

**Institute of Road Transport Engineers**  
**STEERABLE AXLES IN SEMI TRAILERS –**  
**CODE OF PRACTICE**

28 July 2010

Rotorua

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# Overview



## ➤ Steerable axles

- Types of castor/self steer axle
- Key performance criteria



## ➤ History of steerable axles in semi trailers in NZ

- Development and testing
- MOT Steerable Rear Axles Policy
- VDAM rule - 2002

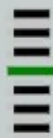
## ➤ In-service performance of quad axle semi trailers 2002 – 2010

## ➤ Semi trailer – Steerable Axle Code of Practice





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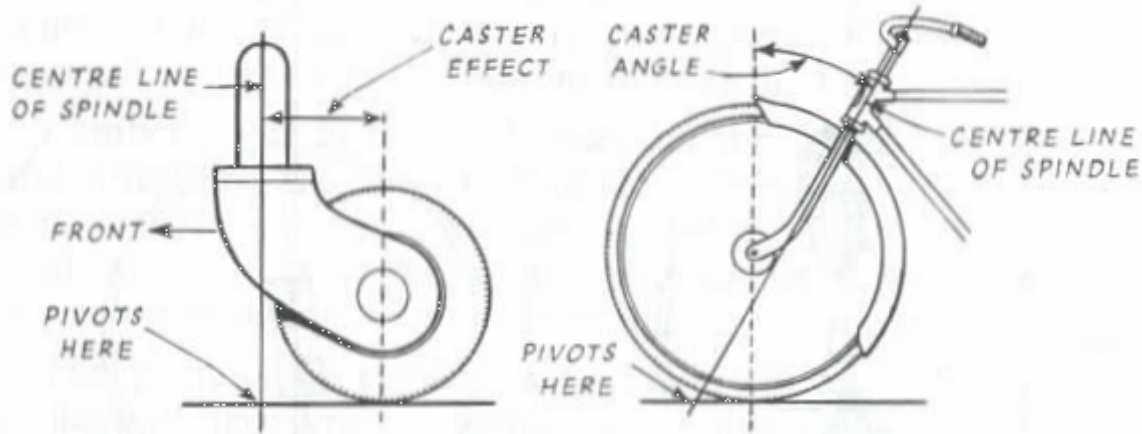
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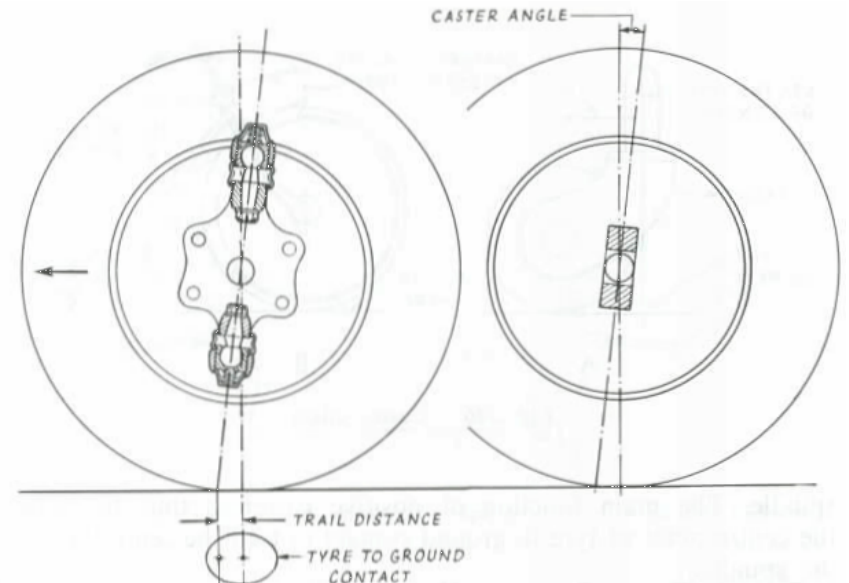
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# Steerable axles



