Memorandum

U.S. Department
of Transportation
Federal Aviation
Administration

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety (ELOS) to 14 Code of Federal Regulations (CFR) § 1.2 (Abbreviations and symbols); All 14 CFR, Part 23 sections, except structural, dealing with stall speeds and related factors; 14 CFR Part 36 Noise standards (Appendix C); 14CFR Part 34; Special Conditions, 23-ACE-87, dated 31 Oct 1997; 14CFR Part 25, Amendment 108(67 FR70812, 26 Nov 2002).): Finding Number: ACE-05-17.

Date: October 31, 2005

From: Manager, Airplane Certification Office, ASW-150

Reply to Attn. of:

To: Manager, Small Airplane Directorate, ACE-100

This memorandum request that your office review and provide concurrence with the proposed finding of Equivalent Level of Safety (ELOS) in accordance with § 21.21(b)(1),) for use of 1-g Stall Speeds Instead of Minimum Speed in the Stall as a Basis for Determining Compliance in the Sino Swearingen Aircraft Company (SSAC) Commuter Category airplane Model SJ30-2.

BACKGROUND:

The SJ30-2 is a 13,500-pound maximum take off weight, five-passenger airplane of conventional metal construction powered by two aft fuselage mounted Williams Rolls FJ44-2A medium bypass turbofan engines. Sino Swearingen Aircraft Corporation intends to obtain a Federal Aviation Administration (FAA) Type Certificate (TC), under 14 CFR Part 23 Commuter Category, for single pilot all weather operation of the SJ30-2. The airframe incorporates wing sweep and area ruling to reduce transonic drag, high lift devices for short field performance, and a cabin designed for a maximum pressurization differential of 12 psi. Maximum operating Mach number is 0.83 and maximum altitude is 49,000 feet.

An Equivalent Level of Safety for the use of 1-g stall speeds, instead of the minimum speeds obtained in the stalling maneuver, as the basis for showing compliance with certain Federal Aviation Regulation (FAR) performance, and noise requirements, was established for several past type certification projects. Pilot objectivity on stall identification has become a key factor in decisions on flying technique, especially where deterrent buffet, or excessively low load factors are developed during stalls to VSMIN. To avoid these problems, and to become consistent with recent certification practice under Part 25, the application of 1-g stall speed criteria has been expanded to include most areas of the transport-related regulations that use stall speed as a factor.

APPLICABLE REGULATIONS:

The relevant applicable regulations listed in the above Issue Paper heading have been equivalently restated in the Compensating Features section below to apply to the SJ30-2 airplane as clarification for defining this Equivalent Level of Safety.

APPLICANT'S POSITION:

Sino Swearingen Aircraft Corporation (SSAC) desires to use 1-g stall speeds, rather than "traditional" V_{SMIN} stall speeds, as the reference datum for regulatory compliance. Use of 1-g stall speeds as the performance basis requires changes to related abbreviations and symbols in FAR 1, and speeds based on multiples of stall speed presented in Subparts B, D, E, and F of FAR 23, FAR 36, Special Conditions, and Exemptions. Speed factors in Subpart C of FAR 23 remain unchanged, similar to the approach used under Part 25, and V_{SMIN} will be used.

FAA POSITION:

FAA agrees with the applicant's position based on the following restatement of definition of terms in the applicable regulations to clarify the Equivalent Level of Safety as listed in the compensating features:

COMPENSATING FEATURES:

The 1-g stall requirements were derived to provide a more realistic and consistent basis for the definition of stall speed as the minimum speed at which wing lift alone can support the weight of the airplane in level flight. Service history has not indicated a safety related deficiency in existing operating speeds that typically have their minimum allowable values defined as a multiple of the V_{SMIN} stall speed. Consequently, the 1-g stall Issue Papers have applied reduced operating speed factors for determining the minimum operating speeds in order to compensate for the 1-g stall speeds being higher than V_{SMIN} speeds. The net result has been little or no change in operating speeds for airplanes with aerodynamic stall, thus leading to a finding of equivalent safety.

