



Section C

Tail Shafts

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Section C — Overview

1. Description

This section of Vehicle Standards Bulletin 6 (VSB6) relates to the minimum design and installation requirements for the fitting of alternate tail shafts to heavy vehicles.

The principal function of the tail shaft assembly is to transmit driveline power or torque from the transmission to the drive axles. The tail shaft must be able to transmit the maximum driveline torque and rotate at the maximum driveline speed, while minimising undue vibration. The tail shaft design should also ensure acceptable working life of all associated components.

Alterations to tail shafts are usually needed when the wheelbase, chassis, engine, transmission, or the axle configuration are modified.

This section covers modifications to single and multi-piece tail shaft assemblies of all heavy vehicles and consists of the following modification code:

C1	Tail shaft alterations
	<ul style="list-style-type: none">reduction in tail shaft lengthincrease in tail shaft length by fitting of longer tuberedesign of tail shaft installationsupgrade of tail shaft and associated components.

2. Related Australian Design Rules

The Australian Design Rules (ADRs) relevant to this section include:

ADR no.	Title
58/..	Requirements for Omnibuses Designed for Hire and Reward

3. Record keeping

The person responsible for certifying the modification should:

- collate complete records, including drawings, calculations, test results and copies of the appropriate issue of Australian Standards and ADRs
- retain the records for a minimum of seven years after commissioning of the modified vehicle
- make the records available upon request for inspection by officers of the relevant federal, state or territory authority or heavy vehicle regulator.

Reports and checklists

The person responsible for certifying the modification must complete and record the following reports and checklists as applicable:

C1 Modification report	Tail shaft modification
C1 Checklist	Tail shaft modification

4. Design requirements

Advanced braking systems

Advanced braking systems are an important safety feature fitted to many new vehicles.

Advanced braking systems are programmed by the vehicle manufacturer and are specific to the vehicle to which they are fitted. Changes made to the vehicle, such as engine, tyre size, steering control, suspension characteristics, vehicle mass and its distribution, may impact the performance of the advanced braking system.

Exercise extra caution when modifying vehicles fitted with advanced braking systems. Electric braking systems may be known as:

- electronic stability control (ESC)
- electronic stability program (ESP)
- vehicle stability control (VSC)
- dynamic stability control (DSC)
- vehicle stability assist (VSA)
- roll stability control (RSC)
- roll control system (RCS)
- electronic braking system (EBS)
- trailer electronic braking system (TEBS).

⚠ Advanced braking systems and their components may be easily damaged by common modification, maintenance, and servicing techniques, such as the use of rattle guns within one metre of the sensors. When undertaking any work on a vehicle fitted with an advanced braking system, ensure all modifiers are familiar with these systems and the precautions that must be taken.

Modification Code C1 — Tail shaft alterations

1. Scope

Modifications covered under this code:

Covered

- reduction in tail shaft length
- increase in tail shaft length by fitting of longer tube
- redesign of tail shaft installations
- upgrade of tail shaft and associated components

Not covered

- increasing tail shaft length by extending the tail shaft tube i.e., by cutting, sleeving, and re-joining the tube
- installation of a tail shaft assembly that has torque and speed capacity less than the maximum torque and speed of the vehicle.

2. Related standards

Modified vehicles must comply with all ADRs, Australian Standards, acts and regulations. Below are some but not all of the areas that may be affected by the modifications in this code and require certification, testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related ADRs.

This...	Must comply with...
Cross-member construction	VSB6 Section H — Chassis
Mounting/aligning centre bearing	VSB6 Section C — Tail shafts
Selection of tail shaft materials	Good engineering practice
Alignment of universal joints	VSB6 Section C — Tail shafts
Tail shaft installation	Good engineering practice

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. <ul style="list-style-type: none"> • If yes, the modification will need to be done in accordance with manufacturer specifications. • If no, the modification will need to be done in accordance with this modification code.
2.	Modifier	Consult with appropriately qualified and accredited C1 authorised vehicle examiner (AVE) for guidance on how to perform the modification.
3.	Modifier	Consult with an AVE who is accredited to certify any other modification for guidance on how any modification is required to be performed. Follow the certification procedure in each applicable modification code. <p><i>For example, where the wheelbase has been extended outside the first manufacturer's option, refer to an accredited H1 AVE and VSB6 Modification Code H1.</i></p>
4.	Modifier	Perform modification in accordance with AVE advice and this code.
5.	Modifier	Organise approval inspection by appropriately qualified and accredited C1 AVE.