Caster effect  
Caster angle





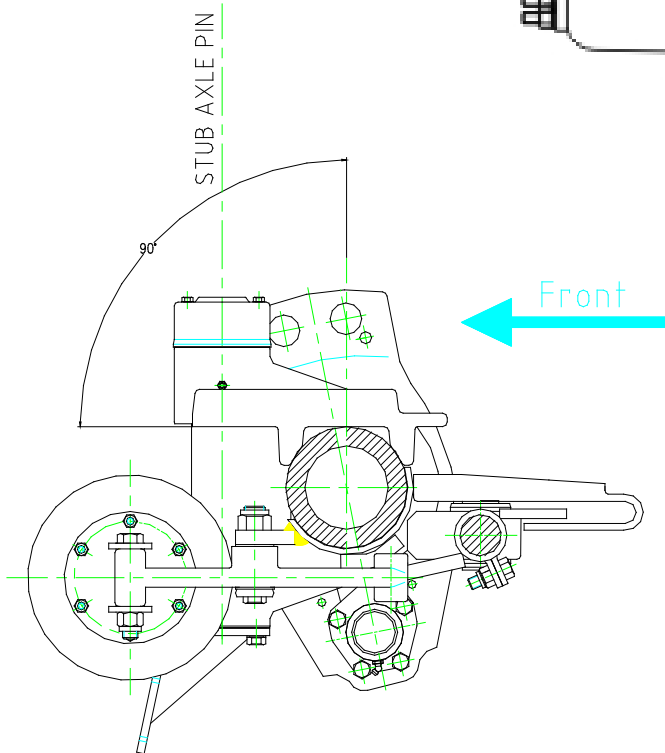
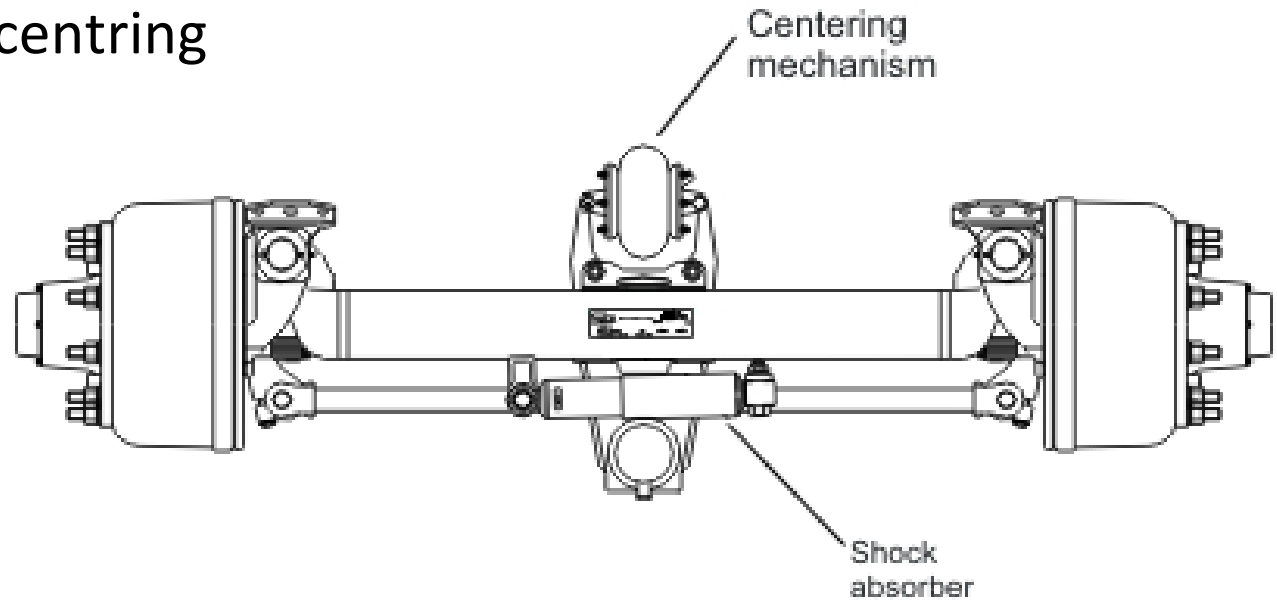
## Steerable axles

