



***ICESTORM 2***  
**MECHANICAL**  
**MAINTENANCE MANUAL**




**CI No. HBO07753-01**


**October 2006**

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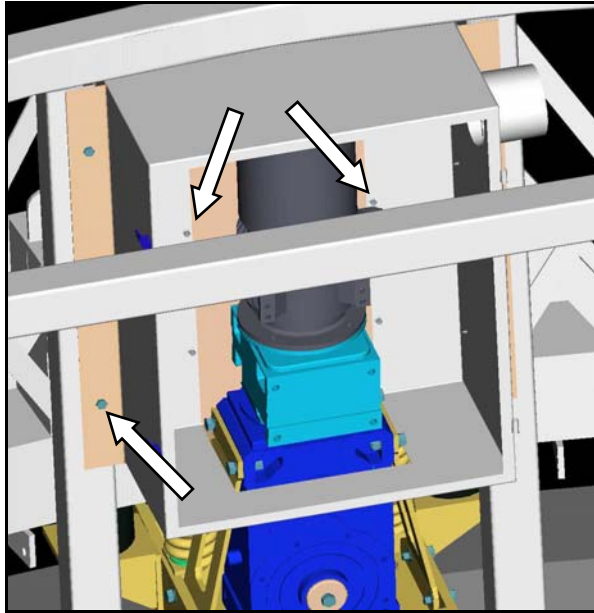
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# 1 AZIMUTH DRIVE

## 1.1 AZIMUTH DRIVE REMOVAL

1. Remove exhaust duct & door from the thermal enclosure.



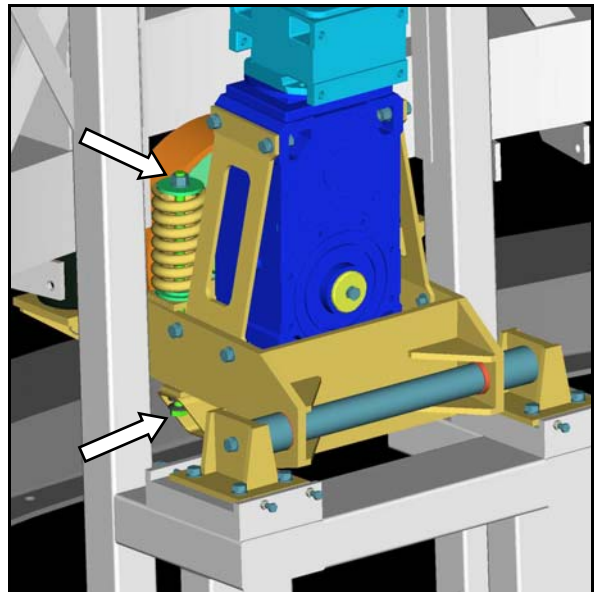
2. Remove the 7 x M6 screws from inside the thermal enclosure, the rear panel is now released. Remove the 4 x Taptite screws, which fasten the thermal enclosure to the vertical RHS. The enclosure can now be lifted away.



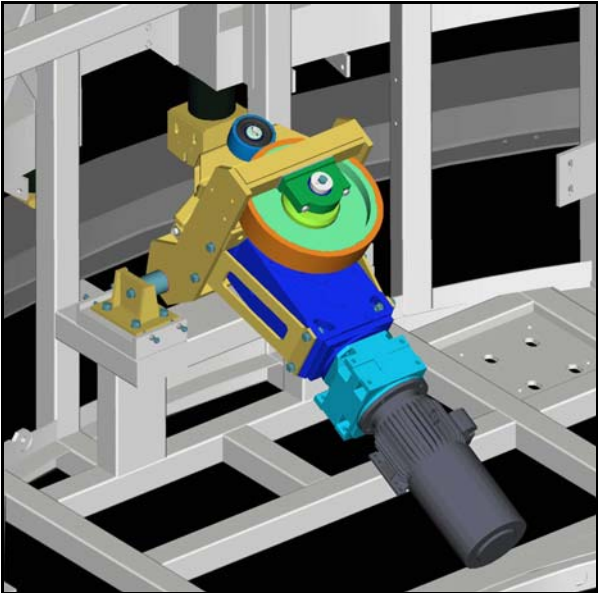
3. Remove the lock nut & tighten the M16 Marsh Mellow compression nuts slightly to take up strain.



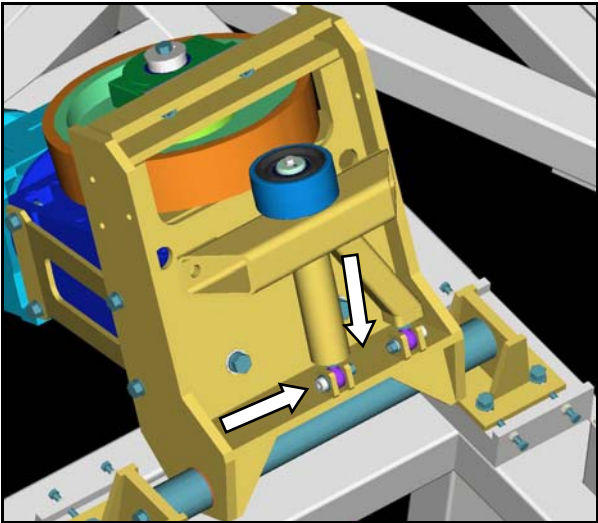
4. Remove the 3 x M16 bolts on each of the marsh mellow mounts. The marsh mellows & their mounts will remain in situ when the drive is laid back.



5. Remove the M20 nut on top of the pinch roller spring retainer. Note that it may be necessary to hold the head of the tension bolt with a ring spanner. The springs should be decompressed evenly. Withdraw the tension bolt from underneath; remove the springs & retainers.



6. The drive is now free to pivot around the shaft and to be laid on its back. If the pinch roller shaft has not already been removed prior to this process, care will need to be taken to maneuver the pinch roller past the ring beam.

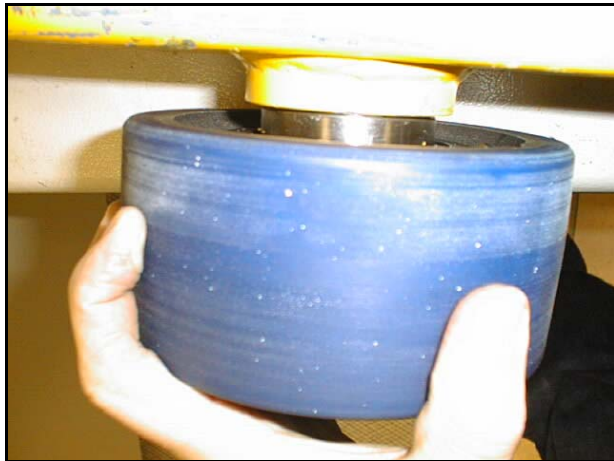


7. With the drive laid on its back, the pinch roller shaft fasteners are easily accessible. Remove the 2 x M12 nuts & shoulder screws.

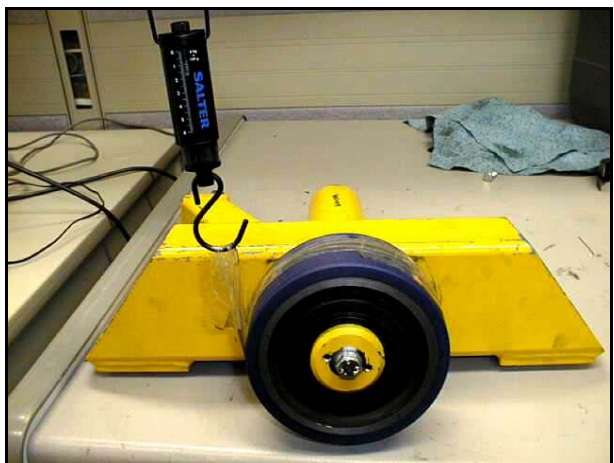
## 1.2 PINCH ROLLER PRELOAD SET-UP PROCEDURE



1. Tighten M10 bolt gradually until the collar and/or shim does not turn when the wheel is rotated. Note: The grub screws may need to be applied slightly to stop the end cap from rotating.



This ensures that there is zero end float and that only a minimal amount of preload is being applied.



2. Using a spring balance, attached to a piece of tape wrapped around the wheel, measure the amount of force required to rotate the wheel.

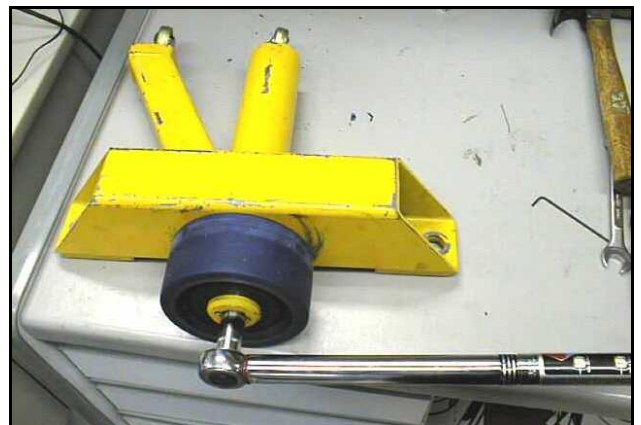
The corresponding friction torque measured at the wheel circumference should be in the range:

- 2.5 – 2.8 kg (static)
- 2.0 – 2.2 kg (dynamic)

This is the torque required to overcome the bearing friction. A reading above this range indicates that the bearing preload is too high & below indicates that the preload on the bearing is insufficient.



3. Unscrew grub screws and apply a low strength thread locking compound e.g. Loctite 222. Reinsert and tighten fully.



4. Tighten M10 bolt to a Torque of 30 Nm

5. Check that friction torque is still in acceptable range. If not repeat steps 2 & 3 and recheck.

### 1.3 AZIMUTH DRIVE SET-UP PROCEDURE

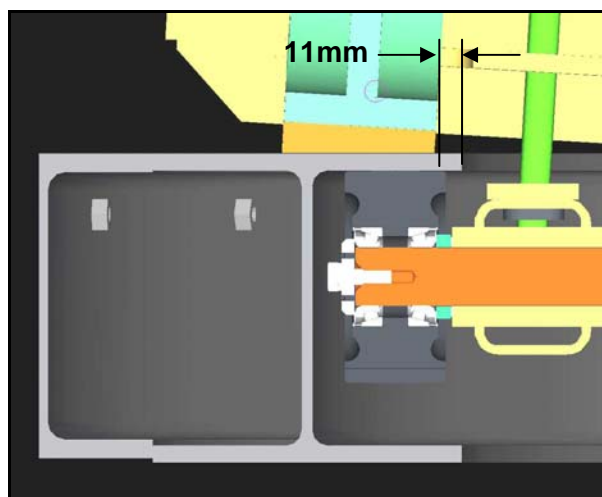
The four steps involved in aligning & setting up the azimuth drive are:

- Radial Position
- Skew Angle
- Marsh Mellow Compression
- Pinch Roller Spring Compression

#### 1.3.1 Radial Position

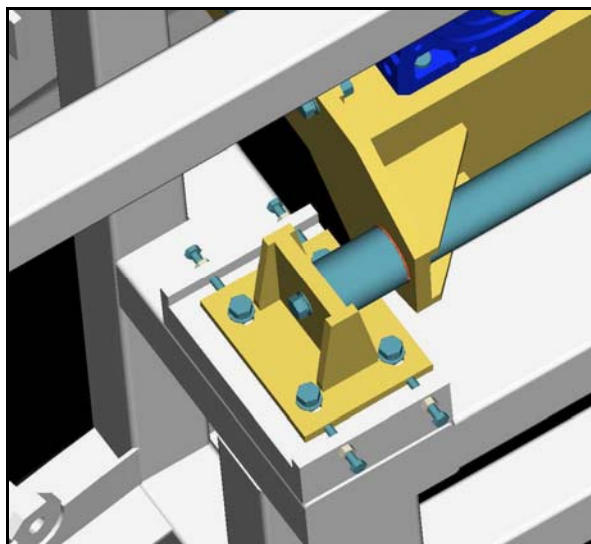
1. If the drive is positioned too far inboard, the inside edge of the pinch roller will overhang the flange edge of the ring beam. If the drive is too far outboard, then the pinch roller will come into contact with the flange to web radius.

