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June 23, 2003

Docket Management System
U.S. Department of Transportation
Room PL401
400 Seventh Street, S.W.
Washington, D.C. 20590-0001

electronic: http://dms.dot.gov

Ref.: **Docket No. FAA 2003-14715; Notice No. 03-05**

The Aerospace Industries of America appreciates the opportunity to respond to the above reference proposed rule. The AIA submittal consists of this letter and the attached comments on, and recommended test for the final rule.

AIA has a proven record of constructively meeting national goals and public expectations. This submittal is consistent with longstanding AIA objectives of promoting meaningful, nondiscriminatory, transparent, performance-based aerospace standards and recommended practices, and developing safer, cleaner and quieter products through technological excellence.

AIA and its member companies fully support the public's need for recreation, rest and reflection. The National Park System is an important national asset providing these and other public benefit. Access to national parks is a critical element necessary to ensure the public will continue to enjoy these benefits.

Manufacturers of civil aviation products have made significant technological progress in reducing aircraft noise and engine emissions. This has been achieved through the international noise and emissions standards and recommended practices (SARPs) established by the International Civil Aviation Organization (ICAO) and as promulgated by the Federal Aviation Administration.

The principles underlying ICAO SARPs are performance-based measures which are competitively neutral. These principles are reflected in this submittal.

Sincerely,

Howard Aylesworth, Jr.

Attachment: AIA Comments – *Implications and Impacts of FAA Docket No. FAA-2003-14715*

Aerospace Industries Association of America, Inc.
1250 Eye Street, N.W. Washington, D.C. 20005-3924

Attachment

Aerospace Industries Association

Implications and Impacts of FAA Docket No. FAA-2003-14715: "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park; Proposed Rule"

OVERVIEW & RECOMMENDATIONS

The Supplemental Notice of Proposed Rulemaking (SNPRM) "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park; Proposed Rule," issued by the FAA on March 24, 2003 (Federal Register, Vol. 68, No. 56, Docket No. FAA-2003-14715) defines a GCNP Aircraft Quiet Technology Designation (QTD) for commercial air tour aircraft operating under 14 CFR 93.301 in Grand Canyon National Park (GCNP). The Aerospace Industries Association (AIA) and U.S. helicopter manufacturers are deeply concerned that the Quiet Technology Designation will prove to be economically devastating to the U.S. civil helicopter manufacturing and operating industries and therefore have the following comments and recommendations in response to the SNPRM:

General Issues

- The current proposed terminology "GCNP Aircraft Quiet Technology Designation" is too general and is inappropriate and misleading when used in connection with such a narrow application as comes under the domain of the National Parks Air Tour Management Act of 2000. [See General Comments and Specific Comment 1 in DISCUSSION]

  Recommendation 1: The term "GCNP Aircraft Quiet Technology Designation" should be modified to "GCNP Aircraft Quiet Air Tour Designation," or something similar, and more clearly defined to better reflect that this is a narrow definition that is linked to the narrow application proposed in the SNPRM and not a de facto noise regulation more stringent than current noise certification requirements.

  [See RECOMMENDED TEXT for amendments to Part 93.303 and Part 93 Appendix A.]

- The intent of The National Parks Air Tour Management Act of 2000 legislation was to mitigate the annoyance due to air tour noise as perceived by visitors to the GCNP. There are, however, likely to be significant unintended adverse consequences to parties not part of the GCNP air tour industry and park users that the legislation was intended to regulate/influence/protect. [See General Comments and Specific Comments 2, 3 and 4 in DISCUSSION]

  Recommendation 2: An economic impact assessment, including a benefit-cost analysis, should be performed prior to issuance of a final rule to determine the potential for broader economic implications of the "QTD" including any adverse impacts to the helicopter manufacturing and operating industries that are

substantially or wholly outside the GCNP air tour industry that the National Parks Air Tour Management Act of 2000 intended to address.

Recommendation 3: The "QTD" should also be more clearly termed and defined to avoid broader application of the designation and minimize the potential for adverse design impacts on noise levels for other flight conditions such as takeoff, approach and hover conditions typical of heliport operations and critical to minimizing local community annoyance levels.

[See RECOMMENDED TEXT for amendments to Part 93.303 and Part 93 Appendix A.]

Recommendation 4: The potential for an unintended consequence of incentives to use/modify existing designs rather than develop newer, safer designs, with potential adverse impacts on overall fleet safety, should be assessed and available for public comment prior to issuance of a final rule.

