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NEAR NOISE FIELD CHARACTERISTICS OF NIKE ROCKET MOTORS FOR APPLICATION TO SPACE VEHICLE PAYLOAD ACOUSTIC QUALIFICATION

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June 1977

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA 23665

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INTRODUCTION

The Space Shuttle launch vehicle/shuttle orbiter combination has been designed to provide low cost transportation to and from earth's orbit. During the launch and ascent flight phases, the vehicle and the payload it carries can be subjected to high level acoustic energy produced by the first stage rocket motors. Concern has been expressed as to the effects of this noise on the payloads being carried in the Orbiter cargo bay. Estimates have been made of the internal acoustic environment of the cargo bay which indicate relatively high levels during lift-off (ref. 1), thus, it may be desirable that certain vehicle and payload components be environmentally qualified utilizing a noise source which would produce a sound field with characteristics similar to the noise environment that had been estimated for the cargo bay.

In the past, several types of sources have been utilized for high level acoustic testing, the exhaust of jet engines, the exhaust of blow down wind tunnels, and others (refs. 2-7). The Nike solid propellent rocket motor was suggested as a source whose noise field may be suitable to reproduce the interior noise environment that had been predicted for the Shuttle Orbiter cargo bay during lift-off. The Nike motor, developed in the 1950's as the booster stage for an antiaircraft missile, is still readily available in reasonable quantity. These motors are easy to handle, are relatively low in cost, and seem to offer the possibility of an acceptable noise source for the proof testing of Shuttle payloads.

The purpose of this paper is to present the results of a series of noise measurements that were made under controlled conditions during the static firing of two Nike solid propellent rocket motors. The objective of the measurements was to assess the usefulness of these motors as sources for general spacecraft noise testing, but in particular to reproduce the noise expected in the cargo bay of the Orbiter.

Presented in the paper are brief descriptions of the Nike motor, the general procedures utilized for the noise tests, and representative noise data including overall sound pressure levels, one-third octave band spectra, and octave band spectra. Data are presented on two motors of different ages in order to show the similarity between noise measurements made on motors having different loading dates. The measured noise from these tests is then compared to that estimated for the Space Shuttle Orbiter cargo bay.

SPACE SHUTTLE VEHICLE

The Space Shuttle flight system is composed of the Orbiter, an external tank (ET) that contains the ascent propellant to be used by the Orbiter main engines, and two solid rocket boosters (SRB's). The Orbiter and SRB's are reusable; the external tank is expended on each launch. A sketch of the complete vehicle is shown in figure 1.

The Orbiter spacecraft contains the crew and payload for the Space Shuttle system. The Orbiter can deliver to orbit payloads of 29,500 kilograms (65,000 pounds) with lengths to 18 meters (60 ft.) and diameters of 5 meters (15 ft.). The Orbiter is comparable in size and weight to modern transport aircraft; it has a dry weight of approximately 68,000 kilograms (150,000 lbs.), a length of 37 meters (122 ft.), and a wingspan of 24 meters (78 ft.). During the launch, the three Orbiter main propulsion engines are used along with the two solid rocket boosters, producing a total thrust at lift-off of approximately 30×10^6 newtons (6.7×10^6 pounds)

A number of estimates have been made of the Orbiter cargo bay noise environment during lift-off; the crosshatched area of figure 2 encompasses the limits of all of these estimates (ref. 1). The predicted octave band levels vary somewhat due to the use of different assumptions (concerning the characteristics of the acoustic field within the cargo bay) and a band encompassing all the estimates is shown in the figure. The generalized spectra tend to reach maximum levels in excess of 145 dB in the frequency range of 100-300 Hz. The objective of the tests as described in the document was to determine if the noise field generated during the static firing of a Nike solid rocket motor was representative of the estimated internal noise environment for the Space Shuttle Orbiter cargo bay.

Apparatus and Methods

Nike Rocket Motor.- The Nike rocket motor was developed in the early 1950's as a first stage for several types of antiaircraft missile systems. One of these, the Nike-Ajax, is shown in the left hand photograph of figure 3. The Nike solid fueled motor was found to be very stable, easy to handle, and highly reliable. These characteristics allowed for its wide use as a booster for scientific payloads in addition to the military mission. One example of this, a Nike-Iraquois, is shown in the right hand photograph of figure 3.

The Nike M-88 (NASA M5-E1 Booster) is a solid propellant rocket motor. The casing weighs approximately 208 kilograms (460 pounds), and the propellant grain weighs approximately 342 kilograms (755 pounds) for a total Nike motor loaded weight of 550 kilograms (1,215 pounds). The motor is approximately 3.6 meters (12 feet) in length and has a maximum outside case diameter of approximately 42 centimeters (16-1/2 inches). The maximum thrust developed by the Nike motor is approximately 204,608 newtons (46,000 pounds), and the burn time is on the order of 3 seconds.

Test Area.- Wallops Flight Center, on the Eastern Shore of Virginia, is approximately 145 km (90 miles) north of the Langley Research Center. The administrative offices, technical service support shops, etc., are located at the Main Base on the mainland. Wallops Island, off the coast of Virginia, is approximately 11 km (7 miles) southeast of the Main Base separated from the mainland by a causeway and bridge. The island is approximately 10 km (6 miles) long and about 0.8 km (1/2 mile) in width at its widest point. Launch sites were established on Wallops Island in 1945 by the Langley Research Center.

Shown in the photograph of figure 4 is an aerial view of Wallops Island looking north. The general area of the pad and blockhouse area chosen for the static firing of the Nike motors for the subject tests is indicated by the arrow. A more detailed pictorial of the blockhouse and pad arrangement is shown in figure 5.

Test Arrangement.- The test motors were mounted on the pad vertically with the exhause nozzle up as shown in the photograph of figure 6. The thrust was transmitted to the concrete pad through a spider-ring assembly, and three guy wire assemblies were utilized to stabilize the motor.

Acoustic Measurements.- In order to determine the characteristics of the near acoustic field of the Nike motors, a microphone array was deployed as indicated in figure 7. As shown in the figure, a total of 16 measurement locations were utilized; 2 microphones were placed in the horizontal plane of the exit nozzle and the other 14 microphones were placed on 1.2 meter stands at distances as indicated. The total acoustic measurement and recording system used for the Nike tests are the standard systems utilized by the Langley Research Center for aircraft noise flyover measurements. This system has a usable frequency range of from approximately 6 Hz to 20 kHz and a maximum acoustic level capability of approximately 160 dB and has been utilized in aircraft certification type testing (ref. 8). A general instrumentation block diagram for the measurement and recording system is shown in figure 8. All signal conditioning, recording, and playback equipment was located in blockhouse number 3 during the tests (see fig. 5).

During the firings "quick look" data analysis was provided for by the use of a narrow band analyzer equipped with a CRT display and hard copier. The "after test" analysis was performed by utilizing a standard General Radio type one-third octave band analyzer with the general specifications as shown required by reference 9.

The firings were made on 2 consecutive days. For Nike 1 the ambient temperature was 1.1°C (93°F), the relative humidity was 83 percent, and the winds were calm. For Nike 2, the ambient temperature was 2.8°C (98°F), the relative humidity was 79 percent, and the winds were 7-8 knots from the south.

RESULTS AND DISCUSSION

Measured Noise Data.- Time histories of the rms value of the overall sound pressure level as measured at microphone 1 for the firing of Nike 1 and Nike 2 are shown in figure 9. One can observe the buildup and decay of the overall noise level over the burn time of the motor and can observe the variations in overall sound pressure level as a function of time. These variations in level were apparent to observers standing outside of the blockhouse during the firing and were described as having a crackling, tearing, characteristic. It can be seen, however, that the overall noise levels for both motors measured at microphone position 1 are approximately the same magnitude, and the burning time of both motors was approximately the same.

In order to determine if there were any distinct tones in the noise spectrum of the two motors, narrow band analyses techniques were utilized.

