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LAND SEA AIR SPACE

AEROSPACE INFORMATION REPORT

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SKID CONTROL SYSTEM VIBRATION SURVEY

1. 1957 SURVEY

During 1957, an industry survey was conducted by SAE Committee A-5 to determine realistic vibration requirements for skid control system specifications. A questionnaire was sent to sixteen airframe manufacturers, three Government agencies, and five skid control system manufacturers. This questionnaire asked for any information that might be available on the vibration characteristics that had been either experienced or calculated on an aircraft in the areas where skid control system components would normally be located, specifically at the axle and at the skid control box locations.

Replies were received from eleven airframe manufacturers, one Government agency, and two skid control manufacturers. Six of these replies stated that they had no information available. Eight airframe manufacturers reported either estimated or measured values as follows:

Company Reporting	Axle Vibration		Skid Control Box Location Vibration	
	Meas.	Est.	Meas.	Est.
Boeing		x		x
Convair, S D			x	
Convair, F W		x	x	
Fairchild	x			
Lockheed	x			
McDonnell	x			
North American	x			
Northrop		x	x	

The reported values are plotted on Figs. 1 and 2 showing the comparison of these values with the vibration requirements of AS 483, Skid Control Equipment.

Study of the figures shows that vibration may occur at the skid control box location with values varying from .03g to 10g and from 5 Hz to 1,000 Hz. Axle vibration values vary from .3g to 200g and 5 Hz to 1,000 Hz.

At the A-5 meeting in October, 1957, the results of this survey were reviewed and it was agreed that skid control system specifications should contain minimum vibration requirements with the stipulation that, if more extreme conditions were anticipated in the aircraft, the higher values should be used in the qualification test. Since the values of the survey are so widely scattered, it would be difficult, if not impossible, to accurately represent more rigorous conditions to be followed in a general specification.

This information is presented merely to show the conditions that exist in some airplanes and it should be used cautiously in requiring higher vibration values for any qualification test. It should be kept in mind that these axle vibration conditions may be transients and only occur for extremely short periods of time during a landing.

2. 1964 SURVEY

In 1964, a survey similar to that which was completed in 1957 was conducted to determine if there was later information that would affect skid control system requirements. Fourteen answers to the questionnaire were received. The results are as follows:

Source	No.	Information
Airframe Manufacturers	6	See following paragraph
Military	0	
Airlines	2	No new information*
Wheel, Brake, and Skid Control Manufacturers	6	No new information
	14	

Information from Airframe Manufacturers:

1 - Nothing new
1 - Same as AS 483
1 - Same as AS 483 but with noise requirement added
3 - Similar to AS 483 but with higher amplitude at low frequency and lower amplitude at very high frequency.

This information is estimated and is included in each of these company's specifications for specific aircraft equipment. One of these airframe manufacturers gave measured values of axle vibration which are slightly higher than indicated in the 1957 survey.

This information has been added to Figs. 1 and 2 as noted in the figure margins.

3. 1976 SURVEY

In 1976, a survey was conducted to obtain updated vibration information for the locations in aircraft where skid control system components are mounted. This survey was similar to those completed in 1957 and 1964 except that it was expanded to include the skid control valve and cockpit display locations. Also, random vibration data was requested for all locations since this type testing is now preferred by MIL-STD-810C, Environmental Test Methods.

Replies were received from thirteen aerospace industry organizations. The results are as follows:

* One airline reported a severe vibration condition of the gear on one model airplane but the skid control system wheel speed transducers did not appear to be adversely affected as compared to the same transducer on other models.

3. (Continued)

Source	Number	Data		No New Data
		Sinusoidal	Random	
Airframe Manufacturers	5	4	3	1
Airlines	1			1
Government Agencies	2	1	1	1
Wheel & Brake Manufacturers	3			3
Skid Control Manufacturers	2	1	1	

The reported data is shown in Tables I through V. This method was chosen for presenting the data since AS 483A, Skid Control Equipment, no longer contains a vibration range curve that can be used for comparison purposes.

A study of the tables shows the following vibration range:

Sinusoidal

Axle - 3 Hz to 4000 Hz and .018g to 50g.
Skid Control Box - 3 Hz to 2000 Hz and .018g to 20g.
Skid Control Valve - 3 Hz to 2000 Hz and .018g to 30g.
Cockpit Display - 5 Hz to 500 Hz and .13g to 16g.

