Federal Aviation Administration

Memorandum

Date:	June 5, 2015
To:	Manager, Certificate Management and Safety Oversight Branch, ACE-102A
From:	Manager, Small Airplane Directorate, ACE-100
Prepared by:	Donald J Young, Certificate Management and Safety Oversight Branch, ACE-102A
Subject:	INFORMATION: Equivalent Level of Safety (ELOS) Finding for Honda Aircraft Company, Model HA-420, Use of 1-g Stall Speed in lieu of Minimum Speed in Stall as a Basis for Determining Compliance, Project #: TC9438AT-A
ELOS Memo#:	ACE-15-08
Regulatory Ref:	14 CFR 1.1, 1.2, 23.49, 23.51, 23.65, 23.67, 23.69, 23.73, 23.143, 23.145, 23.147, 23.149, 23.157, 23.161, 23.175, 23.177, 23.201, 23.203, 23.207, 23.233, 23.729, 23.735, 23.1001, 23.1323, 23.1325, 23.1545, and 23.1587.

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Accountable Directorate on the establishment of an equivalent level of safety finding for the Honda Aircraft Model HA-420.

Background:

The Honda Aircraft Model HA-420 airplane is a normal category, twin engine, Class III airplane. It is designed with conventional metal wings and a composite fuselage. Two General Electric Honda Aero Engines (GHAE), Model HF120, medium bypass turbofan engines mounted in a unique over-the-wing (OTW) configuration power the airplane. The Model HA-420 certification basis includes part 23, as amended by amendments 23-1 through 23-62.

Honda Aircraft Company used 14 CFR part 25 methodology of using 1-g stall speeds rather than the "traditional" method of using the minimum speeds obtained in the stalling maneuver (V_{SMIN}), as the reference stall speeds for regulatory compliance for certification of the Model HA-420 airplane. An ELOS finding for the use of 1-g stall speeds as the basis for showing compliance with certain part 23 performance and 14 CFR part 36 requirements has been 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 develop during stalls to V_{SMIN}. To avoid these problems and become consistent with recent certification practice, the application of 1-g stall speed criteria is being expanded to include most areas of the transport-related regulations that use stall speed as a factor.

Part 23 currently defines stall speed, (using the V_{SMIN} method), at the first occurrence of an uncontrollable downward pitching motion, activation of a stall avoidance device (e.g., stick pusher), or reaching a control stop. When compared to transport airplanes, part 23 airplanes have typically been straight-winged with low wing loadings and generally stalled very close to a normal load factor of 1-g. The introduction of jet-powered part 23 airplanes has produced aircraft that are in some respects similar to part 25 transport category airplanes. The 1-g stall requirements in part 25 were derived to provide a more realistic and consistent basis for the definition of stall speed, V_{SR}, as the minimum speed at which wing lift alone can support the weight of the airplane in level flight.

Applicable regulations:

14 CFR 1.1, 1.2, 23.49, 23.51, 23.65, 23.67, 23.69, 23.73, 23.143, 23.145, 23.147, 23.149, 23.157, 23.161, 23.175, 23.177, 23.201, 23.203, 23.207, 23.233, 23.729, 23.735, 23.1001, 23.1323, 23.1325, 23.1545, and 23.1587.

Regulations requiring an ELOS finding:

14 CFR 1.1, 1.2, 23.49, 23.51, 23.65, 23.67, 23.69, 23.73, 23.143, 23.145, 23.147, 23.149, 23.157, 23.161, 23.175, 23.177, 23.201, 23.203, 23.207, 23.233, 23.729, 23.735, 23.1001, 23.1323, 23.1325, 23.1545, and 23.1587.

Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including changes, limitations, or equipment needed for equivalency):

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 was little or no change in operating speeds for airplanes with aerodynamic stall, thus leading to a finding of equivalent safety.

Adoption of the part 25 1-g stall speeds as the performance basis requires changes to speeds based on multiples of stall speed presented in subparts B, D, and F of parts 23 and 36, and the relevant Special Conditions. Speed factors in subpart C of part 23 remain unchanged, since they have been applied historically to the 1-g stall speeds, not the V_{SMIN} stall speeds.

