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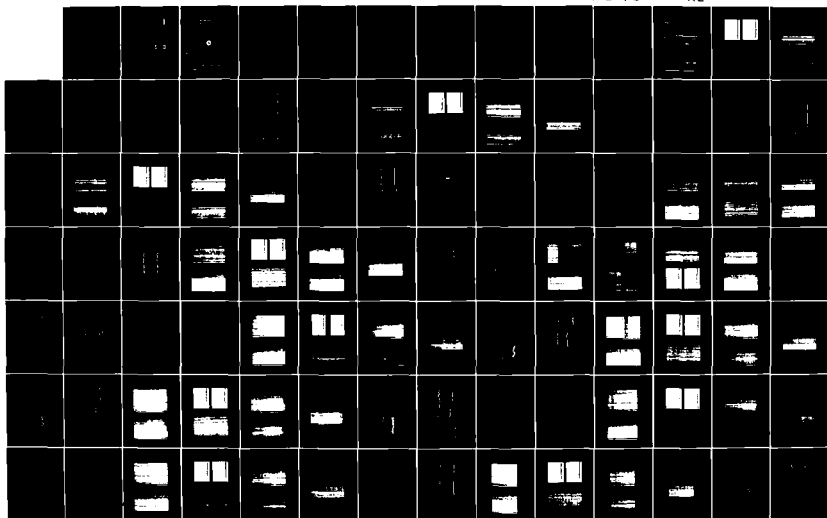
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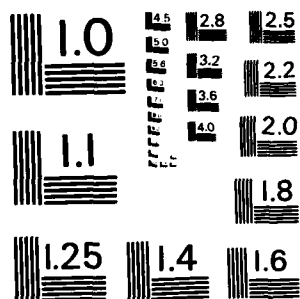
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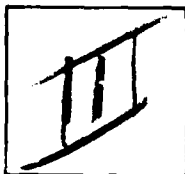


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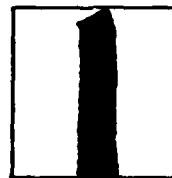
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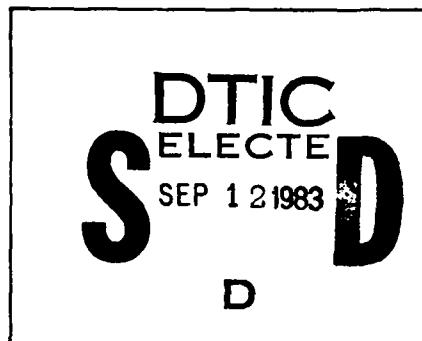
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JET ENGINE BURN-THROUGH INVESTIGATION

VOLUME II: ENGINE TESTS RAW DATA

ADA132357

Richard W. Schumacker



MARCH 1973

FINAL REPORT

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830735

Systems Research & Development Service

Washington D. C., 20591

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15. Supplementary Notes This study was made under a contract administrated by the National Aviation Facilities Experimental Center, Atlantic City, N.J.			
16. Abstract The work performed during this program was directed toward determining the acoustic characteristics of simulated burn-through failures. To determine the feasibility of detecting this failure acoustically two types of jet engines (J-47 and J-57) were modified to simulate burn-through failures. Magnetic tape recordings of the modified engines were made to determine the extent of the acoustic spectrum, the relationship of engine speed to failure related sound pressure levels and acoustic spectrum, the effect of sensor location to detect the failure acoustically and characteristic acoustic spectra at burn-through. The recorded data was analyzed by real time spectrum analysis and mean square techniques. Results indicated that the simulated burn-through failure acoustic spectra consists primarily of broadband random noise above 5 kHz. It was also determined that sensor location is an important factor in detecting burn-through failures. Based on the results it is concluded that acoustic detection of a burn-through failure is feasible. Recommendations for a monitor and detector based on the results of this program have been included. Volume I contains the Sonic Analysis.			
17. Key Words Burner-Can Burn-Through Sonic Engine Analyzer Jet Engine Combusters Combustion Chamber Failure		18. Distribution Statement Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.	
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PREFACE

This report was prepared by the Government and Industrial Group, Fort Wayne Division, The Magnavox Company, Fort Wayne, Indiana, for the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, New Jersey. The work was administered under the direction of Richard Hill, Project Engineer, Propulsion and Fire Protection Branch, Aircraft Safety Division, NAFEC. Appreciation is expressed to Mr. Hill and his staff for their valuable assistance while executing the tests at the NAFEC facility.

APPENDIX LIST

VOLUME II, ENGINE TESTS RAW DATA

<u>Appendix</u>	<u>Title</u>	<u>Page</u>
A	J-47 ENGINE	A-1
B	J-57 ENGINE (PORT)	B-1
C	COMBINED J-47 AND J-57 ENGINE TESTS	C-1
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APPENDIX A

J-47 ENGINE

A.1 J-47 ENGINE, MODIFIED BURNER CAN HOLE COVERED

A series of three test runs were made on the J-47 engine with the modified burner can hole covered. Each test was recorded using five microphones placed as noted in the text. The three tests were run at the following engine speeds:

- (1) 70% RPM (46 in. Hg gage, diffuser case pressure)
- (2) 80% RPM (70 in. Hg gage, diffuser case pressure)
- (3) 90% RPM (97 in. Hg gage, diffuser case pressure)

The purpose of this test was to establish a reference to compare modified burner can closed hole sound energy levels at the three engine speeds with sound energy levels of the modified burner can with three sizes of open holes (1.5, 1.0, and 0.75-inch) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 70% run - pages A-4 through A-12
- (2) 80% run - pages A-13 through A-21
- (3) 90% run - pages A-22 through A-28

A.1.1 Analysis

A.1.1.1 Sound Energy Levels

Output levels of microphones 1 through 5 were measured for RMS sound energy during each test run. Microphone 2 was a broadband instrumentation microphone and microphones 1, 3, 4, and 5 had a lower frequency response but were all of the same type. The data was converted to decibels by conversion factors detailed in Appendix F. Variations in RMS levels of microphones 1, 3, 4, and 5 are attributed to microphone location and proximity to engine machinery (i.e., fuel pumps, etc.).

The closed hole test measurements are representative of a normal engine. These measurements will be used as a reference to compare sound energy levels made during open hole tests which are representative of burner can failure. Microphone sound levels increased from 2 to 5 dB when engine speed was increased from 46 in. Hg to 70 in. Hg, and from 2 to 4 dB when engine speed was increased from 70 in. Hg to 97 in. Hg. Microphone 5 was farthest away from the engine and showed the most change while microphone 3 was closest and showed the least change. The

influence of background exhaust noise was apparent from the sound measurements.

A.1.1.2 Spectrum Analysis

The analysis bandwidth was 0 to 20 kHz for all microphones. In addition, the instrumentation microphone (No. 2) data was analyzed from 0 to 40 kHz. Discrete spectral content due to engine machinery was present in all grams, but as engine speed was increased, there was a noticeable change in broadband noise, the extent of which varied with microphone location. Microphone 5 contained the most broadband noise and microphone 3 the least. The major portion of the energy was below 10 kHz in all cases. Instrumentation microphone No. 2 showed discrete frequencies present up to 30 kHz and some broadband noise up to 40 kHz.

A.1.1.3 Mean Square Analysis

The data from each microphone was analyzed over bandwidths of 0 to 20 kHz and 5 to 20 kHz simultaneously, using mean square techniques. This method of analysis, when recorded, showed the summation of the total spectrum at any given time versus the summation of the spectrum above 5 kHz. Microphones 1, 2, and 3 showed very little variation between changes in engine speed while microphones 4 and 5 showed noticeable variation. The bulk of the spectral content is observed to be below 5 kHz.

A.1.2 Environmental Conditions

The three tests discussed in paragraph A.1 were performed at an ambient temperature of 61° F and 75% relative humidity.

A.1.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table A-1. Microphone Sound Energy Levels at 70% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	13	3	14	12	9
RMS (μBAR)	105	235	110	96	72
dB (a)	114	121	115	114	111

^aReference = 2×10^{-4} μBAR

Table A-2. Microphone Sound Energy Levels at 80% Engine RPM

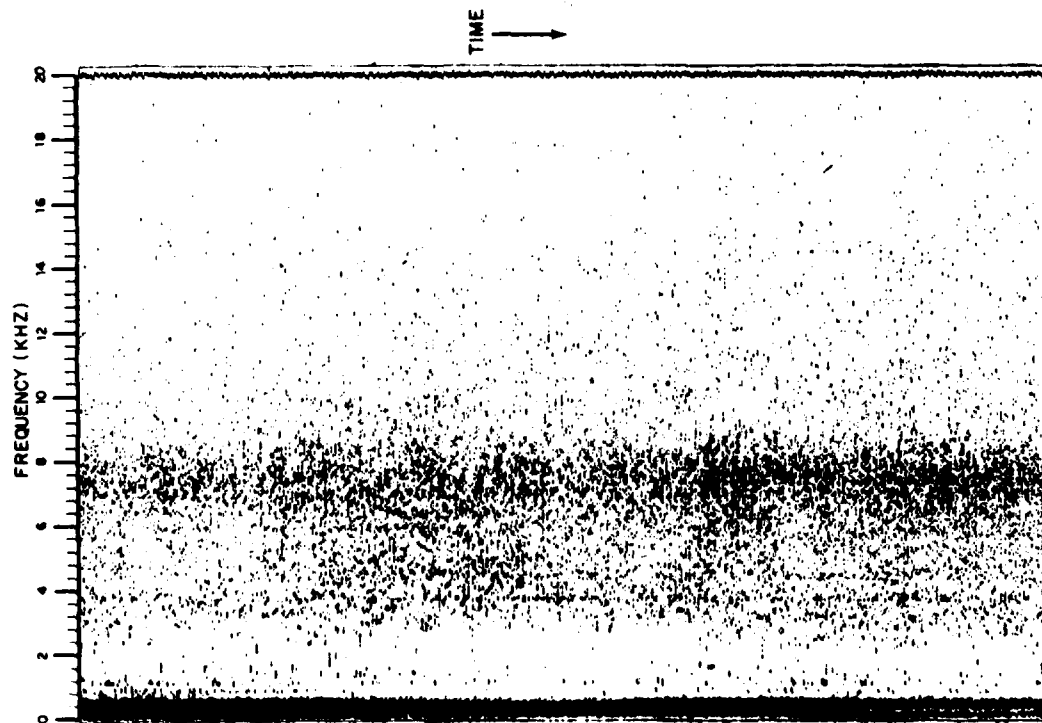
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	23	5	18	22	16
RMS (μBAR)	180	390	145	180	130
dB (a)	119	126	117	119	116

^aReference = 2×10^{-4} μBAR

Table A-3. Microphone Sound Energy Levels at 90% Engine RPM

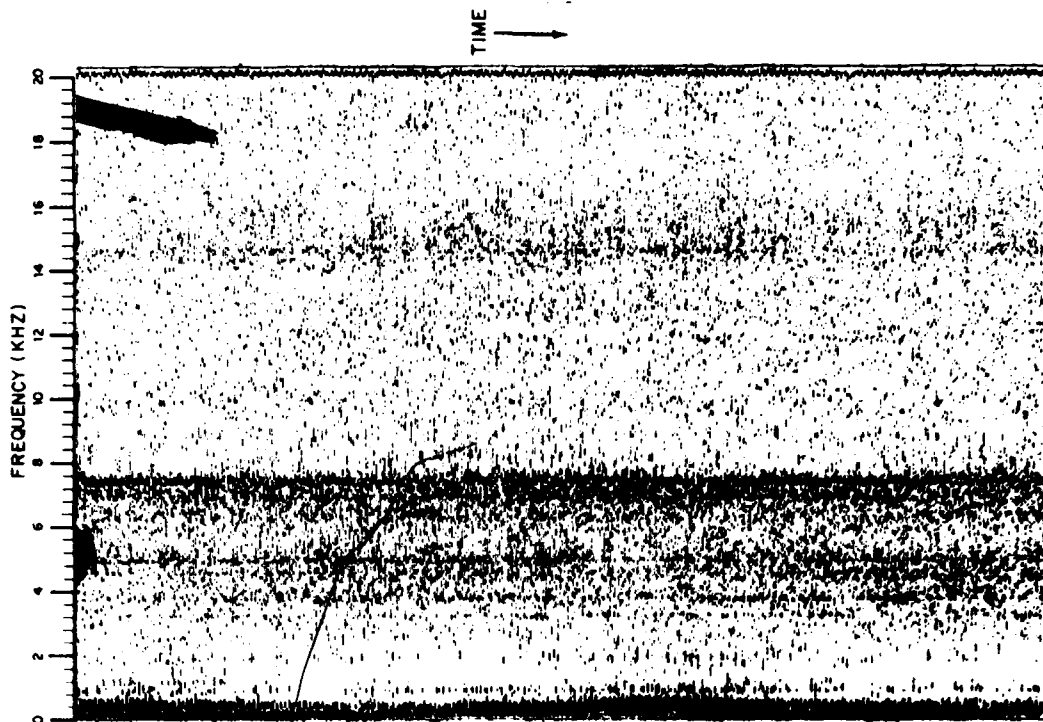
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	28	8	24	30	26
RMS (μBAR)	220	620	190	240	210
dB (a)	121	130	120	122	120

^aReference = 2×10^{-4} μBAR



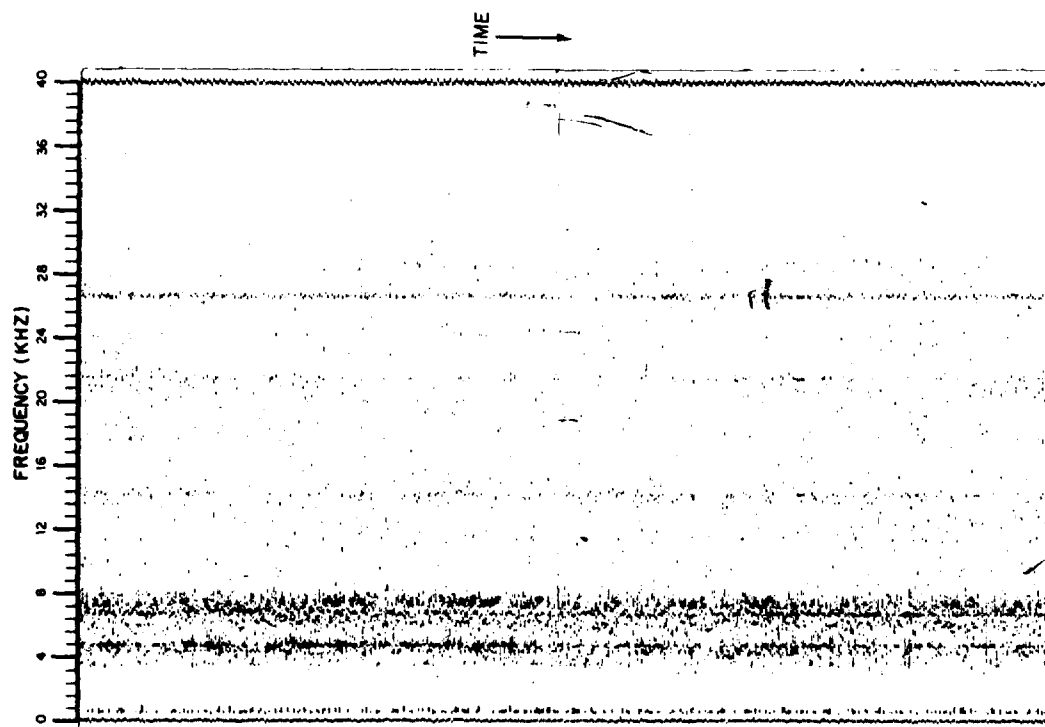
ASN-587-1

Figure A-1. Microphone No. 1 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



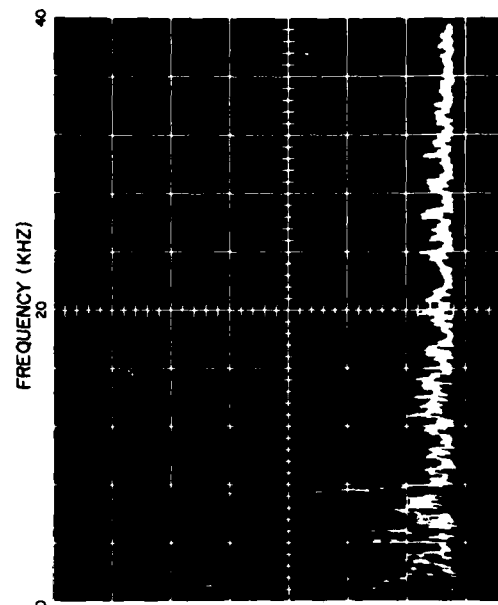
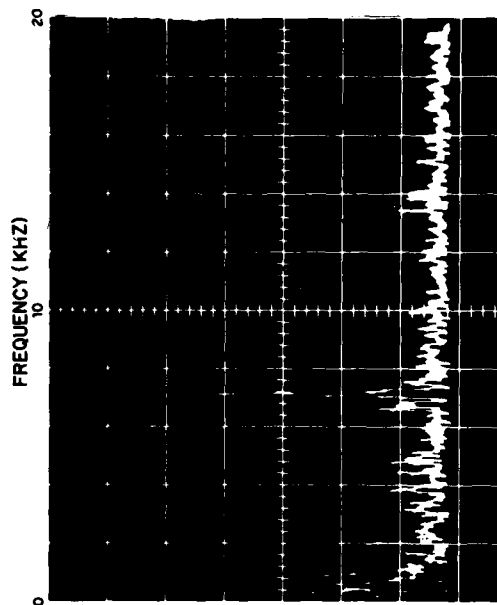
ASN-587-2

Figure A-2. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



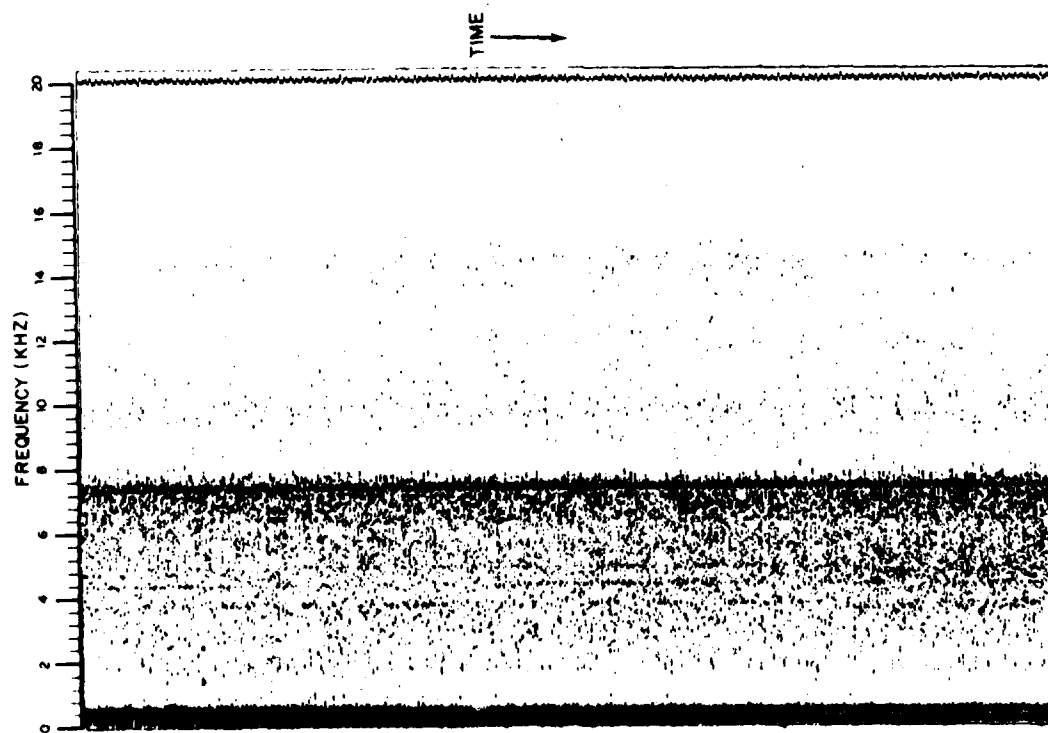
ASW-587-3

Figure A-3. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



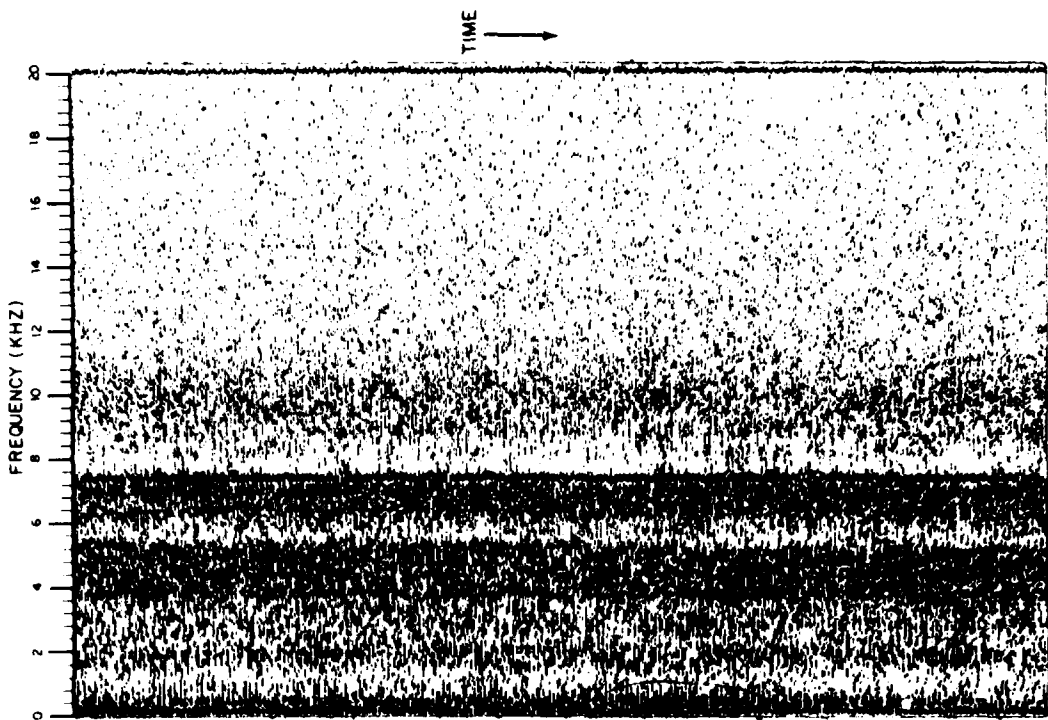
ASW-587-4

Figure A. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



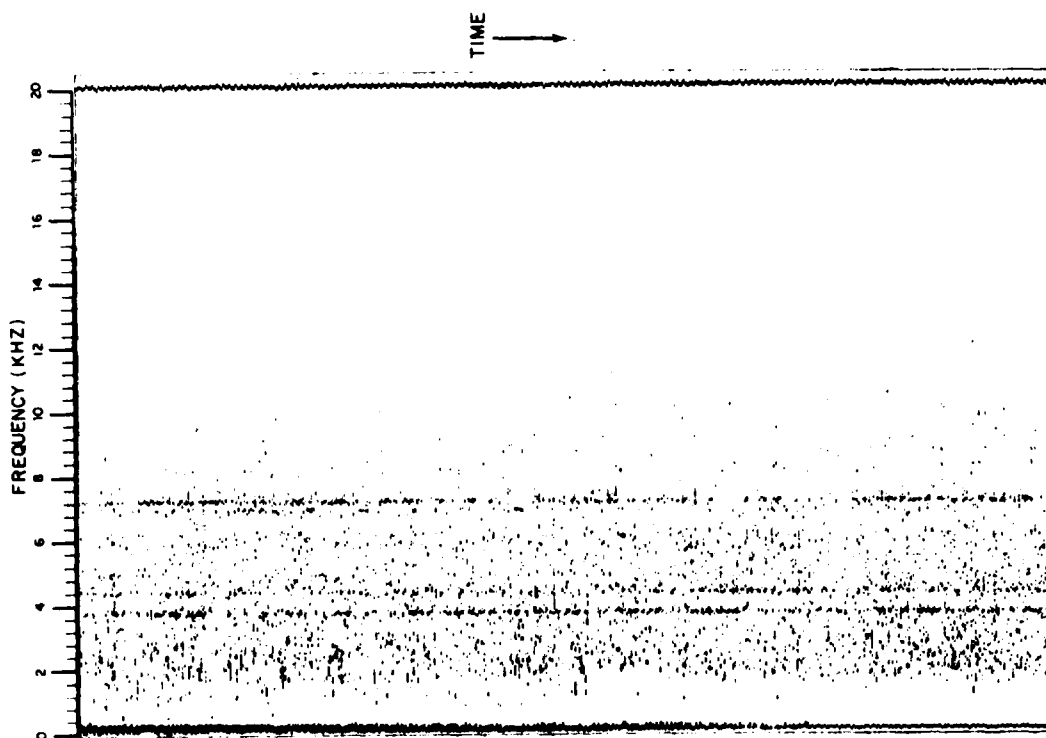
ASW-587-5

Figure A-5. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



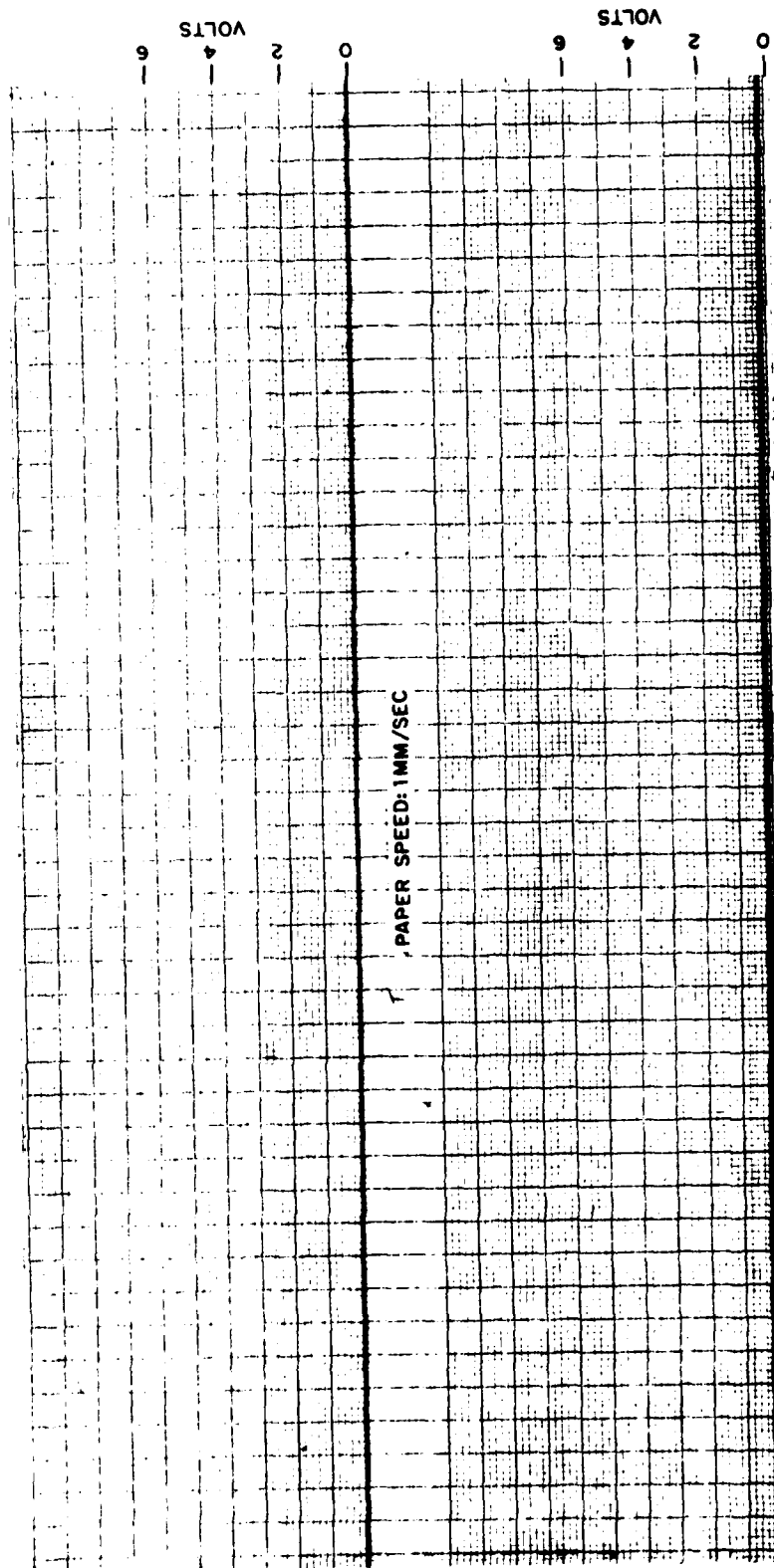
ASW-587-6

Figure A-6. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-7

Figure A-7. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-8

Figure A-8. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

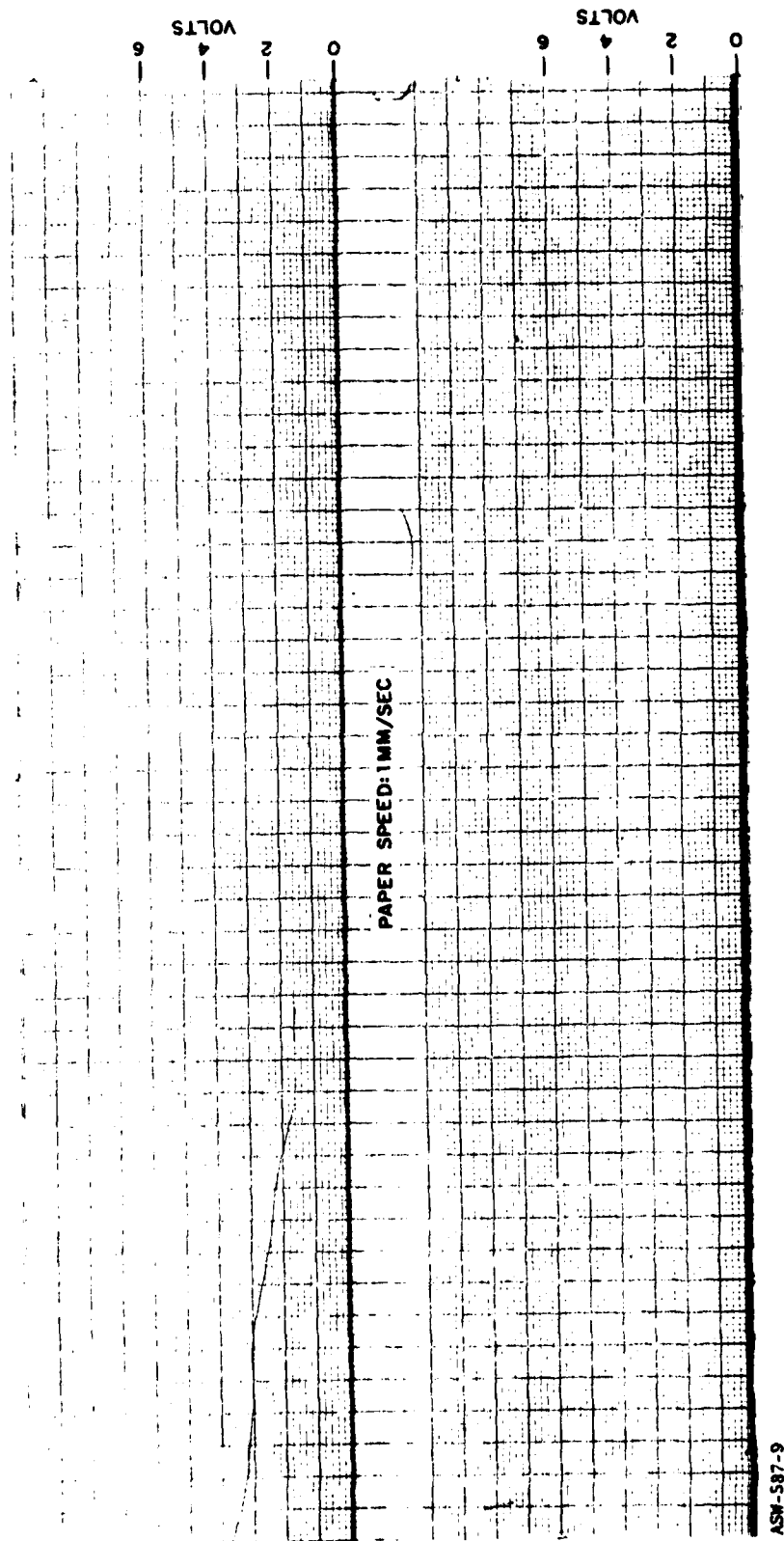
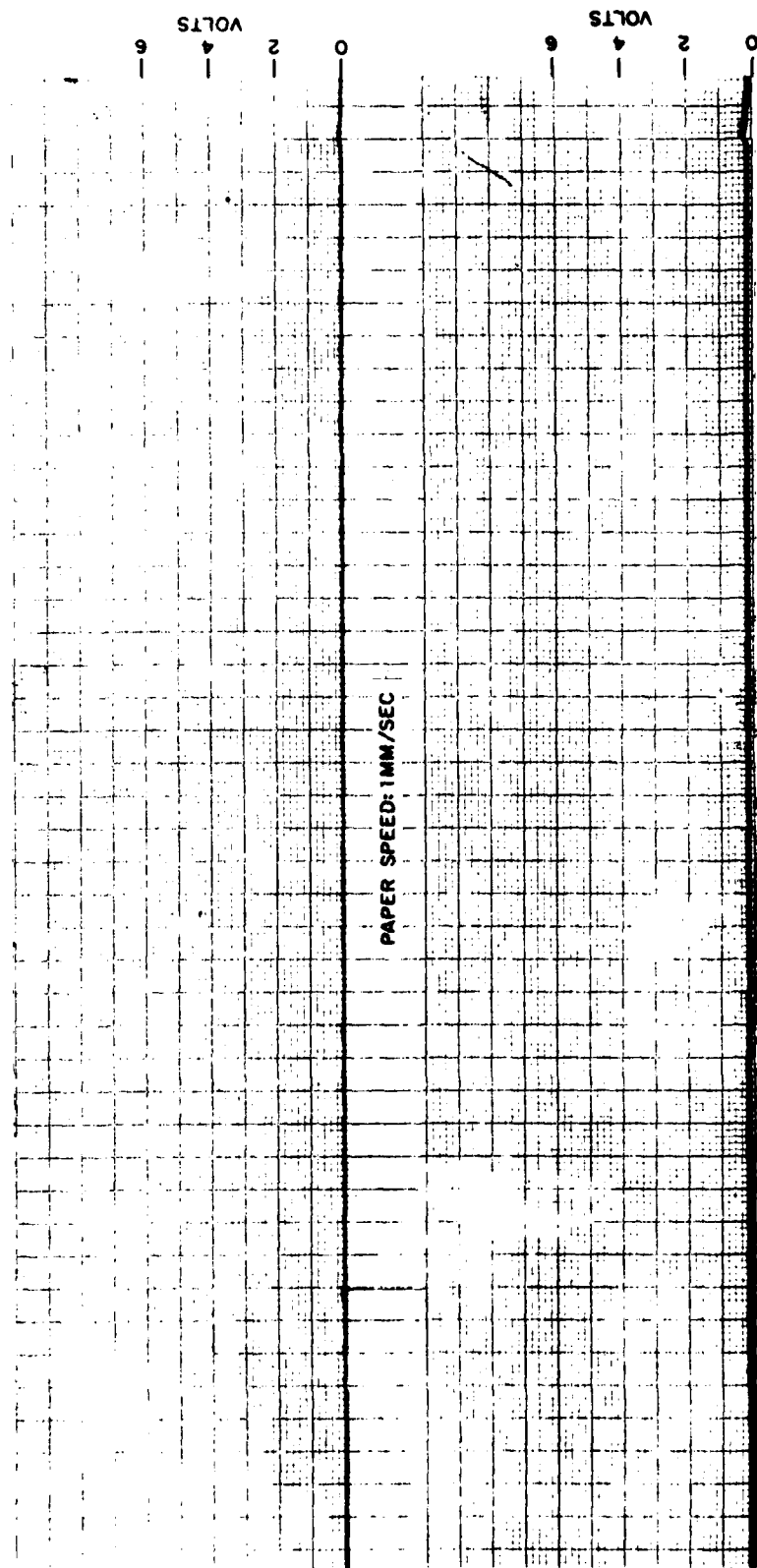


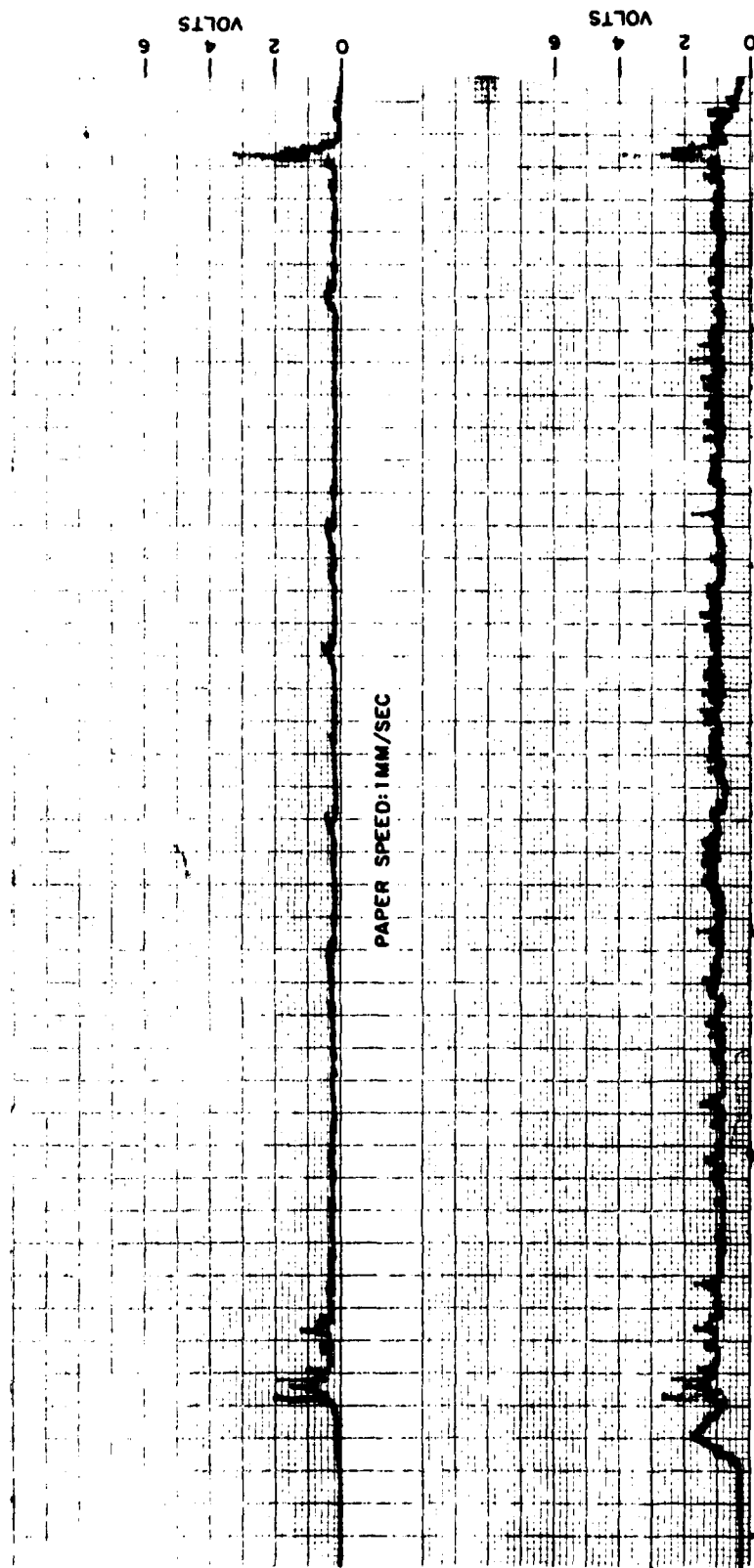
Figure A-9. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASW-587-9



ASN-587-10

Figure A-10. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-11

Figure A-11. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

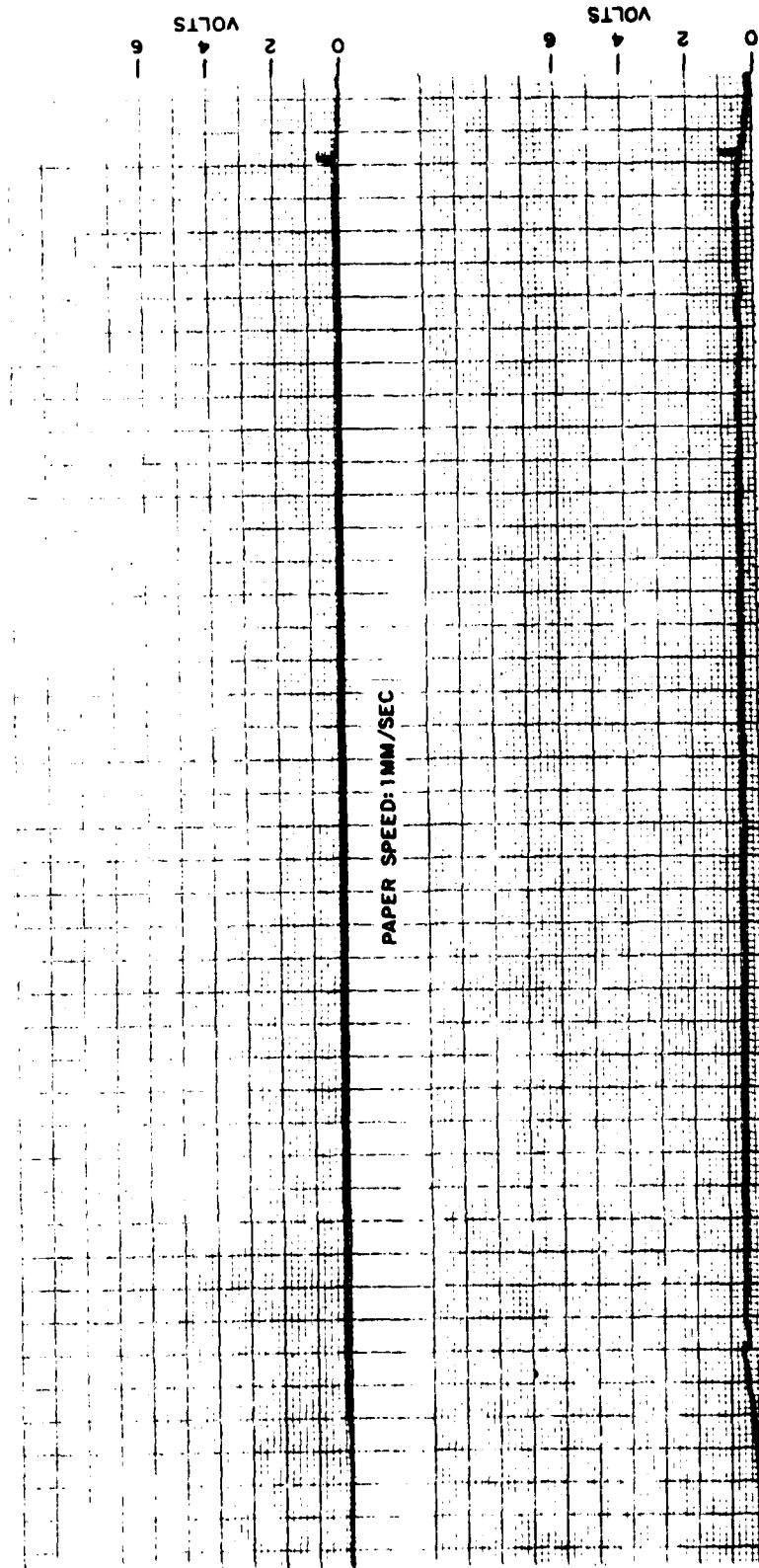
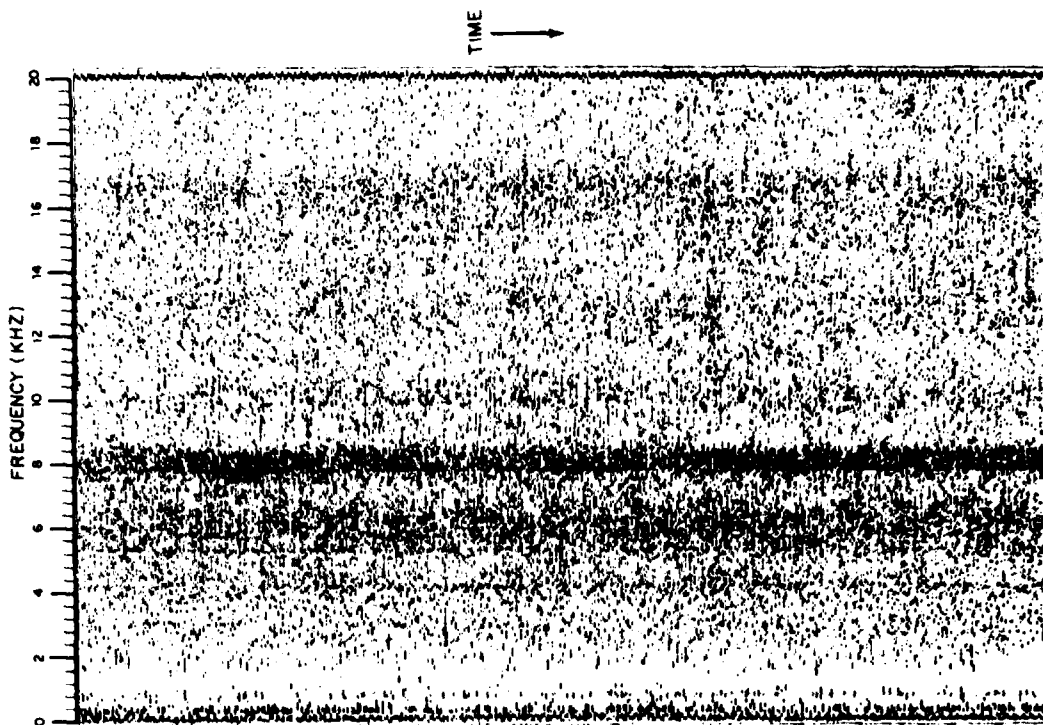


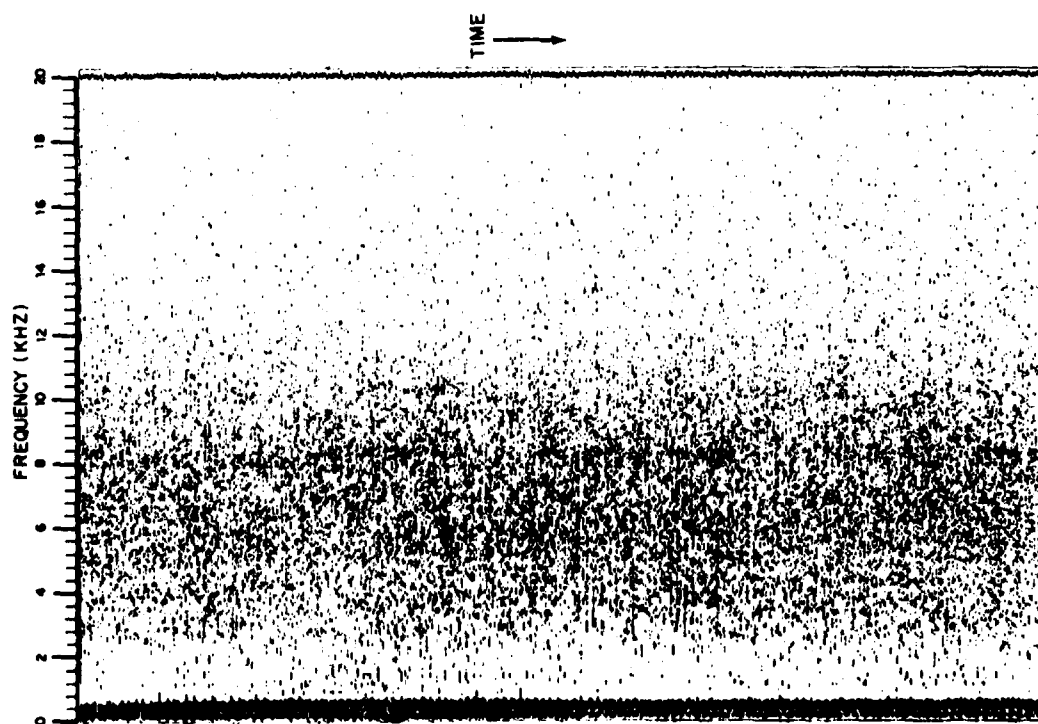
Figure A-12. Microphone No. 5 Mean Square Analysis: Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASW-587-12



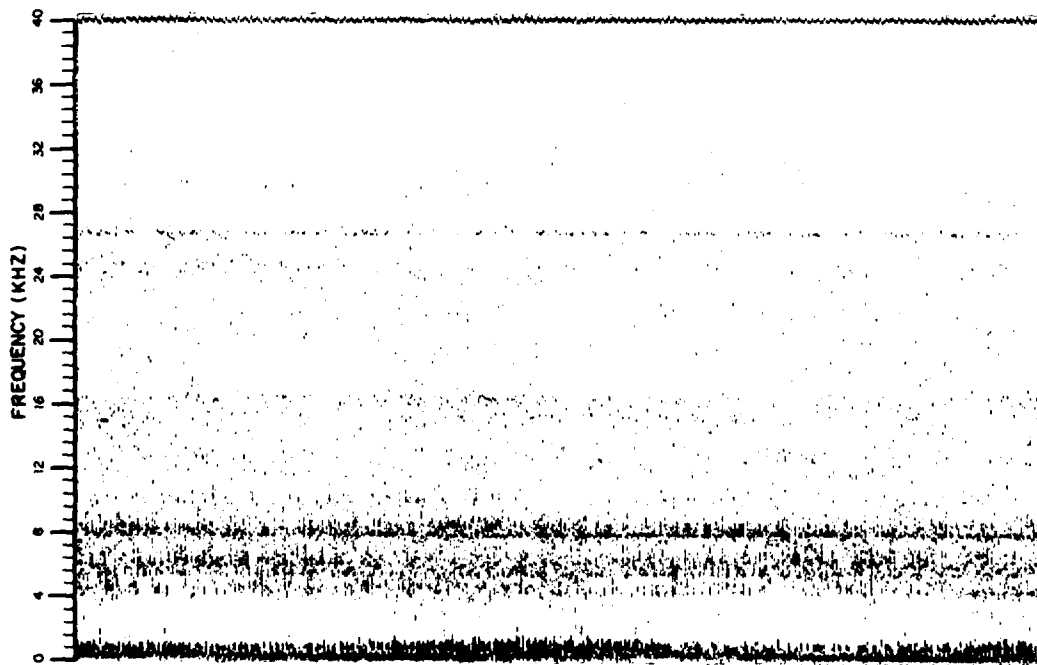
ASN-587-14

Figure A-14. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



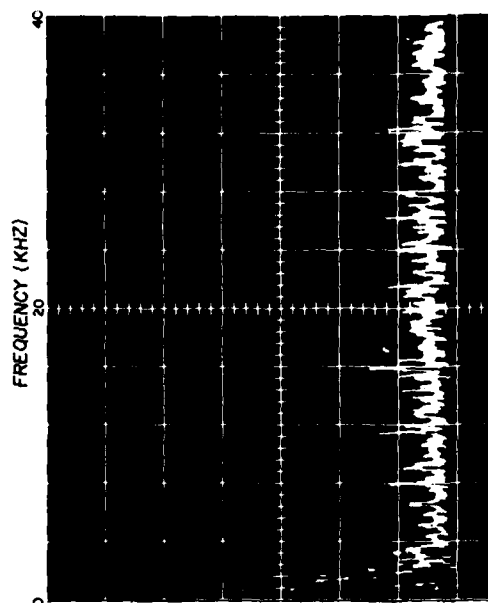
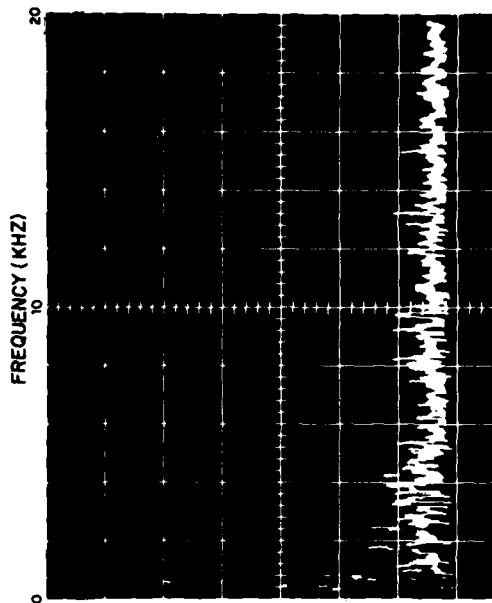
ASN-587-13

Figure A-13. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



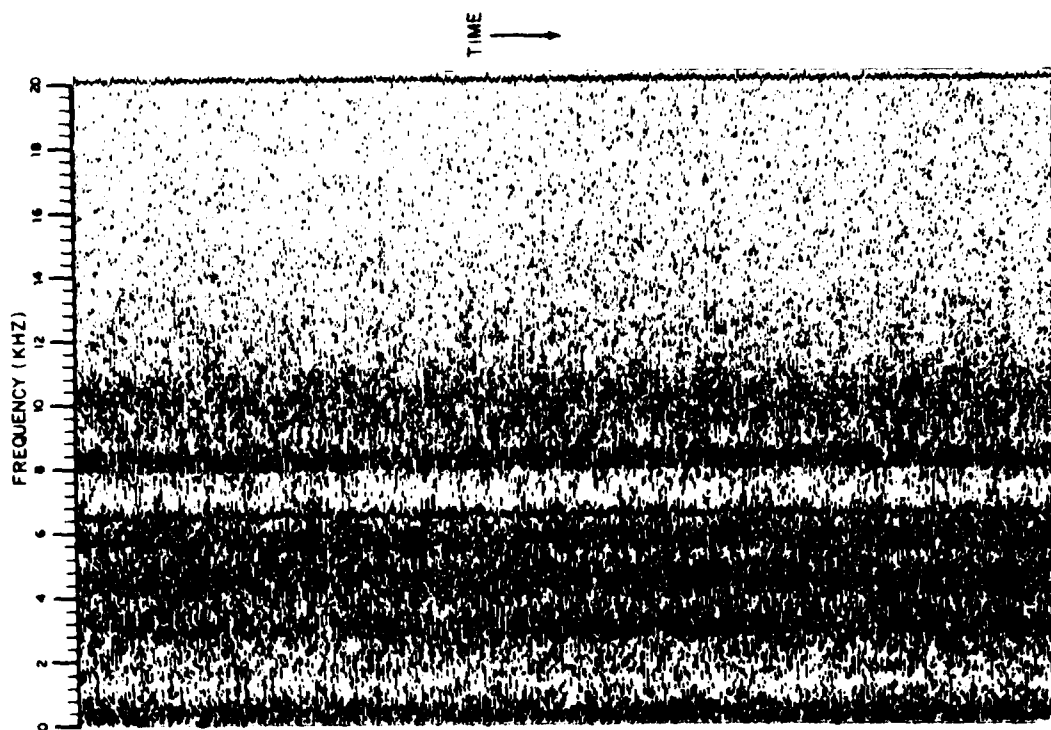
ASW-587-15,

Figure A-15. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



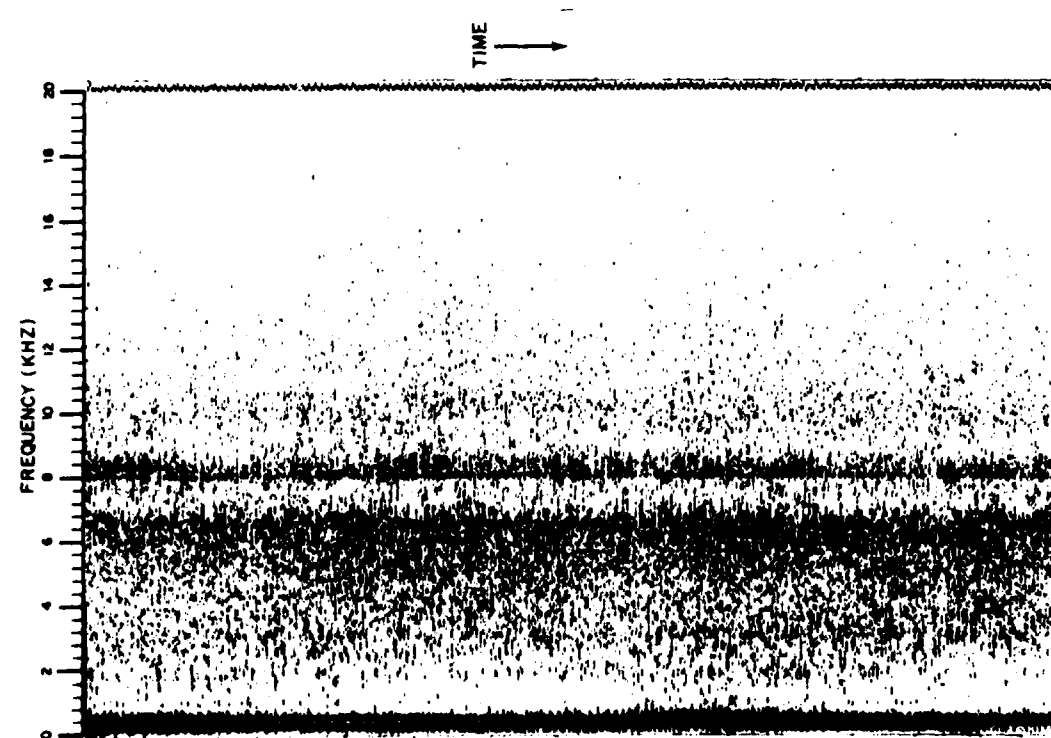
ASW-587-16

Figure A-16. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



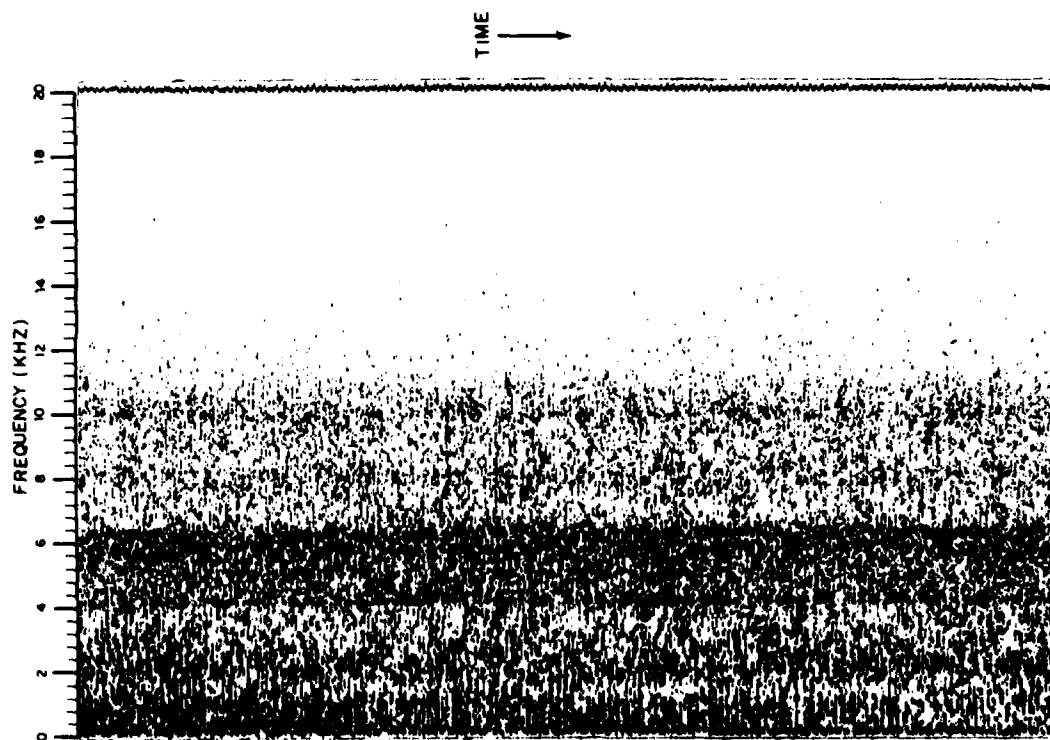
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Figure A-17. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



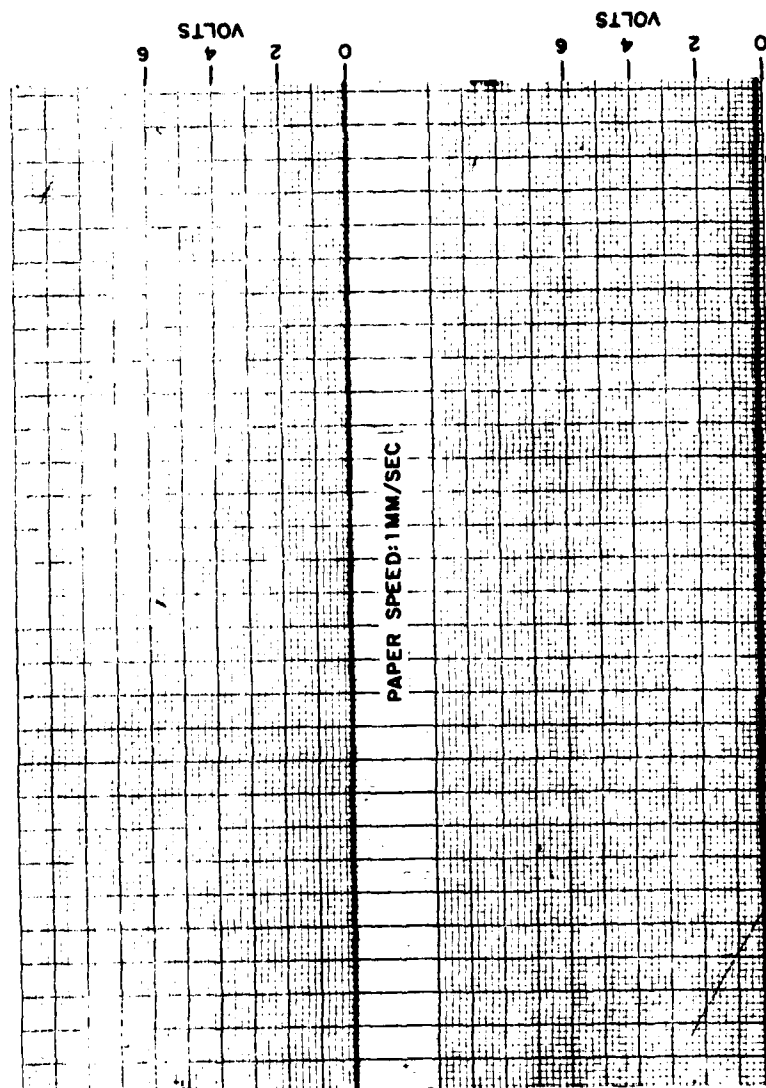
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Figure A-18. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



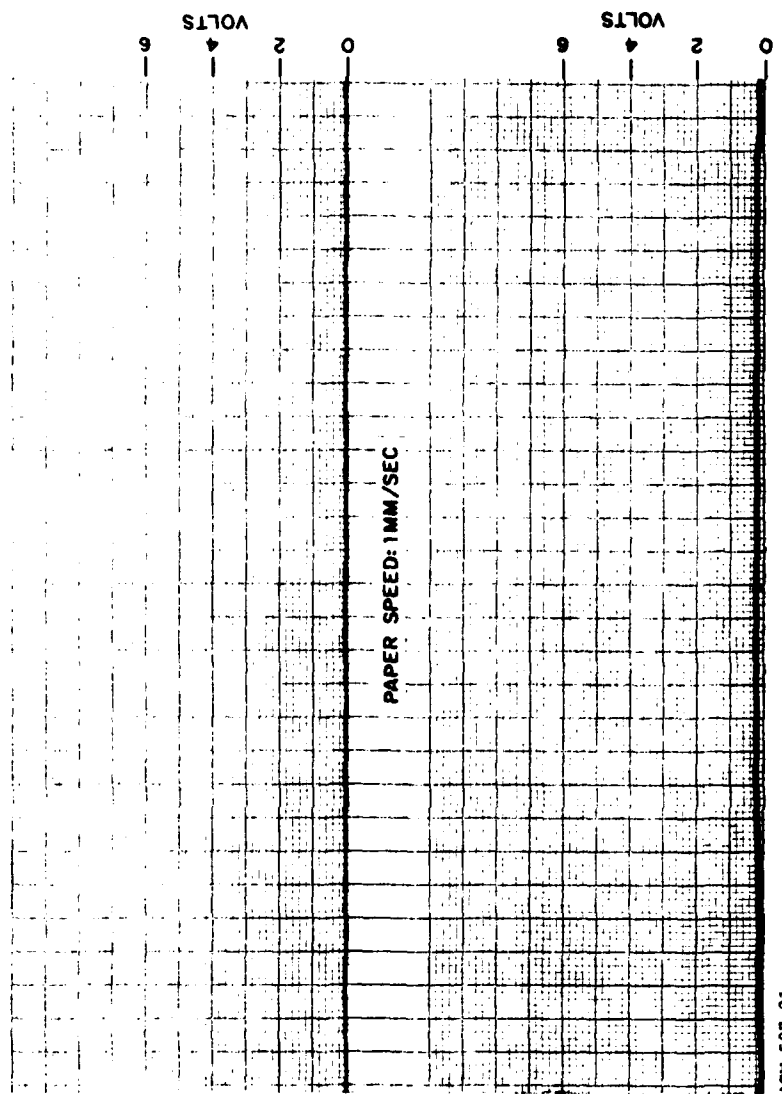
ASW-587-191

Figure A-19. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



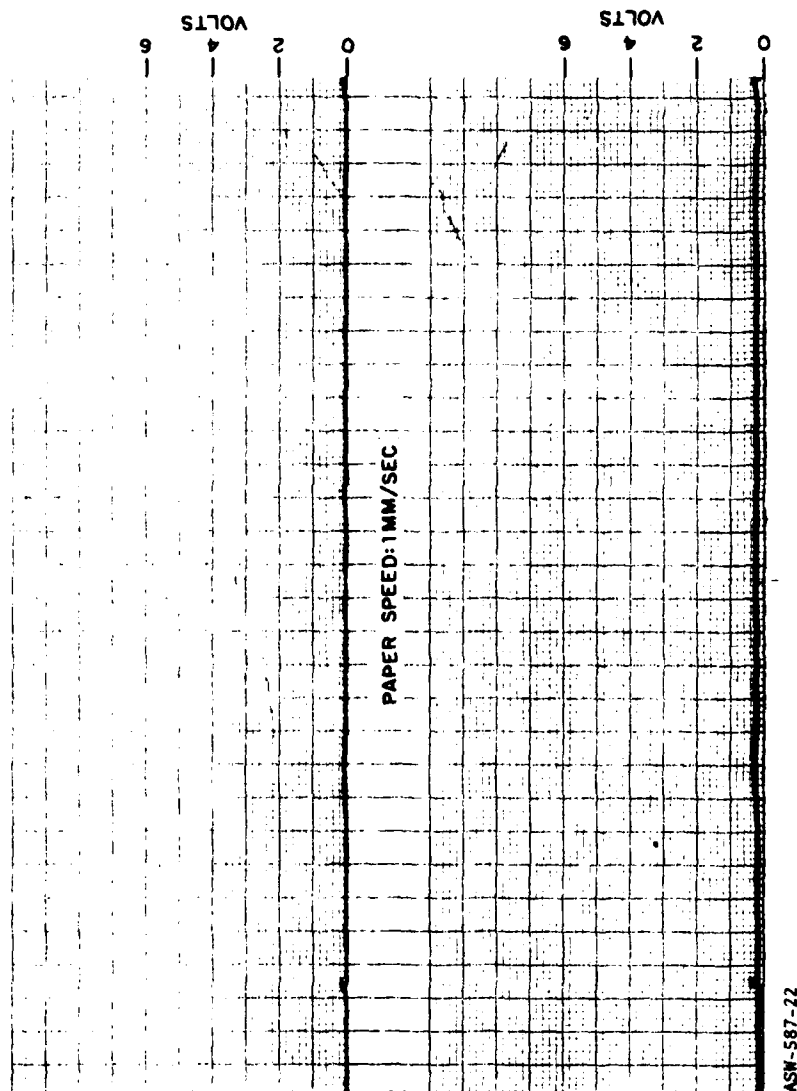
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Figure A-20. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



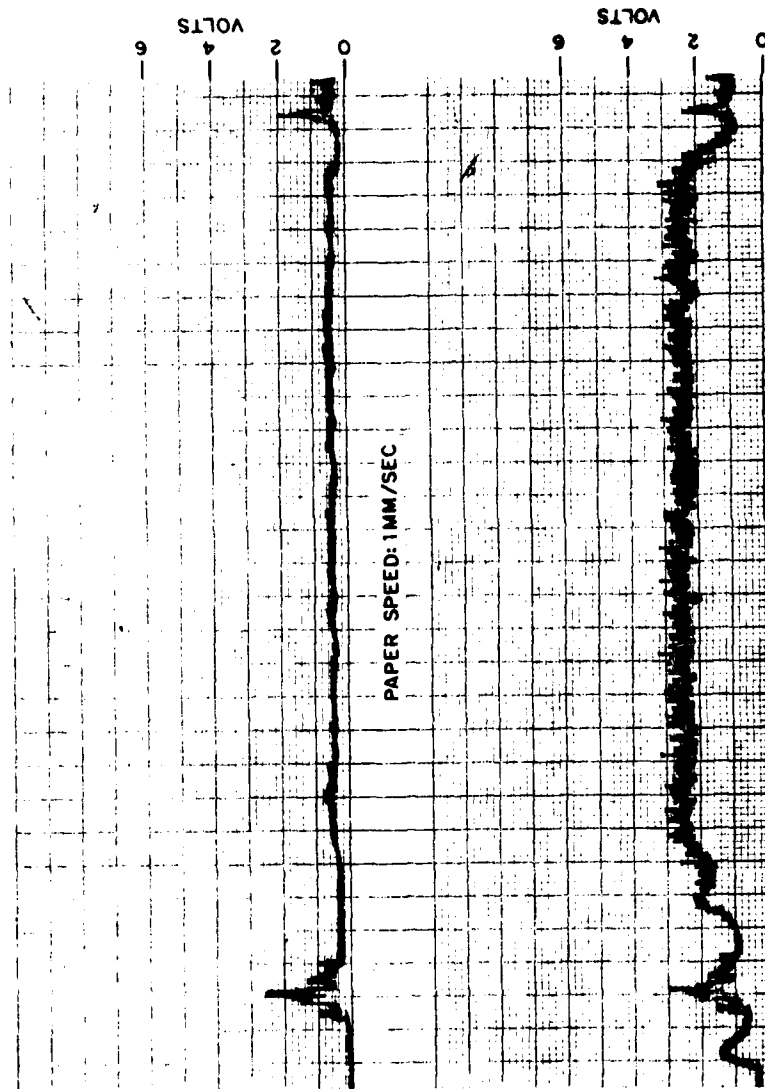
ASN-587-21

Figure A-21. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-22

Figure A-22. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-23

Figure A-23. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

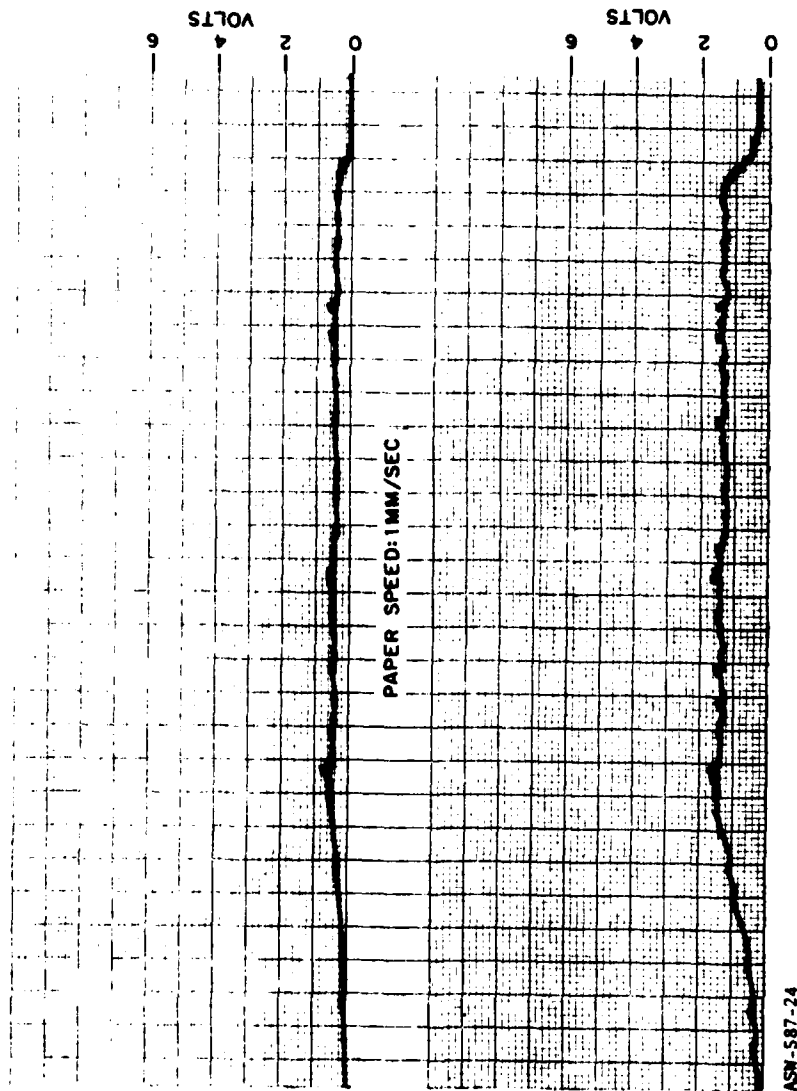
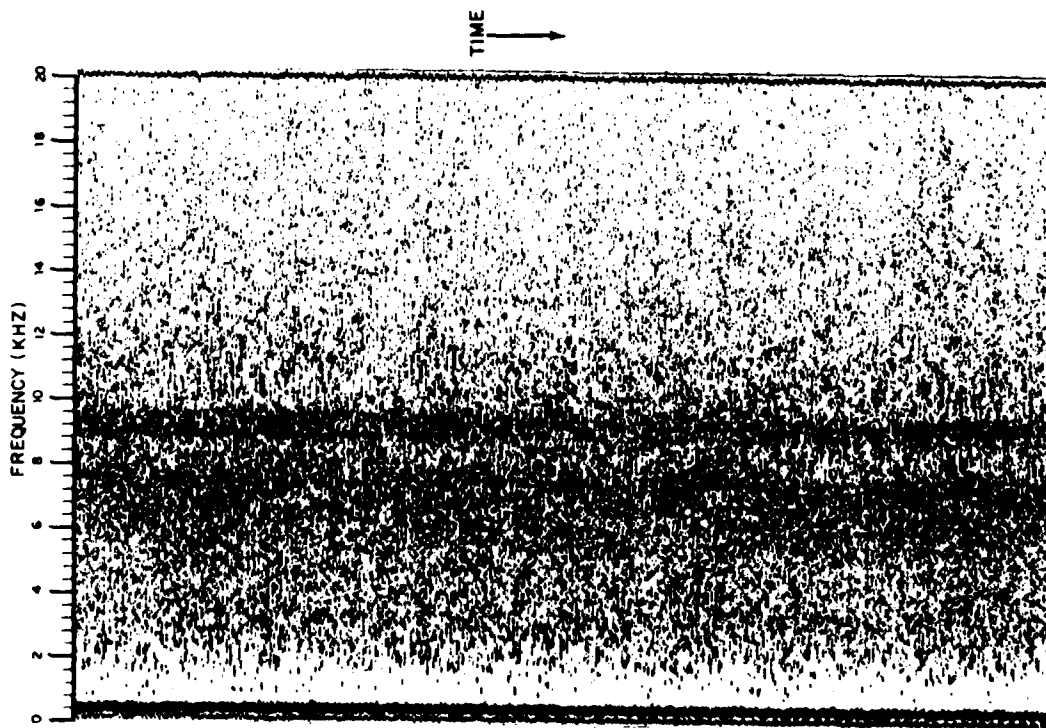
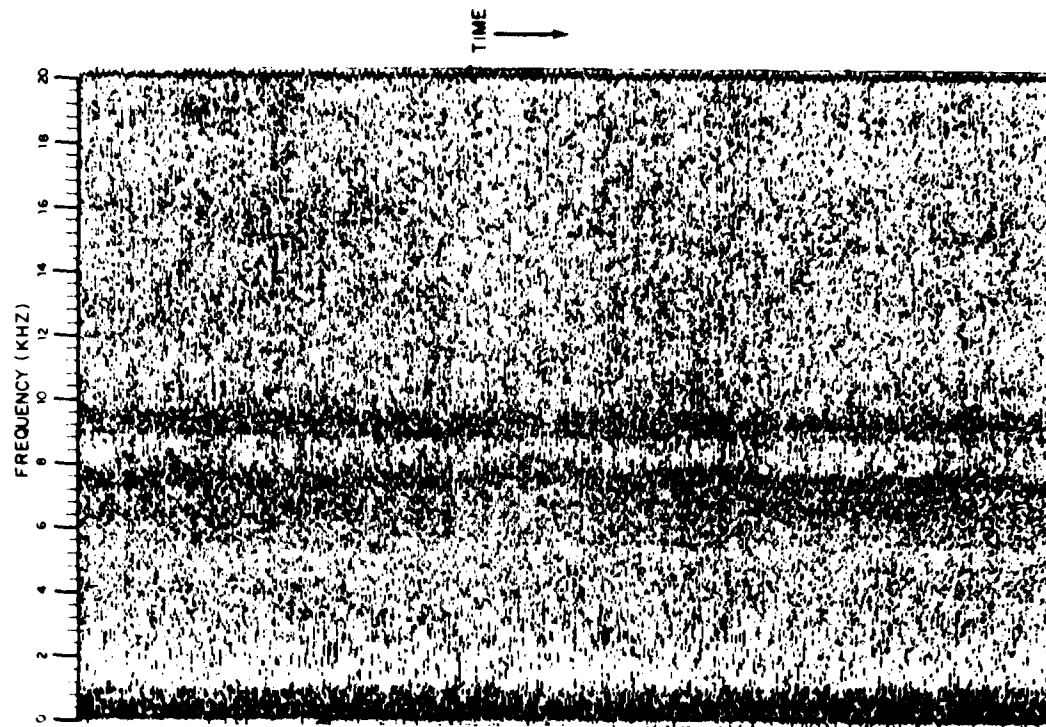


Figure A-24. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



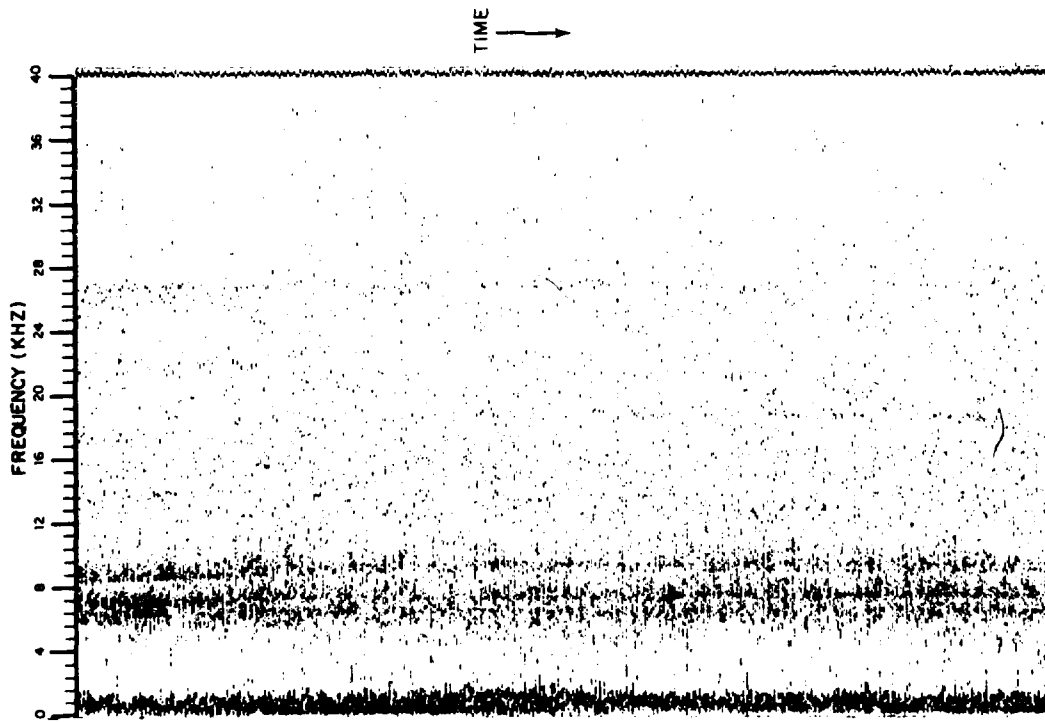
ASW-587-25

Figure A-25. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



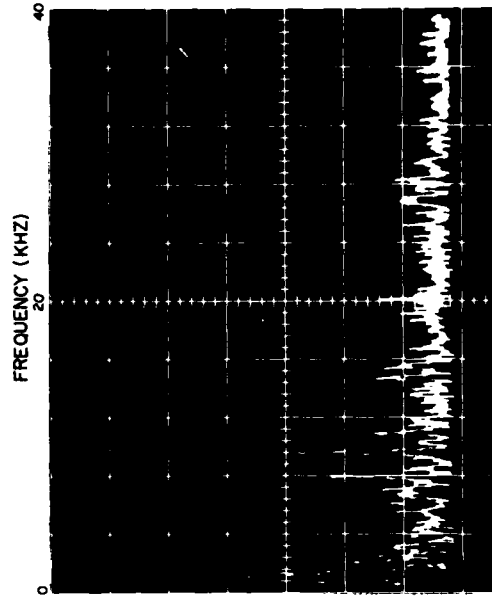
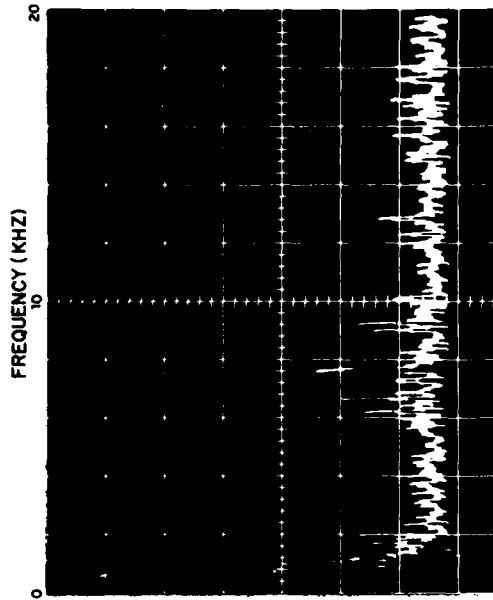
ASW-587-26

Figure A-26. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



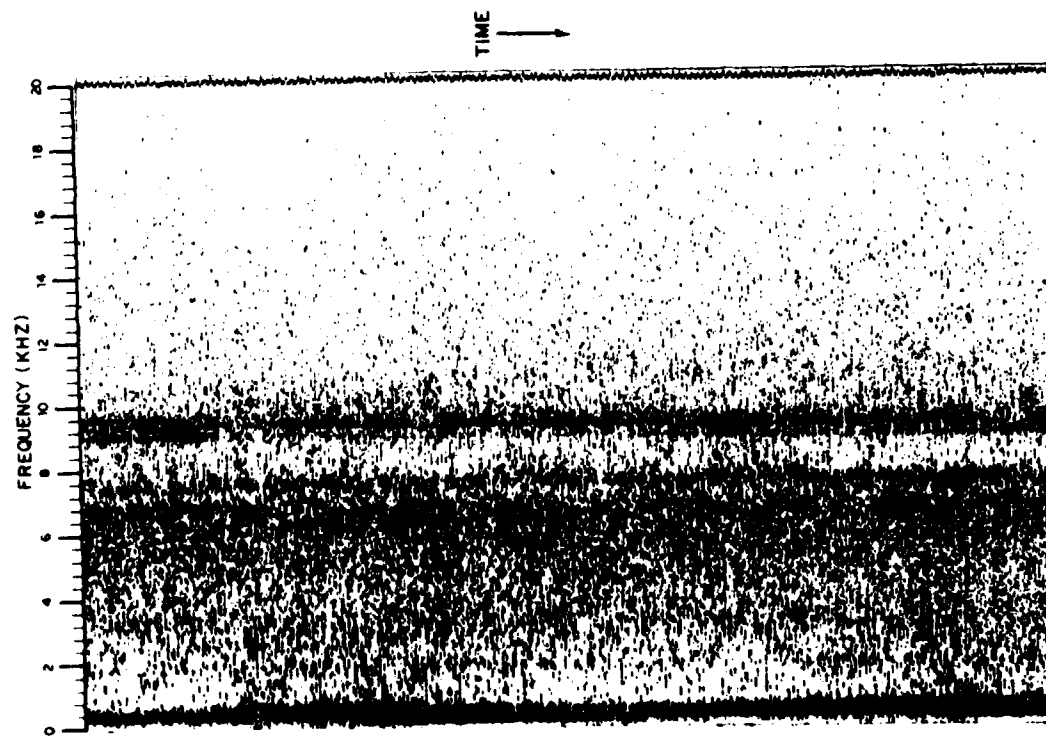
ASW-587-27

Figure A-27. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



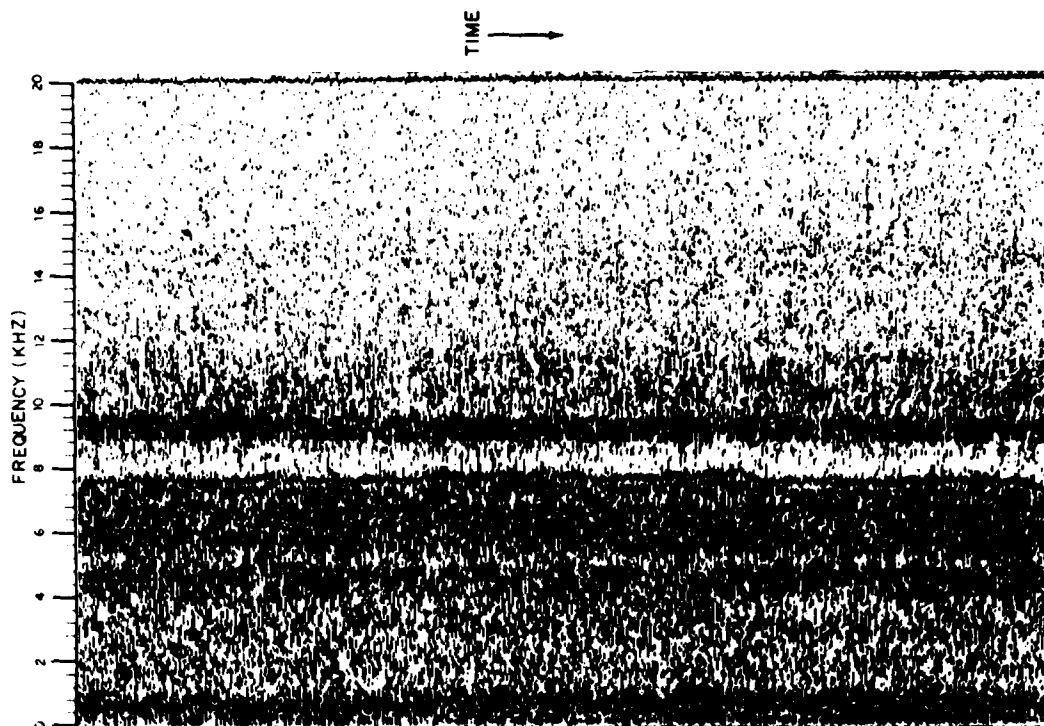
ASW-587-28

Figure A-28. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



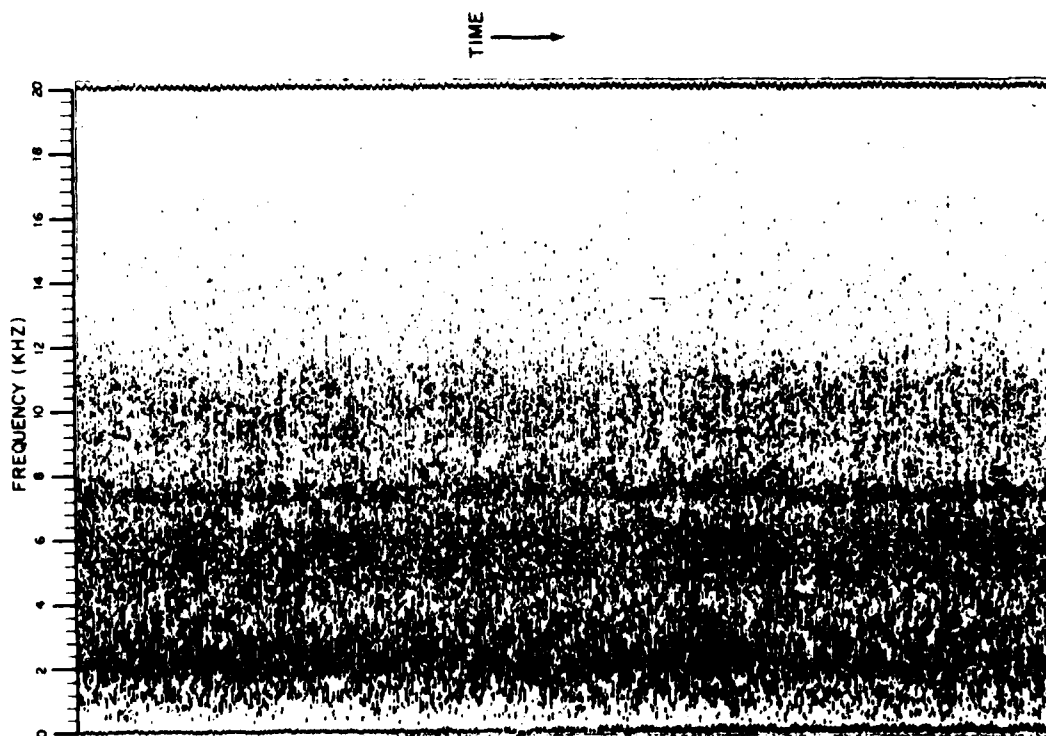
ASN-587-29

Figure A-29. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



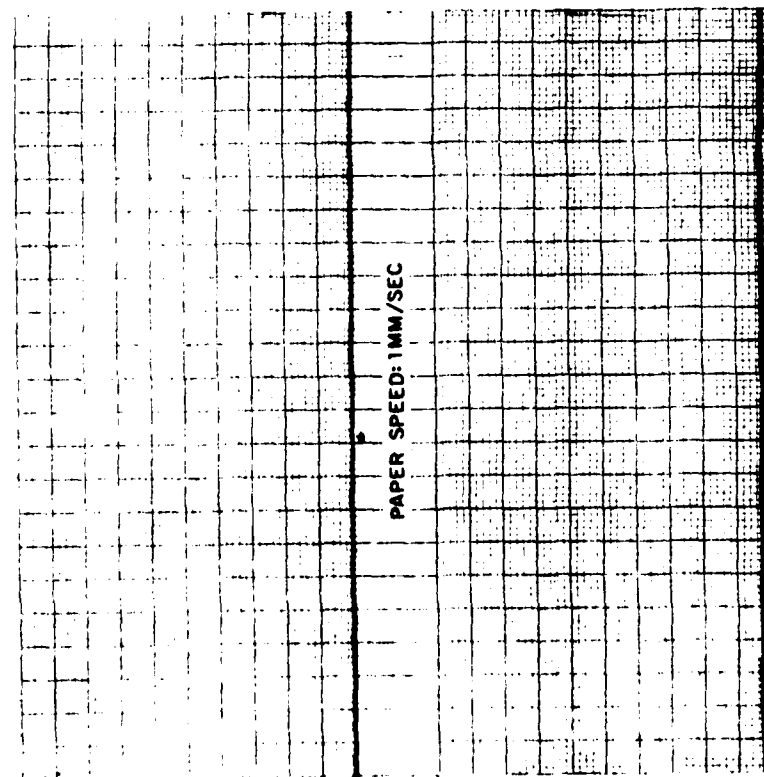
ASN-587-30

Figure A-30. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



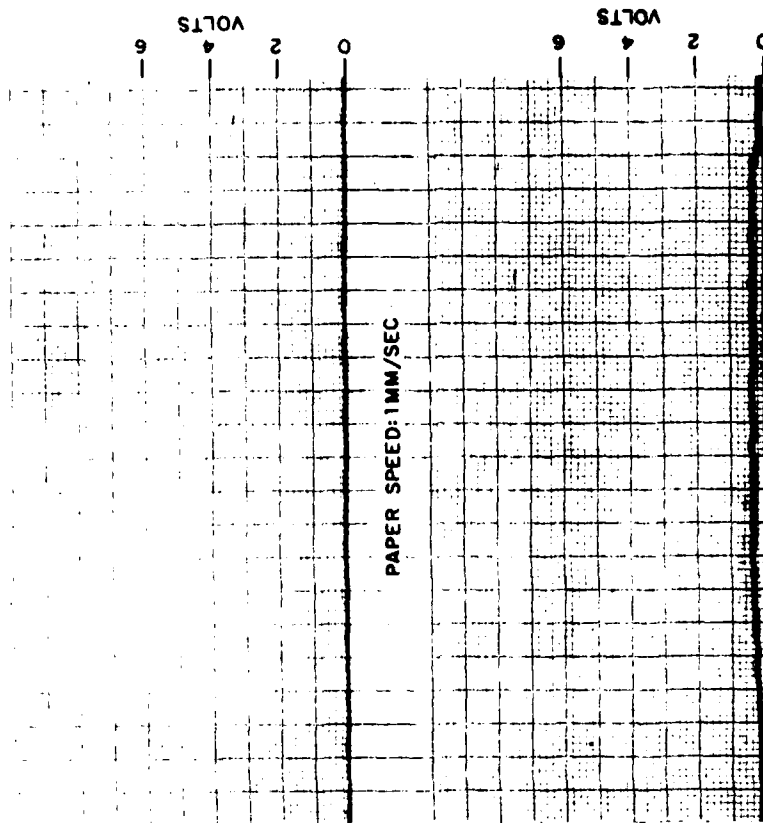
ASH-587-31

Figure A-31. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



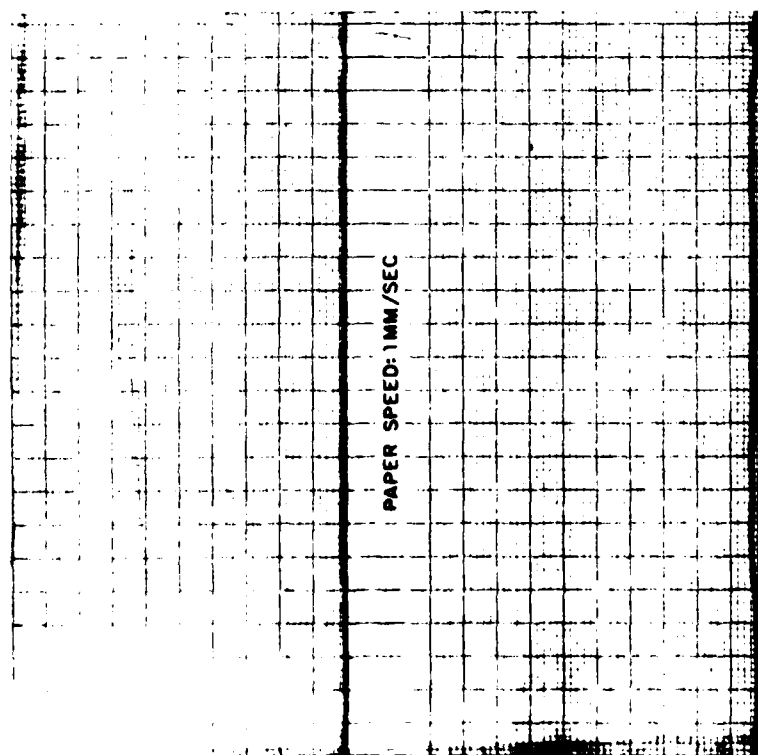
ASW-587-32

Figure A-32. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



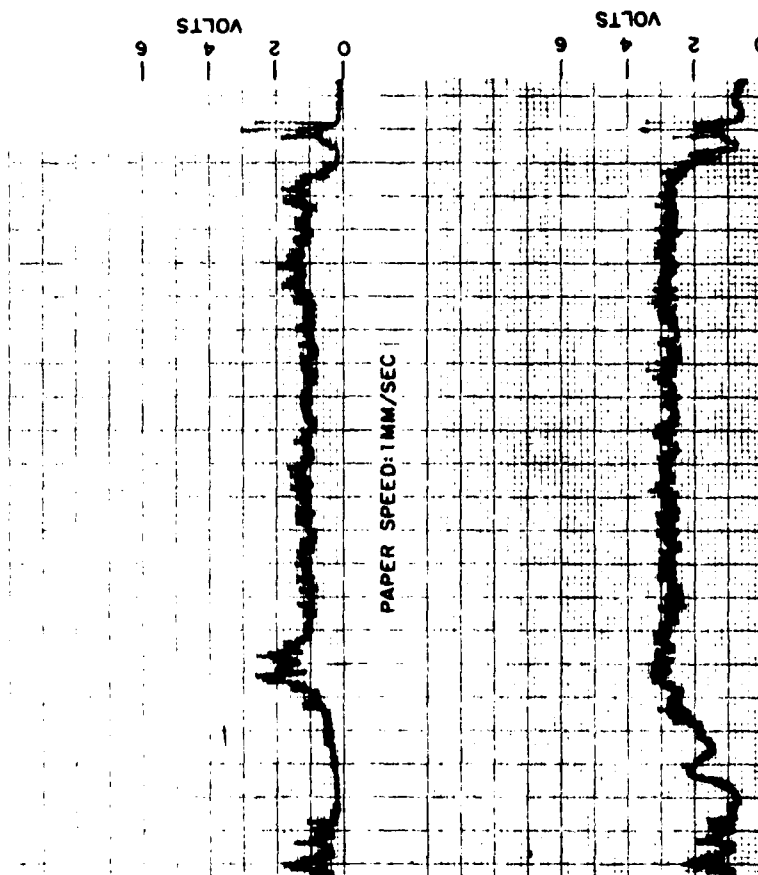
ASW-587-33

Figure A-33. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



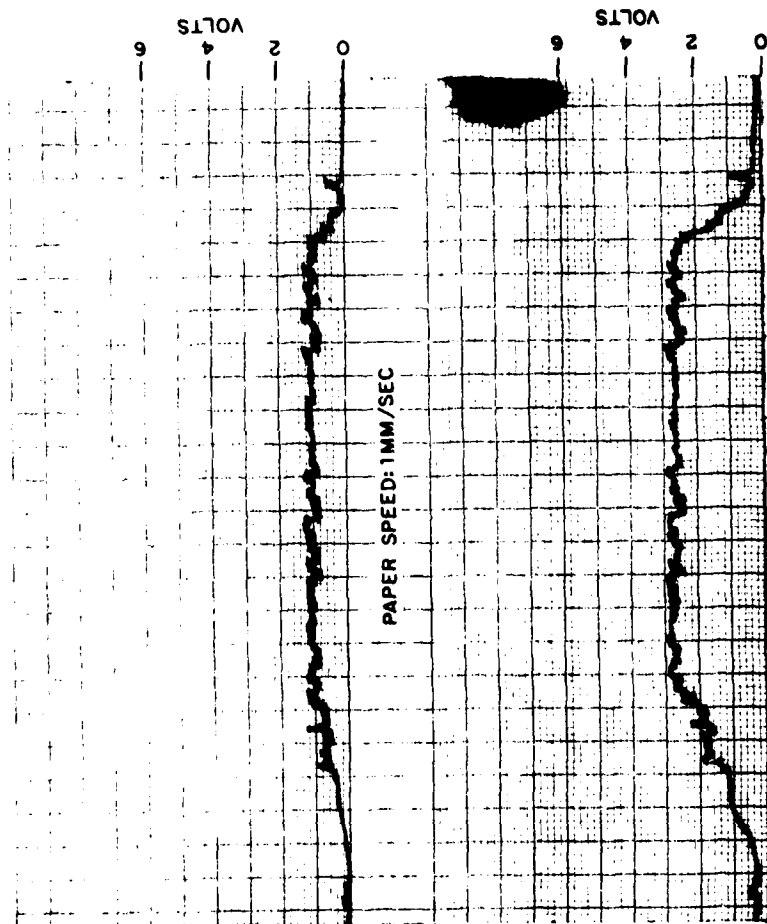
ASN-587-34

Figure A-34. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-35

Figure A-35. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-36

Figure A-36. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

A.2 J-47 ENGINE, MODIFIED BURNER CAN HOLE OPEN - 1.5 INCH DIAMETER

A series of three test runs were made on the J-47 engine with the modified burner can hole masked to a 1.5-inch hole. Each test was recorded using five microphones located in the same positions as for the closed hole tests. The three tests were run at the following engine speeds:

- (1) 70% RPM (46 in. Hg gage, diffuser case pressure)
- (2) 80% RPM (70 in. Hg gage, diffuser case pressure)
- (3) 90% RPM (97 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed hole on the modified burner can and a large open hole (1.5 inches in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 70% run - pages A-32 through A-37
- (2) 80% run - pages A-38 through A-43
- (3) 90% run - pages A-44 through A-50

A.2.1 Analysis

A.2.1.1 Sound Energy Levels

Microphone sound levels increased 3 to 5 dB when the engine RPM was increased from 70% to 80% versus 2 to 5 dB on the closed-hole test. Microphone sound levels increased 1 to 3 dB when the engine RPM was increased from 80% to 90% versus 2 to 4 dB on the closed hole-test. The lowest sound energy occurred on microphone 5 which was farthest away from the hole. Microphone 1 had the highest sound level due to position and location. Sound levels of 27, 21, and 25 dB differentials for the three runs were noted on microphone 1 while the other microphone differentials were much less. Microphone 2 and 3 differentials were about equal as were their distances from the open hole. Microphone 4 had the least change.

A.2.1.2 Spectrum Analysis

As in the closed-hole test, discrete spectral content due to engine machinery was present in all grams. There was a very noticeable change in broadband noise the extent of which was dependent on microphone location. Noise up to 20 kHz was present in all grams, but was more pronounced in those microphones located on the engine mount. Instrumentation microphone No. 2 data was processed over seven analysis bandwidths in order to inspect for sustained discrete frequencies. As

the analysis bandwidth decreased and resolution increased, machinery frequency lines became apparent. The 0- to 100-Hz analyzing band, which had a resolution of 0.1 Hz, showed short, unstable discrete frequency lines. The noise content of microphone 2 was very dense up to 35 kHz before it decreased. Discrete frequencies in the 0- to 40-kHz microphone 2 gram were primarily masked out by the noise.

A.2.1.3 Mean Square Analysis

Microphones 1, 2, and 3 showed a marked increase in energy level from the closed-hole test. The differences were attributed to proximity to the open hole. Microphones 4 and 5, which displayed relatively high levels in the closed-hole tests, displayed the same characteristics in the open-hole tests, but at higher amplitudes. A lesser amount of energy over 5 kHz was noticeable at low engine speed, while at high engine speed the unfiltered recordings approximated the same amplitudes as the filtered recordings. The latter was not true for microphones 1 and 2, which were both located above the open hole. The filtered data from these microphones exhibited approximately half the amplitude of the unfiltered processed data.

A.2.2 Environmental Conditions

The three tests discussed in paragraph A.2 were performed at an ambient temperature of 61° F and 75% relative humidity.

A.2.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table A-4. Microphone Sound Energy Levels at 70% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	300	22	92	40	32
RMS (μBAR)	2400	1700	660	320	260
dB (a)	141	139	131	124	122

^aReference = 2×10^{-4} μBAR

Table A-5. Microphone Sound Energy Levels at 80% Engine RPM

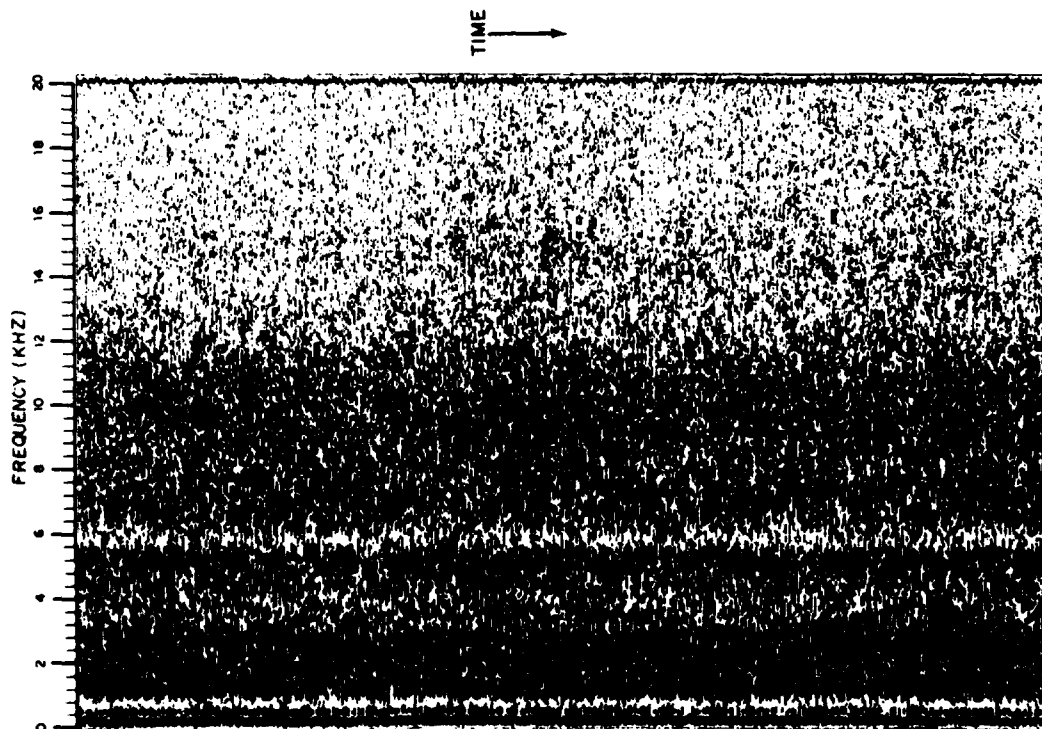
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	410	37	125	58	65
RMS (μBAR)	3100	2900	1000	460	520
dB (a)	144	143	134	127	128

^aReference - 2×10^{-4} μBAR

Table A-6. Microphone Sound Energy Levels at 90% Engine RPM

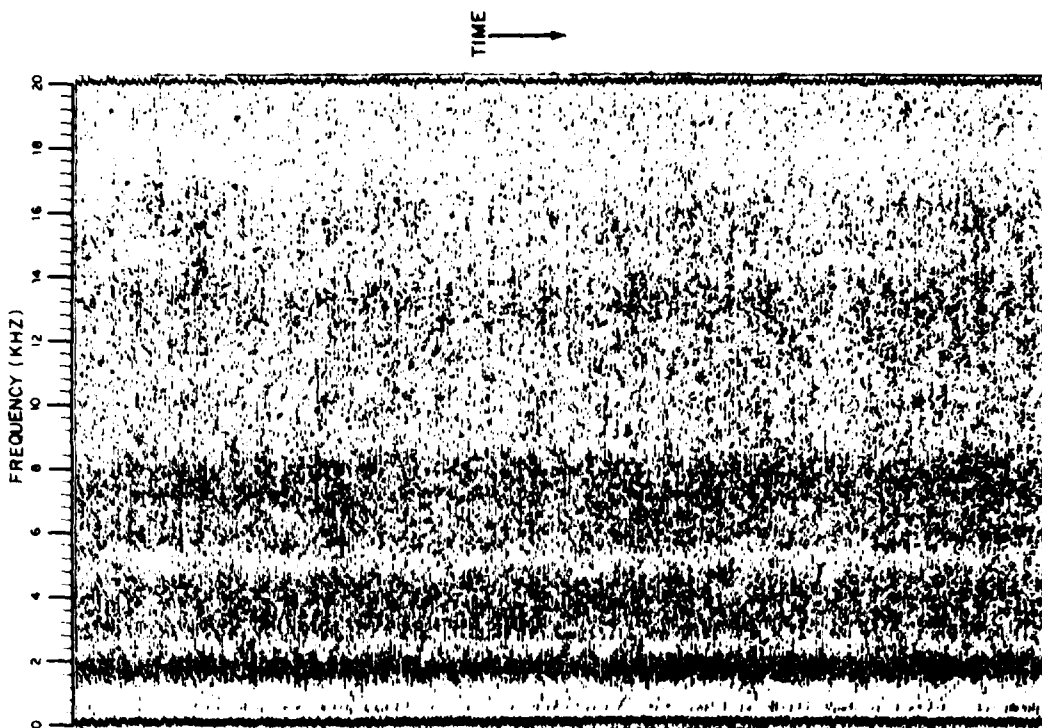
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	540	46	180	80	70
RMS (μBAR)	4300	3600	1450	640	560
dB (a)	147	145	137	130	129

^aReference = 2×10^{-4} μBAR



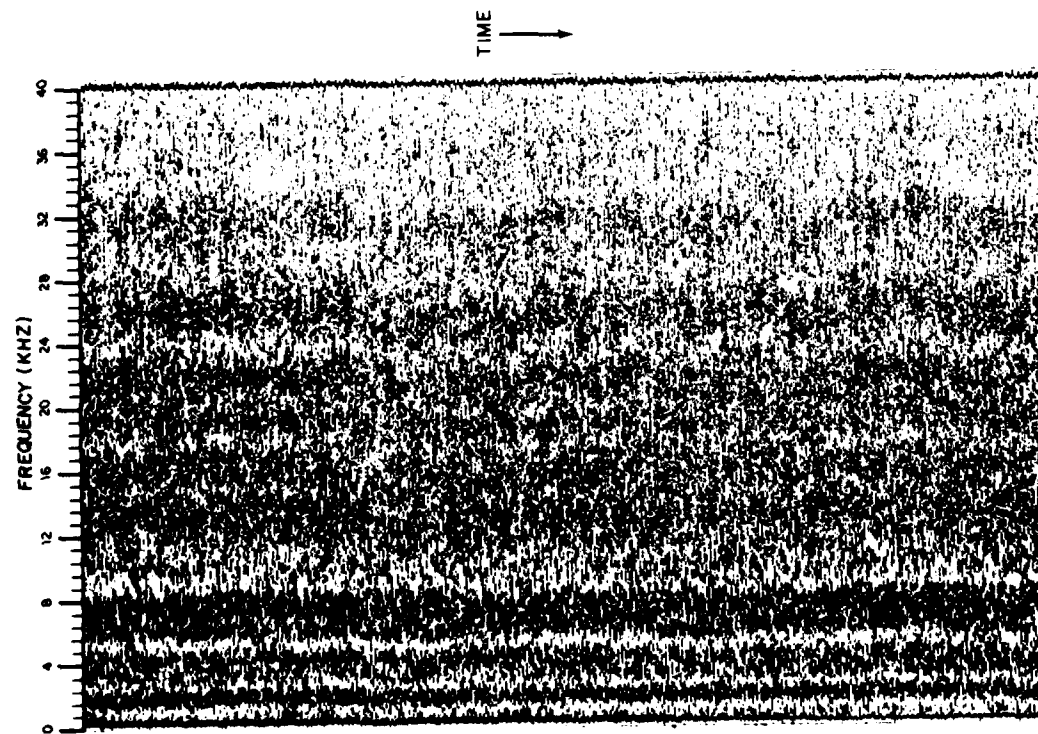
ASW-587-37

Figure A-37. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



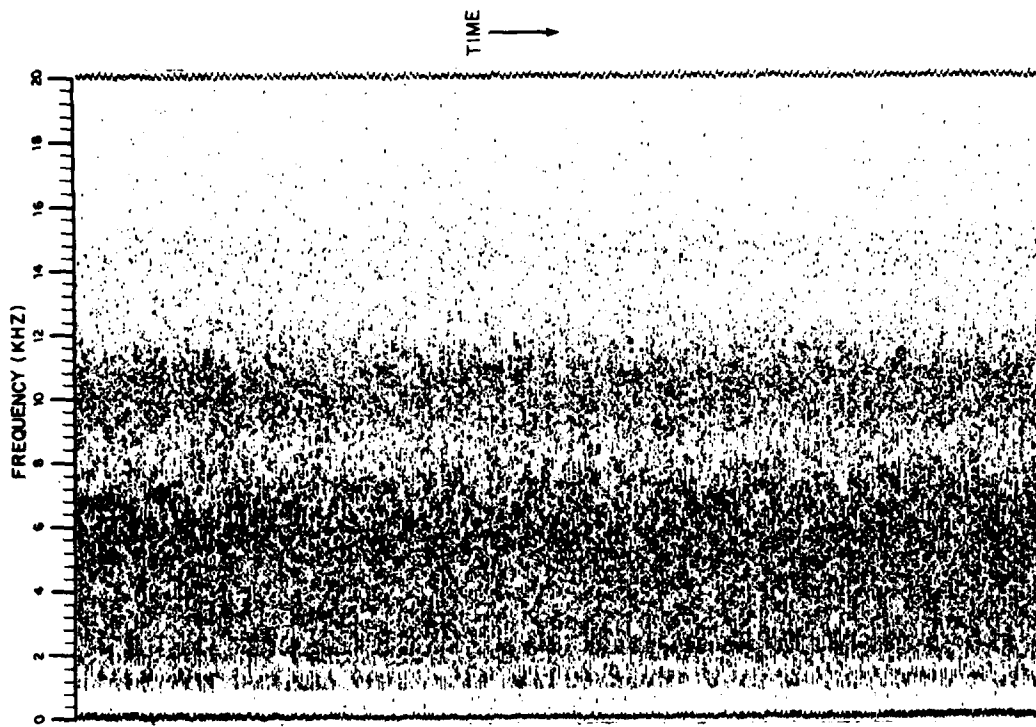
ASW-587-38

Figure A-38. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-39

Figure A-39. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 40 kHz.



