U.S. ARMY

Technical Note 4-68

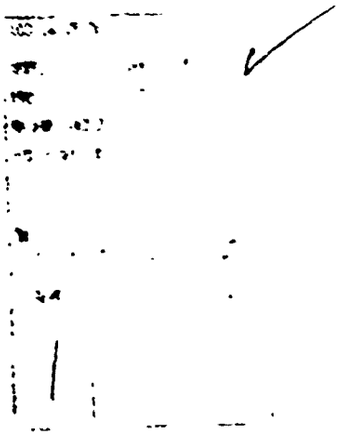
ACOUSTICAL STUDY OF THE CH-47B (CHINOOK) HELICOPTER

Thomas S. Bragg

March 1968

HUMAN ENGINEERING LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND



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ABSTRACT

Sound measurements were conducted in the CH-47B (Chinook) Helicopter under conditions of normal cruise, maximum continuous power, level flight at various air speeds, hover, level accceleration and deceleration, and partial-power descent. Results are presented and compared with applicable parts of Military Specification MIL-A-8806A and U. S. Army Human Engineering Laboratories Standard S-1-63B. Variations of the noise from that specified in these documents are discussed, and it is recommended that the noise be reduced to conform to the specified levels.

CONTENTS

ACOUSTICAL STUDY OF THE CH-47B (CHINOOK) HELICOPTER

INTRODUCTION

Sound measurements were made in the CH-47B (Chinook) Helicopter at the request of the U. S. Army Aviation Test Activity Preliminary Evaluation Team, Edwards Air Force Base, Cal., on 13 and 14 April 1967. The tests were conducted at Philadelphia International Airport, Philadelphia, Pa. The Chinook tested was serial number 65-7992. Measurements were made during level flight at various speeds, during hover conditions, during level acceleration and decelerations, and during partial-power descents. The measurements were checked for compliance with Military Specification MIL-A-8806A (6). For reference purposes, the measurements were also compared with HEL Standard S-1-63B (5).

METHOD

Measurements were made in all or some of three specific locations inside the aircraft for the various flight conditions tested. These locations were (1) Station 95 (in the cockpit) between the heads of the pilot and copilot at approximately ear height, (2) Station 320 (in the cargo area) on the longitudinal axis of the aircraft, and (3) Station 480 (in front of the rear ramp) also on the longitudinal axis of the aircraft (Fig. 86A). In addition, measurements were made outside the aircraft at four positions on the ground while the helicopter hovered 10 feet above. These positions were all approximately 20 meters from the aircraft and were located (1) at 0^{o} (directly in front of the aircraft), (2) at 90^{o} (on the starboard side of the aircraft), (3) at 180^{o} (directly behind the aircraft), and (4) at 270^{o} (on the port side of the aircraft) (Fig. 87A).

Measurements were made at two rotor speeds, 225 rpm and 230 rpm, for most flight conditions; however, data were obtained at only one rotor speed for a few conditions.

Equipment used in making the measurements was (1) A Bruel & Kjaer (B&K) Type 2203 sound-level meter, (2) a B&K Type 1613 octave-filter set, (3) a B&K Type 4131 microphone, and (4) a Nagra Type III-B tape recorder. Equipment was set up as shown in Figure 88A. A sample of noise was recorded in each of the test positions for each test condition. For these recordings, the octave-filter set was bypassed and the sound-level meter served as an attenuator-preamplifier, calibrated

in 10-decibel (dB) steps. To assure veracity of the recordings, the octave-filter set was used to make an on-site octave-band noise analysis, which was later compared with tape-recorded data taken under the same conditions to verify that the readings were the same.

The tape recordings thus obtained were analyzed in the laboratory using (1) the same Nagra Type III-B tape recorder, (2) A B&K Type 1612 band-pass filter set, (3) a B&K Type 2604 microphone amplifier, and (4) a B&K Type 2305 graphic level recorder. This equipment was set up as shown in Figure 89A. A noise sample was played back, using the microphone amplifier as an amplifier and attenuator, through the octave-filter set. The noise spectrum was then traced automatically by the graphic level recorder. For noise samples that do not vary with time such as those obtained during level flight, the octave-filter set sweeps through the octaves automatically, producing a record similar to that shown in Figure 90A. For noises that vary with time, as during an acceleration or deceleration, it is necessary to plot each frequency band separately, producing a set of records similar to that shown in Figure 91A.

Calibration of the above equipment was performed according to manufacturers' instructions and has National Bureau of Standards traceability. Procedures to be followed in calibrating sound-level meters and microphones are covered by ASA Standards (1, 3). A known sound level of 124.0 dB was produced by a B&K Type 4220 pistonphone calibrator. This known sound level was recorded on tape through the same microphone which was used to make the noise recordings. When the noise recordings were analyzed, the known sound level was used to adjust the output of the graphic recorder, assuring accuracy from source to final plot.

Some noise samples taken at Station 480 were taken again with all inside panels, insulation, etc., aft of Station 486 removed to expose the hydraulic lines, etc., in that section. This was done to simulate actual combat conditions, since these aircraft are being flown in the Republic of Vietnam with these panels, etc., removed so that hydraulic-line breaks caused by enemy fire can be quickly observed.

All noise analyses were performed using the "preferred" frequencies of the ASA Standards (2). Both HEL Standard S-1-63B and Military Specification MIL-A-8806A now use these "preferred" frequencies.

RESULTS

Measurements at Normal Cruise-Power Air Speed

These measurements were performed at all three interior positions at a rotor speed of 225 rpm. No data were obtained at a rotor speed of 230 rpm. The results are shown in Table 1A and in Figures 1A to 3A. For normal cruise-power air speed only, an exception was granted by the Detail Specification (4) which increased the allowable octave-band noise levels of the applicable part (Table IV A) of MIL-A-8806A. This new noise level is shown in table and graphs, along with the original level for reference. The HEL Standard was not altered by the Detail Specification, and it is also shown in the table and graphs for reference.

Measurements at Maximum Continuous Power

These measurements were performed at all three interior locations at a rotor speed of 230 rpm. No data were obtained at a rotor speed of 225 rpm. The results are shown in Table 2A and in Figures 4A to 7A. For maximum continuous-power data, MIL-A-8806A has two parts that apply. One (Table III A) applies only when personnel wear protective helmets, and the other (Table I A) applies when helmets are not used. Both are shown for reference in the table and graphs, as is the HEL Standard.

Although the CH-47B's maximum continuous power is 1520 pounds torque, an additional set of measurements was performed under the short duration power of 1720 pounds torque. These data also were obtained only at a rotor speed of 230 rpm. The results are shown in Table 3A and in Figures 8A to 10A. The table and graphs also show the part (Table II B) of MIL-A-8806A that is applicable for short duration conditions, as well as the HEL Standard.

Measurements in Level Flight at Various Air Speeds

These measurements were performed at all three interior locations at rotor speeds of 225 rpm and 230 rpm. The speeds selected for measurement were 30 knots, 40 knots, 60 knots, 80 knots, 100 knots, 120 knots, and 140 knots. The results are shown in Tables 4A to 10A and in Figures 11A to 56A. No data were obtained at Stations 320 and 480, rotor speed 225 rpm, air speed 140 knots, because equipment malfunctioned. Measurements were not made at Station 480 with insulating panels removed at any air speed for rotor speeds of 225 rpm, nor were they made at 30 knots at 230 rpm. In some other records either the first or last point was omitted because of limited dynamic range of the equipment.

The various air speeds may all be considered to be short-duration conditions; hence, the part (Table II A) of MIL-A-8806A that applies to these conditions is shown in the tables and graphs, as is the HEL Standard.

Measuremems During Hover Conditions

Measurements were performed at all three interior locations while the aircraft was hovering (out of ground effect) at rotor speeds of 225 rpm and 230 rpm. At Station 480 measurements were made both with insulating panels in place and with them removed. The results are shown in Table 11A and in Figures 57A to 64A. Since hovering may be considered to be a short-duration condition, the part (Table II A) of MIL-A-8806A that applies to those conditions is shown in the tables and graphs, as is the HEL Standard.

Measurements were also performed at the four exterior positions described earlier (Fig. 2A) while the helicopter was hovering (in ground effect) at approximately 10 feet. These results are shown in Table 12A and in Figures 65A to 68A. Since MIL-A-8806A applies just to noise inside the aircraft, the HEL Standard is the only one shown in the table and graphs.

Measurements During Level Accelerations and Decelerations

Measurements were performed at two interior locations (Stations 95 and 320) at rotor speeds of 225 rpm and 230 rpm during level accelerations from 40 knots true air speed to 140 knots true air speed. The data were analyzed to show the time history of the noise in each octave band. From these analyses the range of the highest to the lowest sound pressure level was obtained for each octave band. These results are shown in Table 13A and as the shaded area in Figures 69A to 72A. The table and graphs also show the part (Table II B) of MIL-A-8806A that is applicable for short-duration conditions as well as the HEL Standard.

Measurements were also performed in the same locations and at the same rotor speeds during level decelerations from 140 knots true air speed to 40 knots true air speed. This data was also analyzed to show time histories of the noise in each octave band from which the range between the highest and lowest sound pressure levels was obtained. These results are shown in Table 14A and as the shaded area in Figures 73A to 76A. The table and graphs also show the part (Table II B) of MIL-A-8806 that is applicable for short duration conditions, as well as the HEL Standard.

Measurements During Partial-Power Descents

Partial-power descents were flown at true air speeds of 60 knots and 100 knots, both with rotor speeds of 230 rpm. Measurements were made at rates of descent of 500 feet per minute, 1000 feet per minute, and 1500 feet per minute. At 60 knots, measurements were made only at Station 95; at 100 knots, measurements were made at both Station 95 and Station 320. Power levels during tests at 60 knots were (1) for 500 feet per minute descent, 750 pounds torque; (2) for 1000 feet per minute descent, 590 pounds torque; and (3) for 1500 feet per minute descent, 120 pounds torque. Power levels during tests at 100 knots were (1) for 500 feet per minute descent, 750 pounds torque; (2) for 1000 feet per minute descent, 540 pounds torque; and (3) for 1500 feet per minute descent, 320 pounds torque.

These data were analyzed to show the time history of the noise in each octave band. From these analyses the range from the highest to the lowest sound pressure level was obtained for each octave band. These results are shown in Tables 15A and 16A and as the shaded area of Figures 77A to 85A. The tables and graphs also show the part (Table II B) of MIL-A-8806A that is applicable for short duration conditions, as well as the HEL Standard.

DISCUSSION

Measurements at Normal Cruise-Power Air Speed

The noise measured at this air speed can be said, in general, to meet the requirements of the exception to MIL-A-8806A. There are a few octave bands where the noise exceeds the specified level by two to four dB, but these instances should not be viewed as serious violations. There is a serious violation of the HEL Standard S-1-63B in the 2000-Hertz (Hz) octave band measured at Station 95, where the noise exceeds the standard by 11 dB. (The noise also exceeds the MIL Specification by three dB at this frequency. It should be noted that the exception to MIL-A-8806A is considerably more lenient than the HEL Standard in this middle frequency range, but it is only shown for reference. The Military Specification governs aircraft testing.) With this one exception, the noise at this air speed also meets the requirements of HEL S-1-63B, or is no more than three dB above the specified levels, at all other positions and octave bands.

Measurements at Maximum Continuous Power

For maximum continuous-power conditions MIL A-8806A specified one maximum noise level for those conditions where helmets are worn and another maximum noise level for conditions where helmets are not worn. Since it is conceivable that either condition could occur in the CH-47B, especially in the cargo area, both of the specified noise levels are included in Table 2A and Figures 4A to 7A.

From Figure 4A it can be seen that the cockpit noise is 14 dB above the specified levels of MIL-A-8806A only in the first octave band, and at other frequencies falls within the limits specified when helmets are used. When helmets are not used (an unlikely situation in the cockpit) the noise exceeds the specified levels in the 2000-Hz and 4000-Hz octave bands by four dB and seven dB. The cockpit noise is above the HEL Standard in all octave bands from 500 Hz to 4000 Hz.

In the cargo area the noise generally meets both the specified levels of the Military Specification and the HEL Standard with one exception which can be seen in Figure 6A. The noise in the 1000-Hz octave band at Station 480 exceeds the HEL Standard by seven dB.

A marked change in the noise at Station 480 occurs when the panels aft of Station 486 are removed, as can be seen in Figure 7A. The high-frequency noise does not meet the provisions of either the HEL Standard or the Military Specification.

For short-duration conditions, MIL-A-8806A specifies yet another set of maximum noise levels. These are shown with the measurements at 1720 pounds torque in Table 3A and Figures 8A to 10A. The noise level in general lies above the HEL Standard but below the Military Specification, and thus is acceptable.

Measurements in Level Flight at Various Air Speeds

The CH-47B meets the requirements of MIL-A-8806A in all three measuring positions at all air speeds tested from 30 knots to 140 knots, except when the panels aft of Station 486 are removed. When the panels are removed, the noise is excessive, with respect to MIL-A-8806A, in all octave bands above 2000 Hz for all the air speeds tested.

When compared with the HEL Standard, the noise is generally acceptable for all air speeds at the positions in the cargo area when the panels aft of Station 486 are in place. When the panels are removed, the noise is above HEL S-1-63B at all air speeds in all the octave bands above 250 Hz. In the cockpit, the noise falls above the levels of the HEL Standard in the 1000-Hz, 2000-Hz, and 4000-Hz octave bands for all air speeds. It is interesting to note the effect that rotor speed has on the shape of the noise spectrum. For all air speeds measured at Station 95, the noise spectrum tends to be flatter in the three octave bands mentioned above (1000 Hz,

2000 Hz and 4000 Hz) at 225 rpm rotor speed than it is at 230 rpm. At 230 rpm, evidence of a peak at 2000 Hz appears in all instances. If the noise in this octave band were reduced sufficiently, the noise in the octave bands on either side of it would probably also decrease and the noise spectrum could be lowered to the levels of HEL S-1-63B. This same peaking at 2000 Hz at 230 rpm is also evident to a lesser extent in measurements made at Station 480, near the rear rotor, indicating the front and rear rotors as possible sources of the noise in that octave band.

At the two highest air speeds, the 1000-Hz octave band at Station 480, shows a peak which raises the noise spectrum to a level exceeding the HEL Standard by four dB or more in the 1000-Hz and 2000-Hz octave bands. These and the occasional points where the noise exceeds the levels set by the HEL Standard by less than three dB may be viewed as insignificant, since the requirements of MIL-A-8806A are met.

Measurements During Hover Conditions

The results of interior measurements while hovering are very similar to those made in level flight. The noise is generally acceptable in the cargo-section positions as long as the panels aft of Station 486 are in place. When the panels are removed the noise exceeds the provisions of MIL-A-8806A in all octave bands 1000 Hz and above, and it exceeds the provisions of HEL S-1-63B in all octave bands 250 Hz and above.

At Station 95 and Station 480 the 2000-Hz octave band shows a peak which brings that part of the noise spectrum above the provisions of HEL S-1-63B, although it is still within the requirements of MIL-A-8806A.

Measurements made outside the helicopter while it was hovering nearby indicate that the noise spectrum at the positions tested exceeds the HEL Standard by as much as nine dB except at the position 20 meters in front of the aircraft. There the noise just meets the provisions of HEL S-1-63B. Prolonged exposure at the other three positions should be avoided.

Measurements During Level Accelerations and Decelerations

The CH-47B meets the requirements of HEL S-1-63B and MIL-A-8806A in the cargo area (Station 320) during level accelerations and decelerations at both rotor speeds tested. In the cockpit (Station 95), the range of noise is extremely loud in the first two octave bands, exceeding both the HEL Standard and the Military Specification. At 225 rpm rotor speed, the noise also exceeds MIL-A-8806A at 4000 Hz during both accelerations and decelerations, while at 230 rpm, the noise exceeds MIL-A-8806A in the 2000-Hz octave band, but only during deceleration. These peaks in the spectrum follow the tendency noted before for the higher rotor speed to give a peak at 2000 Hz, while the lower rotor speed gives a flatter spectrum or a peak at 4000 Hz.

Measurements During Partial Power Descents

At 60 knots true air speed, the CH-47B meets the requirements of MIL-A-8806A at all rates of descent, measured at Station 95. No measurements were made at Station 320 for this condition, but it can be assumed on the basis of other measurements in the aircraft that the noise at Station 320 is no louder than, and probably quieter than, that at Station 95, meaning that it, too, meets the provisions of MIL-A-8806A.

Measurements were made only at a rotor speed of 230 rpm and the peak in the 2000-Hz octave band is evident again in this test. The peak brings the noise above the HEL Standard at this frequency.

At 100 knots true air speed, the noise peak in the 2000-Hz octave band becomes considerably louder, and the noise in the octave bands flanking it (1000 Hz and 4000 Hz) also increases appreciably. The net effect is that the noise in the 2000-Hz and 4000-Hz octave bands either exceeds or just barely meets the criteria of MIL-A-8806A for those frequencies, again in both measuring positions and at all three rates of descent.

SUMMARY

The results of this test indicate that the CH-47B helicopter does not meet all the provisions of MIL-A-8806A. The excess noise is not, however, so loud that it cannot be readily reduced to meet MIL-A-8806A. Principal noise-reduction effort should be aimed at reducing the noise in the 2000-Hz and 4000-Hz octave bands, especially in the short-term and high-power flight conditions. Under normal cruise conditions, the noise is acceptable to MIL-A-8806A.

Operation with the panels aft of Station 486 removed should be avoided. The noise at Station 480 is increased to a level that is considerably above the levels of MIL-A-8806A under all flight conditions.

It is the official position of the U. S. Army Human Engineering Laboratories that operating, training, or maintenance tasks shall not expose personnel to noise that exceeds the levels specified in HEL Standard S-1-63B in any equipment designed, developed or procured by the U. S. Army Materiel Command, with the exception of interior noise of aircraft, which is covered by MIL-A-8806A. The levels of HEL Standard S-1-63B have been included for comparison only, to aid in the study of where noise reduction effort should be concentrated. Since almost every test condition produced levels exceeding the HEL Standard at Station 95, usually in some or all of the octave bands between 500 Hz and 4000 Hz, noise reduction should be concentrated in those frequencies, with an eye toward reducing the overall level in the cockpit as well.

The HEL Standard does apply to exterior noise of the CH-47B. Exterior noise does exceed the HEL Standard on three sides of the aircraft and measures should be taken to assure that personnel are not exposed to these noise levels.

REFERENCES

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3. American Standards Association. American standard specification for general-purpose sound level meters. New York, N. Y., 1961.

4. Boeing-Vertol Corporation. Detail specification for model CH-47B helicopter. Document 114-PJ-602, Philadelphia, Pa., 1967.

5. U. S. Army Human Engineering Laboratories. Maximum noise level for army materiel command equipment. HEL Standard S-1-63B, Aberdeen Proving Ground, Md., 1965.

6. Weapons Engineering Standardization Office. Acoustical noise level in aircraft, general specification for military specification MIL-A-8806A. Naval Engineering Center, Philadelphia, Pa., 1966.

APPENDIX

TABLE 1A

Octave Band Noise Measurements During Level Flight at Normal Cruise Power Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By:			Measured Band Pressure Level*					
				Rotor Speed = 225 rpm			Rotor Speed = 230 rpm		
	HEL Std S-1-63B	MIL-A-8806A Table IV	Exception to MIL-A-8806A Table IV	Station 95	Station 320	Station 480	Station 95	Station 320	Station 480
31.5	-	104	107**	-	-	-			
63	119	104	107	107	107	104			
125	114	104	108	105	107	108			
250	107	104	107	100	104	105			
500	99	96	102	96	97	100			
1000	91	90	97	94	94	94			
2000	89	86	97	100	89	92			
4000	89	75	90	92	84	88			
8000	91	75	78	83	81	84			
Linear	-	106	110**	111	111	112			

NO DATA

* dB re 0.0002 ubar
** (extrapolated value)

TABLE 2A

Octave Band Noise Measurements During Level Flight at Maximum Continuous Power (1520 lbs Torque) in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Std S-1-63B	MIL-A-3806A Table III w/helmets	MIL-A-3806A Table I	Measured Band Pressure Level* Rotor Speed = 225 rpm Station 95	Station 320	Station 480	Rotor Speed = 230 rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	-	111	111				121	120	119	117
63	111	111	111				116	115	109	110
125	113	111	111				113	110	104	104
250	107	111	111				107	107	105	110
500	99	104	105				104	98	100	105
1000	91	106	99				99	93	98	106
2000	89	100	93				97	88	90	107
4000	85	94	87				91	86	89	104
8000	81	94	87				86	82	86	98
Linear	-	117	113				126	121	119	119

* dB re 0.0002 ubar

** Panels aft of Station 480 were removed.

TABLE 3A

Octave Band Noise Measurements During Level Flight at 1720 Lbs. Torque in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Rotor Speed = 230rpm Station 95	Station 320	Station 480
31.5	-	118				128	121	120
63	119	118				117	115	112
125	114	118				115	108	107
250	107	118				109	107	105
500	99	112				103	100	102
1000	91	106				100	97	97
2000	89	100				99	89	92
4000	89	94				94	85	91
8000	91	94				86	83	87
Linear	-	120				128	121	121

NO DATA

* dB re 0.0002 ubar

TABLE 4A

Octave Band Noise Measurements During Level Flight at 30 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	—	118	118	114	112	117	112	108	
63	110	118	105	104	102	108	107	101	N
125	114	113	100	106	103	100	106	101	O
250	107	118	94	99	104	94	101	102	
500	99	112	92	92	96	92	93	96	A
1000	91	106	92	88	91	93	87	93	T
2000	85	100	92	87	92	96	88	90	A
4000	89	94	95	85	89	91	82	89	
8000	91	94	85	81	84	87		85	
Linear	—	120	118	119	117	117	115	113	

* dB re 0.0002 ubar

** Panels aft of Station 486 were removed.

TABLE 5A

Octave Band Noise Measurements During Level Flight at 40 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: USAEL Standard S-1-67B	MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 295	Station 320	Station 480	Rotor Speed = 230rpm Station 295	Station 320	Station 480	Station 480 w/o panels**
31.5	—	113	—	—	—	113	112	105	110
63	111	118	102	101	100	102	108	99	106
125	114	113	100	105	104	100	105	100	105
250	107	118	96	101	103	94	98	100	108
500	96	112	92	92	97	92	93	94	102
1000	91	106	90	88	91	92	89	91	108
2000	86	100	88	88	93	98	87	90	105
4000	80	94	94	92	90	90	84	88	103
8000	71	94	84	80	82	84	82	82	97
Linear	—	120	106	103	108	118	114	109	115

* dB re 0.0002 ubar

** Panels aft of Station 436 were removed

TABLE 6A

Octave Band Noise Measurements During Level Flight at 60 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.	-	113	-	-	-	120	113	111	113
63	119	118	103	105	92	106	106	104	103
125	114	118	[illegible]	106	102	99	104	102	105
250	107	118	94	102	103	92	100	101	108
500	99	112	92	95	96	92	93	96	106
1000	91	106	93	92	93	92	89	92	101
2000	89	100	[illegible]	89	93	90	86	94	103
4000	87	94	91	87	88	92	90	87	104
8000	91	94	83	81	84	83	-	81	97
Linear	-	120	106	109	106	120	113	111	116

* dB re 0.0002 Bar

** Panels aft of Station 486 were removed.

TABLE 7A

Octave Band Noise Measurements During Level Flight at 80 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Measured Band Pressure Level* Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	-	113	-	-	-	122	115	113	116
63	110	113	101	101	99	103	106	103	107
125	114	118	103	105	104	101	107	104	105
250	107	118	96	102	104	93	102	103	109
500	99	112	93	94	98	93	94	97	107
1000	91	106	95	88	92	92	92	91	103
2000	85	100	84	86	91	100	87	91	106
4000	80	94	93	89	88	94	84	86	103
8000	71	94	83	81	83	84	82	82	97
Linear	-	120	108	108	108	122	115	114	118

* dB re 0.0002 ubar

** Panels aft of Station 486 were removed.

TABLE 8A

Octave Band Noise Measurements During Level Flight at 100 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	–	118	–	–	–	121	115	115	120
63	119	118	107	111	102	101	108	104	109
125	114	113	104	108	103	101	108	102	103
250	107	118	98	104	105	99	101	101	108
500	99	112	94	94	98	92	96	96	107
1000	91	106	95	89	93	92	90	92	106
2000	86	100	87	87	93	99	88	89	110
4000	86	94	84	82	88	91	84	88	104
8000	81	94	83	–	84	84	82	84	99
Linear	–	120	109	113	108	121	116	115	120

* dB re 0.0002 ubar

** Panels aft of Station 486 were removed.

TABLE 9A

Octave Band Noise Measurements During Level Flight at 120 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	-	118	-	-	-	122	115	118	119
63	119	118	109	107	104	110	114	108	108
125	114	118	107	106	105	109	109	107	104
250	107	118	100	105	104	106	106	106	109
500	99	112	100	97	100	97	97	98	106
1000	91	106	96	90	92	94	92	97	106
2000	89	100	99	86	93	100	90	90	109
4000	89	94	95	84	88	95	84	89	104
8000	91	94	84	81	87	84	82	86	99
Linear	-	120	110	111	109	122	119	119	121

* dB re 0.0002 ubar

** Panels aft of Station 486 were removed.

TABLE 10A

Octave Band Noise Measurements During Level Flight at 140 Knots True Air Speed in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95	Station 320	Station 480	Measured Band Pressure Level* Rotor Speed = 230rpm Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	—	118	—			126	119	118	118
63	119	118	104			112	114	109	106
125	114	118	105			105	107	105	104
250	107	118	98			98	104	104	110
500	99	112	93			97	97	99	106
1000	91	106	98			96	93	99	104
2000	87	100	100			97	88	92	106
4000	89	94	92			93	84	89	104
8000	91	94	83			84	82	86	88
Linear	—	129	109			126	120	118	119

NO DATA

* dB re 0.0002 ubar

** Panels aft of Station 436 were removed.

TABLE 11A

Octave Band Noise Measurements Hovering (Out of Ground Effect) in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By:		Measured Band Pressure Level*							
			Rotor Speed = 225rpm				Rotor Speed = 230 rpm			
	HEL Standard S-1-63B	MIL-A-8860 (A) Table II	Station 95	Station 320	Station 480	Station 480 w/o panels**	Station 95	Station 320	Station 480	Station 480 w/o panels**
31.5	-	118	122	118	115	113	122	118	112	111
63	119	118	109	101	104	103	107	101	100	103
125	114	118	100	102	99	109	99	102	102	108
250	107	118	91	97	101	109	92	98	100	110
500	99	112	92	94	95	104	93	92	93	104
1000	91	106	92	88	93	107	92	91	93	109
2000	89	100	94	87	93	107	95	90	94	104
4000	89	94	92	85	87	104	91	85	89	103
8000	91	94	85	83	84	100	83	84	85	97
Linear	-	120	122	118	116	117	122	118	112	117

* dB re 0.000.2 ubar

** Panels aft of Station 486 were removed

TABLE 12A

Octave Band Noise Measurements-Exterior Noise-Hovering (IGE)
of the CH-47B Helicopter, 20 Feet Altitude, 20 M Away

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B		Measured Band Pressure Level*			
			0°(Front)	90°(Starboard)	180°(Aft)	270°(Port)
31.5	-		116	116	116	121
63	119		113	118	117	119
125	114		111	116	117	117
250	107		106	111	111	111
500	99		98	105	106	105
1000	91		91	100	95	97
2000	83		80	94	92	93
4000	89		87	91	91	91
8000	91		86	90	88	91
Linear	-		118	122	120	122

* dB re 0.0002 ubar

TABLE 13A

Octave Band Noise Measurements-Level Accelerations 40-140 Knots (TAS) in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level*Specified By: HEL Standard S-1-63B	Band Pressure Level*Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rotor Speed = 225rpm Station 95 Low	Station 95 High	Station 320 Low	Station 320 High	Rotor Speed = 230rpm Station 95 Low	Station 95 High	Station 320 Low	Station 320 High
31.5	-	118	114	123	110	117	111	125	112	118
63	119	118	105	125	100	113	107	116	100	115
125	114	118	102	113	100	108	106	112	101	106
250	107	118	96	105	97	105	100	106	96	104
500	99	112	95	102	91	98	97	101	91	97
1000	91	106	95	100	89	92	95	99	89	93
2000	89	100	95	98	86	89	96	100	86	90
4000	85	94	92	100	83	86	92	94	84	85
8000	91	94	83	84	80	82	82	85	81	82
Linear	-	120	115	125	112	118	116	125	115	119

*dB re 0.0002ubar

TABLE 14A

Octave Band Noise Measurements-Level Decelerations 140-40 Knots (TAS) in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level*Specified By:		Measured Band Pressure Level*							
	HEL Standard S-1-63B	MIL-A-8806A Table II	Rotor Speed = 225rpm				Rotor Speed = 230rpm			
			Station 95		Station 320		Station 95		Station 320	
			Low	High	Low	High	Low	High	Low	High
31.5	-	118	119	125	105	116	121	127	109	116
63	119	118	100	115	102	114	100	116	102	115
125	114	118	101	114	103	108	101	113	104	109
250	107	118	95	108	98	107	96	107	100	106
500	99	112	92	102	92	99	92	102	92	98
1000	91	106	91	98	89	92	92	98	90	92
2000	89	100	94	100	87	89	95	103	85	91
4000	89	94	89	98	83	85	91	95	83	85
8000	91	94	81	84	80	81	82	84	80	82
Linear	-	120	120	125	110	119	120	125	112	119

* dB re 0.0002 ubar

TABLE 15A

Octave Band Noise Measurements-Partial Power Descents, 60 Knots (TAS)
Rotor Speed 230 rpm
in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By: HEL Standard S-1-63B	Band Pressure Level* Specified By: MIL-A-8806A Table II	Measured Band Pressure Level* Rate of Descent = 500 '/min Station 95 Low	Station 95 High	Station 320 Low	Station 320 High	Rate of Descent = 1000 '/min Station 95 Low	Station 95 High	Station 320 Low	Station 320 High	Rate of Descent = 1500 '/min Station 95 Low	Station 95 High	Station 320 Low	Station 320 High
31.5	—	118	116	120			118	123			120	122		
63	11[illegible]	113	102	109		N	101	106		N	98	103		N
125	114	118	100	108		O	98	104		O	100	104		O
250	107	113	99	104			94	100			96	101		
500	9[illegible]	112	[illegible]1	[illegible]7		D	91	99		D	91	94		D
1000	[illegible]1	10[illegible]	1[illegible]	[illegible]		A	[illegible]2	[illegible]		A	90	92		A
2000	8[illegible]	10[illegible]	[illegible]	[illegible]2		T	[illegible]	[illegible]8		T	91	7		T
4000	3[illegible]	[illegible]	[illegible]	[illegible]		A	91	[illegible]		A	87	90		A
8000	91	[illegible]	82	[illegible]3			82	85			81	84		
Linear	—	129	117	12[illegible]			117	122			120	122		

* dB re 0.0002 ubar

TABLE 16A

Octave Band Noise Measurements-Partial Power Descents, 100 Knots (TAS)
Rotor Speed 230 rpm
in the CH-47B Helicopter

