REPAIRCERTNZ
SPECIALIST CERTIFICATION MANAGEMENT (REPAIR) LTD

TECHNICAL BULLETIN
 # 01 - 2026 (January 2026)

Steering System Damage Analysis
Correct Identification and Evaluation of Steering System Damage

Supporting New Zealand's Repair Certification Industry

About RepairCert NZ Technical Bulletins

These Technical Bulletins have been developed to support Specialist Light Vehicle Repair Certifiers (Repair Certifiers) in ensuring autobody repairs are carried out safely and correctly. Repair Certifiers should, in the first instance, be guided by (if available) relevant Vehicle Manufacturer's Information and Repair Industry Information, and in the absence of such information, refer to the guidance provided within RepairCert NZ Technical Bulletins. These Technical Bulletins can be used by the wider autobody repair industry.

Purpose

This Technical Bulletin advises Repair Certifiers about additional inspections, assessments and reports (beyond the information provided in a wheel alignment report) that may be necessary when repair certifying vehicles with steering and suspension damage, particularly in relation to identifying whether the steering system and related components have sustained collateral damage in a collision.

Applicable Requirements

This Technical Bulletin combines non-mandatory Best-practice Guidance, together with the relevant mandatory legislative requirements (referred to as 'applicable requirements') to support Repair Certifiers in relation to this subject.

The applicable requirements stem from *Land Transport Rule: Vehicle Repair 1998 (Repair Rule)*, which specifies that *'a repair to a vehicle, its structure, systems, components or equipment, must restore the damaged or worn vehicle, structure, system, component or equipment so that they are within safe tolerance of the state of the vehicle, structure, system, component or equipment when manufactured.'*

The *Light Vehicle Repair Vehicle Inspection Requirements Manual (Repair VIRM)* sets out the requirements that Repair Certifiers must meet to achieve the objectives of the *Repair Rule* (see the 'Repair VIRM Requirements' section at the back of this Technical Bulletin).

Background

Primarily, Repair Certifiers refer to wheel alignment reports to identify, diagnose, and determine appropriate repair strategies for any steering and suspension damage and/or structural misalignment to ensure that vehicles being repair certified are returned to within the vehicle manufacturer's safe tolerances.

However, wheel alignment reports alone may not necessarily identify and record all steering system and related components that may have been compromised in a collision - sometimes alignment angles can be (or have been adjusted to be) within specification, even though steering system damage and misalignment still exists *(see Note 1)*.

Note 1	To learn more about wheel alignment reports, click *here* to view *RepairCert NZ Information Sheet # 05–2025 Understanding Wheel Alignment Reports* on the *RepairCert NZ website*.

To help Repair Certifiers ensure that a steering system is safe, this Technical Bulletin provides guidance on:

- researching and understanding Vehicle Manufacturer's Information, or Repair Industry Information relating to steering system damage; and
- identifying commonly overlooked steering system-related components that may be damaged; and
- identifying frequently damaged components on each of the two common types of steering systems; and
- aspects of steering system damage that relate to vehicles with advanced driver assistance systems (ADAS); and
- other steering system-related aspects that should be considered by Repair Certifiers.

Understanding the Issues

Direct Damage to the Steering System

When vehicles sustain direct damage to wheels and/or steering and suspension components (such as suspension struts, shock absorbers, axles, control arms, ball joints, linkages, hub carriers, rack ends etc), there is a greater probability that damage can occur to other components that are either related to, or an integral part of, the steering system.

Indirect Damage to the Steering System

This indirect damage can be caused by damage to, and misalignment of, the vehicle structure in and around the locations of steering components, and after the deployment of airbags and supplementary restraint systems (SRS). Many vehicle manufacturers now require comprehensive inspections of the steering system, related components, and attachment points on collision-damaged vehicles. This is particularly relevant to those vehicles that require structural repairs or chassis re-alignment, and/or have sustained an SRS activation or deployment.

Unseen and Hidden Damage

Damage to some steering system components may not be immediately obvious, due to being in concealed locations that require further dismantling, investigation, and in some cases testing, to be able to identify damage or misalignment. Consideration should also be given to steering system components that may be worn beyond the vehicle manufacturer's safe tolerances (referred to as 'fair wear and tear', often found on older and high-mileage vehicles).

Any damaged (or worn) steering system components that go undetected and not repaired or replaced are likely to have an adverse effect on the safe operation of the vehicle, compromise the functionality of electronic systems such as ADAS and SRS *(see Note 2)*, and in a worst-case scenario, cause the vehicle to crash.

Vehicles that have been repaired or partially repaired (either before importation or after de-registration in New Zealand) with suspected steering system damage require an extremely thorough inspection.

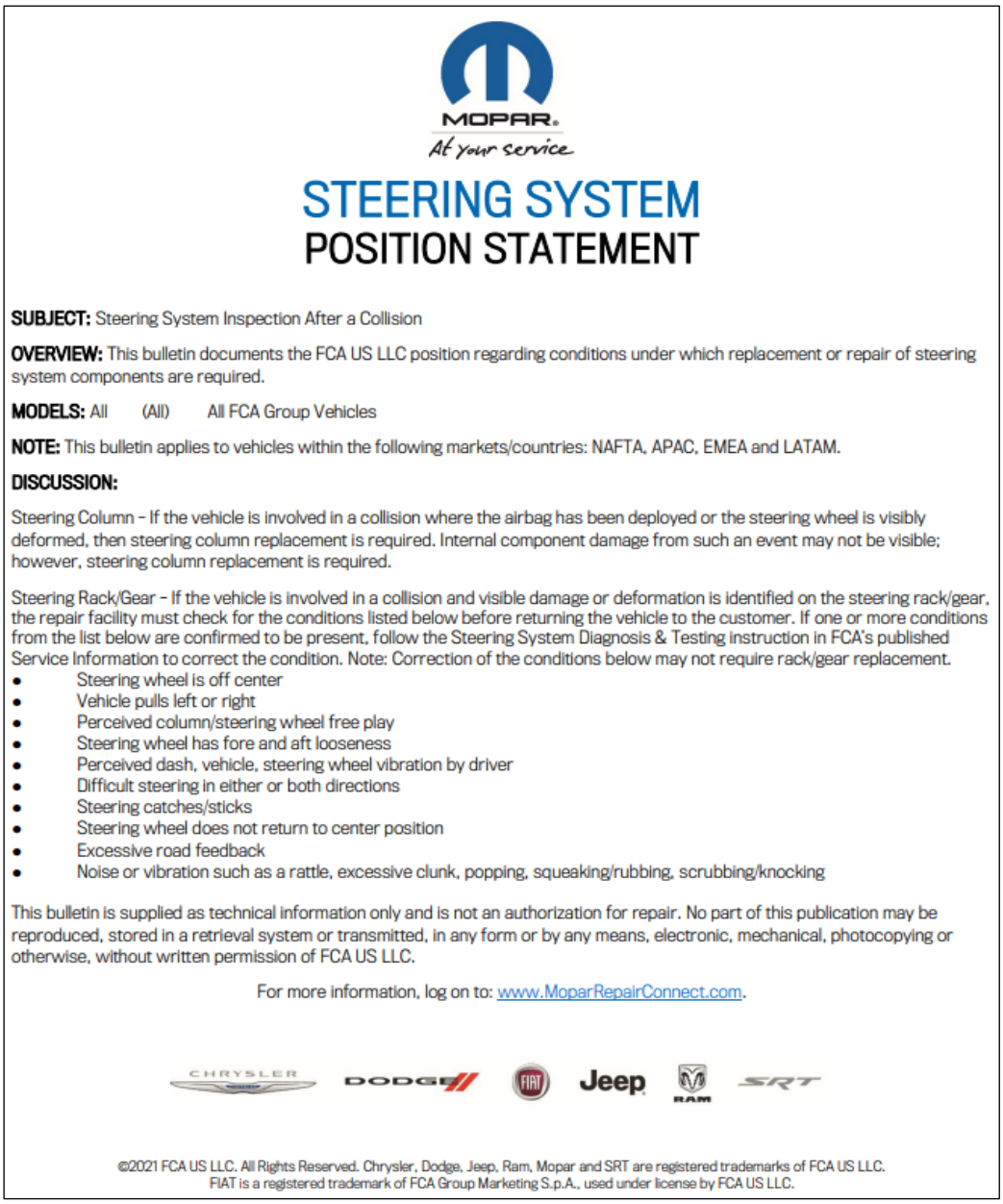
Written-off vehicles with steering system damage (especially Australian statutory write-offs) may have had temporary repairs completed to make the vehicle mobile and more easily transportable. Replacement steering components of unknown origin may have been installed and/or had straightening and welding repairs completed, which can make the vehicle unsafe to operate.

