MOTOR COACH INDUSTRIES

*Welcome to the **MCI**LEARN Series*

Your Webinar Will Begin Shortly

Today's Topic:

Keeping it Straight: Steering and Front-End Alignment

If you do not have an audio connection, please dial 866-339-6642 and enter *8173541434*. The stars must be entered

Agenda

- Steering systems & components used on MCI Coaches
  - MCI E/J Model
  - MCI E/J Model – w/common Axle
    MCI D Model
- Front axle alignment terminology
- Inspection, troubleshooting, diagnosis
- PM Service, inspection & lubrication

Safety Message

- Always use personal protection devices
  - Safety glasses, ear protection, etc

- Always observe all safety precautions list Maintenance Manual including but not limited to:
  - Ensure coach is on a level surface
  - Ensure parking brake is applied
  - Chock wheels
  - Always use jack stands
  - Shut off batteries
  - Utilize Lock Out/Tag Out procedures

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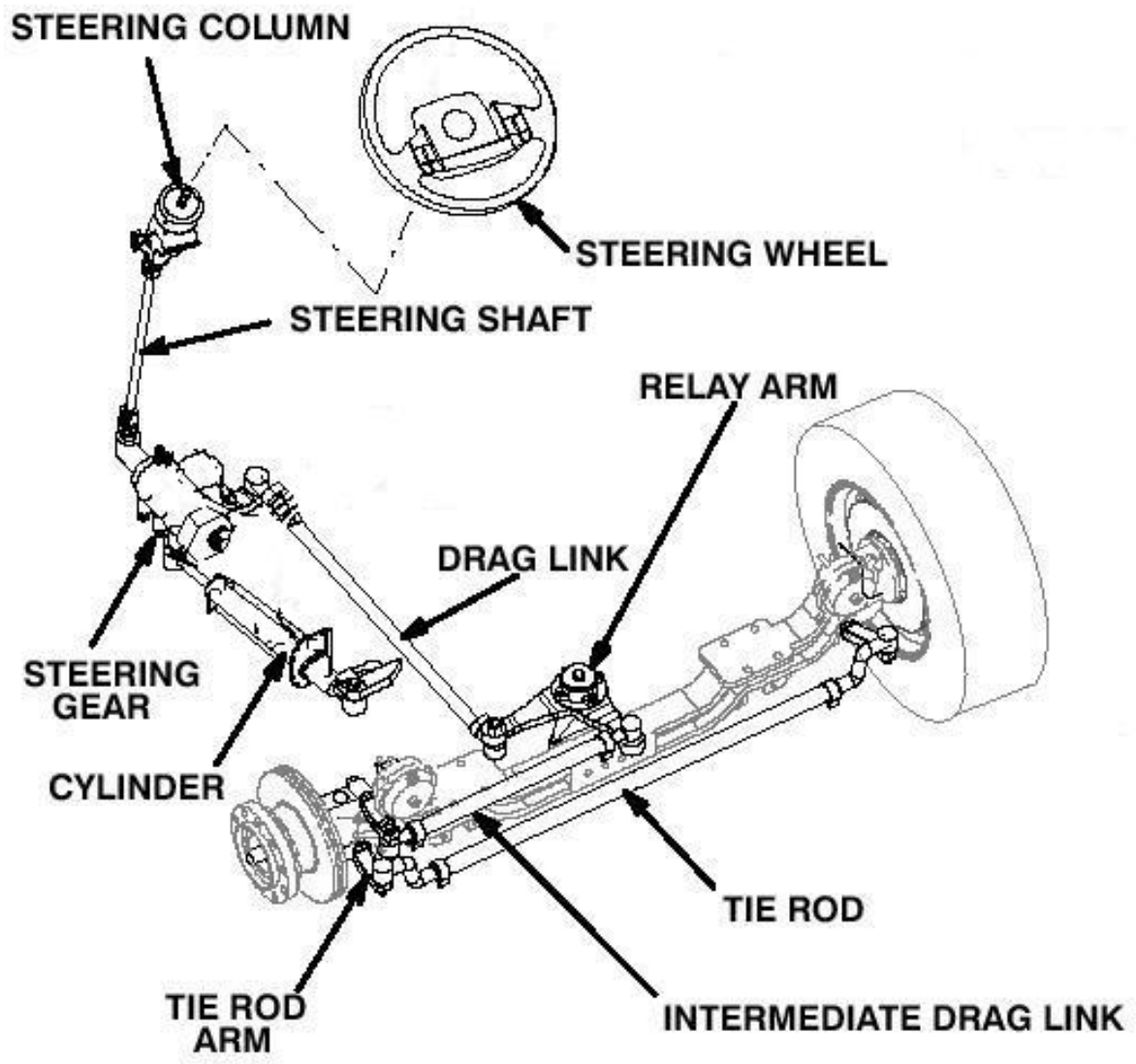
Steering Systems & Components
MCI Coaches

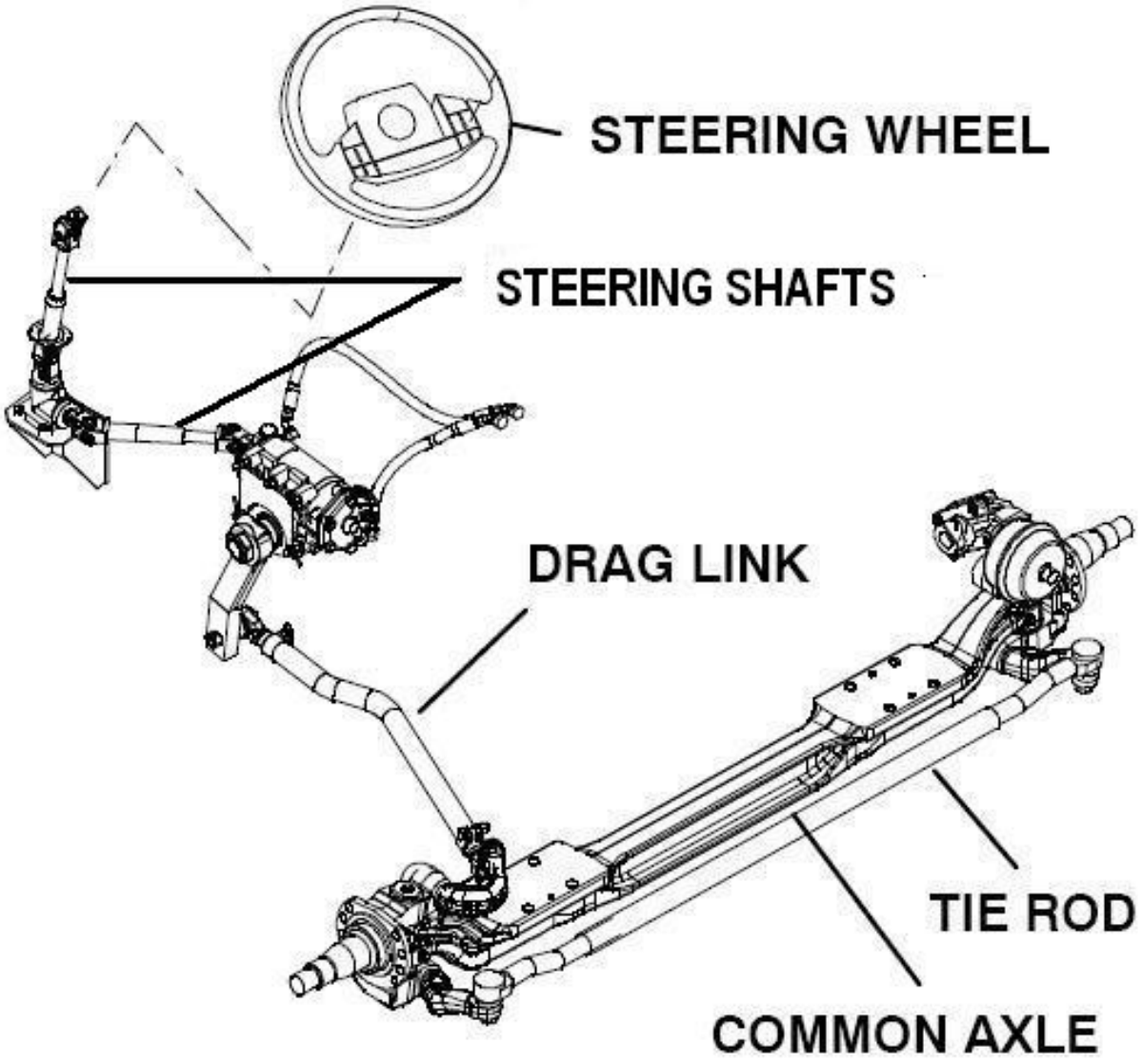
Steering System Mechanical Components

- J Model Coach
  - Steering wheel
  - Steering column and support structure
  - Steering shaft assemblies
    - Lower column shaft
    - Intermediate shaft
  - 90º Miter box
  - Steering gearbox
  - Pitman arm
  - Drag link assembly
  - Tie-rod assembly
  - Front axle assembly
- D Model Coach
  - Steering wheel
  - Steering column and support structure
  - Lower steering column shaft
  - Steering gearbox
  - Pitman arm
  - Drag link assembly
  - Tie rod assembly
  - Front axle assembly

