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Integrated Advanced Microwave Sounding Unit-A (AMSU-A)

Engineering Test Report

AMSU-A1 METSAT Instrument (S/N 105) Qualification Level Vibration Tests of December 1998 (S/O 605445, OC-419)

Contract No. NAS 5-32314
CDRL 207

Submitted to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Submitted by:

Aerojet
1100 West Hollyvale Street
Azusa, California 91702

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INTEROFFICE MEMO

TO: L. T. Paliwoda

FROM: R. J. Heffner

DATE: 18-Feb-1999
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SUBJECT: AMSU-A1 METSAT Instrument (S/N 105) Qualification Level Vibration Tests of December 1998 (S/O 605445, OC-419)

COPIES TO: J. .A. Alvarez, D. H. Brest, D. B. Chi, D. L. Tran, Writer, File

REFERENCES:

1 "Advanced Microwave Sounding Unit-A1 (AMSU-A1) Instrument Assembly METSAT Qualification Level Vibration Testing", Shop Order 605445 (OC-419), July 1998.
2. "METSAT/AMSU A1 Top Assy", Dwg. 1331720.
3. "Vibration and Sine Burst Qualification and Acceptance Test Procedure for the AMSU-A System", Aerojet Process Specification AE-26151/1D, 17 September 1998.
4. "Failure Review Board (FRB) Meetings Held in Dec. 1998 and Jan. 1999 (F/AR 171)", Added Resonance (120 Hz.) after Qualification, latest printing IOM 6146/1999#2, D. Woon.
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6. "AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August 1998 (S/O 565632, OC-417)", 170:8411#98-604, R. J. Heffner, 10 Nov. 1998.
7. "AMSU-A1 EOS Instrument (S/N 202) Qualification Vibration Test Review, 170:8411#98-859, R. J. Heffner, 04 Dec. 1998.
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PURPOSE

The purpose of this memo is to present a summary of the qualification level vibration testing performed on the S/N 105 AMSU-A1 Ref. 2 Instrument during the December 1998 to January 1999 time frame.

SUMMARY

The Ref. 2, S/N 105, METSAT AMSU-A1 instrument was vibration tested to qualification levels per the Ref. 3 procedure and Ref. 1 shop order. The instrument withstood the 8.8 Grms random vibration test, and the 16.3g sine burst test in each of the three orthogonal axes. Z-axis testing (perpendicular to the sidemount) was performed first, with pre-random and post-random low level sine sweep responses showing only minor resonant frequency degradation, primarily in the reflectors. Sine burst produced no changes in response throughout the instrument.

The unit X-axis testing (perpendicular to the baseplate) produced more significant results, with pre and post-random sine sweeps identifying changes throughout the structure. Locations, such as the instrument top panel (Accel#16) experienced an 8 Hz. reduction in 1st natural frequency (129 to 121 Hz.). The upper reflector (Accel#32) and upper motor (Accel#22) saw similar response changes, (1st resonance shifting from 129 to 120 Hz.), while the lower reflector (Accel#31) and the lower motor (Accel#20), each showed an added mode at approximately 120 Hz. The sine burst test, however, produced no significant response changes. The change in the instruments' response was significant enough to be considered as a test anomaly.

After documenting the X-axis qualification level test results anomaly by a failure analysis review (F/AR 171, Ref. 4), and investigating for instrument structural changes, and finding nothing obviously wrong, it was concluded that the S/N 105 instrument had experienced a "settling in effect" by the significant X-axis loading. To insure that the instrument remained stable, with no more "settling in", an added X-axis acceptance level (workmanship) random vibration was performed, Responses before and after the workmanship random vibration, in the pre-sine and post-sine displays, showed nearly identical responses, concluding that the instrument was now stable.

The remaining axis (Y-axis, parallel to the motors' shafts) was run at qual. level and showed through the pre and post-random sine sweeps, only relatively minor changes in response level and frequency. Resonant frequencies degraded by 1 or 2%, while transmissibility's varied. The sine burst test, again in the Y-axis, produced no significant response changes.

With the S/N 105 A1 instrument considered as satisfying the qualification level vibration tests (Limited Performance Tests (LPT's) were passed after Z and X vibrations, and the more involved Comprehensive Performance Test (CPT) was passed after the concluding Y-axis vibration), the instrument was sent to Thermal Cycling Testing. In the 1st Thermal Cycle, however, the instrument displayed an inconsistency at Channel 8, as discussed in Ref. 5. Subsequent repair of the S/N 105 instrument (replacement of the Channel 8 DRO), required an added workmanship (acceptance level) random vibration test be passed.

