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MIL-F-83691B (USAF)
1 MAR 91
Superseding
MIL-S-83691A (USAF)
15 July 1972

MILITARY SPECIFICATION
FLIGHT TEST DEMONSTRATION REQUIREMENTS FOR DEPARTURE RESISTANCE AND POST-DEPARTURE CHARACTERISTICS OF PILOTED AIRPLANES

This specification is approved for use by the Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 PURPOSE

This specification contains the demonstration requirements of the high angle of attack (AOA) flight characteristics of piloted airplanes. Typical demonstration objectives subject to this specification are the verification of service and permissible flight limits, evaluation of natural and artificial stall and loss-of-control warning, evaluation of flight control system functions including AOA limiting and departure prevention devices, and determination of out-of-control characteristics and recovery techniques. A build-up approach to high AOA flight test, using analysis, simulation, and flight test validation, is mandatory to determine compliance with the design requirements and obtain suitable information for the Flight Manual. Flight test demonstration requirements are a function of airplane Class and specific direction from the procuring activity. Resistance to departure from controlled flight and prevention of departures are given the same attention as that directed toward recovery from post-departure gyrations (PDG), deep stalls, and spins. The Backup Information and User Guide to this Specification elaborates the experience and test and analysis techniques which support the following requirements.

Beneficial comments (recommendations, additions, deletions), and any pertinent data which may be of use in improving this document should be addressed to:

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Use the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or comment by letter.

AMSC N/A FSC 1510

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1.2 CLASSIFICATION

An airplane is placed in a Class as specified in MIL-STD-1797 (6.2.1[b]). When operational missions and design capabilities so indicate, an airplane of one Class may be required by the procuring activity to meet selected demonstration requirements ordinarily specified for airplanes of another Class. Generally, the most stringent demonstration requirements apply whenever an airplane fails to come clearly within one of two possible Classes.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

2.1.1 **Specifications, Standards, and Handbooks.** The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

Military

MIL-F-87242 Flight Control Systems, General Specification for

STANDARDS

Military

MIL-STD-1797 Flying Qualities of Piloted Aircraft

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 ORDER OF PRECEDENCE

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 APPLICATION

Unless otherwise specified, the high AOA flight characteristics shall be demonstrated in accordance with the provisions contained herein. Manned airplanes requiring lifting surfaces to cruise or maneuver within the sensible atmosphere shall be tested in accordance with this specification. Aerospace vehicles whose mission includes boost-return, boost-orbit-reentry, low maneuverability/non-powered approaches and landings, etc., normally are not tested in accordance with this specification. Vertical/Short Take-Off and Landing airplanes normally are tested in accordance with this specification only when configured for flight in which the lift is derived primarily from free stream dynamic pressure rather than the propulsive system (6.2.1[c]).

3.2 FLIGHT TEST VEHICLE

Except as specified in 3.2.1 through 3.2.4, the flight test vehicle shall be representative of the production airplane in all significant respects.

3.2.1 Emergency Devices

3.2.1.1 Emergency Recovery Device. An emergency recovery system, approved by the procuring activity, shall be provided for each Class I and IV stall/spin test vehicle and shall, when necessary, be specified by the procuring activity for Class II and Class III test vehicles (6.2.1 [d]). Such emergency devices shall be capable of effecting recovery within a reasonable altitude loss established by the contractor and approved by the procuring activity. The emergency recovery system shall be capable of successful operation under the most adverse flight conditions and control positions possible. The emergency recovery system shall be designed to minimize the possibility of inadvertent activation. The effect of the emergency recovery system on aircraft stability and control characteristics shall be determined prior to high AOA flight testing. Ground and flight tests are conducted to show that the emergency recovery device functions satisfactorily. If the emergency recovery device is not installed within the normal contour of the airplane, tests shall be conducted to verify high AOA characteristics without the device.

3.2.1.2 Emergency Power Systems. When hydraulic or electrical power is required for safe flight, Class I and IV test vehicles shall be equipped with emergency power systems approved by the procuring activity (6.2.1[e]). When necessary, emergency power systems shall be required by the procuring activity for Class II and III test vehicles. The emergency power systems shall be sized to satisfy emergency power loads and to assume those loads without interruption or unsafe transients. The emergency power systems shall be capable of continuous operation for a minimum of ten minutes to allow the test vehicle to be safely recovered and landed. Except when actuated during emergency situations, the emergency power systems shall not restrict the mission time of the test vehicle. Ground and flight tests shall be conducted to show that the emergency power systems function satisfactorily.

3.2.2 Flight Test Instrumentation. The contractor and/or flight test agency shall provide onboard instrumentation as approved by the procuring activity (6.2.1[f]). Real time telemetry capability is desirable and may be required, if requested by the flight test activity and specified by the procuring activity. When very high angular rates are anticipated, variable range or additional rate gyros may be required to provide adequate resolution for the pre-departure and post-departure conditions. The frequency response and sample rate of the instrumentation shall be adequate to measure high-frequency phenomena such as pre-stall buffet. Inertial Measurement Unit (IMU) data may be used for data analysis using a flight test IMU installation or the airplane Inertial Navigation System (INS). If the test airplane is equipped with a flight test noseboom, wind or water tunnel testing shall be performed to determine the effects of the noseboom installation on high AOA characteristics. If the effects of the noseboom are predicted (or determined during flight test demonstration) to be significant, testing shall be conducted without the noseboom installation, or alternate means of sensing AOA and angle of sideslip should be used; e.g., wing- tip mounted booms, external store locations, etc. Actuation of the emergency electrical power system shall not interrupt data acquisition. Consideration shall be given to additional instrumentation for structural purposes when predictive studies or initial flight test results indicate that the airframe or store suspension equipment may experience departure/post-departure loads near or above design values.

