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Ford Motor Company

NHTSA-03-15351-9

DEPT OF TRANSPORTATION DOCKETS

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James P. Vondale, Director
Automotive Safety Office
Environmental & Safety Engineering

August 8, 2003

Jeffrey W. Runge, M.D.
Administrator, National Highway-Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Re: Petition for Reconsideration – FMVSS 213, Child Restraint Systems
(Docket 03-15351; 68 Fed. Reg. 37620, June 24, 2003)

Dear Dr. Runge:

Ford Motor Company, a domestic manufacturer and importer of motor vehicles with offices at One American Road, Dearborn, Michigan 48126-2798, hereby petitions for reconsideration of certain amendments to Standard 213 regarding Child Restraint Systems. This response covers all brands encompassed by Ford Motor Company (Ford, Lincoln, Mercury, Mazda, Volvo, Jaguar, Land Rover, and Aston Martin.) Through Volvo Cars of North America, Ford Motor Company is also a developer, importer and marketer of add-on child restraint systems.

Ford Motor Company supports the agency's efforts to improve testing of child restraint performance. These amendments will improve test technology and make child restraint testing more representative of today's vehicle environment. But changes to the sled test pulse specification raise concerns about objectivity of the performance requirements, and would increase resource requirements without a commensurate increase in child safety.

Sled Test Pulse

Increasing the Maximum Pulse Severity

The pulse corridors adopted by the agency allow a maximum severity pulse, ignoring any effect of lengthening the pulse duration, which is significantly more severe than the current FMVSS 213 pulse. Ford Motor Company believes that the agency intended to lengthen the pulse to achieve a greater velocity change, but did not intend to specify a pulse with a higher average deceleration.

It does not appear from the Notice that the agency intended to increase the average acceleration of the pulse, but the new pulse corridors would allow increased average acceleration. The agency clearly intended to allow a full 30 mph change in velocity (ΔV), and lengthened the maximum permitted duration of the pulse to 90 ms to allow a full 30 mph velocity change. But broadening the pulse corridors from 3g to 6g allows a 30 mph ΔV by increasing average acceleration instead of increasing pulse duration. The width of the pulse corridor in the new Figure 2A is 6g, between 19 and 25 g, while the pulse corridor in the older Figure 2 was only 3g wide, between 21 and 24 peak g. The lengthening of the pulse to 90 ms is a clear indication that the agency intended to reach 30 mph ΔV by extending the length of the pulse, not by increasing the average acceleration of the pulse. The upper bound of the new pulse specified by Figure 2A results in a theoretical maximum ΔV of 36.5 mph, 20% over the 30 mph ΔV specified for the test. Even if a test contractor shortened the pulse effective duration (using a low acceleration for the first few milliseconds) to the minimum of 71 ms permitted by the new corridor, the higher accelerations allowed by the wider corridor can still produce a ΔV greater than 30 mph.

Figure A shows one of the most severe 30 mph theoretical pulses permitted by the new corridors. Note that the Figure A pulse does not maintain the peak acceleration of 25 g for the entire permitted interval, because doing so would exceed the 30 mph limit on ΔV. Figure B shows what appears to be the least severe 30 mph ΔV pulse permitted by the new corridors. Although both of these pulses have a 30 mph ΔV, they are quite different in severity. The acceleration in the Figure B pulse averages 15.2 g, while the Figure A pulse averages 19.4 g, a 27% higher acceleration severity. Although these theoretical pulses cannot be achieved by any existing sled test technology, the latest servo-hydraulic sled control technology can come very close to replicating these pulse shapes. Ford believes that a pulse corridor that allows a potential 25% variation in pulse severity is not sufficiently objective. Further, we believe that the agency did not intend to permit a pulse with a significantly higher average acceleration than the current FMVSS 213 pulse.

