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SUBSYSTEM ACOUSTIC TESTING OF A VERTICAL TAKEOFF AND LANDING DUCTED PROPELLER UNMANNED AERIAL VEHICLE

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13. ABSTRACT *(Maximum 200 Words)*

The definition for a Vertical Takeoff and Landing (VTOL) Ducted Propeller Unmanned Aerial Vehicle (UAV) for this research project was an aircraft that can takeoff in a vertical mode, hover in place, transition into horizontal flight, transition back to vertical flight, and land in a vertical mode. The objectives for this project were to determine the acoustic drivers of a VTOL UAV, determine the acoustic levels of an electric motor alternative, determine the acoustic levels of an alternative UAV configuration, and determine the acoustic levels of muffler alternatives. The 48 acoustic tests were conducted on a variety of different test devices. The test devices consisted of a VTOL Ducted Propeller UAV, an O.S. .32 2-stroke engine, a Master Airscrew 2-bladed propeller, a Jeti electric motor, a Raptor 30 size radio controlled helicopter with a Thunder Tiger .36 engine, and 4 different mufflers. The different mufflers included a Mousse Can Muffler, a MACS Products Pretuned Muffled Tuned Pipe, an O.S. Universal Muffler Assembly, and an O.S. Stock Muffler. The test setup consisted of a vertical test setup to simulate hover flight and a horizontal test setup to simulate horizontal flight.

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1. Acoustic Test Objectives 1

I. INTRODUCTION

By definition a Vertical Takeoff and Landing (VTOL) Ducted Propeller Unmanned Aerial Vehicle (UAV) is an aircraft that can takeoff in a vertical mode, hover in place, transition into horizontal flight, transition back to vertical flight, and land in a vertical mode. This type of flight capability makes a VTOL UAV ideal for operating in areas where runways are not accessible, and in confined areas such as within an urban environment. Despite this advantage, VTOL UAVs have exhibited high acoustic levels while in VTOL flight and in forward flight, that may prohibit their use in confined areas. The objectives of this project were to determine the source of the VTOL UAV acoustic signature, measure the acoustic levels of an alternative electric motor, measure the acoustic levels of an alternative UAV configuration, and measure the acoustic levels of several muffler alternatives.

The System Simulation and Development Directorate (SSDD) of the U. S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC), with support from Auburn University and the Flying C's Radio Controlled Club, conducted an in-depth acoustic test of a VTOL Ducted Propeller UAV in July 2003.

The first objective of the VTOL UAV test was to measure the acoustic levels of each of the components that make up a VTOL UAV, and determine which components are the primary source of the VTOL UAV acoustic signature. The component testing consisted of measuring the acoustic levels of the engine and muffler, the engine with muffler and propeller, and then the VTOL UAV. This objective also included measurement of the VTOL UAV acoustic levels at different heights above the ground. The second objective was to measure the acoustic levels of an electric motor with a propeller to determine if the electric motor could be used in place of a nitro fueled engine to reduce the acoustic levels of the VTOL UAV. The third objective was to measure the acoustic levels of a similarly powered helicopter to determine if a helicopter could be used as an alternative aircraft. The final objective was to measure the acoustic levels of different mufflers to determine if a different muffler could be used to reduce the acoustic levels of the VTOL UAV. This objective was addressed while considering the muffler's impact on system weight and engine output. The technical objectives of the acoustic test are summarized in Table 1.

Table 1. Acoustic Test Objectives

Technical Objectives	**Priority**
Measure the components of a VTOL UAV	1
Electric alternative	1
Muffler alternatives	2
Alternative UAV configuration	2

II. ACOUSTIC TEST OVERVIEW

An acoustic test was conducted from 7 July through 10 July to investigate the acoustic levels of a VTOL UAV. The acoustic test of a VTOL Ducted Propeller UAV was conceived, planned, conducted, and led by the AMRDEC's SSDD. The Adaptive Aerostructures Laboratory at Auburn University provided support for the assembly of the test devices and test equipment as well as support during the test. The tests were conducted at the Flying "C's" Radio Controlled Modeling Club which is owned and operated by Ted and Beverly Cowan. The 60 plus acre field is located in a remote area within the city of Opelika, Alabama. The location was selected because the background Decibel (dB) levels were measured to be below the range capability (less than 40 dB) of the sound meter.

A total of 48 acoustic tests were conducted on the various test articles. These articles consisted of a VTOL Ducted Propeller UAV, an O.S. .32 2-stroke engine, a Master Airscrew 2-bladed propeller, a Jeti electric motor, a Raptor 30 size radio controlled helicopter with a Thunder Tiger .36 engine, and 4 different mufflers. The different mufflers included a Mousse Can Muffler, a MACS Products Pretuned Muffled Tuned Pipe, an O.S. Universal Muffler Assembly, and an O.S. Stock Muffler. A sound level meter was utilized to measure the dB levels of the test devices. Two different test setups were utilized for the tests which were the vertical test setup and the horizontal test setup. The vertical test setup simulated the VTOL UAV and test devices in a hover flight mode, while the horizontal test setup simulated the VTOL UAV and test devices in horizontal flight mode.

A. Description of Test Devices

The VTOL Ducted Propeller UAV airframe utilizes two sets of six stators to attach the lower and upper fuselage to the duct. The propeller is located between the sets of stators. These stators were the primary component of interest on the airframe. Additional components of the VTOL UAV consisted of an O.S. .32 2-stroke model airplane engine, a Master Aircrew 11X5 2-bladed propeller, and a Mousse Can muffler. The O.S. .32 has a displacement of 0.319 cubic inches and weighs 9.5 ounces without a muffler [1]. The engine has an output brake horsepower of 1.2 at 18,000 RPM [1]. The propeller was a constant-pitch Master Airscrew 11X5 injection-molded fiberglass-filled nylon propeller with a National Aeronautics and Space Administration (NASA) airfoil [1]. For the engine component portion of the test, a modified propeller and a brake were used to load the engine while running. The modified propeller, a Master Aircrew 11X5 cut down to 4 $^{11/16}$X5, was also used to cool the engine during the test. A Jeti "Phasor" 45/3 Brushless Motor with a Jeti JES 70-3P Motor Controller running on 24 volts was used for the electric alternative objective. The VTOL Ducted Propeller UAV is illustrated in Figure 1 while close-ups of the stators are illustrated in Figures 2 and 3. Propulsion variants are illustrated in Figures 4 and 5. Propellers are illustrated in Figures 6 and 7.

Figure 1. Auburn University/ Micro Autonomous Systems VTOL Ducted Propeller UAV

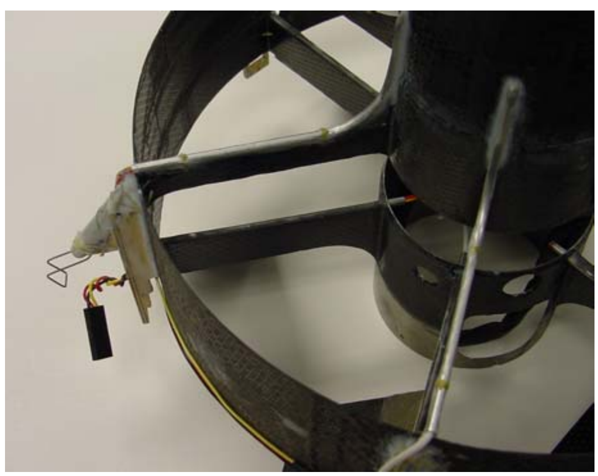

Figure 2. Close-up of an Upper and Lower Stators of the VTOL UAV

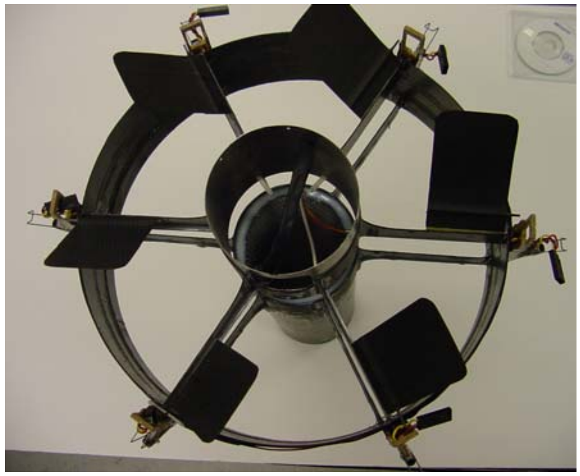

Figure 3. Six Upper and Lower Stators

Figure 4. O.S. .32 2-Stroke Engine [1]

Figure 5. Jeti "Phasor" 45-3 Electric Motor [2]

Figure 6. Master Airscrew 11 X 5 Propeller [1]

Figure 7. Modified Master Airscrew 11 X 5 Cut Down to a 4 11/16 X 5

The alternative UAV was a Raptor 30 size radio-controlled helicopter with a Thunder Tiger Pro-36 H engine [1]. The weight of the helicopter was 6.25 pounds with a main rotor diameter of 49 inches [1]. The engine has a displacement of 0.365 cubic inches and weighs 11.4 ounces with a muffler [1]. The engine has an output horsepower of 1.0 at 14,500 Revolutions Per Minute (RPM) [1]. The gear ratio from the engine to the main rotor was 1:9.56:4.56 [1]. Illustrations of the Raptor 30 are provided in Figures 8 and 9.

