the responsibility of each individual in a test program to fully comply with the requirements of this document and to report any individual not complying. Failure to do so could lead to serious personnel injuries or death.

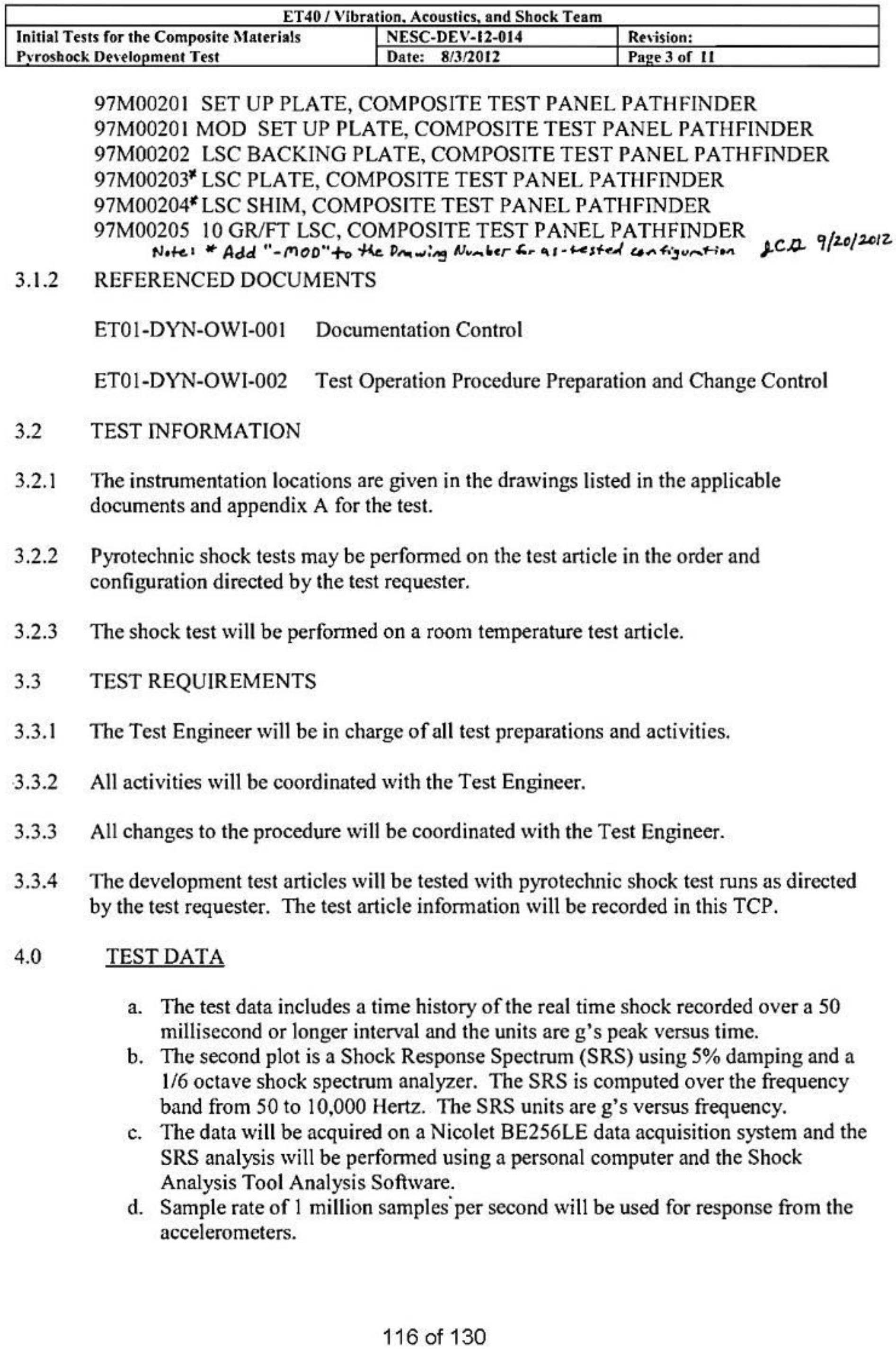
3.0 TEST REQUIREMENTS AND INFORMATION

3.1 DOCUMENTS

3.1.1 APPLICABLE DOCUMENTS

Test Requirements: Pyroshock Response Characterization of Composite Materials Test Plan NESC Task # TI-12-0783, 7/2/2012

Test Procedure: ET01-DYN-SHK-FOP-001 Pyrotechnic Shock Tests



ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	NESC-DEV-12-014 Date: 8/3/2012	Revision: Page 3 of 11

97M00201 SET UP PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00201 MOD SET UP PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00202 LSC BACKING PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00203* LSC PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00204* LSC SHIM, COMPOSITE TEST PANEL PATHFINDER
97M00205 10 GR/FT LSC, COMPOSITE TEST PANEL PATHFINDER

Note: * Add "-MOD" to the Drawing Number for as-tested configuration JCA 9/20/2012

3.1.2 REFERENCED DOCUMENTS

ET01-DYN-OWI-001 Documentation Control

ET01-DYN-OWI-002 Test Operation Procedure Preparation and Change Control

3.2 TEST INFORMATION

3.2.1 The instrumentation locations are given in the drawings listed in the applicable documents and appendix A for the test.

3.2.2 Pyrotechnic shock tests may be performed on the test article in the order and configuration directed by the test requester.

3.2.3 The shock test will be performed on a room temperature test article.

3.3 TEST REQUIREMENTS

3.3.1 The Test Engineer will be in charge of all test preparations and activities.

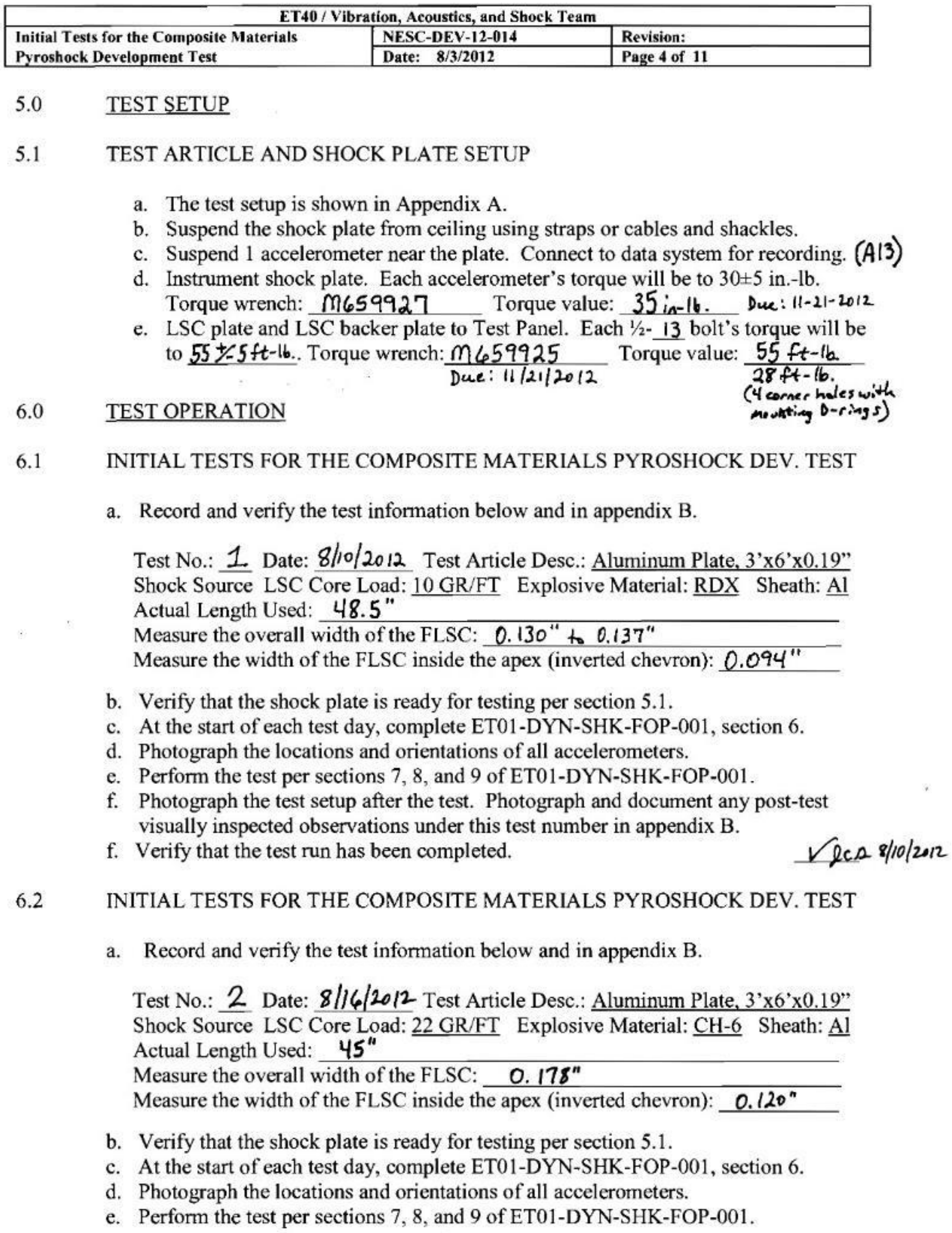
3.3.2 All activities will be coordinated with the Test Engineer.

3.3.3 All changes to the procedure will be coordinated with the Test Engineer.

3.3.4 The development test articles will be tested with pyrotechnic shock test runs as directed by the test requester. The test article information will be recorded in this TCP.

4.0 TEST DATA

a. The test data includes a time history of the real time shock recorded over a 50 millisecond or longer interval and the units are g's peak versus time.
b. The second plot is a Shock Response Spectrum (SRS) using 5% damping and a 1/6 octave shock spectrum analyzer. The SRS is computed over the frequency band from 50 to 10,000 Hertz. The SRS units are g's versus frequency.
c. The data will be acquired on a Nicolet BE256LE data acquisition system and the SRS analysis will be performed using a personal computer and the Shock Analysis Tool Analysis Software.
d. Sample rate of 1 million samples per second will be used for response from the accelerometers.



ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	NESC-DEV-12-014 Date: 8/3/2012	Revision: Page 4 of 11

5.0 TEST SETUP

5.1 TEST ARTICLE AND SHOCK PLATE SETUP

a. The test setup is shown in Appendix A.
b. Suspend the shock plate from ceiling using straps or cables and shackles.
c. Suspend 1 accelerometer near the plate. Connect to data system for recording. (A13)
d. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M659927 Torque value: 35 in-lb. Due: 11-21-2012
e. LSC plate and LSC backer plate to Test Panel. Each ½-13 bolt's torque will be to 55 ±5 ft-lb.. Torque wrench: M659925 Due: 11/21/2012 Torque value: 55 ft-lb. 28 ft-lb. (4 corner holes with mounting O-rings)

6.0 TEST OPERATION

6.1 INITIAL TESTS FOR THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Test No.: 1 Date: 8/10/2012 Test Article Desc.: Aluminum Plate, 3'x6'x0.19"
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.130" to 0.137"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

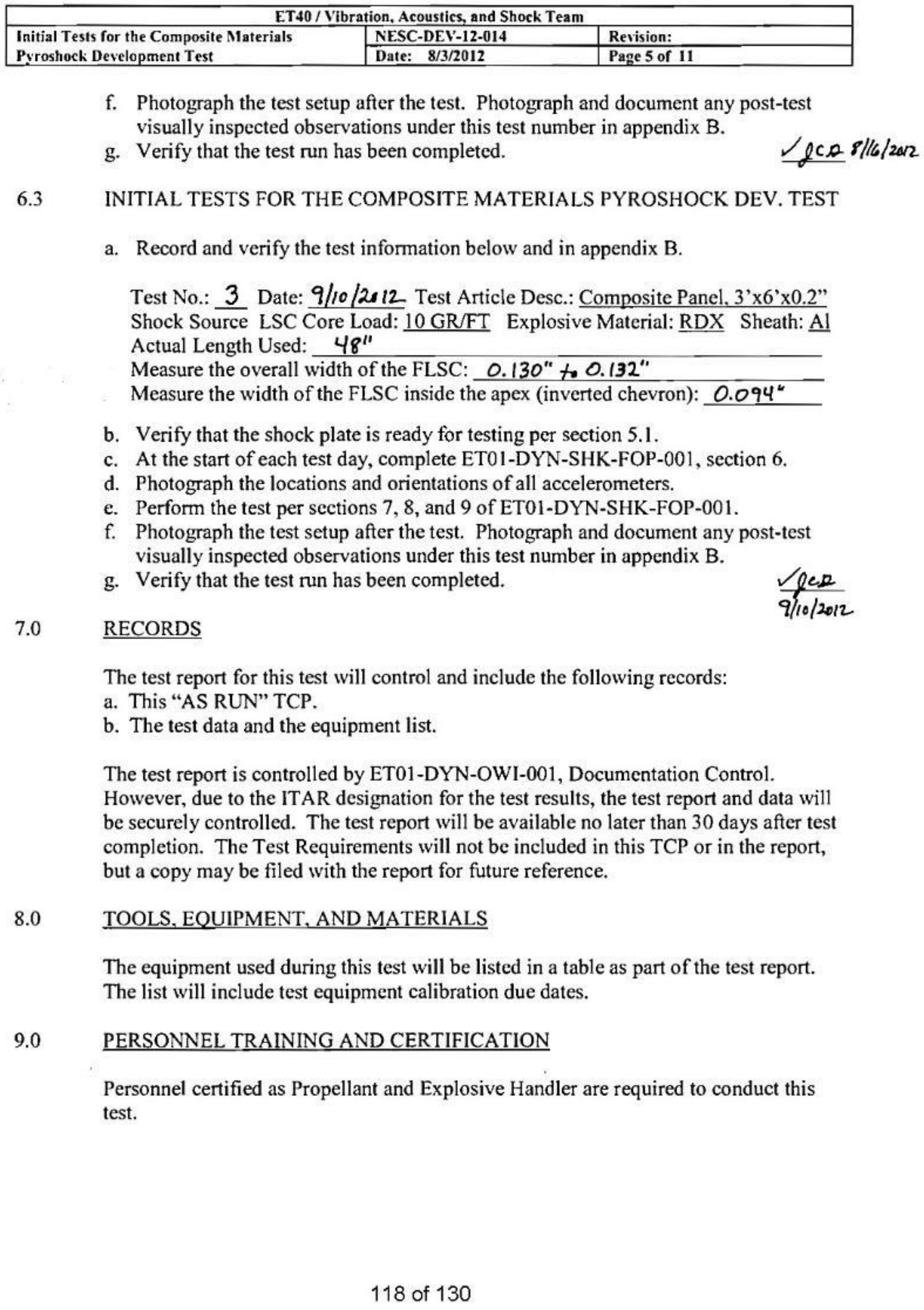
b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
f. Verify that the test run has been completed. ✓ JCA 8/10/2012

6.2 INITIAL TESTS FOR THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Test No.: 2 Date: 8/16/2012 Test Article Desc.: Aluminum Plate, 3'x6'x0.19"
Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al
Actual Length Used: 45"
Measure the overall width of the FLSC: 0.178"
Measure the width of the FLSC inside the apex (inverted chevron): 0.120"

b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.



ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	NESC-DEV-12-014 Date: 8/3/2012	Revision: Page 5 of 11

f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. ✓JCD 8/16/2012

6.3 INITIAL TESTS FOR THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Test No.: 3 Date: 9/10/2012 Test Article Desc.: Composite Panel, 3'x6'x0.2"
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48"
Measure the overall width of the FLSC: 0.130" to 0.132"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. ✓JCD 9/10/2012

7.0 RECORDS

The test report for this test will control and include the following records:
a. This "AS RUN" TCP.
b. The test data and the equipment list.

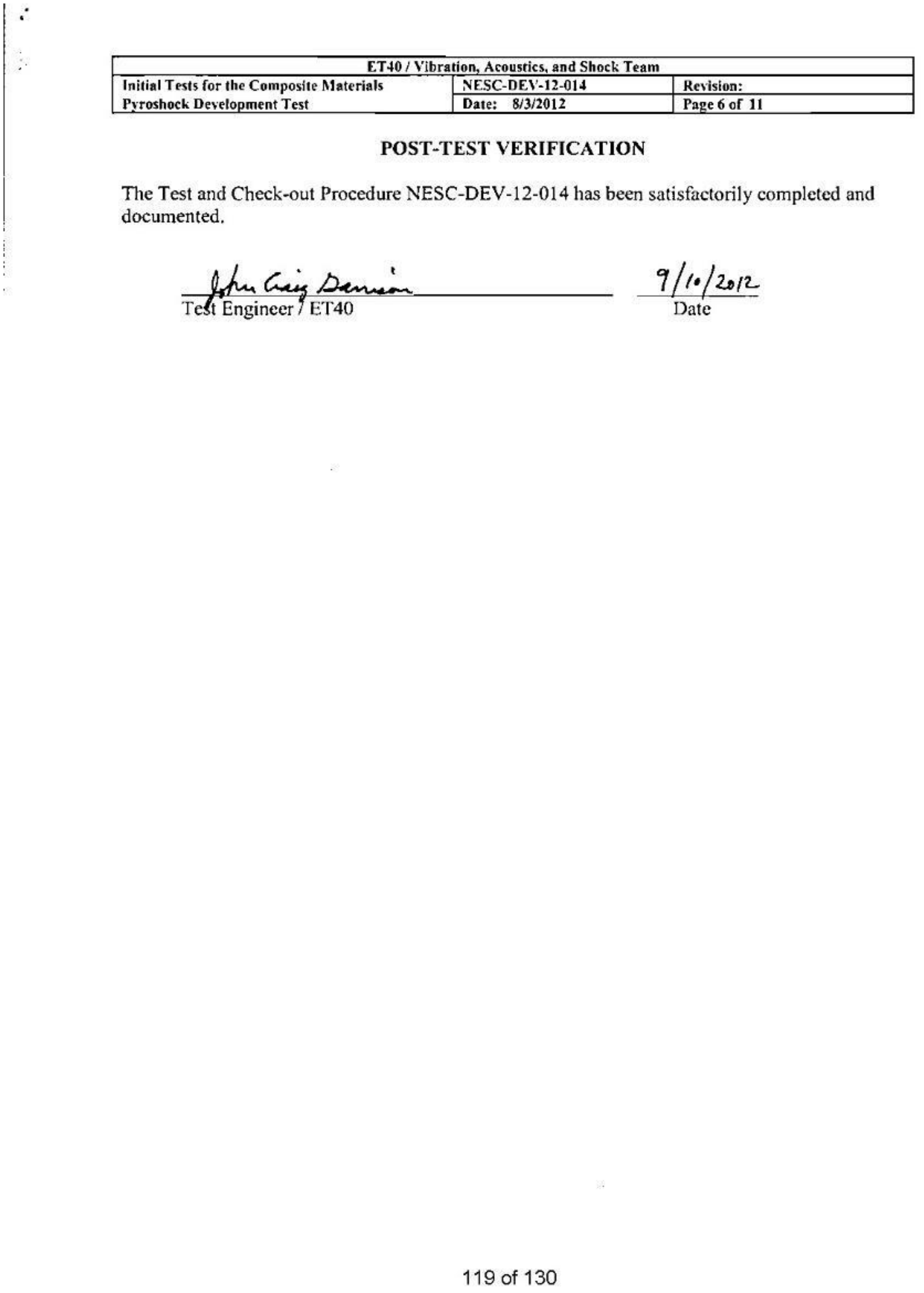
The test report is controlled by ET01-DYN-OWI-001, Documentation Control. However, due to the ITAR designation for the test results, the test report and data will be securely controlled. The test report will be available no later than 30 days after test completion. The Test Requirements will not be included in this TCP or in the report, but a copy may be filed with the report for future reference.

8.0 TOOLS, EQUIPMENT, AND MATERIALS

The equipment used during this test will be listed in a table as part of the test report. The list will include test equipment calibration due dates.

9.0 PERSONNEL TRAINING AND CERTIFICATION

Personnel certified as Propellant and Explosive Handler are required to conduct this test.



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POST-TEST VERIFICATION

The Test and Check-out Procedure NESC-DEV-12-014 has been satisfactorily completed and documented.

John Craig Dennison
Test Engineer / ET40

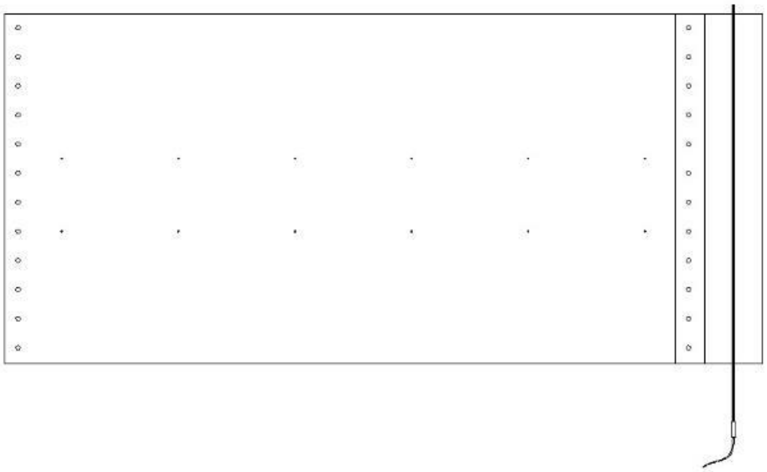
9/10/2012
Date

APPENDIX A

TEST SETUP

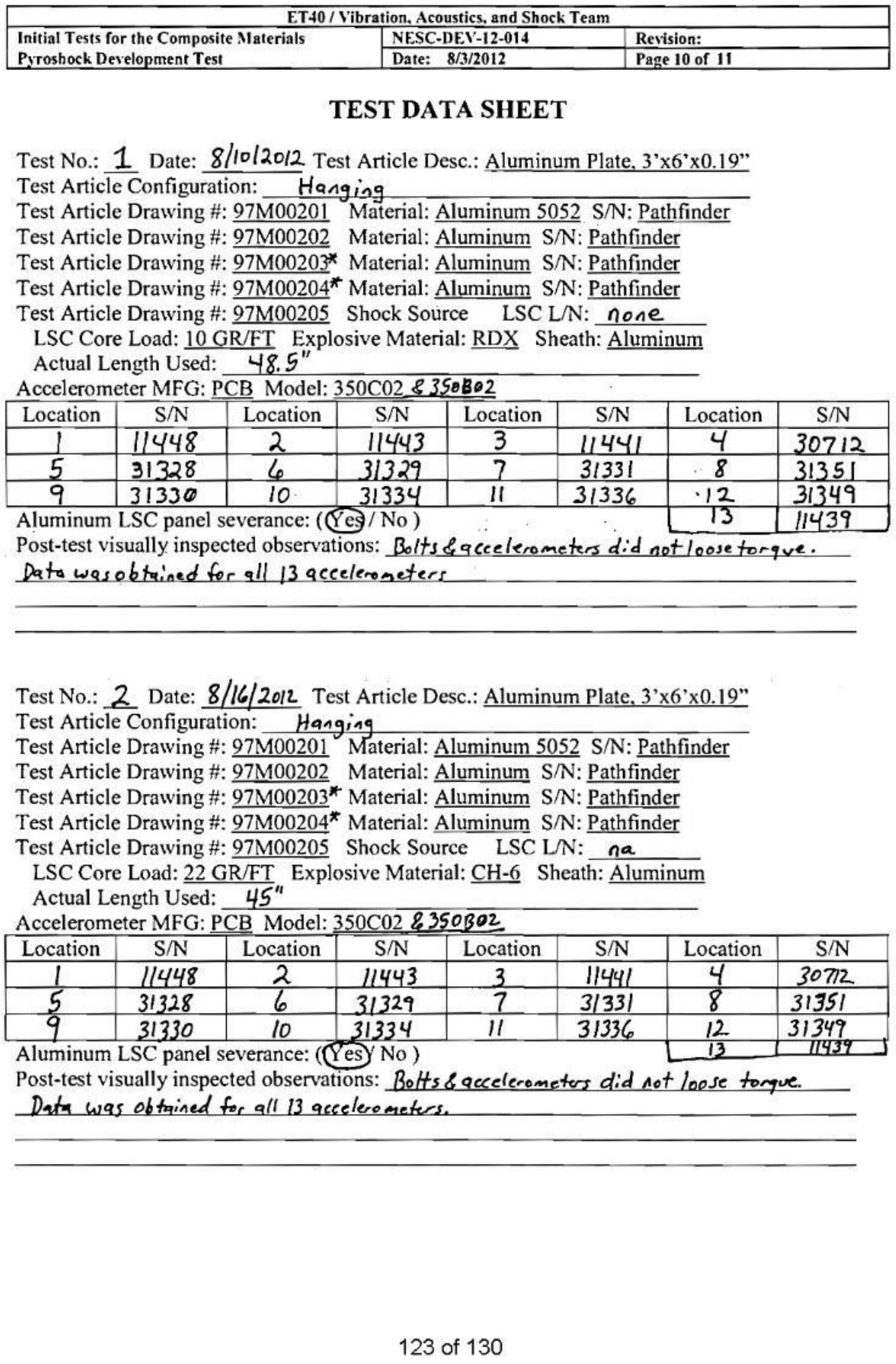
Initial Tests for the Composite Materials Pyroshock Development Test

Test Article Panel:	Aluminum or Composite, Vertical Position
Supports:	Straps and Shackles



APPENDIX B

TEST DATA SHEET



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Pyroshock Development Test	Date: 8/3/2012	Page 10 of 11

TEST DATA SHEET

Test No.: 1 Date: 8/10/2012 Test Article Desc.: Aluminum Plate, 3'x6'x0.19"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00201 Material: Aluminum 5052 S/N: Pathfinder
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02 & 350B02

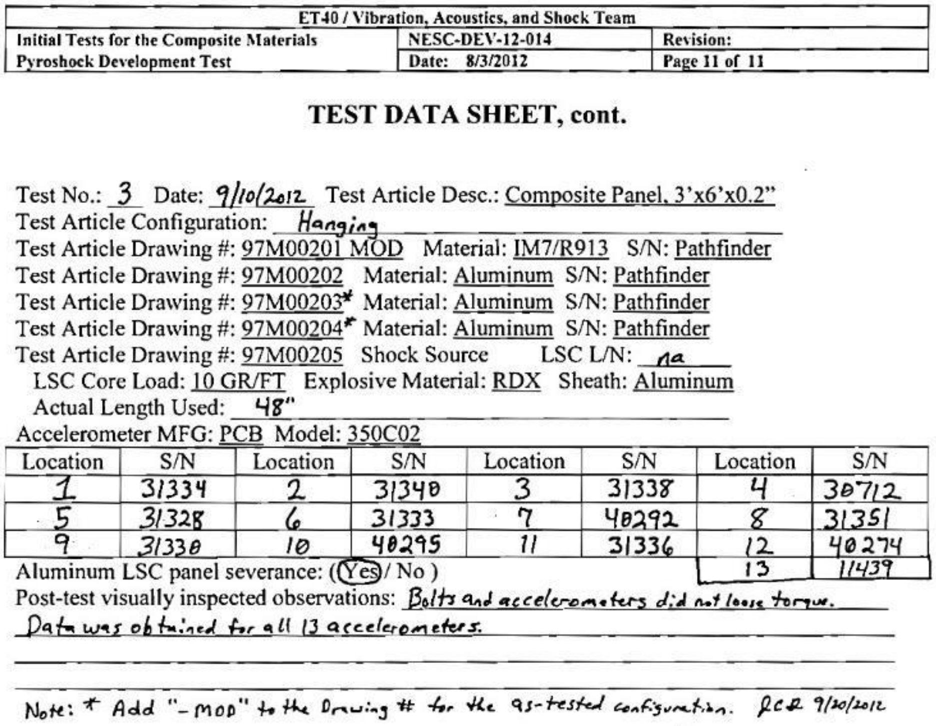
Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	11448	2	11443	3	11441	4	30712
5	31328	6	31329	7	31331	8	31351
9	31330	10	31334	11	31336	12	31349
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: Bolts & accelerometers did not loose torque.
Data was obtained for all 13 accelerometers

Test No.: 2 Date: 8/16/2012 Test Article Desc.: Aluminum Plate, 3'x6'x0.19"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00201 Material: Aluminum 5052 S/N: Pathfinder
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: na
LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Aluminum
Actual Length Used: 45"
Accelerometer MFG: PCB Model: 350C02 & 350B02

Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	11448	2	11443	3	11441	4	30712
5	31328	6	31329	7	31331	8	31351
9	31330	10	31334	11	31336	12	31349
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: Bolts & accelerometers did not loose torque.
Data was obtained for all 13 accelerometers.



ET40 / Vibration, Acoustics, and Shock Team		
Initial Tests for the Composite Materials Pyroshock Development Test	NESC-DEV-12-014 Date: 8/3/2012	Revision: Page 11 of 11

TEST DATA SHEET, cont.

Test No.: 3 Date: 9/10/2012 Test Article Desc.: Composite Panel, 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00201 MOD Material: IM7/R913 S/N: Pathfinder
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204* Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: na
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48"
Accelerometer MFG: PCB Model: 350C02

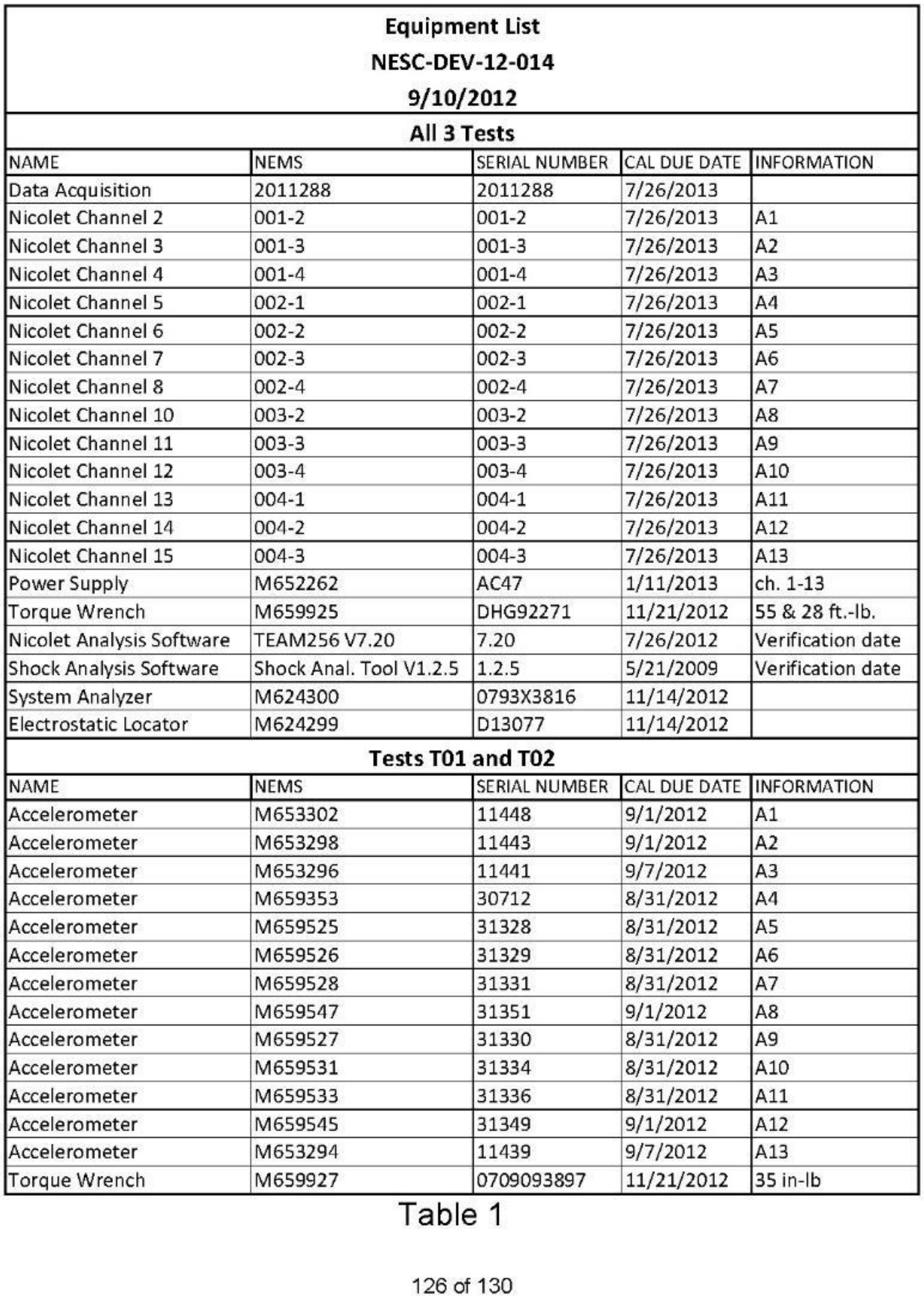
Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	30712
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: Bolts and accelerometers did not loose torque.
Data was obtained for all 13 accelerometers.

Note: * Add "-MOD" to the Drawing # for the as-tested configuration. JCR 9/20/2012

Tables

Data System Settings



Equipment List
NESC-DEV-12-014
9/10/2012

All 3 Tests

NAME	NEMS	SERIAL NUMBER	CAL DUE DATE	INFORMATION
Data Acquisition	2011288	2011288	7/26/2013	
Nicolet Channel 2	001-2	001-2	7/26/2013	A1
Nicolet Channel 3	001-3	001-3	7/26/2013	A2
Nicolet Channel 4	001-4	001-4	7/26/2013	A3
Nicolet Channel 5	002-1	002-1	7/26/2013	A4
Nicolet Channel 6	002-2	002-2	7/26/2013	A5
Nicolet Channel 7	002-3	002-3	7/26/2013	A6
Nicolet Channel 8	002-4	002-4	7/26/2013	A7
Nicolet Channel 10	003-2	003-2	7/26/2013	A8
Nicolet Channel 11	003-3	003-3	7/26/2013	A9
Nicolet Channel 12	003-4	003-4	7/26/2013	A10
Nicolet Channel 13	004-1	004-1	7/26/2013	A11
Nicolet Channel 14	004-2	004-2	7/26/2013	A12
Nicolet Channel 15	004-3	004-3	7/26/2013	A13
Power Supply	M652262	AC47	1/11/2013	ch. 1-13
Torque Wrench	M659925	DHG92271	11/21/2012	55 & 28 ft.-lb.
Nicolet Analysis Software	TEAM256 V7.20	7.20	7/26/2012	Verification date
Shock Analysis Software	Shock Anal. Tool V1.2.5	1.2.5	5/21/2009	Verification date
System Analyzer	M624300	0793X3816	11/14/2012	
Electrostatic Locator	M624299	D13077	11/14/2012	

Tests T01 and T02

NAME	NEMS	SERIAL NUMBER	CAL DUE DATE	INFORMATION
Accelerometer	M653302	11448	9/1/2012	A1
Accelerometer	M653298	11443	9/1/2012	A2
Accelerometer	M653296	11441	9/7/2012	A3
Accelerometer	M659353	30712	8/31/2012	A4
Accelerometer	M659525	31328	8/31/2012	A5
Accelerometer	M659526	31329	8/31/2012	A6
Accelerometer	M659528	31331	8/31/2012	A7
Accelerometer	M659547	31351	9/1/2012	A8
Accelerometer	M659527	31330	8/31/2012	A9
Accelerometer	M659531	31334	8/31/2012	A10
Accelerometer	M659533	31336	8/31/2012	A11
Accelerometer	M659545	31349	9/1/2012	A12
Accelerometer	M653294	11439	9/7/2012	A13
Torque Wrench	M659927	0709093897	11/21/2012	35 in-lb

Table 1

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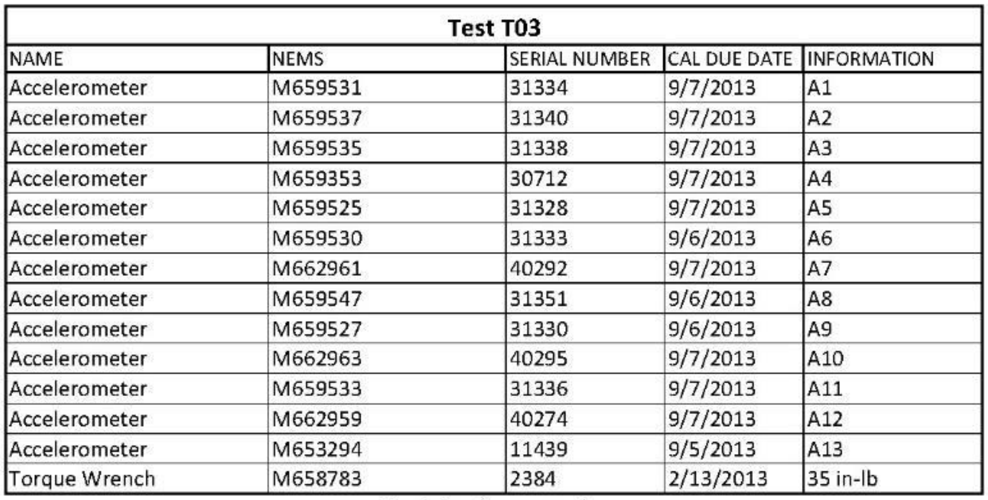
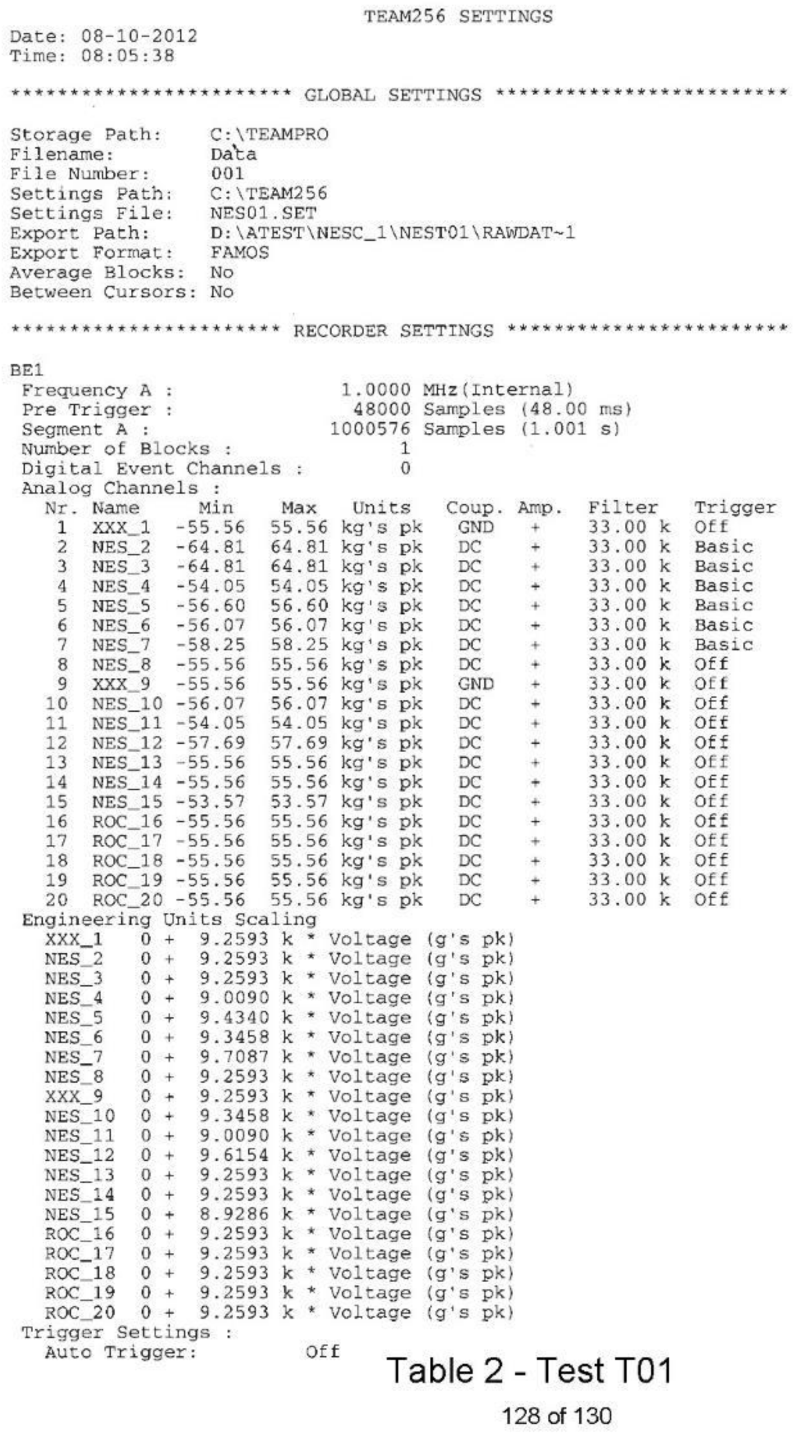


Test T03				
NAME	NEMS	SERIAL NUMBER	CAL DUE DATE	INFORMATION
Accelerometer	M659531	31334	9/7/2013	A1
Accelerometer	M659537	31340	9/7/2013	A2
Accelerometer	M659535	31338	9/7/2013	A3
Accelerometer	M659353	30712	9/7/2013	A4
Accelerometer	M659525	31328	9/7/2013	A5
Accelerometer	M659530	31333	9/6/2013	A6
Accelerometer	M662961	40292	9/7/2013	A7
Accelerometer	M659547	31351	9/6/2013	A8
Accelerometer	M659527	31330	9/6/2013	A9
Accelerometer	M662963	40295	9/7/2013	A10
Accelerometer	M659533	31336	9/7/2013	A11
Accelerometer	M662959	40274	9/7/2013	A12
Accelerometer	M653294	11439	9/5/2013	A13
Torque Wrench	M658783	2384	2/13/2013	35 in-lb

Table 1 - cont.



```
                          TEAM256 SETTINGS
Date: 08-10-2012
Time: 08:05:38

************************ GLOBAL SETTINGS ************************

Storage Path:     C:\TEAMPRO
Filename:         Data
File Number:      001
Settings Path:    C:\TEAM256
Settings File:    NES01.SET
Export Path:      D:\ATEST\NESC_1\NEST01\RAWDAT~1
Export Format:    FAMOS
Average Blocks:   No
Between Cursors:  No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :               1.0000 MHz(Internal)
 Pre Trigger :                48000 Samples (48.00 ms)
 Segment A :                1000576 Samples (1.001 s)
 Number of Blocks :               1
 Digital Event Channels :         0
 Analog Channels :
   Nr. Name     Min     Max   Units     Coup. Amp.   Filter   Trigger
    1  XXX_1  -55.56  55.56  kg's pk    GND    +    33.00 k  Off
    2  NES_2  -64.81  64.81  kg's pk    DC     +    33.00 k  Basic
    3  NES_3  -64.81  64.81  kg's pk    DC     +    33.00 k  Basic
    4  NES_4  -54.05  54.05  kg's pk    DC     +    33.00 k  Basic
    5  NES_5  -56.60  56.60  kg's pk    DC     +    33.00 k  Basic
    6  NES_6  -56.07  56.07  kg's pk    DC     +    33.00 k  Basic
    7  NES_7  -58.25  58.25  kg's pk    DC     +    33.00 k  Basic
    8  NES_8  -55.56  55.56  kg's pk    DC     +    33.00 k  Off
    9  XXX_9  -55.56  55.56  kg's pk    GND    +    33.00 k  Off
   10  NES_10 -56.07  56.07  kg's pk    DC     +    33.00 k  Off
   11  NES_11 -54.05  54.05  kg's pk    DC     +    33.00 k  Off
   12  NES_12 -57.69  57.69  kg's pk    DC     +    33.00 k  Off
   13  NES_13 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   14  NES_14 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   15  NES_15 -53.57  53.57  kg's pk    DC     +    33.00 k  Off
   16  ROC_16 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   17  ROC_17 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   18  ROC_18 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   19  ROC_19 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
   20  ROC_20 -55.56  55.56  kg's pk    DC     +    33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  9.2593 k * Voltage (g's pk)
   NES_2    0 +  9.2593 k * Voltage (g's pk)
   NES_3    0 +  9.2593 k * Voltage (g's pk)
   NES_4    0 +  9.0090 k * Voltage (g's pk)
   NES_5    0 +  9.4340 k * Voltage (g's pk)
   NES_6    0 +  9.3458 k * Voltage (g's pk)
   NES_7    0 +  9.7087 k * Voltage (g's pk)
   NES_8    0 +  9.2593 k * Voltage (g's pk)
   XXX_9    0 +  9.2593 k * Voltage (g's pk)
   NES_10   0 +  9.3458 k * Voltage (g's pk)
   NES_11   0 +  9.0090 k * Voltage (g's pk)
   NES_12   0 +  9.6154 k * Voltage (g's pk)
   NES_13   0 +  9.2593 k * Voltage (g's pk)
   NES_14   0 +  9.2593 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:          Off
```

Table 2 - Test T01

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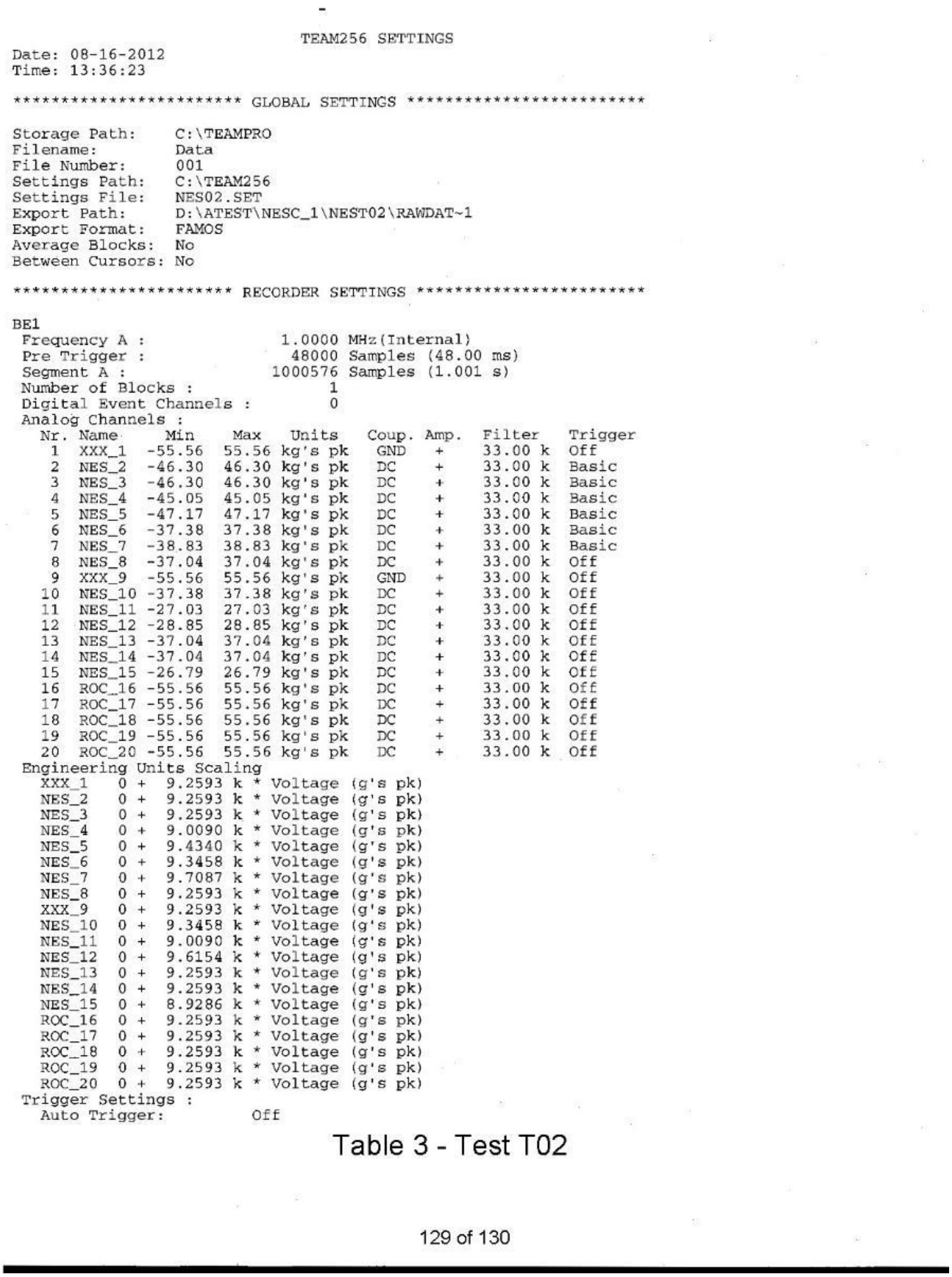

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                         TEAM256 SETTINGS
Date: 08-16-2012
Time: 13:36:23

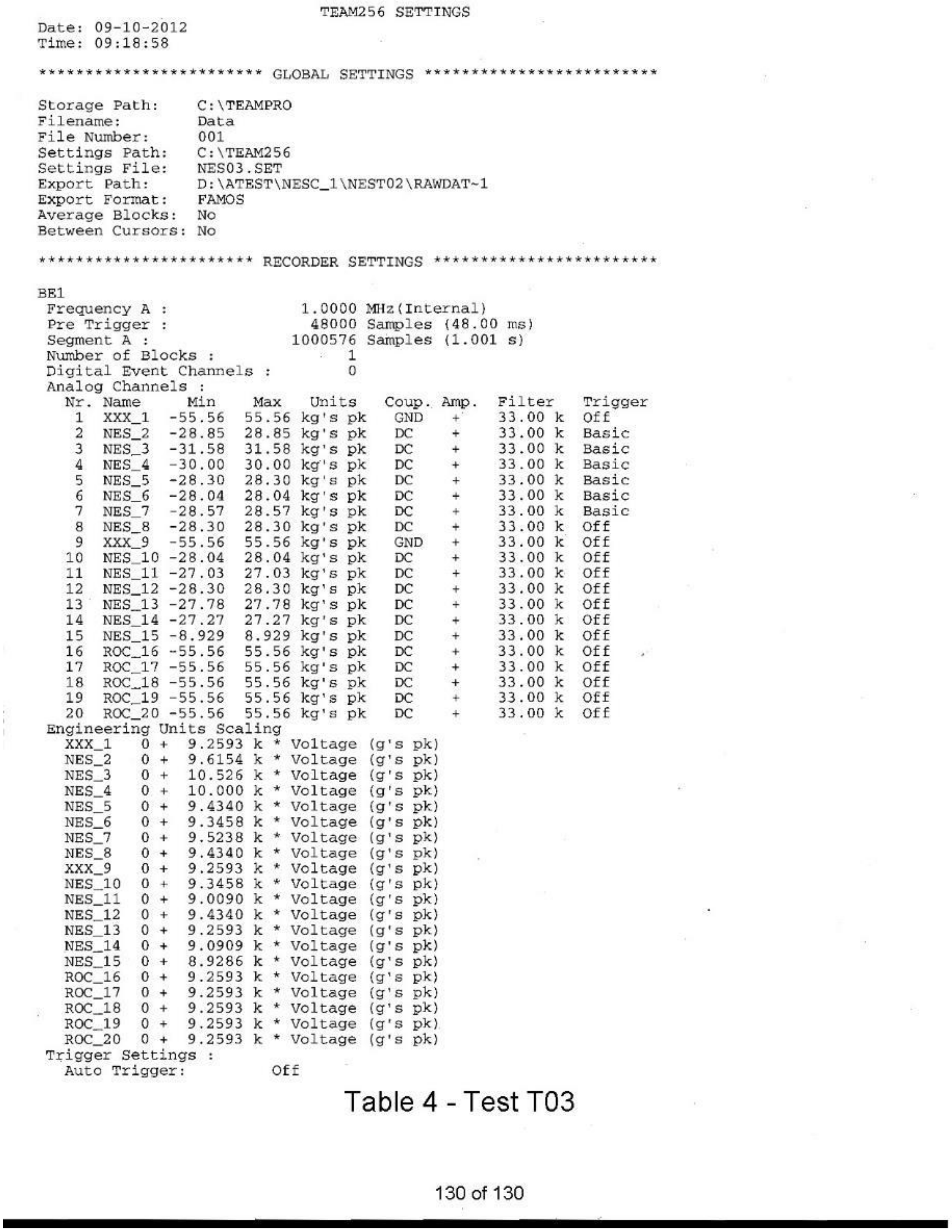
************************ GLOBAL SETTINGS *************************

Storage Path:    C:\TEAMPRO
Filename:        Data
File Number:     001
Settings Path:   C:\TEAM256
Settings File:   NES02.SET
Export Path:     D:\ATEST\NESC_1\NEST02\RAWDAT~1
Export Format:   FAMOS
Average Blocks:  No
Between Cursors: No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :                1.0000 MHz(Internal)
 Pre Trigger :                 48000 Samples (48.00 ms)
 Segment A :                 1000576 Samples (1.001 s)
 Number of Blocks :                1
 Digital Event Channels :          0
 Analog Channels :
   Nr. Name     Min     Max    Units     Coup. Amp.  Filter    Trigger
    1  XXX_1  -55.56  55.56 kg's pk     GND   +     33.00 k  Off
    2  NES_2  -46.30  46.30 kg's pk     DC    +     33.00 k  Basic
    3  NES_3  -46.30  46.30 kg's pk     DC    +     33.00 k  Basic
    4  NES_4  -45.05  45.05 kg's pk     DC    +     33.00 k  Basic
    5  NES_5  -47.17  47.17 kg's pk     DC    +     33.00 k  Basic
    6  NES_6  -37.38  37.38 kg's pk     DC    +     33.00 k  Basic
    7  NES_7  -38.83  38.83 kg's pk     DC    +     33.00 k  Basic
    8  NES_8  -37.04  37.04 kg's pk     DC    +     33.00 k  Off
    9  XXX_9  -55.56  55.56 kg's pk     GND   +     33.00 k  Off
   10  NES_10 -37.38  37.38 kg's pk     DC    +     33.00 k  Off
   11  NES_11 -27.03  27.03 kg's pk     DC    +     33.00 k  Off
   12  NES_12 -28.85  28.85 kg's pk     DC    +     33.00 k  Off
   13  NES_13 -37.04  37.04 kg's pk     DC    +     33.00 k  Off
   14  NES_14 -37.04  37.04 kg's pk     DC    +     33.00 k  Off
   15  NES_15 -26.79  26.79 kg's pk     DC    +     33.00 k  Off
   16  ROC_16 -55.56  55.56 kg's pk     DC    +     33.00 k  Off
   17  ROC_17 -55.56  55.56 kg's pk     DC    +     33.00 k  Off
   18  ROC_18 -55.56  55.56 kg's pk     DC    +     33.00 k  Off
   19  ROC_19 -55.56  55.56 kg's pk     DC    +     33.00 k  Off
   20  ROC_20 -55.56  55.56 kg's pk     DC    +     33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  9.2593 k * Voltage (g's pk)
   NES_2    0 +  9.2593 k * Voltage (g's pk)
   NES_3    0 +  9.2593 k * Voltage (g's pk)
   NES_4    0 +  9.0090 k * Voltage (g's pk)
   NES_5    0 +  9.4340 k * Voltage (g's pk)
   NES_6    0 +  9.3458 k * Voltage (g's pk)
   NES_7    0 +  9.7087 k * Voltage (g's pk)
   NES_8    0 +  9.2593 k * Voltage (g's pk)
   XXX_9    0 +  9.2593 k * Voltage (g's pk)
   NES_10   0 +  9.3458 k * Voltage (g's pk)
   NES_11   0 +  9.0090 k * Voltage (g's pk)
   NES_12   0 +  9.6154 k * Voltage (g's pk)
   NES_13   0 +  9.2593 k * Voltage (g's pk)
   NES_14   0 +  9.2593 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:         Off
```

Table 3 - Test T02



```
                              TEAM256 SETTINGS
Date: 09-10-2012
Time: 09:18:58

*********************** GLOBAL SETTINGS ************************

Storage Path:     C:\TEAMPRO
Filename:         Data
File Number:      001
Settings Path:    C:\TEAM256
Settings File:    NES03.SET
Export Path:      D:\ATEST\NESC_1\NEST02\RAWDAT~1
Export Format:    FAMOS
Average Blocks:   No
Between Cursors:  No