To illustrate the effects of various potential pulses that meet the new pulse specifications, the following table shows 3-year-old Hybrid III dummy predicted results from a MADYMO model of a LATCH child restraint subjected to three 30 mph ΔV pulses that fall within the new pulse corridors; the traditional FMVSS 213 pulse, the 25 g pulse of Figure A, and the 19 g pulse of Figure B. This MADYMO model is not fully representative of typical 213 compliance tests because it assumes a rigid generic child restraint structure, rigid generic LATCH and tether anchors, a short tether strap mounted high on the child restraint, and webbing characteristics similar to typical adult polyester belts. Because the resulting restraint model is stiffer than a typical add-on LATCH child restraint, the results from the model may be more indicative of generic built-in child restraint performance than of typical add-on child restraint test results. All of the simulations appear to meet the required performance criteria, but the differences are substantial, and the resultant chest acceleration during the most severe pulse is only 17% below the compliance limit.

	15 ms HIC	Chest Accel. (3ms)
Shortest Pulse (Fig. A)	346	49.5 g
Old 213 Shape (Fig. C)	237	46.5 g
Longest Pulse (Fig. B)	187	39.0 g

The agency adopted pulse corridors that allow decelerations between 19 and 25 g for much of the pulse duration, a variation of 6 g or about 30%. In contrast, the FMVSS 208 generic pulse specifies a peak g variation of only 2.2 g. We believe that test labs can consistently meet the 2.2 g corridor specified in FMVSS 208. The 19 to 25 g variation would allow a pulse that has an average deceleration about 10 percent higher than the current pulse. Thus the pulse corridors adopted are inconsistent with the intent of the agency to specify an equivalent, but slightly longer pulse. In discussing comments that opposed a more severe pulse, the preamble states (at 37640):

> *NHTSA concurs with these comments that the standard's crash pulse adequately meets a safety need. Increasing the severity could necessitate the redesign of many child restraints and could increase costs of the restraints to manufacturers, without a proportionate safety benefit. Thus, the agency concludes that the pulse should not be made more severe at this time.*

In defending its lengthening of the pulse duration, NHTSA stated (at 37634):

> *Widening the test corridor from 80 ms to approximately 90 ms in duration does enable NHTSA to test child restraints closer to 30 mph than the present. To the extent that the 30 mph tests are more stringent than tests conducted in the past at slightly lower speeds, that result is a desired outcome of the amendment. Widening the corridor improves the effectiveness of the test. Child restraint manufacturers will have to certify that their child restraints meet the requirements of FMVSS No. 213 when tested using the test pulse, possibly at a higher velocity.*

The agency could have increased the velocity change of the pulse without allowing a higher acceleration by maintaining the existing pulse corridors up to about 65 ms, and only widening the pulse bounds after 65 ms by drawing a new line between 15g @ 65 ms and 0g @ 90 ms to represent the new upper bound. The resulting pulse corridors are illustrated in Figure C attached, with the deleted portion of the existing pulse corridor dashed. If the agency wishes to provide an equivalent but simpler pulse that more test labs could consistently achieve, the pulse of Figure 2A could be modified by changing the peak acceleration to 22 g instead of 25 g (between 9 and 56 ms), as shown in Figure D attached. The pulse corridors in Figure D would allow a maximum theoretical velocity change of 33.4 mph over the full 90 ms pulse *interval. This would allow most sled tests to achieve a full 30 mph ΔV, but would limit pulse severity to* about the same average acceleration level specified by the old FMVSS 213 pulse.

Specification of Velocity Change
The test pulse specification is not objectively stated because the agency has not specified the period of time during which the velocity change (ΔV) should occur. We believe that the agency intended that the ΔV specified in 6.1.1(b)(1) is the velocity change prior to the sled acceleration dropping to zero, rather than the ΔV during the 90 ms maximum pulse duration or the ΔV during the 200 to 300 ms effective duration of the test. To be consistent with the pulse specification in FMVSS 208, the figure should also specify "The Time Zero for the test is defined by the point when the sled acceleration achieves 0.5 G's."