6.	C1 AVE	Perform inspection, ensure all modifications have been certified (if applicable), complete C1 checklist and determine if compliance has been achieved. <ul style="list-style-type: none"> • If yes, proceed to step 7. • If no, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
7.	C1 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

If possible, modify the vehicle to a standard specification offered by the vehicle manufacturer to enable the use of a standard driveline layout. If this is not possible, use either the manufacturer's recommendations for tail shaft alterations or this section of VSB6, giving manufacturer recommendations first consideration.

Modifying a heavy vehicle's tail shafts may have significant safety implications. The accidental failure of rotating shafts can cause considerable damage and even injury. Such failures may result from incorrect selection, design, or construction; therefore, any modification of inter-axle shafts or changes to the length and balancing of tail shafts must be made with great care to a high standard of work and only by competent persons and facilities. It should be carried out by specialist workshops able to ensure the tail shaft assembly aligns accurately and is dynamically balanced.

5. Design requirements

The major safety requirement when designing a tail shaft modification is to prevent in-service shaft resonance (shaft whirling). All rotating shafts contain some degree of imbalance or misalignment and therefore vibration, depending on the out-of-balance and the flexibility of the end supports. Reducing (increased angles) or increasing the wheelbase (increased shaft lengths) can affect the vibration characteristics of the tail shaft and result in unacceptable vibration and tooth loading.

The point at which a tail shaft resonates excessively is at critical speeds. When rotation speed approaches the shaft's critical speed, increasing lateral deflection or resonance and possible self-destruction occurs. To prevent this, the chosen shaft length and stiffness must have a sufficient margin between the maximum operating speed and the shaft's critical speed.

➤ Tail shaft manufacturers and distributors may have specialised programs to assist in the design of tail shaft alterations and layouts.

Tail shaft design

Required:

- To design the tail shaft layout, obtain the following details:
 - the position of the centre of the yoke or flange
 - for the transmission output
 - for the rear axle input with the axle (in both the chassis unladen and chassis fully laden conditions)
 - the position of the centre bearings (if applicable)
 - the angle of inclination to the horizontal of the transmission and rear axle
 - the maximum tail shaft speed
 - the maximum driveline torque.
- When selecting a tail shaft determine design variables such as:
 - lengths of shafts
 - size (diameter and wall thickness) of tubing
 - type of universal joints or flanges
 - position of centre bearings, if applicable
 - operational angles of the universal joints.
- Ensure that size of tail shaft components such as universal joints, flanges, centre bearings, tubing diameter and wall thickness, and tail shaft length, are within the manufacturer's specifications so that the maximum driveline torque is transmitted satisfactorily.
- Maximum torque may occur when an auxiliary/endurance brake, such as an engine or transmission retarder, is used so if the vehicle is fitted with one, take this torque into consideration.
- When tail shaft diameters are increased, check clearances from other chassis and body components through the whole range of suspension travel.
- Ensure the effect of any horizontal offsets of engine / transmission / centre bearing(s) / rear axle input is assessed.

Tail shaft support bearings

Required:

- Use support bearings when the distance from transmission to rear axles exceeds the maximum length at which a tail shaft can operate safely. As the wheelbase increases, more than one bearing may have to be used.
- Choose support bearing locations to minimise non-uniformity in angular velocity over complete driveline and in each tail shaft.
- If using adaptor brackets for support bearings, design these to provide adequate strength of attachment to cross-members and bearing housing, without affecting the strength of these parts. Do not pre-load flexible bushings in the support system due to axial misalignment.

Universal joints

Required:

- Install universal joints so they are appropriately phased throughout the driveline to prevent vibration. This is typically in phase, however in some complex driveline systems use out-of-phasing to eliminate vibration.
- Ensure that the driveline is laid out such that working angles of universal joints and lengths of shafts are within manufacturer specifications and enable the whole driveline to operate satisfactorily at maximum driveline speed without causing undue vibration or reducing the working life of any components.
- Before disassembly, removal, or installation of universal joints, mark the parts to ensure they are re-installed in phase.

- Ensure the sliding joint of the slip-shaft never bottoms out or fully extends under any operational conditions.
- Consider all suspension deflections and axle rotation under torque and the shaft length and the amount of slip selected with minimum spline:
 - engagement with joint extended = 1.5 x spline diameter
 - end clearance with joint contracted = 1.0 x spline diameter.