Random

Axle - 10 Hz to 4000 Hz and 18G-RMS to 50G-RMS.
Skid Control Box - 15 Hz to 2000 Hz and 8.9G-RMS to 14.8G-RMS.
Skid Control Valve - 15 Hz to 2000 Hz and 8.91G-RMS.
Cockpit Display - 20 Hz to 2000 Hz and 5.19G-RMS to 8.56G-RMS.

4. NOTES

4.1 Marginal Indicia: The phi (ϕ) symbol indicates technical changes from the previous issue of this document.

PREPARED BY

SAE COMMITTEE A-5, AEROSPACE LANDING GEAR SYSTEMS

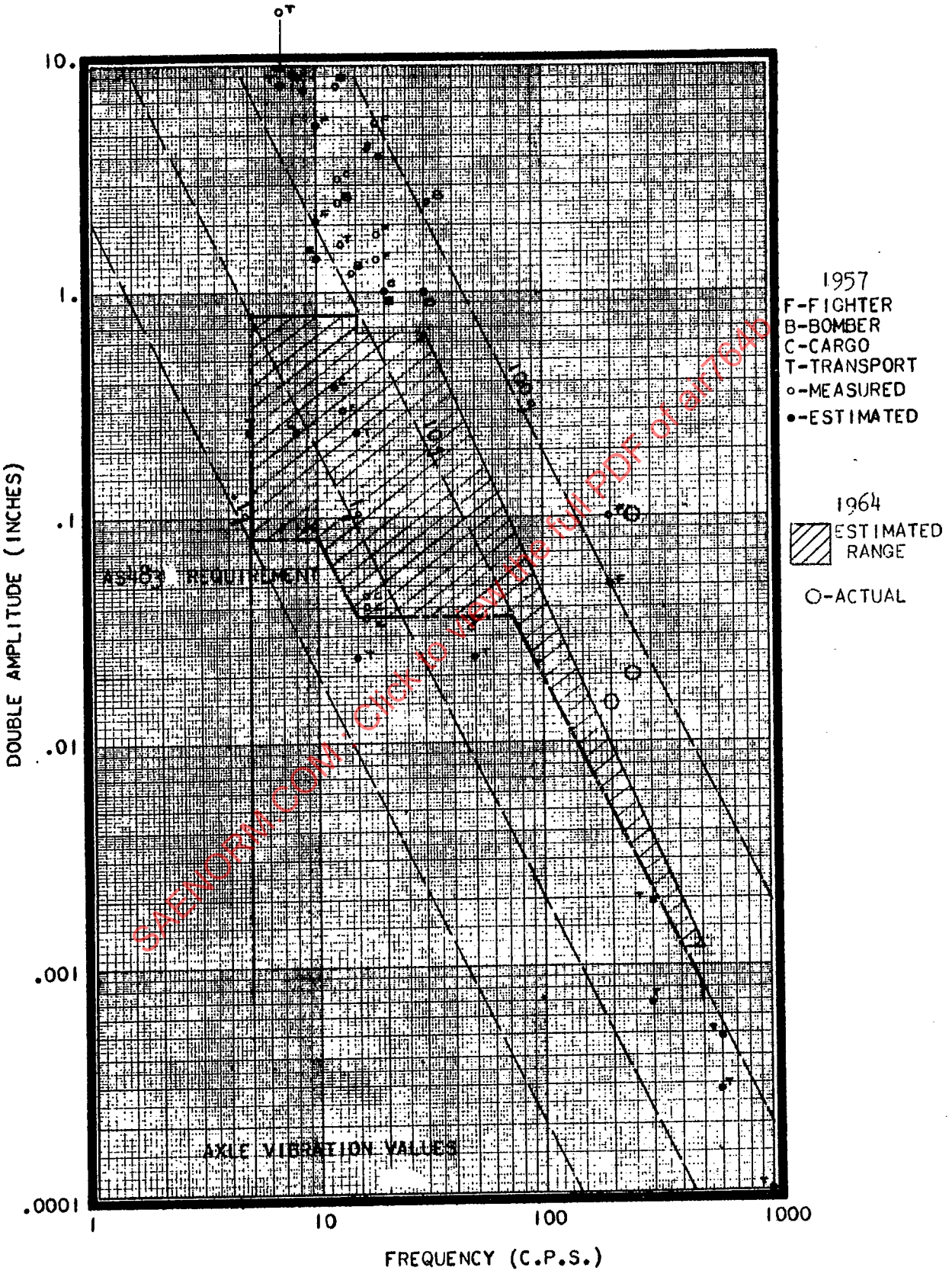

Figure 1

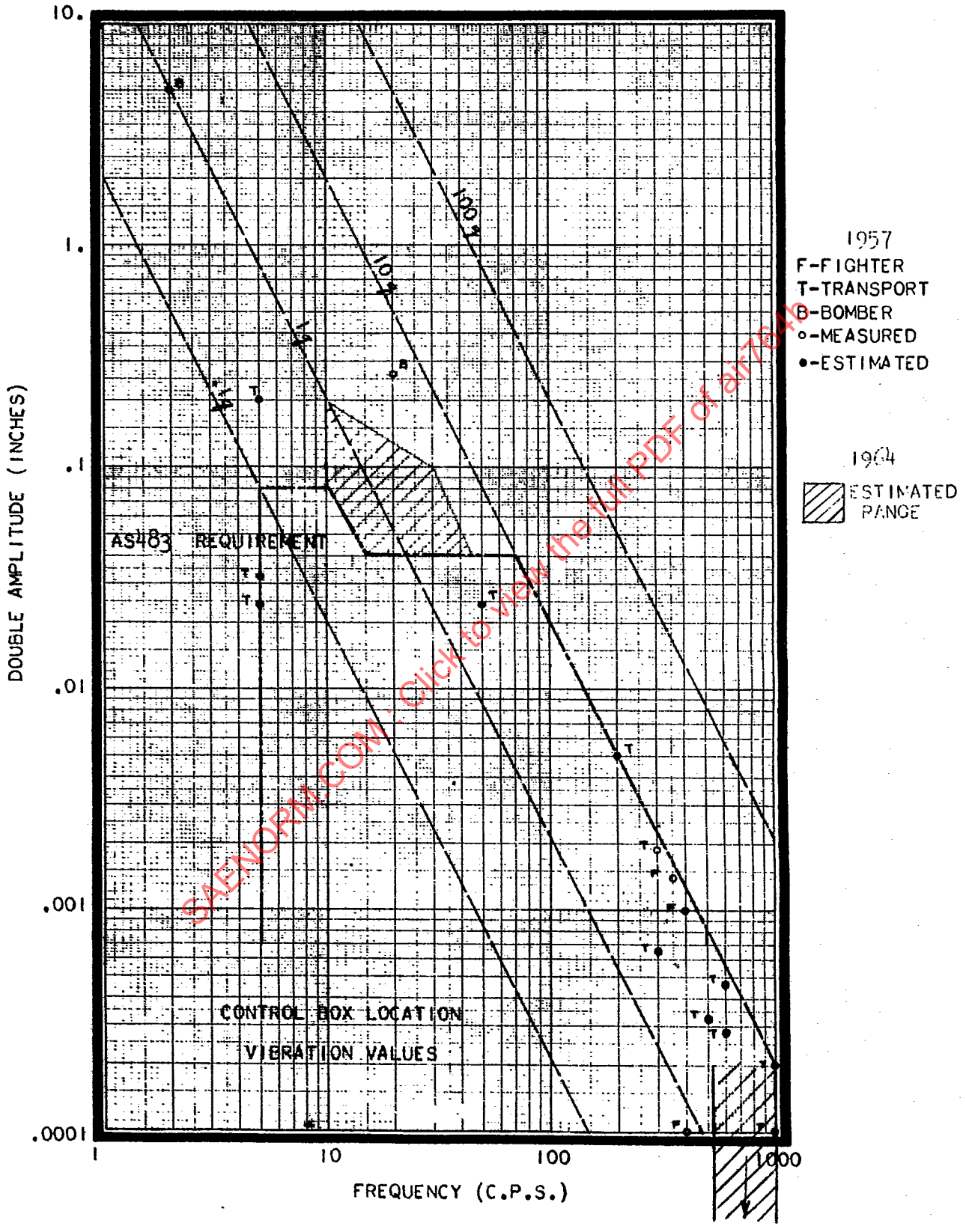

Figure 2

TABLE I - 1976 SINUSOIDAL VIBRATION DATA

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Location: Axle

Aircraft Type	Freq. Hz	Displacement (Double Ampl) Inches	Acceleration (Peak) ±g	Source		Remarks
				Meas.	Est.	
Fighter	5-13	.10	.13-.86		x	
	13-19	.06	.52-1.1		x	
	19-22	.088	1.6 -2.2		x	
	22-74	.036	.89-10		x	
	74-500	.036-.0008	10		x	
Fighter	3-27	.040	.018-1.5		x	
	27-353	.040-.0032	1.5-20		x	Resonance Test
	353-500	.0032-.0016	20		x	
	3-3.6	.03	.14-.20		x	
	3.6-353	.30-.0032	.20-20		x	Endurance Test
	353-500	.0032-.0016	20		x	
Fighter	5-12	.160	.20-1.2		x	
	12-22	.160-.036	1.2-.89		x	
	22-70	.036	.89-9.0		x	
	70-2000	.036-.00005	9.0-10		x	
	50-75	.036	4.6-10		x	Gunfire