Every 30 mph sled or barrier test involves a total velocity change of 60 mph. During a deceleration sled run or a barrier crash, the buck or vehicle is first accelerated to 30 mph, held at that speed for a short time, and then stopped by hitting the barrier or being braked by bending steel bars or other means of rapidly decelerating the sled. The acceleration of the vehicle occurs before the recording of dummy readings starts. A full frontal perpendicular barrier crash always includes some rebound or spring back from the barrier, which occurs during the recorded interval. When using an acceleration sled such as a Hyge sled, the sled buck is rapidly accelerated rearward up to 30 mph and then braked almost immediately to stop the sled well before it hits the end of the sled track. A typical braking deceleration is about 1 g. If the sled were accelerated to 30 mph in 80 ms and then immediately braked at 1 g for the next 220 ms, the ΔV during 300 ms would be 34.8 mph, not 30 mph. If the sled braking were increased to 2 g for the 220 ms, the ΔV during the 300 ms duration of the recordings would increase to 39.6 mph. Any sled braking or resulting velocity change after the full rebound of the dummy and CRS is inconsequential.

Test data in Docket 10053 (Veridian Test Report 22477) shows that the Veridian sled achieves a total ΔV of 59.6 mph during 1.3 seconds over a distance of about 36 feet, using braking that is initially very low (possibly only track friction) but increases to about 2 g's. In this typical test, the ΔV during the 79 ms before the acceleration drops to zero is about 29.8 mph (48 km/h), but the ΔV during the 300 ms of dummy readings is about 32 mph (51.5 km/h). In a preamble footnote the agency commented: "*There have not been any problems with the effect of the braking of Hyge sleds on dummy kinematics and readings during rebound.*" But there could be problems in the future if the agency chooses a different test contractor, and that contractor chooses to use aggressive sled braking. The agency's statement implies that all future compliance tests will be run with braking equivalent to that used by Veridian, the major test contractor for past FMVSS 213 compliance tests, during the time period when dummy readings are being recorded.

Although the highest readings for HIC and chest acceleration typically occur late in the forward movement of the dummy, near the end of the acceleration pulse, built-in child seats may show high readings for HIC during the rebound phase of a Hyge sled test. Dummy rebound always results in head impact, and can involve high neck load readings. The velocity of the head just before the rebound impact varies with sled braking timing and severity. Freestanding seat backs (such as those in minivans and some SUVs, hatchbacks, and wagons) will bend forward during the sled acceleration, and then rebound, pulling the dummy rearward. A seat back that is stiff enough to restrain a 6-year-old child dummy in a severe crash will likely spring forward again after rebounding. The rebounding dummy then hits the seat back as it moves forward. The resulting dummy readings can be highly dependent on sled braking after the initial acceleration pulse. To provide a more objective test, Ford recommends that the agency specify that velocity change includes only the initial pulse, time zero is when acceleration reaches 0.5 g's, and sled braking must be less than 1 g during the time of instrumentation readings.

Effect of Pulse on Resources Required to Offer Built-in Child Seats
Allowing any 30 mph (48 km/h) pulse that can be contained within the corridors in Figure 2A would increase the resources required to offer built-in child seats, including built-in boosters. A vehicle manufacturer can choose to certify compliance of built-in child restraints using either the FMVSS 213 sled test pulse, or using a 30 mph (48 km/h) full-frontal barrier crash of the vehicle. Ford Motor Company prefers to test built-in child seats using the sled test alternative because barrier crash tests require significantly greater engineering resources. Sled test results are also more repeatable, and allow better camera coverage for development of design improvements. If a built-in child seat is to be offered on a new vehicle design, development and compliance crash tests must use hand-built prototype vehicles.

(Early development tests may be run using a sled test buck and the vehicle's expected barrier crash pulse.) The tests of built-in child seats are almost always unique tests from the other vehicle crash tests, because of limits on dummy channel recording capacity, limits on test weight, and the need for camera coverage. Introduction of built-in child seats sometimes lags introduction of a new vehicle by six months to a year to allow some of the barrier crashes to be run using early production vehicles instead of hand-built prototype vehicles.