Octave Band Center Frequency (Hertz)	Band Pressure Level* Specified By:		Measured Band Pressure Level*											
	HEL Standard S-1-63B	MIL-A-8806A Table II	Rate of Descent = 500 '/min				Rate of Descent = 1000 '/min				Rate of Descent = 1500 '/min			
			Station 95		Station 320		Station 95		Station 320		Station 95		Station 320	
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
31.	–	118	123	125	113	116	122	124	113	116	123	125	117	119
63	119	118	108	114	104	111	110	114	107	110	111	115	108	110
12[illegible]	114	118	109	113	106	109	109	113	107	110	110	114	105	108
25[illegible]	107	118	103	108	104	108	103	108	103	107	105	108	101	10[illegible]
[illegible]0	99	112	97	102	98	101	98	102	97	99	99	104	98	100
1000	91	106	95	98	97	100	96	98	99	100	96	100	98	100
2000	89	100	96	102	96	102	96	99	98	103	96	99	99	101
4000	84	94	92	97	[illegible]	97	93	96	[illegible]	97	91	93	97	98
8000	81	[illegible]	84	86	87	90	84	86	87	88	83	85	88	90
Linear	–	120	123	125	116	118	122	124	116	118	123	125	118	11[illegible]

*dB re 0.0002 ubar

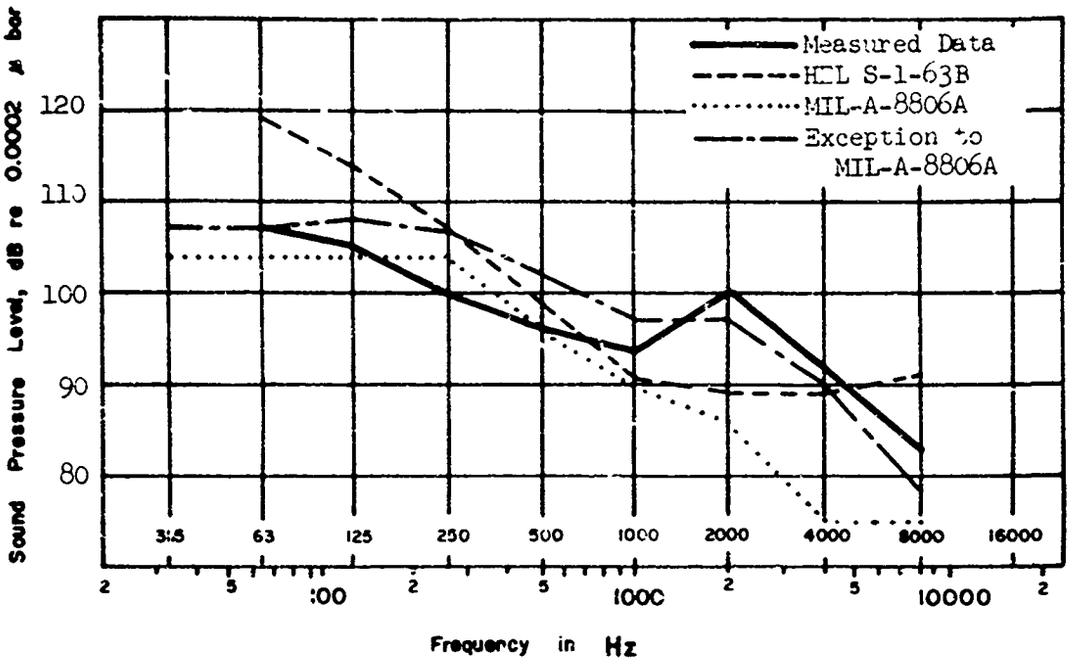

Fig. 1A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT NORMAL CRUISE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

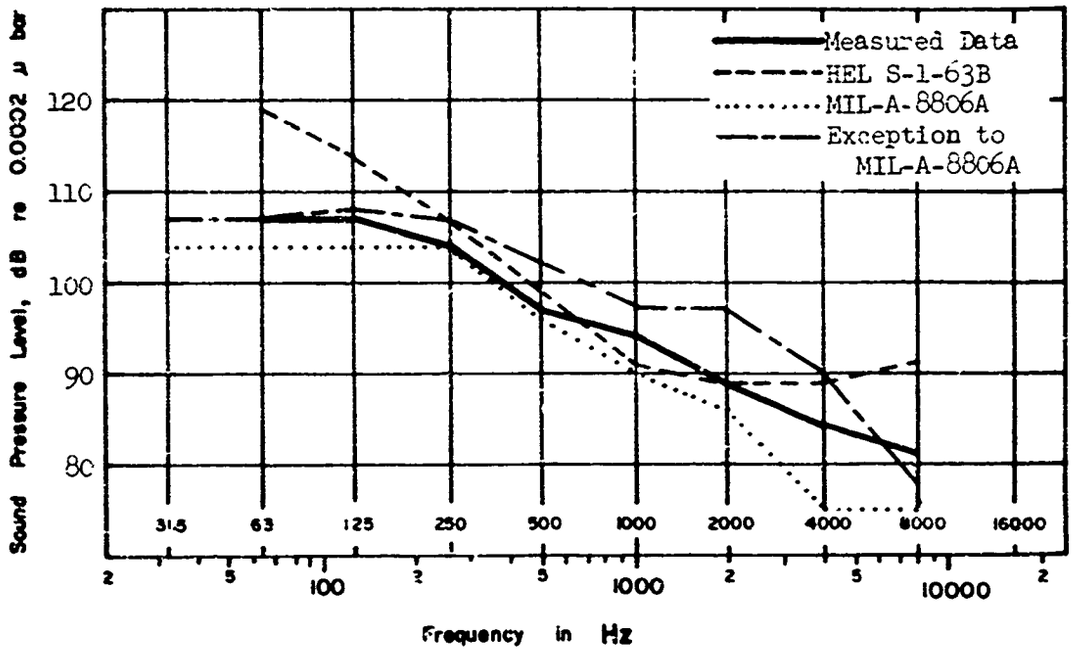

Fig. 2A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT NORMAL CRUISE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

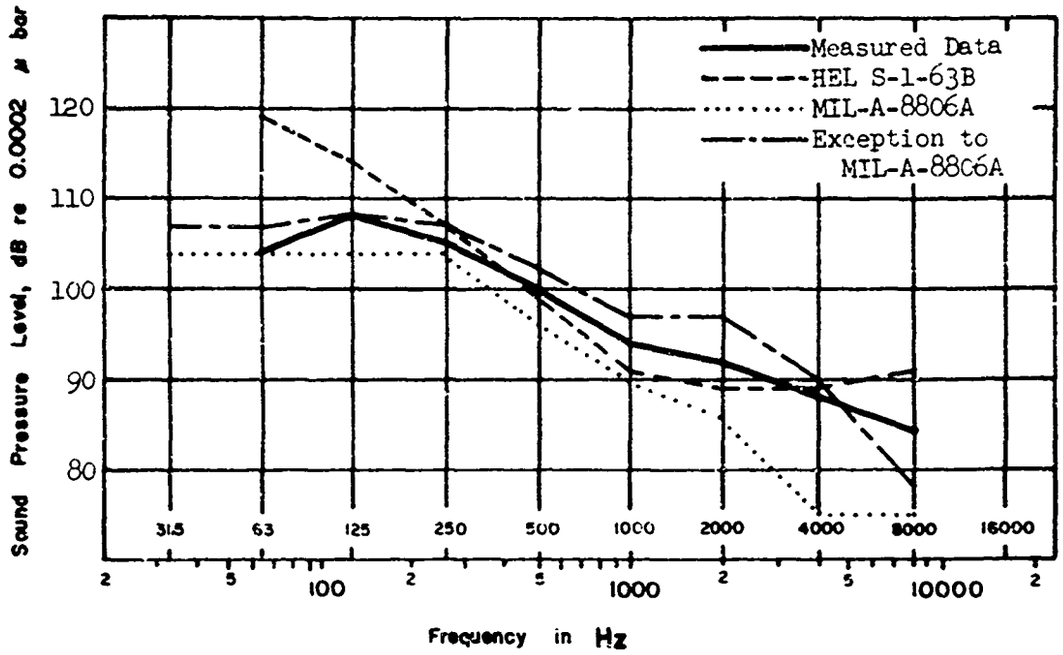

Fig. 3A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT NORMAL CRUISE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

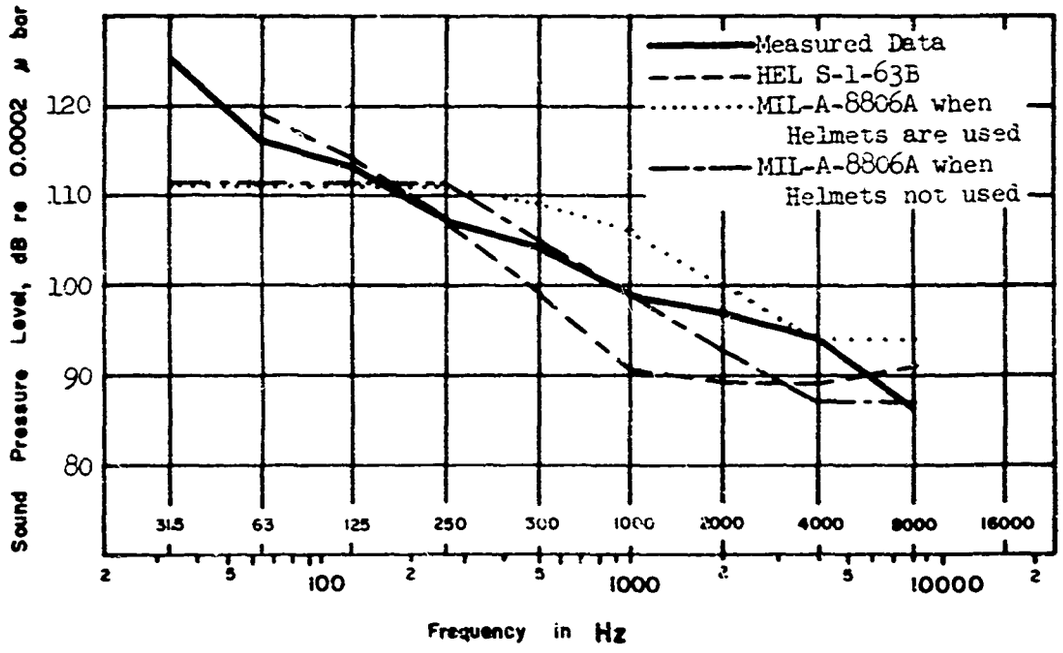

Fig. 4A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT MAXIMUM CONTINUOUS POWER (1520 lbs. torque)
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

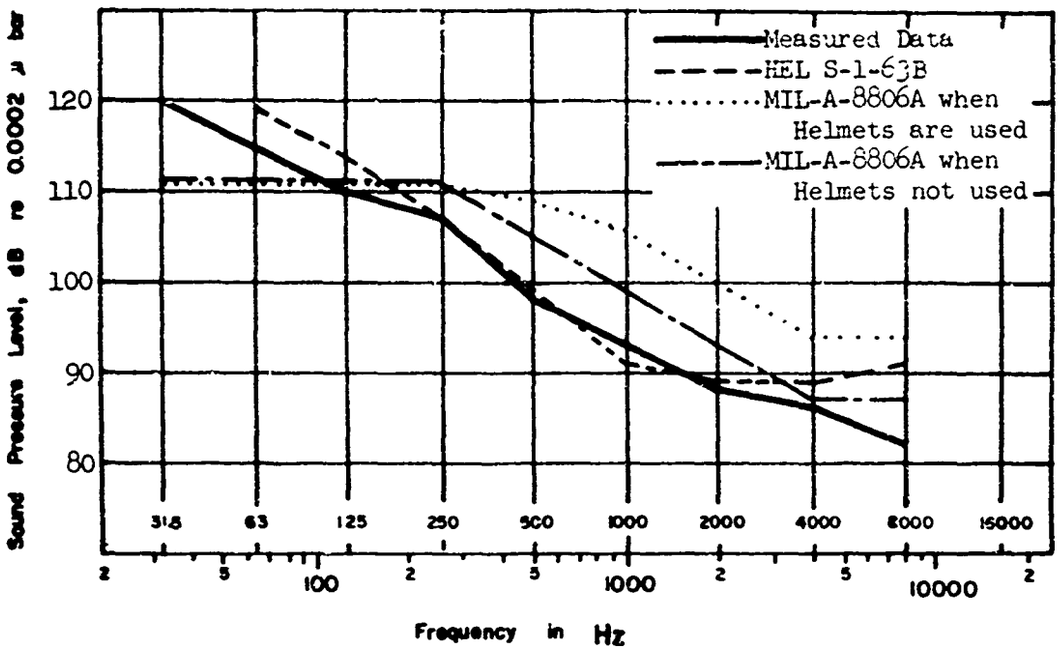

Fig. 5A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT MAXIMUM CONTINUOUS POWER (1520 lbs. torque) (Rotor speed is 230 rpm. Measuring position is at Station 320.)

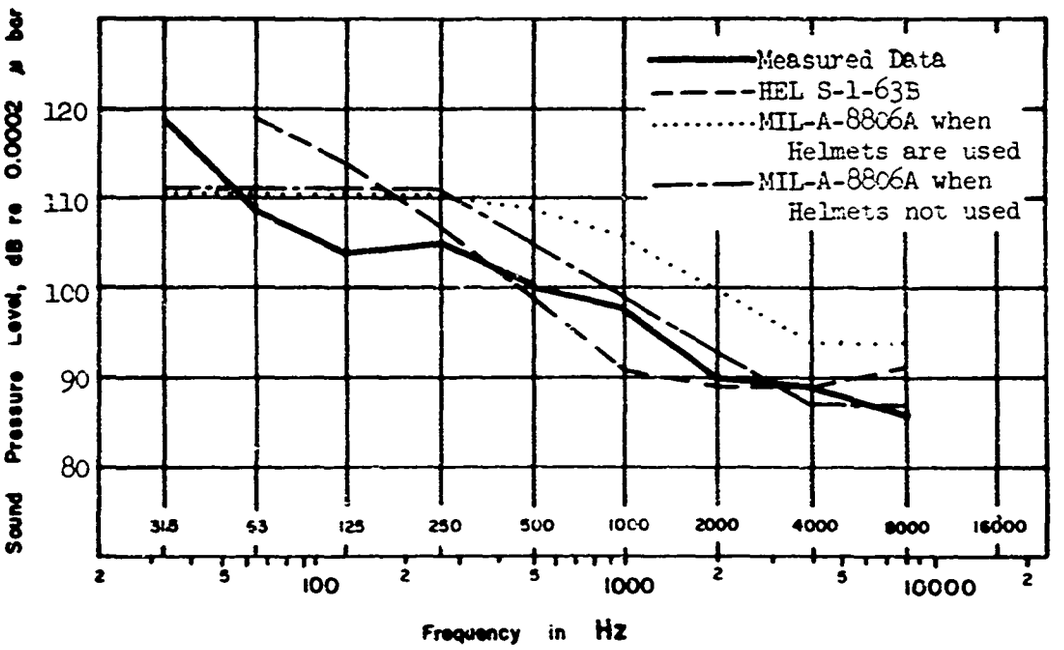

Fig. 6A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT MAXIMUM CONTINUOUS POWER (1520 lbs. torque) (Rotor speed is 230 rpm. Measuring position is at Station 480.)

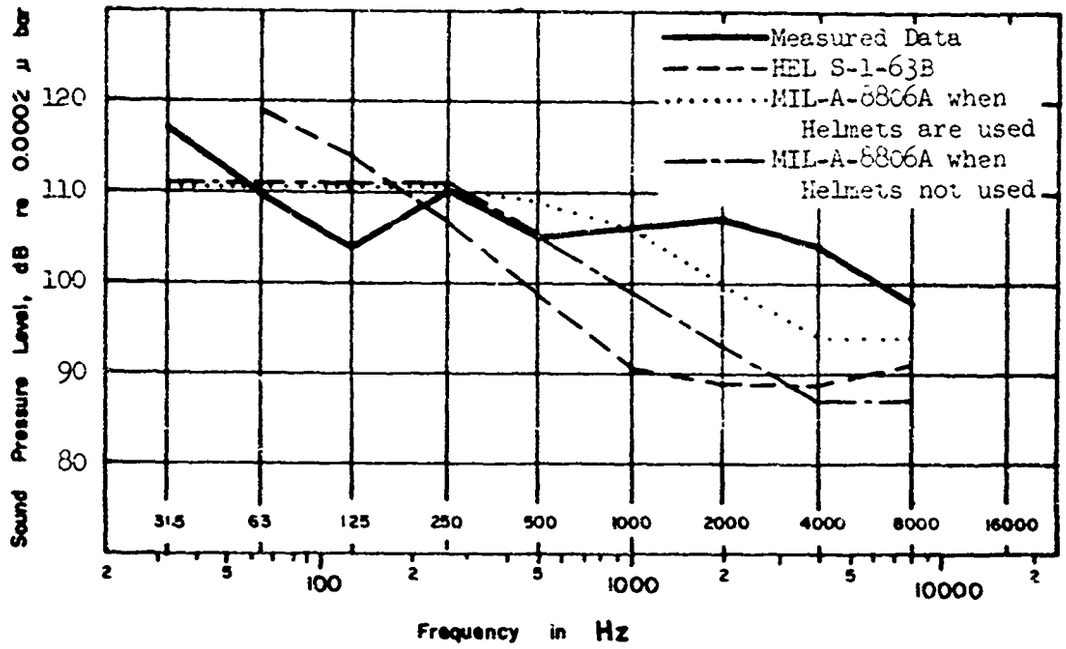

Fig. 7A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT MAXIMUM CONTINUOUS POWER (1520 lbs. torque)
(Rotor speed is 230 rpm. Measuring position is at Station 480.
All panels aft of Station 486 removed.)

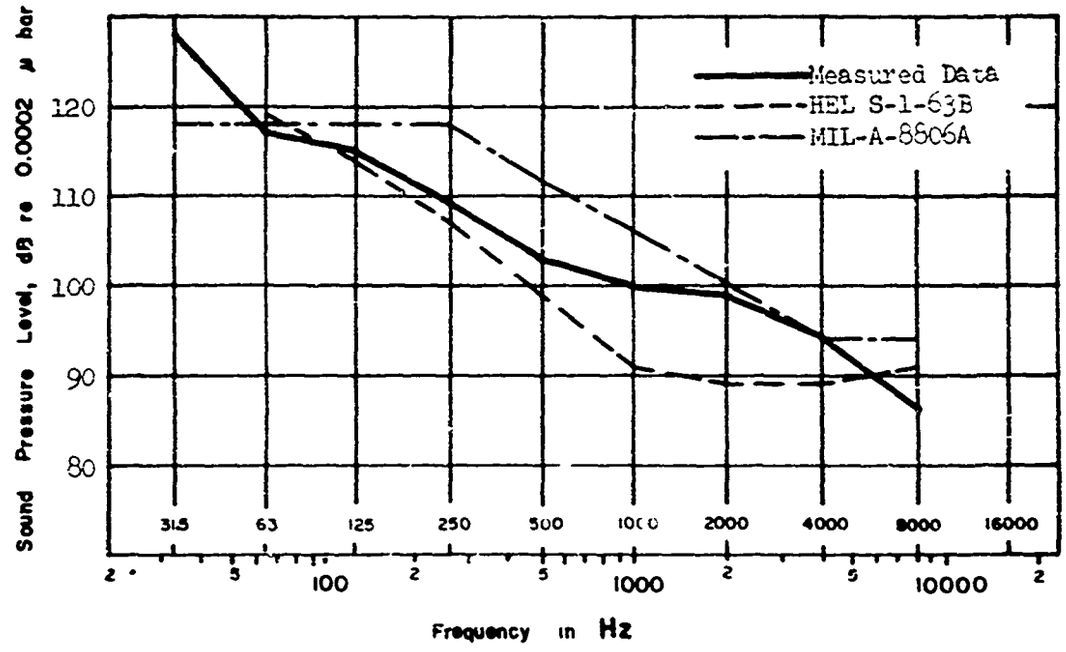

Fig. 8A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT (1720 lbs. torque)
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

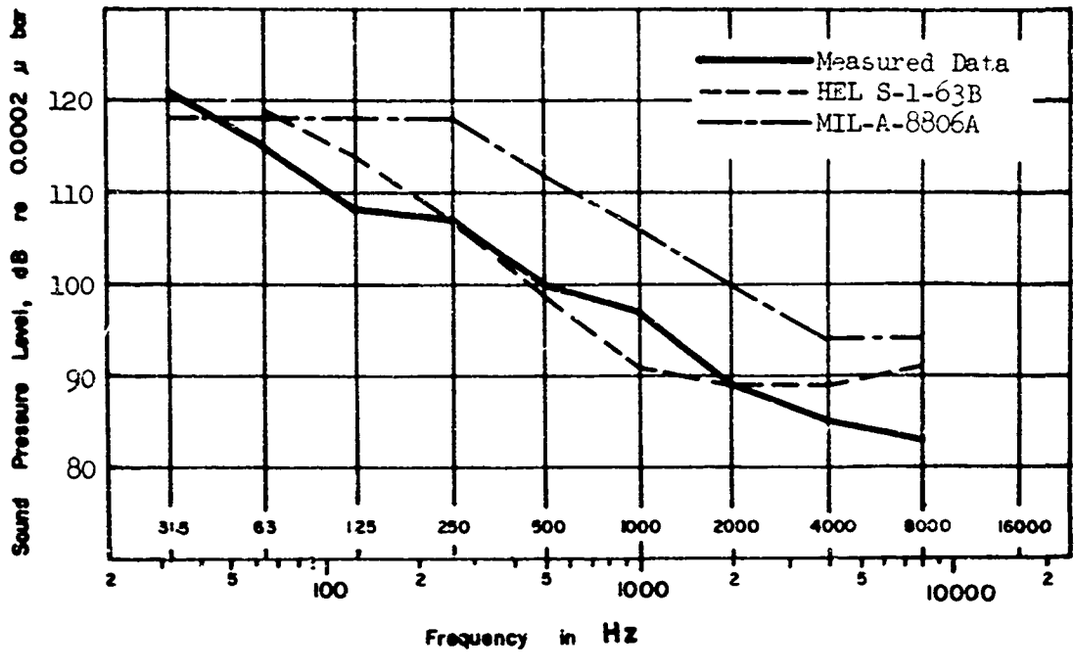

Fig. 9A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT (1720 lbs. torque) (Rotor speed is 230 rpm. Measuring position is at Station 320.)

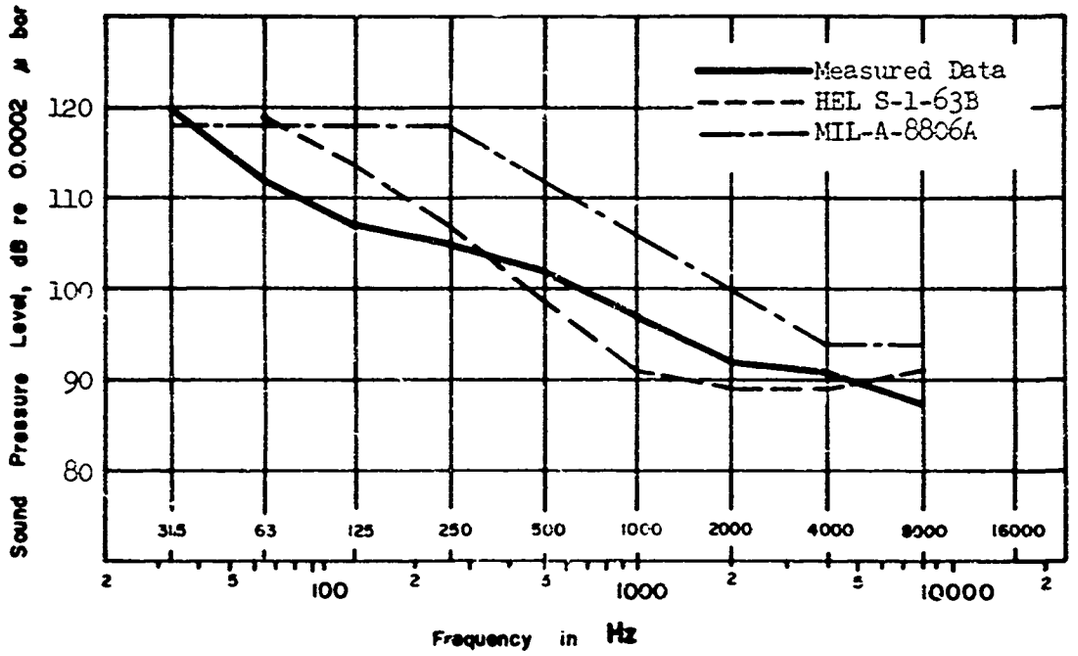

Fig. 10A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT (1720 lbs. torque) (Rotor speed is 230 rpm. Measuring position is at Station 480.)

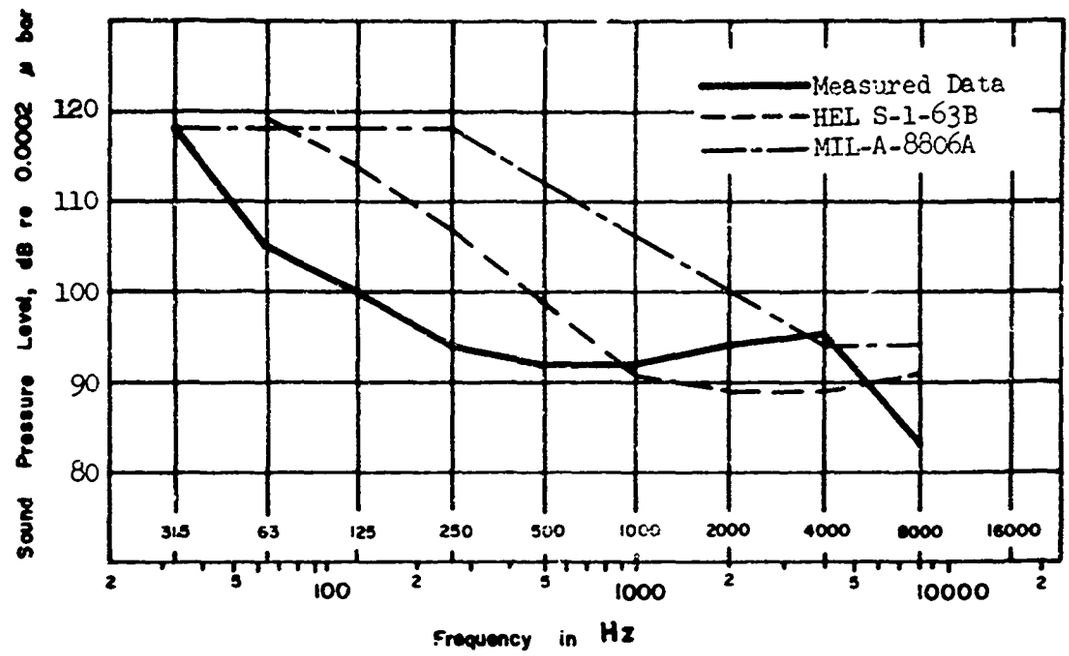

Fig. 11A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT
AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

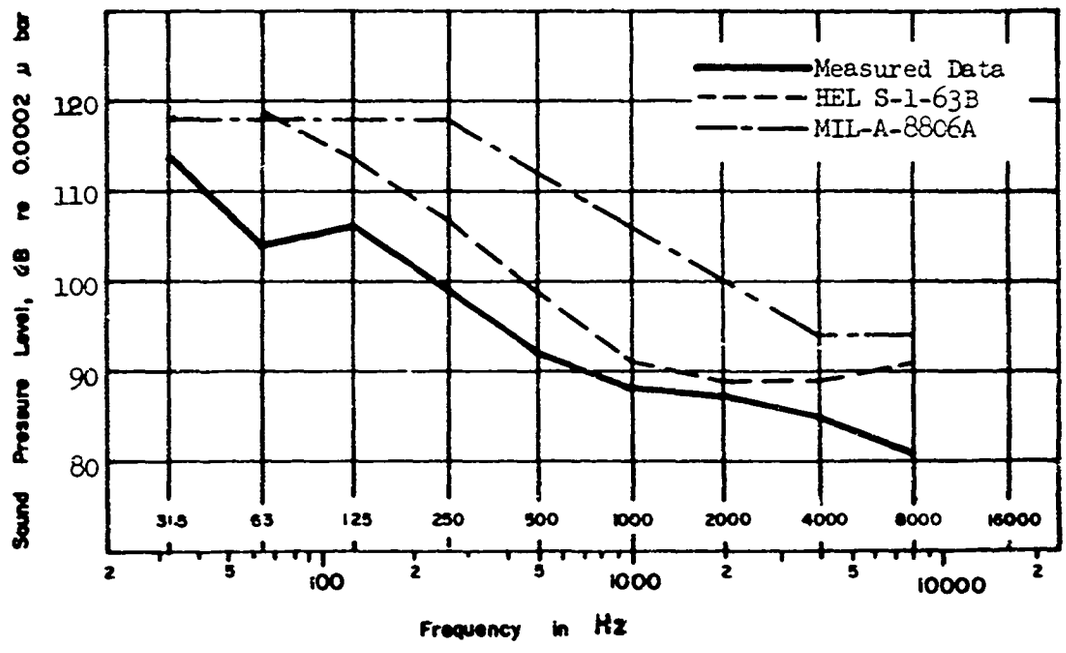

Fig. 12A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT
AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