An example of this type of analysis is shown in figure 10. Represented on the figure is the narrow band (10 Hz bandwidth) spectral characteristics of the noise as measured at microphone 1 for the firing of Nike 1. It can be seen that the only distinct peak occurs at approximately 100 Hz and is thought to be associated with a cavity resonance of the motor. Above that frequency, the noise seems to be somewhat broadband in nature and decreases in level with an increase in frequency.

In order to compare the noise data from the rocket motor firing with the estimates for the Shuttle cargo bay compartment, a one-third octave band analysis was performed on the data from each microphone position for each firing. A complete listing of these data are contained in Table I. Plotted in figure 11 for comparison are the one-third octave data from microphone 1 for both firings. The spectra peak generally in the 160 Hz frequency range and are very similar in shape for the two firings. Inspection of the third octave band listings as shown in Table I indicate that the noise data taken at the same mircophone position for both rocket motors are generally comparable even though one motor was loaded in 1955 and the second loaded in the early 1970's. This is some indication of the stability of the particular propellant grain utilized for the Nike motor. Due to the short burn time of the Nike motor some care must be exercised when interpreting the one-third octave band data below 125 Hz. The total burning time on the Nike motor is on the order of 2-1/2 to 3 seconds; at the lower frequencies, the analysis sample time is too short to give results having reasonable confidence limits. At such frequencies, the levels as indicated in the tables could vary ± several dB. In interpreting the data of Table II, it should also be noted that all acoustic measurements were taken either in or below the plane of the exhaust nozzle. Higher noise levels would be obtained by making measurements along a line approximately 45^{0} to centerline of the exhaust nozzle.

Comparison of Measured With Predicted Levels

In order to determine if the noise field of the Nike rocket motor is suitable for Space Shuttle payload qualification testing, a comparison was made between the measured Nike noise levels and the estimates of reference 1 for the Shuttle Orbiter cargo bay. As the data of reference 1 are shown in octave form, the one-third octave band data for the Nike firings as listed in Table I were corrected to octave band data and the results are listed in Table II.

The boundary lines encompassing the range of estimated noise levels for the Shuttle cargo bay area (from fig. 2) are shown for comparative purposes in figure 12. The range of octave band levels as measured at microphone positions 1, 2, 3, and 5 for the firing of the two Nike motors is indicated by the crosshatched area. These particular measured data are shown as they seem to offer the best "fit" when compared to the range of estimated levels. The levels are in good agreement for the octave bands having center frequencies from 31.5 to 500 Hz. Depending on which estimation technique is used for comparison, the measured levels at frequencies below 125 Hz may be somewhat low, and the measured levels above 1000 Hz frequency tend to be higher than those estimated. However, the data of this figure indicates that the Nike rocket motor may be an acceptable noise source for some qualification testing of Shuttle payloads and perhaps other types of general noise testing. The data of Tables I and II indicate that the spectral shape and level of the noise is fairly constant over the distances for which measurements were made. This would lead one to conclude that a relatively uniform sound field exists for the testing of large objects.

CONCLUDING REMARKS

Noise measurements under controlled conditions have been accomplished during the firing of two Nike rocket motors. These measurements indicate that the Nike rocket motor could be a suitable noise source for the qualification testing of Space Shuttle or other payloads and structures. In addition, the measurements indicate that Nike rocket motors loaded at different times exhibit very similar acoustic characteristics. The level and spectral content of the noise field of these motors may also make them applicable to other acoustic proof testing purposes and the uniformity of the sound field out to distances of approximately 41 meters (135 feet) would allow the noise testing of relatively large objects.

REFERENCES

1. On, F. J.: Shuttle Orbiter Payload Bay Internal Acoustic Environment During Lift-Off. NASA X-321-75-16, 1975.

2. Clevenson, S. A.; Hilton, D. A.; and Lauten, W. T., J .: Vibration and Noise Environmental Studies of Project Mercury. Proceedings of the Institute of Environmental Sciences Annual Technical Meeting, April 5-7, 1961, Washington, DC.

3. Mayes, W. H.; and Edge, P. M., Jr.: Application of a Blowdown Wind Tunnel for Large-Scale Acoustic Environmental Testing. Sound - Its Uses and Control, March-April 1962.

4. Hosier, Robert N.; and Mayes, William H.: A Procedure for Predicting Internal and External Noise Fields of Blowdown Wind Tunnels. NASA TM X-2556, 1972.

5. Benson, Robert W. and Associates: Evaluation of Simulation Procedures for High Intensity Noise Fields. NASA CR-66576, April 1968.

6. Mueller, Arnold W.; and Edge, Philip M., Jr.: Laboratory Simulation of the Combined Acoustic-Vibration Environment of Launch Vehicle Onboard Electronic Equipment. Proceedings of Institute of Environmental Sciences Annual Technical Meeting, Chicago, Illinois, April 21-23, 1965, pp. 299-303.

7. Edge, Philip M., Jr.; and Mayes, William H.: Some Initial Results of Low-Frequency Noise Research. Proceedings of NASA Conference on Langley Research Related to Apollo Mission, Langley Research Center, June 2-24, 1965, pp. 179-188, SP-101.

8. Hosier, R. N.: Some Comparisons of the Flyover Noise Characteristics of DC-9 Aircraft Having Refanned and Hardwalled JT8D Engines, With Special Reference to Measurement ana Analysis Procedures. NASA TM X-72804, 1976.

9. Anon: Federal Aviation Regulation, Part 36, Noise Standards: Aircraft-Type Certification; Federal Register, December 1, 1969, pp. 34-18355.

TABLE I.- ONE-THIRD OCTAVE BAND SOUND PRESSURE LEVELS IN dB RE 0.0002 DYNES/CM^2
FOR THE STATIC FIRING OF NIKE 1 AND NIKE 2