- Castor effect alone does not provide sufficient centring force
  - Most self steer axles will provide additional centring force, can be either:
    - Air pressure centring
    - Kingpin centring
    - Pre-load centring
-



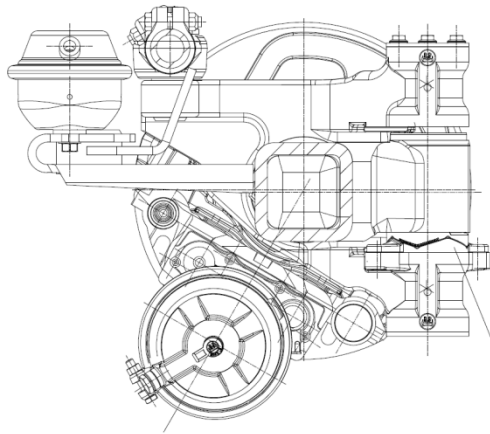
# Steerable axles

## Air pressure centring

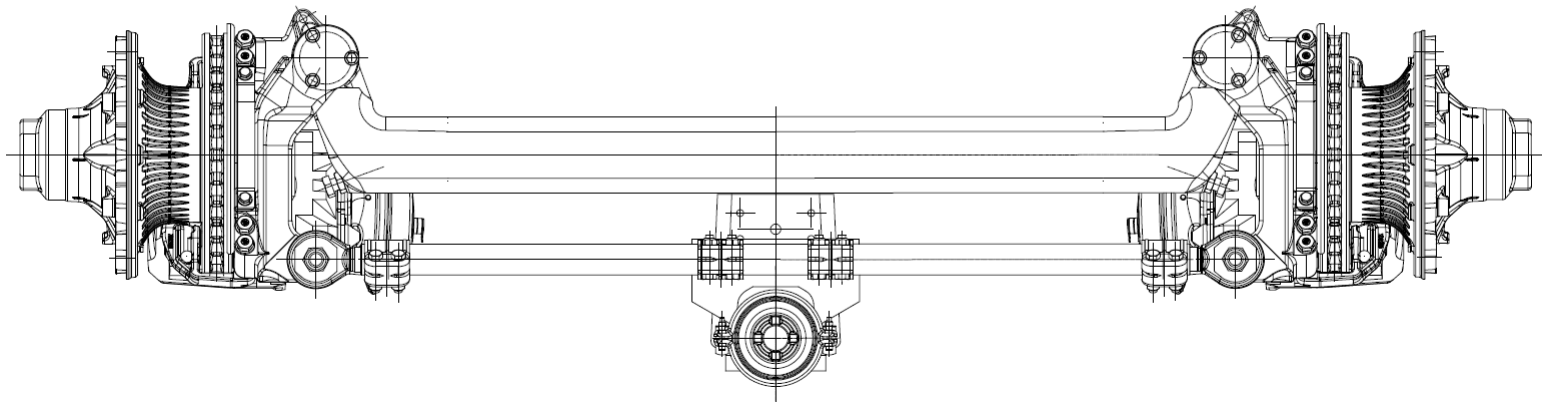
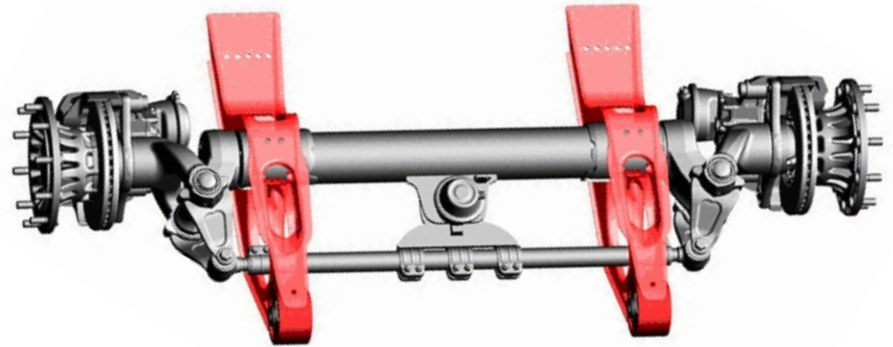