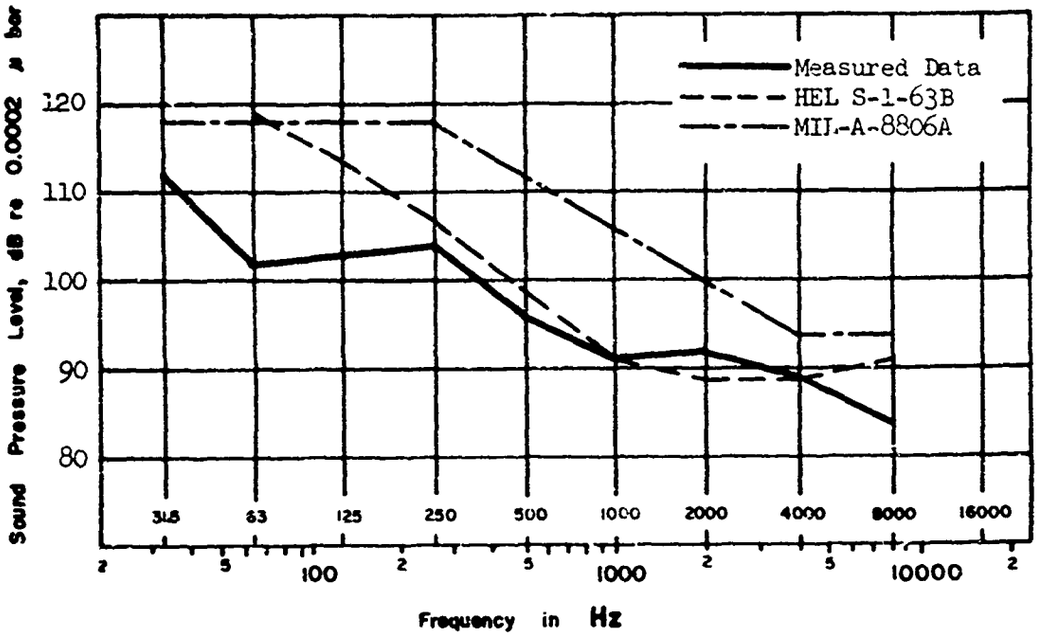

Fig. 13A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

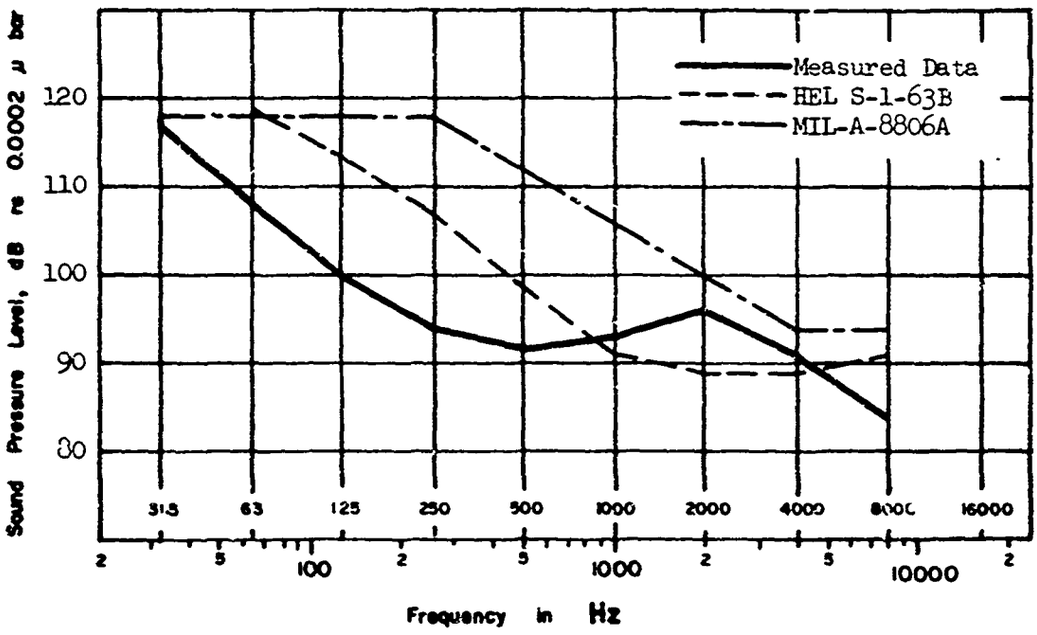

Fig. 14A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

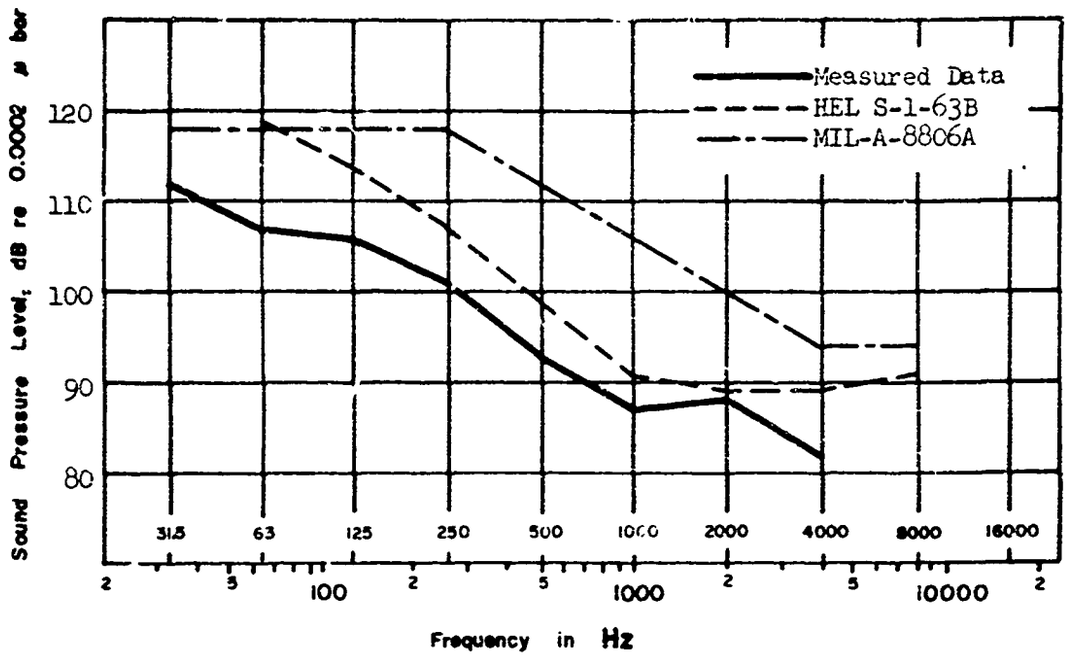

Fig. 15A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

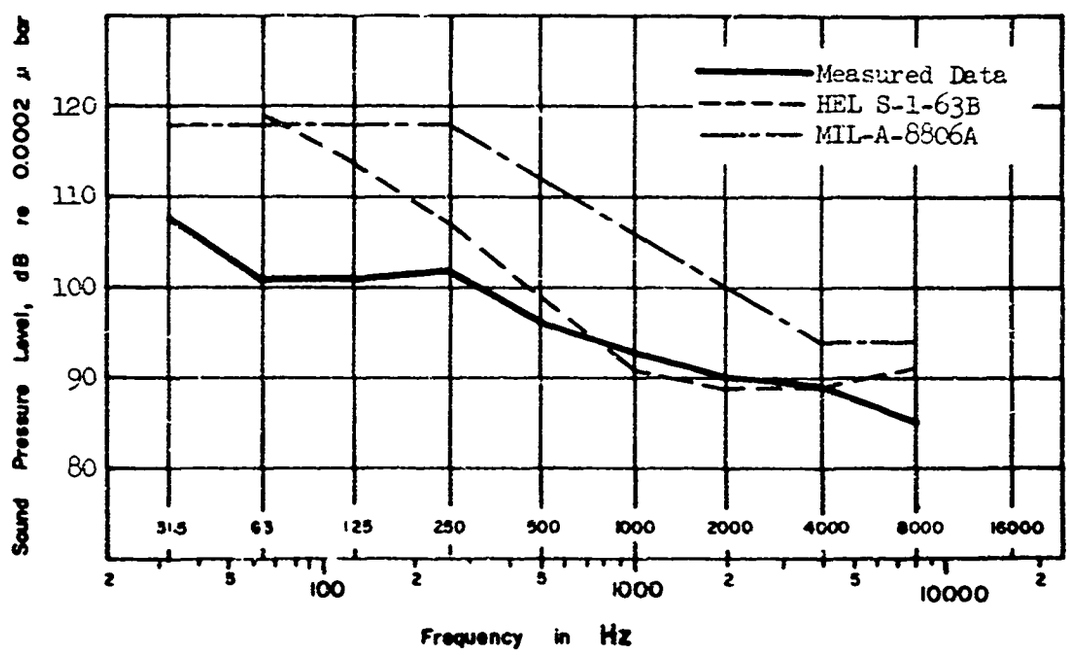

Fig. 16A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 30 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

