

DAIMLERCHRYSLER

01V-273 ①

August 2, 2001

Kenneth Weinstein, Esq.
Associate Administrator for Safety Assurance
National Highway Traffic Safety Administration
Washington, D.C. 20590

DaimlerChrysler Corporation
Matthew C. Reynolds
Director
Vehicle Compliance & Safety Affairs

Dear Mr. Weinstein:

DaimlerChrysler Corporation ("DaimlerChrysler") has reviewed the preliminary test report of an FMVSS No. 201 compliance test conducted for NHTSA in April 2001 by MGA on a Model Year 2001 Dodge Intrepid. In that test, MGA calculated a HIC(d) of 1164 at target point UE2 on the left side. In the film of this test, it is evident that the chin and lower face of the free motion headform (FMH) struck the interior of the vehicle on the B-pillar at approximately the same time as the forehead of the FMH struck the target point. As DaimlerChrysler has previously informed the agency, MGA did not follow all of the test procedures required by FMVSS No. 201, including the test procedure calling for the introduction of a 5°/10° offset of the FMH after it is aimed at the target.

Because the agency's test procedure does not adequately account for the artificial increase in HIC(d) resulting from the contribution of the dummy's chin interaction with the vehicle structure, and because there was substantial dummy chin interaction in the agency's compliance test of the Intrepid, DaimlerChrysler cannot agree that the test result reported by NHTSA is valid, or that the test is a relevant indicator of the real-world risk of head injury addressed by FMVSS No. 201.¹

Nevertheless, DaimlerChrysler does not wish to engage in a protracted dispute with the agency about the enforceability of FMVSS No. 201 test results that involve substantial chin interaction and therefore is willing to conduct a notification and remedy campaign as if it were required by the Vehicle Safety Act. DaimlerChrysler is willing to notify consumers as if the notification were subject to 49 C.F.R. Part 577, and is willing to provide the quarterly reports of recall completion as if they were required by 49 C.F.R. 573.6. DaimlerChrysler will not, however, admit that the vehicles were noncompliant with a valid test of Federal Motor Vehicle Safety Standard No. 201. The reasons for DaimlerChrysler's position are discussed below.

¹ There was no judicial review of the 1995 amendments to FMVSS No. 201. Therefore, DaimlerChrysler may challenge the validity of the standard in any noncompliance enforcement proceeding. The standard of judicial review is the same as if the standard had been challenged at the time of its promulgation. See H.R. Conf. Rep. No. 93-1452, at 32 (1974), reprinted in 1974 U.S.C.C.A.N. 6084, 6095-6096.

1. The Test Result is Invalid Because The HIC(d) Was Artificially Increased by A Substantial Chin Impact.

It is clear in the regulatory history of the upgraded FMVSS No. 201 that there is no independent biomechanical validation of the HIC(d) of 1000. Rather, the HIC(d) is derived from the Head Injury Criterion (HIC) that was developed for FMVSS No. 208 and which is well accepted as biofidelic.

As discussed at length in the FMVSS No. 208 docket, the HIC was developed more than 25 years ago on the basis of the Wayne State Tolerance Curve, which was derived principally from experiments involving forehead impacts into rigid surfaces. In the Final Rule amending FMVSS No. 208 in 1984, NHTSA addressed the issue of whether the HIC was a valid predictor of head injury in the absence of a contact, and explained:

"It is recognized by NHTSA that the Head Injury Criterion (HIC) was primarily developed from tests of forehead impacts, resulting in acceleration of the brain in the anterior-posterior (i.e. forward and backward) directions." Final Rule amending FMVSS No. 208, 49 Fed.Reg. 28962, 29007 (July 17, 1984)(emphasis added).

In the rulemaking proceeding leading to an upgraded FMVSS No. 201, NHTSA recognized that the biofidelity of the Hybrid III head is well-accepted for forehead impacts. NHTSA observed:

"Therefore, NHTSA's primary concern, in developing a component test using the FMH, was whether the FMH responses (for forehead impacts) correlate to those of a Hybrid III dummy subjected to similar loading in sled tests, and whether this correlation holds up for impacts with components that are representative of a wide range of passenger vehicles." NPRM, 58 Fed.Reg. 7506, 7509 (February 8, 1993)(emphasis added).