NIKE	Mic	OA	Third-Octave Band Sound Pressure Level, dB																											
			6	8	10	12	16	20	25	32	40	50	63	80	100	125	160	200	250	320	400	500	630	800	1K	1.25K	1.6K	2K	2.5K	3.2K	4
1	1	150	120	118	117	122	125	123	121	126	126	127	129	129	124	133	141	143	140	186	140	138	138	136	135	135	134	133	133	132	1
	2	150	114	114	118	121	125	125	126	130	130	130	130	130	128	134	141	143	139	137	139	137	138	136	136	136	135	134	134	133	1
	3	149	118	115	116	119	122	121	121	125	126	127	129	128	125	132	140	143	138	136	140	137	137	134	135	134	133	133	132	132	1
	4	150	122	120	122	125	127	125	126	130	129	129	127	125	135	140	144	141	136	143	136	138	135	134	134	134	133	132	133	133	1
	5	149	113	112	117	122	123	121	122	126	127	128	129	129	125	133	141	142	138	136	139	136	137	135	135	135	134	134	134	134	1
	6	148	115	113	114	119	122	122	121	126	126	127	129	131	129	124	133	138	139	139	134	137	136	135	134	134	134	133	133	132	1
	7	147	115	113	114	119	123	123	122	128	127	128	132	133	132	128	129	132	137	139	138	134	135	134	134	124	134	133	131	132	1
	8	145	113	113	114	118	120	120	120	124	124	126	129	131	131	130	129	127	132	137	137	135	132	133	132	133	132	131	132	131	1
	9	143	111	112	114	115	118	119	118	123	122	124	129	130	130	129	129	128	128	130	133	135	131	130	131	131	131	130	129	128	1
	10	143	110	110	112	116	120	119	118	124	124	125	129	130	130	129	130	128	126	127	132	133	132	130	130	130	129	129	128	127	1
	11	143	181	126	126	125	122	123	121	126	125	126	130	130	129	129	131	129	128	128	129	132	132	131	130	130	130	192	128	128	1
	12	141	109	110	111	114	118	118	116	128	128	125	128	129	129	128	130	129	126	127	128	131	131	130	128	129	128	126	125	124	1
	13	142	115	116	115	119	119	118	120	122	123	125	126	128	127	127	131	129	127	128	128	130	132	133	131	131	129	128	126	120	1
	14	140	108	109	110	112	117	117	115	121	121	123	126	127	128	127	129	127	126	126	125	128	128	128	127	126	126	125	124	122	1
	15	151	122	120	120	123	124	121	117	120	126	130	134	135	135	139	139	141	140	141	140	140	139	138	137	137	137	136	136	135	1
	16	147	116	114	112	118	120	119	116	118	119	121	128	133	135	131	134	137	134	137	136	136	134	134	134	134	133	132	131	131	1
2	1	151	116	116	121	123	122	126	128	129	131	133	134	132	128	138	144	143	140	136	139	136	137	136	135	134	134	133	133	133	1
	2	151	115	117	122	125	123	127	130	130	132	134	135	132	127	137	144	144	140	136	139	137	138	137	136	136	135	134	133	134	1
	3	151	119	117	121	123	122	126	129	129	131	133	134	131	127	138	144	144	140	137	139	136	137	136	135	136	134	133	133	132	1
	4	152	122	120	124	125	124	128	129	130	131	133	132	128	135	144	148	140	137	141	135	138	137	135	134	134	133	133	133	133	1
	5	151	117	118	122	124	122	126	129	129	131	133	134	132	127	138	144	143	140	137	139	136	137	136	135	135	135	134	135	132	1
	6	148	112	113	119	122	121	123	128	128	130	132	135	134	130	127	135	139	140	139	134	137	135	135	135	135	133	133	133	132	1
	7	148	112	112	118	122	122	122	127	127	130	132	135	135	134	130	130	133	138	139	137	134	136	134	134	134	134	134	133	132	1
	8	146	109	109	116	120	120	120	125	125	129	131	134	134	133	133	132	127	134	137	138	134	133	133	132	132	131	131	130	129	
	9	144	111	111	114	118	119	118	128	123	127	129	132	132	131	132	132	127	128	131	134	133	130	131	132	131	130	130	129	127	
	10	"NO DATA DUE TO MICROPHONE FAILURE"																													
	11	143	108	108	114	118	119	118	123	123	126	128	131	132	132	133	134	128	125	127	131	132	132	130	130	130	129	129	127	127	
	12	142	108	108	113	117	119	117	122	123	125	128	131	132	132	132	133	128	125	125	129	131	131	129	121	129	128	127	126	124	
	13	143	112	118	119	120	121	121	123	123	125	128	130	131	131	133	133	130	129	129	130	131	131	129	128	128	128	127	125	124	
	14	141	107	107	112	115	118	116	120	121	124	126	129	130	130	131	132	128	126	125	126	129	128	128	127	127	126	125	125	123	
	15	152	121	120	121	123	122	121	124	123	131	136	140	137	138	142	143	141	142	141	140	138	138	137	137	137	136	136	136	135	
	16	148	109	111	117	121	120	118	123	121	121	124	133	137	138	134	138	138	136	137	137	136	135	134	134	134	133	132	132	132	

TABLE II.- OCTAVE BAND SOUND PRESSURE LEVELS FOR THE STATIC FIRING OF NIKE 1 AND NIKE 2

NIKE	Mic.	Octave Band Sound Pressure Level, dB									
		8	16	32	63	125	250	500	IK	2K	4K
1	1	123	127	129	133	141	145	143	139	137	135
2	1	122	128	134	137	144	145	142	139	137	135
1	2	120	128	133	134	141	144	142	140	138	137
2	2	123	129	135	138	144	145	142	140	138	137
1	3	121	125	129	132	140	144	142	139	137	136
2	3	124	128	134	137	145	146	142	139	138	136
1	4	125	130	133	132	145	145	141	138	137	136
2	4	127	130	135	135	149	144	141	139	137	136
1	5	119	126	130	133	141	144	142	139	138	136
2	5	124	129	134	137	144	145	141	139	139	137
1	6	118	125	129	134	134	143	140	139	138	135
2	6	120	126	133	138	136	143	139	139	137	135
1	7	118	126	130	136	134	141	140	138	137	134
2	7	119	126	133	138	136	142	140	138	138	135
1	8	117	124	127	133	134	138	139	137	136	132
2	8	117	124	131	137	137	138	139	137	135	131
1	9	116	122	126	132	133	133	137	135	134	130
2	9	116	123	129	135	136	133	137	135	134	129
1	10	115	123	127	133	13[illegible]	131	137	134	133	129
2		NO DATA DUE TO MICROPHONE FAILURE									
1	11	115	127	128	133	134	132	136	135	133	130
2	11	115	123	128	135	136	131	136	134	133	129
1	12	144	122	126	132	133	131	134	133	131	128
2	12	115	122	127	134	136	131	135	133	131	127

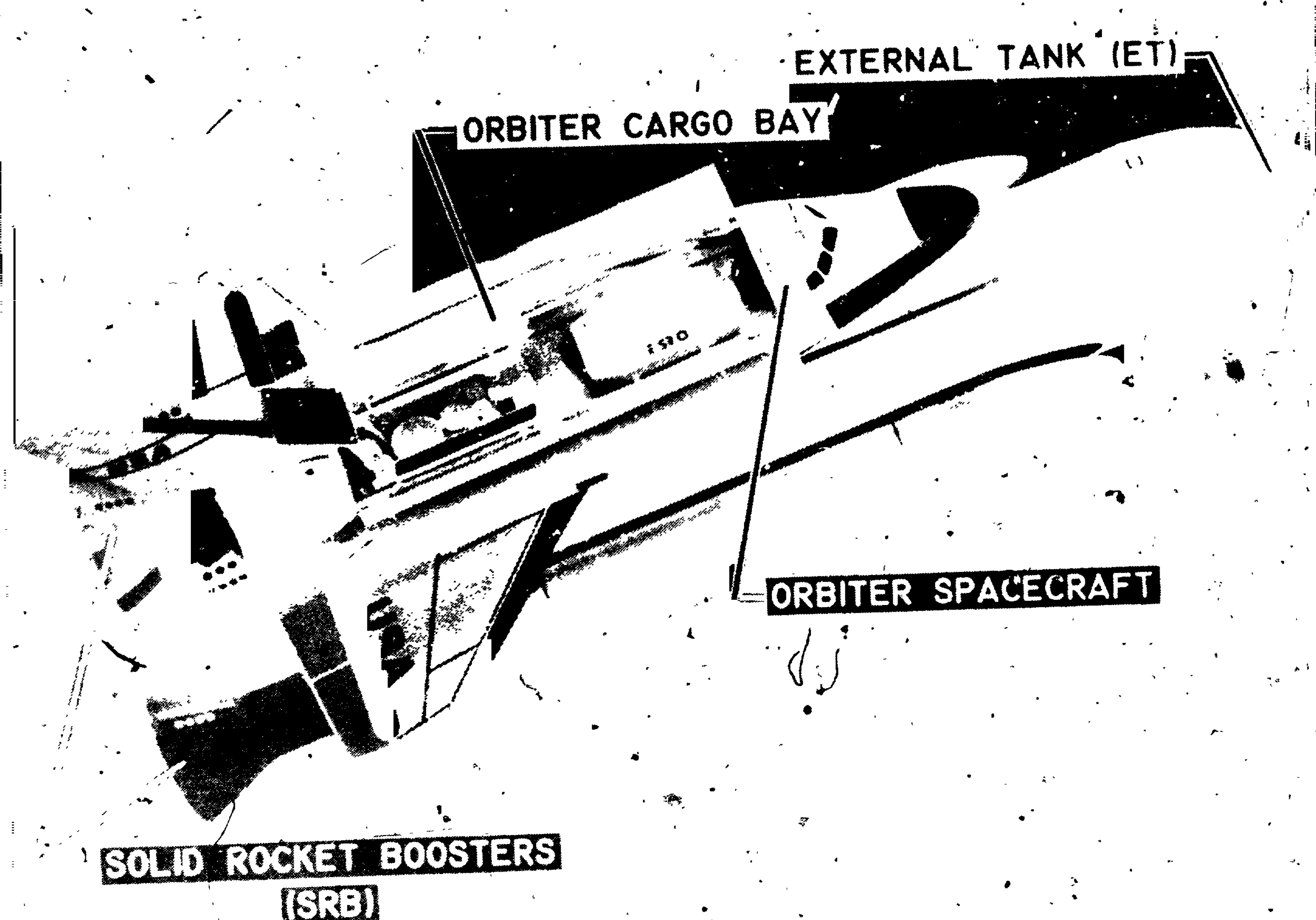


Figure 1.- Space Shuttle vehicle.

