REPAIRCERTNZ
SPECIALIST CERTIFICATION MANAGEMENT (REPAIR) LTD

INFORMATION SHEET
 # 05 - 2024 (September 2024)

Understanding Wheel Alignment Reports

Fundamentals of Angle Measurements in a Wheel Alignment

Supporting New Zealand's Repair Certification Industry

About RepairCert NZ Information Sheets

These Information Sheets have been developed to provide operational information for Repair Certifiers, to assist them in correctly carrying out their repair certification responsibilities.

Purpose

To provide guidance for Specialist Light Vehicle Repair Certifiers (Repair Certifiers) when interpreting wheel alignment reports, to ensure that a damaged vehicle's steering and suspension geometry has been returned to manufacturer's specifications.

Background

Wheel alignment reports provide essential data about the alignment of a vehicle's wheels, steering and suspension components.

It is of vital importance that Repair Certifiers have a fundamental understanding of vehicle steering geometry - in particular, the three primary wheel alignment angles used in wheel alignment reports. This knowledge will help identify any issues that may require further investigation and diagnosis.

The Three Primary Alignment Angles

Camber

When viewed from the front or rear of the vehicle, camber is the measurement of the angle of lean inward or outward of the wheels. If an imaginary line was drawn through the centre of the tyre tread, the camber angle would be the measurement between this line and true vertical, expressed in degrees.

In layman's terms, if the top of the tyre is leaning outward, the wheel would have a positive camber measurement. If the top of the tyre was leaning inward, it would have a negative camber measurement *(see Image 1)*. If the Wheel is sitting perpendicular to the road surface, the wheel would have no camber. A common result of a vehicle with poor camber alignment is the abnormal wear around the entire inner or outer edge of the tyre.

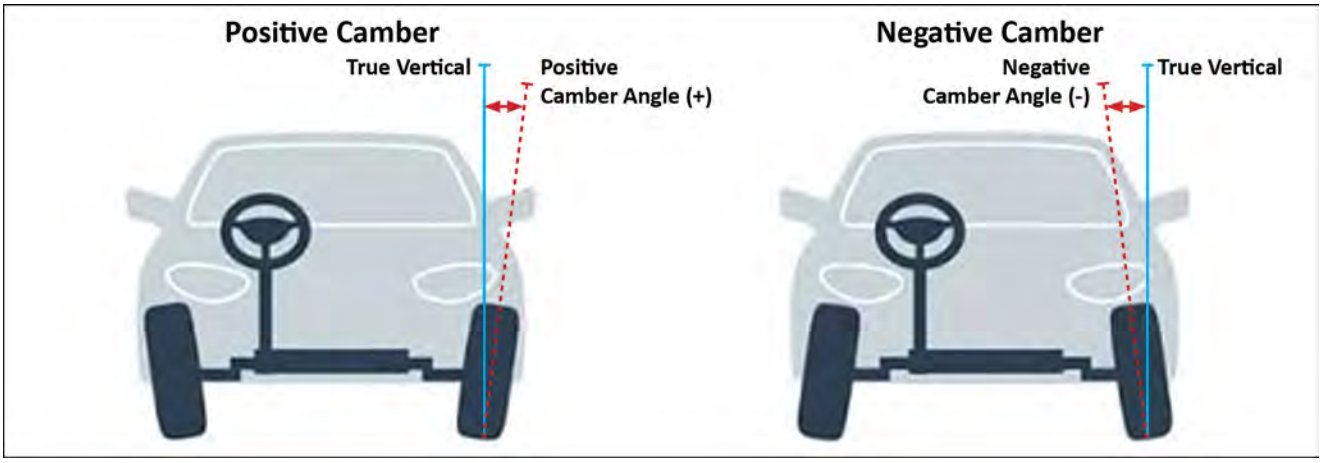


Image 1: *Positive and Negative Camber. Image courtesy of WapCar.*

Toe

Toe is the measurement of how far away from parallel two wheels on the same axle sit relative to each other, and the vehicle's longitudinal centerline. This measurement is expressed in degrees (°) or millimeters (mm). When viewing the vehicle from above, the front edges of the wheels pointing in is known as 'toe-in' or 'positive toe', and pointing out is 'toe-out' or 'negative toe' *(see Image 2)*.

Note that the term 'individual toe angle' measures the toe angle of each wheel separately (L and R), from the vehicle's longitudinal centreline, whereas the term 'total toe angle' measures the combined angles of both wheels.

