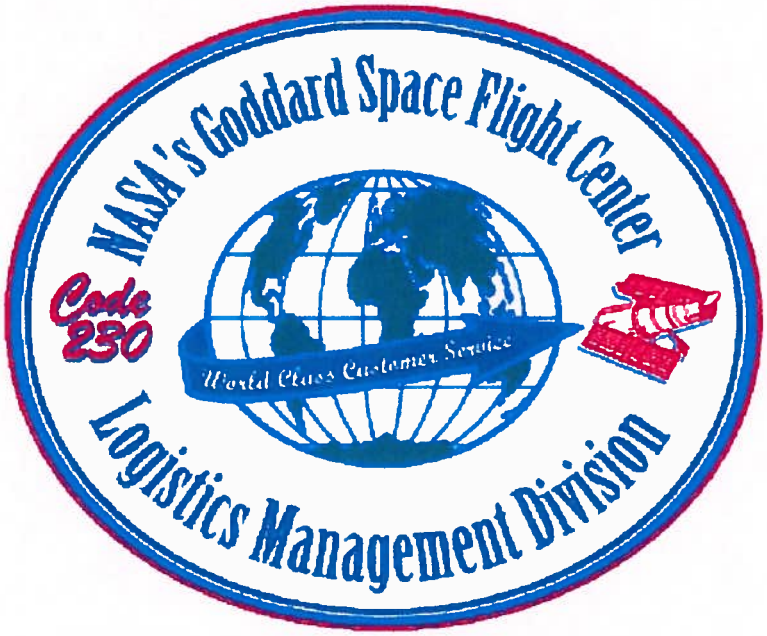

SWIFT OBSERVATORY TRANSPORT REPORT

TRANSPORT DATE: 07/27/04 – 07/29/04

410.4-RPT-0094

Logistics & Transportation Management Branch
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

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08/05/04

SWIFT OBSERVATORY TRANSPORT REPORT

The purpose of this report is to document the data analysis results of the Swift Observatory Transport from the Goddard Space Flight Center (GSFC) to the Cape Canaveral Air Force Station (CCAFS). The transport consisted of the Swift Observatory mounted to the L-Frame. The L-Frame was then secured to the container base of the NASA 1 shipping container via an Aeroflex Isolation System. The data analysis focused on the transportation induced shock loads experienced by the hardware during all phases of the shipment.

The Surface transport of the Swift Flight Instrument commenced at 7:52am, Tuesday, July 27, 2004 at GSFC utilizing an air-ride suspension tractor-trailer and arrived at CCAFS on Thursday, July 29, 2004 at 11:05am.

The data recording systems exhibited excellent correlation through the transport activity. The internal time synchronization between the boards in the data recorders provided high correlation, as all pertinent events registered the same event time across all data recorders. All of these events were able to be cross-correlated to the Vehicle Event Log. The general data quality was very high with no instances of phantom data.

The objective during all phases of the Swift Flight Instrument Transport was to provide and maintain a safe traveling environment for the Swift Observatory. Based on the analysis, it has been concluded that the data sets collected by the recording systems were valid and the transport met all expectations. Loads experienced by the Swift Observatory did not exceed the quasi-static load limits as can be seen in the chart below:

Transport Shock Data Summary

	X, Longitudinal	Y, Lateral	Z, Vertical
Quasi-Static Load Limits (g's)	+/- 1.5	+/- 1.0	+/- 1.4
Above Isolation System, Block 1B on PAF (g's)	**-0.598**	-0.205	**1.002**
Above Isolation System, Block 2A on Lift Point near CG (g's)	0.52	0.294	0.81
Above Isolation System, Block 2B on L-Frame (g's)	-0.324	**0.305**	-0.89
Below Isolation System, Block 1A on Container Floor (g's)	-4.625	-4.333	-9.949

The IST MSR Shock Data Recorders were installed in the following locations as referenced in Figure 5, Shock Data Recorder Locations. Data Recorder 1 was mounted on the un-isolated base of the shipping container and was equipped with two external tri-axial accelerometers. Tri-axial Accelerometer Block 1A was mounted to the shipping container floor to record all un-isolated shock impulses. Tri-axial Accelerometer Block 1B was mounted above the isolation system, at the highest point on the PAF interface. Data Recorder 2 was mounted to the container and was equipped with two external tri-axial accelerometers. Tri-axial Accelerometer Block 2A was located above the isolation system and was mounted to the hard point of the lifting fixture close to the center of gravity of the payload. Tri-axial Accelerometer Block 2B was located above the isolation system, mounted to the horizontal section of the L-Frame. In addition to the IST Data Recorders, three ShockWatch® impact monitors (two 3g and one 4g) were installed for added redundancy.

The accelerometer data acquired during transport showed that the isolation system behaved as expected during shipment of the Swift Observatory to the launch site. Shock response spectra (SRS) processing was performed on the accelerometer time history data to determine the frequency content of the measured acceleration response. The processed data showed that the air-ride isolation system of the trailer had modes in the 1.5 – 2.0 Hz range. The L-Frame and coil-rope isolators had modes in the 5-6 Hz range in the vertical and lateral directions and provided isolation for inputs above 10 Hz. In the longitudinal direction, the L-Frame and isolators had a predominant mode at 12 Hz and provided isolation for inputs in above 20 Hz. The behavior of the trailer and L-Frame measured during shipment to the launch site was consistent with the data measured during the road test of the transporter and pre-shipment analytical predictions.

The Observatory had temperature and humidity specifications, which needed to be regulated throughout the transport. The temperature requirements of the transporter were 70°F +/- 10°F while the relative humidity could not exceed 60%. The temperature remained in specification throughout the transport except for one incident when the temperature exceeded the 80°F limit. The alarm was triggered and the temperature was brought back down to within specification. The relative humidity remained below 60% during the transport except for few circumstances where the humidity spiked above 60% and quickly returned within specification.

SWIFT TRANSPORT REPORT
FROM CHANNEL 1A

Overall Test Results from Channel 1A Data Recorder

Peak G's recorded:

	Event Number	Date and Time of Event	Peak X (g's)	Y (g's)	Z (g's)
1	46	7/29/2004 14:18	**-4.625**	-4.333	-9.346
2	41	7/29/2004 9:07	**-3.752**	-3.765	-9.949
3	19	7/27/2004 17:08	**-0.979**	0.851	-0.574
4	43	7/29/2004 9:32	**-0.727**	-0.538	-0.807
5	2	7/27/2004 7:51	**-0.708**	-0.616	-2.422

	Event Number	Date and Time of Event	X (g's)	Peak Y (g's)	Z (g's)
1	46	7/29/2004 14:18	-4.625	**-4.333**	-9.346
2	41	7/29/2004 9:07	-3.752	**-3.765**	-9.949
3	1	7/27/2004 7:51	-0.533	**-2.259**	-3.394
4	51	7/29/2004 14:56	0.223	**-1.046**	1.216
5	42	7/29/2004 9:28	-0.495	**-0.949**	-2.597

