Exemption No. 4173

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
KANSAS CITY, MISSOURI 64106

In the matter of the petition of

GULFSTREAM AEROSPACE CORPORATION

for an exemption from § 23.49(b)(1) of the Federal Aviation Regulations

006CE

Regulatory Docket No. ~~23925~~

GRANT OF EXEMPTION

By letter dated August 16, 1984, Mr. A. C. Jackson, Post Office Box 22500, Oklahoma City, Oklahoma, 73123, petitioned on behalf of Gulfstream Aerospace Corporation for an exemption from § 23.49(b)(1) of the Federal Aviation Regulations (FAR) to permit type certification of the Gulfstream Aerospace Model 1500 airplane, with a stall speed, V_{SO}, in excess of 61 knots, but not exceeding 75 knots. The Model 1500 is a single-engine, pressurized, turbofan-powered airplane to be certificated to Part 23 of the FAR.

Section(s) of the FAR affected:

Section 23.49(b)(1) requires that the stall speed, V_{SO}, at maximum weight may not exceed 61 knots for single-engine airplanes.

The petitioner's supportive information is as follows:

Section 23.49(b)(1) states that all single-engine airplanes or multiengine airplanes not meeting the minimum climb requirement specified in § 23.67, must have a stall speed, V_{SO}, at maximum weight, of 61 knots or less when configured for landing; i.e., flaps at landing position and landing gear extended. This is an "old" rule that was formulated in the Civil Air Regulations (CAR) recodified into Part 23 of the FAR. Amendment 23-7 changed the original 70 mph to the present 61 knots in 1969.

While the original selection of 70 mph as an upper limit was somewhat arbitrary, it was based on sound engineering judgment, the available technology, and what was considered as good aircraft practice at that time. All general aviation airplanes could readily meet this rule. And by meeting this rule, the severity of accidents and injuries in a forced landing situation would be minimized.

The petitioner contends stall speeds can be safely exceeded if the type design incorporates additional reliability and crashworthy design features that were not envisioned by the 61-knot rule. These design features, when successfully incorporated into the type design, will provide an equivalent or higher level of safety than the safety level envisioned by the regulations for single-engine airplanes. The following detailed discussions are presented by the petitioner to describe and justify these design features.

The prime intent of the 61-knot stall speed is to reduce the possibility of death or injury in an emergency landing and the 61-knot rule is an indirect means of achieving this end. Another approach would be to directly control the factors which cause death or injury. Major design controllable factors have been identified by recent National Aeronautics and Space Administration (NASA), Department of Defense (DOD), and industry studies. These factors include the following key items:

1) Acceleration loads in excess of physiological limits.

2) Secondary impact of the body, especially the head with the aircraft.

3) Post crash toxic fumes.

Dynamic loads experienced in an emergency landing can now be analyzed by computer program codes such as KRASH, DYCAST, MSOMLA, and ACTION. These codes allow the designer to evaluate and optimize seat and airplane structure to dynamic considerations. Through use of these tools, the inertial loads on the occupants can be minimized, and thus, increase the survivability quotient. This approach will be used on the Model 1500.

In order to provide the required level of safety during an emergency landing while operating at stall speeds above 61 knots, the following is proposed in the type design requirements for the Model 1500:

Petitioner will design to the following "Proposed Added Requirements":

1. In addition to the requirements of FAR 23.785, compliance with the following must be shown for seats, berths, safety belts and harnesses;

   (A) Each seat, bench, or other device for crew or passenger occupancy must successfully complete dynamic tests with an occupant weight of 170 pounds in accordance with each of the conditions stated below:

      a. A change in velocity of not less than 38.1-feet per second (fps) when the seat, bench or other seating device is oriented in its nominal position with respect to the airplane's reference system; and the airplane's longitudinal axis is canted upward 60 degrees with respect to the impact velocity vector; and the airplane's lateral axis is perpendicular to a vertical plane containing the impact velocity vector and the airplane's longitudinal axis. For the airplane's most forward row of seats, peak deceleration must occur in not more than .05 seconds after impact and must reach a minimum of 23.7g's. For all other seats, peak deceleration must occur in not more than .06 seconds after impact and must reach a minimum of 18.9g's.