# Steerable axles

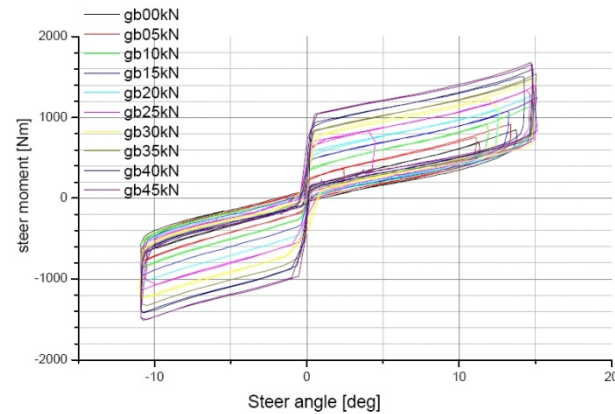
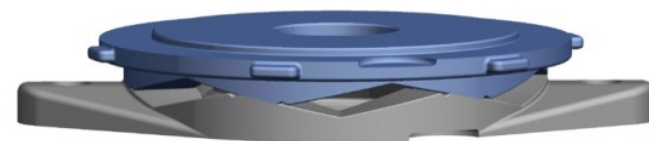
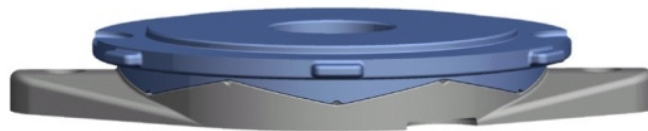
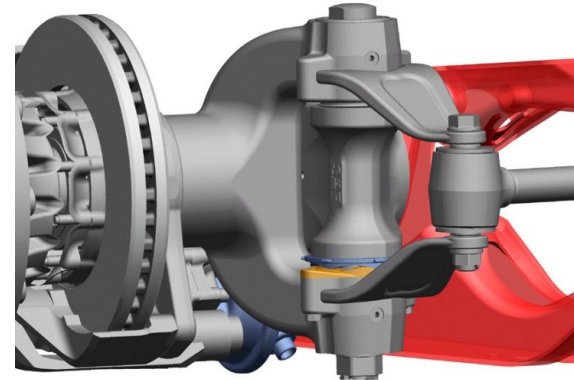
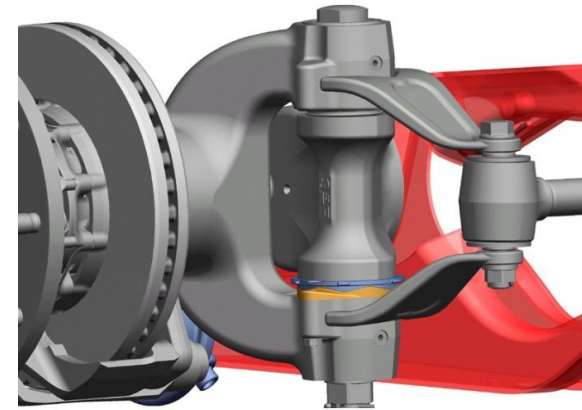
## Kingpin centring



Centering mechanism  
(undulating washer)