- The SNPRM effectively imposes a new flyover noise design standard that U.S. government and industry research funding and efforts have not been addressing. U.S. government and industry research on helicopter noise reduction has been reduced to minimal levels over the past 10 years due to economic issues within both the U.S. government and industry. In addition, the vast majority of the U.S. sponsored research that has been funded in the past has concentrated on main rotor blade vortex interaction noise characteristic during the approach condition, not the flyover condition used as the basis for the "QTD". In contrast, many non-U.S. governments have aggressively funded research on helicopter noise reduction in all areas, but especially in flyover noise reduction.

Recommendation 5: Financial incentives and/or direct U.S. government support for research and development of flyover source noise reduction technologies should be made available to assist U.S. manufacturers in developing new helicopters or modifying current helicopters to be compliant with the "QTD".

Technical Issues

- The National Parks Air Tour Management Act of 2000 does not require that the definition of a "QTD" be limited to use of noise certification data. The use of flyover noise certification data only, even as a ranking metric, is not technically valid for situations where there are significant differences between the noise certification operating conditions and the actual aircraft operating conditions where noise needs to be considered (e.g., helicopter designs that manually or automatically increase rotor speed for operation at the density altitudes typical of air tour operations in GCNP.) Furthermore, the exclusive use of noise certification data acquired to regulatory requirements for "QTD" determination discourages innovation such as development of selectable noise reduction technologies or operations that can be implemented by the pilot and required when flying in the designated corridors in GCNP. [See Specific Comments 5 and 6 in DISCUSSION]

Recommendation 6: Noise levels representative of the aircraft operating conditions required for GCNP operations should be used for determining compliance with a quiet air tour designation.

[See RECOMMENDED TEXT for Part 93 Appendix A.]

- The application of the current proposal is limited to air tour operations, which only involve small helicopters. For helicopters with seating capacities of up to 10 to 12 passengers, the number of air tour passengers will typically increase linearly with the passenger capacity. Above 12 passengers, however, this relationship increasingly breaks down as practical air tour passenger configurations fall below helicopter seating capacities due to helicopter design constraints on cabin geometries. Unlike fixed wing airplanes, every air tour passenger cannot get a window seat for larger helicopters because of these design constraints. Hence intermediate and large helicopters have not been effective or economical for use in GCNP tour operations. Furthermore, the extrapolation of the "QTD" concept and goals for reducing annoyance levels/times to larger passenger helicopters has not been evaluated or validated. Therefore, the definition should specifically exclude the larger helicopters to avoid inappropriate or misleading use of the designation. [See Specific Comment 7 in DISCUSSION]

Recommendation 7: The "QTD" for helicopters should be limited to helicopters with 12 or less passengers.

[See RECOMMENDED TEXT for Part 93.303 and Part 93 Appendix A.]

- The proposed noise limits do not appropriately reflect the scaling of noise reduction technologies with weight when considering helicopter technology that is reasonably achievable. [See Specific Comment 8 in DISCUSSION]

Recommendation 8: For helicopter seating capacities of up to 12 passengers, a more reasonably achievable limit incorporating a slope of *12* Log, rather than the proposed slope of 10 Log should be implemented in the final rule to provide economically and technically achievable limits/incentives for using higher seating capacity helicopters than in current use and provide sufficient room for growth versions of existing quiet designs.

[See RECOMMENDED TEXT for Part 93 Appendix A.]

- The SNPRM does not explicitly define the "number of passenger seats" to be used in calculating a quiet technology noise limit for a given aircraft. [See Specific Comment 9 in DISCUSSION]

Recommendation 9: To provide consistency in the definition and application of a "QTD", the number of passengers seats for determining compliance should be defined as the maximum number of passenger seats that can be installed in a given aircraft model.

[See RECOMMENDED TEXT for Part 93 Appendix A.]

RECOMMENDED TEXT FOR THE FINAL RULE

The following contains AIA recommended changes (noted in bold red, italicized text) to the text proposed in the Supplemental Notice of Proposed Rulemaking (SNPRM) "Noise Limitations for Aircraft Operations in the Vicinity of Grand Canyon National Park; Proposed Rule," issued by the FAA on March 24, 2003 (Federal Register, Vol. 68, No. 56, Docket No. FAA-2003-14715):

PART 93—SPECIAL AIR TRAFFIC RULES AND AIRPORT TRAFFIC PATTERNS

1. The authority citation for part 93 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40103, 40106, 40109, 40113, 44502, 44514, 44701, 44719, 46301.

