

**TRUCK, LIGHTWEIGHT AND TRUCK, LIGHT – ALL TYPES
LAND ROVER 110 4X4 AND 6X6****CONFIGURATION, INSPECTION, MAINTENANCE AND REPAIR OF PROP SHAFTS****GENERAL INSTRUCTION**

This instruction is authorised for use by command of the Chief of Army. It provides direction, mandatory controls and procedures for the operation, maintenance and support of equipment. Personnel are to carry out any action required by this instruction in accordance with EMEI General A 001.

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GENERAL

Introduction

1. The Land Rover fleet of vehicles (FOV) have been in service for over 25 years. During this time, it has been identified that the repair of prop shaft assemblies has not always been conducted IAW Land Rover Australia's stringent design specifications.
2. The purpose of this instruction is to provide configuration, inspection, maintenance and repair level guidelines for Land Rover 110 FOV prop shaft assemblies.
3. This instruction provides guidance for the configuration inspection of prop shafts and details the criteria necessary to determine conformity to Land Rover Australia original design specifications.
4. The 1310 series driveline is used extensively throughout the world, there are many aftermarket manufacturers of componentry and universal joints. Most aftermarket products are not manufactured for extreme 4WD applications, and as such many products will not provide the durability to operate at large angles or high torque and shock loads.
5. Prop shaft manufactures or rebuilders can use the same part number reference for generic components but differing in quality and strength from the original design specification. This has led to the corruption of prop shaft build states across the Land Rover FOVs.

Associated Publications

6. Reference may be necessary to the latest issue of the following documents:
 - a. EMEI Vehicle G 103 – Truck, Utility, Lightweight, MC2 - Land Rover 110, 4X4 - Light Grade Repair;
 - b. EMEI Vehicle G 203 – Truck, Utility, Lightweight, MC2 - Land Rover 110, 6X6 - Light Grade Repair;
 - c. EMEI Vehicle G 109 – Servicing Instruction
 - d. EMEI Vehicle G 209 – Servicing Instruction;
 - e. Technical Regulation of ADF Materiel Manual - Land (TRAMM-L);
 - f. Electronic Supply Chain Manual (ESCM);
 - g. RPS 02185; and
 - h. RPS 02188.

Authorised Tradespersons

7. Actions detailed in this instruction are to be performed by technical maintenance organisations authorised to carry out Light, Medium or Heavy Grade Repairs. The trades approved are ECN 229 – Vehicle Mechanic or Tri-service/civilian equivalents.

PROP SHAFT FAILURES

Remanufactured Prop Shafts.

8. Prop shaft failure RODUMs and subsequent investigations into remanufactured prop shafts have identified the following:
 - a. incorrect lengths (too long or too short);
 - b. the use of cast iron flanges and slip yokes (as opposed to the forged steel specification);
 - c. incorrect male splines (non Glidecoat / Teflon);
 - d. incorrect tube diameters;
 - e. poor quality balancing procedures;
 - f. inferior quality universal joints;
 - g. low weld quality; and
 - h. non conforming ASTM B117 paint.

Modes of Failure

9. Main failure modes reported by RODUM consist of the following (Figures 1, 2 and 3):
- universal Joints fracturing,
 - sliding female spline yoke ears fracturing,
 - prop shaft separation from the sliding yoke, and
 - flanges fracturing.

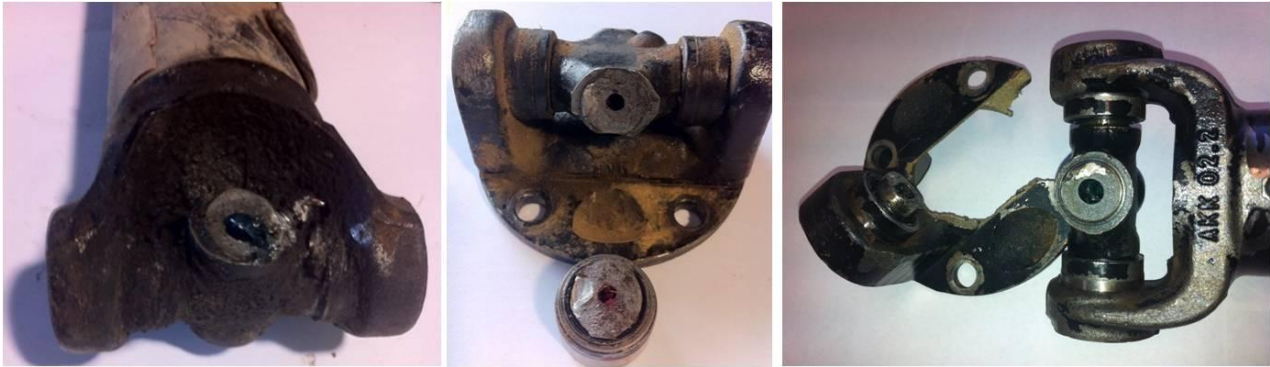


Figure 1 Fractured Universal Joint Examples



Figure 2 Fractured Slip Yoke Examples



Figure 3 Fractured Flange Examples

ORIGINAL CONFIGURATION

Spicer 1310 Series

10. **Characteristics.** The 1310 Series Land Rover prop shaft assembly is a heavy duty configuration specified for defence for the rigorous demands associated with off-highway use.
11. **Functional Torque Limit.** The torque to which the prop shaft can be loaded without yielding or creating plastic deformation of any of the parts that adversely affect the prop shaft kinematics of durability.