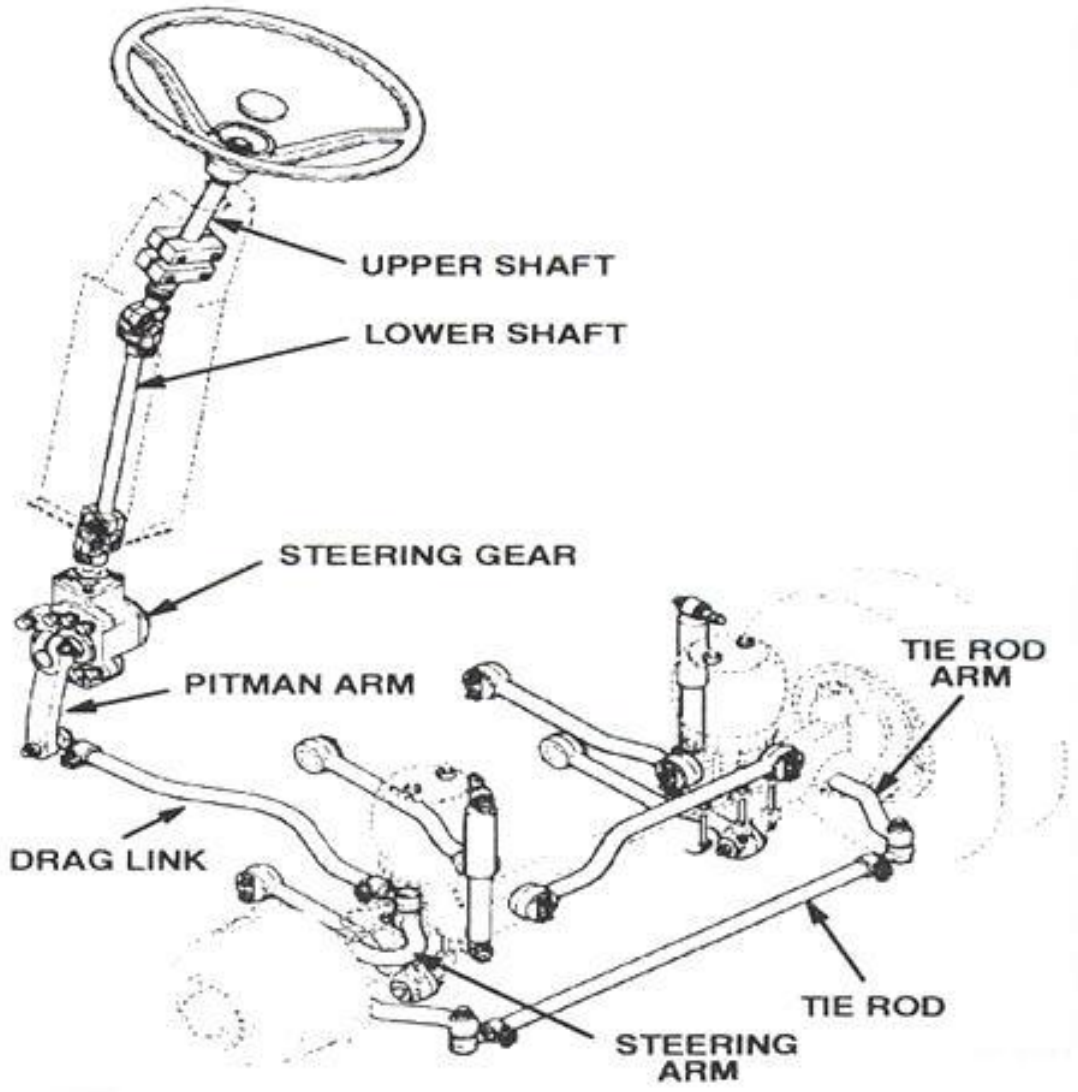
E & J Coach Steering Systems prior to #62806



E & J Coach Steering Systems effective #62806



D Model Steering Column



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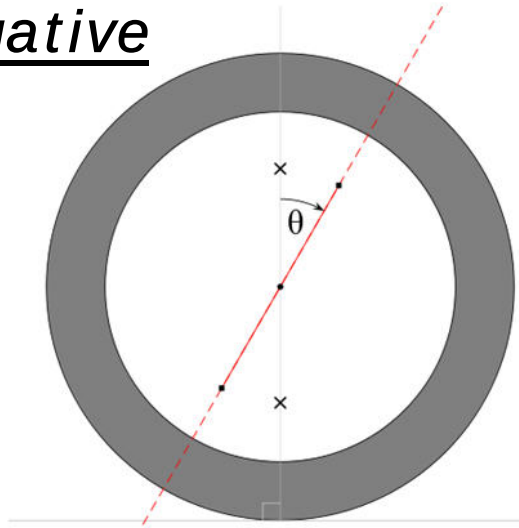
Front Axle Alignment Terminology

Front Axle Alignment Terminology

- Caster angle
- Camber angle
- Toe-in adjustment
- King pin inclination (KPI)
- Thrust line angle
- Scrub angle
- Toe-out on turns
  (Ackerman angle)

Caster Angle

- Caster is the forward or rearward tilt, measured in degrees, of the angle of the king pin as viewed from the side of the vehicle
- If the top of the king pin is tilted towards the rear of the vehicle, caster is ***positive***
- If the king pin is tilted towards the front of the vehicle, the caster is ***negative***

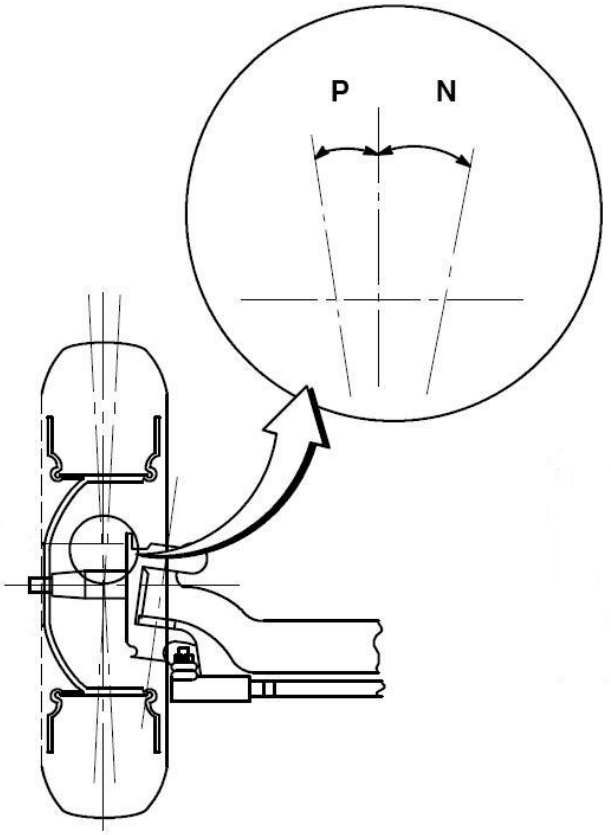


Viewing l/h front wheel, king pin tilted rearward, caster is positive

- Caster adjustment is ***not recommended*** on MCI coach axles, axle is manufactured with a nominal 3º positive caster engineered into axle

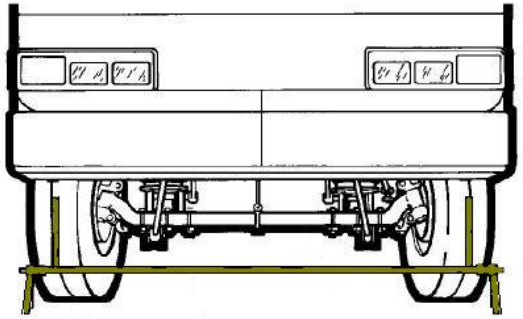
Camber Angle

- Camber is the angle of contact of the tire with the road surface as observed from the front or rear of the vehicle
- A tire which leans outward has *positive* camber, a tire which leans inward has *negative* camber
- Camber is *not* adjustable on MCI coaches Nominal camber setting is 0.25º positive



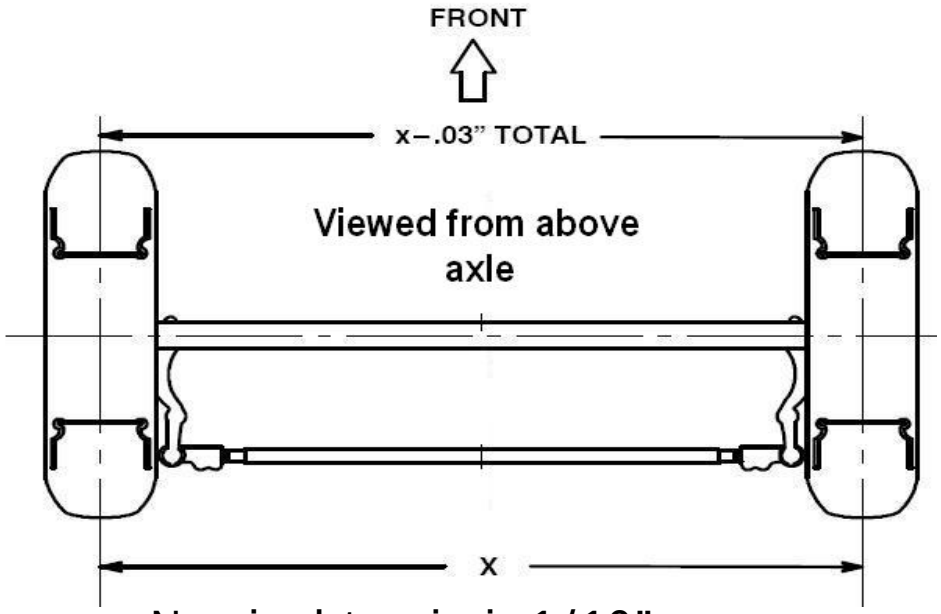
Typical wear pattern for a wheel position w/excessive or abnormal camber