The added workmanship test was to be an X-axis acceptance level test sequence of sine sweep, acceptance random, sine sweep. The pre-random sine sweep was completed. At that time an electrical short was noted in the instrument, further delaying the mechanical vibration testing until the shorting problem was diagnosed and repaired.

After eliminating the electrical short, the instrument was again readied for the workmanship (X-axis) test sequence of sine sweep, acceptance random, sine sweep. The workmanship vibration tests were performed without incident. Pre and post-random sine sweep response comparisons showed adequate agreement, with insignificant frequency and transmissibility variations.

The CPT was again successfully run after completion of the 2nd added acceptance level X-axis vibration. Passing the CPT signified the successful completion of the S/N 105 A1 qualification vibration testing.

DISCUSSION

METSAT qualification level testing was begun on the S/N 105 A1 assembly during the month of December 1998, starting in the METSAT Z-axis (perpendicular to the sidemount). The vibration qualification test sequence, for each axis, per the Ref. 3 procedure was:

1. Low level sine sweep (0.25 g)
2. Full level random vibration (8.8 Grms spec.)
3. Low level sine sweep (0.25g)
4. Acceleration/sine burst (16.3 g)
5. Low level sine sweep (0.25g)

As the 1st test axis, the Z-axis testing was completed without incident on 04 December 1998. See Tables 1 & 2 for natural frequencies, calculated Q levels, and random vibration response levels. After vibration, the LPT was performed, with the instrument passing the test.

X-axis vibration testing followed on 05 December 1998. X-Axis tests produced more significant results, with changes to the structure's frequencies and transmissibility's. The sine sweeps bracketing the full qualification level (8.8 Grms) X-axis random vibration showed significant differences in responses throughout the structure. These differences warranted the issuing of a failure analysis review (F/AR 171, Ref. 4).

The post-random sine sweep identified the following changes.

(1) A new 1st fundamental frequency is seen at accel#20X, lower motor, where the pre-random 1st f_n of 132.7 Hz. splits into the new 1st f_n of 119.2 Hz. and 132.7 Hz.
(2) Accel#22X, upper motor, pre-random 1st and 2nd f_n of 129.0 Hz. and 140.6 Hz. modify to 120.1 Hz. and 139.6 Hz. Thus a new ~120 Hz. frequency is seen at the upper motor.
(3) The accelerometer on the top panel, accel#26X, shows results similar to #22X, with the post random 1st f_n of 120.9 Hz. resulting from the pre-random 129.0 Hz.
(4) The lower reflector (accel#31X) acts much like the lower motor, with post random 1st and 2nd f_n of 120.1 Hz. and 132.7 Hz. resulting from the pre-random 132.7 Hz. 1st mode.
(5) The upper reflector (accel#32X) acts much like the upper motor, with post random 1st and 2nd f_n of 120.1 Hz. and 139.6 Hz. resulting from the pre-random 129.0 Hz. and 140.6 Hz. values.

See Tables 1 & 2 for natural frequencies, calculated Q levels, and random vibration response levels of the X-axis data. After the post-random sine sweep, the X-axis sine burst test was run, without any change seen in the post sine burst sine sweep. After vibration, the LPT was performed, with the instrument passing the test.

In the failure analysis review (F/AR 171, Ref. 4), it was brought to light that the finite element vibration model had predicted a resonant frequency of approx. 120 Hz., as seen in the actual vibration data. Thus it was considered that the instrument, in the Z-axis qual. test, had "re-adjusted" to a state more like the vibration model, and that additional relaxation was not probable. Prove of a 'settled' instrument would come from agreement of the structures' sine sweep responses before and after an additional workmanship random vibration.

The Ref. 4 FRB, F/AR 171 plan, involved the following steps.

(1) Verification of preload torque's of all externally mounted screws without bonded heads.
(2) Running of a new Bode plot.
(3) Close inspection of instrument.
(4) Running an added workmanship (acceptance level) X-axis random vibration.
(5) Running the qualification level Y-axis test sequence.