Flanges

12. Land Rover specifications for the flanges ensure that strength and life hour are maintained within the complete prop shaft assembly. Design features include the following:
- The flange face has 360° of material on the mounting face with a diameter of approximately 97mm.

- b.** The flange is made of a forged steel and not cast iron. (cast iron flanges were prone to failure with early testing).
- c.** The flange thickness is $7 \text{ mm} \pm 0.5 \text{ mm}$. (this measurement is critical for strength and to ensure there is full thread contact with the 4 x locating nuts).
- d.** The flange is scalloped to provide for 20° of angle movement (Figure 4).

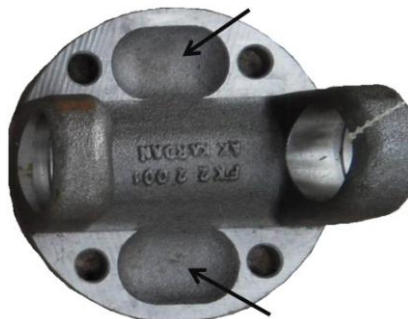
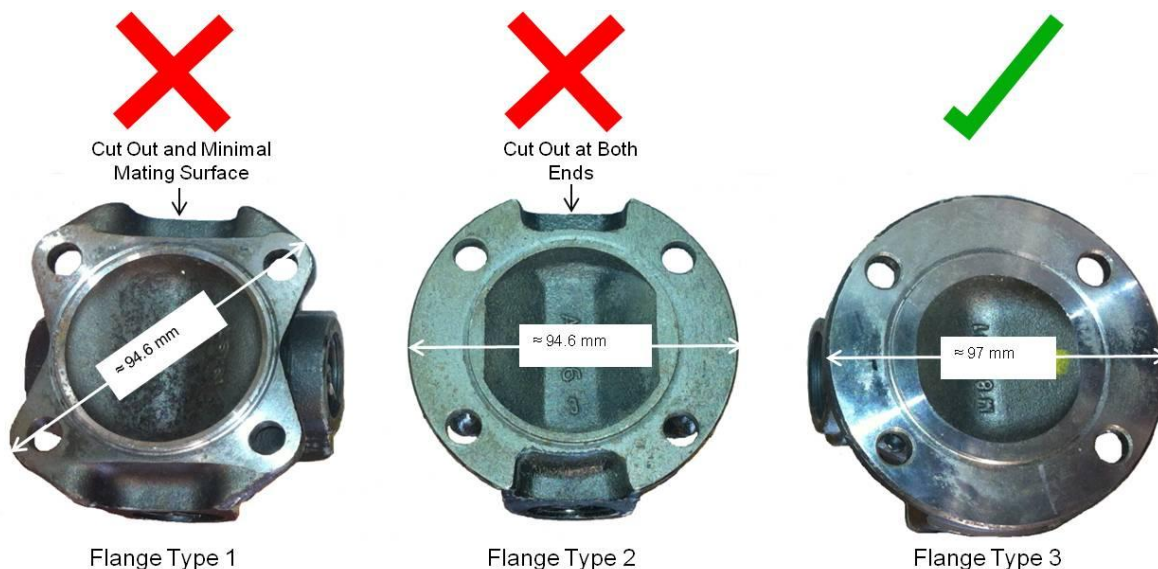


Figure 4 Scalloped Flange

13. Flange Comparisons. Figures 5 and 6 detail comparisons between conforming and non-conforming flanges.



Figure 5 Cast Flange (Non-Conforming) and Forged Steel Flange (Conforming)



Serial	Flange Type	Material	Thickness	Diameter	360° Full Mating Surface	Conforms to Design Specification
1	Type 1	Cast Iron	4.4 – 7.4 mm	≈ 94.6 mm	No	NO
2	Type 2	Cast Iron	5.9 mm	≈ 94.6 mm	No	NO
3	Type 3	Forged Steel	$7 \text{ mm} \pm 0.5$	≈ 97 mm	Yes	YES

Figure 6 Prop Shaft Flange Comparisons

Slip Yoke

14. The LRA specification for the sliding female spline ensures that strength and life hour is maintained within the complete prop shaft assembly. Design features include the following:

- a. The sliding female spline is made of forged steel or heavy duty cast iron. This maximises strength while still providing for the 20° working angle.
- b. The spline plug is coated with either Glidecoat™ or Teflon™ for durability and smooth movement (Figure 7).