Figure 8. Raptor 30 Size Radio Controlled Helicopter

Figure 9. View of Helicopter Muffler

Muffler alternatives consisted of four mufflers that were commercially available in the radio controlled modeling industry. The first was the Mousse Can Muffler which is the actual muffler utilized in the VTOL UAV. The muffler was constructed from a Mousse Can hair product that has the nozzle removed and a ¼-inch diameter stinger added to serve as the exhaust exit. The second muffler was the MACS Products Pretuned Muffled Tuned Pipe designed for the O.S. .25 thru O.S. .32 engine. The third and fourth mufflers were the O.S. Universal Muffler Assembly and the O.S. Stock Muffler which was sold with the O.S. .32 engine. The mufflers are illustrated in Figures 10 through 13, and Figure 14 illustrates a length comparison of the four mufflers.

Figure 10. Mousse Can Muffler

Figure 11. MACS Products Pretuned Muffled Tuned Pipe

Figure 12. Universal Muffler Assembly

Figure 13. Stock Muffler

Figure 14. Length Comparison of the Different Mufflers

B. Test Setup

The two setups utilized for the test were the vertical test setup and the horizontal test setup. The vertical test setup positioned the test article in an orientation to simulate hover flight. The horizontal test setup positioned the test article in an orientation to simulate horizontal flight.

The vertical test setup consisted of measuring the acoustic levels with the articles at a height of 5 feet above the ground. Figures 15 and 16 illustrate the test articles at 5 feet above the ground. In addition to 5 feet, the VTOL UAV was tested at ground level and at 15 feet above the ground (Figs. 17 and 18). Acoustic levels were measured at 45-degree increments around the test devices, at a specified horizontal distance, with 0 degree located at the head of the engine and 90 degrees at the engine exhaust. During the vertical test setup, the VTOL UAV was held at a specified height with a tether and restrained with a set of ropes attached to the ground. For the engine and electric motor test, the devices were mounted on a Dubro Vibration Reducing Motor Mount attached to an aluminum stand (Figs. 19 and 20). The aluminum stand was adjustable and could position the test device in a vertical position. The helicopter was attached to and held into position by a commercially available radio controlled helicopter training stand (Fig.21).

Figure 15. VTOL UAV Tethered 5 Feet Above the Ground

Figure 16. Engine Mounted on Test Stand 5 Feet Above Ground

Figure 17. VTOL UAV Sitting on the Ground

Figure 18. VTOL UAV Tethered 15 Feet Above the Ground

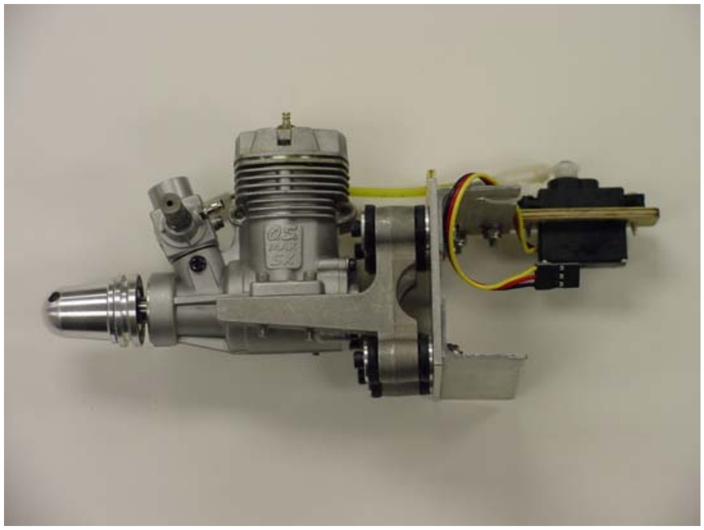

Figure 19. Engine Mounted on Dubro Vibration Reducing Motor Mount

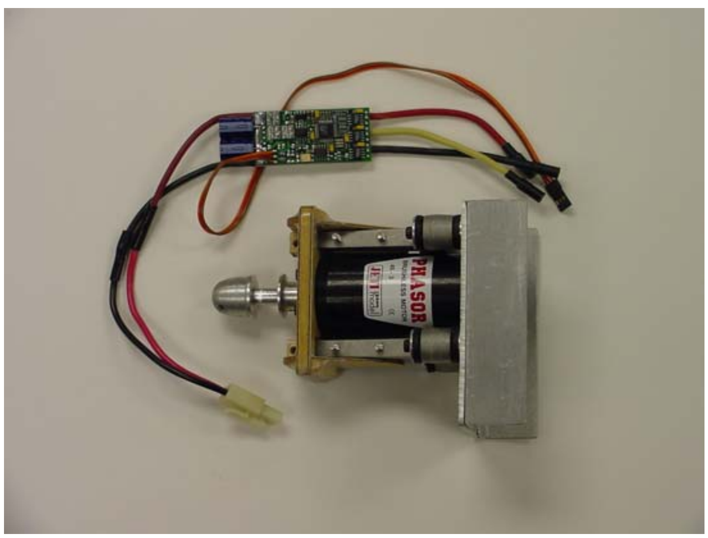

Figure 20. Electric Motor Mounted on Dubro Vibration Reducing Motor Mount

Figure 21. Raptor Helicopter on Test Stand

In the horizontal test setup, the test article was fixed at a vertical height 4 feet above the ground, and acoustic levels were measured in front of and behind the test article. Figures 22 and 23 illustrate representative test articles in the horizontal setup. During the horizontal test setup, the VTOL UAV was held in place by two people positioned on the left and right side of the vehicle (Fig.22). The aluminum test stand used for the vertical test setup was readjusted to position the test device for the horizontal test setup. The helicopter was not tested for horizontal flight since a helicopter will pitch over only about 5 to 10 degrees for forward flight.

Figure 22. VTOL UAV Held at 4 Feet Above Ground

Figure 23. Engine Mounted on Test Stand 4 Feet Above Ground

The vertical height distances for both test setups were measured from the ground to the propeller hub. Acoustic levels were measured from a horizontal distance of 5, 25, 50, 75, and 100 feet away from the center of the test device for both setups.

C. Test Procedures

Acoustic levels were recorded for specified engine RPM settings with a particular test setup, either vertical or horizontal, around the test device. A sound meter was utilized to measure the dB levels of the test devices at specified conditions. The dB levels were measured with the sound meter pointing at the test article and held at either a 5-foot elevation during the vertical test setup, or a 4-foot elevation during the horizontal test setup. Engine RPM setting was determined based on the particular test objective. Three RPM ranges were selected for the VTOL UAV comparisons. These ranges were identified as idle (4,440 to 4,450 RPM), hover (11,760 to 11,820 RPM), and full throttle (13,200 to 13,500 RPM). RPM settings for the electric and O.S. .32 engine portions of the tests were matched to that of the VTOL UAV. For the muffler tests, engine RPM was set to the maximum capability of the engine with the particular test muffler. The purpose was to determine the acoustic levels of the different mufflers while considering the impact on system weight and engine output RPM. For the alternative UAV configuration, the helicopter was set to the RPM required to hover (4,140 RPM).

III. INSTRUMENTATION

A Mannix ASM 120 Sound Level Meter was used to measure the acoustic levels. This meter has a least count of 2 dB and readability of 1 dB and can be tuned to low (range from 40 to 80 dB) or high (80 to 120 dB). An Extech Instruments with anemometer vane probe was used to measure temperature and wind speed which had a least count and readability of 0.1. The RPM outputs of the engine, electric motor, VTOL UAV, and helicopter were recorded with a GloBee Tachometer GLBP0110 meter which has both a readability and least count of 10 RPM. Illustrations of the Mannix Sound Level Meter, Extech anemometer, and GloBee Tachometer are provided in Figures 24, 25, and 26, respectively.

Figure 24. Mannix ASM 120 Sound Level Meter

Figure 25. Extech Instruments with Anemometer Vane Probe

Figure 26. GloBee Tachometer

IV. RESULTS AND CONCLUSIONS

For vertical test setup results described as "averaged" dB levels, the individual dB measurements from 0 to 315 degrees at a specified horizontal distance were recorded and added together. The added total of the 8 dB levels were then divided by eight in order to obtain an average dB level for the test device. For the horizontal test setup, the dB levels are the values record during the test. Tabular and graphical summary of the results for each of the 48 test runs conducted can be found in Appendixes A and B, respectively.

The conclusion for the four objectives of the test were determined based on acoustic data collected on a VTOL UAV, on each of the components that make up a VTOL UAV, on an electric alternative, on an alternative UAV configuration, and on muffler alternatives. The conclusion, for this portion of the report, only considered the dB levels measured from a distance of 100 feet.

A. Components of a VTOL Ducted Propeller UAV

The results discussed in this section are at full throttle which is between 13,200 and 13,500 RPM. The VTOL UAV was used to establish the baseline full throttle RPM setting and the O.S. .32 engine was matched to that RPM.

