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Subject: FAR 121-344, Appendix M Resolution Amendment Request

Reference: Boeing letter B-H300-01-JGD-011, J. Draxler to ARM-1,
Office of Rulemaking, dated May 22, 2001

Dear Sir/Madam:

Summary

The purpose of this letter is to provide additional information and clarification of the information provided in the referenced letter. Boeing is providing this information to support our earlier request for an amendment to the FAR 121.344, Appendix M flight data recorder systems (FDRS) resolution requirements to allow three Boeing airplane models to record certain data parameters using resolution requirements that differ slightly from the current regulation.

Background

Boeing requested in May 2001 an exemption to FAR 121.344, Appendix M resolution requirements for a total of ten parameters on three different model airplanes; the 717, the 757 and the 767. A detailed explanation of the specific parameters and the deviance in the existing resolution from that required in Appendix M is provided in Attachment I to this letter.

Boeing believes that recording of these parameters using the existing resolution does not compromise the integrity of the signal and should not hinder any accident or incident investigation. Use of the existing levels of parameter resolution will allow airlines to use their existing installations and not require costly system revisions that will not provide appreciable benefit.

Analysis

Attachment I to this letter outlines the difference between the existing recorded resolution of a specific parameter and that required by Appendix M. Within the attachment both the direct and indirect effects of the recorded parameter are provided.



While Boeing recognizes that the level of recorded parameter resolution is used during accident investigations to determine whether small deviations from the steady state are real inputs, we also believe that the resolution concerns are neither large enough to result in appreciable change in airplane motion nor do they have a meaningful effect on the overall analysis of an accident.

For example, in the case of the 767 inboard aileron resolution requirement Boeing presently records to a resolution of 0.087 degrees. This resolution would result in the trailing edge of the aileron moving 0.0789 inches, which is less than the total thickness of the trailing edge that measures 0.1213 inch. The difference between the required and actual resolution being recorded at this time of 0.001 degrees corresponds to a total movement of the aileron trailing edge of only 0.0009 inch.

In another example, although the present recorded vertical acceleration resolution of 0.00458g on the 717 exceeds the required resolution of 0.004 g, this difference is equivalent to a negligible error of 58 pounds in determining the weight of a 100,000 pound airplane. This slight deviation was an oversight during the initial design stages and when presented to the Los Angeles Airplane Certification Office in November 1998, an exemption to this specific requirement of FAR 121-344, Appendix M was granted.

Required Modifications

Changes required to the ten existing recorded parameters to meet the Appendix M resolution requirements would require redesigned components, changes to existing dataframes and new sensor installations. We estimate that these changes to the 65 affected 717 airplanes, 103 affected 757 airplanes, and 366 affected 767 airplanes presently operating under FAA authority would result in a total cost of approximately \$38 million. The overall expense of modifying the total affected 76 model 717, 134 model 757 and 969 model 767 airplanes operating worldwide would be approximately \$45 million. Boeing also estimates that redesign of the existing systems would require from six months to one year, with retrofit on affected airplanes requiring an additional one to two years.

Present Compliance

Excepting the 767 inboard aileron position and 717 vertical acceleration resolution, Boeing meets or exceeds the Appendix M range, accuracy, and resolution requirements on all newly delivered airplanes. In addition, excepting the resolution of the ten parameters outlined in Attachment I, Boeing presently has in place modifications that meet or exceed the range, accuracy, and resolution requirements of Appendix M for delivered airplanes



Boeing believes that the use of existing levels of recorded parameter resolution as outlined in Attachment I neither compromises the integrity of the recorded parameter nor will compromise any accident or incident investigation. Boeing also believes that requiring operators to modify the recording systems for these ten parameters in order to meet the requirements of FAR121.344, Appendix M would result in a costly retrofit with no appreciable benefit.



BOEING

Sincerely,

Jerry Mack

Gerald R. Mack

Vice President, Safety and Technical Affairs

Boeing Commercial Airplanes

cc: Mr. Howard Swancy

Attachments:

Attachment I	717/757/767 FDRS Parameters – Resolution Impact Summary
Attachment II	767 Inboard Aileron Travel
Attachment III	717 Vertical Acceleration Resolution Issue

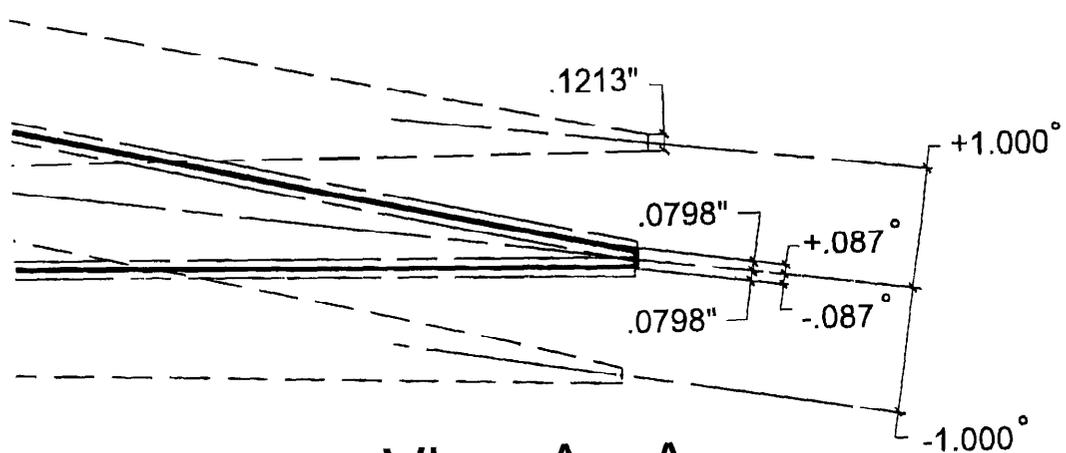
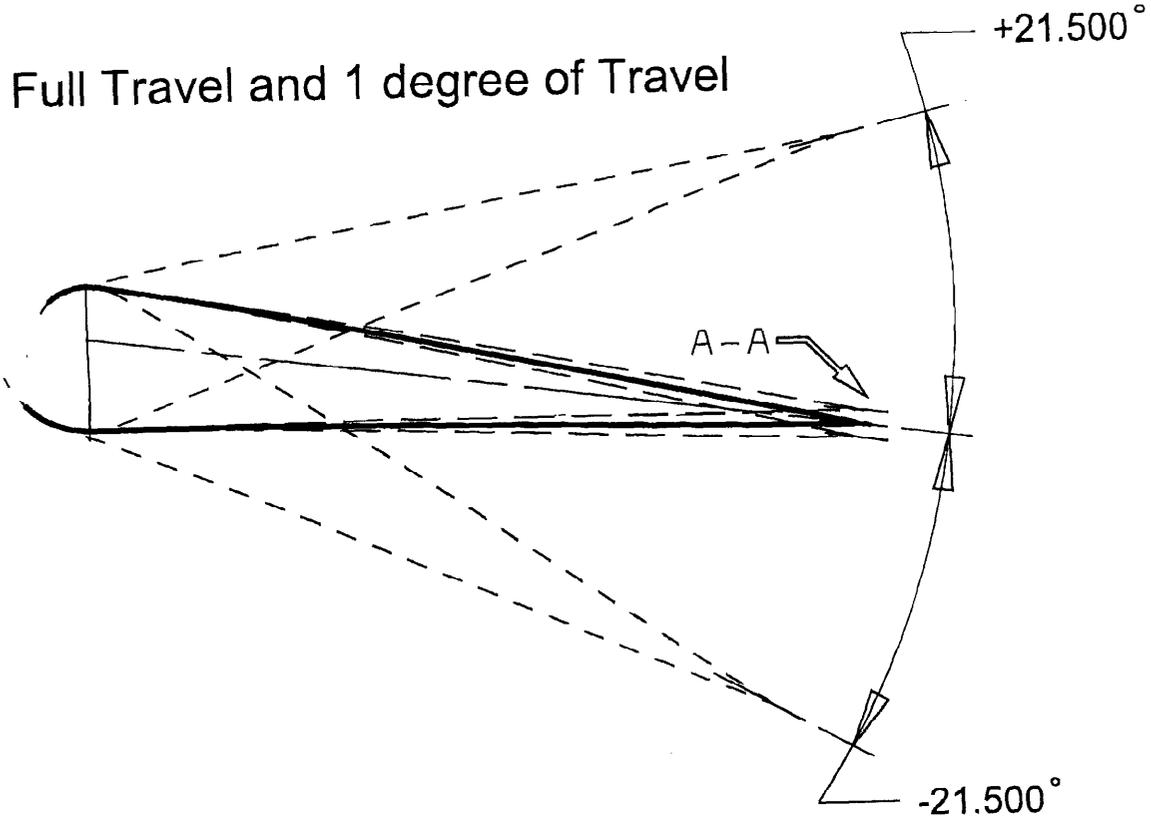
717/757/767 FDRS Parameters - Resolution Impact Summary

717 Parameters	Control Input:			Airplane Free Response:		
		Delta Resolution (Boeing - Required)	Update Rate	Direct Effect:		Indirect Effect:
5. Vertical Acceleration	(Not Applicable)	0.00058 (0.00458 - 0.004)	0.125 sec	Delta Control Surface N/A	Delta Euler Rate (deg./sec.) N/A	Delta Acceleration 0.00058 Nz