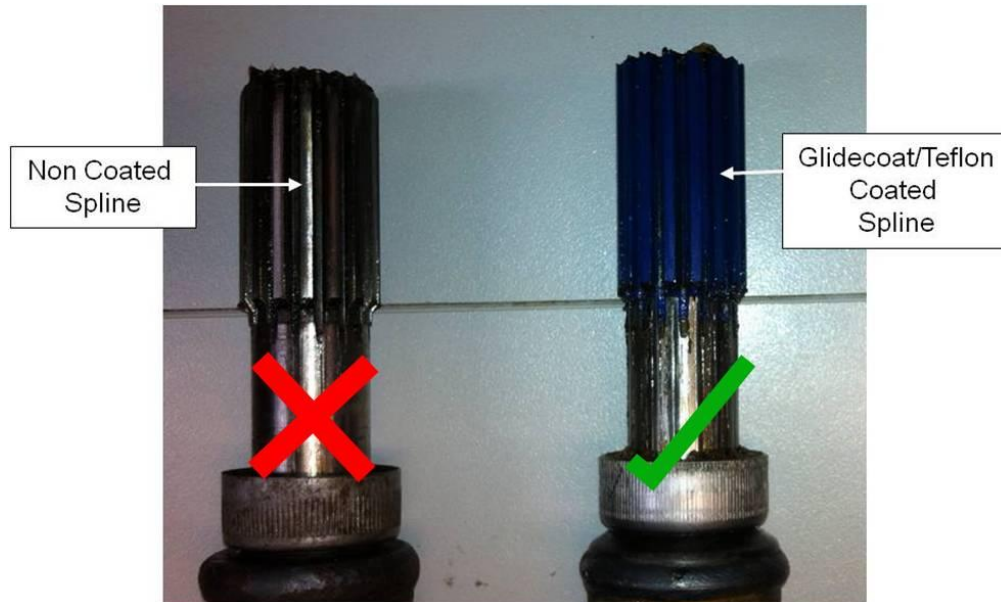


Figure 7 Spline Plug Comparison

Universal Joints

15. There are many inferior universal joints available in the 1310 series. Most universal joint manufacturers are now based in China and the quality varies greatly. Small bearing journals, poor seal quality and steel hardness are common with many of these brands currently in the Australian market.

- a. All genuine LRA prop shaft assemblies are specified with a DLS or EO heavy duty universal joints (Figure 8). Genuine LRA replacement universal joints (GKN) and packaging are shown at Figure 9. Features of both types of universal joints include:
 - (1) Thrust pad between the cross and bearing cap (the thrust pad ensures against cross float and maintains bearing load).
 - (2) A large bearing journal and a triple lip seal to minimise lubrication contamination.

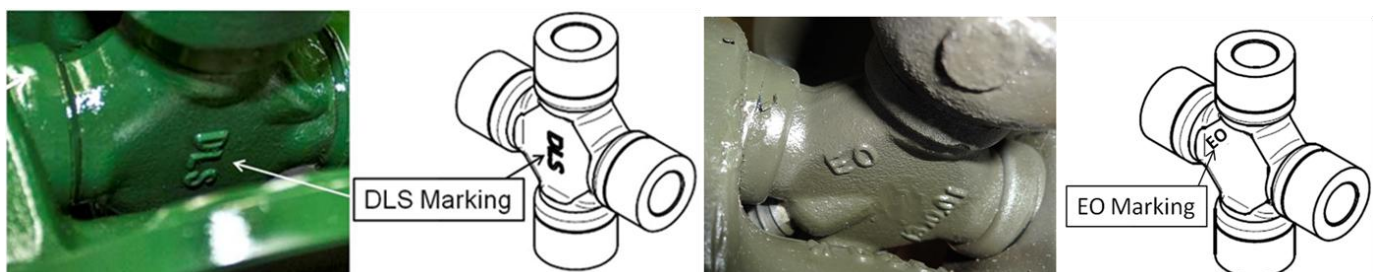


Figure 8 DLS and EO Universal Joints



Figure 9 LRA (GKN) Universal Joint and Packaging - NIIN 99-731-0894 / LRA PNo. RTC3346

Incorrect Prop Shaft Length

16. Possible Damaged Caused by the Prop Shaft being too Long.

- a. Depending on the over length, there is potential for considerable damage to the drivetrain.

NOTE

Universal joints cannot withstand axial thrust loads and breakage may occur.

- b. If the prop shaft cannot compress during suspension travel, the shaft will act as a solid unit and will essentially place excessive axial thrust on the universal joints.
- c. Thrust load on gearbox and diff components can occur causing bearing or premature drivetrain failure.

17. Possible Damage Caused by the Prop Shaft being too Short.

- a. Depending on the shaft length, there is the potential for the shaft to dislodge (separate) from the vehicle during suspension travel. This is a safety issue and has the potential to result in a vehicle accident.
- b. A shaft shorter than the nominated length will not operate with the spline in the desired or working position and premature wear of the driveline components is likely to occur, causing vibration and drivetrain damage.