ASW-587-40

Figure A-40. Microphone No. 3 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

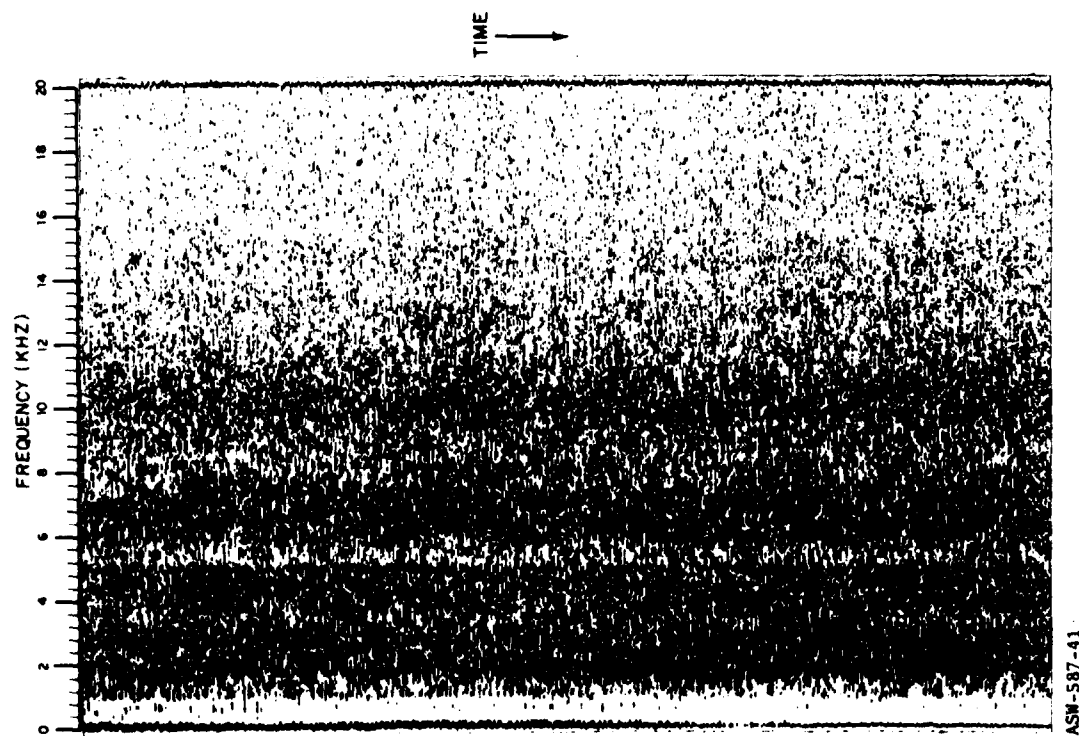


Figure A-41. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

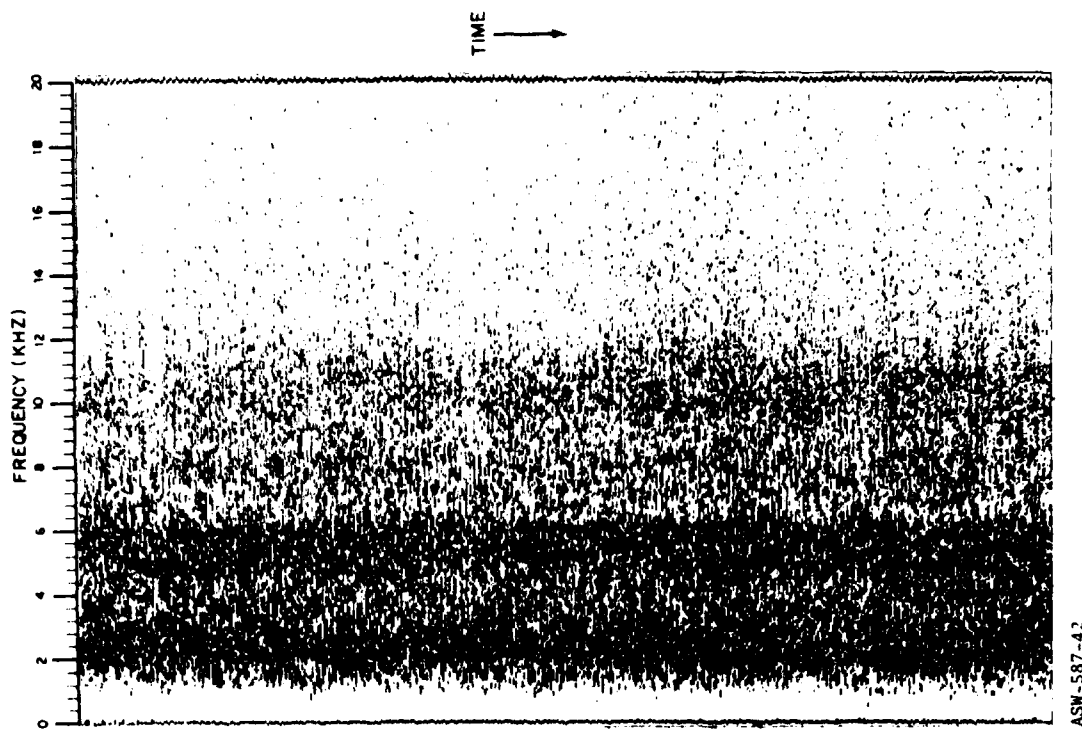
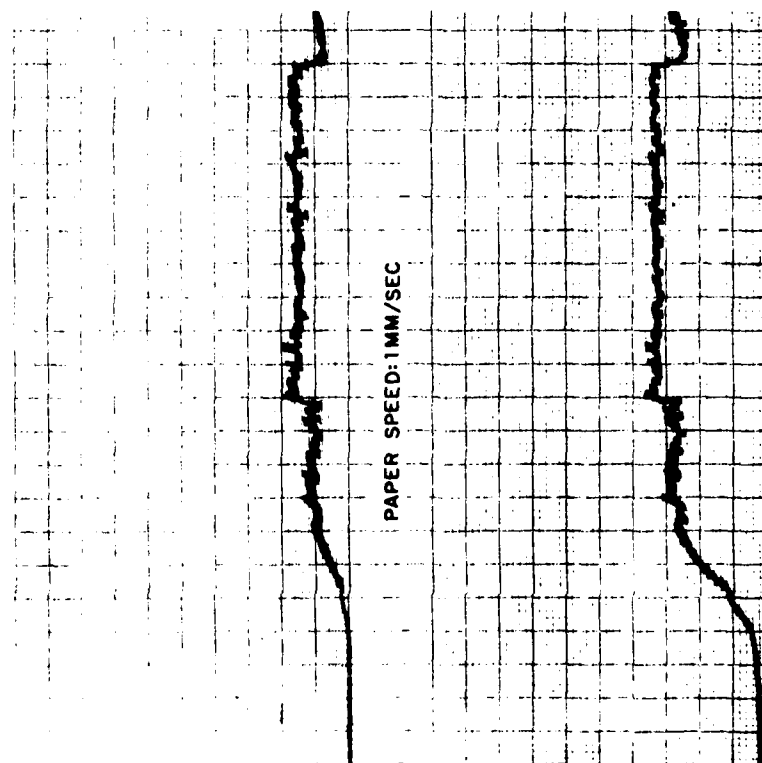
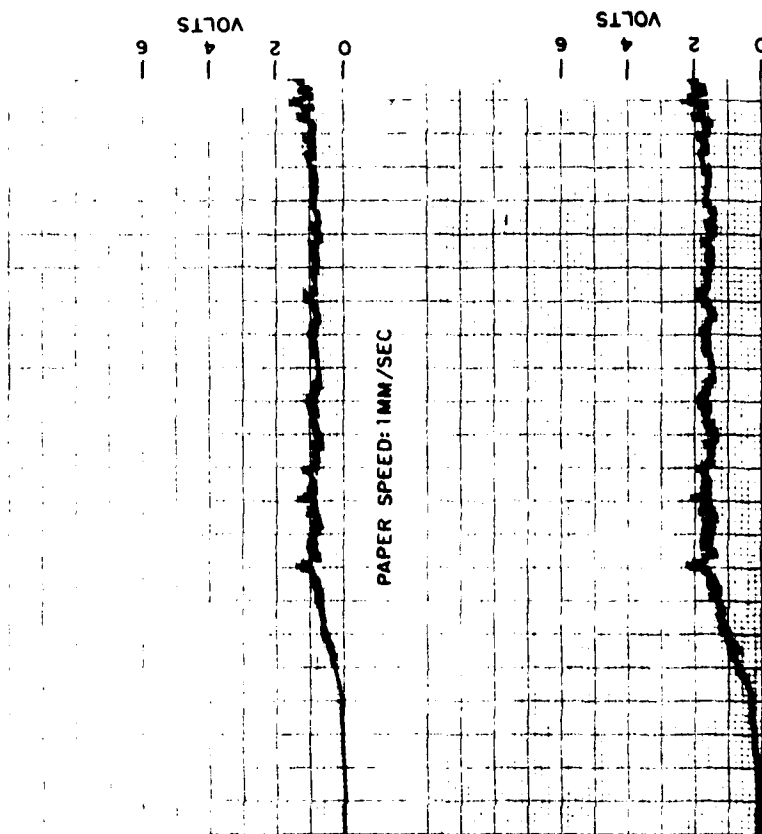


Figure A-42. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



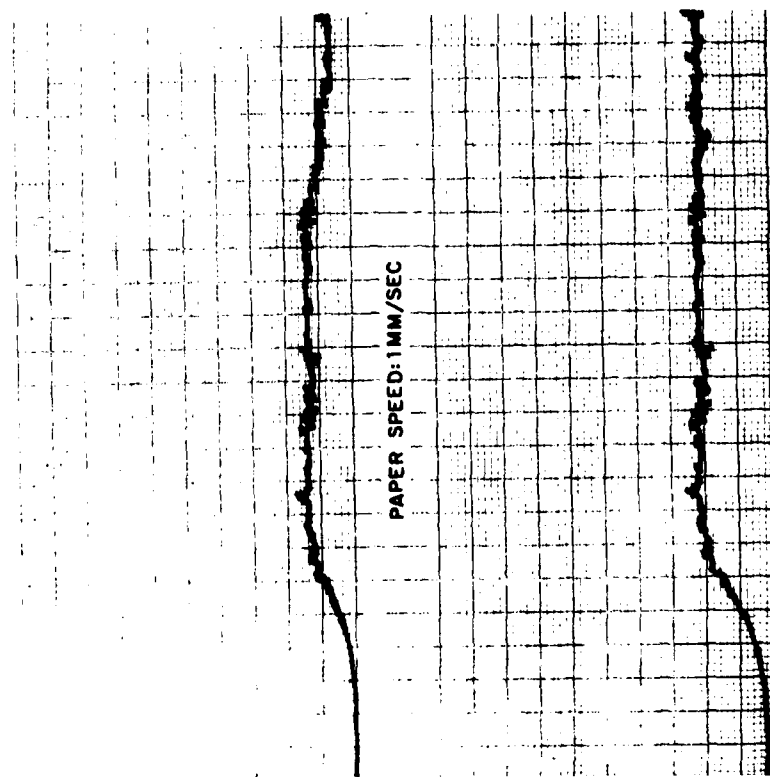
ASN-587-43

Figure A-43. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



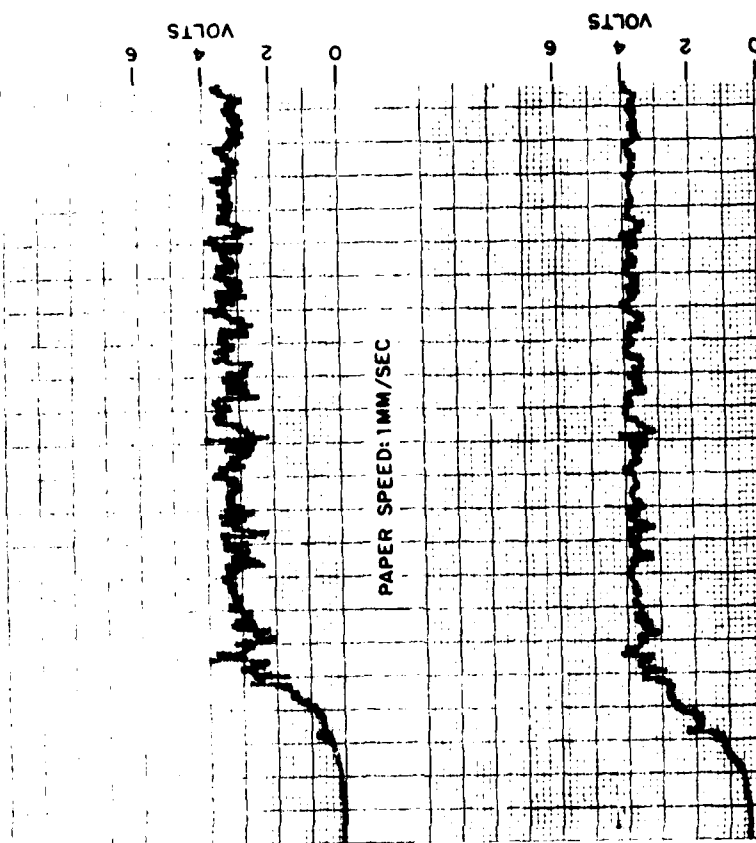
ASN-587-44

Figure A-44. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



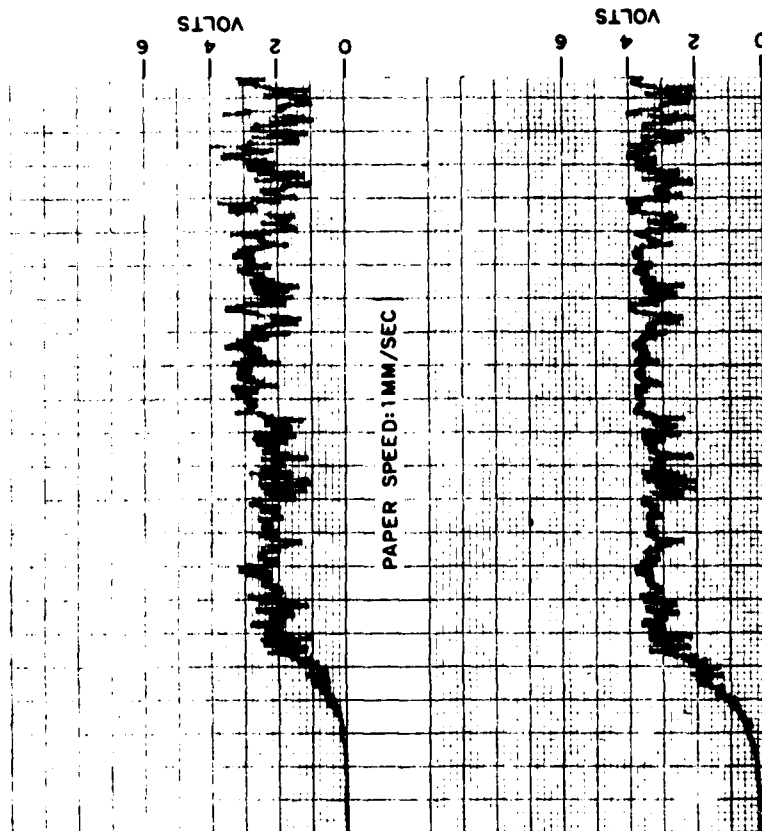
ASW-587-45

Figure A-45. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



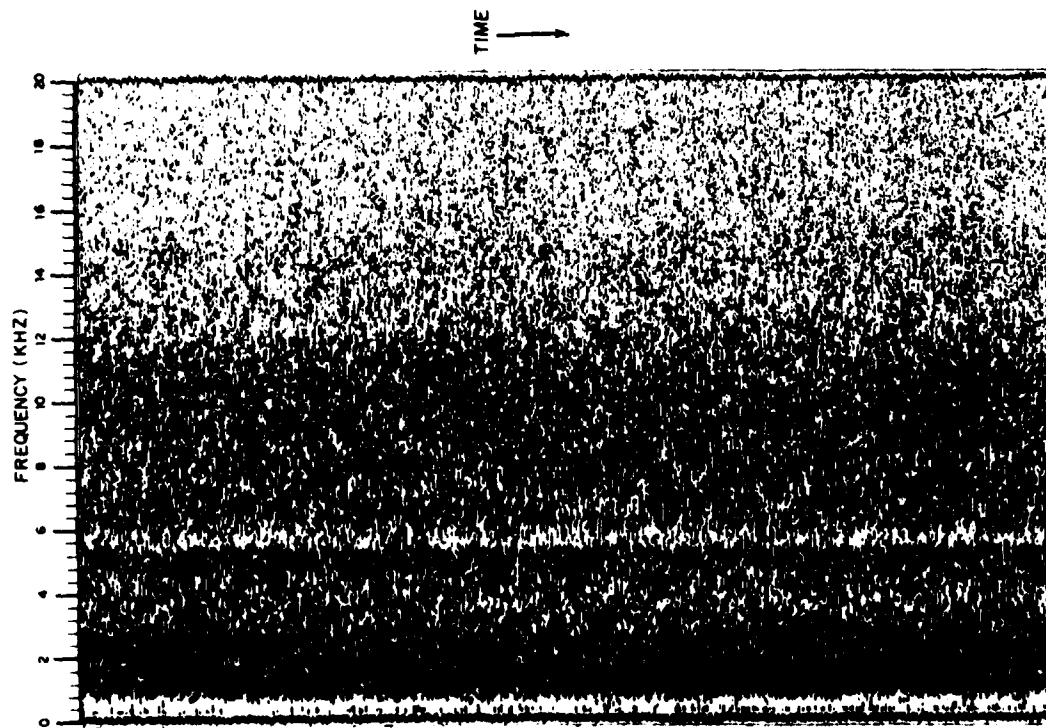
ASW-587-46

Figure A-46. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



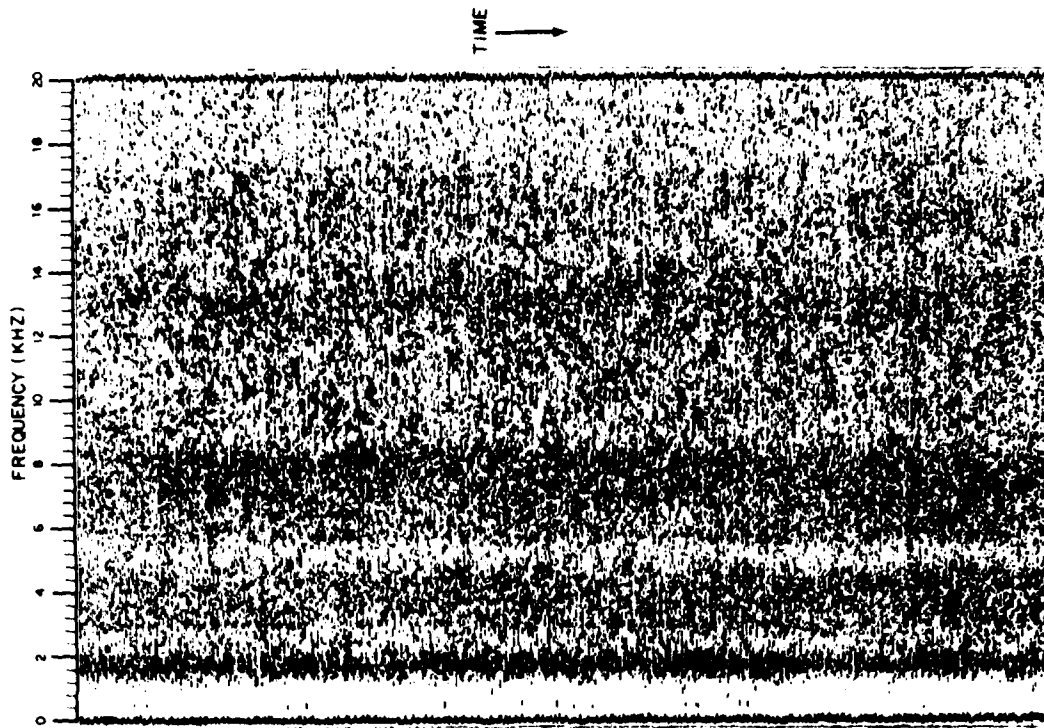
ASN-587-47

Figure A-47. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



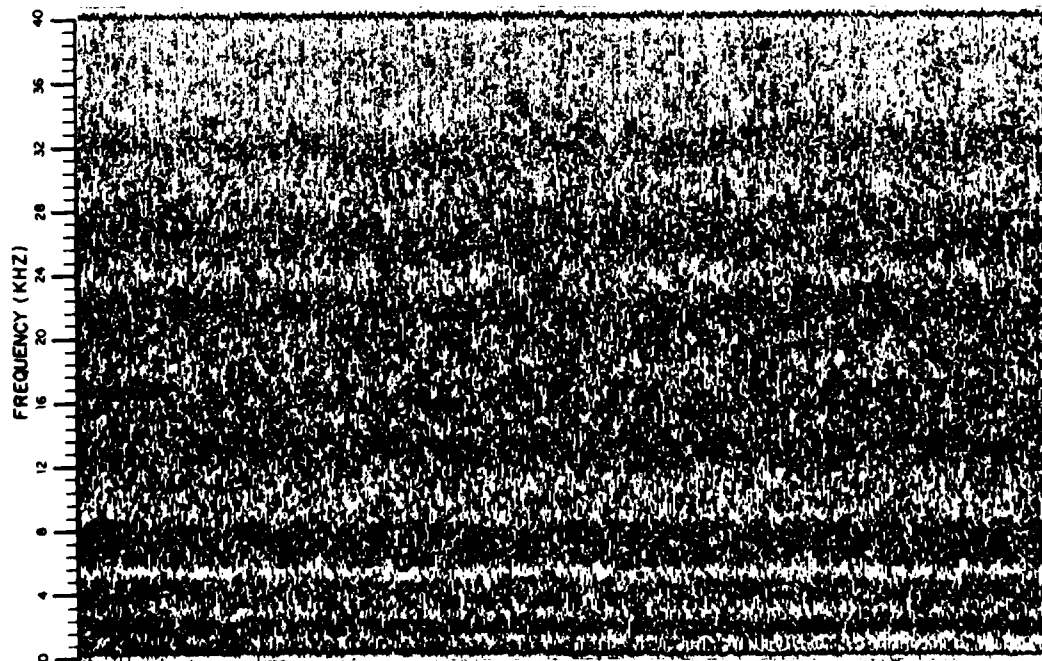
ASW-587-48

Figure A-48. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



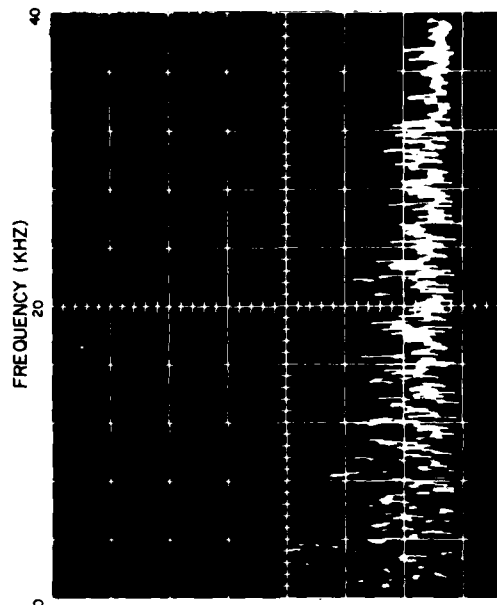
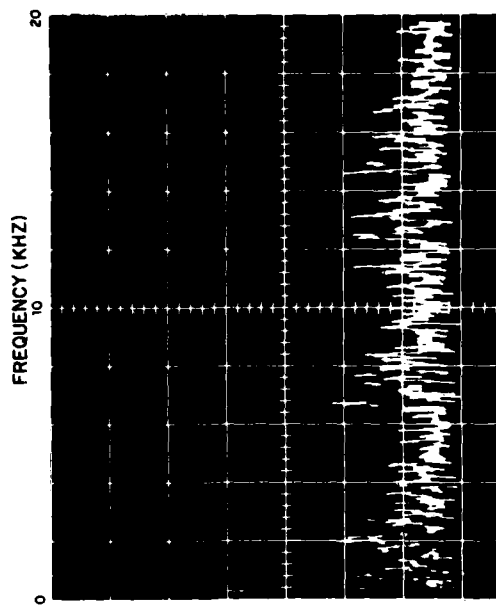
ASW-587-49

Figure A-49. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



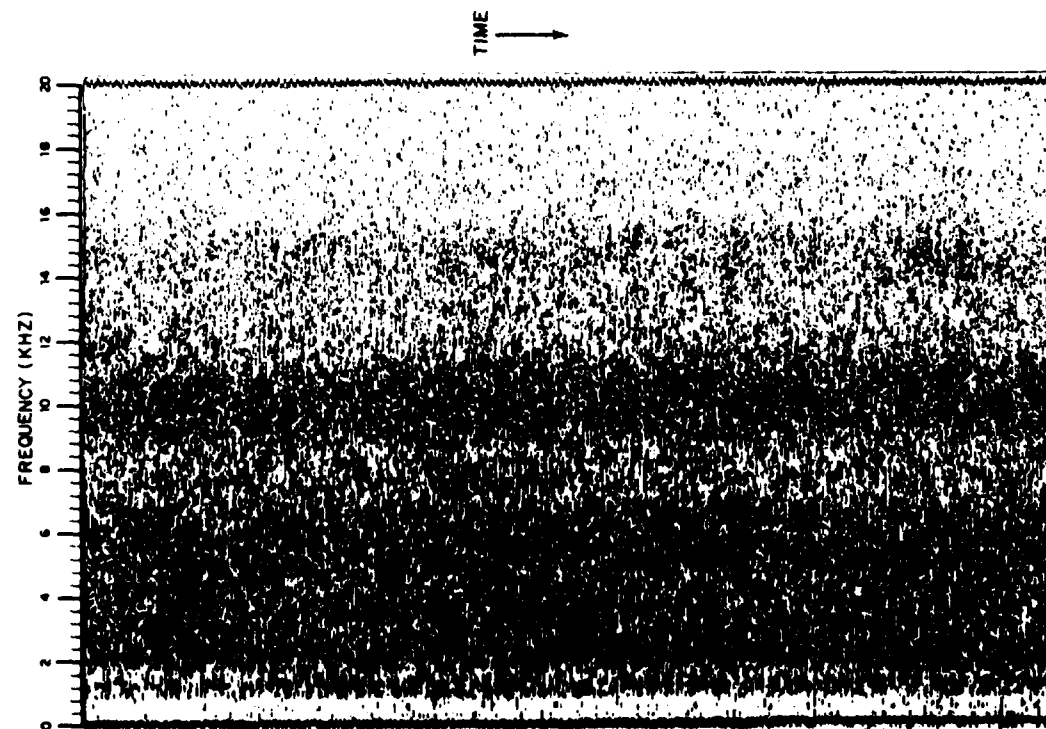
ASW-587-50

Figure A-50. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



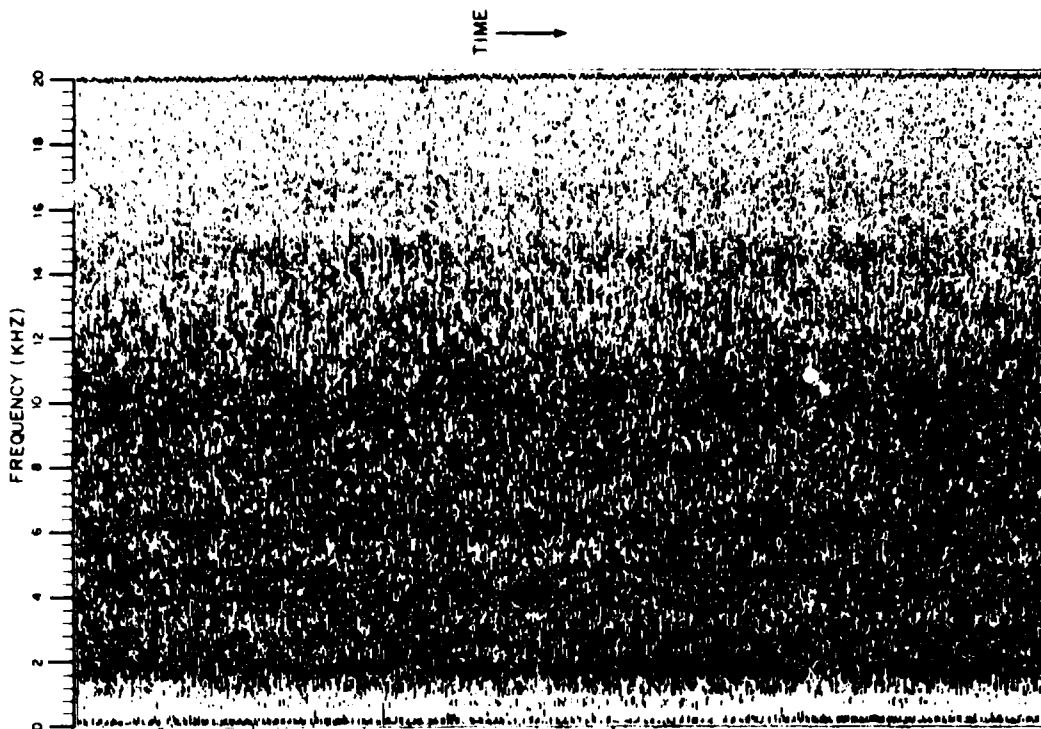
ASW-587-51

Figure A-51. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



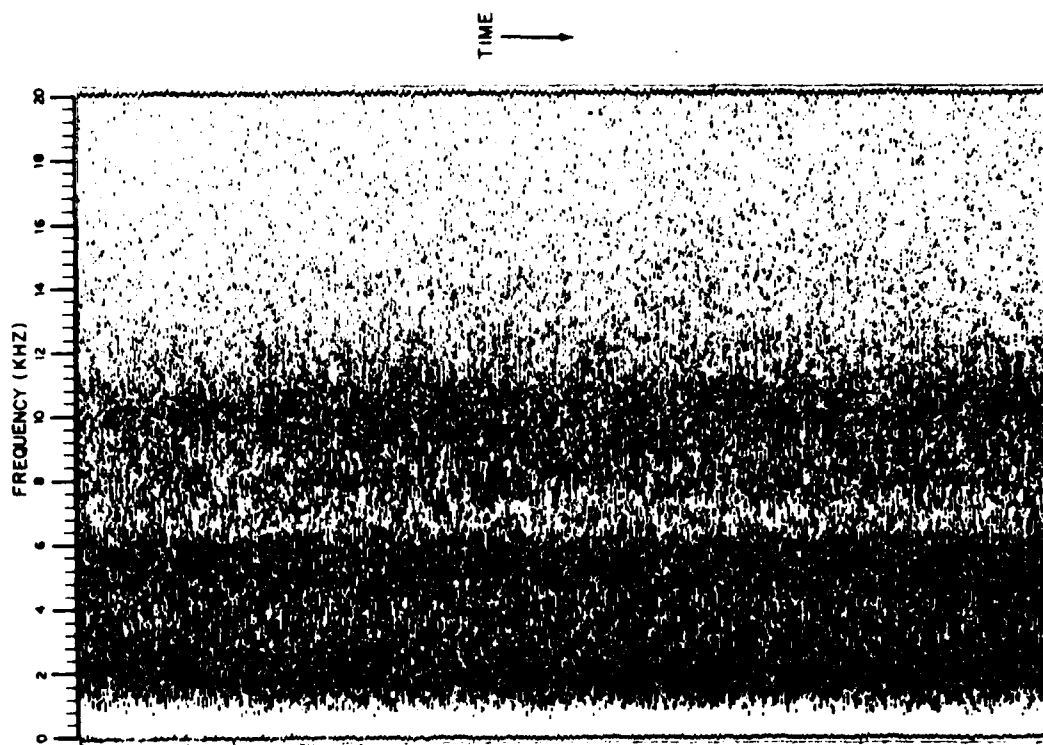
ASW-587-52

Figure A-52. Microphone No. 3 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



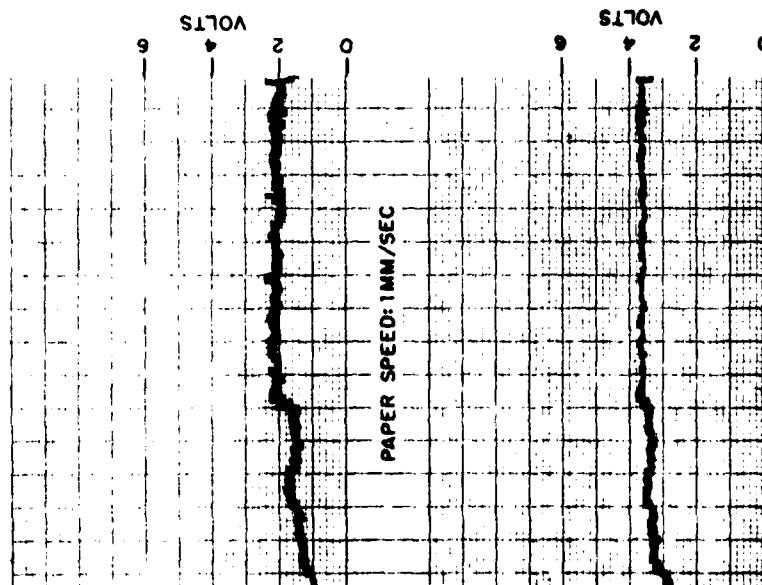
ASW-587-53

Figure A-53. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



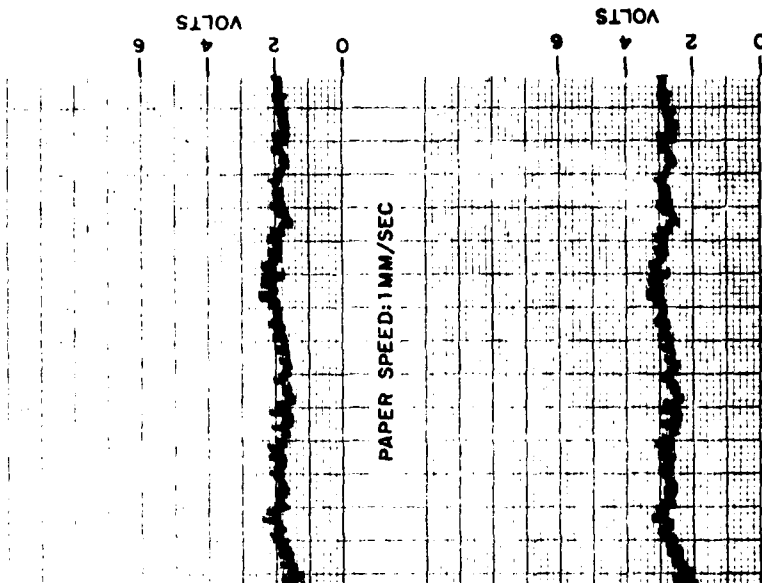
ASW-587-54

Figure A-54. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



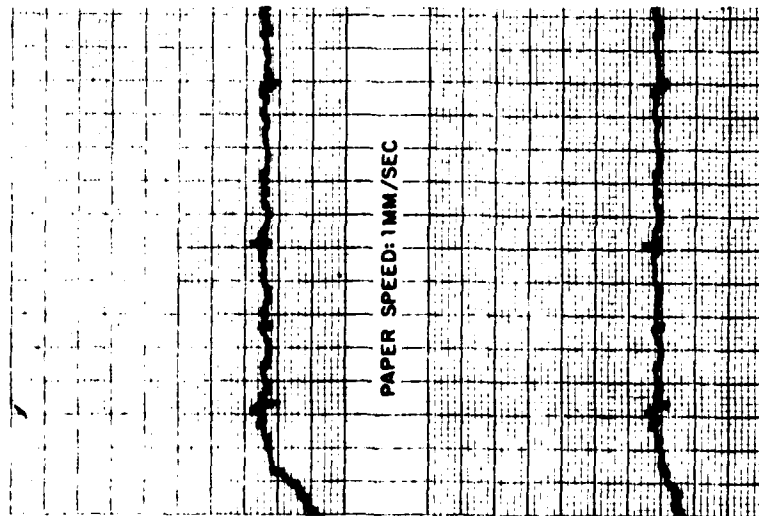
ASW-587-55

Figure A-55. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



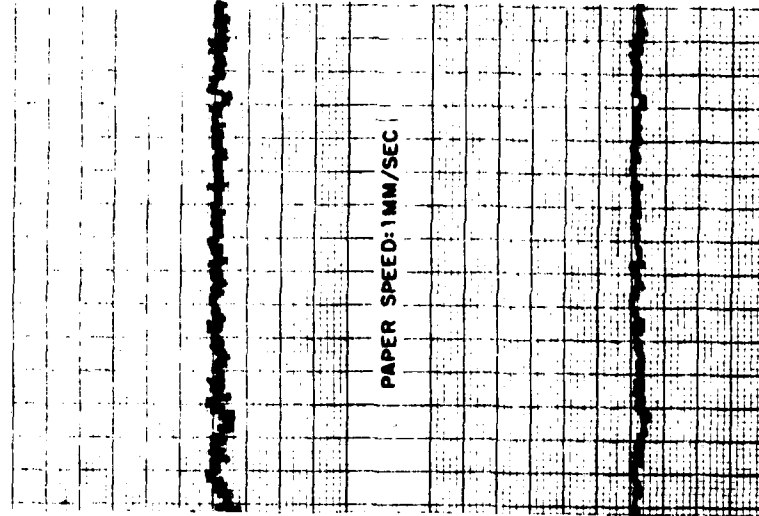
ASW-587-56

Figure A-56. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



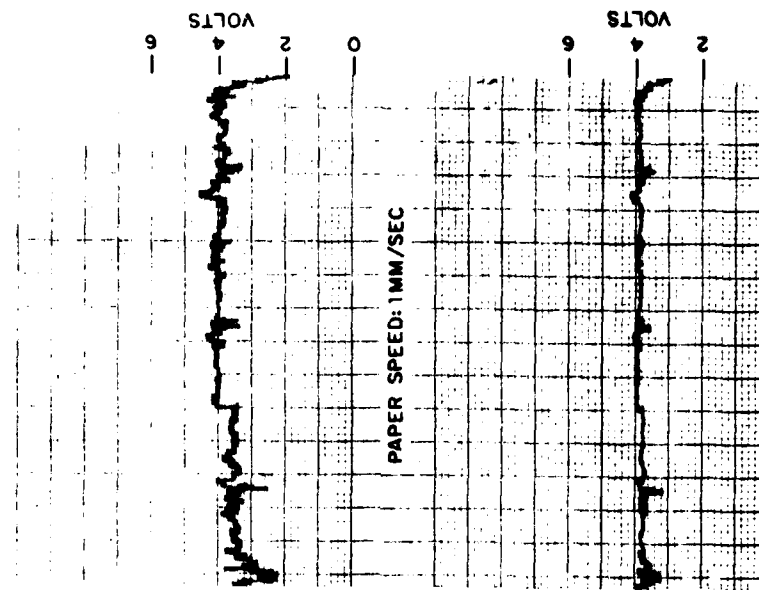
ASN-587-57

Figure A-57. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



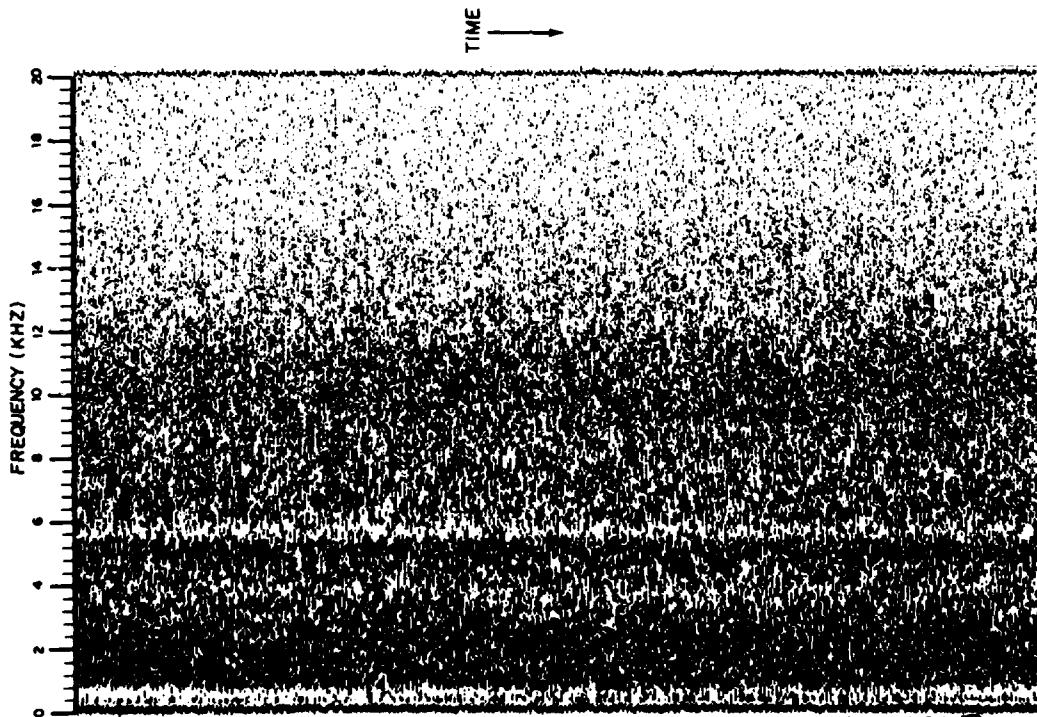
ASN-587-58

Figure A-58. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



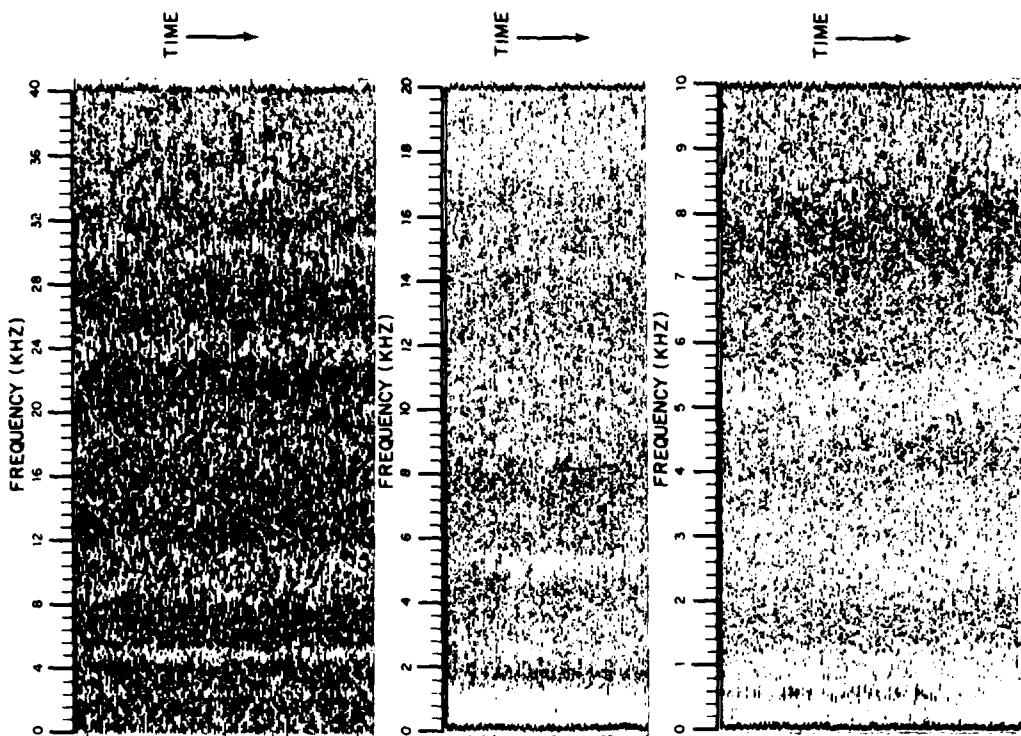
ASN-587-59

Figure A-59. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-60

Figure A-60. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-61

Figure A-61. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 40 kHz, 0 to 20 kHz, and 0 to 10 kHz, respectively.

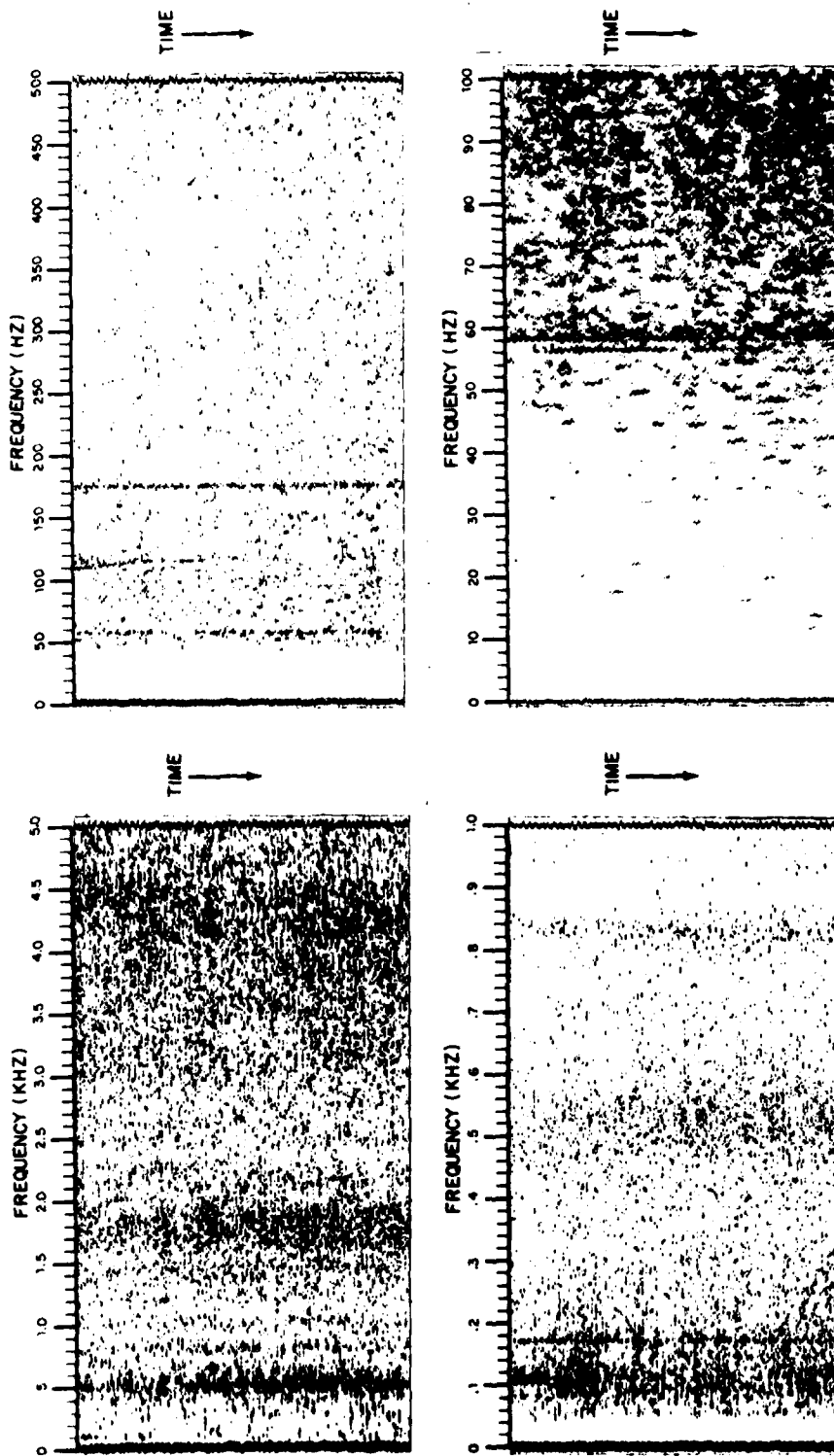
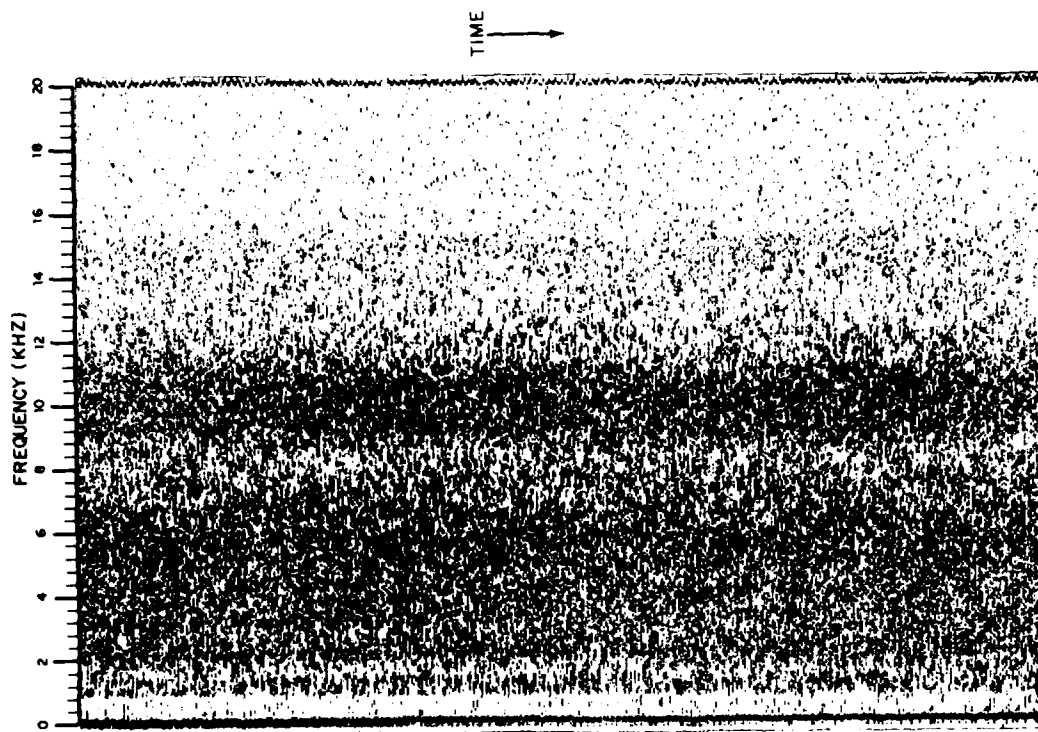


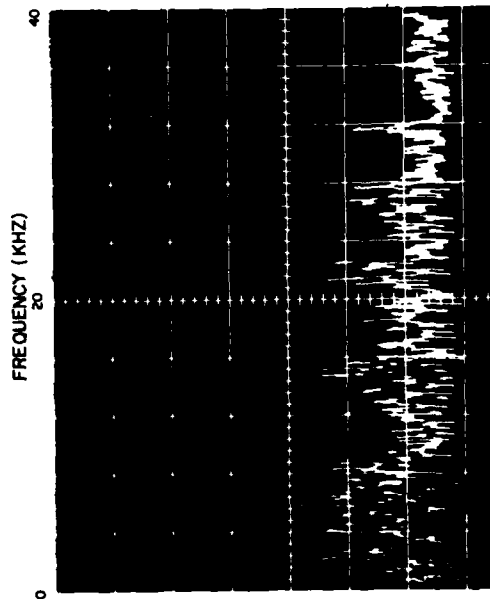
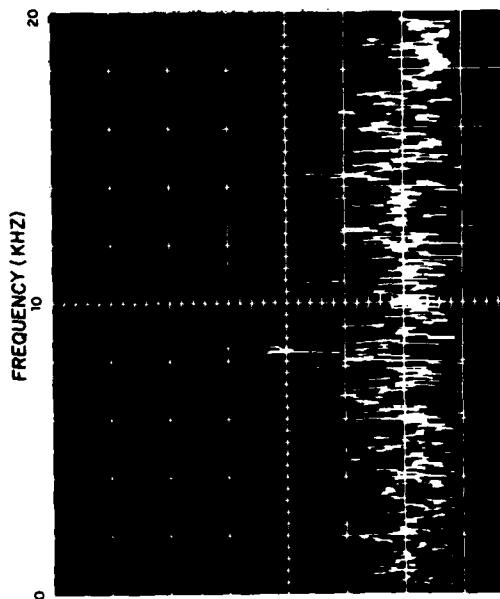
Figure A-62. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 5 kHz, 0 to 1 kHz, 0 to 500 Hz, and 0 to 100 Hz, respectively.

ASW-587-62



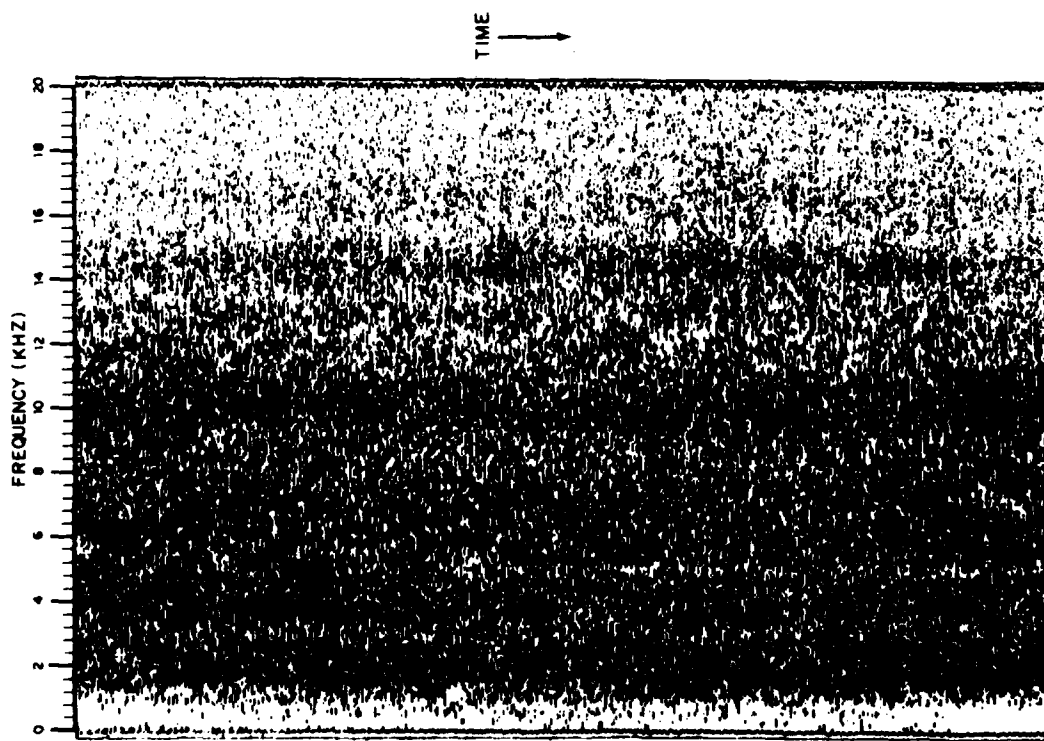
ASW-587-64

Figure A-64. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



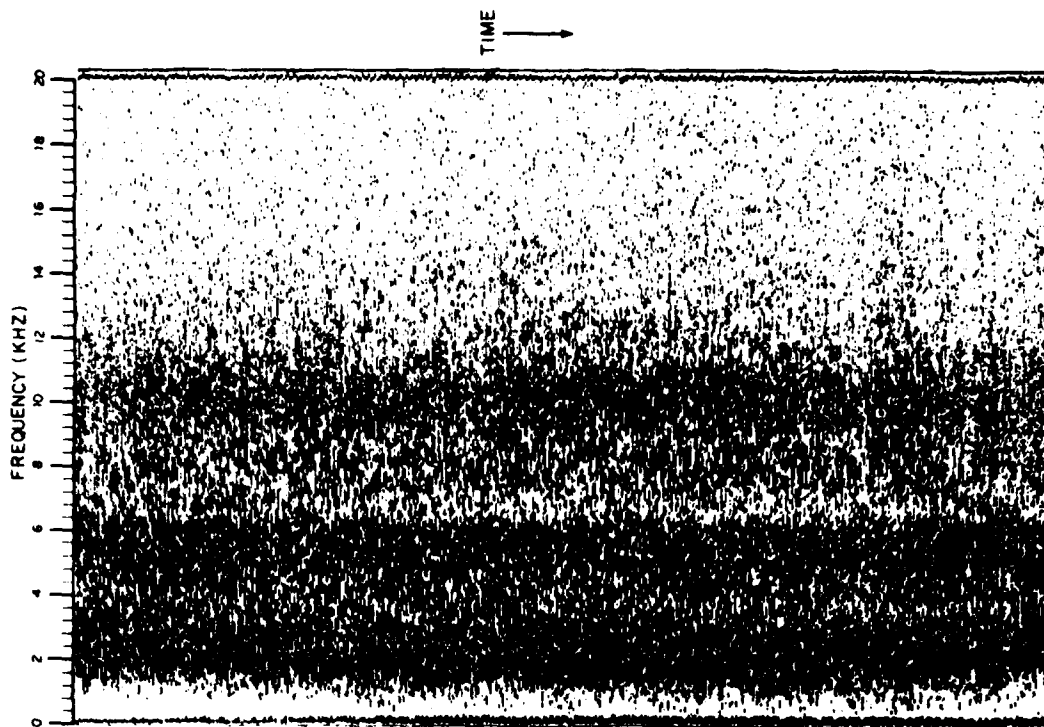
ASW-587-63

Figure A-63. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



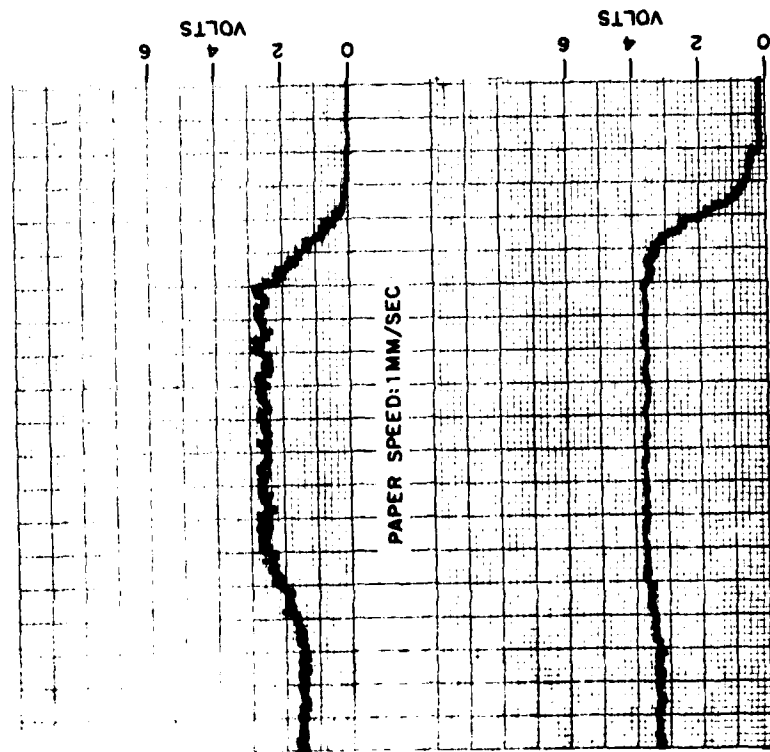
ASW-587-65

Figure A-65. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



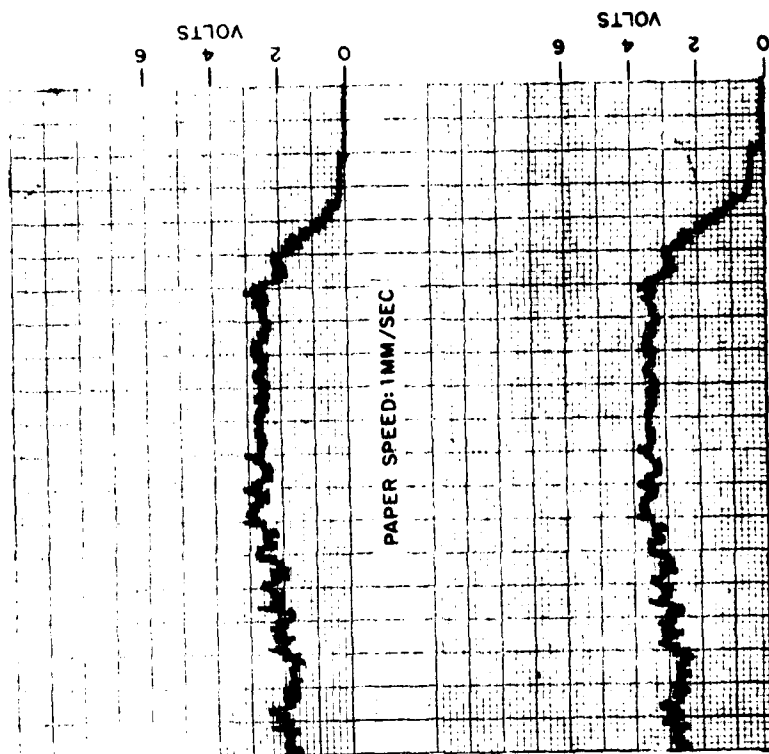
ASW-587-66

Figure A-66. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



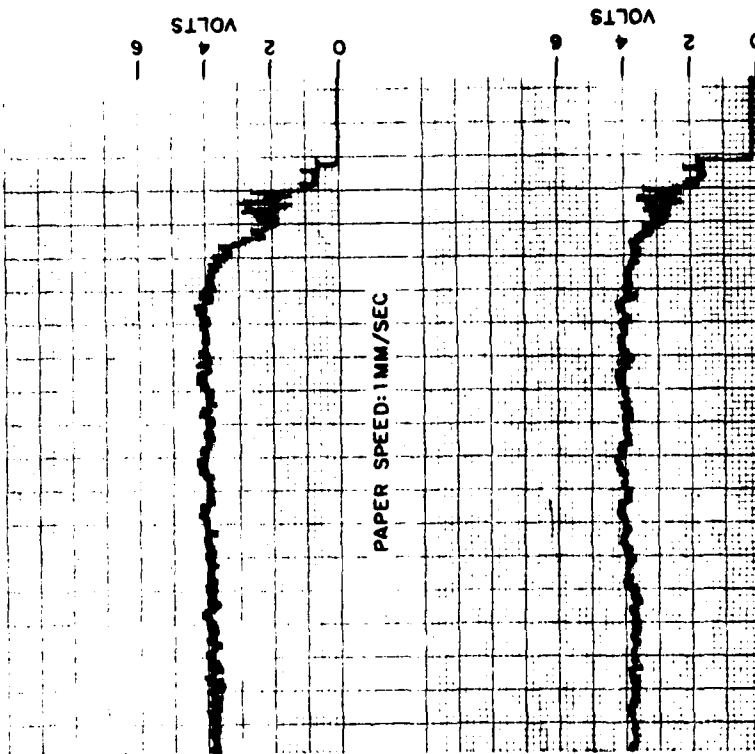
ASW-587-67

Figure A-67. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-68

Figure A-68. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-69

Figure A-69. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

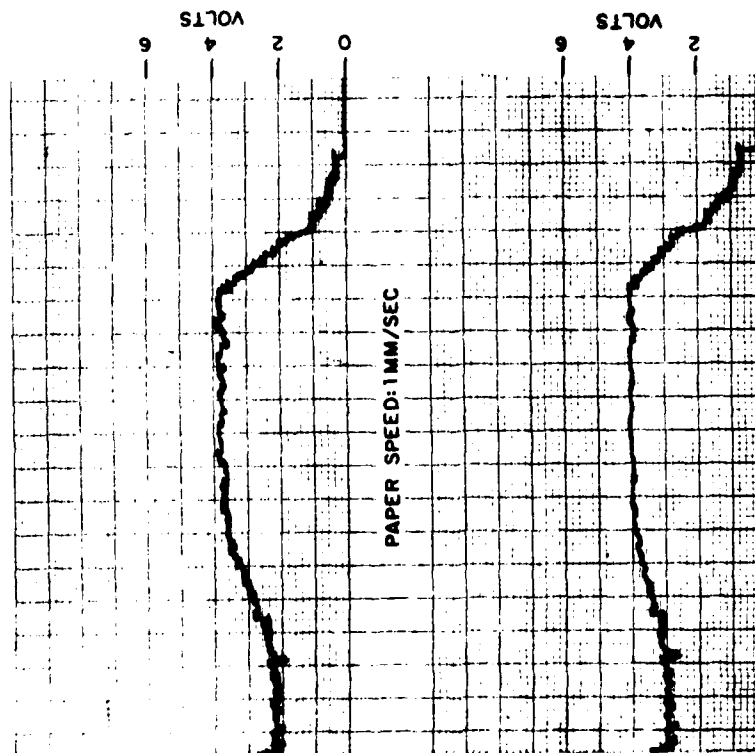
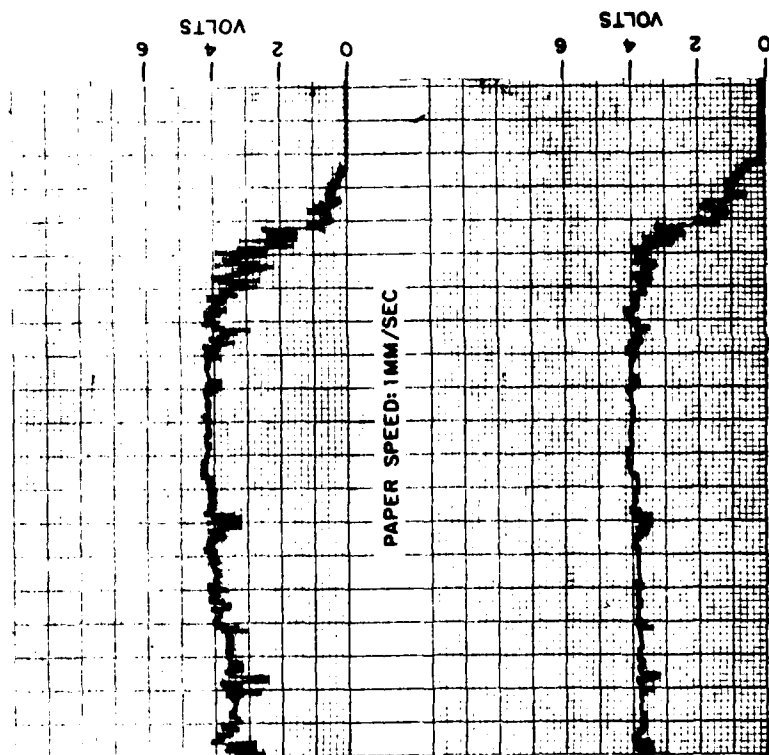


Figure A-70. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-S87-71

Figure A-71. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

A.3 J-47 ENGINE, MODIFIED BURNER CAN HOLE OPEN - 1.0 INCH DIAMETER

A series of three test runs were made on the J-47 engine with the modified burner can hole masked to a 1.0-inch hole. Each test was recorded using five microphones located in the same positions as for the closed-hole tests. The three tests were run at the following engine speeds:

- (1) 70% RPM (46 in. Hg gage, diffuser case pressure)
- (2) 80% RPM (70 in. Hg gage, diffuser case pressure)
- (3) 90% RPM (97 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed-hole on the modified burner can and a medium open hole (1.0 inch in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 70% run - pages A-53 through A-58
- (2) 80% run - pages A-59 through A-64
- (3) 90% run - pages A-65 through A-70

A.3.1 Analysis

A.3.1.1 Sound Energy Levels

There was a decrease in the sound level of all microphones in this test as compared to the 1.5 inch open-hole test. The differences were more pronounced at low engine speed and less pronounced at high engine speed. The change was greatest in microphone 1, which was pointed directly at the open hole. Microphone 2, as in previous runs, approximated microphone 1 results. The 41% reduction in hole size area from 1.5 to 1.0 inch reduced the sound energy level an average of 20%.

A.3.1.2 Spectrum Analysis

The open-hole test results were similar to the 1.5 inch open-hole test results. All grams were less dense due to reduction in noise intensity. No other changes were apparent.

A.3.1.3 Mean Square Analysis

The results of this analysis were similar to the 1.5 inch open-hole analysis with the exception that a greater portion of the spectrum was below 5 kHz. This was especially pronounced in microphones 1 and 4 and for all engine speeds.

A.3.2 Environmental Conditions

The three tests discussed in paragraph A.3 were performed at an ambient temperature of 61° F and 75% relative humidity.

A.3.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table A-7. Microphone Sound Energy Levels at 70% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	140	15	50	20	17
RMS (μBAR)	1100	1200	400	160	140
dB (a)	135	135	126	118	117

^aReference = 2×10^{-4} μBAR

Table A-8. Microphone Sound Energy Levels at 80% Engine RPM

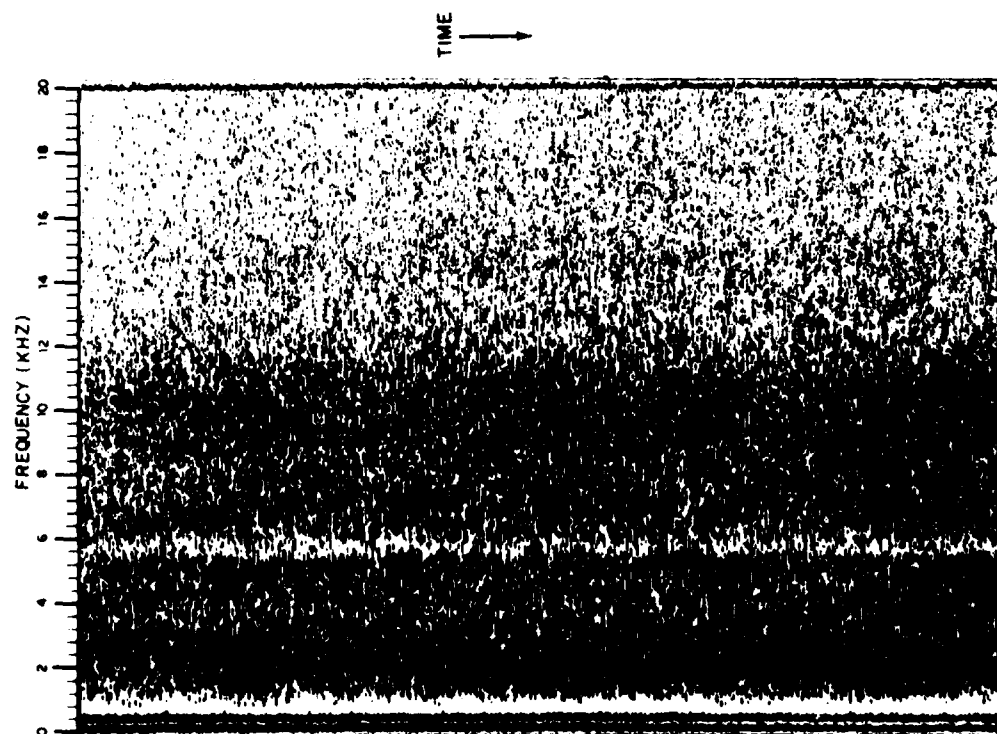
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	240	25	75	40	34
RMS (μBAR)	1900	1950	600	320	280
dB (a)	140	140	130	124	123

^aReference = 2×10^{-4} μBAR

Table A-9. Microphone Sound Energy Levels at 90% Engine RPM

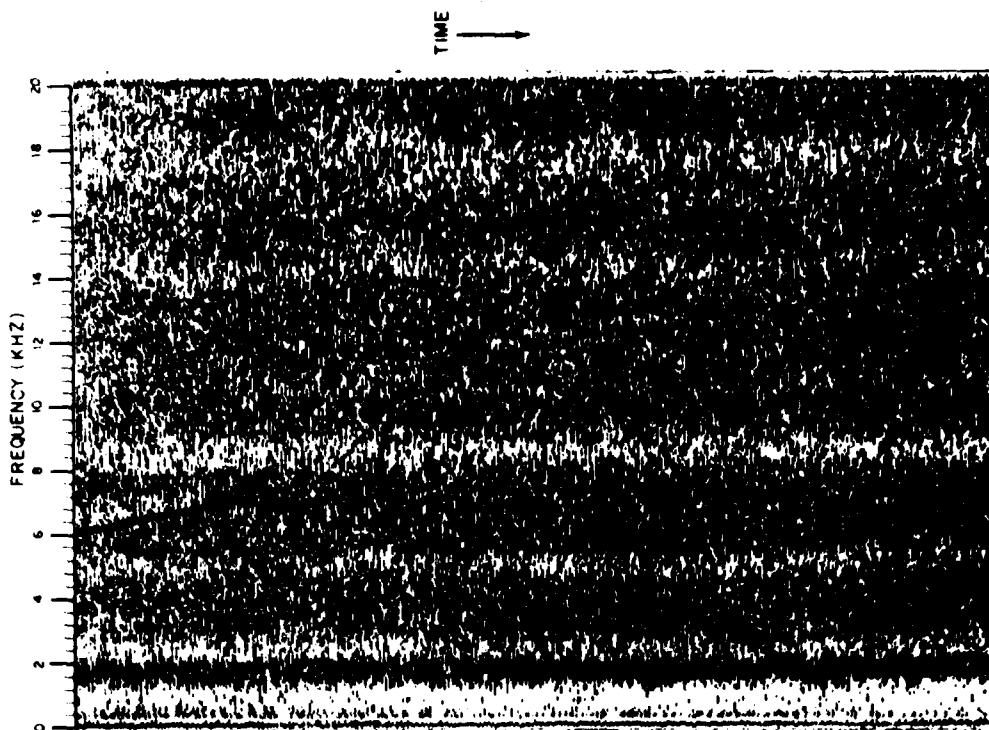
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	370	35	110	54	50
RMS (μBAR)	3000	2800	880	430	400
dB (a)	143	143	133	127	126

^aReference = 2×10^{-4} μBAR



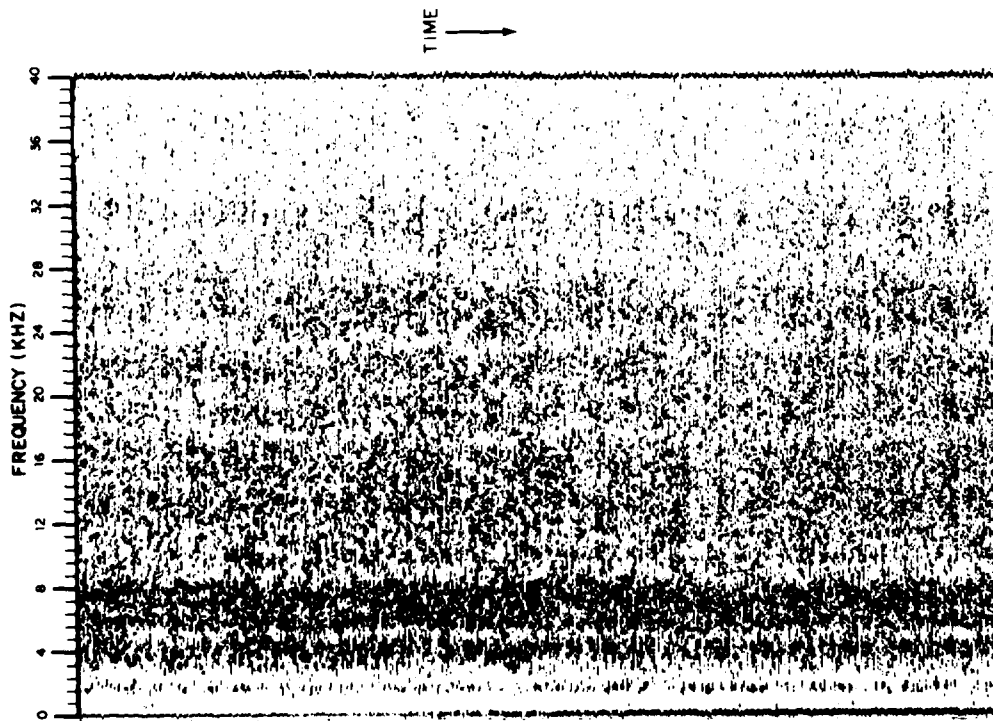
ASN-587-72

Figure A-72. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



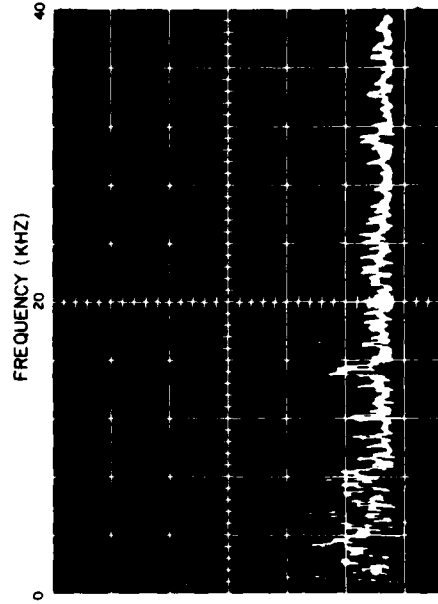
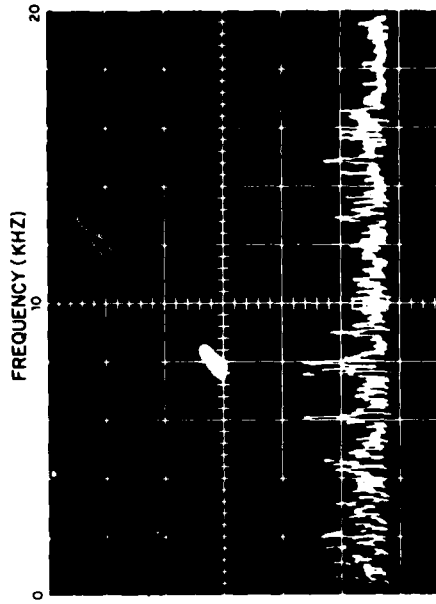
ASN-587-73

Figure A-73. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



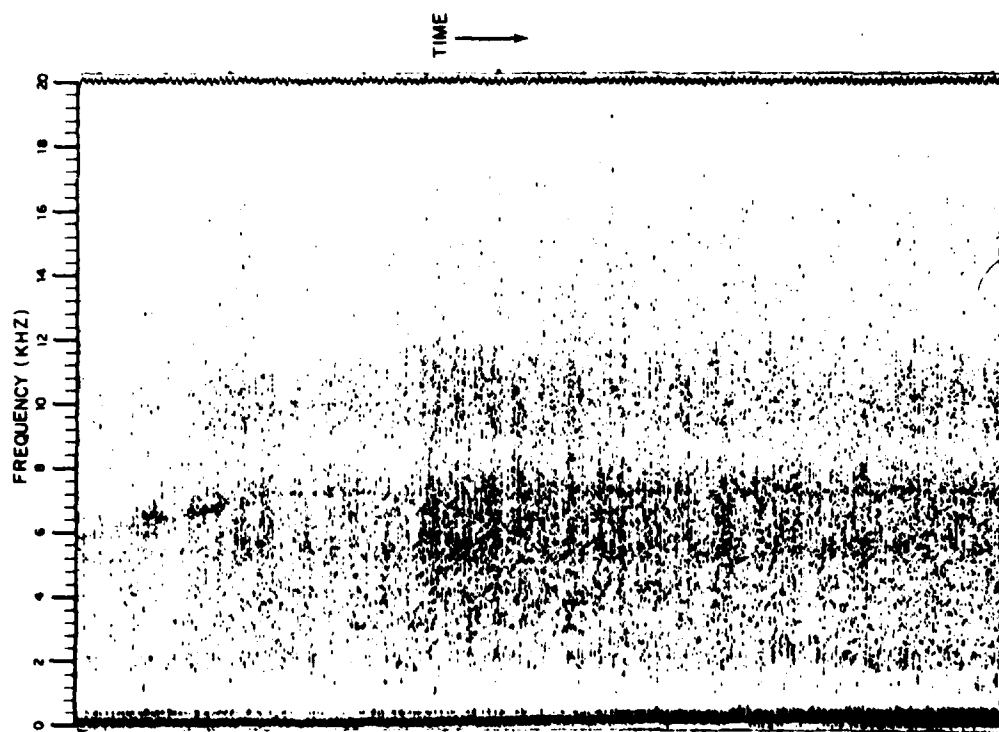
ASW-587-74

Figure A-74. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



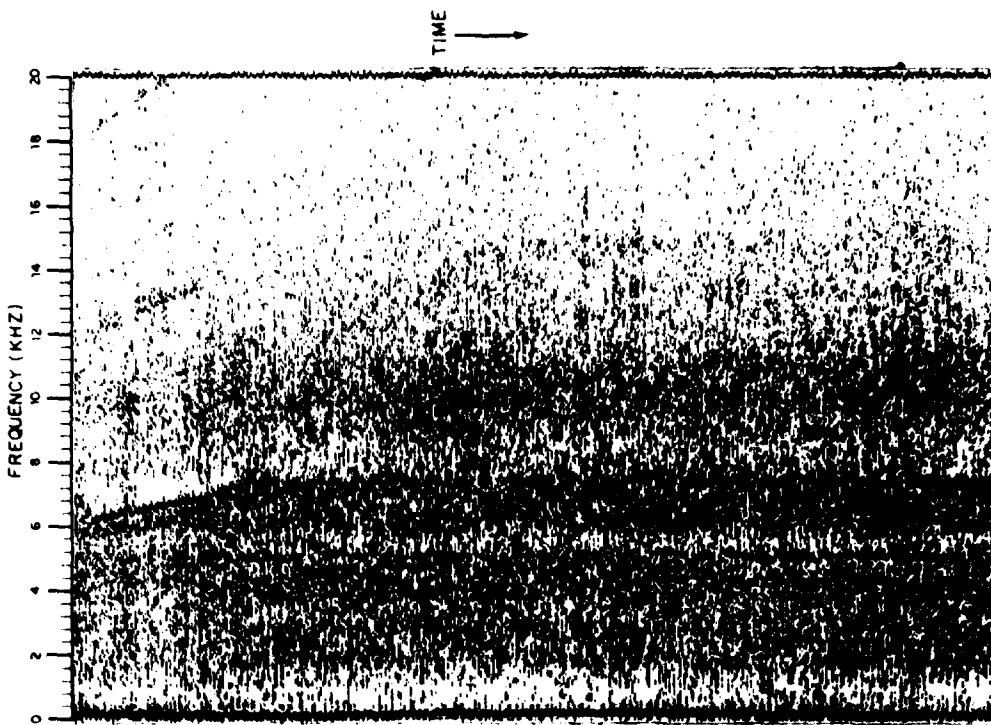
ASW-587-75

Figure A-75. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



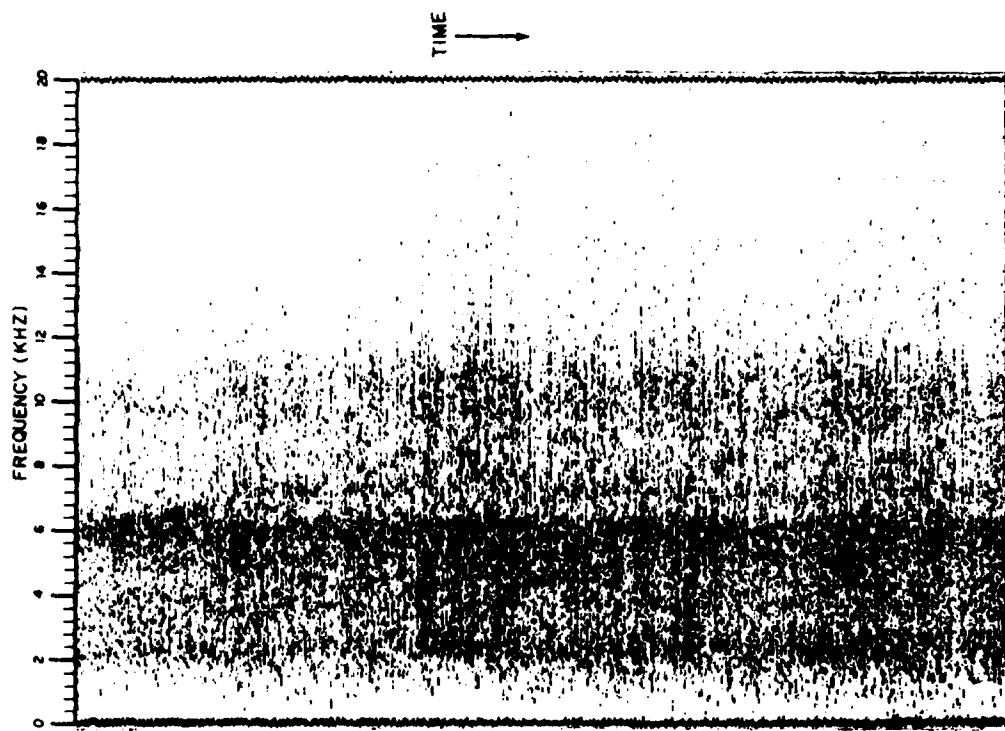
ASN-587-76

Figure A-76. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-77

Figure A-77. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASM-587-78

Figure A-78. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

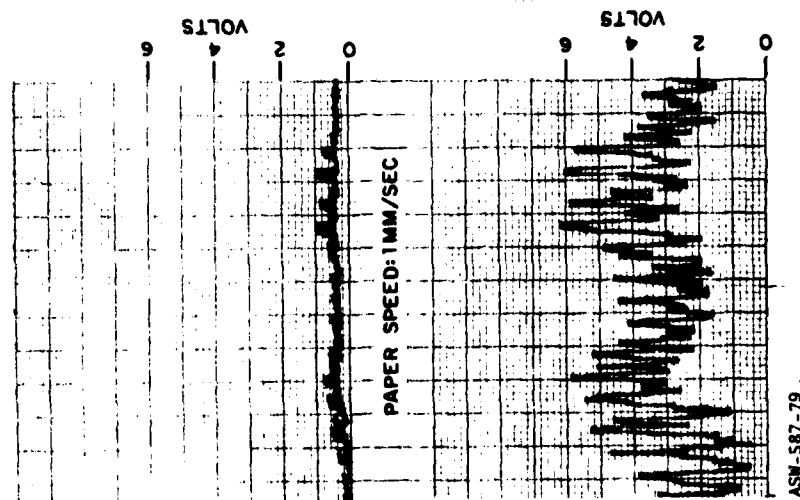


Figure A-79. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

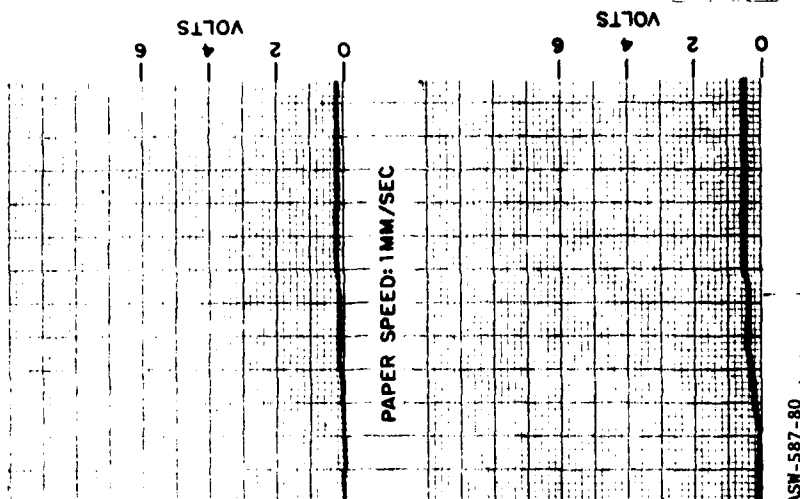
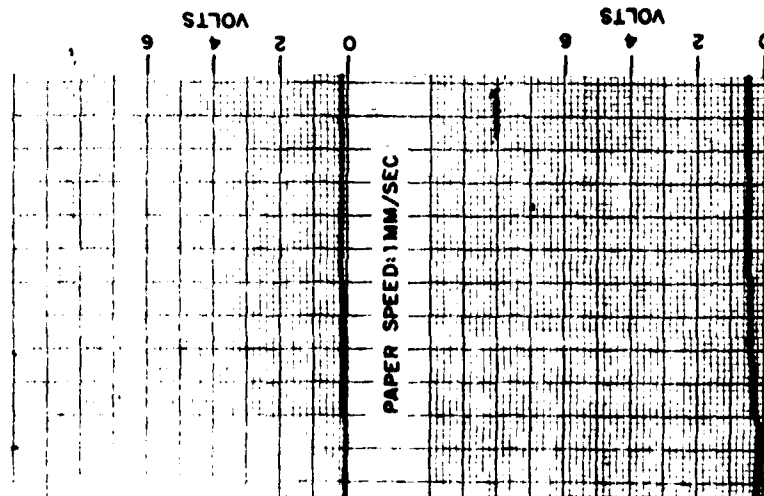


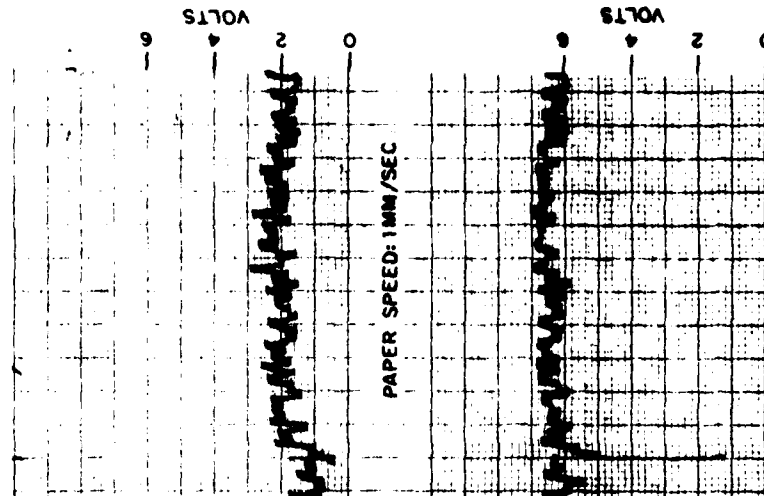
Figure A-80. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-81

Figure A-81. Microphone No. 3

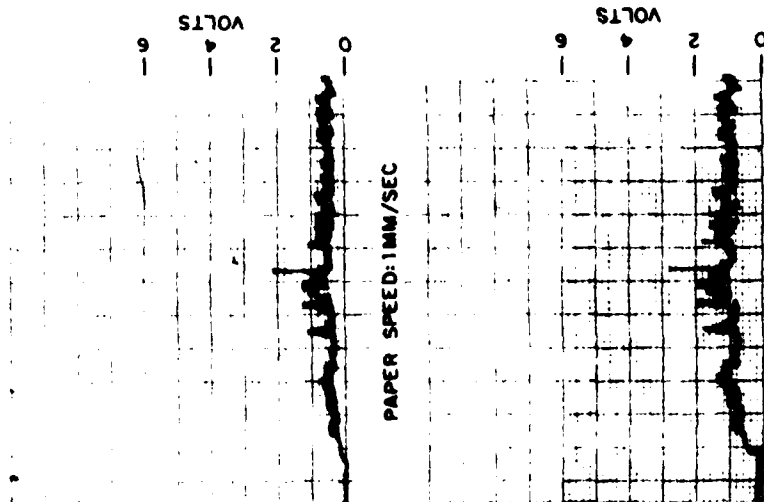
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-82

Figure A-82. Microphone No. 4

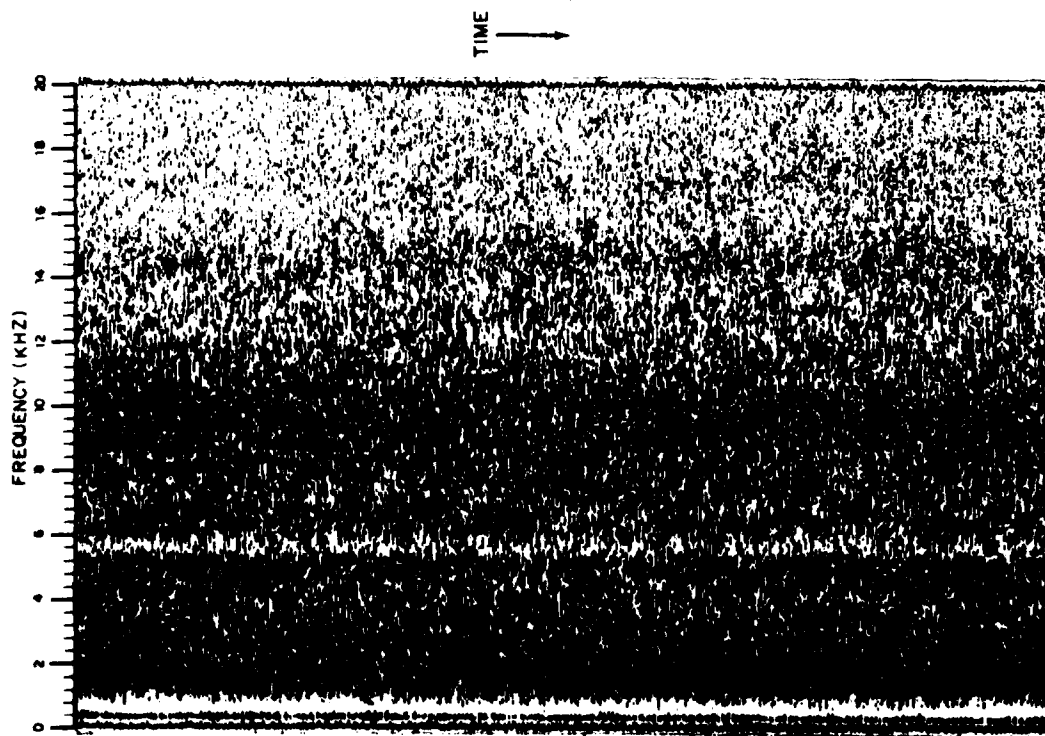
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-83

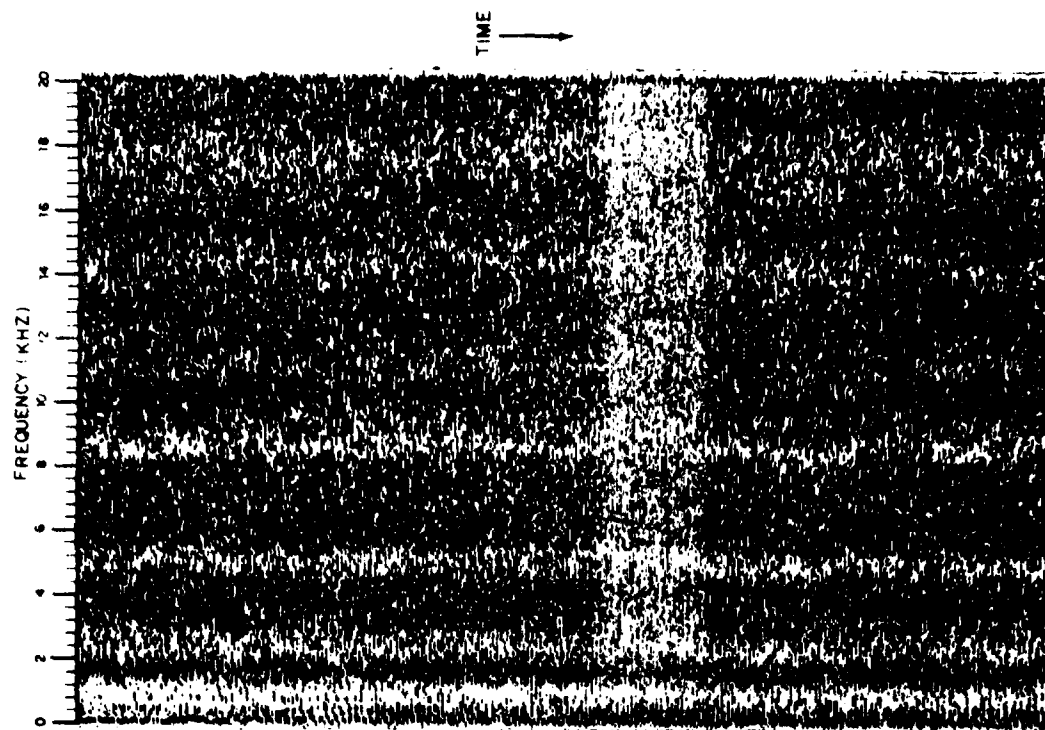
Figure A-83. Microphone No. 5

Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



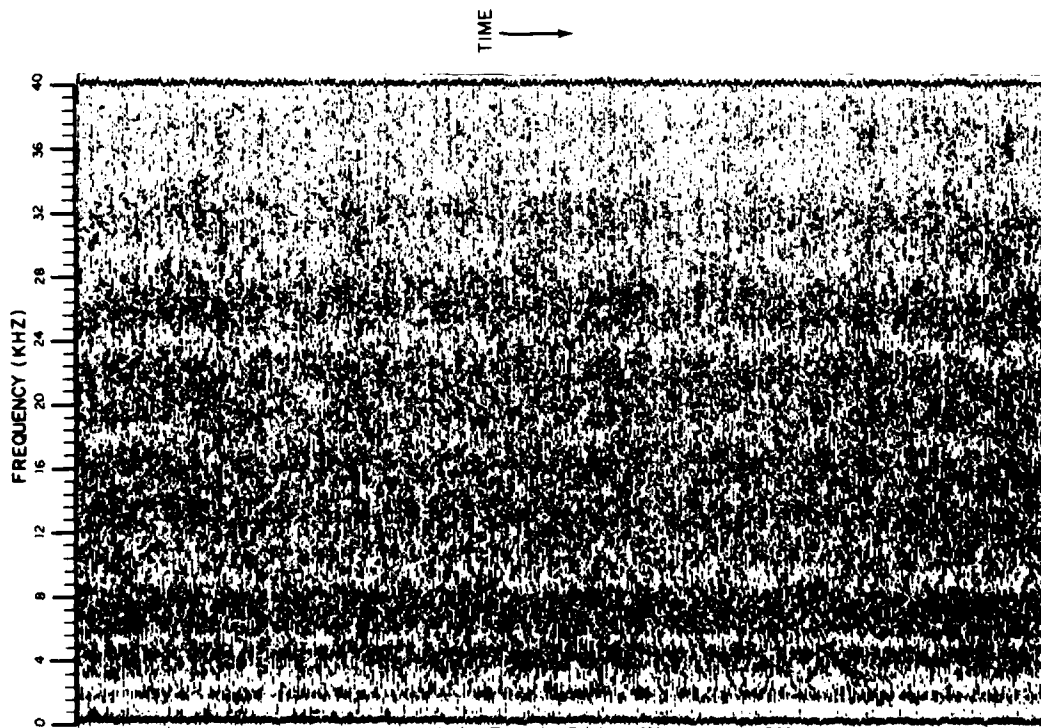
ASW-587-84

Figure A-84. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



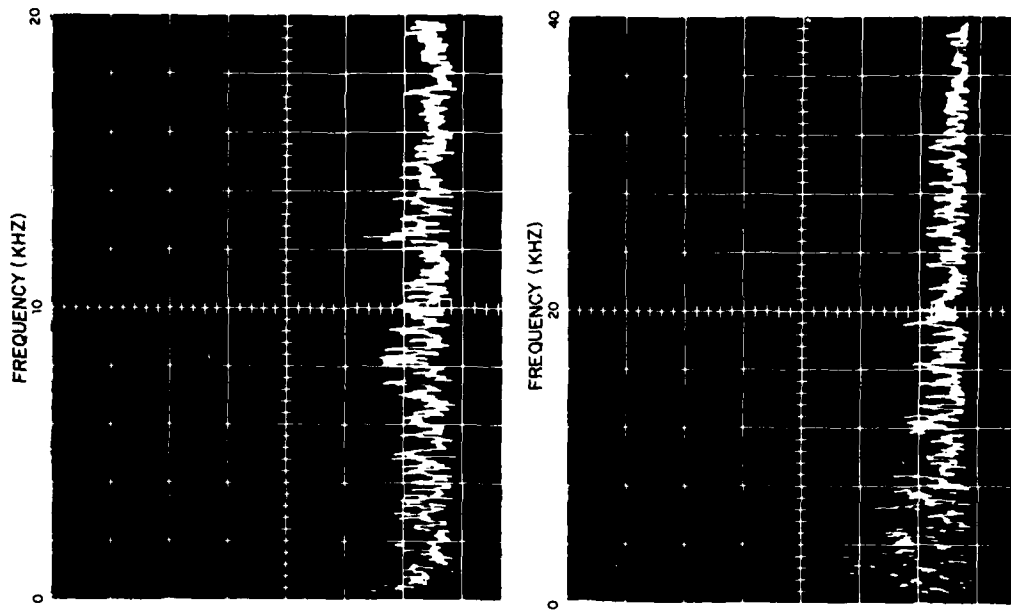
ASW-587-85

Figure A-85. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



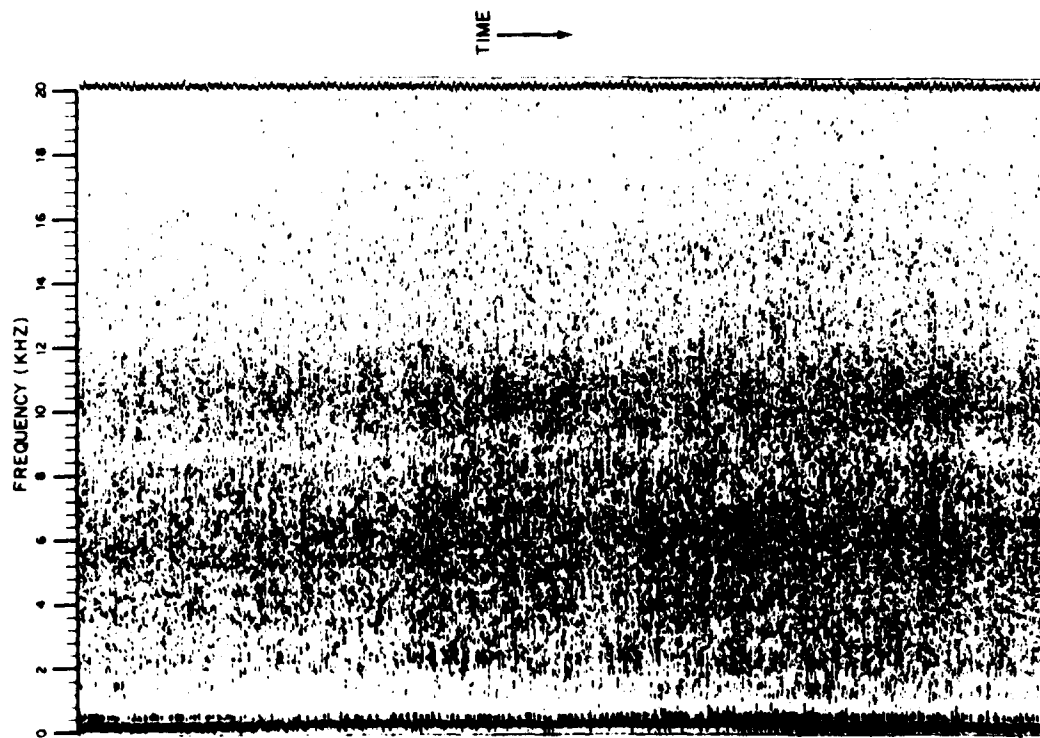
ASW-587-86

Figure A-86. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



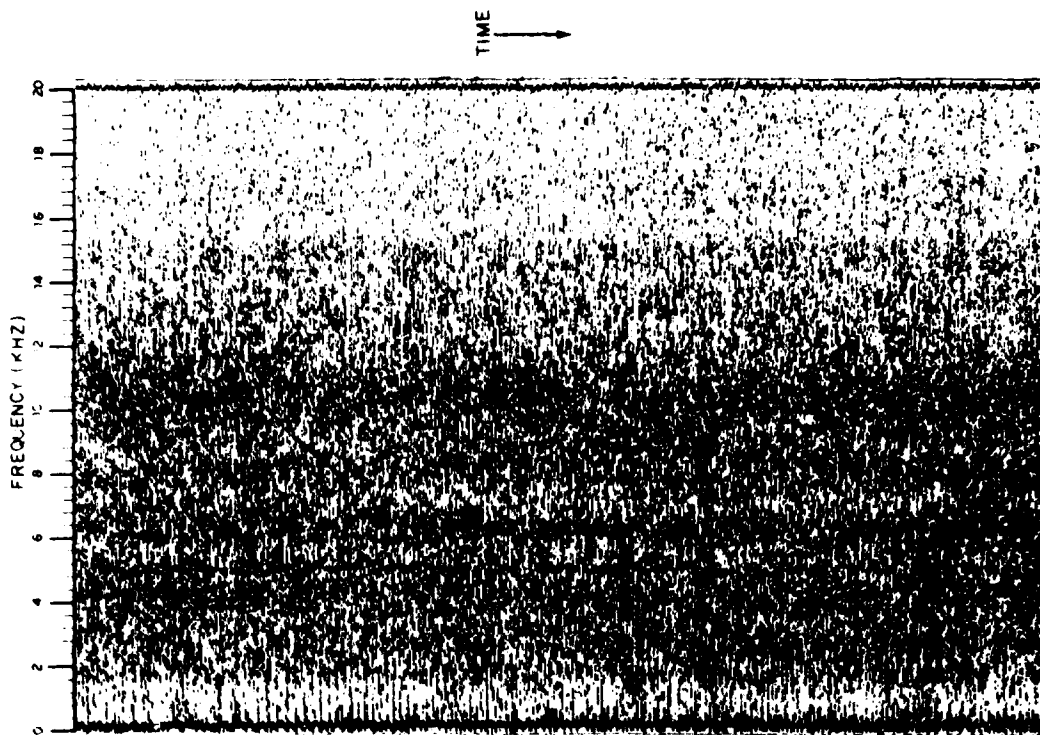
ASW-587-87

Figure A-87. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



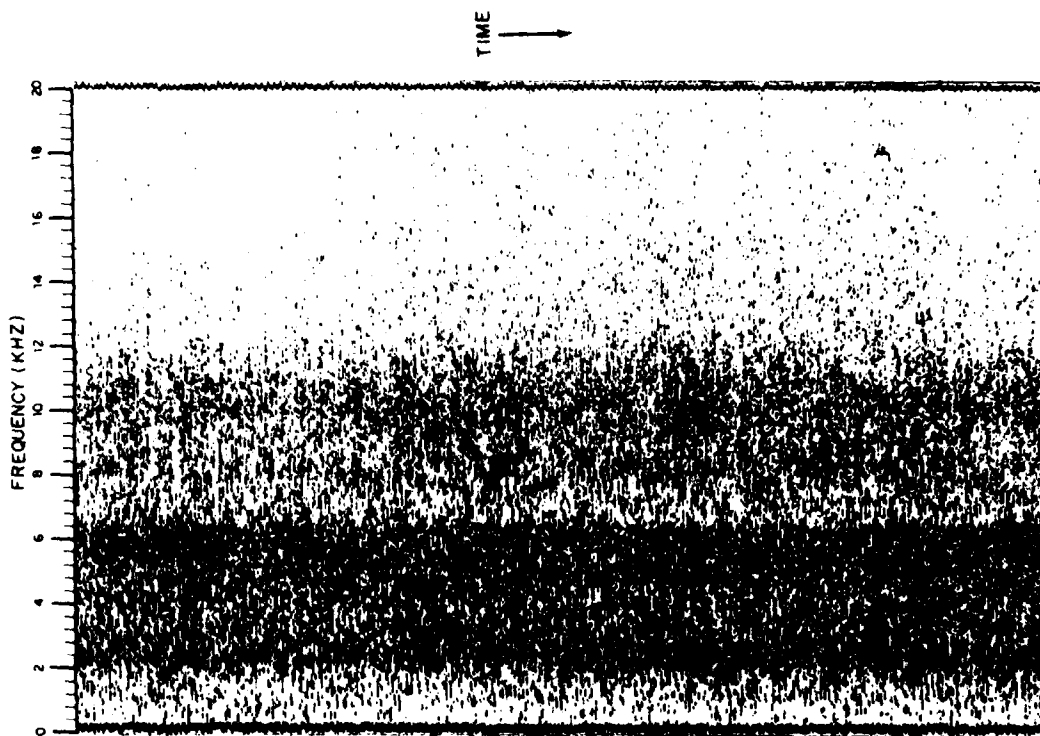
ASW-587-88

Figure A-88. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-89

Figure A-89. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-90

Figure A-90. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

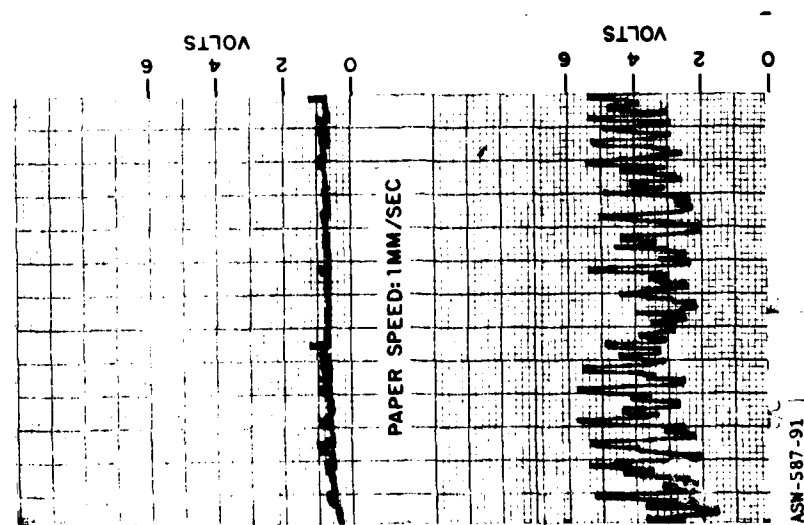


Figure A-91. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

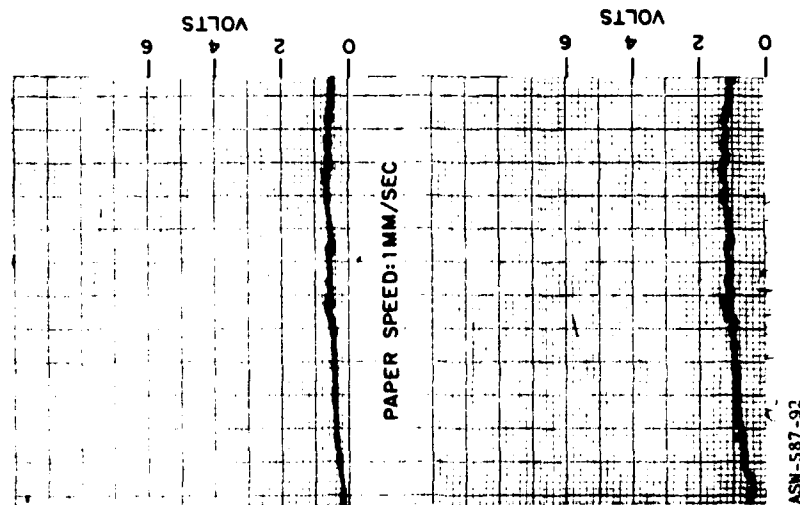
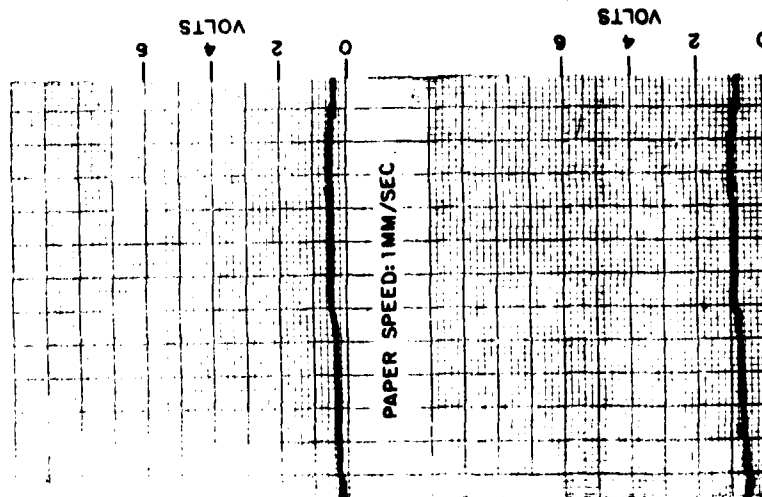
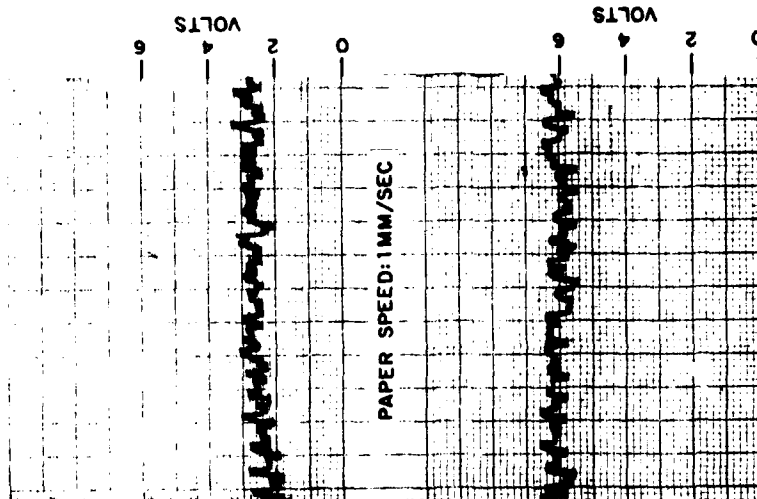


Figure A-92. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



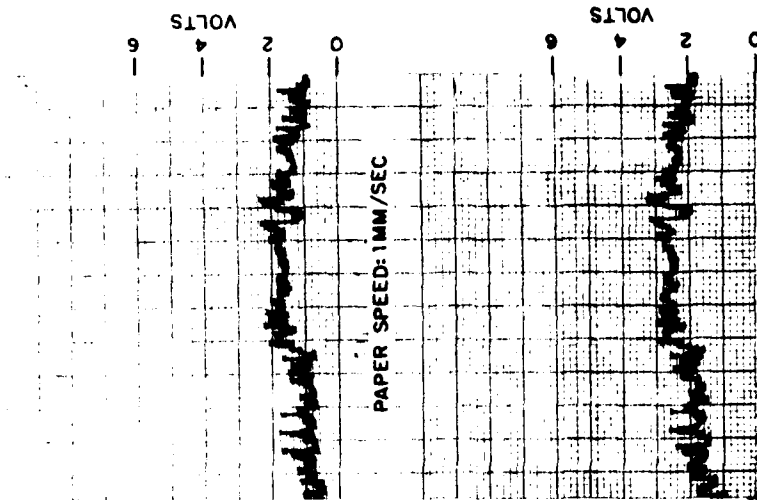
ASN-587-93

Figure A-93. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



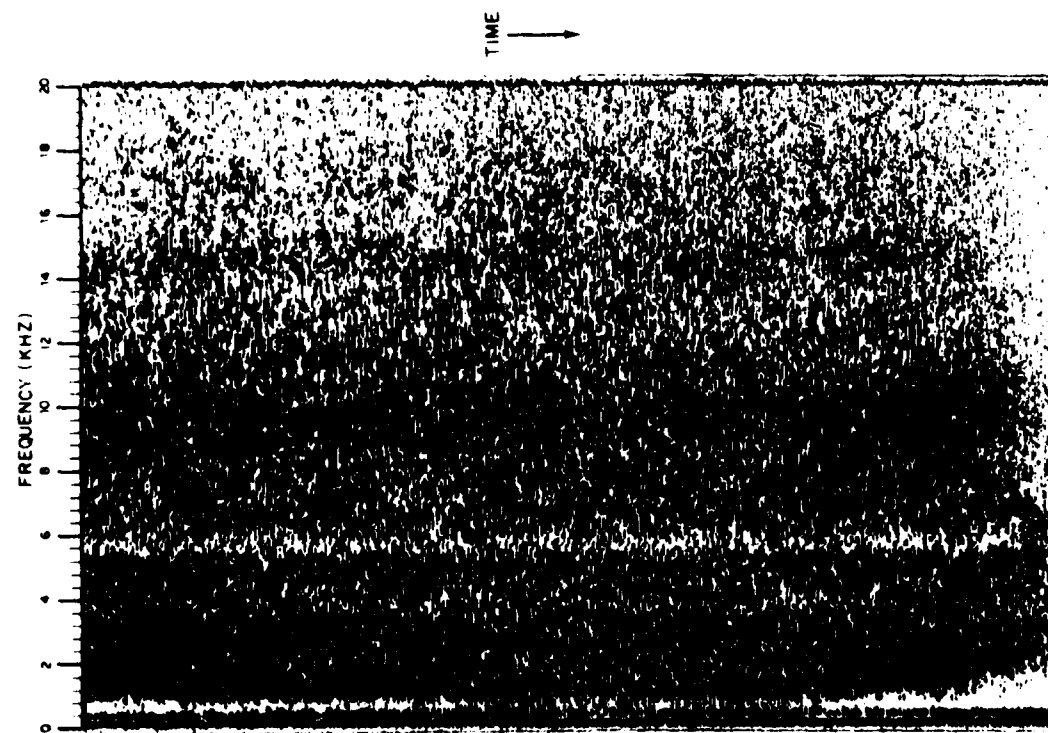
ASN-587-94

Figure A-94. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



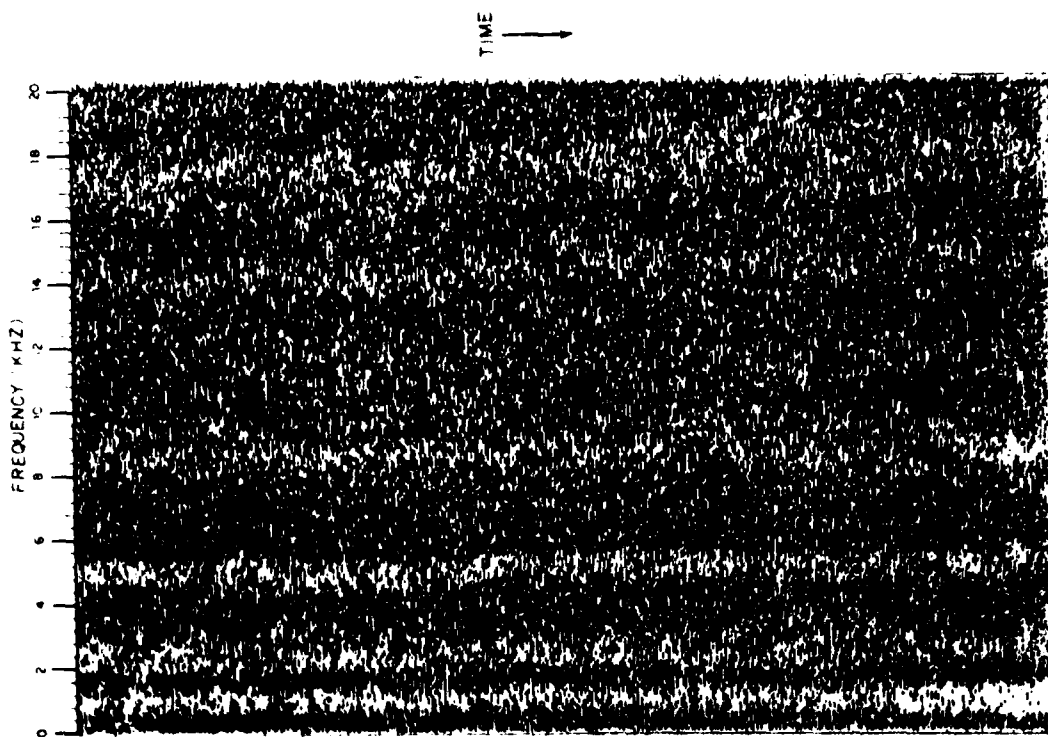
ASN-587-95

Figure A-95. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-96

Figure A-96. Microphone No. 1 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-97

Figure A-97. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

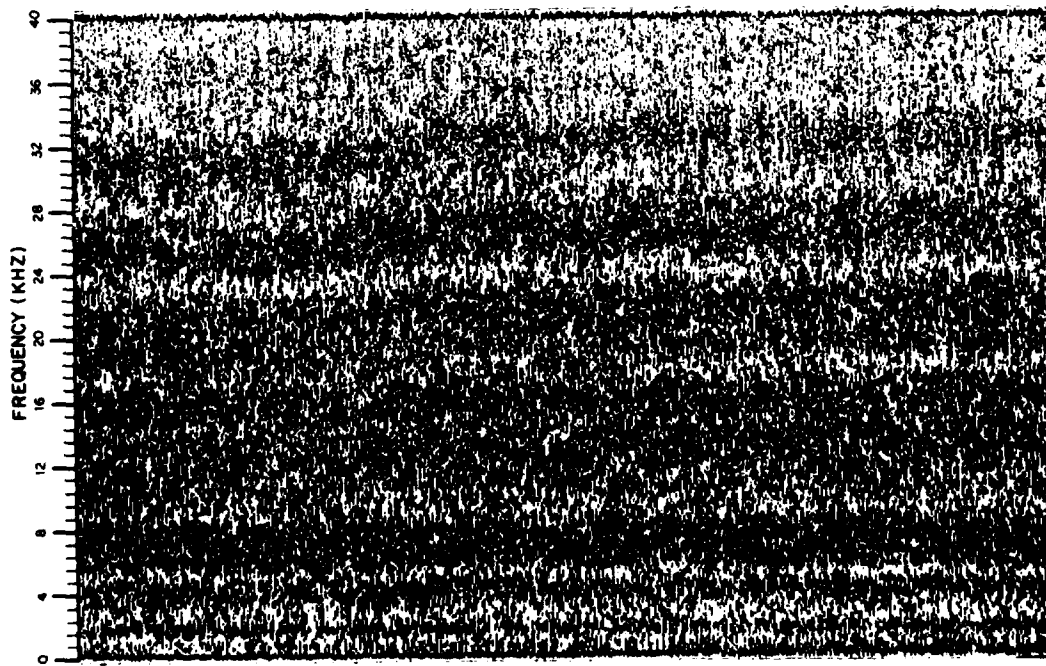


Figure A-98. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.

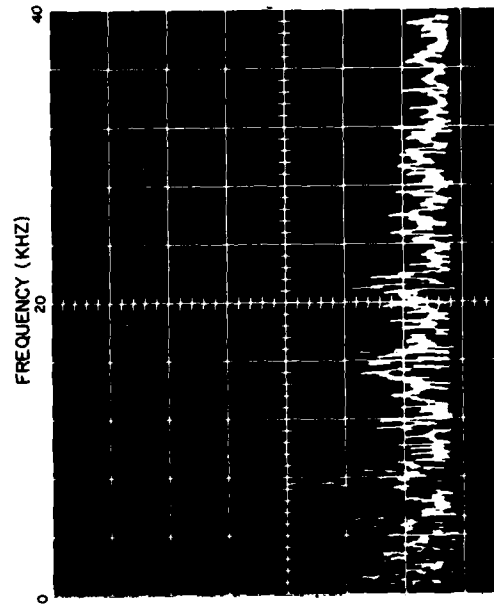
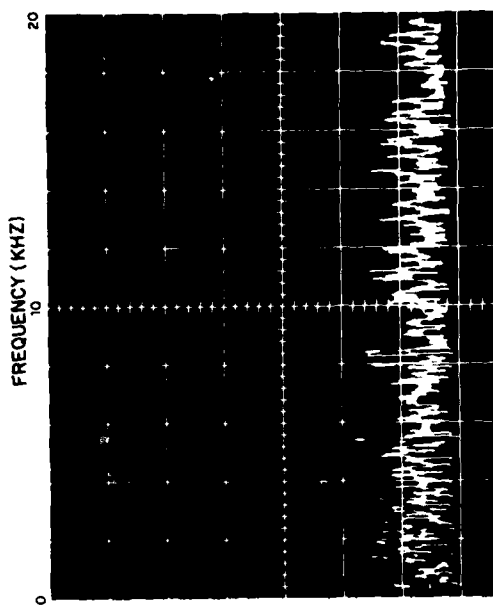
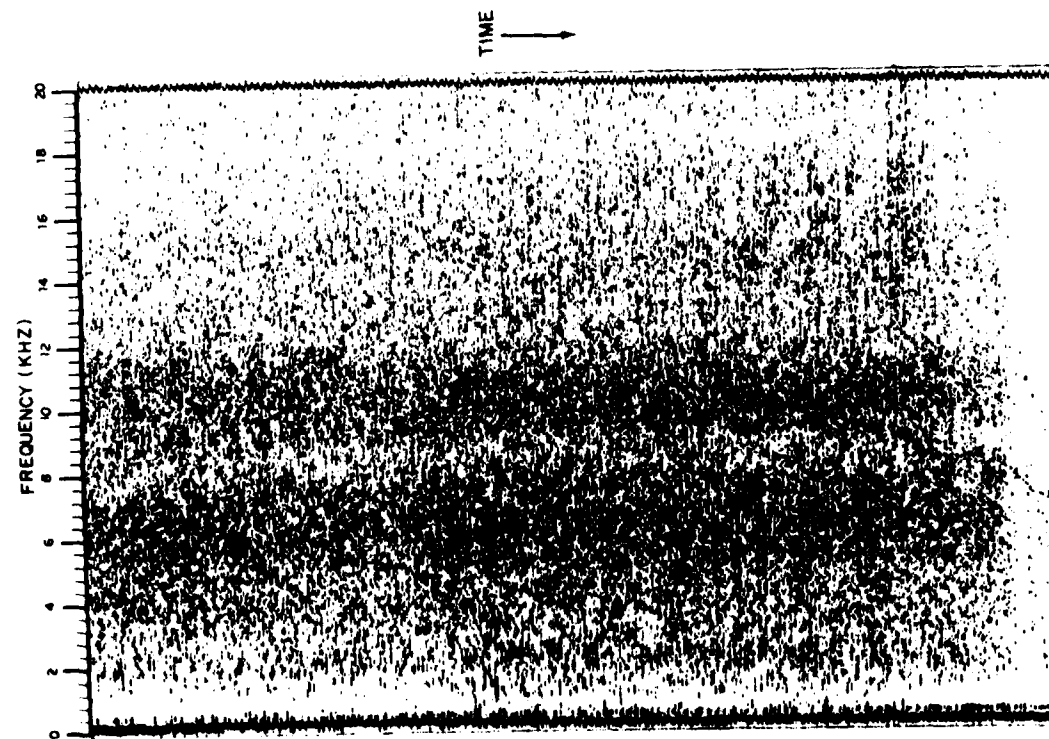
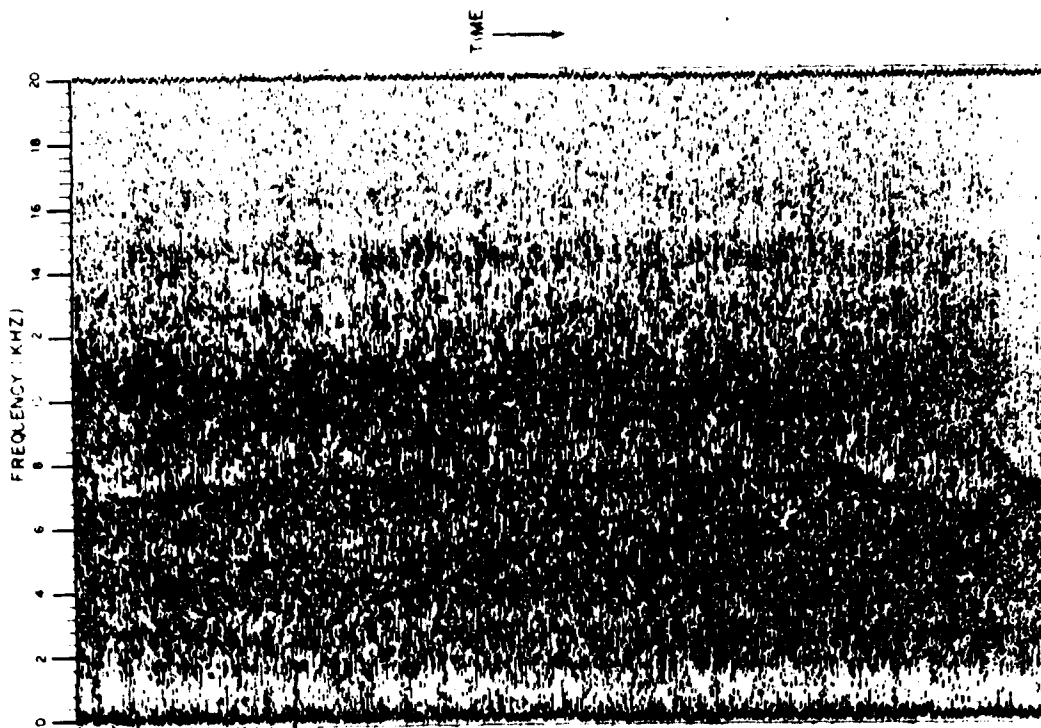


Figure A-99. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



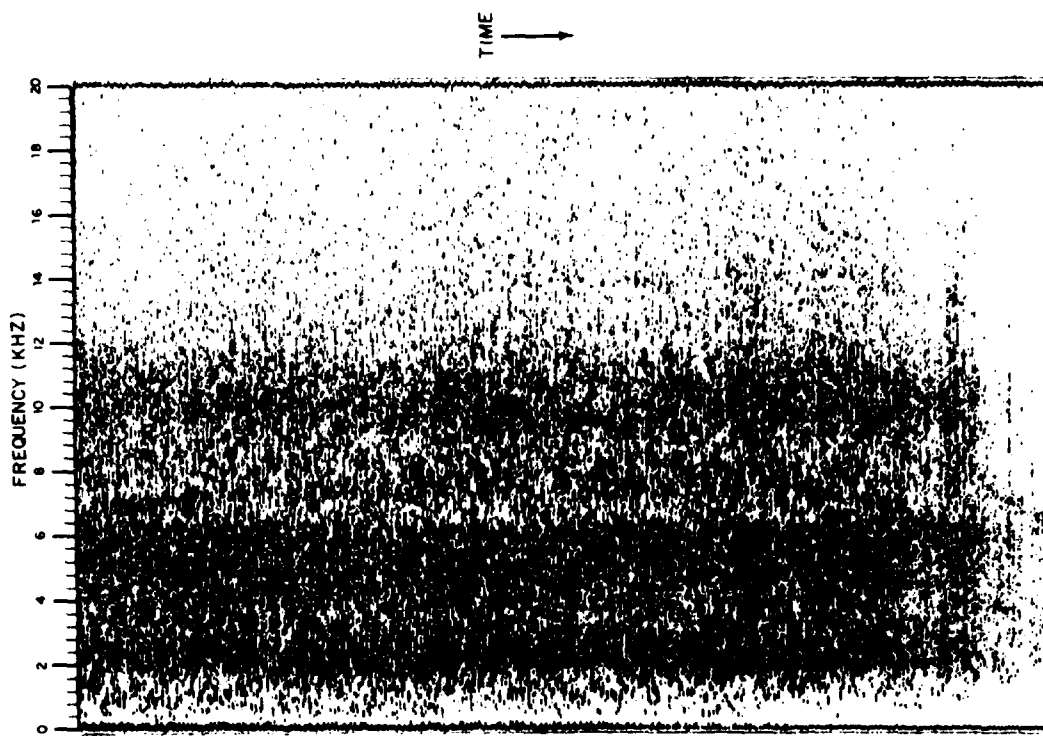
ASW-587-100

Figure A-100. Microphone No. 3 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



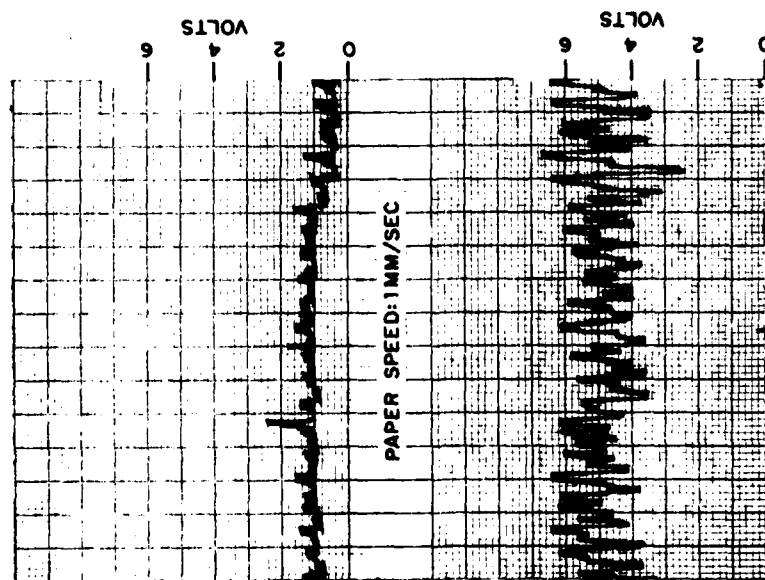
ASW-587-101

Figure A-101. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



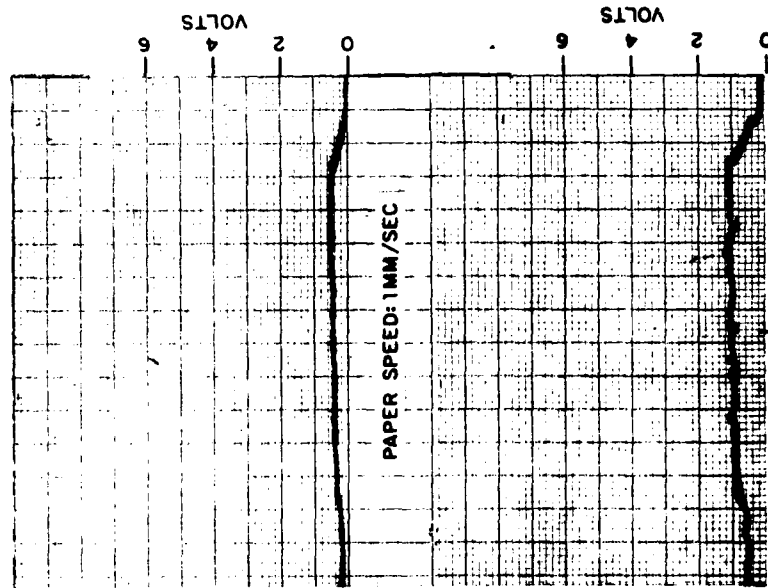
ASW-587-102

Figure A-102. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



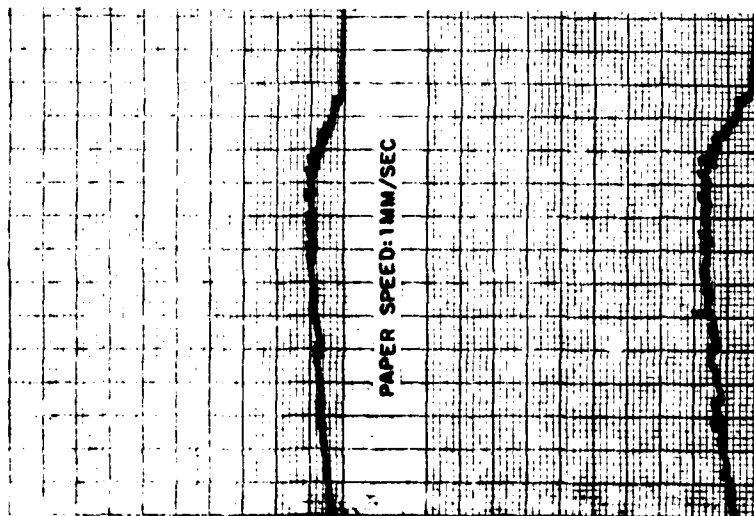
ASW-587-103

Figure A-103. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



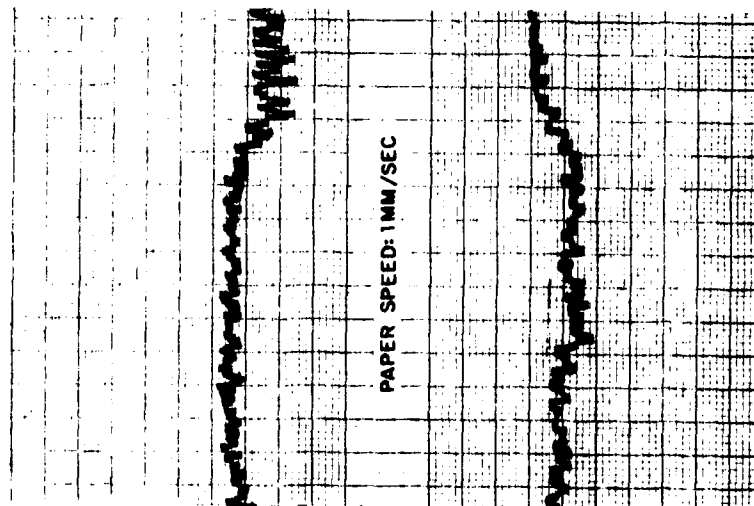
ASW-587-104

Figure A-104. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



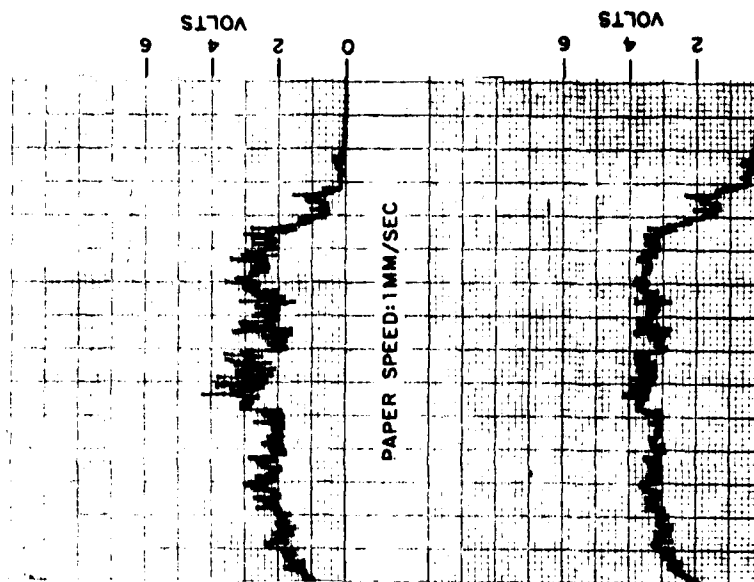
ASW-587-105

Figure A-105. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-106

Figure A-106. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-107

Figure A-107. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.

