Critique of NHTSA-Contracted Elemance Rear Impact Guard Research

Summary: The Department of Transportation (DOT) engaged Elemance LLC in 2022 to evaluate three current designs of rear impact guards. Unfortunately, Elemance conducted Finite Element analysis of two obsolete rear underride guards that were not current designs at the time of the contract. In fact, both of those designs had been proven a decade earlier to be crash-deficient. Their makers have developed designs with safer, stronger rear-guard designs. Elemance compounded that error by employing an erroneous definition of Passenger Compartment Intrusion. Elemance's research findings, *Heavy-Truck Rear-Impact-Guard Finite Element Simulation and Analysis,* are flawed and backwards looking rather than helpful to Congress in evaluating current and future rear underride guard performance and regulatory standards.

Elemance did not test current designs, contrary to the purpose of the research: In August 2022, NHTSA awarded a research contract to Elemance LLC. The purpose of the research was to "…model ***current*** rear underride guards and modify them to meet no window intrusion when a vehicle impacts the rear of the trailer" (emphasis added). For reference, see the contract description in USASpending.gov below:

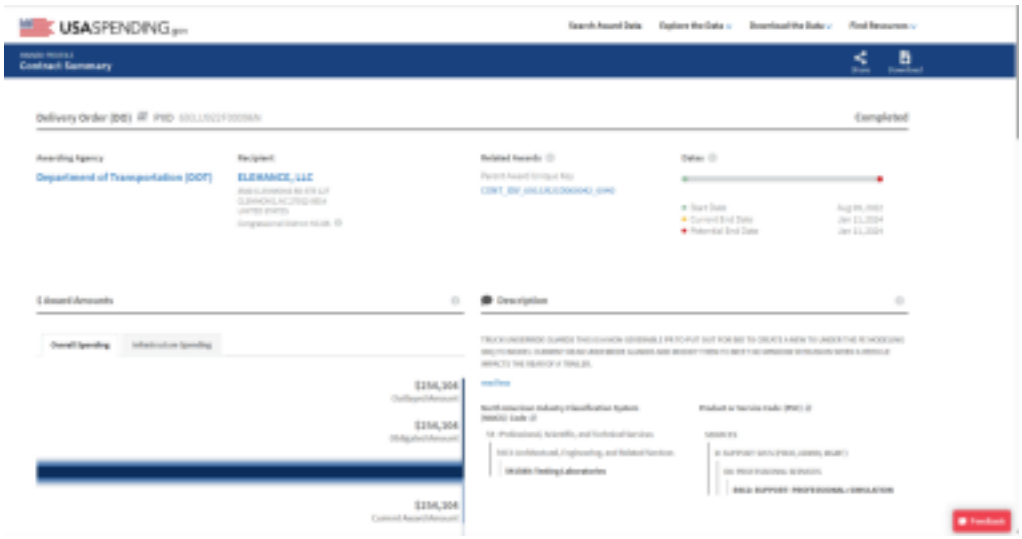

Figure 1: DOT Contract for Rear Guard FEA Evaluation by Elemance LLC

Elemance evaluated designs from Manac, Great Dane, and Wabash National (guards 914-901002-G, GDP11716266, and 05006821-07, respectively). Two of the three designs were outdated when they were evaluated.

The Great Dane guard was an old design that was no longer available for sale on new vehicles in North America as of August 2022. Great Dane had stopped selling these

guards on new trailers in 2017 and was only providing these guards as replacement parts for older trailers. By 2017 Great Dane had upgraded their rear guard to a design that prevents underride and windshield contact in 35 mph full overlap, 50% overlap, and 30% overlap crashes. This guard, named the RIG30, which uses a deeper rectangular profile (rather than square) horizontal member and deeper support posts, supplanted the NHTSA-specified guard as standard equipment for all Great Dane dry van trailers built after December 2018. This guard was crash-tested by the IIHS in 2017, received the TOUGHGUARD award, and is designed to be retrofitted to older Great Dane trailers.

The Wabash guard tested by Elemance was also obsolete. Wabash announced a higher performance and safer RIG 16 rear guard in February of 2016 that was proven to prevent underride and windshield intrusion in 35 mph full overlap, 50% overlap, and 30% overlap crashes. Wabash National had begun selling their RIG-16 guards as an Option on new trailers in 2016.

The only guard of current design that Elemance tested was manufactured by Manac. It was by far the strongest guard of the three. It was the only one of the three designs that prevented PCI at 35 mph. But it is not likely the only current design to achieve that level of protection. Seven of America's nine largest trailer manufacturers now equip their trailers with guards that are superior to the Wabash and Great Dane guard studied in this research.

