

APPENDIX 3.3

CERTIFICATED NOISE LEVELS OF DIFFERENT HELICOPTERS

Appendix 3.3 Certificated Noise Levels of Different Helicopters

	AB 139	S92	S92	S76C+	AS355N
Certification	ICAO	ICAO	FAA	FAA	N/A
Unit	EPNdB	EPNdB	EPNdB	EPNdB	Lmax
Approach	92.6	97.5	97.49	96.1	89.9
Take-off	90.1	94.5	94.55	93.9	86.4
Flyover	89.5	97.2	97.19	91.6	82.4
Take-off Weight (kg)	6,400	11,861	11,861	5,306	2600
Source of Noise data	Manufacturer	Manufacturer	Manufacturer	FAA	The above noise levels being normalized at 120m Information Provided by CAD

COMMERCIAL IN CONFIDENCE

NOISE CHARACTERISTICS

The following noise levels comply with ICAO Annex 16, Chapter 8 "NOISE requirements".

Model: AB139 Engine Pratt & Whitney PT6C-67C Gross Weight 6000 kg						
Configuration	Level flyover EPNL (EPNdB)	Level flyover DBA	Take Off EPNL (EPNdB)	Take Off DBA	Approach EPNL (EPNdB)	Approach DBA
Clean Aircraft No external kits installed	ICAO 89,5	ICAO 81,3	ICAO 90,1	ICAO 78,5	ICAO 92,6	ICAO 81,5

The following noise levels comply with FAR part 36, appendix H.

Model: AB139 Engine Pratt & Whitney PT6C-67C Gross Weight 6000 kg						
Configuration	Level flyover EPNL (EPNdB)	Level flyover DBA	Take Off EPNL (EPNdB)	Take Off DBA	Approach EPNL (EPNdB)	Approach DBA
Clean Aircraft No external kits installed	FAA 89,3	FAA 81,3	FAA 90,1	FAA 78,5	FAA 92,4	FAA 81,5

9.0 S-92A CERTIFICATION NOISE LEVELS

The Sikorsky S-92A as described in Sections 2.0 and 3.0 was flight tested in accordance with the requirements of FAR Part 36 Subpart H and Appendix H under the guidance and witnessing of the FAA. Corrections to the as-measured SPL (e.g., microphone sensitivity, incidence angle, and electronic system frequency response corrections, ambient energy subtraction, and background noise) and as-measured EPNL (Delta 1, Delta 2, and Delta 3) were performed as required by FAR Part 36 Appendix H with FAA approved software [16]. The resultant S-92A certification noise levels in Effective Perceived Noise Level (EPNL) are summarized in Table 9.1.

The S-92A certification noise levels are below the Stage 2 noise limits specified in FAR Part 36 Appendix H for all of the noise certification flight conditions. The takeoff, approach and flyover certification noise levels are 94.5, 97.5, and 97.2 EPN dB, respectively, resulting in margins of 6.19, 4.25, and 2.55 EPN dB to the FAR Part 36 Stage 2 limits. Hence, the S-92A is, on average, 4.33 EPN dB below the Stage 2 noise limits.

The 90% confidence intervals for the S-92A noise certification levels are less than 0.3 dB for each of the noise certification flight conditions. These confidence intervals are well below the 1.5 dB limit specified in FAR Part 36 Appendix H.

Flight Condition	FAR Part 36 Noise Limits	S-92A Certification Noise Levels	Margins to the FAR Limits	Confidence Intervals
Takeoff	100.74	94.55	6.19	0.17
Approach	101.74	97.49	4.25	0.29
Flyover	99.74	97.19	2.55	0.13

Table 9.1 Summary of S-92A Certification Noise Levels (EPN dB)

10.0 ROTORCRAFT FLIGHT MANUAL

In accordance with FAR Part 36 Subpart O and the guidance provided in the FAA Noise Certification Handbook [5], Advisory Circular AC 36-4B dated March 23, 1988, the EPNL data reported in Section 4.0 of this report will be included in the Rotorcraft Flight Manual (RFM). The following is the recommended wording:

CERTIFICATION NOISE LEVELS

The S-92A Aircraft is certificated at gross weights up to and including 26,150 pounds in accordance with the rules and procedures of FAR Part 36, Subpart H for a Stage 2 aircraft.

