

Hybrid II 3-year-old dummies now used by the agency. There was support for the use of the Hybrid III 6-year-old dummy in compliance tests, with the exception of a few commenters (discussed below). There was general concern about the need for and capabilities of the weighted Hybrid III 6-year-old dummy.

i. Hybrid III 6-Year-Old Dummy.

Several commenters expressed concern about the biofidelity of the unweighted Hybrid III (HIII) 6-year-old dummy's neck and hips and the suitability of the dummy for use in testing child restraints. TraumaLink stated that, based on a sled test program it conducted at a test lab, they had "significant concerns" regarding the performance of the dummy. "The tests revealed extremely large neck elongation unlikely to be seen in real children in real crashes and resulted in high calculated injury values. These results suggest a pattern of injuries that we do not see in our real world experience."

SafetyBeltSafe referred to the tests performed by TraumaLink to conclude that "We do not now believe that the HIII 6-year-old dummy is an appropriate test device to simulate a restrained child" because of "unrealistic stretching and bending of this dummy's neck while tightly restrained by a lap-shoulder belt in a booster. The result was that the dummy's face directly contacted the chest, generating an unrealistic and unacceptably high HIC." SafetyBeltSafe also stated that test data from NHTSA's Vehicle Research and Test Center indicated that tests with the dummy generated "[head] excursion increases of from 2.1 to 4.5 inches in a booster with lap-shoulder belt. The likely reason for this is that the neck is not a true Hybrid III type neck, as it lacks the metal disks needed to limit its bending." The commenter was also concerned about the dummy's "permanently flexed hips, which, unlike the new 10-year-old design, do not allow a slouched position and may inhibit submarining in non-optimal booster designs."

Ford Motor Company likewise stated that the Hybrid III dummies are much more likely to experience head-to-knee contacts than Hybrid II dummies, because of the more flexible ribs and neck of the HIII dummies. Further, Ford said that a 1984 study (Culver *et al.*) showed that adult HIII dummy HIC readings were about twice those recorded in dummy head to cadaver knee impacts. Further, Ford stated that because the HIII 6-year-old dummy does not have the metal plates that segment and limit bending of the necks of the HIII adult dummies, the HIII 6-year-old

dummy may be more likely to experience head-to-leg contacts than "the three-year-old." Ford asked in its comment how the agency would treat head acceleration spikes that could be caused by head-to-knee contacts. The commenter also suggested that load cells be used on the ASIS of the pelvis of the 6-year-old dummy to evaluate the tendency to submarining under the lap belt during testing of booster seats, because, Ford stated without elaborating, the current limit on knee excursion is not an effective way to limit submarining in tests of belt-positioning boosters.

NHTSA disagrees with the commenters that the HIII 6-year-old dummy should not be used in FMVSS No. 213 testing. The neck of the HIII 6-year-old is currently performing within the specifications established by the Hybrid III Dummy Family Task Force of the Society of Automotive Engineers (SAE). The agency is not aware of specific test information and/or data substantiating the claims of the commenters that the dummy is an unsuitable test device for FMVSS No. 213 testing.

When the dummy was incorporated into the regulation on anthropomorphic test devices, 49 CFR part 572, the agency made the following determinations (65 FR 2059) about the dummy:

Based on NHTSA's use of the H-III6C 6-year-old dummy in calibration tests and in frontal impact tests involving restraints such as air bags and belts, we have concluded that this dummy is suitable for both research and compliance safety assessments. The dummy is not only considerably more biofidelic than its predecessor, the part 572 subpart I 6-year-old dummy, but it also has considerably more extensive instrumentation to measure impact responses such as forces, accelerations, moments, and deflections in conducting tests to evaluate vehicle occupant protection systems.

The agency continues to believe that the performance of child restraint systems will be more thoroughly and precisely assessed by use of the HIII dummy because of the dummy's enhanced biofidelity and extensive instrumentation. With regard to concerns about the dummy's neck, it should be noted that the Hybrid II dummy currently in use also does not have the metal disks. Since the Hybrid III is more biomechanically based, we continue to believe that it provides a more humanlike response than the Hybrid II version of the dummy.

Sled tests have shown the HIII 6-year-old to be a suitable replacement for the existing HII 6-year-old in FMVSS No. 213 compliance tests. None of the sled

testing conducted with the HIII 6-year-old dummy at VRTC or PAX in support of the TREAD Act has indicated that head-to-chest or head-to-knee impacts is an issue. Such impacts are not typical.¹¹ NHTSA believes that if head-to-knee contact occurs, there are likely design concerns with respect to the particular child restraint that should be addressed to eliminate such contact. We also believe it would be very difficult, if not impossible, to establish an objective means to determine if, and if so to what extent, head-to-knee contact influenced HIC measurement in FMVSS No. 213 compliance testing. Consequently, head acceleration spikes caused by head-to-knee contacts will be included in the HIC computation. Further, the agency continues to believe that the HIII dummy is needed to better assess the injury mechanisms to children.

The agency is not entirely convinced that neck elongation is not occurring to children in real crashes. We believe it possible that neck injury may sometimes not be diagnosed even though it occurs. Since a child's neck is not fully developed, detection of injuries is more difficult and injuries could manifest in later years. Also, for fatal injuries, there is often a reluctance to conduct autopsies in deference to family sensitivity. Consequently, the cause of death may be listed as massive head injury, while injury to the neck may have also occurred.

The agency is continuing to conduct research to establish better neck injury response and injury criteria for children. Research may show the presence of neck injury and a possible need for a neck injury criterion in FMVSS No. 213. If that occurs, a test dummy incorporated into the standard that offers improved biofidelity and neck instrumentation would prove useful. Because we believe that the current neck on the HIII 6-year-old dummy provides improved biofidelity over the current dummy and is suitable for compliance purposes, this final rule adopts the dummy into FMVSS No. 213 as proposed.

ii. Weighted 6-Year-Old Dummy. A majority of commenters raised concerns with the biofidelity of the weighted 6-year-old-dummy, which is intended to model a 50th percentile 8-year-old child. IIHS and NTSB commented on the importance of height in measuring

¹¹ The agency is aware of only one instance in which there was significant head-to-knee contact in an FMVSS No. 213 test environment using a Hybrid III dummy. In this case, a 6-year-old dummy was tested in a backless belt-positioning booster. In the test, the shoulder portion of the belt system slipped off the dummy's shoulder. It is unclear what caused this to happen.