3.2.3 Cockpit Instrumentation and Layout. Cockpit displays in the test vehicle, particularly instruments indicating airspeed, altitude, AOA, turn/slip, normal acceleration, stall warning, attitude reference, and engine parameters, shall be those types to be installed on the production airplane and be similarly located. When special AOA, sideslip, and yaw rate indicators are also provided, they shall be easily readable and compatible in operation with production indicators (e.g., dials turning in the same direction). Unless otherwise specified, controls such as switches or the onboard data recording system, voice tape recorder, gyro cage, and cameras shall be capable of operation from the pilot's position or from another crew station or remotely from the ground to alleviate pilot workload (6.2.1 [g]). The production pilot restraint system shall be used only after predictive studies and sufficient flight test results are available to verify that crew station angular rates and accelerations do not incapacitate or greatly hinder the pilot.

3.2.4 Onboard Cameras. A forward looking camera shall be employed to document airplane motions as observed by the pilot. The camera shall operate at a speed that allows true-time review. An adequate film or videotape supply shall be provided to insure representative documentation during each test mission. Unless otherwise suitably instrumented, the emergency recovery system shall be covered by an onboard camera operating at an appropriate speed.

3.3 ACCOMPLISHMENT OF FLIGHT TEST

The contractor, the flight test agency, or both shall be responsible for demonstrating the flight characteristics of the airplane in accordance with this specification as directed by the procuring activity (6.2.1 [h]). The contractor and flight test agency may share a predetermined percentage of the required maneuvers. The level of participation of the contractor and service flight test agency for each phase of testing shall be specified by the procuring activity (6.2.1[i]) and approved by the service flight test agency.

3.4 FLIGHT TEST DEMONSTRATION

The objectives of high AOA flight test demonstration are to evaluate the airplane characteristics and to validate the aircraft aerodynamic and flight control models for designated store loadings, gross weights, centers of gravity, and inertias as a function of angle of attack, sideslip angle, Mach number, attitude, body axis rates, and rotation rates.

The following approach shall be used to achieve these objectives:

a. Before flight, analysis and simulation shall be used to investigate predicted high AOA flight characteristics for a range of configurations, maneuvers, control inputs, and flight conditions. An initial flight test plan shall be developed from the results of this study.

b. The flight test program shall integrate flight demonstration, analysis, and simulation in a build-up approach to critical test points. At each step, analysis and simulation shall be used to investigate predicted airplane response. Data from flight demonstration shall be used to validate or update the analytical and simulation models.

3.4.1 GENERAL REQUIREMENTS FOR ALL CLASSES OF AIRPLANES. Airplanes that do not employ AOA limiting shall be tested in accordance with Table I. Airplanes that employ AOA limiting shall be tested in accordance with Table II. When AOA limiting is employed, flight testing shall attempt to determine the conditions at which the limiter can be defeated. Table II is designed to take this into account. Both Table I and Table II allow attempts to defeat departure prevention devices such as yaw rate or sideslip limiters. Table II was specifically required for airplanes with AOA limiting since this is such a prominent factor in maneuvering capability and is not adequately addressed in Table I. During flight testing, reasonably delayed recovery attempts after a stall or departure, and exaggerated misapplication of controls following a stall or departure, to simulate possible incorrect pilot responses, shall be investigated under the least conservative circumstances to ascertain the degree of spin and deep stall susceptibility/resistance for operational users. When spins or deep stalls do result as a natural consequence of testing through departures (6.3.10) from controlled flight or as a result of deliberate spin or deep stall attempts, the degree of compliance with MIL-STD-1797 of spin or deep stall recovery technique shall be demonstrated. Unless otherwise specified, the use of prolonged pro-spin controls to sustain a developed spinning condition for more than three turns shall not be required except for trainer type airplanes to be cleared for intentional spins (6.2.1[o]).

3.4.1.1 High AOA Flight Test Variables. The contractor and/or flight test agency shall establish, with the approval of the procuring activity (6.2.1[p]), what ranges and increments of the following variables are to be tested for their influence on high AOA flight characteristics:

a. Configuration.

b. Gross Weight.

c. Center of gravity.

d. Flight control system status.

e. Loadings, both internal and with external stores; critical combinations of aerodynamic and inertial loadings to include:

(1) Symmetric, fuselage heavy.

(2) Symmetric, wing heavy.

(3) Asymmetric (maximum allowable asymmetry).

(4) Any other loadings found critical in preliminary tests and analysis.

f. Speed, altitude, and attitude.

g. Thrust and engine gyroscopic effects.

3.4.1.2 Stall Warning. It shall be determined if stall warning (6.3.3) meets the requirements of MIL-STD-1797.

3.4.1.3 Artificial Stall Warning. When installed, artificial stall warning shall be evaluated. This includes determination of whether it meets the requirements of MIL-STD-1797.

3.4.1.4 Loss-of-Control Warning. The effectiveness of loss-of-control warning or indication (6.3.9) shall be determined for representative flight conditions. It shall be demonstrated whether the warnings are effective in allowing the pilot to prevent departure by application of proper control inputs during the most abrupt maneuvering permitted in service use. The flight test demonstration shall determine if loss-of-control warning signals are clearly distinguishable from stall warning.

3.4.1.5 AOA Limiting and Departure Prevention Devices. When AOA limiting and departure prevention devices have been installed, it shall be demonstrated whether the devices effectively prevent departures under critical combinations of test parameters and maneuvering circumstances and what restrictions are imposed on flight conditions and maneuvering.

3.4.1.6 Demonstration of Departure/Spin/Deep Stall Resistance. The degree of departure/spin/deep stall resistance (6.3.16 - 6.3.19) for all Classes of airplanes specified in 1.2 shall be determined by the test phase in which departures/spins/deep stalls first occur while performing those maneuvers listed in Table I or Table II. Refer to Table III for susceptibility classification.