No significant problems were found in steps 1, 2, and 3. A 07 December 1998 low level sine sweep, performed after steps 1, 2, and 3, verified no change in response from the post sine burst sine sweep. The Y-axis test sequence (step 5) was run after the added workmanship X-axis random vibration of step 4. To insure that the instrument remained stable, with no more "settling in", the added X-axis acceptance level (workmanship) random vibration was performed on 09 December 1998. Responses before and after the workmanship random vibration, in the pre-sine and post-sine displays, showed nearly identical responses, concluding that the instrument was now stable. See Tables 1 & 2 for natural frequencies, calculated Q levels, and random vibration response levels

The Y-axis vibration tests, (parallel to the motors' shafts) were run at qual. level and were completed without incident on 10 December 1998, showing through the pre and post-random sine sweeps, only minor changes in response level and frequency. Resonant frequencies degraded by 1 or 2%, while transmissibility's varied. The sine burst test, again in the Y-axis, produced no significant response changes. See Tables 1 & 2 for natural frequencies, calculated Q levels, and random vibration response levels. After vibration, the LPT was performed, with the instrument again passing the test.

The instrument was next sent to Thermal Cycling Testing, where, in the 1st Thermal Cycle, the instrument displayed an inconsistency at Channel 8 (as discussed in Ref. 5). Subsequent repair of the S/N 105 instrument (replacement of the Channel 8 DRO) was completed. The instrument now required another (2nd) added workmanship (acceptance level) random vibration test be passed. The workmanship random vibration test was performed in the most severe, X-axis.

The 2nd added workmanship test was to be an X-axis acceptance level test sequence of sine sweep, acceptance random, sine sweep. The pre-random sine sweep was completed. At that time an electrical short was noted in the instrument, further delaying the mechanical vibration testing until the shorting problem was diagnosed and repaired.

After eliminating the electrical short, the instrument was again readied for the workmanship (X-axis) test sequence of sine sweep, acceptance random, sine sweep. Run 23 January 1999, the pre and post-random sine sweep response comparisons showed adequate agreement, with insignificant frequency and transmissibility variations. See Tables 1 & 2 for natural frequencies, calculated Q levels, and random vibration response levels for this final acceptance level X-axis vibration.

The post-workmanship vibration CPT was successfully run on 24 January 1999, after completion of the 2nd added acceptance level X-axis vibration test. With the instrument passing the CPT, it signified the successful completion of the S/N 105 A1 qualification vibration testing.

Table 1 is included to show the predicted peak 3σ loads at the motors and reflectors based on the sine sweep responses and Miles' equation, and to show comparisons with Ref. 6 tests. Note the axes' differences between METSAT and EOS. Per Ref. 3,

METSAT X	is	EOS Z
METSAT Y	is	EOS X
METSAT Z	is	EOS Y

Sample calculations of the predicted loads at full level (-0 dB) random vibration, using Miles' equation with low level sine sweep amplification factors, are shown for Accel#20X for X-axis test data, Y response;

$$\begin{aligned}\text{Peak } 3\sigma &= 3 \times [\,(\pi/2)(\text{PSD})(f_{ni})(Q)\,]^{1/2} \\ &= (3)\,[\,(\pi/2)\,(0.072)\,(132)\,(20)\,]^{1/2} \\ &= 52 \text{ g}\end{aligned}$$

From Table 1, the EOS comparison for same axis, same orientation response, is only 24.5 g. Note that the Ref. 6 EOS data is from the AMSU-A1 EOS Model. The EOS qualification instrument mounts via its baseplate. METSAT, like NOAA K, L, M is mounted via its sidemount. Therefore differences between Ref. 6 and the METSAT instrument are to be expected.

Table 2 is developed to identify motor and reflector responses due to random vibration, predict peak 3σ loads and compare these peak 3σ loads with Ref. 6 EOS data, and Ref. 8 calculated levels.

From the Table 2 Y-axis qualification load data, Y response, the projected maximum peak 3σ load is 142.0 g at the lower reflector (with 134.0 g predicted at the upper reflector). Ref. 6, for EOS, determined loads of 82.2 g for the lower reflector and 89.8 g for the upper reflector, per the same loading direction and response. The Ref. 8 maximum loads determined were 224.5 g at the lower reflector and 190.4 g at the upper reflector. METSAT projected loads are appreciably higher than EOS projections. METSAT projected loads, are still below Ref. 8 calculated values.