A.4 J-47 ENGINE, MODIFIED BURNER CAN HOLE OPEN - 0.75 INCH
DIAMETER

A series of three test runs were made on the J-47 engine with the modified can hole masked to a 0.75-inch hole. Each test was recorded using five microphones located in the same positions as for the closed-hole tests. The three tests were run at the following engine speeds:

- (1) 70% RPM (46 in. Hg gage, diffuser case pressure)
- (2) 80% RPM (70 in. Hg gage, diffuser case pressure)
- (3) 90% RPM (97 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed hole on the modified burner can and a small open hole (0.75 inch in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 70% run - pages A-73 through A-75
- (2) 80% run - pages A-79 through A-84
- (3) 90% run - pages A-85 through A-90

A.4.1 Analysis

A.4.1.1 Sound Energy Levels

As in the 1.0 inch open-hole test, there was a decrease in the sound level of all microphones. The decrease, however, was more pronounced at high engine speeds than at low engine speeds. This is the direct opposite of the results of the 1.0 inch open hole test. The magnitude of change from a 1.5 to a 1.0-inch open hole and from a 1.0 to a 0.75-inch open hole was approximately equal. The reduction in 0.75 inch open hole area is approximately 55% of 1.0 inch open hole and 25% of 1.5 inch open hole.

A.4.1.2 Spectrum Analysis

The 0.75 inch open-hole test results were similar to the 1.0 inch open-hole test results. All grams were less dense due to a reduction in noise intensity. The changes were most pronounced in microphones 3 and 5.

A.4.1.3 Mean Square Analysis

The results of this analysis were similar to the 1.0 inch open-hole test. Again, microphone 1 and 4 recordings showed that a large portion of the spectrum was below 5 kHz.

A.4.2 Environmental Conditions

The three tests discussed in paragraph A.4 were performed at an ambient temperature of 61° F and 75% relative humidity.

A.4.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table A-10. Microphone Sound Energy Levels at 70% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	90	8	28	15	13
RMS (μBAR)	720	630	260	120	105
dB (a)	131	130	121	116	114

$$^a_{\text{Ref}} = 2 \times 10^{-4} \mu\text{BAR}$$

Table A-11. Microphone Sound Energy Levels at 80% Engine RPM

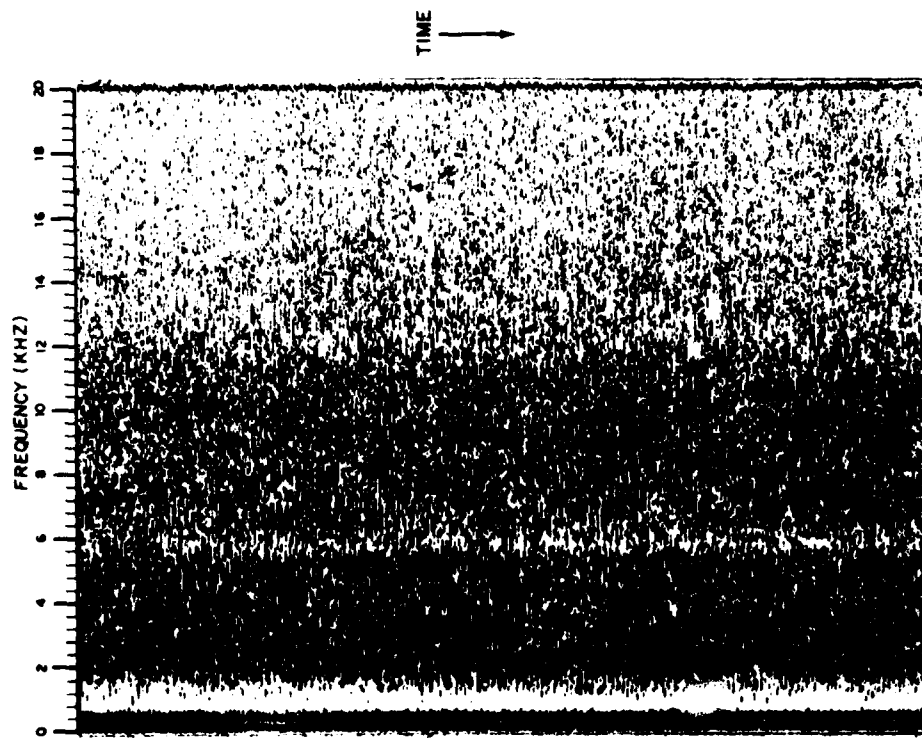
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	170	19	45	26	20
RMS (μBAR)	1350	1500	360	210	160
dB (a)	136	137	125	120	118

$$^a_{\text{Reference}} = 2 \times 10^{-4} \mu\text{BAR}$$

Table A-12. Microphone Sound Energy Levels at 90% Engine RPM

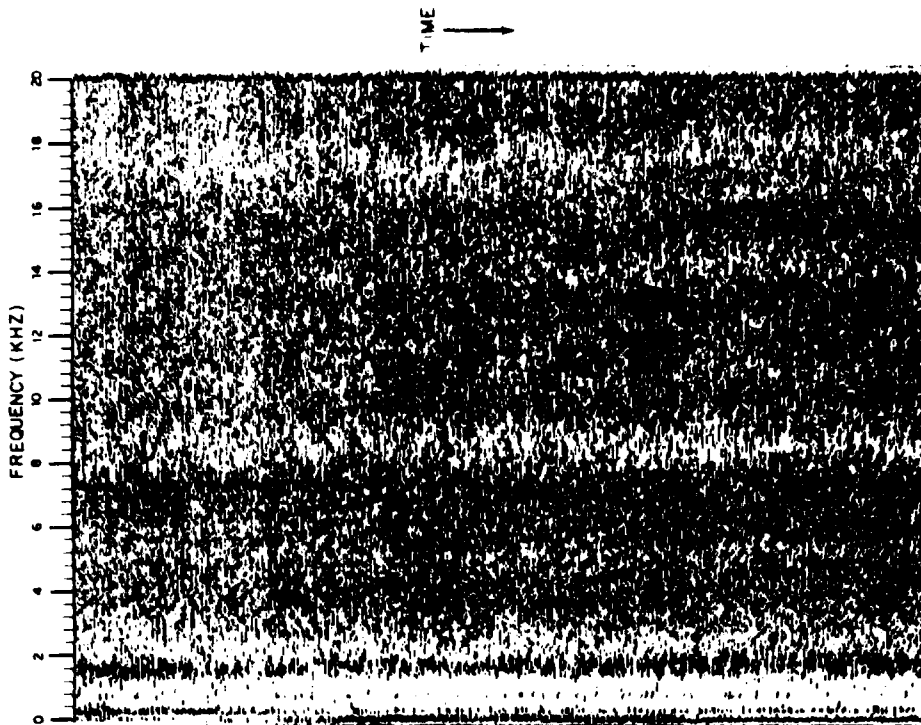
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	240	26	61	33	32
RMS (μBAR)	1900	2000	490	260	250
dB (a)	139	140	128	122	122

$$^a_{\text{Reference}} = 2 \times 10^{-4} \mu\text{BAR}$$



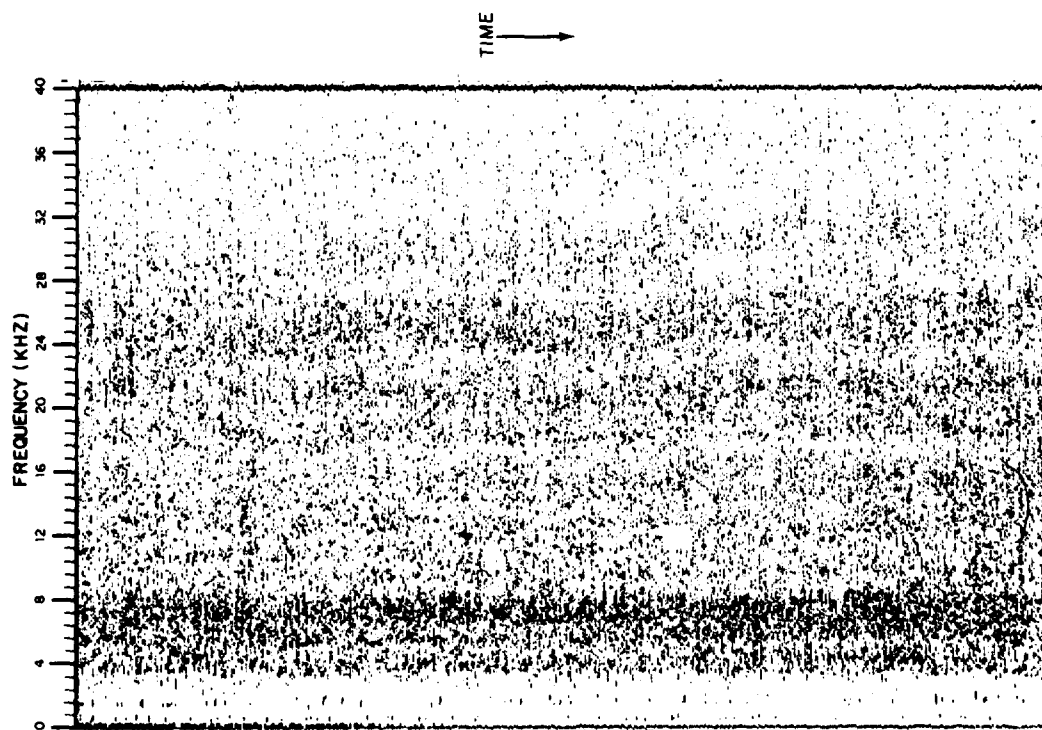
ASM-587-108

Figure A-108. Microphone No. 1 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 KHz.



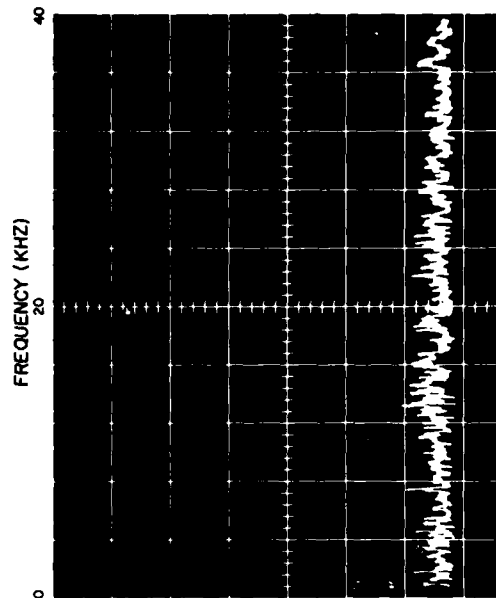
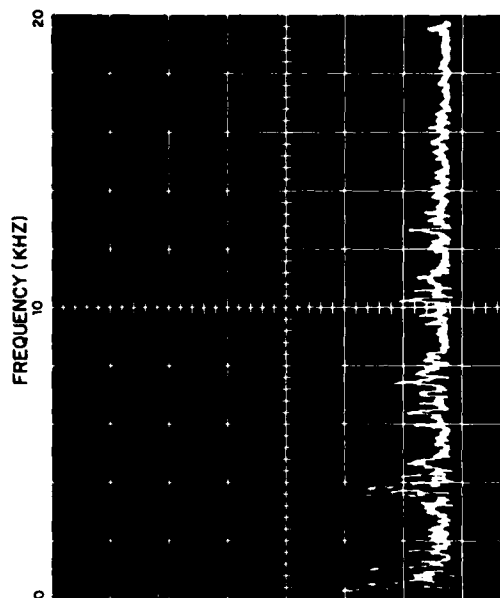
ASM-587-109

Figure A-109. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 KHz.



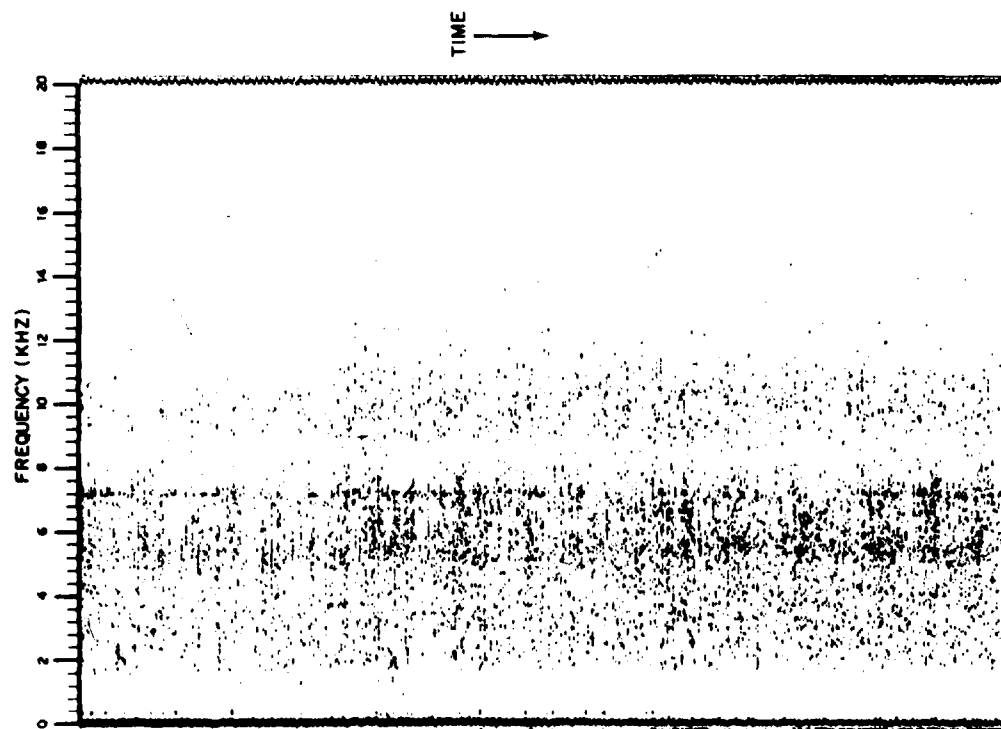
ASW-587-110

Figure A-110. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



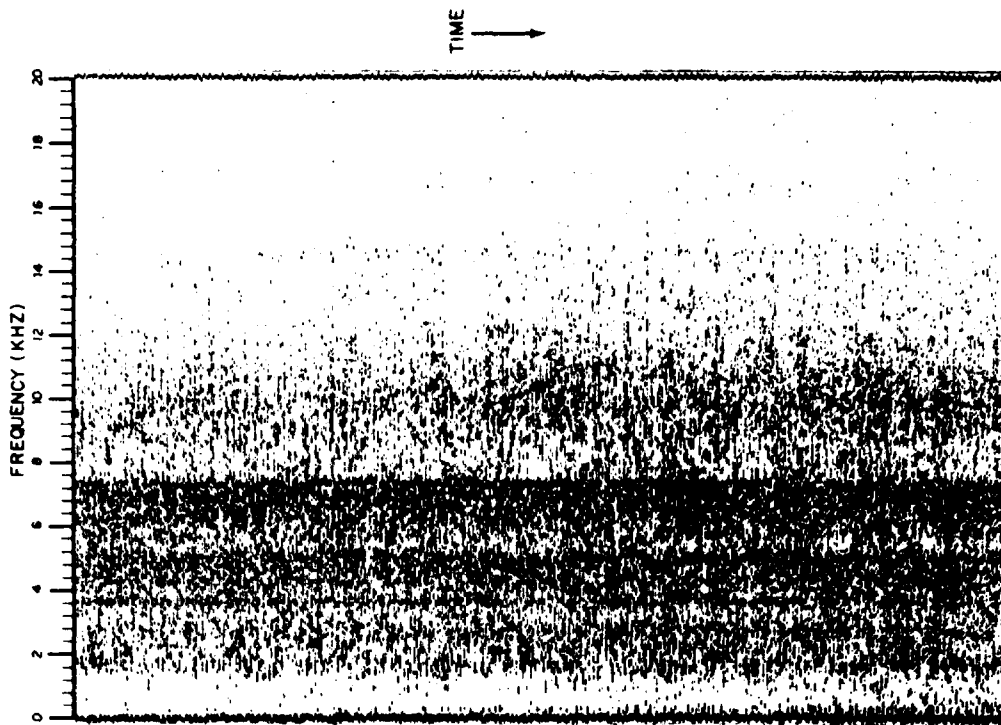
ASW-587-111

Figure A-111. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



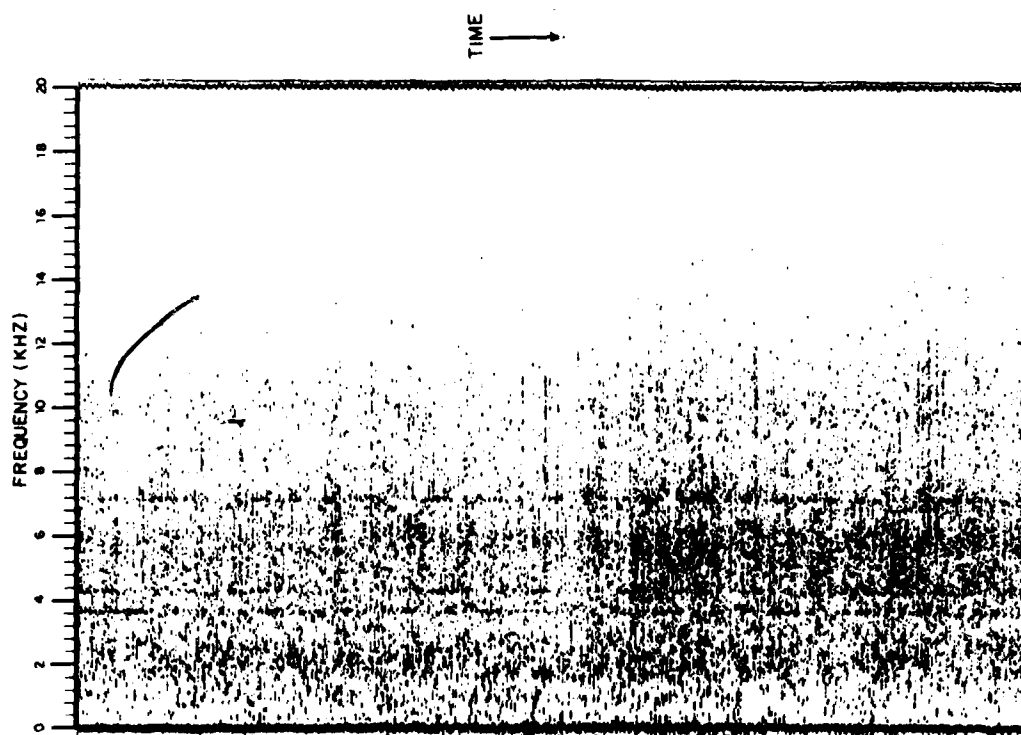
ASW-587-112

Figure A-112. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



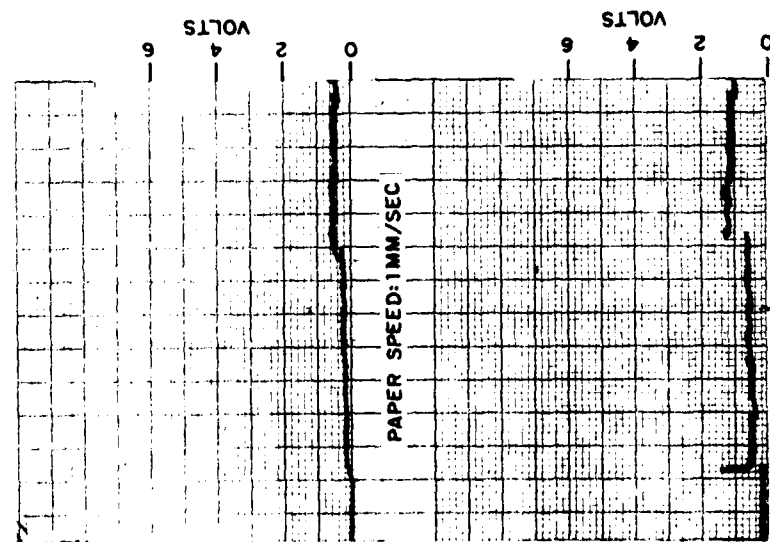
ASW-587-113

Figure A-113. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



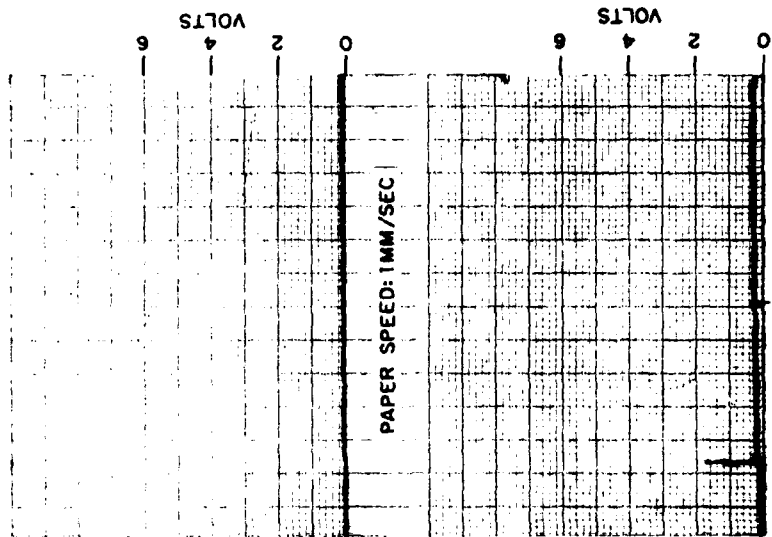
ASW-587-114

Figure A-114. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



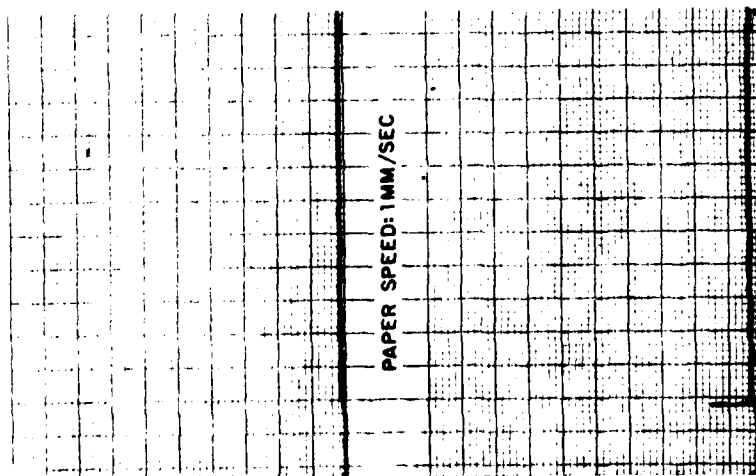
ASN-587-115

Figure A-115. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



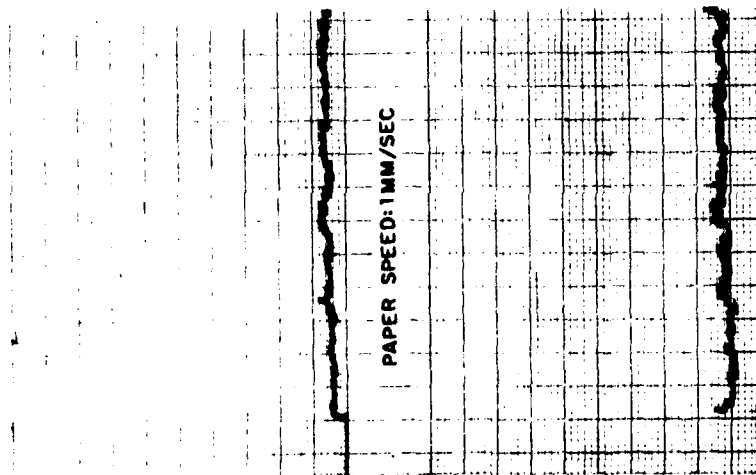
ASN-587-116

Figure A-116. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



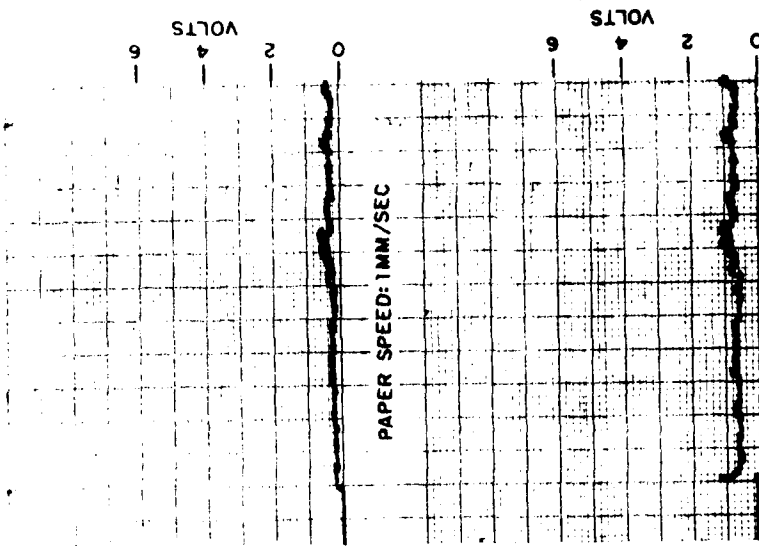
ASW-587-117

Figure A-117. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



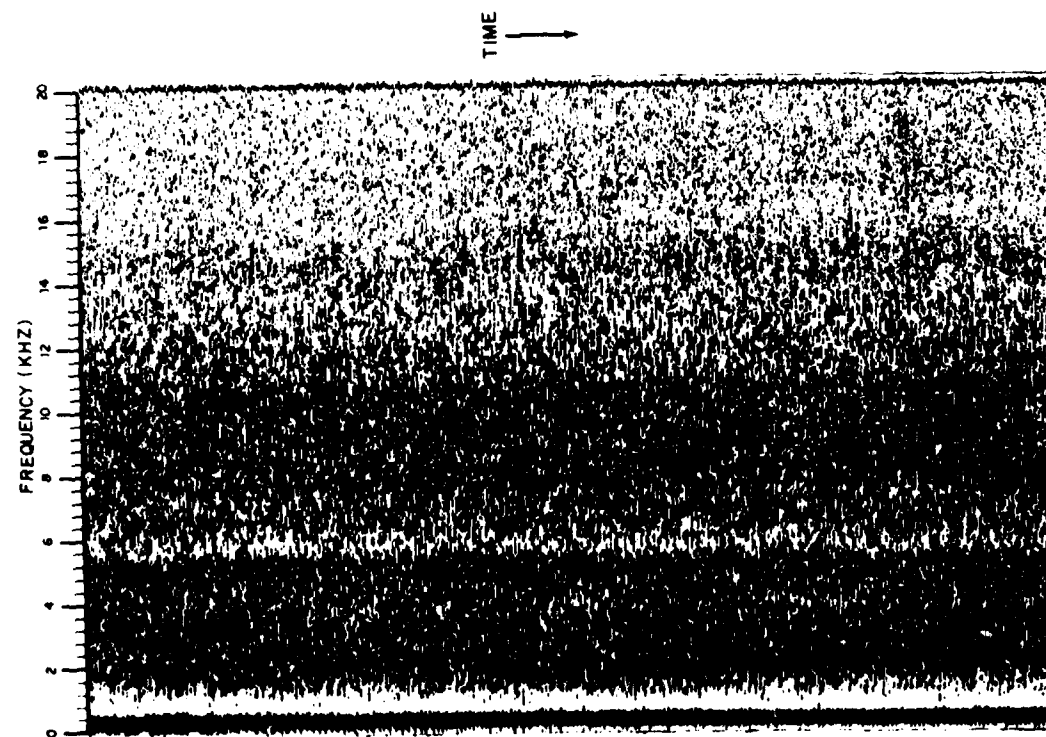
ASW-587-118

Figure A-118. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



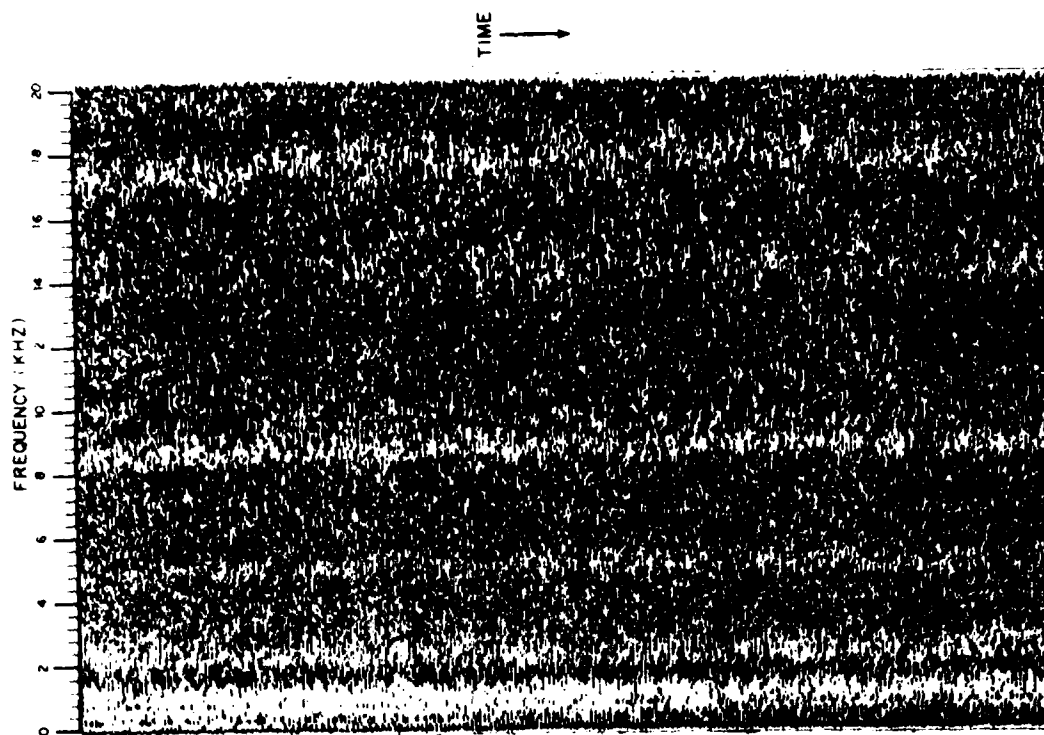
ASW-587-119

Figure A-119. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



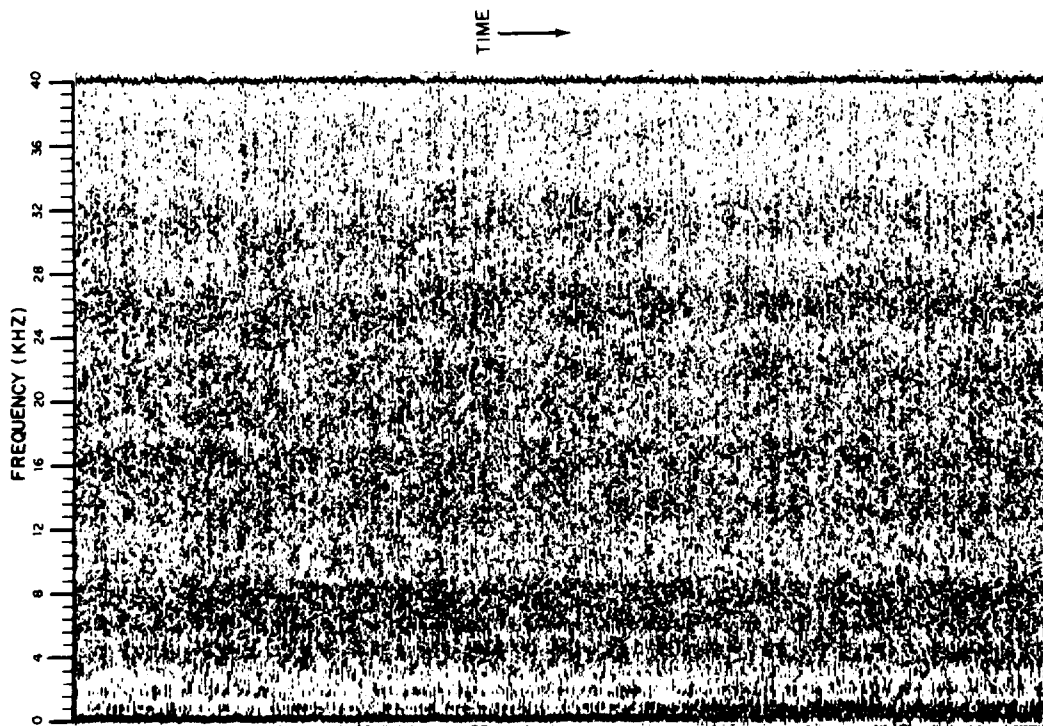
ASN-587-120

Figure A-120. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



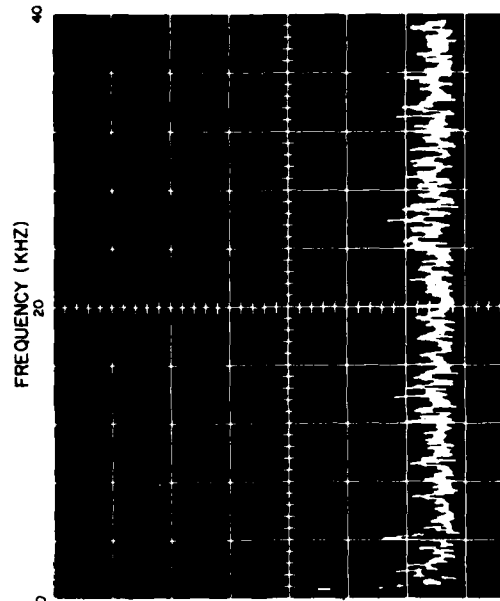
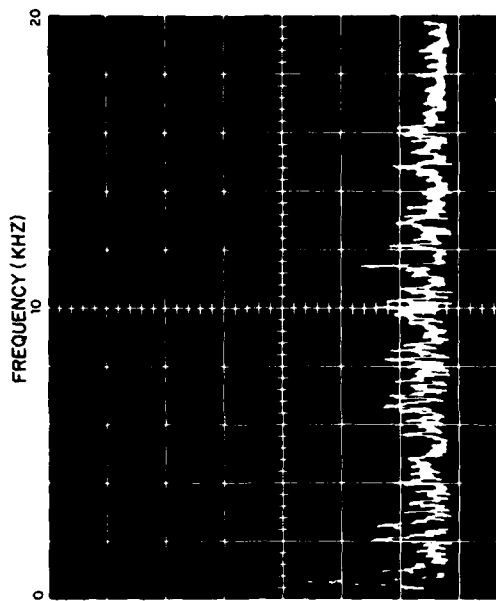
ASN-587-121

Figure A-121. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



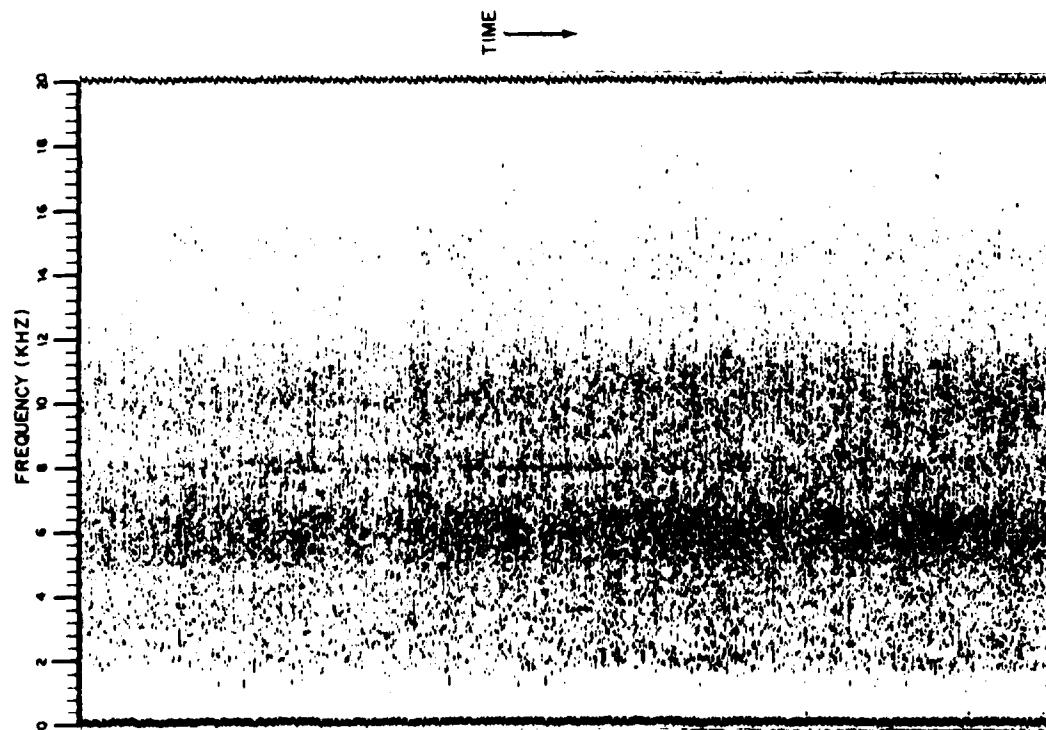
ASW-587-122

Figure A-122. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



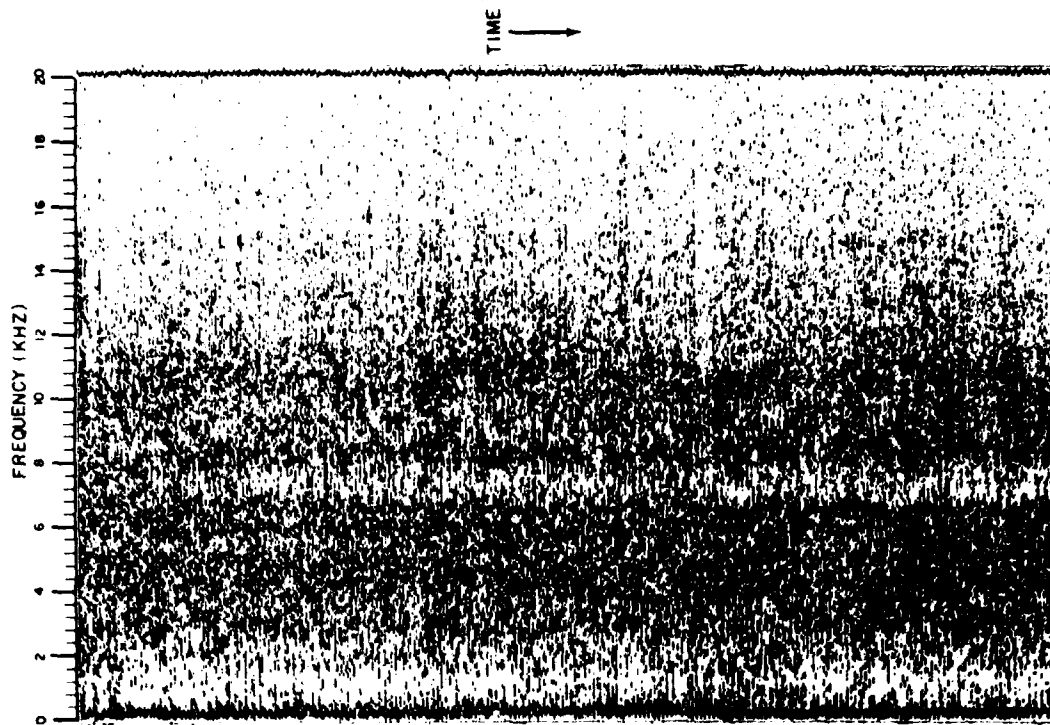
ASW-587-123

Figure A-123. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



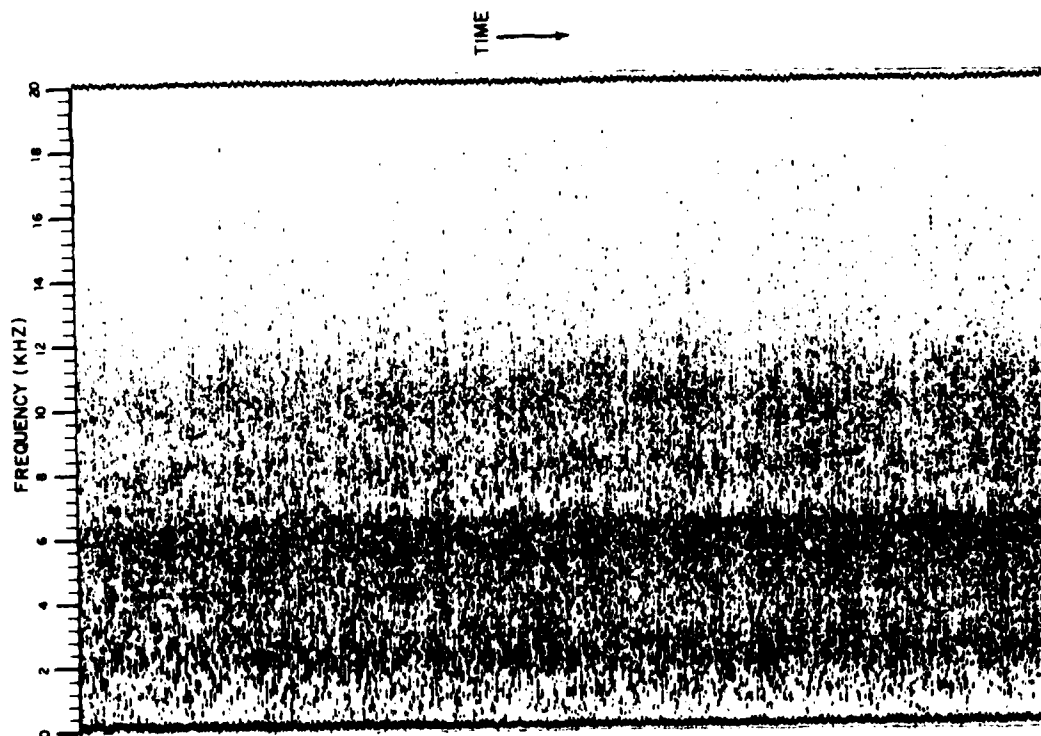
ASM-587-124

Figure A-124. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



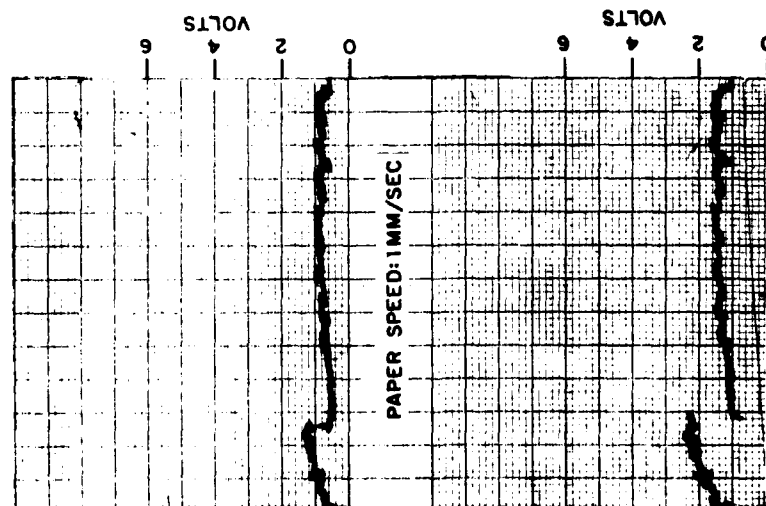
ASM-587-125

Figure A-125. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



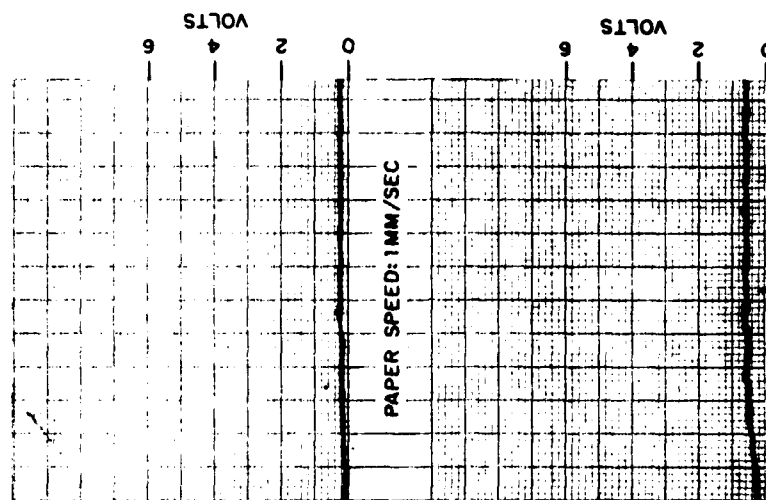
ASN-587-126

Figure A-126. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



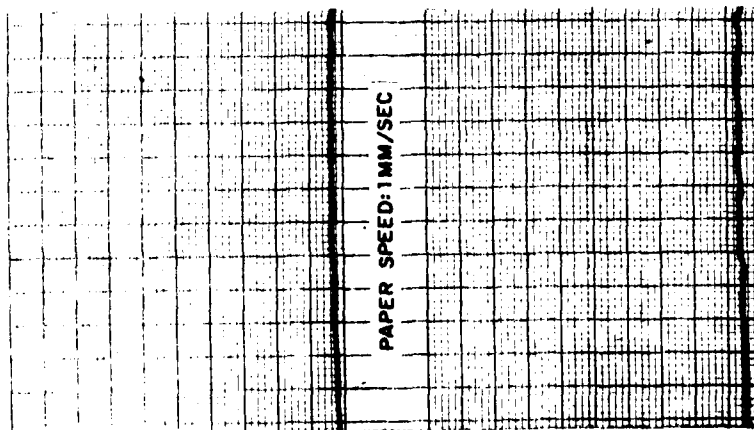
ASN-587-127

Figure A-127. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



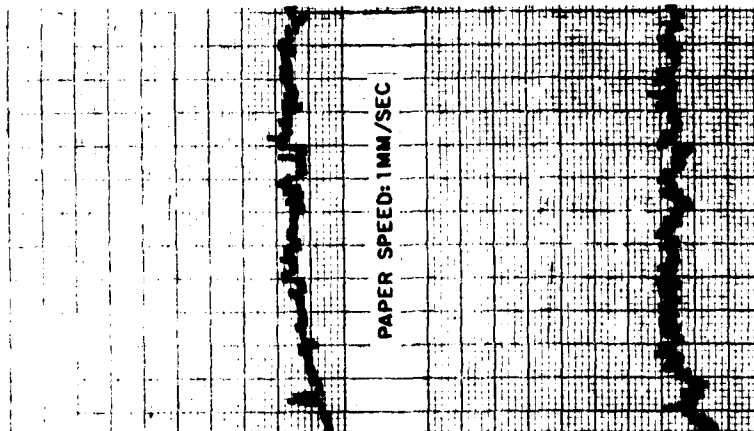
ASN-587-128

Figure A-128. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



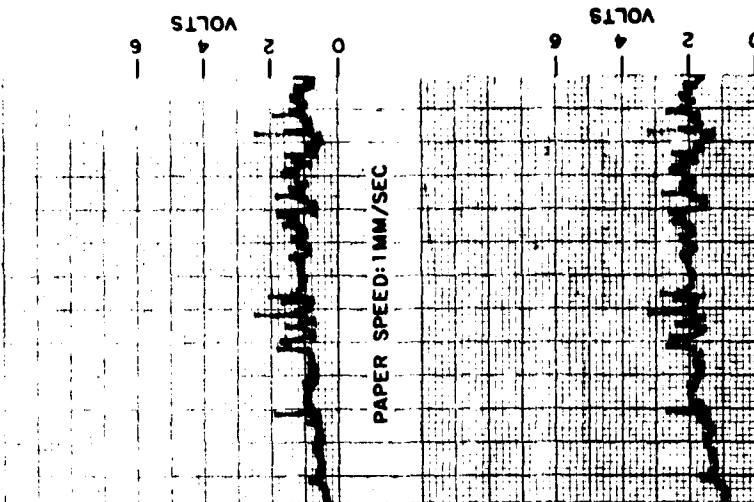
ASM-587-129

Figure A-129. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



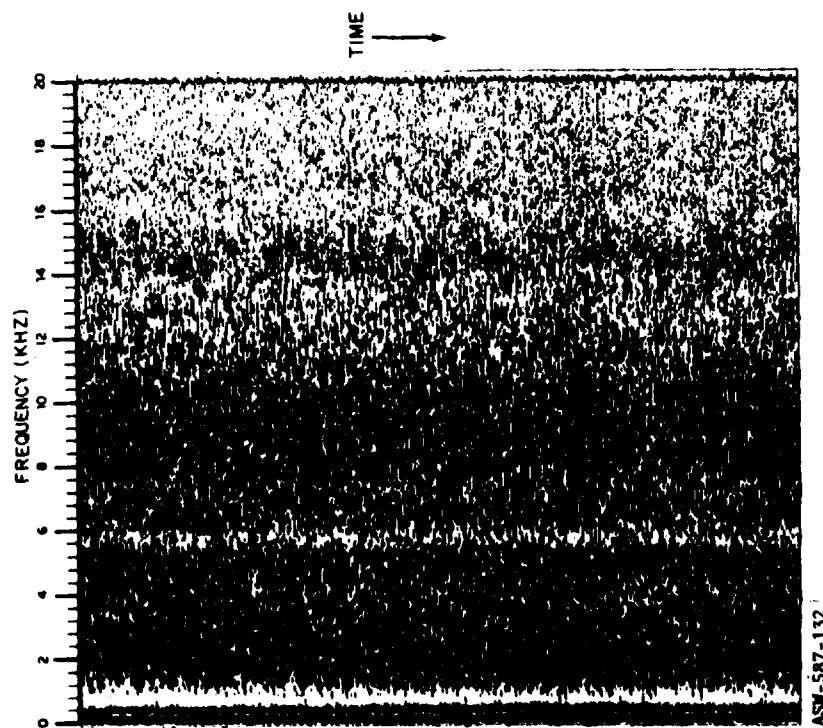
ASM-587-130

Figure A-130. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



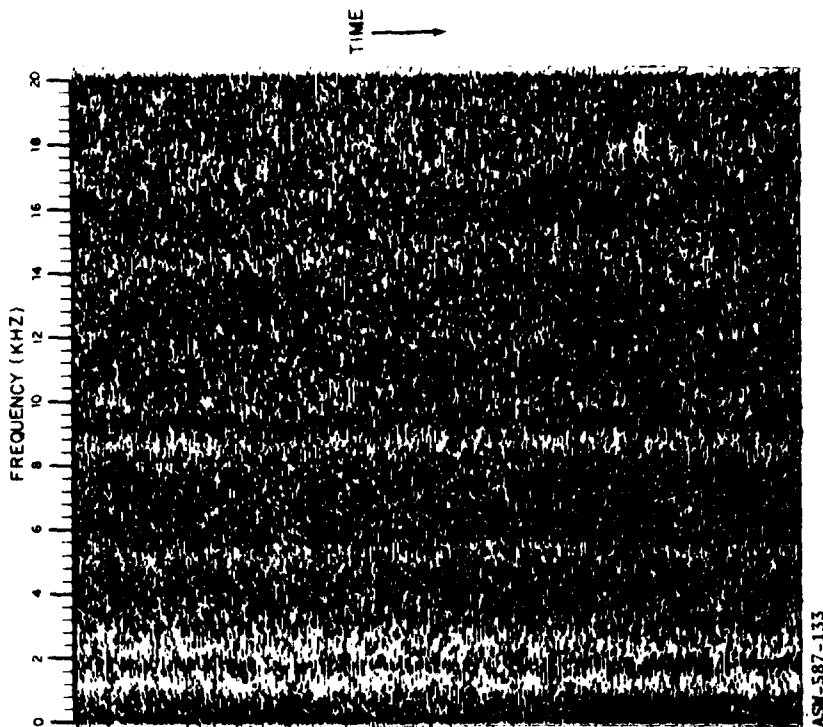
ASM-587-131

Figure A-131. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



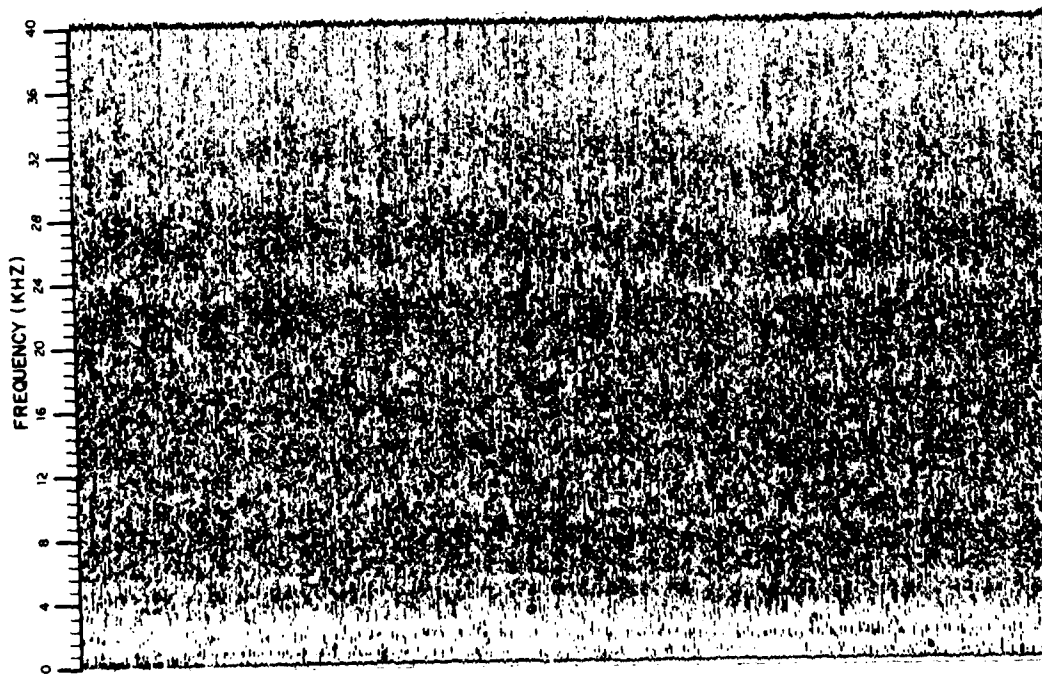
ASM-587-132

Figure A-132. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



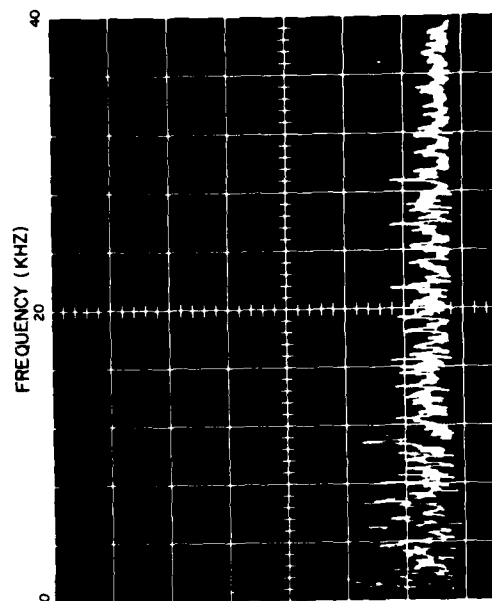
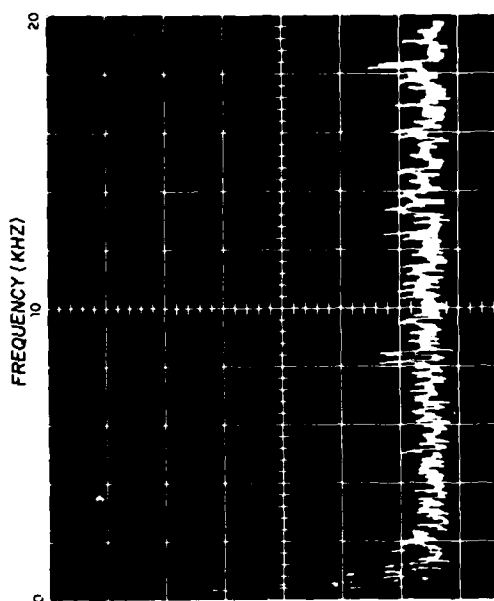
ASM-587-133

Figure A-133. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



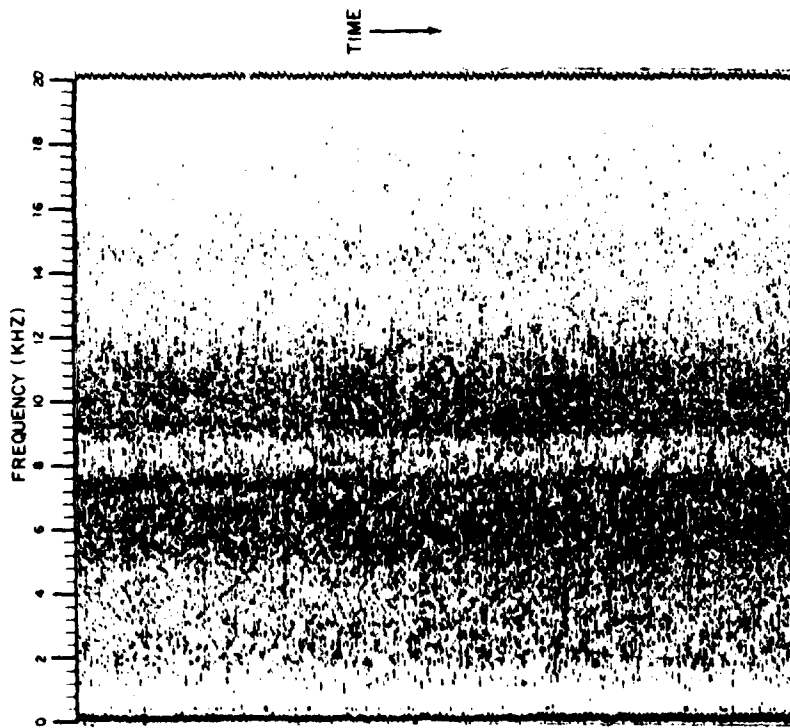
ASW-587-134

Figure A-134. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



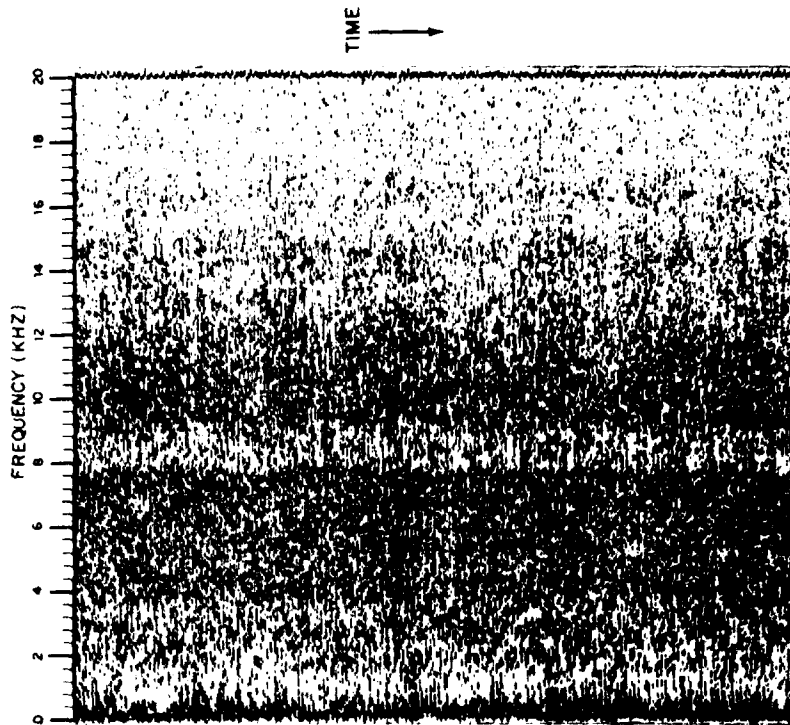
ASW-587-135

Figure A-135. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



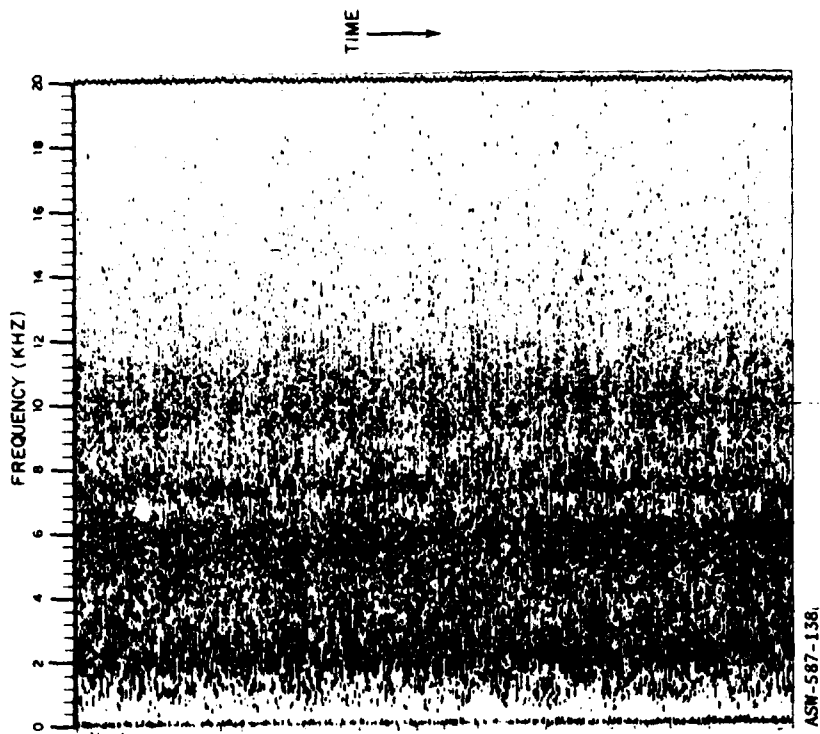
ASW-587-136

Figure A-136. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



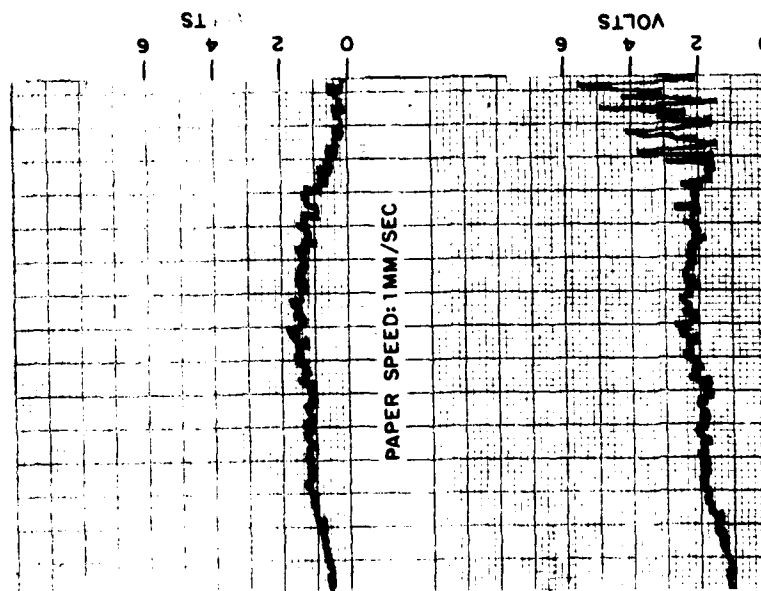
ASW-587-137

Figure A-137. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



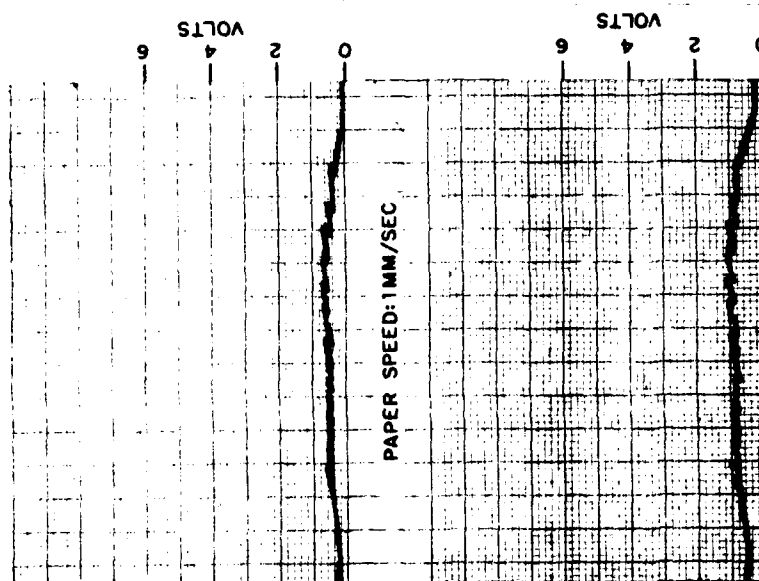
ASN-587-138.

Figure A-138. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



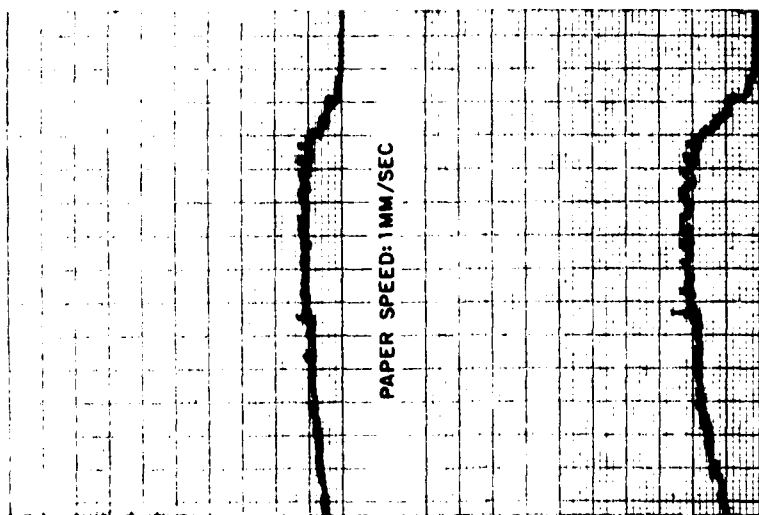
ASW-587-139

Figure A-139. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



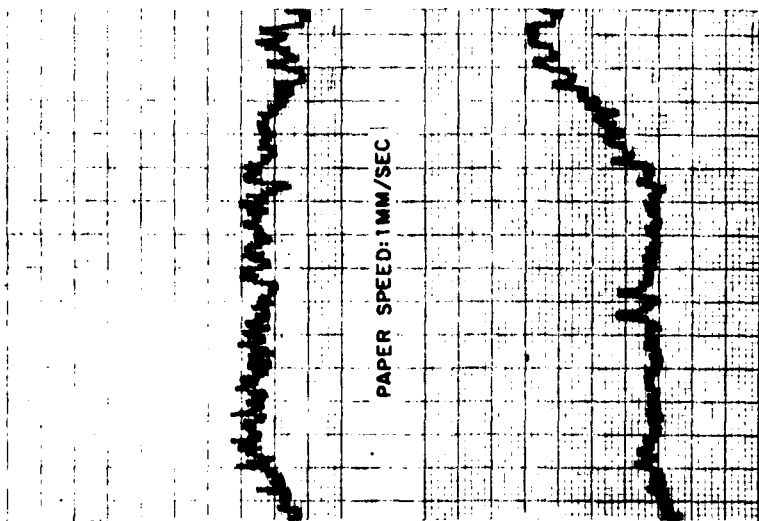
ASW-587-140

Figure A-140. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



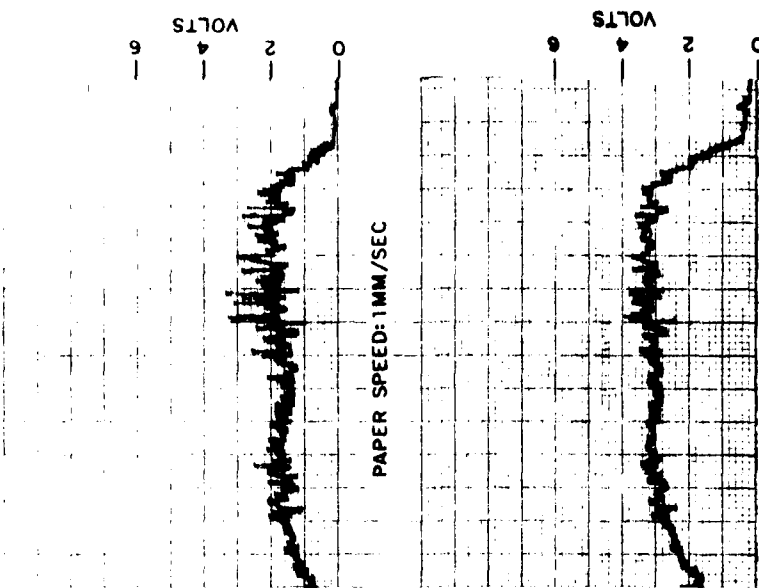
ASW-587-141

Figure A-141. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-142

Figure A-142. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASW-587-143

Figure A-143. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.

AD-A132 357

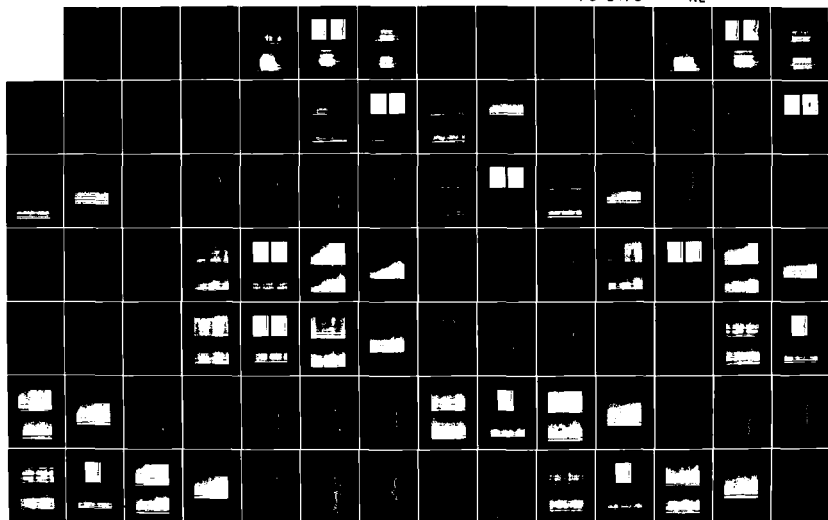
JET ENGINE BURN-THROUGH INVESTIGATION VOLUME 2 ENGINE
TESTS RAW DATA(U) MAGNAVOX CO FORT WAYNE IND FORT WAYNE
DIV R W SCHUMACKER MAR 73 FAA-NA-72-96-2 DOT-FAT2-575

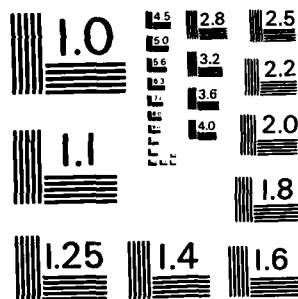
2/4

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

A.5 J-47 ENGINE, MODIFIED BURNER CAN FAILURE No. 1

In order to simulate an actual burner can burn-through, the open hole in the modified burner can on the J-47 engine was masked to a 1.5-inch diameter hole and covered with a 0.1-inch thick lead cap. Lead, with its low melting point, was used to facilitate rapid failure since this engine lacked the power and consequently the heat to burn through a thicker or higher melting point material. The engine was started and power was increased with flame in the can until failure occurred. The test was recorded using five microphones located in the same positions as for the closed hole test. The purpose of this test was to compare the sound energy level of a burn-through with that of an open hole.

Analysis of the recordings made during this test run appear on pages A-93 through A-97.

A.5.1 Analysis

A.5.1.1 Sound Energy Level

The burn-through test resulted in a reading of 121 dB prior to burn-through and 143 dB after burn-through. Readings were taken on microphone No. 1 only, since the lead hole cover melted too rapidly to allow for readings on other microphones. The results compared favorably with microphone No. 1 results for the closed hole test at 80% RPM and the 1.5 inch open hole test at 80% RPM.

A.5.1.2 Spectrum Analysis

The results of the spectrum analysis indicated that the lead plate failed when engine speed was slightly more than 80% RPM. This was determined by comparing discrete machinery frequencies on grams from previous runs to the grams of the burn-through. No discrete frequencies due to the burn-through were apparent. The microphone No. 2 gram was of little value because of an intermittent cable.

A.5.1.3 Mean Square Analysis

The burn-through was most pronounced on the microphone 4 and 5 recordings. The microphone 4 recording again showed a quantity of the spectrum below 5 kHz. This was especially pronounced prior to burn-through.

A.5.2 Environmental Conditions

The test was performed at an ambient temperature of 77° F and 90% relative humidity.

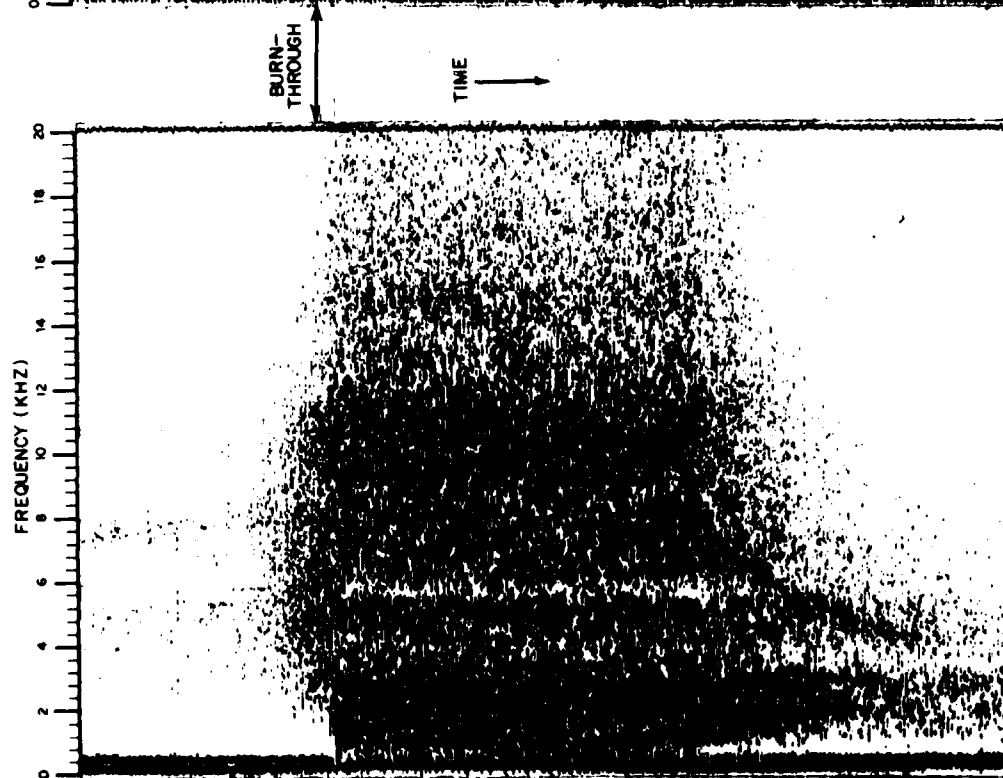
A.5.3 Sound Energy Level

The following table lists the sound energy level of microphone no. 2 before and after burn-through.

Table A-13. Sound Energy Level Before and After Burn-through

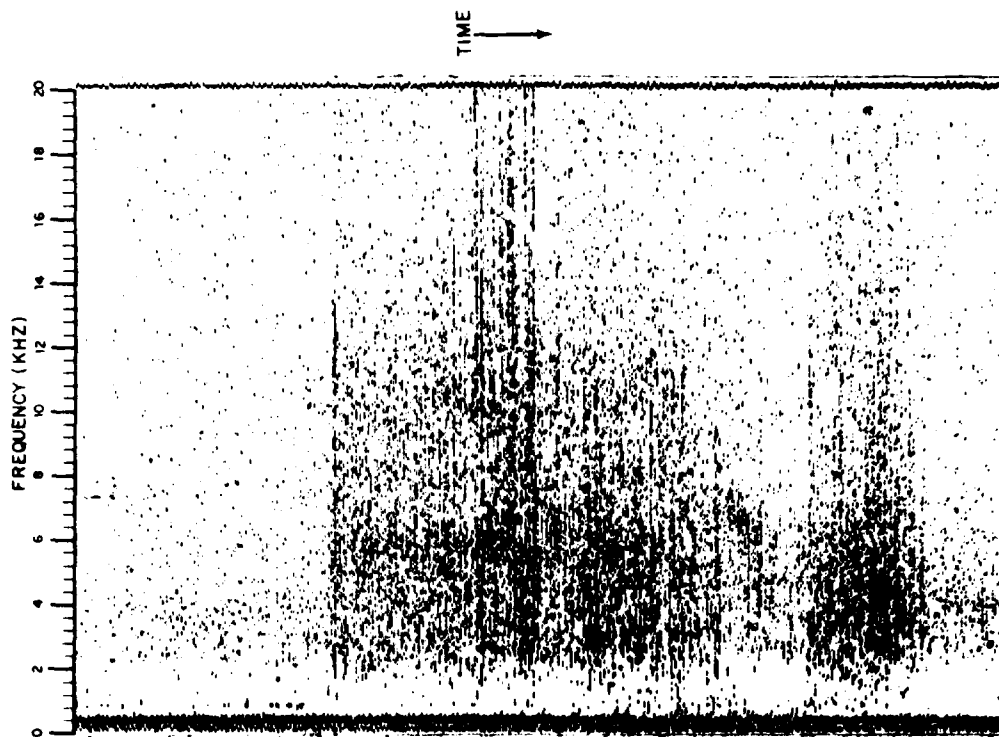
SOUND LEVEL	MICROPHONE No.2	
	BEFORE	AFTER
RMS (mV)	28	370
RMS (μBAR)	230	3000
dB (a)	121	143

^aReference = 2×10^{-4} μBAR



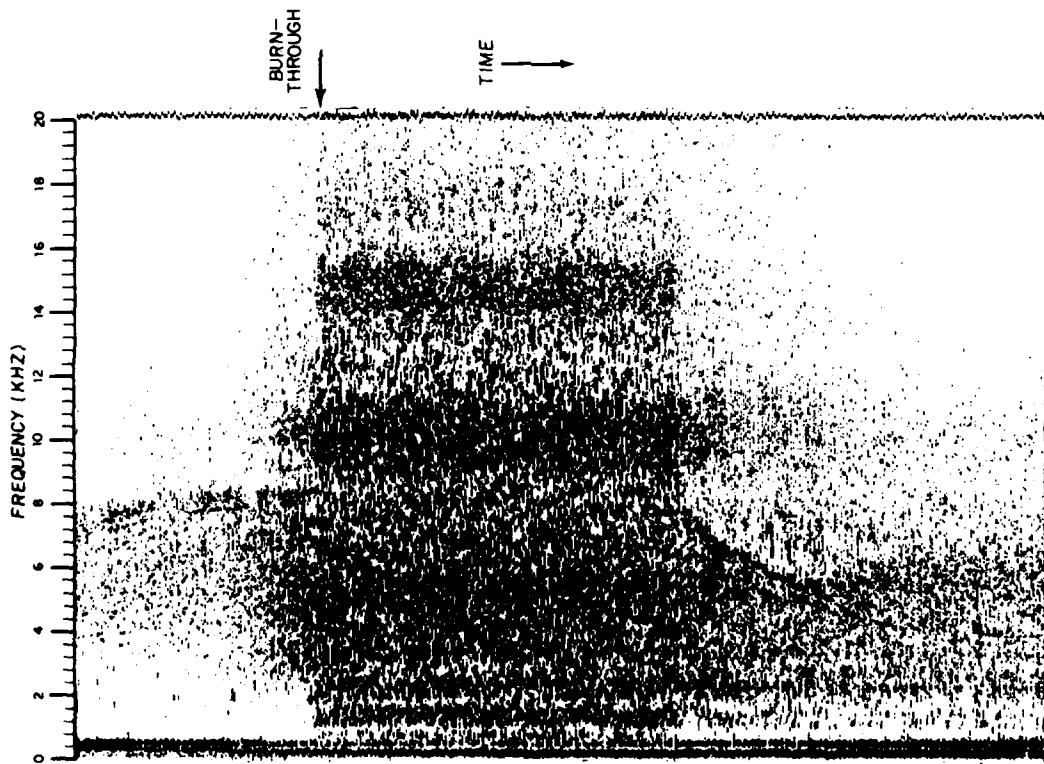
ASN-587-144

Figure A-144. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



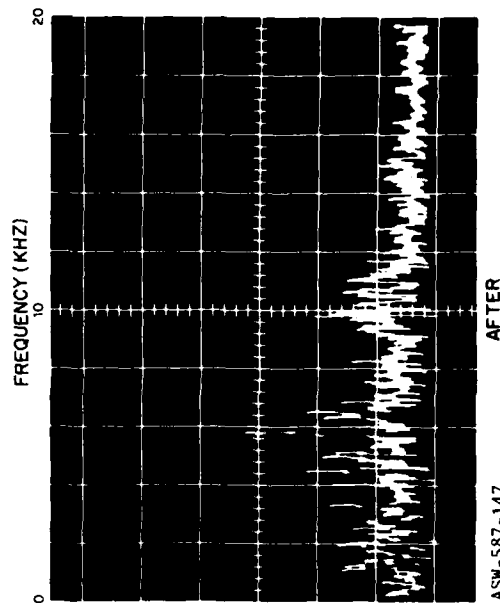
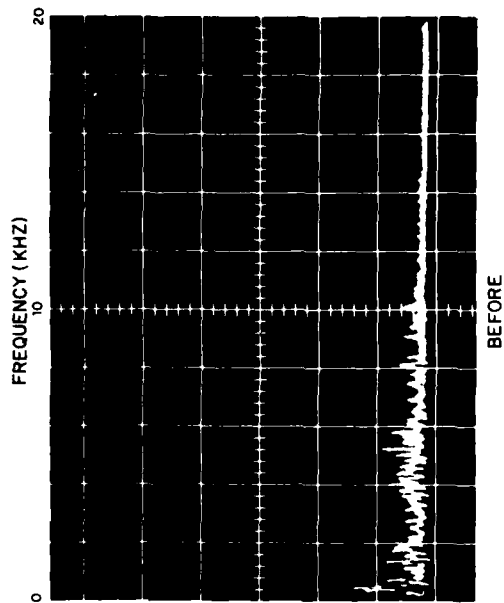
ASN-587-145

Figure A-145. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



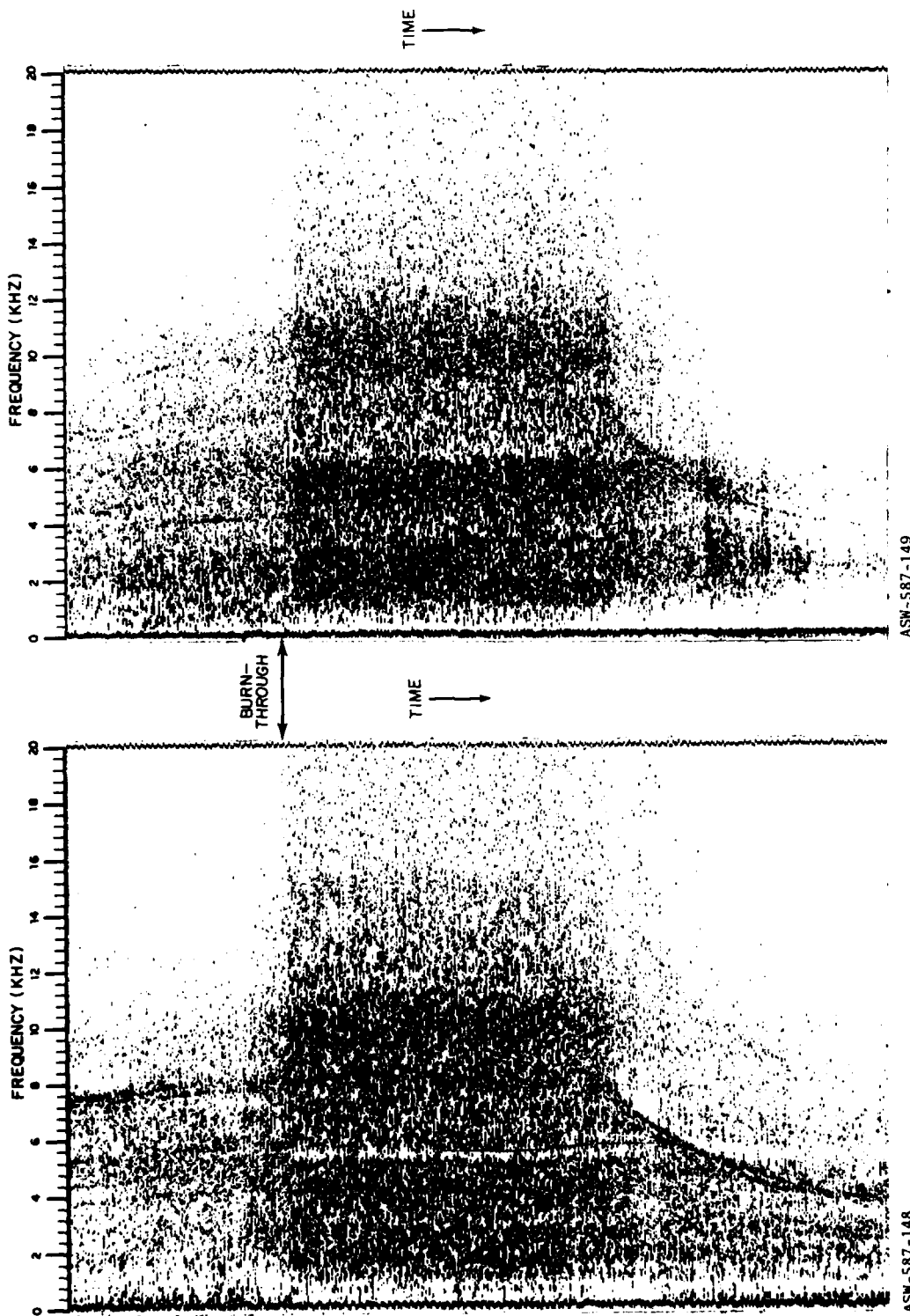
ASW-587-146

Figure A-146. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.



ASW-587-147

Figure A-147. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.

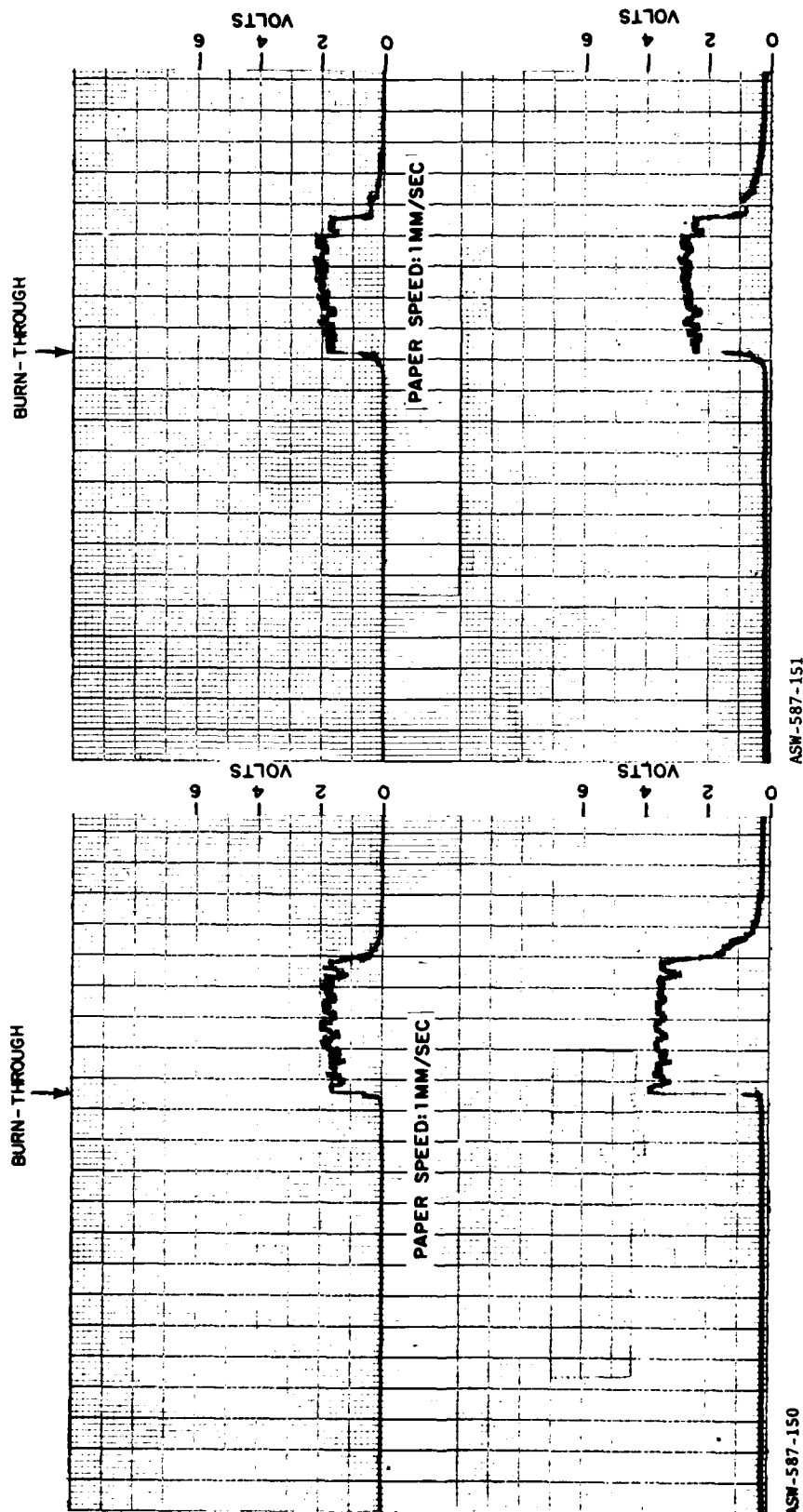


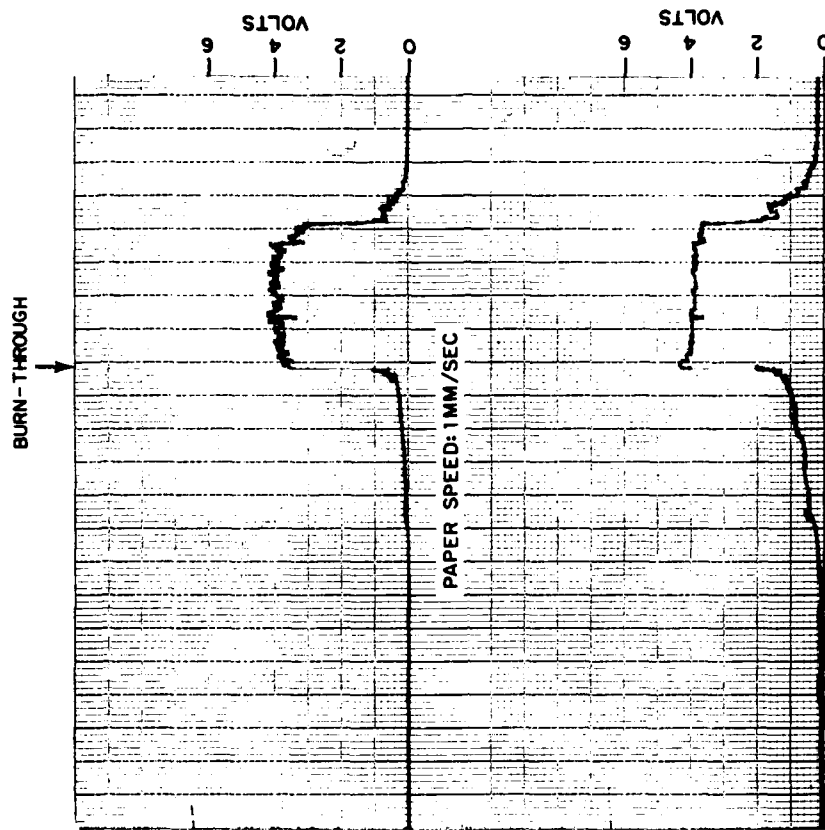
ASW-587-148

Figure A-148. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.

ASW-587-149

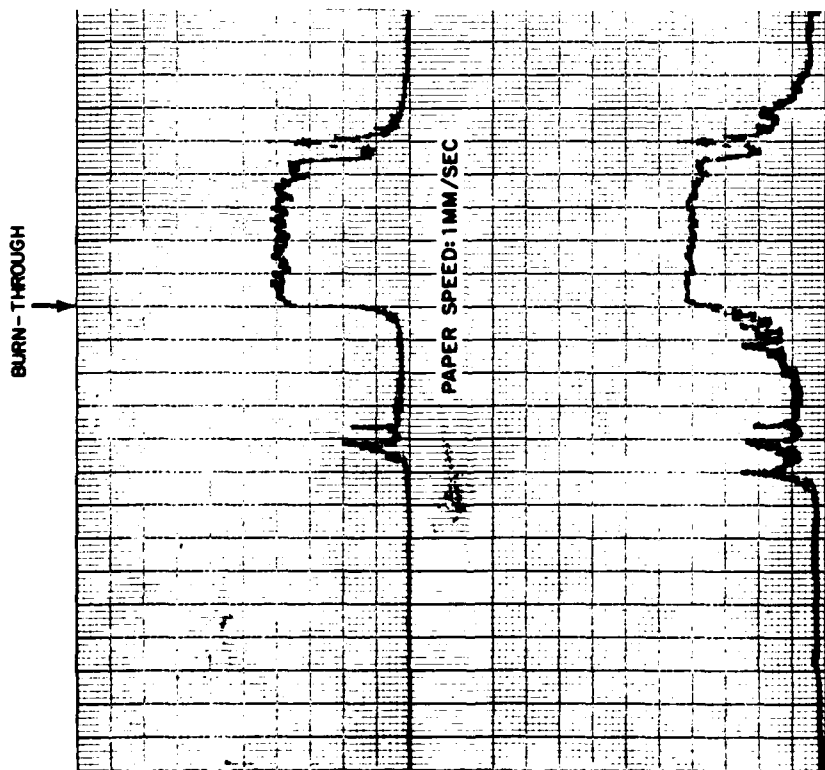
Figure A-149. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.





ASW-587-153

Figure A-153. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-152

Figure A-152. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

A.6 J-47 ENGINE, MODIFIED BURNER CAN FAILURE No. 2

A second test was run, which duplicated the previous burner-can failure, on the J-47 engine.

Analysis of the recordings made during this test run appear on pages A-100 through A-104.

A.6.1 Analysis

A.6.1.1 Sound Energy Level

The second burn-through test resulted in a reading of 116 dB prior to burn-through and 134 dB after burn-through. Meter readings were from microphone No. 4 only for this test. When compared with closed hole and 1.5 inch open-hole test readings, readings from this test indicated that engine speed prior to burn-through was slightly greater than 70% and after burn-through slightly greater than 80%.

A.6.1.2 Spectrum Analysis

The results of the spectrum analysis did not show any discrete frequencies due to burn-through. By comparing the discrete frequencies of the machinery, it was determined that the burn-through occurred at 80% RPM. The microphone No. 2 gram was again of little value because of an intermittent cable.

A.6.1.3 Mean Square Analysis

Microphones 4 and 5 had the most pronounced change in energy levels. The microphone No. 3 recording repeated burn-through No. 1 results in that there was a large portion of low frequency components prior to burn-through.

A.6.2 Environmental Conditions

The test was performed at an ambient temperature of 77° F and 40% relative humidity.

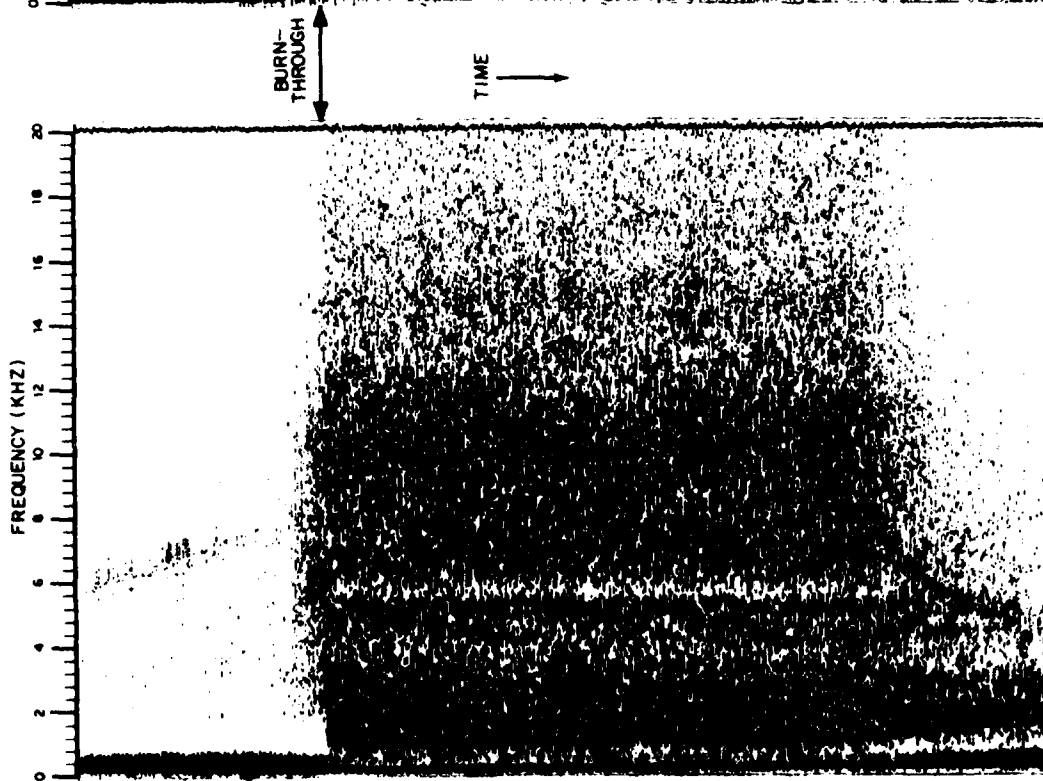
A.6.3 Sound Energy Level

The following table lists the sound energy level of microphone No. 3 before and after burn-through.

Table A-14. Sound Energy Level Before and After Burn-Through

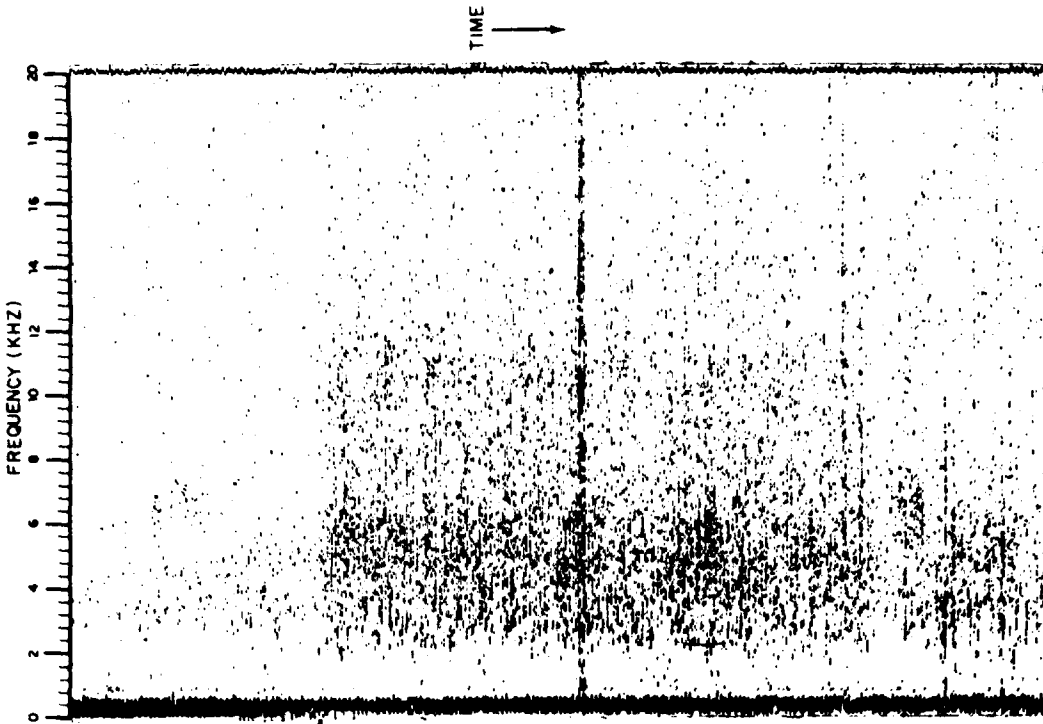
SOUND LEVEL	MICROPHONE No. 3	
	BEFORE	AFTER
RMS (mV)	15	130
RMS (μBAR)	120	1050
dB (a)	116	134

^aReference = 2×10^{-4} μBAR



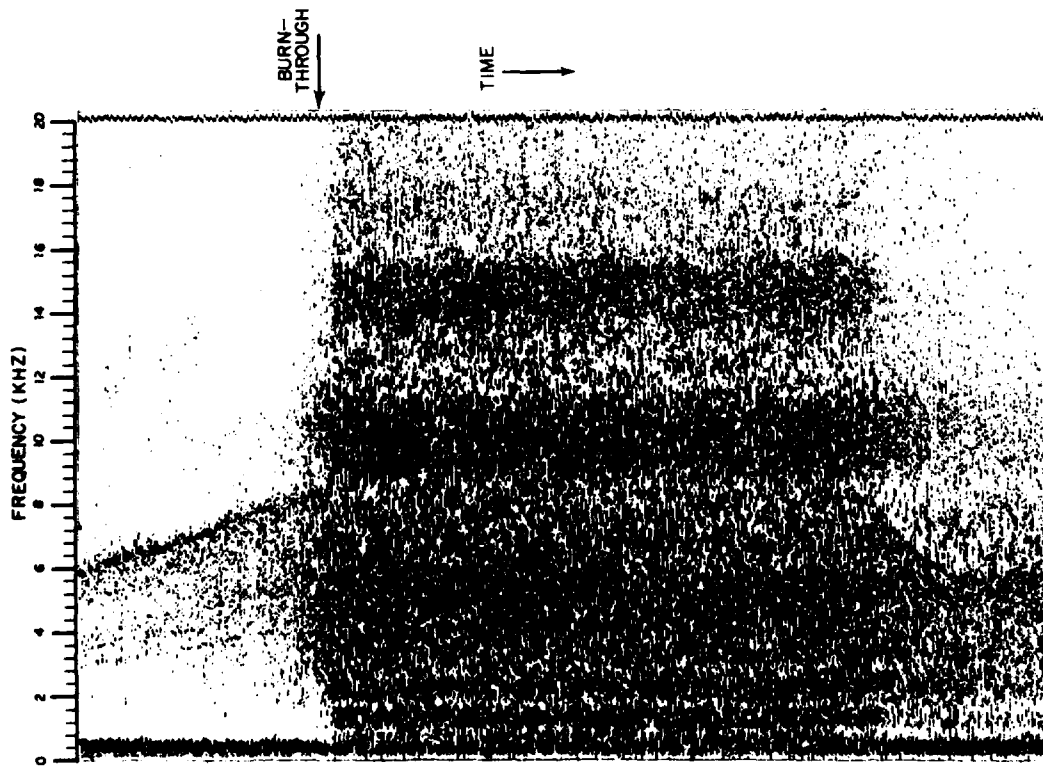
ASN-587-154

Figure A-154. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



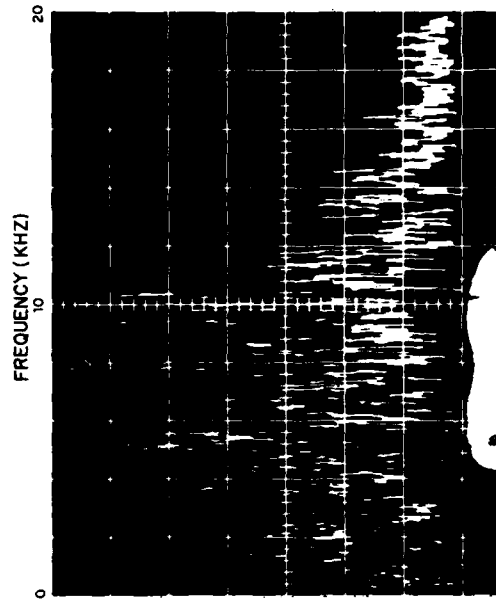
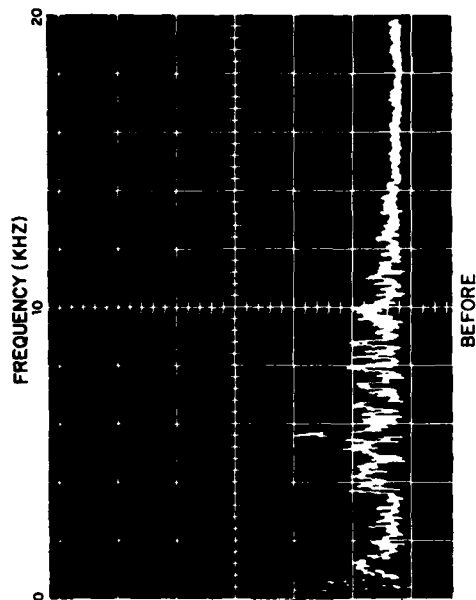
ASN-587-155

Figure A-155. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-156

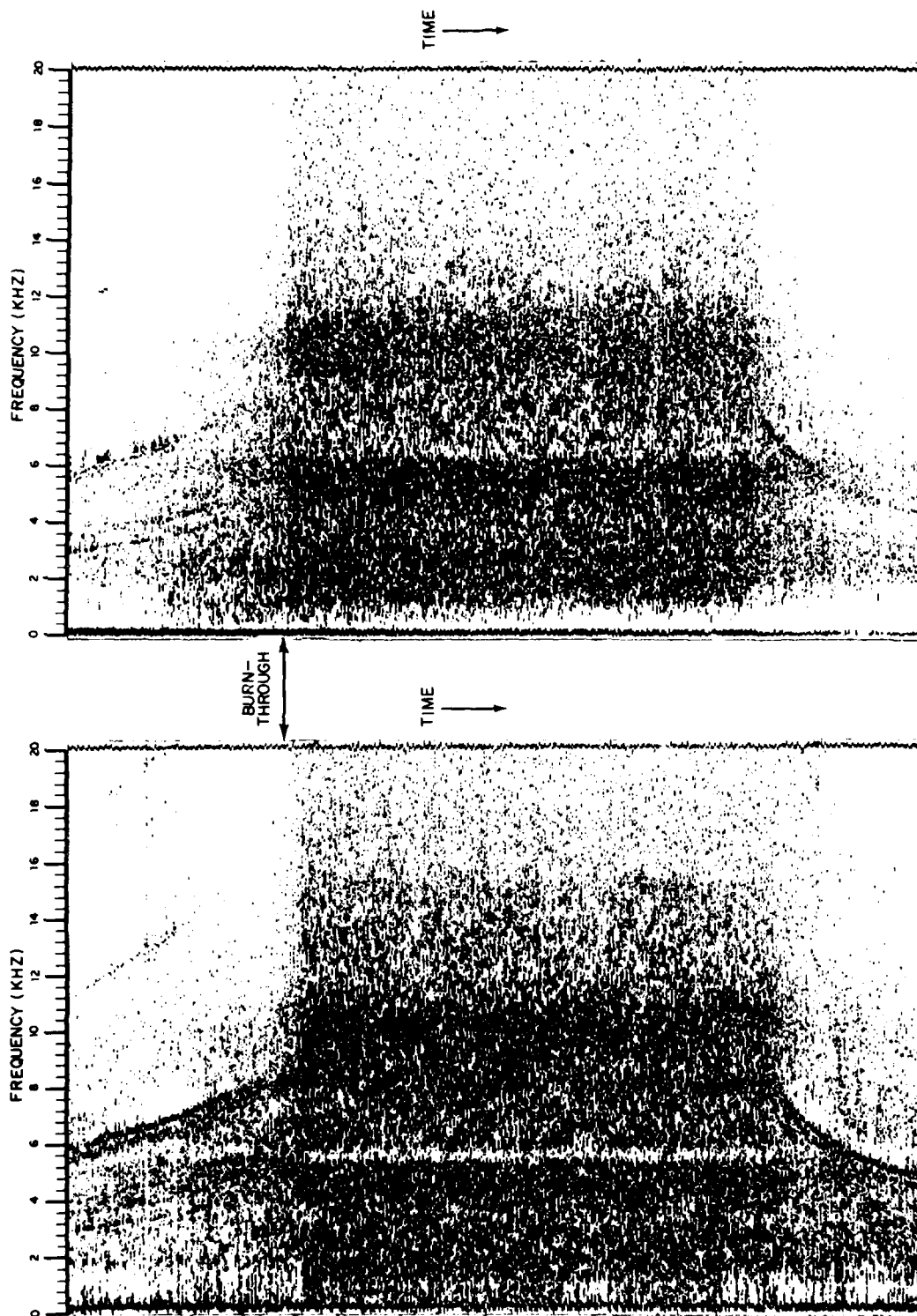
Figure A-156. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-157

AFTER

Figure A-157. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

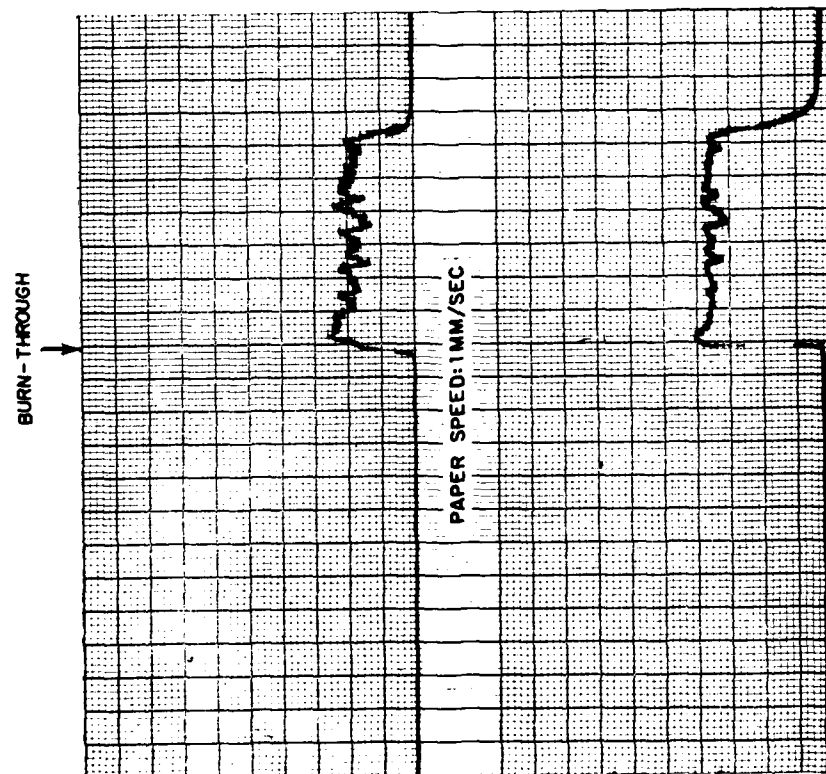


ASW-587-158

Figure A-158. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.

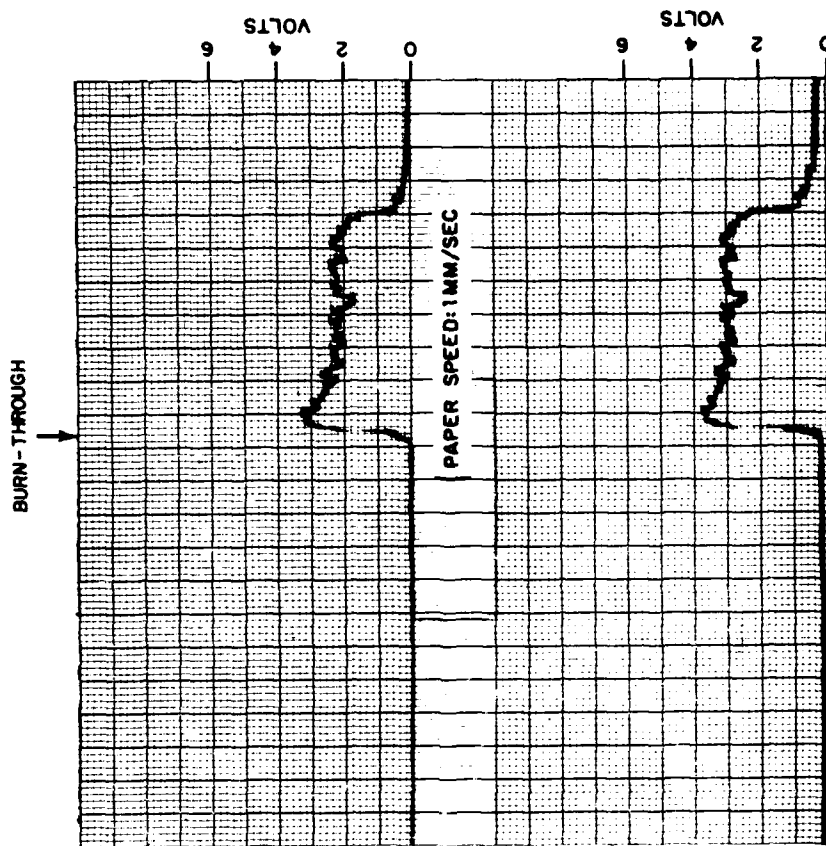
ASW-587-159

Figure A-159. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.



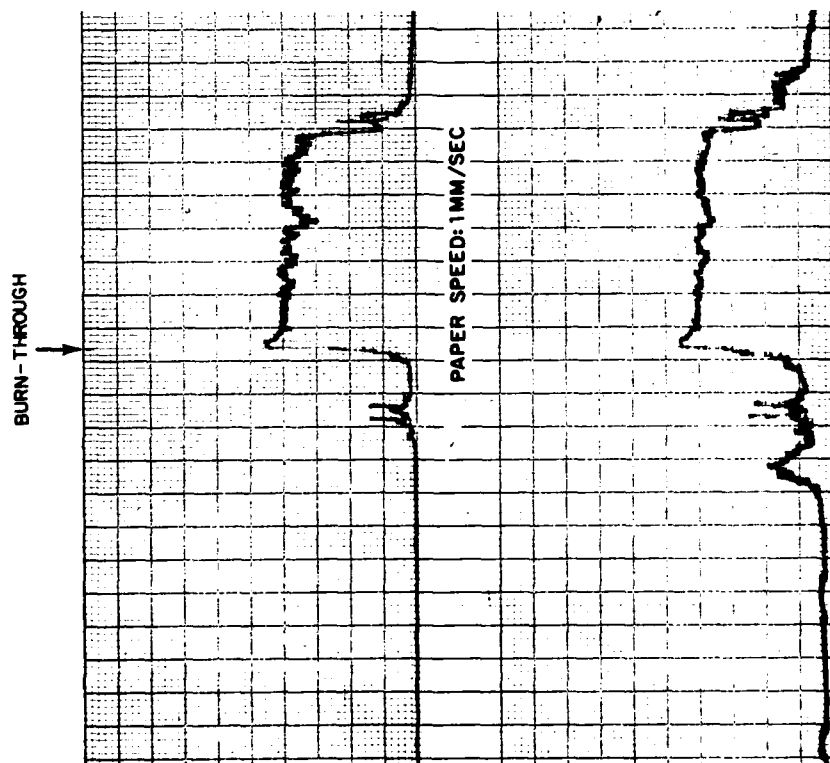
ASW-587-160

Figure A-160. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



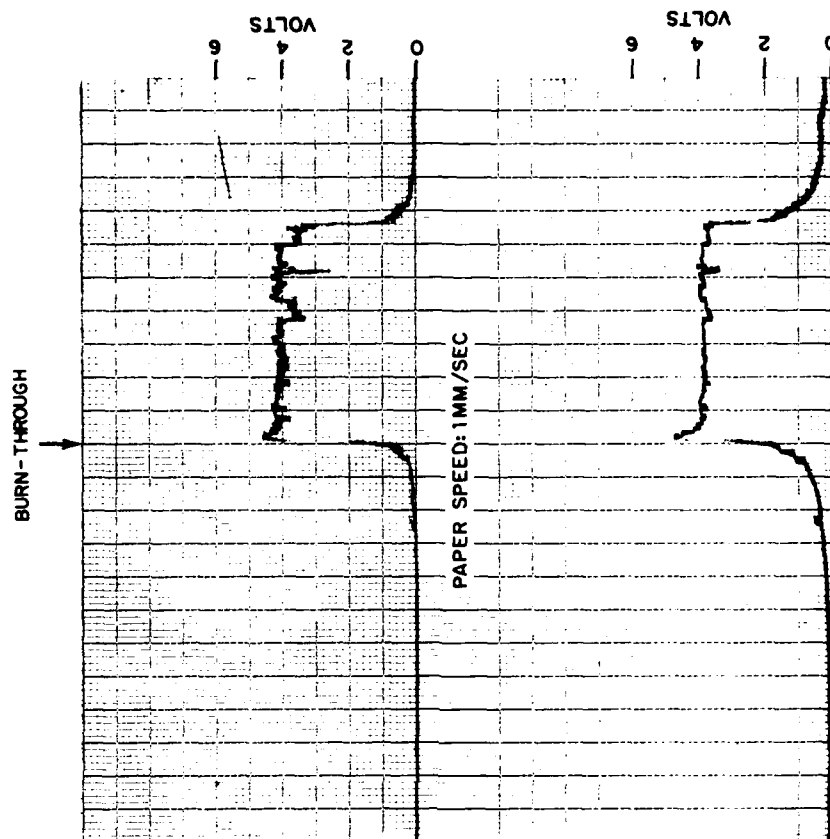
ASW-587-161

Figure A-161. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-162

Figure A-162. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-163

Figure A-163. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

APPENDIX B

J-57 ENGINE (PORT)

B.1 J-57 ENGINE (PORT), MODIFIED BURNER CAN HOLE COVERED

A series of three test runs were made on the J-57 port engine with the modified burner can hole covered. Each test was recorded using five microphones placed as noted in the text. The three tests were run at the following engine speeds:

- (1) 82% RPM (150 in. Hg gage, diffuser case pressure)
- (2) 90% RPM (240 in. Hg gage, diffuser case pressure)
- (3) Max. RPM (270 in. Hg gage, diffuser case pressure)

The purpose of this test was to establish a reference to compare modified burner can closed hole sound energy levels at the three engine speeds with sound energy levels of the modified burner can with three sizes of open holes (1.5, 1.0, and 0.75 inch) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 82% run - pages B-4 through B-10
- (2) 90% run - pages B-11 through B-19
- (3) Max. run - pages B-20 through B-26

B.1.1 Analysis

B.1.1.1 Sound Energy Levels

Output levels of microphones 1 through 5 were measured for RMS sound energy during each test run. Microphone 2 was a broadband instrumentation microphone and microphones 1, 3, 4, and 5 had a lower frequency response and were all of the same type. The data was converted to decibels by conversion factors detailed in Appendix F. Variations in RMS levels of microphones 1, 3, 4, and 5 are attributed to microphone location and proximity to engine machinery (i.e., fuel pumps, etc.).

The closed-hole test measurements are representative of a normal engine. These measurements will be used as a reference to compare sound energy levels made during open hole tests which are representative of a burner can failure. Microphone sound levels decreased from the 82% RPM run to the 90% RPM run. This was due to strong discrete frequencies generated by engine machinery at 82% RPM. The frequencies appeared to be resonant at 82% RPM and to have several harmonics. The resonances dissipated as the engine speed was increased

to 90% RPM. The sound energy levels likewise decreased. Only a small change (1 dB) was noted between the 90% RPM run and the maximum RPM run.

B.1.1.2 Spectrum Analysis

The analysis bandwidth was 0 to 20 kHz for all microphones. In addition, the instrumentation microphone (No. 2) data was analyzed from 0 to 40 kHz. Discrete spectral content was especially evident in the 82% RPM run and most prominent in microphone 1, 2, and 4 grams, all of which were located farthest from the engine accessory drive machinery (fuel pump, oil pump, etc.). Microphone 3 and 5 grams showed less discrete frequencies and more broadband random noise. The 90% and maximum RPM grams were similar, and consisted primarily of broadband random noise with some machinery-created discrete frequency lines. The instrumentation microphone gram showed little noise above 20 kHz.

B.1.1.3 Mean Square Analysis

The data from each microphone was analyzed over bandwidths of 0 to 20 kHz and 5 to 20 kHz simultaneously, using mean square techniques. This method of analysis, when recorded, showed the summation of the total spectrum at any given time versus the summation of the spectrum above 5 kHz. The recordings showed considerable fluctuation at 82% RPM with most of the spectrum below 5 kHz. The recordings smoothed out at 90% and maximum RPM, but again most of the spectrum was below 5 kHz.

B.1.2 Environmental Conditions

The three tests discussed in paragraph B.1 were performed at an ambient temperature of 77° F and 25% relative humidity. Microphone temperatures were as follows:

	MICROPHONE				
	1	2	3	4	5
TEMPERATURE (° F)	130	140	80 (a)	140	80 (a)

^aThe thermocouples were inaccurate below 100° F.

