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**Tests, Impact, Shock Absorber  
Landing Gear, Aircraft**

**RATIONALE**

This specification defines landing impact testing conducted on military aircraft landing gear assemblies including shock absorbers and instrumentation for the tests and required data for the qualification test report. It is intended to standardize impact test procedures on landing gear shock absorbers and to provide sufficient data to allow evaluation of the design with respect to the specified requirements. This document has been determined to contain basic and stable technology which is not dynamic in nature.

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## 1. SCOPE:

### 1.1 Scope:

This specification covers definition of landing impact tests which are to be conducted on landing gear assemblies including shock absorbers, suggested instrumentation for the tests and required data of the resulting test report. It is intended to standardize impact test procedures on landing gear shock absorbers and to provide sufficient data to allow evaluation of the design with respect to requirements of MIL-L-8552 and MIL-S-8959 as applicable.

## 2. APPLICABLE DOCUMENTS:

### 2.1 Government documents:

- 2.1.1 Specifications and standards: Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

#### SPECIFICATIONS

##### MILITARY

MIL-L-8552	Landing Gear, Aircraft Shock Absorber (Air-Oil Type)
MIL-S-8698	Structural Design Requirements, Helicopter
MIL-A-8860	Airplane Strength and Rigidity, General Specification for
MIL-A-8863	Airplane Strength and Rigidity, Ground Loads for Navy Procured Airplanes
MIL-A-8868	Airplane Strength and Rigidity, Data and Reports
MIL-S-8959	Spring, Hydraulic, General Specification for

#### STANDARDS

##### MILITARY

MIL-STD-831 Test Reports, Preparation of

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer).

### 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.

### 3. REQUIREMENTS:

#### 3.1 Method of tests:

The translational free drop method of impact testing is required with the wheels spun up in a reverse direction in order to simulate the effect of spin-up drag load for testing the landing gear shock absorber. Use of other methods of impact testing (rotating beam, incline platform, etc.) must be approved by the procuring activity.

#### 3.2 General:

The aircraft contractor shall furnish test specimen(s) and arrange for the performance of the tests specified herein, or as dictated by contract or supporting contract documentation.

#### 3.3 Required tests:

The following tests shall be conducted on the same complete landing gear assembly including shock absorber, wheels, tires, brakes (or inertia simulation, both rotational and translational, of the brakes) and other structural members, as used on the aircraft. There shall be no substitution of shock absorber parts except seals after the testing has started. Seal failures shall not be cause for rerun of drop test; however, any such failures must be investigated to assure that they are not chronic or that there is not an inherent deficiency in the design.

3.3.1 Design landing tests: In order to validate the metering characteristics and bottoming capability, conduct a minimum of one drop at each of the test conditions outlined in table I.

3.3.1.1 Weights: The weights outlined in table I are derived from the definitions presented in Section 6 of MIL-A-8860, or as defined by MIL-S-8698, Section 3.

3.3.1.2 Attitudes: The attitudes outlined in table I are derived from the definitions presented in MIL-A-8862. For testing main landing gears (of nose wheel type aircraft), use the two-point attitude with the nose tire just clear of the ground for the level landing condition. For testing nose landing gears of nose gear type aircraft, use the three-point attitude for the level landing condition. No tail down conditions are required for nose gears.

3.3.1.3 Wheel speeds at contact: The wheels shall be spinning in the reverse direction at the time of platform contact. The value of  $V_{SL}$  listed in table I is defined in Section 6 of MIL-A-8860 or the  $V_L$  for autorotative landing at design gross as required by MIL-S-8698, Section 3. The tire radius used for determining wheel rpm shall be the mean undeflected radius of the tire, as determined by allowable tolerances and dimensions of the tire, obtained from the tire performance specification.

TABLE I. Design landing tests.

Type Aircraft	Drop Nr	Weight Condition	Rate of Descent $V_V$ (fps)	Attitude*	Wheel Speed at Contact	Maximum Vertical Reaction (g's)
Trainer	1	Landplane Landing Design Gross Weight	13.0	Level	1.2 VSL	*
	2	Landplane Landing Design Gross Weight	13.0	Tail Down	1.0 VSL	*
	3	Maximum Landing Design Gross Weight	8.5	Level	1.2 VSL	*
	4	Maximum Landing Design Gross Weight	8.5	Level	1.2 VSL	**
	5	Maximum Landing Design Gross Weight	8.5	Tail Down	1.0 VSL	*
Other Classes	1	Landplane Landing Design Gross Weight	10.0	Level	1.2 VSL	*
	2	Landplane Landing Design Gross Weight	10.0	Tail Down	1.0 VSL	*
	3	Maximum Landing Design Gross Weight	6.0	Level	1.2 VSL	*
	4	Maximum Landing Design Gross Weight	6.0	Level	1.2 VSL	**
	5	Maximum Landing Design Gross Weight	6.0	Tail Down	1.0 VSL	*
Helicopter	1	Basic Design Gross Weight	8.0	Level	1.0 $V_L$	*
	2	Basic Design Gross Weight	8.0	Level	0.0 $V_L$	*
	3	Basic Design Gross Weight	8.0	Tail Down (Nose Down)	1.0 $V_L$	*
	4	Basic Design Gross Weight	8.0	Tail Down (Nose Down)	0.0 $V_L$	*
	5	Design Alternate Gross Weight	6.0	Level	1.0 $V_L$	*
	6	Design Alternate Gross Weight	6.0	Level	1.0 $V_L$	**
	7	Design Alternate Gross Weight	6.0	Tail Down (Nose Down)	1.0 $V_L$	*