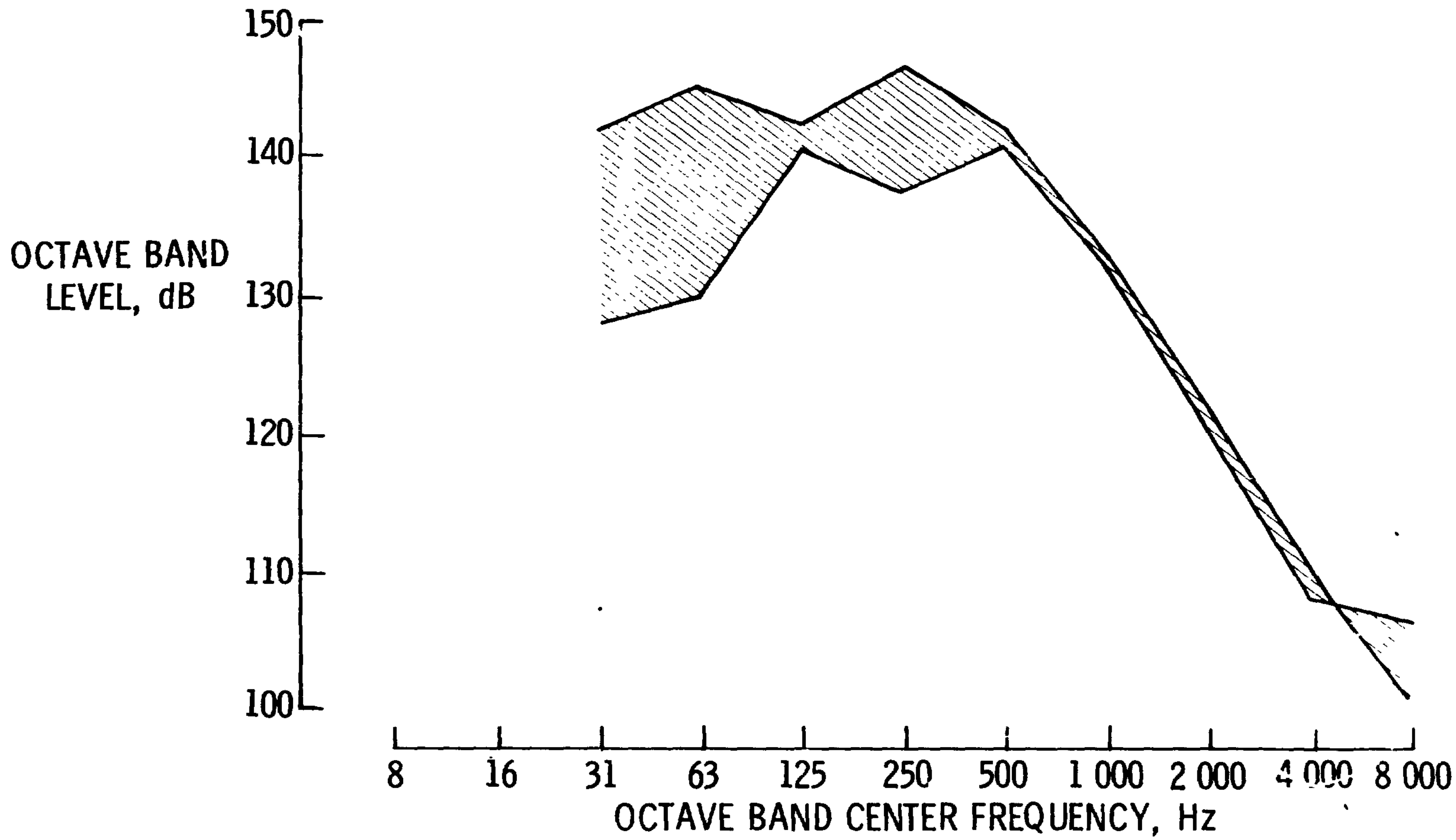


Figure 2.- Estimated noise levels in the orbiter cargo bay during lift-off.

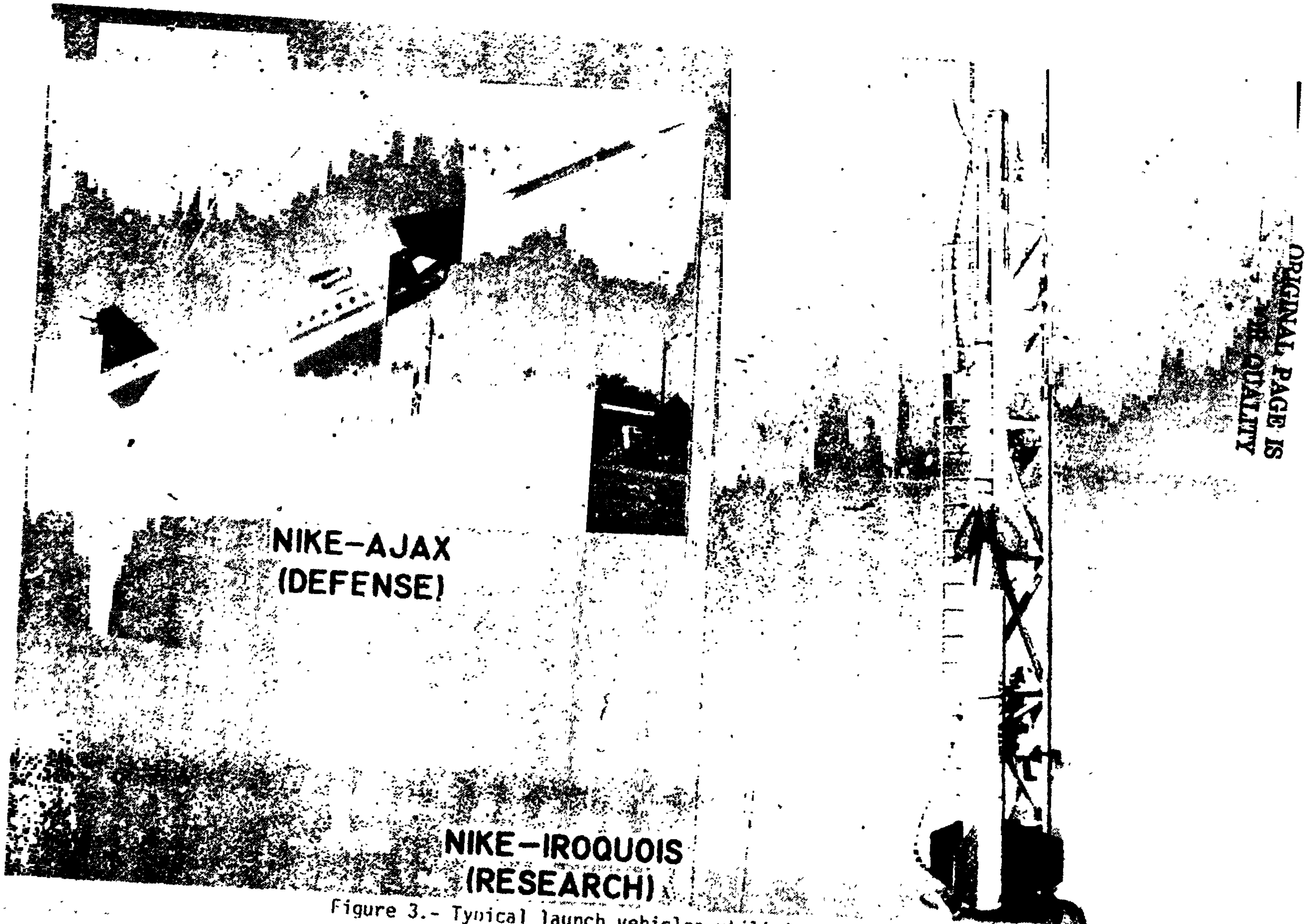


Figure 3.- Typical launch vehicles utilizing a Nike booster.