B.1.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table B-1. Microphone Sound Energy Levels at 82% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	100	39	49	72	37
RMS (μBAR)	800	3100	400	570	300
dB (a)	132	144	126	129	123

^aReference = 2×10^{-4} μBAR

Table B-2. Microphone Sound Energy Levels at 90% Engine RPM

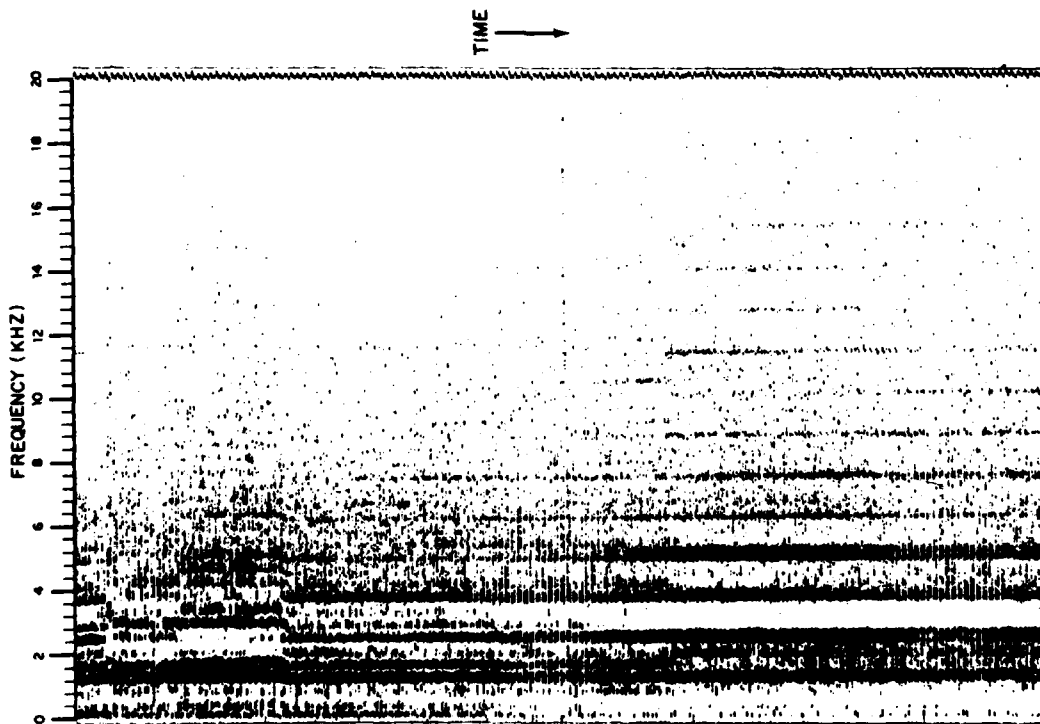
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	40	13	31	30	40
RMS (μBAR)	320	1000	250	240	320
dB (a)	124	134	122	122	124

^aReference = 2×10^{-4} μBAR

Table B-3. Microphone Sound Energy Levels at Maximum Engine RPM

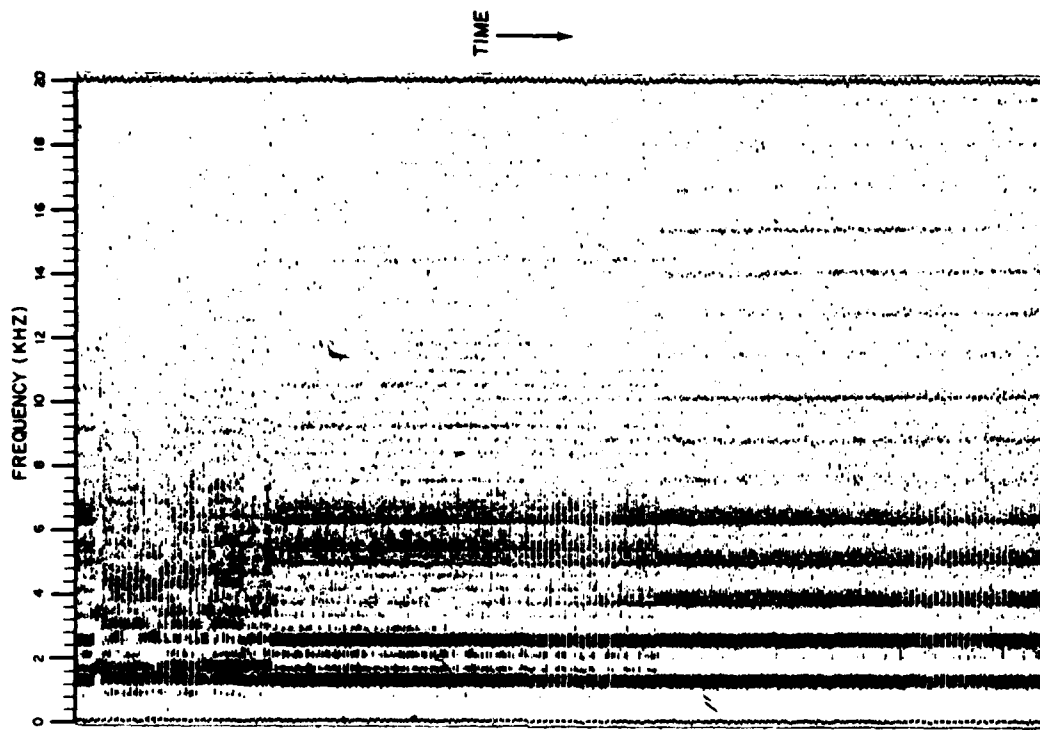
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	45	14	34	33	42
RMS (μBAR)	360	1100	270	260	340
dB (a)	125	135	123	122	125

^aReference = 2×10^{-4} μBAR



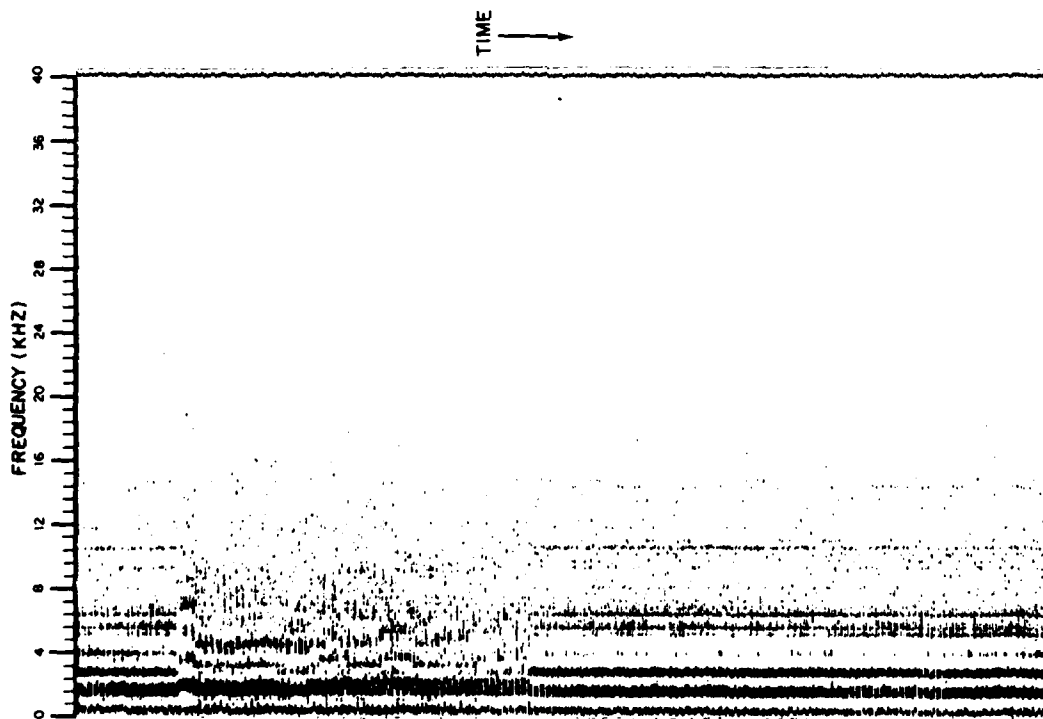
ASW-587-164

Figure B-1. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



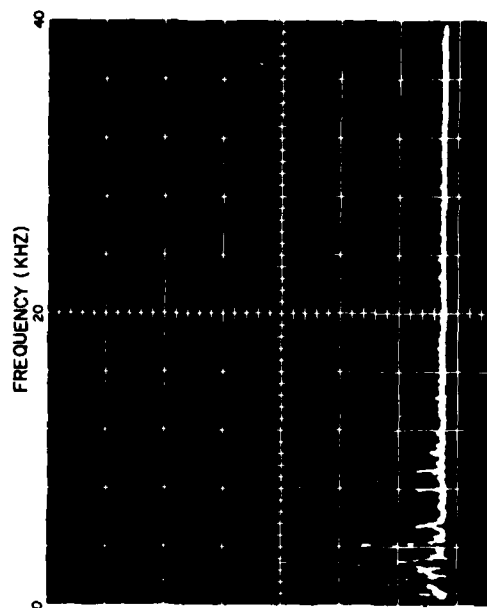
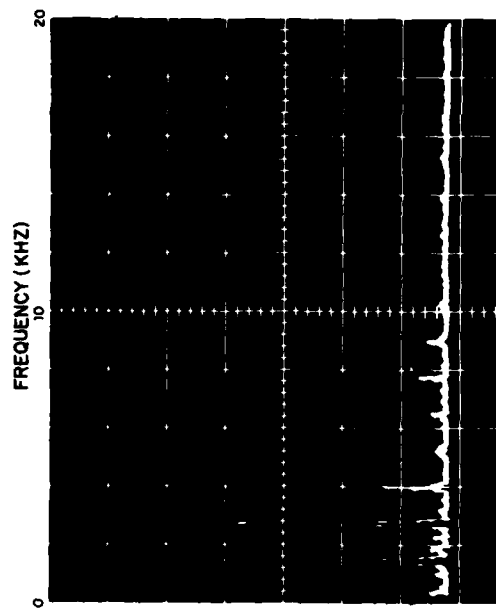
ASW-587-165

Figure B-2. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



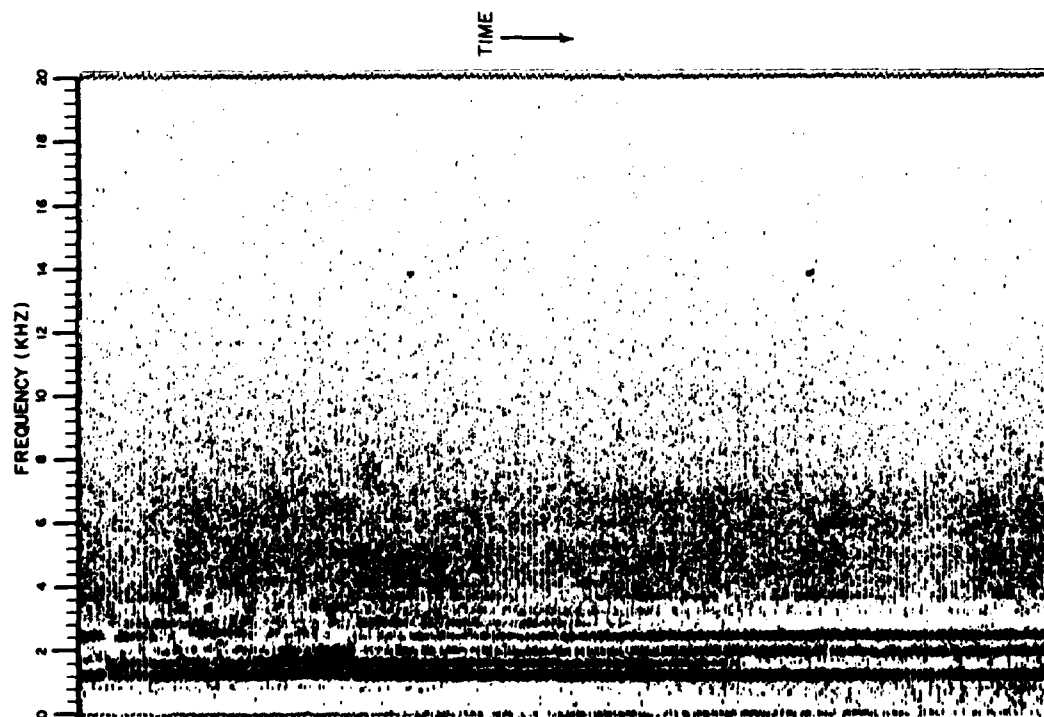
ASW-587-166

Figure B-3. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



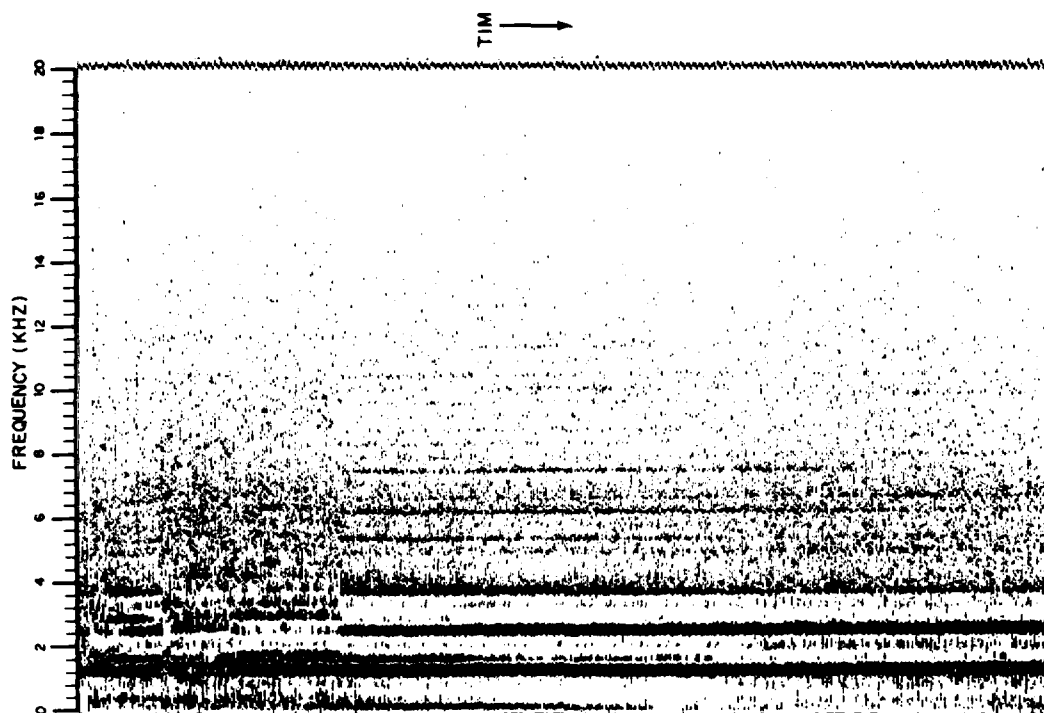
ASW-587-167

Figure B-4. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



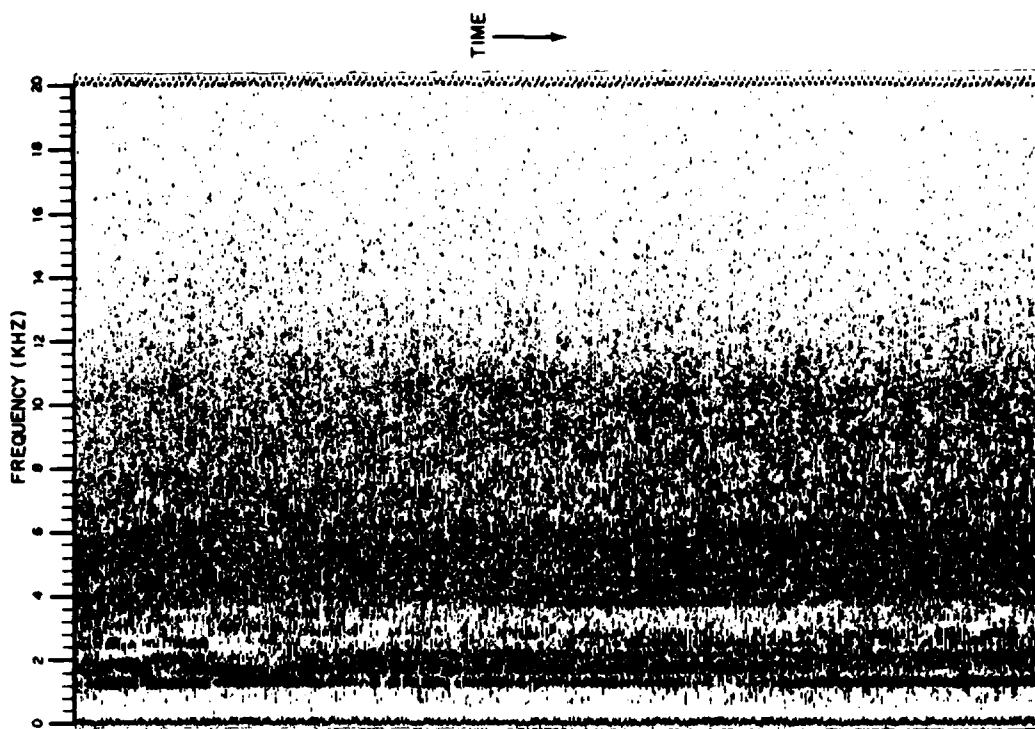
ASW-587-168

Figure B-5. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



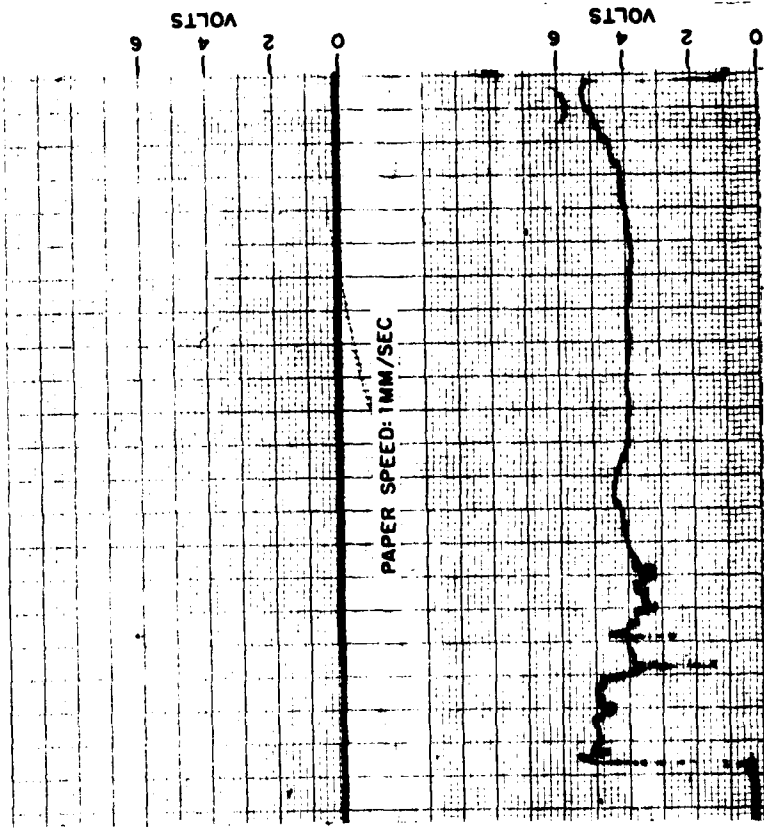
ASW-587-169

Figure B-6. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



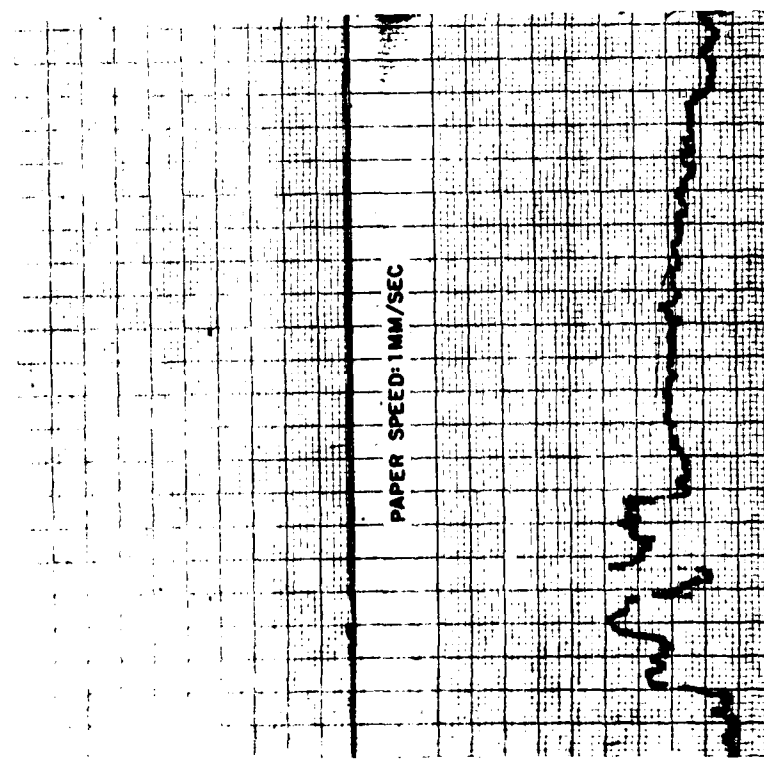
ASW-587-170

Figure B-7. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



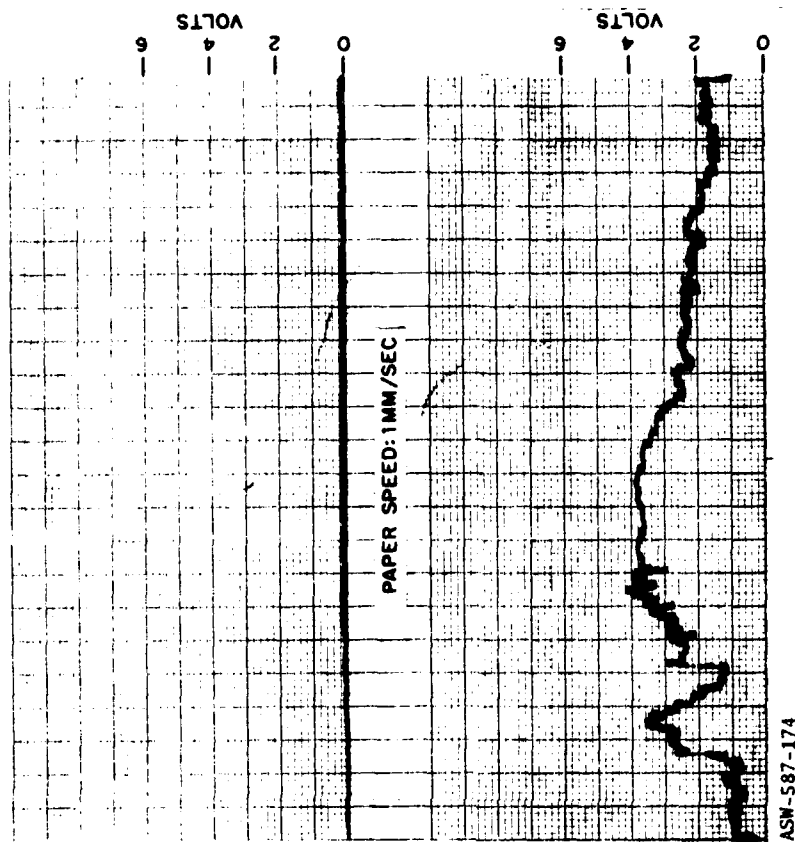
ASN-587-171

Figure B-8. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



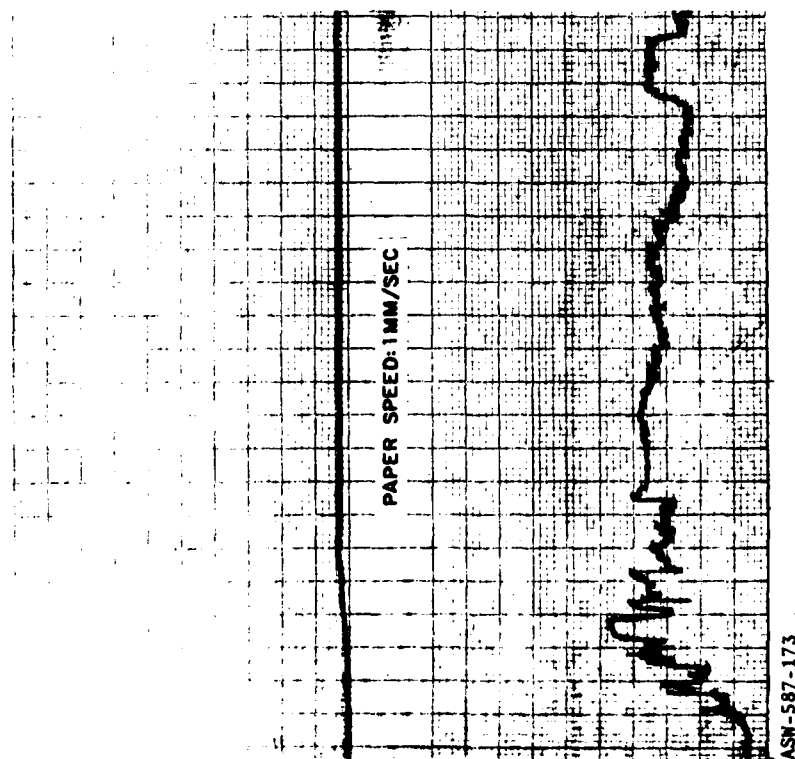
ASN-587-172

Figure B-9. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-174

Figure B-11. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-173

Figure B-10. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

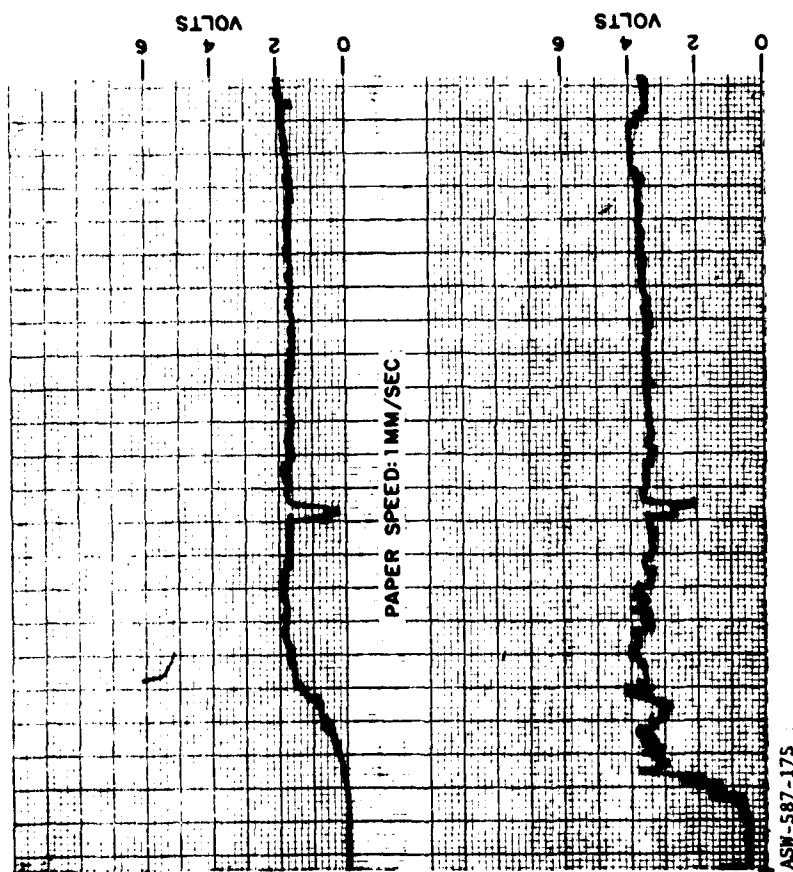
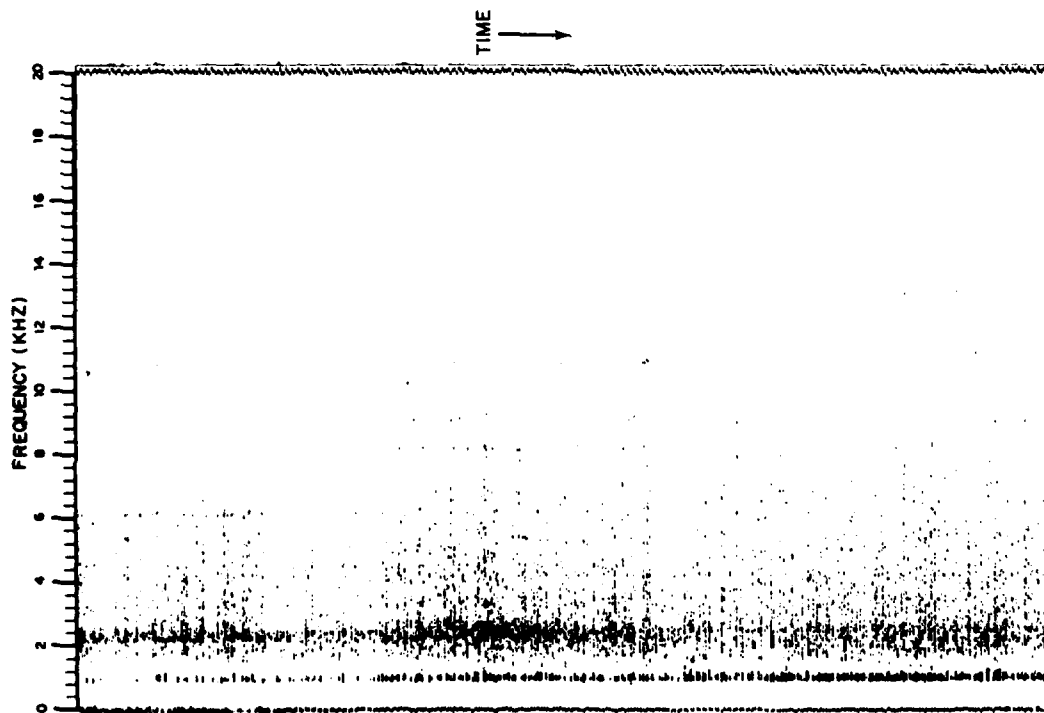
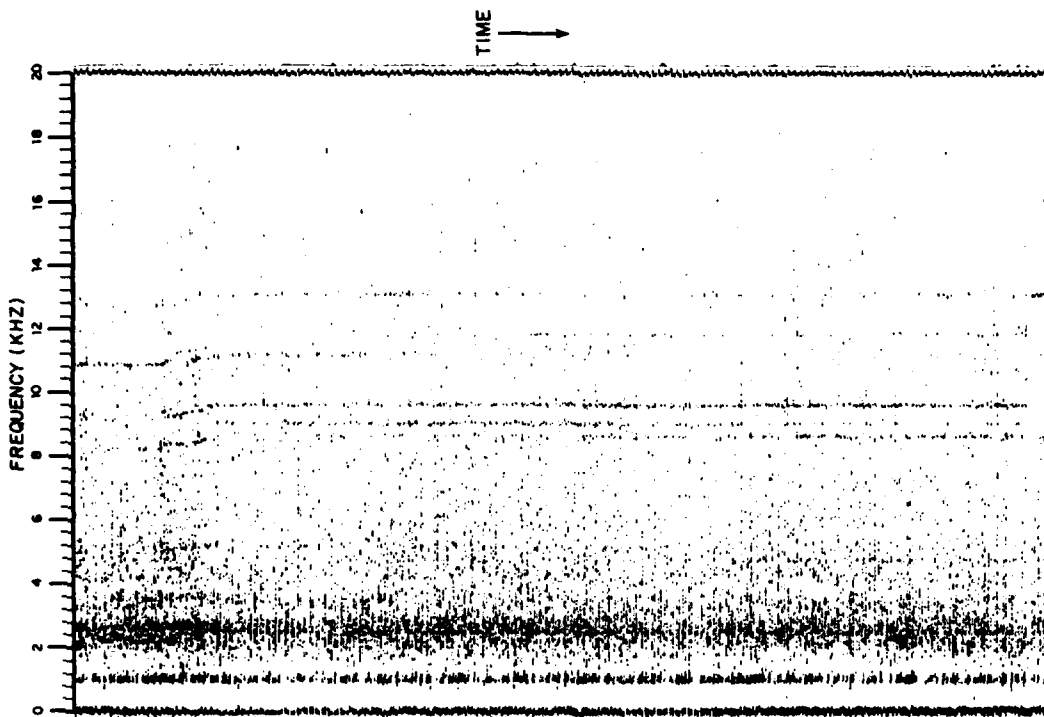


Figure B-12. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



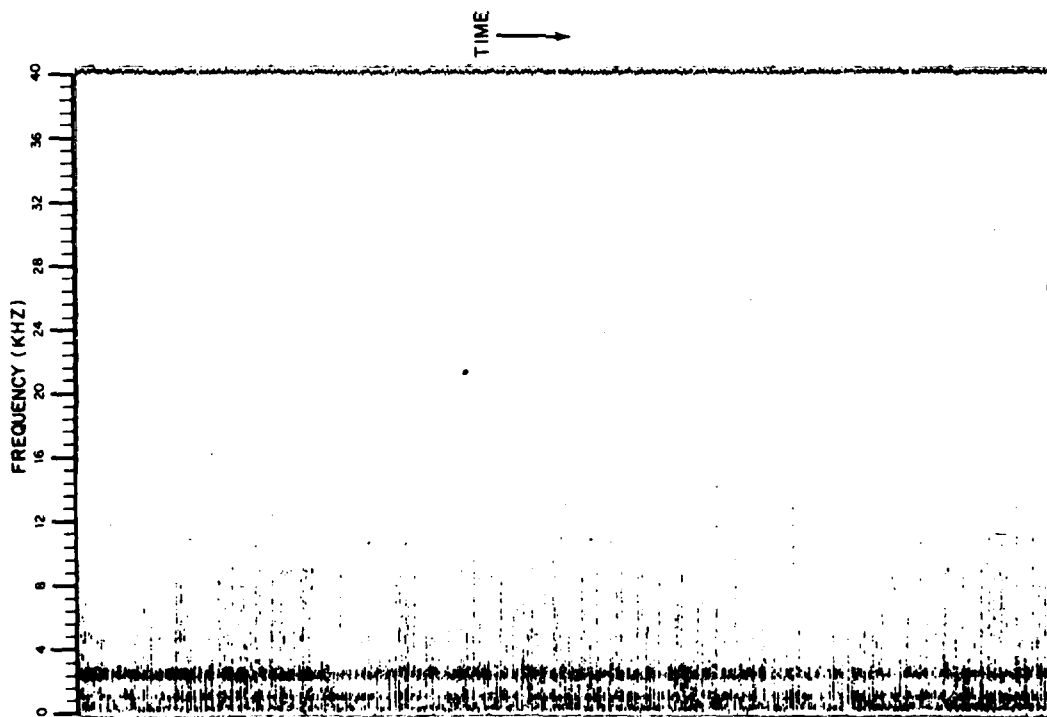
ASW-587-176

Figure B-13. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



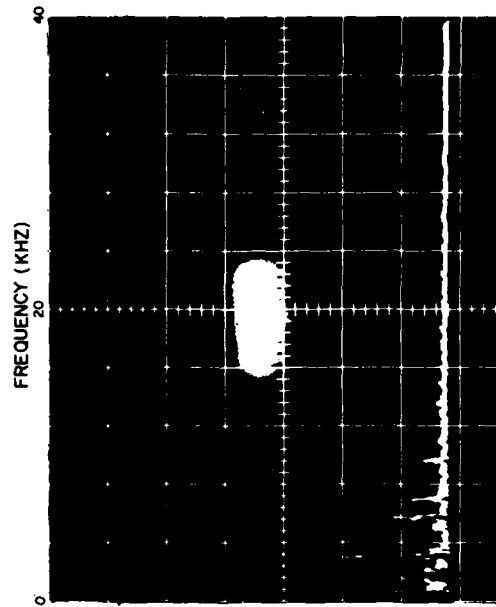
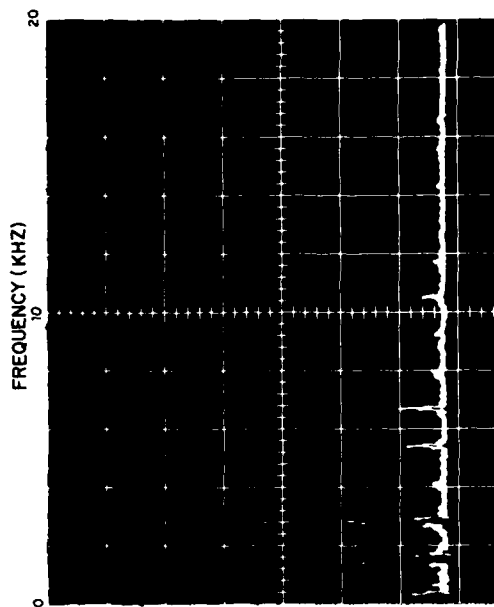
ASW-587-177

Figure B-14. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-178

Figure B-15. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



ASW-587-179

Figure B-16. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.

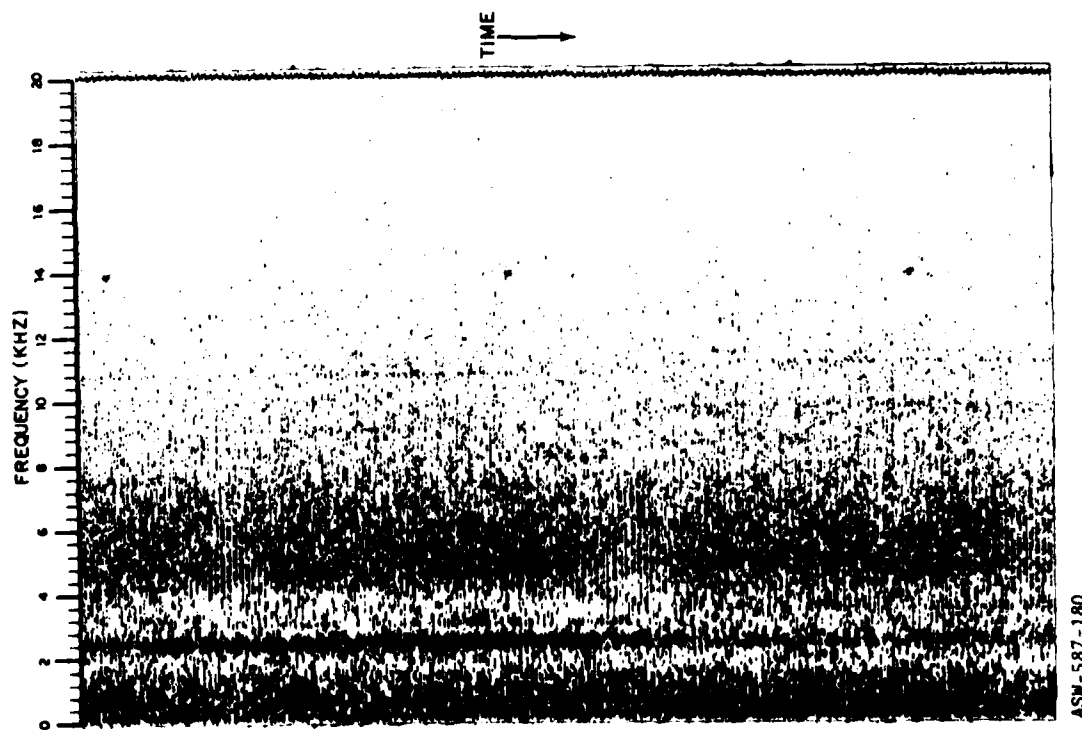


Figure B-17. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

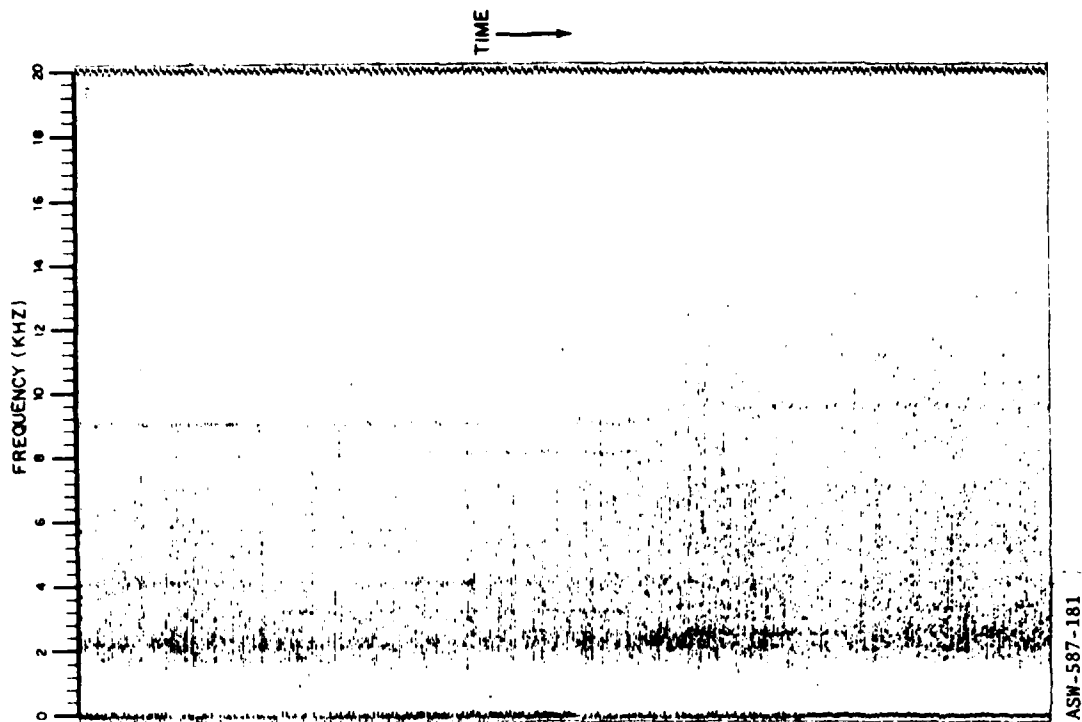
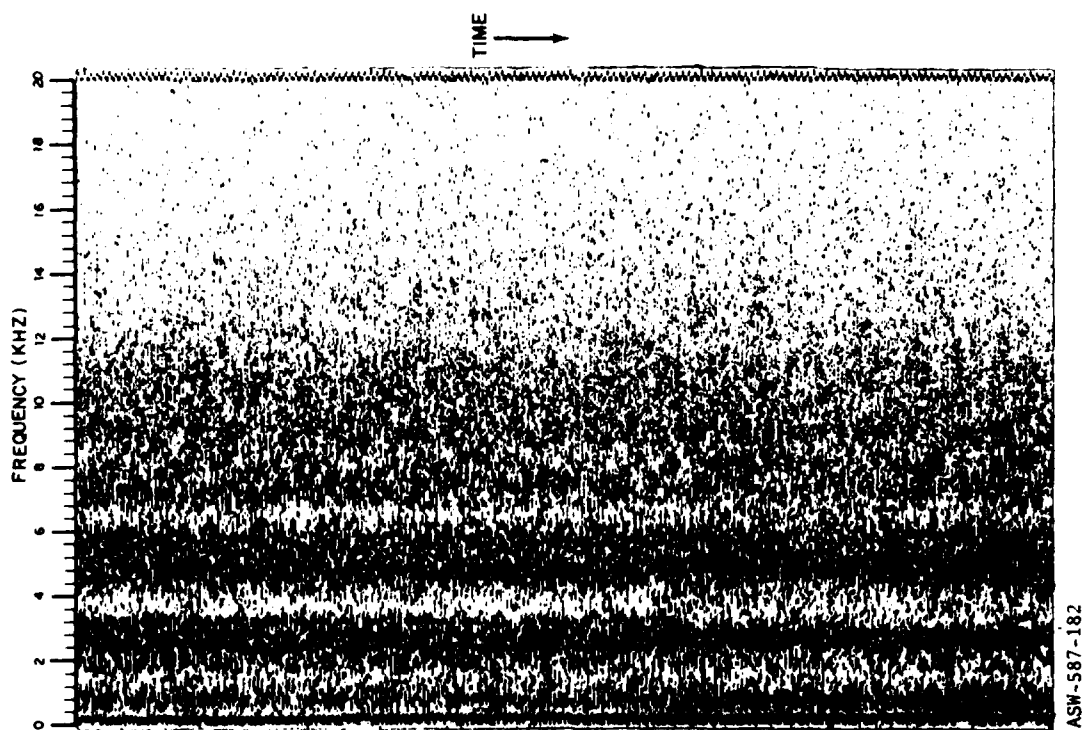
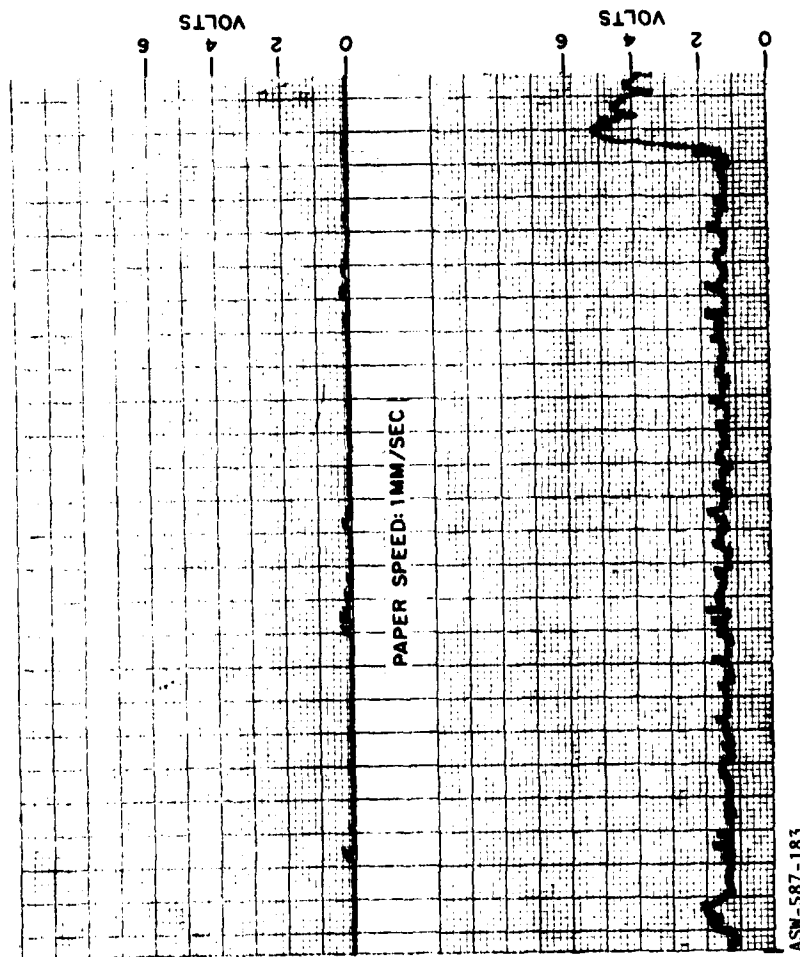


Figure B-18. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-182

Figure B-19. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASN-587-183

Figure B-20. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

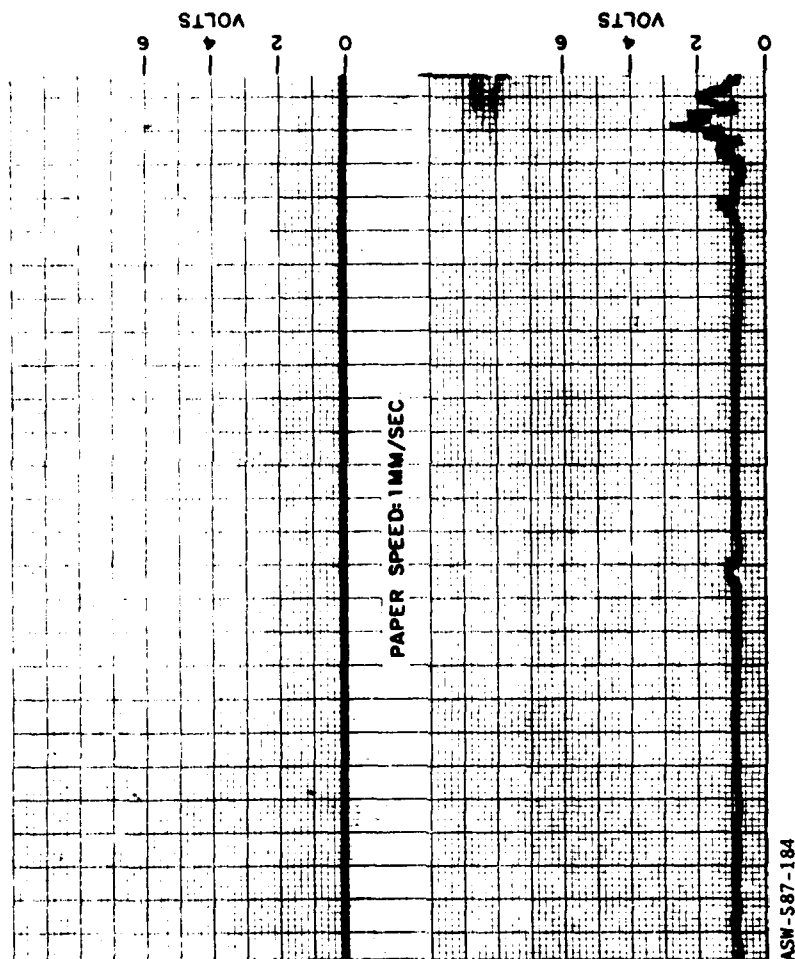
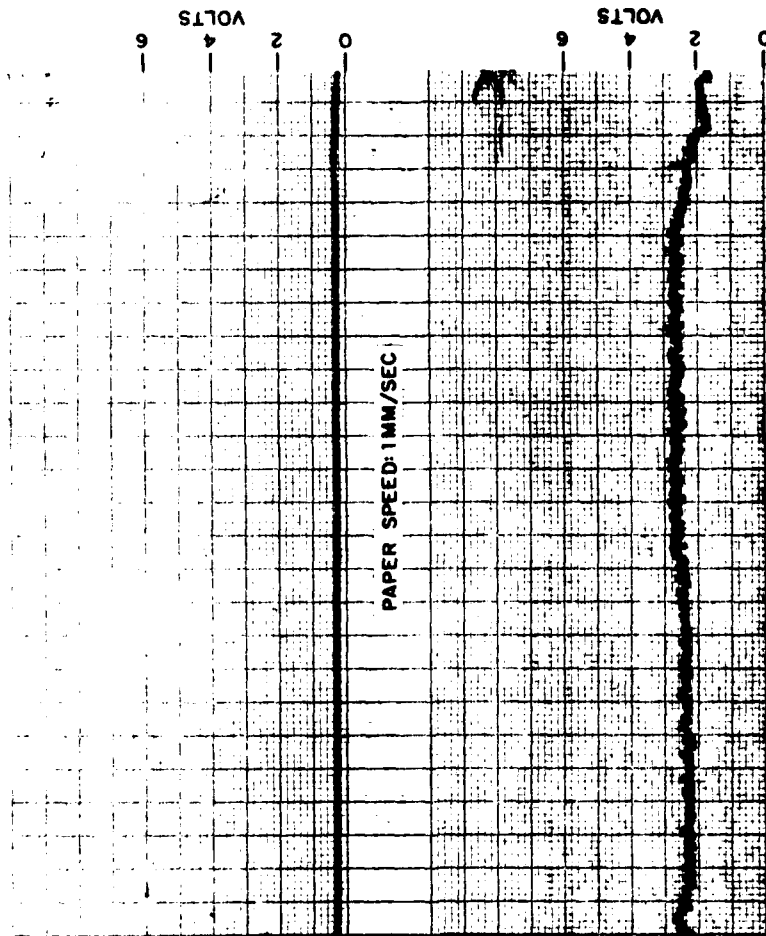


Figure B-21. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-185

Figure B-22. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

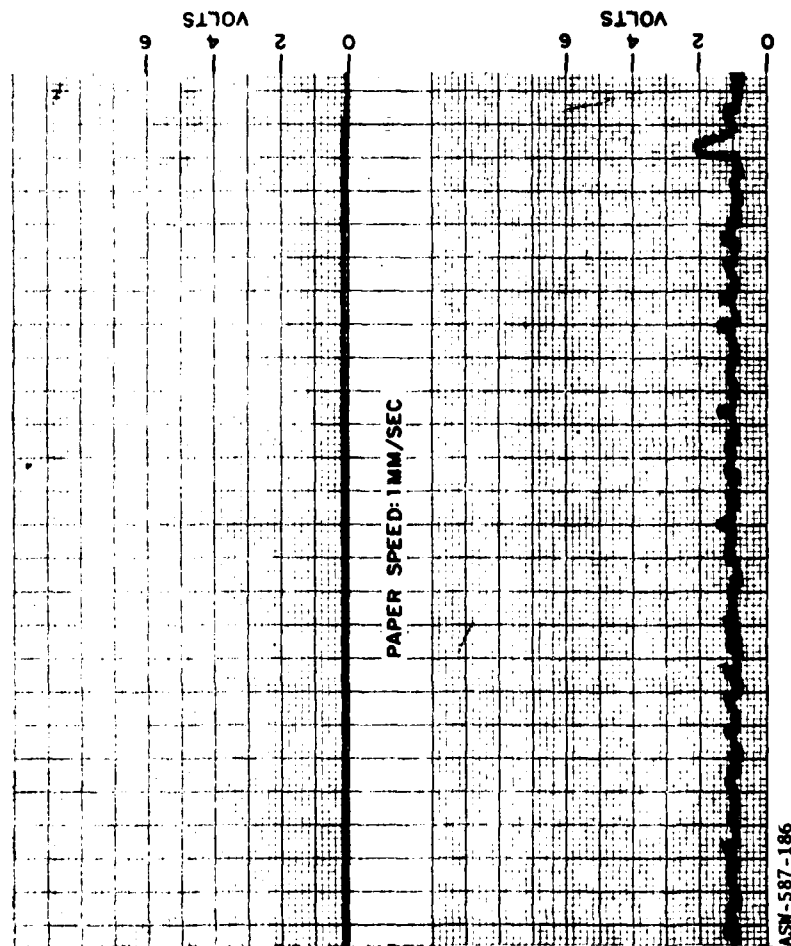


Figure B-23. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

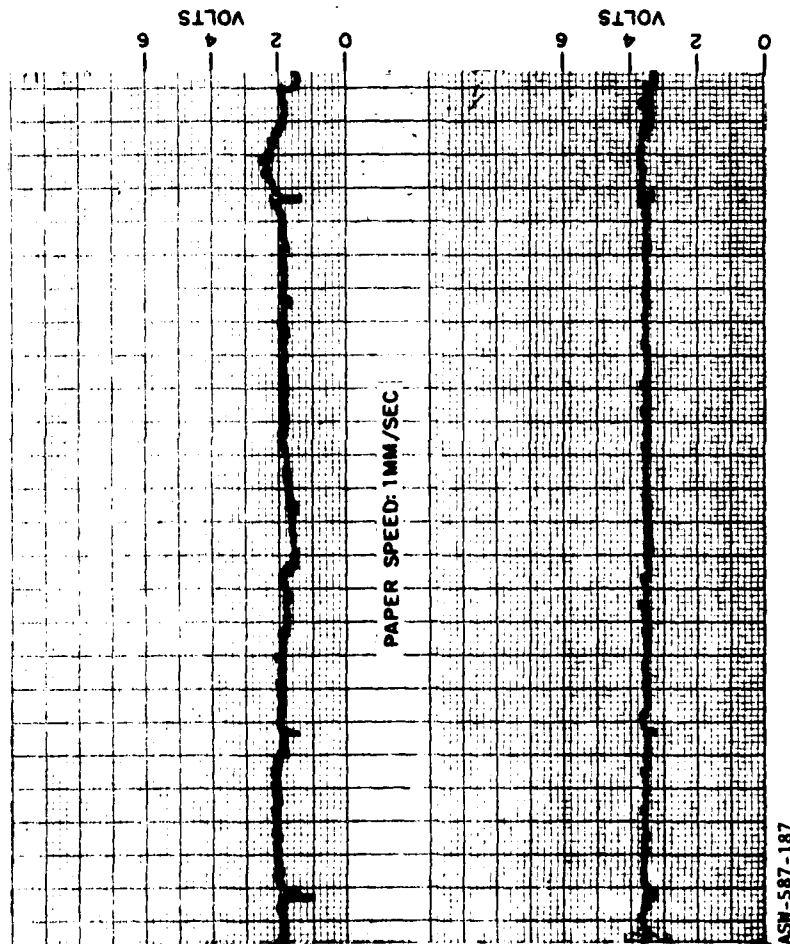


Figure B-24. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

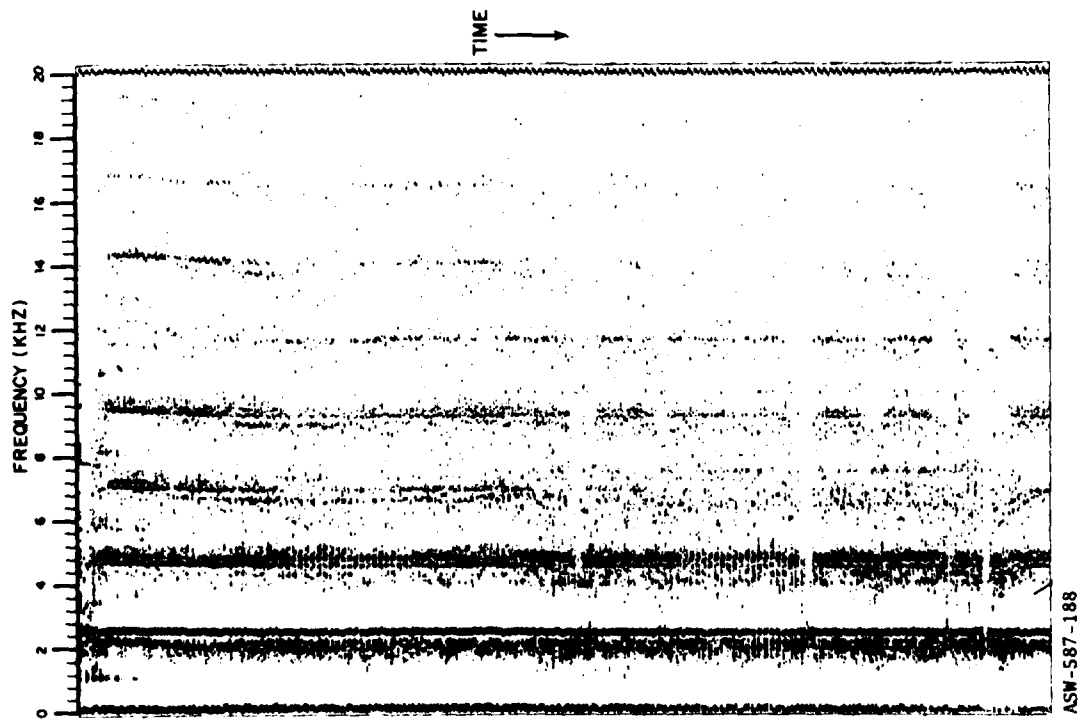


Figure B-25. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

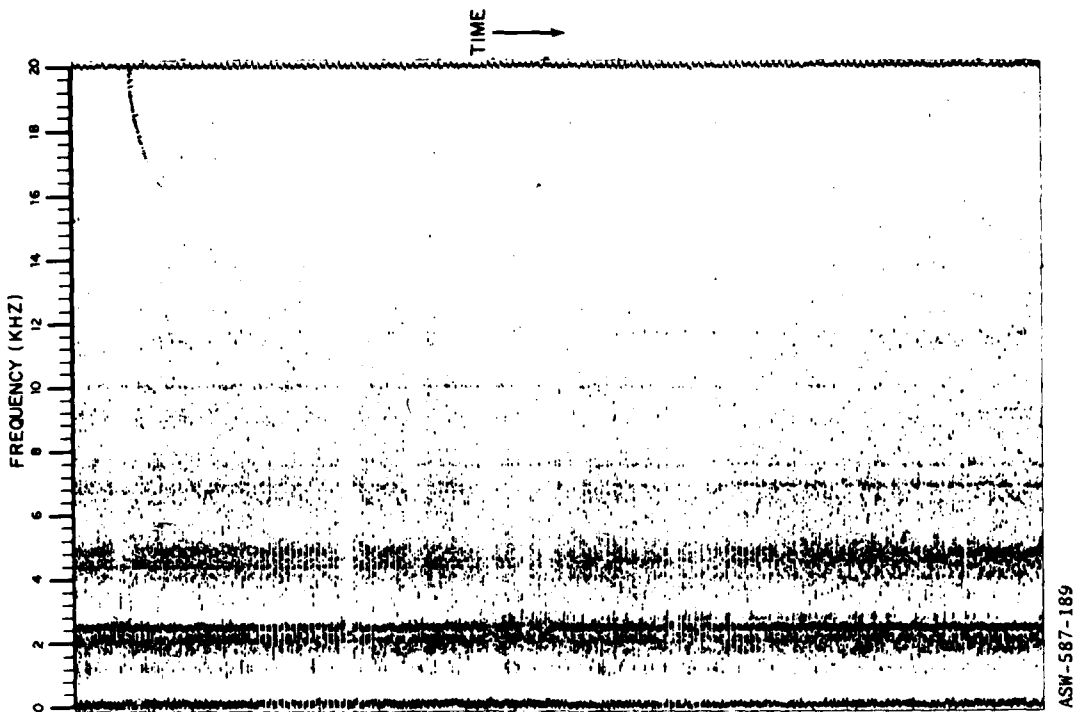
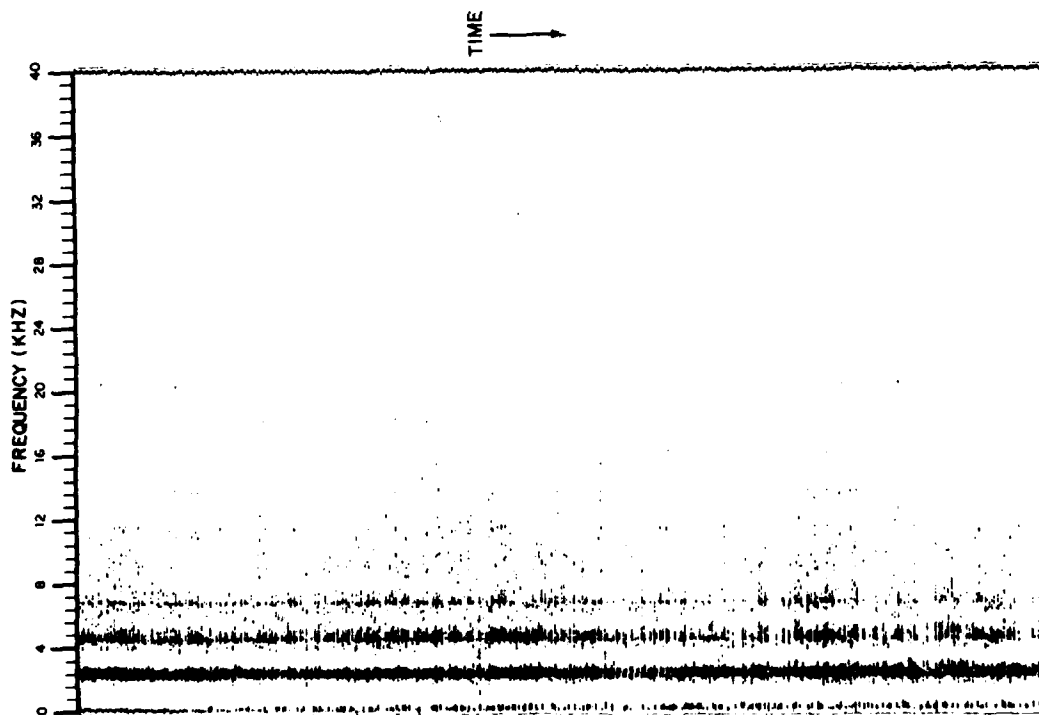
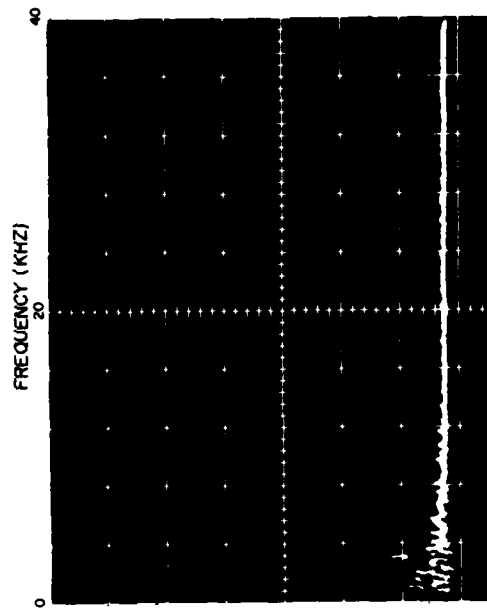
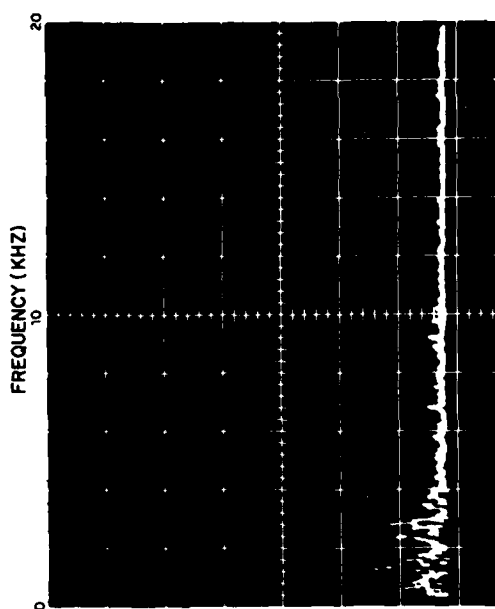


Figure B-26. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



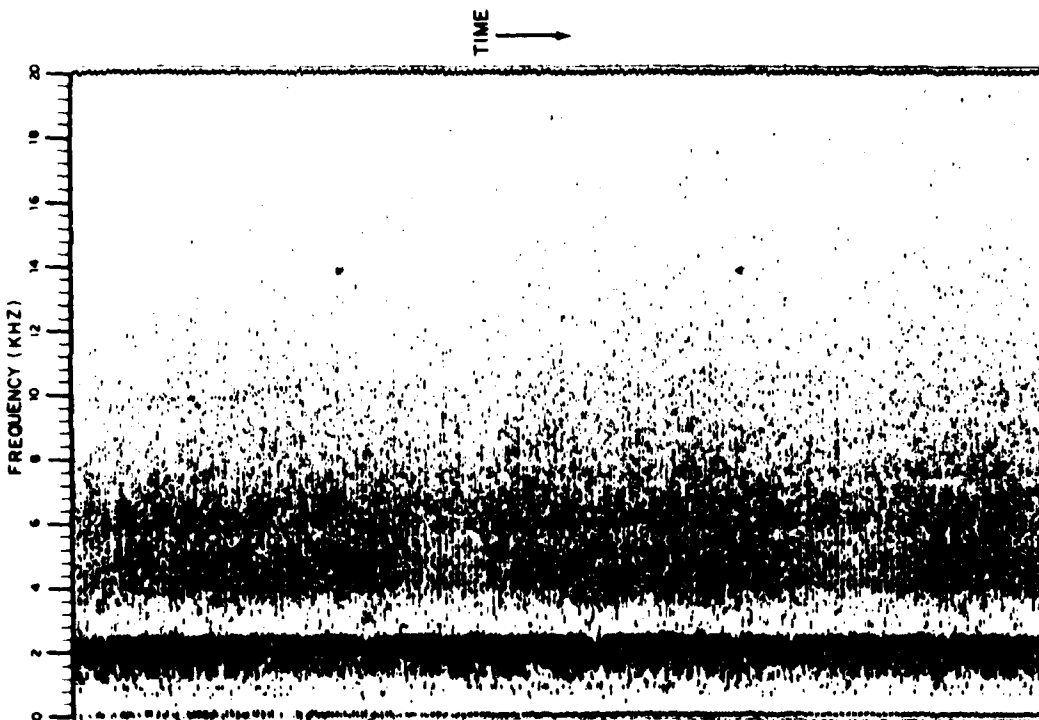
ASW-587-190

Figure B-27. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



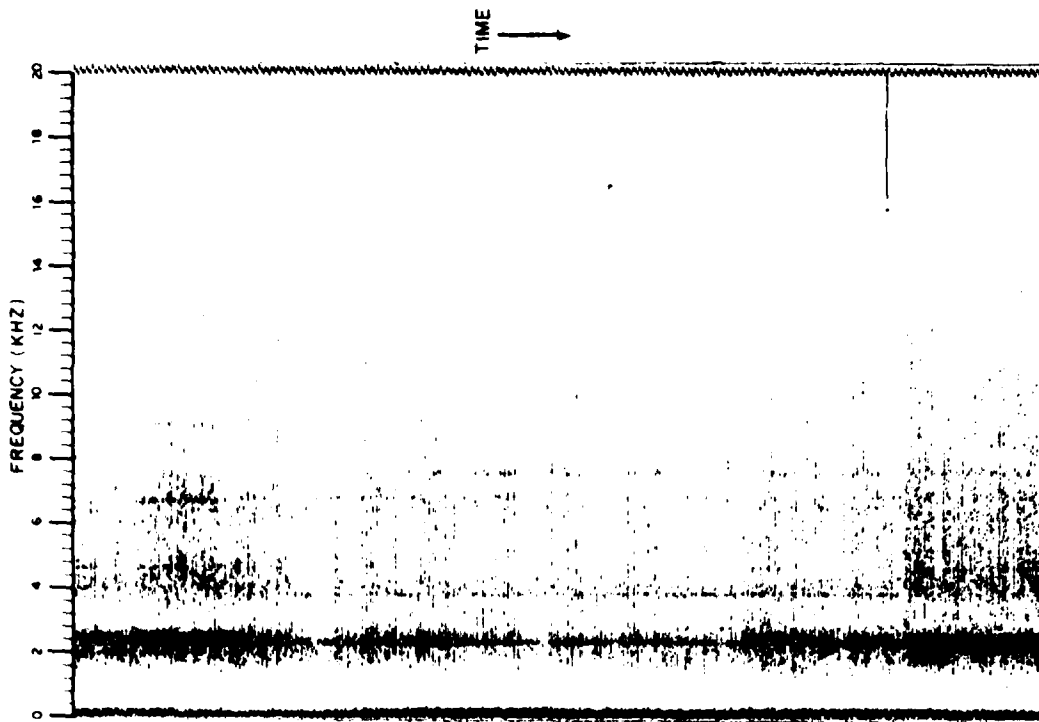
ASW-587-191

Figure B-28. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



ASW-587-192

Figure B-29. Microphone No. 3 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-193

Figure B-30. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

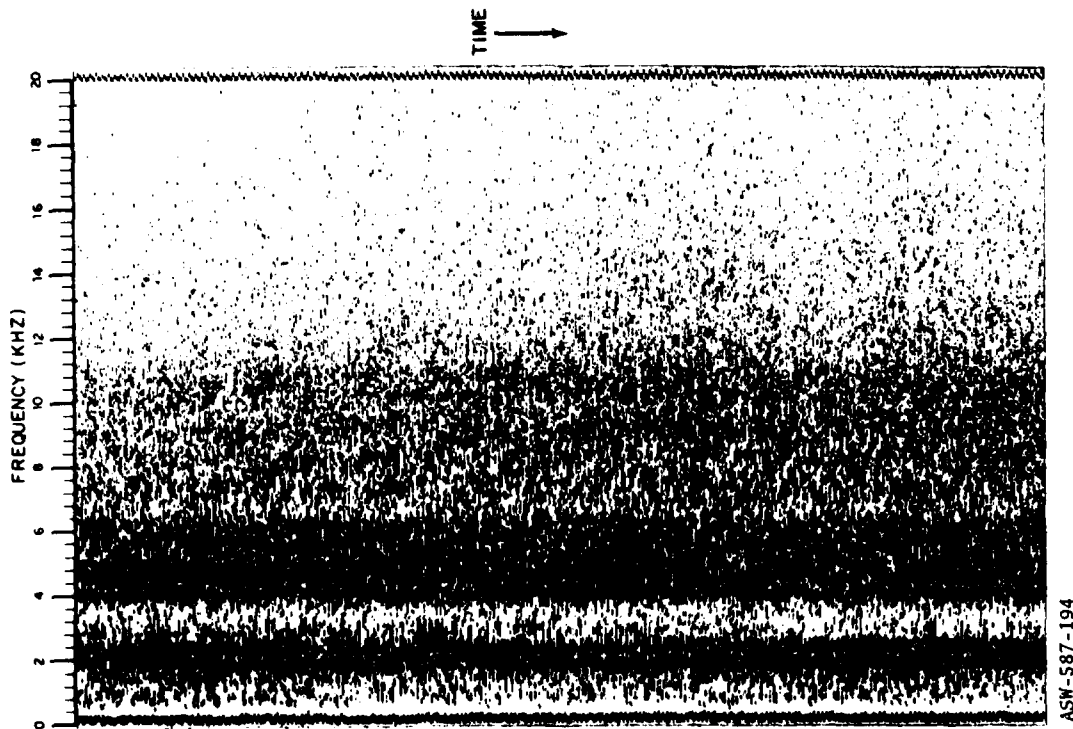


Figure B-31. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

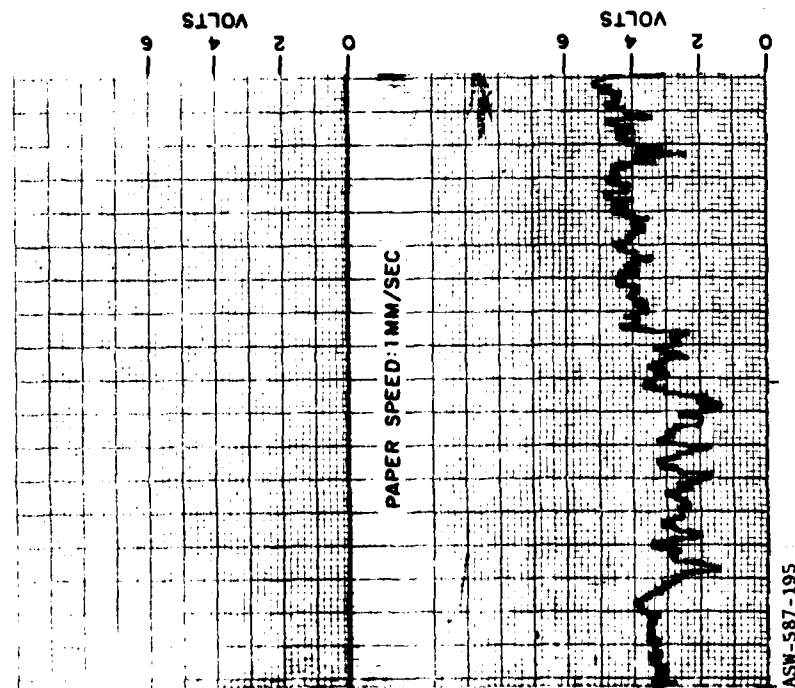


Figure B-32. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

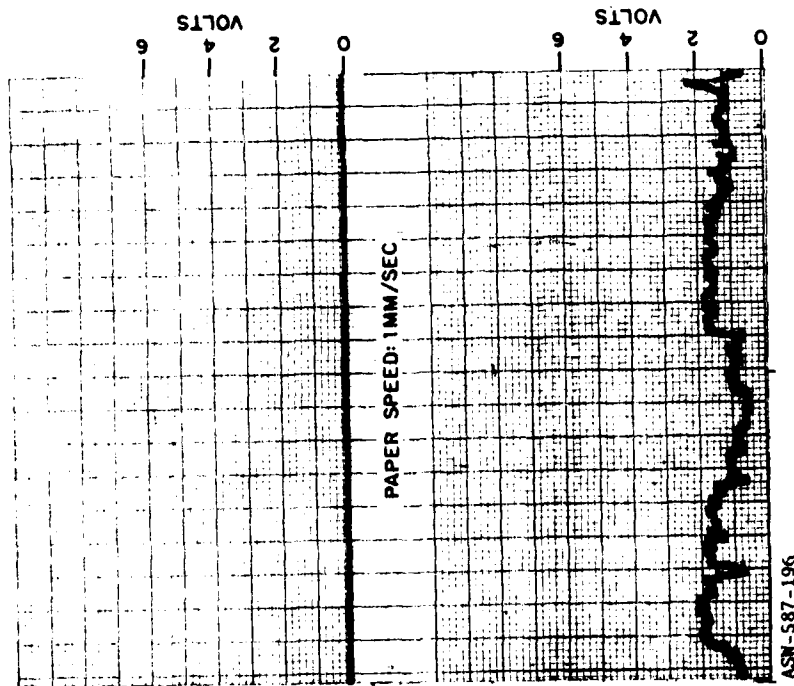


Figure B-33. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

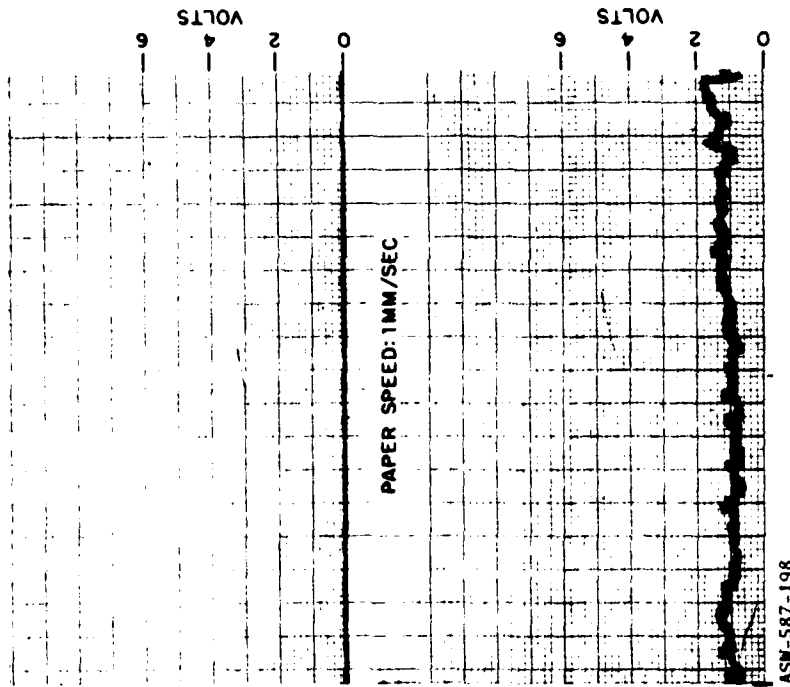


Figure B-34. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

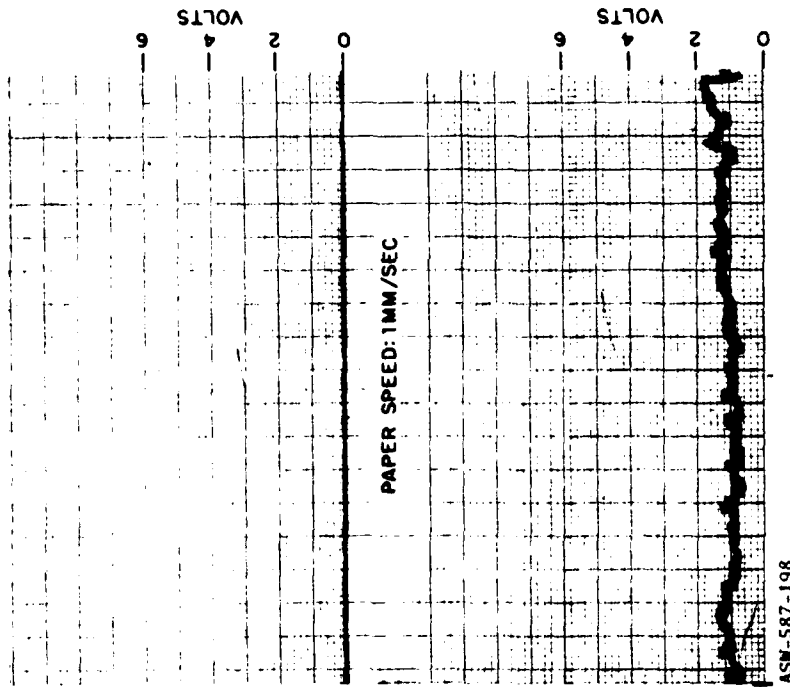


Figure B-35. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

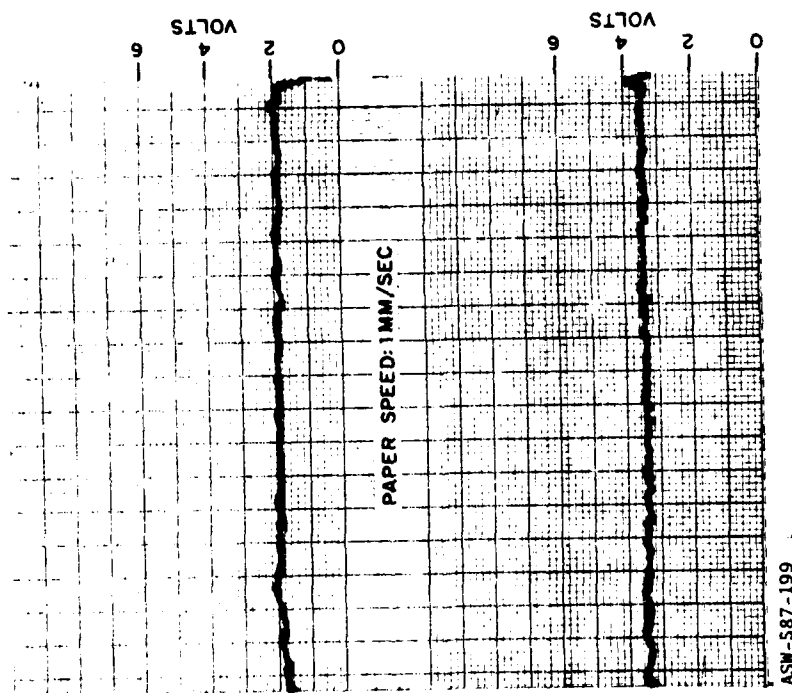


Figure B-36. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.2 J-57 ENGINE (PORT), MODIFIED BURNER CAN HOLE OPEN - 1.5 INCH
DIAMETER

A series of three test runs were made on the J-57 engine with the modified burner can hole masked to a 1.5-inch hole. Each test was recorded using five microphones located in the same positions as for the closed hole tests. The three tests were run at the following engine speeds:

- (1) 82% RPM (150 in. Hg gage, diffuser case pressure)
- (2) 90% RPM (240 in. Hg gage, diffuser case pressure)
- (3) Max. RPM (270 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed hole on the modified burner can and a large open hole (1.5 inches in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 82% run - pages B-30 through B-36
- (2) 90% run - pages B-37 through B-43
- (3) Max. run - pages B-44 through B-50

B.2.1 Analysis

B.2.1.1 Sound Energy Levels

Microphone sound pressure levels stayed almost constant as the engine RPM was increased from 82% to 90% to maximum. There was a 2 to 9 dB increase from the closed-hole test at 82% RPM to the open-hole test. The greatest change in pressure level occurred in microphone 4, which was the second closest to the open hole, and the least pressure level occurred in microphone 2, which was the closest to the hole. A greater change, 3 to 17 dB, was noted between open-hole and closed-hole readings at 90% and maximum RPM. Microphone 4 showed the greatest change and microphone 5, which was farthest from the hole, showed the least change. Microphones 1, 2, and 4 showed the greatest increase, due to their proximity to the open hole, while microphones 3 and 5 showed the least and were farthest from the hole.

B.2.1.2 Spectrum Analysis

The grams were consistent throughout the three test runs from microphone to microphone. The only noticeable change was in gram density as RPM increased. Some discrete frequency lines, all of which were below 10 kHz, were visible. As in previous runs, these lines were caused by engine machinery. Microphone 2, the instrumentation microphone, showed broadband random noise to 40 kHz, the bulk of which was

below 20 kHz. The microphone 5 gram contained the most random noise. The discrete frequencies which appeared in the covered hole test at 82% RPM were apparently masked out by the broadband random noise.

B.2.1.3 Mean Square Analysis

The mean square analysis recordings showed most of the open-hole energy to be above 5 kHz when compared with the closed hole tests. Burner can "flame on" can clearly be seen in the 90% and maximum RPM runs. It is also seen that the "flame" in the burner can creates frequencies primarily above 5 kHz.

B.2.2 Environmental Conditions

The three tests discussed in paragraph B.2 were performed at an ambient temperature of 77° F and 25% relative humidity. Microphone temperatures were as follows:

	MICROPHONE				
	1	2	3	4	5
TEMPERATURE (° F)	120	160	70 (a)	140	60 (a)

B.2.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table B-4. Microphone Sound Energy Levels at 82% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	170	62	61	210	59
RMS (μBAR)	1380	4800	490	1700	470
dB (a)	137	148	128	138	127

^aReference = 2×10^{-4} μBAR

Table B-5. Microphone Sound Energy Levels at 90% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	200	65	70	230	60
RMS (μBAR)	1600	5100	560	1850	480
dB (a)	138	148	129	139	128

^aReference = 2×10^{-4} μBAR

Table B-6. Microphone Sound Energy Levels at Maximum Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	200	65	72	230	60
RMS (μBAR)	1600	5100	580	1850	480
dB (a)	138	148	129	139	128

^aReference = 2×10^{-4} μBAR

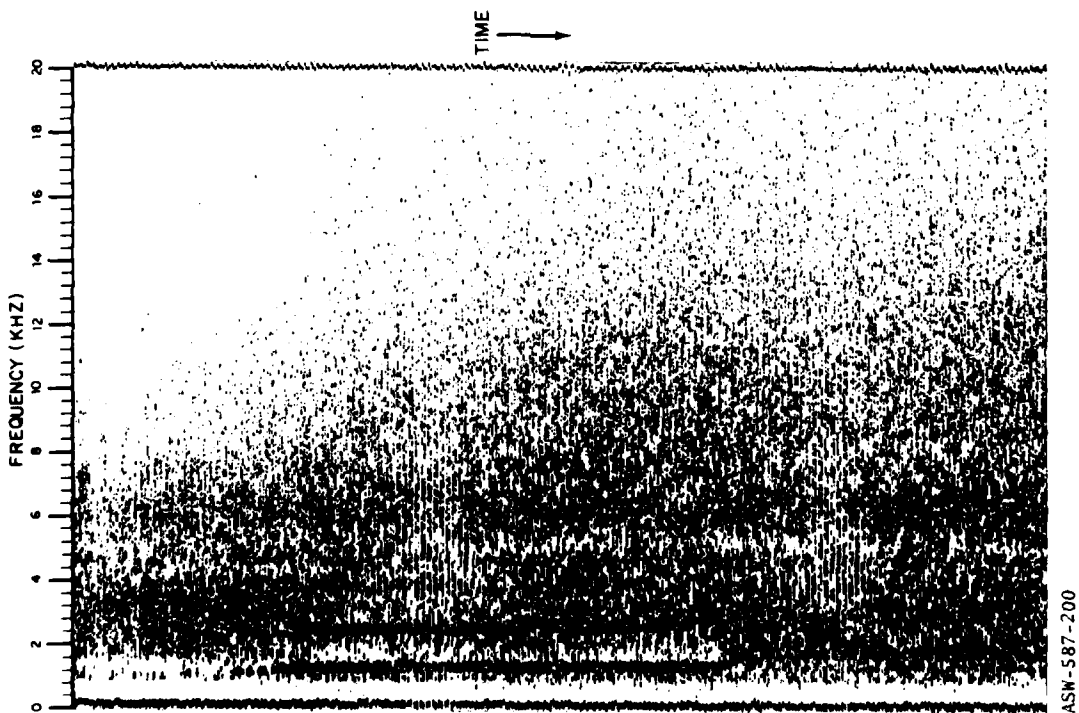


Figure B-37. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

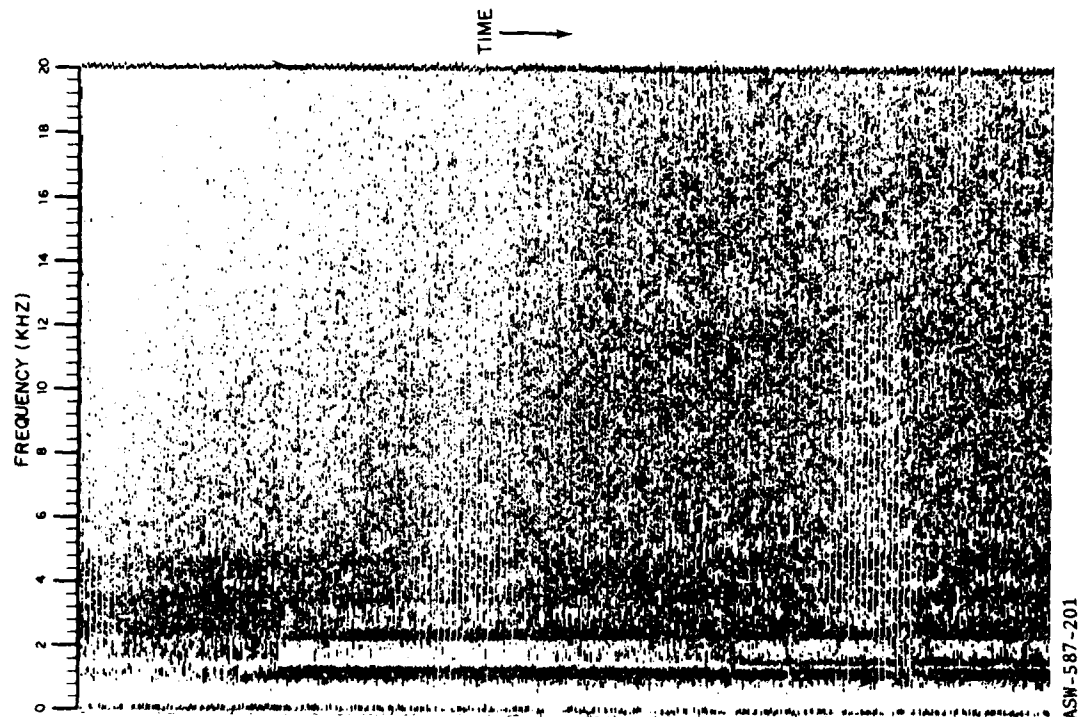
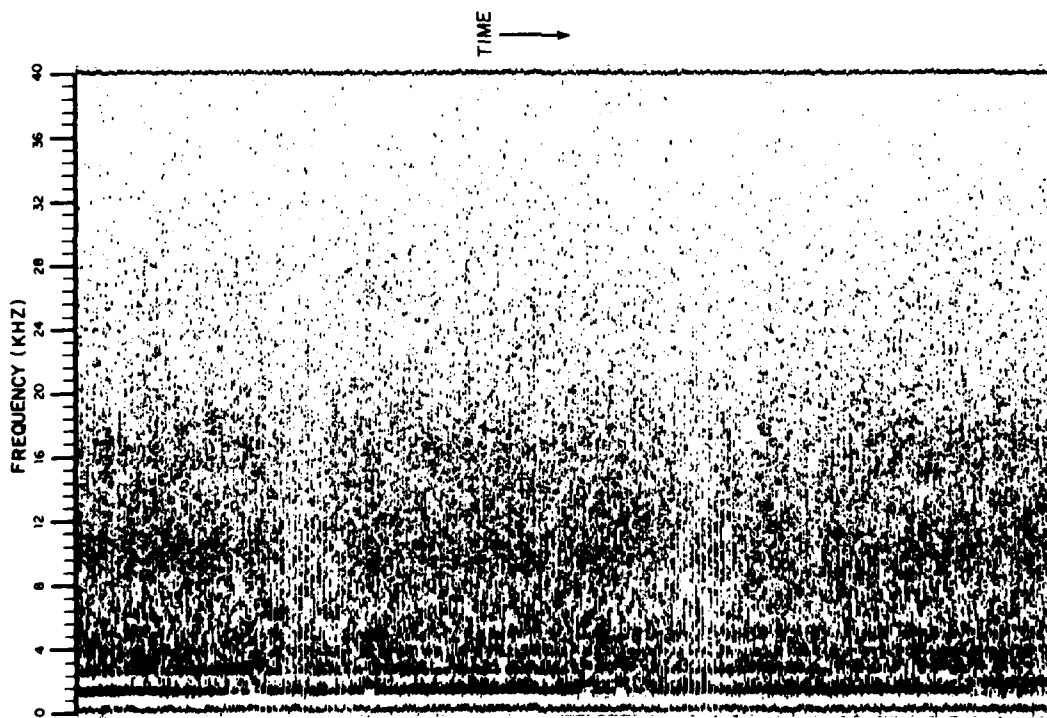
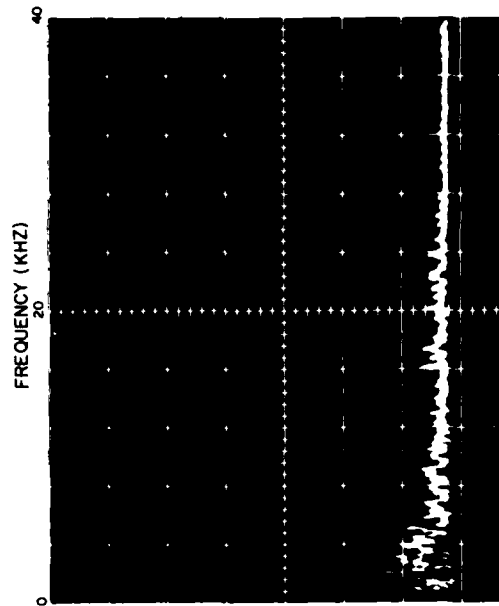
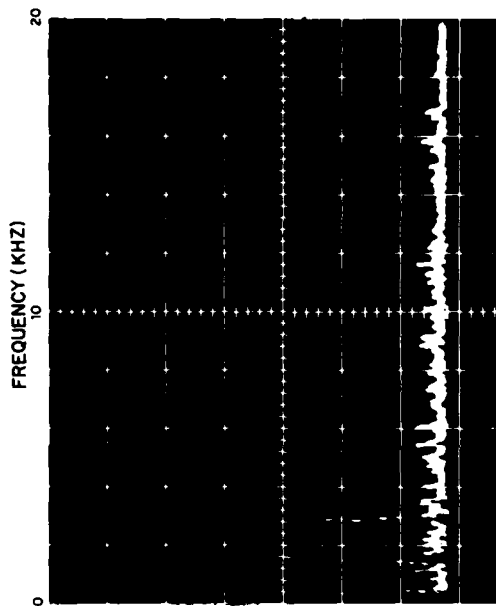


Figure B-38. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



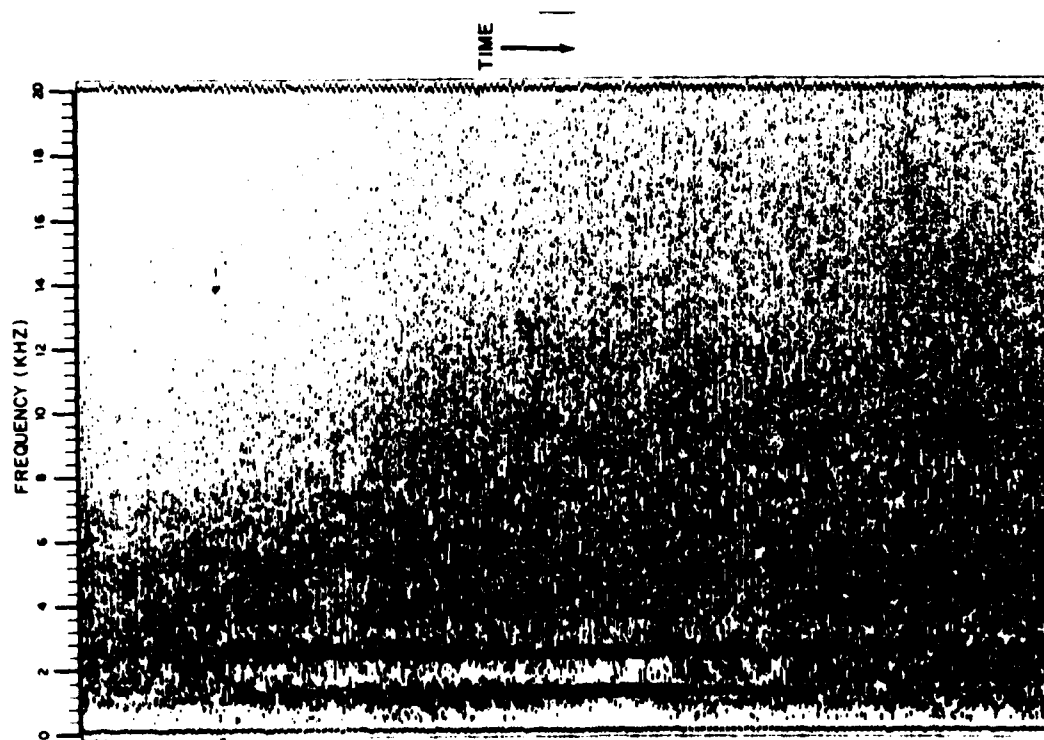
ASN-587-202

Figure B-39. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



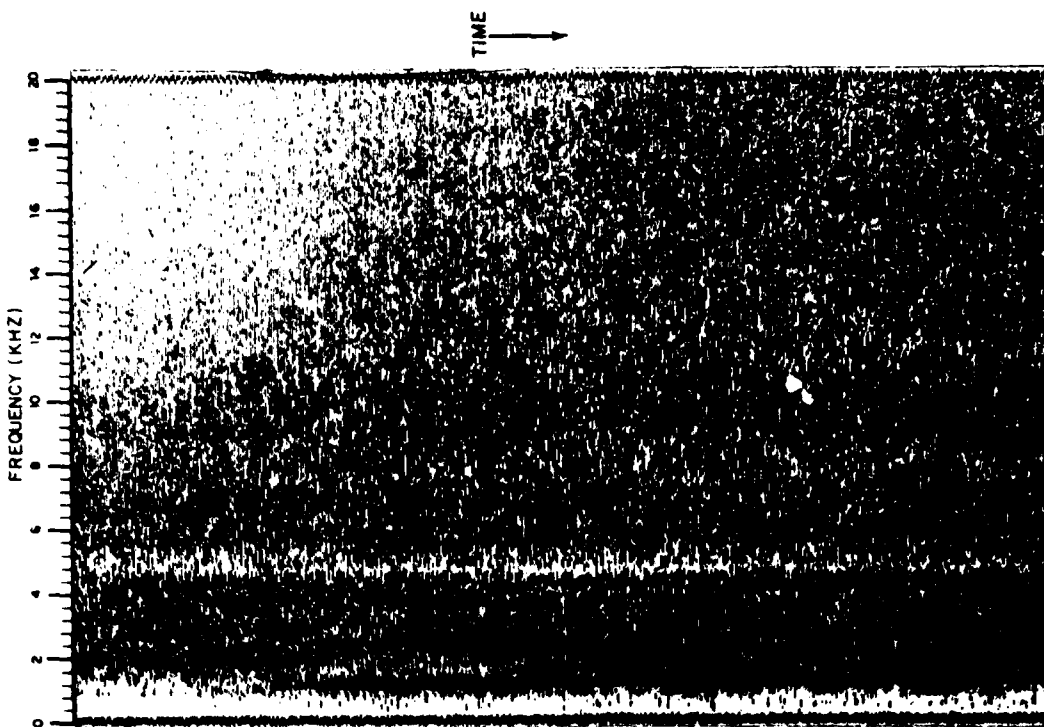
ASN-587-203

Figure B-40. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



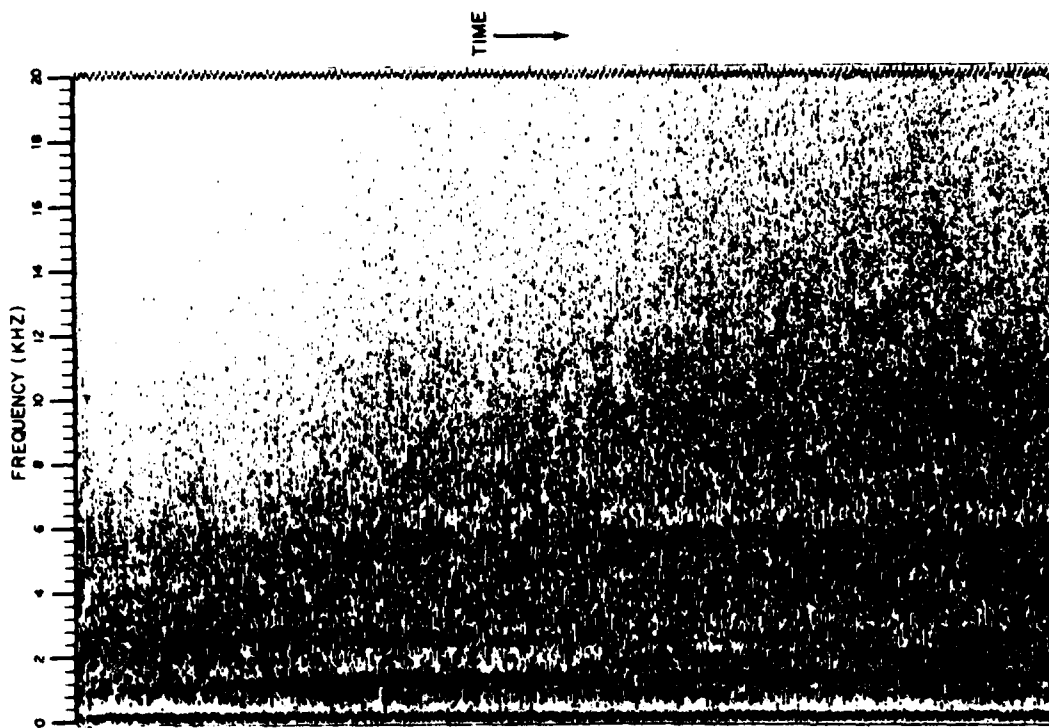
ASN-587-204

Figure B-41. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



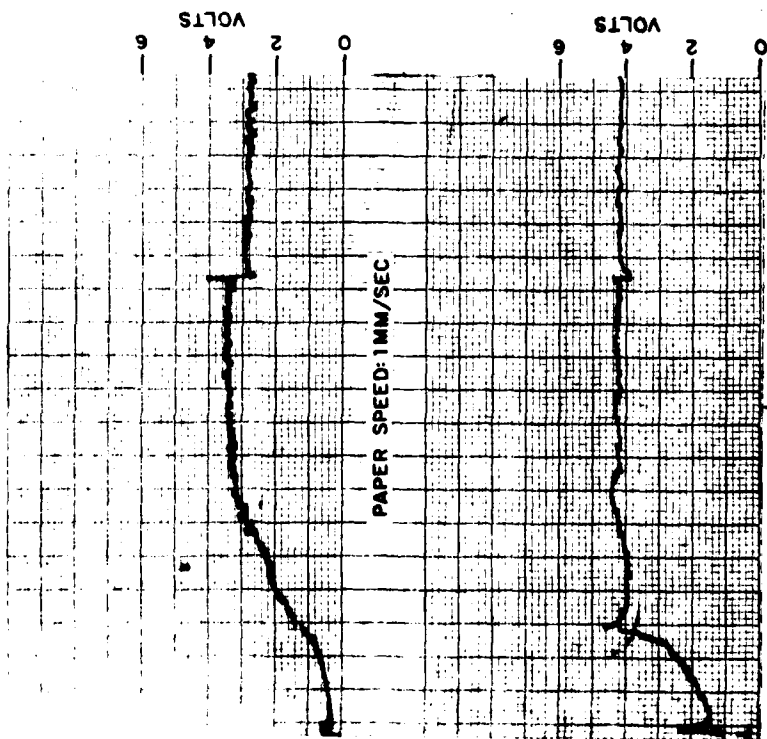
ASN-587-205

Figure B-42. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



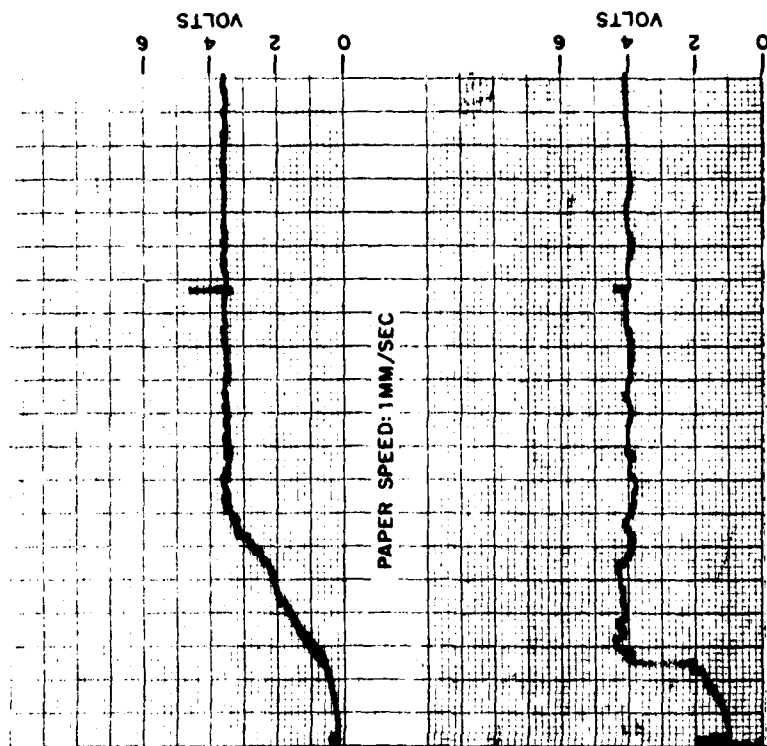
ASW-587-206

Figure B-43. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-207

Figure B-44. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-208

Figure B-45. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

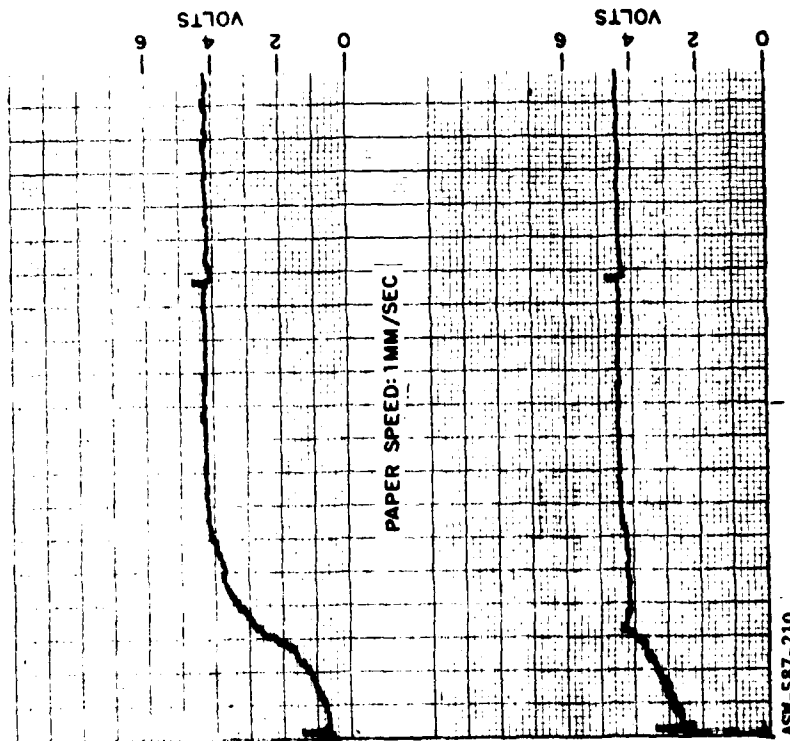


Figure B-46. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

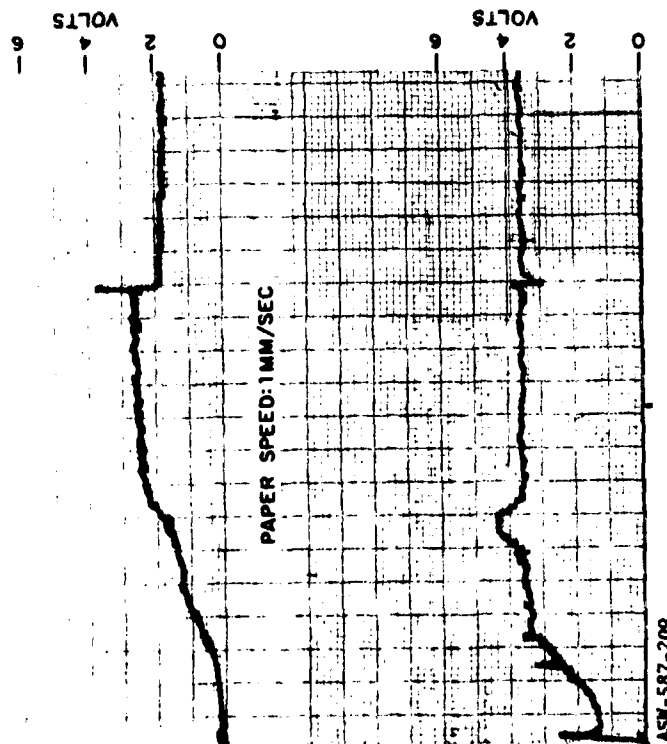


Figure B-47. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

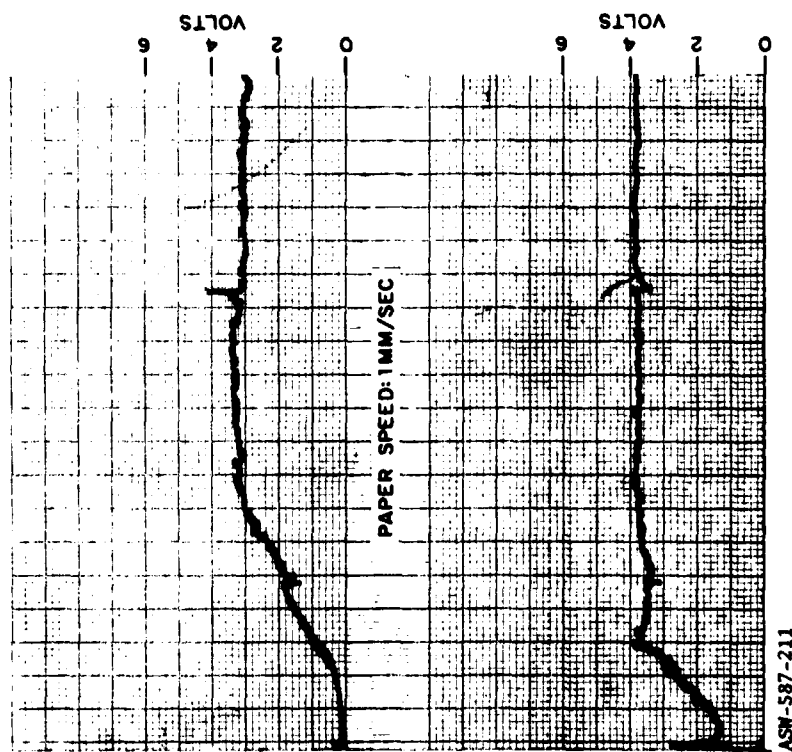


Figure B-48. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

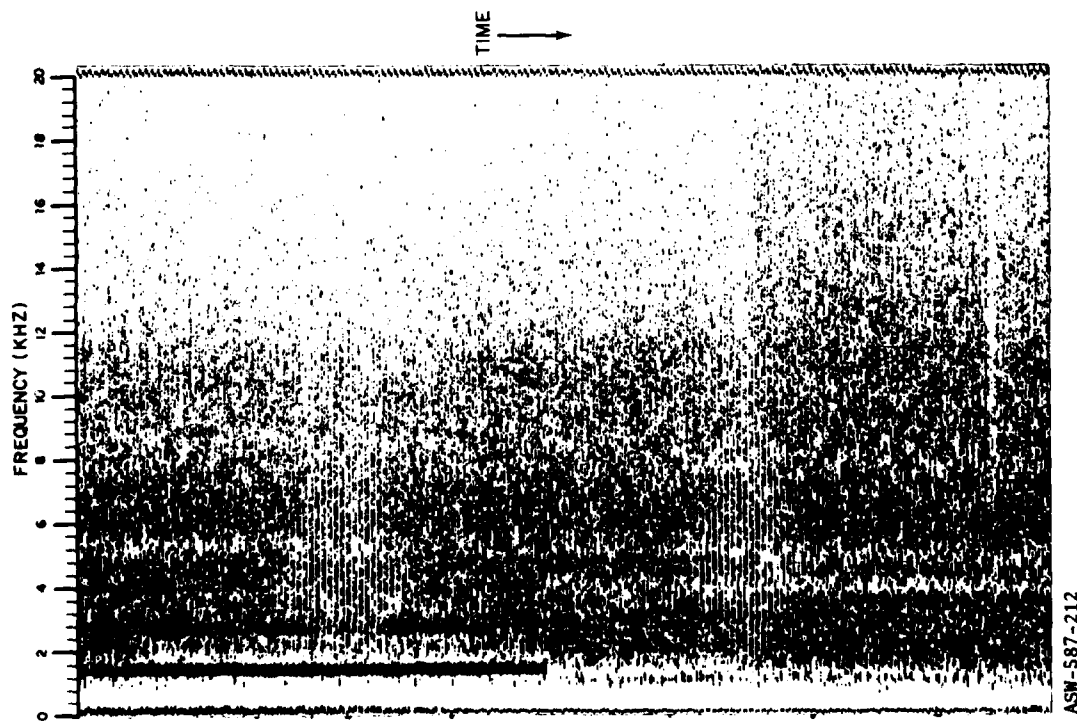


Figure B-49. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

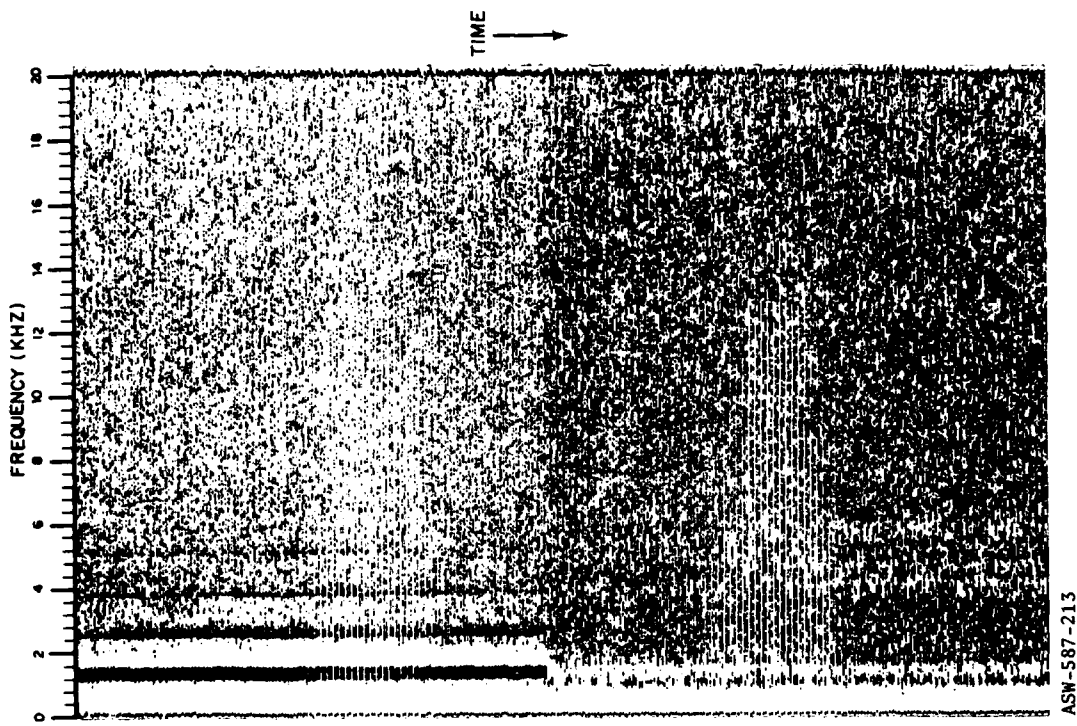
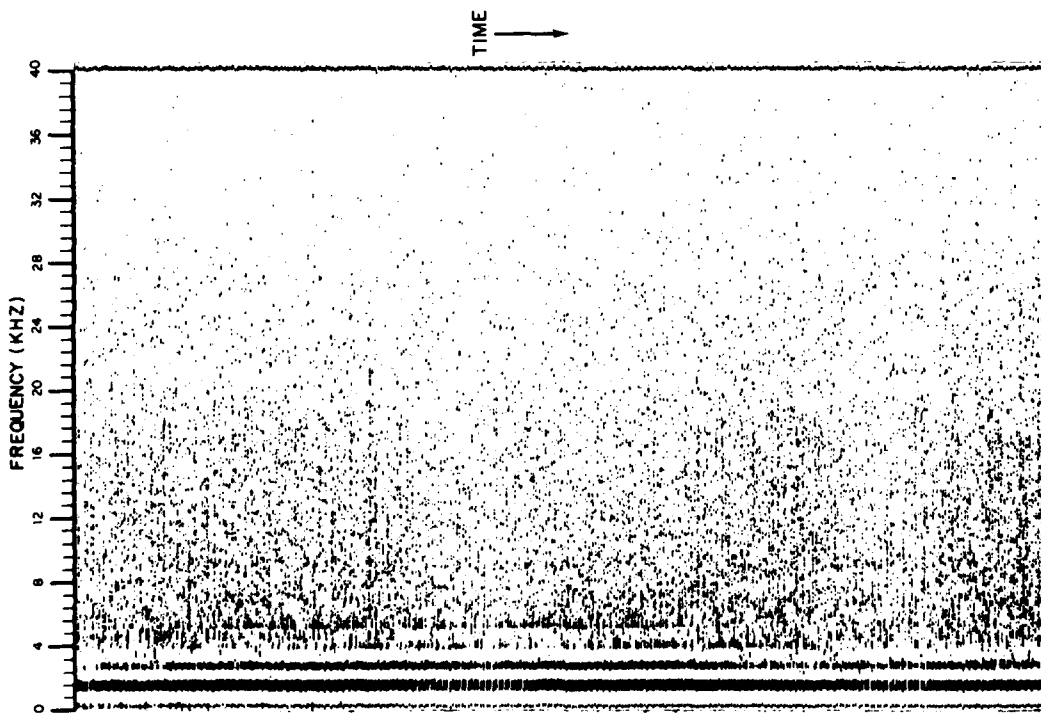
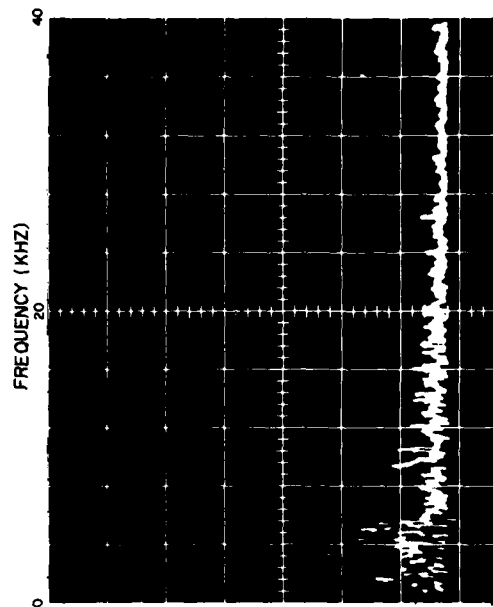
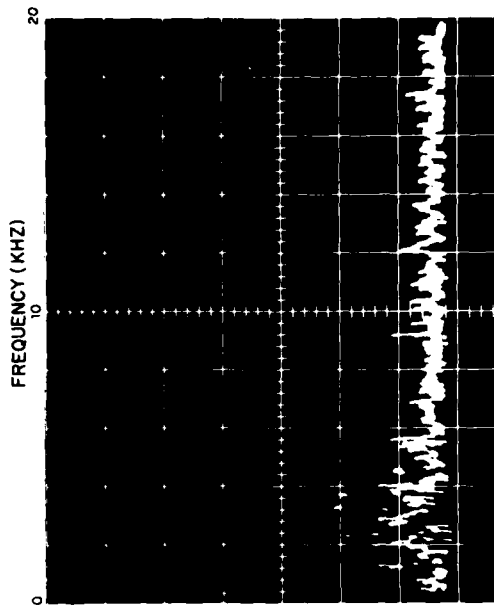


Figure B-50. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



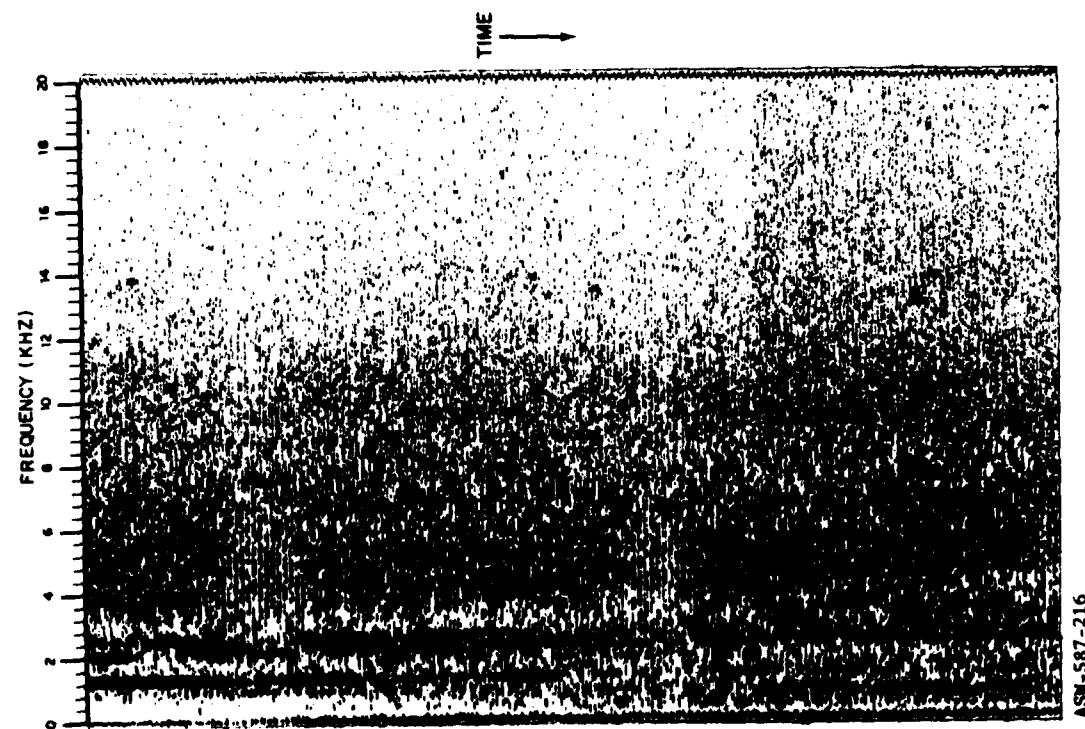
ASW-587-214

Figure B-51. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 KHz.



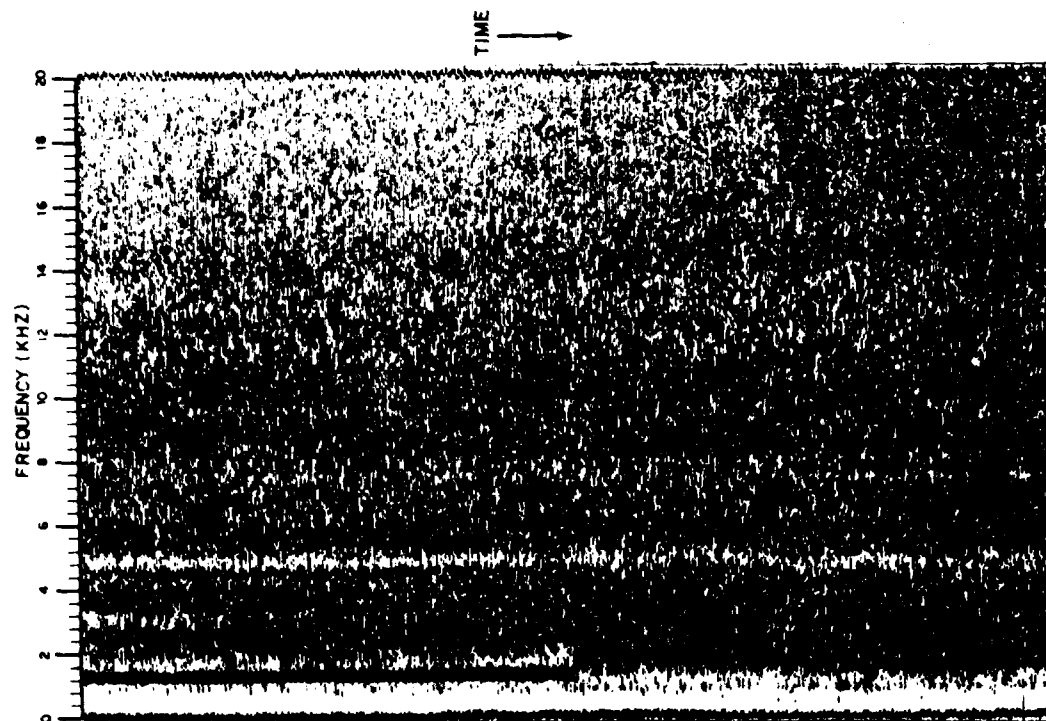
ASW-587-215

Figure B-52. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 KHz and 0 to 40 KHz.