Sample calculations for the predicted peak -0 dB load for the Y-axis, Y response, using the 1/2 power point method, is shown for Accel#31X (lower reflector),

$$\text{Peak } 3\sigma = 3 \times [(165-151)(160)]^{1/2} \quad = 142.0\text{g} \quad \text{Peak at -0dB}$$

RESULTS

Table 1 displays sine sweep data, for the motors and reflectors, for all vibration sequences. In Table 1, for each accelerometer, the 1st natural frequency and transmissibility are listed, along with the PSD level of the random vibration spectrum at f_{n1}, and the peak 3σ load (determined via Miles equation). Ref. 6 EOS loads are listed for comparison.

Table 2 tabulates random vibration data at the reflectors and motors. At each location, the -0 dB 3σ load is found, calculated using the half-power method on the response data. Loads per Ref. 6 (EOS) are also listed for comparison purposes.

As an appendix to this report, the complete list of acceleration and power spectral density (PSD) plots at all response locations, is included.

CONCLUSIONS and RECOMMENDATIONS

The Ref. 2, S/N 105, METSAT, AMSU-A1 Instrument successfully met the qualification level vibration requirements of Ref. 3. Because of an electronic component failure and an inadequate system electrical ground, the instrument saw two additional X-axis acceptance level random vibration tests. These added tests verified the instruments structural integrity.

It is recommended to accept the A1 S/N 105 instrument.

R. J. Heffner

R. J. Heffner
Mechanical Design and Analysis

Table 1 AMSU -A1 METSAT Qual Level Test Data Miles' Equ w/ 1/4 g Sine Sweep

X-Axis 1st Sine Sweep (05 Dec. 98)				Random PSD Level	Peak 3σ Load	Ref. 6* Peak 3σ Load
Accel Location	Accel	1st fn	Q			
Lower Motor	20X	133	6.6	0.074	**30.4**	**12.5**
	Y	132	20	0.072	**52.0**	**24.5**
	Z	131	2.4	0.071	**17.7**	**11.1**
Upper Motor	22X	129	6	0.067	**27.1**	**20.3**
	Y	140	23.2	0.088	**63.6**	**37.7**
	Z	130	7	0.069	**29.8**	**36.7**
Lower Refl	31X	133	5.9	0.074	**28.7**	**56.5**
	Y	168	20.4	0.110	**73.0**	**83.6**
	Z	132	1	0.072	**9.6**	**32.9**
Upper Refl	32X	141	9	0.090	**40.2**	**59.8**
	Y	171	16.8	0.110	**66.8**	**94.6**
	Z	130	5.2	0.069	**25.6**	**34.6**

*Ref. EOS responses per METSAT coordinate system.

Y-Axis 1st Sine Sweep (10 Dec. 98)				Random PSD Level	Peak 3σ Load	Ref. 6* Peak 3σ Load
Accel Location	Accel	1st fn	Q			
Lower Motor	20X	129	12.0	0.067	**38.3**	**22.7**
	Y	128	59.4	0.065	**83.8**	**72.2**
	Z	128	4.6	0.065	**23.3**	**13.3**
Upper Motor	22X	135	5.2	0.078	**27.8**	**30.2**
	Y	134	34.3	0.076	**70.3**	**69.9**
	Z	128	2.2	0.065	**16.1**	**18.7**
Lower Refl	31X	164	52.0	0.110	**115.2**	**74.5**
	Y	163	108.9	0.110	**166.1**	**100.5**
	Z	172	32.0	0.110	**92.5**	**52.0**
Upper Refl	32X	168	26.4	0.110	**83.0**	**53.8**
	Y	168	58.9	0.110	**124.0**	**84.5**
	Z	171	13.2	0.110	**59.2**	**44.4**

*Ref. EOS responses per METSAT coordinate system.

Table 1 AMSU -A1 METSAT Qual Level Test Data Miles' Equ w/ 1/4 g Sine Sweep (Con't)

Z-Axis 1st Sine Swp (04 Dec. 98)				Random PSD	Peak 3σ	Ref. 6* Peak 3σ
Accel Location	Accel	1st fn	Q	Level	Load	Load
Lower Motor	20X	133	1.0	0.074	**11.8**	**39.2**
	Y	134	6.0	0.076	**29.4**	**24.3**
	Z	134	1.2	0.076	**13.2**	**13.1**
Upper Motor	22X	190	2.3	0.244	**38.8**	**22.4**
	Y	144	4.1	0.097	**28.4**	**39.0**
	Z	234	8.9	0.110	**56.9**	**50.3**
Lower Refl	31X	169	6.5	0.110	**41.3**	**55.1**
	Y	170	12	0.110	**56.3**	**67.5**
	Z	178	6.8	0.110	**43.4**	**35.5**
Upper Refl	32X	188	9.0	0.110	**51.3**	**66.6**
	Y	188	12.0	0.110	**59.2**	**101.6**
	Z	189	4.8	0.110	**37.6**	**53.8**

*Ref. EOS responses per METSAT coordinate system.