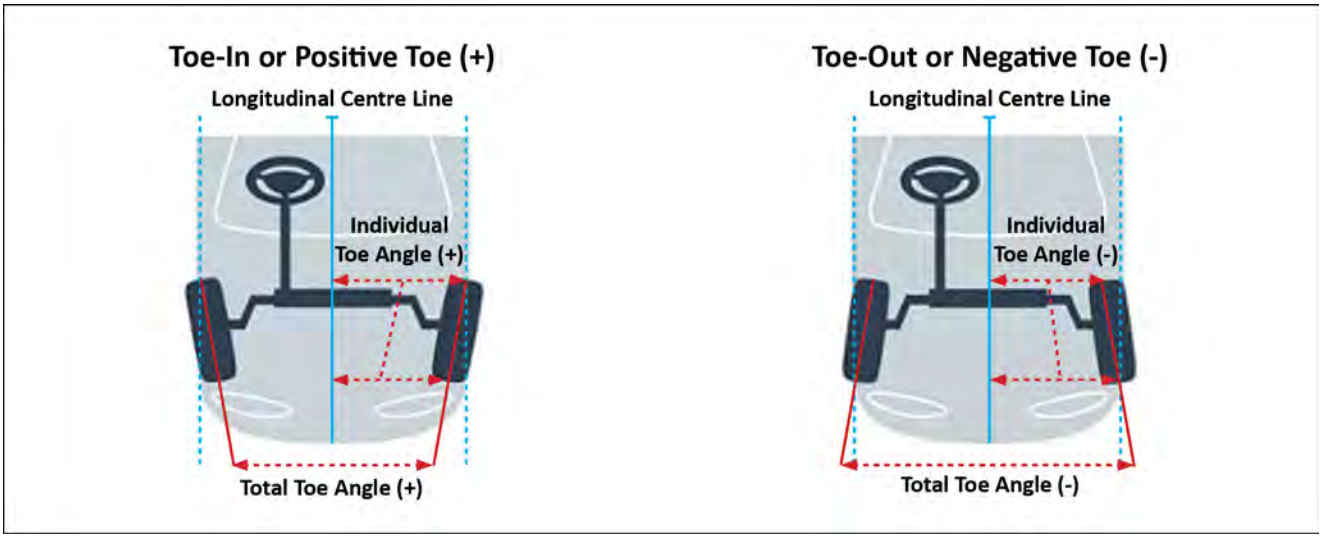


Image 2: *Toe-In (positive toe) and Toe-Out (negative toe). Image courtesy of WapCar.*

Caster

If, looking at a vehicle from side on, an imaginary line was drawn between the top and bottom steering pivots, the caster angle would be the difference between this line and true vertical, expressed in degrees (°).

If the pivots were in a line that was perfectly perpendicular to the road surface, the vehicle would have no caster. If the top pivot was further rearward than the bottom pivot (causing the imaginary line between them to tilt rearward), the vehicle would have a positive caster measurement. Conversly, if the top steering pivot was further forward than the bottom pivot (causing the imagnary line to tilt forward) it would have a negative caster measurement *(see Image 3)*.