3.4.2 Out-of-Control Recovery Procedure. When an airplane is subject to departure from controlled flight while performing the maneuvers outlined in Table I or Table II, a simple out-of-control recovery procedure, acceptable to the using activity, shall be demonstrated. The out-of-control recovery procedure shall be the first reaction required of a pilot to determine the nature or the direction of the post-departure motion in order to properly execute the recovery steps. Other recovery procedures shall be recommended as required for any subsequent, sustained out-of-control event. No other recovery procedures should be recommended unless they are for a deep stall condition, upright spin, or inverted out-of-control events (6.2.1[q]). The deep stall, upright spin, and/or inverted out-of-control recovery procedures, if required shall be added in sequence after the initial, simple out-of-control recovery procedure. With the accepted recovery procedure, the brief recovery dynamics that can be associated with rapid unloading to zero or negative normal acceleration are allowable. A production device, such as a drag chute, may be qualified as a recovery aid. The altitude loss values associated with the out-of-control events shall be determined. It shall be determined if the airplane is subject to any appreciable recovery-inhibiting effects due to asymmetric thrust or drag for possible failed-engine characteristics. It shall also be determined whether flight control systems as specified in MIL-F-87242 adversely affect the control surface displacements that are intended during high AOA flight before and following a stall or departure.

Note: The out-of-control recovery procedure requirements specified in this paragraph are directed primarily toward departures at a positive AOA rather that at a negative AOA. Upright flight is emphasized because out-of-control occurrences in training and operational activities usually take place more often and with more susceptibility at a positive AOA. Also, recovery capabilities from upright out-of-control conditions (positive AOA) are usually less favorable than from inverted situations (negative AOA) and the recommended recovery procedures are correspondingly more extensive. The out-of-control recovery procedure shall always apply to loss of control from upright flight, but it may serve for both upright and inverted flight, if the recovery procedures are identical (neutral controls for example). Or an airplane may experience a departure at negative AOA that can be easily countered by a simple relaxation of pro-departure controls. In this instance, a bold-face, inverted out-of-control recovery procedure may not be warranted since an adequate flight characteristics description in the Flight Manual would suffice. However, if the airplane exhibits a departure at negative AOA that requires an intricate recovery procedure, consideration should be given to specifying both an upright and inverted out-of-control recovery procedure.

Additional steps for spin recovery are allowable in the recovery procedures, if the out-of-control recovery procedure does not satisfy spin recovery requirements.

A separate recovery procedure may be proposed for the deep stall since this out-of-control mode is of a unique nature and may require recovery techniques (prolonged nose down pitch control, control stick pumping, asymmetric thrust, configuration changes, for example) that are significantly more extensive than normal recovery techniques and are totally distinct from the out-of-control and spin recovery requirements.

3.4.3 Sustained Out-of-Control Event Recovery - Class I and IV Airplanes. When departure from controlled flight results in a sustained out-of-control event while performing the maneuvers outlined in Table I or Table II, a satisfactory recovery technique shall be demonstrated. Recovery criteria shall not exceed the values specified in MIL-STD-1797. Under normal application circumstances, the recovery procedure shall not subject the airplane to changes of dynamic mode that prolong recovery. The spin recovery procedure shall be compatible with the out-of-control recovery procedure and possess a minimum of changes or additions. The accomplishment of the recovery procedure shall not be compromised by accelerations at the crew station. Control forces shall not exceed those values specified in MIL-STD-1797.

3.4.4 Automatic Out-of-Control Recovery. When an airplane employs automatic out-of-control recovery devices, satisfactory operation shall be demonstrated for critical combinations of aircraft configuration, entry condition, and maneuver. These combinations shall be determined using analyses and simulations that have demonstrated good correlation with previous high AOA flight test results.

3.4.5 Engine Operating Characteristics. Engine operating characteristics shall be documented while performing the maneuvers outlined in Table I or Table II. When engine malfunction occurs during out-of-control flight, it shall be demonstrated that recovery from the existing or ensuing out-of-control mode(s) can be accomplished at least ten seconds prior to the projected time at which loss of ability to position the flight controls would occur because of the engine malfunction. This requirement shall be met with the throttles remaining in the least conservative position.

3.4.6 Recovery Characteristics. Recovery dynamics and maximum effort dive pullout characteristics shall be thoroughly determined. Altitude loss in post-departure events and total recovery altitude values shall be reported over a wide range of out-of-control maneuvers and store loadings. The flight tests shall also examine steep rolling maneuvers and upright and inverted spirals to determine if these motions may appear similar to out-of-control or recovery events. When potential misinterpretation of the maneuvers can lead to improper control application, all cues to the pilot that allow proper recognition shall be identified.

3.4.7 Training Maneuvers. The contractor or flight test agency shall establish flight training maneuvers, appropriate to the airplane Class and mission, to illustrate the high AOA flight characteristics near the limits of the permissible AOA envelope; inverted flight shall be included as required. It shall be possible for service pilots to safely practice these maneuvers. Specific guidelines concerning the type of training maneuvers to be defined shall be provided by the procuring activity (6.2.1[r]).

3.4.8 Baseline Stability Tests. When the procuring activity anticipates that special modifications, such as a noseboom, or recovery parachute installation, may significantly alter the basic properties of the test airplane, high AOA longitudinal and lateral-directional stability flight tests shall be conducted early in the demonstration program to compare test results with similar data from a production configured airplane (6.2.1[s]).

3.4.9 Production Airplane High AOA Tests. Upon completion of the high AOA flight test demonstration with the instrumented test airplane, representative high AOA maneuvers shall be conducted with a production airplane. The tests shall be conducted in a build-up fashion towards the most critical conditions and exclude maneuvers during which an emergency recovery system might be necessary. The contractor or flight test agency shall compare the high AOA flight characteristics of the flight test and production airplanes (6.2.1[t]). The contractor or flight test agency shall ensure any differences are resolved to provide consistency with the flight handbook. An additional objective of the production high AOA testing should be to develop a set of high AOA maneuvers to be conducted during production aircraft Functional Check Flights.