********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :               1.0000 MHz(Internal)
 Pre Trigger :                48000 Samples (48.00 ms)
 Segment A :                1000576 Samples (1.001 s)
 Number of Blocks :               1
 Digital Event Channels :         0
 Analog Channels :
   Nr. Name     Min     Max   Units    Coup. Amp.  Filter   Trigger
    1  XXX_1  -55.56  55.56 kg's pk   GND    +    33.00 k  Off
    2  NES_2  -28.85  28.85 kg's pk   DC     +    33.00 k  Basic
    3  NES_3  -31.58  31.58 kg's pk   DC     +    33.00 k  Basic
    4  NES_4  -30.00  30.00 kg's pk   DC     +    33.00 k  Basic
    5  NES_5  -28.30  28.30 kg's pk   DC     +    33.00 k  Basic
    6  NES_6  -28.04  28.04 kg's pk   DC     +    33.00 k  Basic
    7  NES_7  -28.57  28.57 kg's pk   DC     +    33.00 k  Basic
    8  NES_8  -28.30  28.30 kg's pk   DC     +    33.00 k  Off
    9  XXX_9  -55.56  55.56 kg's pk   GND    +    33.00 k  Off
   10  NES_10 -28.04  28.04 kg's pk   DC     +    33.00 k  Off
   11  NES_11 -27.03  27.03 kg's pk   DC     +    33.00 k  Off
   12  NES_12 -28.30  28.30 kg's pk   DC     +    33.00 k  Off
   13  NES_13 -27.78  27.78 kg's pk   DC     +    33.00 k  Off
   14  NES_14 -27.27  27.27 kg's pk   DC     +    33.00 k  Off
   15  NES_15 -8.929  8.929 kg's pk   DC     +    33.00 k  Off
   16  ROC_16 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   17  ROC_17 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   18  ROC_18 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   19  ROC_19 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   20  ROC_20 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  9.2593 k * Voltage (g's pk)
   NES_2    0 +  9.6154 k * Voltage (g's pk)
   NES_3    0 +  10.526 k * Voltage (g's pk)
   NES_4    0 +  10.000 k * Voltage (g's pk)
   NES_5    0 +  9.4340 k * Voltage (g's pk)
   NES_6    0 +  9.3458 k * Voltage (g's pk)
   NES_7    0 +  9.5238 k * Voltage (g's pk)
   NES_8    0 +  9.4340 k * Voltage (g's pk)
   XXX_9    0 +  9.2593 k * Voltage (g's pk)
   NES_10   0 +  9.3458 k * Voltage (g's pk)
   NES_11   0 +  9.0090 k * Voltage (g's pk)
   NES_12   0 +  9.4340 k * Voltage (g's pk)
   NES_13   0 +  9.2593 k * Voltage (g's pk)
   NES_14   0 +  9.0909 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:          Off
```

Table 4 - Test T03

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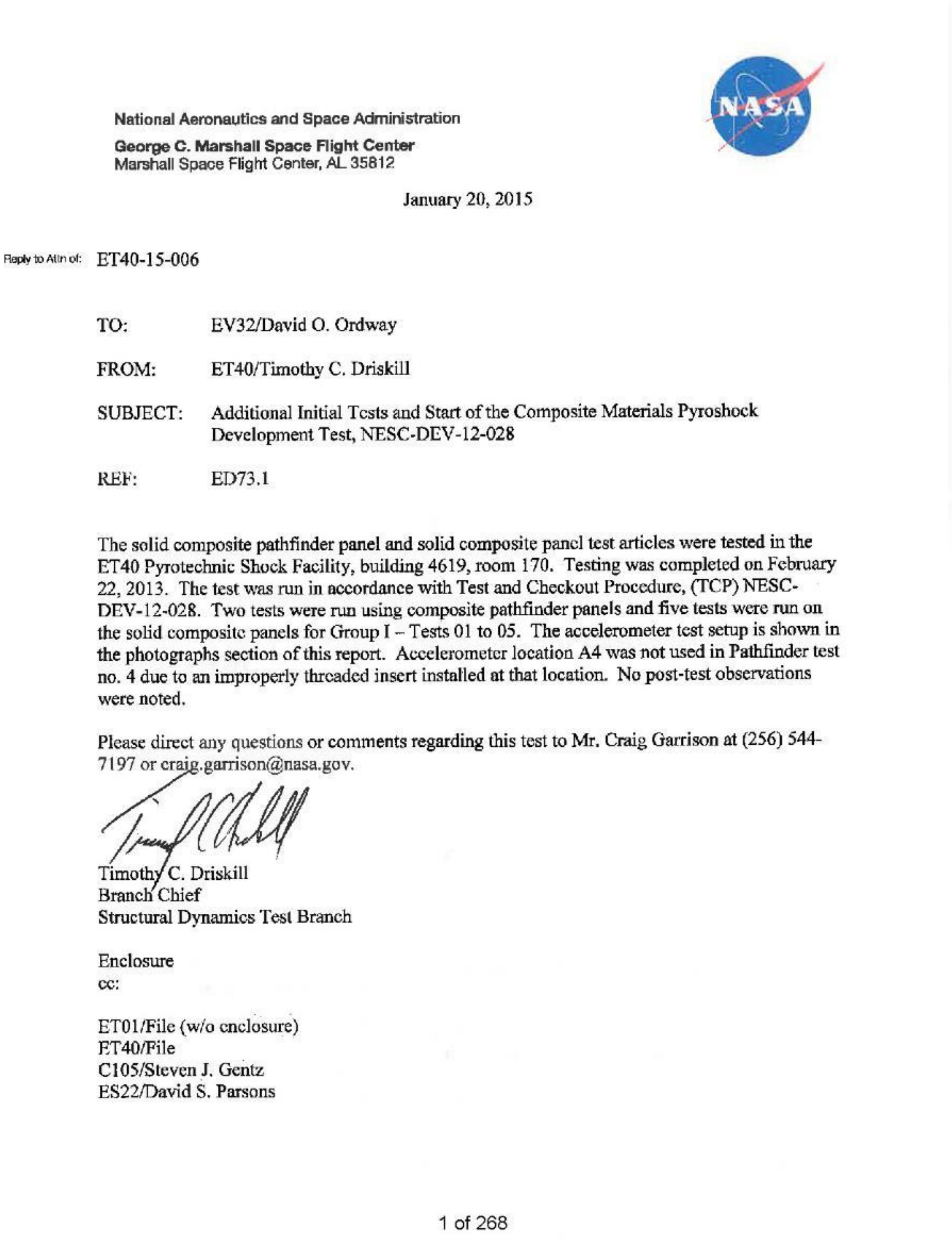
B2. Group I (Monolithic Panel Tests)

The test report documenting pathfinder group tests 4, 5, and the task assessment baseline Group I tests numbers 1 through 10 are documented in the attachments below.



National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

January 20, 2015

Reply to Attn of: ET40-15-006

TO: EV32/David O. Ordway

FROM: ET40/Timothy C. Driskill

SUBJECT: Additional Initial Tests and Start of the Composite Materials Pyroshock Development Test, NESC-DEV-12-028

REF: ED73.1

The solid composite pathfinder panel and solid composite panel test articles were tested in the ET40 Pyrotechnic Shock Facility, building 4619, room 170. Testing was completed on February 22, 2013. The test was run in accordance with Test and Checkout Procedure, (TCP) NESC-DEV-12-028. Two tests were run using composite pathfinder panels and five tests were run on the solid composite panels for Group I – Tests 01 to 05. The accelerometer test setup is shown in the photographs section of this report. Accelerometer location A4 was not used in Pathfinder test no. 4 due to an improperly threaded insert installed at that location. No post-test observations were noted.

Please direct any questions or comments regarding this test to Mr. Craig Garrison at (256) 544-7197 or craig.garrison@nasa.gov.

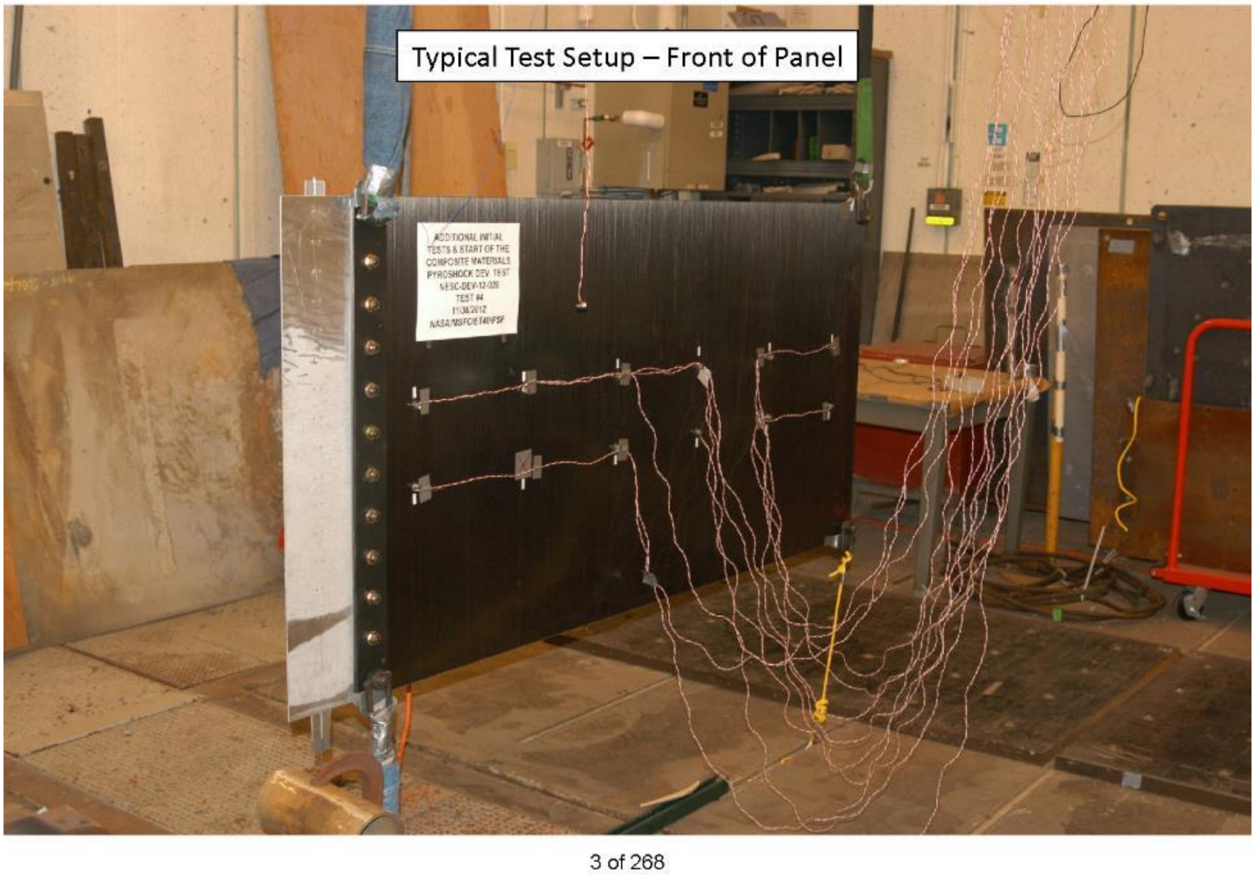
Timothy C. Driskill
Branch Chief
Structural Dynamics Test Branch

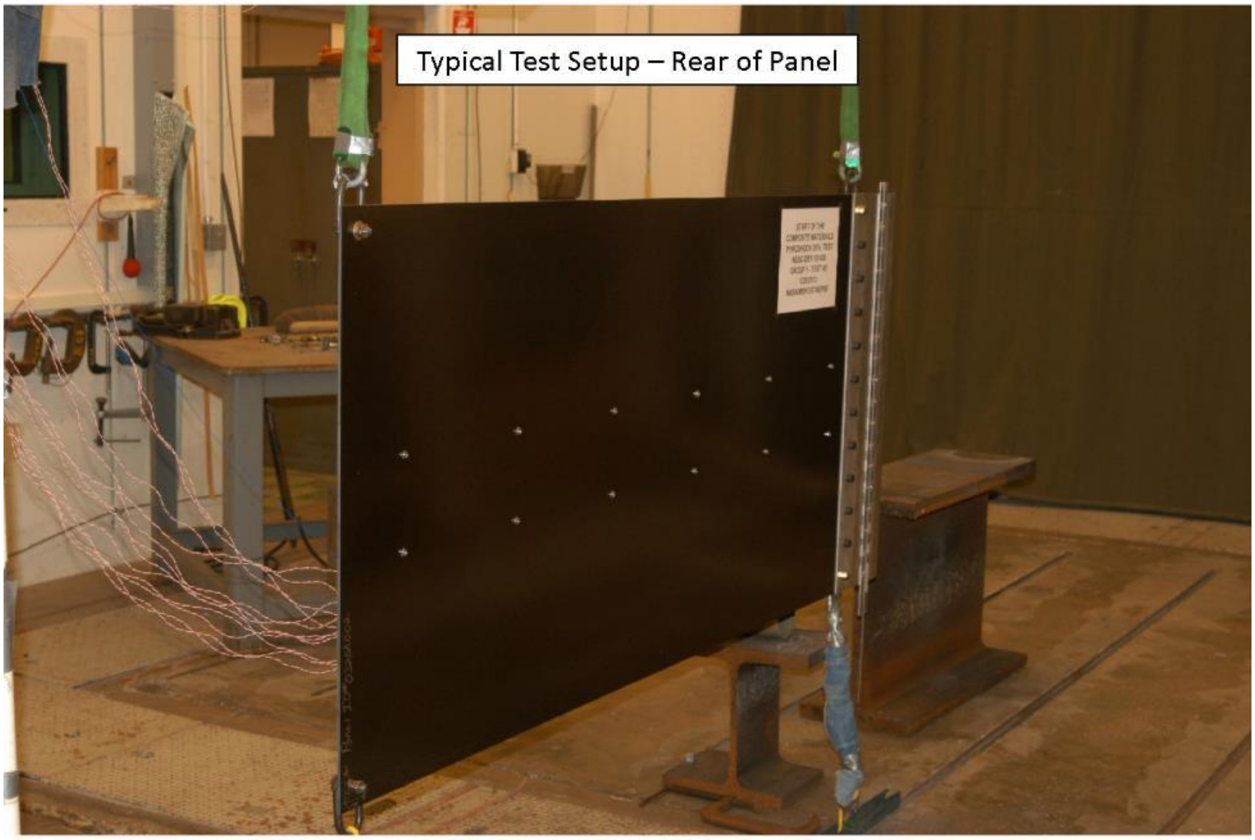
Enclosure
cc:

ET01/File (w/o enclosure)
ET40/File
C105/Steven J. Gentz
ES22/David S. Parsons

NESC-DEV-12-028
Composite Materials
Shock Test

General Test Setup

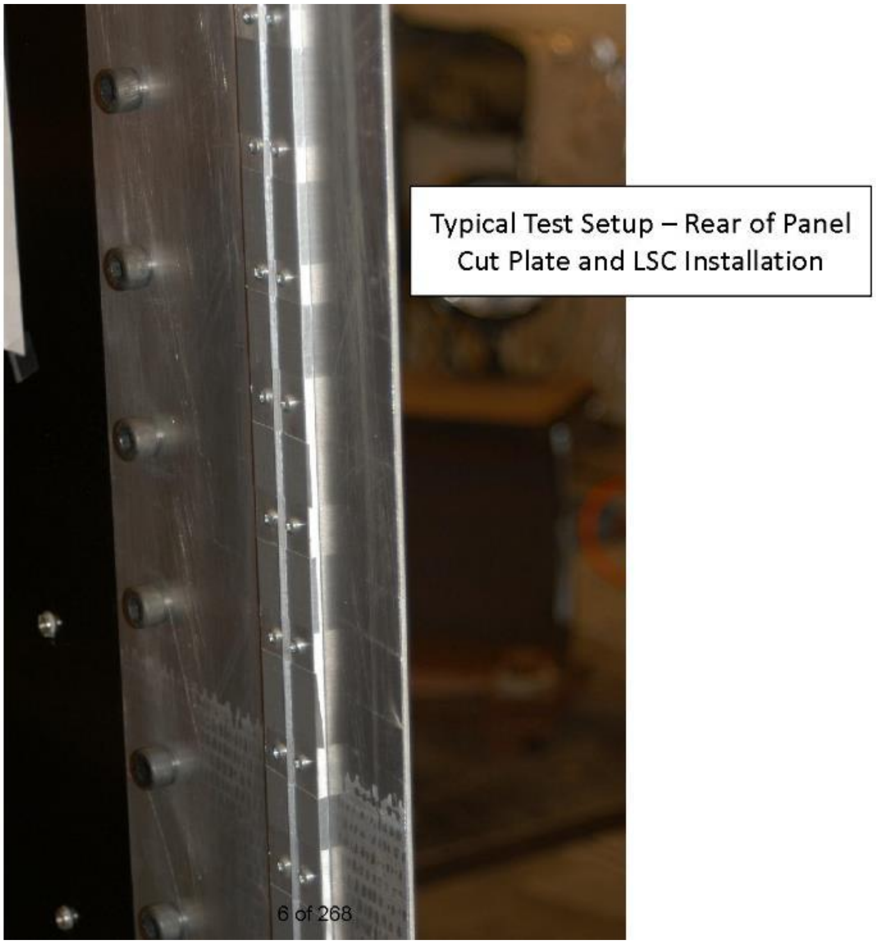

Typical Test Setup – Front of Panel
ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #4
11/30/2012
NASA/MSFC/ET40/PSF
3 of 268



Typical Test Setup – Rear of Panel

4 of 268

Typical Test Setup – Front of Panel Cut Plate and LSC Installation



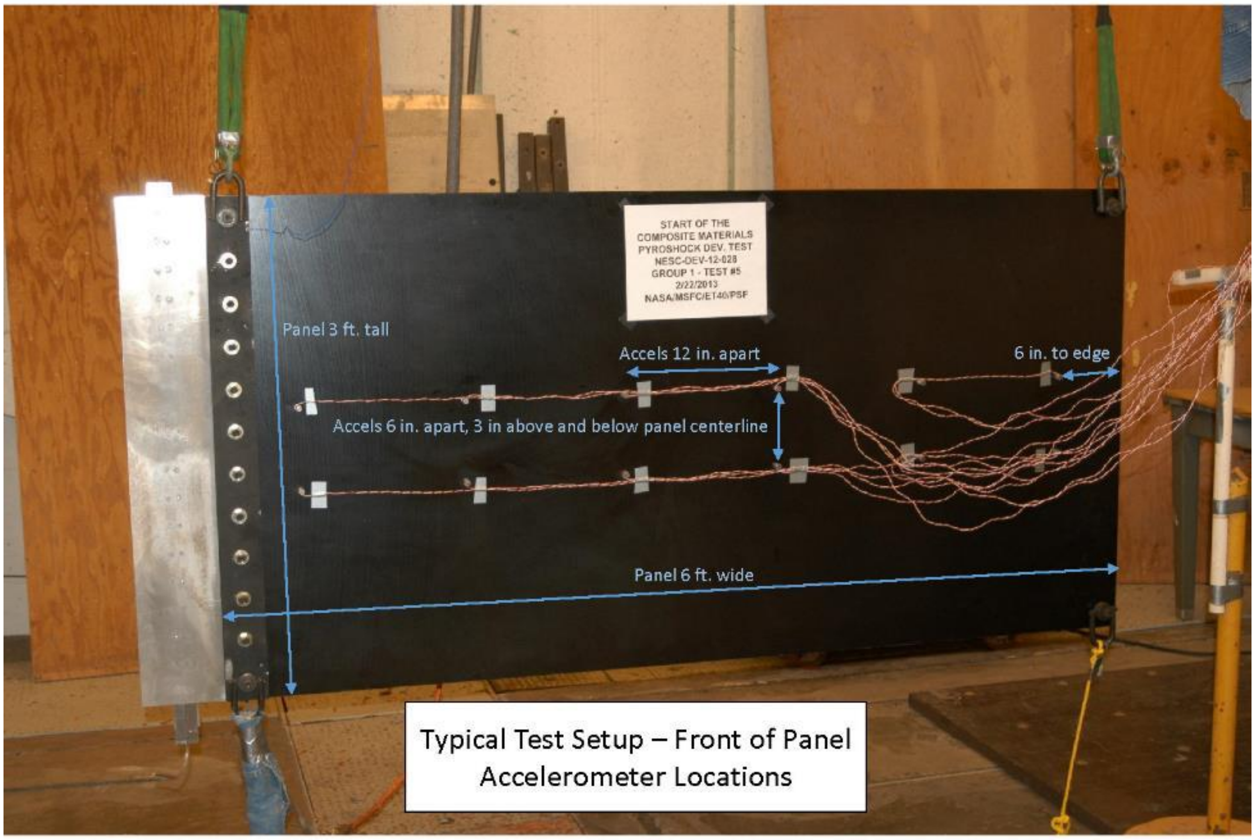
Typical Test Setup – Rear of Panel Cut Plate and LSC Installation

Typical Test Outcome
Cut Plate Severed

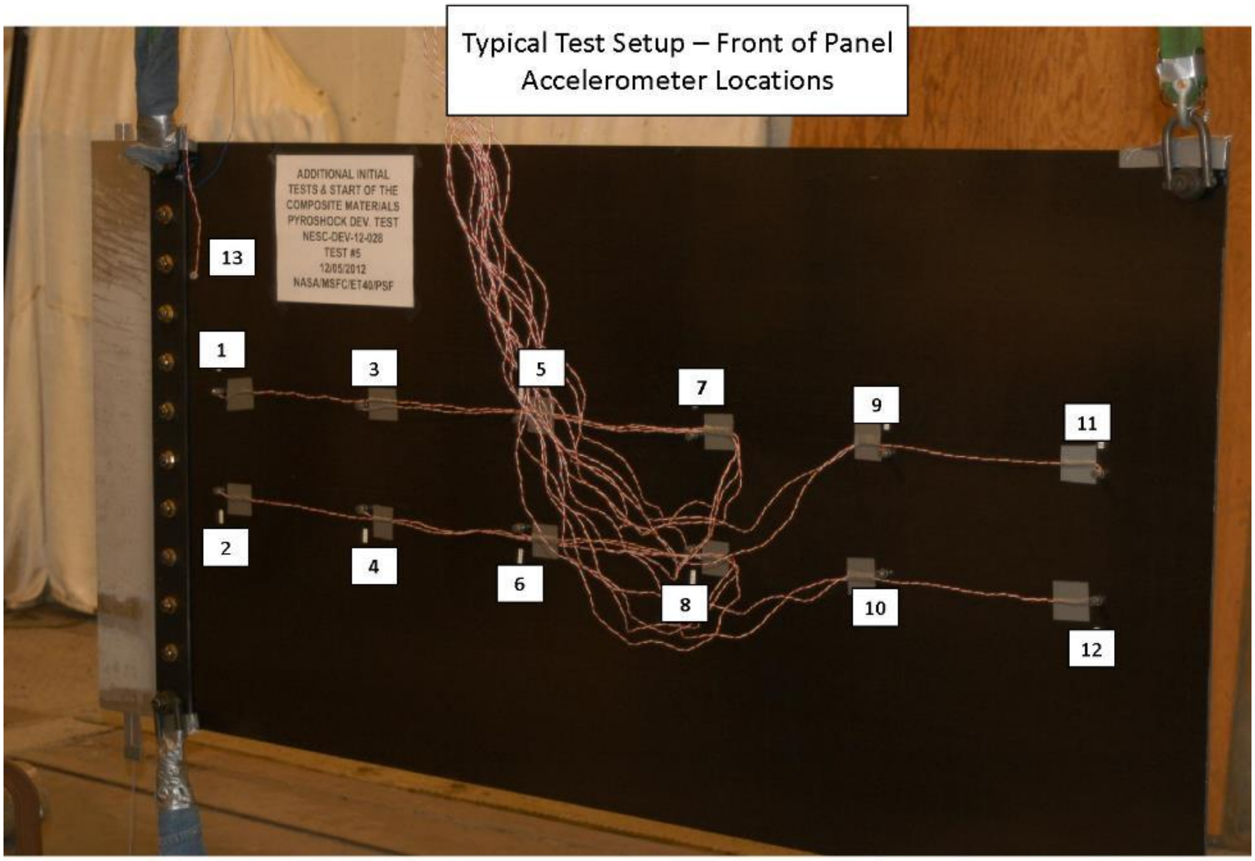
7 of 268

Typical Test Outcome
Cut Plate Severed

Test Matrix As Run			
Test	**Date**	**Panel ID**	**Test ID**
1	11-30-12	Composite Pathfinder #4	Initial Test #4
2	12-5-12	Composite Pathfinder #5	Initial Test #5
3	1-23-13	0320A001	Group 1 Test 1
4	1-29-13	0320A002	Group 1 Test 2
5	2-5-13	0320A004	Group 1 Test 4
6	2-8-13	0320A003	Group 1 Test 3
7	2-22-13	0320A005	Group 1 Test 5

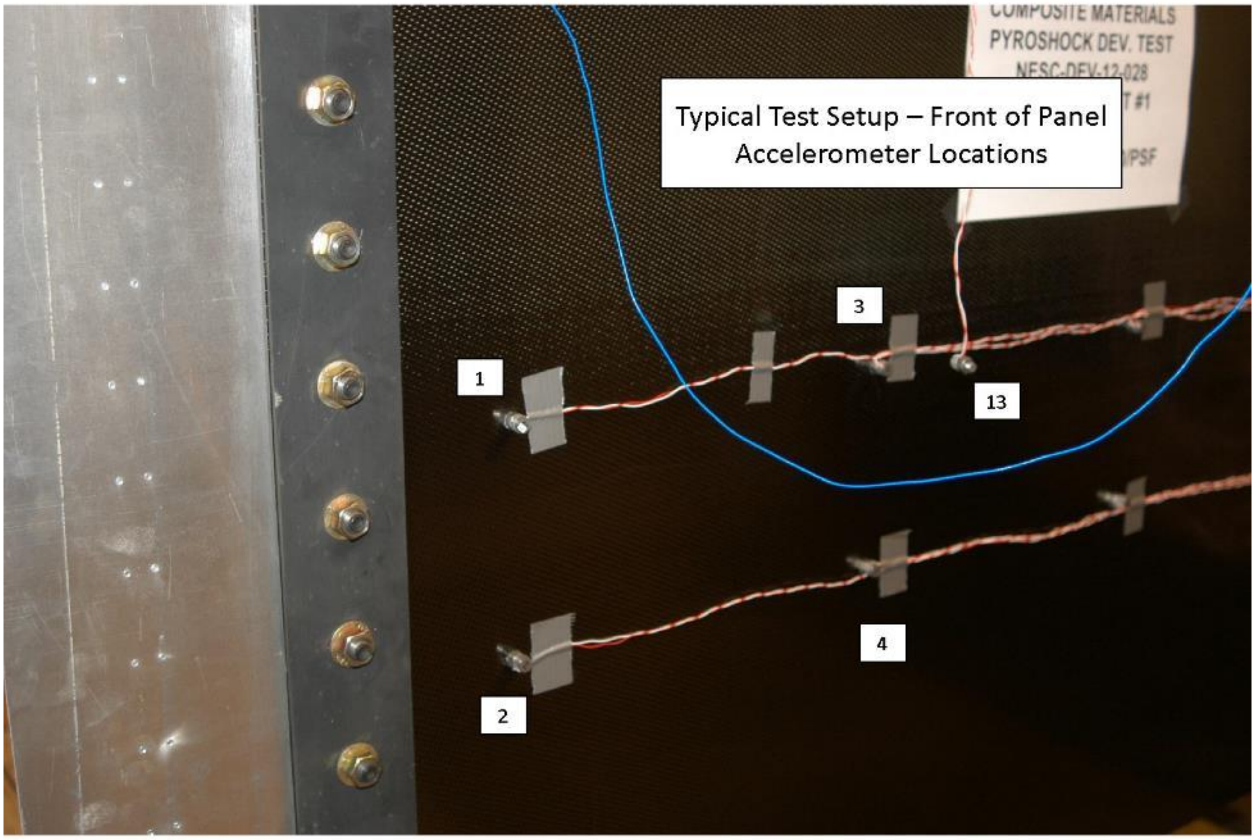


Typical Test Setup – Front of Panel
Accelerometer Locations

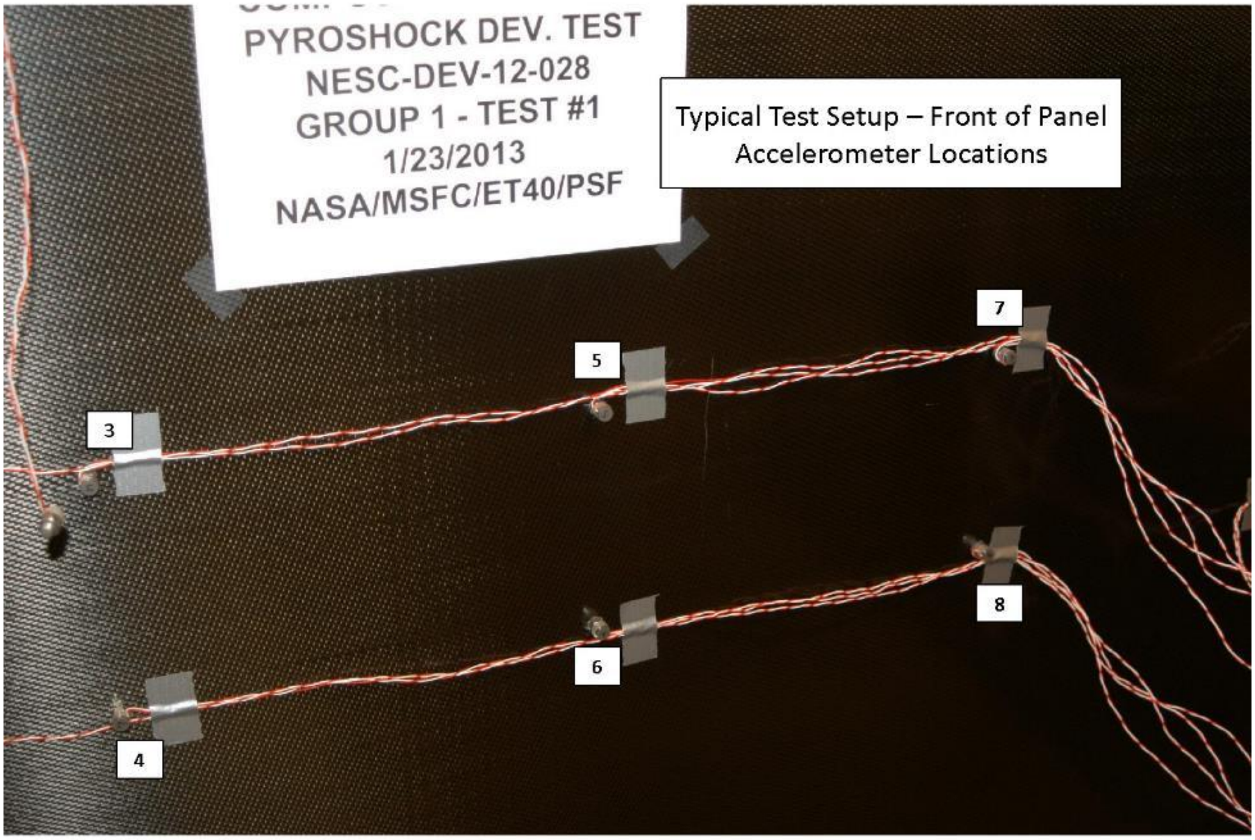


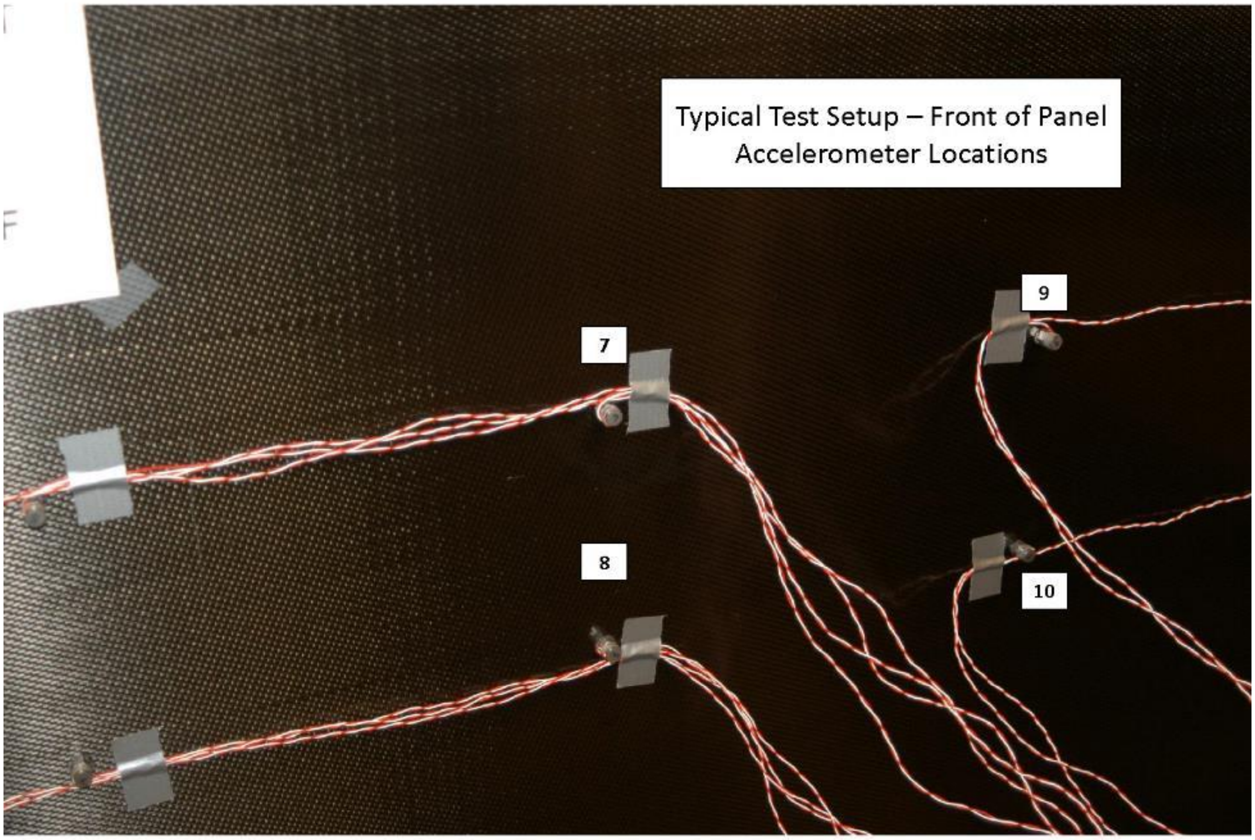
Typical Test Setup – Front of Panel
Accelerometer Locations

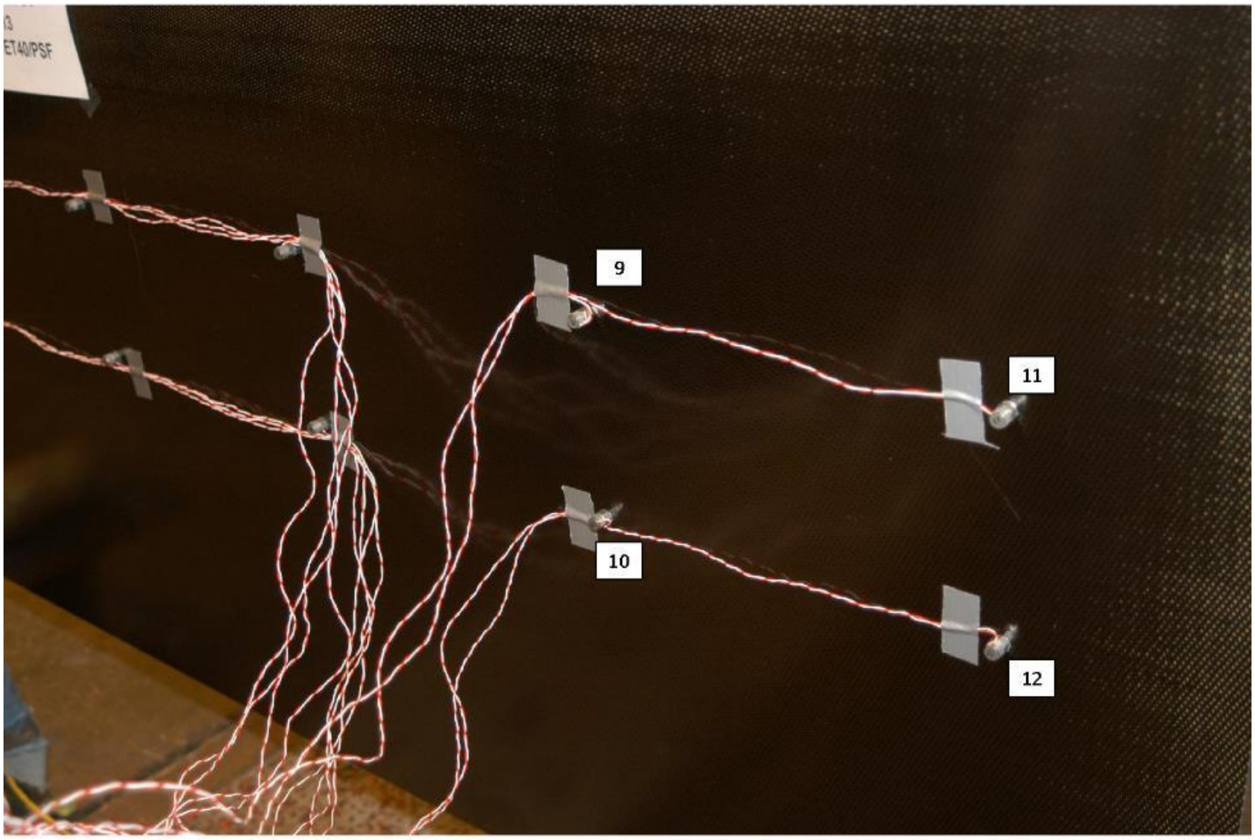
11 of 268

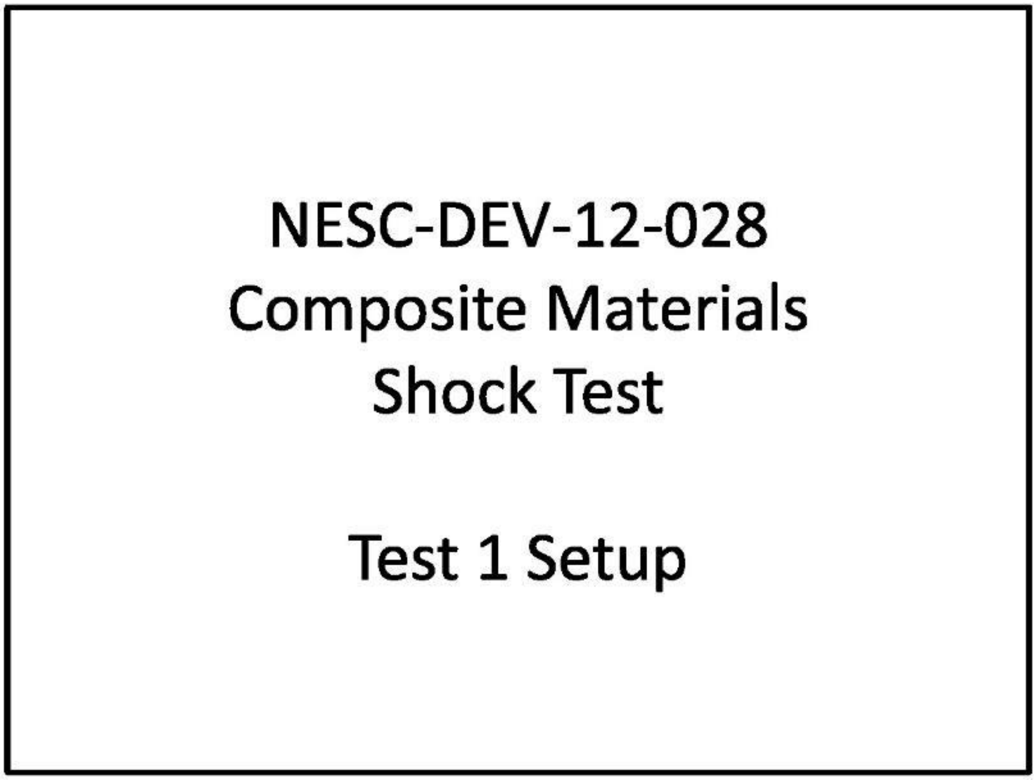


Typical Test Setup – Front of Panel Accelerometer Locations


PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #1
1/23/2013
NASA/MSFC/ET40/PSF
Typical Test Setup – Front of Panel
Accelerometer Locations
7
5
3
8
6
4

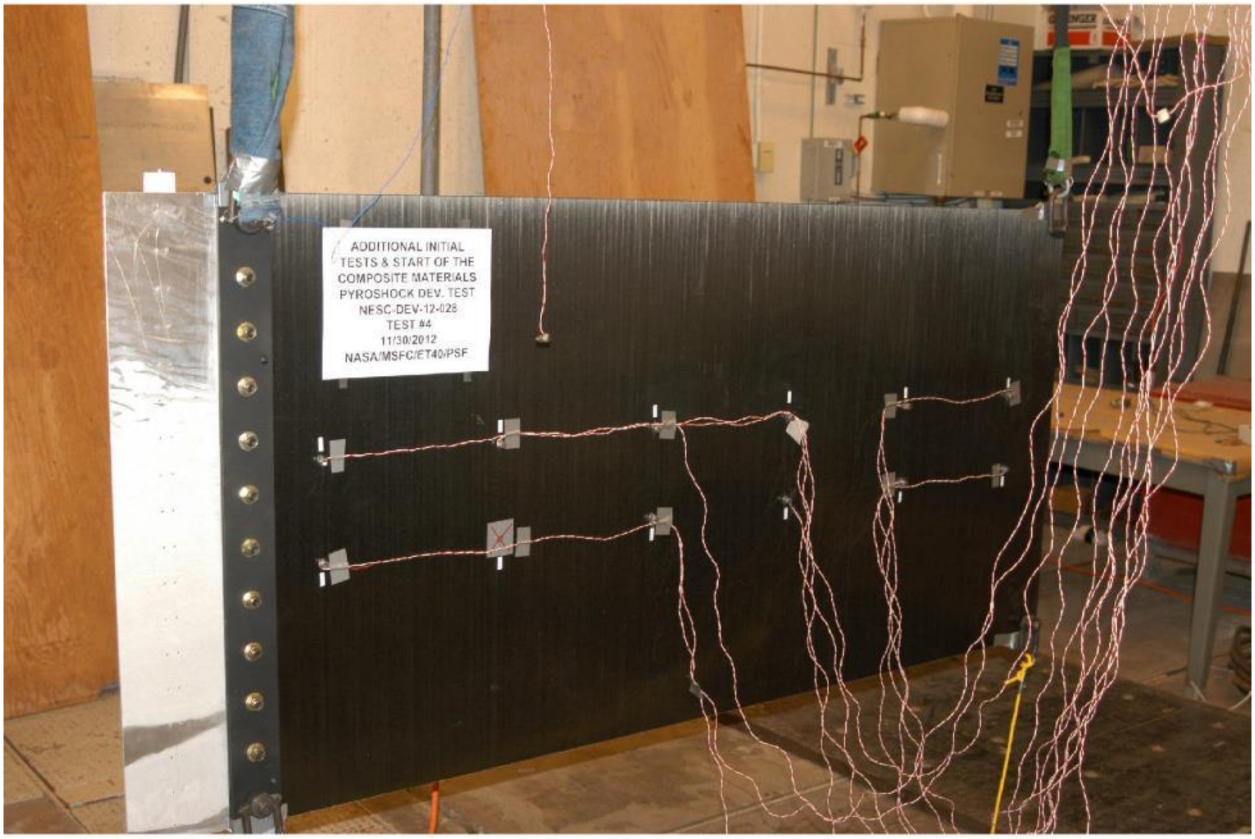

Typical Test Setup – Front of Panel Accelerometer Locations
7
8
9
10


3
ET40/PSF
9
11
10
12



NESC-DEV-12-028
Composite Materials Shock Test

Test 1 Setup


ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #4
11/30/2012
NASA/MSFC/ET40/PSF

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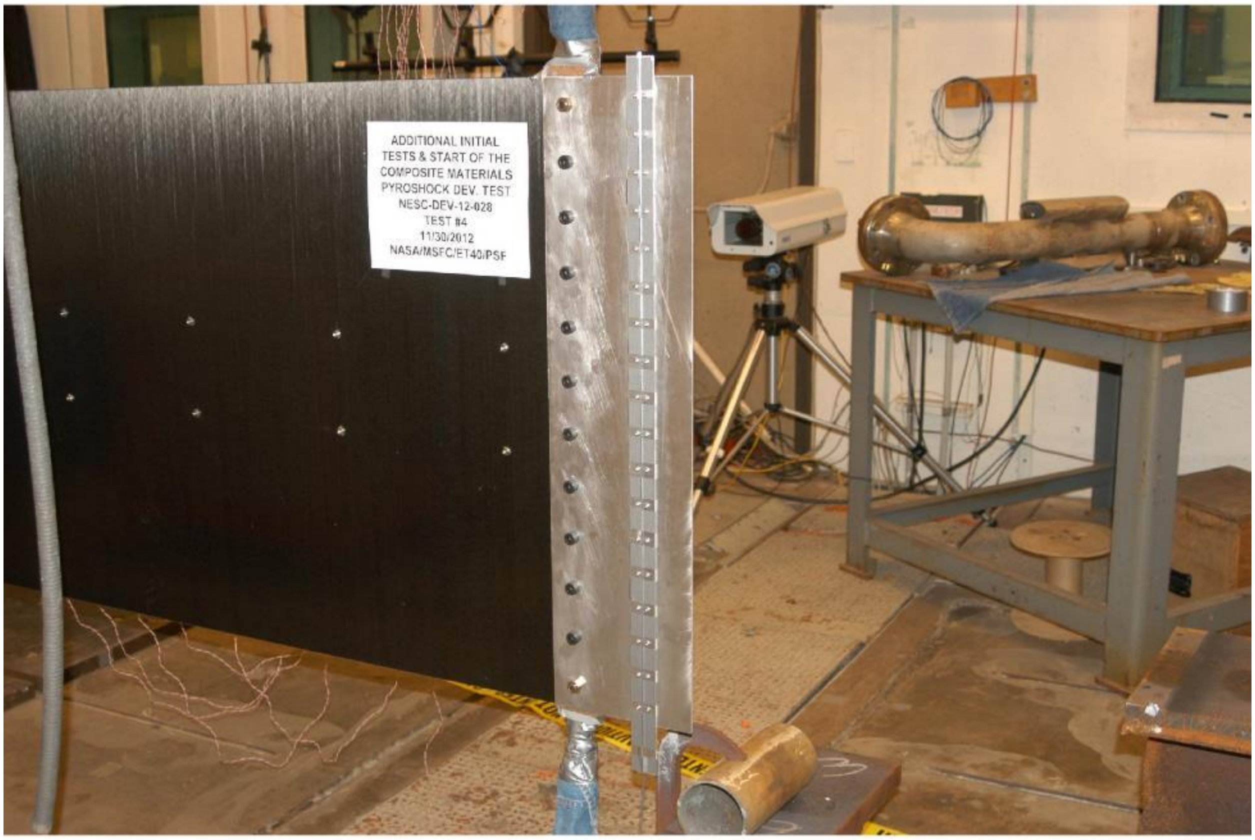
ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #4
11/30/2012
NASA/MSFC/ET40/PSF

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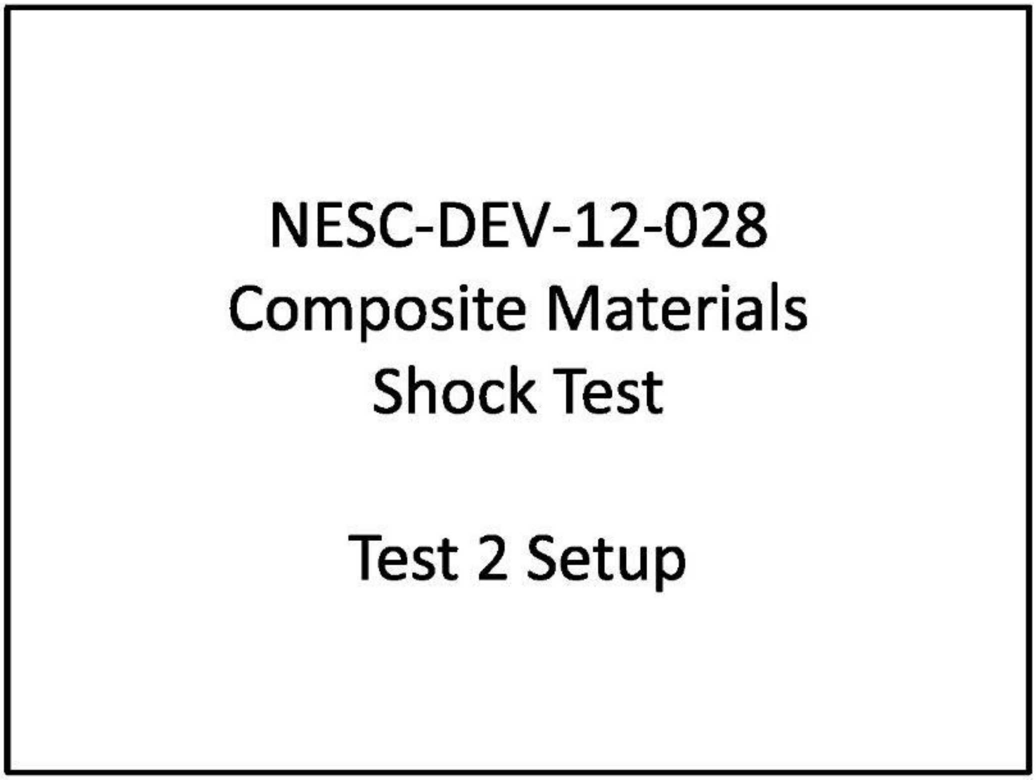
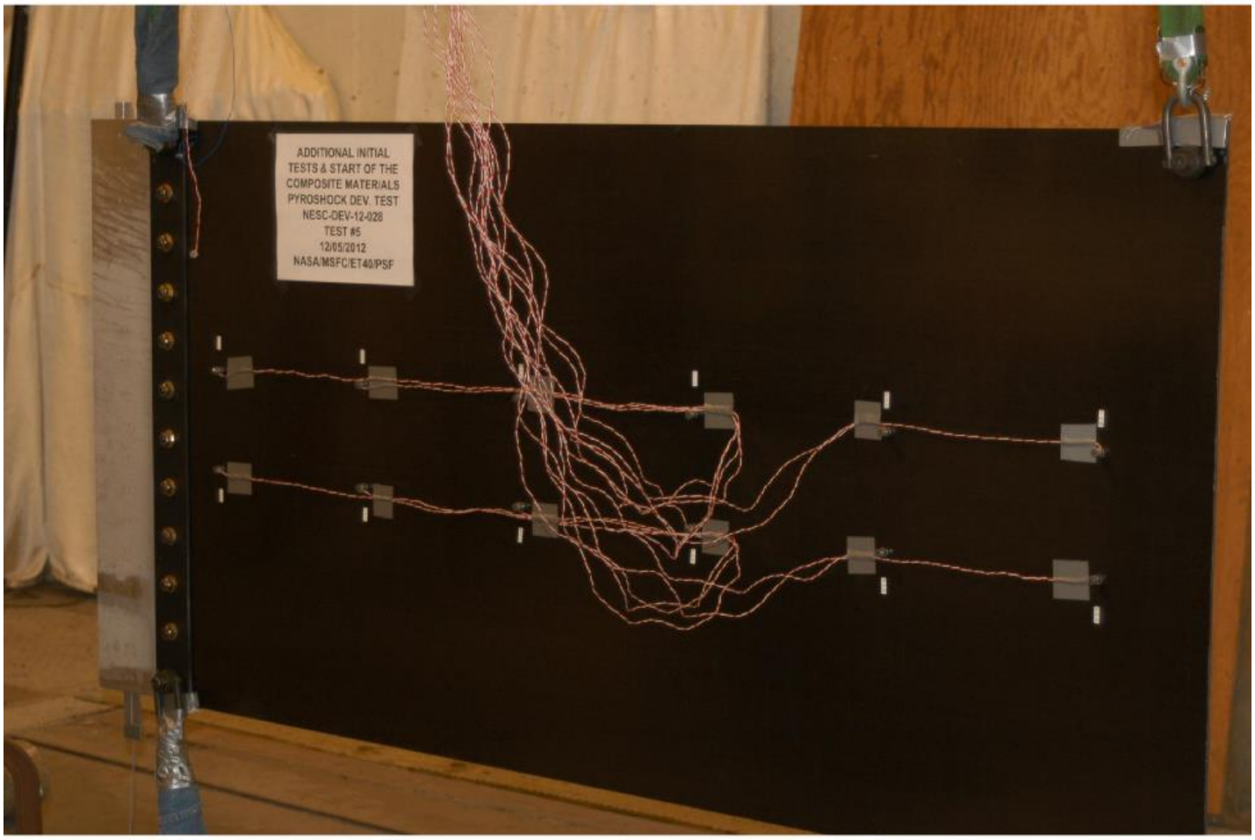
ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #4
11/30/2012
NASA/MSFC/ET40/PSF
DO NOT ENTER
19 of 268


ADDITIONAL IN
TESTS & START (
COMPOSITE MATE
PYROSHOCK DEV
NESC-DEV-12-(
TEST #4
11/30/2012
NASA/MSFC/ET40
20 of 268



NESC-DEV-12-028
Composite Materials
Shock Test

Test 2 Setup


ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #5
12/05/2012
NASA/MSFC/ET40/PSF


ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
TEST #5
12/05/2012
NASA/MSFC/ET40/PSF
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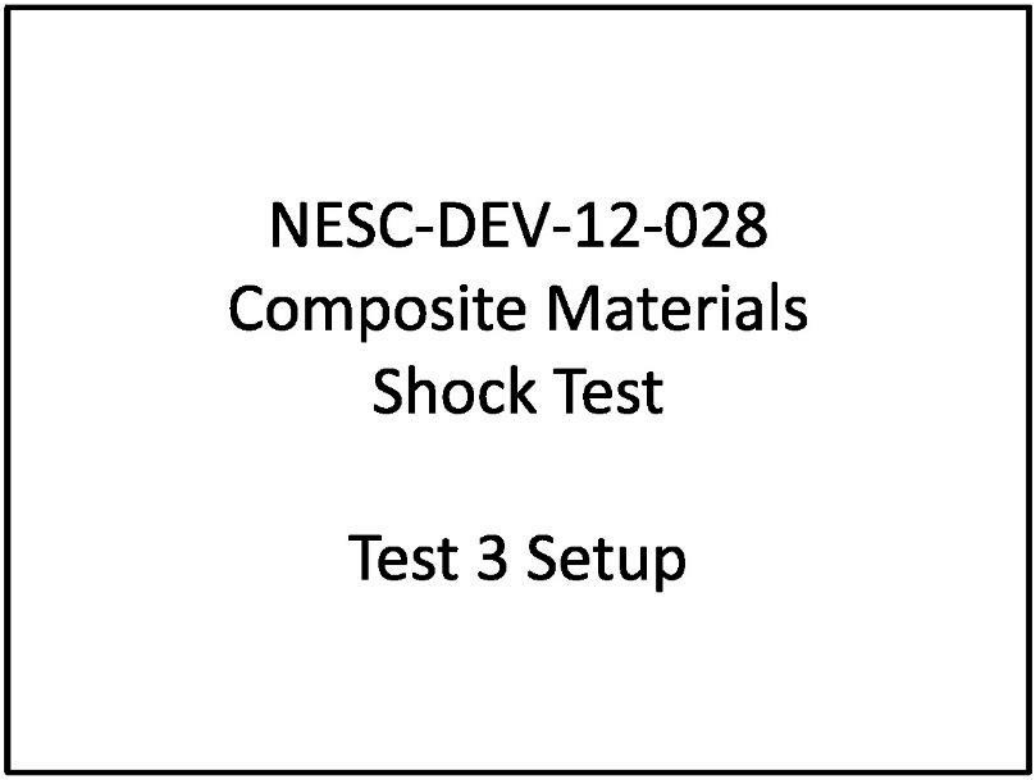
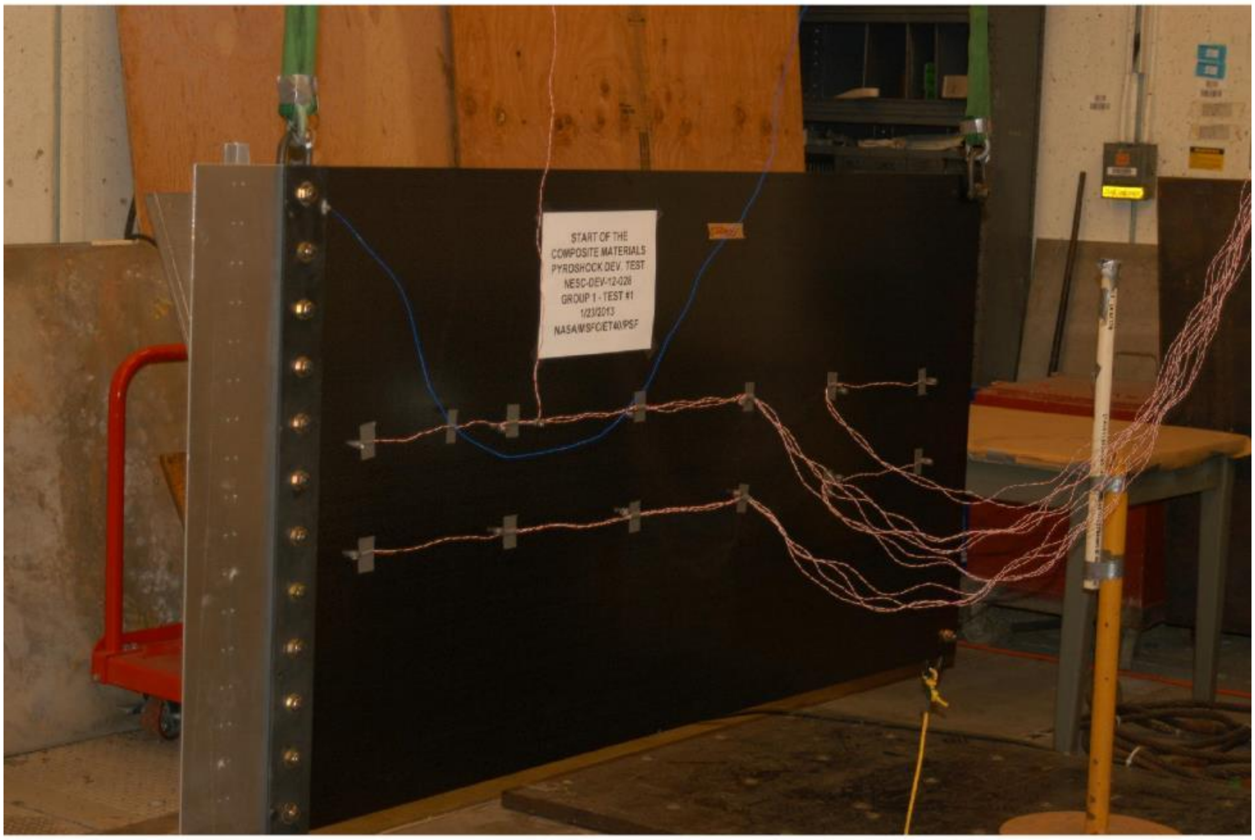
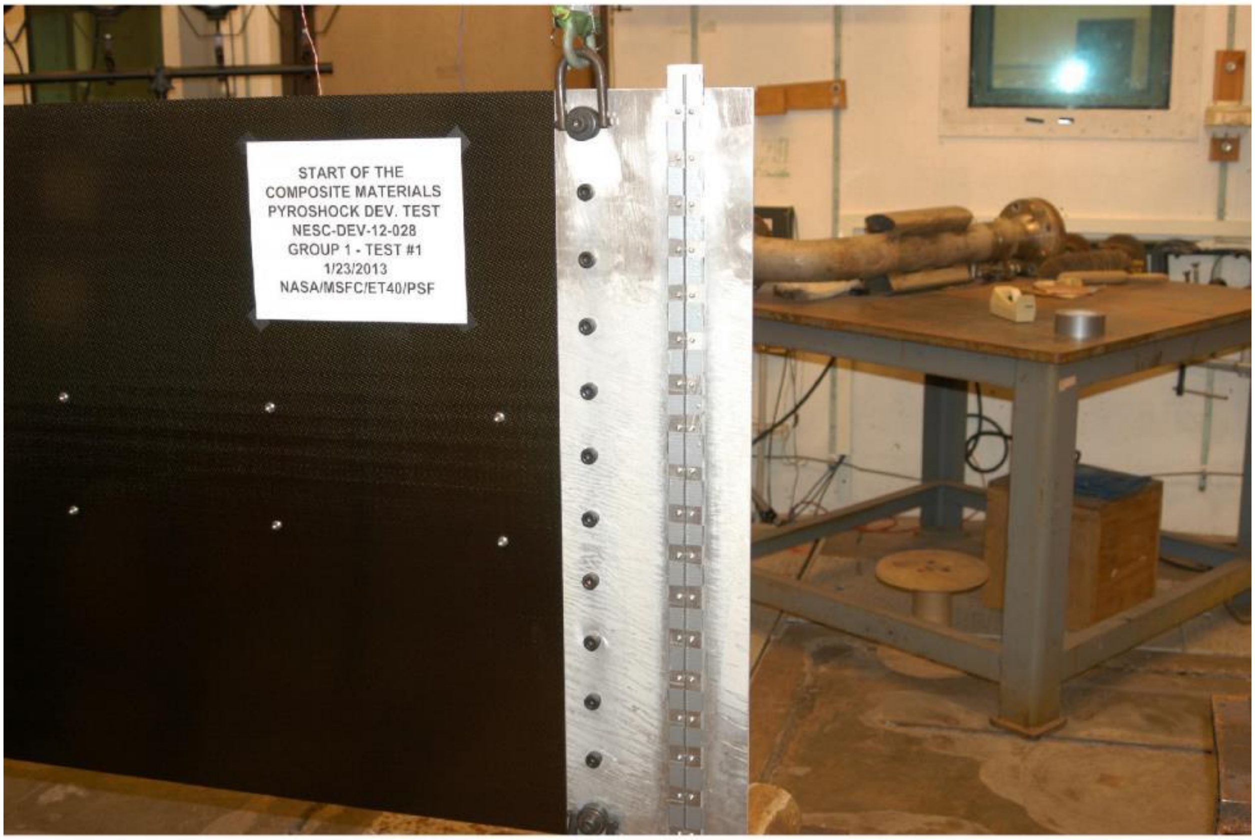
ADDITIONAL INITIAL
TESTS & START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEA-12-006
TEST #6
12/05/2012
NASA/MSFC/ET40/PSF
25 of 268



NESC-DEV-12-028
Composite Materials Shock Test

Test 3 Setup


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #1
1/23/2013
NASA/MSFC/ET40/PSF


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #1
1/23/2013
NASA/MSFC/ET40/PSF

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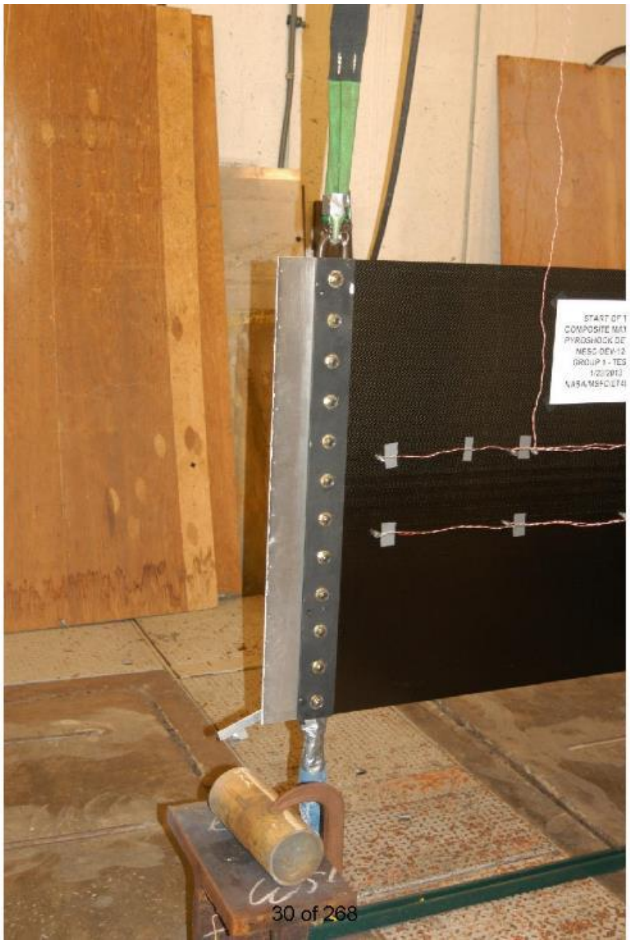
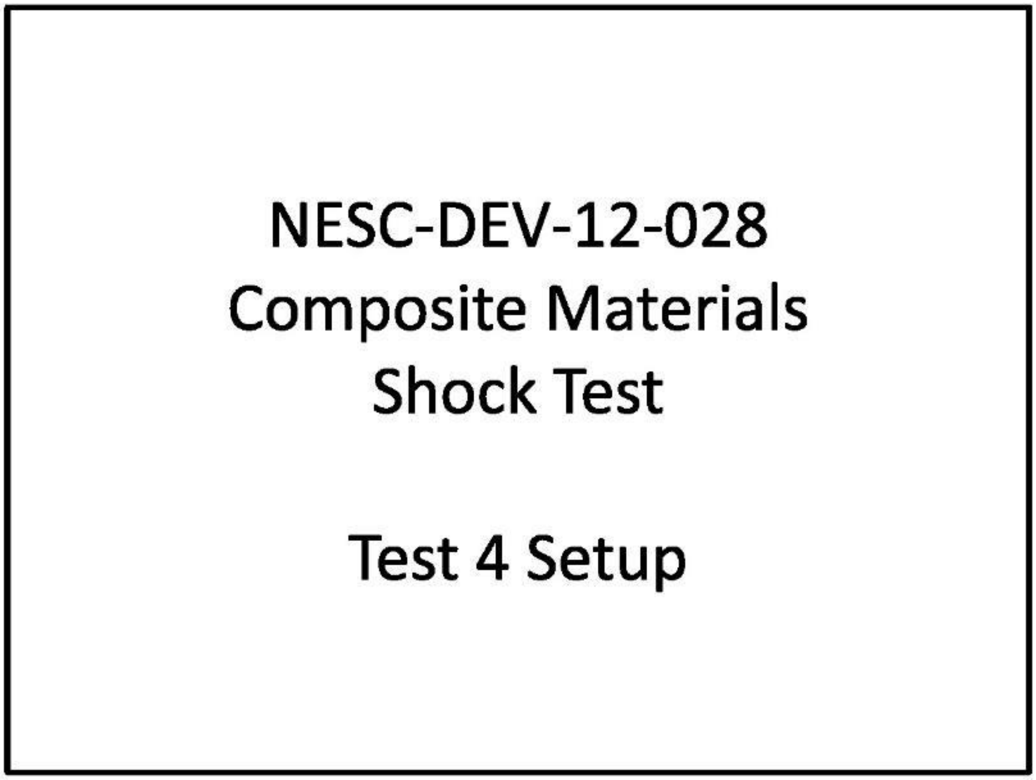
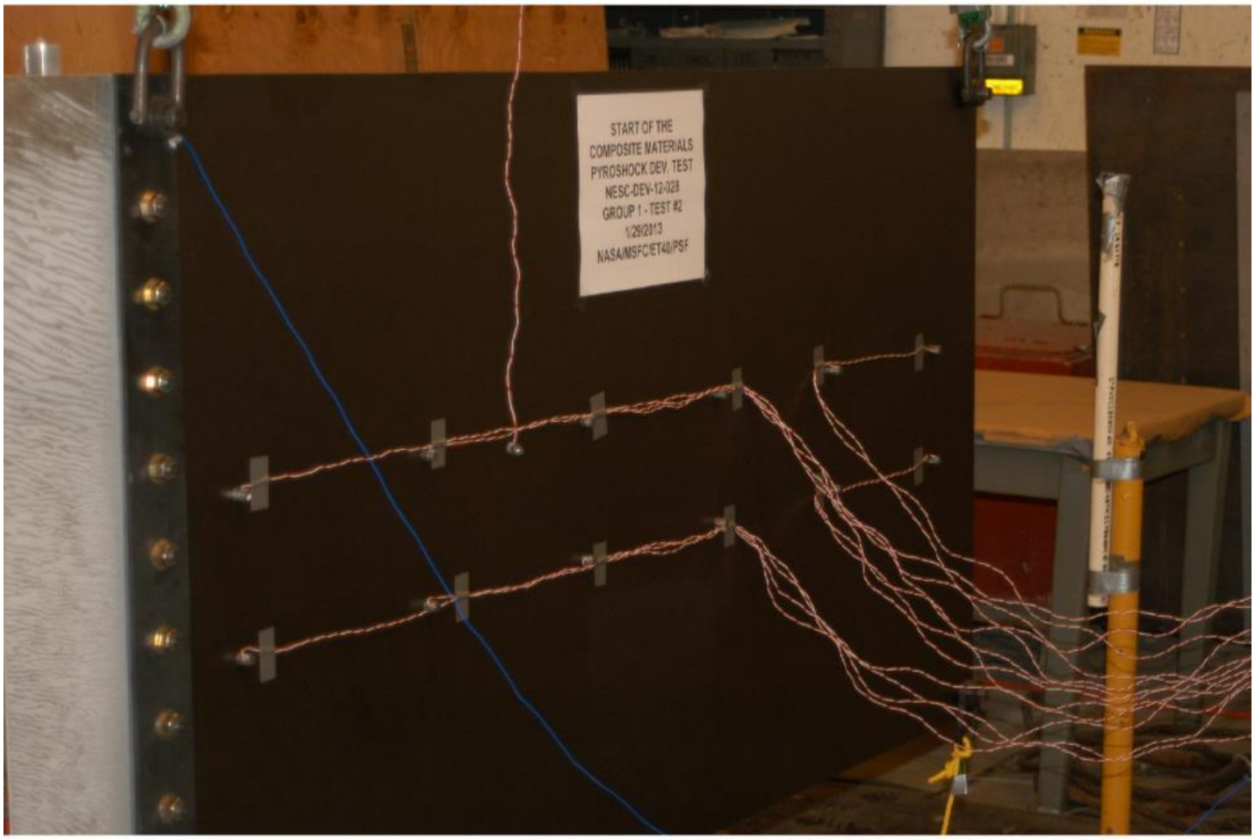
START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #1
1/23/2013
NASA/MSFC/ET40/PSF
29 of 268


START OF T
COMPOSITE MA
PYROSHOCK DE
NESC DEV-12
GROUP 1 - TES
1/22/2013
NASA/MSFC/ET4
30 of 268

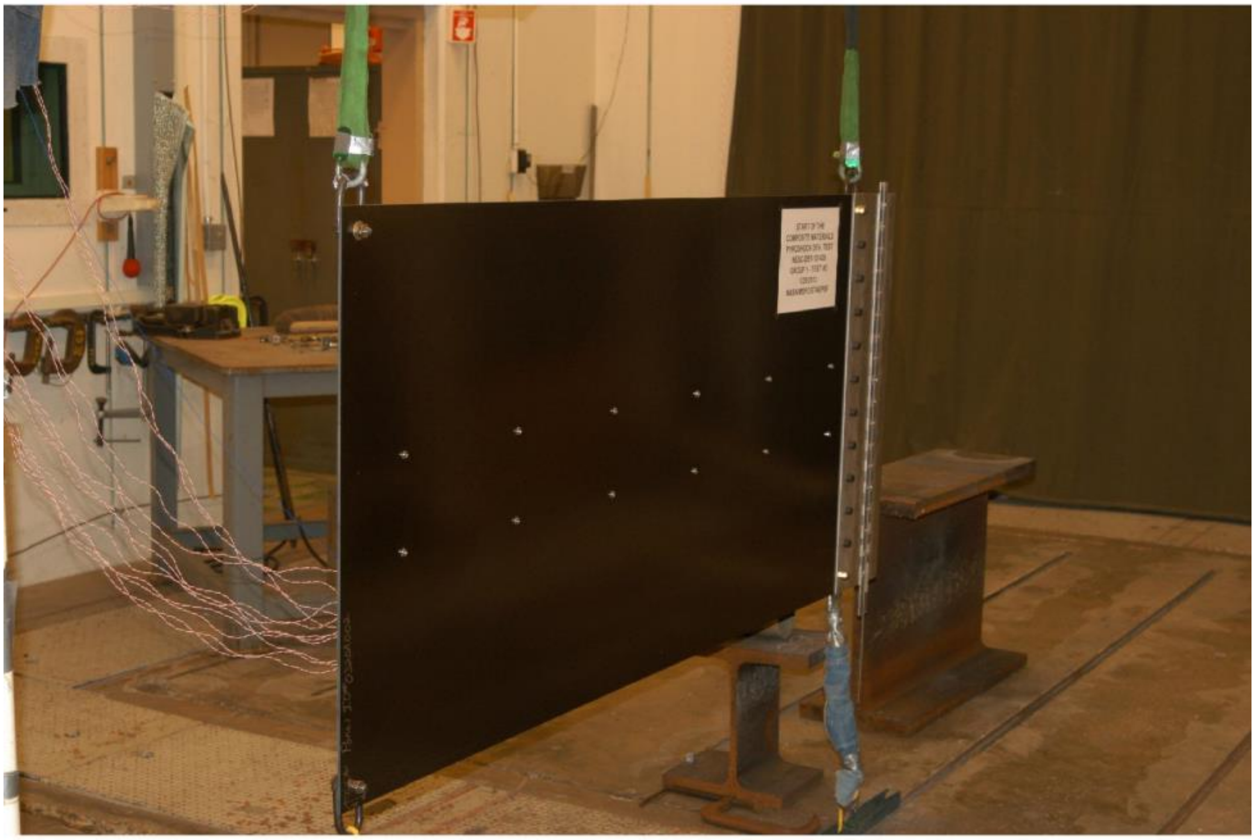


NESC-DEV-12-028
Composite Materials
Shock Test

Test 4 Setup

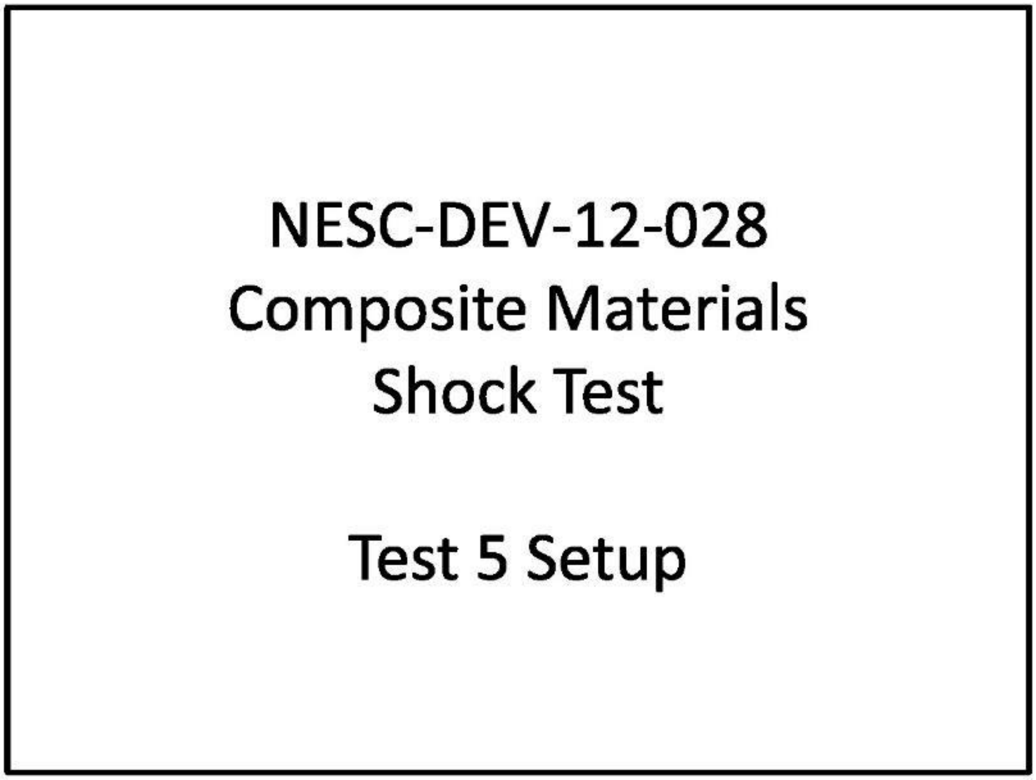

START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #2
1/29/2013
NASA/MSFC/ET40/PSF

32 of 268



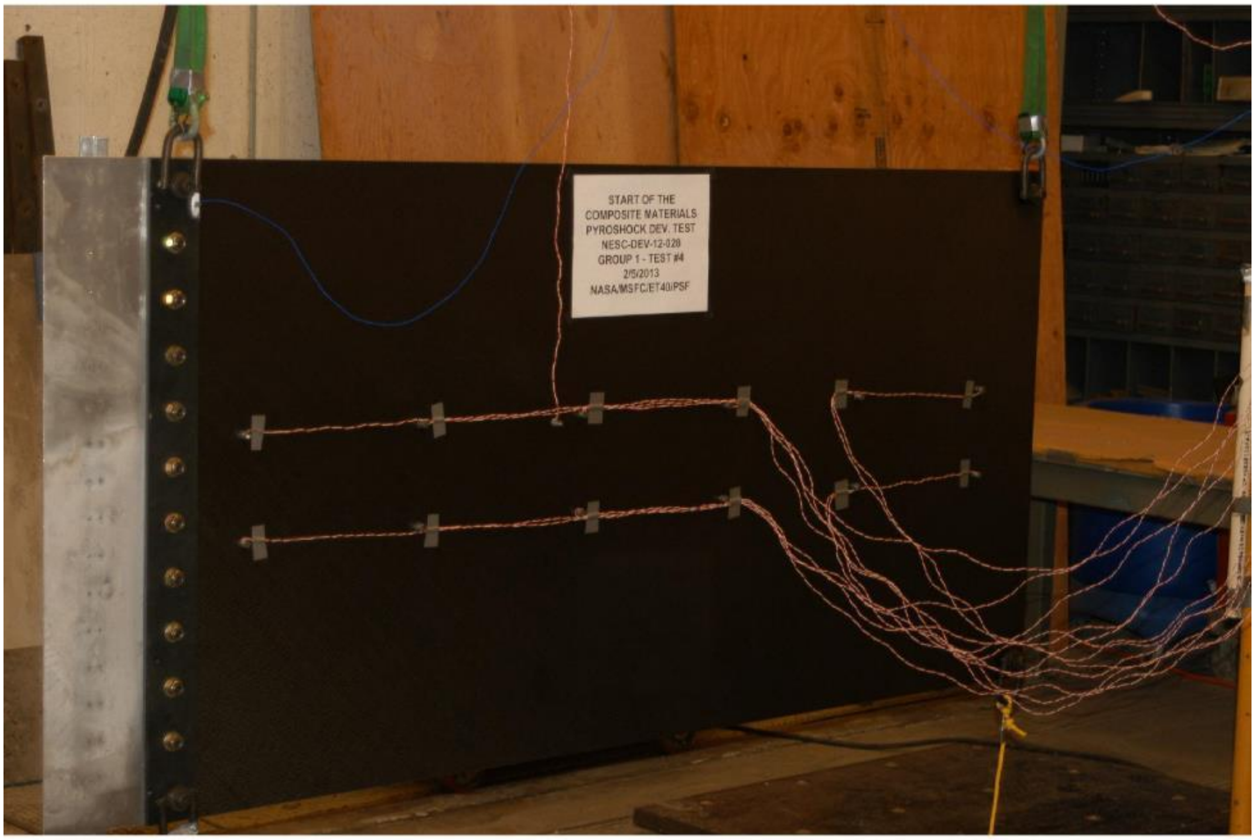

START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #2
1/29/2013
NASA/MSFC/ET40/PSF
34 of 268


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV TEST
GROUP 1 - TEST #2
35 of 268

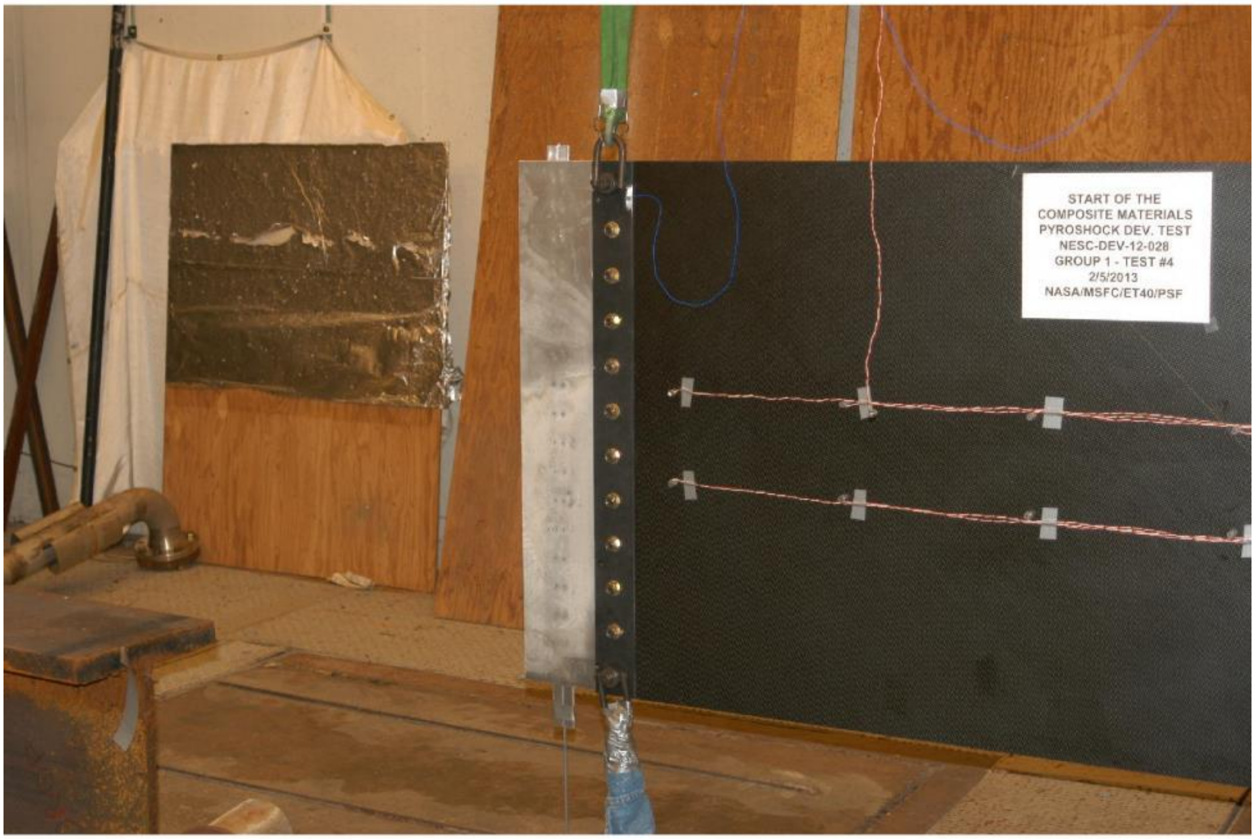


NESC-DEV-12-028
Composite Materials
Shock Test

Test 5 Setup


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #4
2/5/2013
NASA/MSFC/ET40/PSF

37 of 268



START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #4
2/5/2013
NASA/MSFC/ET40/PSF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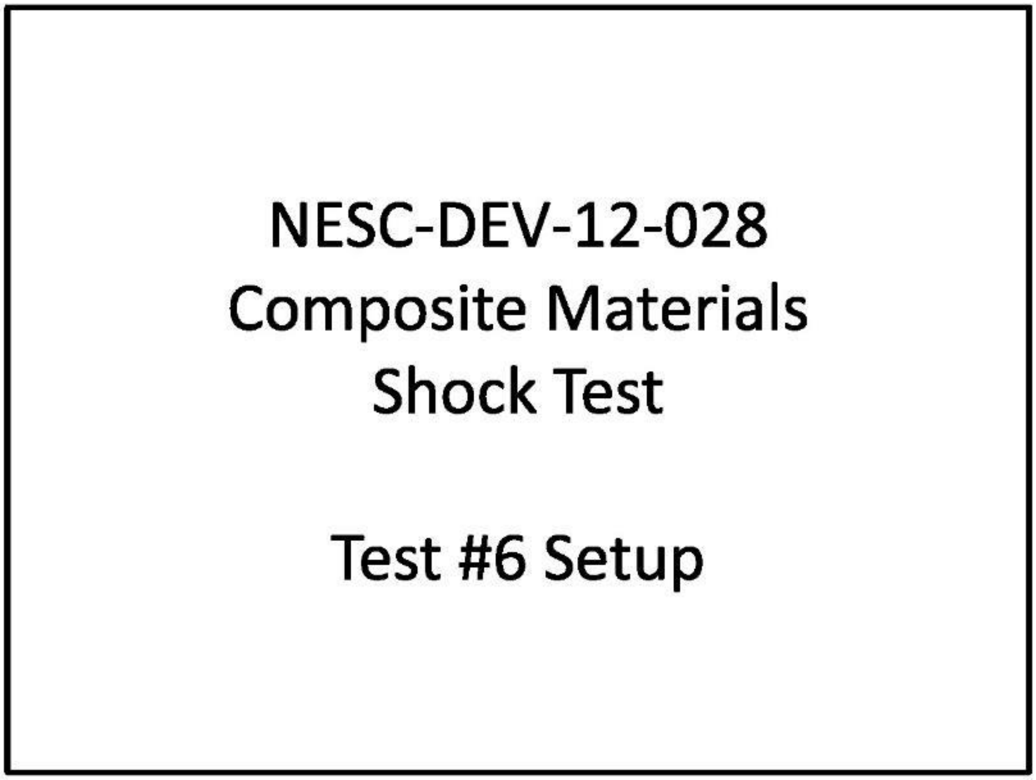
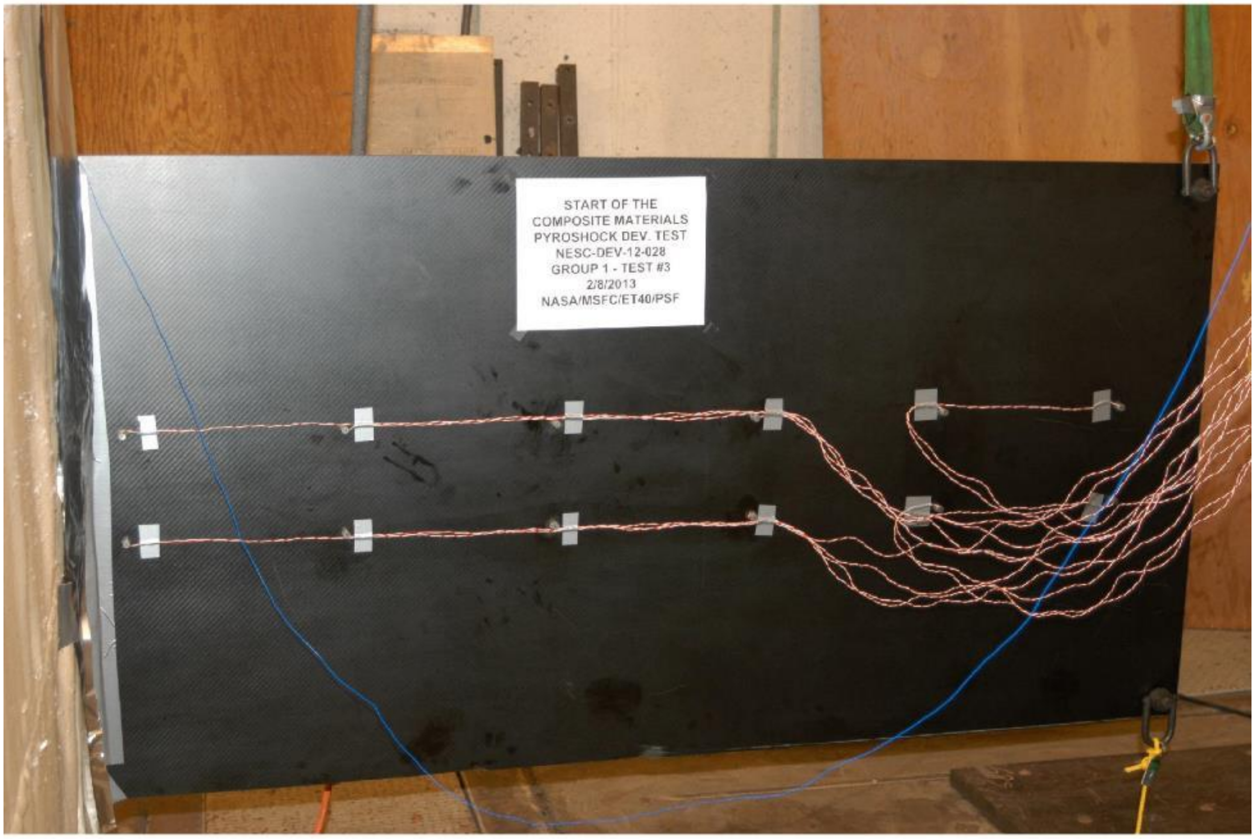
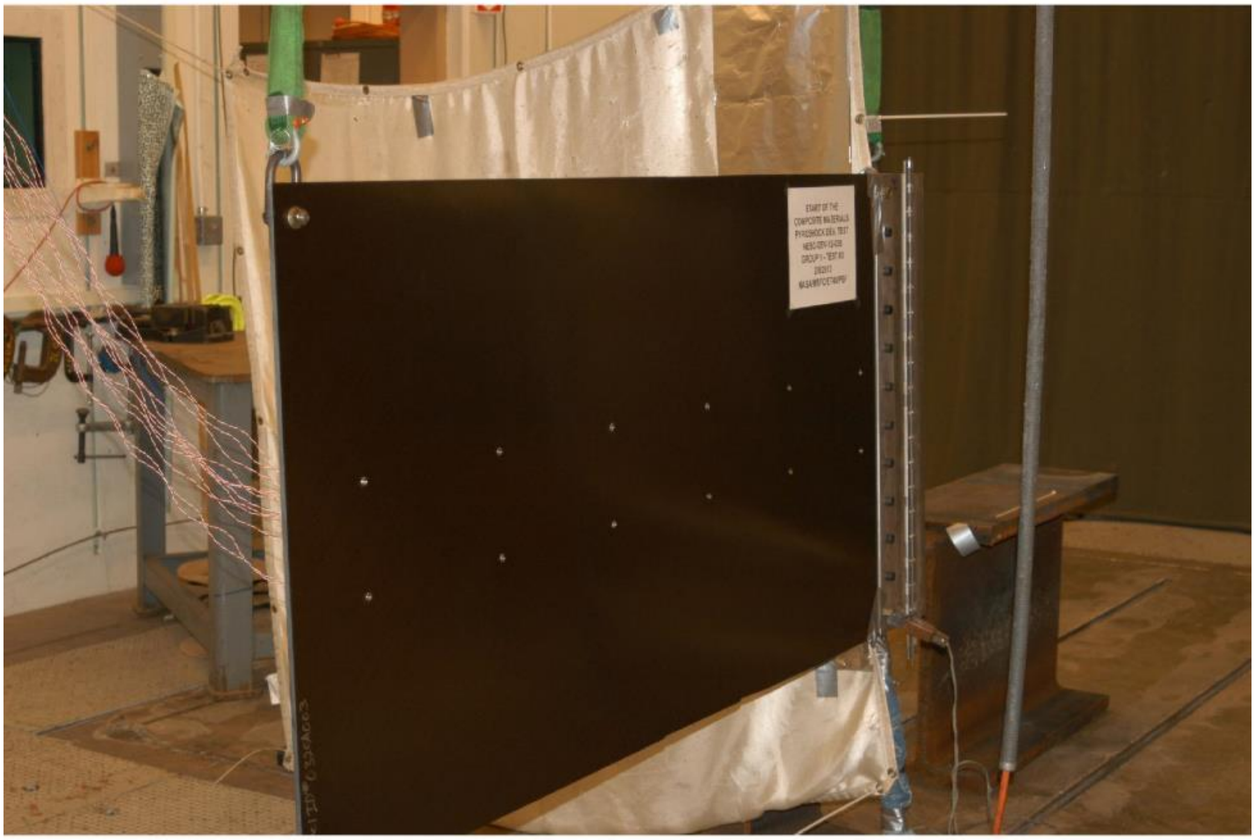
START OF THE
POSITE MATERIALS
OSHOCK DEV. TEST
ESC-DEV-12-028
ROUP 1 - TEST #4
2/5/2013
SA/MSFC/ET40/PSF
22 gr
40 of 268



NESC-DEV-12-028
Composite Materials Shock Test

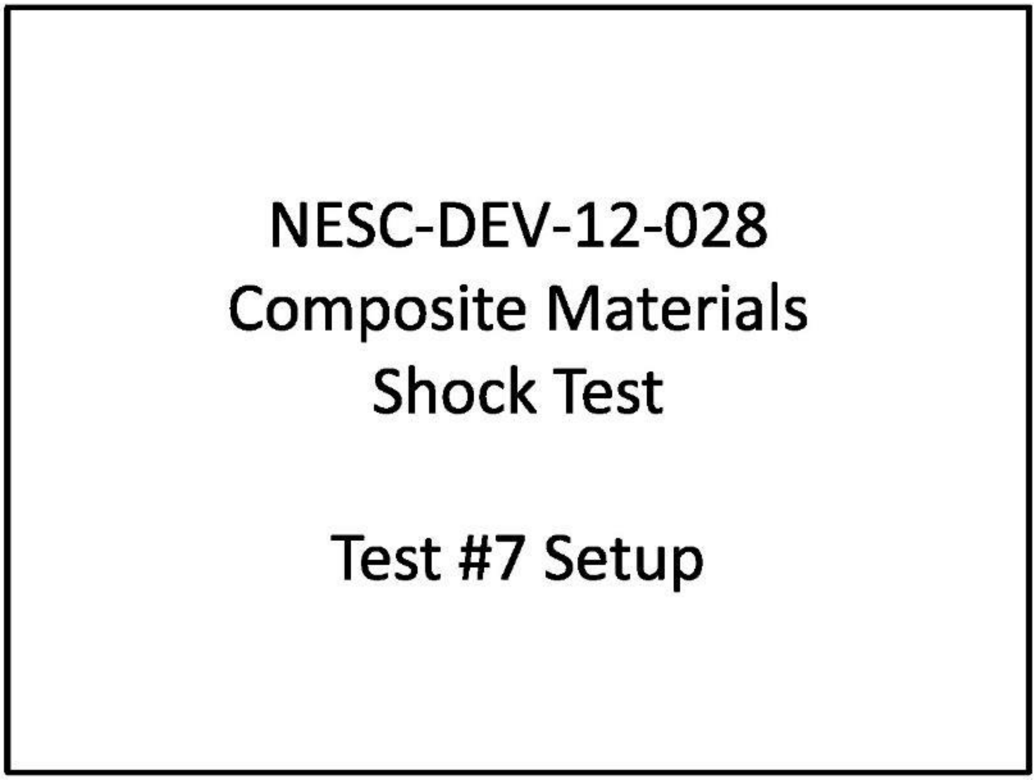
Test #6 Setup


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #3
2/8/2013
NASA/MSFC/ET40/PSF


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST

START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #3
2/8/2013
NASA/MSFC/ET40/PSF
44 of 268


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-326
GROUP 1 - TEST #3
2/8/2013
NASA/MSFC/ET40/PSF
45 of 268



NESC-DEV-12-028
Composite Materials Shock Test

Test #7 Setup


START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST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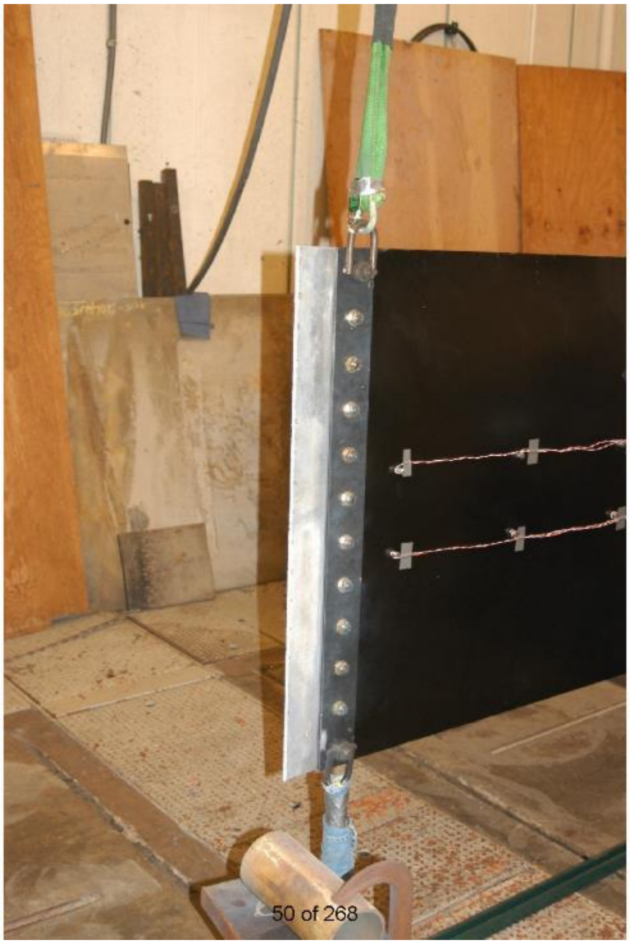
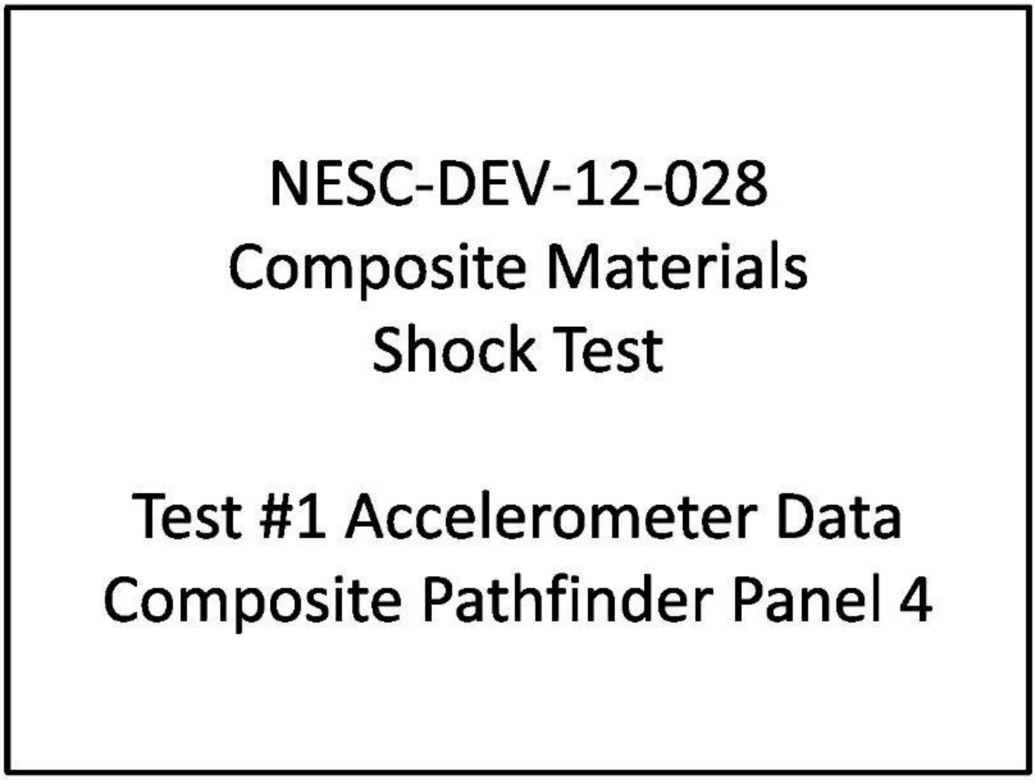
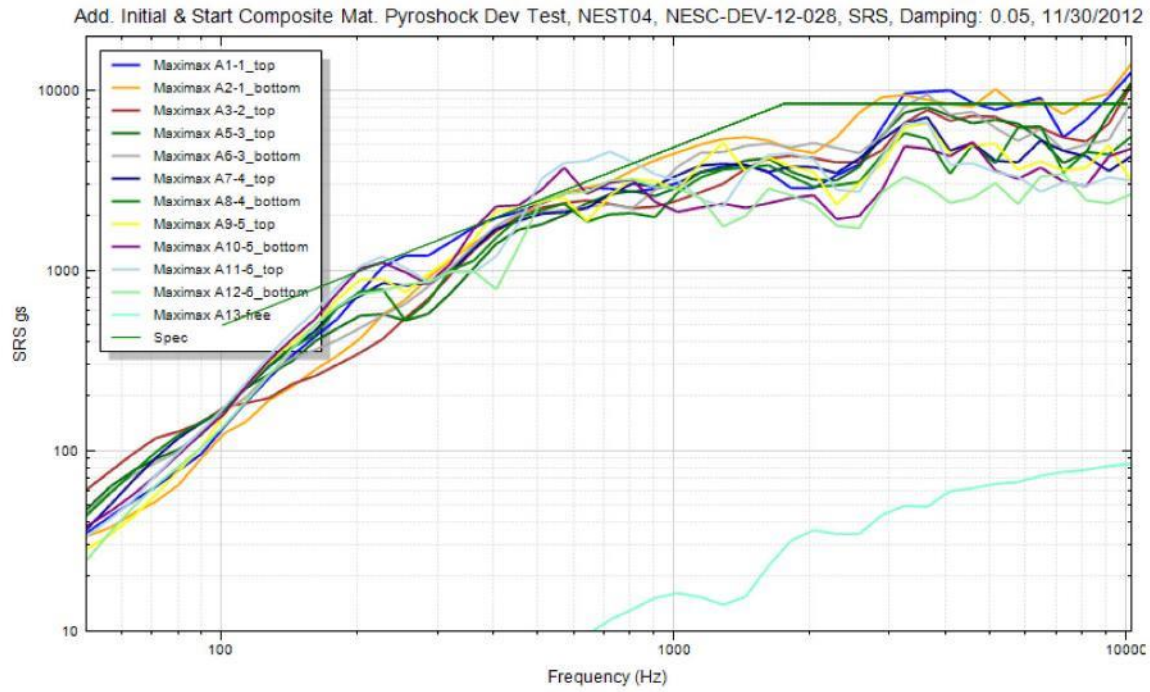
START OF THE
COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-12-028
GROUP 1 - TEST #5
2/22/2013
NASA/MSFC/ET40/PSF
49 of 268


50 of 268



NESC-DEV-12-028
Composite Materials
Shock Test

Test #1 Accelerometer Data
Composite Pathfinder Panel 4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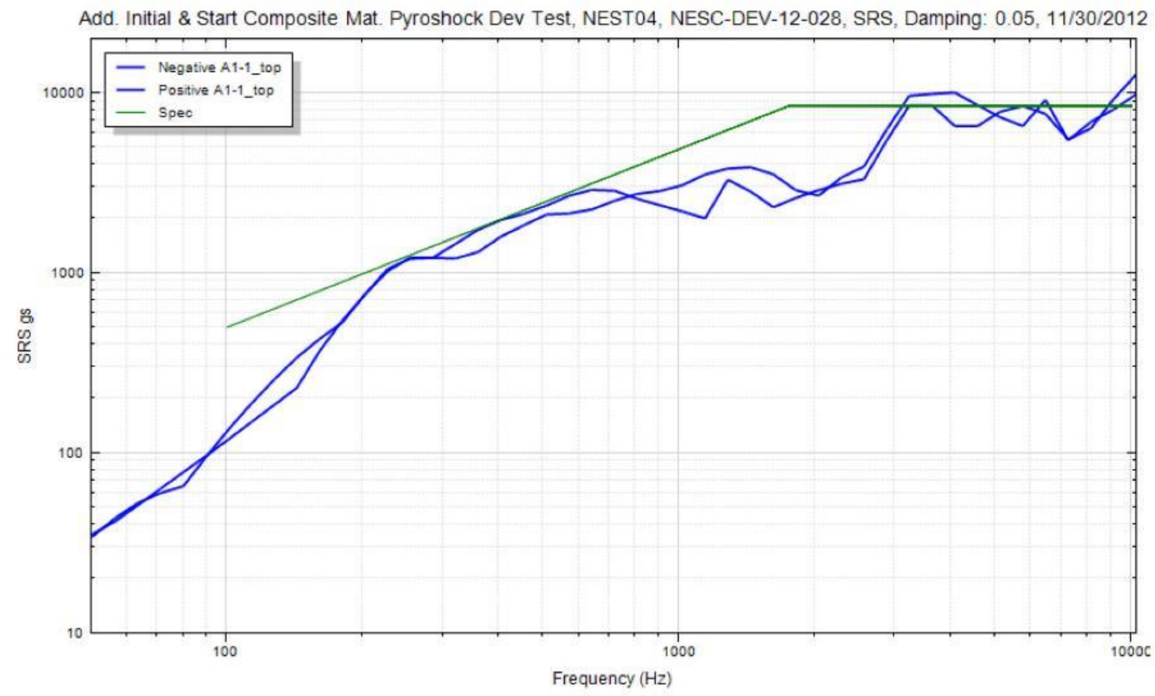
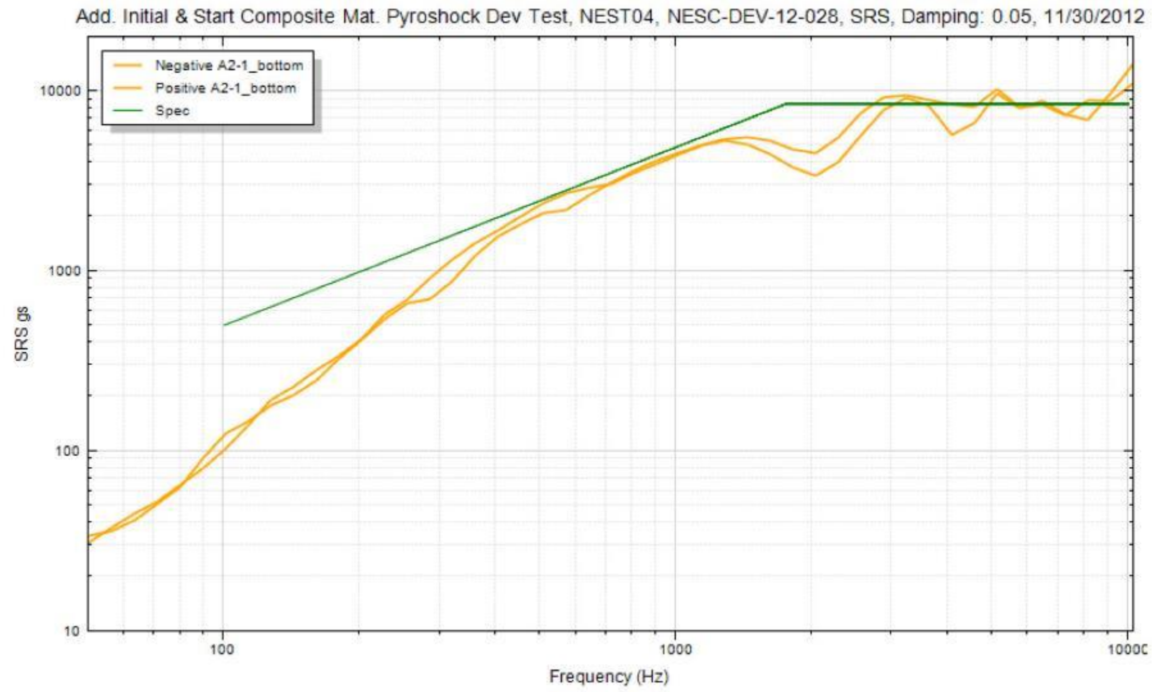
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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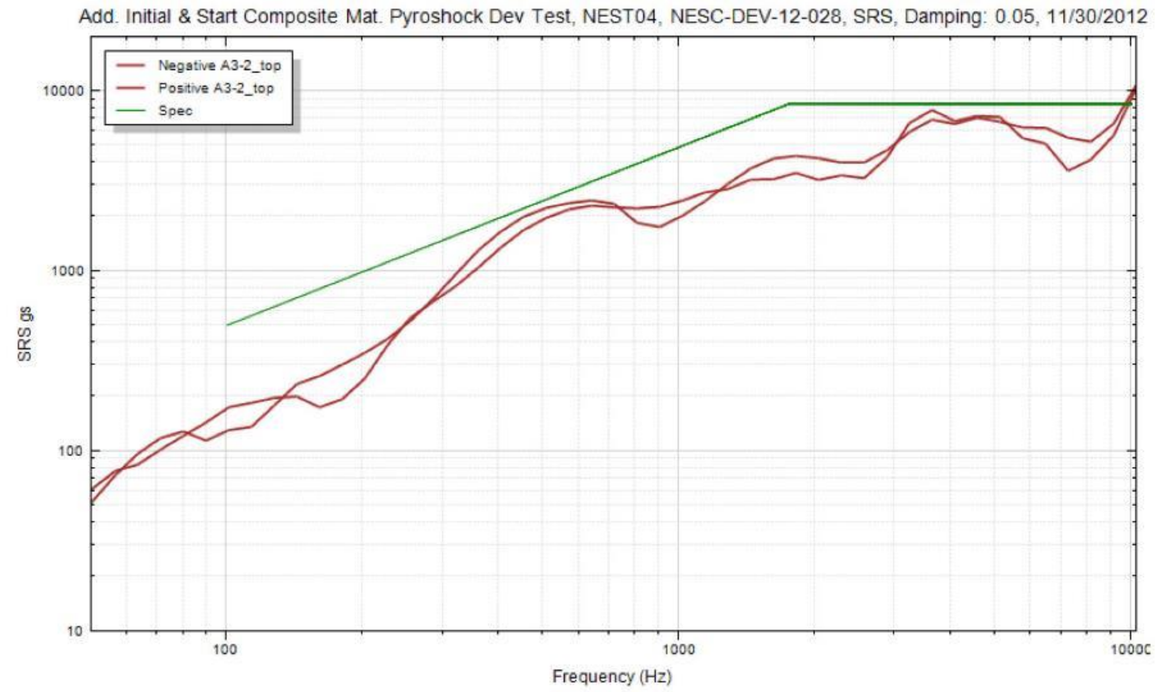
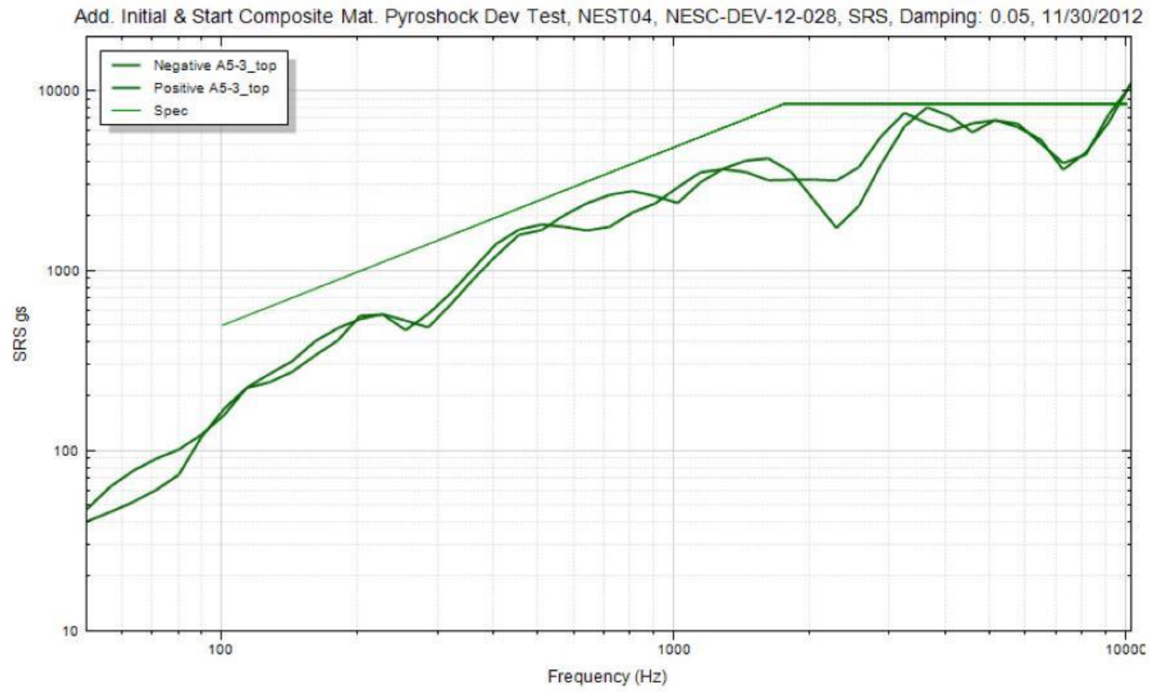
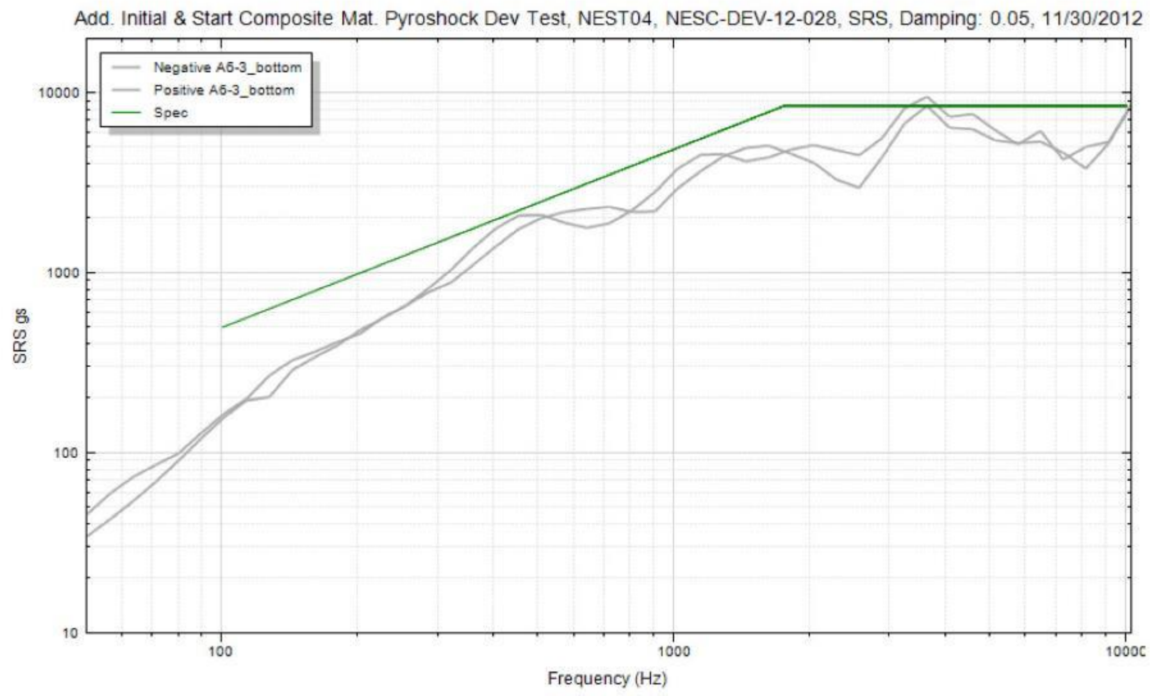
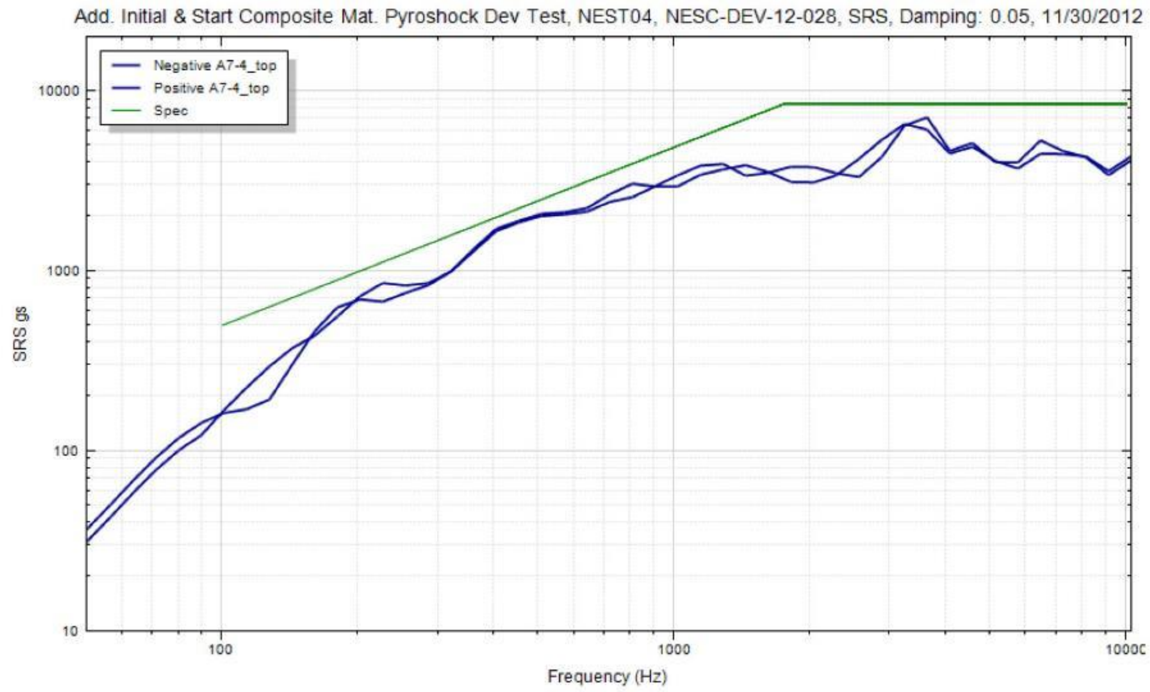
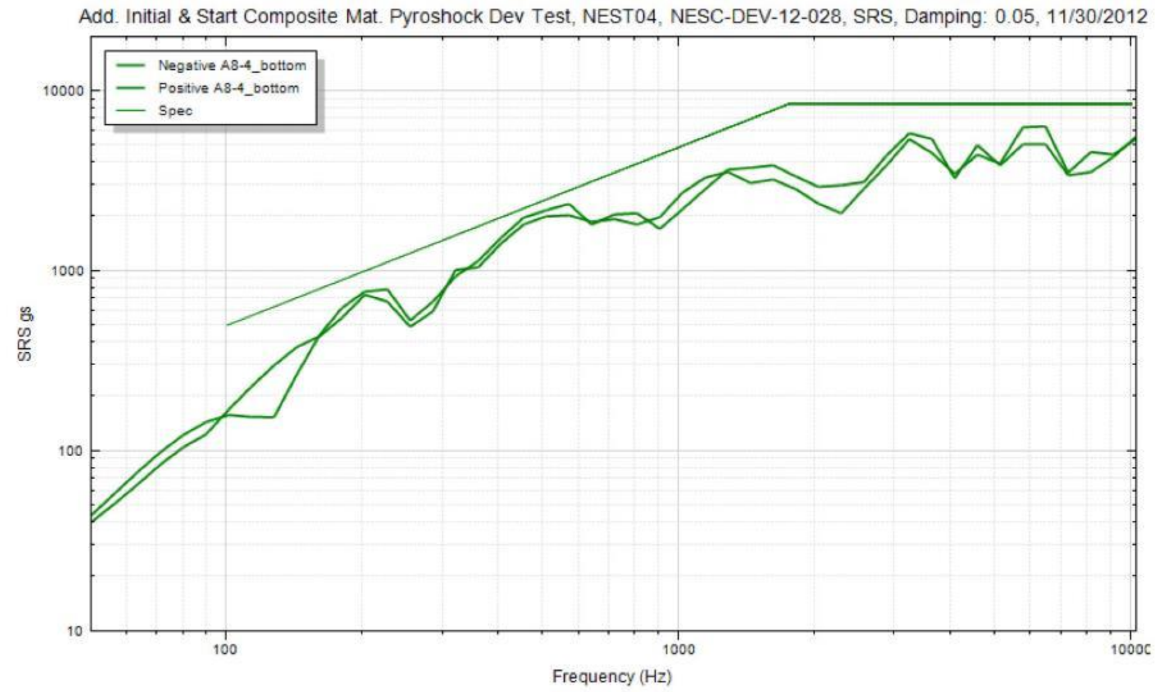

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A3-2_top
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

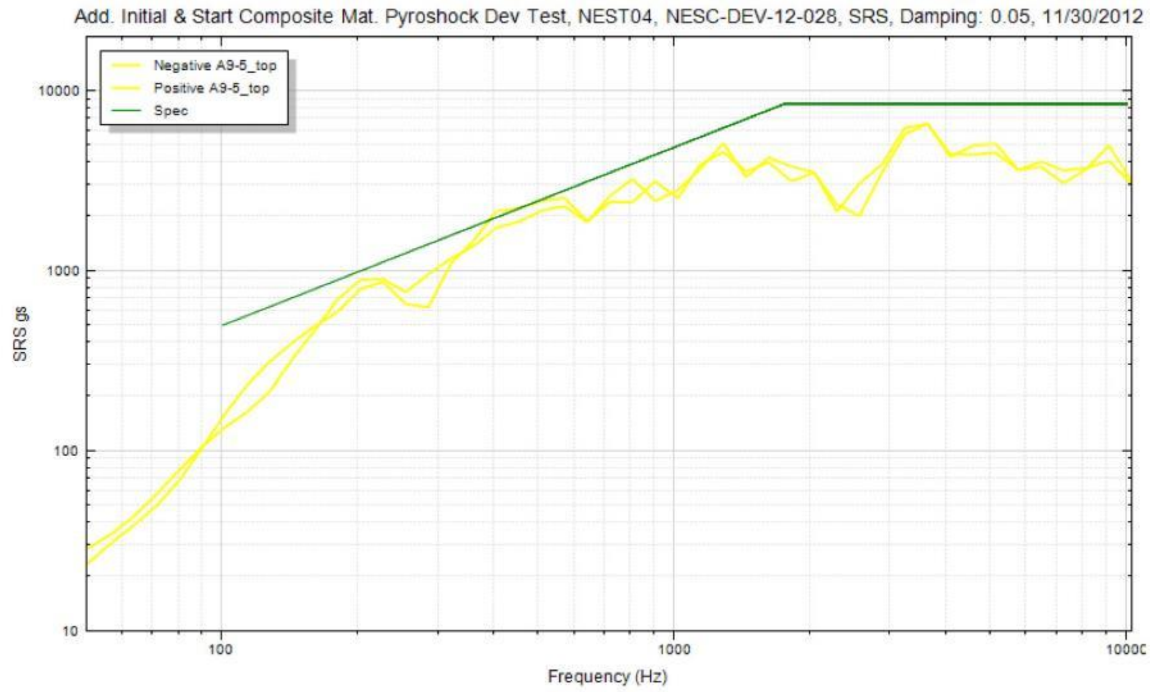
55 of 268

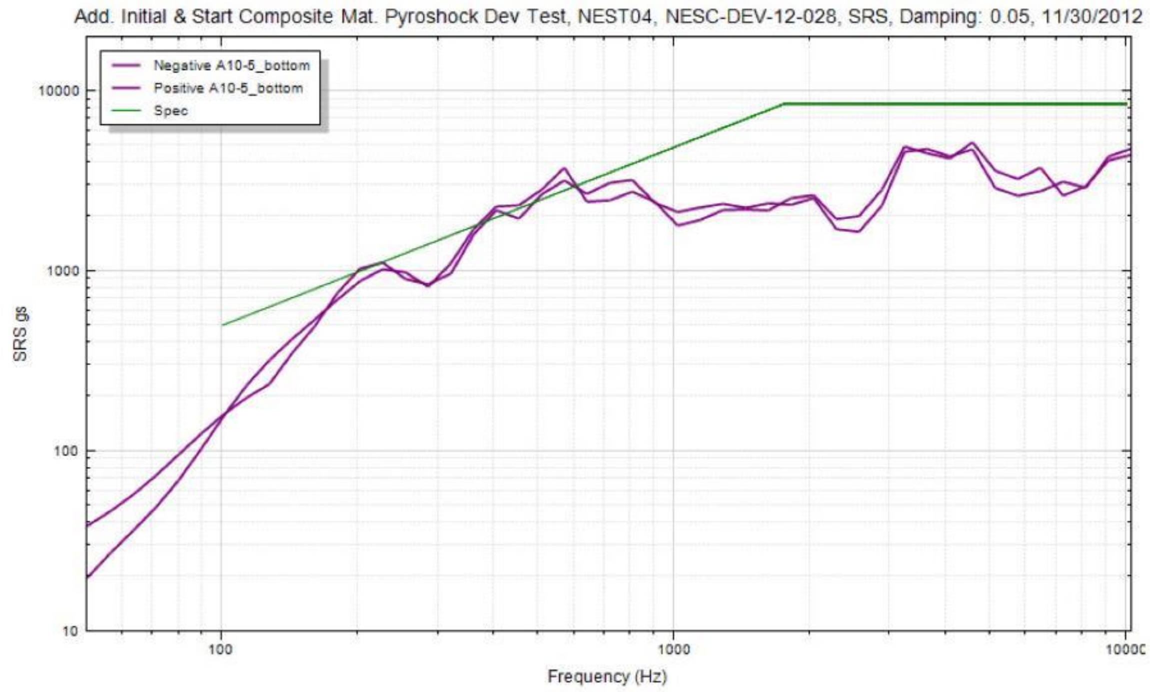

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A5-3_top
Positive A5-3_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

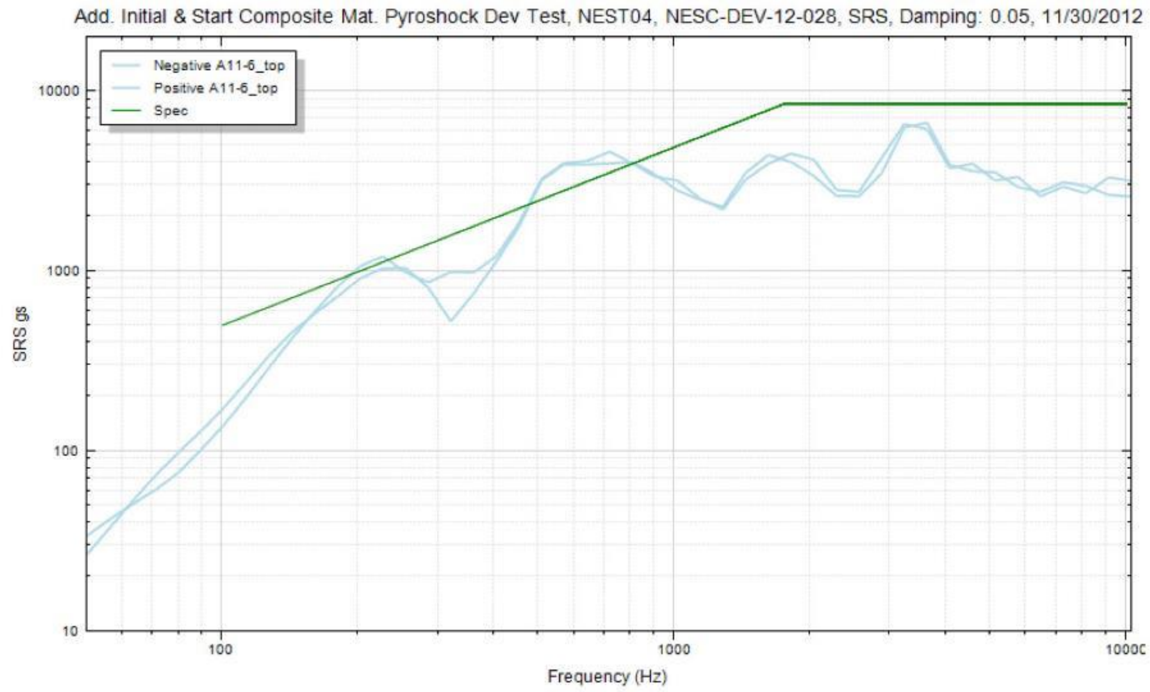

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A6-3_bottom
Positive A6-3_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

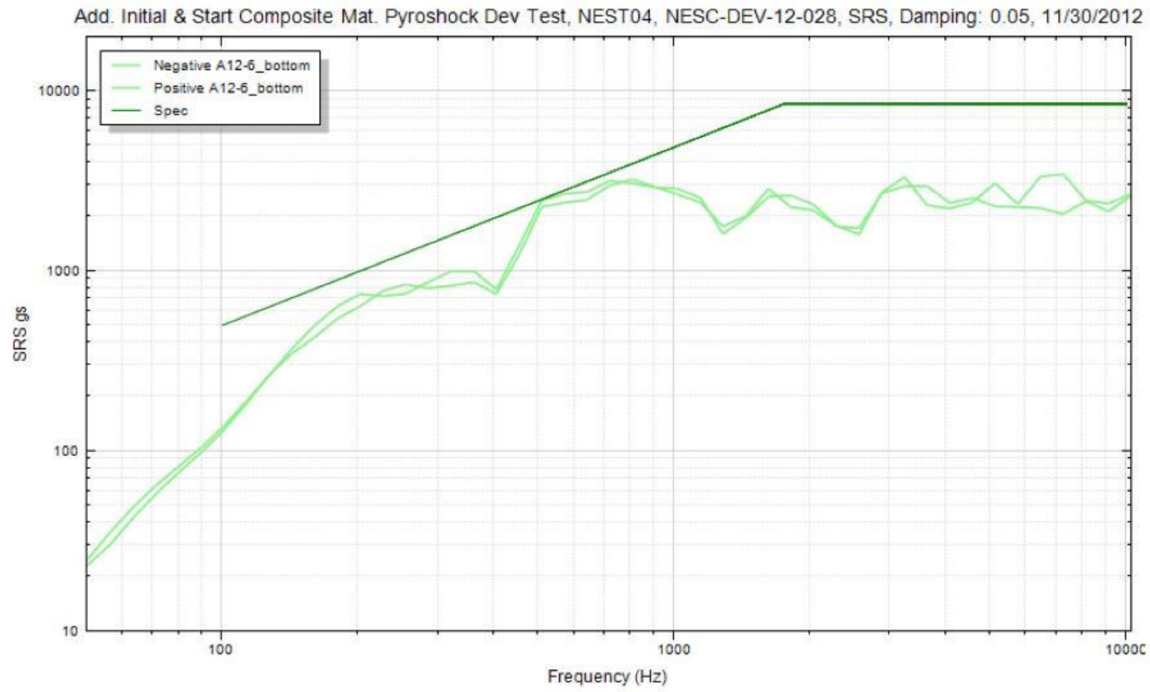

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A7-4_top
Positive A7-4_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

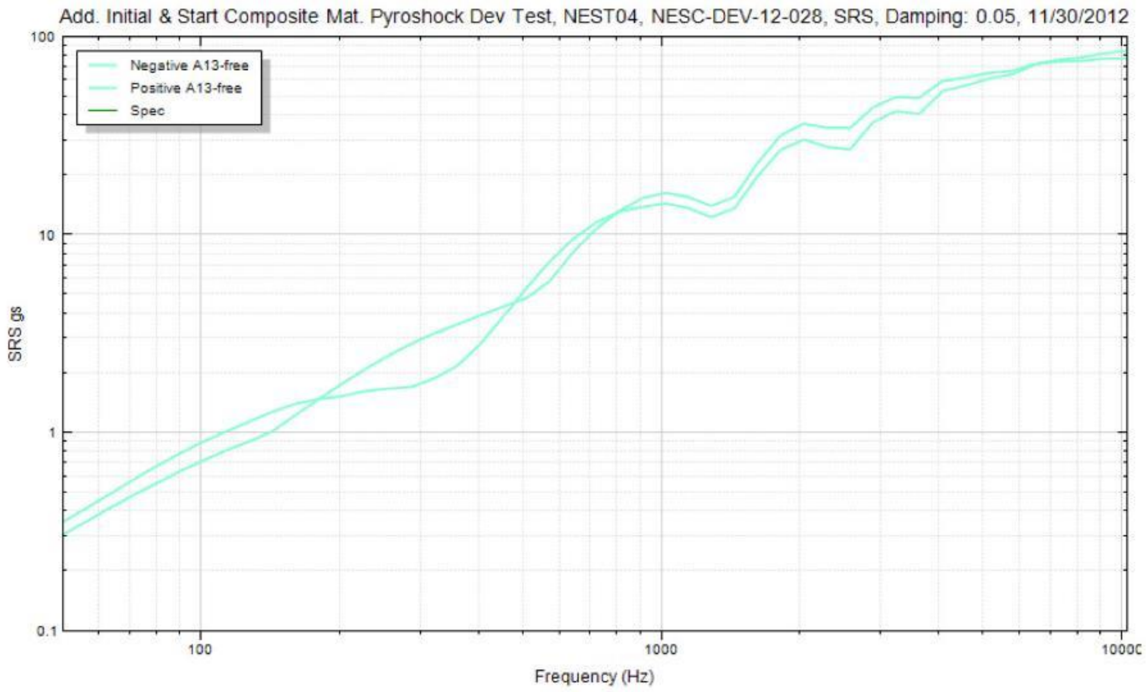

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A8-4_bottom
Positive A8-4_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

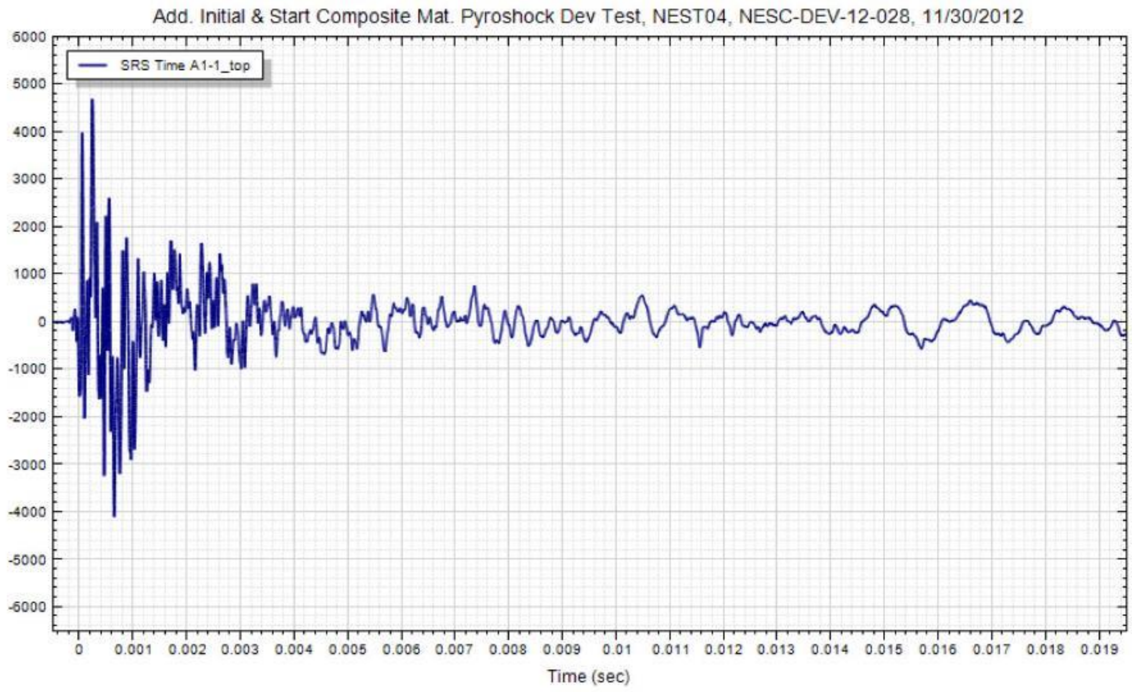

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

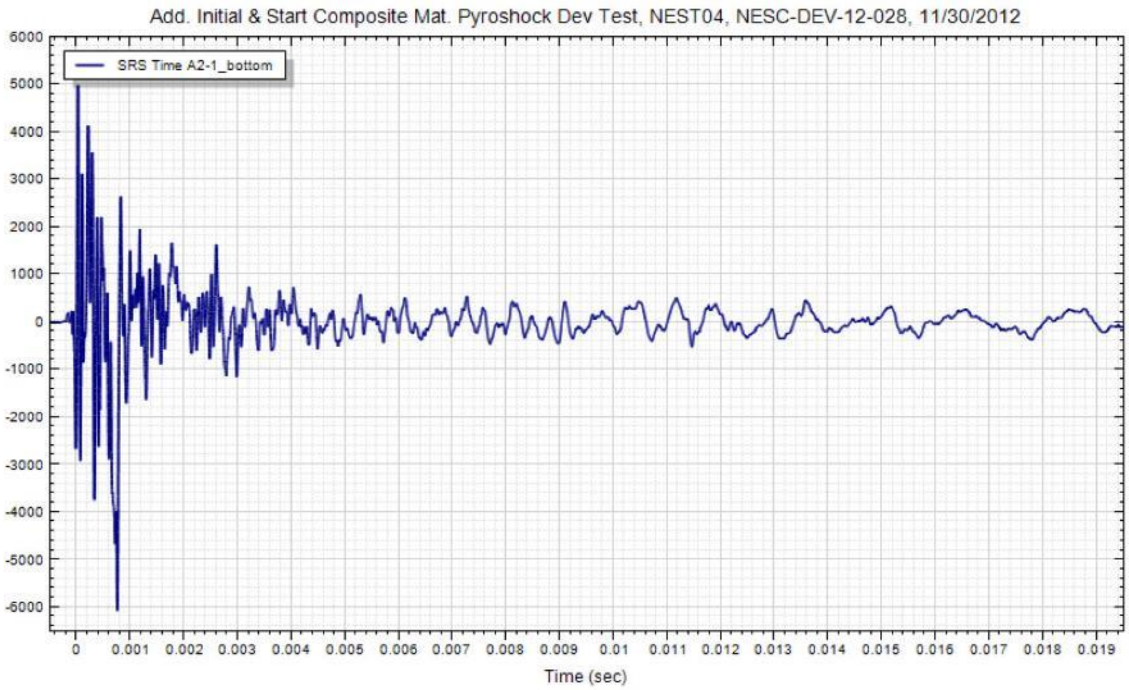

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

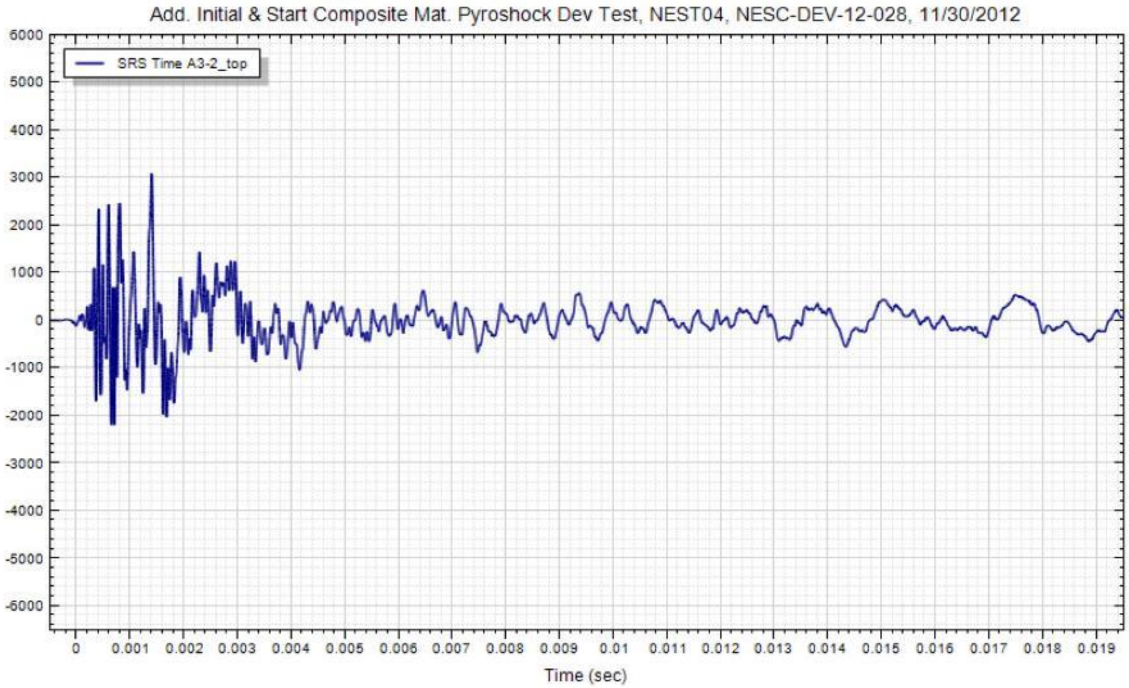

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
10
SRS gs
100
1000
1000C
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, SRS, Damping: 0.05, 11/30/2012
Negative A13-free
Positive A13-free
Spec
SRS gs
100
10
1
0.1
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A1-1_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A2-1_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A3-2_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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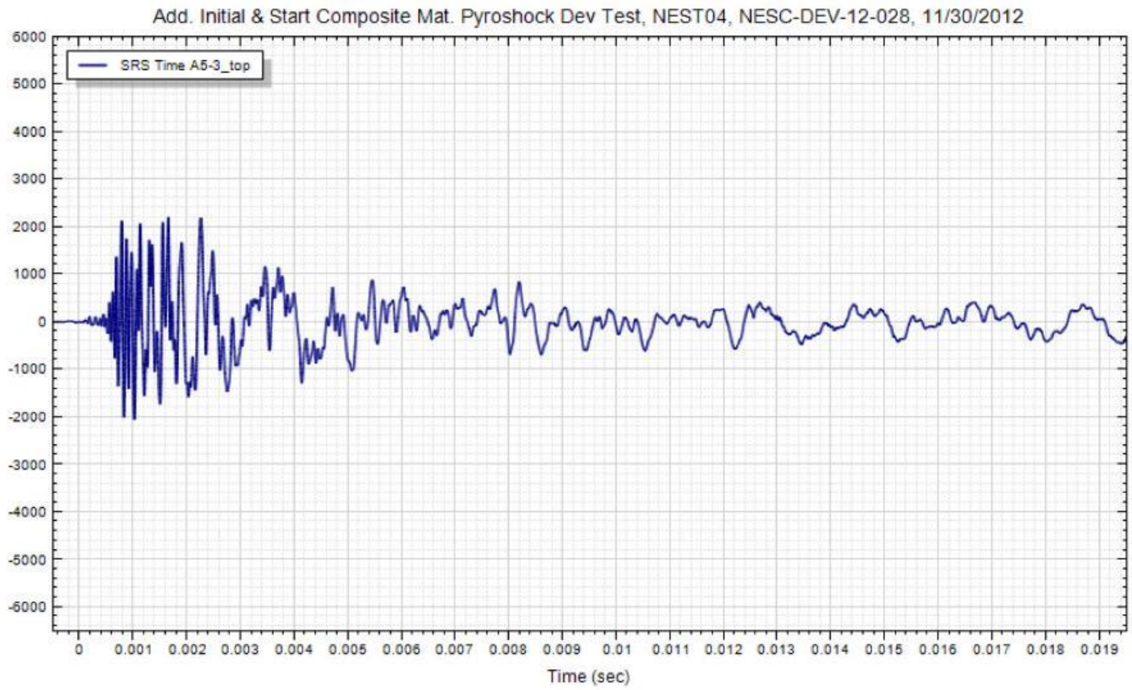
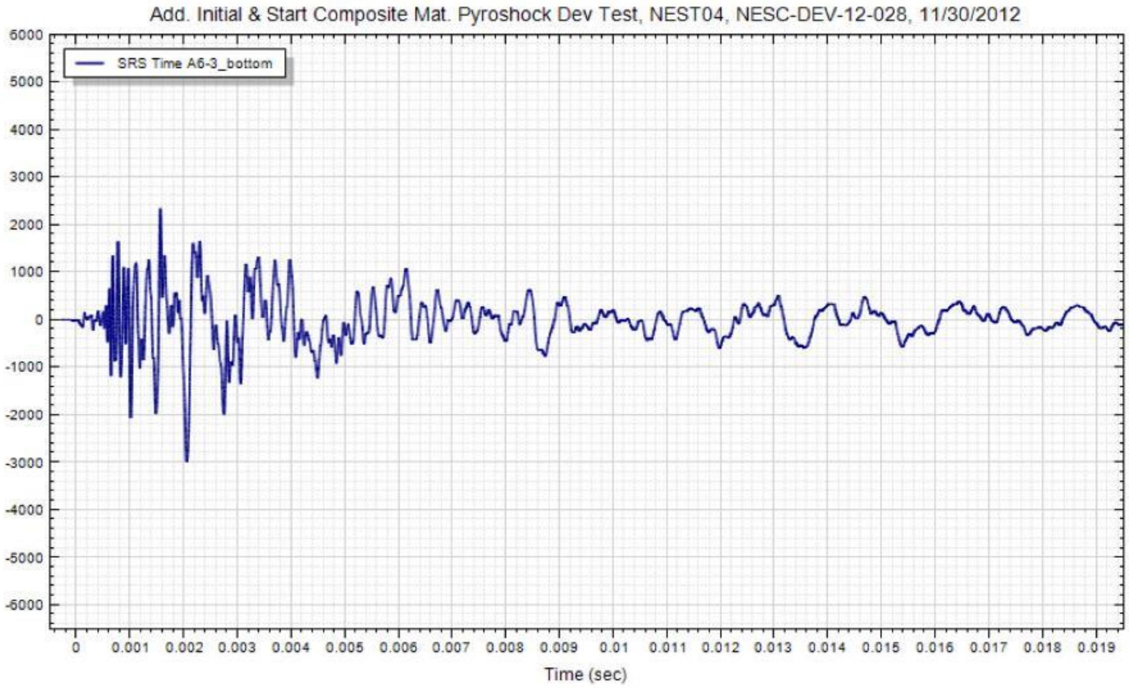
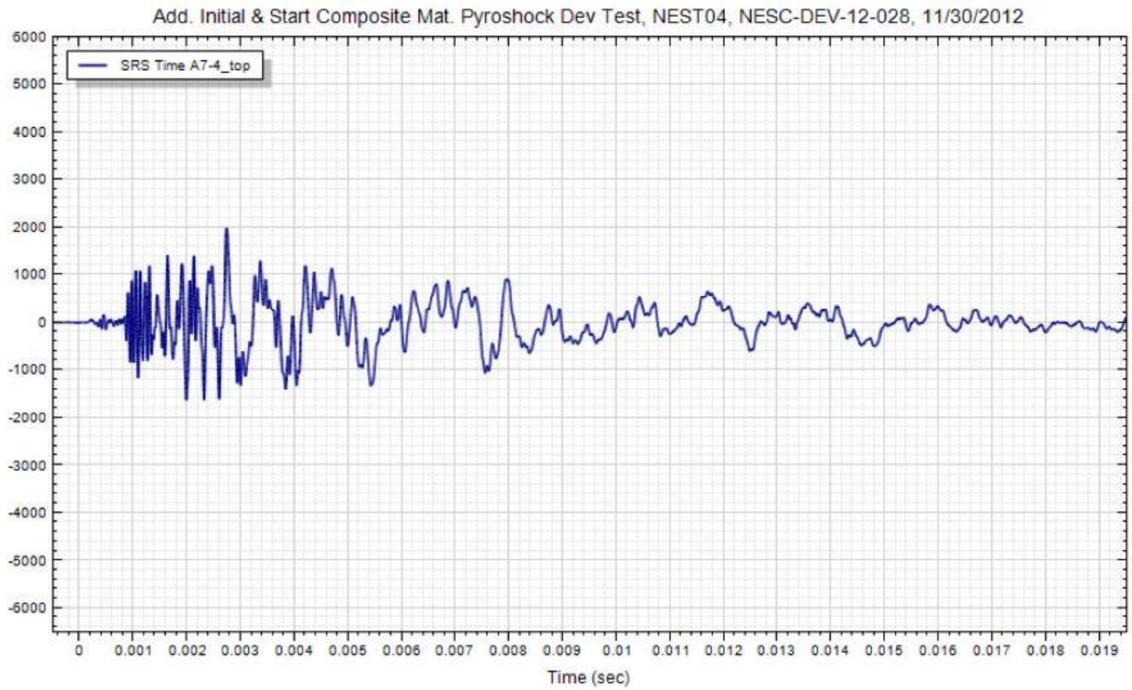
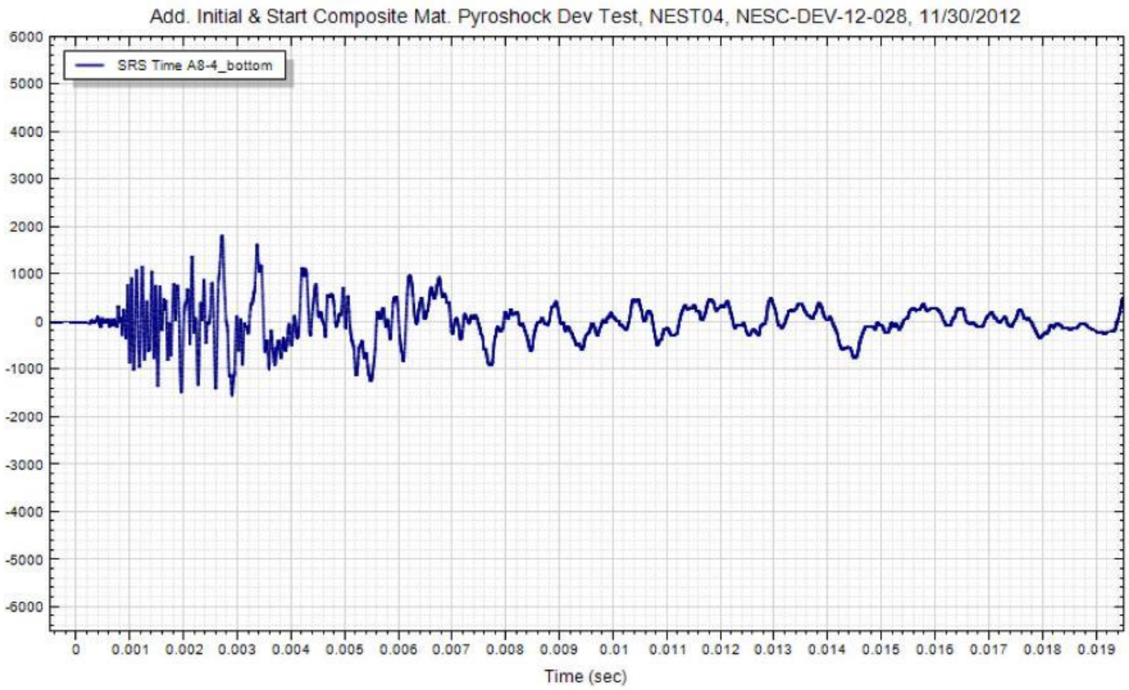
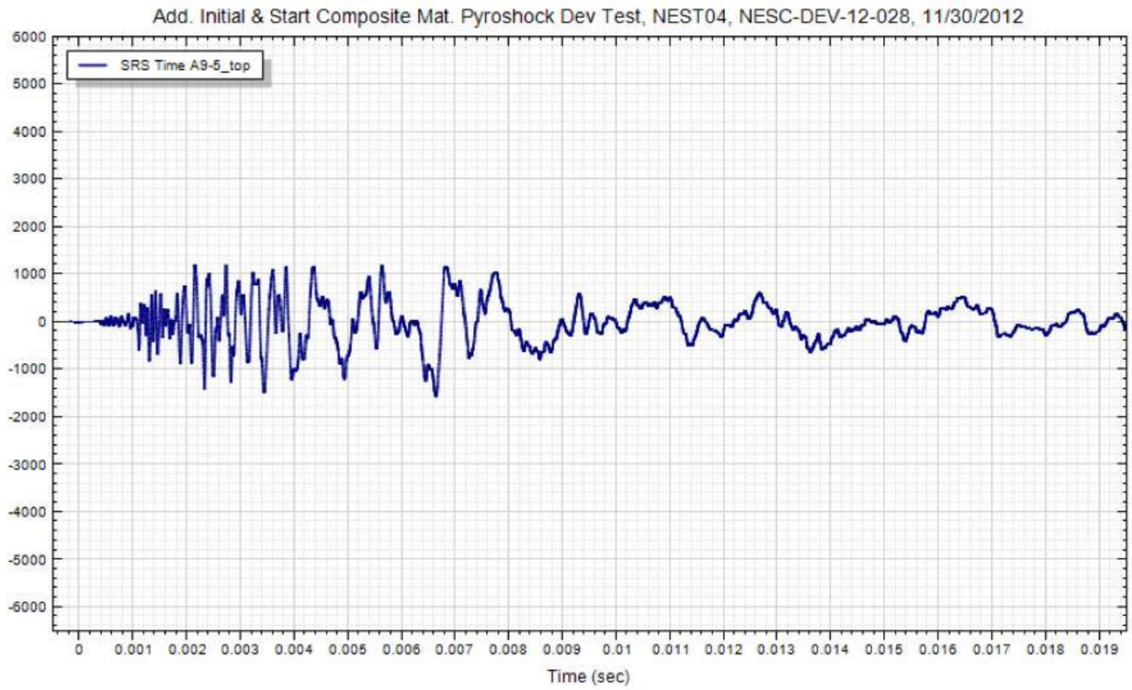
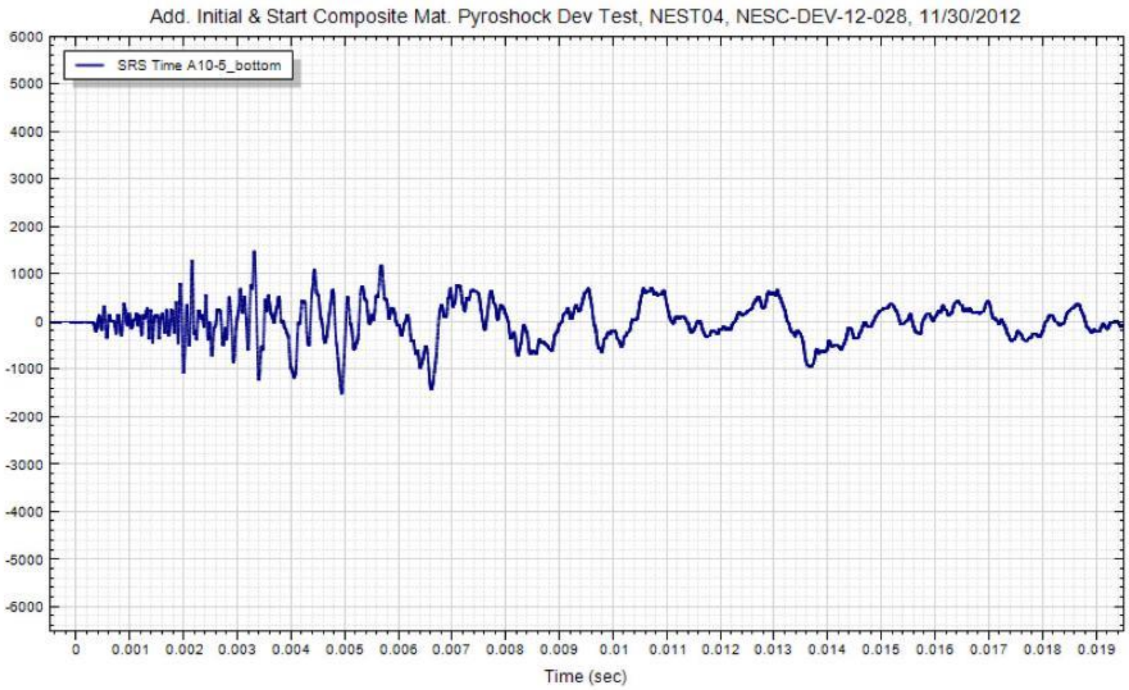

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A5-3_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

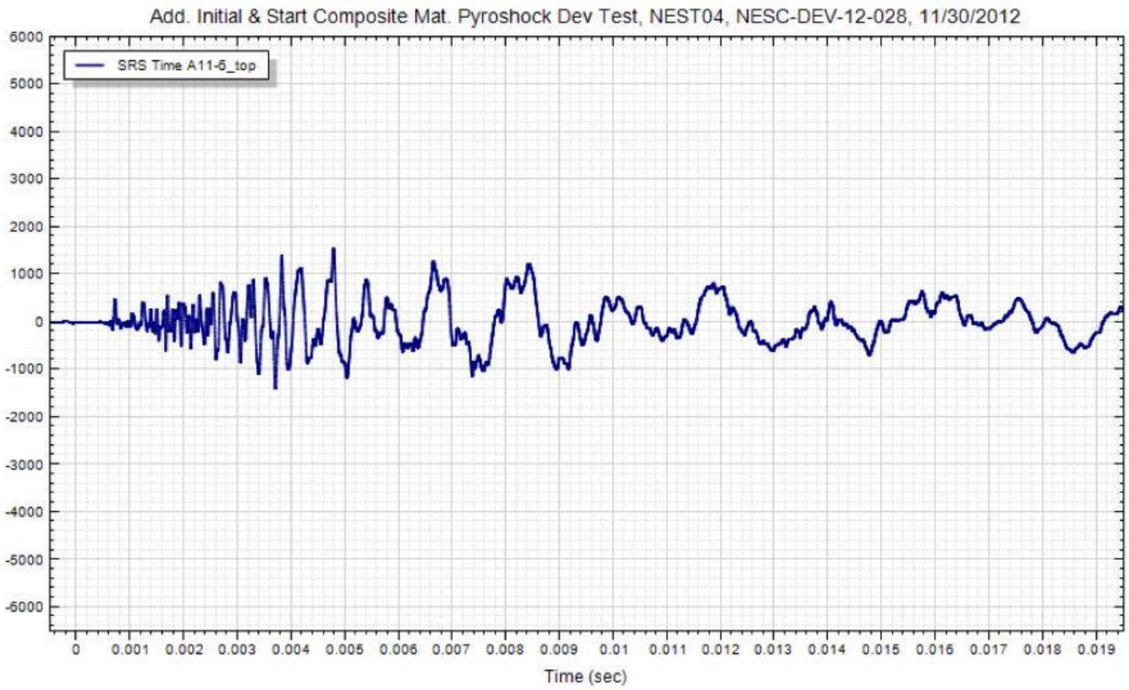

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A6-3_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

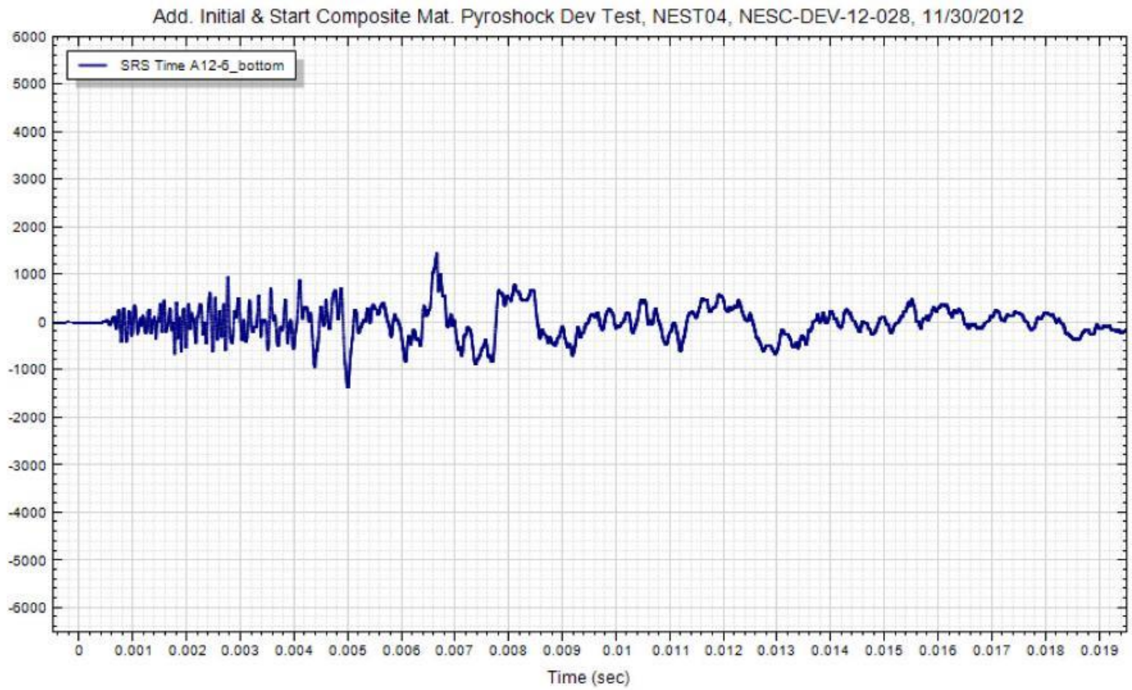

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A7-4_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

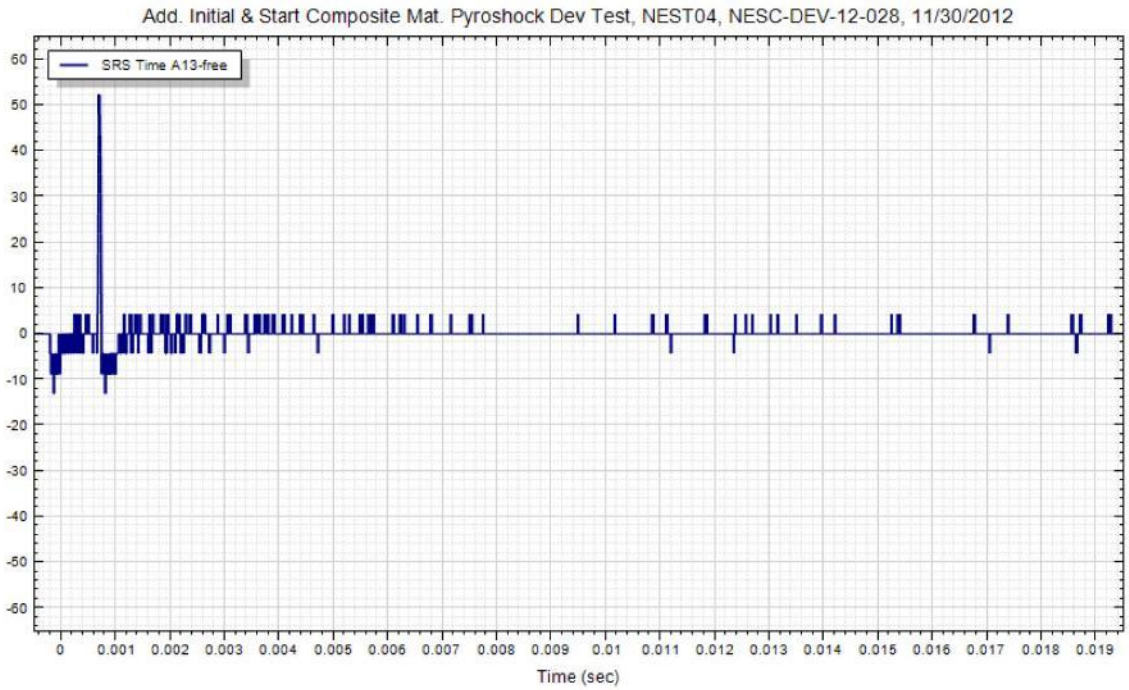

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A8-4_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

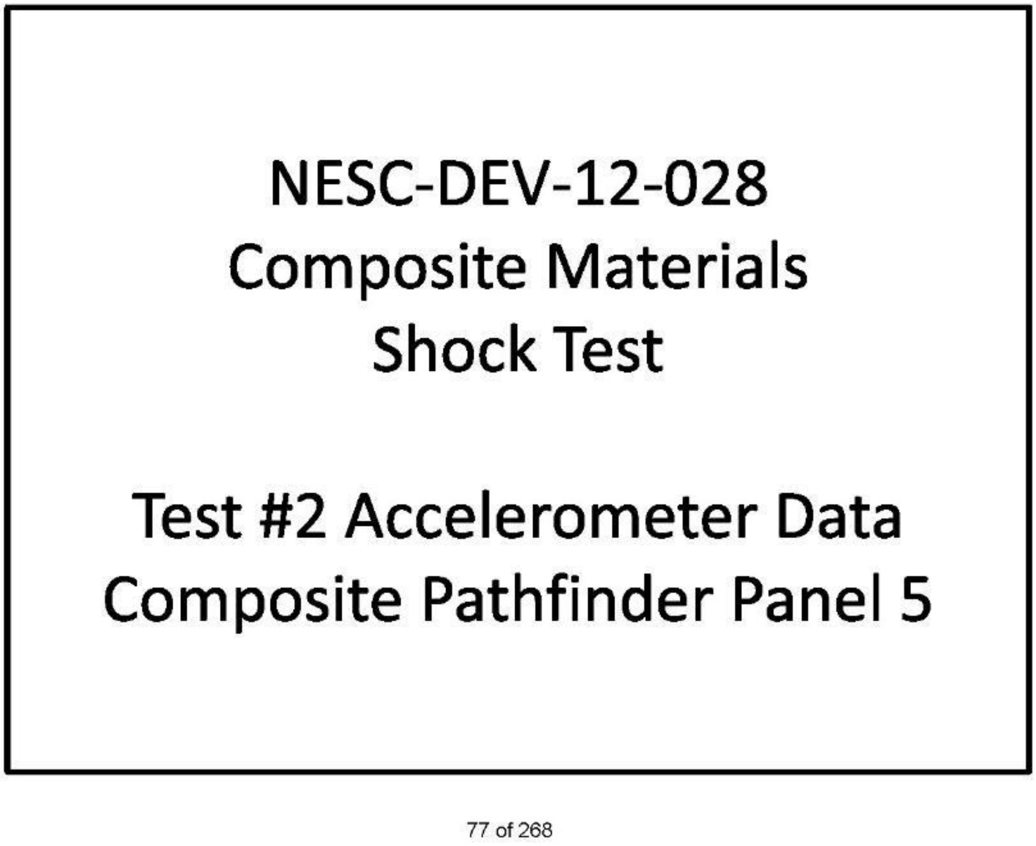

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A9-5_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A10-5_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A11-6_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A12-6_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST04, NESC-DEV-12-028, 11/30/2012
SRS Time A13-free
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)



NESC-DEV-12-028
Composite Materials Shock Test

Test #2 Accelerometer Data
Composite Pathfinder Panel 5

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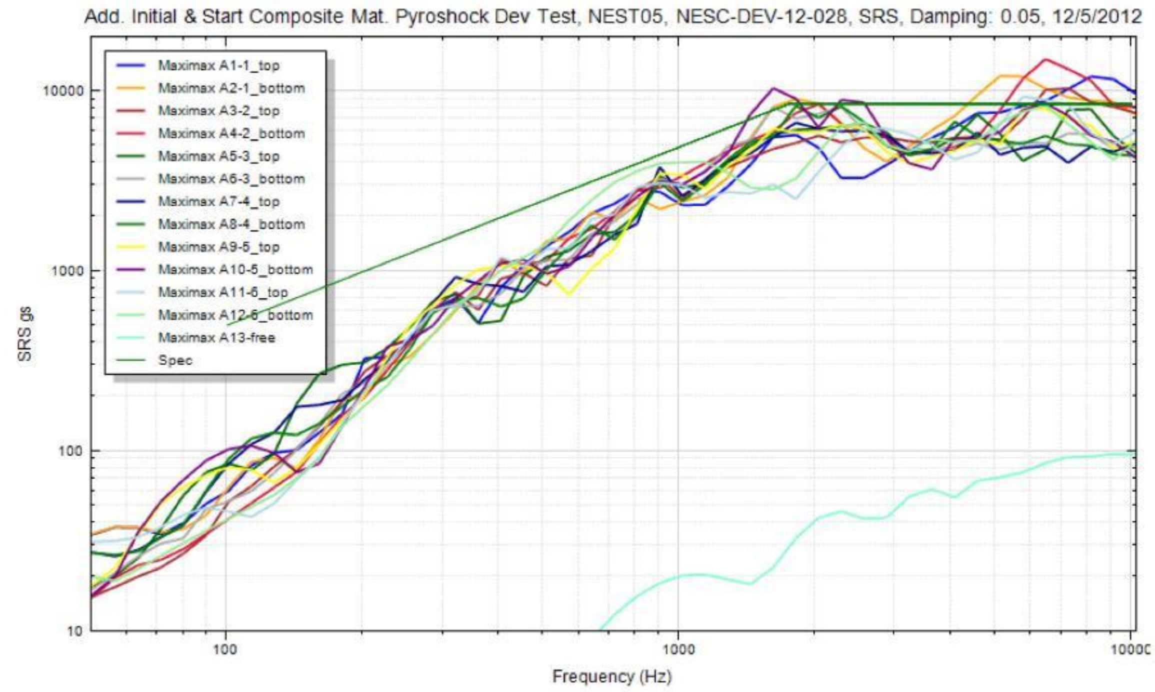
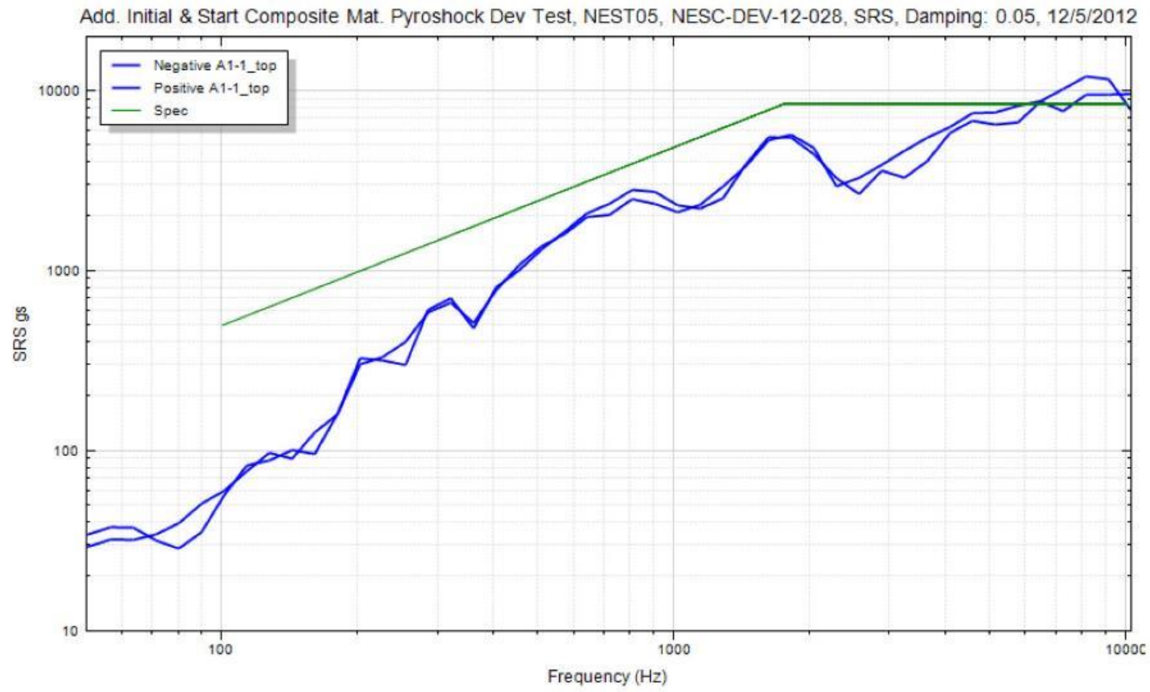
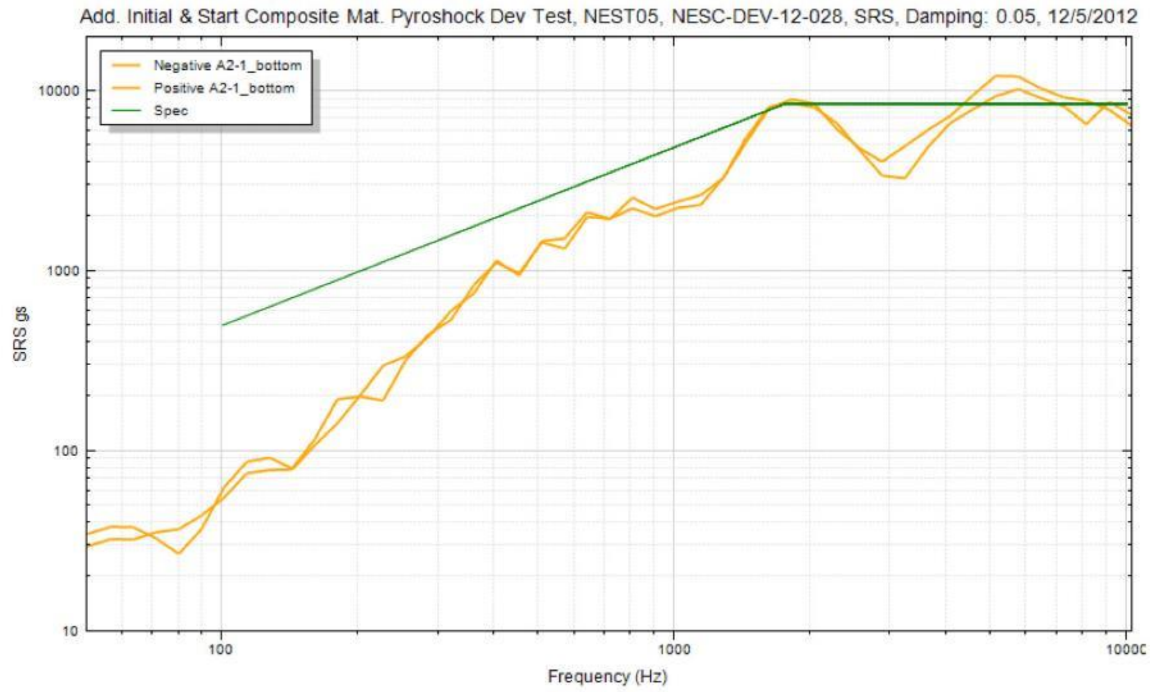
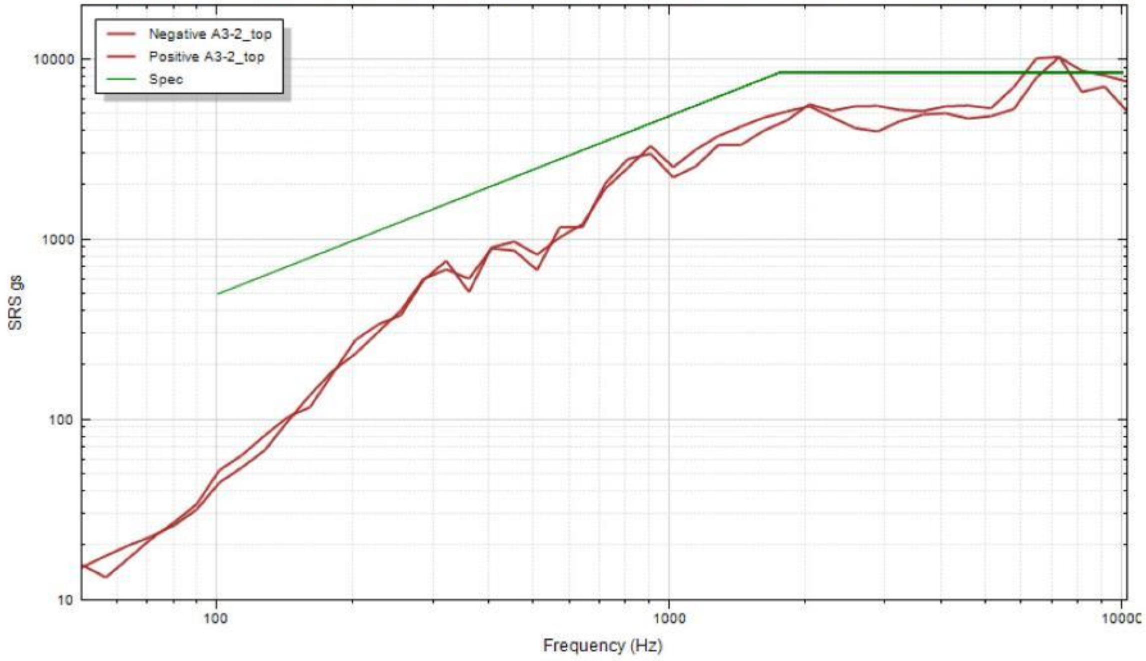

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

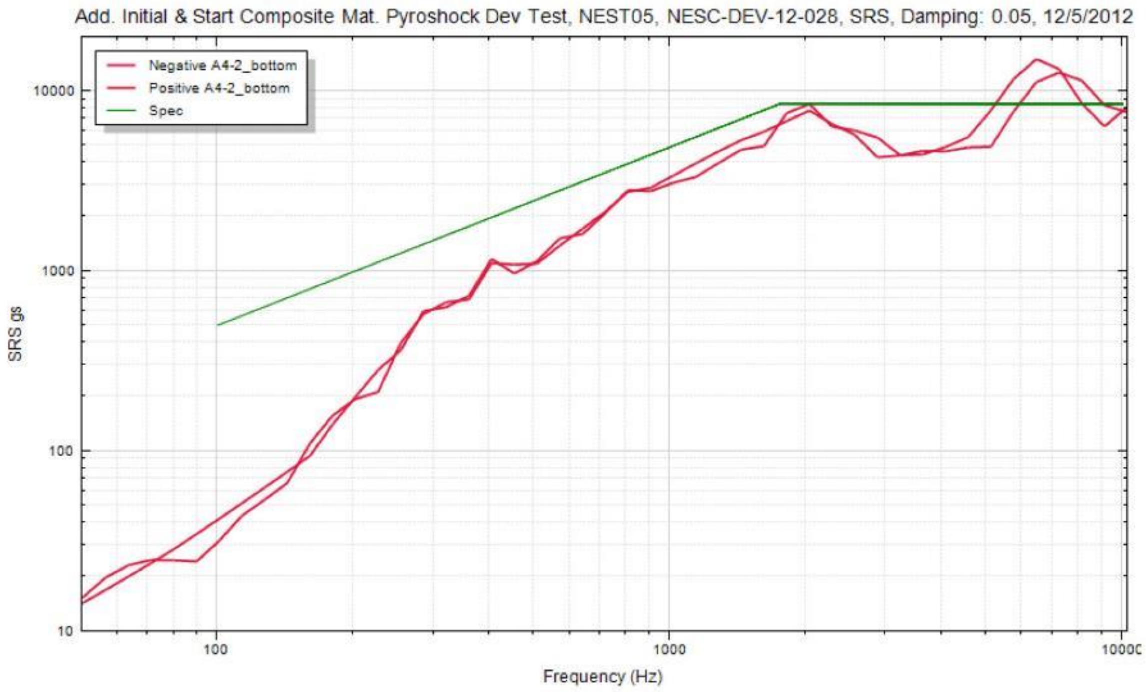


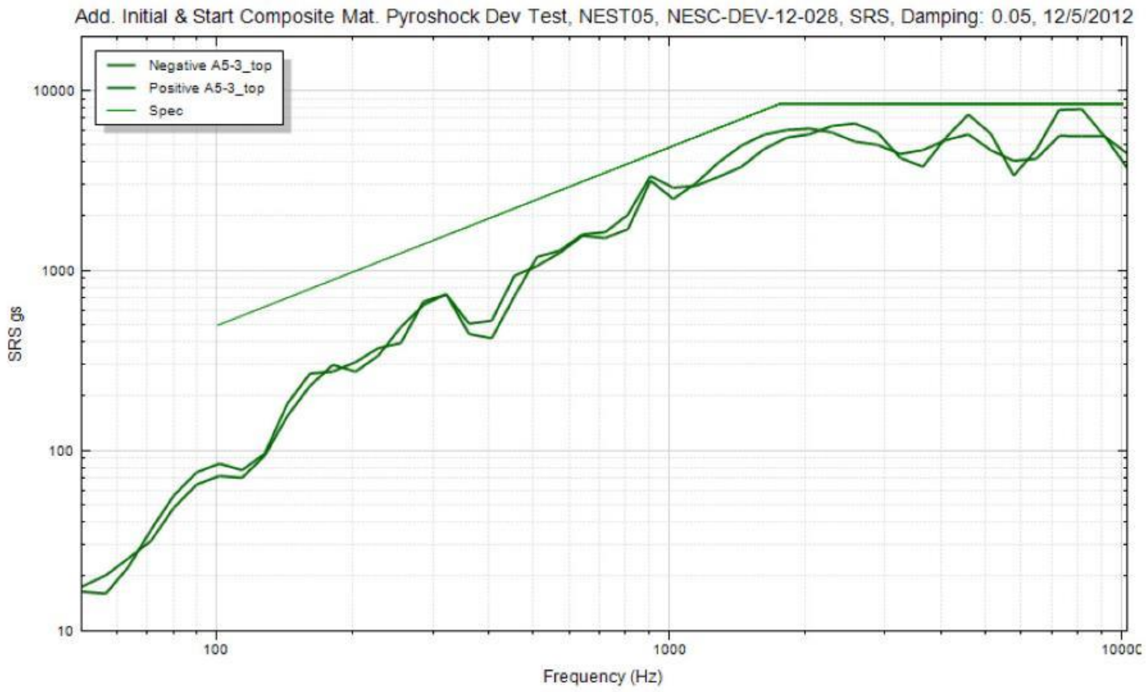
Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

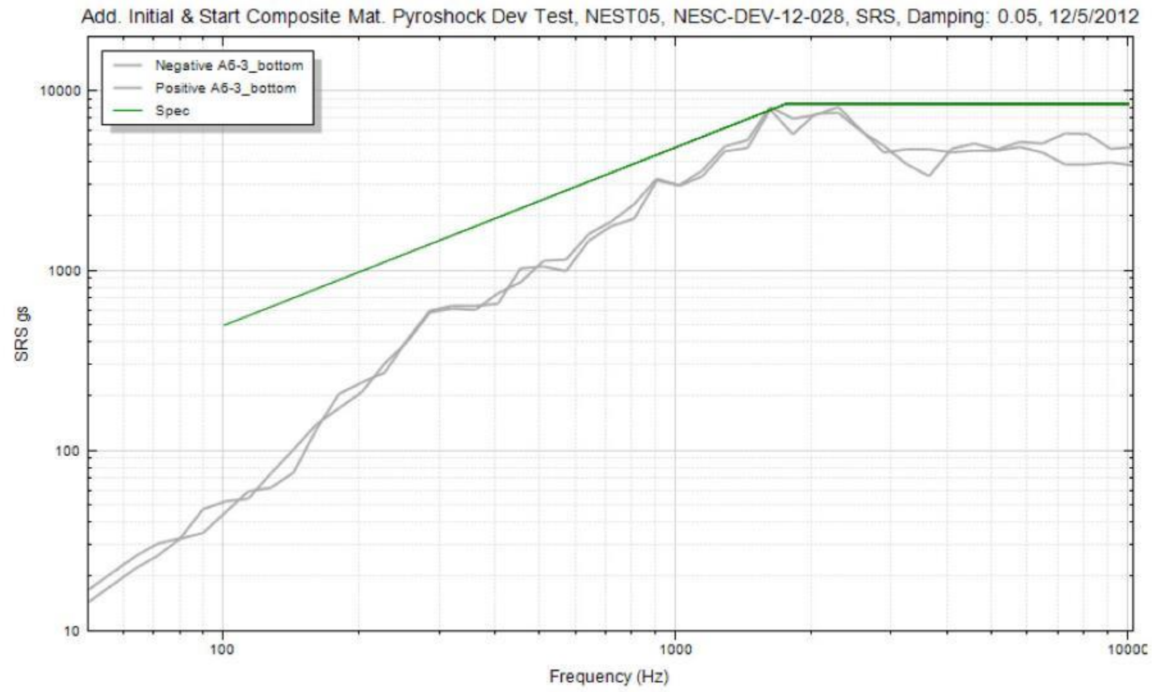

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A2-1_bottom
Positive A2-1_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
1000
Frequency (Hz)

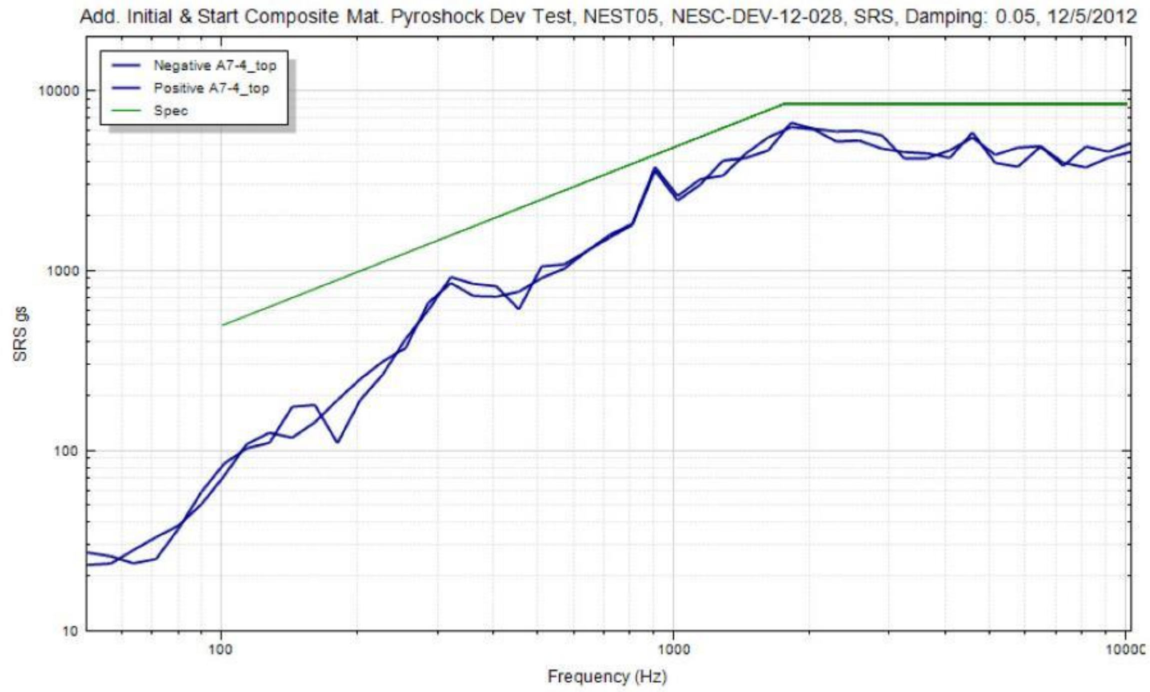
Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012




Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A4-2_bottom
Positive A4-2_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A7-4_top
Positive A7-4_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

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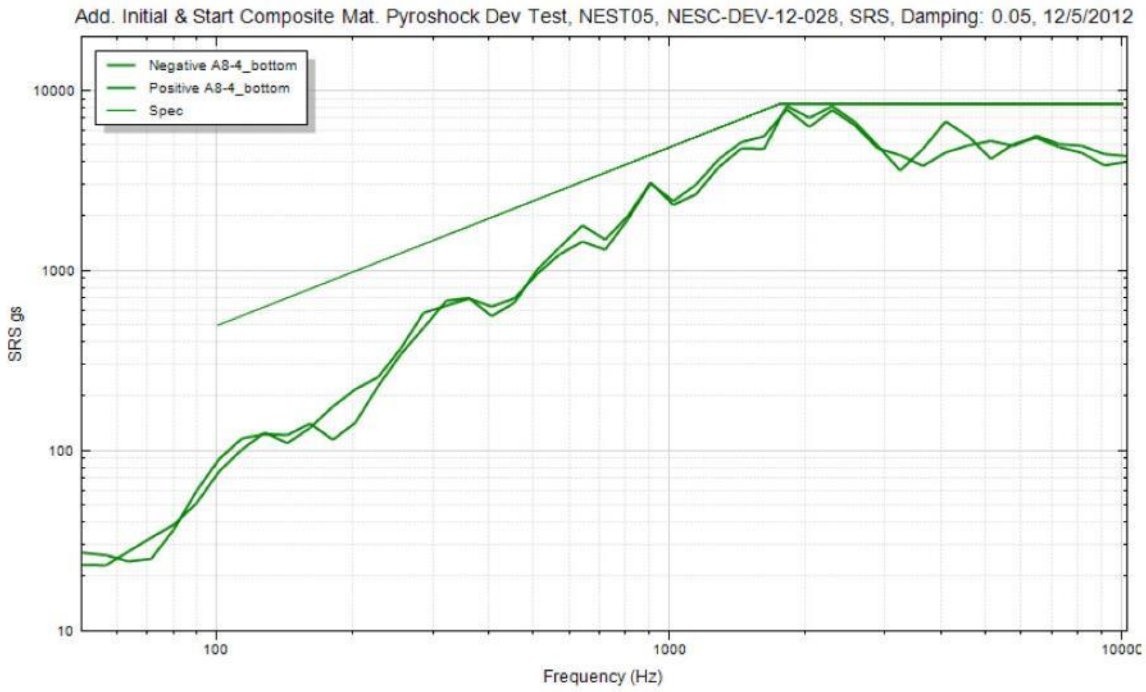
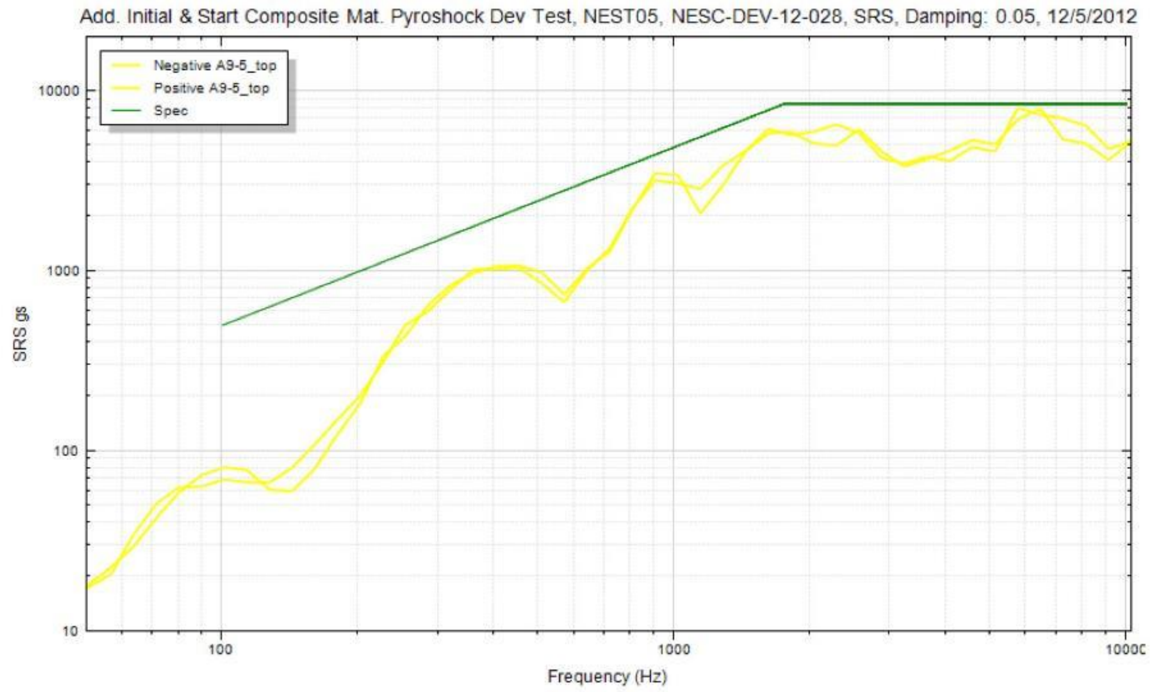

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A8-4_bottom
Positive A8-4_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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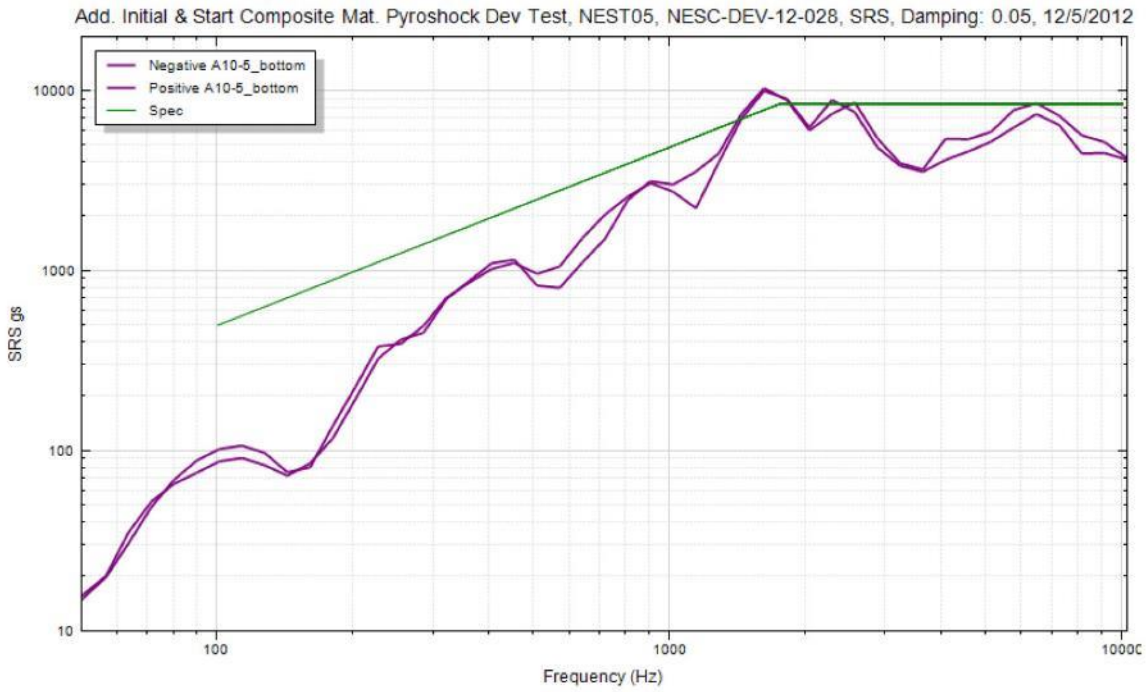
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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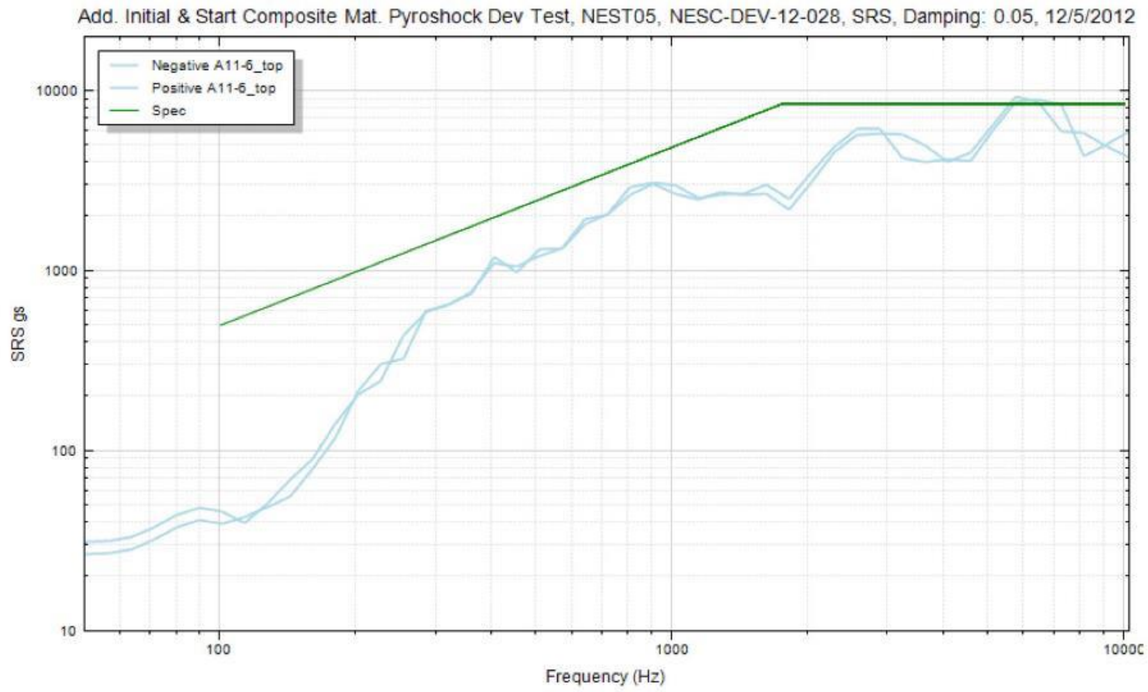
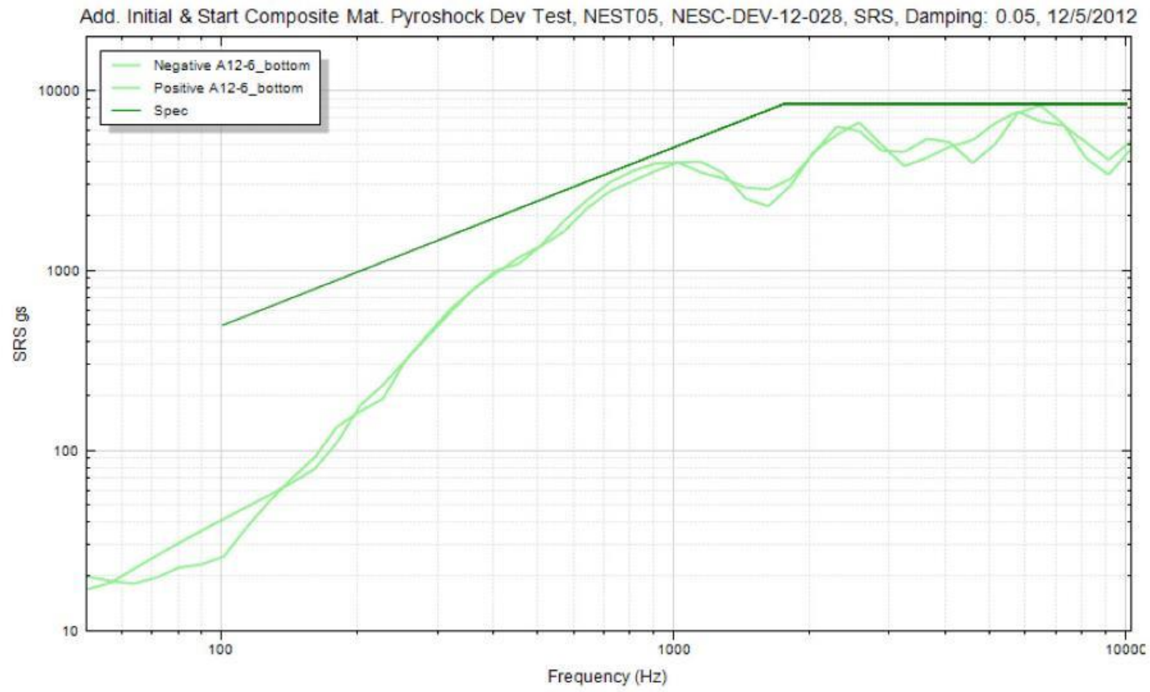
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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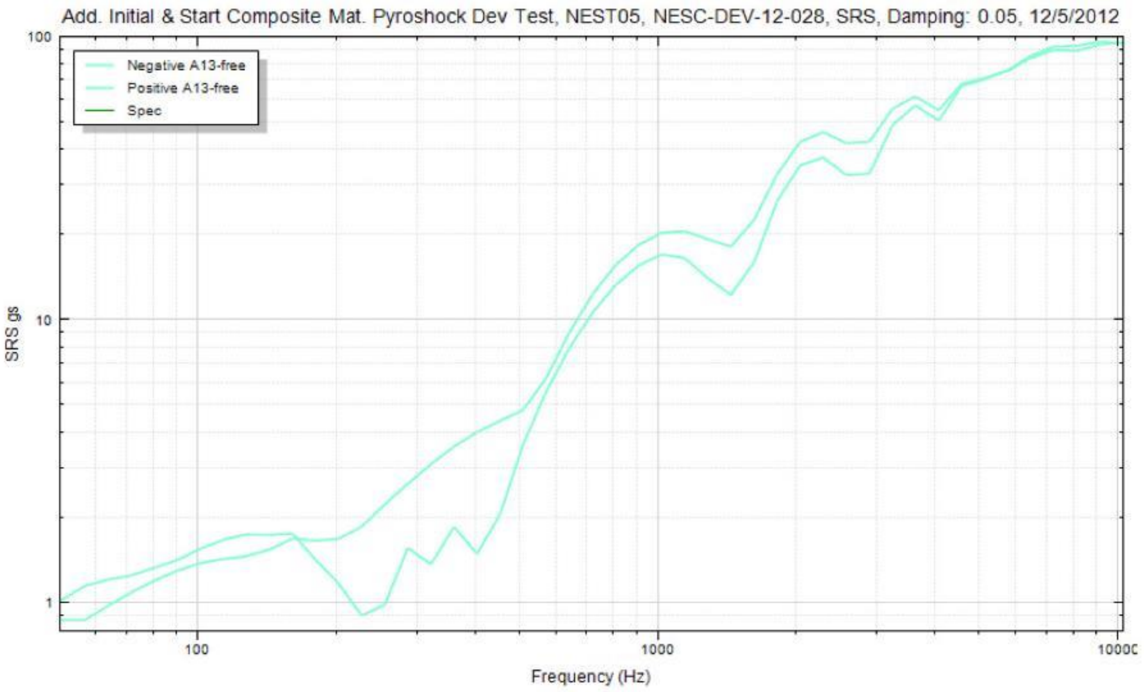
Negative A12-6_bottom
Positive A12-6_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
1000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, SRS, Damping: 0.05, 12/5/2012
Negative A13-free
Positive A13-free
Spec
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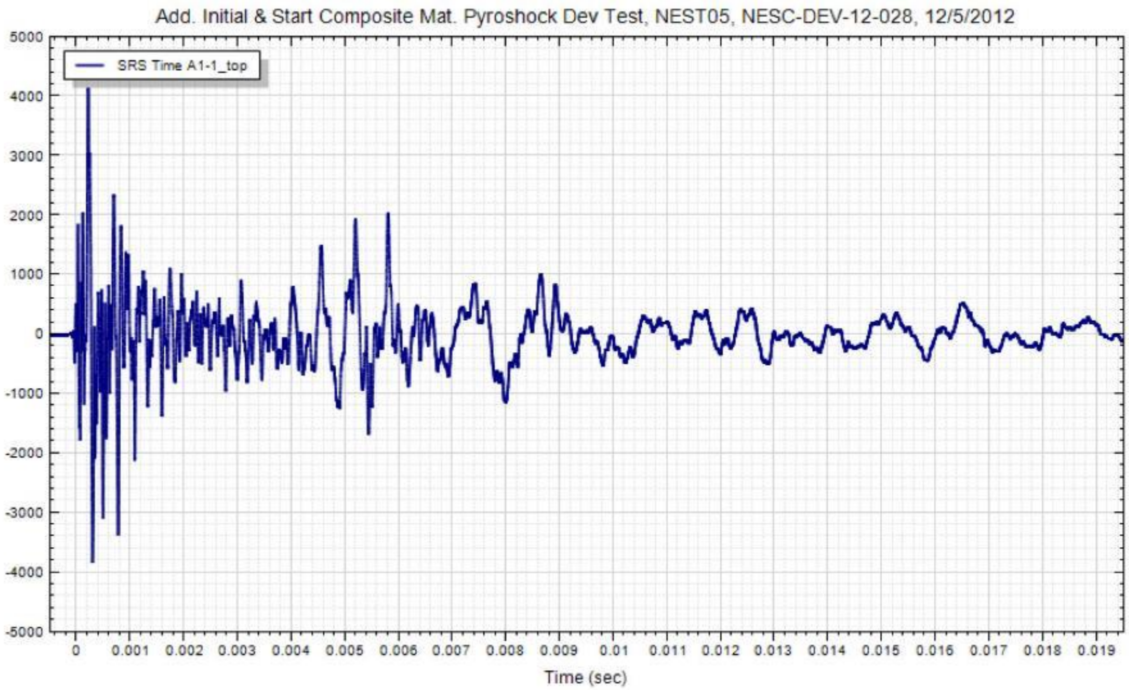
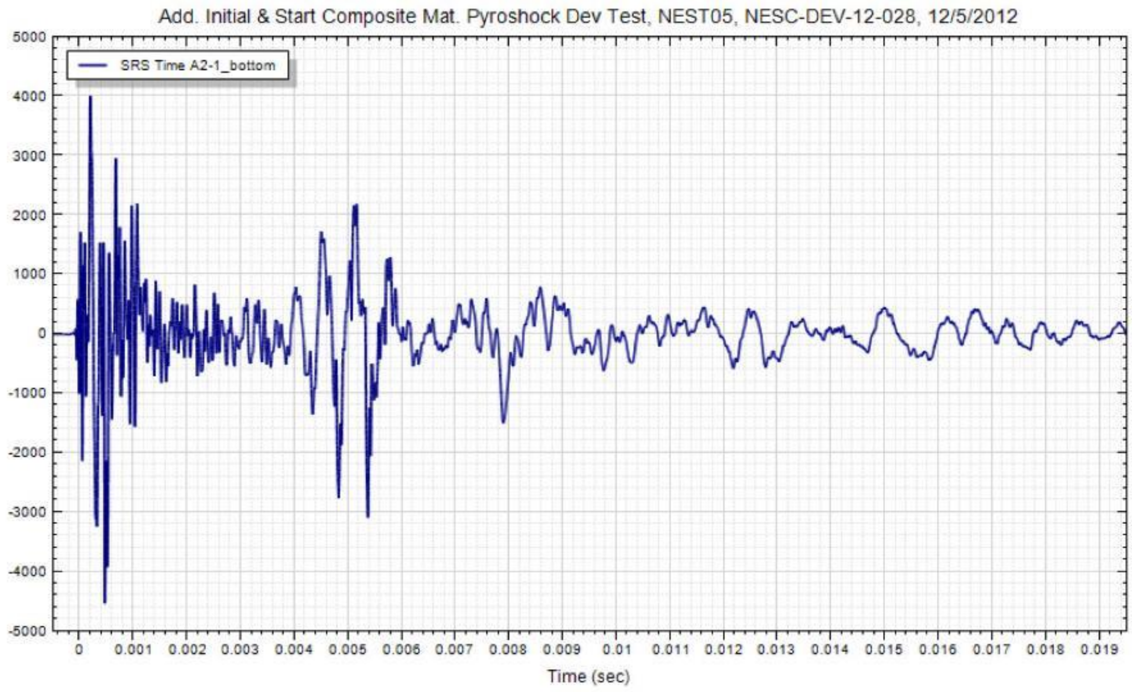
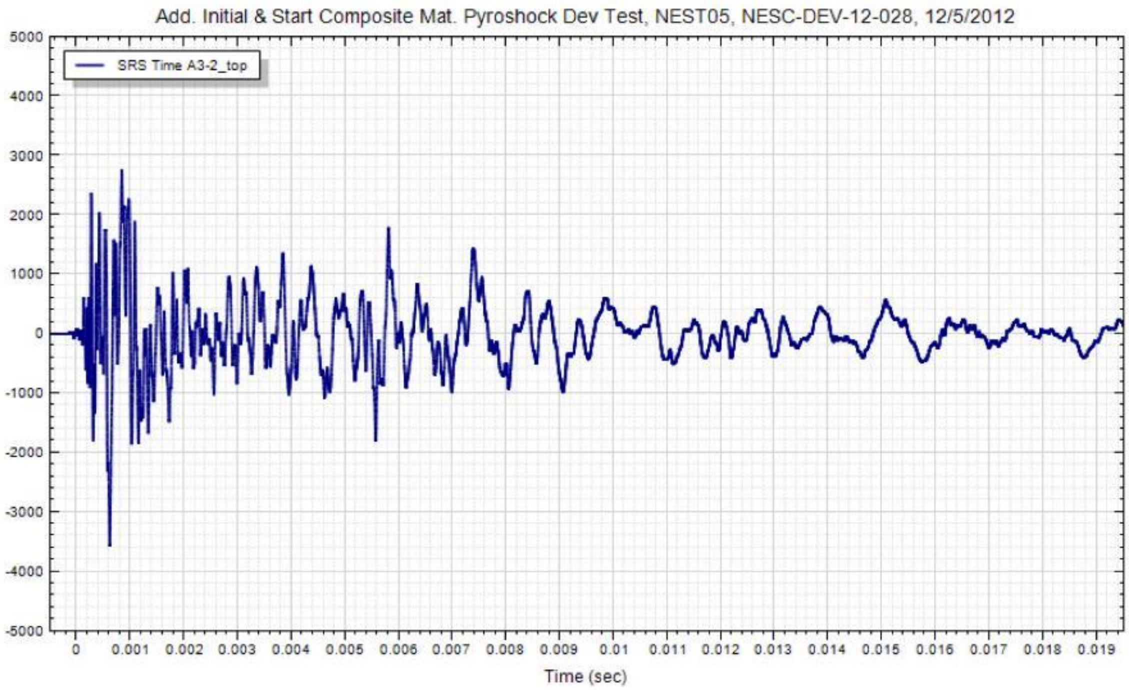
1
SRS gs
100
1000
10000
Frequency (Hz)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A1-1_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A2-1_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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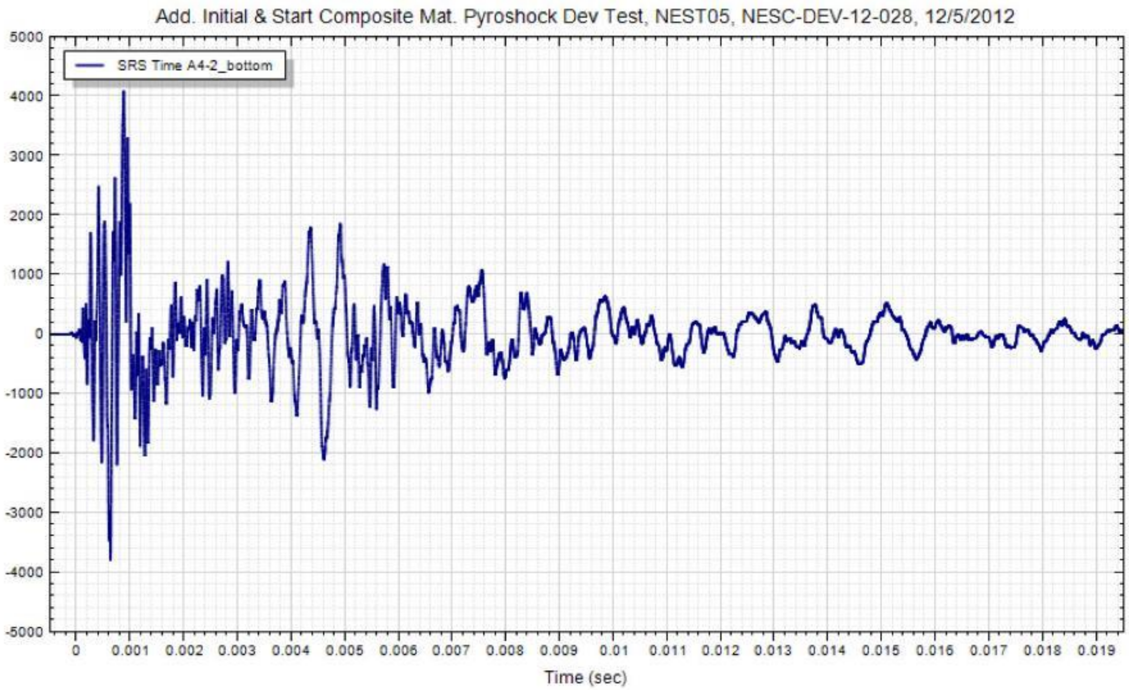
SRS Time A3-2_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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SRS Time A4-2_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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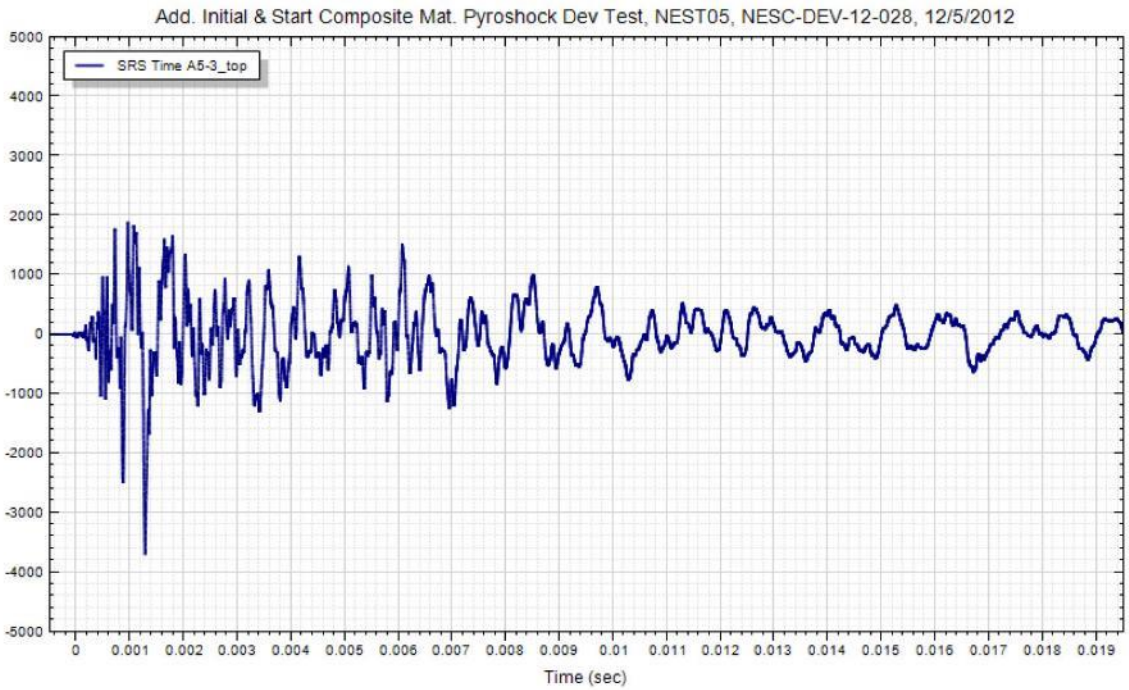
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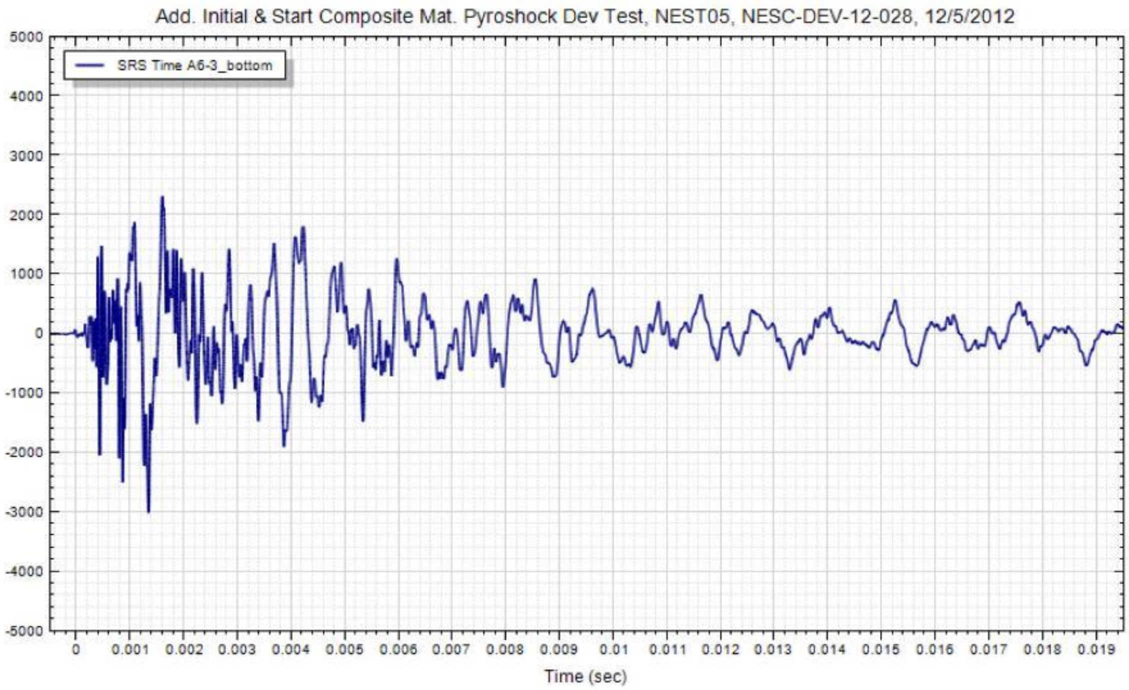
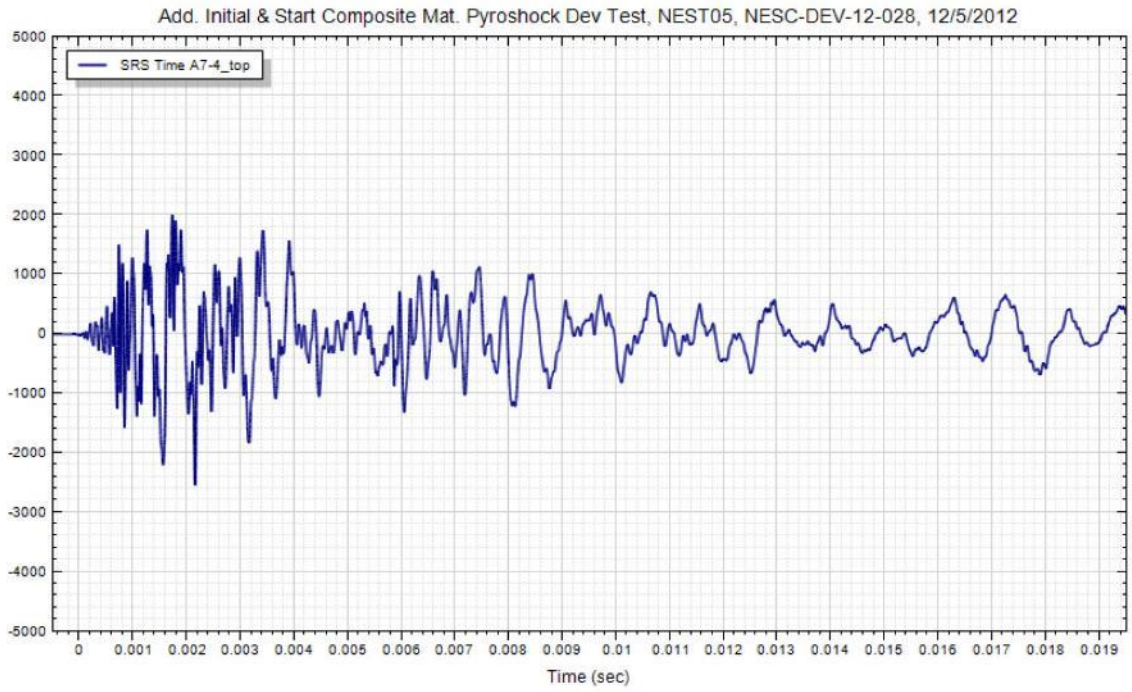
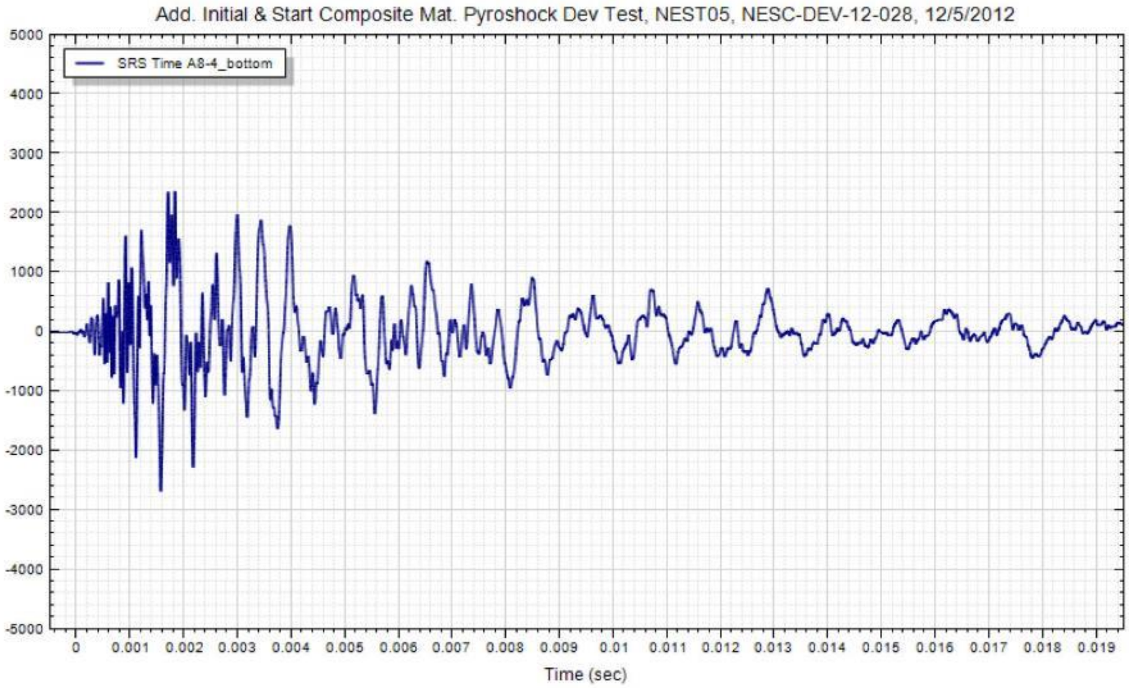
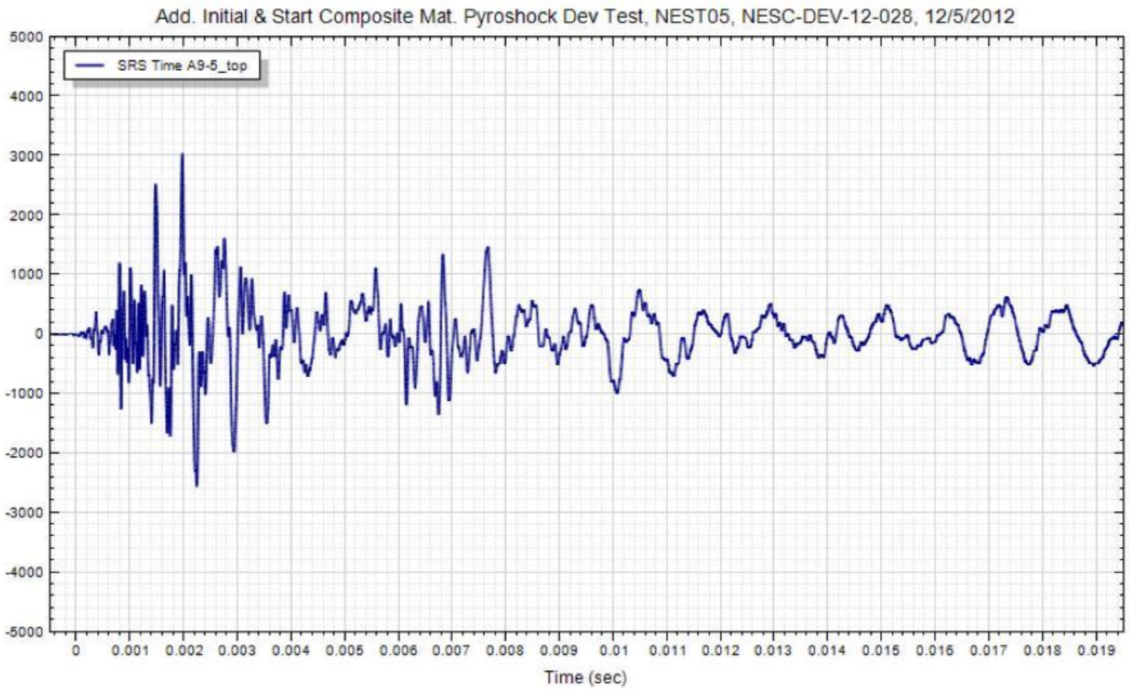
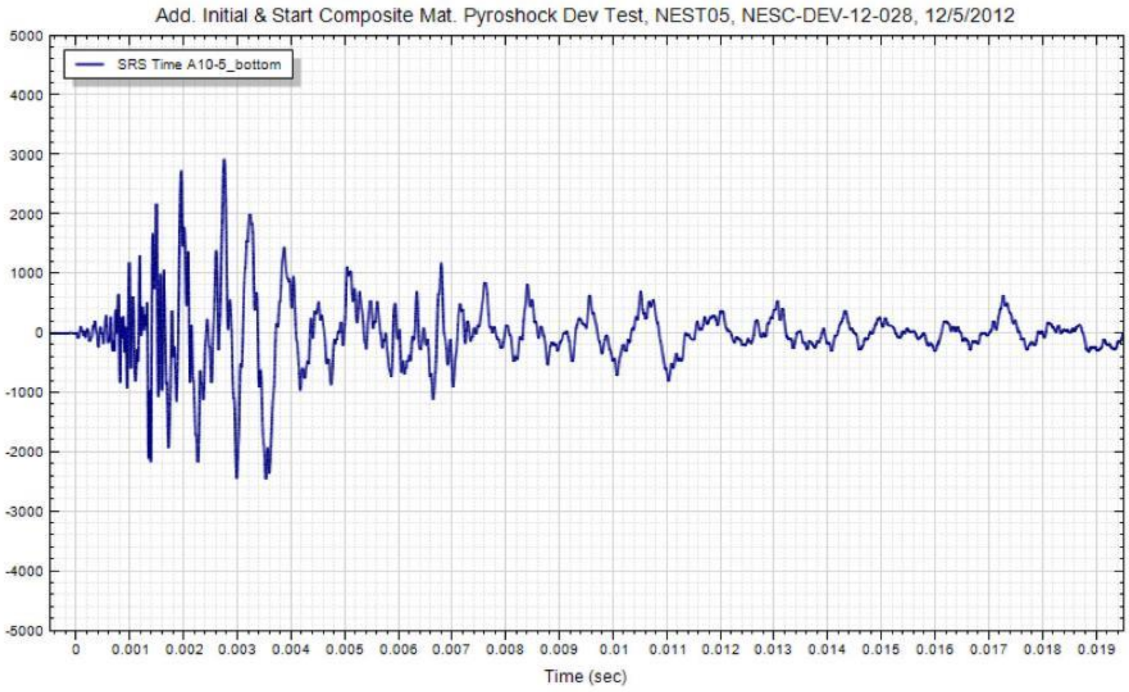
SRS Time A5-3_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

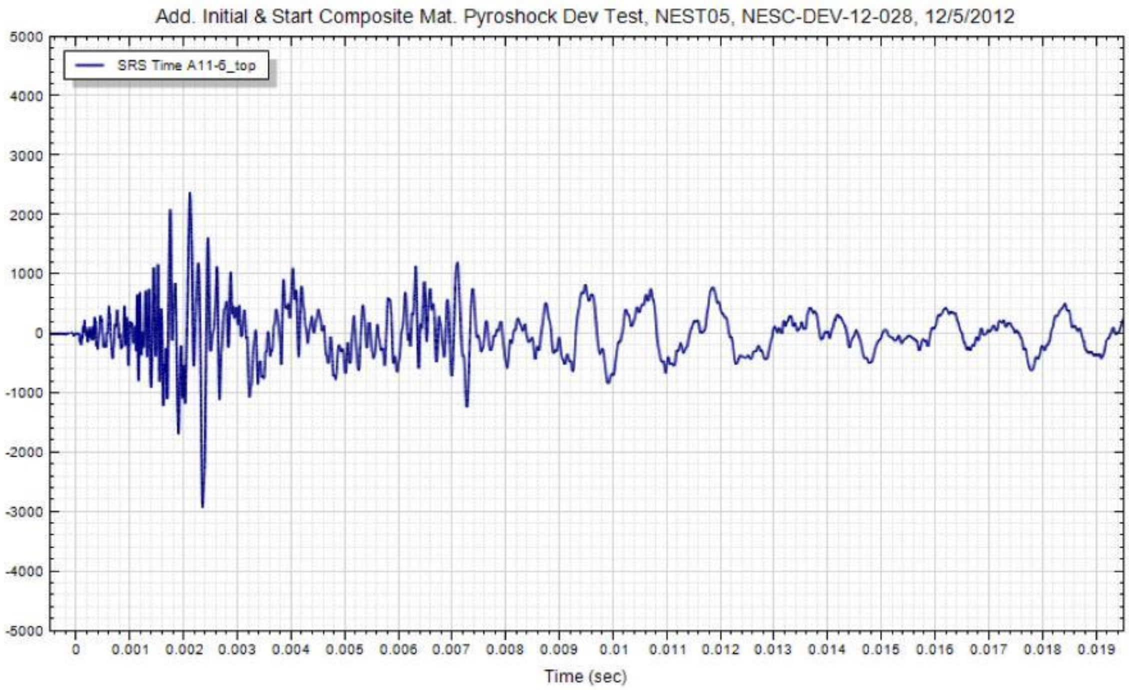

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A6-3_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

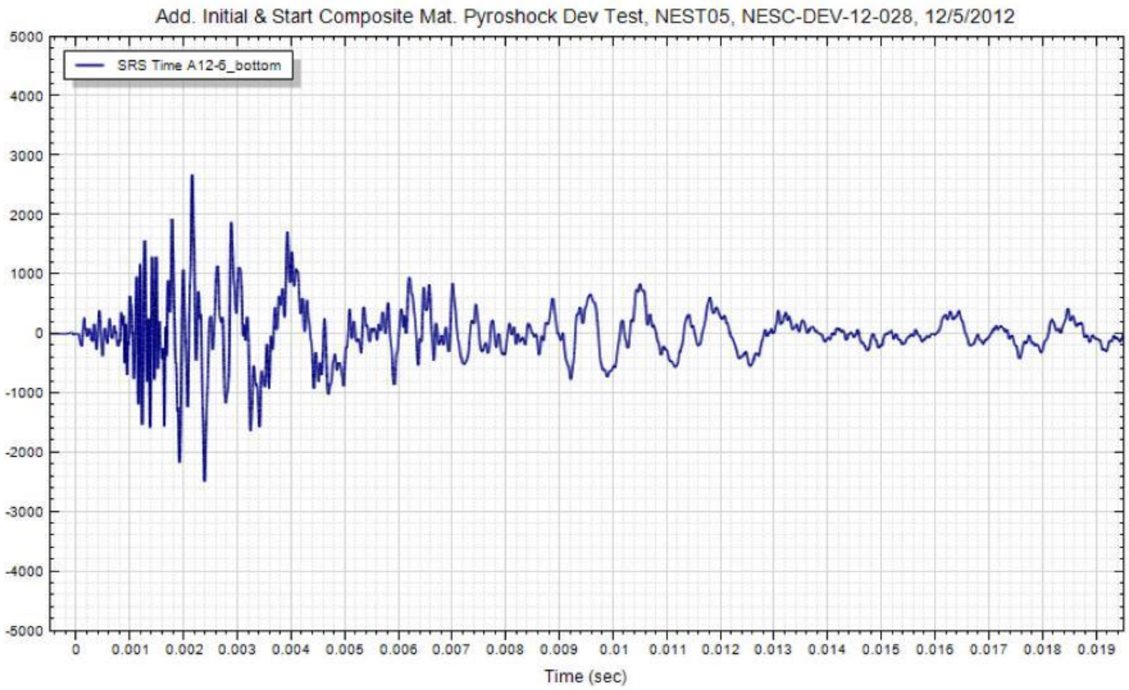

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A7-4_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

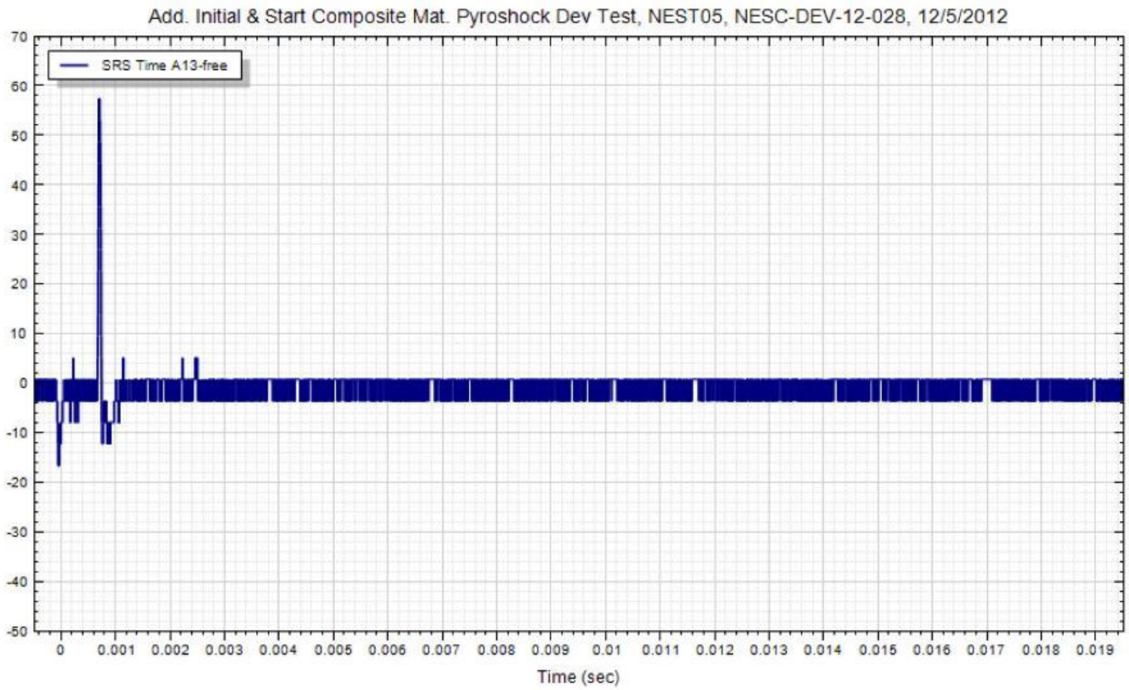

Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A8-4_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A9-5_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A10-5_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A11-6_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Add. Initial & Start Composite Mat. Pyroshock Dev Test, NEST05, NESC-DEV-12-028, 12/5/2012
SRS Time A12-6_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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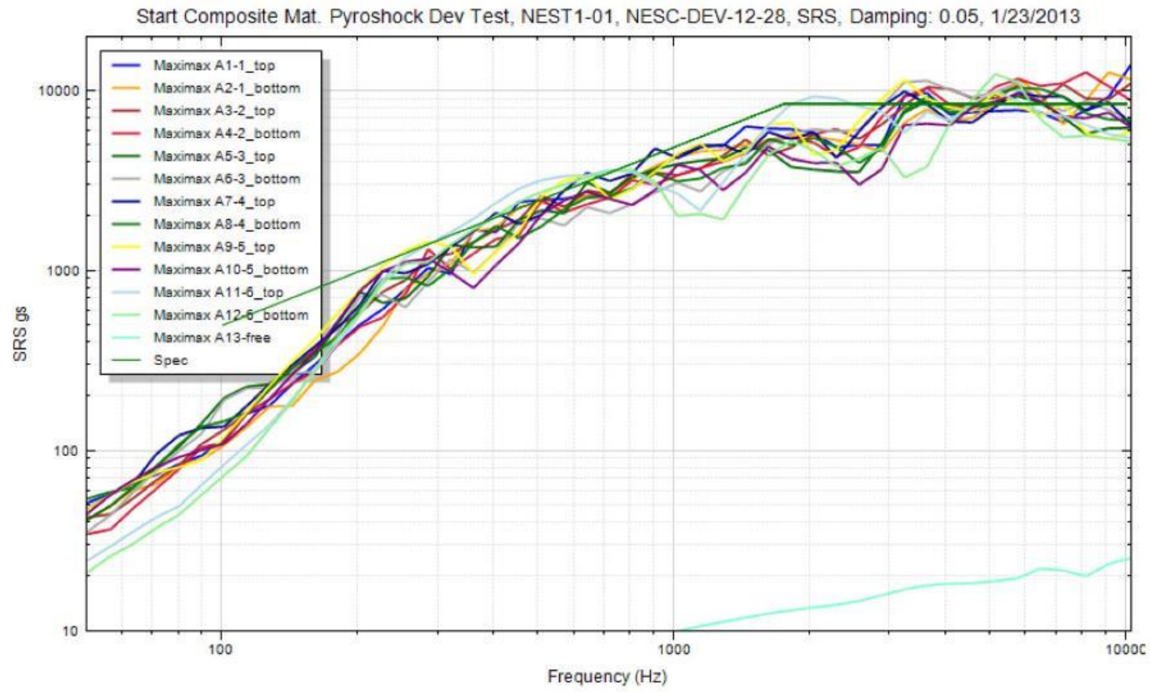
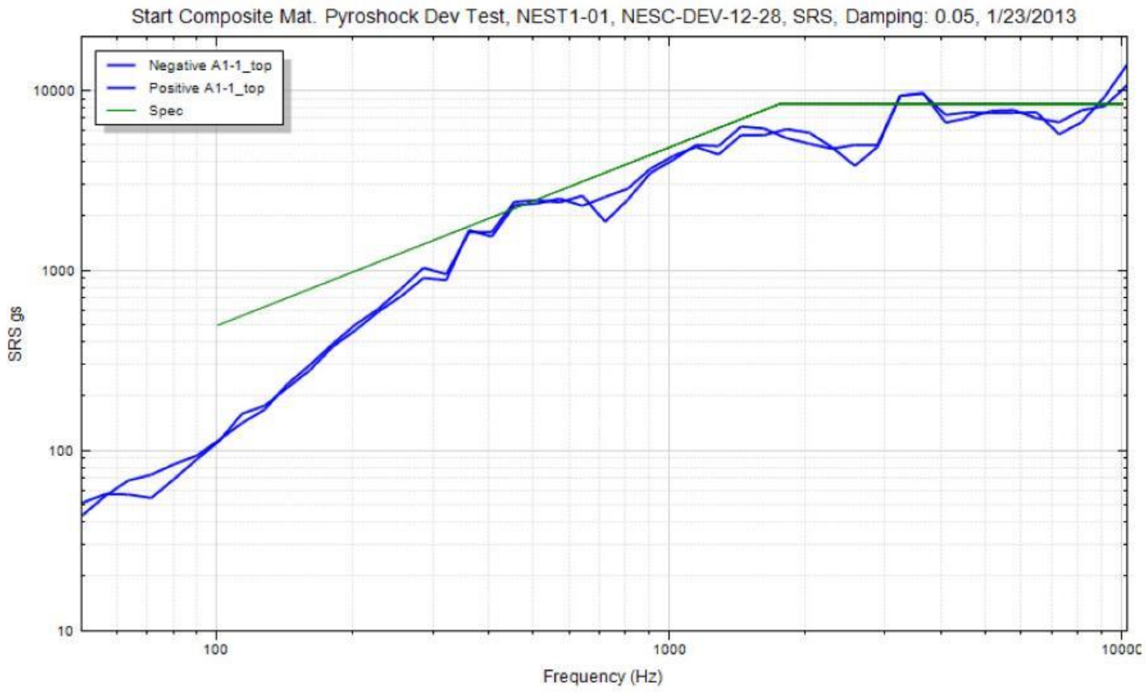
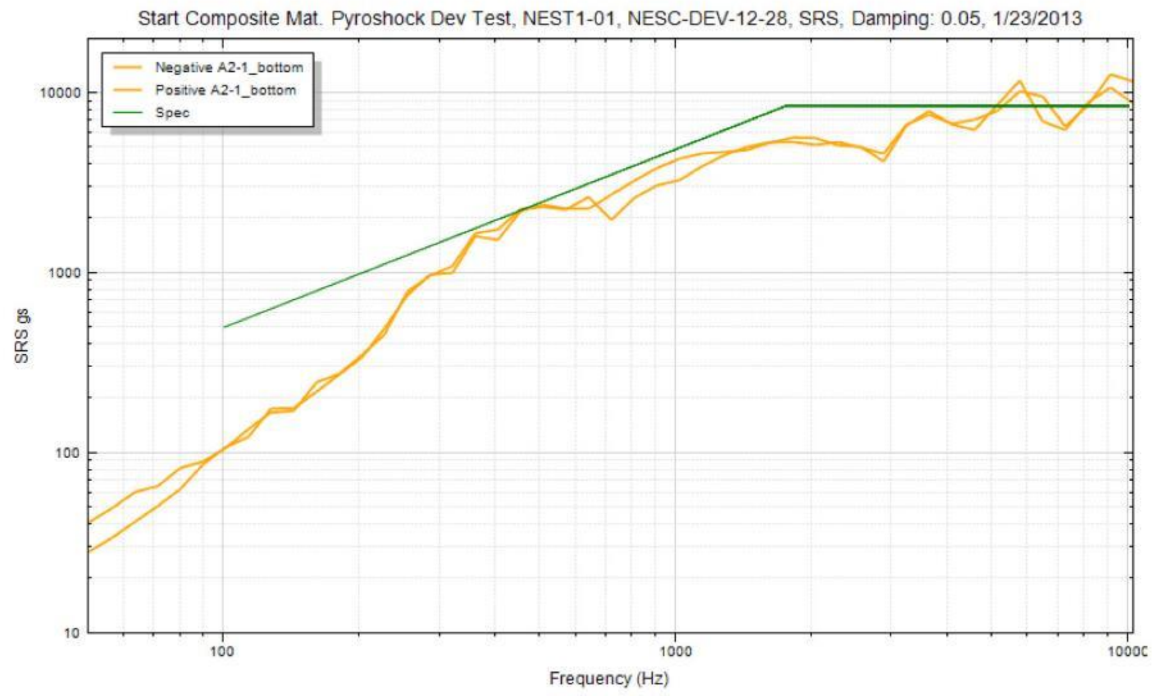
SRS Time A13-free
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

NESC-DEV-12-028
Composite Materials Shock Test

Test #3 Accelerometer Data
Panel 0320A001


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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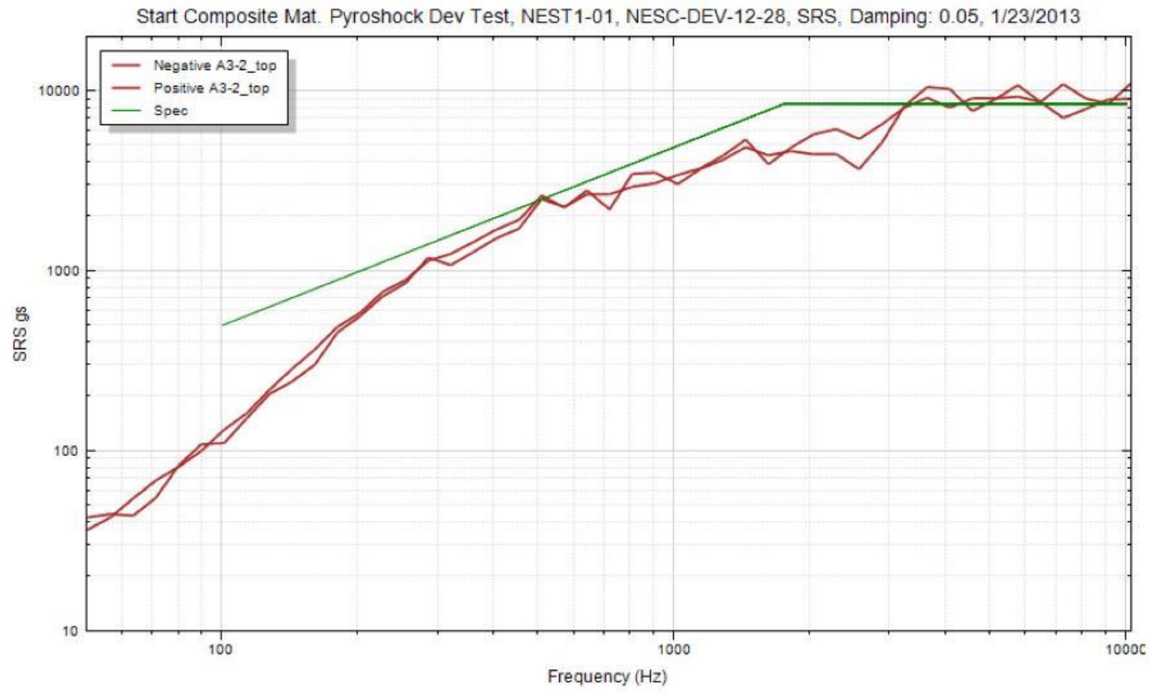
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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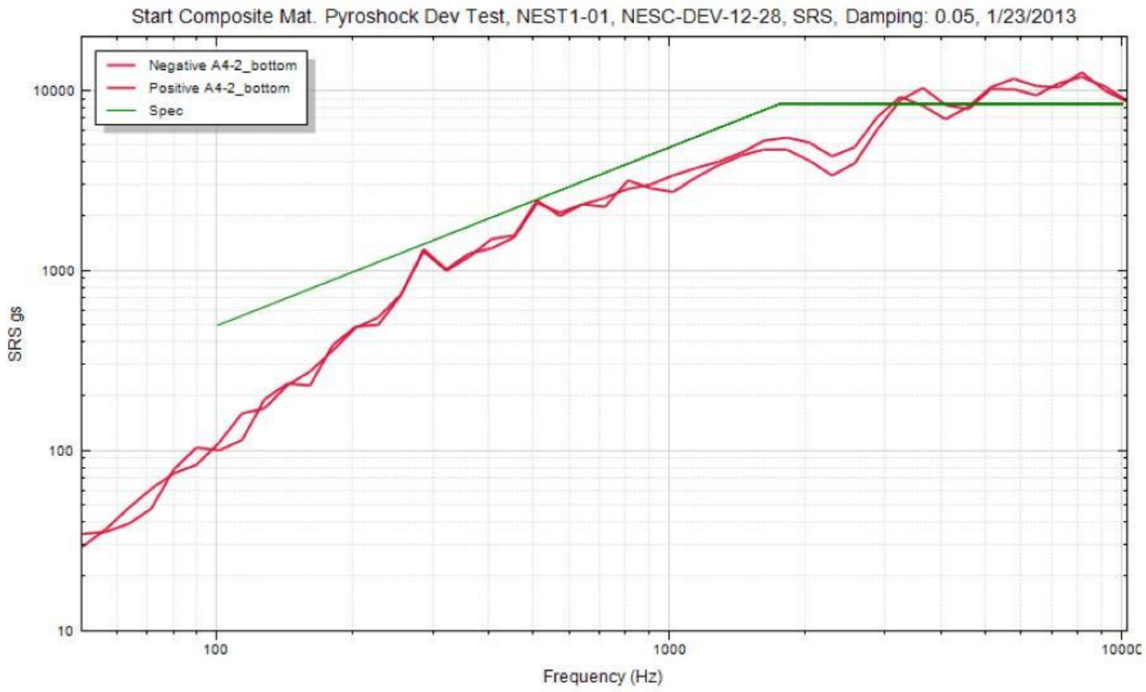
Negative A3-2_top
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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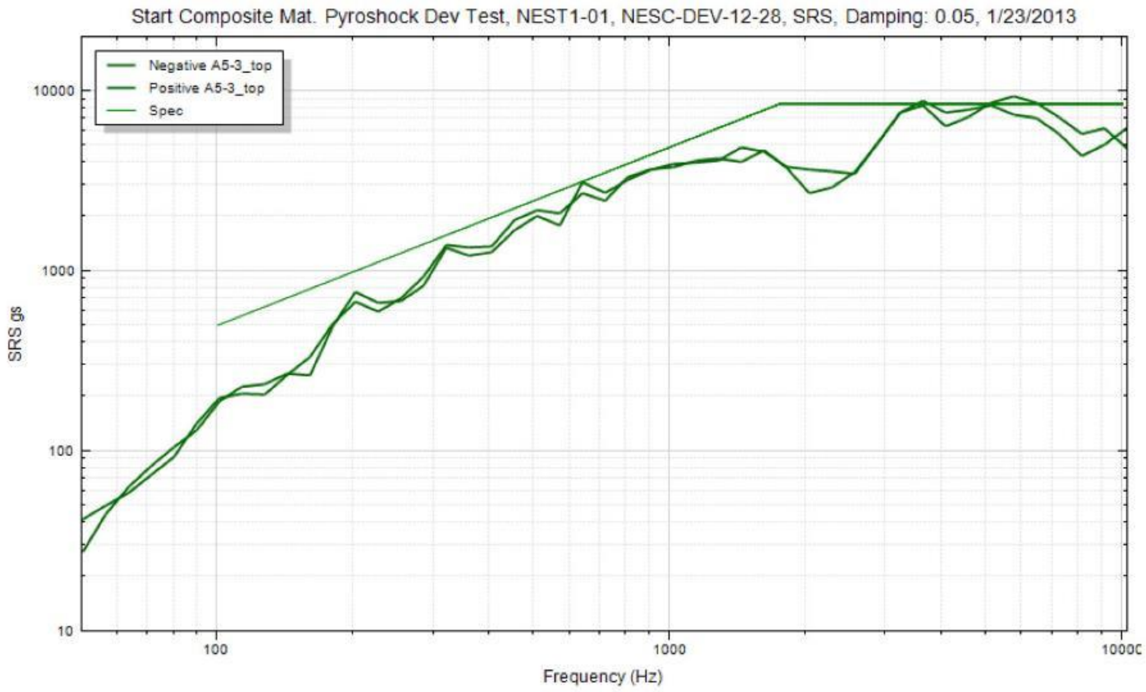
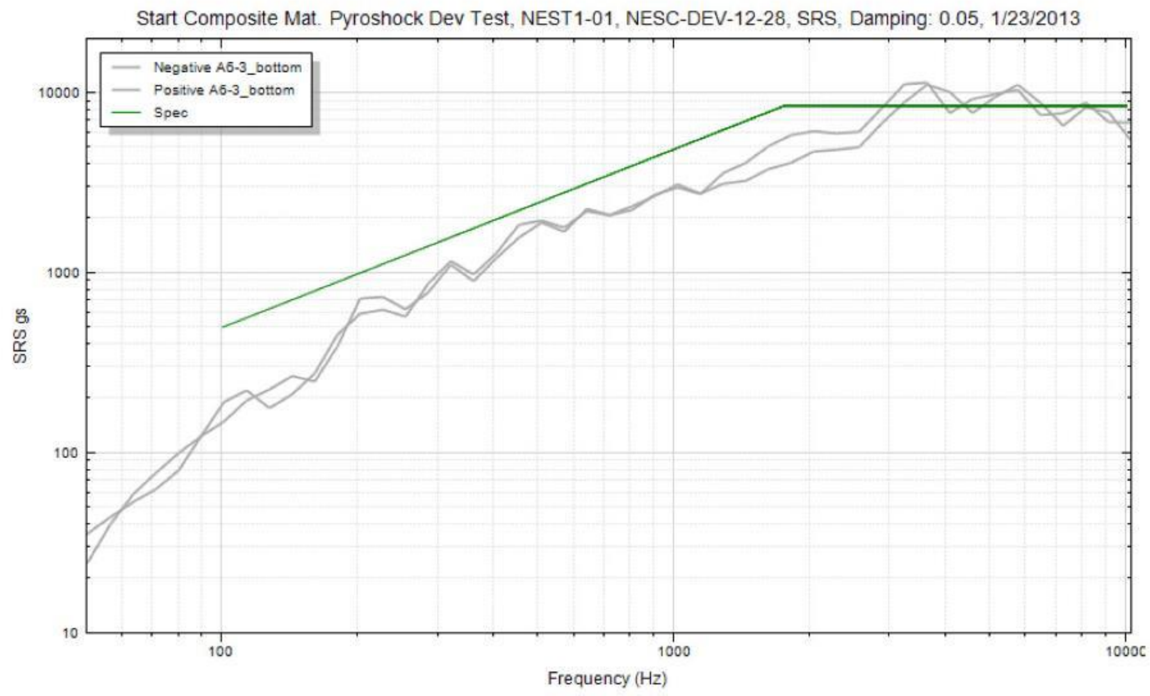
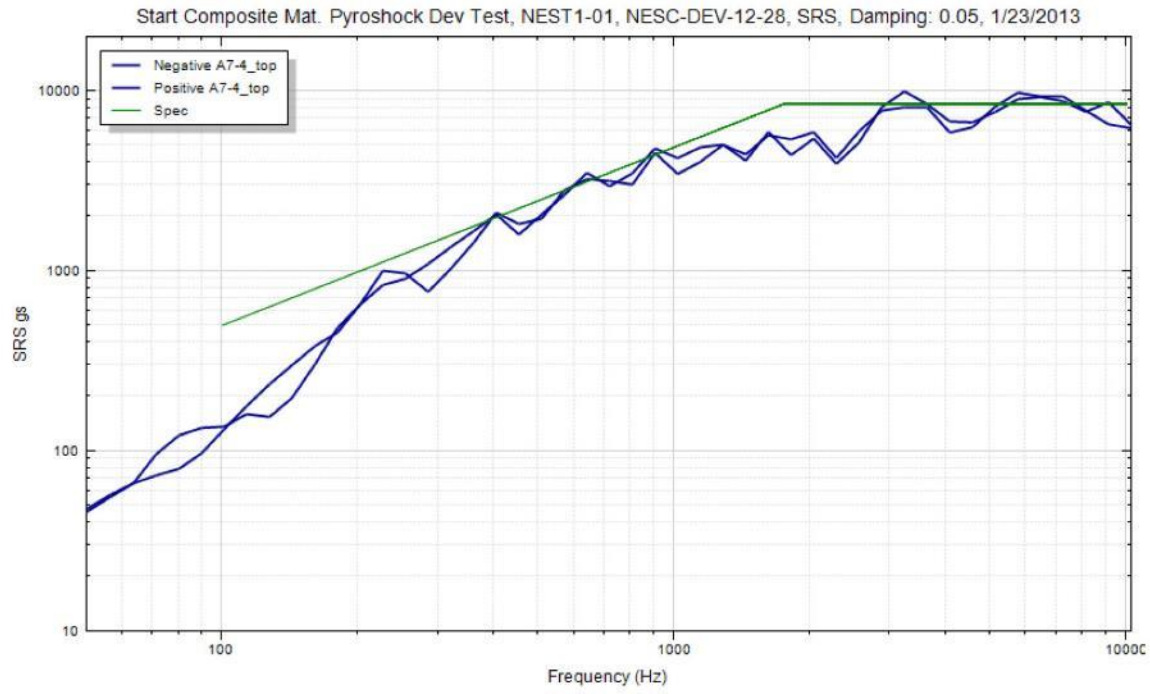
Negative A4-2_bottom
Positive A4-2_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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Negative A7-4_top
Positive A7-4_top
Spec
10000
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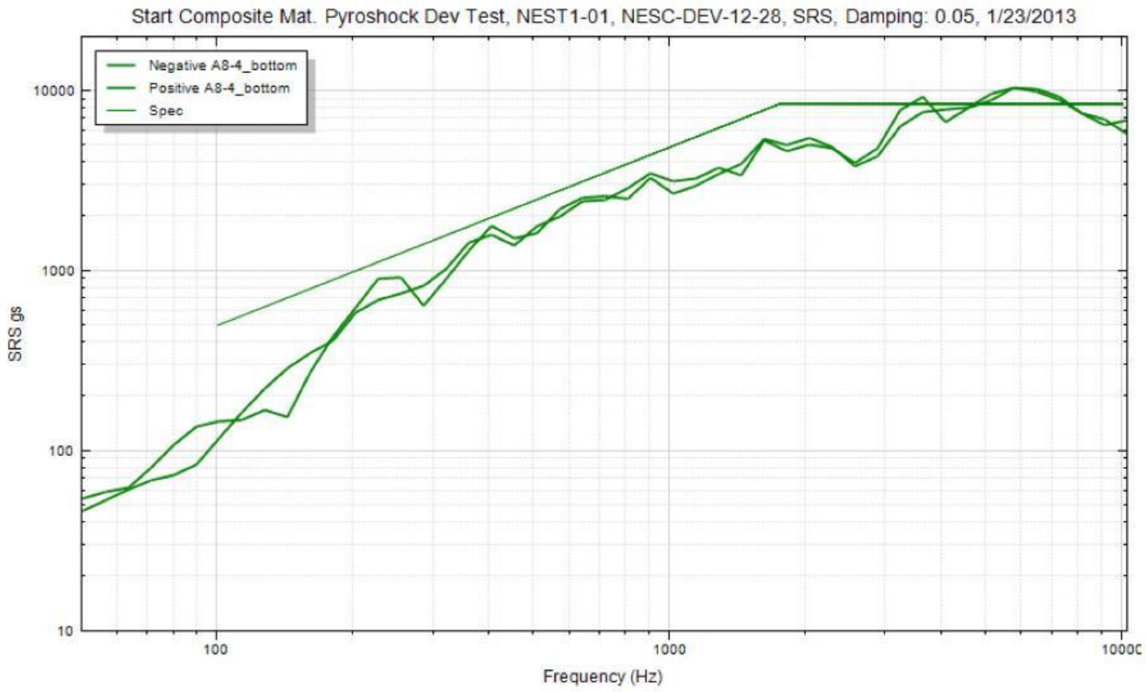
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

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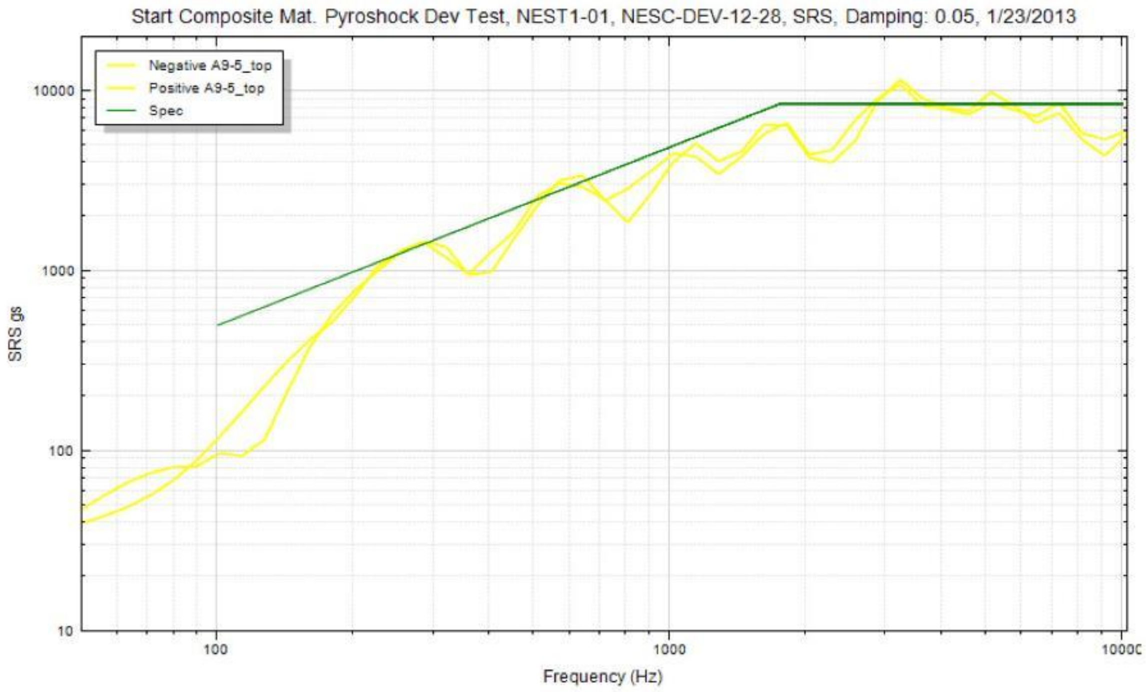
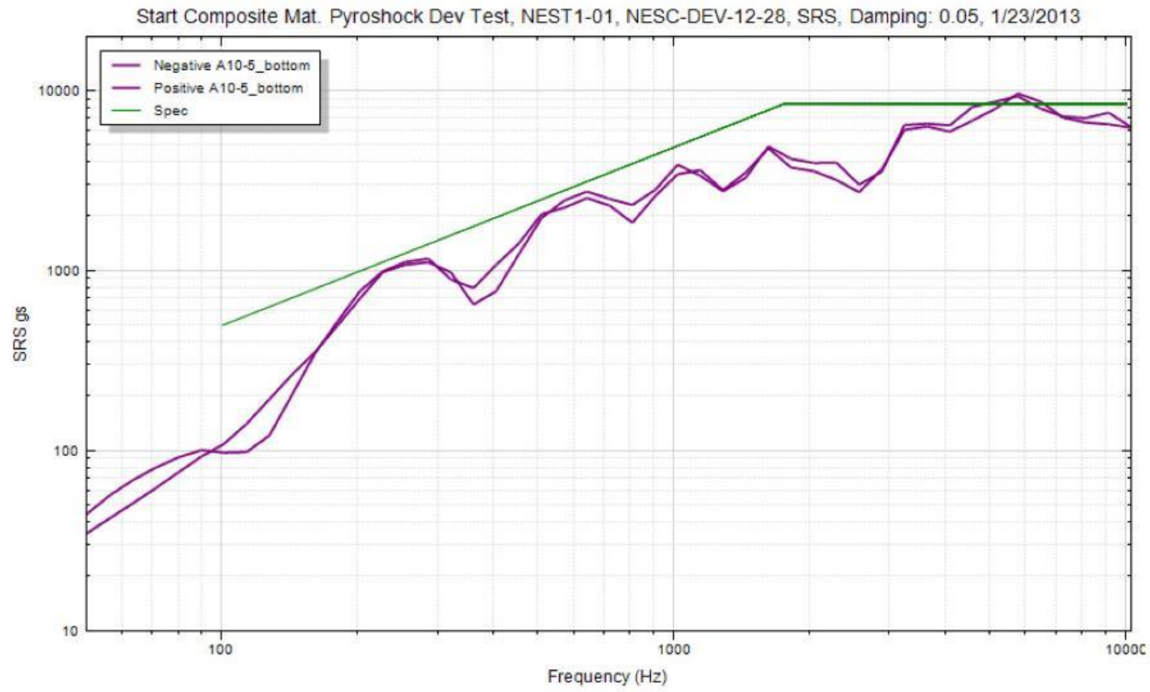
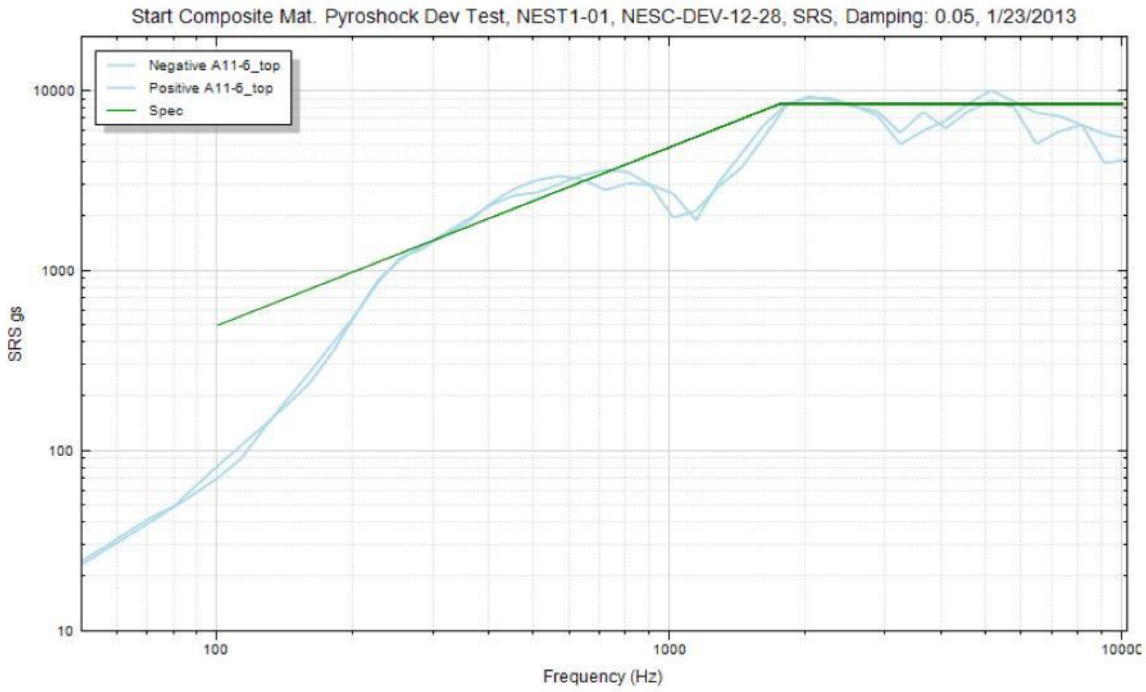

Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
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1000
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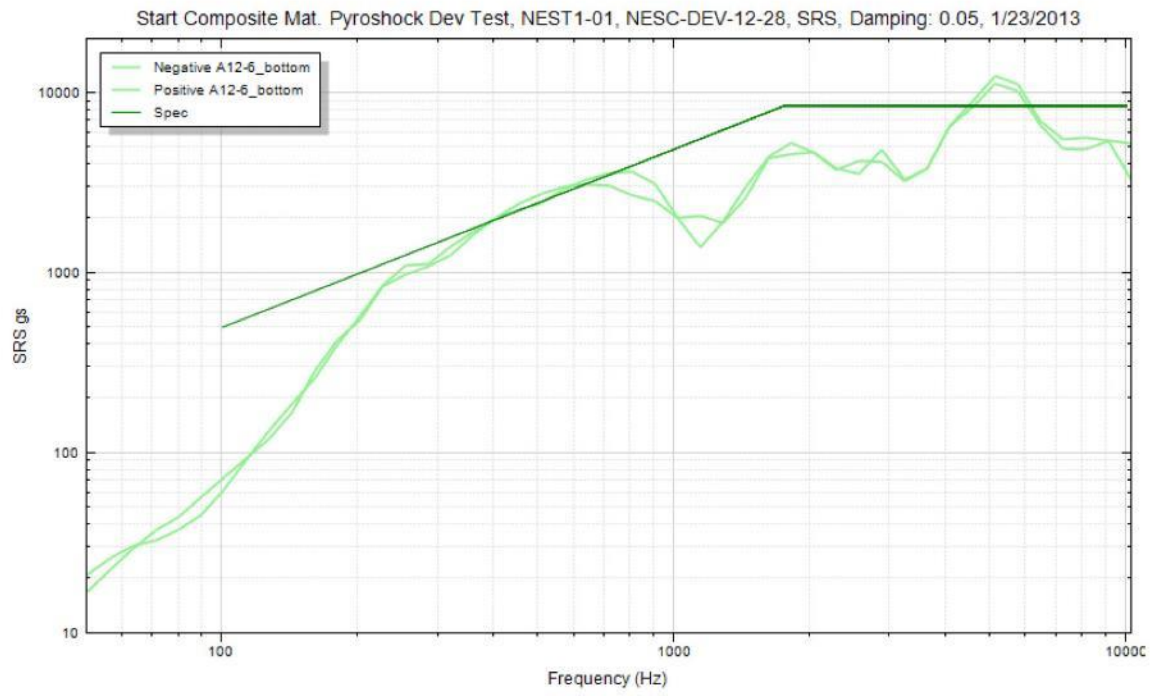