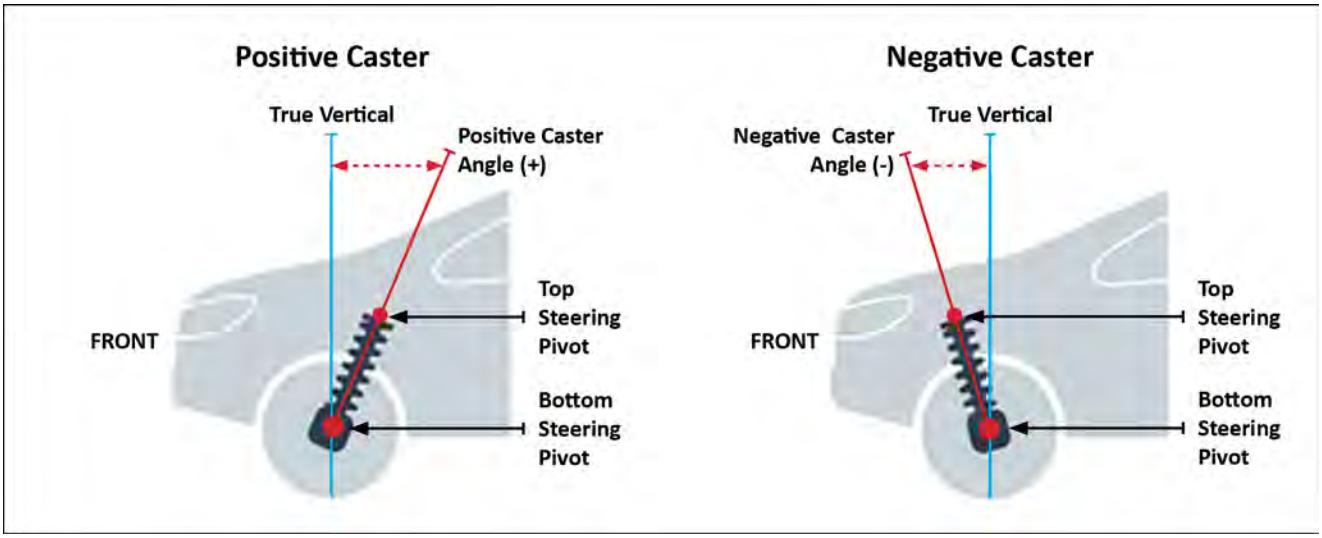


Image 3: *Positive and Negative Caster. Image courtesy of WapCar.*

Secondary Alignment Angles

There are numerous 'secondary' steering alignment angles that may need to be checked (and adjusted/corrected), including (but not limited to) Steering Axis Inclination (SAI) and toe-out on turns (Ackermann angle or TOOT). For further understanding of these angles, Repair Certifiers should seek additional specialist training (outside the scope of this Information Sheet).

However, there is one secondary alignment angle Repair Certifiers should have a fundamental understanding of, known as the 'thrust angle', which relates to the alignment of the rear axle and wheels.

Thrust Angle

Also referred to as the 'thrust line', thrust angle is measured in degrees from an imaginary centreline drawn perpendicular to the rear axle of the of the vehicle (as viewed from above).

The purpose of the thrust angle check is to determine if the rear axle aligns with the centre of the vehicle and the front axle - correct thrust angle will be 0° *(see Image 4).*

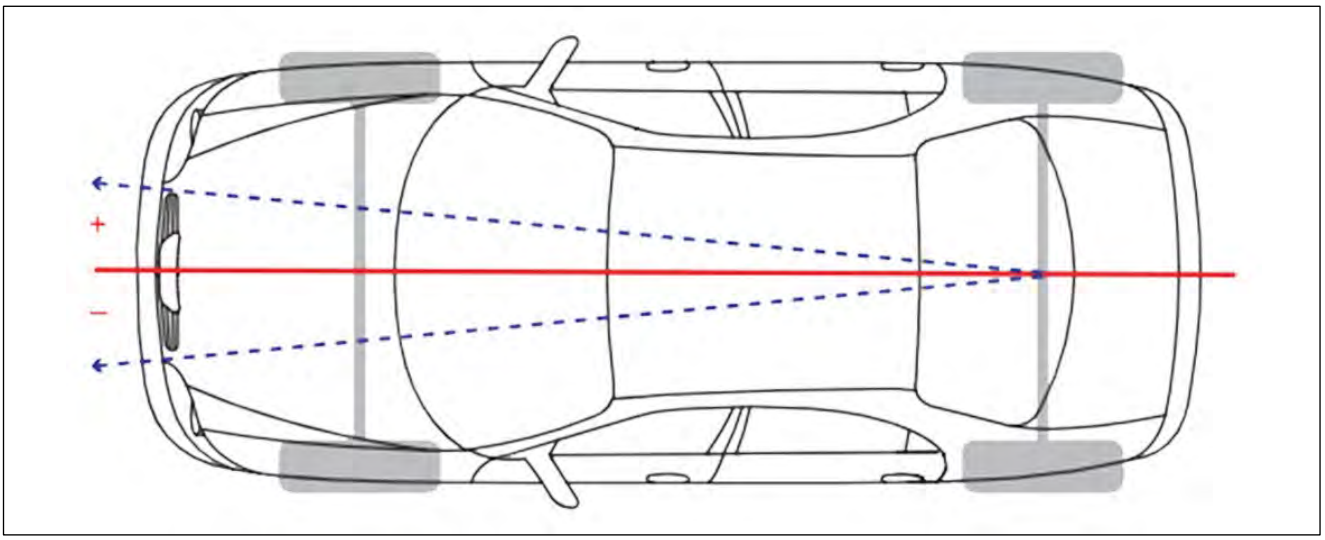


Image 4: *Thrust angle. Image courtesy of Bridgestone.*

Basic Geometry - Understanding the Measuring Units Used Across Wheel Alignment Specifications

Both camber and caster alignment angles are expressed in degrees, as this is the most common (and familiar) unit for measuring angles.