Tail shaft guard

Required:

- Fit tail shaft guards to vehicles required to comply with ADR 58/.. (category MD4 and ME vehicles) as well as vehicles required to comply with the *Australian Dangerous Goods Code*.
- Ensure any necessary tail shaft guards restrain the front end of each tail shaft.
- On vehicles originally fitted with tail shaft guards retain these and also install them on any additional shafts.

Tail shaft calculations

Include all additional components in the driveline, such as drop boxes, auxiliary transmissions, and auxiliary/endurance brakes, when performing driveline, driveshaft, and angle calculations.

With the exception of modifications being performed to manufacturer's specifications, perform and record calculations each time a tail shaft is altered.

Calculations that may be required are outlined below.

Calculation of critical speed of steel tubular tail shaft

All rotating shafts undergo deflection during rotation. The magnitude of deflection of a dynamically balanced shaft depends on rotational speed, distance between supports, magnitude of the secondary couple and the stiffness of the shaft, based primarily upon tube diameter and thickness.

The speed at which maximum deflection occurs is called the critical speed. Running at or near this speed will cause the tail shaft to vibrate excessively and fail, which can severely damage the driveline and surrounding components, so it is important that it operates sufficiently below this speed.

For any given shaft there are an infinite number of critical speeds, however for practical reasons modifiers should use the first order critical speed in all calculations.

Use this formula to calculate the critical speed for a steel tubular tail shaft:

⚠ Please be aware that this information is applicable to steel tubular tail shafts. For tail shafts manufactured from other materials please contact the tail shaft manufacturer

Metric measurements:

$$R.P.M. = \frac{1.21 \times 10^8}{L^2} \times \sqrt{D^2 + d^2}$$

L = length in mm (measured between centrelines of universal joints)

D = outside diameter of tube in mm

d = inside diameter of tube in mm

Imperial measurements:

$$R.P.M. = \frac{4705000}{L^2} \times \sqrt{D^2 + d^2}$$

L = length of driveshaft in inches (measured between centrelines of universal joints)

D = outside diameter of tube in inches

d = inside diameter of tube in inches

These calculations are generic and calculation factors may vary. Consult the vehicle or tail shaft component manufacturer before you make them.

Calculation for critical operating speed

The critical operating speed has a correction factor applied to it, allowing for factors such as bearing movement, length compensation and movement in slip assembly.

Factor for fixed length shaft	= 0.92
Factor for shaft with a slip joint between universal joints	= 0.80

Calculation of safe operating speed

The recommended safe operating speed for a tail shaft is typically at 75% of the adjusted critical speed, so that safe operating speed is as follows for a tail shaft with:

inboard slip joint	= critical speed x 0.80 x 0.75
fixed length, including centre bearing shafts and automotive shafts with sliding transmission yoke (outboard slip joint)	= critical speed x 0.92 x 0.75

It is often possible for fixed length shafts (e.g., single piece automotive shafts) to safely operate at a higher RPM.

Calculation of maximum operating speed using nomogram

Use the following nomogram (Figure 1) to help determine whether a driveshaft of a particular tube size will operate at a safe speed and to identify possible length and speed restrictions on a shaft. For high speed and high angle applications (above 4-5° joint angle), or for shafts operating close to safe speed or length limits, contact the tail shaft manufacturer's technical department for guidance.

The safe operating speeds shown are based on 85% of critical speed (calculated using the appropriate correction factor for the type of shaft, i.e., assuming zero universal joint angles) and lengths from centre line to centre line of the universal joints. When a centre bearing is used, the tail shaft length used to determine critical speed is the distance between the centre lines of the centre bearing and of the universal joint.

Process:

- Determine the length of the tail shaft to be used for a given application.
 - Measure length from centre to centre of the universal joints for a single shaft assembly, or through the centre bearing centreline for a multi-shaft assembly.
- Locate the length of the tube (mm or inches) in the left column, e.g., 1500mm.
- Locate the preferred tube size in the right column, e.g., 2.5" x .095".
- Draw a straight line between the two as shown. The point at which the drawn line crosses the centre column marks the safe operating speed, e.g., 2800rpm.

