



AEROSPACE INFORMATION REPORT

AIR6906™

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Reaffirmed 2023-04

Impulse Towing Loads

RATIONALE

Impulse loads that exceed design loads can occur during aircraft towing operations when a large gap exists between the tow bar and the tow vehicle and no damping or shock-absorbing device is present.

AIR6906 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This SAE Aerospace Information Report (AIR) provides information about impulse loads that occur during normal aircraft towing operations. An instrumented tow bar was used to characterize towing loads. Suggestions to minimize impulse loads by reducing the tow bar to tow vehicle gap are described.

1.1 Purpose

The purpose of this document is to provide information concerning the impulse loads that occur during aircraft towing when a large gap exists between the tow bar and the tow vehicle.

2. REFERENCES

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1353 Cushion Tow Hitches Test

AIR1915 Aircraft Tow Bar

2.2 Military Specifications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>

MIL-A-8863 Airplane Strength and Rigidity

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Documents
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2.3 FAA Specifications

14 CFR 25.509 Towing Loads

2.4 European Specifications

EASA CS 25.509 Towing Loads

2.5 Industry Reports

Chen, S., Liu, H., and Li, F. (2017) *Analysis of Boeing 737 Aircraft Towing Accidents, Engineering Failure Analysis*, 80 pp. 234-240.

Clark, A. and Butterfield, J. (2017) *Hitting the Brakes, ANSYS Advantage*, Issue 2, 2017, pp. 46-48.

3. BACKGROUND

The USAF has experienced multiple towing related nose landing gear failures for a 42300 pound (19187 kg) aircraft. During the incident investigations, it was determined that the tow vehicles were being operated safely. There was no evidence of abusive maneuvers. The aircraft landing gear was designed to the towing requirement of MIL-A-8863, indicating that towing limit loads should not exceed 10054 lbf (44.7 kN) (Figure 1). Calculations were performed to determine the loads imparted on the nose landing gear. Results indicated that loads were well below aircraft towing design loads, even if high deceleration levels were assumed. The nose landing gear was tested in a lab to determine if the gear was able to achieve the design loads. Test results showed that the nose landing gear strength exceeded the MIL-A-8863 limit load requirement. Upon further investigation, it was discovered that the tow bar to tow vehicle interface was not rigid, allowing an impulse load. Calculations, validated with testing, showed that if a field representative gap between the tow bar and tow vehicle was assumed, loads imparted on the nose landing gear could exceed design criteria due to the effects of impulse loading as the tow bar impacts the tow vehicle.