The below table constitutes the proposed FAA Equivalent Safety Finding for the Honda Aircraft Model HA-420 airplane. In order to provide an ELOS to the stall speed requirements of 14 CFR part 1 and part 23, the following changes constitute an ELOS Finding to §§ 1.1, 1.2, and part 23, subparts B, D, E, F, and G (including the applicable Special Conditions) for the Honda Aircraft Model HA-420 airplane.

CFR 14 Reference	Equivalent Interpretations for HACI Model HA-420
	Part 1 (Definitions and abbreviations)
1.1 Add the following definitions:	"*Final takeoff speed* means the speed of the airplane that exists at the end of the takeoff path in the final segment climb in the en route configuration with one engine

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
	inoperative."
	"*Reference landing speed* means the speed of the airplane, in a specified landing configuration, at the point where it descends through the 50 foot height in the determination of the landing distance."
1.2 Add the following new abbreviations:	"V_{FTO} means final takeoff speed, the speed to be flown in the final segment climb."
	"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)

SUBPART B – Flight

23.49 Stalling period

23.49(a) change to read:

"The reference stall speeds, V_{SR0} and V_{SR1}, are calibrated airspeeds defined by the applicant. V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as:

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{ZW}}}$$

where:

V_{CLMAX} = Calibrated airspeed obtained when the load factor-corrected lift coefficient

$$\left(\frac{n_{ZW}W}{qS}\right)$$

is first a maximum during the maneuver prescribed in paragraph 23.201 as modified by 23.201(e). 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_{CLMAX}

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
	W = Airplane gross weight;
	S = Aerodynamic reference wing area; and
	q = Dynamic pressure.
	V_{CLMAX} is determined with:”
23.49(a)(4) change:	“V_{S0} and V_{S1}” to “V_{SR0} and V_{SR1}”
23.49(a)(5) change:	“V_{S0} and V_{S1}” to “V_{SR0} and V_{SR1}”
23.49(a)(6) change:	“V_{S0} and V_{S1}” to “V_{SR0} and V_{SR1}”
23.49(b) change:	“V_{S0} and V_{S1}” to “V_{SR0} and V_{SR1}”
23.49(c) change:	“V_{S0}” to “V_{SR0}”
23.49(d) change:	“V_{S0}” to “V_{SR0}”
23.49(e) Insert a new paragraph 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.”
	NOTE: The flight test settings for the AoA protection system (stall warning and stall identification) should be set at the low AoA tolerance limit for stall speed determination and the high AoA tolerance limits for stall characteristics evaluations unless the AoA protection system production tolerances are acceptably small so as to produce insignificant changes in performance speed determinations.
23.51 Takeoff speeds	
23.51(a)(1) change:	“$1.10V_{S1}$” to “$1.08V_{SR1}$”
23.51(b)(1)(iii) change:	“$1.20V_{S1}$” to “$1.13V_{SR1}$”
23.51(c)(2)(iii) change:	“$1.10V_{S1}$” to “$1.08V_{SR1}$”
23.51(c)(4) change:	“$1.20V_{S1}$” to “$1.13V_{SR1}$”
23.65 Climb: All engines operating	
23.65(b)(4) change:	“A climb speed as specified in Sec. 23.65(a)(4).” to “A climb speed not less than the greater of 1.1 V_{MC} and $1.13V_{SR1}$ for multiengine airplanes and not less than 1.13 V_{SR1} for single-engine airplanes.”
23.67 Climb: One engine inoperative	
23.67 (d)(3)(v) change:	“$1.20V_{S1}$” to “$1.13V_{SR1}$”

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
23.67(d)(4)(iv) change:	"V_{S1}" to "V_{SR1}"
23.67 (d)(4)(v) change:	"$1.5V_{S1}$" to "$1.4V_{SR1}$"
23.69 Enroute climb/descent	
23.69(a)(4) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.69(b)(5) change:	"$1.2V_{S1}$" to "$1.13V_{S1}$"
23.73 Reference landing approach speed	
23.73(c) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.143 General	
23.143(d) insert a new paragraph 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	V2	30°	Asymmetric WAT-Limited.[1]
Takeoff	[2]V2 + XX	40°	All-engines-operating climb.[3]
En route	VFTO	40°	Asymmetric WAT-Limited.[1]
Landing	VREF	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 §25.121 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 V2, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures.

