www.swayguard.net

Date 6-26-2021

Sway Guard White Paper

Sway Guard Vortex Generators (US Pat Pending) are designed to attack the real source of trailer and RV instability due to passing vehicles and cross winds.

Stability application

A well-known phenomenon occurs when pulling a large trailer or driving a motor home down a highway and you are passed by a large Semi truck. The trailer or motor home is drawn toward the large passing vehicle. If the driver is not attentive, the suction toward the passing vehicle can cause the driver to lose control. The reason this occurs is because of Bernoulli's Venturi theory. This effect is also noticeable when ships at sea are "Un-repping" (Transferring cargo or fuel at sea). Because of the Bernoulli Effect there is a minimum safe distance that's ships must keep or they will be drawn together.

The often cited example of the Bernoulli Equation or "Bernoulli Effect" is the reduction in pressure which occurs when the fluid speed increases.

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

P = Pressure Energy

ρv = Kinetic Energy Per Unit Volume

$\rho g h$ = Potential Energy Per Unit Volume

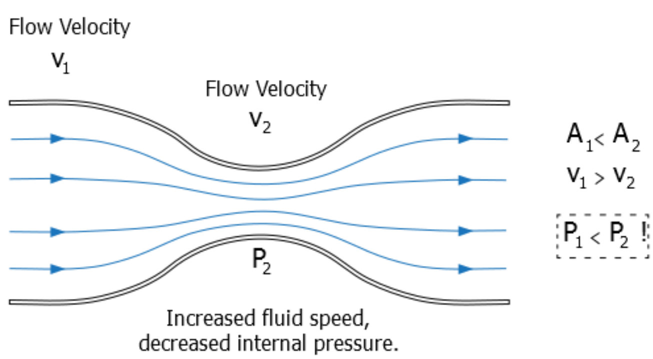

Fig 1 Bernoulli's Theorem

Bernoulli states that the increased velocity thru a Venturi causes a drop in the pressure. The same effect occurs when a Semi is passing a vehicle towing a large trailer or a motor home.

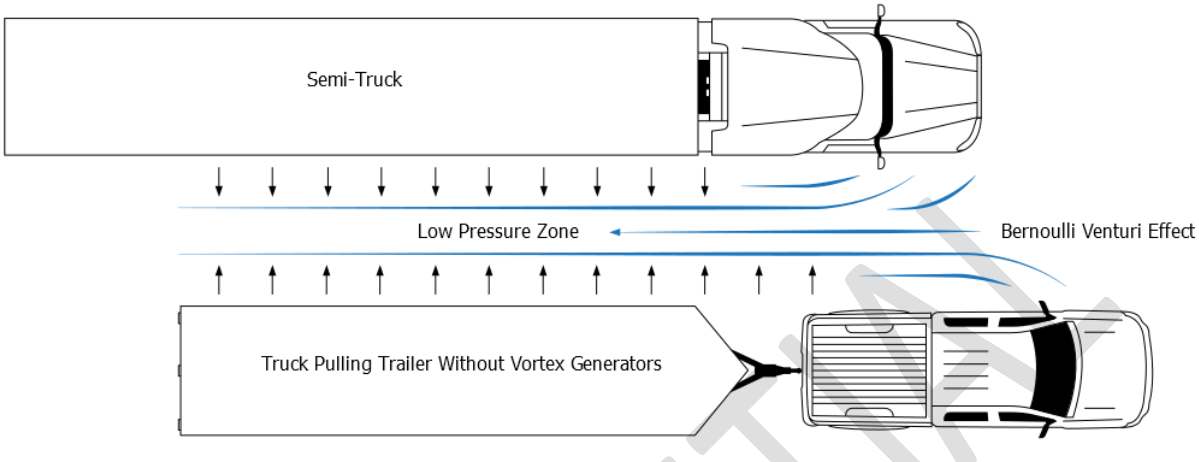

Fig 2 Bernoulli's effect

The air trapped between the vehicles is accelerated between each vehicles bow wave. The resulting low pressure is then distributed along the side of each trailer. This low pressure causes the trailers to attract or suck in toward each other.