Measure the distance between the inside edge of the ring beam flange & the inside edge of the pinch roller. The correct distance should be 11mm +/- 5mm.



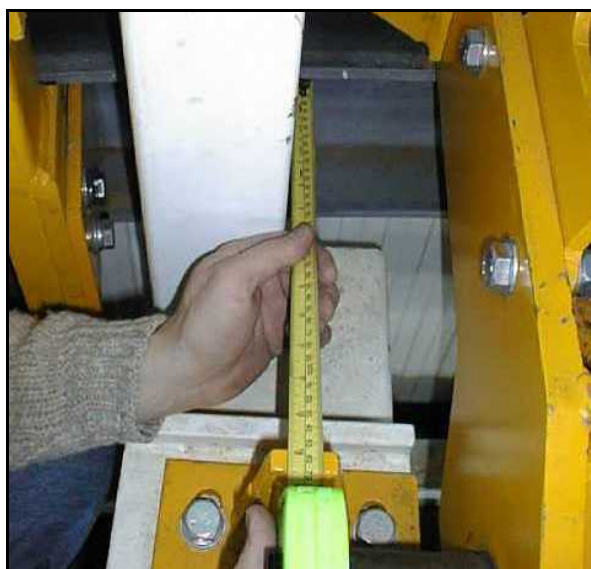
If the drive requires to be repositioned, ensure that excessive force has been removed from the drive wheel & pinch roller.

2. Loosen the 3 x M12 bolts on each marsh mellow retainer plates. Loosen the 4 x M16 bolts on each of the drive bearing plates. By using the jacking screws, move the drive radially to obtain the desired measurement of 11mm.



#### 1.3.2 Skew Angle

3. Measure the distance between the ring beam flange edge & the drive bearing plate for both sides of the drive. The difference between these two measurements will indicate the skew angle of the drive. The jacking screws adjust the skew angle. Identical measurements for each side are the desired result with a differential of 2mm being the maximum allowable tolerance.



When the drives has been satisfactorily aligned radially & angularly, nip up the lock nuts on the jacking screws & fully tighten the 4 x M16 bolts on each drive bearing plate, as well as the 3 x M12 bolts on each marsh mellow retainer plate.



### 1.3.3 Marsh Mellow Compression



1. Remove the lock nut & tighten the M16 marsh mellow compression nuts slightly to take up strain.

2. Jack up azimuth support beam slightly, to take weight off the drive wheel.



3. Loosen the 3 x M16 bolts on each of the marsh mellow mounts.

4. Tighten compression nut so that as the marsh mellow is compressed the mount is raised. The marsh mellow compressed height should be 142mm. A small jack may be used, between the ring beam & the mount, to assist in the compression of the marsh mellow.

5. Fully tighten the marsh mellow mount bolts. Slowly let down jack so that the weight is returned to the drive wheel. Slacken off marsh mellow compression nuts.

6. With the weight back on the drive, check the compression of the marsh mellows. Acceptable measurement is 142mm +/- 3mm.



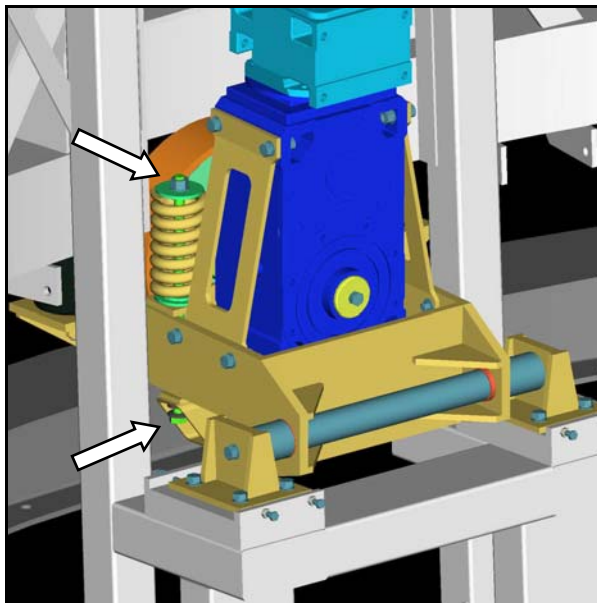
If compression is outside of tolerance, repeat the steps making the necessary change in the compression height for step 4.

7. Once compression height is set, replace & tighten lock nut.

### 1.3.4 Pinch Roller Spring Compression

The pinch roller is used to provide additional normal force to the drive wheel. Under normal operating conditions, the weight of the dome is sufficient to provide enough force on the drive wheel to prevent it from slipping. However, if it is required under adverse conditions (e.g. wet track, or under wind load), the pinch roller will provide the additional traction needed.

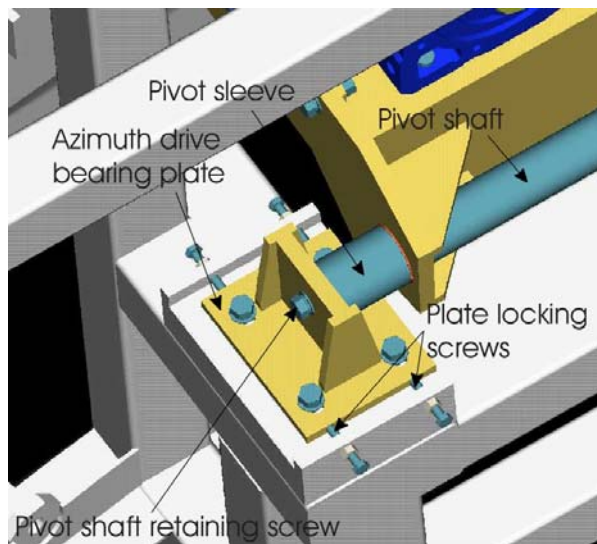
1. Tighten the M20 nut on top of the spring retainer in order to compress the spring. Note that it may be necessary to hold the head of the tension bolt with a ring spanner.



2. Evenly compress both springs 12 mm, i.e.: until the compressed length is measured to be 198mm +/-3mm. Ensure that both springs have the same compressed length.

### 1.3.5 Correcting End Play In Azimuth Drive Pivot Shaft

Determine end play by rotating dome. Measure the gap between the pivot sleeve and the bearing plate. Purchase or make appropriate shim or O-ring to fill the gap.



1. Support azimuth drive pivot shaft with wooden chocks.



2. Mark position of azimuth bearing plate and the position of the bearing plate locking screws.



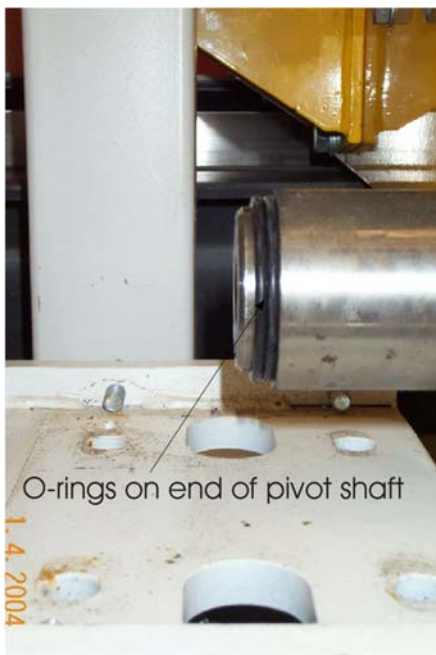
3. Mark position of the pivot shaft retaining screw.



4. Remove the pivot shaft retaining screw and back off a couple of turns. Remove the four securing screws from the azimuth bearing plate.



5. Remove the bearing retainer plate from the end of the pivot shaft. Gentle persuasion with a rubber mallet may be required.
6. Check the end of the pivot shaft for any damage.
7. Place the O-ring spacers or shim on the end of the pivot shaft.



8. Position bearing retaining plate on the end of the pivot shaft and replace fastener on the end of the shaft. The use of a podge bar may be required to align the plate with the locating marks. When in

position nip up the 4 bearing plate locking screws.

9. Replace the four bearing plate-securing screws. Fully tighten remaining fasteners and the locking fastener lock nut.
10. Remove the wooden chocks and ensure that all fasteners tools etc are removed from the ring beam.
11. The dome should be rotated clockwise then counter clockwise to ensure that there is no end play.

## 2 AZIMUTH SUPPORT WHEELS

### 2.1 AZIMUTH BOGEY REMOVAL & REPLACEMENT PROCEDURE



1. Use M16 nut and washer to compress Marsh Mellow spring slightly to take up strain.



2. Jack up azimuth support beam 10-15mm. Ensure that the dome is not raised to a height that will lift the azimuth seal off of the azimuth seal blade. This may result in the inner and outer seals being relocated on the same side of the azimuth seal blade.



**Bogey on 30 degree angle to the ring beam prior to removal**

3. Remove 4 x M16 bolts. Set up block and tackle and attach to azimuth bogey hard point adjacent to bogey that is to be removed. Position the bogey on bump stops and bogey wheel at about 30 degrees to ring beam. Choke the sling around the center of the upper plate of the bogey and attach sling to block and tackle and lower to the floor. The bogey can be manually lifted to the floor by positioning the bogey as outlined above and lifting bogey out through vertical members.



**Azimuth Bogey Hard Point**



**Azimuth Bogey Hard Point in Level 3 Floor**



**Replacing Bogey: Block and Tackle-Sling Arrangement**

4. Replacing the bogey is the reverse of the removal procedure. Lift bogey to required height and position end stop end of bogey at right angles to the ring. Sit the end stop fasteners on the ring beam and support the bogey while the slings are repositioned on the bogey support frame.



Raise the bogey and place the bogey wheel on the ring beam. Remove slings and slide bogey into position.



5. Replace bogey and slightly tighten the 4 x M16 bolts ensuring that new spring washers are used. Check alignment of bogey by measuring distance between tool and edge of ring beam. If required adjust bogey by skewing to obtain equal distance from the edge of the ring beam.



6. Tighten bolts fully to a torque of 70Nm, lower jack, decompress Marsh Mellow spring and remove M16 nut and washer.



7. Adjust bump stop bolts to give 12mm clearance to running surface of ring beam.

8. **Checklist:** Ensure that all fasteners tools etc are removed from the ring beam. Recheck all azimuth seals and ensure that the seals are either side of the azimuth seal blade. Observe bogey while the dome is rotated 180 degrees clockwise and 180 degrees in the counter clockwise direction.

### 2.1.1 Replacement of Bogey behind Level 2 Stairs.

1. The procedure for removal and replacement of the bogey is the same as outlined in this manual apart from the removal of the level 2 stairs. Two people will be required for this operation.



2. Secure chain on fourth step from top of stairs and set up block and tackle above this step. Secure lifting hook to chain. Take up tension on the chain so the weight of the stairs is held by the block and tackle. Remove fasteners from top and bottom of stairs and lower to the ground. Timber levers are required to guide the stairs and ensure that the paint on the vertical members is not damaged.