3.4.10 Permissible Flight Limits. The results of sections 3.4.1.2 through 3.4.9 shall be used to establish flight limitations such as maximum AOA, maximum sideslip, control input restrictions, throttle movement restrictions, and center-of-gravity envelope.

3.5 INTERPRETATION OF QUALITATIVE REQUIREMENTS

In several instances throughout this Specification, qualitative terms such as "intolerable buffet," "normally anticipated," "clear indication," "significantly greater," "premature application," "compatible spin recovery procedure," and "reasonably delayed" have been employed to permit latitude where absolute quantitative criteria might be unduly inflexible for all airplanes to be tested. Final determination of compliance with requirements so worded shall be made by the procuring activity.

4. QUALITY ASSURANCE PROVISIONS

4.1 COMPLIANCE DEMONSTRATION

Compliance with the associated high AOA requirements specified in MIL-STD-1797 and MIL-F-87242 shall be demonstrated through flight test demonstration maneuvers in accordance with this specification.

4.2 PRESENTATION OF PREDICTIVE STUDIES

Required predictive analytical/laboratory studies shall be accomplished and reported sufficiently prior to scheduled initiation of the flight test program to allow for direction and limitation of scope in test planning. Predictive studies can include high AOA wind tunnel and water tunnel tests, dynamic model tests, and piloted and unpiloted computer simulations.

5. PREPARATION FOR DELIVERY

5.1 Section 5 is not applicable to this specification.

6. NOTES

6.1 INTENDED USE

This specification contains the flight test demonstration requirements for determination of piloted airplane compliance with the high AOA design requirements. A concurrent objective of this specification is the acquisition of detailed information for inclusion in the Emergency, Operating Limitations, and Flight Characteristics sections of the airplane Flight Manual.

6.2 ORDERING DATA

Purchasers should exercise any desired options offered herein, and procurement documents should specify the following:

6.2.1 Procurement Requirements

a. Title, number, and date of this specification.

b. Classification of airplane (1.2).

c. V/STOL airplane configuration (3.1).

d. Emergency recovery device (3.2.1.1).

e. Emergency power system (3.2.1.2).

f. Onboard instrumentation (3.2.2).

g. Onboard data switches (3.2.3).

h. Demonstration of flight characteristics (3.3).

i. Service/Contractor participation (3.3).

j. Test phases to be accomplished for Flight Phase Category C tasks (Table I or Table II).

k. Flight control system requirements (Table I or Table II).

l. Margin beyond arbitrary limit(s) (Table I).

m. Magnitude of control application (Table I or Table II).

n. Roll requirements at limiter AOA (Table II).

o. Prolonged pro-spin controls (3.4.1).

p. High AOA variables (3.4.1.1).

q. Deep stall condition, upright spin, or inverted out-of-control events (3.4.2).

r. Guidelines for training maneuvers (3.4.7).

s. Baseline stability tests (3.4.8).

t. Production airplane high AOA tests (3.4.9).

u. Data requirements.

v. Allowable AOA excursions (6.3.11).

6.2.2 Contract Data Requirements. Data required for delivery in connection with this Specification should meet the format, content, and schedule requirements specified by the procuring activity (6.2.1[u]).

6.2.2.1 Documentation of Test Results. The contractor and/or flight test authority may be required to provide documentation of high AOA studies and demonstrations to the procuring activity. This can entail documenting three areas: (1) predictive studies, (2) flight test demonstration, and (3) flight test confirmation of predictive studies.

6.2.2.1.1 Predictive Studies. The contractor should be required to provide documentation in the form of a written report of those studies for which the contractor is responsible. The impact of related high AOA studies conducted by other agencies should be acknowledged by the contractor in a suitable manner.

6.2.2.1.2 Flight Test Demonstration. The flight test high AOA demonstration should be documented with a written technical report and preparation of appropriate flight characteristics descriptions, operating limitations, and emergency procedures for the Flight Manual. In addition, a motion picture presentation may be required if specified by the procuring activity.

6.2.2.1.2.1 Technical Report. The written report should include, but not be limited to, the information that follows:

a. Test airplane: a description of the airplane detailing instrumentation, special modifications such as recovery devices, and differences from production vehicles.

b. High AOA terminology: terminology should be included as defined in 6.3.

c. Test and evaluation: test variables considered, and test techniques used in conducting the flight test demonstration as outlined in accordance with this Specification, should be detailed within the report. The results of the flight test demonstration should be substantiated by sufficient time histories of maneuvers so as to encompass all entry conditions and airplane states. As a function of airplane Class and extent of the maneuvers expected or encountered, the procuring activity may direct that special data presentations supplement time histories for reporting of test results. The report should include operational training maneuvers as determined by flight test.

6.2.2.1.2.2 Flight Manual Synopses. Results of the flight test demonstration should be consolidated into a pilot-oriented presentation for the Flight Characteristics, Operating Limitations, and when necessary, Emergency Procedures sections of the Flight Manual.

6.2.2.1.2.3 Motion Picture. A technical briefing film summary of the flight test demonstration results should be prepared with extensive coverage of in-flight demonstrations of high AOA flight characteristics and out-of-control recovery techniques. At the discretion of the procuring activity, and within the scope of contractual agreement, a formal aircrew training film may be produced. This film should include sufficient information to thoroughly instruct a pilot in high AOA maneuvering, stall and loss-of-control warning, out-of-control and, when applicable, spin and/or deep stall recovery procedures.

6.2.2.1.3 Evaluation of Predictive Studies. A comprehensive evaluation of the overall development and flight test high AOA demonstrations should be prepared, in which predictive studies are to be evaluated and compared to flight test results, conclusions, and recommendations.

6.3 DEFINITIONS

The following standard terminology apply. Terms and definitions stated in 6.3.16 through 6.3.19 may be used to qualify degree of departure susceptibility or resistance for a given flight condition. The same terminology may be used to qualify degrees of departure susceptibility or resistance of the airplane to spin and deep stall entry.

