Installation and Alignment Procedure

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Cummins Power Generation

QSK78 Generator Set

for Eickhoff ANO 110 Gearbox

English – Original Instructions 10-2009 0908-0106 (Issue 2)

FOREWORD

This document details the work procedure for the coupling and alignment of a QSK78 generating set with a Frame 8 HV Alternator via the single stage helical gearbox using dial gauge indicators. This instruction should be read in accordance with the operating manual provide by the gearbox manufacturer. The tasks in this manual are to be undertaken by suitably trained and qualified service personnel **only**.

This manual should form part of the publication package supplied by Cummins Power Generation Limited with specific generator sets. In the event that this manual has been supplied in isolation please refer to other Cummins Power Generation Limited literature, in particular the Health and Safety Manual (0908-0110-00), Product Operation and Maintenance, and Engine Operation Manuals regarding all aspects of the equipment.

The purpose of this manual is to provide the users with sound, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins Power Generation Limited cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation Limited policy of continuous development and improvement, information may change at any time without notice. The users should therefore ensure that before commencing any work, they have the latest information available.

Users are respectfully advised that it is their responsibility to employ competent persons to carry out any installation work in the interests of good practice and safety.

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SECTION 1 – SAFETY

1 Safety

The tasks in this manual are to be undertaken by suitably trained and qualified service personnel **only**.

Before commencing work, the following instructions should be read:

1. Ensure all personnel not working on the coupling installation and alignment are kept safely away from immediate area.
2. Read and understand all procedure instructions before coupling installation and alignment.
3. Components should be supported during handling and wrapped for protection.

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SECTION 2 - PREPARATION

2 Preparation

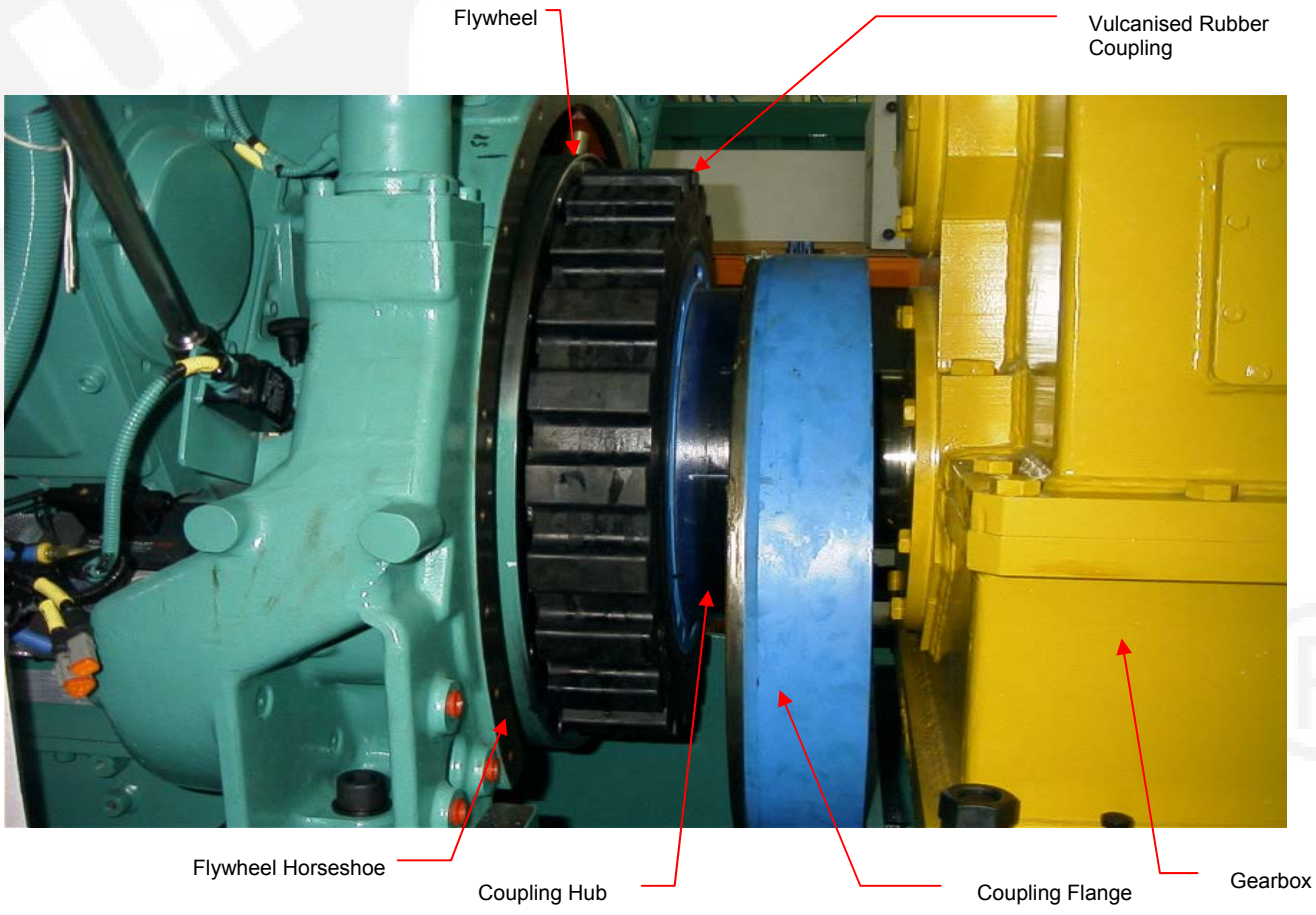
Note: *This task is to be undertaken by suitably trained and qualified service personnel **only**.*

2.1 Preparation of Flexible Coupling

Before the installation begins the flexible coupling can be prepared for installation:

1. The flexible coupling is inspected disassembled.
2. The coupling hub is lifted into the oven and heated to 250°C/482°F for three hours to give sufficient clearance when it is installed on the gearbox shaft.
3. Fit coupling hub on gearbox shaft and allow to cool.
4. Bolt up hub to the rubber disc with vulcanised metal sleeve. Torque settings for hub bolts on the AC 11 F2 coupling are for M24 bolts (grade 8.8) 710 Nm.
5. The flange which connects the rubber disk to the flywheel joins by means of an internally toothed aluminium ring. The torque settings for the bolts securing the SAE 21 flange to the flywheel are M16 (grade 12.9) 210 Nm.

Note: *To carry out the gearbox to engine alignment checks the flange should be dismounted off the rubber disk, therefore **do not** bolt up the flange to the flywheel disk at present – leave it hanging from the coupling hub/gearbox shaft.*



2.2 Preparation of bedframe

To ensure that the engine/gearbox/alternator are accurately aligned the anti vibration spring mounts must be installed and set-up before commencing the alignment procedure, as detailed below:

1. Lift engine onto bedframe using appropriate lifting equipment.
2. Line engine square to the bedframe and fit bolts.
3. Tighten bolts to correct torque setting. M24 bolts (grade 8.8) are set to 670Nm.

2.3 Preparation of gearbox coupling

The gearbox coupling is supplied completely assembled with protecting grease on the gear mesh which should be removed before assembly.