INSPECTION DIMENSIONS

18. Correct prop shaft length is paramount for drive line functionality and personnel safety. The following figures detail inspection tolerance lengths.

4x4 and 6x6 Front Shaft

19. Figure 10 details 4x4 and 6x6 front prop shaft length measurements.

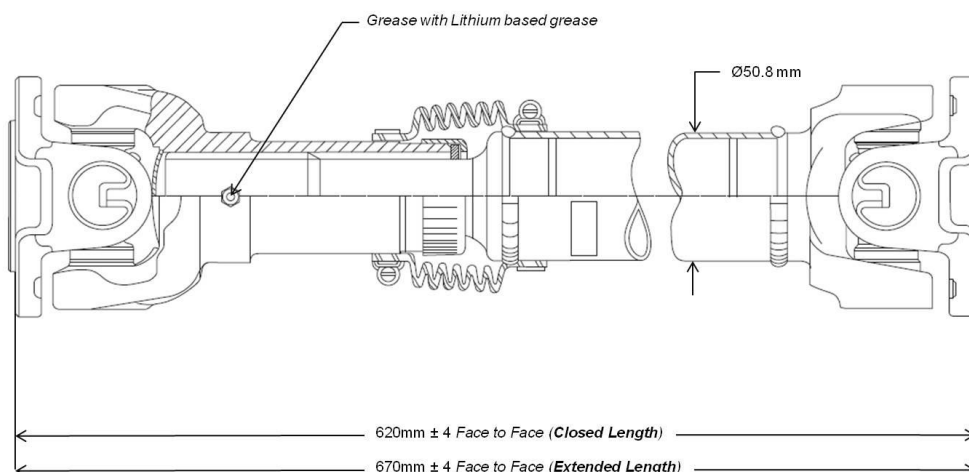


Figure 10 Front Prop Shaft – NIIN 66-128-4256 / LRA PNo: AYG4281

6x6 Shaft with Centre Bearing

NOTE

Critical measurement is from the transmission flange to centre of centre bearing
(1408.5mm \pm 0.5).