6.3.1 Stall Angle of Attack. The stall angle of attack at constant speed for the configuration, weight, center-of-gravity position and external store combination associated with a given Aircraft Normal State; defined as the lowest of the following:

a. Angle of attack for the highest steady load factor, normal to the flight path, that can be attained at a given speed or Mach number.

b. Angle of attack, for a given speed or Mach number, at which uncommanded pitching, rolling or yawing occurs.

c. Angle of attack, for a given speed or Mach number, at which intolerable buffeting is encountered.

6.3.2 Limit Angle of Attack. The minimum AOA which the flight control system is designed to prevent exceeding, either due to pilot manipulation of the cockpit controls or to external disturbances. This applies only to airplanes that employ AOA limiting devices. The limit AOA is usually below the stall AOA.

6.3.3 Stall Warning. That natural airplane behavior or artificial signal(s) that indicates to the pilot the approach of maximum usable lift. Normally, the onset and development of stall warning is described as a function of AOA or airspeed for a given airplane state.

6.3.4 Wing Rock. Uncommanded lateral-directional motion, viewed by the pilot primarily as roll oscillation.

6.3.5 Bucking. Uncommanded pitching oscillation.

6.3.6 Nose Slice. Uncommanded lateral-directional motion viewed by the pilot primarily as a divergence in yaw.

6.3.7 Pitch-Up. Uncommanded, sudden increase in AOA.

6.3.8 Post-Stall. The flight regime involving angles of attack greater than stall angles of attack.

6.3.9 Loss-of-Control Warning. The natural airplane behavior or artificial signal(s) that indicates to the pilot the approach of loss-of-control. As with stall warning, the onset and development of loss-of-control warning is described as a function of AOA or airspeed for a given airplane state.

Note: Natural stall warning and loss-of-control warning encompass successive AOA ranges. For some designs or flight conditions, departure may occur with only a slight increase in AOA beyond that for maximum usable lift. In such cases, stall warning and loss-of-control warning become practically synonymous and descriptions of flight characteristics should emphasize this fact when appropriate. However, in those cases when departure occurs at a significantly higher AOA than that for maximum usable lift, natural stall warning and loss-of-control warning should be independently discussed.

6.3.10 Departure. The event indicating loss of control which may develop into a post-departure gyration, spin, or deep stall condition. The departure may be characterized by divergent, large-amplitude, uncommanded aircraft motions, such as nose slice or pitch-up. An AOA excursion (6.3.11) is not considered a departure.

6.3.11 Limiter Angle of Attack Excursion. The event in which AOA momentarily exceeds the limiter AOA but does not result in uncommanded aircraft motions typical of departures from controlled flight or in spins/deep stalls (6.2.1[v]). A limiter AOA excursion is synonymous with AOA limiter overshoot. AOA excursions occur most often during aggressive maneuvering near the limiter boundaries where aerodynamics, aircraft inertia, flight control lags, and control effector rate and deflection limits may result in dynamic AOA overshoots that return within limiter boundaries within a short time and do not "hang" above the limit.

6.3.12 Post-Departure Gyration (PDG). Uncontrolled motion about one or more airplane axes following departure. When the airplane motion is other than random about all axes, a further classification of the PDG may be used for descriptive purposes. Such terms as snap roll, rolling departure, or tumble may be appropriate; however, they should all imply a PDG. The PDG is differentiated from a spin by the lack of a predominant sustained yawing motion. The PDG is differentiated from a deep stall by the presence of significant angular motions and accelerations.

6.3.13 Post-Stall Gyration (PSG). A post-departure gyration (6.3.12) occurring in the post-stall flight regime. While this type of airplane motion involves angles of attack higher than the stall angle, lower angles may be encountered intermittently in the course of the motion.

6.3.14 Spin. A sustained yaw rotation at AOAs above stall. The rotary motions of the spin may have oscillations in pitch, roll and yaw superimposed upon them. The incipient spin is the initial, transitory phase of the motion during which it is not possible to identify the spin mode. The developed spin is the phase of the spin during which it is possible to identify the spin mode. The fully developed spin is attained when the trajectory has become vertical and no significant change is noted in the spin characteristics from turn to turn.

Note: Spin modes may be identified by average values of AOA and body axis yaw rate and by the magnitude of the three-axis angular oscillations. One modifier from each group listed in Table IV may be used to characterize the mode.

Table IV
SPIN MODE MODIFIERS

SENSE	ATTITUDE	RATE	OSCILLATIONS
Upright	Extremely Steep	Slow	Smooth
Inverted	Steep	Fast	Mildly Oscillatory
	Flat	Extremely Rapid	Oscillatory
			Highly Oscillatory
			Violently Oscilliatory

6.3.15 Deep Stall. An out-of-control flight condition in which the airplane is sustained at an angle of attack beyond that for stall or limiter AOA while experiencing negligible rotational velocities. Depending upon aircraft external store loading, center of gravity location, and flap/slat configuration, some low rate oscillatory yawing, rolling, or pitching motions may be present while in a deep stall.

6.3.16 Extremely Susceptible to Departure: When departure from controlled flight generally occurs with the normal application of pitch control alone or with small roll, yaw, and decoupled (6.3.24) control inputs, the airplane is said to be "extremely susceptible to departure."

6.3.17 Susceptible to Departure: When departure from controlled flight generally occurs with the application or brief misapplication of pitch control and roll, yaw and decoupled (6.3.24) controls that may be anticipated in operational use, the airplane is said to be "susceptible to departure."

6.3.18 Resistant to Departure: When departure from controlled flight occurs only with a large and reasonably sustained misapplication of pitch, roll, yaw, and decoupled (6.3.24) controls, the airplane is said to be "resistant to departure."