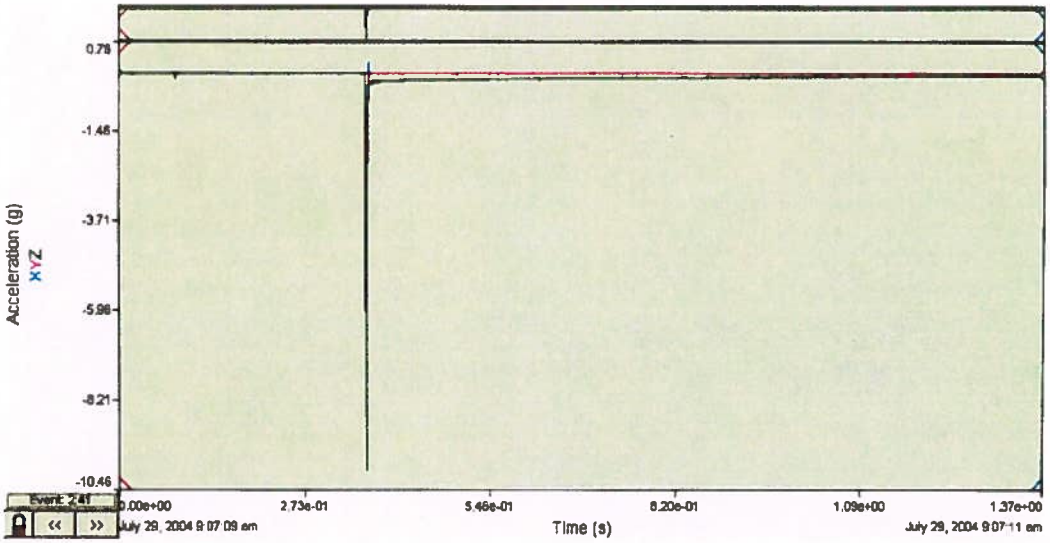
	Event Number	Date and Time of Event	X (g's)	Y (g's)	Peak Z (g's)
1	41	7/29/2004 9:07	-3.752	-3.765	**-9.949**
2	46	7/29/2004 14:18	-4.625	-4.333	**-9.346**
3	1	7/27/2004 7:51	-0.533	-2.259	**-3.394**
4	47	7/29/2004 14:37	-0.495	-0.499	**-2.908**
5	42	7/29/2004 9:28	-0.495	-0.949	**-2.597**

	Channel	Peak G's Recorded	Comments
1	X	-4.625	Shock occurred during container lid removal
2	Y	-4.333	Shock occurred during container lid removal
3	Z	-9.949	Occurred when tractor was removed from trailer at CCAFS

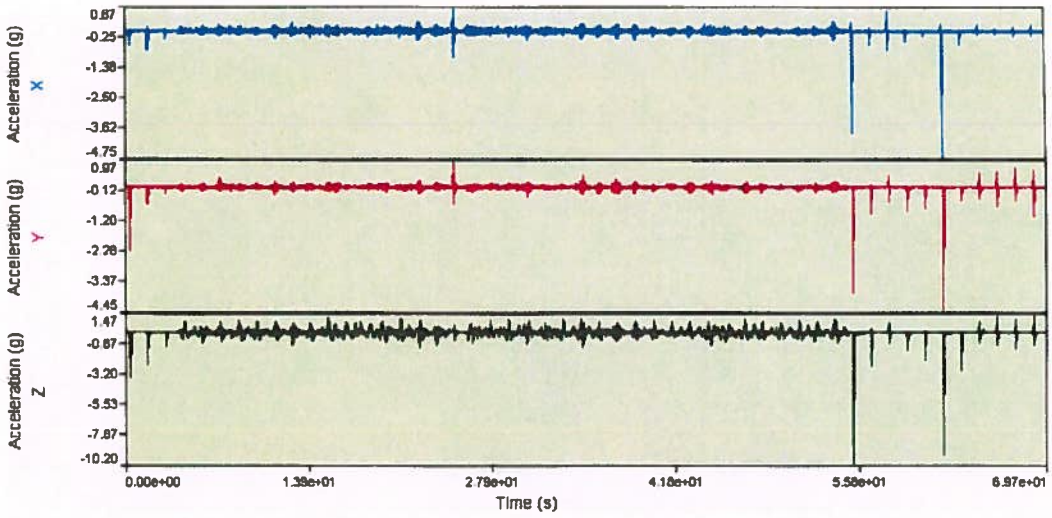
Summary Table: Channel 1A

	Peak X g	Peak Y g	Peak Z g
Average	-0.349	-0.352	-0.451
StdDev	0.829	0.887	2.233
Maximum	0.281	0.851	1.216
Minimum	-4.625	-4.333	-9.949

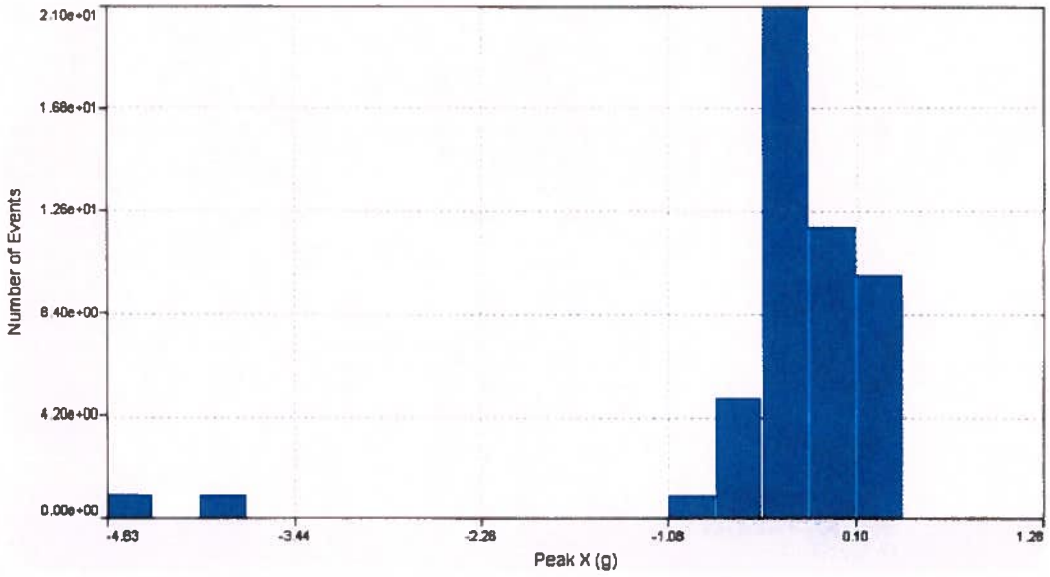
Channel 1A, Event 41 – Largest Shock Data Value Recorded.



Multiple Wave View: Channel 1A – All Transport Events.



Histogram View, Channel 1A – Distribution of the Shock Data.



Transport Test Conclusions:

During the Swift Observatory Transport, the trigger threshold for Channel 1A was set at .75 g's. The axial configuration for the data recorder was orientated so that the X was the direction of travel, Y was lateral, and Z was vertical. Channel 1A was located below the isolation system on the floor of the Container Base, as can be seen in Figure 5. A total of 46 events were recorded above .75 g's. The more substantial shock events occurred either during the initial start-up of the data recorder or upon arrival at CCAFS. This shock response data depicts a typical transport for an isolated load.
It should be noted that the peak G readings from Channel 1A which are located on the truck bed are suspect in terms of validity, especially values that are over 9 g's (events 41 and 46). These are questionable in that one would expect a real shock event to have a rebound of some amount or some ringing which does not show up on the time history.