The results, from a vertical test setup at 5 feet above the ground, of the components of a VTOL Ducted Propeller UAV were broken down into the engine with Mousse Can muffler, the engine with the Mousse Can muffler and a Master Airscrew 11X5, and the VTOL UAV. Figure 21 illustrates the averaged results of the VTOL UAV acoustic signature component breakdown from a distance of 5 feet to 100 feet. The averaged dB levels for the engine with Mousse Can muffler were 97 dB at 5 feet and 70 dB at 100 feet. The averaged dB levels for the engine with Mousse Can muffler and a Master Airscrew 11X5 were 100 dB at 5 feet and 72 dB at 100 feet. The averaged dB levels recorded for the VTOL UAV were 103 dB at 5 feet and 77 dB at 100 feet.

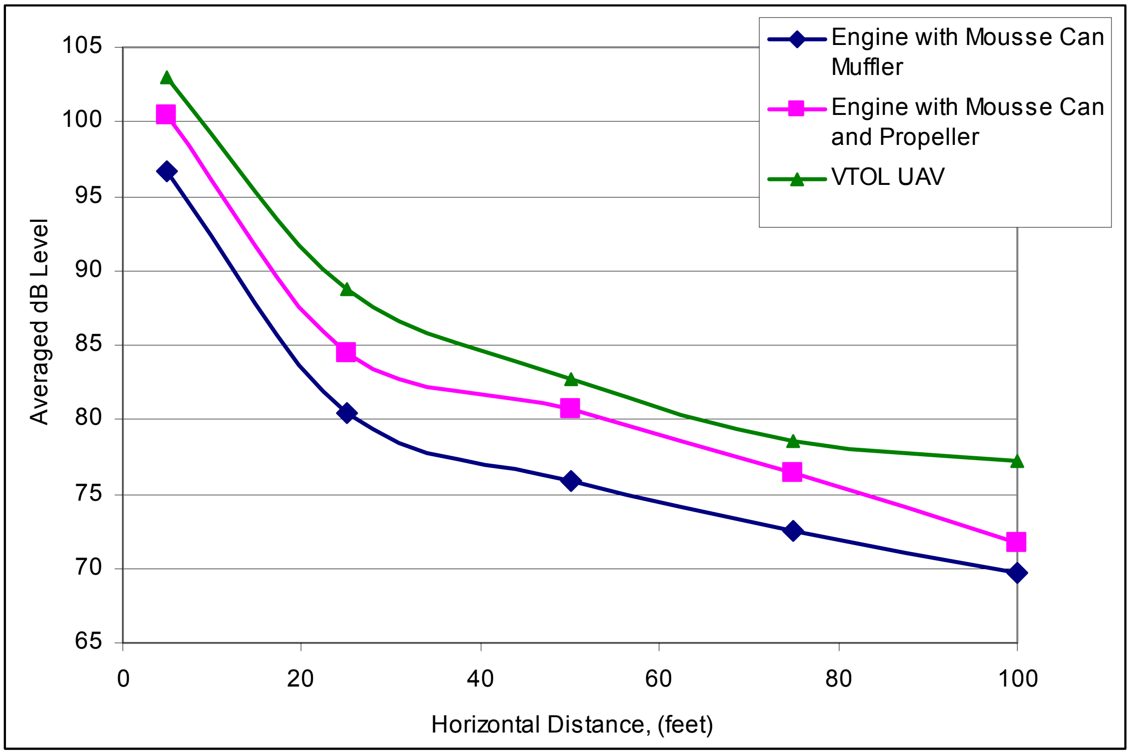

Figure 27. Component Breakdown of the VTOL UAV with a Vertical Test Setup

The averaged dB level of an O.S. .32 engine with a Mousse Can Muffler turning a Master Airscrew 11X5 was 2.9 percent higher than the engine with muffler when measured from 100 feet. Compared to the engine with a Mousse Can Muffler and 11X5 propeller measured at 100 feet, the averaged dB level increased by 6.9 percent with the addition of the VTOL UAV airframe.

The following are the results for the components of a VTOL UAV with a horizontal test setup at a height of 4 feet above the ground. Figure 28 illustrates the averaged results of the VTOL UAV acoustic signature component breakdown from a distance of 5 feet to 100 feet. The dB levels in front of the engine with a Master Airscrew 11x5 were 101 dB at 5 feet and 73 dB at 100 feet, and from the rear were 104 dB at 5 feet and 58 dB at 100 feet. The dB levels for the VTOL UAV were 106 dB at 5 feet and 80 dB at 100 feet in front of the propeller, and 108 dB at 5 feet and 69 dB at 100 feet from the rear of the propeller.

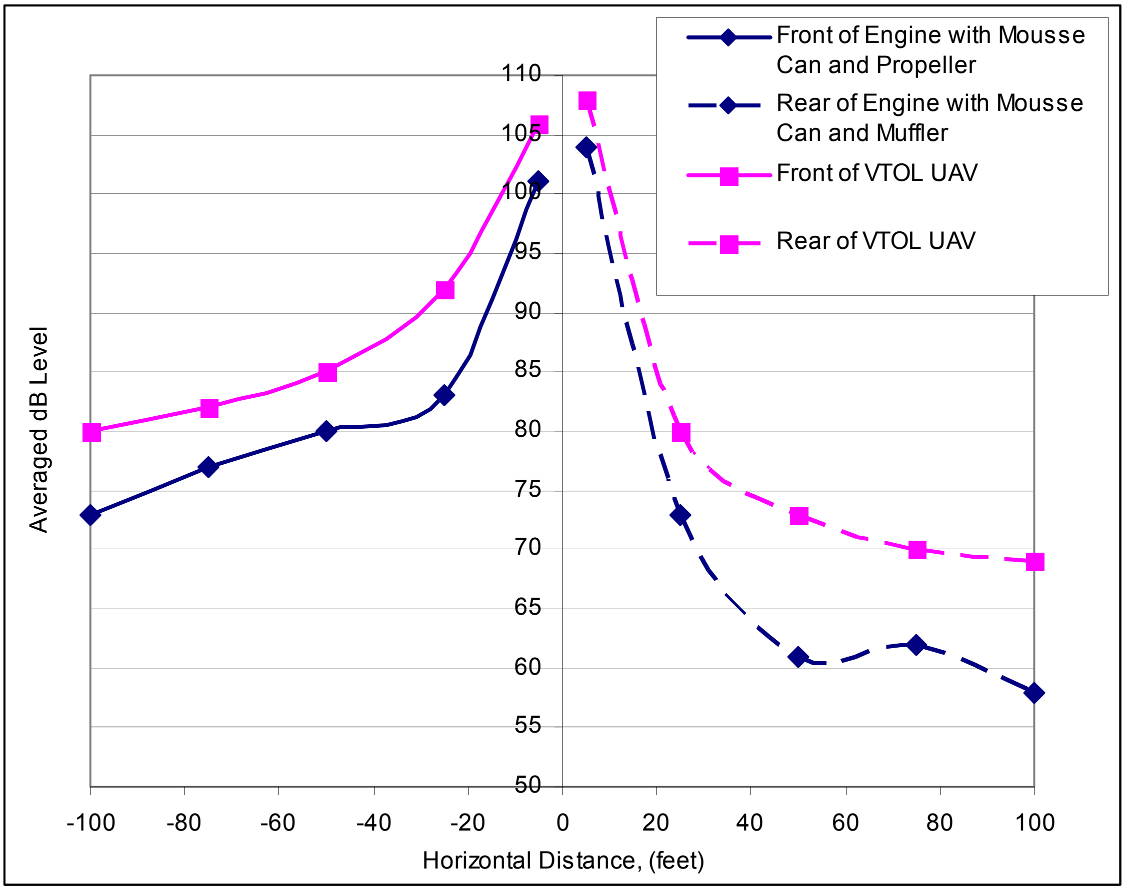

Figure 28. Component Breakdown of the VTOL UAV with a Horizontal Test Setup

At a distance of 100 feet, the dB level, measured in front of the propeller, with the addition of the VTOL UAV airframe increased by 9.6 percent as compared to the engine with a Mousse Can Muffler and propeller. From a distance of 100 feet measured from the rear, the dB levels increased by 19 percent with the addition of the VTOL UAV airframe as compared to the engine with Mousse Can Muffler and propeller.

The results for the dB levels of a VTOL UAV at different heights, with a vertical test setup, were recorded at ground level, 5 feet above the ground, and 15 feet above the ground. Figure 29 illustrates the averaged results of the VTOL UAV acoustic signature at various heights from a distance of 5 feet to 100 feet. The averaged dB levels for the VTOL UAV on the ground, at idle RPM between 4,440 and 4,500 RPM, were 77 dB at 5 feet and 43 dB at 100 feet. At full throttle, the averaged dB levels were 101 dB at 5 feet and 73 dB at 100 feet. At hover RPM between 11,760 and 11,820 RPM, the averaged dB levels at 5 feet above the ground were 100 dB at 5 feet and 71 dB at 100 feet. At 15 feet above the ground, the averaged dB levels were 97 dB at 5 feet and 72 dB at 100 feet. At full throttle RPM, the averaged dB levels at 5 feet above the ground were 103 dB at 5 feet and 77 dB at 100 feet. The averaged dB levels with the VTOL UAV 15 feet above the ground were 98 dB at 5 feet and 77 dB at 100 feet.

