SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

ARP1107 REV. B

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Superseding ARP1107A

Tail Bumpers for Piloted Aircraft

RATIONALE

ARP1107B has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

Changes in this Revision are format/editorial only.

1. SCOPE:

This recommended practice covers the fixed structure, or independent energy absorbing system affixed to the airframe to afford protection to the control surfaces, engine and other portions during ground handling, take-off and landing.

2. PURPOSE:

This document provides recommended practices for the design, installation, qualification, and operational requirements of the tail bumper for piloted aircraft.

3. DESIGN REQUIREMENTS:

3.1 Functional:

The tail bumper general arrangement and design should be such as to provide a minimum clearance of 6 inches between the ground and all parts of the aircraft, including externally mounted stores, exclusive of the tail bumper itself and the landing gear wheels. This clearance should be provided for all pitch attitudes and loading conditions defined in Section 4 with the aircraft rolled laterally five degrees about the fuselage centerline. Structural deflections under the specified dynamic loading conditions should be calculated or conservatively estimated. Flight control surfaces should be in the most critical positions obtainable under the conditions being investigated.

During the takeoff the tail bumper should not restrict the aircraft attitude more than necessary, consistent with the clearance requirements defined above, when maximum elevator deflection is applied prior to and during takeoff rotation.

3.1 (Continued):

The tail bumper may be either fixed or retractable. If takeoff rotation would otherwise be unduly restricted, different positions of the tail bumper should be provided for landing and takeoff.

Selection of the means for energy absorption should be based on expected usage with emphasis on serviceability, maintainability, reliability and safety considerations.

3.2 Tail Bumper Actuation:

A retractable bumper may be positioned by a suitable actuator. Actuator design requirements should be subject to the approval of the procuring activity and should consider the effect of rapid compression of the tail bumper during ground contact.

3.3 Tail Bumper Control:

When a retractable tail bumper is used in conjunction with retractable landing gear, the bumper control should be integral with the landing gear control when practicable. A suitable indicator should be provided where the tail bumper is needed to make a safe landing, or if the extended tail bumper has an unsafe effect. Tail bumpers which contact during landing impact (including occasional contact) should have emergency extension provisions and operate with emergency landing gear control. Where bumper operation other than with landing gear control is dictated (such as bumper retraction during carrier aircraft catapult), control should be integrated with prime control for that condition (such as launch bar extension).

3.4 Mode of Failure:

The tail bumper geometry or energy absorbing device should be such that in the event of an overload, links or struts will not pierce fuel tanks or critical aircraft components.

3.5 Wear Surfaces:

The tail bumper should have an easily replaceable hardened shoe or tire and wheel assembly to absorb the wear and damage of impact. Selection of wheel or shoe for a particular design should be based on such factors as expected frequency of contact, contact velocity, surface roughness, and damage to arresting cables or landing surface.

3.6 General Design and Quality:

The tail bumper system should be as simple, direct, and fool-proof as possible with respect to design, operation, inspection and maintenance. Materials and finishes should be of aircraft quality, and workmanship should be of sufficiently high quality to ensure satisfactory operation and adequate service life.

4. TAIL BUMPER LOADS:

The tail bumper should be designed to accommodate the following load conditions:

4.1 Ground Handling Loads:

The airplane should be rolling backwards on a level surface (down a five degree slope for carrier based aircraft) at a speed of five knots, and brakes should be suddenly applied. The airplane gross weight and center of gravity should be the most critical for the conditions. The tail bumper loads should be those resulting from a dynamic analysis of the aircraft's motion considering a tire coefficient of friction of 0.95.

4.2 Landing and Takeoff Loads:

4.2.1 Landing Loads (Carrier Based Aircraft, Fixed Wing): Tail bumper requirements for carrier landings and field carrier landing practice (FCLP) should be established by dynamic analysis of the airplane motion using the structural landing criteria established in Reference (a). These criteria require investigation of initial landing conditions using a multivariate probability distribution of eight independent variables.

For tail bumper loads the important parameters to be investigated are pitch attitude and sinking speed. Therefore, the landing criteria can be simplified to the following:

$$P_T = P(V_v > V_{vi}) \times P(\theta_p > \theta_{pi}) = 0.0005\text{, or } PV_v \times P\theta_p = 0.0005$$

(The probability of occurrence (Po) is 0.001; therefore, $P_T = P_o \times 0.5 = 0.0005$)

where:

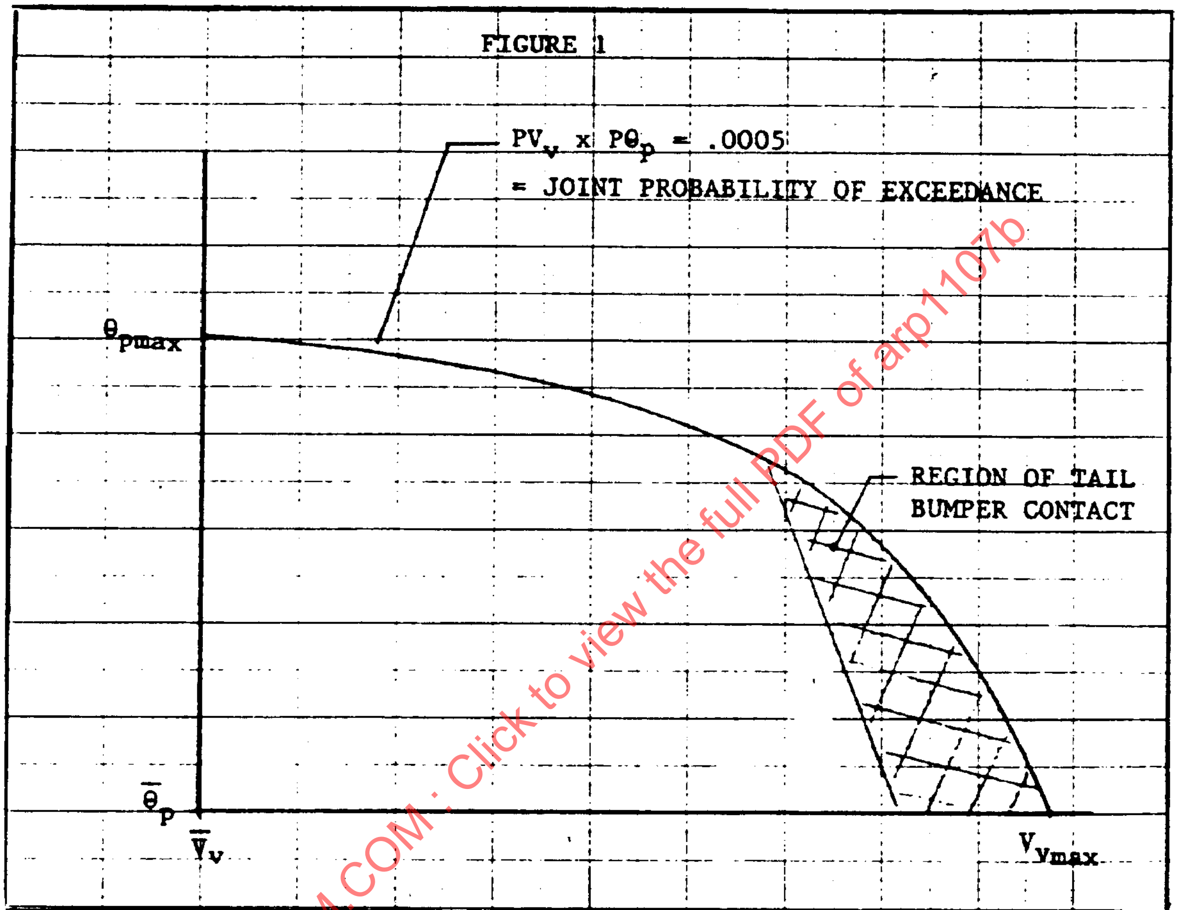
V_v = Airplane sink speed
V_{vi} = Sink speed initial condition value
$\bar{V}_v$ = Mean sink speed value
V_{vmax} = Maximum sink speed value
θ_p = Airplane pitch attitude
θ_{pi} = Pitch attitude initial condition value
$\bar{\theta}_p$ = Mean pitch attitude value
θ_{pmax} = Maximum pitch attitude value

If this joint probability is plotted, the critical tail bumper conditions occur in that quadrant where $\bar{\theta}_p \le \theta_{pi} \le \theta_{pmax}$ and $\bar{V}_v \le V_{vi} \le V_{vmax}$. This is depicted in Figure 1.

For each airplane design there is potentially a region of tail bumper contact within the design envelope (see Figure 1). This region and the corresponding bumper loads must be determined by dynamic analysis.

4.2.1 (Continued):

The equations defining sink speed, pitch attitude, and accompanying parameters to be used in the analysis are contained in Reference (a) or are defined by the procuring activity.



Consideration should also be given, as specified by the procuring activity, to the loads resulting from tail bumper contact with an arresting cable at any time during the landing.

4.2.2 Landing Loads (Land-Based, Fixed Wing Aircraft): Tail bumper landing loads should be established by dynamic analysis of the motion of the aircraft. The analysis should be based on initial contact under the following conditions:

Sink Speed	=	Design limit sink speed, as specified by the procuring activity, relative to the ground.
Gross Weight	=	Landing Design Gross Weight
Center of Gravity	=	Most aft permissible