SAE Aerospace
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AEROSPACE STANDARD

SAE AS439 REV. A

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Stall Warning Instrument
(Turbine Powered Subsonic Aircraft)

FOREWORD

Changes in this Revision are format/editorial only.

1. SCOPE:

This standard covers stall warning instruments to provide positive warning to the pilot of an impending stall. Stall, as defined for the purpose of this standard, is the minimum steady flight speed at which the airplane is controllable.

1.1 Purpose:

This Aerospace Standard establishes the essential minimum safe performance standards for stall warning instruments primarily for use with turbine powered subsonic transport aircraft, the operation of which may subject the instruments to the environmental conditions specified in paragraph 3.4.

2. REFERENCES:

There are no referenced publications specified herein.

3. GENERAL REQUIREMENTS:

3.1 Materials and Workmanship:

3.1.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.1.2 Workmanship: Workmanship shall be consistent with high-grade aircraft instrument manufacturing practice.

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3.2 Identification:

The following information shall be legible and permanently marked on the instrument or nameplate attached thereto:

a. Name of instrument.
b. SAE AS439A.
c. Manufacturer's part number.
d. Manufacturer's serial number or date of manufacture.
e. Manufacturer's name and/or trademark.
f. Rating (electrical, pressure, etc.).
g. Explosion category (if applicable).
h. Aircraft type and model.

3.3 Compatibility of Components:

If components are individually acceptable, but require matching for proper operation, they shall be specified accordingly.

3.4 Environmental Conditions:

The following conditions have been established as minimum design requirements. Tests shall be conducted as specified in paragraphs 5, 6 and 7.

3.4.1 Temperature: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function over the range of ambient temperature shown in Column A below and shall not be adversely affected by exposure to the range of temperature shown in Column B below:

TABLE 1

Instrument Location	A	B
Power Plant Accessory Compartment	0 to 150 °C	-65 to 150 °C
Pressurized Areas	0 to 70 °C	-65 to 70 °C
Non-pressurized or External Areas	-55 to 70 °C	-65 to 70 °C

3.4.2 Altitude: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function from sea level up to the altitudes and temperatures listed below:

TABLE 2

Instrument Location	Altitude (Ft)	Temp (C)
Power Plant Accessory Compartment	50,000	80
Pressurized Areas	15,000	50
Non-pressurized or External Areas	50,000	40

Altitude pressure values are per NACA Report 1235. The instrument shall not be adversely affected following exposure to extremes in ambient pressure of 50 and 3 inches of mercury absolute, respectively.

3.4.3 Vibration (Turbine Powered Subsonic Aircraft): When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and shall not be adversely affected when subjected to vibrations of the following characteristics:

TABLE 3

Instrument Location	Frequency Cycles Per Second	Maximum Double Amplitude (Inch)	(Peak) Maximum Acceleration (g)
Nacelles and Mounts	5-350	.030	5
	350-1000	.0008	10
Wings, Empennage and Wheel Wells	5-1000	.036	10
Fuselage			
Fwd of Spar Area	5-1000	.020	2
Center of Spar Area	5-1000	.020	3
Aft of Spar Area	5-340	.020	6
	340-1000	.001	8
Vibration Isolated Rack	5-55	.020	--
	55-1000	----	.75
Flight Deck Area	5-1000	.020	.25

3.4.4 Humidity: The instrument shall function and shall not be adversely affected following exposure to any relative humidity in the range from 0 to 95% at a temperature of approximately 70 °C.

3.5 Explosion Category:

The instrument component, when intended for installation either in uninhabited areas of non-pressurized aircraft or innon-pressurized areas of pressurized aircraft, shall not cause an explosion when operated in an explosive atmosphere. The component shall meet the requirements applicable to the explosion category below. Specifically, any instrument component which can be an ignition source and is intended for installation in an area in which combustible fluid or vapor may result from abnormal conditions (e.g., fuel line leakage) shall meet the requirements of Category I. If the intended location is an area where combustible fluid or vapor can occur during normal operation (e.g., fuel tank) the instrument component shall meet the requirements of Category II, listed below:

TABLE 4

Category	Definition	Requirement
I	Explosion Proofed: Case not designed to preclude flame or explosion propagation.	Paragraph 7.3.1
II	Explosion Proofed: Case designed to preclude flame or explosion propagation.	Paragraph 7.3.2
III	Hermetically Sealed	Paragraph 6.3
IV	Instrument not capable of causing an explosion.	Shall not be capable of producing a spark of more than 1.0 millijoule of energy and shall not have a short circuit current of more than 100 milliamperes.

