S-35-29

LAND SEA AIR SPACE

# AEROSPACE RECOMMENDED PRACTICE

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## ARRESTING HOOK INSTALLATION, LAND BASED AIRCRAFT, EMERGENCY



1. PURPOSE

To recommend criteria and requirements for the design of emergency arresting hooks for land based aircraft.

2. SCOPE

This document covers the recommended criteria and performance requirements for the design and installation of an aircraft emergency arresting hook intended for use with emergency runway arresting systems. Design criteria for fully operational hooks and for carrier based aircraft hook installations are contained in specification MIL-A-18717.

3. REQUIREMENTS

3.1 Materials: Materials should be as specified in military specifications or industry standards. When materials are used which are not covered by specifications, etc. they should be completely defined in detail specifications, or documents furnished by the contractor.

3.1.1 Protective Treatment: When materials are used for components of the installation that are subject to deterioration when exposed to environmental conditions likely to occur during service usage, they should be protected against such deterioration in a manner that will in no way prevent compliance with the intended design performance.

3.1.2 Selection of Specifications and Standards: Specifications and standards describing necessary systems, commodities, materials, and processes should be selected in accordance with MIL-STD-143. Parts, materials, or processes which are not covered by these documents should be completely described on the manufacturer's documents or detail specifications.

3.2 Design:

3.2.1 Function:

a. The arresting hook installation should be designed and constructed to successfully engage a runway arresting system pendant and decelerate the aircraft to a stop.

b. The particular runway arresting system and its characteristics, for which the aircraft arresting hook installation is to be designed, should be prescribed by the procuring activity. In the event that such a designation is not made, it should be assumed that the installation is designed for use with a BAK-13 system.

3.2.2 Retraction:

a. There is no requirement for retraction of the arresting hook in flight since the installation is intended for emergency use only.

b. The arresting hook should be capable of being retracted and locked up manually on the ground without the use of special tools.

3.2.2 (Continued)

c. The arresting hook should be capable of being extended either prior to or after landing touchdown; however, the system should not be designed for in-flight engagements.

3.2.3 Loads:

a. The arresting hook system should be designed to withstand the loads resulting from engagement during aborted takeoff and emergency landings. The engagement velocities and maximum aircraft weights should be as defined in MIL-A-008860 and/or in the detail aircraft performance specification. The hook loads should be determined from the characteristics of the particular barrier to be engaged. If the barrier is not known, determine the hook loads from Fig. 1. (Loads in Fig. 1 for aircraft weighing less than 30,000 lb should follow the 30,000 lb curve. Test data indicates that below 20,000 to 30,000 lb, cable dynamic loads dominate and are primarily a function of velocity.)

b. It is assumed that the arresting system is engaged after landing impact has been completed and the aircraft is in a stabilized roll with all wheels on the runway.

c. Approximate maximum runout loads can be obtained from Fig. 1.

d. Side loads shall be those components derived from the maximum load obtained in Fig. 1, applied at angle of ±20° from the aircraft centerline in a horizontal plane.

3.2.4 Geometry (See Fig. 2): The arresting hook geometry should be such that the following parameters are satisfied:

a. The arresting hook attach point should be located such that the arresting force does not cause directional instability during the arrestment.

b. The arresting hook should be located so that the arresting force causes the minimum practical increase in nose gear vertical reaction.

c. The aft arresting force shall not cause the nose wheel(s) to be lifted from the runway during any portion of the arrestment.

d. The arresting hook length and down stop shall allow positive contact of the hook point on the runway at a maximum nose down condition (Line N Fig. 2).

e. The arresting hook point shall be so located when up and locked that the point clears the runway by minimum of 14 in. at the maximum tail down landing attitude with the aft struts and tires compressed to the design sinking speed deflection as shown in Fig. 2, Line (T). If this is incompatible with the aircraft basic design, suitable guards should be installed which will prevent inadvertent engagement under these conditions.

f. For other than laterally rigid ("V" type) hooks, the hook should be free to swing laterally not less than 20° each side of center to allow alignment during an off center or yawed engagement. A spring or other suitable device shall be provided to maintain aft trail prior to cable engagement.

g. The in-flight maximum down angular position of the hook should be 80° or less when measured relative to the airplane landing approach line (A) or to the airplane max tail down line (T) (See Fig. 2), whichever is critical.

h. The arresting hook should be positioned to insure engagement after the pendant has been displaced by the nose gear and/or main gear and/or tail bumper where applicable.