2.3.1 Disassembly

For the disassembly procedure there are two sections to refer to, depending on reader's preference. Refer to either Section 5.6 (gearbox shear pin coupling component) or Section 5.7 (gearbox shear pin coupling disassembly and re-assembly instructions). A summary of the disassembling process for the coupling is as follows:

1. Loosen the nuts (19) and remove bolts (18).
2. Remove screws (21) and sleeve (3).
3. Remove the retainer ring (27) and the wire that connects all the shear pins (8) so that the shear pins can be removed.
4. Remove retainer ring (24).
5. Remove the cover (28) by pulling the screw installed in the central hole in the cover (28). The thread size is M10.
6. Remove the retainer ring (23).
7. Using pulling equipment remove the assembly, which houses the inner bearings (4, 9, 11, 12, 13, 20, 22, 31) – see Section 5.8.
8. The shaft (6) is joined to the rigid hub (5) by means of screws (25). Remove the screws (25) in order to have the rigid hub (5) free for installation on the alternator shaft.

2.4 Fitment of Alternator Hub

1. Check that the coupling hubs and shafts are free from nicks and burrs. Check that the bore and shaft are clean and are the correct dimensions.
2. Install the rigid hub (5) on the alternator shaft. For an interference fit ISO H7/m6 (0.005inch/inch) the hub requires to be heated to at least 110°C/230°F. The hub should be heated for 1½ to 2 hours to provide sufficient clearance for fitting, but this is only an approximate guideline. Install the hub (5) and check that the shaft is flush with counterbore of the hub.
3. Install stub shaft (6) to the hub (5) and torque the screws/washers (25, 26) to 79 Nm using a torque wrench.
4. Install the assembly (4, 9, 11, 12, 13, 20, 22, 31) and sleeve (3) onto the shaft (6). Install the inner retainer ring (23) in the groove of the shaft (6). Install the assembly cover (28) by pressing it into the hub (4).
5. Install the outer retainer ring (24) in the internal groove of the hub (4).
6. Insert the shear pins (8), which join the hubs (4 and 5) together. Join the shear pins using the place wire supplied. Install the retainer rings (27) to lock the shear pins in place.
7. Place the cover (7) on the gearbox shaft prior to the installation of the gearbox hub (1).

2.4.1 Fitment of Gearbox Hub

1. Heat the gearbox hub (1). For an interference fit ISO H7/m6 (0.005inch/inch) the hub requires to be heated to at least 110°C/230°F. The hub should be heated for 1½ to 2 hours to provide sufficient clearance for fitting, but this is only an approximate guideline. Install the hub (1) with the longest chamfer hub end towards the gearbox bearing. The hub face must be flush with the end of the shaft. Fit the O-Ring (17) on the hub only after it has cooled down to avoid damage to the O-Ring and seal (17, 15).

Note: *Note do not use an open flame burner to heat hub.*

2. Allow the hub to cool before installing the sleeve cover.
3. With the longest chamfer hub end towards the gearbox bearing. Hub face has to be flush with shaft end. Place ring (17) on the hub only after it cooled down in order to avoid damage of the seal (15).
4. Allow the hub (1) to cool before installing the sleeve (2).
5. Install the sleeve (3) on hub (4) and cover (29).
6. Install and align machines in place.

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SECTION 3 – ALIGNMENT PROCEDURE

3 Alignment Procedure

Note: *This task is to be undertaken by suitably trained and qualified service personnel **only**.*

Radial, angular and axial alignment of the gearbox and alternator in the horizontal axis can be adjusted by turning the horizontal jacking screws, which are fitted at each corner of the gearbox and alternator feet. Radial and angular alignment in the vertical axis can be adjusted by adjusting the vertical jacking screws and shimming under the gearbox and/or alternator.

3.1 Gearbox to Engine Coupling

3.1.1 Radial Alignment (Vertical/Horizontal)

1. Refer to Sections 5.1 to 5.3 for alignment information, clock gauge set up illustrations and an illustrated demonstration of how to carryout and calculate the coupling alignment.
2. Lift gearbox onto bedframe using appropriate lifting equipment.
3. Set-up the clock gauge as in Section 5.2 with the gauge attached to the coupling hub (fitted on the gearbox shaft) and the probe in contact with the outer diameter of the flywheel at TDC (top dead centre). There should be enough clearance to attach the clock gauge and just enough surface on the outside diameter of the flywheel for the probe to make contact. Zero the gauge at this point.
4. Rotate the flywheel via the barring gear using a ¾ inch drive ratchet (the flywheel rotates and coupling hub remains stationary). Rotate one complete revolution taking readings at four points 90° apart (these readings include the zero reading already taken).
5. Calculate any radial misalignment in the vertical and horizontal axes.
6. Depending on the misalignment offsets calculated, align the gearbox to engine as appropriate. It may be preferable to align in the horizontal axis to start with by turning one set of jacking screws (there are two screws/plates for each direction) simultaneously. The vertical alignment is obtained by adjusting the vertical jacking screws and shimming the gearbox as necessary.

3.1.2 Angular Alignment

1. Refer to Sections 5.1, 5.2, 5.3 and 5.4 for alignment information, clock gauge set up illustrations and an illustrated demonstration of how to carryout and calculate the coupling alignment.
2. With the clock gauge still attached to the coupling hub, place the probe so that it makes contact with the flywheel face (on the outer edge of the face) near TDC (top dead centre) of the flywheel.
3. Rotate the flywheel as before taking four readings (zero at 0/360°, 90°, 180° and 270°).
4. From the readings at 0/360° and 180° calculate the angular alignment in the vertical axis, and from the readings at 90° and 270° calculate the angular alignment in the horizontal axis. An example follows (also see Sections 5.4 and 5.5 for calculation illustrations).
5. The example shows that the angular misalignment was within tolerance and no further adjustment/shimming was necessary. If the angular alignment is out off tolerance then shimming or jacking of the gearbox may be required.
6. Once the radial and angular alignment checks have been completed on the gearbox, torque the holding bolts to their correct settings to firmly secure the gearbox in place using Loctite 242 on bolts.
7. Recheck the alignment once the bolts have been tightened down and if it is still within tolerance connect the coupling flange back onto the rubber disk and bolt onto flywheel.

	Reading	Value
1	0/360°	0 (zeroed clock gauge)
2	90°	- 0.205 mm
3	180°	- 0.050 mm
4	270°	- 0.022 mm

	Parameter	Value
	Diameter of measured surface (flywheel)	1367 mm
	Vertical Misalignment	inv. tan(reading 1 – reading 3)/(0.5 x dia) = inv. tan(0 – 0.050)/(0.5 x 1367) = 0.004°
	Horizontal Misalignment	Inv. tan(reading 2 – reading 4)/(0.5 x dia) = inv. tan(0.205 – 0.022)/(0.5 x 1367) = 0.0153°
	Permissible Misalignment	0.3°

3.2 Alternator to Gearbox Coupling

The better the alignment the longer the coupling life, with the exception that a slight angular misalignment (0.05°) is advised in order to have good lubrication conditions.

3.2.1 Radial Alignment (Vertical & Horizontal)

1. Section 5.9 illustrates the set up of the clock gauge for measuring any radial misalignment. Attach the gauge to the hub (4) with the probe contacting the opposite hub (1) alignment surface. Rotate the hub on which the clock gauge is attached and take four readings 90° apart. The vertical and horizontal offsets should be less than 0.15 mm (0.006 inch).
2. Using the alignment plates and jacking screws, which are mounted around the alternator, align/shim the alternator to the gearbox to meet or better the specified offset.