6.3.19 Extremely Resistant to Departure: When departure from controlled flight can only occur after an abrupt and inordinately sustained application of gross, abnormal, pro-departure controls, the airplane is said to be "extremely resistant to departure."

6.3.20 Recovery: The transition from out-of-control conditions to controlled flight. This is normally considered to be that period between pilot initiation of recovery controls and that point when the AOA is at a value below stall or limiter AOA and no significant, uncommanded angular motions remain.

Note: The out-of-control recovery procedure requirements specified in 3.4.2 are directed primarily toward departures at a positive AOA rather than at a negative AOA. Upright flight is emphasized because out-of-control occurrences in training and operational activities usually take place more often and with more susceptibility at a positive AOA. Also, recovery capabilities from upright out-of-control conditions (positive AOA) are usually less favorable than from inverted situations (negative AOA) and the recommended recovery procedures are correspondingly more extensive. The out-of-control recovery procedure should always apply to loss of control from upright flight, but it may serve for both upright and inverted flight, if the recovery procedures are identical (neutral controls for example). Or an airplane may experience a departure at negative AOA that can be easily countered by a simple relaxation of pro-departure controls. In this instance, a bold-face, inverted out-of-control recovery procedure may not be warranted since an adequate flight characteristics description in the Flight Manual would suffice. However, if the airplane exhibits a departure at negative AOA that requires an intricate recovery procedure, consideration should be given to specifying both an upright and inverted out-of-control recovery procedure.

Additional steps for spin recovery are allowable in the recovery procedures in the event the out-of-control recovery procedure does not satisfy spin recovery requirements.

A separate recovery procedure may be proposed for the deep stall since this out-of-control mode is of a unique nature and may require recovery techniques (prolonged nose down pitch control, control stick pumping, asymmetric thrust, configuration changes, for example) that are significantly more extensive than normal recovery techniques and are totally distinct from the out-of-control and spin recovery requirements.

6.3.21 Dive Pullout. The transition from the termination of recovery to level flight.

6.3.22 Total Recovery Altitude. The sum of the altitude losses during the recovery and dive pullout.

6.3.23 Recovery Rolls. Uncommanded rolling motions that may occur during the recovery phase of the spin, PSG, or PDG.

6.3.24 Decoupled Controls. Unconventional controls such as direct normal force, direct sideforce, pitch pointing, yaw pointing, vertical translation, lateral translation, and flight path control using thrust vectoring (excluding V/STOL flight).

6.3.25 Tumble. An autorotative, predominantly pitching motion.

6.4 SUPPRESSION DATA

This issue of MIL-S-83691 is a complete revision that supersedes all previous issues for new aircraft.

Custodians:
Air Force - 12

Review Activities:
Air Force - 11
Air Force - 18

Preparing Activity:
Air Force -12

Project No. 1500-F014
Doc 2617b: Arch 1451b

Table 1
FLIGHT TEST DEMONSTRATION MANEUVERS FOR AIRPLANES NOT EMPLOYING AOA LIMITING DEVICES

		Maneuver Requirements				
		Entry Conditions[1]				
		Smooth AOA Rate[3]		Abrupt AOA Rate[4]		
Test Phase	Control Application	One g	Accelerated[2]	One g	Accelerated[2]	Tactical[5]
A Stalls	Pitch control applied to achieve the specified AOA rate, roll, yaw and decoupled[13] control inputs as normally required for the maneuver task. Recovery initiated after the pilot has a clear indication of: a. a definite g-break, or b. a rapid, uncommanded angular motion, or c. the aft stick stop has been reached and AOA is not increasing, or d. sustained, intolerable buffet	Class: I II III IV	Class: I II III IV	Class: I II III IV	Class: I II III IV	Class: I II III IV
B Stalls with aggravated control inputs	Pitch control applied to achieve the specified AOA rate, roll, yaw and decoupled[13] control inputs as normally required for the maneuver task. When condition a, b, c or d from above has been attained, controls briefly misapplied[7], intentionally or in response to unscheduled airplane motions, before recovery attempt is initiated.	Class: I II III IV	Class: I II III IV	Class: I II III IV	Class: I IV	Class: I IV
C Stalls with aggravated and sustained control inputs[11]	Pitch control applied to achieve the specified AOA rate, roll, yaw and decoupled[13] control inputs as normally required for the maneuver task. When condition a, b, c or d from above has been attained, controls ared misapplied[7,9] intentionally or in response to unscheduled airplane motions, and held for three seconds[8,9] before recovery attempt is initiated.	Class: I II IV	Class: I II IV	Class: I II IV	Class: I IV	Class: I IV
D Post-Stall Gyration, Spin, and Deep Stall Attempts[11] (this phase required only for training airplanes which may be intentionally spun and for Class I and IV airplanes in which sufficient departures and developed spins did not result in Test Phase A, B or C to define characteristics of each possible out-of-control mode)	Pitch control applied to achieve the specified AOA rate, roll, yaw and decoupled[13] control inputs as normally required for the maneuver task. When condition a, b, c or d from above has been attained, controls applied in the most critical[12] manner to attain each possible mode of post-stall motion and held for various lengths of time up to 15 seconds or three spin turns, whichever is longer before the recovery attempt is initiated.[9,10]	Class: I IV	Class: I IV	Class: I IV	Class: I IV	Class: I IV

TABLE I NOTES:

1. Configuration, loadings, cgs, entry speed/attitude, etc., shall be in accordance with 3.4.1.1. With the airplane configured for the Flight Phase Category C tasks identified in MIL-STD-1797, only Test Phases A and B of this specification are required to be accomplished unless the procuring activity specifically requires the next or both remaining Test Phases to be accomplished (6.2.1[j]). An abrupt AOA rate, as a maneuver entry condition, is not required when the airplane is configured for Flight Phase Category C, except as specified at the end of Note 4.