2. Section 93.303 is amended by adding a definition to read as follows:

§ 93.303 Definitions.

* * * * *

Quiet ***air tour designation*** *aircraft* means an aircraft that is ***quiet in the flight operation*** subject to § 93.301 as shown by compliance with the noise limit specified in appendix A of this part. ***This designation applies specifically to cruise operations of aircraft flying commercial air tour operations in the Grand Canyon National Park. For helicopters, this designation applies only to helicopters designed for 12 passenger seats or less.***

* * * * *

3. Appendix A is added to read as follows:

Appendix A to Part 93—GCNP Aircraft Quiet *Air Tour* Designation

This appendix contains procedures for determining the quiet ***air tour designation*** status for each aircraft subject to § 93.301. ***The quiet air tour designation status shall be determined during the noise certification process as prescribed under part 36 of this chapter where the aircraft operating parameters significant to noise are substantially the same as used in the airspace defined in § 93.301. Where rotor***

or propeller speed or other operating parameters of an aircraft must be manually or automatically modified to operate in the airspace defined in § 93.301, noise level data representative of the modified operation shall be used in determining the quiet air tour designation status. Where selectable noise reduction technology or operation is made mandatory for operation to § 93.301, noise level data representative of the modified condition shall be used in determining the quiet air tour designation status. Where no certificated noise level is available ***or applicable***, the Administrator may approve an alternative measurement ***or analytical*** procedure.

1. ***Quiet Air Tour Designation*** *Noise Limit*

A. For helicopters with ***12 or less passengers and*** a flyover noise level obtained in accordance with the measurement procedures prescribed in Appendix H of 14 CFR part 36, the limit is 80 dB for helicopters having two or fewer passenger seats, increasing at ***12*** dB per doubling of the number of passenger seats for helicopters having three or more passenger seats. The limit at number of passenger seats of three or more can be calculated by the formula:

EPNL(H) = 80+***12***log(# PAX seats/2) dB,

where the # PAX seats is defined as the maximum number of passenger seats permitted by the airworthiness certification of the helicopter.

B. For helicopters with ***12 or less passengers and*** a flyover noise level obtained in accordance with the measurement procedures prescribed in Appendix J of 14 CFR part 36, the limit is 77 dB for helicopters having two or fewer passenger seats, increasing at ***12*** dB per doubling of the number of passenger seats for helicopters having three or more passenger seats. The limit at number of passenger seats of three or more can be calculated by the formula:

SEL(J) = 77+*12*log(# PAX seats/2) dB,

where the # PAX seats is defined as the maximum number of passenger seats permitted by the airworthiness certification of the helicopter.

C. For propeller-driven airplanes with a measured flyover noise level obtained in accordance with the measurement procedures prescribed in Appendix F of 14 CFR part 36 without the performance correction defined in Sec. F36.201(c), the limit is 69 dB for airplanes having two or fewer passenger seats, increasing at 3 dB per doubling of the number of passenger seats for airplanes having three or more passenger seats. The limit at number of passenger seats of three or more can be calculated by the formula:

LAmax(F) = 69+10log(# PAX seats/2) dB,

where the # PAX seats is defined as the maximum number of passenger seats permitted by the airworthiness certification of the airplane.

D. In the event that a flyover noise level is not available in accordance with Appendix F of 14 CFR part 36, the noise limit for propeller-driven airplanes with a takeoff noise level obtained in accordance with the measurement procedures prescribed in Appendix G is 74 dB for airplanes having two or fewer passenger seats, increasing at 3 dB per doubling of the number of passenger seats for airplanes having three or more passenger seats. The limit at number of passenger seats of three or more can be calculated by the formula:

LAmax(G) = 74+10log(# PAX seats/2) dB,

where the # PAX seats is defined as the maximum number of passenger seats permitted by the airworthiness certification of the airplane.

DISCUSSION

General Comments

Although the SNPRM attempts to narrowly define the term Quiet Technology Designation (QTD) and make it ostensibly applicable only to aircraft operating in the GCNP under § 93.301, it will have broad application and impacts well beyond its intended target application. In fact, the National Parks Air Tour Management Act of 2000 requires the FAA to develop an air tour management plan for every park that has air tour operations and to (1) give preference to operators using quiet technology aircraft, and (2) for limited capacity parks, incorporate the use of quiet technology aircraft as a selection criteria in the competitive bidding.