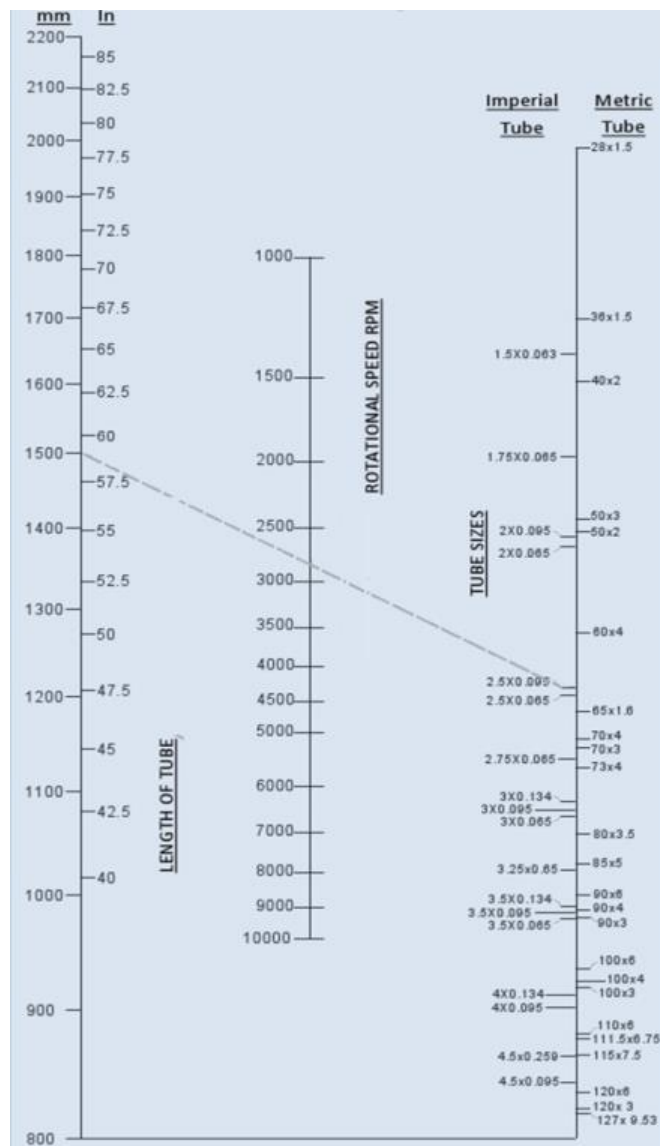


Figure 1: Safe operating speed nomogram (courtesy of Hardy Spicer Ltd)

Calculation of maximum operating speed

The maximum operating speed of the tail shaft is the highest shaft speed that the vehicle is likely to encounter in service. This could be higher than maximum engine speed in top gear (using transmission over-drives, if applicable) to account for downhill coasting.

Unless exceeded by the vehicle manufacturer's specifications, use the following maximum speeds for tail shaft design calculations:

Maximum speeds for:

• Buses 4.5–5t and trucks 4.5–12t	= 160km/h (100mph)
• Buses 5t < and trucks 12t <	= 135km/h (85mph)

OR

- 20% above governed road speed, whichever is less.

Tail shaft speed for the appropriate road speed

Calculate tail shaft speed for the appropriate road speed using the rolling circumference of the tyres and the vehicle's final drive ratio.

Tail shaft speed from engine speed considerations

Calculate the tail shaft speed from engine speed considerations by multiplying maximum engine speed by the highest gear ratio of the transmission, taking into account downhill running or coasting.

The maximum engine speed for engines that are:

diesel	120% of governed engine speed
petrol	120% of maximum recommended engine speed

Maximum safe length of a tail shaft

Normally, the size of tubing, universal joints and flanges or yokes for the modified tail shaft is the same as those in the original. If modifications result in an increase in transmitted torque (e.g., fitting of a larger engine or installation of an auxiliary/endurance brake such as a transmission retarder) then follow the tail shaft manufacturer's guidelines for the selection of components.

For example, find the maximum safe length of a tail shaft of tube size 3.5" (89mm) outside diameter and 0.065" (1.65mm) wall thickness, transmitting torque from an engine with a governed speed of 2400rpm and a transmission with a maximum gear ratio of 0.85:1 (over-drive) using this formula:

$$\text{Maximum tail shaft speed} = 2400 \times 120\% \times \frac{1}{0.85} = 3388\text{rpm}$$

From the nomogram, the maximum safe length would be 63" (1600mm). Even though it may indicate that tail shaft lengths up to 2m or 80" are acceptable, practical considerations in the construction of the tail shafts limit maximum length of shafts to 1.5m or 60". Lengths in excess of 1.5m or 60" may be acceptable, in special circumstances.