Figure 4.- Wallops Flight Center launch area.

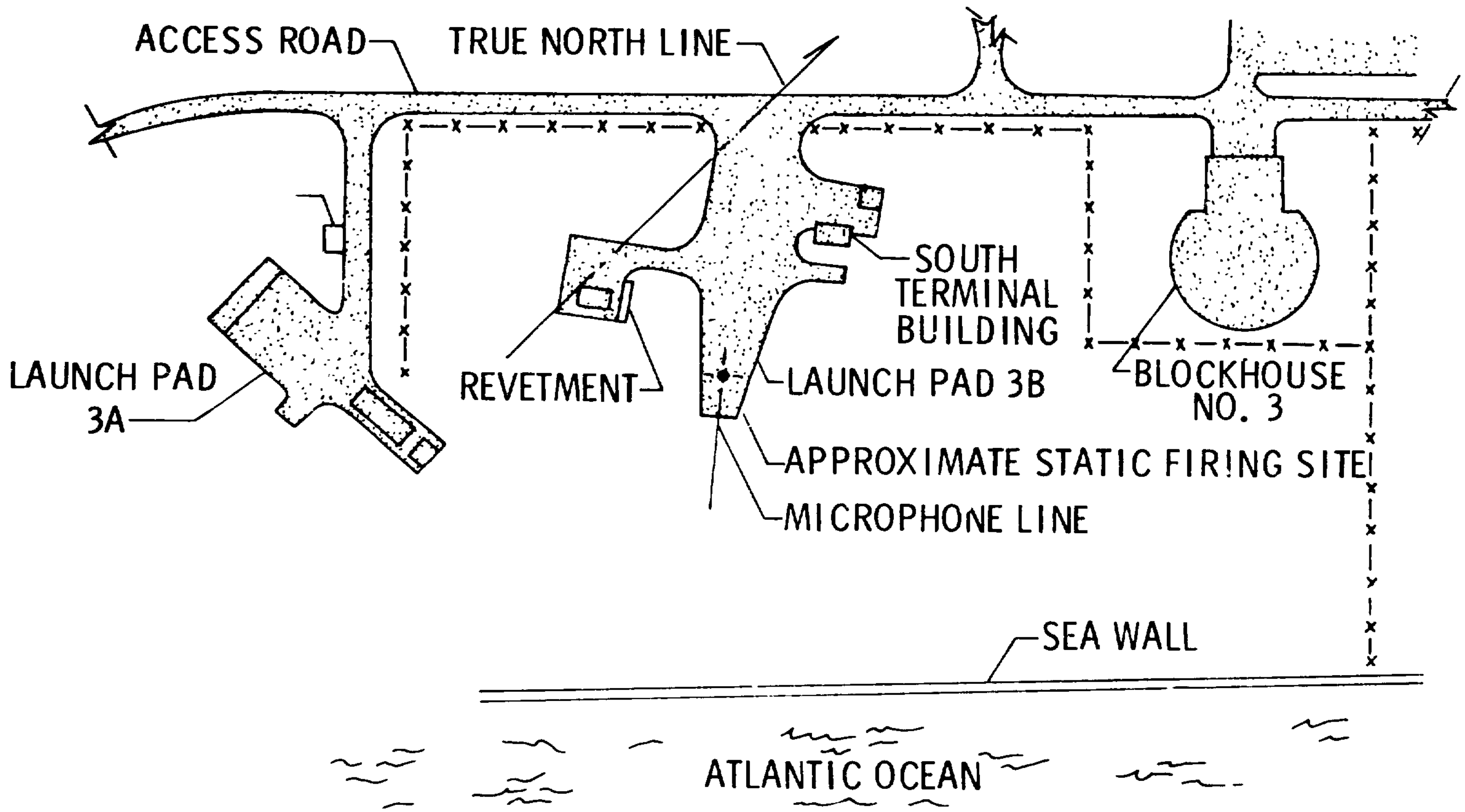
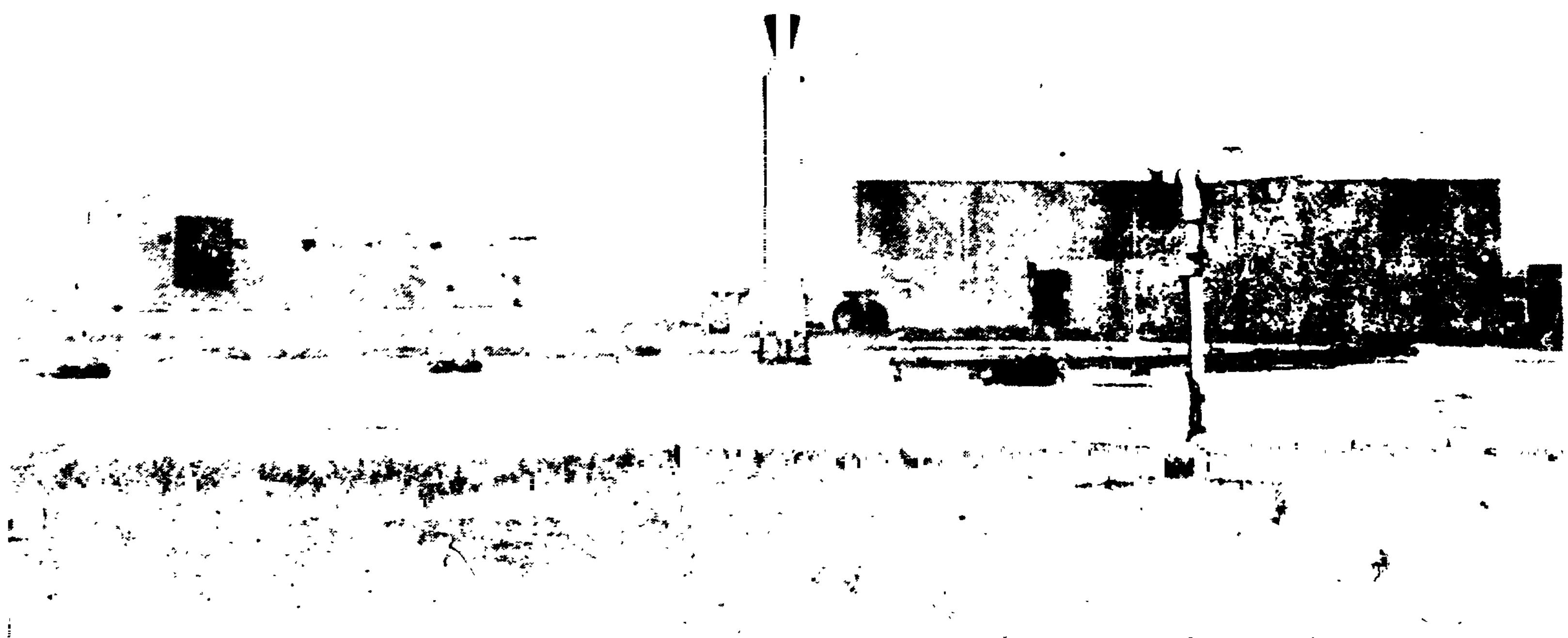
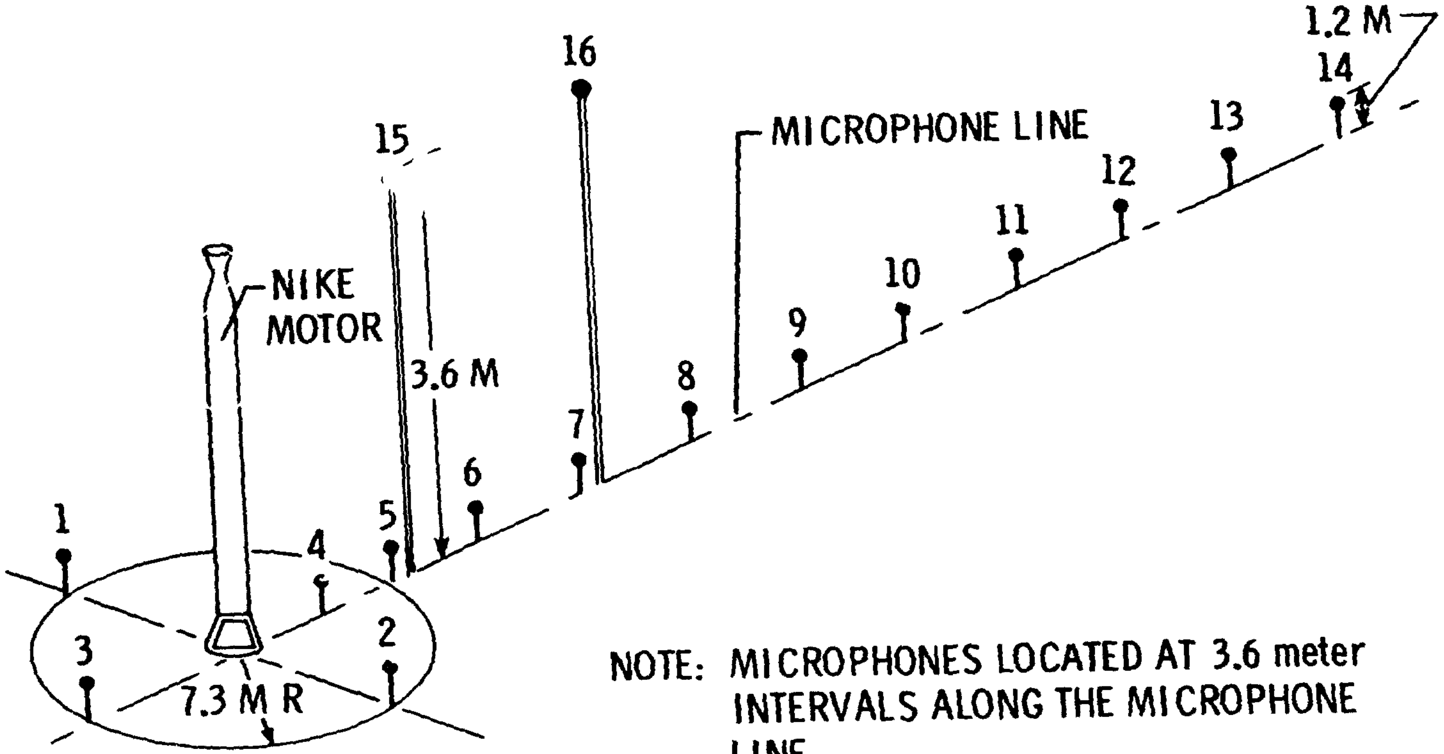