3.2.2 Angular Alignment

1. Section 5.10 illustrates the set up of the clock gauge for measuring the angular misalignment.
2. Attach the gauge to the hub (4) with the probe contacting the opposite hub face (1) surface. Rotate the hub on which the clock gauge is attached and take four readings 90° apart to measure the Z and Y offsets shown. The difference between Y – Z should be less than 0.20 mm (0.008 inches). Align by jacking/shimming alternator as required.

3.2.3 Lubrication

1. Once the coupling has been aligned it must be lubricated before operations can commence.
2. Before bolting up the sleeves (2 & 3), approximately 70% of the gear mesh grease is to be hand packed between the hub (4), the sleeve teeth and surrounding area. Cummins part number for the grease, its grade and supplier brand name is given below:

Cummins Part Number	550226
Supplier Brand Name	Mobil XTC
Grade	NLGI No.1 Lithium Soap Base
Quantity used	1.12 kg

3. After tightening the sleeve bolts (18 & 19) the remaining 30% of the grease is pumped into the sleeve injection holes (14). Both the lubrication plugs at 180° must be removed to vent the inner space (fill from one to evacuate the air from the other). An air lock can result in incomplete filling or in damage to the seals.
4. After lubrication tighten the lubrication plugs to 25 Nm.
5. The purpose of lubricating the bearings is to have a good rotating surface whenever the shear pins might break. The type of grease and Cummins part number is given below.

Cummins Part Number	550224
Supplier Brand Name	Valvoline or other
Grade	EP2
Quantity used	0.09 kg minimum

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SECTION 4 – FINAL ASSEMBLY

4 Final Assembly

Note: *This task is to be undertaken by suitably trained and qualified service personnel **only**.*

1. Install the sleeves (2 & 3), gaskets/o-ring (16), and tighten bolts (18 & 19) to a torque of 328 Nm.

4.1 Special Tools Required:

1. ¾" inch ratchet.
2. Circlip pliers
3. Alignment clock gauge/dial indicator that can magnetically attach to a hub.

Note: *Once the generator set has been lifted into its final working position, the alignment should be rechecked to ensure that there has been no movement during transit.*

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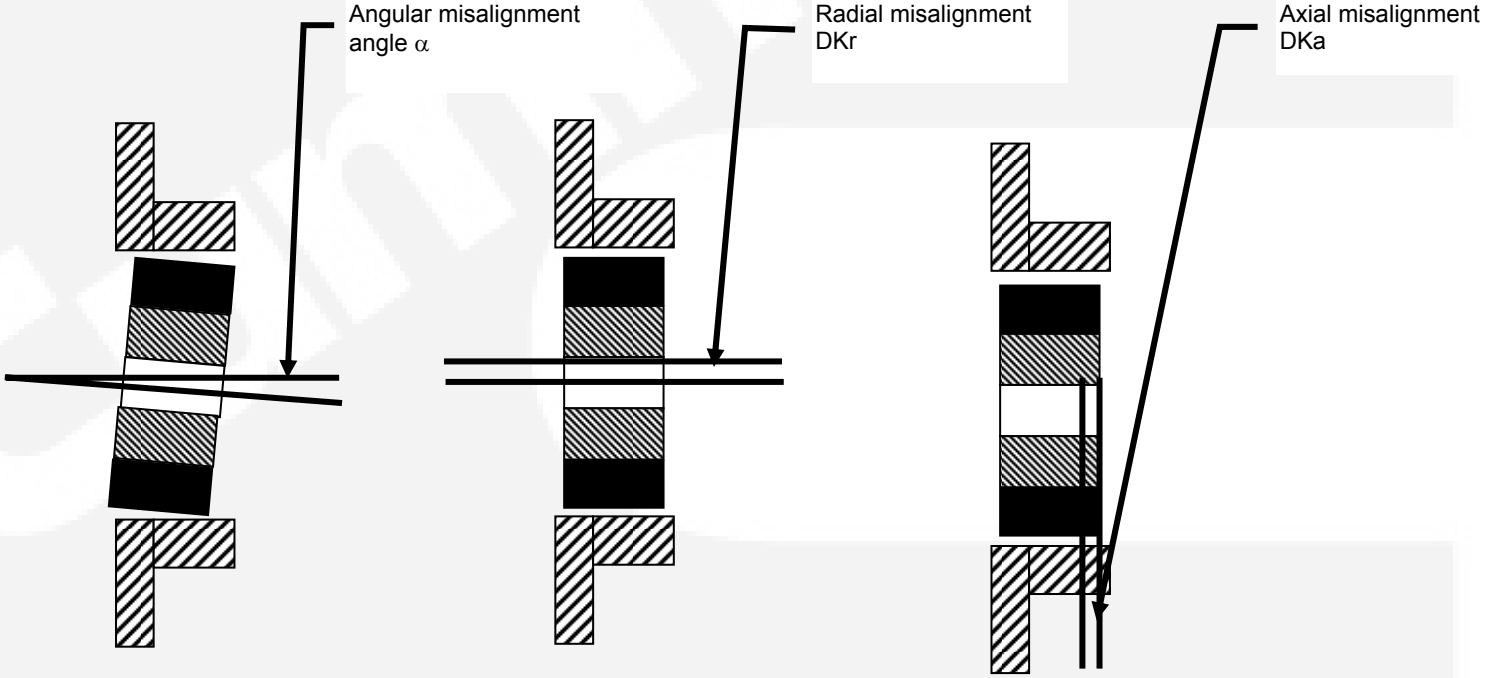
SECTION 5 – ILLUSTRATIONS

