CMH: FAST-TEV-068

PARTIAL MAGNETIC CHARACTERIZATION OF THE C220 VERTICAL GSFC VIBRATION SHAKER IN SUPPORT OF FAST S/C TESTING

NSI Document Number

12-02-1125

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Attachment 1

1. Introduction

1.0 Background

The FAST Flight Spacecraft will be vibration tested in early 1994. Its mission is to explore magnetic phenomena in the earths's polar regions. It is susceptible to even small amounts of magnetic "perming" due to uni-directional magnetic fields. Therefore the FAST project has requested 754.1 to investigate the magnetic flux around the shakers during operation. FAST requirements call for less than 3 Gauss less than 1 foot away from the spacecraft.

1.1 Scope

The scope of this test is to characterize the magnetic field of the C220 GSFC Vibration shaker and identify potential magnetization and field exposure to spacecraft and components under environmental test.

1.2 Purpose

The purpose of this test is to measure the total magnetic field flux density, on the surface and at 1 ft distance from the surface of the C220 vertical shaker (including the head expander) and determine the magnetic compliance of the GSFC vibration facility with the FAST spacecraft specification (the magnetic flux density shall not exceed 3 Gauss at a distance of 1 ft from the surface of the head expander). In addition to the head expander, a 2" Aluminum fixture plate shall support the spacecraft. This investigation will measure magnetic fields during three distinct phases of shaker operation: a. Shaker Power turn-on and turn-off, b. Shaker standby mode, c. Shaker operation.

2.0 Applicable Documents

2.1 GEVS-SE, January 1990
General Environmental Verification Specification for STS&ELV Payloads, Subsystems and Components.

3.0 Test Documentation Requirements

3.1 During Test

Deviations to these procedures during test shall be approved by D. Rogers.

3.2 Test Data

Test data shall be recorded and annotated to show test, date, time, name of responsible individual, etc.

3.3 Test Report

Following the completion of these tests, a report shall be written which documents the results of the tests, including discussion of the data and conclusions and/or recommendations. All spectrum analyzer plots shall be attached. The total magnetic field shall be calculated and reported for all measurement locations, and the highest magnetic field locations per vibration test, per frequency, shall be indicated and evaluated. The earth's total magnetic field (0.5 Gauss) shall be included in all measurements.

4.0 TEST PROCEDURE STEPS

The 60" diameter magnesium head expander shall be in place for this test at all times.
There is a requirement for three measurements per point (a. N-S perpendicular to the head expander, b. N-S parallel to the head expander, c. E-W perpendicular to the head expander), in order to reconstruct the total magnetic field.

A total of five magnetic measurements shall be acquired for 2 cross sections (2" and 14") from the head expander, arranged so that the first corresponds to the center of the cross-section's circle, and the other four at the perimeter of the circle, at the North, South, East and West points (figure 1 A). The 2" and 14" cross sections will be scanned for the maximum magnetic flux density value. Additional measurements shall be performed (shaker at constant output) at the boundary surface defined the FAST specification, in other words, at a 34.5" radius, 2" above the surface of the head expander (figure 1B). The test will consist of 4 major parts, considering as initial condition the shaker in the stand-by power status for at least 30 minutes:

4.1 Magnetic measurements during sine burst simulation testing. Five cycles, of a sin burst, of 20 Hz at 15 G.

4.2 Magnetic measurements during sine dwell "wedge check" for 5 G (acceleration) at 20 Hz.

4.3 Magnetic measurements during random vibration, according to figure 2.

4.4 Magnetic measurements during shaker amplifier turn-on and turn-off. For this test, all 3 magnetic sensors shall be utilized concurrently to minimize time and effort.

4.5 Facilities. All tests shall be conducted in the Building 7, Vibration Facility at GSFC. A DC magnetic field study will be conducted prior to powering up the shaker, and at least three hours after the last powering down.

4.6 Test Equipment

a. Magnetic Instrumentation, Model 902 Gaussmeter (0 to 20,000 Gauss, with a 902T single axis transverse probe.

b. RFL Industries, Model 750 Gaussmeter (0.01 to 50,000) Gauss, with a single axis transverse probe.

c. ALP-10 Magnetic field loop sensing antenna (sensor) connected to a very low frequency (20 Hz to 100 Mhz) HP 8566B/HP 85865A spectrum analyzer and plotter. This test shall monitor magnetic field as a function of the frequency (frequency domain measurements).