23.145 Longitudinal control	
23.145(a) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.145(b)(1) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
	"$1.4V_{S0}$" to "$1.3V_{SR0}$"
23.145(b)(2) change:	"$1.3V_{S0}$" to "$1.23V_{SR0}$"

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.145(b)(3) change:	"$1.1V_{S0}$" to "$1.08V_{SR0}$"
	"$1.1V_{S1}$" to "$1.08V_{SR1}$"
23.145(b)(4) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
23.145(b)(5) change:	"$1.1V_{S0}$" to "$1.08V_{SR0}$"
	"$1.7V_{S0}$" to "$1.6V_{SR0}$"
23.147 Direction and lateral control	
23.147(a) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
23.149 Minimum control speed	
23.149(b) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
	"V_{S1}" to "V_{SR1}"
23.157 Rate of roll	
23.157(b)(4) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
23.161 Trim	
23.161(c)(2) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
23.161(c)(4)(i) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
23.175 Demonstration of static longitudinal stability	
23.175(b)(1)(i) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.175(c) change:	"$1.1V_{S1}$" to "$1.08V_{SR1}$"
	"$1.8V_{S1}$" to "$1.7V_{SR1}$"
23.177 Static direction and lateral stability	
23.177(a)(1) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
23.177(a)(2) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
23.177(b)(1) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.177(b)(2) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.177(d)(1) change:	"$1.2V_{S1}$" to "$1.13V_{SR1}$"
23.201 Wings level stall	
23.201(f)(5)(iii) change:	"$1.5V_{S1}$" to "$1.4V_{SR1}$"
23.201(f)(6) change:	"$1.5V_{S1}$" to "$1.4V_{SR1}$"

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
23.203(c) Turning flight and accelerated turning stalls	
23.203(c)(5)(iii) change:	"$1.5V_{S1}$" to "$1.4V_{SR1}$"
23.203(c)(6) change:	"$1.5V_{S1}$" to "$1.4V_{SR1}$"
23.207 Stall warning	
23.207(c) change to read:	"During the stall tests required by §23.201(b) and §23.203(a)(1), the stall warning must begin at a speed, V_{SW}, exceeding the speed at which the stall is identified by a margin of not less than five knots or five percent CAS, and must continue until the stall occurs. In addition, V_{SW} must exceed the reference stall speed in each configuration by not less than three knots or three percent CAS, whichever is greater."
23.233 Direction stability and control	
23.233(a) change:	"$0.2V_{S0}$" to "$0.2V_{SR0}$"

SUBPART D – Design and Construction

23.729 Landing gear extension and retraction system.	
23.729(a)(1) change:	"$1.6V_{S1}$" to "$1.5V_{SR1}$"
23.729(a)(2) change:	"$1.6V_{S1}$" to "$1.5V_{SR1}$"
23.735 Brakes	
23.735(a)(2) change to read:	"Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel brake assembly may be derived from the following formula: $$KE = 0.0443\frac{WV^2}{N}$$ where: KE = Kinetic energy per wheel (ft.-lb.); W = Design landing weight (lb.); V = Airplane speed in knots. V must be not less than V_{SR}, the power off reference stalling speed of the airplane at sea level, at the design landing weight, and in the landing configuration; and N = Number of main wheels with brakes."