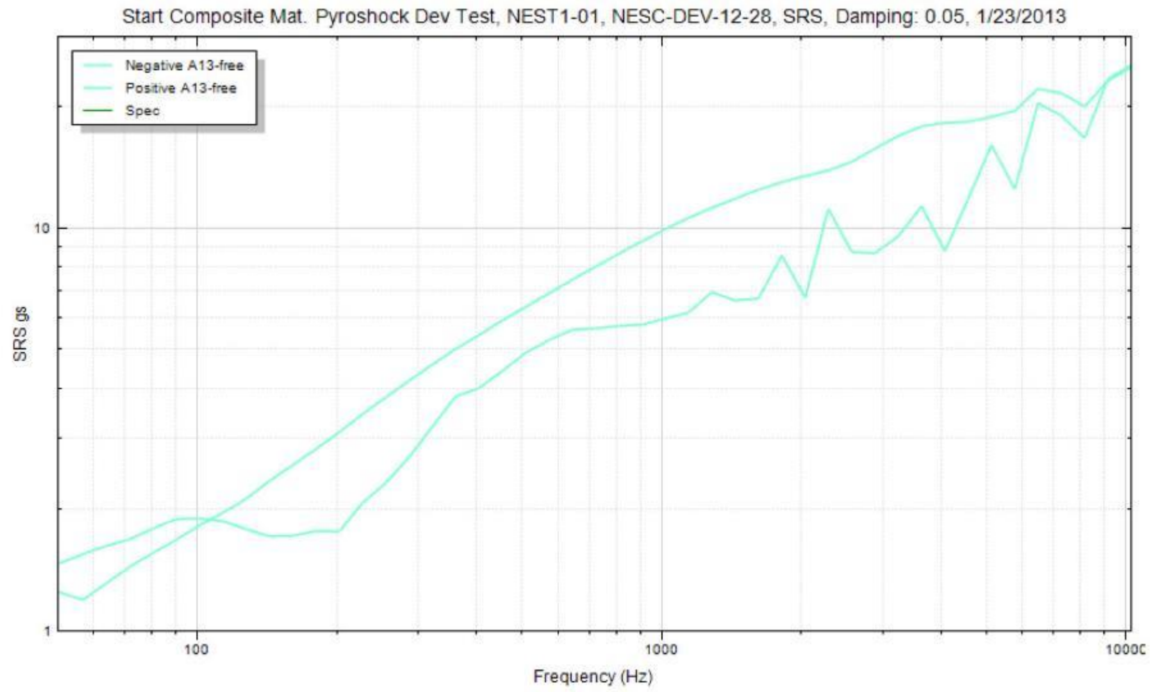
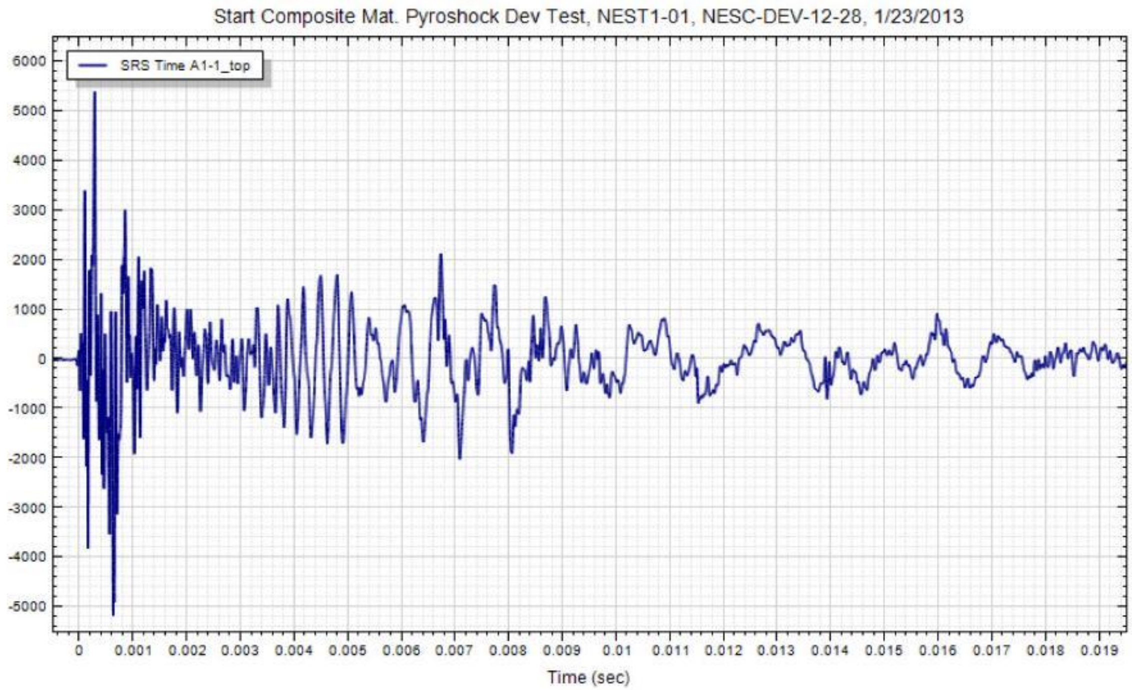
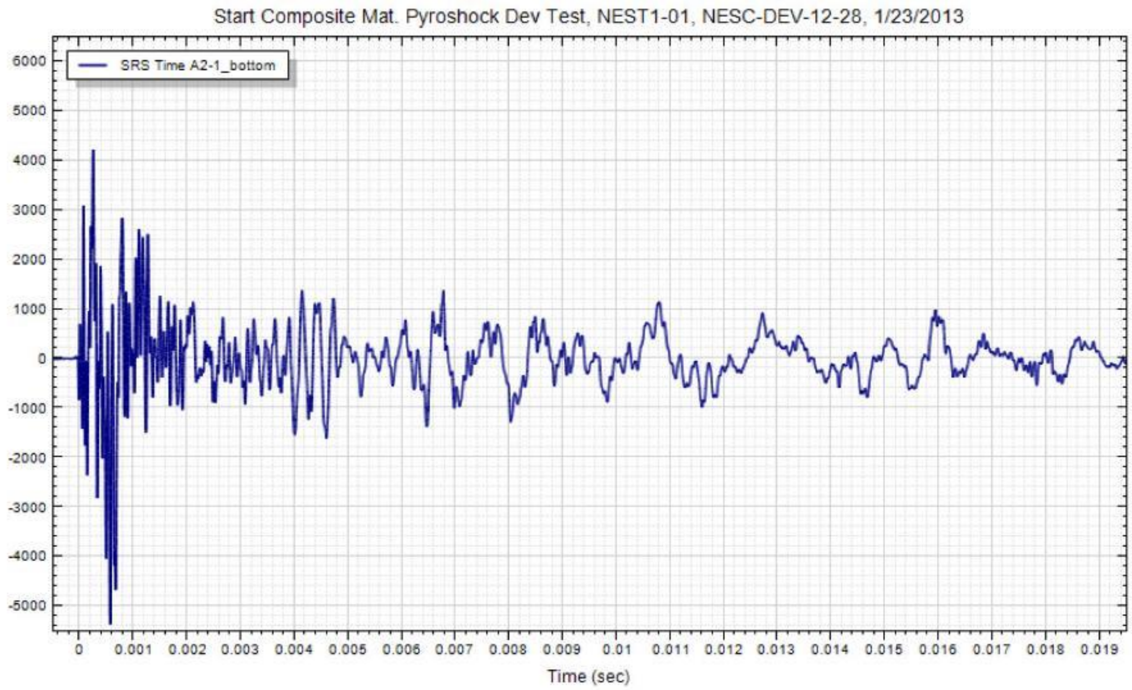
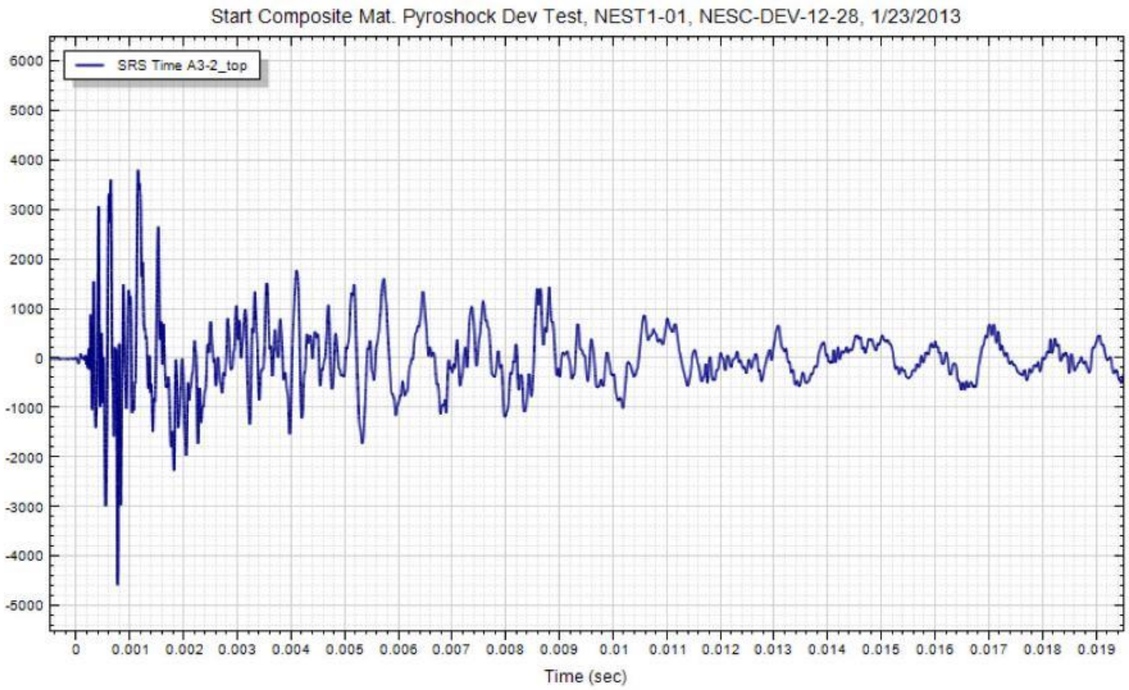
10
100
1000
10000
Frequency (Hz)

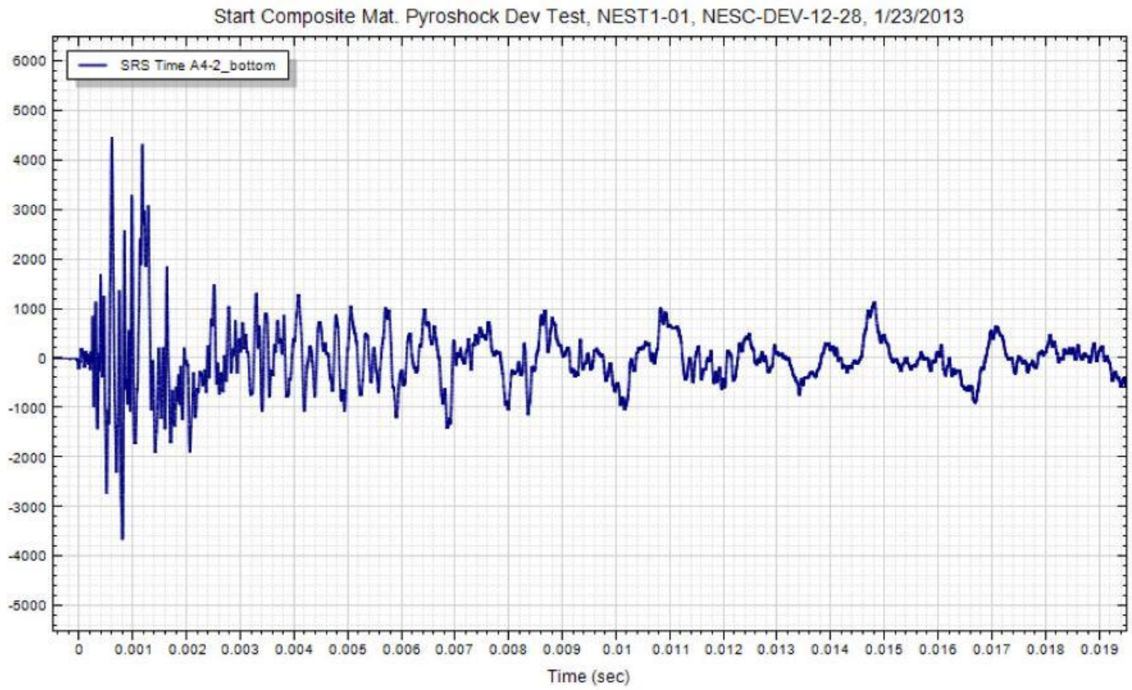

Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, SRS, Damping: 0.05, 1/23/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A1-1_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A2-1_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A3-2_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A4-2_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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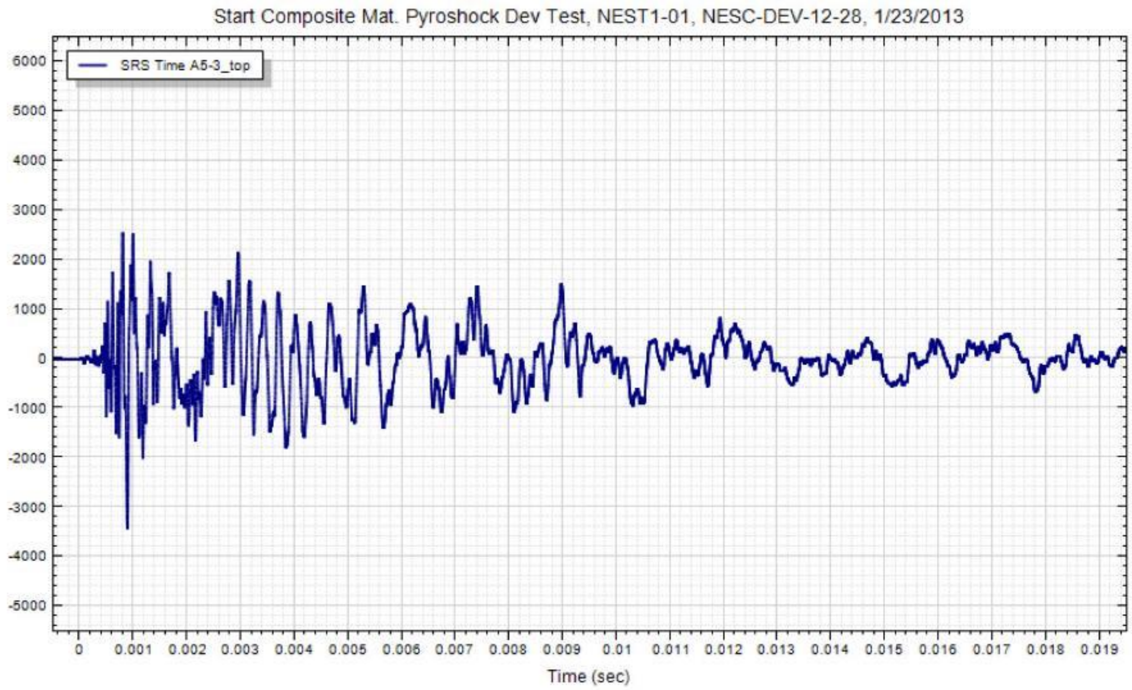
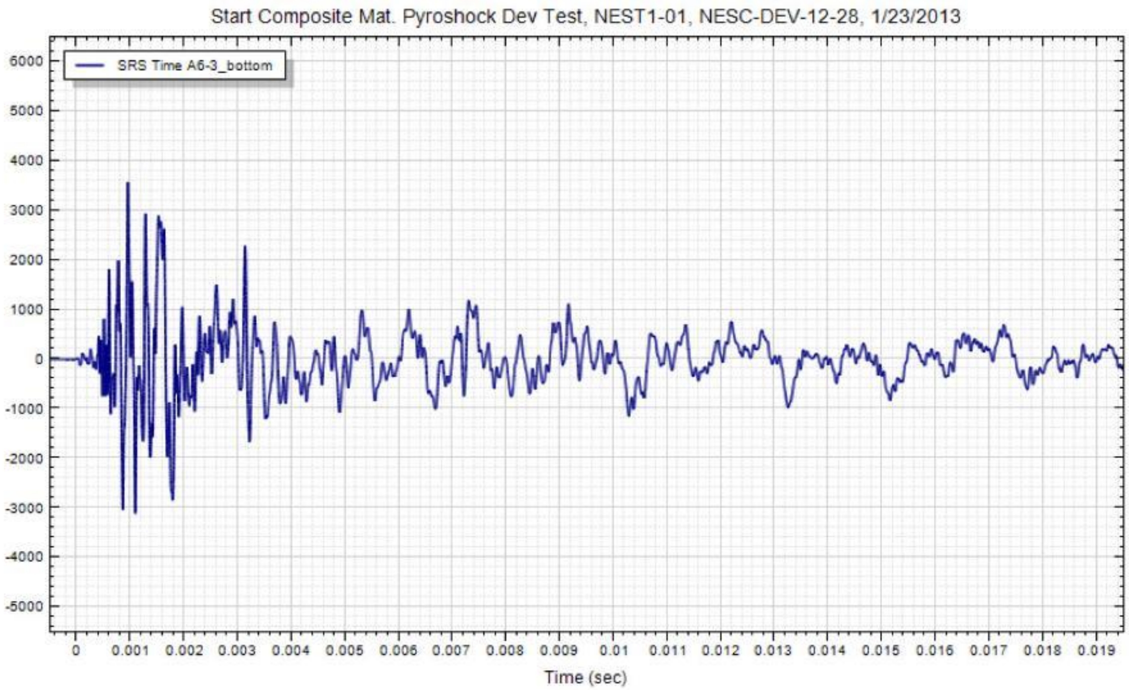
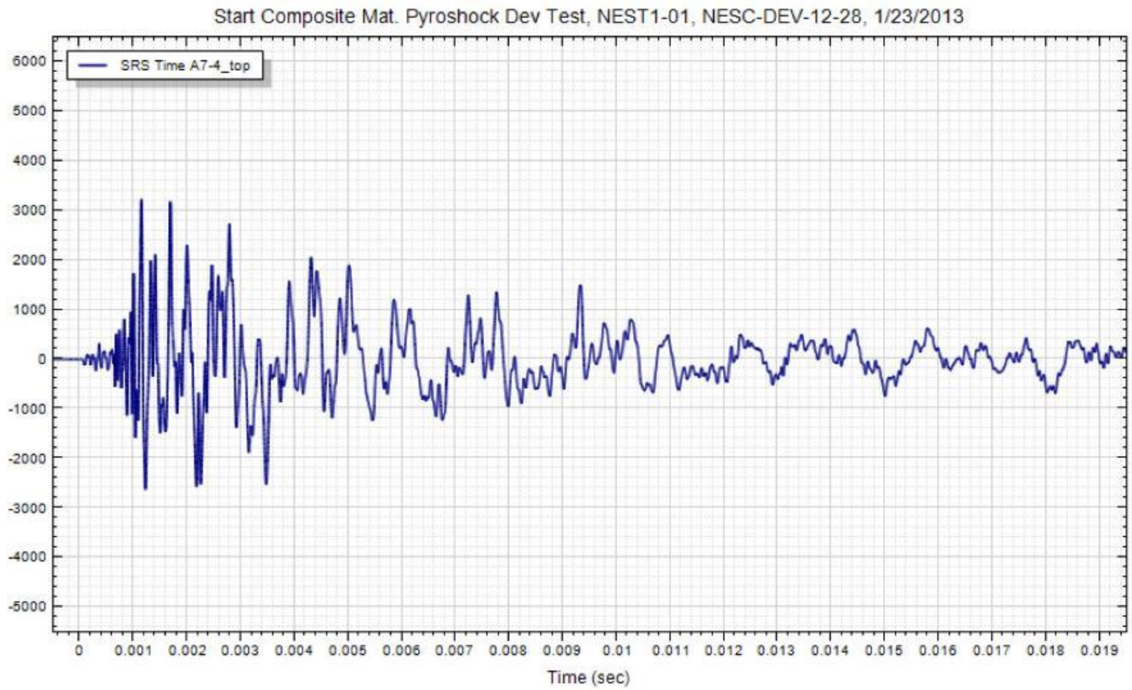
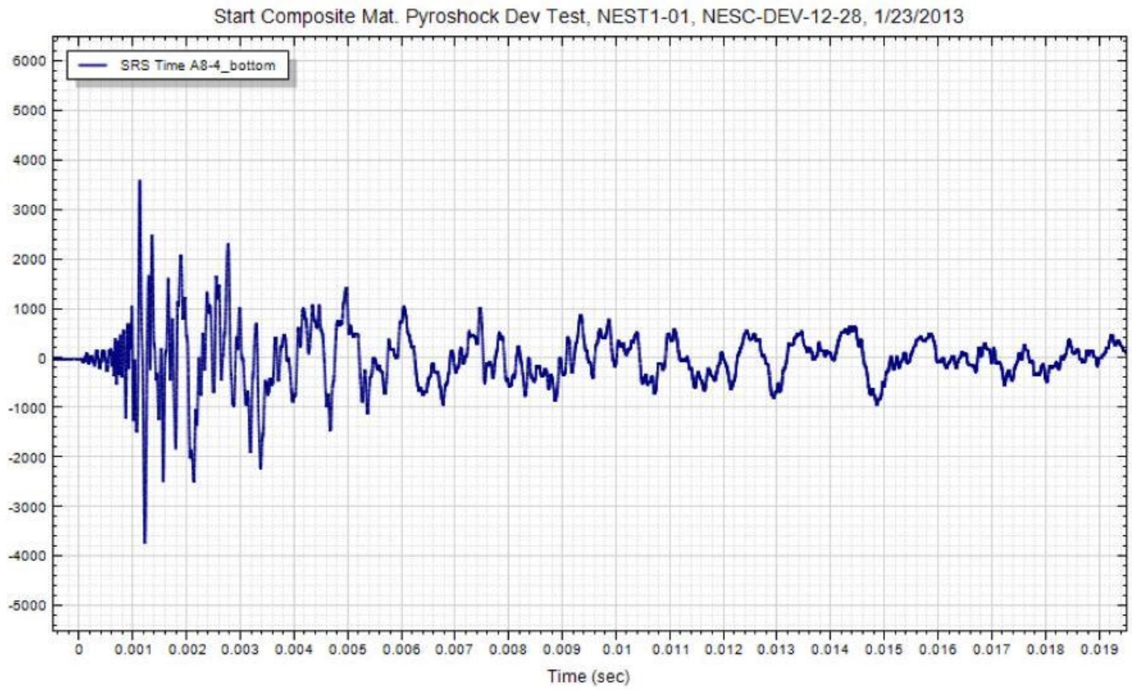

Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A5-3_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A6-3_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A7-4_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A8-4_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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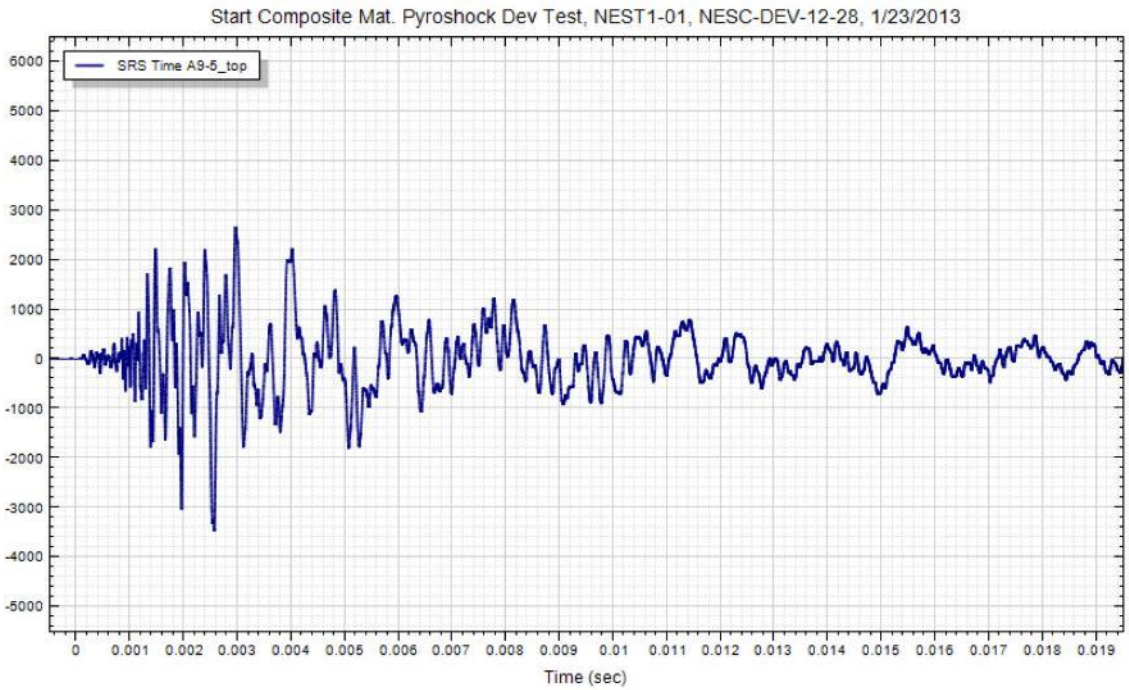
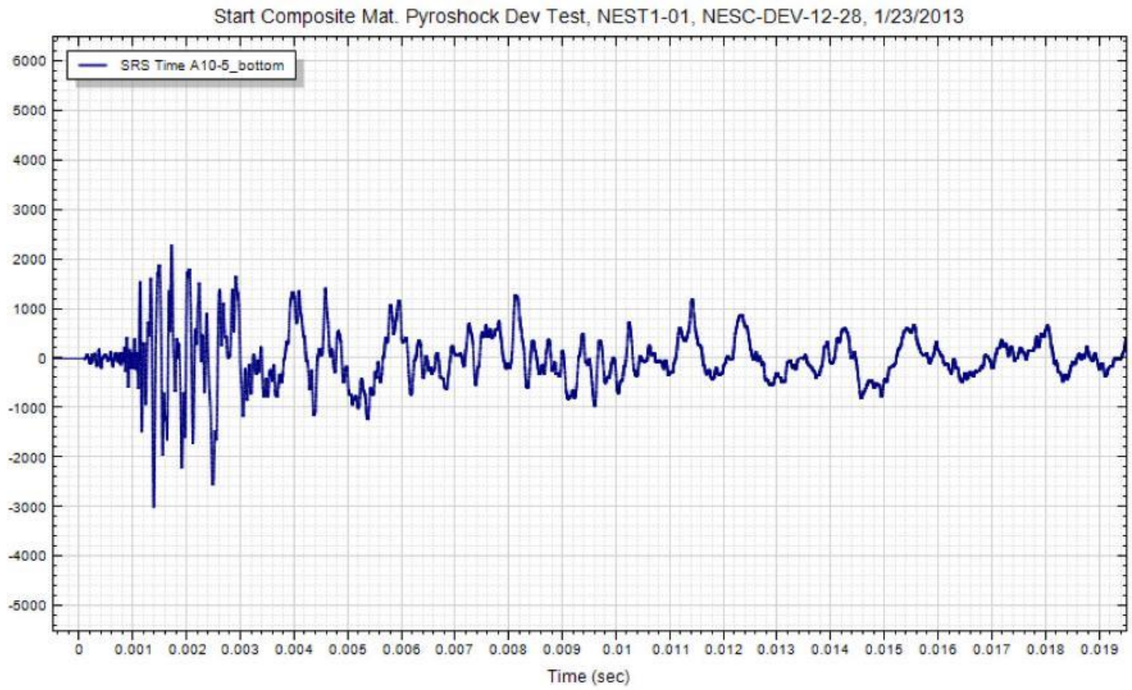
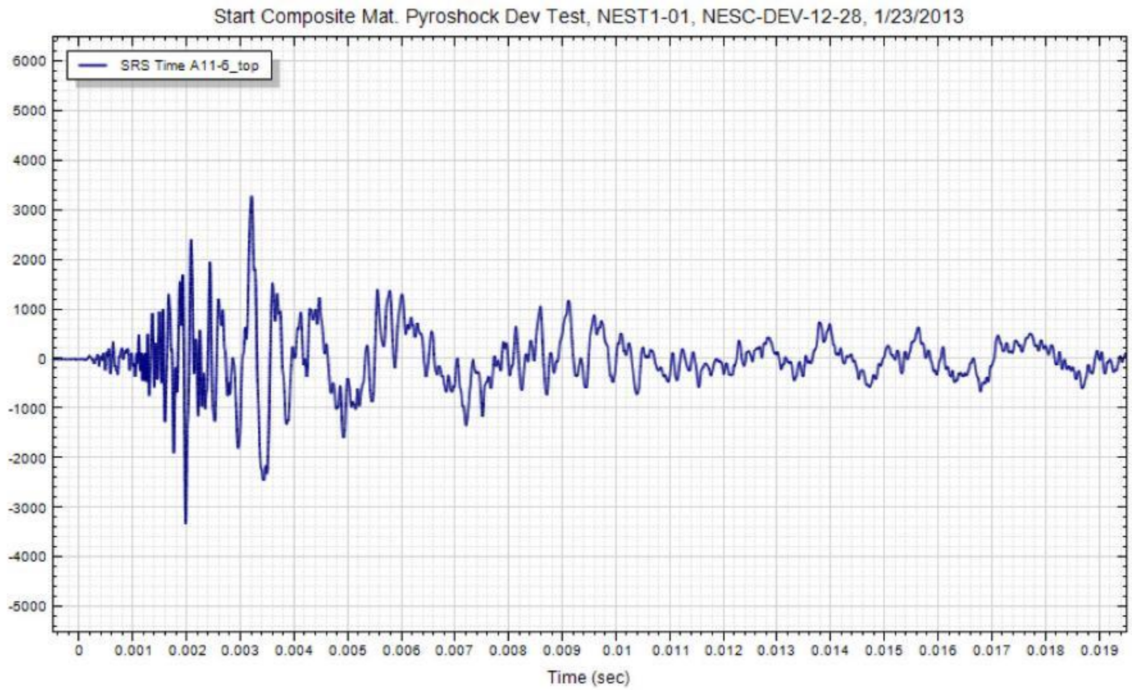
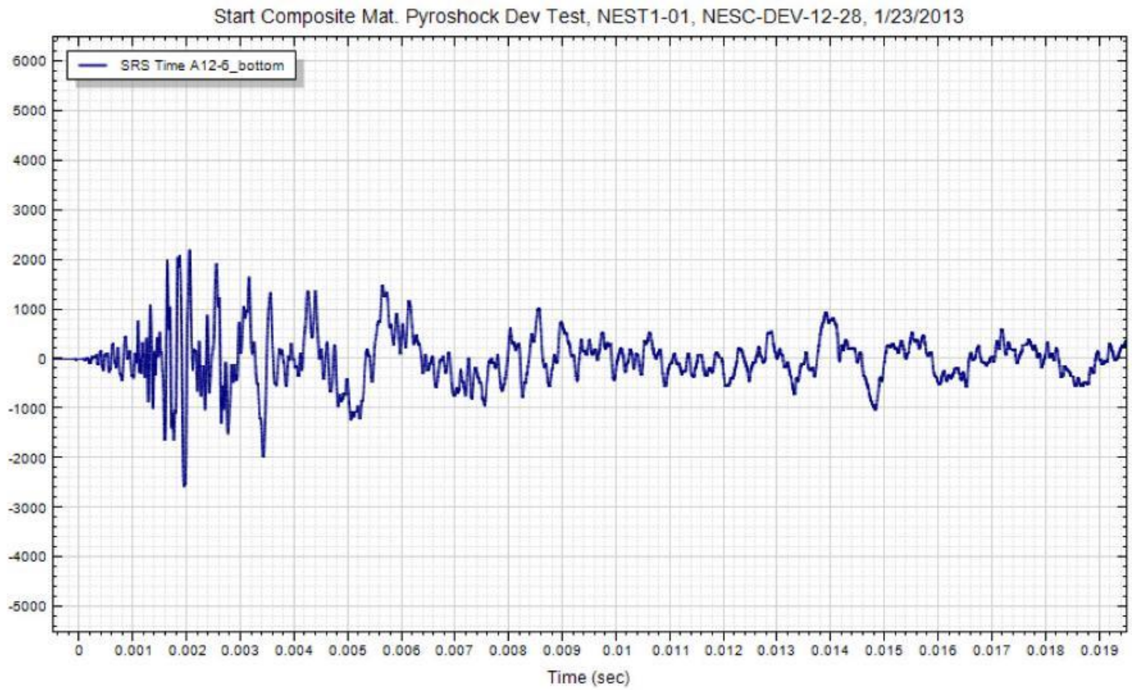
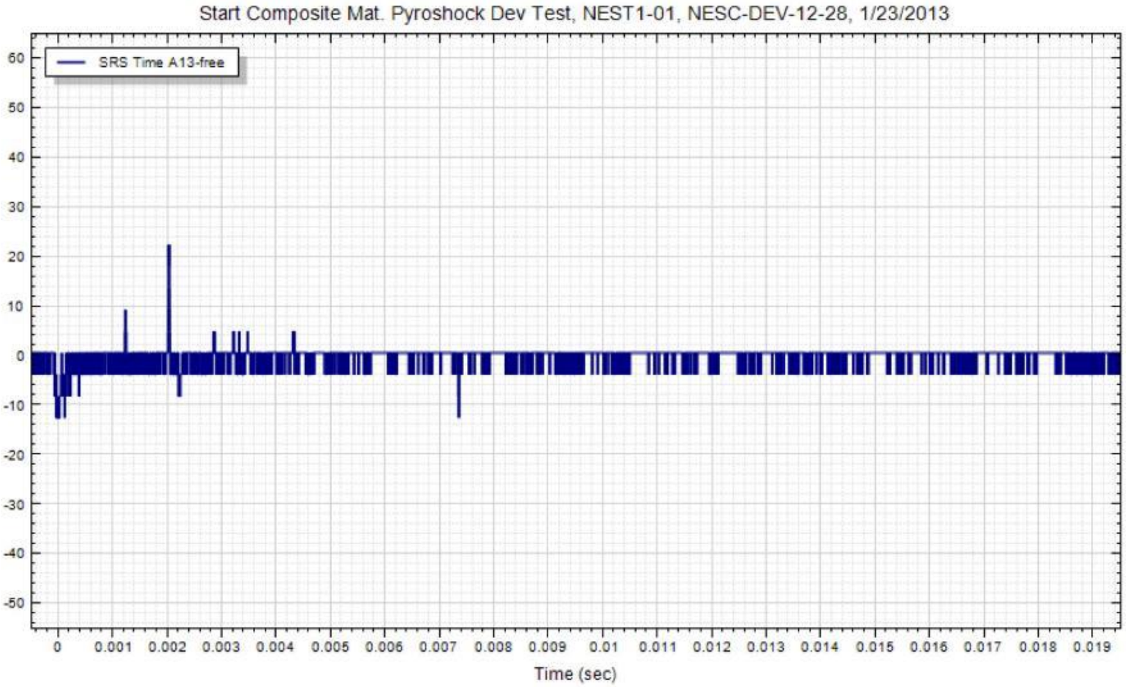

Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A9-5_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A10-5_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A11-6_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)



Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013


Start Composite Mat. Pyroshock Dev Test, NEST1-01, NESC-DEV-12-28, 1/23/2013
SRS Time A13-free
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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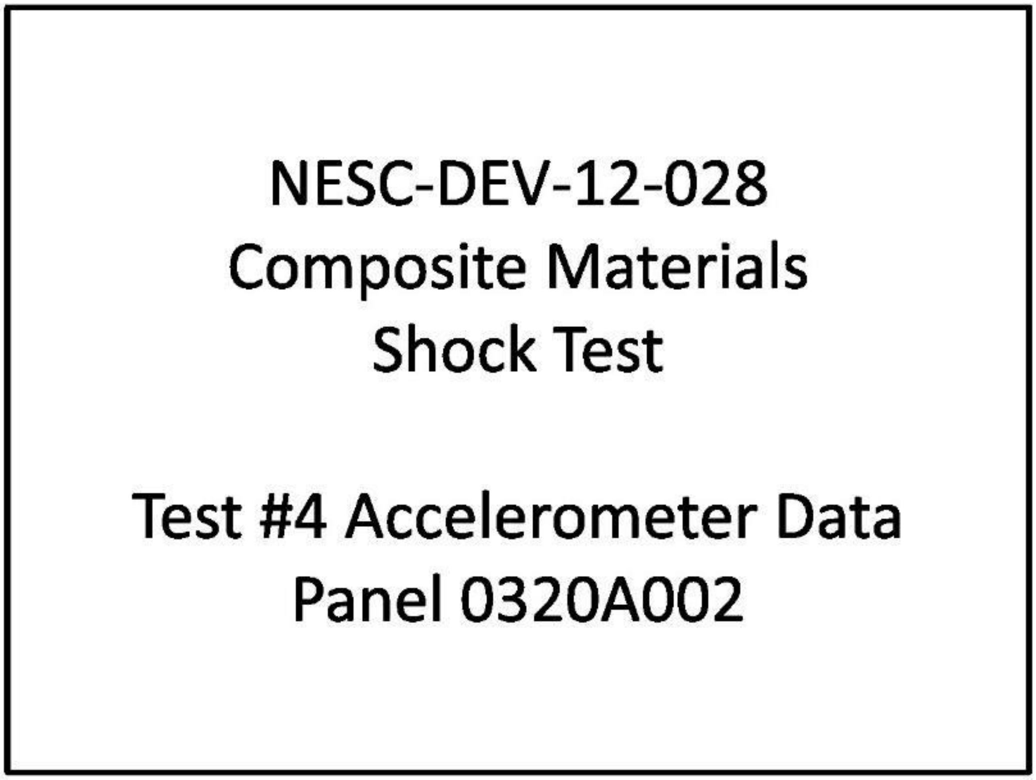

NESC-DEV-12-028
Composite Materials
Shock Test

Test #4 Accelerometer Data
Panel 0320A002

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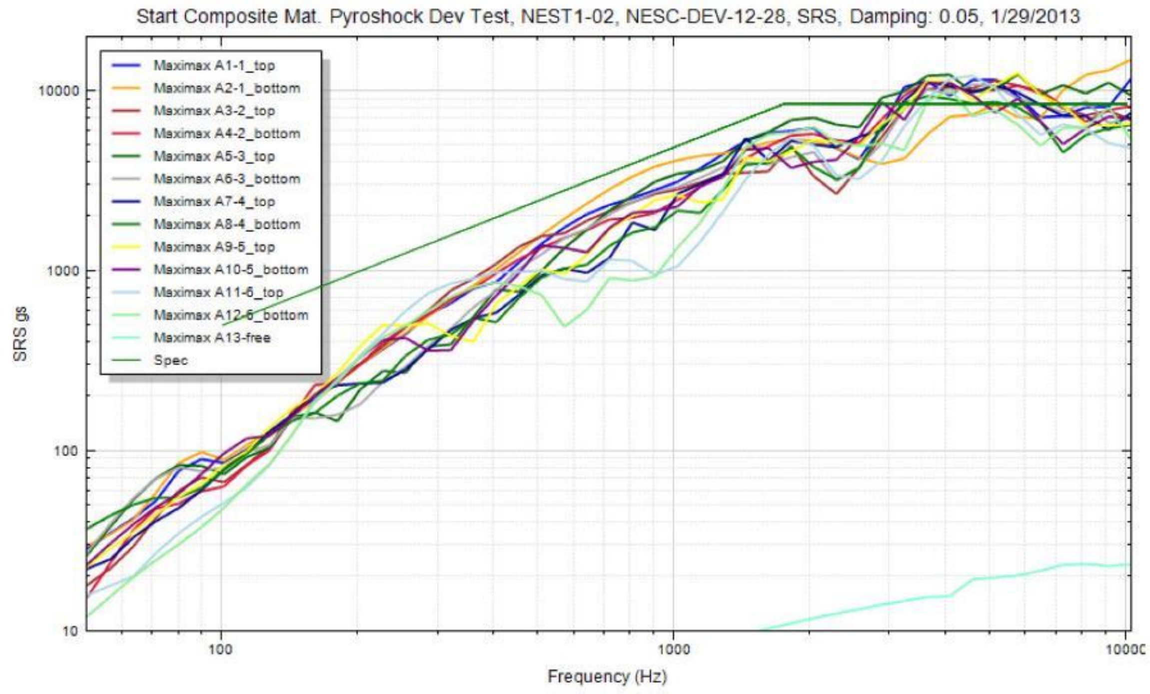
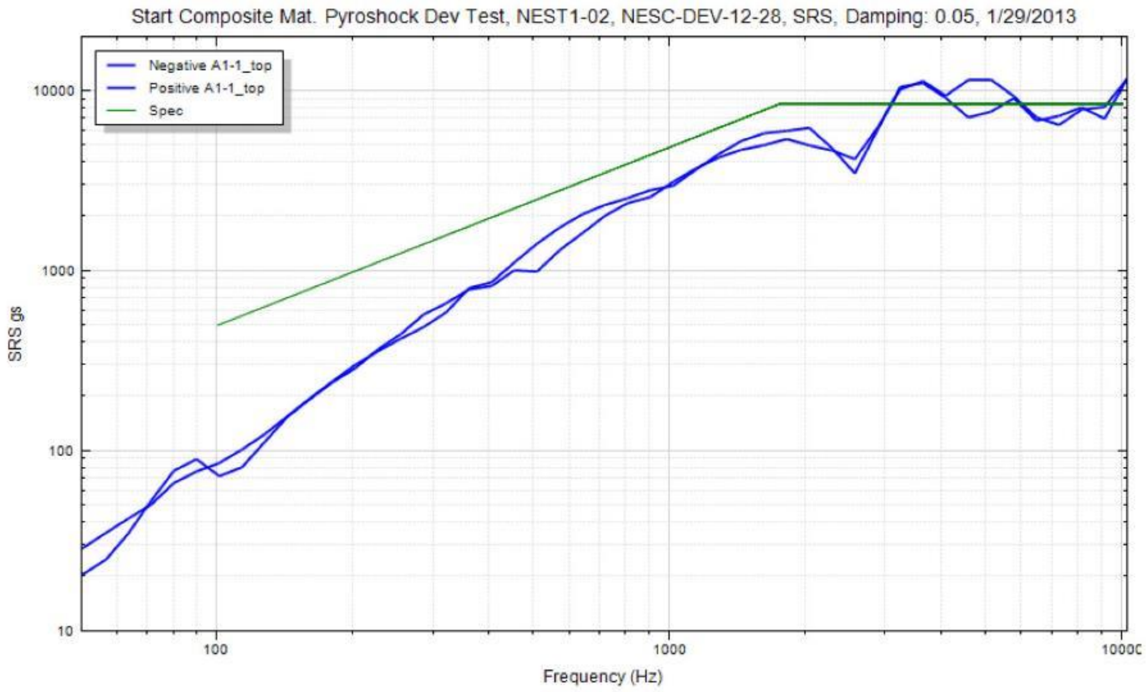
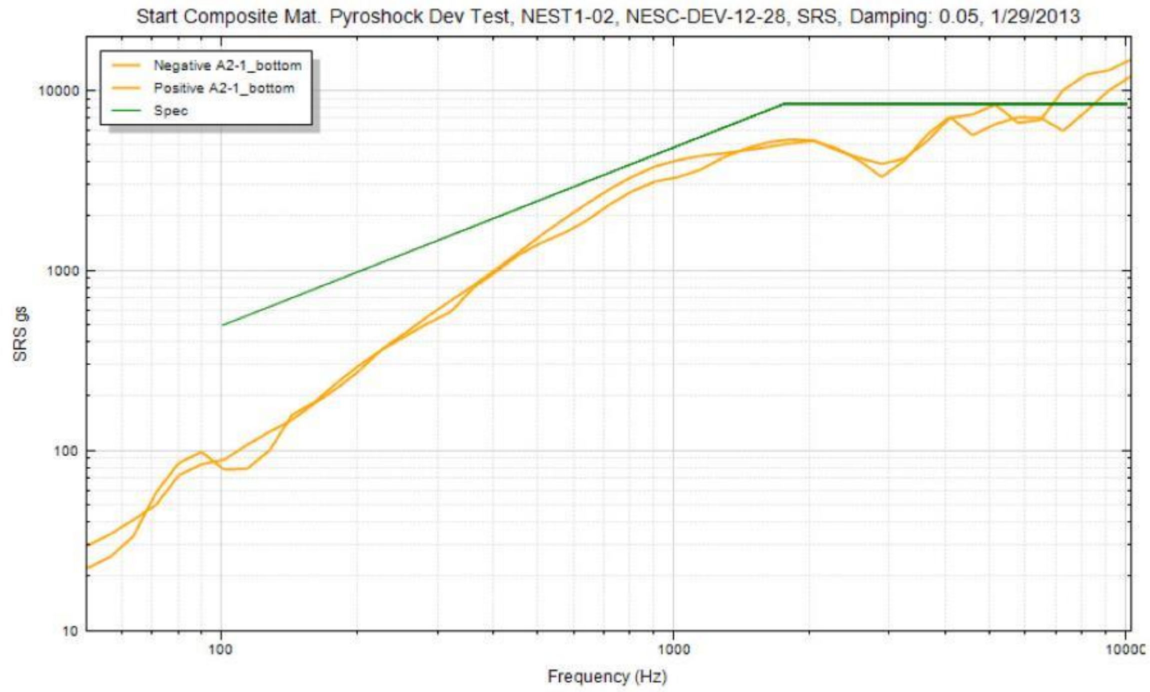

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

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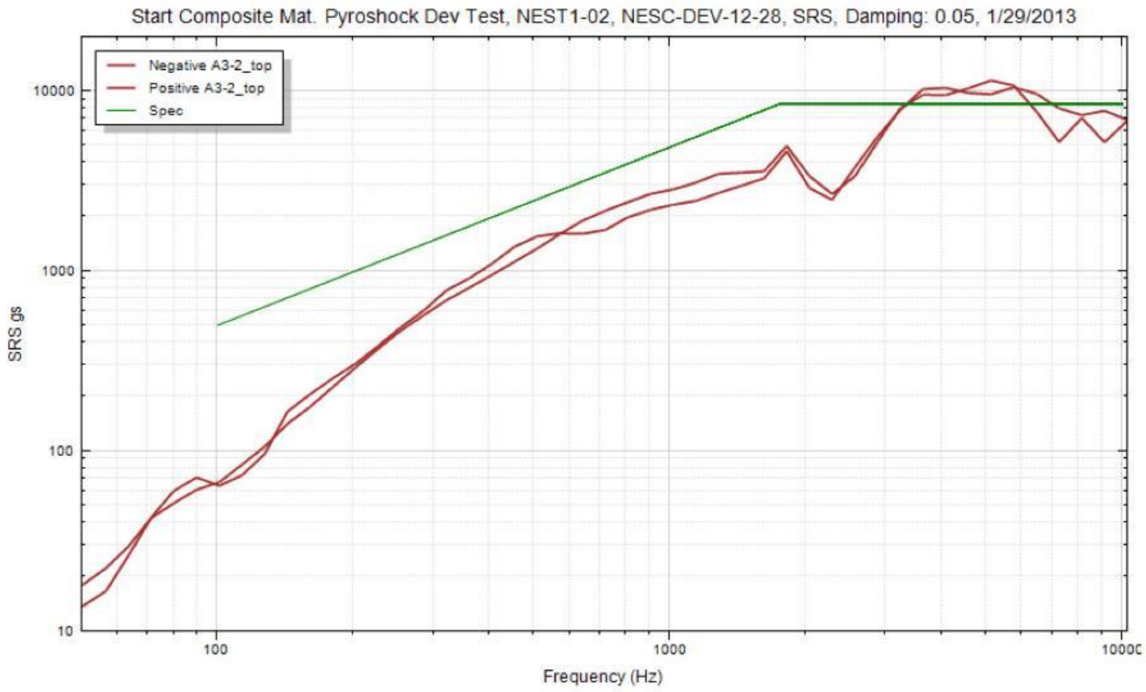
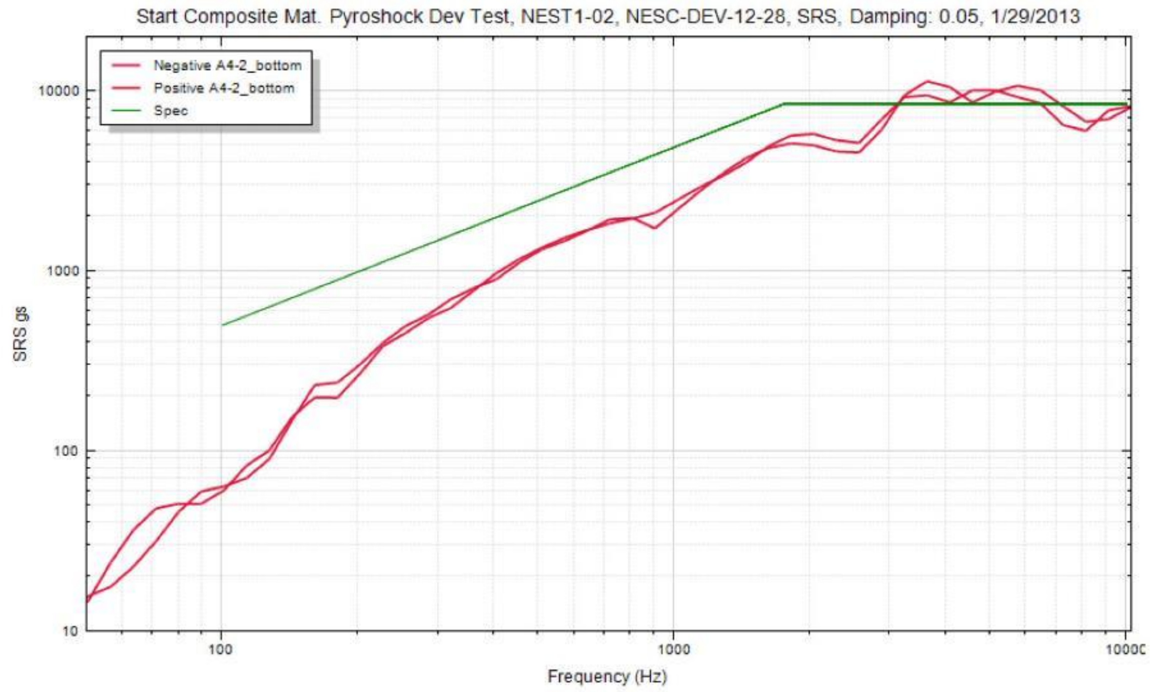
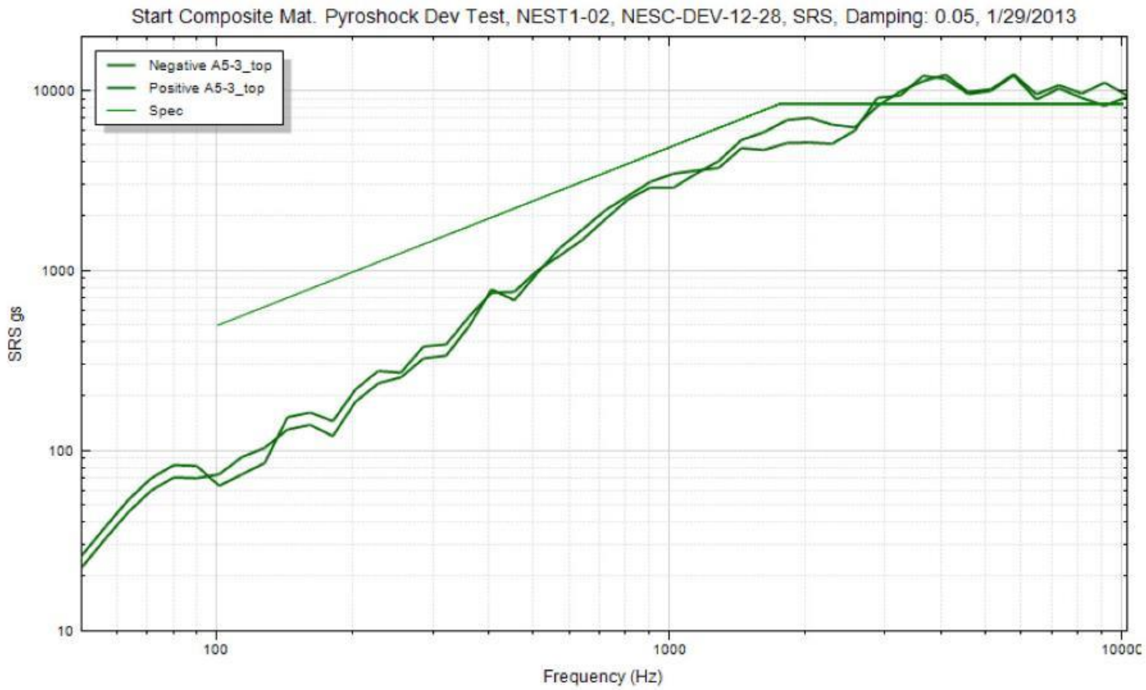
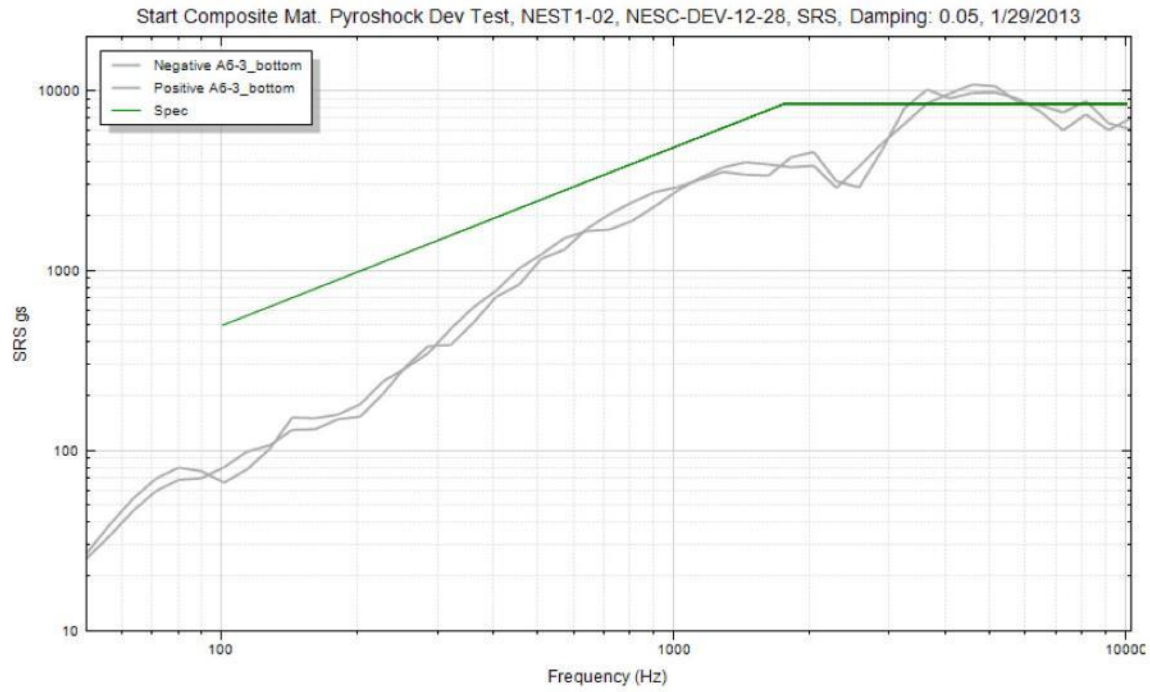
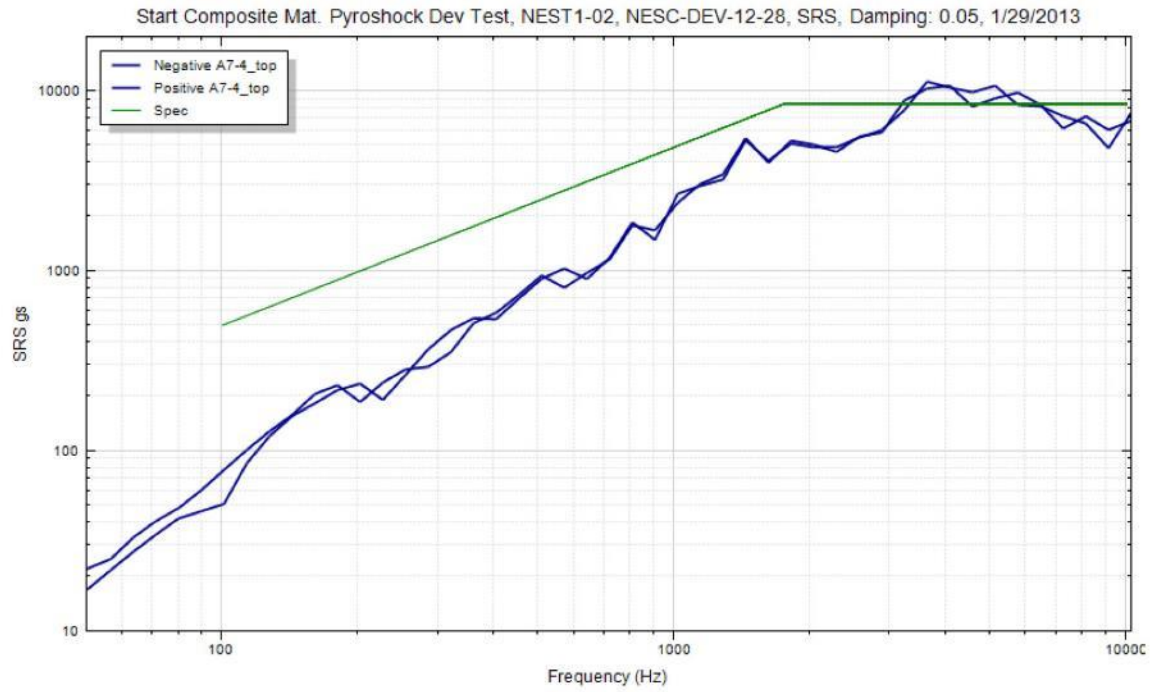

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A3-2_top
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
100
1000
1000C
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A7-4_top
Positive A7-4_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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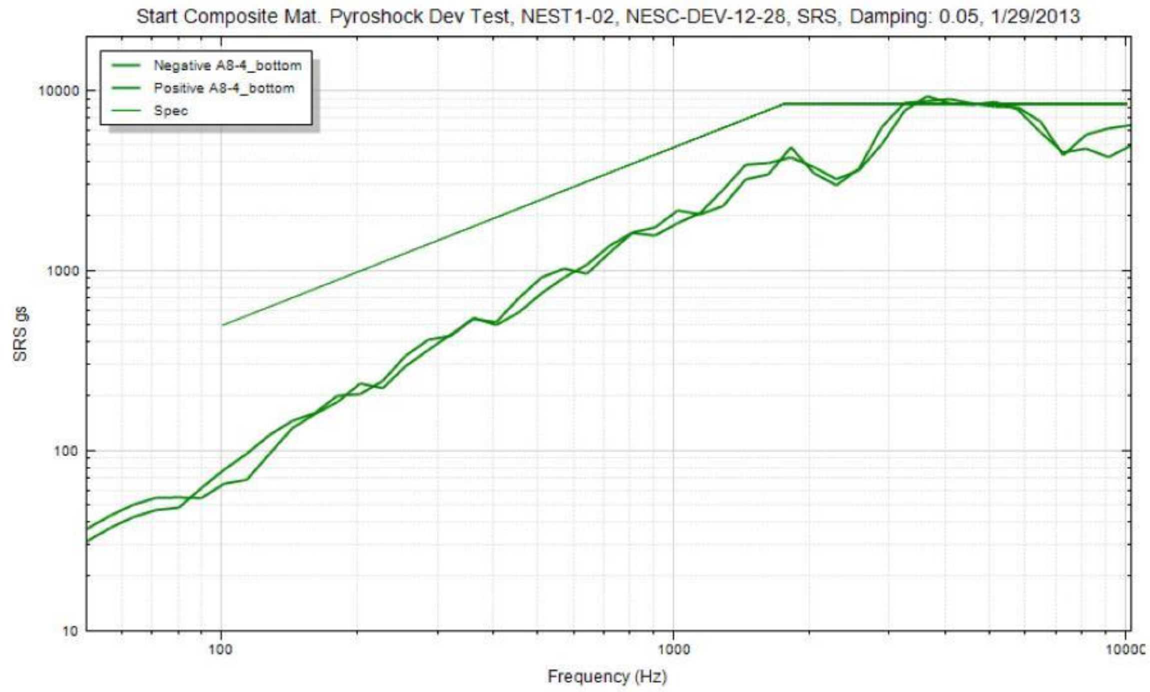
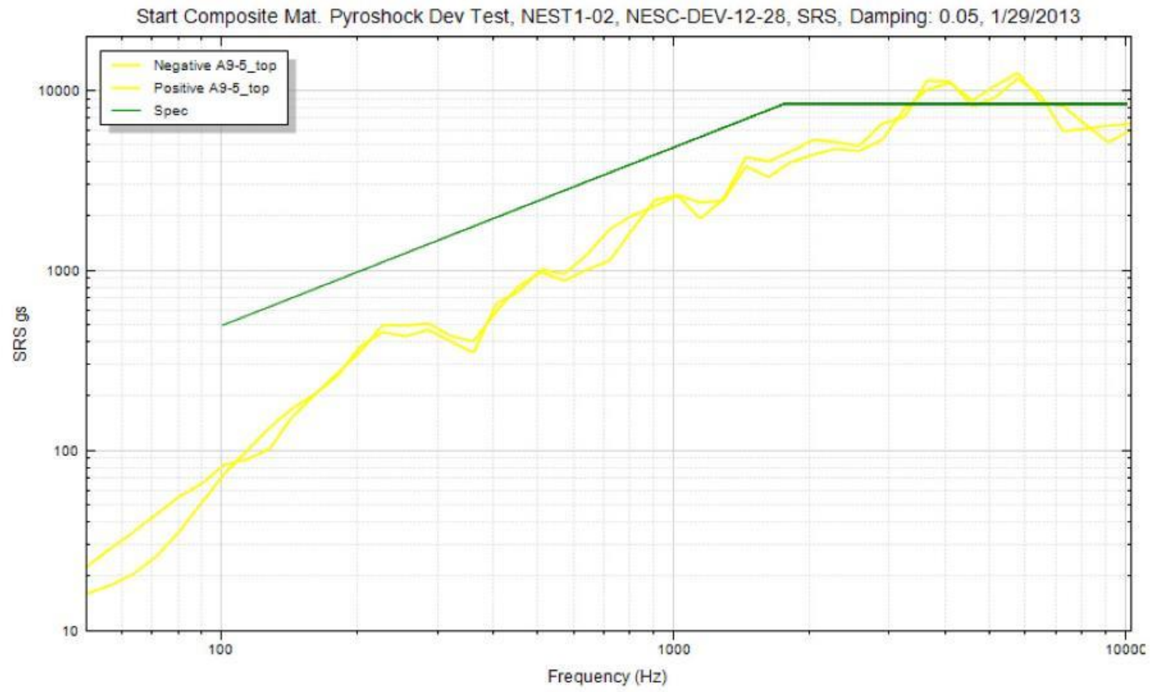
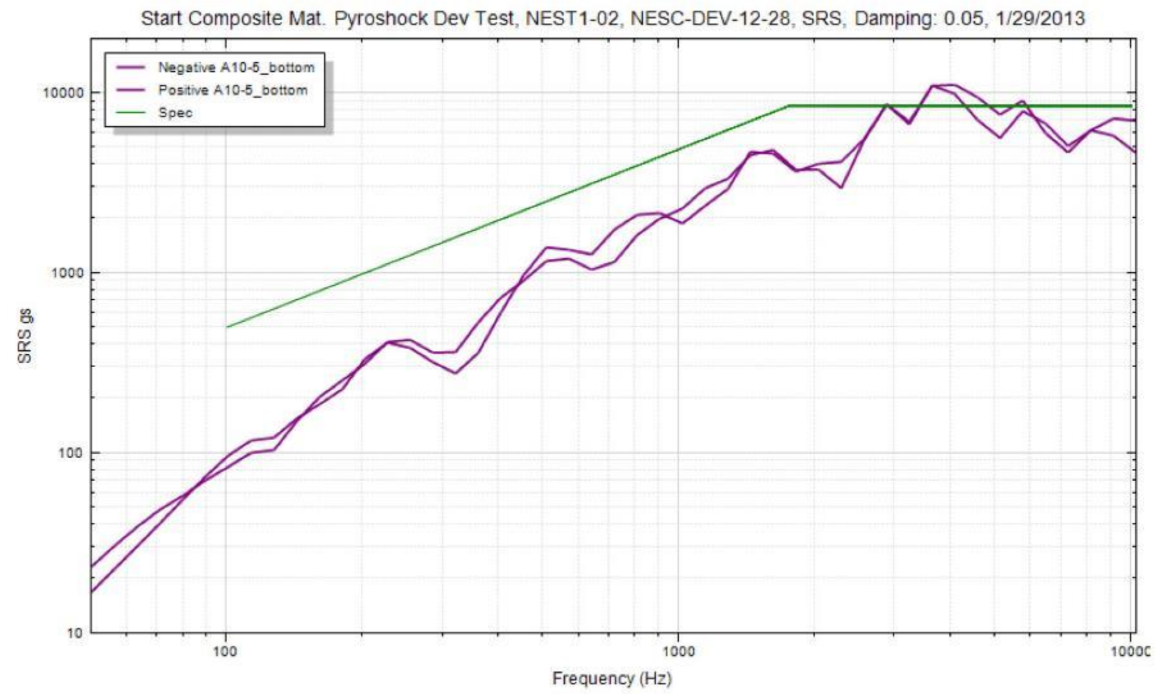
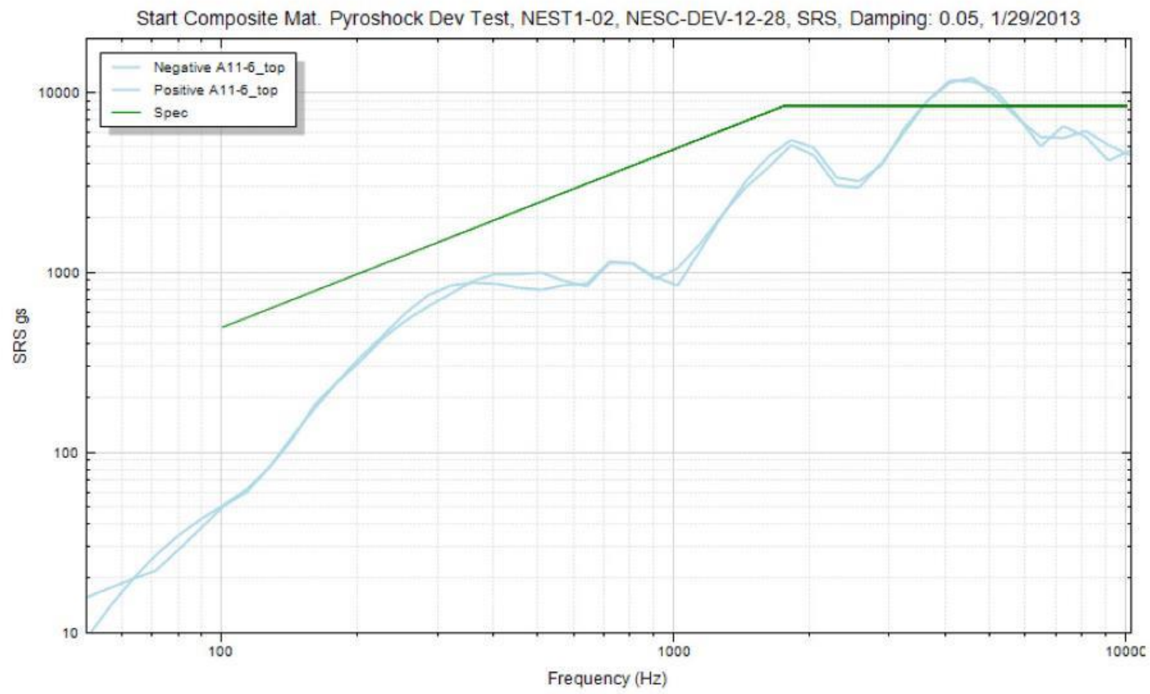

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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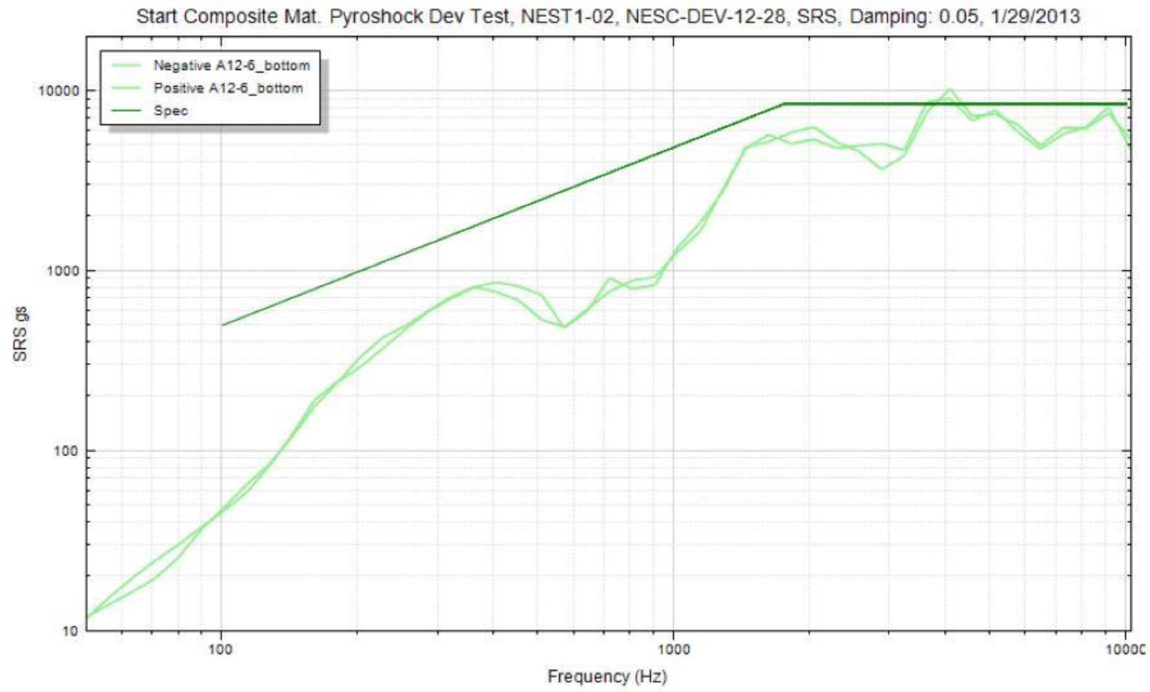
Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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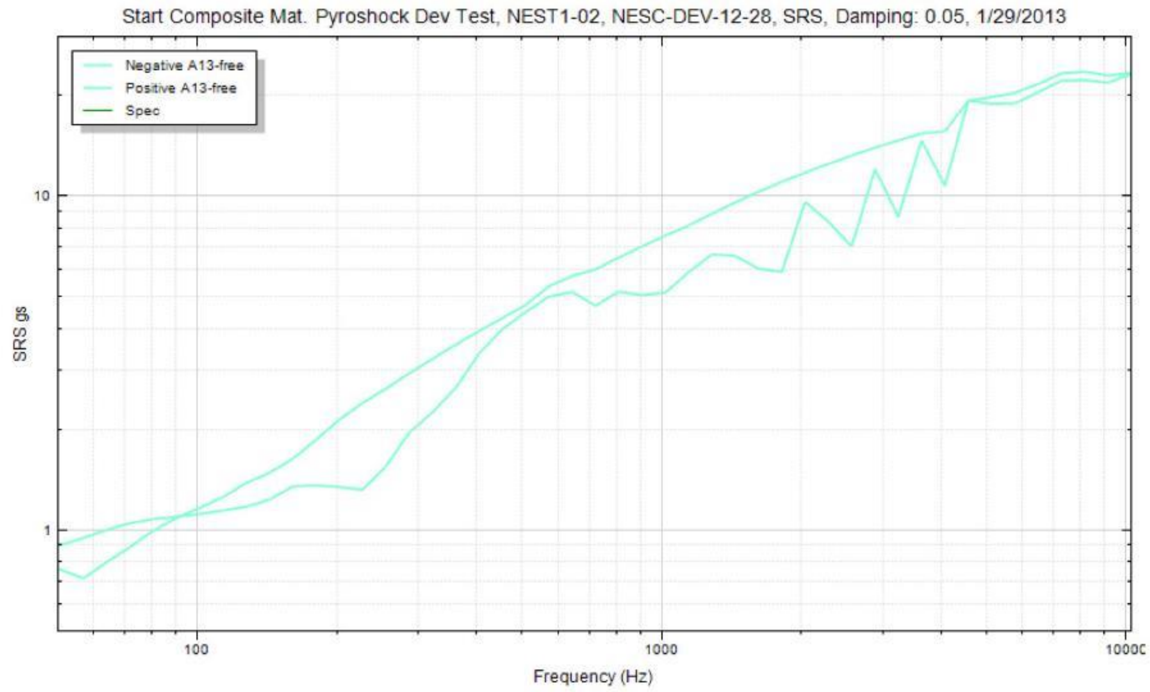
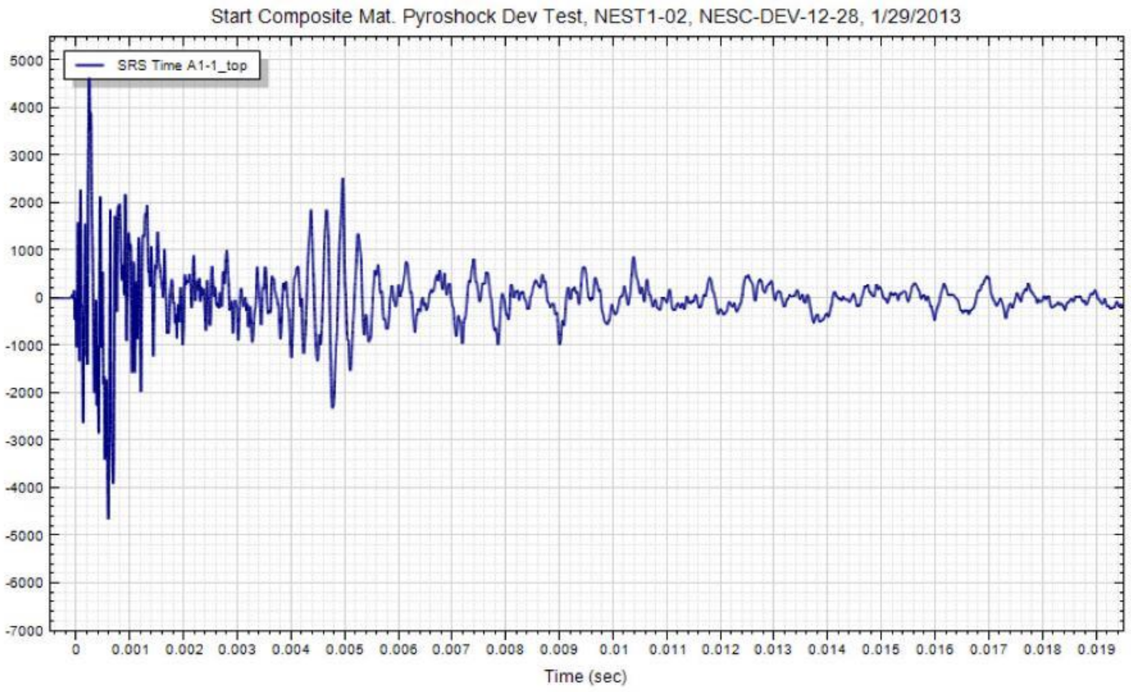

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, SRS, Damping: 0.05, 1/29/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A1-1_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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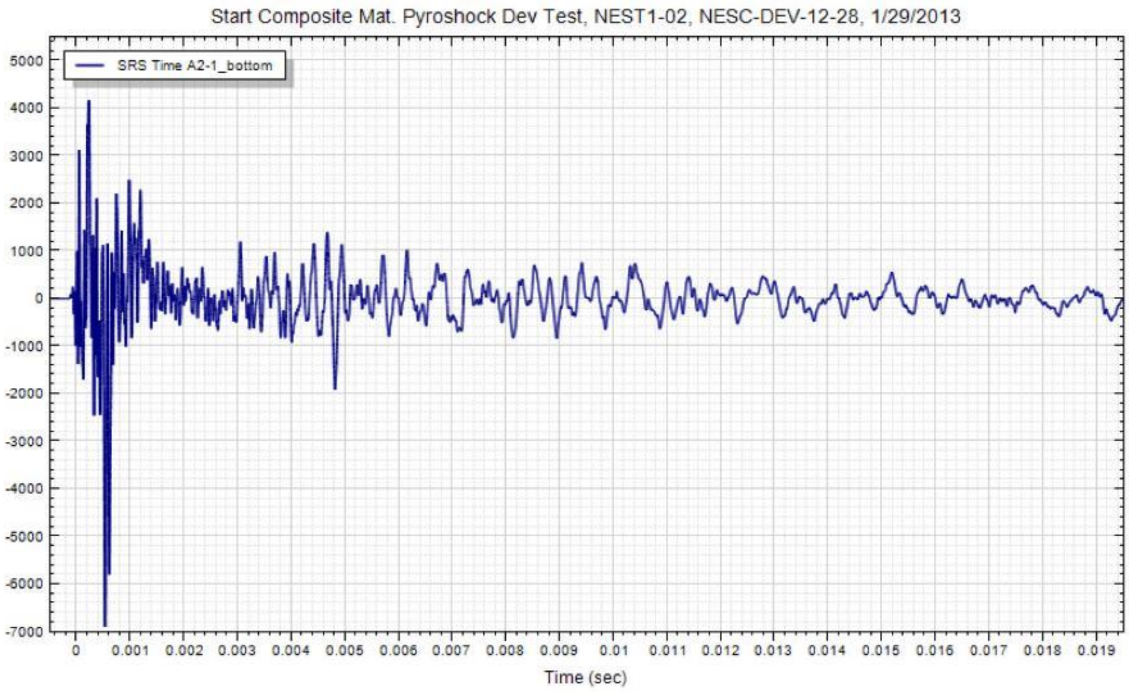
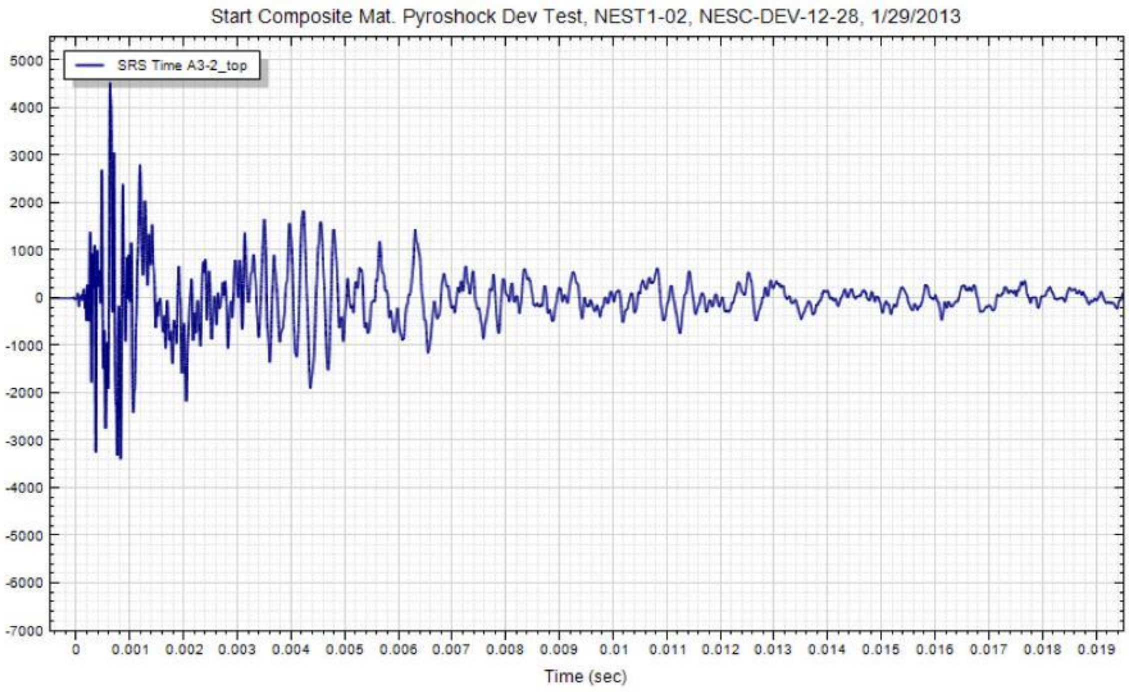
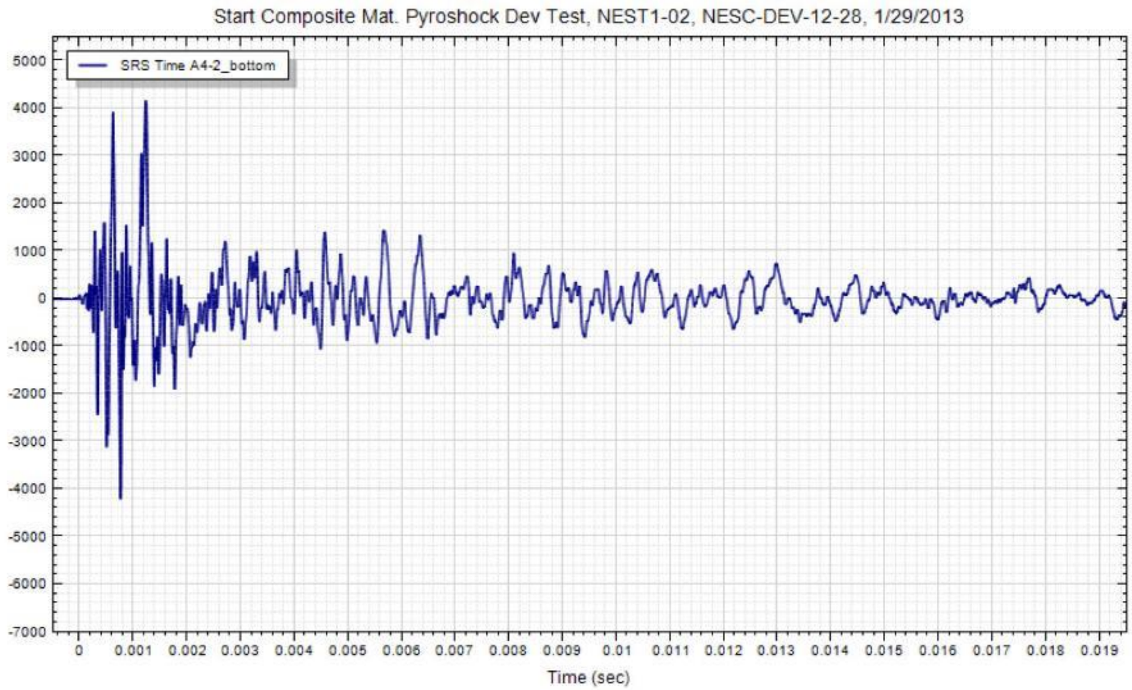
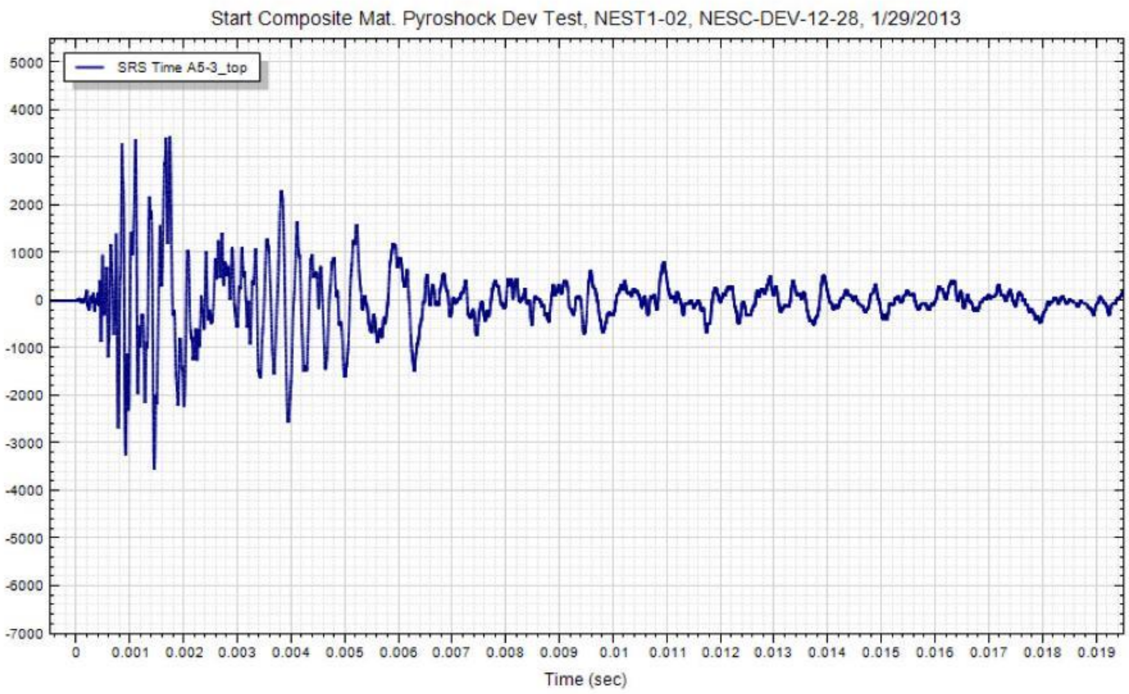
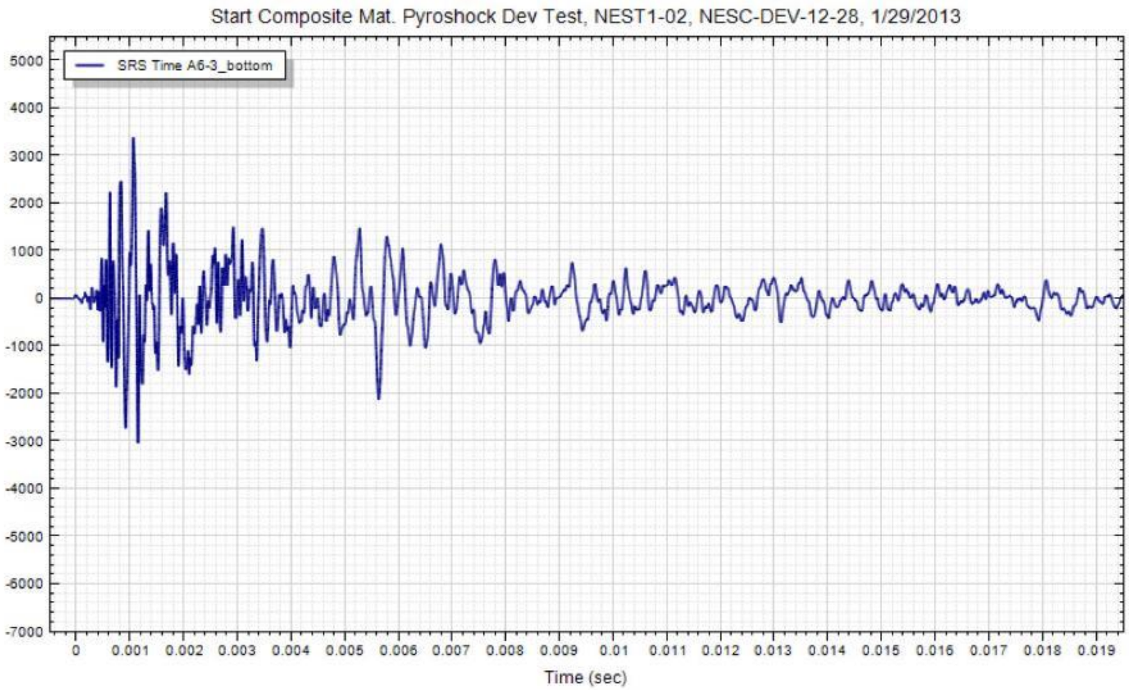
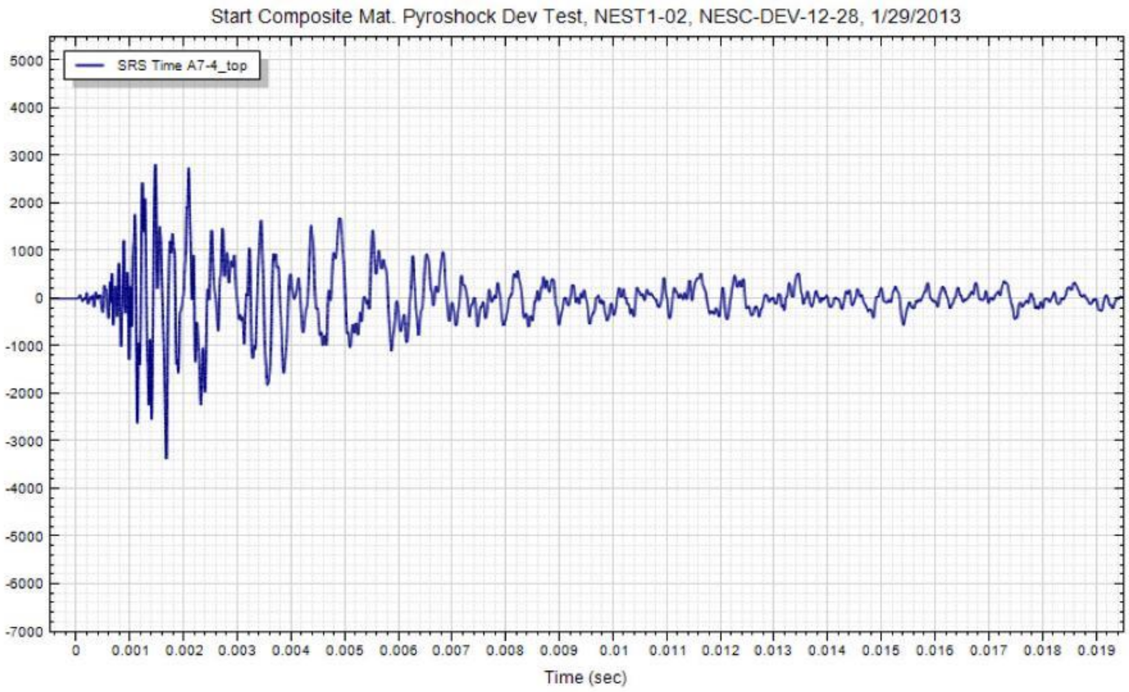

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A2-1_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A3-2_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A4-2_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A5-3_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A6-3_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A7-4_top
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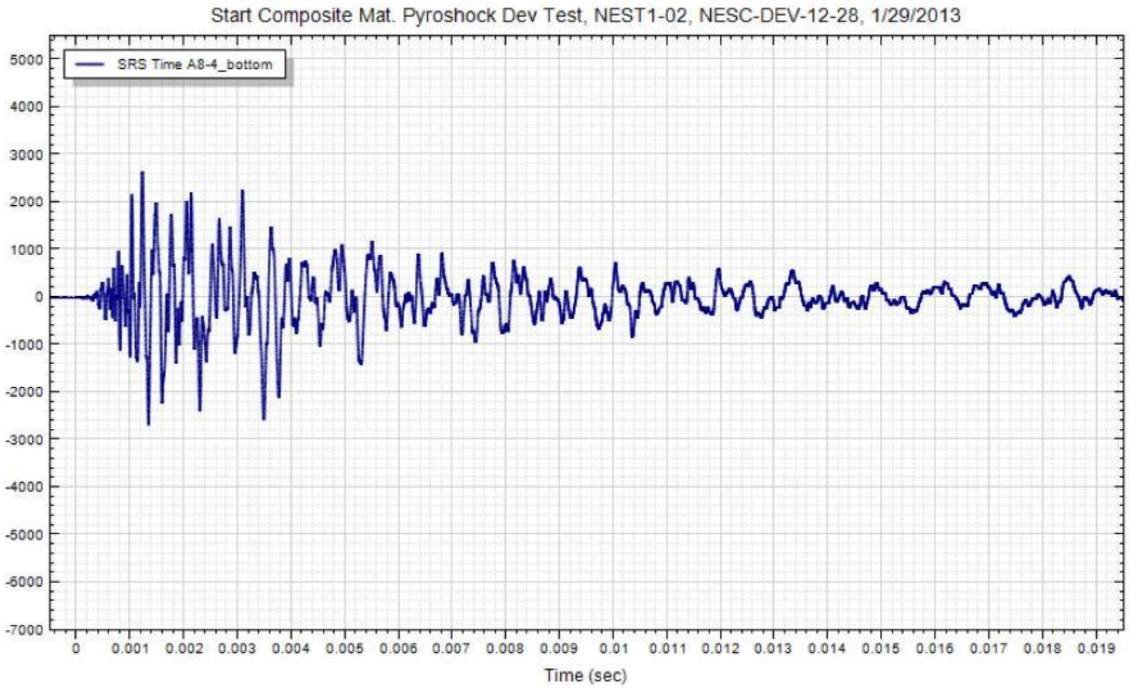
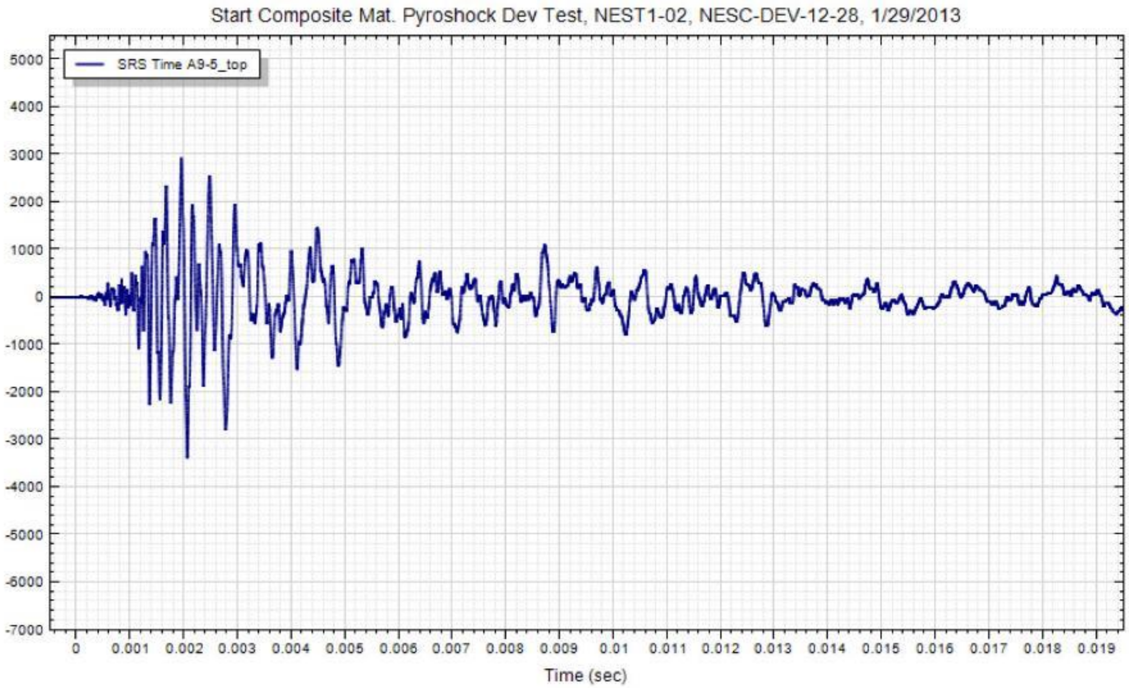
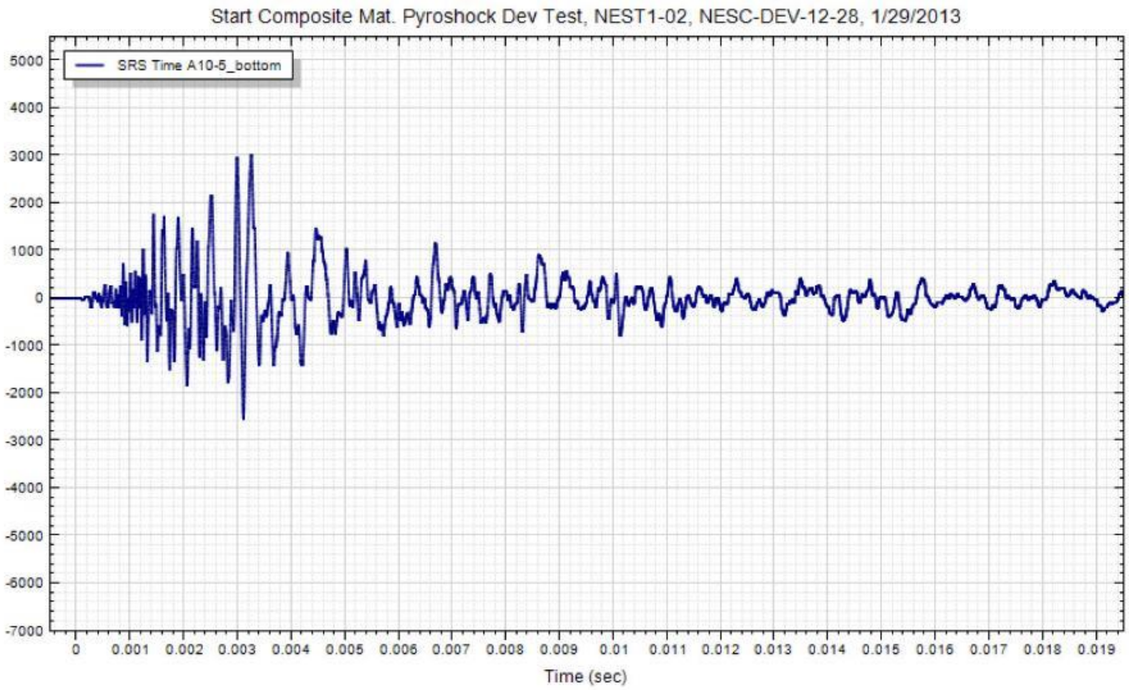
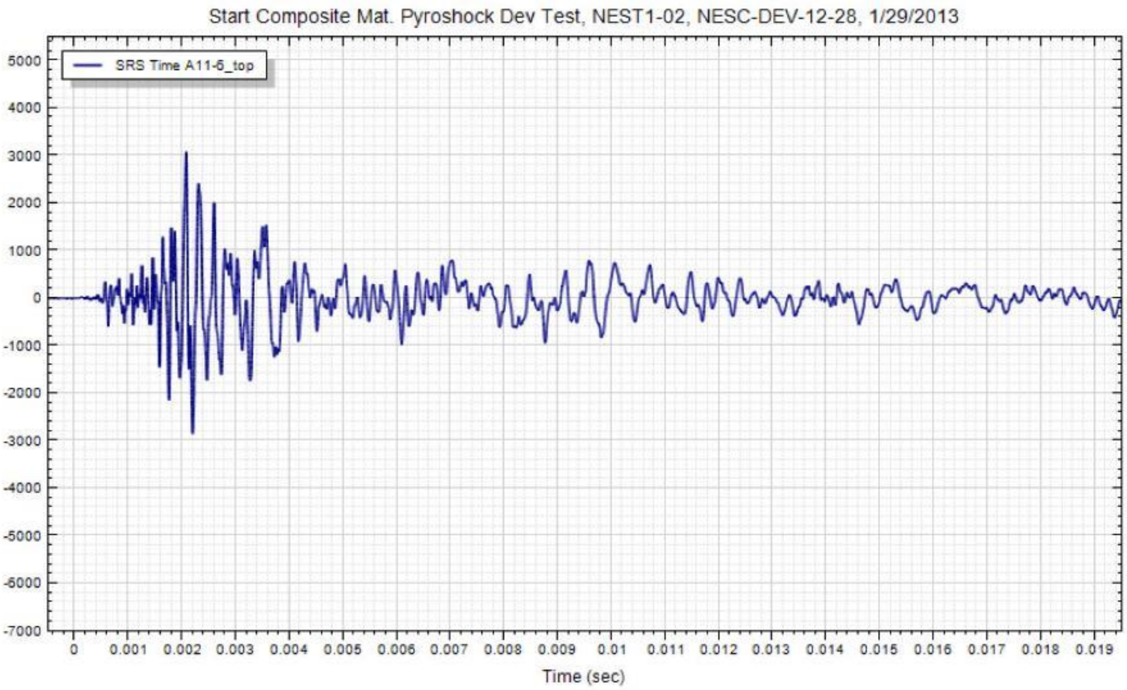
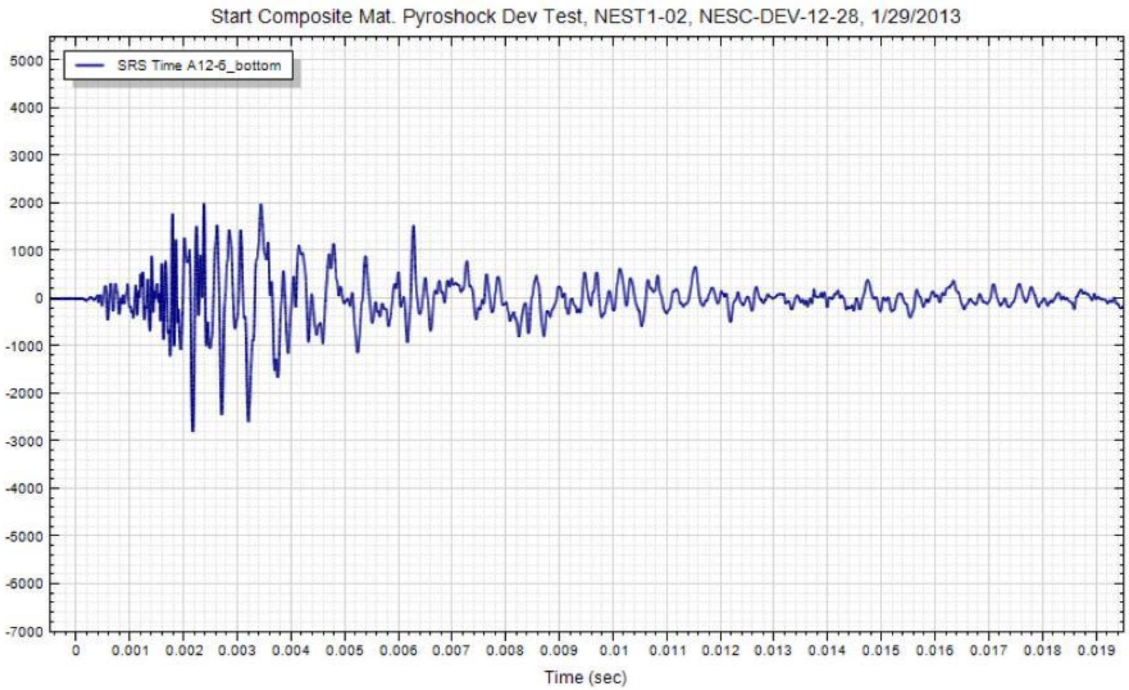
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

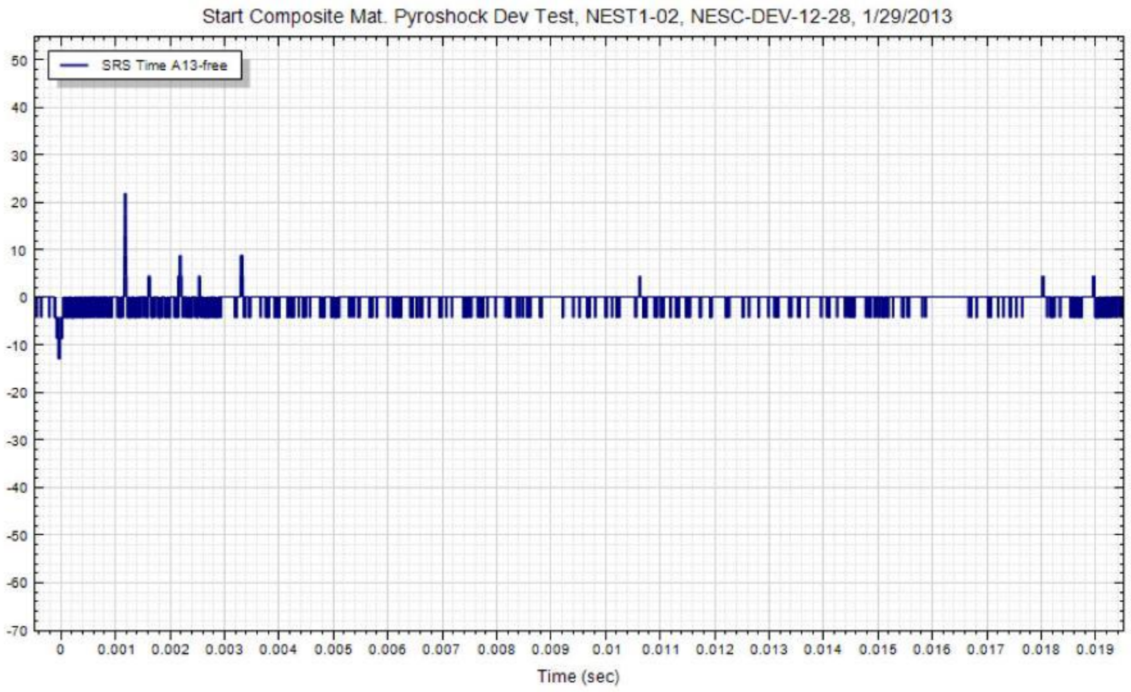

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A8-4_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

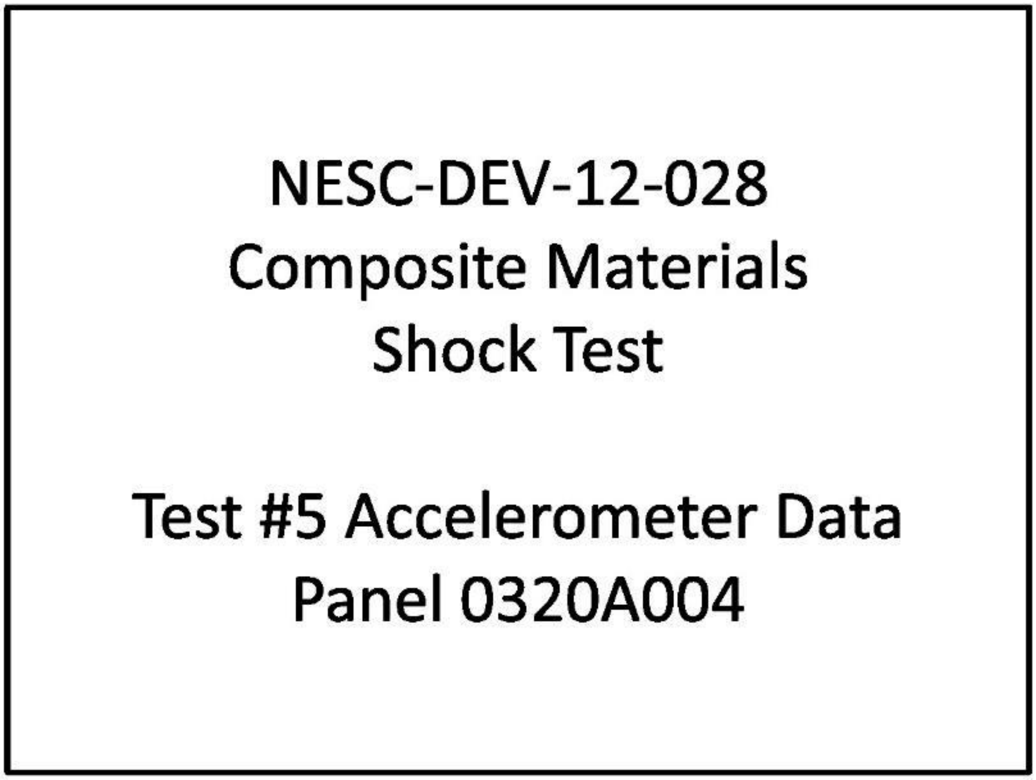

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A9-5_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A10-5_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A11-6_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

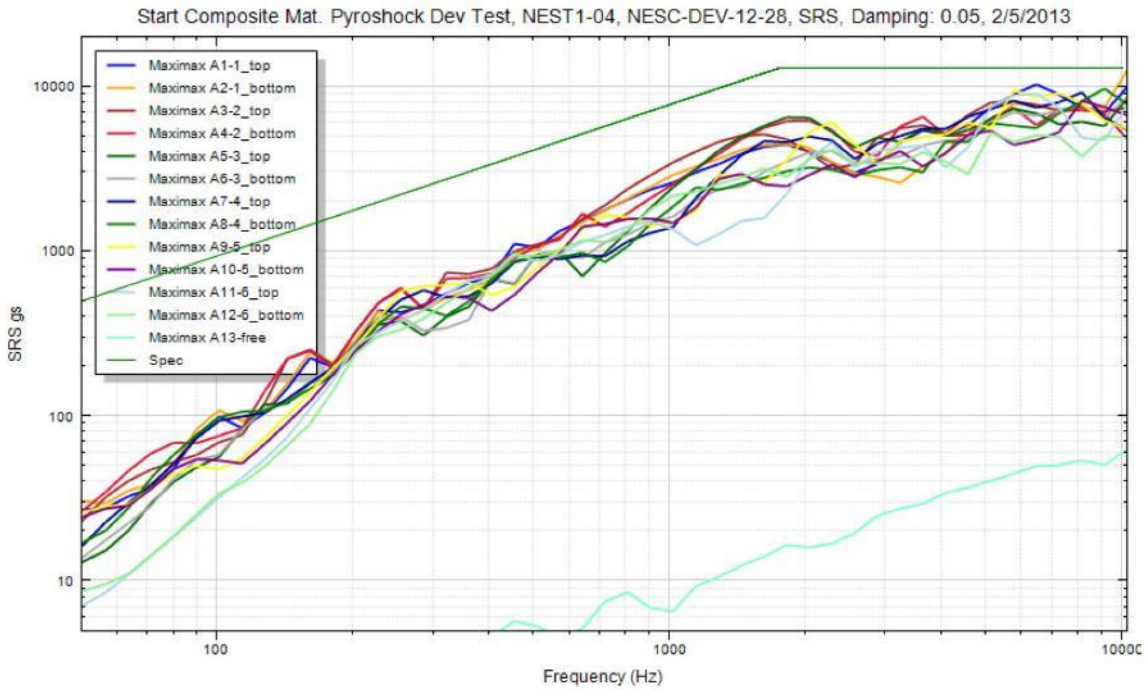

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A12-6_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

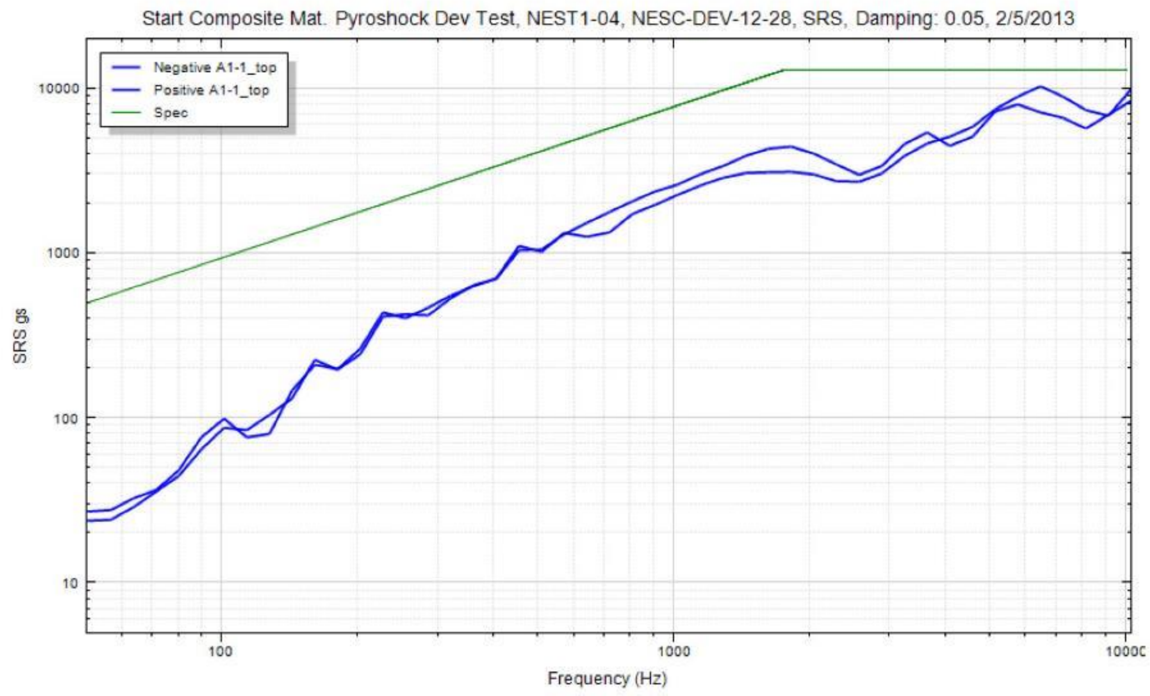

Start Composite Mat. Pyroshock Dev Test, NEST1-02, NESC-DEV-12-28, 1/29/2013
SRS Time A13-free
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

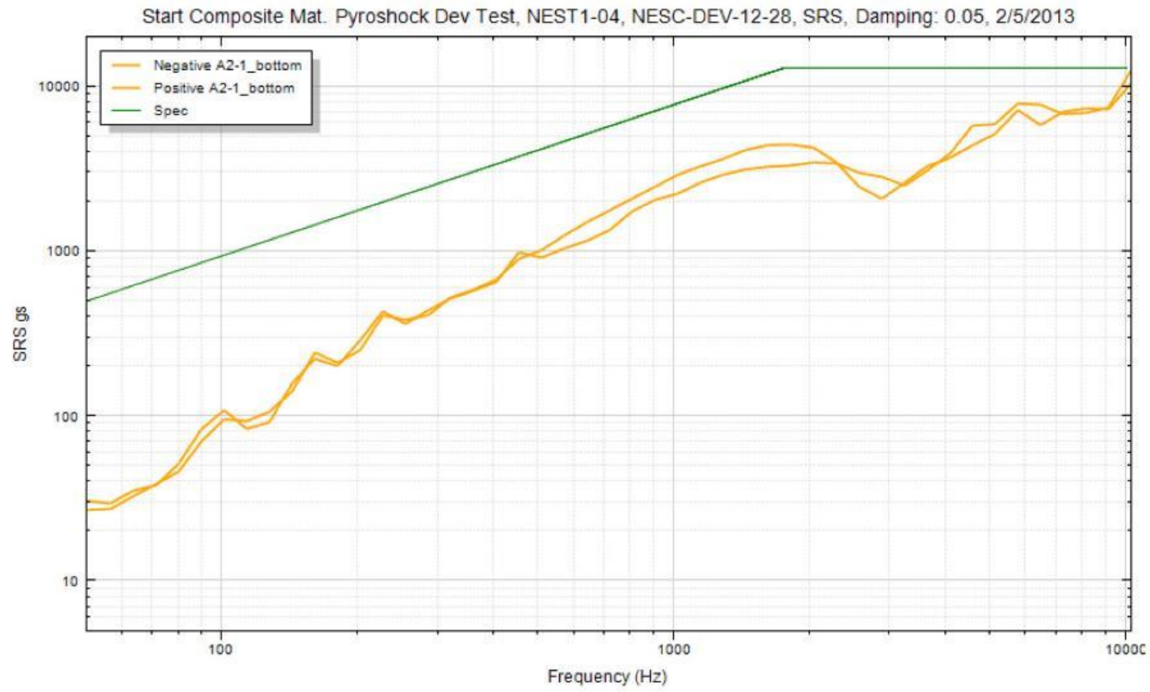


NESC-DEV-12-028
Composite Materials
Shock Test

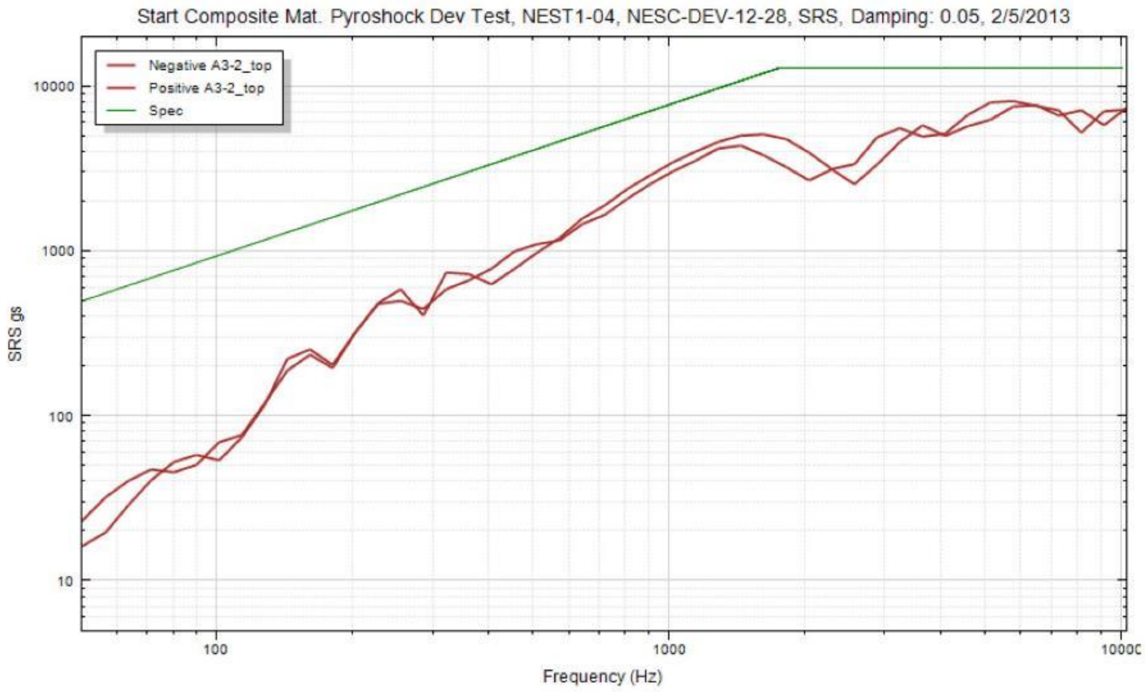
Test #5 Accelerometer Data
Panel 0320A004

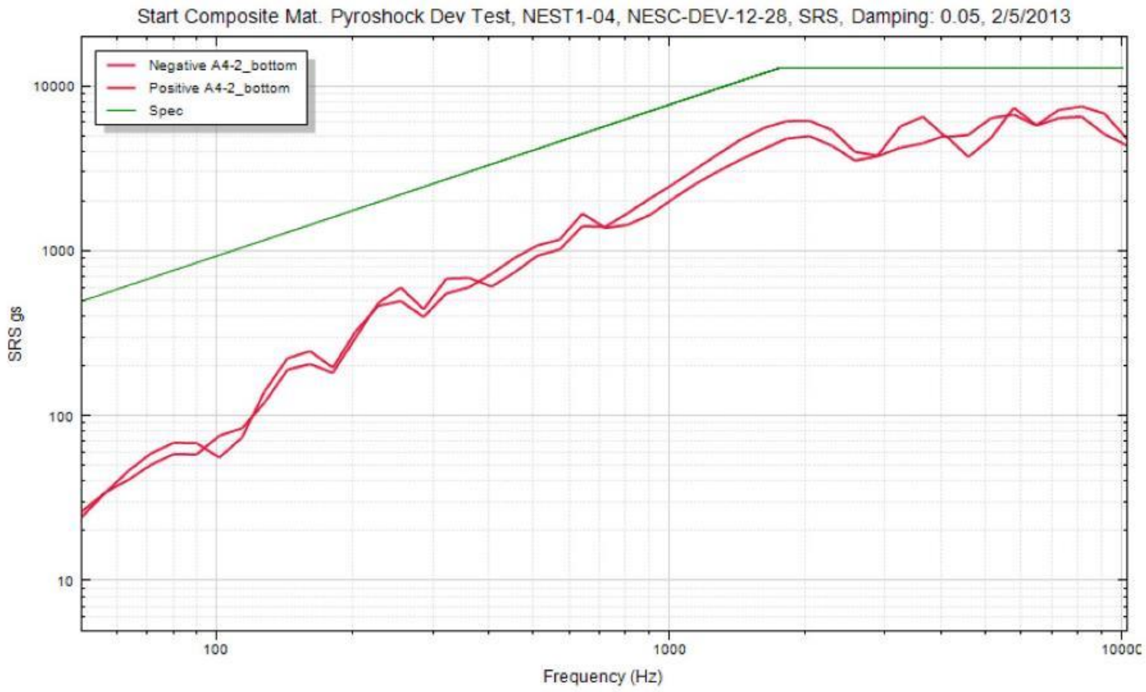

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

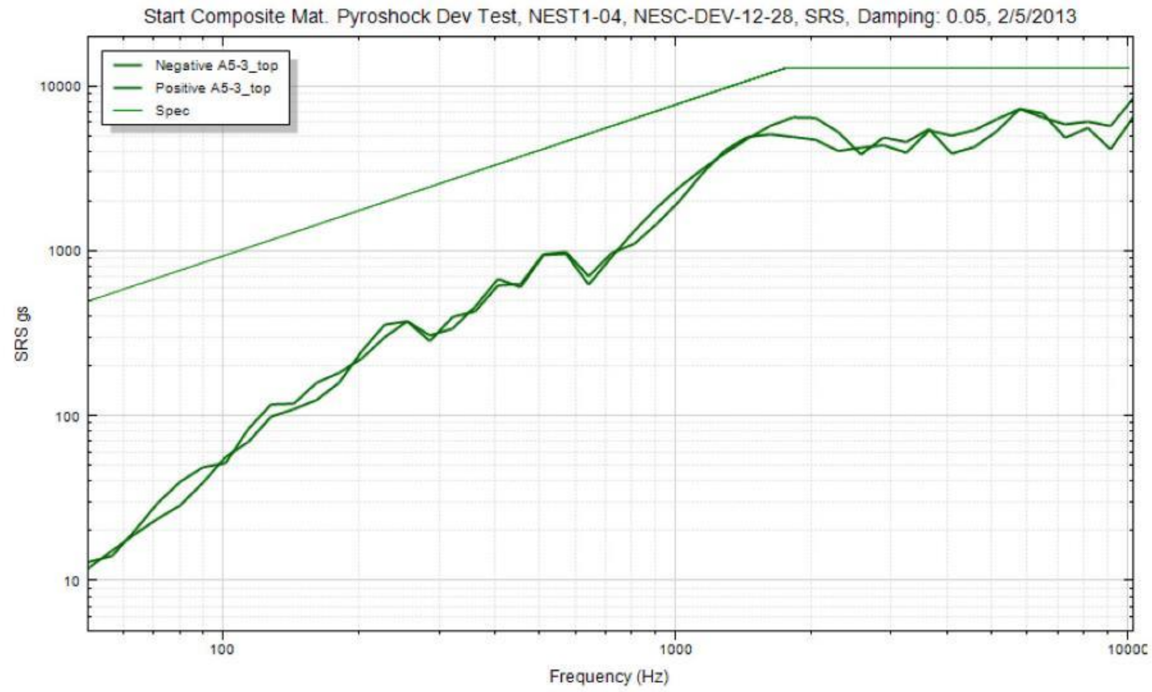

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A1-1_top
Positive A1-1_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)



Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A3-2_top
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

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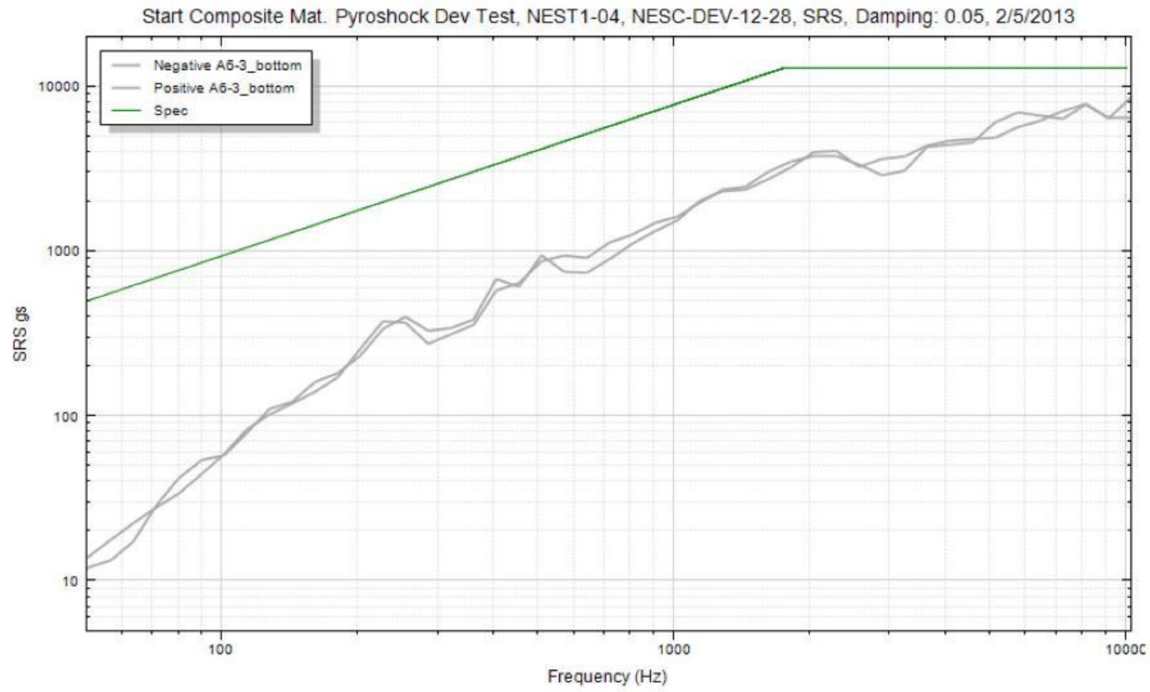
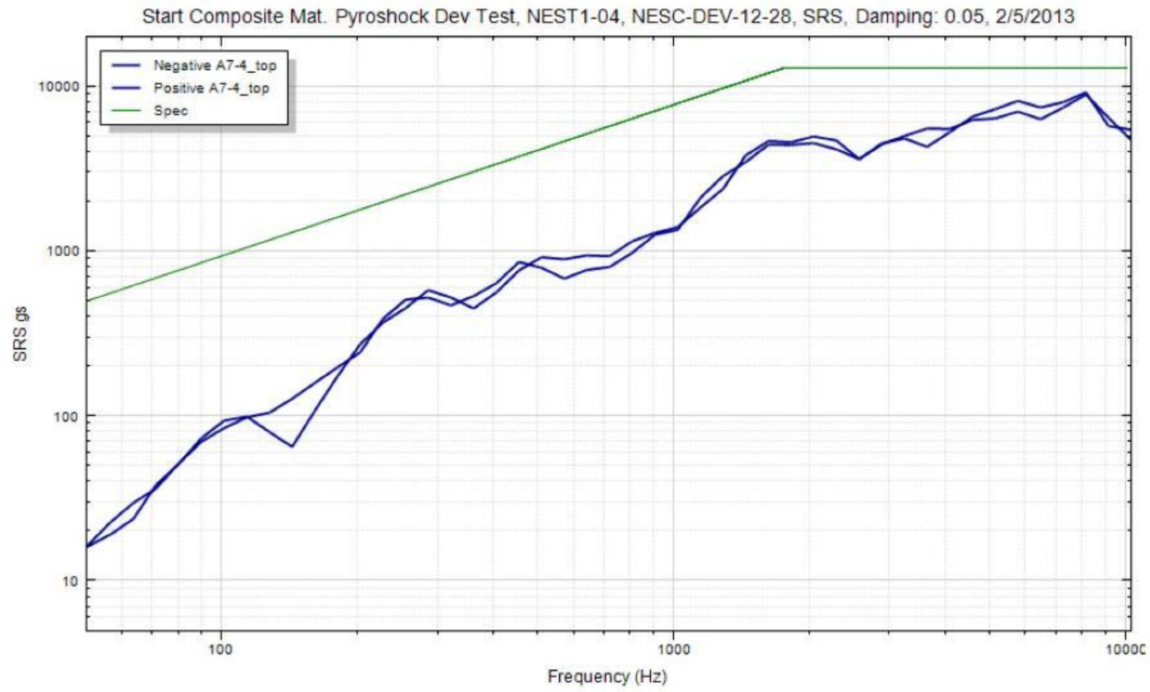
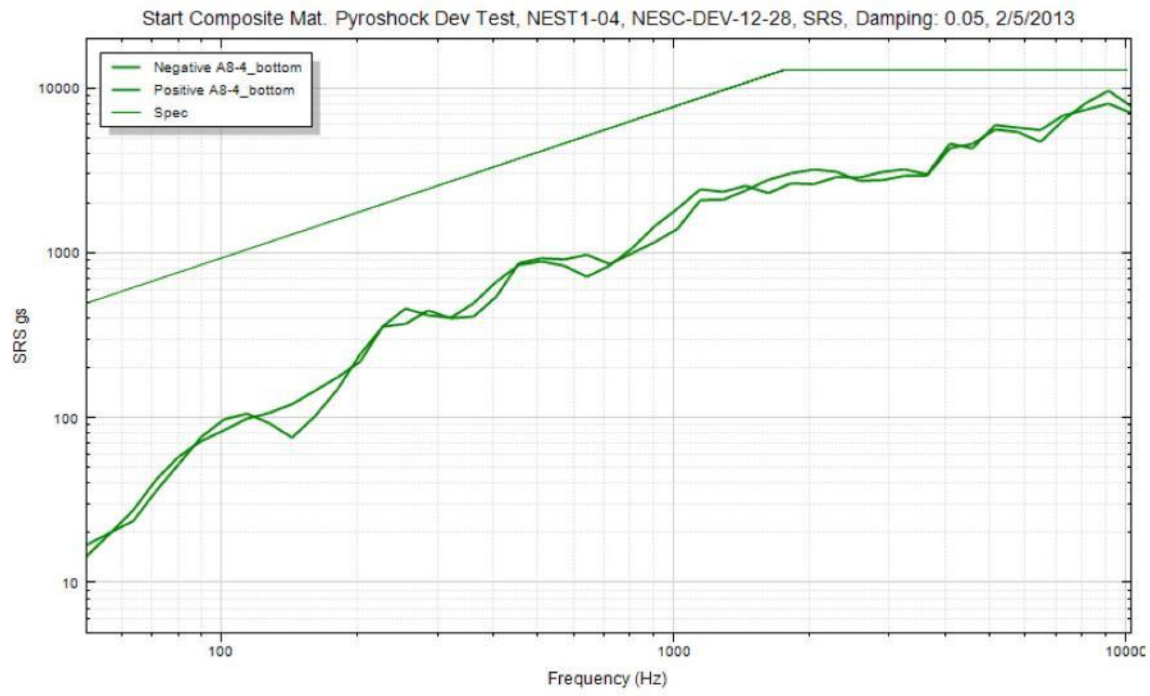
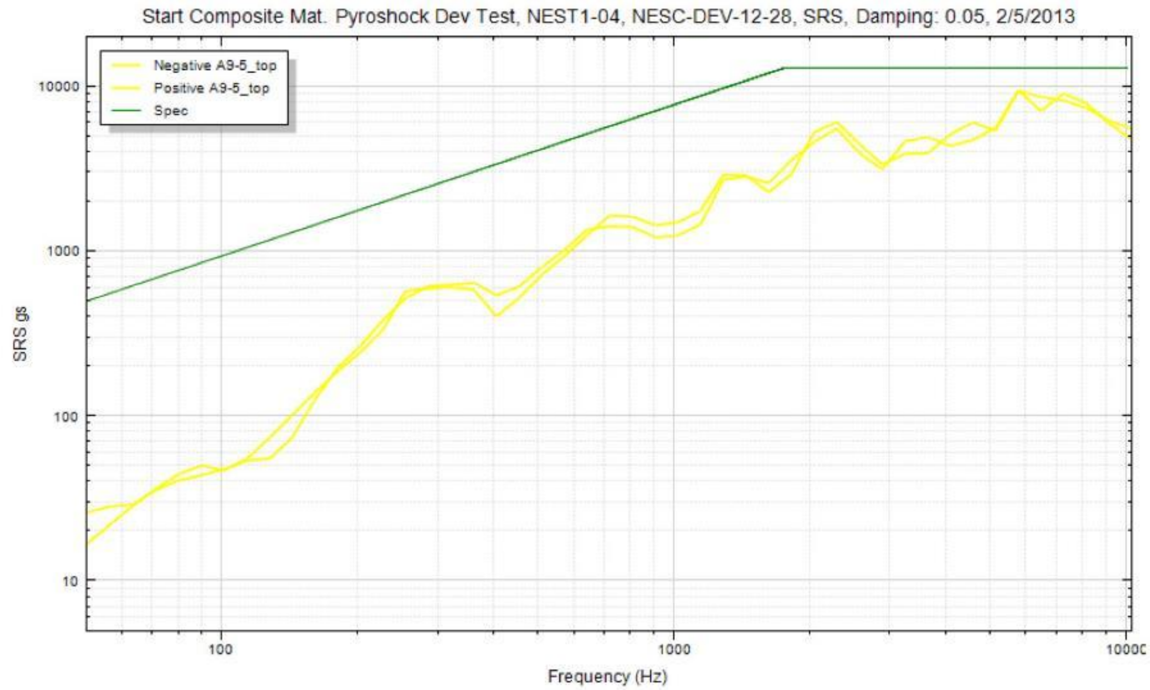
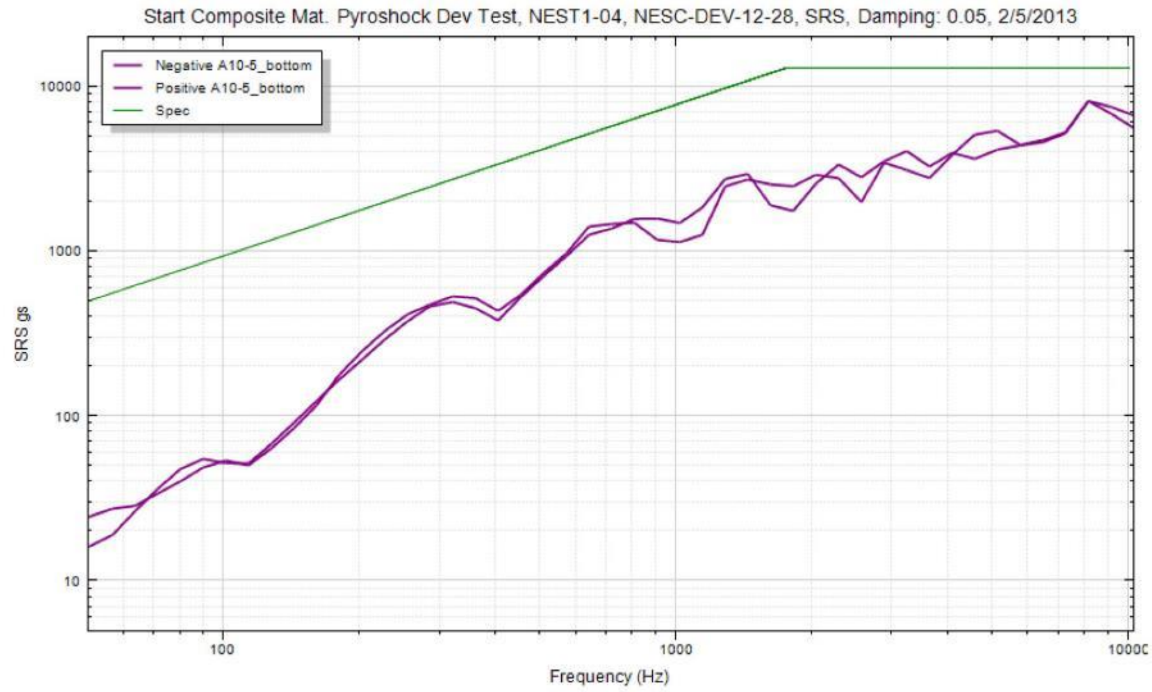
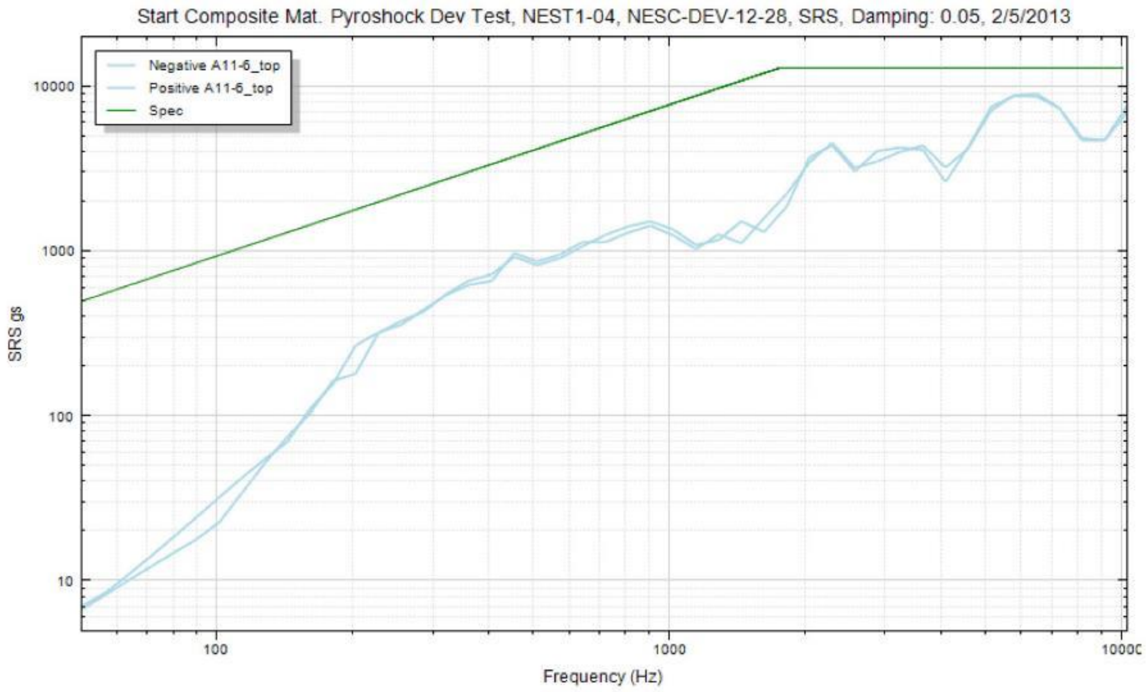

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

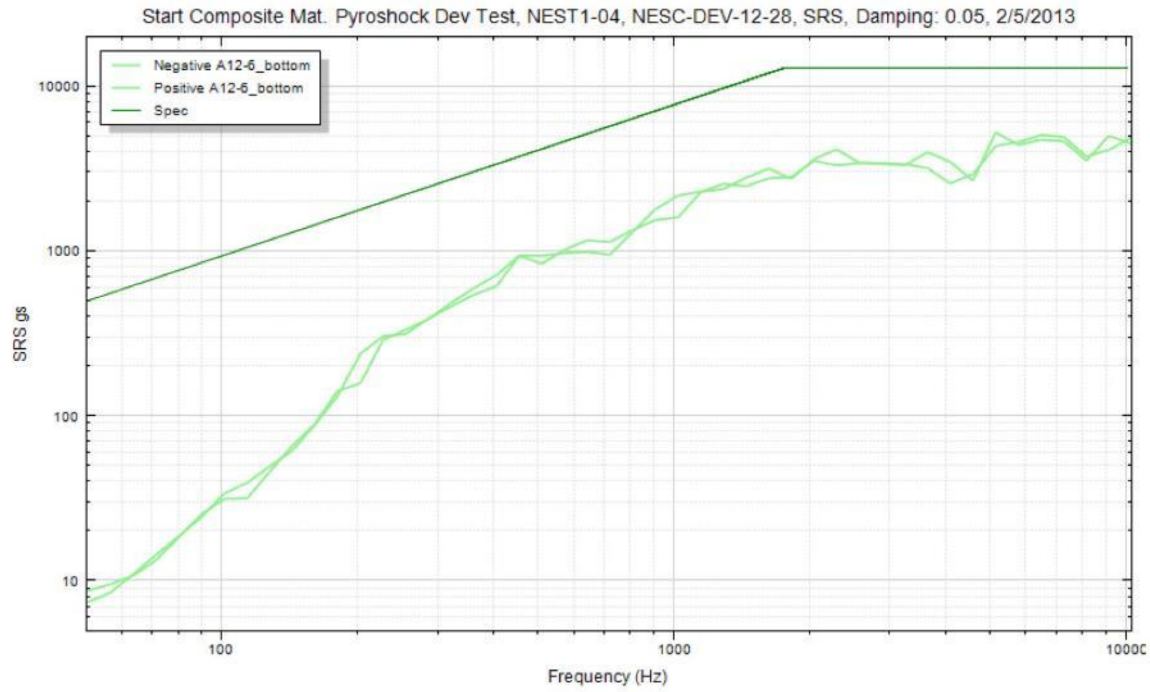

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A7-4_top
Positive A7-4_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
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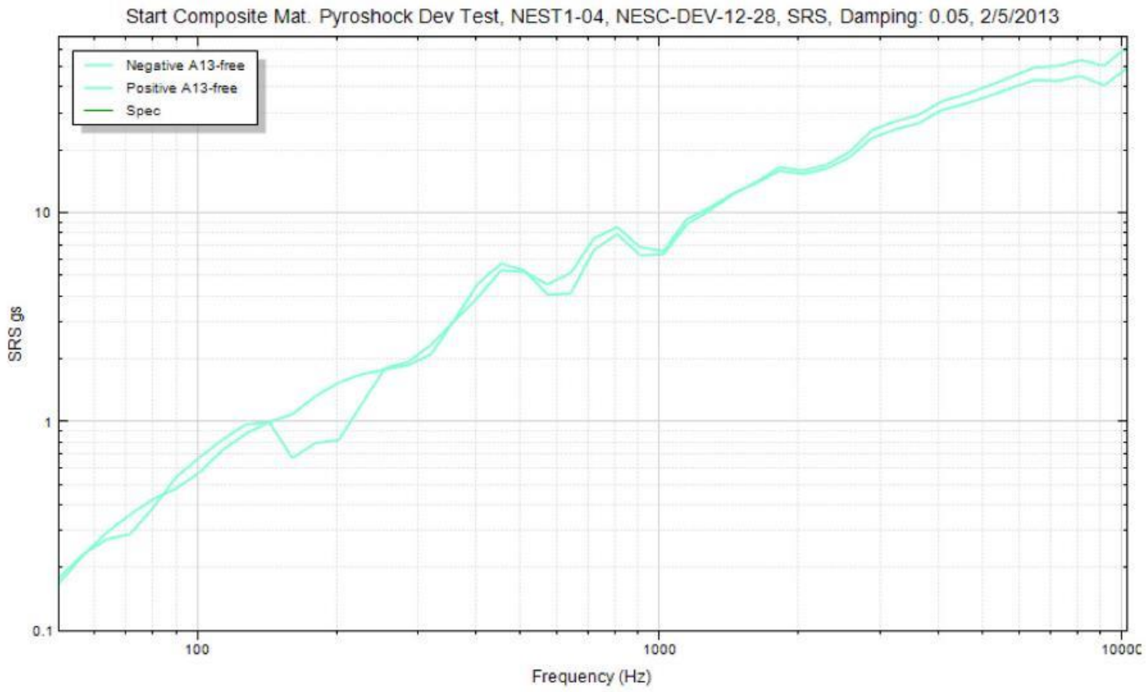
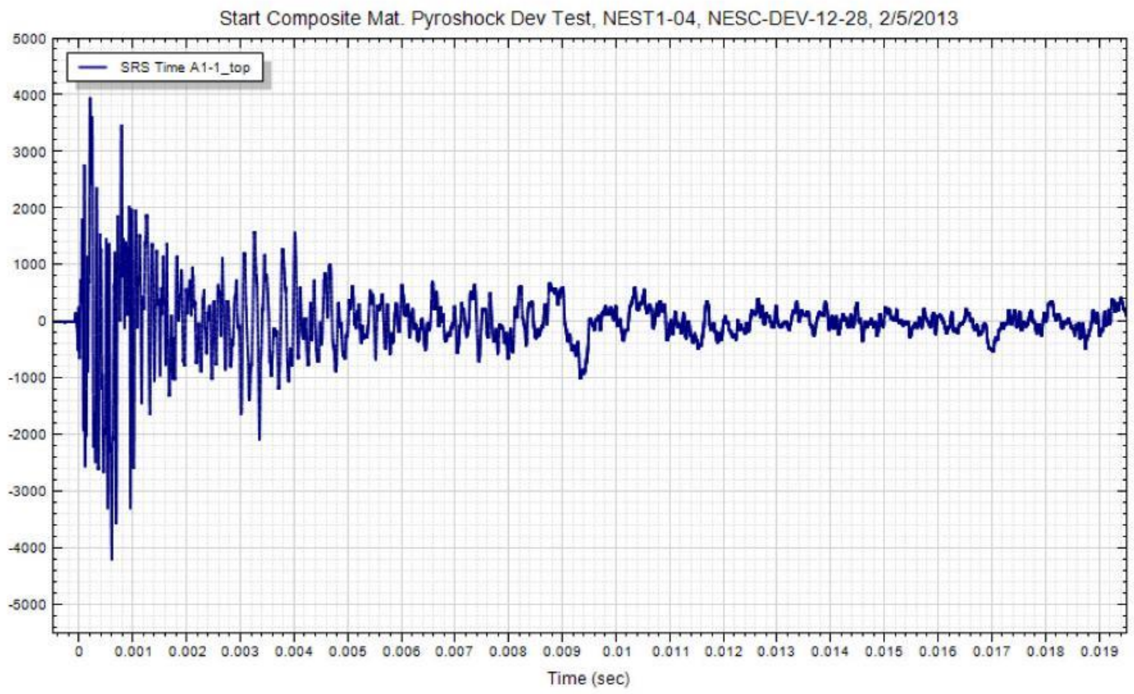
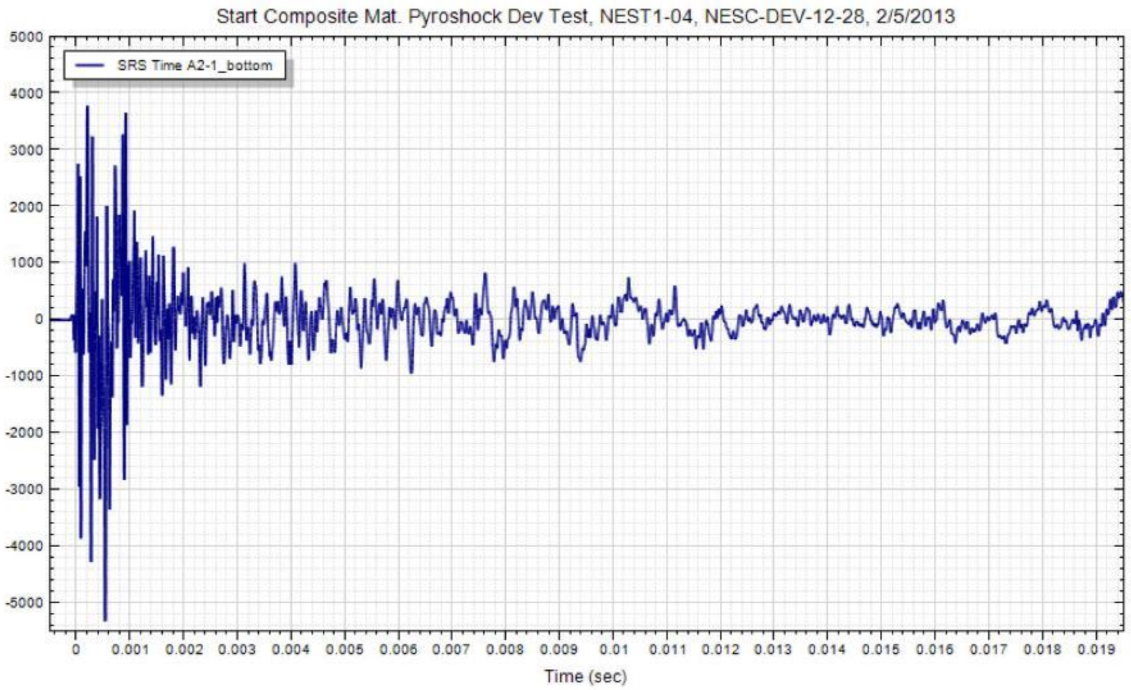
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, SRS, Damping: 0.05, 2/5/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
1000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A1-1_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A2-1_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
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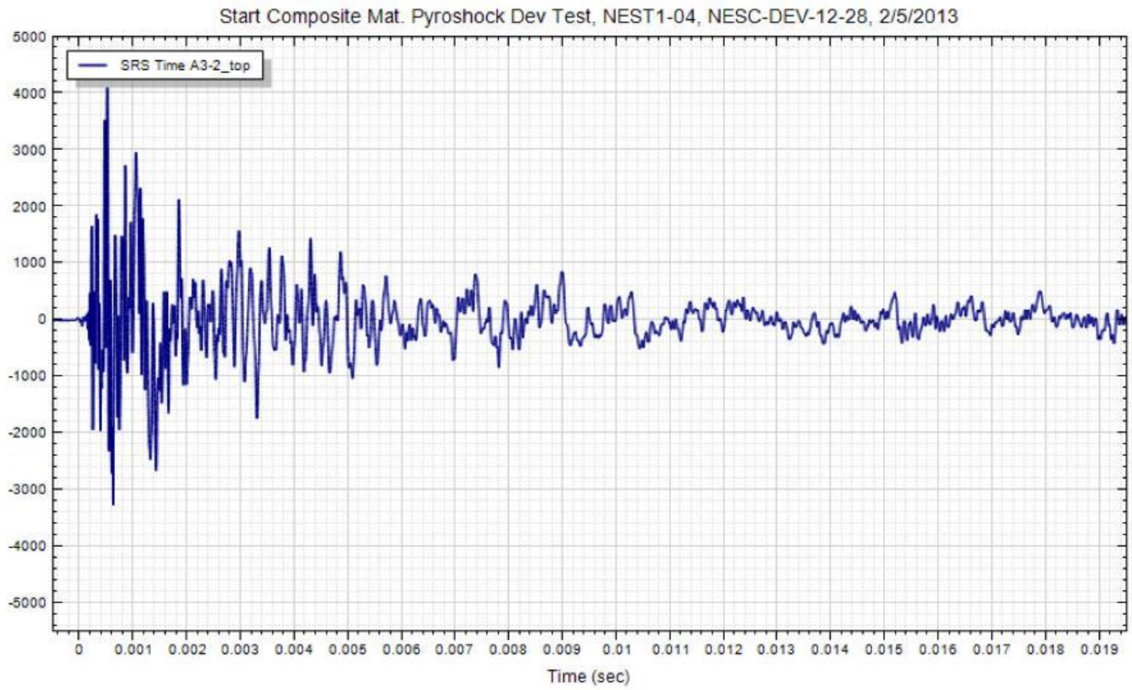
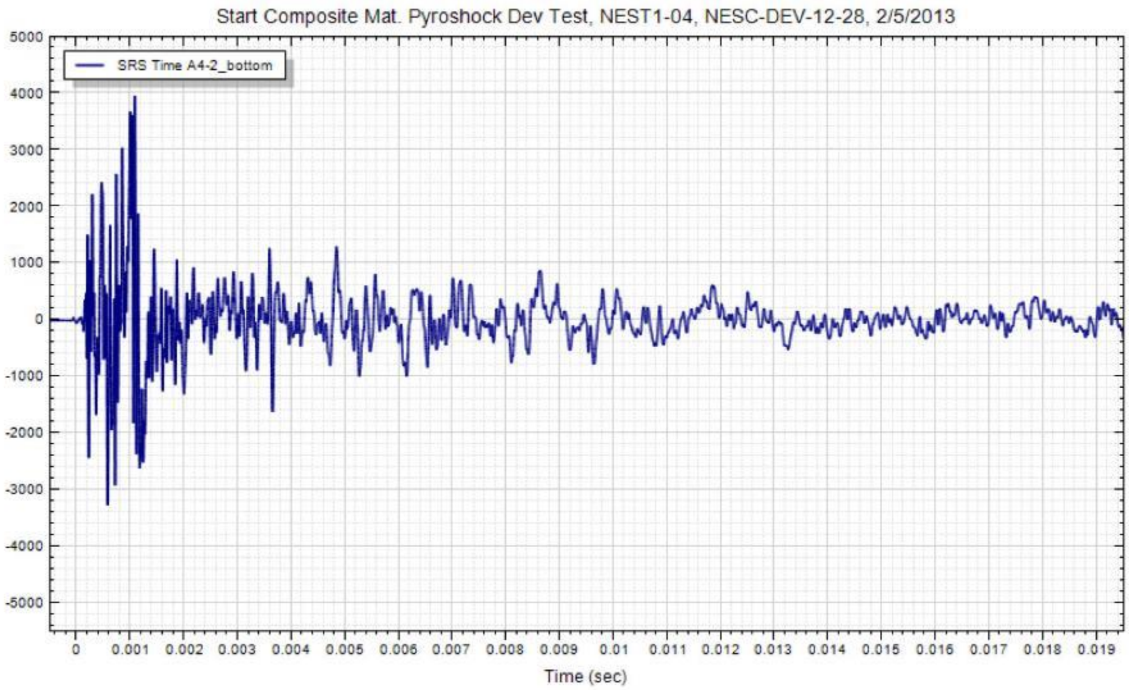
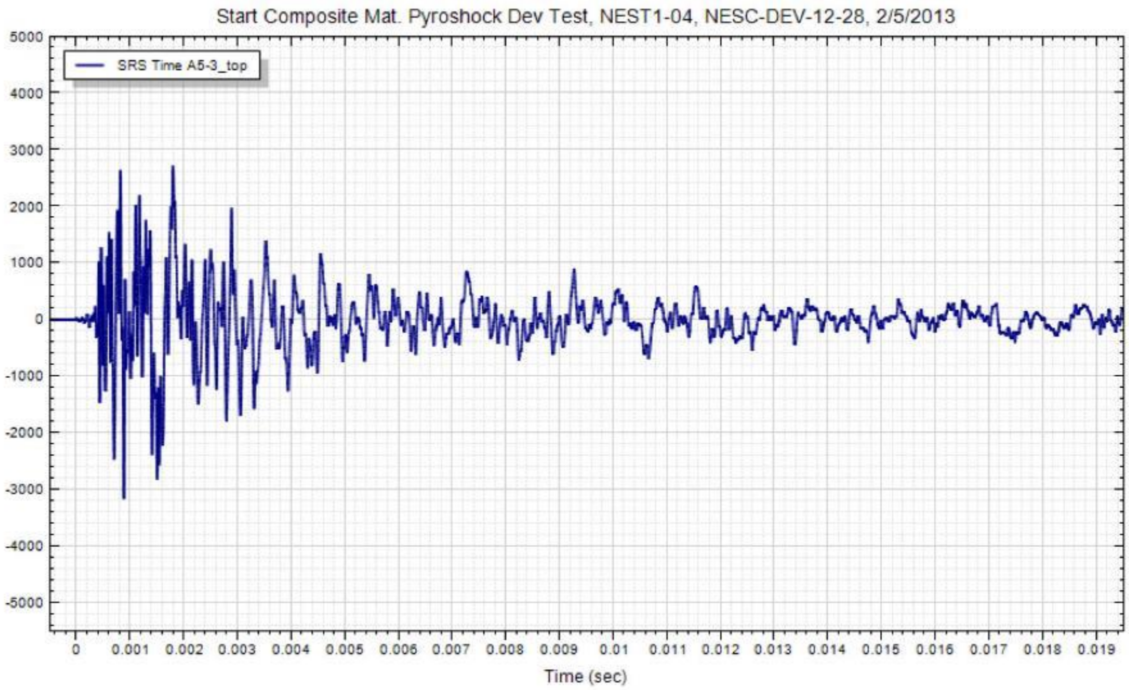
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A3-2_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A4-2_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A5-3_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
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0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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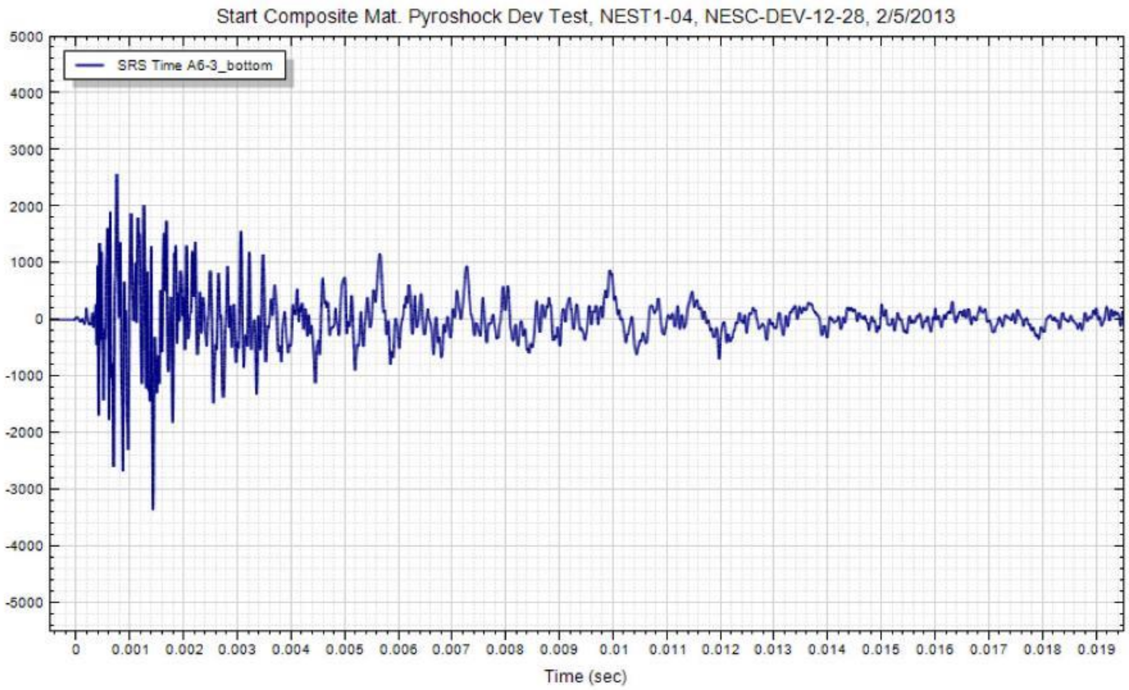
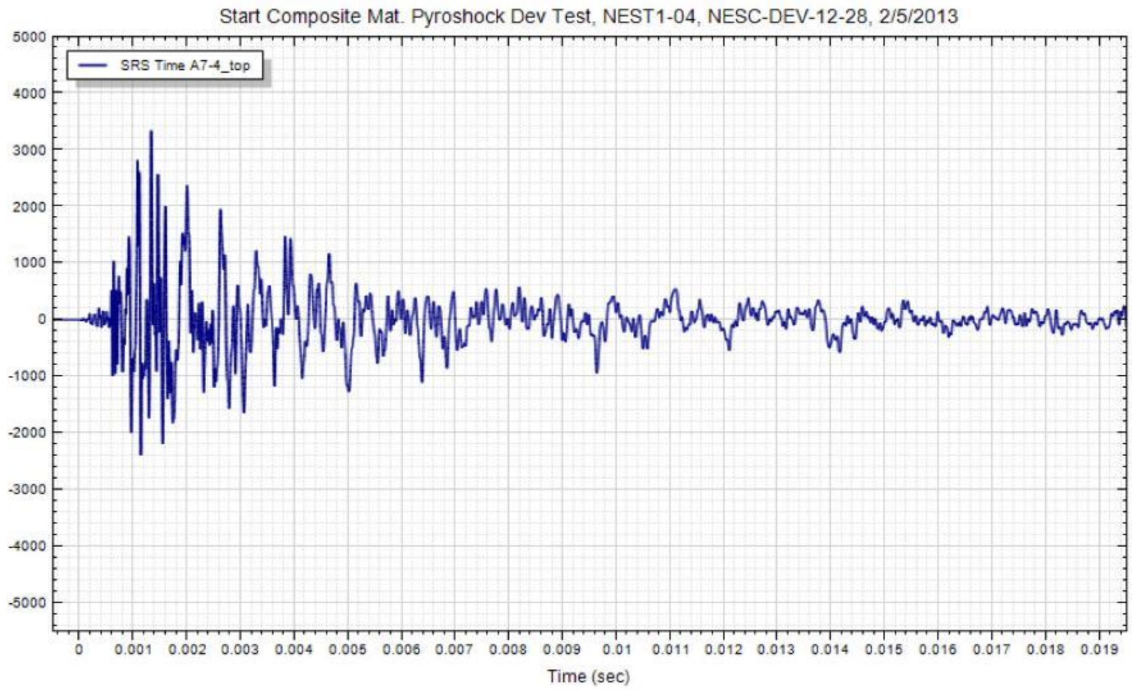

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A6-3_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A7-4_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
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0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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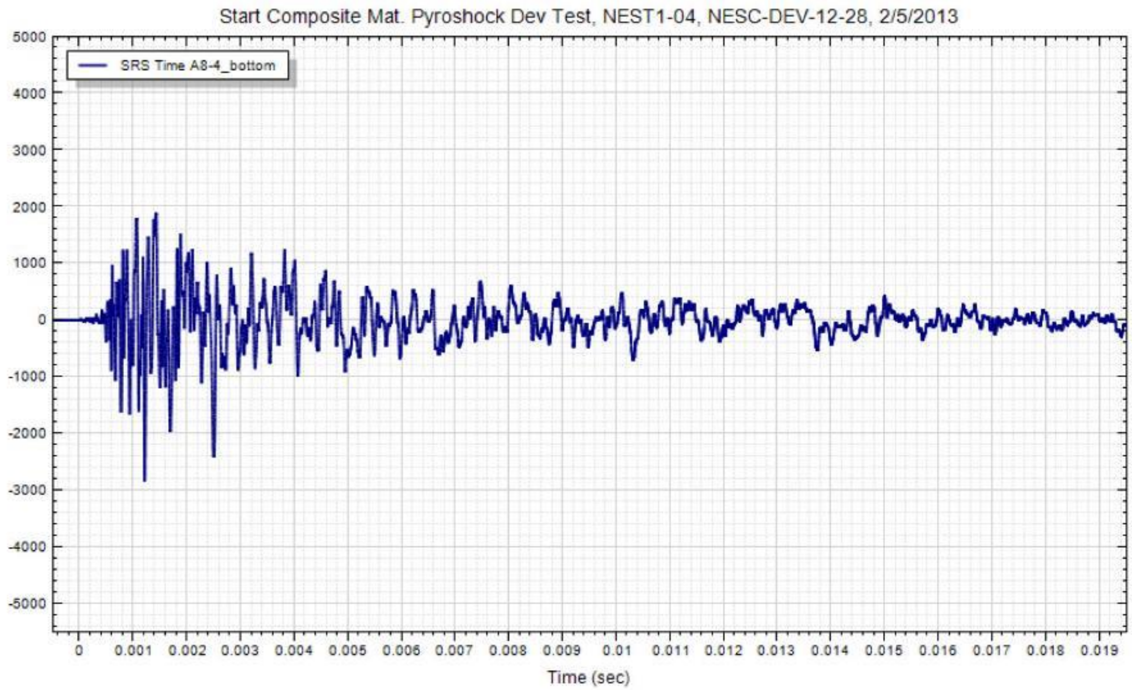
Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A8-4_bottom
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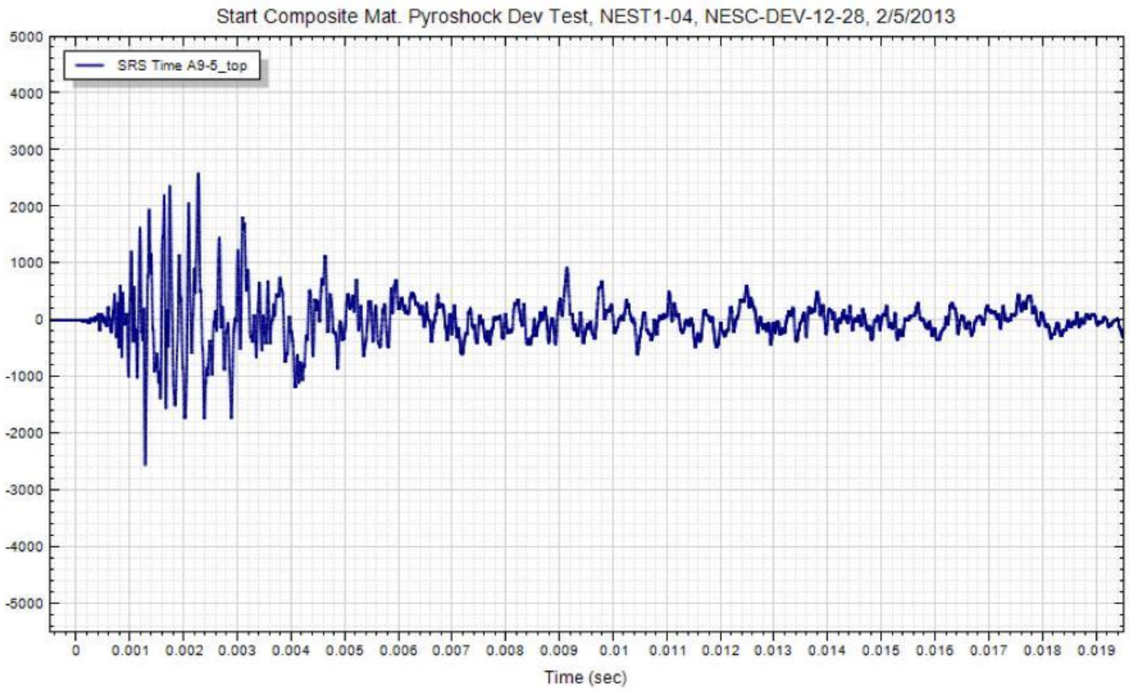
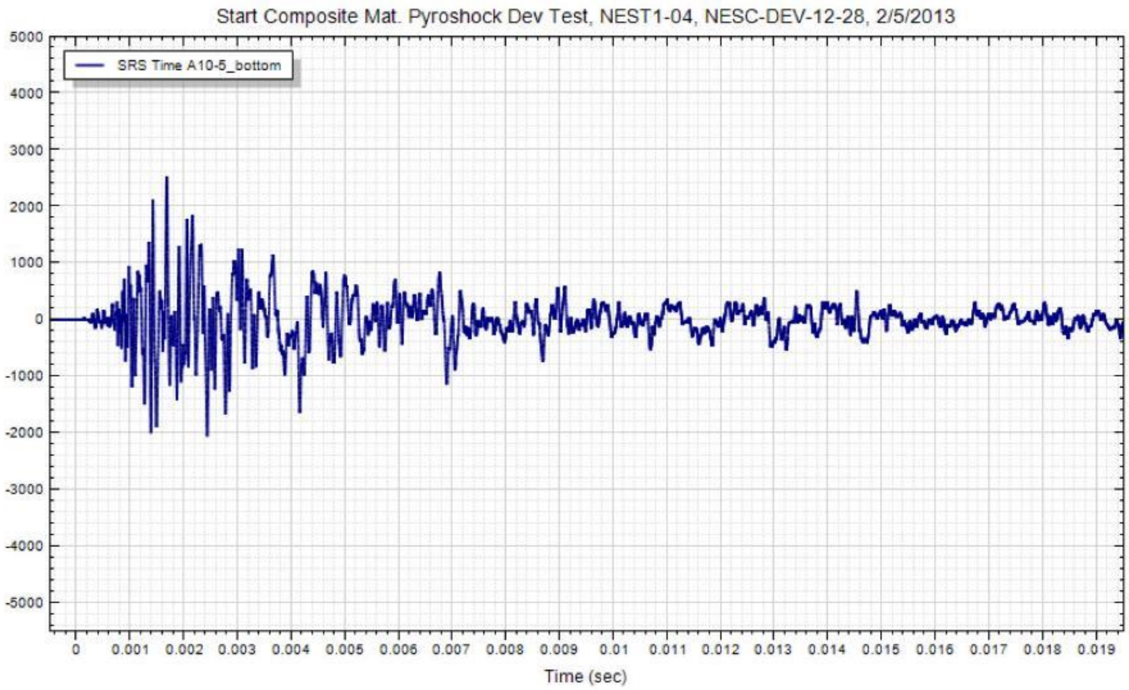
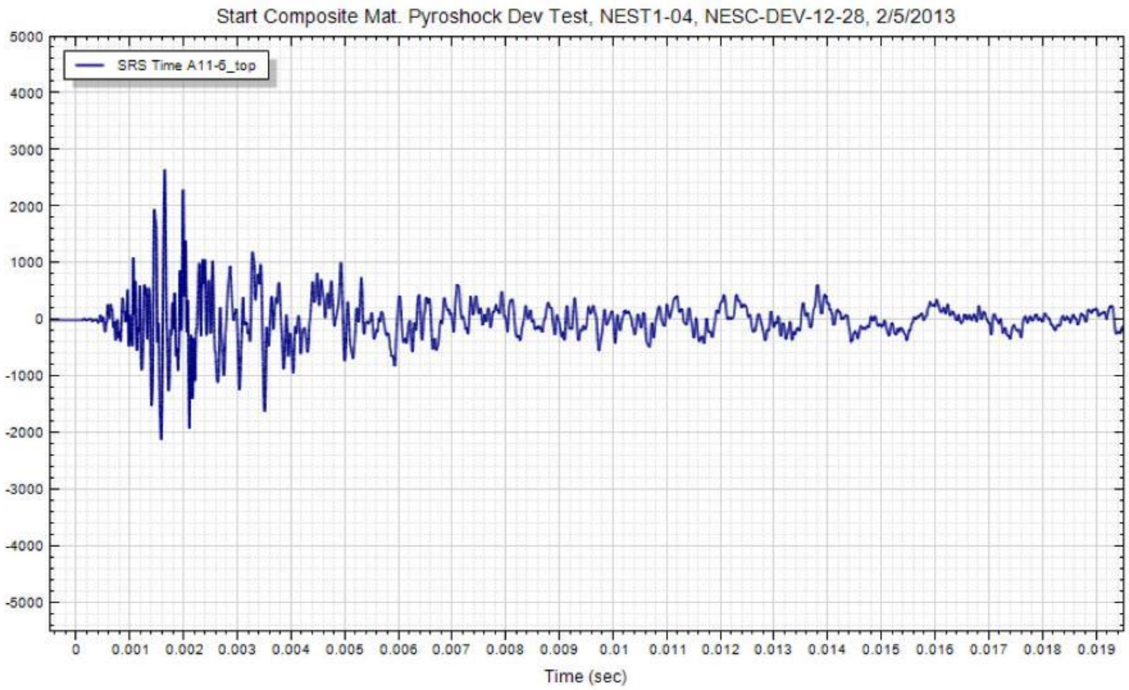
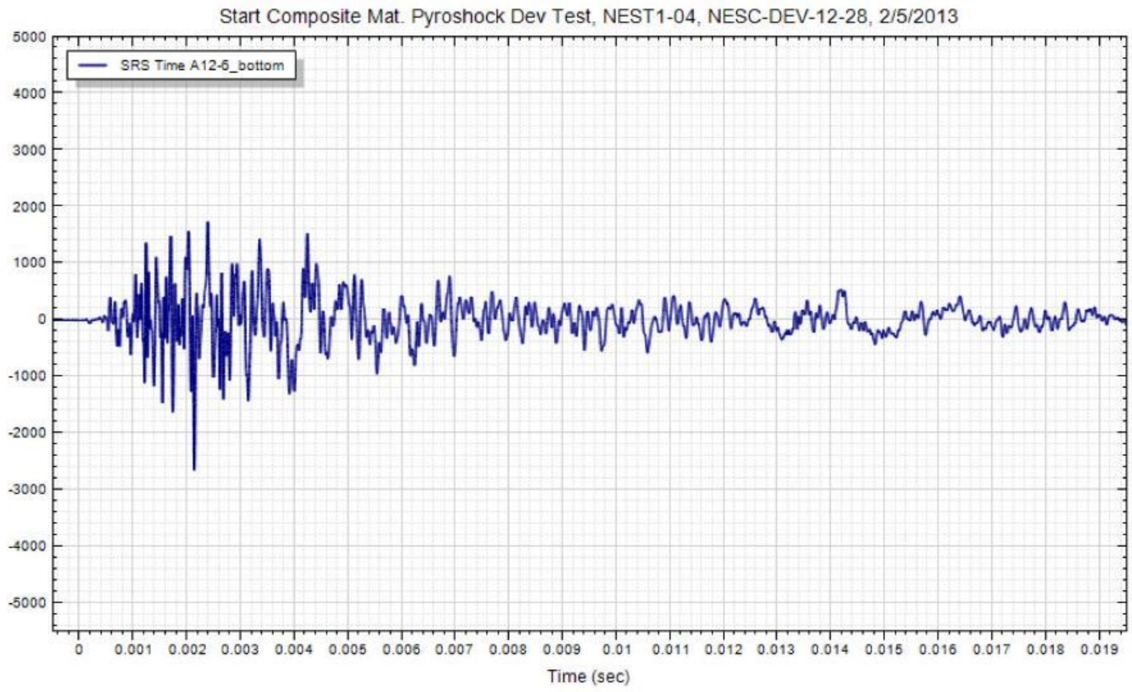
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)



Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A9-5_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A10-5_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A11-5_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A12-6_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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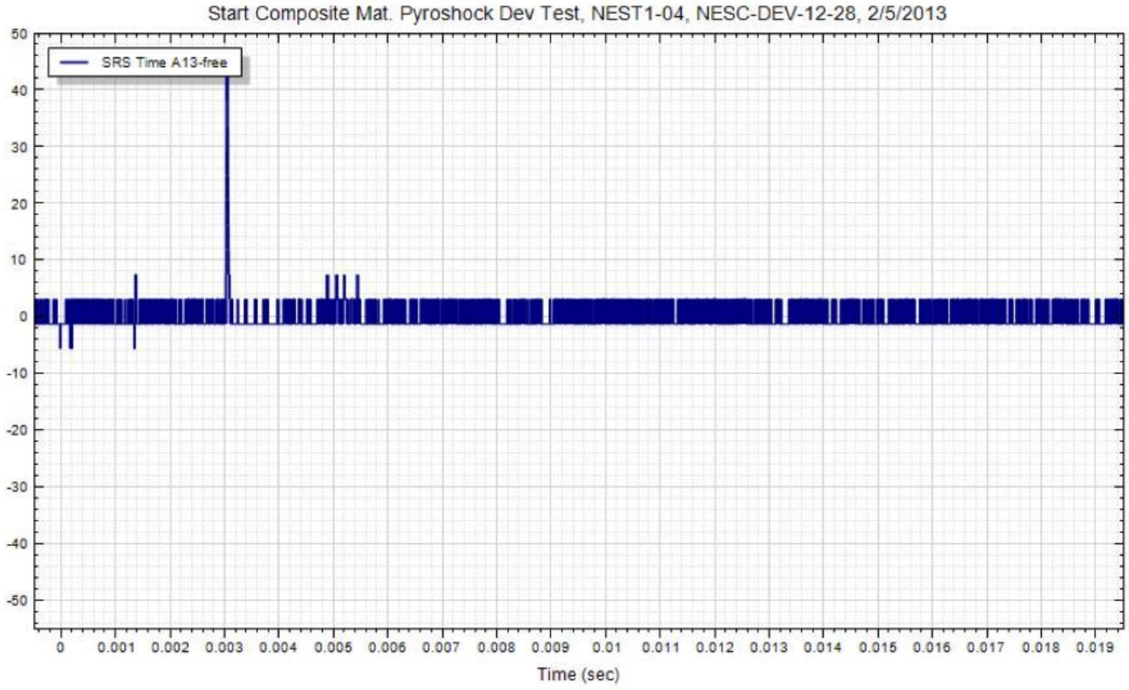
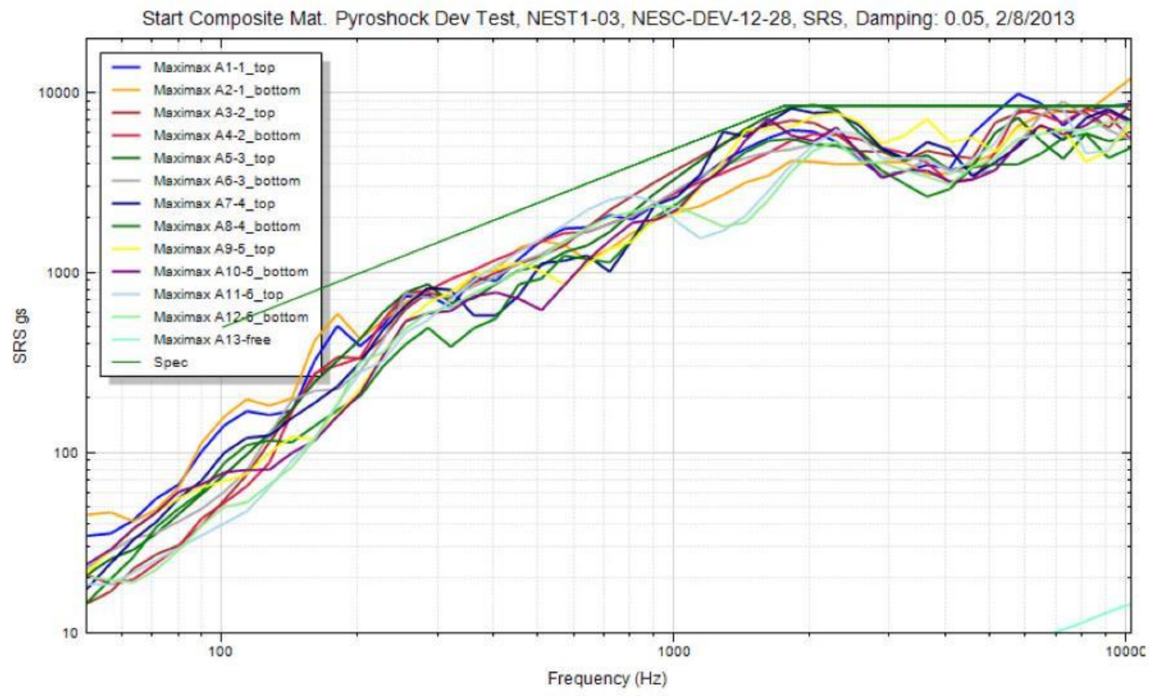
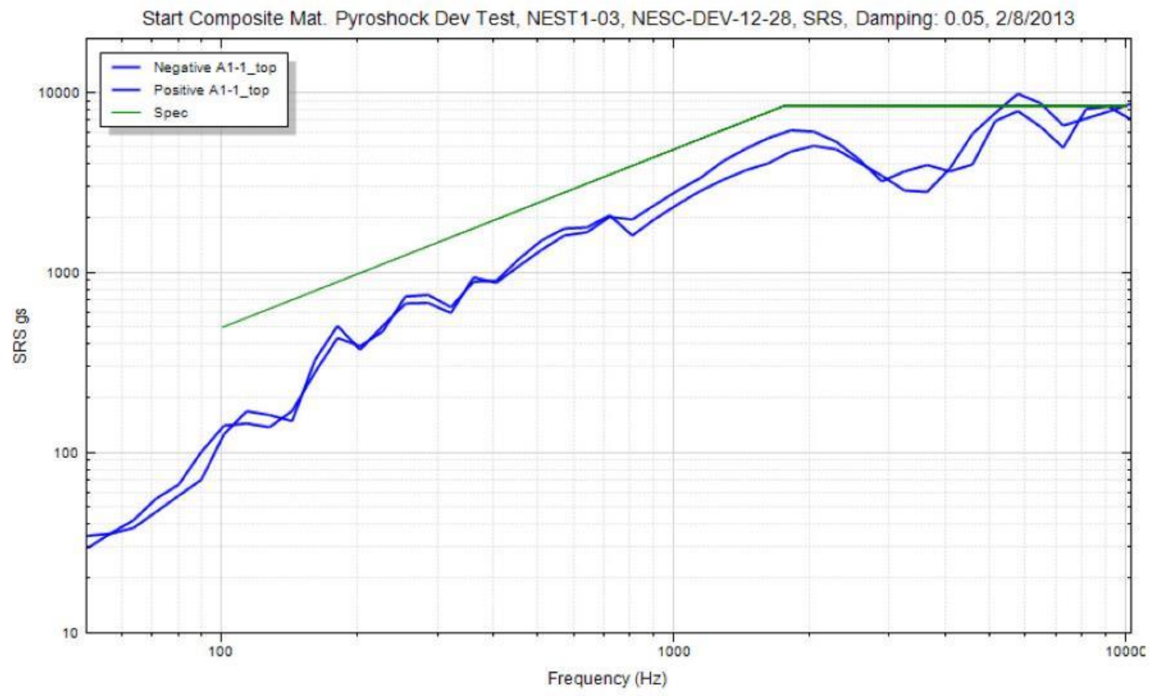
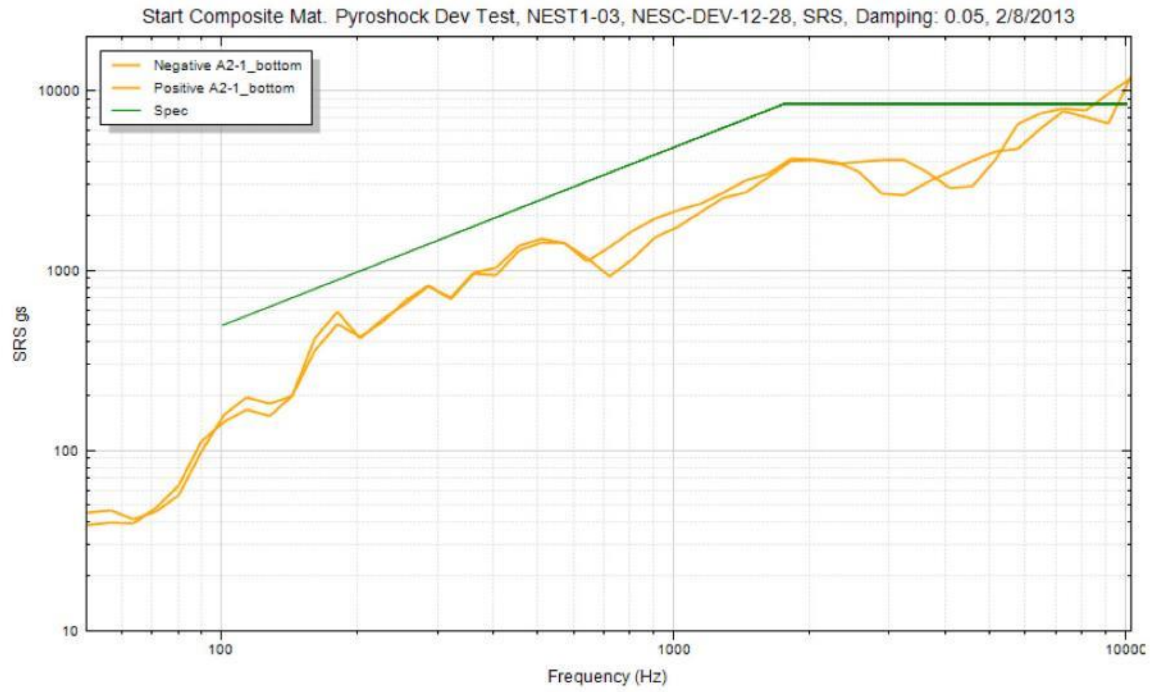

Start Composite Mat. Pyroshock Dev Test, NEST1-04, NESC-DEV-12-28, 2/5/2013
SRS Time A13-free
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

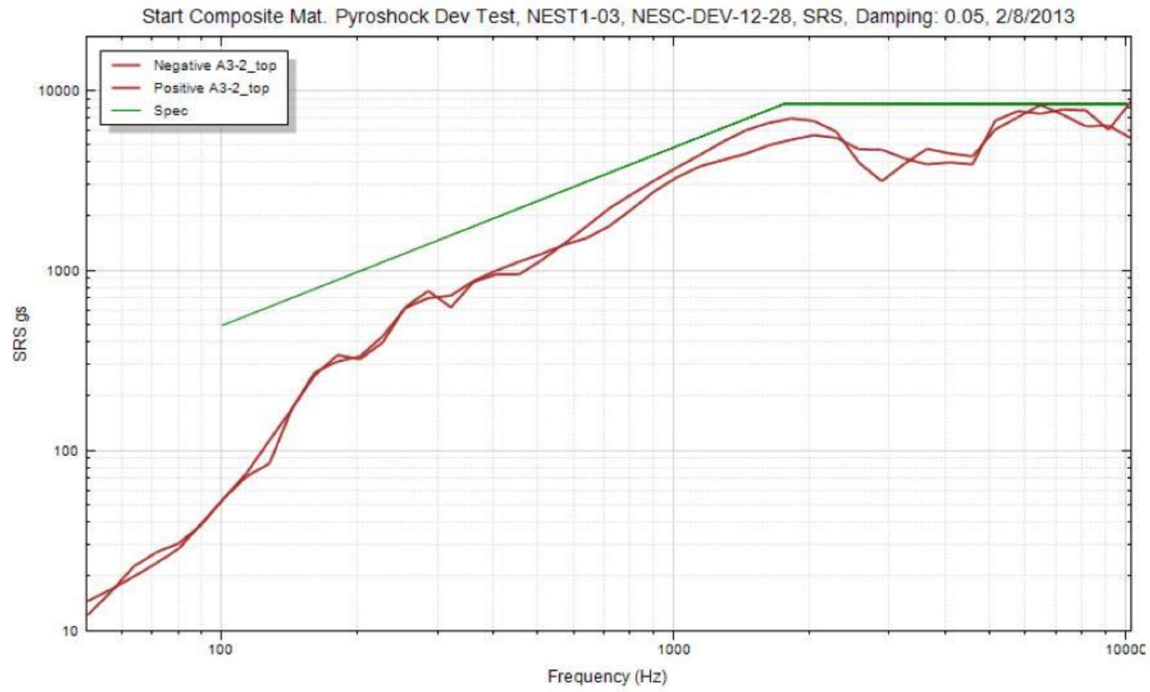
NESC-DEV-12-028
Composite Materials Shock Test

Test #6 Accelerometer Data
Panel 0320A003


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A3-2_top
Positive A3-2_top
Spec
10000
1000
100
10
SRS gs
100
1000
1000C
Frequency (Hz)

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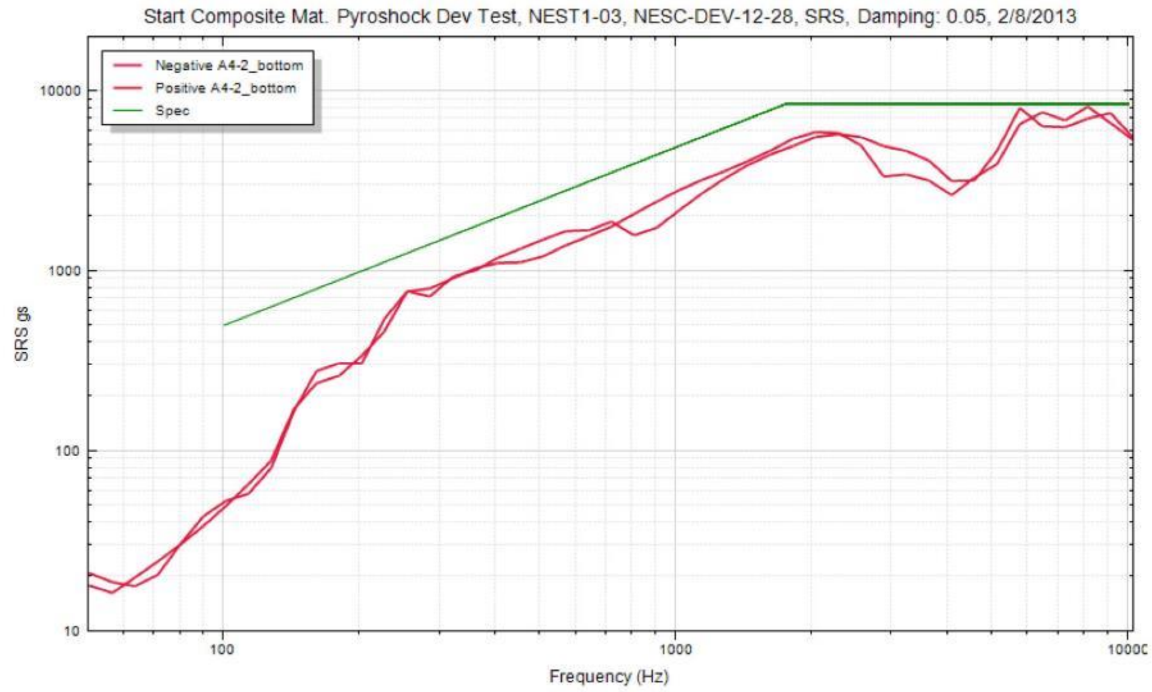
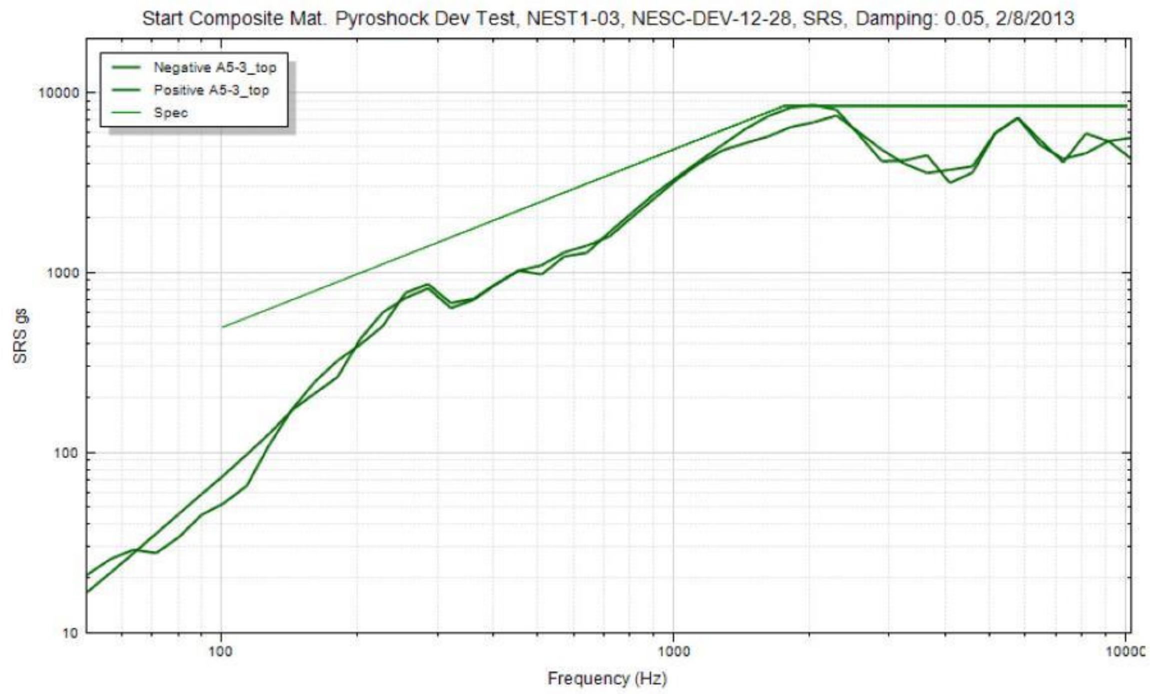

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A5-3_top
Positive A5-3_top
Spec
10000
1000
100
10
SRS gs
100
1000
1000
Frequency (Hz)

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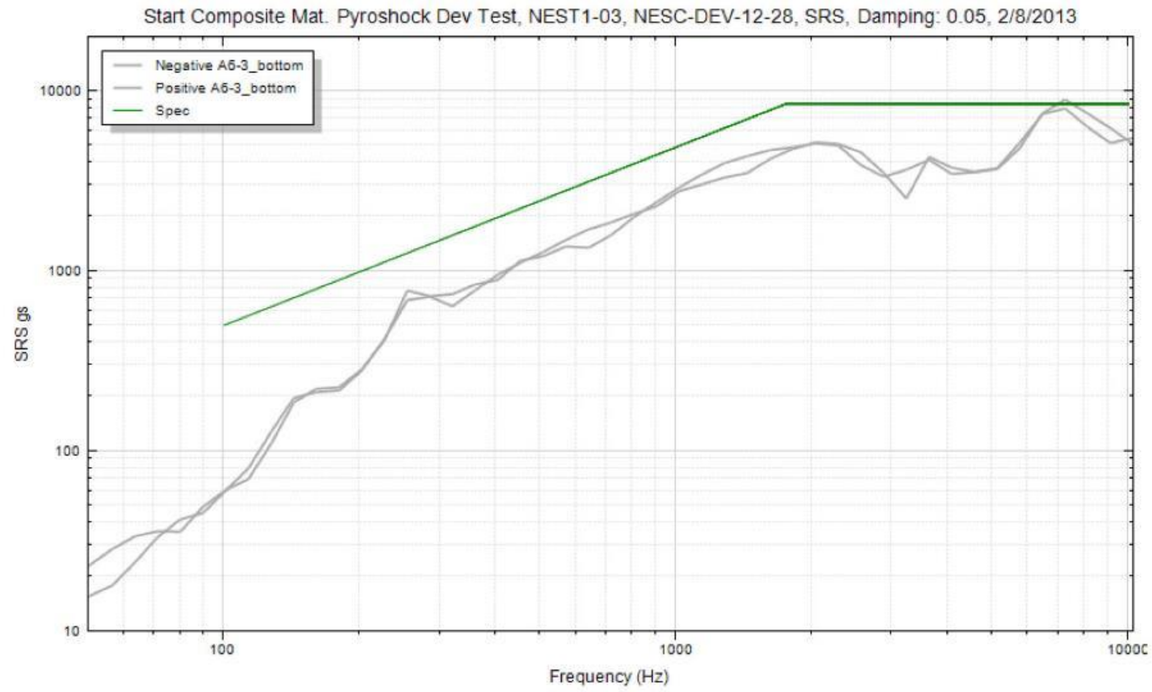
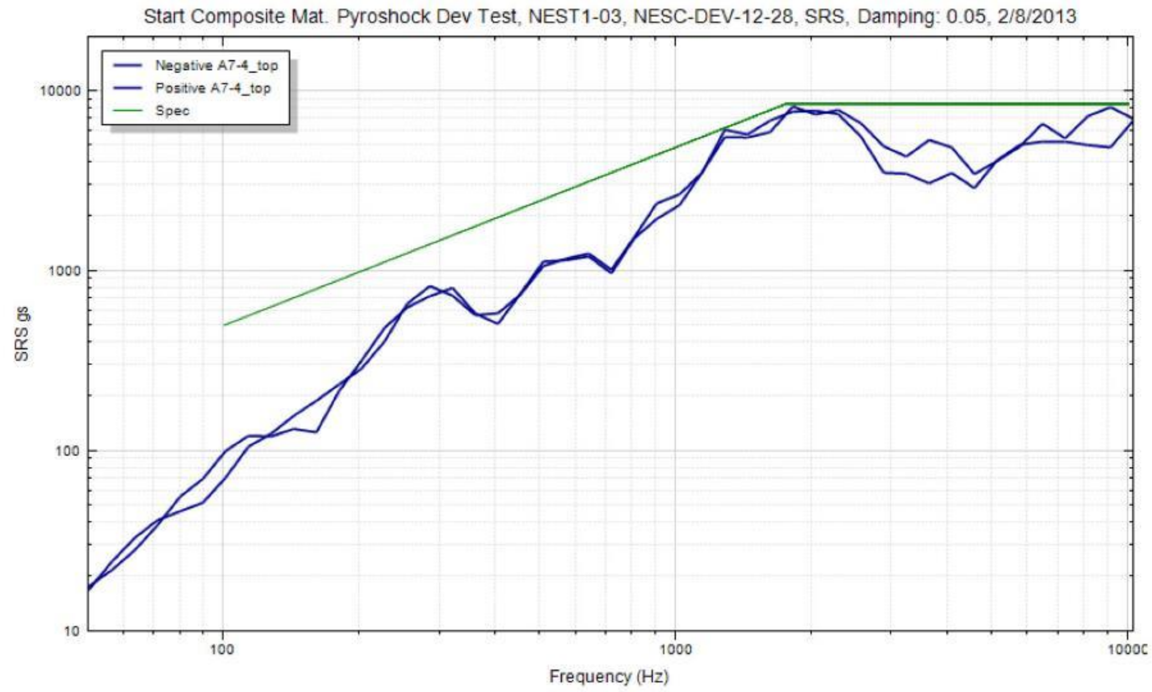
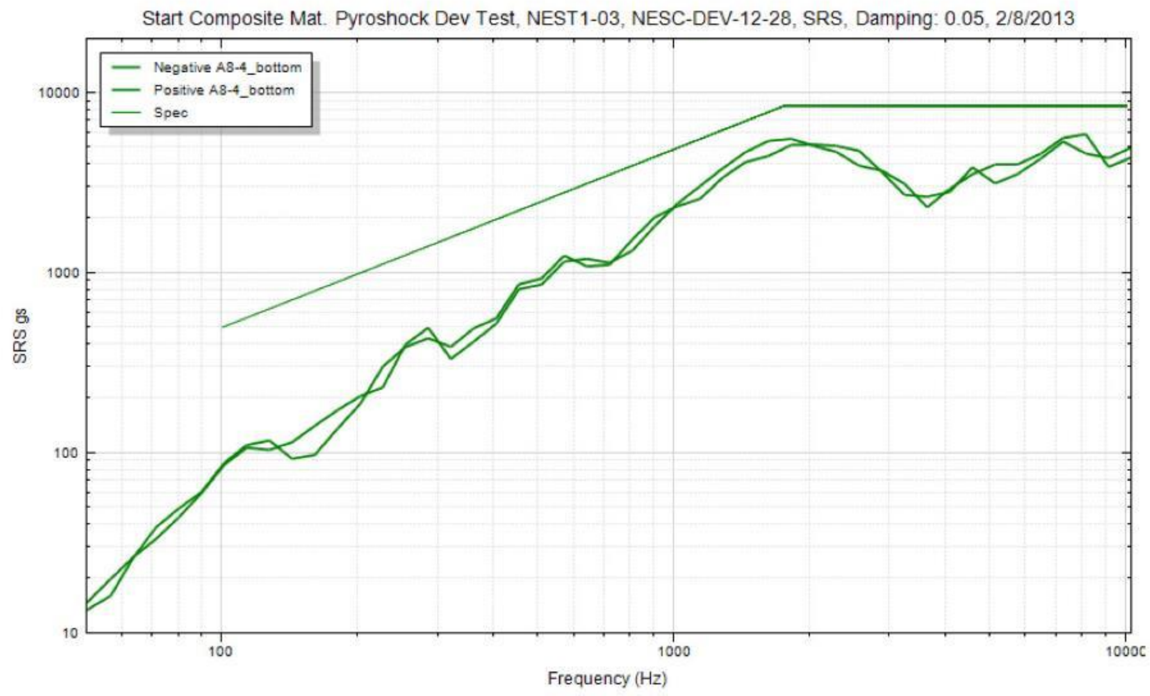
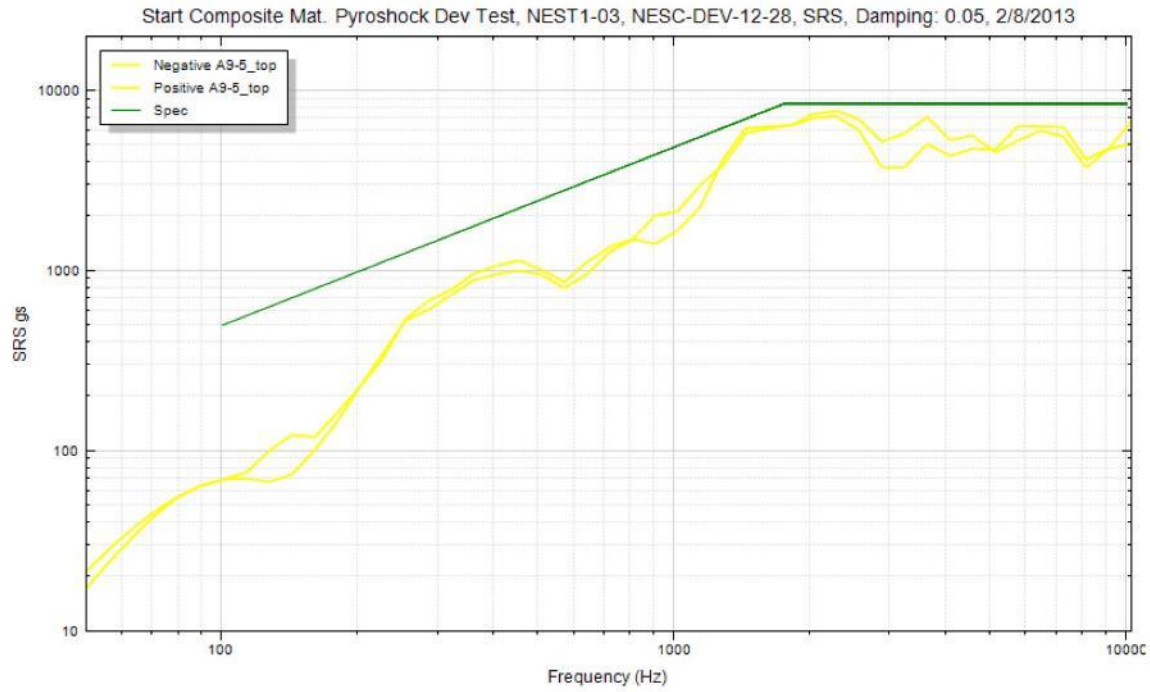
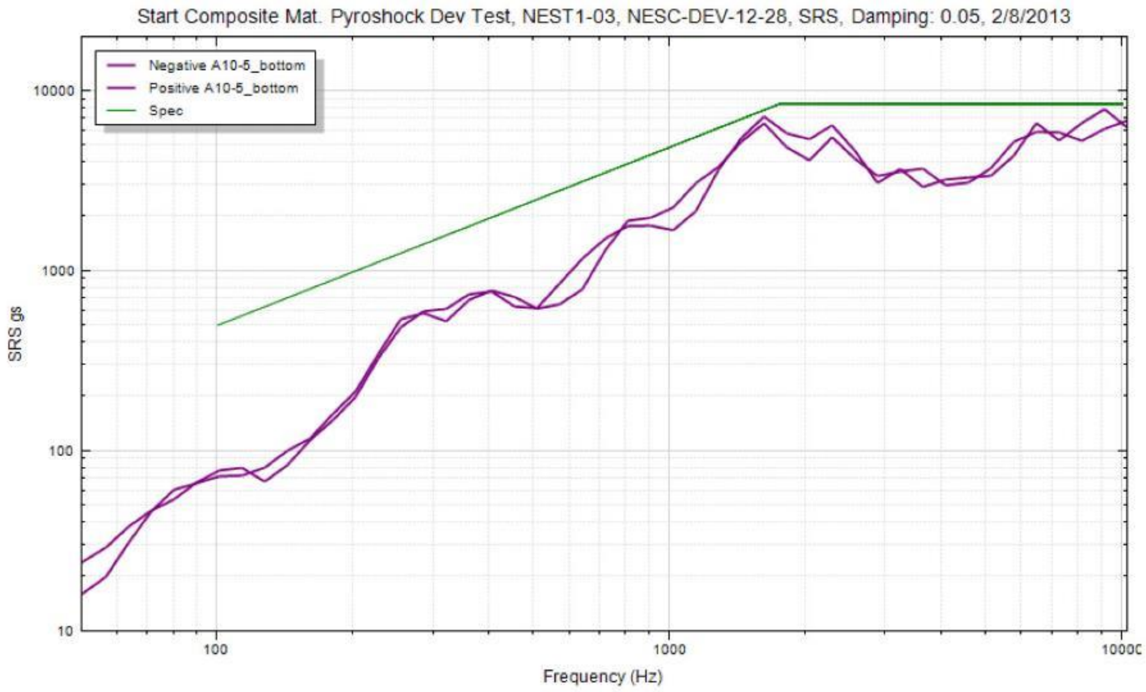

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A7-4_top
Positive A7-4_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

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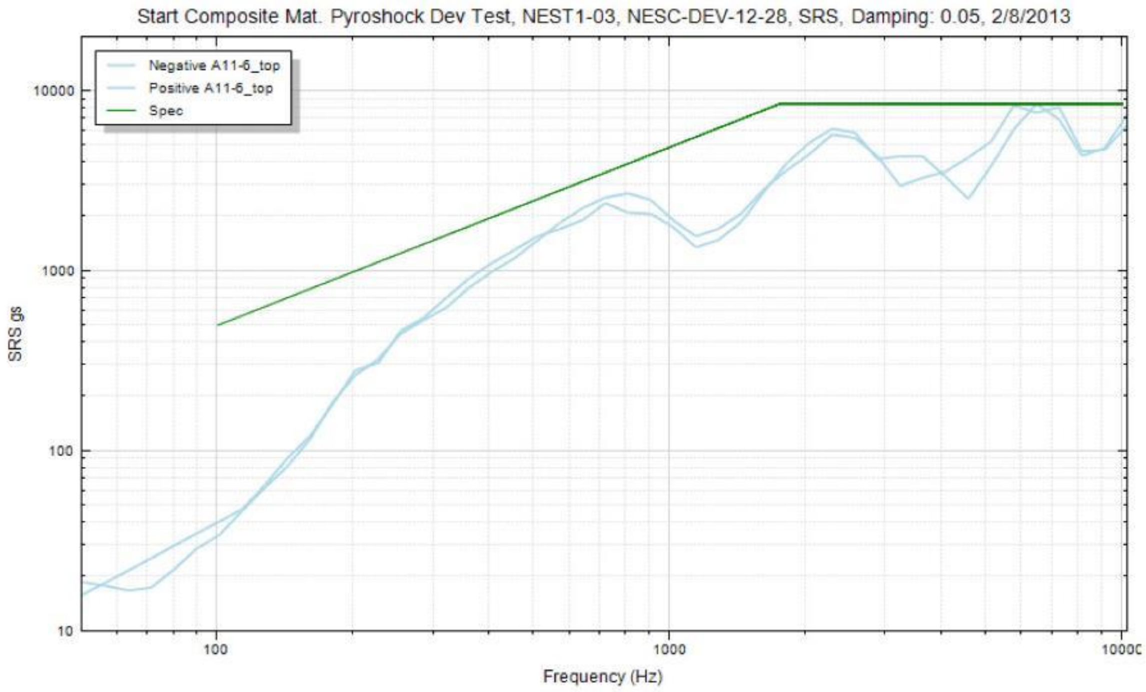
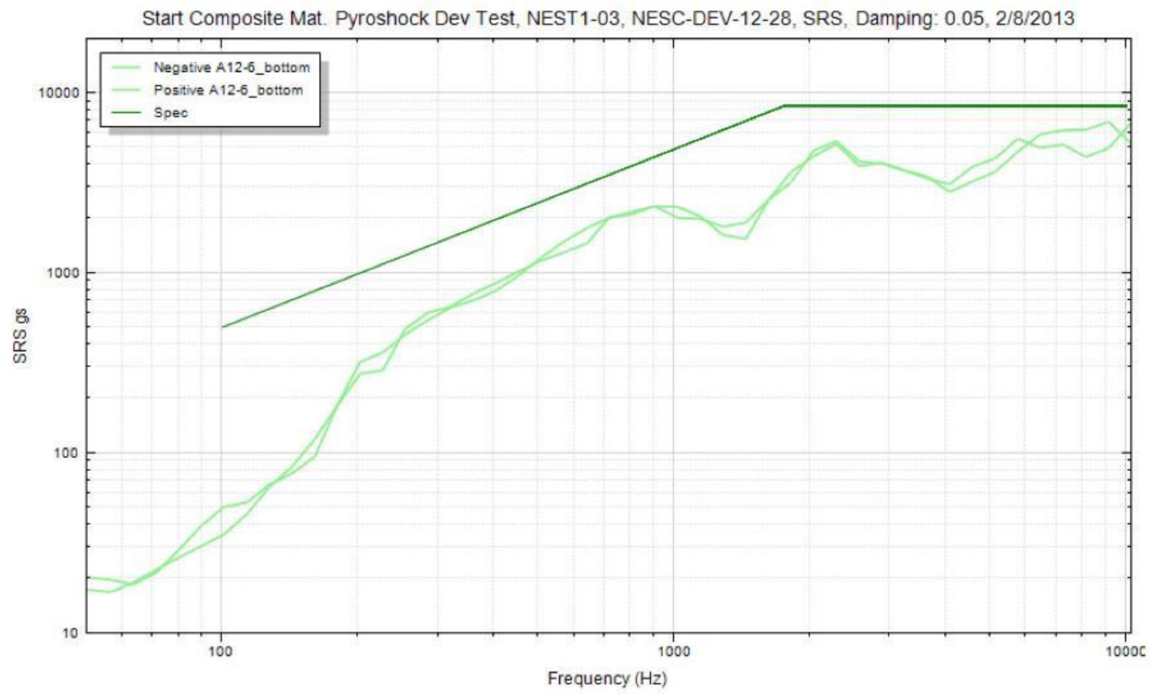
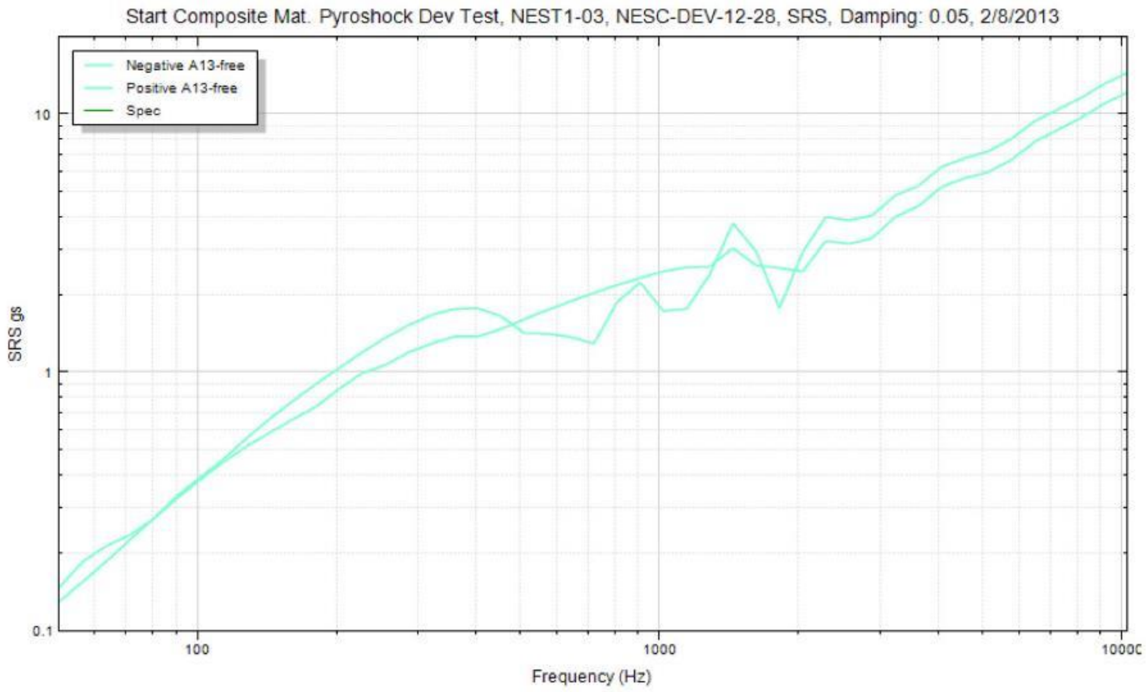
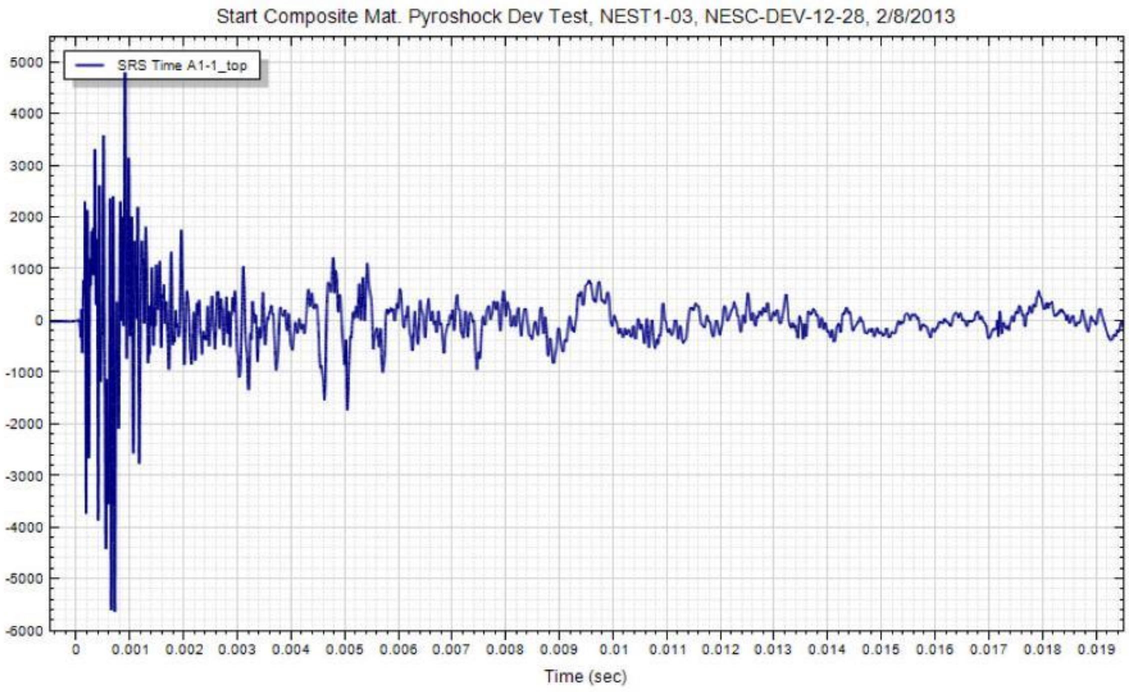
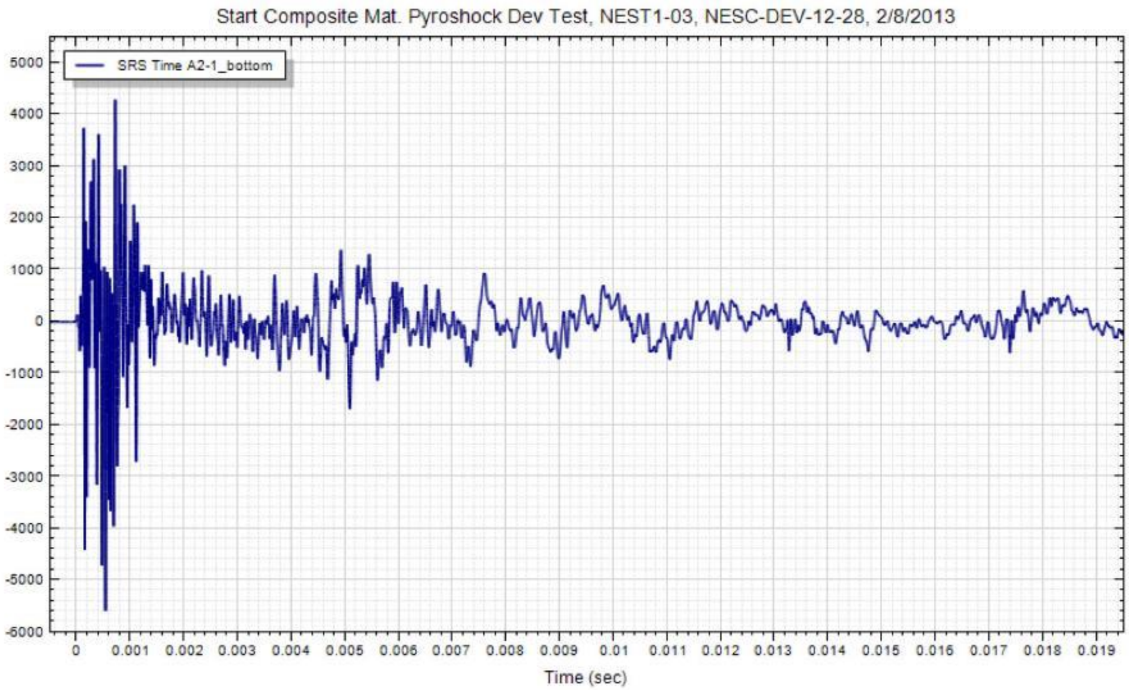
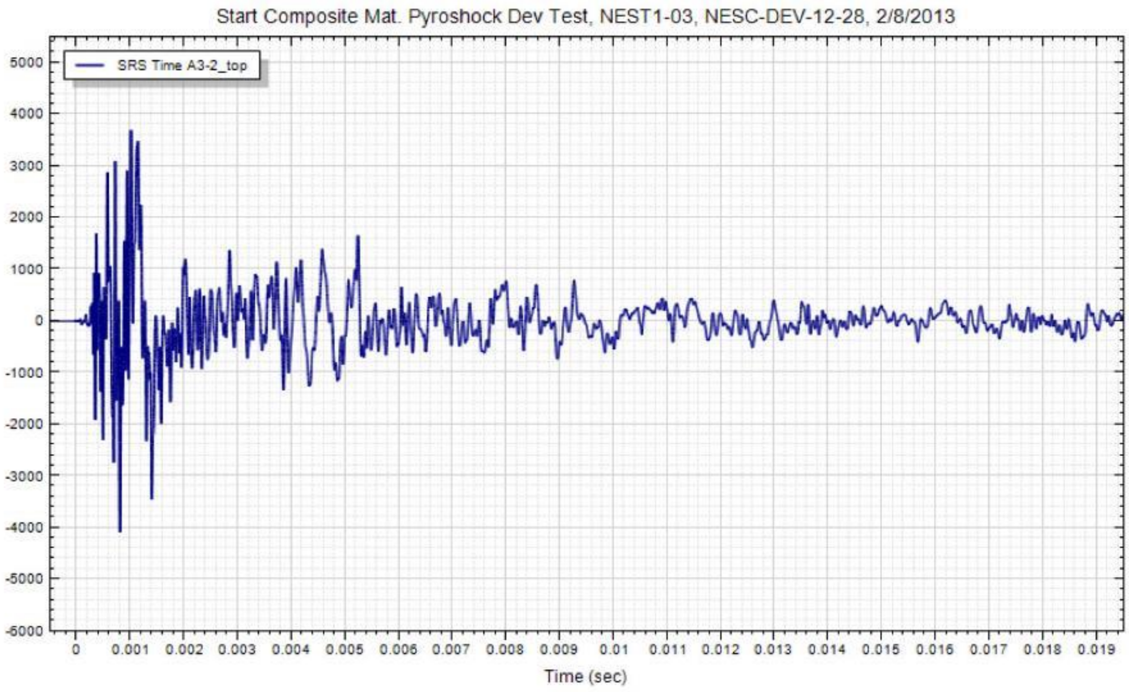

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

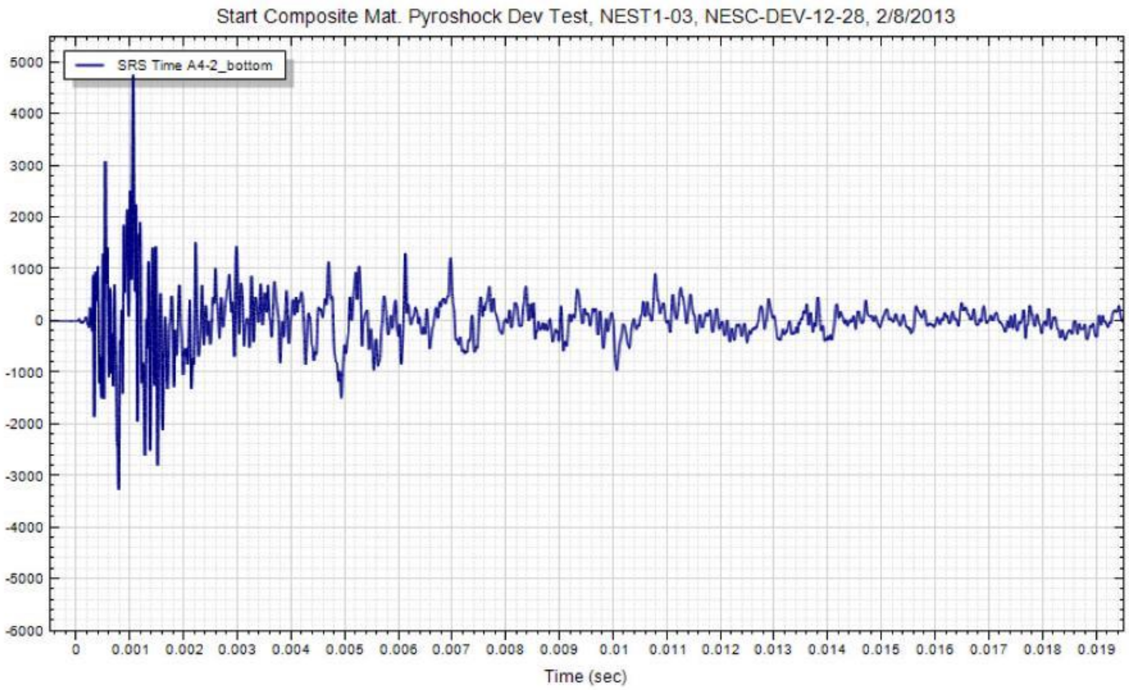

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

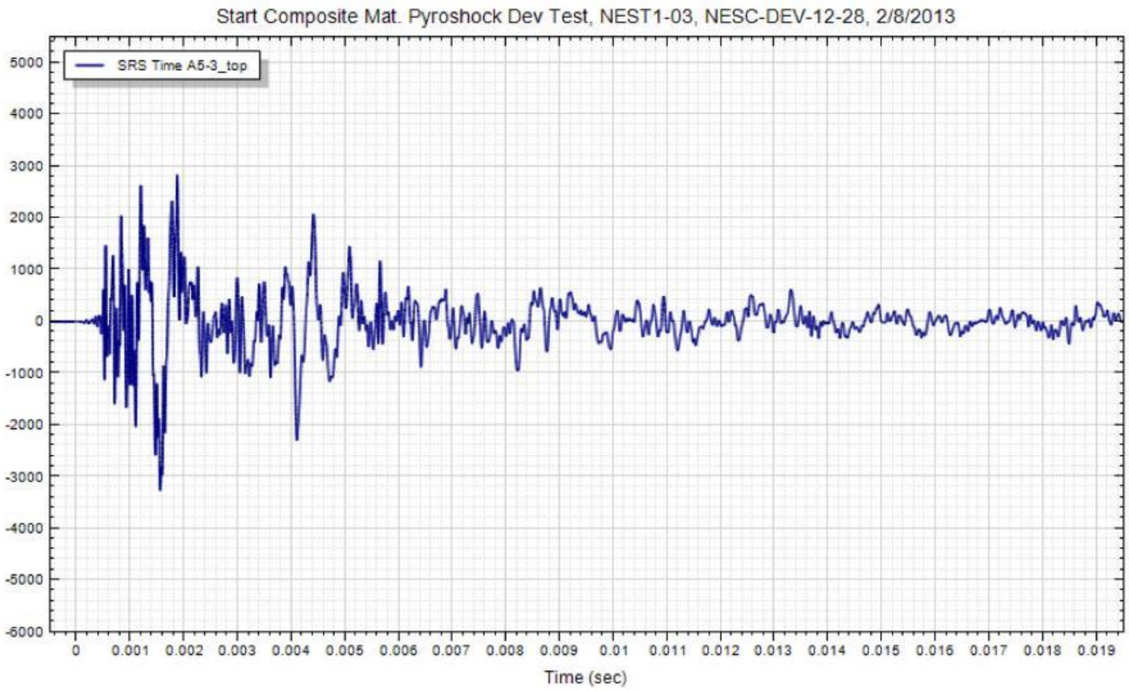

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, SRS, Damping: 0.05, 2/8/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
10000
Frequency (Hz)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A1-1_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A2-1_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A3-2_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A4-2_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A5-3_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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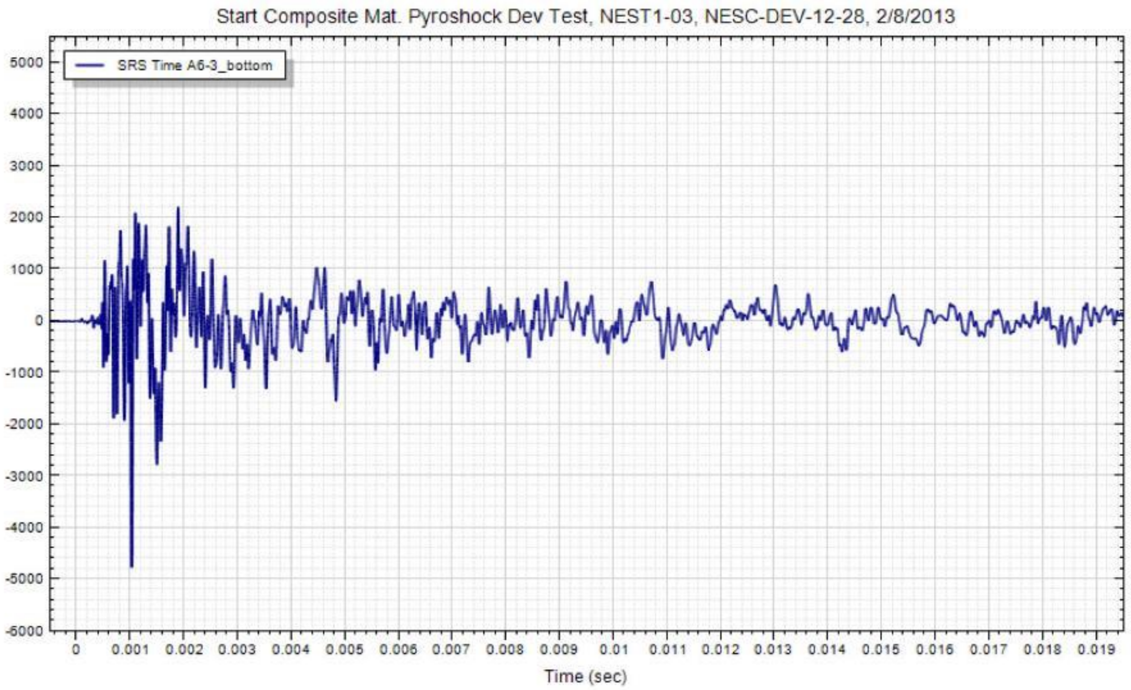
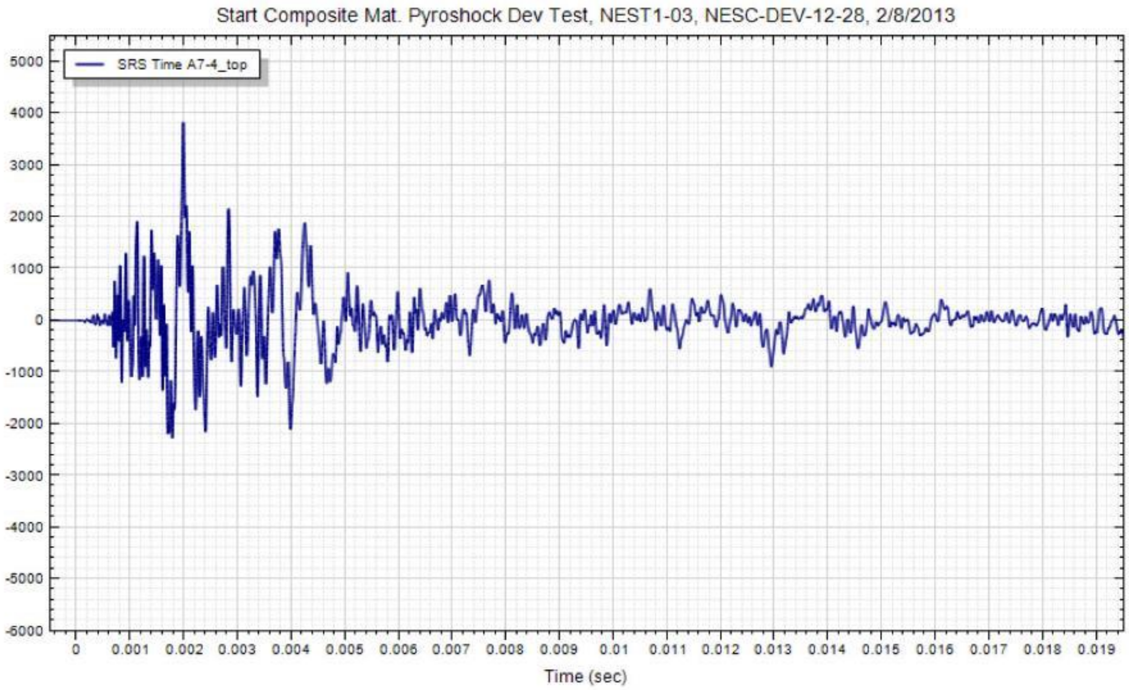
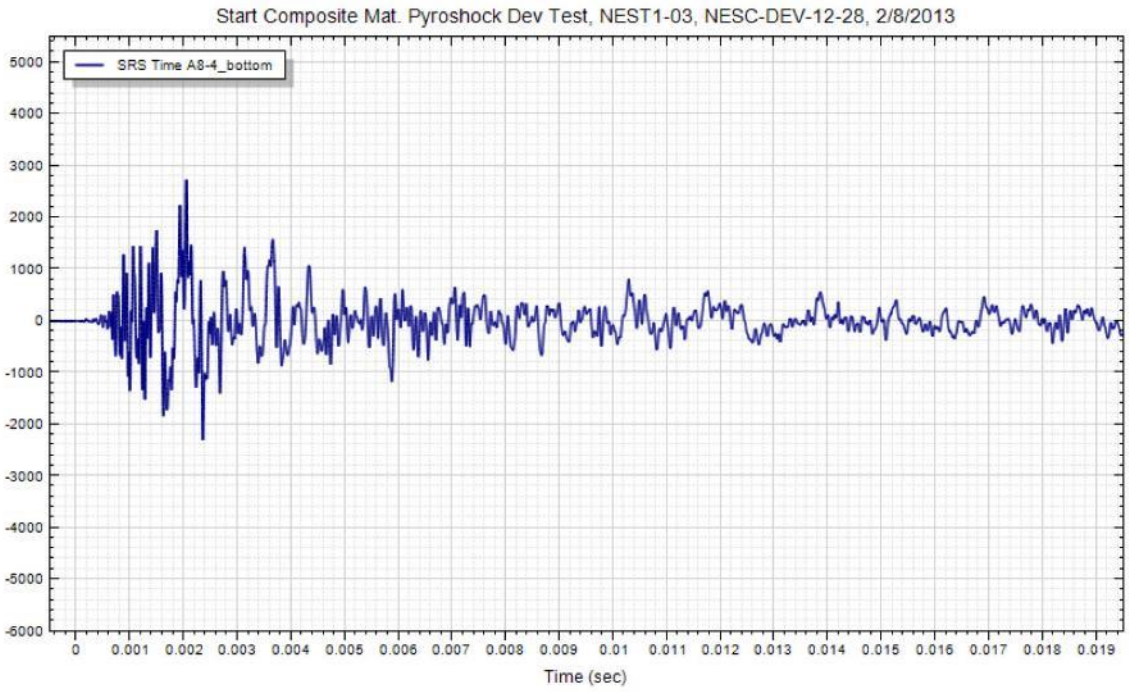
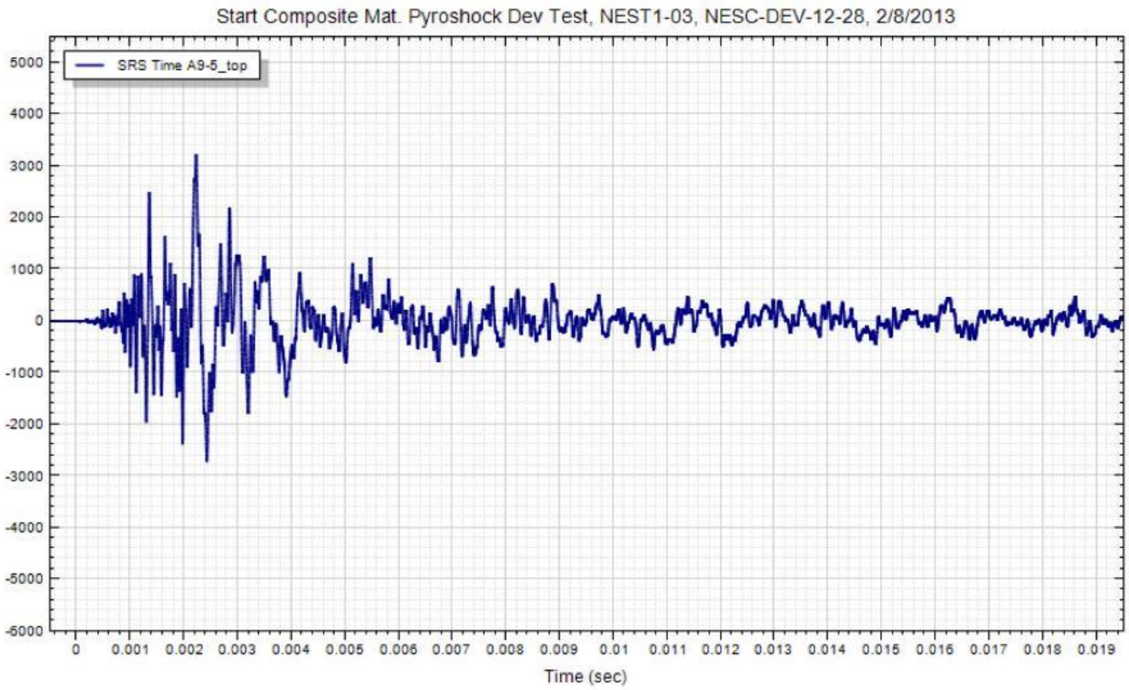
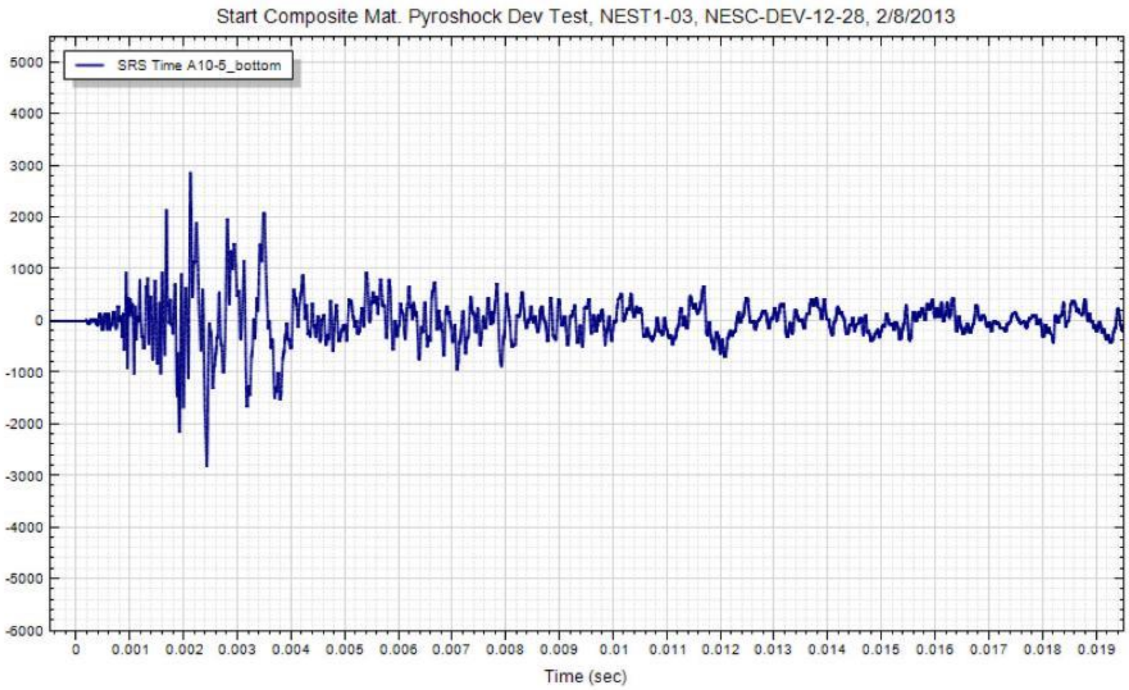
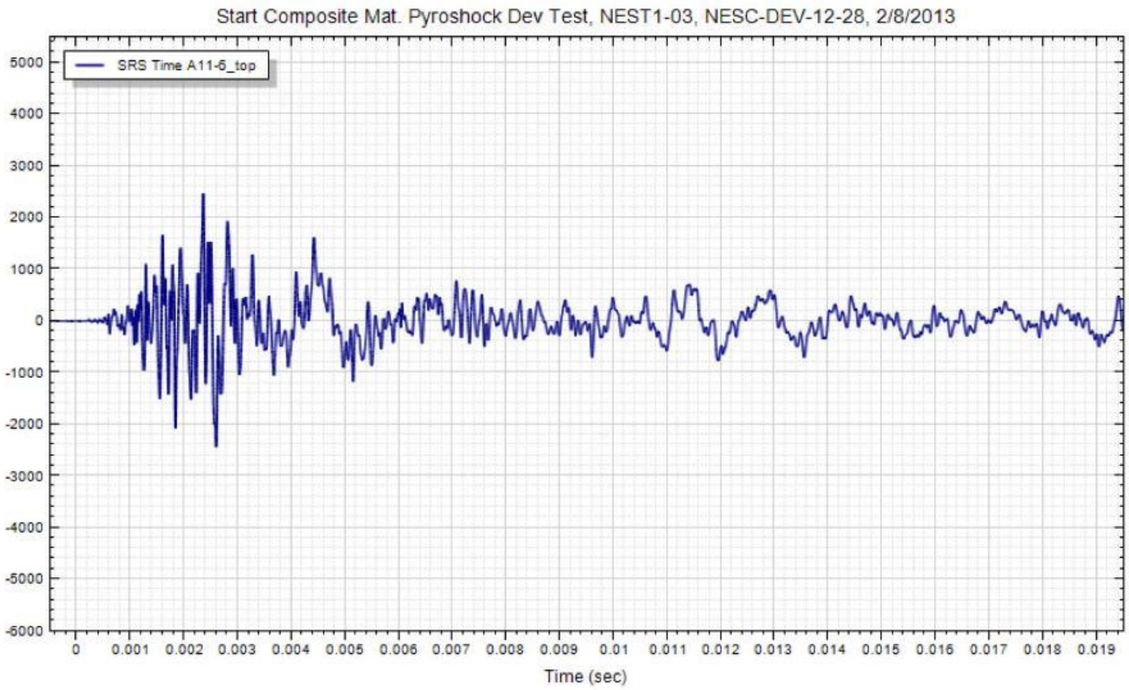

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A6-3_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

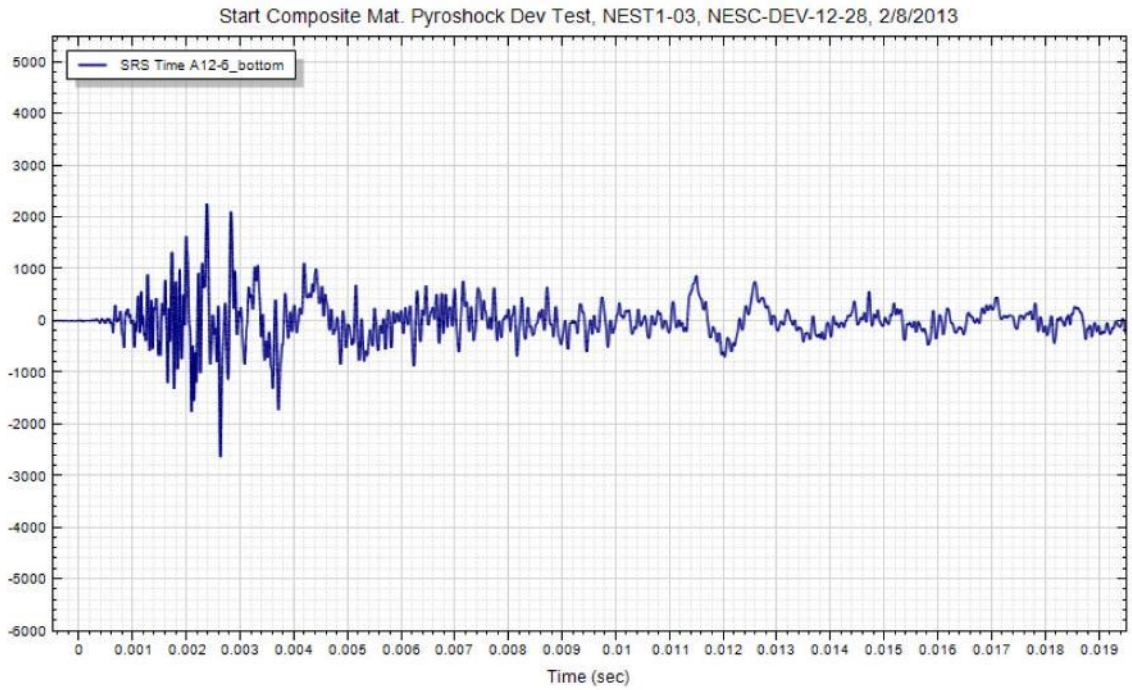

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A7-4_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

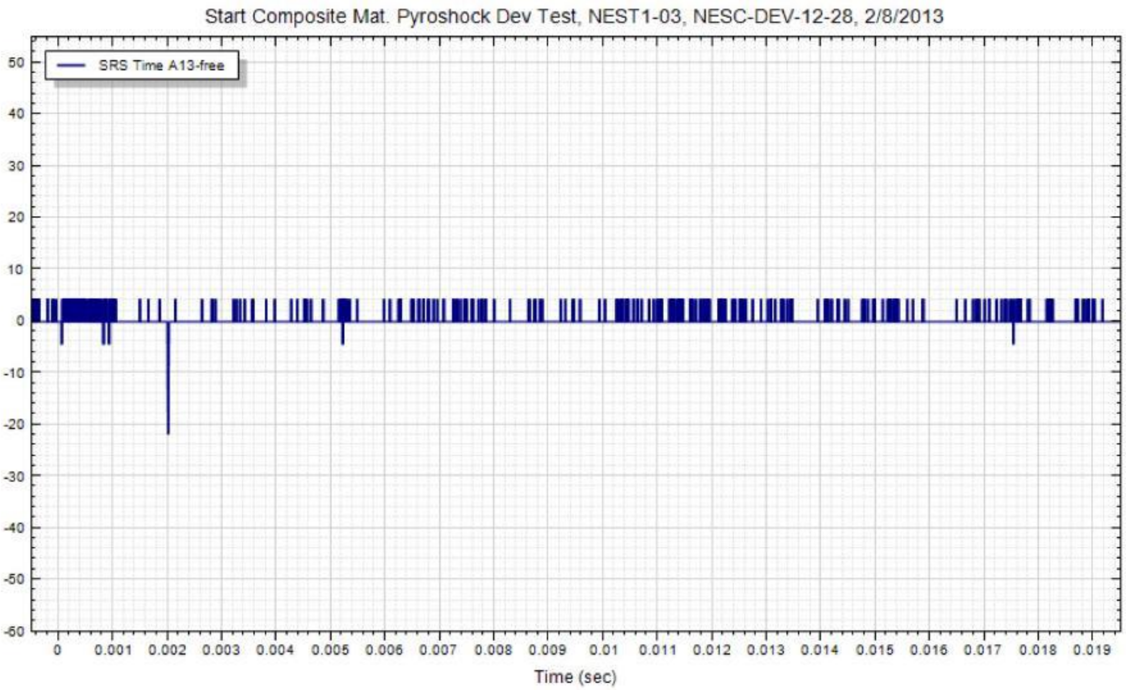

Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A8-4_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A9-5_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A10-5_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A11-6_top
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Start Composite Mat. Pyroshock Dev Test, NEST1-03, NESC-DEV-12-28, 2/8/2013
SRS Time A12-6_bottom
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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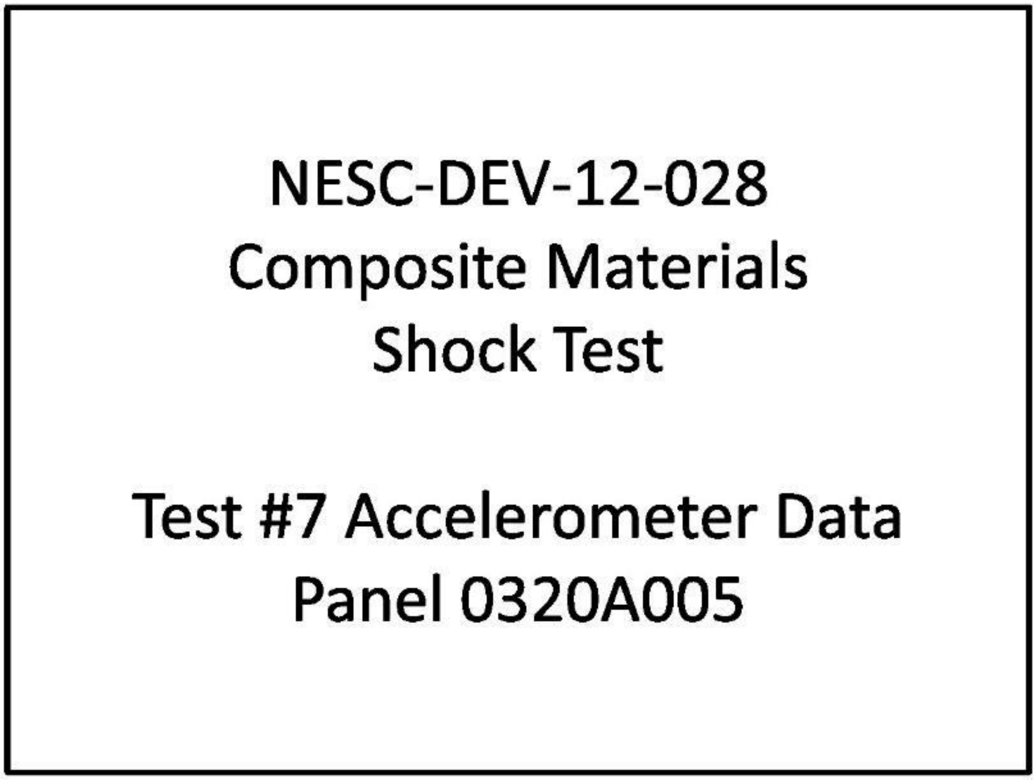
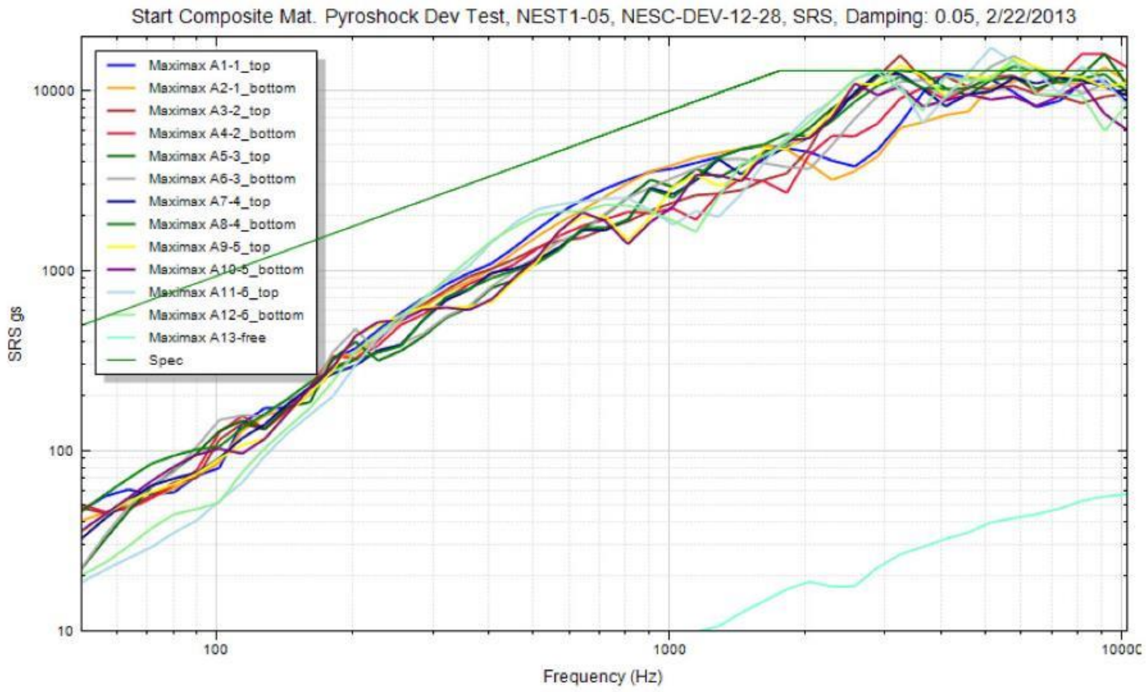
SRS Time A13-free
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)



NESC-DEV-12-028
Composite Materials
Shock Test

Test #7 Accelerometer Data
Panel 0320A005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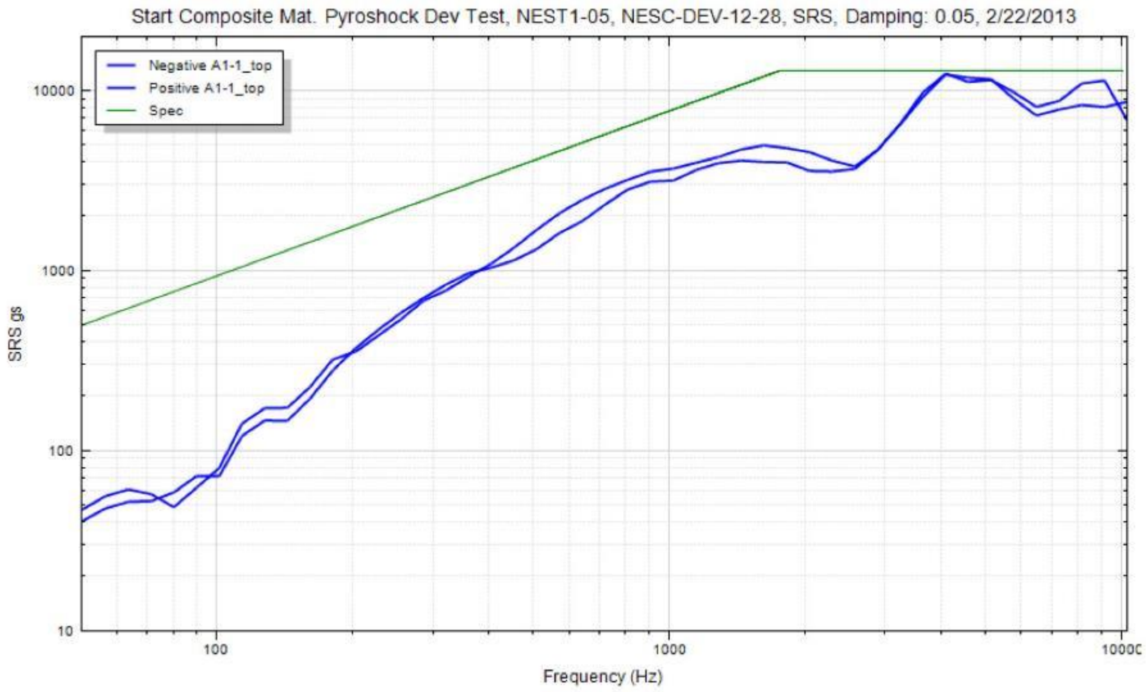
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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Positive A1-1_top
Spec
SRS gs
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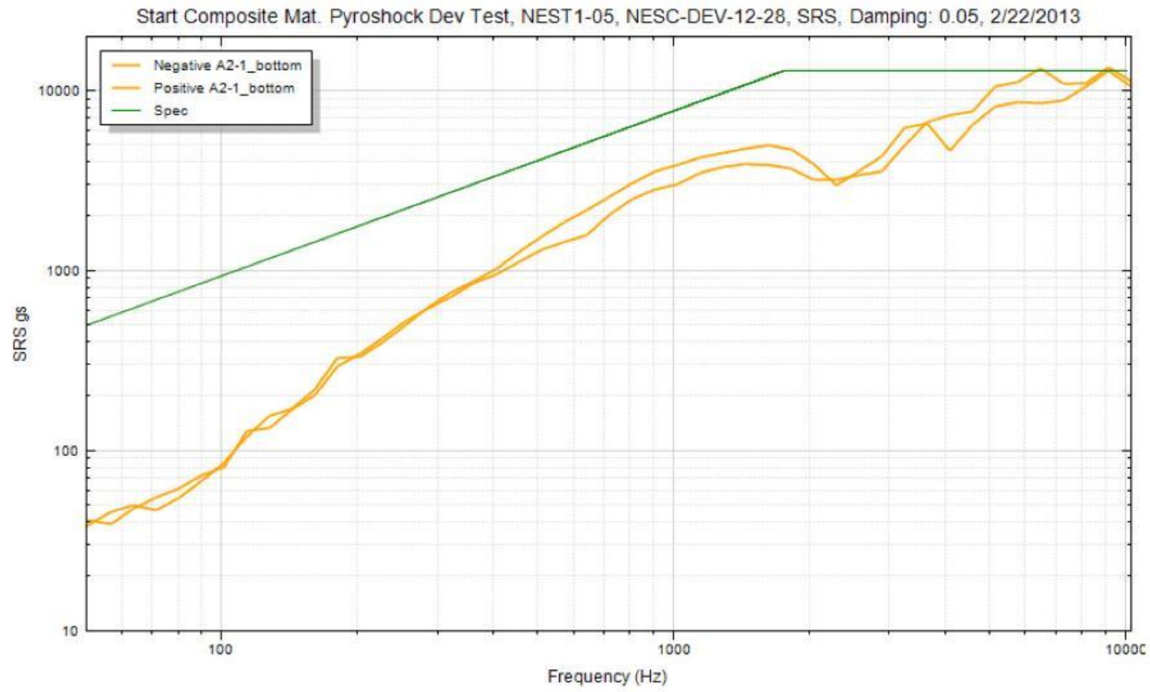
10
100
1000
10000
Frequency (Hz)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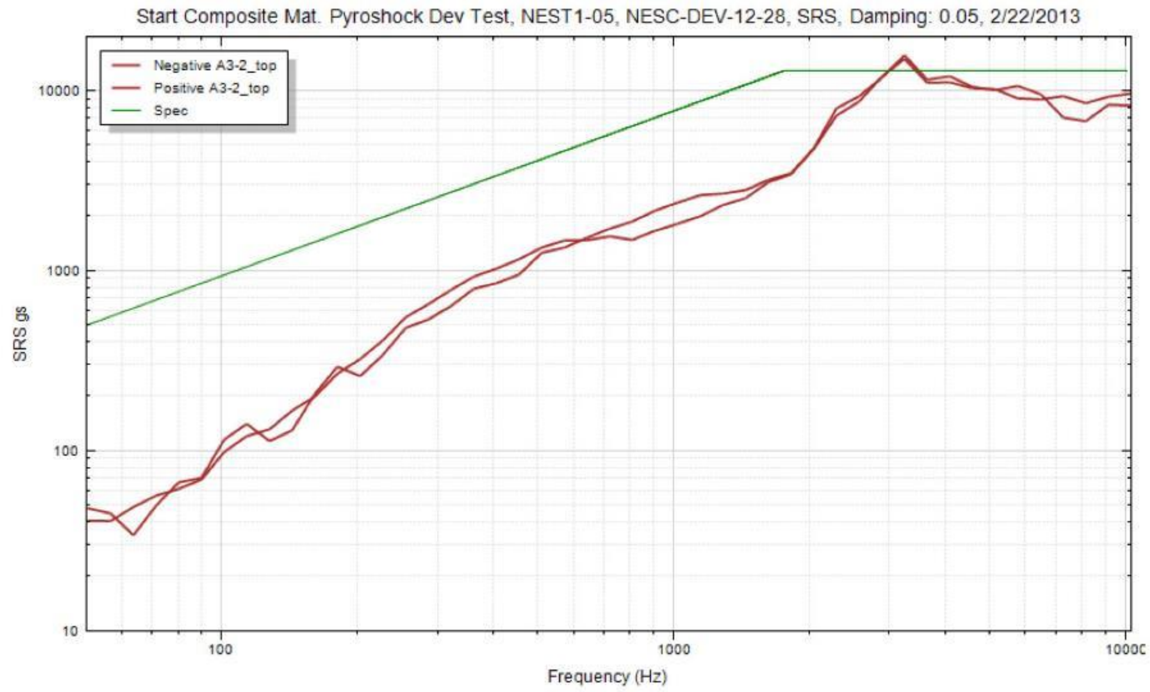
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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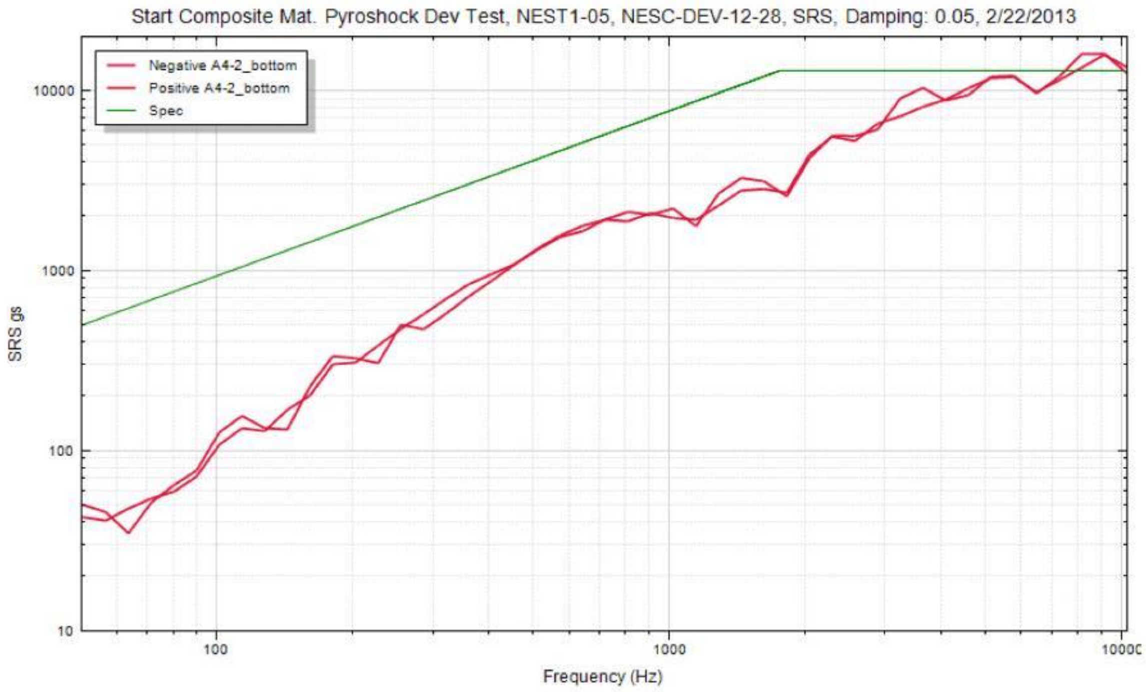
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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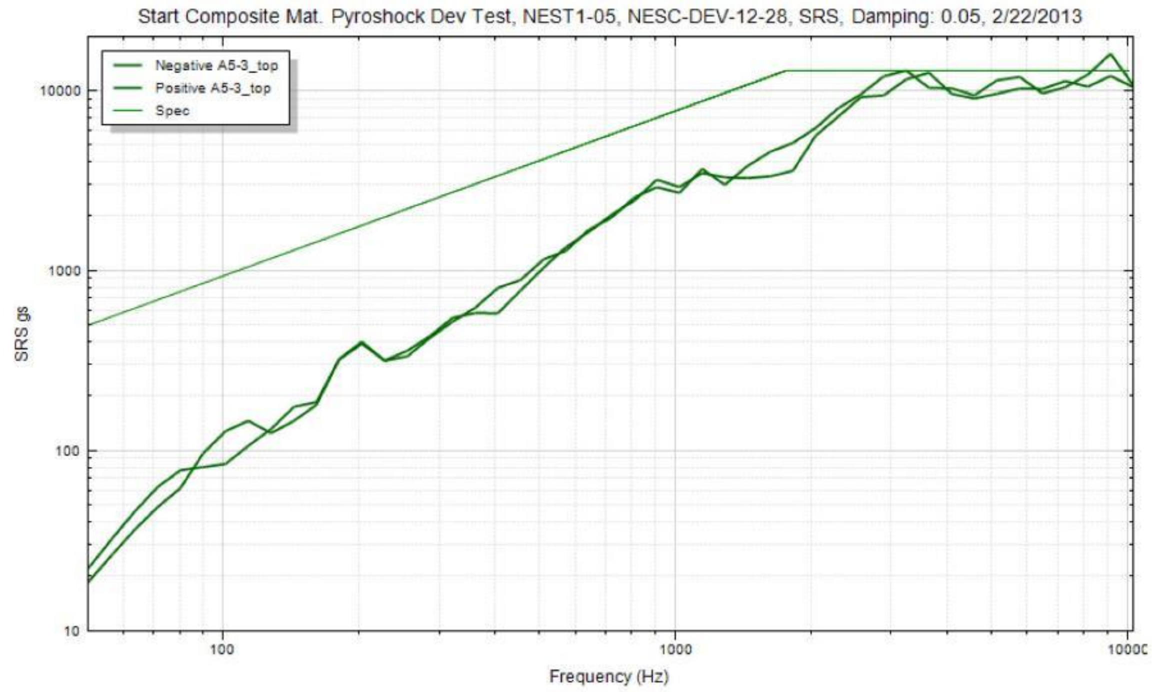
10
100
1000
10000
Frequency (Hz)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Negative A5-3_top
Positive A5-3_top
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SRS gs
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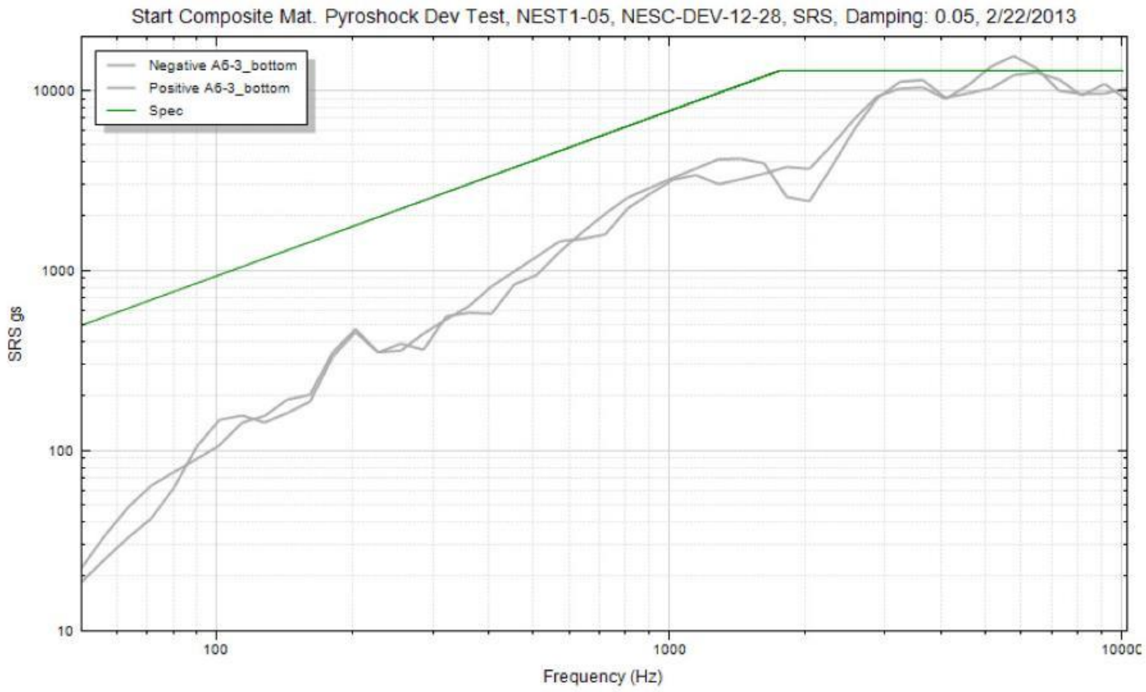
1000
100
10
100
1000
10000
Frequency (Hz)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Negative A6-3_bottom
Positive A6-3_bottom
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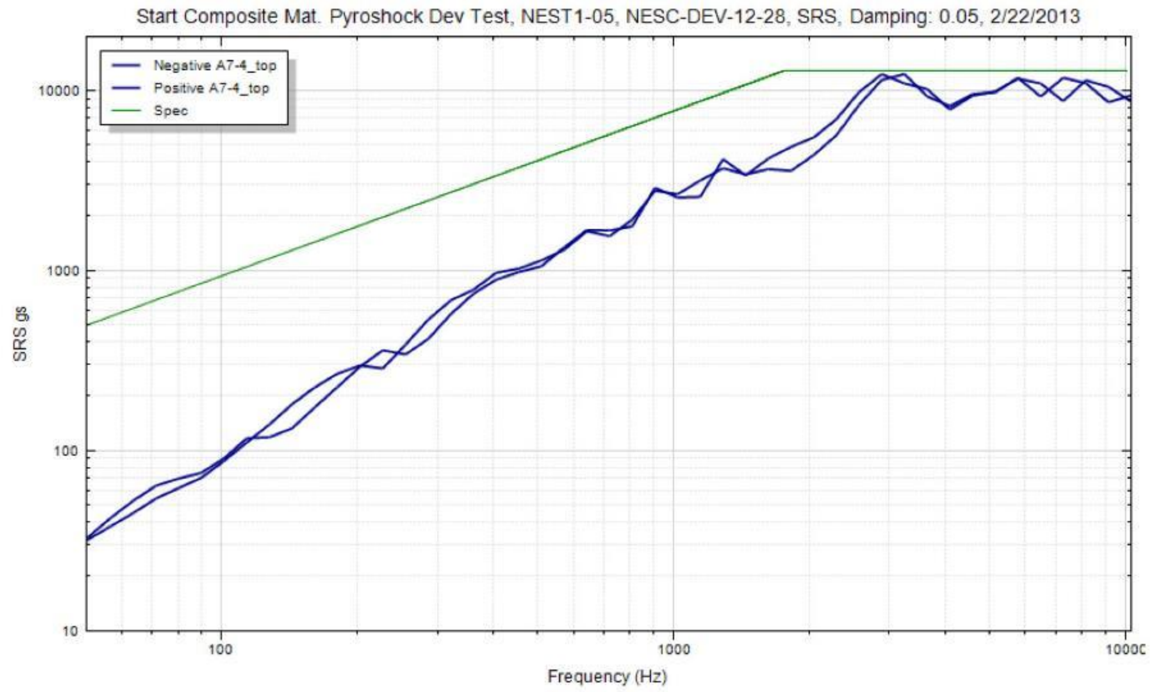
10
100
1000
10000
Frequency (Hz)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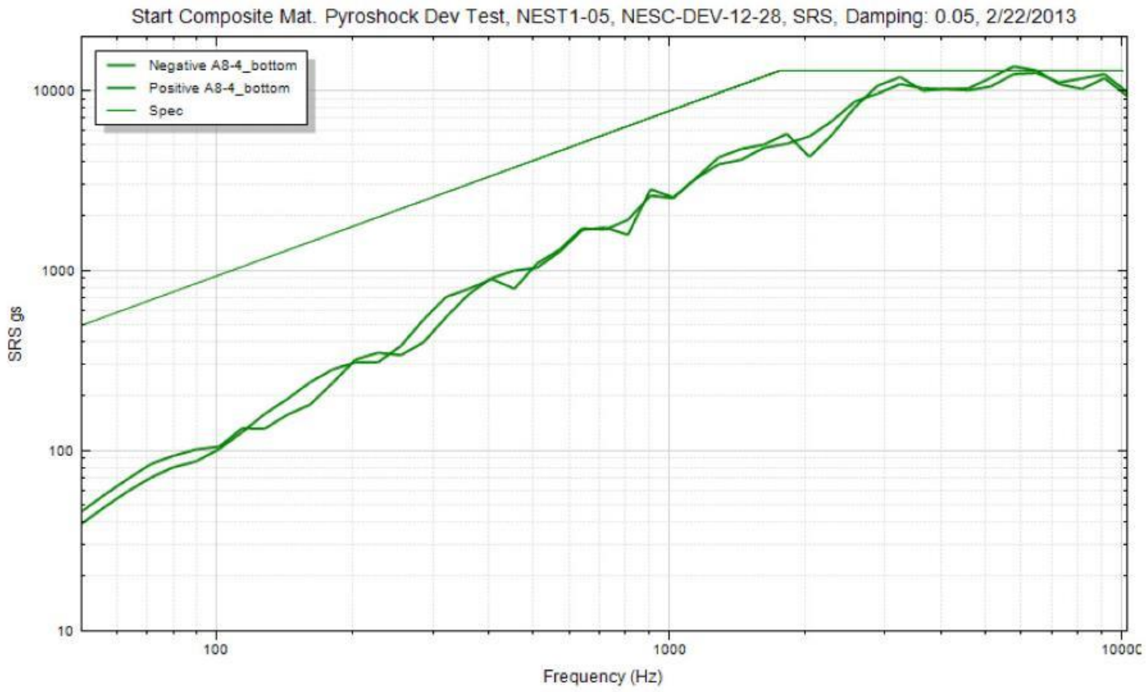
Positive A7-4_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000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Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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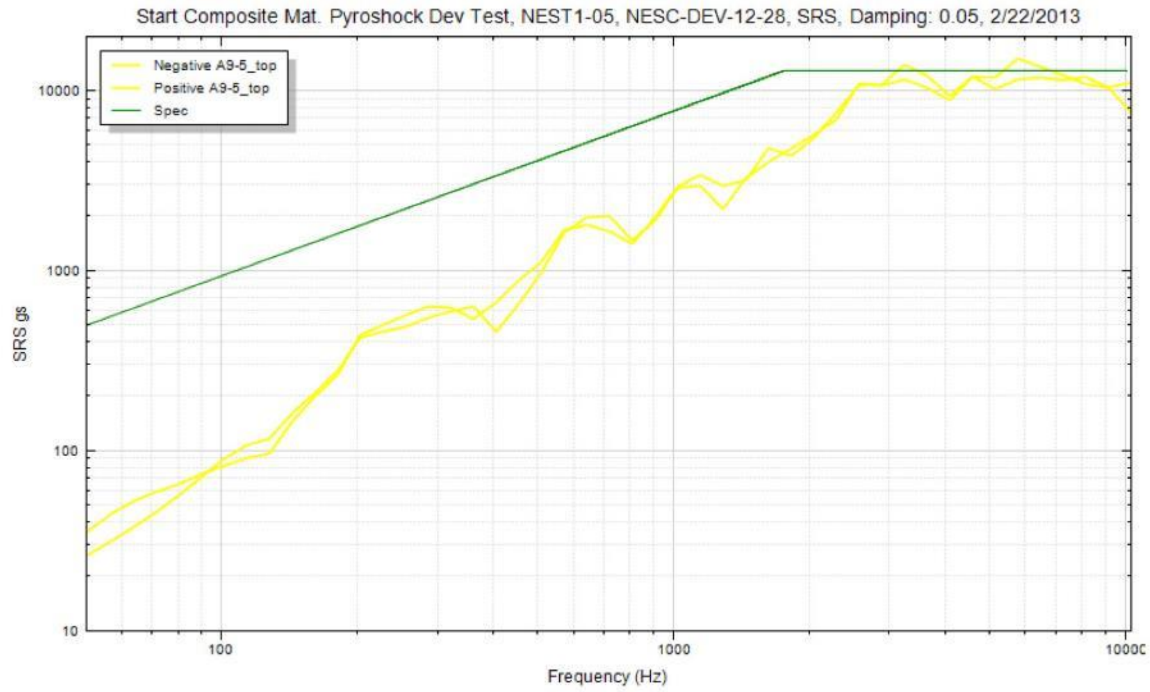
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Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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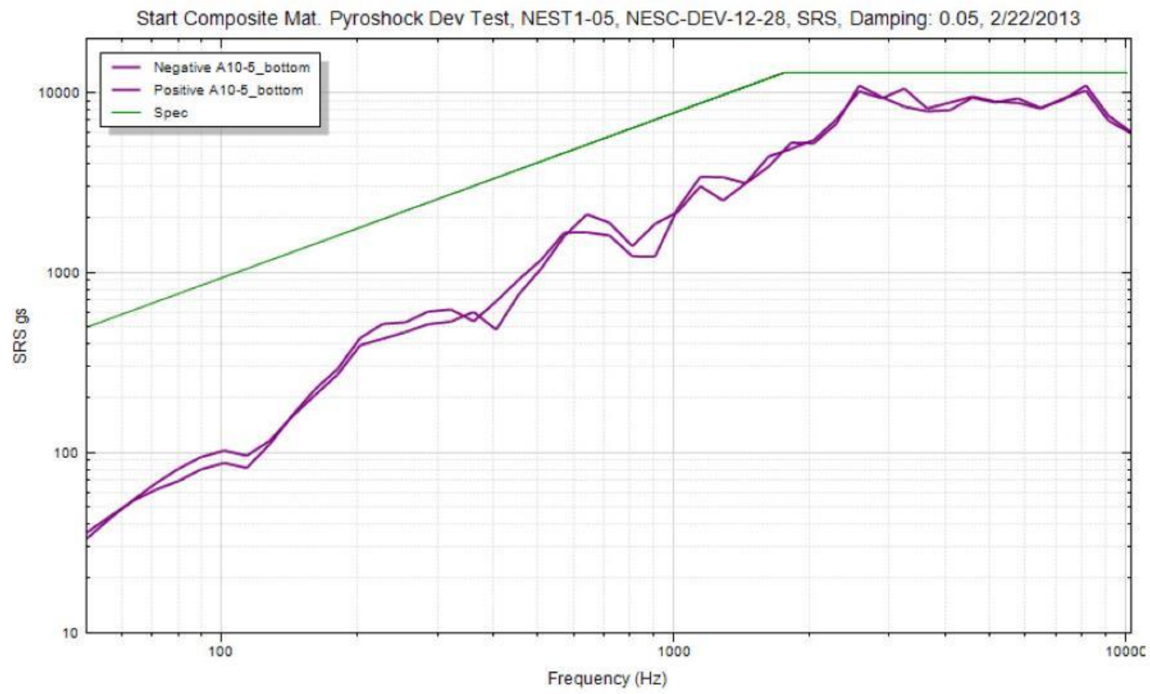
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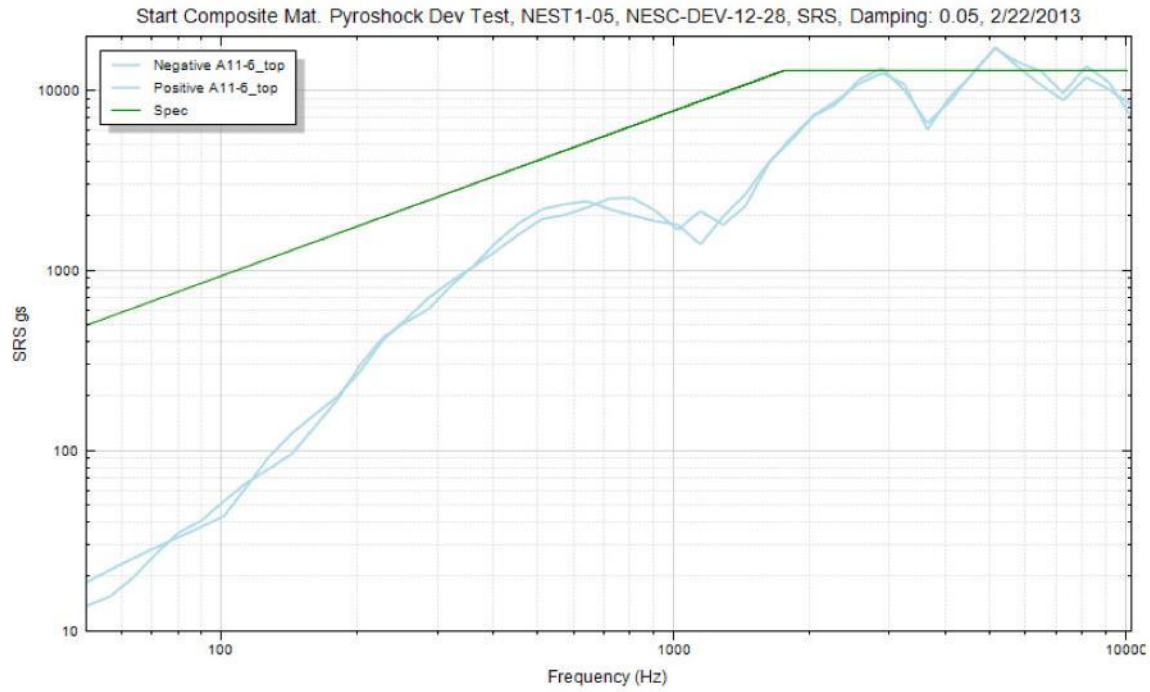
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000



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Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
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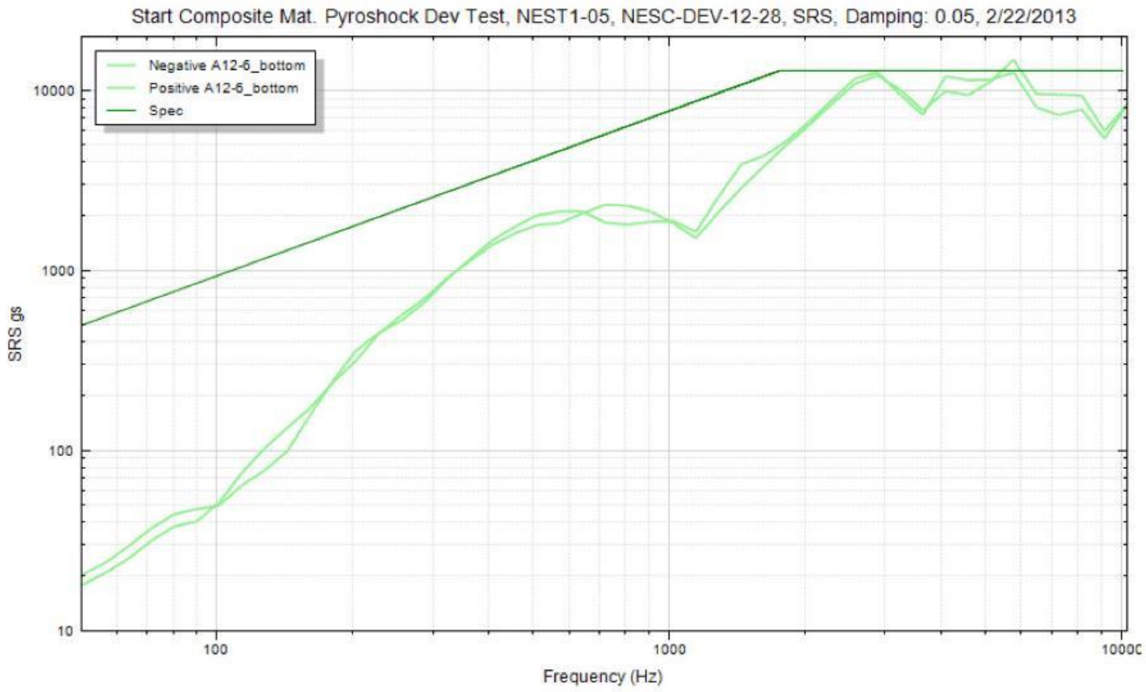
1000
100
10
100
1000
10000
Frequency (Hz)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Positive A12-6_bottom
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SRS gs
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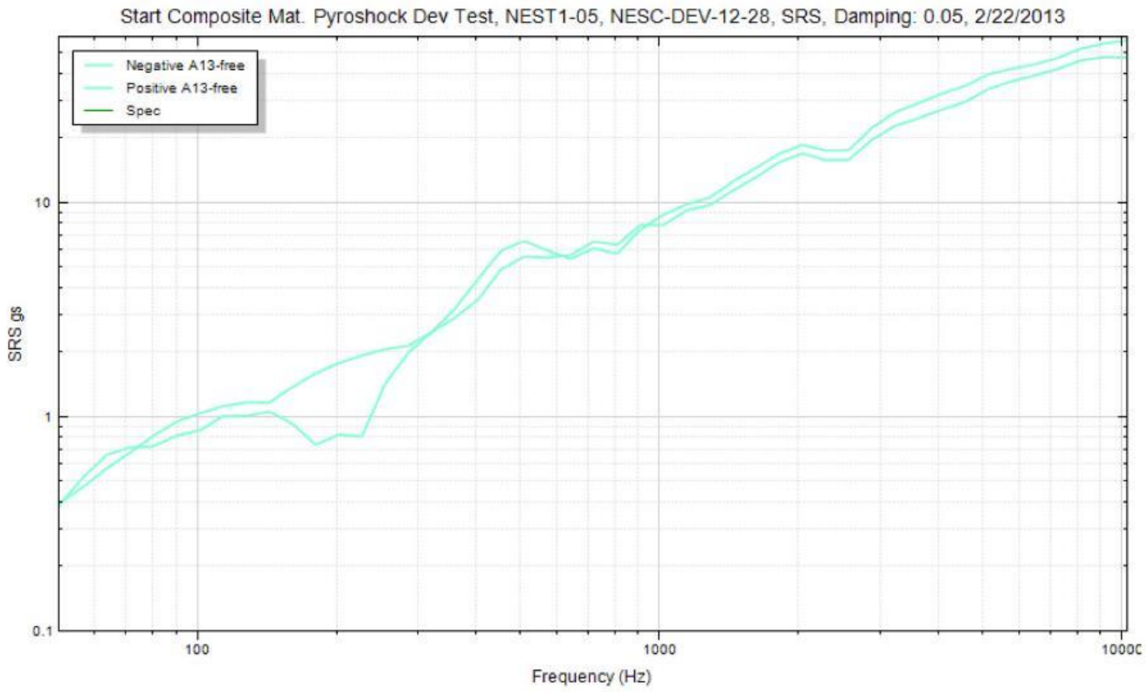
1000
100
10
100
1000
1000C
Frequency (Hz)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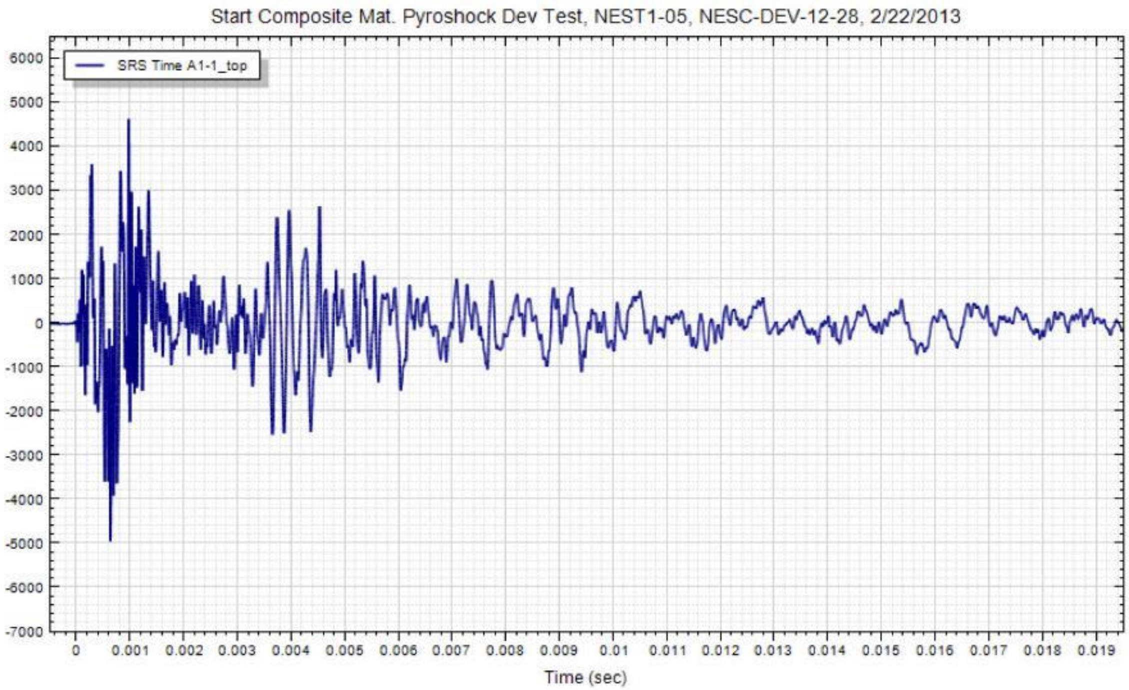
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
10000
Frequency (Hz)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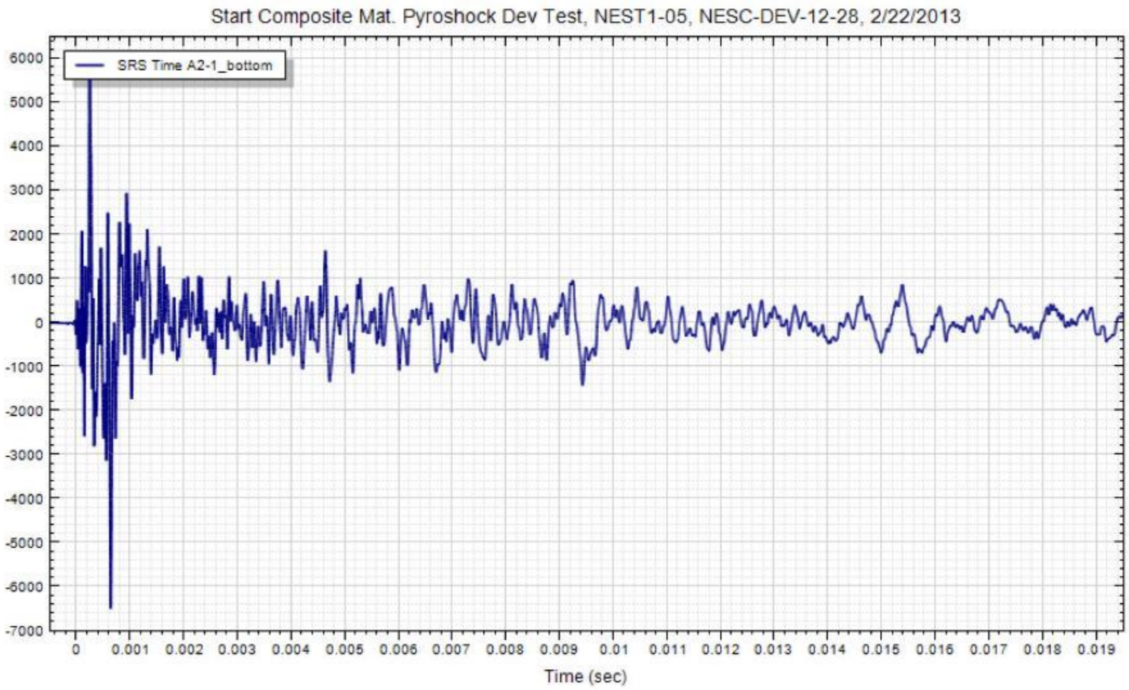
SRS Time A1-1_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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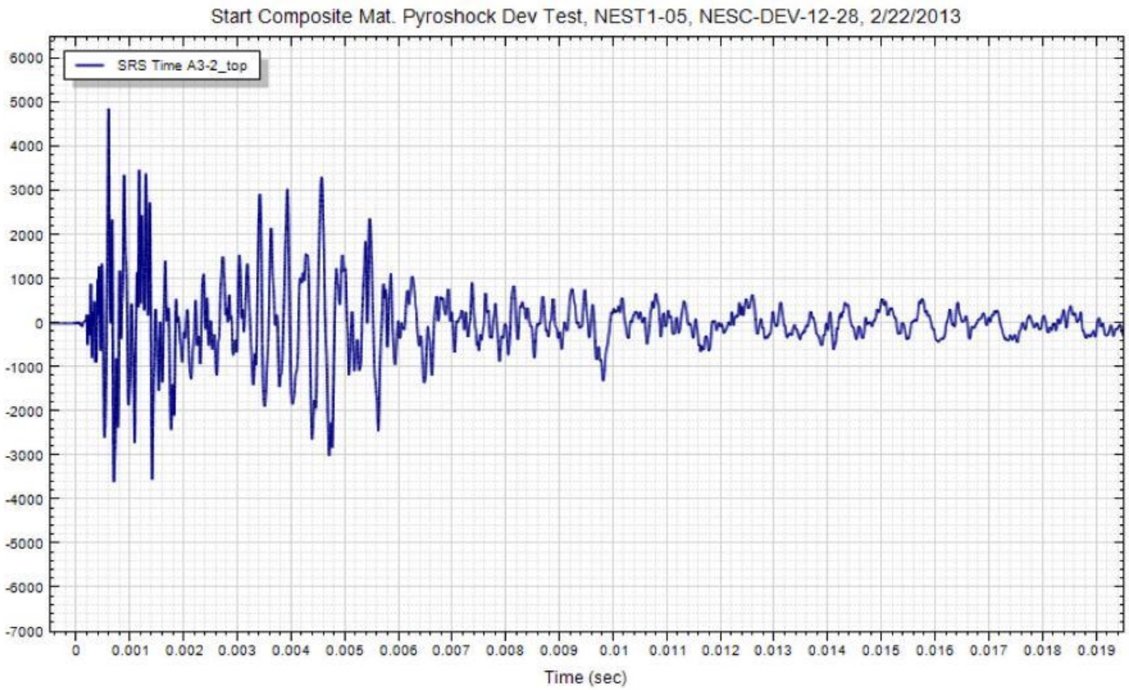
SRS Time A2-1_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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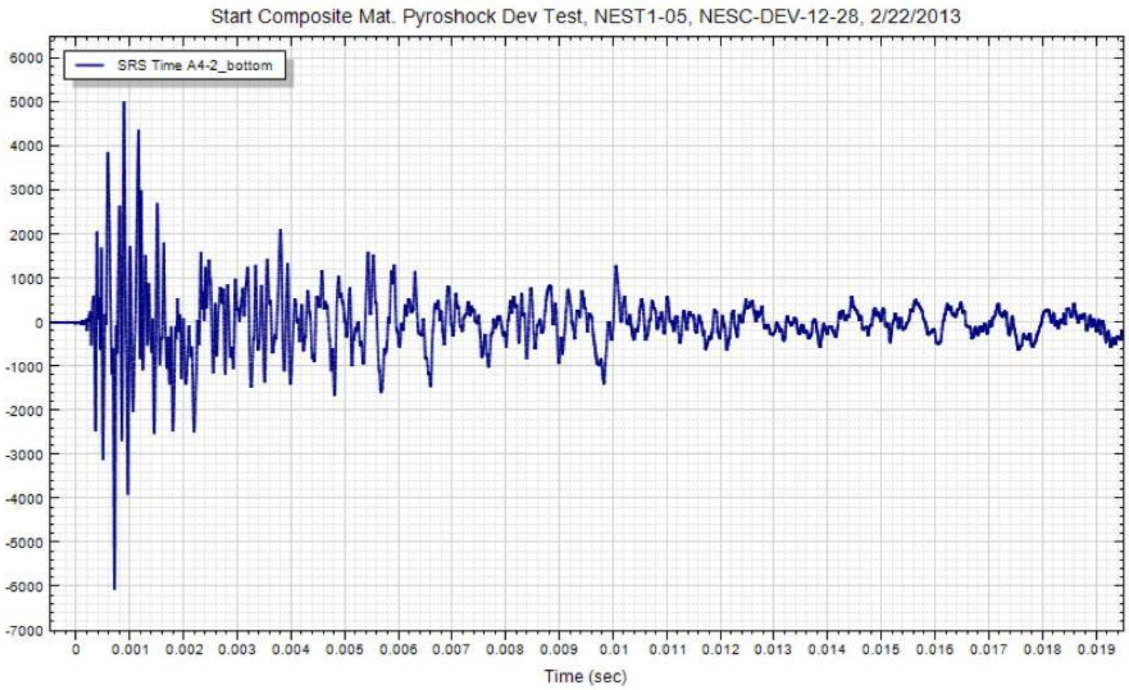
SRS Time A3-2_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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SRS Time A4-2_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
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0.012
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0.014
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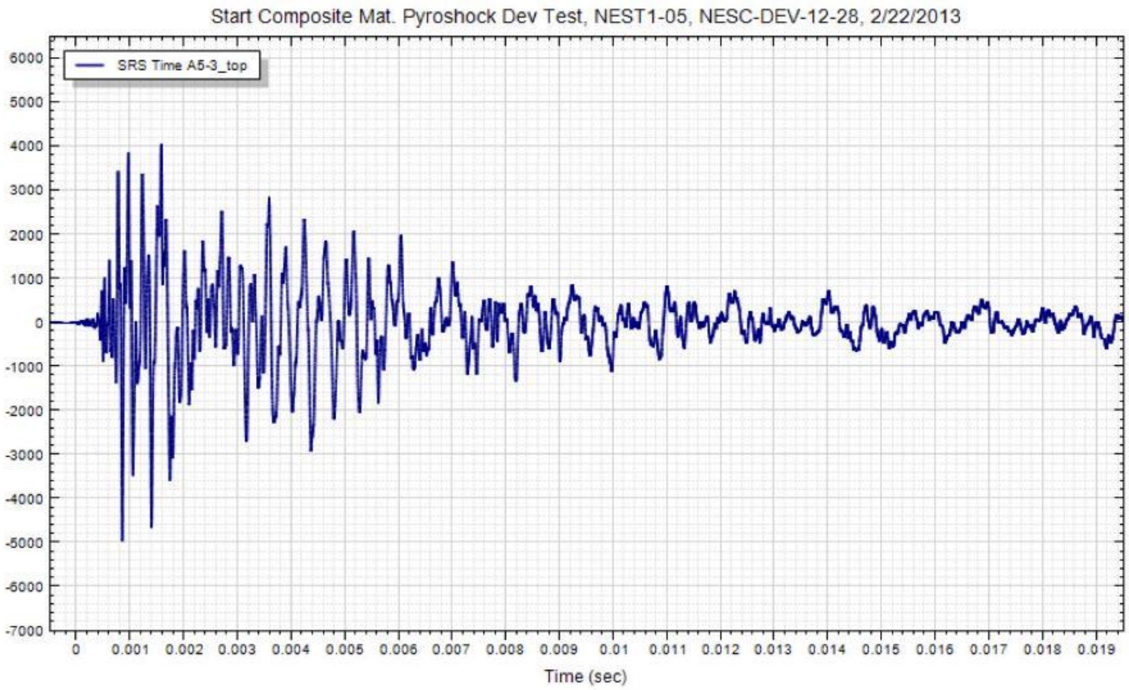
0.016
0.017
0.018
0.019
Time (sec)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SRS Time A5-3_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
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0.01
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0.012
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0.014
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0.016
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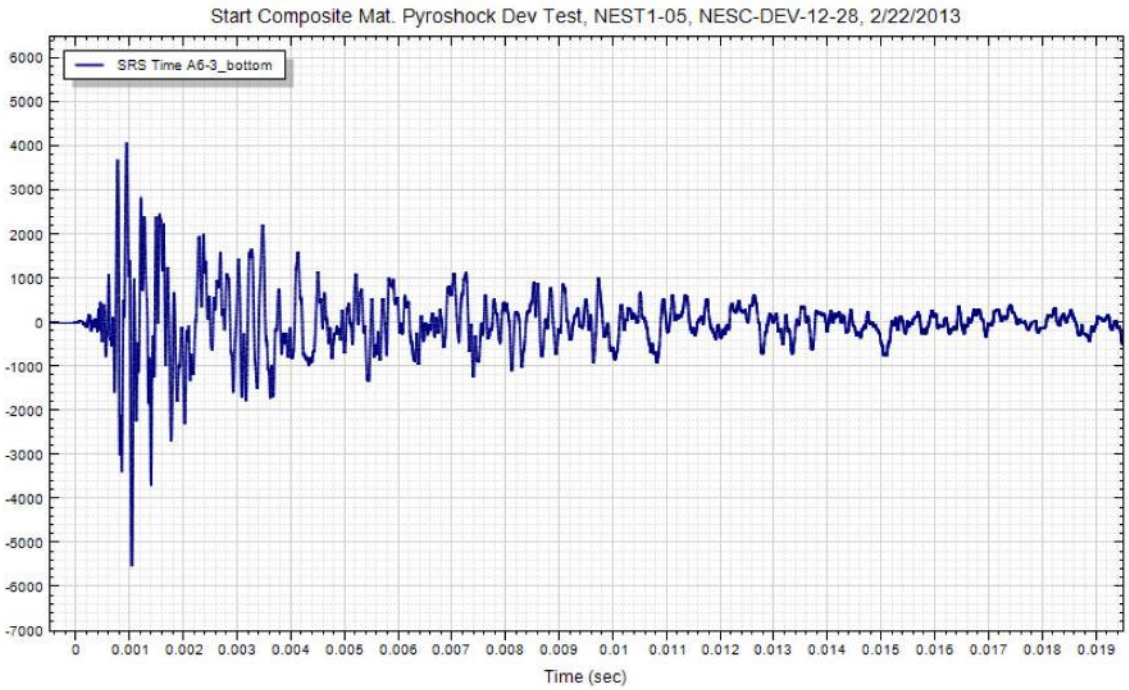
0.018
0.019
Time (sec)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SRS Time A6-3_bottom
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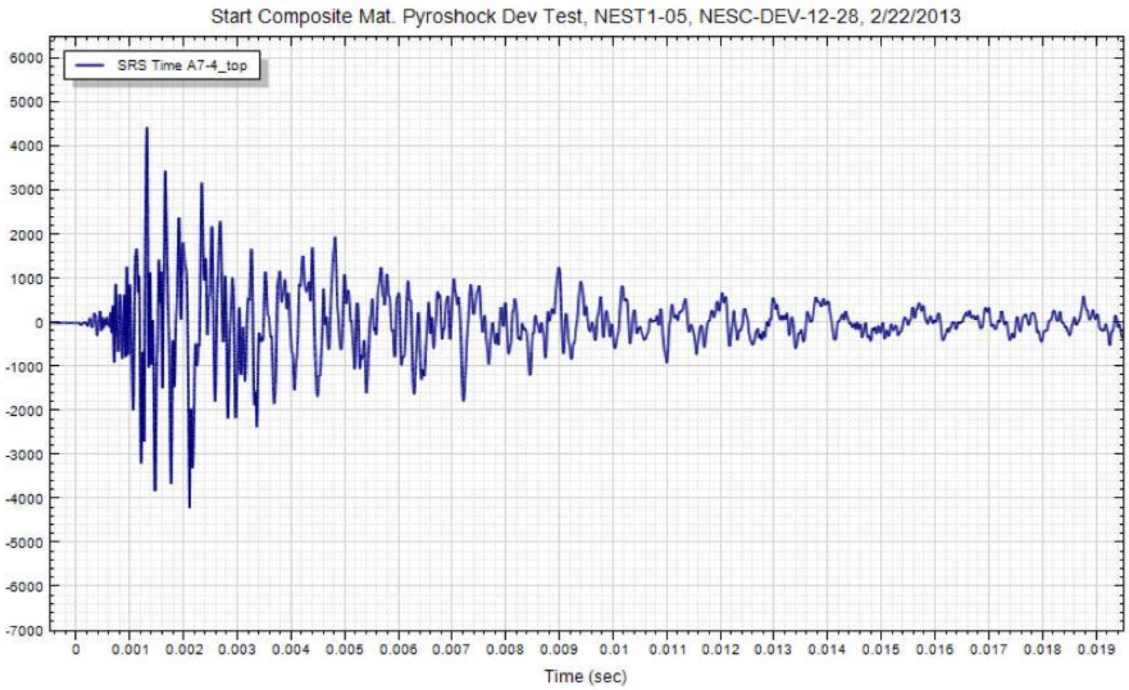
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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SRS Time A7-4_top
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5000
4000
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2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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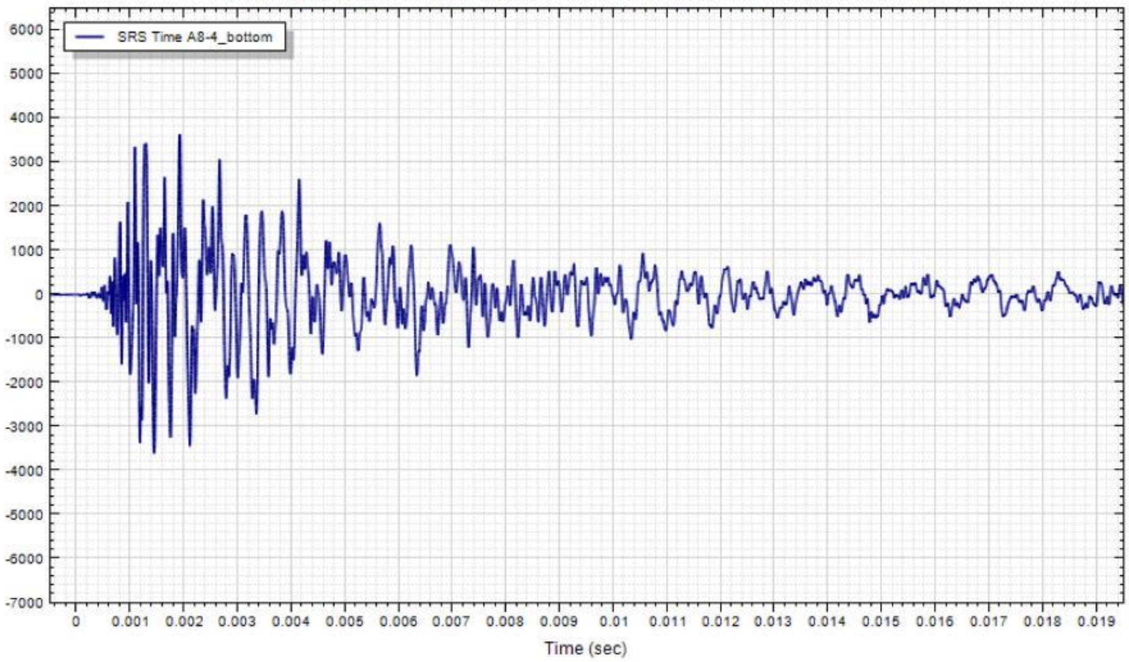

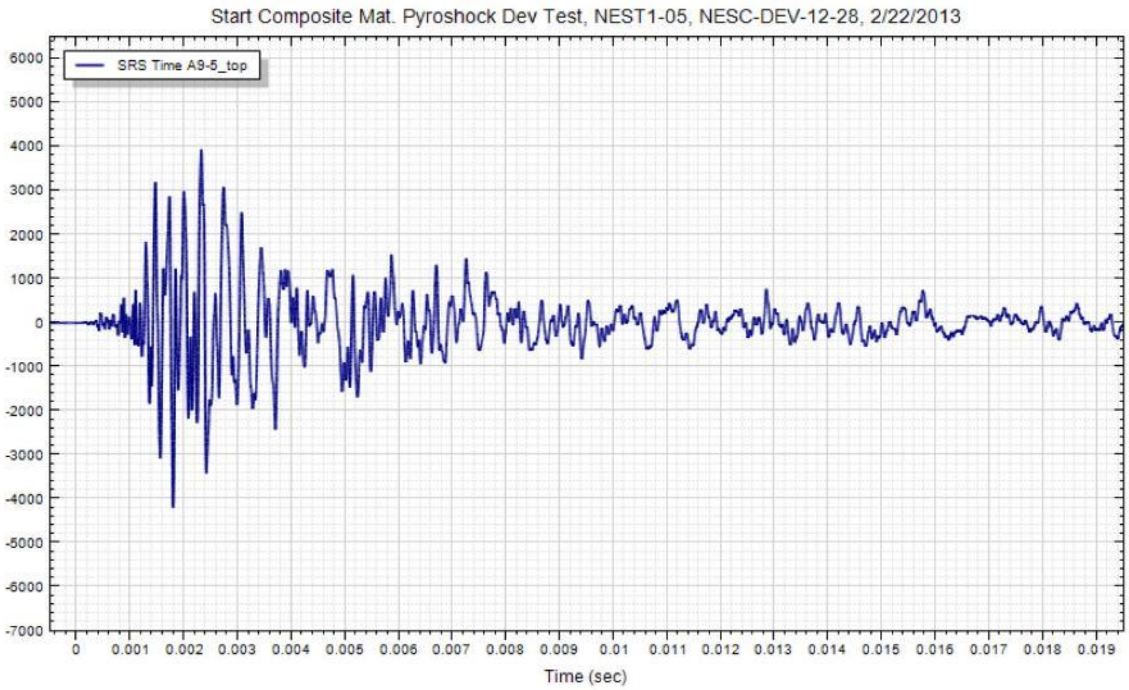
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SRS Time A9-5_top
6000
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4000
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2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
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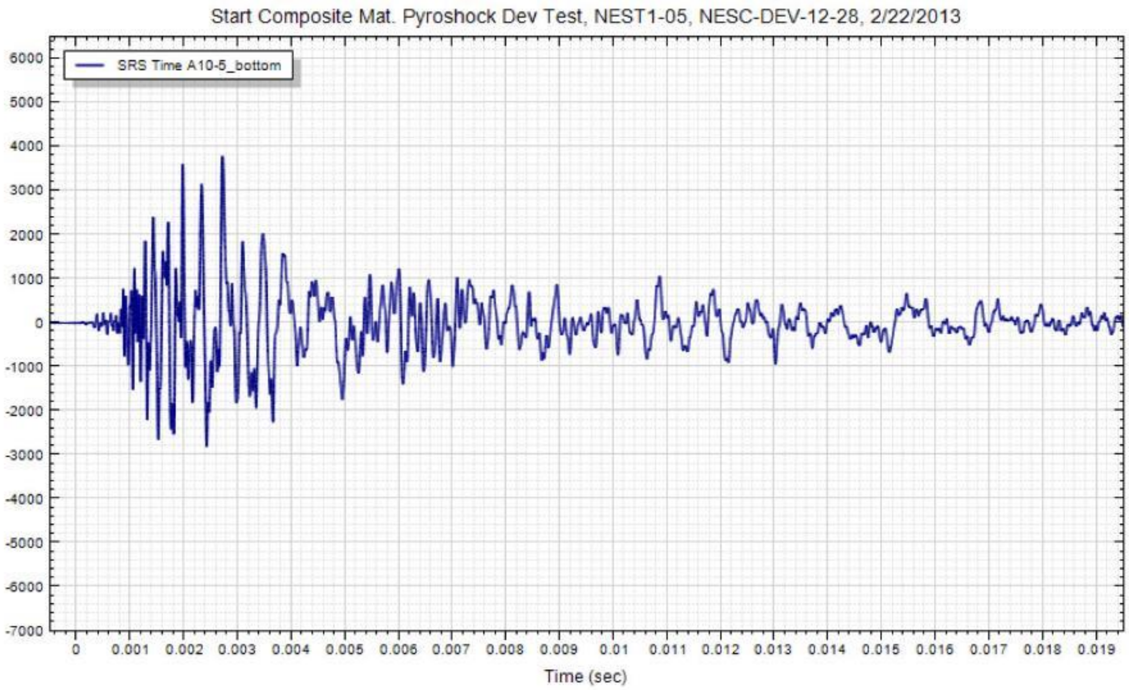
0.019
Time (sec)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-2000
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-4000
-5000
-6000
-7000
0
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0.003
0.004
0.005
0.006
0.007
0.008
0.009
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0.015
0.016
0.017
0.018
0.019
Time (sec)

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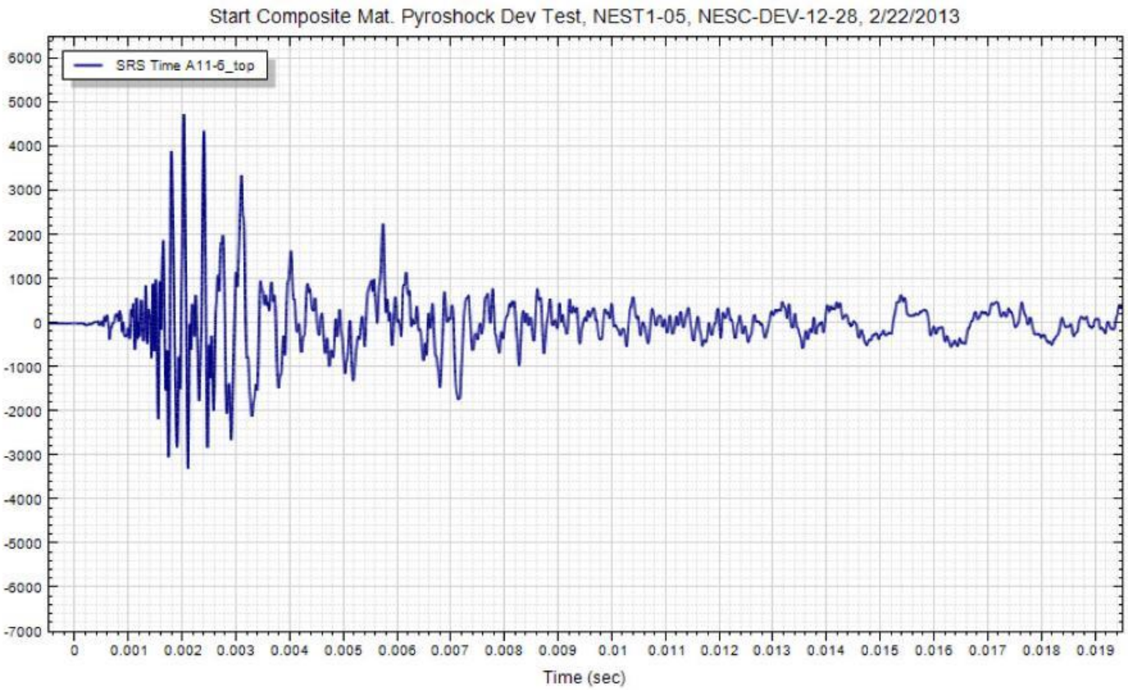
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SRS Time A11-5_top
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0.003
0.004
0.005
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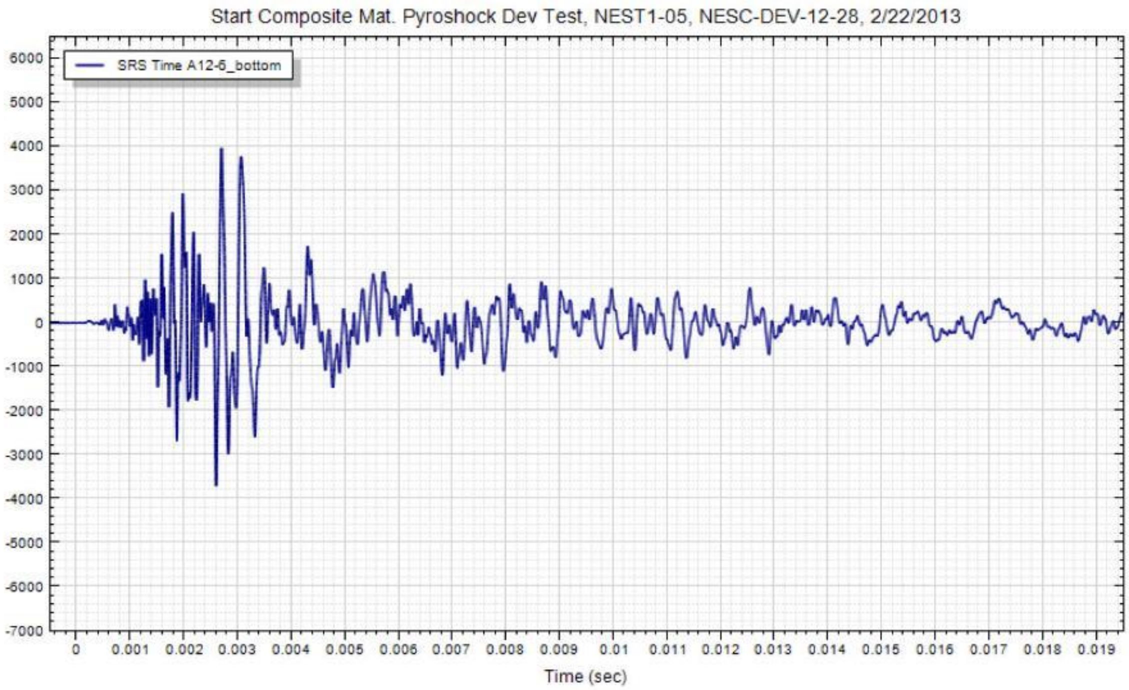
Time (sec)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SRS Time A12-6_bottom
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1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
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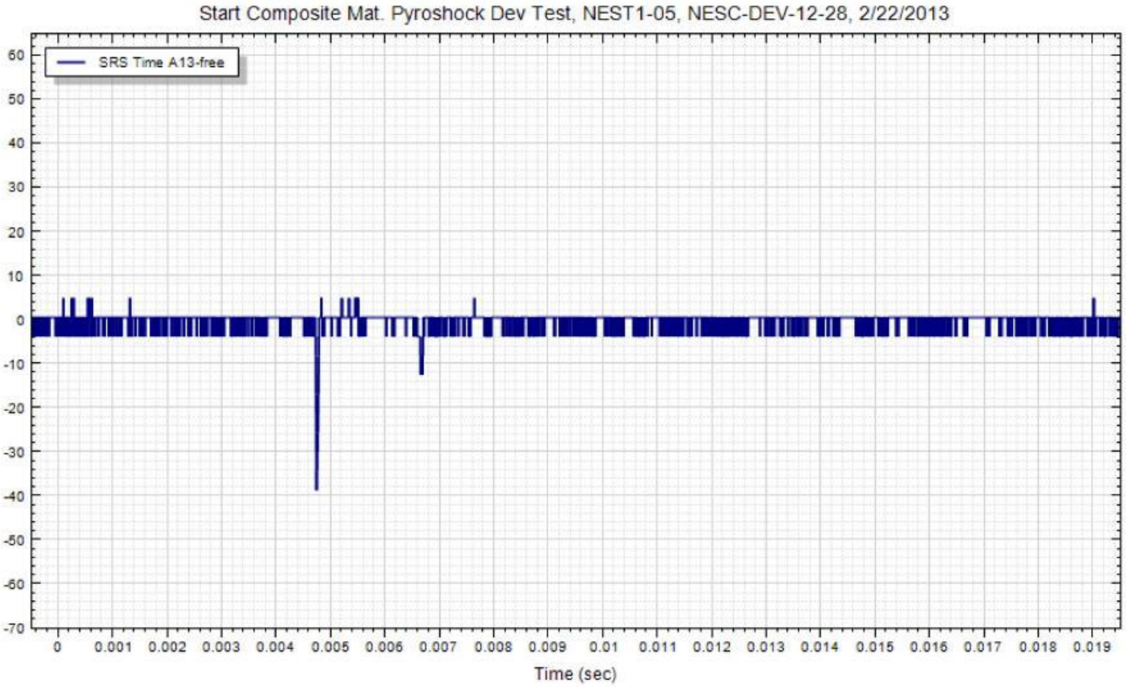
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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SRS Time A13-free
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
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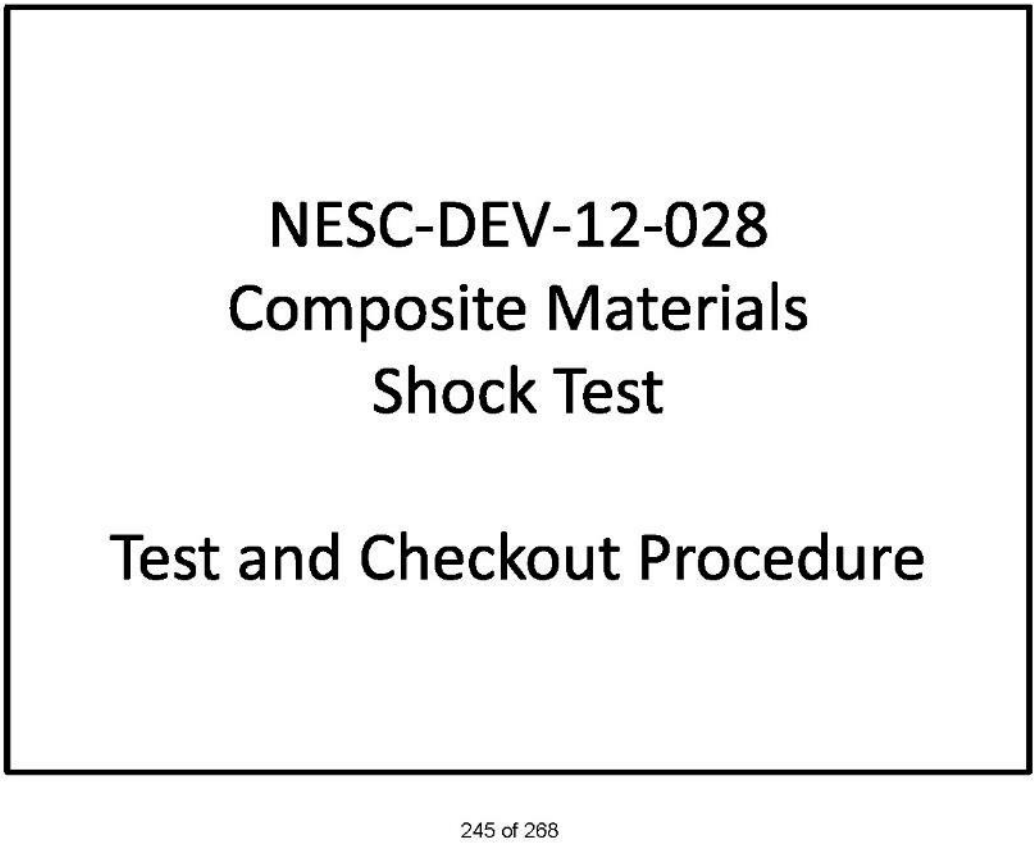
0.019
Time (sec)



NESC-DEV-12-028
Composite Materials Shock Test

Test and Checkout Procedure

