

NHTSA has determined that the 100 Hz filter is the appropriate one to use when determining the accelerations and corresponding forces transmitted through the vehicle structure to the LATCH anchorages. SAE Recommended Practice J211, "Instrumentation for Impact Test—Part 1—Electronic Instrumentation," specifies the various filter classes and associated cutoff frequencies that are to be used in impact tests. SAE J211 specifies Class 60 filters for vehicle accelerometer measurements, using a cutoff frequency of 100 Hz. NHTSA also specifies SAE J211 filtering for dynamic testing, including testing specified in FMVSS No. 208, FMVSS No. 214 ("Side Impact Protection"), and in the New Car Assessment Program, as well as in Part 572, the regulation for anthropomorphic test dummies. This is the filtering methodology that was employed by Transport Canada in obtaining the vehicle acceleration data used in its calculation of the maximum force levels through the center of gravity of the child and child restraint. The Alliance used the identical vehicle pulse using the same filtering methodology, but used a cutoff frequency of 30 Hz, instead of 100 Hz. Use of the 30 Hz cutoff frequency effectively eliminates the shorter duration, higher amplitude peaks that are seen when using a 100 Hz cutoff. However, such a low frequency filter eliminates a significant portion of the energy that is transmitted through the vehicle structure to the LATCH anchors. This is why SAE J211 specifies the higher cutoff frequency for such applications.

The agency examined a total of forty-three 30-mph rigid barrier tests conducted in a joint NHTSA/Transport Canada test program to evaluate air bag performance. Plots were obtained for the left door sill acceleration filtering at both the 100 Hz and 30 Hz cutoff frequencies. The plots are provided in Docket NHTSA-98-3390. Using the industry standard SAE J211, the plots indicate that the average peak deceleration for the entire set of tests is 32.7 g, with a standard deviation of 7.87 g and a maximum of 51.6 g (for the model year 1999 Plymouth Breeze). Based on these data, the agency has assumed the acceleration of the child/CRS system to be 48.4 g. This is based on the mean plus two standard deviations ($32.7 \text{ g} + 2(7.87 \text{ g})$) of vehicle crash pulses conducted by NHTSA and by Transport Canada. We do not believe that one standard deviation is sufficient because with one standard deviation, 16 percent of the crash pulses would fall

above that value. For two standard deviations, only 2.5 percent fall above.

Assuming a child and child restraint mass of 29.7 kg (65 lb), the dynamic force expected to act through the center of gravity of the child/CRS system in a 48.4 g crash is approximately 14,100 N. The agency is not reducing Standard No. 225's 15,000 N load requirement to take account of the static loading condition of the requirement. Notwithstanding the Alliance's comparison of static to dynamic strength of one type of anchorage system, there is no consistent and direct correlation between static and dynamic strength of anchorage systems. Furthermore, the dynamic force on the system could be higher than 15,000 N.

Such is the case when vehicle accelerations are more than 48.4 g. In a 30 mph rigid barrier crash, the model year 1999 Plymouth Breeze had an acceleration of 51.6 g. The dynamic force acting through the center of gravity of the system (generated by a child/CRS mass of 29.5 kg (65 lb)) was 18,500 N. The same calculations for an 80-lb child occupant result in a dynamic force of 20,600 N.⁸

In addition, the requirement is needed for real-world crashes above 30 mph. Data from NHTSA's Fatal Analysis Reporting System and General Estimates System indicate that in 2000, there were 3,390,000 crashes above 30 mph. In response to the TREAD Act, NHTSA initiated a program to include child restraints in certain New Car Assessment Program (NCAP) vehicles. All vehicles and child restraints anchorages tested to date have performed well, with the exception of the model year (MY) 2001 Toyota Echo (see NHTSA-98-3390-58). During the NCAP test conducted at 35 mph and with the Cosco Triad forward-facing LATCH child restraint with a Hybrid III 3-year-old dummy positioned in the rear passenger seat, the tether anchorage in the vehicle sheared. Following this structural failure of the tether anchorage, NHTSA conducted a number of tests in an attempt to understand why the anchorage in this particular vehicle failed when tether anchorages in all other NCAP vehicles tested had performed without incident.

NHTSA had performed a FMVSS No. 225 compliance test on the MY 2000 Toyota Echo, using the 5,300 N belt strap option set forth in Standard No. 225, S6.3.4.1. Both outer anchorages were loaded simultaneously with no

⁸ Note, however, that 80 pounds is the weight of an average 11-year-old. An 80-lb child is likely to be restrained in the vehicle's seat belt system while using a belt-position booster seat. Such seats are not required to have LATCH attachments.

failure of either anchorage. Following the failure of the tether anchorage in the NCAP vehicle, NHTSA performed a compliance test on the tether anchorage at the rear driver's side position of the NCAP vehicle, again using the 5,300 N belt strap load. Again, the tether anchorage passed the compliance test without incident. For information, the test was continued, increasing the load until the anchorage failed. This occurred at a load of approximately 6,300 N (a margin of 18 percent above the requirements of the standard).

Following this compliance test, NHTSA had the facility test the tether anchorage located at the center rear seating position of the MY 2000 Toyota Echo. The configuration and the material of the tether anchorage of the MY 2000 Toyota Echo are the same as that of the MY 2001 model. Instead of using the belt strap to apply a 5,300 N load as had been done on both previous occasions, the agency performed the test using the SFAD 1 test device. This test device attaches to the vehicle via the lap and shoulder belt and the top tether, and a load is applied horizontally through a specified point on the test device. As such, the SFAD 1 closely replicates the loads actually seen on the vehicle anchorages in an actual crash, as opposed to the belt strap test, which only loads the specific anchorage being tested.

The SFAD 1 was loaded to 10,000 N, held for 1 second, and then increased until failure of the tether anchorage.⁹ In addition, the tether strap and the vehicle belt were instrumented to measure their respective loads. In this test, the tether anchorage failed upon application of a load of 13,000 N to the SFAD 1.

In examining possible differences between the Toyota Echo and other NCAP vehicles examined as part of this analysis, the agency measured the Echo's peak deceleration to be 44.3 g, using the SAE J211 filter with a 100 Hz cutoff frequency. This is 4.5 g higher than any other NCAP vehicle evaluated in the analysis, and more than 10 g higher than any vehicle pulse evaluated in the 30 mph crash tests performed jointly between Transport Canada and NHTSA. NHTSA requested information regarding the vehicle pulse of the Toyota Echo in a 30 mph crash from the manufacturer, and was told that it was 34 g.

Toyota informed NHTSA that it had performed static tests with both a belt

⁹ 10,000 N is the peak load required in S6.3.4 of FMVSS No. 225, which represents the Transport Canada alternative compliance option permitted by current Standard No. 25 until August 31, 2004.