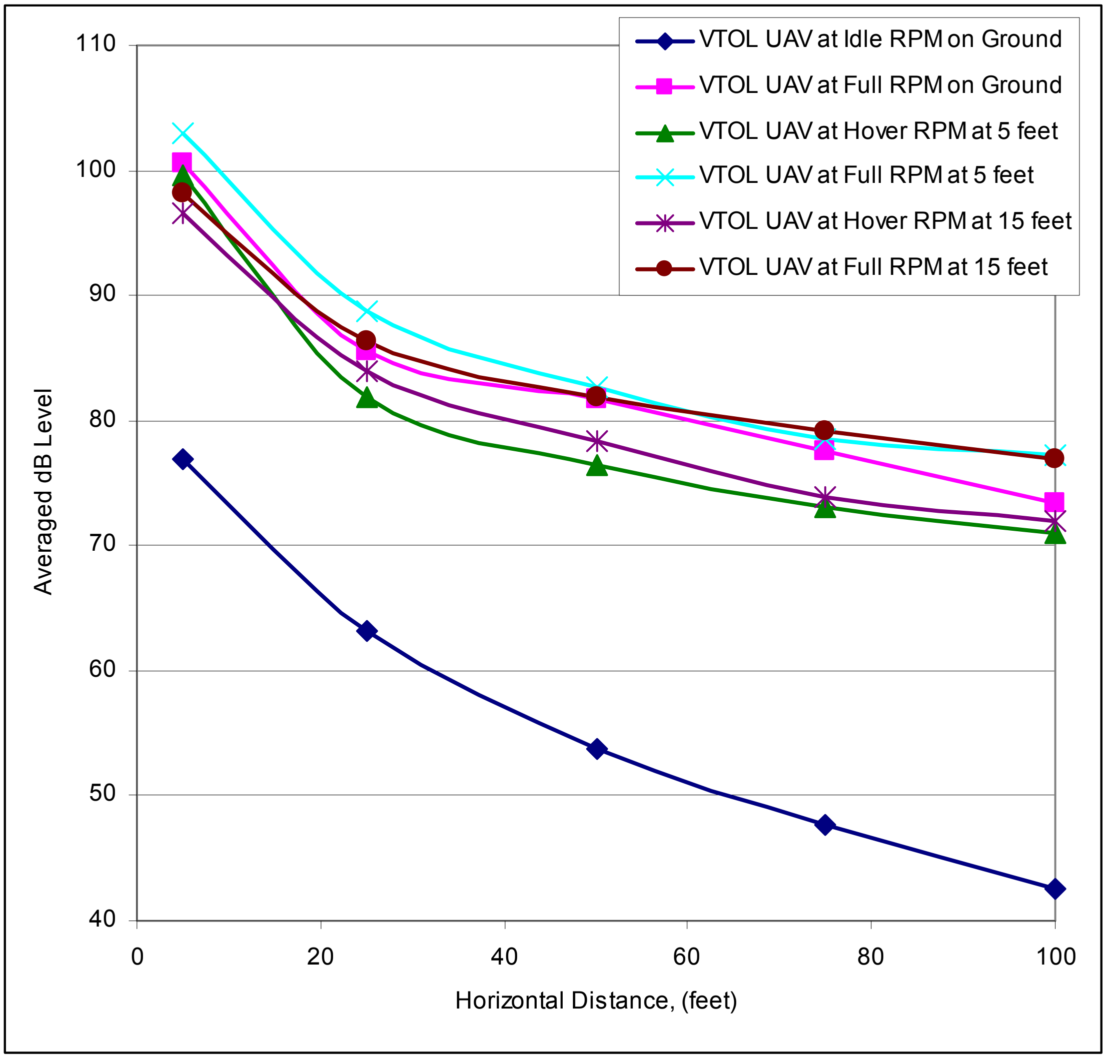

Figure 29. VTOL UAV at Various Heights

The averaged dB level increased by 5.5 percent, measured at 100 feet, when the UAV was moved from the ground to a height of 5 feet above the ground. The averaged dB levels did not change when the VTOL UAV was moved from 5 feet to 15 feet above the ground measured from a distance of 100 feet.

The first objective was to determine and understand the acoustic drivers of a VTOL Ducted Propeller UAV. The acoustic driver was the airframe. The duct should eliminate the tip noise associated with the propeller. However, it was determined that the stator noise drove the dB level to a higher value than the engine with the propeller. This high stator dB level was observed during the horizontal test setup of the VTOL UAV.

B. Electric Alternative

The electric alternative was a Jeti "Phasor" 45/3 Brushless Motor running on 24 volts which was compared to an O.S. .32 with a Mouse Can Muffler running on Blue Thunder 20 percent Nitromethane. Both power plants were turning a Master Airscrew 11X5 2-bladed propeller.

The following are the results for electric motor and engine with a vertical setup 5 feet above the ground. The averaged dB levels of the electric motor at Hover RPM were 92 dB at 5 feet and 63 dB at 100 feet. The averaged dB levels of the engine were 96 dB at 5 feet and 68 dB at 100 feet. At full throttle, the dB levels for the electric motor were 100 dB at 5 feet and 66 dB at 100 feet. The averaged dB levels of the engine were 100 dB at 5 feet and 72 dB at 100 feet.

The results of the horizontal test setup for the electric motor and engine, set at a height of 4 feet above the ground, are as follows. The dB levels in front of the propeller for the electric motor were 86 dB at 5 feet and 60 dB at 100 feet. For the engine, the averaged dB levels were 101 dB at 5 feet and 73 dB at 100 feet. From behind the propeller, the averaged dB levels for the electric motor were 88 dB at 5 feet and 64 dB at 100 feet. The averaged dB levels of the engine were 104 dB at 5 feet and 58 dB at 100 feet.

For comparisons between the electric motor and the engine in a vertical test setup, the RPM was set at both Hover and full throttle at a distance of 100 feet. The averaged dB level of the engine at Hover RPM was 7.9 percent higher than the electric motor. At full throttle, the averaged dB level of the engine was 9.1 percent higher than the electric motor. During the horizontal test setup, the conclusion for dB levels was for a full throttle RPM setting and at a distance of 100 feet. Measured in front of the propeller, the dB level of the engine was 21.7 percent higher than the electric motor. Conversely, the dB level of the engine from behind the propeller decreased 9.4 percent.

The second objective was to determine if the electric motor could be used in place of an engine to reduce the acoustic levels of the VTOL UAV. The dB level of the electric motor was lower than the engine in most cases; however, the VTOL UAV airframe produced levels higher than both of the power plants. As a result, an engine may be the better solution over an electric motor due to the fact that current battery technology may not fly a VTOL UAV for any practical amount of time.

C. Alternative UAV Configuration

The VTOL UAV was acoustically compared to an alternate UAV airframe, which was a Raptor 30 size commercially available radio controlled helicopter. The test RPM was set at the value required to hover each of the vehicles with the VTOL UAV set at 11,760 RPM and the helicopter at 4,140 RPM. Both vehicles were restrained to a height of 5 feet above the ground.

The averaged dB levels for the VTOL UAV were 100 dB at 5 feet and 71 dB at 100 feet. For the helicopter, the averaged dB levels were 96 dB at 5 feet and 71 dB at 100 feet.

The third objective was to measure the acoustic levels of a helicopter with a similar horsepower rated engine as a VTOL UAV and determine if a helicopter could be used as an alternative aircraft. As indicated, when comparing the acoustic levels of both airframes, the averaged dB level at 100 feet was nearly identical. That is, there is no appreciable acoustic advantage of a ducted propeller over a traditional airframe.

D. Muffler Alternatives

A total of four different mufflers were tested in order to determine the acoustic levels of the mufflers while considering the impact on system weight and engine output performance. The test RPM was set to the maximum allowed by the engine with a particular muffler turning a Master Airscrew 11X5.

The Mousse Can Muffler produced the highest RPM of 13,980 RPM with a weigh of 2 ounces and a length of 11 7/8 inches long. The MACS Product Tuned Pipe produced 13,500 RPM while weighing 3.5 ounces and was 16 3/4 inches long. The Stock Muffler supplied with the purchase of the O.S. .32 produced a maximum RPM of 12,360 while weighing 3 ounces and 4 7/8 inches in length. The final muffler alternative was the Universal Silencer which produced 12,120 RPM with a weight of 3 ounces and a length of 9 7/16 inches.

From the highest RPM output to the lowest, the averaged dB levels for the Mousse Can Muffler were 102 dB at 5 feet and 74 dB at 100 feet. The averaged dB levels for the MACS Products Tuned Pipe were 100 dB at 5 feet and 71 dB at 100 feet. For the Stock Muffler, the averaged dB levels were 97 dB at 5 feet and 69 dB at 100 feet. The averaged dB levels for the Universal Muffler were 98 dB at 5 feet and 72 dB at 100 feet.