If Sino Swearingen Aircraft Corporation uses traditional V_{SMIN} to define stall speed, the FAA will require the ratio of $V_{SMIN}/V_{S1\text{-}G}$ to be greater than or equal to 0.94 to ensure that application of the subsequent operating speed margins will provide adequate protection from stall. With this additional limitation on allowable V_{SMIN}, all associated operating speed margins will be calculated based on current FAR 23 requirements (e.g., $V_{2MIN} = 1.2V_{SMIN}$).

As such, the following constitutes the FAA Equivalent Level of Safety for the Sino Swearingen Model SJ30-2 airplane:

14 CFR Reference SJ30-2	Equivalent Interpretations for Sino Swearingen Model
Part 1 (Definitions and Abbreviations)	
1.1	Per AC25-7A, Appendix 5,use the following new abbreviations: "*Final takeoff speed* means the speed of the airplane that exists at the end of the takeoff path in the enroute configuration with one engine inoperative." "*Reference landing speed* means the speed of the airplane, in a specified landing configuration, at the point where it descends through the landing screen height in the determination of the landing distance for manual landings."
1.2	Use the following new abbreviations: "V_{FTO} means final takeoff speed." "V_{REF} means reference landing speed." "V_{SR} means reference stall speed." "V_{SR0} means reference stall speed in the landing configuration." "V_{SR1} means reference stall speed in a specific configuration." "V_{SW} means speed at which onset of natural or artificial stall warning occurs."
Part 23 (Airworthiness Standards: Normal, Utility, Acrobatic and Commuter Category Airplanes) Special Condition 13(a)	Per AC25-7A, Appendix 5, change the method of compliance to read: "The reference stall speed, V_{SR}, is calibrated airspeed defined by the applicant". V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as: $V_{SR} \geq \frac{V_{C_{L_{MAX}}}}{\sqrt{n_{ZW}}}$ Where: $V_{C_{L_{MAX}}}$ = Calibrated airspeed obtained when the load factor-corrected lift coefficient ($n_{zw}W/qS$) is first a maximum during the maneuver prescribed in paragraph (c) of this section. In addition, when the maneuver is limited by a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher), V_{CLMAX} may not be less than the speed existing at the instant the device operates;

n_{ZW} = Load factor normal to the flight path at $V_{C_{L_{MAX}}}$;

W = Airplane gross weight;
S = Aerodynamic reference wing area; and
q = Dynamic pressure.

$V_{C_{L_{MAX}}}$ is determined with:"

Special Condition 13(a)(1) Per AC25-7A, Appendix 5, change the method of compliance to read: "Engines idling, or, if that resultant thrust causes an appreciable decrease in stall speed, not more than zero thrust at the stall speed;"

Special Condition 13(a)(2) Per AC25-7A, Appendix 5, change the method of compliance by adding a new requirement that reads: "The airplane in other respects (such as flaps and landing gear) in the condition existing in the test or performance standard in which V_{SR} is being used;" renumber the old (a)(2) to (a)(3), (a)(3) to (a)(4).

Special Condition 13(a)(3) Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SR}" instead of "V_S".

Special Condition 13(a)(4) Per AC25-7A, Appendix 5, change the method of compliance to read: "The center of gravity position that results in the highest value of reference stall speed, and"

Additional Method Of Compliance For Special Condition 13(a) Per AC25-7A, Appendix 5, add a method of compliance that reads: "The airplane trimmed for straight flight at a speed selected by the applicant, but not less than 1.13 V_{SR} and not greater than 1.30 V_{SR}."

Special Condition 13(b) Per the proposed update to AC25-7A to account for the 1-g stall rule, change the method of compliance to read: "Starting from the stabilized trim condition, apply elevator control to decelerate the airplane so that the speed reduction of the test data brackets a 1.0 knot/second entry rate."