The following noise levels comply with FAR Part 36, Subpart H, Stage 2 noise level requirements and were obtained by analysis of approved data from noise tests conducted under the provisions of FAR Part 36, Amendment 36-24. The test and analysis procedures are essentially equivalent to those required by the International Civil Aviation Organization ((CAO) in Annex 16, Volume I, Chapter 8.

ICAO Annex 16, Volume I, Chapter 8 approval is only applicable after endorsement by the Civil Aviation Authority of the country of aircraft registration.

The certified noise levels are:

EPNL (EPN dB)	FLIGHT CONDITION
94.5	Takeoff
97.5	Approach
97.2	Flyover

Note:

No determination has been made by the Federal Aviation Administration that the noise levels of this aircraft are or should be acceptable or unacceptable for operation at, into, or out of any airport.

A Comparison of S-92A and S-76C+ Noise Levels During Heliport/Helipad Operations

S-92A vs. S-76C+: Approach and Takeoff Noise Comparisons

For the S-92 main rotor, beneficial design characteristics of its "parent" S-70 main rotor design have been combined with additional low noise design features such as main rotor blade anhedral tips and increased main rotor-tail rotor spacing to further enhance low noise emissions. Additionally, the low noise Quiet Tail Rotor (QTR) technology developed for the Sikorsky S-76 has been incorporated in the S-92 tail rotor design to further minimize tail rotor noise contributions to the aircraft noise signature. For a helicopter of its weight class and performance capabilities, the S-92 is, in particular, characteristically quiet for the take off, approach and hover flight conditions necessary for heliport operations. With its low noise characteristics, the S-92A is only 0.6 dB and 1.4 dB higher than the S-76C+ for noise certification takeoff and approaches at V_{BROC} as shown in Table 1. These are significantly lower than the 3.5 dB increases that would be expected for a helicopter that has a maximum takeoff gross weight 2.24 times that of the S-76C+.

With its low noise design features for takeoff and approach conditions, the S-92A compares very favorably with the S-76C+ for heliport/helipad operations as can be seen in Table 2. This comparison of the maximum Takeoff and Approach A-weighted noise levels ($dB_{A_{max}}$) at each certification microphone, derived from the FAA-approved S-76C+ and S-92A noise certification datasets, shows that the $dB_{A_{max}}$ during Takeoff for the S-92A is essentially equivalent to the corresponding S-76C+ levels for the Center and Right certification microphones and 2.5 dB lower for the Left microphone (which will appreciably reduce impacts on noise sensitive areas to the left of the takeoff flight path.). For Approach, the S-92A is 2.9 dB higher at the left microphone, 0.2 dB higher at the Center microphone and 1.9 dB lower at the Right microphone. Because blade vortex interaction (BVI) noise is typically much more pronounced on the right hand side of a helicopter during Approach, the reduced right side noise levels represent a significant gain for the S-92A that will appreciably reduce impacts on noise sensitive areas to the right of the approach flight path. [Note that the Left and Right microphones are sideline microphones located 150 m (492 ft) to the left and right of the flight track during noise certification testing.]