The term Quiet Technology Designation can falsely imply that an aircraft attaining the flyover-based "QTD" will be quiet for other flight operations including airport/heliport operations such as takeoff and landing. Conversely, for an aircraft that does not meet the "QTD" limit, the "QTD" can falsely imply that an aircraft is relatively noisy in other flight operations. As a significant potential exists for the "QTD" to be used and misused both by local jurisdictions in the United States and by other nations, the "QTD" will have substantial economic impacts on aircraft manufacturers and operators well beyond the GCNP. Misapplication of the "QTD" could lead to increased noise levels at airports and heliports and inadvertently encourage manufacturers to sacrifice takeoff, approach and/or hover noise levels in future aircraft designs in order to meet the "QTD" limit. It could also lead to bans on all intermediate and large helicopters, since at this time no helicopters in these categories meet the proposed "QTD" limits.

The options for reducing aircraft noise include quiet technology, quiet design and/or quiet operation. The "QTD" lumps quiet technology and quiet design under one category with potentially adverse consequences. Although quiet technology, such as the Fenestron and NOTAR technologies, can be applied to some small helicopters, quiet design is the primary option for many aircraft such as intermediate to large helicopters because the quiet technologies have not demonstrated the same noise reduction potential when scaled to larger configurations. This is illustrated in Figure 1 for the NOTAR technology and in Figure 2 for the Fenestron technology. These plots show that these technologies scale more in a range of 13 to 17 Log with gross weight for the type of helicopters used in air tours, rather than the generally accepted 10 Log scaling of traditional helicopter technologies with gross weight. Hence, use of the 10 Log relationship for a helicopter "QTD" will make compliance easier for smaller helicopters which is counter to the intent of providing an incentive to use larger helicopters to reduce the number of air tour flights and resulting annoyance times. Although the proposed rule uses the number of passenger seats as the basis of scaling rather than gross weight, helicopters on average hold one passenger per 1,000 lb of gross weight and hence these parameters are essentially equivalent when examining the overall trends by passenger number or helicopter gross weight.

In addition to the adverse performance and cost implications often inherent to "quiet" designs, design requirements and features can lead to tradeoffs between noise levels emitted in different flight operations. This is illustrated in Table 1, which shows the margins to FAR Part 36 Appendix H limits for noise-certificated helicopters. The EC 135 P1 and EC 155 B1, which

incorporate quiet fenestron technology, exhibit an exceptional flyover noise level (high margin) but significantly lower takeoff and approach margins. Conversely, the S-92A and Bell 427, which incorporate low takeoff and approach noise design features, has a relatively higher flyover noise level (a lower margin) but superior takeoff and approach noise margins. These two aircraft illustrate the potential adverse impacts of broader application of the "QTD" beyond GCNP, i.e., both the penalization of helicopters with quiet characteristics in other flight conditions and the potential for takeoff and approach noise levels to be sacrificed in attaining low flyover noise levels for modified or future designs. Also note that the low noise technologies implemented to date, mostly low noise anti-torque (tail rotor) technologies, have primarily benefited flyover noise only as demonstrated by the differences between average and median margins for each flight condition in Table 1. The "QTD" as defined will further skew helicopter noise reduction technology to flyover noise reductions at the expense of noise reduction technology development for the approach and takeoff flight conditions.

Specific Comments

Based on the above and other concerns, U.S. helicopter manufacturers have the following specific concerns and comments regarding the proposed use of flyover noise certification data for a quiet aircraft designation:

1. The Quiet Technology Designation (QTD) is proposed for the very narrow application of commercial air tour operations in national parks, particularly for the GCNP. Furthermore, the designation is narrowly and solely defined by flyover noise as applicable to tour operations. Use, however, of the terminology "Quiet Technology Designation" implies a much broader categorization of quiet technology with the potential for application to aircraft beyond GCNP tour operations by local and/or foreign jurisdictions. A low flyover noise aircraft design does not inherently provide low noise in other flight conditions, such as takeoff, approach and hover, applicable to other noise sensitive flight operations at heliports/helipads and airports. The term "Quiet Technology Designation (QTD)" should be modified to "GCNP Aircraft Quiet Air Tour Designation," or something similar, and more clearly defined to better reflect that this is a narrow definition that is linked to the narrow application proposed in the SNPRM.