Special Condition 13(b)(1), (b)(2) Per AC25-7A, Appendix 5, change the method of compliance by removing these paragraphs.

Additional Method of Compliance For Special Condition 13 Per AC25-7A, Appendix 5, add a method of compliance that reads: "In addition to the requirements of paragraph (a) of this section, when a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher) is installed, the reference stall speed, V_{SR}, may not be less than 2 knots or 2 percent, whichever is greater, above the speed at which the device operates."

Special Condition 39(b)(2)

Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SR}" instead of "V_S".

Special Condition 4(b)(1)

Per AC25-7A, Appendix 5, change the method of compliance to read "1.13 V_{SR}" instead of "1.2 V_S."

First Additional Method Of Compliance For Special Condition 4

Per AC25-7A, Appendix 5, add a method of compliance that reads: "A speed that provides the maneuvering capability specified in additional method of compliance for 23.143".

Second Additional Method Of Compliance For Special Condition 4

Per AC25-7A, Appendix 5, add a method of compliance that reads: "V_{FTO}, in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by Special Condition 10(c), but may not be less than-- (1) 1.18 V_{SR}; and

(2) A speed that provides the maneuvering capability specified in additional method of compliance for 23.143".

NOTE: AOA protection system (stall warning and stall identification) production tolerances are acceptably small, so as to produce insignificant changes in performance determinations. The flight test settings for stall warning and stall identification for stall speed testing should be set at the nominal AOA tolerance limit; the high AOA tolerance limits should be used for characteristics evaluations.

Special Condition 6(a)

Per AC25-7A, Appendix 5, change the method of compliance by replacing "a speed is reached at which compliance with special condition 10, paragraph (c), is shown" with "V_{FTO} is reached."

Special Condition 12(b)

Per AC25-7A, Appendix 5, change the method of compliance to read: "A climb speed of not more than V_{REF}, as defined in special condition 11(a)."

Special Condition 11

Replace "Instead of compliance with sec. 23.75, the following applies:" with "Instead of compliance with sec. 23.73 and 23.75, the following applies". Special condition 11 covers both landing approach speed and landing distance.

Special Condition 10(c)

Per AC25-7A, Appendix 5, change the method of compliance by replacing "not less than 1.25V_S and with the following:" with "V_{FTO} and with –."

Special Condition 10(d)

Per AC25-7A, Appendix 5, change the method of compliance by replacing "In the approach configuration" with "In a configuration", and "V_S" with "V_{SR}", two places".

Special Condition 10(d)(3)

Per AC25-7A, Appendix 5, change the method of compliance by replacing "exceeding 1.5V_S." with "more than 1.4 V_{SR}, and"

Special Condition 10(d)(4)

Per AC25-7A, Appendix 5, change the method of compliance by adding a new paragraph as follows: "Landing gear retracted."

23.69(a)(4) Per AC25-7A, Appendix 5, change the method of compliance to read "$1.23V_{SR1}$" instead of "$1.3V_{S1}$".

23.69(b)(5) Per AC25-7A, Appendix 5, change the method of compliance to read "$1.13V_{SR1}$" instead of "$1.2V_{S1}$".

Special Condition 11(a)(2) Per AC25-7A, Appendix 5, change the method of compliance to read: "A stabilized approach at a gradient of descent not greater than 5.2 percent (3 degrees), with a stabilized airspeed of not less than V_{REF}, must be maintained down to the 50 foot height. V_{REF} may not be less than___
(i) 1.23 V_{SR0}; and
(ii) V_{MCL} established under § 23.149(c); and
(iii) A speed that provides the maneuvering capability specified in additional method of compliance for 23.143".