Toe–In Adjustment



Using a trammel bar to measure toe-in adjustment

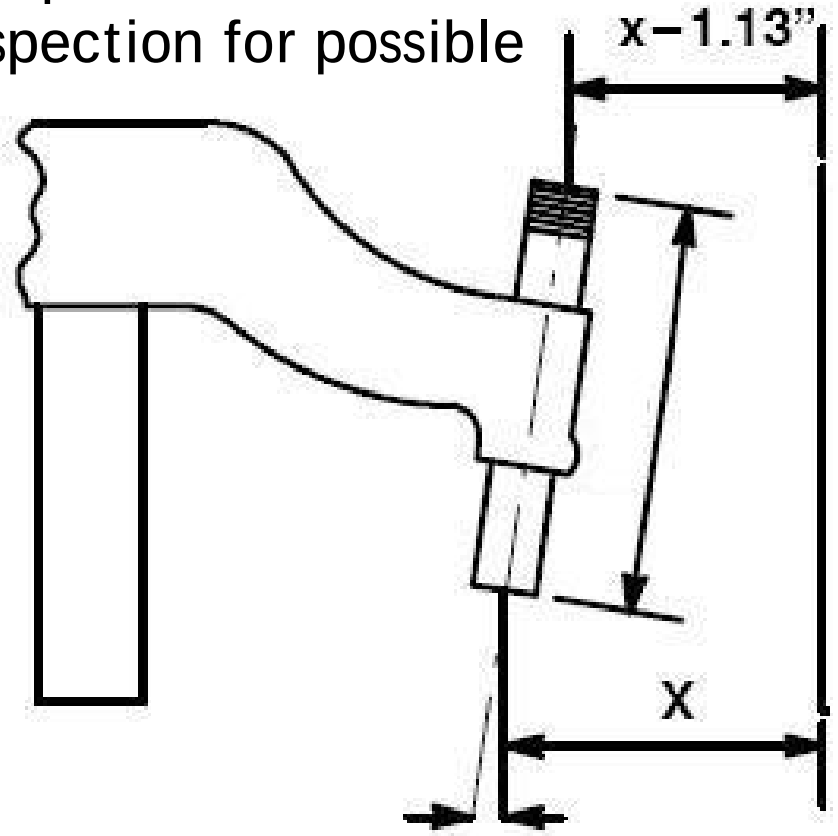
Incorrect or excessive toe-in usually leads to feathered edges on the tire ribs



Nominal toe-in is 1/16", allowable range is 1/32"— 3/32"

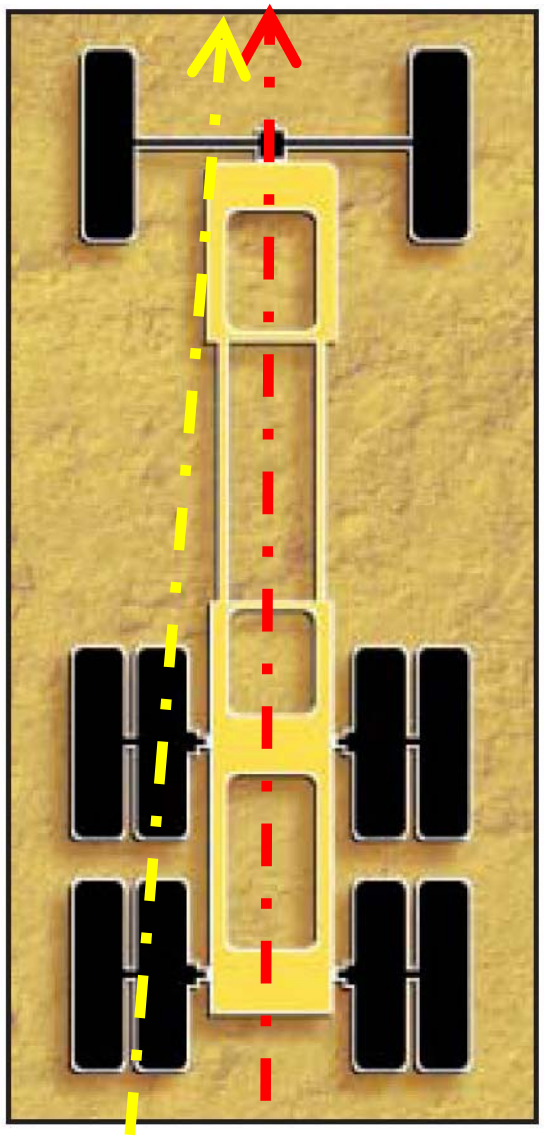
King Pin Inclination (KPI)

- KPI in engineered into the axle during manufacture
- It is not adjustable, but can be checked to determine if the outer end of the axle I-beam is bent
- Illustration shows an axle upside down on a workbench ready for inspection for possible incorrect KPI angle
- An incorrect measured angle would require the axle assembly to be Replaced
- No attempt should ever be made to bend or straighten an axle assembly



Thrust Line Angle

- The thrust line angle is the actual center line that the vehicle will track while moving forward
- The thrust line angle is measured from the center line of the chassis. The four (4) primary wheel spindles are used to determine this center line



Examples of Severe Thrust Angle Condition

- Image 1 illustrates a severe condition that would cause the operator to constantly have to put right turn input to maintain straight ahead travel
- Image 2 illustrates a coach that would have the rear of the coach visibly out of line to the left side while traveling straight ahead, operator would have to correct to the left