ASW-587-216

Figure B-53. Microphone No. 3 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-217

Figure B-54. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

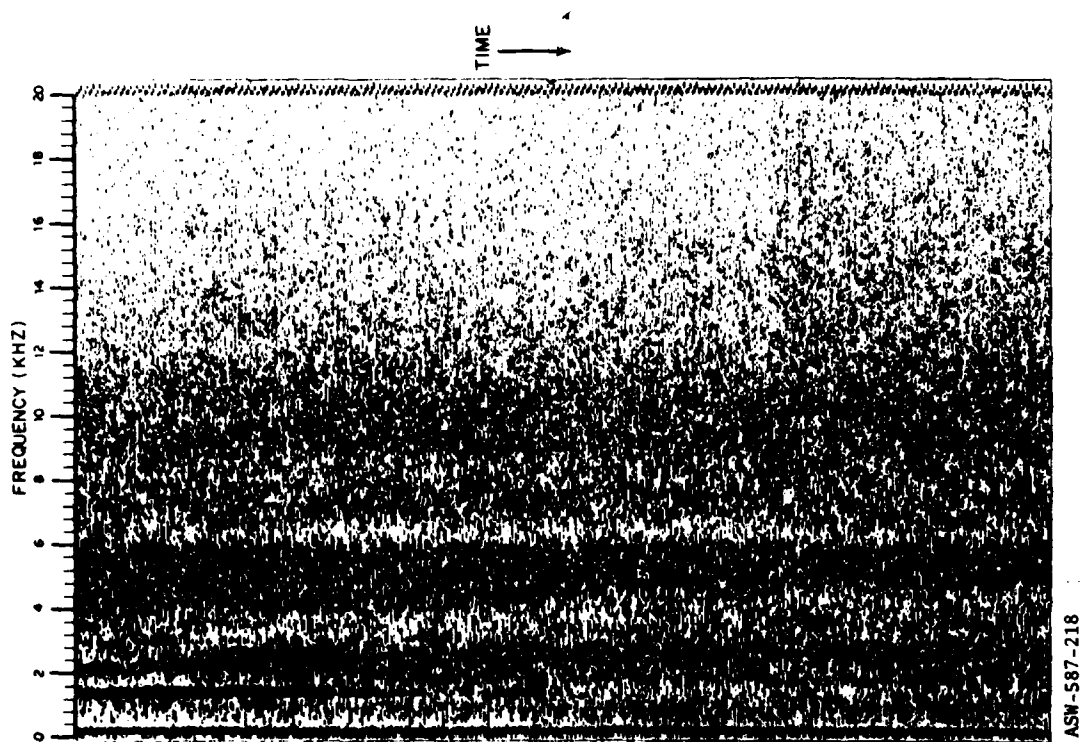


Figure B-55. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 KHz.

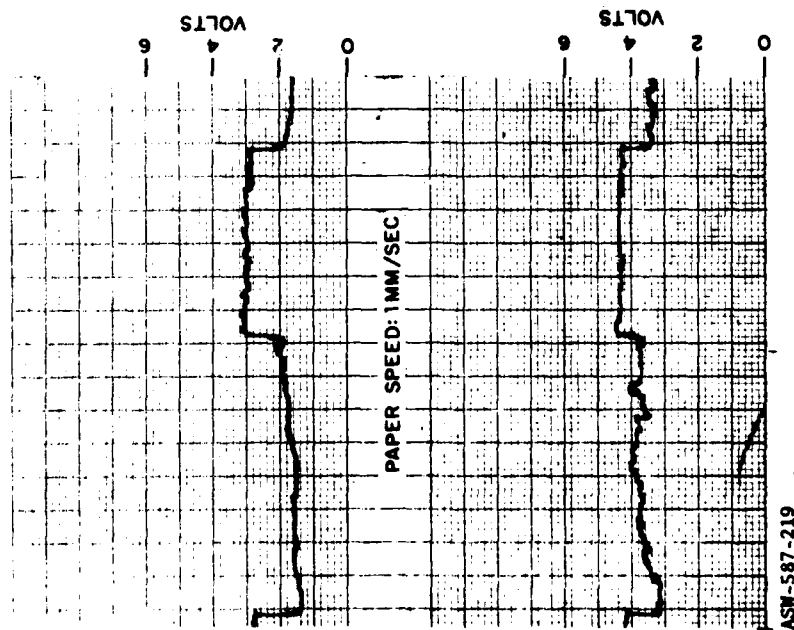


Figure B-56. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

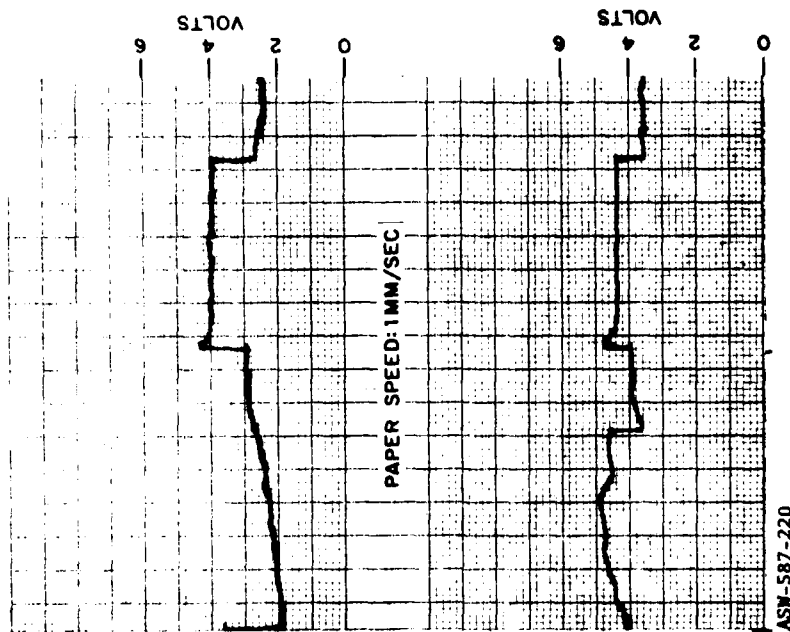
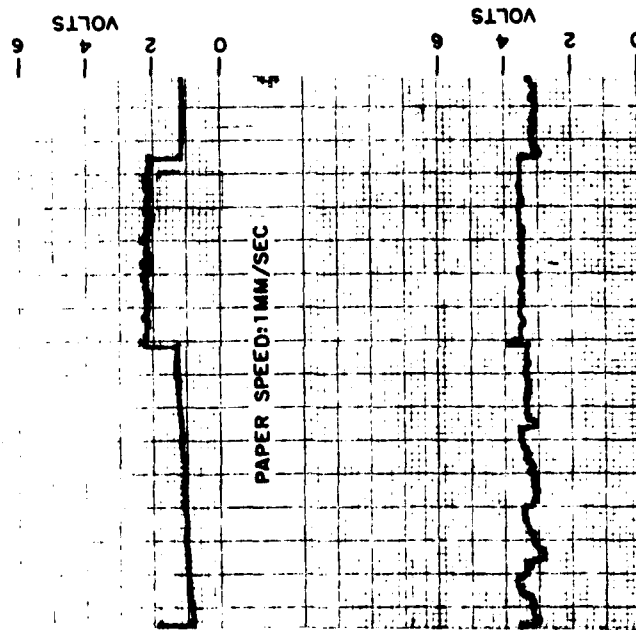
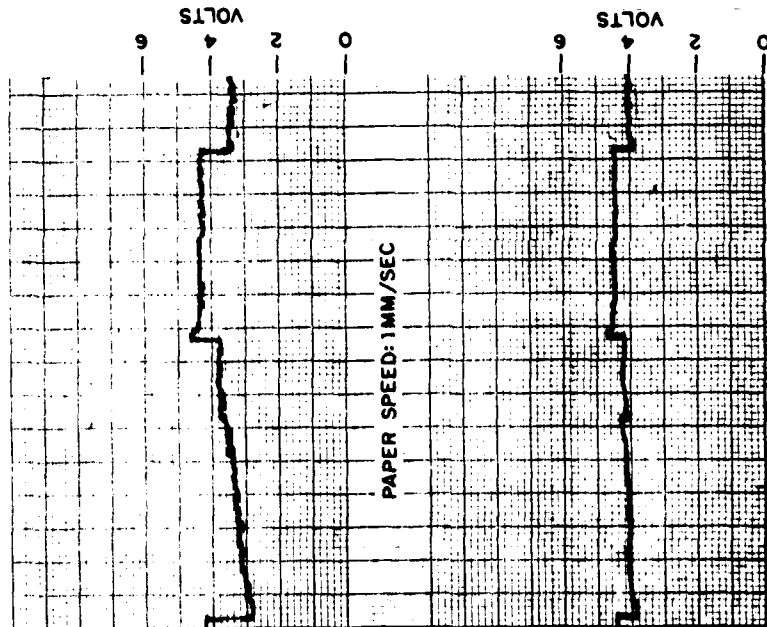


Figure B-57. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-221

Figure B-58. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-222

Figure B-59. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

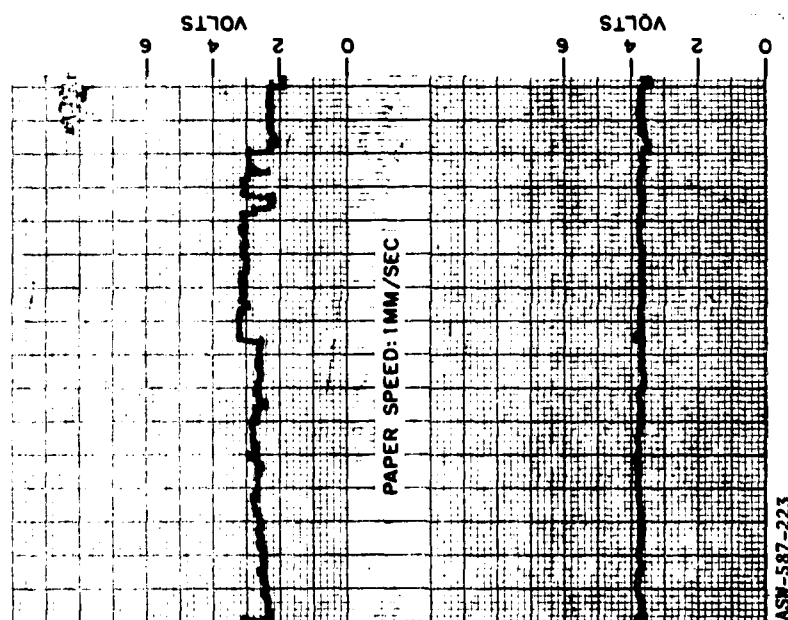
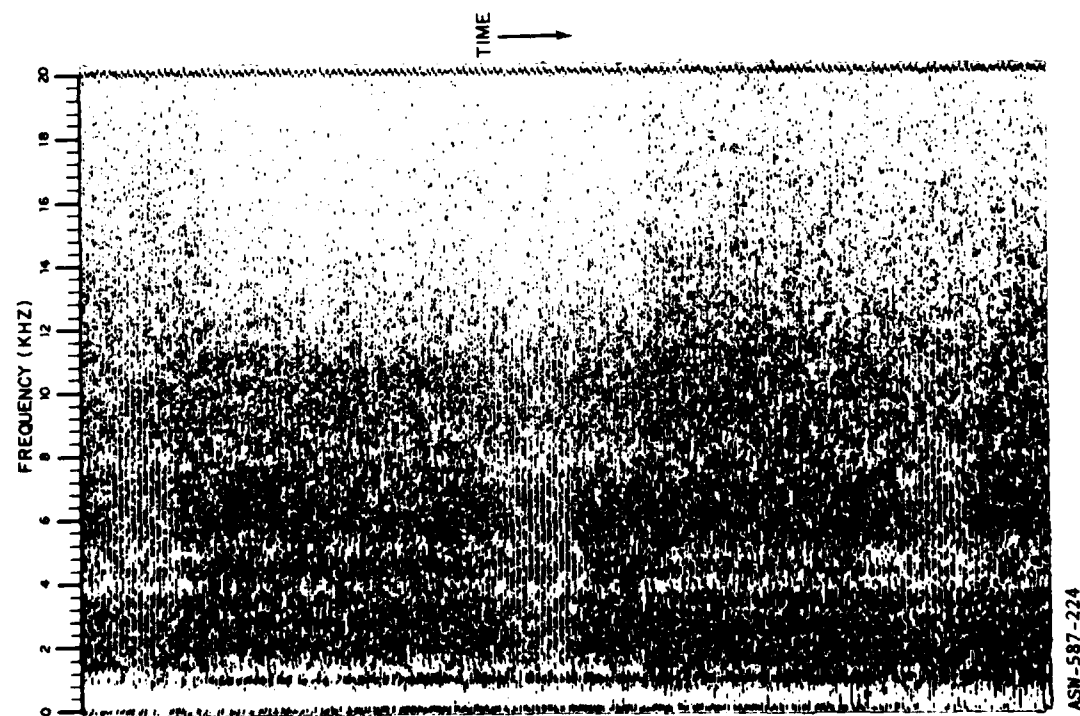
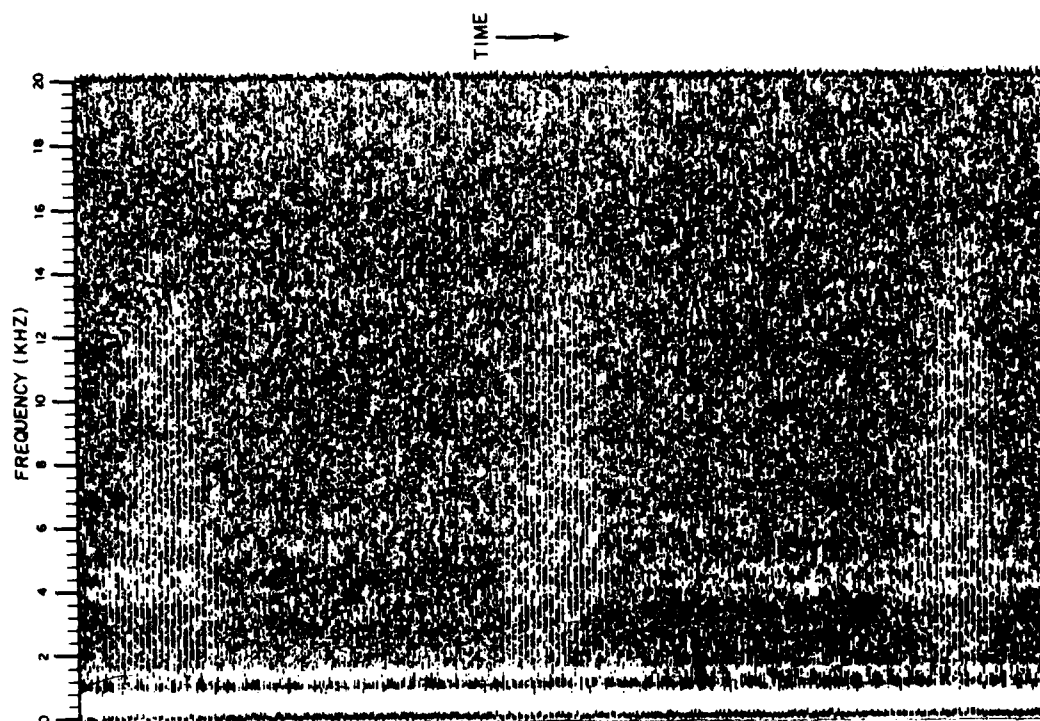


Figure B-60. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



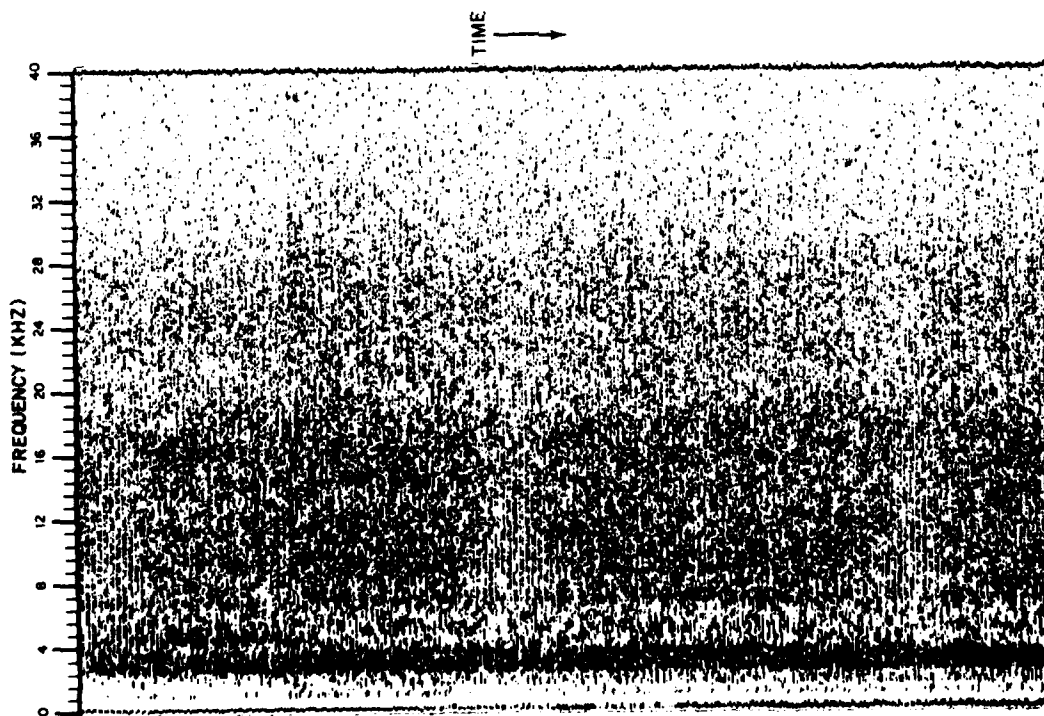
ASN-587-224

Figure B-61. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



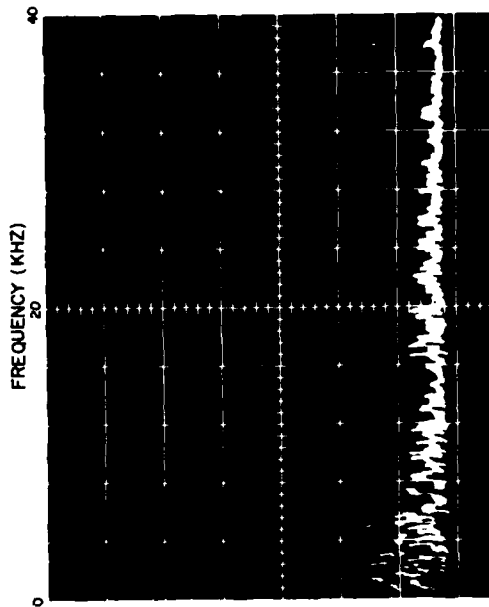
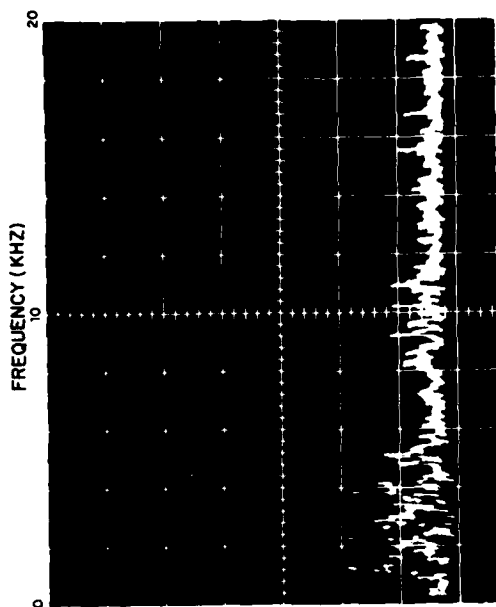
ASN-587-225

Figure B-62. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



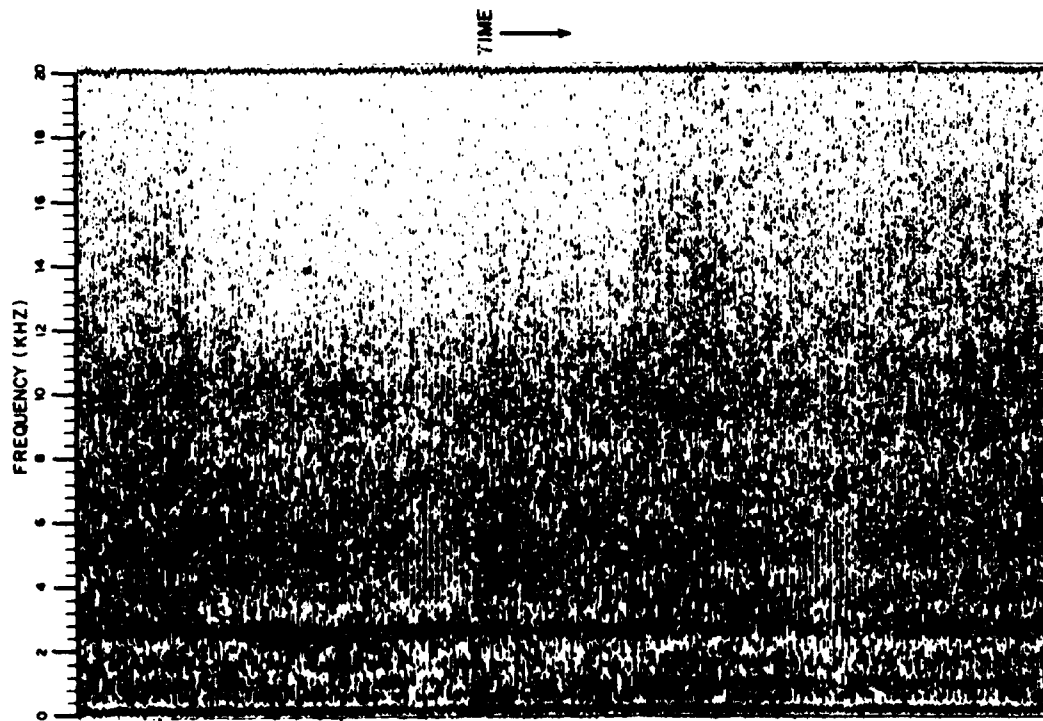
ASW-587-226

Figure B-63. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



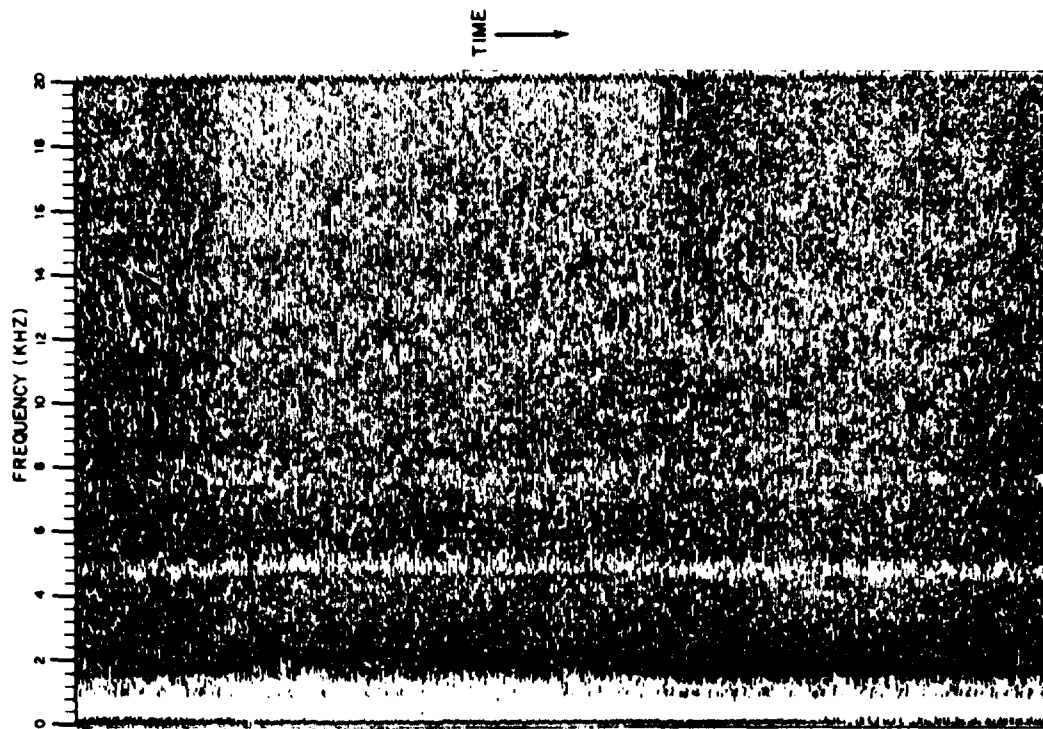
ASW-587-227

Figure B-64. Microphone No. 2 Spectrum Analysis. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



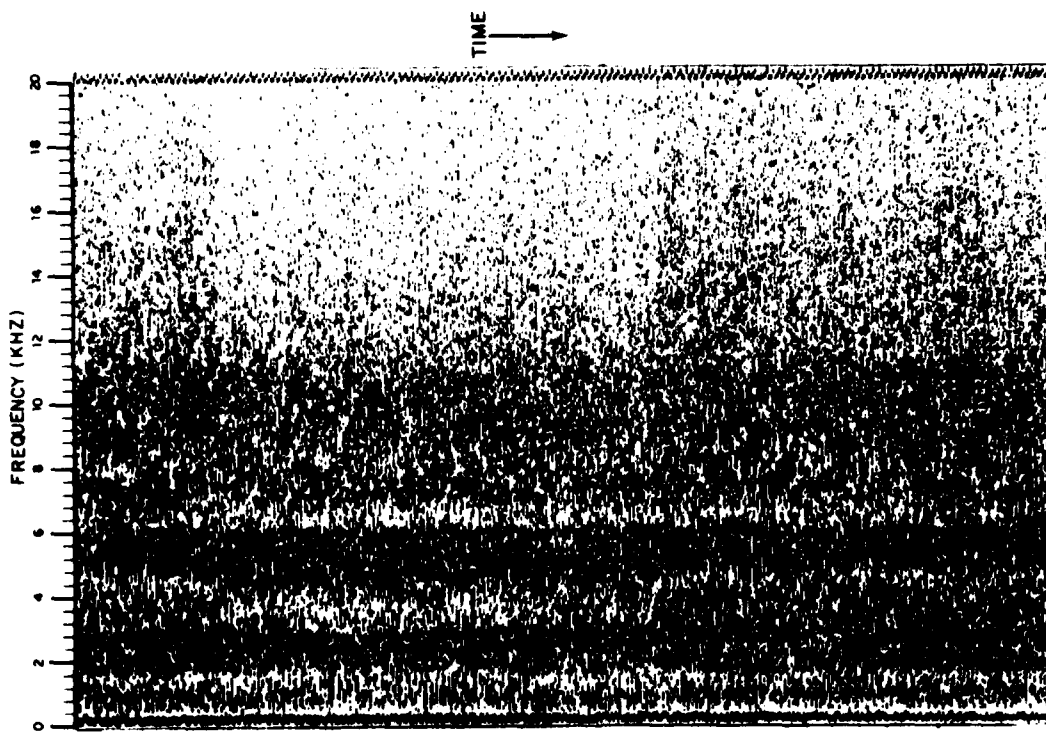
ASN-587-228

Figure B-65. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-229

Figure B-66. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-230

Figure B-67. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 KHz.

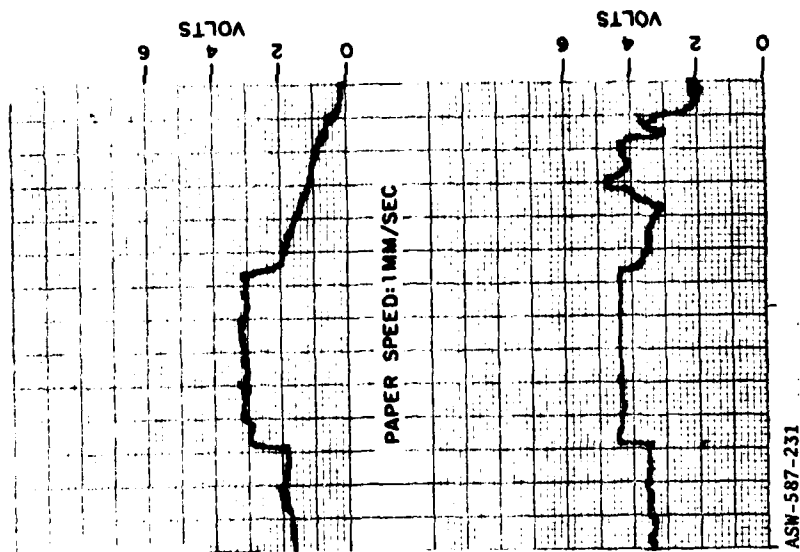


Figure B-68. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

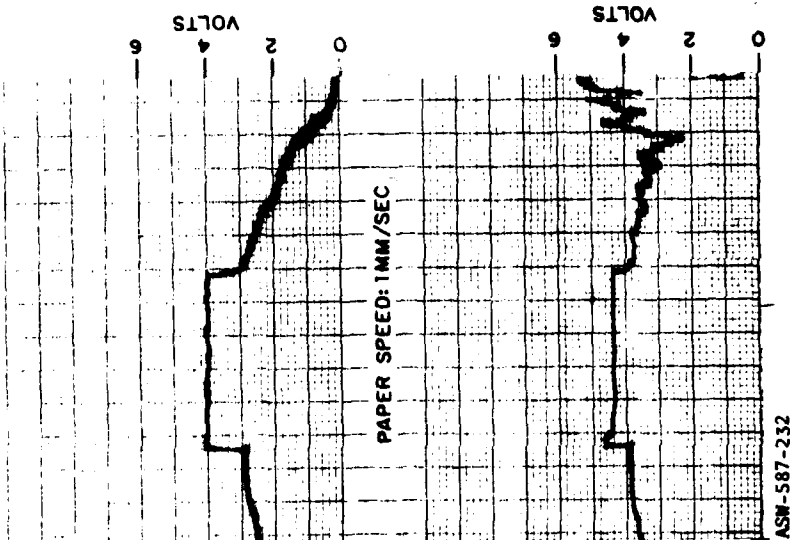


Figure B-69. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

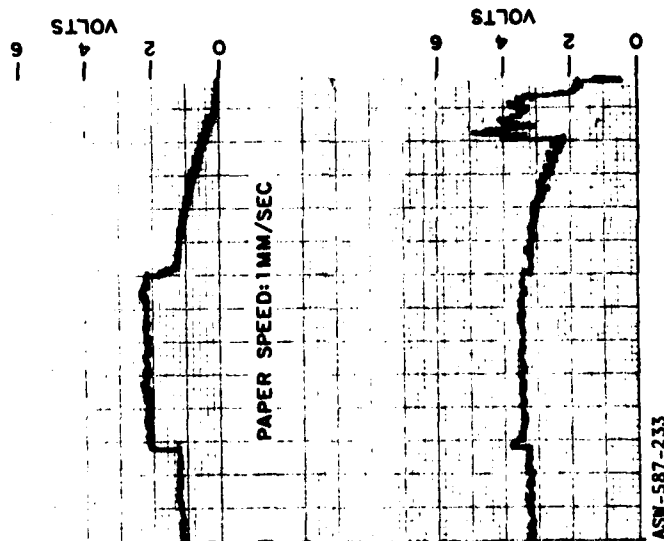


Figure B-70. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

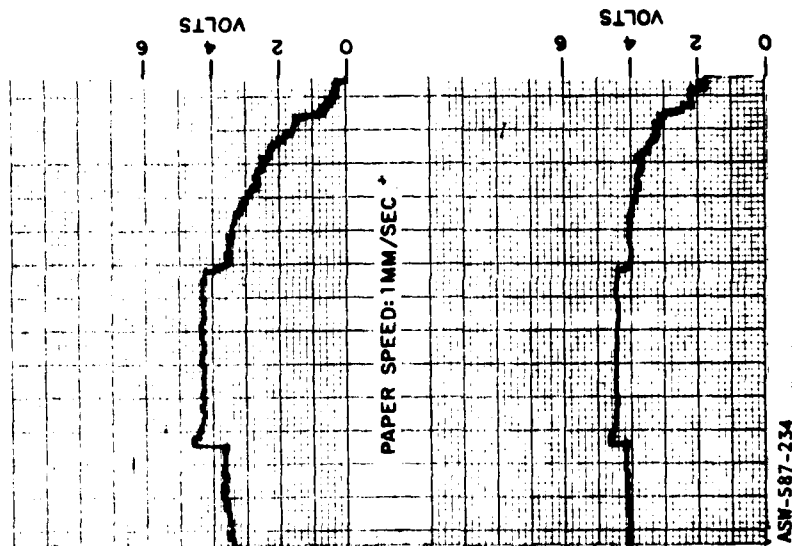


Figure B-71. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

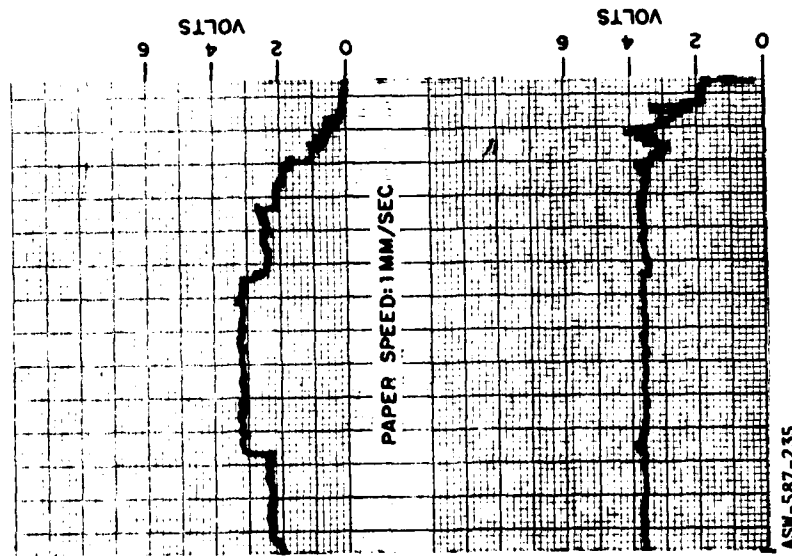


Figure B-72. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.3 J-57 ENGINE (PORT), MODIFIED BURNER CAN HOLE OPEN - 1.0-INCH
DIAMETER

A series of three test runs were made on the J-57 engine with the modified burner can hole masked to a 1.0-inch hole. Each test was recorded using five microphones located in the same positions as for the closed-hole tests. The three tests were run at the following engine speeds:

- (1) 82% RPM (150 in. Hg gage, diffuser case pressure)
- (2) 90% RPM (240 in. Hg gage, diffuser case pressure)
- (3) Max. RPM (270 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed hole on the modified burner can and a medium open hole (1.0 inch in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 82% run - pages B-53 through B-61
- (2) 90% run - pages B-62 through B-68
- (3) Max. run - pages B-69 through B-75

B.3.1 Analysis

B.3.1.1 Sound Energy Levels

The 1.0 inch open-hole readings were similar to the 1.5-inch open-hole readings except that they were slightly lower. This was probably due to hole size reduction. Microphones 3 and 5, which were farthest from the open hole, showed the least change (1 dB drop) while microphones 1 and 4, which were close to the hole, showed 3 to 5 dB drops. Microphone 2, a different type for this run than was used for the closed hole and 1.5 inch open-hole test, is not directly comparable.

As in the closed-hole test, the 82% RPM was very noisy. A greater differential between closed-hole and open-hole tests appear in the 90% and maximum RPM runs.

B.3.1.2 Spectrum Analysis

The grams for this test were almost identical to the 1.5-inch open-hole test. There were no distinct characteristic differences from those noted in the 1.5-inch open-hole test.

B.3.1.3 Mean Square Analysis

The mean square analysis recordings showed a greater portion of the spectral content to be above 5 kHz than for the 1.5-inch open-hole and closed-hole tests. Burner can "flame on" was not as distinct as for the 1.5-inch open-hole test.

B.3.2 Environmental Conditions

The three tests discussed in paragraph B.3 were performed at an ambient temperature of 68° F and 78% relative humidity.

B.3.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table B-7. Microphone Sound Energy Levels at 82% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	88	115	62	145	47
RMS (μBAR)	630	930	500	1150	380
dB (a)	131	133	128	135	125

^aReference = 2×10^{-4} μBAR

Table B-8. Microphone Sound Energy Levels at 90% Engine RPM

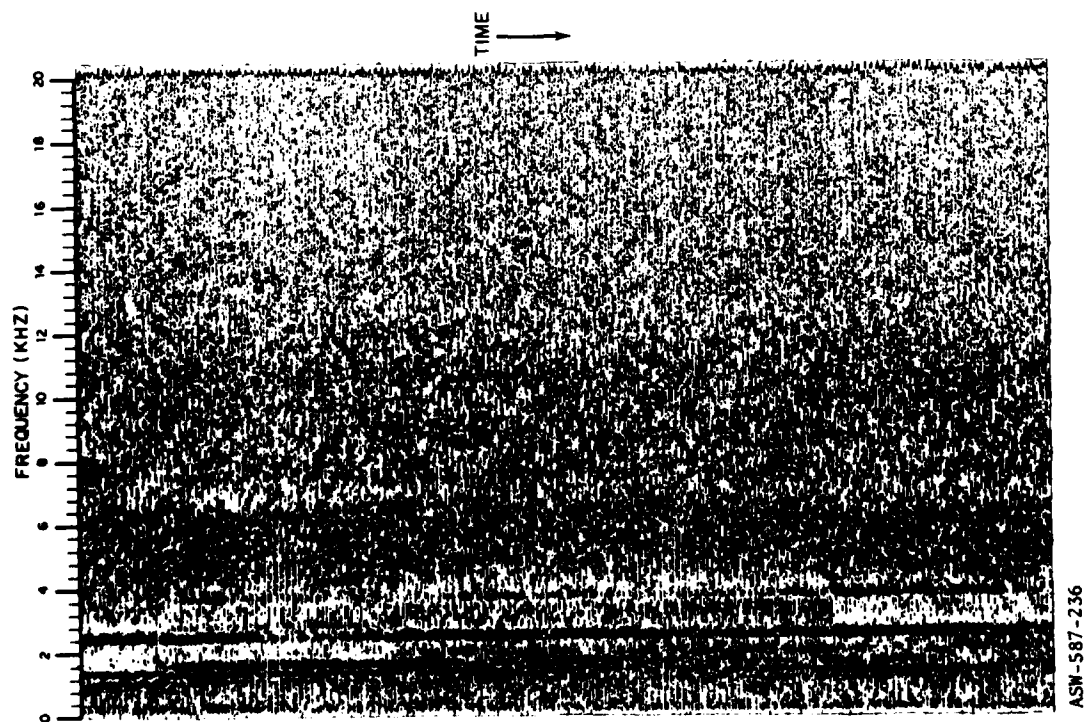
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	95	125	65	125	54
RMS (μBAR)	760	1000	520	1000	430
dB (a)	132	134	128	134	127

^aReference = 2×10^{-4} μBAR

Table B-9. Microphone Sound Energy Levels at Maximum Engine RPM

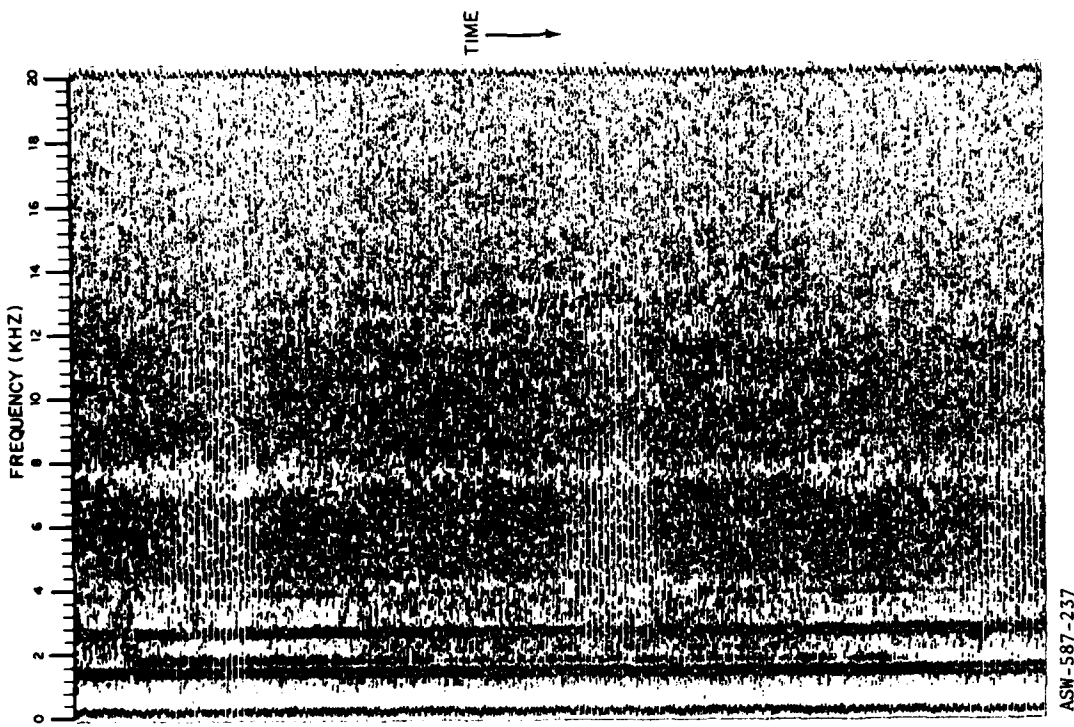
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	100	130	78	130	60
RMS (μBAR)	800	1040	630	1040	480
dB (a)	132	134	130	134	128

^aReference = 2×10^{-4} μBAR



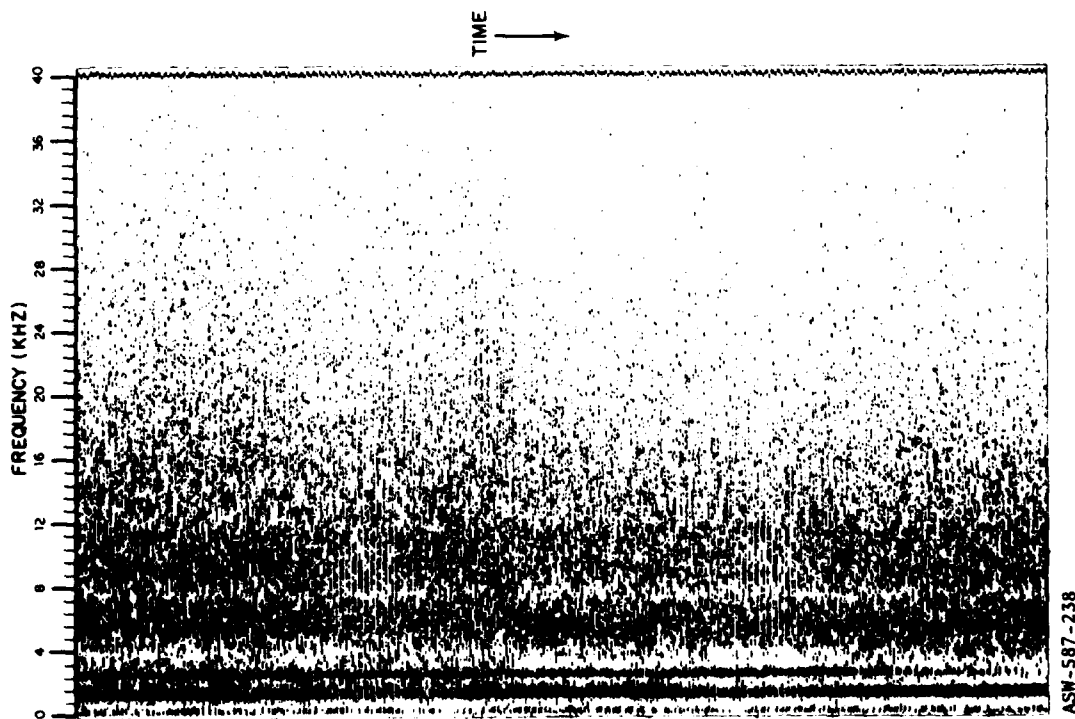
ASW-587-236

Figure B-73. Microphone No. 1 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



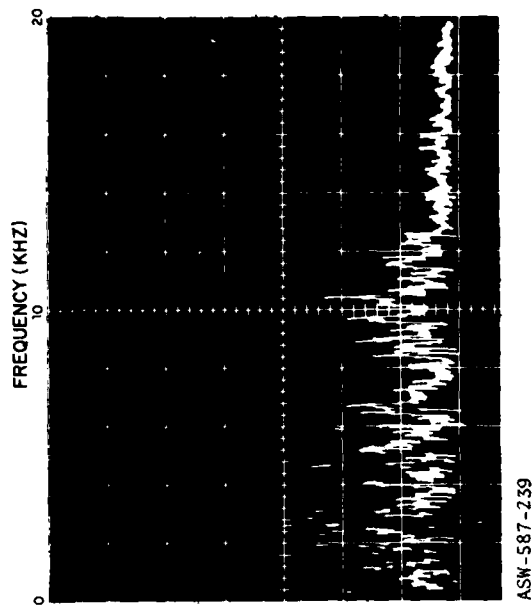
ASW-587-237

Figure B-74. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-238

Figure B-75. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



ASW-587-239

Figure B-76. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

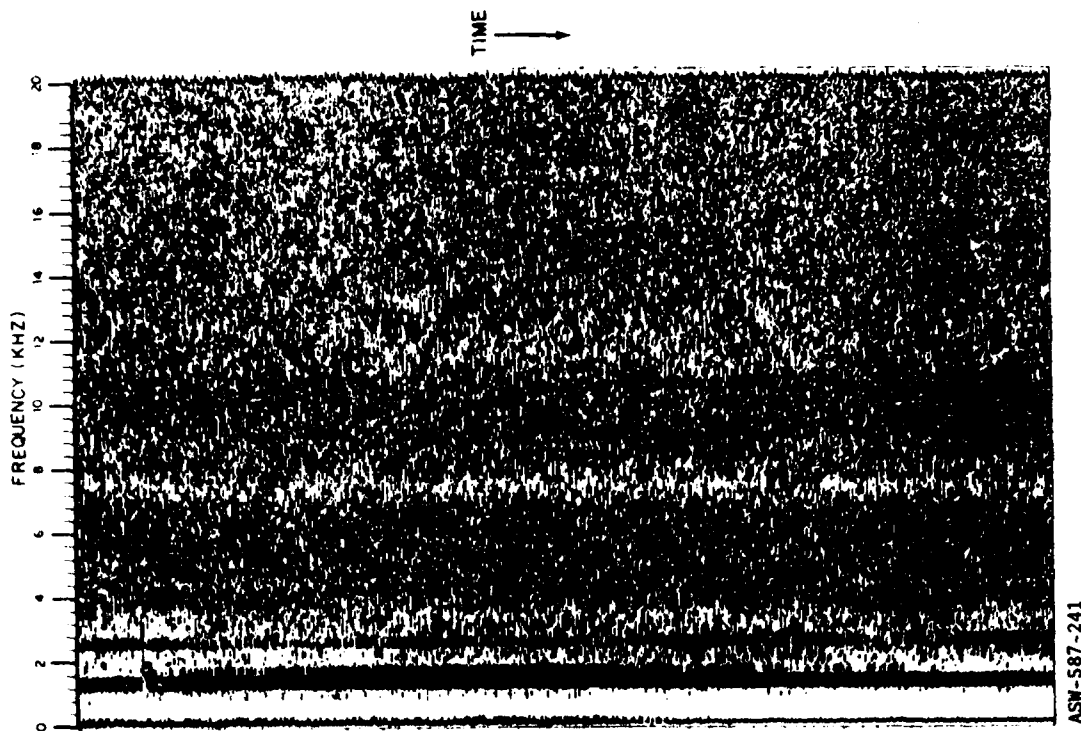


Figure B-78. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

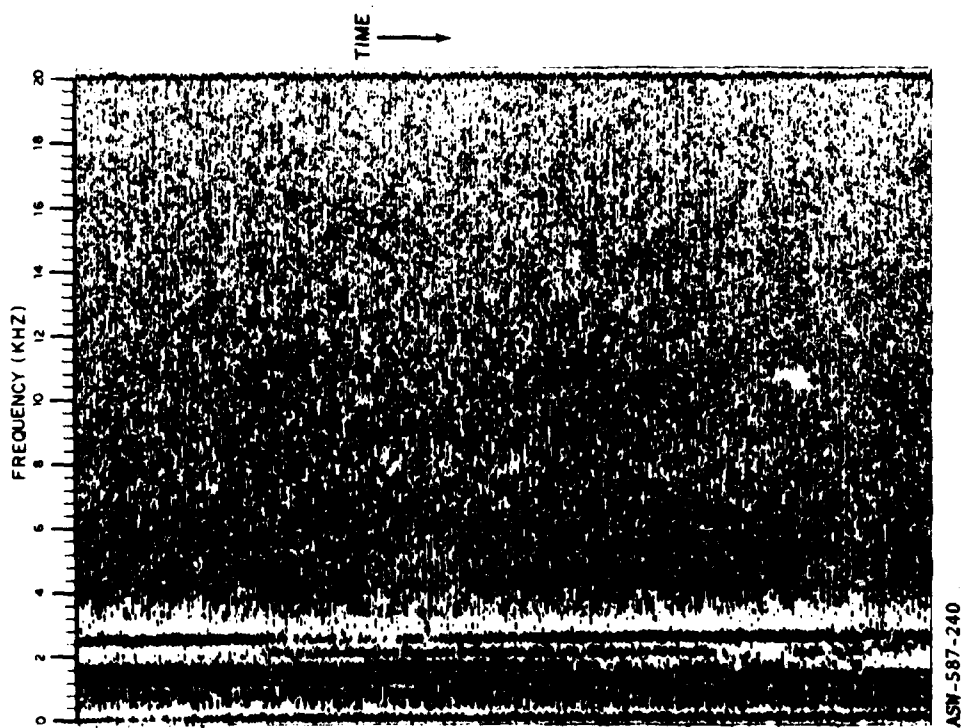


Figure B-77. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

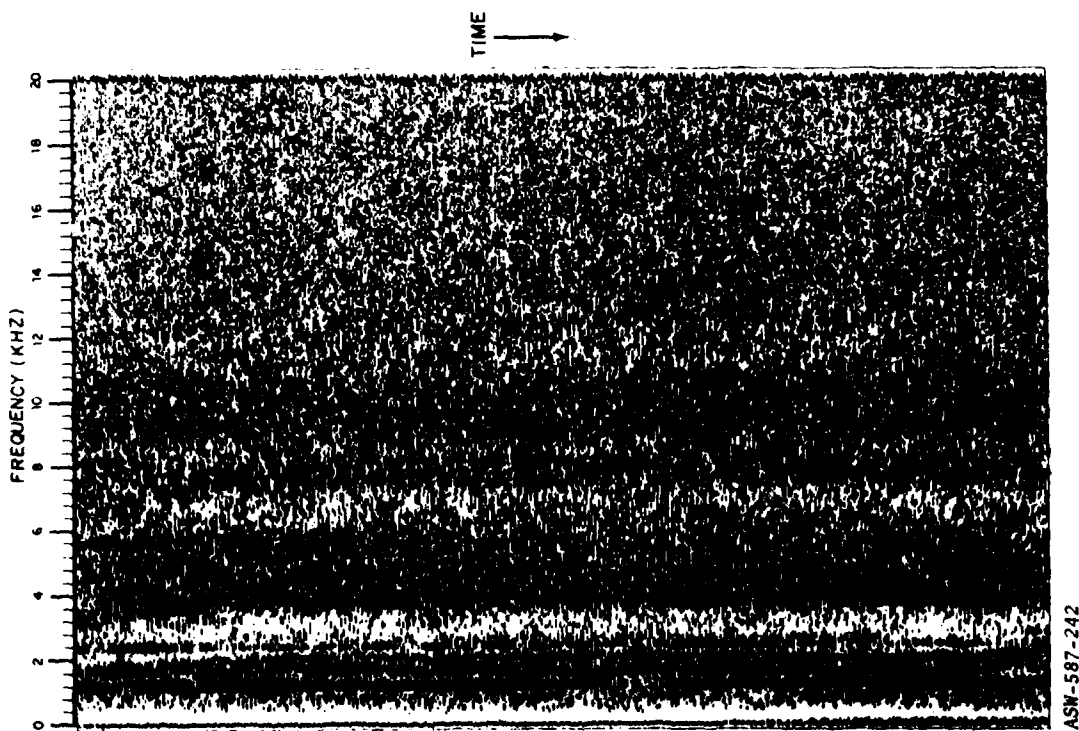


Figure B-79. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

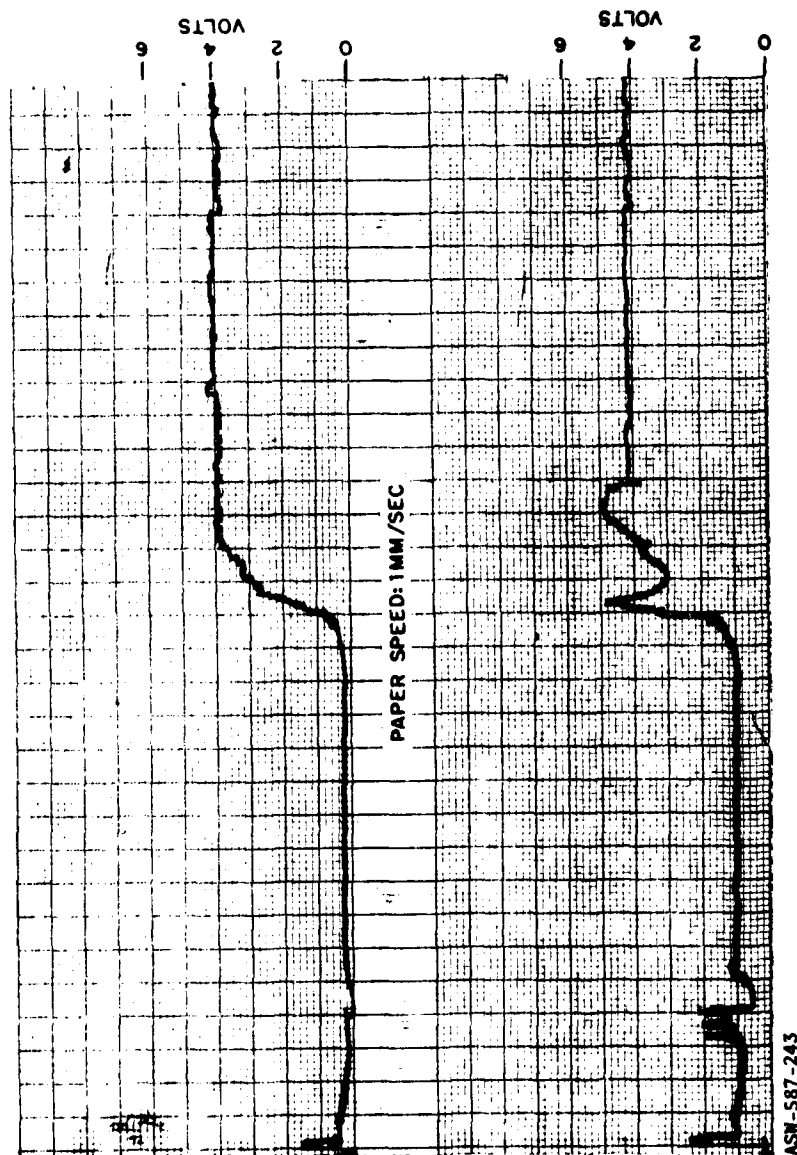


Figure B-80. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASW-587-243

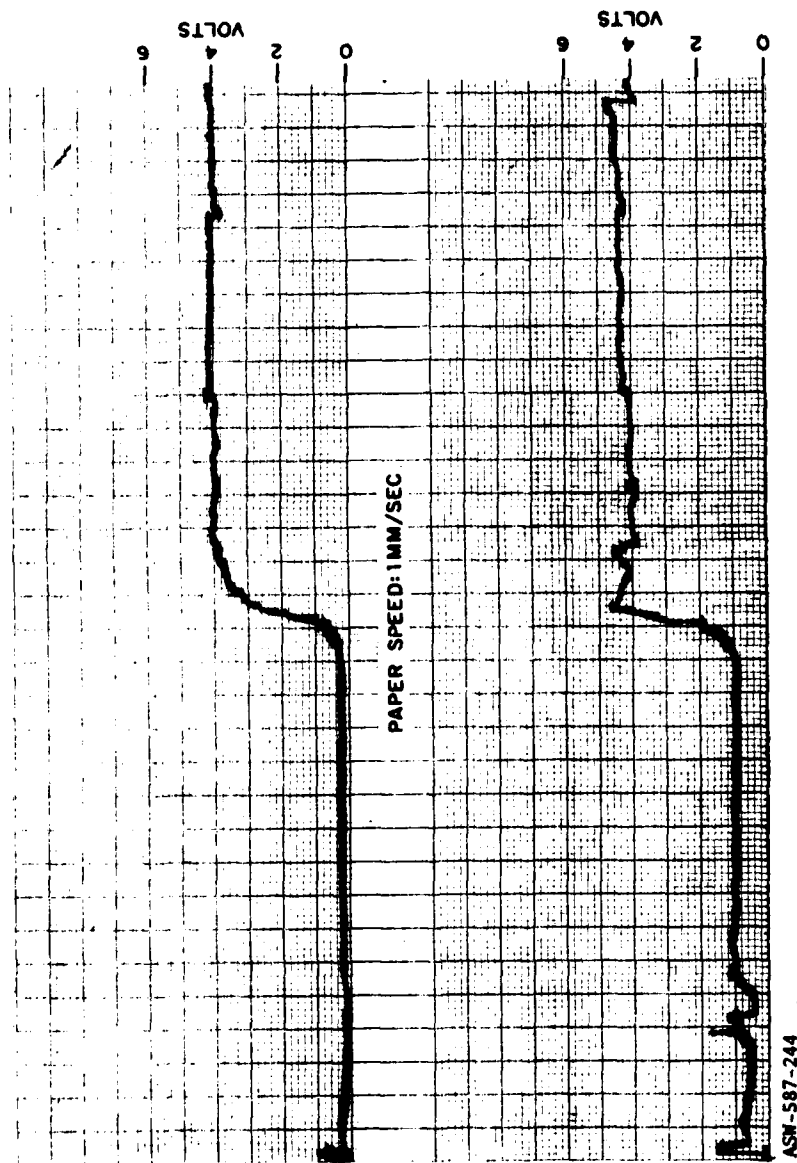


Figure B-81. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

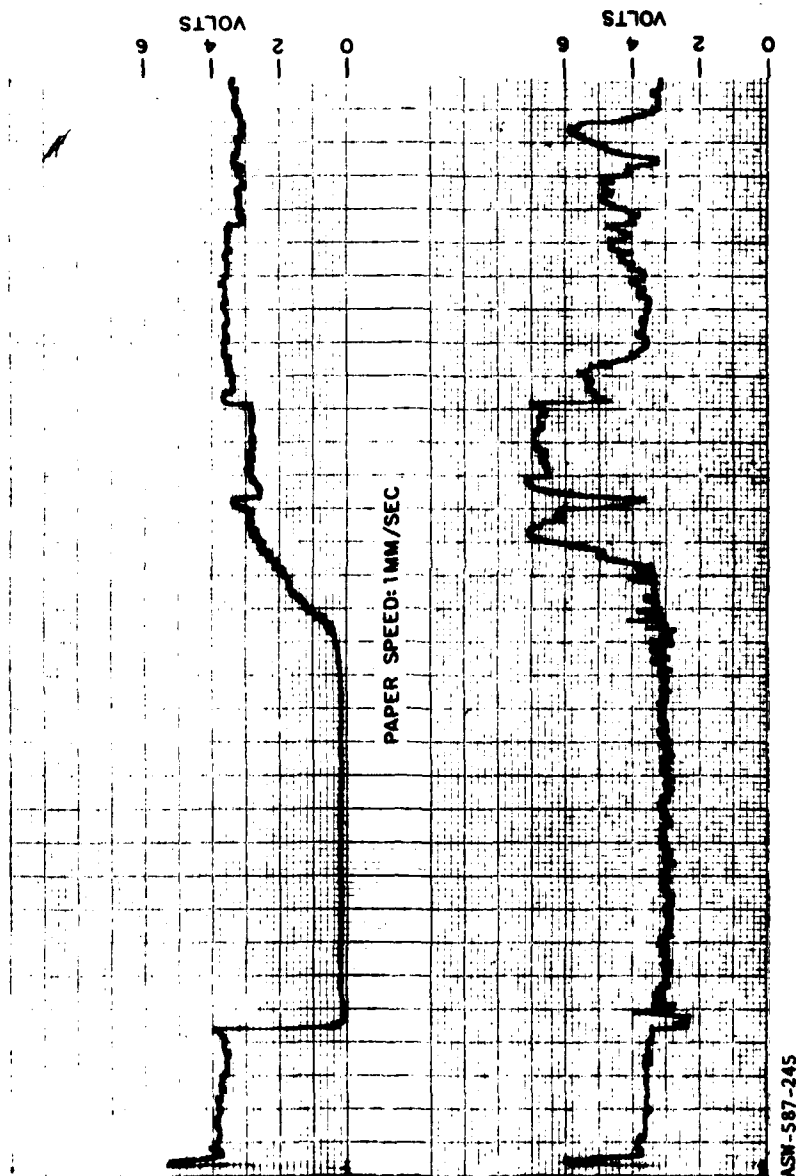


Figure B-82. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASN-587-245

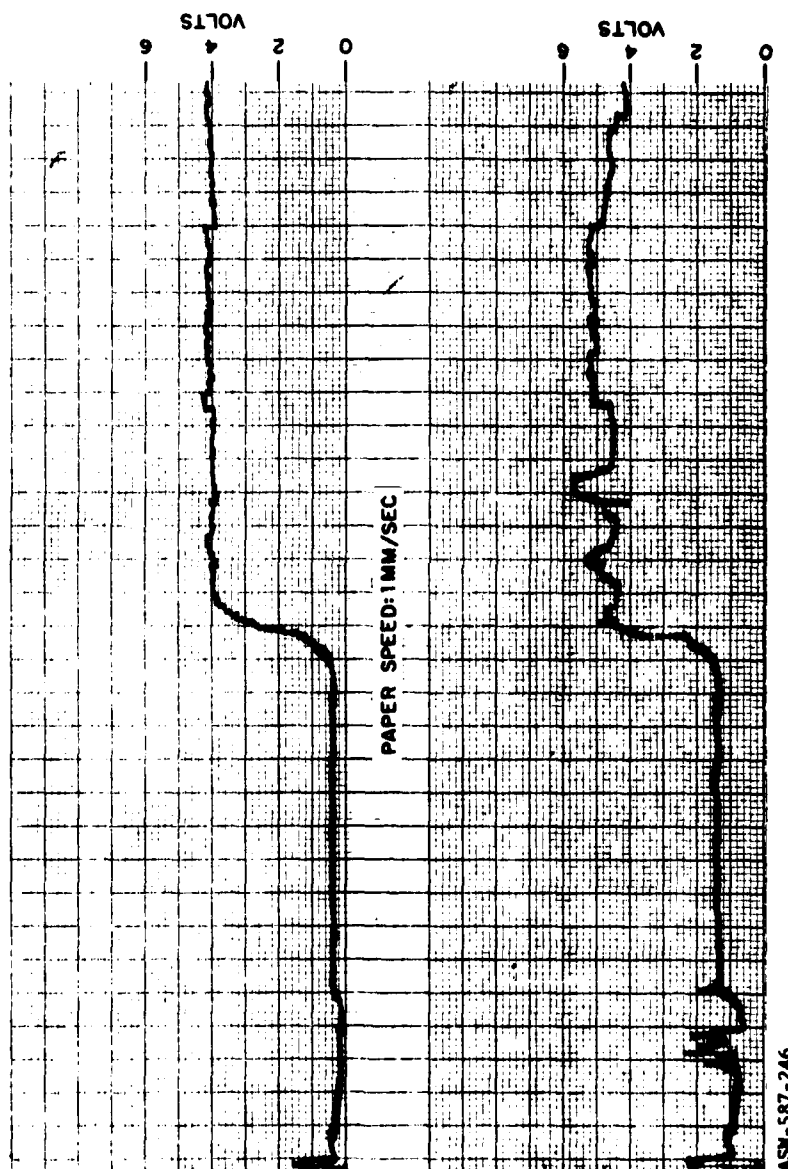


Figure B-83. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASN-587-246

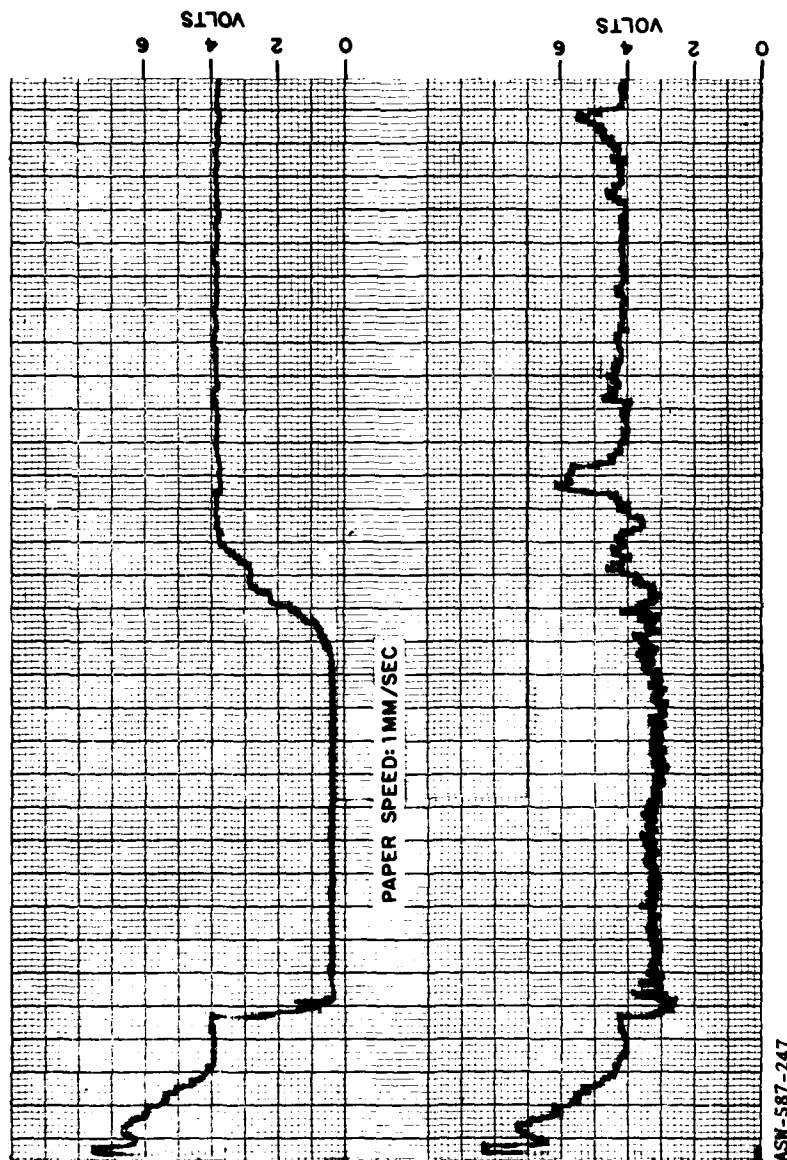
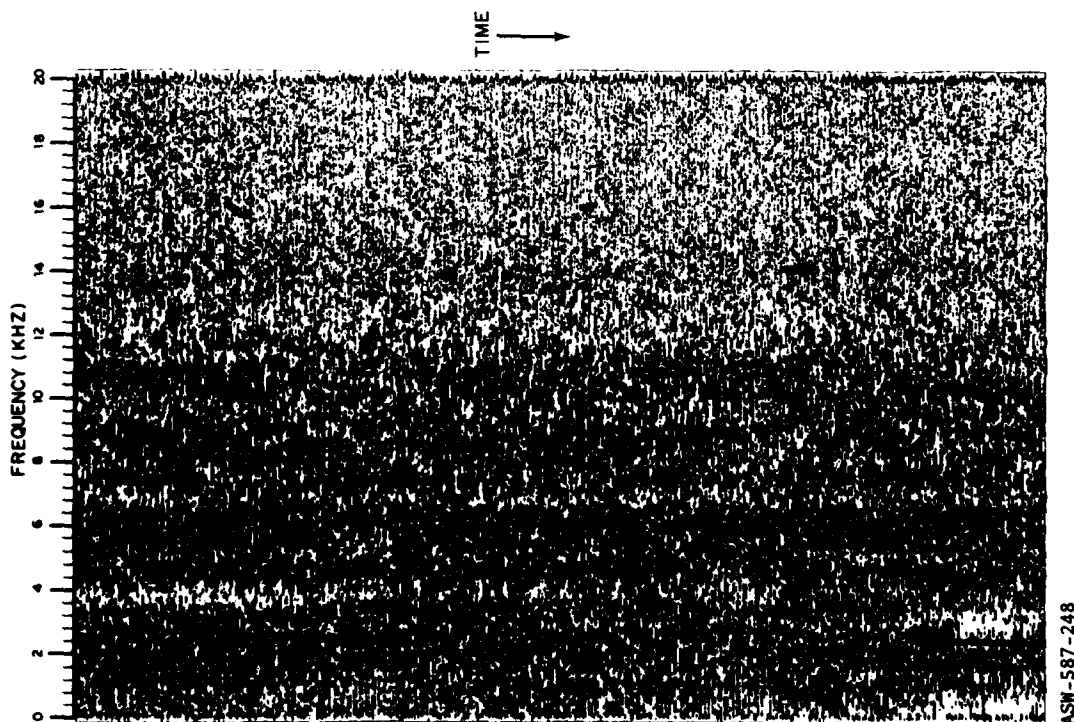
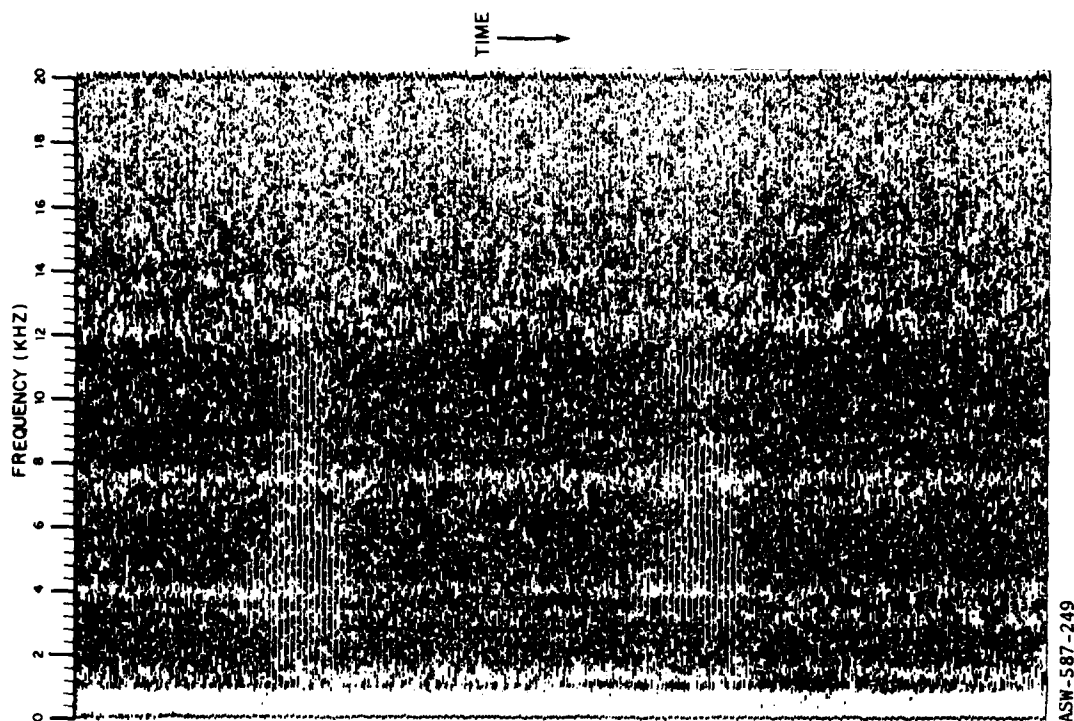


Figure B-84. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



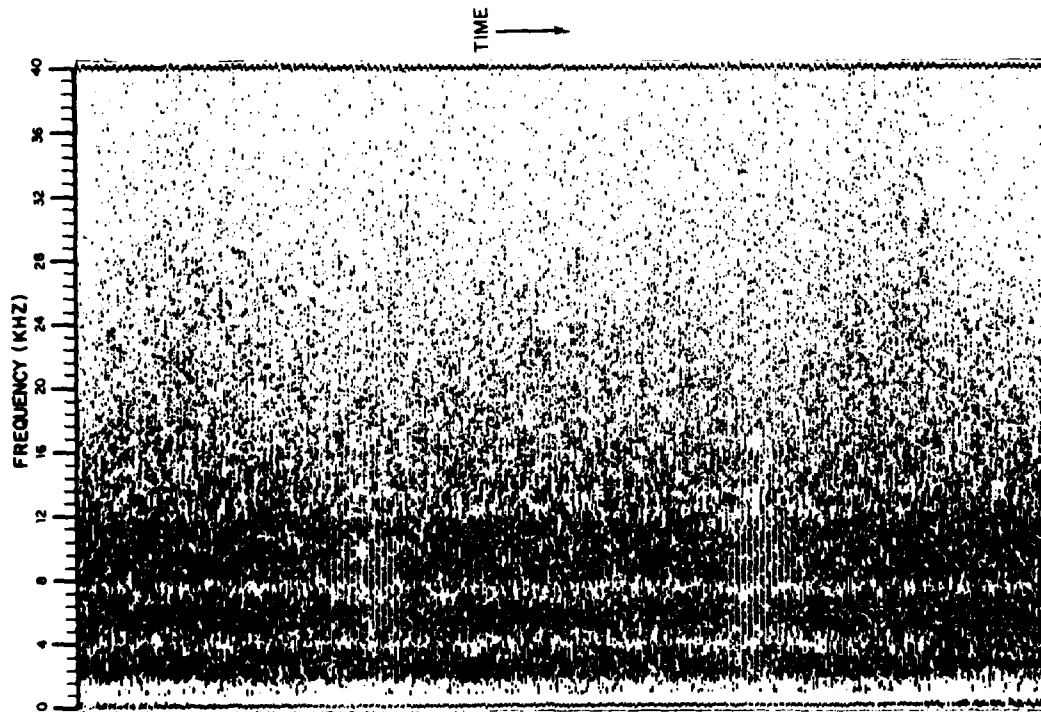
ASW-587-248

Figure B-85. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



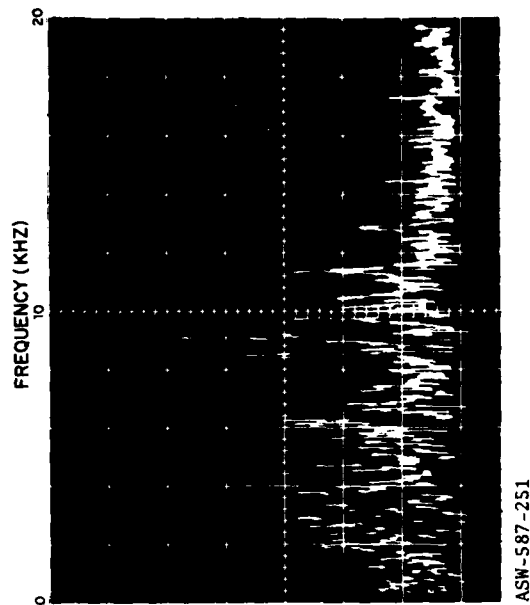
ASW-587-249

Figure B-86. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-250

Figure B-87. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



ASW-587-251

Figure B-88. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

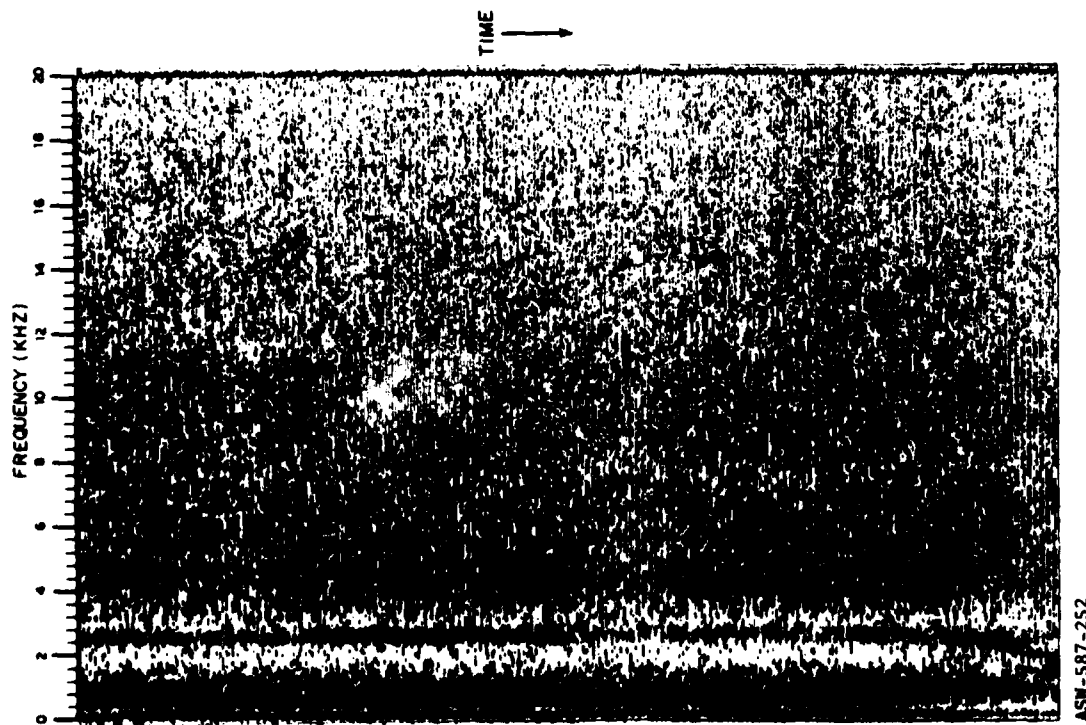


Figure B-89. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

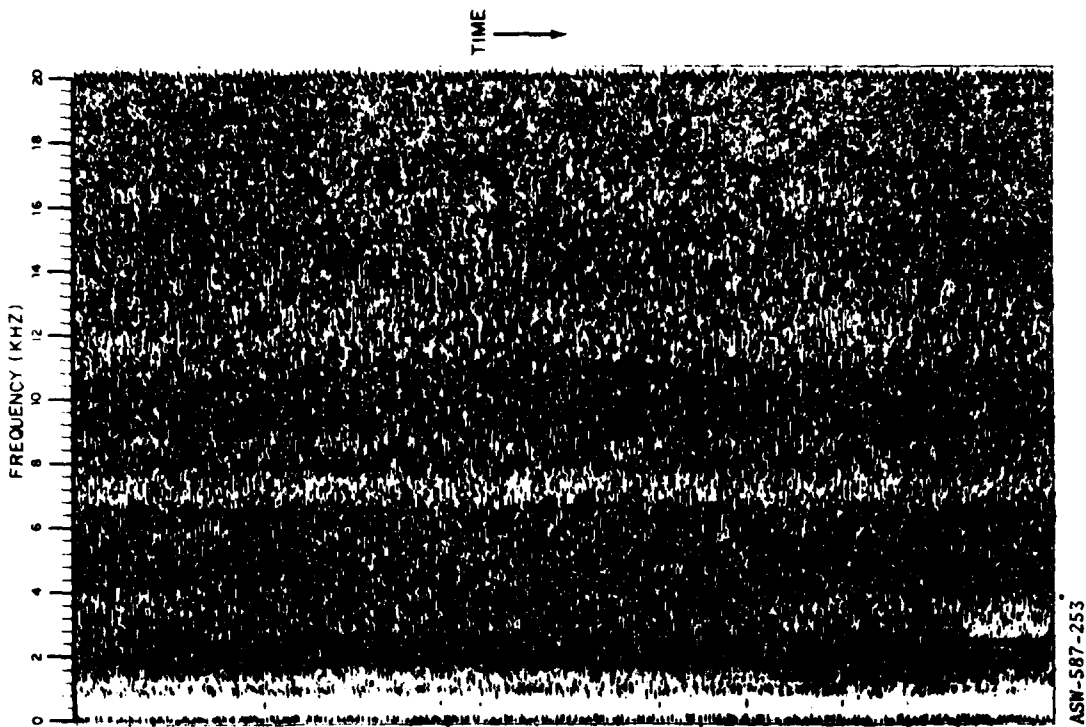


Figure B-90. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

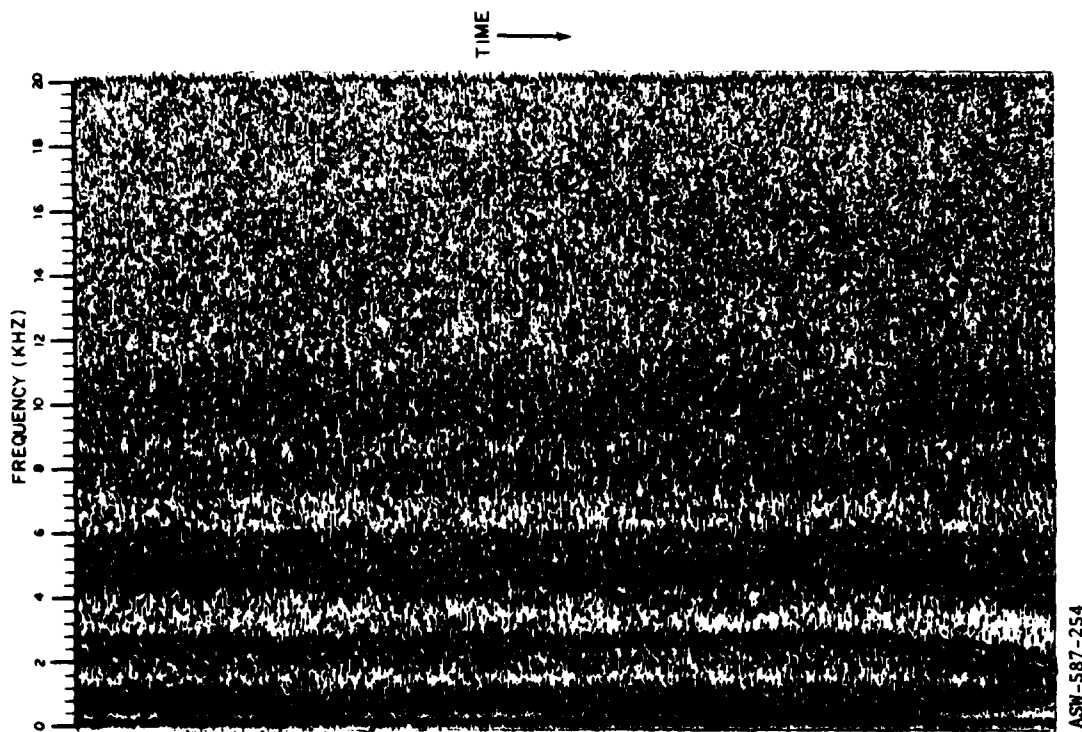


Figure B-91. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

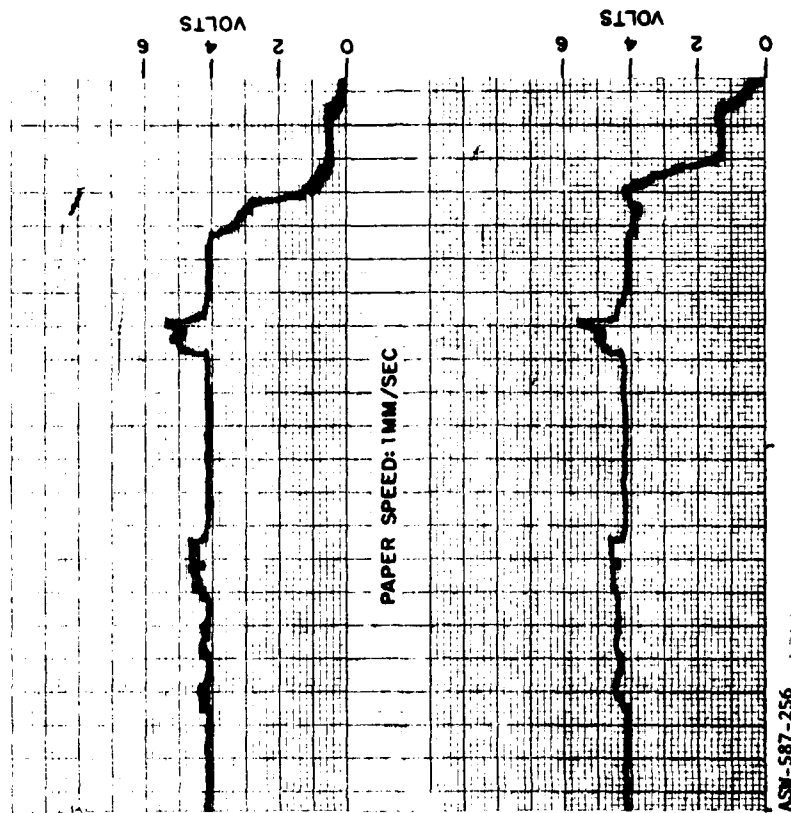


Figure B-93. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

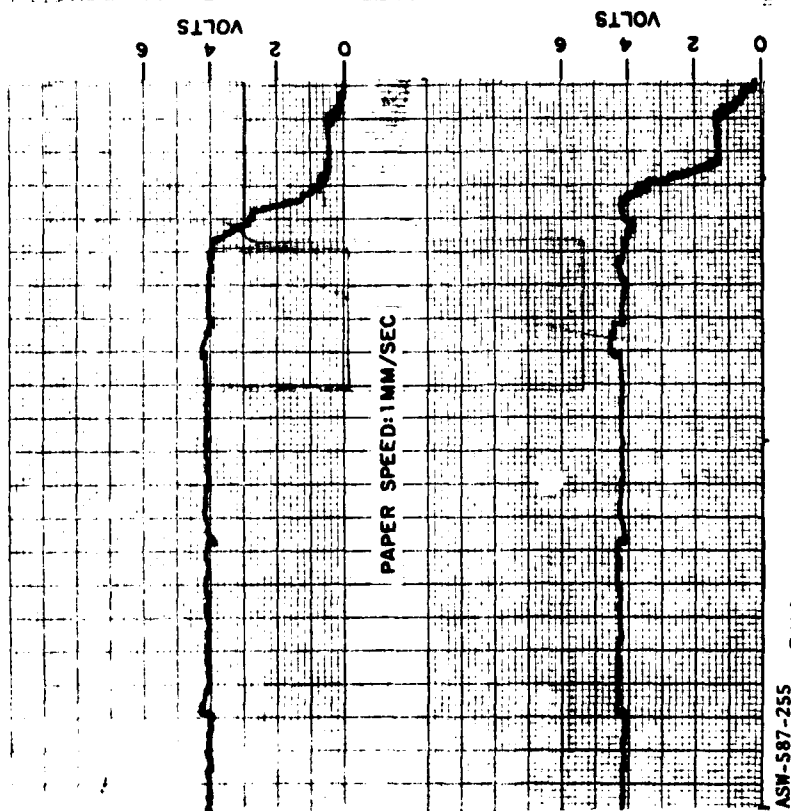


Figure B-92. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

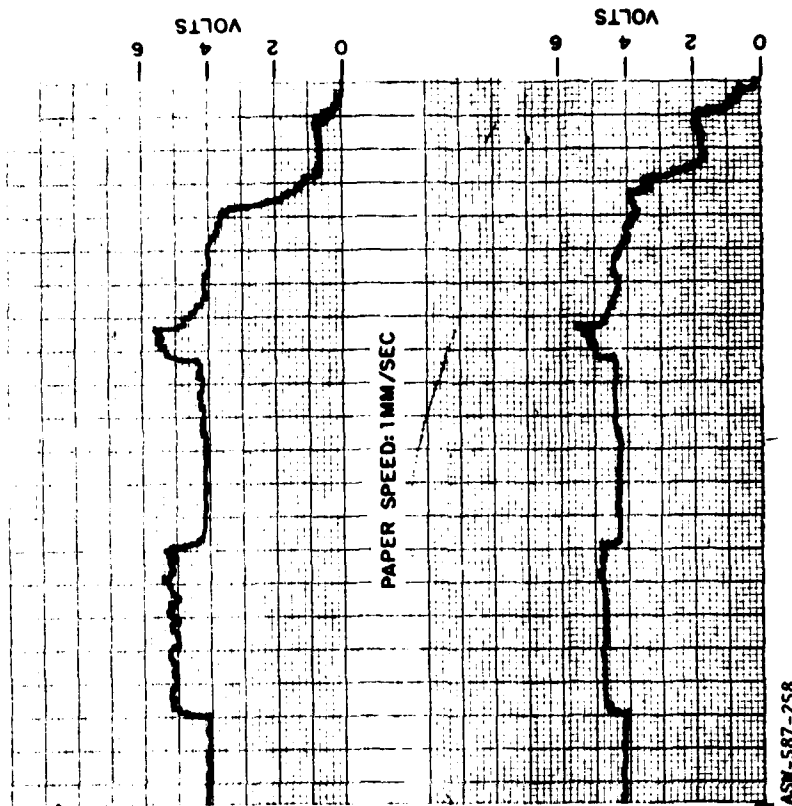


Figure B-94. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

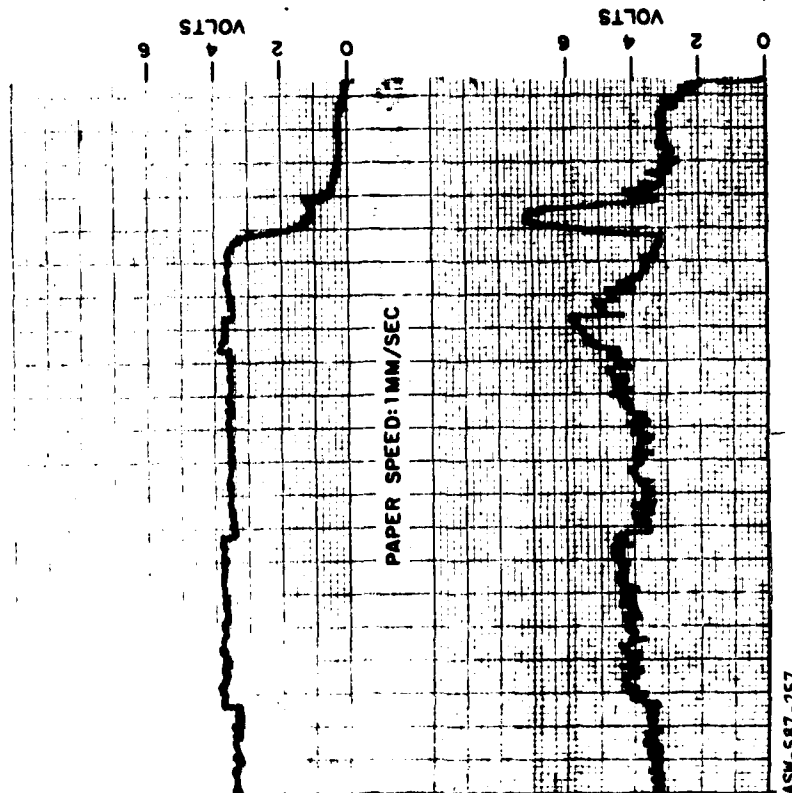
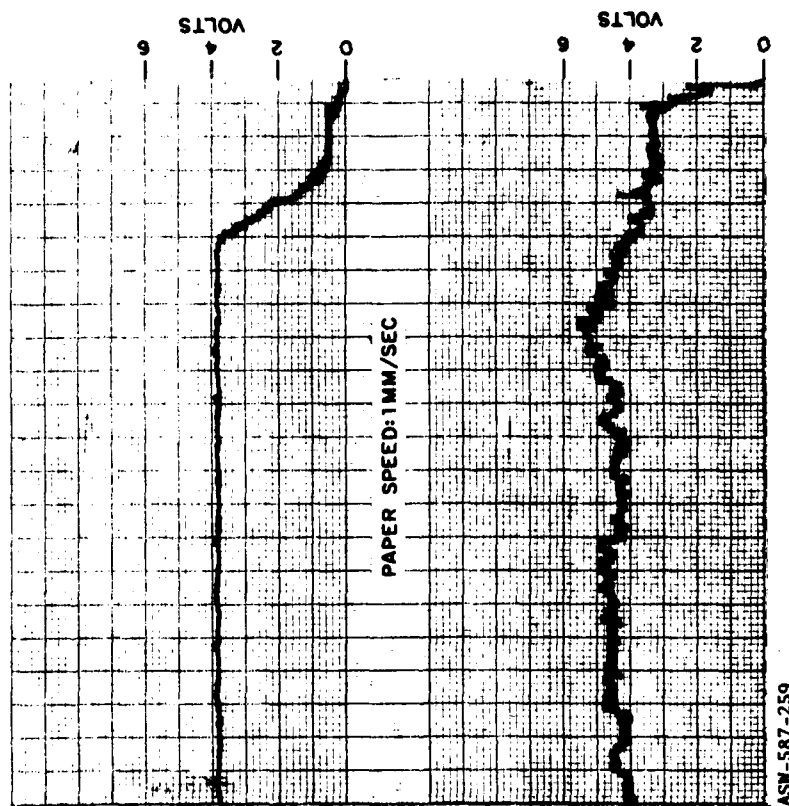
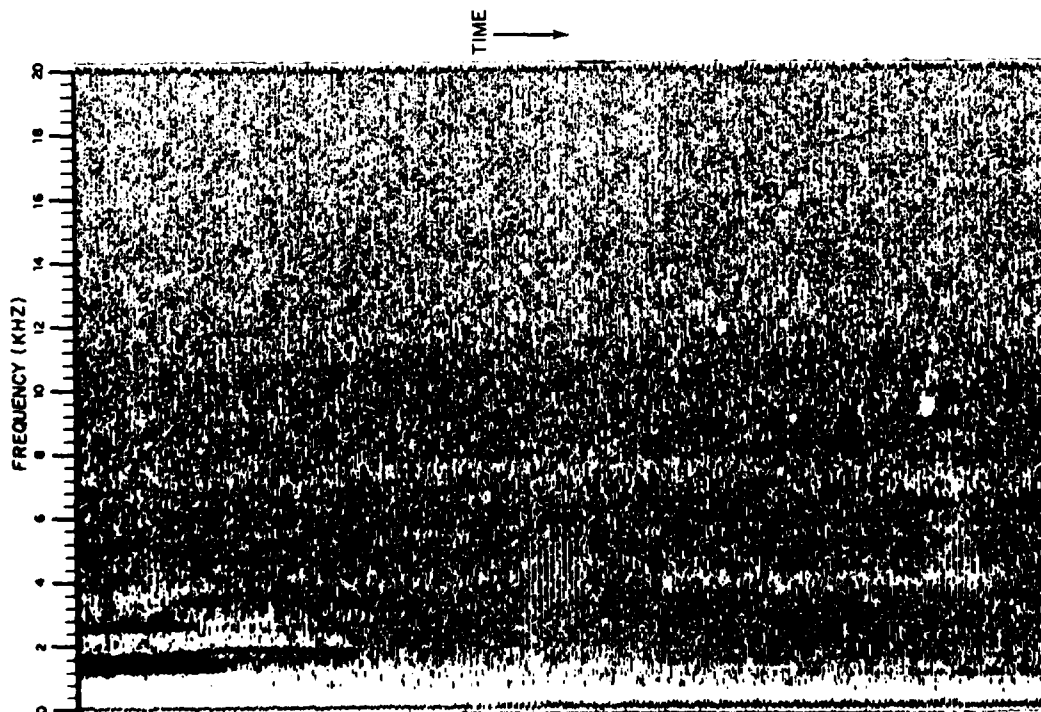


Figure B-95. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



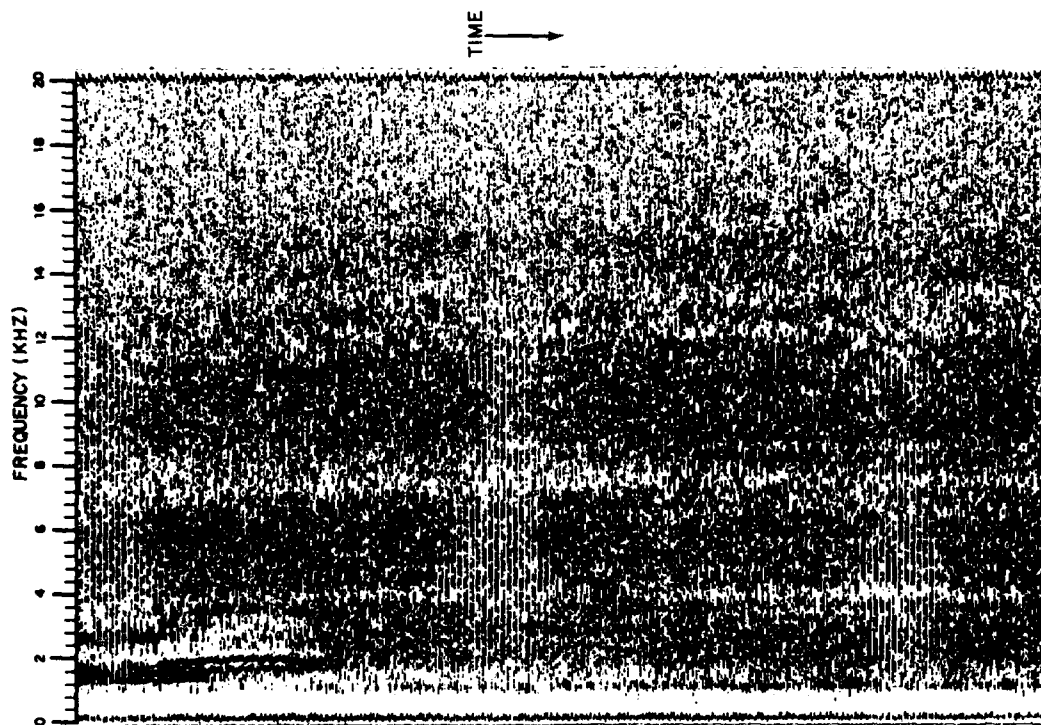
ASW-587-259

Figure B-96. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



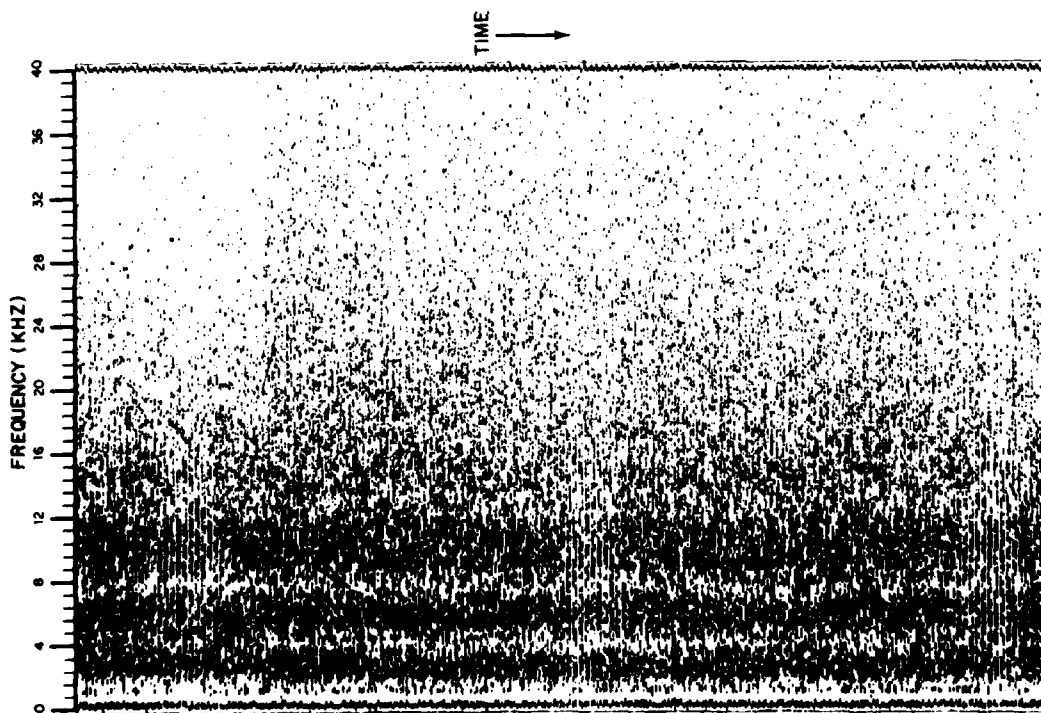
ASW-587-260

Figure B-97. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



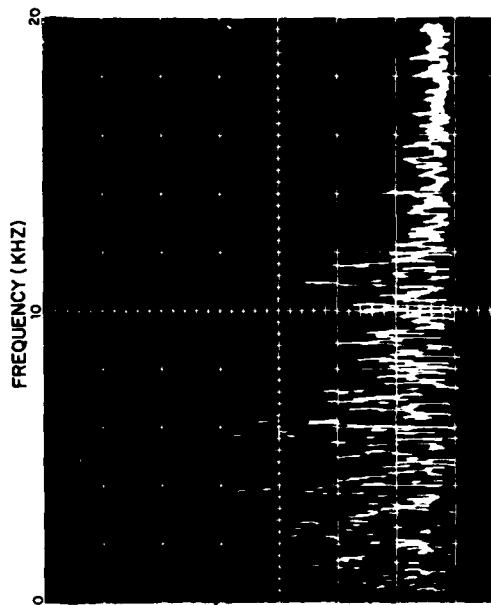
ASW-587-261

Figure B-98. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



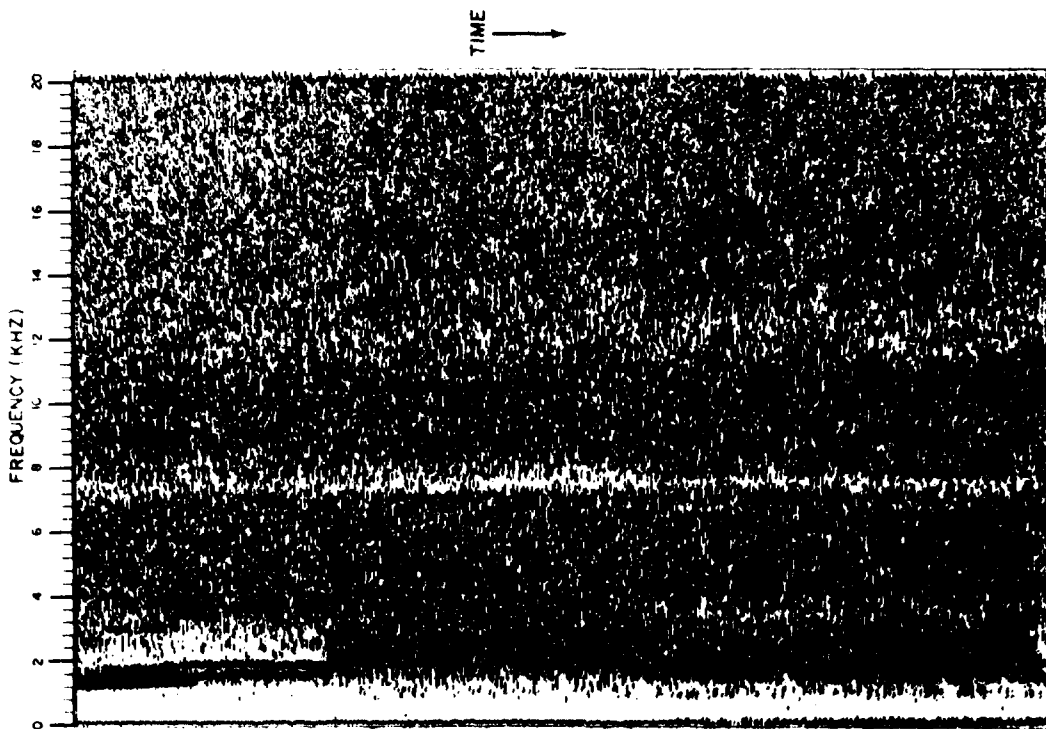
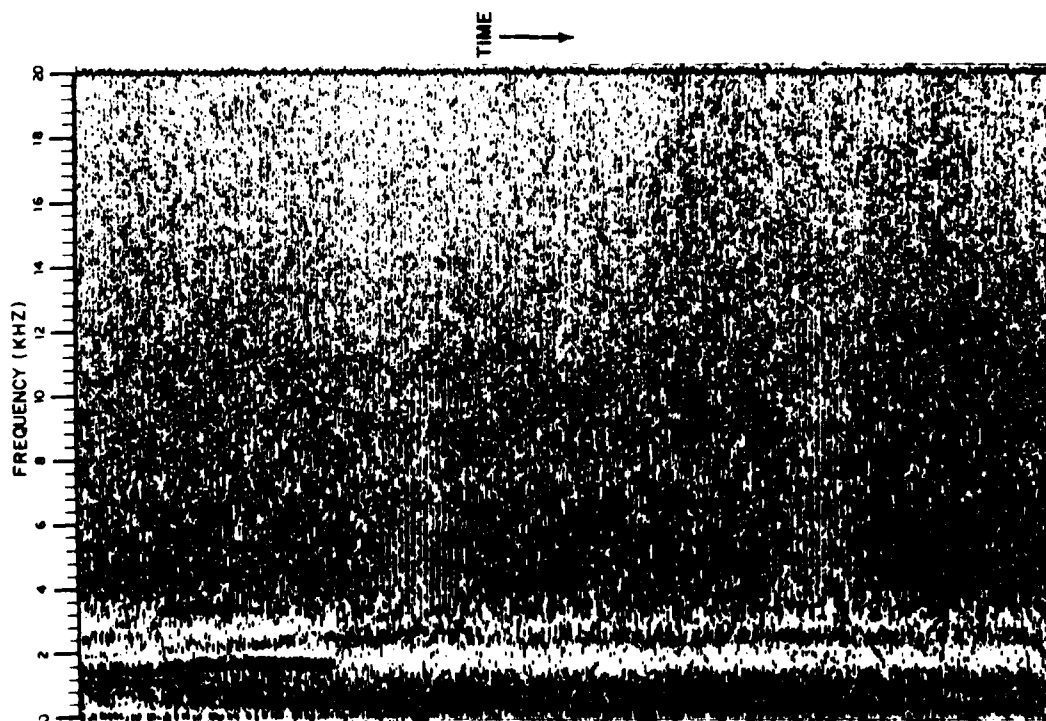
ASW-587-262

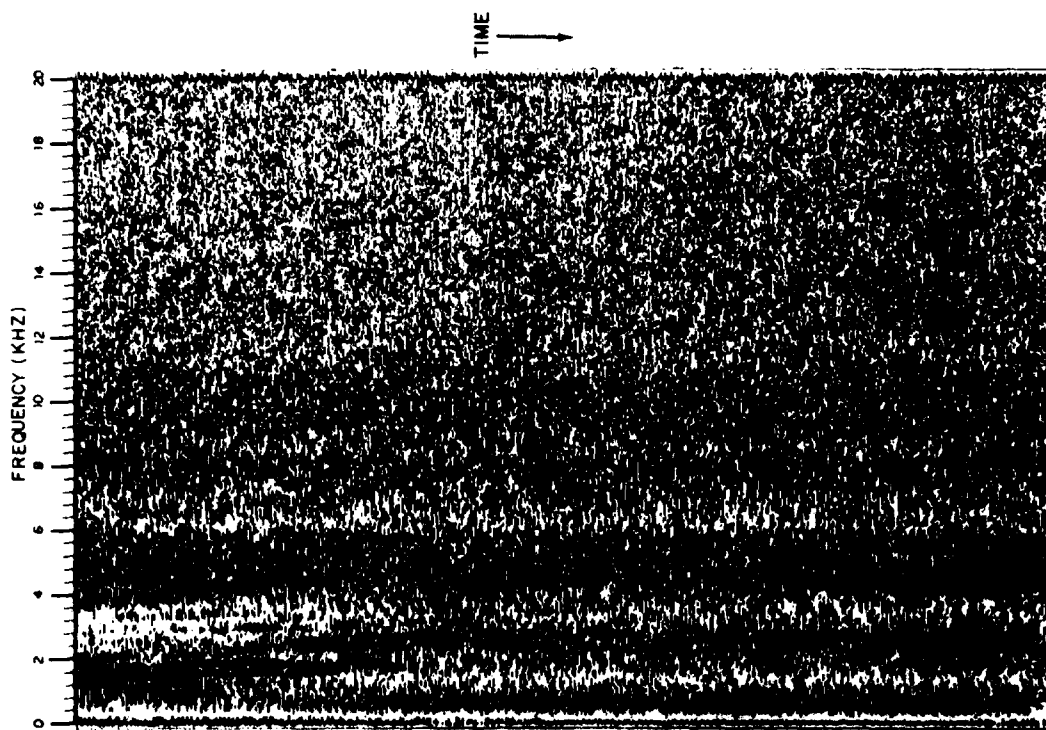
Figure B-99. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 40 kHz.



ASW-587-263

Figure B-100. Microphone No. 2 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.





ASW-587-266

Figure B-103. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

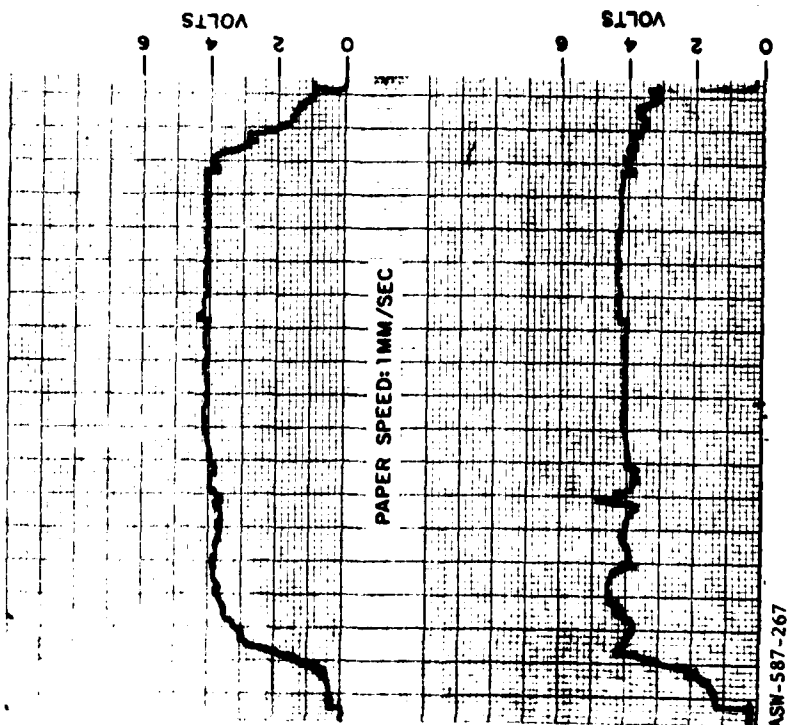


Figure B-104. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

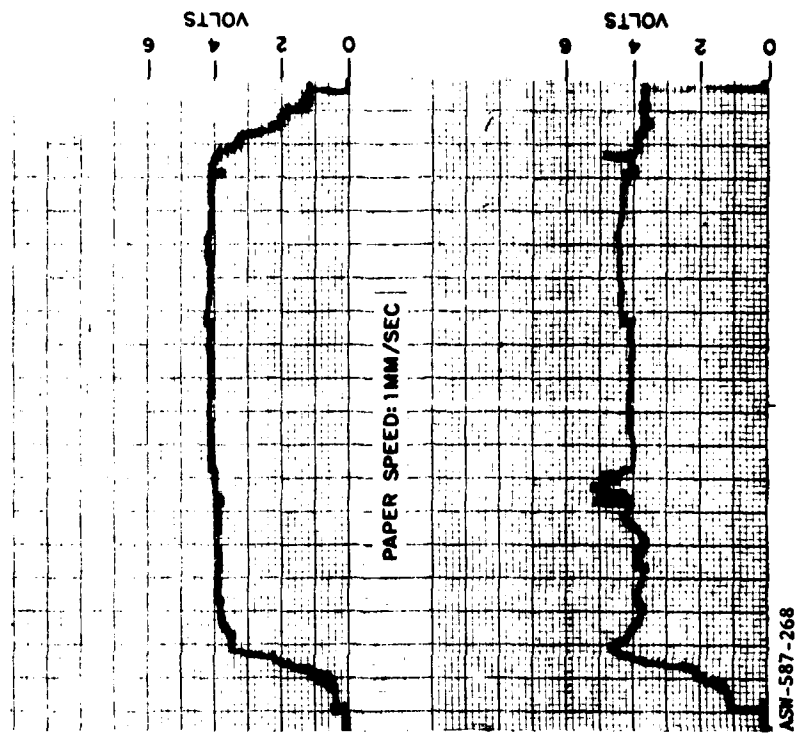
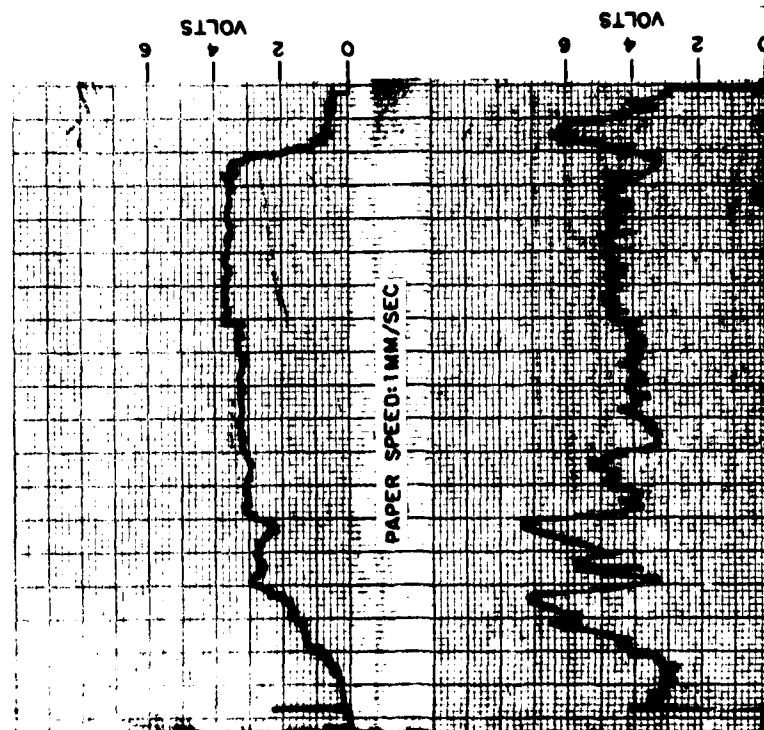
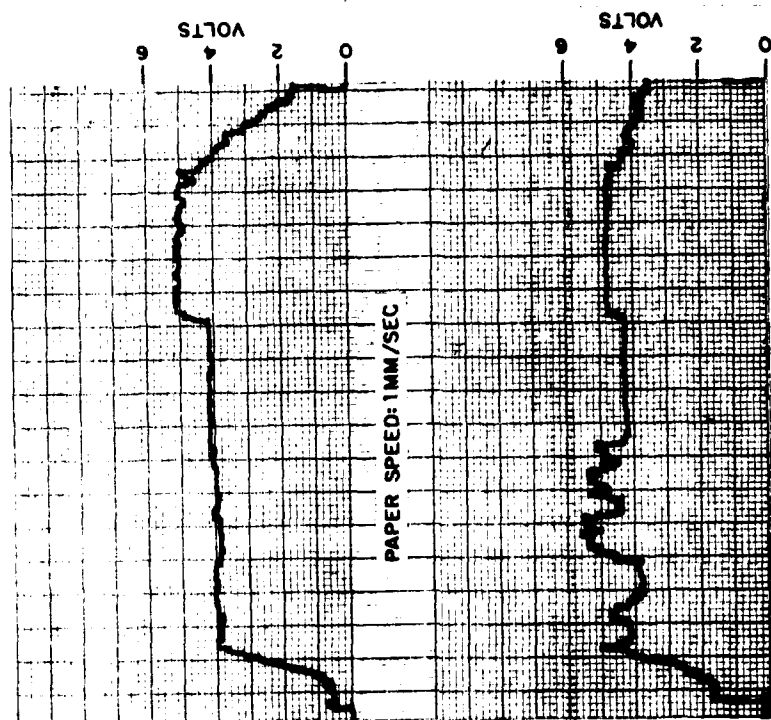


Figure B-105. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-269

Figure B-106. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-270

Figure B-107. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

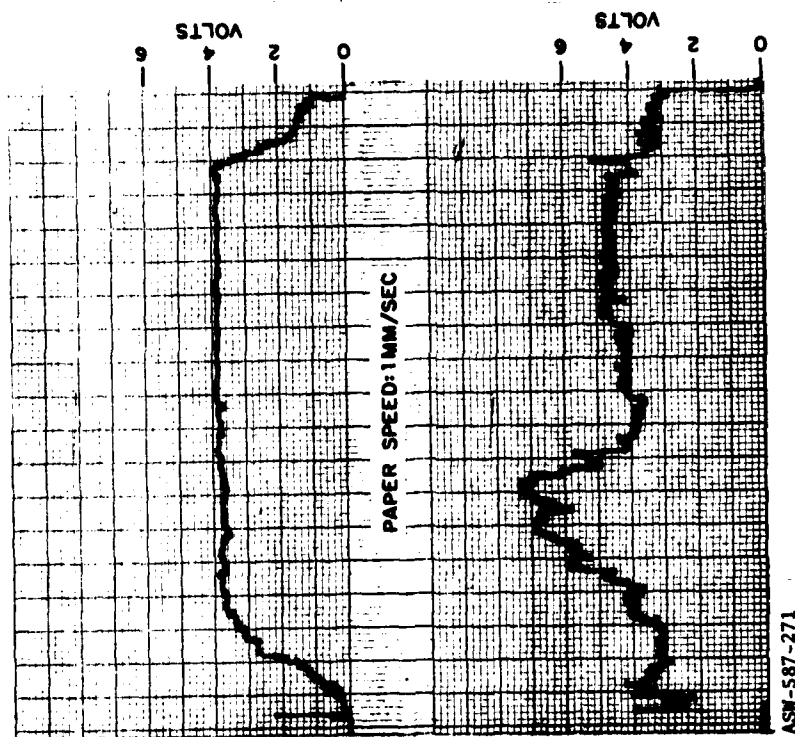


Figure B-108. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.4 J-57 ENGINE (PORT) MODIFIED BURNER CAN HOLE OPEN - 0.75 INCH DIAMETER

A series of three test runs were made on the J-57 engine with the modified can hole masked to a 0.75-inch hole. Each test was recorded using five microphones located in the same positions as for the closed hole tests. The three tests were run at the following engine speeds:

- (1) 82% RPM (150 in. Hg gage, diffuser case pressure)
- (2) 90% RPM (240 in. Hg gage, diffuser case pressure)
- (3) Max. RPM (270 in. Hg gage, diffuser case pressure)

The purpose of this test was to determine the sound energy level differential between a closed hole on the modified burner can and a small open hole (0.75 inch in diameter) at like engine speeds.

Analysis of the recordings made during the three runs is given on the following pages:

- (1) 82% run - pages B-78 through B-86
- (2) 90% run - pages B-87 through B-93
- (3) Max. run - pages B-94 through B-100

B.4.1 Analysis

B.4.1.1 Sound Energy Levels

Further reduction in hole size yielded further reduction in meter readings. The least change appeared on microphones 3 and 5, as was the case in the 1-inch open-hole test. These microphones were farthest from the open hole. There was only a 1 to 2 dB differential for the 82% RPM run between the closed-hole and 0.75-inch open hole-test. A similarity between the closed-hole and 0.75-inch open-hole tests appeared for all microphones. The higher energy levels apparent in the closed-hole test, due to machinery frequencies at 82% RPM, also appeared in the 82% RPM, 0.75-inch open-hole test. The sound levels dropped at 90% RPM and stayed the same or increased slightly at maximum RPM closely following the closed hole results. The microphones close to the open hole showed a 3 to 8 dB increase over closed-hole tests at maximum RPM.

B.4.1.2 Spectrum Analysis

The grams from this test, at 82% RPM, are similar to the closed-hole tests in that there are many discrete machinery frequencies visible with what could be called an overlay of broadband noise. It is again apparent that the random noise created by the open-hole masks the discrete machinery frequencies.

B.4.1.3 Mean Square Analysis

The microphones farthest from the open hole contained a greater quantity of the spectrum below 5 kHz than did those located close to the hole. Recordings from microphones 3 and 5 in the 0.75 inch open-hole test are especially good examples of this fact. Microphones 1, 2, and 4 showed much less spectrum below 5 kHz.

B.4.2 Environmental Conditions

The three tests discussed in paragraph B.4 were performed at an ambient temperature of 68° F and 78% relative humidity.

