The final rating intructions to the vehicle drivers taken from page 417

Use the rank of “1” to mean “not good, don’t like or want it” and use the rank of “10” to mean its a terrific idea, and you would like to have one in your truck and/or think other drivers should want it also.

Q. 84 Table: Raw Data Rating Scores for each FMT Device (1 to 10 scale)*

USA	Fatigue Management Technologies				
Driver Number	CoPilot PERCLOS	SleepWatch	SafeTRAC	Howard Power Center Steering	
031	1	3	3	10	
032	1	5	5	10	
033	1	5	7.5	10	
034	8	9	8	9	
035	2.5	9	8	5	X
036	2	5	7	4	X
037	5	9	10	6	X
038	2	4	9	7	X
039	1	1	8	10	
040	2	8	10	10	
041	3	10	5	10	
042	7	5	9	9	
N=12	N=12	N=12	N=12	N=12	
Average Rating	2.96	6.08	7.46	8.33	
Percent ≥ 9	0%	33%	33%	67%	

River City Products,Inc. - Comment:

It is obvious from the answers and comments that several of the drivers did not understand how to use the Howard Power Center Steering System. This explains the four hard to understand low scores (x).

The trucks used in the test were taken at random from a fleet of in-service used trucks, and equipped with the Howard Power Center Steering System.

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A BREAKTHROUGH IN TECHNOLOGY ACHIEVES LOW FATIGUE HEAVY VEHICLE DRIVABILITY TO A NEW LEVEL OF PERFECTION THAT ESTABLISHES THE NEXT MAJOR STEP FOR IMPROVING HEAVY VEHICLE HIGHWAY SAFETY

This document contains details on the function of the system.

This paper describes the overall function and related highway safety benefits of the Howard Precision Steer Wheel Control Technology (HPCS System) that was **used in the Pilot Test Of Fatigue Management Technologies conducted by the Federal Motor Carrier Safety Administration.**

The following excerpts were taken from The Tech Brief prepared by the Federal Motor Carrier Safety Administration and Transportation Reseach Board (TRB) Paper #05-1234.

“Among all FMT technologies deployed however, drivers were significantly more enthusiastic about the benefits of the Howard Power Center Steering® and Safetrack®….” **(FMCSA Tech Brief)**

“the HPCS system was designed to lessen physical fatigue associated with drivers “fighting” the steering wheel in cross winds. Heavy Vehicle stability and control problems contribute to the “work” of driving a truck, inducing fatigue due to the often continuous amount of driver steering corrections needed to counteract the unstable behavior of the castered truck wheels. The physical workload associated with “fighting” the steering wheel in cross winds is particularly fatiguing to neck and shoulder muscles. There was a need to determine whether a technology that lessened this physical workload on drivers would result in less fatigue. ***The technology that best fulfilled this requirement and was tested in the pilot study was the Howard Power Center Steering system.”*** **(Precision Steer Wheel Control System). (TRB Paper #05-1234)**

This document has been written to be understood by the largest number of readers.

In addition to the Pilot Test Of Fatigue Management Technologies conducted by the Federal Motor Carrier Safety Administration, this document is based on millions of in-service miles of heavy buses, trucks, and recreational vehicles.

The amazing improvement in Directional Stability achieved with the Precision Steer Wheel Control System is greatly appreciated by both the professional heavy vehicle drivers and the non professional recreational vehicle drivers. The most enthusiastic comments made by all of the heavy vehicle drivers is about the reduction in driving fatigue. However, the drivers who have experienced steer wheel tire blowouts with the system are universal in their amazement about the smooth directional control during such occurrences. The amazing improvement in crosswind drivability and the absence of road wander and steering wheel pull are what the drivers liked most about driving a Directionally Stable Heavy Vehicle. The drivers of trucks pulling trailers are most enthusiastic about the significant reduction in driving fatigue when operating a Directionally Stable truck. The lack of Directional Stability in pickup trucks when pulling trailers is also a significant source of driving fatigue. On pickup trucks that are equipped with the Precision Steer Wheel Control System, the drivers are also very enthusiastic about the reduction in driving fatigue when pulling a trailer.

For going on a hundred years, the geometry of the steer wheels of heavy over-the-road vehicles has changed relatively little. It can be reasoned that the present day heavy vehicle steering geometric design has little room for improvement. Therefore, advancing the state of the art in heavy vehicle directional stability and related highway safety will require new advanced technology, such as the Howard Power Center Steering System for going straight, and existing power steering for turning, with both systems working in harmony for the lowest driving fatigue and greatest improvement in highway safety.

River City Products is dedicated to improving heavy vehicle highway safety, as we know the industry is also. We will be happy to provide assistance to the industry for testing our directional stability concept.

The development of The Howard Precision Steer Wheel Control Technology (Power Center Steering System) advances the state of the art in heavy vehicle directional stability to a new level of perfection that results in a major reduction in driving fatigue and related heavy vehicle highway accidens.

- The New Technology completely solves the puzzling long-standing premature heavy vehicle steer wheel tire wear problem. The considerable savings in steer wheel tire expense will pay for the new technology. Heavy vehicle operators have verified a 75,000 mile increase steer wheel tire life.
- The New Technology achieves an amazing level of steer wheel tire blowout controllability, verified by an impressive number of documented steer wheel blowouts where drivers report easy vehicle controllability, without the customary directional steering control problems caused by a blown steer wheel tire.
- The New Technology does away with the inordinate amount of driver steering corrections required to control the unstable behavior of the steer wheels that conventional steering geometry does not control or prevent, thereby making a major reduction in heavy vehicle driving fatigue.
- The New Technology makes a considerable improvement in crosswind drivability, by preventing the steer wheels from castering downwind in response to the wind gusts, thereby making a major reduction in crosswind driving fatigue.
- The New Technology completely eliminates the customary heavy vehicle road wander that is caused by the unstable behavior of the steer wheels that conventional steering geometry is not able to prevent.
- The New Technology does away with steering wheel pull on crowned or slanted roads that is caused by steer wheel castering to the low side of the road.

The Developement Of Howard Precision Power Center Steering Technology

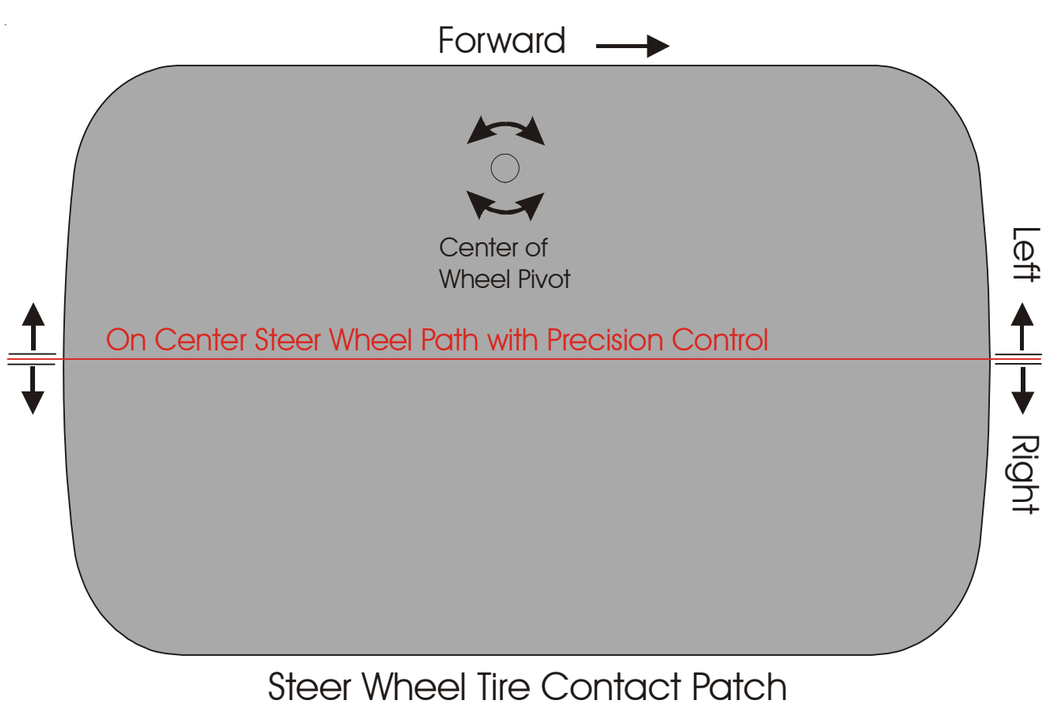
The first production test models featured a driver control panel, because of the many different heavy vehicles that would possibly need some degree of difference in centering pressure or directional trim.The thousands of heavy buses, trucks and recreational vehicles that have the system, have functioned very well and established that the standard systems installed on the production line would not require the driver control panel. The System would be preset at the time of installation and would not require driver fine-tuning, thereby making a highly worthwhile reduction in cost and complexity.

HEAVY VEHICLE STEER WHEEL TIRE CONTACT PATCH TEST VERIFIES THE CRITICAL NEED FOR PRECISION STEER WHEEL CONTROL

Heavy vehicle steer wheel contact patch tests were conducted using a highly accurate method of measuring and recording steer wheel directional activity while driving. The illustration shown is of the steer wheel contact patch of the test vehicle. The experienced test driver made a concerted effort to minimize the corrective steering input to only the amount required to maintain directional control.

The information in this report was recorded on a smooth highway with light and variable winds. At a vehicle speed of 65 M.P.H. with the steer wheel contact patch off-center only 12-14 thousandths of an inch, the test vehicle made lane changes in ten to twelve seconds unless the test driver made necessary steering corrections to keep the vehicle tracking straight.

The tests were repeated on the same vehicle using the Howard Precision Steer Wheel Control System. The steer wheels tracked exceptionally straight with very little driver steering input to maintain directional control .



THE WIDELY MISUNDERSTOOD ADVERSE EFFECTS OF CONVENTIONAL HEAVY VEHICLE STEERING GEOMETRY

In the beginning as the size and weight of motor vehicles increased, the steering tiller was traded for a steering gear and steering wheel that initially presented a problem. The steering wheel would stay turned after turning a corner. The lack of steering wheel returnability was solved by the simple method of slanting the steer wheel king pins aft at the top end to accomplish a ***turning-lift effect*** that is created by the steer wheel that turns to the aft down side of the slanted king pin, thereby lifting the vehicle by a small amount while the opposite steer wheel turns to the up-side of the slanted king pin, thereby tending to increase the weight applied to the wheel that lifted the vehicle. When the vehicle driver releases the steering wheel after turning, the weight of the vehicle causes the steer wheel that lifted the vehicle to return toward the lower most on-center position. Because the steer wheels are connected by a tie rod, both wheels are made to return to the on center driving position. To better understand the turning-lift effect, a graphic example that most everyone is familiar with is the post of a farm gate that becomes slanted due to the weight of the gate in the closed position. When the gate is opened in either direction, the low end of the gate is lifted by turning to a non-slanting side of the post, creating a turning-lift effect. When the gate is released, the weight of the gate will cause it to swing back to the lower most closed position of the slanted post, where the turning-lift effect diminishes and becomes neutral and is not able to hold the gate closed, requiring a suitable method of securing the gate in the closed position. In a similar manner to the turning-lift of the farm gate, when the steer wheels of a vehicle return toward the on-center driving position, the turning-lift effect also diminishes and does not have enough centering force to keep the steer wheels in the on-center driving position. Therefore, the unstable behavior of the steer wheels allows them to vary from the on-center driving position requiring an excessive amount of tedious driver steering corrections to maintain directional vehicle control, resulting in the major cause of driving fatigue and related highway safety issues.

The identical slanted king pin angle, that produces the turning-lift effect, also produces a steer wheel castering effect that adds to the unstable behavior of the steer wheels instead of making them go straight. It is amazing that over the many years because of an unintentional misleading choice of terms, the adverse effect of steer wheel castering has failed to be better understood. It can be reasoned that in the beginning, because the turning lift and caster angles are one and the same, the shorter term **caster angle** was possibly chosen over a more complex term such as **king pin turning-lift angle.**

For as long as anyone can remember, the standard reference for the required king pin turning lift angle in vehicle specification manuals has always been referred to in degrees of ***caster angle***. Therefore, it is not surprising that because the specified king pin angle required to achieve steering wheel returnability is referred to as caster angle. Because of this, it has been mistakenly assumed throughout the many years that steer wheel castering in some manner must have been beneficial to heavy vehicle directional stability, when in fact the opposite is true. Over the years, the majority of the text books and engineering papers that have been written about heavy vehicle steering geometry, have copied and repeated the mistaken assumption that castering the steer wheels somehow makes a contribution to the directional stability of heavy over-the-road vehicles. Unfounded theories attempting to explain how the castered wheel functions to make a vehicle directionally stable, have been repeated in various technical publications, greatly adding to the confusion. A good example of the lack of directional stability of castered wheels is to observe how the castered wheels of a desk chair allow it to be moved freely in any direction.

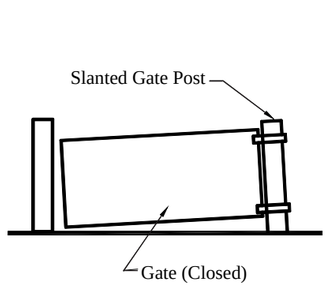


Figure A

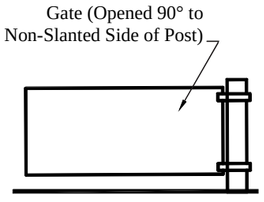


Figure B

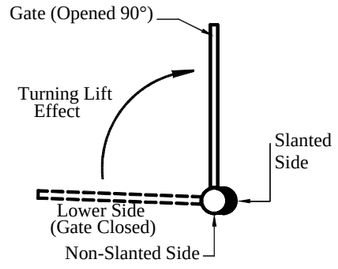
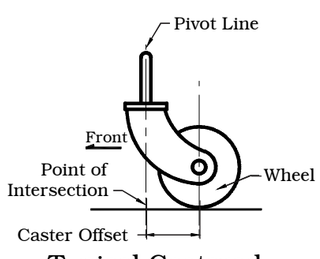
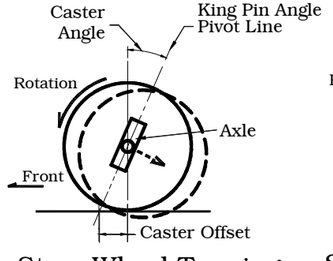


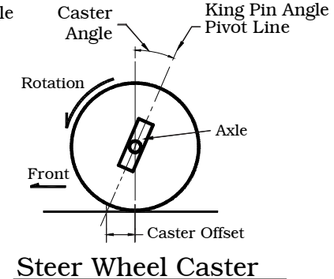
Figure C



Typical Castered Wheel
(Figure D)



Steer Wheel Turning Lift Effect
(Figure E)



Steer Wheel Caster
(Figure F)

STEER WHEEL CASTERING: THE PRIMARY CAUSE OF EXCESSIVE CROSSWIND DRIVING FATIGUE

When driving in a crosswind, the castered wheels steer downwind in response to the lateral vehicle movement caused by the varying wind force acting on the side of the vehicle, thereby requiring driver corrective steering input to keep the vehicle directionally under control. Professional heavy vehicle drivers universally agree that crosswind driving is one of the most fatiguing driving conditions they frequently must endure.

During crosswind driving with The Howard Precision Steer Wheel Control System, the steer wheels are prevented from castering and are made to track exceptionally straight, thereby doing away with excessive driver steering corrections required to keep a heavy vehicle tracking straight and under control, resulting in a major improvement in crosswind drivability that greatly reduces crosswind driving fatigue.

A BREAKTHROUGH IN TECHNOLOGY THAT WORKS IN HARMONY WITH HEAVY VEHICLE STEERING GEOMETRY

Over the many years, heavy vehicle designers have worked diligently seeking to optimize the steering geometry, to improve heavy vehicle drivability. Some of the improvements were made as a trade-off, wherein a much needed gain was achieved at the cost of a highly adverse side effect, such as slanting the king pin aft at the top end to create a turning lift effect that achieved the direly needed steering wheel returnability that, in turn, is responsible for the adverse crosswind drivability caused by the steer wheel castering effect. Some highway bus operators have been known to reverse the trade-off, accepting the lack of steering wheel returnability for greatly improved crosswind drivability. However, when it came to reducing excessive heavy vehicle driver steering effort the development of power steering was the correct answer without a negative trade-off. After a hundred years of experimenting with the heavy vehicle steering geometry, it has not been possible to achieve the direly needed steer wheel directional stability, even with a steering geometry trade-off. Therefore, the New Precision Power Center Steering is the correct answer to achieving the direly needed heavy vehicle directional stability that does away with the crosswind drivability problems, without a negative trade-off, while also achieving a major reduction in overall heavy vehicle driving fatigue, and related highway safety issues.