Degree measurements are derived from a 'complete angle' or 'full angle', which is a full circle made up of 360° *(see Image 5).* The measure of an angle (in degrees) is the amount of rotation from the *initial line* to the *terminal line (see Image 6).*

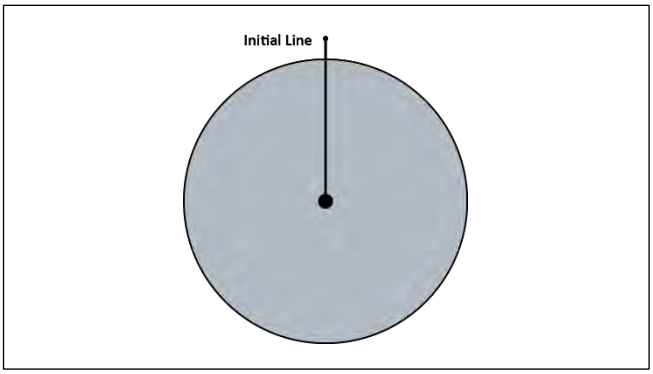


Image 5: *Complete angle or full angle (exactly 360°).*

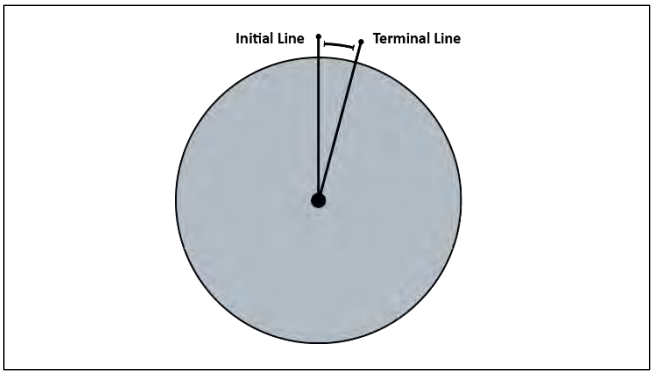


Image 6: *Measuring an angle.*

While a single degree is a relatively small increment of measurement, wheel alignment angle specifications will (typically) also include 'part' degrees (or measurements that are less than a single degree).

These smaller increments of measurement are expressed in 'minutes' (') (with 60' equalling 1°) *(see Image 7),* or (for typically later generation alignment systems) 'decimal degrees' *(see Image 8)*.