3. Place a board over the stairs to provide a stable work area. And remove bogey as per previous instructions.



4. Replace the stairs. Podgers and timber levers will be required to perform this task. The stairs should be raised with the block and tackle-chain on approx. a 15 degree angle to the vertical. This will ensure that there is ample lateral movement each way for inserting the fasteners when the stairs are lifted into position.



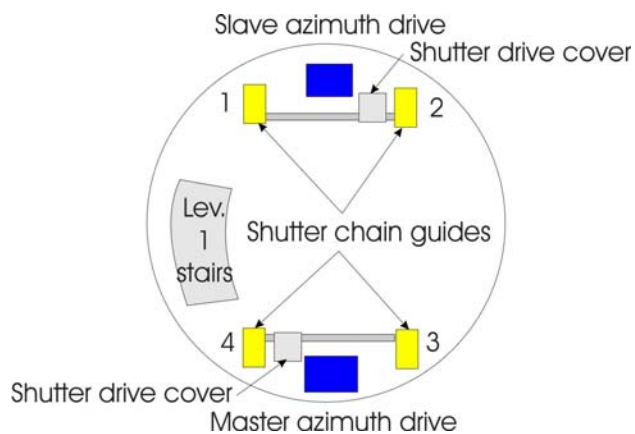
## 2.1.2 Replacement of Bogeys Adjacent to Shutter Chain Guides

The removal and installation of these bogeys requires a different technique to that described in Section 2.1 of these procedures.

Bogeys at locations 1 and 3 require the removal of the chain guards. The procedure is then the same as that outlined in section 2.1 **Azimuth Bogey Removal & Replacement Procedure**.



For Bogeys at locations 2 and 4 the procedure for their removal is outlined below.



1. Remove chain guard, cactus and shutter drive cover. The cactus can be tied off on the azimuth drive after removal from the shutter drive cover.



2. Use M16 nut and washer to compress Marsh Mellow spring slightly to take up strain.



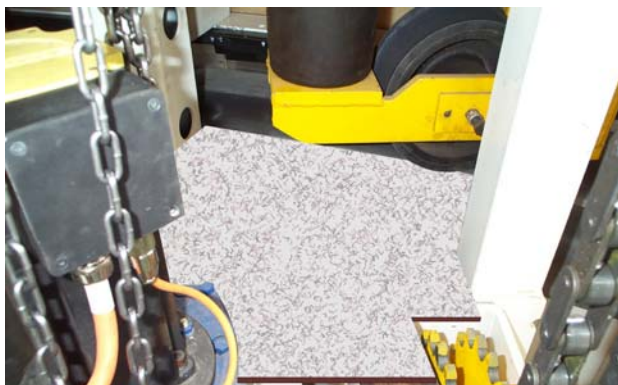
3. Jack up azimuth support beam 10-15mm. Ensure that the dome is not raised to a height that will lift the azimuth seal off of the azimuth seal blade. This may result in the inner and outer seals being relocated on the same side of the azimuth seal blade. Also remember to check the clearance between the azimuth hurricane hooks and the underside of the ring beam.



3. Remove 4 x M16 bolts. Set up block and tackle and attach to azimuth bogey hard point directly above the shutter drive.



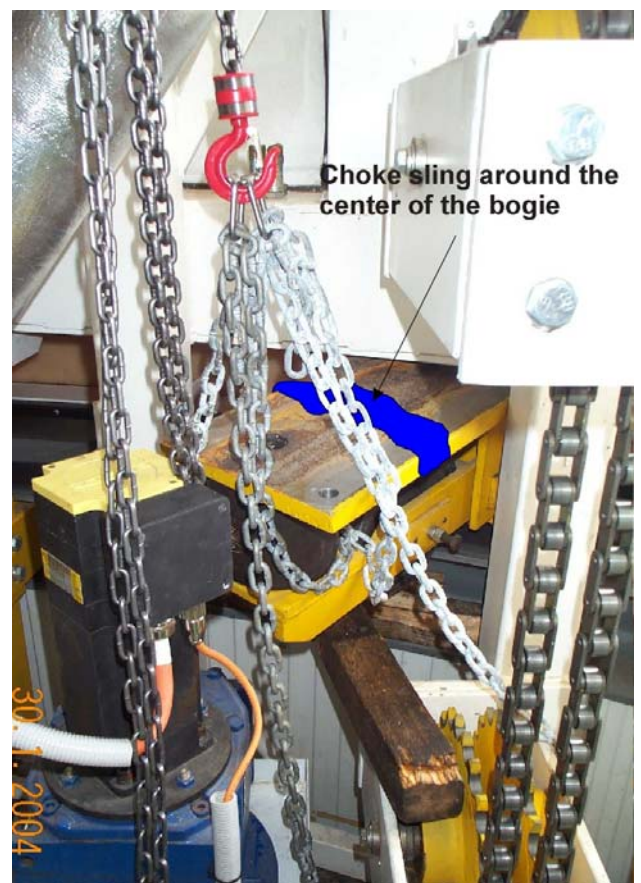
4. Roll bogey onto the support plate ensuring that the bogey is clear of all obstructions.



**Proposed Bogey Support Platform**

5. Choke the sling around the center of the upper plate of the bogey and attach sling to block and tackle Note: The hook of the block and tackle should be as attached as close as possible to the top plate of the bogey. Raise the bogey until it is above the shutter drive, the bogey will need to be held away from the drive until the bogey is above the drive unit. To avoid the shutter drive the bogey will need to be pulled towards the pier as it is lowered to the floor; this is best achieved by tying a rope to the sling and pulling towards center of enclosure.

**The photograph below does not reflect the above description. The block and tackle hook would normally be attached to the blue sling. The block of wood would be replaced by the “bogey support plate”.**



**Choke sling around the center of the bogie**

6. The installation of the azimuth support bogey is the reverse of the removal procedure. Ensure that new spring washers are used on the bogey fasteners and remove the marsh mellow securing nut.

7. Replace motor cover, chain guard and cactus. Re-tape the cactus to the top of the shutter drive cover.

## 2.2 AZIMUTH SUPPORT WHEEL REPLACEMENT

1. Replacement of azimuth support wheel should be performed on the level 2 floor, as the bogey is heavy and awkward to transport to any other part of the enclosure. Ensure that a plastic sheet or equivalent protective medium is placed on the level 2 floor prior to dismantling the bogey.
2. Loosen locking nuts on the axle preload plate.



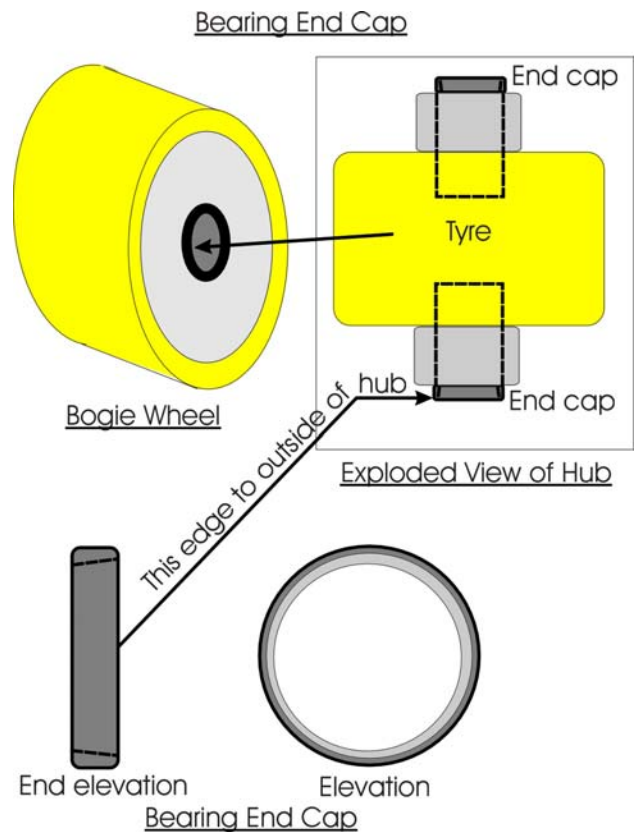
3. Remove axle retaining screw and the two plate retaining screws from the azimuth wheel swing arm.
4. Support azimuth wheel and remove axle preload plate and axle from azimuth wheel swing arm. This may require gentle persuasion with a drift and hammer. Place drift on end of axle (opposite end to axle preload plate) and gently tap until axle is removed from housing.
5. Remove wheel from swing arm and carefully remove shims and bearings from hub of wheel.
6. Check bearing and shims for damage. Clean shims and repack bearings.

**NOTE: Bearing and end caps are not matched sets and can be interchanged. Check for excessive endplay in bearings and replace if necessary.**

7. Straddle the old wheel on two wood chocks and with a suitable drift gently tap out the bearing end caps. Clean the end caps and check for damage. If

the end cap is damaged replace with a new end cap. Place the two end caps in a plastic bag and place in a freezer for a minimum of half an hour.

8. When driving the end caps into the wheel hub ensure that the wheel is on a stable structure i.e. a concrete floor, and sheet of cardboard is placed between the wheel and the concrete. This will minimize the risk of damage occurring to the wheel.



9. Place the bearing end cap on the wheel hub ensuring that the cap is level. The tapered side of the end cap is pointed towards the outside of the wheel rim. Place dollie (drawing of dollie on page #25) on cap and gently tap dollie using copper headed hammer until end cap sits firmly on flange in inner hub. Repeat for end cap on other side of wheel.

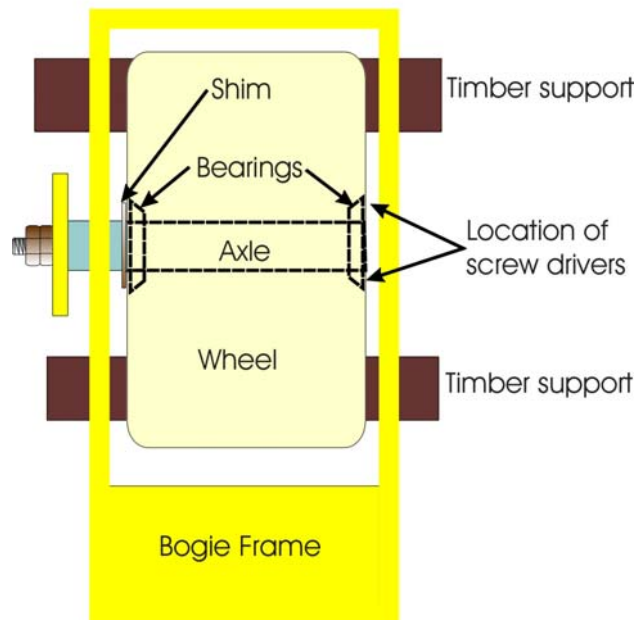


10. Place bogey wheel vertically on a clean surface and seat bearings in the end caps and place wheel inside swing arm. Position wheel using wooden chocks so the swing arm axle can be inserted through the wheel hub.

11. Insert axle into swing arm so axle protrudes a couple of millimeters inside of swing arm frame. Using a set of long nose pliers place the shim on the end of the axle. Gently push the axle through the first bearing and into the inner hub. Do not push axle all the way through the inner hub.

12. Support the bearing on the opposite side of the wheel with two thin flat end screwdrivers. The bearing needs to be supported on the edge of the bearing so the axle path is not impeded.

Screw driver locations



13. Gently push the axle through the bearing until the end of the axle is visible. Again using a long nose pliers place the shim over the end of the axle and push the axle through the shim and the outer edge of the swing arm frame.