Figure 5.- Nike static firing site - launch pad 3B.



... motor mounted on pad 3B for static firing.



NOTE: MICROPHONES LOCATED AT 3.6 meter INTERVALS ALONG THE MICROPHONE LINE.

Figure 7.- Microphone array as utilized for the Nike static firing noise measurements.

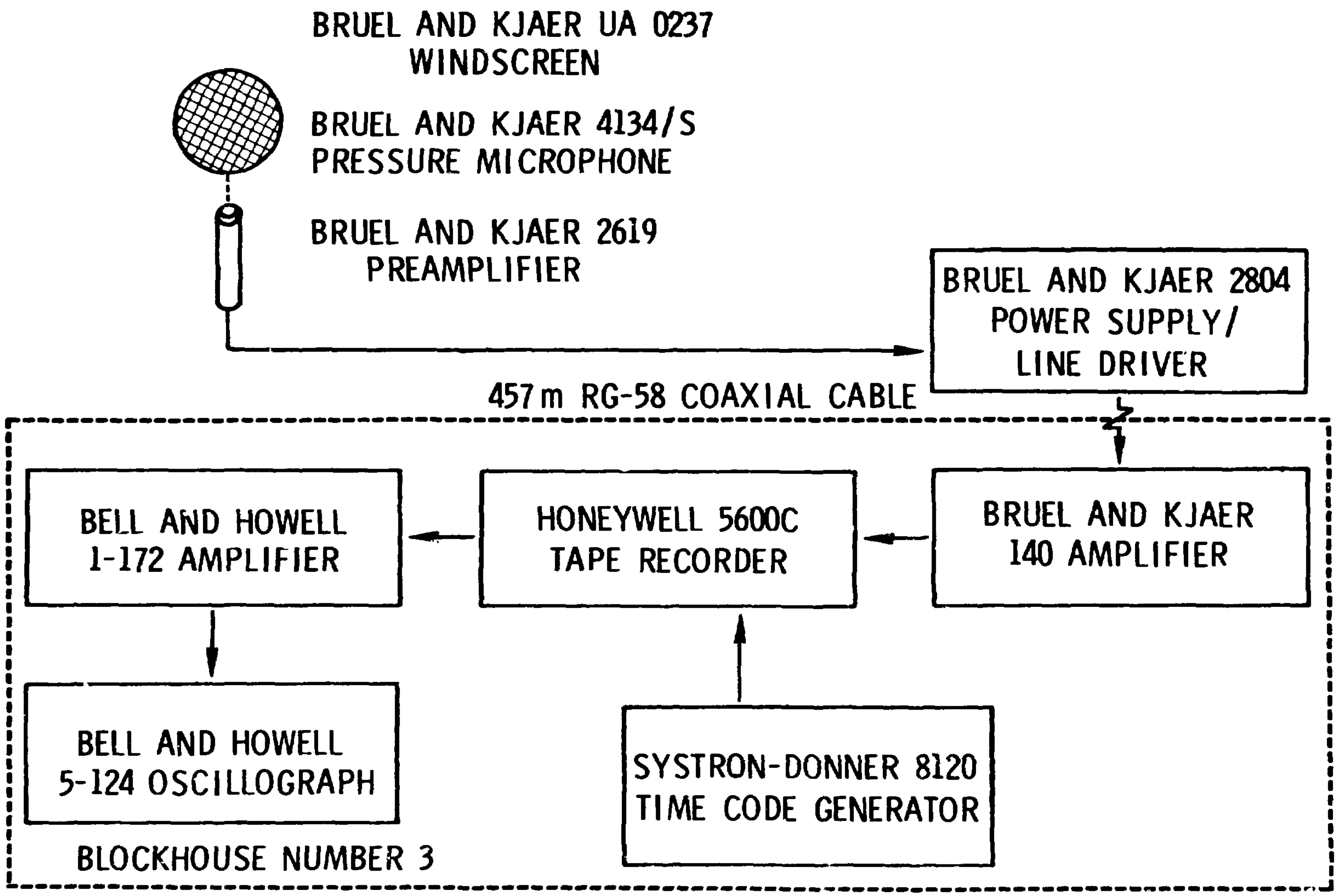


Figure 8.- Instrumentation block diagram - Nike static noise measurements.