	75-300	.036-.0022	10		x	
Fighter	5-10	.08	.10-.41		x	
	10-15	.08-.036	.41		x	
	15-52	.036	.41-5.0		x	
	52-500	.036-.0004	5.0		x	
Fighter	10-18	.20-.06	1.0		x	
	18-100	.06	1.0-30		x	
	100-500	.06-.0023	30		x	
	500-2000	.004-.0002	50		x	
	2000-4000	.0001-.00002	20		x	
Bomber	5-2000	.50-.00015	.64-30		x	Operating
	5-2000	.50-.0002	.64-40		x	Nonoperating
Bomber	5-28	.50	.64-20		x	
	28-2000	.50-.0001	20		x	

TABLE II - 1976 SINUSOIDAL VIBRATION DATA

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Location: Skid Control Box

Aircraft Type	Freq. Hz	Displacement (Double Ampl) Inches	Acceleration (Peak) ±g	Source		Remarks
				Meas.	Est.	
Fighter	5-10	.06	.076-.31		x	
	10-20	.10	.51-2.0		x	
	20-23	.065	1.3-1.8		x	
	23-74	.036	.97-10		x	
	74-500	.036-.0008	10		x	
Fighter	3-27	.04	.018-1.5		x	
	27-353	.04-.0032	1.5-20		x	Resonance Test
	353-500	.0032-.0016	20		x	
	3-3.6	.30	.14-.20		x	
	3.6-353	.30-.0032	.20-20		x	Endurance Test
	353-500	.0032-.0016	20		x	
Fighter	5-11	.18	.23-1.1		x	
	11-22	.18-.036	1.1-.89		x	
	22-40	.036	.89-2.9		x	
	40-300	.036-.0007	2.9-3.2		x	
	300-2000	.0018-.00004	8.3-8.2		x	
Fighter	5-10	.08	.10-.41		x	
	10-15	.08-.036	.41		x	
	15-52	.036	.41-5.0		x	
	52-500	.036-.0004	5.0		x	