SUBPART E – Powerplant

23.1001 Fuel jettisoning system	
23.1001(b)(1) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"

CFR 14 Reference	**Equivalent Interpretations for HACI Model HA-420**
23.1001(b)(3) change:	"$1.4V_{S1}$" to "$1.3V_{SR1}$"
	SUBPART F – Equipment
23.1323 Airspeed indicating system	
23.1323(b)(1) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.1323(b)(2) change:	"$1.3V_{S1}$" to "$1.23V_{SR1}$"
23.1325 Static pressure system	
23.1325(e) change:	"$1.3V_{S0}$" to "$1.23V_{SR0}$"
	"$1.8V_{S1}$" to "$1.7V_{SR1}$"
	SUBPART G – Operating Limitations and Information
23.1545 Airspeed indicator	
23.1545(b)(3) change:	"V_{S1}" to "V_{SR1}"
23.1545(b)(4) change:	"V_{S0}" to "V_{SR0}"
23.1587 Performance Information	
23.1587(a)(1) change:	"V_{S0} and V_{S1}" to "V_{SR0} and V_{SR1}"

Explanation of how design features or alternative Methods of Compliance (MoC) provide an equivalent level of safety intended by the regulation:

The use of the 1-g methods for stall speed identification has been accepted for part 25 airplanes. The use of the 1-g methods on the part 23 Honda Aircraft Model HA-420 airplane is based on the special conditions imposed from the part 25 regulations and the initial type rating training required by the flight crews.

Data is not available to determine if the 0.94 factor is appropriate for part 23 jet-powered airplanes; however, there are other mitigating factors that can provide an equivalent factor of safety. First, in addition to changing the reference stall speed definition, the part 25 compliance method requires maneuvering margin flight tests at speeds above and below stall warning because the airplane will be operating closer to the aerodynamic stall limit of the airplane. These tests ensure there is not a reduction of the safe airspeed margins provided in part 23 using the V_{SMIN} approach (i.e., that no hazardous condition(s) exist in relation to stall characteristics, which a pilot might accidentally encounter).

Secondly, part 23 still requires demonstration and investigation of stall characteristics per §§ 23.201 and 23.203. These demonstrations are required to the current/classic stall definition provided in § 23.201(b). Also, all AC23-8C, Flight Test Guide for Certification of Part 23 Airplanes, guidance material related to §§ 23.201 and 23.203 is still applicable; particularly the guidance related to a stick pusher system.

As previously stated, 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. The 1g-stall method applies 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 is little or no change in operating speeds for airplanes with aerodynamic stall, thus leading to an ELOS finding.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper F-4. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Accountable Directorate has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section (TCs & ATCs) or in the Limitations and Conditions section of the STC.

Equivalent Level of Safety Findings have been made for the following regulations:

14 CFR 1.1	General
14 CFR 1.2	Abbreviations and symbols
14 CFR 23.49	Stalling Period
14 CFR 23.51	Takeoff speeds
14 CFR 23.65	Climb: All engines operating
14 CFR 23.67	Climb: One-engine inoperative
14 CFR 23.69	Enroute climb/descent
14 CFR 23.73	Reference landing approach speed
14 CFR 23.143	General
14 CFR 23.145	Longitudinal control
14 CFR 23.147	Directional and lateral control
14 CFR 23.149	Minimum control speed
14 CFR 23.157	Rate of roll
14 CFR 23.161	Trim
14 CFR 23.175	Demonstration of static longitudinal stability
14 CFR 23.177	Static directional and lateral stability
14 CFR 23.201	Wings level stall
14 CFR 23.203	Turning flight and accelerated turning stall
14 CFR 23.207	Stall warning
14 CFR 23.233	Directional stability and control
14 CFR 23.729	Landing gear extension and retraction system
14 CFR 23.735	Brakes
14 CFR 23.1001	Fuel jettisoning system
14 CFR 23.1323	Airspeed indicating system
14 CFR 23.1325	Static pressure system
14 CFR 23.1545	Airspeed indicator
14 CFR 23.1587	Performance information

(Documented in ELOS Memo ACE-15-08)

//SIGNED// June 5, 2015

Earl Lawrence, Manager, Small Airplane Directorate, Aircraft Certification Service

Date

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