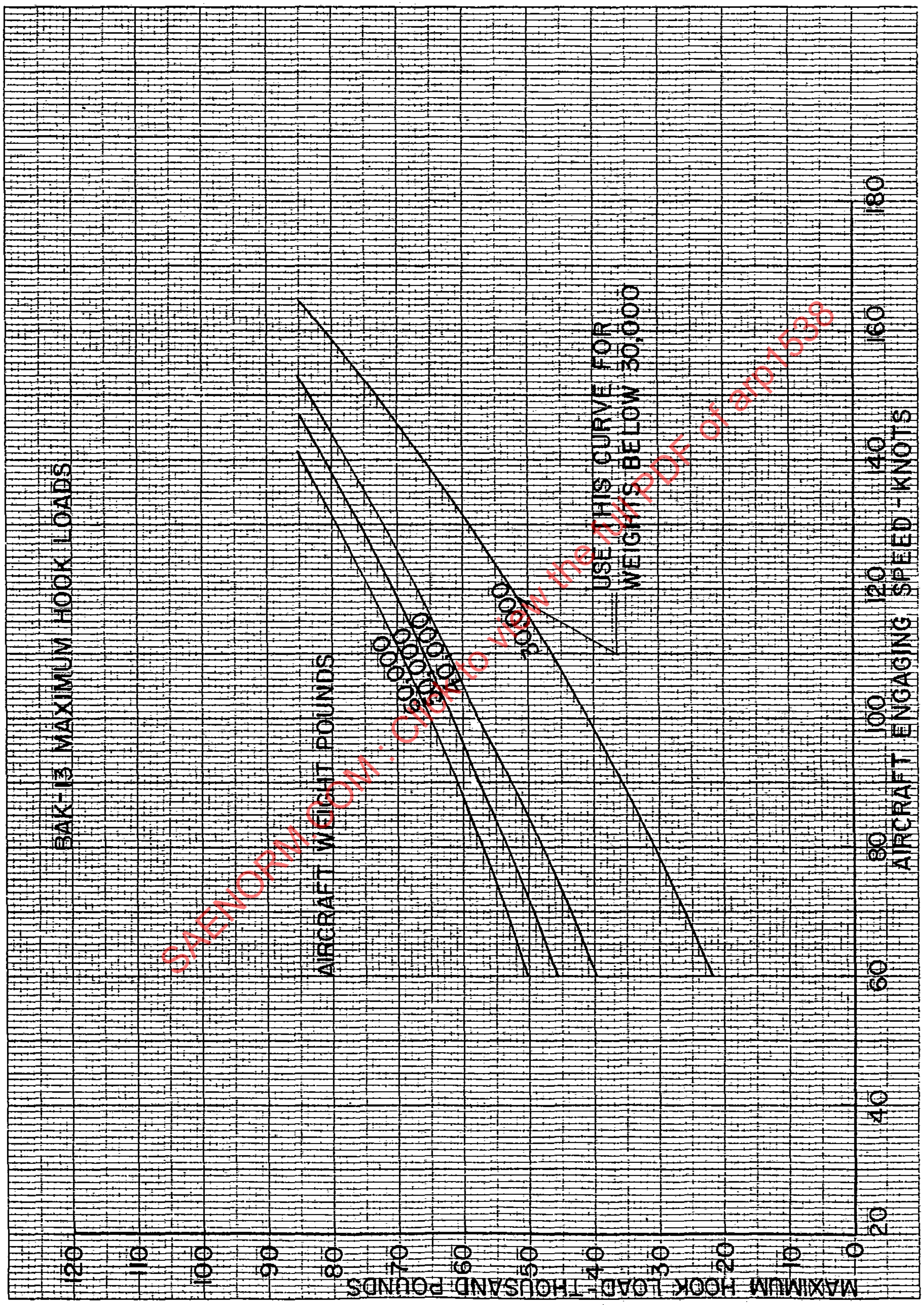
BAK-13 MAXIMUM HOOK LOADS
AIRCRAFT WEIGHT POUNDS
USE THIS CURVE FOR
WEIGHTS BELOW 30,000
MAXIMUM HOOK LOAD-THOUSAND POUNDS
AIRCRAFT ENGAGING SPEED -KNOTS

FIGURE 1

3.2.4.1 Definition of Ground Lines:

Static Ground Line S - The ground line with the aircraft at rest, in the basic mission take-off configuration.

Design Landing Ground Line L - The ground line related to aircraft centerline at the aircraft landing attitude for the design landing configuration (as defined in the detail aircraft specification) with the shock struts and tires deflected to the corresponding landing loads.

Landing Approach Line A - A theoretical line determined by increasing the angle of line L by vectorially adding the design sinking speed, $V_v$ less the max design headwind, $V_W$ to the design landing speed, V.

Maximum Tail Down Ground Line T - The maximum tail down attitude possible, limited by either aircraft structure or the tail bumper (if installed) compressed to maximum working stroke. The shock struts compressed and tires deflected corresponding to design landing loads.