3.6 Fire Hazard:

The instrument shall be designed to safeguard against hazards to the aircraft in the event of malfunction or failure, and the maximum operating temperature of surfaces of any instrument component contacted by combustible fuel or vapor shall not exceed 200 °C due to self-heating. All materials shall be non-combustible and shall not liberate gases or fumes which will result in such corrosion as to cause malfunction of equipment or discoloration of dial or indicia, nor shall toxic gases or fumes that are detrimental to performance of aircraft or health of personnel be liberated under the operating conditions specified herein.

3.7 Radio Interference:

The instrument shall not be the source of objectionable interference under operating conditions at any frequencies used on aircraft, either by radiation, conduction or feedback in any electronic equipment installed in the same aircraft as the instruments, in accordance with MIL-I-6181, latest revision.

3.8 Magnetic Effect:

The magnetic effect of the instruments shall not adversely effect the performance of other instruments installed in the same aircraft.

3.9 De-Compression:

When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and not be adversely affected following exposure to a pressure decrease from 22 to 2 inches of mercury in 2 seconds.

3.10 Interchangeability:

Instruments and components which are identified in accordance with paragraph 3.2 shall be directly and completely interchangeable.

3.11 Precipitation and Ice:

The instrument shall be designed so that it will continue to function properly and provide reliable stall warning during flight through rain and moderate icing conditions, per paragraph 7.10.

4. DETAIL REQUIREMENTS:

4.1 Indication:

The signal to the pilot must be positive and command his attention through hearing and/or feeling and must be a continuous warning during conditions under which warning is required. There shall be no means whereby the stall warning instrument may remain disconnected when unattended during flight.

4.2 Operating Range:

Figure 1 shall be supplied by the aircraft manufacturer for each aircraft configuration (combination of flaps, speed brakes, power, gear, etc.) for which stall warning is required. The warning point shall be adjustable within the shaded area. The instrument shall operate within a tolerance of ±5% of the set point.

NOTE: The shaded area lying between 95% T.L.F. and 75% T.L.F. represents the region in which the warning signal shall first commence in the approach toward the stall and cease upon retreat from the stall. The stall warning shall commence at no less than 5% of Vs_1, above Vs_1.

EXAMPLE: At speed "D" the aircraft stalls at a T.L.F. of "A". Point "B" is 95% of "A" and point "C" is 75% of "A". The warning shall occur between points "C" and "B".

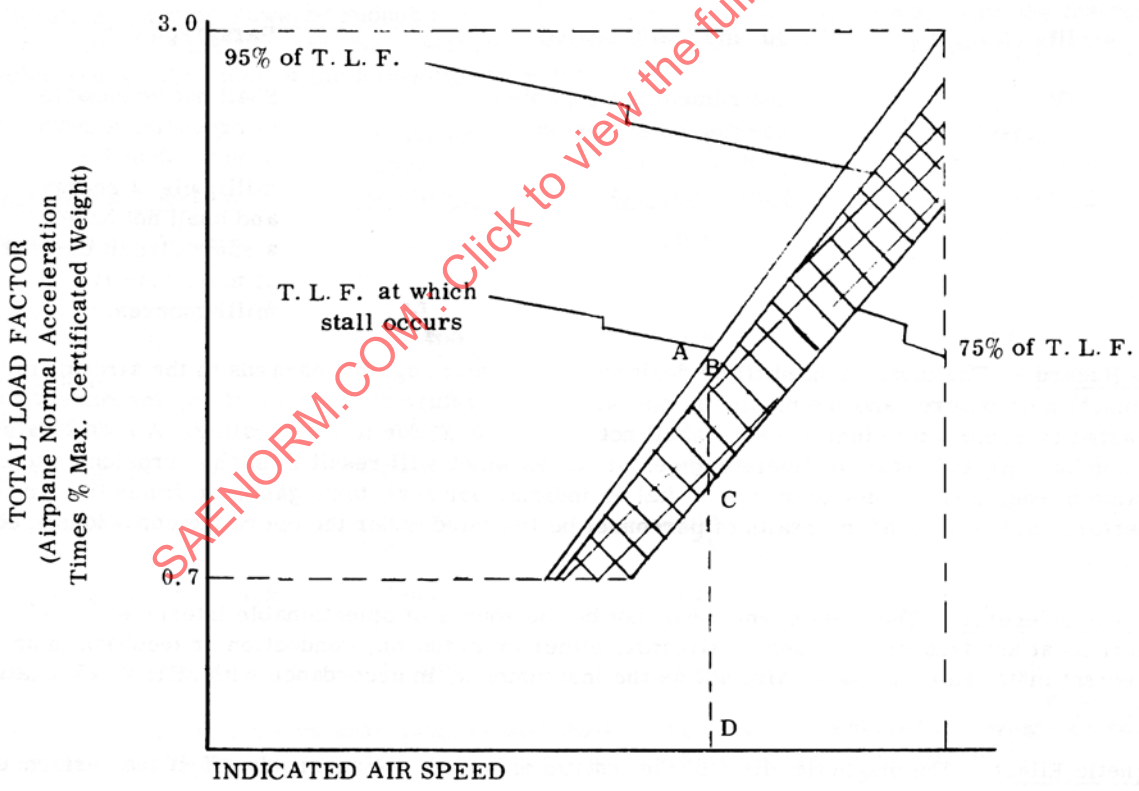

FIGURE 1 - T. L. F.