Engine requirements shall include:

a. Takeoff (TO) configuration: All engines at TO thrust; critical engine inoperative, others at TO thrust (stall approach, Test Phase A only).

b. Power Approach (PA) configuration: All engines at normal approach thrust; critical engine inoperative, others at required approach thrust.

c. Climb (CL) configuration: All engines at normal climb thrust; critical engine inoperative, others at normal climb thrust.

d. Cruise (CR) configuration: All engines at thrust for level flight (TLF); all engines at idle thrust.

e. Combat (CO) configuration: All engines at military rated thrust (MRT), maximum augmented thrust (MAT).

Throttle requirements for those cases where flameouts or compressor stalls occur shall include:

f. Throttle retarded to idle from the maneuver entry setting position for a malfunctioning engine (for MAT, MRT, TLF).

g. Throttle left at the entry setting position until recovery has been accomplished (for MAT, MRT, TLF) unless compliance would result in exceeding engine operating limitations.

Flight control system requirements shall be approved by the procuring activity (6.2.1[k]) and include:

h. All modes (normal or degraded) of flight control systems that have a reasonable probability of being engaged during or previous to flight at high AOA.

i. Degraded, reversion, reconfiguration and backup modes that can be expected to be engaged during flight at high AOA. The test airplane should be configured so that these modes can be safely engaged during flight test.

The airplane shall be trimmed (controls and throttle[s]) at settings consistent with the maneuver task. The effects of each designated flight test variable, from 3.4.1.1 and (a) through (i) above shall be determined individually in each required Test Phase or until such effects are definitely established and predictable for succeeding Test Phases. Variables need to be tested in combination only when that combination could possibly yield less conservative results from those obtained by individual testing.

2. Accelerated entries, encompassing a representative range of Mach number, dynamic pressure and allowable load factor, shall include wind-up turns, constant-altitude turns and wings-level pullouts from dives appropriate to the airplane Class and mission.

3. Smooth, 1-g entries shall be approached using a slow control rate which would produce a speed deceleration of approximately one knot per second for normal stalls (1g). Smooth, accelerated entries shall be approached using a control rate to achieve an AOA rate of approximately one-half degree per second.

4. In the required abrupt entries, the entry AOA rate for Category A and B Flight Phases shall be at least:

Class I	4 deg/sec
Class II	2 deg/sec
Class III	1 deg/sec
Class IV	8 deg/sec

except as limited by maximum available control deflections and rate. The magnitudes of the abrupt entry rates for Class I, II and IV airplanes may be graduated in Test Phases A through C, commensurate with the increasing severity of the control requirements, but the stated minimum AOA rates shall be achieved in Test Phase C. For those airplanes designated for Category C Flight Phase investigation beyond Test Phases A and B, abrupt AOA rates suitable to the configuration and Test Phase shall be employed.

5. These entries shall be initiated from offensive/defensive, ground-attack, or other tactical maneuvers associated with the capability and Class of the airplane. The maneuvers, conducted with a suitable AOA rate, may include:

a. Inverted stalls and aborted vertical reversements, loops, or Immelmanns to investigate inverted out-of-control events.

b. High AOA turn reversals with roll control only, with coordination attempted, and with yaw control only.

c. High pitch attitudes (greater than 45 degrees).

d. Head-out-of cockpit air combat maneuvering or ground-attack maneuvering.

e. High-g, supersonic turns/transonic decelerations.

f. Sudden idle power/speed brake decelerations.

g. Sudden asymmetric thrust transients prior to stall.

6. For those Class II or III airplanes where clear indications of stall are not evident and considerations as identified in MIL-STD-1797 define the minimum permissible speed other than stall speed, recovery may be initiated somewhat beyond the arbitrary limit(s) and the respective margins to be tested beyond the limit(s) are subject to the approval of the procuring activity (6.2.1[l]).

7. Misapplied controls shall consist of moving controls in the most critical directions an amount significantly greater than that expected during operational use. This shall generally require full deflection for Class I and IV airplanes and somewhat less for other classes depending upon the mission and expected pilot reactions. The magnitude of the control misapplication shall be approved by the procuring activity (6.2.1[m]).

8. This time requirement may be increased for airplanes that do not exhibit a clear indication to the pilot of impending loss of control.

9. The test pilot shall insure that routine familiarity with stalls, post-stall gyrations and spins does not negate the intent of the delay/misapplication simulation and does not result in premature application of spin recovery controls before a developed spin has been attained (as subsequently confirmed by the flight records when necessary).

10. For trainer airplanes, recovery shall also be demonstrated from a fully developed spin if such a spin is attainable within a limited number of turns after spin entry.

11. In addition to the demonstration of a satisfactory spin recovery procedure, the effect of delayed application of the out-of-control recovery procedure shall be investigated during the final phase of testing. The effects of premature application of the spin recovery procedure(s) under consideration, if different from the out-of-control recovery procedure, shall be be determined.

12. With respect to spin attempts, "critical" control positions shall include, but not be necessarily restricted to full pro-spin settings. For some combinations of airplane state and entry test variables, the spinning motion may be sustained with controls in positions (neutral, out-of-control recovery settings, or stick forward, for example) other than full pro-spin positions, and a recovery attempt with controls displaced from the former positions may result in recovery capability, duration, or reversal tendency materially different from that which would occur if recovery were initiated from the full pro-spin condition. The possibility of reversal or secondary stall should be investigated by holding full recovery control for a brief period after recovery is attained. If it appears possible to encounter these circumstances in service use, the "critical" controls shall be any setting necessary to define all out-of- control modes and determine recovery characteristics specifically applicable to operational users.