B.4.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones at three engine test speeds:

Table B-10. Microphone Sound Energy Levels at 82% Engine RPM

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	72	92	60	110	42
RMS (μBAR)	580	740	480	880	340
dB (a)	129	131	128	133	124

^aReference = 2×10^{-4} μBAR

Table B-11. Microphone Sound Energy Levels at 90% Engine RPM

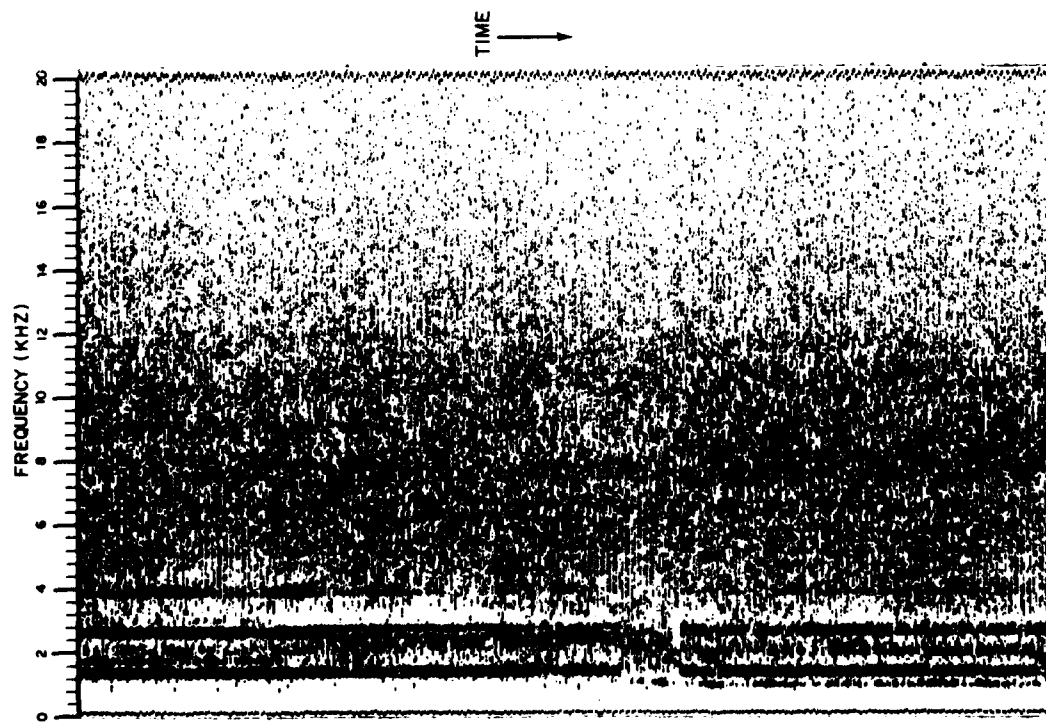
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	52	68	54	70	50
RMS (μBAR)	420	540	430	560	400
dB (a)	126	129	127	129	126

^aReference = 2×10^{-4} μBAR

Table B-12. Microphone Sound Energy Levels at Maximum Engine RPM

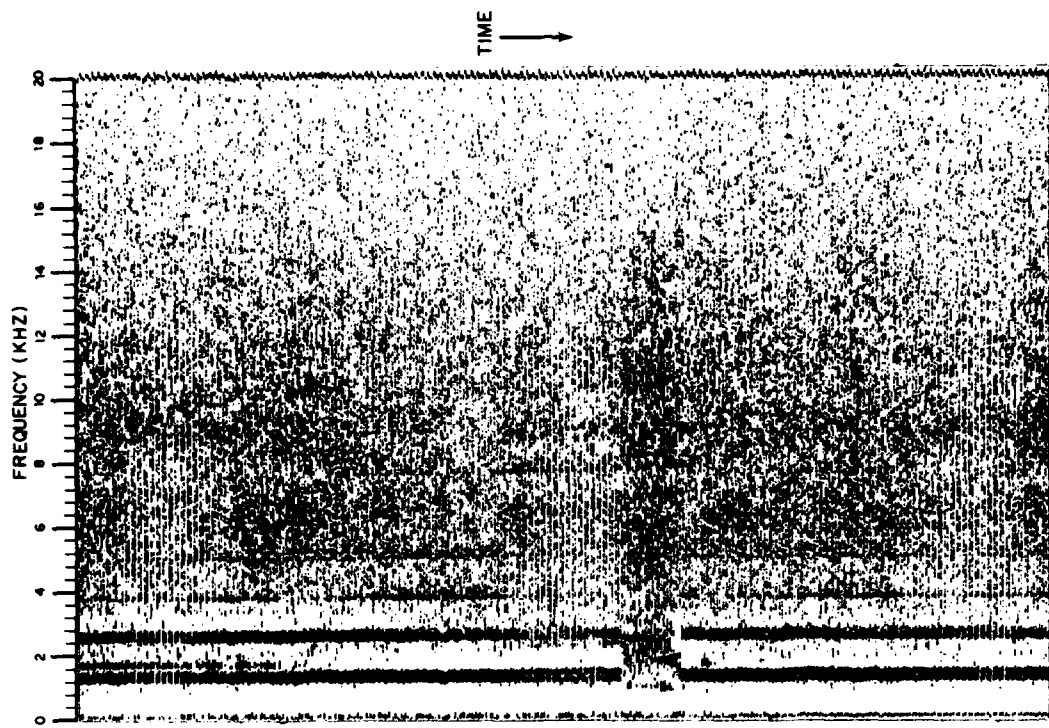
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	66	80	70	88	52
RMS (μBAR)	520	640	560	700	420
dB (a)	128	130	129	130	126

^aReference = 2×10^{-4} μBAR



ASW-587-272

Figure B-109. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-273

Figure B-110. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

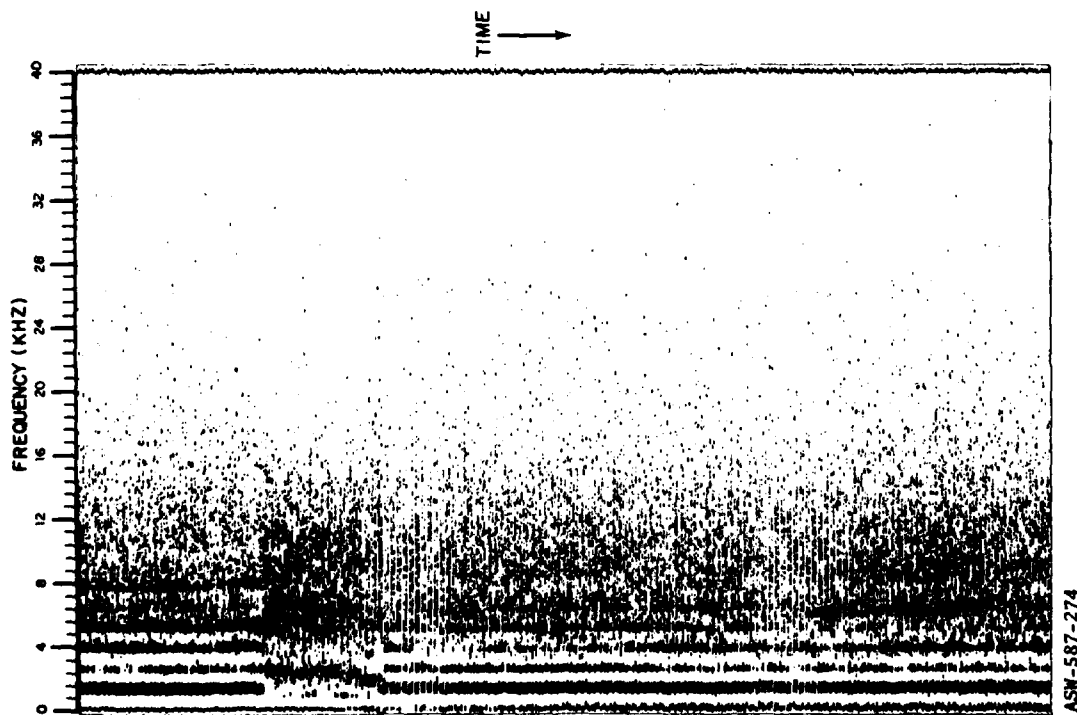


Figure B-111. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.

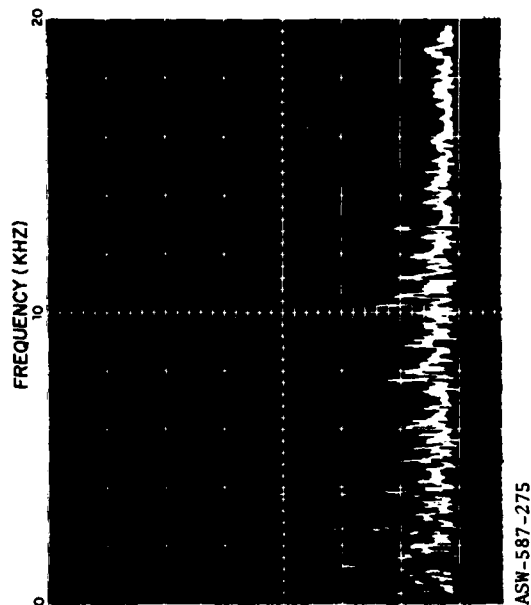
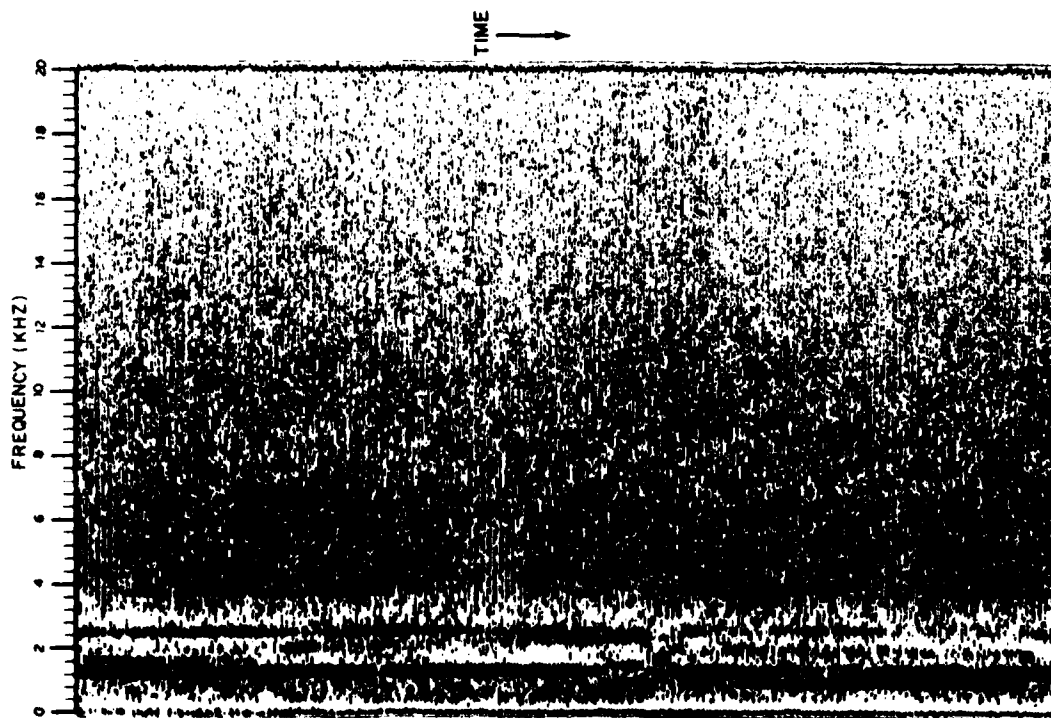
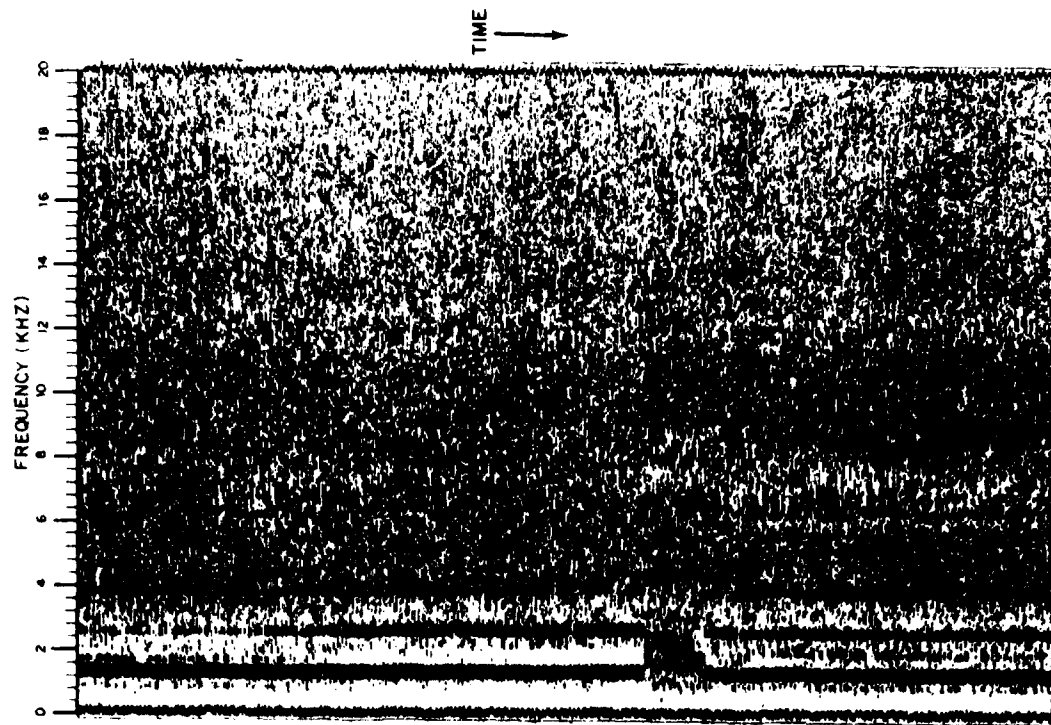


Figure B-112. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



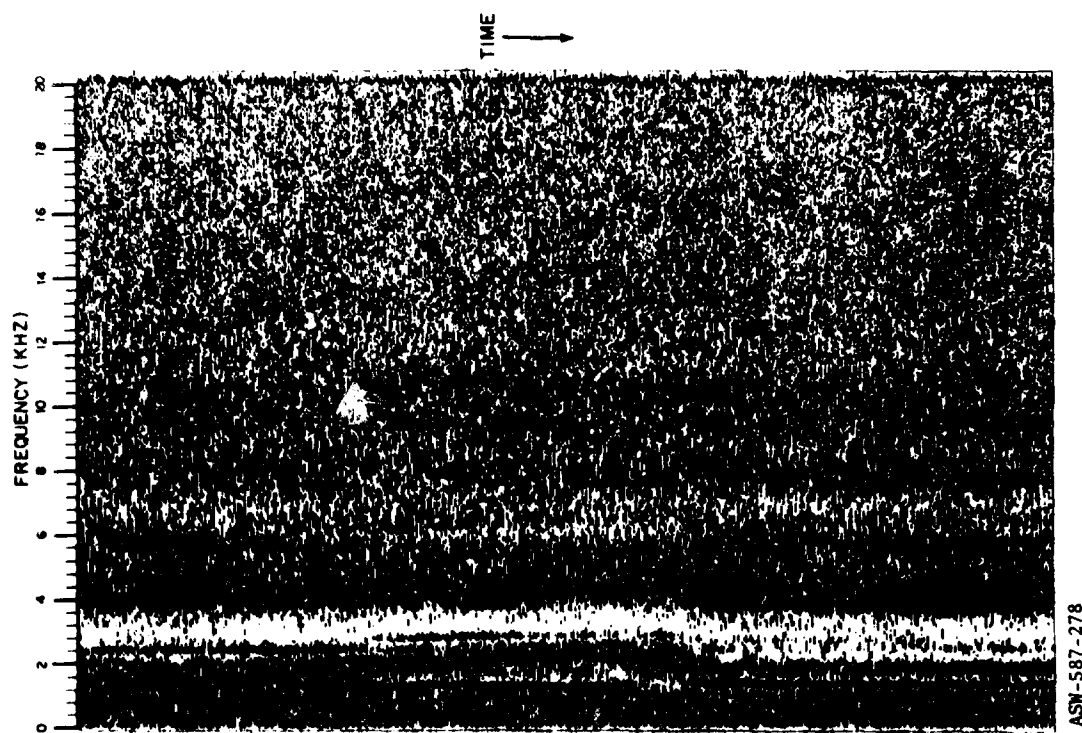
ASN-587-276

Figure B-113. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-277

Figure B-114. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-278

Figure B-115. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

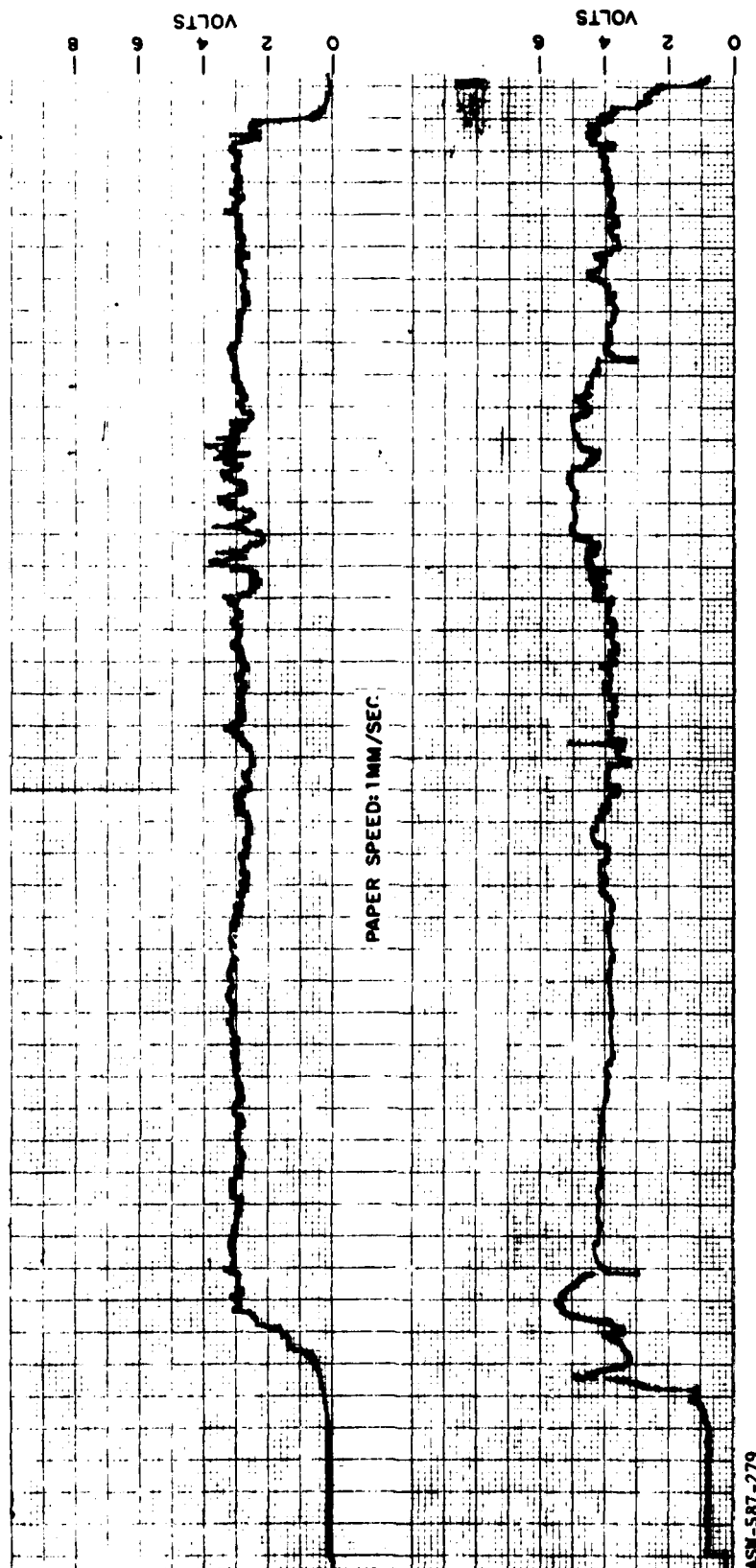


Figure B-116. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASN-587-279

AD-A132 357

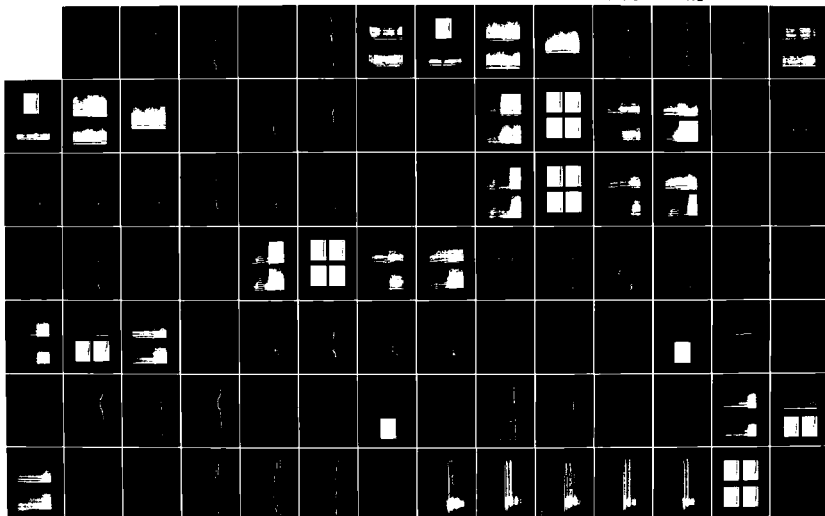
JET ENGINE BURN-THROUGH INVESTIGATION VOLUME 2 ENGINE
TESTS RAW DATA(U) MAGNAVOX CO FORT WAYNE IND FORT WAYNE
DIV R W SCHUMACKER MAR 73 FAA-NA-72-96-2 DOT-FAT2-575

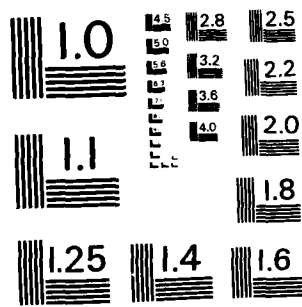
34

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

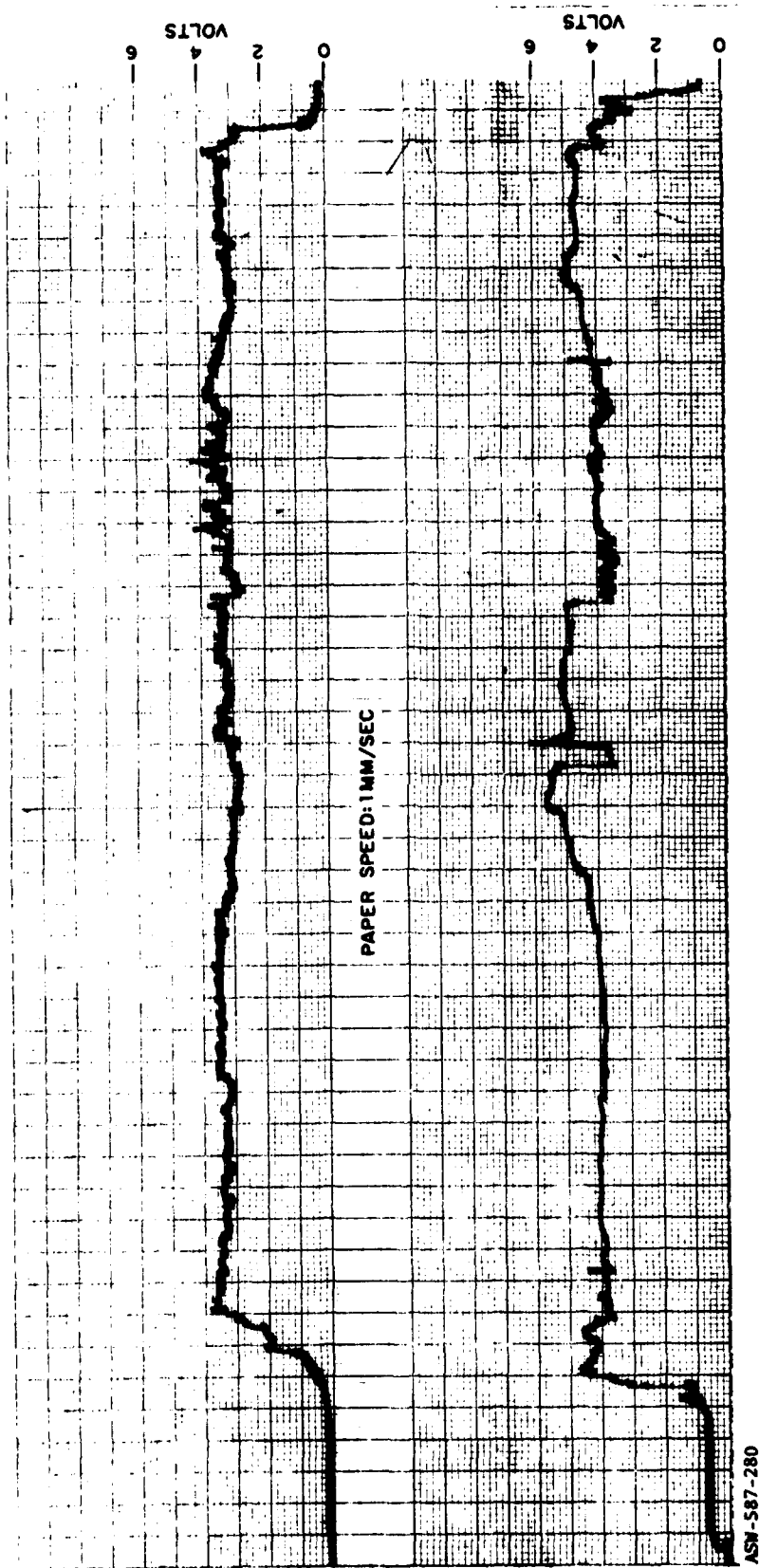


Figure B-117. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

ASW-587-280

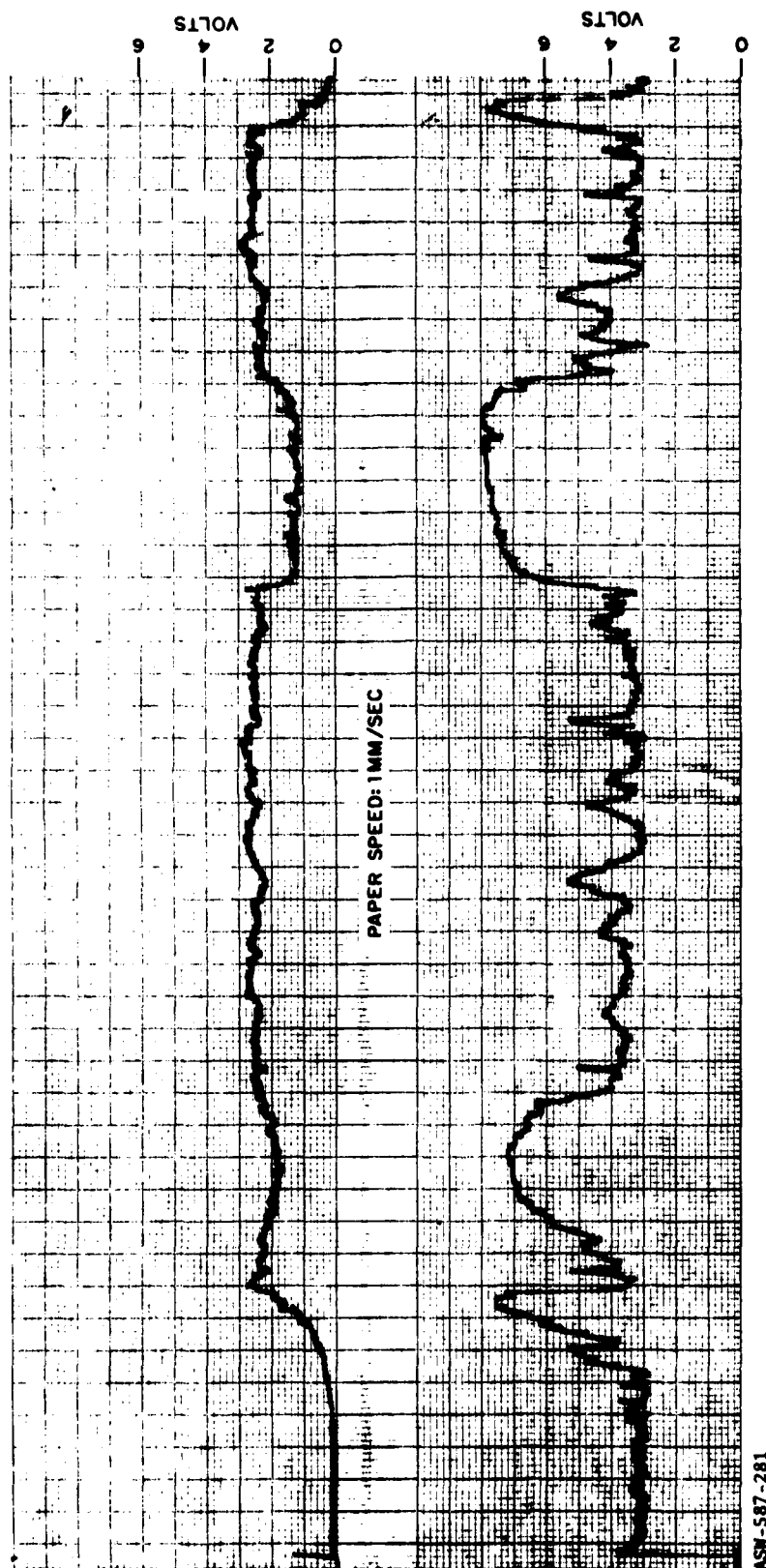


Figure B-118. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

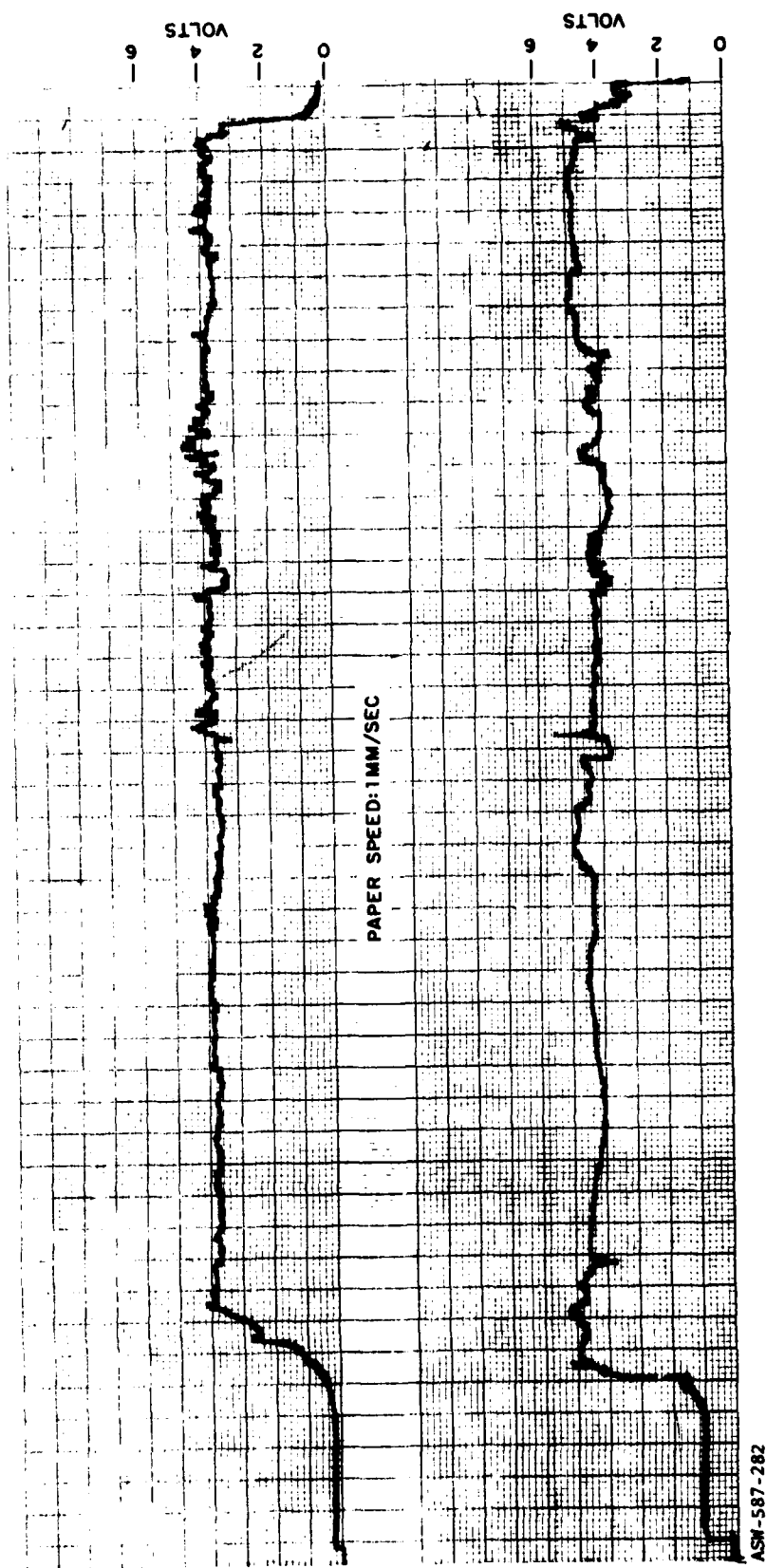


Figure B-119. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

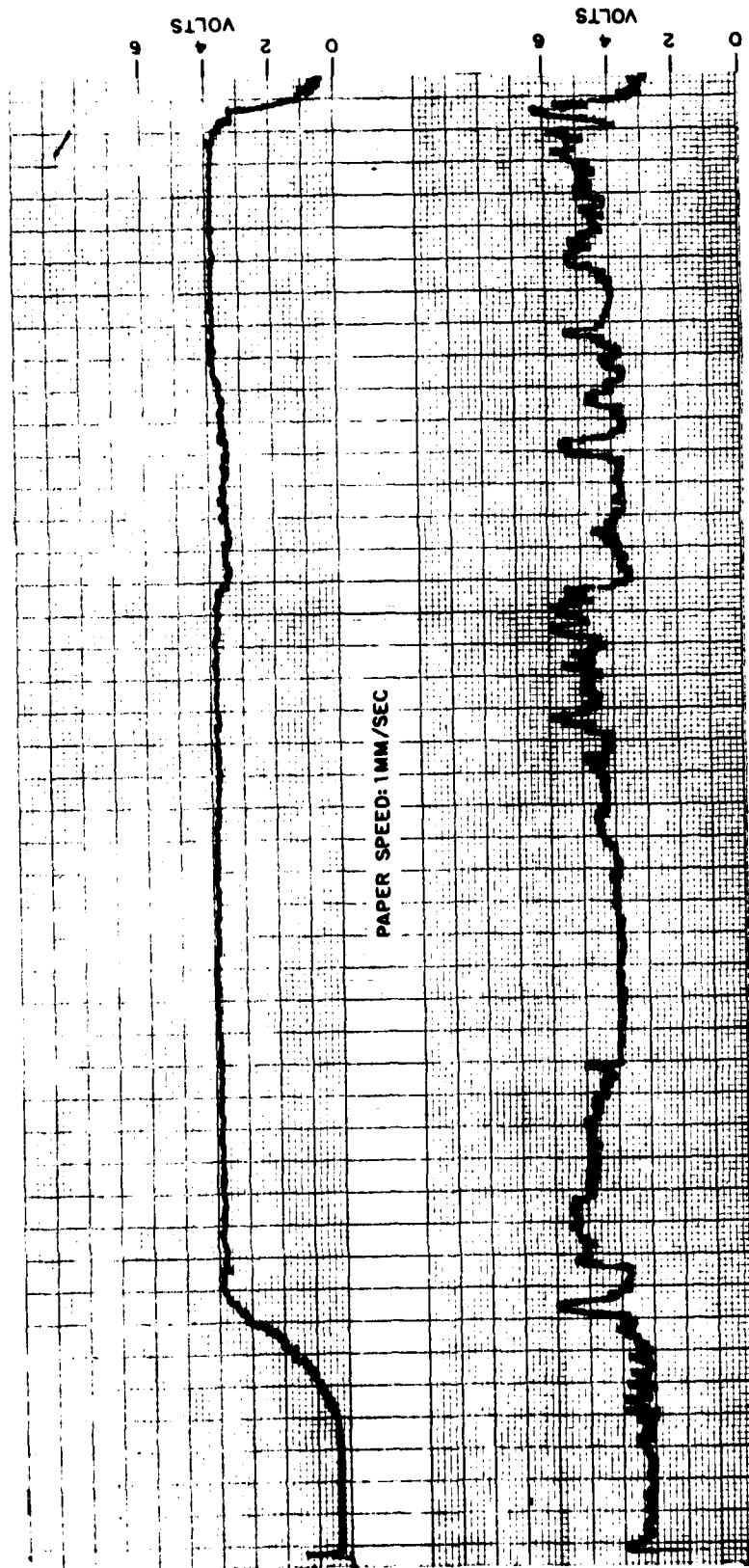
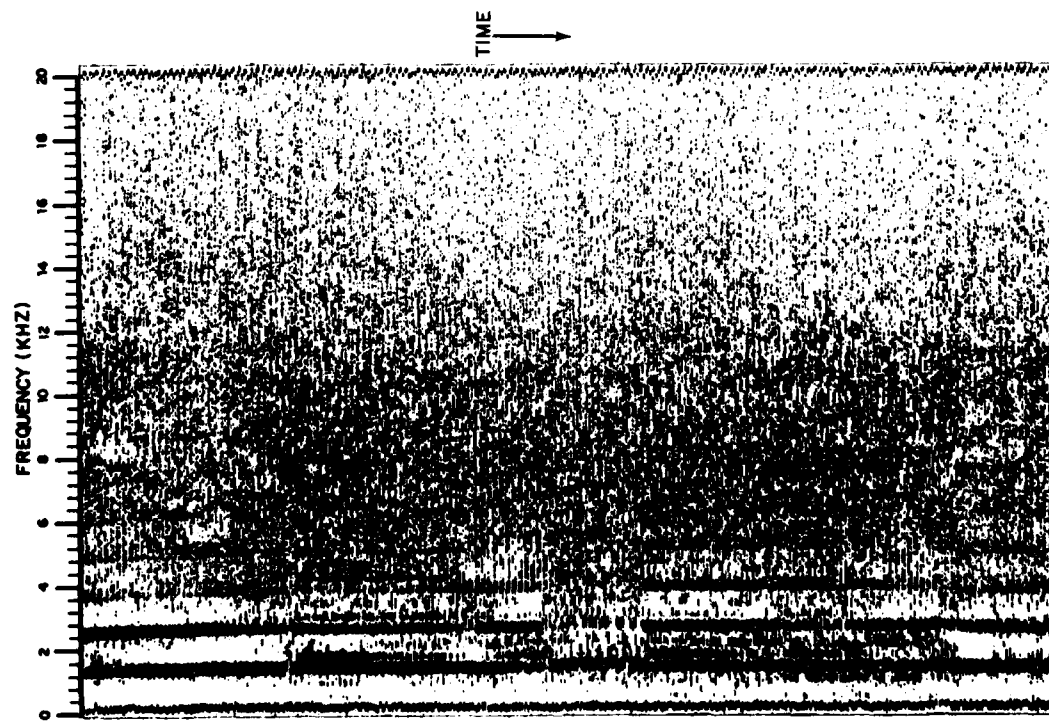
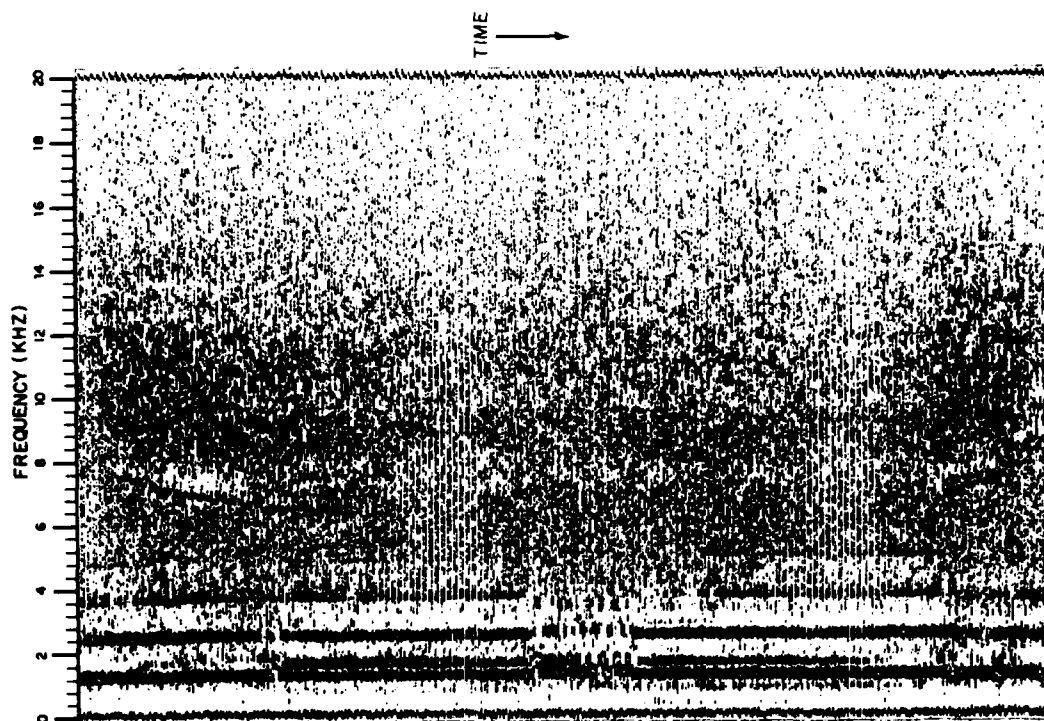


Figure B-120. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-284

Figure B-121. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-285

Figure B-122. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

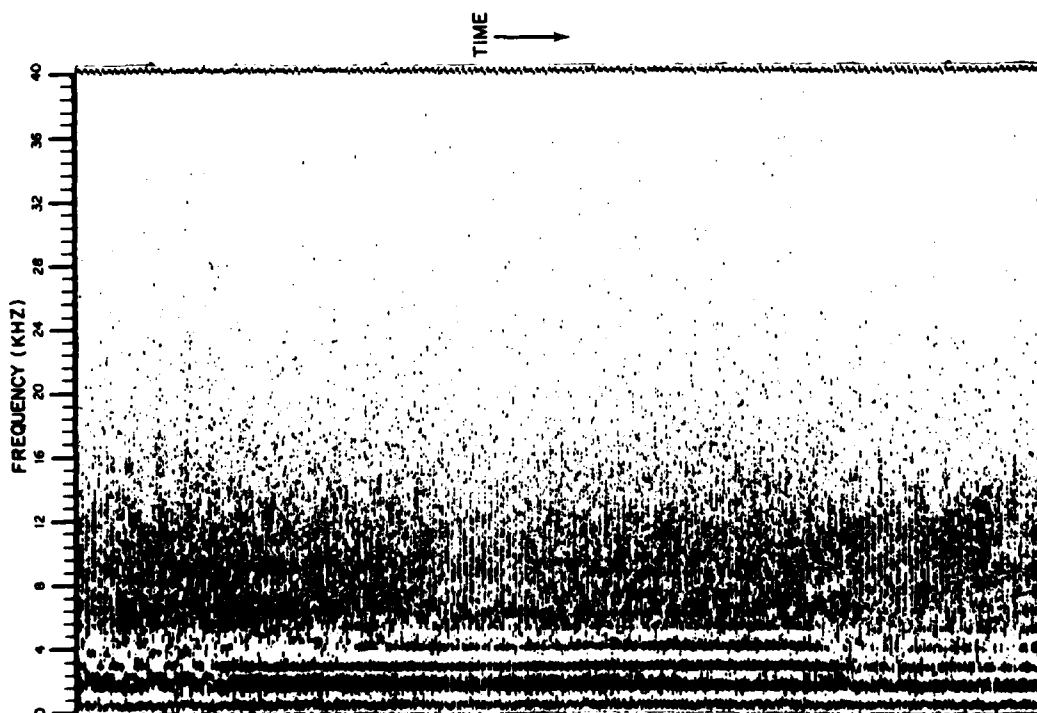


Figure B-123. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.

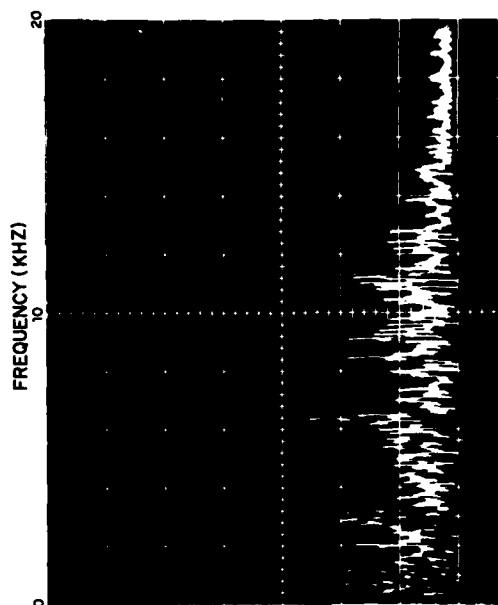


Figure B-124. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

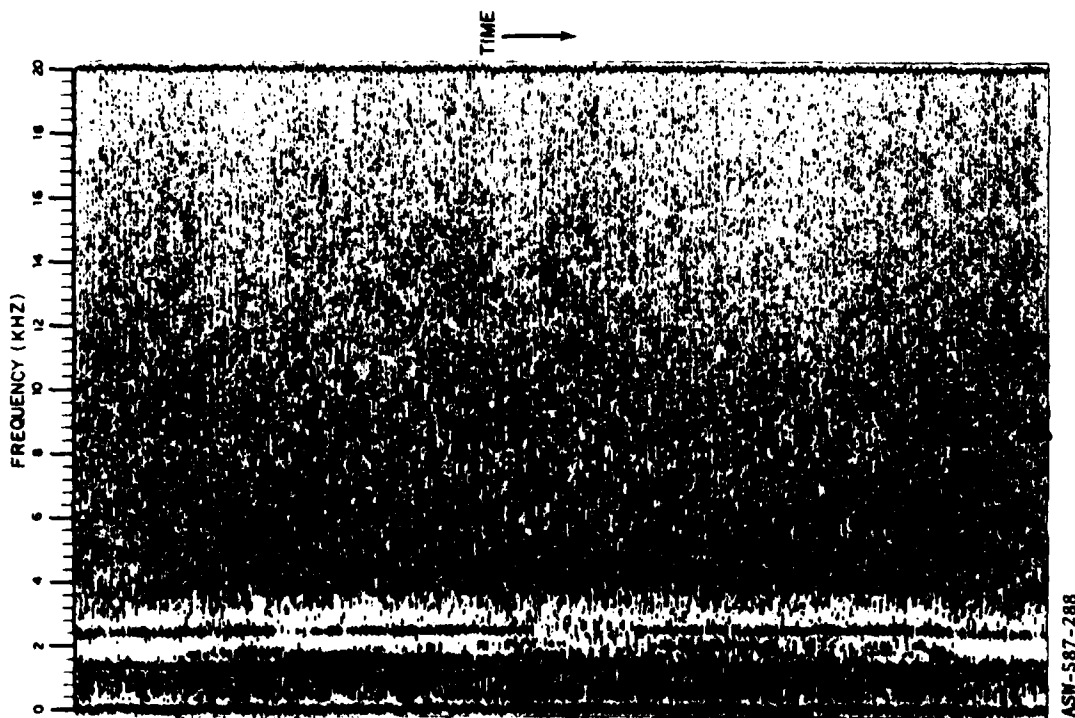


Figure B-125. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

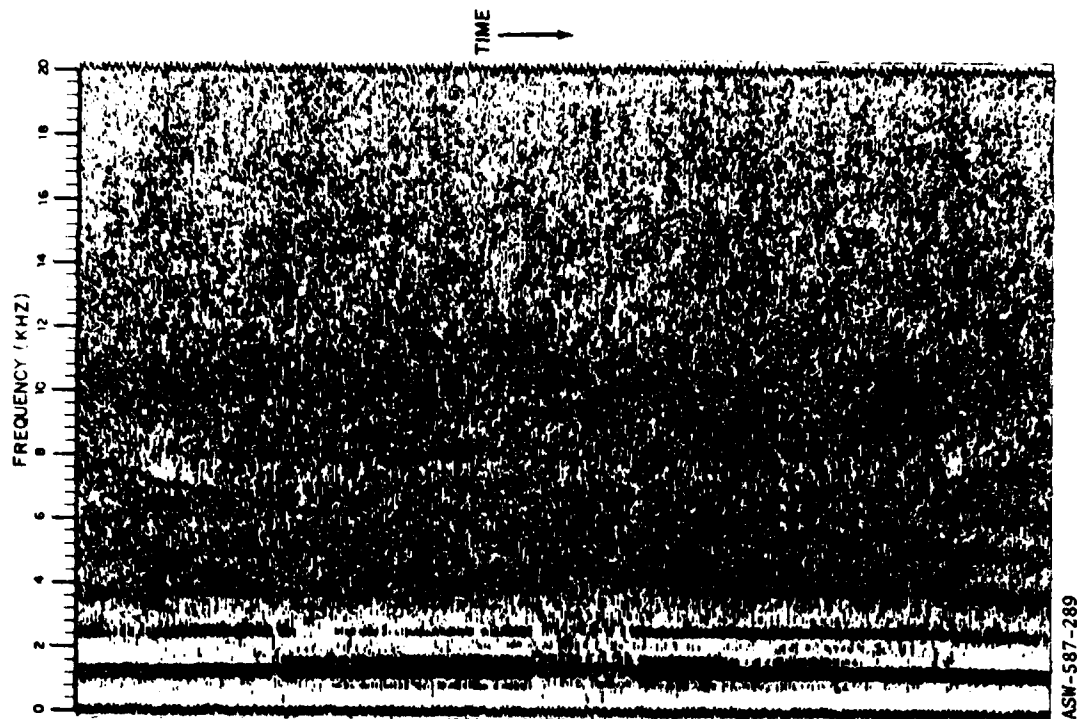
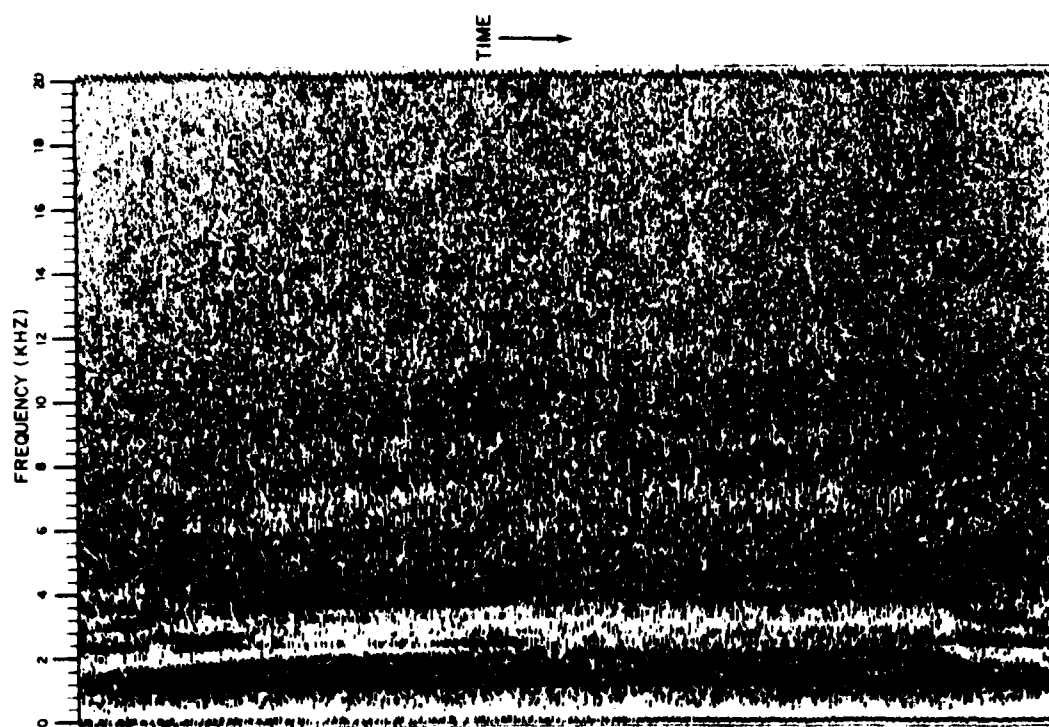


Figure B-126. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-290

Figure B-127. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

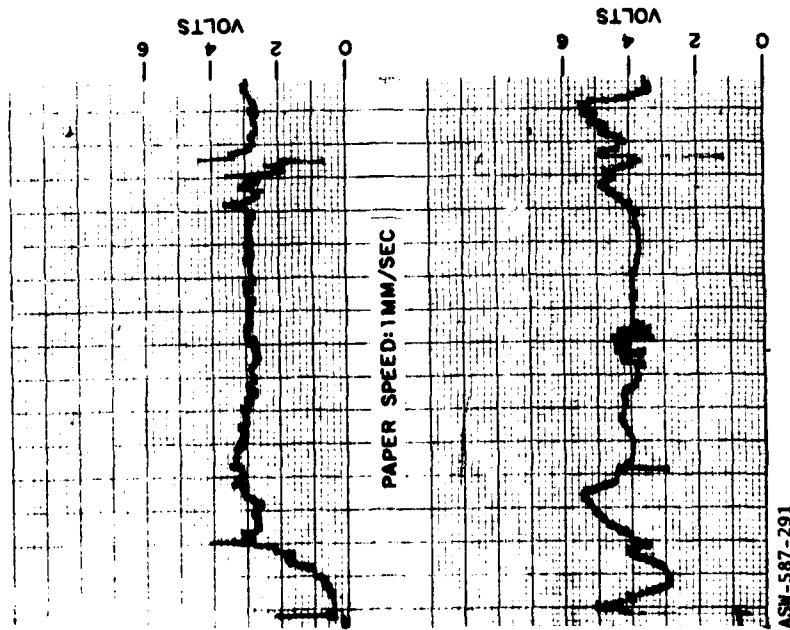


Figure B-128. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

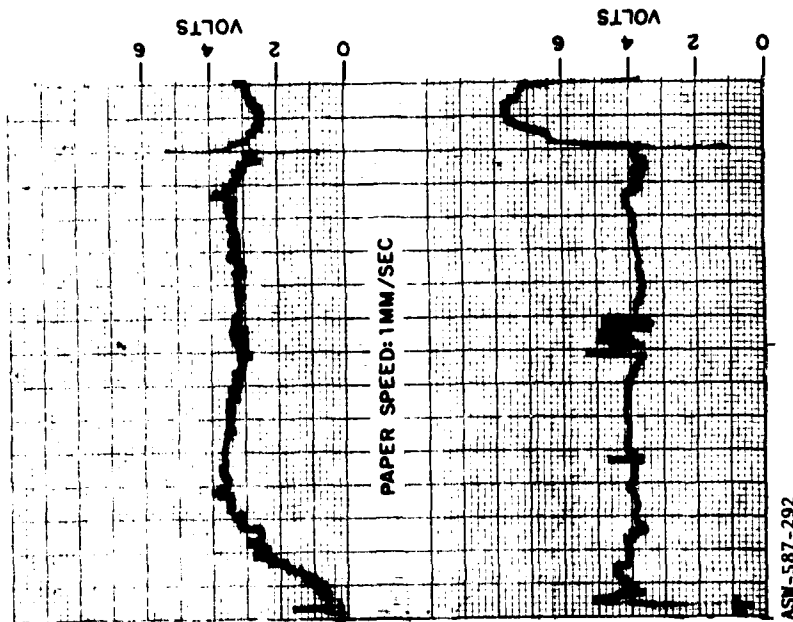
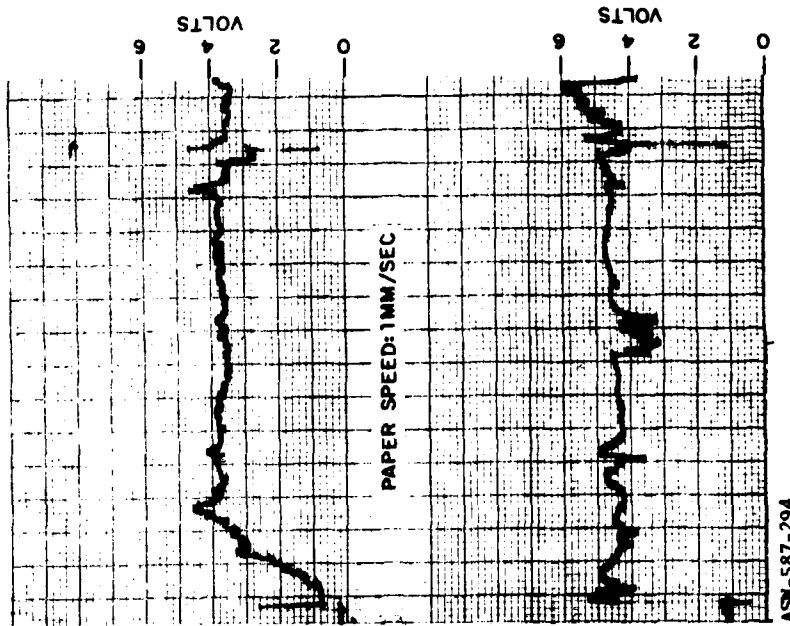
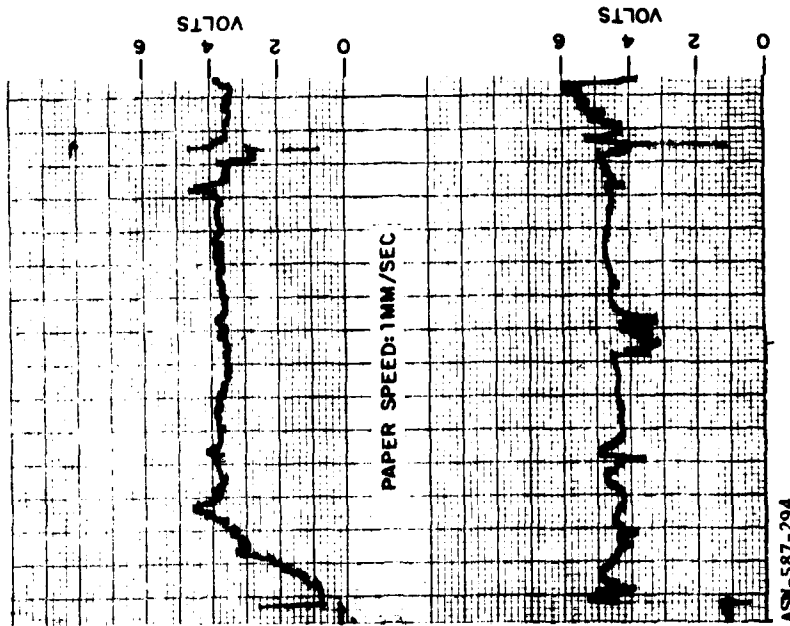


Figure B-129. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



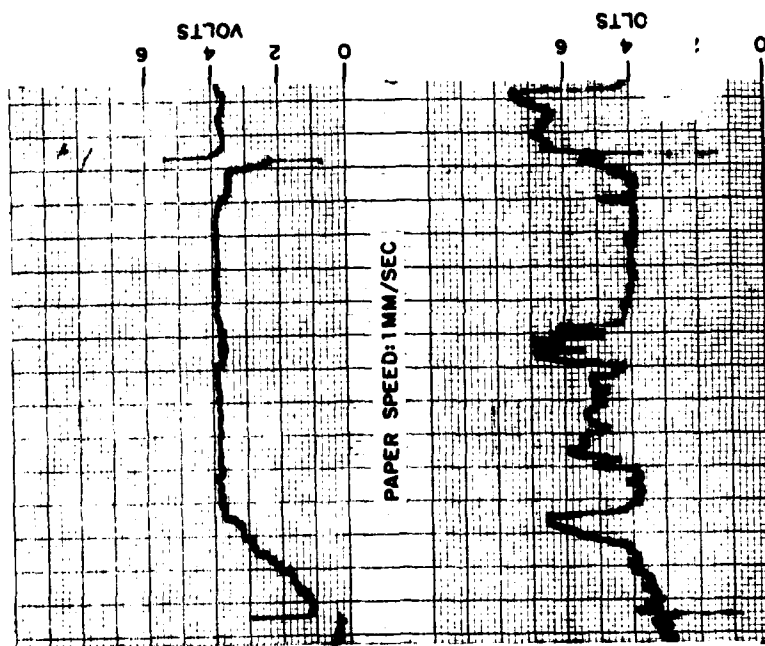
ASN-587-293

Figure B-130. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



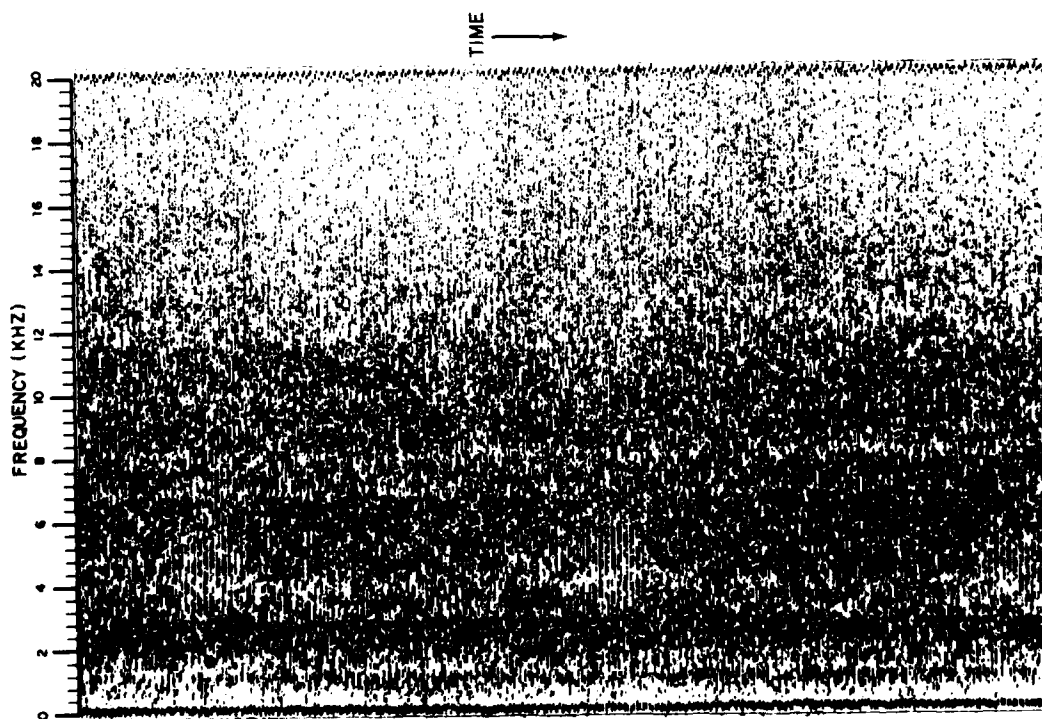
ASN-587-294

Figure B-131. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



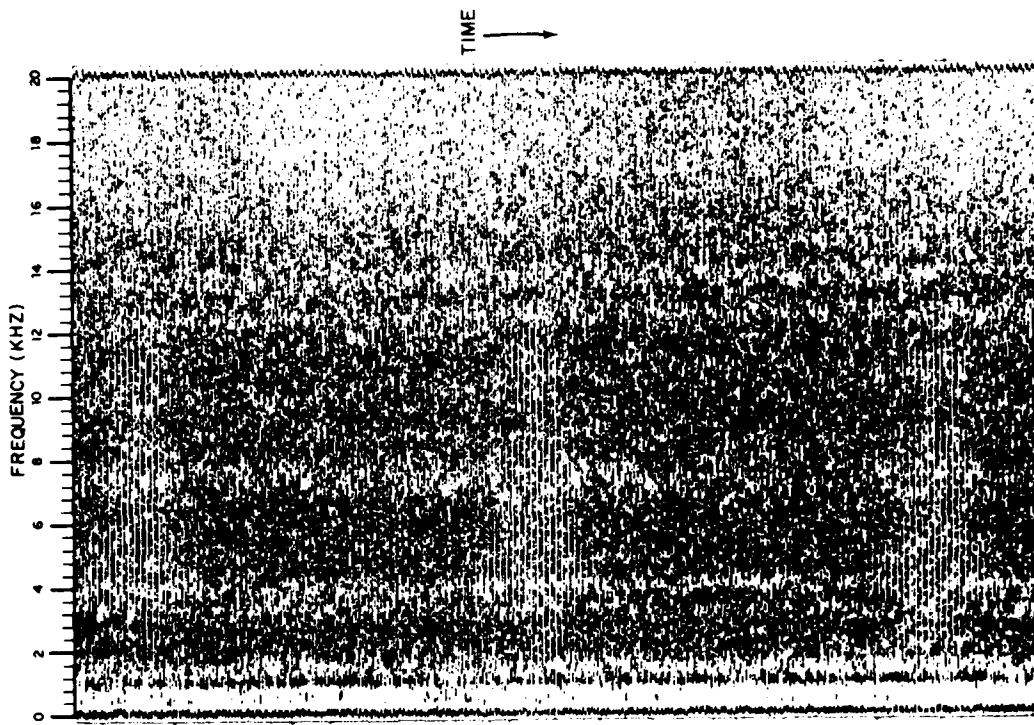
ASN-587-295

Figure B-132. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-296

Figure B-133. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-297

Figure B-134. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

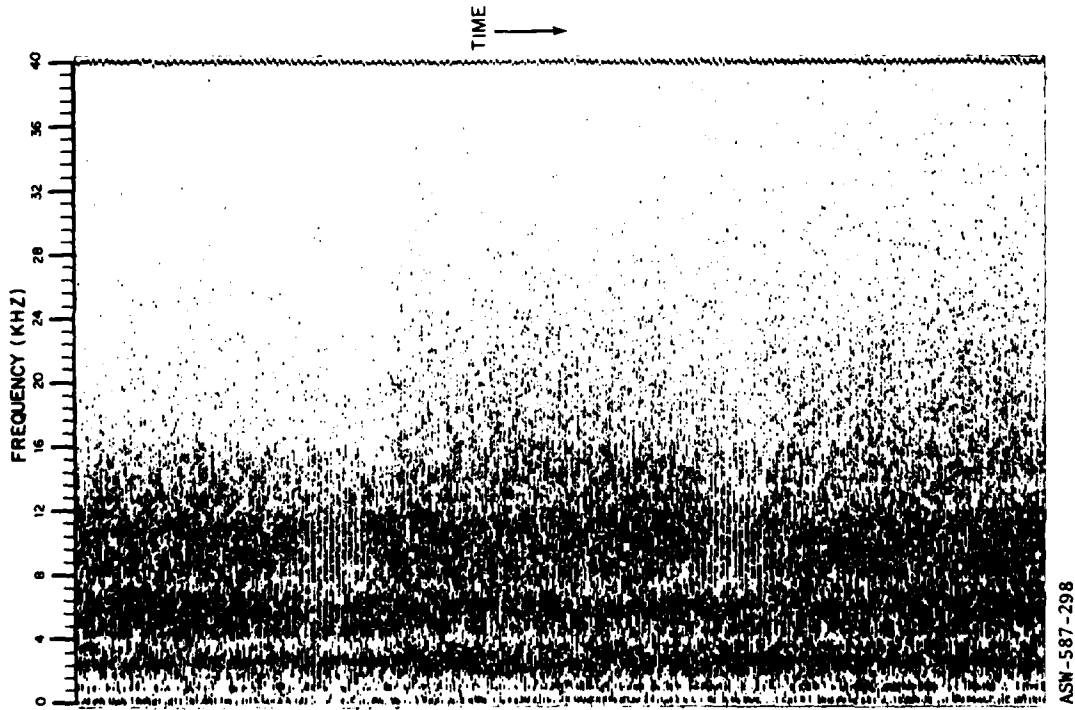


Figure B-135. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.

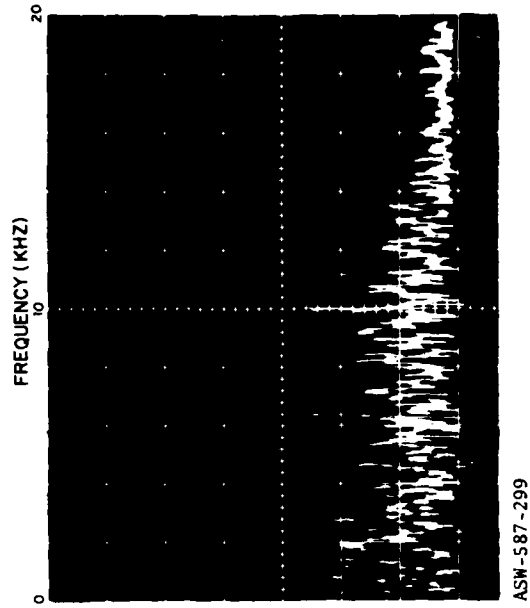
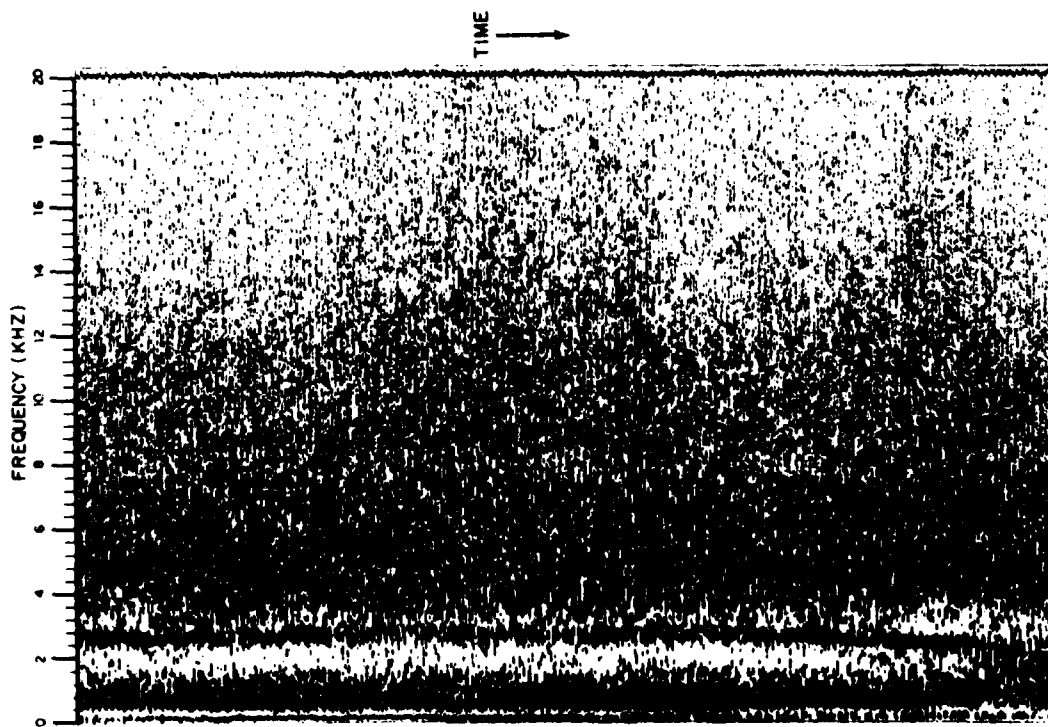
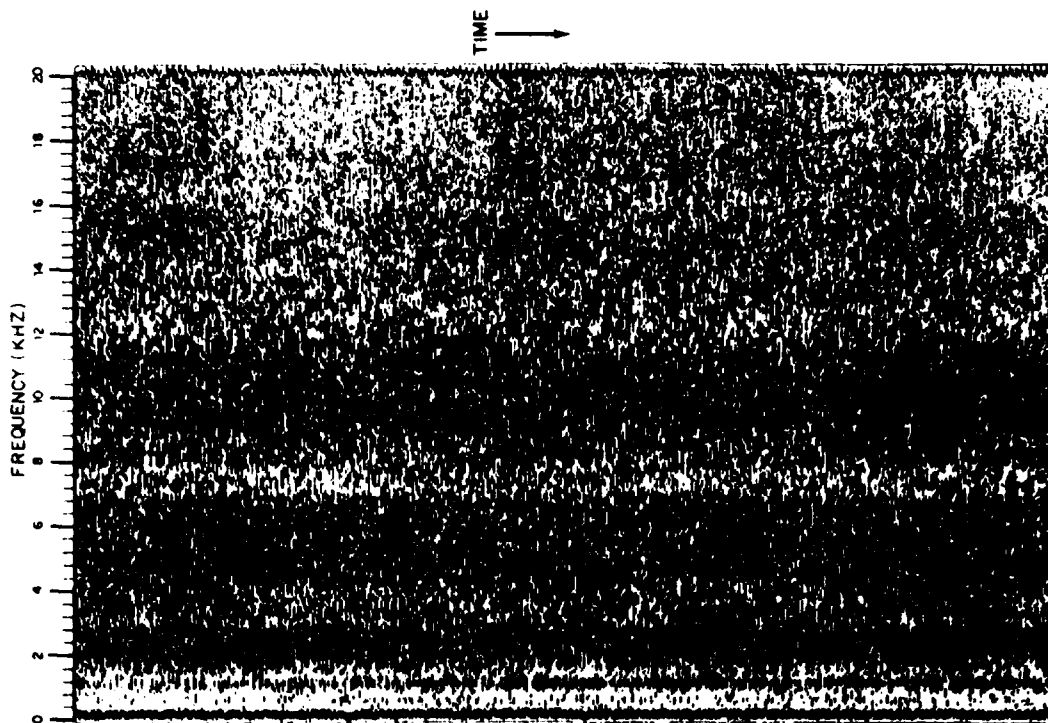


Figure B-136. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



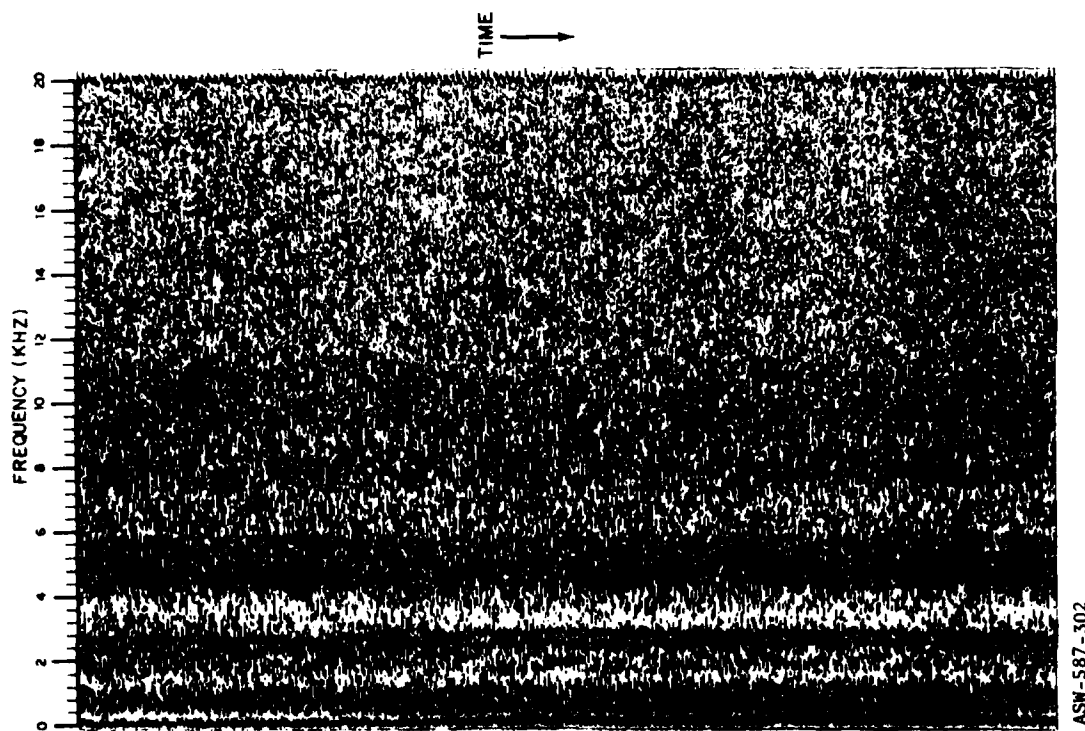
ASN-587-300

Figure B-137. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-301

Figure B-138. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASN-587-302

Figure B-139. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

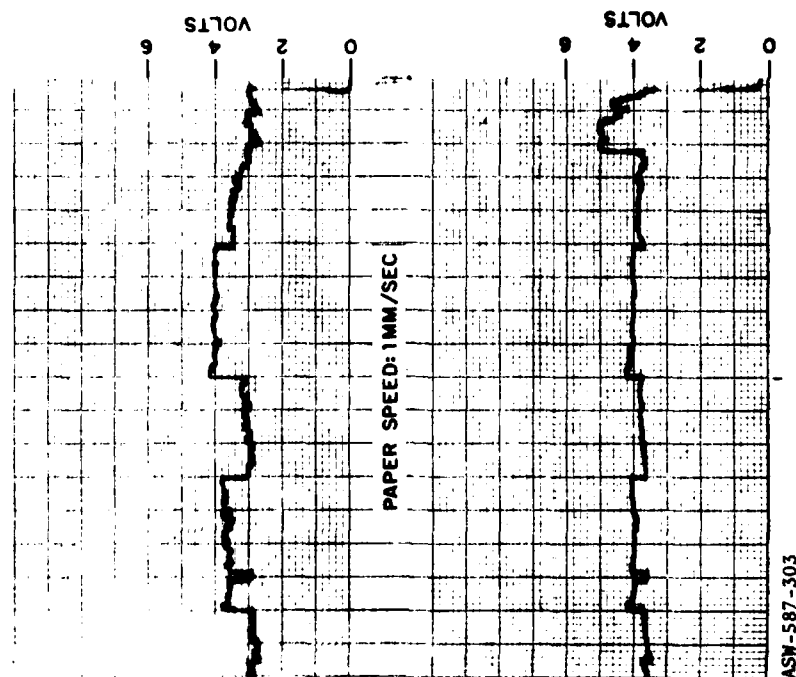


Figure B-140. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

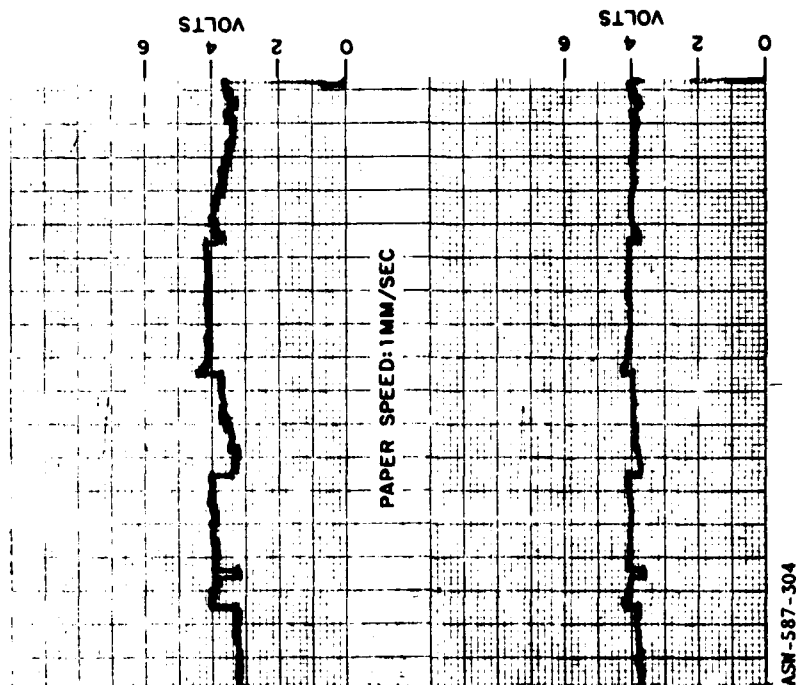


Figure B-141. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

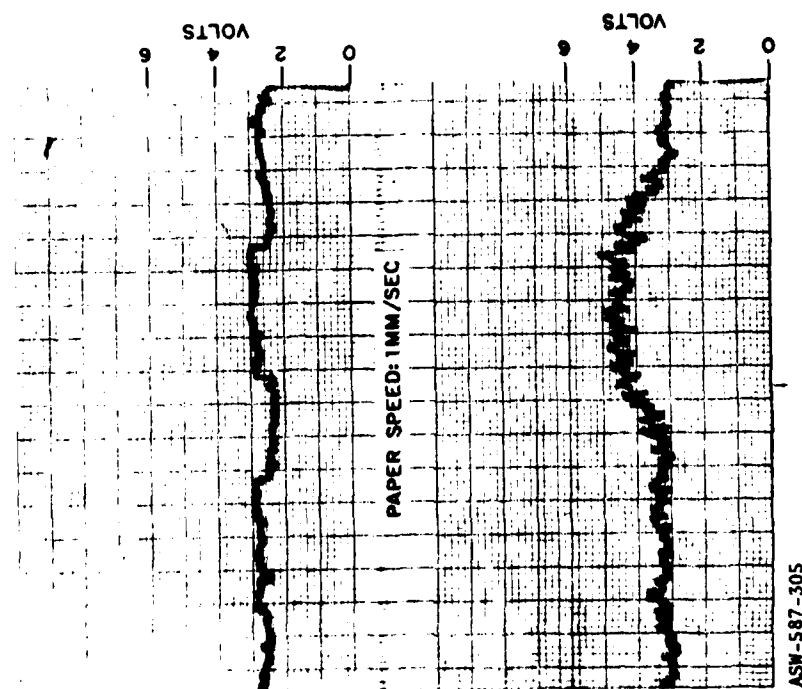


Figure B-142. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

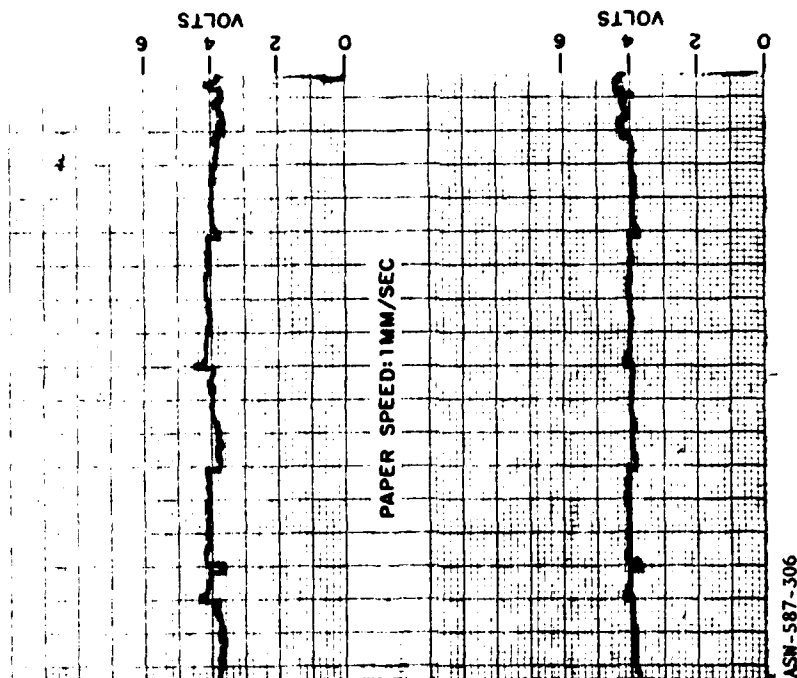
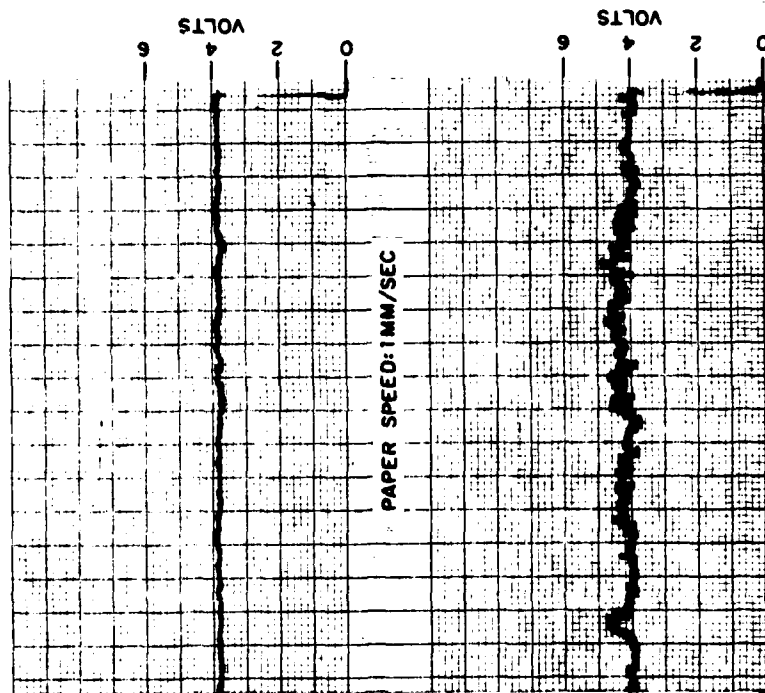


Figure B-143. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-307

Figure B-144. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.5 J-57 ENGINE, MODIFIED BURNER CAN FAILURE - 82% RPM

In order to simulate an actual burner can burn-through, the open hole in the modified burner can on the J-57 engine was masked to a 1.5-inch diameter hole and covered with a 0.062-inch thick aluminum cap. In addition, a 0.05 inch thick piece of material was fastened to the cowling. The effect of the two thicknesses of material was to simulate actual conditions. The engine was started and power was increased with flame in the can until failure occurred. The test was recorded using five microphones located in the same positions as for the closed-hole test. The purpose of this test was to compare the sound energy level of a burn-through with that of an open hole.

Analysis of the recordings made during this test run appear on pages B-103 through B-114.

B.5.1 Analysis

B.5.1.1 Sound Energy Levels

The meter readings recorded prior to and after burn-through are within 1 dB of both the closed-hole and open-hole runs for like conditions. Only microphone 4 was recorded for this test.

B.5.1.2 Spectrum Analysis

The grams clearly show the same discrete frequency lines that appeared in the closed-hole test prior to burn-through. When the burner can cap ruptured, a dark band of broadband random noise appeared. The noise subsided momentarily, then increased as the cowling cover ruptured. The intensity of the noise after cowling rupture was not as great as for the burner can cap rupture. No discrete burn-through frequencies were apparent. The major portion of the spectrum appeared below 10 kHz tapering off gradually as the frequency increased. Instrumentation microphone No. 2 data was analyzed to 40 kHz.

B.5.1.3 Mean Square Analysis

Previous tests indicated that much of the broadband random noise created by engine machinery was below 5 kHz whereas the burn-through broadband random noise was above 5 kHz. To illustrate and confirm this assumption, instrumentation microphone No. 2 was analyzed at 2 to 20 kHz, 3 to 20 kHz, 4 to 20 kHz, and 5 to 20 kHz using raw DATA (0 to 70 kHz) analysis as a direct comparison. Burn-through was hardly discernable in the raw processed recording but became increasingly more visible as the low band frequency cutoff was raised.

B.5.2 Environmental Conditions

The test was performed at an ambient temperature of 77° F and 25% relative humidity. Microphone temperatures were as follows:

	MICROPHONE				
	1	2	3	4	5
TEMPERATURE (^o F)	100	130	80 (a)	110	70 (a)

^aThe thermocouples were inaccurate below 100^o F.

B.5.3 Sound Energy Level

The following table lists the sound energy level of microphone No. 4 before and after burn-through.

Table B-13. Sound Energy Level Before and After Burn-through

SOUND LEVEL	MICROPHONE No. 4	
	BEFORE	AFTER
RMS (mV)	78	230
RMS (μBAR)	540	1850
dB (a)	130	139

^aReference = 2×10^{-4} μBAR

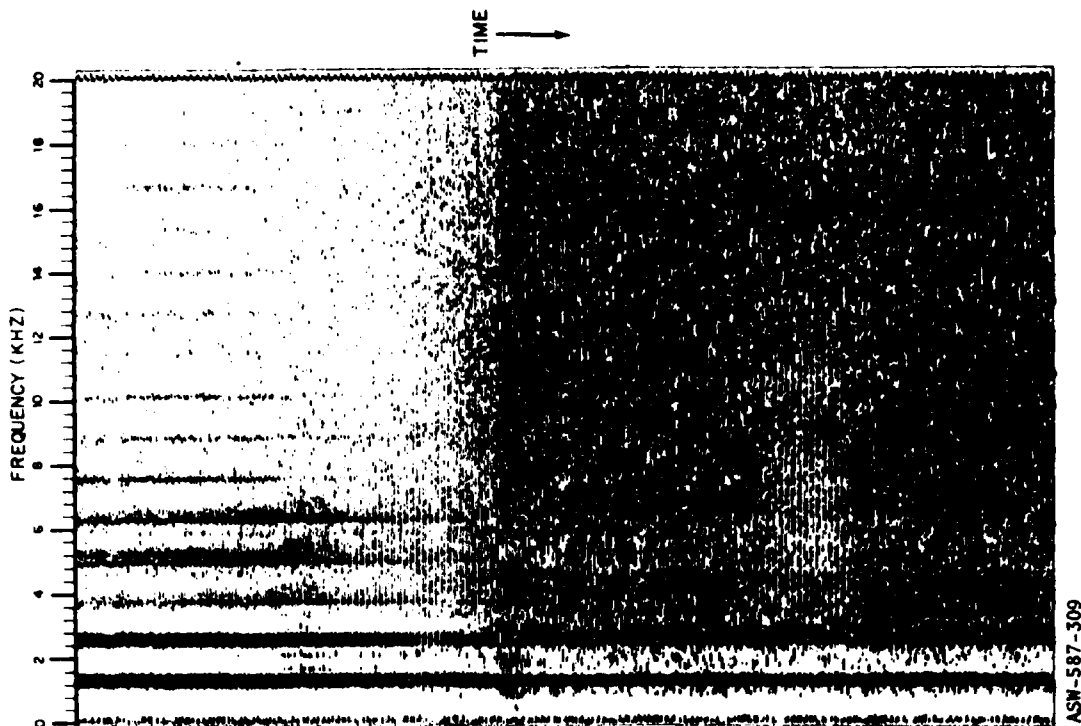


Figure B-145. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

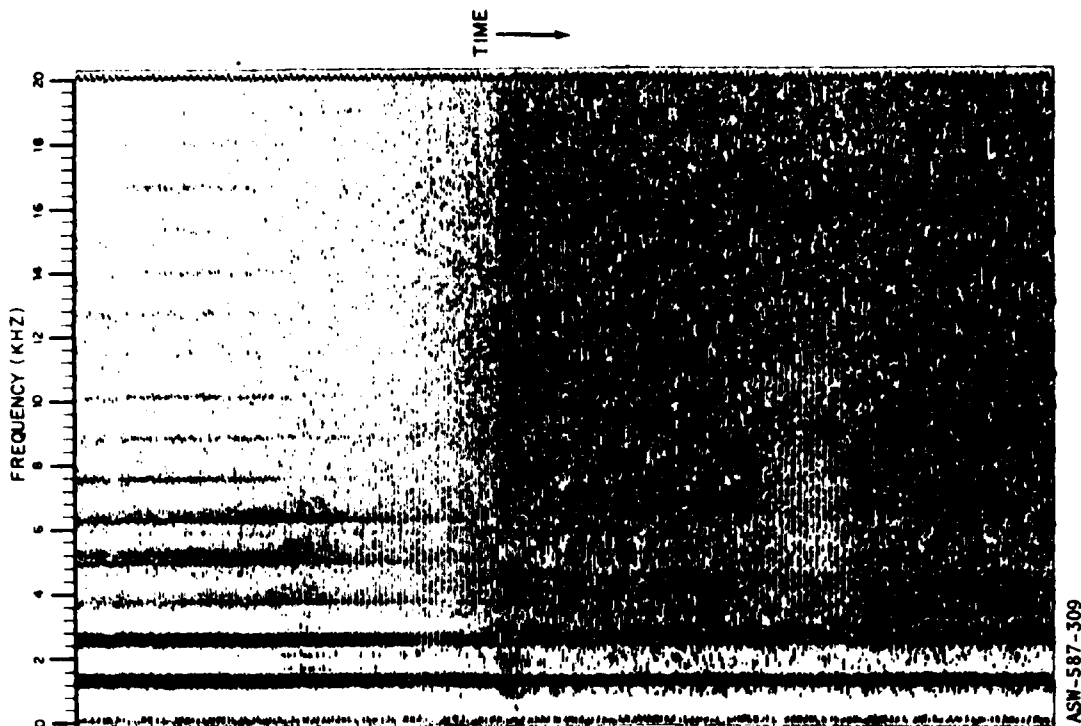
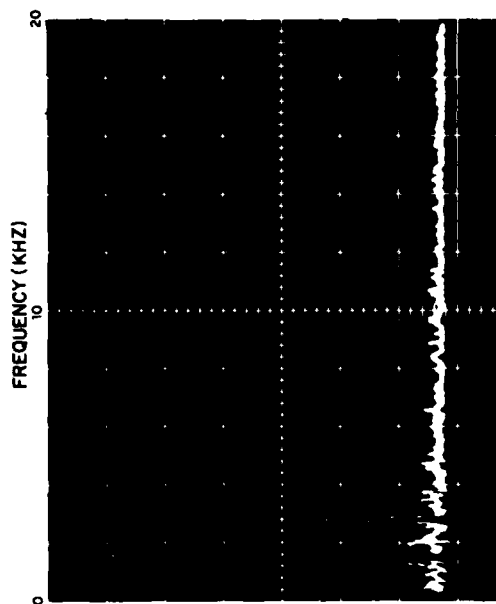
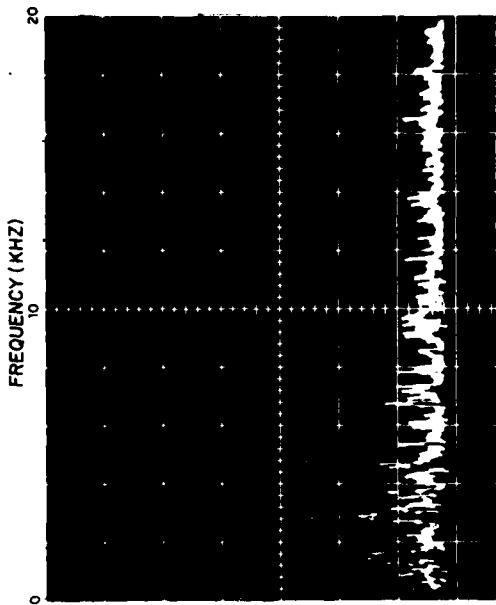


Figure B-146. Microphone No. 2 Spectrum Analysis. Analysis bandwidth is 0 to 20 kHz.



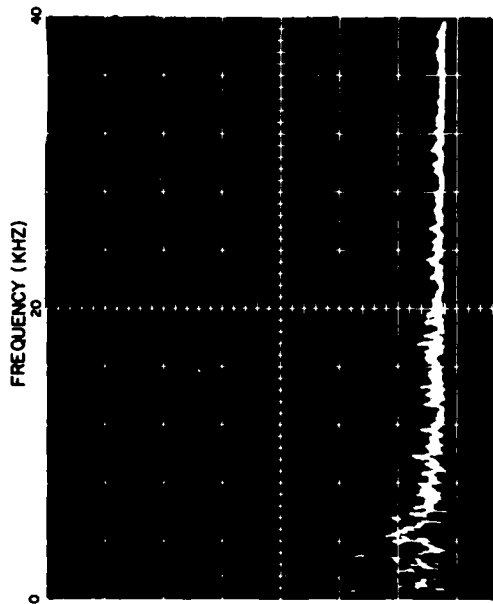
ASW-587-310

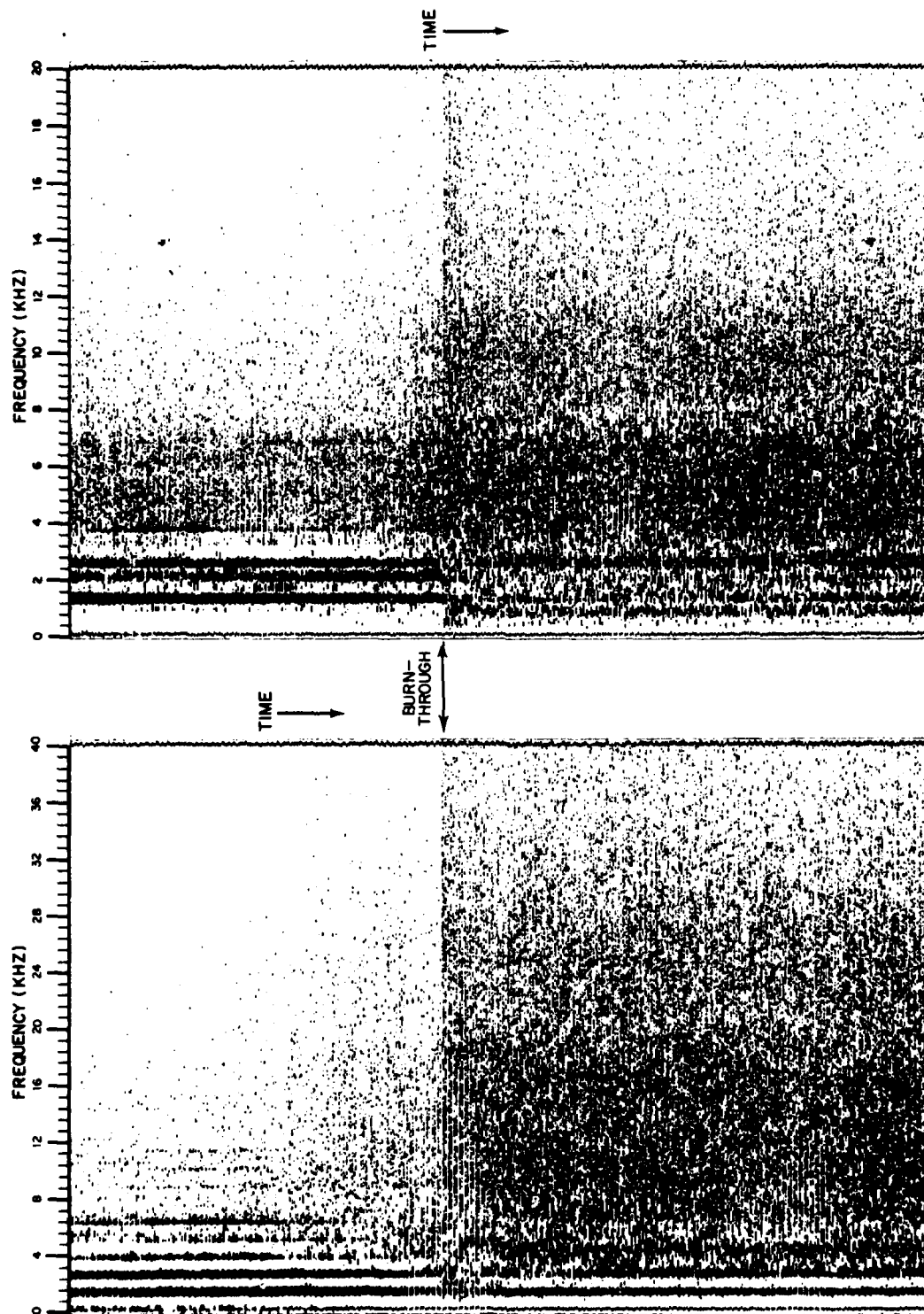
Figure B-147. Microphone No. 2 Spectrum Analysis Before Burn-through. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



ASW-587-311

Figure B-148. Microphone No. 2 Spectrum Analysis After Burn-through. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



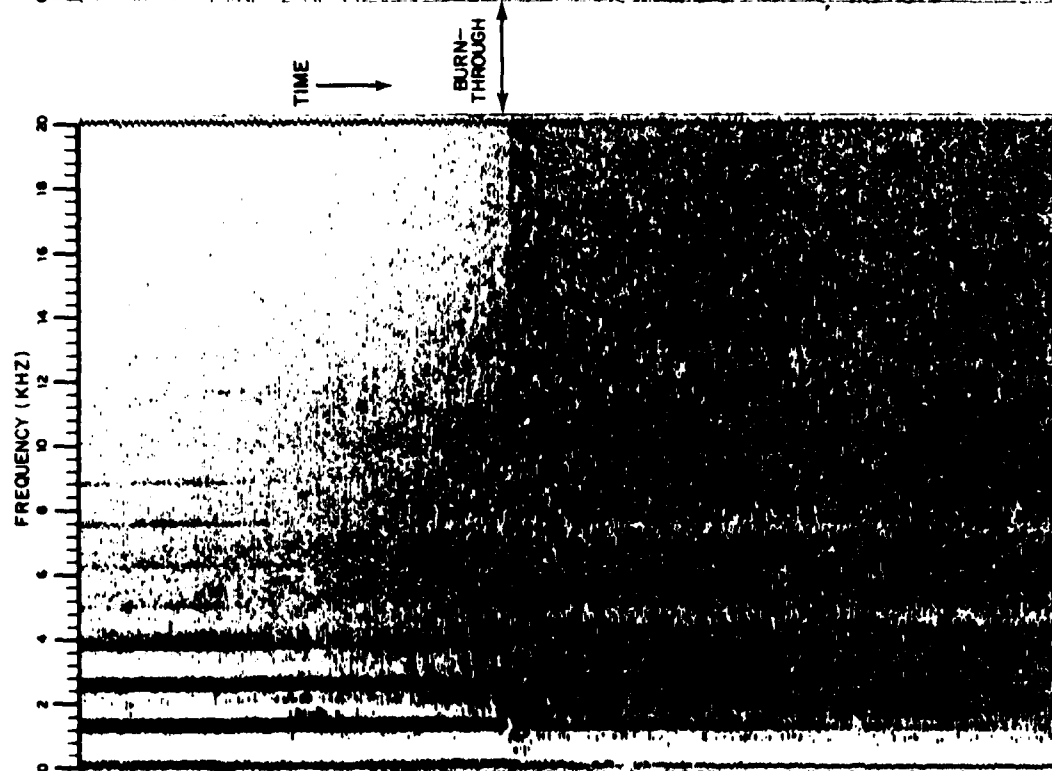


ASW-587-312

Figure B-149. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.

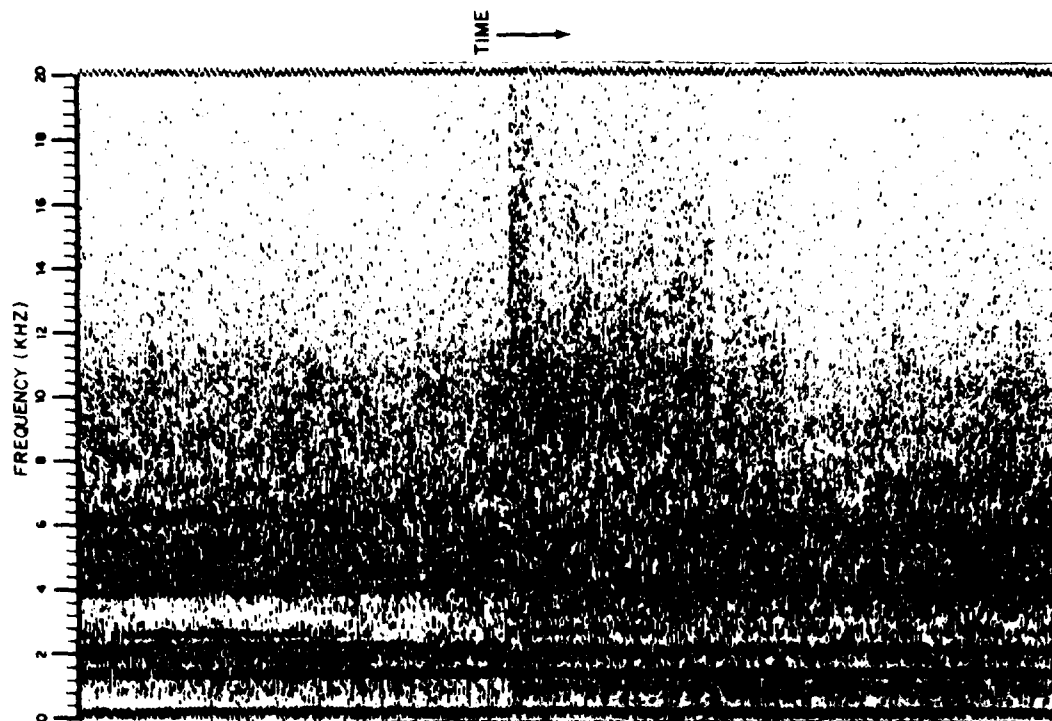
ASW-587-313

Figure B-150. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-314

Figure B-151. Microphone No. 4 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.



ASW-587-315

Figure B-152. Microphone No. 5 Spectrum
Analysis. Analysis Bandwidth
is 0 to 20 kHz.

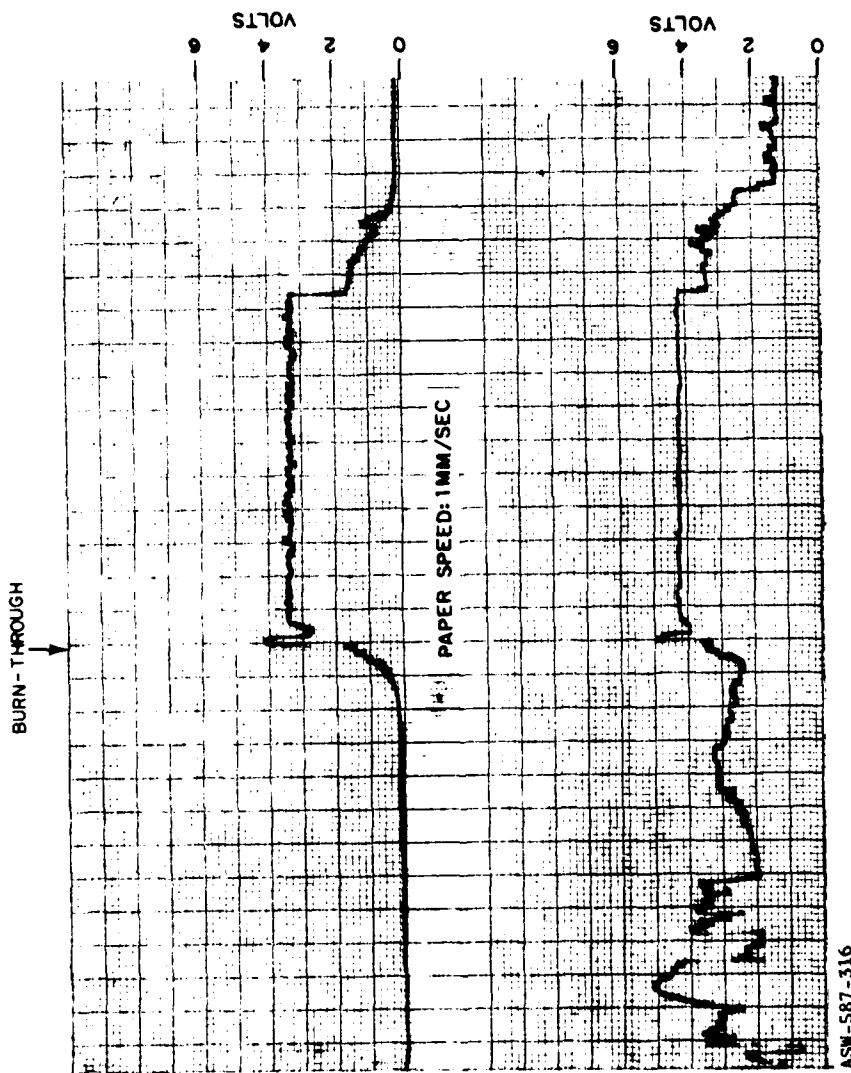


Figure B-153. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

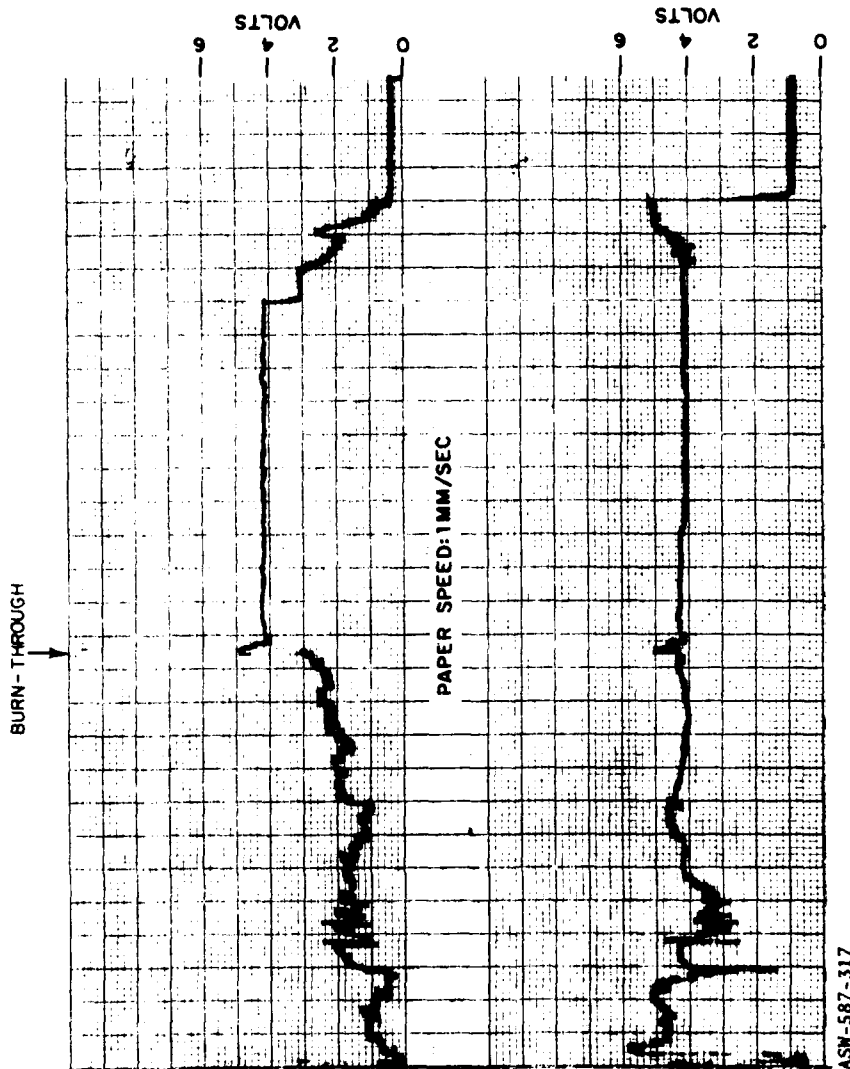


Figure B-154. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 2 to 20 kHz.

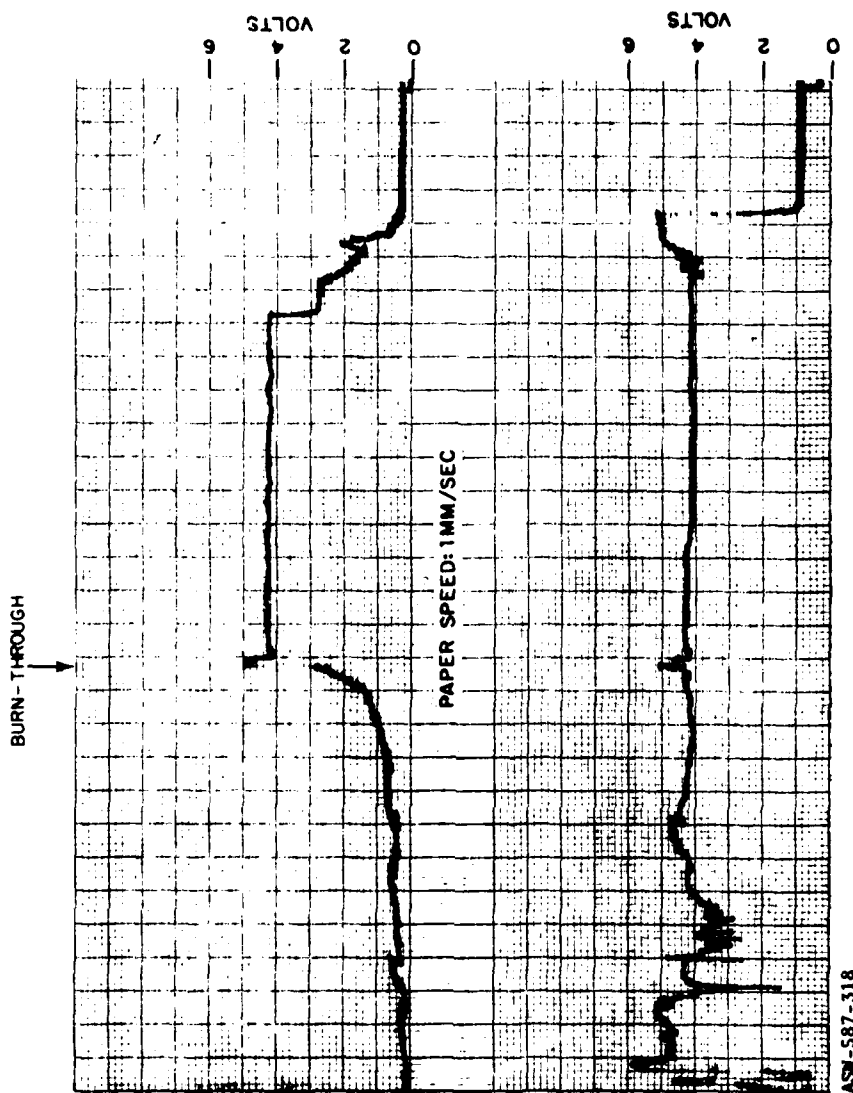


Figure B-155. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 3 to 20 kHz.

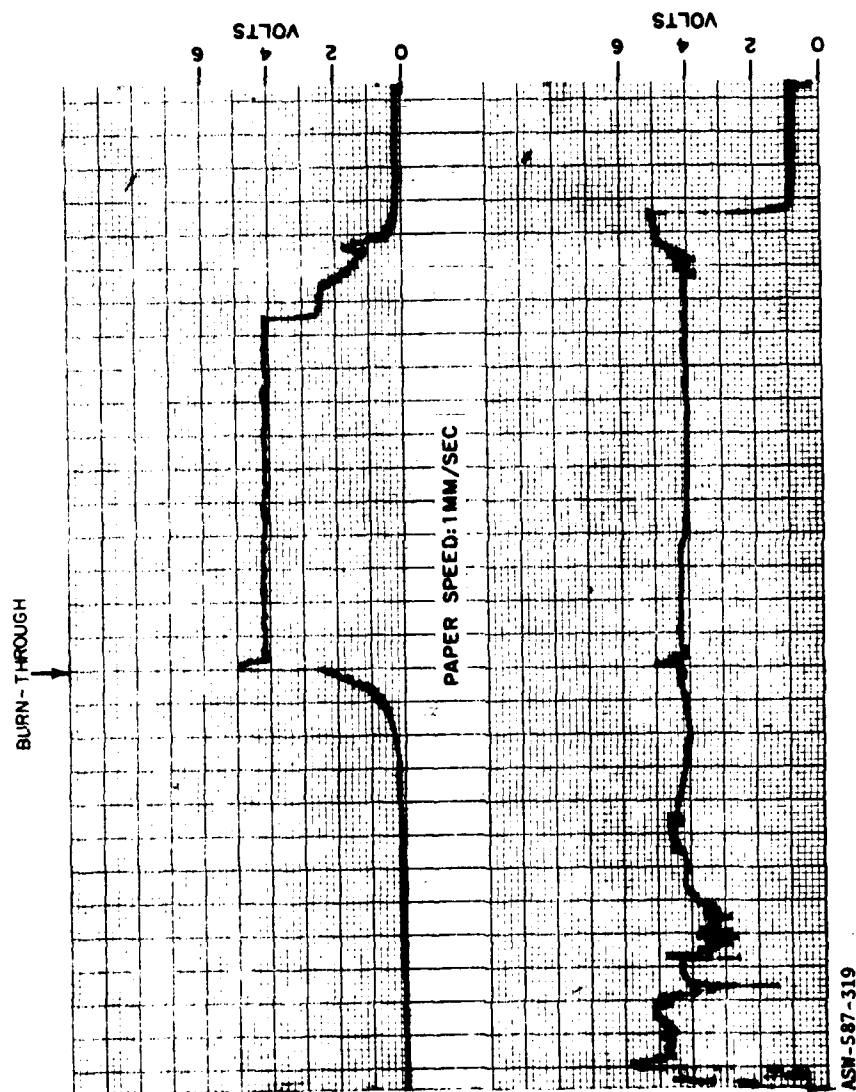


Figure R-156. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 4 to 20 kHz.

ASN-587-319

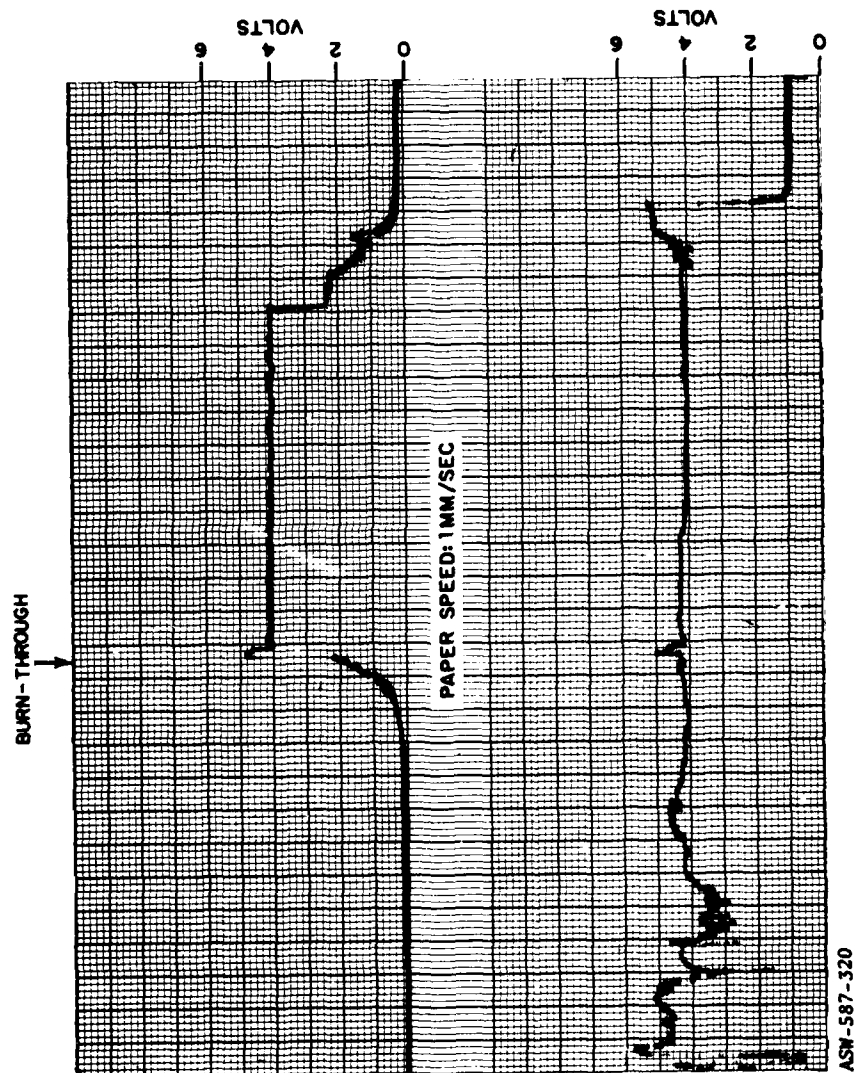


Figure B-157. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

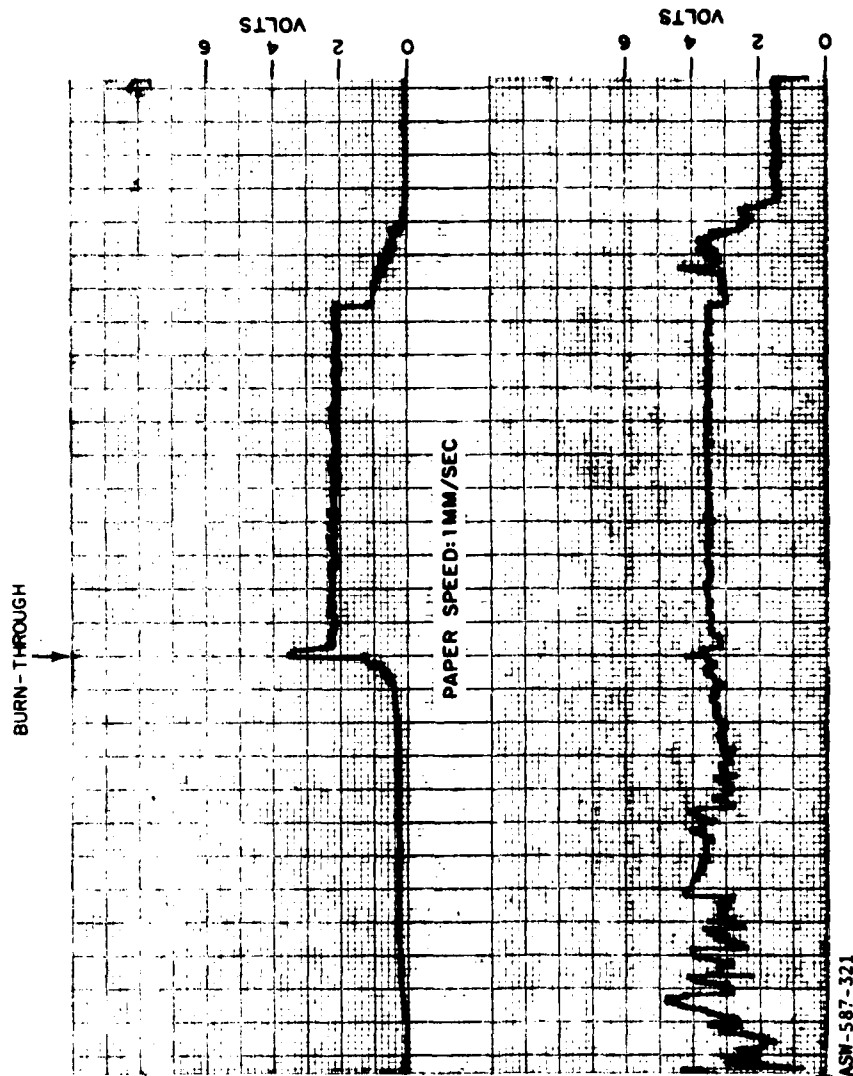


Figure B-158. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

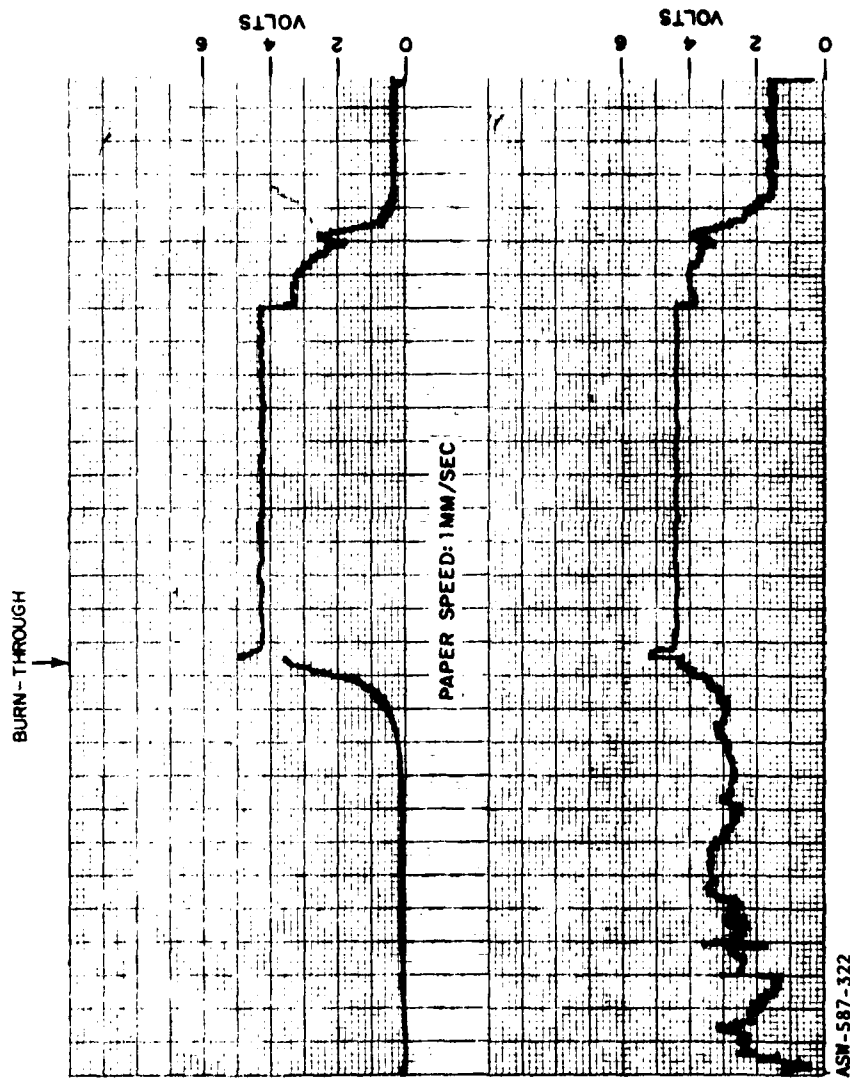


Figure B-159. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

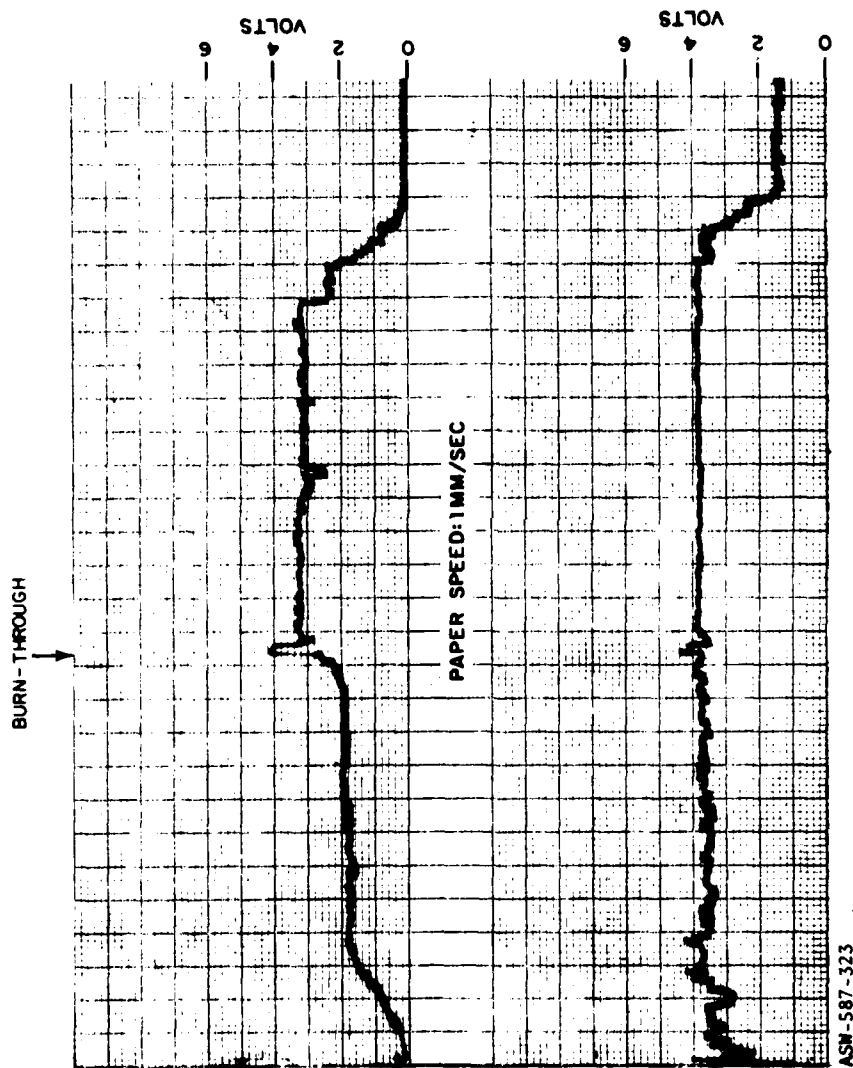


Figure B-160. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.6 J-57 ENGINE, MODIFIED BURNER CAN FAILURE - 90% RPM

A second test was run which duplicated the previous burner-can failure test except that the engine speed was increased to 90% RPM.