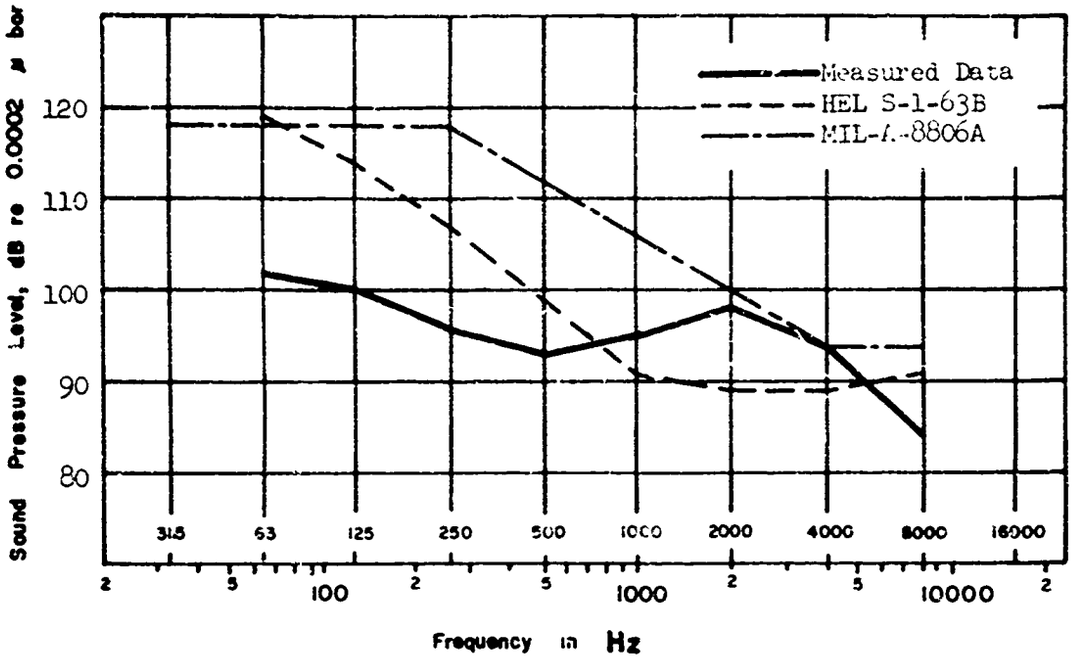

Fig. 17A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

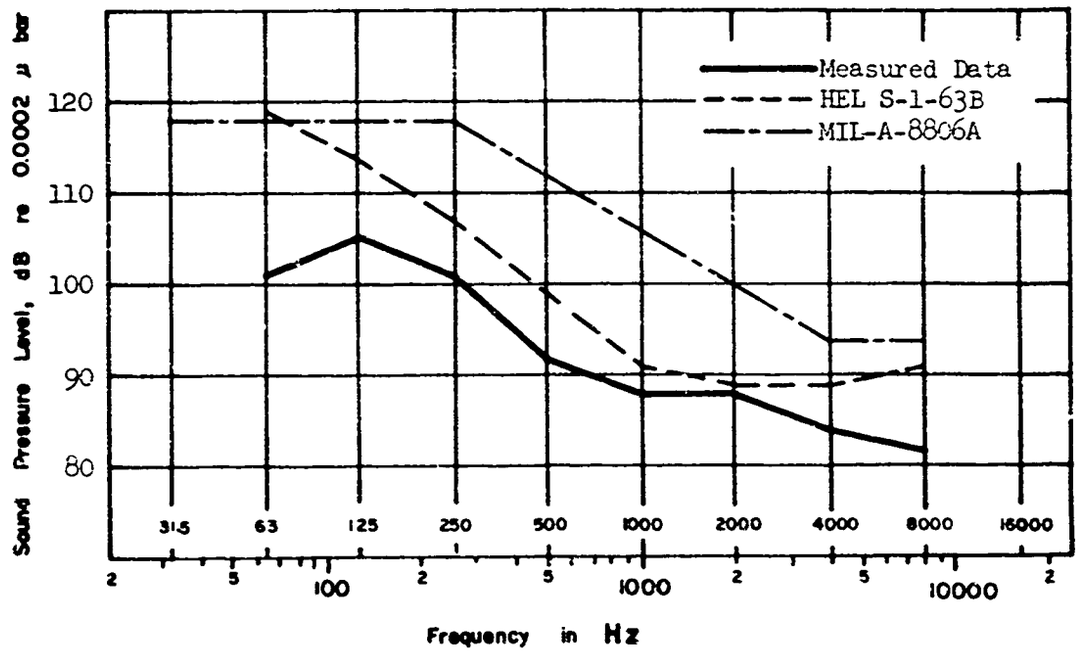

Fig. 18A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

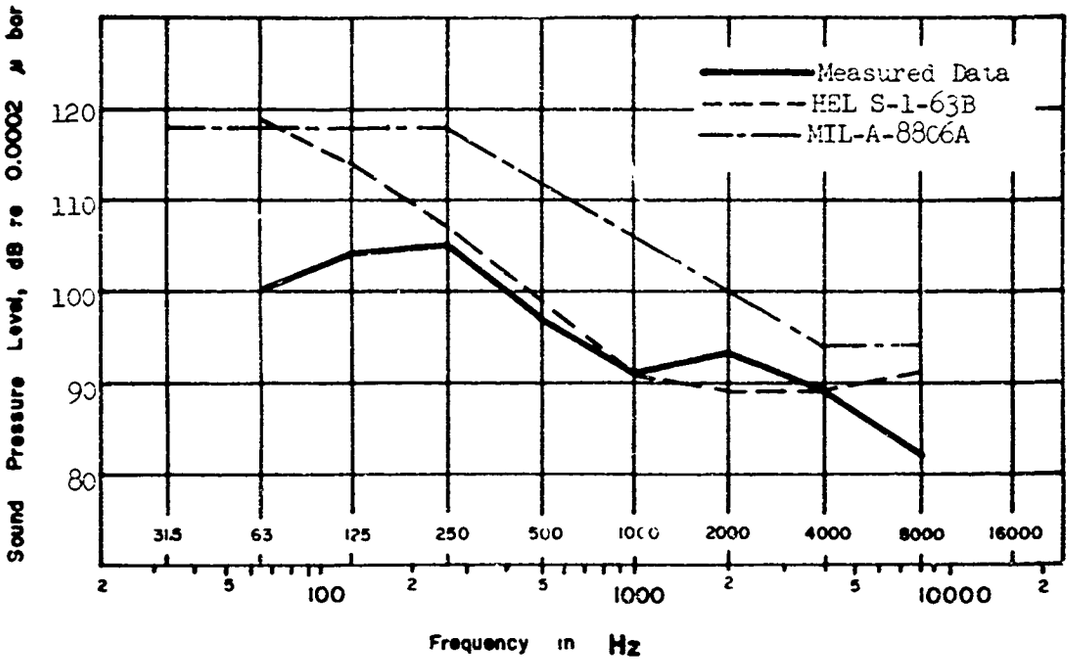

Fig. 19A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

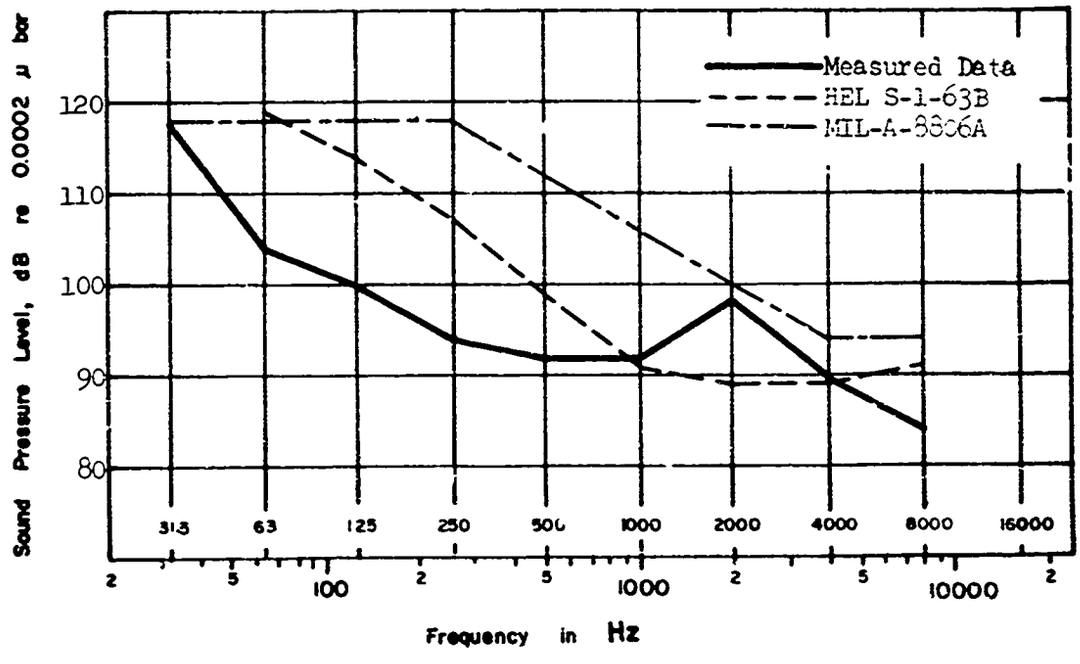

Fig. 20A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

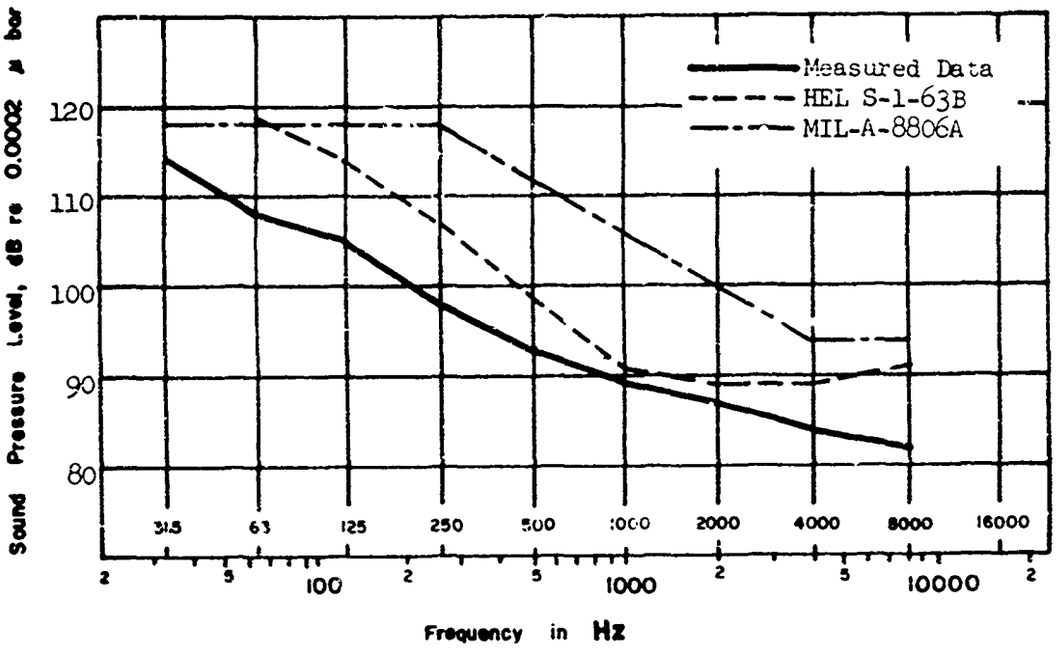

Fig. 21A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

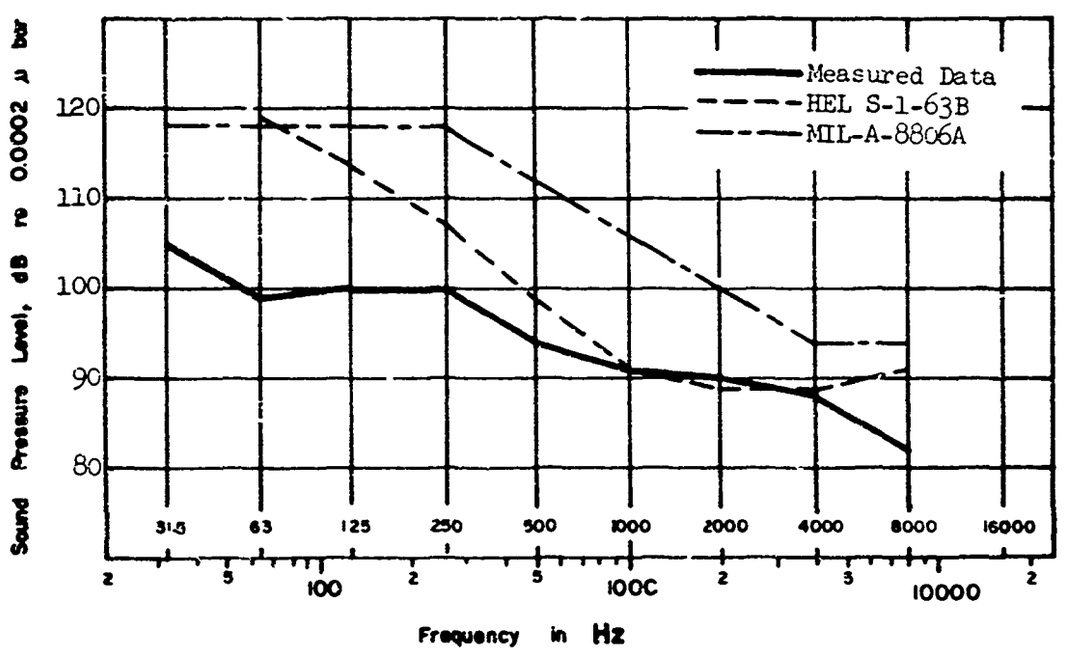

Fig. 22A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

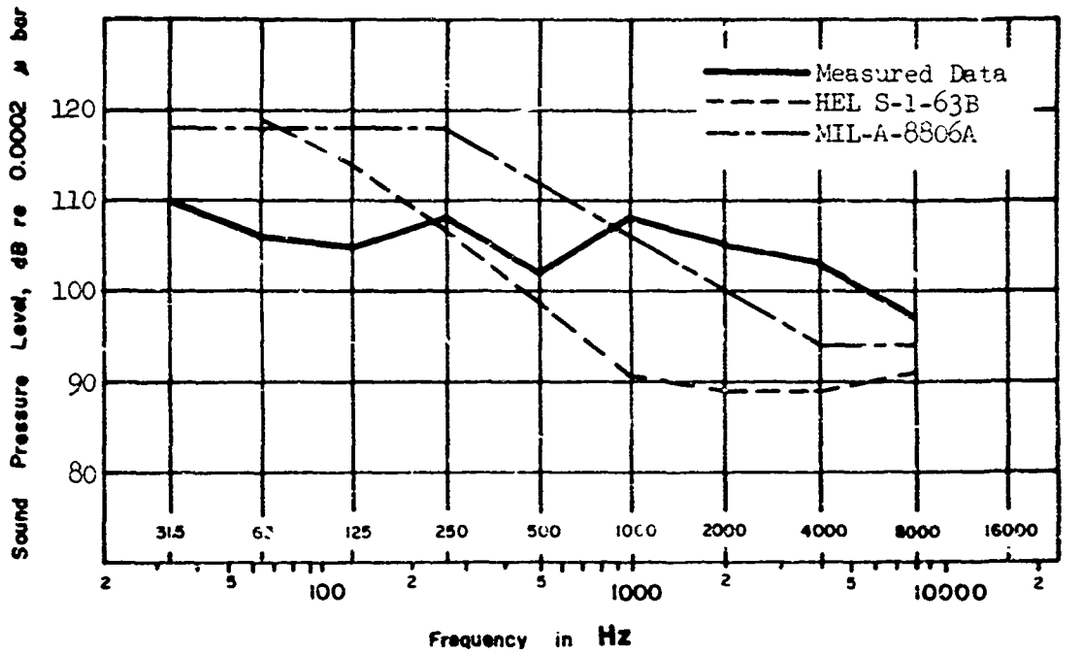

Fig. 23A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

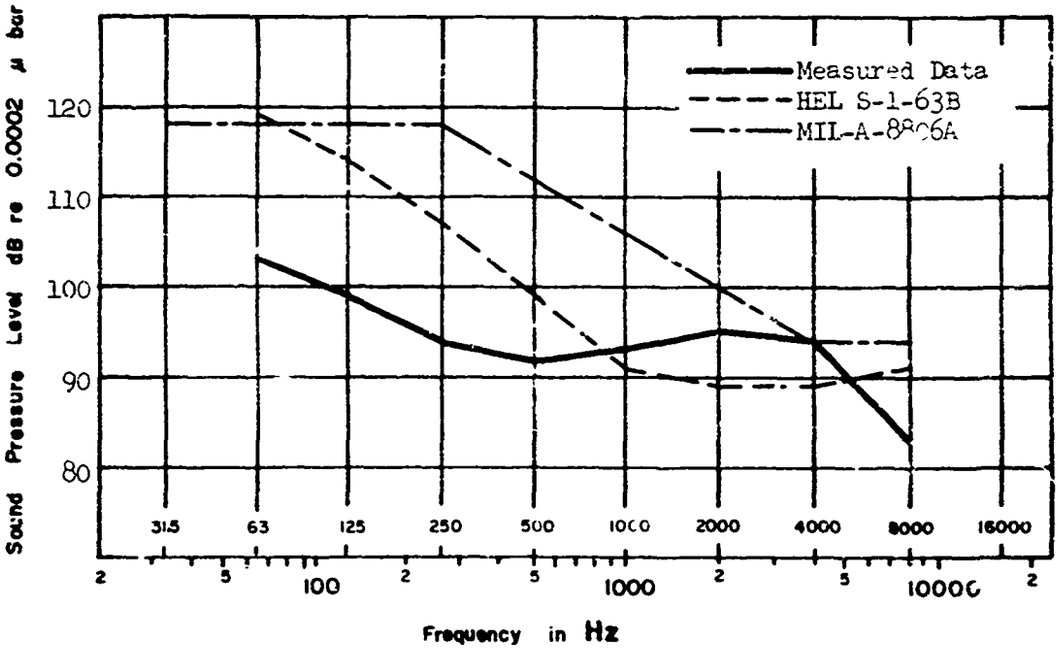

Fig. 24A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

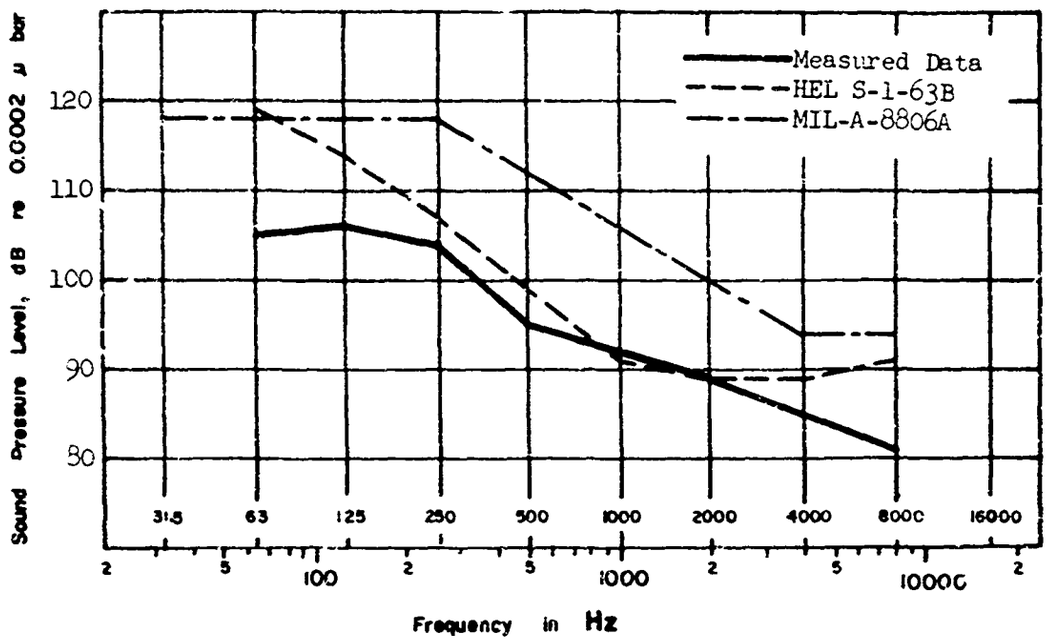

Fig. 25A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

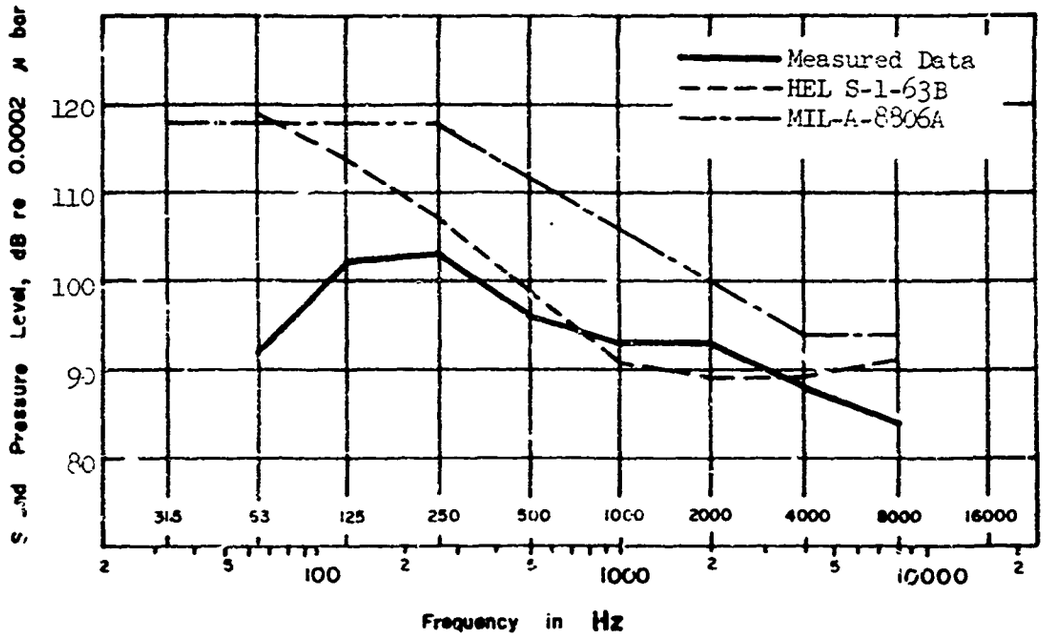

Fig. 26A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

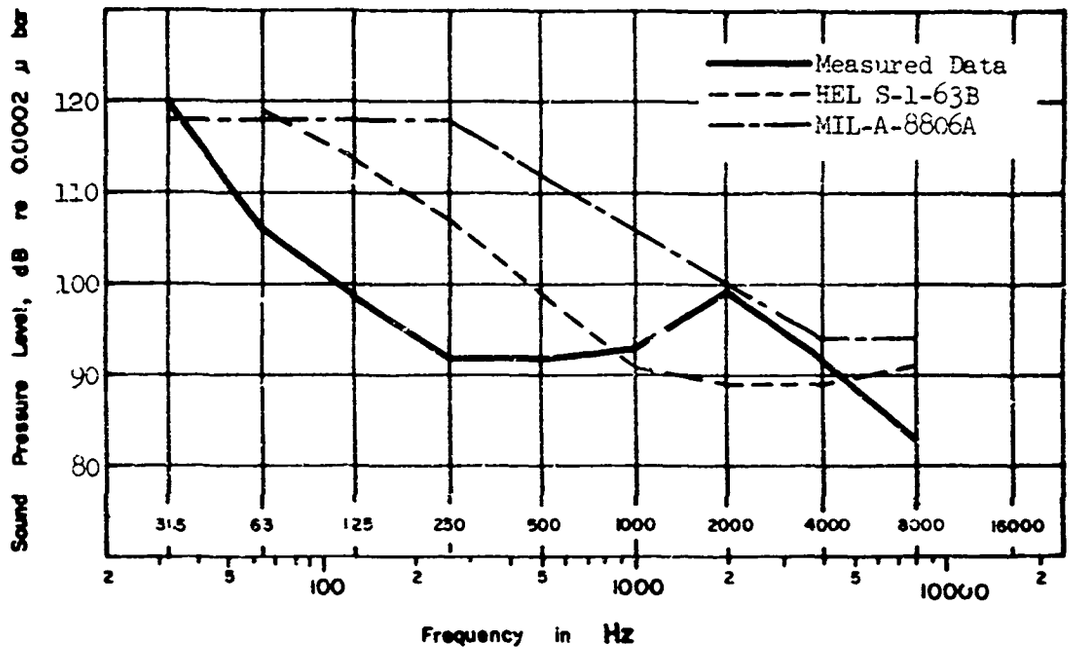

Fig. 27A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

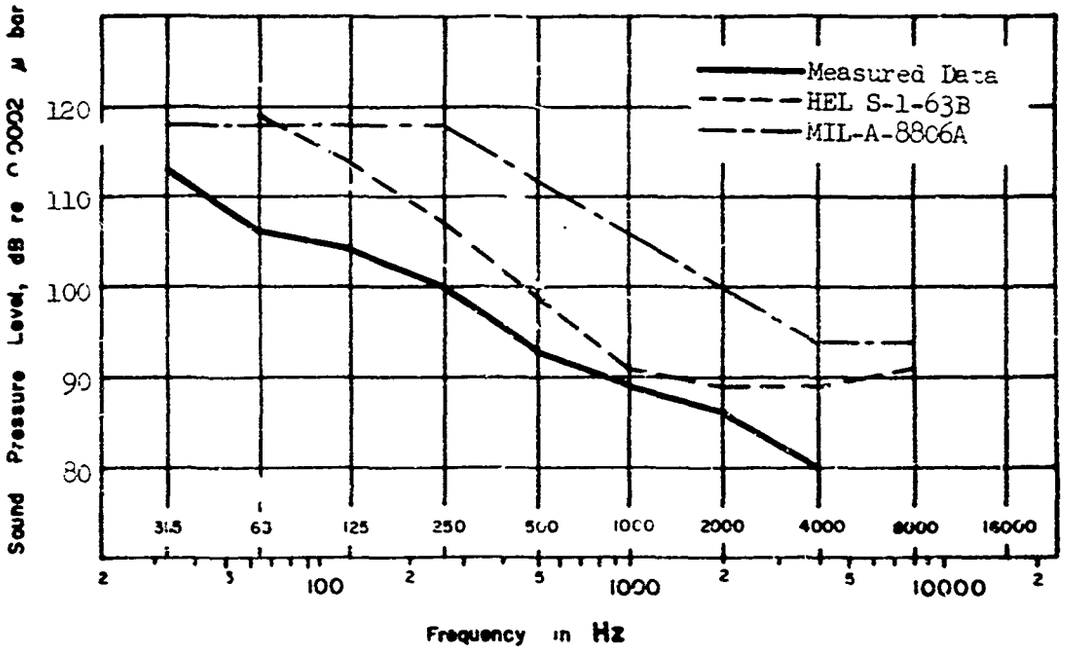

Fig. 28A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

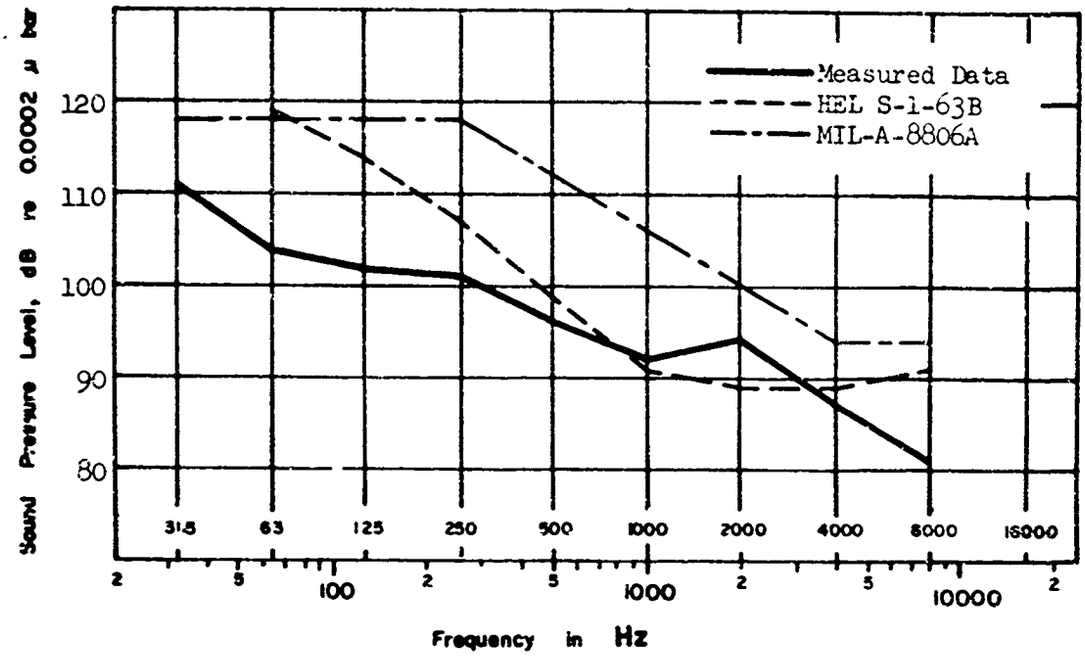

Fig. 29A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

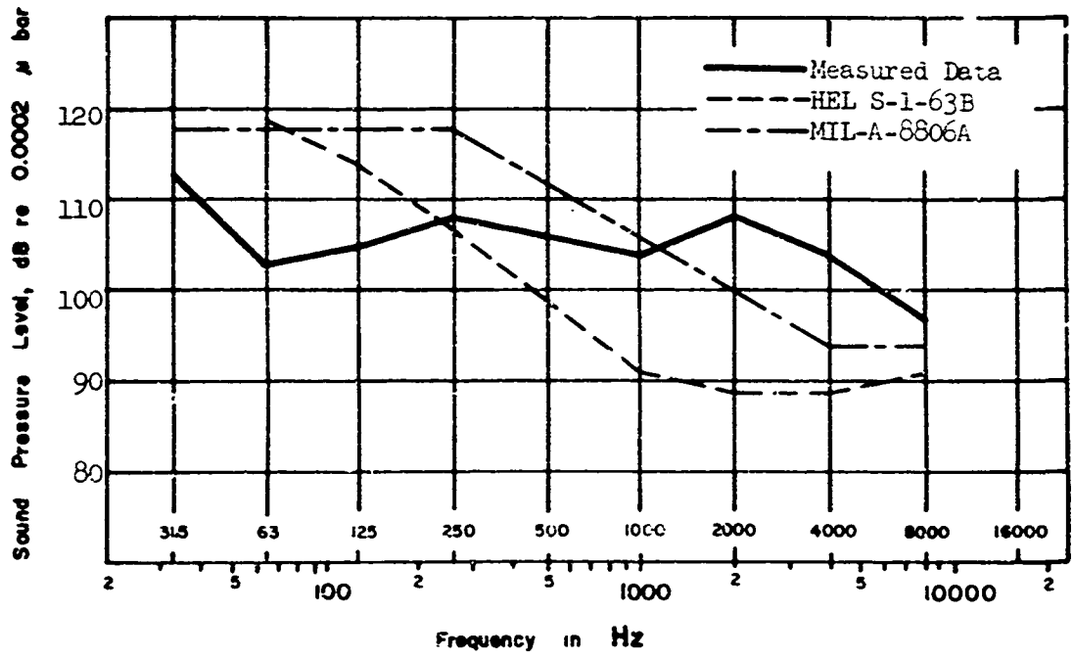

Fig. 30A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

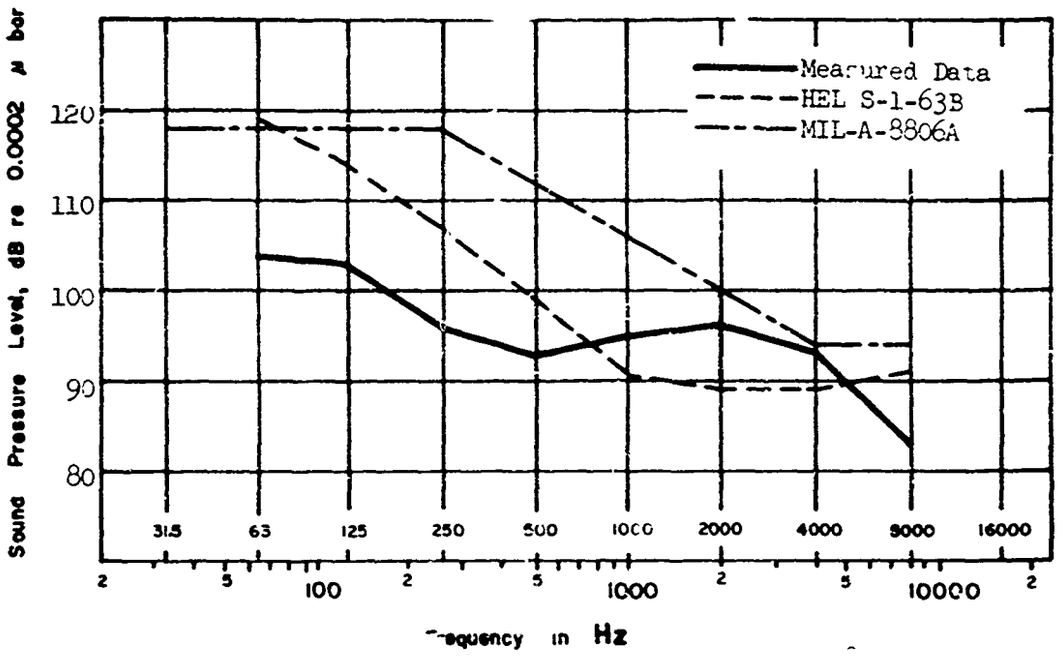

Fig. 31A. NOISE OF THE CH-[illegible]B HELICOPTER IN LEVEL FLIGHT
AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

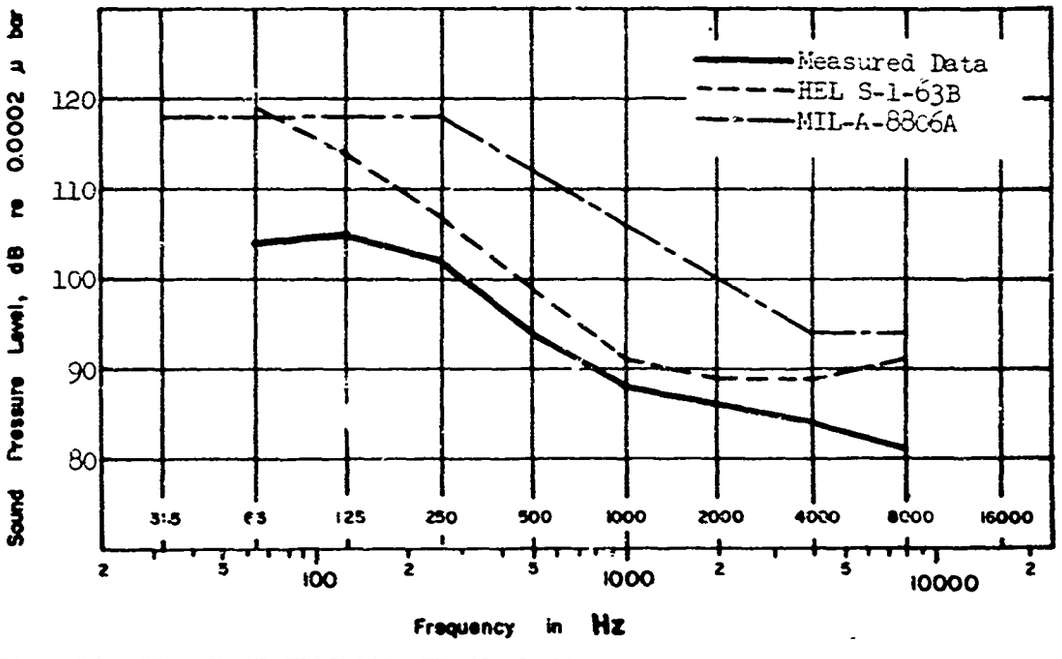

Fig. 32A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT
AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

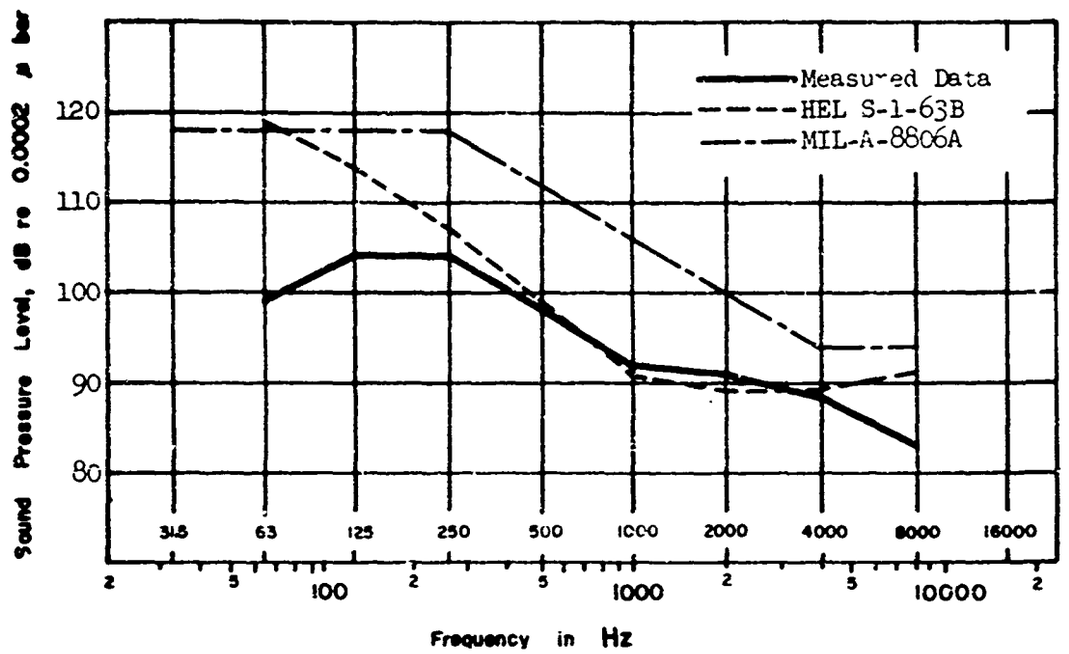

Fig. 33A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

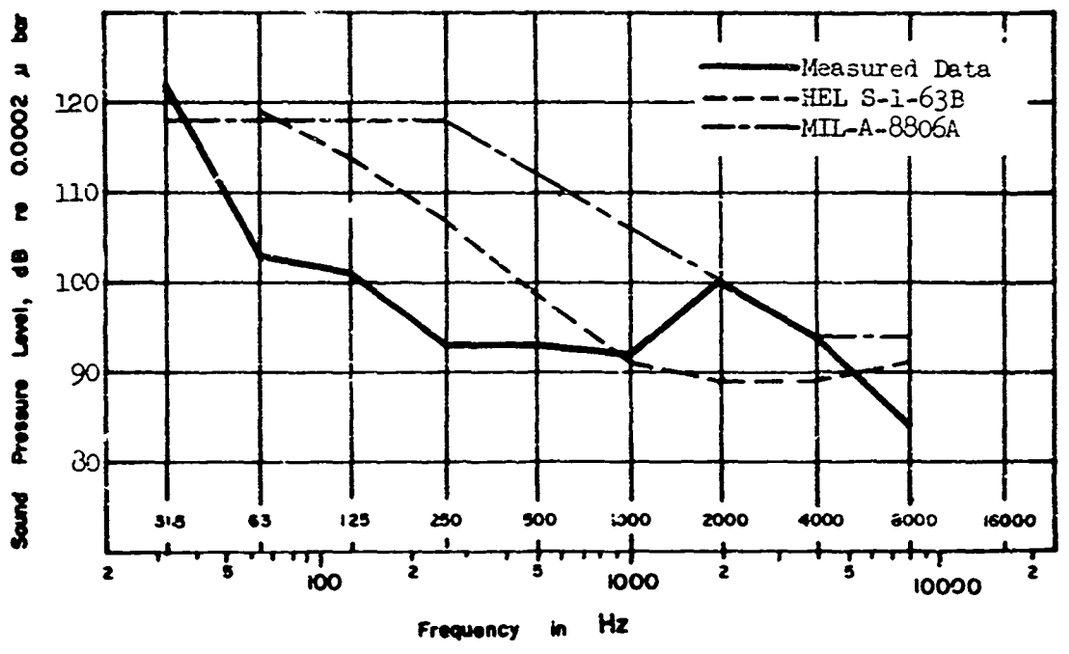

Fig. 34A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

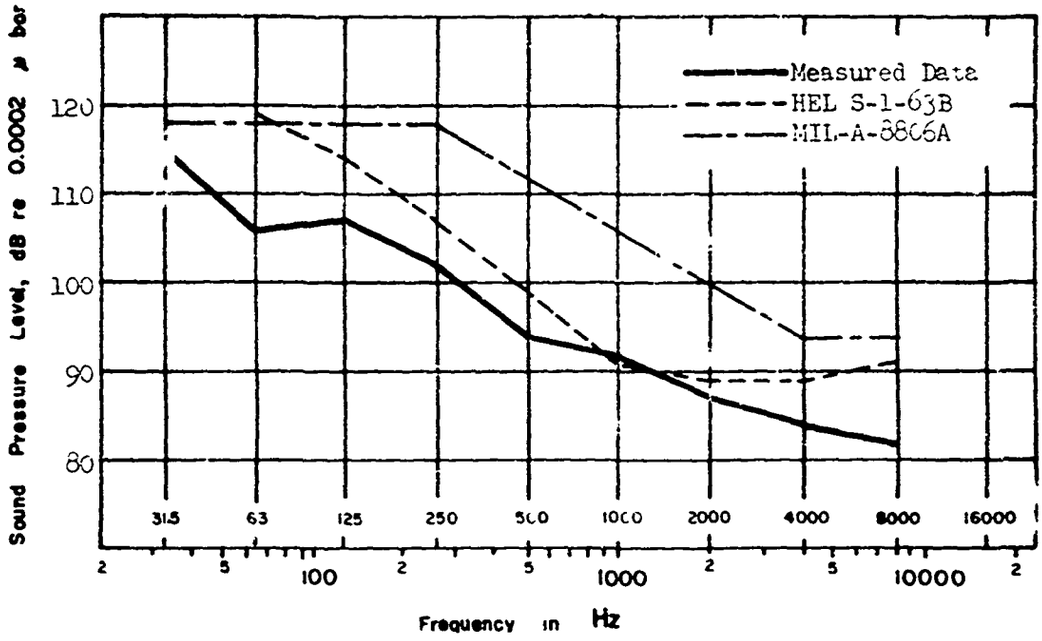

Fig. 35A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

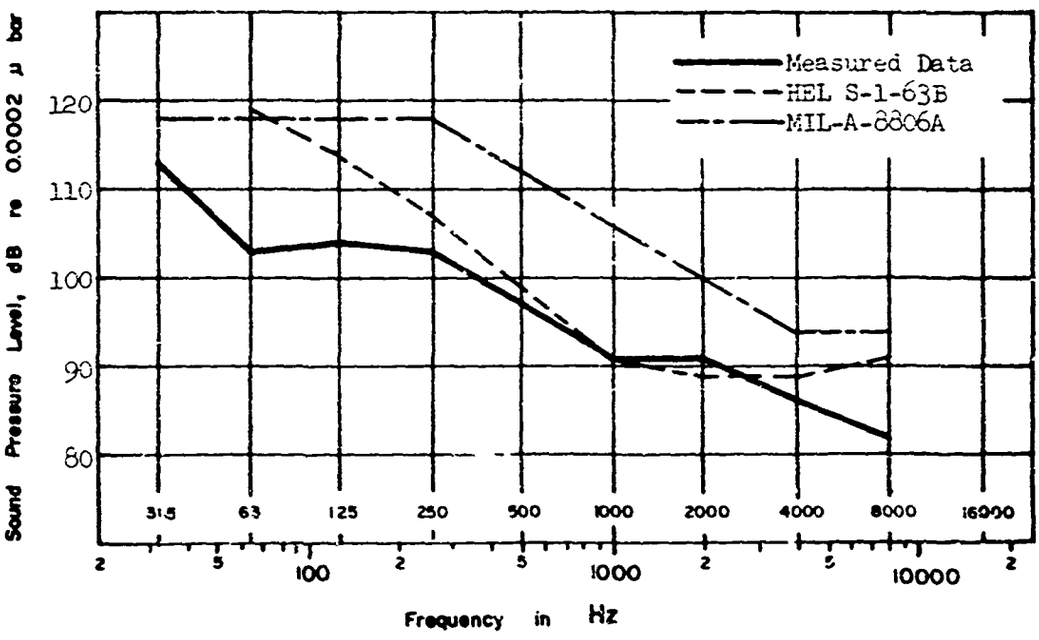

Fig. 36A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

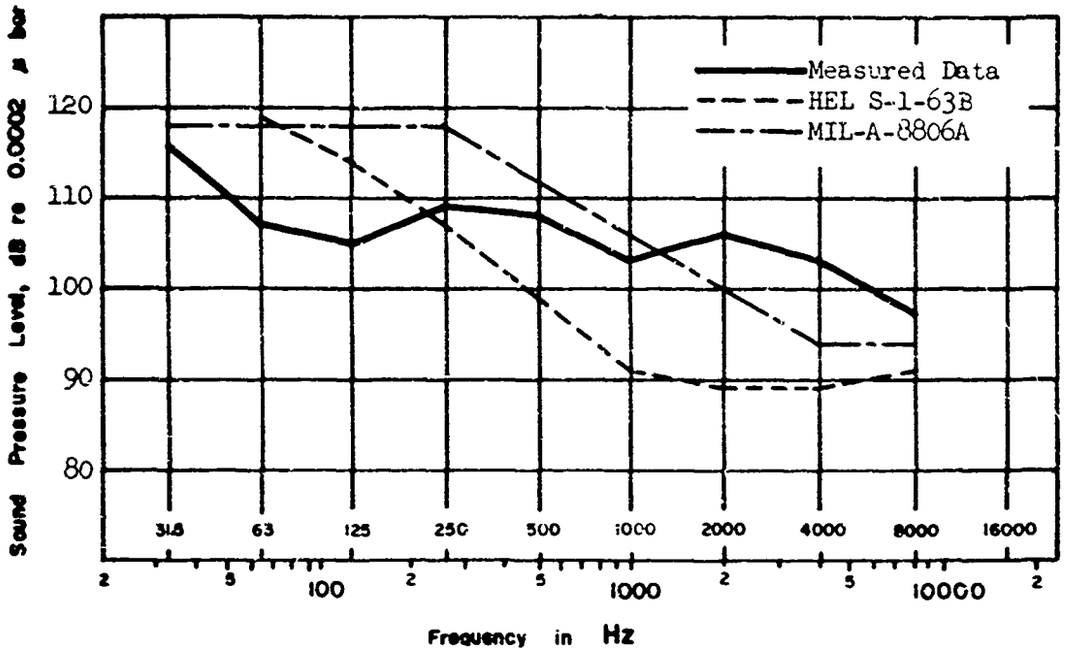

Fig. 37A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 80 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

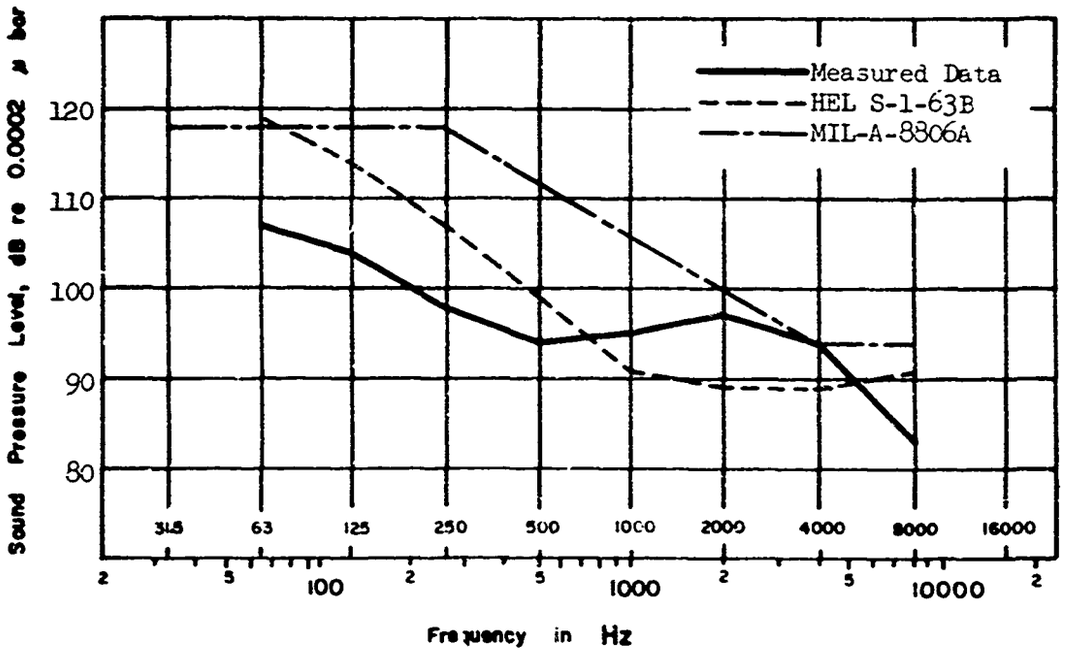

Fig. 38A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

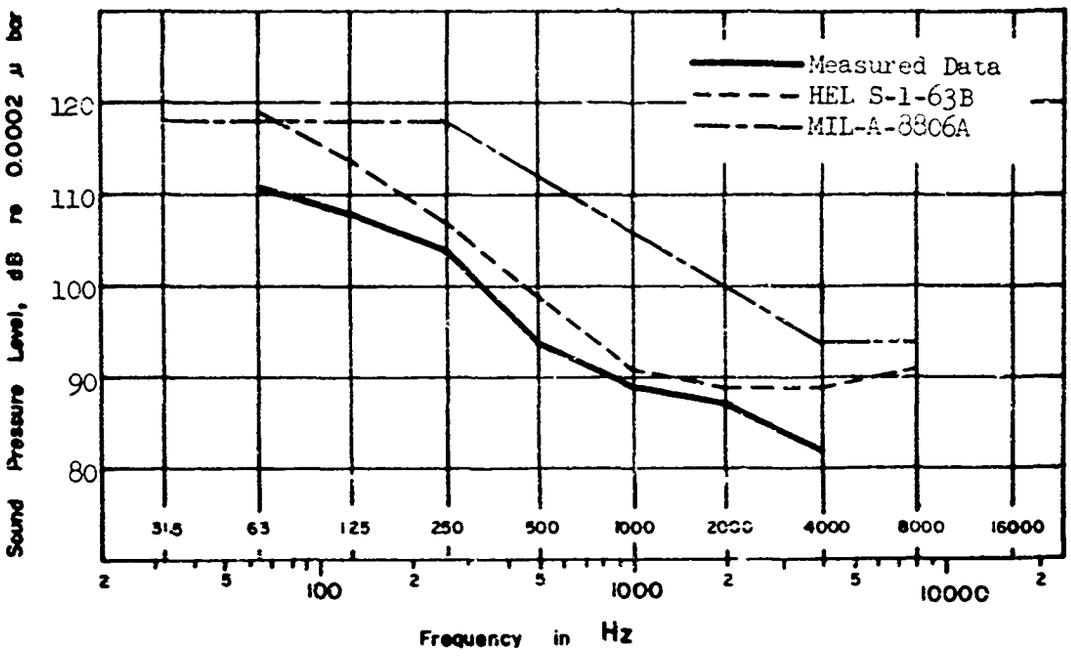

Fig. 39A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

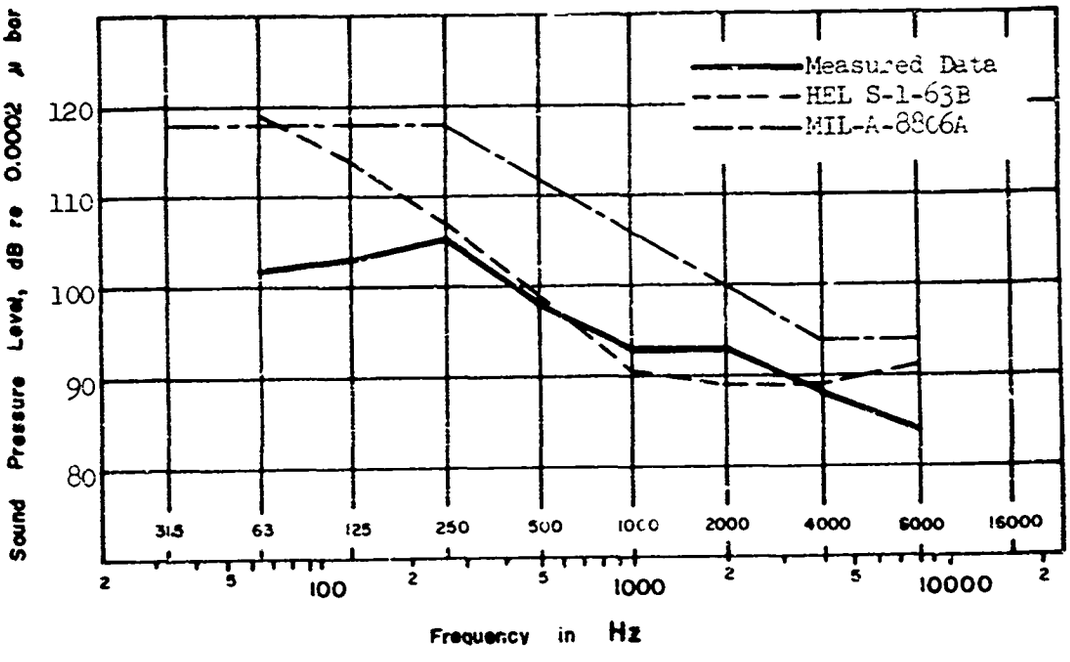

Fig. 40A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

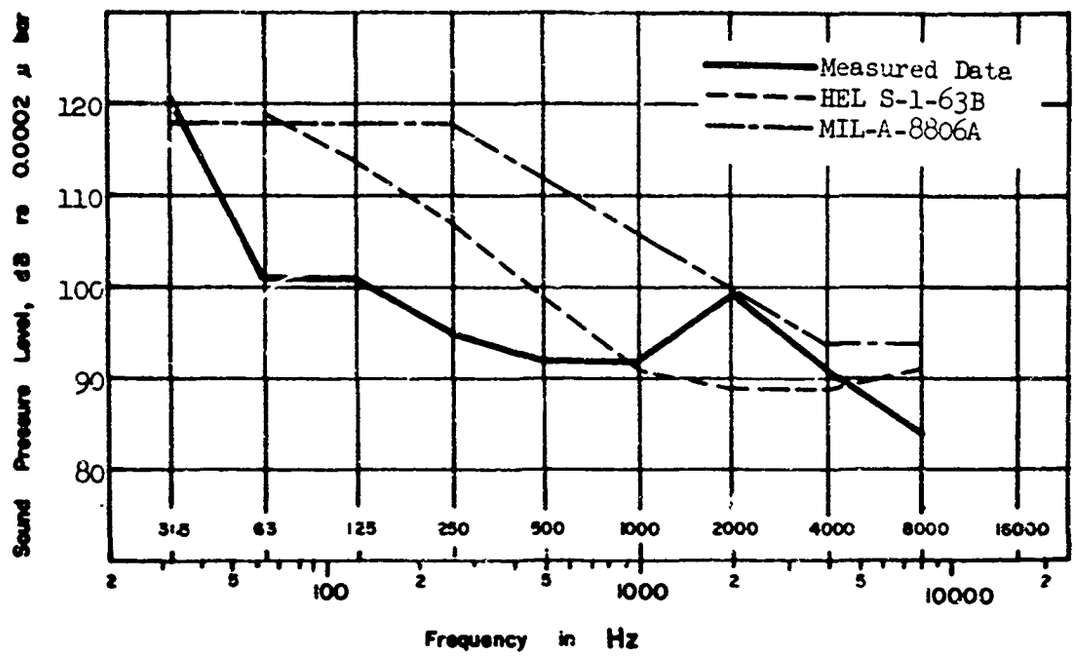

Fig. 41A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

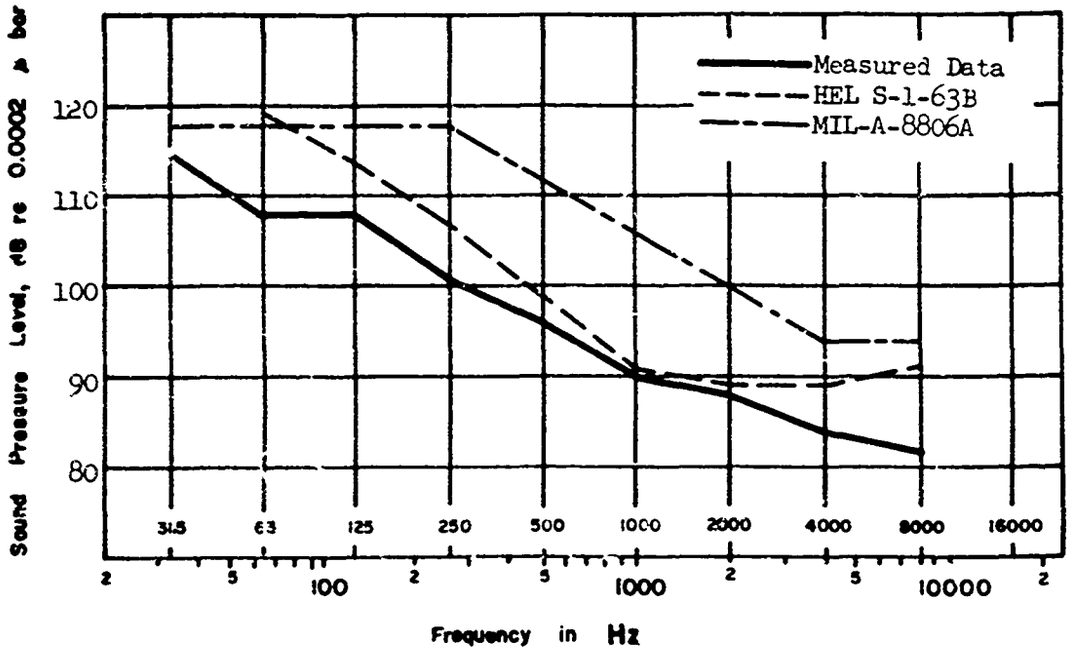

Fig. 42A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

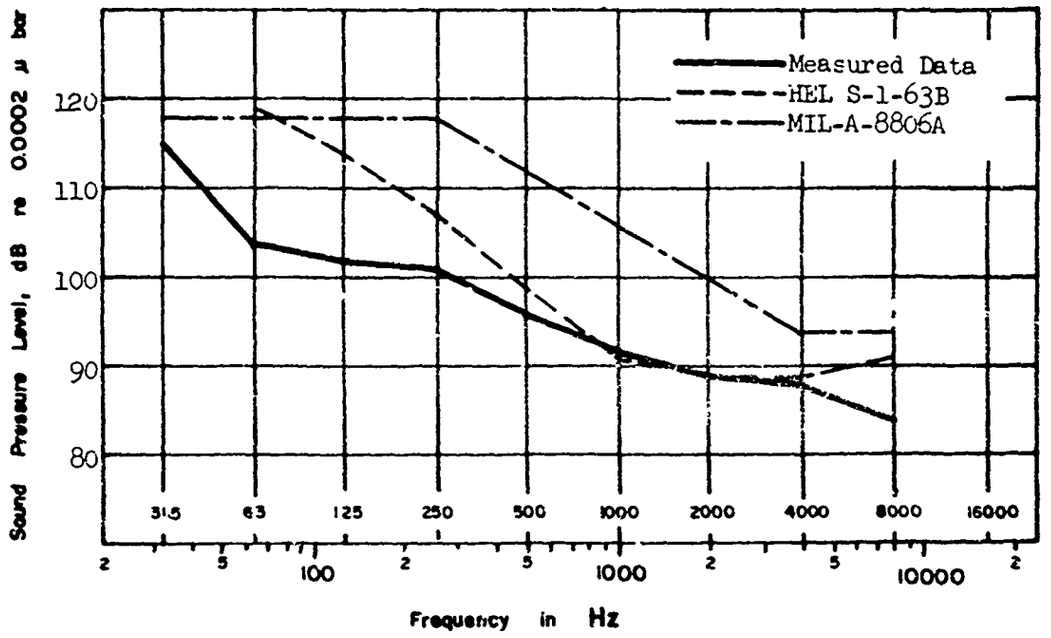

Fig. 43A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT
AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

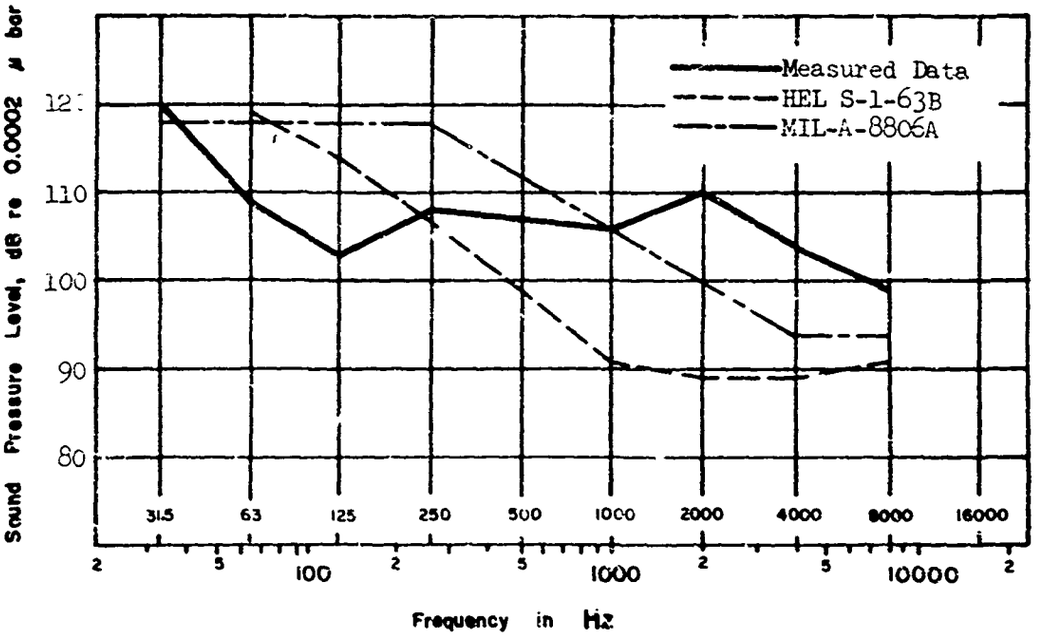

Fig. 44A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT
AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

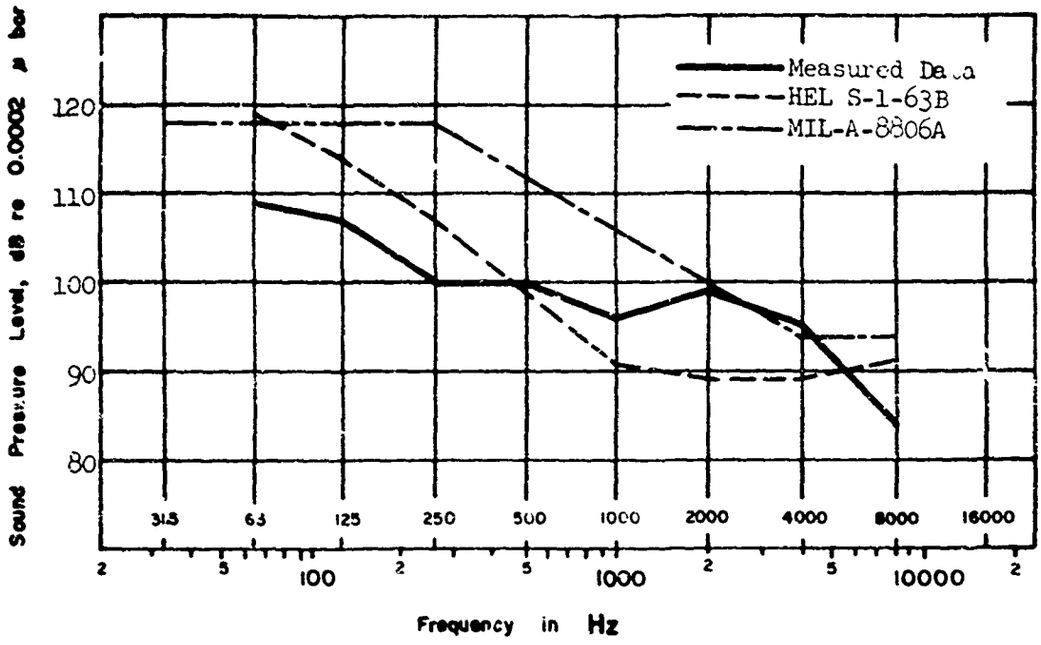

Fig. 45A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

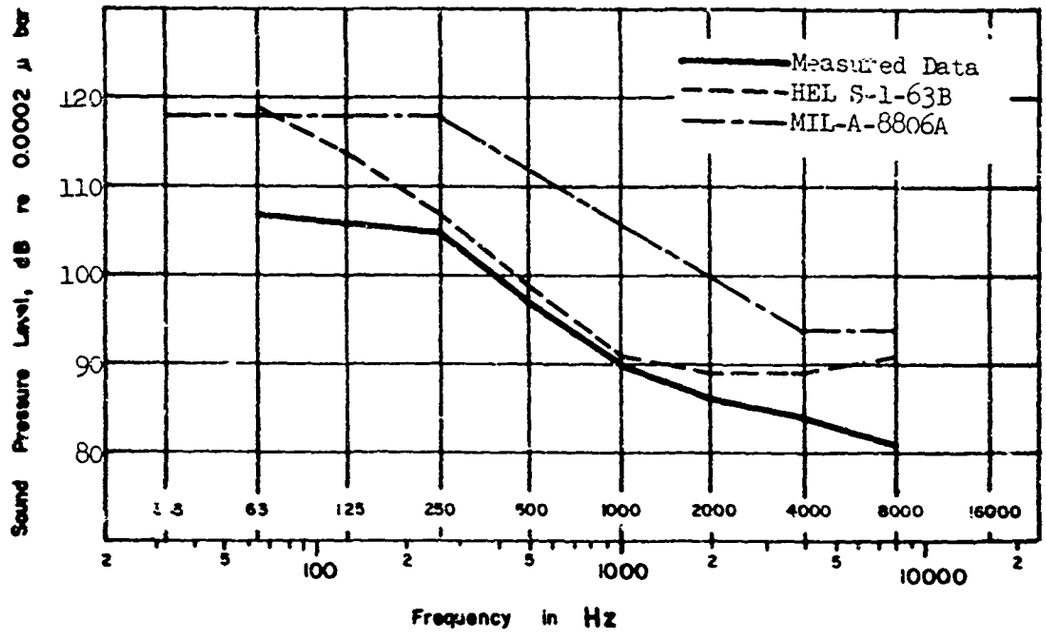

Fig. 46A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

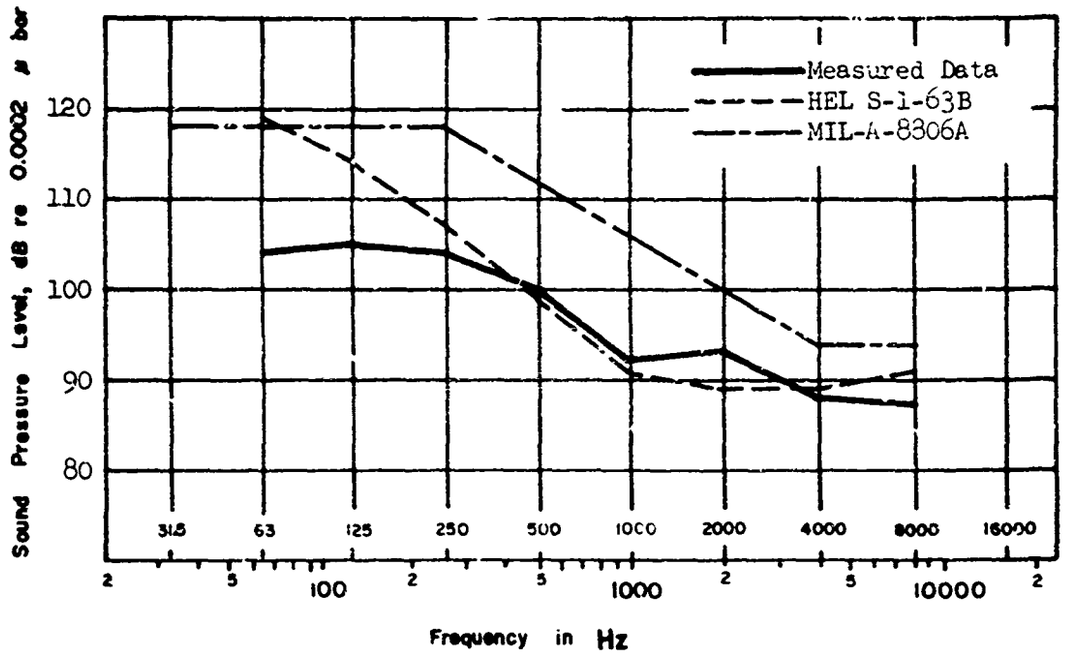

Fig. 47A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

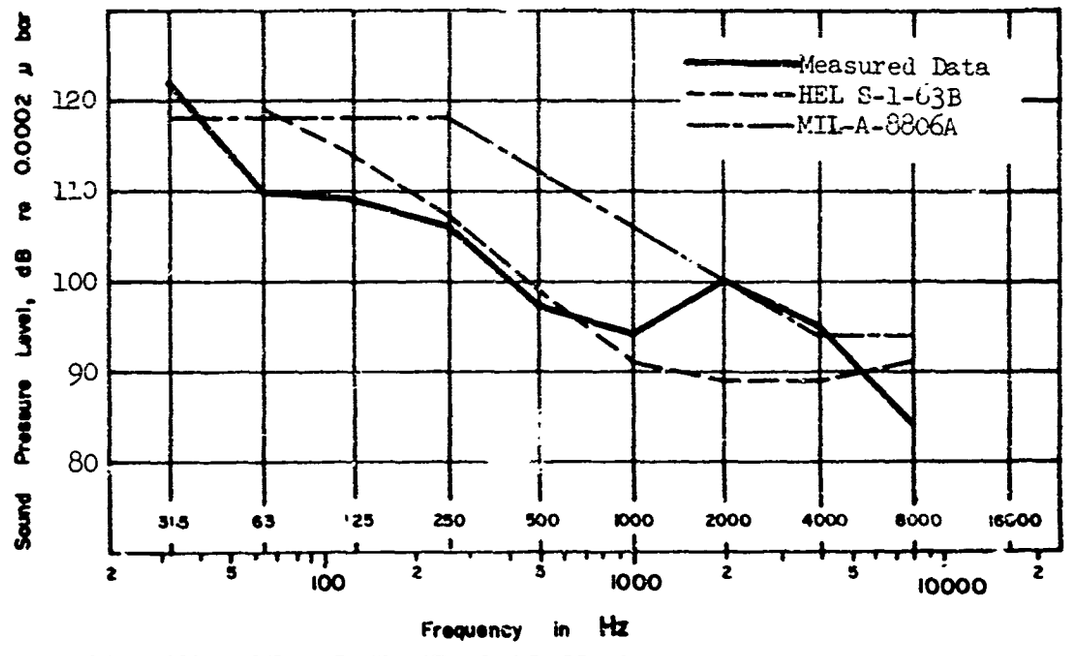

Fig. 48A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

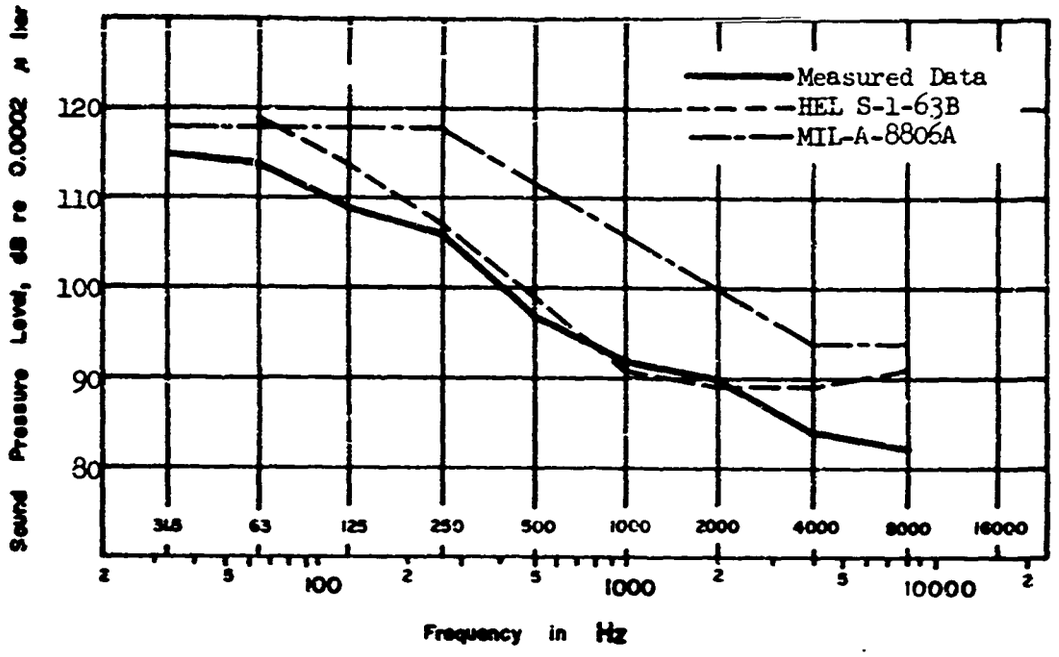

Fig. 49A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

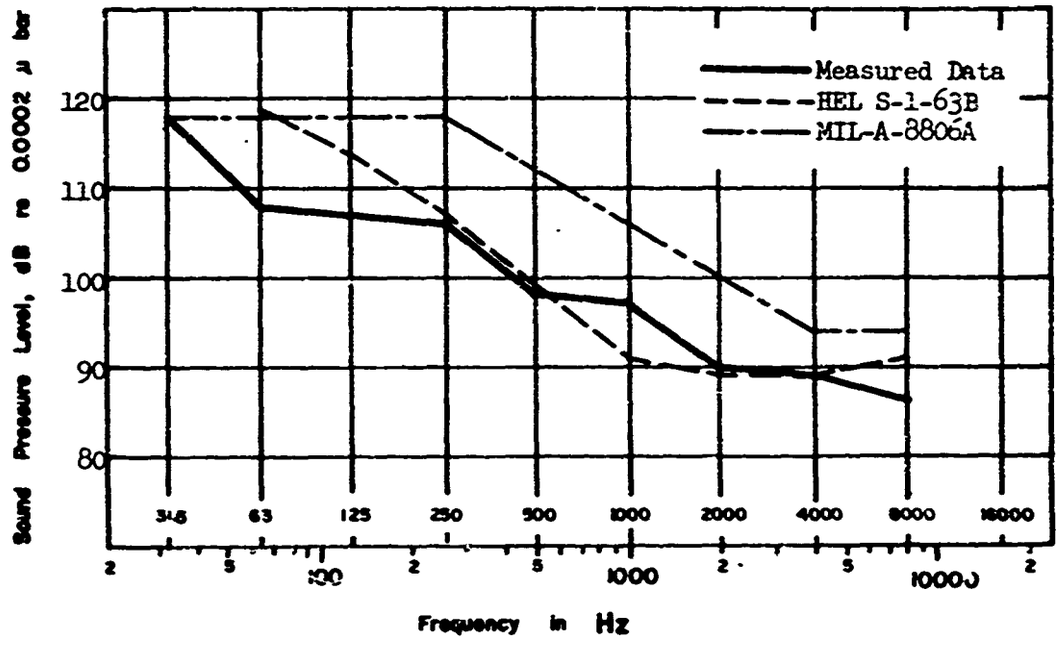

Fig. 50A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

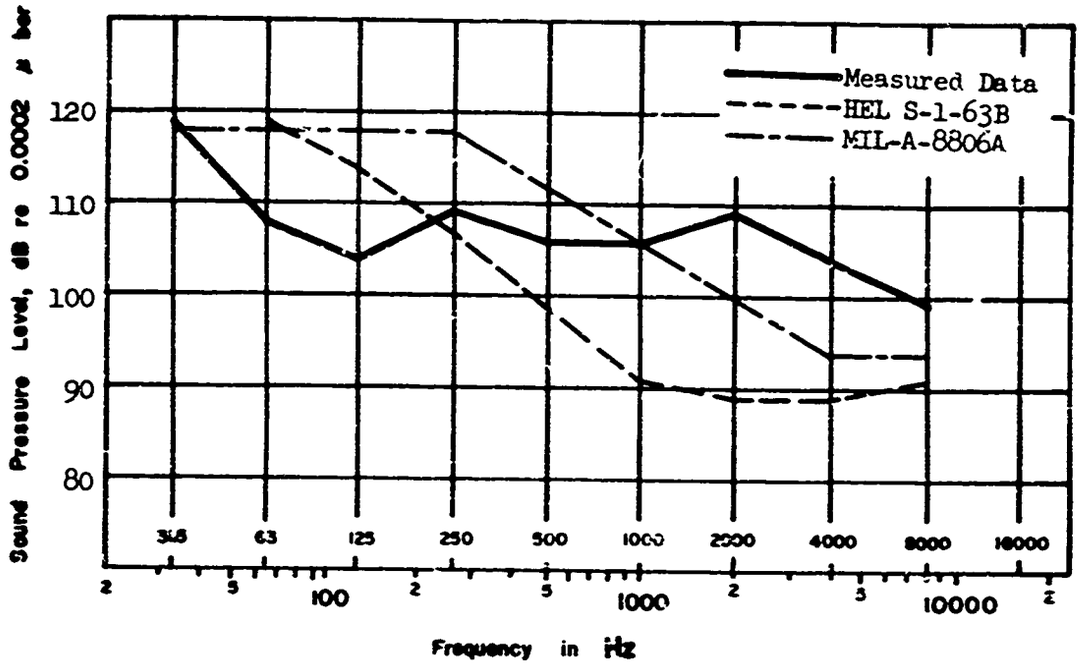

Fig. 51A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 120 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

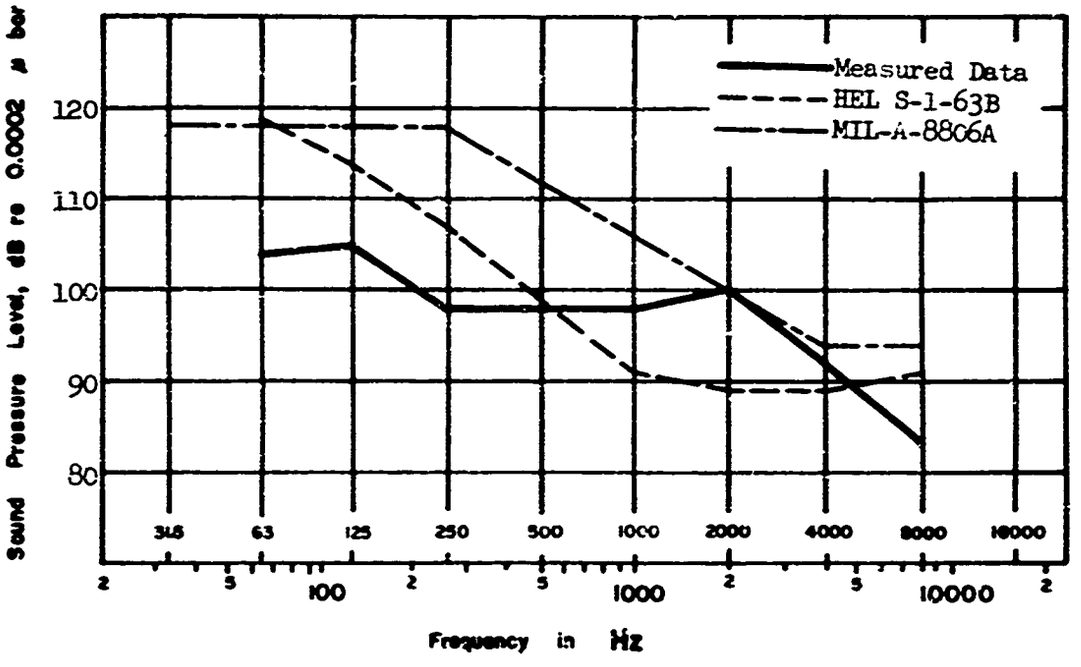

Fig. 52A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

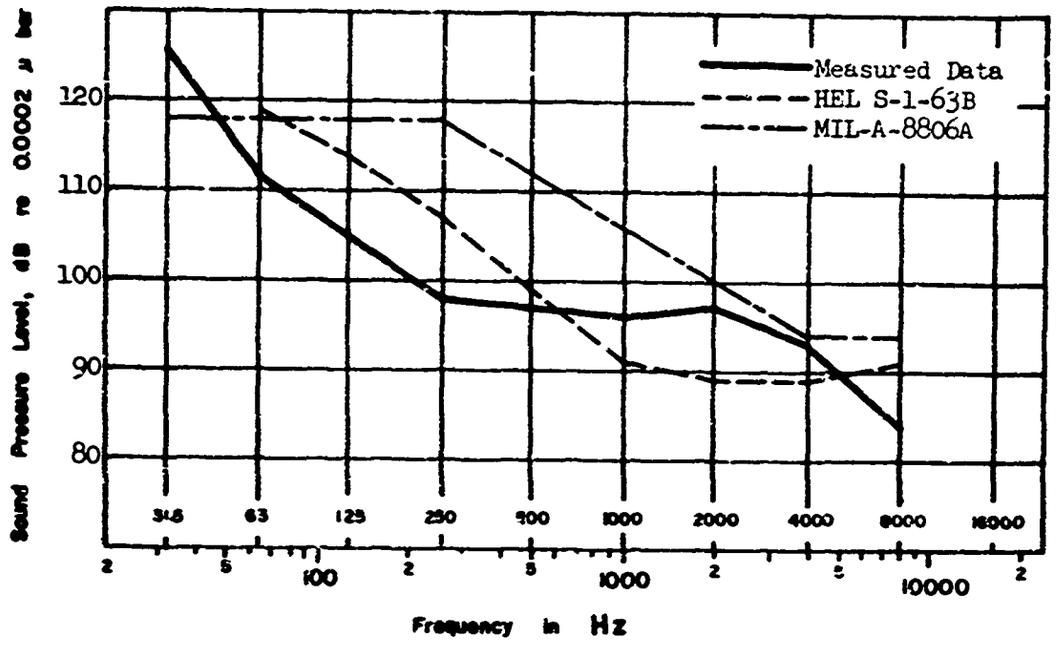

Fig. 53A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

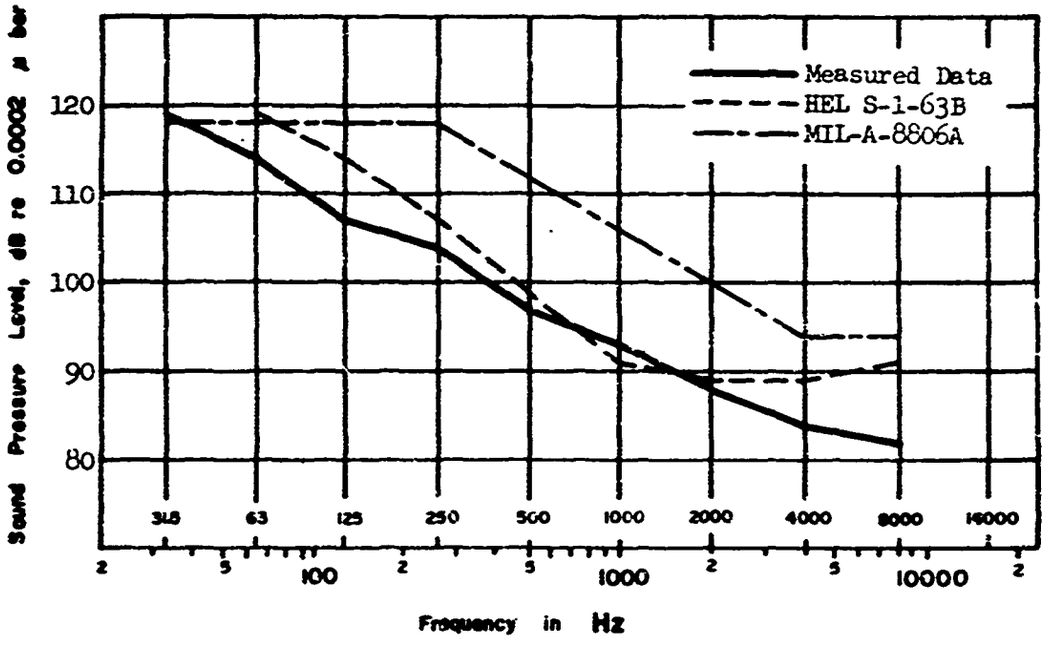

Fig. 54A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

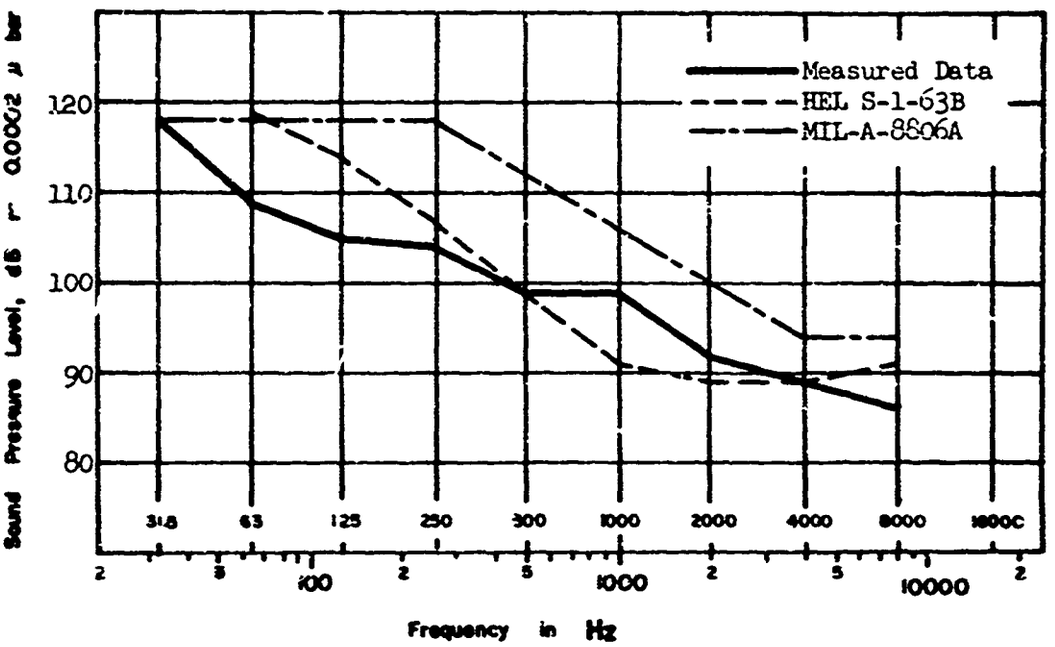

Fig. 55A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

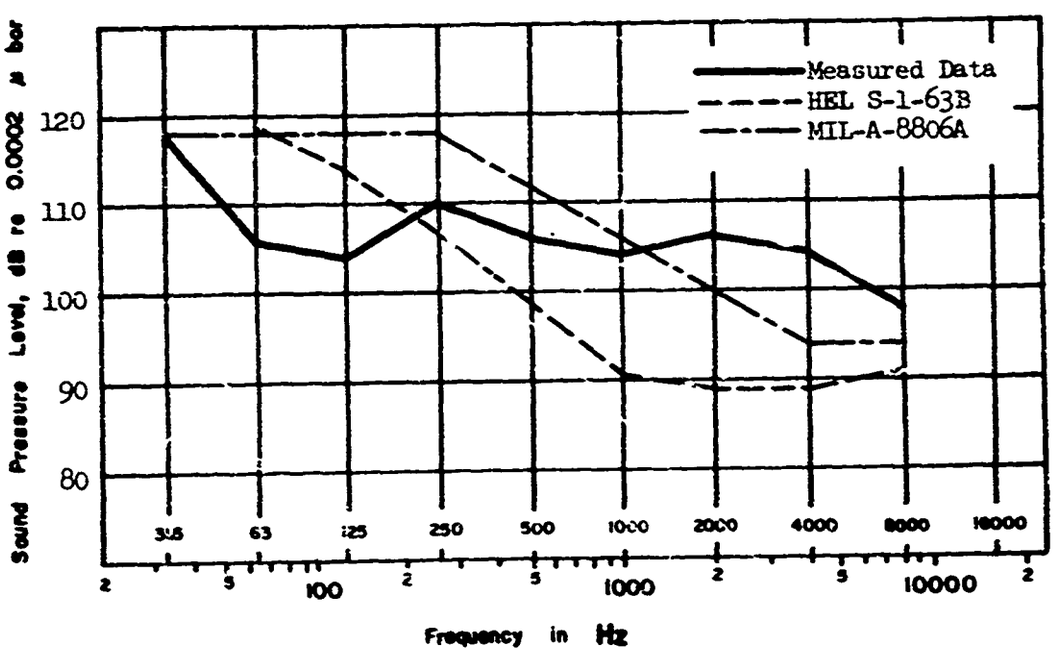

Fig. 56A. NOISE OF THE CH-47B HELICOPTER IN LEVEL FLIGHT AT 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

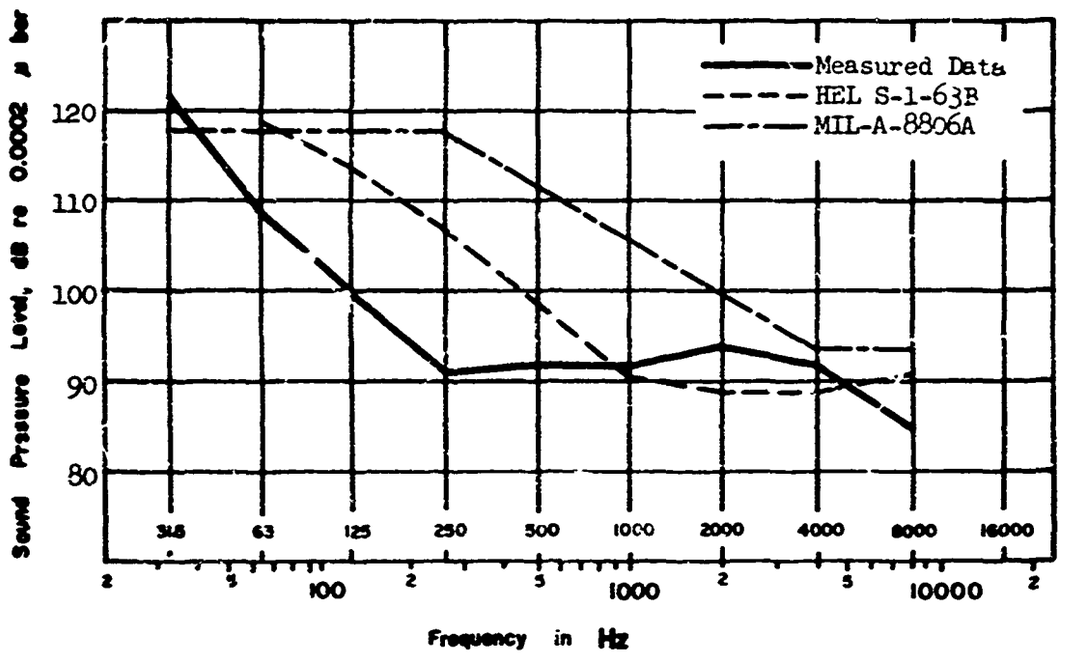

Fig. 57A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

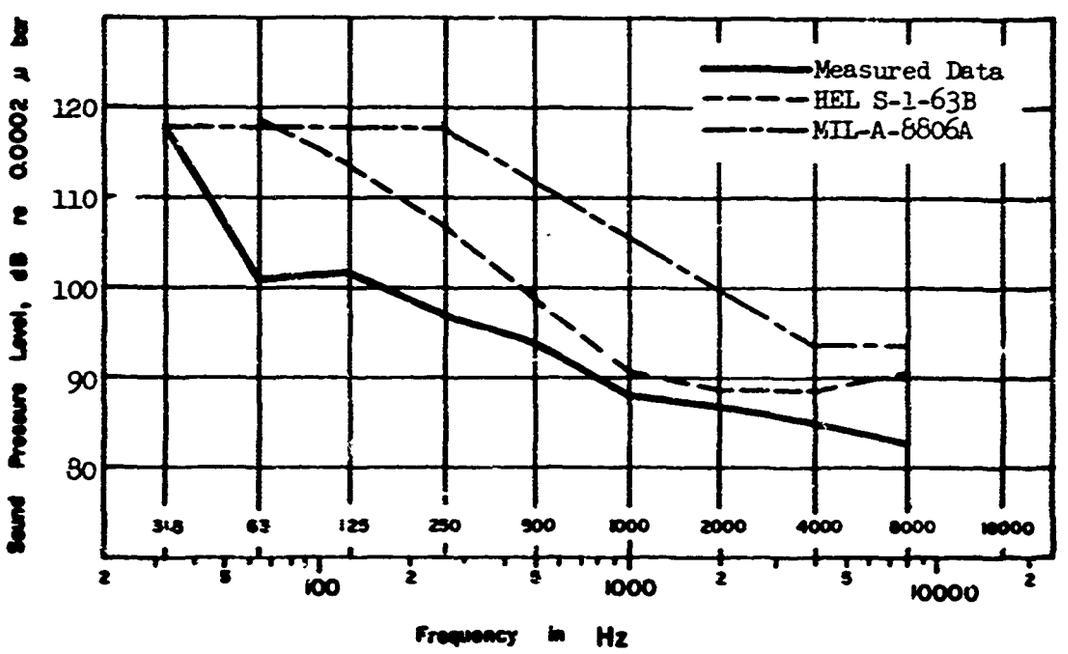

Fig. 58A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

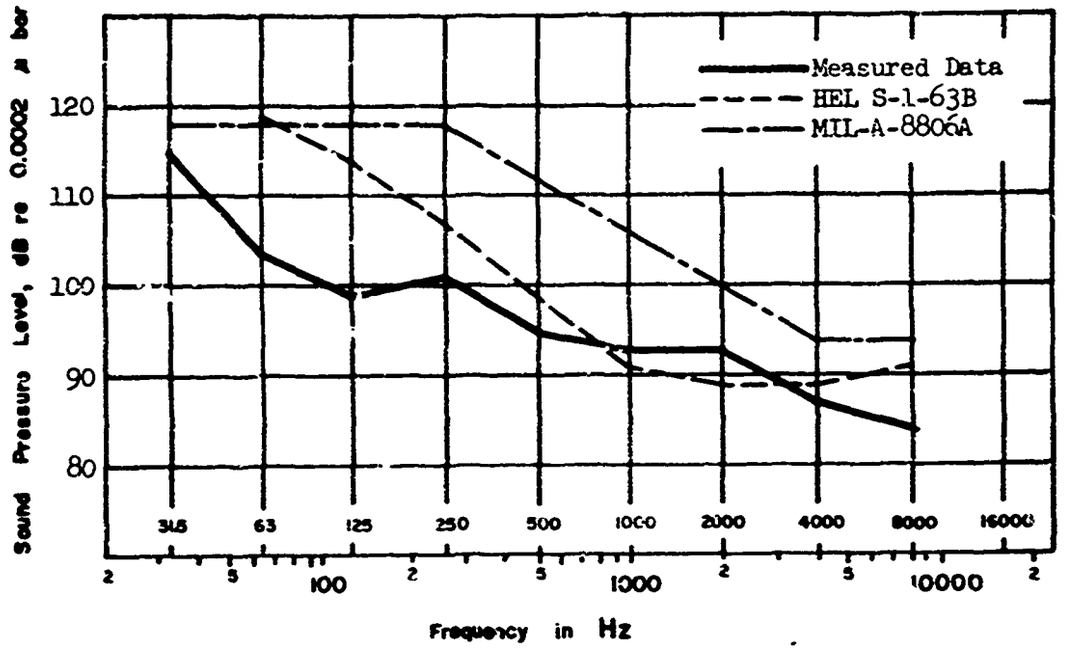

Fig. 59A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 225 rpm. Measuring position is at Station 480.)

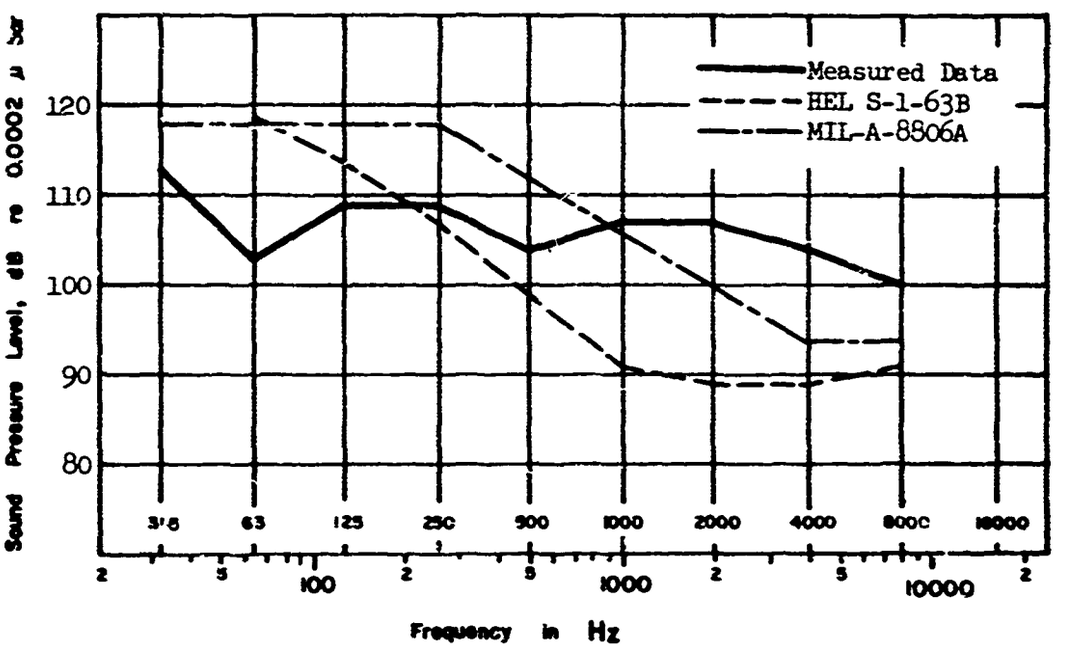

Fig. 60A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 225 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

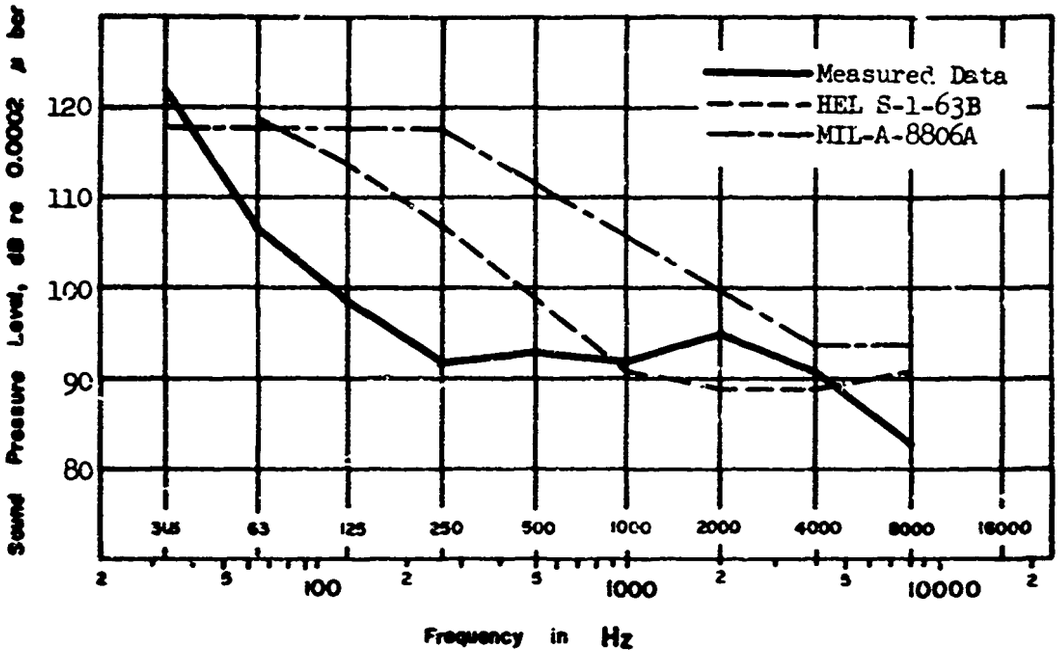

Fig. 61A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

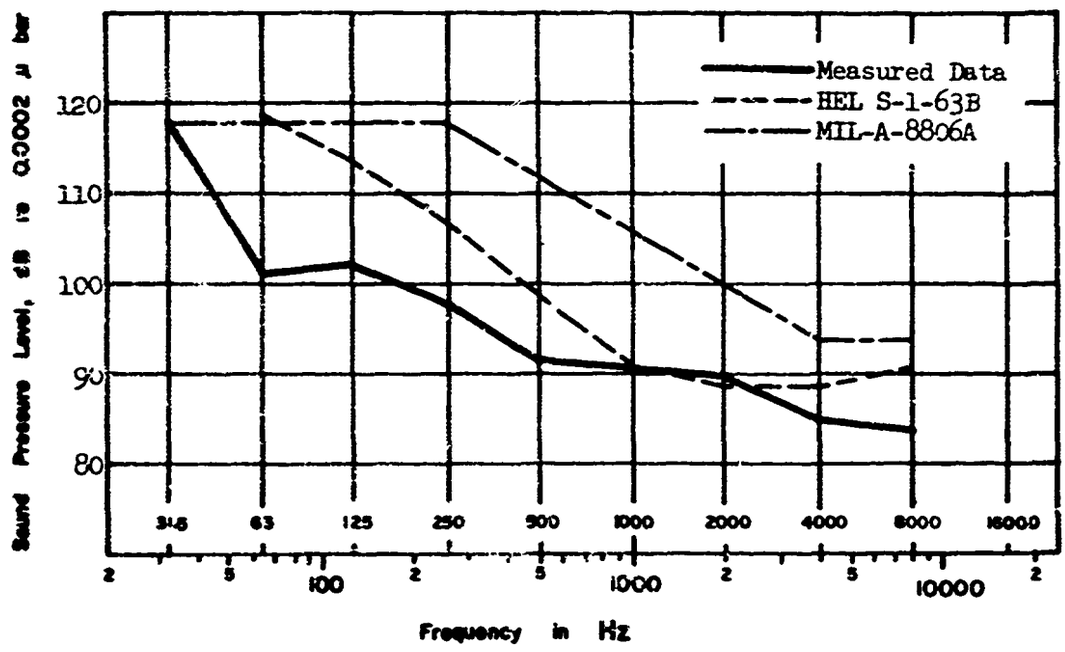

Fig. 62A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

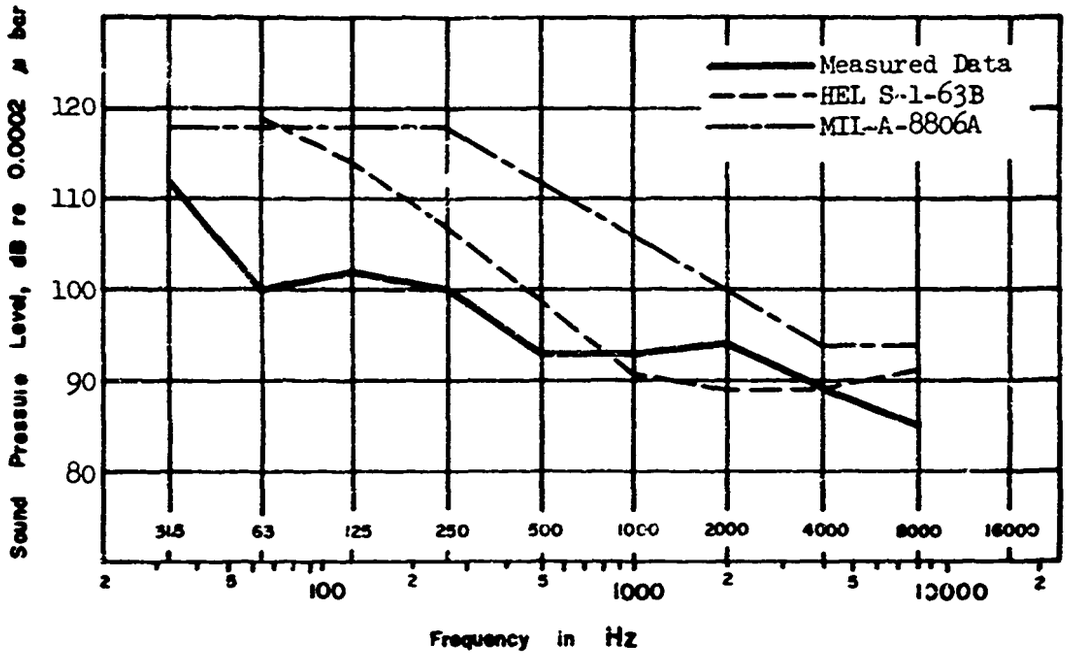

Fig. 63A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 230 rpm. Measuring position is at Station 480.)

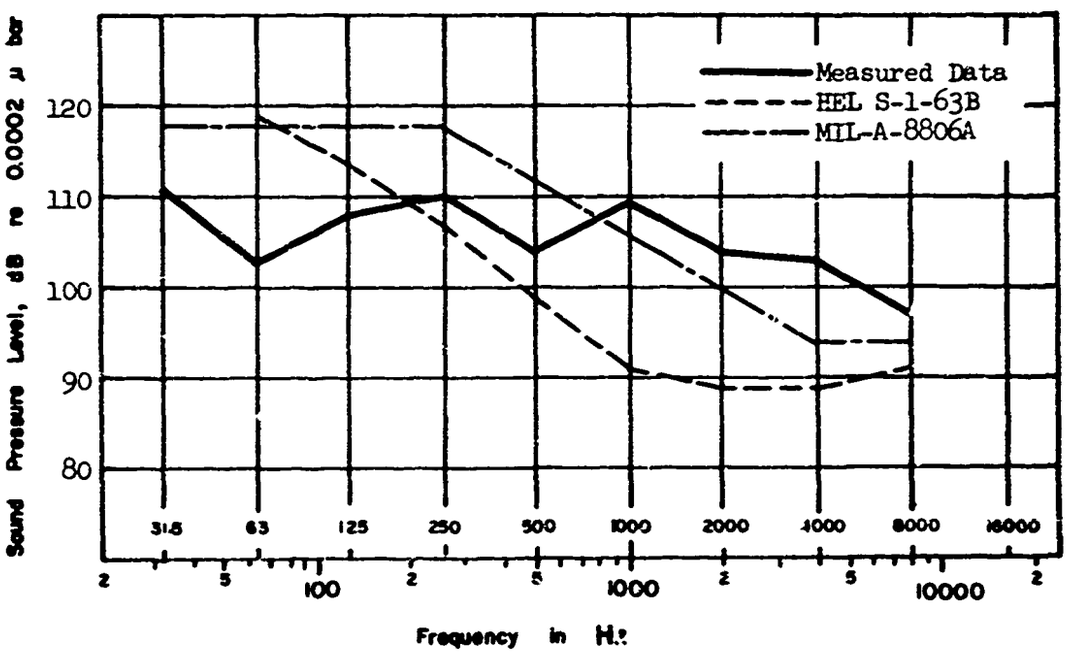

Fig. 64A. NOISE OF THE CH-47B HELICOPTER WHILE HOVERING OUT OF GROUND EFFECT
(Rotor speed is 230 rpm. Measuring position is at Station 480.)
(All panels aft of Station 486 removed.)

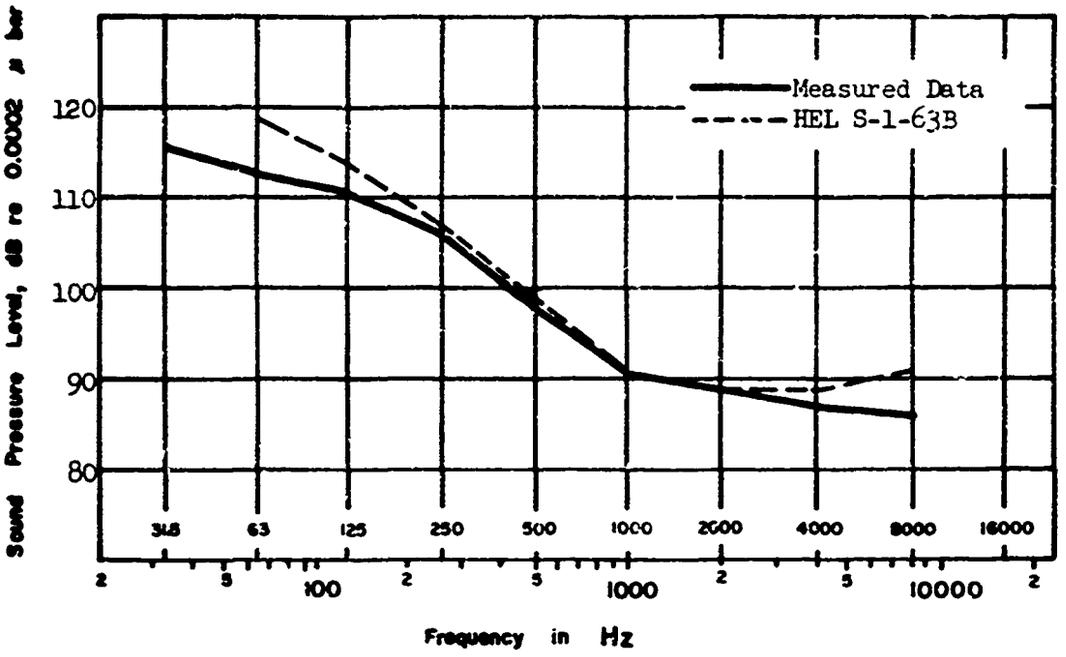

Fig. 65A. NOISE OUTSIDE THE CH-47B HELICOPTER WHILE HOVERING (IN GROUND EFFECT) AT 10 FEET ALTITUDE (Rotor speed is 230 rpm. Measuring position is 20 meters in front of the aircraft; 0^{o} with the axis.)

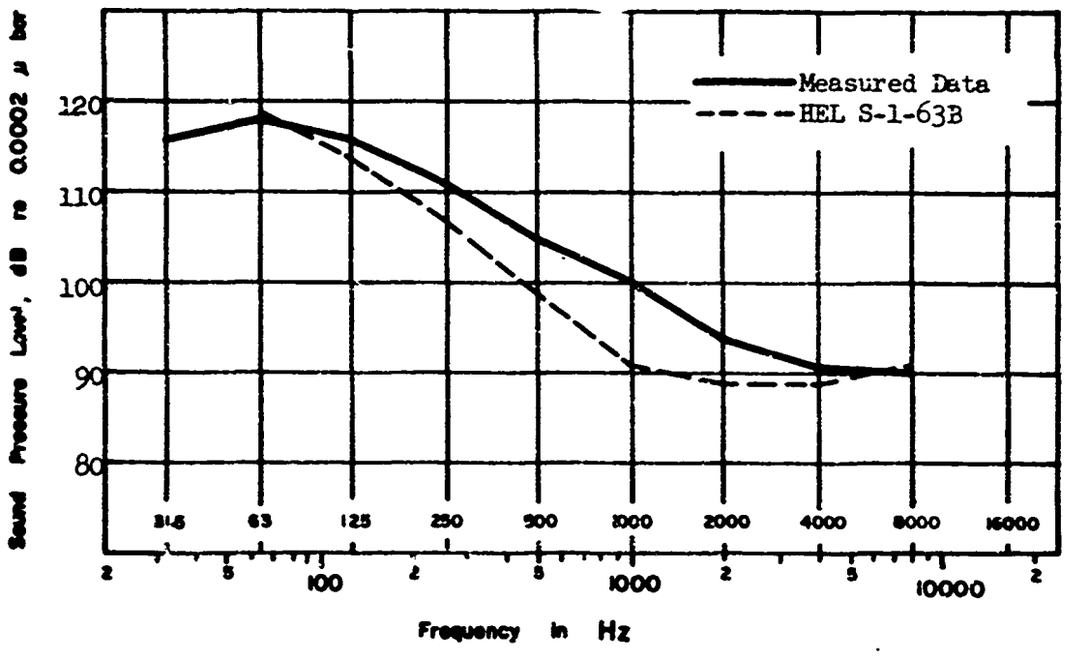

Fig. 66A. NOISE OUTSIDE THE CH-47B HELICOPTER WHILE HOVERING (IN GROUND EFFECT) AT 10 FEET ALTITUDE (Rotor speed is 230 rpm. Measuring position is 20 meters starboard of the aircraft; 90^{o} with the axis.)

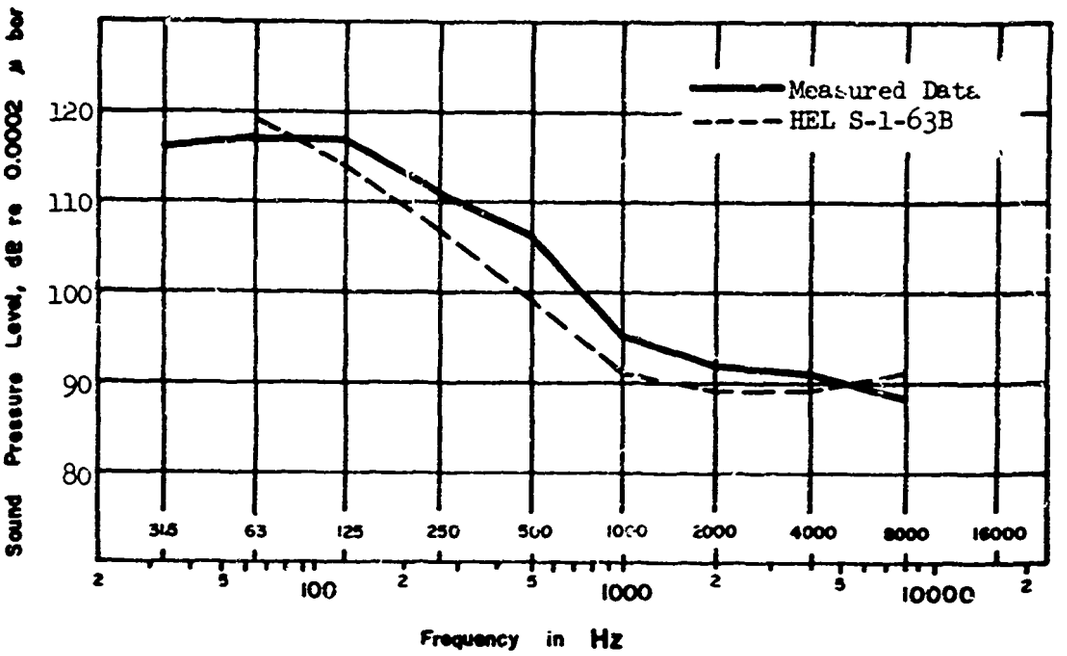

Fig. 67A. NOISE OUTSIDE THE CH-47B HELICOPTER WHILE HOVERING (IN GROUND EFFECT) AT 10 FEET ALTITUDE (Rotor speed is 230 rpm. Measuring position is 20 meters behind the aircraft; 180° with the axis.)

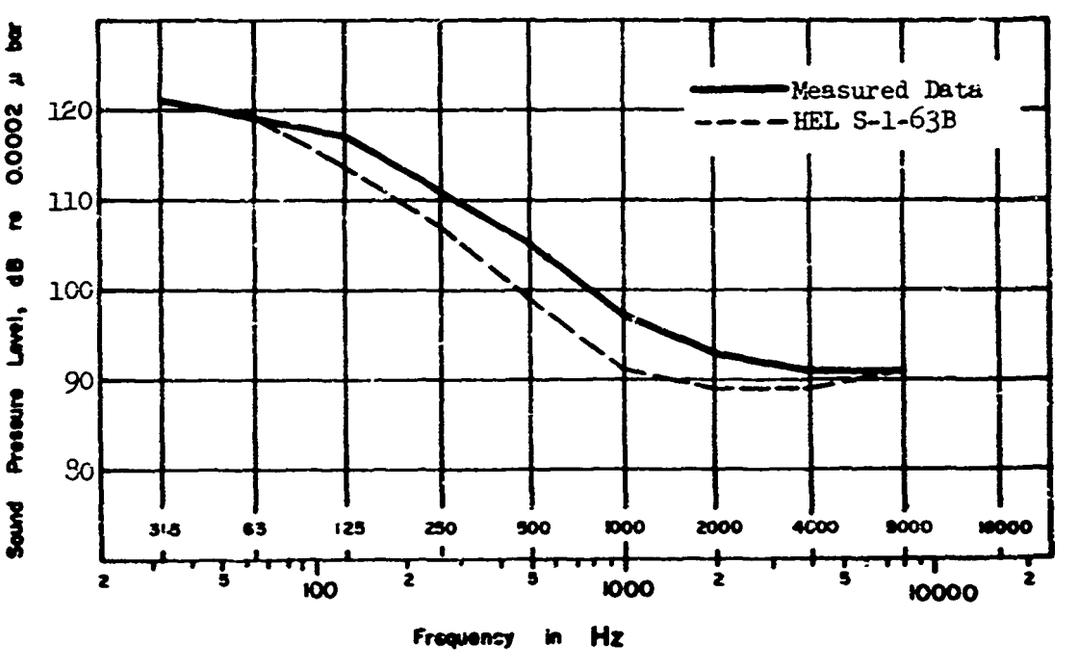

Fig. 68A. NOISE OUTSIDE THE CH-47B HELICOPTER WHILE HOVERING (IN GROUND EFFECT) AT 10 FEET ALTITUDE (Rotor speed is 230 rpm. Measuring position is 20 meters port of the aircraft; 270° with the axis.)

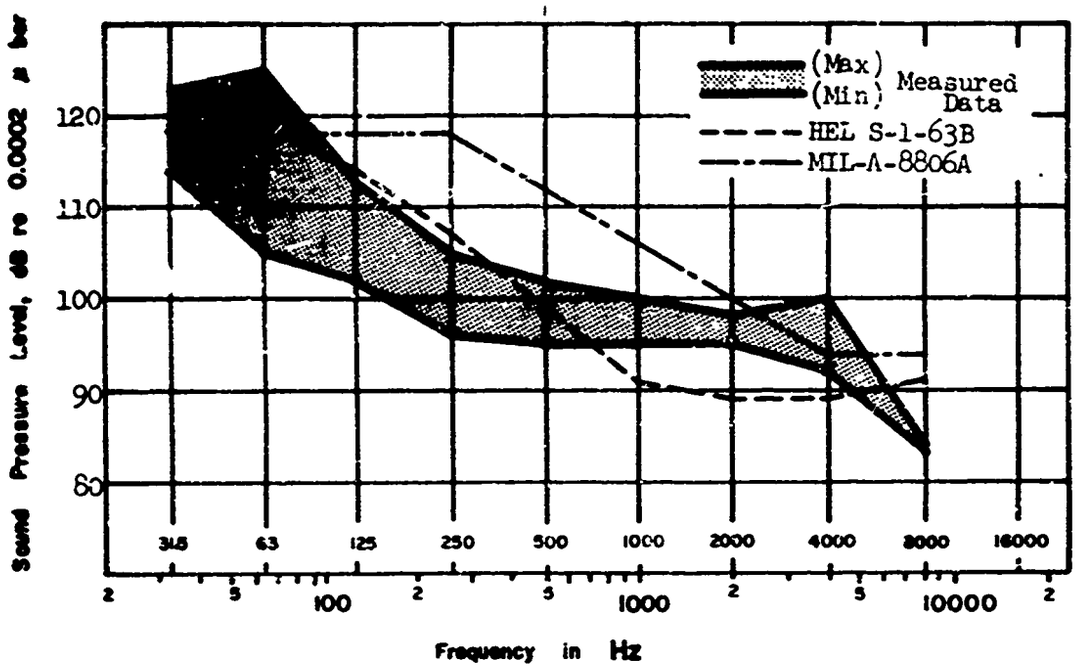

Fig. 69A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL ACCELERATION FROM 40 KNOTS TRUE AIR SPEED TO 140 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

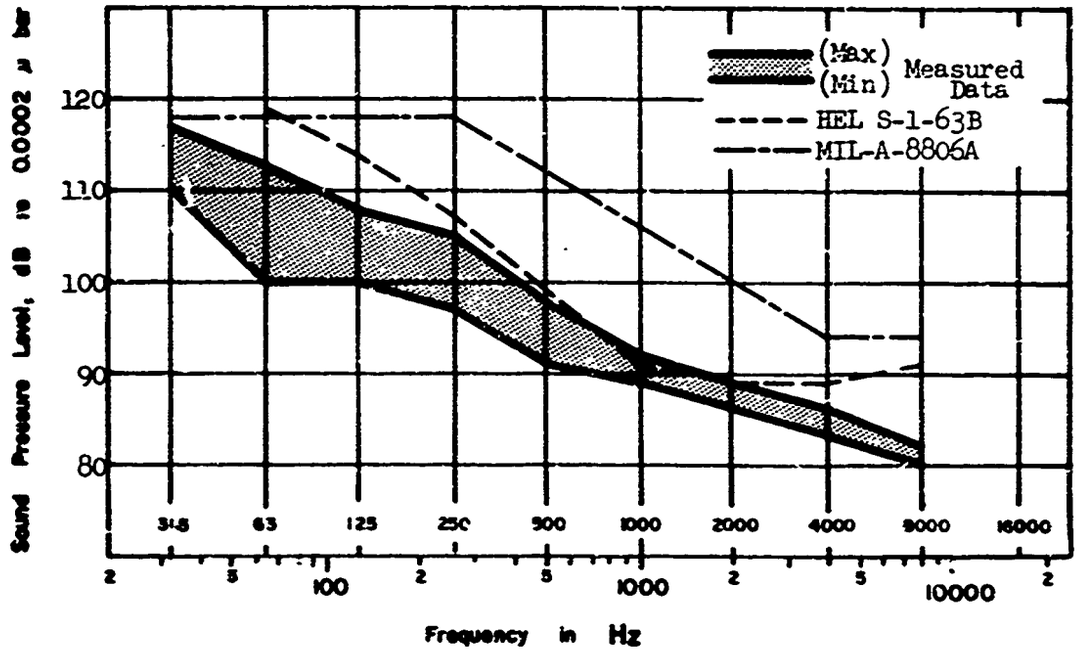

Fig. 70A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL ACCELERATION FROM 40 KNOTS TRUE AIR SPEED TO 140 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

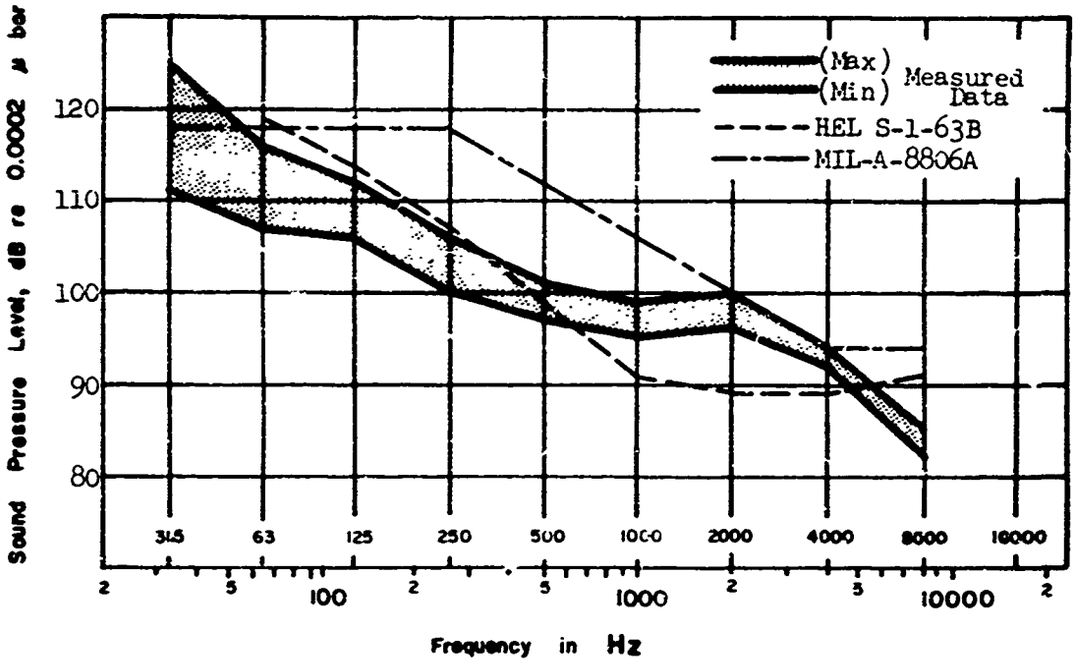

Fig. 71A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL ACCELERATION FROM 40 KNOTS TRUE AIR SPEED TO 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

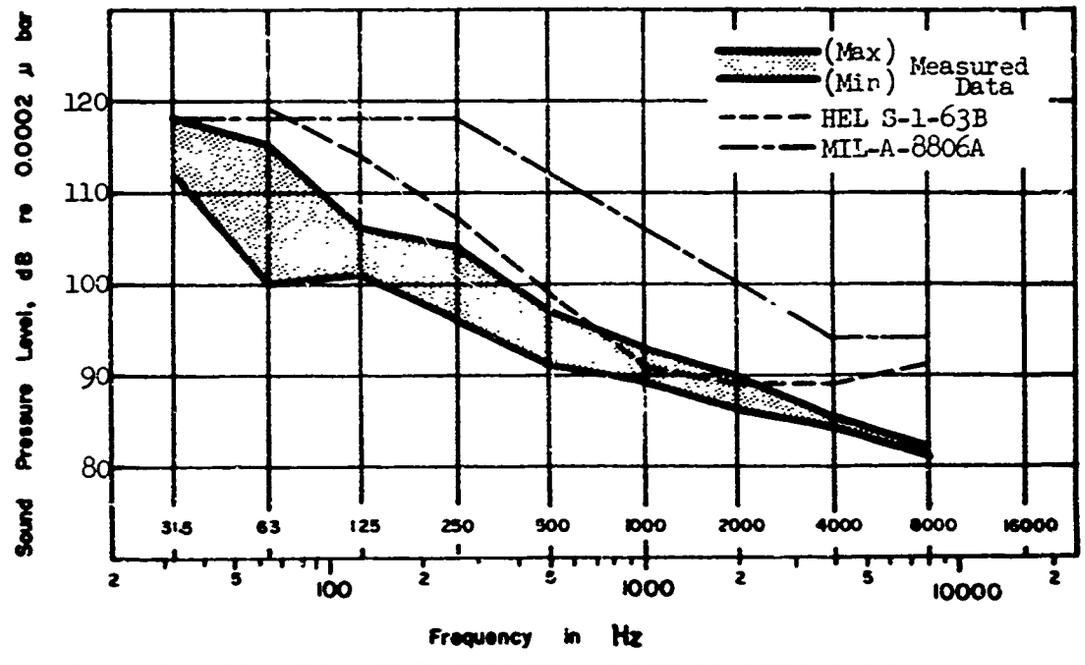

Fig. 72A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL ACCELERATION FROM 40 KNOTS TRUE AIR SPEED TO 140 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

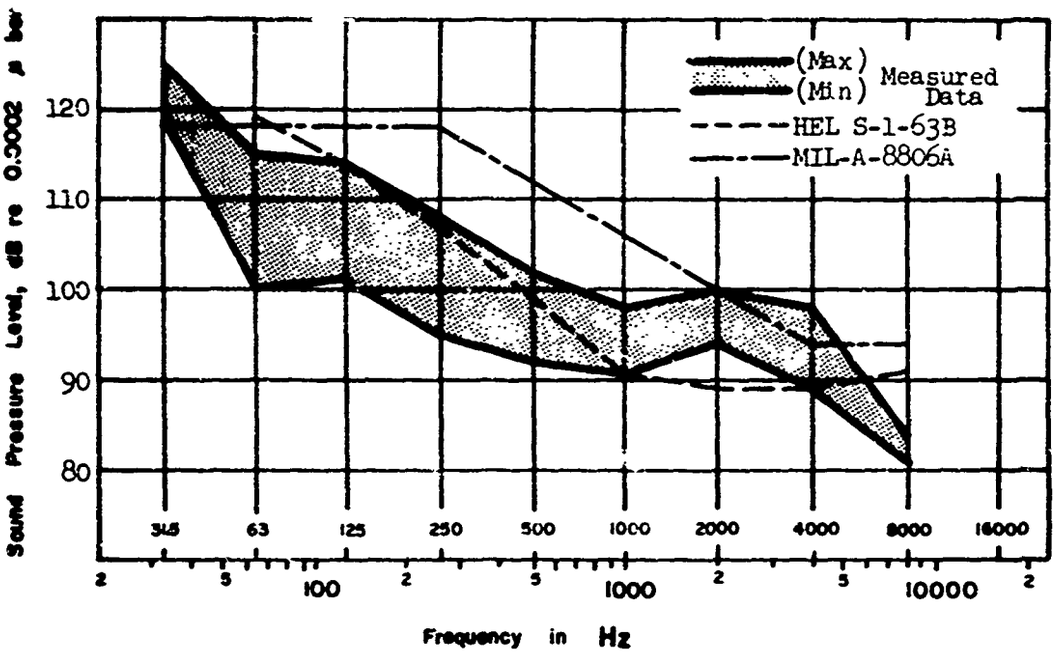

Fig. 73A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL DECELERATION FROM 140 KNOTS TRUE AIR SPEED TO 40 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 95.)

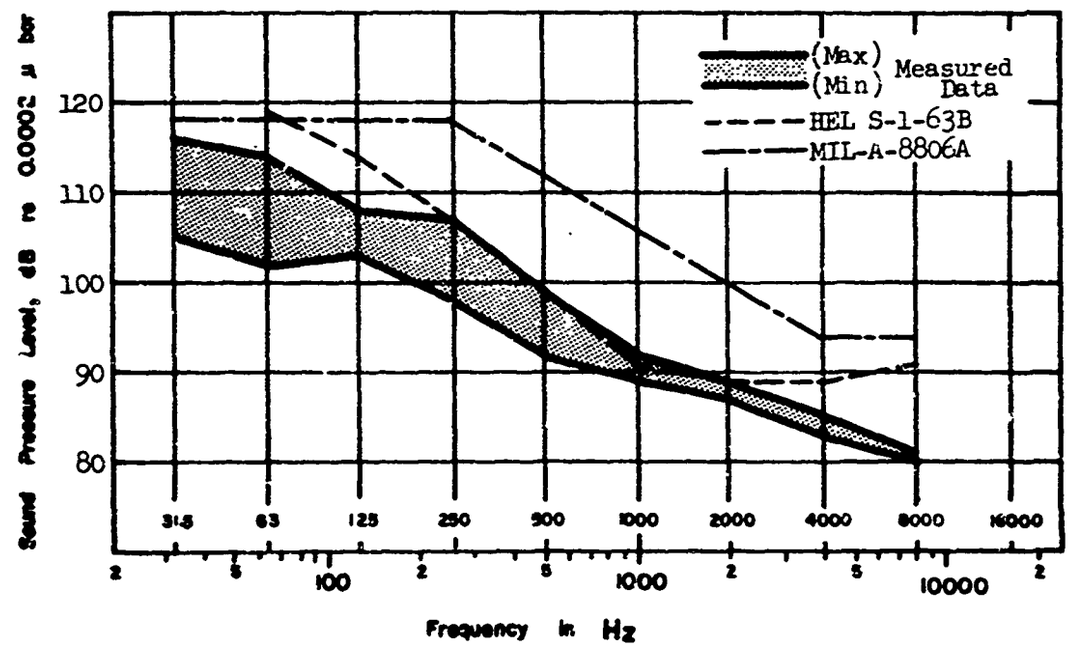

Fig. 74A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL DECELERATION FROM 140 KNOTS TRUE AIR SPEED TO 40 KNOTS TRUE AIR SPEED
(Rotor speed is 225 rpm. Measuring position is at Station 320.)

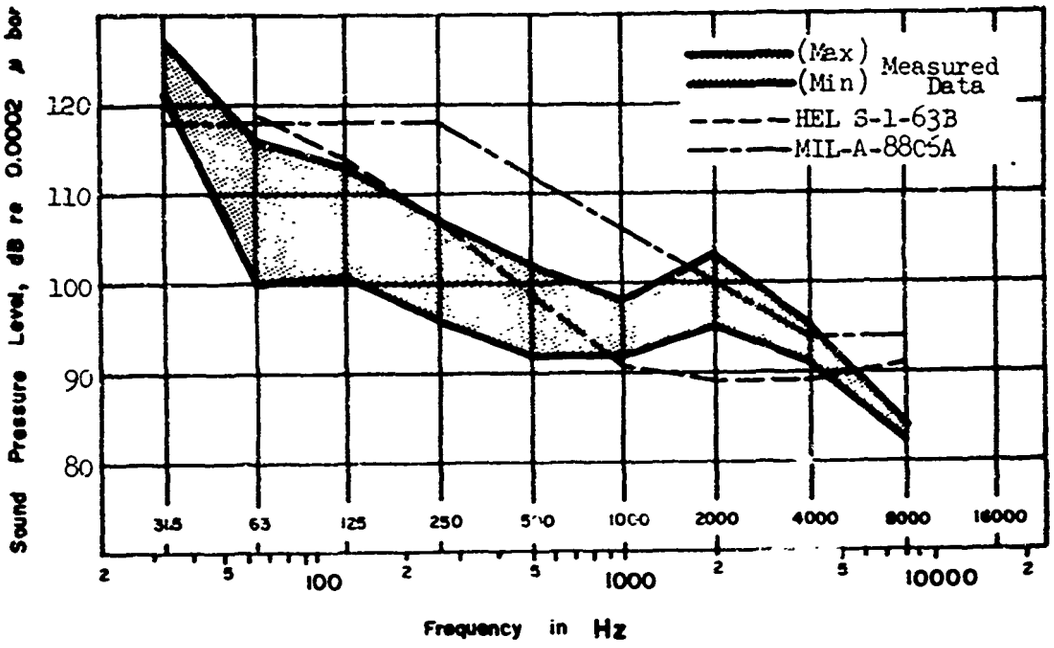

Fig. 75A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL DECELERATION FROM 140 KNOTS TRUE AIR SPEED TO 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

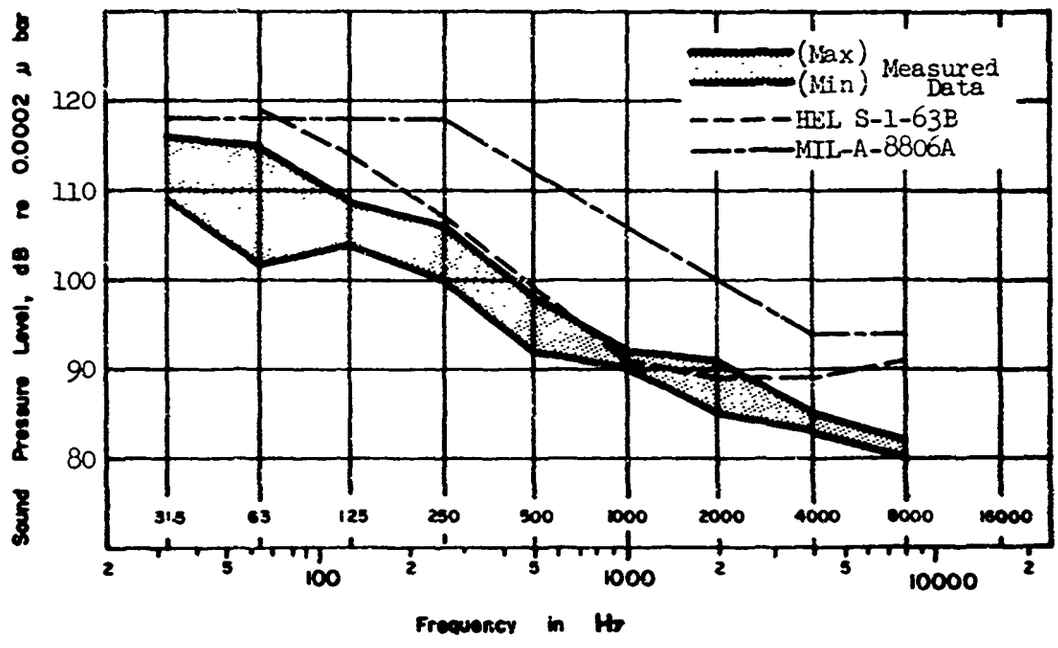

Fig. 76A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A LEVEL DECELERATION FROM 140 KNOTS TRUE AIR SPEED TO 40 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

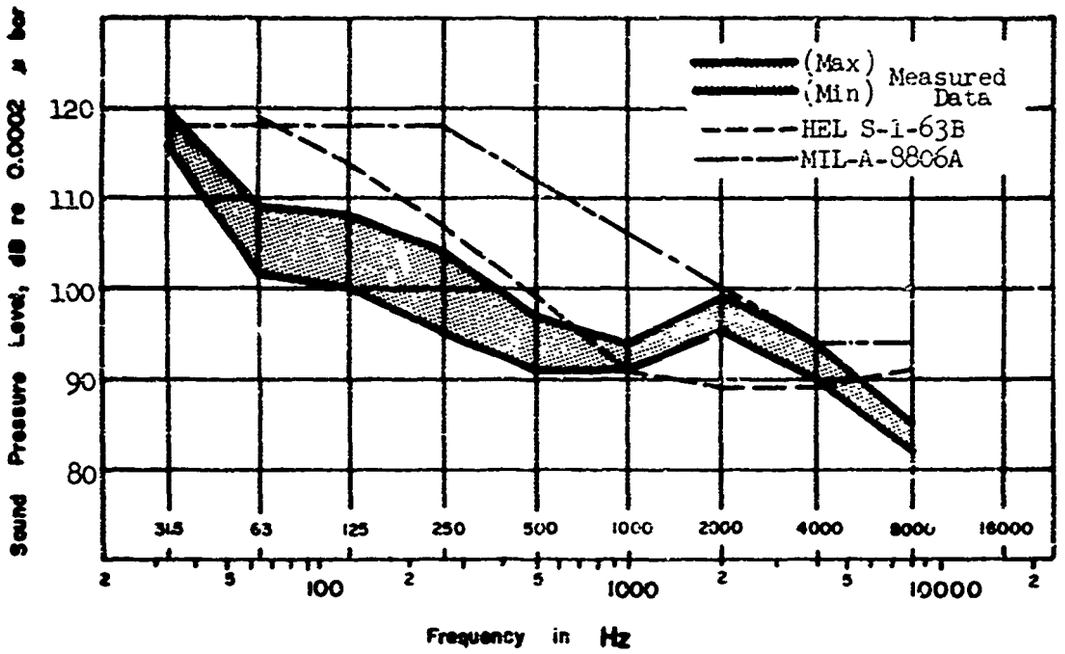

Fig. 77A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 500 FEET PER MINUTE AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

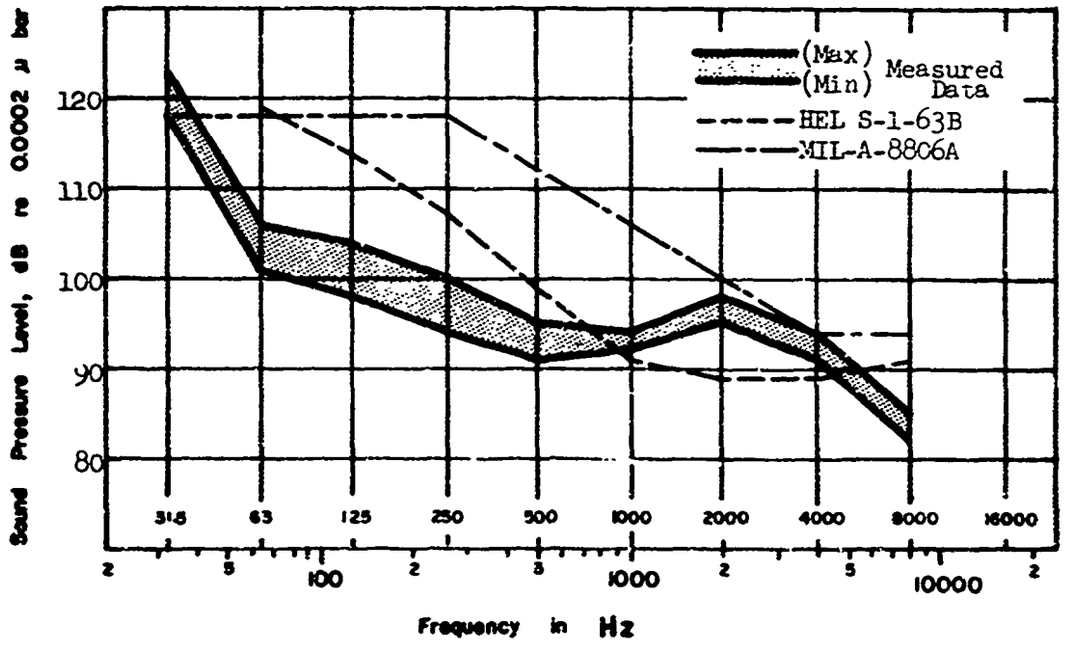

Fig. 78A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1000 FEET PER MINUTE AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

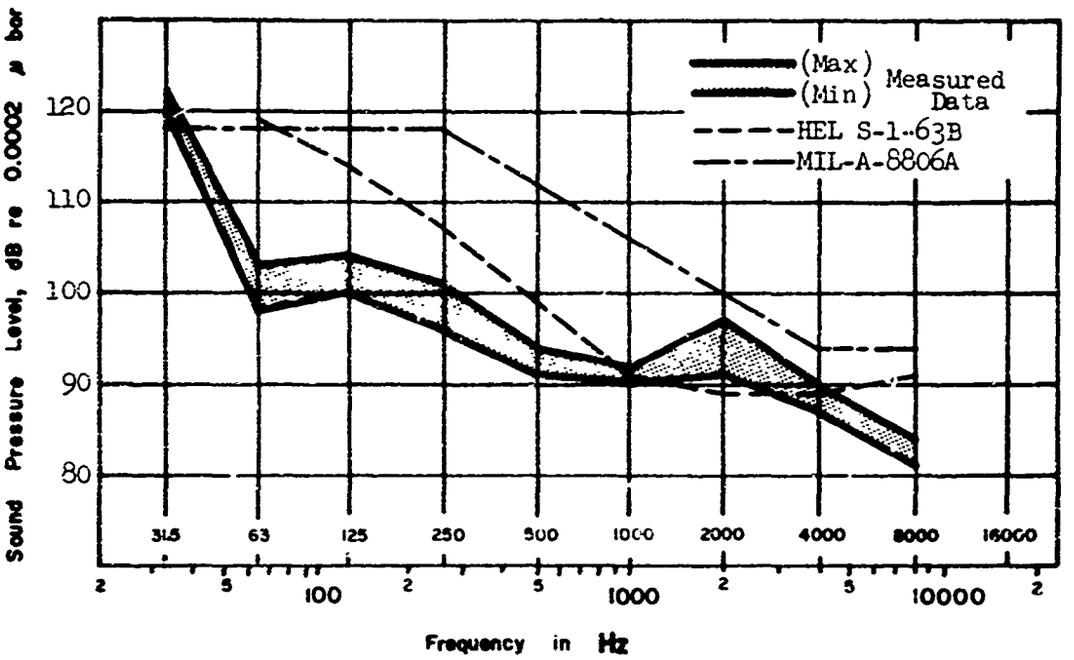

Fig. 79A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1500 FEET PER MINUTE AT 60 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

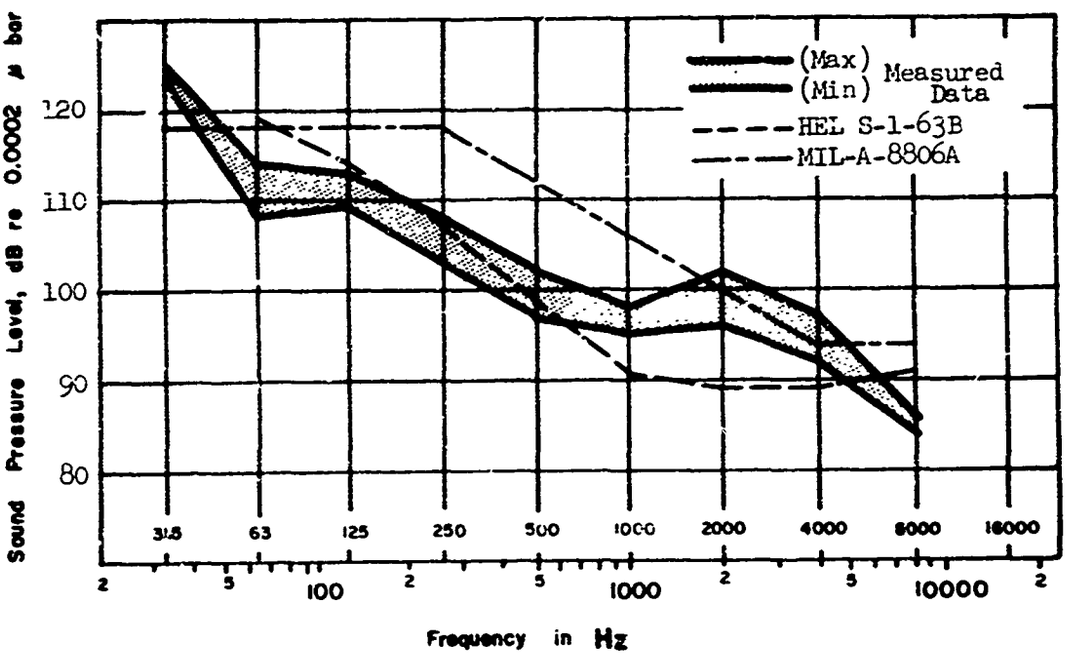

Fig. 80A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 500 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

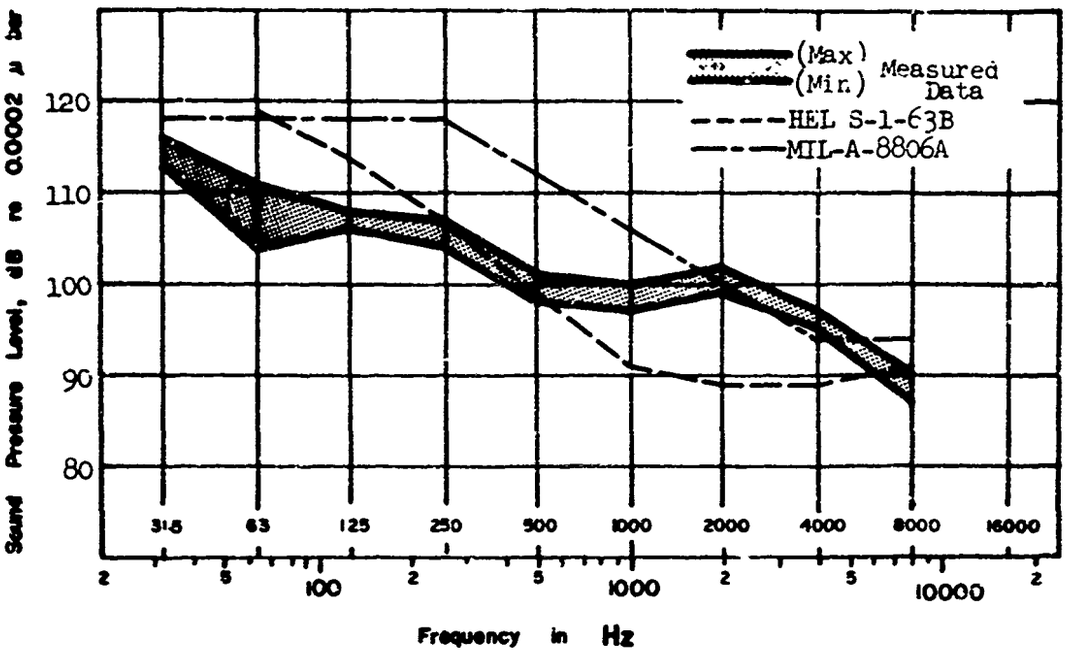

Fig. 81A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 500 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