Note 2	To learn more about SRS, click *here* to view *RepairCert NZ Technical Bulletin # 06–2025 Post-collision SRS Reinstatement* on the *RepairCert NZ website*.

Accessing Appropriate Information

Vehicle Manufacturer Information and Repair Industry Information

Comprehensive and appropriate steering system inspection and assessment on collision-damaged vehicles (especially for newer generation models with ADAS) will often require consulting the relevant Vehicle Manufacturer's Information. This information can include general guidelines, position statements, or specific information on inspections, scanning, programming (also known as coding or initialisation), calibration requirements, repair recommendations, and replacement procedures for the selected vehicle's steering and suspension systems *(see Image 1)*.



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STEERING SYSTEM
POSITION STATEMENT

SUBJECT: Steering System Inspection After a Collision

OVERVIEW: This bulletin documents the FCA US LLC position regarding conditions under which replacement or repair of steering system components are required.

MODELS: All (All) All FCA Group Vehicles

NOTE: This bulletin applies to vehicles within the following markets/countries: NAFTA, APAC, EMEA and LATAM.

DISCUSSION:

Steering Column – If the vehicle is involved in a collision where the airbag has been deployed or the steering wheel is visibly deformed, then steering column replacement is required. Internal component damage from such an event may not be visible; however, steering column replacement is required.

Steering Rack/Gear – If the vehicle is involved in a collision and visible damage or deformation is identified on the steering rack/gear, the repair facility must check for the conditions listed below before returning the vehicle to the customer. If one or more conditions from the list below are confirmed to be present, follow the Steering System Diagnosis & Testing instruction in FCA's published Service Information to correct the condition. Note: Correction of the conditions below may not require rack/gear replacement.

- Steering wheel is off center
- Vehicle pulls left or right
- Perceived column/steering wheel free play
- Steering wheel has fore and aft looseness
- Perceived dash, vehicle, steering wheel vibration by driver
- Difficult steering in either or both directions
- Steering catches/sticks
- Steering wheel does not return to center position
- Excessive road feedback
- Noise or vibration such as a rattle, excessive clunk, popping, squeaking/rubbing, scrubbing/knocking

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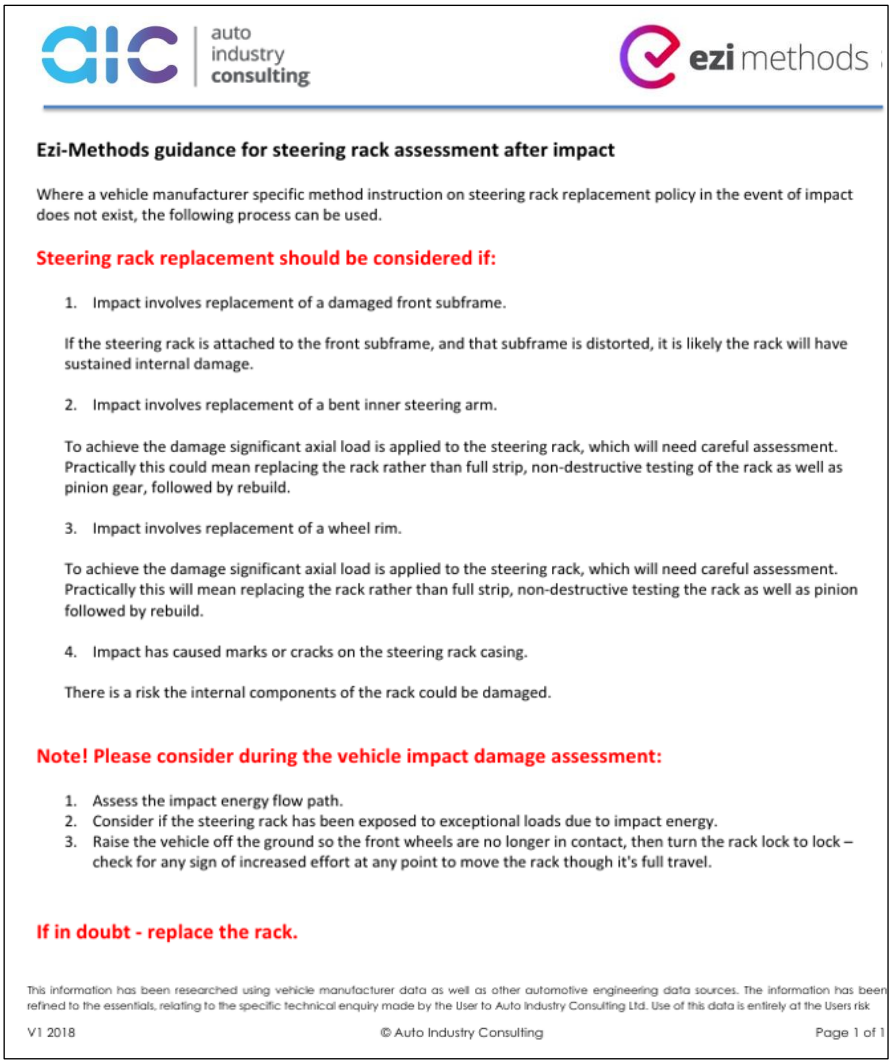
Image 1: *Example of a steering system position statement (FCA/Stellantis).*

Alternatively, Repair Industry Information sources (e.g. I-CAR, Thatcham Research or Ezi-methods) may also have make and model-specific or general steering system information available *(see Image 2)*.



auto industry consulting

ezi methods

Ezi-Methods guidance for steering rack assessment after impact

Where a vehicle manufacturer specific method instruction on steering rack replacement policy in the event of impact does not exist, the following process can be used.

Steering rack replacement should be considered if:

1. Impact involves replacement of a damaged front subframe.

If the steering rack is attached to the front subframe, and that subframe is distorted, it is likely the rack will have sustained internal damage.

2. Impact involves replacement of a bent inner steering arm.

To achieve the damage significant axial load is applied to the steering rack, which will need careful assessment. Practically this could mean replacing the rack rather than full strip, non-destructive testing of the rack as well as pinion gear, followed by rebuild.

3. Impact involves replacement of a wheel rim.

To achieve the damage significant axial load is applied to the steering rack, which will need careful assessment. Practically this will mean replacing the rack rather than full strip, non-destructive testing the rack as well as pinion followed by rebuild.

4. Impact has caused marks or cracks on the steering rack casing.

There is a risk the internal components of the rack could be damaged.

Note! Please consider during the vehicle impact damage assessment:

1. Assess the impact energy flow path.
2. Consider if the steering rack has been exposed to exceptional loads due to impact energy.
3. Raise the vehicle off the ground so the front wheels are no longer in contact, then turn the rack lock to lock – check for any sign of increased effort at any point to move the rack though it's full travel.

If in doubt - replace the rack.