Analysis of the recordings made during this test run appear on pages B-117 through B-124.

B.6.1 Analysis

B.6.1.1 Sound Energy Levels

The meter readings recorded prior to burn-through are 2 dB greater than those recorded for the closed-hole test. The readings after burn-through are the same as for the 1.5 inch open-hole test.

B.6.1.2 Spectrum Analysis

Each gram was unique for the 90% RPM burn-through test. They varied not only in discrete frequency content, but also displayed the burner can and cowling ruptures in distinctly different manners. Broad-band random noise also varied greatly.

B.6.1.3 Mean Square Analysis

The low frequency cutoff was varied in the same manner as the 82% RPM burn-through. The results were similar but not as vivid because of less low frequency content in the spectrum. Microphone 5, farthest from the burn-through, had greater frequency content in the spectrum and showed less change even when filtered.

B.6.2 Environmental Conditions

The test was performed at an ambient temperature of 77° F and 25% relative humidity. Microphone temperatures were as follows:

	MICROPHONE				
	1	2	3	4	5
TEMPERATURE (° F)	110	130	70 (a)	110	70 (a)

^aThe thermocouples were inaccurate below 100° F.

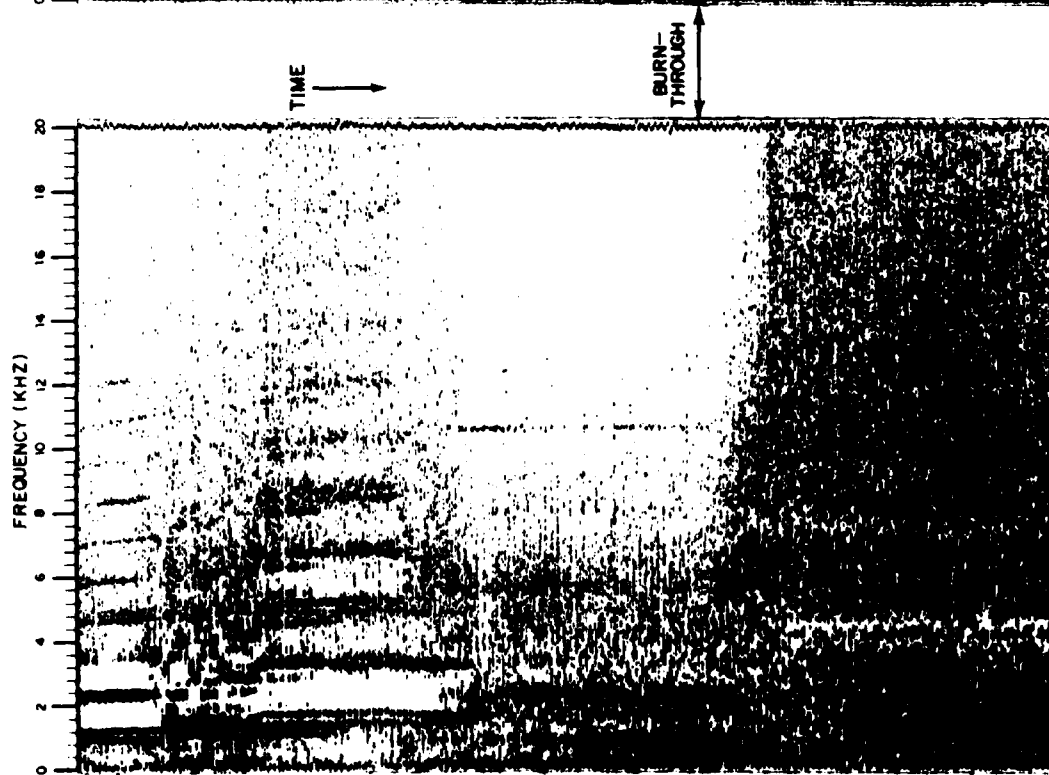
B.6.3 Sound Energy Levels

The following table lists the sound energy level of microphone 4 before and after burn-through.

Table B-14. Sound Energy Level Before and After Burn-through

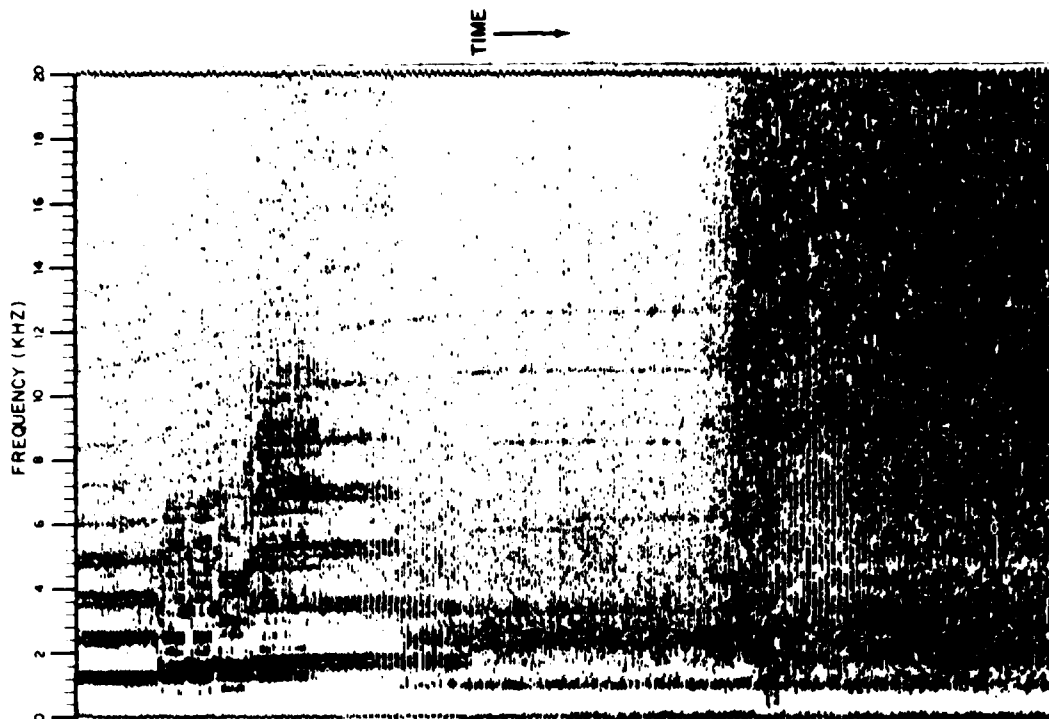
SOUND LEVEL	MICROPHONE No. 4	
	BEFORE	AFTER
RMS (mV)	38	220
RMS (μBAR)	300	1750
dB (a)	124	139

^aReference = 2×10^{-4} μBAR



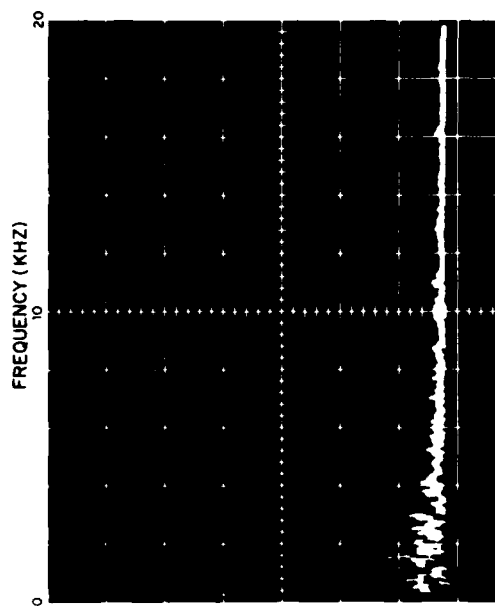
ASN-587-324

Figure B-161. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.



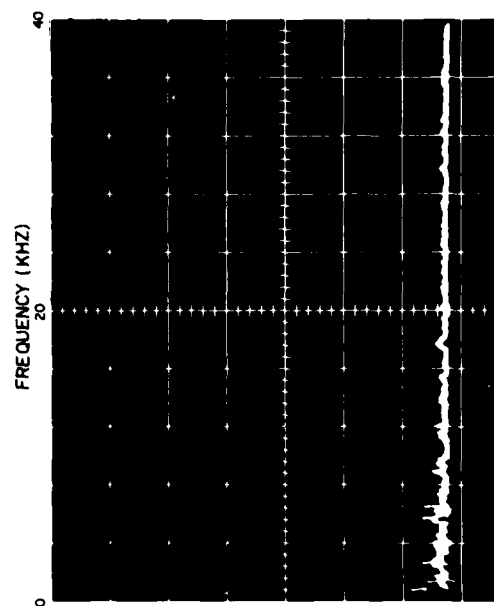
ASN-587-325

Figure B-162. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 KHz.



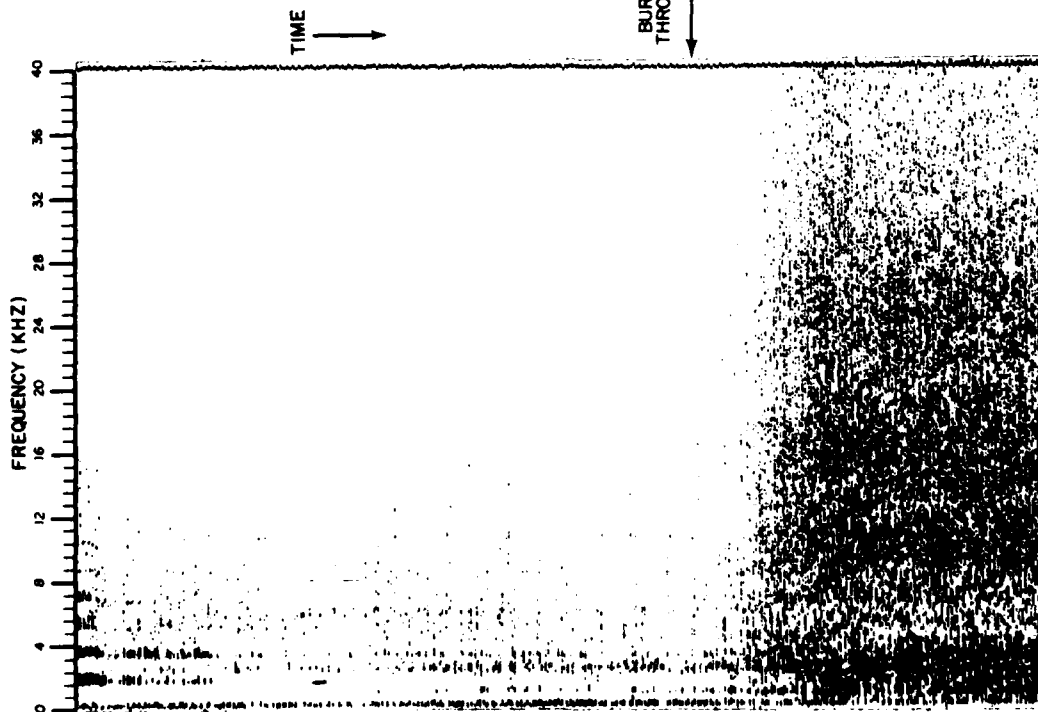
ASW-587-326

Figure B-163. Microphone No. 2 Spectrum Analysis Before Burn-through. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



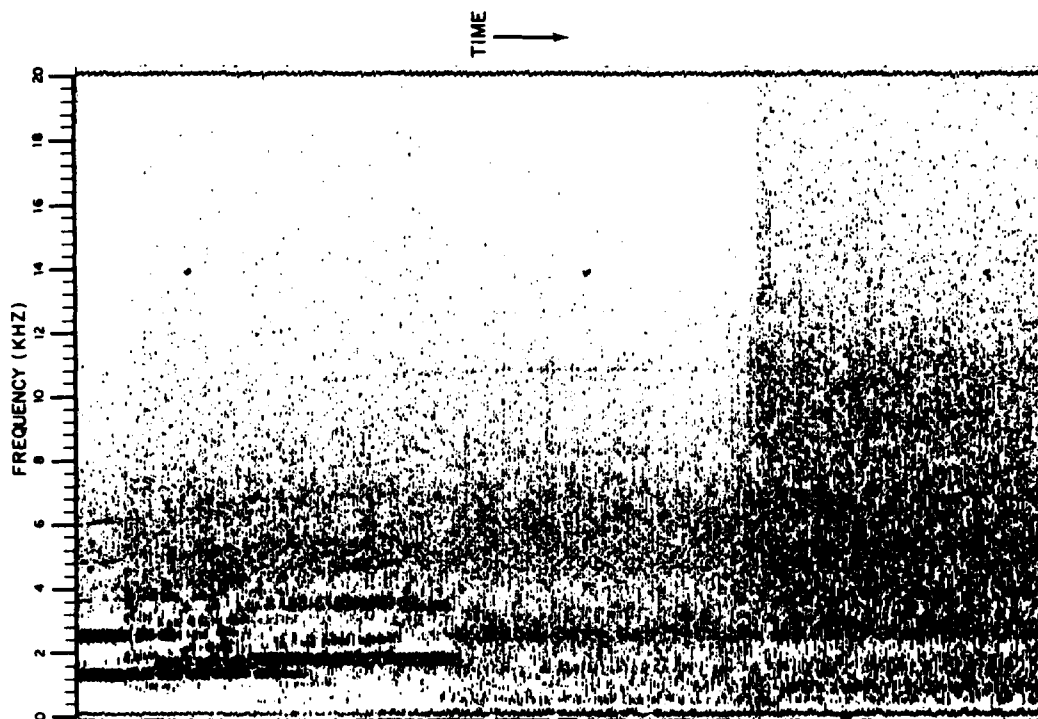
ASW-587-327

Figure B-164. Microphone No. 2 Spectrum Analysis After Burn-through. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



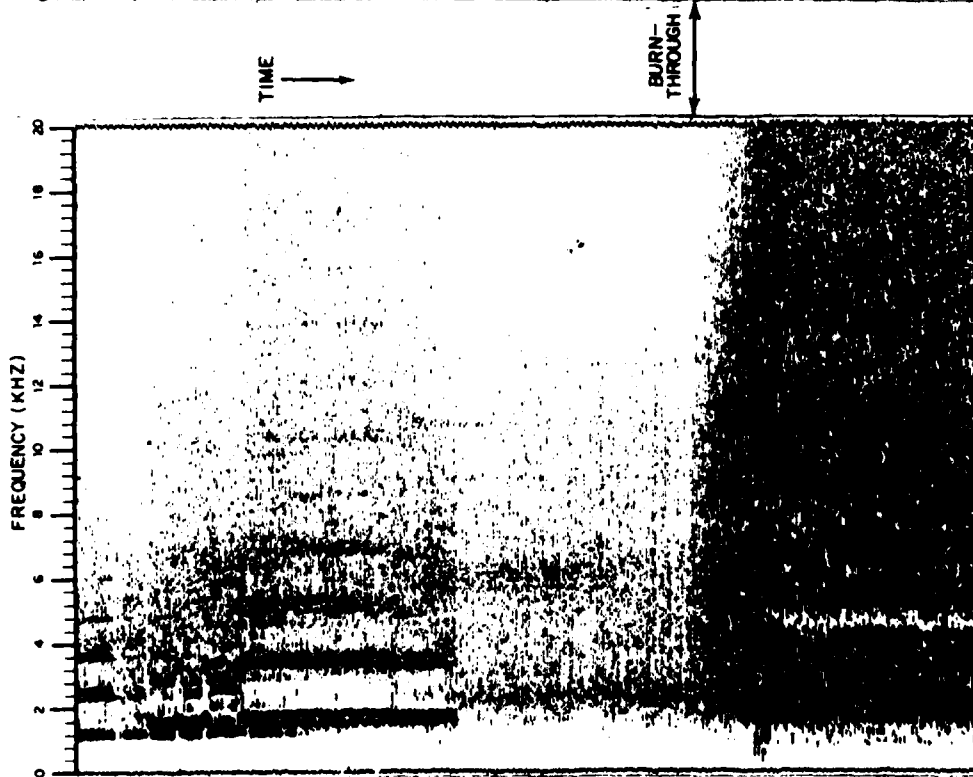
ASW-587-328

Figure B-165. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



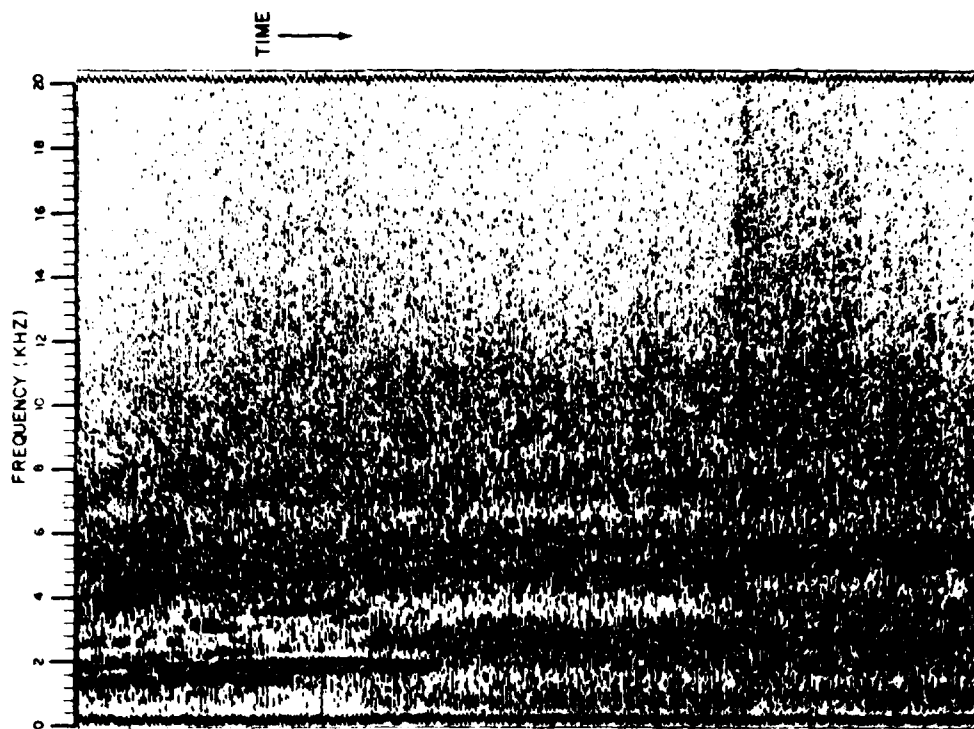
ASW-587-329

Figure B-166. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



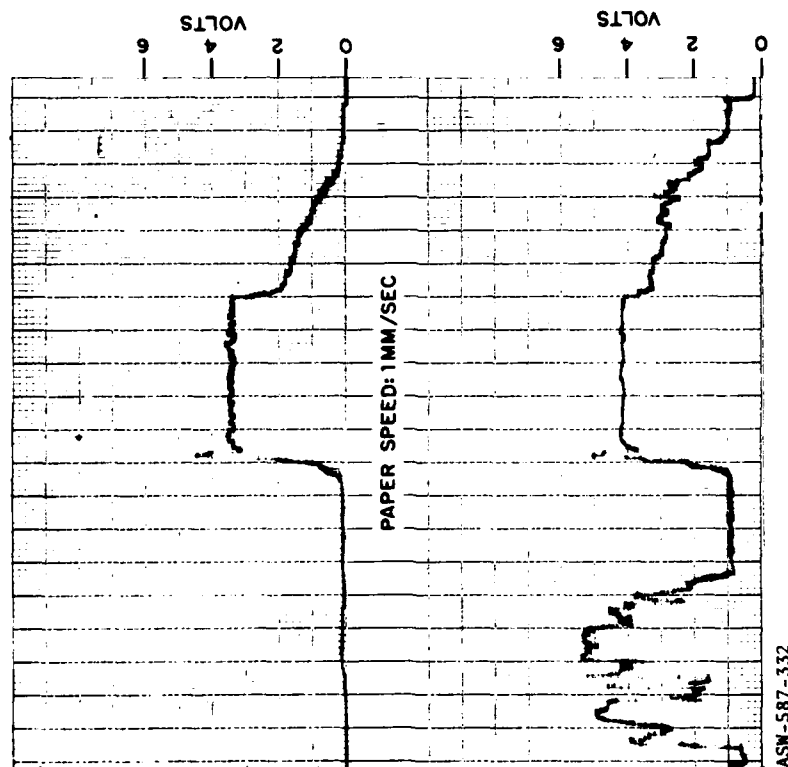
ASW-587-330

Figure B-167. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



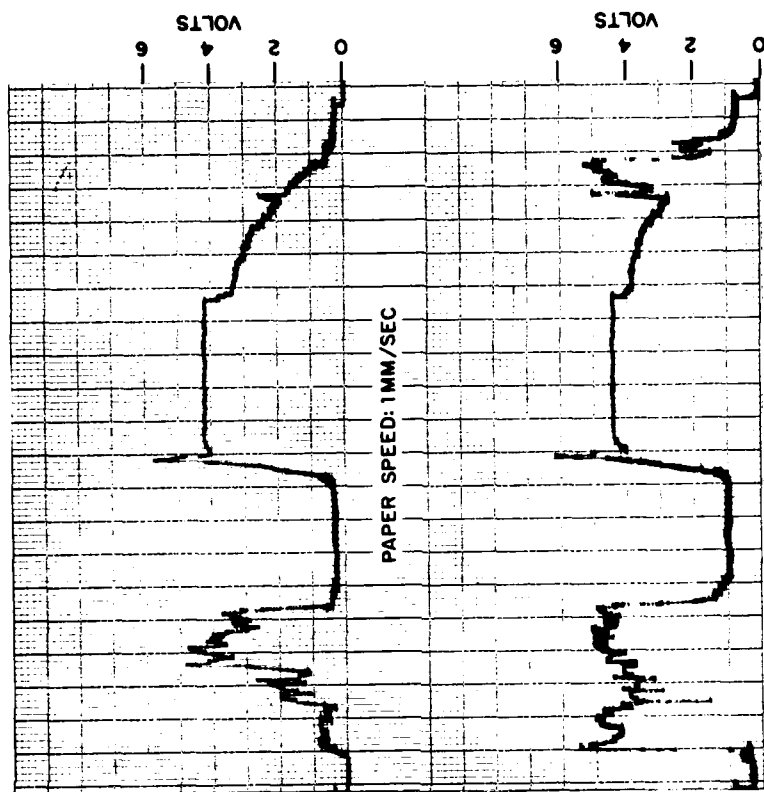
ASW-587-331

Figure B-168. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



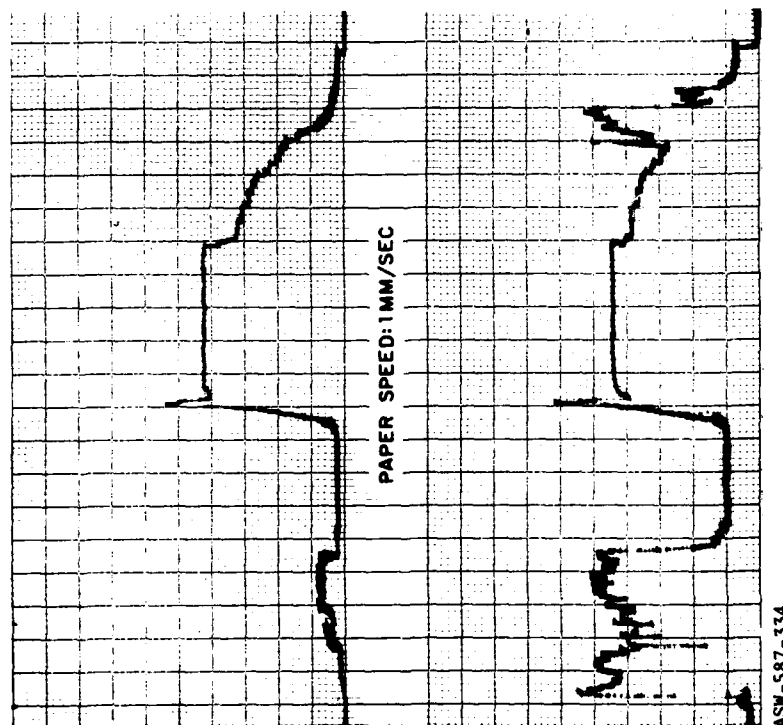
ASW-587-332

Figure B-169. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



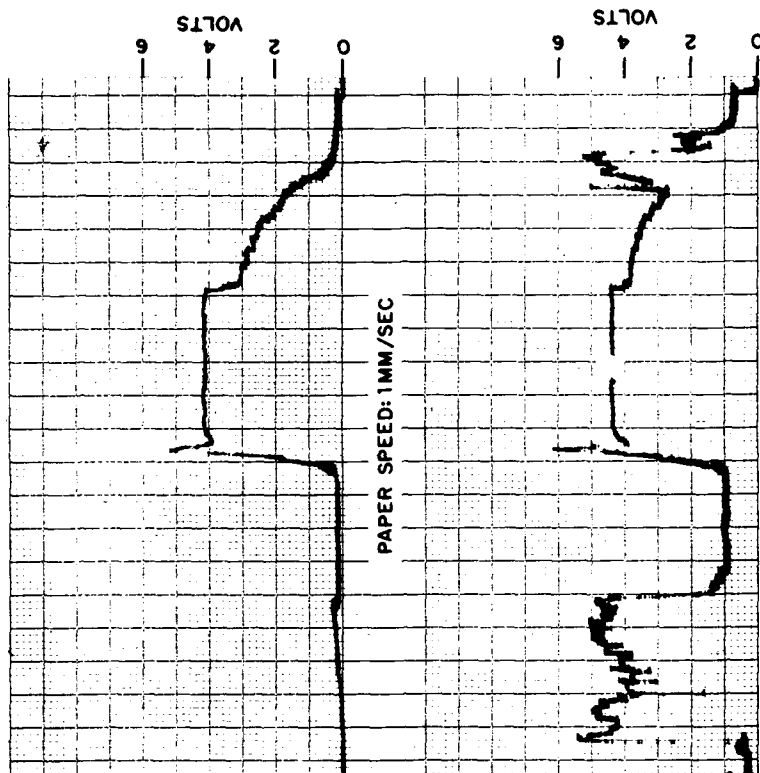
ASW-587-333

Figure B-170. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 2 to 20 kHz.



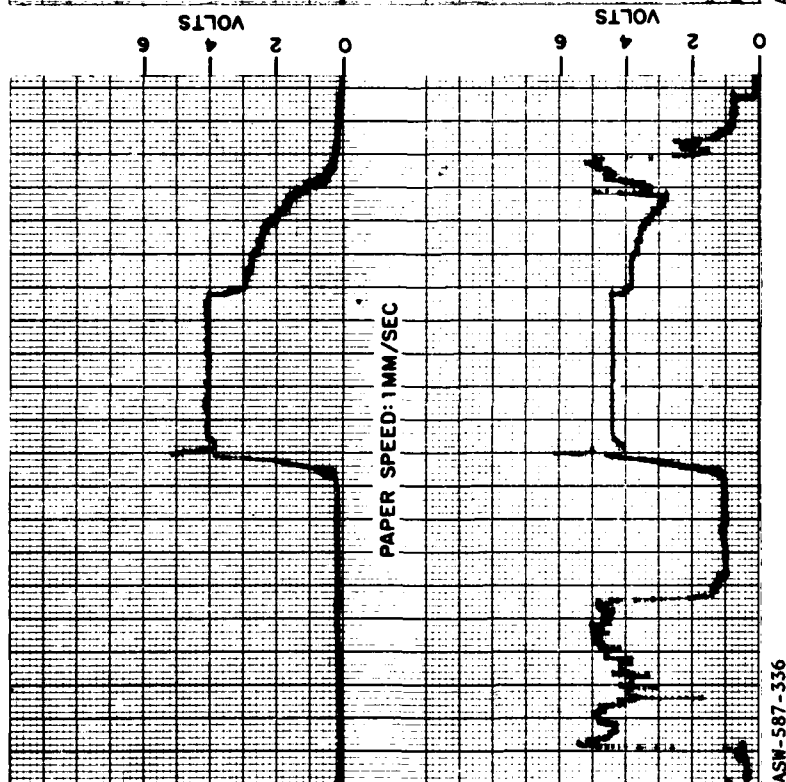
ASW-587-334

Figure B-171. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 3 to 20 kHz.



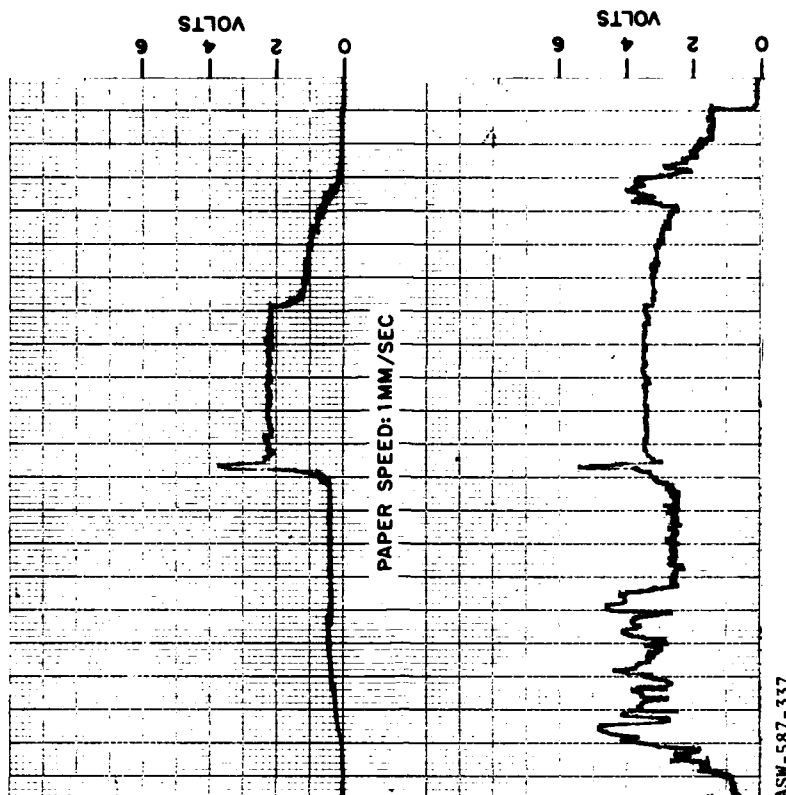
ASW-587-335

Figure B-172. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 4 to 20 kHz.



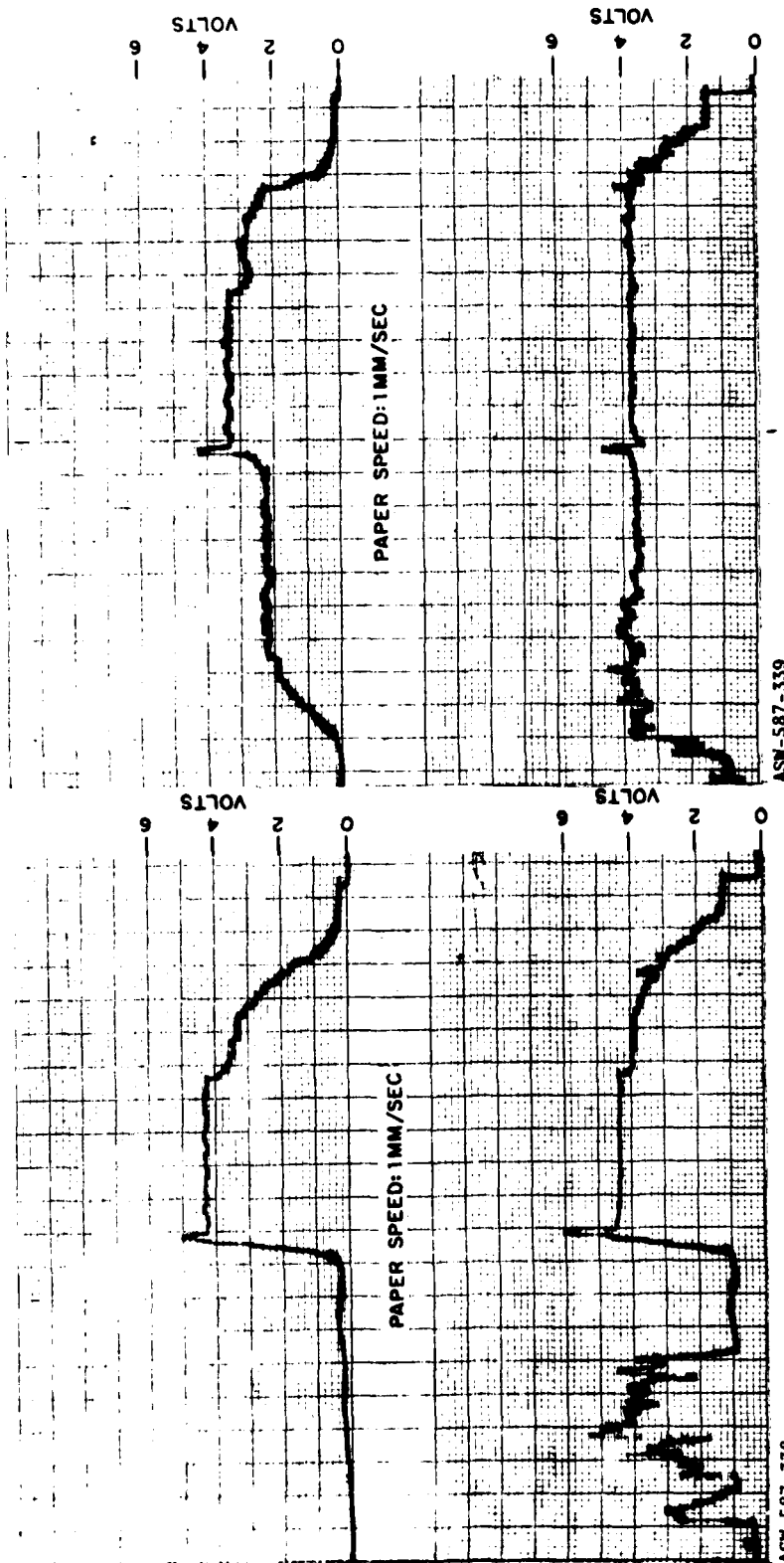
ASW-587-336

Figure B-173. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-337

Figure B-174. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



B.7 J-57 ENGINE, MODIFIED BURNER CAN FAILURE - MAXIMUM RPM

A third test was run which duplicated the previous two-burner can failure tests except that the engine speed was increased to maximum RPM.

Analysis of the recordings made during this test run appear on pages B-127 through B-134.

B.7.1 Analysis

B.7.1.1 Sound Energy Levels

The meter readings recorded prior to burn-through were 2 dB greater than those recorded for the closed-hole test. The readings after burn-through were the same as for the 1.5 inch open-hole test.

B.7.1.2 Spectrum Analysis

All grams showed the burn-through except the microphone 5 gram. The broadband random noise was so dense that point of burn-through was not clearly discernible. This microphone was farthest from the burn-through.

B.7.1.3 Mean Square Analysis

The low frequency cutoff was varied in the same manner as for the 82% RPM burn-through. The results were similar to the 90% RPM test except that, as noted in the spectrum analysis, microphone 5 recordings did not clearly depict the burn-through.

B.7.2 Environmental Conditions

The test was performed at an ambient temperature of 70° F and 37% relative humidity. Microphone temperatures were as follows:

	MICROPHONE				
	1	2	3	4	5
TEMPERATURE (° F)	100	160	70 (a)	100	60 (a)

^aThe thermocouples were inaccurate below 100° F.

B.7.3 Sound Energy Levels

The following table lists the sound energy level of microphone 4 before and after burn-through.

Table B-15. Sound Energy Level Before and After Burn-through

SOUND LEVEL	MICROPHONE No. 4	
	BEFORE	AFTER
RMS (mV)	47	235
RMS (μBAR)	380	1900
dB (a)	125	139

^aReference = 2×10^{-4} μBAR

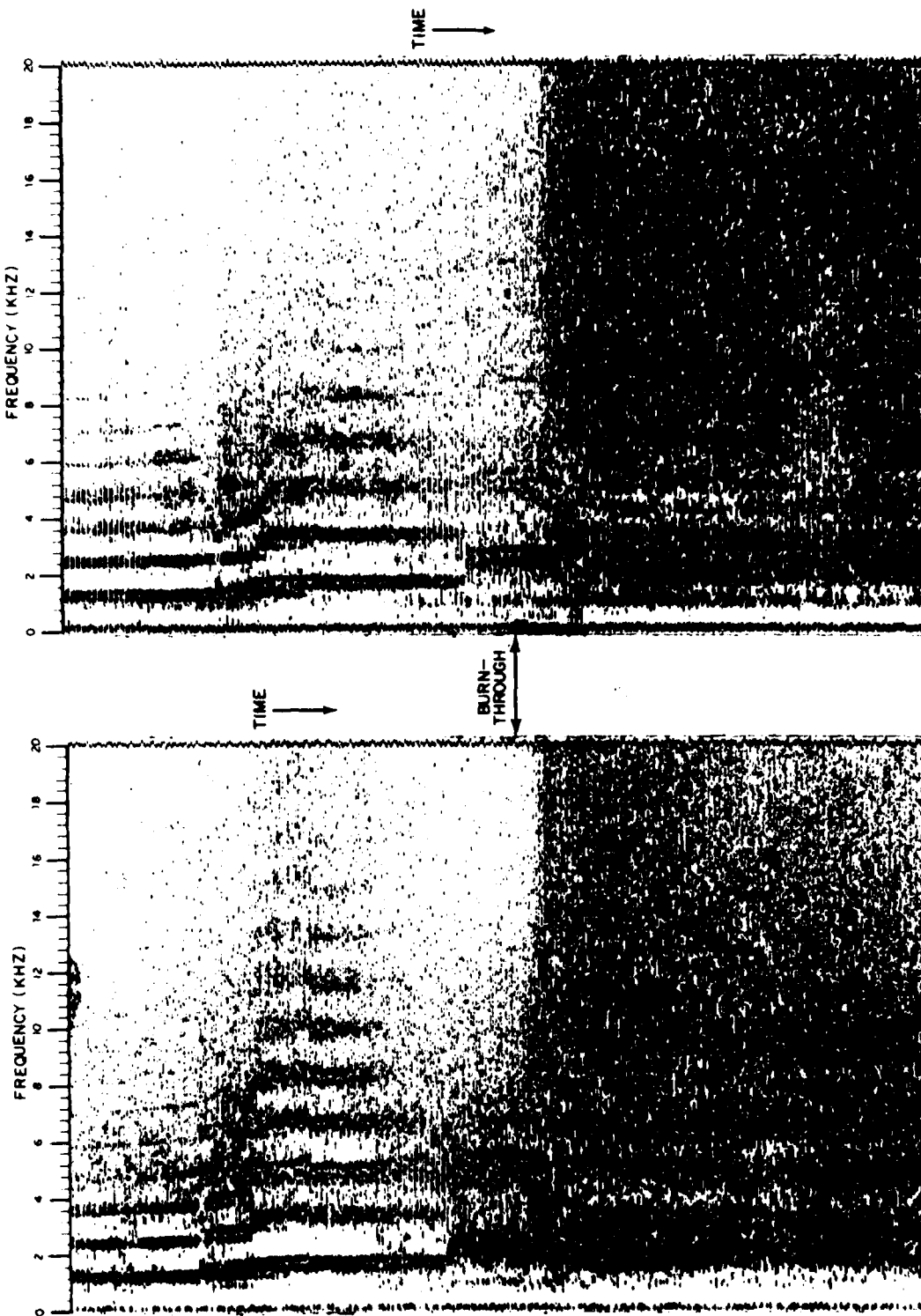
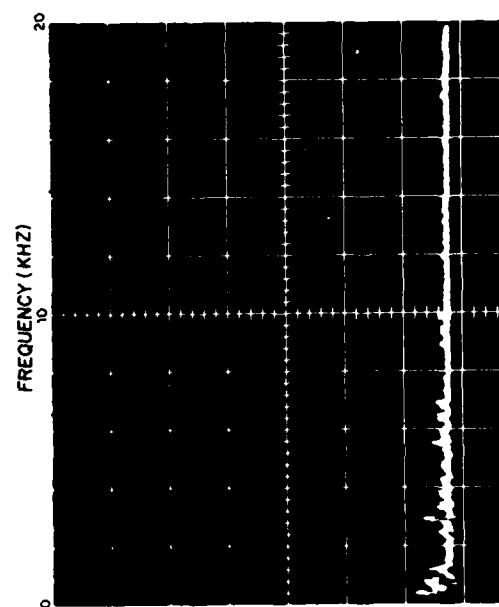


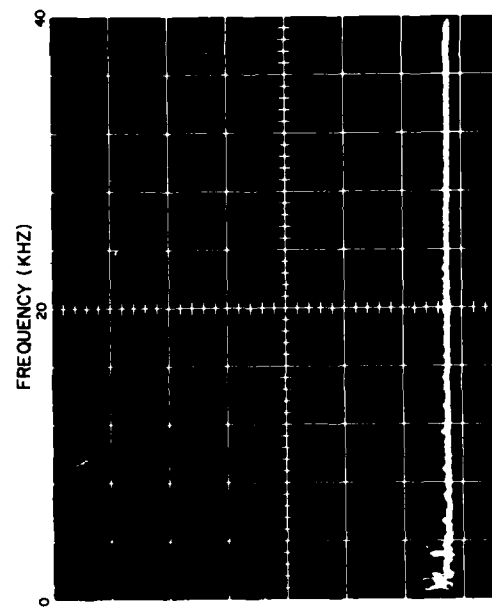
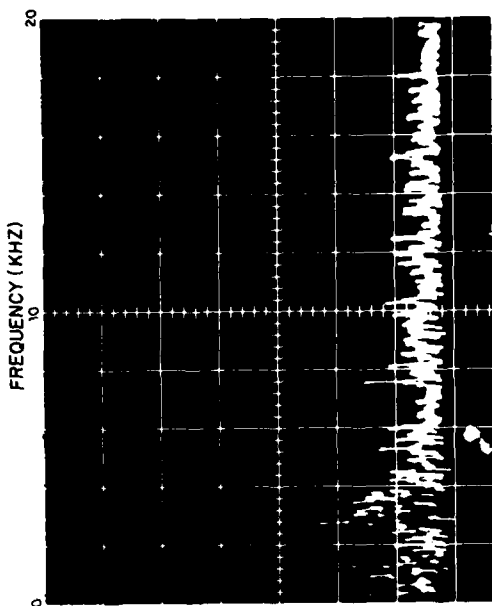
Figure B-177. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

Figure B-178. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



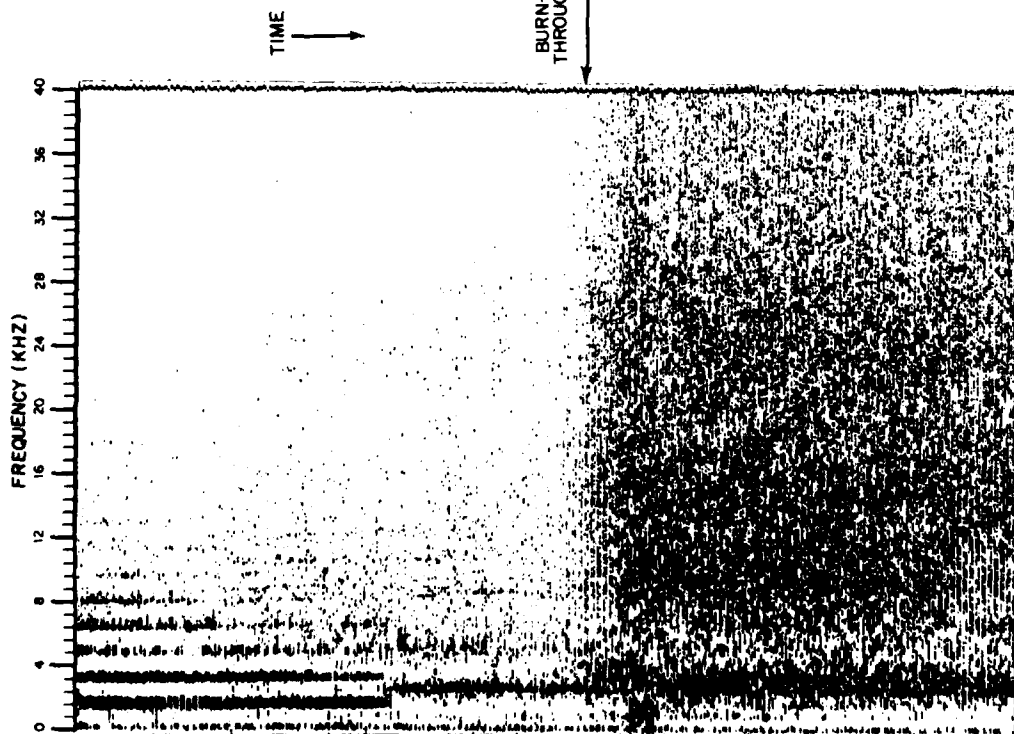
ASW-587-342

Figure B-179. Microphone No. 2 Spectrum Analysis Before Burn-through Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



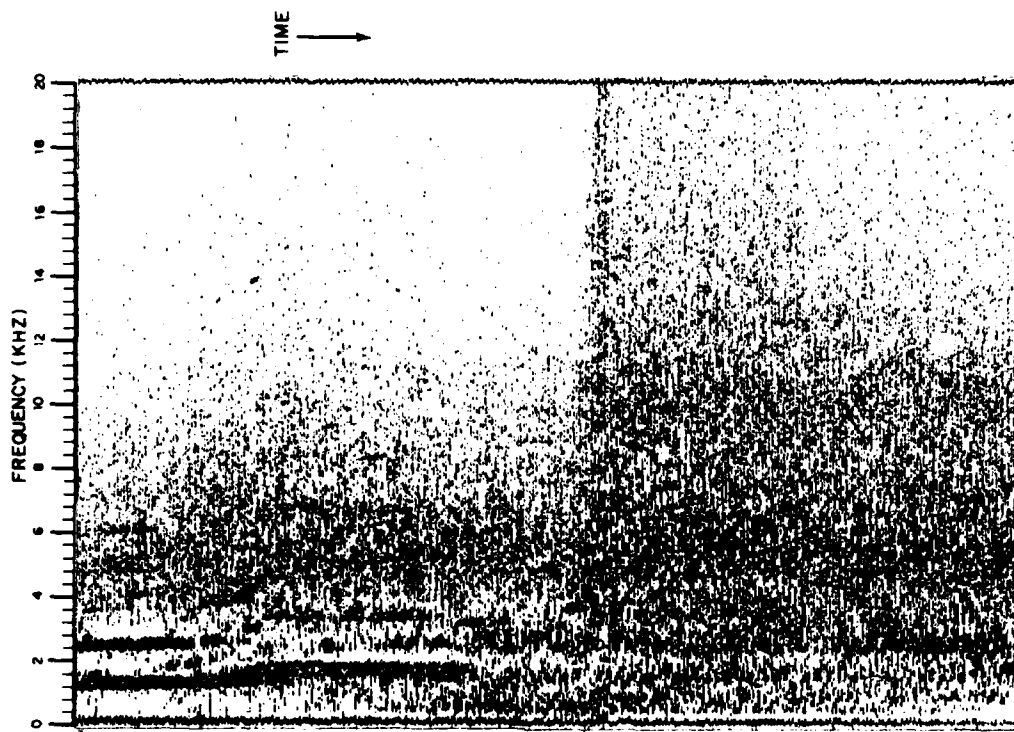
ASW-587-343

Figure B-180. Microphone No. 2 Spectrum Analysis After Burn-through. Analysis Bandwidths are 0 to 20 kHz and 0 to 40 kHz.



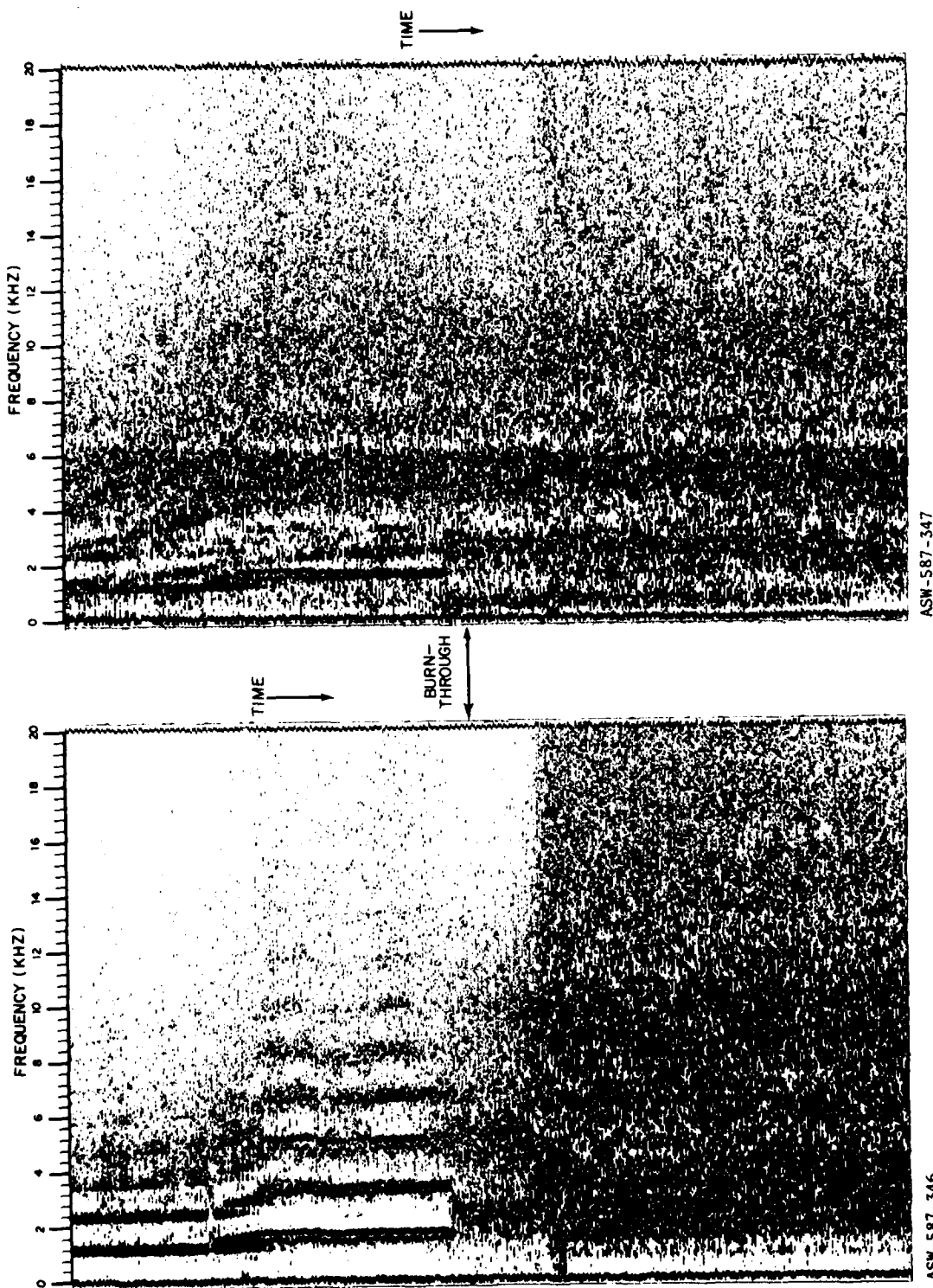
ASW-587-344

Figure B-181. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 40 kHz.



ASW-587-345

Figure B-182. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

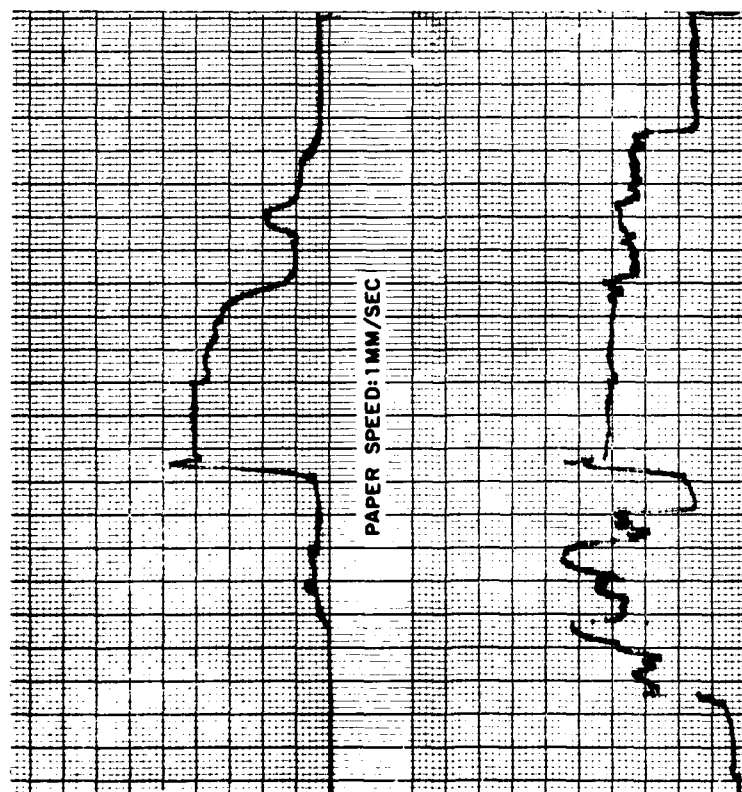


ASW-587-346

Figure B-183. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

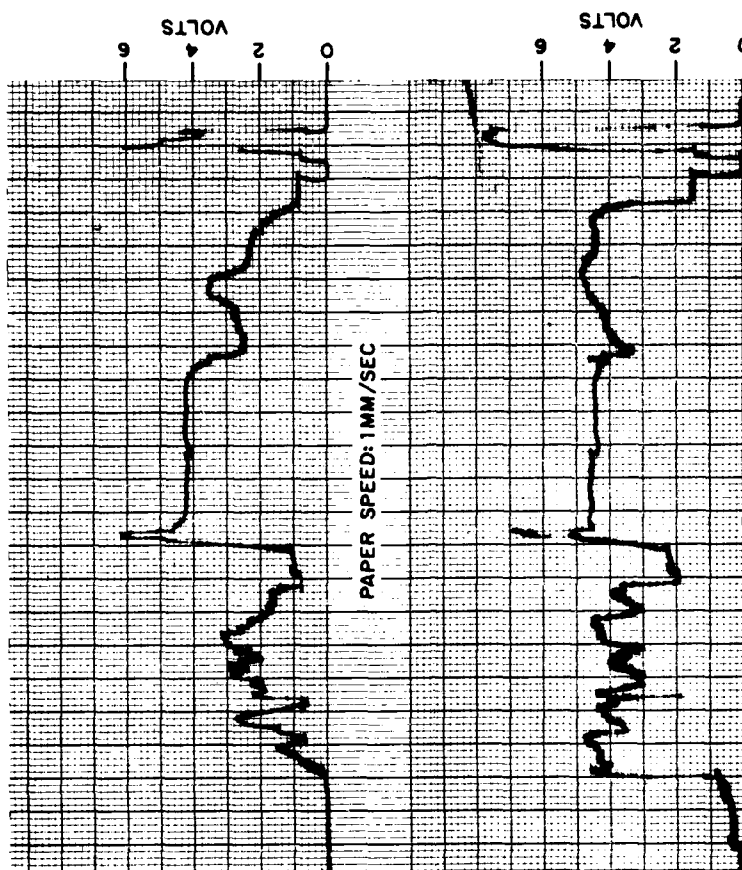
ASW-587-347

Figure B-184. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-348

Figure B-185. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-349

Figure B-186. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 2 to 20 kHz.

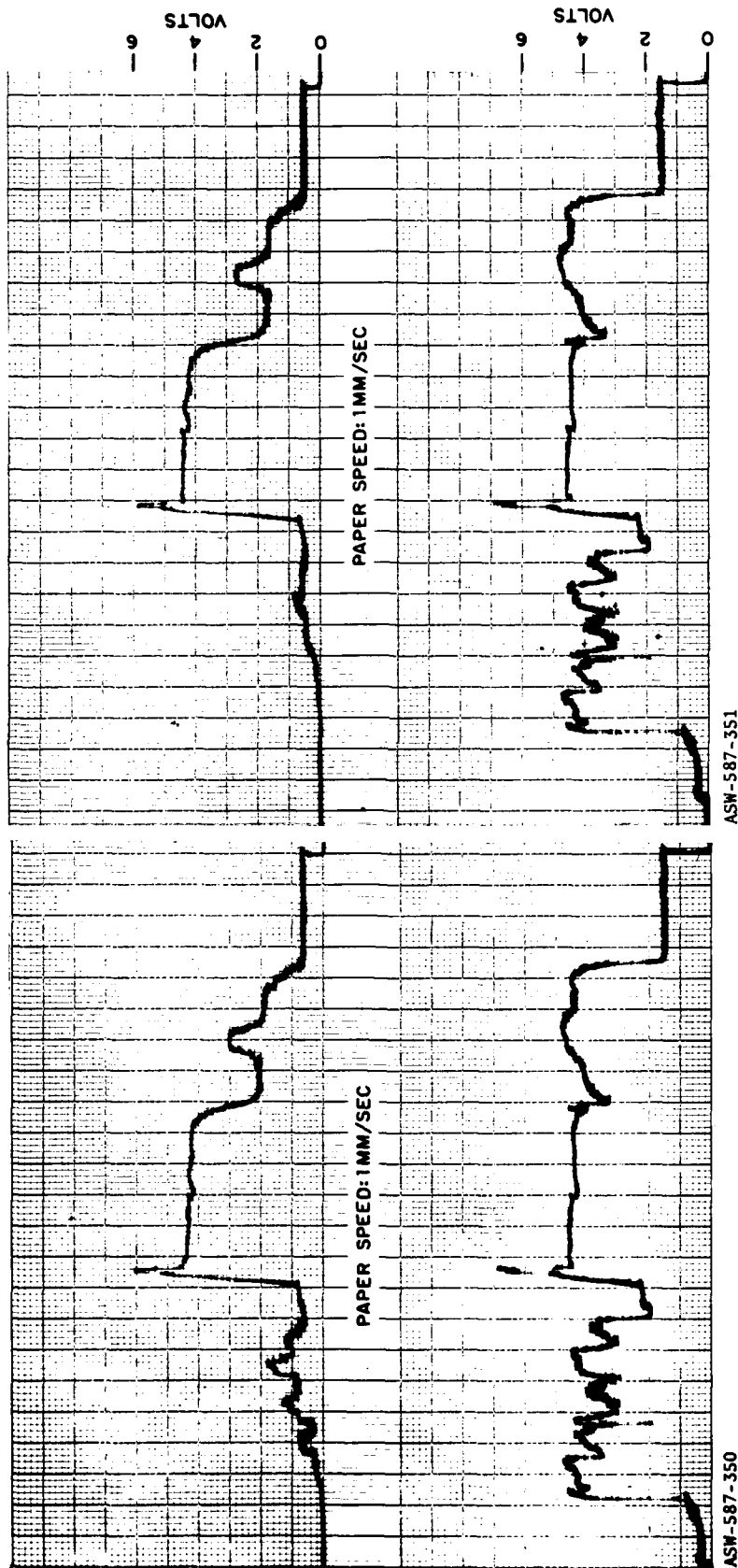


Figure B-187. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 3 to 20 kHz.

Figure B-188. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 4 to 20 kHz.

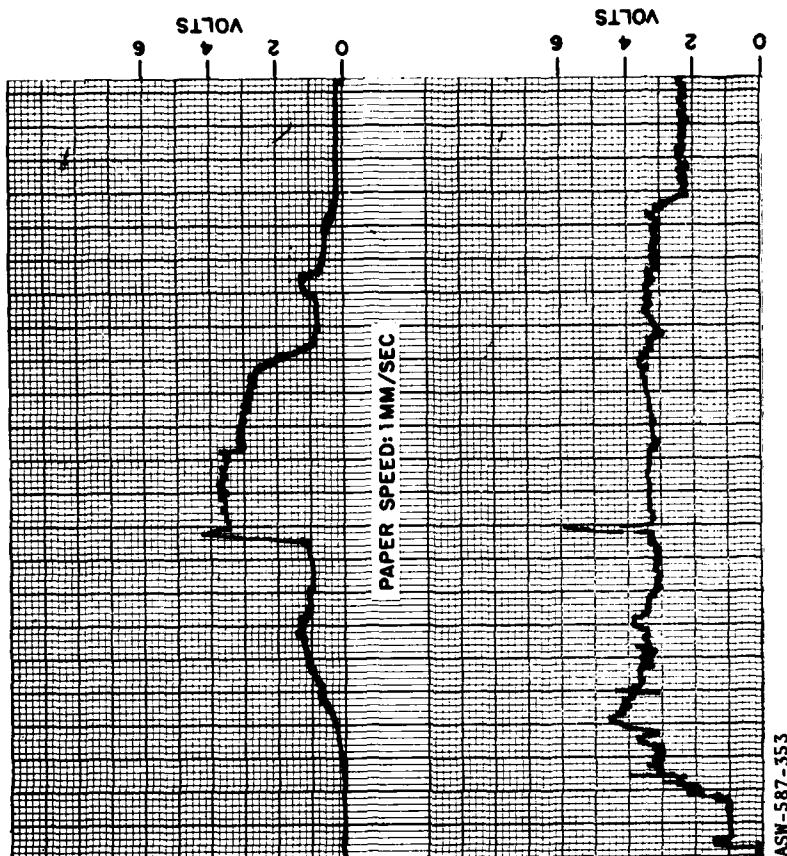


Figure B-189. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

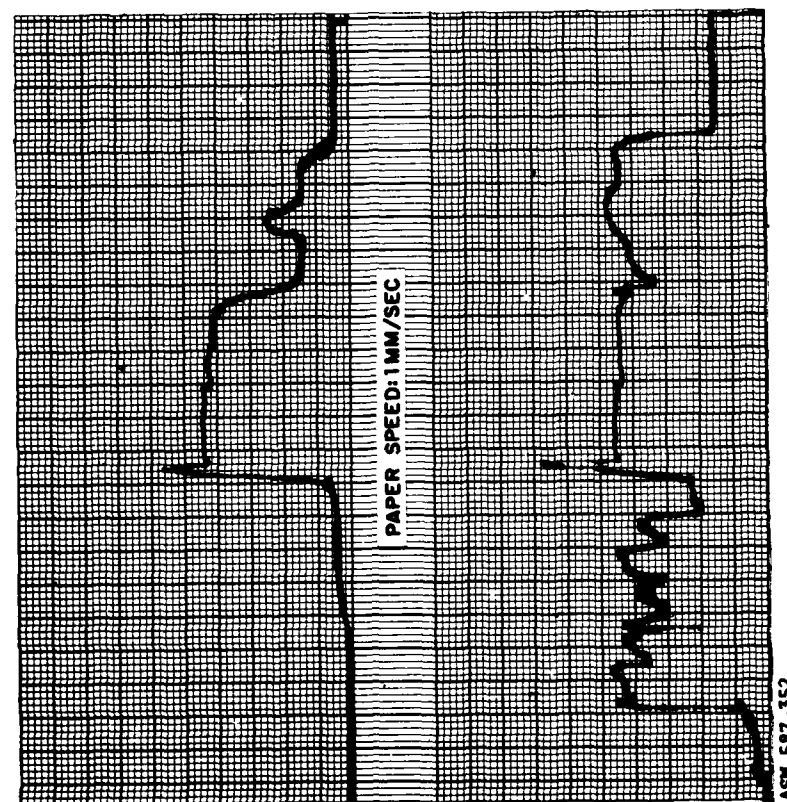
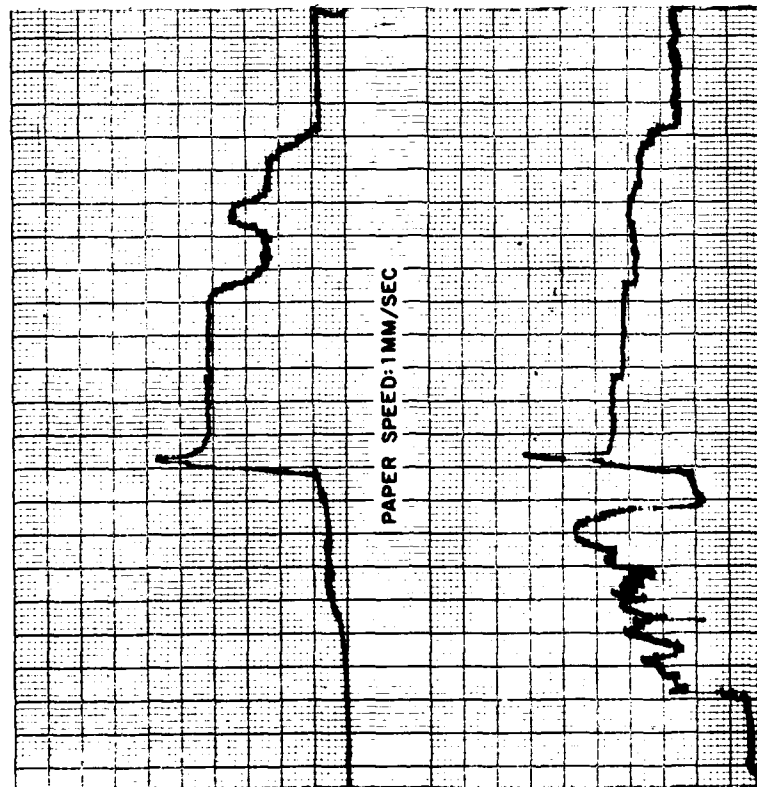
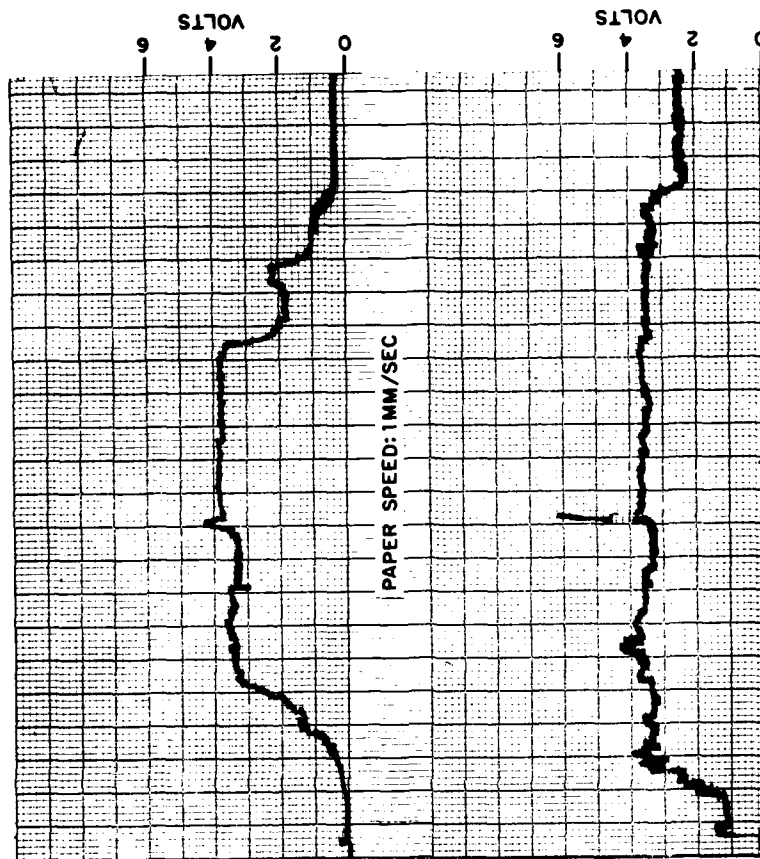


Figure B-190. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-354

Figure B-191. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-355

Figure B-192. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

B.8 J-57 ENGINE, MODIFIED BURNER CAN FAILURE

This test was similar to the previous three burn-through tests except that instrumentation microphone No. 2 was replaced by a microphone of the same type as microphones 1, 3, 4, and 5.

Analysis of the recordings made during this test run appear on pages B-137 through B-144.

B.8.1 Analysis

B.8.1.1 Sound Energy Levels

The meter readings prior to burn-through vary from the no hole test, but it is felt that variations are due to recalibration of equipment prior to this test. The meter readings after burn-through also vary from previous 1.5-inch open-hole tests, again probably due to recalibration.

B.8.1.2 Spectrum Analysis

All grams show the burn-through and are similar to previous burn-through test grams.

B.8.1.3 Mean Square Analysis

All recordings show the burn-through. Microphone 5, the farthest from the burn-through, was again not as clear as the other microphones.

B.8.2 Environmental Conditions

The test was performed at an ambient temperature of 75°F and 82% relative humidity.

B.8.3 Sound Energy Levels

The following tables list the sound energy level of the five microphones before and after burn-through.

Table B-16. Sound Energy Levels Before Burn-through

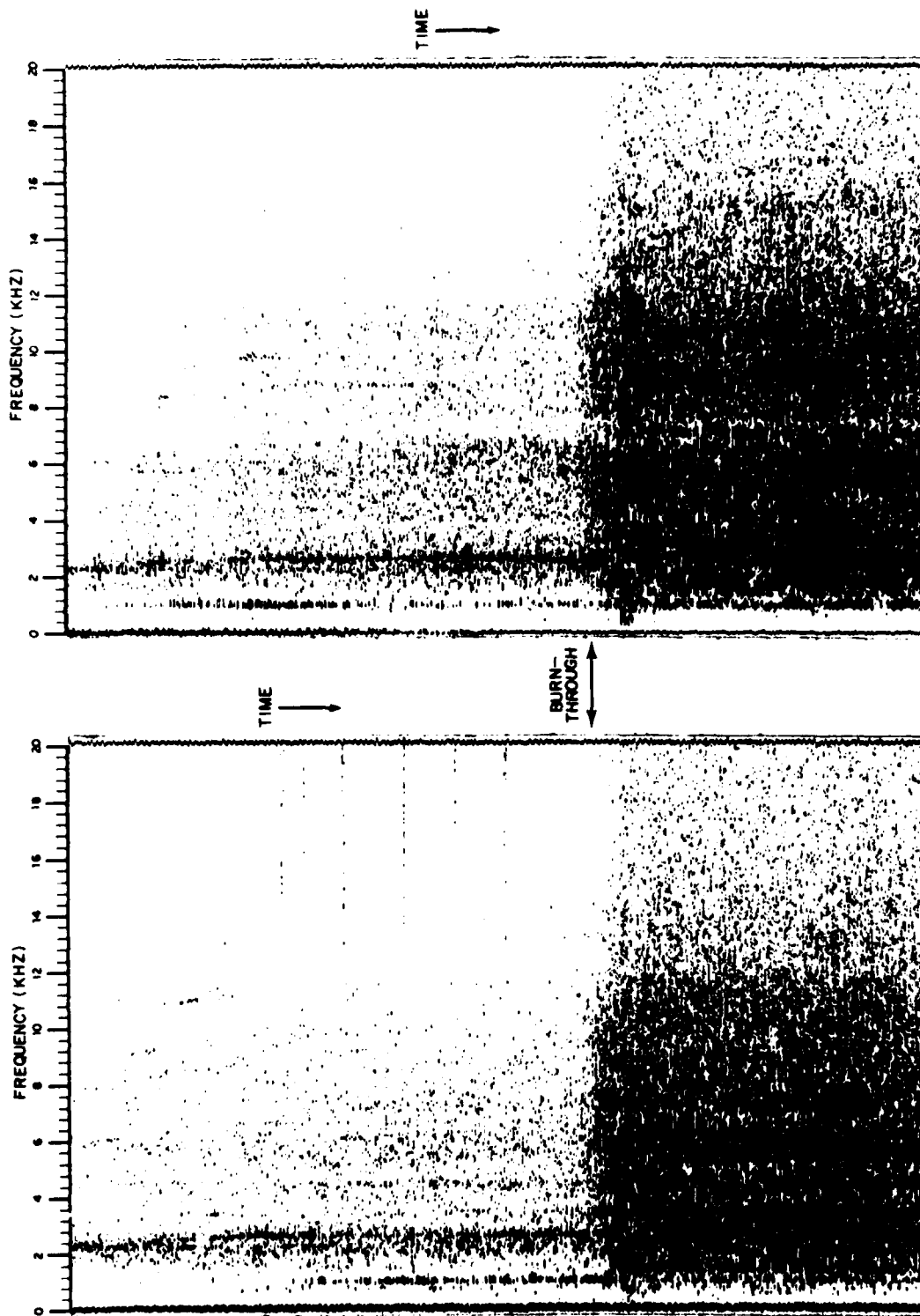
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	37	39	62	48	49
RMS (μBAR)	300	310	500	380	390
dB (a)	123	124	127	126	126

^aReference = 2×10^{-4} μBAR

Table B-17. Sound Energy Levels After Burn-through

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	170	230	105	235	72
RMS (μBAR)	1370	1820	85	1900	580
dB (a)	137	139	132	139	129

^aReference = 2×10^{-4} μBAR

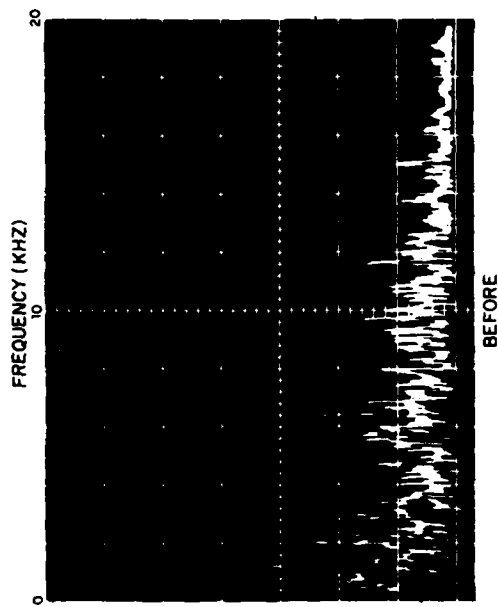


ASN-587-356

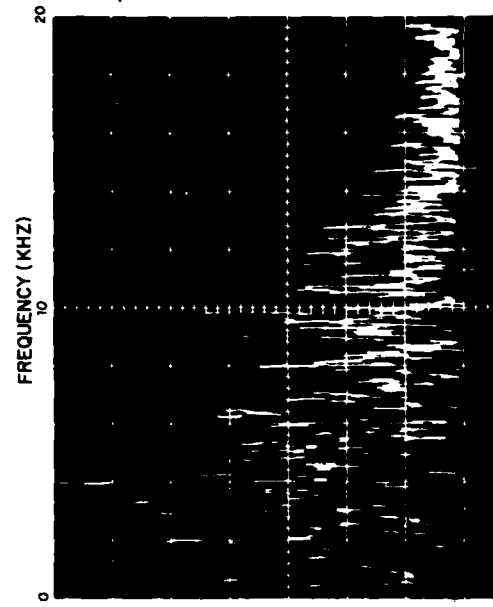
Figure B-193. Microphone No. 1 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

ASN-587-357

Figure B-194. Microphone No. 2 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



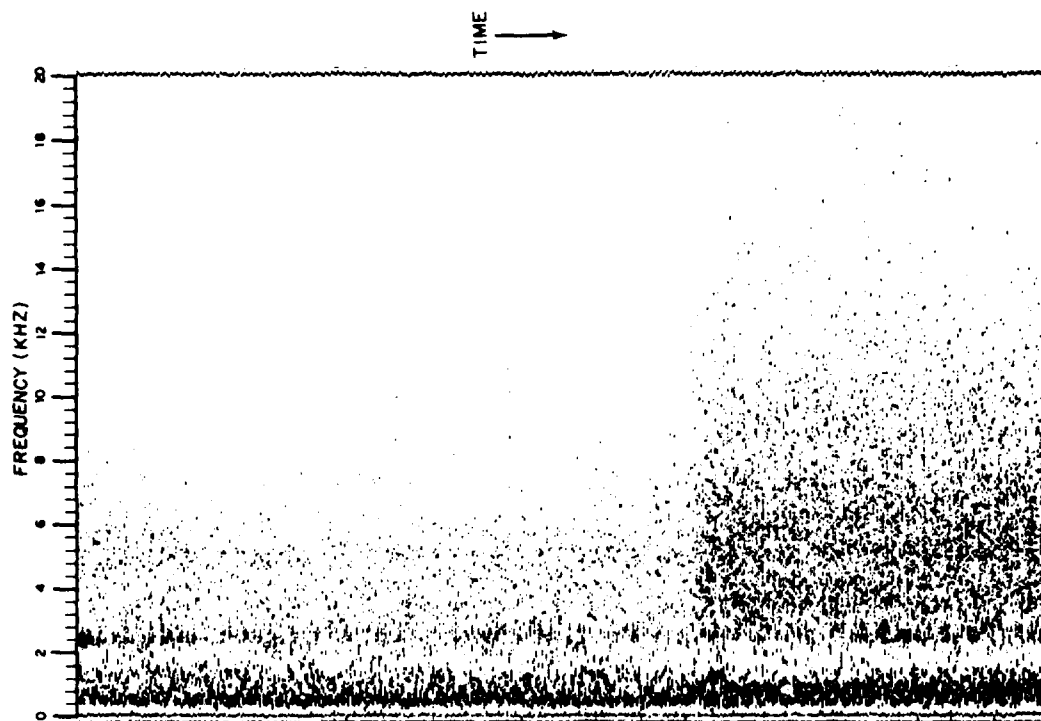
BEFORE



AFTER

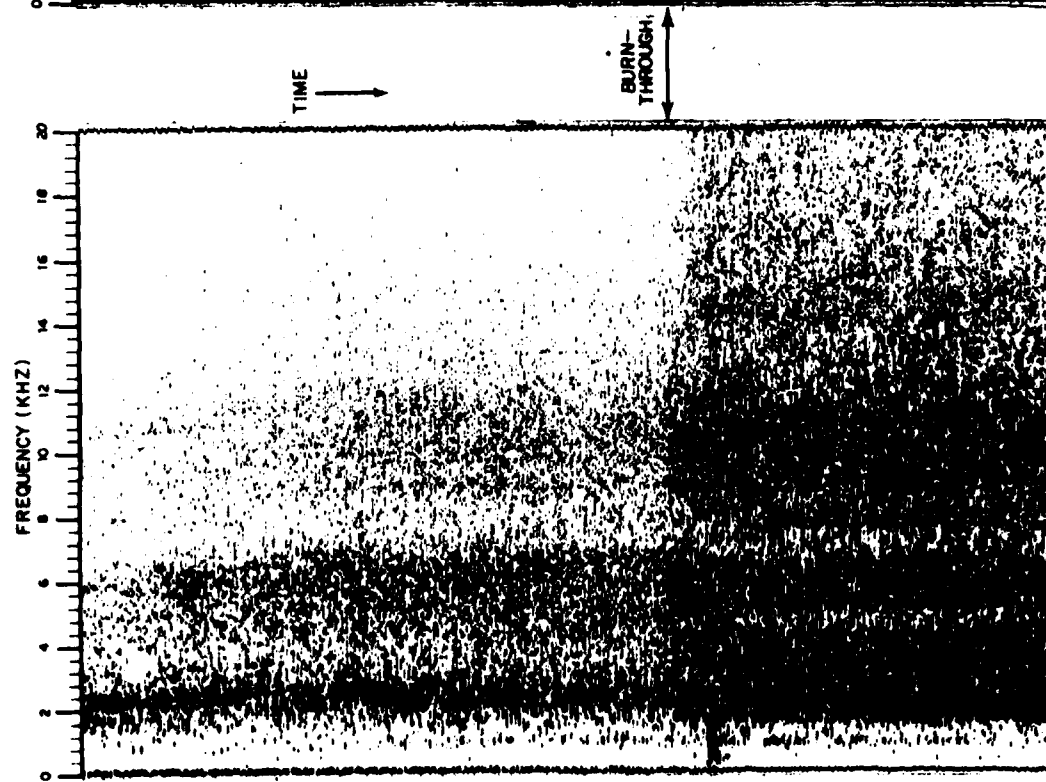
ASW-587-358

Figure B-195. Microphone No. 2 Spectrum Analysis Before and After Burn-through. Analysis Bandwidth is 0 to 20 kHz.



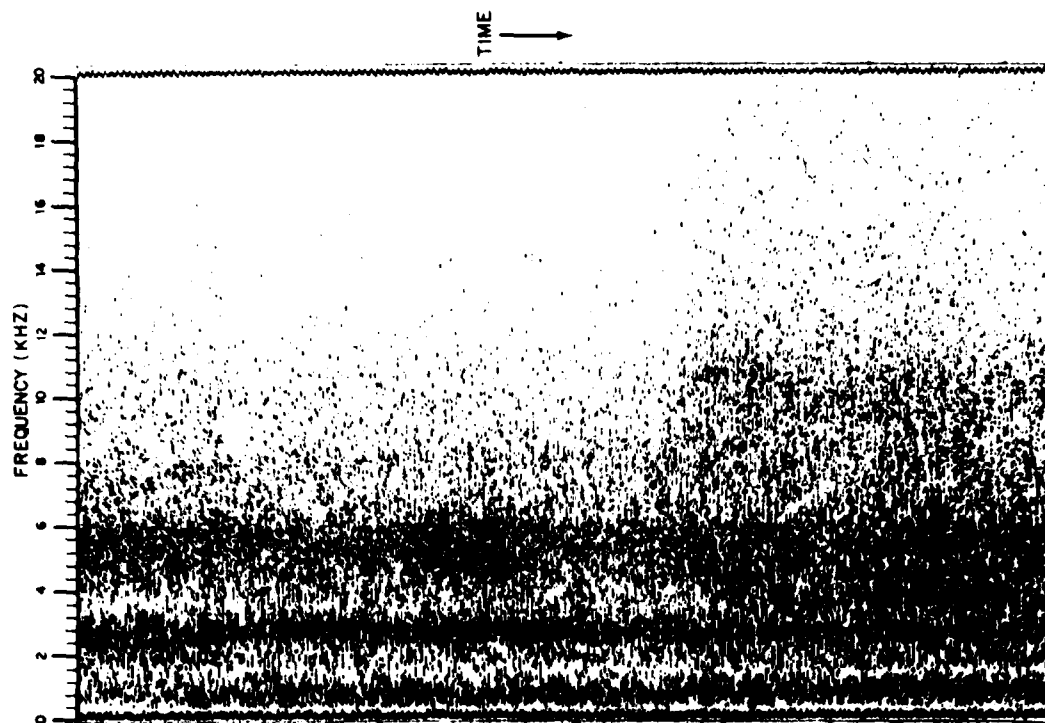
ASW-587-359

Figure B-196. Microphone No. 3 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-360

Figure B-197. Microphone No. 4 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.



ASW-587-361

Figure B-198. Microphone No. 5 Spectrum Analysis. Analysis Bandwidth is 0 to 20 kHz.

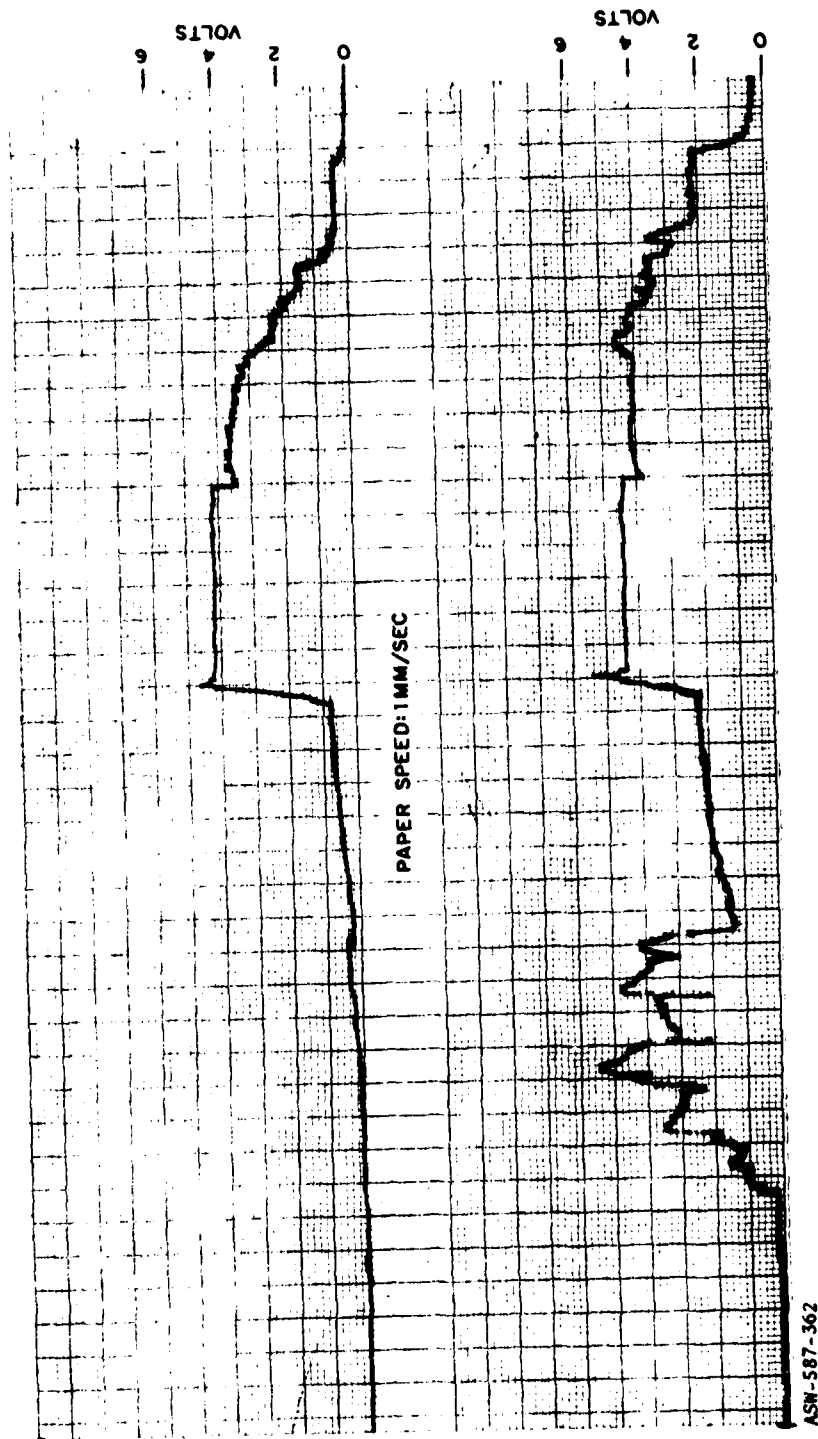


Figure B-199. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

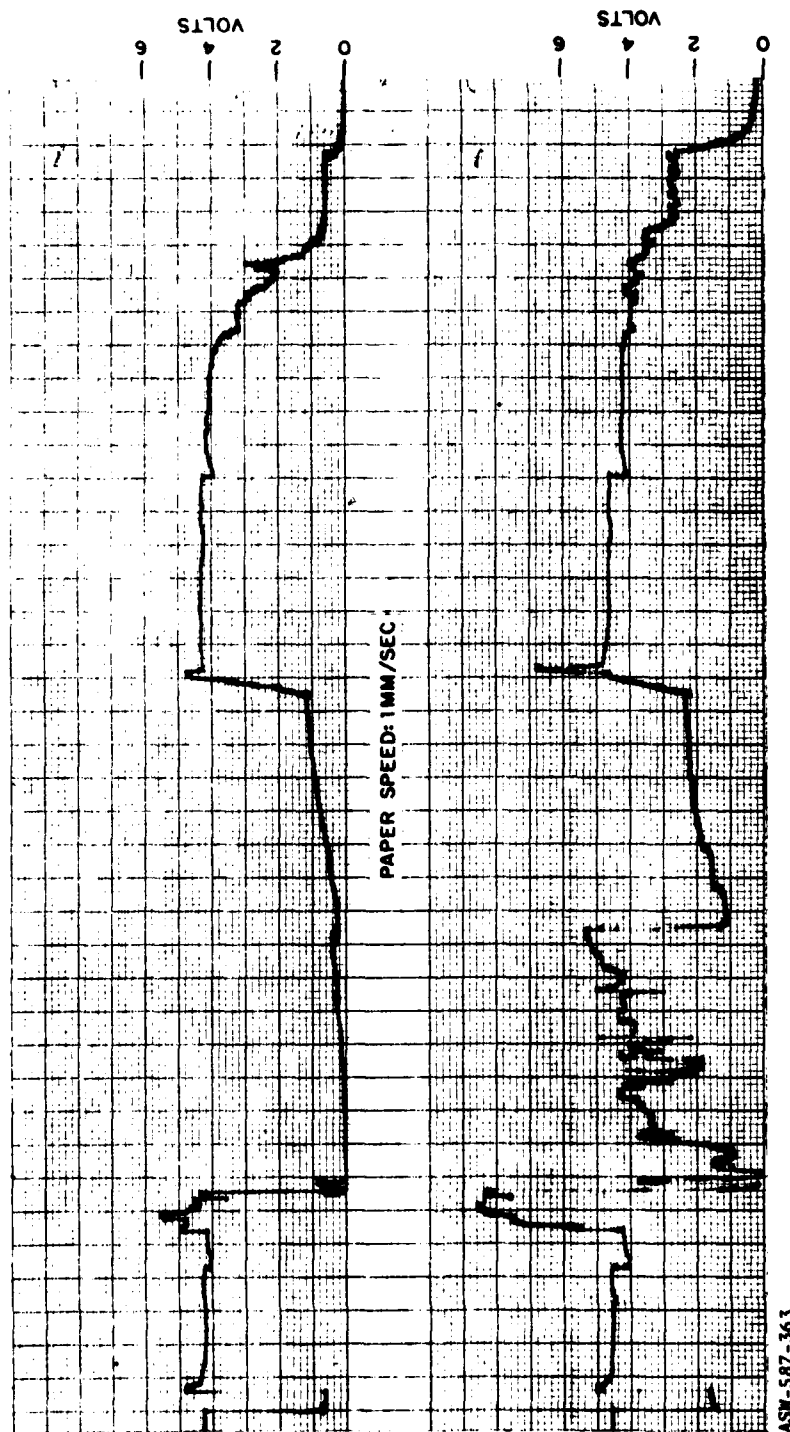
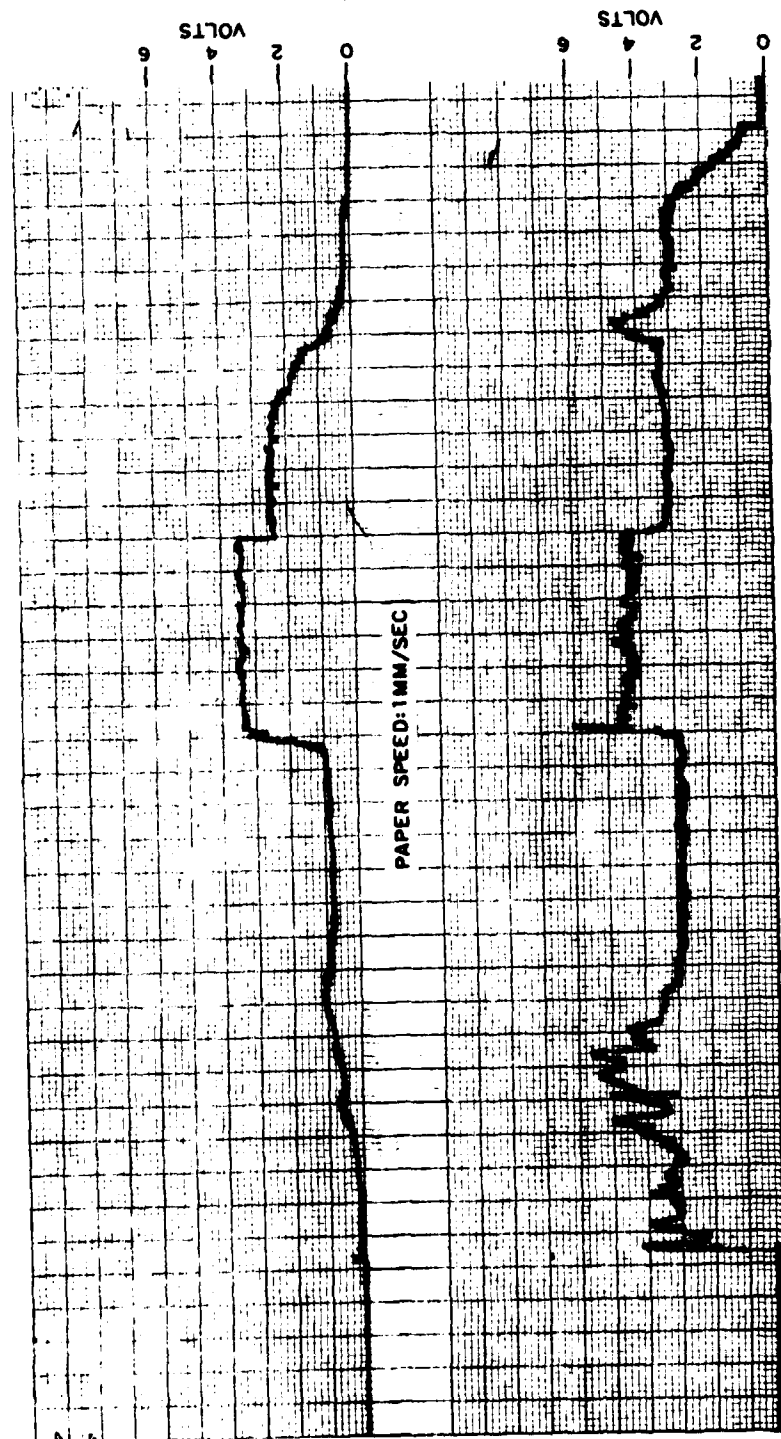
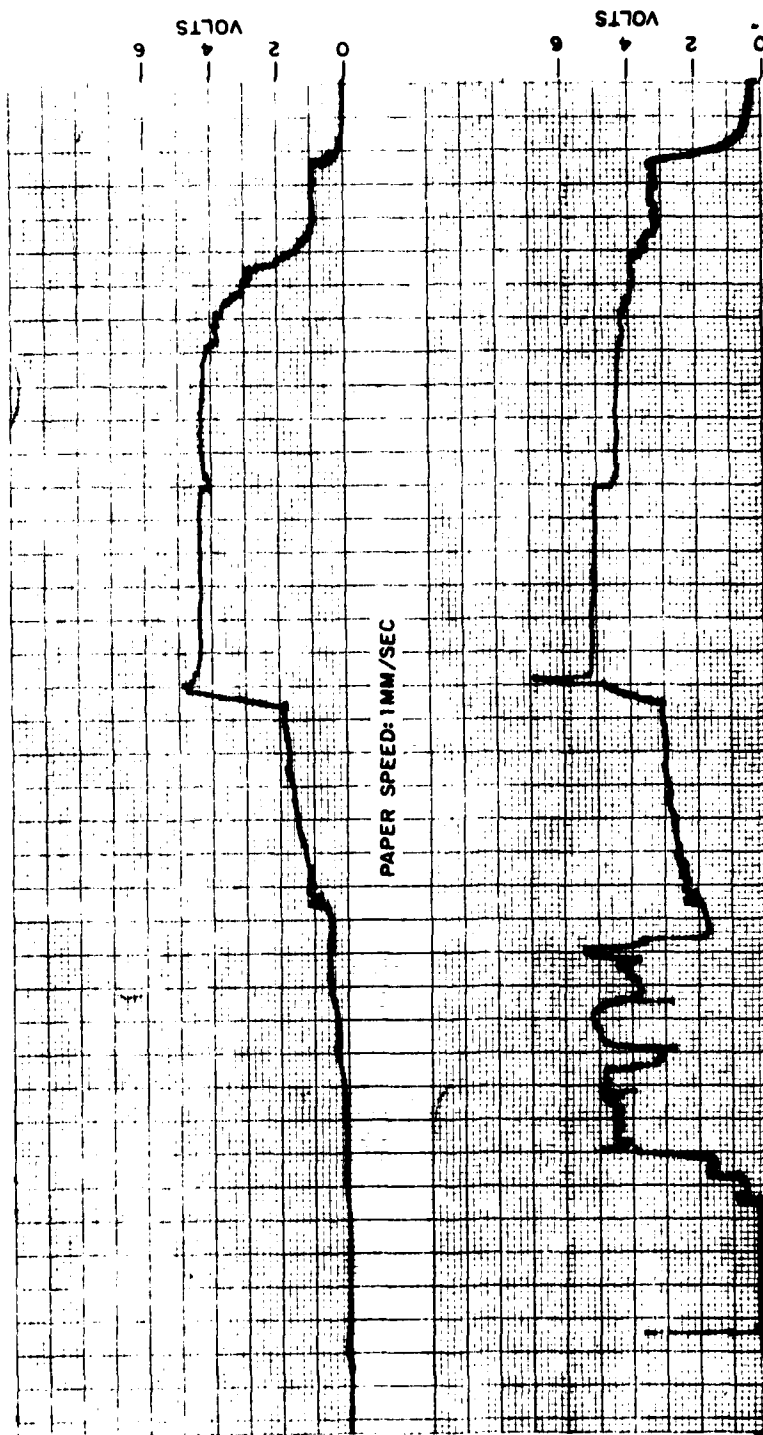


Figure B-200. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



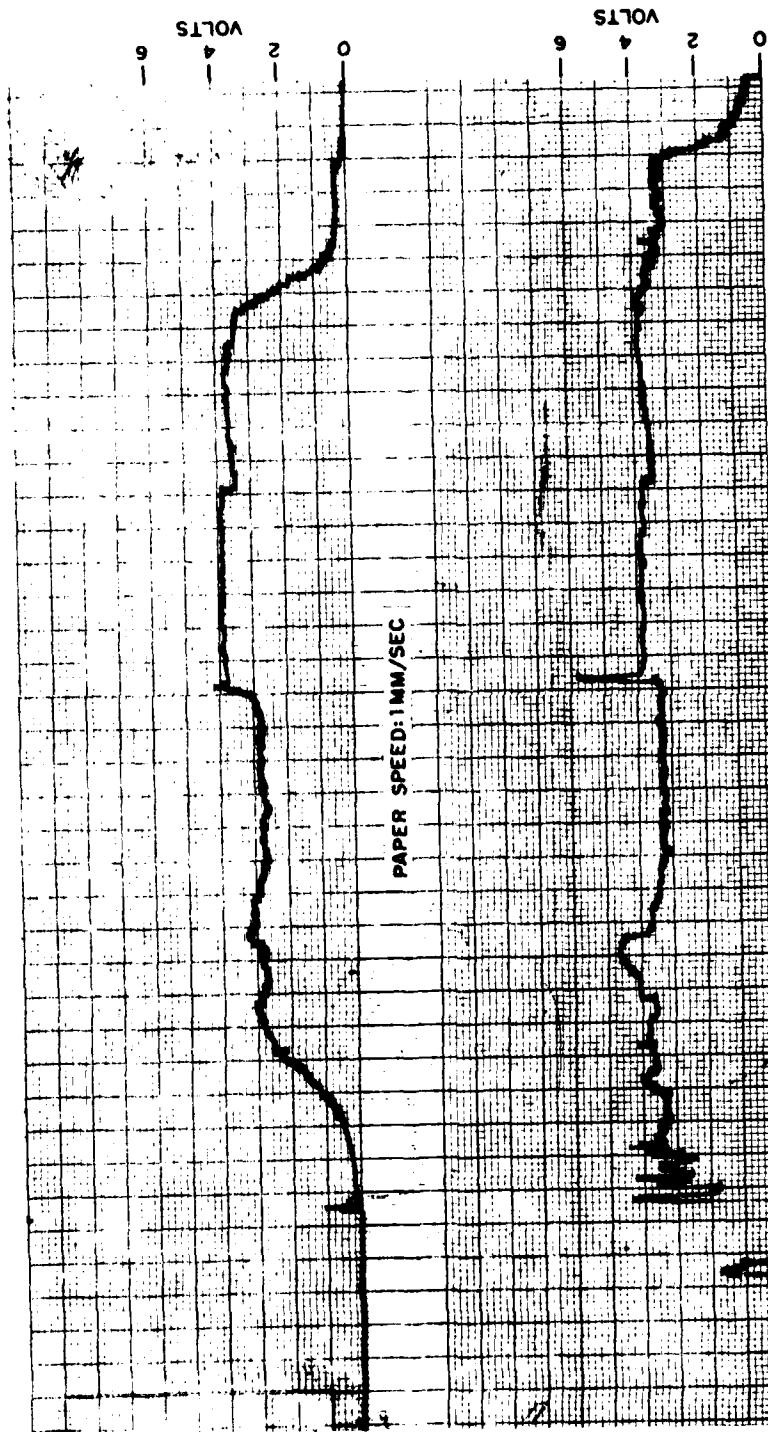
ASN-587-364

Figure B-201. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-365

Figure B-202. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-366

Figure B-203. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

APPENDIX C
COMBINED J-47 and J-57 ENGINE TESTS

C.1 J-47 ENGINE AT MAXIMUM RPM, J-57 PORT ENGINE QUIET

A series of tests were developed to determine the interference from other engines in close proximity to the engine under test. Five microphones were placed on the J-57 port engine in the same locations as for appendix B tests. The J-47 engine was run up to maximum RPM and the output of the microphones recorded.

Analysis of the recordings made during this test run appear on pages C-3 through C-10.

C.1.1 Analysis

C.1.1.1 Sound Energy Levels

The sound energy levels were very low for this test. Microphones 3 and 5 showed the highest reading, probably due to their proximity to a partially open hatch and an engine starter opening. Microphones 1, 2, and 4 were mounted in an area which was tightly cowled.

C.1.1.2 Spectrum Analysis

Grams produced from microphone 3 and 5 data showed small amounts of low frequency random noise while grams produced from microphones 1, 2, and 4 data showed very little or none. This data correlates with the sound energy levels.

C.1.1.3 Mean Square Analysis

Recordings produced from microphone 3 and 5 data contain low frequency spectrum all of which is below 5 kHz. The other microphone recordings show only small amounts of energy.

C.1.2 Environmental Conditions

The test was performed at an ambient temperature of 75° F and 68% relative humidity.

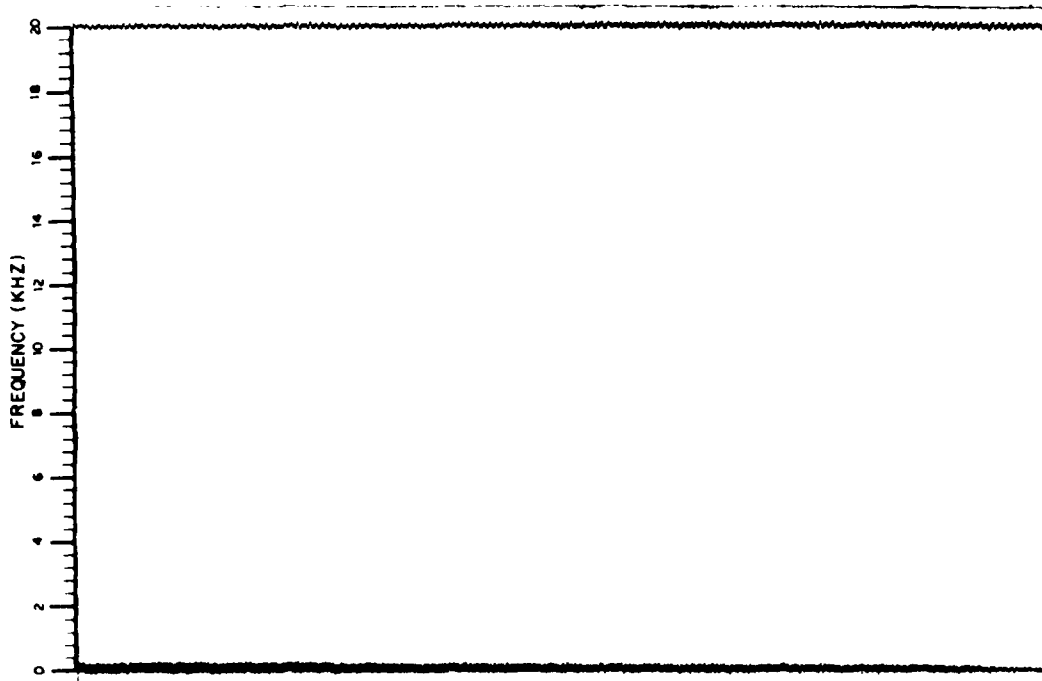
C.1.3 Sound Energy Levels

The following table lists the sound energy levels of the five microphones for this test.

Table C-1. Microphone Sound Energy Levels

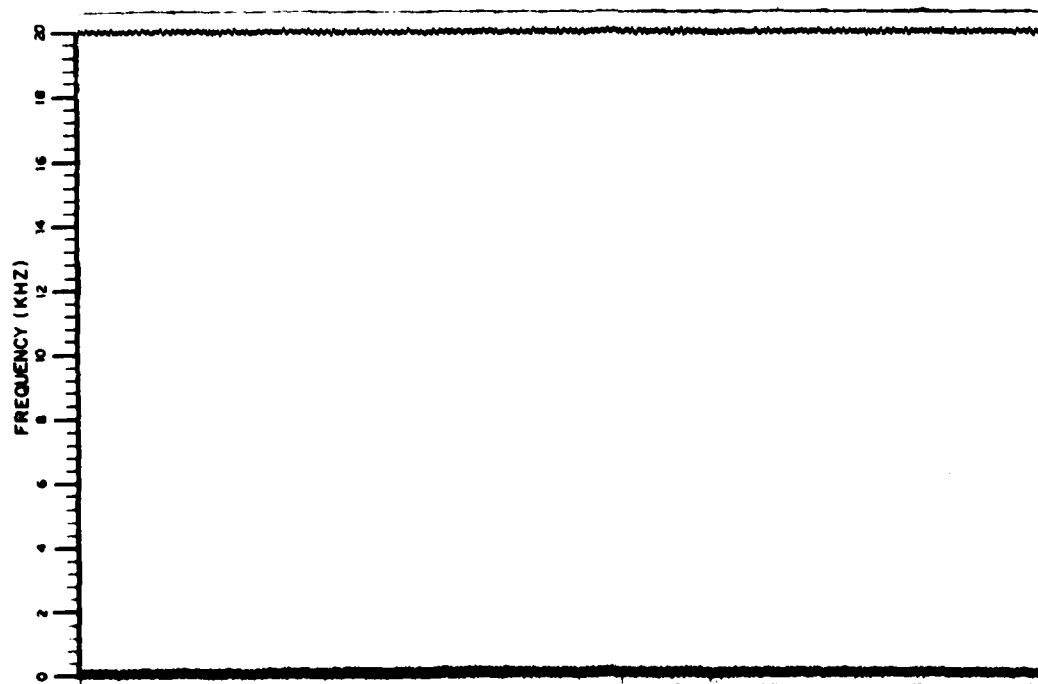
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	10	9	24	12	16
RMS (μBAR)	80	72	190	96	128
dB (a)	112	111	120	114	116

^aReference = 2×10^{-4} μBAR



ASW-587-368

Figure C-2. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



ASW-587-367

Figure C-1. Microphone No. 1 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

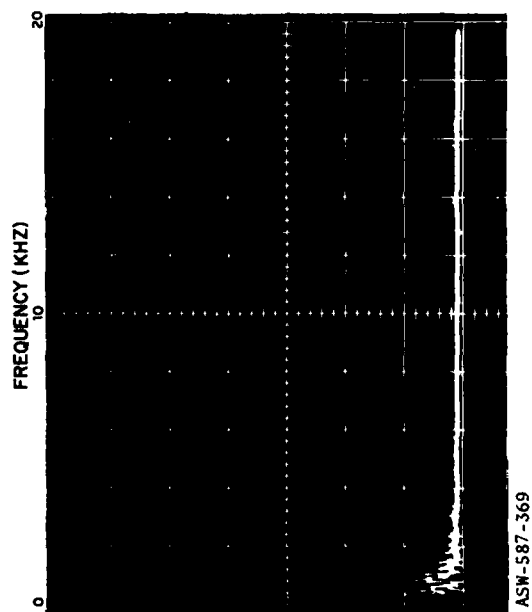


Figure C-3. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

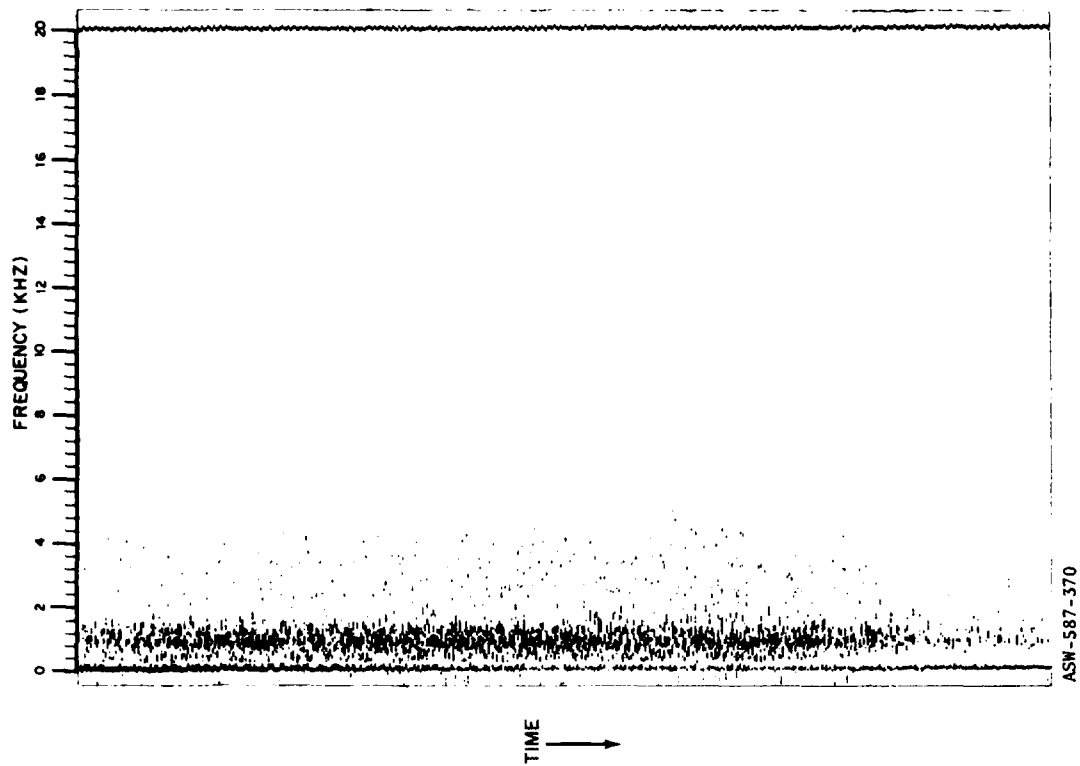
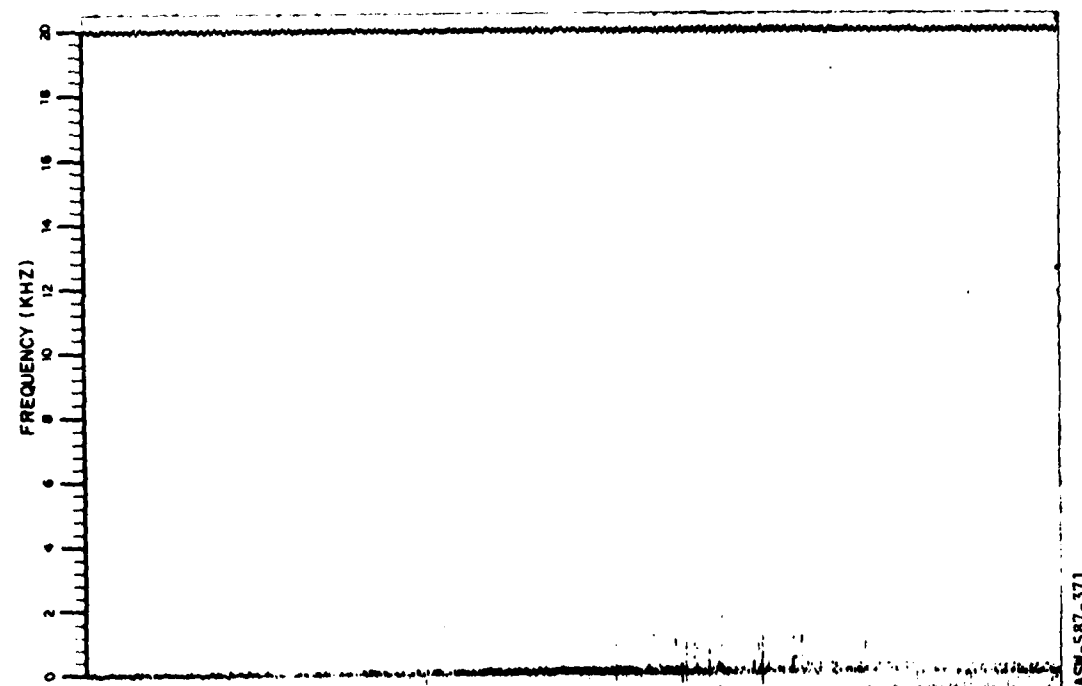
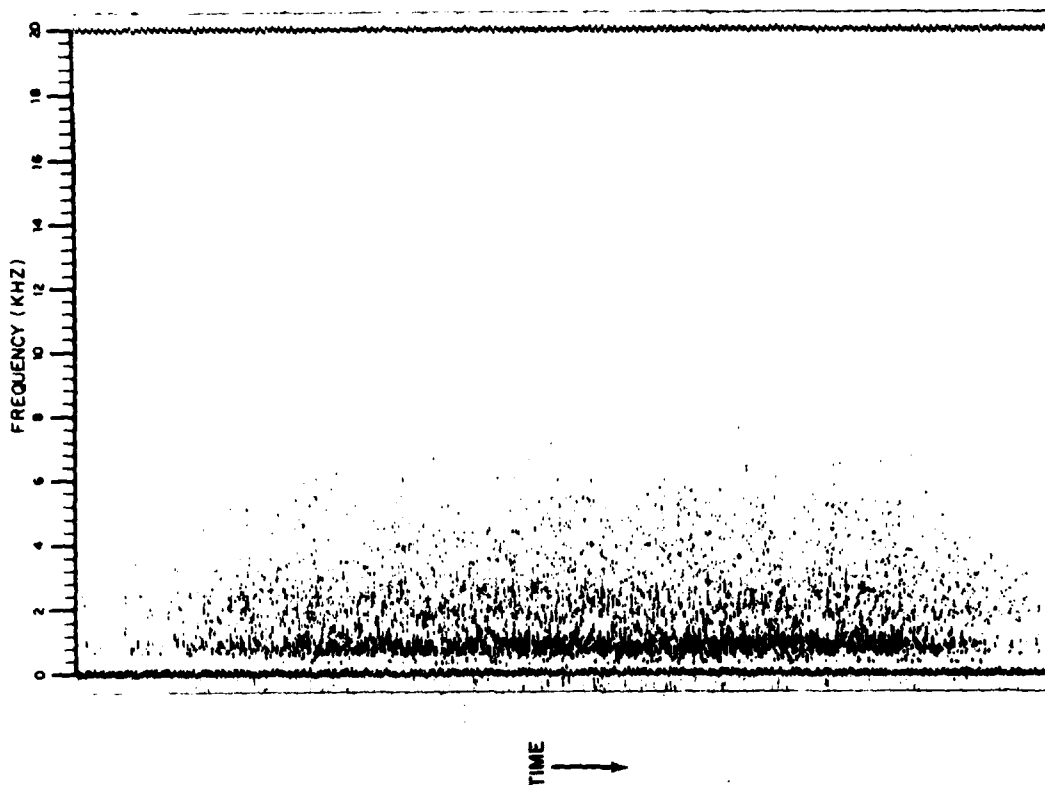


Figure C-4. Microphone No. 3 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



ASW-587-371

Figure C-5. Microphone No. 4 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



ASW-587-372

Figure C-6. Microphone No. 5 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

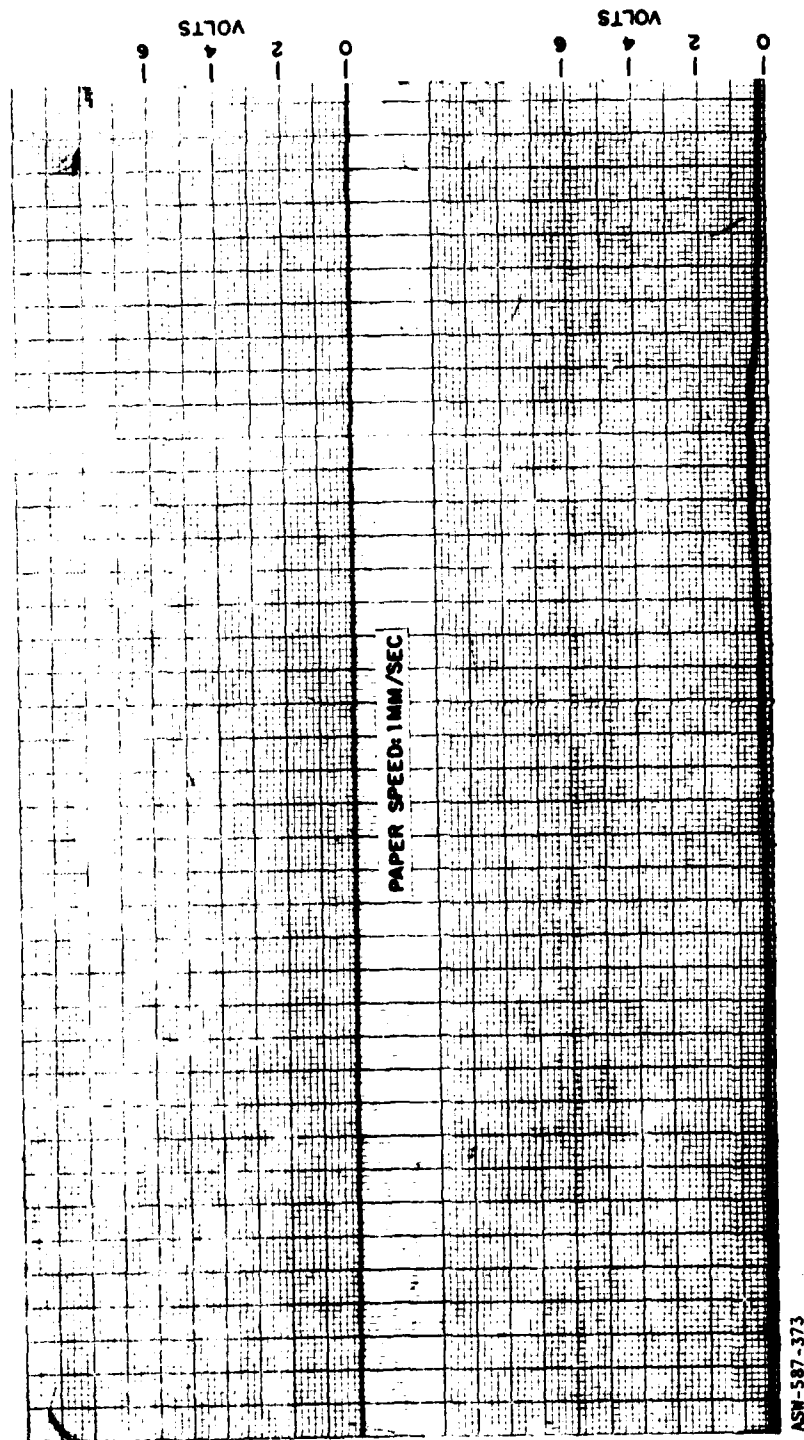
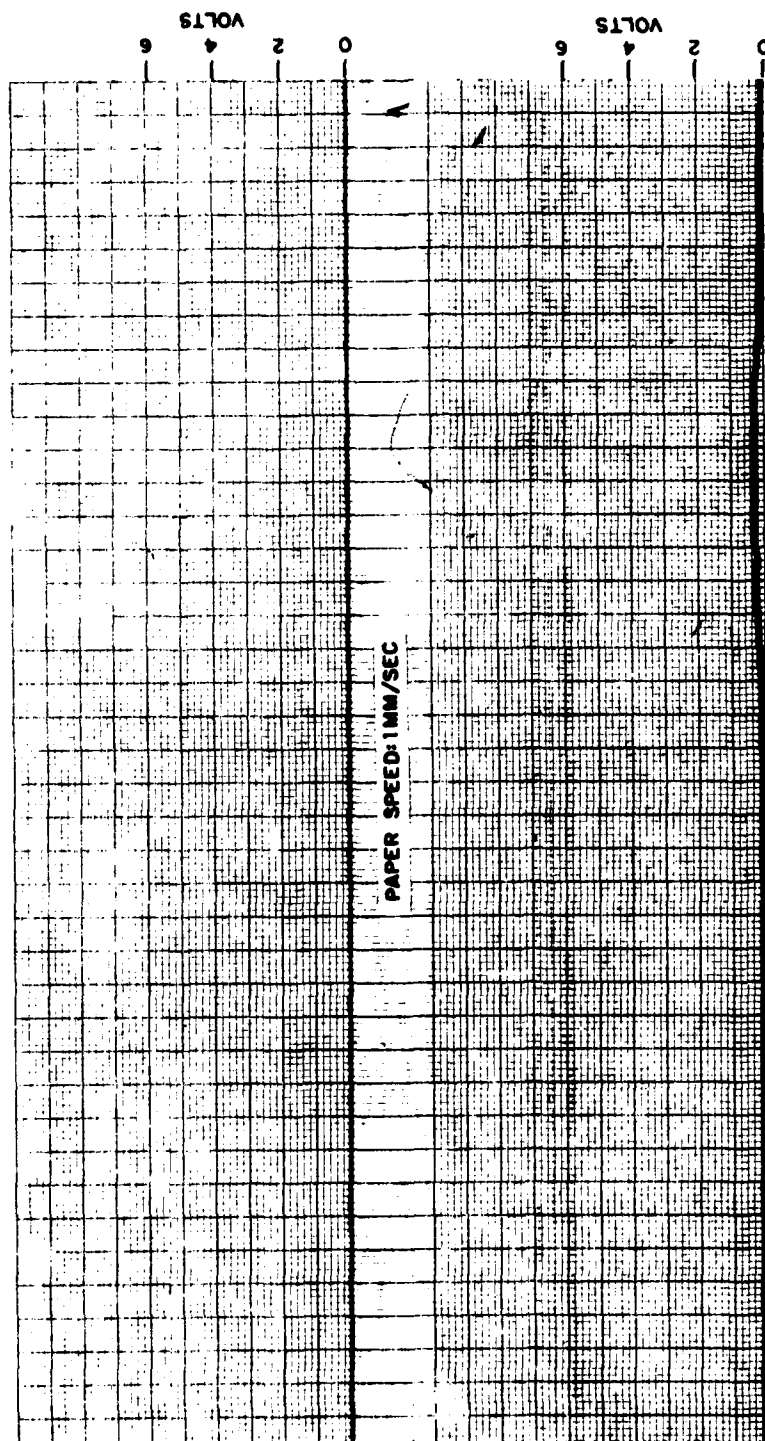
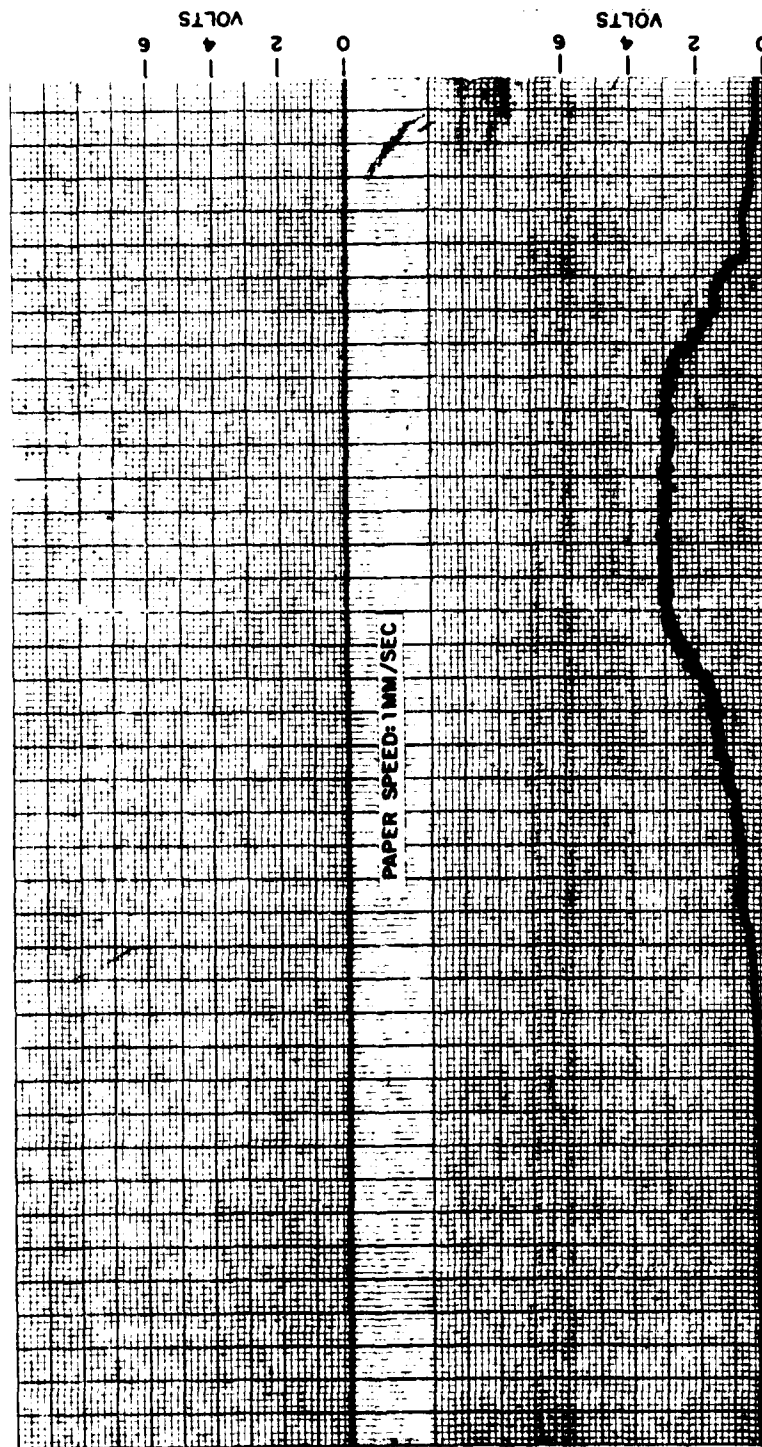


Figure C-7. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



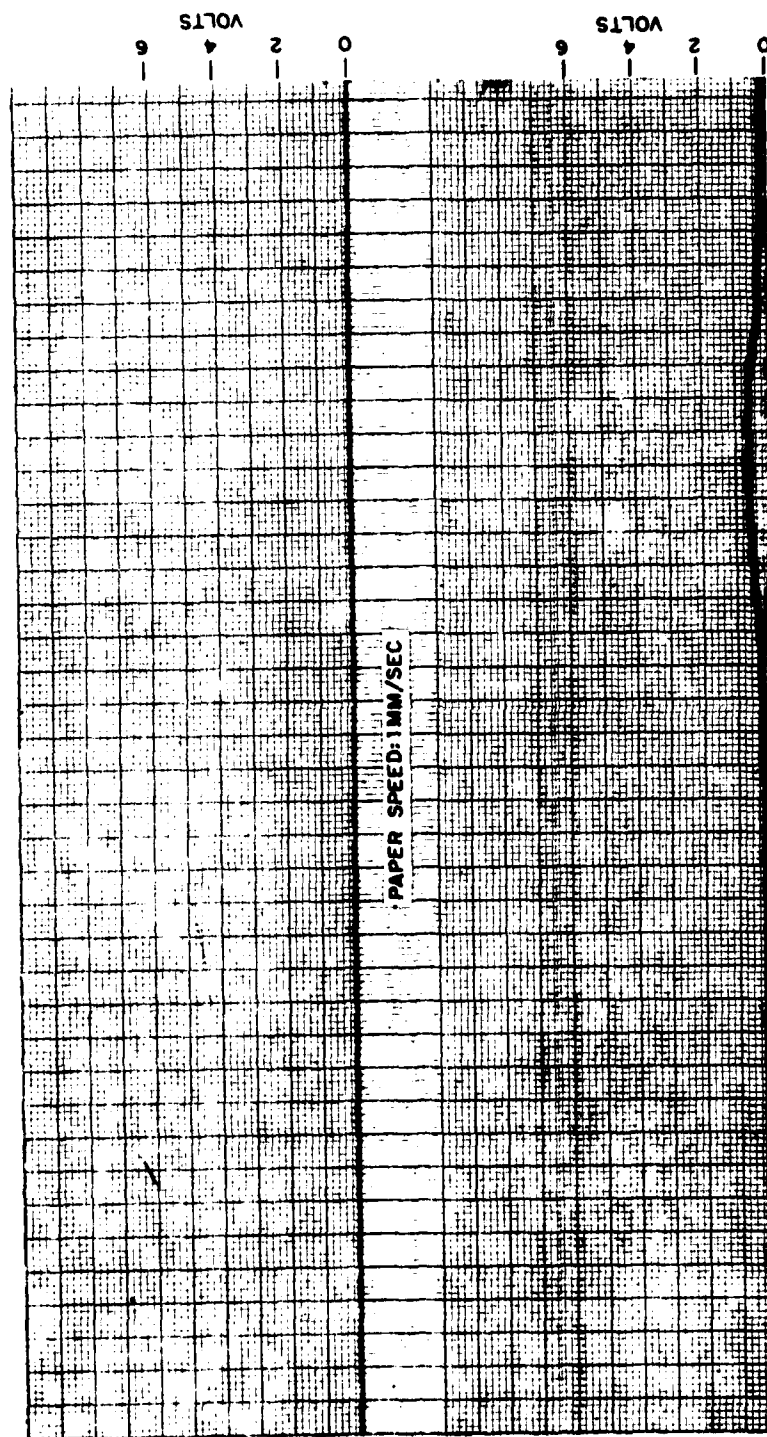
ASM-587-374

Figure C-8. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



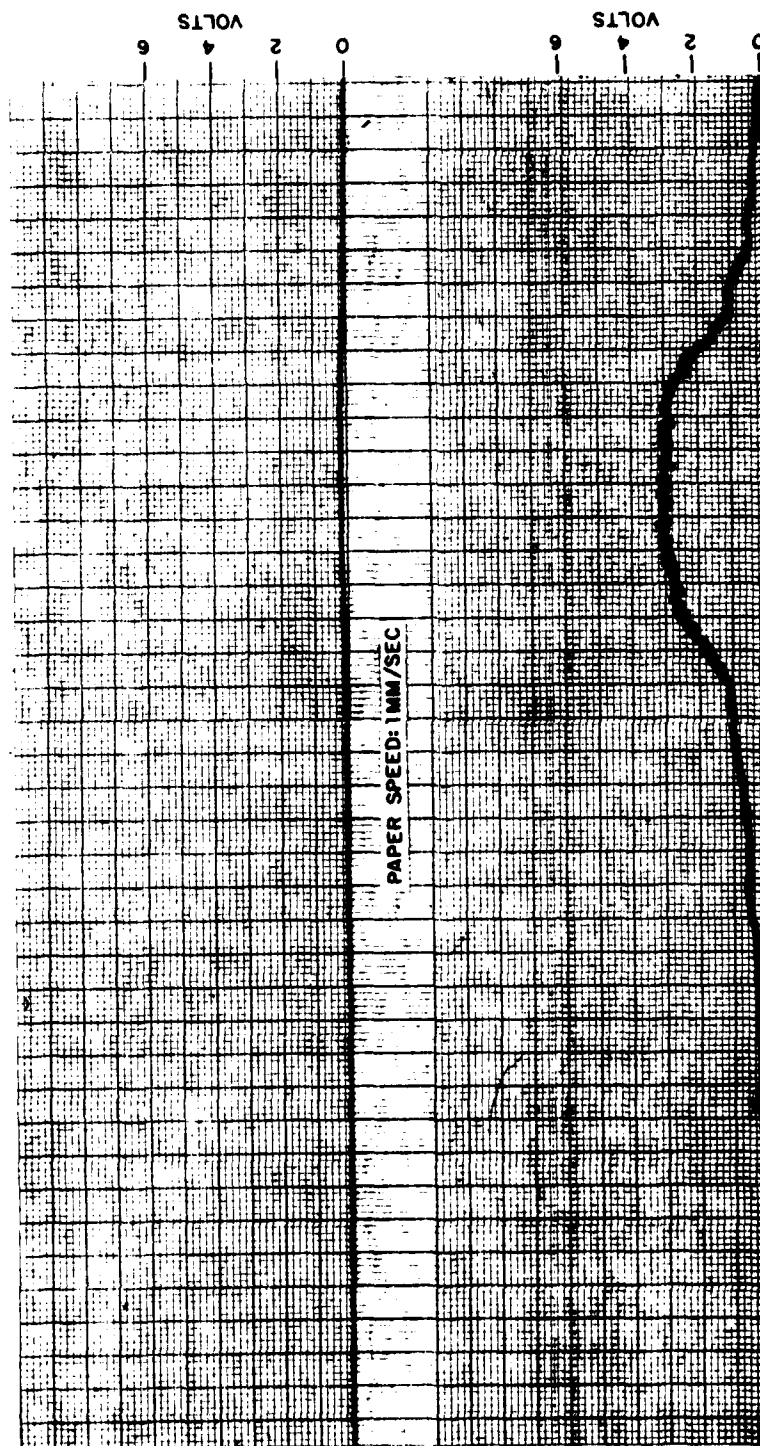
ASN-587-375

Figure C-9. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-376

Figure C-10. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-567-377

Figure C-11. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

C.2 J-57 STARBOARD ENGINE AT MAXIMUM RPM, J-57 PORT ENGINE QUIET

A second test to determine the effect of external sound sources was run with the J-57 starboard engine running at maximum speed and the J-57 port engine quiet. The same test arrangement was utilized for this test as for the previous test.