20. Figure 11 details the 6x6 centre bearing prop shaft length measurements.

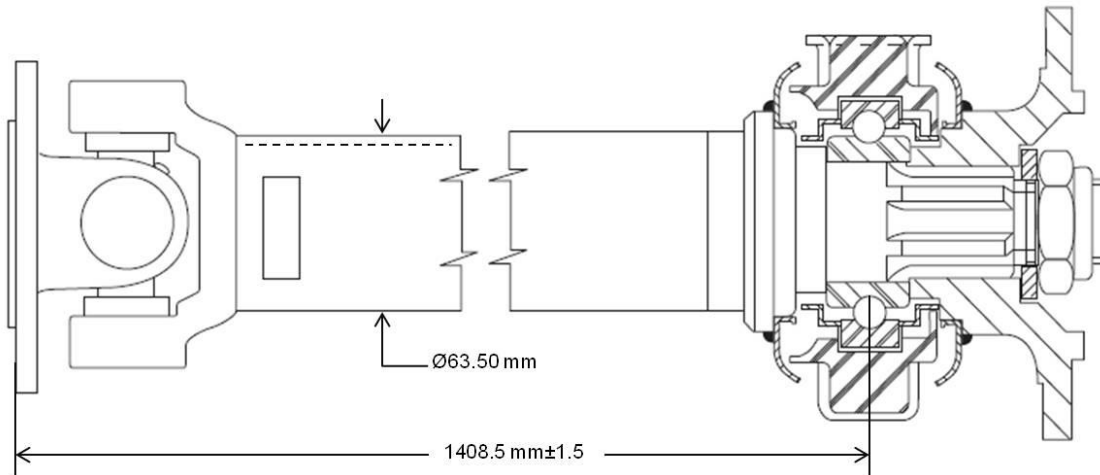


Figure 11 6x6 Shaft W-Centre Bearing – NIIN 66-128-5663 / LRA PNo: AYG7333

4x4 Rear Shaft

21. Figure 12 details the 4x4 rear prop shaft length measurements.

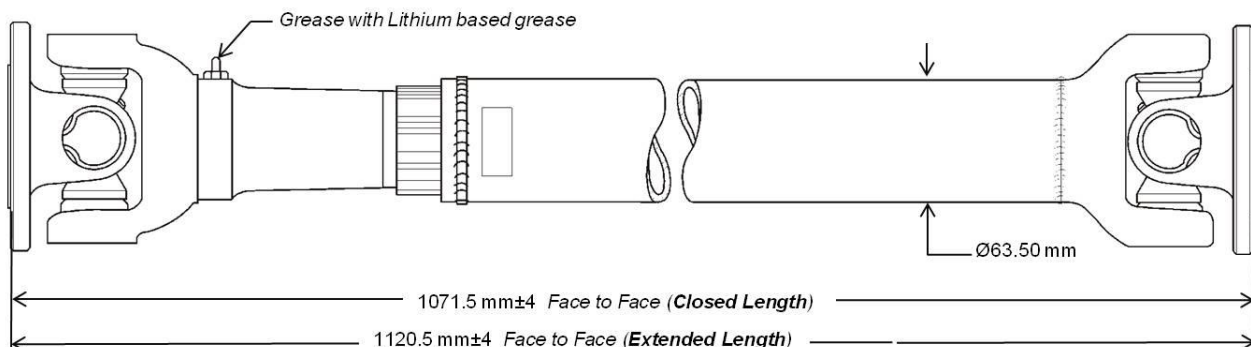


Figure 12 4x4 Rear Prop Shaft – NIIN 66-128-4249 / LRA PNo: AYG7332

6x6 Gearbox to Intermediate Axle Shaft

22. Figure 13 details the 6x6 gearbox to intermediate axle prop shaft length measurements.

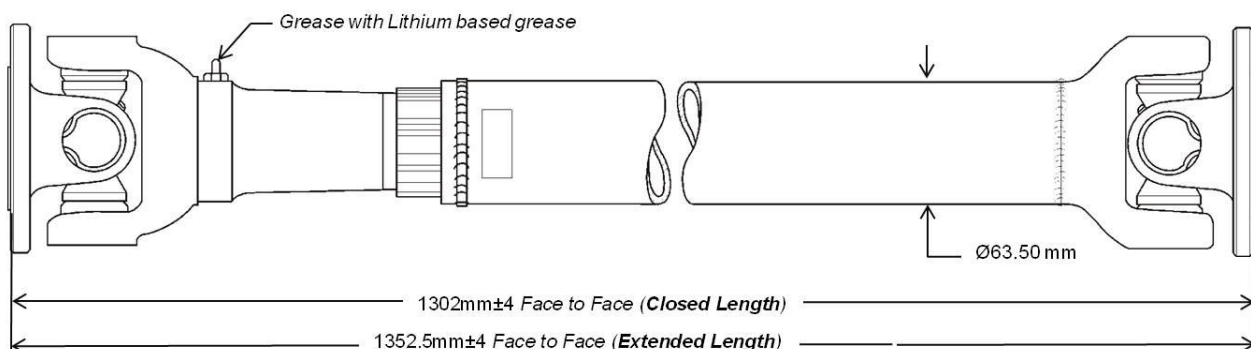


Figure 13 6x6 Gearbox to Intermediate Axle Prop Shaft – NIIN 66-128-5662 / LRA PNo: AYG7331

6x6 Centre Bearing to Rear Axle Shaft

23. Figure 14 details the 6x6 centre bearing to rear axle prop shaft length measurements.

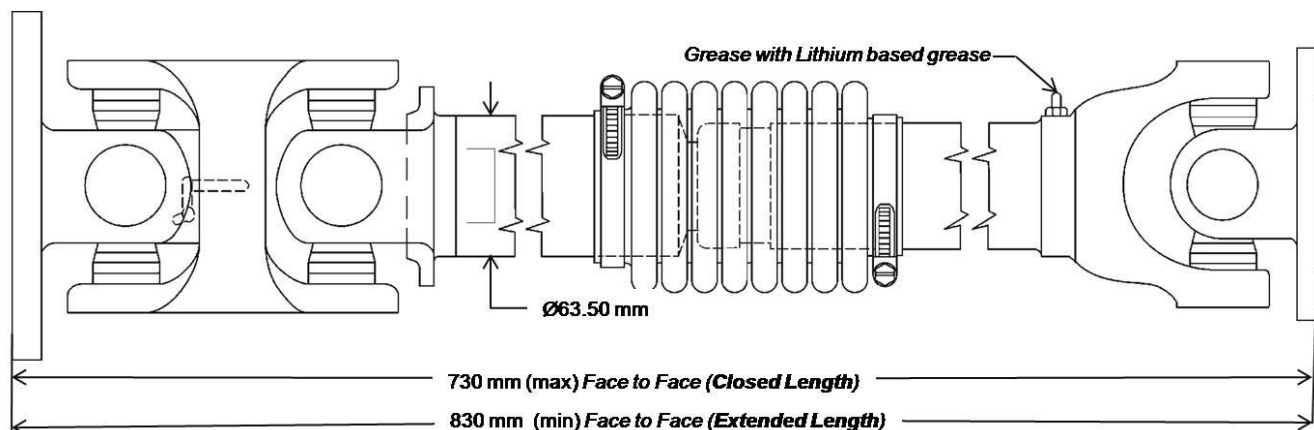


Figure 14 6x6 Centre Bearing to Rear Axle Prop Shaft – NIIN 66-128-5667 / LRA PNo: AYG7202

OFF VEHICLE PROPSHAFT CONFIGURATION INSPECTION

NOTE

The sequence of inspection is designed to identify non-conforming prop shafts in an efficient process IOT minimise excessive labour costs. It does not detail routine inspection criteria.

24. For prop shafts **not fitted** to vehicles (i.e. RP and SV stock), the sequence (Stages) for inspection are as follows:

NOTE

Prior to prop shaft configuration inspections, ensure that the slip yoke is serviceable IAW the vehicle variant Light Grade Repair EMEI.