Operating angles of universal joints

If a manufacturer's standard driveline layout is not available, the operating angles of a proposed driveline layout need to be determined to ensure the tail shafts and associated components have a good working life.

The operating angle of the universal joint is calculated by subtracting the inclination angle of the transmission from the inclination angle of the tail shaft, or the inclination angle of one tail shaft from the inclination angle of the adjacent tail shaft, or the inclination angle of the tail shaft from the inclination angle of the drive axle.

In the case of a single tail shaft driveline, only adjust the operating angles at the universal joints by changing the inclination angle of the engine/transmission or drive axle.

In the case of a multi-piece driveline, only adjust the operating angles at the universal joints by changing inclination angles of the tail shafts by changing the height of the centre bearing.

Recommended operational angles

Operating angles for heavy vehicles should be a maximum of 6°. However, vibrational problems may arise even at this angle, so to minimise this possibility and to maximise the working life of the universal joints, avoid operational angles for:

heavy duty trucks	greater than 4°
light duty trucks	greater than 6°

Universal joints

Do not allow joints to operate at very low angles for extended periods to prevent brinelling of journals and cups by the needle rollers. To prevent the load between the needles and journals or cups being applied in the one region all the time, a minimum operating angle of 0.5° should be ensured so the needles are required to roll slightly.

Hence, operating angles for universal joints should fall between:

heavy duty trucks	0.5° and 4°
light duty trucks	0.5° and 6°

A longer service life of the universal joints of the rearmost tail shaft can generally be expected if the change in operating angles of the joints can be minimised. Achieve this by using a tail shaft as long as practicable as it will reduce the actual change in angle of the tail shaft for any given axle movement.

Positions of transmission output and drive axle input yokes

When the positions of the yoke or flange of the transmission output and the drive axle input, and the inclination angles of the transmission and drive axles are known, the operating angles of the universal joints may be calculated.

Define the positions of the transmission output yoke and drive axle input yoke by horizontal (longitudinal) and vertical coordinates from a convenient datum.

horizontal position	define as a distance from the front axle
vertical position	define as a distance from either the upper or lower side of the chassis rail, as opposed to the distance from the ground

Offset from the centre of the axle

Drive axles often have the input yoke transversely offset from the centre of the axle. This is not shown in examples below to simplify calculations, however, it should be considered in any modification.

Horizontal position of centre bearing

The horizontal position of the centre bearing depends on placement of components suitable for mounting of the bearing (cross-members, etc.) and associated attachment brackets, and the lengths of the shafts. To determine position of the yoke immediately to the rear of the centre bearing, find out the distance from the centre bearing to the centre of the front yoke.

Axle installation angles

Follow the drive axle manufacturer's recommendations for axle installation angles to ensure correct operating angles of the universal joints of the inter-axle tail shaft. Installation of the inter-axle tail shaft will not be of concern to the vehicle modifier.

Depending on the type of suspension used, the angle of inclination of the drive axle may change during excursion of the axle from the unladen position to the loaded position.

Consider any change in angle when calculating the operating angle of the universal joint at the input to the rear axle.

Place the working angle of the forward universal joint of the inter-axle tail shaft as near to that of the rear universal joint as possible.

Example:

Determine the working angles of the yokes in the two-shaft tail shaft arrangement shown in Figure 2. Ignore the working angles of the inter-axle tail shaft yokes.

In this example the operating angle at point B, 0.17°, is less than the recommended minimum of 0.5° but can be rectified by adjusting the height of the centre-bearing. However, when the height of the centre-bearing is changed, the operating angles at

points A, B and C will all change, and must be recalculated and checked.