The principle of the "Sway Guard" Vortex generator is to eliminate the bow wave on the trailer they are attached to. As shown in Figure 3, thereby destroying a large portion of the Bernoulli Effect.

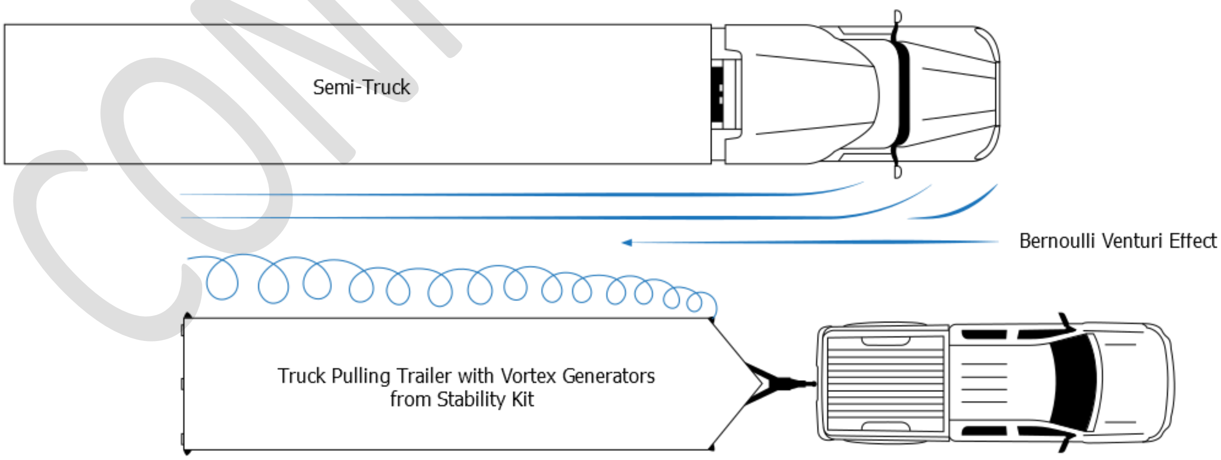

Fig 3 Sway Guard Vortex generator effect

As seen in this plan view (Fig 3), the leading edge of the trailer has a series of tall vortex generators that disrupt the flow off of the front of the trailer and eliminate the bow wave. This in turn dramatically reduces the Bernoulli Effect. An added side benefit is reduced aerodynamic drag which also reduces fuel consumption. Since the effective frontal area of the trailer is the sweep of the bow wave, reducing the bow wave has the effect of decreasing the projected frontal area.

The Sway Guard Vortex generators are arranged in 4 pairs of two. As shown in Figure 4. Each pair is positioned 45 degrees to each other and equally spaced along the extreme edge of the front of the

Trailer or motor home.