The final objective was to measure the acoustic levels of different mufflers while considering the impact on system weight and engine output performance, then determine if a different muffler could be used to reduce the acoustic levels of the VTOL UAV. The Mousse Can Muffler was found to produce the highest RPM output as well as the lightest of the mufflers tested during the investigation. However, the Mousse Can Muffler produced the highest dB levels when compared to the other mufflers which produced a lower RPM. When comparing the Mousse Can Muffler at the same RPM as the MACS Products Tuned Pipe, the dB levels were measured to be the same during the vertical test setup and in front of the propeller. Some difference was noted from behind the propeller, and was attributed to the difference in stinger designs of the two mufflers. The conclusion was that the propeller RPM setting was the driver for the acoustic levels.

V. RECOMMENDATIONS

Two airframe modifications are recommended in order to study and possibly reduce the acoustic levels associated with the VTOL Ducted Propeller UAV. The first recommendation was to redesign the UAV to have an odd number of stators when using a propeller with an even number of blades and measure the dB levels [3]. This redesign allows one blade to pass over a stator while the other is in clean air [3]. Another potentially beneficial modification would be to change the number of stators from 6 to 4 and measure the dB levels. This setup will have both blades passing over a stator simultaneously; however, this test will quantify the effect of stator removal on dB levels.

REFERENCES

1. Web page, http://www.towerhobbies.com.

2. Web page, http://www.hobby-lobby.com.

3. Prouty, R., *Military Helicopter Design Technology*, Krieger Publishing Company, Malabar, Florida, 1998.

APPENDIX A
TEST DATA RECORDED

Appendix A – Test Data Recorded

Table A.1 Acoustic Level Results for the 48 Tests Conducted

Jeti Electric Motor with Master Aircrew 11 X 5 running on 12 volts								
Test Number:	1, Idle Vertical Setup 5 ft above ground				Test RPM:	4440		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	60	-	-	-	-	-	-	-
25	40	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 running on 24 volts								
Test Number:	2, Vertical Setup 5 ft above ground				Test RPM:	11,800		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	92	-	-	-	-	-	-	-
25	73	-	-	-	-	-	-	-
50	68	-	-	-	-	-	-	-
75	64	-	-	-	-	-	-	-
100	63	-	-	-	-	-	-	-

Jeti Electric Motor with brake and aluminum disk								
Test Number:	3, Idle Vertical Setup 5 ft above ground				Test RPM:	4440		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	46	-	-	-	-	-	-	-
25	40	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Jeti Electric Motor with brake and aluminum disk								
Test Number:	4, Hover Vertical Setup 5 ft above ground				Test RPM:	11,760		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	60	-	-	-	-	-	-	-
25	42	-	-	-	-	-	-	-
50	40	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	5, Idle on ground				Test RPM:	4,440-4,450		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	77	77	77	78	77	77	76	76
25	63	63	64	63	62	64	63	64
50	53	54	54	54	53	54	54	54
75	47	48	49	48	47	48	47	48
100	42	43	43	43	42	43	42	42

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	6, Full Throttle on ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	100	101	101	101	100	101	101
25	83	88	84	87	85	87	84	87
50	80	82	81	82	81	84	81	83
75	74	78	77	80	77	80	76	78
100	72	74	73	75	71	76	72	74

Jeti Electric Motor with Master Airscrew 11 X 5 running on 24 volts								
Test Number:	7, Vertical Setup 5 ft above ground				Test RPM:	13,280		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	-	-	-	-	-	-	-
25	84	-	-	-	-	-	-	-
50	74	-	-	-	-	-	-	-
75	72	-	-	-	-	-	-	-
100	66	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 running on 24 volts								
Test Number:	8, Front of Propeller Horizontal Setup 4 ft above ground				Test RPM:	13,280		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	86	-	-	-	-	-	-	-
25	72	-	-	-	-	-	-	-
50	67	-	-	-	-	-	-	-
75	61	-	-	-	-	-	-	-
100	60	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 running on 24 volts								
Test Number:	9, Rear of Propeller Horizontal Setup 4 ft above ground				Test RPM:	13,280		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	88	-	-	-	-	-	-	-
25	72	-	-	-	-	-	-	-
50	68	-	-	-	-	-	-	-
75	66	-	-	-	-	-	-	-
100	64	-	-	-	-	-	-	-

Jeti Electric Motor with brake running on 24 volts								
Test Number:	10, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	66	-	-	-	-	-	-	-
25	52	-	-	-	-	-	-	-
50	42	-	-	-	-	-	-	-
75	40	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20%								
Test Number:	11, Idle Vertical Setup 5 ft above ground				Test RPM:	4440-4450		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	70	72	71	72	70	67	65	71
25	54	57	56	57	54	52	52	56
50	46	46	47	48	45	43	43	46
75	44	44	46	48	44	40	40	47
100	-	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20%								
Test Number:	12, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	13,500		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	100	101	101	102	100	101	98	100
25	84	85	86	86	85	83	83	84
50	80	79	81	82	82	80	80	82
75	77	75	77	78	77	75	75	77
100	70	72	73	73	72	71	71	72

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20%								
Test Number:	13, Hover Vertical Setup 5 ft above ground				Test RPM:	11,820		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	95	96	96	99	96	96	96	97
25	77	80	80	82	80	78	78	82
50	73	74	74	75	75	73	74	76
75	70	72	71	74	73	70	70	73
100	67	68	68	69	68	67	65	68

O.S. .32 with Mousse Can Muffler, brake, and aluminum disk running on Blue Thunder 20%								
Test Number:	14, Idle Vertical Setup 5 ft above ground				Test RPM:	4,500-4,560		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	70	71	72	73	72	68	69	72
25	56	56	58	60	57	53	54	58
50	49	50	50	52	50	48	48	50
75	47	48	50	52	49	44	44	49
100	44	45	46	47	43	40	40	44

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	15, Hover Tethered Vertical Setup 5 ft above ground				Test RPM:	11,760		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	98	102	100	99	101	99	99	99
25	82	82	82	82	82	82	82	81
50	75	77	76	76	75	79	78	76
75	74	72	72	72	73	74	74	74
100	70	71	71	71	71	71	71	72

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	16, Full Throttle Tethered Vertical Setup 5 ft above ground				Test RPM:	13,200		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	104	103	102	104	103	105	101	102
25	86	92	87	89	87	92	88	89
50	80	84	82	85	81	85	82	83
75	77	78	80	80	78	80	76	79
100	74	76	78	81	77	79	75	78

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	17, Hover Tethered Vertical Setup 15 ft above ground				Test RPM:	11,820		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	97	95	94	96	97	96	98
25	84	84	83	86	85	84	84	82
50	78	78	78	77	81	78	80	77
75	75	73	73	75	74	73	75	73
100	72	72	72	72	73	72	72	71

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	18, Full Throttle Tethered Vertical Setup 15 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	101	99	96	97	99	96	97	101
25	85	86	87	87	88	86	86	86
50	82	81	81	83	81	83	81	83
75	80	79	79	80	77	81	79	78
100	76	78	76	78	75	80	75	77

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	19, Full Throttle Front of Propeller Horizontal Setup 4 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	106	-	-	-	-	-	-	-
25	92	-	-	-	-	-	-	-
50	85	-	-	-	-	-	-	-
75	82	-	-	-	-	-	-	-
100	80	-	-	-	-	-	-	-

UAV with O.S. .32, Master Airscrew 11 X 5 and Mousse Can muffler running on Blue Thunder 20%								
Test Number:	20, Full Throttle Rear of Propeller Horizontal Setup 4 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	108	-	-	-	-	-	-	-
25	80	-	-	-	-	-	-	-
50	73	-	-	-	-	-	-	-
75	70	-	-	-	-	-	-	-
100	69	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler, brake, and Master Airscrew 11 X 5 cut down to 4 11/16" running on Blue Thunder 20%								
Test Number:	21, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	13,500		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	94	98	97	101	98	92	93	100
25	81	81	80	82	81	78	79	81
50	76	77	76	78	79	73	72	76
75	72	73	73	76	73	70	70	73
100	71	71	71	73	69	67	66	70

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20%								
Test Number:	22, Front of Propeller Horizontal 4 ft above ground				Test RPM:	13,380		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	101	-	-	-	-	-	-	-
25	83	-	-	-	-	-	-	-
50	80	-	-	-	-	-	-	-
75	77	-	-	-	-	-	-	-
100	73	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20%								
Test Number:	23, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	13,380		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	104	-	-	-	-	-	-	-
25	73	-	-	-	-	-	-	-
50	61	-	-	-	-	-	-	-
75	62	-	-	-	-	-	-	-
100	58	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	24, Front of Propeller Horizontal 4 ft above ground				Test RPM:	13,980		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	103	-	-	-	-	-	-	-
25	83	-	-	-	-	-	-	-
50	80	-	-	-	-	-	-	-
75	77	-	-	-	-	-	-	-
100	73	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	25, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	13,980		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	104	-	-	-	-	-	-	-
25	73	-	-	-	-	-	-	-
50	64	-	-	-	-	-	-	-
75	61	-	-	-	-	-	-	-
100	62	-	-	-	-	-	-	-