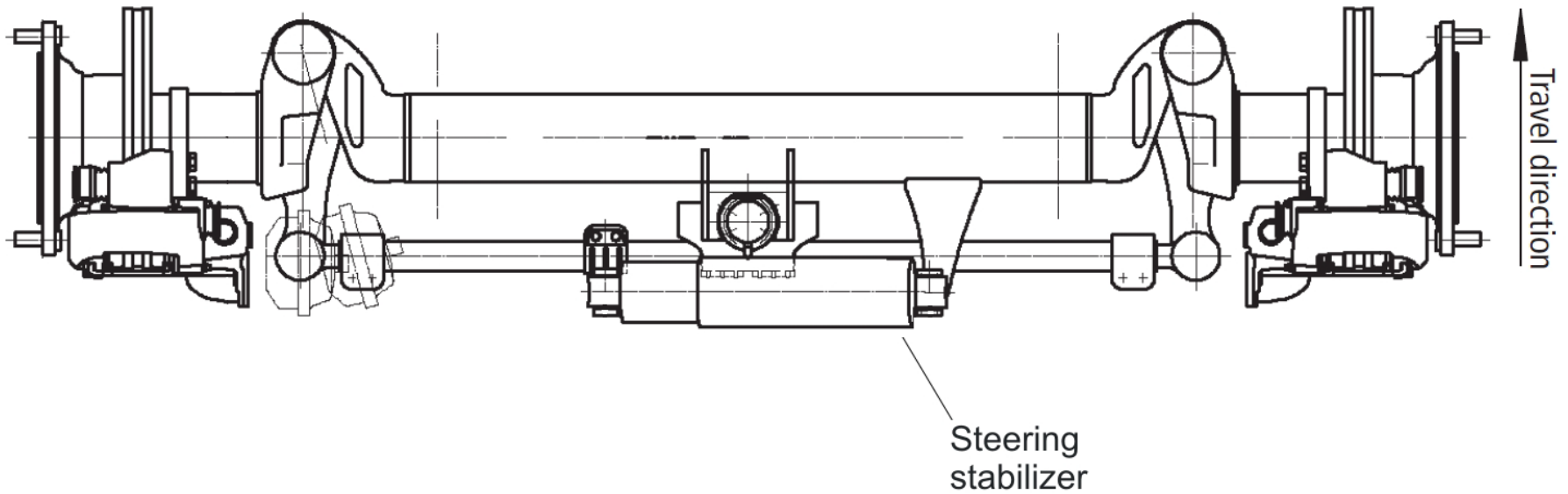
# Steerable axles





# Steerable axles

## Pre-load centring



# Steerable axles

## Key performance criteria

- Castor effect or mechanical trail
  - Caster angle (recommended and limits)
  - Level and type of additional centring
    - Load and angle sensing
    - Load sensing
  - Coulomb friction
  - Damping
-

# History

- Castor steer axles first fitted in the late 1960's
  - Some tri-axle semi trailers fitted with two castor steer axles in 1970's
  - Semi trailers with rear castor steer limited to 37 tonne GCM
  - Physical testing and computer simulation of tri-axle semis with rear steer - late 1980's and early 1990's resulted in GCM increase to 39 tonne
  - Suppliers had axles assessed and tested
-







# History

- MOT Steerable Rear Axles Policy developed during 1990's
- Revision 3 – 1996, contained requirements for:
  - Axle suppliers
    - Issue signed certificate of conformity to trailer manufacturer stating:
      - that axle meet the steerable rear axle policy, including the performance requirements and stability analysis
      - Maximum axle rating and Gross Combination Mass resulting from stability analysis
      - Other information to ensure the safe fitment and operation of the axle (i.e torpress operating pressures)
    - Provide parts list to identify all components
    - Provide schedule of minimum maintenance requirements



# History

- Trailer builders/engineers
    - Suspension design had to be certified as meeting the policy
    - Trailer information plate detailing the 5<sup>th</sup> wheel height range, steer axle model and approval number, approved tyre sizes etc
    - Provide maintenance log book to owner
  - Trailer owner
    - Shall ensure the operator is conversant with the requirements of the maintenance log book and that all servicing requirements are met
    - Maintenance log book to be kept up to date at all times and made available during each COF inspection
  - Vehicle inspector
    - Check that LT approval number has been loaded into inspection database
    - Inspect maintenance log book during COF inspections
-

# History

- Stability analysis included
    - Determination of High speed transient offtracking (HSTO) by computer simulation – had to be less than 0.6 metres (this performance measure was used to limit GAWR and GCM)
    - Straight line braking with left to right brake imbalance – lateral trailer swing not to exceed 0.5 metres
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# History



# History



# History

- Vehicle Dimension and Mass Rule 2002
    - Semi trailers with quad axle groups permitted
    - Two steering axles required in the quad axle group, either axles 1 and 4 or 3 and 4
    - Minimum steering angle of 15 degrees (required certification)
    - Explicit performance requirements for steer axles from MOT policy not included
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## 2006 – low speed turning tests