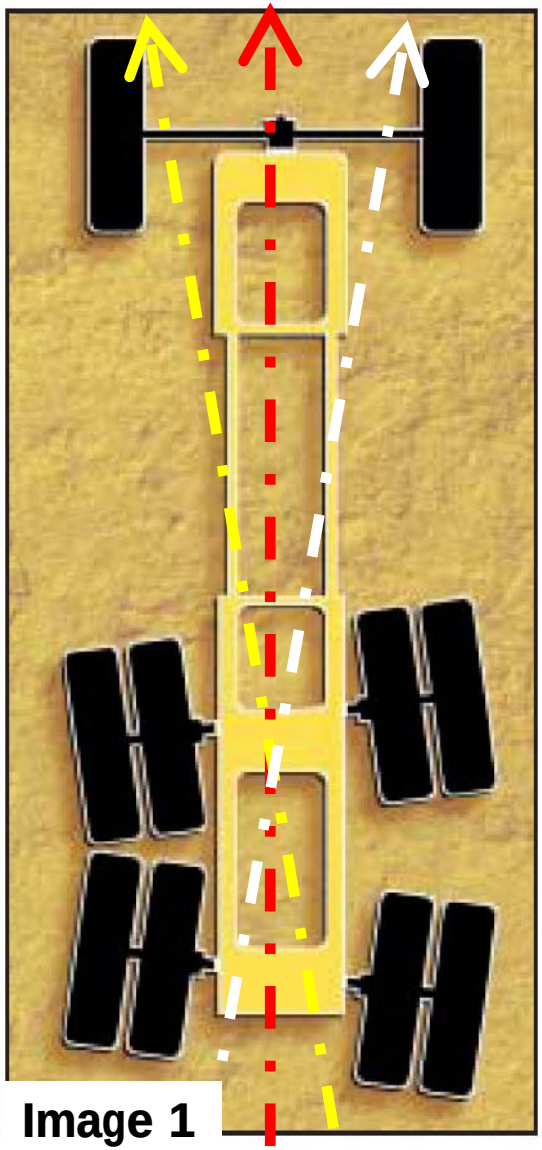


Image 1

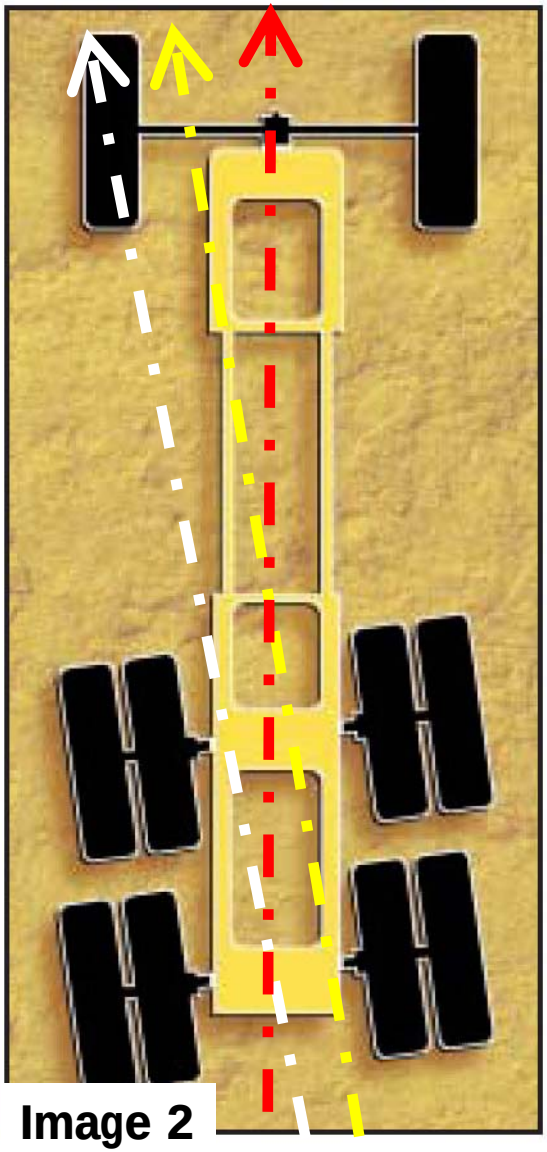
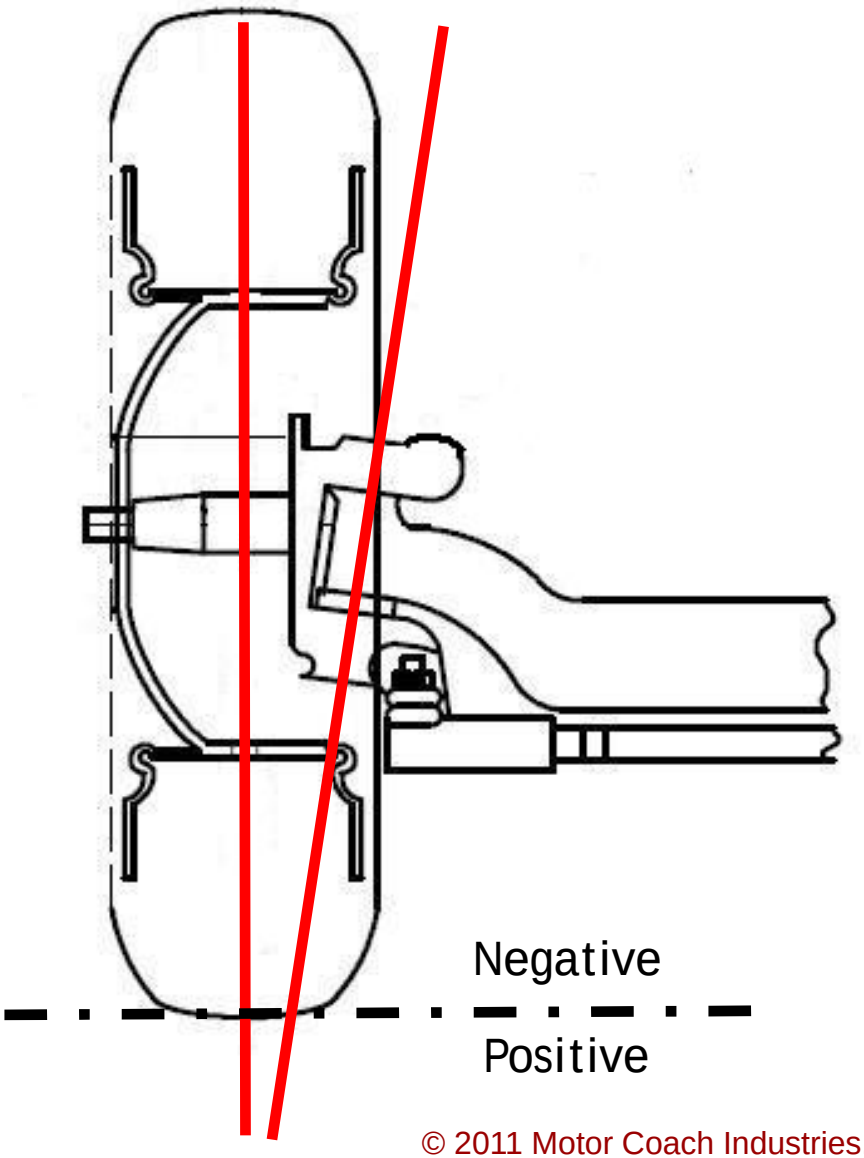


Image 2

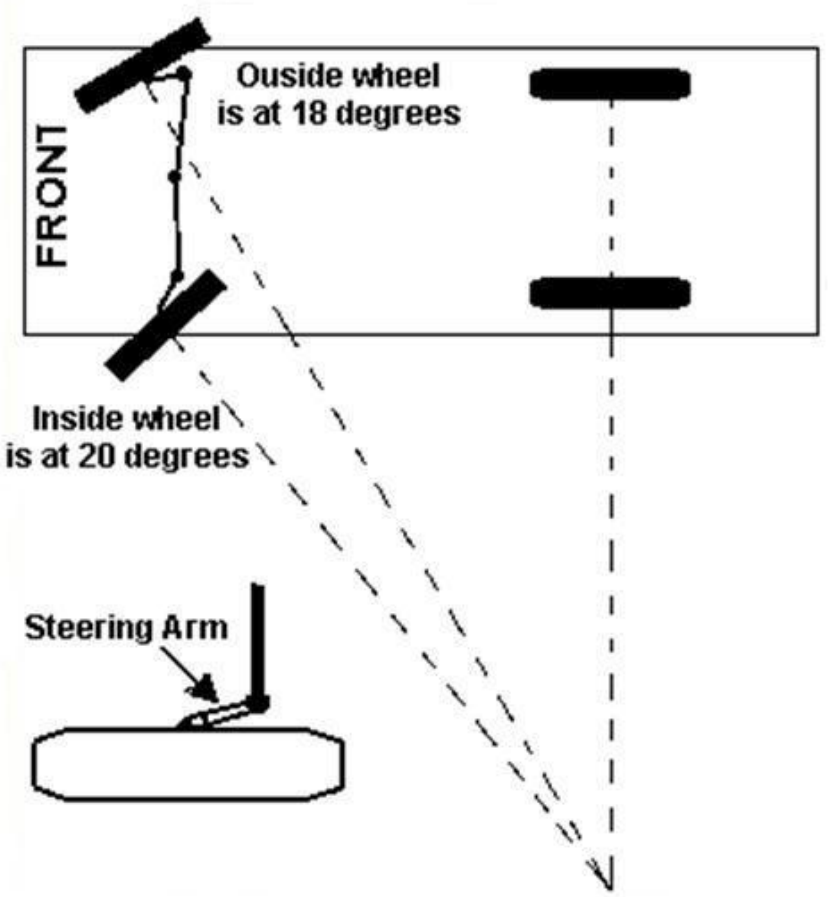
Scrub Angle



- The angle formed by the vertical center line of the tire and the center line of the pivot point (king pin) of the axle spindle
- If these lines would intersect below the road surface the scrub angle is ***positive***, if they intersect above the road surface the scrub angle in ***negative***

Toe-Out on Turns (Ackerman Angle)

- The Ackerman angle is another ‘designed in’ feature of modern axles
- The idea is constantly have all spindle and axle center lines meet in the same point during a turn
- To prevent the steer axle tires from sliding on the road surface, the designers must cause to inside wheel to have more ‘cut’ than the outer wheel
- This is mostly accomplished with a combination of KPI and the oddly shaped steering arms installed on the axle spindle assemblies



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Quiz 1

Answers to Quiz 1

1. Early E coaches had a Pitman arm which traveled horizontally to reduce ‘bump’ steer

   True

2. The caster adjustment of the axle is ‘designed in’ and no attempt should be made to correct the adjustment

   True

3. Toe-in adjustment can be performed in a shop using common tools and a trammel bar or a tape measure

   True

4. Overloading the front axle can cause the camber adjustment to change from negative to positive

   False

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Inspection, Troubleshooting, & Diagnosis

Steering Gear Center Point

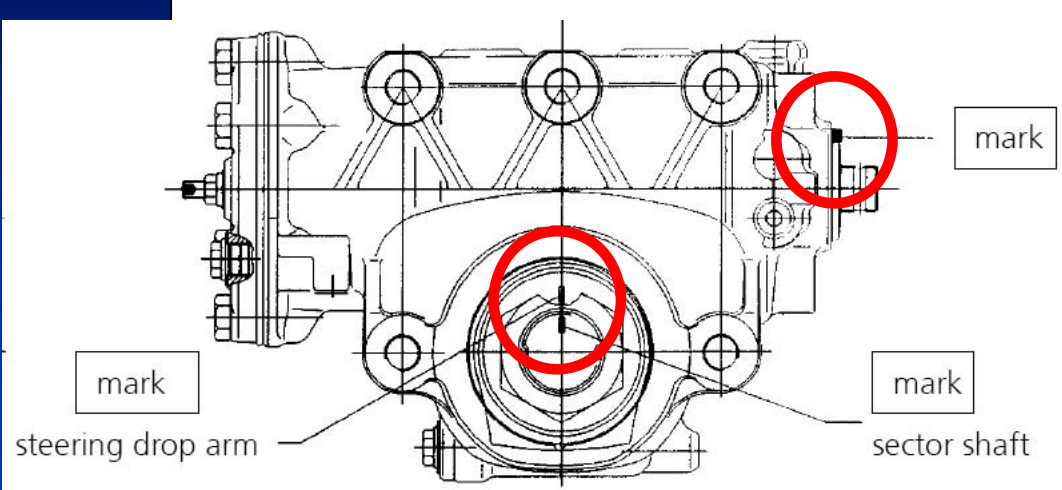
- All steering gears have a ‘center point’ which must be maintained before, during & after alignment
- Performing a complete alignment to the coach, or even adjusting the toe-in setting and the re-aligning the steering wheel on the column defeats this center point feature and can lead to complaints from operator about coach steering or ‘pulling’ to one side or the other