NESC-DEV-12-028
11/15/2012

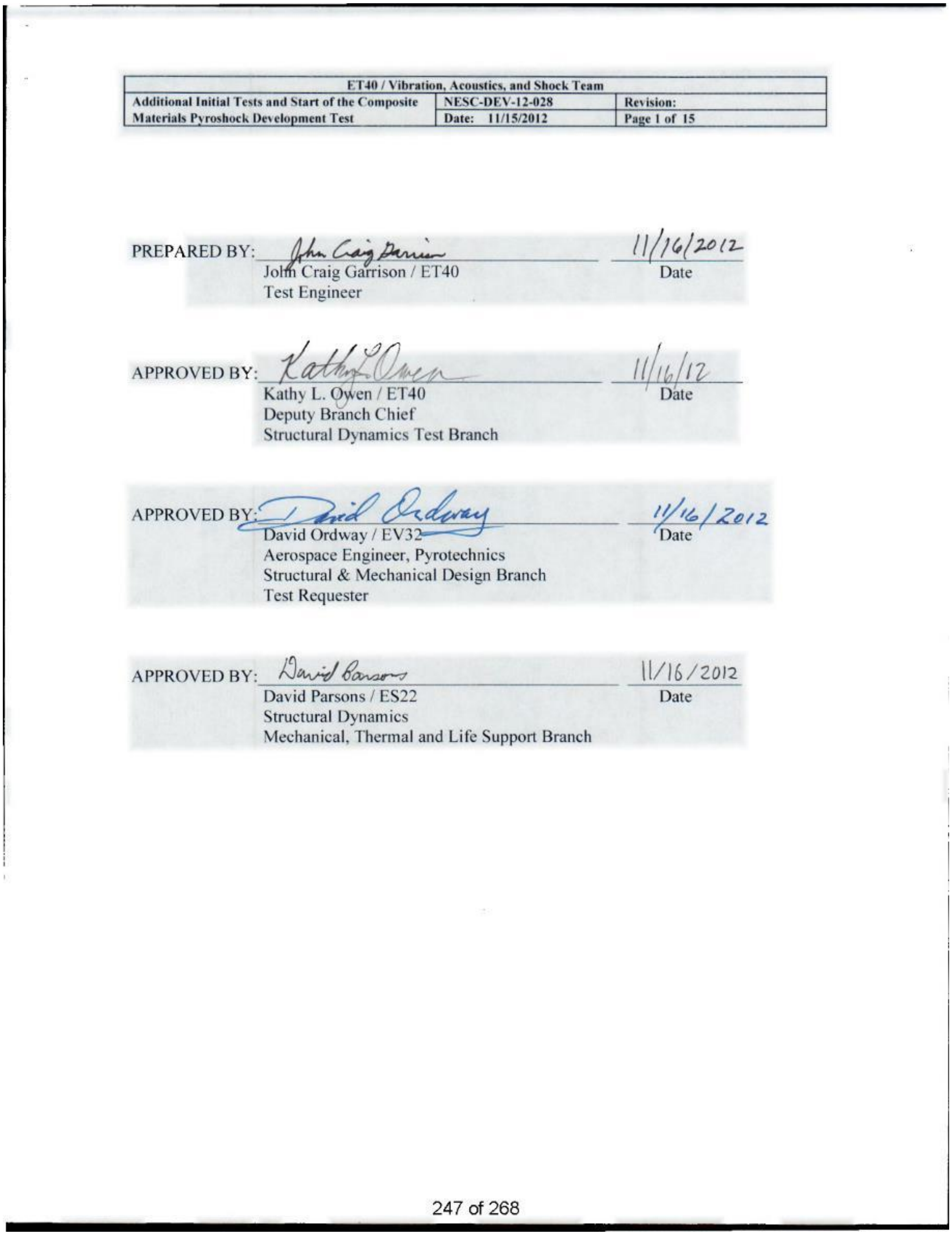
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

TEST AND CHECK-OUT PROCEDURE

ET40 / VIBRATION, ACOUSTICS, AND SHOCK TEAM

ADDITIONAL INITIAL TESTS AND START OF THE COMPOSITE MATERIALS PYROSHOCK DEVELOPMENT TEST

This Procedure Describes
Safety Critical Operations



ET40 / Vibration, Acoustics, and Shock Team		
Additional Initial Tests and Start of the Composite Materials Pyroshock Development Test	NESC-DEV-12-028	Revision:
	Date: 11/15/2012	Page 1 of 15

PREPARED BY: John Craig Garrison 11/16/2012
John Craig Garrison / ET40 Date
Test Engineer

APPROVED BY: Kathy L. Owen 11/16/12
Kathy L. Owen / ET40 Date
Deputy Branch Chief
Structural Dynamics Test Branch

APPROVED BY: David Ordway 11/16/2012
David Ordway / EV32 Date
Aerospace Engineer, Pyrotechnics
Structural & Mechanical Design Branch
Test Requester

APPROVED BY: David Parsons 11/16/2012
David Parsons / ES22 Date
Structural Dynamics
Mechanical, Thermal and Life Support Branch

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this procedure is to define the steps necessary to perform a pyrotechnic shock test in the Pyrotechnic Shock Facility in Building 4619 using pyrotechnic devices.

Initial Test Articles: 3'x6'x0.2" solid composite pathfinder panel with LSC plate and LSC backing plate. One panel with all ply orientations at 0 degrees, and one panel with all ply orientations at 90 degrees, as specified in table II test 4 & 5 of the applicable test plan.
Test Matrix Test Articles: 3'x6' solid composite panel with LSC plate and LSC backing plate. The first 5 test articles of the test matrix are described in Table III, Group I, tests 1 to 5.
Program: NESC Type of Test: Pyrotechnic Shock Development Test
Test Purpose: To capture the acceleration time history of initial test setup and instrumentation checkout panels.

The Pyrotechnic Shock Facility is located in Rooms 170, 170A and 170B of Building 4619. Room 170A is designated as the Control Room. The area between Room 169 and 170 is used for storage of secondary pyrotechnic devices. Room 170B is used for storage of initiators. All detonation of pyrotechnic devices will be in Room 170.

1.2 SCOPE

This document contains the steps and/or references the procedure to conduct the test.

2.0 SAFETY

Follow all emergency and safety requirements specified in ET01-DYN-SHK-FOP-001.

2.1 Responsibilities

The Test Engineer will be responsible for all activities occurring in the hazardous test area and for the safety of personnel involved in the test activities. It is the responsibility of each individual in a test program to fully comply with the requirements of this document and to report any individual not complying. Failure to do so could lead to serious personnel injuries or death.

3.0 TEST REQUIREMENTS AND INFORMATION

3.1 DOCUMENTS

3.1.1 APPLICABLE DOCUMENTS

Test Requirements: Pyroshock Response Characterization of Composite Materials Test Plan Revision A, NESC Task # TI-12-0783 (SLS ADO-21), 11/8/2012

Test Procedure: ET01-DYN-SHK-FOP-001 Pyrotechnic Shock Tests

PANEL #4 - #5 COMPOSITE PATHFINDER PANEL
97M00200-GRP I-TEST 1-5 COMPOSITE TEST PANEL, GROUP I, TEST #1-#5
97M00202 LSC BACKING PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00203-MOD LSC PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00204-MOD-2-10 LSC SHIM, COMPOSITE TEST PANEL 10 GPF LSC
97M00204-MOD-2-22 LSC SHIM, COMPOSITE TEST PANEL 22 GPF LSC
97M00205 10 GR/FT LSC, COMPOSITE TEST PANEL PATHFINDER

3.1.2 REFERENCED DOCUMENTS

ET01-DYN-OWI-001 Documentation Control

ET01-DYN-OWI-002 Test Operation Procedure Preparation and Change Control

3.2 TEST INFORMATION

3.2.1 The instrumentation locations are given in the drawings listed in the applicable documents and appendix A for the test.

3.2.2 Pyrotechnic shock tests may be performed on the test article in the order and configuration directed by the test requester.

3.2.3 The shock test will be performed on a room temperature test article.

3.3 TEST REQUIREMENTS

3.3.1 The Test Engineer will be in charge of all test preparations and activities.

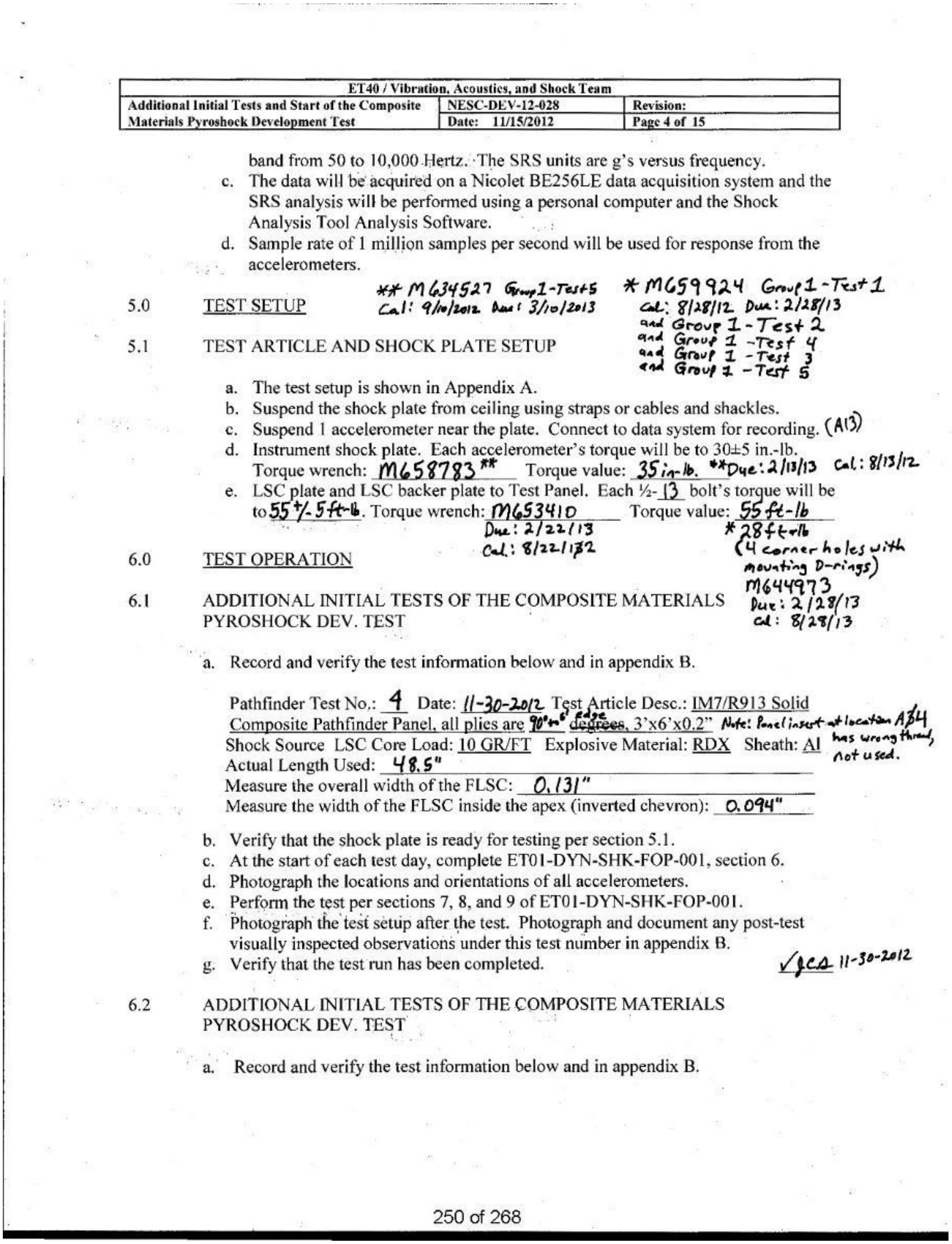
3.3.2 All activities will be coordinated with the Test Engineer.

3.3.3 All changes to the procedure will be coordinated with the Test Engineer.

3.3.4 The development test articles will be tested with pyrotechnic shock test runs as directed by the test requester. The test article information will be recorded in this TCP.

4.0 <u>TEST DATA</u>

a. The test data includes a time history of the real time shock recorded over a 20 millisecond or longer interval and the units are g's peak versus time.
b. The second plot is a Shock Response Spectrum (SRS) using 5% damping and a 1/6 octave shock spectrum analyzer. The SRS is computed over the frequency



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band from 50 to 10,000 Hertz. The SRS units are g's versus frequency.

c. The data will be acquired on a Nicolet BE256LE data acquisition system and the SRS analysis will be performed using a personal computer and the Shock Analysis Tool Analysis Software.

d. Sample rate of 1 million samples per second will be used for response from the accelerometers.

**M634527 Group 1-Test 5
Cal: 9/10/2012 Due: 3/10/2013

*M659924 Group 1-Test 1
Cal: 8/28/12 Due: 2/28/13
and Group 1-Test 2
and Group 1-Test 4
and Group 1-Test 3
and Group 1-Test 5

5.0 TEST SETUP

5.1 TEST ARTICLE AND SHOCK PLATE SETUP

a. The test setup is shown in Appendix A.

b. Suspend the shock plate from ceiling using straps or cables and shackles.

c. Suspend 1 accelerometer near the plate. Connect to data system for recording. (A13)

d. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783** Torque value: 35 in-lb. **Due: 2/13/13 Cal: 8/13/12

e. LSC plate and LSC backer plate to Test Panel. Each ½-13 bolt's torque will be to 55 +/- 5 ft-lb. Torque wrench: M653410 Torque value: 55 ft-lb
Due: 2/22/13
Cal: 8/22/1~~3~~2
*28 ft-lb
(4 corner holes with mounting D-rings)
M644973
Due: 2/28/13
Cal: 8/28/13

6.0 TEST OPERATION

6.1 ADDITIONAL INITIAL TESTS OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Pathfinder Test No.: 4 Date: 11-30-2012 Test Article Desc.: IM7/R913 Solid Composite Pathfinder Panel, all plies are 90° to 6' edge ~~degrees~~, 3'x6'x0.2" Note: Panel insert at location A34 has wrong thread, not used.
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.131"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

b. Verify that the shock plate is ready for testing per section 5.1.

c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.

d. Photograph the locations and orientations of all accelerometers.

e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.

f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.

g. Verify that the test run has been completed. ✓ JCA 11-30-2012

6.2 ADDITIONAL INITIAL TESTS OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

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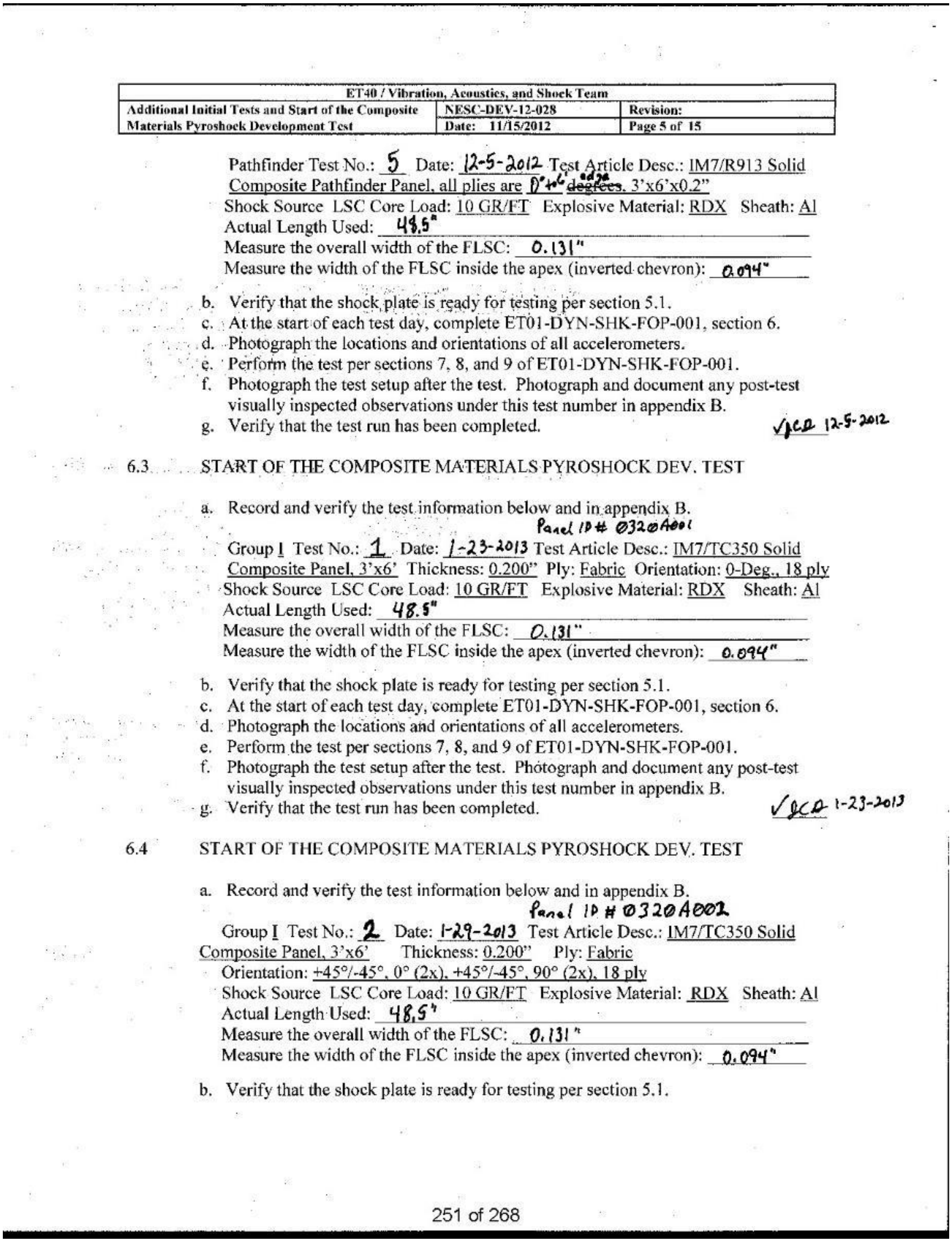

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Pathfinder Test No.: 5 Date: 12-5-2012 Test Article Desc.: IM7/R913 Solid Composite Pathfinder Panel, all plies are 0° to 6' edge ~~degrees~~. 3'x6'x0.2"
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.131"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. √JCD 12-5-2012

6.3 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Panel ID # 0320A001
Group I Test No.: 1 Date: 1-23-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, 3'x6' Thickness: 0.200" Ply: Fabric Orientation: 0-Deg., 18 ply
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.131"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

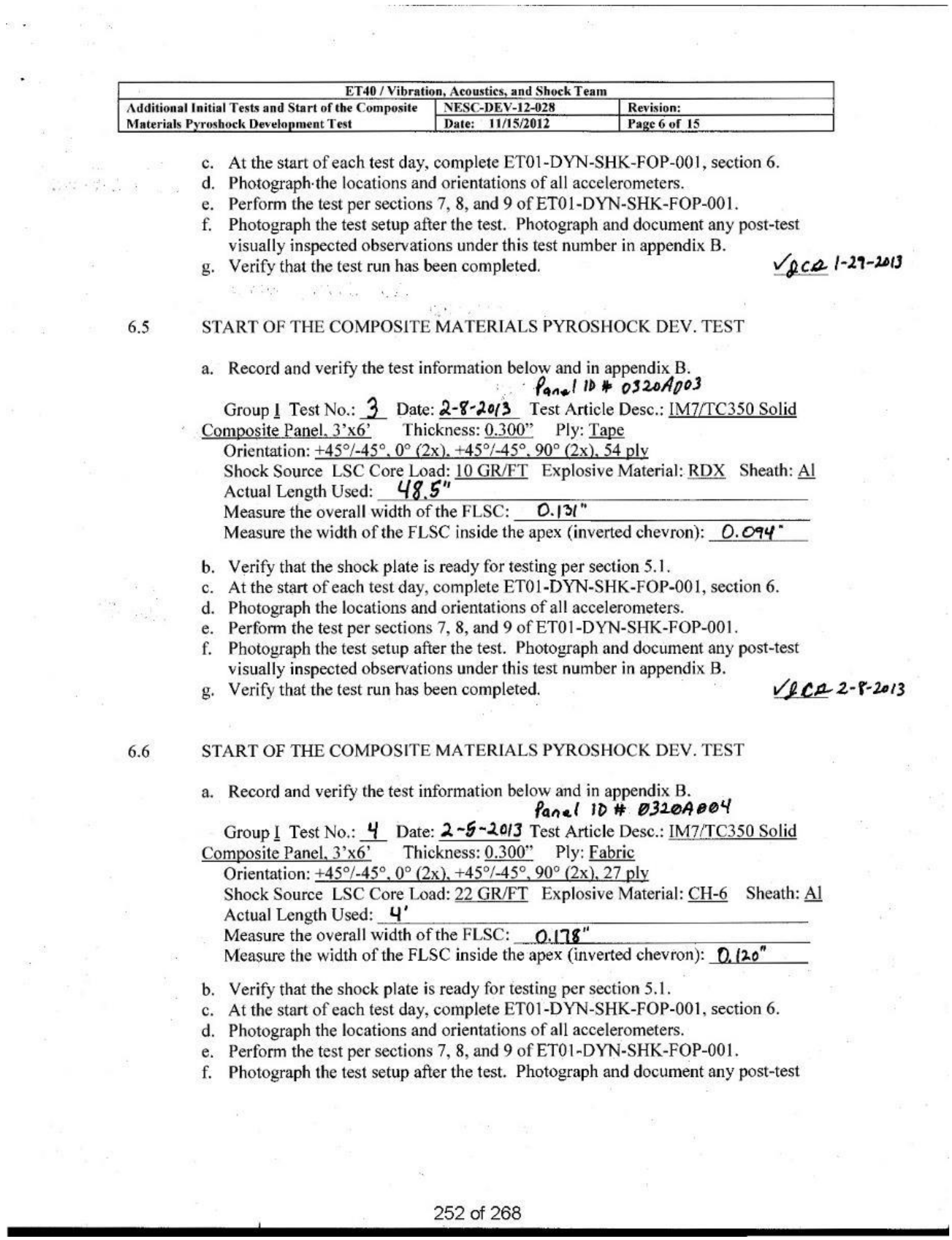
b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. √JCD 1-23-2013

6.4 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Panel ID # 0320A002
Group I Test No.: 2 Date: 1-29-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, 3'x6' Thickness: 0.200" Ply: Fabric
Orientation: +45°/-45°, 0° (2x), +45°/-45°, 90° (2x), 18 ply
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.131"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

b. Verify that the shock plate is ready for testing per section 5.1.



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c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. √JCA 1-29-2013

6.5 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Panel ID # 0320A003
Group I Test No.: 3 Date: 2-8-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, 3'x6' Thickness: 0.300" Ply: Tape
Orientation: +45°/-45°, 0° (2x), +45°/-45°, 90° (2x), 54 ply
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 48.5"
Measure the overall width of the FLSC: 0.131"
Measure the width of the FLSC inside the apex (inverted chevron): 0.094"

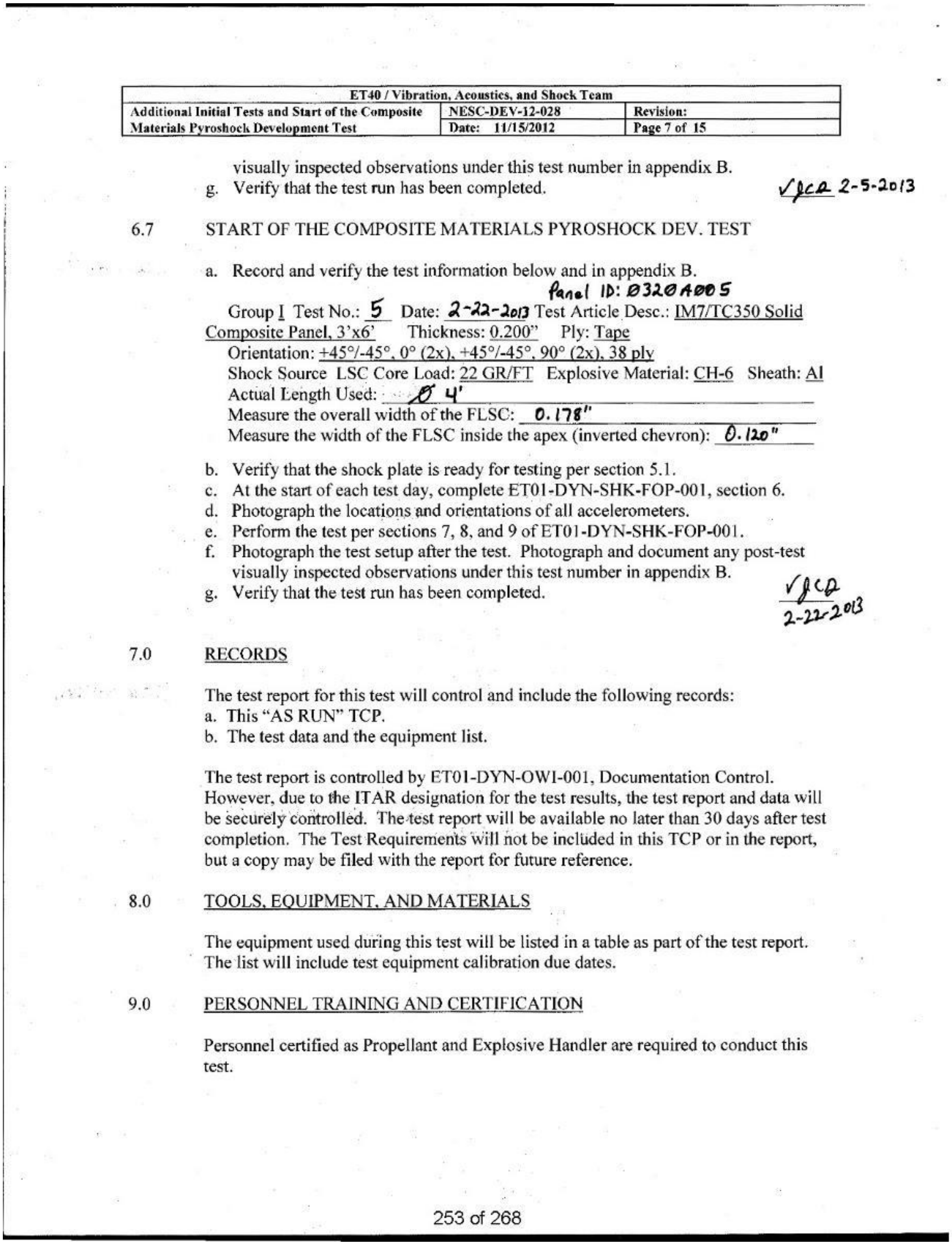
b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed. √JCA 2-8-2013

6.6 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Panel ID # 0320A004
Group I Test No.: 4 Date: 2-5-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, 3'x6' Thickness: 0.300" Ply: Fabric
Orientation: +45°/-45°, 0° (2x), +45°/-45°, 90° (2x), 27 ply
Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al
Actual Length Used: 4'
Measure the overall width of the FLSC: 0.178"
Measure the width of the FLSC inside the apex (inverted chevron): 0.120"

b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test



visually inspected observations under this test number in appendix B.

g. Verify that the test run has been completed. √JCA 2-5-2013

6.7 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix B.

Panel ID: 0320A005

Group I Test No.: 5 Date: 2-22-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, 3'x6' Thickness: 0.200" Ply: Tape

Orientation: +45°/-45°, 0° (2x), +45°/-45°, 90° (2x), 38 ply

Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al

Actual Length Used: 0 4'

Measure the overall width of the FLSC: 0.178"

Measure the width of the FLSC inside the apex (inverted chevron): 0.120"

b. Verify that the shock plate is ready for testing per section 5.1.
c. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.
d. Photograph the locations and orientations of all accelerometers.
e. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
f. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix B.
g. Verify that the test run has been completed.

√JCA
2-22-2013

7.0 RECORDS

The test report for this test will control and include the following records:
a. This "AS RUN" TCP.
b. The test data and the equipment list.

The test report is controlled by ET01-DYN-OWI-001, Documentation Control. However, due to the ITAR designation for the test results, the test report and data will be securely controlled. The test report will be available no later than 30 days after test completion. The Test Requirements will not be included in this TCP or in the report, but a copy may be filed with the report for future reference.

8.0 TOOLS, EQUIPMENT, AND MATERIALS

The equipment used during this test will be listed in a table as part of the test report. The list will include test equipment calibration due dates.

9.0 PERSONNEL TRAINING AND CERTIFICATION

Personnel certified as Propellant and Explosive Handler are required to conduct this test.

POST-TEST VERIFICATION

The Test and Check-out Procedure NESC-DEV-12-028 has been satisfactorily completed and documented.

Craig Damin
Test Engineer / ET40

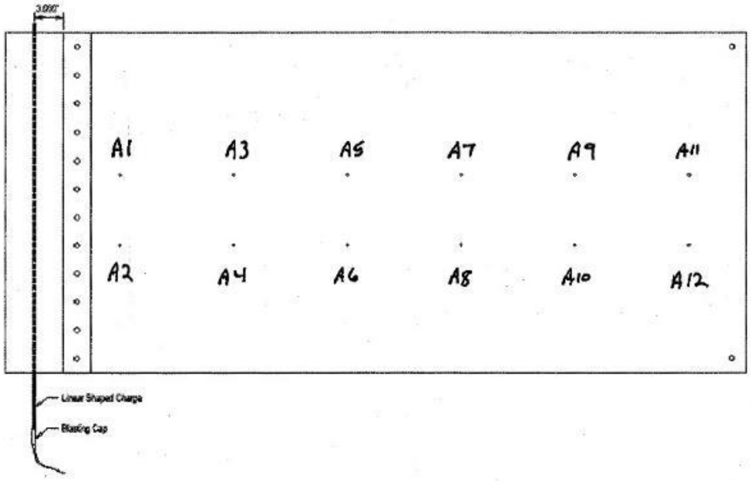
2/22/2013
Date

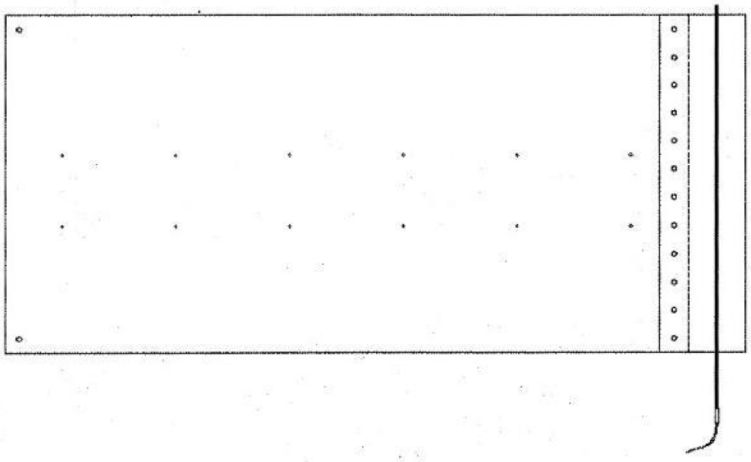
APPENDIX A

TEST SETUP

Additional Initial Tests and Start of the Composite Materials Pyroshock Development Test

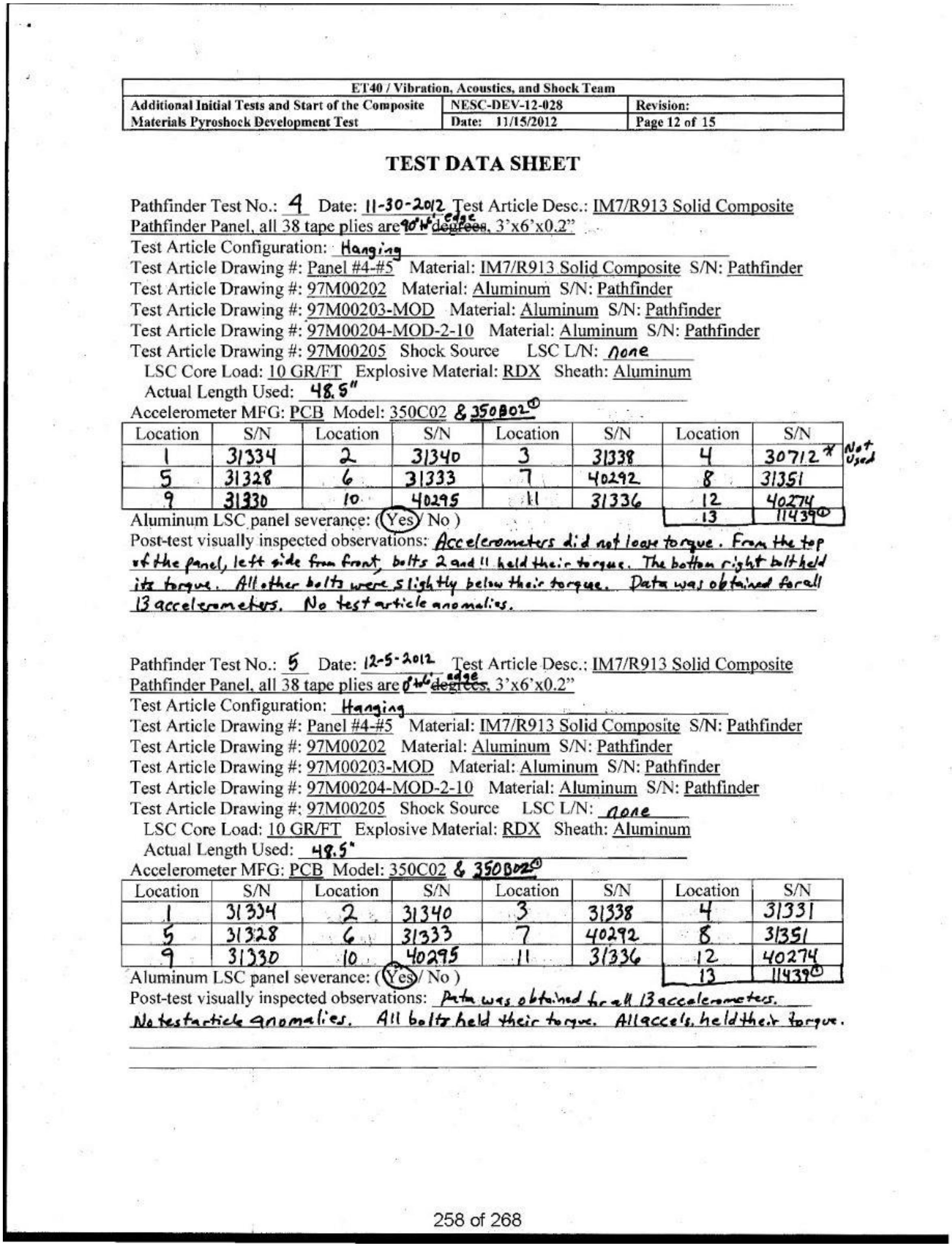
Test Article Panel:	Composite, Vertical Position
Supports:	Straps and Shackles





APPENDIX B

TEST DATA SHEET



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Pathfinder Test No.: 4 Date: 11-30-2012 Test Article Desc.: IM7/R913 Solid Composite Pathfinder Panel, all 38 tape plies are 90° to edge ~~degrees~~, 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: Panel #4-#5 Material: IM7/R913 Solid Composite S/N: Pathfinder
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02 & 350B02①

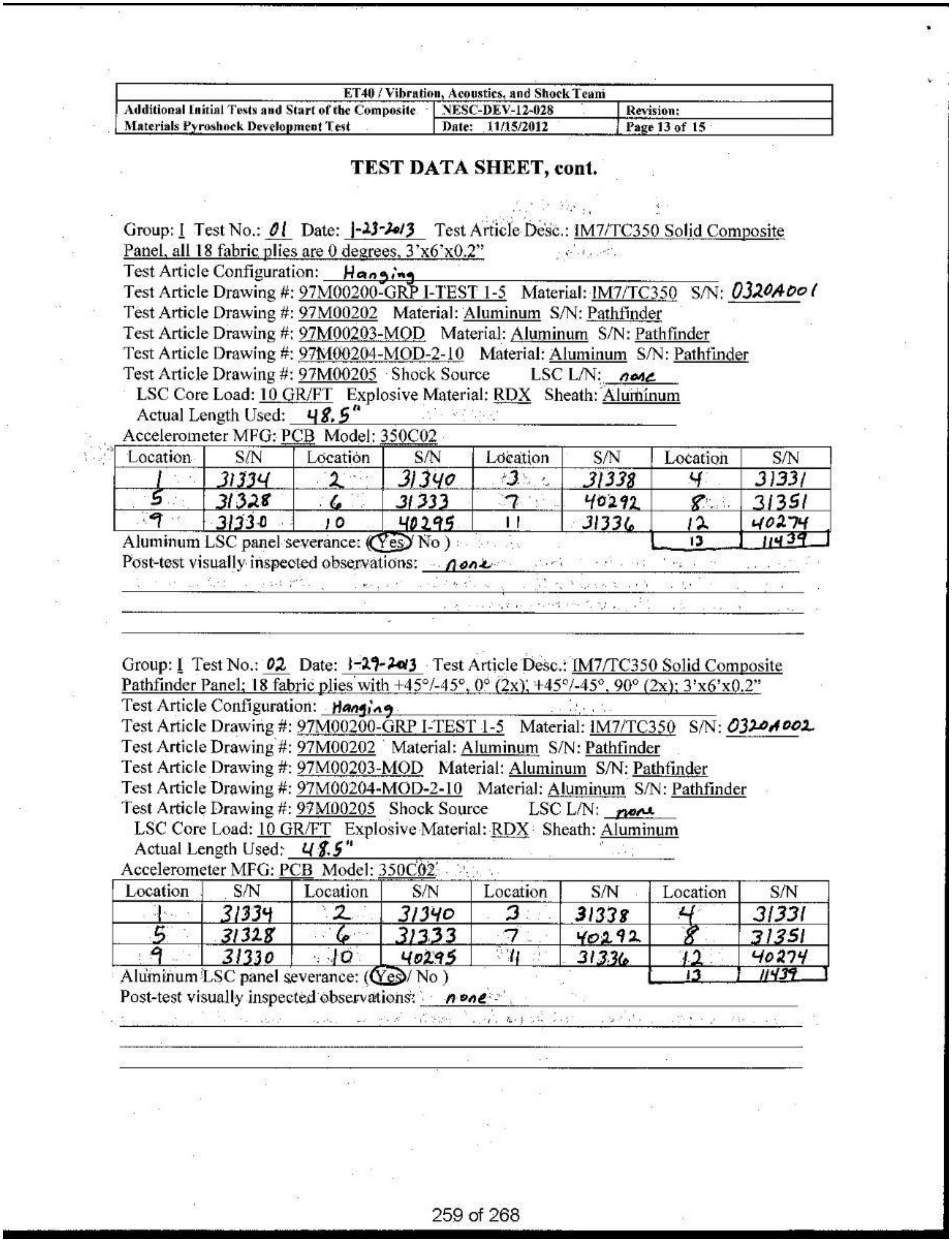
Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	30712* Not Used
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439①

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: Accelerometers did not loose torque. From the top of the panel, left side from front, bolts 2 and 11 held their torque. The bottom right bolt held its torque. All other bolts were slightly below their torque. Data was obtained for all 13 accelerometers. No test article anomalies.

Pathfinder Test No.: 5 Date: 12-5-2012 Test Article Desc.: IM7/R913 Solid Composite Pathfinder Panel, all 38 tape plies are 0° to edge ~~degrees~~, 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: Panel #4-#5 Material: IM7/R913 Solid Composite S/N: Pathfinder
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02 & 350B02①

Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439①

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: Data was obtained for all 13 accelerometers. No test article anomalies. All bolts held their torque. All accels. held their torque.



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TEST DATA SHEET, cont.

Group: I Test No.: 01 Date: 1-23-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, all 18 fabric plies are 0 degrees, 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00200-GRP I-TEST 1-5 Material: IM7/TC350 S/N: 0320A001
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02

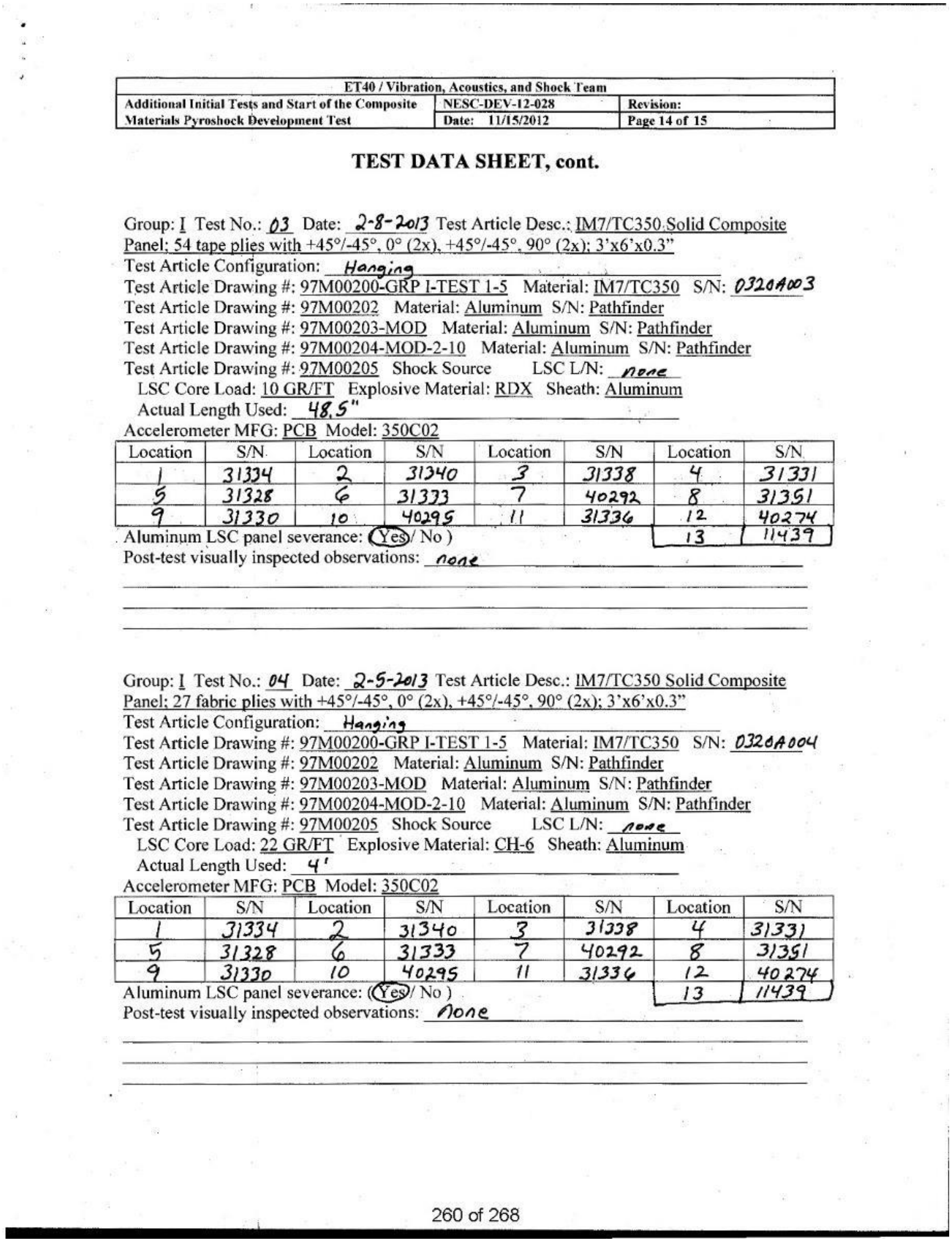
Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: none

Group: I Test No.: 02 Date: 1-29-2013 Test Article Desc.: IM7/TC350 Solid Composite Pathfinder Panel; 18 fabric plies with +45°/-45°, 0° (2x); +45°/-45°, 90° (2x); 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00200-GRP I-TEST 1-5 Material: IM7/TC350 S/N: 0320A002
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02

Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: none



TEST DATA SHEET, cont.

Group: I Test No.: 03 Date: 2-8-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel; 54 tape plies with +45°/-45°, 0° (2x), +45°/-45°, 90° (2x); 3'x6'x0.3"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00200-GRP I-TEST 1-5 Material: IM7/TC350 S/N: 0320A003
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Aluminum
Actual Length Used: 48.5"
Accelerometer MFG: PCB Model: 350C02

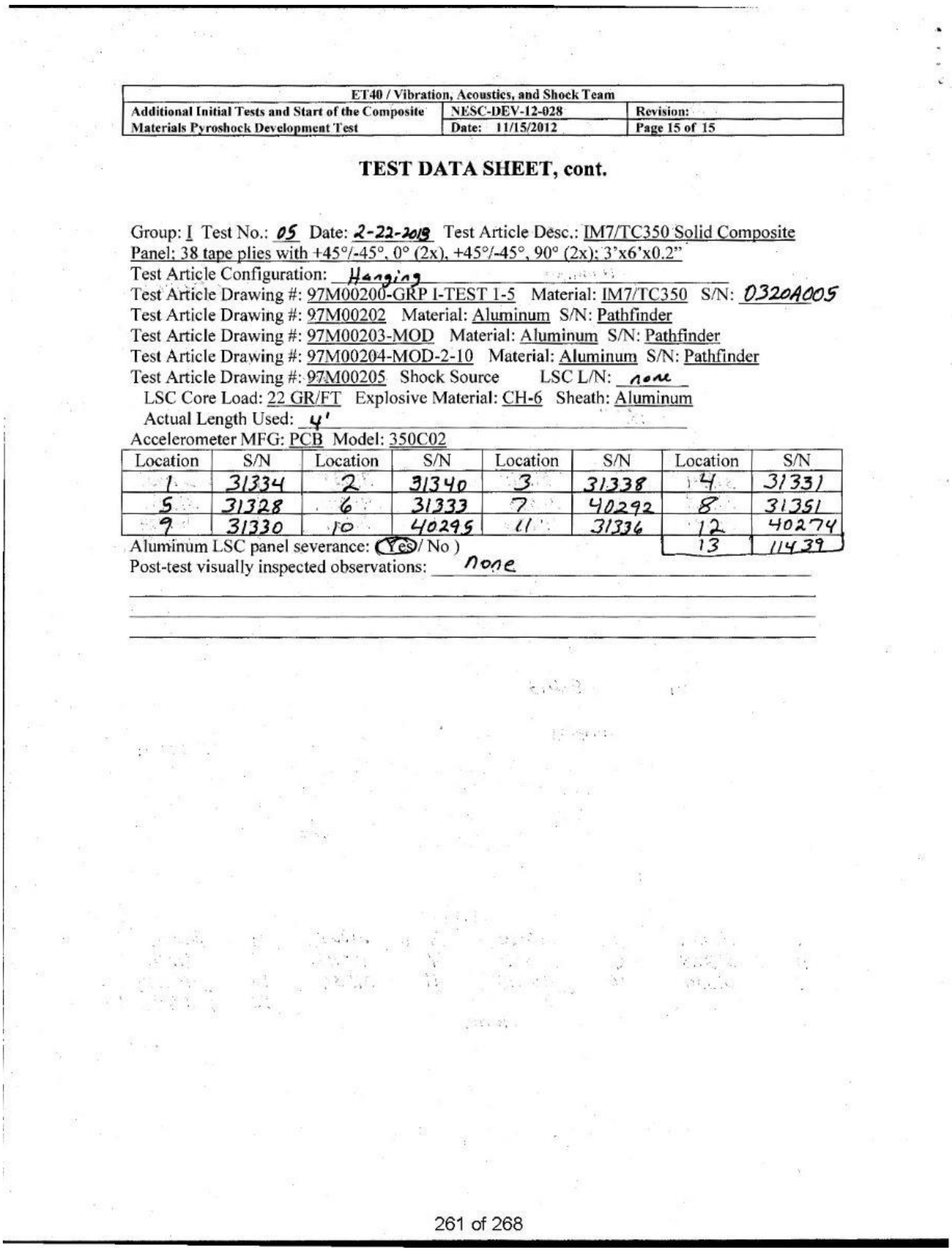
Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes]/ No)
Post-test visually inspected observations: none

Group: I Test No.: 04 Date: 2-5-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel; 27 fabric plies with +45°/-45°, 0° (2x), +45°/-45°, 90° (2x); 3'x6'x0.3"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00200-GRP I-TEST 1-5 Material: IM7/TC350 S/N: 0320A004
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Aluminum
Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350C02

Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes]/ No)
Post-test visually inspected observations: none



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TEST DATA SHEET, cont.

Group: I Test No.: 05 Date: 2-22-2013 Test Article Desc.: IM7/TC350 Solid Composite
Panel: 38 tape plies with +45°/-45°, 0° (2x), +45°/-45°, 90° (2x); 3'x6'x0.2"
Test Article Configuration: Hanging
Test Article Drawing #: 97M00200-GRP I-TEST 1-5 Material: IM7/TC350 S/N: 0320A005
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00205 Shock Source LSC L/N: none
LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Aluminum
Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350C02

Location	S/N	Location	S/N	Location	S/N	Location	S/N
1	31334	2	31340	3	31338	4	31331
5	31328	6	31333	7	40292	8	31351
9	31330	10	40295	11	31336	12	40274
						13	11439

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: none

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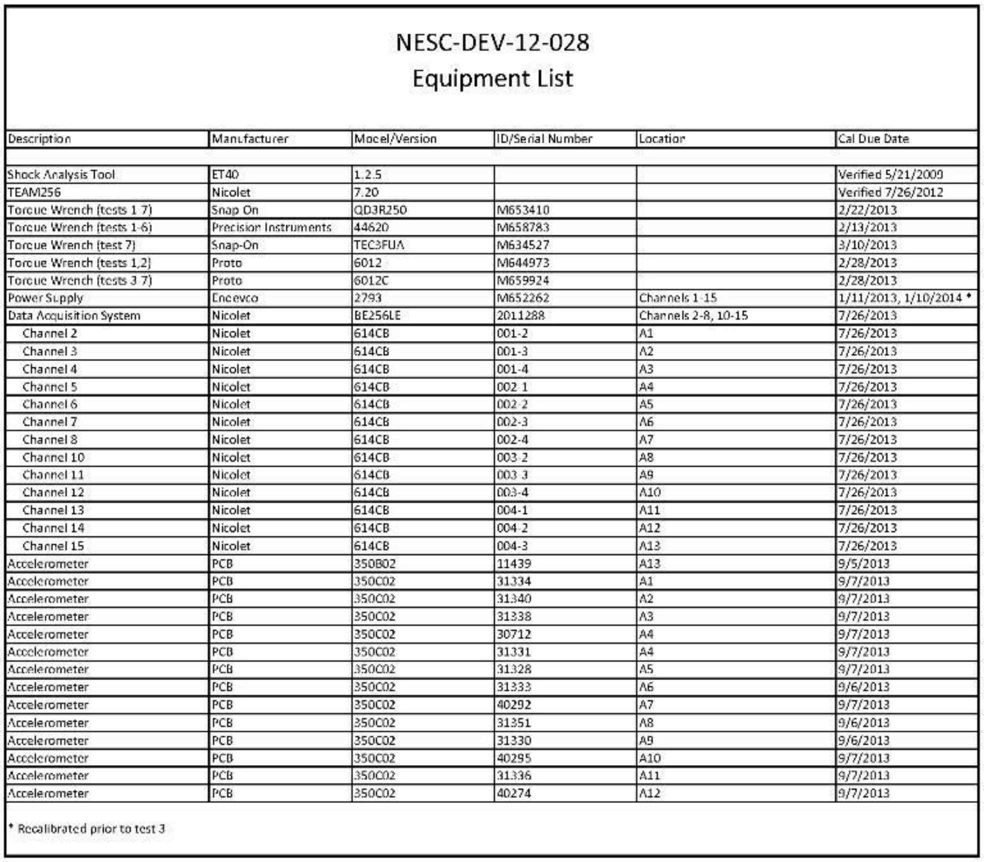
Composite Materials
Shock Test

Equipment List

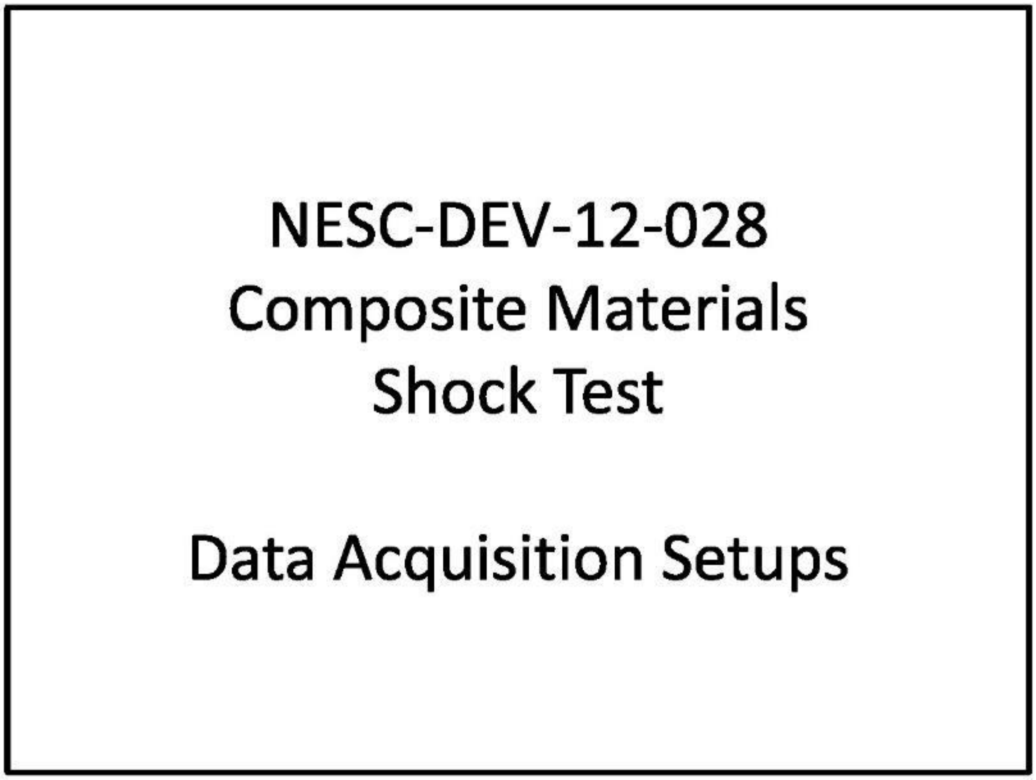


NESC-DEV-12-028

Equipment List

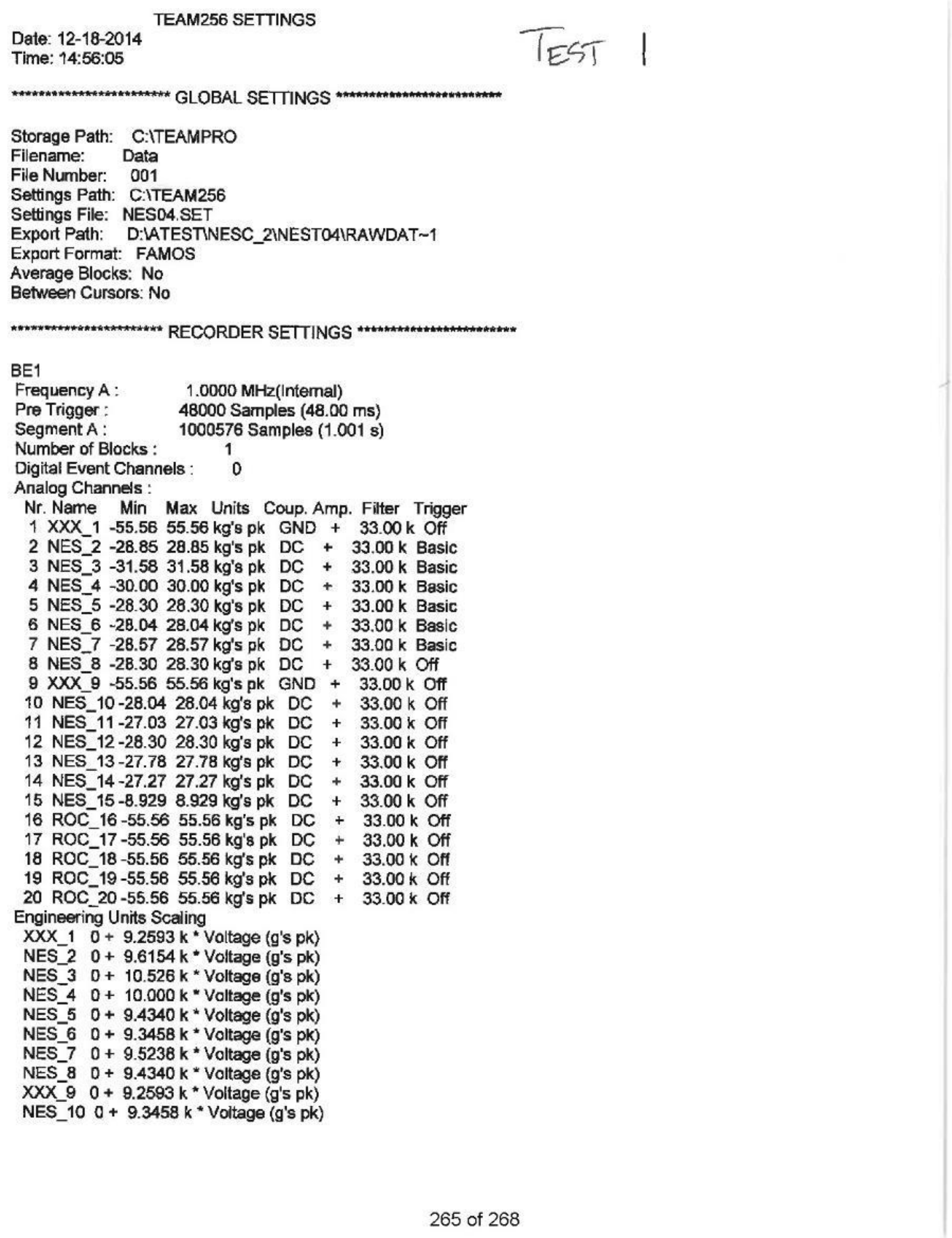
Description	Manufacturer	Model/Version	ID/Serial Number	Location	Cal Due Date
Shock Analysis Tool	ET40	1.2.5			Verified 5/21/2009
TEAM256	Nicolet	7.20			Verified 7/26/2012
Torque Wrench (tests 1-7)	Snap On	QD3R250	M653410		2/22/2013
Torque Wrench (tests 1-6)	Precision Instruments	44620	M658783		2/13/2013
Torque Wrench (test 7)	Snap-On	TEC3FUA	M634527		3/10/2013
Torque Wrench (tests 1,2)	Proto	6012	M644973		2/28/2013
Torque Wrench (tests 3-7)	Proto	6012C	M659924		2/28/2013
Power Supply	Endevco	2793	M652262	Channels 1-15	1/11/2013, 1/10/2014 *
Data Acquisition System	Nicolet	BE256LE	2011288	Channels 2-8, 10-15	7/26/2013
Channel 2	Nicolet	614CB	001-2	A1	7/26/2013
Channel 3	Nicolet	614CB	001-3	A2	7/26/2013
Channel 4	Nicolet	614CB	001-4	A3	7/26/2013
Channel 5	Nicolet	614CB	002-1	A4	7/26/2013
Channel 6	Nicolet	614CB	002-2	A5	7/26/2013
Channel 7	Nicolet	614CB	002-3	A6	7/26/2013
Channel 8	Nicolet	614CB	002-4	A7	7/26/2013
Channel 10	Nicolet	614CB	003-2	A8	7/26/2013
Channel 11	Nicolet	614CB	003-3	A9	7/26/2013
Channel 12	Nicolet	614CB	003-4	A10	7/26/2013
Channel 13	Nicolet	614CB	004-1	A11	7/26/2013
Channel 14	Nicolet	614CB	004-2	A12	7/26/2013
Channel 15	Nicolet	614CB	004-3	A13	7/26/2013
Accelerometer	PCB	350B02	11439	A13	9/5/2013
Accelerometer	PCB	350C02	31334	A1	9/7/2013
Accelerometer	PCB	350C02	31340	A2	9/7/2013
Accelerometer	PCB	350C02	31338	A3	9/7/2013
Accelerometer	PCB	350C02	30712	A4	9/7/2013
Accelerometer	PCB	350C02	31331	A4	9/7/2013
Accelerometer	PCB	350C02	31328	A5	9/7/2013
Accelerometer	PCB	350C02	31333	A6	9/6/2013
Accelerometer	PCB	350C02	40292	A7	9/7/2013
Accelerometer	PCB	350C02	31351	A8	9/6/2013
Accelerometer	PCB	350C02	31330	A9	9/6/2013
Accelerometer	PCB	350C02	40295	A10	9/7/2013
Accelerometer	PCB	350C02	31336	A11	9/7/2013
Accelerometer	PCB	350C02	40274	A12	9/7/2013

* Recalibrated prior to test 3



NESC-DEV-12-028
Composite Materials
Shock Test

Data Acquisition Setups



TEST 1

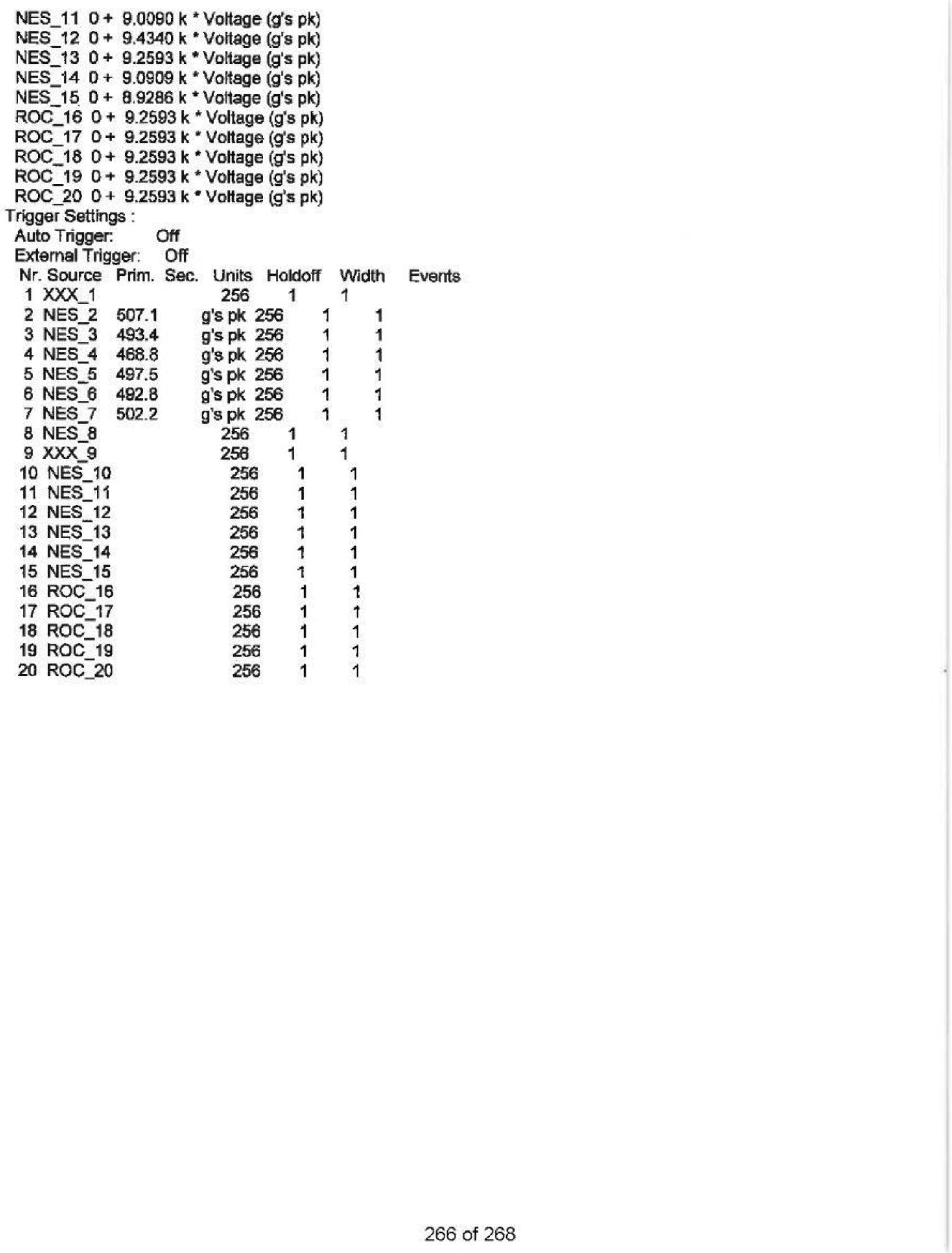
```
                  TEAM256 SETTINGS
Date: 12-18-2014
Time: 14:56:05