The public comments filed in response to this NPRM and to subsequent notices published by NHTSA seeking comment on FMVSS No. 201 test procedures pointed out that the FMH responses were being skewed (and increased artificially) when the FMH's chin came in contact with the vehicle's interior during the test. The commenters noted that the chin of the FMH is stiffer than a human chin, and is therefore not biofidelic. The commenters asked NHTSA to take steps to ensure that chin impacts during FMVSS No. 201 compliance tests would not result in artificially increased HIC(d) values. See, for example, comments filed by General Motors:

"A modified Hybrid III head is specified in the NPRM for use in testing. The modified Hybrid III head utilized as a free motion headform presents an essentially flat surface between the forehead and the chin. During most of the impact duration, both the forehead and the chin of the headform can load the component. This is not appropriate for a valid test because the chin of the

Hybrid III is much more rigid than the chin of a human and therefore is not blastable. When the Hybrid III chin is involved early in the impact event, it can significantly change the measured acceleration values, and subsequently the calculated HIC(d) values. This change in measured acceleration value is a mere artifact of the test device. It is not representative of the vehicle component's true performance. As a result, such a test cannot possibly predict the potential effect of a similar impact on a human occupant. The chin artifact strongly resembles the nose artifact that the agency resolved earlier by removal of the nose." Docket NHTSA-97-1703-071 at pages 26-27 (November 19, 1993)(emphasis added).

General Motors supplemented these comments shortly thereafter with test data documenting a 68% increase in the HIC(d) for the same roof pillar joint when the FMH chin impacted the B-pillar compared with when it did not. General Motors explained:

"...if, during a component test, the chin of the Hybrid III head is involved early in the impact event, the measured acceleration values, and subsequently the calculated HIC(d) values will not be representative of the vehicle component's true performance. This is because the Hybrid III's chin is very rigid (unlike the chin of a human)." Docket NHTSA-97-1703-076 (November 30, 1993)(emphasis added).

NHTSA did not disagree with these comments. To the contrary, NHTSA addressed these comments in the final rule by adding a provision to the test procedure to tilt the FMH forward by 5° for targets on the A-pillar and rear-most pillar and 10° for any other pillar. NHTSA explained this decision, saying:

"Tilting the head creates a chin offset clearance that will delay chin contact beyond the time of the HIC calculation, which was less than 20 ms in duration in agency testing." Final Rule, 60 Fed. Reg. 43031, 43036 (August 18, 1995)(emphasis added).

This adjustment to the test procedure was made specifically "[i]n response to concerns about early chin contact." *Id.* The Final Economic Assessment accompanying the final rule stated:

"Early FMH lips/chin contact has been shown to affect HIC values and a method has been incorporated into the test procedure to delay the early chin contact so as to minimize its effect on the calculated value of HIC." FEA at pages III-2 (August 16, 1995)(emphasis added).

Later in the Final Economic Analysis, NHTSA discussed the issue further:

"NHTSA reexamined 15 B-pillar tests described in the NPRM and concluded that chin contact generally occurs during the time frame needed for the HIC calculation. *The chin contact can be delayed beyond the time frame of the HIC calculation by specifying a sufficient FMH off-set angle (or chin off-set*

clearance) in the test procedure. NHTSA determined that a 10 degree off-set angle (approximately 20 mm off-set clearance) for fairly vertical pillar surfaces ... will delay the chin/face contact sufficiently that the HIC calculation may not be affected." FEA at page III-63 (August 16, 1995)(emphasis added).

The agency reiterated this view after several manufacturers petitioned for reconsideration of the 5°/10° offset, arguing that it was not enough to accomplish the goal of ensuring that chin/face contact will be delayed sufficiently so that it does not artificially increase the HIC(d) calculation. NHTSA responded:

"In the final rule, the agency added the five degree offset in response to manufacturer concerns about chin contact. NHTSA never stated that this amount was sufficient to prevent chin contacts, only that it would delay chin contact. Because NHTSA continues to believe this amount is sufficient for this purpose, it is not making any further changes." Final Rule Responding to Petitions for Reconsideration, 62 Fed.Reg. 16718, 16723 (April 8, 1997)(emphasis added).