**Replacing Wheel Shims**

14. Align dowel pins on axle preload plate with locating holes on swing arm. Replace plate on opposite side of swing arm and insert plate and axle retaining bolts.

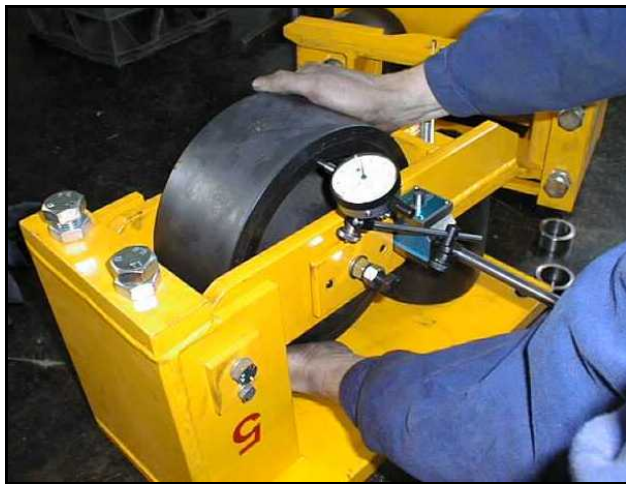
15. Then follow **Azimuth Support Wheel Preload Set-Up Procedure** outlined in section 2.3 of this document.

### 2.3 AZIMUTH SUPPORT WHEEL PRELOAD SET-UP PROCEDURE

1. Loosen the M12 locking nut followed by the M12 adjusting nut. If required the wheel may be tapped lightly with a rubber hammer to release any preload from the bearings.



2. Tighten the M12 adjusting nut gradually until the shims do not turn when the wheel is rotated. This ensures that there is zero end float and that only a minimal amount of preload is being applied.



3. A dial gauge indicator may also be used to check for any end float.

4. Using a spring balance, attached to a piece of tape wrapped around the wheel, measure the amount of force required to rotate the wheel.



The corresponding force measured at the wheel circumference should be in the range:

- 0.8 – 1.2 kg (static)
- 0.6 – 1.0 kg (dynamic)

This is the torque required to overcome the bearing friction. A reading above this range indicates that the bearing preload is too high & a reading below this range indicates that the preload on the bearing is insufficient.

5. Tighten the M12 locking nut. Note that the M12 adjusting nut needs to be held firmly with a spanner. Any slight movement of the adjusting nut will result in a change to the preload setting.

6. Using the spring balance, check that friction torque is still in the acceptable range. If not repeat steps 1 to 5 and recheck.

## 2.4 AZIMUTH BOGEY SHIMMING PROCEDURE

To adjust the camber angle of the bogey, shims are placed between the azimuth support beam and the top-mounting surface of the bogey. If the tyre has a flat spot that is biased towards the inner edge, then the shims are placed on the outside of the support beam. This will cause the bogey to pivot around the inside edge in order to correct the misalignment. Conversely, if the flat spot is biased towards the outside of the tyre, then the shims are placed on the inside.



1. Use M16 nut and washer to compress Marsh Mellow spring slightly to take up strain. This method is not true for the camber compliant bogey. A special compression tool is required. See page #24.



2. Jack up azimuth support beam until wheel is 5mm clear of ring beam.



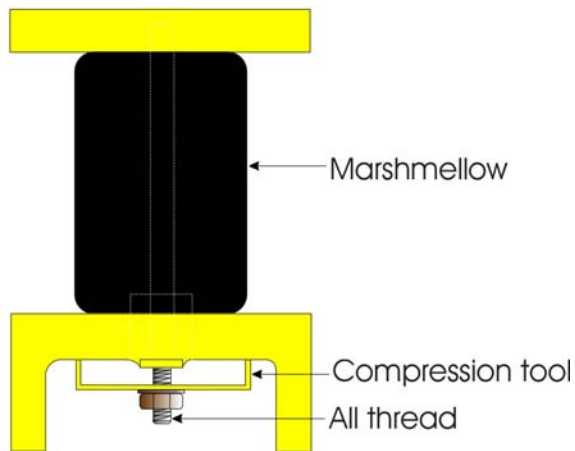
3. Loosen 4 x M16 bolts so bogey drops slightly to enable insertion of shim material.



4. Insert shims on either inside or outside of support beam. (Outside shown)

**Shim sizing calculator:** measure the front or rear gap when the tyre is just touching the ring beam with feeler gauges. Multiply gap by 3 and that will be the shim size required.

End View of Camber Compliant  
Azimuth Support Bogie with  
Compression Tool



5. Tighten bolts fully to a torque of 70 Nm, lower jack, decompress Marsh Mellow spring and remove M16 nut and washer.



## 2.5 TOOLING REQUIRED

List of tools and other related items required for the bogey drive setup, installation, removal and alignment procedures. Tools may be repeated in 2

### Removing the bogey drive.

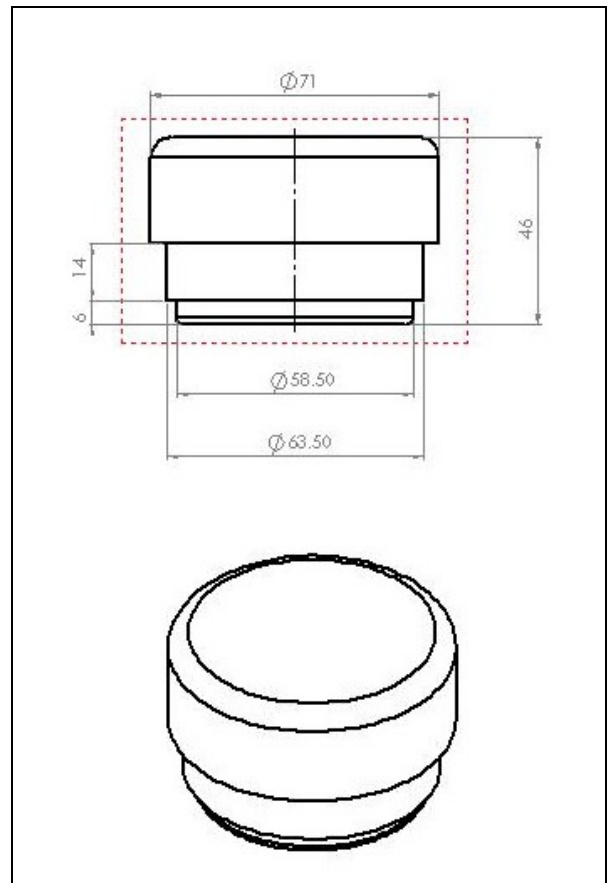
- M16 nuts and oversized washers for compressing the marshmallow.
- 2 eight ton bottle jack maximum un-extended height of 300mm. It is recommended that if multiple bogeys are to be removed (i.e. in the case of wheel replacement) that 2 bottle jacks are used.
- Miscellaneous timber blocks at least 10.
- Drop sheets-enough to cover the level 2 floor.
- 2 slings with a maximum rating of 1 ton-2 x 1000mm.
- Spring washers M16 high tensile- Minimum 100.
- Ring spanners-4 of 1" x 15/16".
- Long shanked socket 1" and ratchet.
- Block and tackle with capacity of 1 ton.
- Rubber mallet and ball pin hammer.
- 

### Replacing bogey wheel

- Ring spanners 18mm open ended and ring-2 of.
- Ring spanners ½" ring and open ended-2 of
- 1 set of metric and 1 set of imperial sockets-max 20mm.
- Grease cartridges (minimum of 4) and grease gun.
- Cellophane tape.
- Spring scale 0-5 kilograms.
- Brass drift for removing bearing cups.
- Rubber mallet and ball pin hammer.
- Azimuth bogey bearing end cap dollie.



**Azimuth Bogey Bearing End Cap Dollie**



**Azimuth bogey bearing end cap dollie dimensions made from nylon or similar material**

- Emery sand paper (fine grade).
- 3 lb. mallet with copper end for knocking in bearing end caps.
- 2 round 1 meter slings.
- 2 small flat head screwdrivers.
- 1 set of long nose pliers.



Brass Drift and mallet with copper head

### 3 AZIMUTH GUIDE ROLLERS

Azimuth Guide Rollers are in place to keep the dome in alignment from of any horizontal movement due to wind or other external factors. The Azimuth Guide Rollers also are in place as hurricane hook in case of severe wind causing the dome to lift. It is important to have the correct preload settings on the bearings; the wrong preload setting will damage the roller. Azimuth Guide Rollers must also be installed and aligned correctly to prevent damage to the dome and increase the durability of the rollers.

The following is a set of instructions to remove the azimuth guide roller, service the bearings, and adjust the preload settings on the bearings and to install the azimuth guide rollers.

#### 3.1 REMOVAL OF AZIMUTH GUIDE ROLLER



1. Loosen top bolts, 2 x M20.



2. Loosen locking nut on bottom bolt and remove bottom bolt, M20.



3. Lift Azimuth Guide Roller with leverage bar. Remove top bolts, 2 x M20.
4. Lift out Azimuth Guide Roller (35kg).

### 3.2 CHANGING BEARINGS AND REGREASING ROLLER

Aim is to inspect and service bearings and wheel.



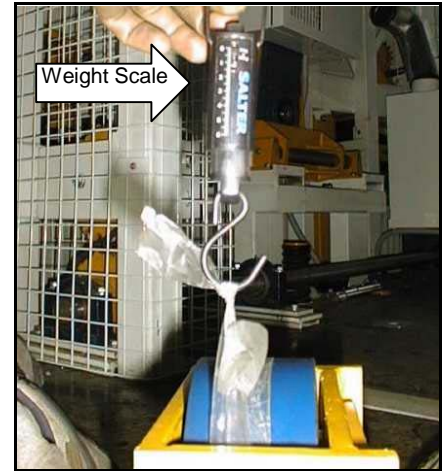
1. Remove 2x M8 nylock nut.
2. Remove azimuth guide wheel - axle.
3. Remove azimuth guide wheel – preload spacer. It may need to be tapped with a hammer to loosen from azimuth guide wheel box.
4. Remove azimuth guide wheel, shim washers and short preload spacer.
5. Remove Bearings from wheel. Check if bearings are acceptable (free of grit, smooth and seal is good) and the inner housing of the wheel is also acceptable (clean, free of grit and no scratch marks).
6. If bearings and wheel are acceptable then regrease and put bearing back in wheel. If bearings or wheel are not acceptable then replace them.
7. Regrease bearings with appropriate low temperature grease (Castrol LM or equivalent) using bearing grease-packing tool.
8. Clean the azimuth guide roller box, preload spacer, short preload spacer, shim washers, wheel axle and wheel so excess grease does not attract dust.
9. Fit azimuth guide roller back together. It is helpful to stick the shim washers to the wheel before installation using a dab of grease.
10. Put 2x M8 nylock nut back on studs and if necessary gives a pump of grease through grease nipple on wheel.

### 3.3 ADJUSTING PRELOAD SETTING ON BEARINGS

The aim is to get minimum friction torque and minimum endfloat with zero play.



1. Gradually and evenly tighten the 2 x M8 nylock nuts until the endfloat is removed.
2. Tighten 2 x M8 nylock nuts only by a fraction of a turn, at one time, until bearing seals and shims do not move when wheel is rotated.
3. Sticky tape a one meter belt to the wheel, wrap belt around circumference of wheel and connect belt to simple spring weight scale. Pulling from the weight scale find the static friction force required to make the wheel move. A force between 2.0 and 2.5 kg is acceptable.