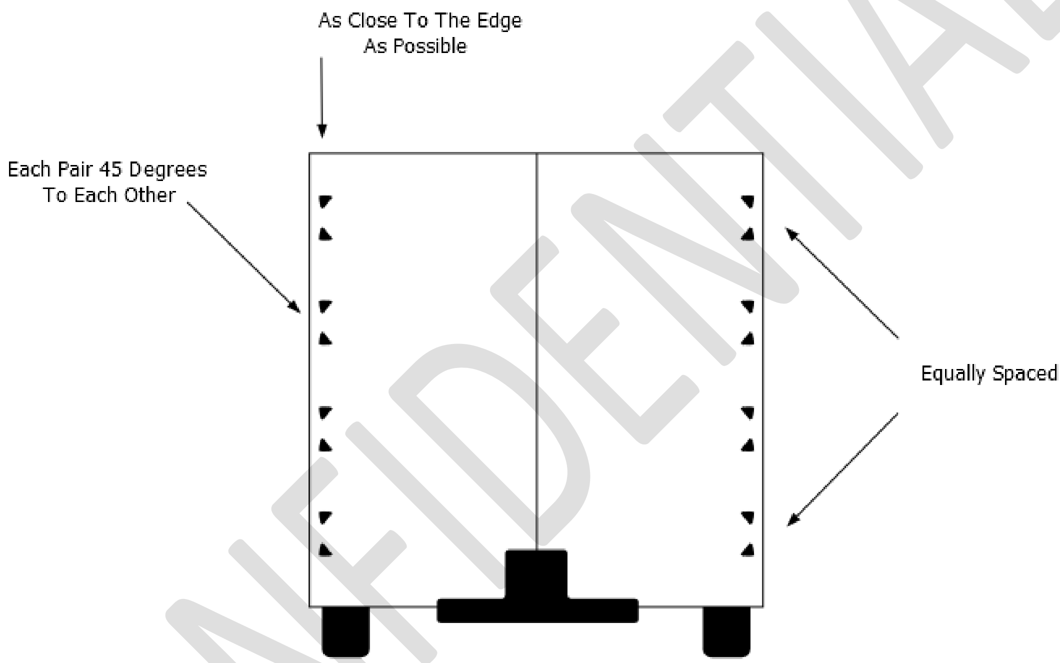

Fig 4 Sway Guard vortex generator placement

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Fig 5 Sway Guard vortex generator prototype

Another form of trailer instability occurs when a large vehicle like a Semi Truck approaches from the rear.

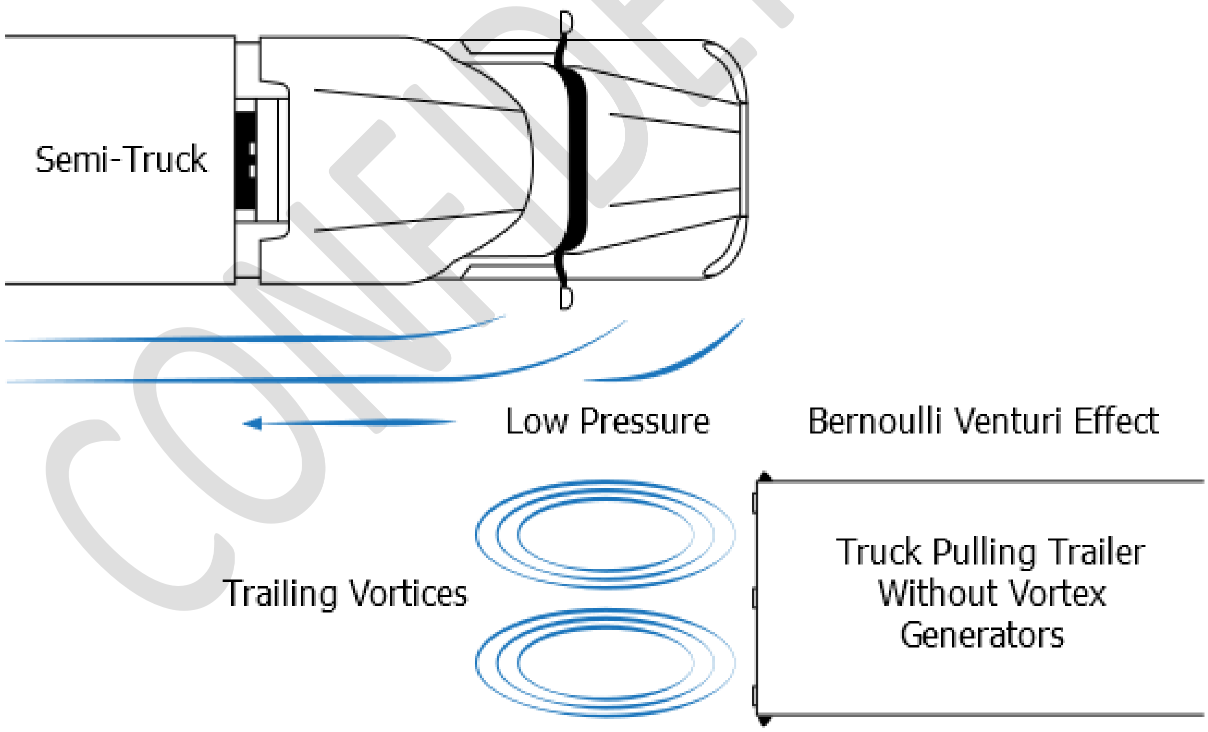


Fig 6 Rear instability

The towed trailer generates a pair of trailing vortex's, when one of these vortexes comes in close proximity of the bow wave of a passing vehicle, another suction effect is created again according to Bernoulli's theory. The driver of the towed vehicle will feel a sharp "tail wag".