Analysis of the recordings made during this test run appear on pages C-12 through C-16.

C.2.1 Analysis

C.2.1.1 Sound Energy Levels

The meter readings for this test were the lowest of all tests. Microphones 3 and 5, which had the highest levels in previous tests, had the highest levels in this test.

C.2.1.2 Spectrum Analysis

Microphone 3 and 5 data analysis grams show low frequency lines and some random noise. Microphone 3 has a discrete line at 1500 Hz and microphone 5 a line at 2000 Hz. All other grams are blank.

C.2.1.3 Mean Square Analysis

Microphone 3 and 5 recordings show small changes in amplitude. All of the spectrum was below 5 kHz.

C.2.2 Environmental Conditions

The test was performed at an ambient temperature of 75° F and 68% relative humidity.

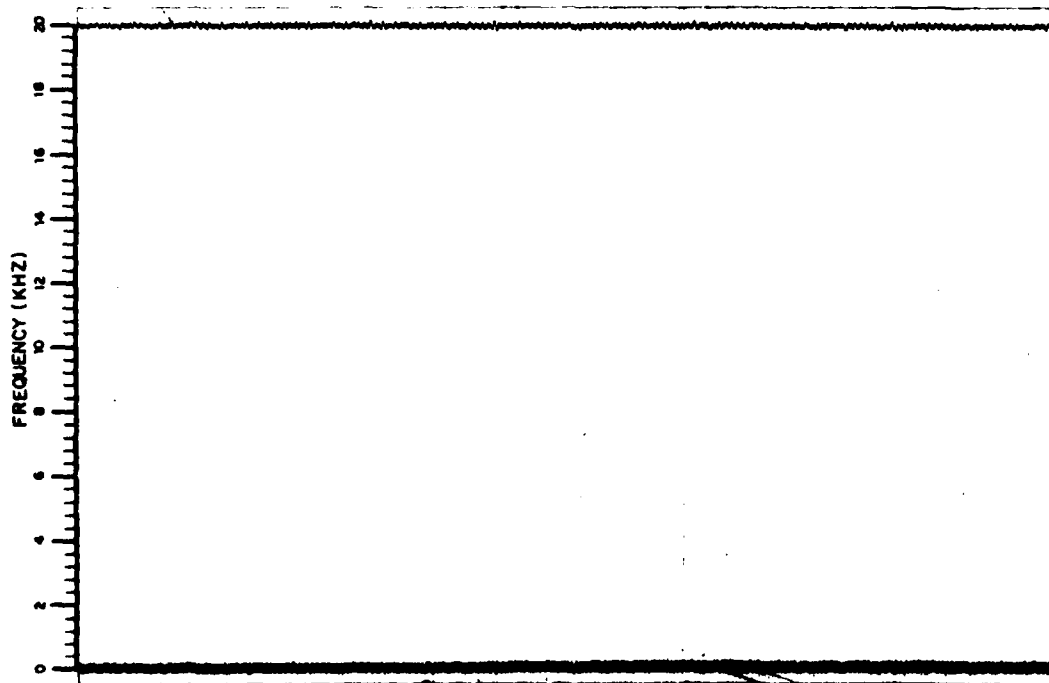
C.2.3 Sound Energy Levels

The following table lists the sound energy levels of the five microphones for this test.

Table C-2. Microphone Sound Energy Levels

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	3	2	6	3	4
RMS (μBAR)	24	16	48	24	32
dB (a)	102	98	108	102	104

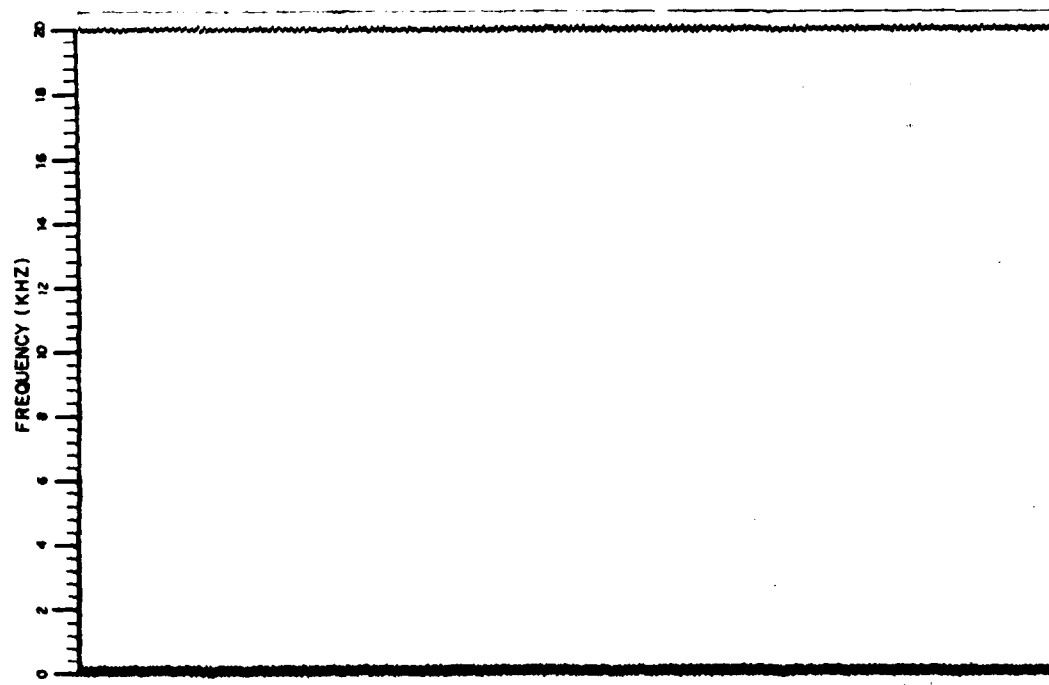
*Reference = 2×10^{-4} μBAR



ASH-587-378

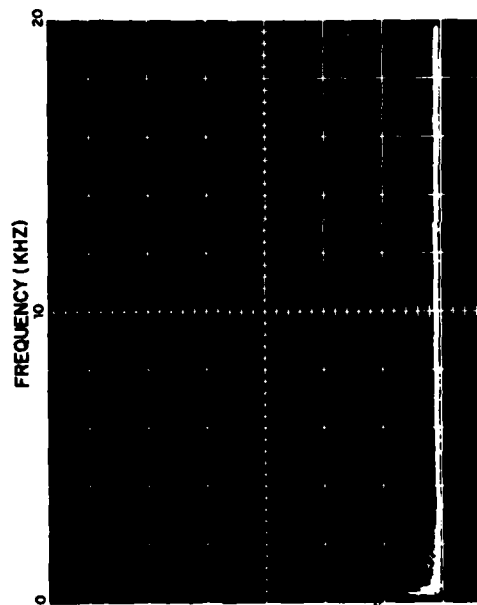
Figure C-12. Microphone No. 1 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

TIME →



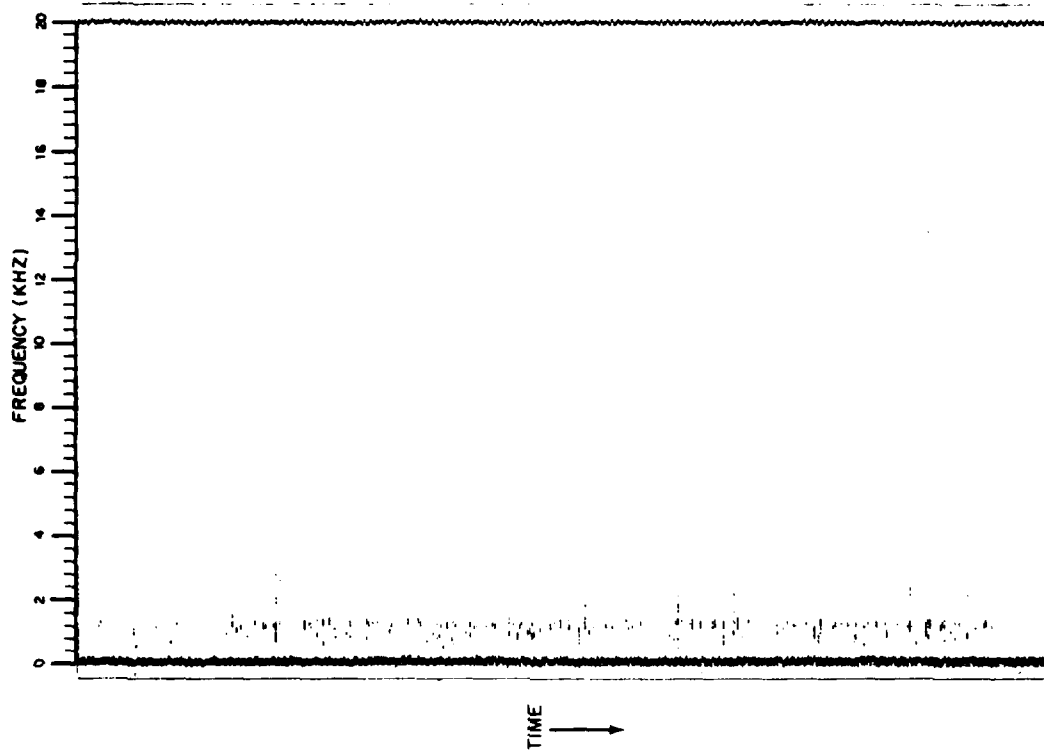
ASH-587-379

Figure C-13. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



ASW-587-380

Figure C-14. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



ASW-587-381

Figure C-15. Microphone No. 3 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

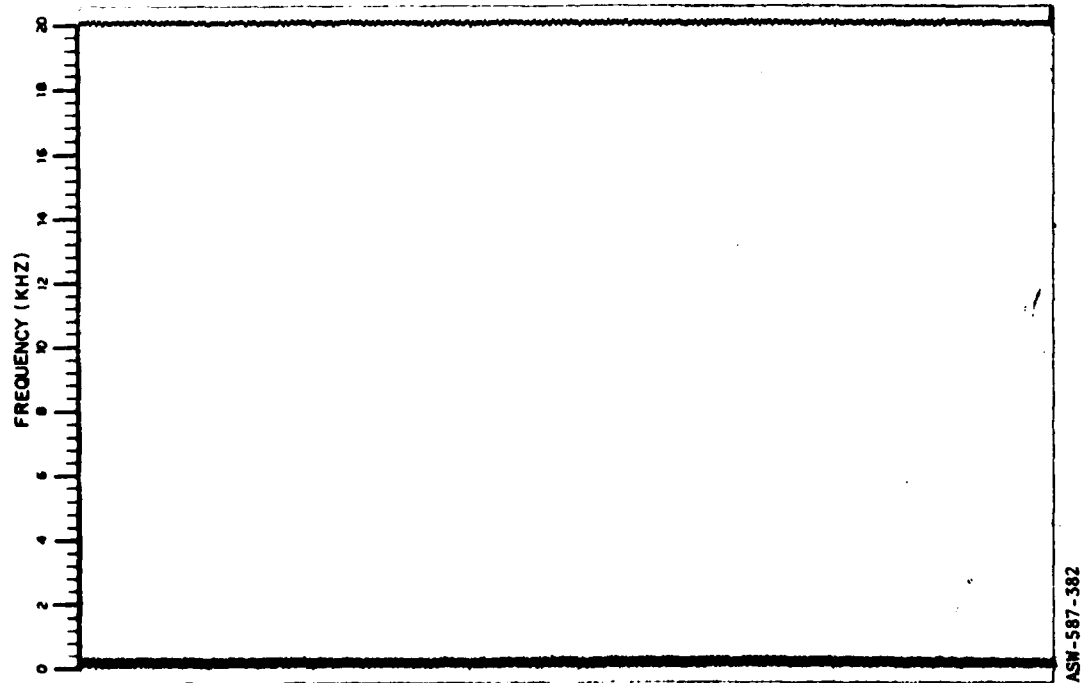


Figure C-16. Microphone No. 4 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

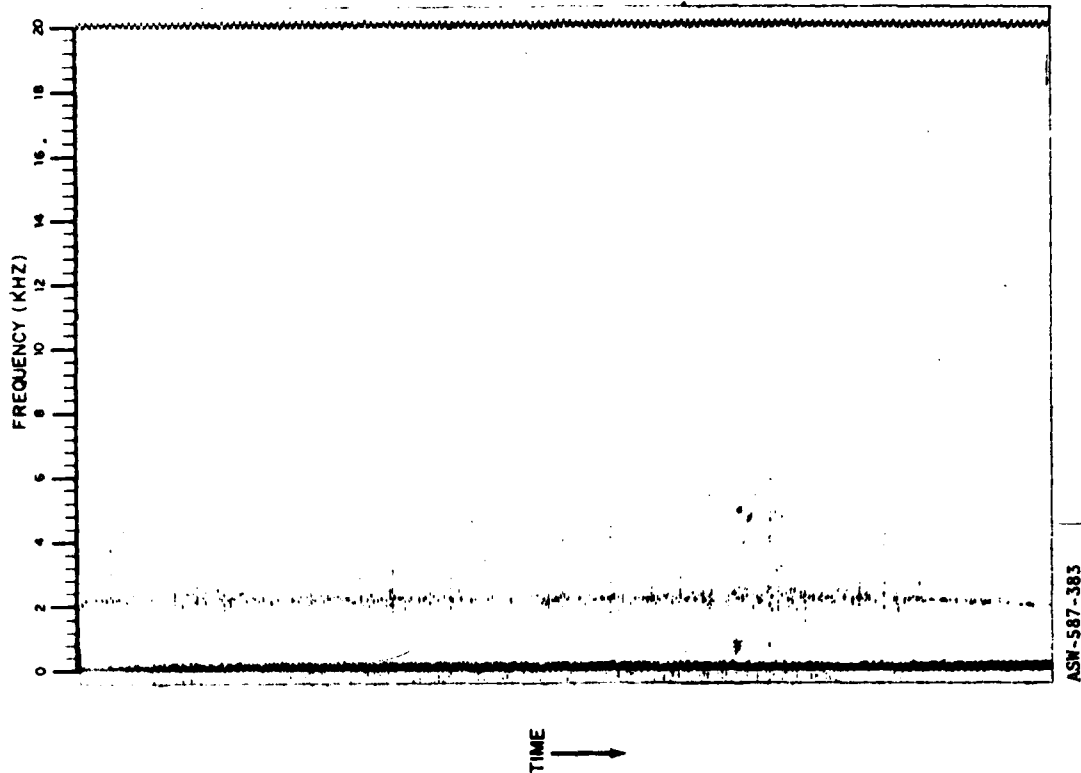
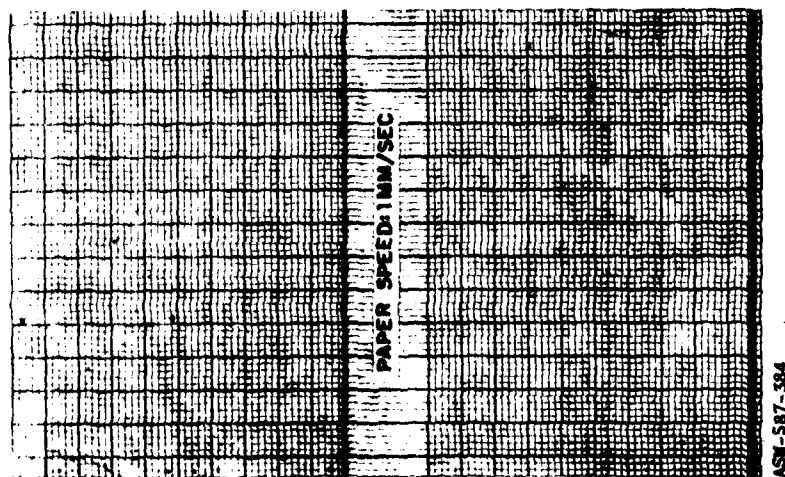
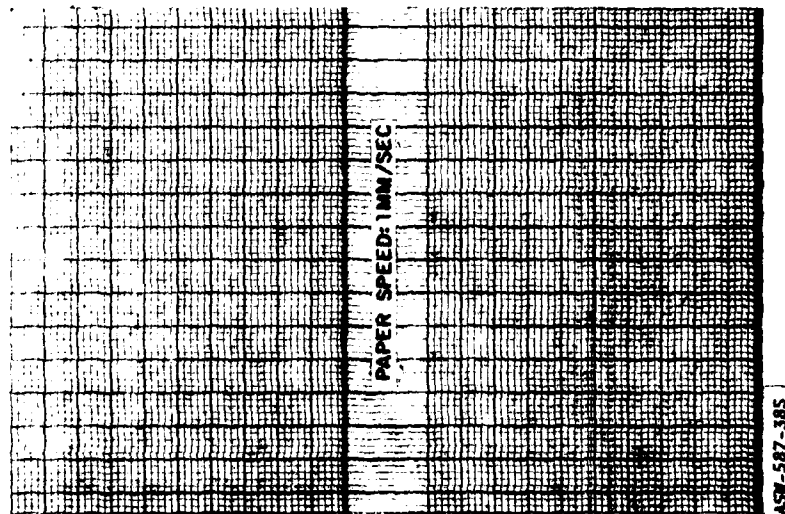


Figure C-17. Microphone No. 5 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



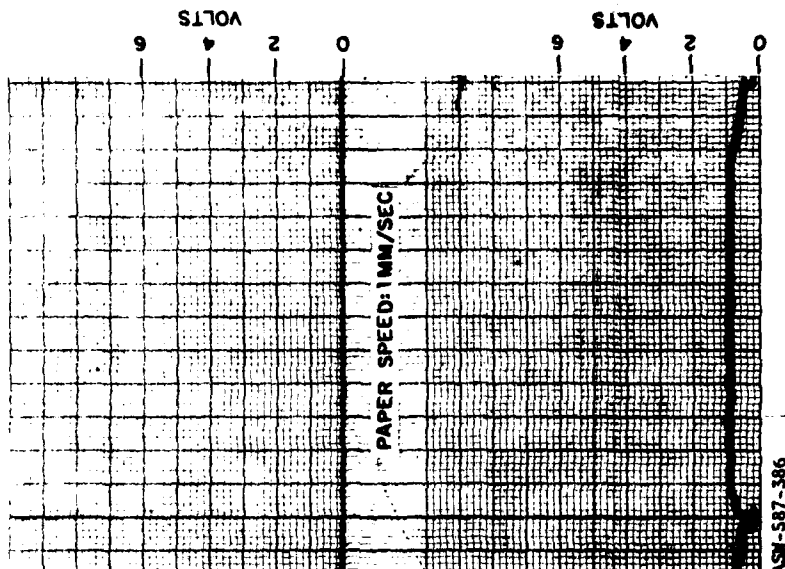
ASW-587-384

Figure C-18. Microphone No. 1
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



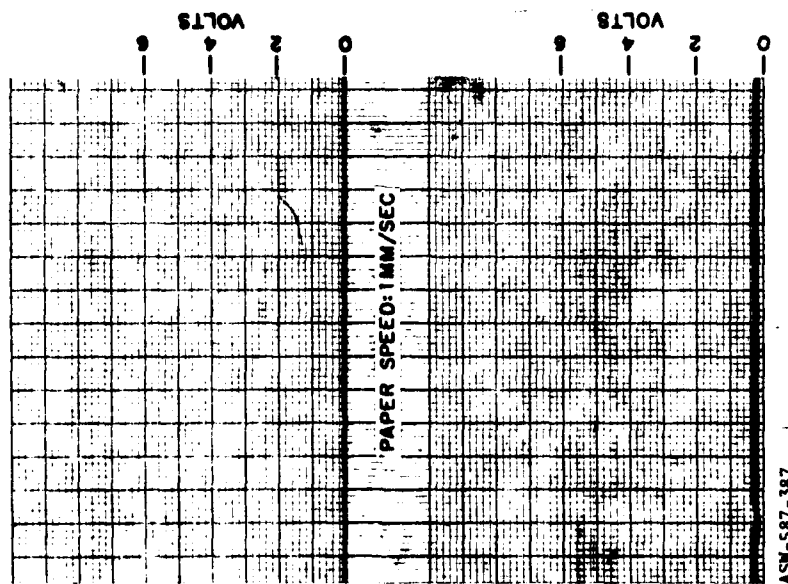
ASW-587-385

Figure C-19. Microphone No. 2
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



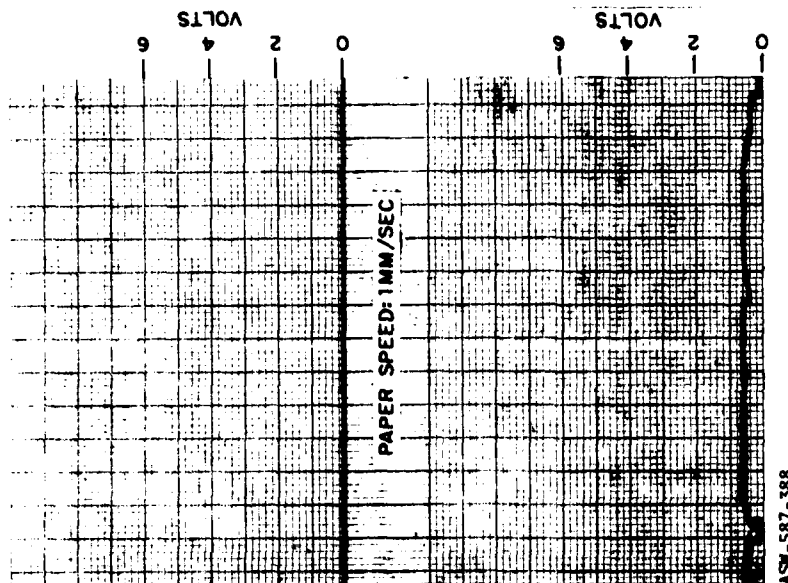
ASW-587-386

Figure C-20. Microphone No. 3
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASM-587-387

Figure C-21. Microphone No. 4
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.



ASM-587-388

Figure C-22. Microphone No. 5
Mean Square Analysis.
Analysis Bandwidth of Lower
Trace is Full Recorded
Bandwidth; of Upper
Trace, 5 to 20 kHz.

C.3 J-47 ENGINE AT MAXIMUM RPM, J-57 PORT ENGINE BURN-THROUGH

A final test was run with the J-47 engine running at maximum speed and the modified burner can on the J-57 engine capped and run to maximum RPM to produce a burn-through. All microphone locations and burner-can modifications were the same as for the burn-through tests in Appendix B.

Analysis of the recordings made during this test run appear on pages C-19 through C-26.

C.3.1 Analysis

C.3.1.1 Sound Energy Levels

Readings taken prior to burn-through were higher on microphones 3, 4, and 5. Data from the previous interference tests indicate that some of the increase may be due to the J-47 engine. There was some change in microphone 3 and 5 readings after burn-through but was insignificant and, as noted above, may be contributed to external engine noise.

C.3.1.2 Spectrum Analysis

The grams show no change from previous burn-through tests on this engine. (Refer to Appendix B.)

C.3.1.3 Mean Square Analysis

The recordings are similar to those in Appendix B, which were analyzed from similar data.

C.3.2 Environmental Conditions

The test was performed at an ambient temperature of 75° F and 68% relative humidity.

C.3.3 Sound Energy Levels

The following tables list the sound energy levels of the five microphones before and after burn-through.

Table C-3. Sound Energy Levels Before Burn-through

SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	44	49	61	56	50
RMS (μBAR)	350	390	490	450	400
dB (a)	125	126	128	127	126

^aReference = 2×10^{-4} μBAR

Table C-4. Sound Energy Levels After Burn-through

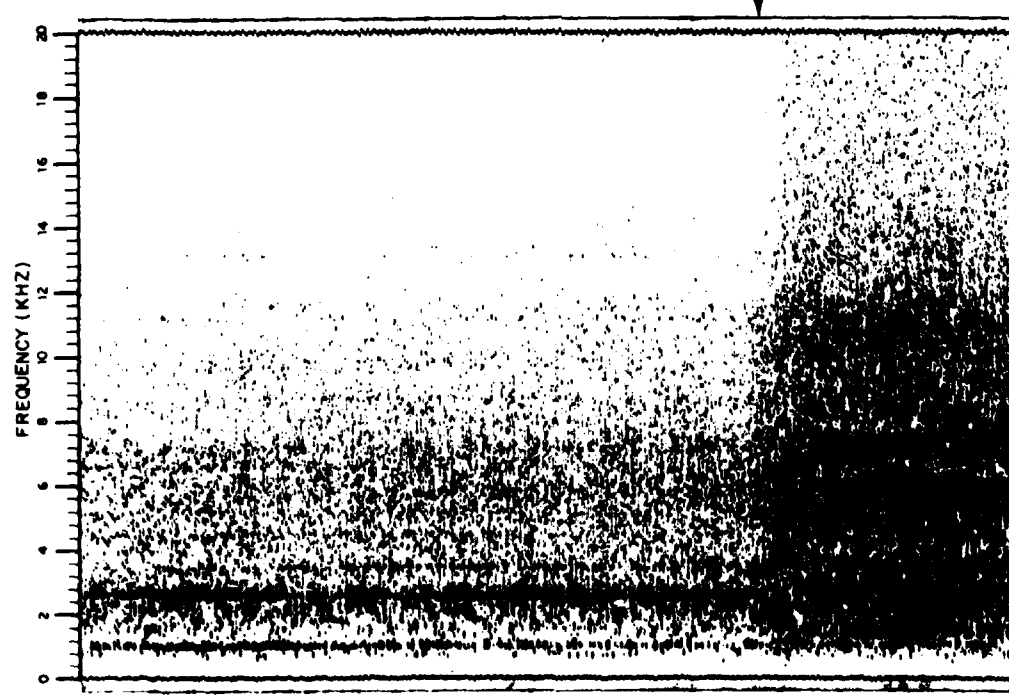
SOUND LEVEL	MICROPHONE				
	1	2	3	4	5
RMS (mV)	170	230	110	230	70
RMS (μBAR)	1370	1820	880	1820	560
dB (a)	137	139	133	139	129

^aReference = 2×10^{-4} μBAR



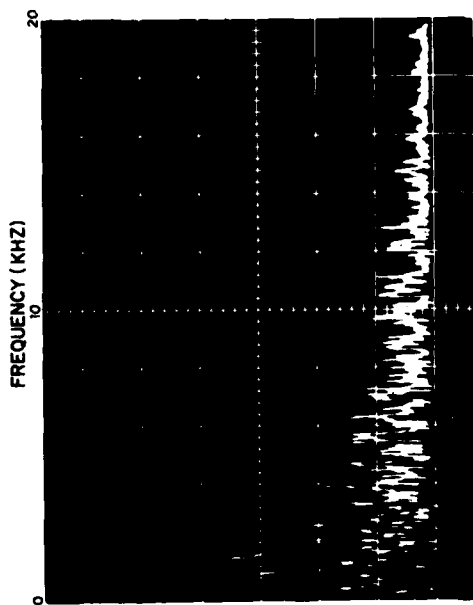
ASM-587-390

Figure C-24. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

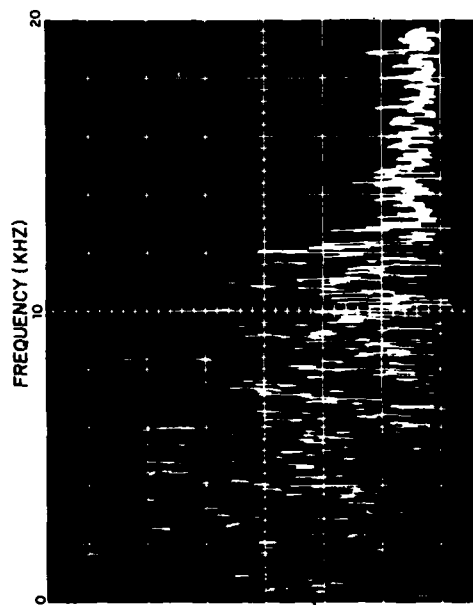


ASM-587-389

Figure C-23. Microphone No. 1 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

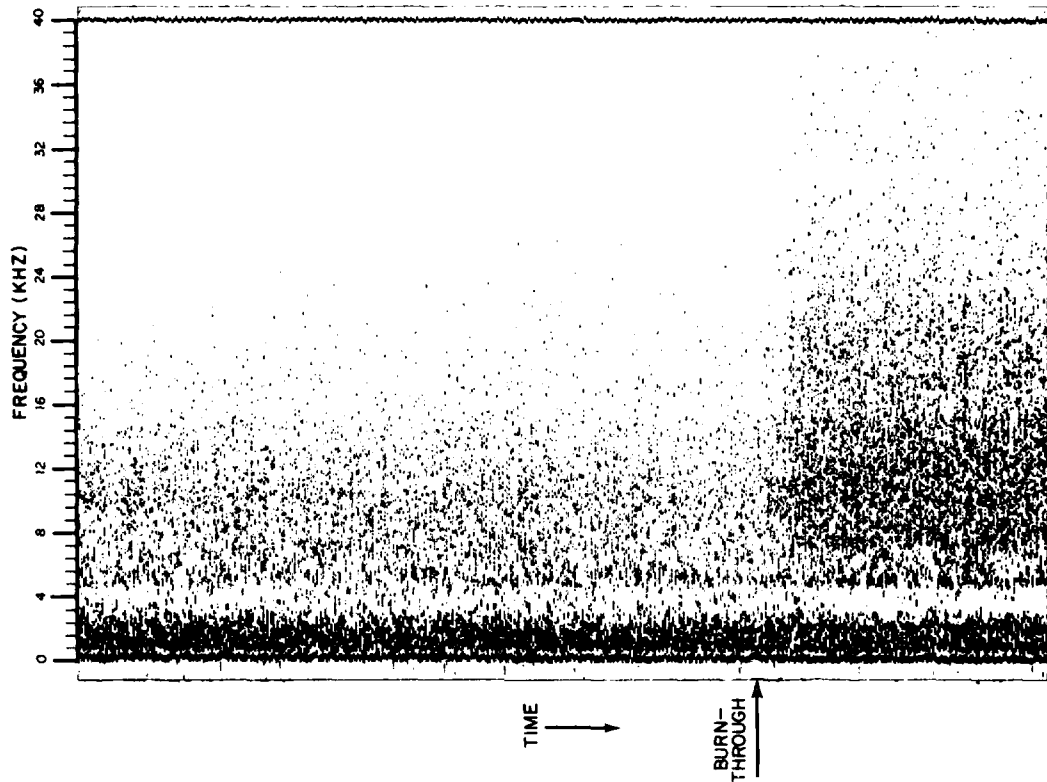


BEFORE BURN-THROUGH



AFTER BURN-THROUGH

Figure C-25. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



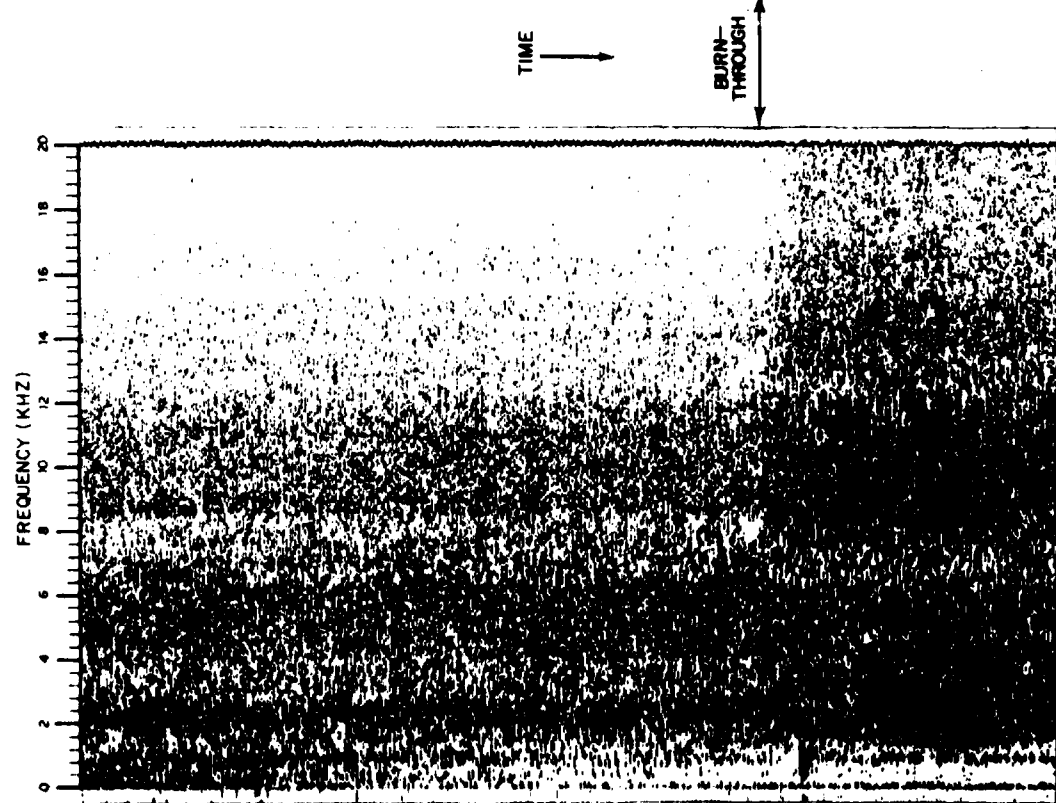
ASW-587-392

Figure C-26. Microphone No. 3 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



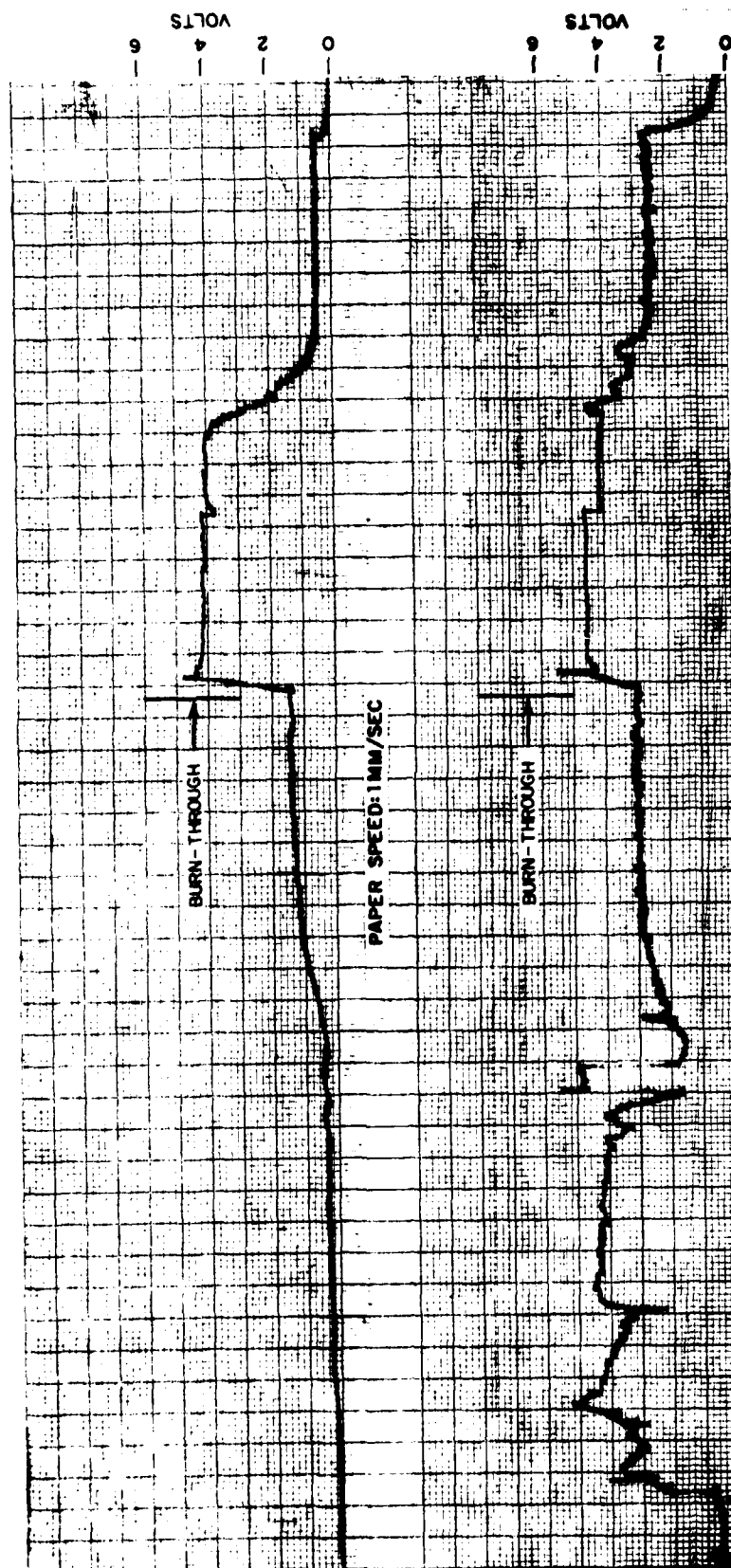
ASN-587-393

Figure C-27. Microphone No. 4 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



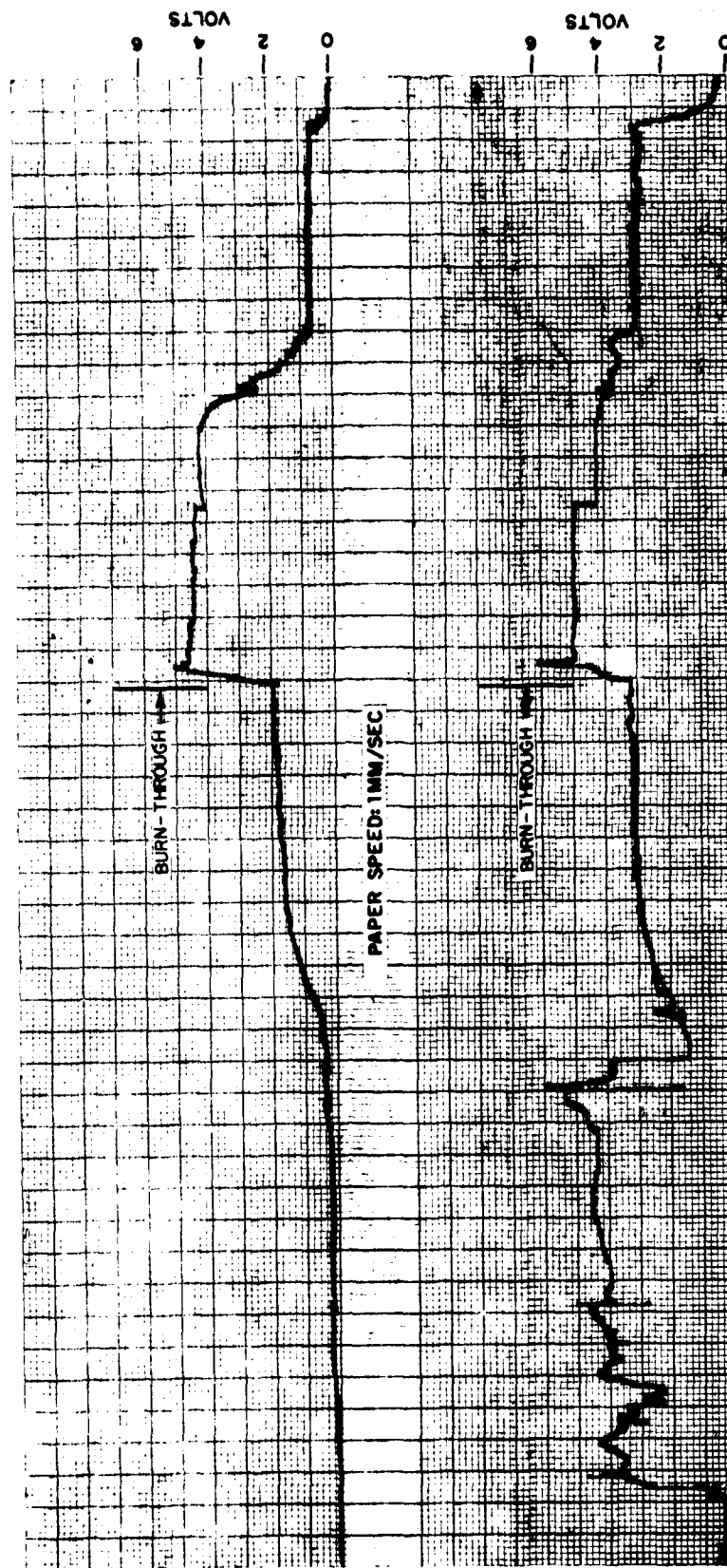
ASN-587-394

Figure C-28. Microphone No. 5 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



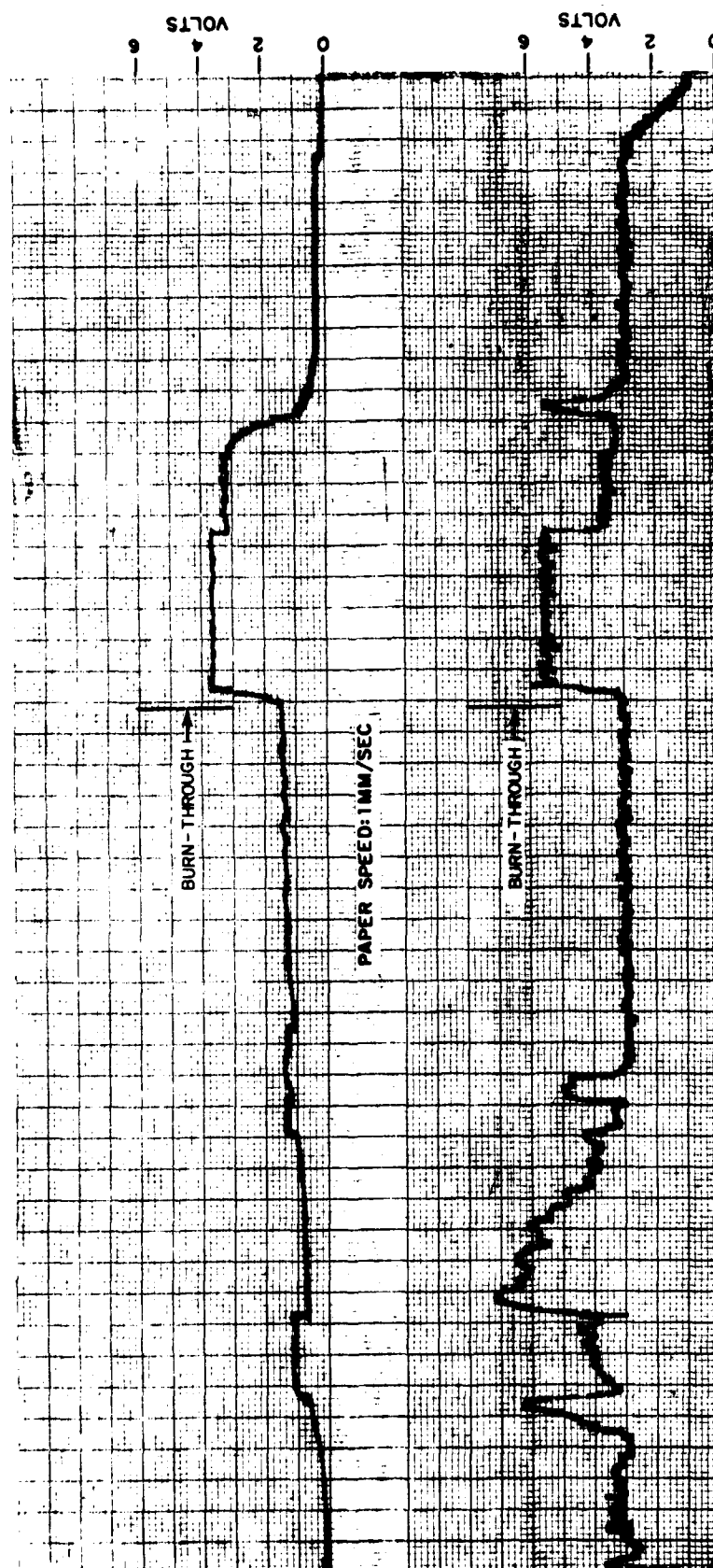
ASN-587-395

Figure C-29. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-396

Figure C-30. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASW-587-397

Figure C-31. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

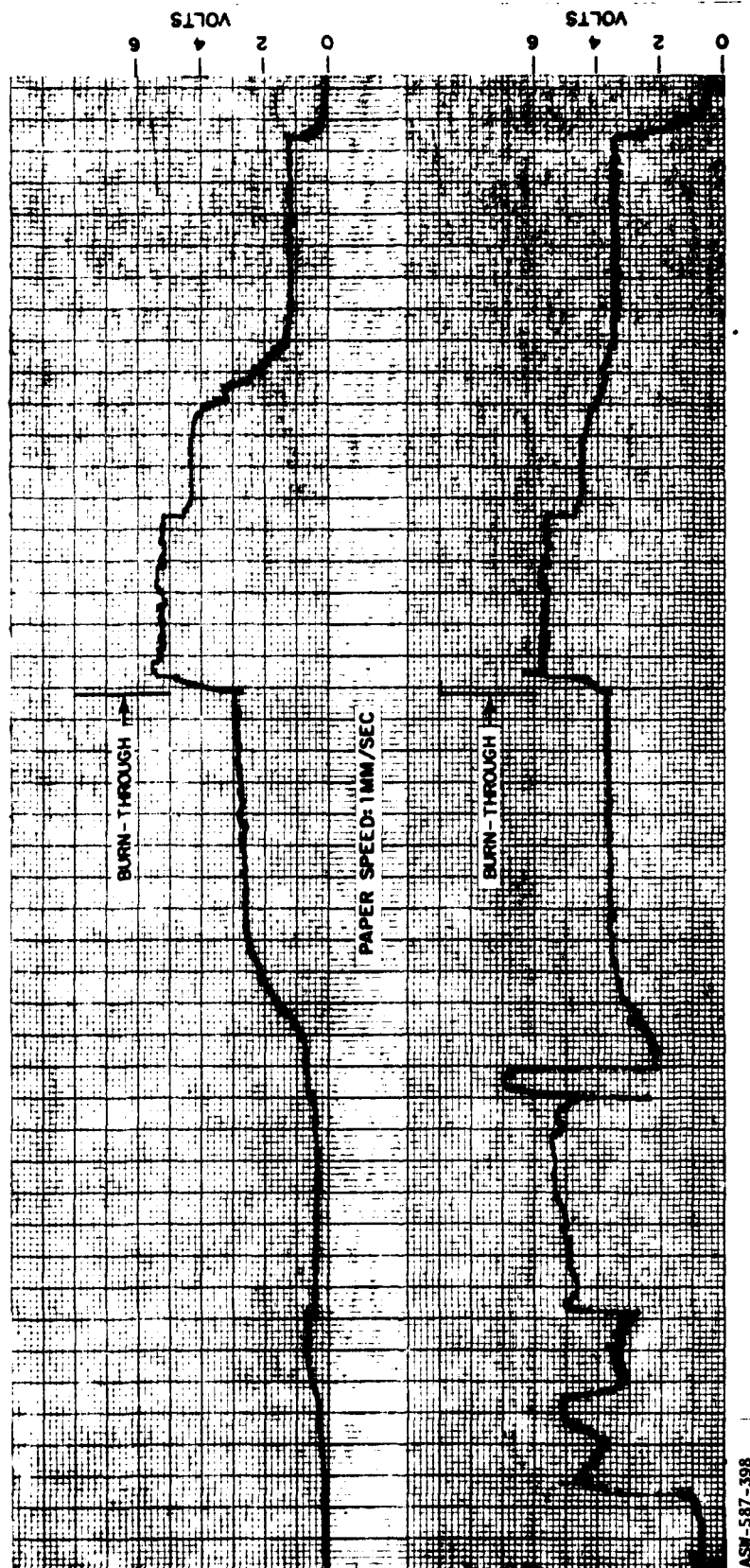
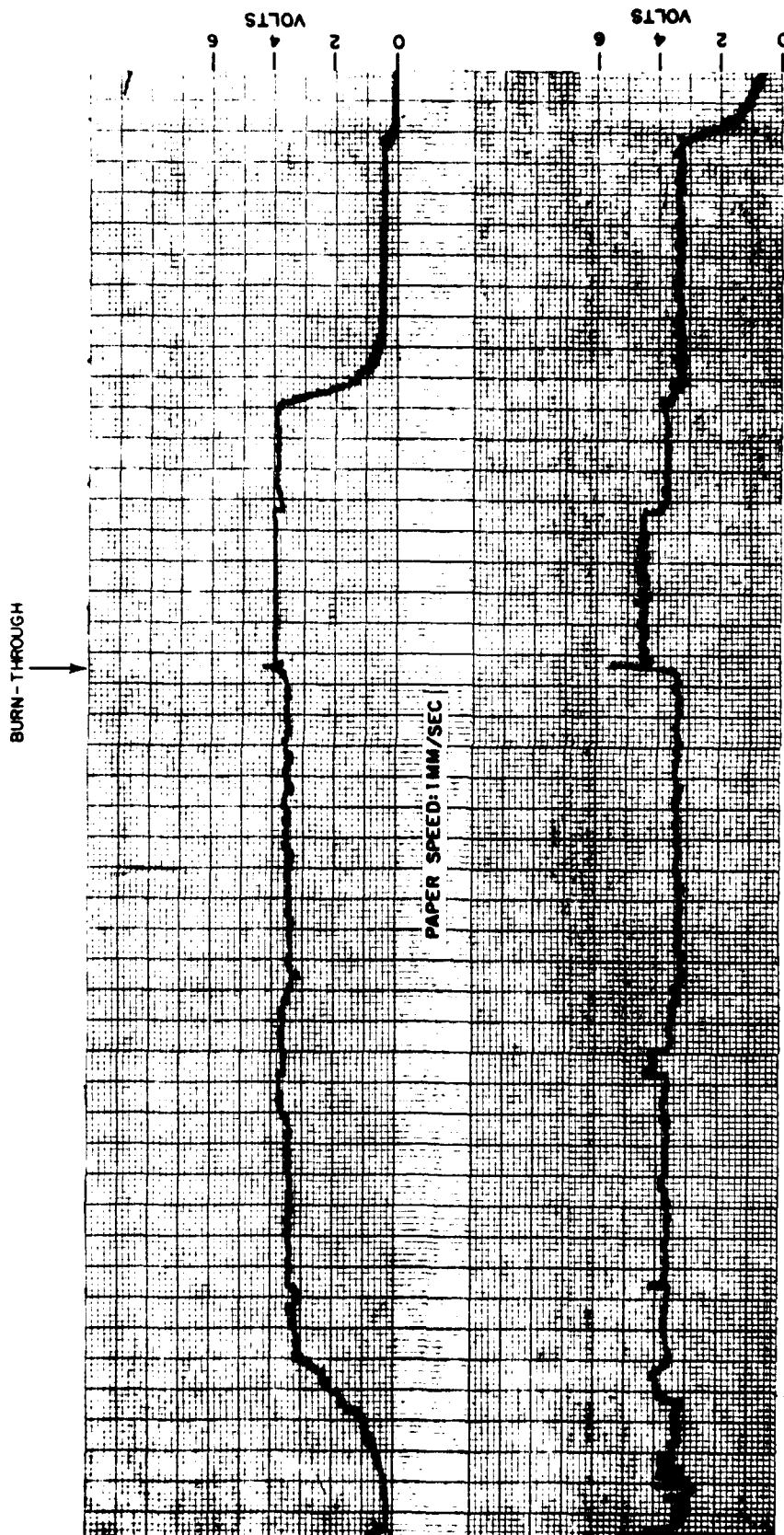


Figure C-32. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASH-587-399

Figure C-33. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

APPENDIX D
J-57 STARBOARD ENGINE FUEL LINE FAILURE

D.1 J-57 STARBOARD ENGINE FUEL LINE FAILURE

The J-57 starboard engine was modified by opening the engine housing and puncturing the fuel line leading to the modified burner can. The housing opening was welded closed and the test performed. The engine was run up to maximum RPM and fuel turned on to the ruptured line. Burn-through occurred shortly thereafter and the engine was immediately shut down.

Analysis of this run appears on pages D-2 through D-12.

D.1.1 Analysis

D.1.1.1 Sound Energy Levels

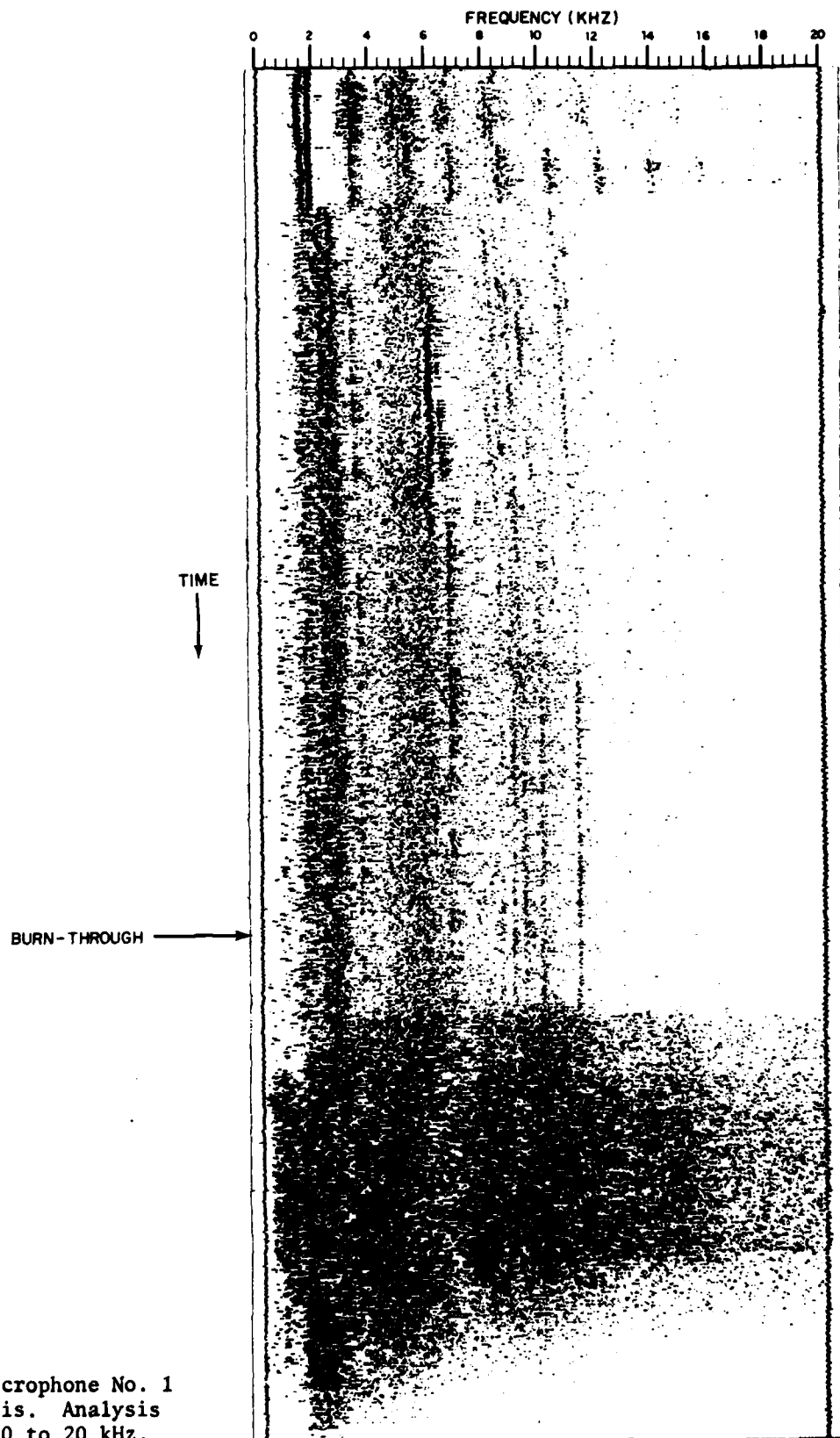
No readings were taken.

D.1.1.2 Spectrum Analysis

All grams were similar to closed-hole tests. Discrete machinery frequency lines were present up to 11.5 kHz and some broadband random noise was present up to 20 kHz prior to burn-through. At burn-through, intense broadband random noise was generated. The proximity of the microphones to the point of burn-through was directly related to the intensity of the random noise on the grams.

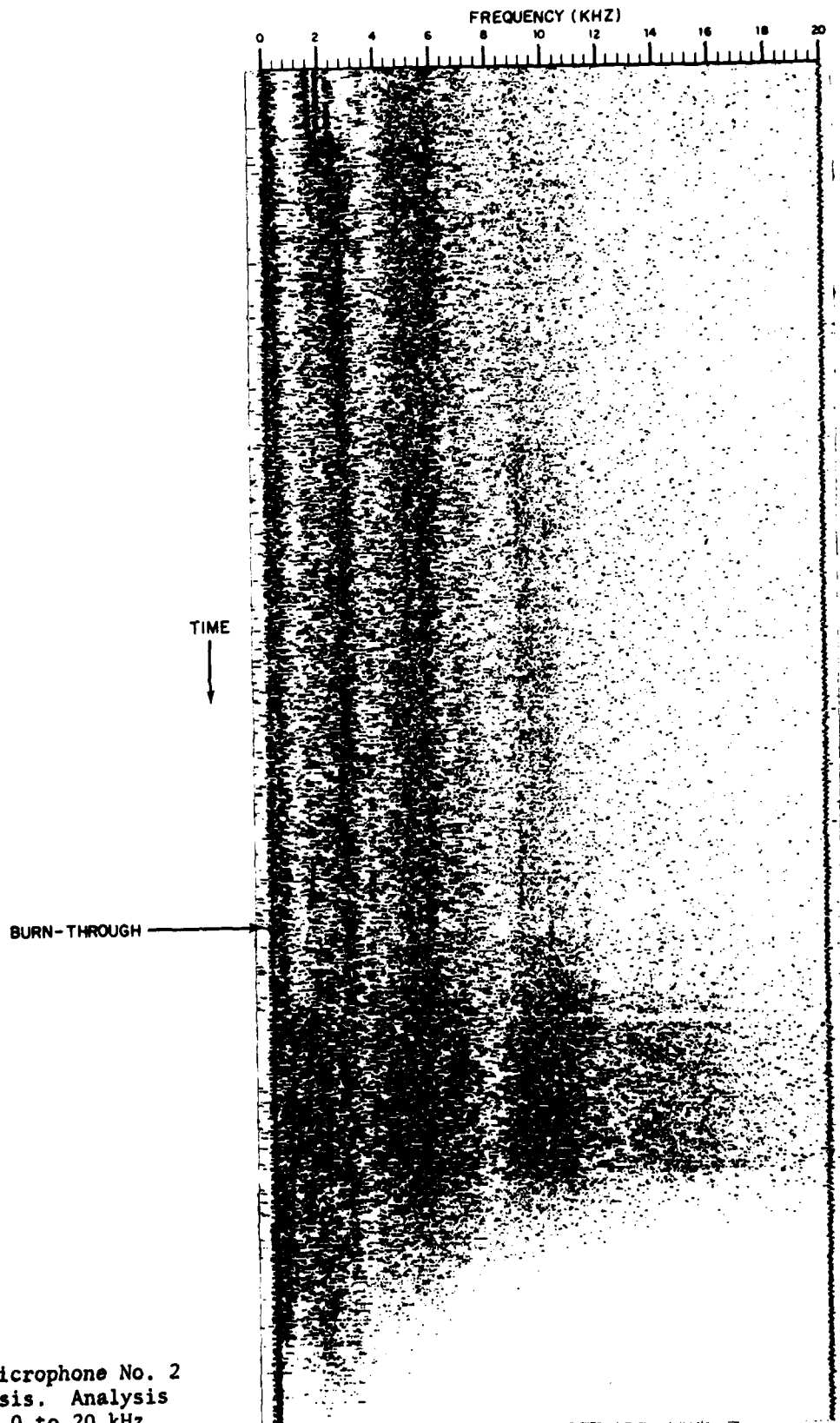
D.1.1.3 Mean Square Analysis

The burn-through was more pronounced on all grams than for any previous burn-through test. Low frequency components discussed in appendix B, which are characteristic of this type engine, were again evident. The burn-through spectral content was primarily above 5 kHz.



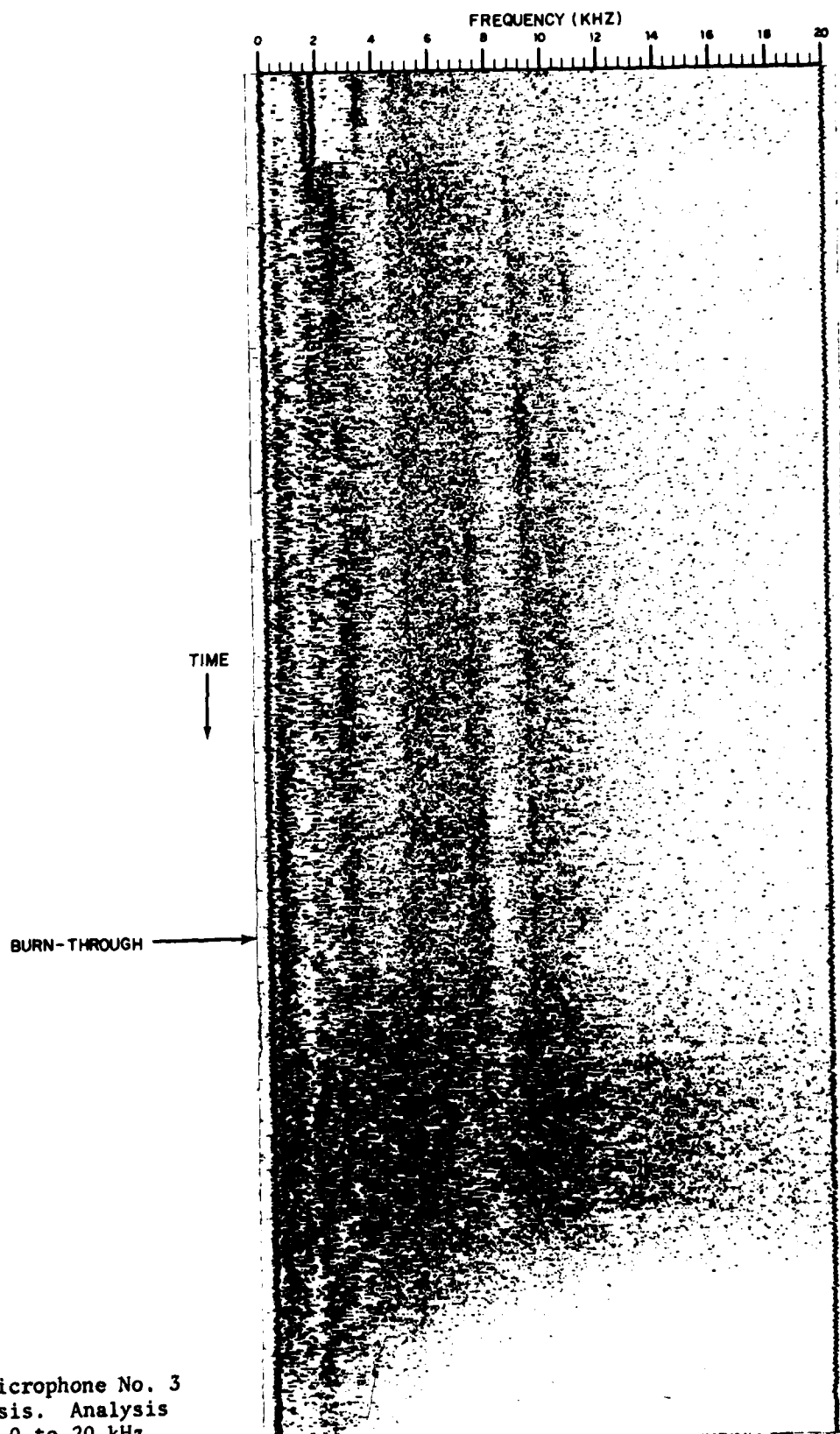
ASW-587-400

Figure D-1. Microphone No. 1
Spectrum Analysis. Analysis
Bandwidth is 0 to 20 kHz.



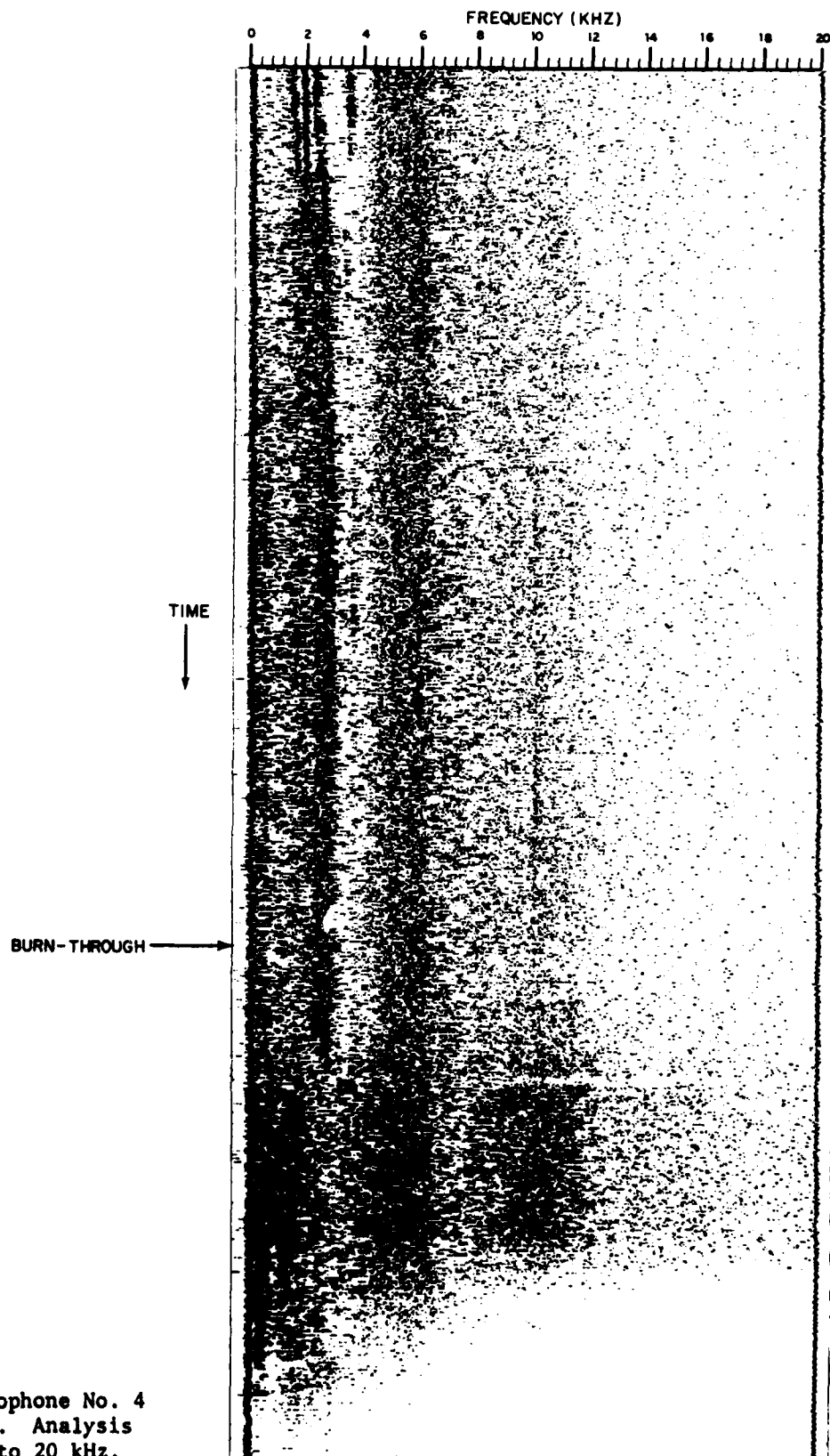
ASN-587-401

Figure D-2. Microphone No. 2
Spectrum Analysis. Analysis
Bandwidth is 0 to 20 kHz.



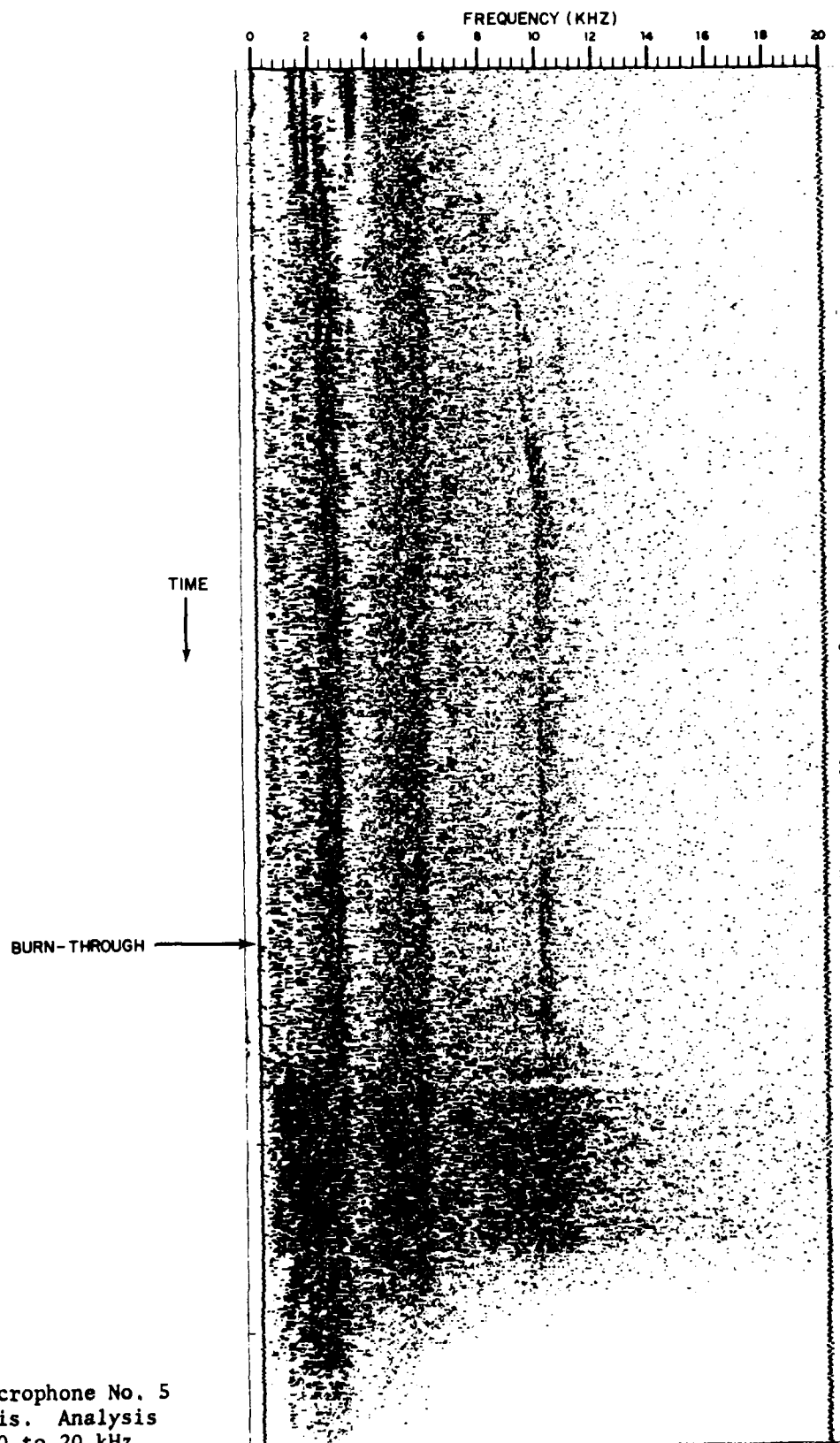
ASN-587-402

Figure D-3. Microphone No. 3
Spectrum Analysis. Analysis
Bandwidth is 0 to 20 kHz.



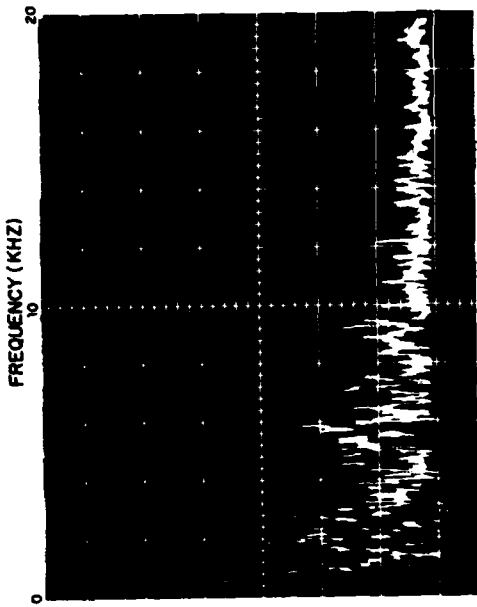
ASW-587-403

Figure D-4. Microphone No. 4
Spectrum Analysis. Analysis
Bandwidth is 0 to 20 kHz.

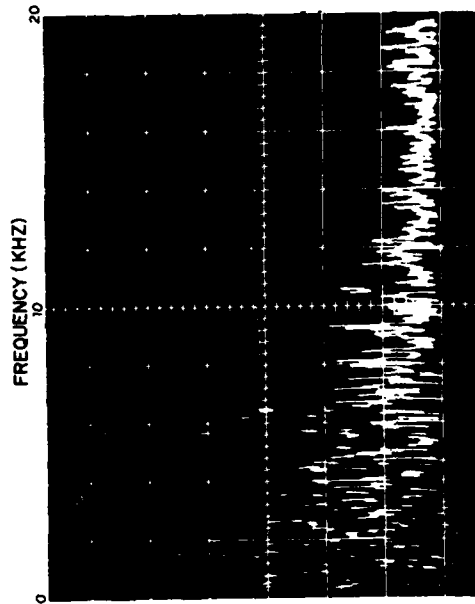


ASW-587-404

Figure D-5. Microphone No. 5
Spectrum Analysis. Analysis
Bandwidth is 0 to 20 kHz.

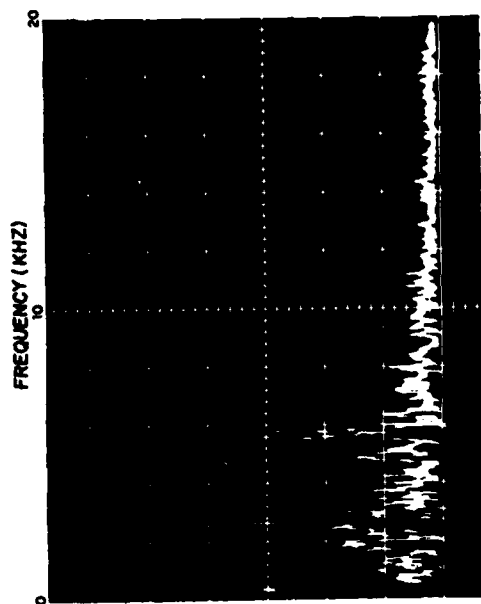


JUST BEFORE

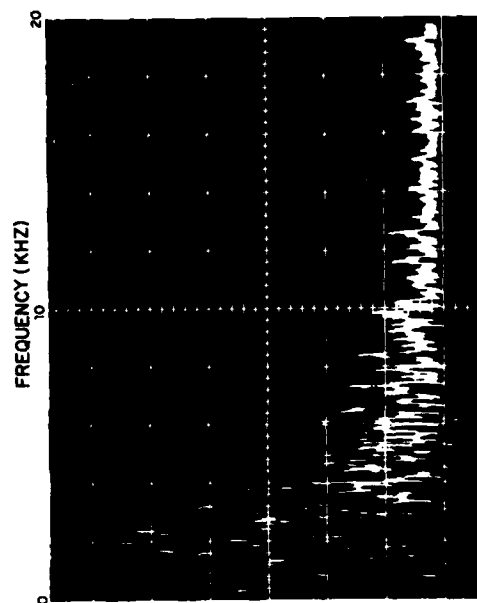


ASW-587-406 AFTER BURN THROUGH

Figure D-7. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.



BEFORE



ASW-587-405 INITIAL BURN THROUGH

Figure D-6. Microphone No. 2 Spectrum Analysis.
Analysis Bandwidth is 0 to 20 kHz.

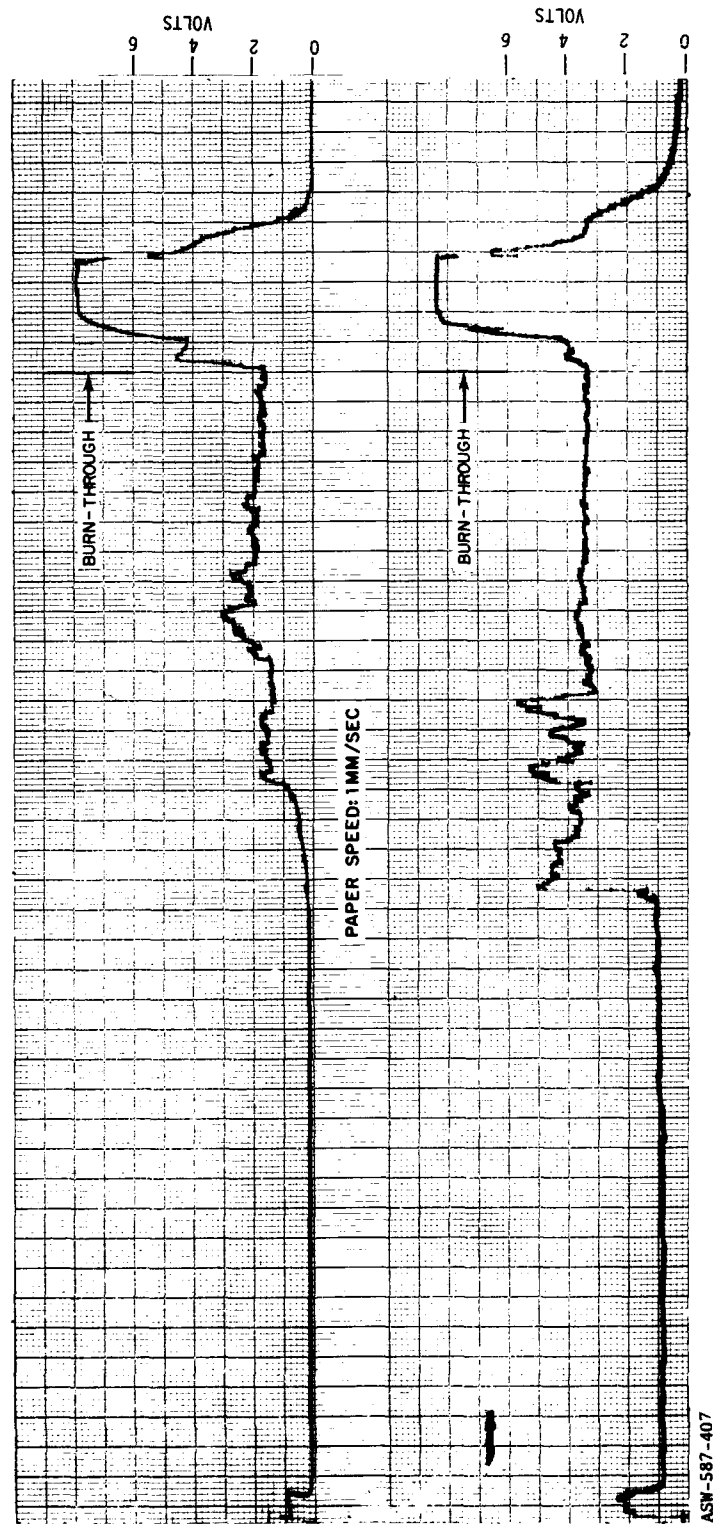


Figure D-8. Microphone No. 1 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

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JET ENGINE BURN-THROUGH INVESTIGATION VOLUME 2 ENGINE
TESTS RAW DATA(U) MAGNAVOX CO FORT WAYNE IND FORT WAYNE
DIV R W SCHUMACKER MAR 73 FAA-NA-72-96-2 DOT-FAT2-575

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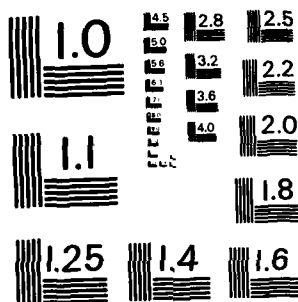
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MICROCOPY RESOLUTION TEST CHART
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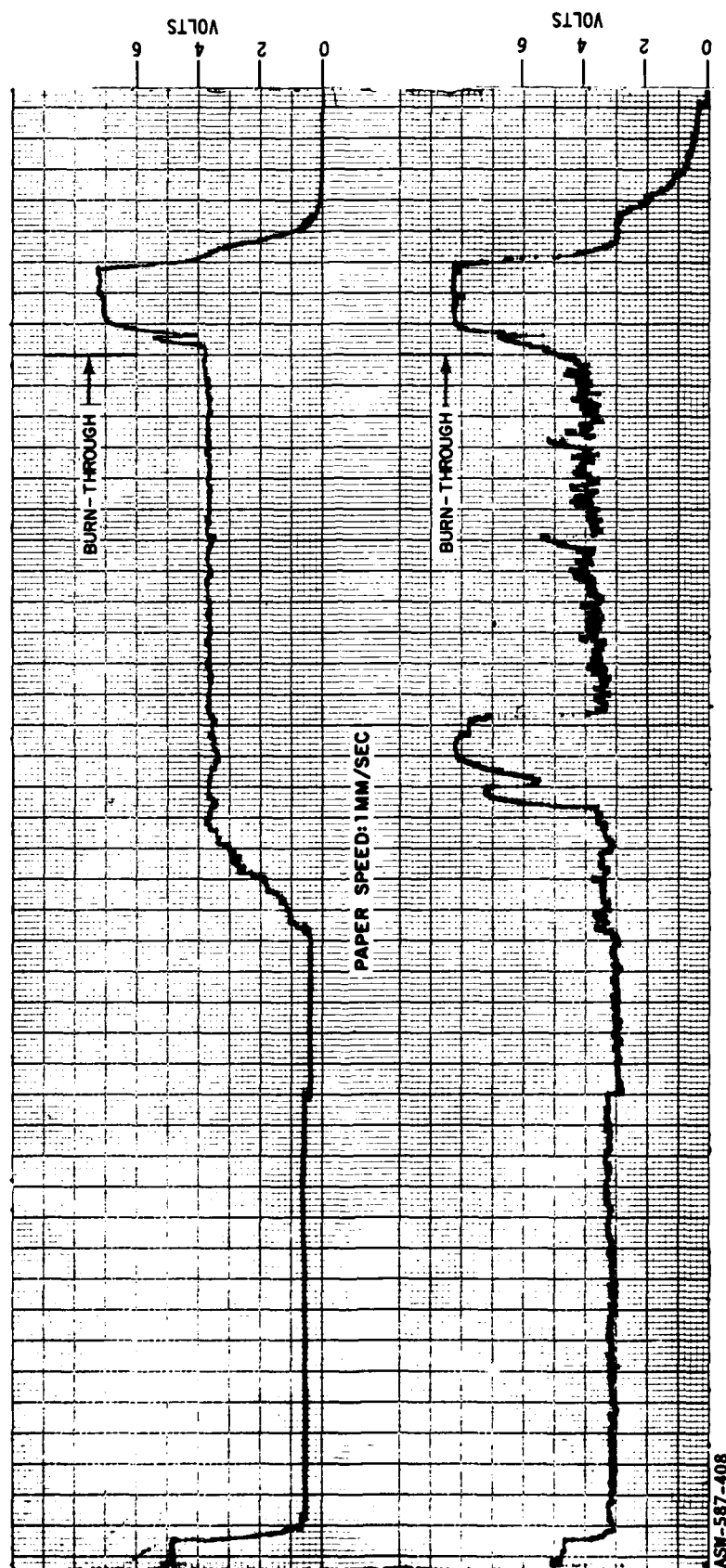


Figure D-9. Microphone No. 2 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

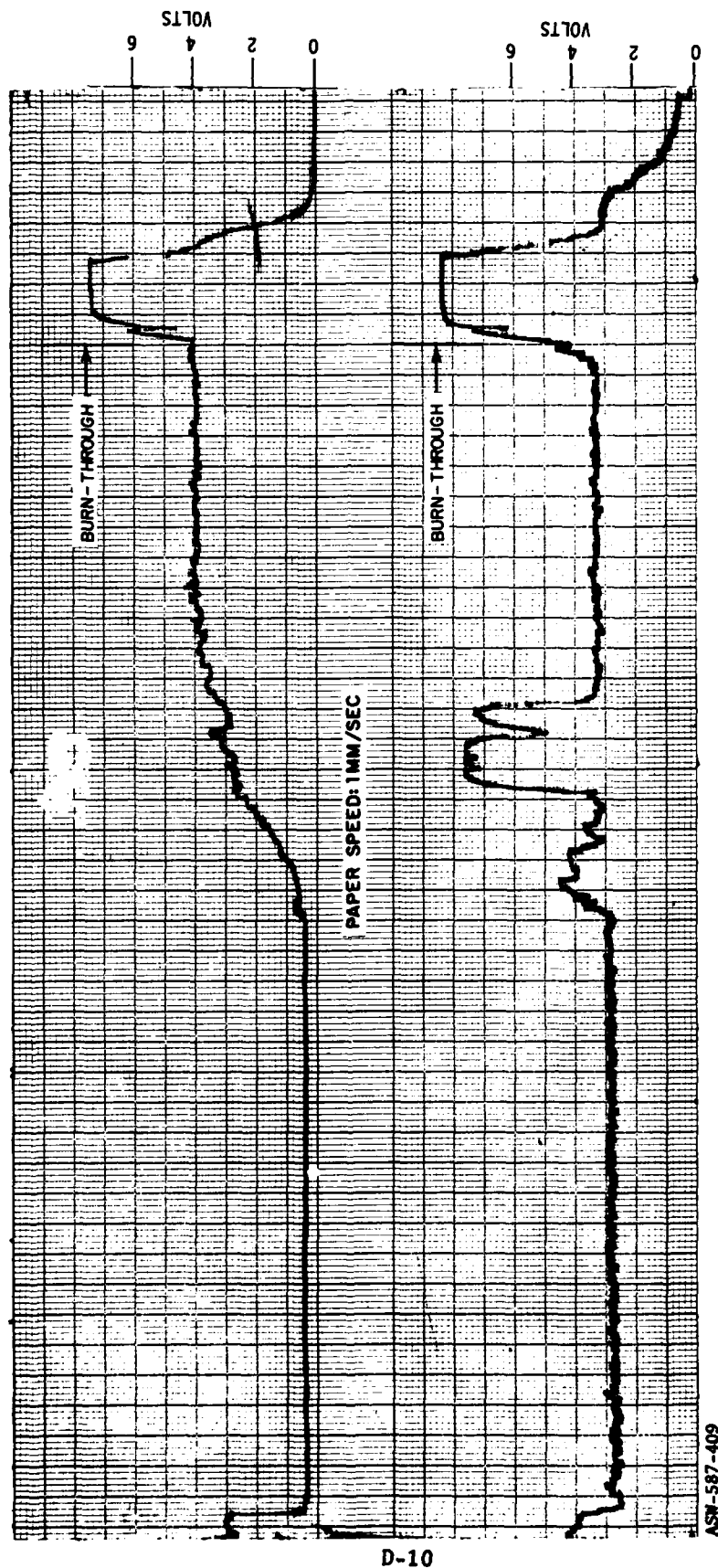


Figure D-10. Microphone No. 3 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

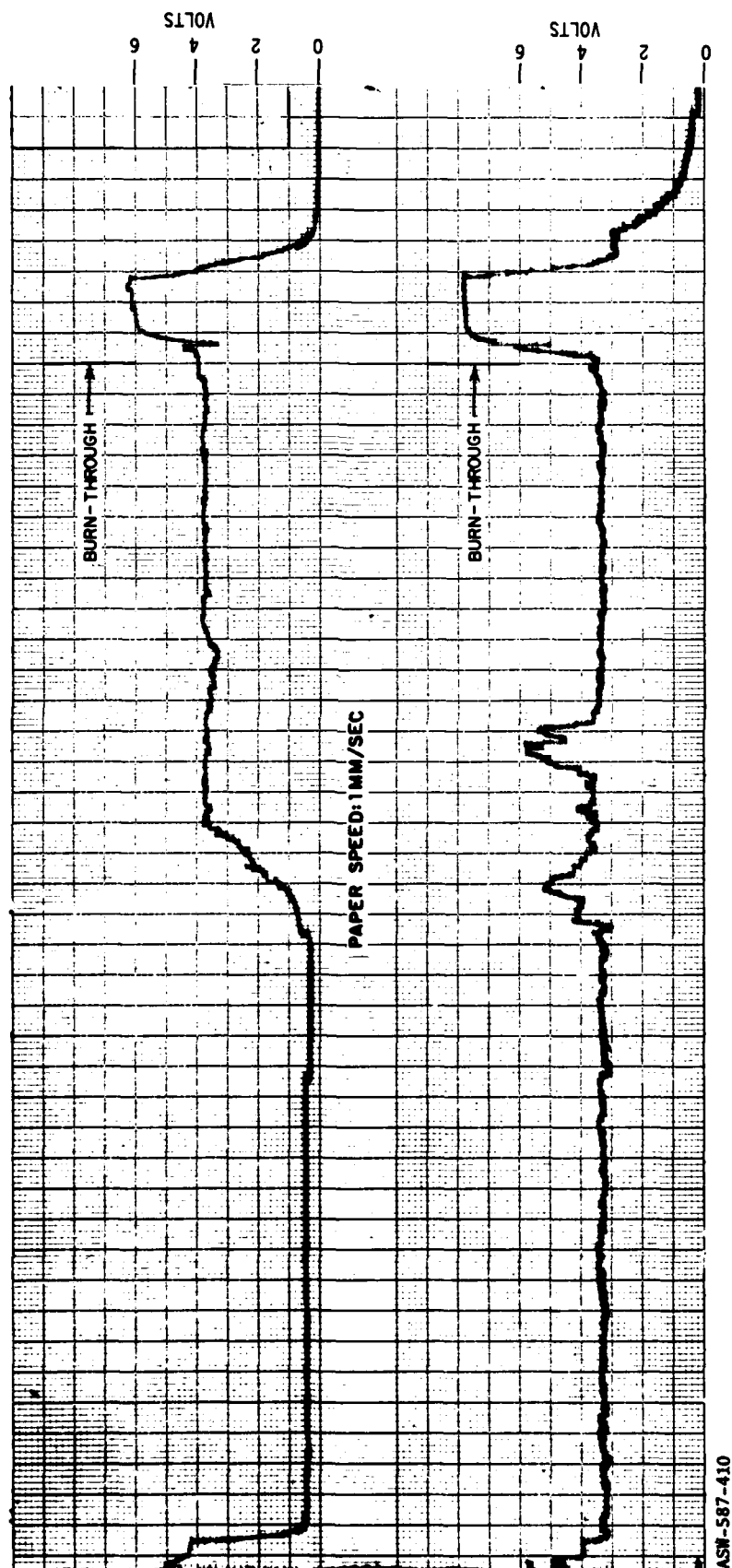
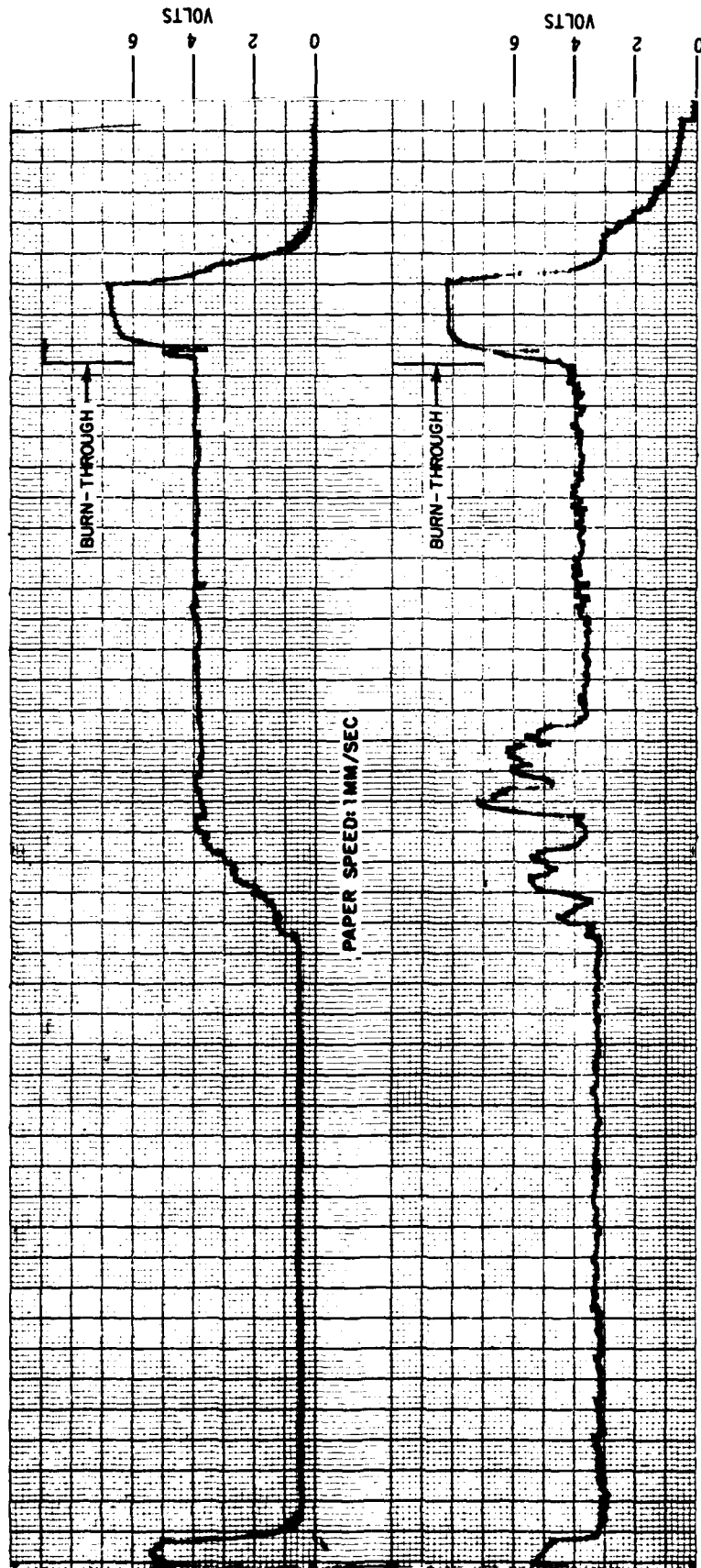


Figure D-11. Microphone No. 4 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.



ASN-587-411

Figure D-12. Microphone No. 5 Mean Square Analysis. Analysis Bandwidth of Lower Trace is Full Recorded Bandwidth; of Upper Trace, 5 to 20 kHz.

APPENDIX E
MICROPHONE CHARACTERISTICS

E.1 MICROPHONE CHARACTERISTICS

Two types of microphones, with markedly different characteristics, were used during the recording phase of the program. The wide rangy microphone was a condenser type, Bruel and Kjaer, Model 4138, with a type 2619 preamplifier. The two parts, microphone and preamplifier, formed an integral unit. The general-purpose microphones were Shure Brothers, model 515SB dynamic types with direct coil outputs.

E.1.1 Bruel and Kjaer 4138 Characteristics:

- (1) Frequency response - (See figure E-1.)
- (2) Open circuit sensitivity at 1 kHz (microphone and pre-amp) - $80.4 \mu\text{V}/\mu\text{BAR}$
- (3) Buffer amplifier loss - 16 dB
- (4) Overall sensitivity - $12.8 \mu\text{V}/\mu\text{BAR}$
- (5) Output voltages for typical Sound Pressure Level values
 - a. $20 \mu\text{BAR}$ (100 dB) = 256 μV
 - b. 2.0 mBAR (140 dB) = 25.6 mV

E.1.2 Shure 515SB Characteristics:

- (1) Frequency response - (See figure E-2.)
- (2) Open circuit sensitivity at 1 kHz - $89 \mu\text{V}/\mu\text{BAR}$
- (3) Output voltages for typical Sound Pressure Level values at 1 kHz
 - a. $20 \mu\text{BAR}$ (100 dB) = 1.78 mV
 - b. 2.9 mBAR (140 dB) = 178 mV

- (4) Noise response - because of the pronounced hump in the microphone response at 5 kHz, the response to noise of uniform spectral density differs from that for a sine wave at 1 kHz.

A first approximation to the "white" noise response may be obtained by assuming an even distribution of noise in a 0- to 10-kHz band with a total received power of 1 watt. Thus, each 1-kHz segment of the spectrum contributes 100 mW to the received power. The microphone output power will be different in each 1-kHz band, however, because of the irregular response.

Letting 0 dB stand for unity power gain through the transducer, the output power for each 1-kHz segment of the 1-kHz band is approximately as follows:

BAND (KHZ)	OUTPUT (mW)
0-1	80
1-2	130
2-3	160
3-4	180
4-5	250
5-6	400
6-7	400
7-8	200
8-9	100
9-10	60
0-10	1960

The output power in the 10-kHz band would be 1.96 W giving the microphone a "gain" of 2.9 dB in that band. Thus, the response to white noise in a 10-kHz band is 2.9 dB higher than that to a sine wave of equivalent amplitude at the 1-kHz reference frequency. In the 10-kHz band then, white noise gives the following:

- a. Open circuit sensitivity - 125 mV/ μ BAR
- b. Typical outputs:
 1. 20 μ BAR (100 dB) = 2.5 mV
 2. 2.0 mBAR (140 dB) = 250 mV

E.1.3 Conversion of Output Voltage in mV to Sound Pressure Level in μ BAR and dB

(Reference = 2×10^{-4} μ BAR)

Using the relationships established above, the input Sound Pressure Level for a given microphone may be inferred from its output voltage (V_o). For the B and K microphone, the reverse transfer function is

$$\text{Sound Pressure Level } (\mu\text{B}) = \frac{2 \times 10^{-3} V_o}{25.6 \times 10^{-3}} = 0.0783 V_o = 78.3 \times (\text{Value of } V_o \text{ in mV})$$

$$\text{Sound Pressure Level (dB)} = 20 \log \frac{V_o}{0.00256 \mu\text{V}} = 100 + 20 \log \frac{V_o}{256 \mu\text{V}}$$

For the Shure microphone, the reverse transfer function is

$$\begin{array}{l} \text{Sound} \\ \text{Pressure } (\mu\text{B}) \\ \text{Level} \end{array} = \frac{2 \times 10^{-3} V_o}{250 \times 10^{-3}} = 0.008 V_o = 8 \times (\text{Value of } V_o \text{ in mV})$$

$$\begin{array}{l} \text{Sound} \\ \text{Pressure (dB)} \\ \text{Level} \end{array} = 20 \log \frac{V_o}{0.025 \mu\text{V}} = 100 + 20 \log \frac{V_o}{2.5 \text{ mV}}$$

These equations are plotted in figures E-3 and E-4 for reference.

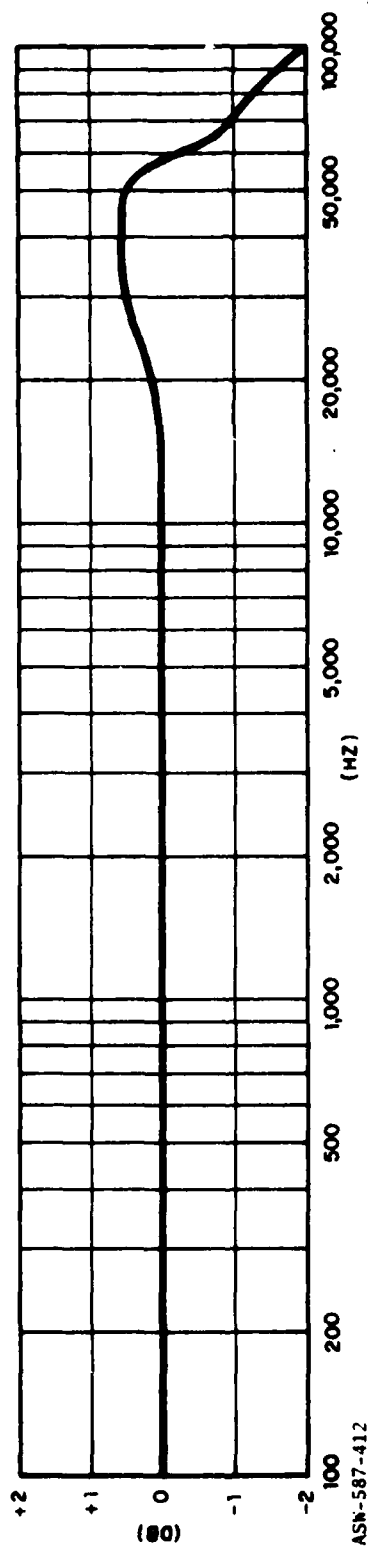


Figure E-1. B & K 4138 Response

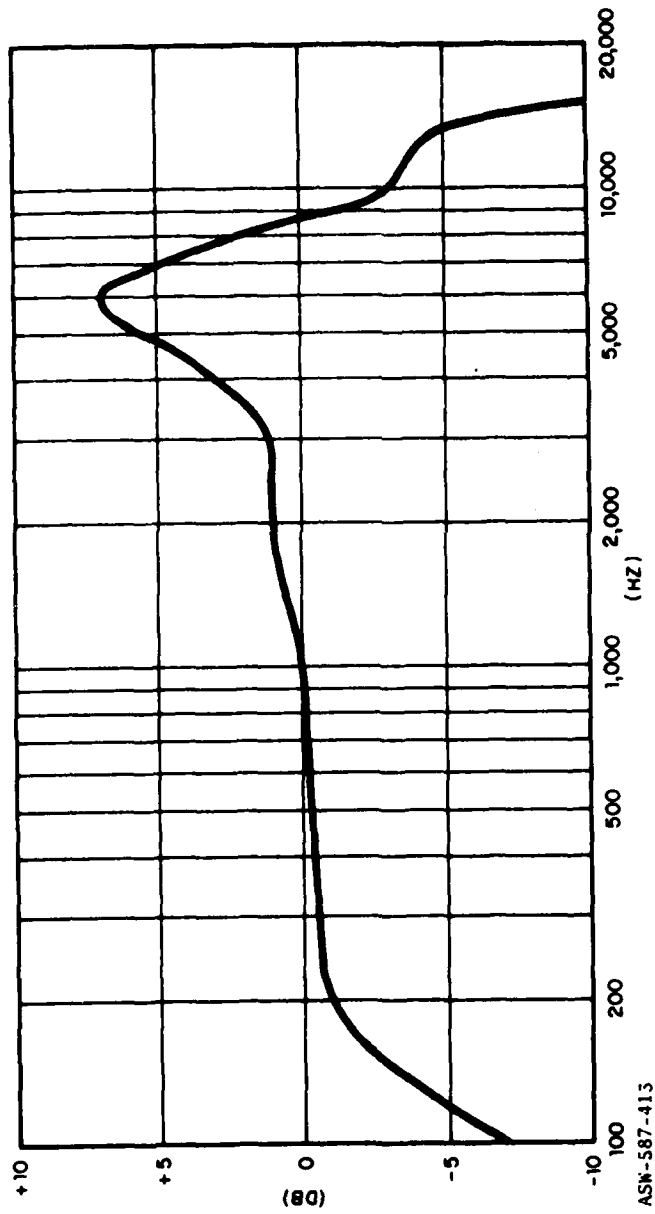


Figure E-2. Shure 515SB Response

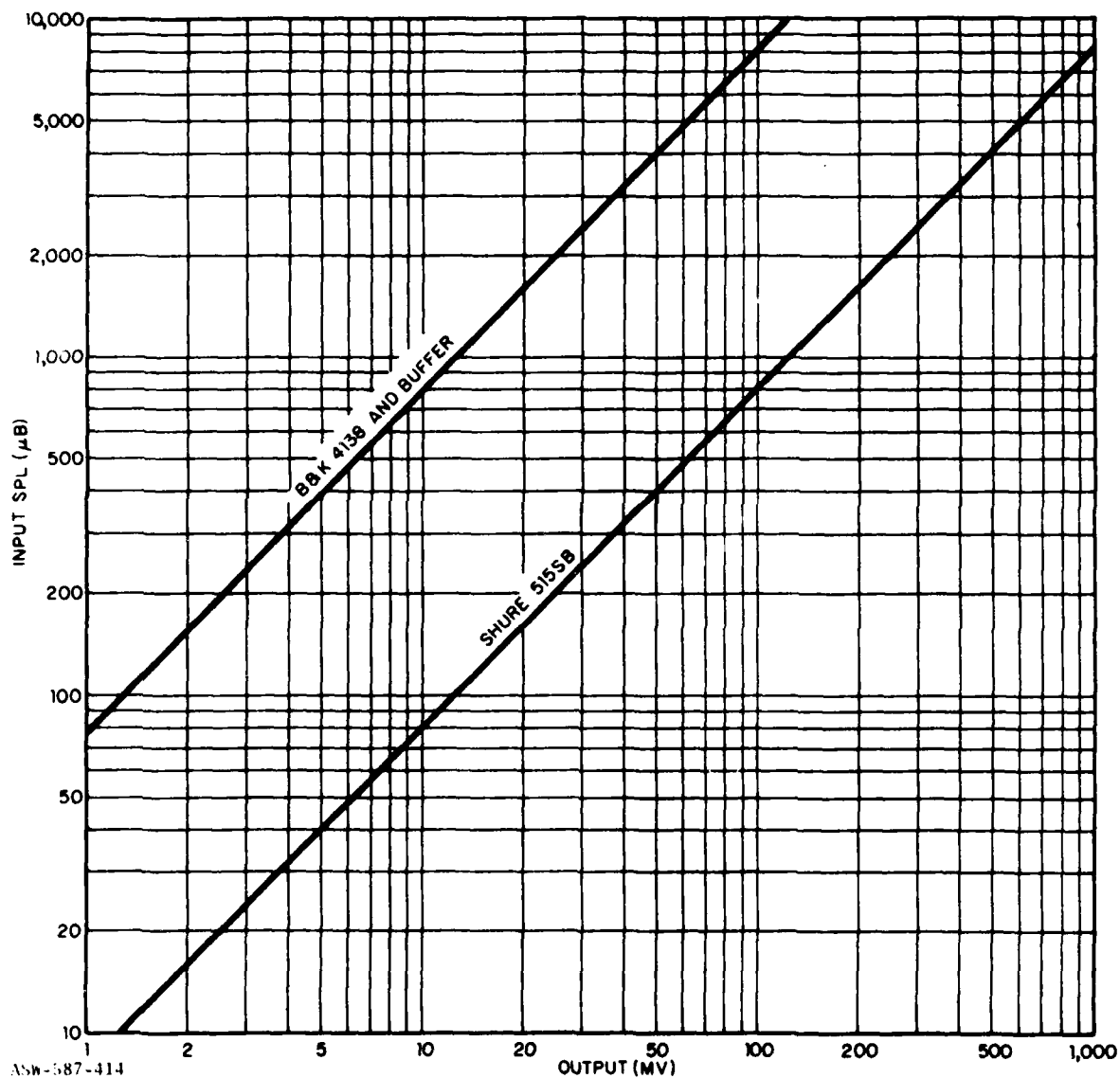


Figure E-3. Mike Input SPL (μB) vs Output (mV)

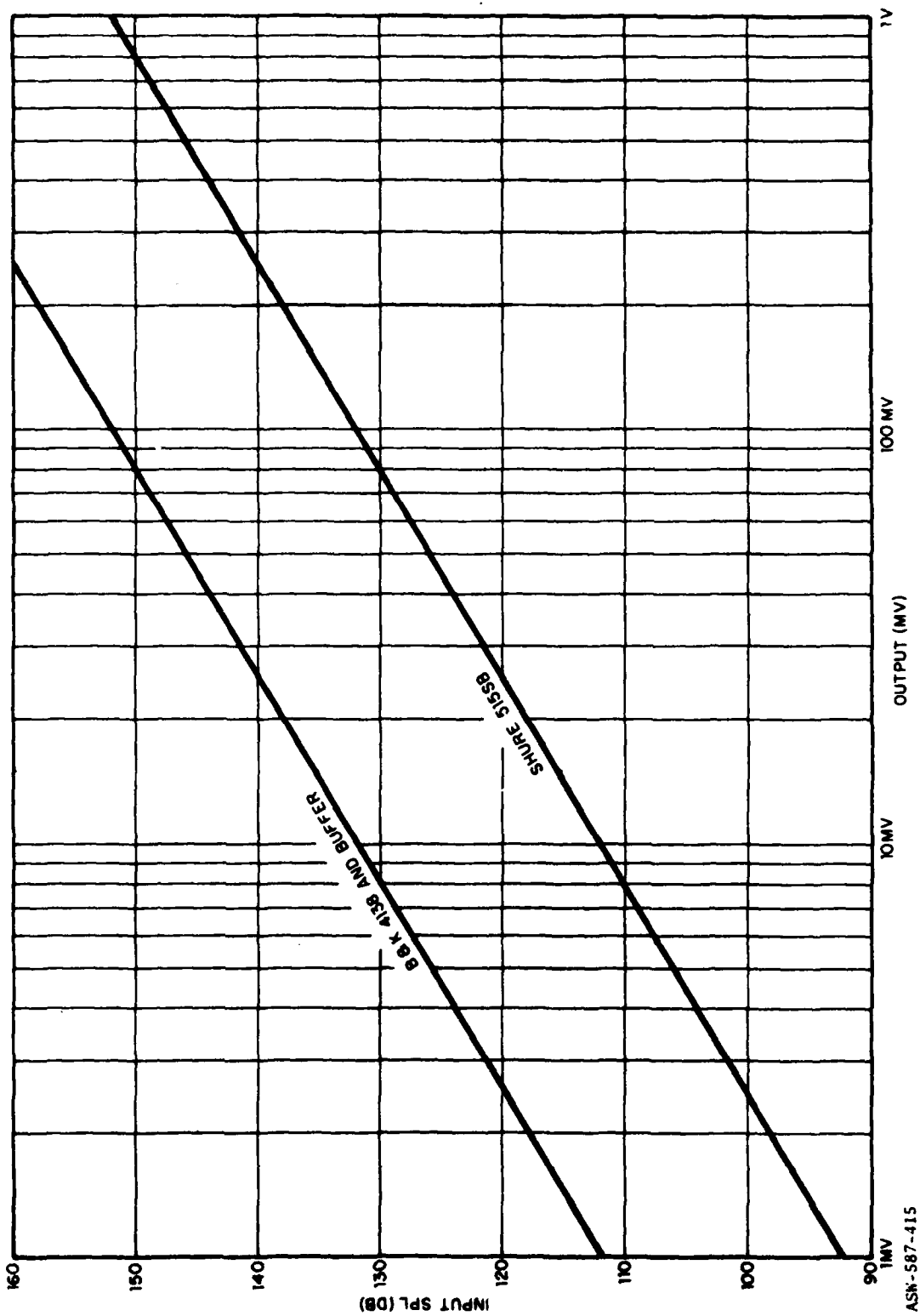


Figure E-4. Mike Input SPL (db) vs Output (mV)

ASN-587-415

APPENDIX F

RECORDING AND ANALYSIS EQUIPMENT LIST

F.1 RECORDING EQUIPMENT

- (1) Magnetic Tape Recorder
7 Channel, 1/2" tape
Model: Sangamo 3562
Serial No.: 4315
- (2) Microphone (4)
Low impedance
Model: Shure 515SB
UNIDYNE B
- (3) Microphone (1)
1/8" Cartridge, Type 4138, B & K Instruments, Inc.
Serial No.: 363842
- (4) Microphone Adaptor (1)
1/8" - 1/2", B & K Instruments, Inc.
Type UA0036
- (5) Microphone Preamplifier (1)
B & K Instruments, Inc.
Type 2619
- (6) Microphone Power Supply
B & K Instruments, Inc.
Type 2801
- (7) Monitor Scope, Five Channel
Calico Monitor Scopes
Calico Instruments Corp.
Model: 7211
Serial No.: 345
- (8) Monitor Scope
Tektronics Type 545B
Serial No.: 008741
Type CA Plug-in
Serial No.: 017251
- (9) Power Supply
Harrison Labs Model No. 800A-2
Serial No.: MU 1883-08
- (10) Amplifier
Hewlett Packard Type 465A
Serial No.: 38289-1

- (11) RMS Meter
Ballantine Model No. 300
Serial No.: 18948
- (12) Voice Microphone
Shure Model 215S
- (13) Playback Audio Amplifier and Speaker
Magnavox Co.
- (14) Buffer Amplifier
Special Design
Magnavox Co.

F.2 SPECTRUM ANALYSIS EQUIPMENT

- (1) Magnetic Tape Recorder
7 Channel, 1/2" Tape
Sangamo Model 3562
Serial No.: 4315
- (2) Spectrum Analyzer, Ubiquitous
Federal Scientific Corp
Model No.: UA-7B
Serial No.: 35246-5
- (3) Oscilloscope, Monitoring
Tektronix
Model No. 801RL
Serial No. 007929
- (4) DC Amplifier
California Instrument Co.
Calico Model No.: 3300A
Serial No.: 110
- (5) Paper Recorder
Reytheon Co.
Model No.: PER-196B-6
Serial No.: 085
- (6) Playback Audio Amplifier and Speaker
Magnavox Co.

F.3 MEAN SQUARE ANALYSIS EQUIPMENT

- (1) Magnetic Tape Recorder
7 Channel, 1/2" Tape
Sangamo Model 3562
Serial No.: 4315
- (2) Band Pass Filter
Krohn-Hite Model No. 330MR
Serial No. 19390
- (3) True RMS VTVM
Balantine Laboratories, Inc.
Model No.: 320A
Serial No.: 8426
- (4) R-A-P Voltmeter
Balantine Laboratories, Inc.
Model No.: 321
Serial No.: 730
- (5) Dual Channel DC Amplifier - Recorder
Sanborn Company
Model No.: 320
Serial No.: 34064-1

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