\*Data supplied by Airframe Contractor.

\*\*Flat Strut Drop Test.

- 3.3.1.4 Equipment servicing: Except for the flat strut tests outlined in table I, the tire inflation pressure and shock strut servicing pressure shall be those prescribed in the recommended procedures for operation at aircraft maximum design gross weight. The shock absorber oil level shall be recommended design level. The inflation pressure for the flat strut test will be atmospheric with the strut extended. Plugs with valves will be in a service configuration.
- 3.3.2 Miscellaneous landing tests: After successful completion of the design tests (3.3.1) the miscellaneous landing tests of table II shall be performed. Upon completion of these tests, there should be no evidence of permanent set or functional impairment.
- 3.3.2.1 Weights: The weight required in table II is derived from the definition presented in Section 6 of MIL-A-8860 or MIL-S-8698, Section 3.
- 3.3.2.2 Attitude and wheel contact speeds: See explanation in 3.3.1.2 and 3.3.1.3 respectively, for level attitude.
- 3.3.2.3 Equipment servicing: For the tests outlined in table II, the tire inflation pressure shall be that recommended for operation at aircraft maximum design gross weight. The variations in strut servicing pressure of the two first drops of table II are designed to evaluate the capability of the shock absorbers as required by MIL-A-8862. The last two drops of table II satisfy the testing requirements of Section 3 of MIL-L-8552.
- 3.3.2.4 Strut stowage: If the shock absorber is normally stowed in such a position that the shock strut centerline has the lower end above a line  $10^\circ$  from horizontal or is stowed in other than the fully extended position, then drops 1, 2, and 3 of the miscellaneous landing tests of table II shall be conducted in the following manner:
- Position strut with centerline of strut at retracted attitude\* relative to horizontal or in the normal stowed extension
  - Allow strut to extend and position in landing attitude and hold 120 seconds  $\pm 20$  seconds
  - Conduct drops as prescribed.
- \*If strut purging of dynamic chamber due to retract attitude can be demonstrated, then attitude placement may be eliminated.
- 3.3.3 Airplane growth tests: After successful completion of miscellaneous tests of 3.3.2, table II, the landing tests of table II shall be performed with the same gear assembly. Upon completion of these tests, there shall be no evidence of functional impairment.

TABLE II. Miscellaneous landing tests.

Aircraft	Drop Nr	Weight Condition	Sink Speed (fps)	Attitude	Wheel Speed	Strut Inflation Pressure (% Rated)	Oil Volume (% Recommended)	Remarks
Trainer	1	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	90	100	
	2	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	110	100	
	3	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	100	100	*
	4	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	100	100	Within 5 min of previous drop *
	5	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	100	100% minus equivalent 1/2 inch of oleo stroke	*
	6	Landplane Landing	13.0	Level	1.2V <sub>SL</sub>	100	100% minus equivalent 1/2 inch of oleo stroke	Within 5 min of previous drop *
Other	1	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	90	100	
	2	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	110	100	
	3	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	100	100	*
	4	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	100	100	Within 5 min of previous drop *
	5	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	100	100% minus equivalent 1/2 inch of oleo stroke	*
	6	Landplane Landing	10.0	Level	1.2V <sub>SL</sub>	100	100% minus equivalent 1/2 inch of oleo stroke	Within 5 min of previous drop *

TABLE II. Miscellaneous landing tests. - Continued

Aircraft	Drop Nr	Weight Condition	Sink Speed (fps)	Attitude	Wheel Speed	Strut Inflation Pressure (% Rated)	Oil Volume (% Recommended)	Remarks
Helicopter	1	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	90	100	
	2	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	110	100	
	3	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	100	100	*
	4	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	100	100	Within 5 min of previous drop *
	5	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	100	100% minus equivalent 1/2 inch of oleo stroke	*
	6	Basic Design Gross Weight	8.0	Level	1.0V <sub>L</sub>	100	100% minus equivalent inch of oleo stroke	Within 5 min of previous drop *

\*These drops may be deleted if oil level above the orifice is equal to at least 125 percent of piston diameter or 5 inches, whichever is less. These drops may also be deleted if the air and oil are physically separated (i.e., inverted strut, etc.). These drops are only applicable to those shock struts designed in accordance with MIL-L-8552.