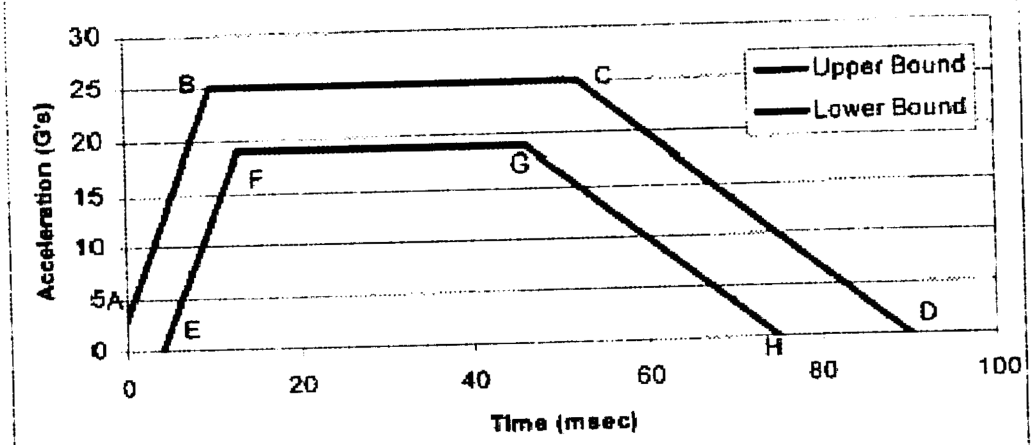
It would be substantially more difficult to consistently meet every FMVSS 213 test criterion using the most severe pulse permitted by the wider corridors of Figure 2A, however it is likely that more built-in child seat designs would have to be tested using the full-frontal barrier crash option. Increased use of the barrier crash alternative would unnecessarily increase development and certification test resource requirements, would delay introduction of built-in child seats, and therefore may further reduce potential availability of built-in child seats.

If you or your staff has any questions about this petition, please contact Mr. D. E. Kizyma on (313) 248-3792.

Sincerely,

James P. Vondale

Attachments



Upper Bound			Lower Bound		
Point	Time	Acceleration	Point	Time	Acceleration
A	0	3	E	4	0
B	10	25	F	13	19
C	52	25	G	46	19
D	90	0	H	75	0