4.2.1 Sideslip or Yaw: When installed in accordance with the instrument manufacturer's instructions, the stall warning margins shown in Figure 1 shall also apply under conditions of ±5% degrees sideslip or yaw.

4.3 Power Variation:

The instrument shall properly function with ±15% variation in DC voltage and ±5% variation in frequency, or hydraulic pressure limits of ±30% of rated value.

4.4 Power Malfunction Indication:

Means shall be incorporated in the instrument to provide a fail safe signal when adequate power (voltage and/or current) is not being made available to all phases required for the proper operation of the instrument. The indicating means shall indicate a failure or a malfunction in a positive manner.

4.5 Synchro Requirements:

The synchro requirements should be in accordance with the conditions specified in ARP461B.

4.6 Altitude and Differential Pressures:

Altitude pressure values shall be in accordance with those specified in NACA Report 1235, "Standard Atmosphere - Tables and Data for Altitudes to 65,800 Feet."

5. TEST CONDITIONS:

5.1 Atmospheric Conditions:

Unless otherwise specified herein, all tests required by this standard shall be made at an atmospheric pressure of approximately 29.92 inches of mercury, an ambient temperature of approximately 25 °C and a relative humidity of not greater than 85%. When tests are conducted with the atmospheric pressure or temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 Vibration to Minimize Friction:

Unless otherwise specified herein, all tests for performance may be conducted with the instrument subjected to a maximum vibration of 0.001 inch double amplitude at a frequency of 10 to 60 cycles per second. The term double amplitude, as used herein, indicates the total displacement from positive maximum to negative maximum.

5.3 Vibration Equipment:

Vibration equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the instrument at frequencies and amplitudes consistent with the requirements of paragraph 3.4.3.

5.4 Power Conditions:

Unless otherwise specified herein, all tests shall be conducted at the power rating recommended by the manufacturer.

5.5 Position:

Unless otherwise specified herein, all tests shall be conducted with the instrument in its normal operating position.

6. INDIVIDUAL PERFORMANCE REQUIREMENTS:

All instruments shall be subjected to tests by the instrument manufacturer to demonstrate specific compliance with this standard, including the following requirements where applicable:

6.1 Operating Range Test:

The instrument shall be tested at appropriate air speeds in accordance with curves similar to Figure 1. These curves shall be supplied by the aircraft manufacturer for each aircraft configuration (combination of flap position, speed brake position, gear position, power, etc.) for which stall warning is required. The instrument shall initiate the warning signal within a tolerance of ±5% of the set point.

6.2 Lag:

No more than a one-half (1/2) second lag shall exist shall exist between the time the stall sensitive unit is actuated and the corresponding warning is indicated.

6.3 Dielectric:

Each instrument shall be tested by the method of inspection listed in paragraphs 6.3.1 and 6.3.2.

6.3.1 Insulation Resistance: The insulation resistance measured at 200 V DC for 5 seconds between all electrical circuits connected together and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc., since this measurement is intended only to determine adequacy of insulation.

6.3.2 Overpotential Tests: The instruments shall not be damaged by the application of a test potential between electrical circuits and between electrical circuits and the metallic case. The test potential shall be a sinusoidal voltage of a commercial frequency with an R.M.S. value of five times the maximum circuit voltage, or per paragraph 6.3.2.1 or 6.3.2.2, whichever applies. The potential shall start from zero and be increased at a uniform rate to its test value. It shall be maintained at this value for 5 seconds, and then reduced at a uniform rate to zero.

Since these tests are intended to insure proper electrical isolation of the circuit components in question, these tests shall not be applied to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc.

6.3.2.1 Hermetically sealed instruments shall be tested at five times the maximum circuit voltage up to a maximum of 200 V R.M.S.

6.3.2.2 Circuits that operate at potential below 15 V are not to be subjected to overpotential tests.

6.4 Sealing:

Hermetically sealed components shall be tested for leaks by means of a mass spectrometer type of helium leak detector or equivalent. The leak rate shall not exceed 0.0434 micron cubic feet per hour per cubic inch of filling gas at a pressure differential of one atmosphere.