SWIFT TRANSPORT REPORT
FROM CHANNEL 1B

Overall Test Results from Channel 1B Data Recorder

Peak G's recorded:

	Event Number	Date and Time of Event	Peak X (g's)	Y (g's)	Z (g's)
1	3	7/28/2004 9:06	**-0.598**	-0.146	1.002
2	1	7/27/2004 13:30	**-0.598**	-0.127	-1.002
3	4	7/28/2004 14:21	**-0.519**	-0.185	-0.982
4	2	7/27/2004 18:25	**-0.5**	-0.205	0.885
5	5	7/28/2004 14:22	**-0.46**	-0.185	0.885

	Event Number	Date and Time of Event	X (g's)	Peak Y (g's)	Z (g's)
1	2	7/27/2004 18:25	-0.5	**-0.205**	0.885
2	5	7/28/2004 14:22	-0.46	**-0.185**	0.885
3	4	7/28/2004 14:21	-0.519	**-0.185**	-0.982
4	3	7/28/2004 9:06	-0.598	**-0.146**	1.002
5	1	7/27/2004 13:30	-0.598	**-0.127**	-1.002

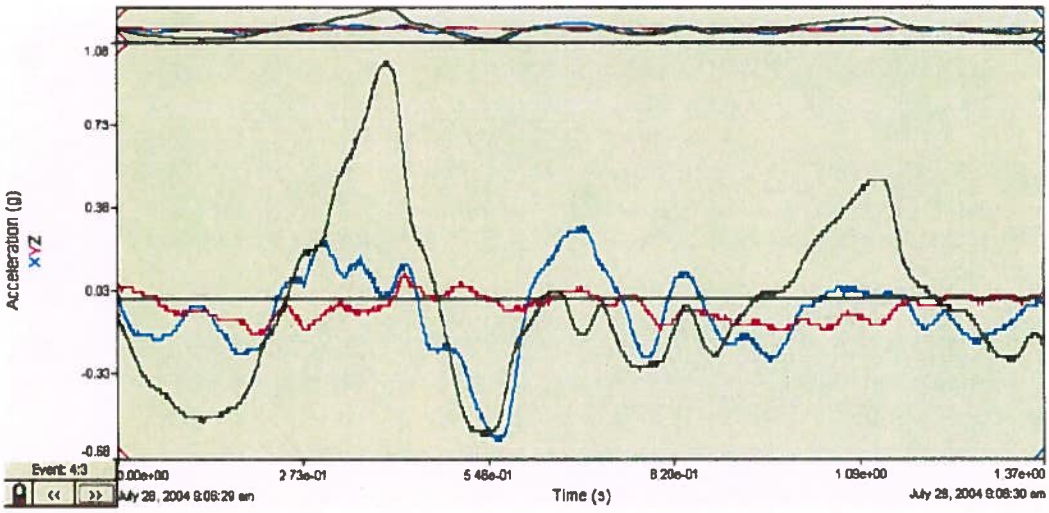
	Event Number	Date and Time of Event	X (g's)	Y (g's)	Peak Z (g's)
1	3	7/28/2004 9:06	-0.598	-0.146	**1.002**
2	1	7/27/2004 13:30	-0.598	-0.127	**-1.002**
3	4	7/28/2004 14:21	-0.519	-0.185	**-0.982**
4	2	7/27/2004 18:25	-0.5	-0.205	**0.885**
5	5	7/28/2004 14:22	-0.46	-0.185	**0.885**

	Channel	Peak G's Recorded	Comments
1	X	-0.598	Shock resulting from overpass in construction area of I-95
2	Y	-0.205	Shock resulting from overpass on I-95
3	Z	1.002	Shock resulting from overpass in construction area of I-95

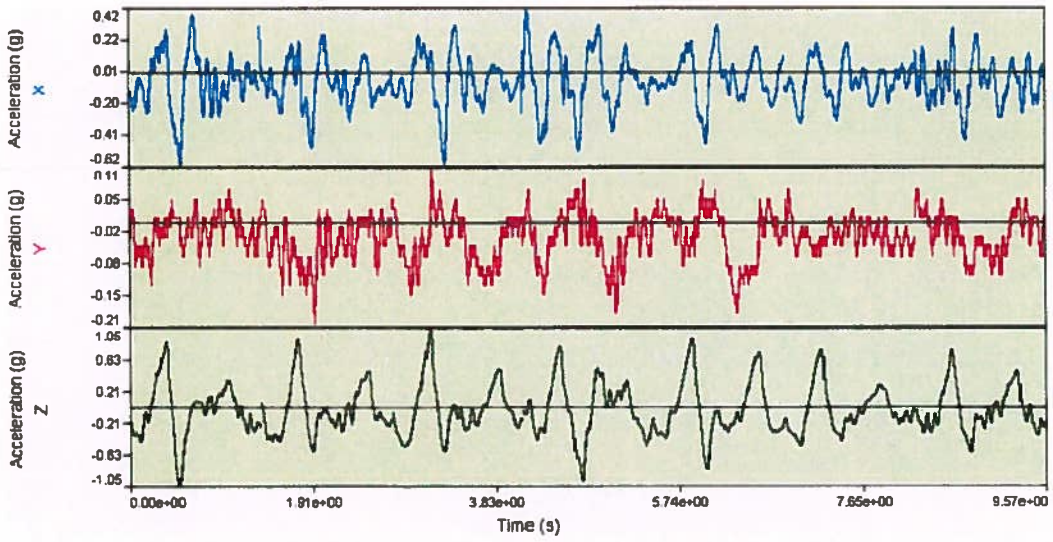
Summary Table: Channel 1B

	Peak X g	Peak Y g	Peak Z g
Average	-0.494	-0.146	0.326
StdDev	0.09	0.049	0.905
Maximum	-0.343	-0.068	1.002
Minimum	-0.598	-0.205	-1.002

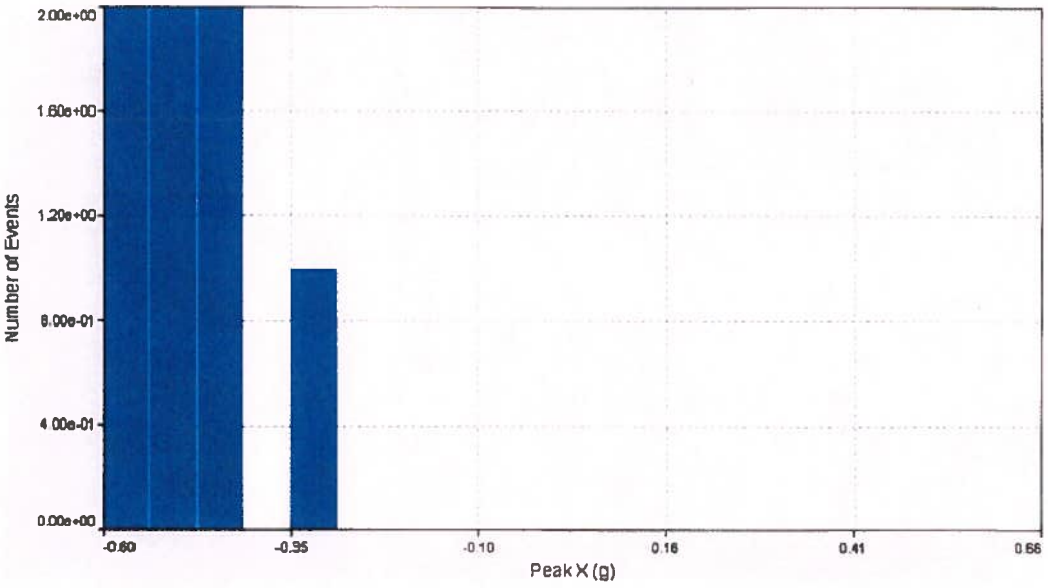
Channel 1B, Event 3 – Largest Shock Data Value Recorded.



Multiple Wave View: Channel 1B – All Transport Events.



Histogram View, Channel 1B – Distribution of the Shock Data.