      b. A change in velocity of not less than 51.7-feet-per-second when the seat, bench or other seating device is oriented in its nominal position with respect to the airplane's reference system and the airplane's longitudinal axis is yawed 10 degrees either right or left of the impact velocity vector (but in such a way as to cause the greatest load on the upper torso restraint system), the airplane's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. For the airplane's first row of seats, peak deceleration must occur in not more than .05 seconds after impact and must reach a minimum of 32.1 g's. For all other seats, peak deceleration must occur in not more than .06 seconds after impact and must reach a minimum of 25.7g's. The velocity change shall be pure translation to the reference system with no angular acceleration considered.

c. The floor rails used to attach the seating device to the airframe must be misaligned with respect to each other by at least 10 degrees vertically (i.e., out of parallel), with the direction at the option of the manufacturer, to account for floor warp.

d. Dynamic tests in accordance with the conditions stated in paragraph (A), subparagraphs (a), (b), and (c) are considered to be successfully completed when the performance measures (i) through (vi) are demonstrated.

(i) Loads in individual upper torso straps do not exceed 1750 pounds. If dual straps are used for retaining the upper torso, the total strap loads do not exceed 2000 pounds.

(ii) The maximum pelvic load as measured in a 11CFR572 dummy does not exceed 1500 pounds.

(iii) The occupant's upper torso strap or straps remain on or in the immediate vicinity of the occupant's shoulder during the impact.

(iv) The lap belt remains on the occupant's pelvis during the impact.

(v) The occupant's head either does not contact any portions of the cockpit or cabin or, if it does, the head impact does not exceed a Head Impact Criteria (HIC) of 1000, as determined by the test procedures defined in SAE J921.

(vi) The attachment between the seating device and the airplane's structure remains intact (although the structure can have exceeded its limit load) and the restraint remains intact (although it also can have experienced separation that is intended as part of its design) as long as the conditions contained in (i) through (v) are met.

(B) In addition to the dynamic tests and criteria defined in paragraph (A) and its subparagraphs (a) through (d)(vi), all seats, benches, or other seating devices and its supporting structure must be designed to withstand the static loads imposed by a 215-pound-occupant when subjected to the airplane's design loads as defined in the airplane's approved flight/ground envelope.

(C) There shall be a safety belt and shoulder harness for each occupant. All rearward facing seats shall provide a headrest capable of resisting the dynamic loads imposed by these requirements. The mass of the head is to be 13.5 pounds.

2. The airplane must be equipped with a device that will provide angle of attack (A.O.A.) information to the pilot. This device shall allow determination of approach configuration A.O.A. to achieve flight manual performance. This device shall display A.O.A. for optimum glide path with the engine stopped. This device shall not rely on engine operation for its power source.

3. In addition to the requirements of § 23.697 of the FAR, compliance shall be shown with the requirement that operation of the wing flaps shall not depend solely on normal operation of the engine or any engine mounted equipment.

4. In addition to the requirements of § 23.853 of the FAR, compliance shall be shown with the requirement of § 25.853 of the FAR, which adds the requirement for use of self-extinguishing materials in cabin.

5. In addition to the requirements of § 23.853 of the FAR, compliance shall be shown with the requirements of § 25.851, which adds the requirement for cabin fire extinguishers.

6. Notwithstanding reference to multiengine airplanes, § 23.1189 shall be a requirement which adds requirement for a firewall fuel shutoff valve.

7. In addition to the requirements of § 23.1587, the flight manual shall provide glide path information with the engine inoperative; including recommended airplane configuration, airspeed, time to descend, and ground distance in still air and correction factors for headwinds.

The petitioner contends that the Model 1500 airplane has a considerable increase in safety level. Further, the petitioner proposes to show correlation of the proposed increased maximum stall speed and its crashworthiness in quantifiable terms.