This information has been researched using vehicle manufacturer data as well as other automotive engineering data sources. The information has been refined to the essentials, relating to the specific technical enquiry made by the User to Auto Industry Consulting Ltd. Use of this data is entirely at the Users risk

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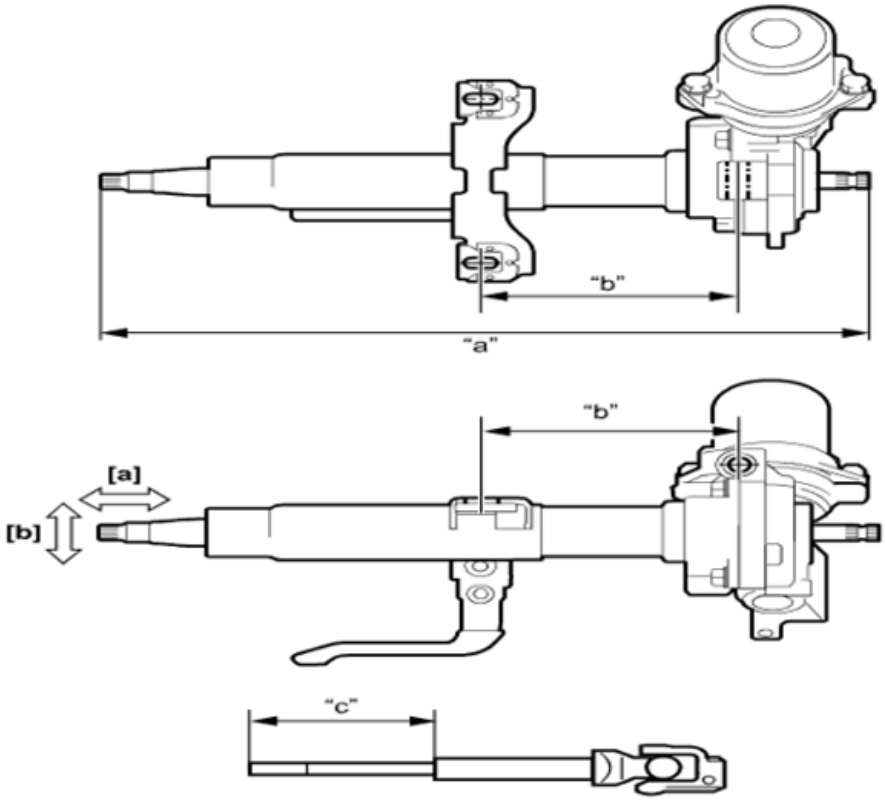
***Image 2**: Example of Repair Industry Information on steering systems (Ezi-methods).*

Vehicle Manufacturers Information and Repair Industry Information may include:

- thorough physical inspection and testing of the complete steering system and related components, prior to carrying out any removal, repair, or replacement operations; and
- examination and evaluation of steering system mounting points/locations and mounting hardware; and
- removal of the complete steering system and other associated steering system components (such as the steering wheel, steering column and mounting hardware) from the vehicle for inspection, repair and/or replacement *(see Note 3 and Image 3)*; and
- for vehicles fitted with electronic power steering systems (EPS), inspection and appraisal of EPS electronic components (e.g. wiring harnesses, connectors, the control module, and electric motor) *(see Image 4)*; and
- the locations and specifications of one-time or single-use fasteners (may also be described as torque-sensitive bolts or stretch bolts); and
- pre-scanning and post-scanning, programming, and any necessary calibration of SRS and ADAS that are associated with the steering system.

Note 3	Depending on the vehicle manufacturer, steering system inspection and service information, specifications and requirements, together with SRS and ADAS information, can be found in the body repair manual (BRM), the general service manual, or in separate documents such as a position statement or technical bulletin.



- Check that distances "a", "b" and "c" shown in figure are as specified.

Power steering column length

"a": 423.0 mm (16.65 in.)
"b": 141.0 ± 1.4 mm (5.551 ± 0.055 in.)
"c": 112.0 mm (4.409 in.)

- Check steering column assembly for looseness in arrow directions [a] and [b] in figure with tilt lever locked.

***Image 3**: Steering column inspection procedure (from a Suzuki BRM).*

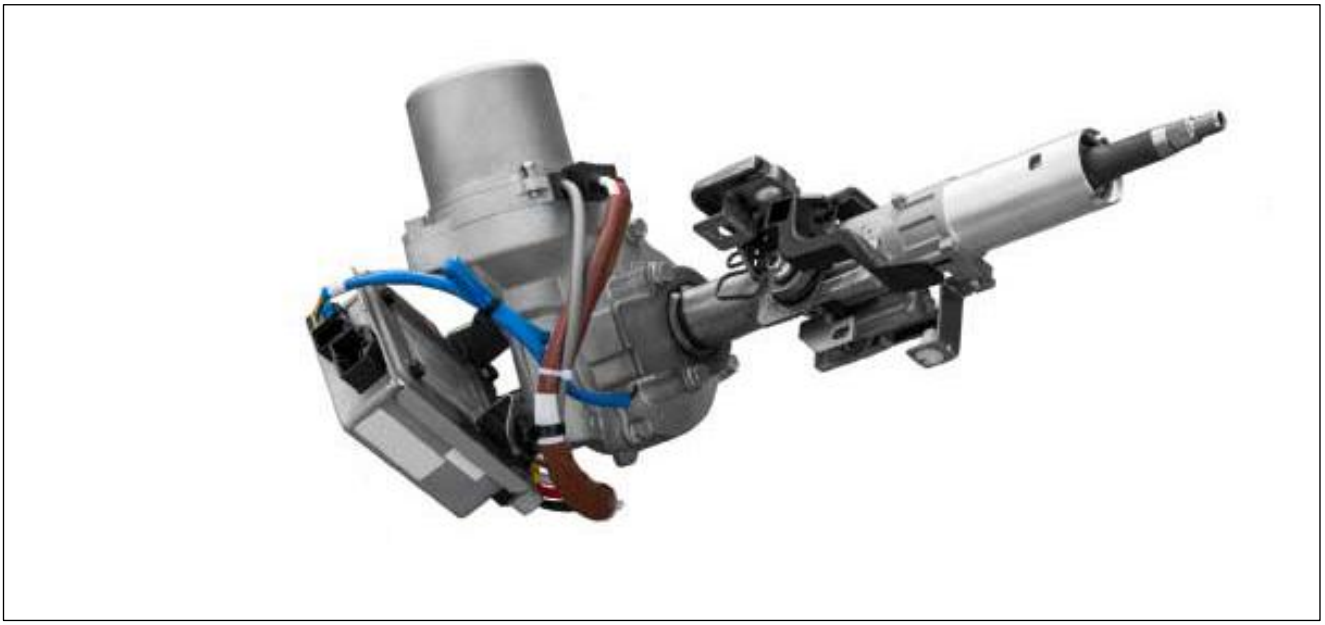


***Image 4:** Typical (column-mounted) electric power steering system (EPS). Image credit [(1)].*

Where steering system-related Vehicle Manufacturer Information or Repair Industry Information (e.g. I-CAR, Thatcham Research, or Ezi-methods) is unavailable or incomplete, this Technical Bulletin provides Best-practice Guidance for steering system inspection and damage analysis for the two most common steering system types.

Inspecting and Analysing Rack and Pinion Steering Systems

Overview of a Rack and Pinion Steering System

Damage can occur to numerous components (both internal and external) within a rack and pinion steering system *(see Image 5)*. Particular attention should be paid to the inner and outer tie rod components, and the rack itself.