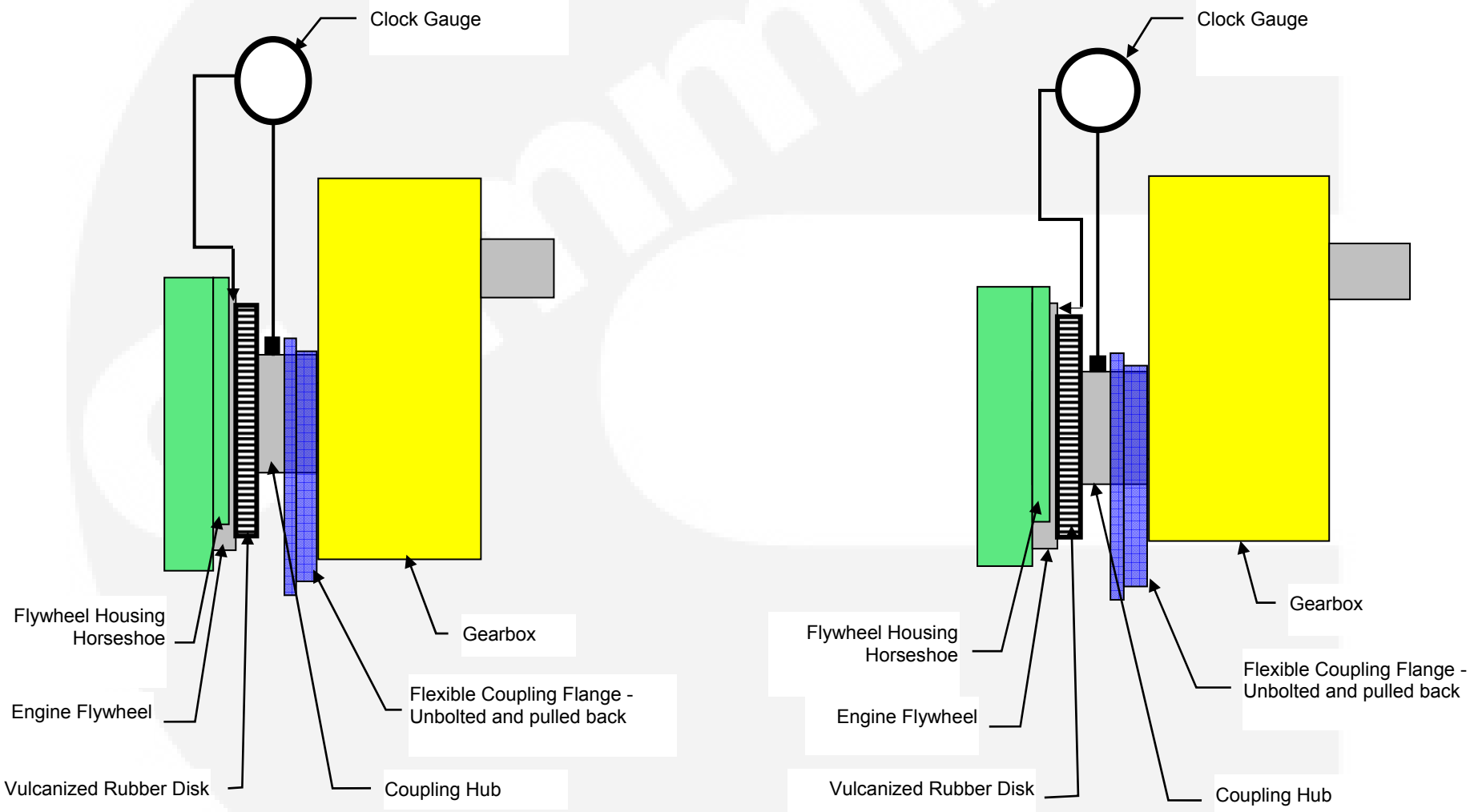
5 Illustrations

5.1 Alignment of Flexible Coupling to Engine Flywheel – Tolerance Information

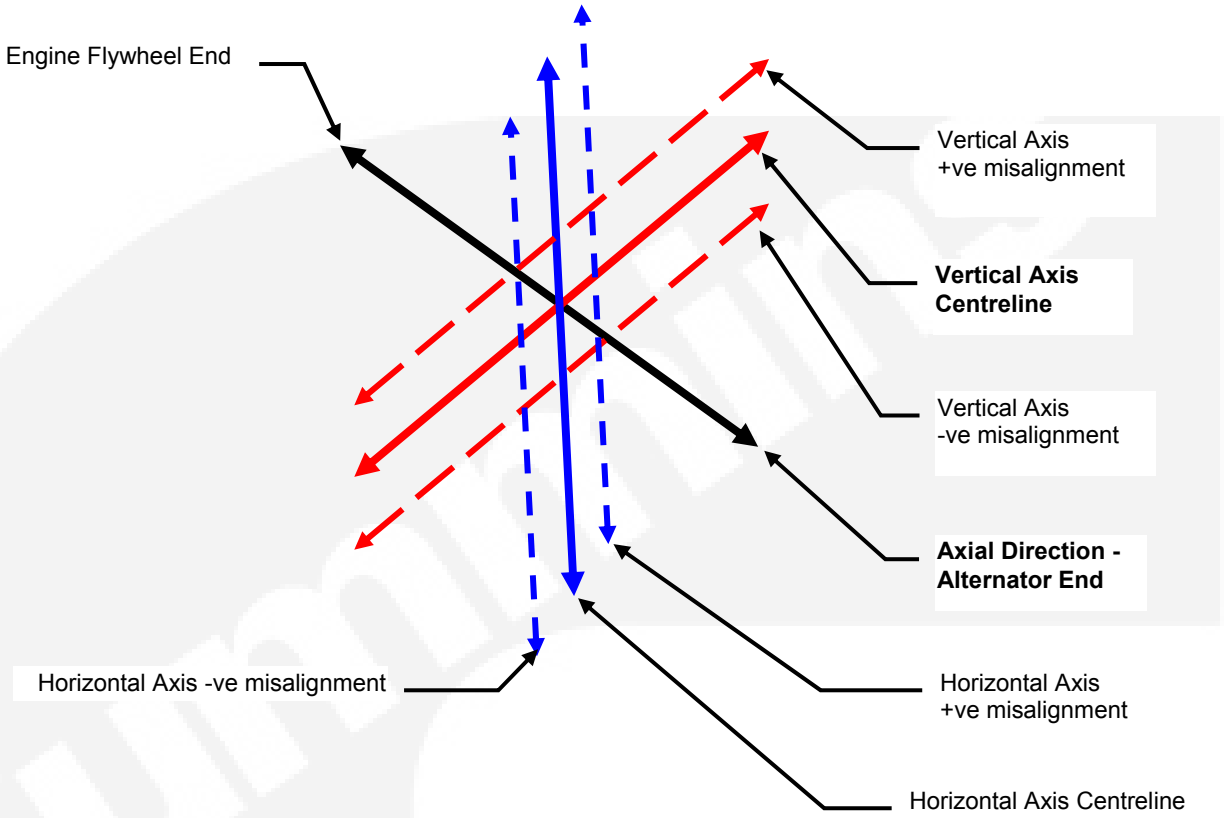


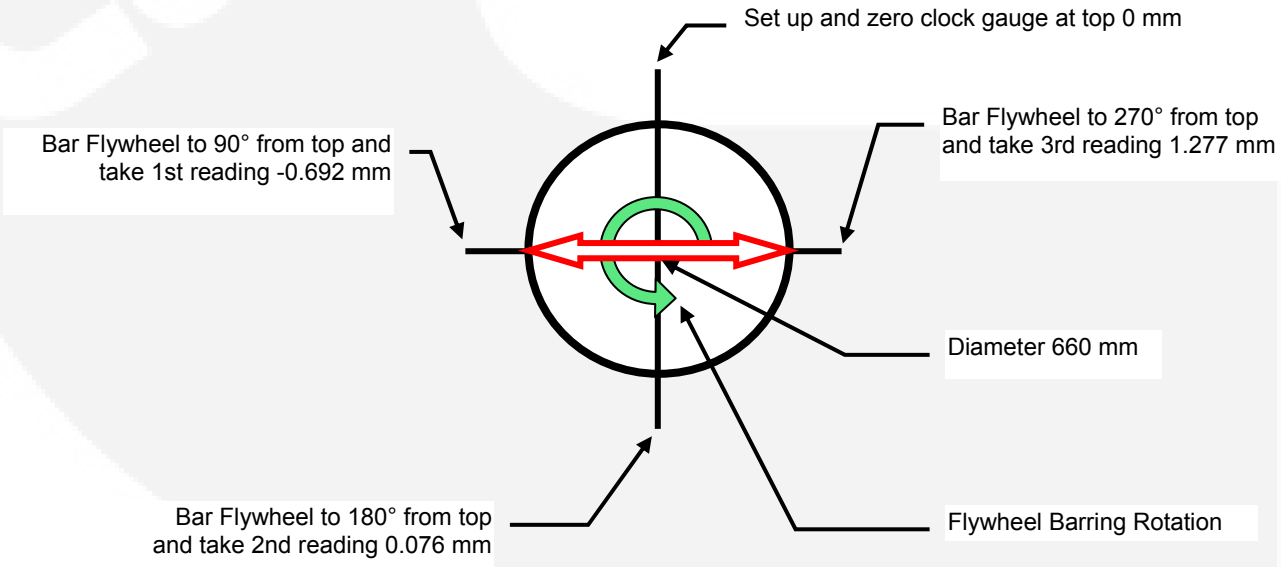
Arcusaflex Size	AC 11
Permissible radial misalignment Kr	1.5 - 1.0 mm
Permissible angular misalignment degree	0.3°
Permissible axial misalignment Ka	Several millimeters, but whole tooth depth of the rubber element must be in contact (see table dimensions in supplier's manual).