4. If the force to move when the endfloat has been removed is unacceptable:
  - Loosen off bolts and try procedure again.
  - Bearings may not be functioning, check bearings.
5. Check for any endfloat and check to see if bearing seals or shims are moving when the wheel is rotated. The bearing seals and shims must not rotate when wheel is turned.

### 3.4 REFITTING AND ADJUSTING AZIMUTH GUIDE ROLLER

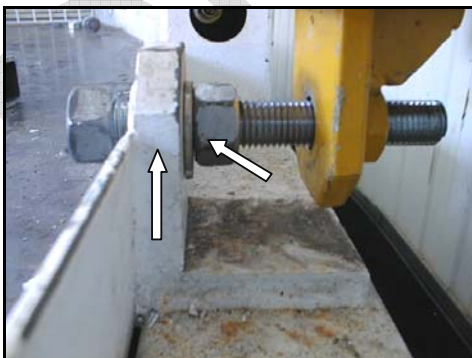
The aim is to align the azimuth guide roller box 10 mm below the top of the track and the roller 3 mm away from the track.



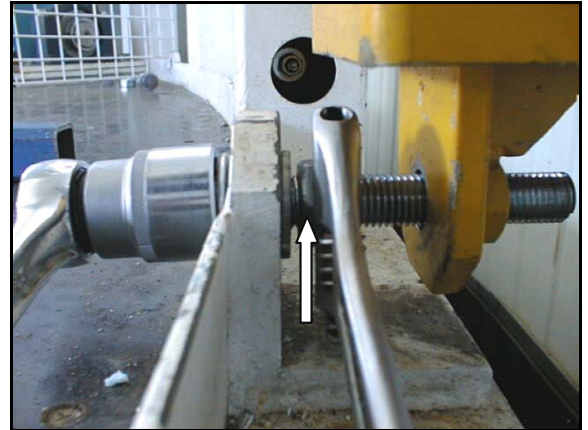
1. Place azimuth guide roller on leverage bar.
2. Align the top holes on the azimuth guide roller with the top bolts. Tighten top bolts and nuts to finger tight.



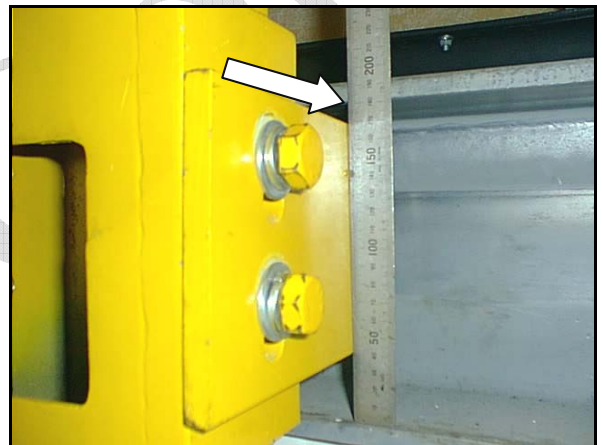
3. Use leverage bar to assist the alignment of the bottom hole and bolt.



4. Push azimuth guide roller so the roller is touching the track. Tighten the bolt and locking nut so they are flush against the adjuster bracket.



5. Unwind the locking nut one rotation. Hold the nut with a spanner and tighten the bolt to 70 Nm.
6. Tighten the top bolts, 2 x M20 to 40 Nm.



7. The top of the azimuth guide roller box should be 10 to 15 mm away from the top of the track. If the box is more than 15 mm away from the top of the track then adjust. Loosen the M16 hex bolts, move the box to 10 mm away from the top of the track and tighten the bolts to 90 Nm.
8. Check the distances between the azimuth guide roller and the track. Check that the bolts are tightened to recommended torque settings.

## 4 SHUTTER CHAIN

### 4.1 SHUTTER CHAIN TENSIONING PROCEDURE

#### 4.1.1 Location of Components

Figure 4.1 shows the area of the enclosure in which the Chain tensioner components are located.

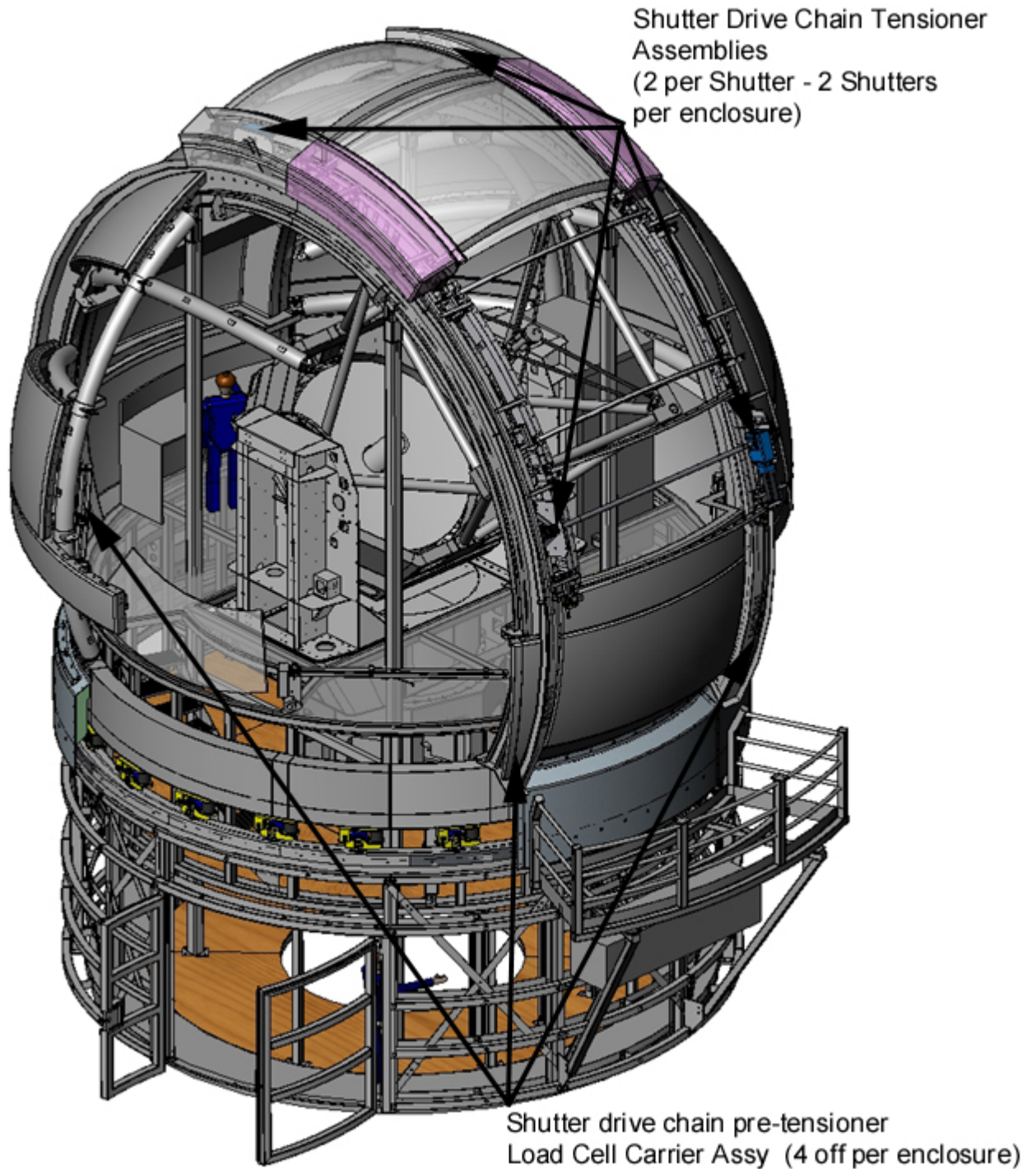


Figure 4.1

#### 4.1.2 Procedure For Tensioning Chain.

To begin the tensioning of the shutter chain, it is assumed that the Front Shutter (AD-07715) Rear Shutter (AD-07716), Shutter Drive Chain Pre-tensioner Assembly (AD-08062) and Load Cell Carrier Assembly (AD 500013) have been fitted to the Archbeams as shown in Figure 4.3.

- a) Ensure front and rear shutters are in the position shown in Figure 4.2, also see figure 4.3 for additional reference.