X-Axis Sine Sweep (09 Dec. 98) Repeated				Random PSD	Peak 3σ	Ref.* Peak 3σ
Accel Location	Accel	1st fn	Q	Level	Load	Load
Lower Motor	20X	133	3.8	0.074	**23.0**	**30.4**
	Y	133	17	0.074	**48.7**	**52.0**
	Z	121	1.7	0.054	**12.6**	**17.7**
Upper Motor	22X	120	3.9	0.053	**18.7**	**27.1**
	Y	140	11	0.088	**43.8**	**63.6**
	Z	120	4.4	0.053	**19.8**	**29.8**
Lower Refl	31X	168	25.8	0.110	**82.1**	**28.7**
	Y	168	40	0.110	**102.2**	**73.0**
	Z	168	8.8	0.110	**47.9**	**9.6**
Upper Refl	32X	171	10.0	0.110	**51.6**	**40.2**
	Y	171	32	0.110	**92.2**	**66.8**
	Z	183	5	0.110	**37.7**	**25.6**

*Ref. from initial X-Axis sine sweep (05 Dec. 98)

Table 1 AMSU -A1 METSAT Qual Level Test Data Miles' Equ w/ 1/4 g Sine Sweep (Con't)

X-Axis Final Sine Sweep (23 Jan. 99) Repeated Accel Location	Accel	1st fn	Q	Random PSD Level	Peak 3σ Load	Ref.* Peak 3σ Load
Lower Motor	20X	130	4.1	0.069	**22.8**	**23.0**
	Y	130	19.2	0.069	**49.3**	**48.7**
	Z	119	1.2	0.051	**10.2**	**12.6**
Upper Motor	22X	118	5	0.050	**20.4**	**18.7**
	Y	133	16.8	0.074	**48.4**	**43.8**
	Z	120	7	0.053	**25.0**	**19.8**
Lower Refl	31X	167	18.8	0.110	**69.9**	**82.1**
	Y	167	32	0.110	**91.2**	**102.2**
	Z	175	8.4	0.110	**47.8**	**47.9**
Upper Refl	32X	166	7.3	0.110	**43.4**	**51.6**
	Y	173	14.8	0.110	**63.1**	**92.2**
	Z	120	5.2	0.053	**21.6**	**37.7**

*Ref. from previous X-Axis sine sweep (09 Dec. 98)

Table 2 AMSU-A1 METSAT Qual Level Test Data 1/2 Power Points

X-Axis Full Qualification Level (05 Dec. 98)

Accel Location	Accel	Total Grms	lin. 1st fn low	lin. 1st fn high	1st fn low	1st fn high	1st Res G2/Hz	1st Res Pk Grms	-0 dB Peak 3σ Load	Ref. 6 -0 dB Pk 3σ Load
Lower Motor	20X	14.1								
	Y	13.3	0.2983	0.4035	123	132	1.5	3.7	**11.0**	6.0
	Z	16.5								
Upper Motor	22X	12.3								
	Y	20.0	0.3553	0.4868	128	140	2.9	5.9	**17.7**	11.5
	Z	18.4								
Lower Refl	31X	78.0	0.6579	0.7456	158	168	4.0	6.3	**19.0**	
	Y	60.1	0.6316	0.7807	155	172	12	14.3	**42.8**	17.7
	Z	56.8	0.9649	-	195	209	0.29	2.0	**6.0**	
Upper Refl	32X	75.1	0.8991	-	187	205	4.7	9.2	**27.6**	25.7
	Y	51.6	0.6681	0.7920	159	173	16	15.0	**44.9**	52.8
	Z	56.9	0.7149	0.8816	164	184	0.52	3.2	**9.7**	

Y-Axis Full Qualification Level (10 Dec. 98)