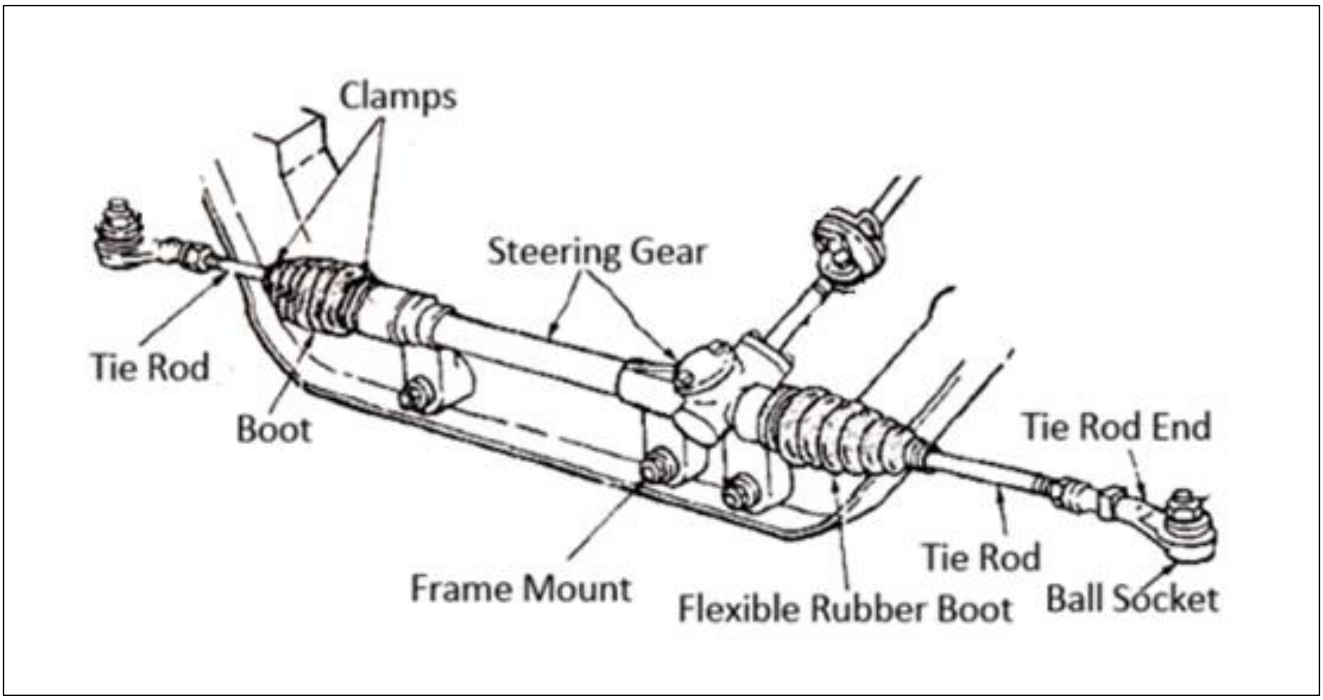


Image 5: *Typical layout of a rack and pinion steering system. Image credit [2].*

The components within a rack and pinion steering system are shown in *Image 6,* and a basic layout of the rack and pinion mechanism is shown in *Image 7*.

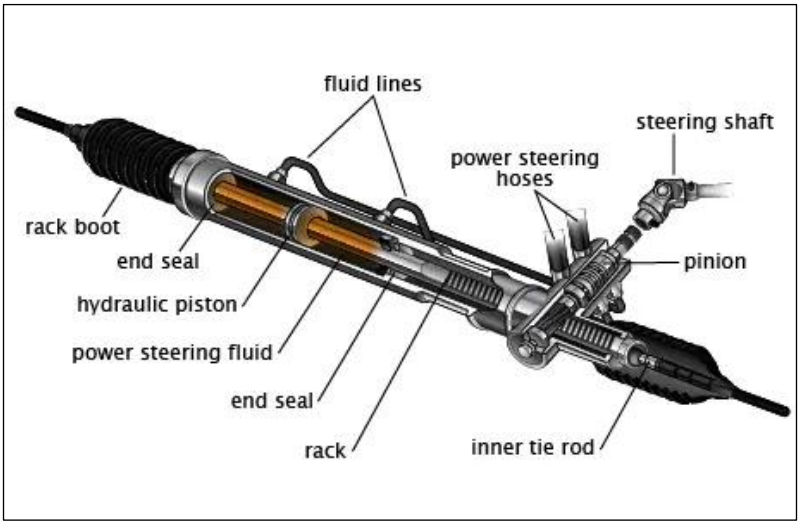


Image 6: *Rack and pinion steering rack components (hydraulic power steering type shown). Image credit [3].*

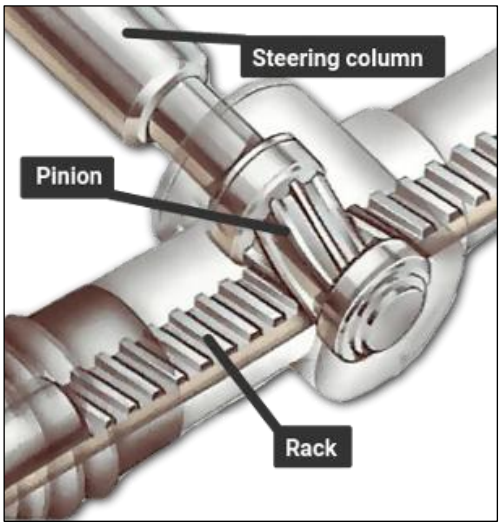


Image 7: *Basic layout of the rack and pinion mechanism. Image credit [4].*

Inner and Outer Tie Rod Components

On rack and pinion steering systems, the most common (and readily identified) components that are damaged in a collision are the inner and outer tie rod ends (and the protective rubber boots or 'bellows'). While these are typically available as individual components, they are often replaced together on collision-damaged vehicles *(see Image 8)*.

Image 8: *Inner and outer tie rod end components.*

The Rack

- A bend in the rack will create tight spots in the steering action, as the steering is turned from side to side.
- Chipped teeth on the rack can cause binding and grinding in the steering action, as the steering is turned from side to side.
- Cracks or fractures in the rack can result in sudden, catastrophic failure of the steering system operation.

The Pinion

- Chipped teeth on the pinion gear prevents proper meshing with the rack, creating tight spots and grinding in the steering action, as the steering is turned from side to side.
- Cracks or fractures in the pinion gear can result in sudden catastrophic failure of the steering system operation.
- Twisting and misalignment of the splines of the pinion (where it attaches to the steering shaft), will affect wheel alignment geometry/alignment angles and steering 'lock-to-lock' functionality *(see Image 9)*.

Steering Shaft to Pinion Alignment

Correct alignment from the steering shaft through to the pinion is critical, as illustrated by the image below *(see Image 9)*.

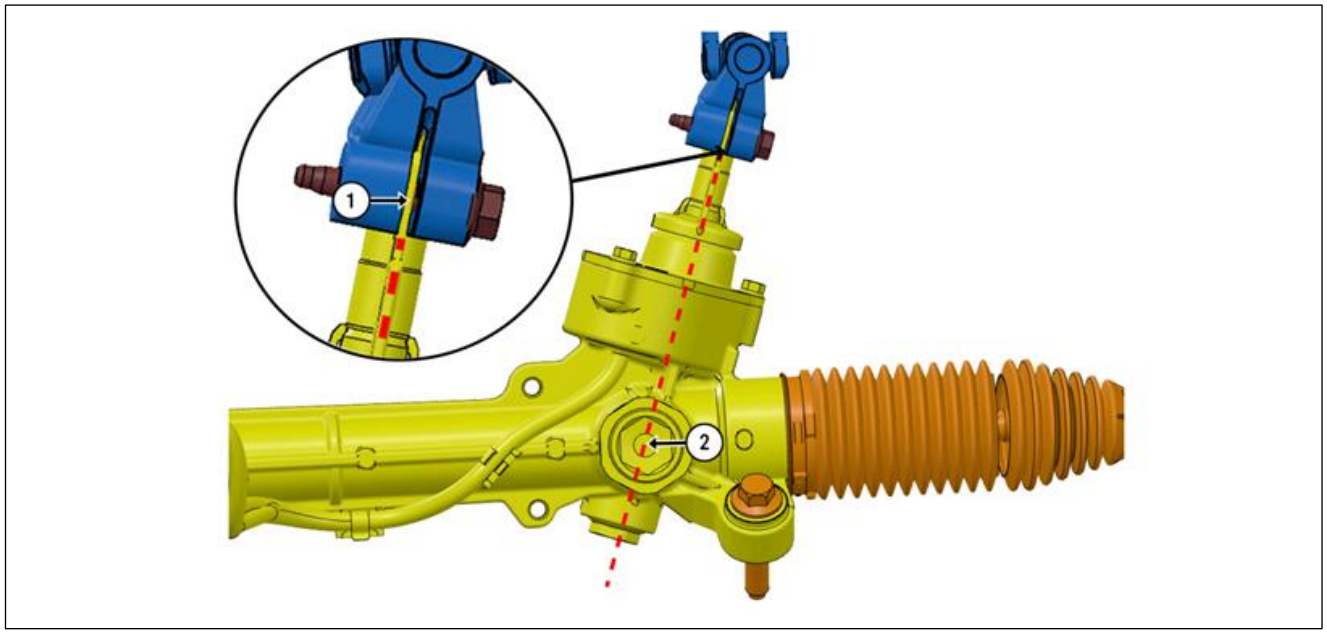


Image 9: *Steering shaft to pinion alignment guide (excerpt from a Rivian service manual). Image credit [5].*

Fluid Seals, Pipes, Hoses and Connections (on Hydraulic Power Steering Systems)

- Bruised and split seals (both internal and external) reduce operational performance and create fluid leaks.
- Bent connections, pipes, and crimped hoses also reduce operational performance and create fluid leaks.