Thus, it is clear that NHTSA accepted the evidence offered by the industry about the artificial increase in HIC(d) that results from chin contact during the time of the HIC calculation, and adopted the 5°/10° offset in order to "delay chin contact beyond the time of the HIC calculation" in order to solve the problem identified by the industry.

As the rulemaking record reflects, however, there was substantial skepticism that the 5°/10° offset would be sufficient to "delay chin contact beyond the time of the HIC calculation." Several manufacturers presented evidence at a meeting with the agency on August 19, 1998 showing that chin impacts can artificially increase the HIC(d) significantly, and that the 5°/10° offset is not sufficient to prevent that from occurring. One presentation, from Mitsubishi, apparently resembled this case, in that a series of tests aimed at an upper roof target area resulted in contact between the lower face of the FMH and a nearby B-pillar target within 6 ms of the forehead striking the intended target. Mitsubishi presented information showing that these HIC(d)'s were 50% higher than that measured when no lower face contact occurred. See NHTSA Docket 98-3847-6 at page 3 (March 19, 1999).

The test result at issue here proves that the manufacturers were right: a 5°/10° offset is not sufficient to "delay chin contact beyond the time of the HIC calculation." In fact, the HIC calculation in this case includes substantial contribution from chin contact, thus artificially increasing the HIC(d) beyond the intention of the agency in establishing the test procedure and beyond the likely real-world experience of an occupant who might encounter the target point during a collision.

There is no dispute in the rulemaking record about the artificial increase in HIC(d) that can occur when the FMH chin strikes the vehicle interior during the time period in which the HIC is calculated. NHTSA attempted to solve this problem by introducing a small offset angle before the FMH is launched; however, it is now clear that the small offset angle is not sufficient to solve the problem. Because NHTSA never

intended to include the acceleration from chin strikes in HIC(d), and tried to solve the problem of artificially high HIC(d) values from chin strikes by offsetting the angle of the FMH before launch, the agency must now recognize that HIC(d)'s that include accelerations from chin strikes during the time in which HIC(d) is calculated are invalid and artificially high.

2. The Transform Function Does Not Adequately Account for Chin Impacts.

Despite the fact that the rulemaking record clearly establishes that NHTSA intended to exclude chin contacts from contributing to the HIC(d) calculation, a 1999 interpretation from the Chief Counsel suggests for the first time that it is appropriate to include chin and lower face impacts in the HIC(d) calculation. In this letter, the Chief Counsel states:

"Although the data presented at the August 19, 1998 meeting indicate that the existing five and ten degree offsets may not be sufficient to prevent lower face contact during the time of HIC calculation, the agency has reconsidered its earlier position implying that accelerations from lower face contact occurring within 20 milliseconds of forehead impact should not be included in the HIC score." Interpretation letter to George Parker, AIAM, February 19, 1999 at page 4, docketed at NHTSA Docket 98-3847-6 (March 19, 1999).

The Chief Counsel explained that his position was based on a review of the research data used during development of FMVSS No. 201 to construct the transform function used to translate the accelerations received on the FMH into a HIC(d) that should replicate the HIC that would have been received on a full Hybrid III dummy. The Chief Counsel argued:

"In some of these impacts, portions of the lower face of the FMH struck portions of the target structure during the period in which the HIC calculation was taking place. As these data were used to develop the method of determining HIC scores in Standard 201, consideration of the effects of impacts of the lower front surface of the FMH on interior surfaces has already been integrated into the transform function. Because the transform function provides the means for determining HIC when the FMH strikes an interior surface, any implication that lower face contact should not be allowed during the time of the HIC calculation because that contact would improperly influence HIC, is contrary to the research data used in developing the Standard. Accordingly, lower face impacts should be included in Standard 201's evaluation of vehicle performance in those instances in which lower face contact results in a higher HIC score." Interpretation letter to George Parker, AIAM, February 19, 1999 at page 4, docketed at NHTSA Docket 98-3847-6 (March 19, 1999)

DaimlerChrysler respectfully disagrees with the suggestion that the transform function adequately accounts for the artificial increase in HIC(d) that results from early chin/lower face impacts. The NHTSA report of the research supporting the development of the transform function itself states:

"Since the FMH is essentially a Hybrid III head, it was developed for use in forehead impacts. The biofidelity of the Hybrid III head in impacts to the lower face and jaw areas has not been established." DOT HS 807 865, Upper Interior Head Protection, Volume I: The Development of a Research Test Procedure at page 33 (November 1991)(emphasis added).