Additional Method Of Compliance For 23.143 Per AC25-7A, Appendix A, add a method of compliance that reads: "The maneuvering capabilities in a constant speed coordinated turn at forward center of gravity, as specified in the following table, must be free of stall warning or other characteristics that might interfere with normal maneuvering:

CONFIGURATION	SPEED	MANEUVERING BANK ANGLE IN A COORDINATED TURN	THRUST/POWER SETTING
TAKEOFF	V_2	30°	ASYMMETRIC WAT-LIMITED [1]
TAKEOFF	V_2 + XX[2]	40°	ALL-ENGINES OPERATING CLIMB [3]
ENROUTE	V_{FTO}	40°	ASYMMETRIC WAT-LIMITED [1]
LANDING	V_{REF}	40°	SYMMETRIC FOR -3° FLIGHT PATH ANGLE

(1) A combination of weight, altitude and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in Special Condition 10 for the flight condition.

(2) Airspeed approved for all-engines-operating initial climb.

(3) That thrust or power setting which, in the event of failure of the critical engine and without any crew action to adjust the thrust or power of the remaining engines, would result in the thrust or power specified

for the takeoff condition at V_2, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures."

23.145(a)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.23V_{SR1}" instead of "1.3V_{S1}"
23.145(b)(1)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.3V_{SR1}" instead of "1.4V_{S1}", (2 places); and "1.3V_{SR0}" instead of "1.3V_{S0}."
23.145(b)(2)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.23V_{SR1}" instead of "1.3V_{S1}", and "1.23V_{SR0}" instead of "1.3V_{S0}", 2 places.
23.145(b)(3)	Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SW}" instead of "1.1V_{S1}", and "V_{SW}" instead of "1.1V_{SO}".
23.145(b)(4)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.3V_{SR1}" instead of "1.4V_{S1}".
23.145(b)(5)	Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SW}" instead of "1.1V_{SO}", and "1.6V_{SR0}" instead of "1.7V_{S0}".
23.147(a)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.3 V_{SR1}" instead of "1.4 V_{S1}."
23.149(b)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.13 V_{SR}" instead of "1.2 V_S", and "V_{SR1}" instead of "V_{S1}".
23.157(b)(4)	Per AC25-7A, Appendix A, change the method of compliance to read "1.13V_{SR1}" instead of "1.2V_{S1}".
Special Condition 14(b), (c)(1), (c)(2)(i), (c)(3), (d)	Per AC25-7A, Appendix A, change the method of compliance to read "1.3 V_{SR1}" instead of "1.4 **V_{S1}."**
Special Condition 16(a)(2), (b)(1), (b)(2), (b)(3), (c)(4)	Per AC25-7A, Appendix A, change the method of compliance to read "1.3 V_{SR1}" instead of "1.4 V_{S1}."
Special Condition 16(b)(2)(ii)	Per AC25-7A, Appendix A, change the method of compliance to read "(V_{MO} + 1.3 V_{SR1})/2" instead of "V_{MO} + 1.4 V_{S1}/2."
Special Condition 16(c)	Per AC25-7A, Appendix A, change the method of compliance to read "V_{SW}" instead of "1.1V_{S1}", and "1.7V_{SR1}" instead of "1.8 V_{S1}."
Special Condition 16(d)	Per AC25-7A, Appendix A, change the method of compliance to read "V_{SW}" instead of "1.1V_{S0}", and "1.23V_{SR0}" instead of "1.3 V_{S0}."

