U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: **ACTION**: Equivalent Level of Safety to § 23.221; Cirrus Designs SR-20; Finding No. ACE-96-5

Date: 6/10/98

From: Manager, Chicago Aircraft Certification Office, ACE-115C

Reply to Attn. of: L. Foster
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To: Manager, Small Airplane Directorate, ACE-100

This memorandum requests your office to review and provide concurrence with the proposed finding of equivalent level of safety to the spin requirements of § 23.221 of 14 CFR Part 23.

BACKGROUND:

The Cirrus SR-20 is a 2,900 pound single-engine, four-place, fixed-gear airplane powered by a 200 hp reciprocating engine. It has a conventional tractor configuration and utilizes composites for the structure. Some unique features of the SR-20 include sidestick controls and a ballistic recovery system based on the General Aviation Recovery Device (GARD) 150 certificated for the Cessna 150/152 series airplane. Cirrus plans to offer the GARD system as standard equipment, meeting special conditions specifically for a TC'd installation. The special conditions for the GARD prior to the SR-20 were for a supplemental safety device and not a primary safety device. Cirrus is incorporating the GARD as a primary safety device and requests the FAA to give them credit for the system by accepting it as a safety device equivalent to § 23.221 Spins.

APPLICABLE REGULATIONS:

Section 23.221 requires that single-engine, normal category airplanes must demonstrate compliance with either the one-turn spin or the spin-resistant requirements. The airplane, for spin compliance, must recover from a one-turn spin or a three-second spin, whichever takes longer, in not more than one additional turn after the controls have been applied for recovery. This is required to be demonstrated for all configurations.

APPLICANT POSITION:

The Cirrus SR20 will include a GARD, emergency aircraft recovery parachute system, as a part of its type design. This system provides an Equivalent Level of Safety to 14 CFR Part 23, § 23.221 Spinning.

1. **Level of Safety Baseline:** Section 23.221 provides for a level of safety to the occupants. This establishes a baseline to which other means of achieving this level of safety may be compared. The level of safety attained provides for a "margin of safety" when recovery from a stall is delayed by one turn or three seconds, whichever is longer. The "margin of safety" must be a recovered aircraft within one additional turn. Significant amounts of data exist, which creates the foundation for the baseline, to substantiate the typical altitude loss for similar class aircraft.

2. **Alternate Equivalent Level of Safety:** The inclusion of the parachute recovery system in the original type design provides for an appropriate "safety margin," or equivalent level of safety. In order for the system to deliver this level of safety, the altitude loss for recognition and deployment of the emergency chute must be shown to be less than or equal to the typical altitude loss for a spin. A three-second delay is recommended to simulate the recognition period of this event.

3. **Compliance:**

Baseline Established

a) Compile historical spin data.
b) Examine spin data for similar class aircraft.
c) Determine typical altitude loss for two turn spins, "A" feet.

Parachute System Level of Safety Established

a) Apply control input during stall to initiate spin.
b) Allow three-second delay from initiation.
c) Complete GARD system activation procedures.
d) Allow for full chute inflation.
e) Measure total altitude loss from initial stall, "B" feet.

Compliance Disposition

If "A" is greater than or equal to "B," the GARD system provides an equivalent level of safety to that of the baseline.

The basic plan outlined above provides a rational means for establishing the equivalent level of safety.

FAA POSITION:

The current rule requires that normal category, single-engine airplanes must recover from a one-turn spin in less than one additional turn with no limit to altitude loss. To show equivalent safety, an applicant must show that the action taken provides a level of safety equal to that established by the regulation from which relief is sought. There has been confusion in the past as to what constitutes "equivalent" safety. The confusion is between using the literal "letter" of the rule and the "spirit" of the rule. Not all rules have one-to-one equivalents. Behind each rule there is an intent, the protection envisioned as a result of the rule. Equivalent safety findings must show equivalency, either by a one-to-one equivalent or by meeting that original safety intent of the rule. The spin recovery requirements of § 23.221 were intended to ensure that the pilot had a chance to safely recover the airplane after inadvertently departing controlled flight into a flight regime that is often fatal. These recovery requirements are only effective if the pilot applies the correct anti-spin controls and there is enough altitude to recover.

The GARD system must meet the special conditions associated with this type certificate. The special conditions include requirements to show that serious injury to the occupants is unlikely, including operation during adverse weather conditions. The landing protection provided by the GARD system meeting these special conditions is assumed to generally allow the occupants to walk away, provided the system was activated above the minimum deployment altitude. All discussion concerning the GARD system is based on the special conditions being met.