Transport Test Conclusions:

During the Swift Observatory Transport, the trigger threshold for Channel 1B was set at .75 g's. The axial configuration for the data recorder was orientated so that the X was the direction of travel, Y was lateral, and Z was vertical. Channel 1B was located above the isolation system on the highest vertical location on the PAF, as can be seen in Figure 5. Only 5 events were recorded that registered above .75 g's. The shock response data depicts that the hardware sustained an excellent transport.

SWIFT TRANSPORT REPORT
FROM CHANNEL 2A

Overall Test Results from Channel 2A Data Recorder

Peak G's recorded:

	Event Number	Date and Time of Event	Peak X (g's)	Y (g's)	Z (g's)
1	320	7/28/2004 9:52	**0.52**	0.176	-0.42
2	196	7/27/2004 15:55	**0.482**	-0.137	0.498
3	135	7/27/2004 15:52	**0.482**	-0.137	0.42
4	394	7/29/2004 8:00	**0.443**	0.255	0.537
5	244	7/27/2004 17:37	**0.443**	0.216	0.517

	Event Number	Date and Time of Event	X (g's)	Peak Y (g's)	Z (g's)
1	308	7/28/2004 9:40	0.328	**0.294**	0.4
2	337	7/28/2004 12:17	0.366	**0.255**	0.673
3	359	7/28/2004 14:23	-0.25	**0.255**	0.556
4	307	7/28/2004 9:39	0.405	**0.255**	0.537
5	394	7/29/2004 8:00	0.443	**0.255**	0.537

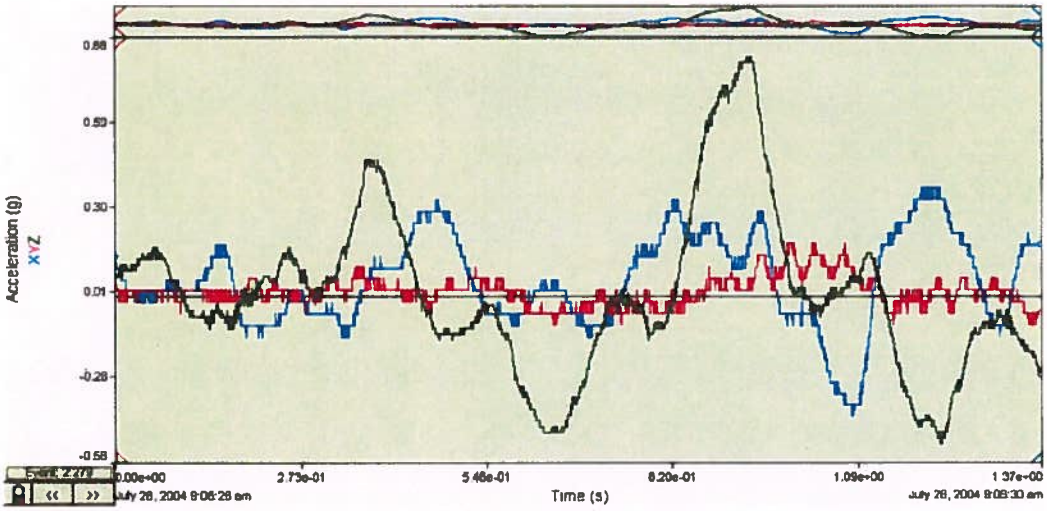
	Event Number	Date and Time of Event	X (g's)	Y (g's)	Peak Z (g's)
1	279	7/28/2004 9:06	-0.405	0.176	**0.81**
2	251	7/27/2004 18:25	0.405	0.137	**0.751**
3	337	7/28/2004 12:17	0.366	0.255	**0.673**
4	50	7/27/2004 13:20	0.25	0.137	**0.654**
5	357	7/28/2004 14:22	-0.328	-0.137	**0.654**

	Channel	Peak G's Recorded	Comments
1	X	0.52	Shock from rough road in construction area of I-95
2	Y	0.294	Shock from rough road in construction area of I-95
3	Z	0.81	Shock resulting from overpass in construction area of I-95

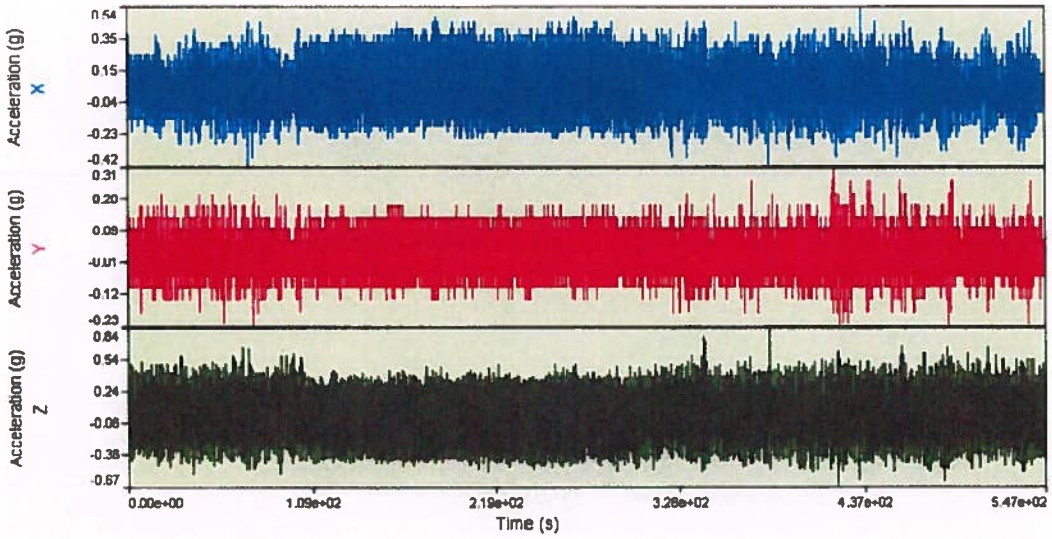
Summary Table: Channel 2A

	Peak X g	Peak Y g	Peak Z g
Average	0.304	0.06	0.068
StdDev	0.148	0.137	0.454
Maximum	0.52	0.294	0.81
Minimum	-0.405	-0.216	-0.634

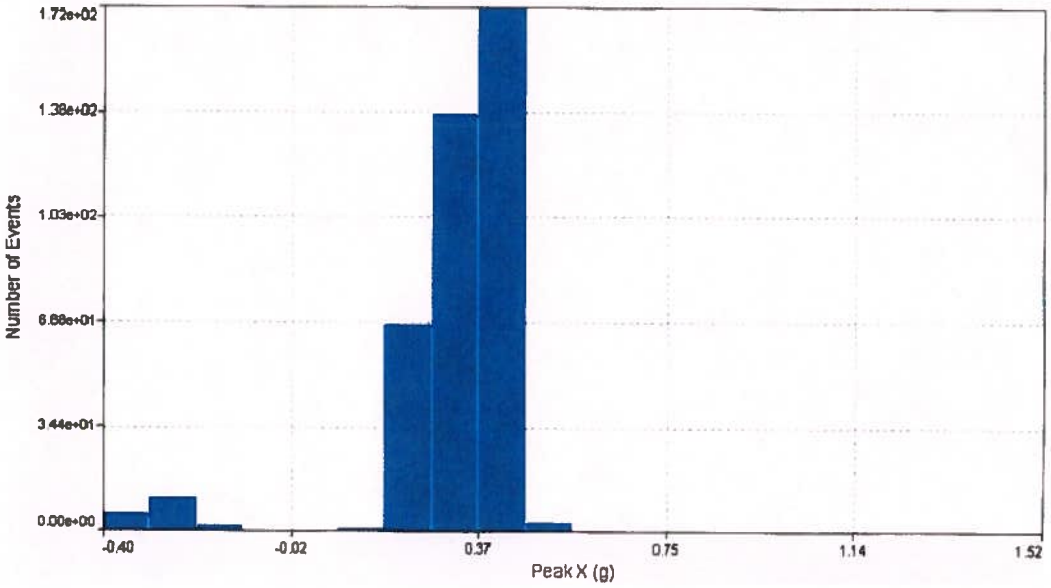
Channel 2A, Event 279 – Largest Shock Data Value Recorded.