Elemance used an erroneous definition of PCI: Elemance defined passenger compartment intrusion (PCI) incorrectly. In the report, PCI is defined as occurring "when there is trailer ***contact*** with the windshield, A-pillars, or roof of the striking vehicle" (emphasis added). The authors incorrectly note that this is the same definition used by IIHS in their underride protocol. IIHS does not define PCI in their underride test protocol. The IIHS does, however, define what they consider to be "a successful test (i.e., no underride)" as one in which there is no contact. The IIHS's definition of a successful test does not evaluate injury risk. The Elemance authors have conflated the IIHS definition of a successful test with PCI. The widely accepted definition of PCI, also referred to as occupant compartment deformation, is "loss of the integrity of the vehicle occupant compartment due to a crash […] resulting in a violation of the occupant compartment" which can be measured directly as the distance the vehicle structure has intruded into the occupant space.

It is well known that the amount of PCI is directly correlated to the injury severity for that affected occupant. In frontal impact crash tests the IIHS defines allowable location-dependent passenger compartment intrusion values for each rating (Figure 1). The Manual for Assessing Roadside Hardware (MASH) uses similar intrusion values as

the IIHS to differentiate between tests that pass and fail.

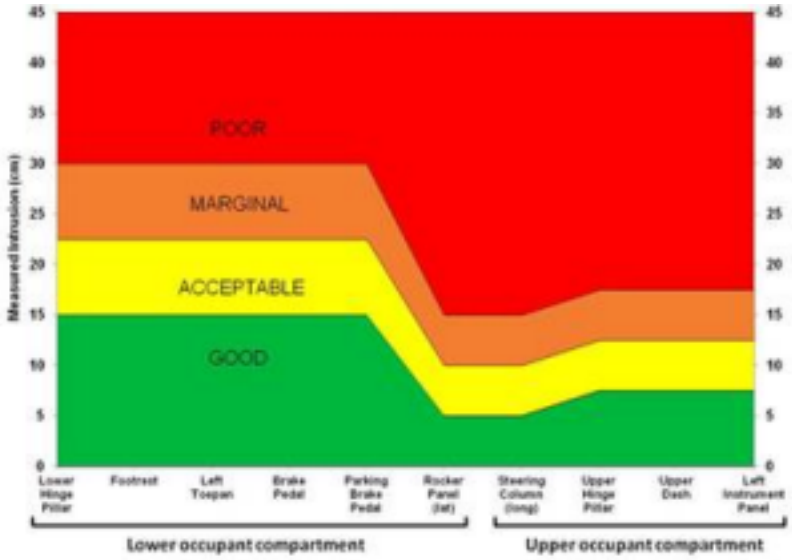

Figure 1. IIHS Guidelines for rating occupant compartment intrusion (IIHS, 2024)

The incorrect definition of PCI in Elemance's report was prejudicial**.** The incorrect definition of PCI makes it appear that the underride guards performed worse than they actually did. By redefining PCI, the authors are only reporting whether or not there was *contact* between the underride guard/trailer and the striking vehicle and not if there was
actual intrusion into the occupant compartment. This is highlighted by the IIHS 30% overlap test conducted with the Manac guard (pg. 45, footnote 11 in the report) in which PCI was prevented in the physical test but *contact* was not prevented.

The occurrence of PCI (as defined by the authors) is not necessarily related to injury risk and a focus on *contact* between the guard/trailer and striking vehicle is a red herring. Some amount of occupant compartment intrusion can likely be allowed while still limiting the risk of serious injury to occupants. Simply focusing on PCI, especially when defined incorrectly, is not particularly useful with regard to actual injury risk in these crash scenarios.

The injury assessment results in the report demonstrate that predicted injury risk for the 40 and 45 mph impacts was not associated with the guard type or the authors' definition of PCI (i.e., *contact*). Importantly, no interactions between the occupants and the underride guard/trailer were noted for the 40 mph and 45 mph scenarios which produced PCI. Finally, the predicted injury risk for chest injury are concerning for two reasons:

1. First, the authors used an older version of the THOR-50M finite element model (v2.7, 2019). This model was developed by the University of Virginia (under

contract with NHTSA). The manual for this model indicates that the response of the thorax was only calibrated against the impactor force. It is unknown if the THOR-50M v2.7 chest deflection was calibrated as no calibration results are presented in the manual or Elemance report. This is particularly important since the injury risk metric the authors used was based on chest deflection.

2. Second, IIHS conducted a small overlap test (25% overlap at 40 mph) with the Honda Accord (the same car used in the study) which is similar to the 30% overlap underride test simulated in the report. In their crash test, the IIHS recorded much lower chest deflection and injury risk than what the authors calculated for the similar impact. This indicates that there is likely an issue with the way the THOR-50M v2.7 model is measuring chest injury risk.

Furthermore, Elemance indicated that they would conduct parameter and optimization studies which "will involve evaluating safety implications for a range of parametric values. Optimization studies […] will include multiple parameters [...] to enhance the safety performance." However, material wall thickness was the only parameter adjusted in the study. This limited scope should be expanded to include more parameters so efficient geometric strength enhancements such as deeper section tubes (relied upon in the Great Dane RIG30) or additional connections can be fully evaluated.

Conclusion: In view of the defects in the Elemance report, a follow up study should be commissioned to evaluate examples of current state of the art rear impact guards ***that have been in service since 2016 and 2017 respectively.*** The study should utilize the correct definition of PCI and more accurately assess injury risk.

Respectfully submitted,

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