Tail shaft installation angles	
Angle of tail shaft I =	$\tan^{-1} \frac{335-305}{3010-2080} = 1.85^\circ$ (to chassis rail)
Angle of tail shaft II in unladen condition =	$\tan^{-1} \frac{385-335}{4425-3010} = 2.02^\circ$ (to chassis rail)
Angle of tail shaft II in loaded condition =	$\tan^{-1} \frac{300-335}{4425-3010} = -1.42^\circ$ (to chassis rail)
Operating angles at universal joints	
Operating angle at A =	$2.50^\circ - 1.85^\circ = 0.65^\circ$
Operating angle at B in unladen condition =	$1.85^\circ - 2.02^\circ = -0.17^\circ$
Operating angle at B in loaded condition =	$1.85^\circ - (-1.42^\circ) = 3.27^\circ$
Operating angle at C in unladen condition =	$2.02^\circ - 3.00^\circ = -0.98^\circ$
Operating angle at C in loaded condition =	$-1.42^\circ - 3.00^\circ = -4.42^\circ$

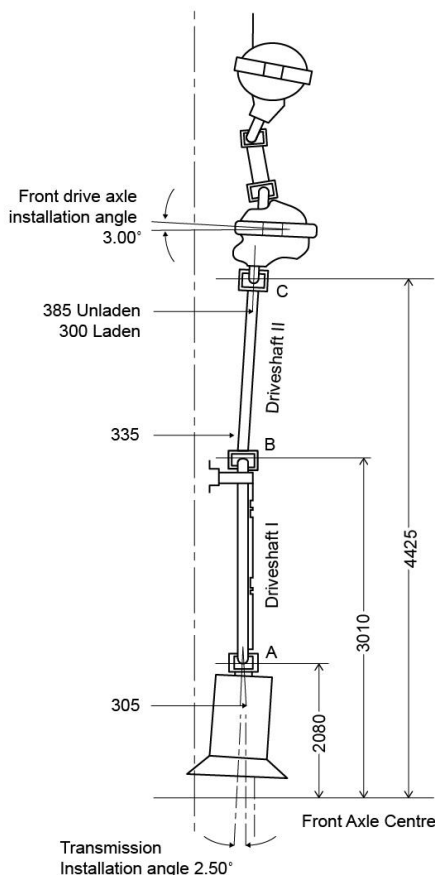


Figure 2: Driveline layout

Calculate angular relationship between joints

For satisfactory operation with a three joint, two tail-shaft system, maintain specific angular relations between the joints. There are two ways outlined below to evaluate whether a layout is suitable:

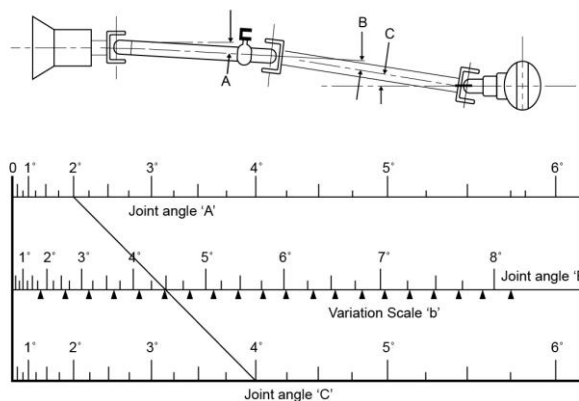
1. The nomogram process.
2. The calculation process.

1. Nomogram process

Only use this process if all joint angles are approximately in the same longitudinal plane.

1. Draw a straight line between joint angles A and C.
2. Check where the line intersects joint angle B and determine the value.

Provided B is within three graduations on the variation scale, then cancellation of the angular acceleration is within the accepted limits and should prove satisfactory.



e.g. If Joint A is 2° and Joint C is 4°, Joint B should be 4.5°. This can be 4.1° to 4.8° without any adverse effect on its operations.

Figure 3: Universal joint angles — three joint drivelines

2. Calculation process

This process provides a measure of tail shaft installation based on operational angles of the universal joints and relates to the accelerations of tail shaft components, which are inevitable when operational angles of the universal joints are greater than zero.

Non-uniformity of a tail shaft layout should be used as only a secondary check of tail shaft layout and should lie between 0 and 8.0×10^{-3} . The lower the value, the longer the expected service life of the universal joints.

For simplicity, consider only the angles to the horizontal plane.

Calculate non-uniformity for both unladen and loaded conditions using the formula:

- Measure of non-uniformity of angular velocity, $N = (\sin A \times \tan A) - (\sin B \times \tan B) + (\sin C \times \tan C) - (\sin D \times \tan D) + \dots$
Where A, B, C, D... are operational angles in degrees of universal joints starting from the transmission and ending at the rear axle input.