Multiple Wave View: Channel 2A – All Transport Events.



Histogram View, Channel 2A – Distribution of the Shock Data.



Transport Test Conclusions:

During the Swift Observatory Transport, the trigger threshold for Channel 2A was set at .75 g's. The axial configuration for the data recorder was orientated so that the X was the direction of travel, Y was lateral, and Z was vertical. Channel 2A was located above the isolation system on a lift point near the center of gravity of the Flight Instrument, as can be seen in Figure 5. Only 2 events were recorded that had a value greater than .75 g's. The shock response data depicts that the hardware sustained an excellent transport.

SWIFT TRANSPORT REPORT
FROM CHANNEL 2B

Overall Test Results from Channel 2B Data Recorder

Peak G's recorded:

	Event Number	Date and Time of Event	Peak X (g's)	Y (g's)	Z (g's)
1	93	7/27/2004 13:32	**-0.324**	-0.25	-0.646
2	272	7/28/2004 9:40	**0.305**	-0.231	-0.646
3	270	7/28/2004 9:39	**0.305**	-0.287	-0.496
4	238	7/28/2004 9:20	**-0.305**	-0.139	-0.347
5	216	7/28/2004 8:33	**-0.287**	0.194	-0.422

	Event Number	Date and Time of Event	X (g's)	Peak Y (g's)	Z (g's)
1	273	7/28/2004 9:40	-0.231	**0.305**	0.384
2	380	7/28/2004 16:40	-0.213	**-0.305**	-0.403
3	270	7/28/2004 9:39	0.305	**-0.287**	-0.496
4	63	7/27/2004 13:06	-0.213	**-0.268**	0.403
5	311	7/28/2004 12:45	-0.194	**0.268**	-0.347

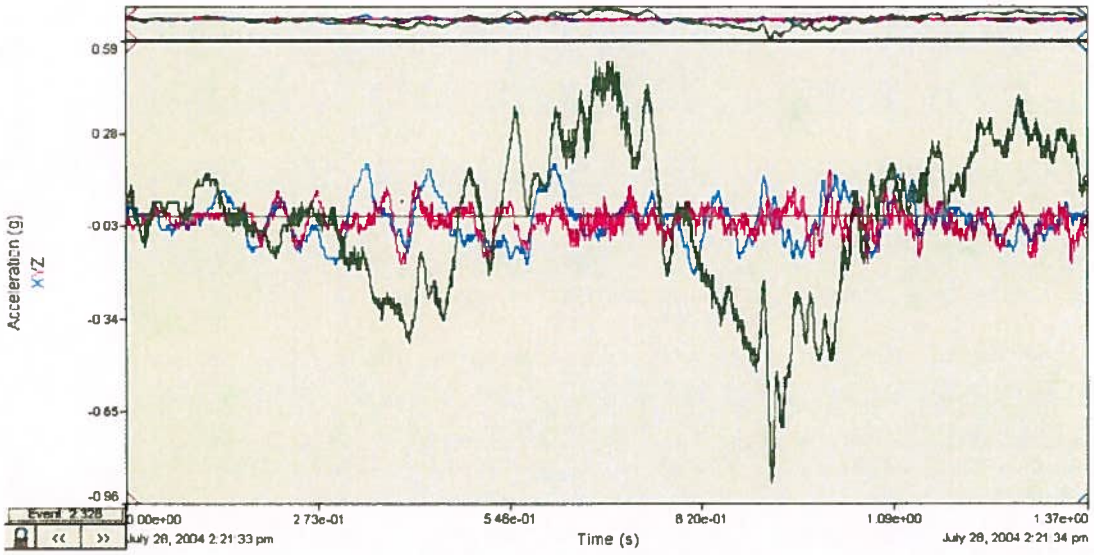
	Event Number	Date and Time of Event	X (g's)	Y (g's)	Peak Z (g's)
1	328	7/28/2004 14:21	-0.194	-0.157	**-0.89**
2	224	7/28/2004 9:06	-0.176	-0.12	**0.89**
3	182	7/27/2004 18:25	-0.231	-0.176	**0.871**
4	390	7/29/2004 8:00	-0.268	-0.176	**0.852**
5	297	7/28/2004 10:15	-0.25	-0.213	**0.777**

	Channel	Peak G's Recorded	Comments
1	X	-0.324	Shock resulting from rough road on 295
2	Y	0.305	Shock from rough road in construction area of I-95
3	Z	-0.89	Shock from rough road in construction area of I-95

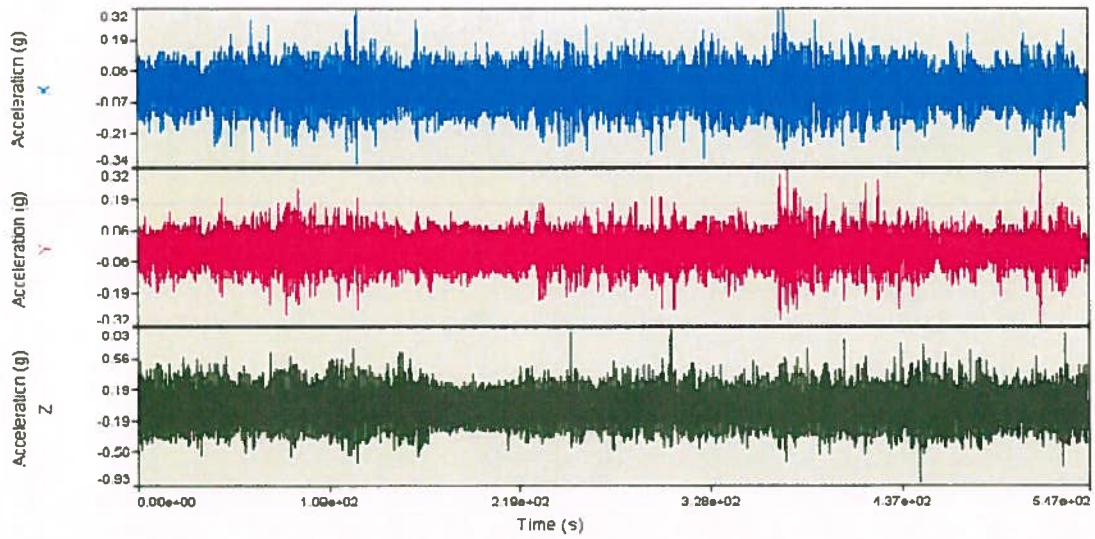
Summary Table: Channel 2B

	Peak X g	Peak Y g	Peak Z g
Average	-0.115	-0.099	-0.014
StdDev	0.114	0.094	0.421
Maximum	0.305	0.305	0.89
Minimum	-0.324	-0.305	-0.89