O.S. .32 with Mousse Can Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	26, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	13,980		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	101	102	102	103	103	101	101	102
25	81	82	83	85	84	81	80	83
50	78	79	79	80	81	78	78	80
75	74	75	76	76	76	75	74	76
100	73	73	74	76	74	74	72	74

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	27, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	12,360		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	97	98	98	98	97	94	94	98
25	80	81	80	81	81	78	79	80
50	74	75	73	73	75	71	74	75
75	71	73	73	71	72	68	71	72
100	68	71	71	70	70	67	68	70

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	28, Front of Propeller Horizontal 4 ft above ground				Test RPM:	12,540		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	98	-	-	-	-	-	-	-
25	80	-	-	-	-	-	-	-
50	75	-	-	-	-	-	-	-
75	73	-	-	-	-	-	-	-
100	71	-	-	-	-	-	-	-

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	29, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	12,540		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	97	-	-	-	-	-	-	-
25	74	-	-	-	-	-	-	-
50	63	-	-	-	-	-	-	-
75	60	-	-	-	-	-	-	-
100	56	-	-	-	-	-	-	-

O.S. .32 with MACS Tuned Pipe and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	30, Front of Propeller Horizontal 4 ft above ground				Test RPM:	13,500		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	101	-	-	-	-	-	-	-
25	81	-	-	-	-	-	-	-
50	78	-	-	-	-	-	-	-
75	75	-	-	-	-	-	-	-
100	73	-	-	-	-	-	-	-

O.S. .32 with MACS Tuned Pipe and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	31, Rear of Propeller Horizontal 4 ft above ground				Test RPM: 13,500			
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	106	-	-	-	-	-	-	-
25	86	-	-	-	-	-	-	-
50	80	-	-	-	-	-	-	-
75	78	-	-	-	-	-	-	-
100	75	-	-	-	-	-	-	-

O.S. .32 with MACS Tuned Pipe and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	32, Full Throttle Vertical Setup 5 ft above ground				Test RPM: 13,500			
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	103	99	101	99	98	99	97	100
25	84	82	82	80	82	80	81	83
50	80	78	79	75	80	77	77	79
75	77	74	76	72	76	73	73	75
100	73	71	72	69	74	71	69	72

O.S. .32 with Universal Silencer Assembly and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	33, Full Throttle Vertical Setup 5 ft above ground				Test RPM: 12,120			
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	98	101	98	96	97	98	96	99
25	80	81	82	80	81	80	78	81
50	76	75	76	75	75	74	74	75
75	74	74	75	71	74	74	72	73
100	72	73	71	70	72	71	71	72

O.S. .32 with Universal Silencer Assembly and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	34, Front of Propeller Horizontal 4 ft above ground				Test RPM:	12,180		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	101	-	-	-	-	-	-	-
25	82	-	-	-	-	-	-	-
50	78	-	-	-	-	-	-	-
75	74	-	-	-	-	-	-	-
100	71	-	-	-	-	-	-	-

O.S. .32 with Universal Silencer Assembly and Master Airscrew 11 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	35, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	12,180		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	92	-	-	-	-	-	-	-
25	77	-	-	-	-	-	-	-
50	68	-	-	-	-	-	-	-
75	66	-	-	-	-	-	-	-
100	63	-	-	-	-	-	-	-

Raptor 30 with Thunder Tiger 36 running on Omega 10%								
Test Number:	36, Hover mounted on stand at 5 ft above ground				Test RPM:	4,140		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	92	94	96	100	98	96	94	98
25	80	80	84	84	84	80	80	80
50	72	74	80	78	78	74	74	74
75	70	74	78	78	78	72	74	72
100	68	68	74	74	72	70	70	72

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 cut down to an 8 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	37, Front of Propeller Horizontal 4 ft above ground				Test RPM:	17,400-17,600		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	-	-	-	-	-	-	-
25	82	-	-	-	-	-	-	-
50	78	-	-	-	-	-	-	-
75	75	-	-	-	-	-	-	-
100	72	-	-	-	-	-	-	-

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 cut down to an 8 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	38, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	17,400-17,600		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	-	-	-	-	-	-	-
25	74	-	-	-	-	-	-	-
50	69	-	-	-	-	-	-	-
75	64	-	-	-	-	-	-	-
100	60	-	-	-	-	-	-	-

O.S. .32 with Stock Muffler and Master Airscrew 11 X 5 cut down to an 8 X 5 running on Blue Thunder 20% ** Carburetor Full Open								
Test Number:	39, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	17,400		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)*	270 (deg)*	315 (deg)
5	104	104	101	103	102	101	99	102
25	87	88	87	85	84	85	83	85
50	80	80	81	80	78	80	79	80
75	79	76	77	78	75	74	72	76
100	76	75	76	75	73	74	72	75

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to 4 11/16"running on 24 volts								
Test Number:	40, Vertical Setup 5 ft above ground				Test RPM:	13,440		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	74	-	-	-	-	-	-	-
25	58	-	-	-	-	-	-	-
50	50	-	-	-	-	-	-	-
75	45	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to 4 11/16"running on 24 volts								
Test Number:	41, Front of Propeller Horizontal 4 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	76	-	-	-	-	-	-	-
25	60	-	-	-	-	-	-	-
50	54	-	-	-	-	-	-	-
75	50	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to 4 11/16"running on 24 volts								
Test Number:	42, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	13,320		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	70	-	-	-	-	-	-	-
25	58	-	-	-	-	-	-	-
50	49	-	-	-	-	-	-	-
75	40	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to an 8 X 5 running on 24 volts								
Test Number:	43, Front of Propeller Horizontal 4 ft above ground				Test RPM:	15,460		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	96	-	-	-	-	-	-	-
25	80	-	-	-	-	-	-	-
50	72	-	-	-	-	-	-	-
75	70	-	-	-	-	-	-	-
100	68	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to an 8 X 5 running on 24 volts								
Test Number:	44, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	15,460		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	94	-	-	-	-	-	-	-
25	62	-	-	-	-	-	-	-
50	56	-	-	-	-	-	-	-
75	54	-	-	-	-	-	-	-
100	45	-	-	-	-	-	-	-

Jeti Electric Motor with Master Airscrew 11 X 5 cut down to an 8 X 5 running on 24 volts								
Test Number:	45, Vertical Setup 5 ft above ground				Test RPM:	15,600		
Distance (ft)	dB level							
	0 (deg), engine head	45 (deg)	90 (deg), exhaust	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	92	-	-	-	-	-	-	-
25	75	-	-	-	-	-	-	-
50	73	-	-	-	-	-	-	-
75	66	-	-	-	-	-	-	-
100	63	-	-	-	-	-	-	-

Jeti Electric Motor with APC 11 X 5 running on 24 volts								
Test Number:	46, Full Throttle Vertical Setup 5 ft above ground				Test RPM:	13,200		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	98	-	-	-	-	-	-	-
25	80	-	-	-	-	-	-	-
50	72	-	-	-	-	-	-	-
75	68	-	-	-	-	-	-	-
100	64	-	-	-	-	-	-	-

Jeti Electric Motor with APC 11 X 5 running on 24 volts								
Test Number:	47, Front of Propeller Horizontal 4 ft above ground				Test RPM:	13,200		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	102	-	-	-	-	-	-	-
25	81	-	-	-	-	-	-	-
50	78	-	-	-	-	-	-	-
75	75	-	-	-	-	-	-	-
100	72	-	-	-	-	-	-	-

Jeti Electric Motor with APC 11 X 5 running on 24 volts								
Test Number:	48, Rear of Propeller Horizontal 4 ft above ground				Test RPM:	13,200		
Distance (ft)	dB level							
	0 (deg)	45 (deg)	90 (deg)	135 (deg)	180 (deg)	225 (deg)	270 (deg)	315 (deg)
5	100	-	-	-	-	-	-	-
25	66	-	-	-	-	-	-	-
50	56	-	-	-	-	-	-	-
75	51	-	-	-	-	-	-	-
100	48	-	-	-	-	-	-	-

APPENDIX B
GRAPHS

Appendix B – Graphs

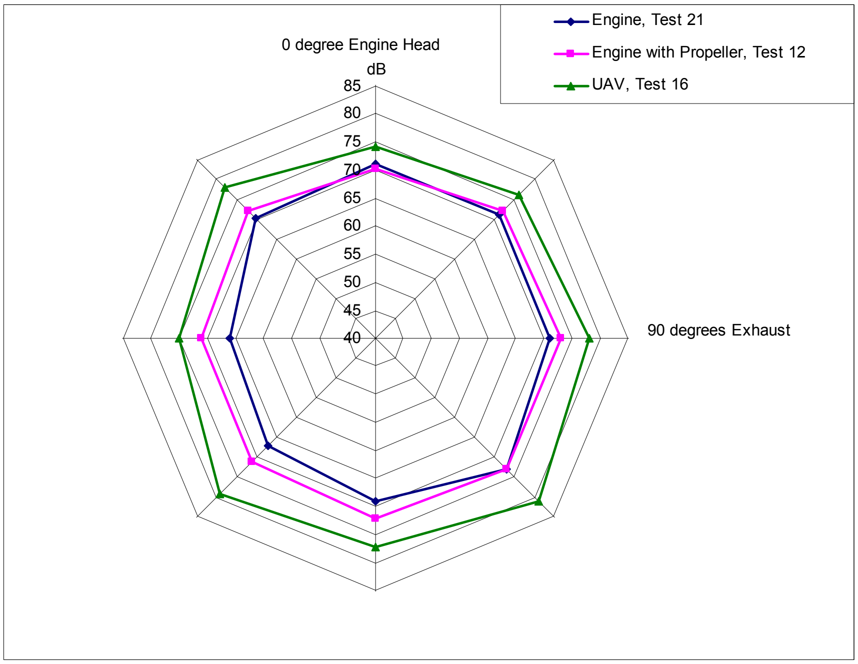

Figure B.1 dB Levels for RPM between 13,200-13,500 at a Distance of 100 feet with Vertical Setup 5 feet above Ground