When a second set of VG's are added to the end of the trailer using the same pattern as the forward VG's the resulting disruption of the flow over the edge of the trailer reduces the size of the twin trailing vortexes that were attaching to the back of the trailer.

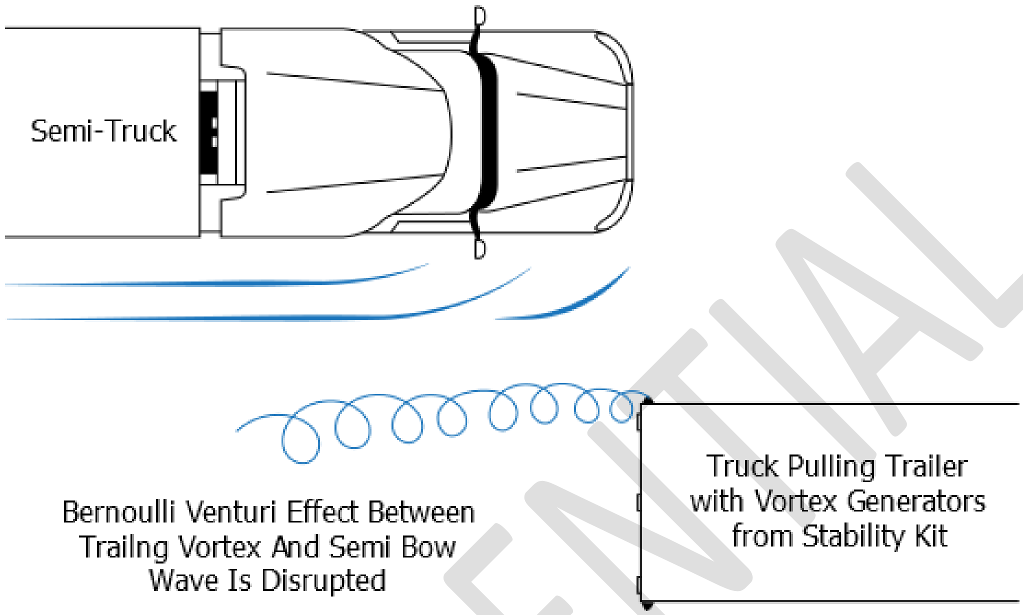


Fig 7 Reduced trailing vortex

The forward and rear Vortex Generators (VG's) comprise the stability application, the total number is 32.

Crosswind Application

Another major cause of trailer and RV instability are cross winds. It is counter intuitive, but trailers and RV's are not blown sideways by the wind pressure, they are in fact "sucked over". When a cross wind strikes a trailer, a large stagnation zone of dead air builds up on the upwind side of the trailer as shown in Fig 8. This stagnation zone serves to deflect the oncoming wind gust over the edge of the trailer. This sharp edge trips the gust and it curls up into a very large vortex. This vortex is naturally drawn to the downwind side of the trailer where it establishes itself. The core of this vortex is a very low pressure and that low pressure is distributed over the surface of the downwind trailer side. This is the force that draws the trailer over.