2. Without a terminology change (e.g., to "GCNP Aircraft Quiet Air Tour Designation") to more accurately reflect the narrow application and definition of the "QTD", the potential for broader economic implications of the "QTD" is both substantial and adverse to the helicopter manufacturing and operating industries. Since these groups are substantially or wholly outside the application that the "legislation" intended to address, either the SNPRM needs to be modified to eliminate these unintended adverse consequences or the adverse impact needs to be considered in the SNPRM. Hence the conclusion that no economic impact assessment is required for implementation of the "QTD" would no longer be valid for the SNPRM. The potential for local and/or foreign jurisdictions to more broadly apply or misapply the QTD could result in significant costs for both helicopter manufacturers and operators. These costs would include the redesign and re-certification of existing helicopter designs by manufacturers and the forced replacement of aircraft by helicopter operators. Without definition and terminology changes to reflect the narrow application and definition of the "QTD", an economic impact assessment including a benefit-cost analysis should be performed prior to issuance of a final rule.

3. The currently proposed definition of the "QTD" assumes that the attainment of the "QTD" will be the result of an implementation of low noise technology. Achieving low flyover noise levels sufficient to meet the "QTD" can, however, result from either technology implementation or design changes. Helicopter design changes optimized for low flyover noise with existing technology will potentially have adverse impacts on other flight conditions more representative of heliport/helipad operations such as takeoff, approach and/or hover. Designing a helicopter typically requires attaining an acceptable compromise between cruise (flyover) and hover performance to meet aircraft performance requirements while minimize acquisition and operating costs. Skewing a given design to improve flyover noise could adversely impact hover, takeoff and approach noise levels. To minimize the potential for adverse design impacts on noise levels for these other flight conditions, the "QTD" should again be more clearly termed and defined to clearly define the applicability of the designation.

4. As FAA certification requirements for safety continue to increase, new helicopter designs will incur some weight penalties for meeting safety regulations. Because helicopter noise levels trend with weight, the resulting increase in weight per passenger seat will typically result in increased flyover noise. Hence, the proposed "QTD" builds in an incentive to continue to use/modify existing designs rather than develop newer, safer designs and so could potentially have adverse safety impacts. Any potential adverse impacts on overall safety should be assessed prior to issuance of a final rule.

5. The National Parks Air Tour Management Act of 2000 does not require that the definition of "QTD" be limited to use of noise certification data for acceptance. The proposed requirement, in fact, discourages innovation and the development of "selectable" noise reduction technologies or operations that can be implemented by the pilot when flying in the designated corridor. To reinforce the intent of the Act, other means of reducing noise such as selectable noise reduction technologies or operations should be allowed with noise levels representative of the operating conditions required for GCNP operations used for determining compliance with a quiet air tour designation. Subsequent to issuance of the final rule, the FAA should work with industry to develop technically and economically reasonable procedures for determining these representative noise levels.

6. In meeting performance requirements, several existing helicopter designs manually or automatically increase rotor speeds by as much as 5% at the density altitudes typical of air tour operations in GCNP. Helicopters that operate at higher rotor speeds than tested for flyover noise certification at sea level will have higher noise emissions than indicated by noise certification levels and hence may not contribute to the restoration/maintenance of natural quiet in GCNP as intended by establishment of a "QTD" in the SNPRM. Noise levels representative of the operating conditions required for GCNP operations should be used for determining compliance with a quiet air tour designation. Subsequent to issuance of the final rule, the FAA should work with industry to develop technically and economically reasonable procedures for determining these representative noise levels.

7. The application of the current proposal is limited to air tour operations, which only involve small helicopters because of passenger configuration design limitations and operating costs. For helicopters with seating capacities of up to 10 to 12 passengers, the number of air tour

passengers will typically increase linearly with the passenger capacity. Above 12 passengers, however, this relationship increasingly breaks down as practical air tour passenger configurations fall below helicopter seating capacities due to helicopter design constraints on cabin geometries. Unlike fixed wing airplanes, every air tour passenger cannot get a window seat for larger helicopters because of these design constraints and hence the full seating capacity of larger helicopters cannot be effectively used for air tour operations and larger helicopters have not been economical for use in GCNP tour operations. Furthermore, the extrapolation of the "QTD" concept and goals for reducing annoyance levels/times to larger passenger helicopters has not been evaluated or validated. Therefore, the definition should specifically exclude the larger helicopters to avoid inappropriate or misleading use of the designation.

8. The proposed limits will eliminate growth versions of many current helicopters that currently meet the limit (e.g., the EC 135T2 growth version of the EC 135T1). Furthermore, the proposed limits will not only eliminate all recent low noise designs in the intermediate and large categories (e.g., EC155 and EH-101), but also become increasingly difficult to meet by larger helicopters which may in fact adversely impact the intended goal of the "QTD" to foster use of quieter, higher passenger helicopters. These unintended consequences are due to the fact that (1) noise levels of current quiet technologies increase at a rate faster than the 10 Log line when scaled to higher gross weights, and (2) noise levels of growth versions of helicopters increase due to the incorporation of new capabilities, which result in a weight increase or a rotor modification (normally without an increase in passenger seats). The proposed rule therefore contradicts the intent of the National Parks Air Tour Management Act of 2000, which requires the FAA to define quiet aircraft technology requirements for helicopters that is reasonably achievable in order to further restore natural quiet. A more reasonably achievable goal would be to use an equation that incorporates a slope of *12* Log, rather than the proposed slope of 10 Log for helicopter seating capacities of up to 12. A slope of *12* Log for seating capacities of 12 or less will include one or two additional helicopter models, which will not substantially change the number of current designs designated as quiet technology aircraft while providing economically and technically reasonable and achievable goals for future designs. It is a reasonable compromise between the 10 Log slope proposed in the SNPRM and the 13 to 17 Log slope demonstrated by current technology (as highlighted in Figures 1 and 2).

9. The SNPRM does not explicitly define the "number of passenger seats" to be used in calculating the "QTD" limit for a given aircraft. The preamble uses the phrase "number of passenger seats on the typical configuration of that aircraft type". This definition appears to be highly subject to interpretation and could lead to one operator meeting the "QTD" criteria while another operator using the same equipment fails the "QTD" criteria. For instance, it is undefined whether the copilot seat, which is often used to carry a passenger, can be counted. Also, the term "typical" could be interpreted as the average passenger load for that operator, rather than the actual number of seats installed. To provide consistency in the definition and application of a "QTD", this variable should be defined as the maximum number of passenger seats that can be installed in a given aircraft model. In general, use of the maximum number of passengers should be representative of GCNP air tour operations as commercial air tour operators have strong financial incentives to maximize the number of passengers per air tour.

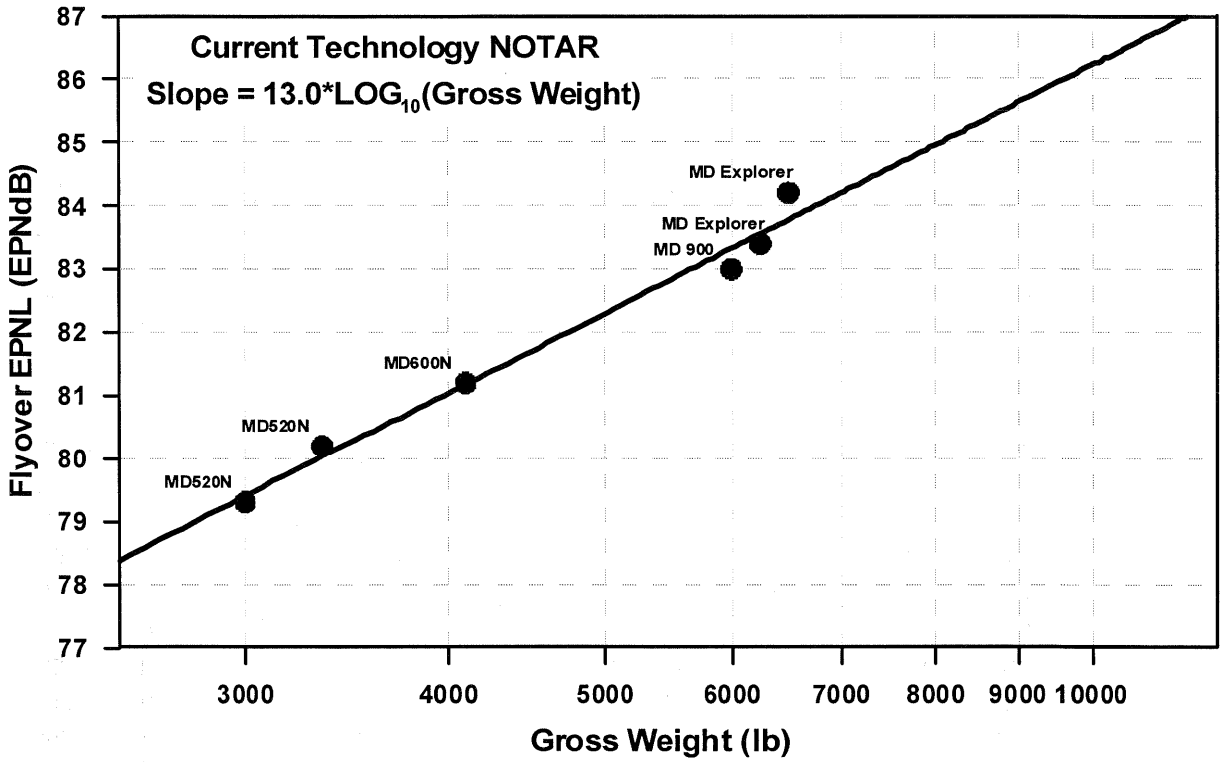

Figure 1. Scaling of NOTAR technology with gross weight.

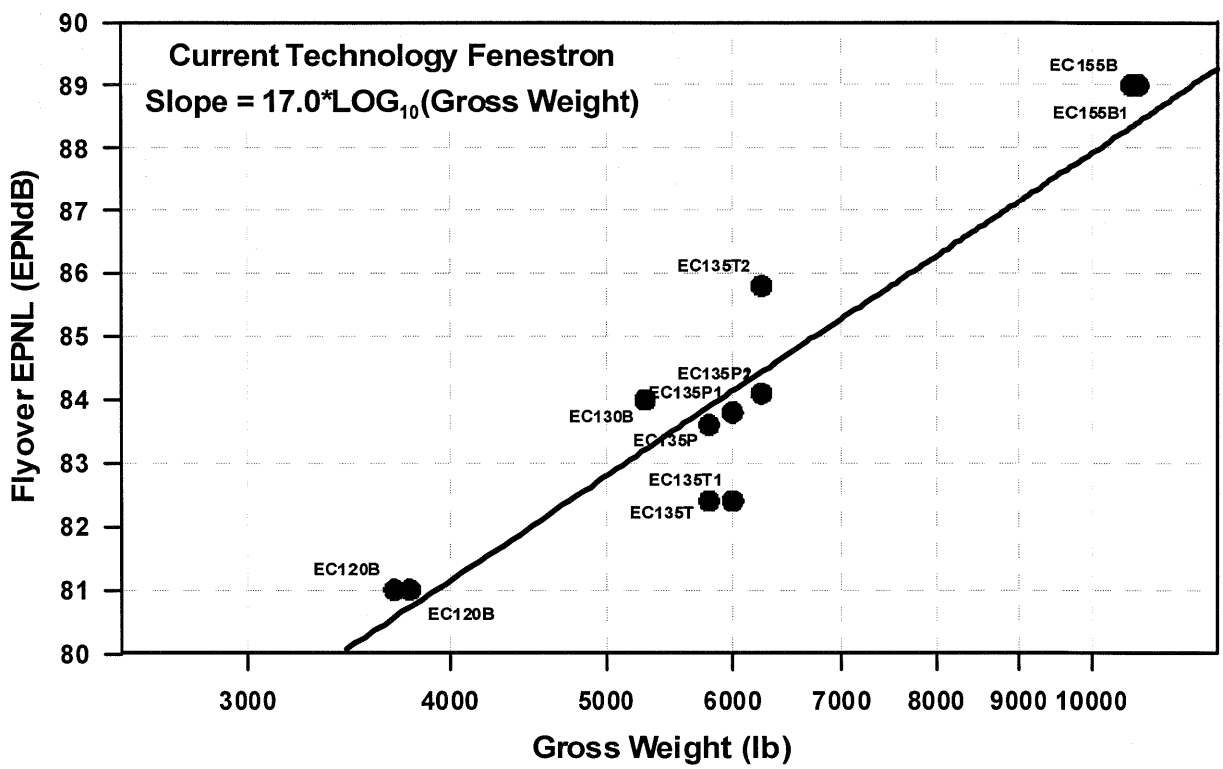

Figure 2. Scaling of Fenestron technology with gross weight.