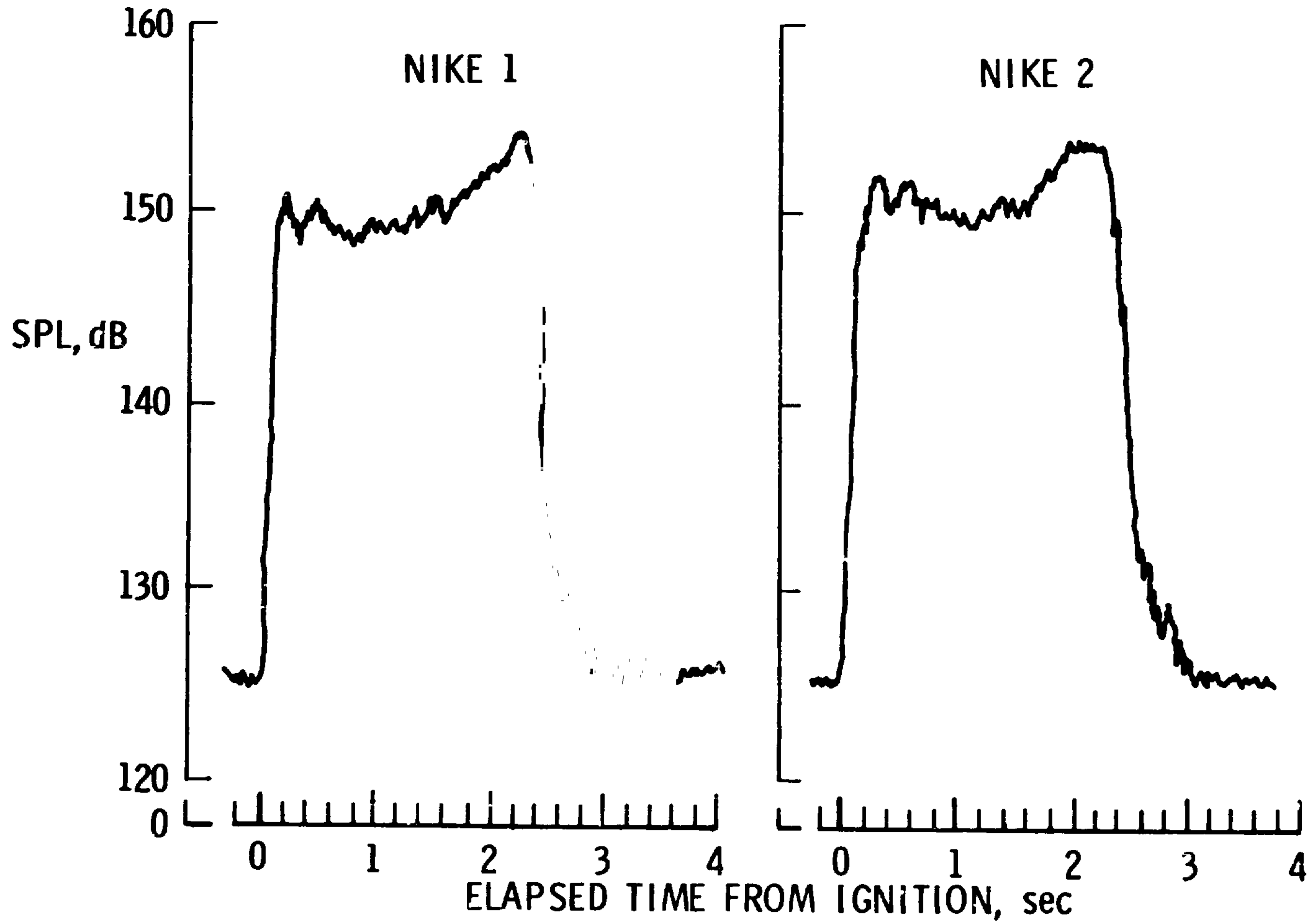


Figure 9.- Overall noise time histories as measured at microphone position 1 during the static firing of Nike 1 and Nike 2.

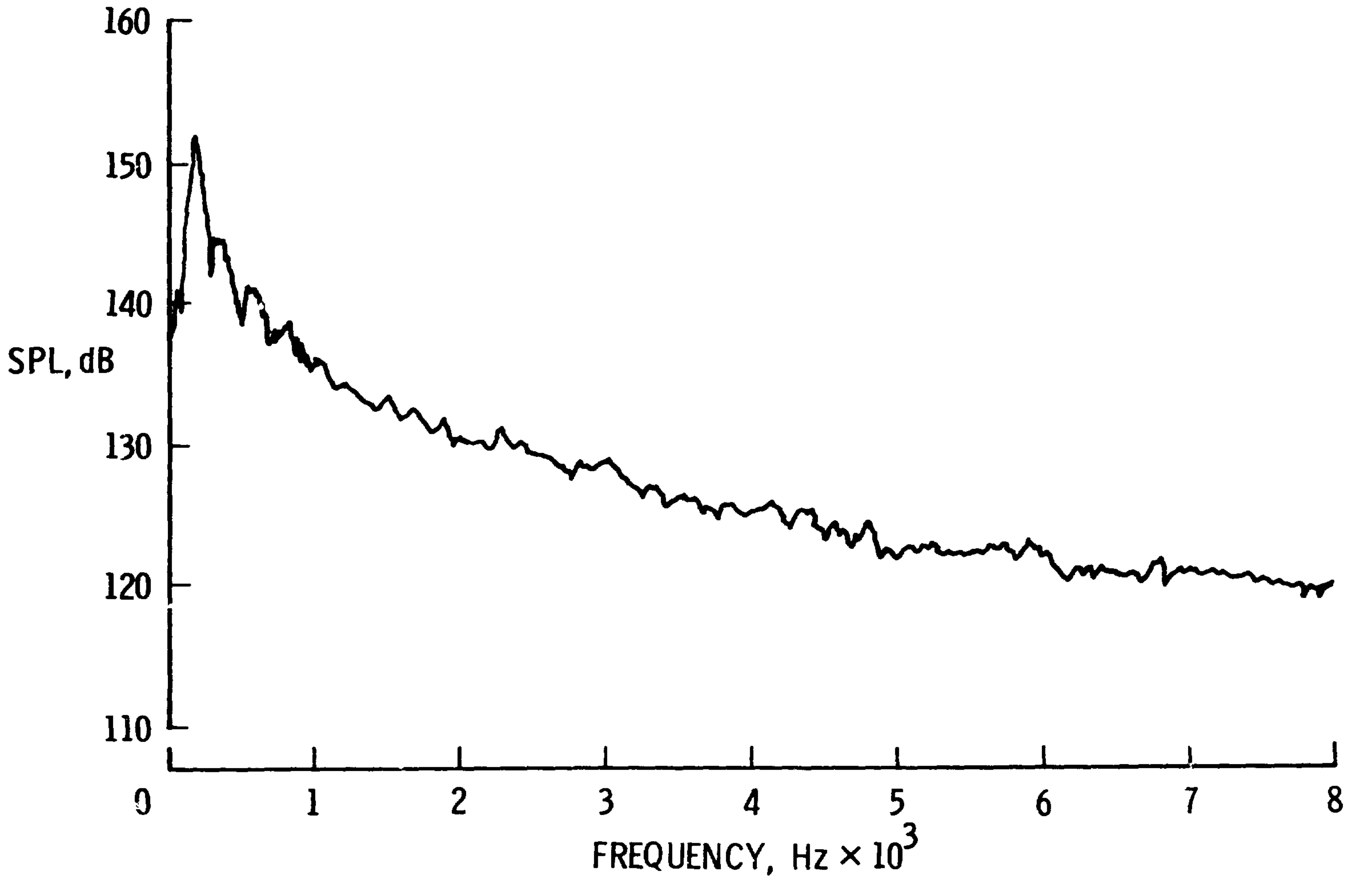


Figure 10.- Narrow band analysis (10 Hz bandwidth) of the noise as measured at microphone position 1 during the static firing of Nike 1 and Nike 2.