From the previous example:

Working angles of the tail shafts in the laden condition are:

transmission output: A =	0.65°
Second universal: B =	3.27°
Rear axle input: C =	4.42°

Therefore, non-uniformity:

$N =$	0.00283
$(\sin 0.65 \times \tan 0.65) - (\sin 3.27 \times \tan 3.27)$	
$+ (\sin 4.42 \times \tan 4.42) =$	

6. Testing requirements

The vehicle, or a prototype (if a number of similar vehicles are to be built), must be road tested on smooth and undulating surfaces under a range of mass conditions and over the whole speed range to establish that no unacceptable vibrations are present.

C1 Checklist – Tail shaft modification (example)

C1 Checklist — Tail shaft modification

This checklist is for use by the approved vehicle examiner (AVE) when certifying modification of tail shafts

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	Vehicle chassis no. (if applicable):	Vehicle modifier (company name):

Advanced braking systems

Braking systems	Check Yes, No, N/A as applicable:	Yes	No	N/A
1 Is the advanced braking system (where fitted) un-effected or re-certified after the vehicle modification?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Modification details

Modification criteria	Check Yes, No as applicable:	Yes	No
1 Has the modification been performed in accordance with the manufacturer's guidelines?		<input type="checkbox"/>	<input type="checkbox"/>

Installation details

Tail shaft installation	Check Yes, No, N/A as applicable:	Yes	No	N/A
1 Is the length of the tail shaft(s) within the allowable limit for the maximum tail shaft speed and maximum transmitted torque?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Are the tail shaft components (i.e. tubing, universal joints and flanges) adequate for the transmitted torque?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Are the universal joint operating angles within the recommended values under all operational conditions?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Are the tail shaft yokes phased as per the driveline manufacturer's recommendations or VSB6 (as applicable)?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Does the slip-joint have an appropriate extended engagement length for all operational conditions?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 If the tail shaft has been lengthened by fitting a longer tube, has a new full length seamless tube been used?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Compliance

Modification	Check Yes, No as applicable:	Yes	No
1 Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code C1?		<input type="checkbox"/>	<input type="checkbox"/>
2 Is the quality of the work to an accepted industry standard?		<input type="checkbox"/>	<input type="checkbox"/>
3 Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?		<input type="checkbox"/>	<input type="checkbox"/>

Authorisation

Other than modification criteria, if the answer to any relevant question is NO the modification is not acceptable.			
Comments:			
Examined by:	Company (if applicable):	AVE no.:	
Signed:	Modification certificate no.:	Modification plate no.:	Date:

Vehicle chassis no./VIN:	Date:	Signed:

C1 Modification report – Tail shaft modification (example)

C1 Modification report — Tail shaft modification

📌 This report is for use by approved vehicle examiners (AVEs) when assessing modifications of tail shafts.

Vehicle and modifier details

Vehicle make:		Vehicle model:	Month and year of manufacture:
VIN (if applicable):		Vehicle chassis no. (if applicable):	Vehicle modifier (company name):

Report no.:

Describe the drive line modification

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Diagram of drive line modification (when printed)

--

Enter details

Details		Before modification			After modification		
Diameter	Shafts item no. ¹	1	2	3	1	2	3
Wall thickness							
Length							
Maximum RPM ²							
Safe working speed — nomogram							
Maximum torque transmitted							
Universal joints	Shafts item no. ¹	1	2	3	1	2	3
Type							
Rated capacity							
Installed angle — unladen							
Installed angle — laden							
Support bearing	Shafts item no. ¹	1	2	3	1	2	3
Type							
Rated capacity							
Safety loop Y/N							
Slip joints static tests	Shafts item no. ¹	1	2	3	1	2	3
Clearance (contracted)							
Engagement (extended)							
Minimum shaft clearance to chassis etc.							
Slip joint dynamic test	Shafts item no. ¹	1	2	3	1	2	3
Road test (vibration)							

¹ If a system with more than three shafts is being modified, create an additional modification report page to include the additional information.

² At road speed: Buses 4.5–5t and trucks 4.5–12t 160kph, buses 5t < and trucks 12t < 135kph or 20% above governed speed.

Authorisation

Comments:			
Examined by:	Company (if applicable):		AVE no.:
Signed:	Modification certificate no.:	Modification plate no.:	Date:

Vehicle chassis no./VIN:	Date:	Signed:
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