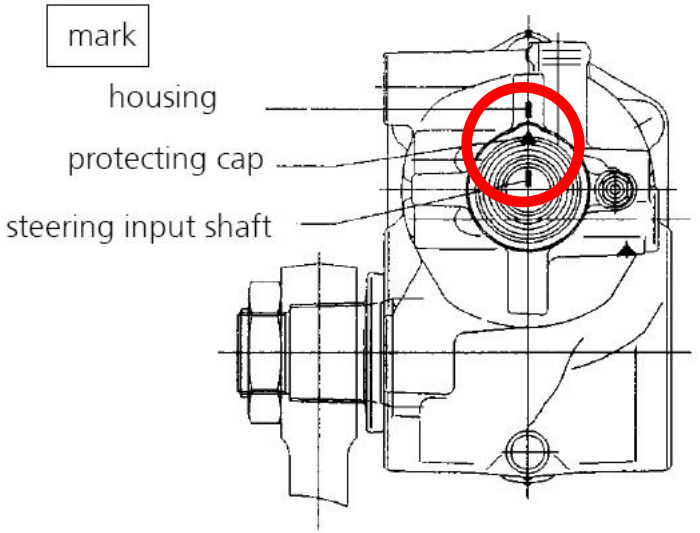
Steering Gear Center Point

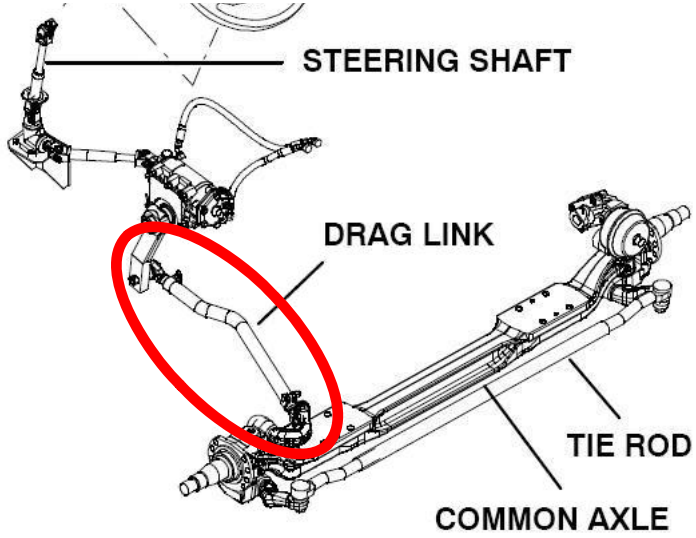
- On late model coaches with ESC, this practice could:
  - Nullify the SAS (Steer Angle Sensor) calibration
  - Cause the ATC fault light to come ‘On’
  - Cause the ESC system to become disabled
- Try not to cycle the coach Master switch during the alignment procedure
- *Normal, routine adjustments to the steering system should not create an issue!*

J Model Coach Without RAS

ZF Servocom 8098 steering gearbox center point

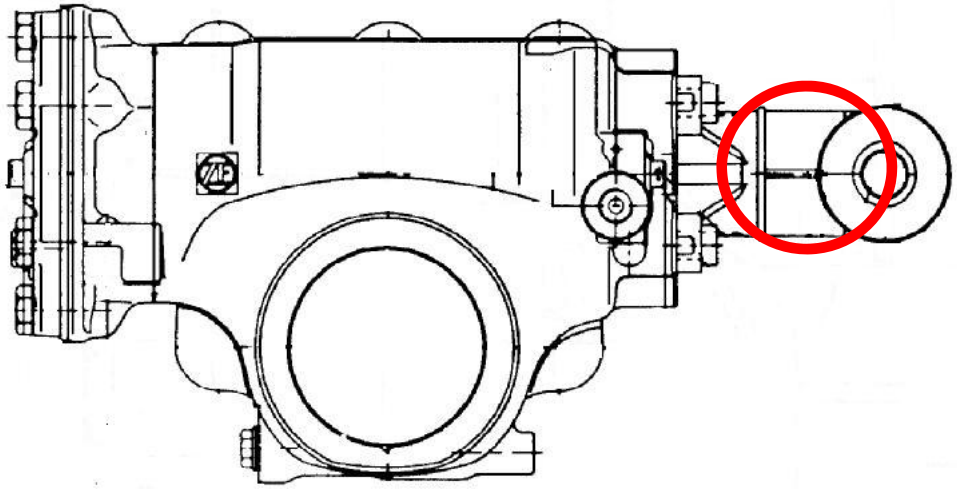


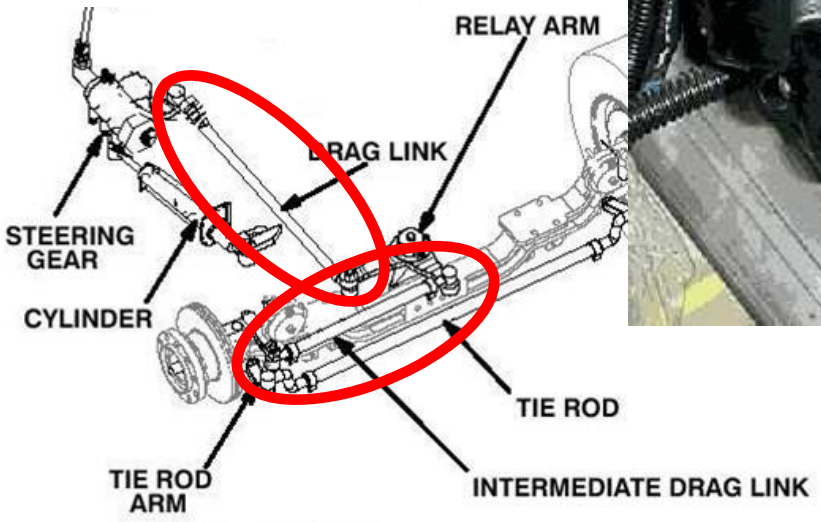




E Model Coach With RAS

ZF Servocom 8096 steering gearbox center point

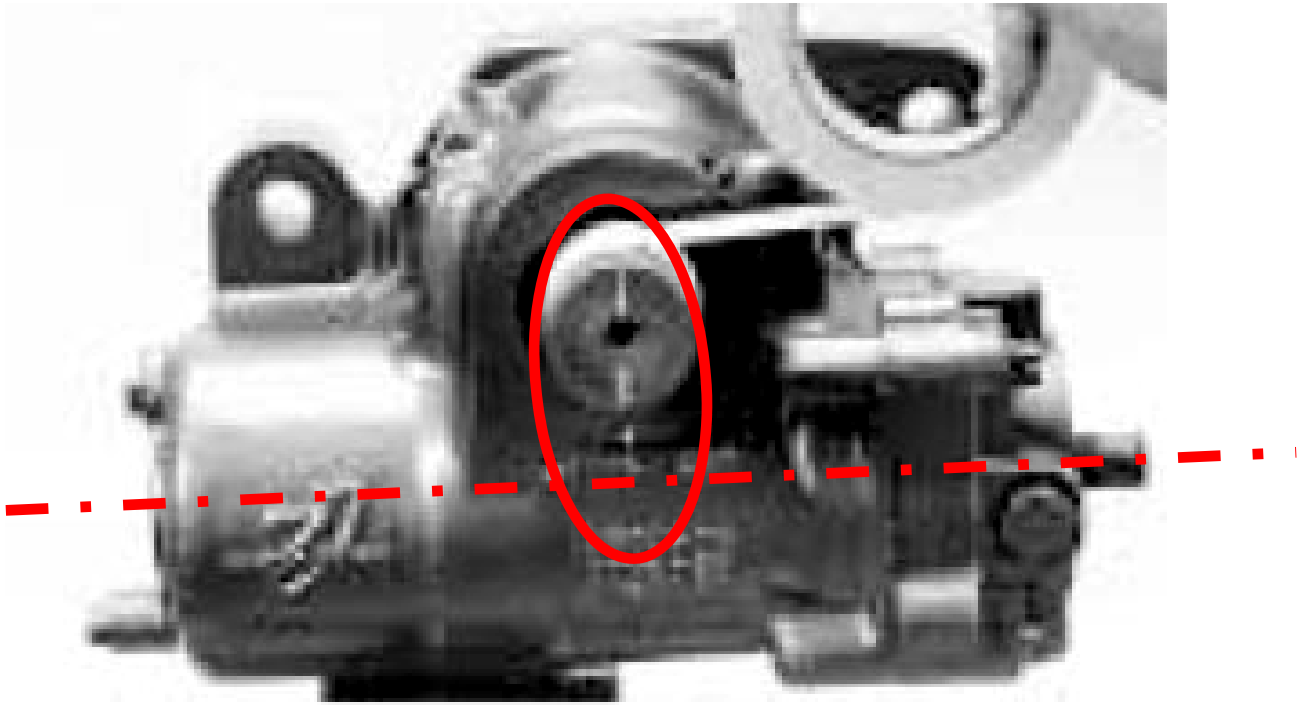




D Model Coach

TRW TAS 85 steering gear

- Gearbox is centered when scribe mark on sector shaft is 90º to center line of the input shaft