Steering Rack Housing

- Cracks, splits, or fractures (irrespective of size and location) in the (predominately) cast aluminium rack housing can lead to complete steering system failure *(see Image 10)*.

Image 10: *A crack/fracture in the steering rack housing.*

Steering Rack Attachment

- Bent or distorted mounting points and mounting hardware (that attach the steering rack to the vehicle) may cause the steering rack assembly to no longer be retained securely or remain in its original attachment position. This will affect wheel alignment geometry/alignment angles and steering 'lock-to-lock' functionality. Clunking noises and erratic steering behaviour may also become apparent *(see Image 11).*
- Cracked or split mounting lugs (on the steering rack housing) can allow the steering rack assembly to flex and move around, creating erratic steering behaviour which can ultimately lead to complete detachment *(see Image 12)*.
- Split, displaced or worn mounting bushes can allow the steering rack assembly to move around, creating clunking sounds and erratic steering behaviour *(see Images 13 and 14).*

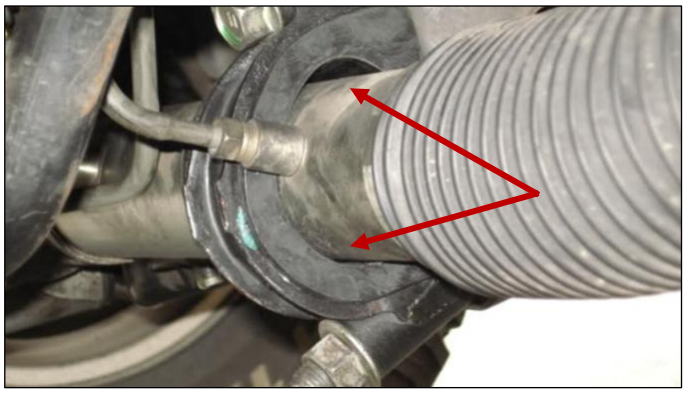


Image 11: *Bent or distorted mounting points and mounting hardware.*

Image 12: *A cracked steering rack mounting lug.*

Image 13: *Example of mounting bush damage.*

Image 14: *Example of mounting bush damage.*

Inspecting and Analysing Parallelogram Steering Systems

Overview of a Parallelogram Steering System

Parallelogram steering systems (and to a lesser extent, 'cross-steer' and 'Haltenberger' steering system variations) were used extensively on older (typically pre-1980s) vehicles - especially light commercials of body-over-frame construction. While most vehicles today utilise rack and pinion steering systems, there remains a substantial number of vehicles on New Zealand roads with parallelogram steering (or it's variants) *(see Image 15)*.

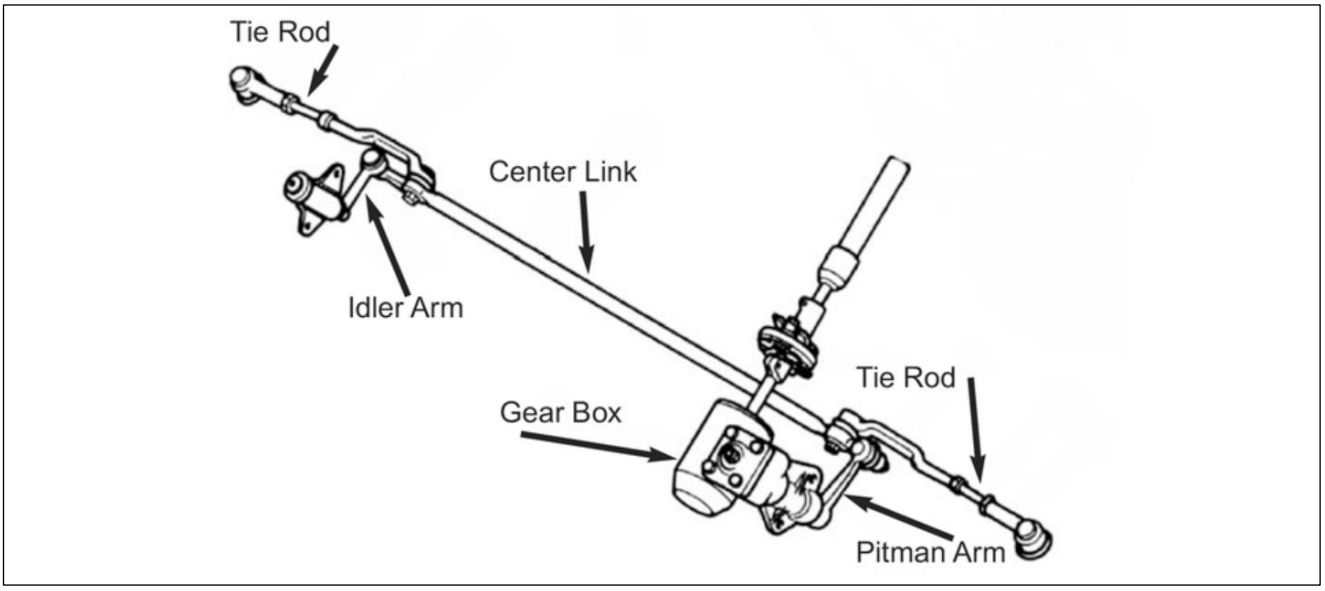


Image 15: *Typical components within a parallelogram steering system. Image credit [6].*

While the configuration of the parallelogram steering linkage system at first glance appears to be a rather complex arrangement of rods and pivot points, a clear and comprehensive external examination and evaluation of the various steering linkage components that make up the system can usually be performed while they are still in place, without the need to remove other components to gain access for inspection and evaluation *(see Image 16)*.

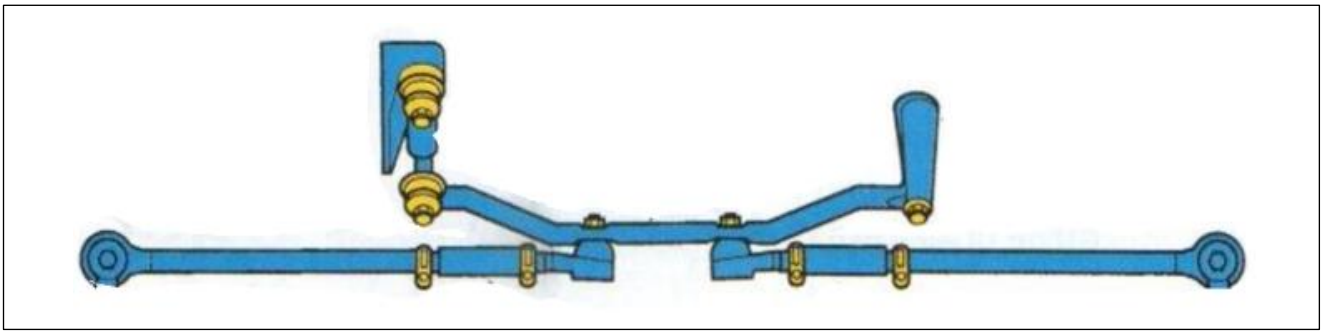


Image 16: *Basic layout of a parallelogram steering linkage system. Image credit [7].*

Inner and Outer Tie Rod Ends and Ball Joints

The inner and outer tie rod ends thread into either side of an adjusting sleeve, and are secured with clamps *(see Image 17)*. The outer tie rod ball joints attach to the steering knuckles on both sides of the vehicle, while the inner tie rod ball joints are connected to each side of the centre link or drag link (see page 12 for information on the centre link).