Maximum Nose Down Ground Line N - The maximum nose down ground line caused by either of the following:

a. Brake drag of .31 times the main gear reaction for the weight and C.G. location causing the most nose down attitude, with the strut and tire deflections as appropriate for the applied brake load and weight.

b. A flat nose strut and a flat nose tire for the weight and C.G. location causing the most nose down attitude with main strut and tire deflections as appropriate for the weight.

c. Brake drag of .31 times the main gear reaction for the minimum landing weight and appropriate C.G. with the shock struts and tires serviced at aircraft maximum gross weight and with strut and tire deflections as appropriate for the minimum landing weight and applied brake load.

d. A flat nose strut and a flat nose tire for the minimum landing weight with the main struts and tires serviced at aircraft maximum gross weight and with main struts and tire deflections as appropriate for the minimum landing weight.

Aircraft assumed to have zero roll angle.



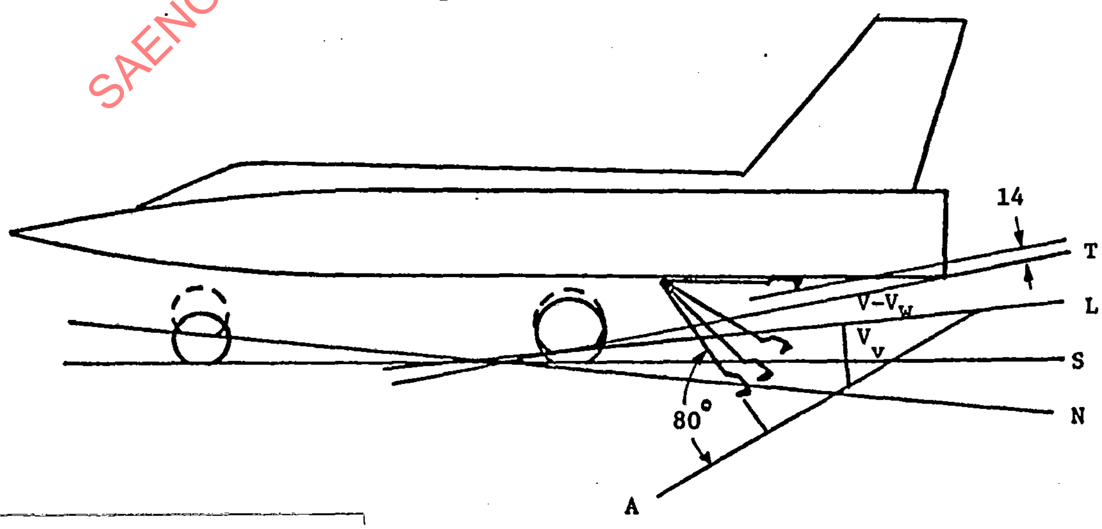


Figure 2

3.2.4.1 (Continued)