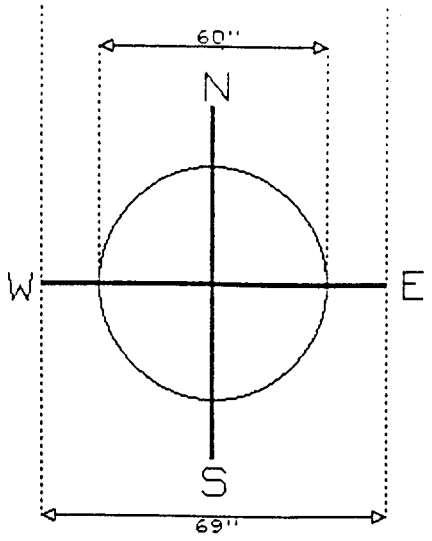


FIGURE 1 A

C220 Head Expander, Magnetic Measurement Locations

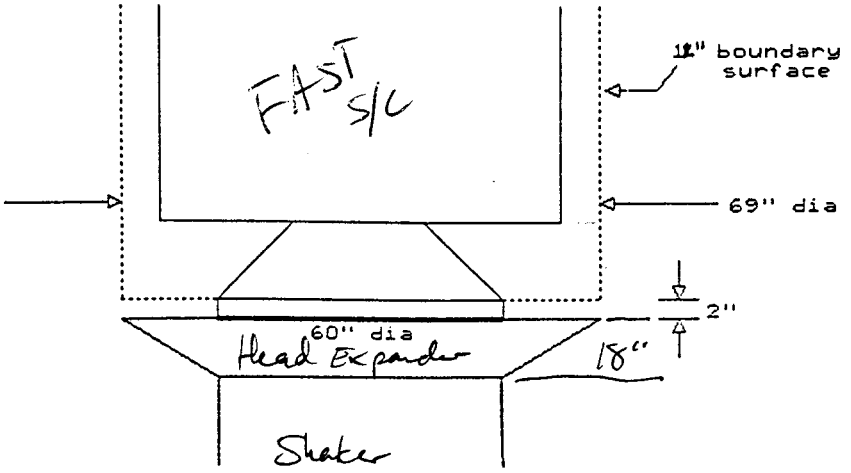


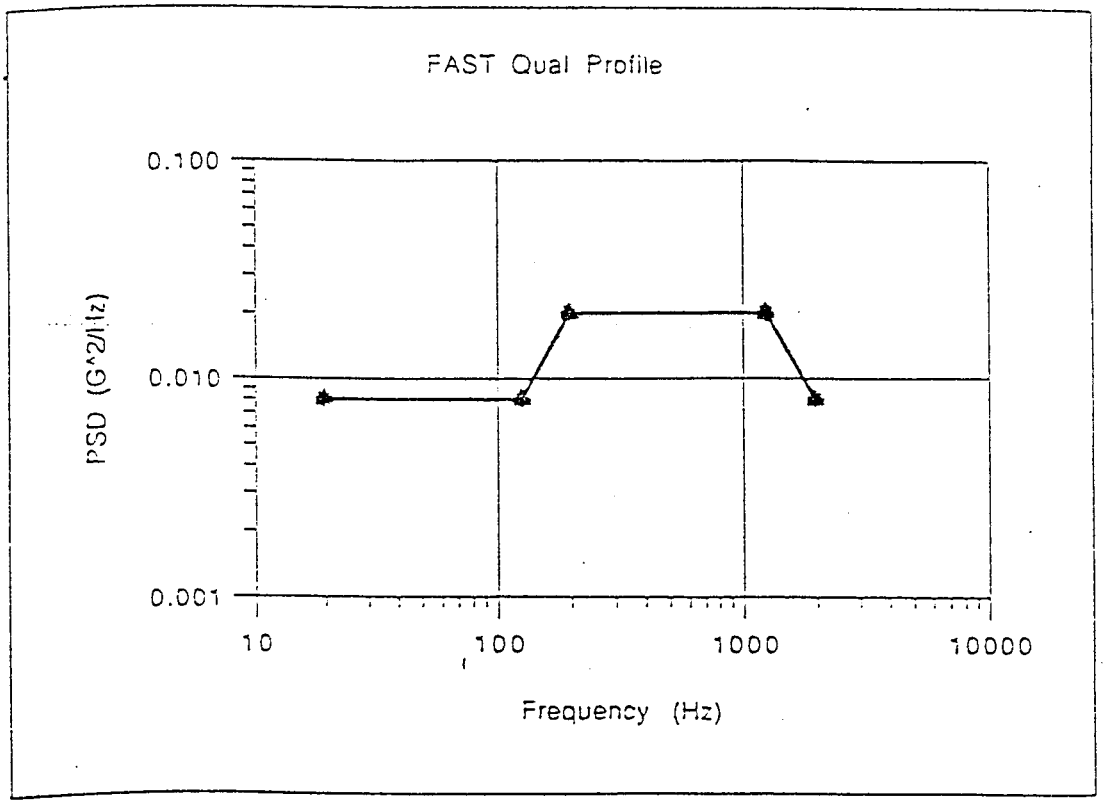
FIGURE 1 B

FAST S/C Mounting on the C220 GSFC Vibration Shaker

FIGURE 2

Combined PEGASUS (including FAST S/C) Qualification

Frequency	G^2/Hz	Area	Slope (dB/Oct.)
20	0.008		
127	0.008	0.86	
200	0.020	0.99	6.07
1250	0.020	21.00	
2000	0.008	9.48	-5.87
		5.69 Grms	



March 4, 1994

TO: 750.2/Pete Mule'

FROM: 754.1/Peter Rossoni

SUBJECT: Vertical C220 Shaker Magnetic Measurements

Enclosed please find the NSI report detailing the magnetic measurements of the C220 vertical shaker.

In summary, the magnetic levels determined were near the limits specified by FAST project. A number of remedies were suggested: move the FAST space craft further from the shaker with a tall adapter plate; or cover the shaker with special magnetic field reduceing sheets.

If you have any questions, please call me.

Peter Rossoni

cc: D. Hershfeld/754.1 w/o enc.
S. Wojnar/754 w/o enc.
J. Stecher/750 w/o enc.

Date: January 31, 1994

To: P. Rossoni, Code 754.1

From: P. K. Harris, Code 750.5

Subject: Partial Magnetic Characterization of the C220 Vertical GSFC Vibration Shaker in Support of FAST S/C Testing

Introduction

This test was performed to measure the total magnetic field flux density of the C220 vertical shaker (including the head expander) and to determine the magnetic compliance of the GSFC vibration facility with the FAST S/C specification per NSI Document 12-02-1125 (Attachment 1). What follows is a characterization of the data acquired on November 1, 1993.

Test Description

NSI Document 12-02-1125 requires the measurement of the magnetic flux density at 2" and 14" above the surface of the C220 shaker to determine compliance with the FAST S/C specification. The specification requires that the magnetic flux shall not exceed 3 Gauss within 1 ft. of the surface of the spacecraft. Figure 1B of Attachment 1 shows that the one foot FAST boundary coincides with a surface 2" above the head expander. The test was performed to measure magnetic fields during three phases of shaker operation: (a) shaker power turn-on and turn-off, (b) shaker standby mode, and (c) normal shaker operation.

Test Results

The initial transient power turn-on and turn-off test involved measurements at the center of the shaker with the head expander. Specifically, a 2" non-ferromagnetic aluminum supporting plate was used to hold the single-axis Hall-Effect sensing probe of the RFL Industries Model 750 gaussmeter. This instrument was used to measure the vertical (z) magnetic flux component. The ALP-10 magnetic sensing antenna was used to measure the AC component. (Since the AC component is not significant and was well below 0.2 Gauss, the data from this instrument is not presented here.)

The transient measurements fluctuated from 3.3 to 5.4 Gauss. A major transient occurred after the shaker was turned off. All measurements exceed the spacecraft specification of 3 Gauss during transients at a distance of 2" above the surface of the shaker's head expander.

The next data measurements were acquired during the shaker stand-by test. These measurements were taken at the North, East, South, and West points of the shaker for all three components

(according to NSI Document 12-02-1125). The total magnetic field magnitude calculated from the data is as follows:

	2" above expander
N	2.91 Gauss
E	3.89 Gauss
S	3.19 Gauss
W	3.06 Gauss

It is noteworthy to mention that the average measured vertical component field at the center is 3.8 Gauss at 2" above the head expander. The vertical component reduced with distance from the center of the shaker towards the edge. In contrast, the horizontal component increased from the center to the edge. At 2" above the head expander surface, the total field again exceeds (on a major portion of the surface) the 3 Gauss FAST S/C specification limit.

The final set of data measurements were taken during normal shaker operation tests. These tests included: (1) sine burst testing of five cycles of 20 Hz at 15 G, (2) sine dwell "wedge check" for 5 G acceleration at 20 Hz, and (3) random vibration. The data is as follows:

sine burst	wedge check	random
3.6 Gauss	3.5 Gauss	3.65-3.8 Gauss

All data was taken at 2" above the head expander surface. The random vibration tests were performed at frequencies of 20, 127, 200, 1250, and 2000 Hz, as required by Figure 2 of NSI Document 12-02-1125. As in the previous tests performed, the total field exceeded the 3 Gauss FAST S/C specification at 2" above the head expander.

One final set of data was taken per Section 4.5 of NSI Document 12-02-1125. A DC magnetic field study was conducted prior to powering up the shaker and at least three hours after the last powering down to determine background magnetic field levels. These levels did not exceed that of the earth's magnetic field (0.5 Gauss).

Recommendations

Based on the transient measurements, it is recommended that shaker system power turn-on should be performed prior to mounting the spacecraft on the shaker. In addition, the spacecraft should be removed from the shaker chamber before power turn-off.

Because the total magnetic field exceeds the 3 Gauss FAST S/C specification at 1 ft. from the spacecraft in its current

mounting position, one recommendation is to mount the spacecraft so that its interface is at least 14" above the head expander, where the field is just below the 3 Gauss limit during standby operation as shown in the following table:

	14" above expander
N	2.44 Gauss
E	2.44 Gauss
S	2.96 Gauss
W	1.72 Gauss

As shown by the data in the previous section, standby operation has similar magnetic field intensities as the normal shaker operation mode, so it is expected that the field levels at 14" during shaker operation would be similar to the above values. Based on the above recommendation, the spacecraft would need to be mounted 1 ft. above its proposed mounting shown in Figure 1B of Attachment 1.

An alternative recommendation, based on the shaker operation test data, is to use degaussing coils or to provide shielding material (such as Mu Metal) adjacent to and immediately above the head expander surface to reduce the stray magnetic fields on the C220 vibration shaker. This may be simpler than raising the FAST S/C an additional foot. Additional testing would be required to verify that the shielding material brings magnetic exposure within the specification limits.

P. K. Harris
Magnetics Engineer

PKH/pkh

cc: T. Cesko, Code 750.5
D. R. Baker, Code 750.5

SMALL EXPLORER (SMEX) DOCUMENTATION CONTROL FORM

ACTION CODE	NAME	MAIL CODE	ACTION CODE	NAME	MAIL CODE	ACTION CODE	NAME	MAIL CODE
	M. ADAMS	741		T. GRUNER	745.2		W. POWELL	822
	R. ALEMAN	740.4		K. HERSEY	737.1		G. RAKOW	743.3
	M. ANDERSON	745.2		L. HILLIARD	740.4		M. REID	512.2
	J. ARRISON	740.4		T. HUBER	700		M. RODRIQUEZ/MDAC	724.4
	D. BAKER	690		F. HUEGEL	743.3		G. ROSANOVA	741.3
	M. BAXTER/STX	740.4		T. JACOBS	743.2		P. SALERNO	743.1
	D. BERRY	512.1		B. JOYCE	301		R. SCHNURR	745.2
	D. BETZ	740.4		D. JUNG	734.5		B. SETTLES	743.3
	M. BLAU	743.3		K. KEADLE-CALVERT	743.2		A. SHERMAN	700
	T. BUDNEY	745		J. KELLOGG	741.1		D. SHREWSBERRY	740
	J. BURT	740.4		R. KOLECKI	740.4		D. SILVA	470
	J. BYRD	740.4		T. LAFOURCADE	743.1		SMEXFOT/ATSC	740.4
	J. CATENA	740.4		J. LYONS	734.4		G. SNEIDERMAN	741.3
	G. CHIN	693.1		H. MALDONADO	737.3		T. SPITZER	734.1
	C. CLAGETT	745.1		S. MANNING/UNISYS	740.4		M. STEINER	743.1
	SMEX CM	740.4		R. MENCIA/SWALES	724	✓	R. STONE	743
	G. COOPER	743.1		S. MEYERS	741		S. STRAKA	724.4
	T. CORRELL	745.2		T. MICHAELIS	745.1		T. TRENKLE/MMS	743.1
	B. DEDALIS	302		P. MULE	750.2		B. VERNIER	470
	T. DOD/SWALES	737		Y. NGAN	737.3		M. WALKER	745.1
✓	D. EVERETT	743.1		D. NGUYEN	724	✓	J. WATZIN	740.4
	B. FAFAUL	311.1		Q. NGUYEN	743.2		R. WEAVER	740
	L. FANTANO	724.1		D. OLNEY	745.1		J. ZEMBOWER/INTER	740.4
	O. FIGUEROA	740.4		D. OLSEN/STX	740.4			
	J. FIORA	740.4		K. PARRISH	724.1			
	J. GALLEHER/HEI	740.4		R. PATSCHKE	743.1			
	D. GATES/ATSC	740.4		S. PATTON	741.1			
✓	T. GEHRINGER	740.4		C. PETRUZZO	745			
	D. GILMAN/NASA HQ	SZD		R. PFAFF	696			

NUMBER OF ENCLOSURES OR ATTACHMENTS INCLUDED 1

SUBJECT: Vertical C220 Shaker Magnetic Measurements Test Report (7AST-TEV-068)

COMMENTS: FYI

Distributed by: Smw/cm Date: 3/7/94