DISCUSSION:

From 1945 to 1962, all normal category airplanes under 4,000 pounds had to meet the one-turn spin test. Prior to 1945, the requirement was a six-turn spin with recovery in no more than one and one-half additional turns with controls neutral and power off. Amendment 3-7 of CAR 3, in 1962, eliminated the 4,000 pound limit for single-engine airplanes and deleted the spin requirement for multiengine airplanes. The rationale for deleting the spin requirements for twin-engine airplanes was that spin prevention will contribute more toward reducing stall-spin accidents than spin recovery; therefore, the engine-inoperative stall requirements were revised to preclude inadvertent spin tests. No reason was provided for requiring all single-engine airplanes, regardless of weight, to meet the spin requirement.

The requirement to demonstrate spin recovery for the private pilot's license was eliminated in 1949[1]. Since then, the stall/spin accident rate has improved. However, the overall fatal accident rate in general aviation is basically unchanged over the past 15 years. The 1994 Nall Report on accident trends and factors indicates that over 40 percent of the serious accidents in fixed-gear, single-engine airplanes today begin in maneuvering flight A stall/spin accident is almost always the end result, except that most airplanes never get to the spin phase before impacting the ground,

[1] Private pilot's license only requires that the pilot know the spin recovery procedure. No requirement to even do a spin. With the exception of flight instructor, all subsequent pilot ratings don't even require full stalls, only recovery from incipient stalls.

indicating that this is really a stall problem. These findings suggest that the FAA should consider new approaches to enhance the stall handling characteristics. Half (864 out of 1771) of the fatal accidents studied by the directorate involving spins are in airplanes certificated in the utility or acrobatic categories and approved for multiple turn spins, unlike normal category airplanes, which are prohibited from intentional spins.

Using FAA accident data that went back to 1972, a total of 1,771 "stall/spin" accidents were reviewed. The single-engine airplanes that were studied had to, as a minimum, demonstrate recovery from one-turn spins. By reading each of the remarks sections of the accident report and correlating that with the "phase of flight" field, it was possible to evaluate whether or not the airplane was above or below pattern altitude. An inadvertent departure below pattern altitude is considered unrecoverable; one above pattern altitude, especially at a safe training altitude, was considered to be recoverable. Out of the 1,771 accidents, only 7% (130) were above pattern altitude. Almost half of those 7% were in airplanes that had undergone extensive spin testing for certification. These 3.3% were approved for multiple turn spins. The remaining 3.7% of the airplanes that crashed were only tested for recovery from one turn spins and were certificated as prohibited from intentional spins. Further evaluation revealed that, out of the 3.7% of the airplanes prohibited from spinning, 87% of the those involved weather. So, only about 0.5% of the total airplanes, or just short of 1% of those prohibited from spinning (9 airplanes in this study), were in an environment that would have allowed a recovery.

The FAA believes that the GARD system will increase the safety for the low altitude departure cases. The FAA did consider the case that in an inadvertent stall/spin at altitude, pilots may try to recover the airplane and crash before they use the GARD system due to a fear of damaging the airplane. The FAA acknowledges that an unknown percentage of pilots will probably try to recover the airplane and will crash. This is the same scenario as the military experiences with ejection seats. The majority of crews use the ejection seats and survive, but a minority of crews stay with the airplane, passing up the opportunity to safely eject.

The number of inadvertent departures that occur annually are unknown. The FAA could speculate that it is a low number because if the number of inadvertent departures were large, the FAA would be aware of them. One possible explanation that this reported rate is low is because aircraft are required to meet a spin recovery standard. The FAA also sees merit in exploring the post stall flight regime; however, based on a typical flight profile, the opportunity for stall above pattern altitude is very low except for training. Therefore, the FAA believes this high altitude risk of departure is low considering the possible benefits of addressing the low altitude environment, where the risk of stall is much higher.

Our current stall handling characteristic tests were intended to provide a margin of safety from inadvertent stall that results in departing controlled flight. The safety record indicates that compliance does not provide an adequate safety margin. The FAA, therefore, is concerned that an applicant installing the GARD system would not conduct any spin or spin entry evaluation and could have little margin of safety from inadvertent departure (using current stall handling characteristic requirements). The result leaves the pilot with little margin from a departure and forces the use of the GARD system. There is unanimous agreement within the FAA that the

GARD system was never intended as a routine solution to inadvertent spins. It was intended as device of "last resort" should the airplane ever depart controlled flight. Serious damage to the airplane in an off-field landing is not the same as returning to home base with an undamaged airplane.