757 Parameters	Control Input:			Airplane Free Response:		
	Baseline (<i>Large</i>) Control Displacement (light-mid. weight; aft CG, cruise condition)	Delta Resolution (Boeing - Required)	Update Rate	Direct Effect:		Indirect Effect:
12a. Control Column Position	8.0775 degree push 9.923 degree pull	0.038 (0.082 - 0.044)	0.5 sec	Delta Control Surface - Peak (deg.) 0.086 / 0.101 deg elevator	Delta Euler Rate - Peak (deg./sec.) .003 / .009 pitch	Delta Acceleration - Peak (g's) 0.0004 Nz
14a. Rudder Pedal Position	3.2 inch input	0.028 (0.088 - 0.06)	0.5 sec	0.011 deg rudder	.010 yaw, .058 roll	0.00036 Ny
19. Stabilizer Position	1.1 degree increment, leading edge up/down	0.022 (0.068 - 0.046)	1 sec		.075 / .046 pitch	0.0011 / 0.0002 Nz
23. Speedbrake Handle Position	70 degree input	0.196 (0.352 - 0.156)	1 sec	0.089 deg spoiler	.0116 roll	0.0009 Nz

767 Parameters	Control Input:			Airplane Free Response:		
	Baseline (<i>Large</i>) Control Displacement (light-mid. weight; aft CG, cruise condition)	Delta Resolution (Boeing - Required)	Update Rate	Direct Effect:		Indirect Effect:
12a. Control Column Position	6.5 degree push 9.0 degree pull	0.049 (0.088 - 0.039)	0.5 sec	Delta Control Surface - Peak (deg.) 0.080 / 0.100 deg elevator	Delta Euler Rate - Peak (deg./sec.) 0.15 / 0.08 pitch	Delta Acceleration - Peak (g's) 0.001 / 0.0008 Nz
14a. Rudder Pedal Position	6.5 degree input	0.028 (0.088 - 0.06)	0.5 sec	0.016 deg rudder	0.012 yaw, 0.10 roll	0.0004 Ny
16. Aileron Position (Inboard)	18.314 degree input	0.001 (0.087 - 0.086)	0.5 sec		0.0011 roll	0.000004 Nz
19. Stabilizer Position	1.5 deg. increment, leading edge up / down	0.021 (0.064 - 0.043)	1 sec		0.06 / 0.04 pitch	0.021 / 0.0001 Nz
23. Speedbrake Handle Position	65 degree input	0.196 (0.352 - 0.156)	1 sec	0.151 deg spoiler	0.005 pitch	0.0003 Nz

767 INBOARD AILERON TRAVEL



View A - A

The smallest amount of movement recorded (resolution) is .087 degrees.
The required resolution is .2% of full range, which equates to 086 degrees.
The difference between the required and actual resolution, .001 degrees, would move the tip of the aileron .0009 inches.

Vertical Acceleration Resolution Issue:

Vertical Acceleration (N_z) defines the relationship of Lift to Weight.

$$N_z = \text{Lift}/\text{Weight}$$

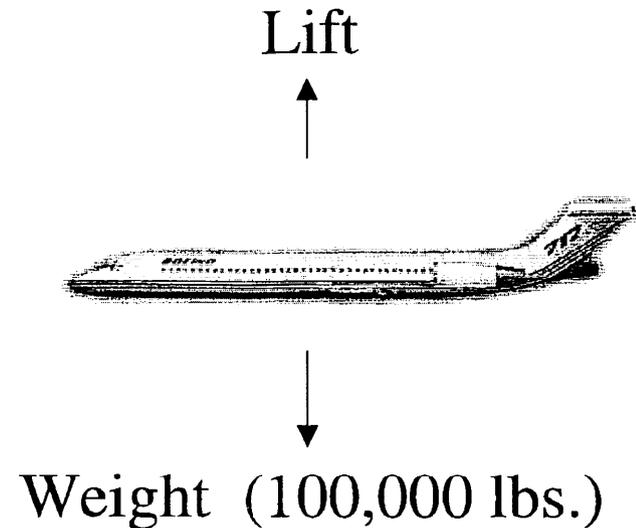
For level flight, $\text{Lift} = \text{Weight}$,
Hence $N_z = 1$.

Resolution Increment Impact:

N_z resolution requirement = .004g

Boeing resolution capability = .00458g

$$\Delta N_z = .00058g$$



For a 100,000 pound airplane, $\Delta N_z = .00058g$ is equivalent to 58 pounds of weight.



100 lbs.

Relating this to a 100 pound person, this would be equivalent to not knowing one's weight to within .058 pounds (less than one ounce).