5.2 Alignment of Flexible Coupling to Engine Flywheel – Clock Gauge Set up



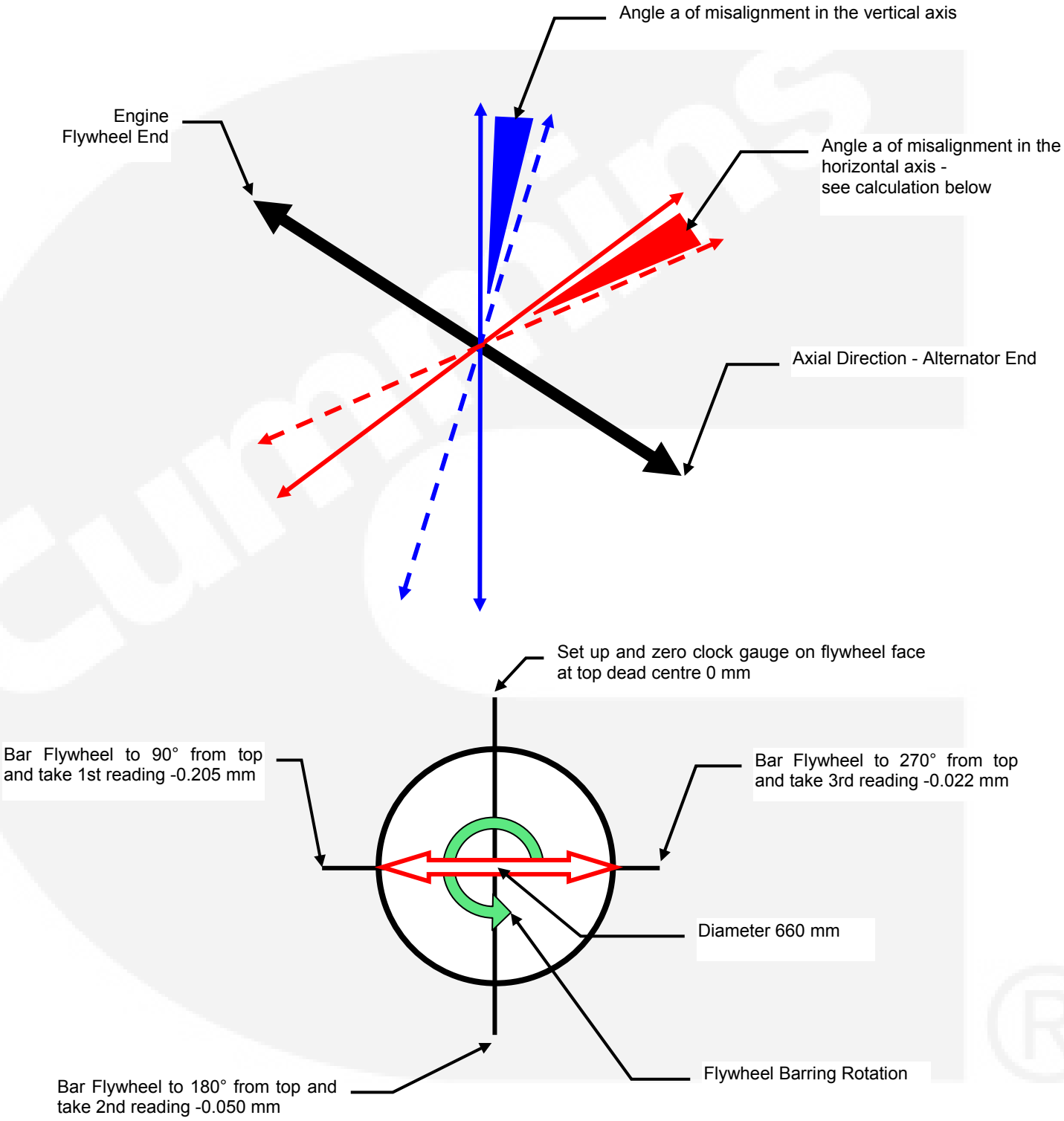
5.3 Radial Alignment of Gearbox to Engine Calculation



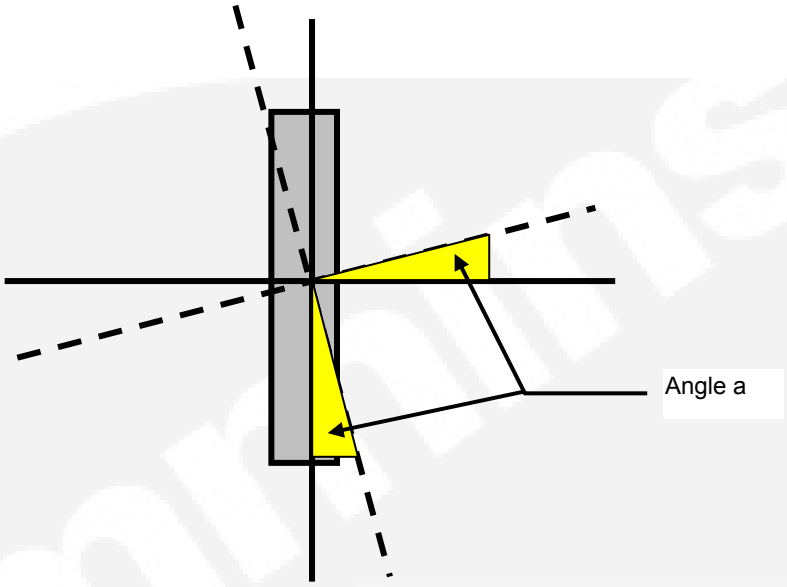


Arcusaflex Size	AC 11	Result
Permissible radial misalignment Kr	1.5 - 1.0 mm	
Calculated Radial misalignment vertical axis	0 - 0.076 = 0.076 mm	Approved
Calculated Radial misalignment horizontal axis	1.277 - (-0.692) = 1.969 mm	Adjust