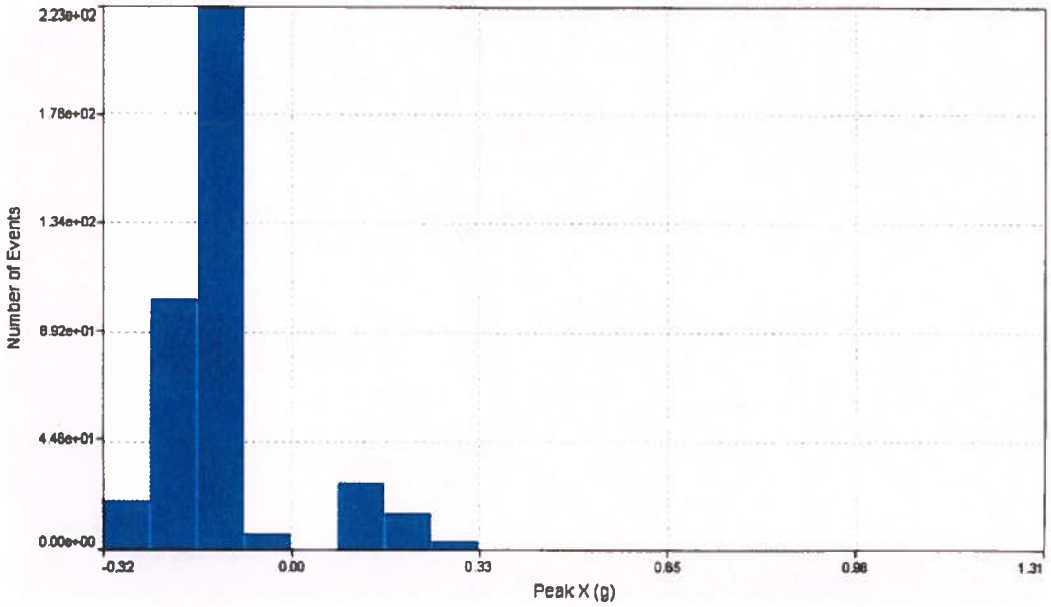
Channel 2B, Event 328 – Largest Shock Data Value Recorded.



Multiple Wave View: Channel 2B – All Transport Events.



Histogram View, Channel 2B – Distribution of the Shock Data.



Transport Test Conclusions:

During the Swift Observatory Transport, the trigger threshold for Channel 2B was set at .75 g's. The axial configuration for the data recorder was orientated so that the X was the direction of travel, Y was lateral, and Z was vertical. Channel 2B was located above the isolation system mounted to the horizontal section of the L-Frame, as can be seen in Figure 5. Only 5 events were recorded that had a value greater than .75 g's. The shock response data depicts that the hardware sustained an excellent transport.

ShockWatch® Impact Monitors:

A total of three ShockWatch® impact monitors were installed on the L-Frame for added redundancy (See Figure 5). A 3g and a 4g unit were mounted on the horizontal sections of the L-Frame in order to monitor impulses in the lateral and longitudinal directions. A second 3g unit was mounted vertically on the L-Frame in order to monitor induced shocks in the vertical and longitudinal direction. Upon arrival at CCAFS none of the three ShockWatch® impact monitors had been tripped.

Air Ride Pressure Setting: Ranged from 54 to 56 PSI throughout the transport.

Overall Observatory Transport Conclusions:

Detailed analysis of the data illustrated that the objective to provide and maintain a safe traveling environment for the Swift Observatory was met. The isolation system in conjunction with the air-ride trailer yielded G levels well within the quasi-static load limits required by Swift. All aspects of the transporter system responded as expected. After downloading and a quick analysis of the data at CCAFS, the results were reviewed with the project and a representative from Spectrum Astro. It was confirmed that the data was within the load limits and a transfer of ownership of the Observatory took place.

Swift Observatory Temperature and Humidity Data

A Transporter Log was taken during the hours when the transporter was parked for its layovers. During these hours the temperature, humidity, and nitrogen purge levels were recorded as can be seen on the following page.

TRANSPORTER LOG

Date / Time	T/H Recorder		Environmental Control Unit		Purge	
7/27/2004	Temp	R H	Temp	R H	Pressure	Flow
2000	66 F	53%	68 F	55%	1050 PSIG	22 SCFH
2100	69 F	53%	71 F	57%	800 PSIG	22 SCFH
2200	69 F	50%	72 F	52%	650 PSIG	22 SCFH
2300	69 F	53%	72 F	52%	2600 PSIG	22 SCFH
2400	68 F	53%	72 F	62%	2500 PSIG	22 SCFH
0100	68 F	58%	72 F	53%	2300 PSIG	22 SCFH
0200	65 F	57%	72 F	53%	2100 PSIG	22 SCFH
0300	69 F	47%	74 F	46%	1900 PSIG	22 SCFH
0400	67 F	56%	71 F	52%	1900 PSIG	22 SCFH
0500	70 F	48%	66 F	47%	1600 PSIG	22 SCFH
0600	69 F	45%	65 F	56%	1450 PSIG	22 SCFH

NOTES:

2000 – 0700 ECU set at 70 F & 55% RH

2400 – Converted from ECU 1 & 2 running to ECU # 1 unit as primary and ECU unit # 2 as back-up

0200 – Set ECU to 75 F & 45%

0300 – Set ECU to 70 F & 45%

Date / Time	T/H Recorder		Environmental Control Unit		Purge	
7/28/2004	Temp	R H	Temp	R H	Pressure	Flow
1900	70 F	34%	75 F	24%	1300 PSIG	22 SCFH
2000	68 F	35%	72 F	26%	1100 PSIG	22 SCFH
2100	69 F	46%	72 F	68%	900 PSIG	22 SCFH
2200	67 F	39%	72 F	31%	850 PSIG	22 SCFH
2300	65 F	38%	69 F	31%	(500 PSIG, changed bottles) 2700 PSIG	22 SCFH
2400	65 F	39%	69 F	31%	2550 PSIG	22 SCFH
0100	64 F	40%	69 F	32%	2300 PSIG	22 SCFH
0200	64 F	40%	67 F	34%	2150 PSIG	22 SCFH
0300	66 F	34%	62 F	40%	1950 PSIG	22 SCFH
0400	66 F	35%	62 F	40%	1700 PSIG	22 SCFH
0500	62 F	41%	65 F	35%	1550 PSIG	21 SCFH
0600	61 F	41%	65 F	35%	1350 PSIG	21 SCFH

NOTES:

2100 Found system off on low pressure and ECU set for humidification. Switched to back-up, reset pressure switch and let system regain pressure

0100 – Set ECU to 65 F

TRANSPORTER CHART ANALYSIS

7/26/04

The Environmental Control Unit (ECU) was started at 1615 hours. The humidity went to 70%, the ECU was shut down, and the ducts were disconnected at the transporter container interface. The ECU was restarted, set to 85°F in the open loop configuration, and then the ducts were reattached to the container. The humidity dropped to less than 60% by 1650 hours with one exception at 1750 hours where it had a momentary peak at 64% then returned to within specification. See Figure 1 for details.

7/27/04

The container went above the high temperature specification (80°F max.) at 1550 hours, the alarm was activated and the transporter was stopped so that measures to return the temperature to within specification could begin. The temperature was returned to within specification by 1650 hours and the transport continued. At 1915 hours the humidity cycled between 50% and 65% in a 6-minute cycle and continued until 2300 hours. At 2300 hours the ECU was converted from a dual active system to a single active system with a single back-up system. The humidity cycle changed to 52% - 62% with the same time period. The humidity level on the ECU was then set to 45% and the cycle went to 45% - 55%. See Figure 2 for details.

7/28/04

The temperature and humidity remained within specification with the exception of one humidity spike at 0830 hours that reached 65% and then returned to within specification at 0837 hours. See Figure 3 for details.