- 3.3.3.1 Weights: Minimum flying weight and landplane design gross weight outlined in table II are defined in Section 6 of MIL-A-8860 and MIL-S-8698, Section 3.
- 3.3.3.2 Equipment servicing: For the equivalent energy test outlined in table II, the tire and strut servicing pressures shall be a minimum of 100 percent rated values up to and including maximum design gross weights. When the test weight condition exceeds maximum design gross weight, the tire and strut pressures shall be adjusted accordingly in a manner prescribed by the specific component servicing instructions. For multiple-chambered gears requiring separate servicing, coordination with the design agency is required and it is normally assumed that the chamber which affects the normal landing conditions is the only one which may be serviced.

TABLE III. Landing tests.

Type Aircraft	Drop Nr	Weight Condition	Sink Speed (fps)	Attitude	Wheel Speed	Strut Inflation Pressure (% Rated)	Oil Volume (% Recommended)	Remarks
Trainer	1	.75 x Landplane Landing	15	Level	1.2V <sub>SL</sub>	100	100	Equivalent Energy Test
	2	1.174 x Landplane Landing	12	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.2	100	Equivalent Energy Test
	3	1.397 x Landplane Landing	11	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.2	100	Equivalent Energy Test
	4	Minimum Flying Weight	13.0	Level	1.2V <sub>SL</sub>	100	100	Servicing Evaluation Test
	*5	Minimum Flying Weight	13.0	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.3	100	Servicing Evaluation
Other Aircraft	1	.825 x Landplane Landing	11	Level	1.2V <sub>SL</sub>	100	100	Equivalent Energy Test
	2	1.2346 x Landplane Landing	9	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.2	100	Equivalent Energy Test
	3	1.5000 x Landplane Landing	8.165	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.2	100	Equivalent Energy Test
	4	Minimum Flying Weight	10	Level	1.2V <sub>SL</sub>	100	100	Servicing Evaluation Test
	*5	Minimum Flying Weight	10	Level	1.2V <sub>SL</sub>	See Para. 3.3.3.3	100	Servicing Evaluation Test

TABLE III. Landing tests. - Continued

Type Aircraft	Drop Nr	Weight Condition	Sink Speed (fps)	Attitude	Wheel Speed	Strut Inflation Pressure (% Rated)	Oil Volume (% Recommended)	Remarks
Helicopter	1	.827 Basic Design Gross Weight	8.8	Level	1.0V <sub>L</sub>	100	100	Equivalent Energy
	2	1.30 x Basic Design Gross Weight	7.0	Level	1.0V <sub>L</sub>	Adjusted for G.W. (100% min)		Equivalent Energy
	3	1.50 x Basic Design Gross Weight	6.5	Level	1.0V <sub>L</sub>	Adjusted for G.W.	100	Equivalent Energy
	4	Minimum Weight	8.0	Level	1.0V <sub>L</sub>	100	100	Servicing Evaluation Test
	5	Minimum Weight	8.0	Level	1.0V <sub>L</sub>	150	100	Servicing Evaluation Test
	6	Minimum Weight	8.0	Level	1.0V <sub>L</sub>	200	100	Servicing Evaluation Test
	7	Minimum Weight	8.0	Level	1.0V <sub>L</sub>	250	100	Servicing Evaluation Test
Continue until design vertical platform load is reached.								

\*Continue with noted increased servicing until design vertical reaction is reached or maximum service condition is attained

- 3.3.3.3 For the servicing evaluation test, the tire inflation pressure shall be that recommended for 100 percent usage at maximum design gross weight. The strut servicing pressure shall be increased in increments of 50 percent or less of rated pressure until a maximum static inflation pressure of 2500 psi or design vertical reaction is reached. If a deviation to the 2500 psi servicing pressure limit defined in Section 3 of MIL-L-8552 has been granted, this limit is extended to that permitted in the deviation.
- 3.3.3.4 Attitude and wheel contact: See explanation in 3.3.1.2 and 3.3.1.3, respectively.
- 3.3.3.5 Design vertical reaction: Design vertical reaction is defined as the load at the wheel associated with a drop at landplane landing weight, level attitude and design sink speed, or basic gross weight.
- 3.3.4 Reserve energy tests: After completion of the tests outlined in 3.3.1, 3.3.2 and 3.3.3, conduct the tests outlined in table IV with the same gear assembly.