Image 17: *Typical outer and inner tie rod end, ball joint, and adjusting sleeve assemblies.*

Damaged tie rod ends and ball joints typically display:

- a bend or visible distortion in the tie rod itself; or
- distortion and stripping, or tearing, of the tie rod threads *(see Images 18 and 19)*; or
- a bend in the tapered threaded shaft of the ball fitting of the ball joint (this will often only be identifiable after separating the ball joint from the connecting component) *(see Image 20)*; or
- tears or splits in the protective rubber dust boot (some of the grease that lubricates the ball joint socket will probably have squeezed out through the split or tear) *(see Image 21)*; or
- looseness in the connection between the ball joint and the component that it connects to (i.e. a steering knuckle) – even though the threaded retainer nut has not been loosened. This happens when the matching taper on the component (i.e. a steering knuckle) that the ball joint shaft fits into, has been distorted, breaking the taper lock between the two components *(see Image 22)*; or
- complete separation of the ball from its socket housing.

Image 18: *Distorted and stripped the threads.*

Image 19: *Torn threads.*

Image 20: *Bent ball joint threaded shaft.*

Image 21: *Protective rubber boot damage.*

Image 22: *The tapered hole on this steering knuckle has been distorted from an impact, breaking the taper lock between it, and the connecting tie rod ball joint.*

Tie Rod End Adjusting Sleeves (and Clamps)

Adjusting sleeves and clamps connect the inner and outer tie rod ends together, providing (a substantial range of) toe-in and toe-out adjustment. Being a hollow threaded sleeve *(see Image 23)*, they are vulnerable to distortion from an impact which can make the sleeve out of round and cause damage to the internal threads.

While adjusting sleeves and the threaded portion of the tie rod ends provide for a wide range of toe-in and toe-out adjustment, after a wheel alignment has been completed, the adjustment measurements (amount of exposed thread visibly protruding out of the adjusting sleeves) should be even between the inner and outer tie rod ends, and consistent when comparing the left and right hand sides' assembled components. Importantly, the threaded portion of the tie rod ends should also extend deeply into the adjusting sleeves *(see Image 24)*.

If it is observed that any of these adjustment parameters are inconsistent, it's likely that steering and/or suspension component damage or misalignment may still exist, or components have been installed (or reinstalled) incorrectly.

Image 23: *Typical tie rod adjusting sleeve (with clamps).*

Image 24: *Tie rod ends correctly installed into the adjusting sleeve (evenly adjusted and securely clamped). Note the correct positioning of the clamps on the adjusting sleeve.*

Centre Link Assembly

The centre link (also known as a drag link) connects to the pitman arm on the driver's side and the idler arm on the passenger side (as described below), via a conventional ball joint at each end. A tapered hole in a flattened section of the bar on each side (inward of the ball joints) receives the inner and outer tie rod end assemblies *(see Image 25)*.

Depending on the vehicle year, make, and model, some centre links may have the ball joints at each end preinstalled into the pitman and/or idler arm, rather than on the centre link *(see Image 28)*.

Images 25: *Typical example of a centre link assembly.*

The centre link/drag link should be inspected for damage to the:

- ball joints (at each end, if fitted) by referring to the information for tie rod ball joint damage described on pages 9 to 11; and
- bar (main forging) for bends, distortion, strain marks, cracks, or flaking paint (especially in and around the tapered hole locations where the inner tie rod end ball joints are connected).

Pitman Arm

The pitman arm (also known as a 'steering arm' or 'drop arm') is a one-piece heavyweight forged steel arm that connects the driver's side of the centre link (as described above) to the steering gearbox (as described on pages 13 and 14), via a tapered hole at each end of the pitman arm. The larger tapered hole is also splined and attaches to a simarly splined and tapered shaft on the steering gearbox *(see Image 26).*

The pitman arm should be inspected for:

- bends or distortion anywhere on the arm (flaking paint is a tell-tale sign that the arm is bent); and
- stress cracks or fractures; and
- burrs on the splines; and
- ball joint damage (if fitted) by referring to the information for tie rod ends and ball joints on pages 9 to 11.

Image 26: *Typical example of a pitman arm (also called a steering arm or drop arm).*

Idler Arm

The idler arm is typically made up of a heavyweight forged steel arm, sleeved bushes, and a mounting bracket *(see Image 27).* The idler arm is essentailly the pivoting support that connects, via a ball joint, the passenger side of the centre link with a mounting bracket attaching to the vehicle frame, subframe, or unitary structure.

Image 27: *Typical example of an idler arm.*

Image 28: *Examples of a typical ball joint-type pitman arm and idler arm.*

The idler arm should be inspected for:

- bends or distortion anywhere on the arm (flaking paint is a telltale sign that the arm is bent); and
- stress cracks or fractures; and
- bends in the mounting bracket; and
- sheared mounting bolts; and
- splits in the bushes and a bend in the sleeve; and
- ball joint damage (if fitted) by referring to the information for tie rod ends and ball joints on pages 9 to 11.

Steering Gearbox

In simple terms, the steering gearbox (often referred to as just the 'steering box') is the mechanism that enables steering input from the driver to be transmitted to the wheels through the various steering linkages, as previously described *(see Image 29)*.

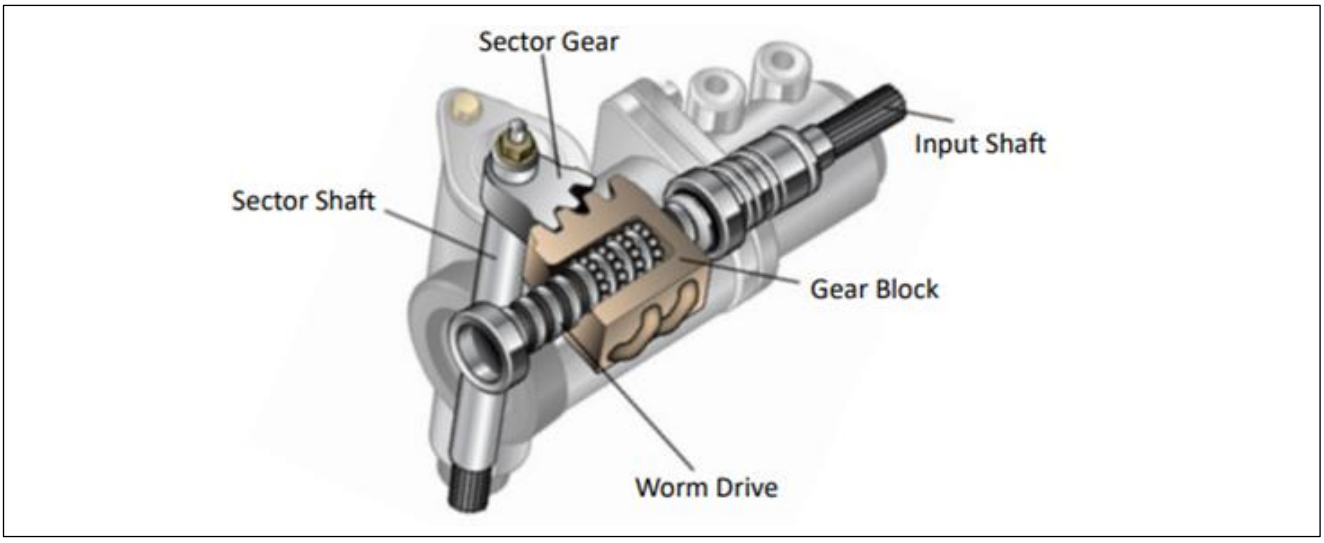


Image 29: *Typical steering gearbox layout, showing the main components. Image credit [8].*

Often Overlooked Steering Gearbox Component

Of the various moving components that make up the steering gearbox, the most common to be damaged in an impact is the sector shaft - a safety critical component that is often overlooked because virtually the entire sector shaft is hidden from view inside the steering gearbox housing (and also by the pitman arm) *(see Image 30)*.