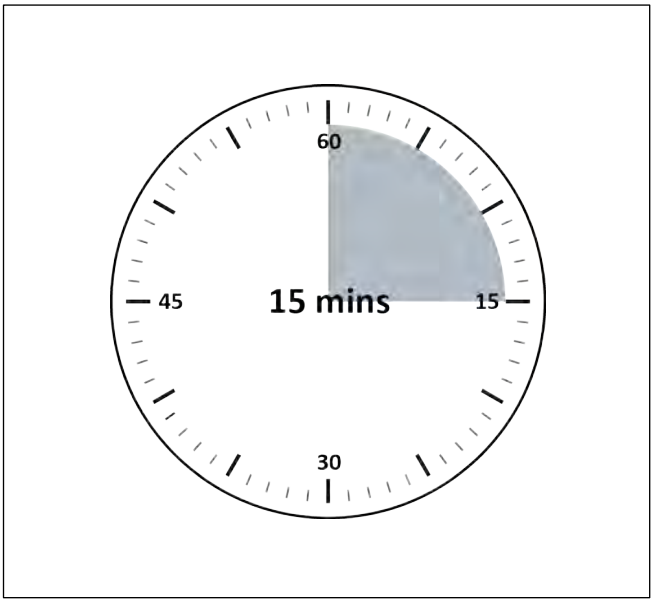


Image 7: *60' = 1°. This example: 15 mins (or 0.25°).*

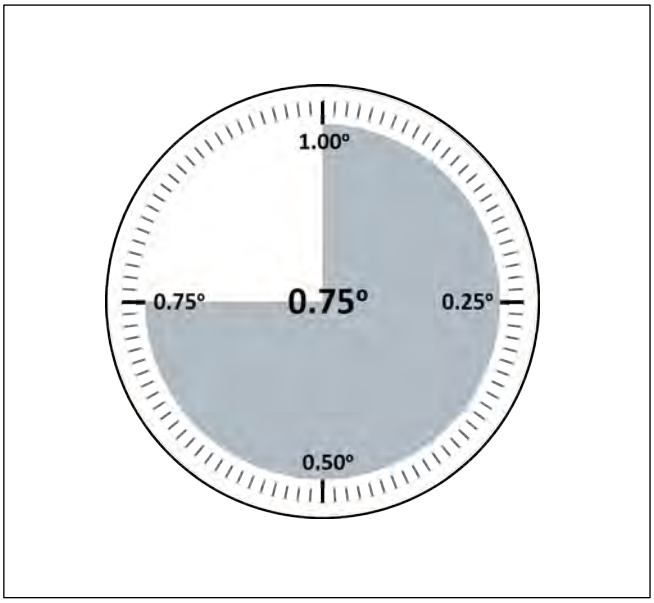


Image 8: *100 decimal (°) = 1°. This example: 0.75° (or 45').*

Specifications

Specification ranges will usually be presented in one of two ways: either as a maximum and minimum value, meaning that the actual measurement must fall within that range, or as a +/- range. In the latter case, a preferred measurement value is provided, and the actual value must fall within the range of the preferred value plus or minus the tolerance value.

The below table shows identical specifications expressed in degrees as decimal points and minutes.

Measurement	Decimal			Minutes		
	Range	Preferred	Range +/-	Range	Preferred	Range +/-
Front Left Camber	-0.5° to 0.5°	0.0°	+/- 0.5°	-0° 30' to 0° 30'	0° 00'	+/- 0° 30'
Front Left Caster	-2.57° to 0.43°	-1.07°	+/- 1.5°	-2° 34' to 0° 26'	-1° 04'	+/- 1° 30'

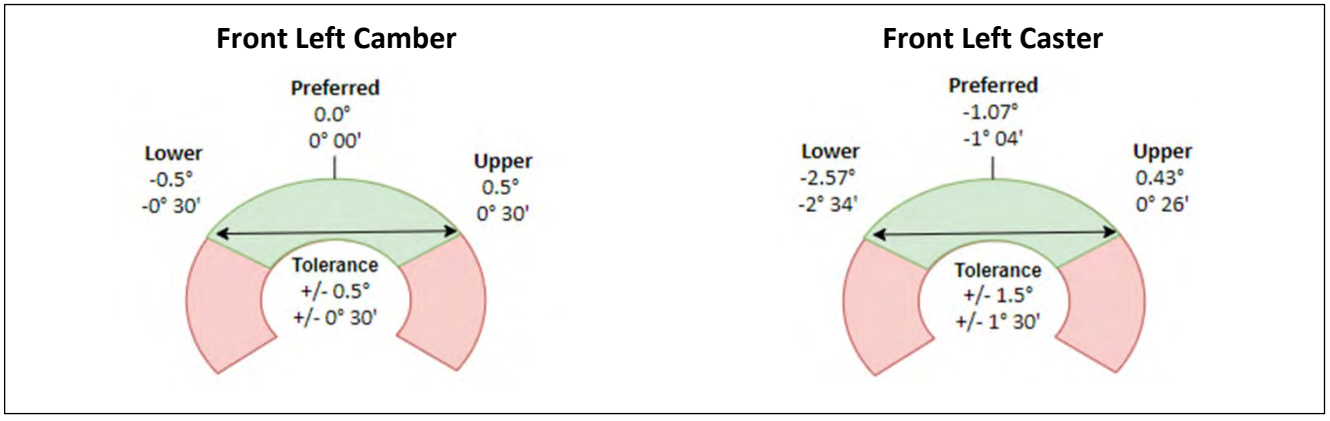


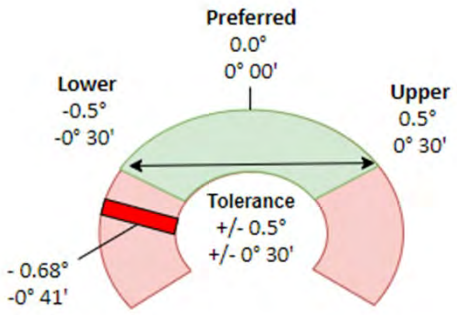
Image 9: *Front Left Camber and Front Left Caster comparison.*