If the researchers intended to include lower face and jaw impacts in developing the transform function, they would have said so. To the contrary, the report makes clear that the researchers recognized the lack of biofidelity in the lower face/chin area of the Hybrid III head. Moreover, if the researchers intended to account for chin/lower face impacts through the transform function, they would have ensured that every one of the FMH impacts conducted as part of the transform function research included a full chin contact during the time period of the HIC calculation. But, as the Chief Counsel's letter acknowledges, only "some of these impacts" involved chin or lower face contacts. Indeed, nothing in the written reports of the transform function research suggests that any chin contacts occurred, much less that they occurred in every impact. (By contrast, the research emphatically notes that the nose of the FMH was "interfering" with test results, and was therefore removed. DOT HS 807 866, Upper Interior Head Protection, Volume II: Fleet Characterization and Countermeasure Evaluation at page 3 (November 1991)).

Even if averaging HIC calculations that included chin impacts with those that do not were a valid method of accounting for chin impacts (which DaimlerChrysler does not concede), the fact that only "some" of the impacts considered in the transform function included chin impacts means that only "some" of the effect of chin impacts has been taken into account. If, hypothetically, full chin contact occurred during the HIC calculation in half of the research impacts, then the transform function accounts for only half of the contribution to HIC(d) that occurs from chin impacts. If full chin contact occurred during the HIC calculation in one-quarter of the research impacts, then the transform function accounts for only one-quarter of the contribution to HIC(d) that occurs from chin impacts, and so forth. If, as the Chief Counsel states, there were chin contacts in only "some of these impacts" in the transform function research, then the transform function does not adequately account for the elevated HIC(d) that results when there is early chin/lower face contact during the HIC(d) calculation.

In fact, however, it is inappropriate to attempt to account for chin interaction by averaging HIC calculations that included chin impacts with those that did not. Such an averaging does not account for the fact that forehead impacts on the Hybrid III head are recognized as biofidelic, while chin impacts on that dummy are not. Averaging valid test results with invalid test results does not cure the problem with the invalid results. Since the Wayne State Telephone Curves used to develop HIC initially were based on forehead strikes, and the subsequent work to correlate dummy HIC's to the risk of human injury

has focused on risks of skull fractures from impacts in the forehead area, there is no valid biomechanical basis to include chin contacts in the HIC(d) calculation. Given the uncontested fact that the chin and lower face of the Hybrid III dummy are not biofidelic and cannot be used validly to predict the risk of head injury, the Chief Counsel's letter to Mr. Parker suggests the possibility that the transform function is itself invalid, if it was not carefully developed to exclude extraneous data inputs, such as from the chin and lower face.

3. The Transform Function and Test Procedure May Be Invalid For Other Reasons.

a. **Transform Function.** The Chief Counsel's letter implies that the transform function was developed to incorporate all of the research conducted to correlate the FMH accelerations with the responses observed on full Hybrid III dummies, and that any change to the test procedure to exclude chin/lower face contacts would be "contrary to the research."

In fact, however, NHTSA itself excluded certain of its research tests from the development of the transform function, and the reasons for doing so cast doubt on the Chief Counsel's assumption that the transform function has integrated real world risks of head injury into the equation. For example, NHTSA conducted simulated A-pillar sled tests as well as vehicle back sled tests to obtain data inputs for the transform function, but later decided to exclude the vehicle back sled tests from the transform function development. The research report explains why:

"Also in the vehicle back sled tests, the lower portions of the dummy's body often contacted the interior of the vehicle. This was especially evident in the side roof rail and B-pillar tests, where the shoulder of the dummy contacted the door prior to, or concurrent with, the head to structure contact. In at least one case, the head response showed a noticeable acceleration due to body contact, prior to head contact with the structure. This tended to produce full dummy HIC responses that were artificially low compared to those measured by the FMH." DOT HS 807 866, Upper Interior Head Protection, Volume II: Fleet Characterization and Countermeasure Evaluation at page 2 (November 1991).