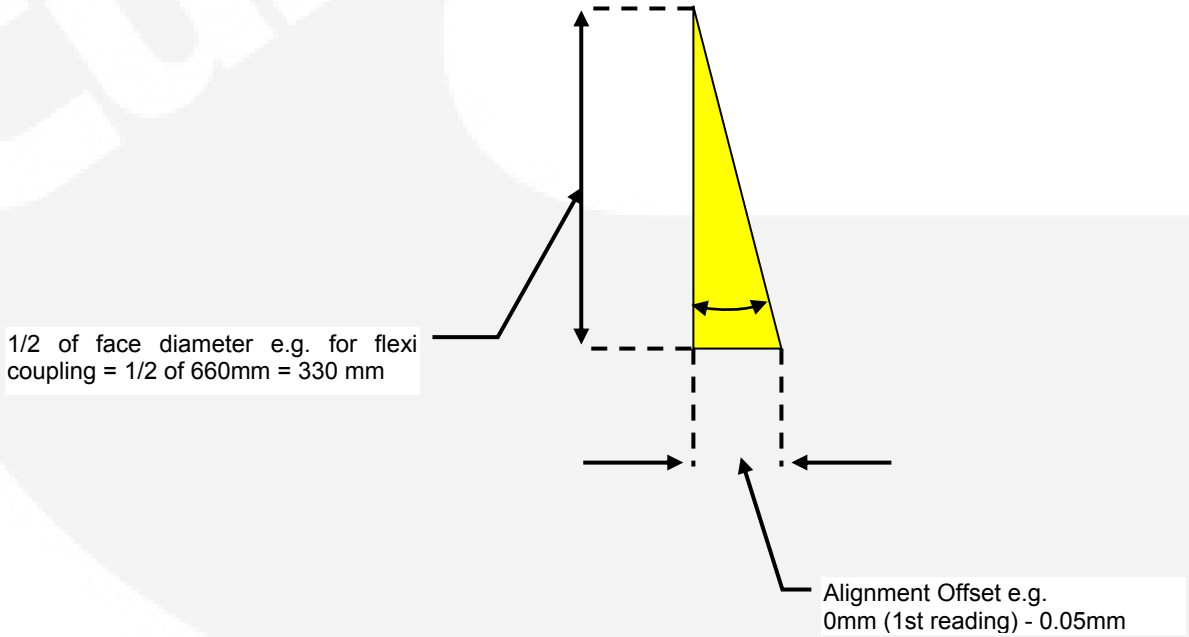
5.4 Angular Alignment of Gearbox to Engine (Calculation Sheet 1 of 2)



5.5 Angular Alignment of Gearbox to Engine (Calculation Sheet 2 of 2)



5.5.1 Calculation of Angular Alignment



Calculation:

Vertical Angle a = inv tan{(0 - 0.05)/(660/2)} = 0.0087°
Horizontal Angle a = inv tan{(0.205 - 0.022)/(660/2)} = 0.032°
Therefore both angles within 0.3° tolerance as per manufacturer's instructions

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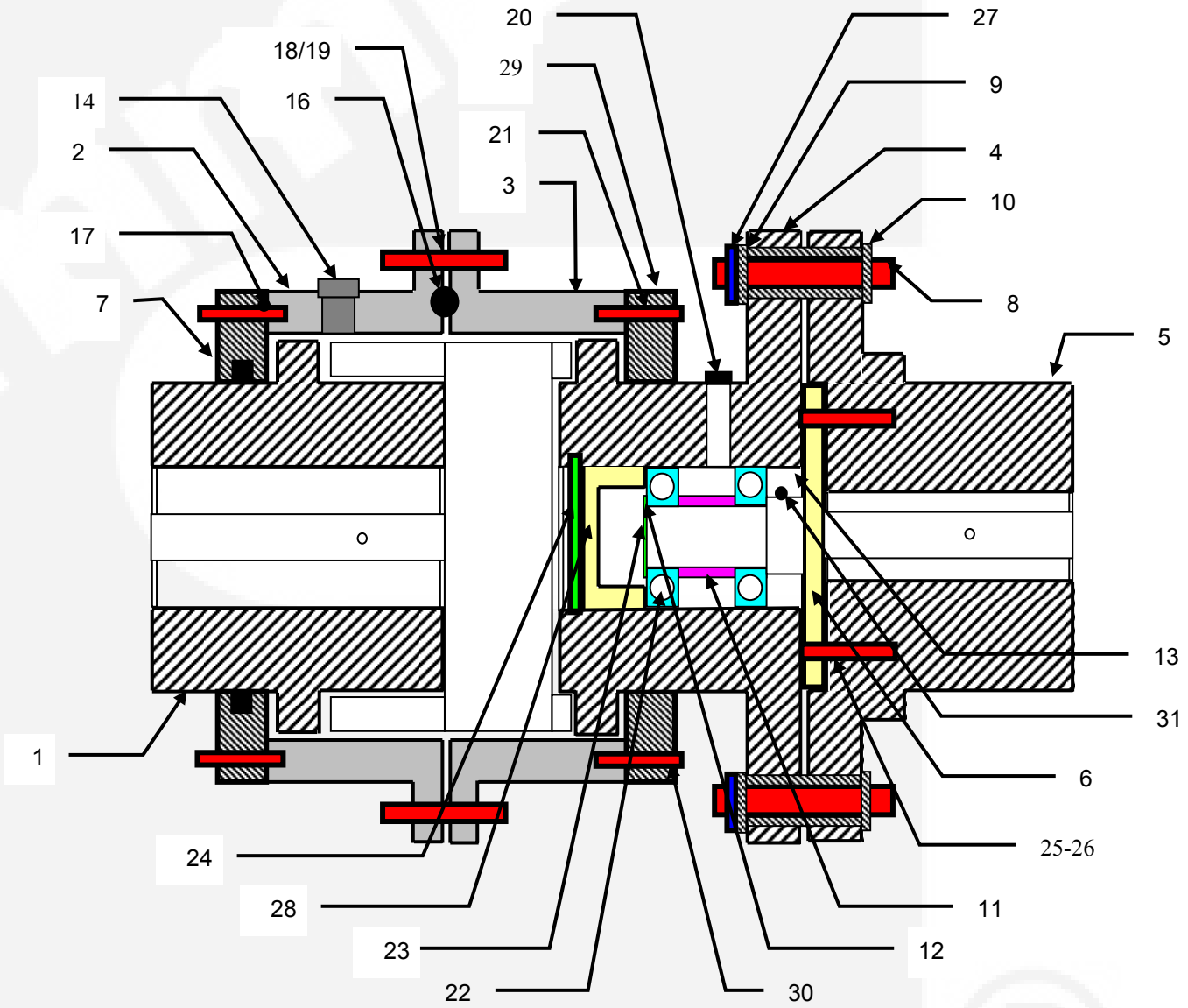
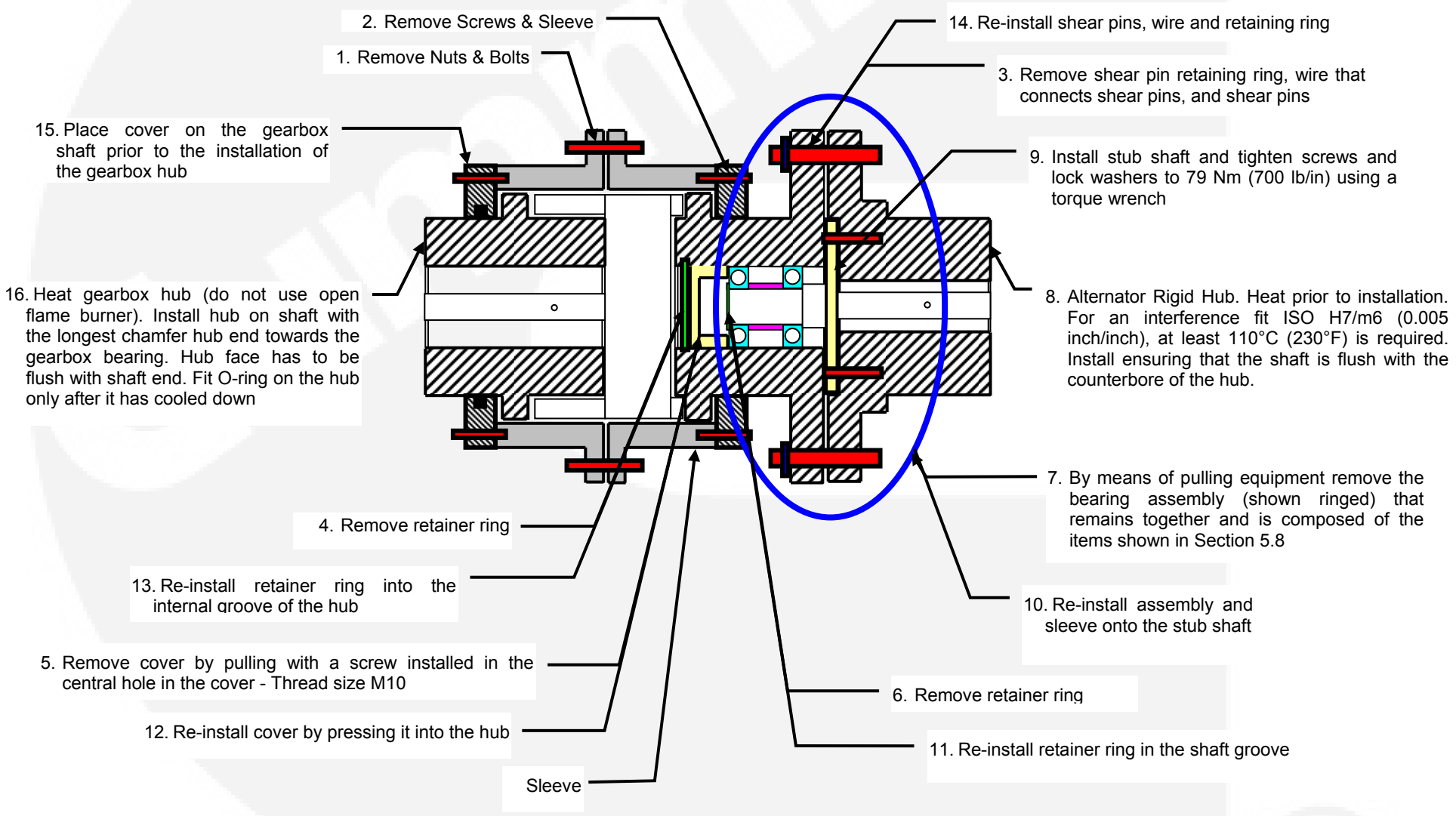
5.6 Gearbox Shear Pin Coupling – Component Identification

