U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety

Date: December 13, 2002

From: Manager, Boston Aircraft Certification Office

Reply to Attn. of:

To: Manager, Rotorcraft Directorate, ASW-100

Sikorsky S-92A Helicopter Type Certification Project TC0309BO-R

Background

Compliance with the current requirements of FAR 29.173, static longitudinal stability, and FAR 29.175, demonstration of static longitudinal stability, requires that forward motion of the longitudinal cyclic control be necessary to increase speed to greater than the trim speed, and rearward motion be necessary to decrease speed to less than the trim speed. It further requires that the slope of the longitudinal control position versus airspeed curve be positive.

A Notice of Proposed Rulemaking (NPRM) (Ref: Encl letter forwarding NPRM from ARAC to FAA, dated February 20, 2002), Performance and Handling Qualities Requirements for Rotorcraft, has recently been proposed to allow neutral or negative static stability in limited areas of the flight envelope if adequate compensating characteristics are present and the pilot can maintain airspeed within 5 knots of the desired trim speed during the conditions specified in the proposed FAR 29.175.

Sikorsky's certification compliance flight tests have shown that the aircraft does not comply with the requirements of the current §29.173/175.

Sikorsky subsequently obtained stability data utilizing the following flight conditions defined in FAR 29.175, as amended by the proposed NPRM:

- Climb condition at speeds from Vy - 10 kt, to Vy + 10 kt with maximum continuous power, landing gear retracted, and the rotorcraft trimmed at V_y.
- Cruise condition at speeds from 0.8 Vne - 10 kt to 0.8 Vne + 10 kt. with power required for 0.8 Vne, landing gear retracted, and the rotorcraft trimmed at 0.8 Vne.

- Cruise condition at speeds from Vne - 20 kt to Vne with maximum continuous power, landing gear retracted, and the rotorcraft trimmed at Vne – 10 kt.
- Autorotation at speeds from minimum rate of descent airspeed Vminrd - 10 kt. to Vminrd + 10 kt., with landing gear extended and the rotorcraft trimmed at Vminrd.
- Autorotation at speeds from best angle of glide airspeed Vglide - 10 kt. to Vglide + 10 kt., with landing gear retracted and the rotorcraft trimmed at Vglide.

Results of those flight tests, found in Sikorsky document SER 920261, Appendix A1, are summarized in the following table:

Flight Condition	light fwd		light aft		heavy fwd		heavy aft	
	pull	push	pull	push	pull	push	pull	push
Climb, VY	n	+	n	+	+	+	+	+
Cruise, 0.8VNE	+	+	+	+	+	+	+	+
Cruise, VNE-10	+	+	+	n+	+	n+	+	+
Autorotation, $V_{min\ ROD}$	+	+	+	+	+	+	+	+
Autorotation, $V_{max\ glide}$	+	+	+	+	+	n+	n+	n+

The (+) symbols indicate flight conditions in which positive stability was shown throughout the required speed range. The (n+) symbols indicate flight conditions in which the initial cyclic movement from trim is positive but cyclic position then becomes neutral at subsequent airspeeds. The (n) symbols indicate flight conditions in which the cyclic position is neutral throughout the speed range tested.

Sikorsky believes that the S-92A meets the intent of the NPRM in that neutral stability is present in limited flight conditions and that airspeed is easily maintained within ±5 kias of the desired trim speed. Therefore, Sikorsky requests that an equivalent level of safety finding be granted.

FAA agreed that company data shows that neutral stability is present in limited portions of the flight envelope and agrees with the concept of granting a finding of equivalent safety by showing compliance with the NPRM requirements.

Final acceptance of compliance with the static longitudinal stability requirements and any compensating features of the S-92A helicopter was based upon a qualitative pilot workload evaluation during FAA flight tests on a conformed aircraft. The evaluation for workload and suitability for VFR operations consisted of the following elements:

1. Ability of the pilot to maintain desired climb airspeed (trim at or near Vy) within ±5 kias while performing an all engines operating, MCP, climb and one engine inoperative

climb utilizing 30 minute power on the remaining engine. The evaluation included turns utilizing nominal bank angles. Configuration: Light gross weight, forward and aft c.g., gear retracted.

2. Ability of the pilot to maintain a level flight airspeed of 0.8Vne (trim) ±5 kias utilizing power for level flight. The evaluation included turns utilizing nominal bank angles. Configuration: Heavy gross weight, forward c.g., gear retracted.

3. Ability of the pilot to maintain desired autorotation airspeed (trim at or near Vmax glide) within ±5 kias while performing autorotative descents. The evaluation included turns utilizing nominal bank angles. Configuration: Heavy gross weight, aft c.g., gear extended.

The FAA S-92A equivalent safety evaluations did not reveal any unsafe characteristics regarding static longitudinal stability characteristics. Pilot ability to maintain the above airspeeds in VFR conditions within ± 5 kias during climbs, level flight and autorotation was clearly present with minimal workload. The flat gradients for longitudinal stick position across the speed ranges exist only in limited envelope conditions. Sufficient cueing, such as pitch attitude feedback and visual changes, was available to the pilot to sense speed changes about trim.

The Boston Aircraft Certification Office recommends the Rotorcraft Directorate approve this Equivalent Level of Safety finding for 29.173 and 29.175 in accordance with 21.21(b)(1).

Robert G. Mann

Concur	Concur
Signature: _____	Signature: _____
Manager, Rotorcraft Standard Staff, ASW-110	Manager, Rotorcraft Directorate, ASW-100
Date: _____	Date: _____

Encl

cc:

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