S-92A Noise Abatement Flight Procedures

The S-92A can achieve significant noise abatement during heliport operations with relatively small and simple changes in operational procedures. Unlike the S-76C+, approach noise levels decrease as airspeed is reduced below the best-rate-of-climb speed of 80 knots (V_{BROC}), and test data indicate that the S92 main rotor exhibits its peak approach noise levels above ~ 90 kt. Hence the blade vortex interaction (BVI) effects that drive approach noise levels for helicopters occur above the noise certification test airspeed of 80 kts for the S-92A in contrast to the S-76, which incurs peak BVI below its approach noise certification airspeed of 74 kts (see Figure 1). While proper approach angle (glide slope)/rate-of-descent (ROD) and deceleration rate are critical to achieving S-76C+ noise abatement in approach, S-92A approach noise levels are not significantly affected by either ROD or deceleration below 75

knots airspeed, permitting simple and effective noise abatement approach procedures for the S-92A achievable by reducing airspeed during any descent conditions - including a CAT A approach. Note, however, that some benefit is obtained by maximizing approach angle/rate-of-descent to increase height above ground level and the resulting noise attenuation distance. A copy of the draft HAI Fly Neighborly Flight Procedures for the S-92A is appended.

Hover Operations

Sikorsky Aircraft has acquired comparative hover noise data in back-to-back testing of the S-92A and S-76C+. Noise levels were acquired at 150 m in 45° increments, resulting in eight azimuthal measurements circling each aircraft. The results obtained for in-ground-effect hover (HIGE) and out-of-ground-effect hover (HOGE) are presented in Figures 2 and 3, respectively. Although some directivity differences are exhibited in these plots, on average the S-92A hover noise levels are essentially equivalent to the S-76C+ hover noise levels for both IGE and OGE hover despite the more than doubling of gross weight between the S-76 and S-92 helicopters (i.e., from 11,700 lb to 26,150 lb). The low hover noise characteristics of the S-92A main rotor are further demonstrated in Figures 4 and 5. These whirl test data show that the design improvements incorporated in the S-92A main rotor achieved significant gains in hover noise versus the "parent" S-70 main rotor design, both at the design rotor speed of 105% N_r and as compared to the S-70 at 100% N_r . These comparisons again demonstrate the beneficial elements of the S-92A main rotor and tail rotor designs for heliport operations.

	<u>S-76C+</u>	<u>S-92A</u>
Takeoff @ V_{EROC}	93.9 dB	94.5 dB
6° Approach @ V_{EROC}	96.1 dB	97.5 dB
6° Approach @ 60 kts	~97.5 dB	96.4 dB
6° Approach @ 50 kts	~97.0 dB	95.8 dB

Table 1. Noise Certification Levels – S-92A vs. S-76C+

	<u>S-76C+</u>	<u>S-92A</u>	<u>Delta</u>
Takeoff			
Left Mic	83.3	80.8	-2.5
Center Mic	83.2	83.3	0.1
Right Mic	80.8	80.7	-0.1
Approach			
Left Mic	79.3	82.2	2.9
Center Mic	87.6	87.8	0.2
Right Mic	87.7	86.8	-1.9

Table 2. Comparison of Takeoff and Approach dBA_{max} Noise Levels By Microphone as Derived from the S-76C+ and S-92 Noise Certification Datasets