Examples of Tolerance

Example 1: Actual Camber is -0.68° (-0° 41')

Measurement	Decimal			Minutes		
	Range	Preferred	Range +/-	Range	Preferred	Range +/-
Front Left Camber	-0.5° to 0.5°	0.0°	+/- 0.5°	-0° 30' to 0° 30'	0° 00'	+/- 0° 30'

Front Left Camber

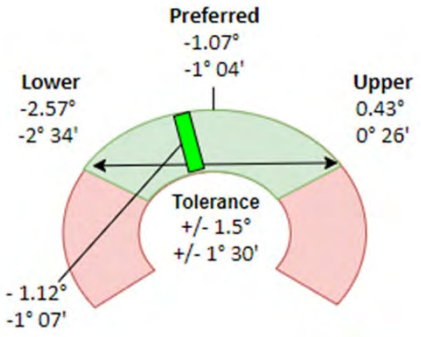


Solution: Since -0.68° is less than the lower tolerance of -0.5°, this value is out of specification.

Example 2: Actual Caster -1.12° (-1° 07')

Measurement	Decimal			Minutes		
	Range	Preferred	Range +/-	Range	Preferred	Range +/-
Front Left Caster	-2.57° to 0.43°	-1.07°	+/- 1.5°	-2° 34' to 0° 26'	-1° 04'	+/- 1° 30'

Front Left Caster



Solution: Since -1.12° is more than the lower tolerance limit of -2.57° but less than the upper tolerance limit of 0.43°, this value is within specification.

How to Read a Report

The report will show both the initial and final measurements. The initial measurements are prior to any adjustments by the wheel alignment technician and the final are the measurements after adjustment. It is the final measurements we are concerned with, and wheel alignment final measurements must be within the manufacturers specified range.

On some reports, you will need to manually check that the reading falls between the maximum and minimum tolerance values; on other reports, the reading will be categorised by colour.

Measurement	Decimal		Minutes	
	Actual	Range +/-	Actual	Range +/-
Front Left Camber	-0.68°	-0.5° to 0.5°	-0° 41'	-0° 30' to 0° 30'
Front Left Caster	-1.12°	-2.57° to 0.43°	-1° 07'	-2° 34' to 0° 26'
Front Right Toe	0.2mm	-1.9mm to 1.9mm		
Front Left Toe	0.2mm	-1.9mm to 1.9mm		

Green Zone: *Values within the specified range indicated by the manufacturer. These are considered optimal, and no adjustment is required.*

Red Zone: *Values outside the specified range indicated by the manufacturer, requiring immediate attention and adjustment to prevent tyre wear, handling issues, and safety concerns.*

Please note *that not all wheel alignment reports are created equal. We come across many different report types, with some being much easier to read than others. If you would like a second opinion with reading a wheel alignment report, please don't hesitate to contact RepairCert NZ technical staff.*

Variation from Manufacturer's Specifications

A wheel alignment report must show that the vehicle wheel alignment is within manufacturer's specifications.

There are some exceptions to this; for example, where a vehicle has been lowered and staying within the manufacturer's specifications is no longer possible. In this case, clear notes explaining any variation from specifications must be included in the Repair Certification File, along with the report. You may wish to contact RepairCert NZ technical staff before you accept a variation to specifications.

Common Issues

Occasionally you may come across measurements in wheel alignment reports that go beyond 60', such as -0° 75'. This discrepancy could suggest a problem with the equipment or the measurement procedure, possibly resulting in inaccurate alignment data. In such instances, it might be wise to question the accuracy of the machine's readings and consider asking for a new report from a different wheel alignment system.

Another issue that arises is the use of 'customised' reports. This occurs when the wheel alignment technician overrides the preset measurement specifications and inputs customised parameters instead. As a result, the vehicle's wheel alignment may not be restored to manufacturer's specifications, even though the report will indicate that the parameters are within specification.

Further Learning

Watch this Mevotech webinar on *How to Read and Understand a Wheel Alignment Report*.

In Summary

By following this Information Sheet, a Repair Certifier can correctly assess a wheel alignment report and make decisions aligned with the relevant legislation and/or requirements, which will be consistent with other Repair Certifiers.

If a Repair Certifier is unclear on their responsibilities and technical understanding of wheel alignment reports, a technical staff member of RepairCert NZ should be contacted for further assistance.

FOR FURTHER INFORMATION PLEASE CONTACT REPAIRCERT NZ.