Flyover		Takeoff		Approach	
500 N (520 N)	10.6	R22	8.8	AS 332 L	5.7
EC 135 P1	9.5	EC 130B	8.3	A109C	5.3
EC 130B	8.6	EC 145/BK 117C2	7.5	EC 145/BK 117C2	5.2
EH101-300,-500	7.4	AS 332 L	7.4	AS 332 L1	5.1
EC 145/BK 117C2	7.3	AS 332 L1	6.7	500 E	5.0
AS 332 L	7.3	230 (Skid Gear)	6.7	500 N (520 N)	4.9
EC155 B1	7.0	230 (Wheels)	6.7	AS 332 L2	4.6
EH101-310,-510	7.0	500 N (520 N)	6.4	427	4.5
EC 155B	6.9	S-92A	6.2	EC 130B	4.3
206 L-4	6.8	AS 355 F	6.0	S-92A	4.2
R22	6.7	427	6.0	A109E (P&WC Engines)	4.2
AS 332 L1	6.7	EC 135 P1	5.9	BO105 CBS-5	3.9
R22 Mariner	6.6	AS 332 L2	5.4	R22	3.3
500 E	6.5	AS 355 F1	5.4	R22 Mariner	3.3
AS 355 N	6.5	BK 117B2	5.4	206 L-4	3.3
AS 355 F2R	5.4	500 E	5.3	430	3.3
AS 350 B3	5.2	AS 355 F2	5.3	W-3A Sokol	3.2
AS 332 L2 (Avg.)	5.2	AS 355 N	5.2	AS 350 B3	3.2
AS 355 F2	5.2	AS 355 F2R	5.0	AS 350 BB	3.1
AS 350 BB	5.1	R22 Mariner (Avg.)	4.8	AS 350 B1	3.1
AS 350 B1	5.1	BO105 CBS-5	4.8	EH101-310,-510	3.1
AS 350 BA	4.9	EC155 B1	4.7	AS 350 B2	3.1
AS 350 B2 (Median)	4.9	EC 155B (Median)	4.6	EH101-300,-500 (Avg.)	3.0
AS 355 F1	4.9	206 L-4	4.6	AS 350 BA (Median)	2.9
MH 2000A	4.8	BK 117C1	4.6	AS 355 F	2.9
AS 365 N3	4.8	412 HP/412 EP	4.5	EC 135 P1	2.8
427	4.8	S-76A+	4.3	412 HP/412 EP	2.7
W-3A Sokol	4.6	W-3A Sokol	4.3	412	2.7
A109C	4.6	412	4.1	230 (Skid Gear)	2.6
S-76C+	4.6	EH101-310,-510	4.0	230 (Wheels)	2.6
230 (Skid Gear)	4.3	EH101-300,-500	3.9	S-76A+	2.3
AS 355 F	4.1	AS 350 B3	3.8	AS 355 N	2.3
AS 365 N2	4.1	AS 350 BB	3.7	A109E (Turbomeca Engi	2.2
230 (Wheels)	4.0	AS 350 B1	3.7	EC155 B1	2.2
369 ER (500 ER)	3.6	AS 350 B2	3.7	S-76C+	2.1
430	3.5	369 ER (500 ER)	3.7	EC 155B	2.1
BK 117C1	3.2	430	3.7	369 ER (500 ER)	2.0
S-76A+	3.1	AS 365 N3	3.3	MH 2000A	1.8
BK 117B2	3.0	S-76C+	3.3	AS 355 F2	1.7
S-76C	3.0	A109E (P&WC Engines)	3.3	AS 355 F1	1.6
412 HP/412 EP	2.9	AS 365 N2	3.1	AS 355 F2R	1.2
412	2.9	MH 2000A	2.8	AS 365 N3	1.2
A109E (P&WC Engines)	2.7	A109E (Turbomeca Eng	2.7	AS 365 N2	1.2
A109E (Turbomeca Engi	2.6	AS 350 BA	2.1	BK 117B2	0.5
S-92A	2.5	A109C	2.0	S-76C	0.5
BO105 CBS-5	2.1	S-76C	1.2	BK 117C1	0.2

Table 1. Comparison of Margins to 14 CFR Part 36 Limits – Helicopters Certificated to Appendix H