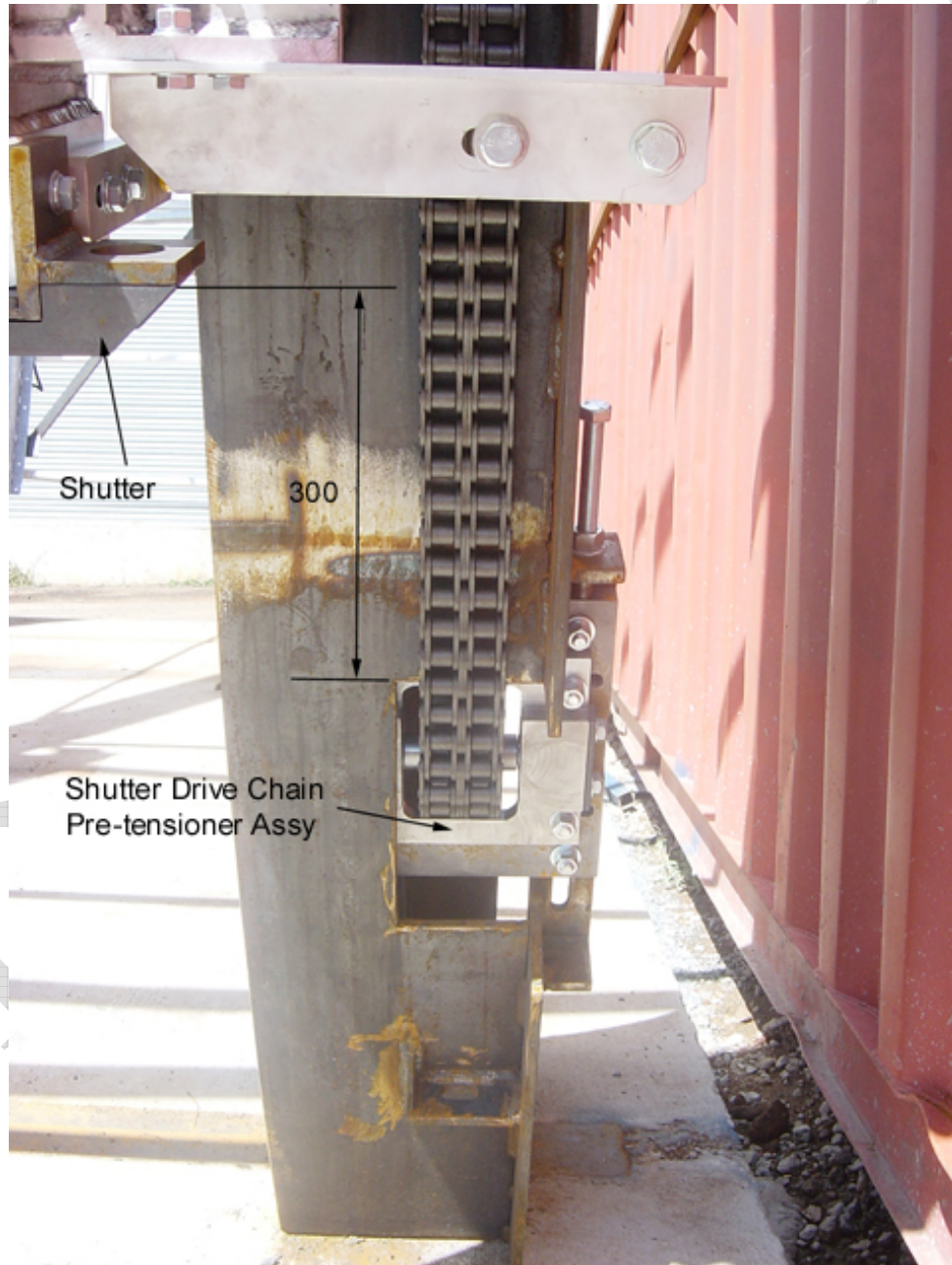


Figure 4.2



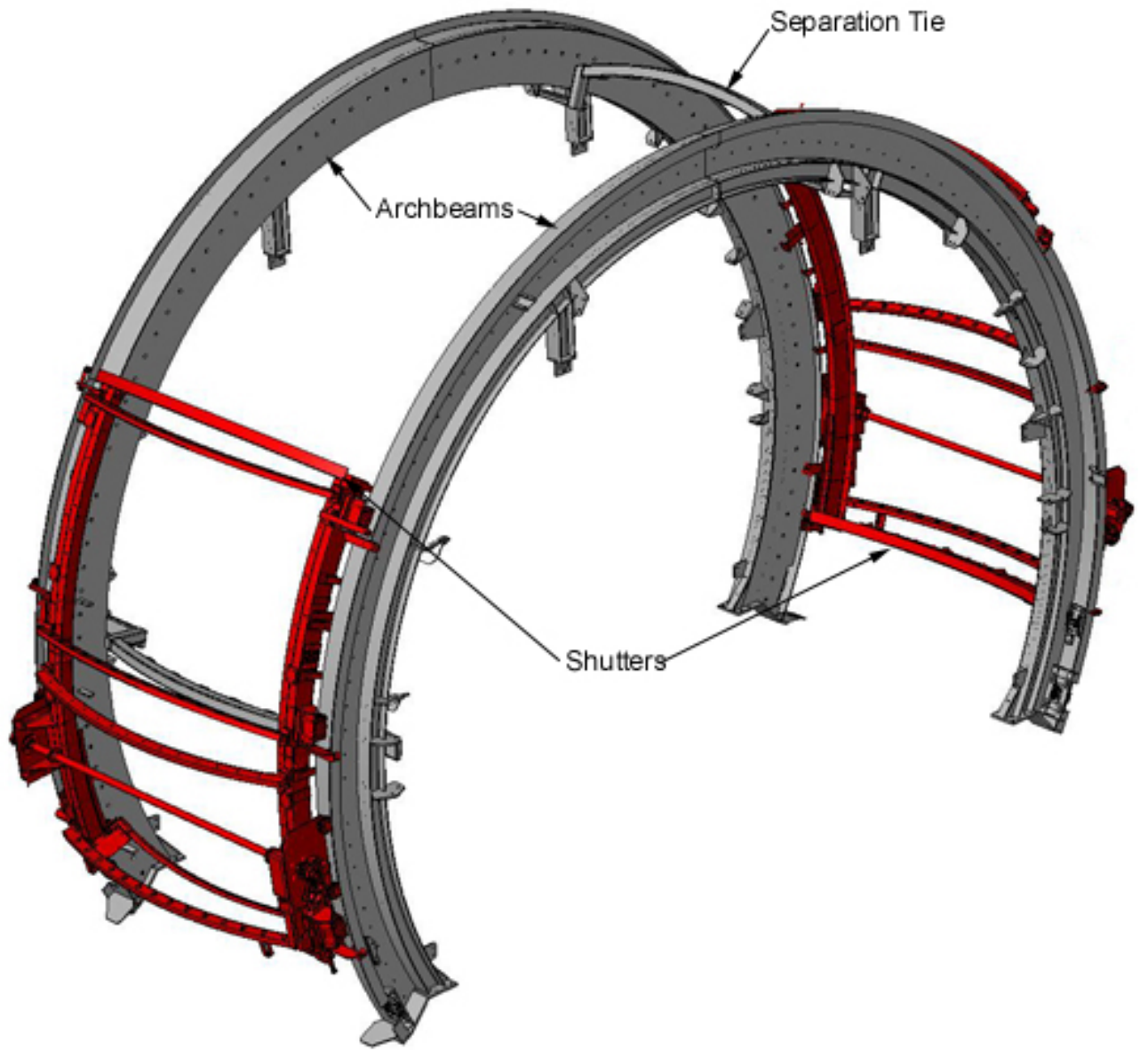


Figure 4.3

- b) Ensure that the shutters are centred with respect to the archbeam- and that the Drive Transfer Shaft is horizontal – see Figure 4.4.  
The position of the shutters can be supported and adjusted by using cum-alongs mounted to the Shutter Frame and Separation ties.

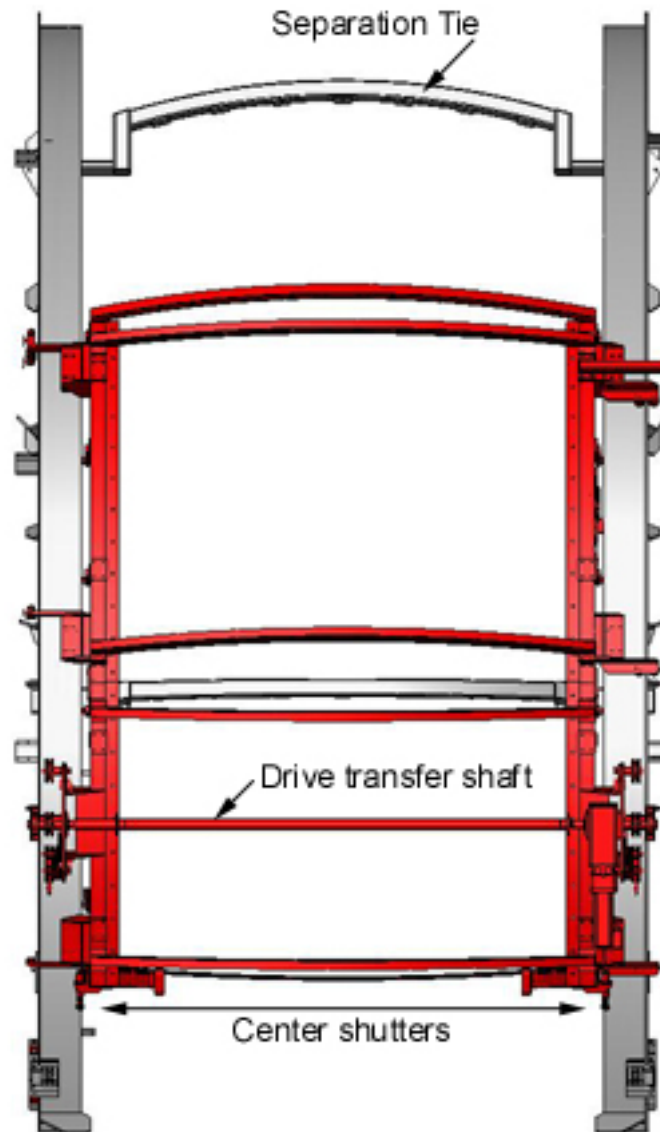


Figure 4.4

- c) Thread both chains through Shutters and Chain Tensioners as per GAD ASY500714

- d) When attaching chain to Load Cell carrier, ensure that M14 Shoulder Bolt is inserted past 5mm sighting hole in Chain Yoke – see Figure 4.5 and Figure 4.6.

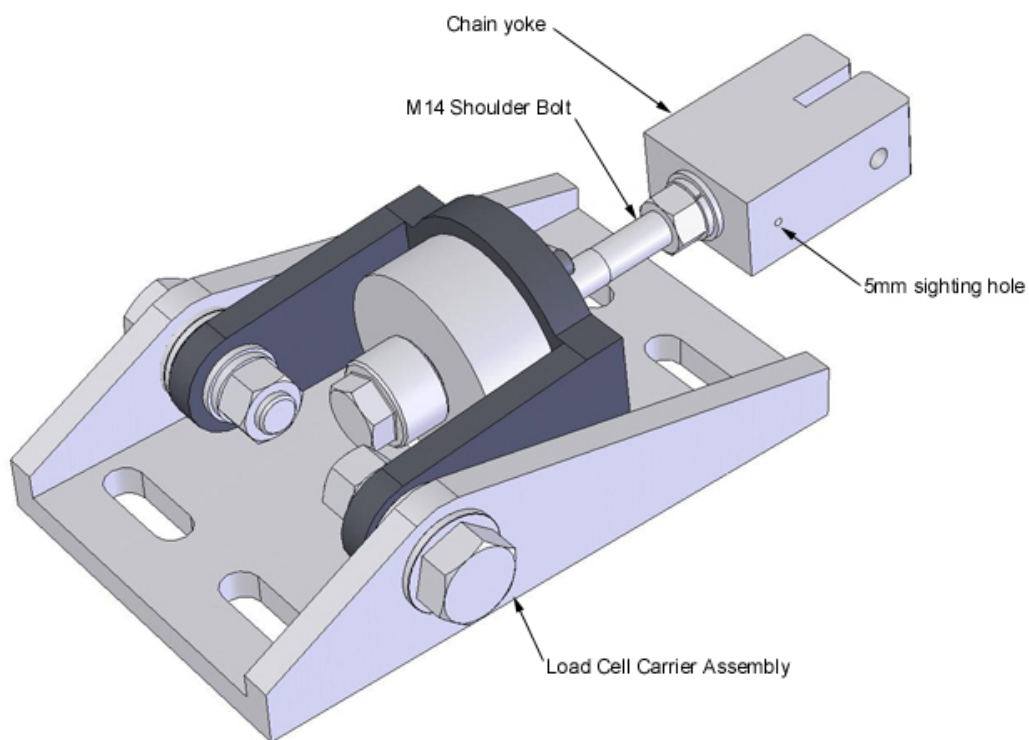


Figure 4.5

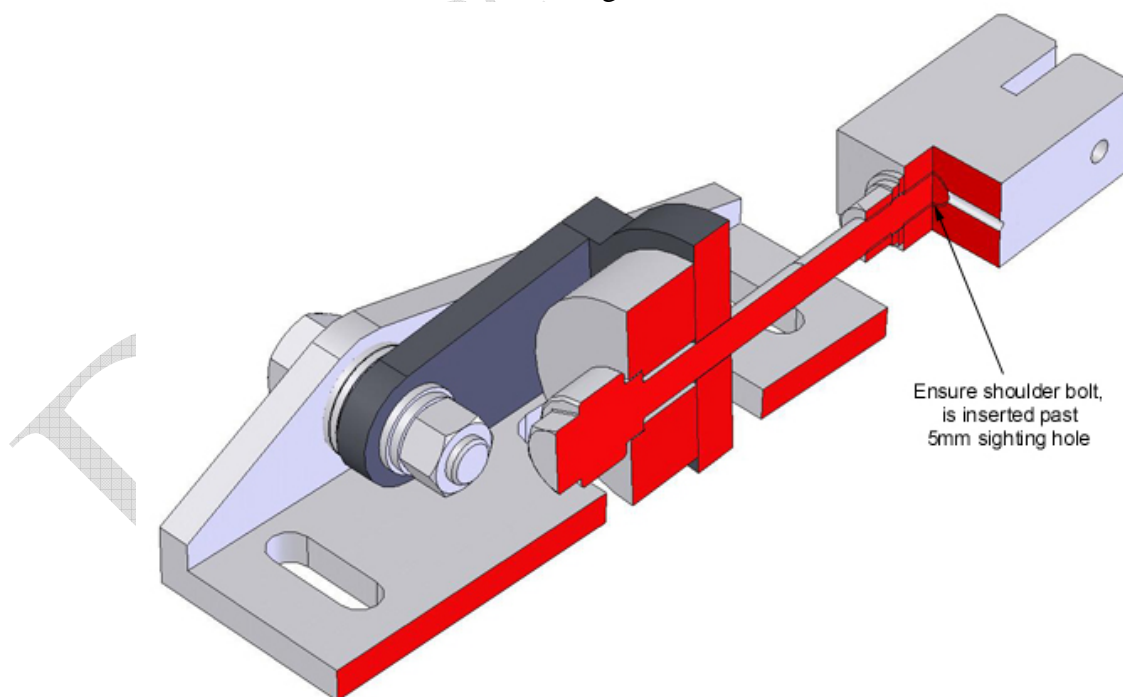


Figure 4.6

- e) Remove cum-alongs from shutters.
- f) Working on one corner of the archbeam.  
Loosen the longitudinal adjustment clamping screws shown in Figure 4.7.