NOTE

There is no requirement to disassemble the slip yoke to inspect for a Glidecoat™ or Teflon™ coated spline as detailed at Para 14.

- a. **Stage 1.** Inspect prop shaft for correct flange configuration as detailed at Paras 12 and 0.
 - (1) **Correct Flanges Fitted.** Go to Stage 2.
 - (2) **Incorrect Flanges Fitted:**
 - (a) Inspect prop shaft length as detailed at Paras 19 through to 23.
 - i. **Correct Length** (Within Tolerances). Go to Stage 3.
 - ii. **Incorrect Length** (Outside Tolerances). Dispose of IAW current disposal instructions.
- b. **Stage 2.** Inspect prop shaft length as detailed at Paras 19 through to 23.
 - (1) **Correct Length** (within Tolerances). Go to stage 3.
 - (2) **Incorrect Length** (Outside Tolerances). Dispose of IAW current disposal instructions.

CAUTION

Prop shafts that pass Stage 2 and are classified as RP are only authorised to have repairs done IAW EMEI Vehicle G 103 and EMEI Vehicle G 203. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in damage or destruction to the equipment.

NOTE

As part of Stage 3 where incorrect flanges require replacement, ensure that the universal joints, as detailed at Table 1, Serial 6, are replaced as well.

- c. **Stage 3.** Inspect the correctly configured prop shaft for serviceability. Repair and/or classify accordingly.

ON VEHICLE PROPSHAFT CONFIGURATION INSPECTION

NOTE

The sequence of inspection is designed to identify non-conforming prop shafts in an efficient process IOT minimise excessive labour costs. It does not detail routine inspection criteria.

25. For prop shafts **fitted** to vehicles, the sequence (Stages) for inspection are as follows:

NOTE

The removal of the prop shaft assembly is not required during the initial flange configuration inspection stage. Subsequent stage requires the removal of the prop shaft assembly from the vehicle IOT replace flange/s and universal joint/s.

- a. **Stage 1.** Inspect prop shaft for correct flange configuration, as detailed at Paras 12 and 13.

- (1) **Correct Flanges Fitted** (Figure 15). Vehicle prop shaft assembly configuration is serviceable.

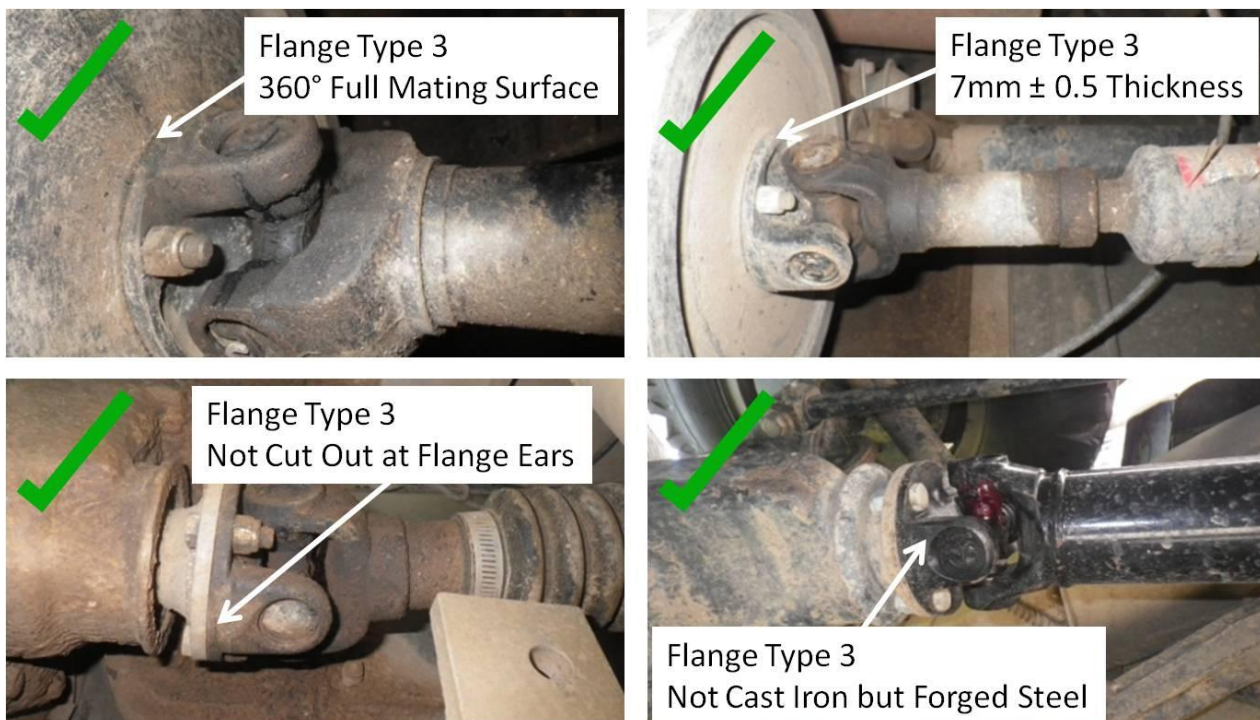


Figure 15 Correct Flanges Fitted (For flange identification details, refer to Figure 5)

- (2) **Incorrect Flanges Fitted** (Figure 16): Go to stage 2.