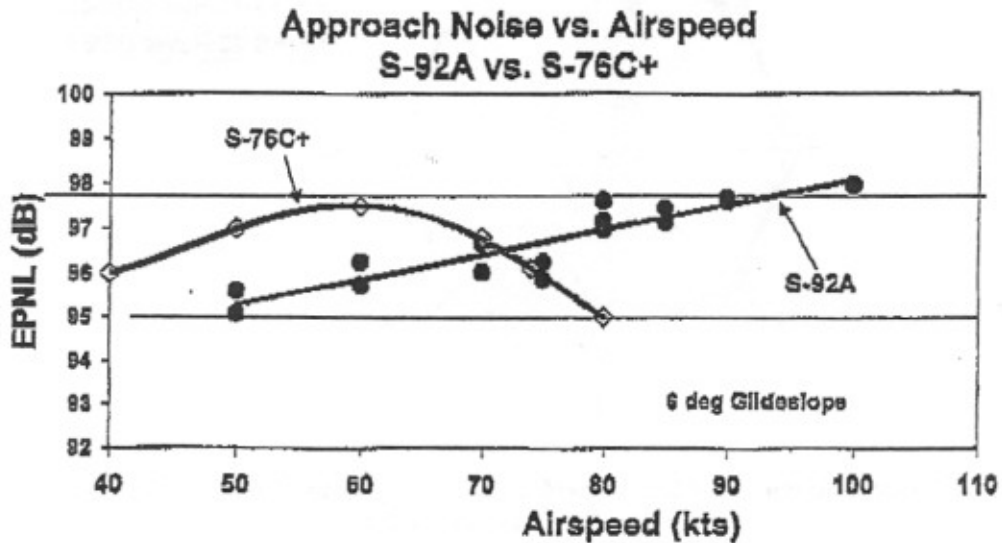


Figure 1. S-92A & S-76C+ Approach Noise Levels vs. Airspeed

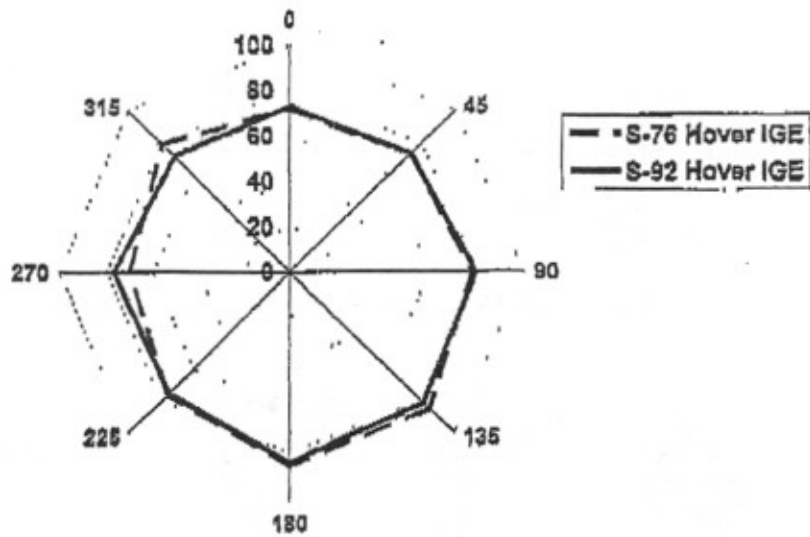


Figure 2. Comparison of S-92A and S-76C+ In-Ground-Effect (IGE) Hover Noise Levels at 150 m (dBA)

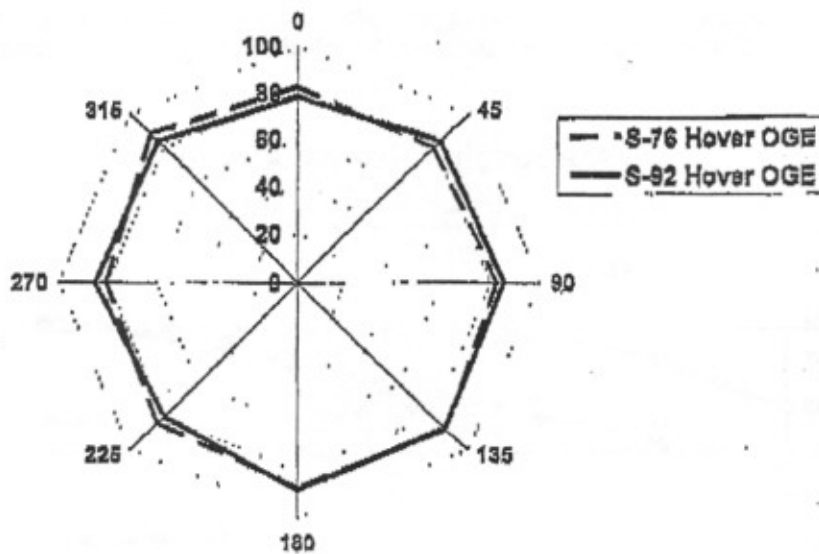


Figure 3. Comparison of S-92A and S-76C+ Out-of-Ground-Effect (OGE) Hover Noise Levels at 150 m (dBA)