************************* GLOBAL SETTINGS *************************

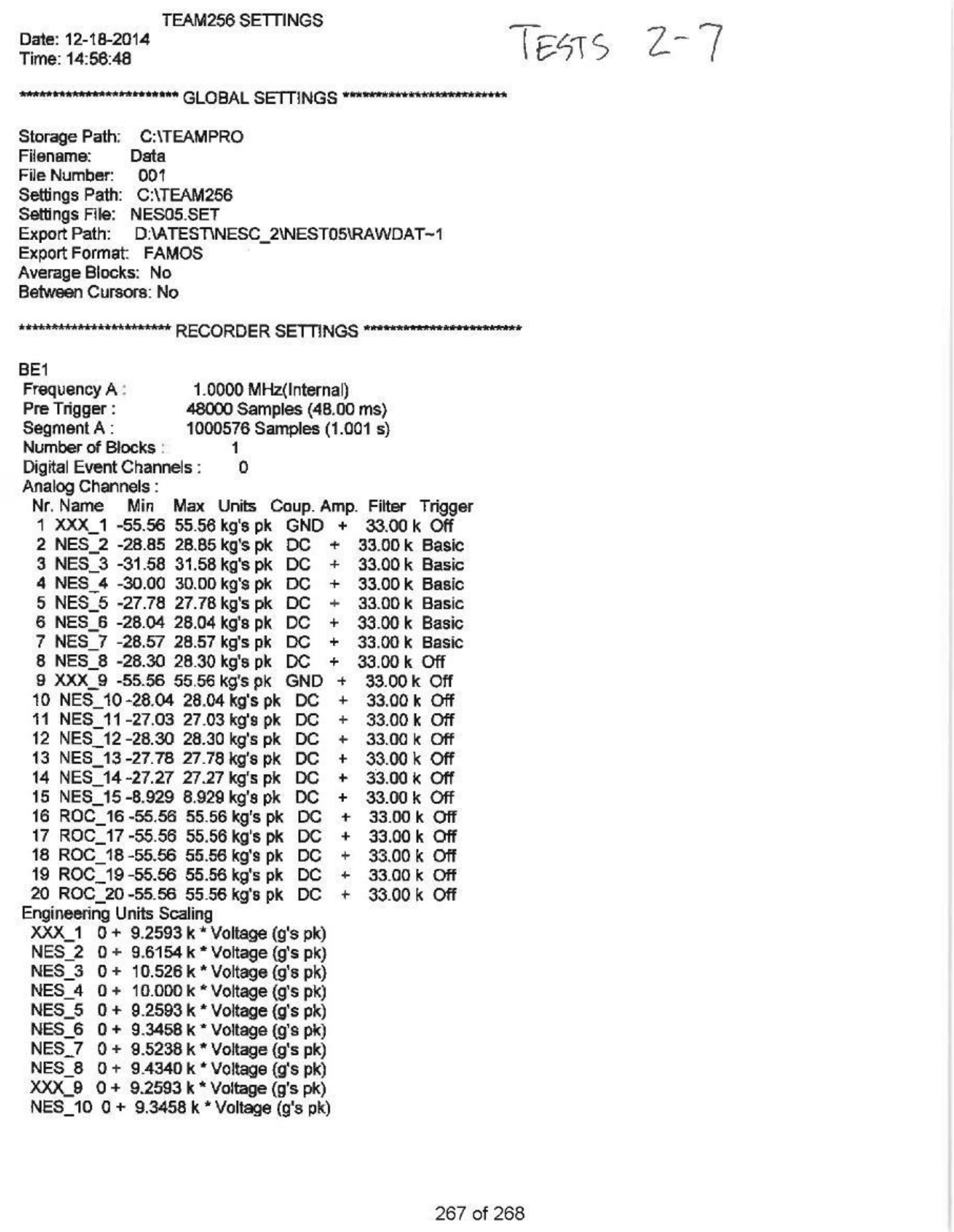
Storage Path:   C:\TEAMPRO
Filename:       Data
File Number:    001
Settings Path:  C:\TEAM256
Settings File:  NES04.SET
Export Path:    D:\ATEST\NESC_2\NEST04\RAWDAT~1
Export Format:  FAMOS
Average Blocks:  No
Between Cursors: No

************************ RECORDER SETTINGS ************************

BE1
 Frequency A :           1.0000 MHz(Internal)
 Pre Trigger :           48000 Samples (48.00 ms)
 Segment A :             1000576 Samples (1.001 s)
 Number of Blocks :          1
 Digital Event Channels :    0
 Analog Channels :
   Nr. Name     Min    Max   Units   Coup. Amp. Filter  Trigger
    1 XXX_1  -55.56  55.56 kg's pk  GND   +    33.00 k  Off
    2 NES_2  -28.85  28.85 kg's pk  DC    +    33.00 k  Basic
    3 NES_3  -31.58  31.58 kg's pk  DC    +    33.00 k  Basic
    4 NES_4  -30.00  30.00 kg's pk  DC    +    33.00 k  Basic
    5 NES_5  -28.30  28.30 kg's pk  DC    +    33.00 k  Basic
    6 NES_6  -28.04  28.04 kg's pk  DC    +    33.00 k  Basic
    7 NES_7  -28.57  28.57 kg's pk  DC    +    33.00 k  Basic
    8 NES_8  -28.30  28.30 kg's pk  DC    +    33.00 k  Off
    9 XXX_9  -55.56  55.56 kg's pk  GND   +    33.00 k  Off
   10 NES_10 -28.04  28.04 kg's pk  DC    +    33.00 k  Off
   11 NES_11 -27.03  27.03 kg's pk  DC    +    33.00 k  Off
   12 NES_12 -28.30  28.30 kg's pk  DC    +    33.00 k  Off
   13 NES_13 -27.78  27.78 kg's pk  DC    +    33.00 k  Off
   14 NES_14 -27.27  27.27 kg's pk  DC    +    33.00 k  Off
   15 NES_15 -8.929  8.929 kg's pk  DC    +    33.00 k  Off
   16 ROC_16 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   17 ROC_17 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   18 ROC_18 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   19 ROC_19 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   20 ROC_20 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
 Engineering Units Scaling
   XXX_1   0 +  9.2593 k * Voltage (g's pk)
   NES_2   0 +  9.6154 k * Voltage (g's pk)
   NES_3   0 +  10.526 k * Voltage (g's pk)
   NES_4   0 +  10.000 k * Voltage (g's pk)
   NES_5   0 +  9.4340 k * Voltage (g's pk)
   NES_6   0 +  9.3458 k * Voltage (g's pk)
   NES_7   0 +  9.5238 k * Voltage (g's pk)
   NES_8   0 +  9.4340 k * Voltage (g's pk)
   XXX_9   0 +  9.2593 k * Voltage (g's pk)
   NES_10  0 +  9.3458 k * Voltage (g's pk)
```



```
 NES_11  0 +  9.0090 k * Voltage (g's pk)
 NES_12  0 +  9.4340 k * Voltage (g's pk)
 NES_13  0 +  9.2593 k * Voltage (g's pk)
 NES_14  0 +  9.0909 k * Voltage (g's pk)
 NES_15  0 +  8.9286 k * Voltage (g's pk)
 ROC_16  0 +  9.2593 k * Voltage (g's pk)
 ROC_17  0 +  9.2593 k * Voltage (g's pk)
 ROC_18  0 +  9.2593 k * Voltage (g's pk)
 ROC_19  0 +  9.2593 k * Voltage (g's pk)
 ROC_20  0 +  9.2593 k * Voltage (g's pk)
Trigger Settings :
 Auto Trigger:        Off
 External Trigger:     Off
 Nr. Source  Prim.  Sec.  Units  Holdoff   Width    Events
  1  XXX_1                  256      1        1
  2  NES_2   507.1       g's pk  256      1        1
  3  NES_3   493.4       g's pk  256      1        1
  4  NES_4   468.8       g's pk  256      1        1
  5  NES_5   497.5       g's pk  256      1        1
  6  NES_6   492.8       g's pk  256      1        1
  7  NES_7   502.2       g's pk  256      1        1
  8  NES_8                  256      1        1
  9  XXX_9                  256      1        1
 10  NES_10                  256      1        1
 11  NES_11                  256      1        1
 12  NES_12                  256      1        1
 13  NES_13                  256      1        1
 14  NES_14                  256      1        1
 15  NES_15                  256      1        1
 16  ROC_16                  256      1        1
 17  ROC_17                  256      1        1
 18  ROC_18                  256      1        1
 19  ROC_19                  256      1        1
 20  ROC_20                  256      1        1
```



TESTS 2-7

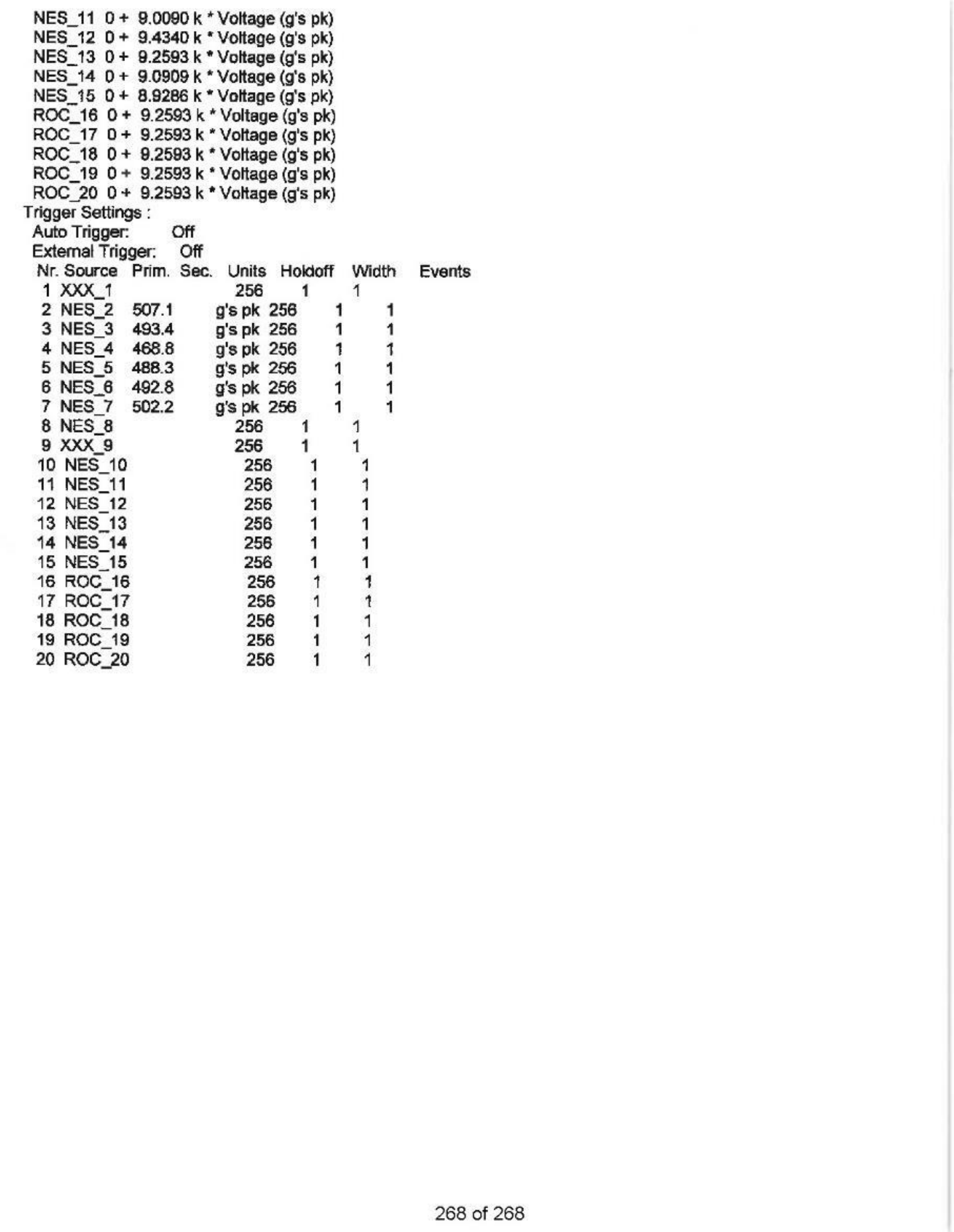
```
                    TEAM256 SETTINGS
Date: 12-18-2014
Time: 14:56:48

************************ GLOBAL SETTINGS ************************

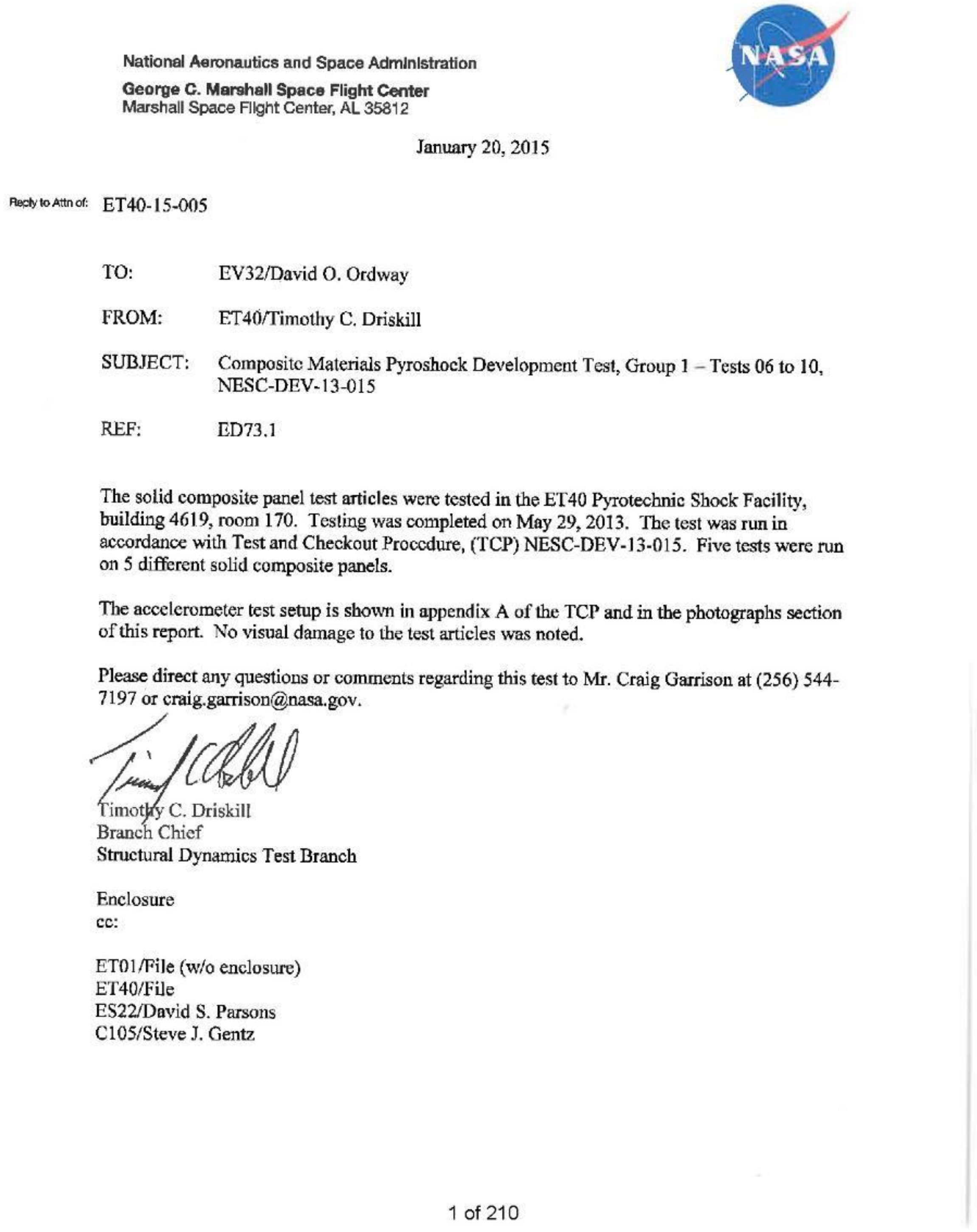
Storage Path:   C:\TEAMPRO
Filename:       Data
File Number:    001
Settings Path:  C:\TEAM256
Settings File:  NES05.SET
Export Path:    D:\ATEST\NESC_2\NEST05\RAWDAT~1
Export Format:  FAMOS
Average Blocks: No
Between Cursors: No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :           1.0000 MHz(Internal)
 Pre Trigger :           48000 Samples (48.00 ms)
 Segment A :             1000576 Samples (1.001 s)
 Number of Blocks :           1
 Digital Event Channels :      0
 Analog Channels :
   Nr. Name    Min    Max   Units   Coup. Amp.  Filter  Trigger
    1 XXX_1  -55.56  55.56 kg's pk  GND   +    33.00 k  Off
    2 NES_2  -28.85  28.85 kg's pk  DC    +    33.00 k  Basic
    3 NES_3  -31.58  31.58 kg's pk  DC    +    33.00 k  Basic
    4 NES_4  -30.00  30.00 kg's pk  DC    +    33.00 k  Basic
    5 NES_5  -27.78  27.78 kg's pk  DC    +    33.00 k  Basic
    6 NES_6  -28.04  28.04 kg's pk  DC    +    33.00 k  Basic
    7 NES_7  -28.57  28.57 kg's pk  DC    +    33.00 k  Basic
    8 NES_8  -28.30  28.30 kg's pk  DC    +    33.00 k  Off
    9 XXX_9  -55.56  55.56 kg's pk  GND   +    33.00 k  Off
   10 NES_10 -28.04  28.04 kg's pk  DC    +    33.00 k  Off
   11 NES_11 -27.03  27.03 kg's pk  DC    +    33.00 k  Off
   12 NES_12 -28.30  28.30 kg's pk  DC    +    33.00 k  Off
   13 NES_13 -27.78  27.78 kg's pk  DC    +    33.00 k  Off
   14 NES_14 -27.27  27.27 kg's pk  DC    +    33.00 k  Off
   15 NES_15 -8.929  8.929 kg's pk  DC    +    33.00 k  Off
   16 ROC_16 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   17 ROC_17 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   18 ROC_18 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   19 ROC_19 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
   20 ROC_20 -55.56  55.56 kg's pk  DC    +    33.00 k  Off
 Engineering Units Scaling
   XXX_1   0 +  9.2593 k * Voltage (g's pk)
   NES_2   0 +  9.6154 k * Voltage (g's pk)
   NES_3   0 +  10.526 k * Voltage (g's pk)
   NES_4   0 +  10.000 k * Voltage (g's pk)
   NES_5   0 +  9.2593 k * Voltage (g's pk)
   NES_6   0 +  9.3458 k * Voltage (g's pk)
   NES_7   0 +  9.5238 k * Voltage (g's pk)
   NES_8   0 +  9.4340 k * Voltage (g's pk)
   XXX_9   0 +  9.2593 k * Voltage (g's pk)
   NES_10  0 +  9.3458 k * Voltage (g's pk)
```