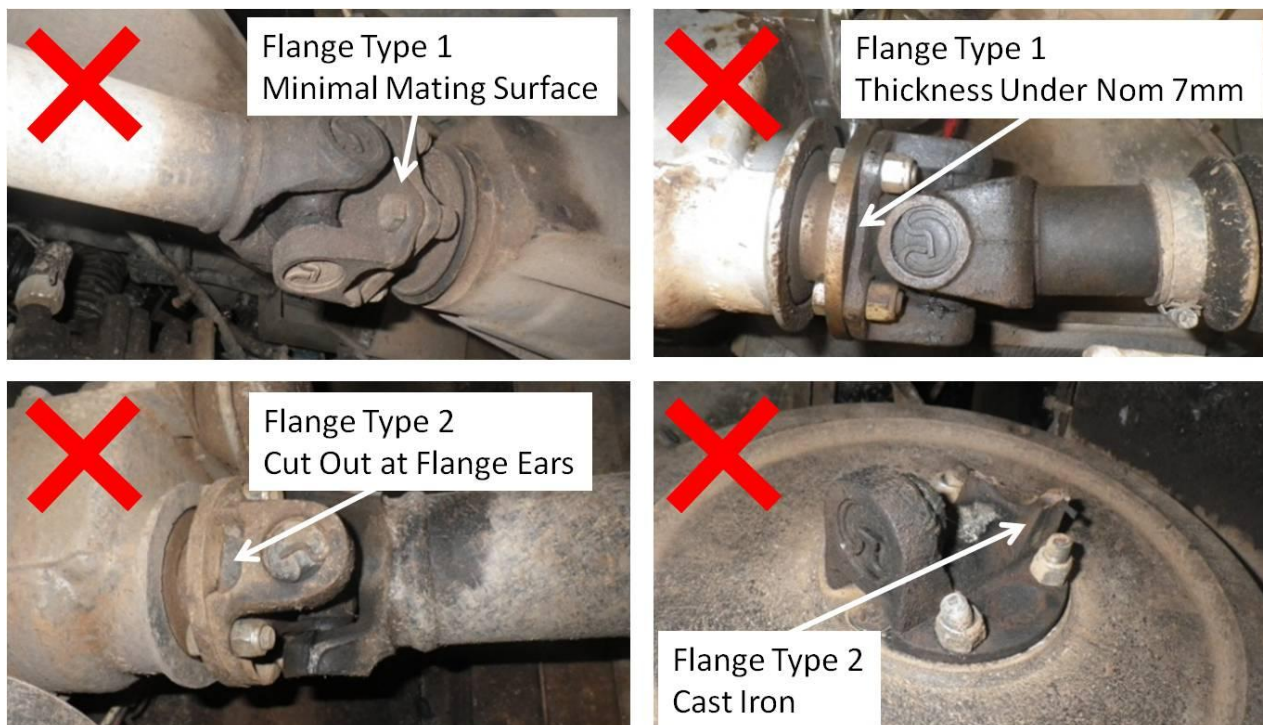


Figure 16 Incorrect Flanges Fitted (for flange identification details, refer to Figures 4, 5 and 6)

- b. Stage 2.** Remove non conforming prop shaft assembly from the vehicle.

NOTE

Prior to the replacement of any flange and universal joints, ensure that the slip yoke is serviceable IAW the vehicle variant Light Grade Repair EMEI.

- (1)** Inspect prop shaft length as detailed at Paras 19 through to 23.
- (a)** *Correct Length* (within Tolerances).
- i.** Replace incorrect flange/s and universal joint/s IAW vehicle variant Light Grade Repair EMEI.
 - ii.** Refit conforming prop shaft assembly to vehicle.
- (b)** *Incorrect Length* (Outside Tolerances). Dispose of IAW current disposal instructions.

FAILURE ANALYSIS GUIDE

26. Prop shaft component failures can result from improper maintenance, installation or assembly procedures. The following reference guide assists tradespersons in recognising component failures and identifying probable causes.

WARNING

Excessive looseness across the ends of the universal joint bearing cup assemblies can cause imbalance or vibration in the driveline assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. Serious personal injury and damage to components can result.

End Galling

- 27.** Probable causes for end galling include (Figure 17):
- a.** excessive universal joint operating angles;

- b. improper assembly procedures;
- c. sprung or bent yoke; and
- d. lack of lubrication (improper maintenance).



Figure 17 End Galling

Burned Universal Joint Cross

28. Probable causes for a burned universal joint cross include (Figure 18):
- a. lack of lubrication (improper maintenance);
 - b. wrong lubrication type; and
 - c. improper application.