Special Condition 16(d)(5)	Per AC25-7A, Appendix A, change the method of compliance to read "1.3 V_{SR0}" instead of "1.4 V_{S0}."
Special Condition 17(a), (b)(1)	Per AC25-7A, Appendix A, change the method of compliance to read "1.13 V_{SR1}" instead of "1.2 V_{S1}."
Special Condition 18(a)(2)	Per AC25-7A, Appendix A, change the method of compliance to read "1.5 V_{SR1}" instead of "1.6 V_{S1}", "V_{SR1}" instead of "V_{S1}", and "reference stall speed" instead of "stalling speed."
Special Condition 20(c)	Per AC25-7A, Appendix 5, change the method of compliance to read: "When the speed is reduced at rates not exceeding one knot per second, in straight flight with engines idling and at the center-of-gravity position specified in Special Condition 13(a)(4), stall warning must begin, in each normal configuration, at a speed, V_{SW}, exceeding the reference stall speed by not less than three knots or three percent, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which the stall warning began."
First Additional Method of Compliance For Special Condition 20	Per AC25-7A, Appendix 5, add a method of compliance that reads: "In slow-down turns at 1.5g load factor normal to the flight path and airspeed deceleration rates greater than two knots per second, with the flaps and landing gear in any normal position, the stall warning margin must be sufficient to allow the pilot to prevent stalling (as defined in Special Condition 18(d)) when recovery is initiated not less than one second after the onset of stall warning."
Second Additional Method Of Compliance For Special Condition 20	Per AC25-7A, Appendix 5, add a method of compliance that reads: "Stall warning must also be provided in each abnormal configuration of the high lift devices likely to be used in flight following system failures (including all configurations covered by Airplane Flight Manual procedures)."
23.233(a), and	Per AC25-7A, Appendix 5, change the method of compliance to read "0.2 V_{SR0}" instead of "0.2 V_{S0}."
SUBPART D	
23.729(a)(1), (a)(2)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.5V_{SR1}" instead of "1.6V_{S1}".
23.735(a)(2)	Per AC25-7A, Appendix 5, change the method of compliance to read: "V = V_{REF}/1.3. V_{REF} = Airplane steady landing approach speed, in knots, at the design landing weight, and in the landing configuration at sea level; and"

23.735(e)	Per AC25-7A, Appendix 5, change the method of compliance to read: "V = Ground Speed associated with the maximum value of V_1 selected in accordance with special condition 4"
SUBPART E	
23.1001(b)(1), (b)(3)	Per AC25-7A, Appendix 5, change the method of compliance to read "$1.3V_{SR1}$" instead of "$1.4V_{S1}$".
SUBPART F	
23.1323(b)(1), (b)(2)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.23 V_{SR1}" instead of "1.3 V_{S1}."
23.1325(e)	Per AC25-7A, Appendix 5, change the method of compliance to read "1.23 V_{SR0}" instead of "1.3 V_{S0}", and "1.7 V_{SR1}" instead of "1.8 V_{S1}."
23.1545(b)(3)	Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SR1}" instead of "V_{S1}". Note: A pending Equivalent Level Of Safety Request may affect this change.
23.1545(b)(4)	Per AC25-7A, Appendix 5, change the method of compliance to read "V_{SR0}" instead of "V_{S0}". Note: A pending Equivalent Level Of Safety Request may affect this change.

Additional Considerations:

The stall warning and identification (stick shaker and pusher) device will meet the current Part 25 standards for reliability, operation, and maintenance; however, a higher probability of stalling must be used to reflect the Part 23, single pilot environment. This guidance is available in AC-25-7, Chapter 8, section (e), "System Reliability and Safety." Paragraph (e)(1)(ii) assigns a value of 10^{-5} per flight hour as the probability of entering a stall. Part 23/Part 91 operations would expect at least an order of magnitude higher probability of entering a stall when compared to Part 25/Part 135&121 operations.

The reason for this additional requirement is the Part 23 accident history, which includes several Part 23 jets. Stall accidents are in the top 5 fatal accident causes for all Part 23 classes including Part 23 jets.

RECOMMENDATION:

Based on the SSAC showing of the compensating features of their design per the Advisory Circulars we recommend the issuance of this Equivalent Level of Safety finding for the Sino Swearingen Model SJ30-2 airplane.

CONCURRENCES:

Michele W. Owsley	*10/31/05*
Manager, Airplane Certification Office, ASW-150	Date

John Colomy	*11/4/05*
Manager, Standards Office, Small Airplane Directorate, ACE-110	Date

John Colomy	*11/4/05*
Acting Manager, Small Airplane Directorate, ACE-100	Date