How Damage to the Sector Shaft Occurs

The pitman arm fits directly onto the tapered spline at the bottom of the sector shaft (where the shaft extends through the steering gearbox housing) and is secured with a substantial nut. A direct impact, in particular to the front wheels or any of the linkage components previously described (even if there is little or no damage to these components), can transfer impact energy through to the pitman arm and subsequently into the sector shaft.

Inspecting for Sector Shaft Damage

Inspection of the sector shaft first requires the removal of the pitman arm *(see Note 4)*. In most circumstances this is able to be performed with the steering gearbox still attached to the vehicle. With the pitman arm removed, the sector shaft can then be closely examined for damage *(see image 31)*.

The sector shaft should be inspected for:

- twisting of the tapered splines; and
- cracks or fractures in the tapered splines and/or the shaft.

Image 30: *Very little of the sector shaft is visible for inspection.*

Image 31: *Example of a cracked and twisted sector shaft.*

Note 4	Removal of the pitman arm can be challenging as there is a very strong taper lock between it and the sector shaft. The large, course-threaded nut that secures the pitman arm is also under a very high torque load. Additionally, corrosion may have formed between the threads, making removal more difficult.

Other Important Aspects of Sector Shaft Damage

- Twisted sector shaft splines change steering toe angle - unfortunately, because toe angle has a wide range of adjustment on parallelogram steering systems, inexperienced wheel alignment technicians will often just re-adjust the toe angle back to specification, unaware that the sector shaft may be twisted.
- Of major concern are sector shaft cracks that go undiagnosed. A cracked sector shaft could fail completely at any time, resulting in a sudden, catastrophic loss in steering.
- Damaged sector shafts are not repairable and should be replaced. In most instances, the complete steering box assembly is replaced, rather than just the sector shaft.

ADAS Considerations for Steering System Damage

ADAS Safety Features

Virtually every new or late model vehicle incorporates one or more ADAS safety features (with various levels of autonomy). Many of these interact directly, or in conjunction with, the steering system, including (but not limited to):

- adaptive steering control (ASC); and
- lane keep assist (LKA); and
- electronic stability control (ESC); and
- automatic emergency steering (AES); and
- lane departure warning (LDW); and
- automatic emergency braking (AEB); and
- anti-lock braking system (ABS).

Pre-scanning and Post-scanning Programming/Calibration Requirements

Irrespective of the complexity and functionality, ADAS rely on sensors, including radar, LiDAR, SONAR, video cameras, and a global navigation satellite system or GNSS (such as GPS). Almost without exception, these sensors will require pre-scanning and post-scanning, together with any necessary programming/calibration following a collision.

Steering Angle Sensors

An additional component that is fundamental to steering-related ADAS functionality (as described above) is the steering angle sensor (SAS).

The SAS is typically located at the top of the steering column, directly behind the steering wheel. It monitors the driver's steering input and direction and interacts with electronic control modules and other sensors that control/assist in steering direction and crash avoidance performance.

Dependent of the vehicle make, model, and year, the SAS can be integrated into the (SRS) clock spring and/or the multi-function switch *(see Image 32)*.

Image 32: *Examples of steering angle sensors.*

How Damage to the SAS Occurs

Damage to the SAS can be caused by a number of factors, including direct physical impact, such as damage to the steering column and steering wheel, airbag deployment, water ingress, corrosion, wear and tear, and improper alignment and calibration after repairs.

Typically, any damage to the SAS is non-repairable, requiring the replacement of the component.

What Vehicle Manufacturers Say

Depending on the make and model of vehicle, even carrying out a basic wheel alignment (e.g. after the fitting of new tyres) may necessitate a reset/adjustment or recalibration of the SAS according to the vehicle manufacturer. For vehicles that have sustained damage to suspension and steering components, or have deformation or misalignment of the vehicle structure, the SAS will almost always require resetting/adjusting or recalibrating.

Some vehicle manufacturers may provide a specific set of instructions relating to the SAS that should be followed prior to conducting even simple operations such as battery disconnection or basic component removal. This is to ensure that ADAS functionality is restored correctly, and any diagnostic trouble codes (DTCs) that may have been logged in the system, can be cleared appropriately *(see Image 33 and Note 5).*

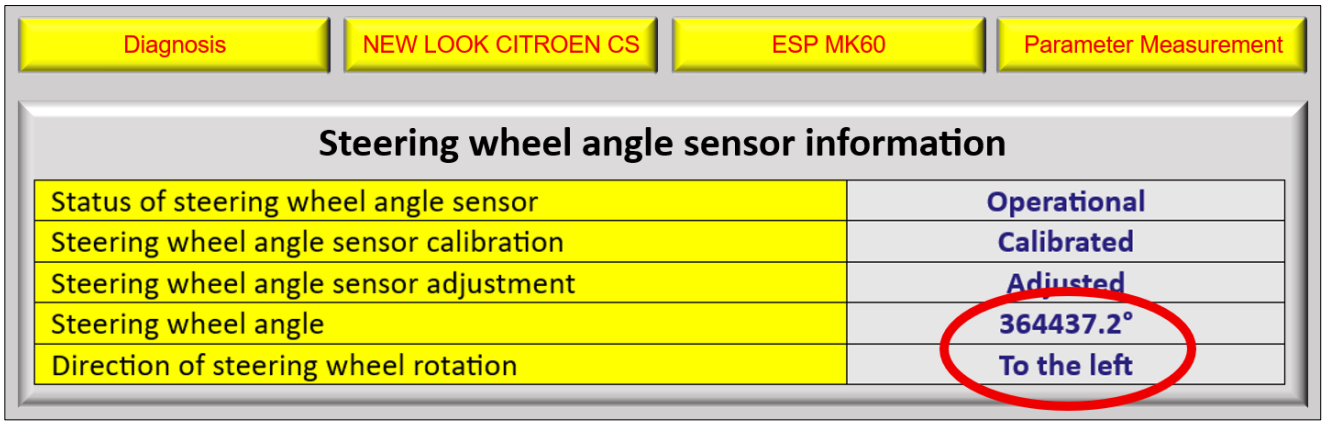


Image 33: *Example of a vehicle manufacturer's instructions relating to steering angle sensors.*

Note 5	Some (especially newer model) vehicles have self-calibrating or auto-calibrating capabilities for some steering system-related (and other) ADAS features. Failure of the system to self or auto calibrate may be an indication that the steering angle sensor (or associated components, such as other sensors or wiring) have been compromised.

Other Steering System-related Aspects that Should be Considered

Corrosion Damage

Corrosion damage to steering system components (as well as areas in and around their mounting locations), is relatively common on older vehicles, but may also be present on later models, depending on the environment the vehicle has been driven in or exposed to. While most corrosion-affected steering system components are replaced in the first instance, inspection and evaluation of corrosion-affected steering system mounting points and other hardware should be carried out to determine whether the corrosion damage identified is significant and structural.

Previously or Temporarily Repaired Vehicles

Vehicles that have been previously repaired, or temporarily repaired, require very careful inspection and evaluation to ensure all:

- components replaced are of like, kind, and quality (LKQ), regardless of whether new or second-hand components have been used *(see Notes 6 and 7)*; and
- repairs carried out have not included any welding or heating (other than as used in the original manufacturing process) and were completed in accordance with the relevant Vehicle Manufacturer's Information (if any), and within the vehicle manufacturer's safe tolerances.

Note 6	Repair Certifiers should always complete a *RepairCert NZ Declaration Form #DF01 Second Hand Replacement Components* whenever second-hand replacement components will be (or have been) used in any vehicle that is undergoing repair certification. Click *here* to view *Declaration Form #DF01* in the Repair Certifiers' area of the *RepairCert NZ website*.
Note 7	Repair Certifiers should refer to *RepairCert NZ Information Sheet #02-2023 Guidelines for using Second Hand Components from Water and Flood Damaged Vehicles* for more information relating to the use of water-damaged replacement components. Click *here* to view *Information Sheet #02-2023* on the *RepairCert NZ website*.