```
  NES_11  0 +  9.0090 k * Voltage (g's pk)
  NES_12  0 +  9.4340 k * Voltage (g's pk)
  NES_13  0 +  9.2593 k * Voltage (g's pk)
  NES_14  0 +  9.0909 k * Voltage (g's pk)
  NES_15  0 +  8.9286 k * Voltage (g's pk)
  ROC_16  0 +  9.2593 k * Voltage (g's pk)
  ROC_17  0 +  9.2593 k * Voltage (g's pk)
  ROC_18  0 +  9.2593 k * Voltage (g's pk)
  ROC_19  0 +  9.2593 k * Voltage (g's pk)
  ROC_20  0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
  Auto Trigger:       Off
  External Trigger:     Off
   Nr. Source  Prim.  Sec.  Units  Holdoff   Width     Events
    1  XXX_1                  256      1        1
    2  NES_2   507.1      g's pk  256      1        1
    3  NES_3   493.4      g's pk  256      1        1
    4  NES_4   468.8      g's pk  256      1        1
    5  NES_5   488.3      g's pk  256      1        1
    6  NES_6   492.8      g's pk  256      1        1
    7  NES_7   502.2      g's pk  256      1        1
    8  NES_8                  256      1        1
    9  XXX_9                  256      1        1
   10  NES_10                  256      1        1
   11  NES_11                  256      1        1
   12  NES_12                  256      1        1
   13  NES_13                  256      1        1
   14  NES_14                  256      1        1
   15  NES_15                  256      1        1
   16  ROC_16                  256      1        1
   17  ROC_17                  256      1        1
   18  ROC_18                  256      1        1
   19  ROC_19                  256      1        1
   20  ROC_20                  256      1        1
```



National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

January 20, 2015

Reply to Attn of: ET40-15-005

TO: EV32/David O. Ordway

FROM: ET40/Timothy C. Driskill

SUBJECT: Composite Materials Pyroshock Development Test, Group 1 – Tests 06 to 10, NESC-DEV-13-015

REF: ED73.1

The solid composite panel test articles were tested in the ET40 Pyrotechnic Shock Facility, building 4619, room 170. Testing was completed on May 29, 2013. The test was run in accordance with Test and Checkout Procedure, (TCP) NESC-DEV-13-015. Five tests were run on 5 different solid composite panels.

The accelerometer test setup is shown in appendix A of the TCP and in the photographs section of this report. No visual damage to the test articles was noted.

Please direct any questions or comments regarding this test to Mr. Craig Garrison at (256) 544-7197 or craig.garrison@nasa.gov.

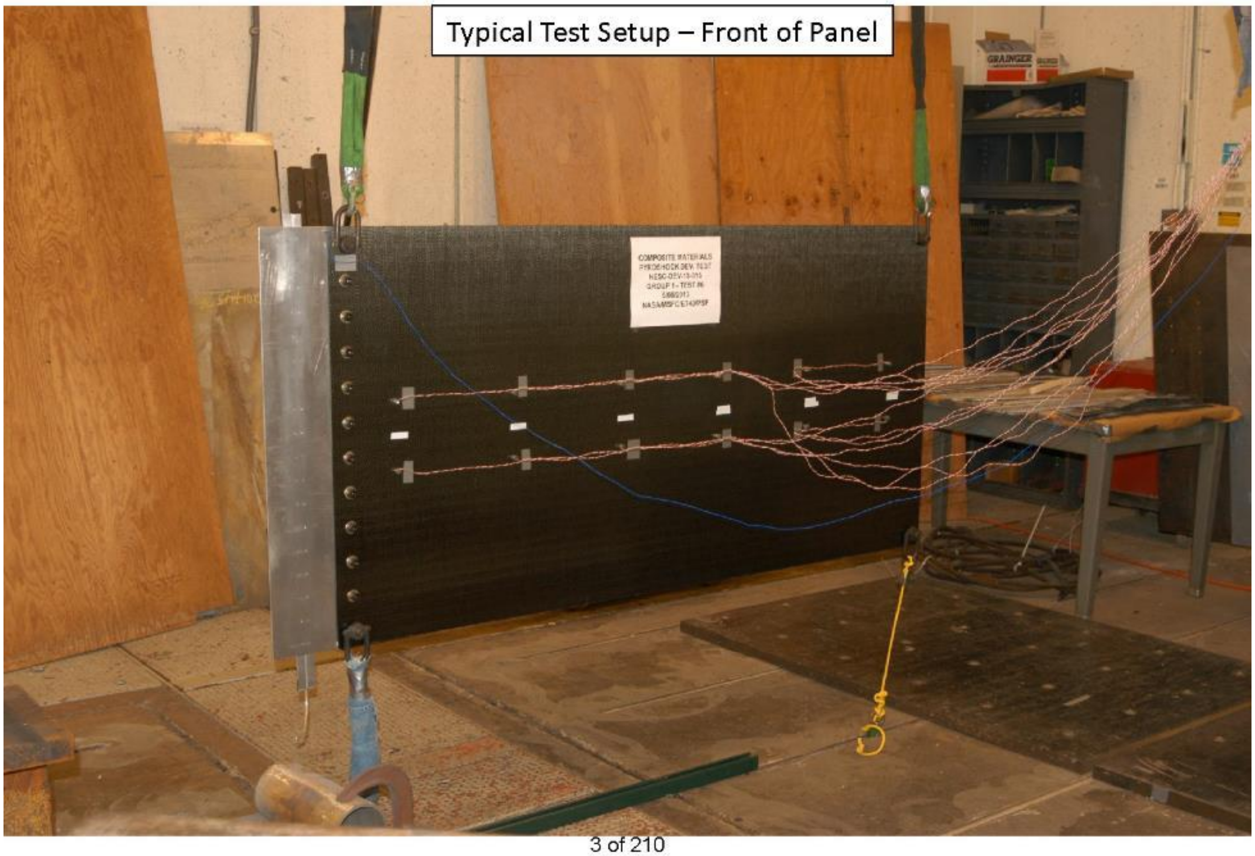
Timothy C. Driskill
Branch Chief
Structural Dynamics Test Branch

Enclosure
cc:

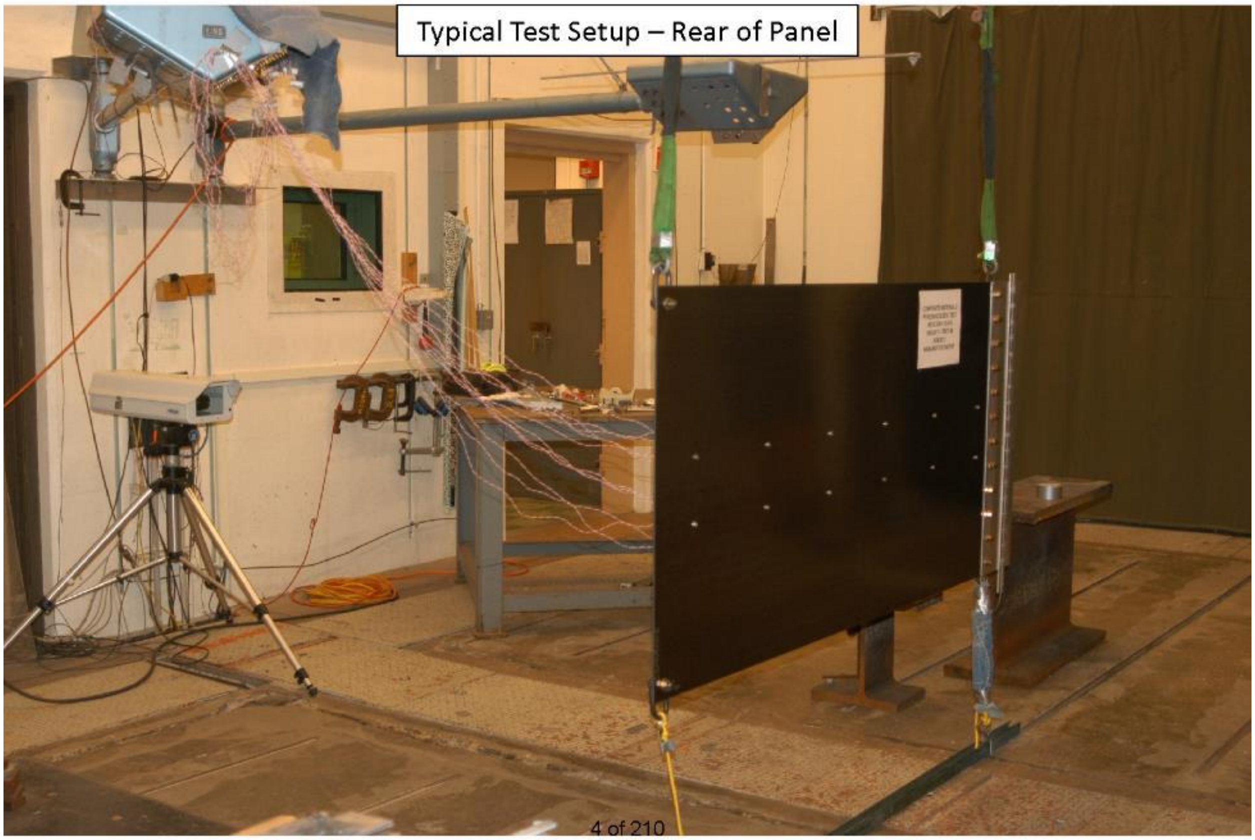
ET01/File (w/o enclosure)
ET40/File
ES22/David S. Parsons
C105/Steve J. Gentz

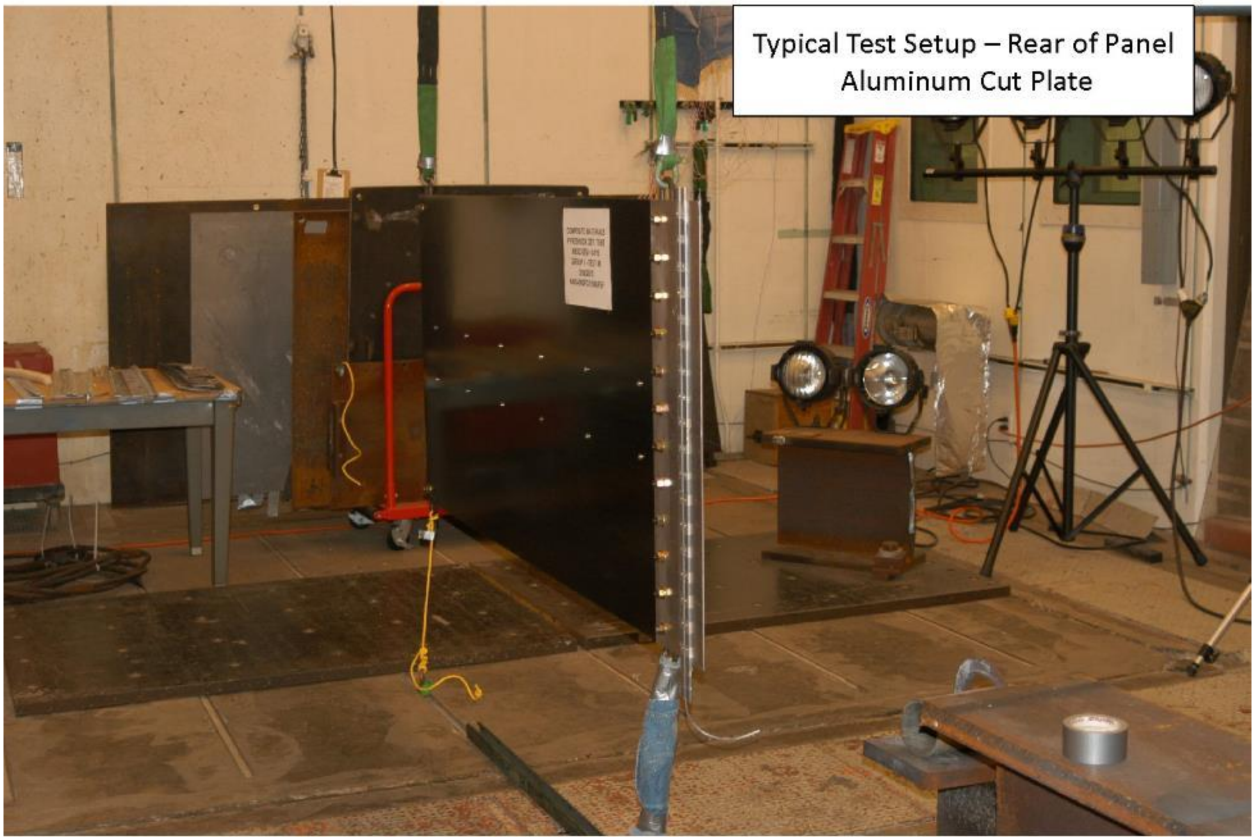
NESC-DEV-13-015
Composite Materials Shock Test

General Test Setup

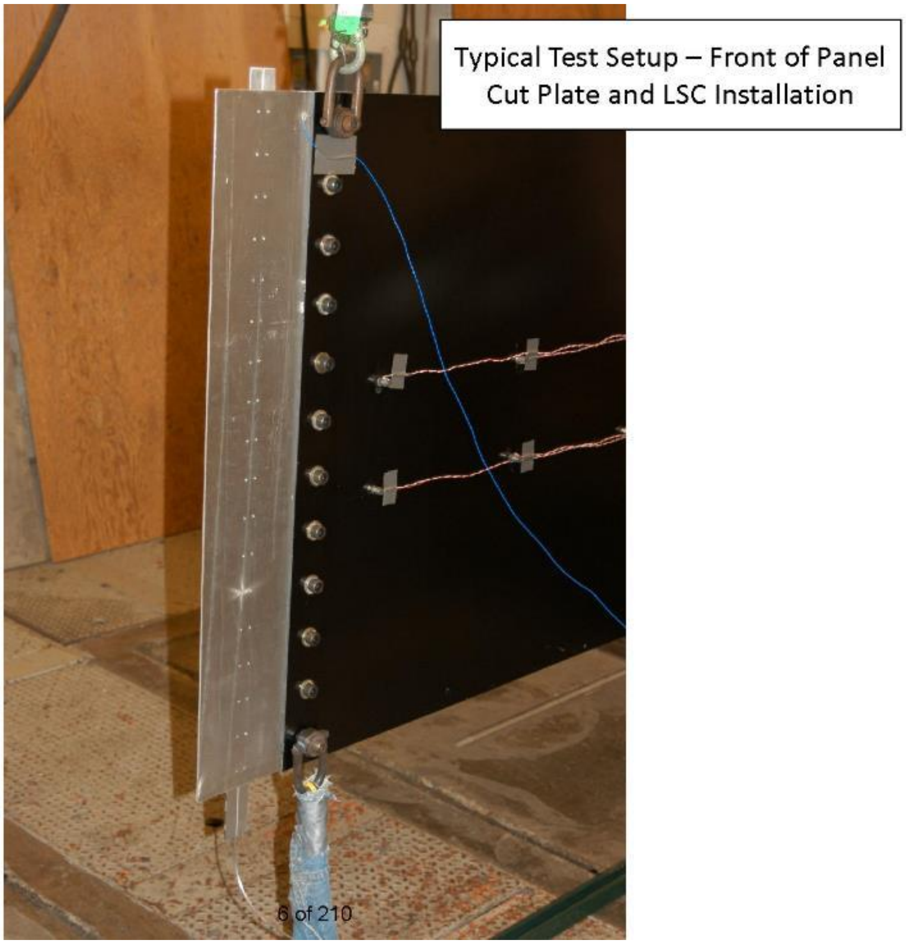


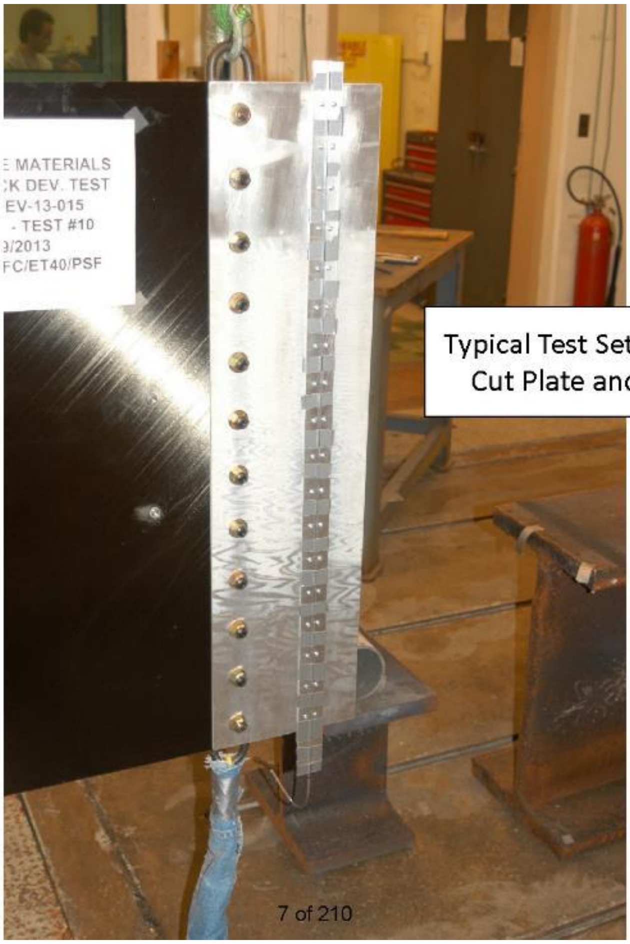
Typical Test Setup – Front of Panel


Typical Test Setup – Rear of Panel
4 of 210



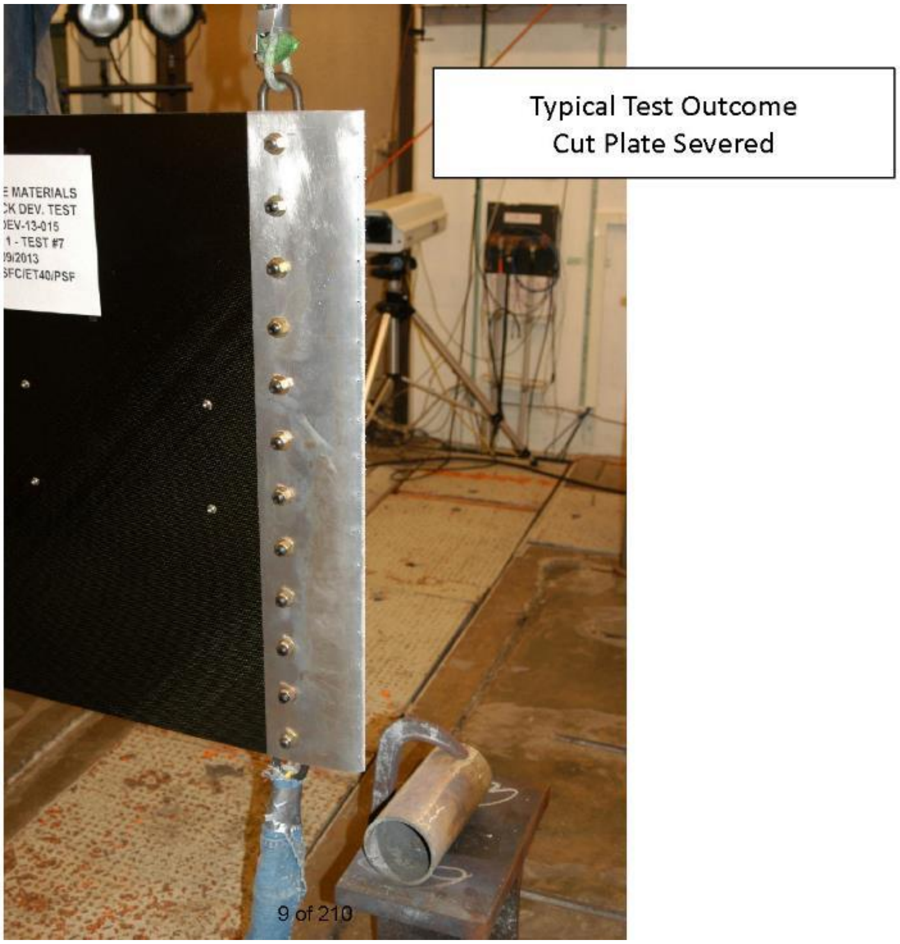
Typical Test Setup – Rear of Panel
Aluminum Cut Plate


Typical Test Setup – Front of Panel Cut Plate and LSC Installation
6 of 210

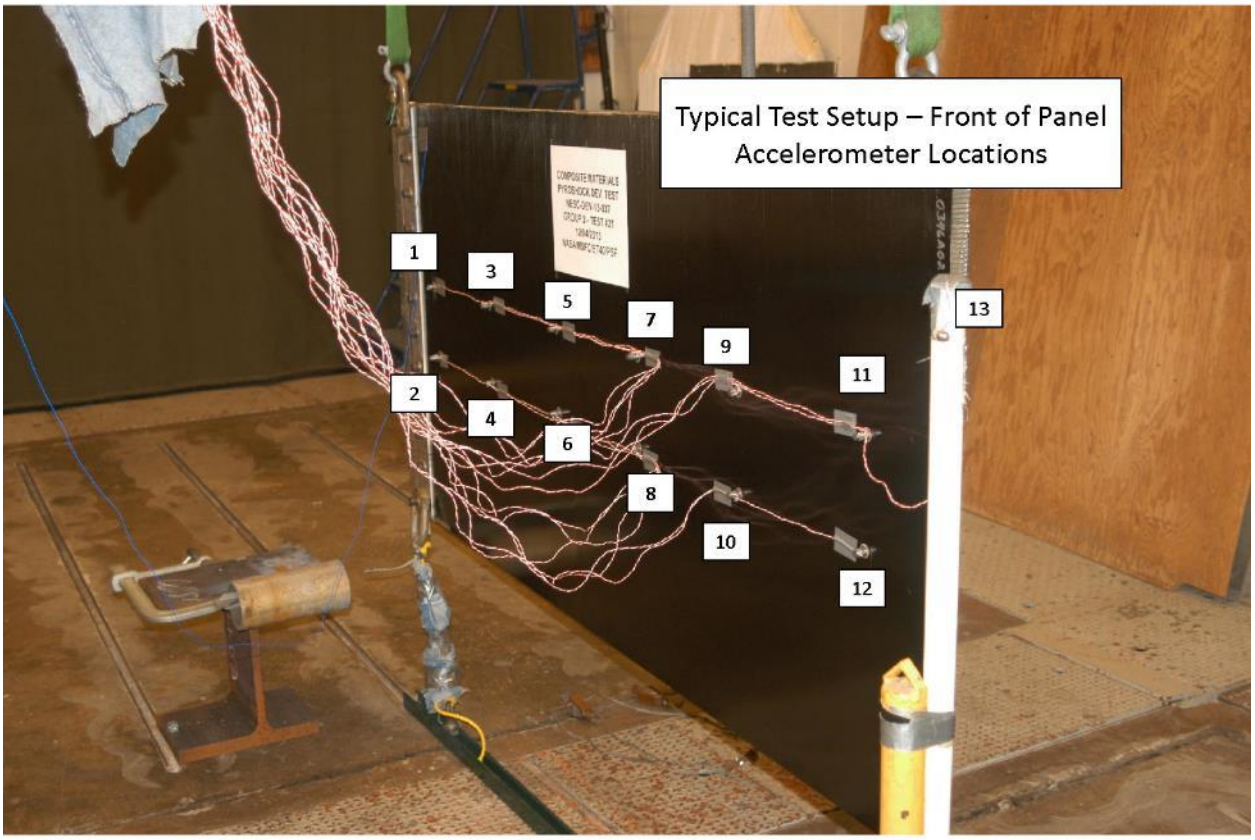


Typical Test Setup – Rear of Panel Cut Plate and LSC Installation

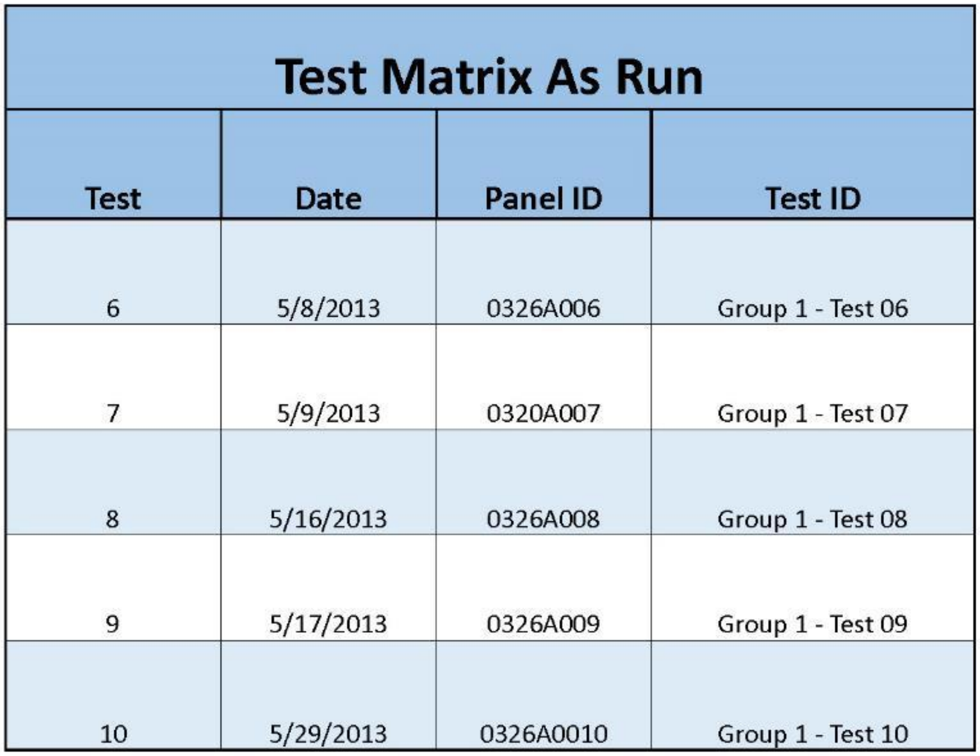
Typical Test Outcome
Cut Plate Severed



Typical Test Outcome
Cut Plate Severed

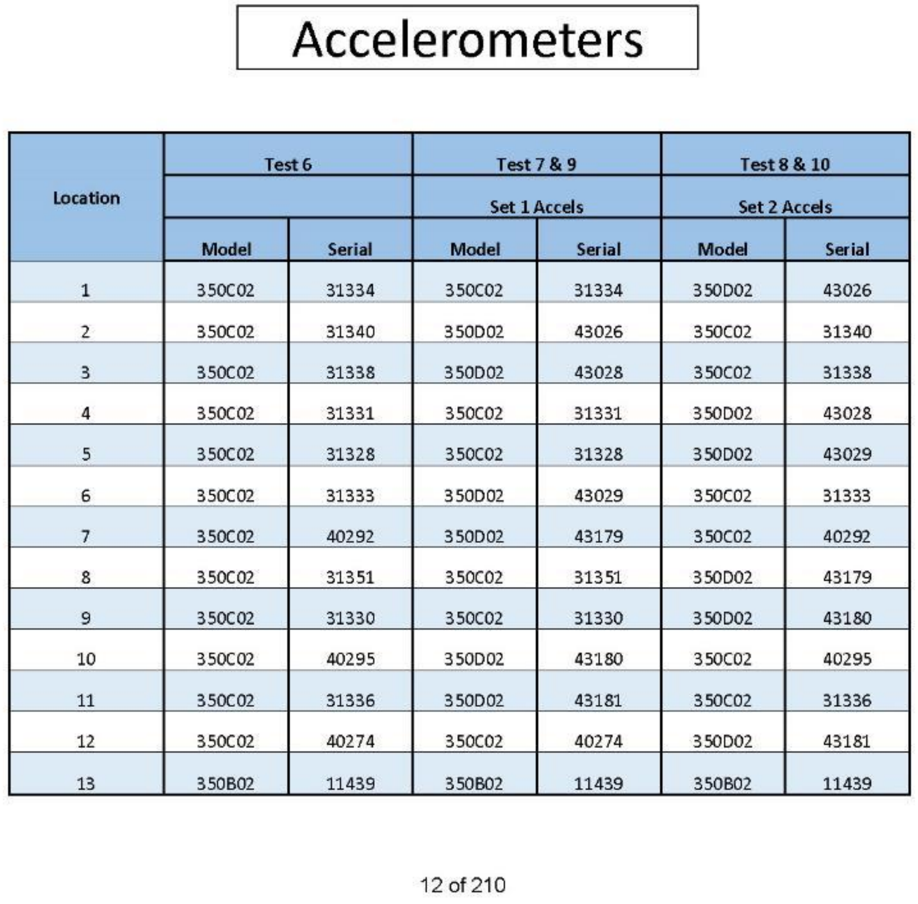

Typical Test Setup – Front of Panel
Accelerometer Locations
1
3
5
7
9
13
11
2
4
6
8
10
12

10 of 210



Test Matrix As Run

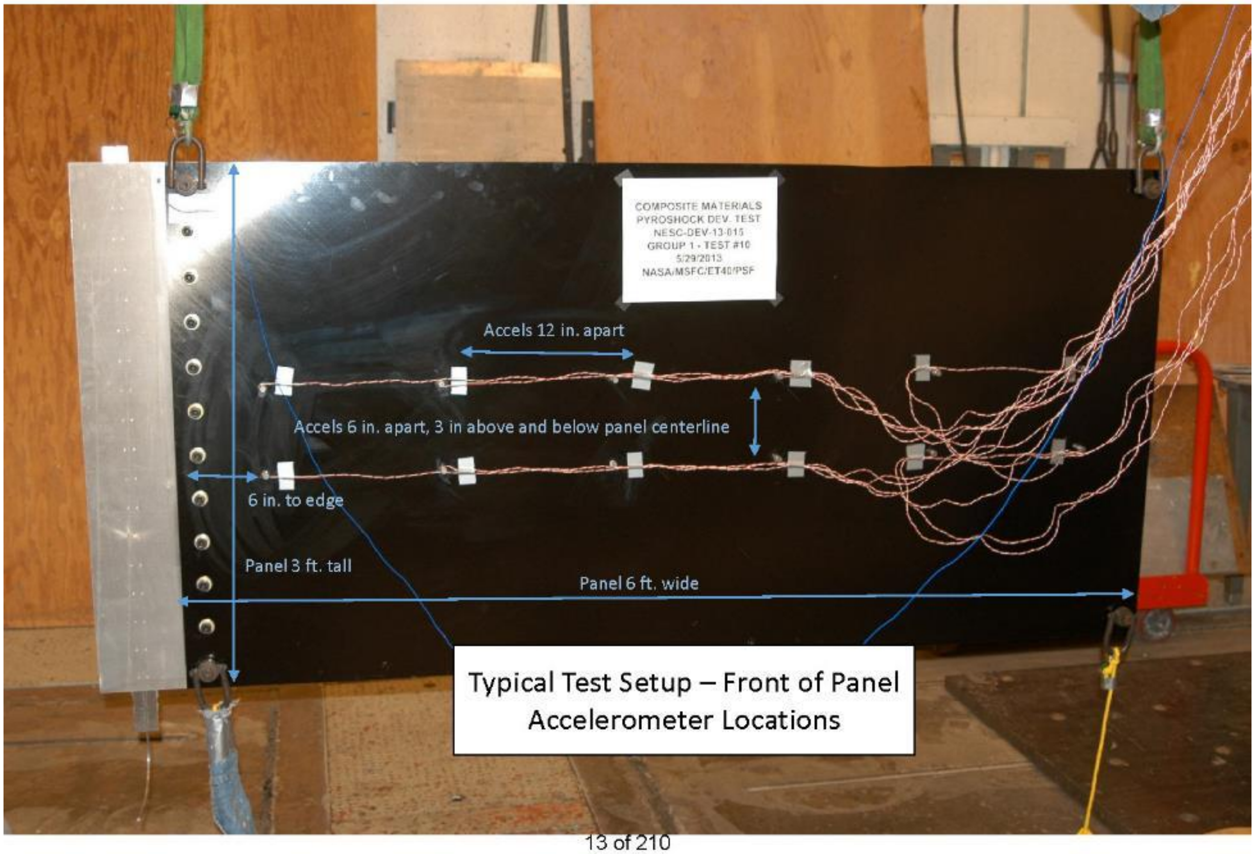
Test	Date	Panel ID	Test ID
6	5/8/2013	0326A006	Group 1 - Test 06
7	5/9/2013	0320A007	Group 1 - Test 07
8	5/16/2013	0326A008	Group 1 - Test 08
9	5/17/2013	0326A009	Group 1 - Test 09
10	5/29/2013	0326A0010	Group 1 - Test 10

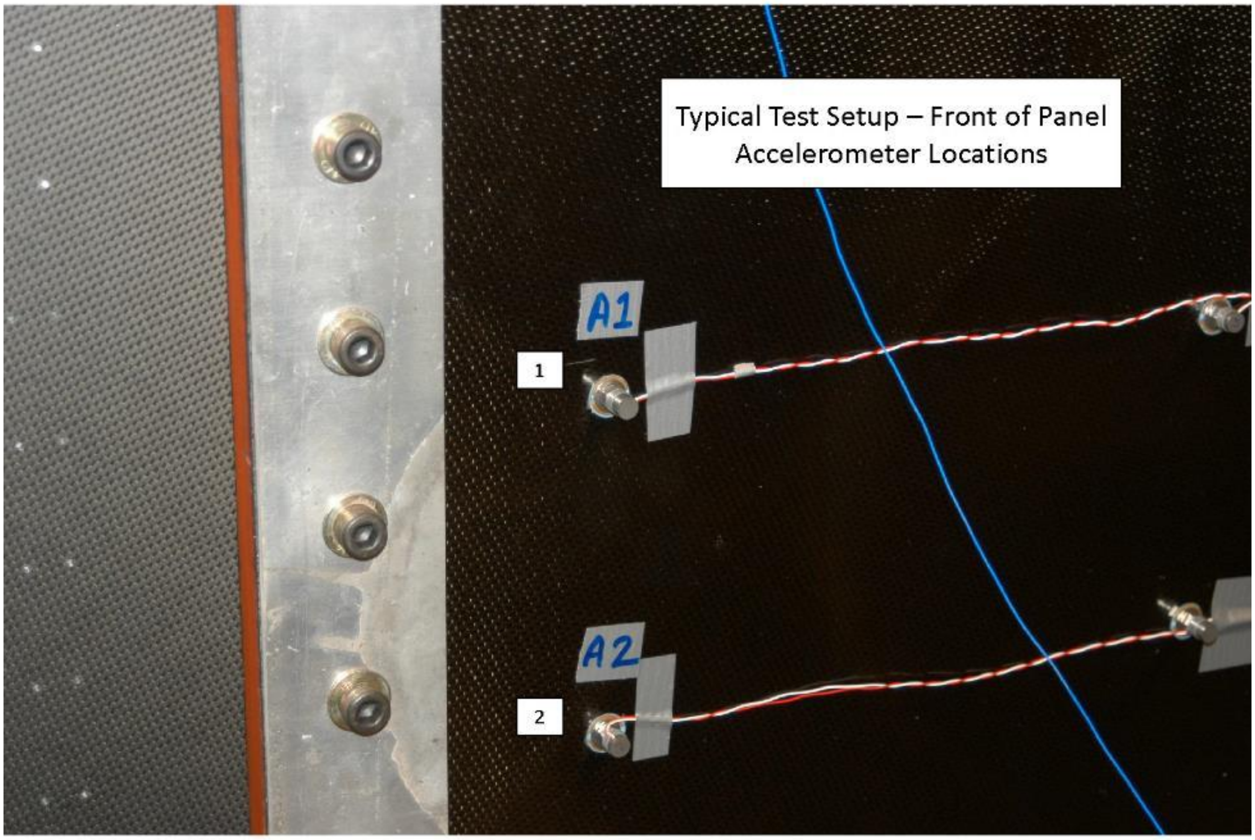


Accelerometers

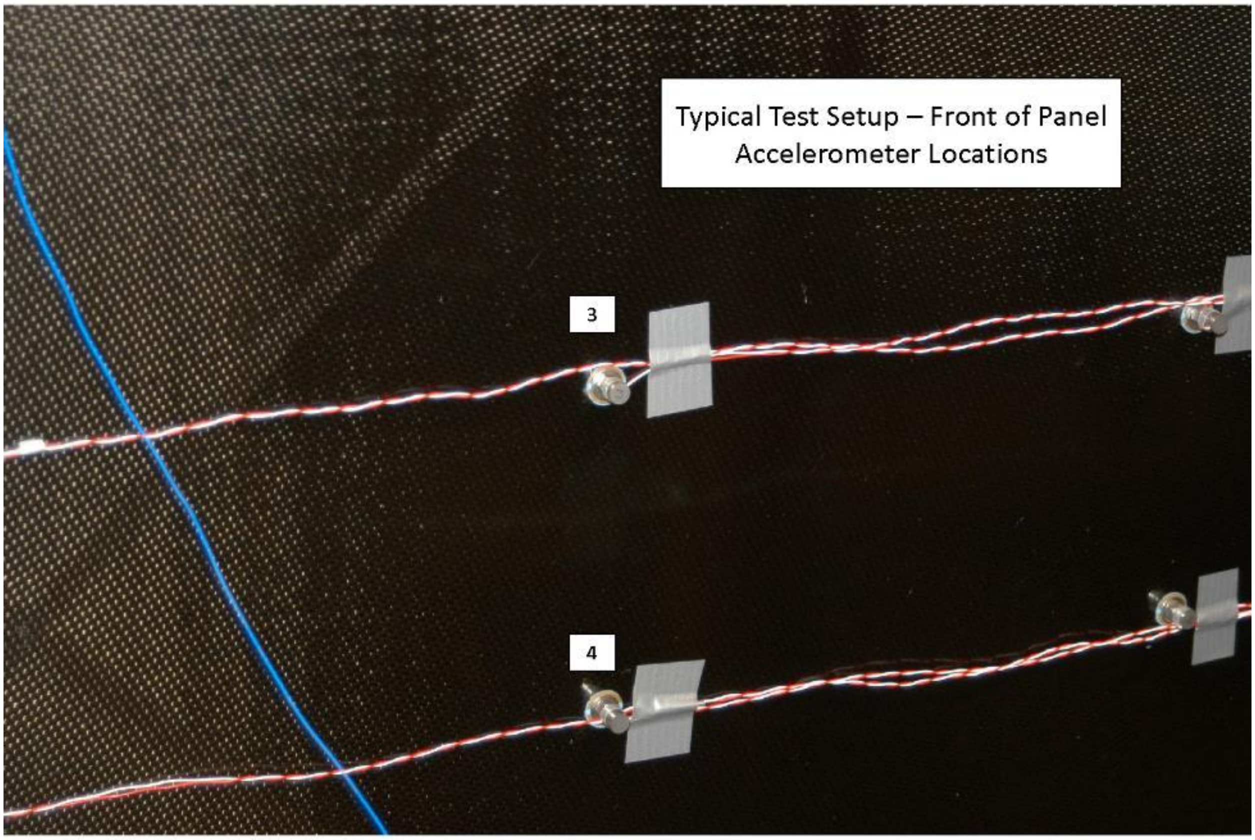
Location	Test 6		Test 7 & 9		Test 8 & 10	
			Set 1 Accels		Set 2 Accels	
	Model	Serial	Model	Serial	Model	Serial
1	350C02	31334	350C02	31334	350D02	43026
2	350C02	31340	350D02	43026	350C02	31340
3	350C02	31338	350D02	43028	350C02	31338
4	350C02	31331	350C02	31331	350D02	43028
5	350C02	31328	350C02	31328	350D02	43029
6	350C02	31333	350D02	43029	350C02	31333
7	350C02	40292	350D02	43179	350C02	40292
8	350C02	31351	350C02	31351	350D02	43179
9	350C02	31330	350C02	31330	350D02	43180
10	350C02	40295	350D02	43180	350C02	40295
11	350C02	31336	350D02	43181	350C02	31336
12	350C02	40274	350C02	40274	350D02	43181
13	350B02	11439	350B02	11439	350B02	11439

12 of 210

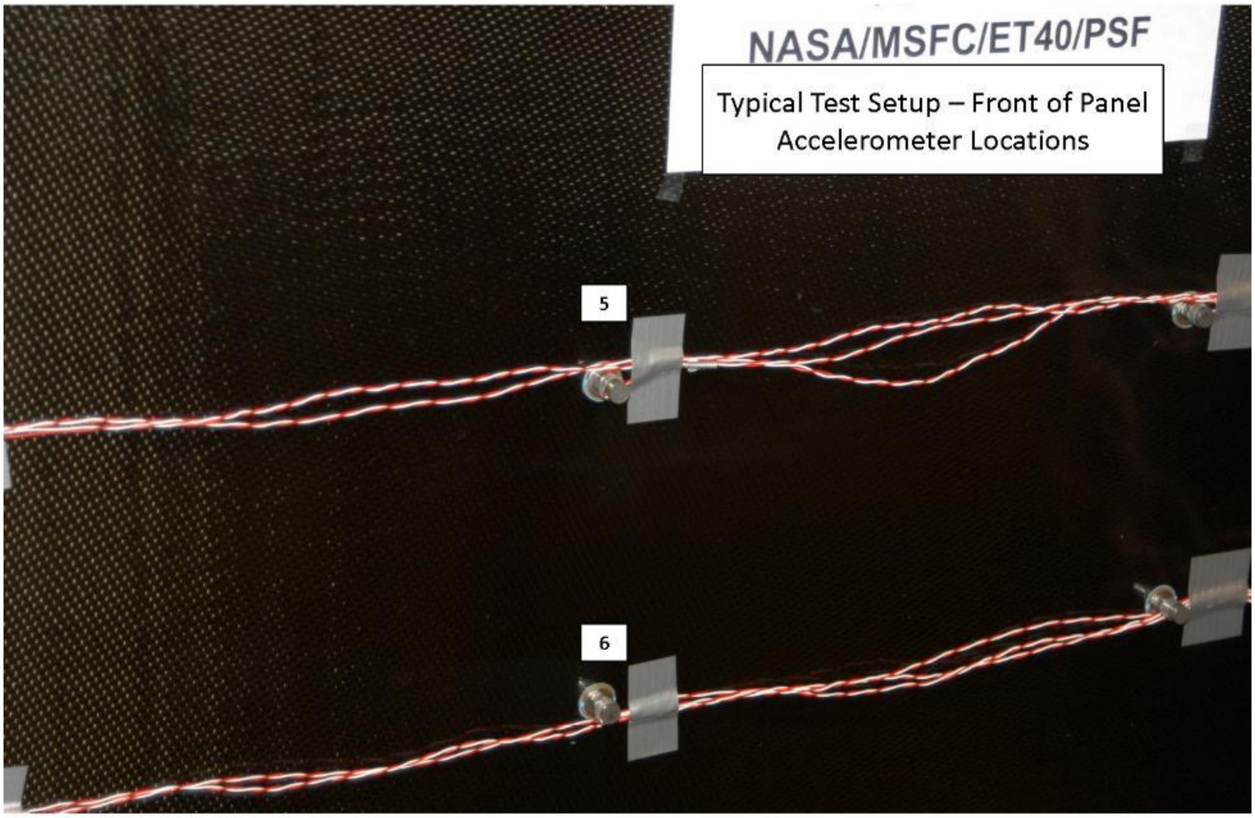

COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-13-015
GROUP 1 - TEST #10
5/29/2013
NASA/MSFC/ET40/PSF
Accels 12 in. apart
Accels 6 in. apart, 3 in above and below panel centerline
6 in. to edge
Panel 3 ft. tall
Panel 6 ft. wide
Typical Test Setup – Front of Panel
Accelerometer Locations


Typical Test Setup – Front of Panel
Accelerometer Locations
A1
1
A2
2

14 of 210

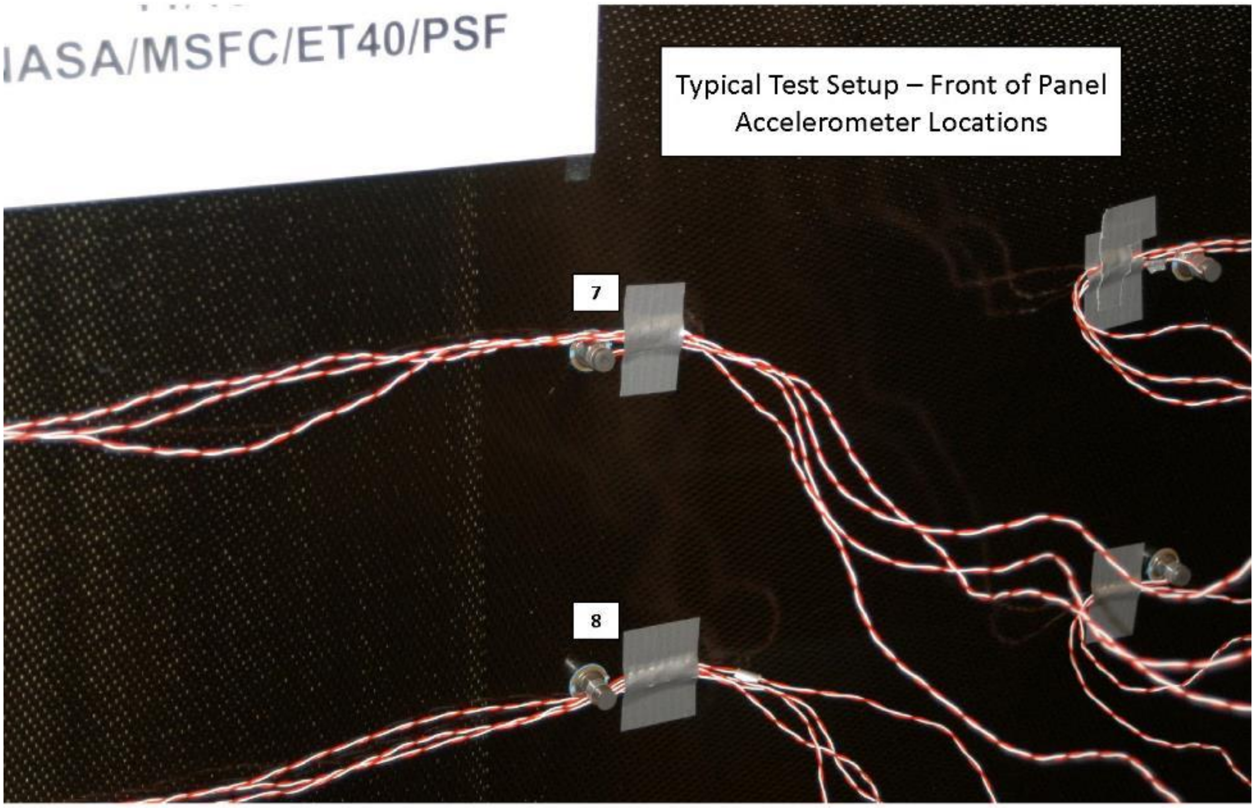


Typical Test Setup – Front of Panel Accelerometer Locations

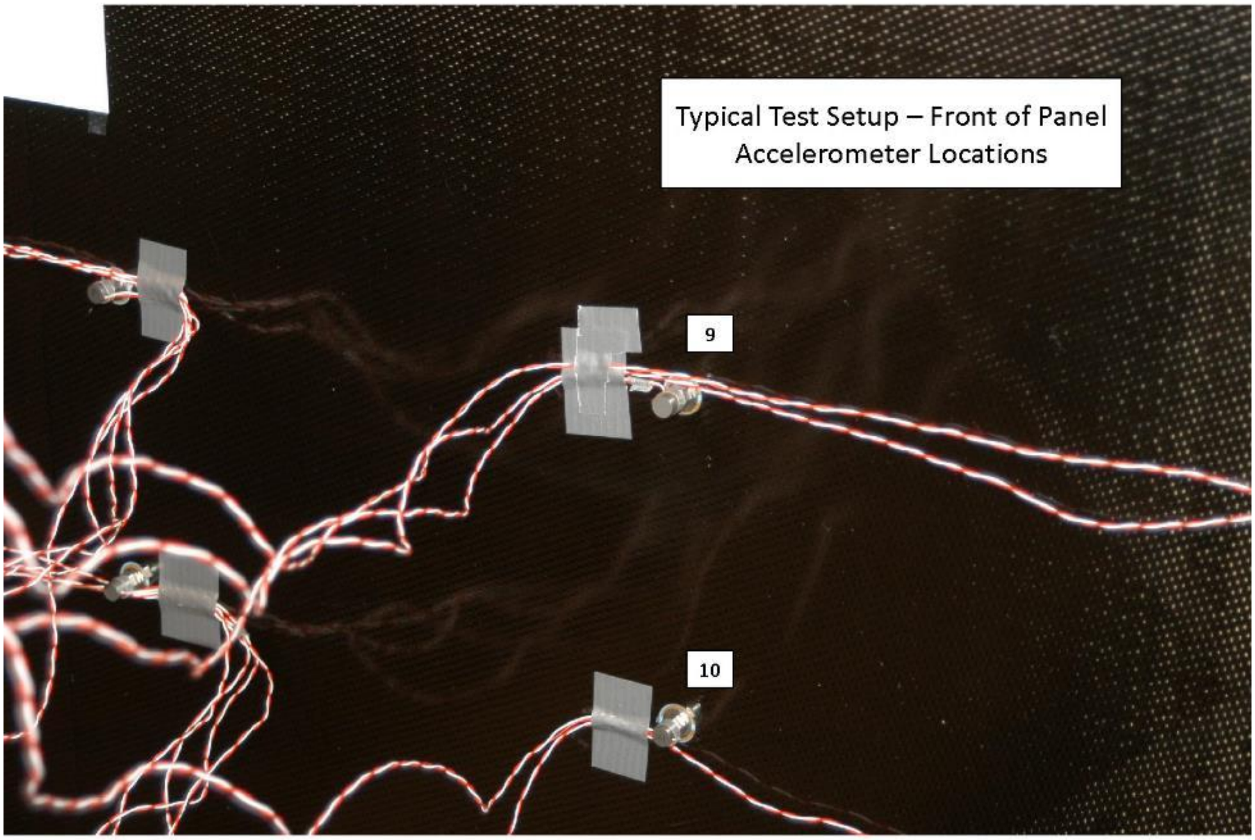


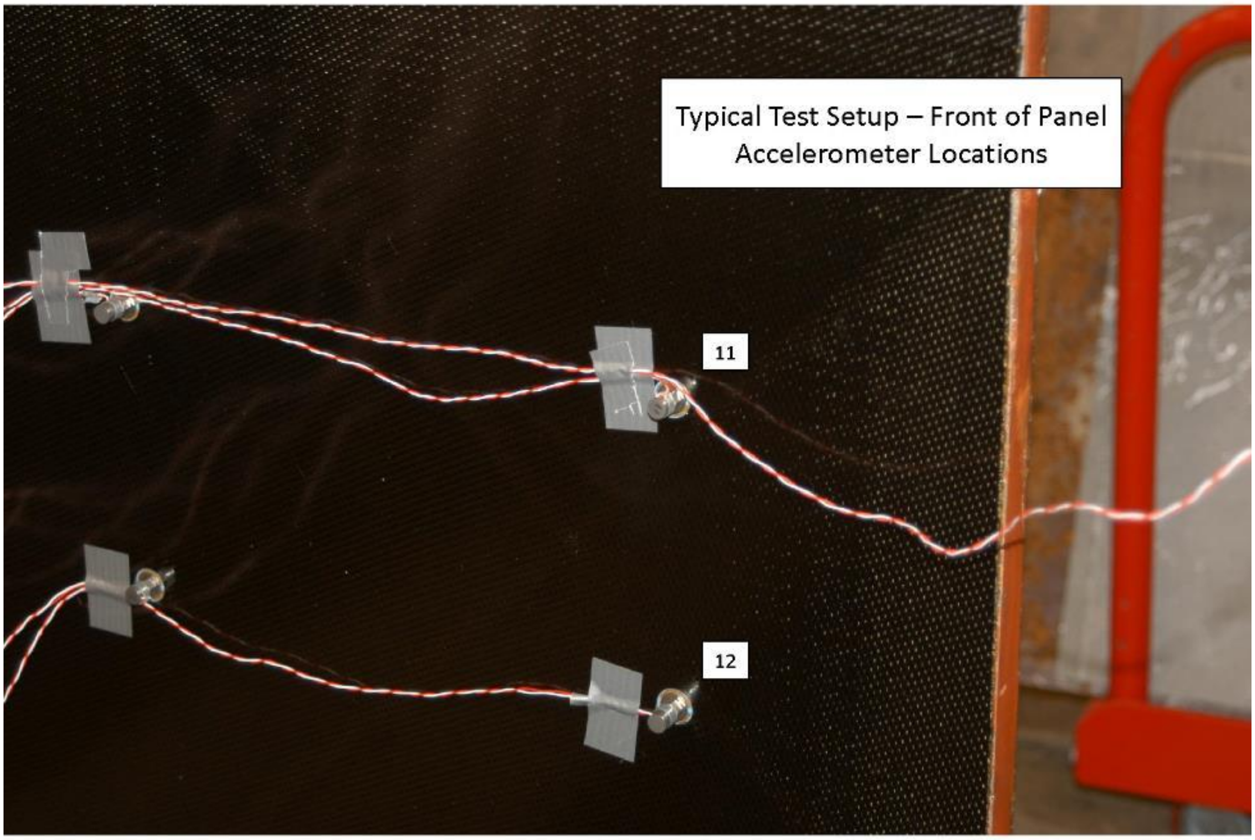
NASA/MSFC/ET40/PSF

Typical Test Setup – Front of Panel
Accelerometer Locations

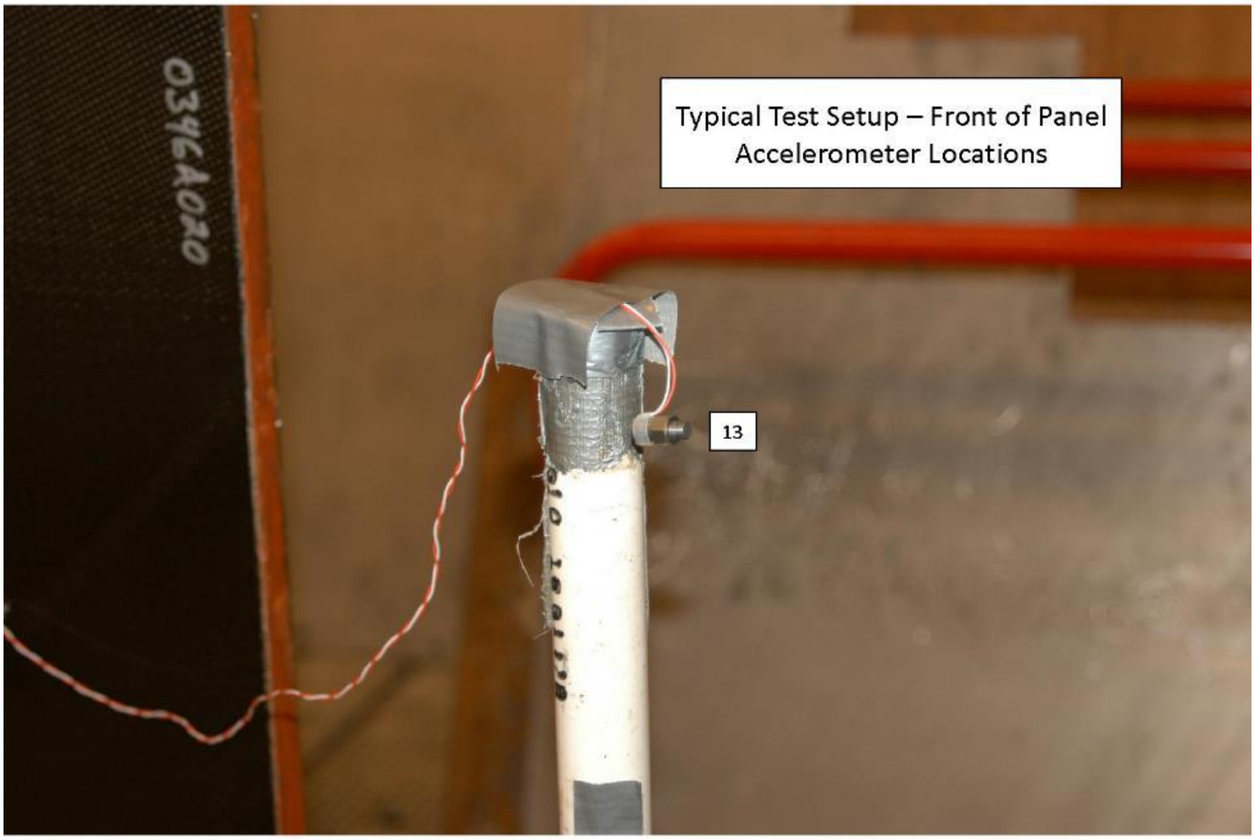


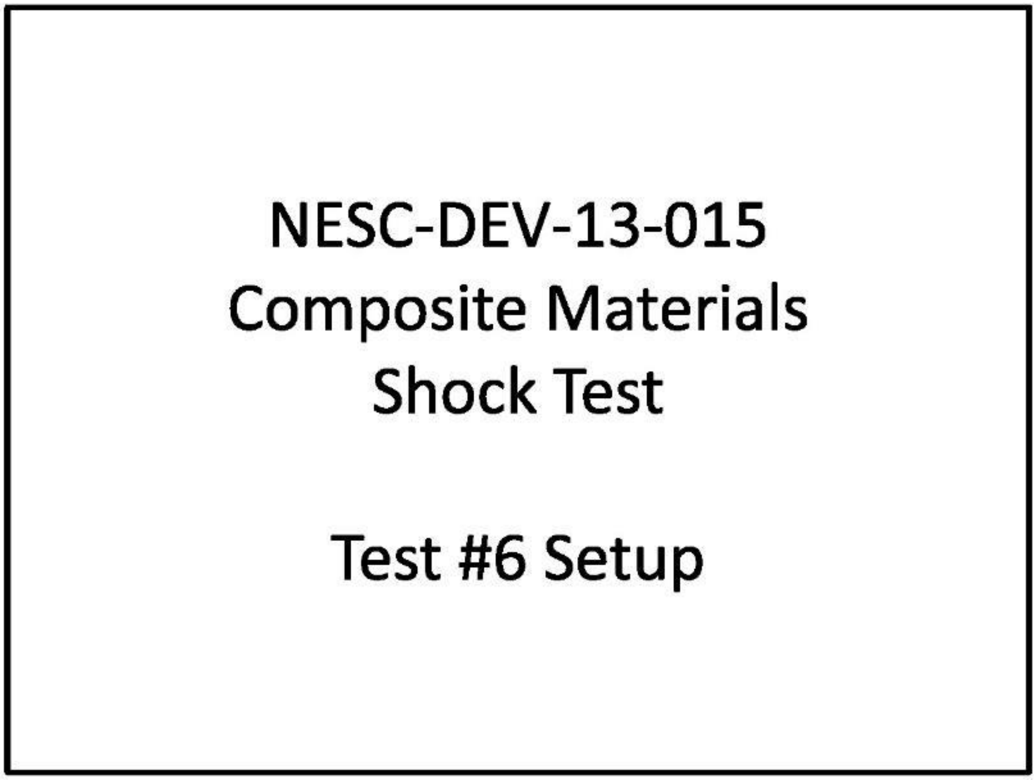
Typical Test Setup – Front of Panel
Accelerometer Locations


Typical Test Setup – Front of Panel Accelerometer Locations



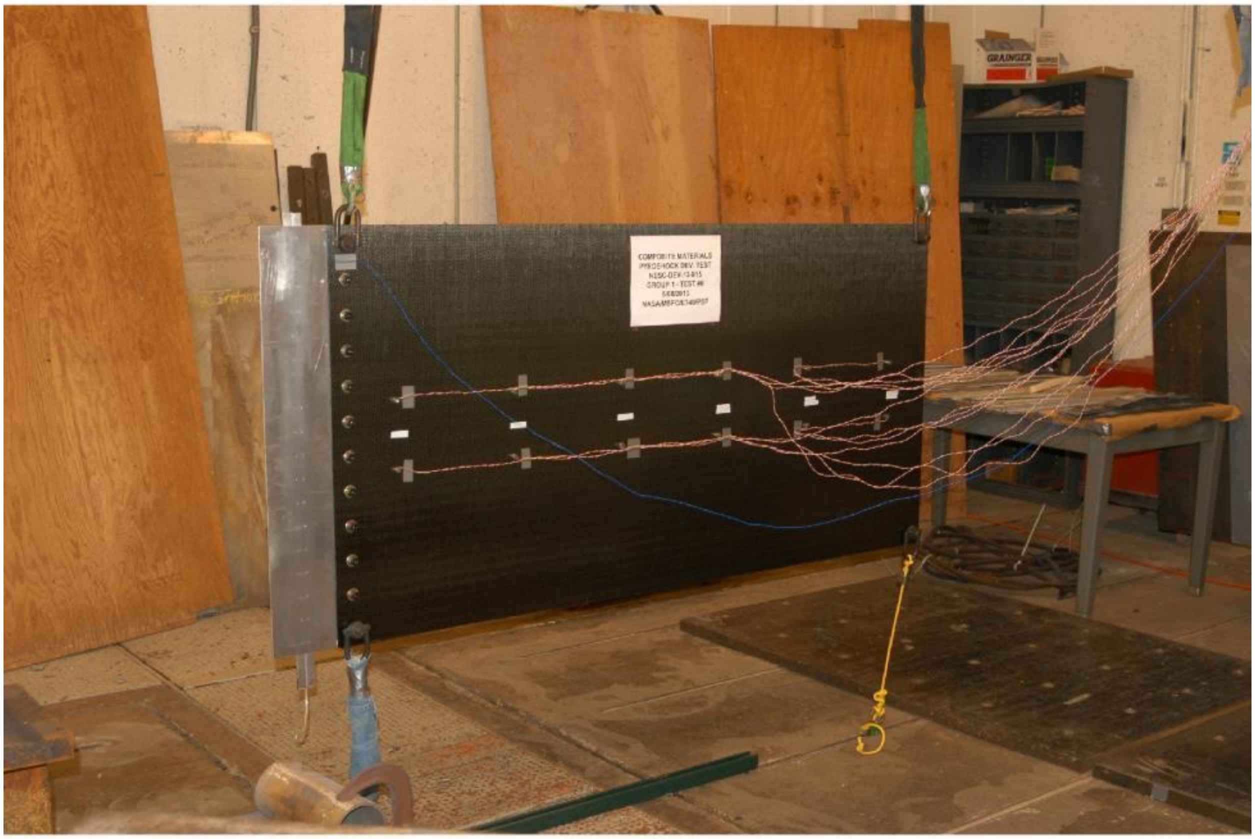
Typical Test Setup – Front of Panel
Accelerometer Locations


Typical Test Setup – Front of Panel Accelerometer Locations



NESC-DEV-13-015
Composite Materials
Shock Test

Test #6 Setup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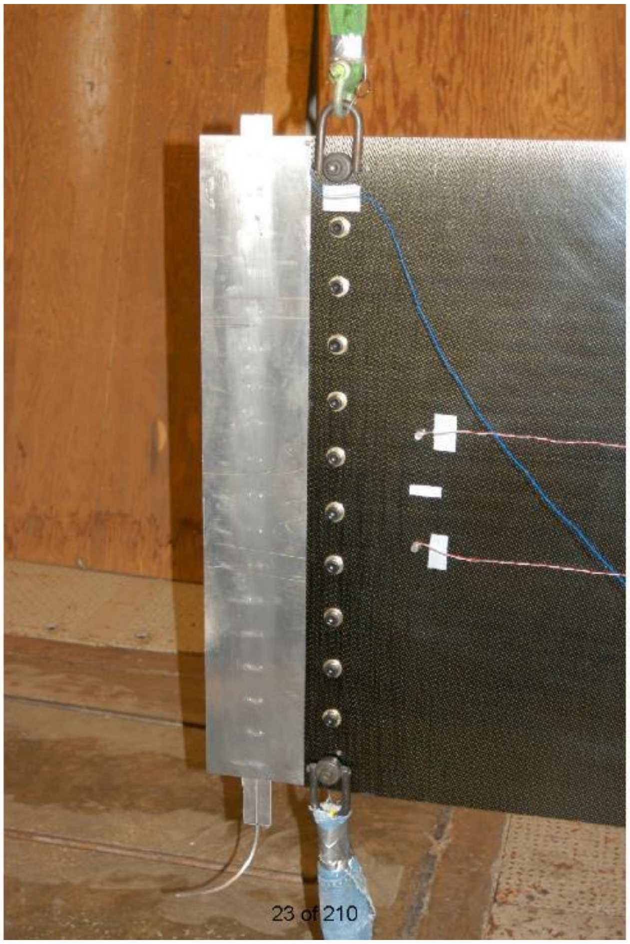
PYROSHOCK DEV. TEST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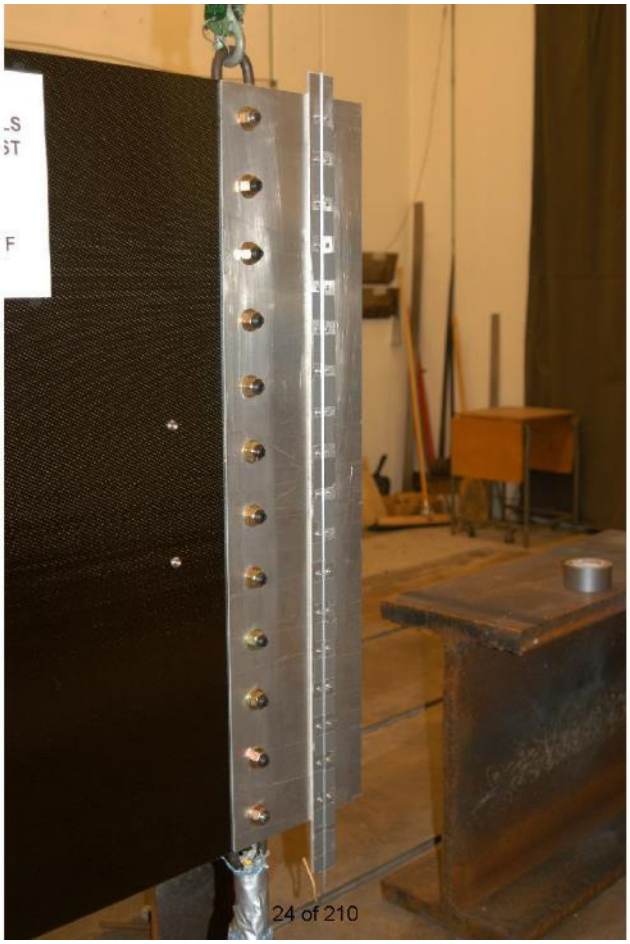
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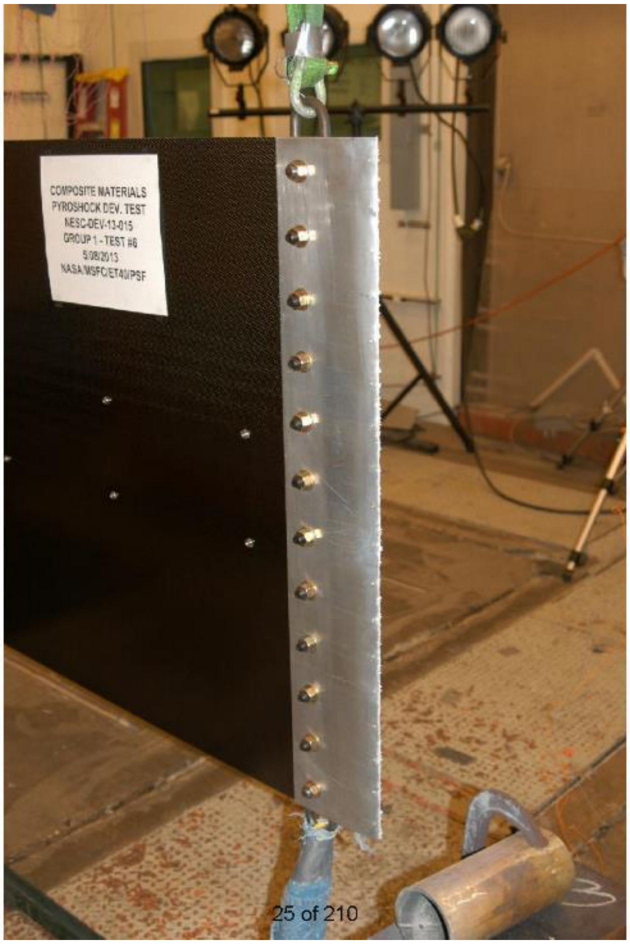
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NESC-DEV-13-015
GROUP 1 - TEST #6
5/08/2013
NASA/MSFC/ET40/PSF
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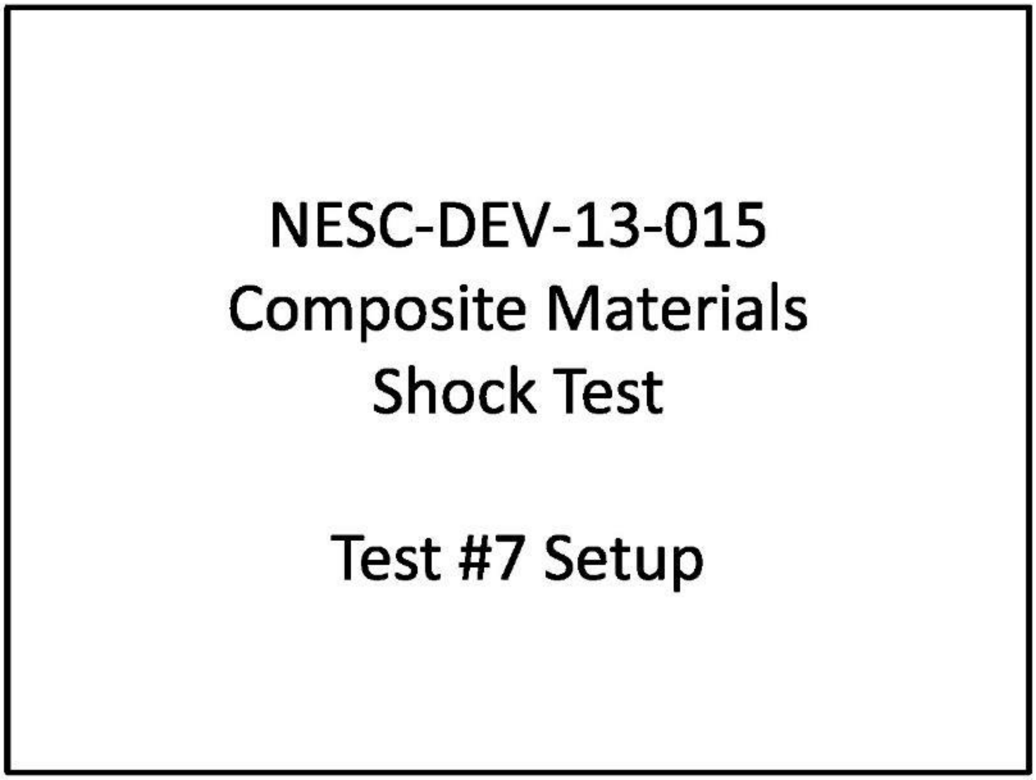
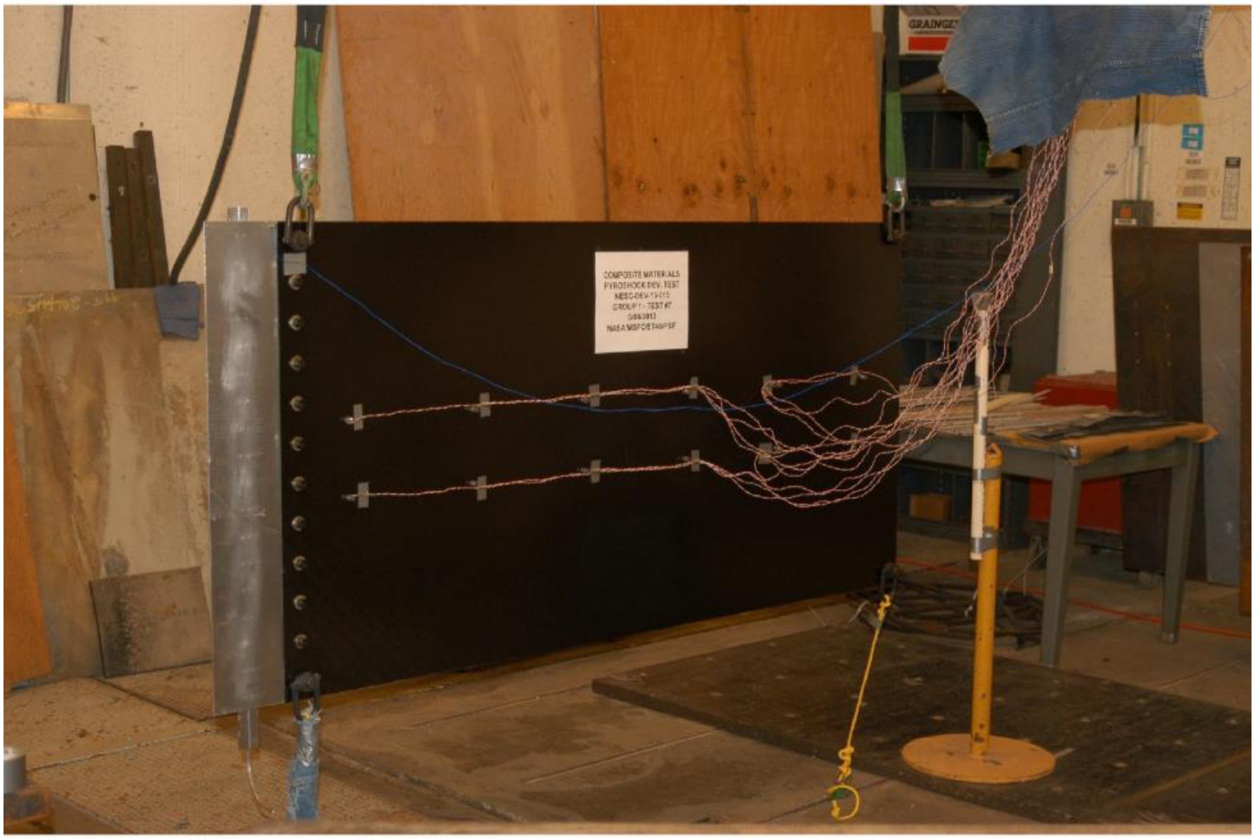


NESC-DEV-13-015
Composite Materials
Shock Test

Test #7 Setup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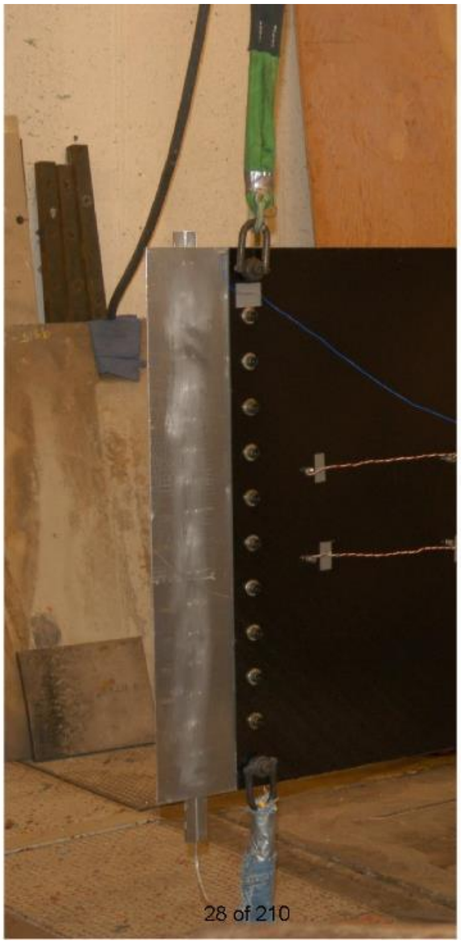
PYROSHOCK DEV. TEST
GROUP 1 - TEST #7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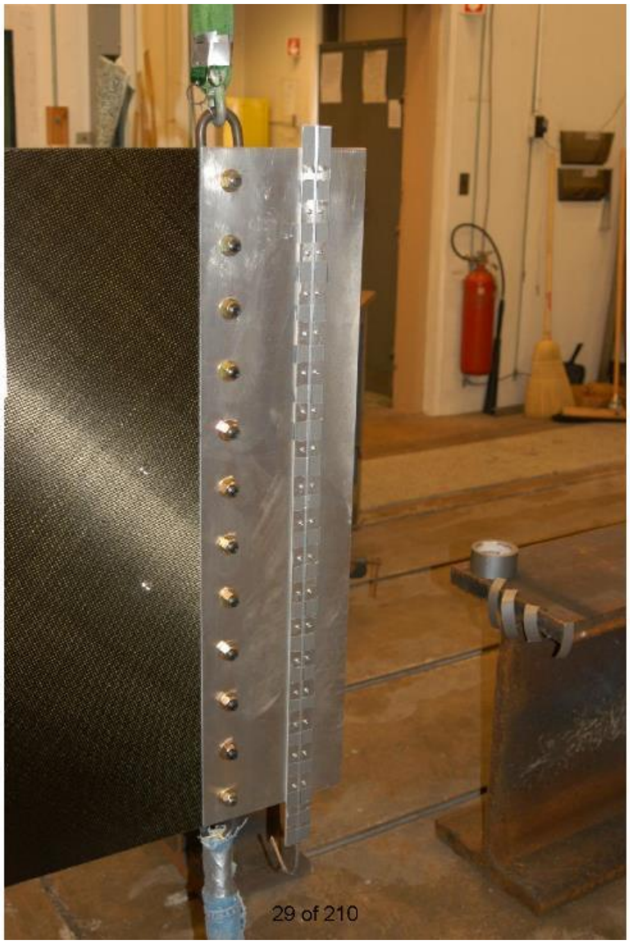
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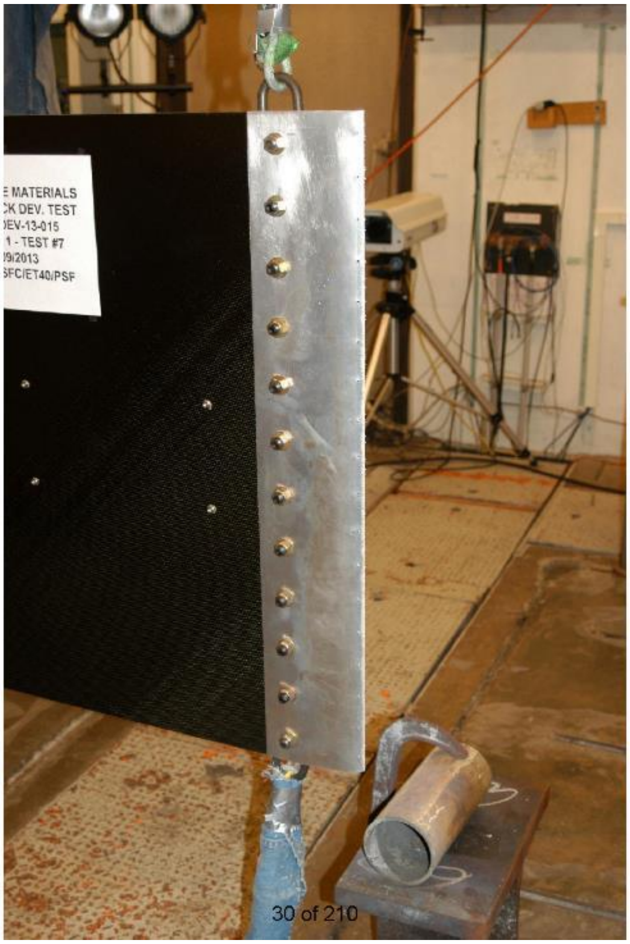
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DEV-13-015
1 - TEST #7
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SFC/ET40/PSF
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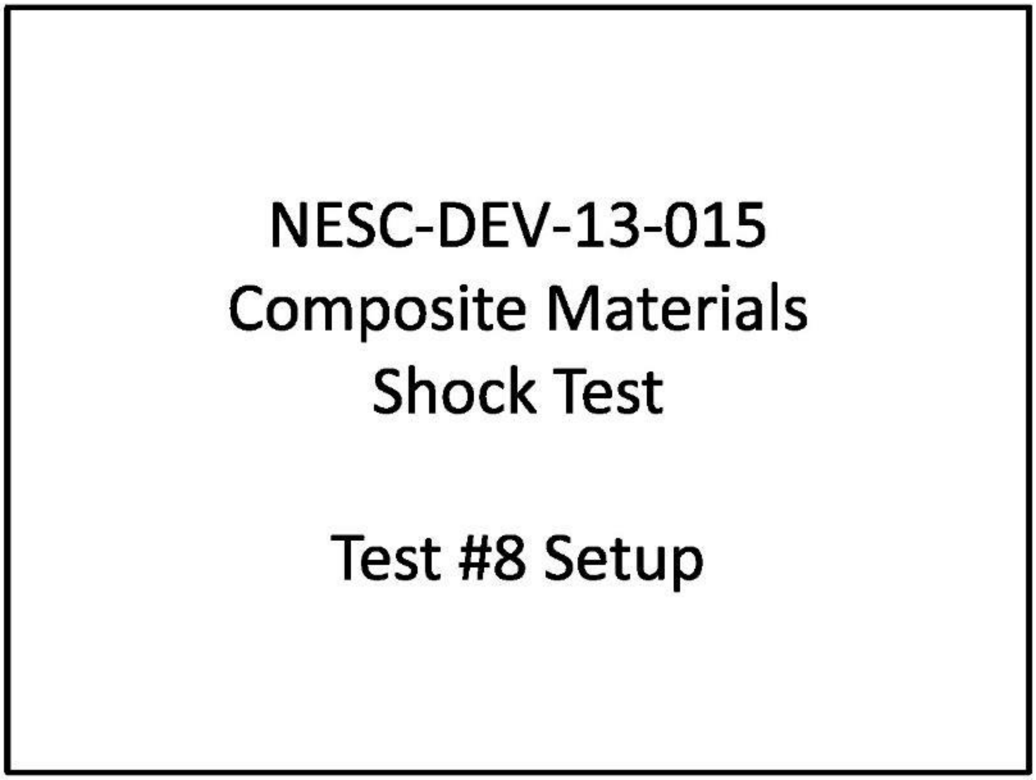

NESC-DEV-13-015
Composite Materials Shock Test

Test #8 Setup


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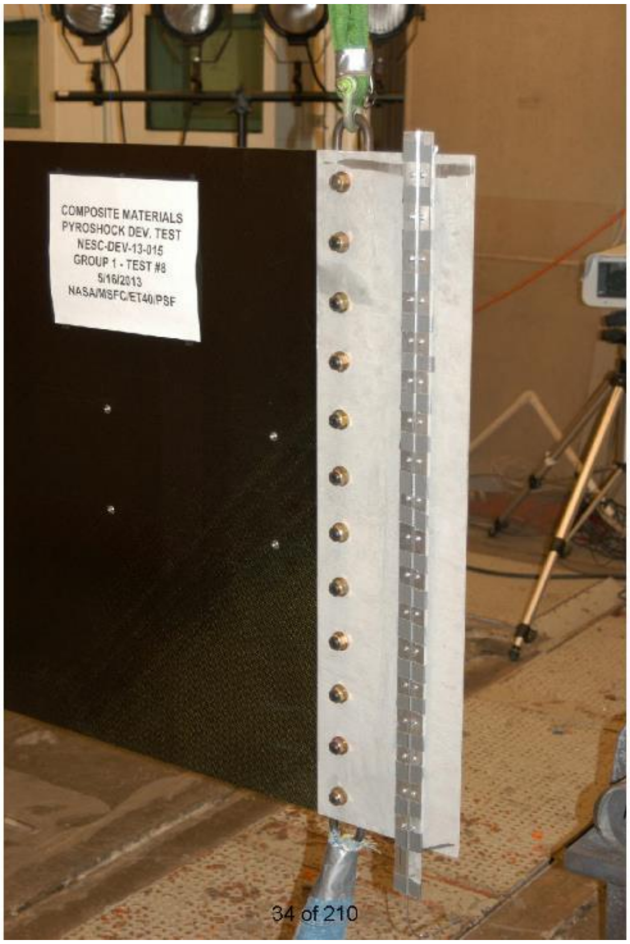
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NESC-DEV-13-015
GROUP 1 - TEST #8
5/16/2013
NASA/MSFC/ET40/PSF
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COMPOSITE MATERIALS
PYROSHOCK DEV. TEST
NESC-DEV-13-015
GROUP 1 - TEST #8
5/15/2013
NASA/MSFC/ET40/PSF
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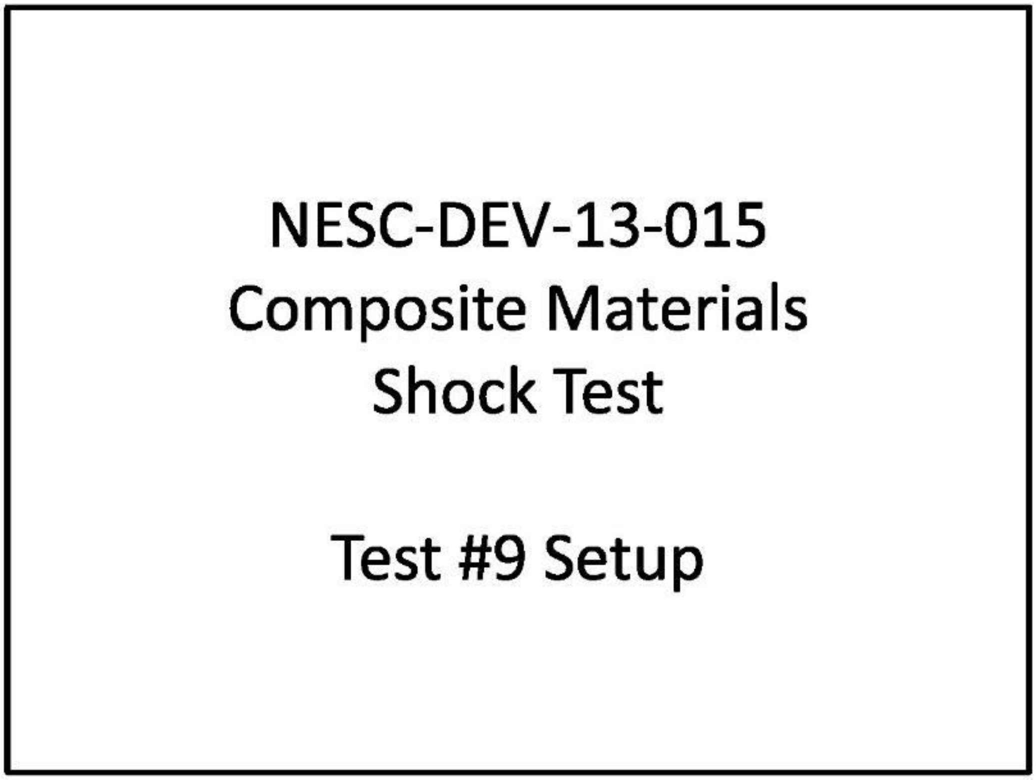
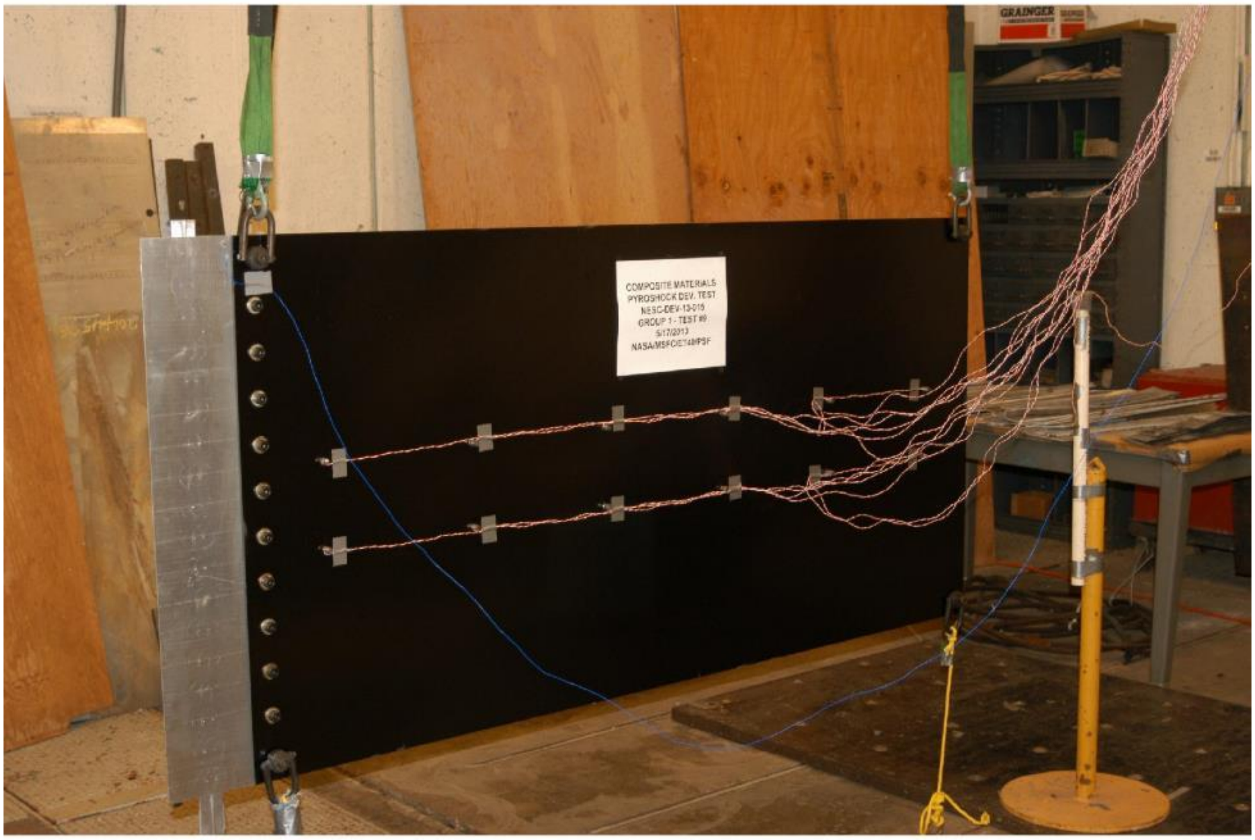


NESC-DEV-13-015
Composite Materials
Shock Test

Test #9 Setup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NESC-DEV-13-015
GROUP 1 - TEST #9
5/17/2013
NASA/MSFC/ET40/PSF


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EST #9
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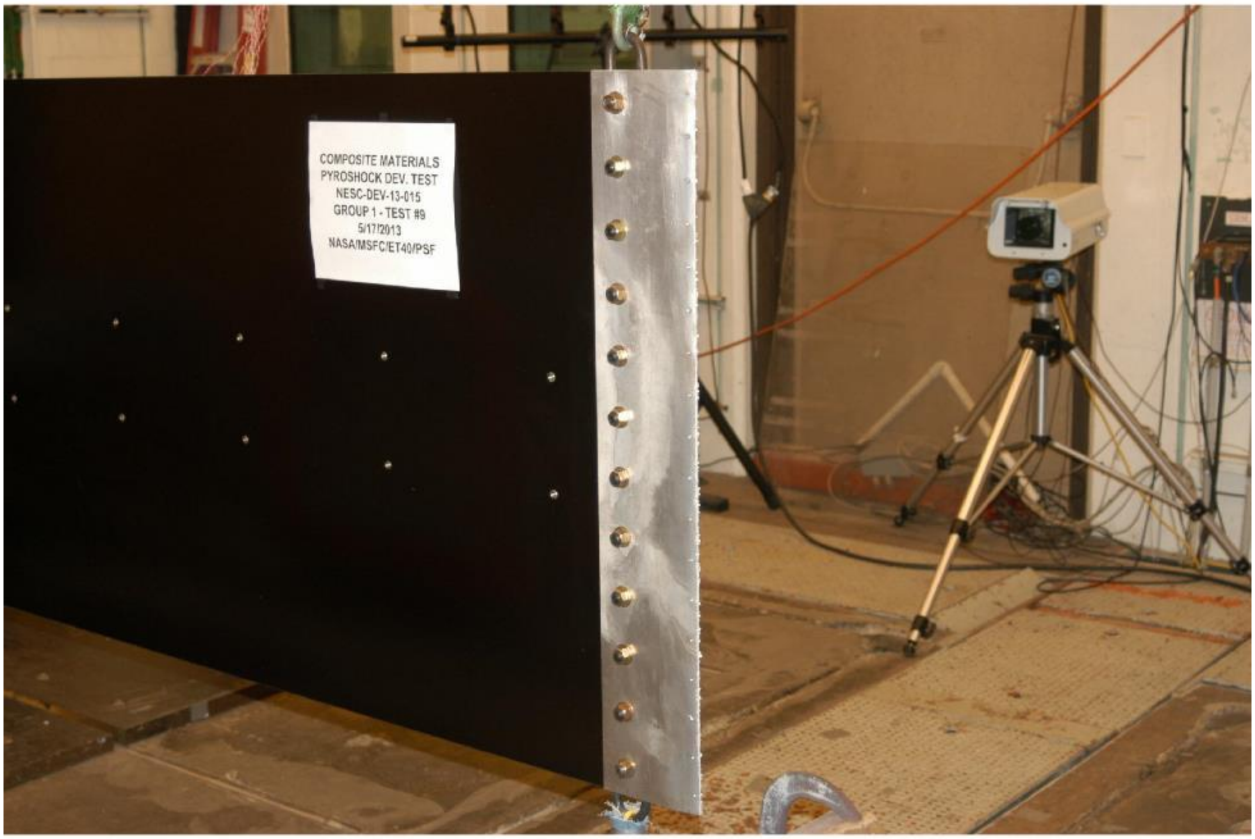
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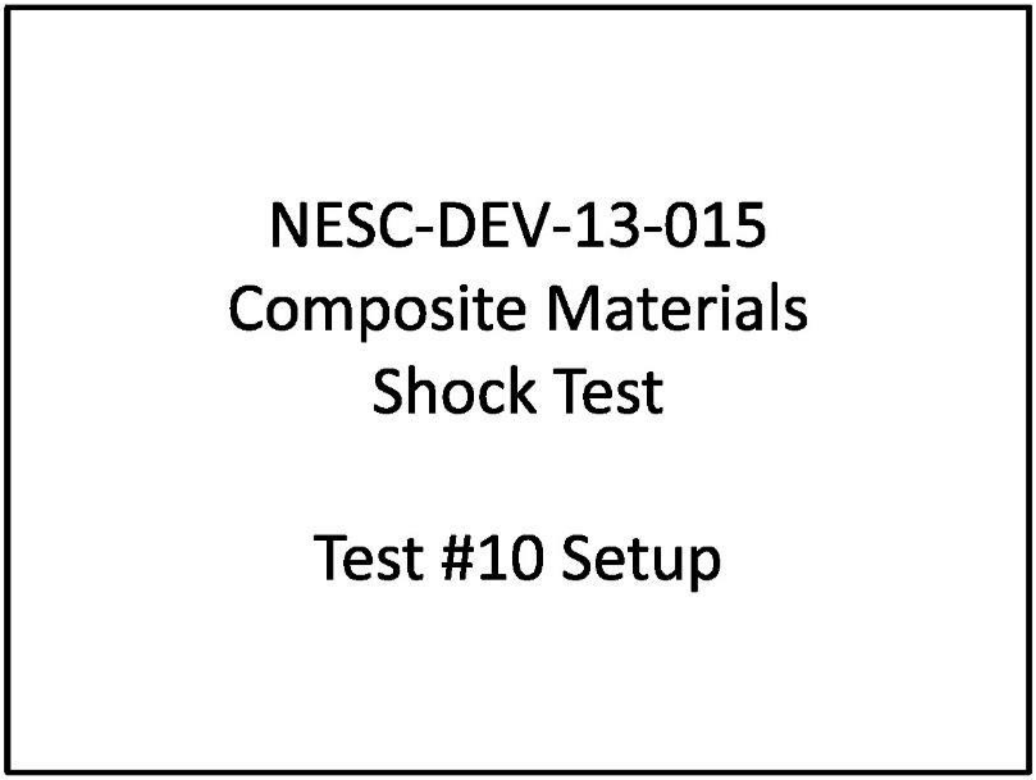
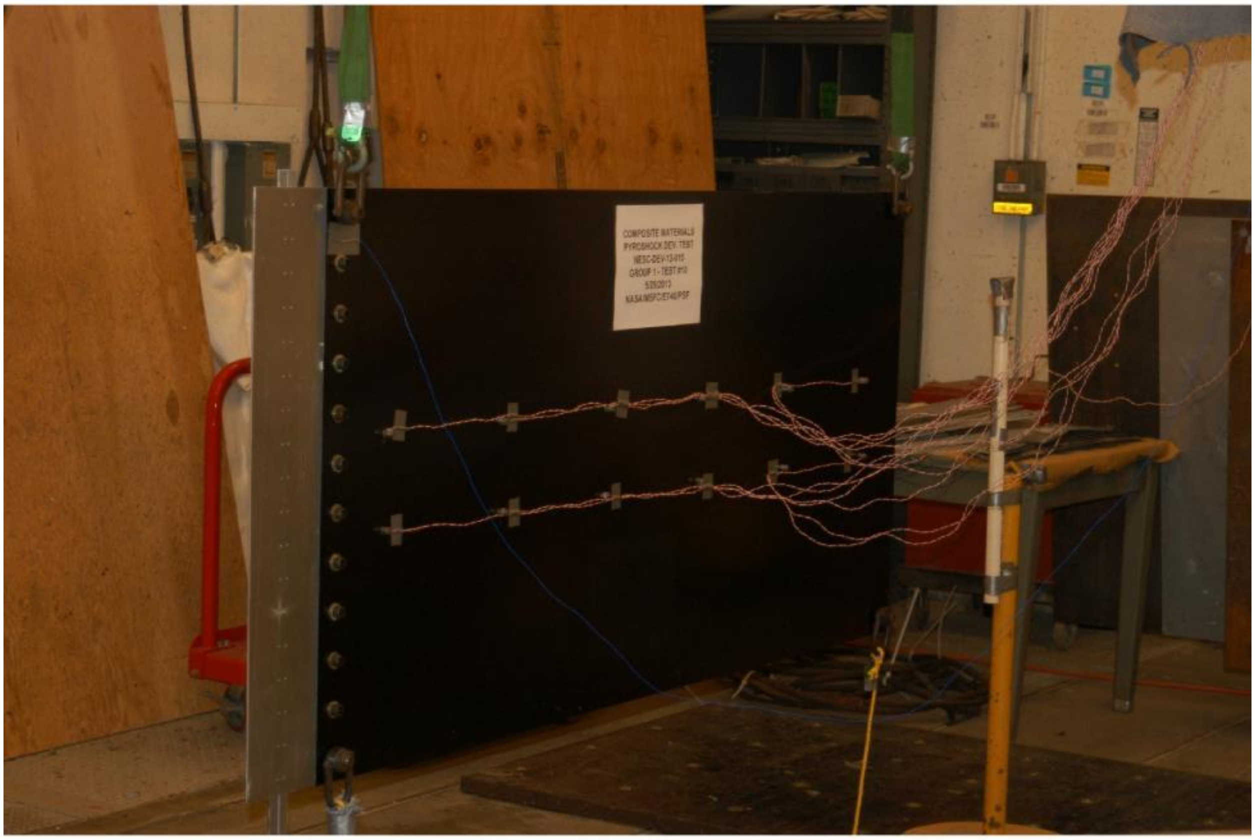
NASA/MSFC/ET40/PSF



NESC-DEV-13-015
Composite Materials
Shock Test

Test #10 Setup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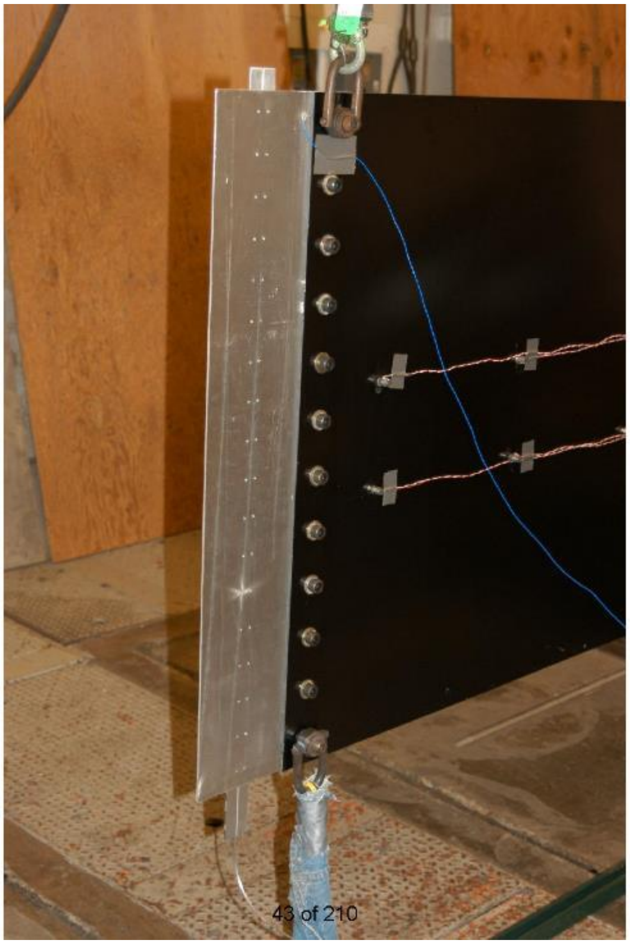
NESC-DEV-13-015
GROUP 1 - TEST #10
5/29/2013
NASA/MSFC/ET40/PSF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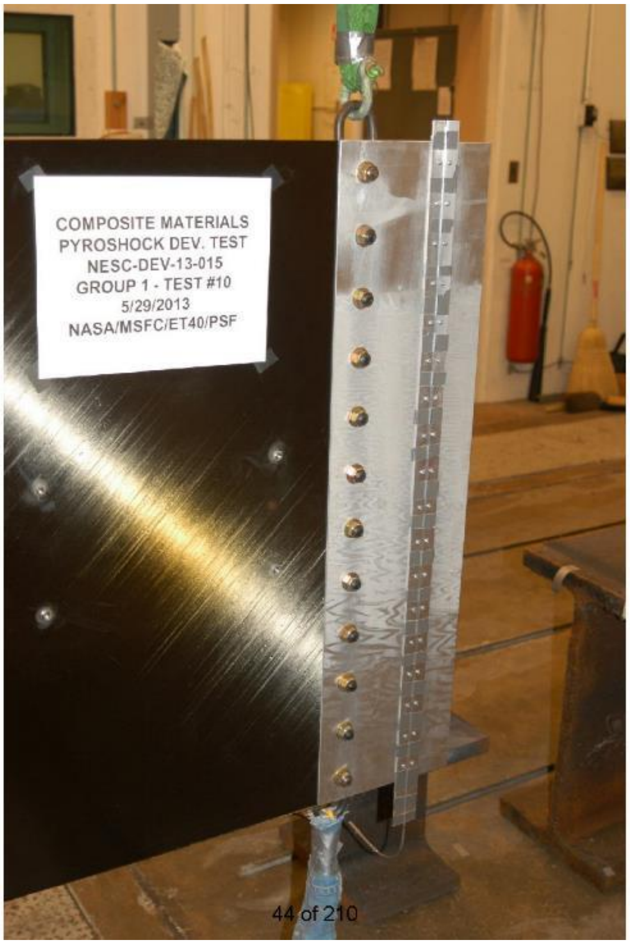
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PYROSHOCK DEV. TEST
NESC-DEV-13-015
GROUP 1 - TEST #10
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SITE MATERIALS
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C-DEV-13-015
JP 1 - TEST #10
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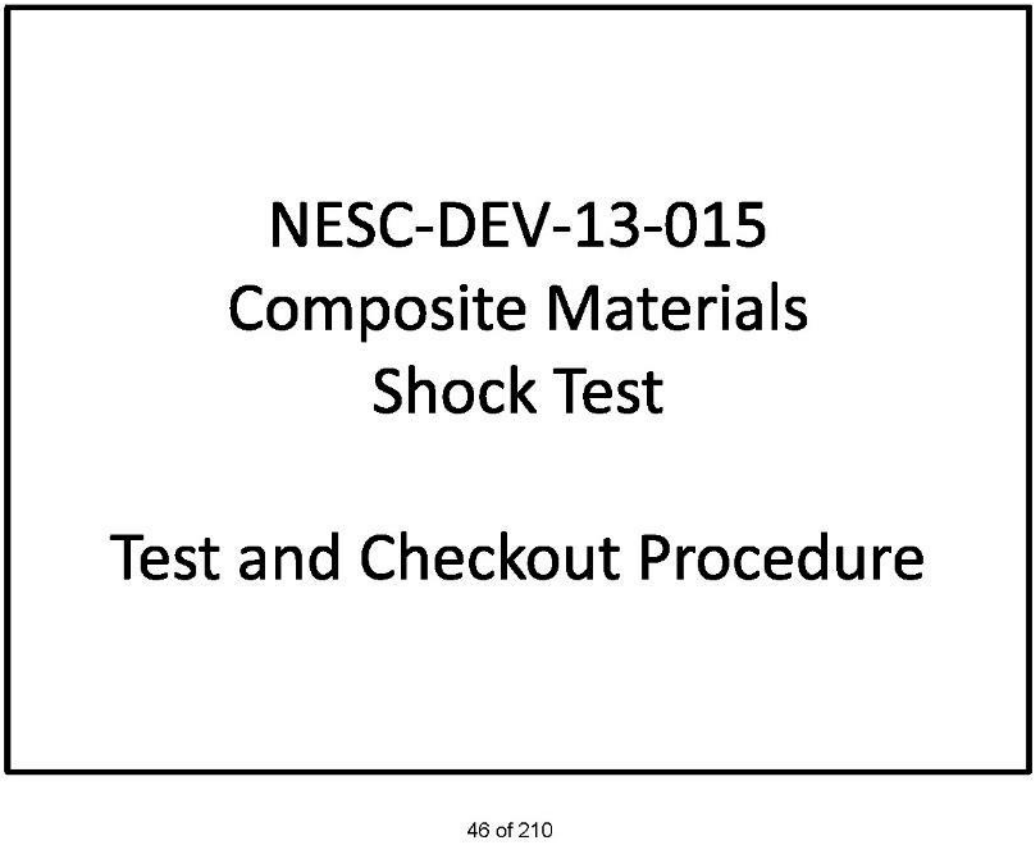
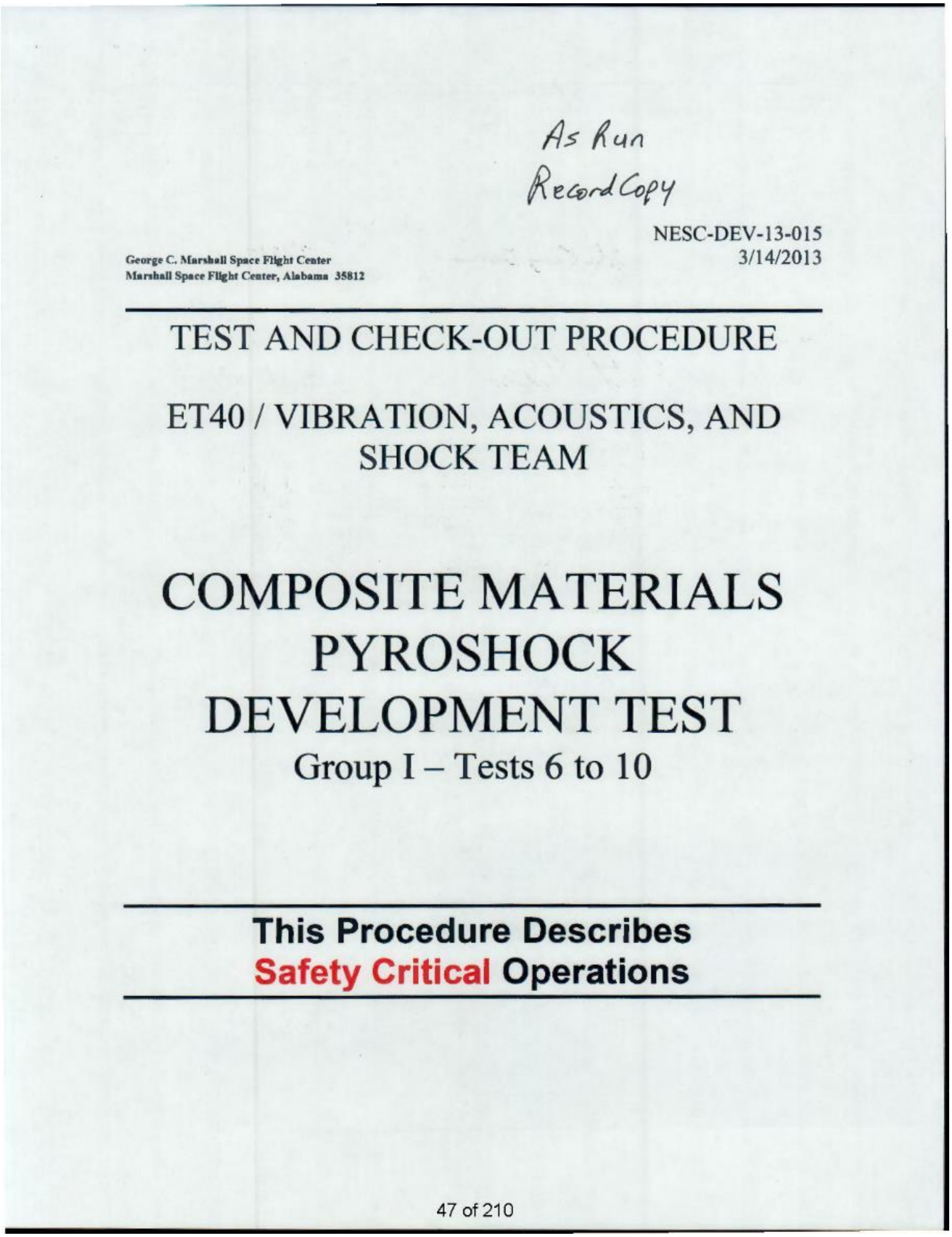


NESC-DEV-13-015
Composite Materials Shock Test

Test and Checkout Procedure



As Run
Record Copy

NESC-DEV-13-015
3/14/2013

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

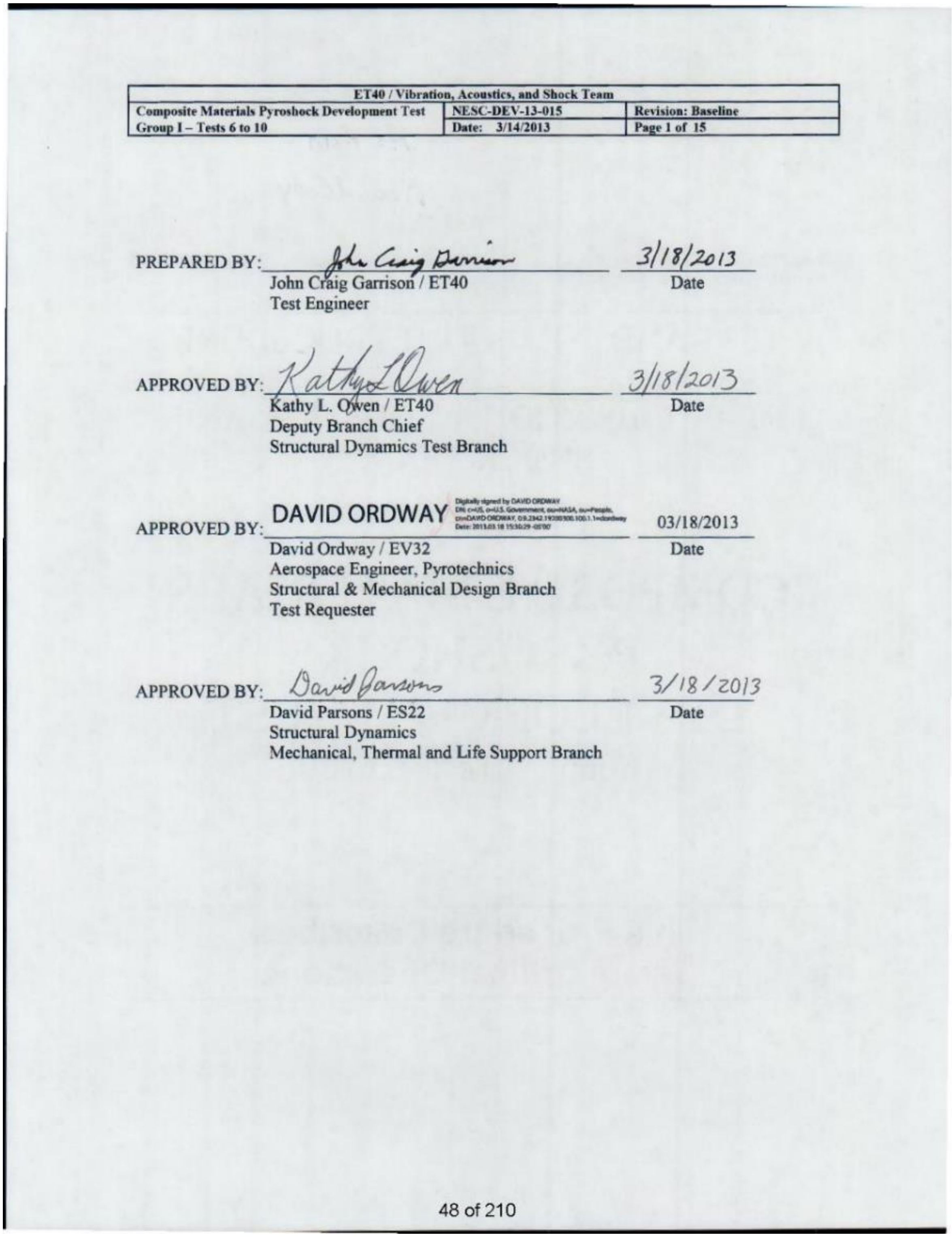
TEST AND CHECK-OUT PROCEDURE

ET40 / VIBRATION, ACOUSTICS, AND SHOCK TEAM

COMPOSITE MATERIALS PYROSHOCK DEVELOPMENT TEST

Group I – Tests 6 to 10

This Procedure Describes
Safety Critical Operations



ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	NESC-DEV-13-015	Revision: Baseline
Group I – Tests 6 to 10	Date: 3/14/2013	Page 1 of 15

PREPARED BY: John Craig Garrison 3/18/2013
John Craig Garrison / ET40 Date
Test Engineer

APPROVED BY: Kathy L Owen 3/18/2013
Kathy L. Owen / ET40 Date
Deputy Branch Chief
Structural Dynamics Test Branch

APPROVED BY: DAVID ORDWAY Digitally signed by DAVID ORDWAY
Date: 2013.03.18 15:30:29 -05'00' 03/18/2013
David Ordway / EV32 Date
Aerospace Engineer, Pyrotechnics
Structural & Mechanical Design Branch
Test Requester

APPROVED BY: David Parsons 3/18/2013
David Parsons / ES22 Date
Structural Dynamics
Mechanical, Thermal and Life Support Branch

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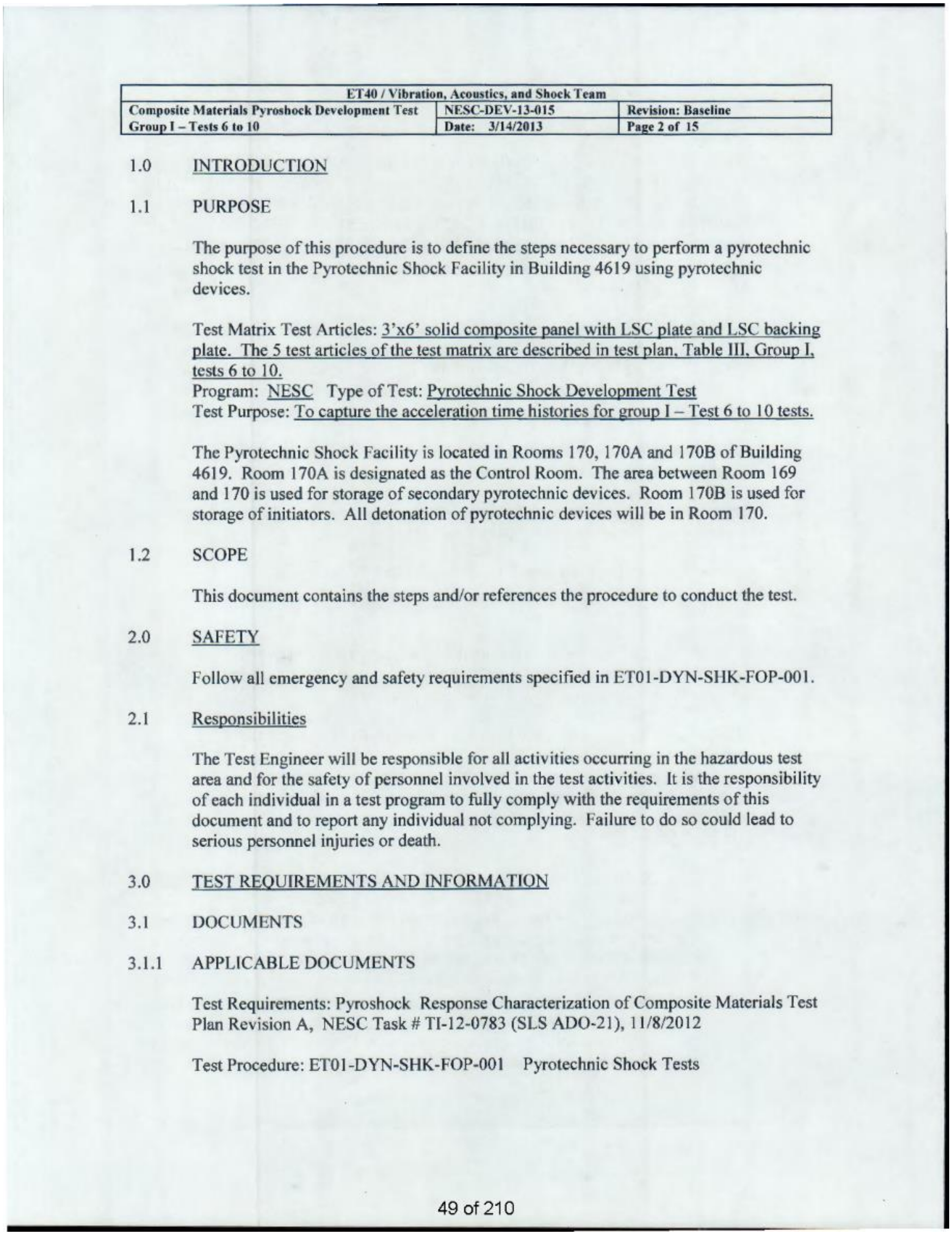


1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this procedure is to define the steps necessary to perform a pyrotechnic shock test in the Pyrotechnic Shock Facility in Building 4619 using pyrotechnic devices.

Test Matrix Test Articles: 3'x6' solid composite panel with LSC plate and LSC backing plate. The 5 test articles of the test matrix are described in test plan, Table III, Group I, tests 6 to 10.
Program: NESC Type of Test: Pyrotechnic Shock Development Test
Test Purpose: To capture the acceleration time histories for group I – Test 6 to 10 tests.

The Pyrotechnic Shock Facility is located in Rooms 170, 170A and 170B of Building 4619. Room 170A is designated as the Control Room. The area between Room 169 and 170 is used for storage of secondary pyrotechnic devices. Room 170B is used for storage of initiators. All detonation of pyrotechnic devices will be in Room 170.

1.2 SCOPE

This document contains the steps and/or references the procedure to conduct the test.

2.0 SAFETY

Follow all emergency and safety requirements specified in ET01-DYN-SHK-FOP-001.

2.1 Responsibilities

The Test Engineer will be responsible for all activities occurring in the hazardous test area and for the safety of personnel involved in the test activities. It is the responsibility of each individual in a test program to fully comply with the requirements of this document and to report any individual not complying. Failure to do so could lead to serious personnel injuries or death.

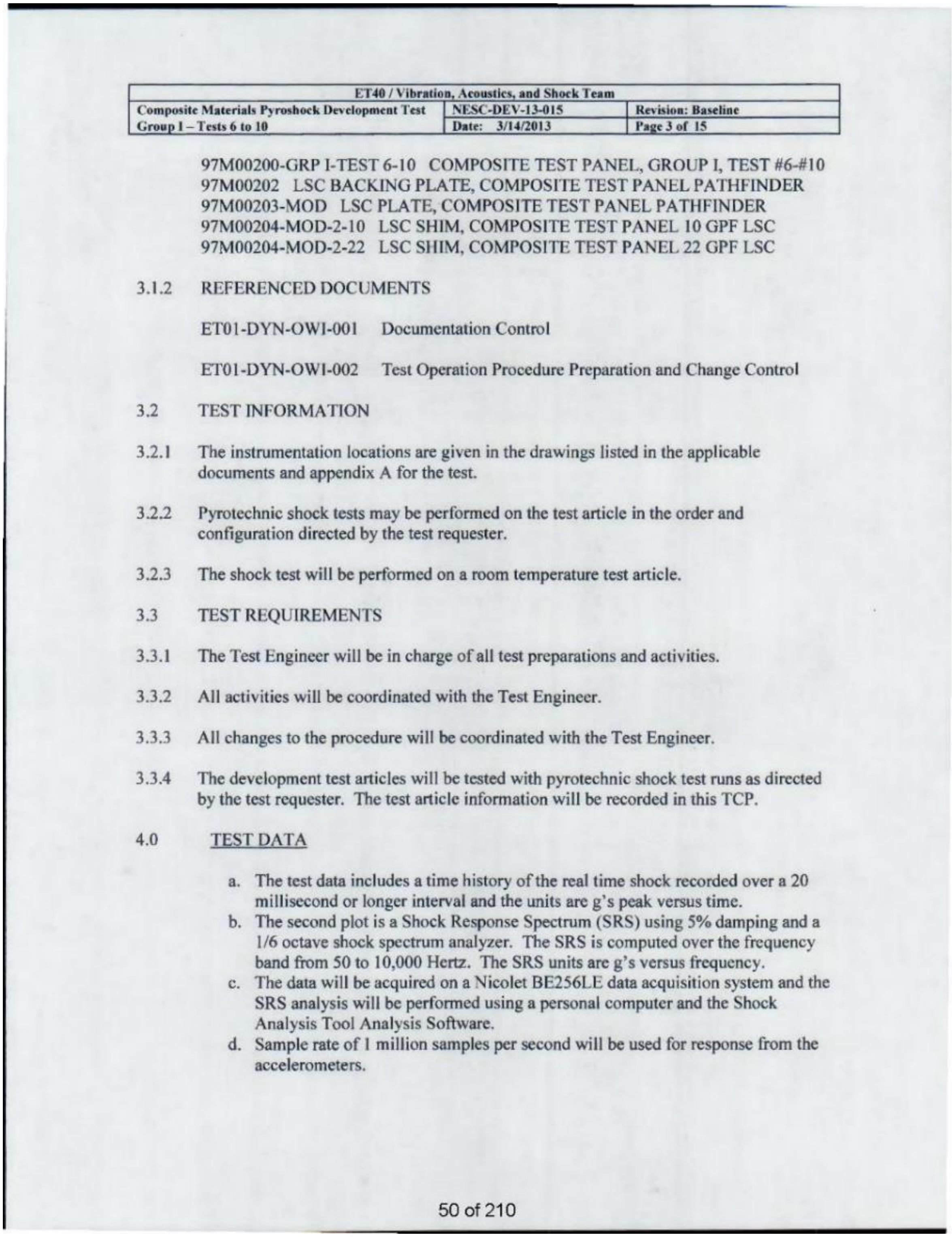
3.0 TEST REQUIREMENTS AND INFORMATION

3.1 DOCUMENTS

3.1.1 APPLICABLE DOCUMENTS

Test Requirements: Pyroshock Response Characterization of Composite Materials Test Plan Revision A, NESC Task # TI-12-0783 (SLS ADO-21), 11/8/2012

Test Procedure: ET01-DYN-SHK-FOP-001 Pyrotechnic Shock Tests



97M00200-GRP I-TEST 6-10 COMPOSITE TEST PANEL, GROUP I, TEST #6-#10
97M00202 LSC BACKING PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00203-MOD LSC PLATE, COMPOSITE TEST PANEL PATHFINDER
97M00204-MOD-2-10 LSC SHIM, COMPOSITE TEST PANEL 10 GPF LSC
97M00204-MOD-2-22 LSC SHIM, COMPOSITE TEST PANEL 22 GPF LSC

3.1.2 REFERENCED DOCUMENTS

ET01-DYN-OWI-001 Documentation Control

ET01-DYN-OWI-002 Test Operation Procedure Preparation and Change Control

3.2 TEST INFORMATION

3.2.1 The instrumentation locations are given in the drawings listed in the applicable documents and appendix A for the test.

3.2.2 Pyrotechnic shock tests may be performed on the test article in the order and configuration directed by the test requester.

3.2.3 The shock test will be performed on a room temperature test article.

3.3 TEST REQUIREMENTS

3.3.1 The Test Engineer will be in charge of all test preparations and activities.

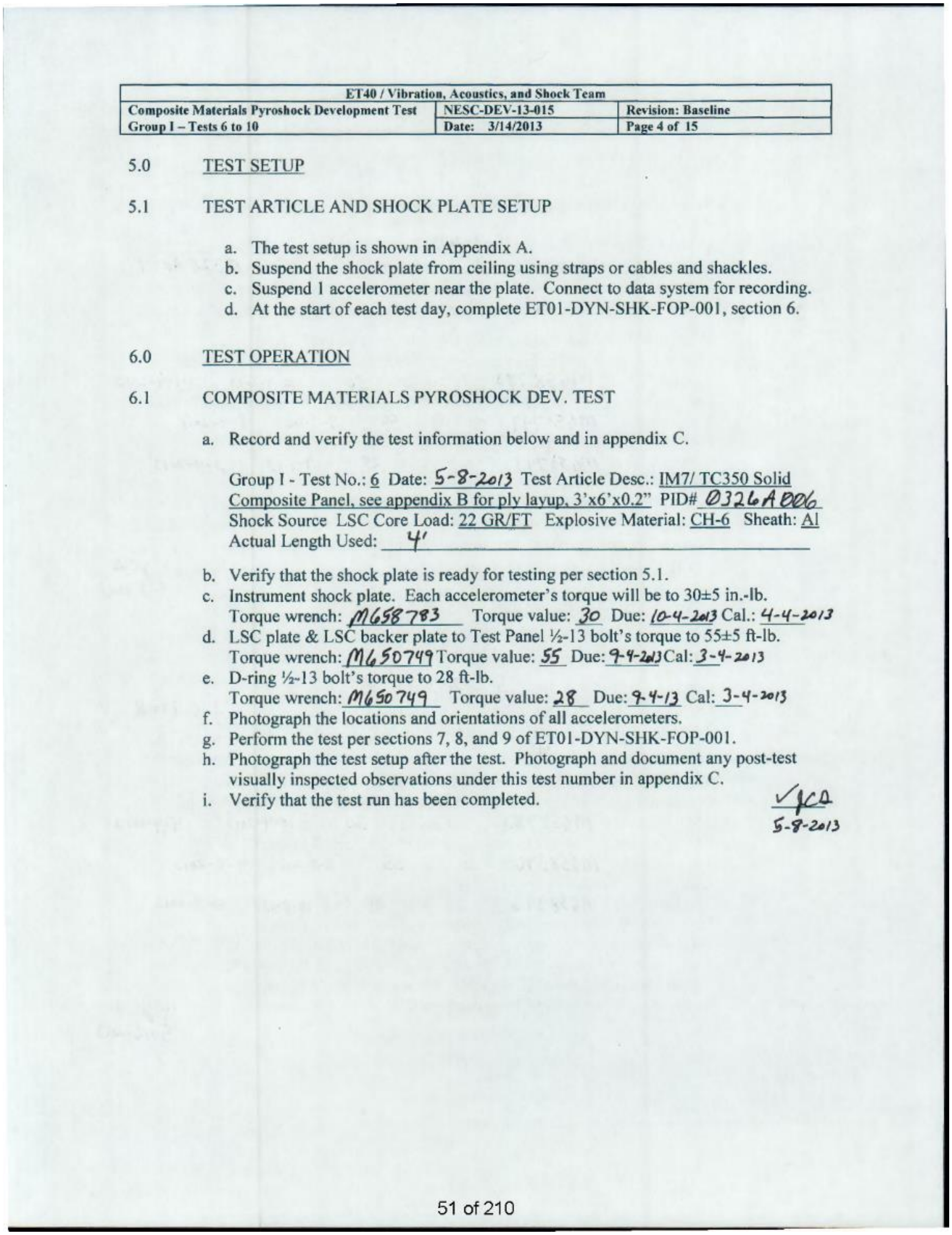
3.3.2 All activities will be coordinated with the Test Engineer.

3.3.3 All changes to the procedure will be coordinated with the Test Engineer.

3.3.4 The development test articles will be tested with pyrotechnic shock test runs as directed by the test requester. The test article information will be recorded in this TCP.

4.0 TEST DATA

a. The test data includes a time history of the real time shock recorded over a 20 millisecond or longer interval and the units are g's peak versus time.
b. The second plot is a Shock Response Spectrum (SRS) using 5% damping and a 1/6 octave shock spectrum analyzer. The SRS is computed over the frequency band from 50 to 10,000 Hertz. The SRS units are g's versus frequency.
c. The data will be acquired on a Nicolet BE256LE data acquisition system and the SRS analysis will be performed using a personal computer and the Shock Analysis Tool Analysis Software.
d. Sample rate of 1 million samples per second will be used for response from the accelerometers.



5.0 TEST SETUP

5.1 TEST ARTICLE AND SHOCK PLATE SETUP

a. The test setup is shown in Appendix A.
b. Suspend the shock plate from ceiling using straps or cables and shackles.
c. Suspend 1 accelerometer near the plate. Connect to data system for recording.
d. At the start of each test day, complete ET01-DYN-SHK-FOP-001, section 6.

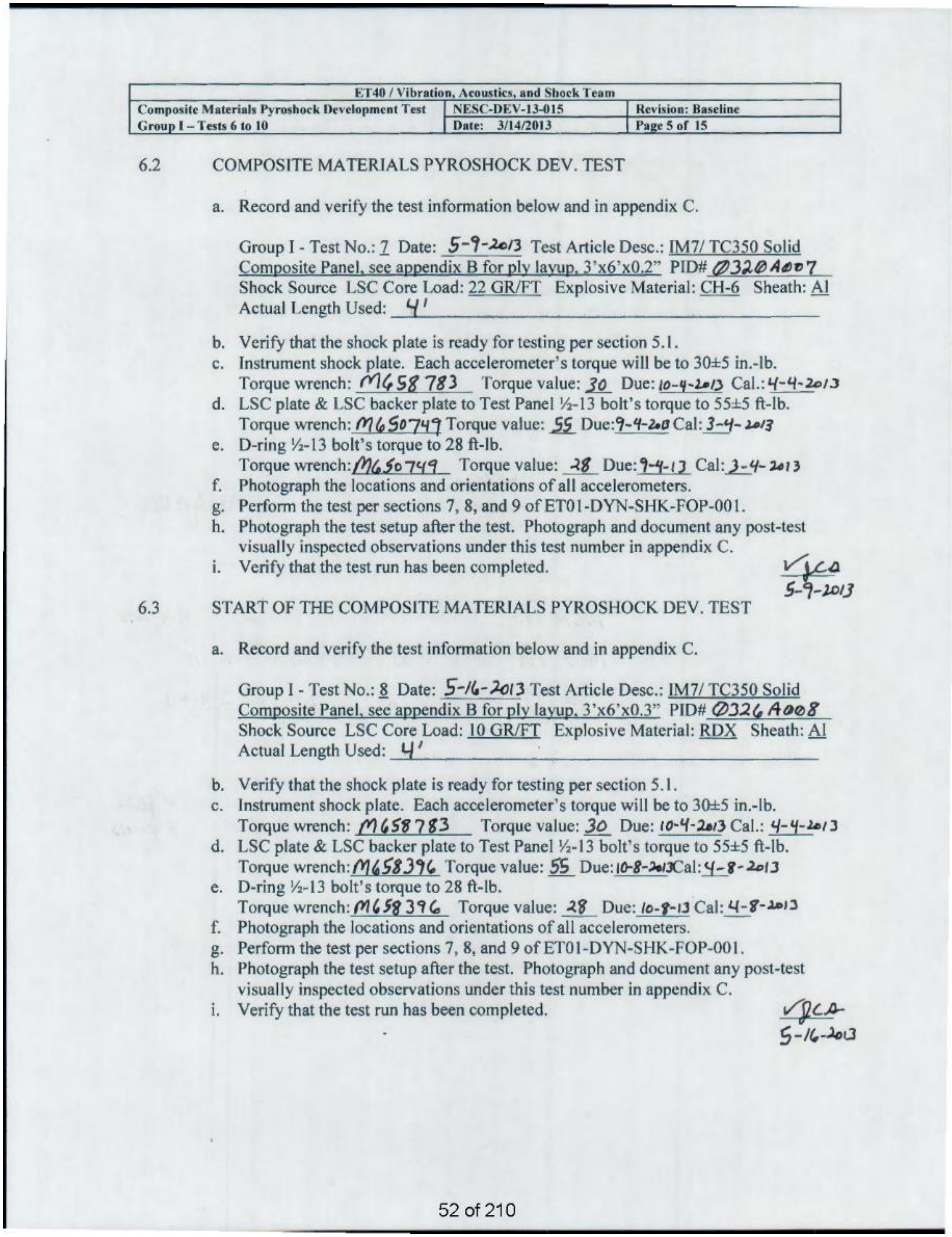
6.0 TEST OPERATION

6.1 COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix C.

Group I - Test No.: 6 Date: 5-8-2013 Test Article Desc.: IM7/ TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2" PID# 0326A006
Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al
Actual Length Used: 4'

b. Verify that the shock plate is ready for testing per section 5.1.
c. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783 Torque value: 30 Due: 10-4-2013 Cal.: 4-4-2013
d. LSC plate & LSC backer plate to Test Panel ½-13 bolt's torque to 55±5 ft-lb.
Torque wrench: M650749 Torque value: 55 Due: 9-4-2013 Cal: 3-4-2013
e. D-ring ½-13 bolt's torque to 28 ft-lb.
Torque wrench: M650749 Torque value: 28 Due: 9-4-13 Cal: 3-4-2013
f. Photograph the locations and orientations of all accelerometers.
g. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
h. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix C.
i. Verify that the test run has been completed. ✓JCA
5-8-2013



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Composite Materials Pyroshock Development Test	NESC-DEV-13-015	Revision: Baseline
Group I – Tests 6 to 10	Date: 3/14/2013	Page 5 of 15

6.2 COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix C.

Group I - Test No.: 7 Date: 5-9-2013 Test Article Desc.: IM7/ TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2" PID# 0320A007
Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al
Actual Length Used: 4'

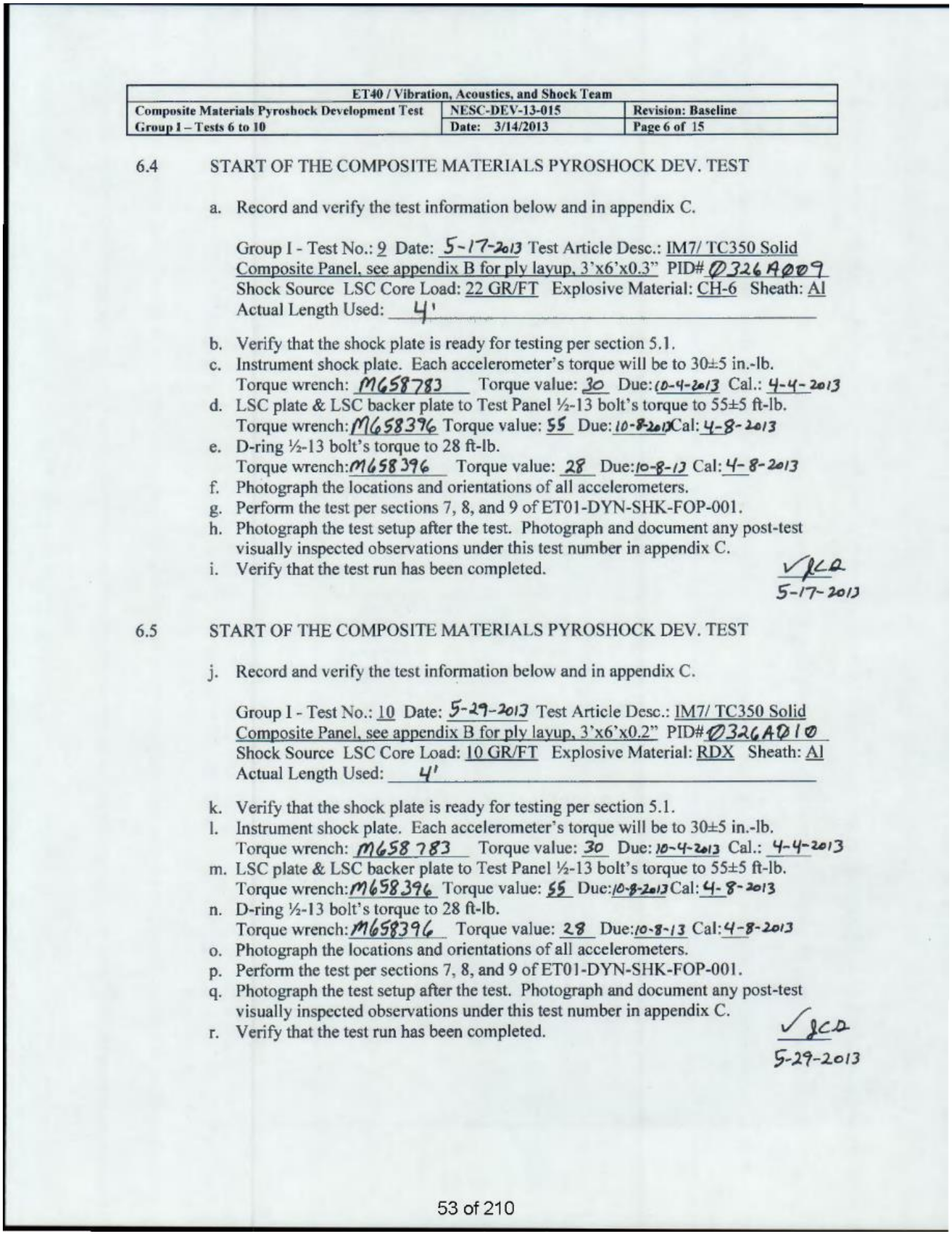
b. Verify that the shock plate is ready for testing per section 5.1.
c. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783 Torque value: 30 Due: 10-4-2013 Cal.: 4-4-2013
d. LSC plate & LSC backer plate to Test Panel ½-13 bolt's torque to 55±5 ft-lb.
Torque wrench: M650749 Torque value: 55 Due: 9-4-2013 Cal: 3-4-2013
e. D-ring ½-13 bolt's torque to 28 ft-lb.
Torque wrench: M650749 Torque value: 28 Due: 9-4-13 Cal: 3-4-2013
f. Photograph the locations and orientations of all accelerometers.
g. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
h. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix C.
i. Verify that the test run has been completed. ✓JCA 5-9-2013

6.3 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix C.

Group I - Test No.: 8 Date: 5-16-2013 Test Article Desc.: IM7/ TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.3" PID# 0326A008
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 4'

b. Verify that the shock plate is ready for testing per section 5.1.
c. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783 Torque value: 30 Due: 10-4-2013 Cal.: 4-4-2013
d. LSC plate & LSC backer plate to Test Panel ½-13 bolt's torque to 55±5 ft-lb.
Torque wrench: M658396 Torque value: 55 Due: 10-8-2013 Cal: 4-8-2013
e. D-ring ½-13 bolt's torque to 28 ft-lb.
Torque wrench: M658396 Torque value: 28 Due: 10-8-13 Cal: 4-8-2013
f. Photograph the locations and orientations of all accelerometers.
g. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
h. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix C.
i. Verify that the test run has been completed. ✓JCA 5-16-2013



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Group I – Tests 6 to 10	Date: 3/14/2013	Page 6 of 15

6.4 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

a. Record and verify the test information below and in appendix C.

Group I - Test No.: 9 Date: 5-17-2013 Test Article Desc.: IM7/ TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.3" PID# 0326A009
Shock Source LSC Core Load: 22 GR/FT Explosive Material: CH-6 Sheath: Al
Actual Length Used: 4'

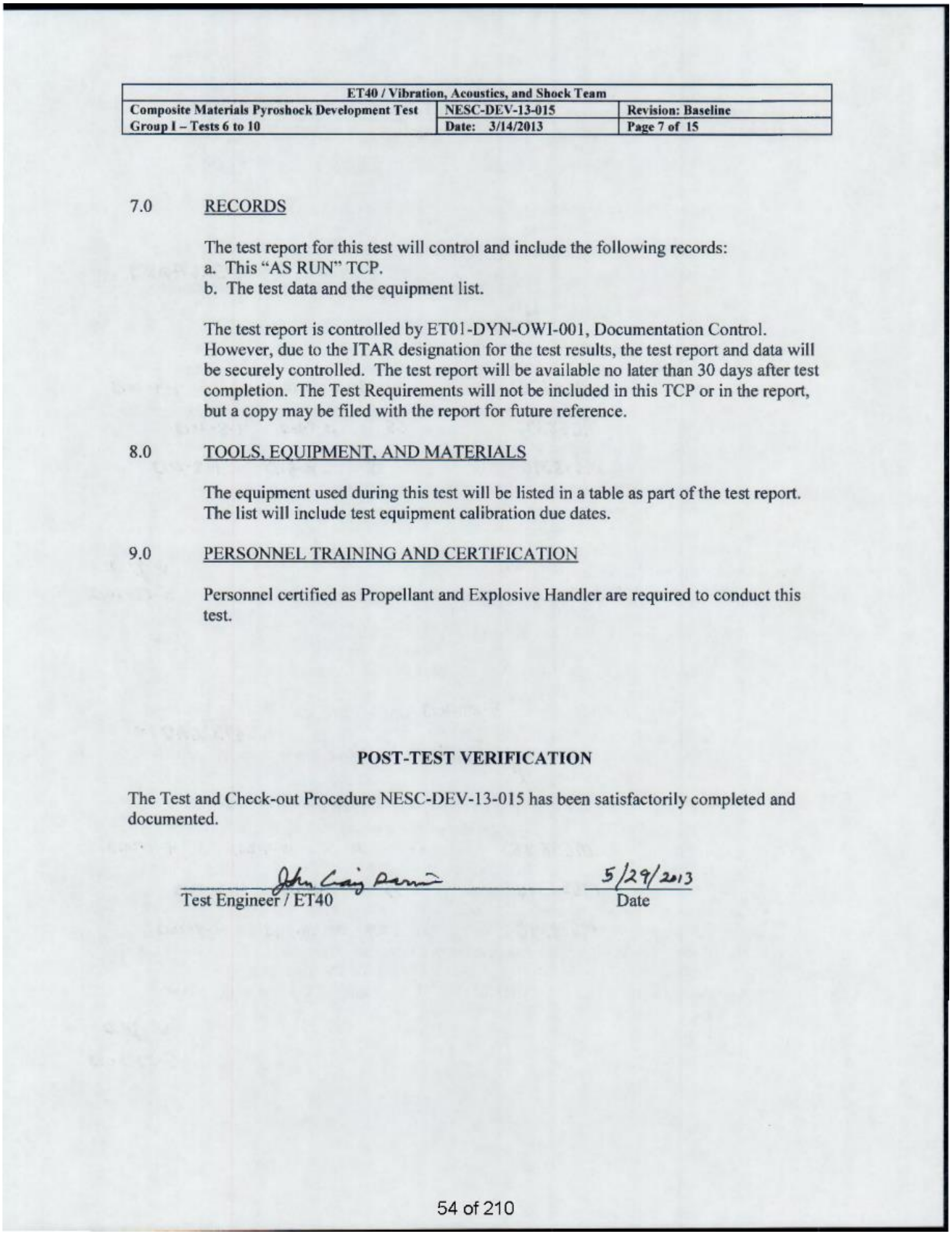
b. Verify that the shock plate is ready for testing per section 5.1.
c. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783 Torque value: 30 Due: 10-4-2013 Cal.: 4-4-2013
d. LSC plate & LSC backer plate to Test Panel ½-13 bolt's torque to 55±5 ft-lb.
Torque wrench: M658396 Torque value: 55 Due: 10-8-2013 Cal: 4-8-2013
e. D-ring ½-13 bolt's torque to 28 ft-lb.
Torque wrench: M658396 Torque value: 28 Due: 10-8-13 Cal: 4-8-2013
f. Photograph the locations and orientations of all accelerometers.
g. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
h. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix C.
i. Verify that the test run has been completed. ✓ JCD 5-17-2013

6.5 START OF THE COMPOSITE MATERIALS PYROSHOCK DEV. TEST

j. Record and verify the test information below and in appendix C.

Group I - Test No.: 10 Date: 5-29-2013 Test Article Desc.: IM7/ TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2" PID# 0326A010
Shock Source LSC Core Load: 10 GR/FT Explosive Material: RDX Sheath: Al
Actual Length Used: 4'

k. Verify that the shock plate is ready for testing per section 5.1.
l. Instrument shock plate. Each accelerometer's torque will be to 30±5 in.-lb.
Torque wrench: M658783 Torque value: 30 Due: 10-4-2013 Cal.: 4-4-2013
m. LSC plate & LSC backer plate to Test Panel ½-13 bolt's torque to 55±5 ft-lb.
Torque wrench: M658396 Torque value: 55 Due: 10-8-2013 Cal: 4-8-2013
n. D-ring ½-13 bolt's torque to 28 ft-lb.
Torque wrench: M658396 Torque value: 28 Due: 10-8-13 Cal: 4-8-2013
o. Photograph the locations and orientations of all accelerometers.
p. Perform the test per sections 7, 8, and 9 of ET01-DYN-SHK-FOP-001.
q. Photograph the test setup after the test. Photograph and document any post-test visually inspected observations under this test number in appendix C.
r. Verify that the test run has been completed. ✓ JCD 5-29-2013



7.0 RECORDS

The test report for this test will control and include the following records:
a. This "AS RUN" TCP.
b. The test data and the equipment list.

The test report is controlled by ET01-DYN-OWI-001, Documentation Control. However, due to the ITAR designation for the test results, the test report and data will be securely controlled. The test report will be available no later than 30 days after test completion. The Test Requirements will not be included in this TCP or in the report, but a copy may be filed with the report for future reference.

8.0 TOOLS, EQUIPMENT, AND MATERIALS

The equipment used during this test will be listed in a table as part of the test report. The list will include test equipment calibration due dates.

9.0 PERSONNEL TRAINING AND CERTIFICATION

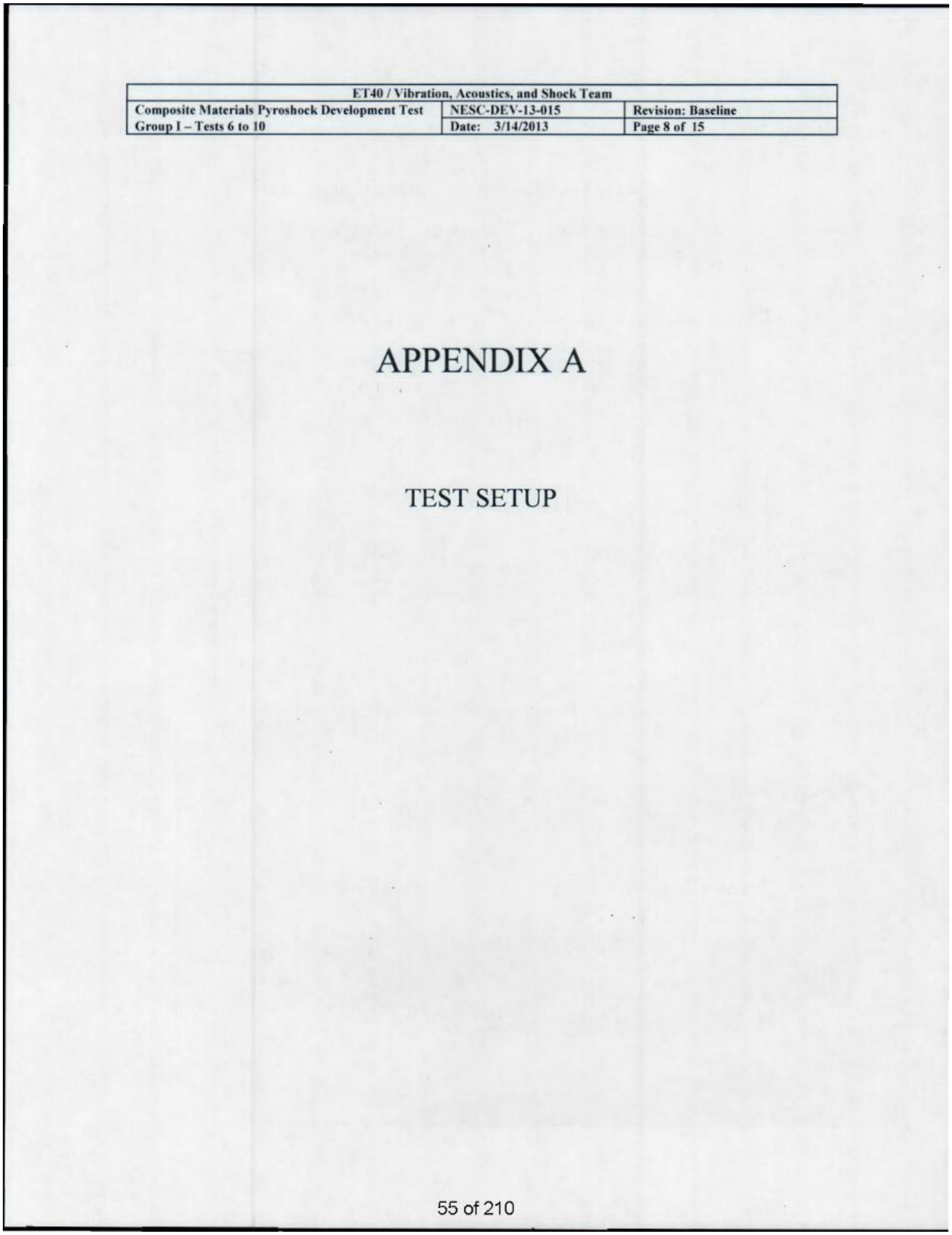
Personnel certified as Propellant and Explosive Handler are required to conduct this test.

POST-TEST VERIFICATION

The Test and Check-out Procedure NESC-DEV-13-015 has been satisfactorily completed and documented.

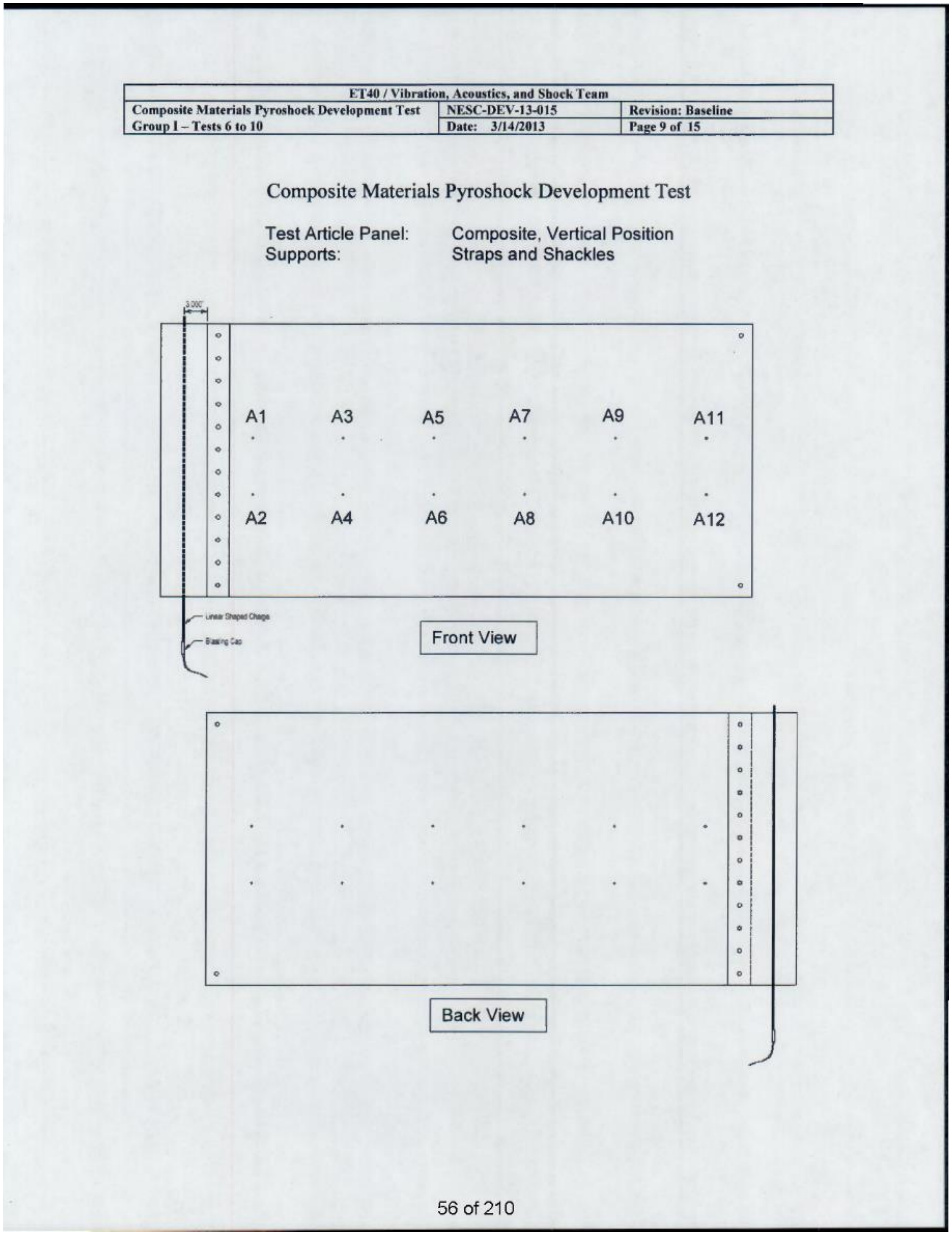
John Craig
Test Engineer / ET40

5/29/2013
Date



APPENDIX A

TEST SETUP



ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	NESC-DEV-13-015	Revision: Baseline
Group I – Tests 6 to 10	Date: 3/14/2013	Page 9 of 15

Composite Materials Pyroshock Development Test

Test Article Panel: Composite, Vertical Position
Supports: Straps and Shackles

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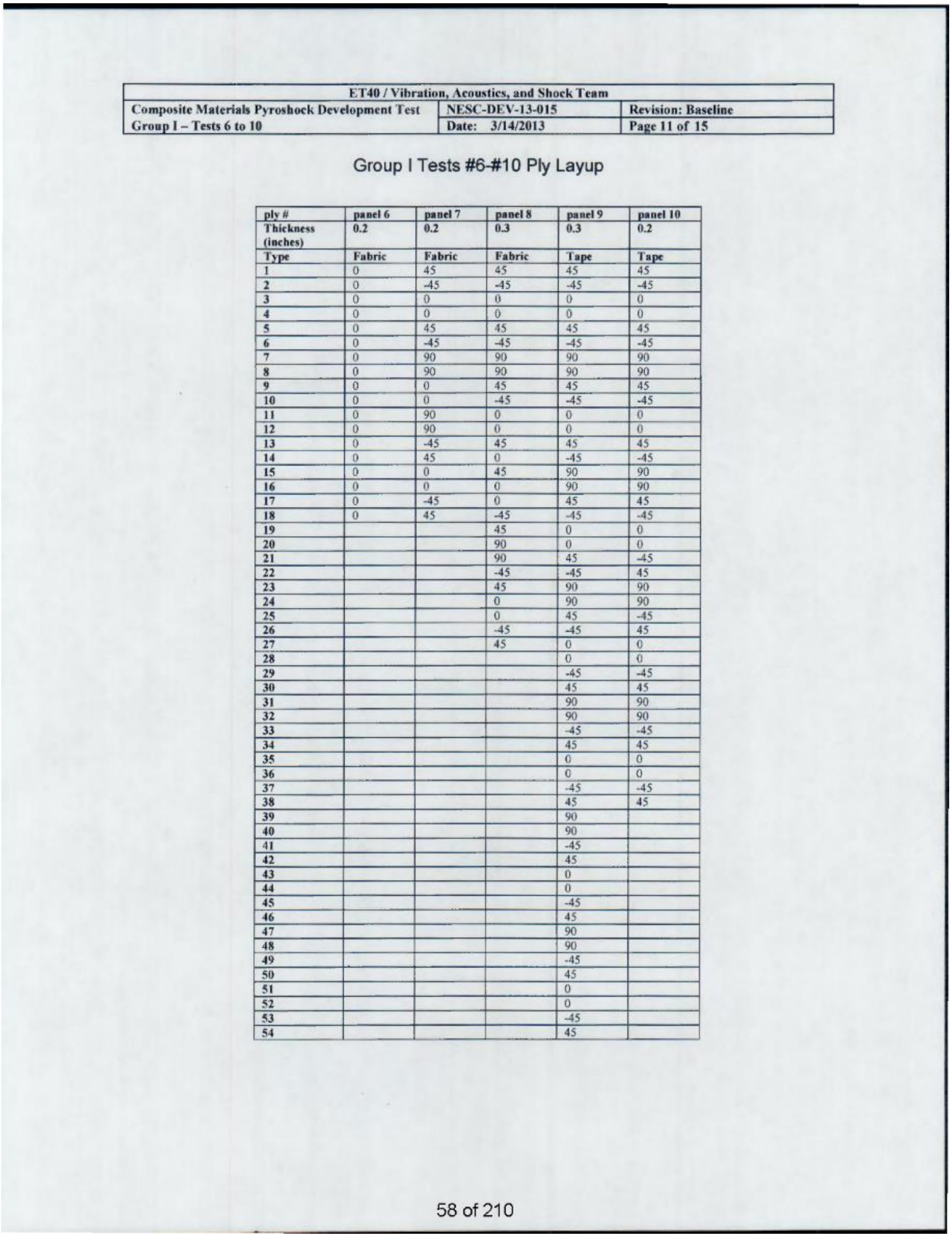
APPENDIX B

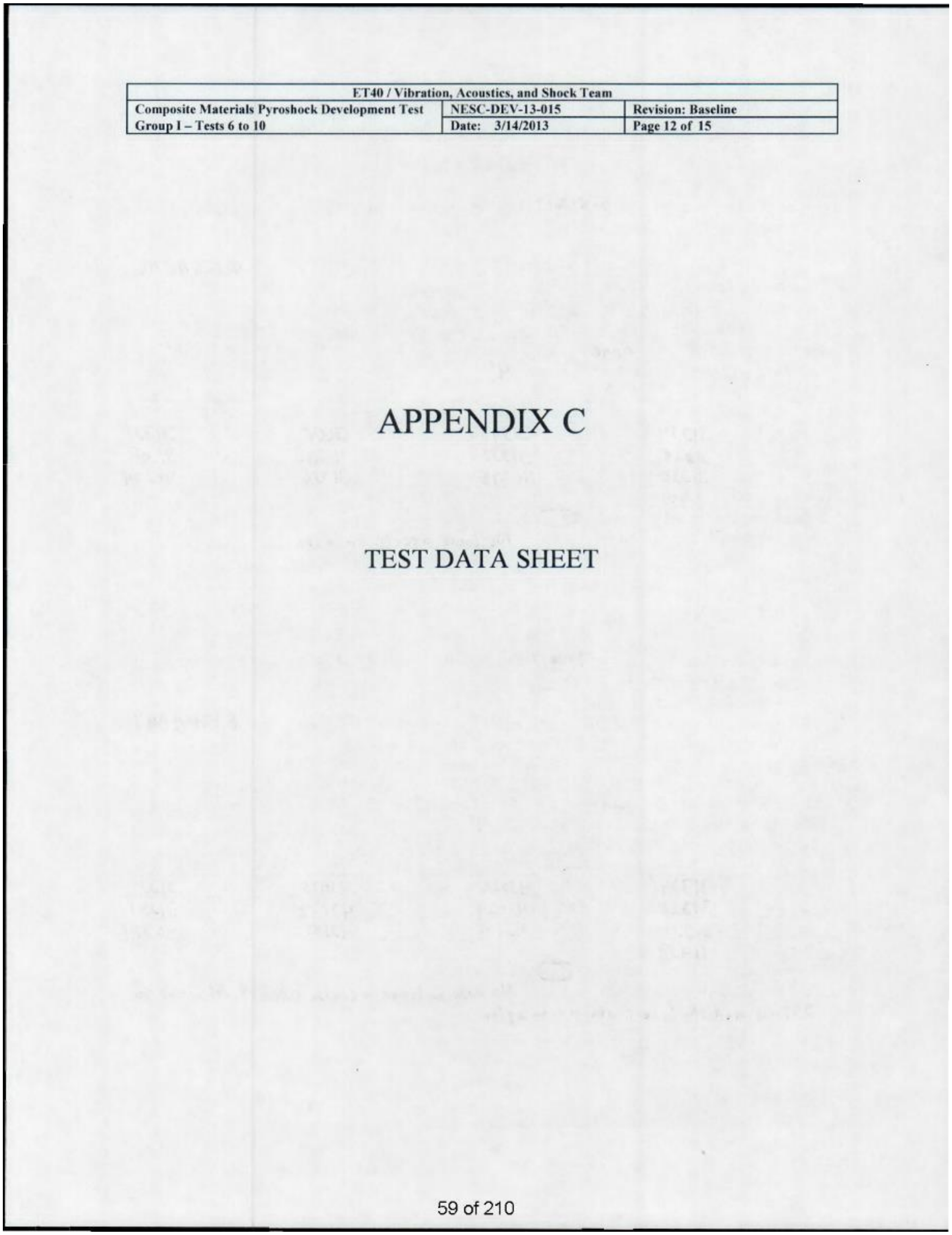
GROUP I – TEST #6 - #10 PLY LAYUP



ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	NESC-DEV-13-015	Revision: Baseline
Group I – Tests 6 to 10	Date: 3/14/2013	Page 11 of 15

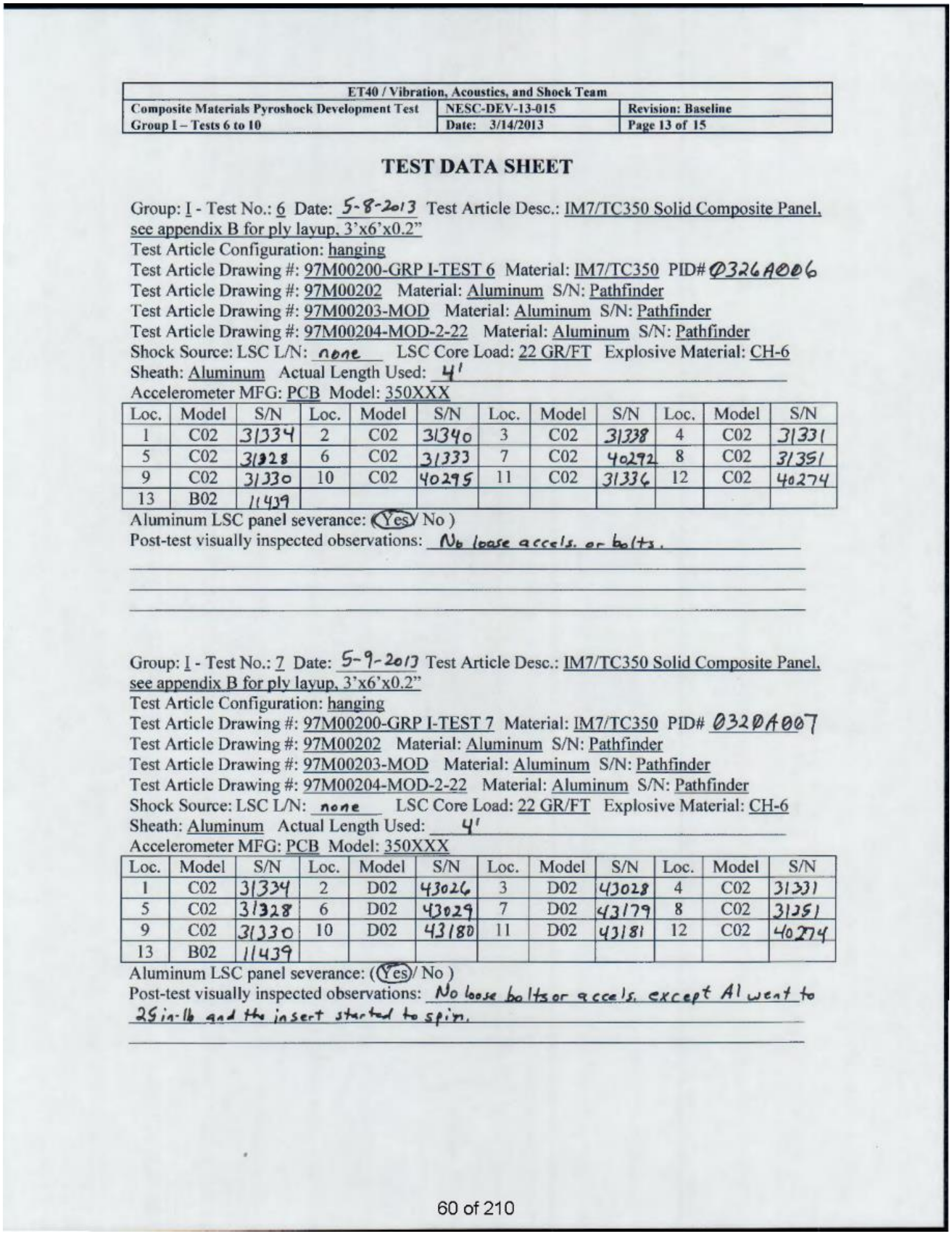
Group I Tests #6-#10 Ply Layup

ply #	**panel 6**	**panel 7**	**panel 8**	**panel 9**	**panel 10**
Thickness (inches)	**0.2**	**0.2**	**0.3**	**0.3**	**0.2**
Type	**Fabric**	**Fabric**	**Fabric**	**Tape**	**Tape**
1	0	45	45	45	45
2	0	-45	-45	-45	-45
3	0	0	0	0	0
4	0	0	0	0	0
5	0	45	45	45	45
6	0	-45	-45	-45	-45
7	0	90	90	90	90
8	0	90	90	90	90
9	0	0	45	45	45
10	0	0	-45	-45	-45
11	0	90	0	0	0
12	0	90	0	0	0
13	0	-45	45	45	45
14	0	45	0	-45	-45
15	0	0	45	90	90
16	0	0	0	90	90
17	0	-45	0	45	45
18	0	45	-45	-45	-45
19			45	0	0
20			90	0	0
21			90	45	-45
22			-45	-45	45
23			45	90	90
24			0	90	90
25			0	45	-45
26			-45	-45	45
27			45	0	0
28				0	0
29				-45	-45
30				45	45
31				90	90
32				90	90
33				-45	-45
34				45	45
35				0	0
36				0	0
37				-45	-45
38				45	45
39				90	
40				90	
41				-45	
42				45	
43				0	
44				0	
45				-45	
46				45	
47				90	
48				90	
49				-45	
50				45	
51				0	
52				0	
53				-45	
54				45	



APPENDIX C

TEST DATA SHEET



ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	**NESC-DEV-13-015**	**Revision: Baseline**
Group I – Tests 6 to 10	**Date: 3/14/2013**	**Page 13 of 15**

TEST DATA SHEET

Group: I - Test No.: 6 Date: 5-8-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2"
Test Article Configuration: hanging
Test Article Drawing #: 97M00200-GRP I-TEST 6 Material: IM7/TC350 PID# 0326A006
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-22 Material: Aluminum S/N: Pathfinder
Shock Source: LSC L/N: none LSC Core Load: 22 GR/FT Explosive Material: CH-6
Sheath: Aluminum Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350XXX

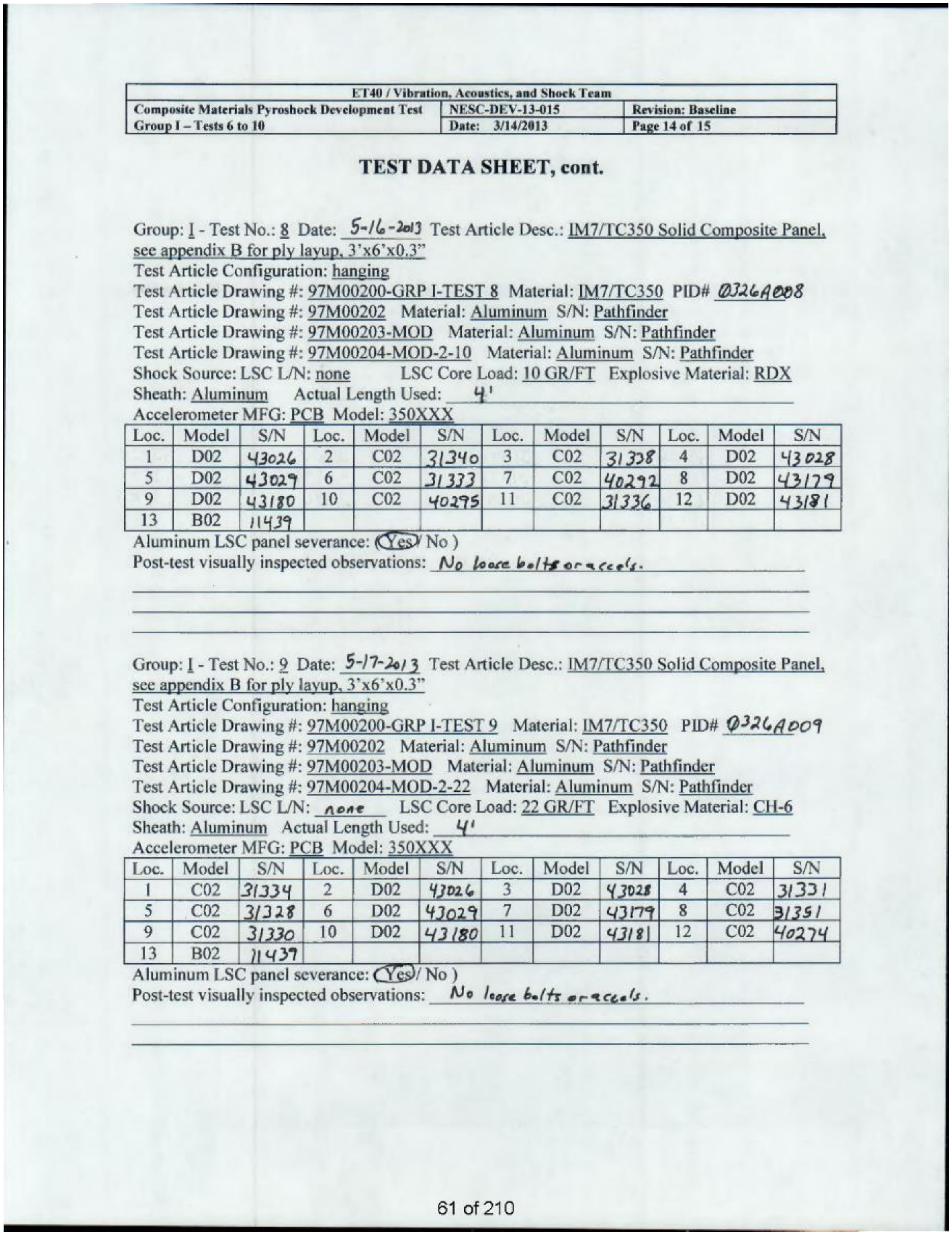
Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N
1	C02	31334	2	C02	31340	3	C02	31338	4	C02	31331
5	C02	31328	6	C02	31333	7	C02	40292	8	C02	31351
9	C02	31330	10	C02	40295	11	C02	31336	12	C02	40274
13	B02	11439									

Aluminum LSC panel severance: ([✓ Yes]/ No)
Post-test visually inspected observations: No loose accels. or bolts.

Group: I - Test No.: 7 Date: 5-9-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2"
Test Article Configuration: hanging
Test Article Drawing #: 97M00200-GRP I-TEST 7 Material: IM7/TC350 PID# 0320A007
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-22 Material: Aluminum S/N: Pathfinder
Shock Source: LSC L/N: none LSC Core Load: 22 GR/FT Explosive Material: CH-6
Sheath: Aluminum Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350XXX

Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N
1	C02	31334	2	D02	43026	3	D02	43028	4	C02	31331
5	C02	31328	6	D02	43029	7	D02	43179	8	C02	31351
9	C02	31330	10	D02	43180	11	D02	43181	12	C02	40274
13	B02	11439									

Aluminum LSC panel severance: ([✓ Yes]/ No)
Post-test visually inspected observations: No loose bolts or accels. except Al went to 25 in-lb and the insert started to spin.



ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	**NESC-DEV-13-015**	**Revision: Baseline**
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TEST DATA SHEET, cont.

Group: I - Test No.: 8 Date: 5-16-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.3"
Test Article Configuration: hanging
Test Article Drawing #: 97M00200-GRP I-TEST 8 Material: IM7/TC350 PID# 0326A008
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Shock Source: LSC L/N: none LSC Core Load: 10 GR/FT Explosive Material: RDX
Sheath: Aluminum Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350XXX

Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N
1	D02	43026	2	C02	31340	3	C02	31338	4	D02	43028
5	D02	43029	6	C02	31333	7	C02	40292	8	D02	43179
9	D02	43180	10	C02	40295	11	C02	31336	12	D02	43181
13	B02	11439									

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: No loose bolts or accels.

Group: I - Test No.: 9 Date: 5-17-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.3"
Test Article Configuration: hanging
Test Article Drawing #: 97M00200-GRP I-TEST 9 Material: IM7/TC350 PID# 0326A009
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-22 Material: Aluminum S/N: Pathfinder
Shock Source: LSC L/N: none LSC Core Load: 22 GR/FT Explosive Material: CH-6
Sheath: Aluminum Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350XXX

Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N
1	C02	31334	2	D02	43026	3	D02	43028	4	C02	31331
5	C02	31328	6	D02	43029	7	D02	43179	8	C02	31351
9	C02	31330	10	D02	43180	11	D02	43181	12	C02	40274
13	B02	11439									

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: No loose bolts or accels.

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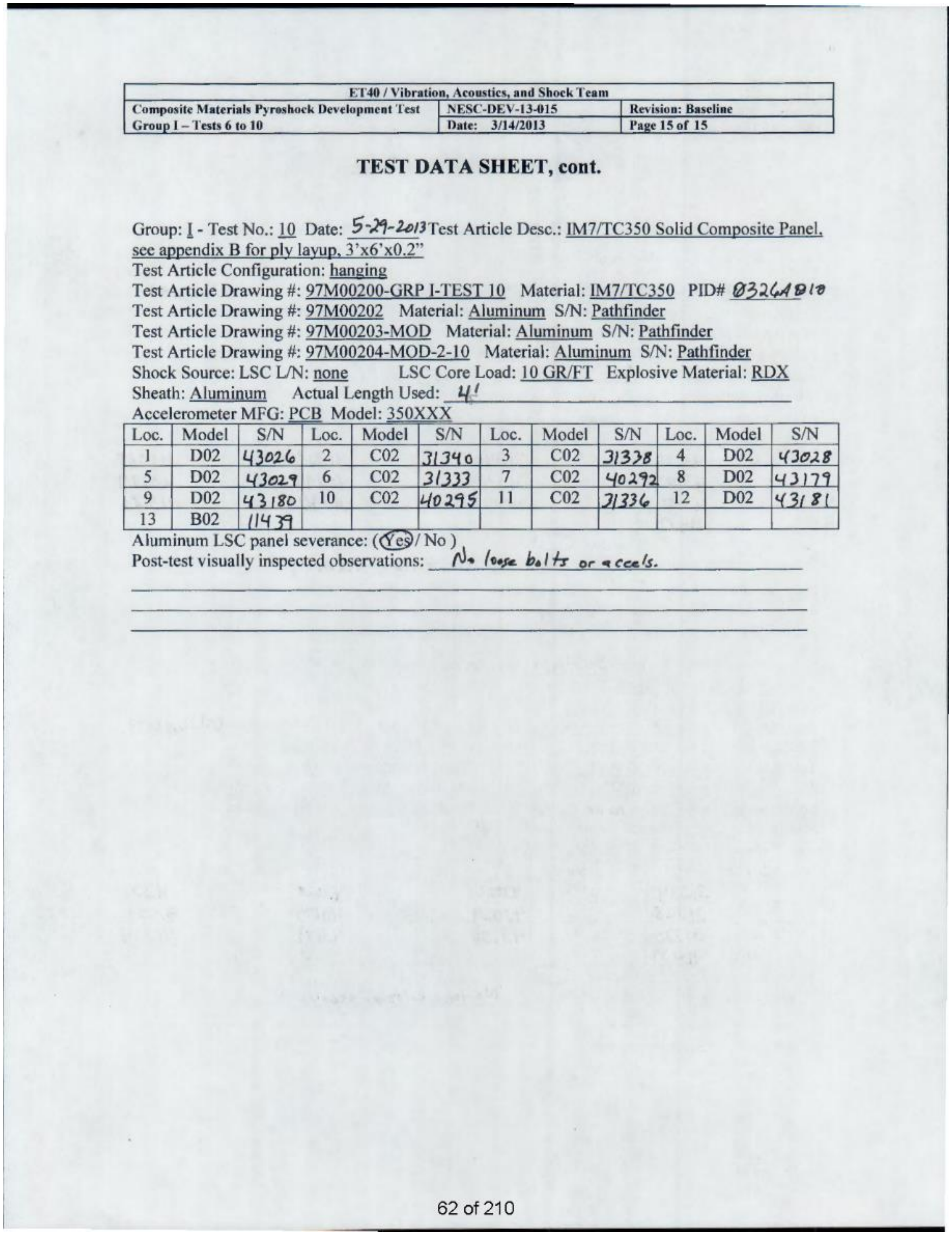

ET40 / Vibration, Acoustics, and Shock Team		
Composite Materials Pyroshock Development Test	NESC-DEV-13-015	Revision: Baseline
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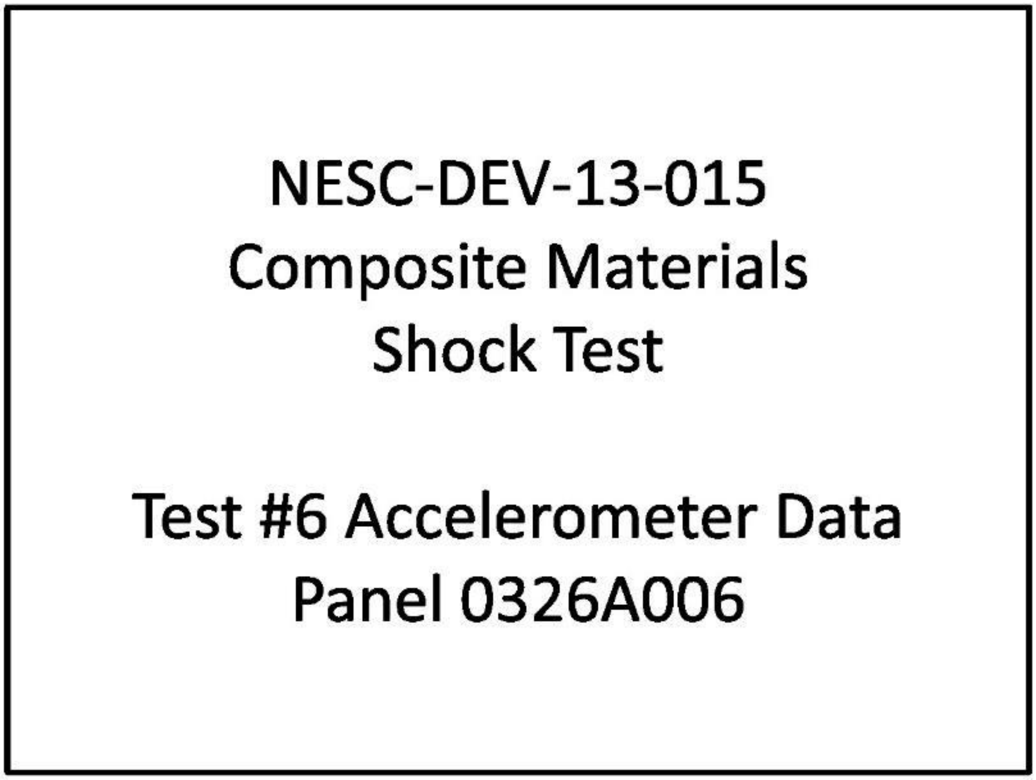
TEST DATA SHEET, cont.

Group: I - Test No.: 10 Date: 5-29-2013 Test Article Desc.: IM7/TC350 Solid Composite Panel, see appendix B for ply layup, 3'x6'x0.2"
Test Article Configuration: hanging
Test Article Drawing #: 97M00200-GRP I-TEST 10 Material: IM7/TC350 PID# 0326AB10
Test Article Drawing #: 97M00202 Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00203-MOD Material: Aluminum S/N: Pathfinder
Test Article Drawing #: 97M00204-MOD-2-10 Material: Aluminum S/N: Pathfinder
Shock Source: LSC L/N: none LSC Core Load: 10 GR/FT Explosive Material: RDX
Sheath: Aluminum Actual Length Used: 4'
Accelerometer MFG: PCB Model: 350XXX

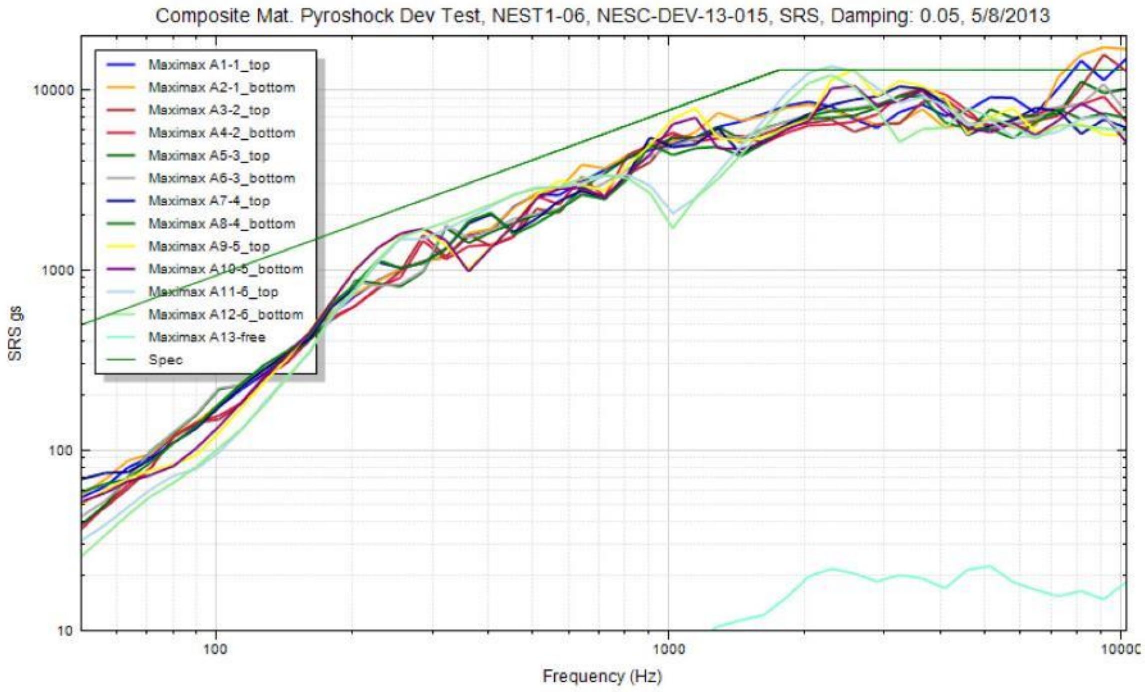
Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N	Loc.	Model	S/N
1	D02	43026	2	C02	31340	3	C02	31338	4	D02	43028
5	D02	43029	6	C02	31333	7	C02	40292	8	D02	43179
9	D02	43180	10	C02	40295	11	C02	31336	12	D02	43181
13	B02	11439									

Aluminum LSC panel severance: ([✓ Yes] / No)
Post-test visually inspected observations: No loose bolts or accels.



NESC-DEV-13-015
Composite Materials Shock Test

Test #6 Accelerometer Data
Panel 0326A006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Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
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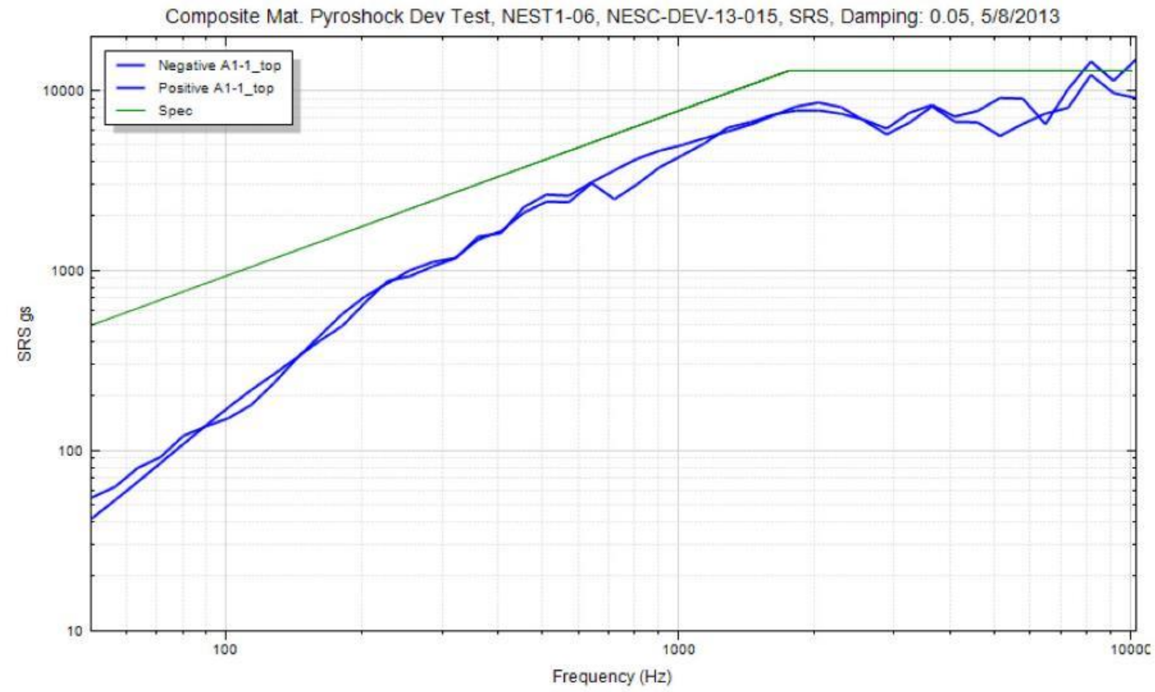
10
100
1000
10000
Frequency (Hz)



Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, SRS, Damping: 0.05, 5/8/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
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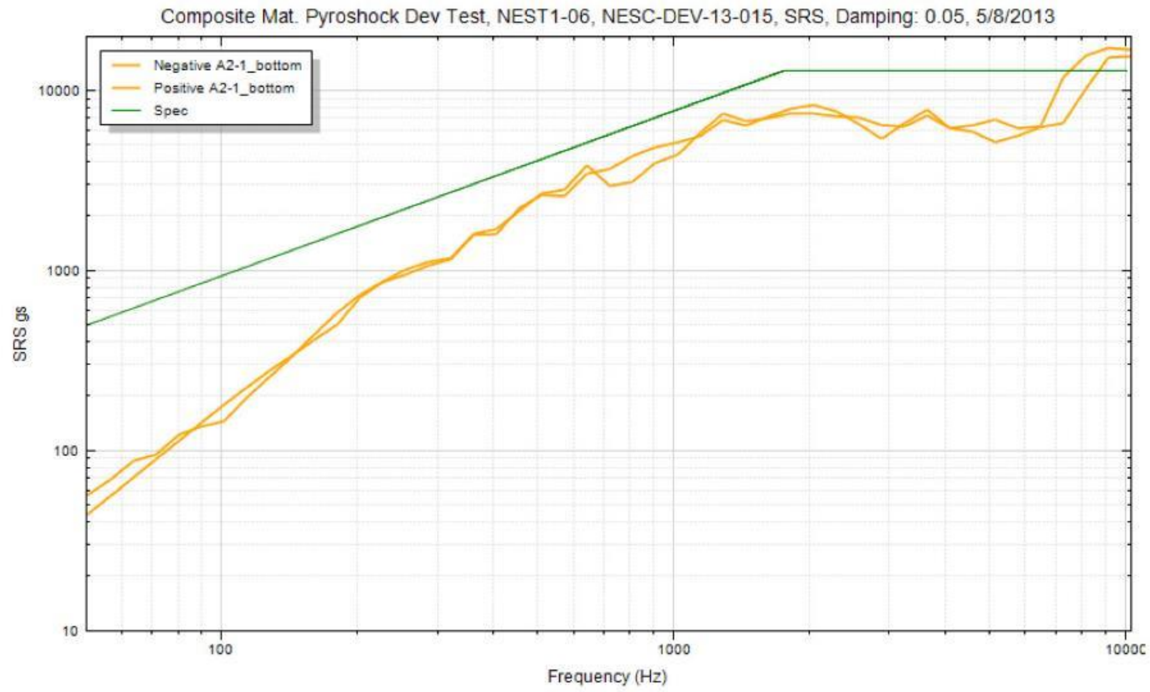
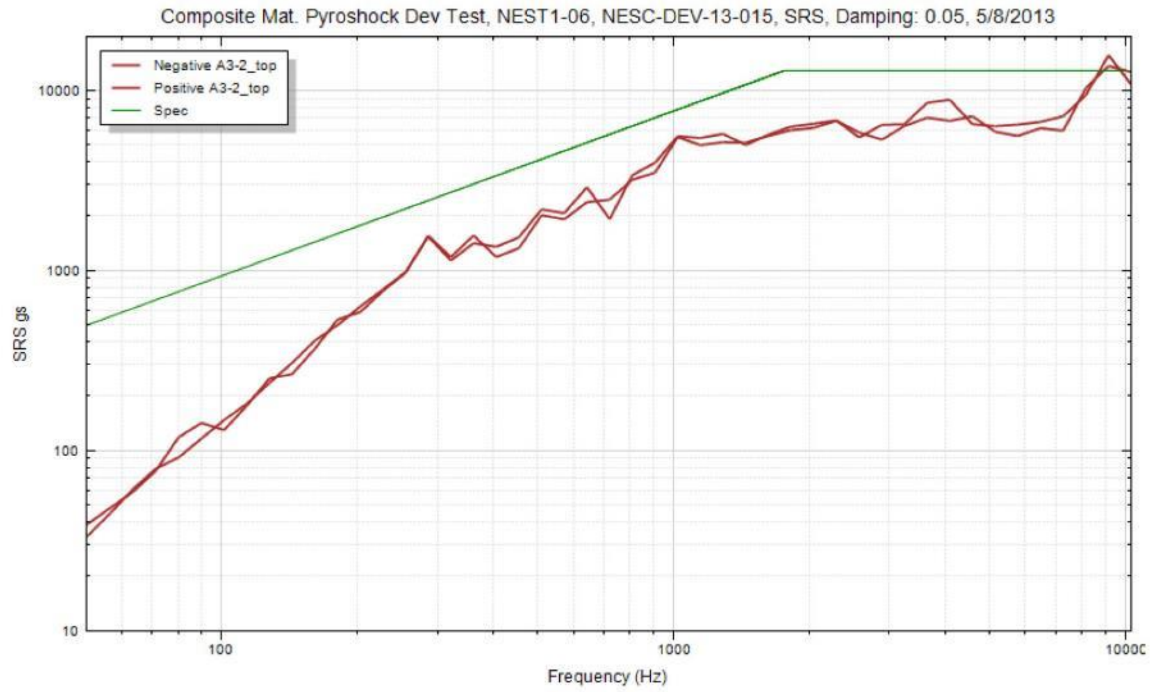
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, SRS, Damping: 0.05, 5/8/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)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Positive A3-2_top
Spec
SRS gs
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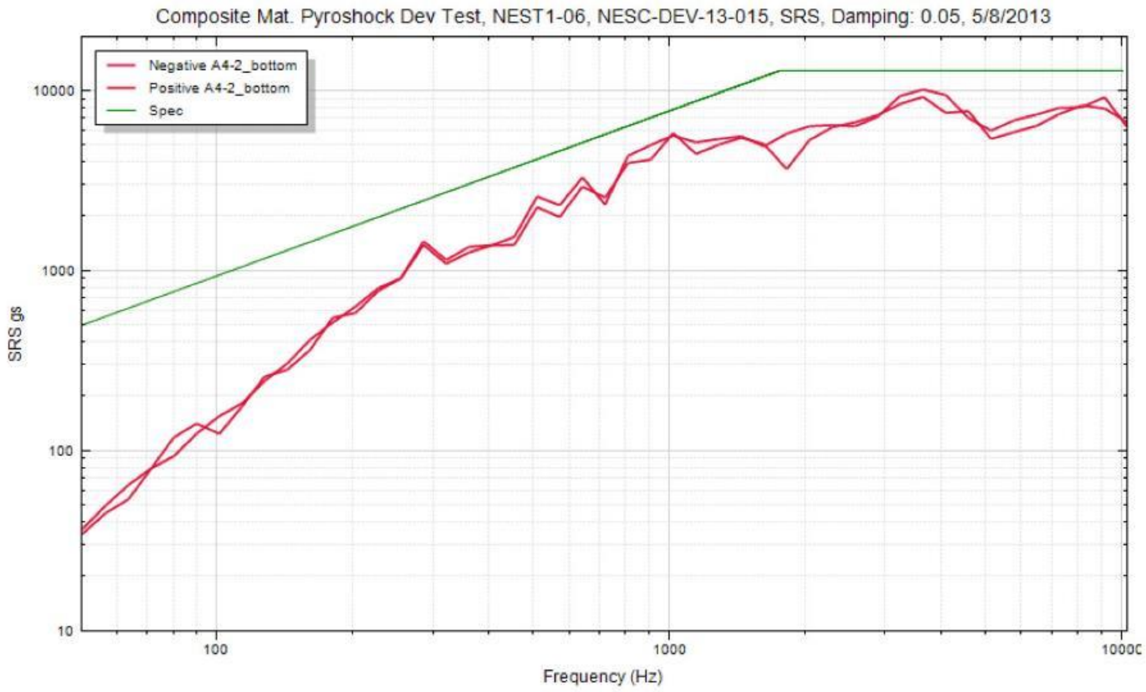
100
10
100
1000
10000
Frequency (Hz)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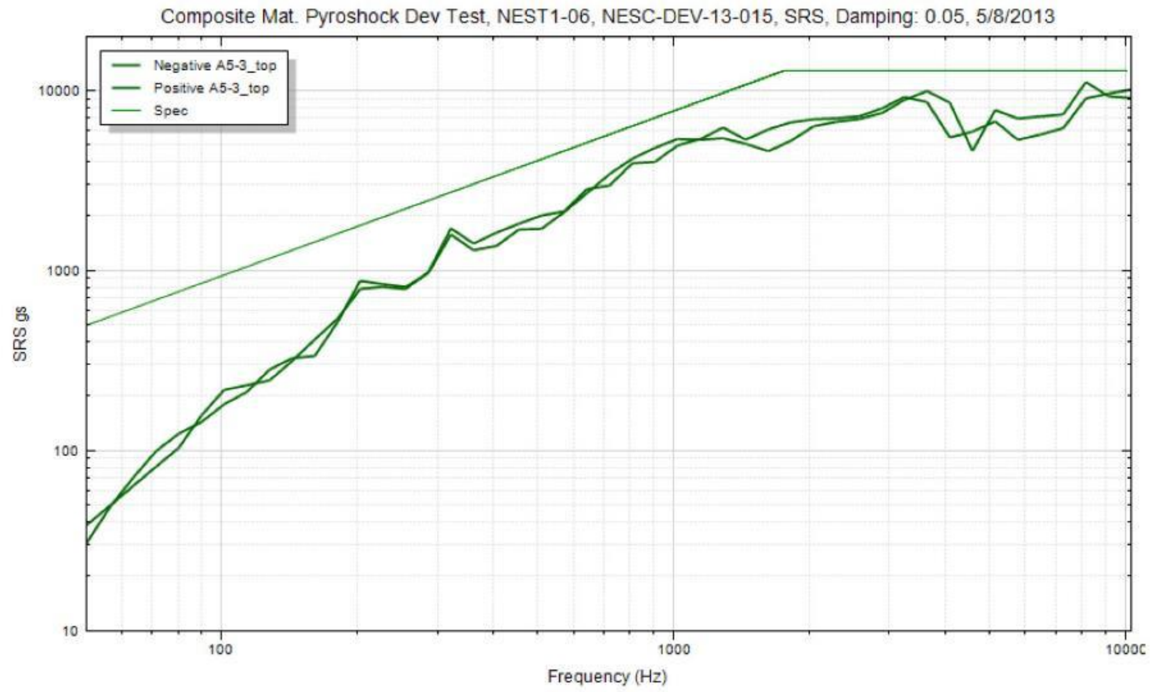
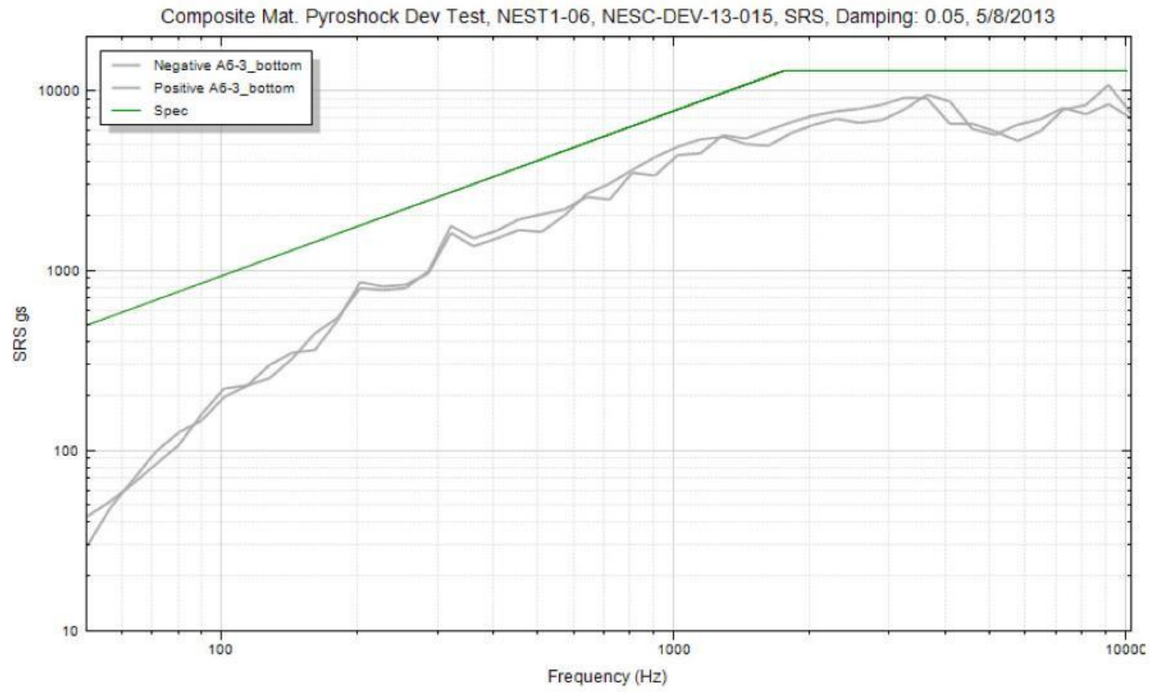
Negative A4-2_bottom
Positive A4-2_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, SRS, Damping: 0.05, 5/8/2013
Negative A5-3_top
Positive A5-3_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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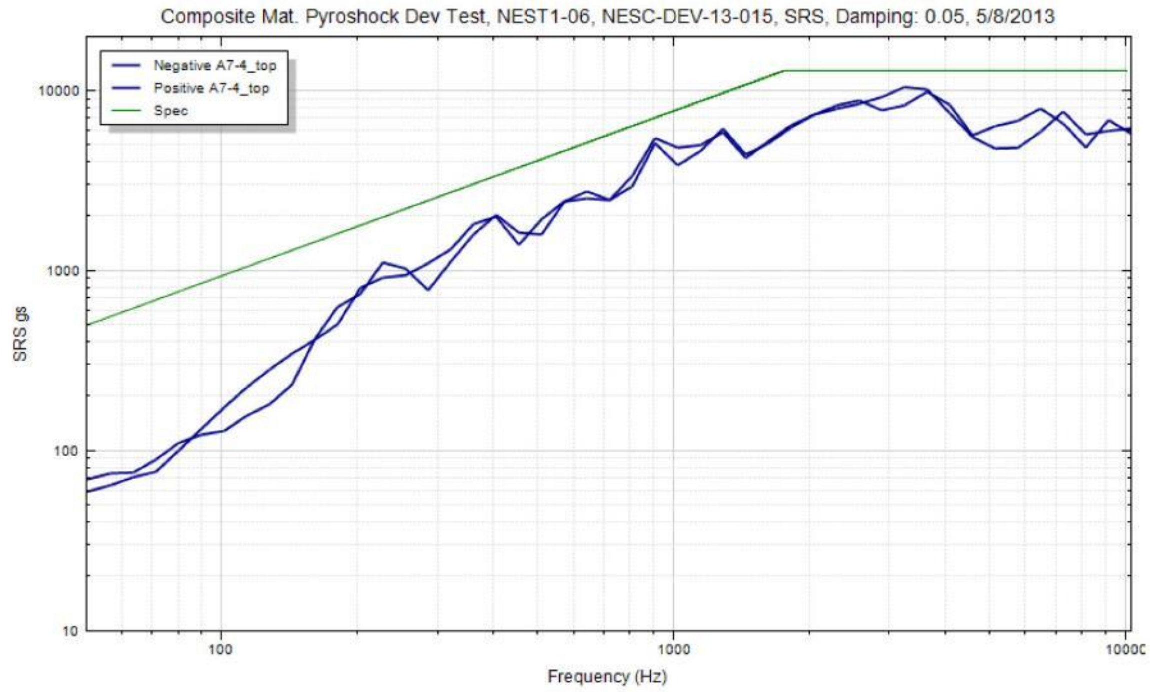
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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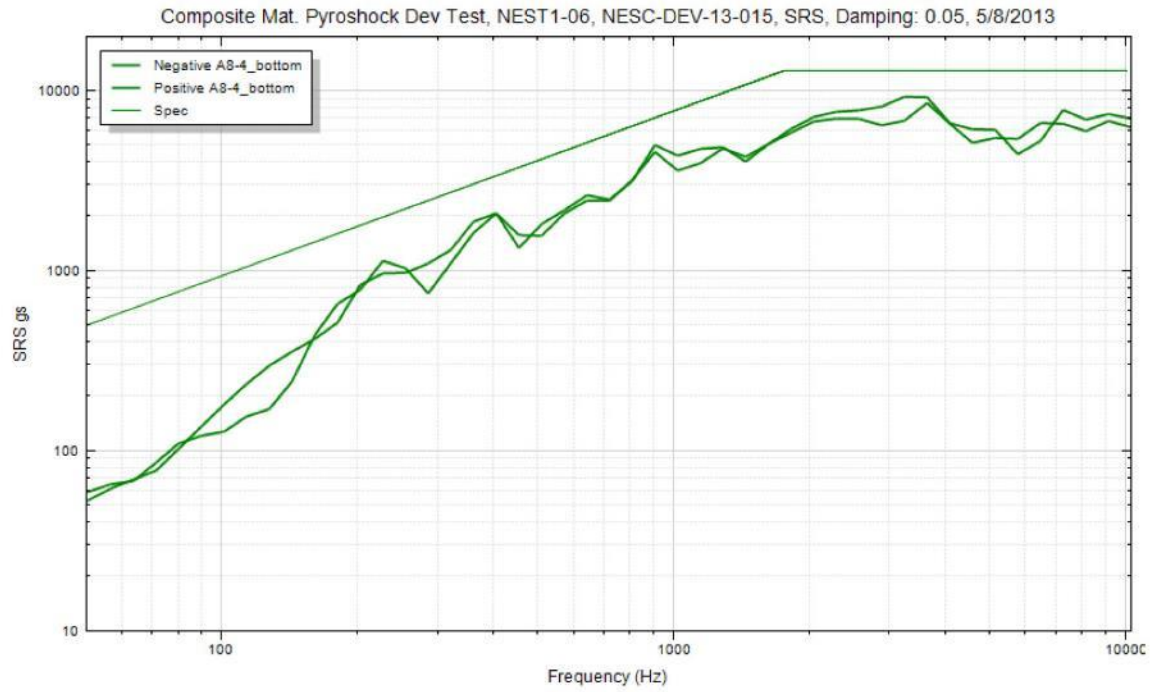
Positive A7-4_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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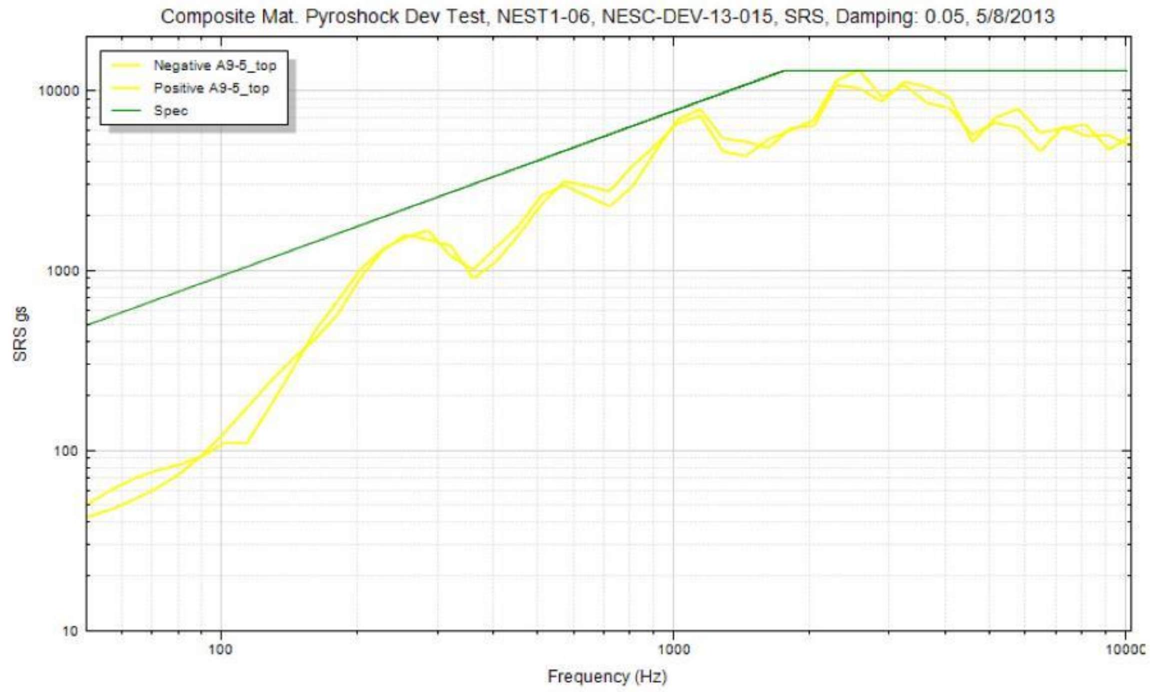
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, SRS, Damping: 0.05, 5/8/2013
Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
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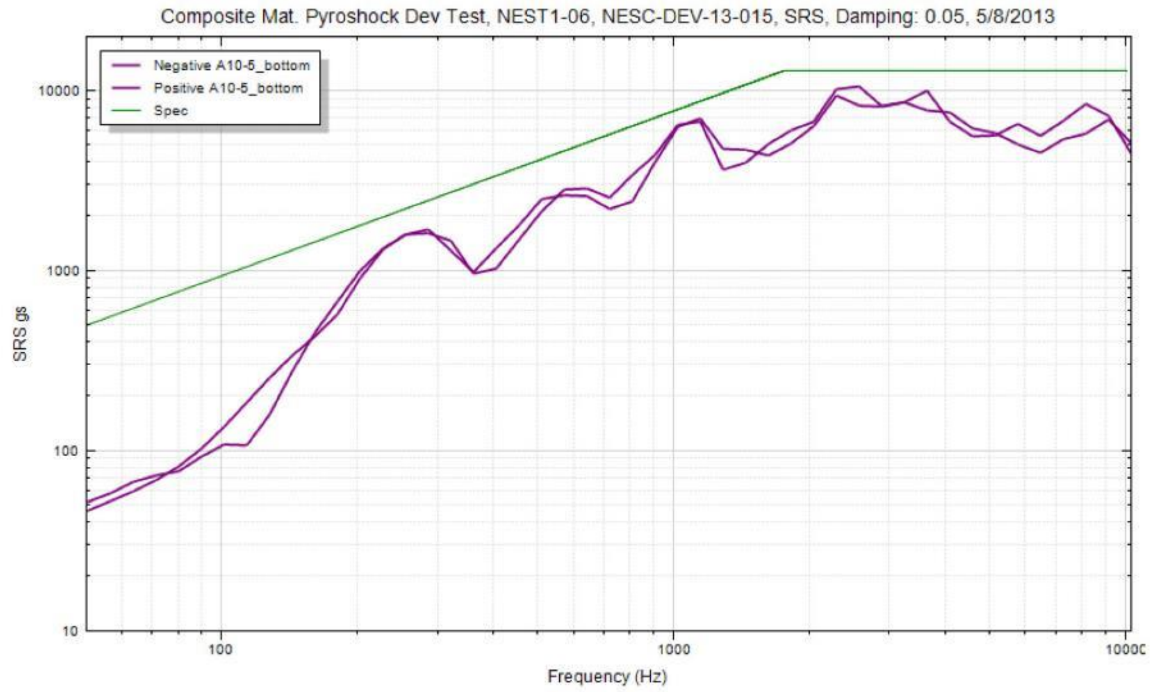
1000
100
10
Frequency (Hz)
100
1000
10000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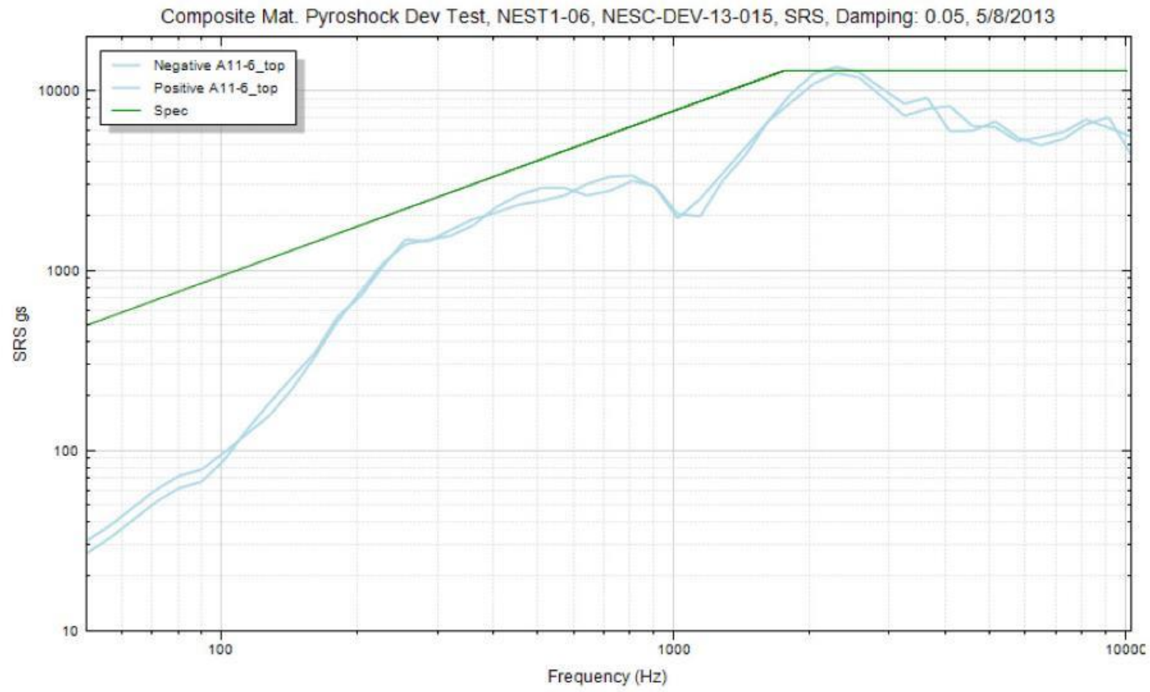
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)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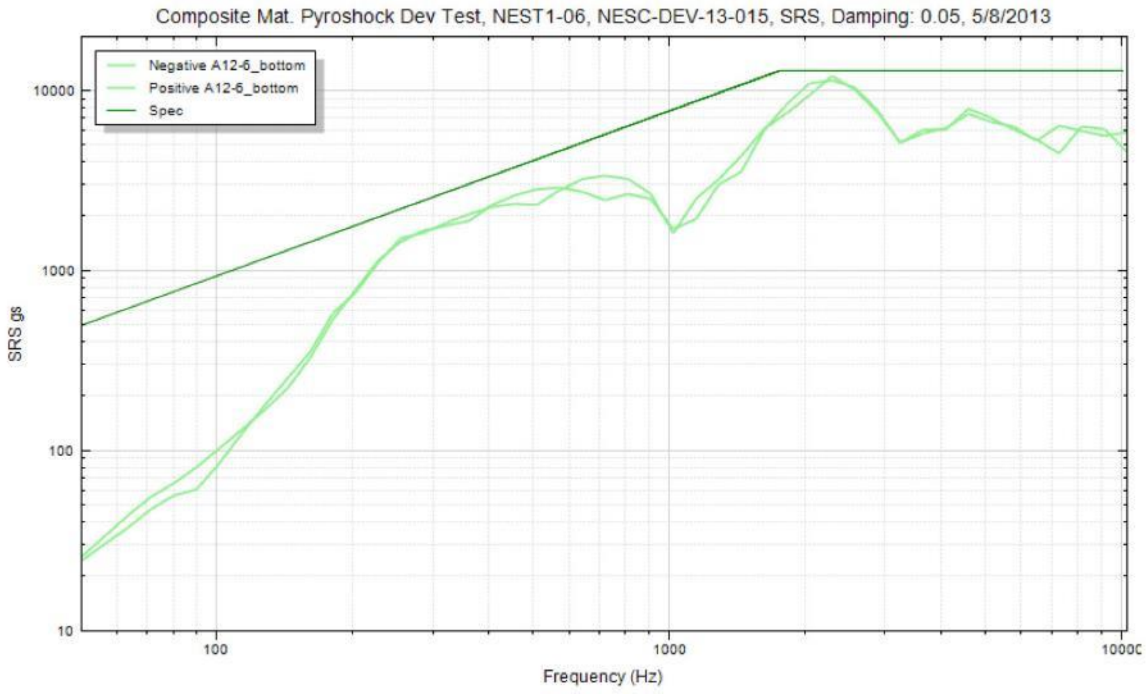
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

75 of 210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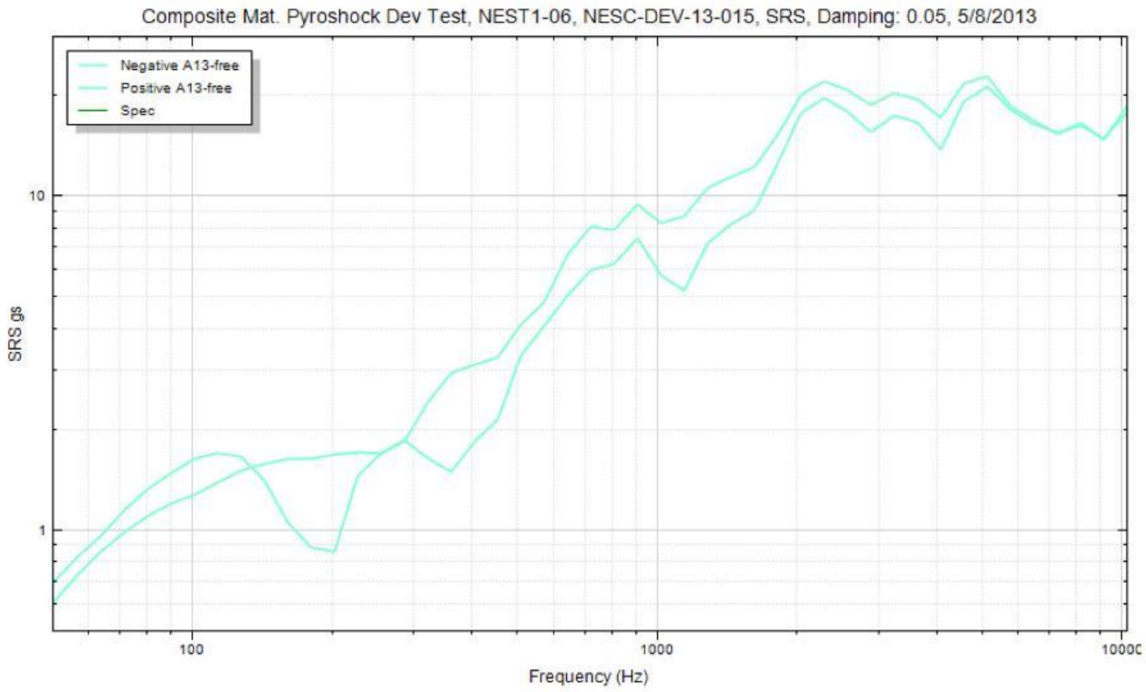
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000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Negative A13-free
Positive A13-free
Spec
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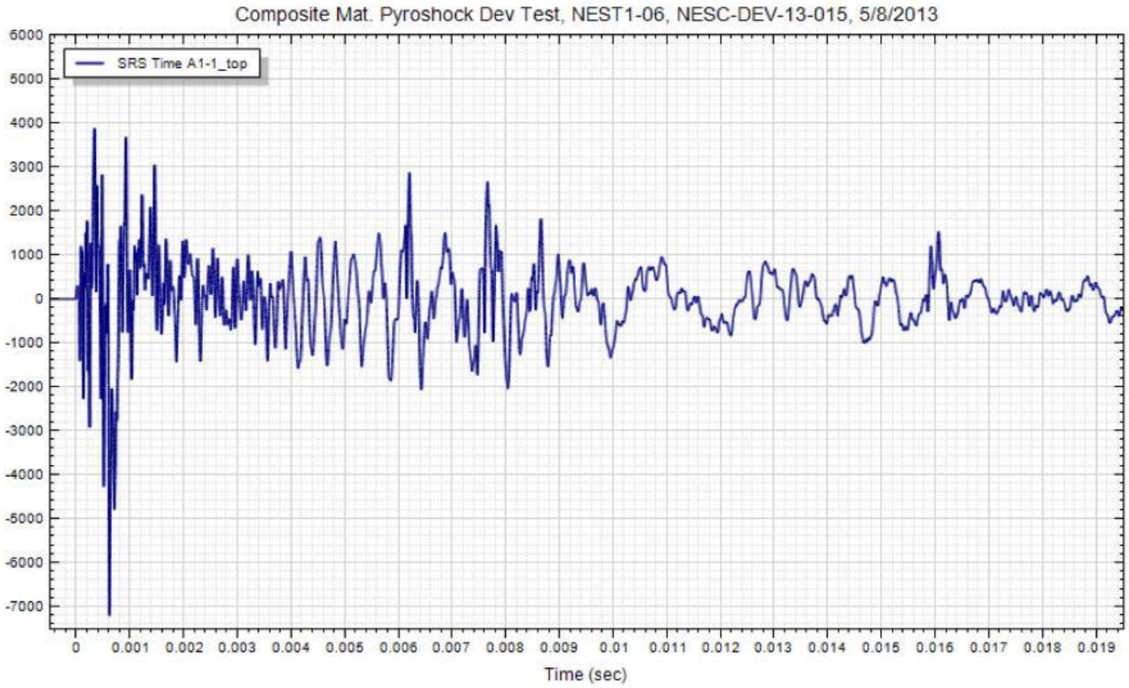
1
SRS gs
100
1000
10000
Frequency (Hz)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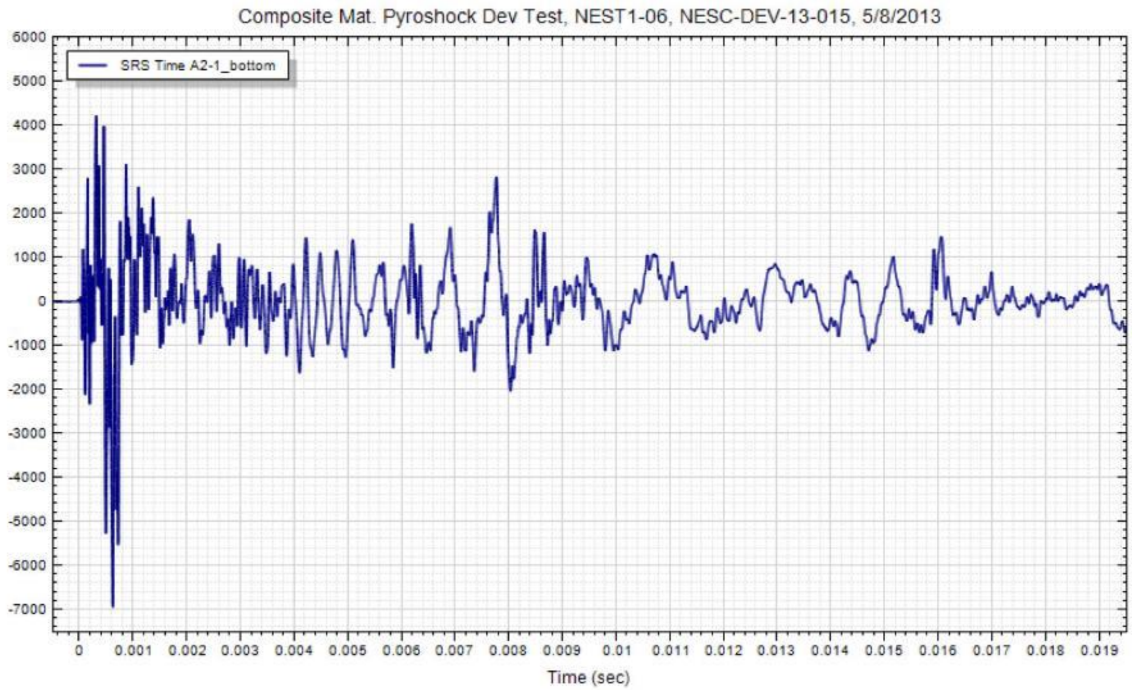
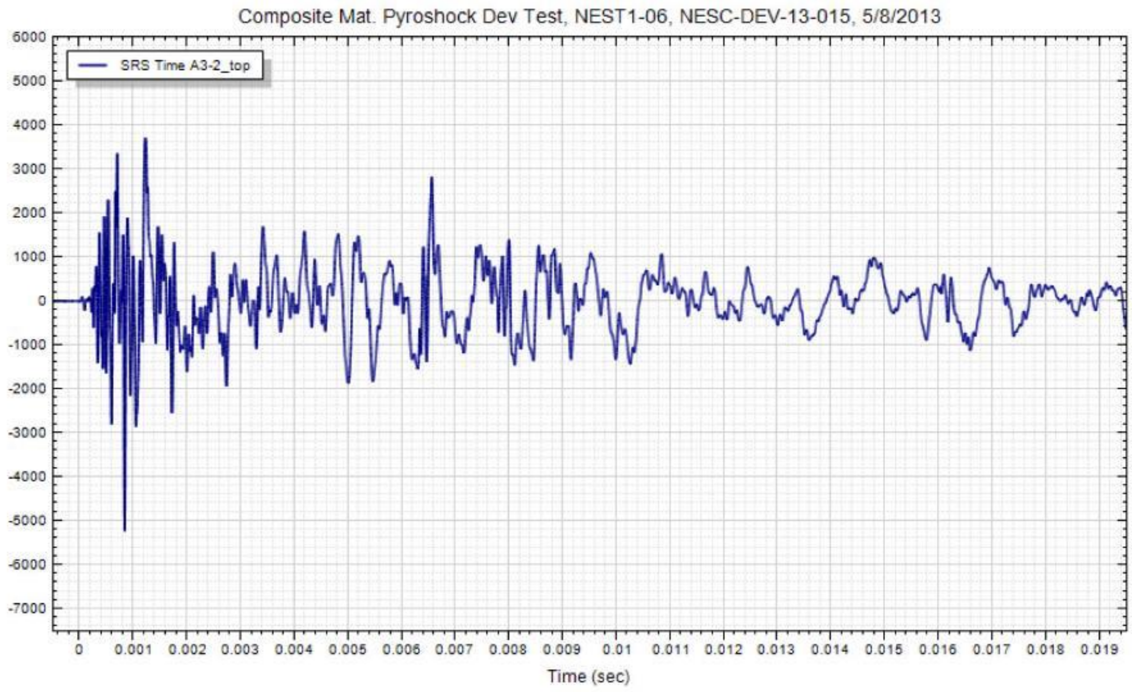
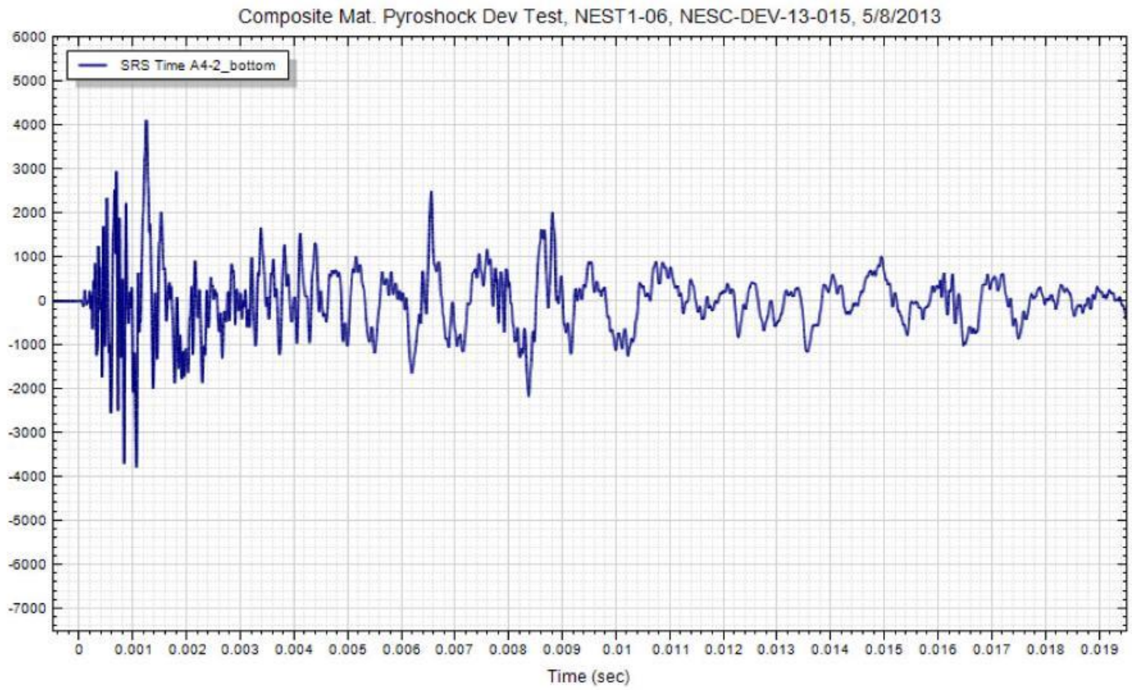
SRS Time A1-1_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A2-1_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A3-2_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)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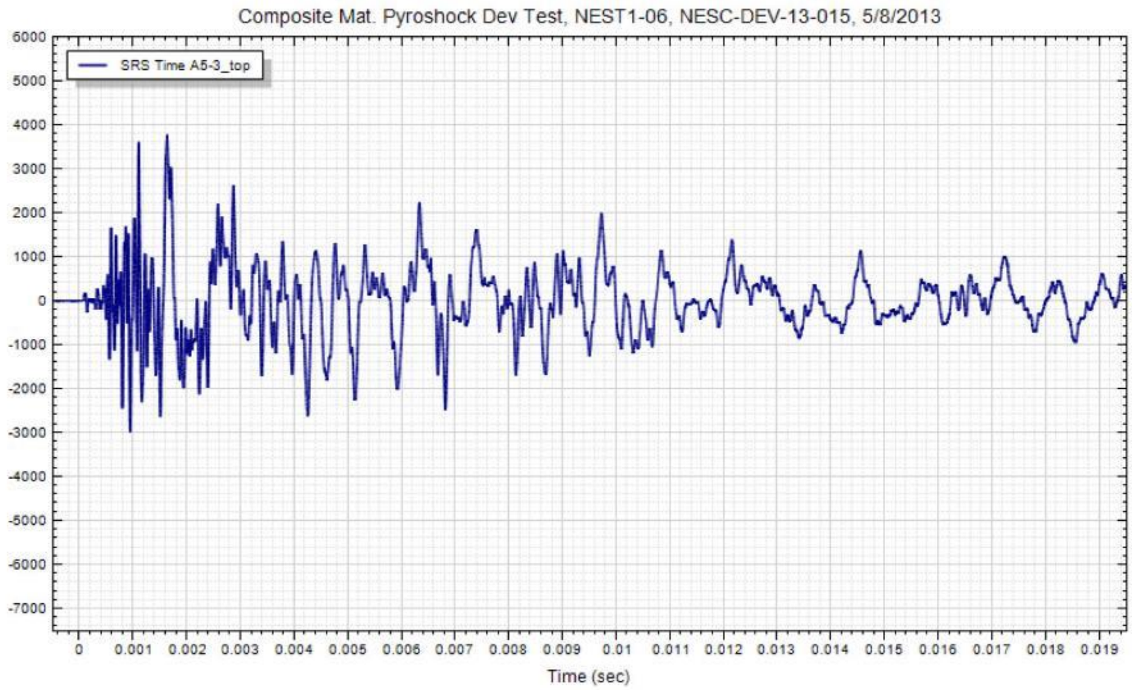
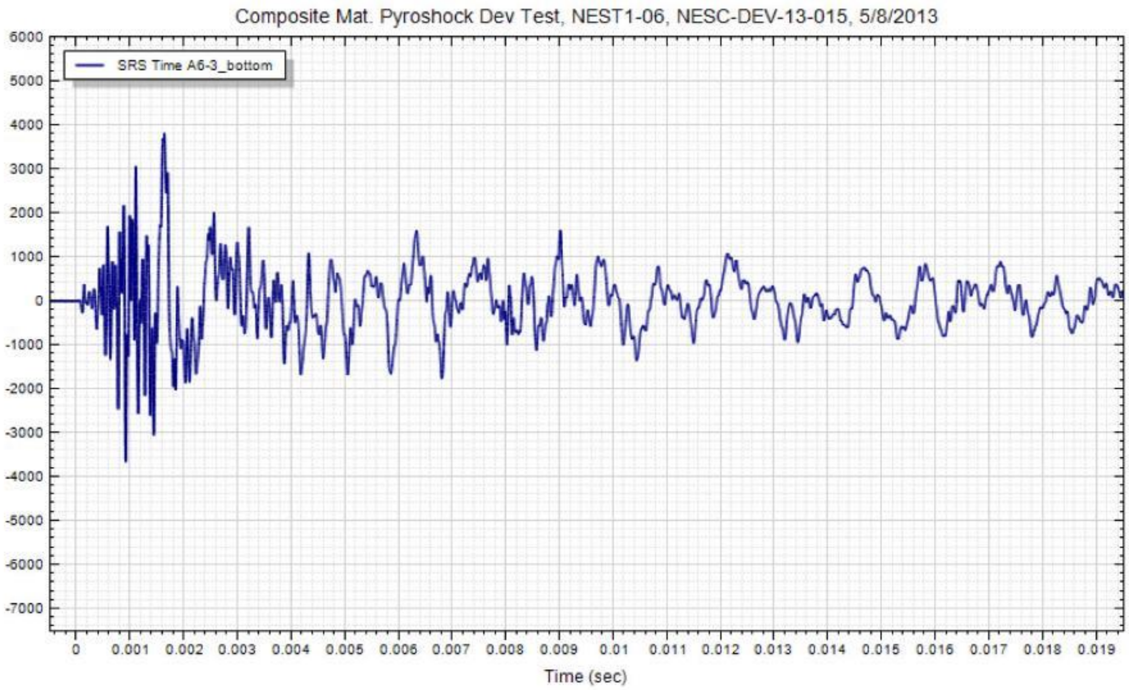
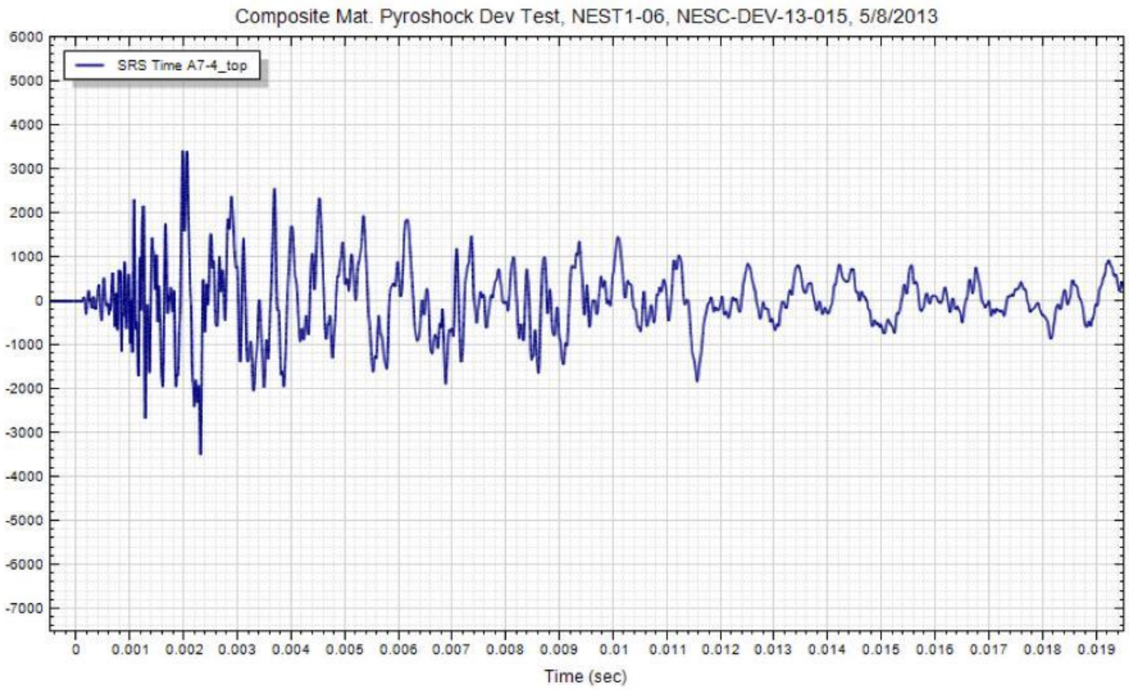
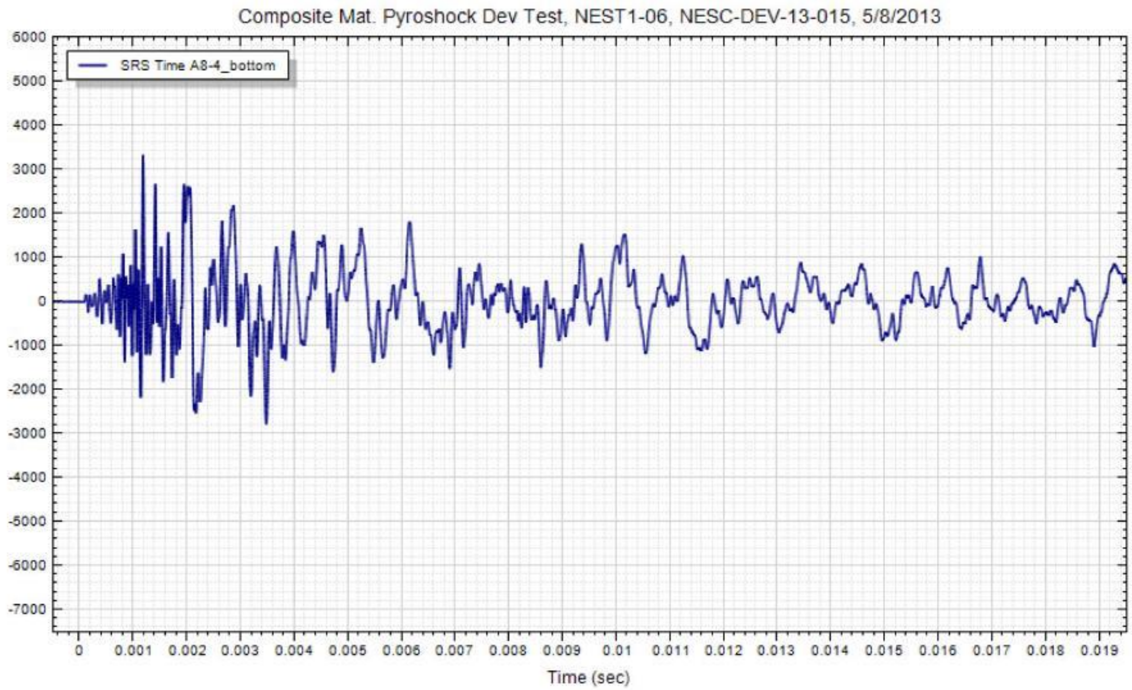
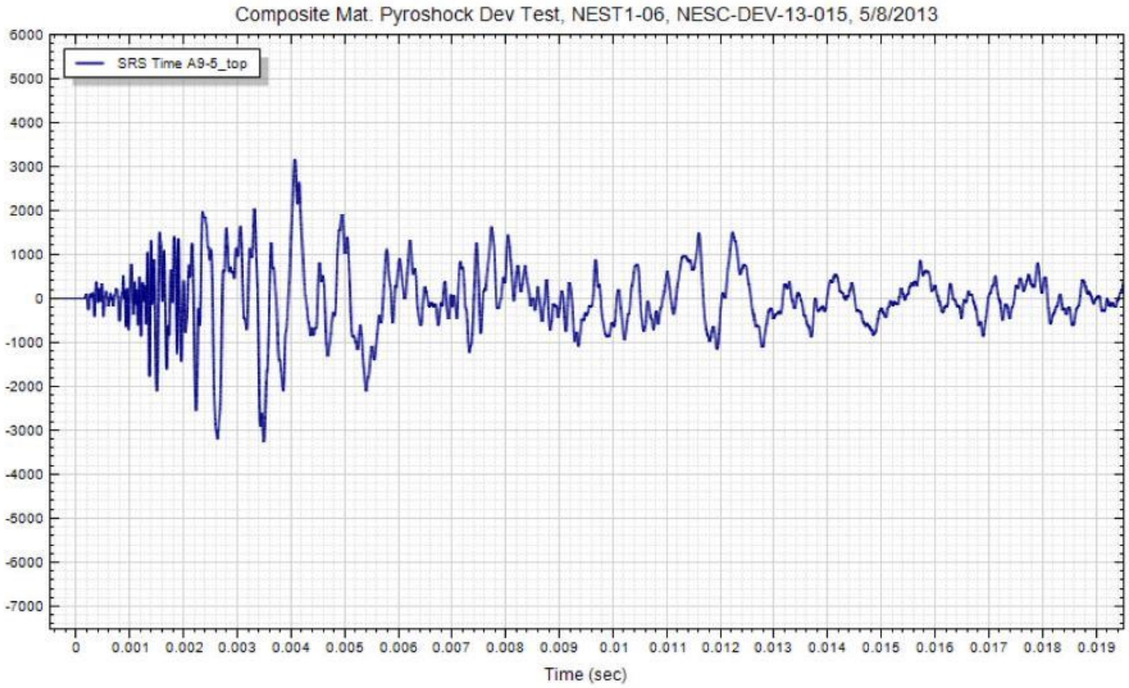
SRS Time A4-2_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

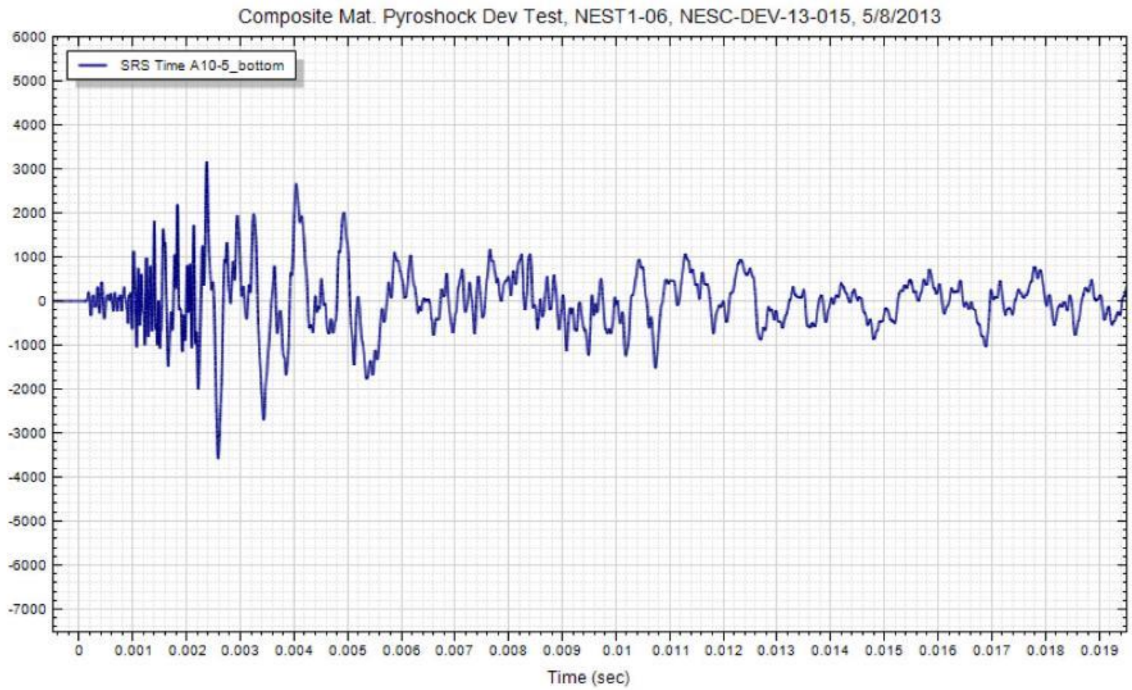

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A5-3_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

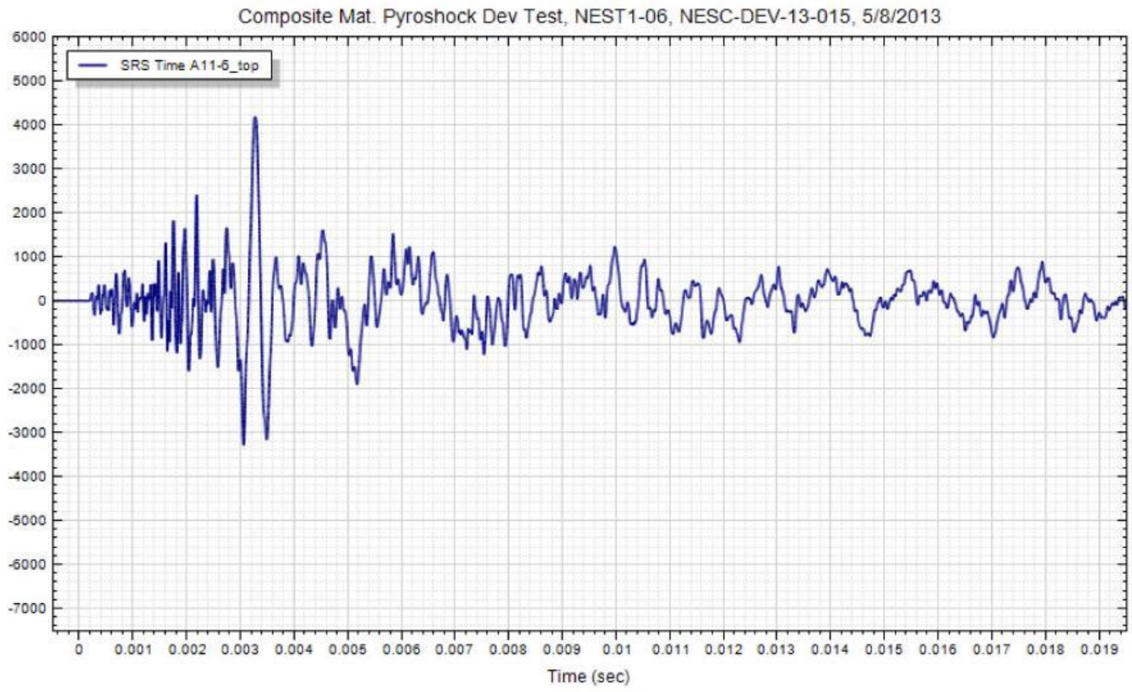

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A6-3_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

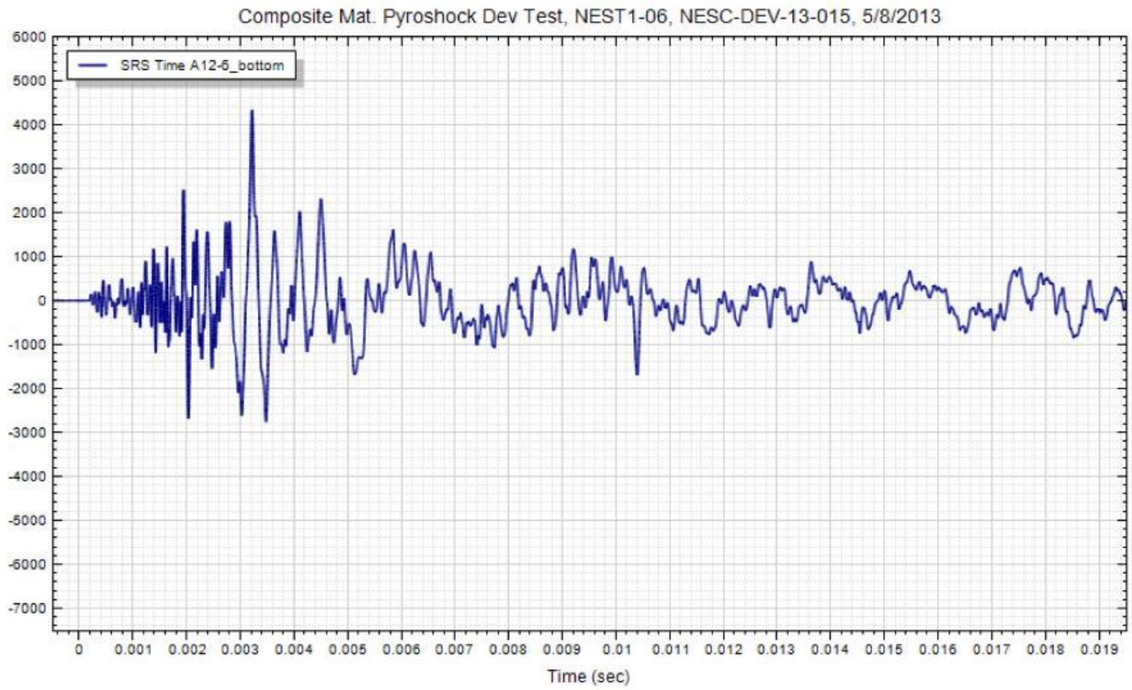

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A7-4_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

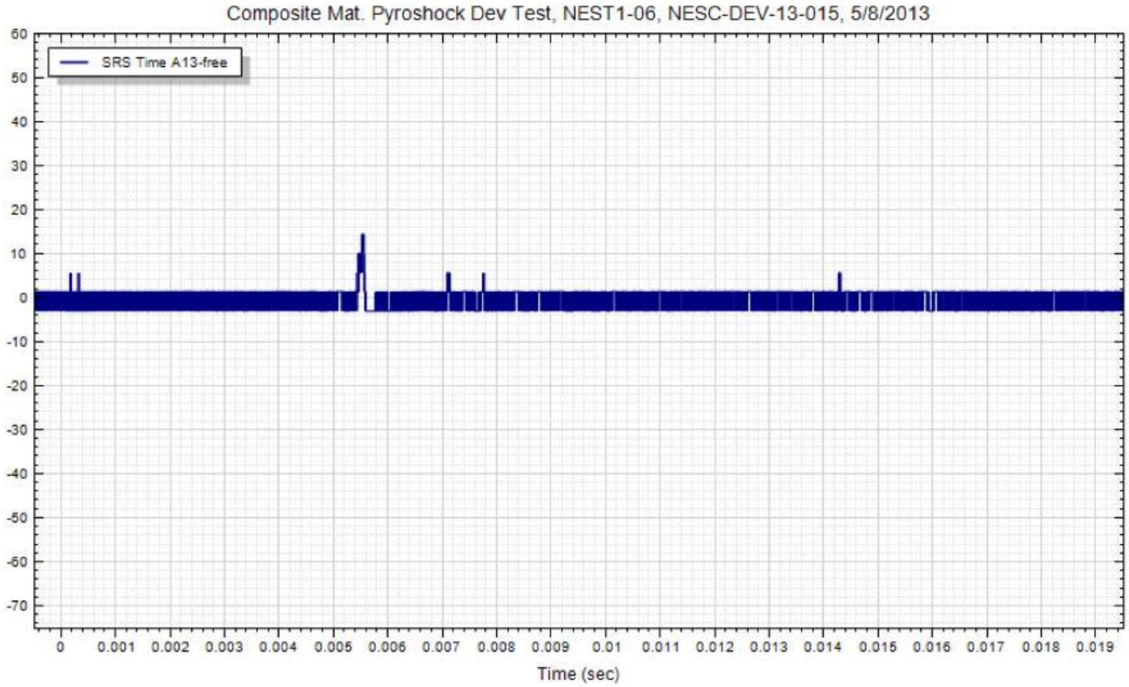

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A8-4_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

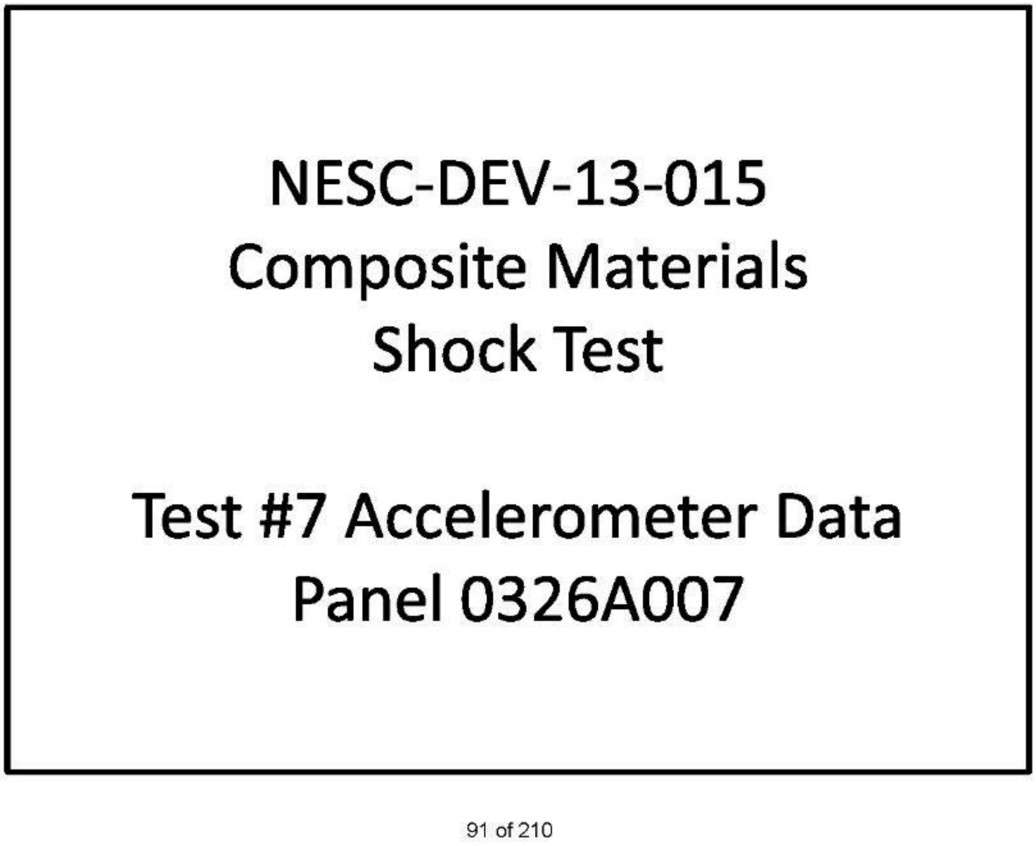

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A9-5_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A10-5_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A11-6_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

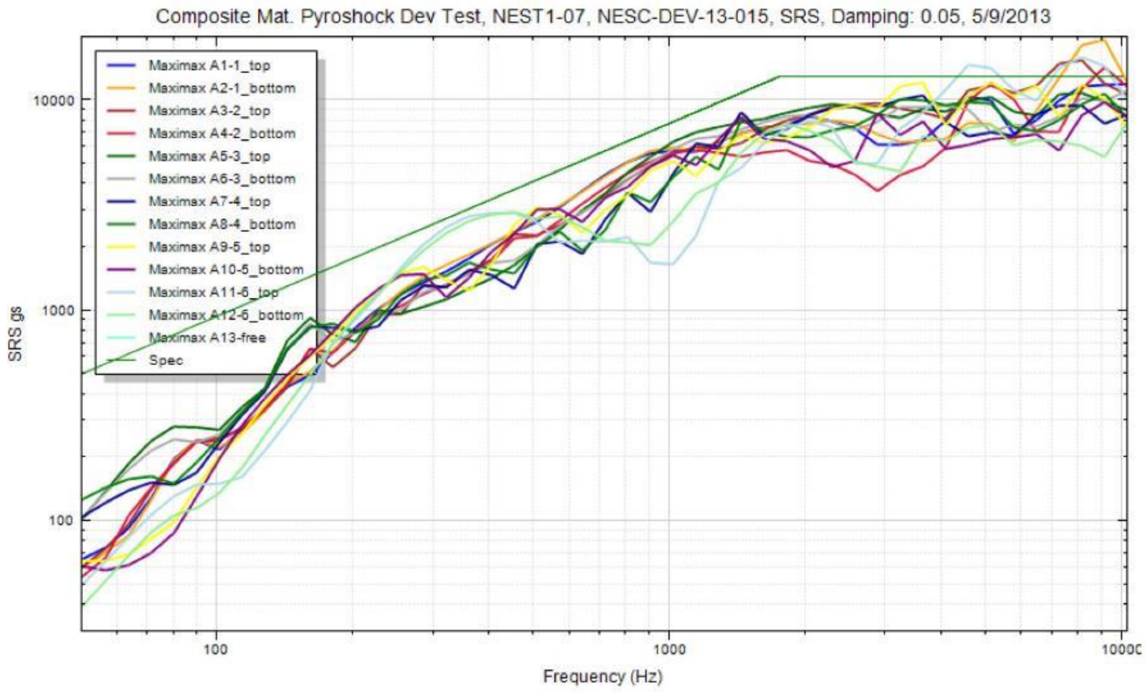

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A12-6_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

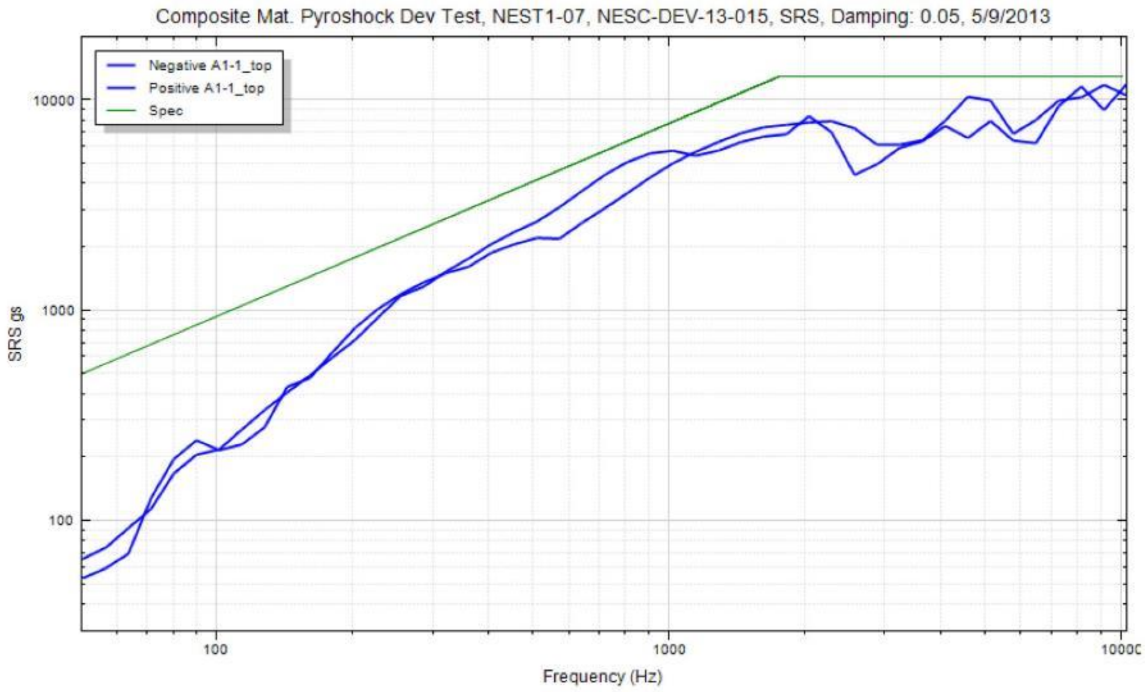

Composite Mat. Pyroshock Dev Test, NEST1-06, NESC-DEV-13-015, 5/8/2013
SRS Time A13-free
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

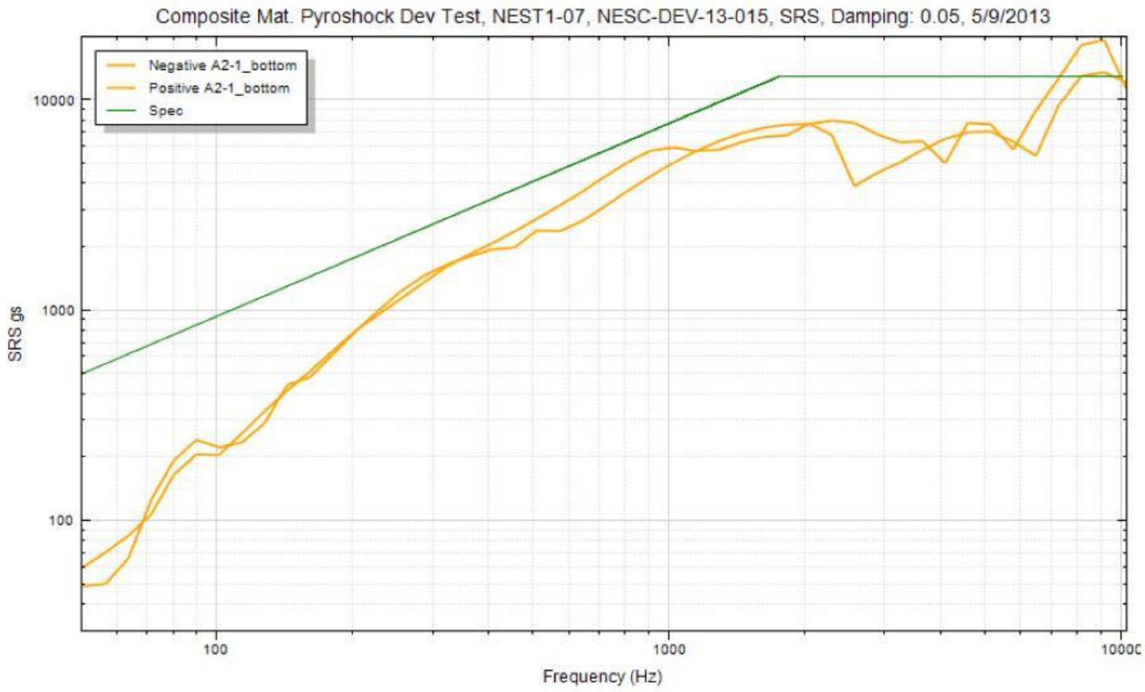


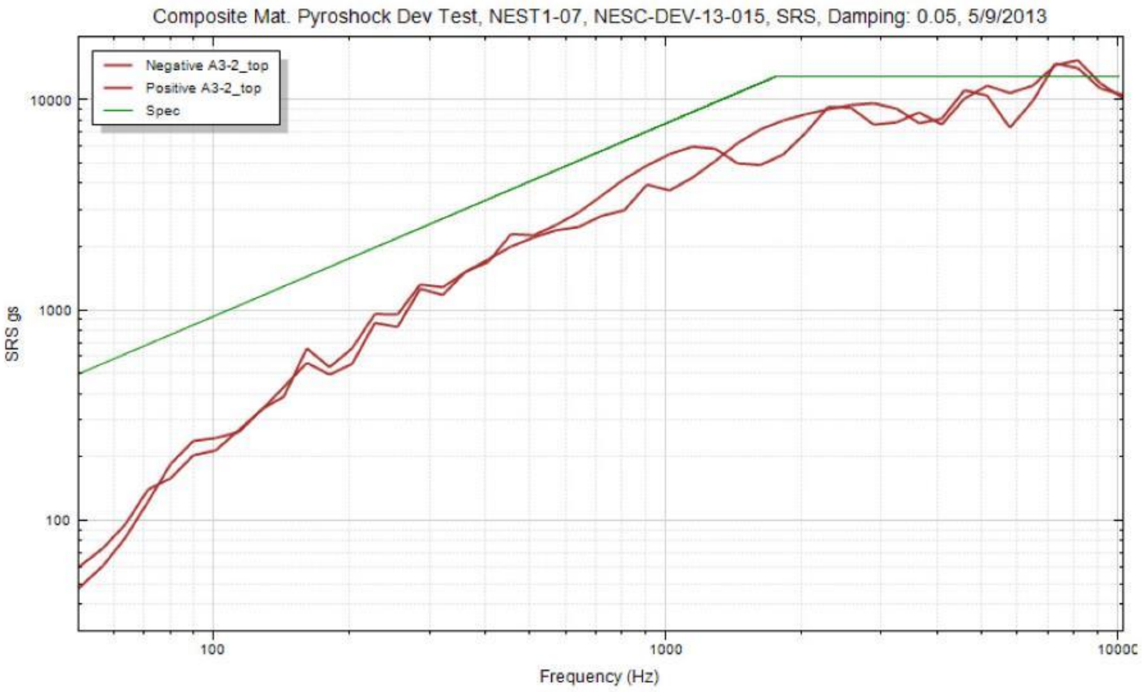
NESC-DEV-13-015
Composite Materials
Shock Test

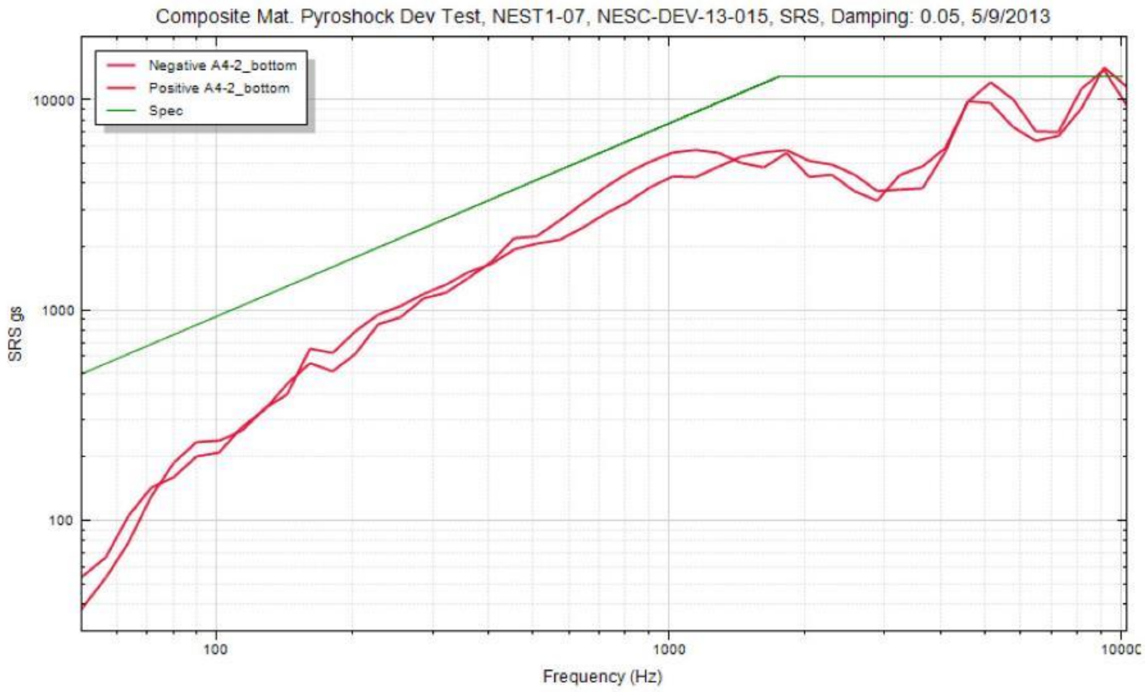
Test #7 Accelerometer Data
Panel 0326A007

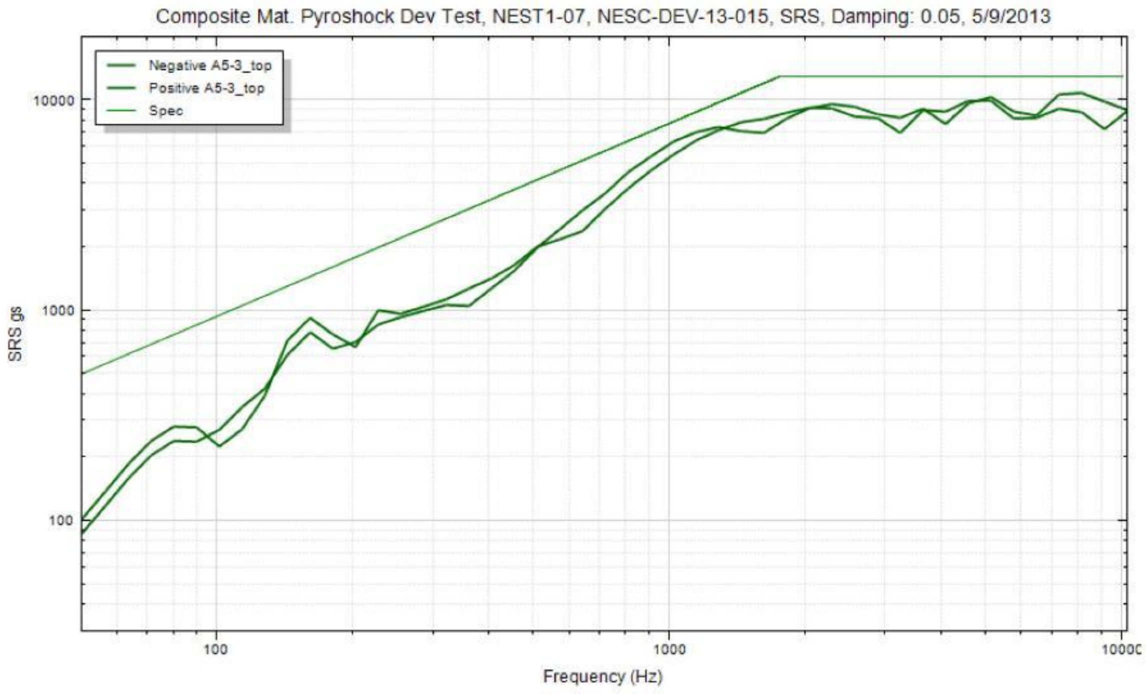

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
100
1000
10000
Frequency (Hz)

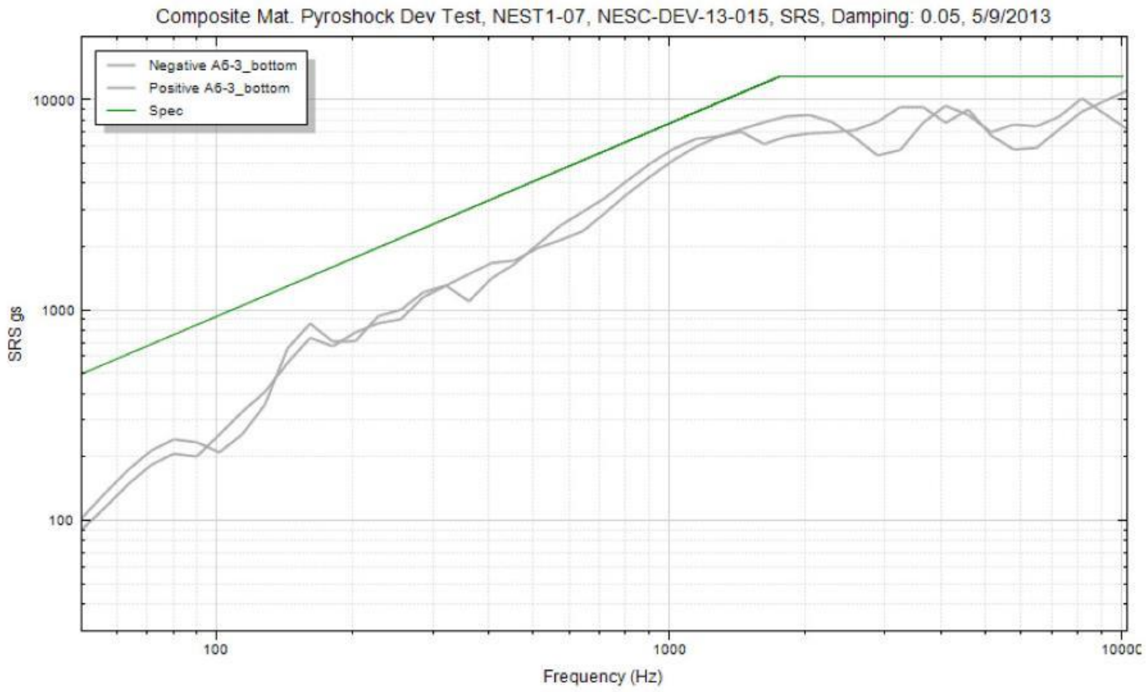

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
Frequency (Hz)
100
1000
10000

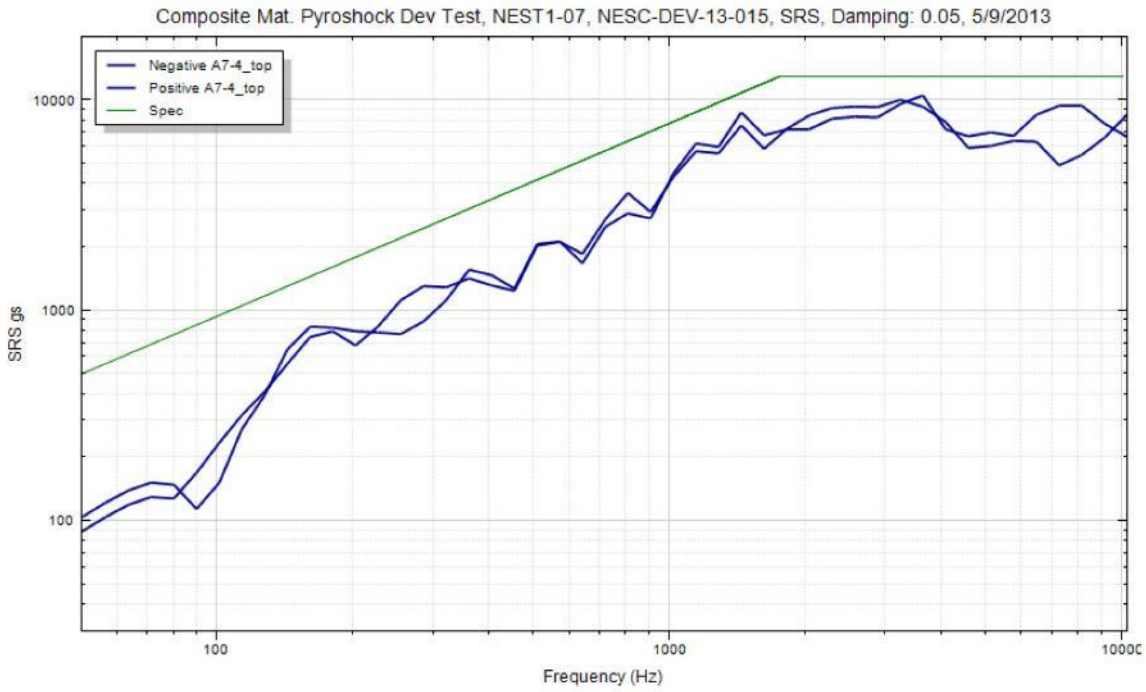

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
100
1000
10000
Frequency (Hz)

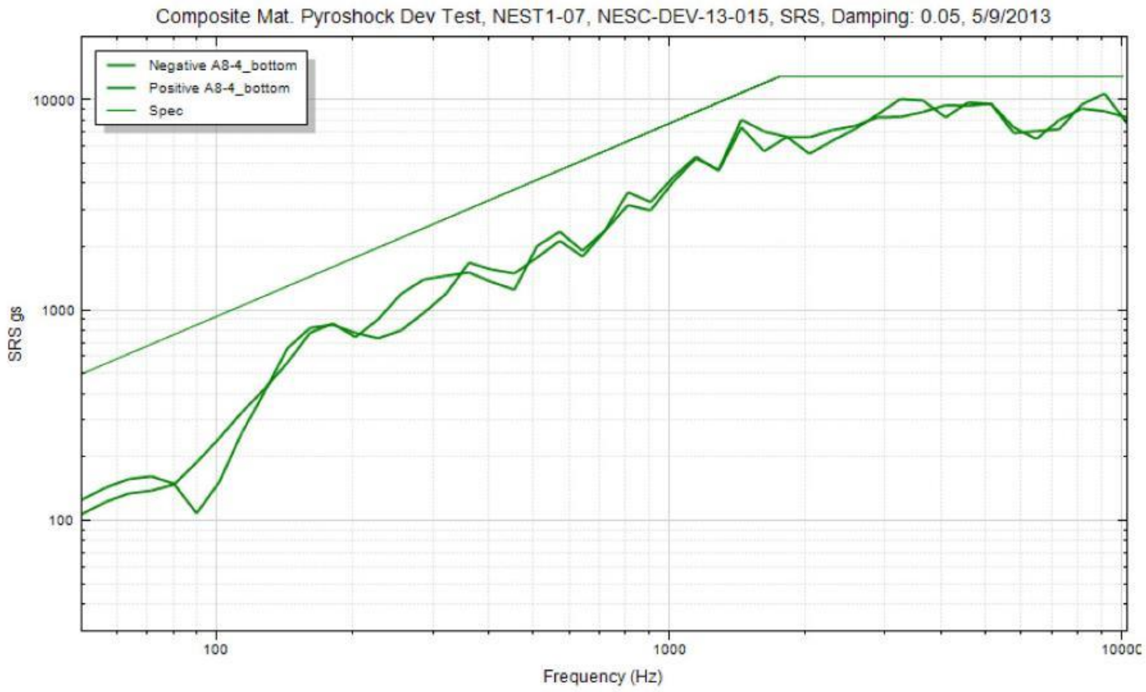

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A3-2_top
Positive A3-2_top
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)

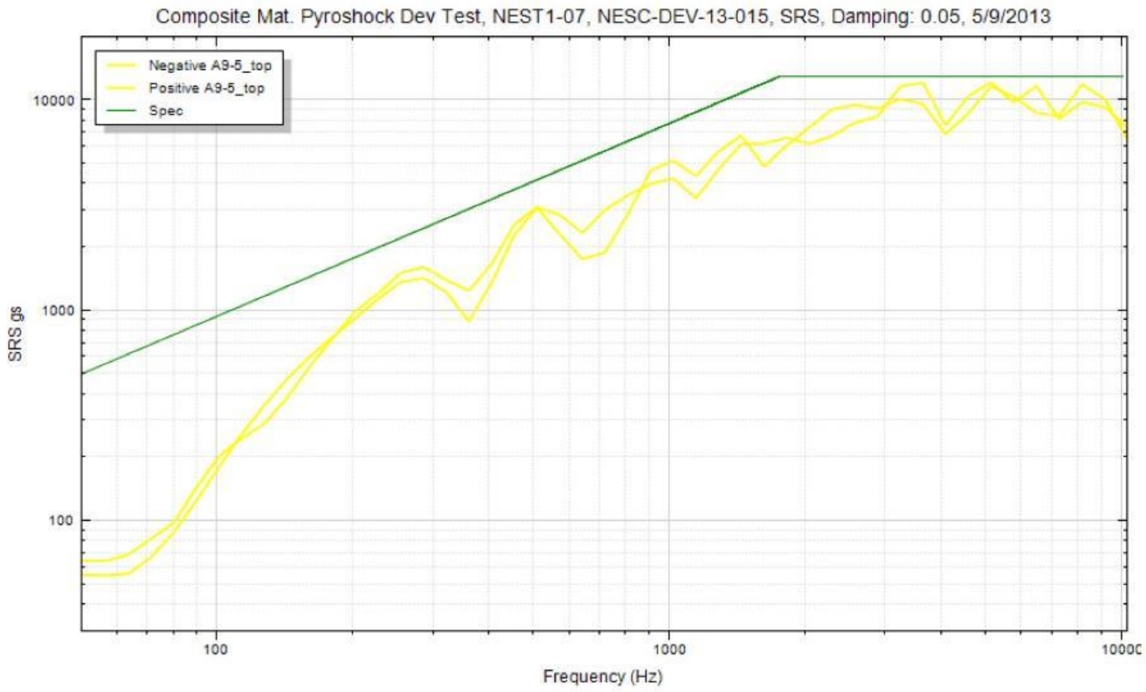

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
Frequency (Hz)
100
1000
10000


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A7-4_top
Positive A7-4_top
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
Frequency (Hz)
100
1000
10000


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
10000
1000
100
100
1000
10000
Frequency (Hz)

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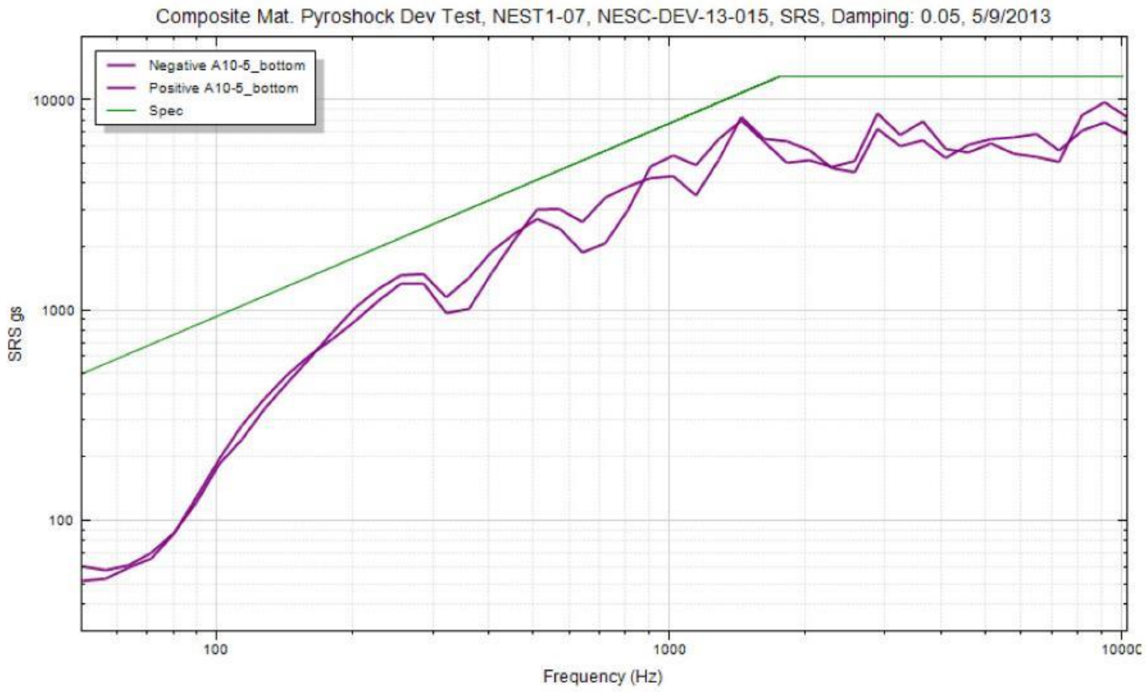
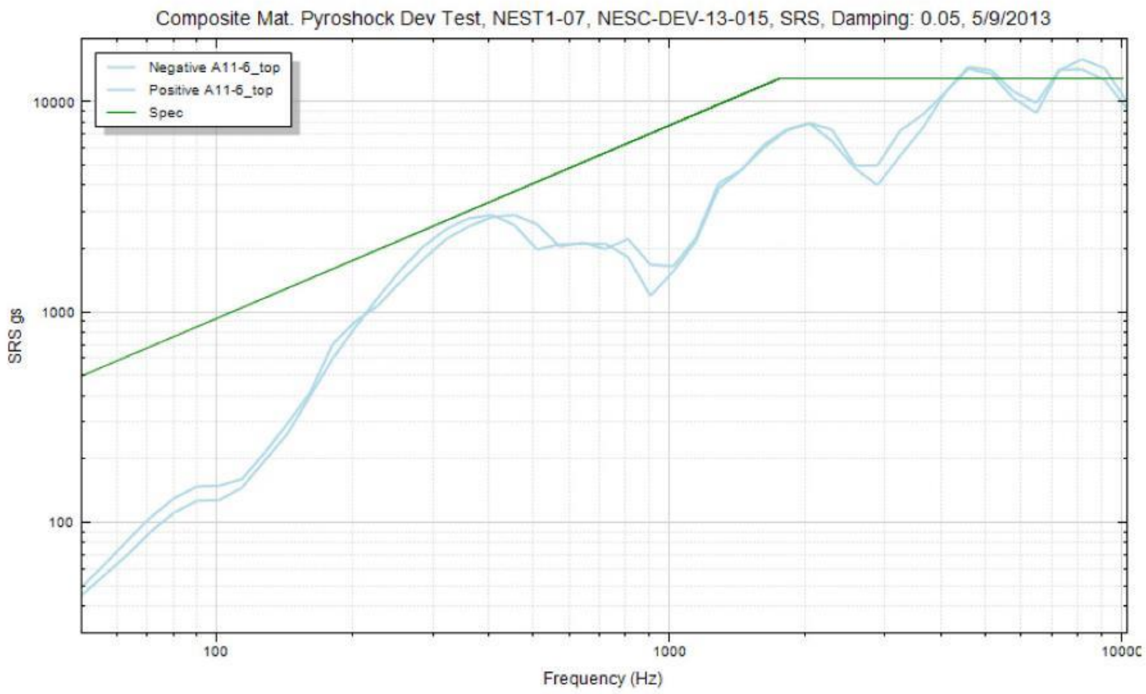
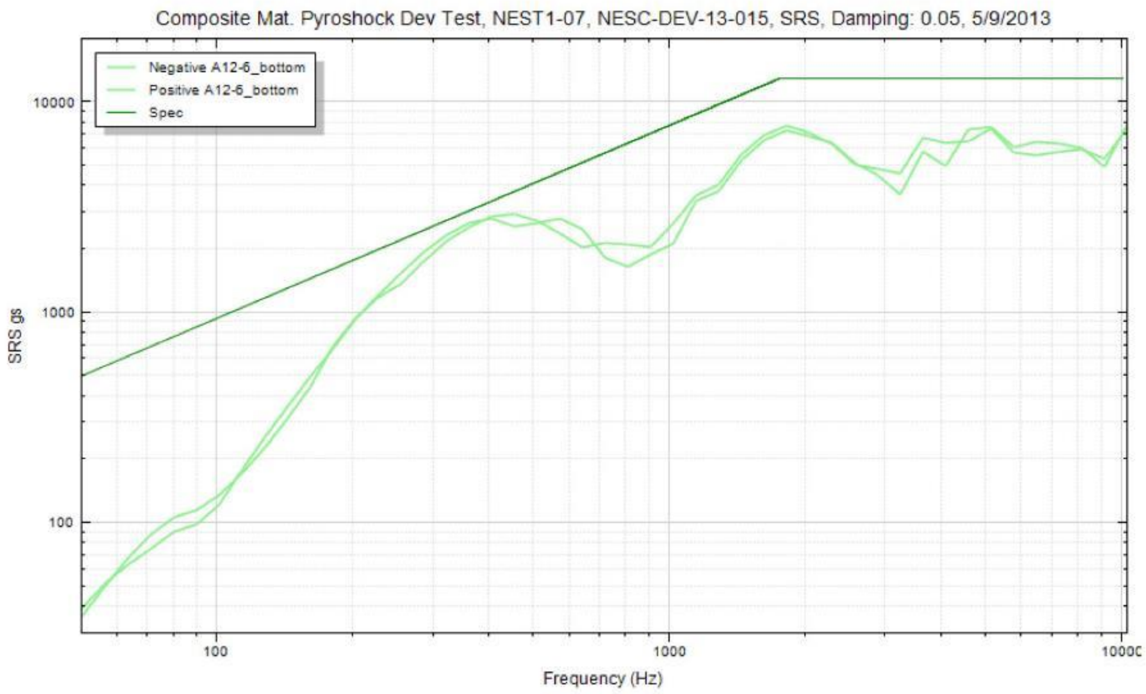
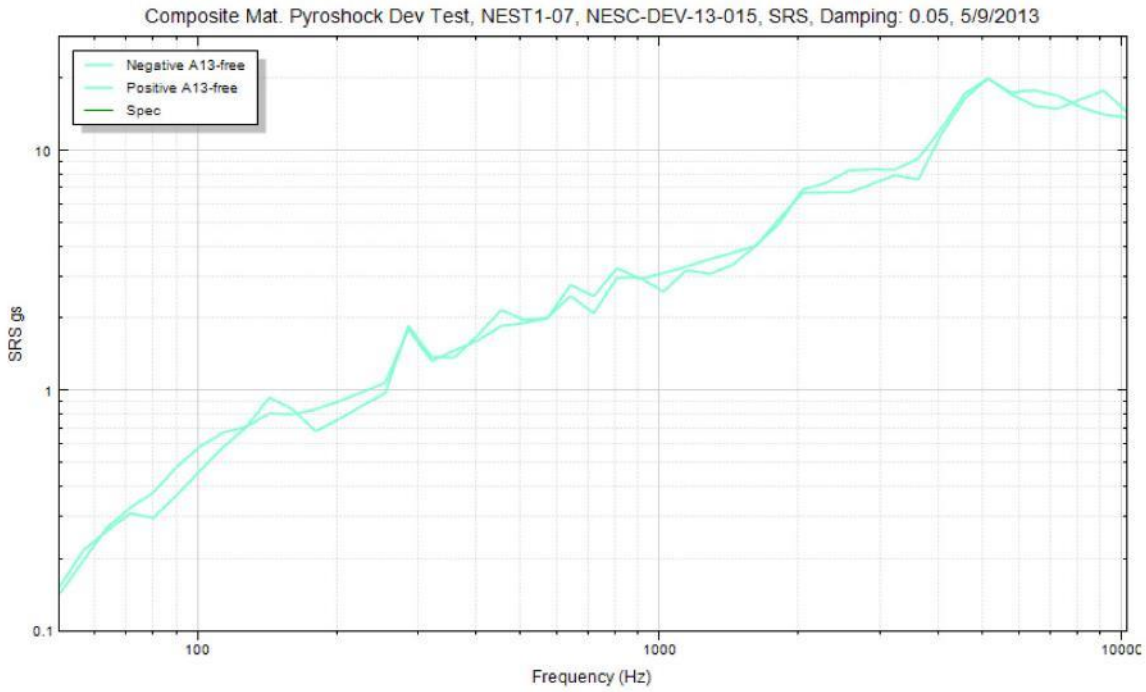
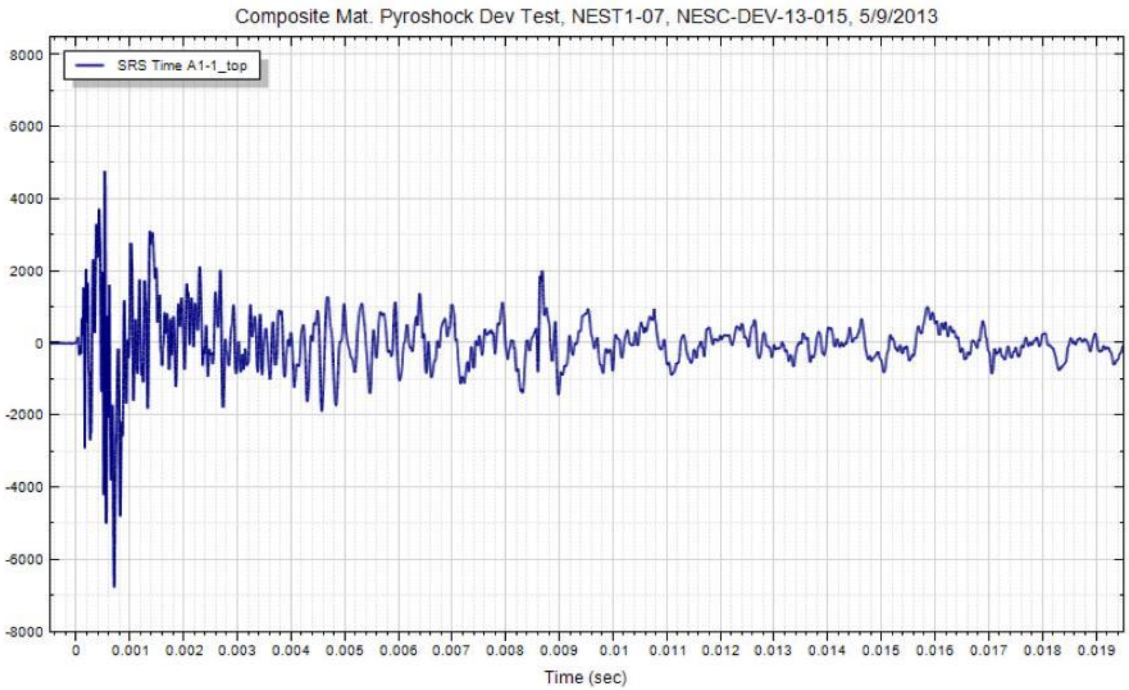

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)

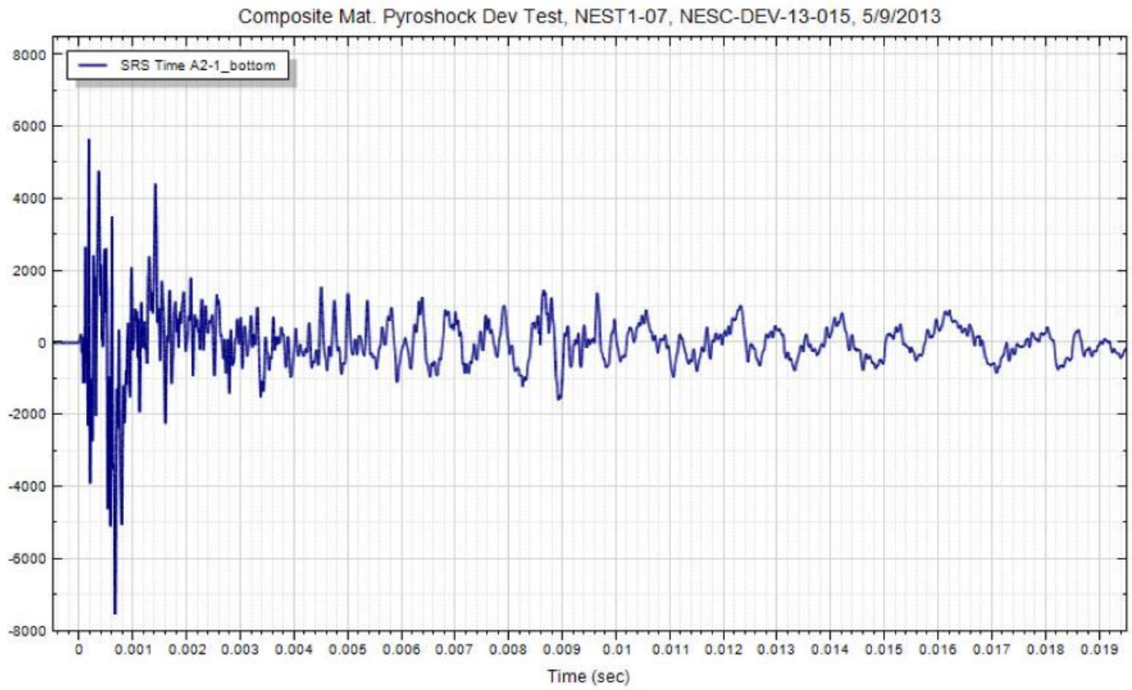

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
10000
1000
100
SRS gs
100
1000
10000
Frequency (Hz)

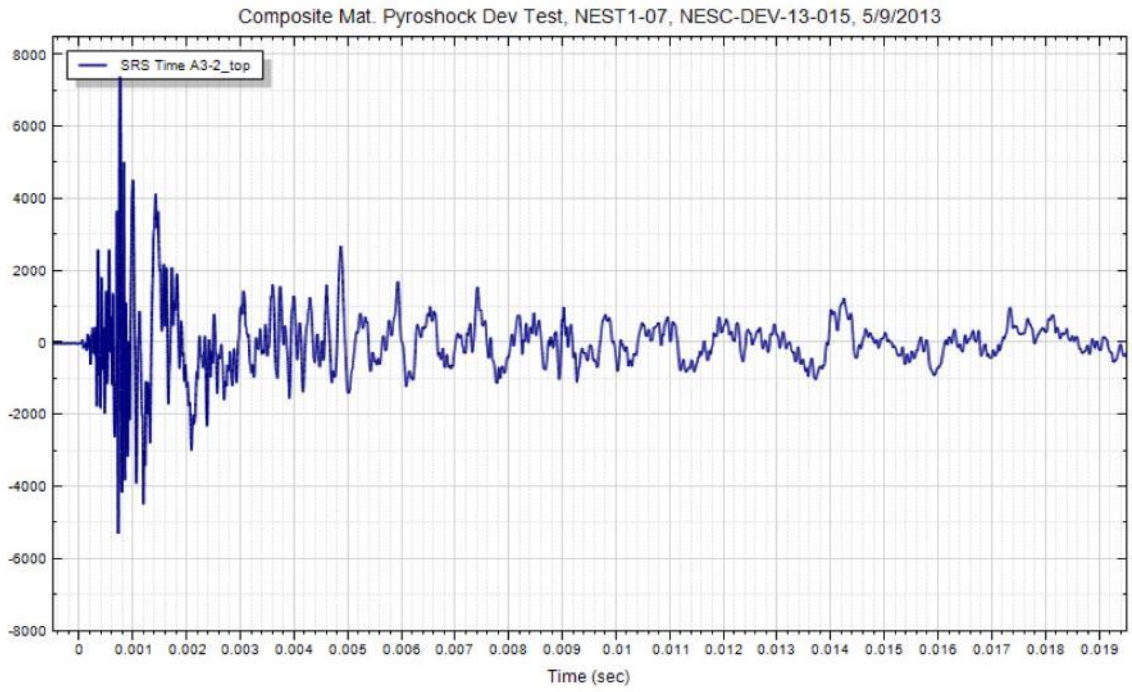
104 of 210

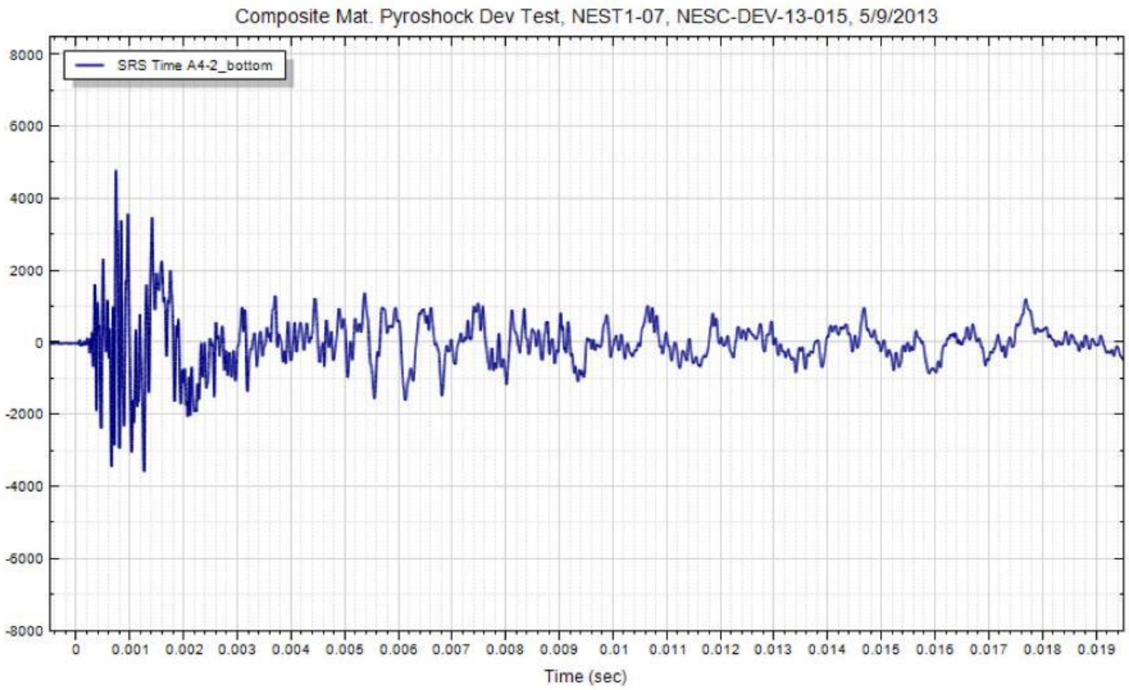

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, SRS, Damping: 0.05, 5/9/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
10000
Frequency (Hz)

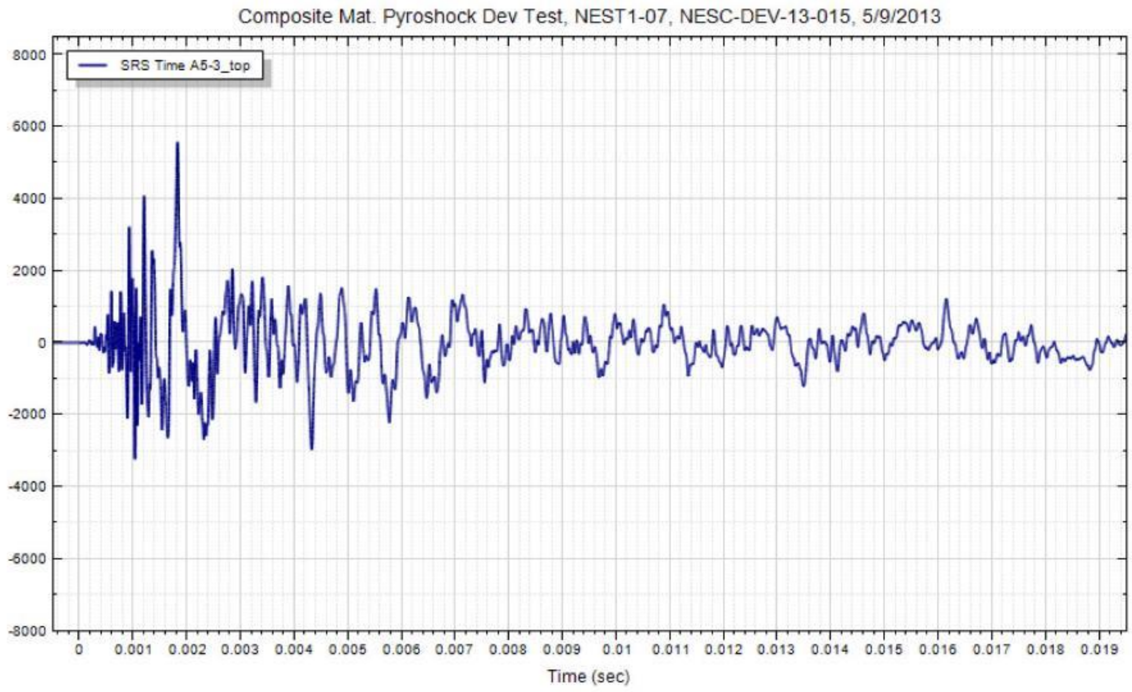

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A1-1_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

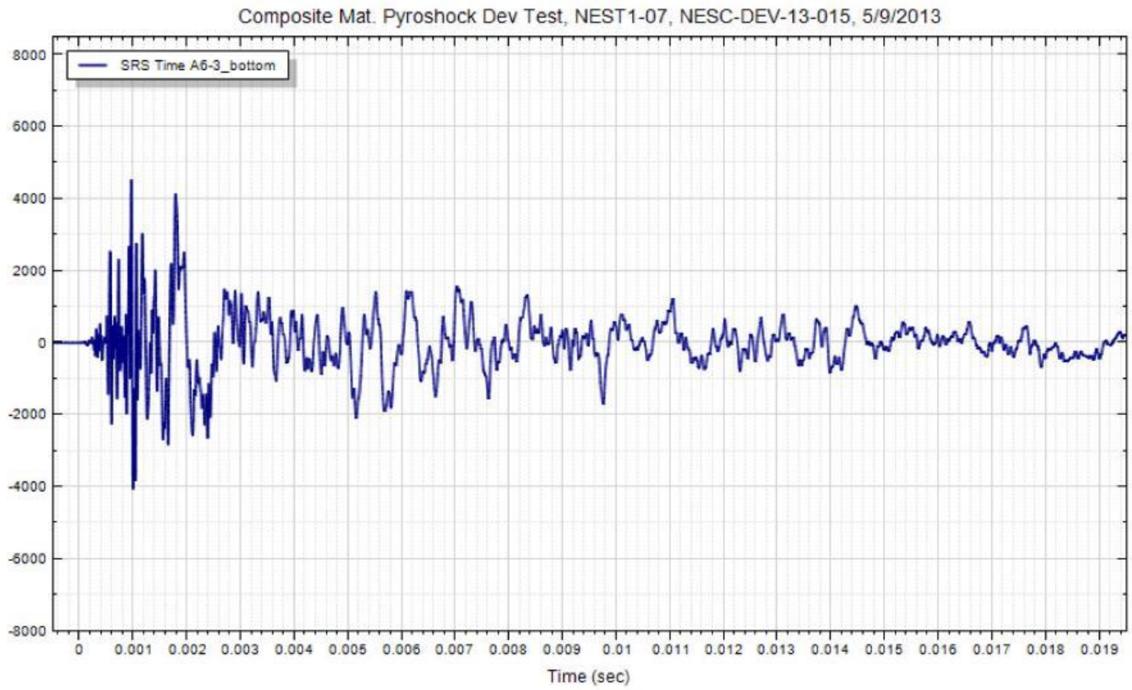
106 of 210

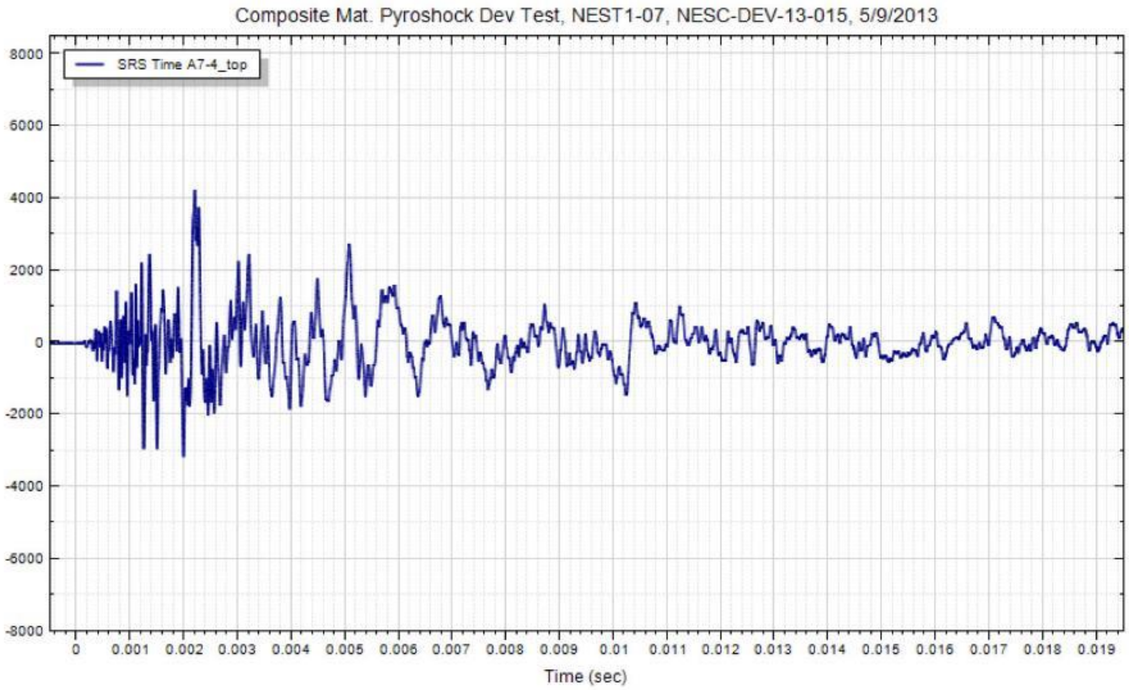

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A2-1_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

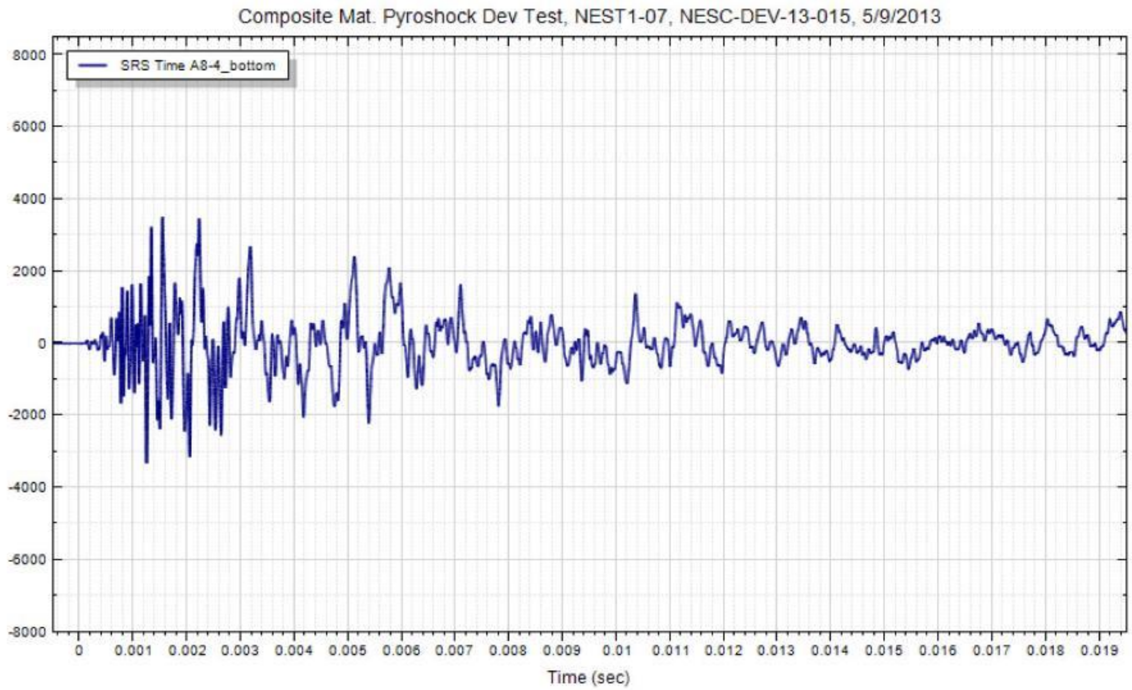

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A3-2_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

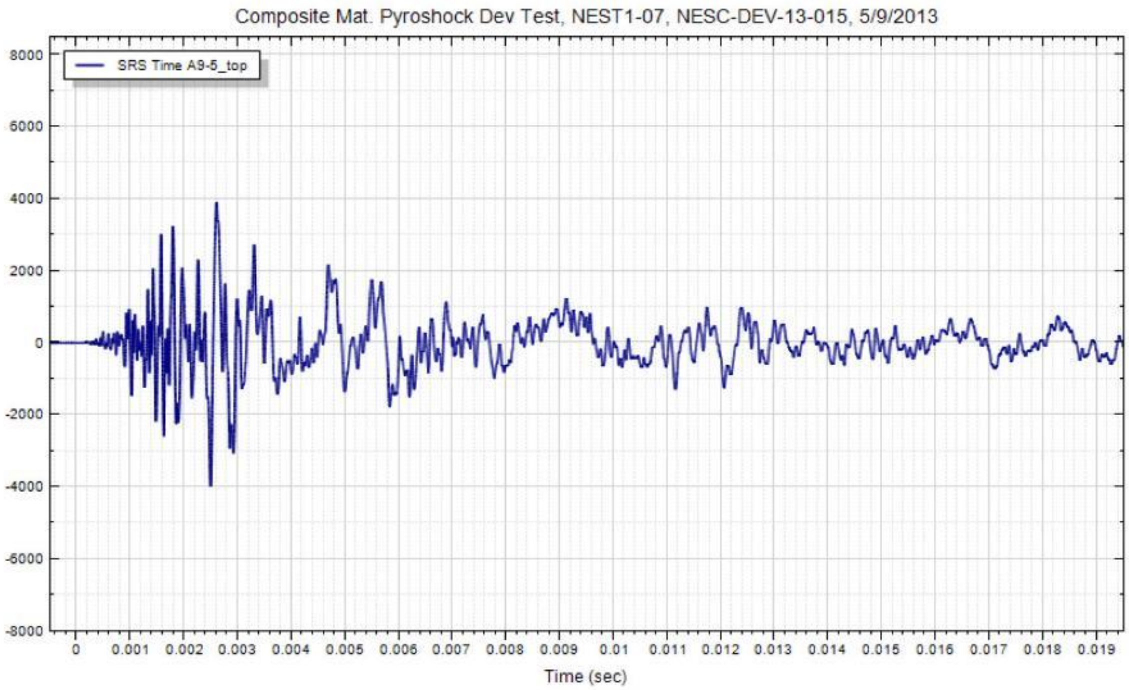

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A4-2_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

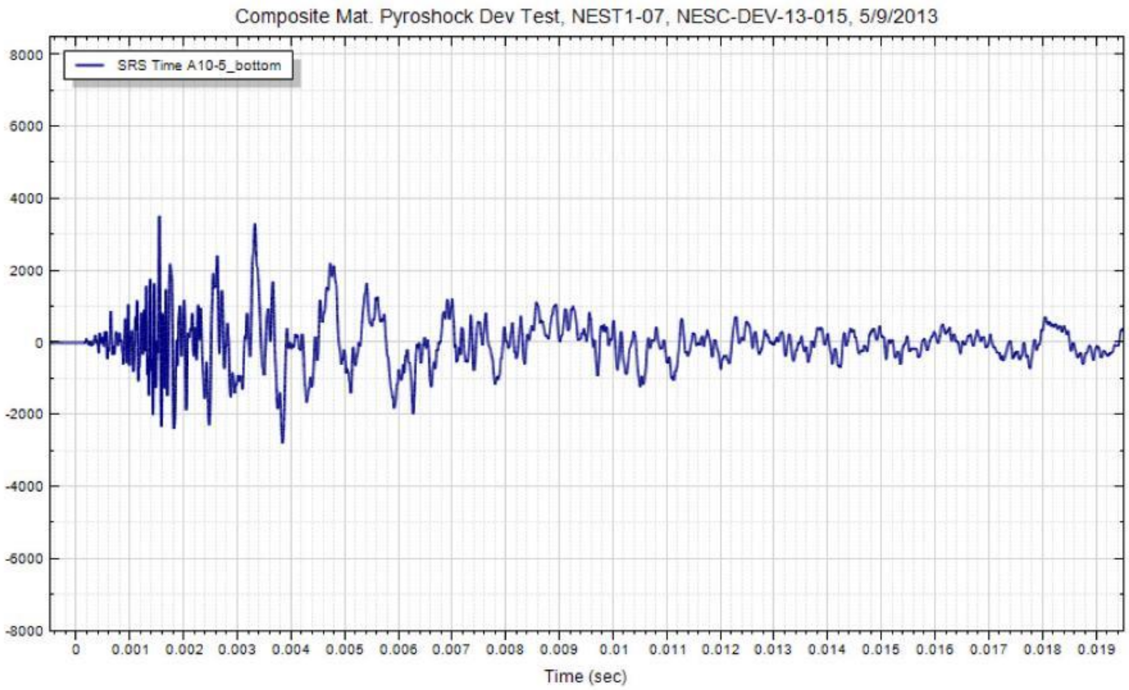

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A5-3_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

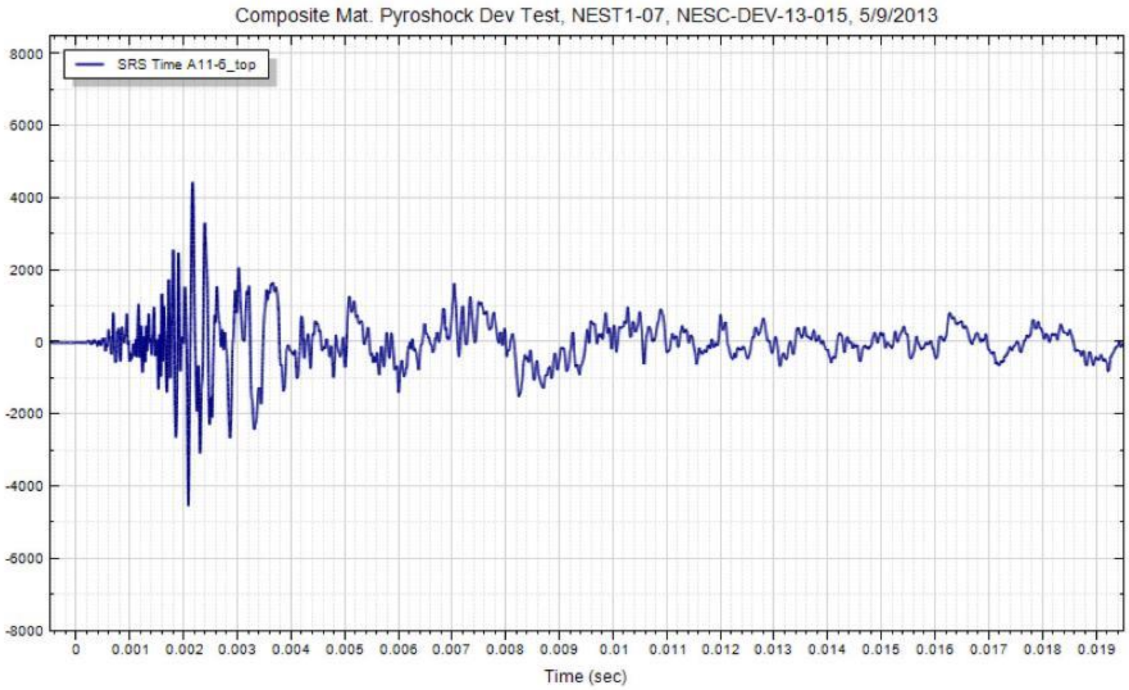

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A6-3_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

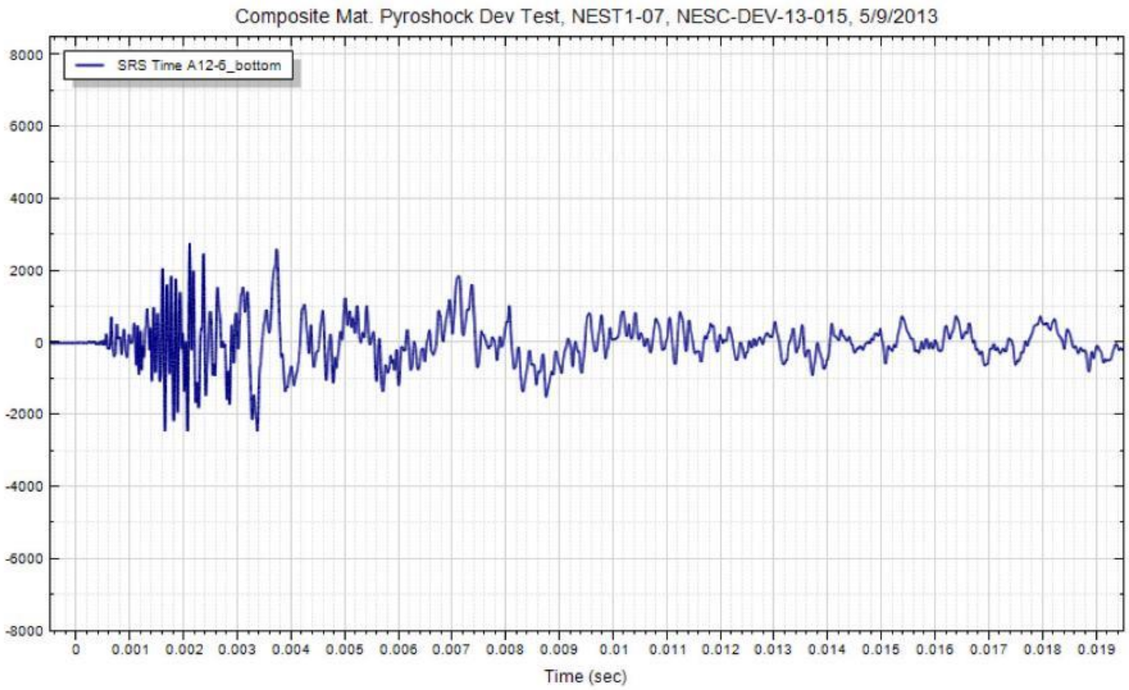

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A7-4_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

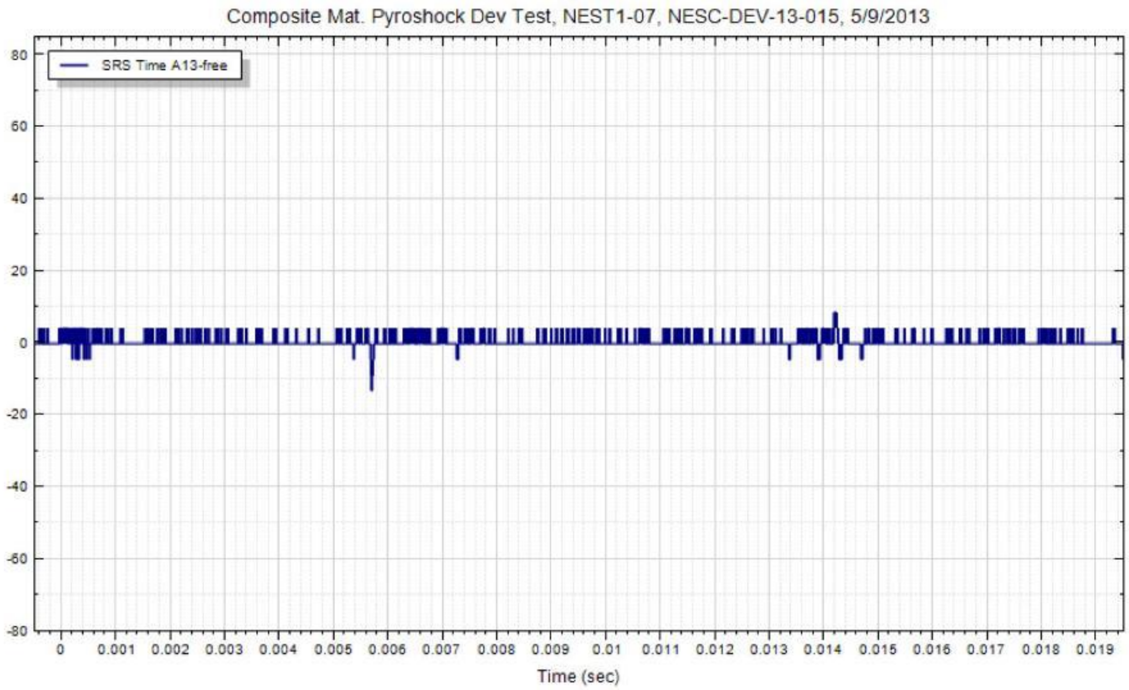

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A8-4_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

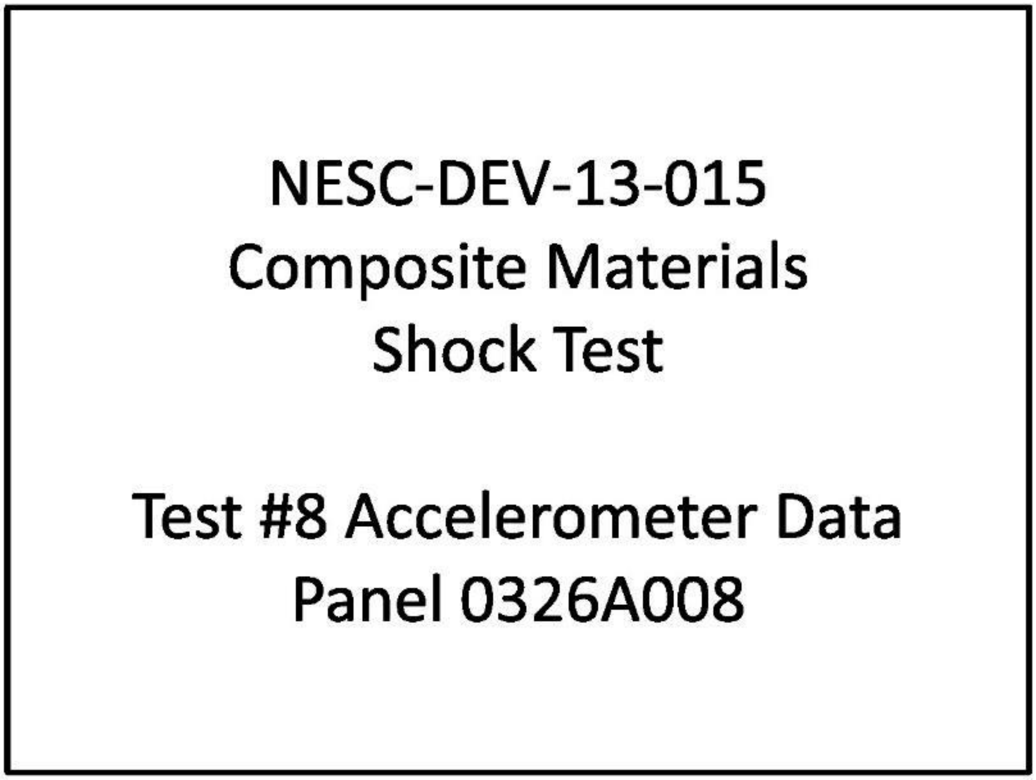

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A9-5_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A10-5_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A11-5_top
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

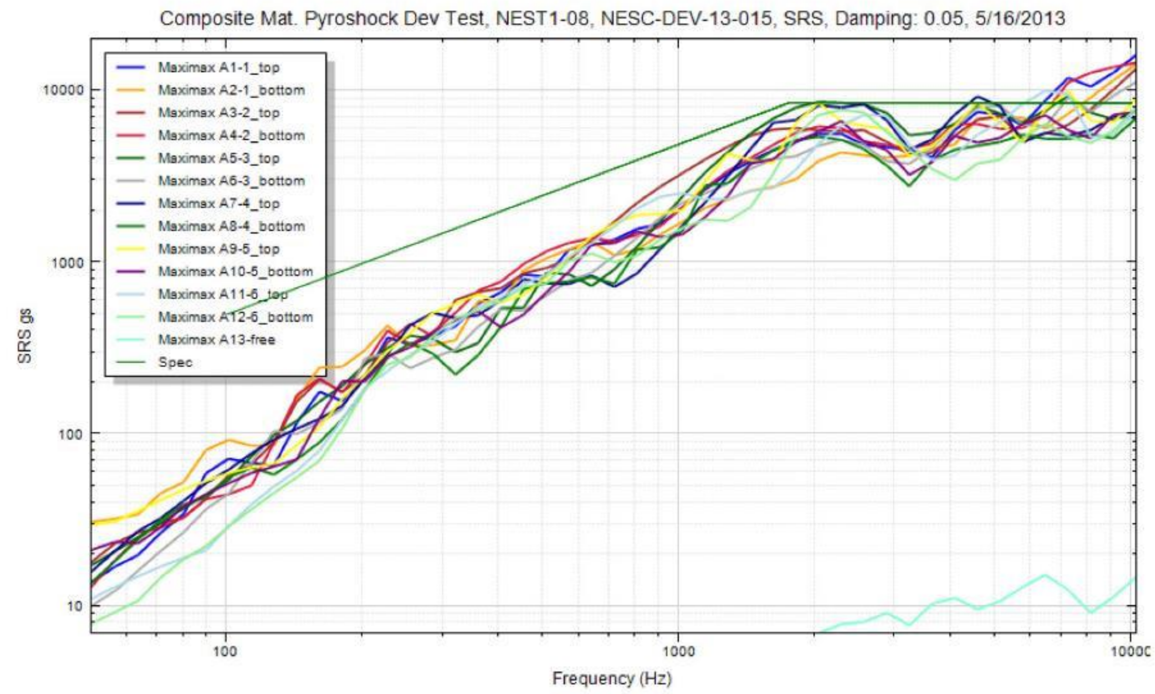

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A12-6_bottom
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

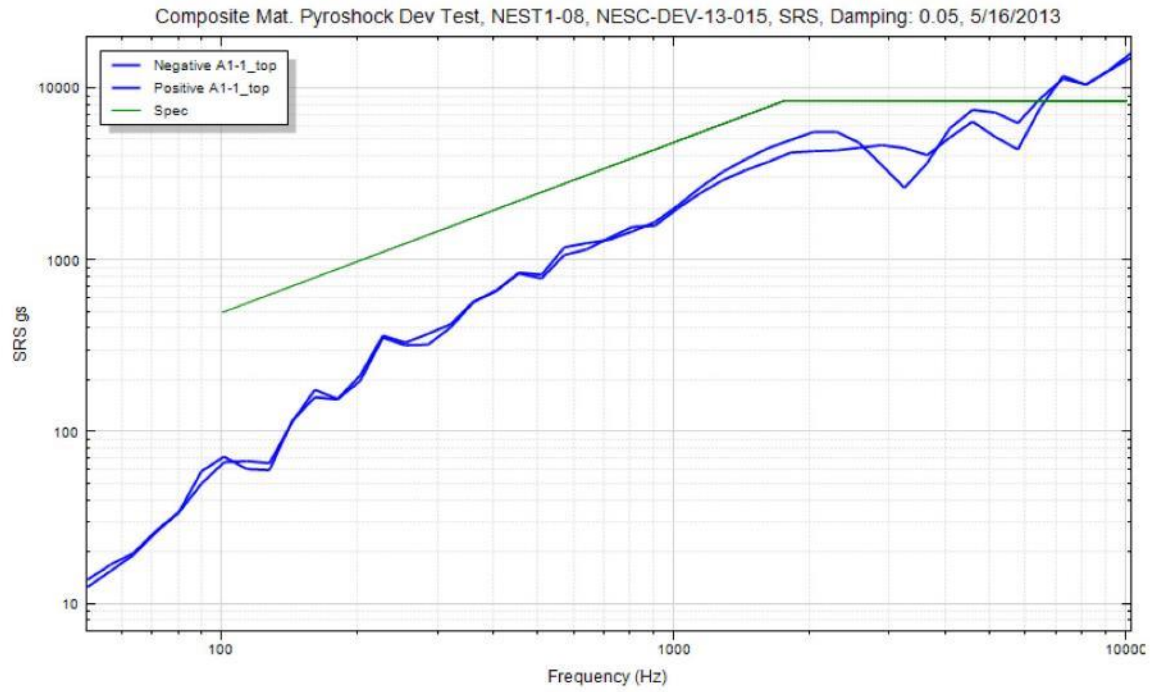

Composite Mat. Pyroshock Dev Test, NEST1-07, NESC-DEV-13-015, 5/9/2013
SRS Time A13-free
80
60
40
20
0
-20
-40
-60
-80
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

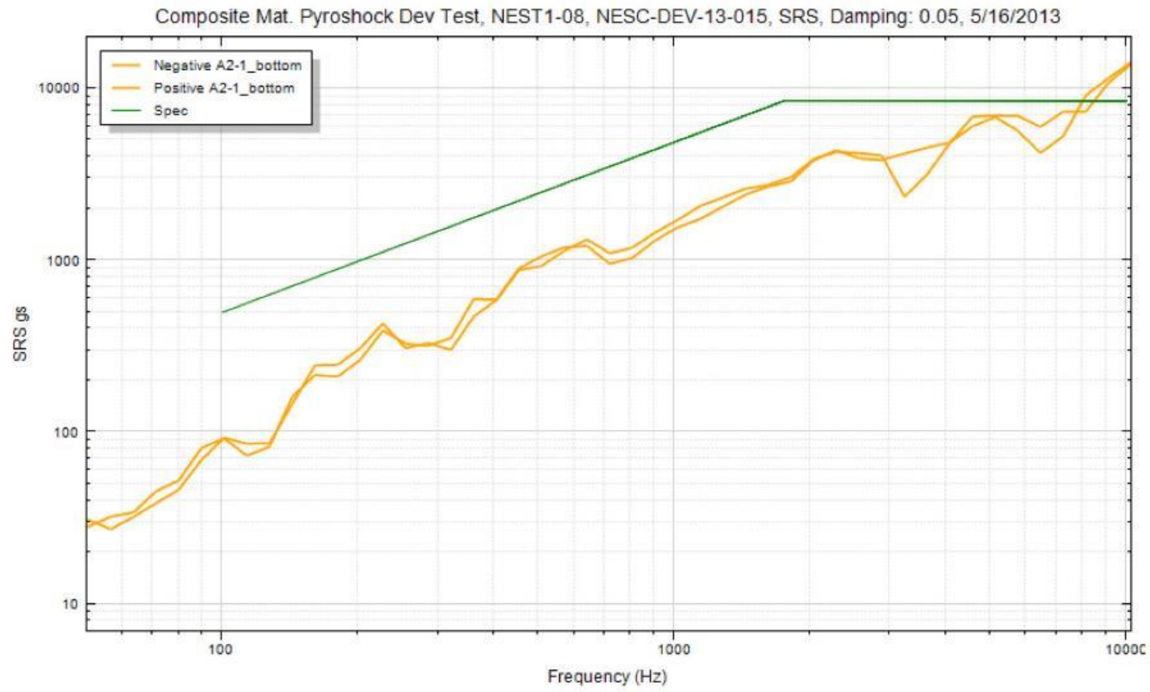


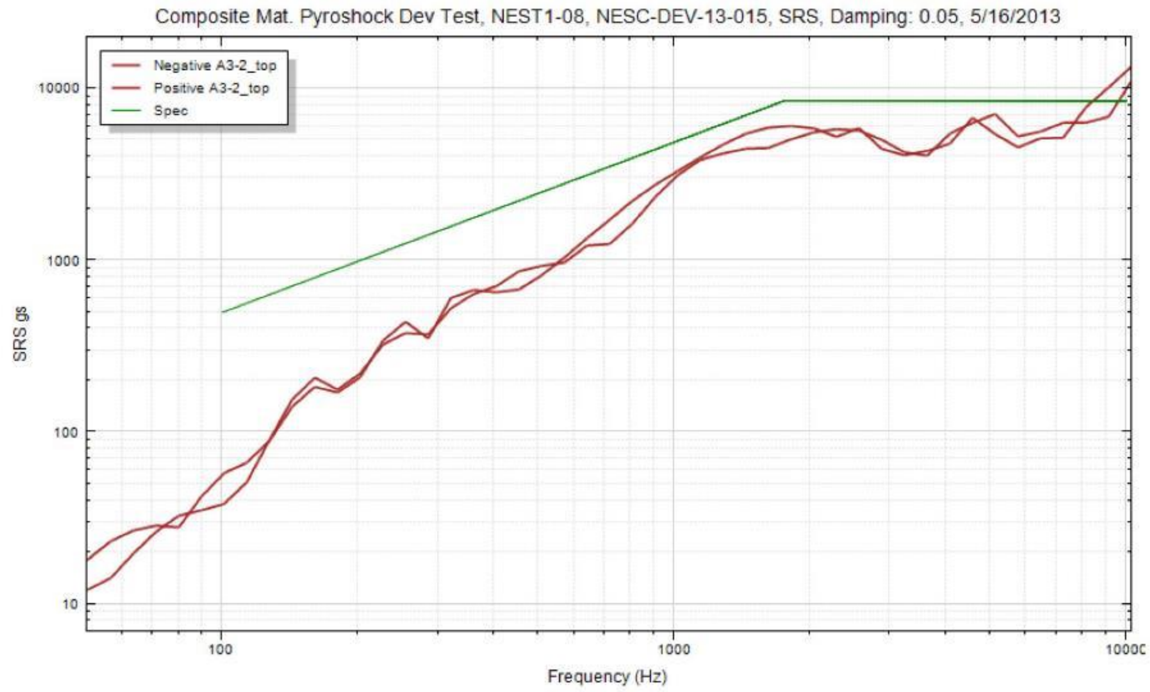
NESC-DEV-13-015
Composite Materials
Shock Test

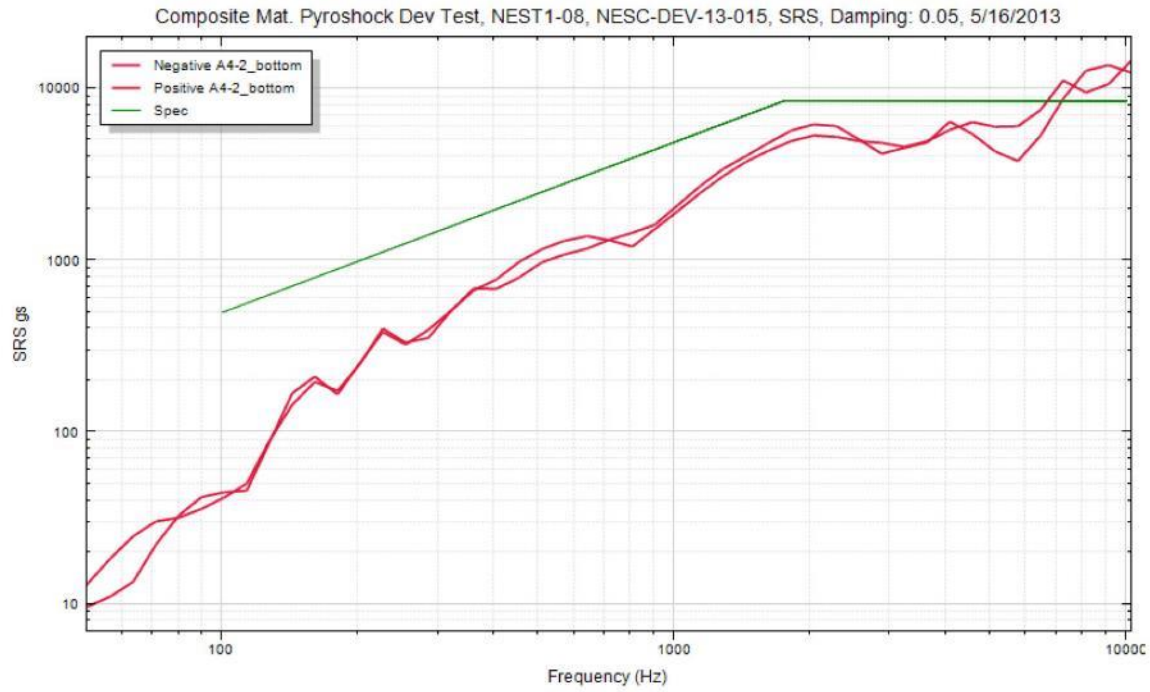
Test #8 Accelerometer Data
Panel 0326A008

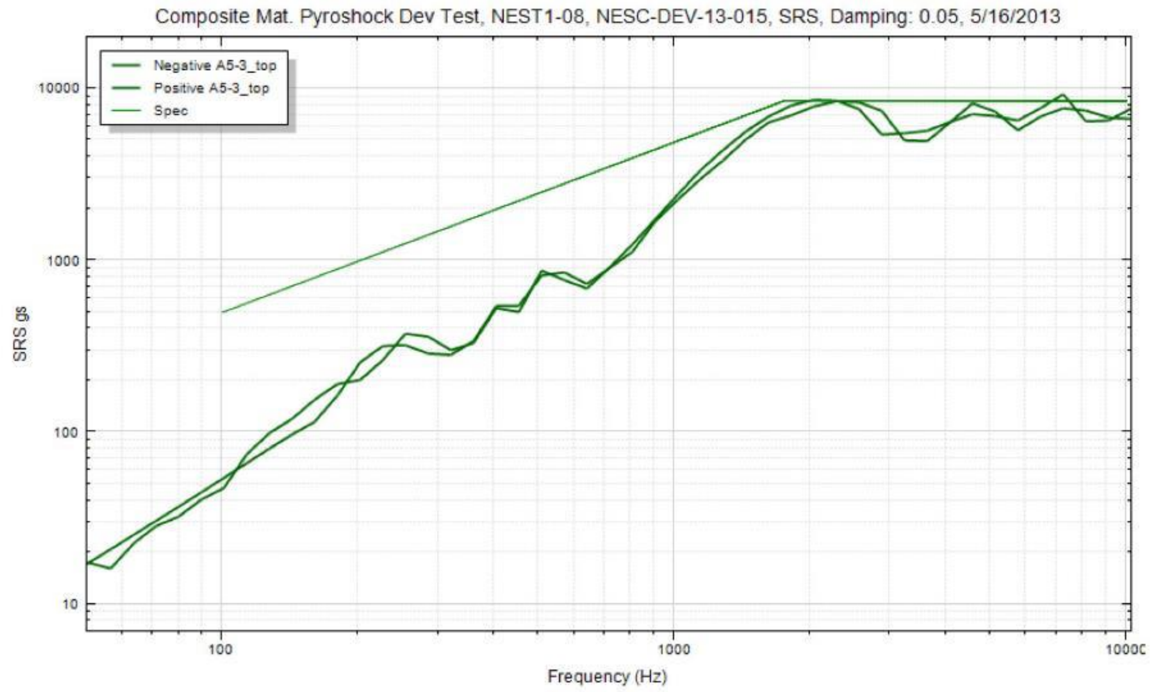

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

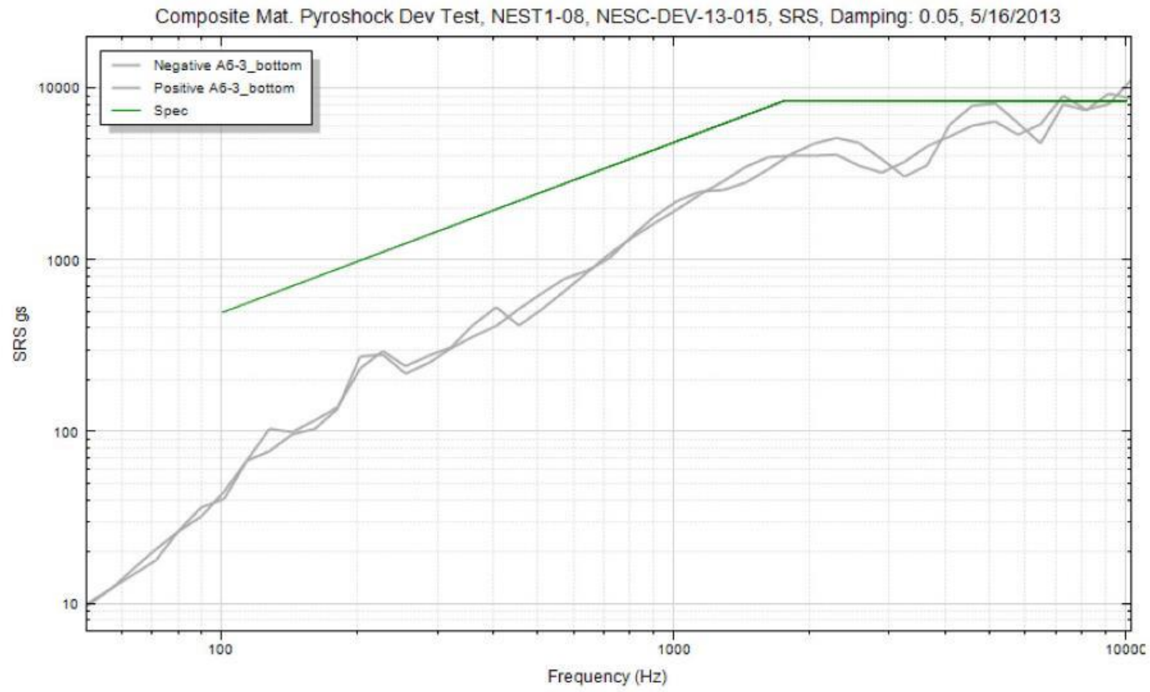

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A1-1_top
Positive A1-1_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

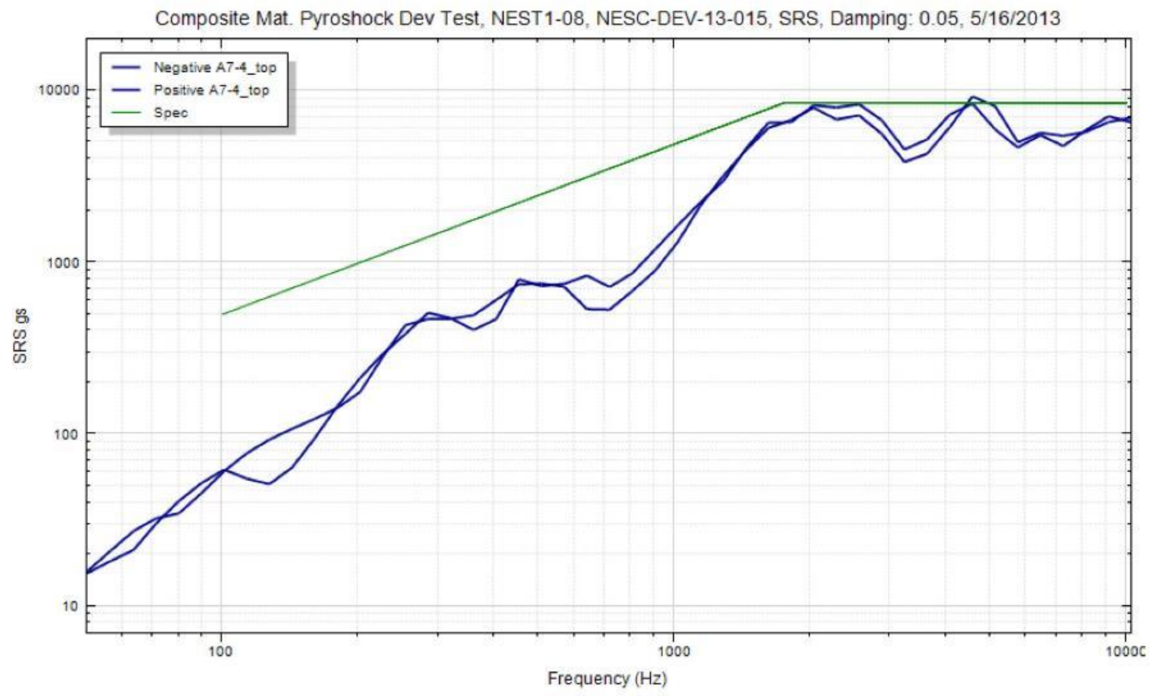

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

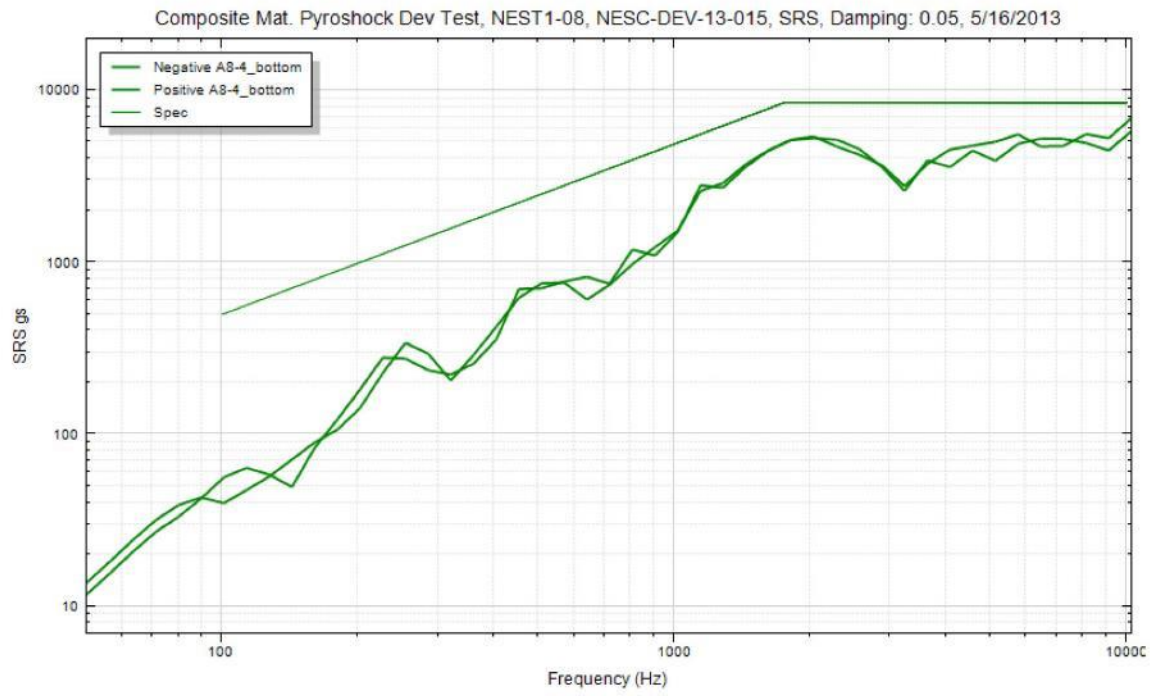

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A3-2_top
Positive A3-2_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

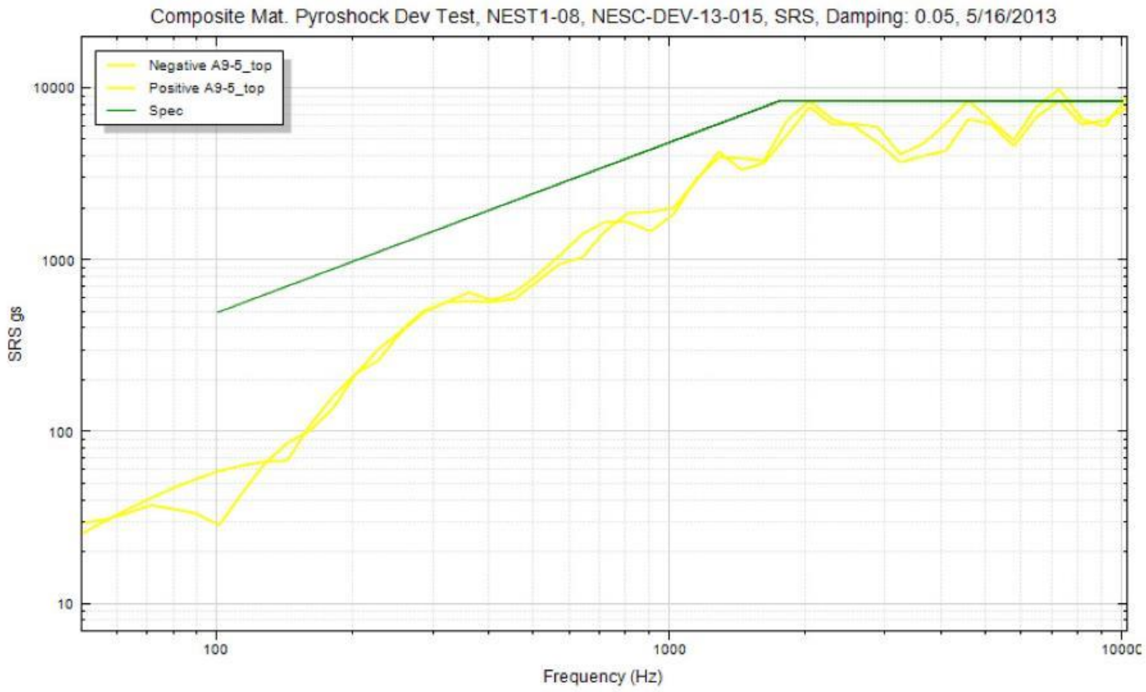

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

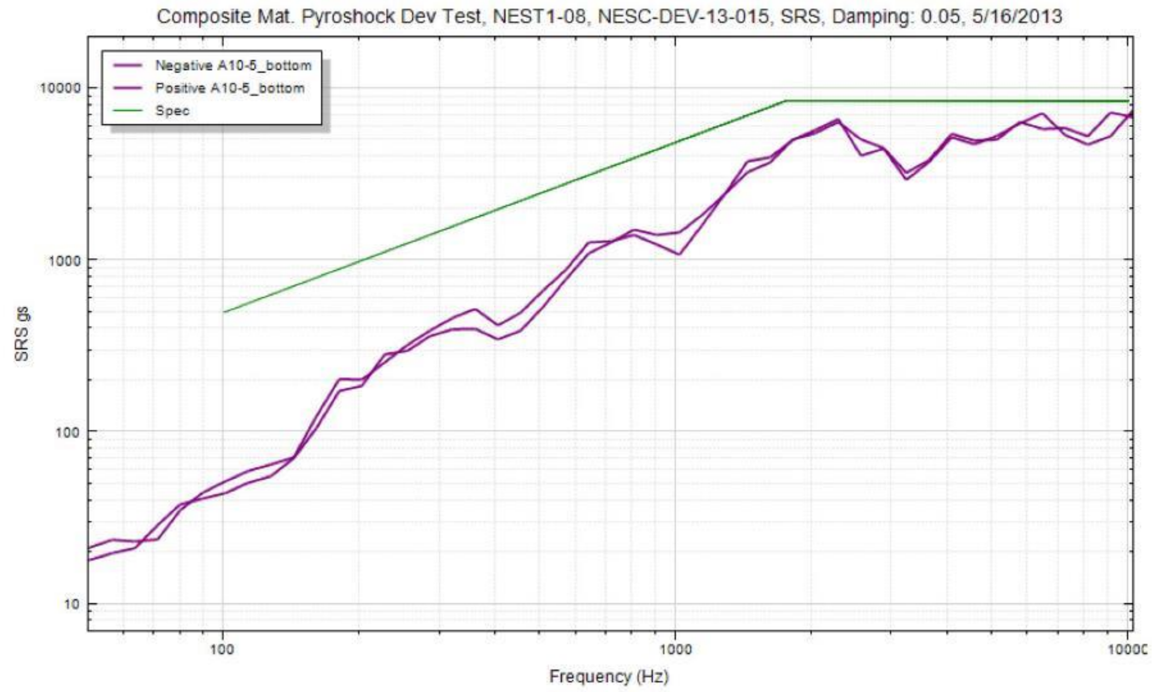

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A5-3_top
Positive A5-3_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

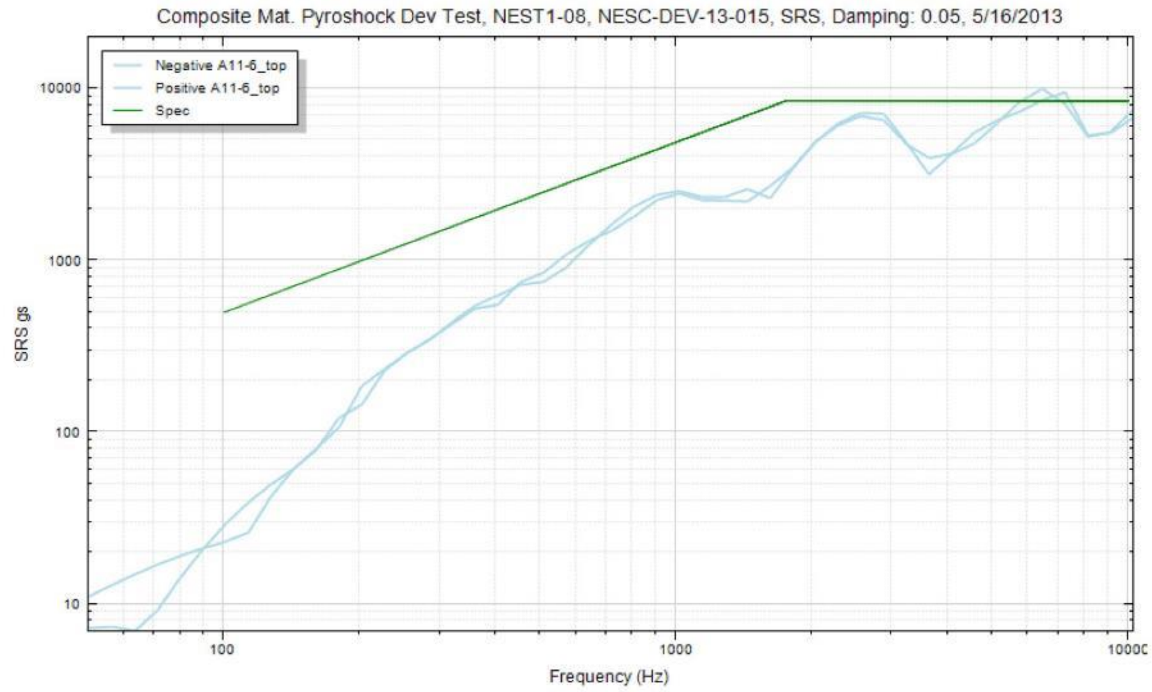

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

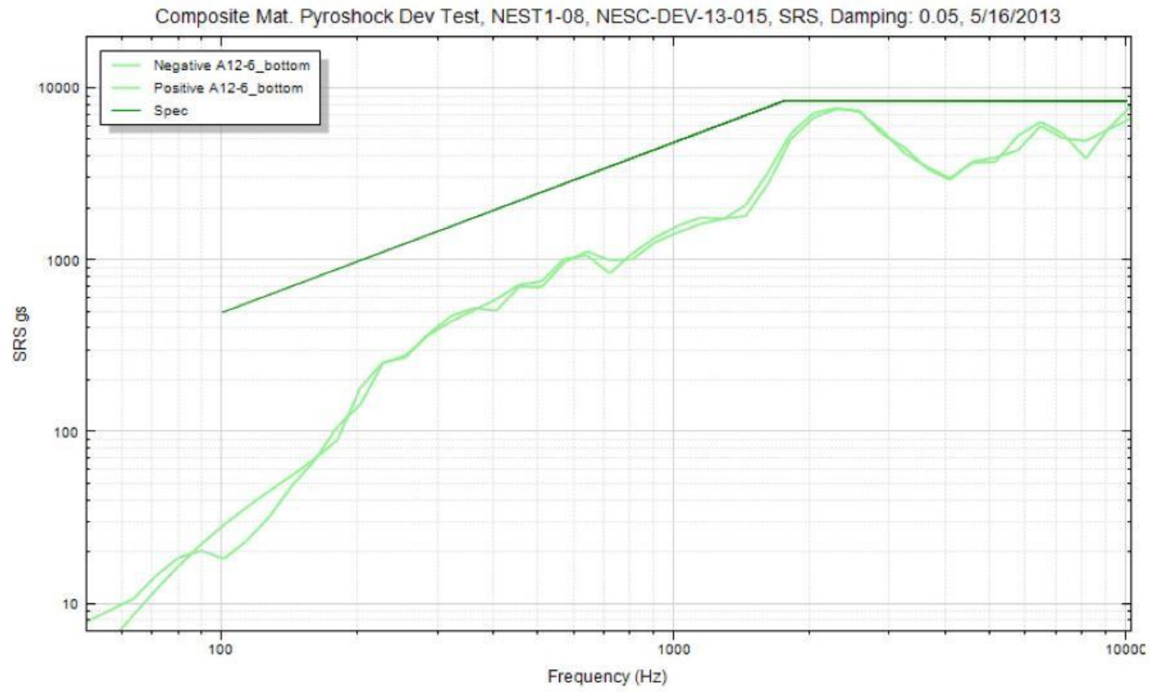

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A7-4_top
Positive A7-4_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

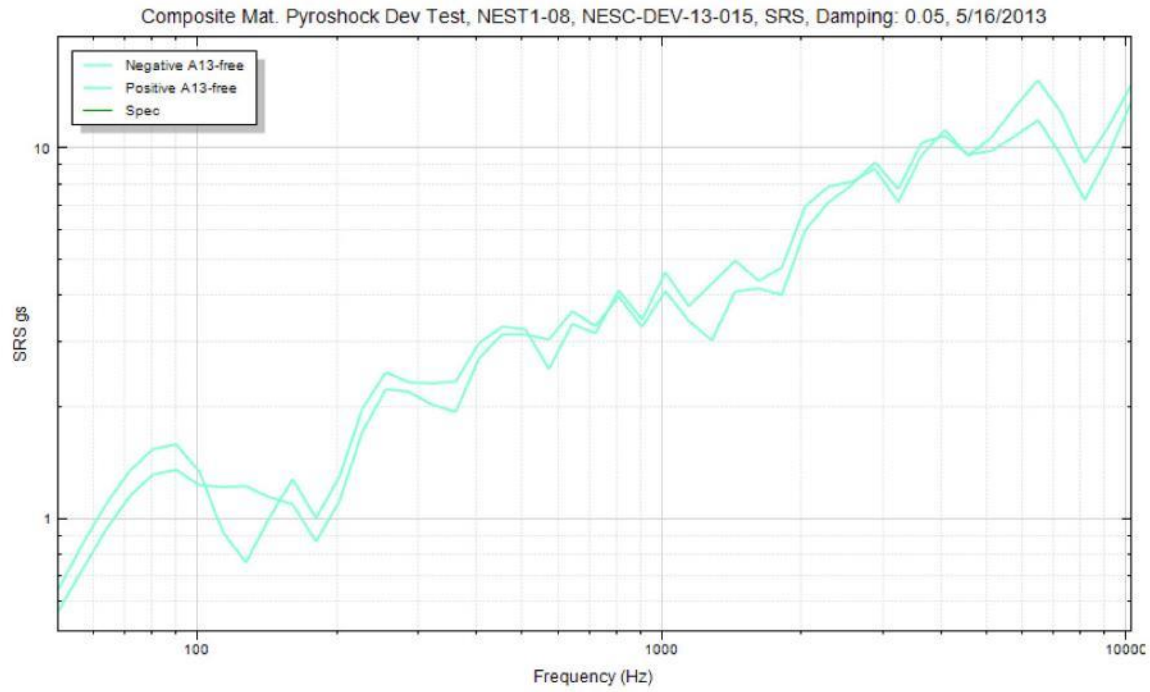

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000


Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

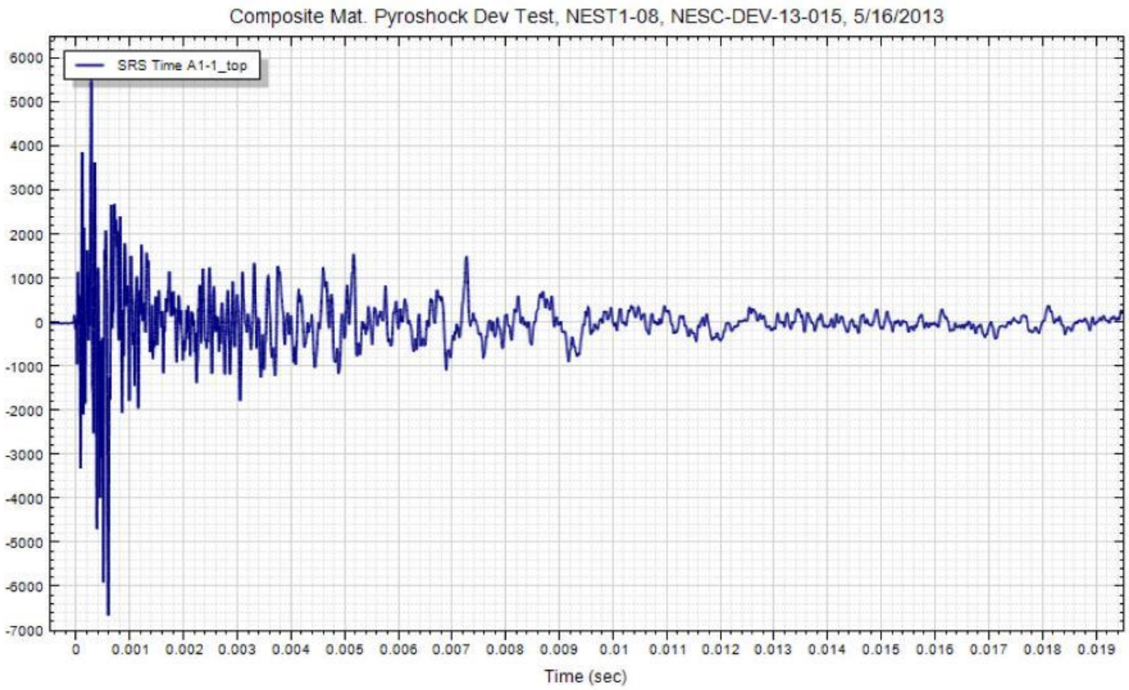

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

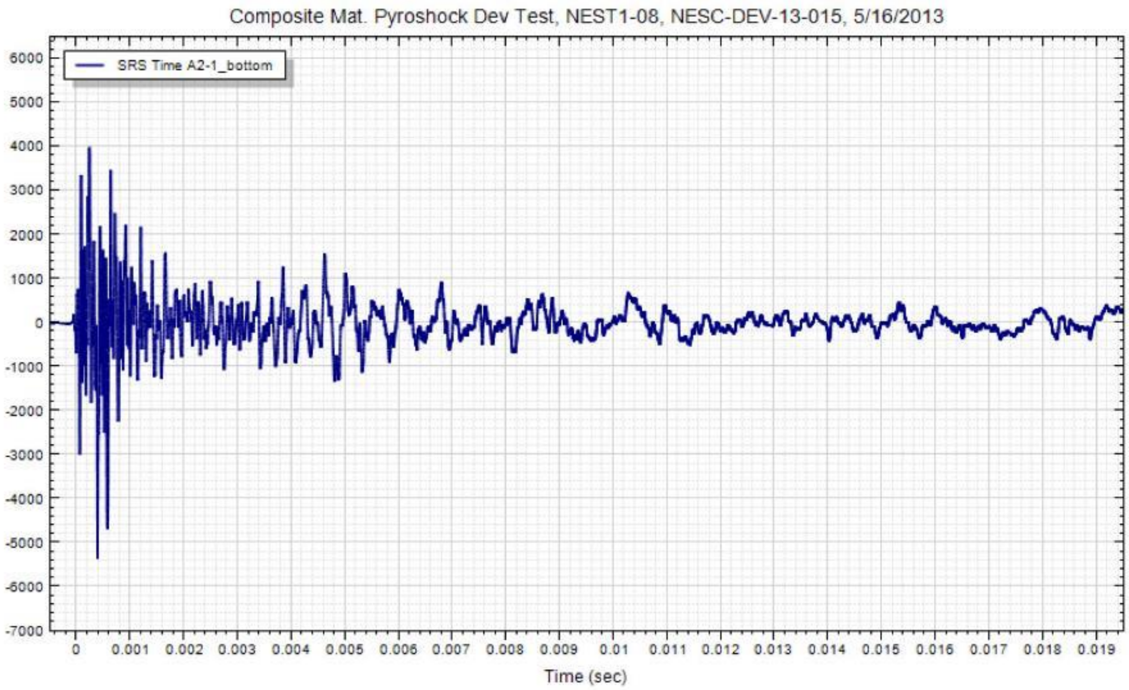

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

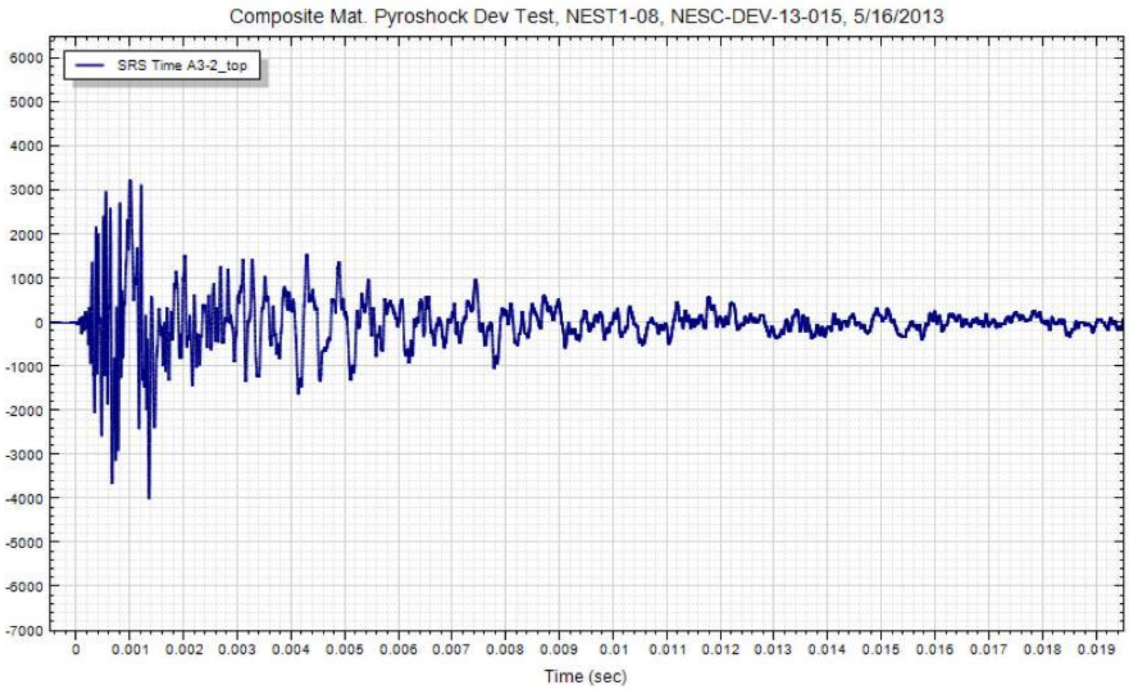

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, SRS, Damping: 0.05, 5/16/2013
Negative A13-free
Positive A13-free
Spec
10
1
SRS gs
100
1000
10000
Frequency (Hz)

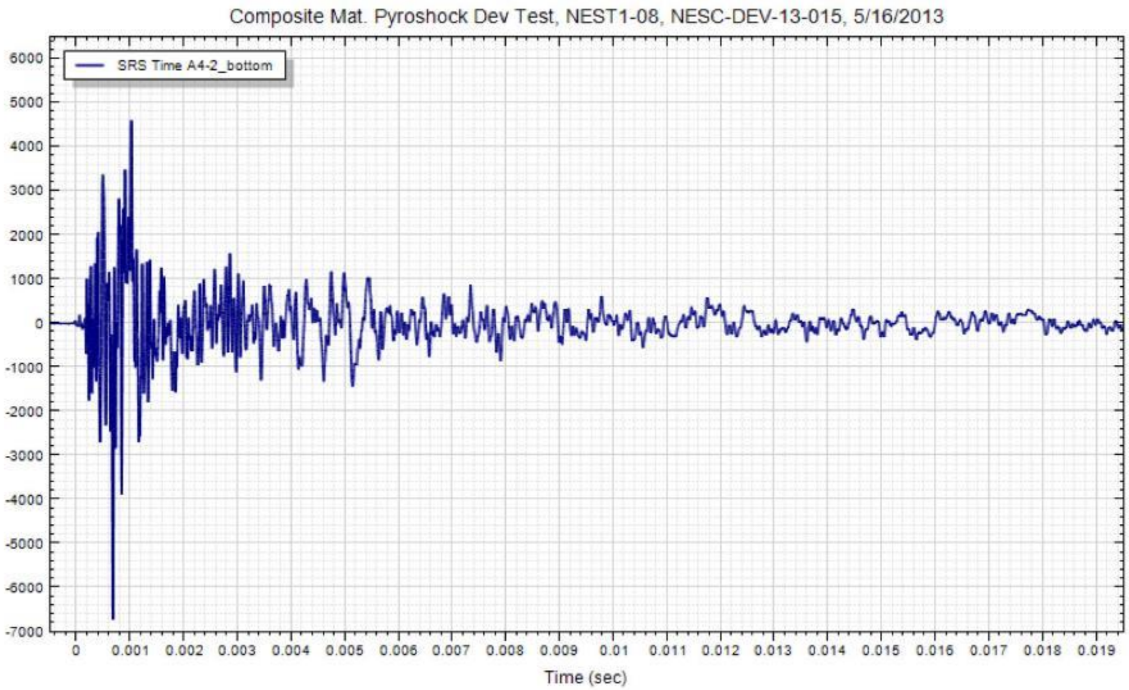
133 of 210

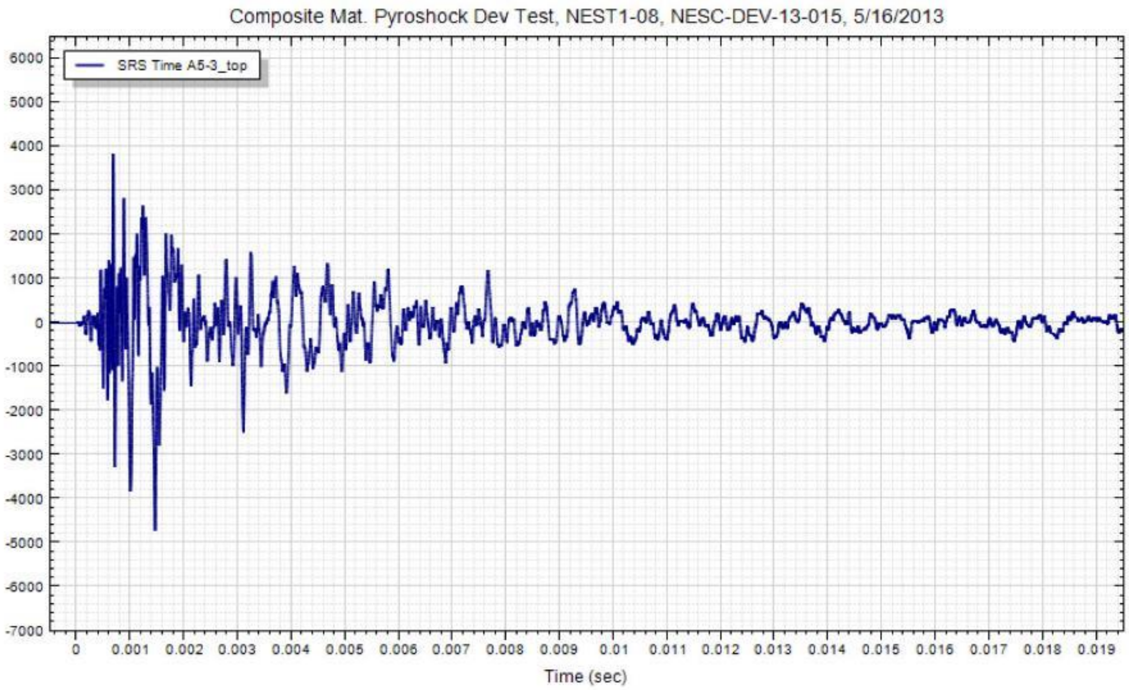

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A1-1_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

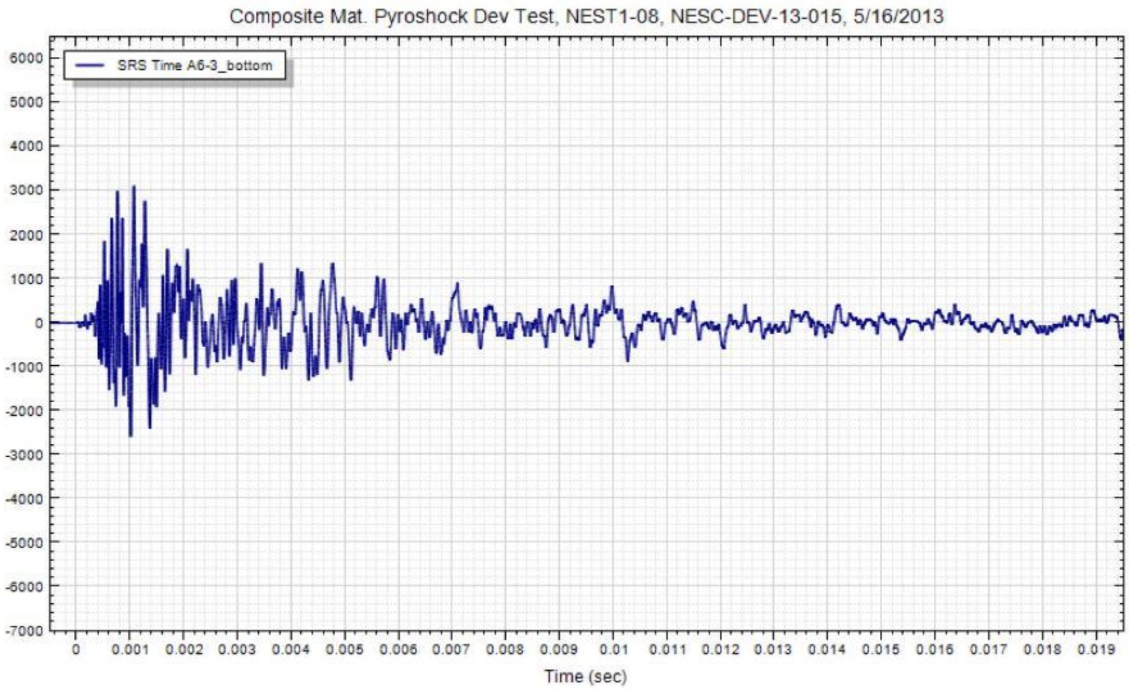

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A2-1_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

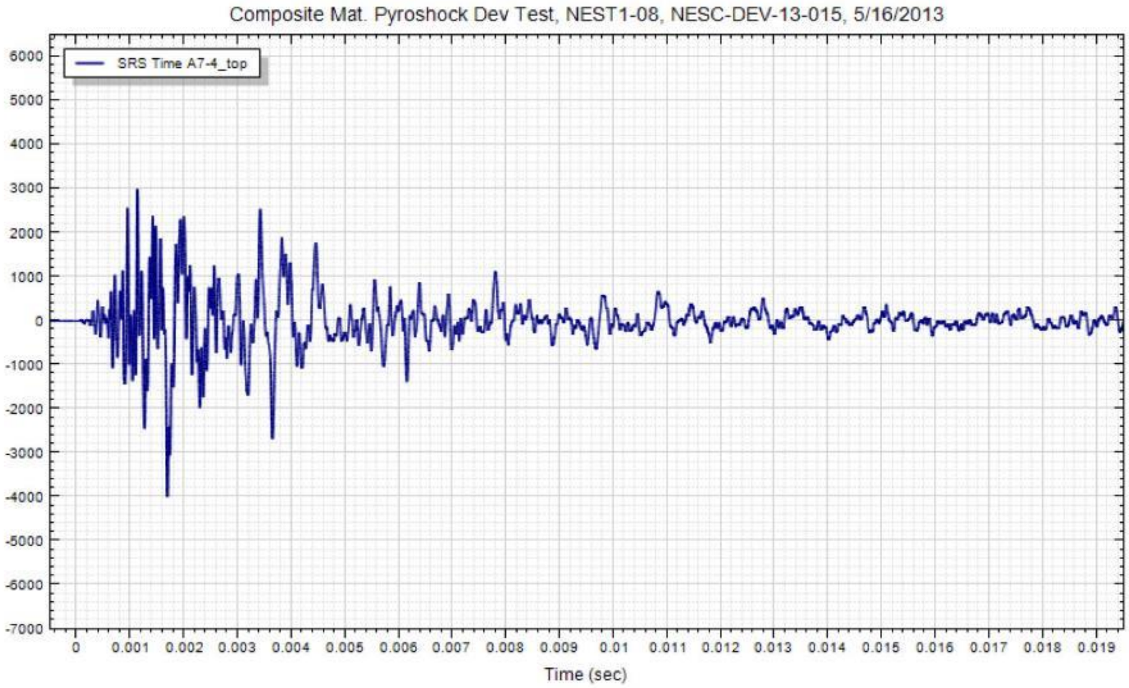
135 of 210

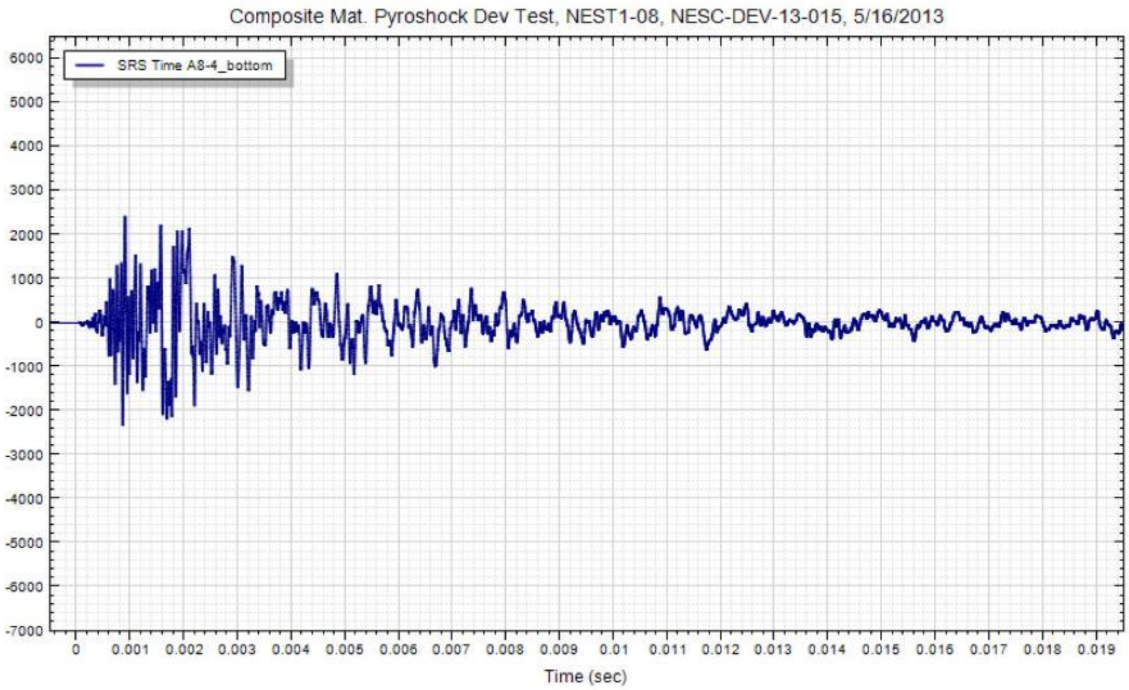

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A3-2_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

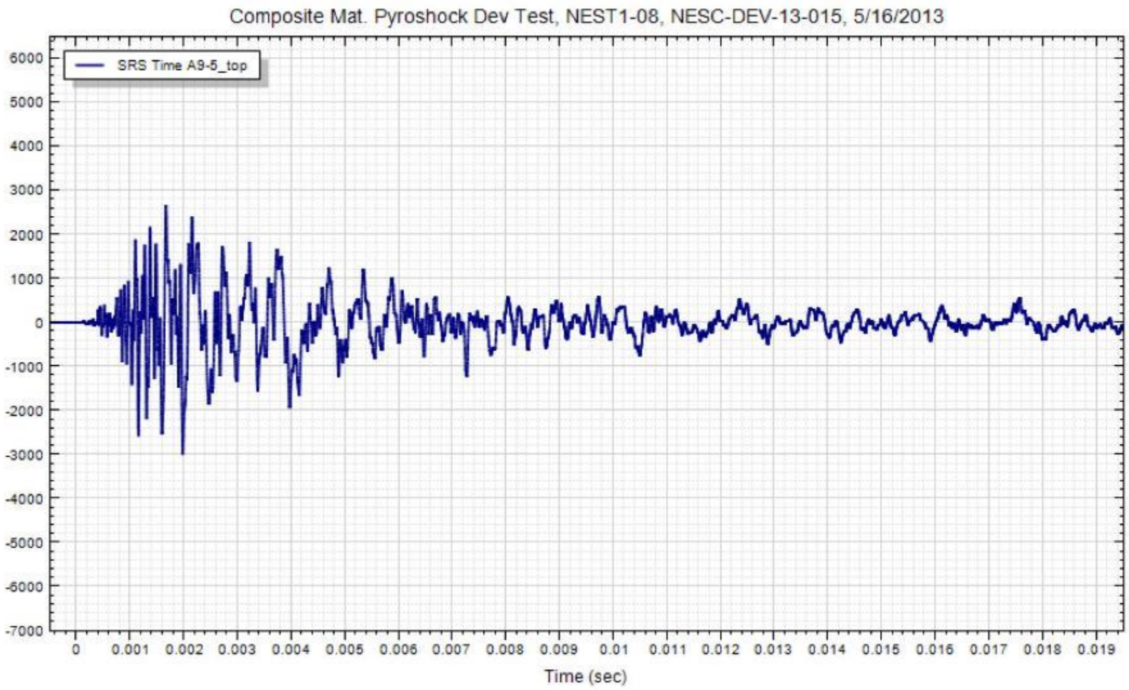

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A4-2_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

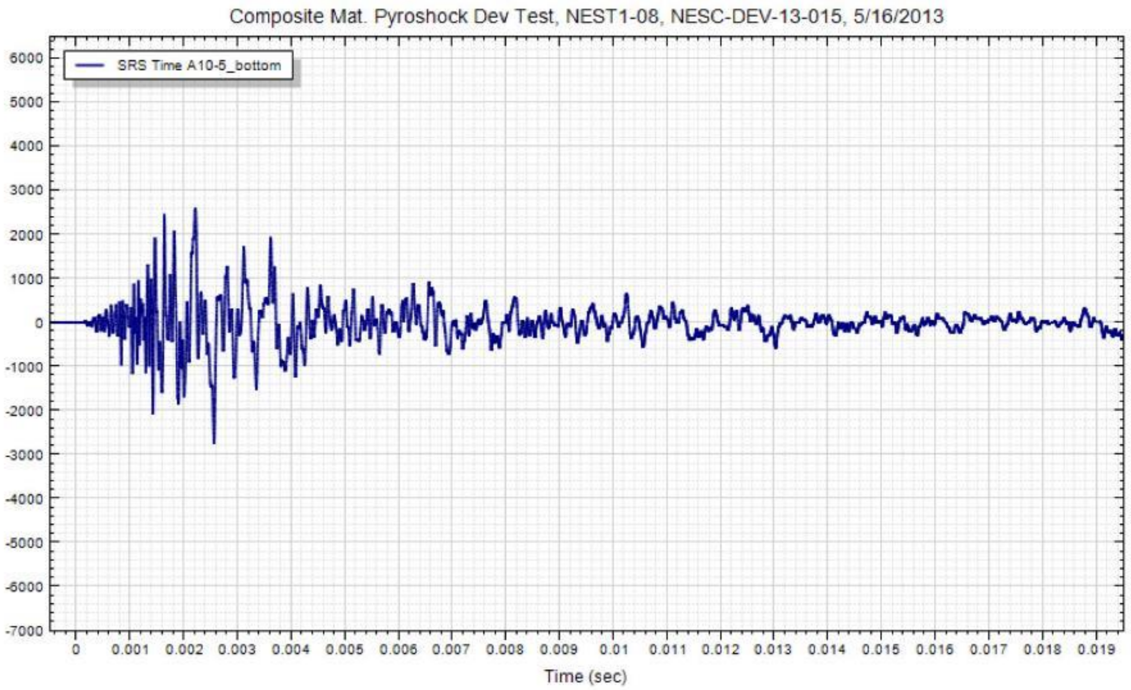

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A5-3_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

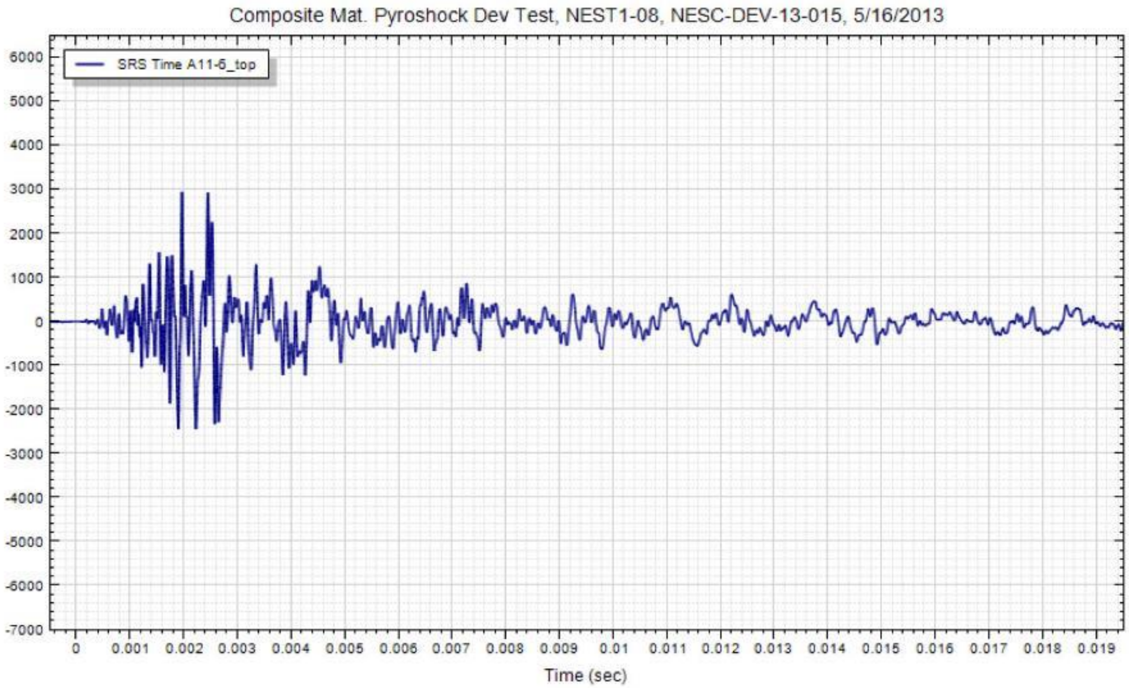

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A6-3_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

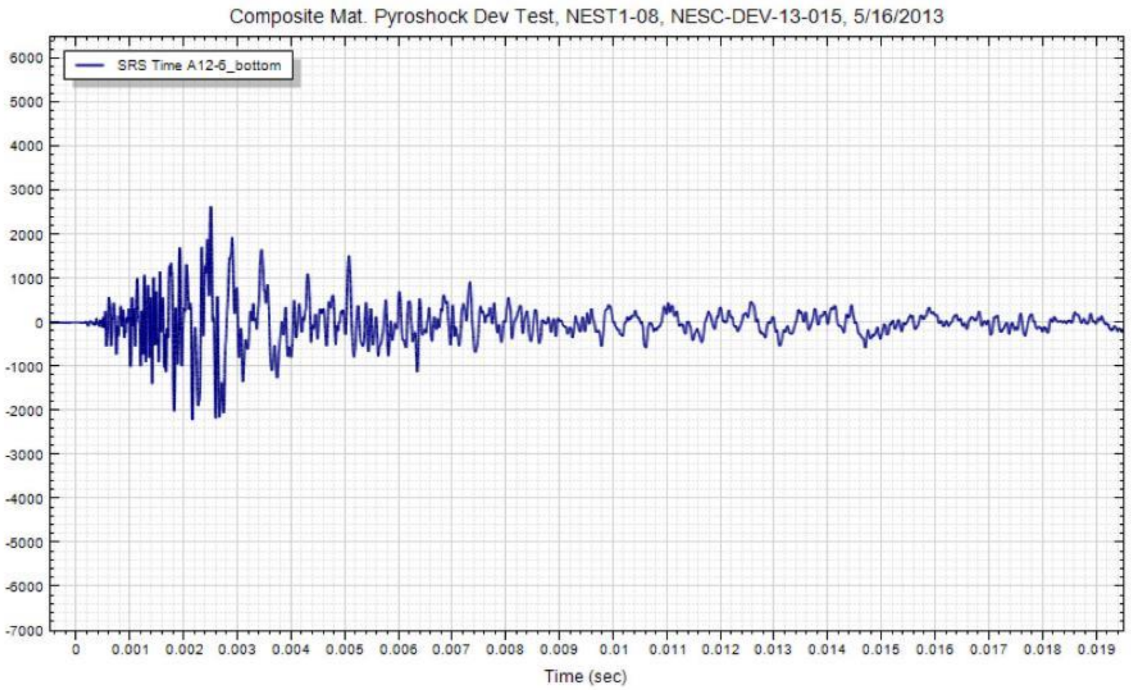

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A7-4_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

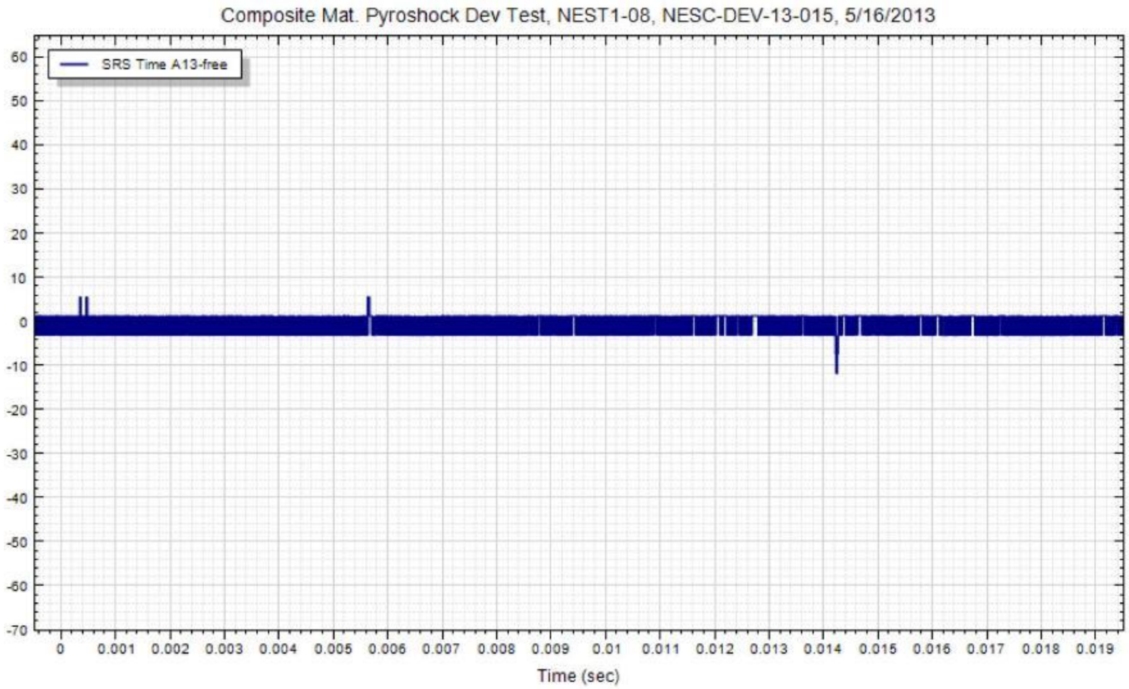

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A8-4_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A9-5_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A10-5_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

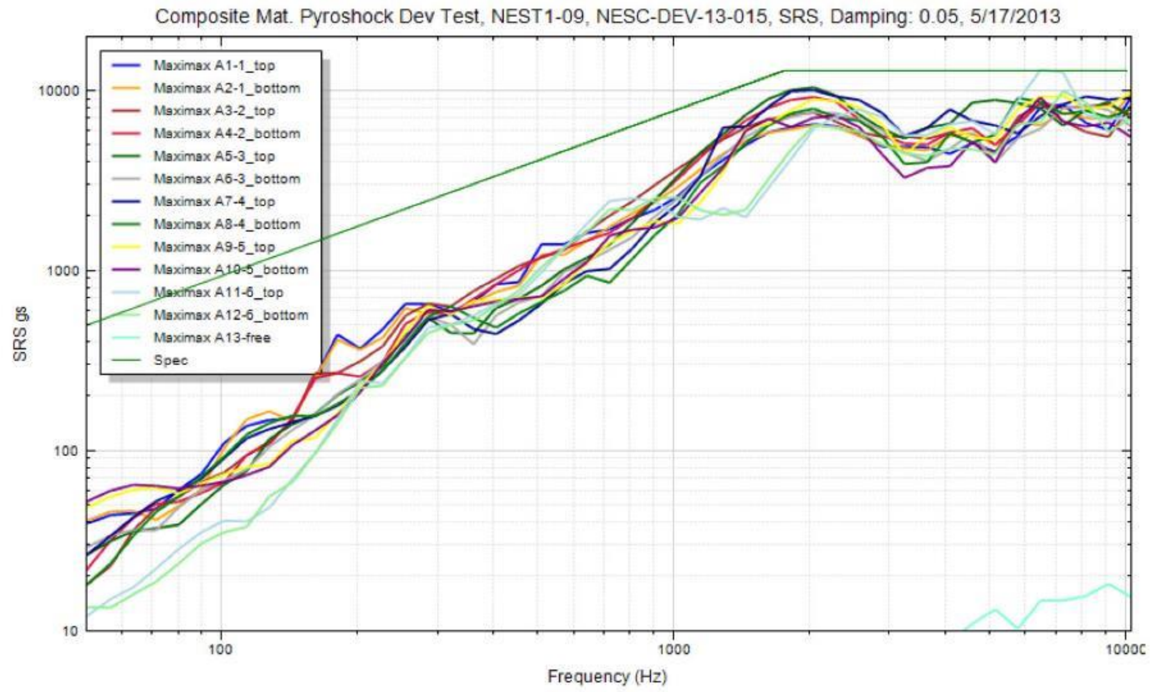

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A11-6_top
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

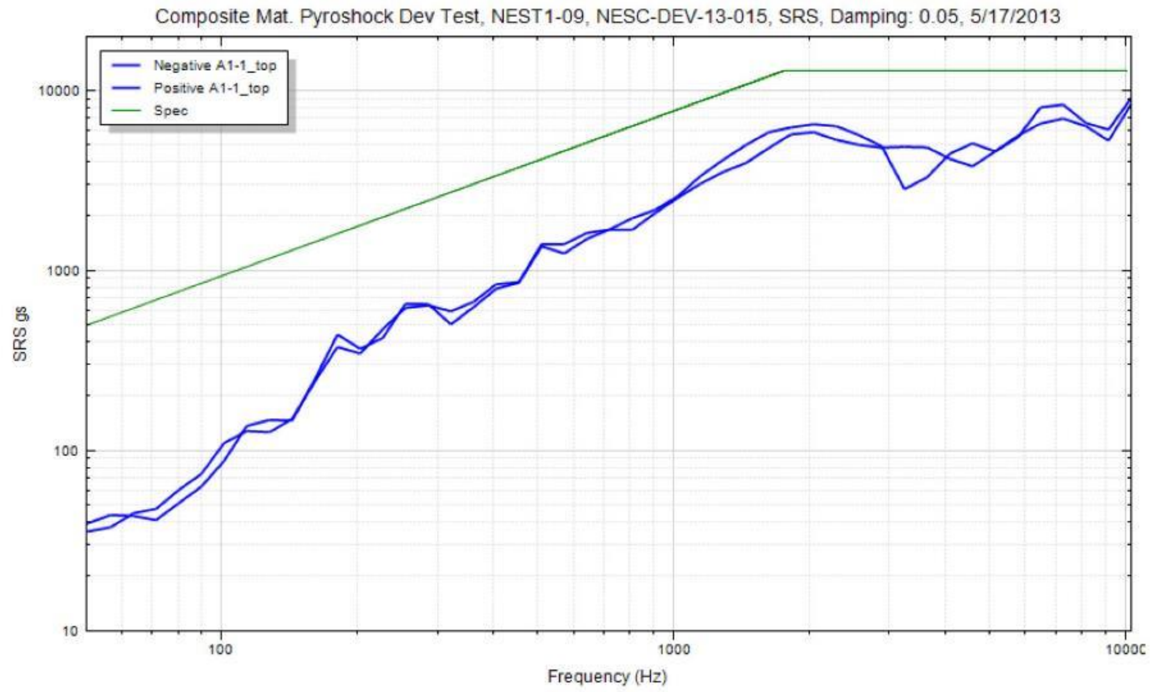

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A12-6_bottom
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

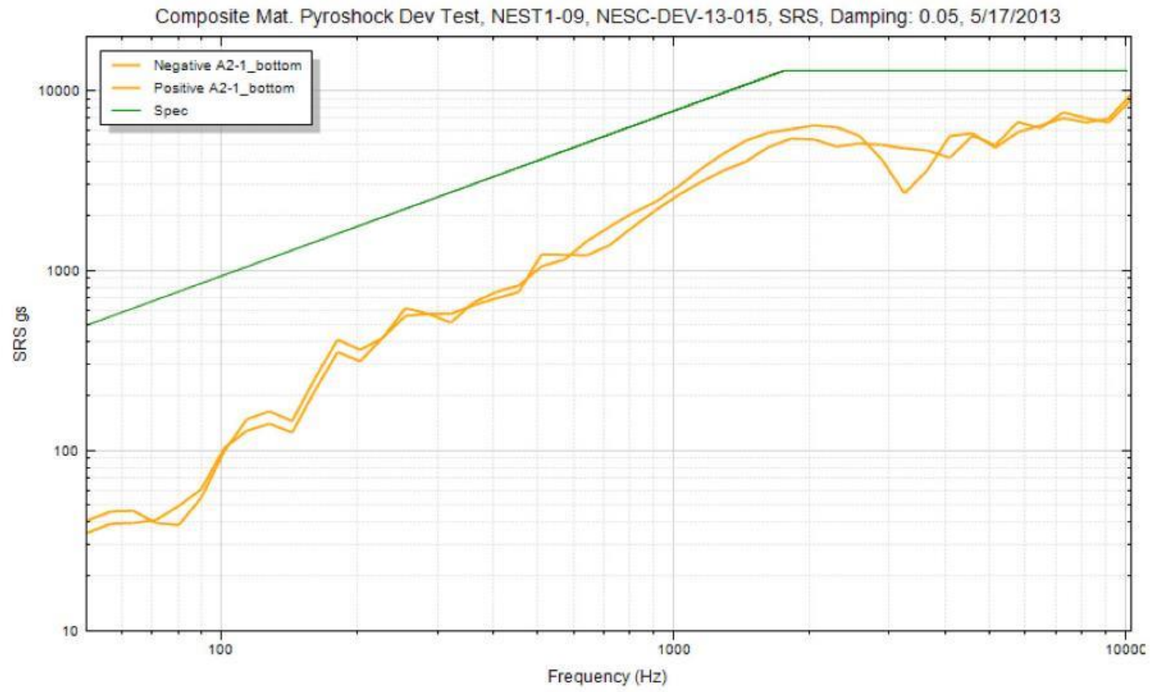

Composite Mat. Pyroshock Dev Test, NEST1-08, NESC-DEV-13-015, 5/16/2013
SRS Time A13-free
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

NESC-DEV-13-015
Composite Materials Shock Test

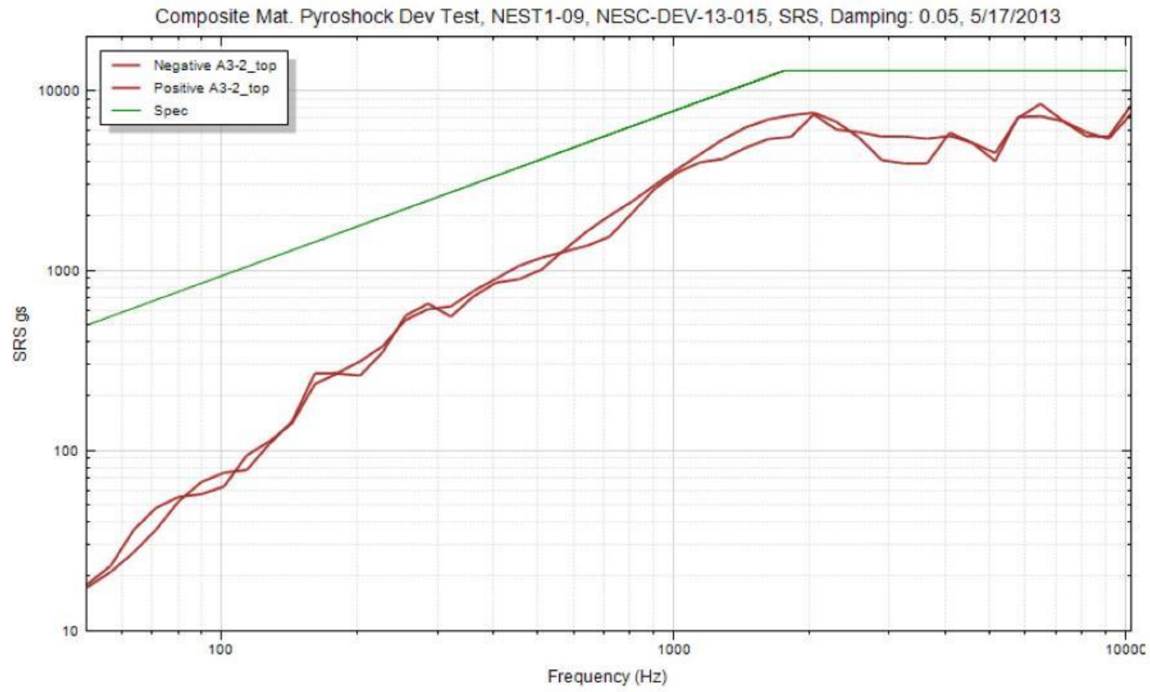
Test #9 Accelerometer Data
Panel 0326A009

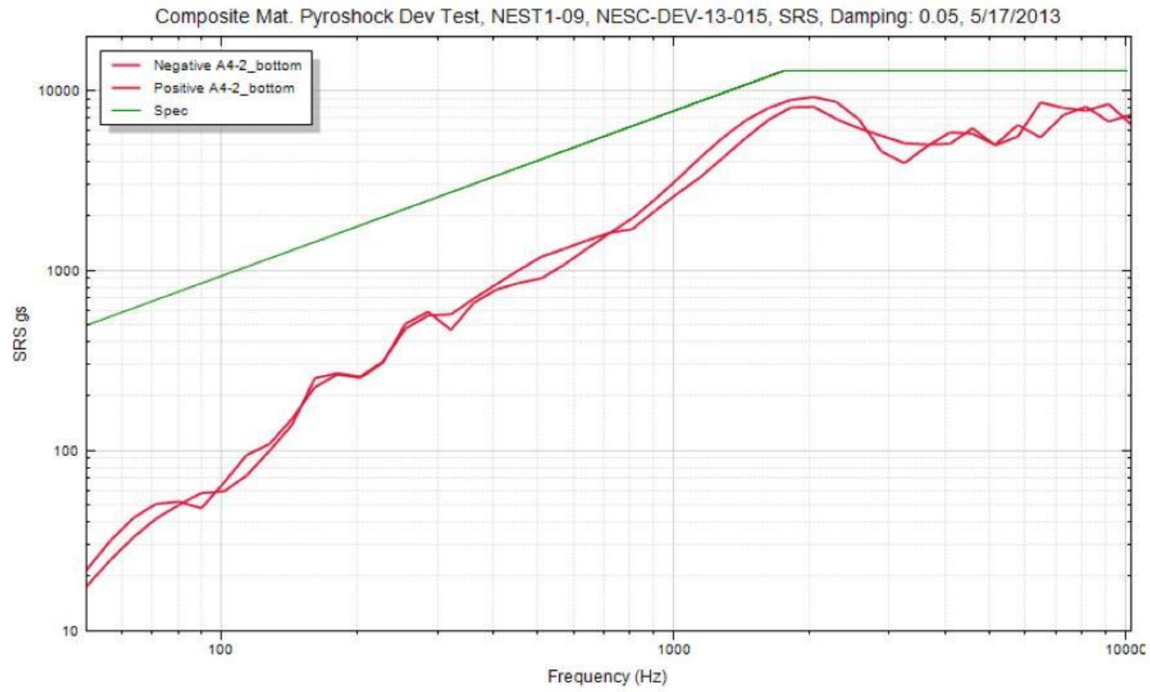

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

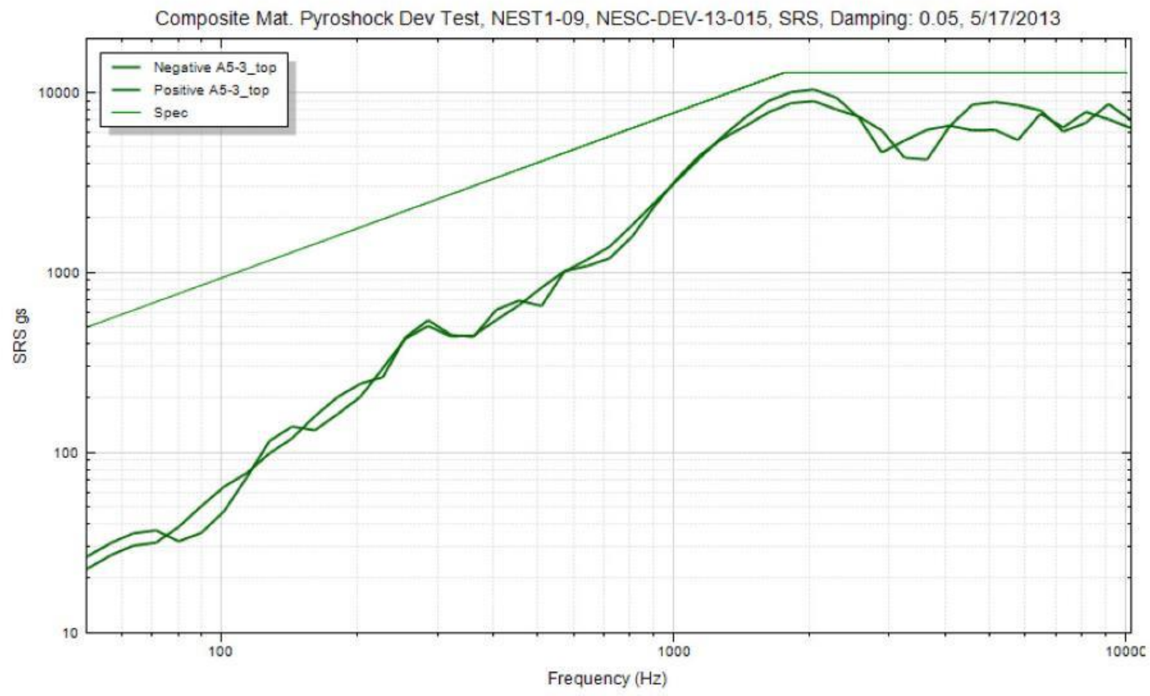

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

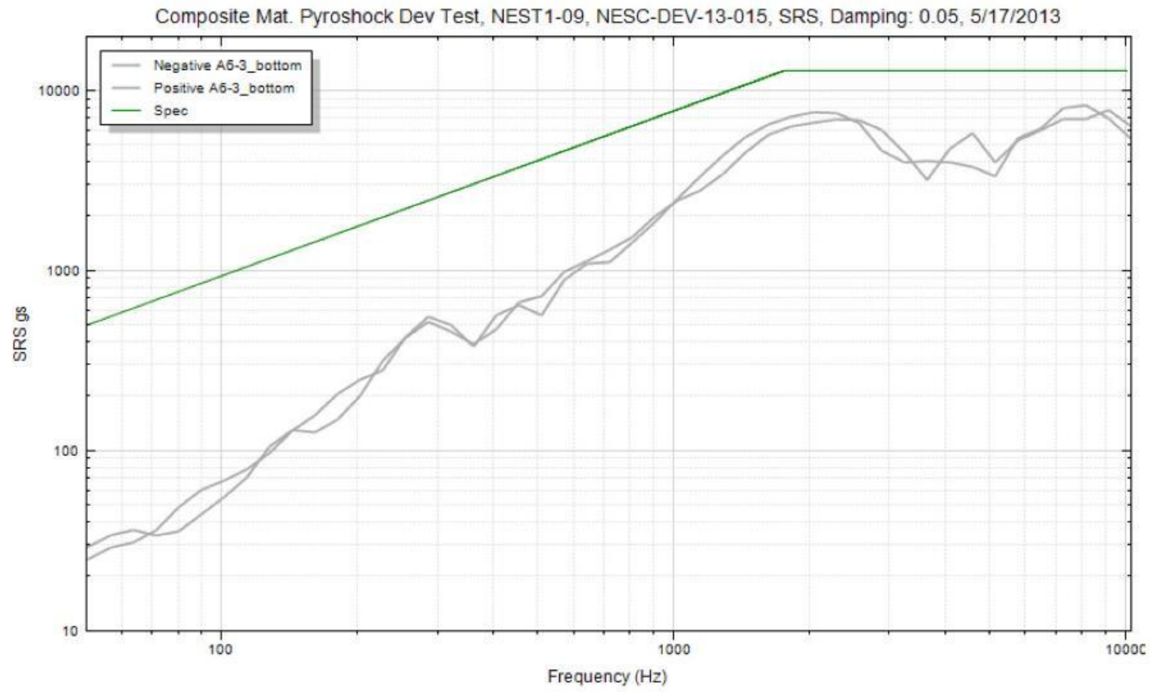
150 of 210

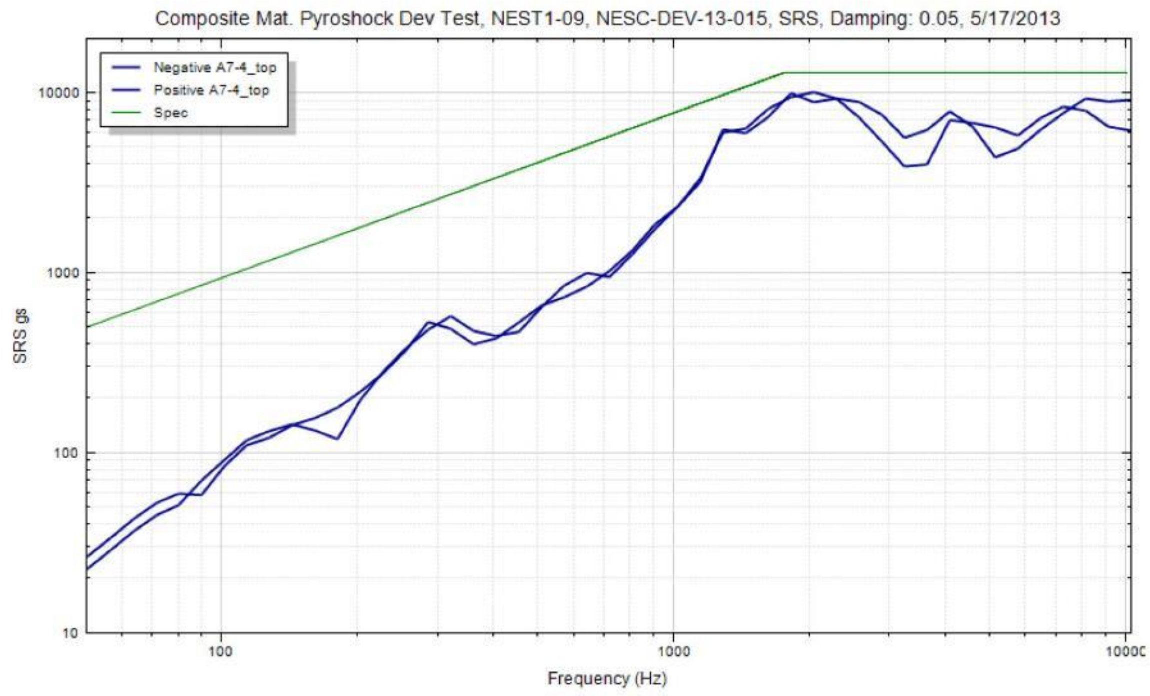

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A3-2_top
Positive A3-2_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

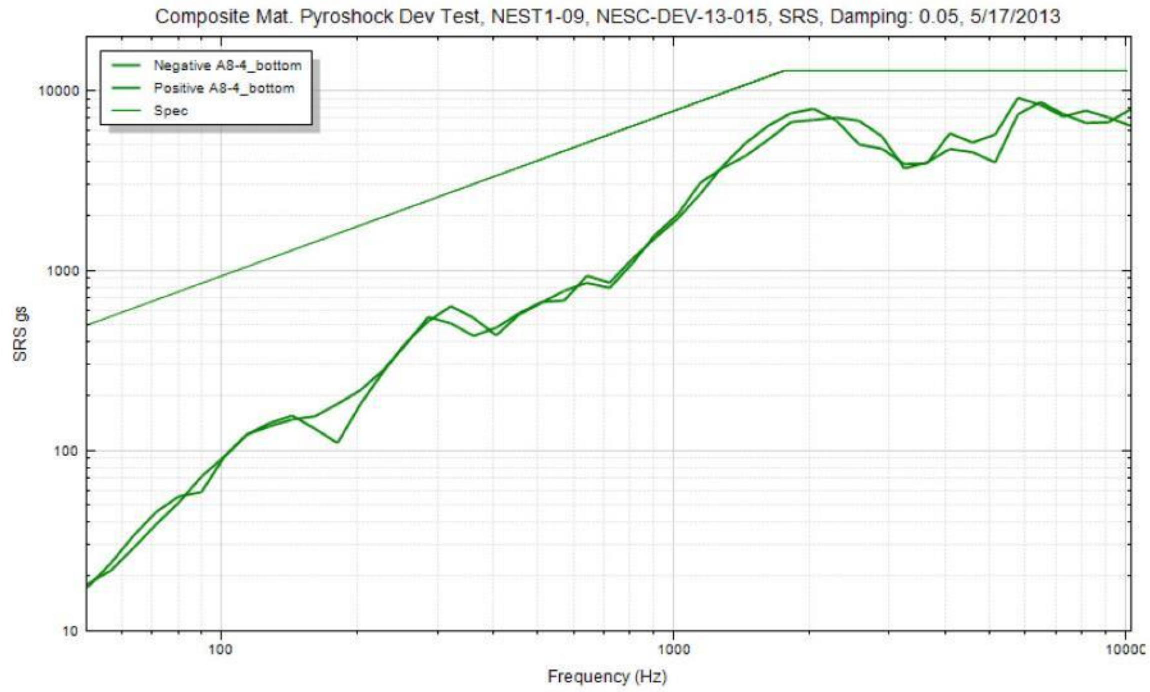

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)



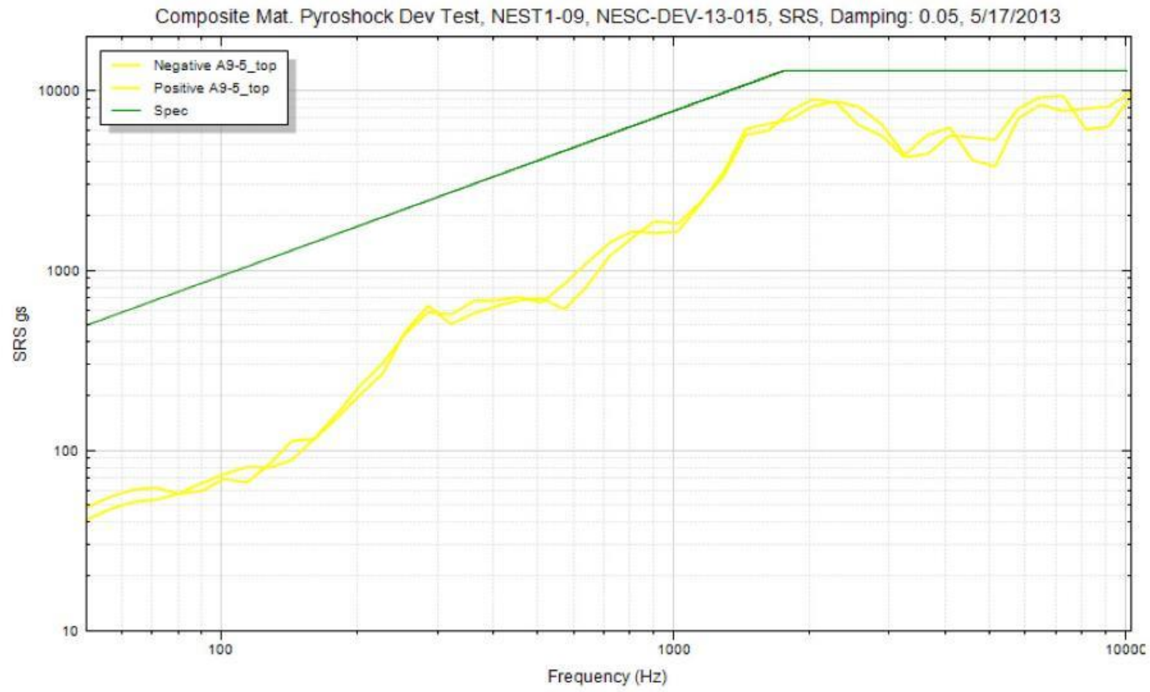
Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

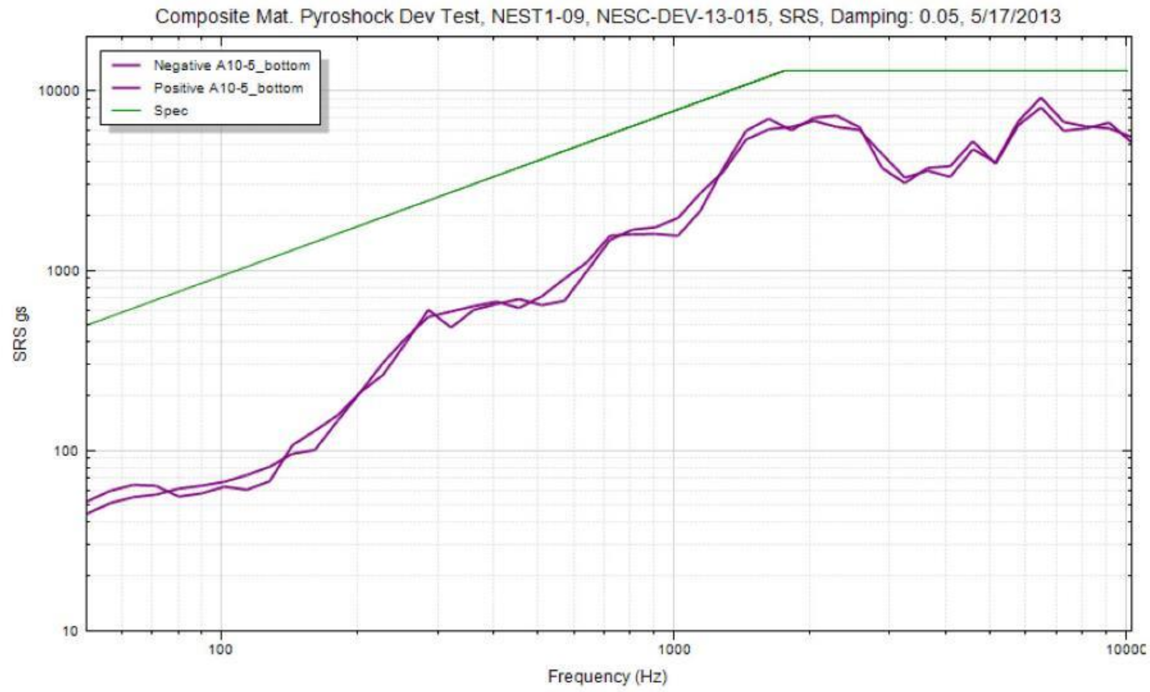

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

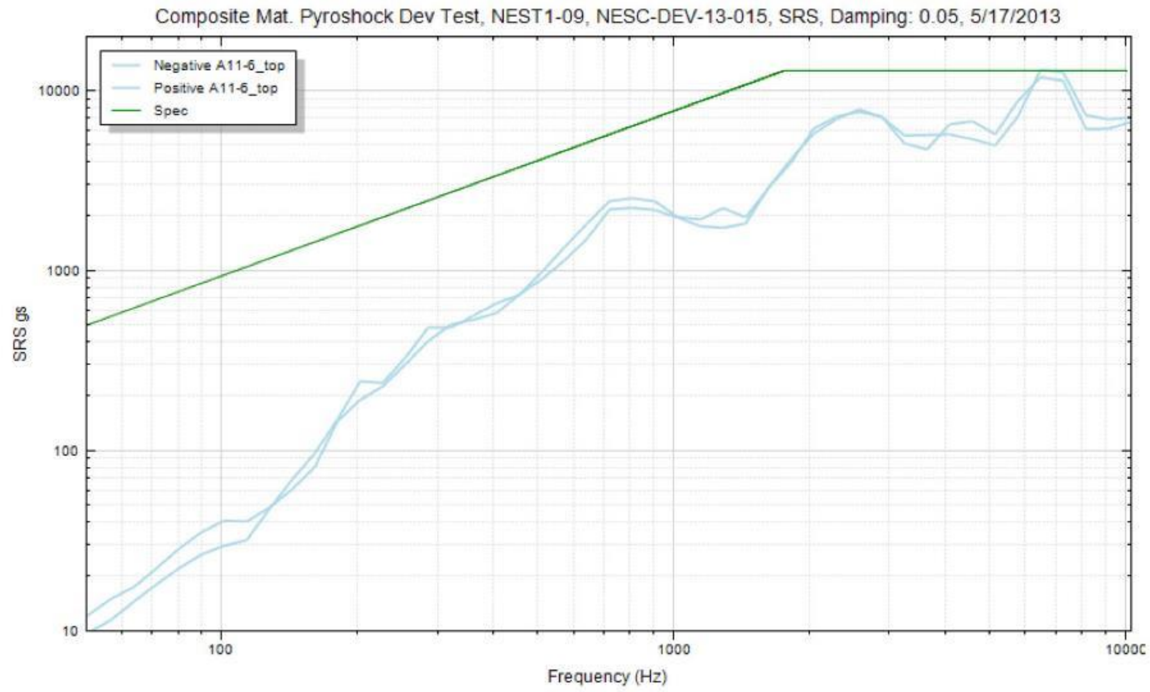

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A7-4_top
Positive A7-4_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

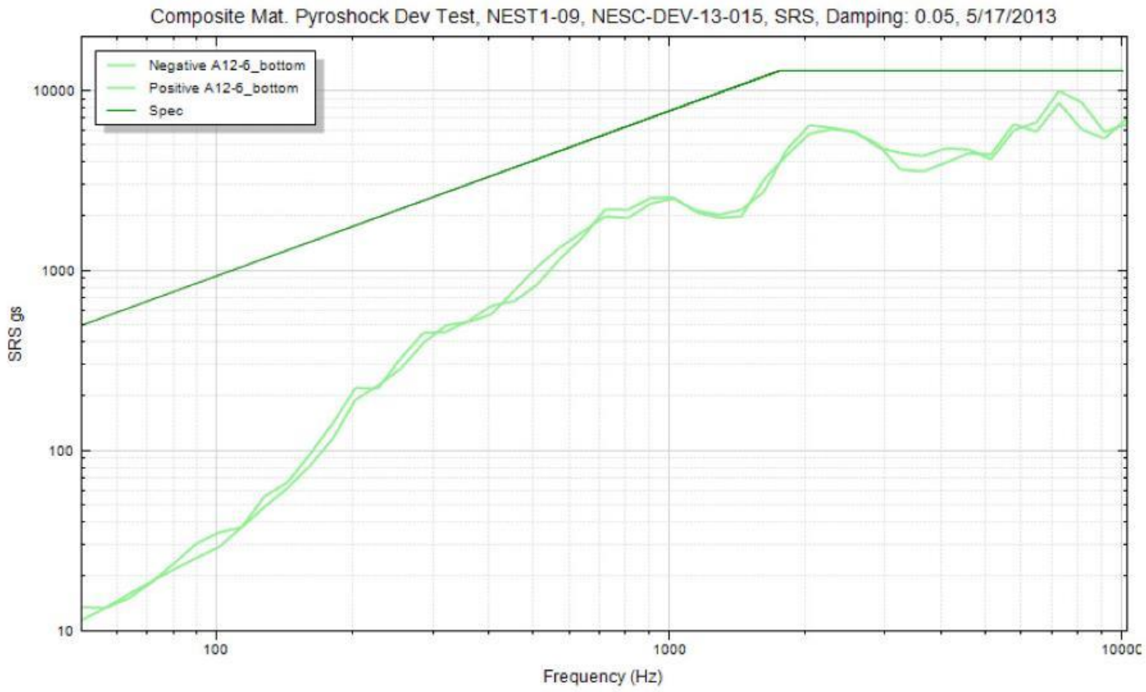

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

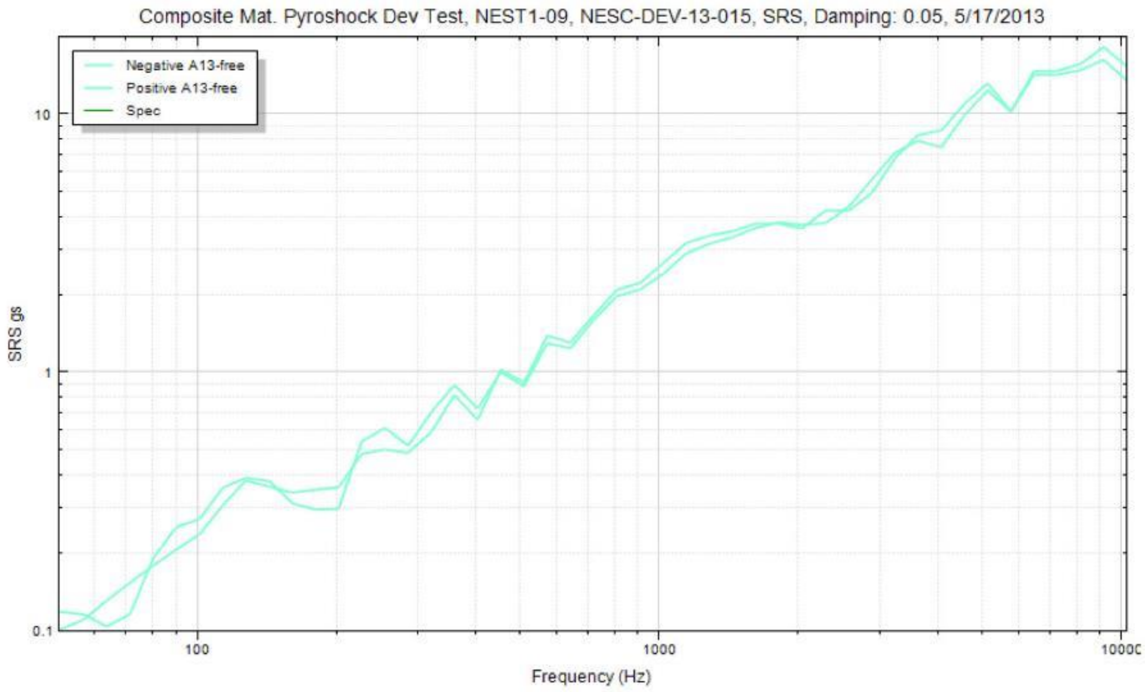
156 of 210


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A9-5_top
Positive A9-5_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A11-6_top
Positive A11-6_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, SRS, Damping: 0.05, 5/17/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
10000
Frequency (Hz)

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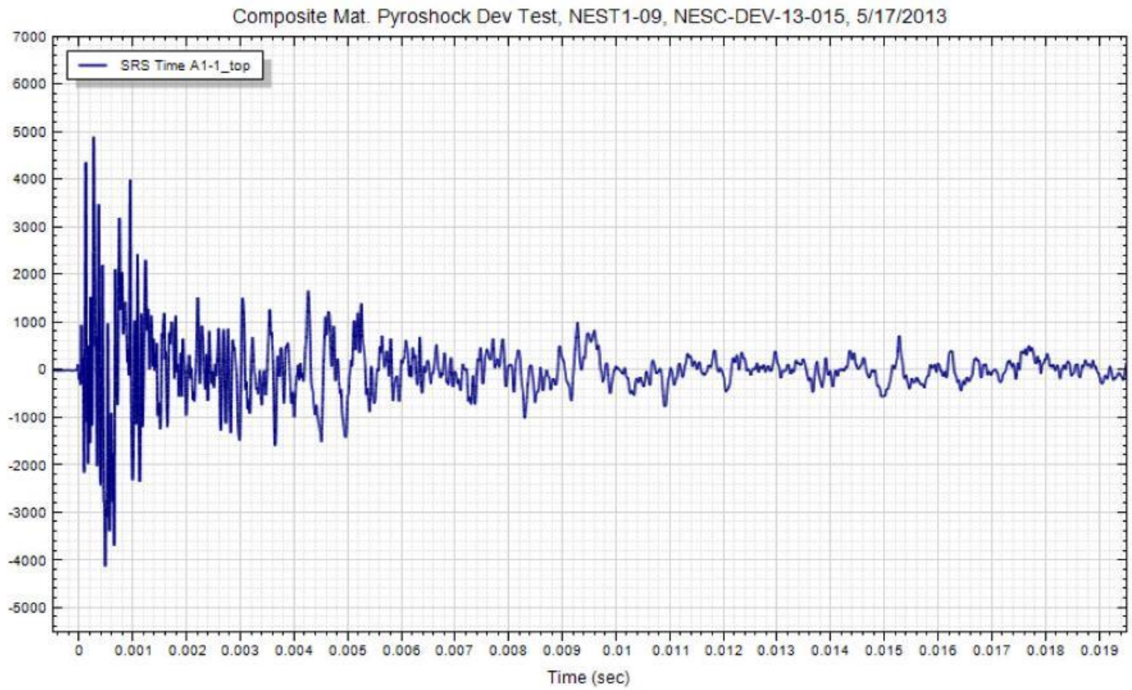
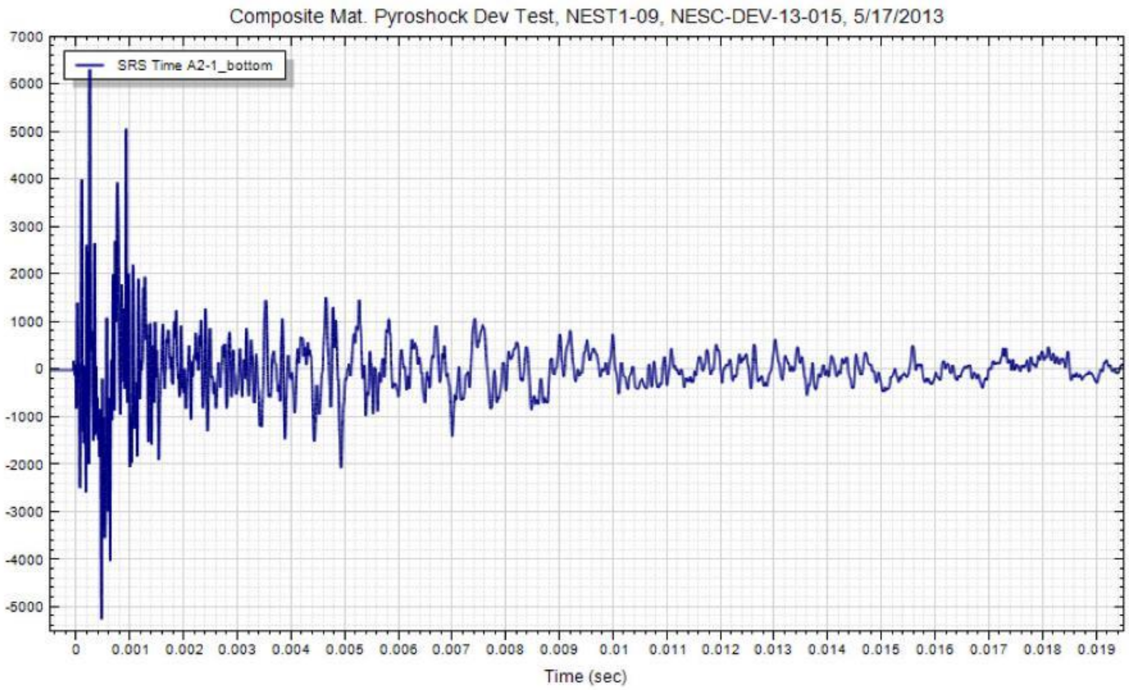
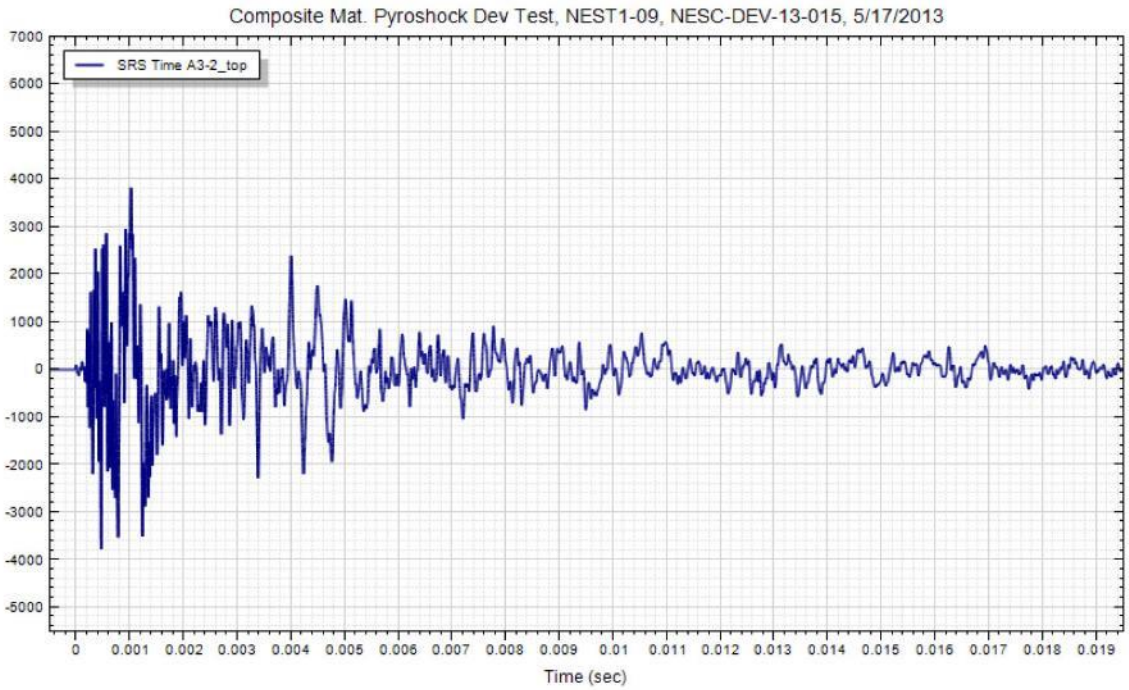
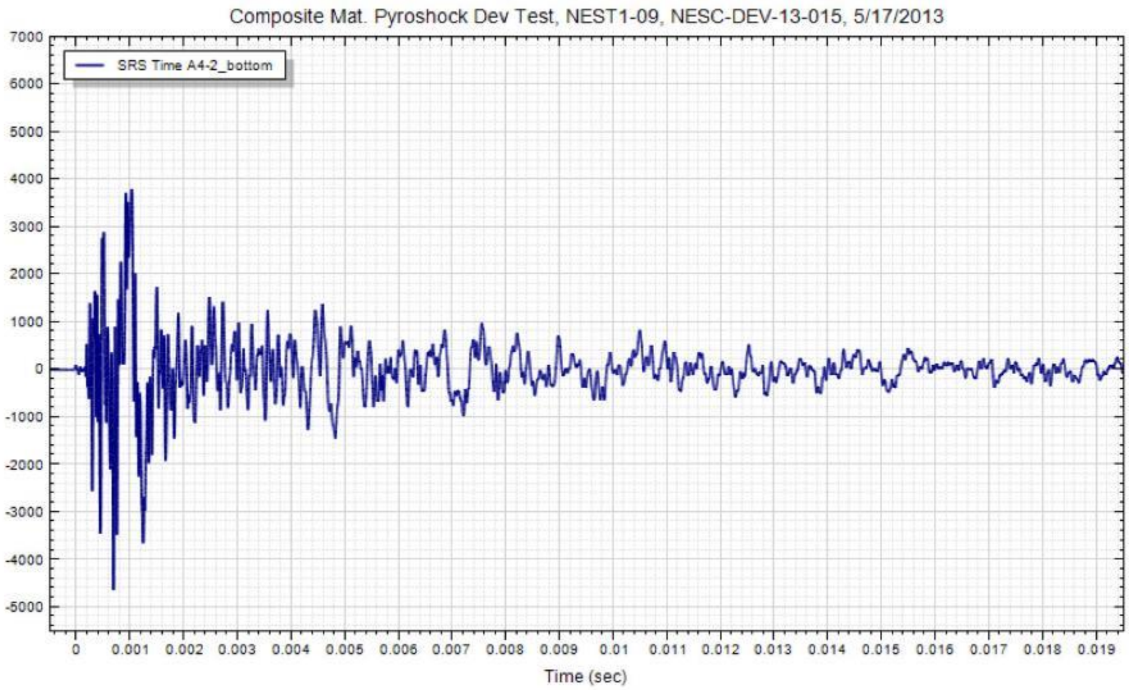
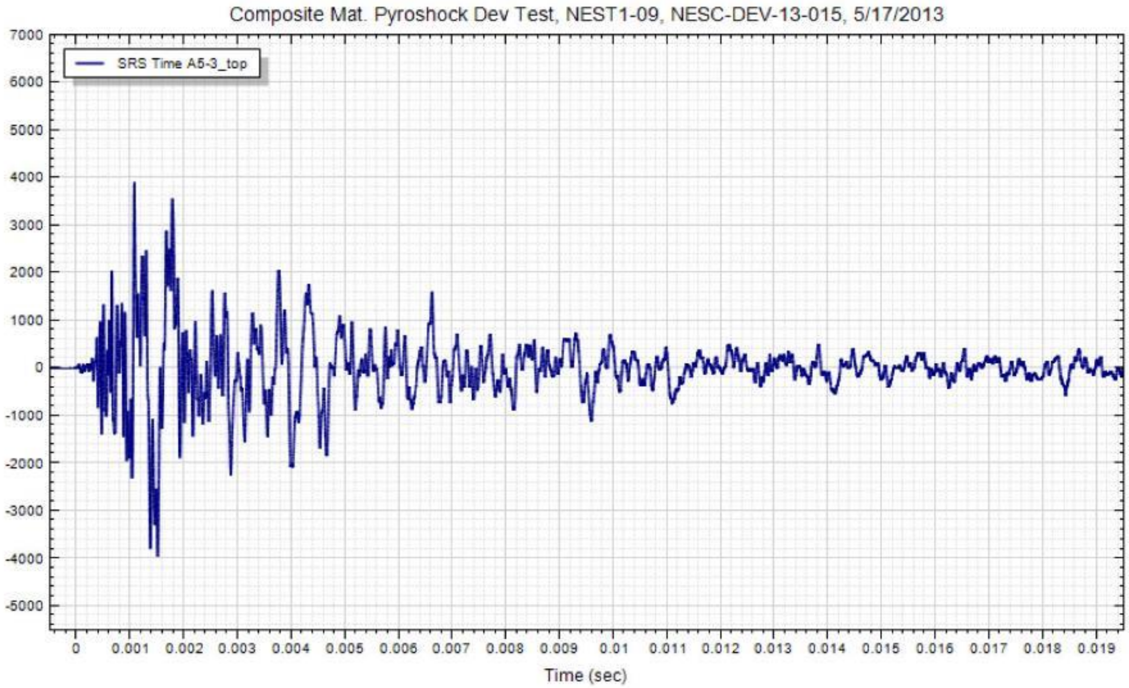

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A1-1_top
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

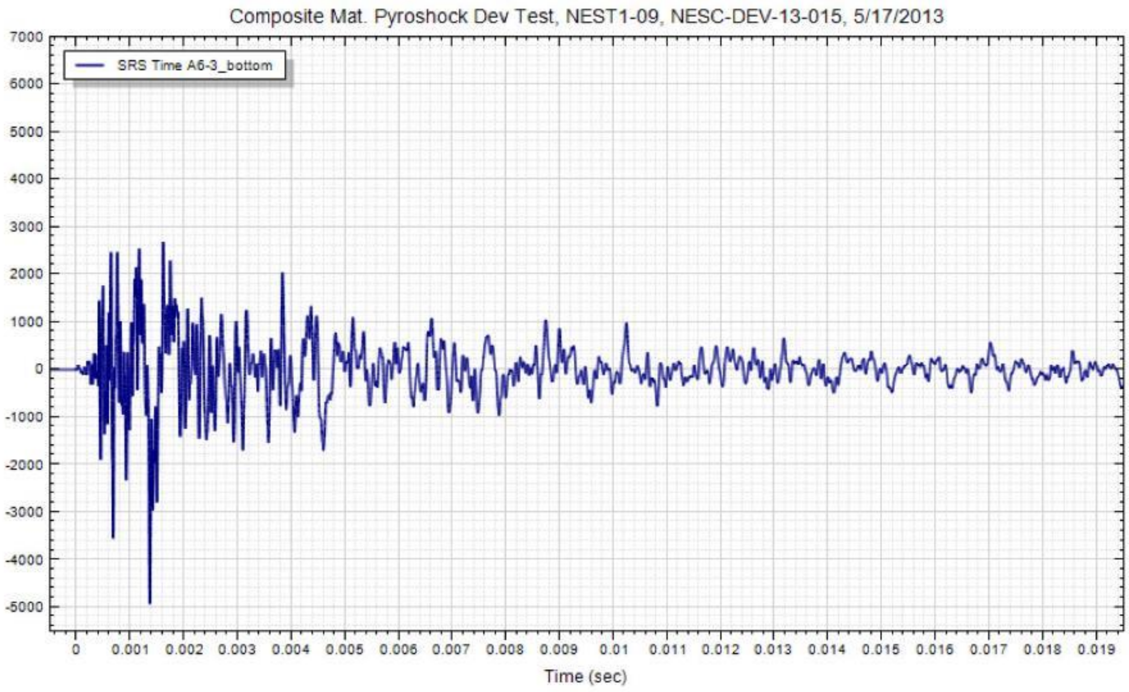


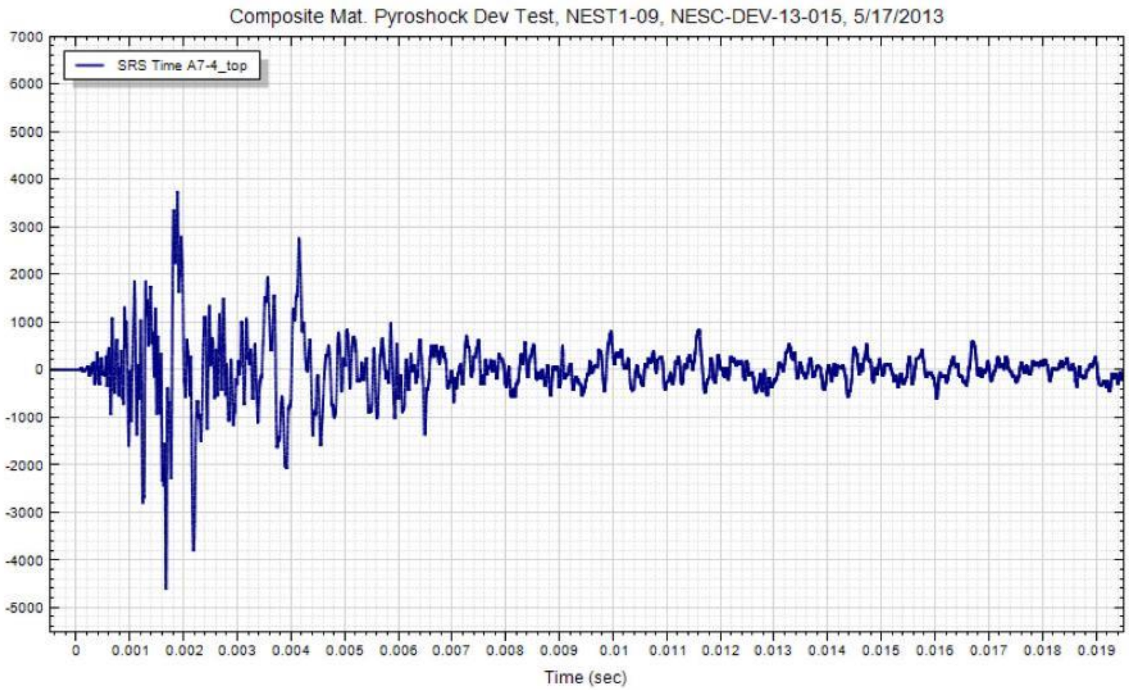
Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A2-1_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

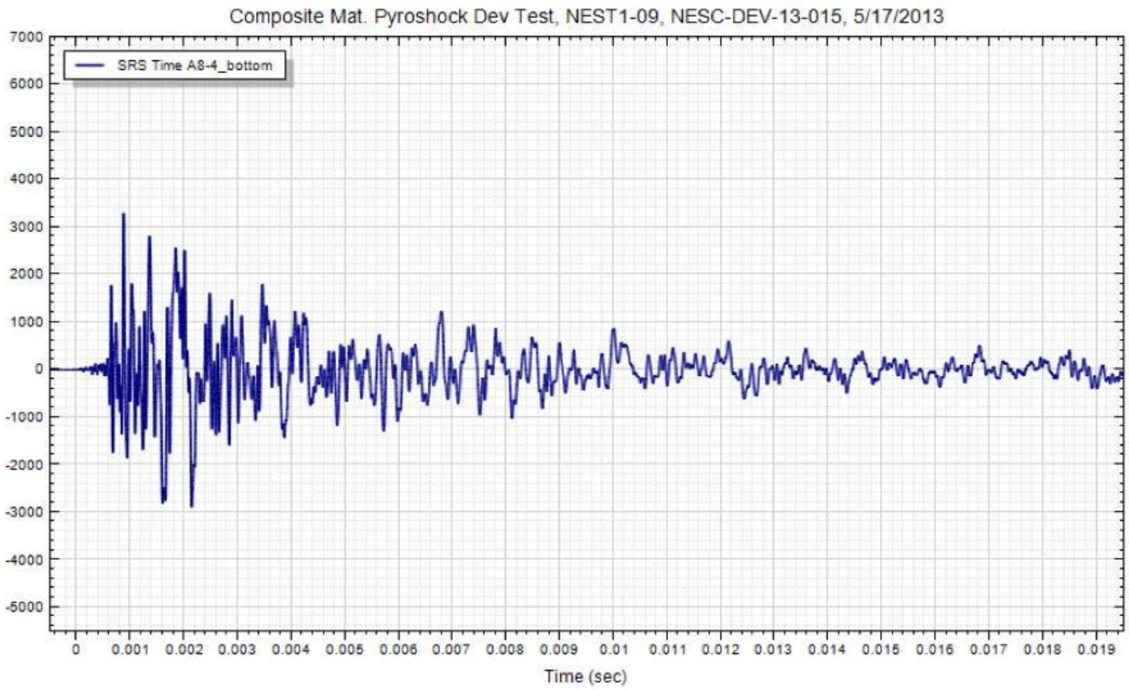

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A3-2_top
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

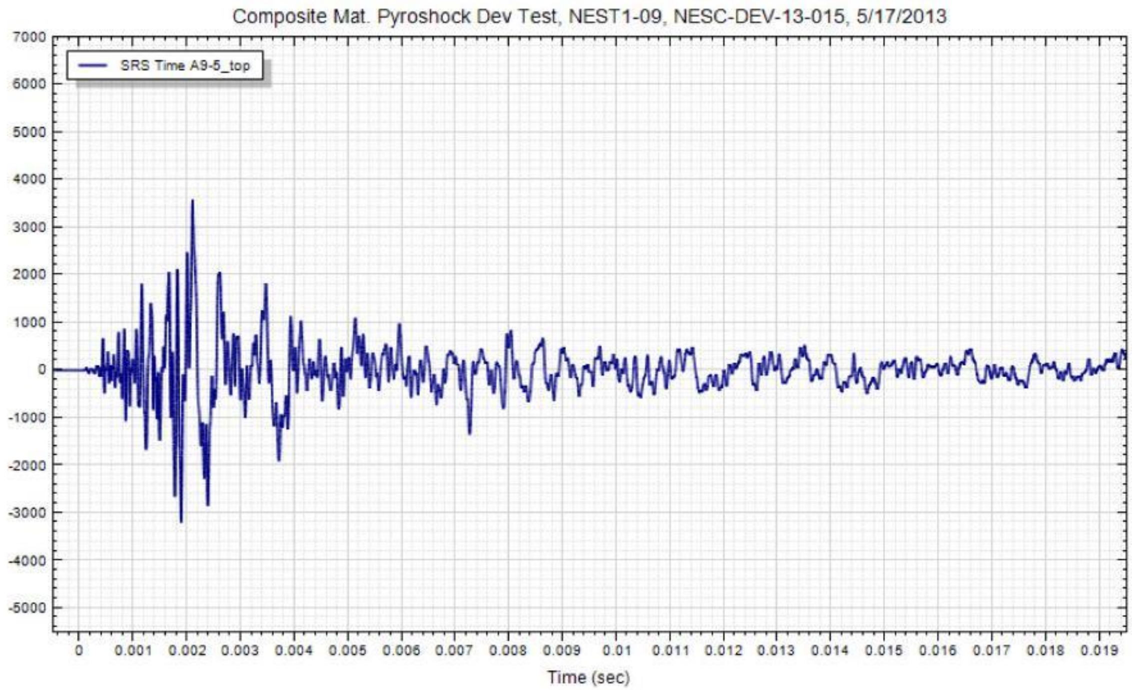

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A4-2_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

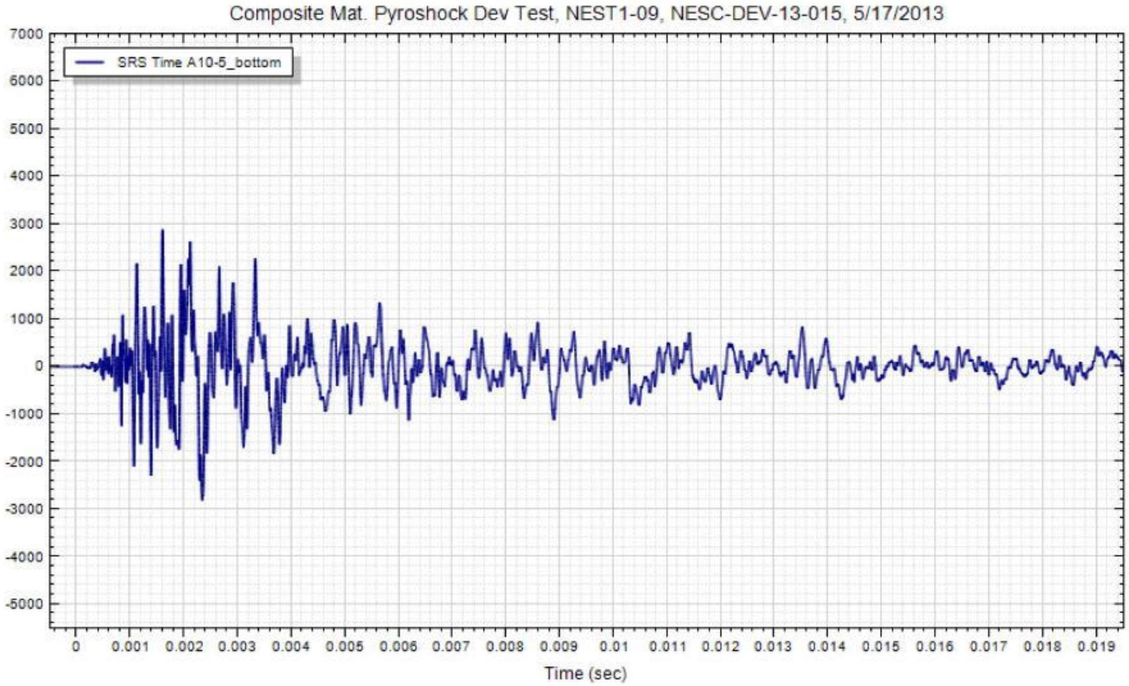

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A5-3_top
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A6-3_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

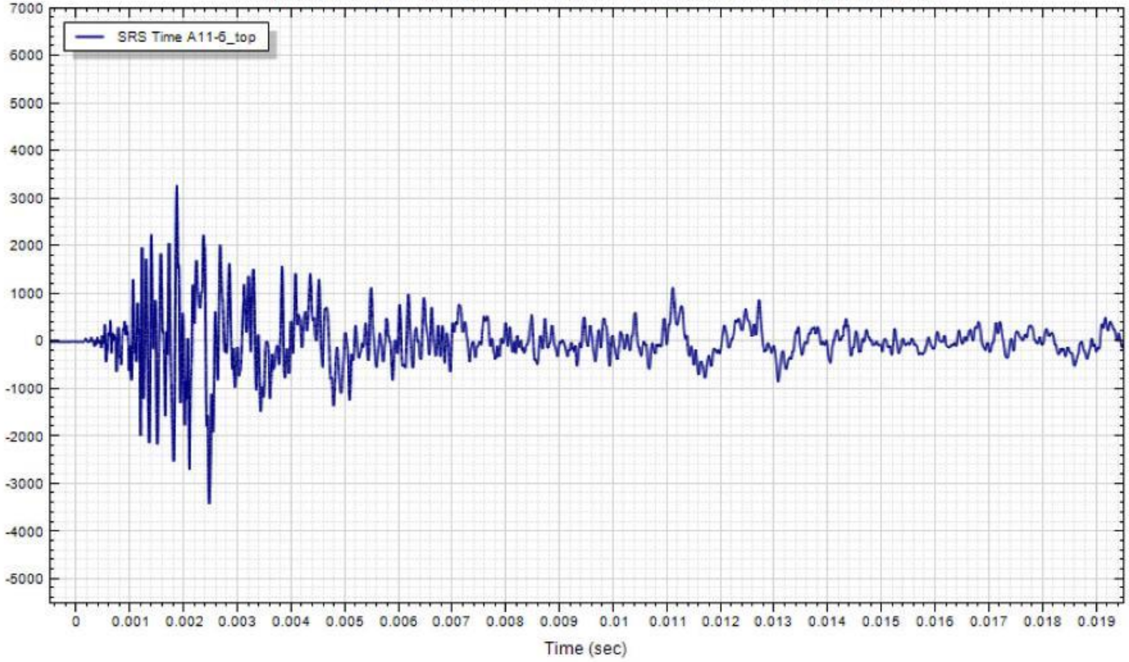

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A7-4_top
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

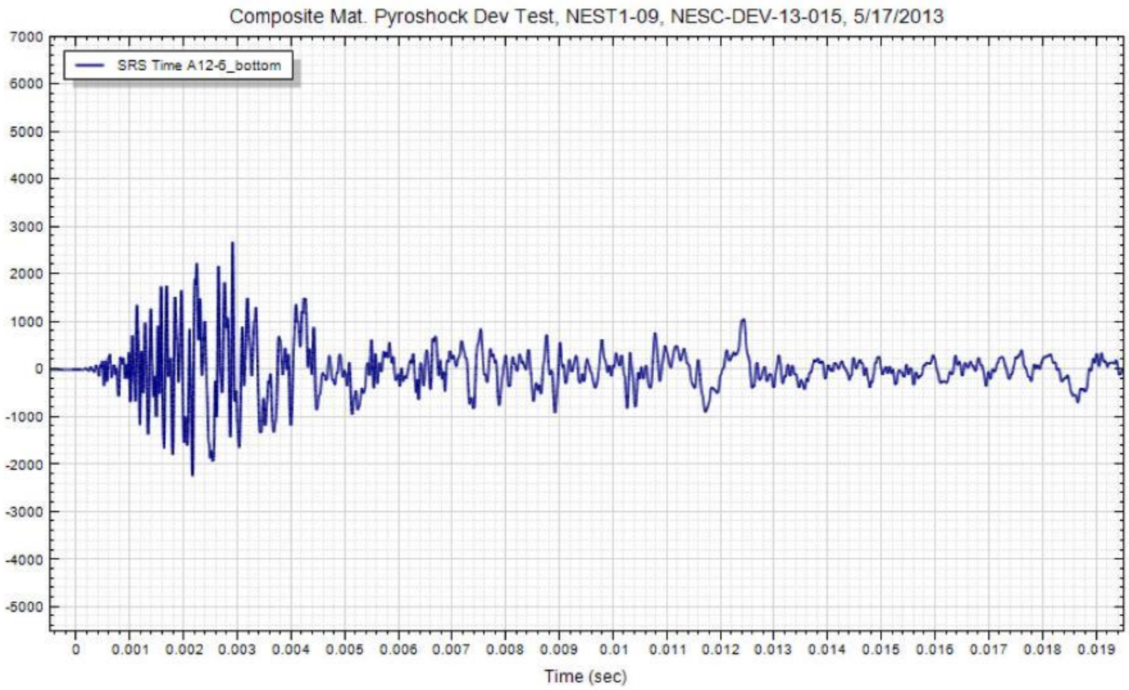

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A8-4_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

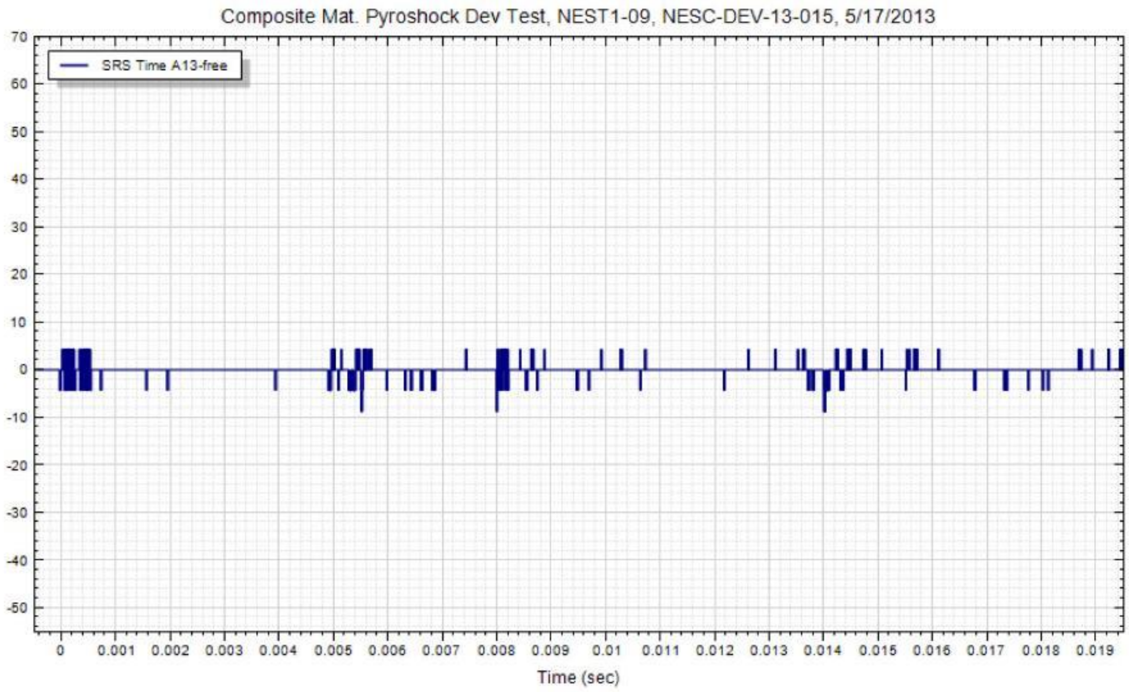

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A9-5_top
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

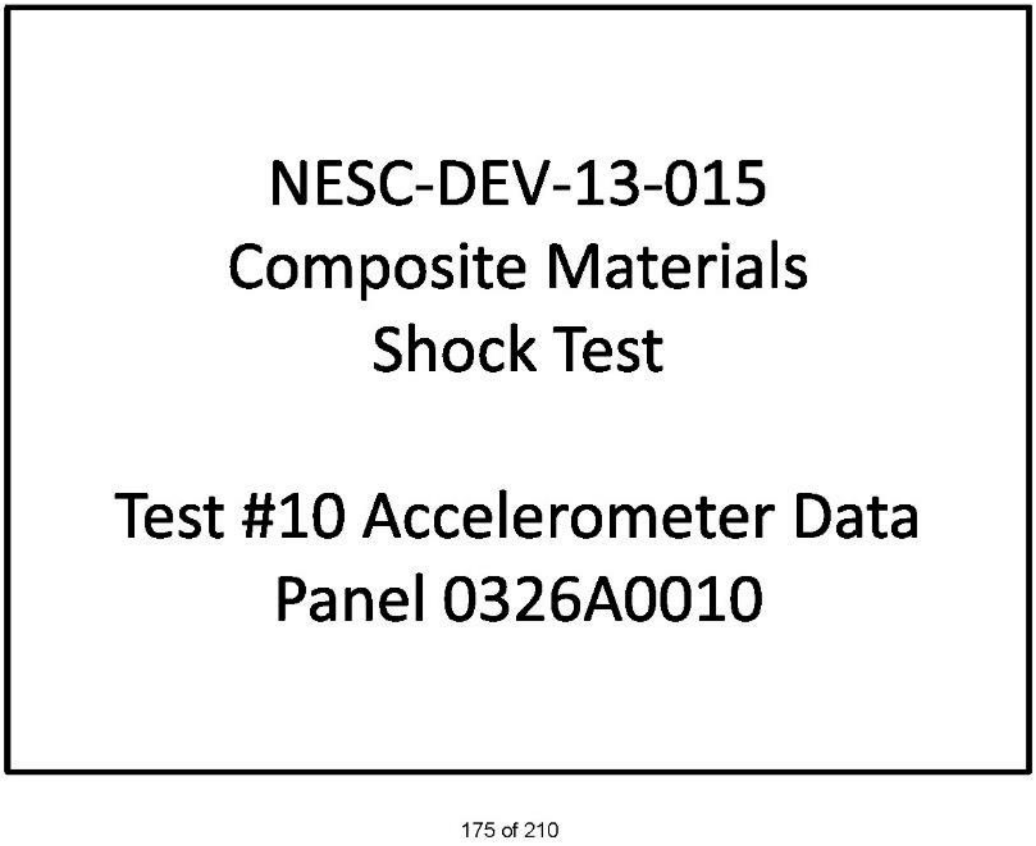

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A10-5_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013



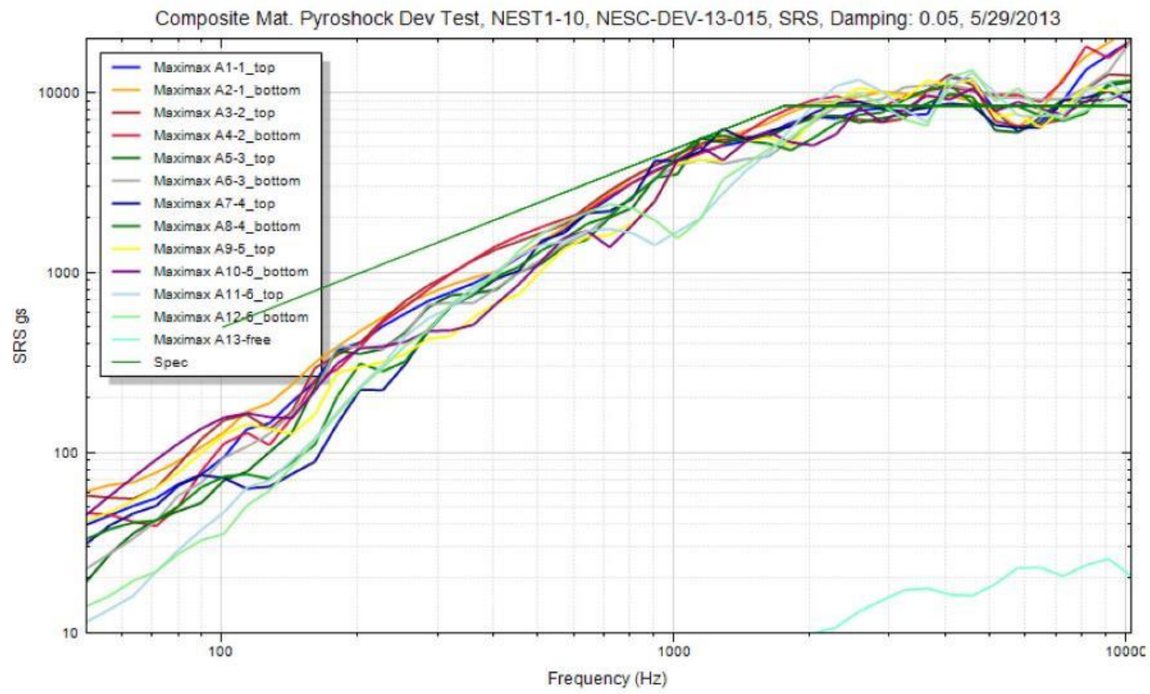

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A12-6_bottom
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

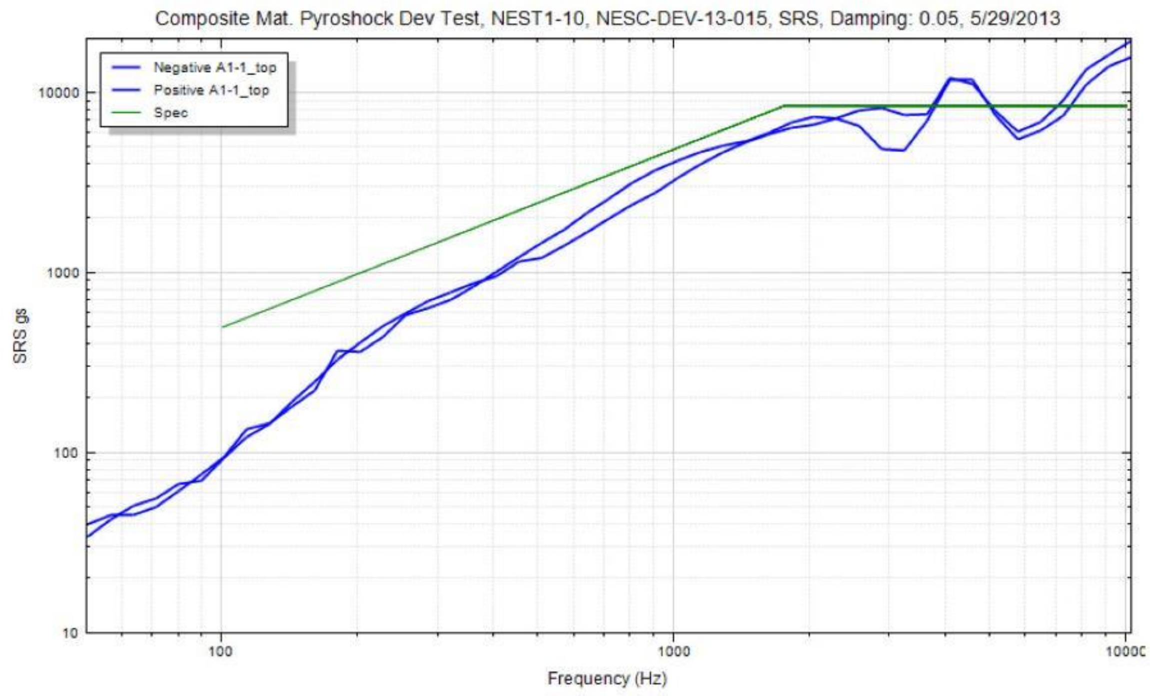

Composite Mat. Pyroshock Dev Test, NEST1-09, NESC-DEV-13-015, 5/17/2013
SRS Time A13-free
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

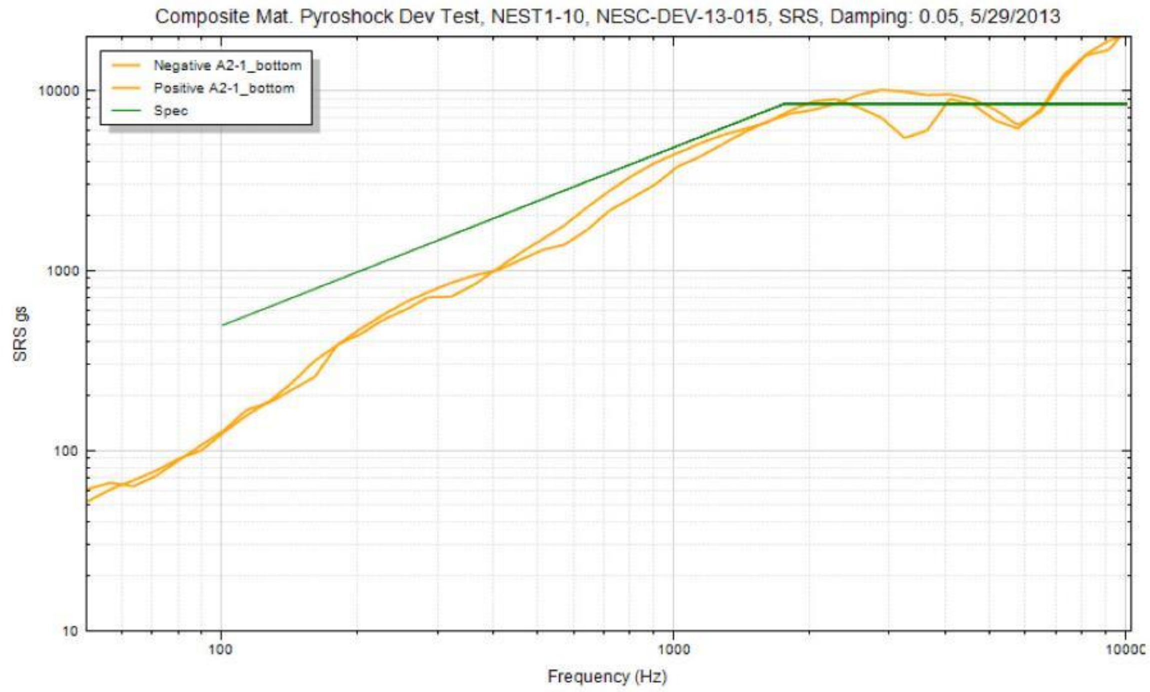


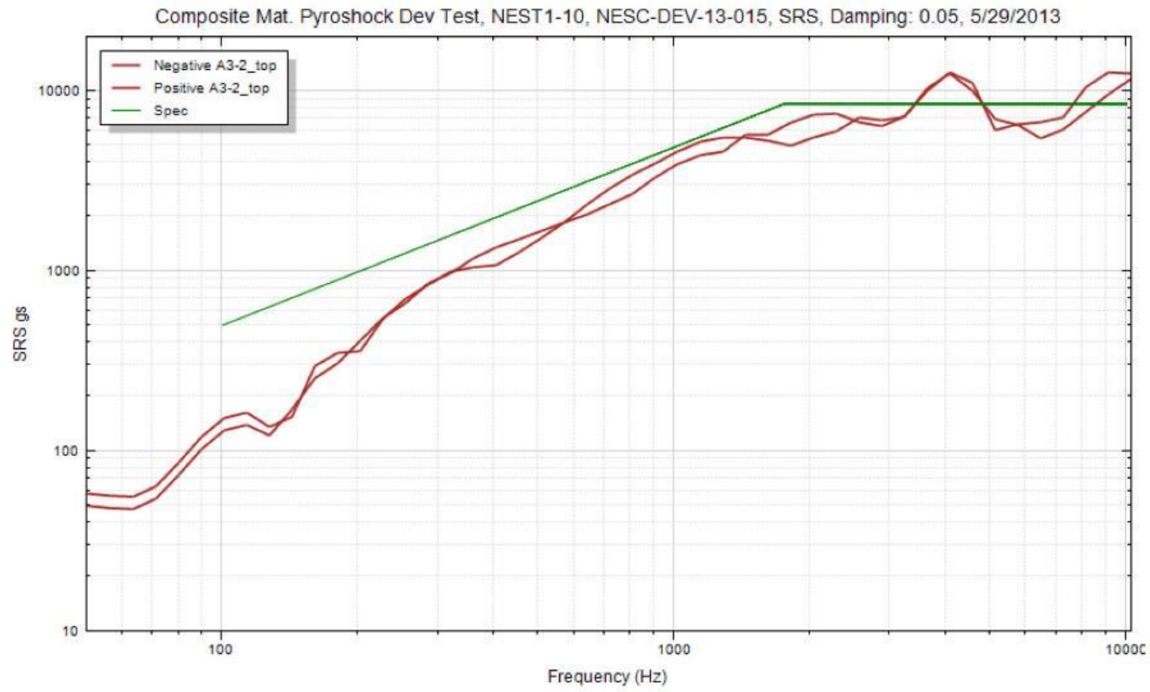
NESC-DEV-13-015
Composite Materials
Shock Test

Test #10 Accelerometer Data
Panel 0326A0010

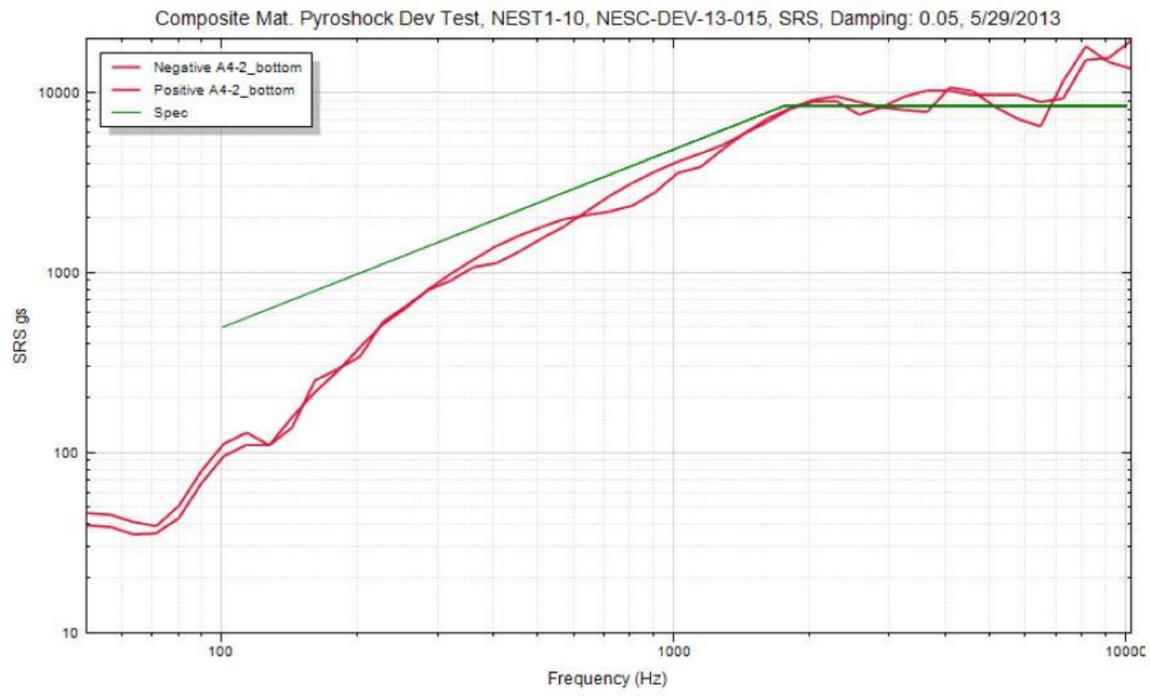

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Maximax A1-1_top
Maximax A2-1_bottom
Maximax A3-2_top
Maximax A4-2_bottom
Maximax A5-3_top
Maximax A6-3_bottom
Maximax A7-4_top
Maximax A8-4_bottom
Maximax A9-5_top
Maximax A10-5_bottom
Maximax A11-6_top
Maximax A12-6_bottom
Maximax A13-free
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

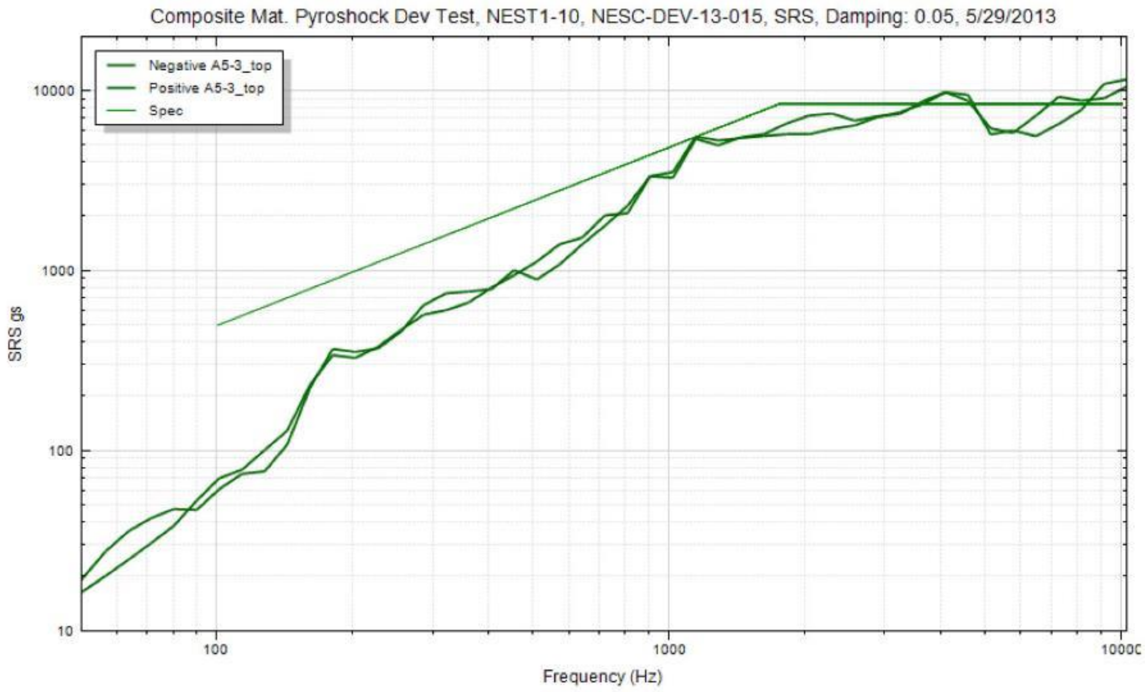

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A1-1_top
Positive A1-1_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A2-1_bottom
Positive A2-1_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)



Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A3-2_top
Positive A3-2_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A4-2_bottom
Positive A4-2_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A5-3_top
Positive A5-3_top
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

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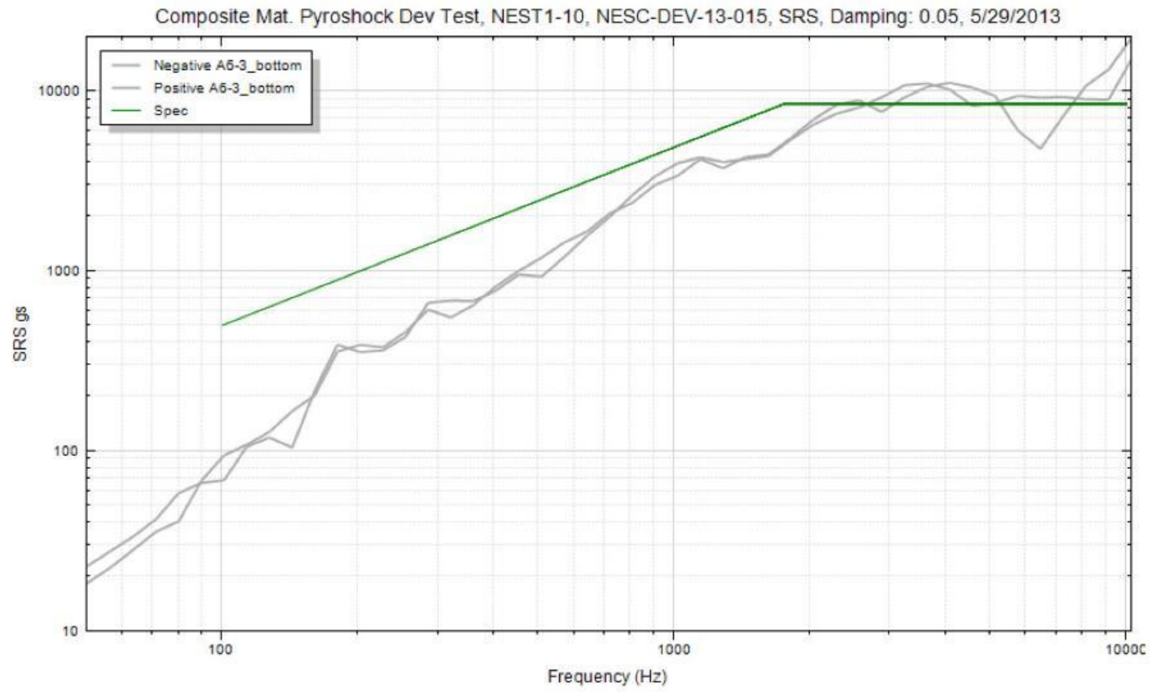
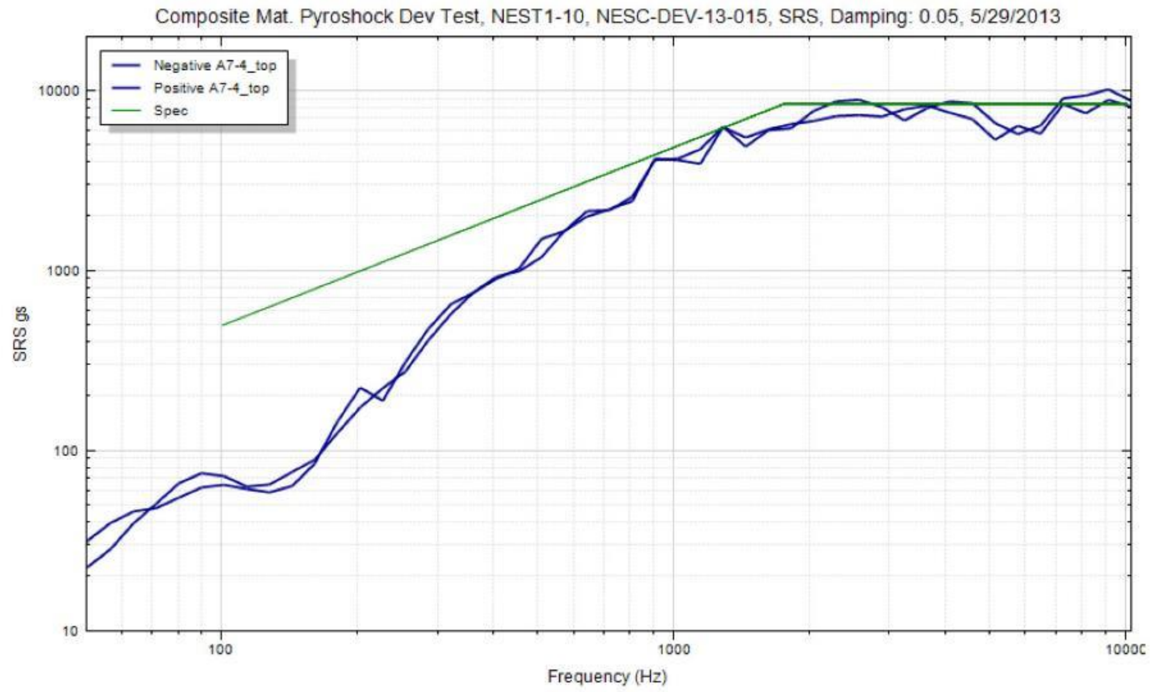

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A6-3_bottom
Positive A6-3_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A7-4_top
Positive A7-4_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

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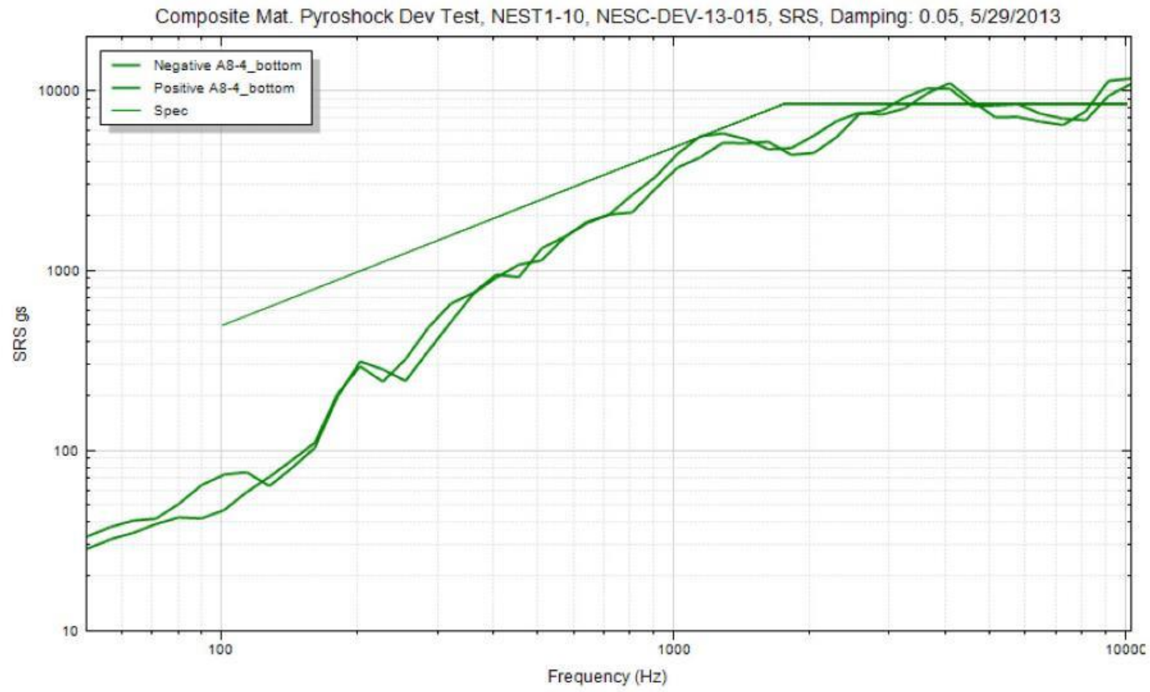
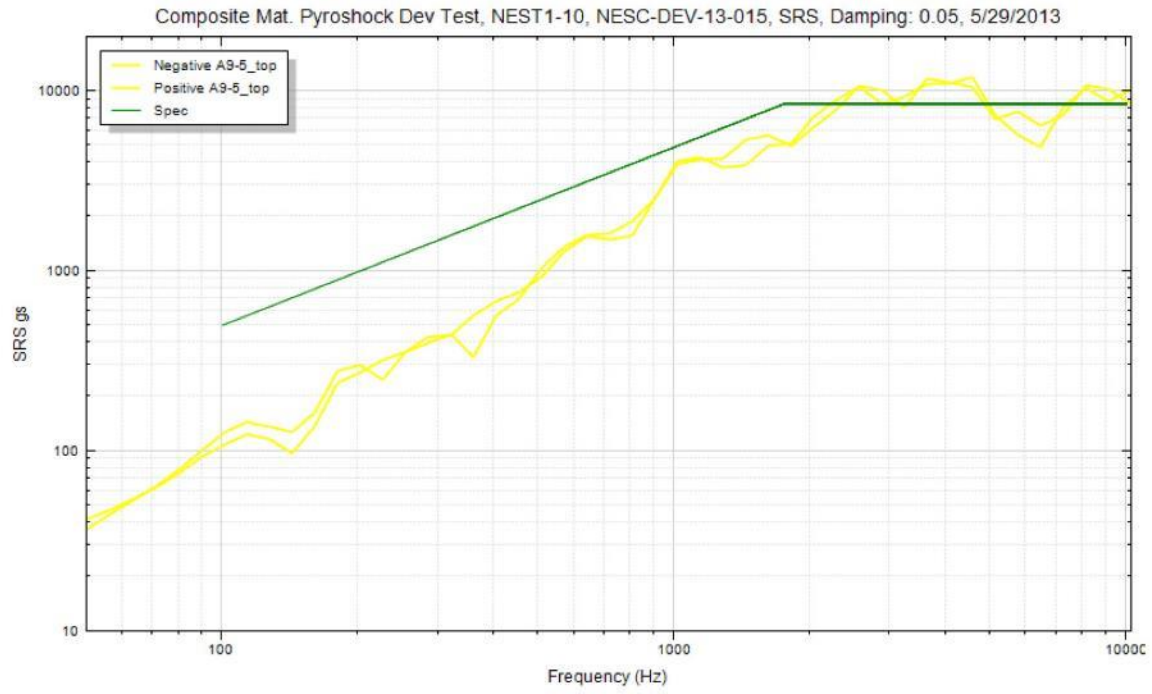
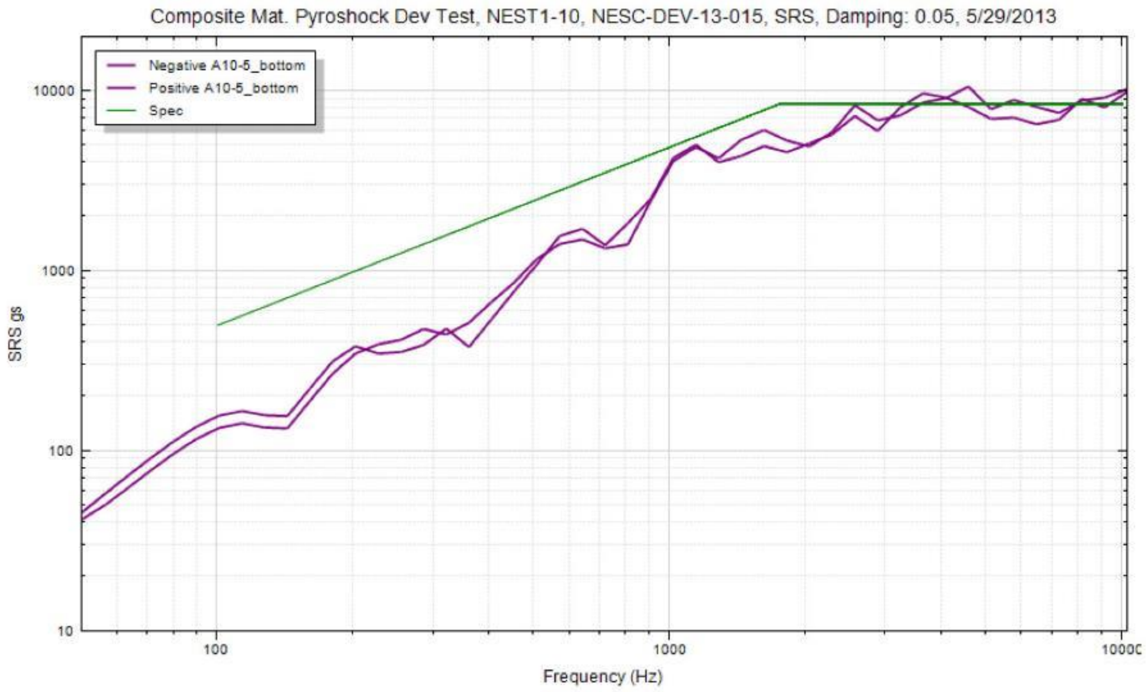
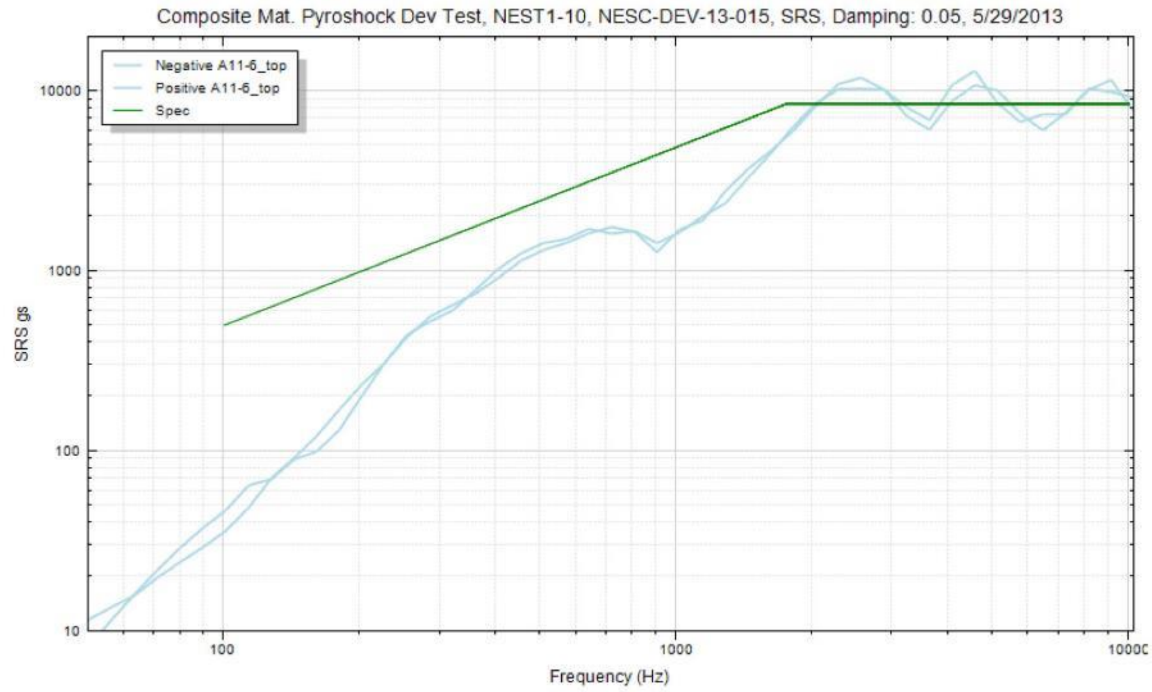
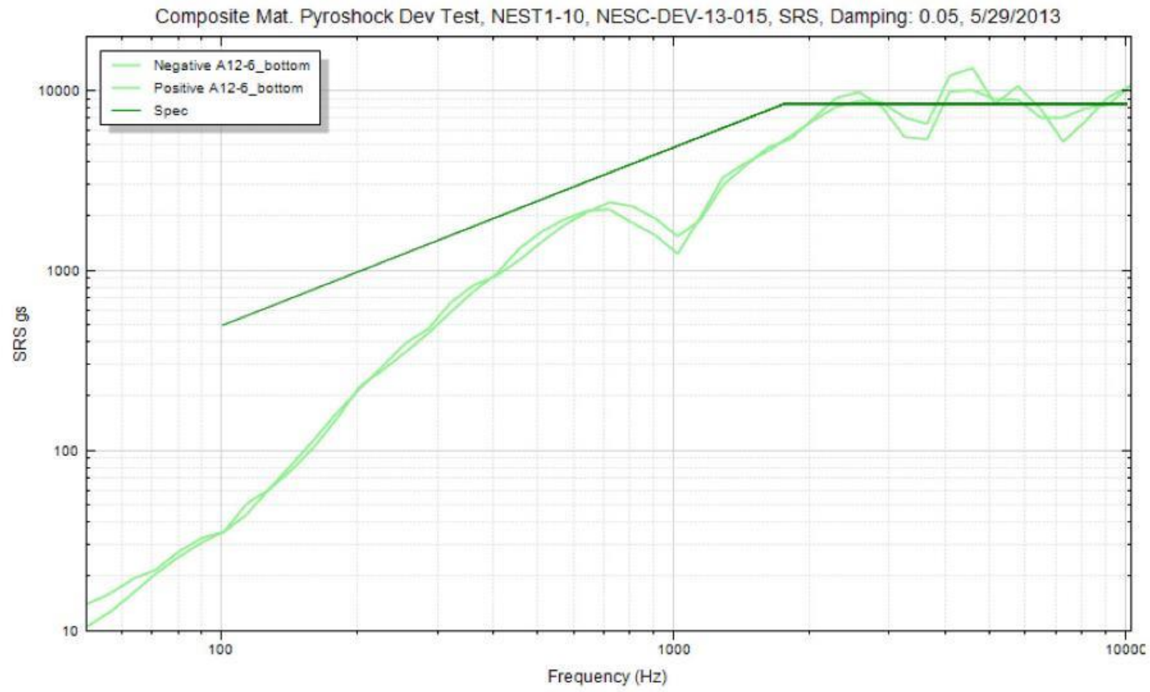
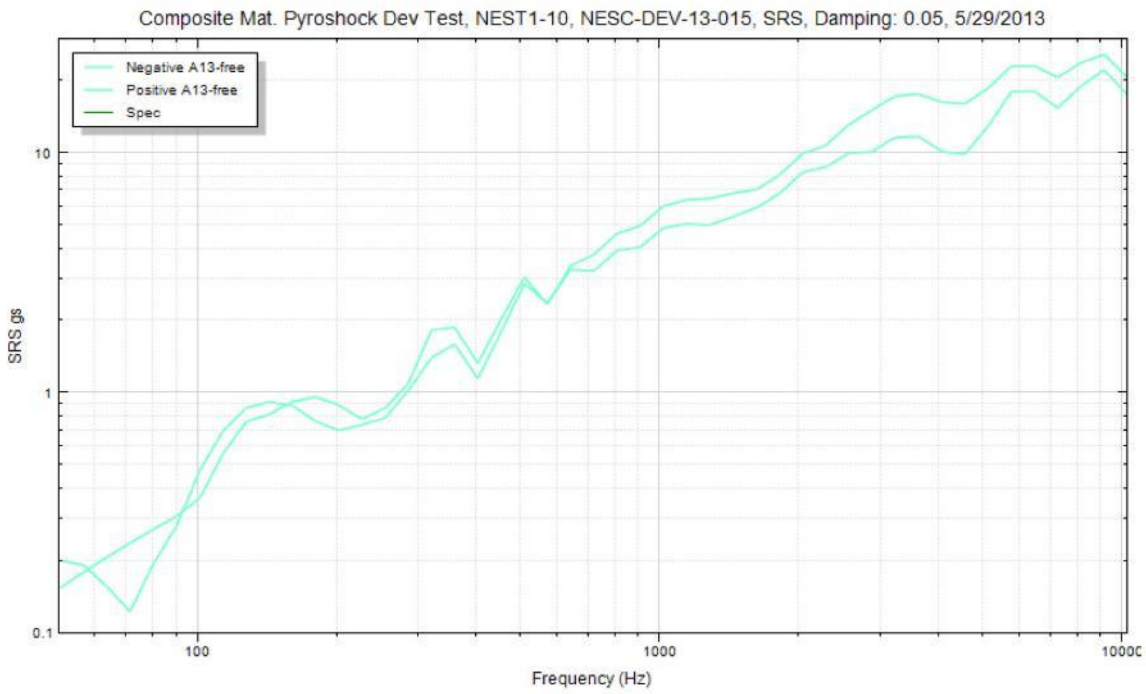

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A8-4_bottom
Positive A8-4_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

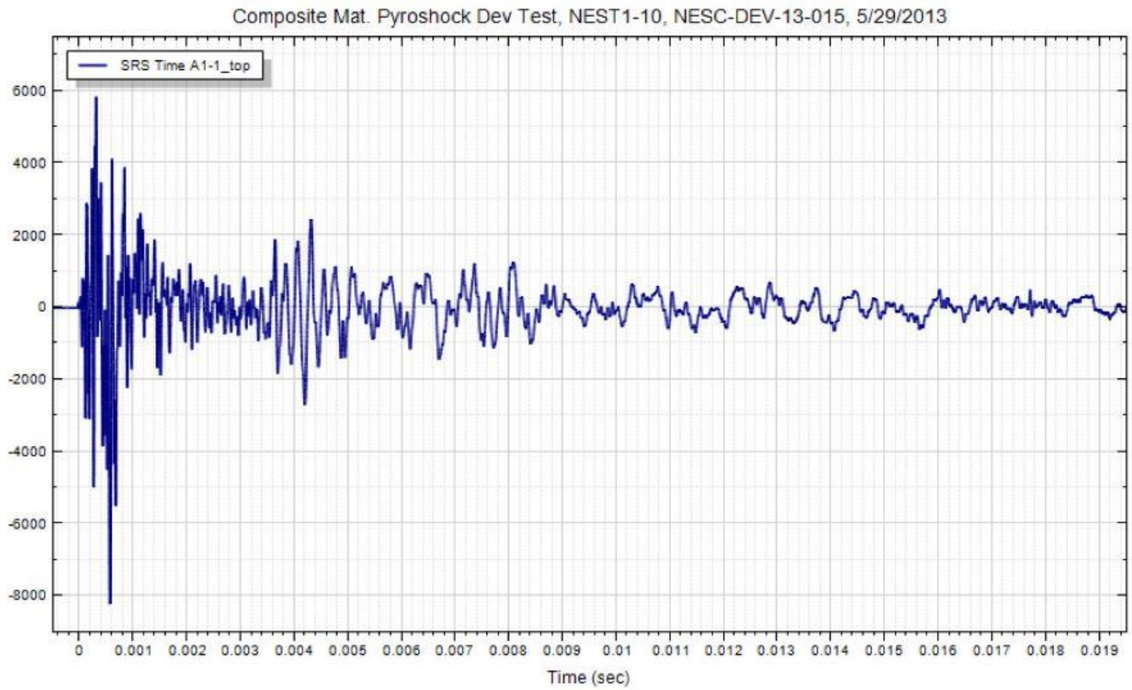

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A9-5_top
Positive A9-5_top
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

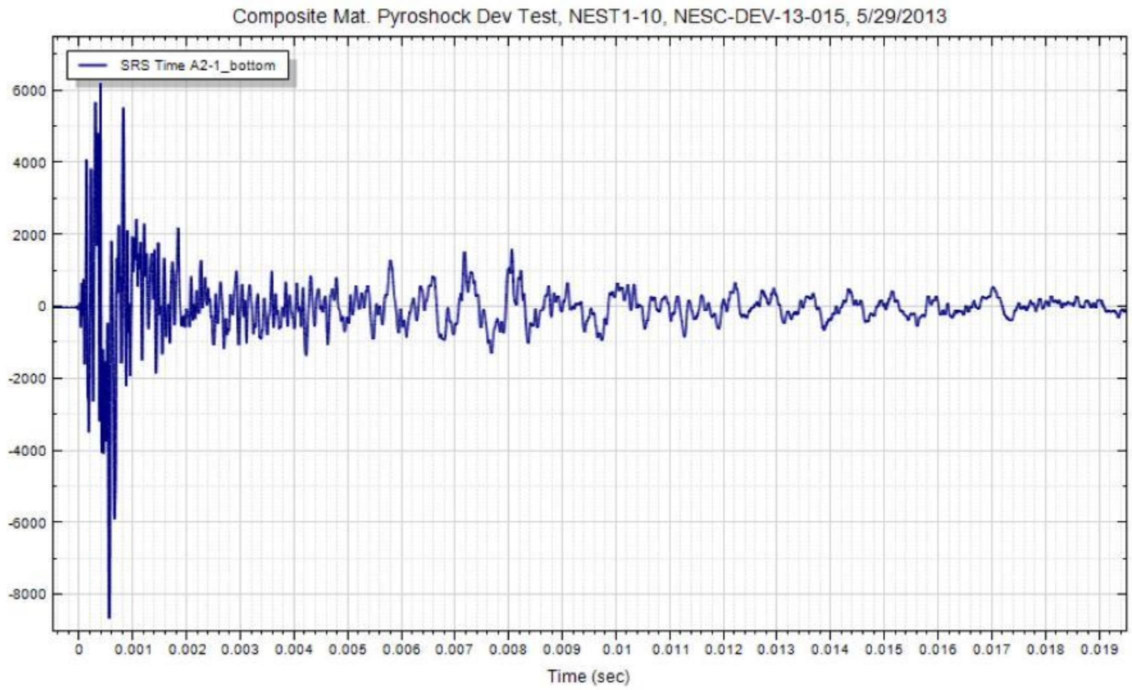

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A10-5_bottom
Positive A10-5_bottom
Spec
10000
1000
100
10
SRS gs
100
1000
10000
Frequency (Hz)

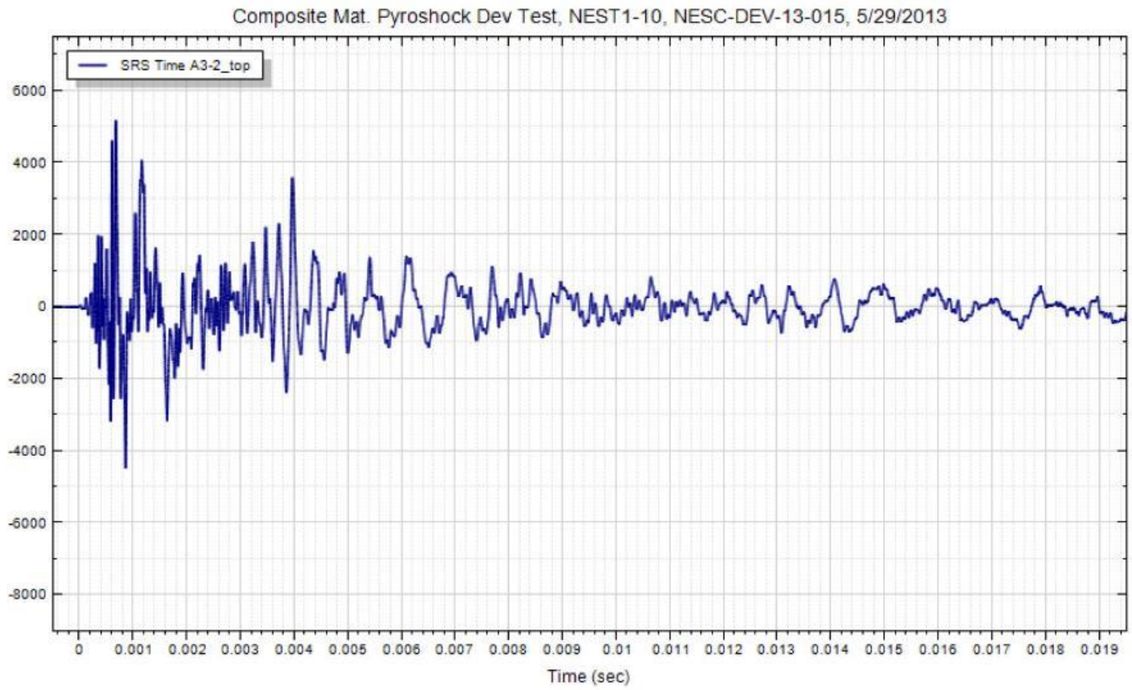

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A11-6_top
Positive A11-6_top
Spec
SRS gs
10000
1000
100
10
Frequency (Hz)
100
1000
10000

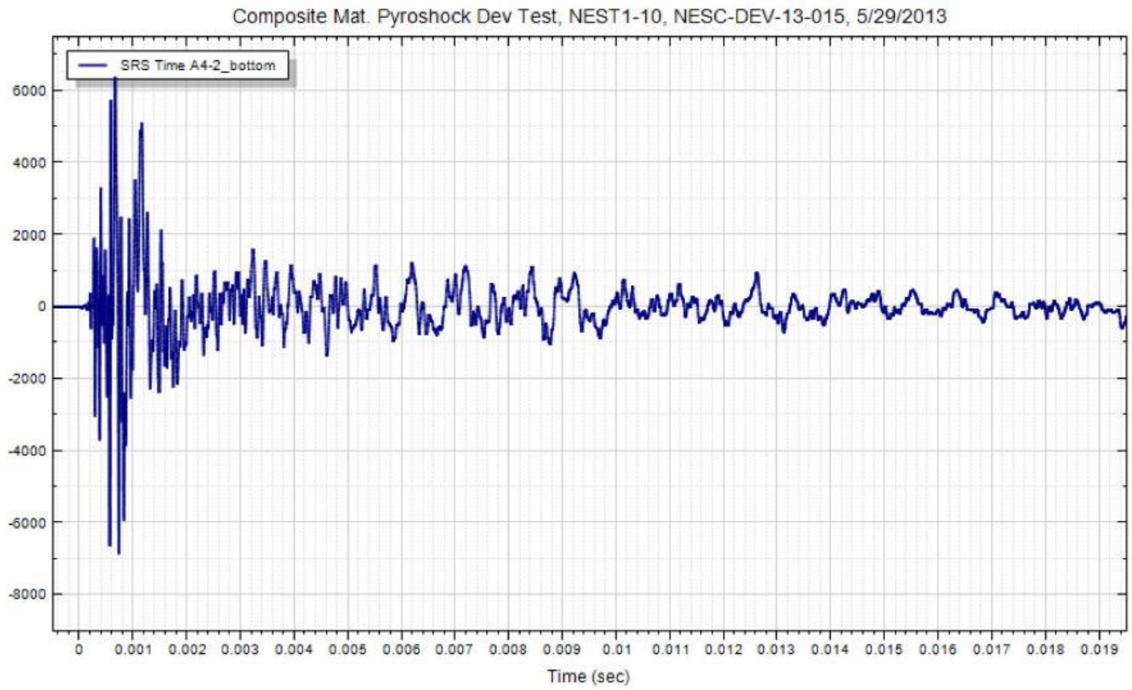

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A12-6_bottom
Positive A12-6_bottom
Spec
SRS gs
10000
1000
100
10
100
1000
10000
Frequency (Hz)

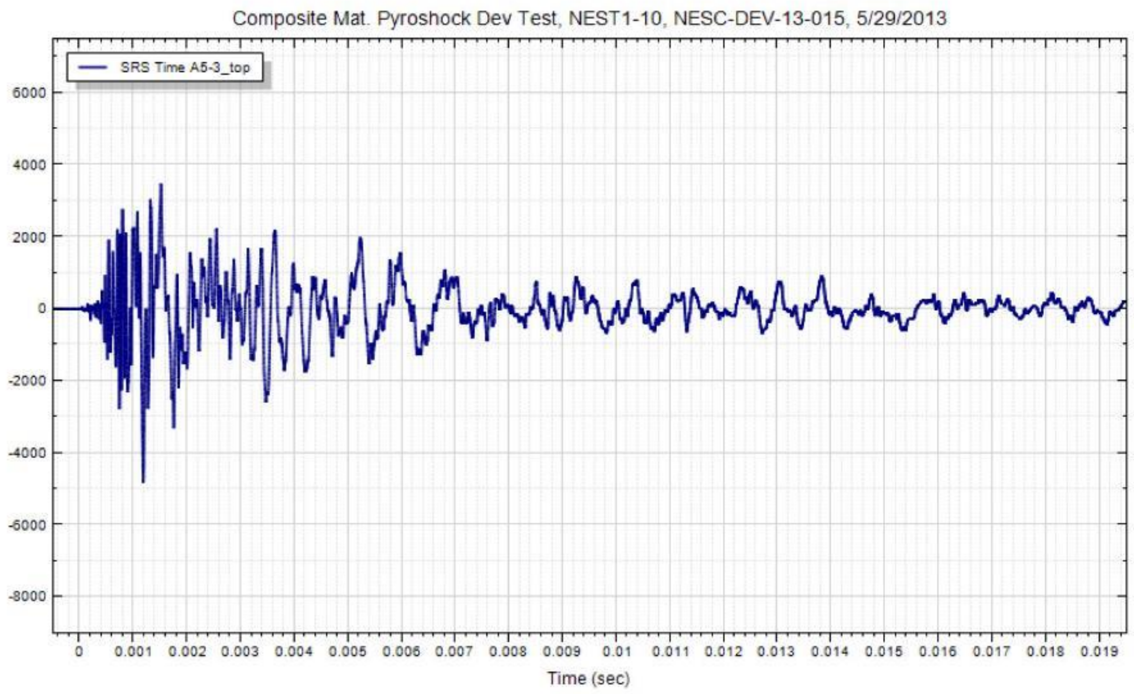

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, SRS, Damping: 0.05, 5/29/2013
Negative A13-free
Positive A13-free
Spec
SRS gs
10
1
0.1
100
1000
1000C
Frequency (Hz)

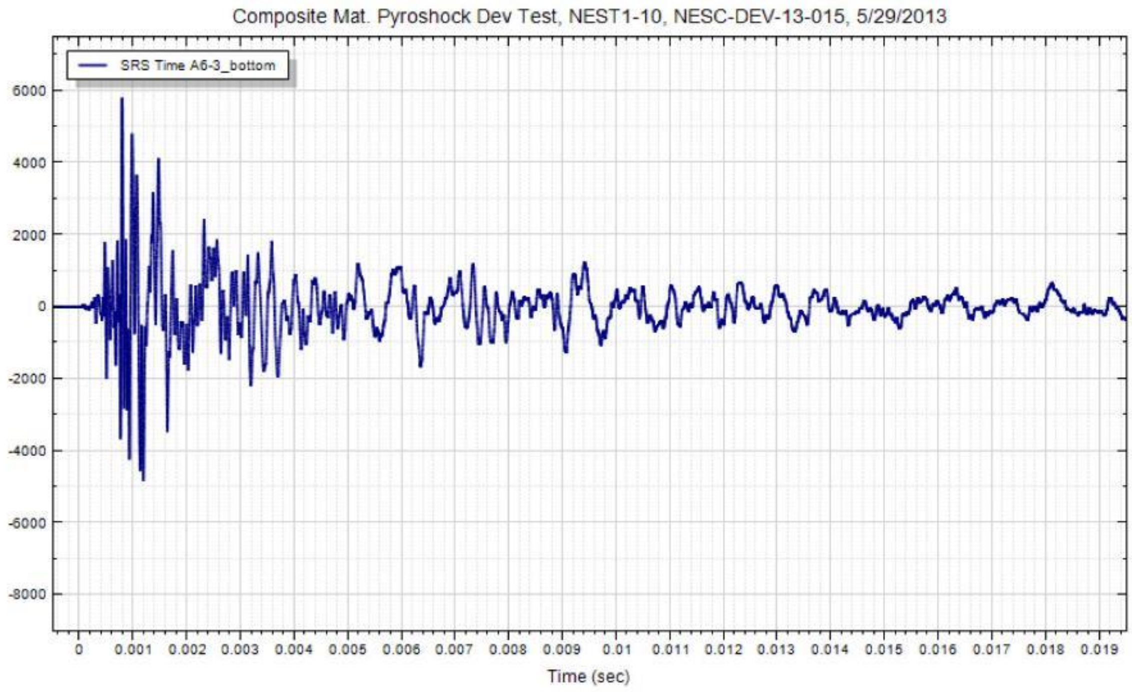

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A1-1_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

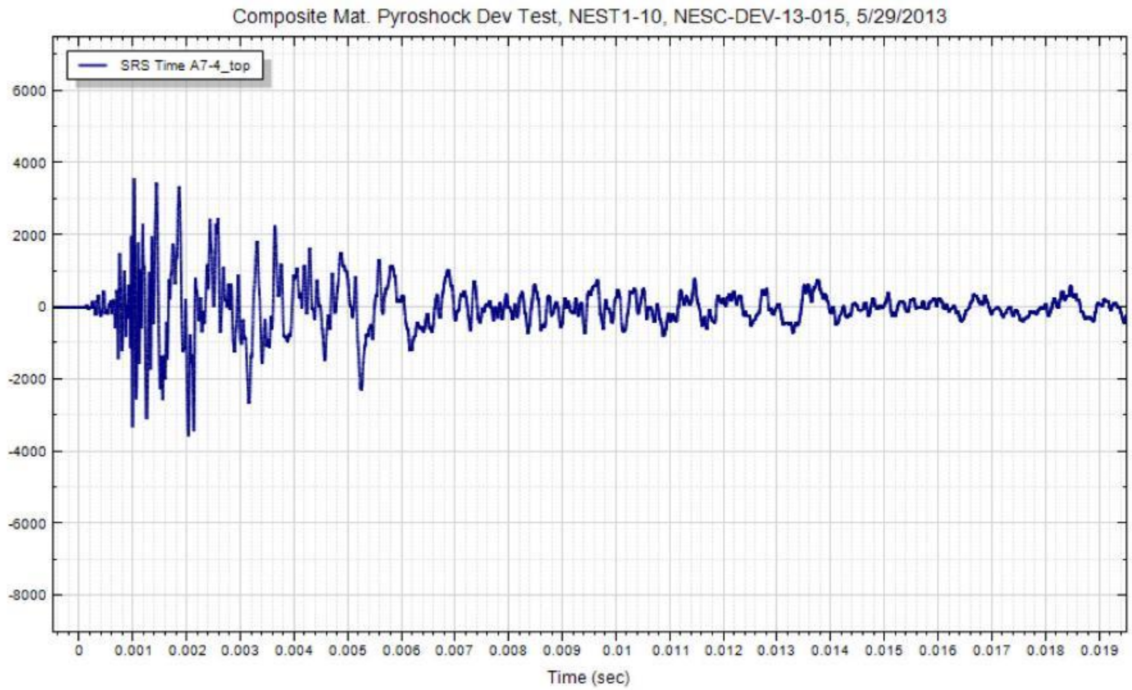

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A2-1_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

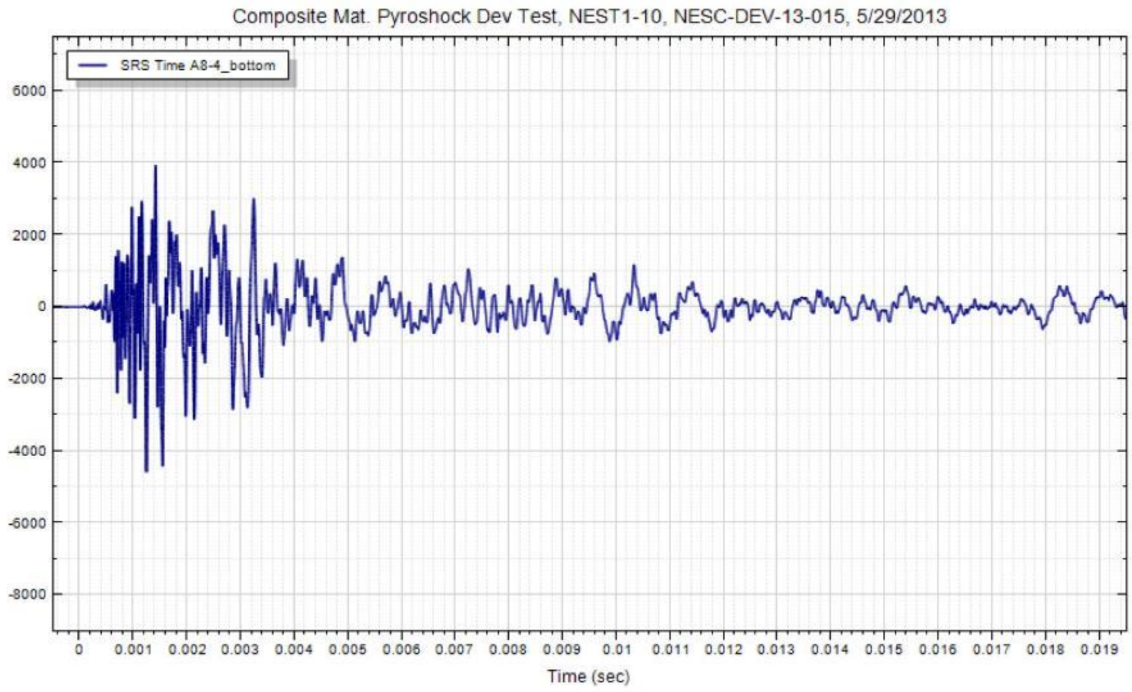

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A3-2_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

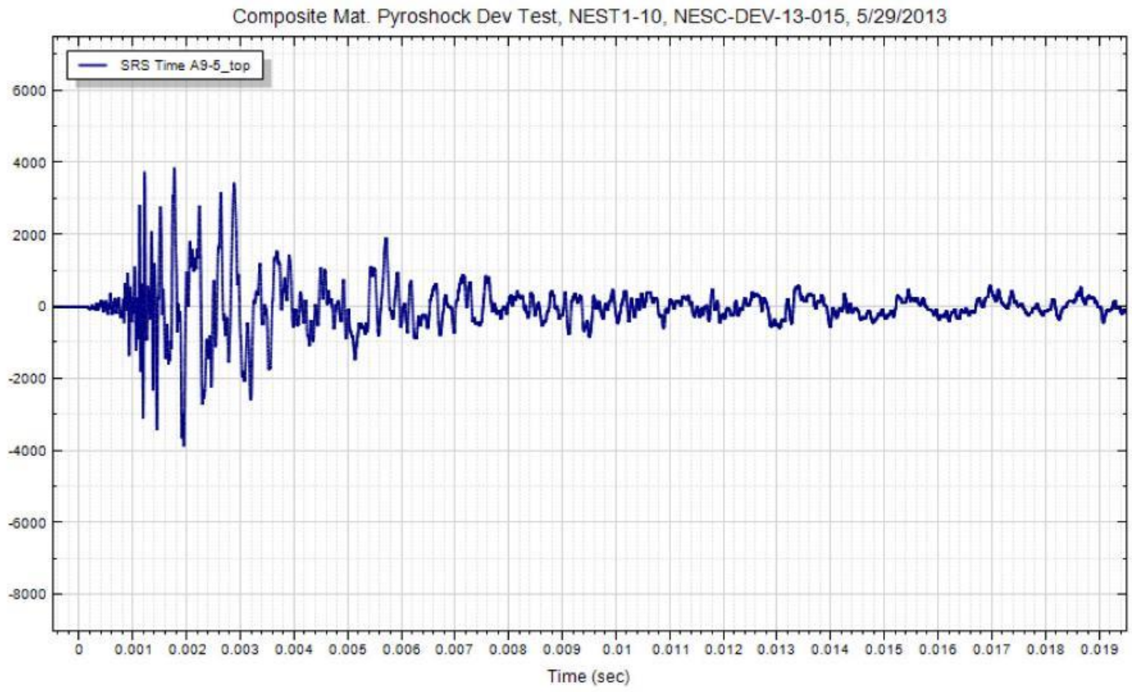

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A4-2_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A5-3_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A6-3_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A7-4_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A8-4_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A9-5_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

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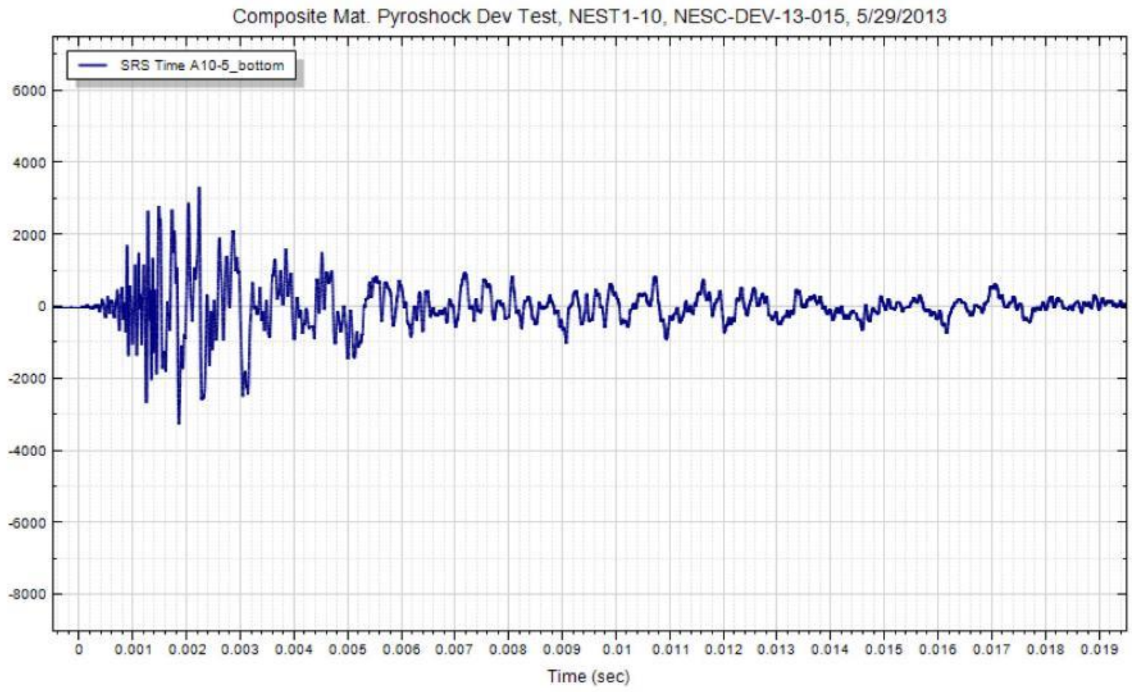
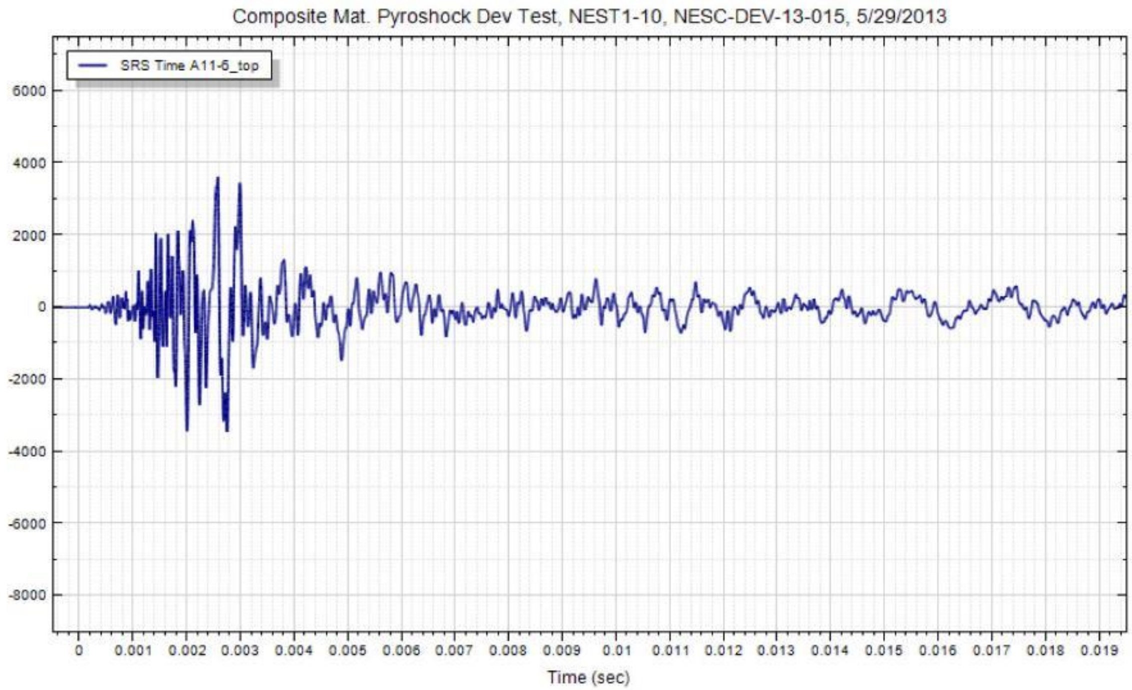
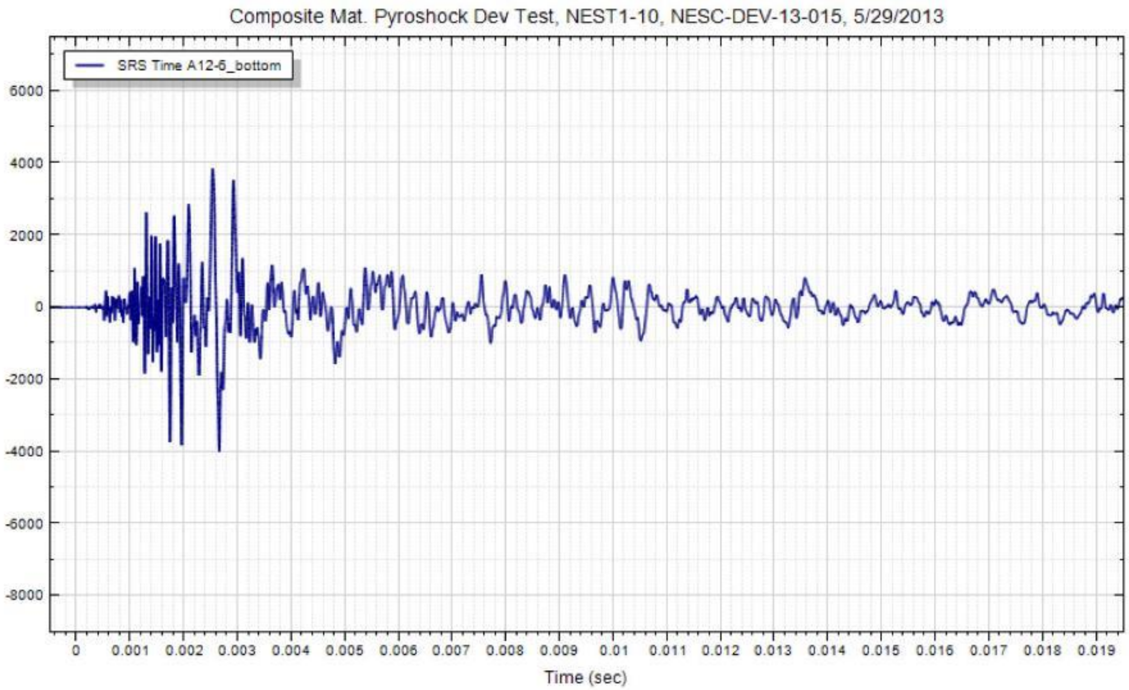
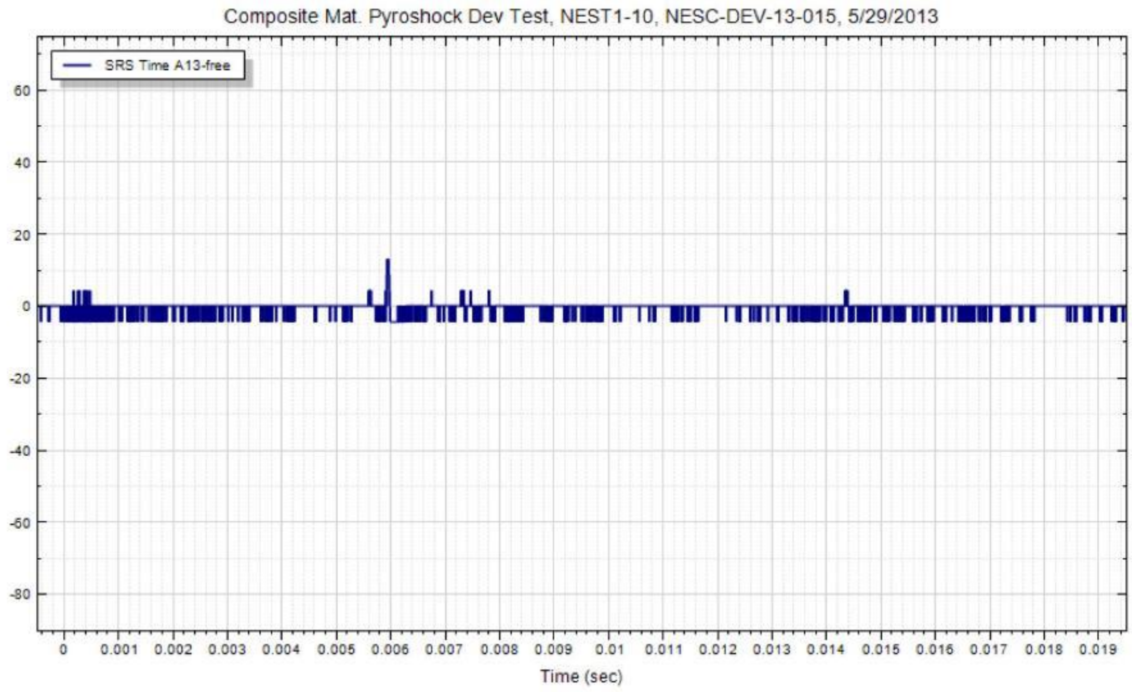

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A10-5_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

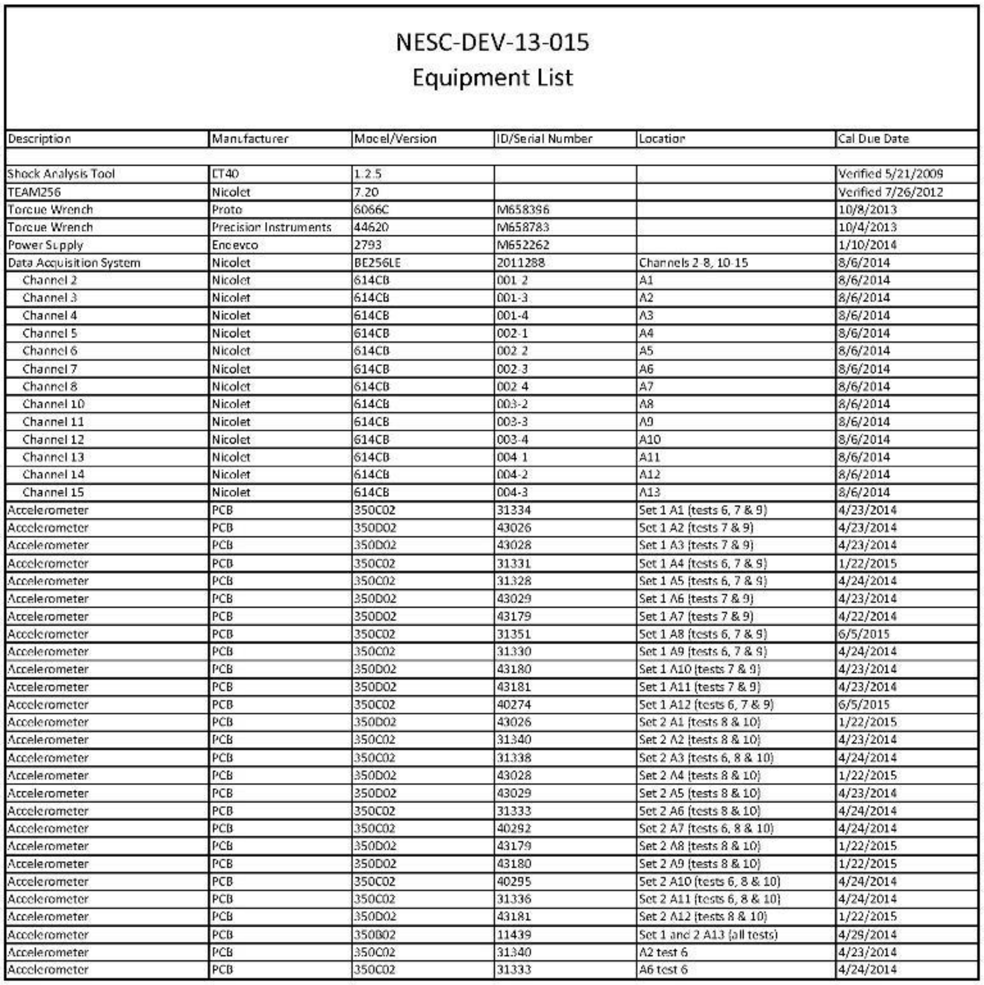

Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A11-6_top
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A12-6_bottom
6000
4000
2000
0
-2000
-4000
-6000
-8000
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)


Composite Mat. Pyroshock Dev Test, NEST1-10, NESC-DEV-13-015, 5/29/2013
SRS Time A13-free
60
40
20
0
-20
-40
-60
-80
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
Time (sec)

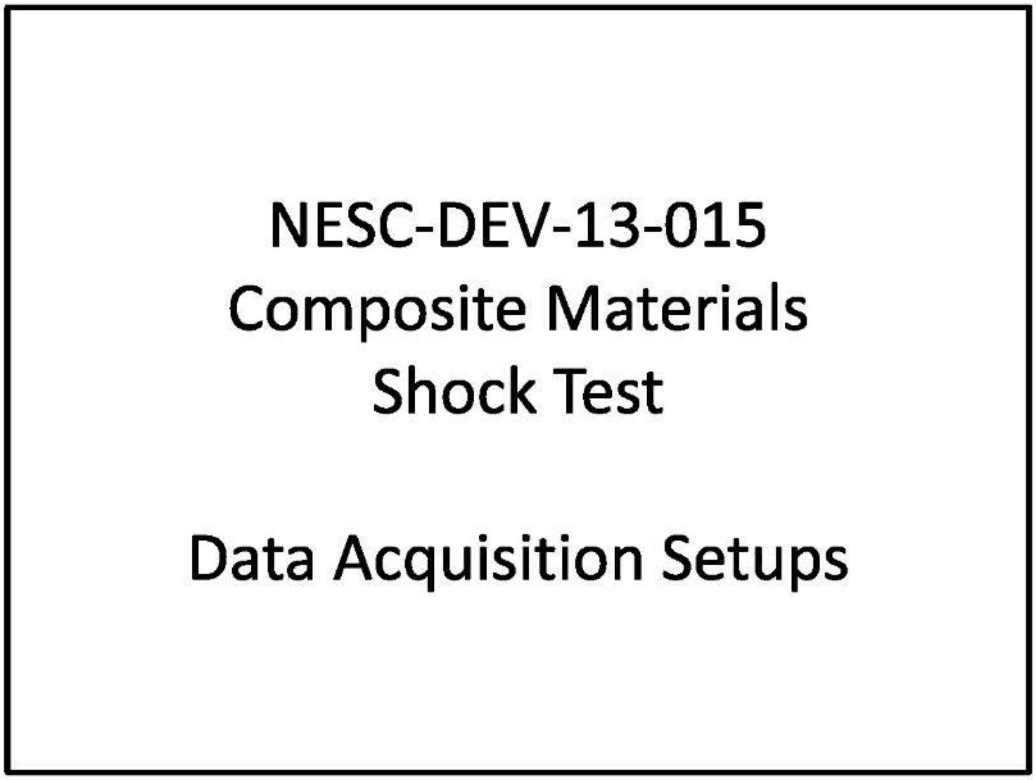
NESC-DEV-13-015
Composite Materials
Shock Test

Equipment List



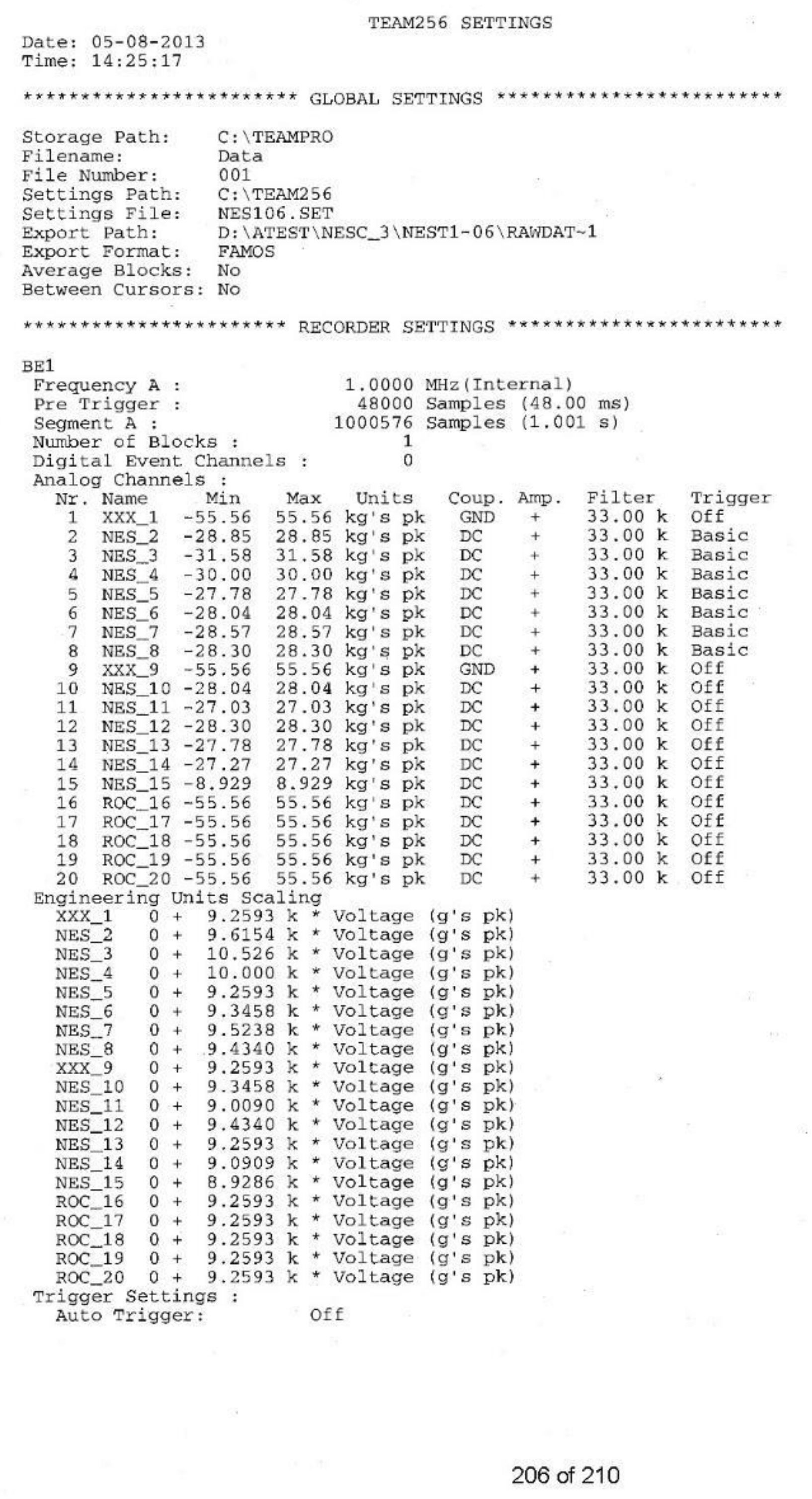
NESC-DEV-13-015
Equipment List

Description	Manufacturer	Model/Version	ID/Serial Number	Location	Cal Due Date
Shock Analysis Tool	ET40	1.2.5			Verified 5/21/2009
TEAM256	Nicolet	7.20			Verified 7/26/2012
Torque Wrench	Proto	6066C	M658396		10/8/2013
Torque Wrench	Precision Instruments	44620	M658783		10/4/2013
Power Supply	Endevco	2793	M652262		1/10/2014
Data Acquisition System	Nicolet	BE256LE	2011288	Channels 2-8, 10-15	8/6/2014
Channel 2	Nicolet	614CB	001-2	A1	8/6/2014
Channel 3	Nicolet	614CB	001-3	A2	8/6/2014
Channel 4	Nicolet	614CB	001-4	A3	8/6/2014
Channel 5	Nicolet	614CB	002-1	A4	8/6/2014
Channel 6	Nicolet	614CB	002-2	A5	8/6/2014
Channel 7	Nicolet	614CB	002-3	A6	8/6/2014
Channel 8	Nicolet	614CB	002-4	A7	8/6/2014
Channel 10	Nicolet	614CB	003-2	A8	8/6/2014
Channel 11	Nicolet	614CB	003-3	A9	8/6/2014
Channel 12	Nicolet	614CB	003-4	A10	8/6/2014
Channel 13	Nicolet	614CB	004-1	A11	8/6/2014
Channel 14	Nicolet	614CB	004-2	A12	8/6/2014
Channel 15	Nicolet	614CB	004-3	A13	8/6/2014
Accelerometer	PCB	350C02	31334	Set 1 A1 (tests 6, 7 & 9)	4/23/2014
Accelerometer	PCB	350D02	43026	Set 1 A2 (tests 7 & 9)	4/23/2014
Accelerometer	PCB	350D02	43028	Set 1 A3 (tests 7 & 9)	4/23/2014
Accelerometer	PCB	350C02	31331	Set 1 A4 (tests 6, 7 & 9)	1/22/2015
Accelerometer	PCB	350C02	31328	Set 1 A5 (tests 6, 7 & 9)	4/24/2014
Accelerometer	PCB	350D02	43029	Set 1 A6 (tests 7 & 9)	4/23/2014
Accelerometer	PCB	350D02	43179	Set 1 A7 (tests 7 & 9)	4/22/2014
Accelerometer	PCB	350C02	31351	Set 1 A8 (tests 6, 7 & 9)	6/5/2015
Accelerometer	PCB	350C02	31330	Set 1 A9 (tests 6, 7 & 9)	4/24/2014
Accelerometer	PCB	350D02	43180	Set 1 A10 (tests 7 & 9)	4/23/2014
Accelerometer	PCB	350D02	43181	Set 1 A11 (tests 7 & 9)	4/23/2014
Accelerometer	PCB	350C02	40274	Set 1 A12 (tests 6, 7 & 9)	6/5/2015
Accelerometer	PCB	350D02	43026	Set 2 A1 (tests 8 & 10)	1/22/2015
Accelerometer	PCB	350C02	31340	Set 2 A2 (tests 8 & 10)	4/23/2014
Accelerometer	PCB	350C02	31338	Set 2 A3 (tests 6, 8 & 10)	4/24/2014
Accelerometer	PCB	350D02	43028	Set 2 A4 (tests 8 & 10)	1/22/2015
Accelerometer	PCB	350D02	43029	Set 2 A5 (tests 8 & 10)	4/23/2014
Accelerometer	PCB	350C02	31333	Set 2 A6 (tests 8 & 10)	4/24/2014
Accelerometer	PCB	350C02	40292	Set 2 A7 (tests 6, 8 & 10)	4/24/2014
Accelerometer	PCB	350D02	43179	Set 2 A8 (tests 8 & 10)	1/22/2015
Accelerometer	PCB	350D02	43180	Set 2 A9 (tests 8 & 10)	1/22/2015
Accelerometer	PCB	350C02	40295	Set 2 A10 (tests 6, 8 & 10)	4/24/2014
Accelerometer	PCB	350C02	31336	Set 2 A11 (tests 6, 8 & 10)	4/24/2014
Accelerometer	PCB	350D02	43181	Set 2 A12 (tests 8 & 10)	1/22/2015
Accelerometer	PCB	350B02	11439	Set 1 and 2 A13 (all tests)	4/29/2014
Accelerometer	PCB	350C02	31340	A2 test 6	4/23/2014
Accelerometer	PCB	350C02	31333	A6 test 6	4/24/2014



NESC-DEV-13-015
Composite Materials Shock Test

Data Acquisition Setups



```
                              TEAM256 SETTINGS
Date: 05-08-2013
Time: 14:25:17

*********************** GLOBAL SETTINGS ************************

Storage Path:    C:\TEAMPRO
Filename:        Data
File Number:     001
Settings Path:   C:\TEAM256
Settings File:   NES106.SET
Export Path:     D:\ATEST\NESC_3\NEST1-06\RAWDAT~1
Export Format:   FAMOS
Average Blocks:  No
Between Cursors: No

********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :                1.0000 MHz(Internal)
 Pre Trigger :                 48000 Samples (48.00 ms)
 Segment A :                 1000576 Samples (1.001 s)
 Number of Blocks :                1
 Digital Event Channels :          0
 Analog Channels :
   Nr. Name     Min     Max   Units    Coup. Amp.  Filter   Trigger
    1  XXX_1  -55.56  55.56 kg's pk    GND   +    33.00 k  Off
    2  NES_2  -28.85  28.85 kg's pk    DC    +    33.00 k  Basic
    3  NES_3  -31.58  31.58 kg's pk    DC    +    33.00 k  Basic
    4  NES_4  -30.00  30.00 kg's pk    DC    +    33.00 k  Basic
    5  NES_5  -27.78  27.78 kg's pk    DC    +    33.00 k  Basic
    6  NES_6  -28.04  28.04 kg's pk    DC    +    33.00 k  Basic
    7  NES_7  -28.57  28.57 kg's pk    DC    +    33.00 k  Basic
    8  NES_8  -28.30  28.30 kg's pk    DC    +    33.00 k  Basic
    9  XXX_9  -55.56  55.56 kg's pk    GND   +    33.00 k  Off
   10  NES_10 -28.04  28.04 kg's pk    DC    +    33.00 k  Off
   11  NES_11 -27.03  27.03 kg's pk    DC    +    33.00 k  Off
   12  NES_12 -28.30  28.30 kg's pk    DC    +    33.00 k  Off
   13  NES_13 -27.78  27.78 kg's pk    DC    +    33.00 k  Off
   14  NES_14 -27.27  27.27 kg's pk    DC    +    33.00 k  Off
   15  NES_15 -8.929  8.929 kg's pk    DC    +    33.00 k  Off
   16  ROC_16 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
   17  ROC_17 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
   18  ROC_18 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
   19  ROC_19 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
   20  ROC_20 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  9.2593 k * Voltage (g's pk)
   NES_2    0 +  9.6154 k * Voltage (g's pk)
   NES_3    0 +  10.526 k * Voltage (g's pk)
   NES_4    0 +  10.000 k * Voltage (g's pk)
   NES_5    0 +  9.2593 k * Voltage (g's pk)
   NES_6    0 +  9.3458 k * Voltage (g's pk)
   NES_7    0 +  9.5238 k * Voltage (g's pk)
   NES_8    0 +  9.4340 k * Voltage (g's pk)
   XXX_9    0 +  9.2593 k * Voltage (g's pk)
   NES_10   0 +  9.3458 k * Voltage (g's pk)
   NES_11   0 +  9.0090 k * Voltage (g's pk)
   NES_12   0 +  9.4340 k * Voltage (g's pk)
   NES_13   0 +  9.2593 k * Voltage (g's pk)
   NES_14   0 +  9.0909 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:          Off
```

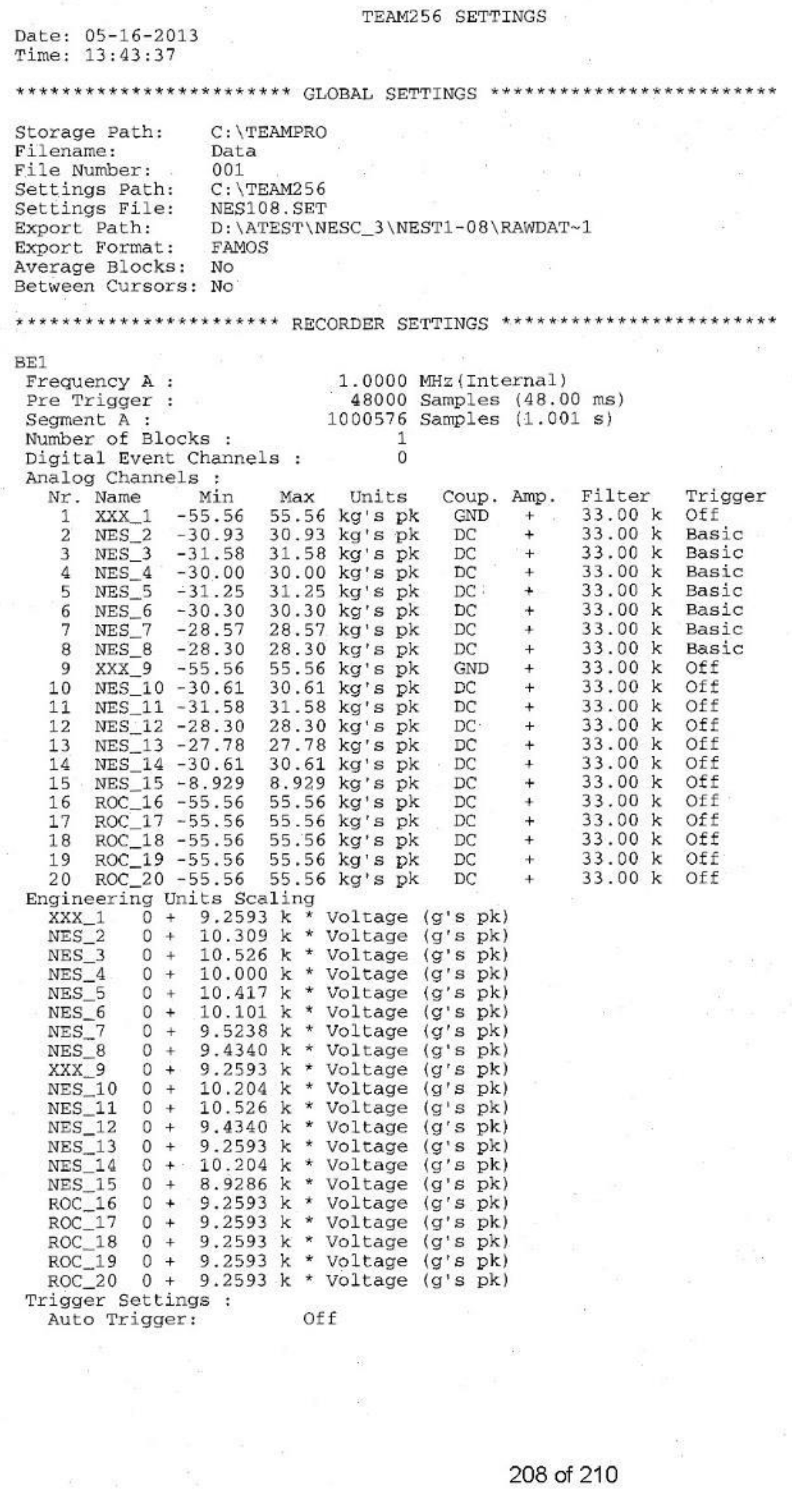
```
                              TEAM256 SETTINGS
Date: 05-09-2013
Time: 16:03:37

************************ GLOBAL SETTINGS ************************

Storage Path:     C:\TEAMPRO
Filename:         Data
File Number:      001
Settings Path:    C:\TEAM256
Settings File:    NES107.SET
Export Path:      D:\ATEST\NESC_3\NEST1-07\RAWDAT~1
Export Format:    FAMOS
Average Blocks:   No
Between Cursors:  No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :                 1.0000 MHz(Internal)
 Pre Trigger :                  48000 Samples (48.00 ms)
 Segment A :                  1000576 Samples (1.001 s)
 Number of Blocks :                 1
 Digital Event Channels :           0
 Analog Channels :
   Nr. Name     Min     Max   Units    Coup. Amp.  Filter   Trigger
     1 XXX_1  -6.000  6.000 kg's pk    GND   +    33.00 k  Off
     2 NES_2  -28.85  28.85 kg's pk    DC    +    33.00 k  Basic
     3 NES_3  -30.93  30.93 kg's pk    DC    +    33.00 k  Basic
     4 NES_4  -31.25  31.25 kg's pk    DC    +    33.00 k  Basic
     5 NES_5  -27.78  27.78 kg's pk    DC    +    33.00 k  Basic
     6 NES_6  -28.04  28.04 kg's pk    DC    +    33.00 k  Basic
     7 NES_7  -30.30  30.30 kg's pk    DC    +    33.00 k  Basic
     8 NES_8  -30.61  30.61 kg's pk    DC    +    33.00 k  Basic
     9 XXX_9  -6.000  6.000 kg's pk    GND   +    33.00 k  Off
    10 NES_10 -28.04  28.04 kg's pk    DC    +    33.00 k  Off
    11 NES_11 -27.03  27.03 kg's pk    DC    +    33.00 k  Off
    12 NES_12 -31.58  31.58 kg's pk    DC    +    33.00 k  Off
    13 NES_13 -30.61  30.61 kg's pk    DC    +    33.00 k  Off
    14 NES_14 -27.27  27.27 kg's pk    DC    +    33.00 k  Off
    15 NES_15 -8.929  8.929 kg's pk    DC    +    33.00 k  Off
    16 ROC_16 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
    17 ROC_17 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
    18 ROC_18 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
    19 ROC_19 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
    20 ROC_20 -55.56  55.56 kg's pk    DC    +    33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  1.0000 k * Voltage (g's pk)
   NES_2    0 +  9.6154 k * Voltage (g's pk)
   NES_3    0 +  10.309 k * Voltage (g's pk)
   NES_4    0 +  10.417 k * Voltage (g's pk)
   NES_5    0 +  9.2593 k * Voltage (g's pk)
   NES_6    0 +  9.3458 k * Voltage (g's pk)
   NES_7    0 +  10.101 k * Voltage (g's pk)
   NES_8    0 +  10.204 k * Voltage (g's pk)
   XXX_9    0 +  1.0000 k * Voltage (g's pk)
   NES_10   0 +  9.3458 k * Voltage (g's pk)
   NES_11   0 +  9.0090 k * Voltage (g's pk)
   NES_12   0 +  10.526 k * Voltage (g's pk)
   NES_13   0 +  10.204 k * Voltage (g's pk)
   NES_14   0 +  9.0909 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:           Off
```



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                                TEAM256 SETTINGS
Date: 05-16-2013
Time: 13:43:37

************************ GLOBAL SETTINGS *************************

Storage Path:    C:\TEAMPRO
Filename:        Data
File Number:     001
Settings Path:   C:\TEAM256
Settings File:   NES108.SET
Export Path:     D:\ATEST\NESC_3\NEST1-08\RAWDAT~1
Export Format:   FAMOS
Average Blocks:  No
Between Cursors: No

*********************** RECORDER SETTINGS ************************

BE1
 Frequency A :                 1.0000 MHz(Internal)
 Pre Trigger :                  48000 Samples (48.00 ms)
 Segment A :                  1000576 Samples (1.001 s)
 Number of Blocks :                 1
 Digital Event Channels :           0
 Analog Channels :
   Nr. Name      Min     Max    Units    Coup. Amp.  Filter   Trigger
    1  XXX_1  -55.56  55.56 kg's pk   GND    +    33.00 k  Off
    2  NES_2  -30.93  30.93 kg's pk   DC     +    33.00 k  Basic
    3  NES_3  -31.58  31.58 kg's pk   DC     +    33.00 k  Basic
    4  NES_4  -30.00  30.00 kg's pk   DC     +    33.00 k  Basic
    5  NES_5  -31.25  31.25 kg's pk   DC     +    33.00 k  Basic
    6  NES_6  -30.30  30.30 kg's pk   DC     +    33.00 k  Basic
    7  NES_7  -28.57  28.57 kg's pk   DC     +    33.00 k  Basic
    8  NES_8  -28.30  28.30 kg's pk   DC     +    33.00 k  Basic
    9  XXX_9  -55.56  55.56 kg's pk   GND    +    33.00 k  Off
   10  NES_10 -30.61  30.61 kg's pk   DC     +    33.00 k  Off
   11  NES_11 -31.58  31.58 kg's pk   DC     +    33.00 k  Off
   12  NES_12 -28.30  28.30 kg's pk   DC     +    33.00 k  Off
   13  NES_13 -27.78  27.78 kg's pk   DC     +    33.00 k  Off
   14  NES_14 -30.61  30.61 kg's pk   DC     +    33.00 k  Off
   15  NES_15 -8.929  8.929 kg's pk   DC     +    33.00 k  Off
   16  ROC_16 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   17  ROC_17 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   18  ROC_18 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   19  ROC_19 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
   20  ROC_20 -55.56  55.56 kg's pk   DC     +    33.00 k  Off
 Engineering Units Scaling
   XXX_1    0 +  9.2593 k * Voltage (g's pk)
   NES_2    0 +  10.309 k * Voltage (g's pk)
   NES_3    0 +  10.526 k * Voltage (g's pk)
   NES_4    0 +  10.000 k * Voltage (g's pk)
   NES_5    0 +  10.417 k * Voltage (g's pk)
   NES_6    0 +  10.101 k * Voltage (g's pk)
   NES_7    0 +  9.5238 k * Voltage (g's pk)
   NES_8    0 +  9.4340 k * Voltage (g's pk)
   XXX_9    0 +  9.2593 k * Voltage (g's pk)
   NES_10   0 +  10.204 k * Voltage (g's pk)
   NES_11   0 +  10.526 k * Voltage (g's pk)
   NES_12   0 +  9.4340 k * Voltage (g's pk)
   NES_13   0 +  9.2593 k * Voltage (g's pk)
   NES_14   0 +  10.204 k * Voltage (g's pk)
   NES_15   0 +  8.9286 k * Voltage (g's pk)
   ROC_16   0 +  9.2593 k * Voltage (g's pk)
   ROC_17   0 +  9.2593 k * Voltage (g's pk)
   ROC_18   0 +  9.2593 k * Voltage (g's pk)
   ROC_19   0 +  9.2593 k * Voltage (g's pk)
   ROC_20   0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:          Off
```

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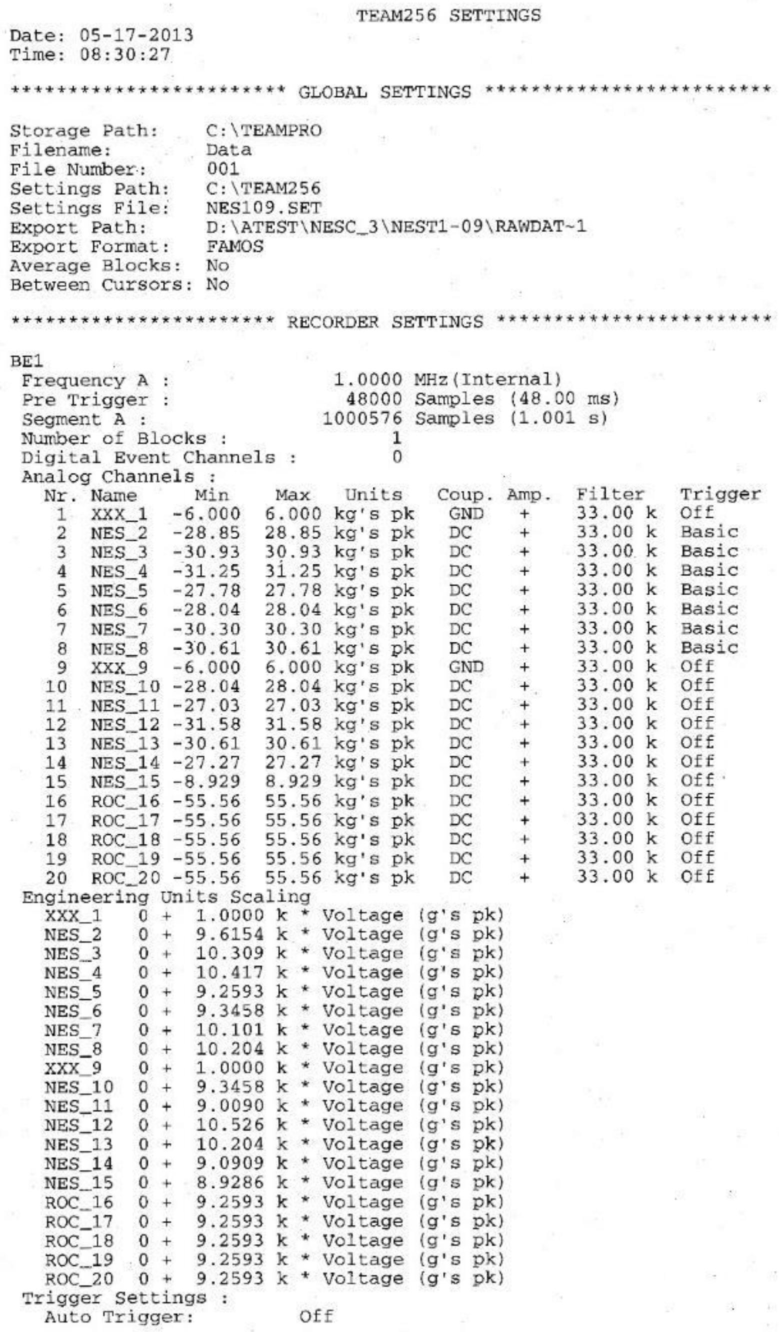

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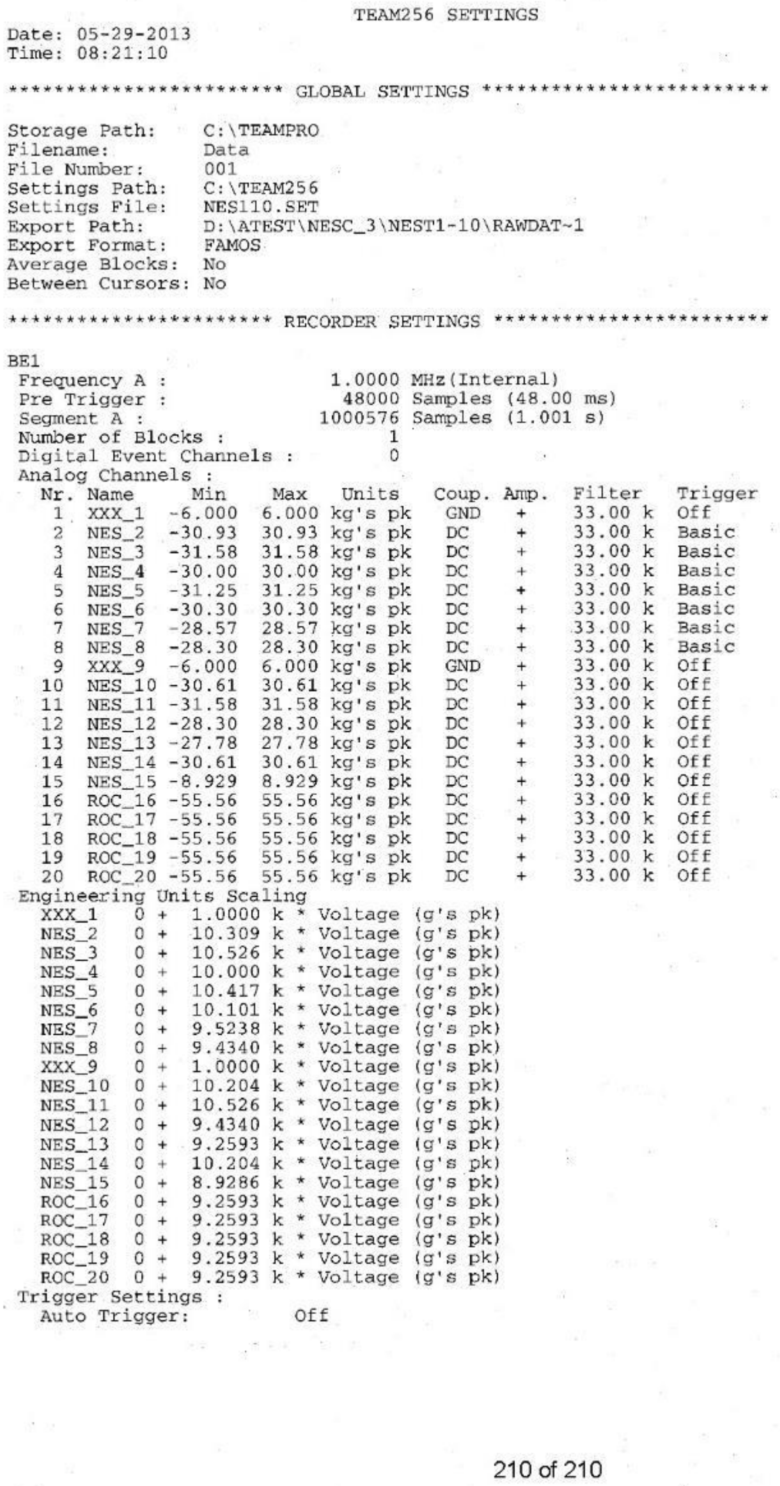
                              TEAM256 SETTINGS
Date: 05-17-2013
Time: 08:30:27

*********************** GLOBAL SETTINGS ************************

Storage Path:     C:\TEAMPRO
Filename:         Data
File Number:      001
Settings Path:    C:\TEAM256
Settings File:    NES109.SET
Export Path:      D:\ATEST\NESC_3\NEST1-09\RAWDAT~1
Export Format:    FAMOS
Average Blocks:   No
Between Cursors:  No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :               1.0000 MHz(Internal)
 Pre Trigger :                48000 Samples (48.00 ms)
 Segment A :                1000576 Samples (1.001 s)
 Number of Blocks :               1
 Digital Event Channels :         0
 Analog Channels :
   Nr. Name      Min     Max   Units    Coup. Amp.  Filter   Trigger
    1  XXX_1  -6.000   6.000 kg's pk    GND    +    33.00 k  Off
    2  NES_2  -28.85   28.85 kg's pk    DC     +    33.00 k  Basic
    3  NES_3  -30.93   30.93 kg's pk    DC     +    33.00 k  Basic
    4  NES_4  -31.25   31.25 kg's pk    DC     +    33.00 k  Basic
    5  NES_5  -27.78   27.78 kg's pk    DC     +    33.00 k  Basic
    6  NES_6  -28.04   28.04 kg's pk    DC     +    33.00 k  Basic
    7  NES_7  -30.30   30.30 kg's pk    DC     +    33.00 k  Basic
    8  NES_8  -30.61   30.61 kg's pk    DC     +    33.00 k  Basic
    9  XXX_9  -6.000   6.000 kg's pk    GND    +    33.00 k  Off
   10  NES_10 -28.04   28.04 kg's pk    DC     +    33.00 k  Off
   11  NES_11 -27.03   27.03 kg's pk    DC     +    33.00 k  Off
   12  NES_12 -31.58   31.58 kg's pk    DC     +    33.00 k  Off
   13  NES_13 -30.61   30.61 kg's pk    DC     +    33.00 k  Off
   14  NES_14 -27.27   27.27 kg's pk    DC     +    33.00 k  Off
   15  NES_15 -8.929   8.929 kg's pk    DC     +    33.00 k  Off
   16  ROC_16 -55.56   55.56 kg's pk    DC     +    33.00 k  Off
   17  ROC_17 -55.56   55.56 kg's pk    DC     +    33.00 k  Off
   18  ROC_18 -55.56   55.56 kg's pk    DC     +    33.00 k  Off
   19  ROC_19 -55.56   55.56 kg's pk    DC     +    33.00 k  Off
   20  ROC_20 -55.56   55.56 kg's pk    DC     +    33.00 k  Off
 Engineering Units Scaling
   XXX_1   0 +  1.0000 k * Voltage (g's pk)
   NES_2   0 +  9.6154 k * Voltage (g's pk)
   NES_3   0 +  10.309 k * Voltage (g's pk)
   NES_4   0 +  10.417 k * Voltage (g's pk)
   NES_5   0 +  9.2593 k * Voltage (g's pk)
   NES_6   0 +  9.3458 k * Voltage (g's pk)
   NES_7   0 +  10.101 k * Voltage (g's pk)
   NES_8   0 +  10.204 k * Voltage (g's pk)
   XXX_9   0 +  1.0000 k * Voltage (g's pk)
   NES_10  0 +  9.3458 k * Voltage (g's pk)
   NES_11  0 +  9.0090 k * Voltage (g's pk)
   NES_12  0 +  10.526 k * Voltage (g's pk)
   NES_13  0 +  10.204 k * Voltage (g's pk)
   NES_14  0 +  9.0909 k * Voltage (g's pk)
   NES_15  0 +  8.9286 k * Voltage (g's pk)
   ROC_16  0 +  9.2593 k * Voltage (g's pk)
   ROC_17  0 +  9.2593 k * Voltage (g's pk)
   ROC_18  0 +  9.2593 k * Voltage (g's pk)
   ROC_19  0 +  9.2593 k * Voltage (g's pk)
   ROC_20  0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:           Off
```



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Date: 05-29-2013
Time: 08:21:10

*********************** GLOBAL SETTINGS ************************

Storage Path:     C:\TEAMPRO
Filename:         Data
File Number:      001
Settings Path:    C:\TEAM256
Settings File:    NES110.SET
Export Path:      D:\ATEST\NESC_3\NEST1-10\RAWDAT~1
Export Format:    FAMOS
Average Blocks:   No
Between Cursors:  No

*********************** RECORDER SETTINGS ***********************

BE1
 Frequency A :                 1.0000 MHz(Internal)
 Pre Trigger :                  48000 Samples (48.00 ms)
 Segment A :                  1000576 Samples (1.001 s)
 Number of Blocks :                 1
 Digital Event Channels :           0
 Analog Channels :
   Nr. Name      Min     Max    Units    Coup. Amp.  Filter   Trigger
     1 XXX_1  -6.000   6.000  kg's pk    GND    +    33.00 k  Off
     2 NES_2  -30.93   30.93  kg's pk    DC     +    33.00 k  Basic
     3 NES_3  -31.58   31.58  kg's pk    DC     +    33.00 k  Basic
     4 NES_4  -30.00   30.00  kg's pk    DC     +    33.00 k  Basic
     5 NES_5  -31.25   31.25  kg's pk    DC     +    33.00 k  Basic
     6 NES_6  -30.30   30.30  kg's pk    DC     +    33.00 k  Basic
     7 NES_7  -28.57   28.57  kg's pk    DC     +    33.00 k  Basic
     8 NES_8  -28.30   28.30  kg's pk    DC     +    33.00 k  Basic
     9 XXX_9  -6.000   6.000  kg's pk    GND    +    33.00 k  Off
    10 NES_10 -30.61   30.61  kg's pk    DC     +    33.00 k  Off
    11 NES_11 -31.58   31.58  kg's pk    DC     +    33.00 k  Off
    12 NES_12 -28.30   28.30  kg's pk    DC     +    33.00 k  Off
    13 NES_13 -27.78   27.78  kg's pk    DC     +    33.00 k  Off
    14 NES_14 -30.61   30.61  kg's pk    DC     +    33.00 k  Off
    15 NES_15 -8.929   8.929  kg's pk    DC     +    33.00 k  Off
    16 ROC_16 -55.56   55.56  kg's pk    DC     +    33.00 k  Off
    17 ROC_17 -55.56   55.56  kg's pk    DC     +    33.00 k  Off
    18 ROC_18 -55.56   55.56  kg's pk    DC     +    33.00 k  Off
    19 ROC_19 -55.56   55.56  kg's pk    DC     +    33.00 k  Off
    20 ROC_20 -55.56   55.56  kg's pk    DC     +    33.00 k  Off
 Engineering Units Scaling
   XXX_1   0 +  1.0000 k * Voltage (g's pk)
   NES_2   0 +  10.309 k * Voltage (g's pk)
   NES_3   0 +  10.526 k * Voltage (g's pk)
   NES_4   0 +  10.000 k * Voltage (g's pk)
   NES_5   0 +  10.417 k * Voltage (g's pk)
   NES_6   0 +  10.101 k * Voltage (g's pk)
   NES_7   0 +  9.5238 k * Voltage (g's pk)
   NES_8   0 +  9.4340 k * Voltage (g's pk)
   XXX_9   0 +  1.0000 k * Voltage (g's pk)
   NES_10  0 +  10.204 k * Voltage (g's pk)
   NES_11  0 +  10.526 k * Voltage (g's pk)
   NES_12  0 +  9.4340 k * Voltage (g's pk)
   NES_13  0 +  9.2593 k * Voltage (g's pk)
   NES_14  0 +  10.204 k * Voltage (g's pk)
   NES_15  0 +  8.9286 k * Voltage (g's pk)
   ROC_16  0 +  9.2593 k * Voltage (g's pk)
   ROC_17  0 +  9.2593 k * Voltage (g's pk)
   ROC_18  0 +  9.2593 k * Voltage (g's pk)
   ROC_19  0 +  9.2593 k * Voltage (g's pk)
   ROC_20  0 +  9.2593 k * Voltage (g's pk)
 Trigger Settings :
   Auto Trigger:         Off
```

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
01- 07 - 2015

2. REPORT TYPE
Technical Memorandum

3. DATES COVERED *(From - To)*
April 2012 - April 2015

4. TITLE AND SUBTITLE
Empirical Model Development for Predicting Shock Response on Composite Materials Subjected to Pyroshock Loading
Appendices

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Gentz, Steven J.; Ordway, David O.; Parsons, David S.; Garrison, Craig M.;
Rodgers, C. Steven; Collins, Brian W.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER
869021.05.05.09.13

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
NASA Langley Research Center
Hampton, VA 23681-2199

8. PERFORMING ORGANIZATION REPORT NUMBER
L-20591 NESC-RP-12-00783

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSOR/MONITOR'S ACRONYM(S)
NASA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
NASA/TM-2015-218781/Volume II/Part 1

12. DISTRIBUTION/AVAILABILITY STATEMENT
Unclassified - Unlimited
Subject Category 24 Composite Materials
Availability: NASA STI Program (757) 864-9658

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The NASA Engineering and Safety Center (NESC) received a request to develop an analysis model based on both frequency response and wave propagation analyses for predicting shock response spectrum (SRS) on composite materials subjected to pyroshock loading. The model would account for near-field environment (~9 inches from the source) dominated by direct wave propagation, mid-field environment (~2 feet from the source) characterized by wave propagation and structural resonances, and far-field environment dominated by lower frequency bending waves in the structure. This document contains appendices to the Volume I report.

15. SUBJECT TERMS
NASA Engineering and Safety Center; Shock response spectrum; Pyroshock loading; Model development

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
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