Items to Consider During Inspection

General condition of tires

- Are all tires properly inflated?
- Tread condition, tread depth, tread run-out
  - Lateral run-out of tread
  - Run-out of tread and tire casing (valley of the tread)
- Similar tread design or pattern
- Tire installation on wheel-check the lay line
- Tires are the same size and load rating
- Check that the tires are not contacting any suspension, steering and chassis components
- Check adjustment of the steering stop bolts on the spindles

Items to Consider During Inspection

- Wheels
  - Check run-out of wheel rims at disc and bead seat
  - Is wheel correctly piloted on hub or studs?
  - Wheel properly torqued to the hub assembly
  - Look for obvious defects of the wheel assembly
- Hubs
  - Check bearing end play using a dial indicator
  - Check that the brake foundations are operating correctly and not interfering with the normal hub operation

Additional Items to Consider During Inspection

Check the general condition of the suspension components

- Radius rods and links
- Sway bars and end links
- Is coach @ correct ride height? Are air springs and bellows in serviceable condition
- Shock absorber bushings & mounting pins
  - Recommended to check shock absorbers using an infrared pyrometer
  - If adjustable, are settings the same across the axle?
- Suspension support brackets attached / fastened to the axle

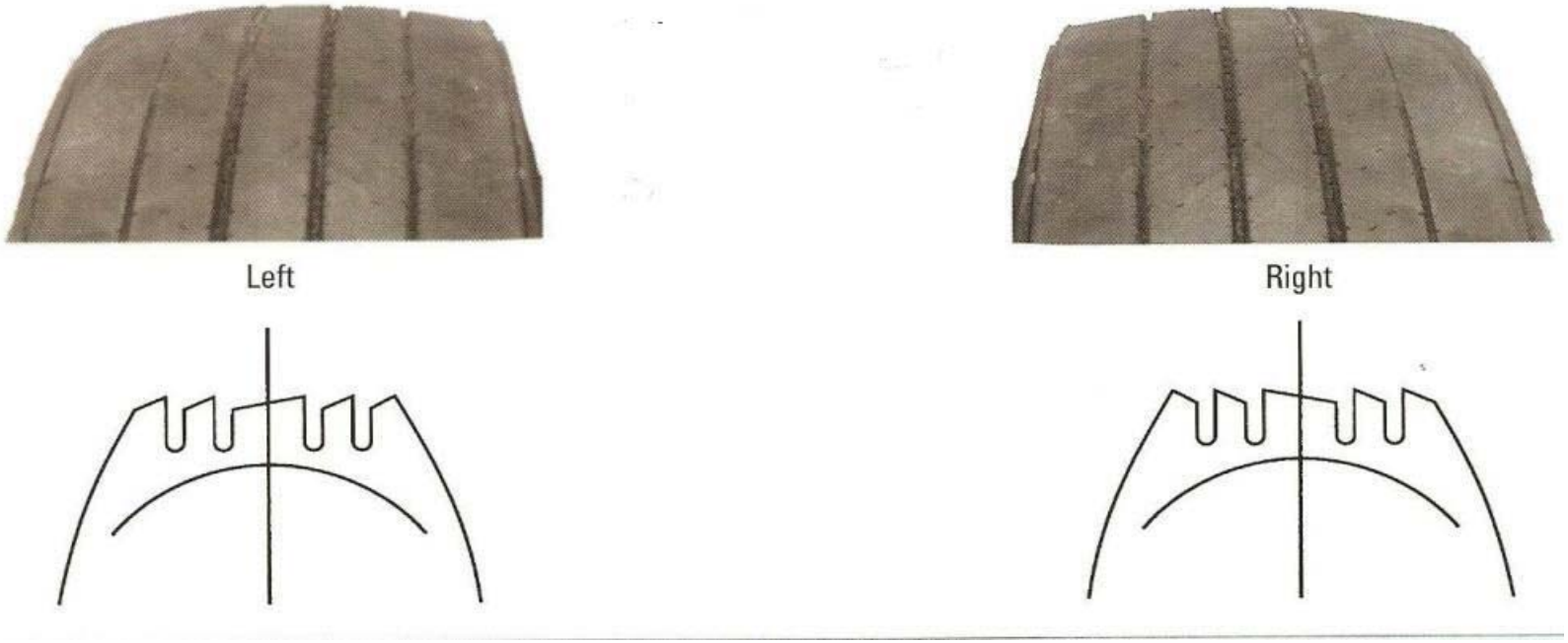
Additional Items to Consider During Inspection

Check the steering components

- Condition of the steering column, u-joints and slip yokes
- Check for excessive free play in miter gearbox (E&J Coach)
- Check that the steering gear is securely fastened to the chassis
- Check that the Pitman arm is securely attached to the gearbox sector shaft
- Check the condition of the drag link / tie-rod / intermediate rod knuckle ends
- Check condition of the king pin bushings
  - Bushing clearance and thrust bearing vertical end play
- Trailing axle steering?

Toe-In /Toe-Out Wear

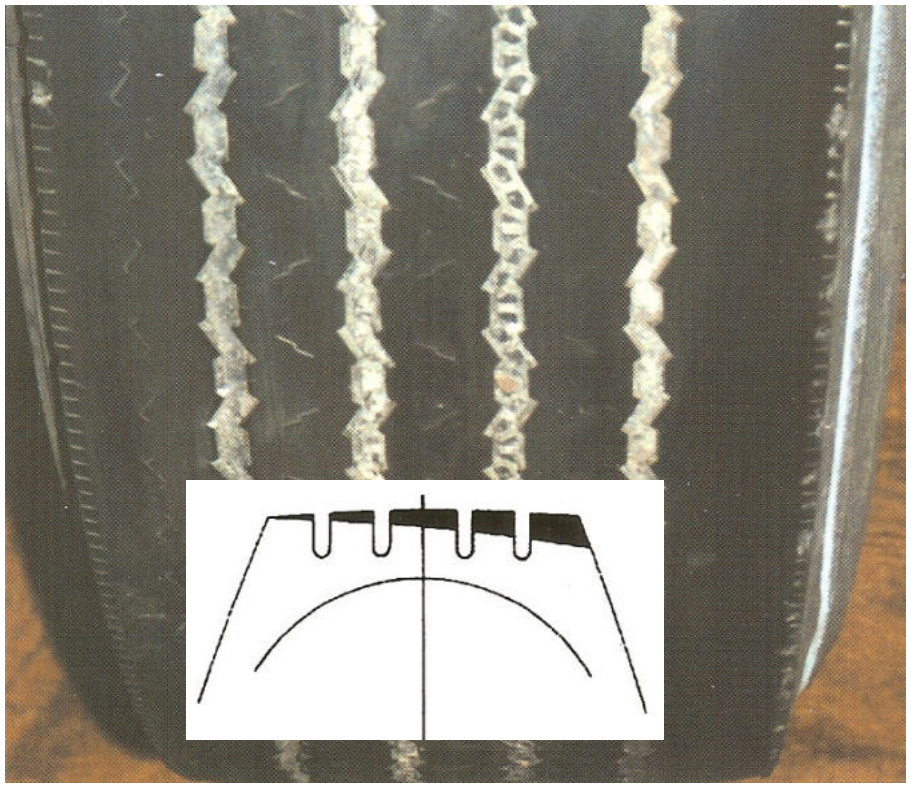
- Caused by improper toe-in adjustment of the tie rod assembly
- If wear is reversed to the inside of the tires, wheels would be in toe-out condition



One Sided Tread Wear (Camber)

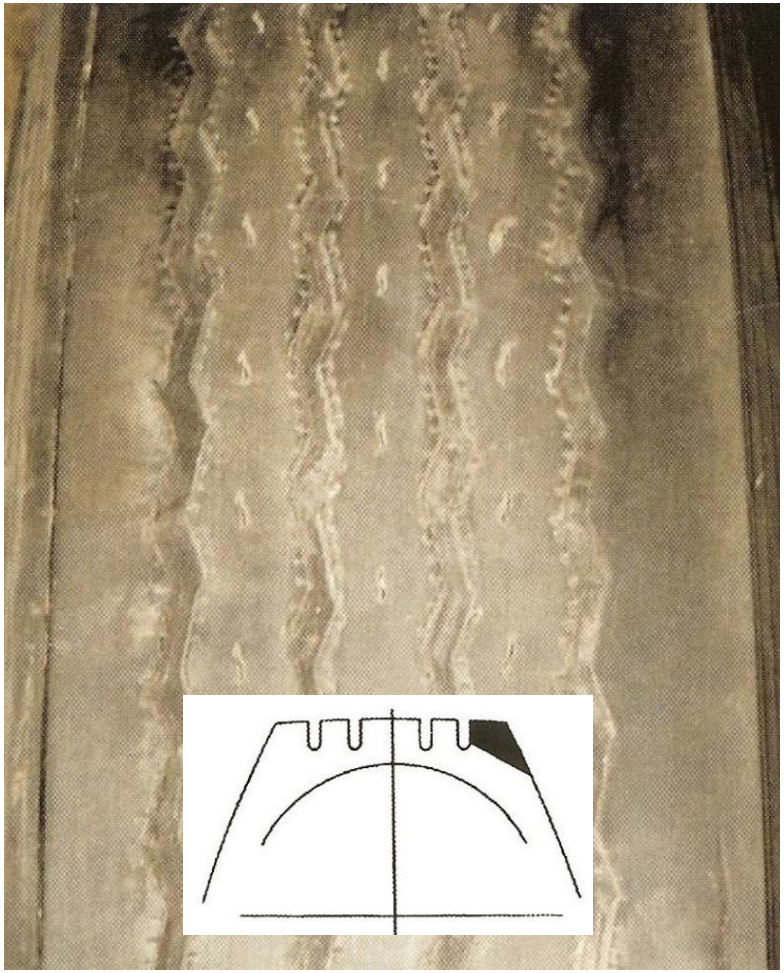
Common cause improper camber setting and/or drive axle misalignment