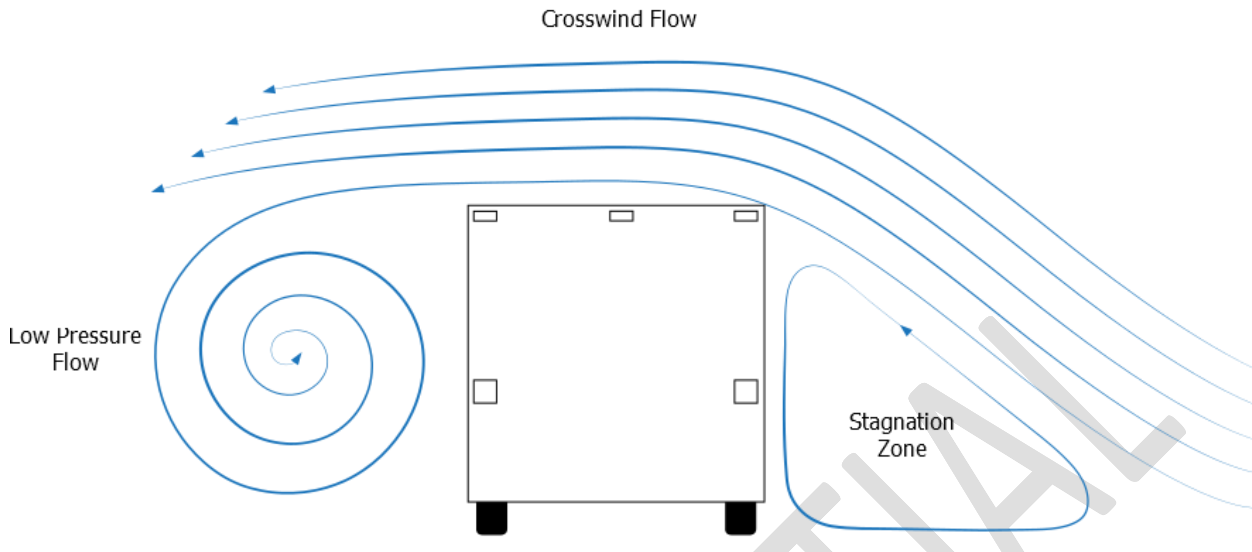


Fig 8 cross wind flow

When a series of VG's are placed along the edges of the trailer aligned such that they are parallel with the fwd direction of travel, these VG's break up the solid sharp trailer edge into a series of "Saw teeth"

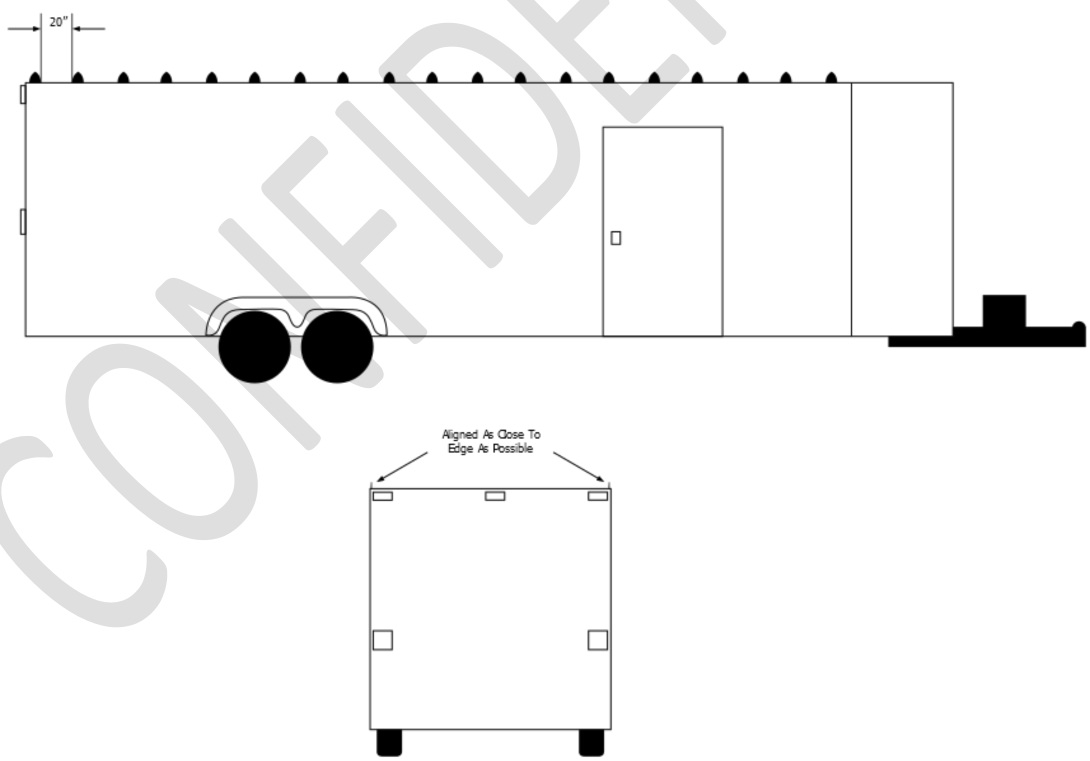


Fig 9 cross wind VG placement

These crosswind VG's do not disrupt the normal Fwd flow, therefore they do not contribute to additional aerodynamic drag of the truck/trailer combination. The only condition that cause these VG's to disrupt flow is a crosswind.