The petitioner states the General Aviation Safety Panel (GASP) presented to the FAA on June 7, 1984, a proposal to upgrade the crash tolerance for small Part 23 General Aviation Aircraft with fewer than 10 passenger seats. Gulfstream Aerospace Corporation proposes to accept the GASP criteria as state-of-the-art for single-engine airplanes with stall speeds up to 61 knots, and will develop mathematically the relationship between stall speed and the crashworthiness required for the Model 1500 airplane with a maximum stall speed of 75 knots to provide an equivalent level of safety for its occupants.

Gulfstream Aerospace Corporation proposes to design beyond the GASP criteria by the ratio of the Model 1500 stall speed to the current maximum stall speed, that is 75kcas/61kcas= 1.23. This results in a 23 percent increase in the GASP criteria as applicable to the Model 1500.

In addition to the above "Proposed Added Requirements", the petitioner provided in the petition additional information on crash impulse mathematics and impulse momentum principles, engine reliability, pilot skills, airplane design and performance considerations, energy savings, cost impact analysis for designing to the current maximum 61 knot requirement, operational costs, accident analysis, maintenance information, and justification for equivalent safety. This additional supporting information is included in the docket file.

The petitioner contends that compliance with the intent of §23.49(b)(1) of the FAR is to be by alternate means which will show equivalent safety, and that the energy absorbing design criteria, when combined with the increased stall speed will result in an improved level of safety from that provided by conventional design requirements when combined with a stall speed of 61 knots. This alternate means to assure equivalent safety is provided in the "Proposed Added Requirements."

The petitioner contends exemption is in public interest because:

- Jet powered aircraft have become the preferred means of travel due primarily to their speed, comfort, and safety.

- The speed does not impose additional costs as compared to turbopropeller or reciprocating engine type aircraft.

- The businessman who cannot justify the high cost of jet transportation must compromise for the slower more noisy propeller-driven, twin-engine airplane.

- The current single-engine airplanes do not offer the speed, payload, range and all-weather dispatch safety required by many businesses.

- This concept (single-engine jet) offers the speed, comfort, and safety desired by the business executive, but at a much reduced cost than for twin-engine jet aircraft.

Comments to published petition summary:

A summary of petition was published in the Federal Register (49 FR 36592) on September 18, 1984, and no comments were received in response to the summary.

The Federal Aviation Administration's (FAA) analysis is as follows:

To obtain the exemption, the petitioner must show, as required by § 11.25(b)(5) of the FAR, that: (1) granting the request is in the public interest, and (2) the grant of exemption would not adversely affect safety, or that a level of safety will be provided which is equal to that provided by the rule from which the exemption is sought.

The FAA has carefully reviewed all of the information contained in the petitioner's request for exemption.

From the crashworthiness viewpoint, the FAA concludes that the level of safety for occupant protection in the Model 1500 will be equal to or greater than that required by the present rules provided the petitioner's airplane design incorporates the features proposed as added requirements. The proposed dynamic testing of the seat/restraint system is considered adequate to assure the integrity of the system to perform its intended function of occupant protection. The concept of using the ratio of the maximum stall speed of the Model 1500 to 61 knots is a reasonable method of increasing the dynamic conditions. The use of compartment interior materials meeting more stringent tests, the installation of a hand fire extinguisher, and a firewall fuel shutoff valve, are further crashworthiness enhancements to support the petitioner's request.

Flight safety will be improved by the installation of an angle of attack indicator to enable the pilot to optimize performance. The angle of attack indicator and wing flap operation will not depend solely on normal operation of the engine nor any engine mounted equipment, thereby, providing operation in case of engine failure. In addition, performance information will be provided in the Airplane Flight Manual with the engine inoperative, including recommended airplane configuration, airspeed, time to descend, and ground distance in still air plus correction factors for headwinds.

The FAA has evaluated the petitioner's contentions related to the public interest in a grant of the petition and concludes that a grant of exemption would be in the public interest for the reasons stated by the petitioner.