The exposure to the hazard of an inadvertent stall/spin at a cruising altitude is very low. Conversely, every flight requires a takeoff and landing. Exposure to the hazard of low altitude inadvertent stall is high. Stall/spin accidents occur at pattern altitude or lower because that is where the airplane is flying at speeds near stall. In all scenarios (see chart - attachment 1) at low altitude, the GARD system has the potential to provide an equal or greater level of safety than that offered by the spin recovery requirements. In most cases, the airplane will impact the ground before completing one revolution, so spin recovery is not even an issue. Installation of the GARD system incentives and encourages new approaches to compliance that may improve the safety over that offered by the existing light airplane fleet.

Based on the foregoing, the FAA will grant relief from the spin requirements of § 23.221. In doing so, the FAA must also consider all possible applications of any position taken, so that policy positions are consistently applied and available to all manufacturers. Even though the FAA believes that the GARD system should increase the level of protection offered for inadvertent stalls at low altitude, the FAA has a responsibility to be conservative concerning the high altitude departures. Therefore, to show equivalent safety from spin recovery, in addition to the GARD recovery system, the FAA believes that the margin of protection from spin entry provided by the stall handling characteristics requirements must be increased. The current stall requirements, §§ 23.201 and 23.203, are demonstrated in a coordinated stall.

The intention for increasing the margin of protection is to provide a reasonable level of confidence that an unintentional, uncoordinated stall will not result in a spin entry. The FAA has the intention of increasing the margin of safety around the stall. This approach should not be confused with the "spin resistance" provision in § 23.221, which requires the airplane to fly through "extreme" cross-controlled maneuvers. Though the stall handling concepts are the same, the spin resistance requirements are very conservative and show equivalency to spins.

Compensating Features:

The compensating features include:

The FAA finds that the GARD system offers the same level of safety as provided for in § 23.221 spins, provided the following conditions are met:

1. The GARD system must recover the airplane in the same or less altitude than airplanes that are in the same class typically take to recover from the one-turn spin requirement of § 23.221.

2. The GARD system must not be deployed before one turn or three seconds, whichever takes longer, after spin initiation.

3. The Cirrus Model SR-20 must demonstrate enhanced stall characteristics that parallel the following guidelines:

a. During the stall maneuvers contained in § 23.201, if an uncontrollable downward pitching does not occur, the pitch control must be held against the stop and controllability must be demonstrated. Using coordinated rudder and aileron control inputs, it must be possible to maintain wings level flight within 15 degrees of bank of level flight without using exceptional skill or alertness. Additionally, it must be possible to roll the airplane from 15 degrees of bank in one direction to 15 degrees of bank in the opposite direction in the stick full aft condition without use of exceptional skill or alertness.

b. If an uncontrollable downward pitching does occur, it must be possible to hold the stick full aft for at least two seconds after the nose pitches downward while maintaining wings level within 15 degrees of bank. At the end of two seconds, standard stall recovery control inputs must produce an immediate return to unstalled flight without any undue tendencies towards spin entry.

c. The stall characteristics must not be unduly sensitive to sideslip during stall entries. There must be no uncontrollable tendency to spin with small deviations from coordinated flight during the stall and the recovery. The use of aileron and rudder controls must not require a high degree of skill or alertness. The ailerons must produce correct, unreversed and effective response throughout the stall and recovery.

d. Following an uncoordinated stall entry, the aircraft must respond immediately and normally without unreversed use of the controls and without exceeding the temporary control forces specified in § 23.143(c) to regain coordinated unstalled flight.

4. An additional limitation must be added to § 23.1583 to require GARD deployment if the airplane departs controlled flight.

5. The GARD must meet the special conditions prescribed for the Cirrus Model SR-20 airplane.

Concurred by:

for Thomas L. Kolick 6/10/98

Manager, Chicago Aircraft Certification Office, ACE-115C Date

Ronald K. Rothlisberger 7-2-98

ACT's Manager, Standards Office, ACE-110 Date

Michael Gallagher 7/9/98

Manager, Small Airplane Directorate, Date
Aircraft Certification Service, ACE-100

Attachment 1

Figure 1.

Inadvertent Case	Current Spin Req.	GARD Equipped
Training (at altitude)	**recovers**	**recovers**
Takeoff - gust,stall	won't recover	won't recover
Takeoff - crosswind turn	won't recover	may recover
Takeoff - excessive nose-up trim - stall	won't recover	won't recover
turning downwind to base	may recover	**recovers**
turning base to final	won't recover	may recover
landing - gust, stall	won't recover	won't recover
maneuvering - high	**recovers**	**recovers**
maneuvering - low	won't recover	may recover
IFR - disoriented - departs	won't recover	**recovers**
Go around - excessive nose-up trim - stall	won't recover	may recover

Note: A recovery for the GARD system refers to occupant protection only. The airplane will be damaged or destroyed anytime the GARD system is used.