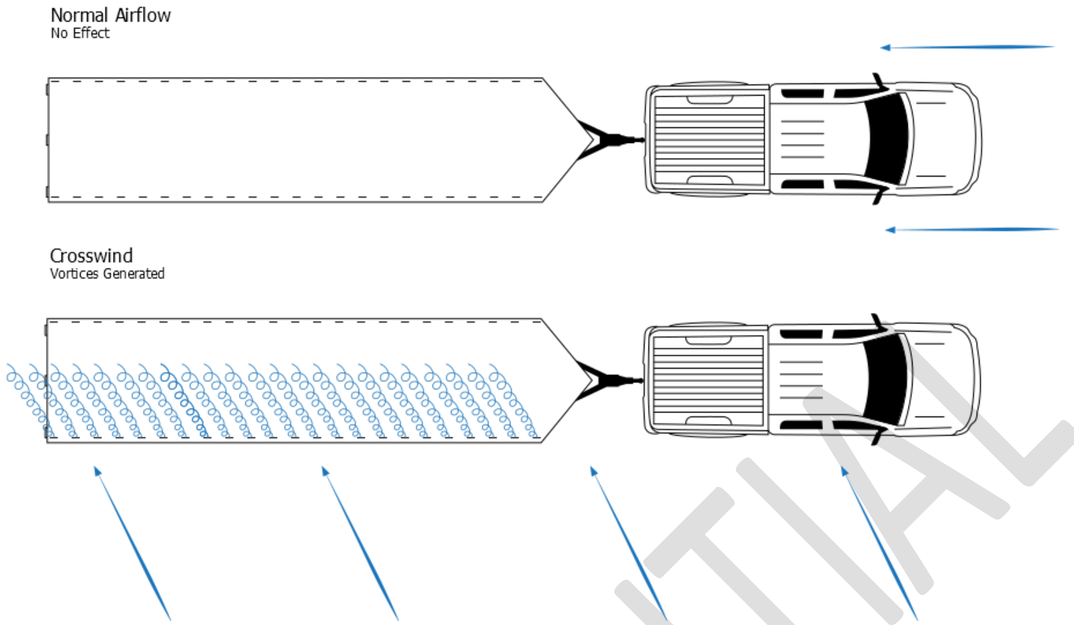


Fig 10 cross wind VG effect

As shown in Figure 10, a crosswind gust is broken up into tiny vortexes. The energy of the gust is dissipated by the small vortexes that are formed, most importantly is the direction of the spin axis of these small vortexes. They are 90 degrees from the direction that original large vortex that would normally form. The effect of these crosswind VG's is dramatic. I have driven this trailer/ truck combination in a 45 mph 90 degree side wind with both hands off the steering wheel.

SwayGuard VG - Sway Force Reduction Trial

SwayGuard VG's have been extensively road tested, the test trailer has recorded over 10,000 miles of long distance driving. Sway Guard prototype VG's have been installed on 12 trailers. To obtain objective data we conducted the following road test with an instrumented test trailer.

Background:

Our innovative sway reduction technology is designed to reduce the sideways pull that passing vehicles, especially trailers or semis, produce on a mobile home, box truck, or trailer. This sideways motion is often unexpected and needs to be corrected by the driver. Corrective action can be difficult for novice drivers and while experienced drivers may be more adept at correcting such a sway, even they could benefit from the added peace of mind given by reducing or eliminating this effect.