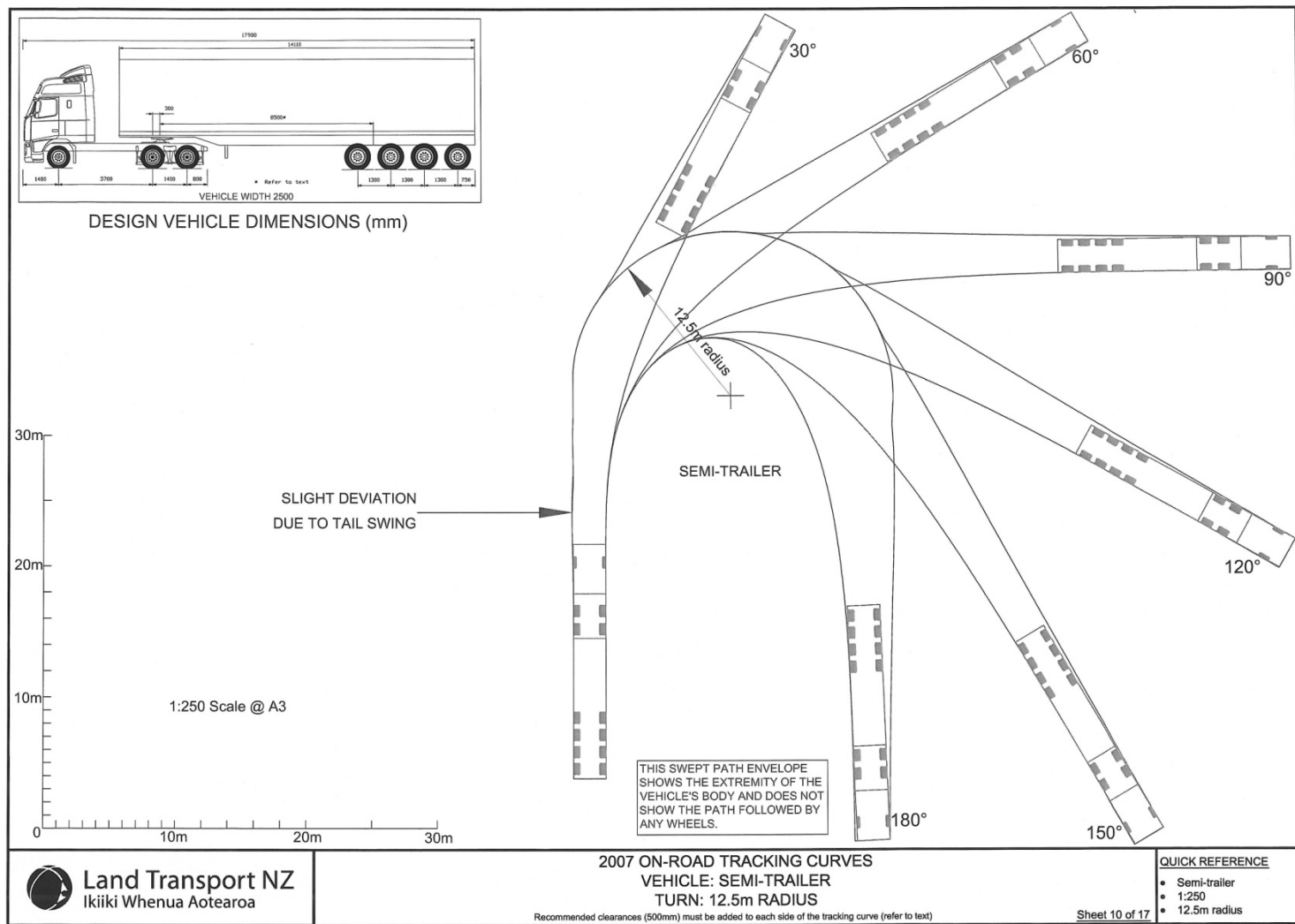




# Characteristics of HV cont

## ➤ Swept path

RTS – 18 NZ on-road tracking curves: 2007











Quote NZ Herald Blog:

“The truck driver is a close family member of mine. Our family is so devastated. We are all in disbelief. Why do our roads take so many of our loved ones away??? Is it always the drivers, or a combination of other factors???”