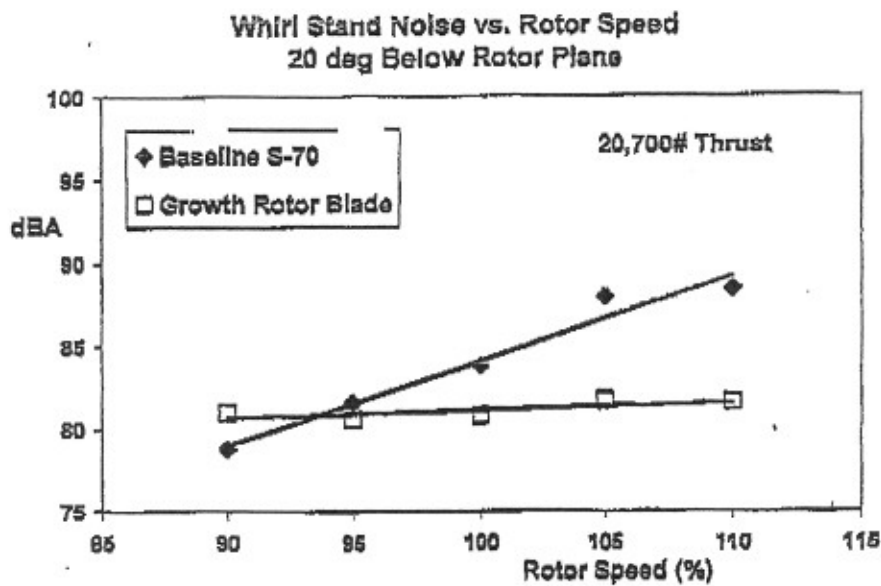


Figure 4. Whirl Stand Comparison of S-92A Main Rotor Blade vs. Parent S-70 Main Rotor Blade at 20,700 lb Thrust – Sound Pressure Level Measured 20° Below Plane

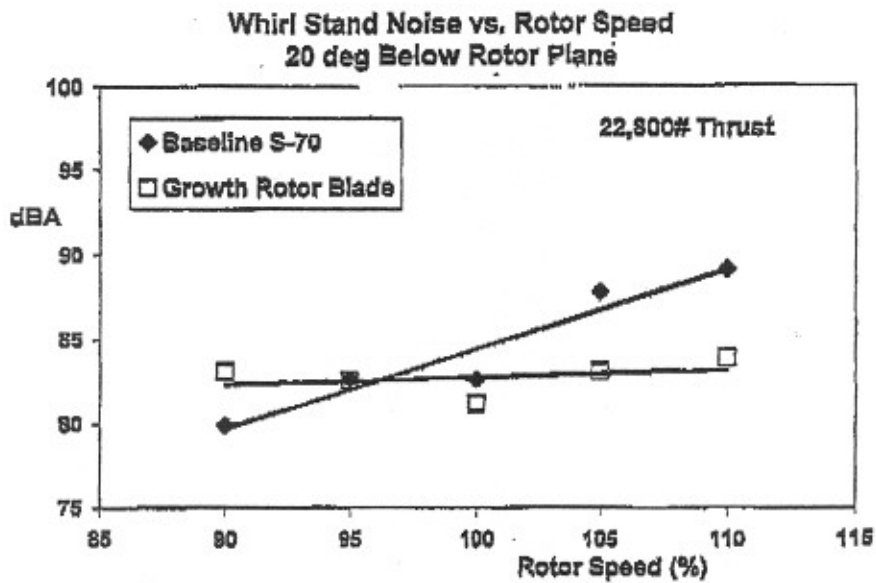


Figure 5. Whirl Stand Comparison of S-92A Main Rotor Blade vs. Parent S-70 Main Rotor Blade at 22,800 lb Thrust – Sound Pressure Level Measured 20° Below Plane