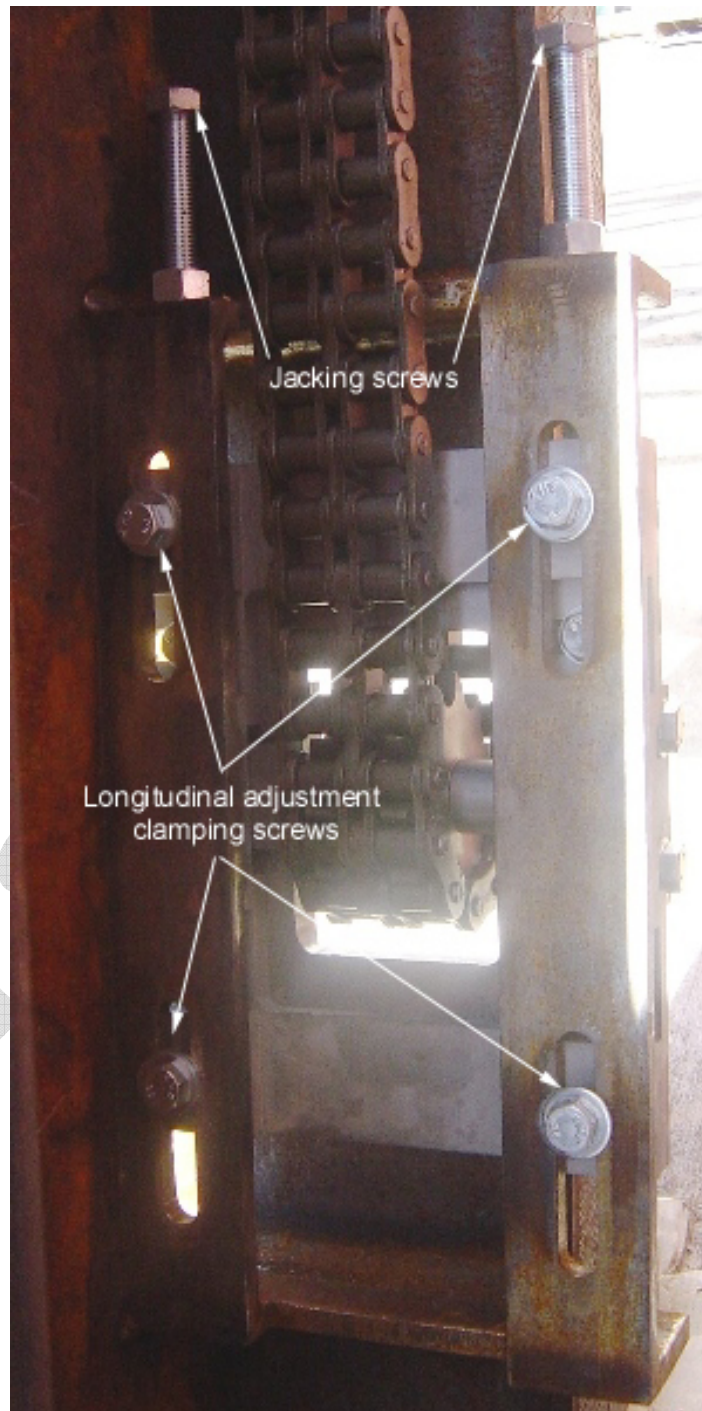


Figure 4.7

- g) Check the Shutter Drive Chain Tensioner Assembly dimension shown in Figure 4.9. If this dimension is not 94mm or the Indicator nut is not hard up against the backing plate, then contact EOS site supervisor.

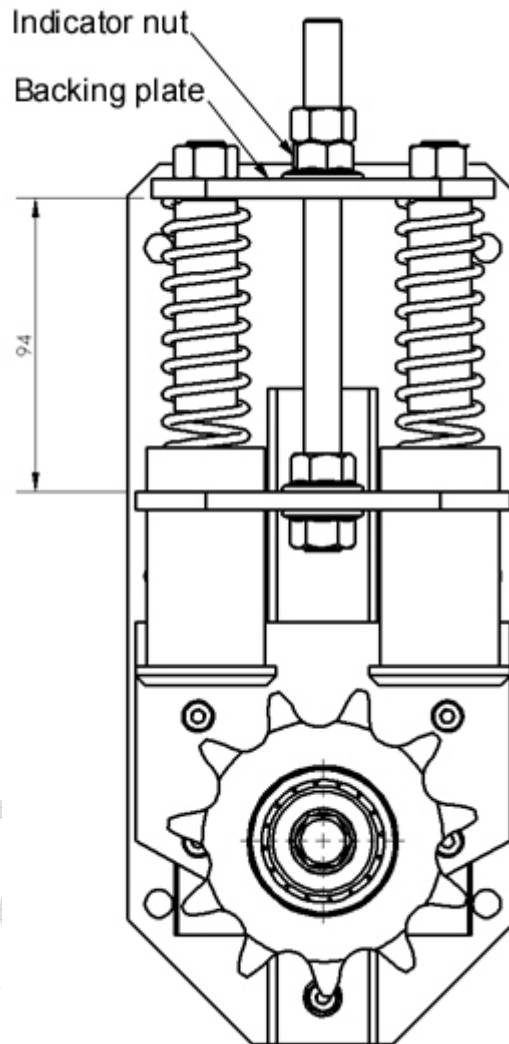


Figure 4.9

- h) There are 2 jacking screws per Shutter Drive Chain Pre-tensioner Assembly. Loosen the lock nuts on both of the Jacking screws. Tighten the jacking screws as shown in Figure 4.10, care should be taken to ensure that the Jacking screws are tightened by equal amounts to prevent the chain tensioner assembly from moving out of line with the archbeam. Continue to tighten until the distance between the backing plate and indicator nut is 35mm- see Figure 4.11.



Figure 4.10

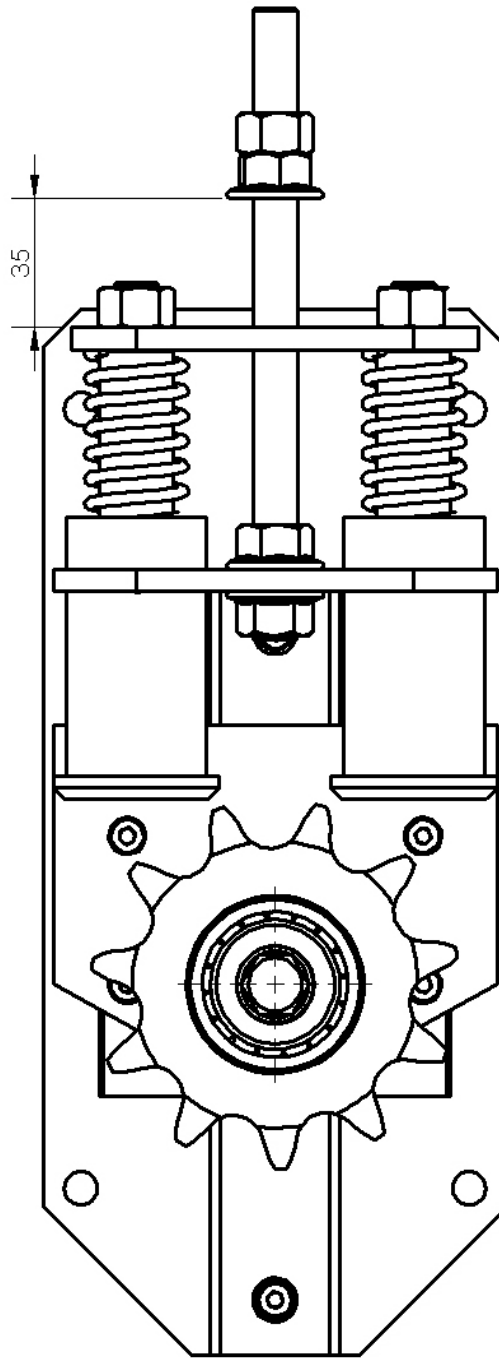


Figure 4.11

- i) Check the distance from the underside of the jacking screw bolt head, to the outside of the Shutter Drive Chain Pre-tensioner Assembly plate(see Figure 4.12) on both jacking screws, and check to ensure they are equal.

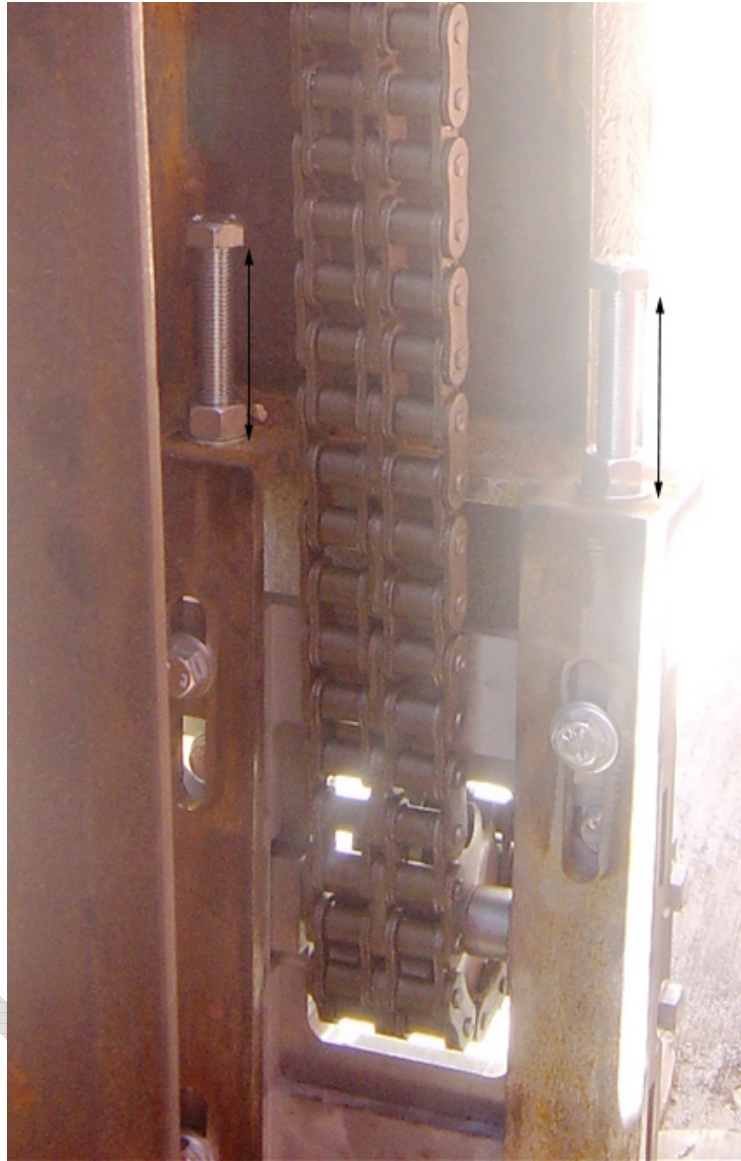


Figure 4.12

- j) Tighten down lock nuts on jacking screw.
- k) Tighten longitudinal adjustment clamping screws.