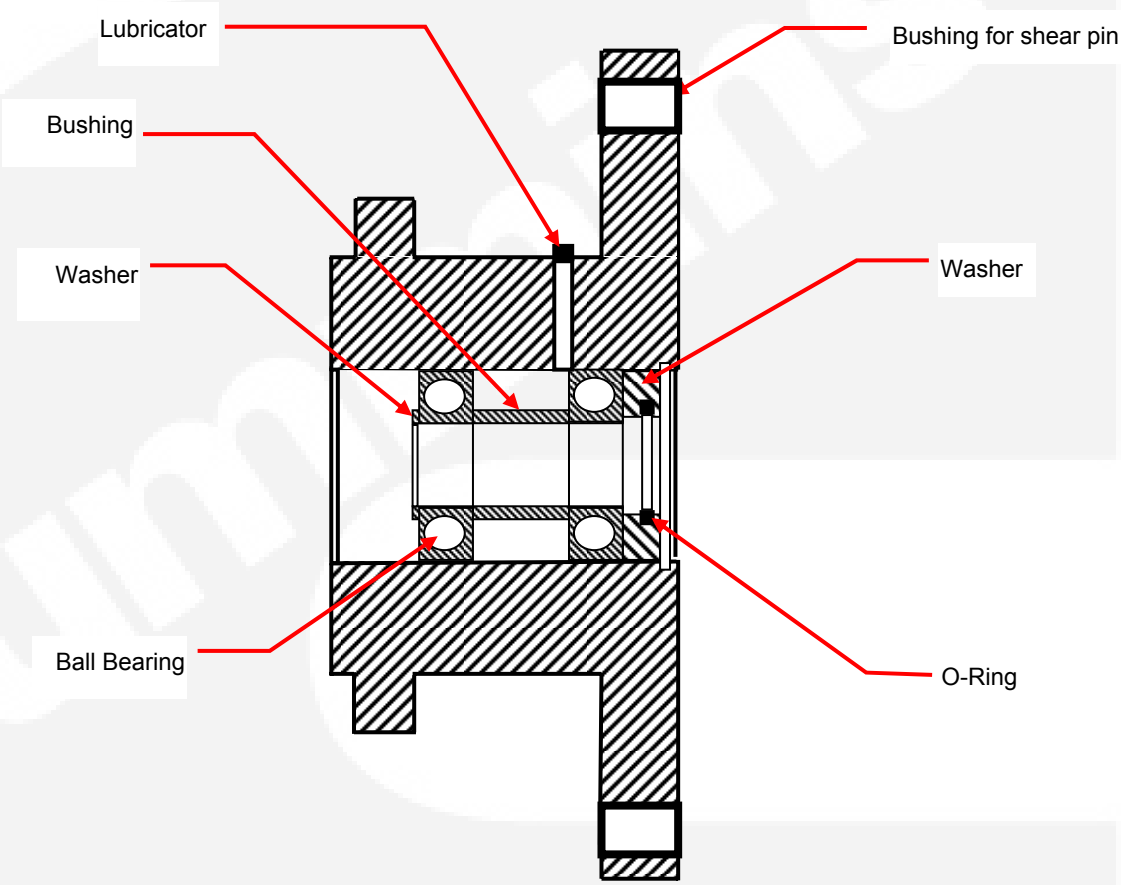
Item	Description
1.	Hub
2.	Sleeve
3.	Sleeve
4.	Hub
5.	Rigid Hub
6.	Shaft
7.	Cover
8.	Shear Pin
9.	Bushing
10.	Bushing
11.	Bushing
12.	Washer
13.	Washer
14.	Oil Nipple
15.	Seal
16.	O-Ring
17.	O-Ring
18.	Bolt
19.	Nut
20.	Lubricator
21.	Screw
22.	Ball Bearing
23.	Retainer Ring
24.	Retainer Ring
25.	Screw
26.	Gromer Washer
27.	Retainer Ring
28.	Cover
29.	Cover
30.	Screw
31.	O-Ring