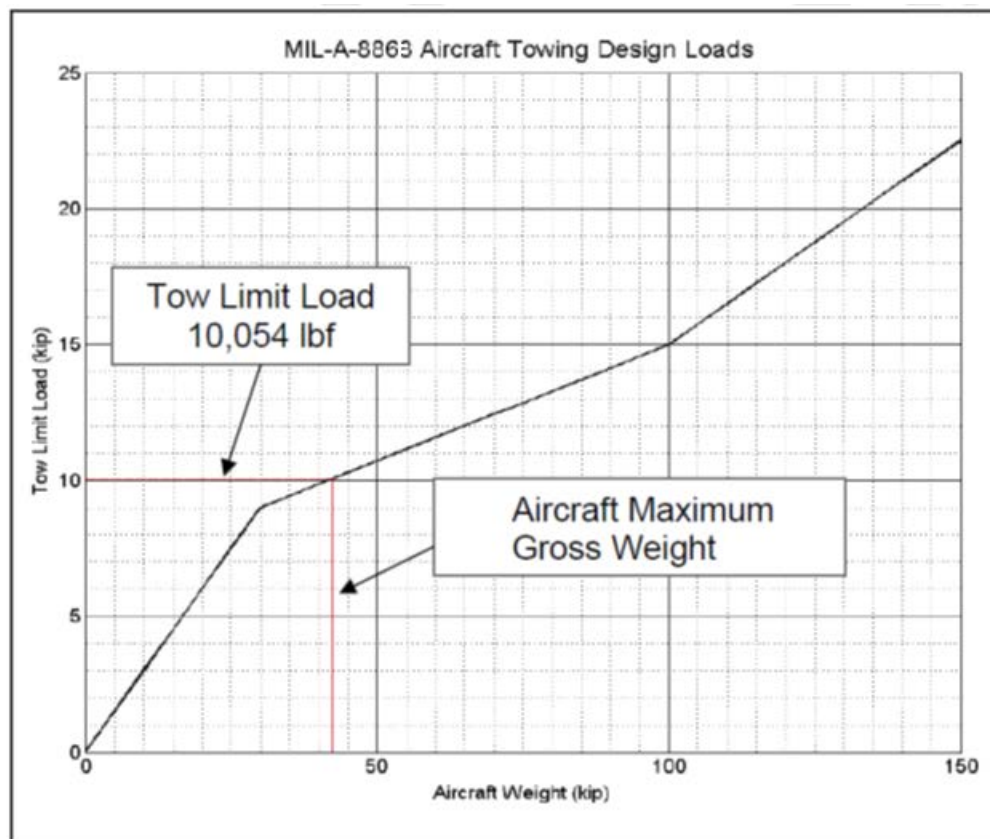


Figure 1 - Towing load design criteria per Figure 10 of MIL-A-8863



Documents

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There are two different types of hitches commonly used on tow vehicles to interface with the tow bar, a pintle hitch and a pin and clevis hitch, Figure 2. Both hitches do not provide a rigid connection to the tow bar. The tow bar is able to move forward and aft on both interfaces, typically resulting in an approximately 0.775-inch (19.7 mm) gap between the tow vehicle and tow bar, Figure 3.



Figure 2 - Pintle and pin and clevis hitch-tow interfaces

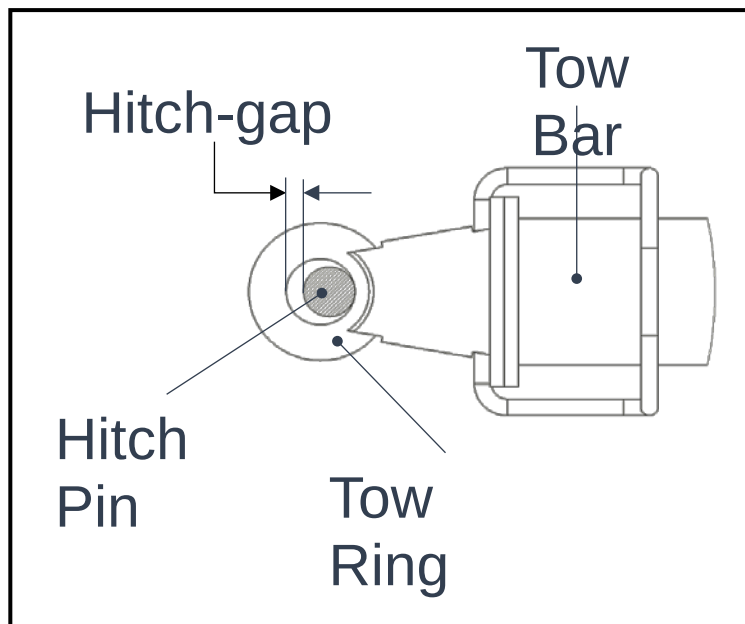


Figure 3 - Hitch-gap diagram

4. TOW LOADS TESTING

4.1 Test Setup

In an effort to understand towing loads acting on a 42300 lbf (19187 kg) aircraft, tow testing was conducted on the aircraft and a representative simulated mass. Both aircraft and simulated mass testing incorporated multiple test conditions by varying factors of weight, acceleration time, maximum velocity, and stopping time. In contrast to aircraft testing, simulated mass testing also included a hitch-gap manager, effectively a metal sleeve placed over the hitch pin to reduce the clearance between tow vehicle and tow bar to 0.030 inch (0.762 mm). Test results were measured and recorded using an instrumented MD-1 universal tow bar. As shown in Figure 4, the tow bar was equipped with instruments to measure position, velocity, acceleration, and towing loads. Figures 5 and 6 show the test equipment used for both aircraft and simulated mass testing.