Figure 2A

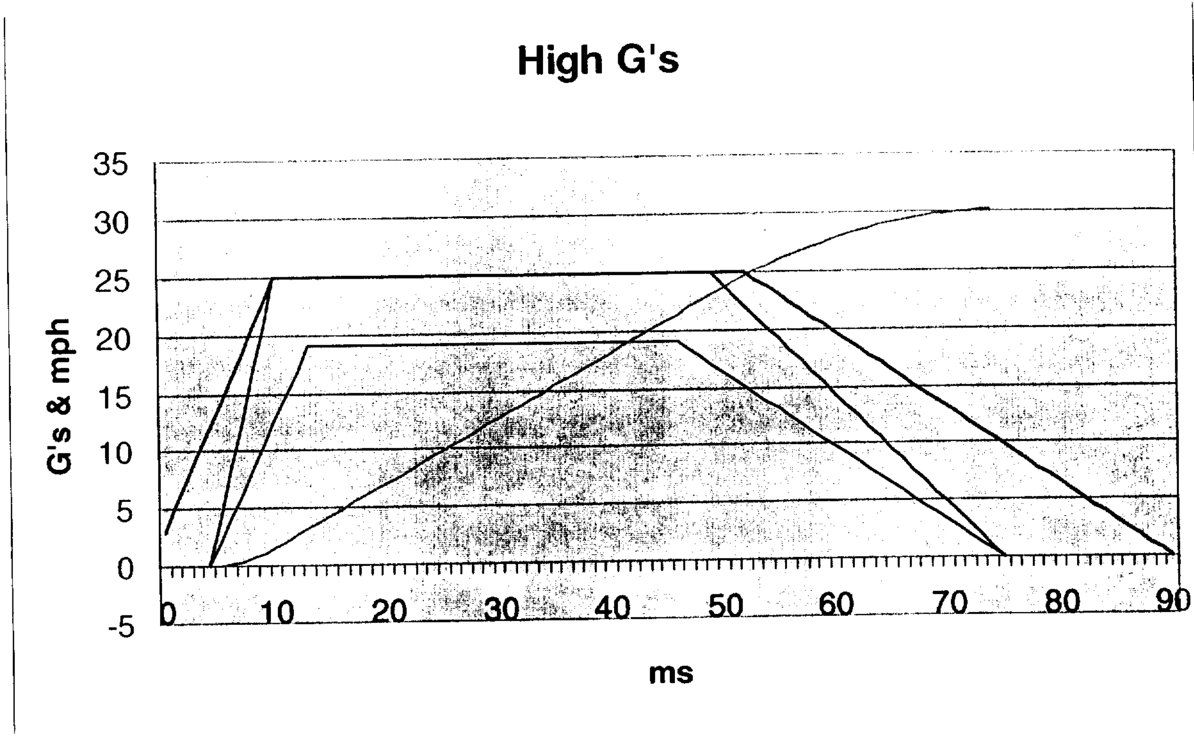


Figure A – High G 30 mph pulse

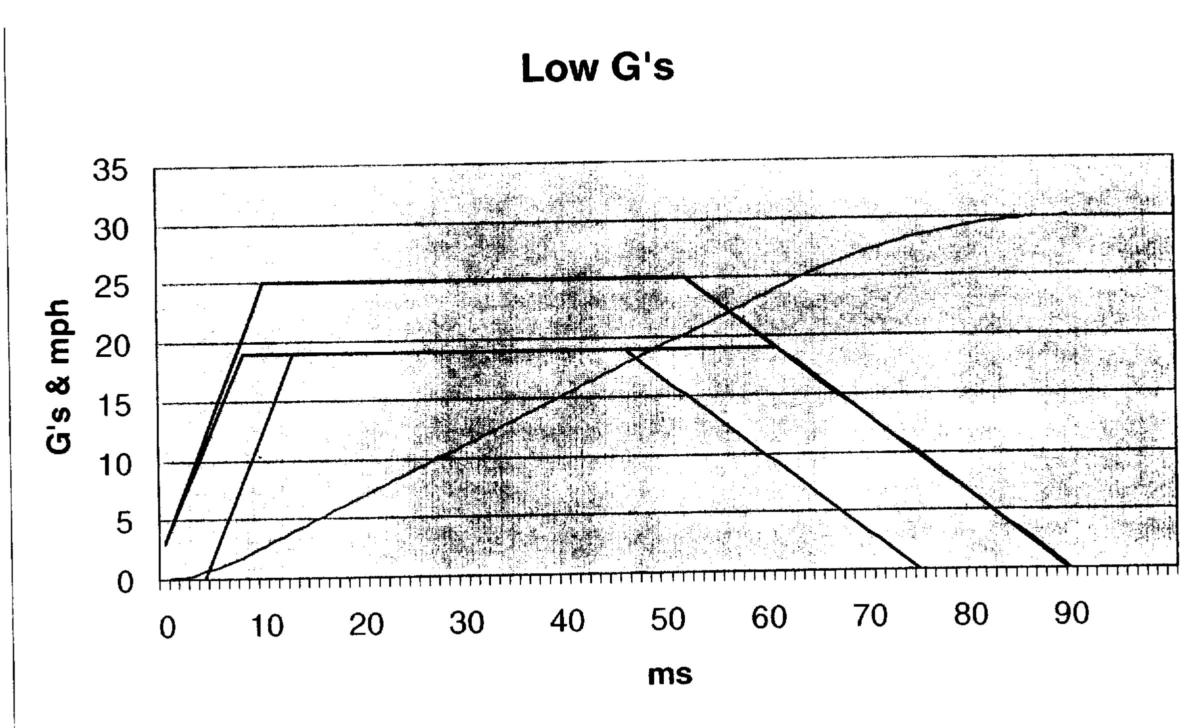


Figure B – Low G 30 mph pulse