5.7 Gearbox Shear Pin Coupling – Disassembly and Re-Assembly



5.8 Roller Bearing Assembly



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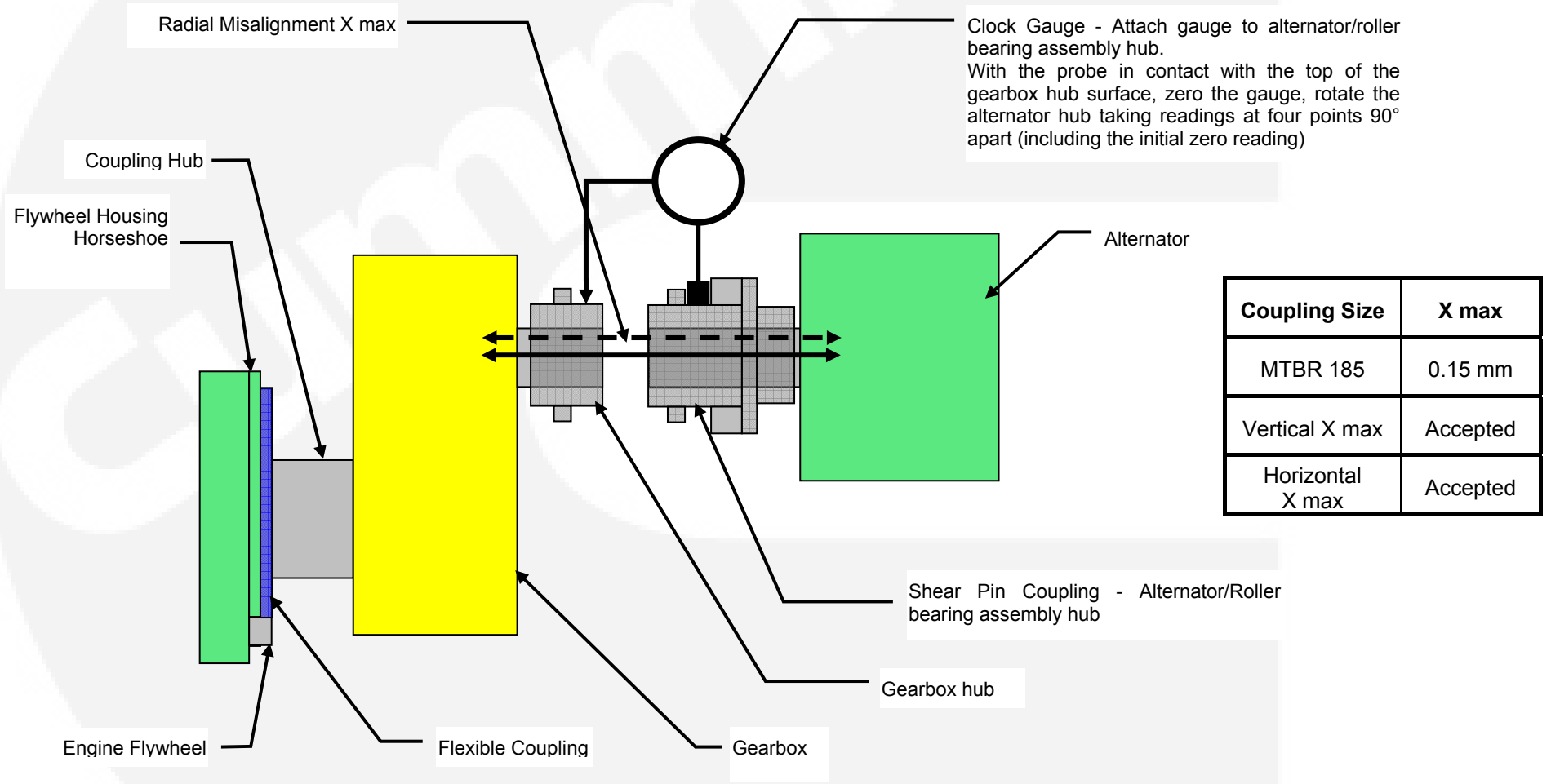
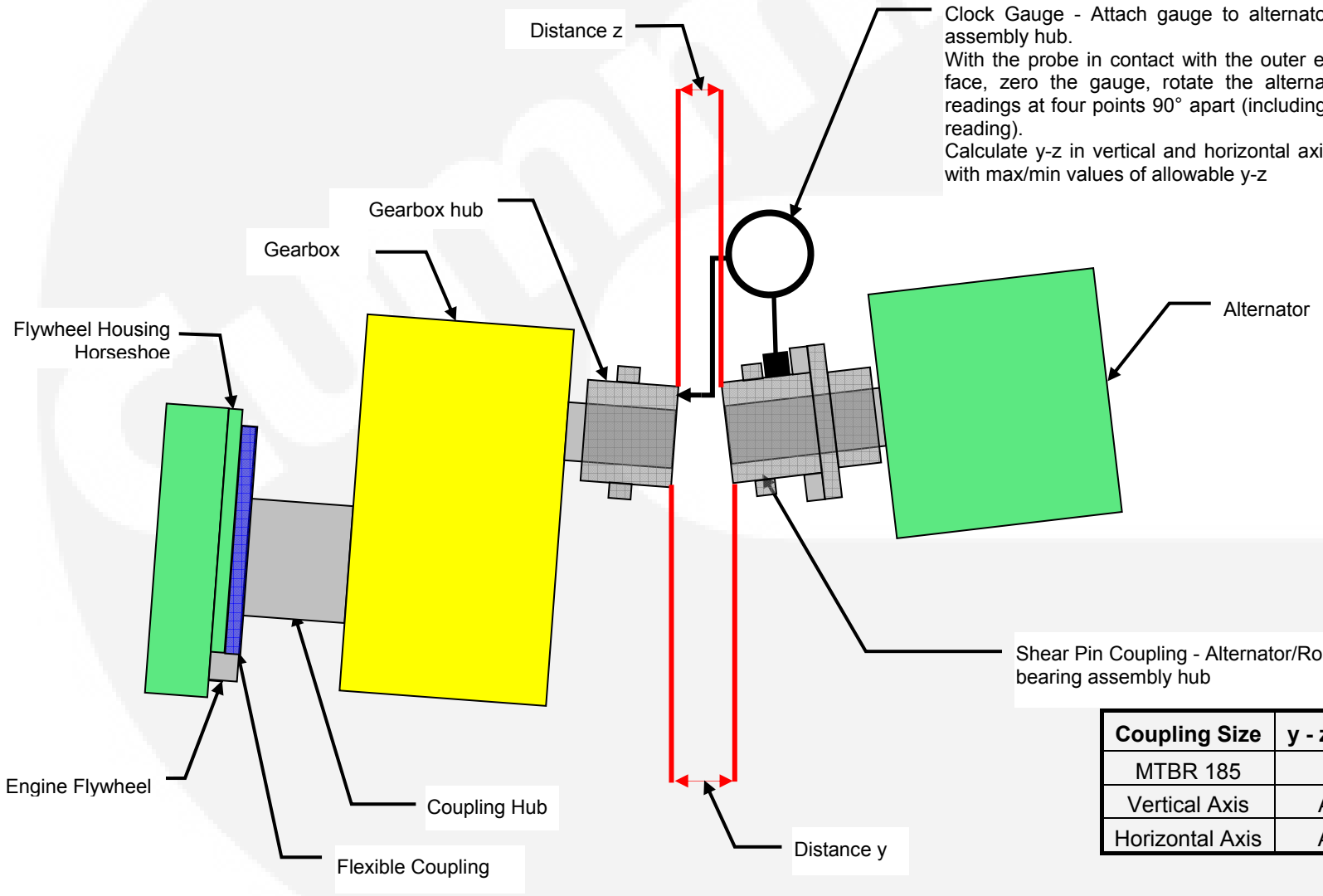
5.9 Alternator to Gearbox Axial Alignment in Vertical/Horizontal Axis



Coupling Size	X max
MTBR 185	0.15 mm
Vertical X max	Accepted
Horizontal X max	Accepted

5.10 Alternator to Gearbox Alignment – Angular Alignment



Coupling Size	y - z max (mm)	y - z min (mm)
MTBR 185	0.2	0.008
Vertical Axis	Accepted	Accepted
Horizontal Axis	Accepted	Accepted

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