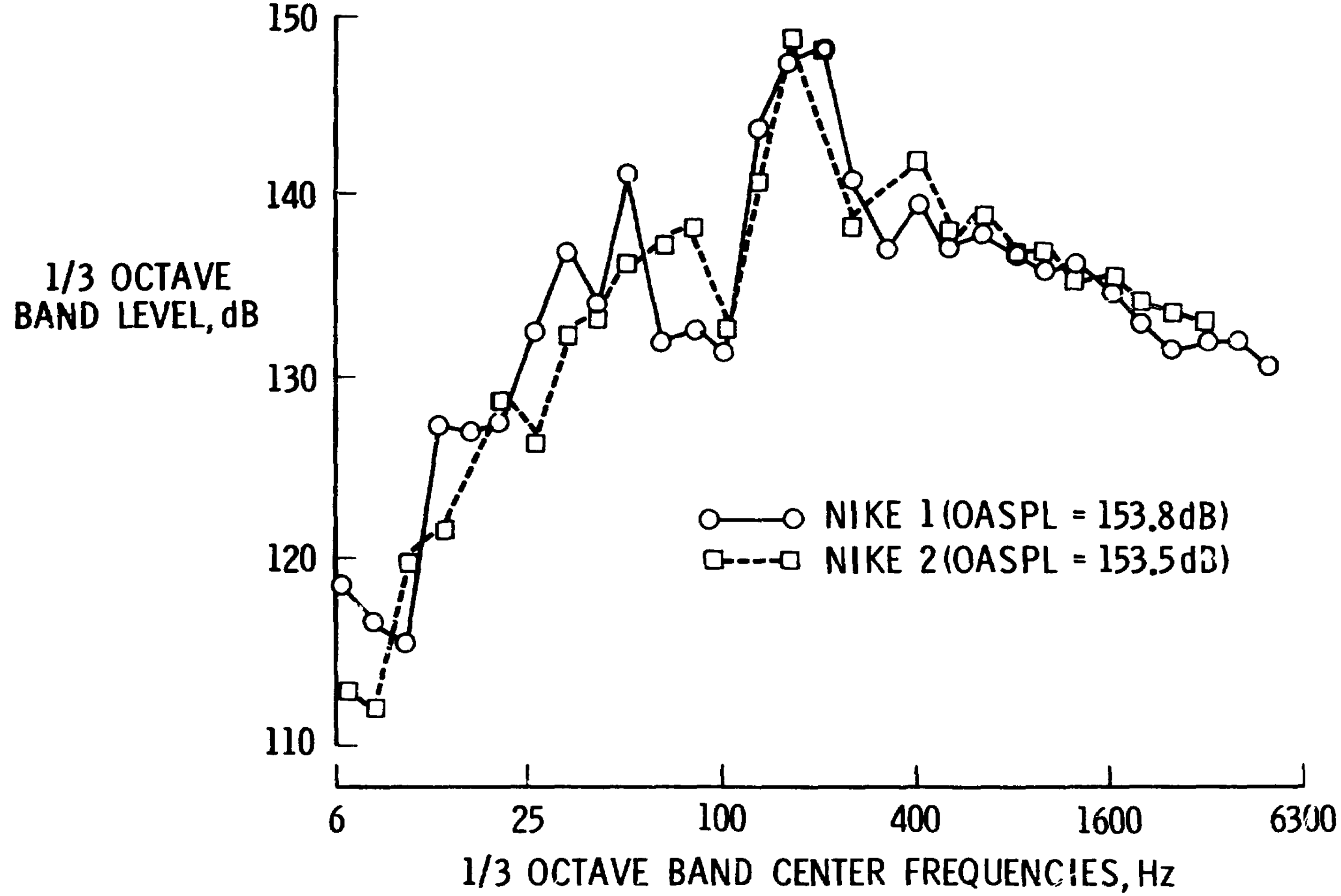


Figure 11.- One-third octave band analysis of the noise as measured at microphone position 1 during the static firing of Nike 1 and Nike 2.

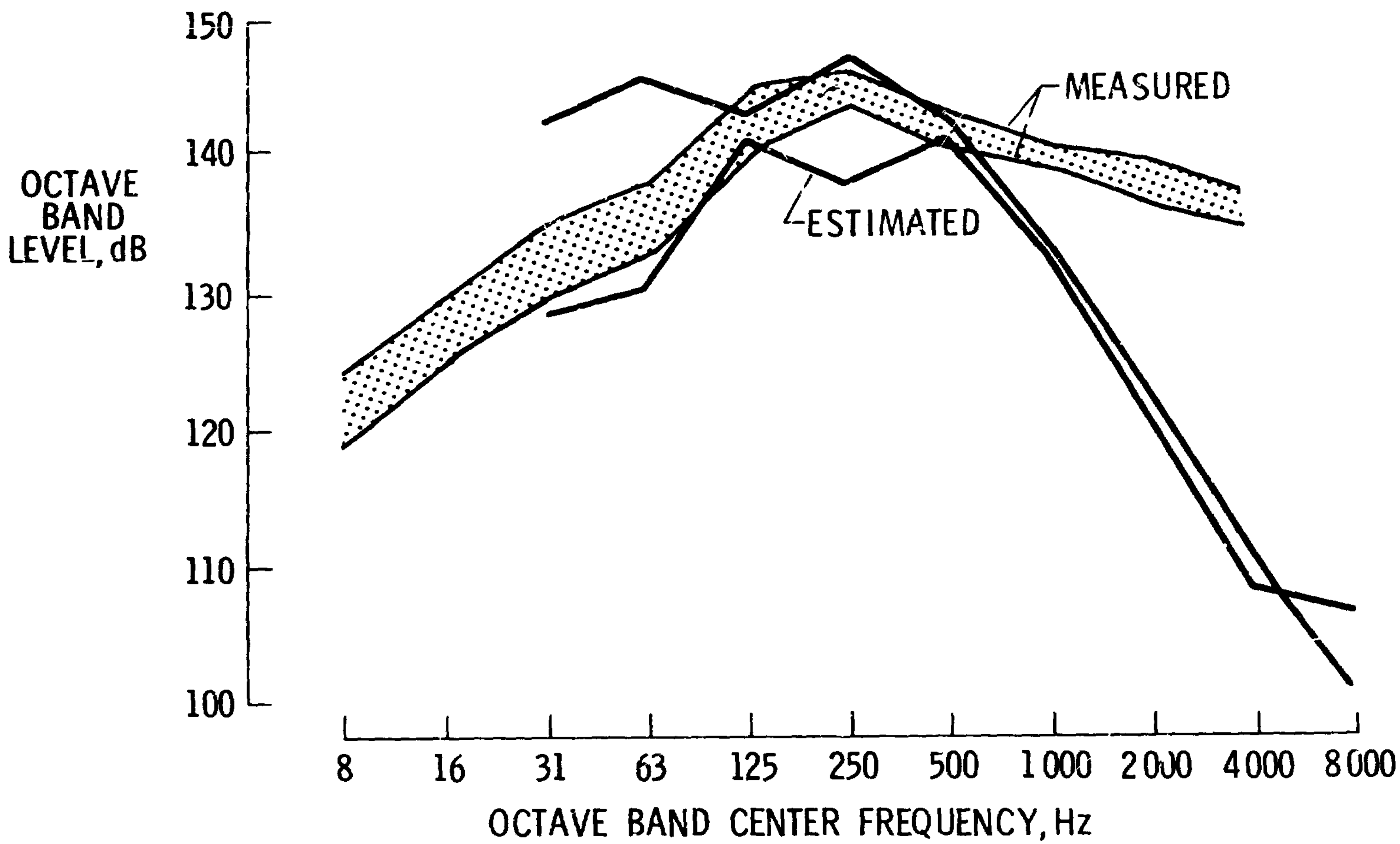


Figure 12.- Comparison of the estimated noise levels in the orbiter cargo bay with the range of noise levels measured at microphone positions 1, 2, 3, and 5 during the static firing of Nike 1 and Nike 2.

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15. Supplementary Notes

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16. Abstract During the launch and ascent flight phases of large space vehicles such as the Space Shuttle, the vehicle itself and the payload it carries can be subjected to high level acoustic energy produced by the first stage rocket motors. It is highly desirable that certain vehicle and payload components be environmentally qualified before flight and considerable effort has been expended in the search for suitable noise sources that could be used conveniently for the proof testing of space vehicle structures and payloads. It had been suggested that the exhaust noise of a Nike solid propellent rocket motor might be suitable to reproduce the interior noise environment that had been predicted for the Shuttle Orbiter cargo bay during lift-off. The Nike motor is easy to handle, readily available in reasonable quantity, and relatively low in cost. In order to document the noise field of a typical Nike motor during static firing, noise measurements were recently accomplished at the NASA Wallops Flight Center during the firing of two Nike boosters. The boosters were mounted vertically with the exhaust nozzle up and an array of 16 microphones was located around the test stand. Two boosters of different ages were fired in order to determine the degree of correlation between noise measurements made on motors having different loading dates. This paper presents the results of these measurements in octave and 1/3 octave form along with corresponding overall noise level listings. There was very good agreement between the data as measured for the two Nike motors tested although the first motor was loaded in 1955, and the second motor was loaded in the early 1970's. As applied to the specific case of the Space Shuttle; the noise field of the Nike motor provided a reasonable reproduction of the estimated interior noise levels.

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