- Additionally, worn king pins,
- Improper hub bearing adjustment
- Excessive axle weight loads could cause of condition



Full Shoulder Wear

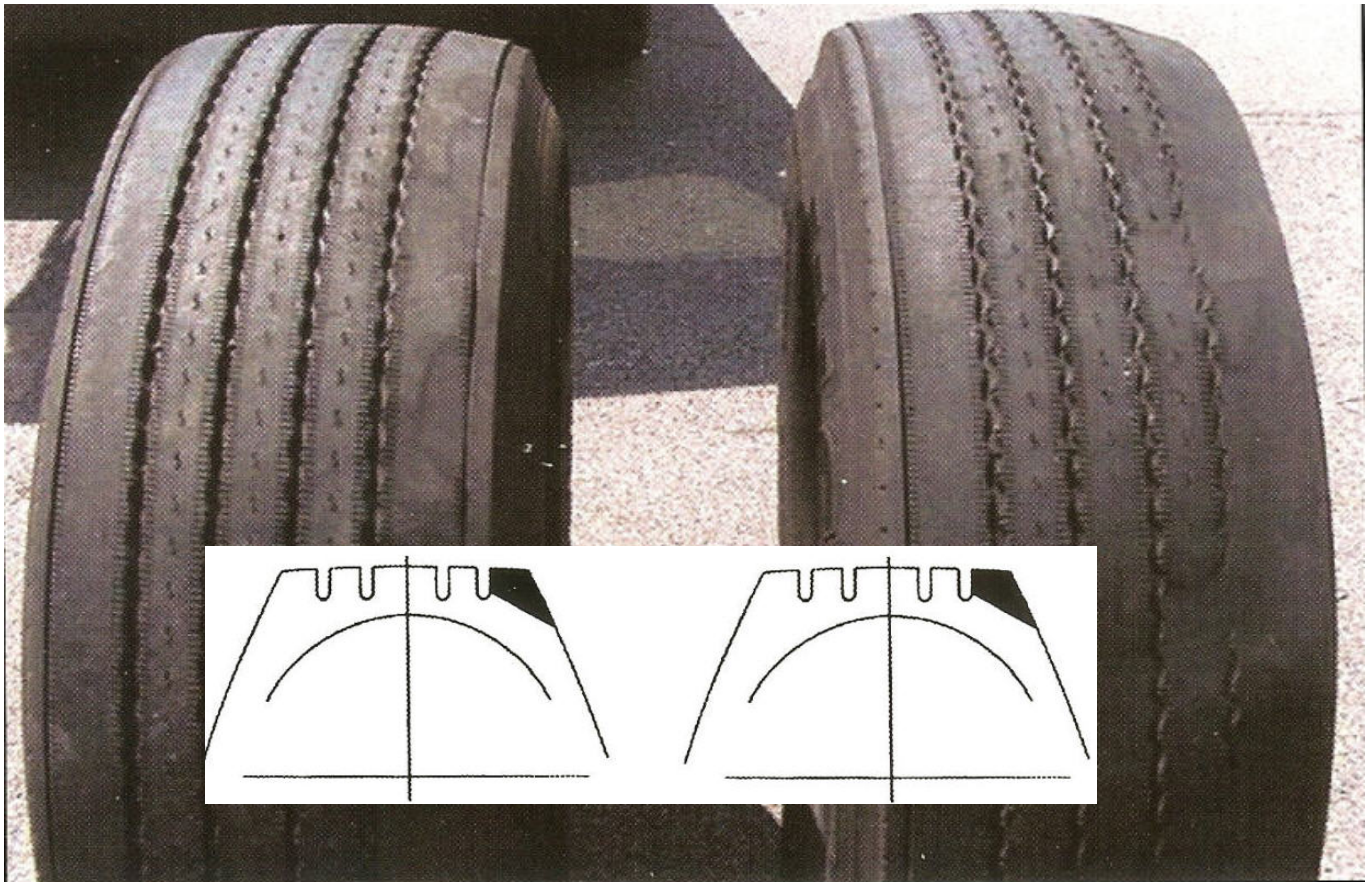
- Indication of scrubbing of tire, caused by:
  - Improper toe-in adjustment
  - Drive axle misalignment
  - Damaged or worn out suspension
  - Steering components can also cause this condition
- Often seen on steering trailing axles where toe-in is correct but:
  - Applied to one wheel only, one wheel straight in locked position and all toe adjustment imposed on opposite tire



Thrust Angle Induced Wear

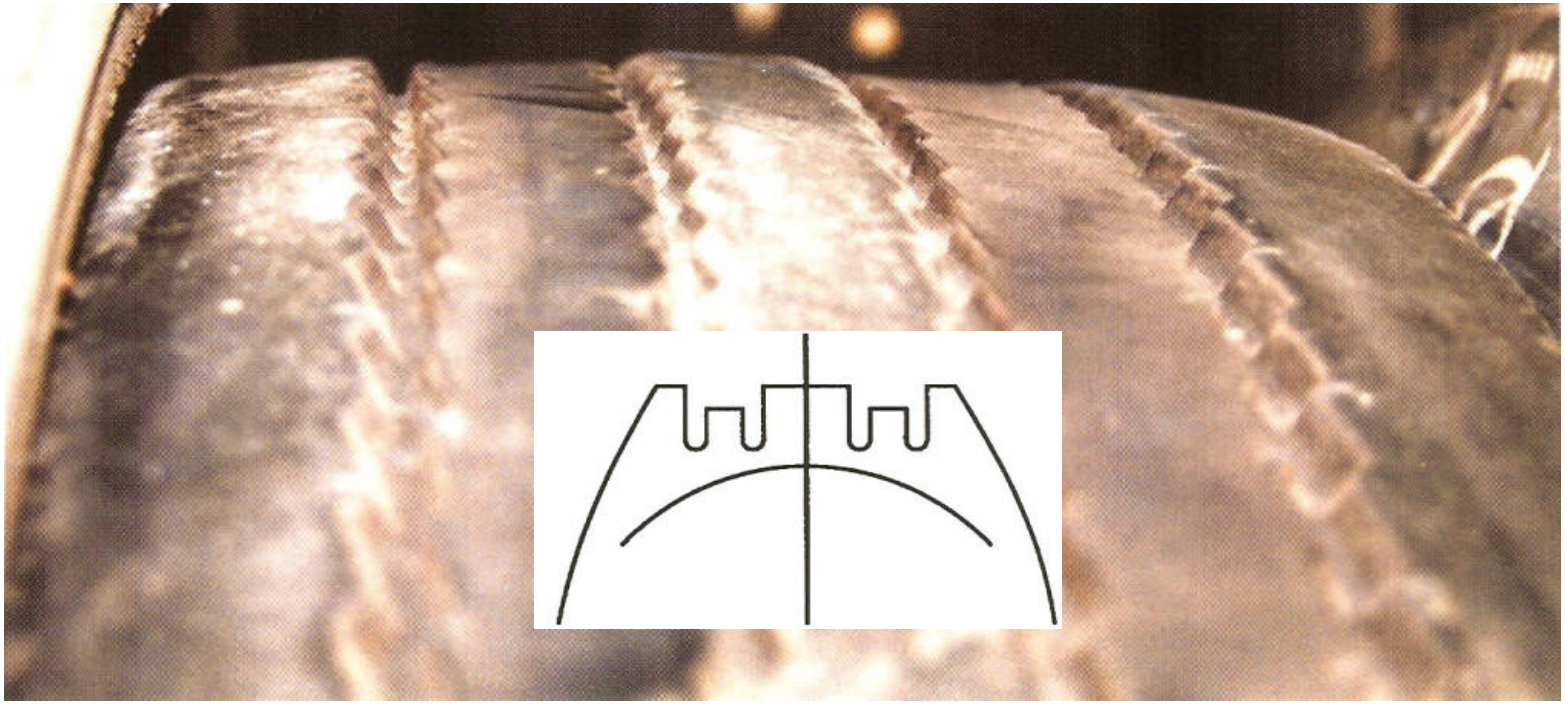
Inside shoulder of one tire, outside shoulder of the opposite tire

- Caused by misalignment of the drive axle



Inner Rib Depression Wear (Rib punch)

- Primary cause - under inflation
- Secondary causes:
  - Lack of shock absorber control
  - Improper seating on wheel
  - Improper hub bearing adjustment
  - Severe out-of-balance condition