Purpose:

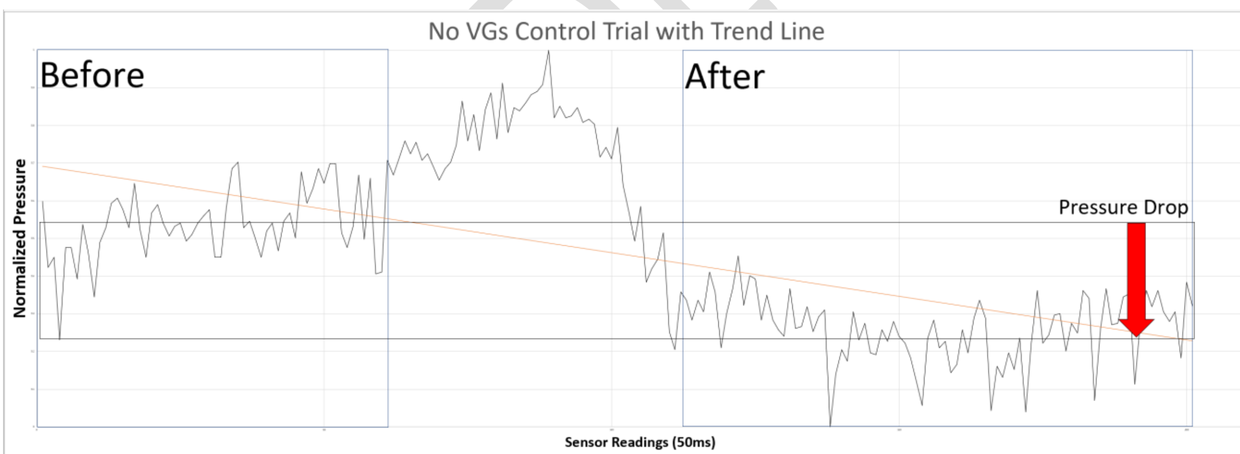
In this brief study, we examine the barometric pressure on the driver's side of a towed 24' trailer. Our goal was to determine if the installation of our sway reduction technology reduces the variation of air pressure while another vehicle passes on the side of our test trailer, thereby reducing the sideward force created by such a variation. To analyze this data, we compared the pressure recorded by our barometric sensor just before and during a semi-truck driving next to our test vehicle.

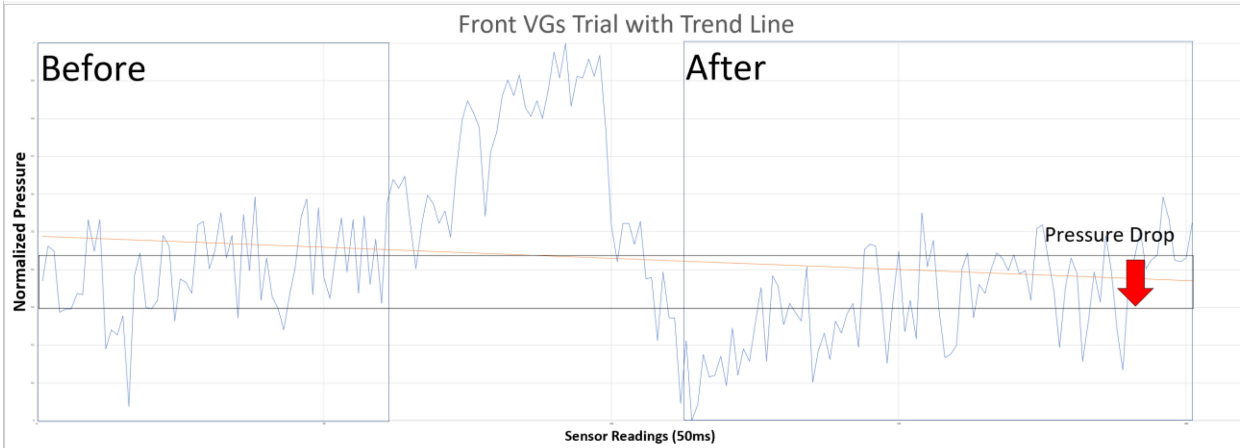
Test:

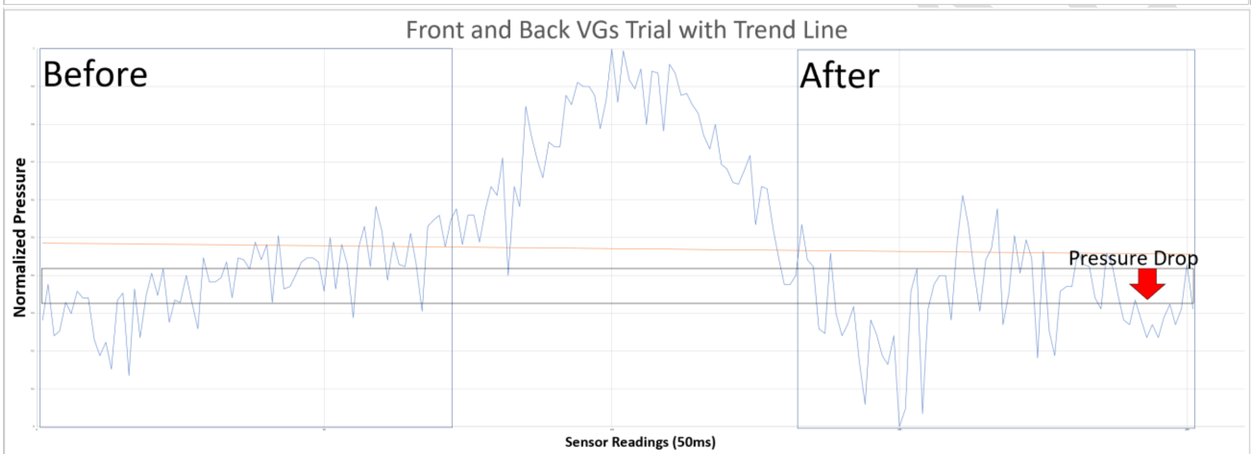
To measure air pressure, a BMP180 microcontroller monitored barometric pressure sensor was installed in the middle of the driver's side of our 24' test trailer. The trailer was pulled at highway speed along a selected stretch of North/South running highway. We simultaneously recorded video and sensor data to synch timestamps from the two data sets. By referencing the video timestamp, we extracted sections of sensor data that recorded 5 seconds before a truck drove next to our test vehicle and 5 seconds into the truck driving next to our test vehicle. We repeated this in three different configurations representing a control and two test parameters.

The first trial was a baseline control run without our system installed. The second was run with our sway guard system installed on the front of the trailer. The third trial was a front and back installation of our system. For each trail we did the same route and speed at very nearly the same time of day within the same weather conditions. We recorded random incidences of semis passing us on the driver's side of our test vehicle and looked for instances in each trial where conditions of the pass were most similar. These comparable instances from each trial are compared below.

Data:







Results	No VGs	Front VGs	Both VGs
Pressure Before (Pa)	98891.4	99194.5	98608.1
Pressure During (Pa)	98826.8	99177.7	98599.3
Pressure Difference (Pa)	64.6	16.8	8.8
Sway Force (lbs)	259.0	67.3	35.3
Percent Reduction		**74.0%**	**86.4%**

Conclusion:

We present here the preliminary trial data for our sway reduction technology. From the trial data we see that with our technology installed, there is a reduction of pressure variation on the side of the test trailer while a semi passed by as compared to the control. This led to a 74% reduction in sideways force and sway with the front set of our VGs installed. With both the front and back sets installed, there was an 86.4% reduction in sideways force. From this data, we attempt to quantify what has been qualified by our test drivers and first users. That is that our system reduces sway from passing vehicles and provides a sense of stability, safety, and peace of mind to the driver.

Our future studies will include further investigation into these reduction effects and similar applications. Within our random incidences, we recorded other vehicles with similar cross-sections to semis passing our test trailer. These other vehicles included rental moving trucks and other small box trucks. We noticed much higher force values incident on our test vehicle from these smaller box trucks. They tended to pass by our vehicle quicker than the semis and caused a noticeable disturbance in our trailer. We did not include these incidences in this report as they were too varied to compare directly. These events are worth studying in a future trial as, without our system installed, the small box trucks had a larger acute effect on our trailer than did the semis. Finally, our system is being tested in another application for the reduction of dangerous cross wind effects on trailers, semis, and mobile homes.

Appendix:

The test trailer setup is pictured below: