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# **BEE LINE COMPANY**

## **TOTAL VEHICLE WHEEL ALIGNMENT AND THE BENEFITS OF CAMBER CORRECTION**



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# TOTAL VEHICLE WHEEL ALIGNMENT

In the Heavy Duty Truck Alignment industry there are several concepts on what constitutes a sufficient truck alignment to achieve maximum efficiency. Alignment equipment on the market today varies widely in areas of overall design, technology, and the extent of capabilities. Inexpensive and basic systems may only use mechanical equipment to gauge some alignment angles. More expensive equipment may take only a few basic alignment measurements and then input the findings into a computer to analyze the alignment condition. Even some computerized alignment equipment still may only allow you to measure and adjust basic toe and tracking errors.

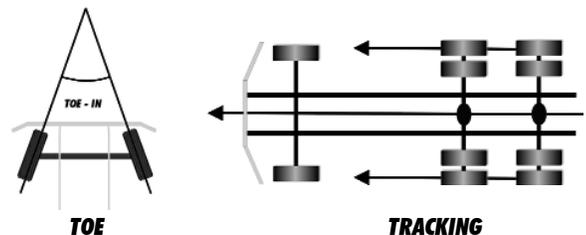
Bee Line recognized a long time ago that measurement and correction of all the major alignment angles is necessary to achieve maximum truck efficiency. That is why Bee Line promotes the concept of "Total Vehicle Wheel Alignment" to extend tire wear, maximize fuel efficiency, and improve vehicle handling. **Total Vehicle Wheel Alignment means measuring and correcting all alignment angles, not just toe and rear tracking.**

The alignment checks that Bee Line equipment allows you to make are:

## Toe and Tracking

Excess or too little toe-in will make the front wheels fight each other, increasing wear. Tracking misalignment, common among certain suspensions, will also cause irregular tire wear in the steer tires!

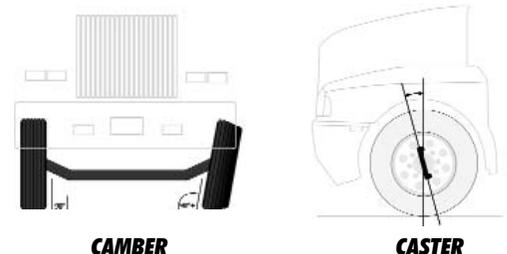
Bee Line gauging equipment incorporates lasers to measure for proper toe and sets the tracking parallel to the centerline of the chassis.



## Camber and Caster

Camber allows the weight of the vehicle to be carried directly below the spindle. Too much camber causes wear on the outer half of the tire tread, too little will wear the inside. Caster is the angle of the front axle and effects vehicle handling.

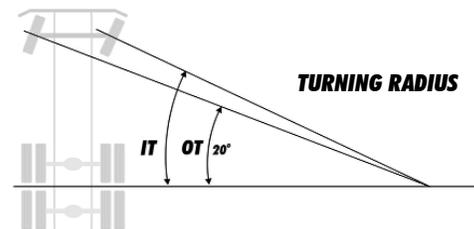
Bee Line measures for the perfect camber and caster settings for your vehicle. This ensures the best axle correction for longer tire and vehicle life.



## Turning Radius

An improper turning radius leads to irregular shoulder wear or feathering. It's a reading that should never be ignored but often is.

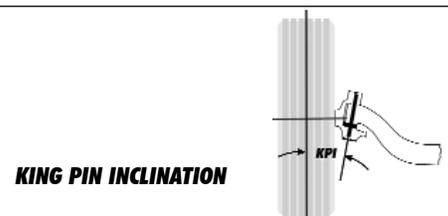
Bee Line measures and displays the Ackerman Angle for proper turning radius. This notifies us if your vehicle's turning radius is sufficient or if the Ackerman arm needs to be replaced.



## Check King Pin Inclination

KPI is the angle needed to pinpoint bent spindles, bent king pins, and more. Since it is vital to read KPI when aligning a vehicle, it shouldn't be treated as an afterthought.

Some shops use alignment systems that provide only basic angles in their standard readout. Bee Line measures true King Pin Inclination (KPI).



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## Measurement And Correction

Bee Line recognizes that in addition to allowing the measurement of critical alignment angles, it is important that alignment equipment allows you to correct all out of tolerance alignment angles. After all, what good is it knowing the truck is out of alignment if you cannot correct the problems? This means not just correcting toe and/or rear tracking, but also correcting camber and caster. Customers who want their truck aligned should expect that the shop can not only measure the alignment angles, but also have the proper equipment to correct any errors found.

**With the ability to correct toe, rear tracking, and camber, Bee Line allows you to fix the #1, #2, and #3 causes of tire wear and increase fuel efficiency.** Also, with the ability to easily correct caster, vehicle handling can be improved increasing driver comfort and safety.

**The Bee Line Advanced Aligner Runway machine and our alignment tooling is designed to allow a shop to perform all necessary alignment corrections.** The machine places the truck at a comfortable working height, either in a pit or above ground. It allows you room to make adjustments to not only toe and tracking, but also camber and caster. It also allows you easy access to the vehicle's front end to inspect for worn front end parts and to perform necessary measurements and corrections. There is no fixed beam or equipment hindering access or making it difficult to work on the vehicle.

**Bee Line's patented camber tooling** can correct out of tolerance camber on all axle sizes and also correct any axle twist. The floating beam system is designed to be easily attached to the vehicle axle for corrections and removed and placed out of the way when the correction is finished. Special Bee Line fixtures also allow easy removal and replacement of caster wedges.

**Bee Line's state of the art computerized alignment system** utilizes lasers which are more accurate than string or infrared sensors. The bright laser beams are highly visible and show any alignment errors on the vehicle. Bee Line lasers provide the most accurate alignment readings on the market today. While most systems only measure to one hundredths of an inch (.01), Bee Line uses a system capable of measuring alignment variables to one thousandths of an inch (.001).

All corrections and adjustments to a vehicle's alignment are done with a "live" reading. The readings for toe, rear tracking, and camber are shown on the computer screen or a wireless Remote Display and reflect all changes as corrections are being made to insure accuracy,

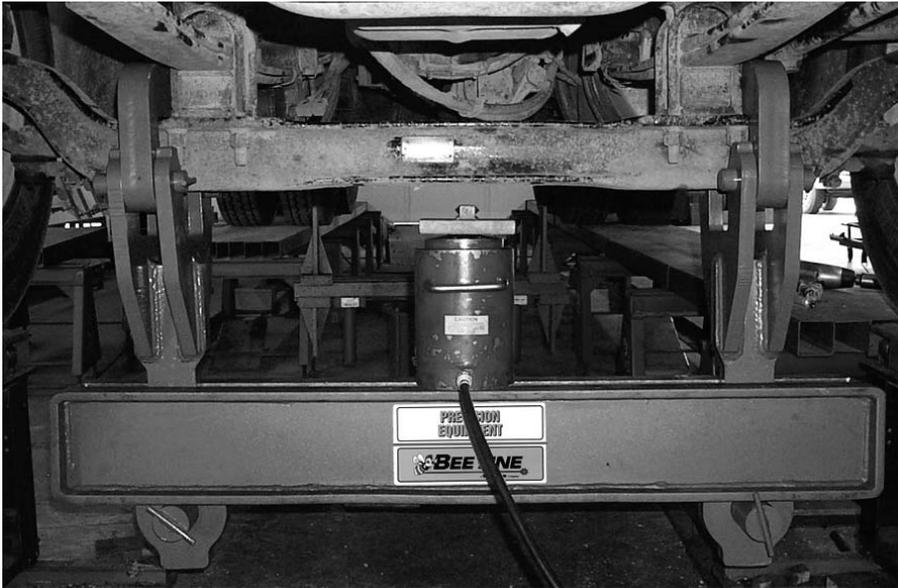
**Calibration is built in on Bee Line equipment.** Calibration is an important part of any alignment system and should be done frequently to insure accurate alignment readings. Bee Line's equipment has built in calibration capability and can be calibrated by the operator at any time in just a few minutes. There is no long period needed between calibrations and no extra expense while waiting for some outside party to come and calibrate the equipment.



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## Camber Correction

Bee Line has long been a proponent of the benefits of camber correction. We know that our patented camber correction equipment, along with our many years of experience and extreme accuracy allow users of Bee Line equipment to perform camber correction safely and accurately. Camber correction, as part of a "Total Vehicle Wheel Alignment", allows vehicle owners to achieve maximum tire life and fuel efficiency from their vehicle. The following information is designed to help you understand the benefits of camber correction.



**Figure 1:**  
BEE LINE'S PATENTED "FLOATING BEAM" METHOD FOR AXLE CORRECTION PROVIDES AN UNPARALLELED DEGREE OF ACCURACY AND SAFETY.

Nearly all passenger cars and light trucks have adjustments for camber, or have aftermarket shim adjustments so camber can be changed and fine tuned. This is because it is known that adjusting the camber to preferred settings increases tire life while improving vehicle handling. Conversely, most heavy duty trucks have straight axles that do not have similar accommodations for camber adjustment. As a result, the only way to change the camber is to correct, set, or bend the axle.

This is where Bee Line technology has been utilized for over 80 years. An early inventor and automotive enthusiast, George L. Hunt manufactured the first axle correction equipment in the 1920's and called it the Bee Line press. Eventually this is how Bee Line became the pioneer in the early automotive and truck alignment landscape. Over the years, Bee Line's mission has been to effectively manufacture cutting edge wheel alignment equipment that helps solve irregular handling and tire wear conditions.

Camber is a known tire wear and vehicle handling issue in the trucking industry that needs to be addressed if vehicle owners are interested in maximum performance from their trucks. Bee Line is confident that our equipment and patented methodology represent the safest and most effective way to correct camber on truck axles.

There are thousands of shops and trucking fleets that perform truck alignment, including camber correction, who realize the only practical way to change camber is to correct, set, or bend the axle. They do this because they and the vehicle owners see first hand the benefits of a proper camber setting in relation to tire wear, fuel efficiency, and the overall operating costs of the vehicle.



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With our experience as a guide and numerous studies of the effect of camber on tire wear, Bee Line promotes a tighter specification or a "preferred" specification to achieve maximum tire mileage. The Truck Maintenance Council (or TMC - a council of the American Trucking Association) also recognizes the benefit of setting a vehicles toe, rear tracking, and camber to preferred specifications. These preferred specifications are shown in their TMC RP642 manual. The following graphic is a page from the TPC RP642 manual.

Guidelines for Total Vehicle Alignment

## CHAPTER 10: RECOMMENDED ALIGNMENT TARGETS

The following values for alignment specifications represent an industry-established midpoint or target value. Striving to hit these targets during the alignment process should help to minimize the inherent variation in measurement systems and human error.

**NOTE:** Vehicle manufacturers' specifications may differ from these. Consult the vehicle manufacturer for their specific recommendation. Adjustment should only be done during an all-axle alignment by a qualified alignment provider.

**Figure 2:**

THIS GRAPHIC IS A PAGE FROM THE MAINTENANCE COUNCIL'S TPC RP642 MANUAL.

ALIGNMENT SPECIFICATION <sup>(1)</sup>	TARGET VALUE <sup>(2)</sup>
<b>STEER AXLE:</b>	
TOTAL TOE	1/16" (0.08°, 0.06", 1.5mm/M)
CAMBER	Less than 1/4° <sup>(3)</sup>
CASTER	L + 3-1/2° R +4°
SETBACK	0" or 0°
<b>DRIVE AXLE (S):</b>	
THRUST (SQUARE)	0° or 0"
SCRUB (PARALLELISM)	0° or 0"
LATERAL OFFSET	0"
<b>TRAILER AXLES &amp; DOLLIES:</b>	
THRUST (SQUARE)	0° or 0"
SCRUB (PARALLELISM)	0° or 0"
LATERAL OFFSET	0"
<b>NOTES:</b>	
1. All specifications are measured with vehicle in static, unladen condition.	
2. All specifications are stated in inches or degrees (where applicable).	
3. Camber angle changes normally involve bending the axle beam, which may void the axle manufacturer's warranty. If the measurement exceeds this value consult the vehicle, axle, and/or alignment equipment manufacturer.	

In the "Notes" section it states that a camber angle change normally involves bending the axle and that this "may" void the axle manufacturer's warranty. This is understandable as no axle manufacturer can be sure of the process or method a shop may use to bend or correct an axle. **However, Bee Line's tooling and methodology using cold axle bends has been proven over time to be a safe and effective method of correcting camber with no damage or weakening of axle integrity.**



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It is also important to note that the camber setting recommended by the TMC is tighter than most axle manufacturer's original specifications and Bee Line's preferred settings are even tighter than the TMC specs. Therefore, a lot of axles will be outside of the TMC and Bee Line specs. That is why the TMC suggests, that if camber specifications exceed those listed in the TMC manual, to "consult the vehicle, axle, and/or alignment equipment manufacturer". Bee Line does not promote that camber is a warranty issue. Nearly all manufacturers leave the decision of correcting the camber to preferred settings up to the vehicle owner.

If the camber is within the axle or truck manufacturer's tolerances, but outside the TMC or Bee Line specs, it is the vehicle owner's responsibility to determine if they want to adjust their camber to the preferred settings. Bee Line has proven that our preferred camber settings make a significant difference in tire life. That is why truck owners across the country choose to reset their camber to the Bee Line preferred settings and achieve maximum tire mileage for their vehicles.

Bee Line and the group of companies listed below participated in the formation of the TMC RP642. It is their consensus that the preferred alignment settings in the chart shown previously will help achieve the best tire mileage. The following graphic is a page from that manual acknowledging the participation of these companies.

Guidelines for Total Vehicle Alignment

## ACKNOWLEDGMENTS

TMC wishes to recognize the following companies who participated in the development of this RP by donating their expertise and resources:

ArvinMeritor  
Bandag  
Beeline Co.  
Bridgestone/Firestone Tire Sales Co.  
Dana/Eaton  
Euclid Ind.  
Freightliner Corp.  
Goodyear Tire and Rubber Co.  
Hendrickson Suspension  
Hunter Engineering  
International Truck and Engine  
JOSAM  
Kenworth Truck Co.  
Mack Trucks, Inc.  
Michelin North America  
MD Alignment  
Peterbilt Motors Co.  
Spicer Trailer Axle  
TRW Commercial Steering Systems  
Volvo Trucks North America  
Western Star Trucks, Inc.

**Figure 3:**

THIS GRAPHIC IS ALSO A PAGE FROM THE MAINTENANCE COUNCIL'S TPC RP642 MANUAL.



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## Case Study - Effects of Camber and Toe

In addition, there have been studies over the years on wheel alignment conditions and tire wear. In 1992 an SAE Technical Paper series 922485 was released titled Camber and Toe Effect on SBFA Heavy Truck Steering Axle Tire Wear. <Credits Tom McNorton Rockwell International (now Meritor Axle) and Fred Wheeler Michelin Americas.> The chart below summarizes the effect of camber on trucks in a controlled experiment in conjunction with the May Trucking Fleet. Fifteen heavy duty class 8 trucks had their toe set to the accepted industry setting of +0.040. Five variable groups of three trucks were created out of these 15 trucks. Group one had three trucks set to identical camber settings and driven for nearly two years in order to gauge tire wear. Group two had slightly different camber settings and so on. The following chart illustrates the outcome of having identical toe settings while varying camber setting vs. the average tire life for each group.

Camber Setting (in degrees)		Toe Setting (in inches)
Left	Right	
		<b>+0.040</b> <i>This is the accepted industry standard setting.</i>
<b>-3/4</b>	<b>-1</b>	<b>157,000 mi.</b> Average Tire Life, 90% of Optimal Setting.
<b>-1/4</b>	<b>-1/2</b>	<b>155,000 mi.</b> Average Tire Life, 89% of Optimal Setting.
<b>+1/4</b>	<b>-0</b>	<b>175,000 mi.</b> <i>Optimal Camber and Toe Setting (100%)</i>
<b>+3/4</b>	<b>+1/2</b>	<b>137,000 mi.</b> Average Tire Life, 78% of Optimal Setting.
<b>+2</b>	<b>+1 3/4</b>	<b>127,000 mi.</b> Average Tire Life, 73% of Optimal Setting.

**Figure 4:**  
THE CHART REFLECTS THE RESULTS OF CAMBER AS NOTED IN THE MAY TRUCKING STUDY.

It was concluded that +1/4 Left Camber and -0 Right Camber was the optimal setting. Other settings varied as much as 27% from the optimal setting before the tires needed to be replaced! This study justified what Bee Line has known for decades. Camber is a vital characteristic in extending tire life and significantly lowering the vehicles operating costs.

If you would like to know more about Bee Line's proven alignment philosophy and our cutting edge technology featuring our camber correction tools, contact us today at 800-728-7828 or visit us online at [www.beeline-co.com](http://www.beeline-co.com)