7/29/04

The temperature and humidity remained within specification until the transporter was secured in building AE at CCAFS. See Figure 4 for details.

NOTE:

Temperature specification,	70°F +/- 10°F
Humidity specification,	60 % maximum
Temperature Alarms,	High – 80°F, Low – 60°F
Humidity Alarms,	High – 60 %, Low – 10 %

Figure 1: Temperature Humidity Recorder Chart from Monday July 26th

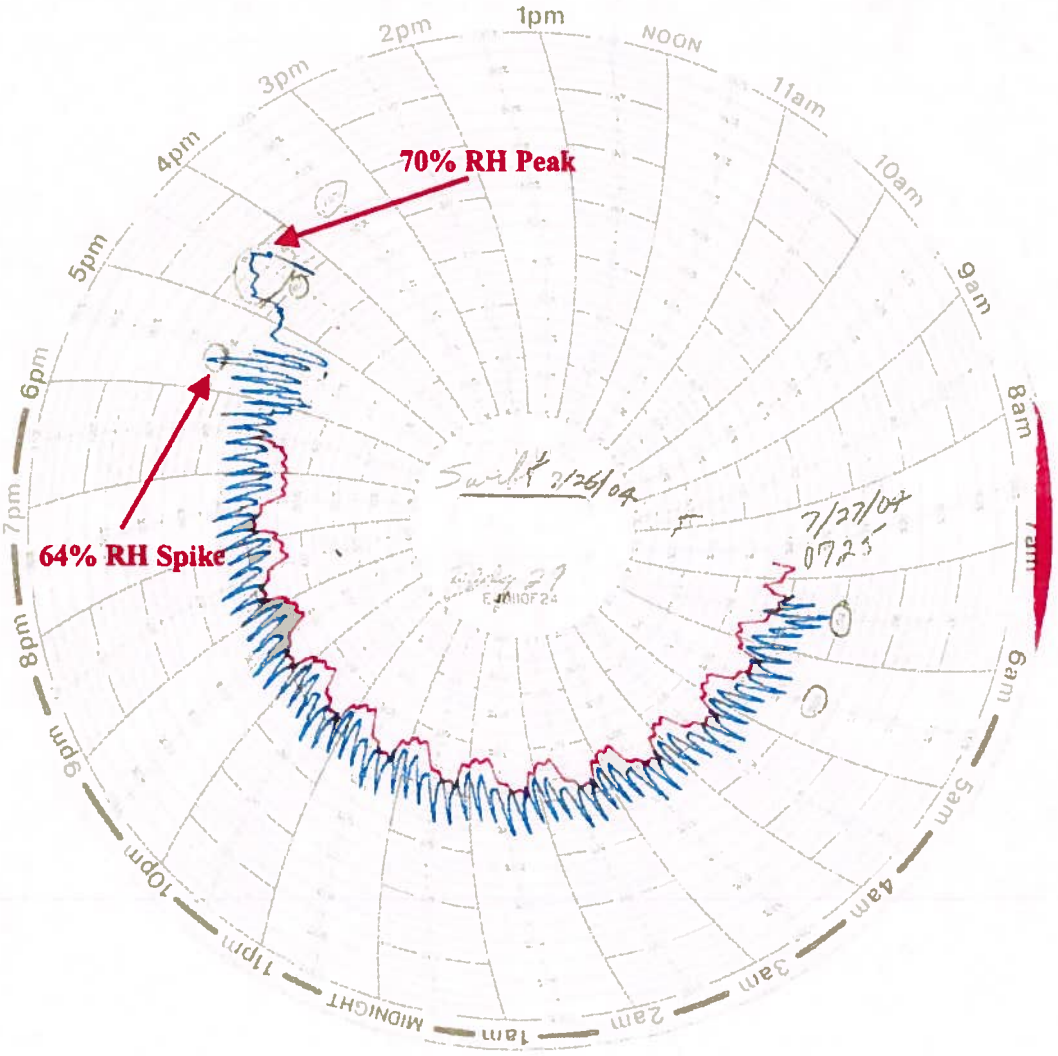


Figure 2: Temperature Humidity Recorder Chart from Tuesday July 27th

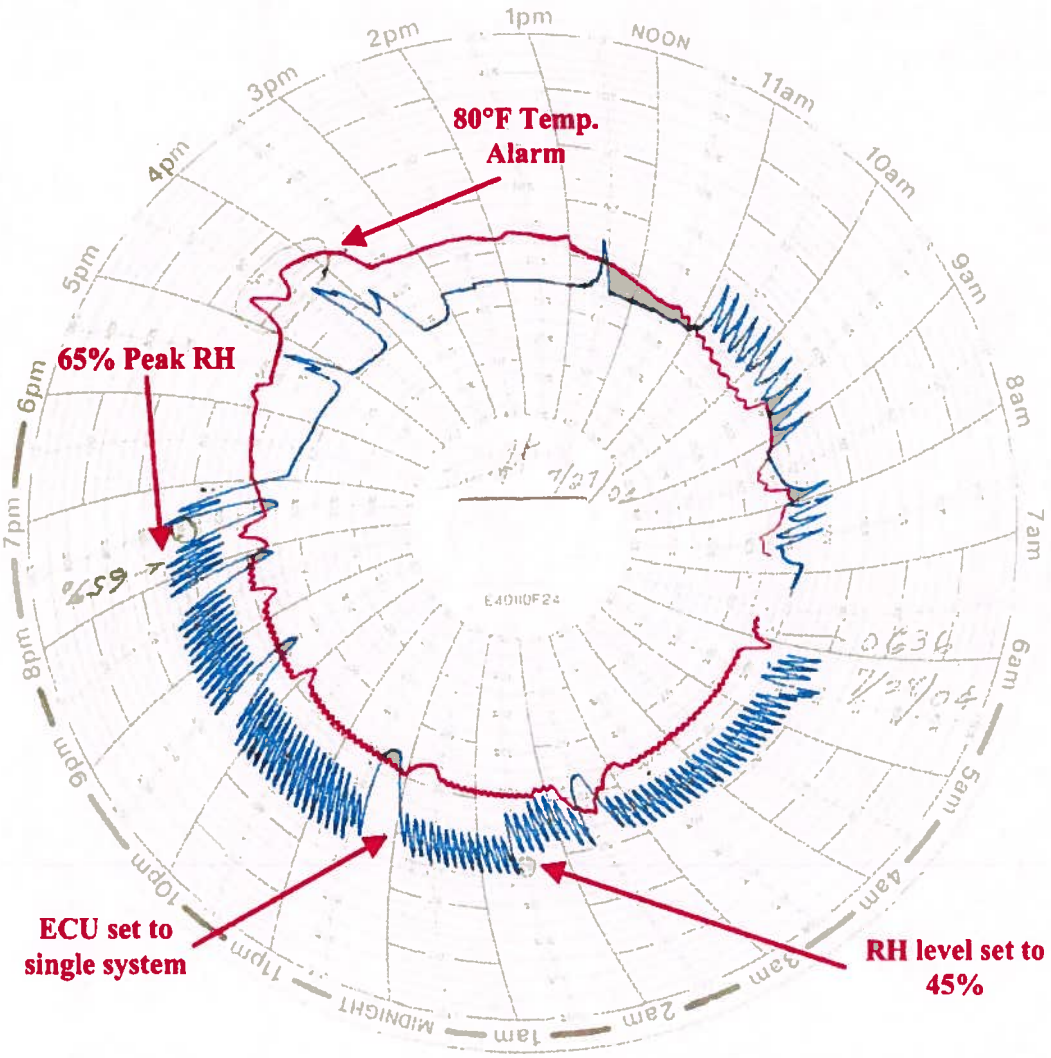


Figure 3: Temperature Humidity Recorder Chart from Wednesday July 28th

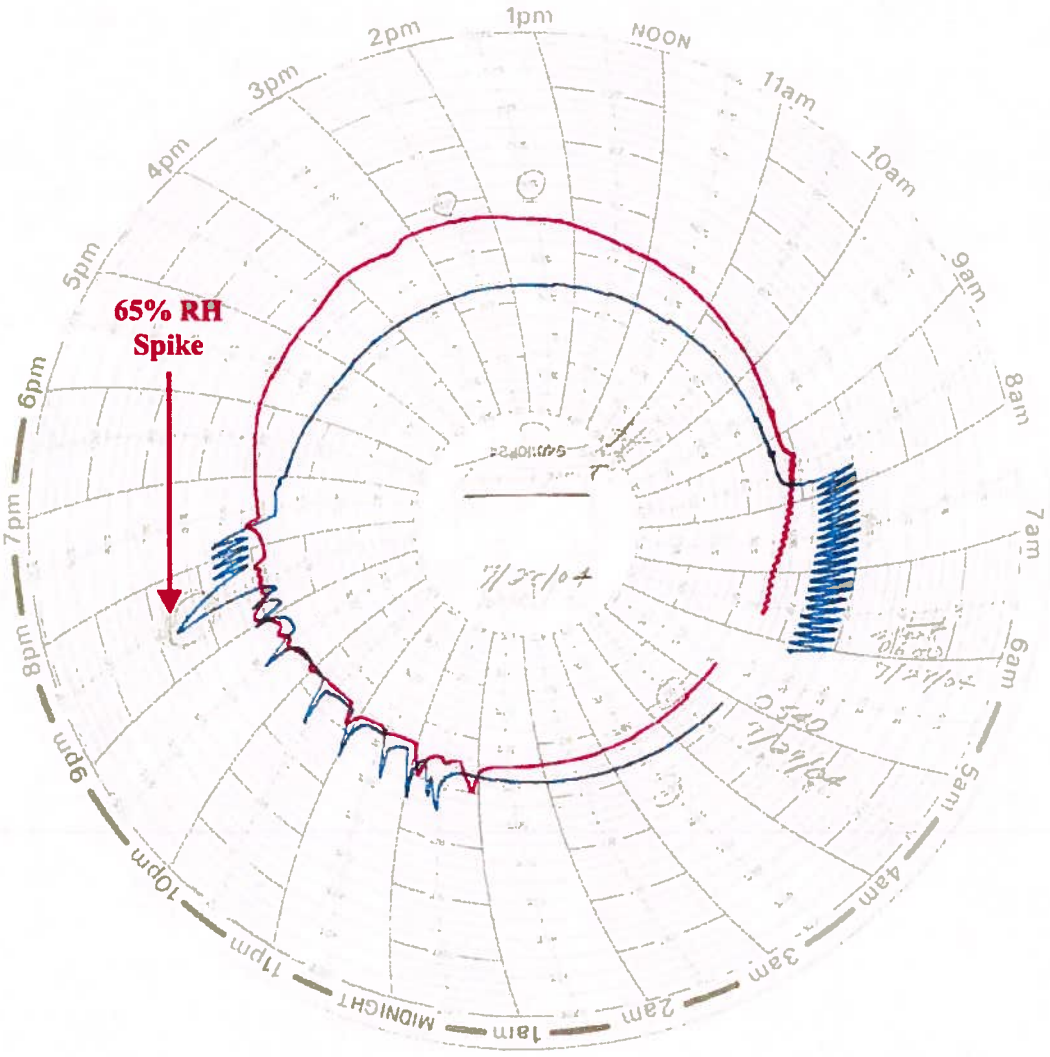


Figure 4: Temperature Humidity Recorder Chart from Thursday July 29th

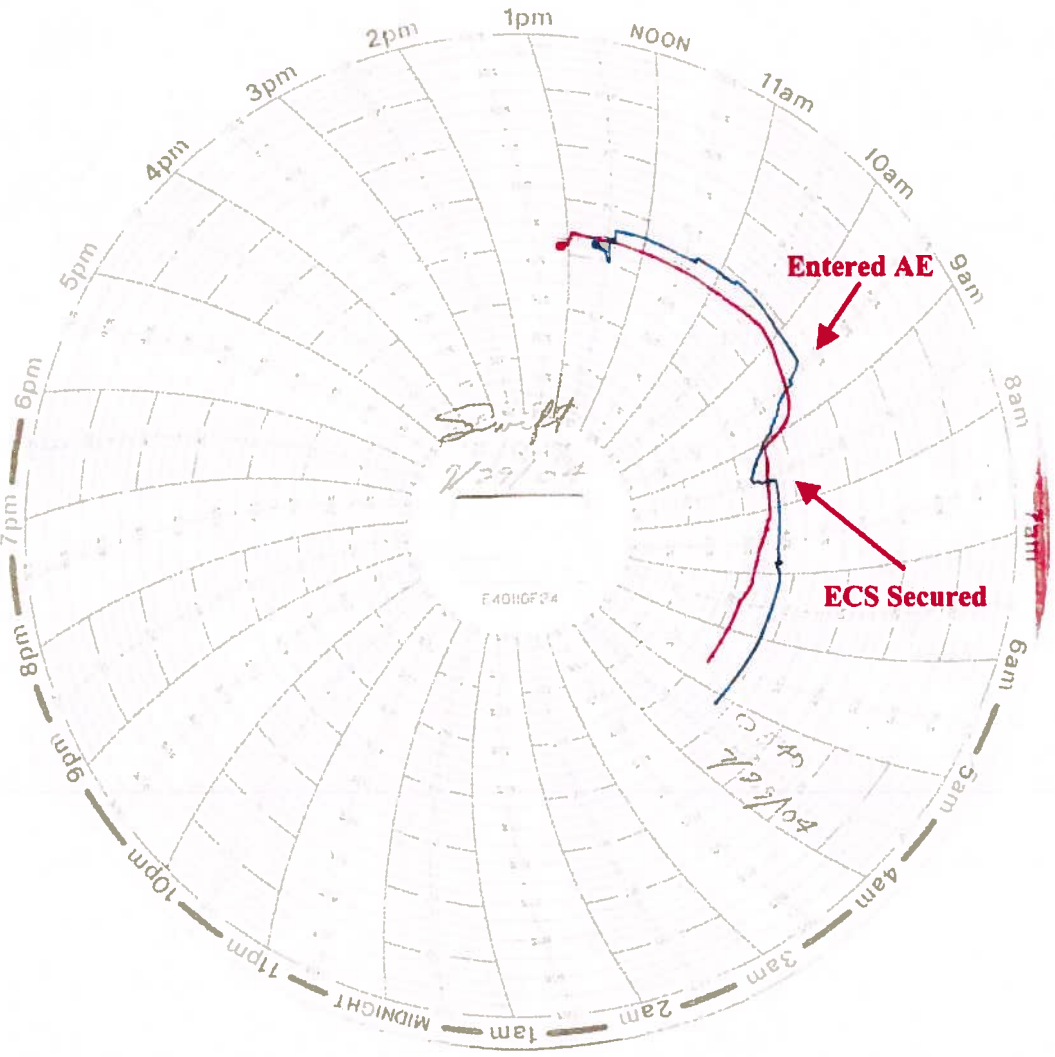


Figure 5: Shock Data Recorder Locations