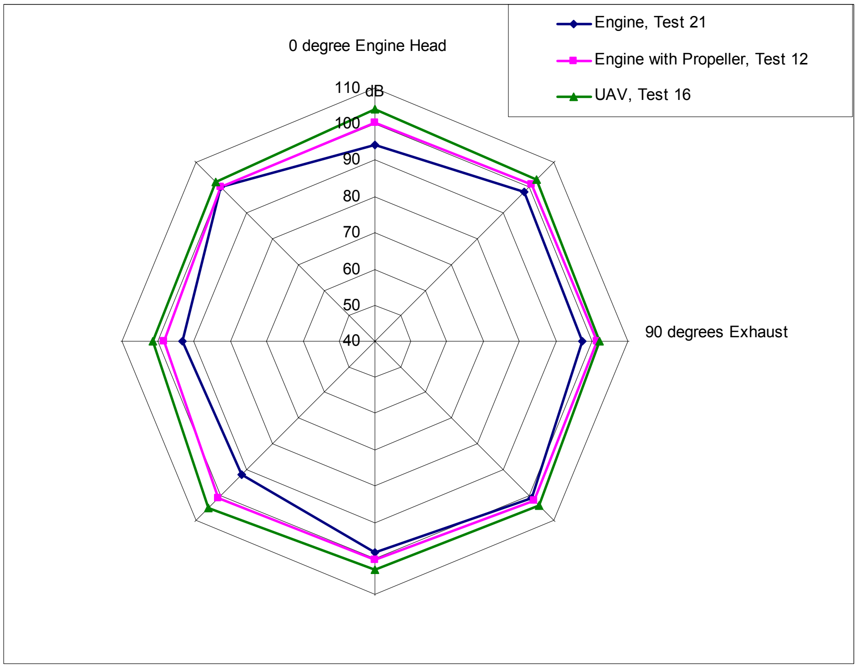

Figure B.2 dB Levels for RPM between 13,200-13,500 at a Distance of 5 feet with Vertical Setup 5 feet above Ground

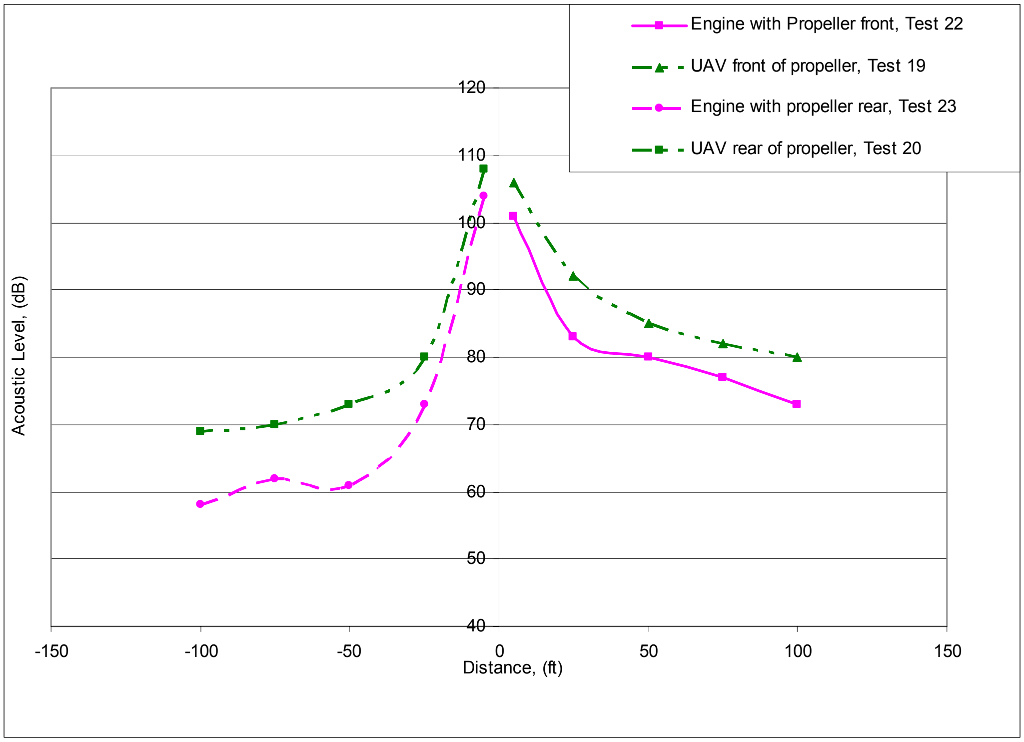

Figure B.3 dB Levels for RPM between 13,280-13,380 with Horizontal Setup 4 feet above Ground