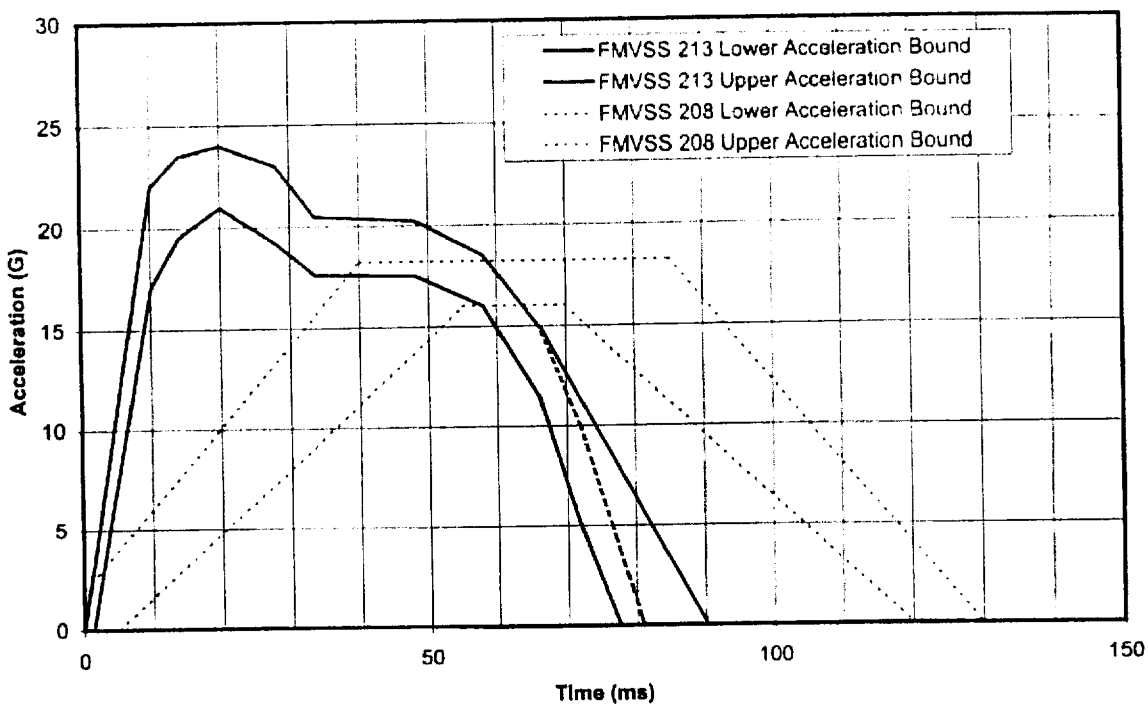


Figure C – 90 ms Traditional FMVSS 213 Pulse

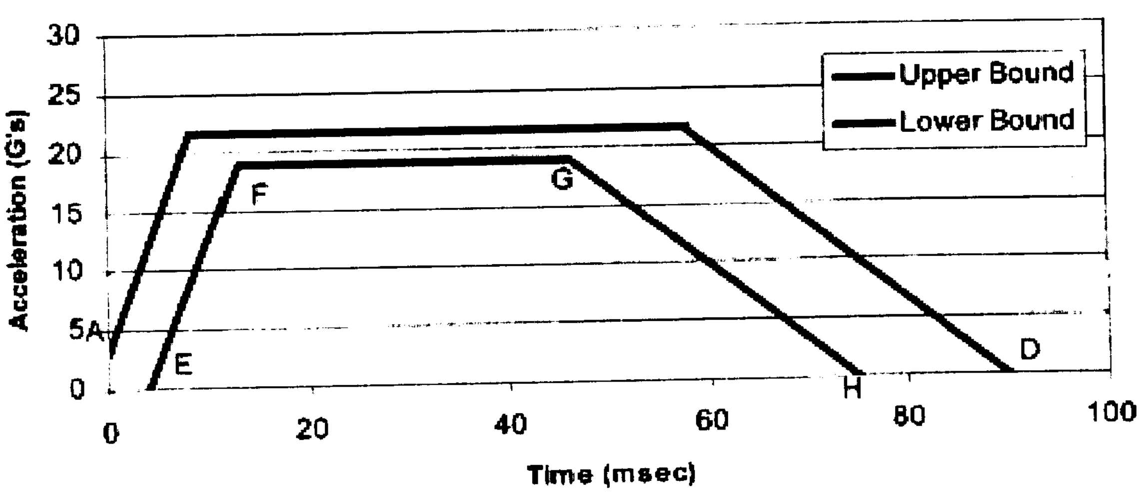


Figure D – Modified Figure 2A Pulse (22 G)