Non-destructive Testing

RepairCert NZ recommends that all safety-critical steering system (and steering system-related) components undergo an appropriate non-destructive test (NDT) if:

- second-hand components have been used; or
- there is suspected damage that can't be determined with a visual inspection only.

Final Inspection Recommendations

RepairCert NZ recommends that Repair Certifiers, as part of their final inspection procedure:

- complete a thorough physical examination of the steering system operation; and
- engage a suitably skilled and experienced mechanical expert to inspect the completed repairs to the steering system, and record their inspection on a *RepairCert NZ Declaration Form # DF05 Mechanical (see Note 8)*; and
- ensure that a comprehensive road test is carried out (by either the Repair Certifier or the repairer who has carried out the necessary steering system repairs) to confirm that the repaired vehicle is safe and compliant.

Note 8	The person who fills out the *Declaration Form # DF05 Mechanical* may be either the repairer if the Repair Certifier considers the repairer to be a suitably skilled and experienced mechanical expert, or if that is not the case the Repair Certifier should engage a suitably skilled and experienced mechanical expert who is independent of the repair process. Click *here* to view *Declaration Form # DF05 Mechanical* in the Repair Certifiers' area of the *RepairCert NZ website*.

Repair VIRM Requirements

Mandatory Content

While the Best-practice Guidance contained in this Technical Bulletin (up to the Repair VIRM Requirements heading above) is provided as (non-mandatory) supporting information to help a Repair Certifier achieve the best possible outcomes, the following requirements have been taken from the *Repair VIRM* (consolidated for clarification) and must in all cases be applied.

Appropriate Repair Methods

Vehicle Manufacturer's Information must be applied in the first instance, and where this is not available or not relevant, then available and relevant Repair Industry Information must be applied.

It is the responsibility of the Repair Certifier to justify any departure from the relevant Vehicle Manufacturer's Information or Repair Industry Information, and prove that the vehicle is returned to within a safe tolerance of its state when manufactured.

General VIRM Requirements for Steering Systems

In general terms, a Repair Certifier must ensure that a steering system and any related components that could affect directional control is:

- in good condition and provides the vehicle with safe, efficient, convenient and sensitive control, and
- strong, durable and fit for their purpose; and
- within safe tolerance of their manufactured state.

Specific VIRM Requirements for Steering Systems

Steering Wheel and Column

The steering wheel must be securely attached to the steering shaft.

The steering column must:

- be secure; and
- if of a collapsible design, have been replaced.

Steering and Suspension Components

Any steering rack and pinion assembly, steering box, linkage, joint, arm, kingpin, ball joint, tie rod, tie rod end, lock-stop, or suspension component which could affect steering geometry:

- must be secure; and
- must operate smoothly; and
- must not:
  - exhibit excessive play, roughness, or stiffness; or
  - be damaged, significantly corroded, distorted, or cracked; or
  - show signs of welding or heating after manufacture; or
  - foul the vehicle structure, wheel, tyres, or brake components.

Steering and Suspension Mounting Points

All steering component mounting points:

- must be secure; and
- must not be damaged, significantly corroded, distorted, buckled, or cracked.

Fasteners

Fasteners within the steering system:

- if subjected to impact loads, must have been replaced; and
- if of one-time use design, must have been replaced; and
- if replaced, must be of the same grade and size as the original fasteners.

Component Replacement, Heating and Welding, and NDT

A Repair Certifier must ensure that:

- any damaged steering or suspension components have been replaced; and
- unless specific permission is provided by the relevant Vehicle Manufacturer's Information, a steering or suspension component has not been heated or welded as part of a repair; and
- any steering or suspension component retained during the repair process that may have been damaged has been disassembled and subjected to appropriate non-destructive testing (NDT) by an approved and qualified CBIP Inspector.

Wheel Alignment

A Repair Certifier must ensure that a four-wheel alignment, undertaken by a suitably skilled and experienced technician using calibrated equipment, has been carried out if:

- collision damage has affected any steering or suspension component; or
- corrosion has affected any steering or suspension attachment.

Repair Certification Documents

A Repair Certifier must upload to NZTA's electronic file repository (SharePoint), as part of the *Repair Certification File*:

- invoices for all replaced steering components; and
- a copy of the *RepairCert NZ Declaration Form # DF05 Mechanical*; and
- a copy of the wheel alignment report; and
- where it has been undertaken, a copy of any NDT reports; and
- invoices for all replaced steering system-related SRS and ADAS components; and

- where it has been undertaken, a copy of the SRS pre-scan; and
- a copy of the SRS post-scan, and any necessary programming/calibration reports; and
- where it has been undertaken, a copy of the *NZTA Declaration Form for SRS, ABS, and/or ESC Inspections*; and
- all Vehicle Manufacturer's Information, or other Repair Industry Information, which is relevant to the SRS or ADAS reinstatement process, that is referred to or relied upon to guide the repair process.

In Summary

Wheel Alignment Reports

In certain circumstances, inspection and repair certification of steering system damage can be far more involved than just requesting, reviewing, and approving the data contained in a conventional wheel alignment report. A Repair Certifier shouldn't assume that the presence of a completed wheel alignment report means that a vehicle's steering system is safe and fit for purpose.

The relevant Vehicle Manufacturer's Information relating to steering systems should always be referred to in the first instance.

Responsibility for Repairs to Steering Systems

Some steering system inspections will require the removal (or part removal) of the steering system and related components, to be able to correctly identify and evaluate damage.

It is recognised that Repair Certifiers are typically panel beaters, and not motor mechanics, so being expected to take overall responsibility (as is required by the *Land Transport Rule: Vehicle Standards Compliance 2002 [Compliance Rule]*) for the safe repairs of a steering system which has been affected by collision damage can be challenging. For this reason, RepairCert NZ strongly recommends that a Repair Certifier:

- engages a suitably skilled and experienced mechanical expert to inspect the completed repairs to the steering system (and fill out a RepairCert NZ Declaration Form # DF05 Mechanical); and
- despite the involvement by a mechanical expert, develops a fundamental understanding of basic wheel alignment geometry, as well as the components associated with the two types of steering systems used in light vehicles - which is the very reason that RepairCert NZ has developed this Technical Bulletin for Repair Certifiers.

Modern Steering Systems

Steering damage on later model vehicles that have ADAS features associated with the steering system, will almost without exception, require inspection of any steering-related ADAS sensors, pre-scanning and post-scanning, programming, and any necessary calibrations.

Corrosion Damage and Previous Repairs

While the focus of this Technical Bulletin is on the inspection of collision-damaged steering systems, Repair Certifiers should also consider other aspects of steering system damage, including corrosion damage, any previous repairs, and/or vehicles that have had temporary repairs carried out.

Non-destructive Testing

Non-destructive testing (NDT) of certain components, comprehensive final inspections that confirm correct steering system operation, and a final road test can assist Repair Certifiers in confirming that the repaired vehicle is safe and compliant.

Ensuring Correct and Compliant Decisions

By following the Best-practice Guidance in this Technical Bulletin, a Repair Certifier's decisions will be correct, and compliant with the *Repair Rule* and the *Repair VIRM*.

FOR FURTHER INFORMATION PLEASE CONTACT REPAIRCERT NZ.

Image Credits

(1) *https://www.freeasestudyguides.com/steering-eps-control-module.html*
(2) *https://4mechtech.blogspot.com/2014/11/manual-rack-and-pinion-steering.html*
(3) *https://clearmechanic.com/*
(4) *https://www.startmycar.co.za/blogs/technical-articles/rack-n-ruin-when-steering-racks-go-bad*
(5) *https://www.oem1stop.com/sites/default/files/Rivian_SG_Steering-System-Overview%283-2-23%29.pdf*
(6) *https://www.larescorp.com/toolbox/skinned-knuckles-articles/manual-steering-gear-and-linkage/*
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