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in Sections 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator (14 CFR 11.53), Gulfstream Aerospace Corporation is hereby granted an exemption from § 23.49(b)(1) of the Federal Aviation Regulations (FAR) to the extent necessary to permit the type certification of its Model 1500 airplane with a maximum weight stalling speed, V_{SO}, not to exceed 75 knots, provided the airplane type design is shown to comply with the following:

1. In addition to the requirements of § 23.785 of the FAR, as amended through Amendment 23-28, compliance with the following must be shown:

   (a) Each seat, bench or other device for crew or passenger occupancy must successfully complete dynamic tests with an occupant weight of 170 pounds in accordance with each of the following conditions:

      (1) A change in velocity of not less than 38.1 feet per second when the seat, bench or other seating device is oriented in its nominal position with respect to the airplane's reference system; and the airplane's longitudinal axis is canted upward 60 degrees with respect to the impact velocity vector; and the airplane's lateral axis is perpendicular to a vertical plane containing the impact velocity vector and the airplane's longitudinal axis. For the airplane's most forward row of seats, peak deceleration must occur in not more than .05 seconds after impact and must reach a minimum of 23.7g's. For all other seats,

peak deceleration must occur in not more than .06 seconds after impact and must reach a minimum of 18.9g's.

(2) A change in velocity of not less than 51.7 feet per second when the seat, bench, or other seating device is oriented in its nominal position with respect to the airplane's reference system and the airplane's longitudinal axis is yawed 10 degrees either right or left of the impact velocity vector in such a way as to cause the greatest load on the upper torso restraint system, the airplane's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. For the airplane's first row of seats, peak deceleration must occur in not more than .05 seconds after impact and must reach a minimum of 32.1 g's. For all other seats, peak deceleration must occur in not more than .06 seconds after impact and must reach a minimum of 25.7g's.

Note: The airplane's reference system, is defined as consisting of three mutually perpendicular axes, where the vertical axis is perpendicular to a waterline reference system of the airplane and parallel to the station reference system and the longitudinal axis is perpendicular to the station reference system and parallel to the waterline reference system. The velocity change must be pure translation with no angular acceleration considered.

(3) The floor rails used to attach the seating device to the airframe must be misaligned with respect to each other by at least 10 degrees vertically (i.e., out of parallel), with the direction at the option of the petitioner, to account for floor warp.

(b) Dynamic tests must be accomplished in accordance with the conditions stated in paragraph (a), and compliance with paragraphs (1) through (6) of this paragraph must be shown:

(1) Loads in individual upper torso straps must not exceed 1750 pounds. If dual straps are used for restraining the upper torso, the total strap loads must not exceed 2000 pounds.

(2) The maximum pelvic load must not exceed 1500 pounds. Compliance may be shown by use of an anthropomorphic test dummy, as defined in the Code of Federal Regulations, Title 49, Part 572 (49 CFR 572).

(3) The occupant's upper torso strap or straps must remain on or in the immediate vicinity of the occupant's shoulder during the impact.

(4) The lap belt must remain on the occupant's pelvis during the impact.

(5) Each occupant must be protected from serious head injury when experiencing the inertia forces prescribed in paragraph (a) above. Compliance may be shown by the test procedures described in Society of Automotive Engineers, Inc., Document J-921 and the head impact does not exceed a Head Impact Criteria (HIC) of 1000.

(6) The attachment between the seating device and the airplane's structure must remain intact, although the structure can have exceeded its limit load, and the restraint must remain intact, although it also can have experienced separation that is intended as part of its design, as long as the conditions contained in (1) through (5) are met.

2. In addition to the dynamic tests and requirements stated in paragraph 1, all seats, benches, or other seating devices and its supporting structure must withstand the static loads imposed by a 215-pound-occupant when subjected to the airplane's design loads, as defined in the airplane's approved flight/ground envelope.

3. There must be a safety belt and shoulder harness for each occupant. All rearward facing seats must provide a headrest capable of resisting the dynamic loads imposed by the requirements of paragraph 1.(b). The mass of the head must be at least 13.5 pounds.

4. The airplane must be equipped with a device that will provide angle of attack (A.O.A.) information to the pilot. This device must allow determination of approach configuration A.O.A. to achieve flight manual performance. This device must display A.O.A. for optimum glide path with the engine stopped. This device must not rely on engine operation for its power source.

5. In addition to the requirements of § 23.697 of the FAR, compliance must be shown that operation of the wing flaps do not depend solely on normal operation of the engine or any engine mounted equipment.