It is odd that the research report would characterize the full dummy HIC response as "artificially low," because the transform function was supposed to translate the FMH accelerations into an equivalent full dummy HIC, not the other way around. In the vehicle back sled tests, the full dummy's shoulders encountered the vehicle interior first, decreasing the acceleration of the head before the head strike. By excluding this data from the transform function calculation, NHTSA artificially narrowed the gap between the higher FMH responses obtained in the research and the lower full dummy responses. If these data had been included in the development of the transform function, the conversion from an FMH HIC to HIC(d) would have resulted in lower HIC(d) calculations.

Another example that calls into doubt the accuracy of the transform function is the decision by NHTSA to exclude from the transform function calculation the early tests of the FMH impacting a 20 mph simulated A-pillar. The research report explained that the FMH used at that stage of the research had a nose and glued headskin, both of which were found to have interfered with the test results. The later tests were run with an FMH without a nose and without glue on the headskin.

A comparison of the early FMH tests (that were subsequently excluded from the transform calculation) and the later FMH tests is interesting: in all but one condition (45°/padded), the early FMH tests that included a nose on the FMH had lower HIC values than the later FMH tests that should have been otherwise identical. In some cases, the difference in FMH HIC's is substantial -- for example, at 30°/baseline, the early FMH yielded a HIC of 477, while the later FMH yielded a HIC of 793. Likewise, at 35°/baseline, the early FMH yielded a HIC of 890, while the later FMH yielded a HIC of 1116. (Compare FMH results on Table 3.2 in Volume I of the research report to the FMH results on Table 3.3 in Volume II of the research report.)

Although DaimlerChrysler has no quarrel with the decision to modify the FMH to delete the nose, because it was not biofidalic, these substantial differences in HIC when the early and late FMH's are compared underscores the concern that test results can be substantially influenced by the design of the dummy, without necessarily reflecting real world changes in risk of injury. Since the chin of the FMH is also not biofidalic, the calculation of HIC(d) must be made without considering the accelerations that result from chin contact, consistent with NHTSA's decision with respect to the nose.

b. **Test Procedure.** The test procedure chosen by MGA for the Intrepid test employed a combination of approach angles and FMH orientation that is highly unrealistic and unlikely to occur in the real world. While the angles and orientation are permitted by the FMVSS No. 201 test procedure, the unlikelihood that these conditions would ever occur in the real world underscores the concerns raised during the rulemaking proceeding that the standard does not meet the need for motor vehicle safety.

The selected target was on the driver's side of the vehicle, with the FMH oriented toward the left, as if the passenger were looking out the driver's side window. During the FMVSS 201 test, the FMH forehead struck the upper rail target point and the FMH chin struck the B-pillar at virtually the same time. As DaimlerChrysler understands the occupant kinematics that would be required to replicate this scenario in the real world, this test condition replicates the circumstance in which the passenger's head and upper body move unobstructed past the driver and his seat without contacting either one and without the passenger's shoulders first striking the B-pillar. (Recall that in the vehicle sled back tests conducted by NHTSA to develop the transform function, the dummies' shoulders frequently interacted with the B-pillar before the head impact, resulting in "artificially low" HIC responses). The MGA test cannot predict the outcome of the driver's head striking the target, because the driver's head could not realistically accelerate to 15 mph before striking the target zone a short distance above his head. Therefore, the MGA test can only be thought to predict the outcome of the passenger's

head striking the target, after traveling laterally across the vehicle during a collision. DaimlerChrysler submits that the scenario of a passenger accelerating across the vehicle to the driver's side, and striking the target zone, but not slowing down from encountering the driver and/or his seat and/or from experiencing shoulder interaction with the B-pillar, is highly unrealistic and beyond what is necessary to meet the need for motor vehicle safety. The test result is an artifact of an isolated headform devoid of realistic interactions between an occupant's body and other objects in the vehicle interior.