Figure 18 Burned Universal Joint Cross

Spalling

29. Probable causes for spalling include (Figure 19):
- a. water contamination,
 - b. wrong lubrication type, and
 - c. lubrication failure.



Figure 19 Spalling

Fractured Universal Joint

- 30.** Probable causes for a fractured universal joint include (Figure 20):
- a.** excessive torque loads,
 - b.** shock loads, and
 - c.** improper application.



Figure 20 Fractured U-Joint

Brinelling

- 31.** Probable causes for brinelling include (Figure 21):
- a.** continuous excessive torque loads,
 - b.** seized slip yoke splines, and
 - c.** excessive driveline angles.



Figure 21 Brinelling

Fractured Spline

- 32.** Probable causes for a fractured spline are (Figure 22):
- a.** excessive torque loads,
 - b.** shock loads, and
 - c.** improper application.



Figure 22 Fractured Spline

AUTHORISED REPAIR PROCEDURE

4 x 4 Variants

WARNING

Repair prop shafts IAW EMEI Vehicle G 103. Do not conduct repair procedures outside those detailed within EMEI Vehicle G 103. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in personal injury or death.

CAUTION

Repair prop shafts IAW EMEI Vehicle G 103. Do not conduct repair procedures outside those detailed within EMEI Vehicle G 103. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in damage or destruction to the equipment.

33. EMEI Vehicle G 103 details the following authorised maintenance procedures for the LR 4 x 4 variant prop shaft assemblies:

- a. removal,
- b. installation,
- c. replacement,
- d. inspection, and
- e. specifications.

6 x 6 Variants

WARNING

Repair prop shafts IAW EMEI Vehicle G 203. Do not conduct repair procedures outside those detailed within EMEI Vehicle G 203. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in personal injury or death.

CAUTION

Repair prop shafts IAW EMEI Vehicle G 203. Do not conduct repair procedures outside those detailed within EMEI Vehicle G 203. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in damage or destruction to the equipment.

34. EMEI Vehicle G 203 details the following authorised maintenance procedures for the LR 6 x 6 variant prop shaft assemblies:

- a. removal,
- b. installation,
- c. replacement,
- d. inspection, and
- e. specifications.

Spare Parts**WARNING**

The use of non-genuine LRA replacement parts can compromise the design integrity of the prop shaft assembly. Use only genuine LRA parts. Failure to do so could result in personal injury or death.

CAUTION

The use of non-genuine LRA replacement parts can compromise the design integrity of the prop shaft assembly. Use only genuine LRA parts. Failure to do so could result in damage or destruction to the equipment.

35. As detailed in this instruction, investigations into prop shaft failures highlighted that reported failures occurred at the non-conforming part proximity. All maintenance staff are to ensure that only genuine LRA approved replacement parts are used when repairing a Land Rover prop shaft assembly. Table 1 details authorised parts to be used.

Table 1 Authorised Replacement Parts

Serial	Part Description	NIIN	LRA Part Number	Remarks
1	4 x 4 & 6 x 6 Prop shaft – Front	66-128-4256	AYG4281	
2	4 x 4 Prop shaft – Rear	66-128-4249	AYG7332	
3	6 x 6 Gearbox to Intermediate Axle	66-128-5662	AYG7331	
4	6 x 6 Shaft W/Centre Bearing	66-128-5663	AYG7333	
5	6 x 6 Centre Bearing to Rear Axle	66-128-5667	AYG7202	
6	Universal Joint Kit	99-731-0894	RTC3346	Do not use NIIN's 99-806-9754, 66-128-5988 or civilian P/No's Dana Spicer 5/153X, Hardy Spicer K5-13XR.
7	Flange Prop shaft	66-139-0111	HYL8667	Do not use civilian P/No 2-2-329
8	6 x 6 Centre Bearing	66-128-5664	AYG7166	Do not use civilian P/No 210088-1X
9	Boot Assembly, Joint	66-128-4496	AYG4202	
10	Rubber Gaiter	99-796-5401	AEU1584	
11	Universal Joint (single hooks joint)	99-796-5403	AEU1997	

IP RESTRICTIONS**WARNING**

Repair of Land Rover prop shaft assemblies outside the parameters contained within this instruction is not authorised. Failure to comply could result in compromising the design integrity of the prop shaft assembly resulting in personal injury or death.

36. The information contained within this instruction is only authorised to be used for the purpose of identifying and inspecting the configuration of in-service Land Rover prop shaft assemblies and parts thereof. It is not to be used for the purpose of, or as an authority for, the rebuilding of prop shafts by non LRA authorised suppliers including but not limited to the following types of repairs:

- a. replacing spline plugs,
- b. replacing slip yokes,
- c. replacing tube yokes,

- d.** tube replacement, and
- e.** balancing.

END

Distribution List: **VEH G 16.0 – Code 1** (Maint Level)
(Sponsor: CGSVSPO Light B Vehicle Section)
(Authority: EC-005798)