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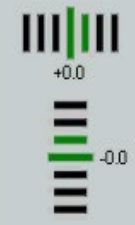




H4554







Frame Time  
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Event Recorder  
ER905F4C

Date  
25/03/2010

Time  
7:03:01 a.m. NZ



# Semi trailer - Steerable axle code of practice

- Quad code of practice developed because of concerns over the on-road performance of quads
  - Starting point MOT steerable axle policy
  - Covers equipment supplier, trailer builder and operator responsibilities
  - Extended to cover all axle semi trailers with self steer axles
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# Semi trailer - Steerable axle code of practice

## ➤ Equipment suppliers

- Specify the ride height range of the suspension and the maximum height change across the axle group
  - If the axle does not provide additional centring force above that provided by the mechanical trail then the trailer builder must be made aware of the need to lock the third axle above 30 km/h
  - Provide wheel alignment and maintenance specifications to trailer builder
  - Ensure all brakes supplied are auto-adjusting
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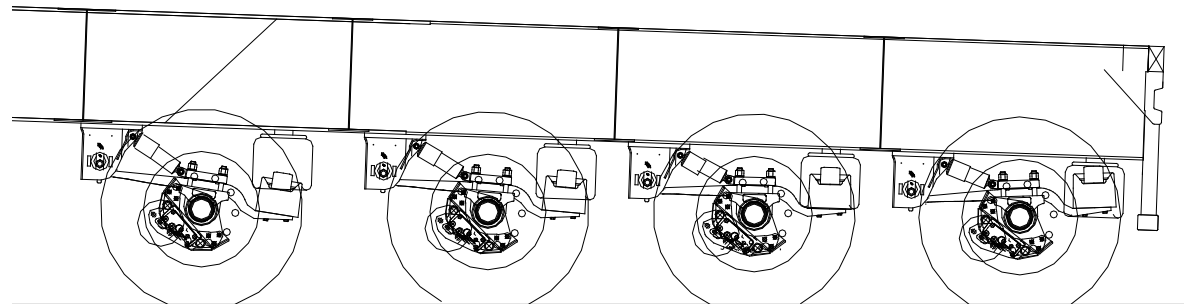


# Semi trailer - Steerable axle code of practice



## ➤ Trailer builder

- Ensure that the suspension height change across the axle group is within the limits specified by the manufacturer. (One degree of chassis slope equates to 70 mm height change across 4 m axle group spacing)
- The design 5<sup>th</sup> wheel height and tolerance must be specified on the vehicle data plate
- If the steer axle centring force is insufficient to provide consistent return to centre performance then the steering system of the third axle must be automatically locked at speeds above 30 km/h.





# Semi trailer - Steerable axle code of practice

- Install warning system so that driver has feedback of loss of suspension air pressure.
  - If docking valve or suspension dump system is installed provide automated reset to ride height functionality which operates at speeds above 20 km/h.
  - Ensure that the air charging system does not give priority to spring brake release.
  - Install load proportioning braking system with ABS.
  - Provide trailer manual to owner/operator detailing operation of trailer, ride height range, suspension settings, design 5<sup>th</sup> wheel height and wheel alignment specifications. If the third axle is locked at speeds detail the operating speed of the lock and how it is achieved. For steer axles using an air pressure centring mechanism provide the air pressure settings for the laden and unladen conditions.
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# Semi trailer - Steerable axle code of practice



## ➤ Operator

- Maintenance requirements
    - The suspension ride height setting is correct and suspension controls operating correctly
    - The steer axle centering devices and locking mechanism are functioning correctly and within manufacturers wear limits
    - Ensure periodic wheel alignment checks are carried out
    - Regular tyre checks are carried out ensuring that the pressure differential left to right on the steer axle tyres is no greater than 140 kpa (20 psi) and the state of wear, left to right is approximately the same
    - Ensure the correct functioning of automatic brake adjustment devices
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# Semi trailer - Steerable axle code of practice

## ➤ Operator

- Tractor unit specification
    - Speed limited to 90 km/h
    - 5<sup>th</sup> wheel height correct for semi trailer
  - Driver training detailing
    - Handling and tracking performance of quad semi trailers
    - The operation of locking mechanisms
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