National Highway Traffic Safety Administration

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Side Underride Guards

Submitted By:

Truck Sail Inc.

1442 Osprey Dr. Unit #4

Ancaster ON. L9G 4V5

CANADA

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Contact:

Paul G.L. Andrus. M.D., B.A.Sc. (Engineering)

President, Truck Sail Inc.

905-977-0903 pglandrus@live.ca

Gayle Campbell-Andrus, B.A.Sc. (Engineering)

CEO, Truck Sail Inc.

905-977-0028 gayle@trucksail.com

Introduction

We are grateful for the opportunity to provide our perspectives on the side underride problem and its many engineering and economic challenges. It is difficult to see an exposed rear wheel bogie of a semi-trailer driving at any speed and not think this represents an unaddressed public safety hazard for cars, cyclists and pedestrians. However, as the NHTSA benefit-cost example analysis reveals for the addition of heavy strutted structural guards, attempting to solve the problem

in this manner can generate multiple other unintended and more costly problems.

Truck Sail has developed and patented technology for fuel-saving devices (boattail, trailer skirts and gap fairing) with imbedded advanced driver assistance systems (ADAS) technology. Over the course of our research and product development, we believe that we have devised a multi-layered solution to side underride which addresses the shortcoming and cost barriers of alternative approaches.

Engineering Approach Considerations

There are some established engineering points of reference which can guide a design with the objectives of providing effective vehicle deceleration without rebound, at very low payload-displacing/fuel-consuming device weight. Airbags are a well-proven concept inside the car cabin compartment. A key operating feature for their effectiveness is that they begin to deflate immediately after inflation. As to whether an exterior airbag can withstand a direct automotive impact, ZF has developed an exterior side impact car airbag (there is a video of this online) in which the car crumples, but the airbag appears remarkably undamaged. The objective here is different, but it shows the force-withstanding capacity of a light exterior airbag.

Another well-established and effective vehicle decelerating concept is high strength cable. This is seen on aircraft carriers to hook and decelerate the aircraft upon landing. Both of these established engineering approaches to similar problems work well at minimizing G forces at a tiny fraction of the weight of the object being stopped.

The standard test method in which a car is driven perpendicularly into a stationary trailer is a scenario much better primarily managed by car and trailer (vehicle to vehicle) advanced driver assistance systems (ADAS) technology which may include wide-angle deeply imbedded radar low to the road (car level) protected from snow and ice accumulation. It may also include lighting and sound alerts with variable intensity. Roadside billboard lighting could reasonably be considered a driving distraction, whereas vehicular lighting of appropriate intensity and dispersion in front of the rear wheel bogie, which is essentially a

very dangerous second exposed vehicle forebody at car level, could very reasonably be considered forward vehicle safety lighting.

Hump clearance contact issues generally begin about 24” below the trailer. A minimum skirt height is 30”, and optimum skirt height for fuel economy is as close to the road as reasonably possible, around 39” height, which leaves about 4-5” of road clearance. So even a minimum skirt will take contact and suffer permanent shape alteration over time. Adding a heavy rigid underride guard structure behind the skirt will further compromise its ability to flex to ground contact. However, folding the skirt upwardly at the 24” safe clearance level for slow speed railway crossing or dock ramp situations, and then extending it to maximum height on the highway, would then provide optimum function during both docking and driving.

Truck Sail Underride Avoidance

The Truck Sail design comprises an outer ring of aircraft cable(s) within a round aluminum tube, wrapping the entire underbody. It is anchored to or pulled through (adding rounded elbows) the rear underride structural beam and extends forwardly to the landing gear structure. (See attached photos). Upon high-speed impact the rear underride beam would bend at both ends to absorb the energy of impact. The commonly existing gaps behind the skirt but in front of the wheel bogie (typically 4-6’), and behind the wheel bogie (6-8’) are covered as well, which no heavy structural strut design can do unless wheel repositioning is disabled with associated increased operating costs. Kevlar cable has three times the strength per weight of aircraft cable but is more expensive.

In a very high energy crash scenario where the cable and its anchoring structure are sufficiently deformed the airbag (skirt) then takes over. The skirt is ram air pressurized when driving by a plug-resistant air scoop which then serves the necessary controlled deflation function upon impact. The inner side and bottom surfaces buckle with lateral side impact, driving force down onto the car’s front bumper and hood, and up onto the trailer I-beams. Many variations of both safety cable/tube and airbag are possible, but in all cases the capacity for controlled deceleration on a per weight basis (and the zone covered) is far superior to a strutted guard rail approach. The overall weight of our system can be around 200 pounds. It is mounted by two light rails onto the trailer I beams, and so adds no

structural rigidity to the trailer, which if present can lead to premature trailer structural failure.

The skirt (airbag) automatically folds up to the 24” safe clearance level (internally protected actuator) at slow speed to allow for high railway crossings and steep dock ramps, to avoid costly re-routing and docking interference/downtime.

Radar is imbedded two feet deep under the trailer at the level of cars, cyclists and pedestrians for wide angle coverage within the self-de-icing protective shell of the skirt to preserve radar reliability in this debris-accumulation prone region. Snow and ice which can disable radar, and which normally accumulates on the trailer underbody and behind a conventional 2D skirt is shed by frequent slight surface shape changes of the airbag surface as its pressure changes with speed. This principle has also been used in aircraft wing de-icing.

Variations of the system could be developed for non-van trailer configurations.

Testing

We have tested our radar proximity sensor inside-skirt placement and effectiveness but have yet to perform a stationary side car impact test to establish the optimum choice of safety cable(s) and any needed modifications to the airbag to optimally harness this highly weight-favorable concept. We are seeking funding to validate the speed effectiveness of the cable and airbag elements. Our platform can certainly improve the reliability and durability of ADAS sensors and alerts which we think should be the first line of underride defence.

Economic Considerations

Other cost considerations beyond avoidance of payload-displacing/fuel consuming weight and re-routing fuel and time losses, include taking a currently typical 4% fuel-reducing skirt to 6% by riding lower to the road, to 7% by adding one panel behind the skirt forward the wheels, and to 10% with complete 20’ bogie slider zone panel coverage. Each panel can be folded up to allow maintenance access. Over 100,000 annual trailer miles at say 10 mpg and $4/gal, each 1% fuel improvement yields $400, or $2400 annually for the full potential 6% advantage over the 4% skirt baseline.

Maximizing fuel economy and minimizing engine/battery peak load demand in high cross winds also translates into a proportionate extension of engine/battery range and life cycle as these relate directly to energy throughput. The speed-regulated retraction system is inside the skirt to avoid weather fouling but may be optional as the skirt could be shorter in height and just passively flex to ground contact without permanent shape distortion as occurs with flexible composite skirts.

Appropriate soft glow illumination can be from LED strips along the ribs inside and/or diffuse even backlight, but at any light level or configuration can also illuminate high value third party ads as a lucrative revenue stream for trucking fleets. These ads would be corporate sponsorships of energy efficiency and road safety, and help to reduce shipping costs and improve profit margins. The presentation surface is shape-preserved and vibration-stabilized.

Conclusion

Thank you for your consideration of our potentially uniquely viable solution to side underride crashes with other financial benefits to the industry. Truck Sail is currently seeking funding to further test and refine our underride safety system.

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President, Truck Sail Inc.

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905-977-0903

Gayle Campbell-Andrus

CEO, Truck Sail Inc.

gayle@trucksail.com

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Website: www.trucksail.com

See 2 attached photos which are visualizations of the Truck Sail design.