CONCLUSION

DaimlerChrysler submits that the rulemaking record clearly establishes that the HIC(d) is not a valid measure of the risk of head injury from interior impacts if the calculation includes accelerations from chin or lower face involvement. It is undisputed that the Hybrid III dummy was not intended to be used to evaluate risks from chin strikes. It is also undisputed that the human chin would react very differently than the Hybrid III dummy's chin, making any HIC(d) calculation that includes chin strikes an unrealistic measurement that is not representative of the vehicle component's true performance. Finally, NHTSA itself agreed with these conclusions, and attempted to ensure that chin strikes would not be included in the HIC(d) calculation. NHTSA's efforts were, however, insufficient.

Moreover, the standard requires compliance under conditions that are highly unrealistic and unlikely to occur in the real world. DaimlerChrysler does not believe that the MGA compliance test is a valid indicator of the risk of injury from interior impacts in the real world.

For these reasons, the test procedure contained in FMVSS No. 201 is invalid, insofar as it does not adequately account for the artificial contribution to HIC(d) from chin strikes during the HIC calculation and does not adequately confine the test conditions to those reasonably likely to occur in the real world.

Sincerely,



for- Matthew C Reynolds

Enclosure: Information Report #991

cc: M. Jacobs, NHTSA - OVSC
 Division of Occupational Safety & Health
 California Department of Industrial Relations

Submission date: August 1, 2001

Identifying classification of vehicles potentially affected:

Make	Model	Model Inclusive Dates		Volume	Other
		Year	of Manufacture		
Dodge	Intrepid	2000/ 2001	11/25/99 to 06/29/01	192,508	Non-Sunroof Only
Chrysler	Concorde	2000/ 2001	07/19/99 to 06/29/01	64,620	Non-Sunroof Only
Chrysler	300M	2000/ 2001	11/25/99 to 06/29/01	13,885	Non-Sunroof Only
Chrysler	LHS	2000/ 2001	07/19/99 to 06/29/01	11,457	Non-Sunroof Only

Estimated percentage containing issue: 100

Background and chronology:

- In April 2001, NHTSA's test contractor (MGA) conducted FMVSS 201 compliance testing on a 2001 MY Dodge Intrepid. As part of that testing, MGA obtained a HIC(d) of 1164 on a point on the boundary of the upper roof zone, just above the B-pillar, with the head form aimed at an angle that makes the face and chin effectively flush with the surface. FMVSS 201 permits a HIC(d) calculation of equal to or less than 1000.
- The company's investigation of the test revealed that MGA had not conducted the test in accordance with the procedures specified in FMVSS 201. The company informed NHTSA of these inconsistencies in May 2001.
- The company undertook its own investigation into the tests, including considerable testing with potential additional FMVSS 201 countermeasures to remove any ongoing issues.
- The company believes that the HIC(d) number reflects a well documented artifact of the Free Motion Headform (FMH). The test procedure used by MGA -- and further confirmed by internal testing -- allows the chin and lower face of the FMH to contribute unrealistically to the HIC(d) calculation. This FMH artifact was, and continues to be, the subject of considerable rulemaking discussion and has been recognized as an issue by NHTSA.
- We believe that NHTSA's answers to the artifact have not sufficiently accounted for the FMH chin artifact. As a result, we dispute any assertion of a noncompliance with FMVSS 201 premised on testing that does not adequately account for the unrealistic chin and lower face interaction of the free moving head form with the vehicle structure.
- This data was presented to the Vehicle Regulations Committee which, to avoid a protracted dispute with the government concerning the validity of compliance testing that allows the chin and lower face of the FMH to contribute to the HIC(d) calculation, decided to conduct a product

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improvement field action to add countermeasure material to the affected areas on the affected vehicles. The committee further decided that the field action would be executed in accordance with the regulations and corporate processes applicable to safety related recalls. This action does not constitute a noncompliance determination.

Statement of measures to be taken:

- In resolution of the issue and to avoid a potentially protracted dispute, the company has redesigned the headliner for the 2002 MY start of production on the affected vehicles.
- To further resolve the matter, the company is considering and working on developing a countermeasure that may be applied to 2000 and 2001 MY vehicles in the field.
- Timing relative to execution of any field action will be provided to NHTSA when available.