TABLE IV. Reserve energy tests.

Type Aircraft	Drop Nr	Weight Condition	Sink Speed (fps)	Attitude	Wheel Speed	Strut Inflation Pressure (% Rated)	Oil Volume (% Recommended)	Remarks
Trainer	1	Landplane Landing	13.5	Level	1.2V <sub>SL</sub>	100	100	No Functional Impairment
	2	Landplane Landing	14.5	Level	1.2V <sub>SL</sub>	100	100	No Functional Impairment
	3	Landplane Landing	16.0	Level	1.2V <sub>SL</sub>	100	100	Permanent Set-No Failure
Other Aircraft	1	Landplane Landing	10.5	Level	1.2V <sub>SL</sub>	100	100	No Functional Impairment
	2	Landplane Landing	11.5	Level	1.2V <sub>SL</sub>	100	100	No Functional Impairment
	3	Landplane Landing	12.5	Level	1.2V <sub>SL</sub>	100	100	Permanent Set-No Failure
Helicopter	1	Basic Design Gross Weight	8.5	Level	1.0V <sub>L</sub>	100	100	No Functional Impairment
	2	Basic Design Gross Weight	9.0	Level	1.0V <sub>L</sub>	100	100	No Functional Impairment
	3	Basic Design Gross Weight	9.8	Level	1.0V <sub>L</sub>	100	100	Permanent Set-No Failure

- 3.3.4.1 Weights: All of the reserve energy tests will be conducted with landplane landing design gross weights, as defined in Section 6 of MIL-A-8860 or MIL-S-8698, Section 3 as applicable.
- 3.3.4.2 Attitude and wheel speed: See explanation of 3.3.1.2 and 3.3.1.3, respectively.
- 3.3.4.3 Equipment servicing: Tire and shock absorber inflation pressures shall be required pressures for maximum design gross weight.
- 3.4 Test witnesses:

The procuring activity representative shall be notified in sufficient time so that he or his representative may witness the tests and certify results and observations contained in the test report.

### 3.5 Test equipment:

Unless specifically approved by the procuring activity, the tests shall be performed on a stationary drop tower incorporating a carriage dropping mass which will support the test article. A steel grating or other suitable surface shall be installed on the reaction platform or test floor in the contact area, which will produce a minimum of .55 coefficient of friction between the tire and simulated landing surface. If analysis shows that a lower coefficient utilized during spin-up produces a more critical loading, this shall be used. Approval of this variation shall be obtained from the procuring activity. This coefficient of friction shall not vary more than  $\pm 30$  percent throughout the test program. Wing-life may be simulated by mechanical means or compensated for by adjusted mass method and is subject for review and approval by the procuring activity. If mechanical means are used, the wing-life simulation device shall be capable of exerting an average constant  $\pm 10$  percent lifting force down to 2 fps  $V_v$  throughout each test.

### 3.6 Test report data:

Test report data shall be prepared in accordance with the general guidance furnished in MIL-A-8868 and MIL-STD-831 (see 6.3).

#### 3.6.1 Instrumentation: Record the following minimum information or equivalent data as a function of time\* for each drop test required in 3.3 of this specification.

- a. Carriage mass displacement normal to contact surface
- b. Vertical or platform reaction
- c. Horizontal (drag) reaction at contact surface
- d. Shock absorber axial stroke
- \*e. Wheel rotational speed at time of release.
- f. Wing lift force (if mechanical)
- g. For multiple-axle gears, vertical load on each axle or multiple platform
- h. Gear side load (when required)
- i. Strut axial load.

\*Except as noted.

3.6.2 Data presentation: The following information shall be presented in the test report:

- a. Labeled oscillograph traces of each item listed in 3.6.1 for each test condition. Drops from table III, 5 and on, need only show the maximum condition tested
- b. Suitable calibration data
- c. A plot of vertical reaction versus stroke for the tests outlined in table I and the highest sink speed drop of table IV
- d. A plot of calculated and actual static load versus stroke
- e. An identification by part number of all the landing gear or shock strut components
- f. A sketch or drawing showing the full details of the final metering arrangement
- g. A measured recording of strut and tire inflation pressures just prior to each drop
- h. Drawing or sketch showing attitude of gear with respect to ground and test jig for level landing and tail-down attitude drops
- i. All pertinent calculations made in performance of tests
- j. The design air volume for fully compressed, static and fully extended positions shall be noted in the report
- k. An inspection analysis of the condition of the gear assembly after the completion of the prescribed tests
- l. A plot of calculated tire deflection versus time.

3.7 Wing lift:

The required wing lift may be compensated for by any appropriate means.

3.7.1 Adjusted mass method: This method of simulating wing lift may be used in a drop test jig without a mechanical device for producing the vertical lift force.