6. In addition to the requirements of § 23.853 of the FAR, compliance must be shown with the following:

   Materials (including finishes or decorative surfaces applied to the materials) used in each compartment occupied by the crew or passengers must meet the following test criteria as applicable:

   (a) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments, other than underseat stowage compartments and compartments for stowing small items such as magazines and maps, must be self-extinguishing when tested vertically in accordance with the applicable portions of Appendix F of Part 23 of the FAR, or other approved equivalent methods. The average burn length must not exceed 6 inches and the average flame time after removal of the flame source must not exceed 15 seconds. Drippings from the test specimen must not continue to flame for more than an average of three seconds after falling.

   (b) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, thermal and acoustical insulation and insulation covering, air ducting, joint and edge covering, cargo compartment liners, insulation blankets, cargo covers, and transparencies, molded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in paragraph 6.(c) of this paragraph, must be self extinguishing when tested vertically in accordance with the applicable portions of Appendix F of Part 23 of the FAR, or other approved equivalent methods. The average burn length must not exceed 8 inches and the average flame time after removal of the flame source must not exceed 15 seconds. Drippings from the test specimen must not continue to flame for more than an average of 5 seconds after falling.

(c) Acrylic windows and signs, parts constructed in whole or in part of elastomeric materials, edge lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tiedown equipment, including containers, bins, pallets, etc., used in passenger or crew compartments, must not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of Appendix F of Part 23 of the FAR and the following horizontal test procedure, or other approved equivalent methods.

Horizontal test procedure. A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface when installed in the airplane must be face down for the test. The specimen must be exposed to a Bunsen burner or Tirrell burner with a nominal three-eights inch I.D. tube adjusted to give a flame of 1 1/2 inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be at least 1550°F. The specimen must be positioned so that the edge being tested is three-fourths of an inch above the top of, and on the center line of, the burner. The flame must be applied for 15 seconds and then removed. A minimum of 10 inches of the specimen must be used for timing purposes, approximately 1 1/2 inches must burn before the front reaches the timing zone, and the average burn rate must be recorded.

(d) Except for electrical wire and cable insulation, and for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that the Administrator finds would not contribute significantly to the propagation of a fire, materials in items not specified in paragraphs 6.(a), (b), or (c) above must not have a burn rate greater than 4.0 inches per minute when tested horizontally in accordance with the procedures stated in paragraph (c) above, or other approved equivalent methods.

(e) Each disposal receptacle for towels, paper, or waste must be fully enclosed and constructed of at least fire resistant materials, and must contain fires likely to occur in it under normal use. The ability of the disposal receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test. A placard containing the legible words "No Cigarette Disposal" must be located on or near each disposal receptacle door.

(f) Lavatories must have "No Smoking" or "No Smoking in Lavatory" placards located conspicuously on each side of the entry door, and self-contained removable ashtrays located conspicuously on or near the entry side of each lavatory door, except that one ashtray may serve more than one lavatory door if the ashtray can be seen readily from the cabin side of each lavatory door served. The placards must have red letters at least one-half inch high on a white background of at least one inch high. (A "No Smoking" symbol may be included on the placard.)

7. Hand fire extinguishers. Compliance with the following must be shown.

(a) Each hand fire extinguisher must be approved.

(b) The types and quantities of each extinguishing agent used must be appropriate to the kinds of fires likely to occur where used.

(c) There must be at least one hand fire extinguisher readily accessible to the pilot while seated at his station.

(d) There must be at least one hand fire extinguisher readily accessible to occupants of the passenger compartment.

(e) Each extinguisher for use in a personnel compartment must be designed to minimize the hazard of toxic concentrations.

8. Notwithstanding the applicability to multiengine airplanes, compliance with § 23.1189 must be shown.

9. In addition to the requirements of § 23.1587, the Airplane Flight Manual must contain engine-inoperative glide path information, including recommended airplane configuration, airspeed, time to descend, and ground distance in still air plus correction factors for headwinds.

Issued in Kansas City, Missouri, on November 9, 1984.

Myron E. Smith