Accel Location	Accel	Total Grms	lin. 1st fn low	lin. 1st fn high	1st fn low	1st fn high	1st Res G2/Hz	1st Res Pk Grms	-0 dB Peak 3σ Load	Ref. 6 -0 dB Pk 3σ Load
Lower Motor	20X	10.9								
	Y	31.3	0.2632	0.3684	120	129	29	16.2	**48.5**	46.5
	Z	13.6								
Upper Motor	22X	11.5								
	Y	35.1	0.3158	0.5	124	141	29	22.2	**66.6**	50.7
	Z	11								
Lower Refl	31X	73.7	0.5965	0.7281	151	166	37	23.6	**70.7**	52.5
	Y	73.1	0.5921	0.7193	151	165	160	47.3	**142.0**	82.2
	Z	54.3								8.7
Upper Refl	32X	84.4	0.5307	0.7456	144	168	21	22.4	**67.3**	78.2
	Y	72.4	0.5351	0.7281	145	166	95	44.7	**134.0**	89.8
	Z	48.5								16.7

Table 2 AMSU-A1 METSAT Qual Level Test Data 1/2 Power Points (Con't)

Z-Axis Full Qualification Level (04 Dec. 98)

Accel Location	Accel	Total Grms	lin. 1st fn low	lin. 1st fn high	1st fn low	1st fn high	1st Res G2/Hz	1st Res Pk Grms	-0 dB Peak G Load	Ref. 6 -0 dB Pk 3σ Load
Lower Motor	20X	12.1								
	Y	22.4	0.7851	0.8728	172	183	0.42	2.1	**6.4**	10.9
	Z	26.9								
Upper Motor	22X	10.4								
	Y	16.3	0.8026	0.9298	174	190	0.5	2.8	**8.5**	30.7
	Z	15.2								45.3
Lower Refl	31X	92.8								20.4
	Y	58.5	0.6667	0.807	159	175	2.6	6.4	**19.3**	35.2
	Z	82.6								6.4
Upper Refl	32X	73.6	-	-	220	230	19	13.8	**41.4**	56.3
	Y	35.7	0.693	0.7851	162	172	3.0	5.5	**16.4**	114.6
	Z	52.8								33.7

X-Axis Full Acceptance Level (09 Dec. 98)

Accel Location	Accel	Total Grms	lin. 1st fn low	lin. 1st fn high	1st fn low	1st fn high	1st Res G2/Hz	1st Res Pk Grms	-0 dB Peak G Load	Ref. 6 -6 dB Pk 3σ Load
Lower Motor	20X	8.7								
	Y	8	0.3114	0.4342	124	135	1.45	4.0	**12.0**	3.7
	Z	9.0								
Upper Motor	22X	6.7								
	Y	10.8	0.3947	0.5175	131	143	1.25	3.9	**11.6**	9.4
	Z	10.1								
Lower Refl	31X	47.6								
	Y	29.5	0.6578	0.7412	158	167	10	9.5	**28.5**	19.9
	Z	37.7								
Upper Refl	32X	44.7								18.1
	Y	31.1	0.7061	0.7939	163	173	17	13.0	**39.1**	39.1
	Z	46.1								

Table 2 AMSU-A1 METSAT Qual Level Test Data 1/2 Power Points (Con't)

X-Axis Full Acceptance Level (23 Jan. 99)

Accel Location	Accel	Total Grms	lin. 1st fn low	lin. 1st fn high	1st fn low	1st fn high	1st Res G2/Hz	1st Res Pk Grms	-0 dB Peak 3σ Load	Ref. 6 -6 dB Pk 3σ Load
Lower Motor	20X	8.1								
	Y	8.2	0.2719	0.3991	121	132	0.85	3.1	**9.2**	3.7
	Z	7.5								
Upper Motor	22X	5.5								
	Y	10	0.2018	0.4386	115	136	1.35	5.3	**16.0**	9.4
	Z	8.2								
Lower Refl	31X	40								
	Y	27	0.6491	0.7456	157	168	6.2	8.3	**24.8**	19.9
	Z	31.5								
Upper Refl*	32X	43.1								18.1
	Y	20.4	0.6535	0.7851	157	172	2	5.5	**16.4**	39.1
	Z	25.9								

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16. ABSTRACT (*Maximum 200 words*)

This is the Engineering Test Report, AMSU-A1 METSAT Instrument (S/N 105) Qualification Level Vibration Tests of December 1998 (S/O 605445, OC-419), for the Integrated Advanced Microwave Sounding Unit-A (AMSU-A).

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