Bomber	5-63	.25-.015	.32-3.0		x	Operating
	63-100	.015	3.0-7.7		x	
	5-63	.34-.02	.43-4.0		x	Nonoperating
	63-100	.02	4.0-10.2		x	
Bomber	5-15	.175	.22-2.0		x	
	15-150	.175-.0017	2		x	
Transport	5-15	.1	.13-1.1	x		
	15-100	.108-.0024	1.25	x		Service Level
	100-150	.0005-.0002	.25	x		

TABLE III - 1976 SINUSOIDAL VIBRATION DATA

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Location: Skid Control Valve

Aircraft Type	Freq. Hz	Displacement (Double Ampl) Inches	Acceleration (Peak) ±g	Source		Remarks
				Meas.	Est.	
Fighter	5-10	.06	.076-.31		x	
	10-20	.10	.51-2.0		x	
	20-23	.065	1.3-1.8		x	
	23-74	.036	.97-10		x	
	74-500	.036-.0008	10		x	
Fighter	3-27	.04	.018-1.5		x	
	27-353	.04-.0032	1.5-20		x	Resonance Test
	353-500	.0032-.0016	20		x	
	3-3.6	.30	.14-.20		x	
	3.6-353	.30-.0032	.20-20		x	Endurance Test
	353-500	.0032-.0016	20		x	
Fighter	5-12	.16	.20-1.2		x	
	12-22	.16-.036	1.2-.89		x	
	22-70	.036	.89-9.0		x	
	70-2000	.036-.00005	9.0-10		x	
Fighter	5-10	.08	.10-.41		x	
	10-15	.08-.036	.41		x	
	15-52	.036	.41-5.0		x	
	52-500	.036-.0004	5.0		x	
Bomber	5-2000	.50-.0001	.64-20		x	Operating
	5-2000	.50-.00015	.64-30		x	Nonoperating
Bomber	5-28	.50	.64-20		x	
	28-2000	.50-.0001	20		x	