13. Decoupled controls are defined in section 6.3.24.

Table II
FLIGHT TEST DEMONSTRATION MANEUVERS FOR AIRPLANES THAT EMPLOY AOA LIMITING DEVICES

Test Phase	Maneuver Requirements[1]	Demonstration Requirements (Classes)
A	Longitudinal maneuvers to the limiter AOA ranging from 1-g decelerations[2] to maximum-g decelerations and wind-up turns[3] and pushover-pullups[3] to the limiter AOA over the airspeed range between the minimum sustainable speed and maximum level flight speed. Recovery attempts should be initiated immediately after departure occurs.	I, II, III, IV
B	Combinations of pitch, roll, yaw and decoupled[4] controls[7] applied while the airplane is at or near limiter AOA[3,5] within the airspeed range between minimum sustainable speed and maximum level flight speed. These maneuvers include rolls6 and sideslips at limiter AOA. Recovery attempts should be initiated immediately after departure occurs.	I, II, III, IV
C	Combinations of pitch, roll, yaw and decoupled[4] controls[7] applied while the airplane is at or near limiter AOA[3,5] outside of the airspeed range between minimum sustainable speed and maximum level flight speed. These maneuvers include high pitch attitude low airspeed recoveries and high speed dive pullouts.[8] Recovery attempts should be initiated immediately after departure occurs.	I, II, IV
D	Combinations of pitch, roll, yaw and decoupled[4] controls[7] applied of a gross and abnormal nature not likely to occur during operational use of the aircraft.[8,9,10] This includes deliberate out-of-control events, held for various lenghts of time up to 15 seconds or three spin turns, whichever is longer, to demonstrate out-of-control recovery.	I, IV

TABLE II NOTES:

Configuration, loadings, cgs, entry speed/attitude, etc., shall be in accordance with 3.4.1.1. With the airplane configured for the Flight Phase Category C tasks identified in MIL-STD-1797, only Test Phases A and B of this specification are required to be accomplished unless the procuring activity specifically requires the next or both remaining Test Phases to be accomplished (6.2.1[j]).

Engine requirements shall include:

a. Takeoff (TO) configuration: All engines at TO thrust; critical engine inoperative, others at TO thrust (stall approach, Test Phase A only).

b. Power Approach (PA) configuration: All engines at normal approach thrust; critical engine inoperative, others at required approach thrust.

c. Climb (CL) configuration: All engines at normal climb thrust; critical engine inoperative, others at normal climb thrust.

d. Cruise (CR) configuration: All engines at thrust for level flight (TLF); all engines at idle thrust.

e. Combat (CO) configuration: All engines at military rated thrust (MRT), maximum augmented thrust (MAT).

Throttle requirements for those cases where flameouts or compressor stalls occur shall include:

f. Throttle retarded to idle from the maneuver entry setting position for a malfunctioning engine (for MAT, MRT, TLF).

g. Throttle left at the entry setting position until recovery has been accomplished (for MAT, MRT, TLF) unless compliance would result in exceeding engine operating limitations.

Flight control system requirements shall be approved by the procuring activity (6.2.1[k]) and include:

h. All modes of multi-mode flight control systems that can be expected to be engaged during flight at high AOA.

i. Degraded, reversion, reconfiguration and backup modes that can be expected to be engaged during flight at high AOA. The test airplane should be configured so that these modes can be safely engaged during flight testing.

1. The airplane shall be trimmed (controls and throttle[s]) at settings consistent with the maneuver task. The effects of each designated flight test variable, from 3.4.1.1 and (a) through (i) above shall be determined individually in each required Test Phase or until such effects are definitely established and predictable for succeeding Test Phases. Variables need to be tested in combination only when that combination could possibly yield less conservative results from those obtained by individual testing.

2. 1-g decelerations to the limiter AOA will be performed using a slow control rate which will produce a speed deceleration of approximately one knot per second.

3. AOA rate during accelerated maneuvers and pushover-pullups to the limiter AOA will be increased in a buildup fashion until the maximum attainable AOA rate or the maximum suitable AOA rate (if considered less than maximum attainable) is demonstrated.

4. Decoupled controls are defined in section 6.3.24.

5. Controls should be applied below limiter AOA if predictions indicate the possibility of inducing a departure. This includes combinations of roll, yaw, and decoupled control inputs below limiter AOA while AOA is increasing both at smooth and abrupt rates.

6. Category I and IV airplanes will not be required to roll in excess of 360 degrees or another limit as specified by the procuring activity (6.2.1[n]). Category II and III airplanes will not be required to roll in excess of 120 degrees or another limit as specified by the procuring activity (6.2.1[n]).

7. The control inputs shall consist of applying controls in the most critical directions, combinations, and rates of application. This shall generally require full deflection for Class I and IV airplanes and somewhat less for other classes depending upon the mission and expected pilot reaction. The control applications shall be approved by the procuring activity (6.2.1[m]).

8. In addition to demonstration of out-of-control, spin, and deep stall recovery procedures, the effects of premature and delayed application of these controls shall be investigated during the final phase of testing.

9. Trainer airplanes required to spin shall demonstrate the ability to recover from fully developed spins if fully developed spins are attainable.

10. With respect to spin attempts, "critical" control positions shall include, but not be necessarily restricted to full pro-spin settings. For some combinations of airplane state and entry test variables, the spinning motion may be sustained with controls in positions (neutral, out-of-control recovery settings, or stick forward, for example) other than full pro-spin positions, and a recovery attempt with controls displaced from the former positions may result in recovery capability, duration, or reversal tendency materially different from that which would occur if recovery were initiated from the full pro-spin condition. If it appears possible to encounter these circumstances in service use, the "critical" controls shall be any setting necessary to define all out-of-control modes and determine recovery characteristics specifically applicable to operational users.

Table III
SUSCEPTIBILITY/RESISTANCE CLASSIFICATION

The airplane is classified as	Extremely Susceptible to departure, spin, or deep stall if that event occurs in Test Phase A
	Susceptible to departure, spin, or deep stall if that event occurs in Test Phase B
	Resistant to departure, spin, or deep stall if that event occurs in Test Phase C
	Extremely Resistant to departure, spin, or deep stall if that event occurs in Test Phase D