Tire Out-of-Round Wear

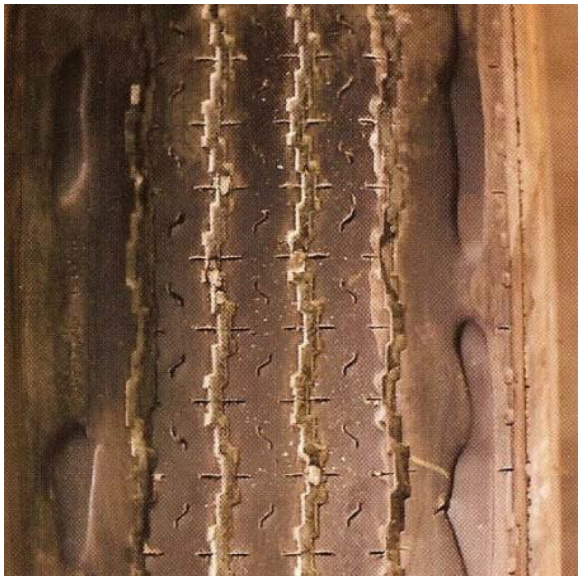
Caused by excessive run-out condition of rotating assembly

- Tread run-out excessive
- Casing not centered inside of cap
- Possible problem with hub
- Mounting stud circle
- Wheel stud holes
- Improperly seated tire

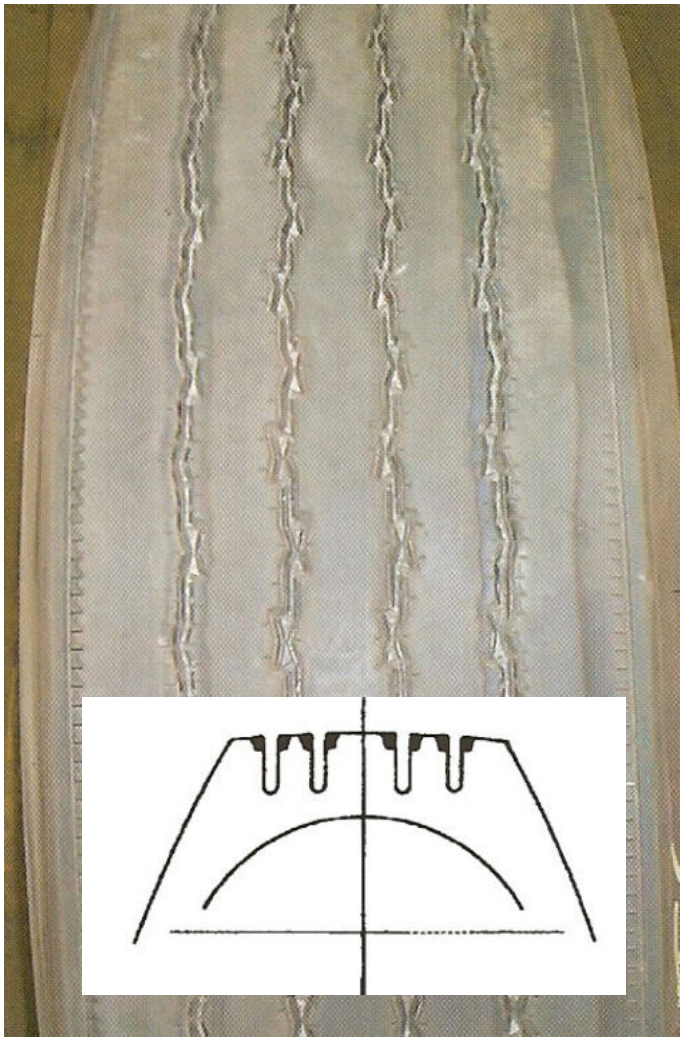
Cupping/Scalloping of Shoulder Wear

Moderately to severely out-of-balance condition:

- Lack of shock absorber control
- Loose/worn king pin bushings,
- Improperly adjusted wheel bearings,
- Long periods of operation at high speeds while under-inflated



Erosion/River Wear



Indication of slow wear rate on trailing axle

- Common on extended high speed operation with limited loading and minimal turning of vehicle
- Wear pattern is not normally a cause for concern

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Quiz 2

Answers to Quiz 2

1. While performing an alignment, it is critical to maintain the center point of the steering gearbox

   True

2. Old, defective shock absorbers have no effect on how steering axle tires will wear

   False

3. Improper positioning of the drive & tag axles has no effect upon how the steering axle tires will wear

   False

4. Too much positive camber will cause the tire tread to wear across the entire tread surface at a slight taper to the outside edge of the tire

   True

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Preventive Maintenance, Recommended Inspection, & Lubrication Intervals

Front Axle Steering System Preventative Maintenance

Regular routine inspections:

- 5,000 Mile Service Interval — Critical
- 10,000 Mile Service Interval
- 15,000 Mile Service Interval
- 20,000 Mile Service Interval
- 25,000 Mile Service Interval
- 30,000 Mile Service Interval
- 50,000 Mile Service Interval
- 75,000 Mile Service Interval

Warranty Coverage of Steering Components

- 25,000 Miles
  - Front wheel alignment covered as a secondary failure
- 50,000 Miles, or one (1) year
  - Wheel bearings, suspension bushings, sway-bar links and hardware
- No coverage for normal wear on components or accelerated wear due to failure to perform routine maintenance and lubrication

Typical System Components Periodic Inspection

MAINTENANCE OPERATION	Location Key*	SERVICE INTERVAL (Miles)												
		Reg Int	5,000	10,000	15,000	20,000	25,000	30,000	50,000	60,000	75,000	100,000	200,000	300,000
1 – FRONT AXLE														
INSPECT FRONT AXLE		•												
CHECK FRONT AXLE WHEEL ALIGNMENT		•												
TAKE THE WEIGHT OFF THE STEERING AXLE AND CHECK KING PIN PLAY								•						
TAKE THE WEIGHT OFF THE STEERING AXLE AND LUBE THE KING PIN								•						
LUBRICATE FRONT AXLE KNUCKLE PINS & BUSHINGS								•						
INSPECT AND REPLACE RADIUS ROD BUSHINGS IF REQUIRED								•						
LUBRICATE TIE ROD ENDS								•						
CHECK WHEEL BEARING OIL LEVEL		•												
DRAIN & FILL WHEEL BEARING OIL						•								
2 – DRIVE AND TAG AXLES														
CHECK OIL LEVEL – (DIFFERENTIAL)		•												
INSPECT DRIVE AXLE		•							•					
CHECK AND ADJUST TOE-IN IF REQUIRED				•										
CHANGE DIFFERENTIAL OIL							•							
CHECK TAG AXLE WHEEL BEARING GEAR OIL LEVEL		•												
DRAIN & FILL TAG AXLE BEARING OIL						•								
INSPECT TAG AXLE SEALS AND BEARINGS											•			

Typical System Components Periodic Inspection

MAINTENANCE OPERATION	Location Key*	SERVICE INTERVAL (Miles)												
		Reg Int	5,000	10,000	15,000	20,000	25,000	30,000	50,000	60,000	75,000	100,000	200,000	300,000
11 - STEERING														
CHECK AND FILL POWER STEERING RESERVOIR	2	•												
LUBRICATE ALL CHASSIS GREASE POINTS				•										
LUBRICATE DRAG LINK ENDS	6									•				
REPLACE POWER STEERING FILTER (IN-LINE)	32									•				
REPLACE POWER STEERING FILTER (RESERVOIR)	31									•				
CHANGE POWER STEERING FLUID										•				
INSPECT AND LUBRICATE STEERING COLUMN	22									•				
TURN WHEEL FROM RH TO LH AND BACK AND CHECK FOR FREE TRAVEL				•										
INSPECT ALL STEERING COMPONENTS FOR TIGHTNESS				•										
REPLACE POWER STEERING OIL AND FILTER										•				
INSPECT TIE-ROD END BOOT										•				

12 - SUSPENSION														
CHECK RIDE HEIGHT		•												
INSPECT RADIUS ROD BUSHINGS & SHOCK ABSORBER MOUNTS								•						
INSPECT AND REPLACE SHOCK ABSORBER IF REQUIRED								•						
INSPECT AND REPLACE ANTI-SWAY BAR BUSHING IF REQUIRED								•						
REBUILD OR REPLACE ALL LEVELING VALVES								•						
REPLACE SUSPENSION AIR FILTER	33									•				
INSPECT SUSPENSION AIR SPRING BELLOWS ASSEMBLIES		•												

Typical System Components Periodic Inspection

MAINTENANCE OPERATION	Location Key*	SERVICE INTERVAL (Miles)												
		Reg Int	5,000	10,000	15,000	20,000	25,000	30,000	50,000	60,000	75,000	100,000	200,000	300,000
15 – WHEELS, HUBS & TIRES														
CHECK TIRE PRESSURE AND RECORD		•												
CHECK TIRE TREAD DEPTH AND RECORD		•												
CHECK SPARE TIRE PRESSURE AND TREAD DEPTH		•												
CHECK AND FILL WHEEL BEARINGS (OIL LUBED)		•												
LUBRICATE WHEEL BEARINGS (OIL LUBED)	3					•								
INSPECT WHEEL BEARINGS AND SEALS											•			
INSPECT TIRES, TIRE PRESSURE AND WHEEL NUTS		•												

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Quiz 3

Answers to Quiz 3

1. Usually, front end alignment defects will create unsatisfactory tire wear conditions in 25,000 miles or less

   True

2. An initial inspection & lubrication of the steering system components is critical to ensure dependable service

   True

3. 'River wear' is a condition that should be monitored but is not considered cause for an alignment to be performed

   True

4. Improperly adjusted or failing wheel bearings will not create abnormal wear patterns on the steer axle tires

   False

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Questions and Answers

Press the * on your phone to ask your question

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Thank you for your business