NOTE: A micron cubic foot per hour leak rate is defined as that gas leakage which would change the pressure of a one cubic foot volume by the amount of one micron (one millionth of a meter of mercury) in one hour.

7. QUALIFICATION TESTS:

As many instruments of components deemed necessary by the manufacturer to demonstrate that all instruments will comply with the requirements of this section shall be tested in accordance with his recommendation.

7.1 Temperature Characteristics:

7.1.1 Low Temperature Operation: The instrument shall be subjected to the applicable low ambient temperature listed in Column A of paragraph 3.4.1 for a period of 5 hours without operating. The instrument shall meet, at that temperature, the applicable individual performance tests.[1]

7.1.2 High Temperature Operation: The instrument shall be subjected to the applicable high ambient temperature listed in Column A of paragraph 3.4.1 for a period of 5 hours without operating. (Electrical equipment shall be energized.) At that temperature, the instrument shall meet the applicable individual performance tests.[1]

7.1.3 Extreme Temperature Exposure: The instrument shall be exposed to the applicable low and high temperatures listed in Column B of paragraph 3.4.1 for a period of 24 hours at each extreme temperature, without operating. After a delay of 3 hours at room temperature, the instrument shall meet the applicable individual performance tests[1] at room temperature. There shall be no evidence of damage as a result of exposure to the extreme temperatures specified.

7.1.4 Altitude: The instrument shall be subjected to the ambient temperature and pressure listed in paragraph 3.4.2 for a period of 3 hours while operating. The instrument shall then meet, at the conditions specified, the applicable individual performance tests.[1]

The instrument shall be exposed alternately to 50 inch Hg absolute and 3 inch Hg absolute, non-operating. The instrument shall meet the applicable individual performance tests[1] at a atmospheric pressure following this test.

7.2 Vibration:

After the completion of the following vibration tests, no damage shall be evident and the instrument shall meet the applicable individual performance tests.[1]

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[1] Paragraph 6 et seq., except 6.3 et seq.

7.2.1 Resonance: The instrument, while operating, shall be subjected to a resonant frequency survey of the appropriate range specified in paragraph 3.4.3 in order to determine if there exists any resonant frequencies of the parts. The amplitude used may be any convenient value that does not exceed the maximum double amplitude and the maximum acceleration specified in paragraph 3.4.3.

The instrument shall then be subjected to vibration at the appropriate maximum double amplitude or maximum acceleration specified in paragraph 3.4.3 at the resonant frequency for a period of 1 hour along each axis. If more than one resonant frequency is encountered with vibration applied along any one axis, a test period may be accomplished at the most severe resonance, or the period may be divided among the resonant frequencies, whichever shall be considered most likely to produce failure. The test period shall not be less than one-half hour at any resonant mode. When resonant frequencies are not apparent within the specified frequency range, the instrument shall be vibrated for 2 hours along each axis in accordance with the vibration requirements schedule (paragraph 3.4.3) at the maximum double amplitude and frequency to provide the maximum acceleration.

7.2.2 Cycling: The instrument, while operating, shall be tested with the frequency cycled between limits specified in paragraph 3.4.3 in 15 minute cycles for a period of 1 hour along each axis at an applied double amplitude specified in paragraph 3.4.3, or an acceleration specified in paragraph 3.4.3, whichever is the limiting value.

7.3 Explosion Proof:

The instrument component shall be subjected to whatever requirements are applicable for the specific category listed in paragraph 3.5. The following requirements cover only two categories.

7.3.1 Category I: The instrument component shall be subjected, while in the test chamber, to an ambient temperature in the range of 20 to 50 °C. The test shall be conducted while the component is operating, and if applicable, it shall be connected electrically to related system components located externally to the test chamber. It shall be possible to operate the electrical and/or the mechanical controls and to apply electrical and/or mechanical loads, as appropriate, to the component. All making and breaking electrical contacts shall be operated at least ten times while the component is being tested.

The test chamber pressure shall be reduced to a pressure approximately 10,000 ft above the altitude pressure test point at which the test is to be conducted to compensate for increase in pressure when fuel is introduced. Tests shall be conducted at pressure altitudes at approximately sea level, 10,000, 20,000, 30,000, 40,000 and 50,000 ft for turbine aircraft application only. The introduction of the explosive mixture into the chamber shall be made at each test altitude, and the amount of fuel used shall be appropriate for the test chamber, the test altitude pressure, and the prevailing atmospheric conditions. The test shall be conducted utilizing an explosive mixture in the lean sector of the explosive range, and capable of producing an instantaneous explosion when ignited by a spark plug. The fuel used for conducting the tests shall be aviation grade 100/130 gasoline or commercial butane.