AEROSPACE RECOMMENDED PRACTICE

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

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# SKID CONTROL PERFORMANCE EVALUATION



## 1. PURPOSE

The purpose of this ARP is to recommend, for design and evaluation purposes, methods of defining skid control system performance criteria.

## 2. SCOPE

This document provides recommended methods for measuring performance of skid control systems. It includes test items and equipment.

## 3. DEFINITION

The direct measure of performance is the utilization of the available horizontal ground reaction force between the aircraft tire and the runway, as a result of brake application over the complete range of aircraft operating conditions.

## 4. DISCUSSION

Performance is being specified in greater detail in procurement specifications without definite guidance for design. Standard procedures are necessary to test and evaluate equipment as well as to present results in a uniform and easily comparable manner.

Evaluation of performance on the aircraft is of prime importance. Tests, other than those on an aircraft, may be used to provide complementary performance data. During system design and prior to aircraft availability, other tests such as dynamometer or computer tests may be utilized.

Testing requires the continuous application of sufficient metered pressure to the skid control valve to assure cyclic variations in wheel speed.

Recognition may be given to the measurement of performance indirectly (i.e.; records of braking torque or pressure [in this order]) because there is correlation between them and the horizontal ground reaction force.

## 5. TESTING

Because it is neither the purpose nor scope of this document to modify existing FAA or military documents, the following paragraphs are test recommendations only.

5.1 Aircraft Testing

5.1.1 Data - During aircraft tests, information regarding the following should be noted:

(a) Aircraft configuration including weight, throttle, spoiler, and flap position
(b) Ground speed
(c) Runway location, condition, type, and whether grooved
(d) Tire and brake - condition and type (Condition refers to new or worn tire. Type means manufacturer and whether dimpled, grooved, etc.)
(e) Atmospheric conditions
(f) Any procedure or component change since certification that could affect ground performance.

5.1.2 Replacement Systems - Where standard certification data on an aircraft equipped with a skid control system is available, select three or more of those stops in which a number of pressure releases were recorded and repeat those stops with the alternate skid control system. A direct comparison of field distance can then be made.

If original certification oscillograph records of brake torque (or brake drag) and/or pressure are available, records should be obtained with the alternate system, and performance may be calculated per Section 6.

5.1.3 New System - Certificated Aircraft - Where standard certification data on an aircraft not equipped with a skid control is available, select at least three of those landings or stops where aircraft weights were low. Repeat selected stops with skid control system installed. Compare field distances for performance.

If original certification records of brake torque (brake drag) and/or pressure are available, records should be obtained with the skid-control system, and performance may be calculated per Section 6.

5.1.4 New System - Non Certificated Aircraft - Where certification data is not available, proceed as follows:

Install a multi-channel recorder and necessary transducers to record:

Wheel speed
Brake torque (or drag), where possible
Metered hydraulic pressure upstream of skid-control valve
Pressure at brake inlet port
Valve signal

From oscillograph records, performance can be calculated per Section 6.

5.2 Computer Studies - Proper recognition should be

given to computer studies of skid-control systems. These studies may range from complete electrical simulation of system and components to the inclusion of actual components. For example, an actual valve coil or valve with simulated or actual hydraulic system (including return lines and reservoir back pressure), and a control box may be incorporated in their entirety in the analog system. Ground reaction forces, tire and runway conditions, and speed may be synthesized and used to simulate a wide range of optimum as well as extreme conditions.

The computer makes it possible to study effects of tire friction under wet and dry runway conditions and gear oscillations to insure compatibility and to distinguish between real and false incipient skid conditions.

5.3 Dynamometer Tests - Test items to conduct skid control performance should include, but not be limited to, the following: wheel, brake, and tire assembly, speed sensor, skid-control valve, control box, hydraulic system (including return lines and reservoir back pressure), oscillograph, and necessary transducers.

The following parameters should be recorded with appropriate calibrations: dynamometer speed, test wheel speed, ground reaction force (drag), brake torque, supply and modulated braking pressure, vertical load, rolling radius, tire tread (design and condition). Note should be made whether or not the tire rolling radius if fixed or floating.

Dynamometer conditions should be conducted at the appropriate inertia equivalents and ground speeds. In order to induce skids, the tire loads may be reduced. Tire inflation pressure should be reduced to maintain the same tire deflections. Generally, reductions of 25% to 40% in load are sufficient to induce skids.

More refined testing may require alternate test conditions and equipment, as they are made available, such as programmed tire loading, varying loads, and surface conditions. When wet testing is required, care must be taken to insure that uniform water is applied across the tire tread. Also, when paired wheel control is used with a single valve, an extra brake should be plumbed to the valve.

## 6. DATA PRESENTATION AND CALCULATIONS

Oscillographs are recommended with appropriate transducers. Traces need be identified and appropriate calibrations be supplied. Sketch 1 shows a partial record of torque, brake pressure, and drag recorded as functions of time. Zero levels are indicated.

NOTE: An examination of the wheel speed (and pressure) traces must show there is sufficient variation, both in magnitude and frequency to insure that the brake torque is not suppressed. No perturbations in the speed and pressure traces can indicate that brake pressure is not sampling for operation at higher levels to take advantage of possible increases in ground coefficient following a skid correction.

Curves are faired by drawing lines from peak to peak. After dividing the charts into appropriate lengths, a planimeter may be used to measure areas between the actual and faired curves and the appropriate zero level line. The ratio of the actual to faired areas gives a measure of performance.



PREPARED BY
SUBCOMMITTEE A-5A, WHEELS, BRAKES AND SKID CONTROLS,
OF COMMITTEE A-5, AEROSPACE LANDING GEAR SYSTEMS