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National Transportation Safety Board

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Office of the Chairman

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Dear Sir/Madam:

The Safety Board has reviewed Special Federal Aviation Regulation (SFAR) No. 89 "Digital Flight Data Recorder [DFDR] Resolution Requirements" dated August 22, 2001, and concurs with the intent of the regulatory change to provide temporary relief to the operators of specified airplanes from the FDR resolution requirements of appendix M for certain parameters.

Because this SFAR was the direct result of a petition for exemption from the Boeing Company (Boeing), the Safety Board believes that its comments would be most effective if specifically directed toward the Boeing petition. To that end, the Safety Board requested and received a copy of the May 22, 2001, letter from Boeing to the Federal Aviation Administration (FAA) Office of Rulemaking that requested the exemption from FAR 121.344, appendix M resolution requirements for certain parameters on some Boeing airplane models. In reviewing this letter, the Safety Board found a number of exemption requests, regulation updates, and position statements that go beyond what is addressed by this SFAR. The Safety Board believes that some of the positions and opinions expressed in that letter could significantly influence subsequent DFDR rulemaking. Therefore, the Safety Board offers the following comments to the May 22, 2001, letter from Boeing that requests an exemption from FAR 121.344, appendix M resolution requirements.

The Boeing letter requests that FAR 121.344, appendix M be amended to take into account parameter accuracy requirements when determining the resolution requirement. The letter states "...the resolution requirements should not be many orders of magnitude greater than the accuracy requirements." Although we are in general agreement with this statement, the Boeing letter goes on to say that if their definition of resolution were followed there would be no need for the FAR to list a minimum resolution requirement. The Safety Board does not agree with this position and believes that the resolution requirements should remain in the rules as written.

Parameter resolution can impact the quality of digital data; too coarse a resolution could result in a significant event going undetected. There is an economic incentive to use coarse resolution: finer resolution equates to increased memory requirement, and increased memory equates to increased recorder costs. Therefore, the rules must retain the explicit resolution requirements so as to minimize the opportunity for any misinterpretation that would reduce data quality to an unacceptable level.

The Safety Board recognizes that regulations must be written in terms that can be uniformly applied and, as a result, may not be directly applicable in all instances. This circumstance is especially true for FDR rules where detailed technical specifications must be crafted into rule language that references recognized technical standards (such as EUROCAE document ED-55) while attempting to harmonize with the regulatory requirements of other nations. Because of this need, there will be occasions when rule language will result in requirements that are more stringent than necessary.

With the exception of vertical acceleration on the Boeing 717, all of the parameters for which Boeing is requesting an exemption involve flight controls for which the resolution requirements are based on a percentage of the parameter's full range of travel. Because the range of travel for these parameters varies greatly from one model aircraft to another, it would not be practical to express the range of travel for all aircraft. Therefore, the resolution requirements are presented as a percentage of the parameter's full range of travel. As a result, when the full range of a parameter is relatively short, the resolution requirements may be more stringent than necessary. When this situation arises, the minimum resolution for a given parameter should be evaluated to determine if regulatory relief could be granted and the accuracy requirements maintained. With this in mind, the Safety Board has reviewed the Boeing request for exemption from the FDR resolution requirements in FAR 121.344, appendix M, and with the exception of vertical acceleration for the 717, found no objection to granting the requested exemptions.

With regard to parameter vertical acceleration for the 717, it is not clear why the minimum resolution requirements cannot be met. A review of the 717 FDR system documentation indicates that the parameter vertical acceleration is being written as a 12-bit word, which is normally more than sufficient to meet the minimum resolution requirements of "0.004g" (for example, on MD-80s, vertical acceleration is recorded in a 12-bit word and the resolution is 0.0022895g).

The Boeing letter also contains a definition for "Recorder Resolution." Although we are in general agreement with this definition, we believe that the reference to "facilitating the conversion of recorded data" could be misinterpreted when complex conversion algorithms are required. Therefore, the Safety Board suggests the following modified version:

> Recorder Resolution
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> Resolution is the smallest change in the recorded parameter, which is the least significant data bit recorded, and should be such that it does not compromise the accuracy of the parameter (resolution should be approximately an order of magnitude finer than the required parameter accuracy).

The Boeing letter goes on to provide additional discussion on digital data accuracy, which includes the following statement: "The accuracy of a digital signal should not need to be any greater than the accuracy required by the originating system." Although this statement is true for many digital parameters, there are cases where it does not apply. An example would be the flight control surface position on early model Boeing 757 and 767 airplanes, which recorded the flight control position data displayed to the crew via the Engine Indication and Crew Alerting System (EICAS). These data were heavily filtered and smoothed so as to produce a clear presentation on the cockpit display. However, these filtered data lacked sufficient accuracy to allow for a detailed analysis of the flight control position time history during dynamic events. To correct this problem, appendix M now includes the following statement: "The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions." Therefore, the Safety Board does not agree with the following Boeing definition of digital data accuracy:

> Digital Accuracy Definition
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> When a digital data bus provides the input signal to the flight recorder system, the accuracy requirement is "as Installed" and (equal to the accuracy requirement of the originating system that digitizes the data).

The Boeing letter also identified 11 areas in appendix M for update. The following discussion gives the Safety Board position on Boeing's proposed updates:

Parameter 5, Normal Acceleration

Boeing Position: The accuracy required is +/- 1% of full range (+6 to -3g), which equates to +/- 0.09g. A resolution that is an order of magnitude finer than the accuracy is 0.018g. The same resolution that is in appendix B should be retained "0.01g" not "0.004g."

Safety Board Position: The parameters vertical, lateral, and longitudinal accelerations are unique in that their resolution requirement can at times be more significant to the investigation than their absolute value. For example, investigators often use the momentary spikes in the acceleration values to determine specific events, such as an aircraft departing the paved surface of the runway, brake release, or the onset of an abrupt maneuver. In these instances the absolute value of the "g" spike is less significant than the detection of the event. Too coarse a resolution and these critical events could go undetected. Therefore, the Safety Board concludes that the resolution of these parameters should not be changed. Boeing and other aircraft manufacturers typically assign a 12-bit word to record vertical acceleration, which is more than adequate to meet the FAR resolution requirements.

Parameter 12a, Pitch Control

Boeing Position: Accuracy should be the same as other primary controls (12b through 17) "+/- 2°" not "+/- 2%."

Safety Board Position: This appears to be a typo and should be corrected during the current rulemaking effort.

Parameter 19, Pitch Trim

Boeing Position: Accuracy should be the same as the other surface position requirements (parameters 15, 16, and 17) "+/- 2°" not "+/- 3%."
Safety Board Position: The sensitivity of the pitch trim/stabilizer requires a higher accuracy. A resolution of "+/- 3%" also harmonizes the FAR with ED-55.

Parameter 87, Ground Spoiler/Speed Brake

Boeing Position: Accuracy should be consistent with parameter 23, Ground Spoiler/Speed Brake "+/- 2°" not "+/- 5%."
Safety Board Position: Parameter 23 is less stringent as it applies to existing aircraft and aircraft under contract to be constructed when the rule was issued. Parameter 87 applies to aircraft manufactured after August 19, 2002, and harmonizes with ED-55 and, therefore, should not be changed.

Parameters 12 through 17, Primary Controls and Surfaces; 19, Pitch Trim; and 23 and 87, Ground Spoiler/Speed Brake

Boeing Position: Resolution should be only an order of magnitude finer than accuracy and in the same units "0.4°" not "0.2%."
Safety Board Position: FAR 121.344, appendix M should not be changed, but the resolution requirements could be relaxed if it can be demonstrated that compliance would not be practical and the resolution could be maintained at least at a magnitude finer than the accuracy.

Parameter 85, Trailing Edge Flap/Cockpit Control

Boeing Position: Accuracy should be consistent with Parameter 20, Leading Edge Flap/Cockpit Control "+/- 3°" not "+/- 5%."
Safety Board Position: We agree with the Boeing position; the wording change would harmonize the FAR with ED-55.

Parameter 86, Leading Edge Flap/Cockpit Control

Boeing Position: Accuracy should be consistent with Parameter 20, Leading Edge Flap/Cockpit Control "+/- 3°" not "+/- 5%."
Safety Board Position: We agree with the Boeing position; the wording change would harmonize the FAR with ED-55.

Parameters 20 and 85, Trailing Edge Flap/Cockpit Control; and 21 and 86, Leading Edge Flap/Cockpit

Boeing Position: Resolution should be only an order of magnitude finer than accuracy and in the same units "0.6°" and not "0.3%."
Safety Board Position: FAR 121.344, appendix M should not be changed, but the resolution requirements could be relaxed if it can be demonstrated that compliance would not be practical and the resolution could be maintained at least at a magnitude finer than the accuracy.

Parameter 26, Radio Altitude

Boeing Position: There is no resolution requirement below 500 ft; "1 ft below 500 ft" should be added.
Safety Board Position: We agree with the Boeing position; "1 ft below 500 ft" should be added; this addition would also harmonize the FAR with ED-55.

Parameter 56, Multi-function/Engine Alerts Display Format

Boeing Position: The remarks section contains the following notation: "off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded." It is believed that some text was excluded from the remarks and should be similar to the remarks in EUROCAE MOPS for Flight Data Recorder Systems (ED-55) "e.g., off, normal, fail, and the identity of displayed pages for emergency procedures checklist. Information in checklists and procedures need not be recorded."
Safety Board Position: We agree with the Boeing position; the wording change would harmonize the FAR with ED-55.

Parameters 82, Trim Control-Pitch; 83, Trim Control-Roll; 84, Trim Control-Yaw; 88, Control Forces

Boeing Position: Resolution should be only an order of magnitude finer than the accuracy "1%" not "0.2%."
Safety Board Staff Position: FAR 121.344, appendix M should not be changed, but the resolution requirements could be relaxed if it can be demonstrated that compliance would not be practical, and the resolution could be maintained at least at a magnitude finer than the accuracy.

The Safety Board is very interested in maintaining the quality of FDR data and will give its full support to this rulemaking effort to ensure that the Board's position on this important subject is clearly understood.

Sincerely,

Marion C. Blakey
Chairman