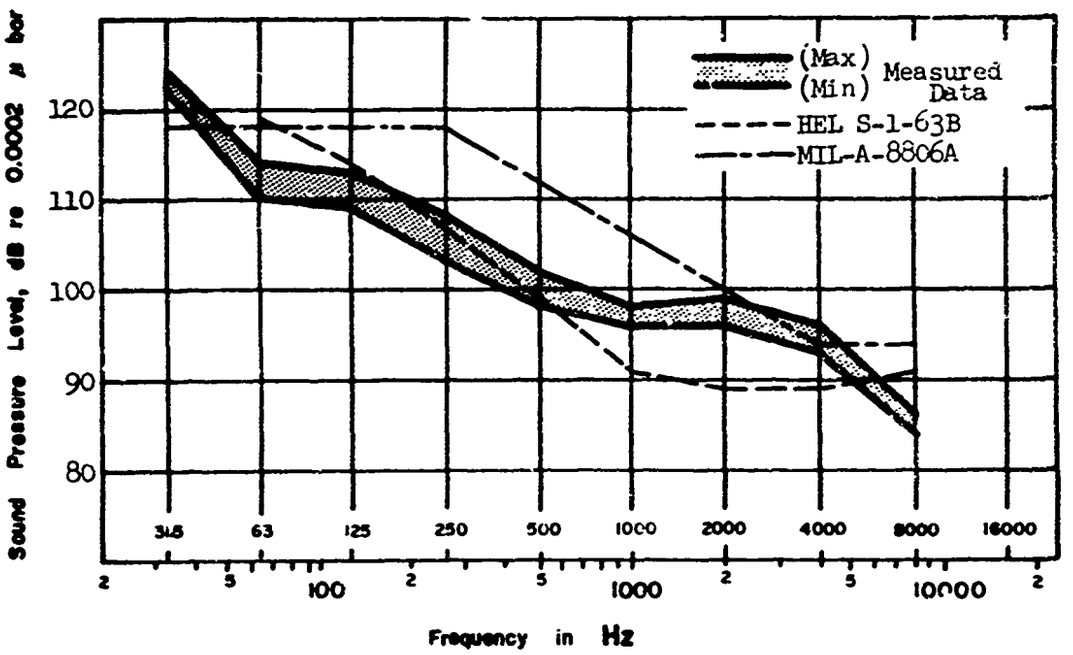

Fig. 82A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1000 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

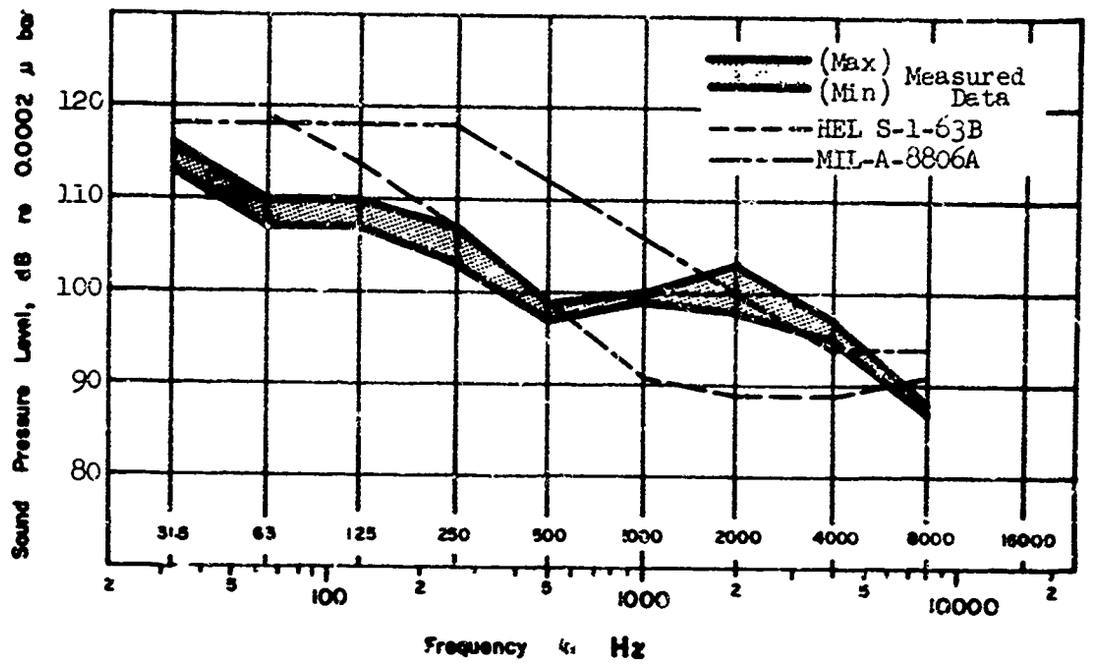

Fig. 83A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1000 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

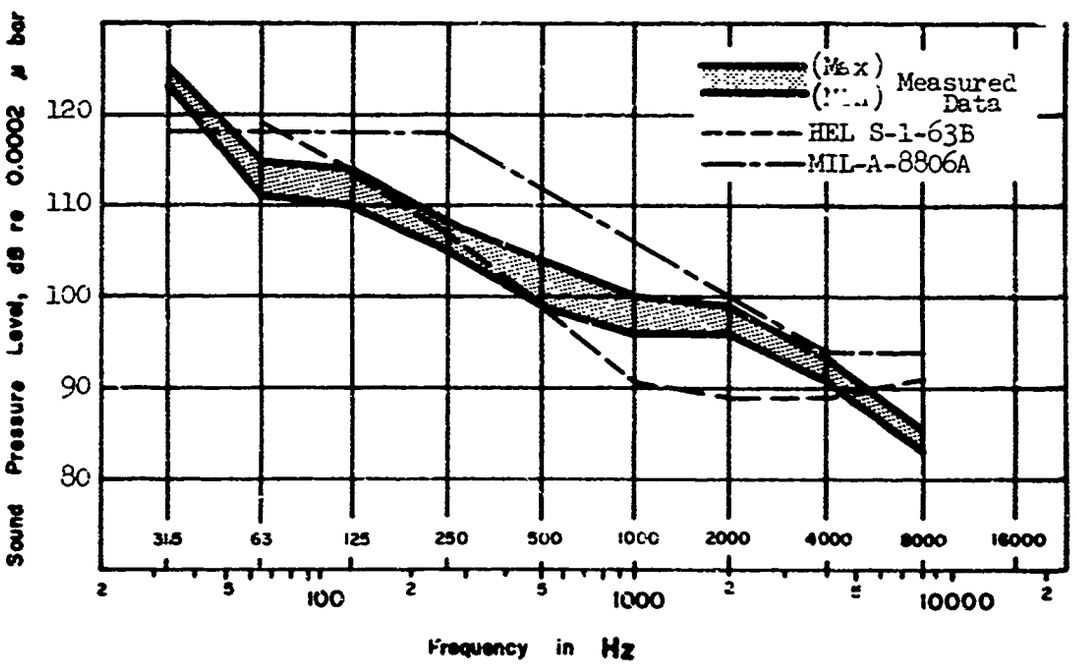

Fig. 84A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1500 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 95.)

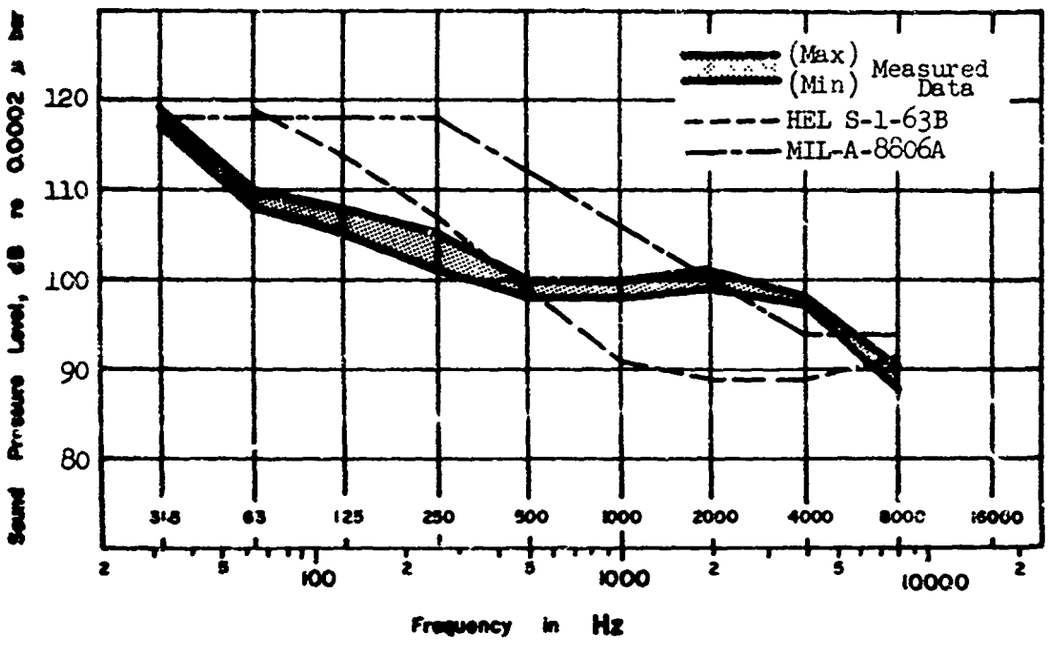

Fig. 85A. RANGE OF NOISE IN THE CH-47B HELICOPTER DURING A PARTIAL POWER DESCENT OF 1500 FEET PER MINUTE AT 100 KNOTS TRUE AIR SPEED
(Rotor speed is 230 rpm. Measuring position is at Station 320.)

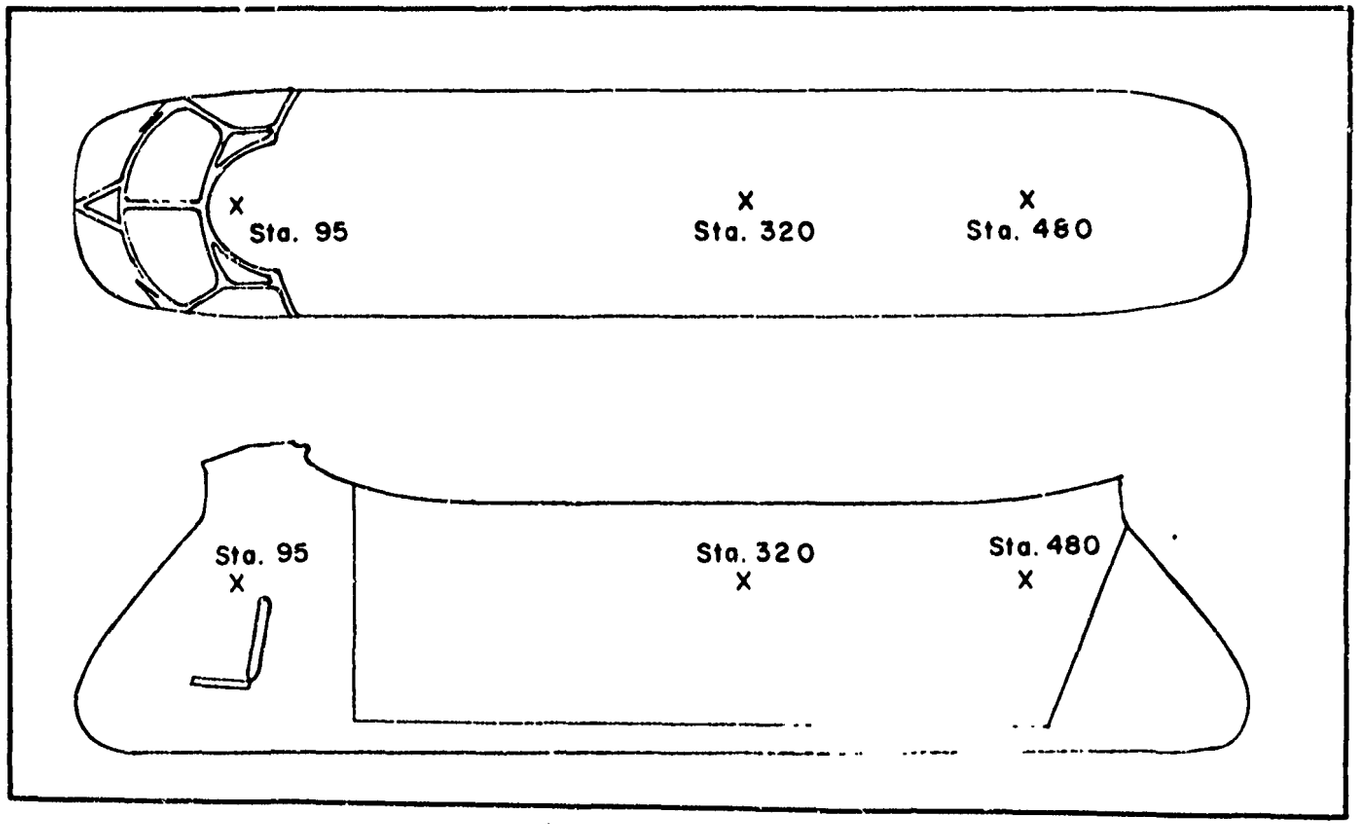

Fig. 86A. MICROPHONE POSITIONS USED TO OBTAIN DATA INSIDE THE CH-47B HELICOPTER

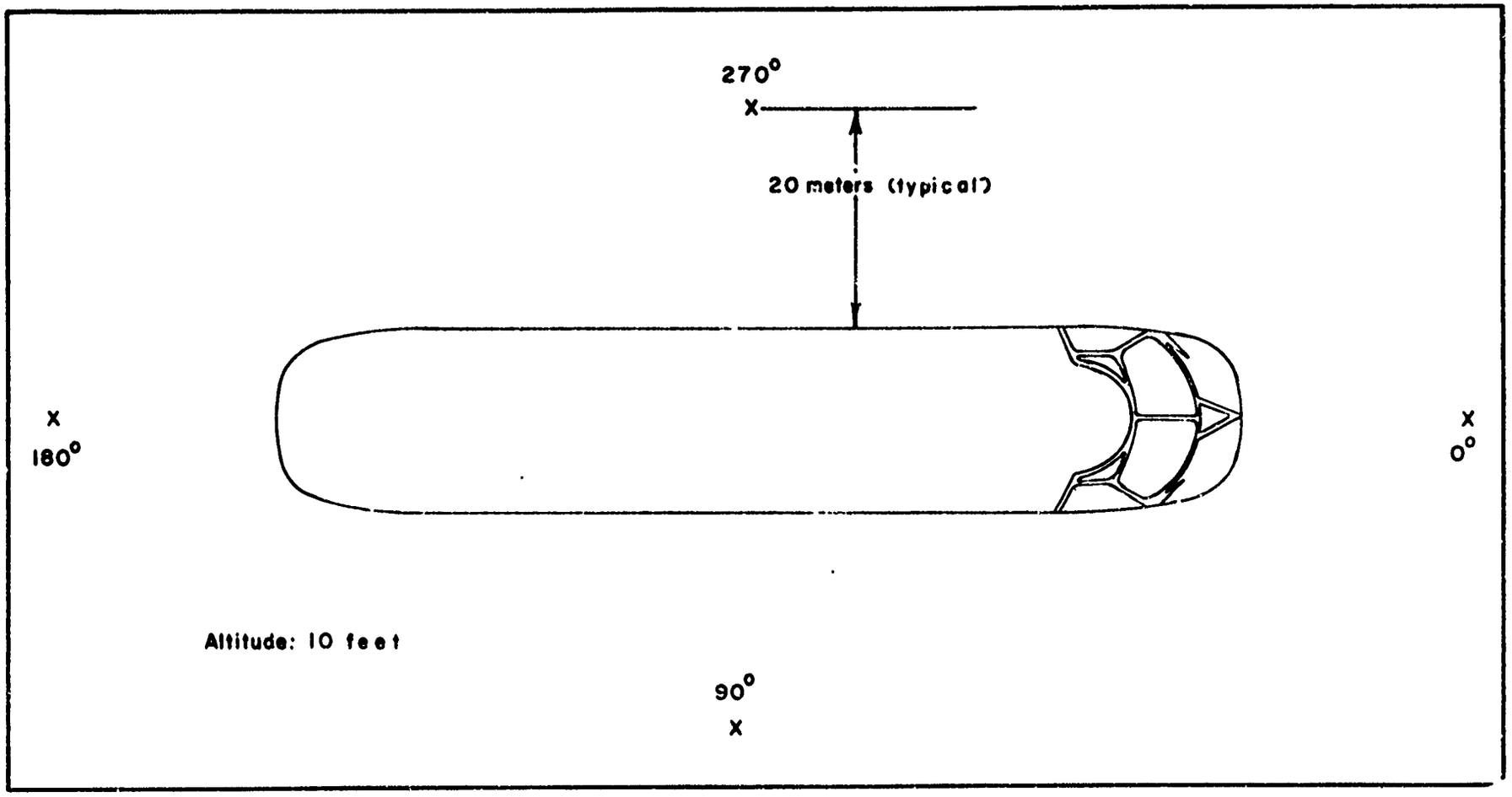

Fig. 87A. MICROPHONE POSITIONS USED TO OBTAIN DATA OUTSIDE THE CH-47B HELICOPTER

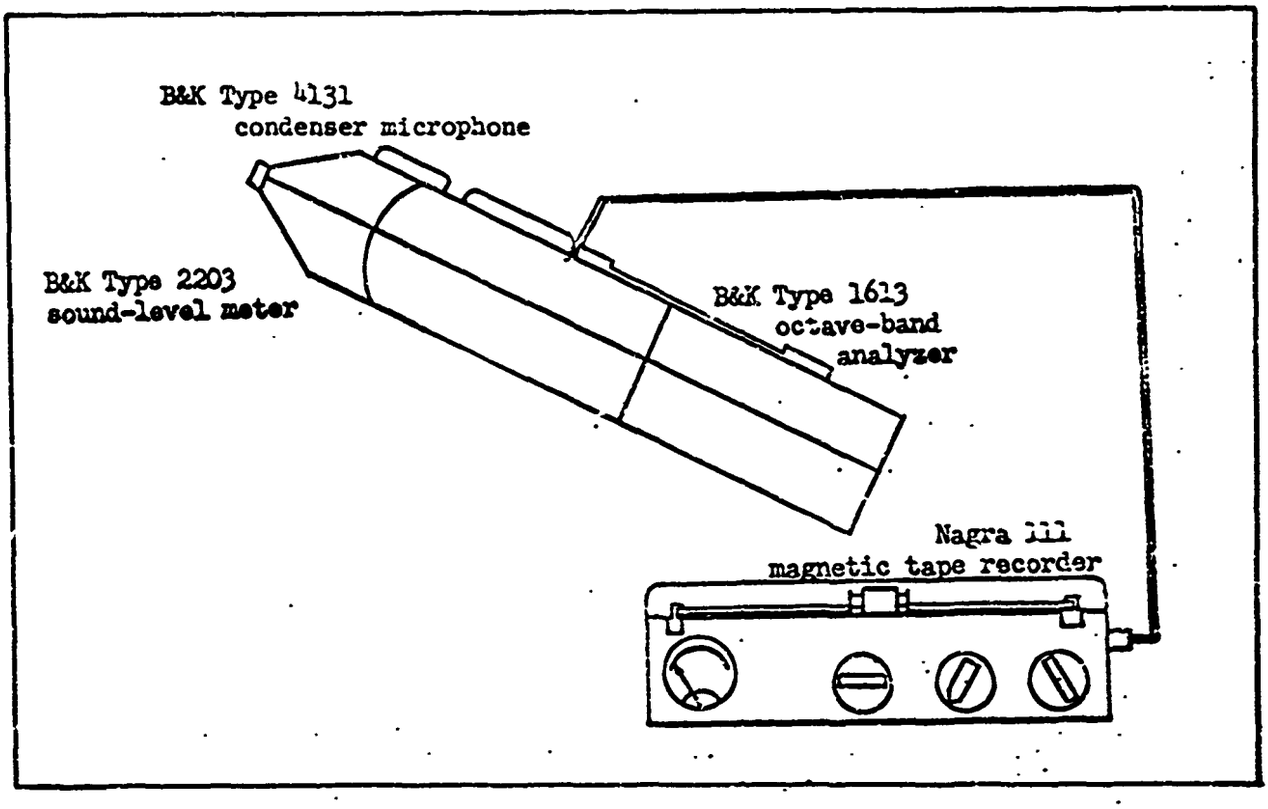

Fig. 88A. EQUIPMENT USED TO OBTAIN AND RECORD DATA IN THE CH-47B HELICOPTER

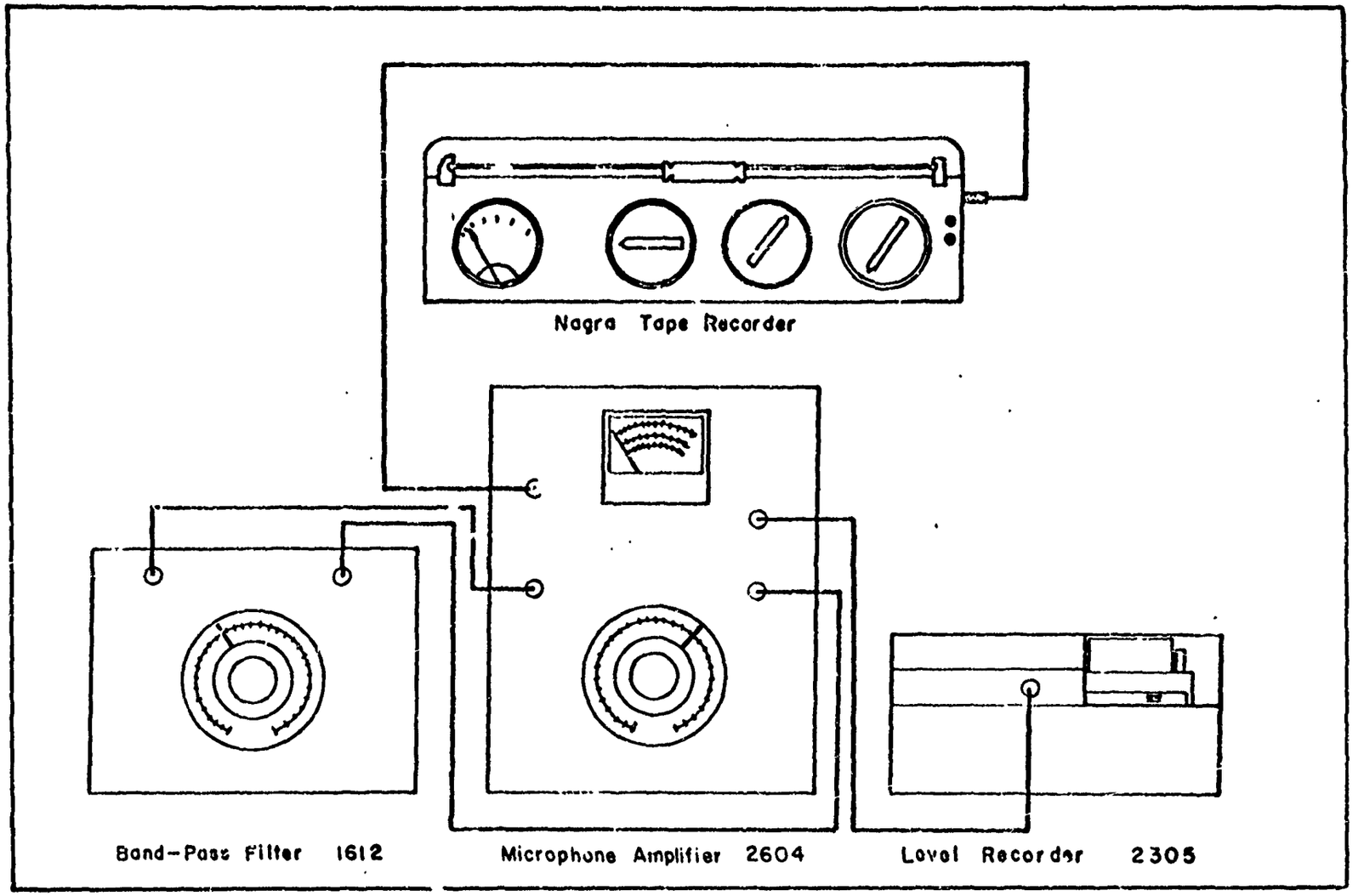

Fig. 89A. EQUIPMENT USED TO ANALYZE TAPE RECORDED CH-47B HELICOPTER DATA

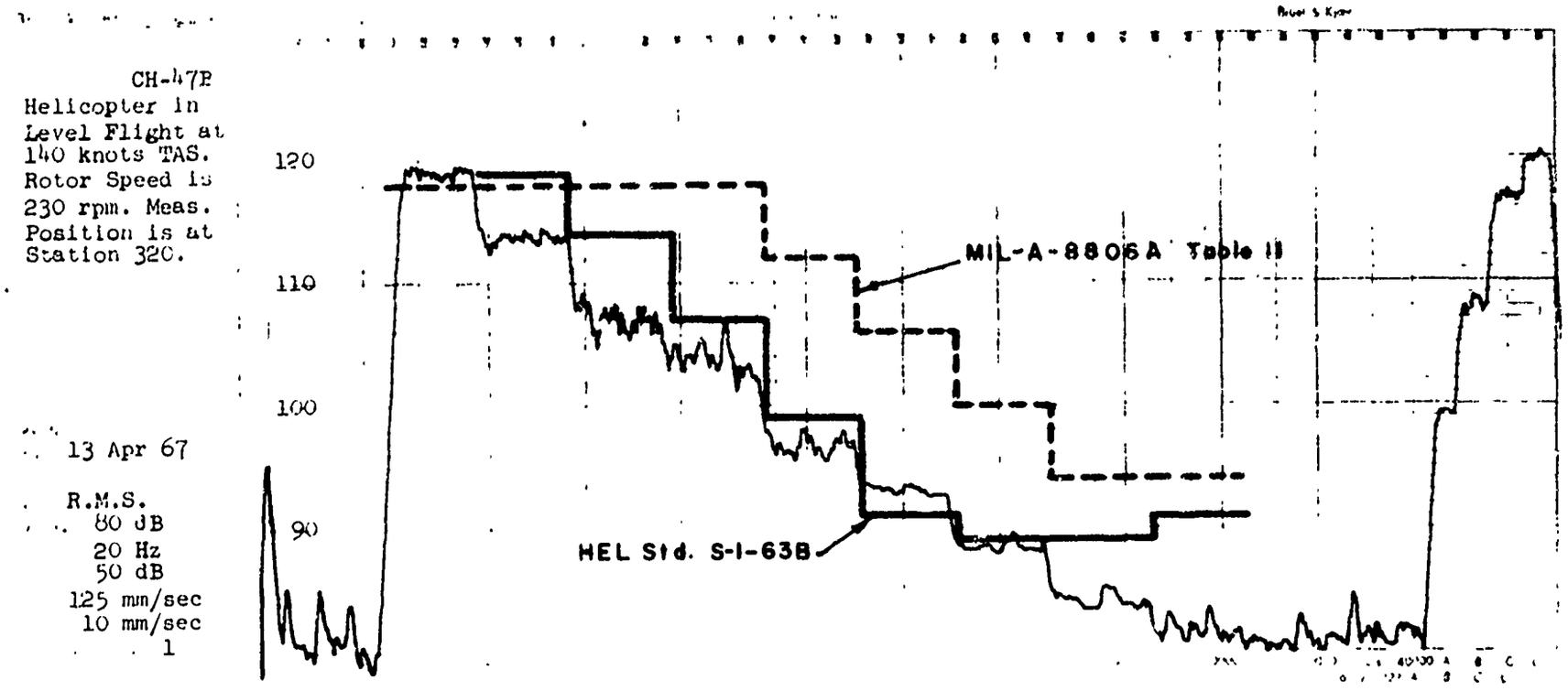

Fig. 90A. TYPICAL OCTAVE BAND RECORD USED IN ANALYSIS OF DATA FOR THE CH-47B HELICOPTER

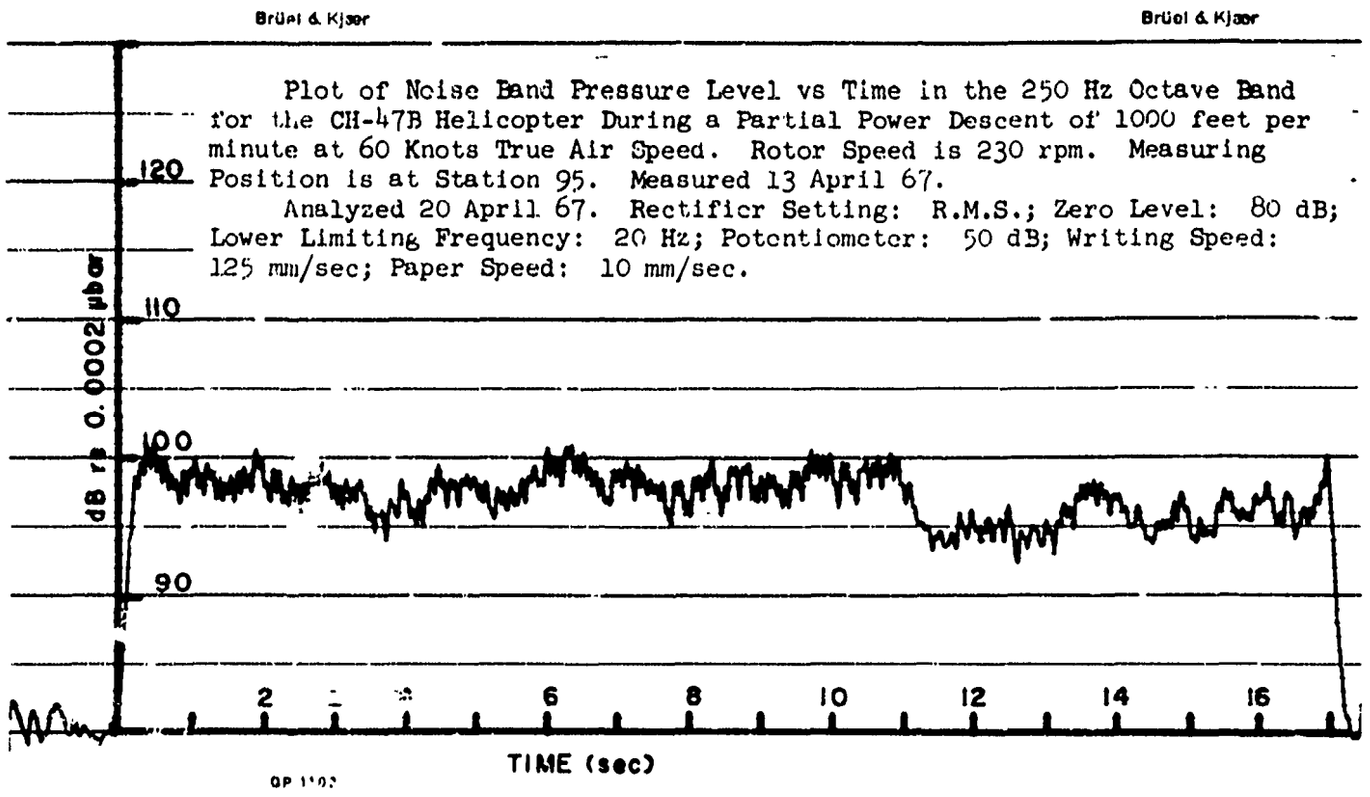

Fig. 91A. TYPICAL GRAPHIC LEVEL RECORD OF A TIME-VARYING NOISE IN THE CH-47B HELICOPTER

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Human Engineering Laboratories Aberdeen Proving Ground, Maryland 21005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

ACOUSTICAL STUDY OF THE CH-47B (CHINOOK) HELICOPTER

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Thomas S. Bragg

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
March 1968	83	6

8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Note 4-68 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

Sound measurements were conducted in the CH-47B (Chinook) Helicopter under conditions of normal cruise, maximum continuous power, level flight at various air speeds, hover, level acceleration and deceleration, and partial-power descent. Results are presented and compared with applicable parts of Military Specification MIL-A-8806 and U. S. Army Human Engineering Laboratories Standard S-1-63B. Variations of the noise from that specified in these documents are discussed, and it is recommended that the noise be reduced to conform to the specified levels.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Human Factors Engineering CH-47B Helicopter Acoustical Study Sound Measurements						