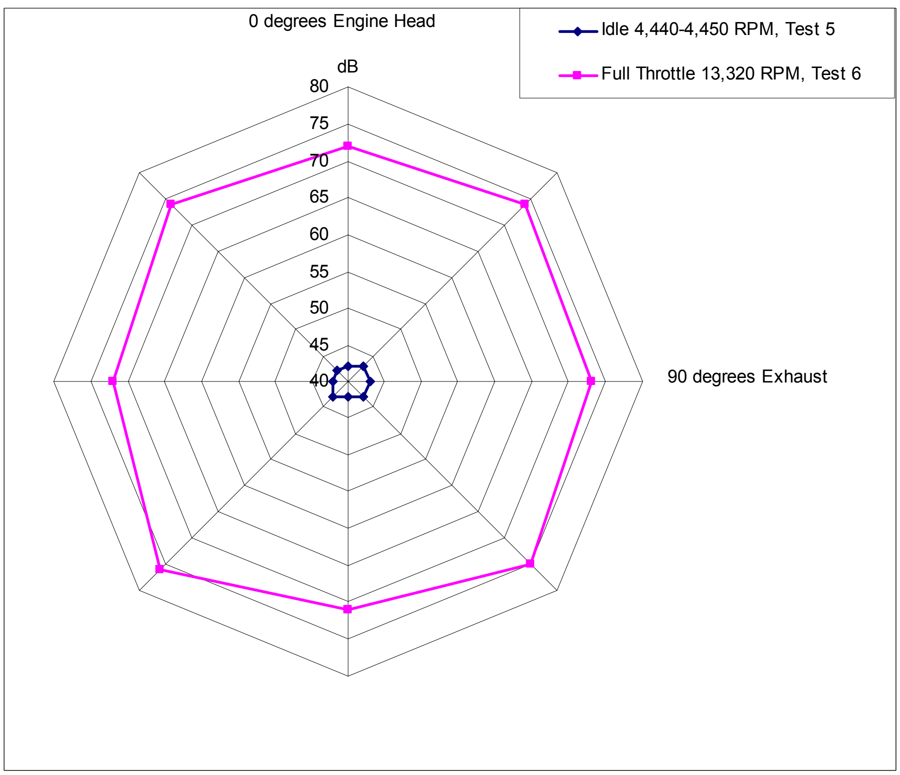

Figure B.4 dB Levels at a Distance of 100 feet with UAV on Ground

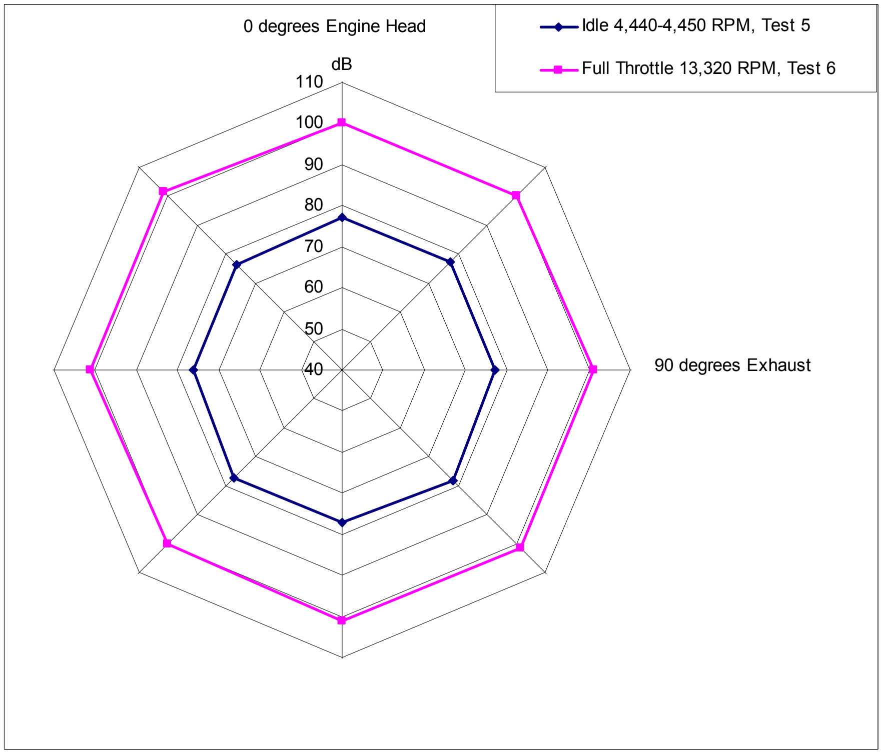

Figure B.5 dB Levels at a Distance of 5 feet with UAV on Ground

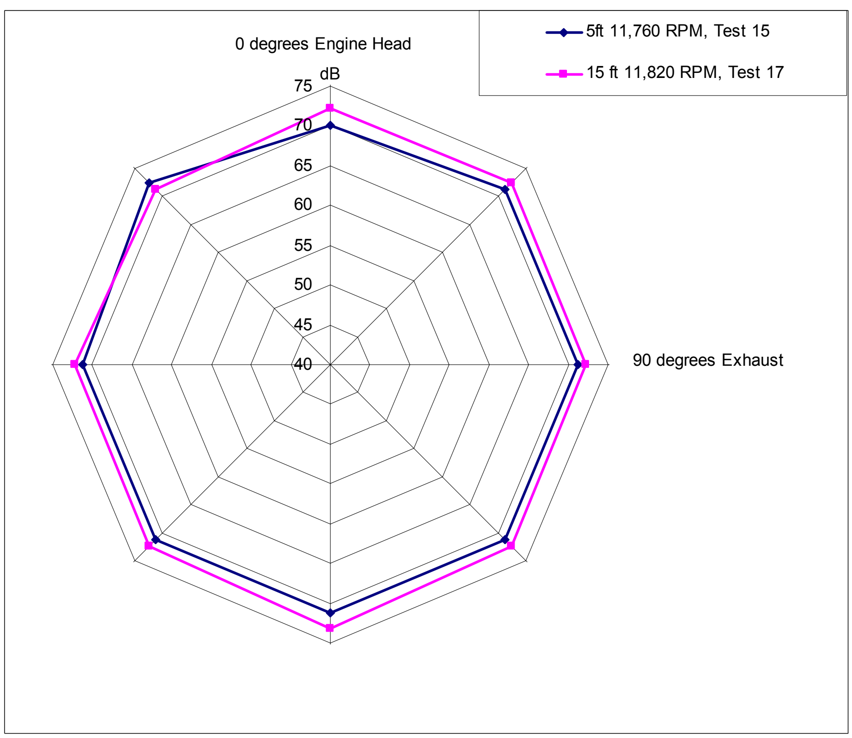

Figure B.6 dB levels at a Distance of 100 feet with UAV at Hover RPM and Tethered

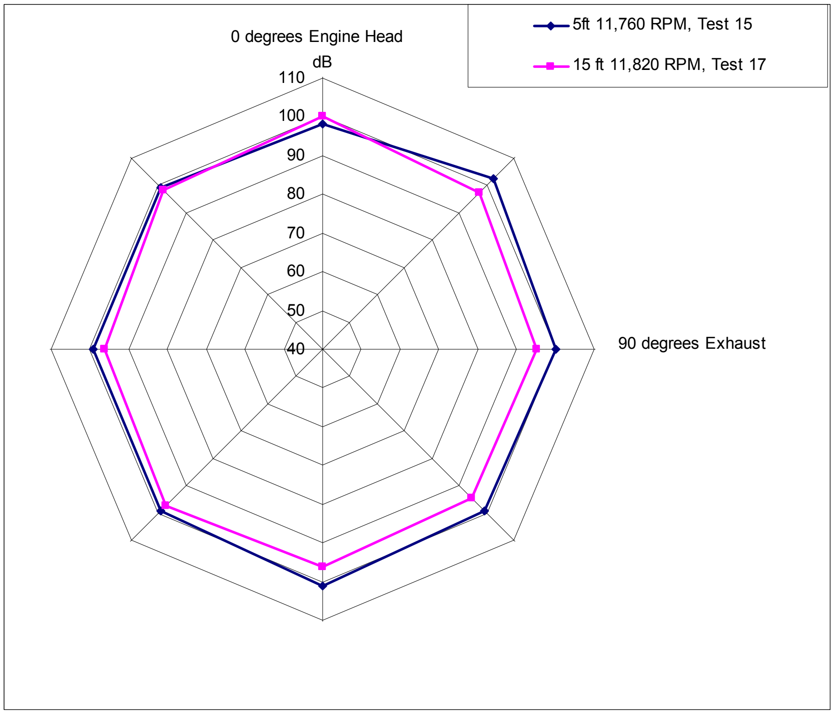

Figure B.7 dB Levels at a Distance of 5 feet with UAV at Hover RPM and Tethered

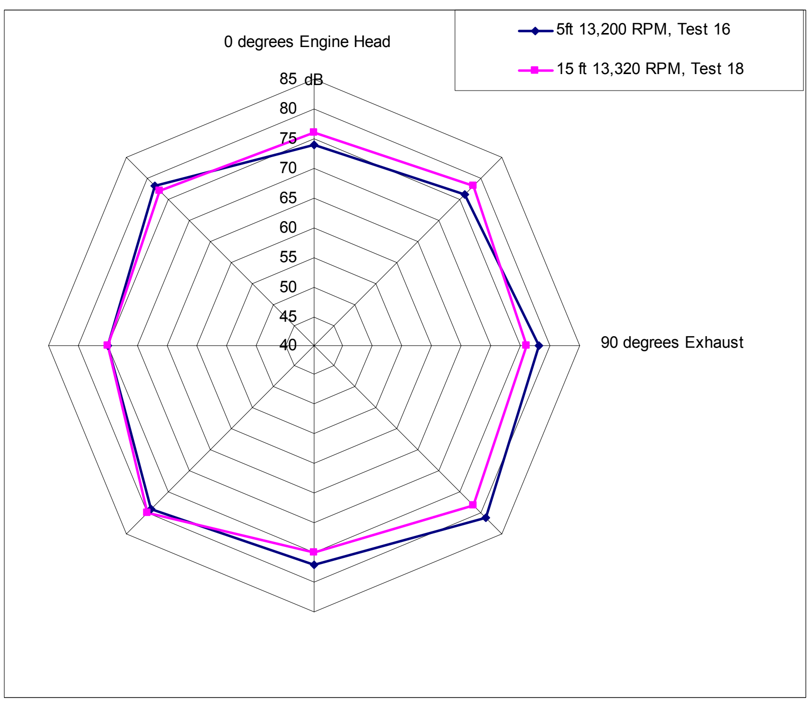

Figure B.8 dB Levels at a Distance of 100 feet with UAV at Full Throttle RPM and Tethered

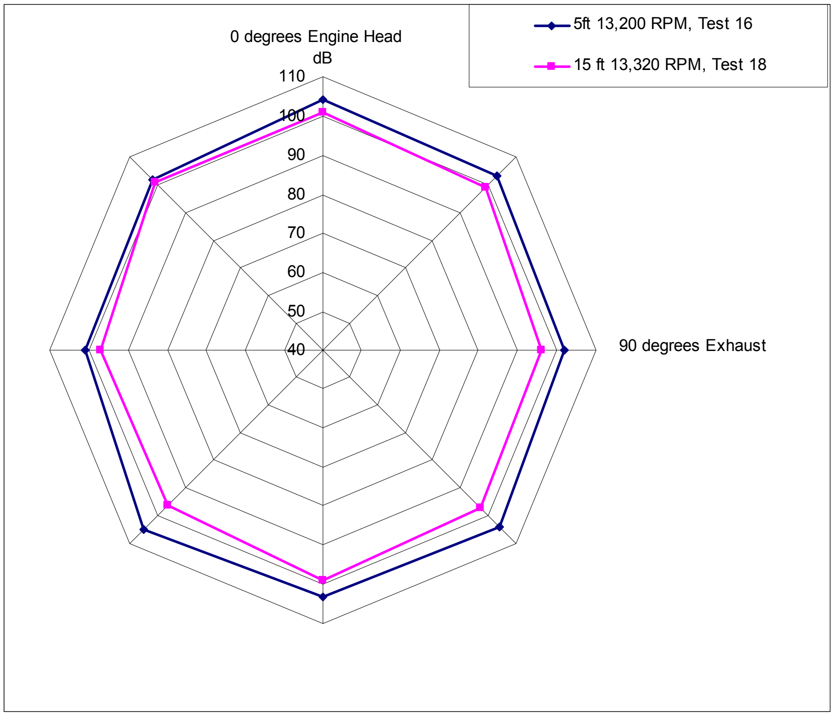

Figure B.9 dB Levels at a Distance of 5 feet with UAV at Full Throttle RPM and Tethered

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