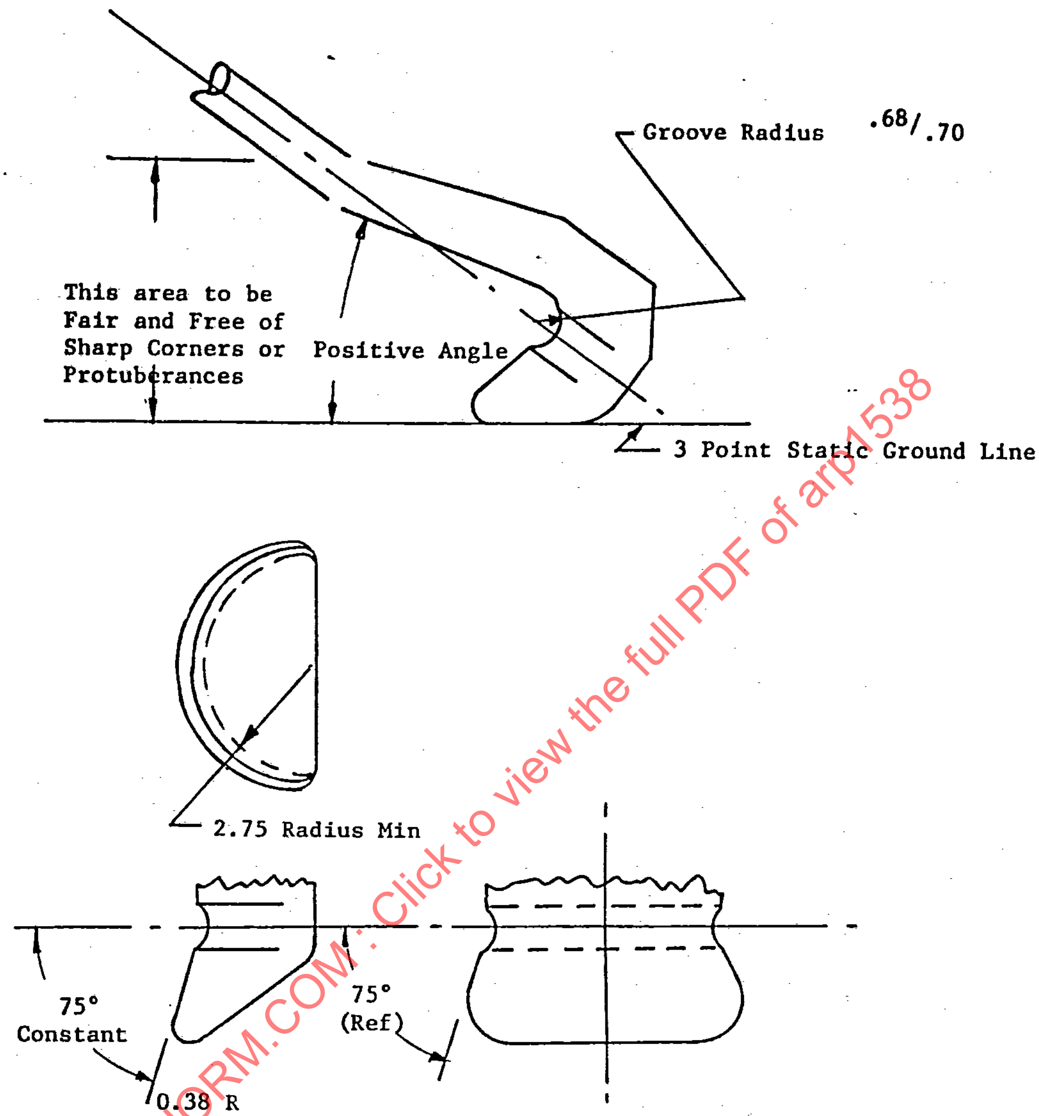


Figure 3 Hook Point Dimensions



3.2.5 Components: Design of the various components of the installation should comply with the following requirements:

a. The hook point contour should be configured as shown in Fig. 3 unless otherwise directed by the procuring activity.

b. The hook point should be easily removable from the shank to allow for replacement in the field. The attachment shall not be loosened or damaged by the normal wear expected during engagement with the runway.

3.2.5 (Continued)

c. A force should be provided to lower and maintain the hook extended against air loads equivalent to the gear down placard speed. This force may or may not be from the same source as the "hold down" moment.

d. The hook should be fully extended and stabilized ready for arrestment within 2 sec after the cockpit release control has been actuated.

e. A "hold down" moment about the hook attach point should be provided to load the hook point against the runway. The following minimum values of hold down moment at various hook positions should be provided; and should not be less than 100 lb at the hook point.

| | |
|---|---|
| Hook on runway, A.C. in 3 point attitude | $M = {}^{I}/15$ |
| Hook full up | $M = {}^{I}/15$ |

Where I = weight moment of inertia of hook about the pivot point in pound-inches squared.

If air is used to provide the hold down and extension moment, a pressure gauge which can be readily observed during normal pre-flight should be incorporated. Any air system should be designed to provide proper load when subjected to the required extreme changes in temperature between servicing and actual use.

f. An energy absorbing device to prevent hook bounce should be provided. The device should limit hook bounce to 2-1/4 in. when taxiing over runway discontinuities and slab mismatch irregularities up to 1/4 inch. The energy absorber should incorporate a load relief device which will allow the necessary rapid movement of the hook during pendant engagement without overloading the hook assembly or back-up structure. The energy absorber may be eliminated if analytical and operational test data can be presented indicating that the hook can be made stable by other means. This data should be approved by the procuring activity prior to release for manufacture of the first article.

g. An uplock mechanism should be provided to retain the arresting hook in the up position during all required aircraft flight and landing conditions and which releases the hook upon command of the pilot. The cockpit controls should be located in accordance with the requirements of AFSCM 80-1 and MIL-STD-203. A manually operated mechanical system independent of the proper function of any other aircraft system is desired. A powered system would be acceptable provided the source of operating force is not adversely affected by the failure of any single airplane power source. The uplock should be readily released and reset from the ground without special tools.

h. A suitable removable ground safety lock with appropriate flag should be provided to prevent accidental actuation of the uplock.

i. An indicator should be provided in the cockpit which indicates when the arresting hook is in the proper position for pendant engagement.

j. If necessary, an up-stop bumper or energy absorber should be provided to prevent damage to the aircraft during overshoot of the hook from initial pendant engagement or from cable wave loads during runout. The device should prevent the hook from causing any damage to the aircraft structure or internal equipment under the most adverse required pendant engagement.