### 4.1.3

### Procedure For Alignment Of Chain.

- a) Continuing to work on the same corner of the archbeam, loosen transverse adjustment clamping screws on Shutter Drive Chain Pre tensioner, see Figure 4.13.

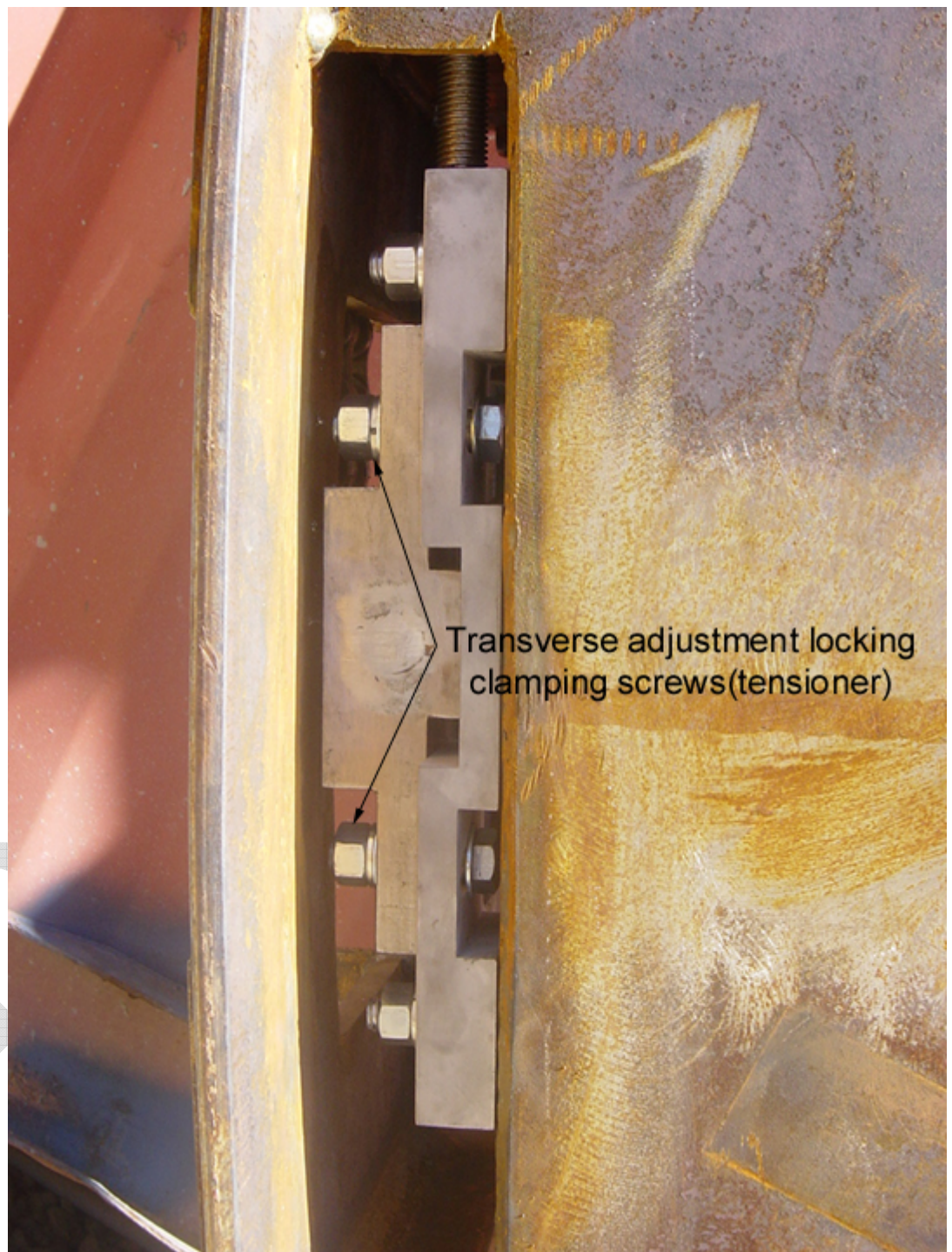


Figure 4.13

- b) Loosen transverse adjustment clamping screws on Load Cell Carrier Assy-  
See Figure 4.14.

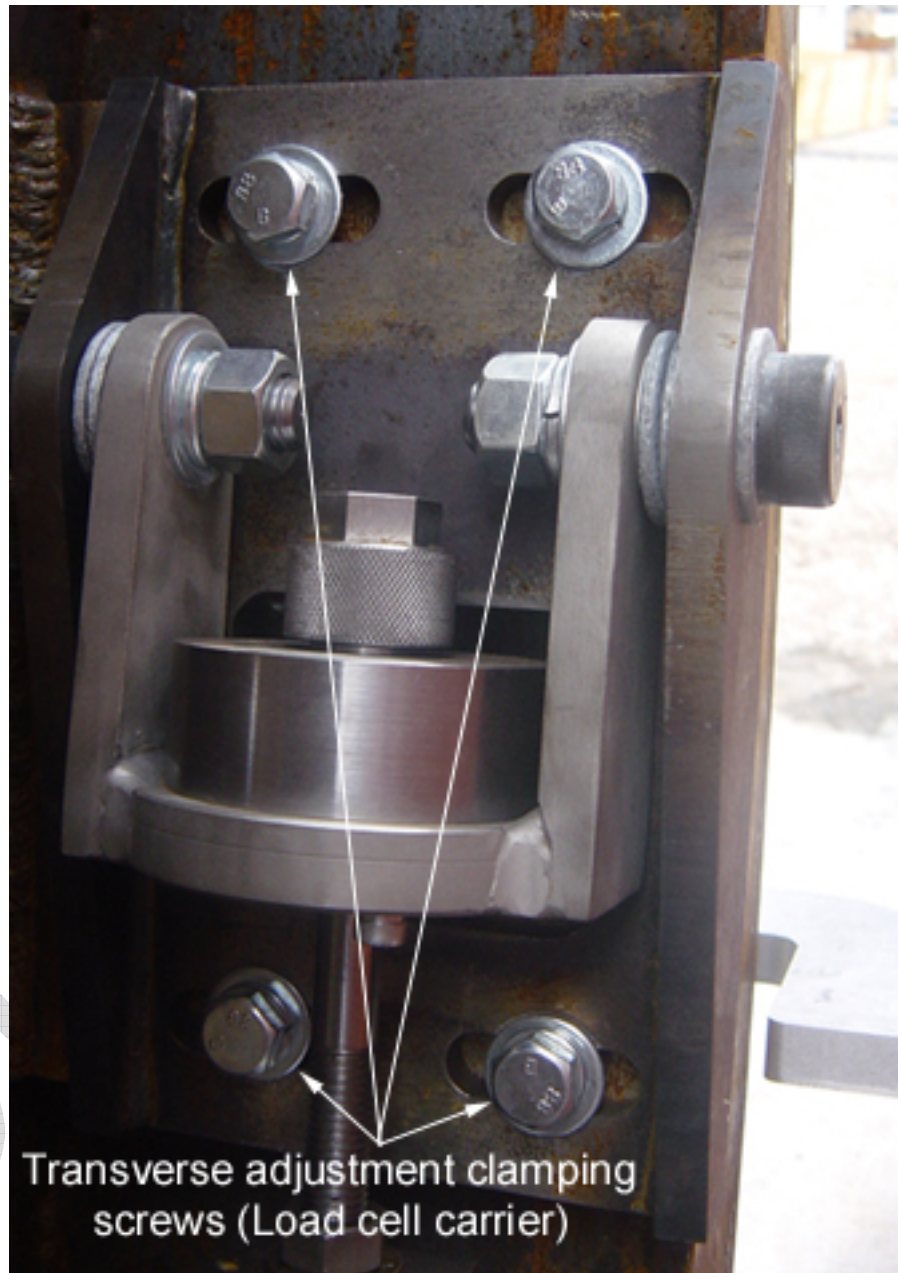


Figure 4.14

- c) Slide the load cell carrier (the Shutter Drive Chain Pre-tensioner should follow as the load cell is moved – but it may require some additional force to move) until the chain is parallel with the archbeam – this is achieved by measuring the distance between the chain and archbeam in two places on both sides of the archbeam -see Figure 4.15 and 4.16, until the chain is parallel to the edge of the archbeam.

It should be assumed that the edge of the archbeam is straight and normal to the ground, but if by sight this is not the case, then an alternative straight and perpendicular edge should be used.

To double check this measurement, seek an alternative edge to measure against. see Figure 4.17.

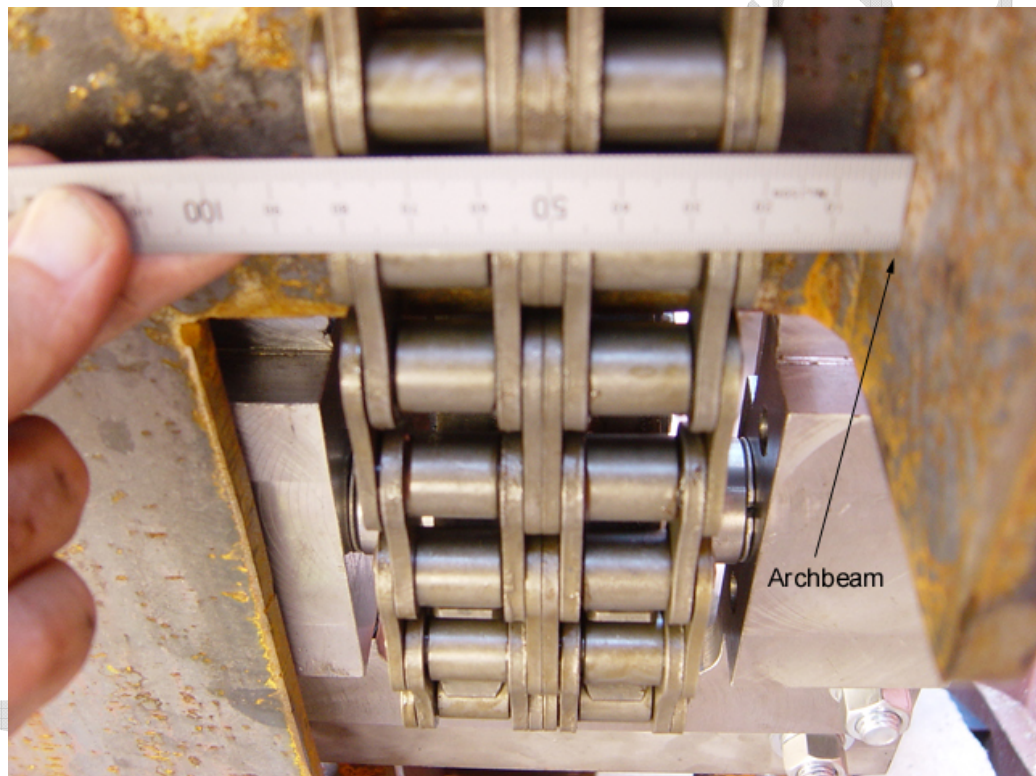


Figure 4.15



Figure 4.16

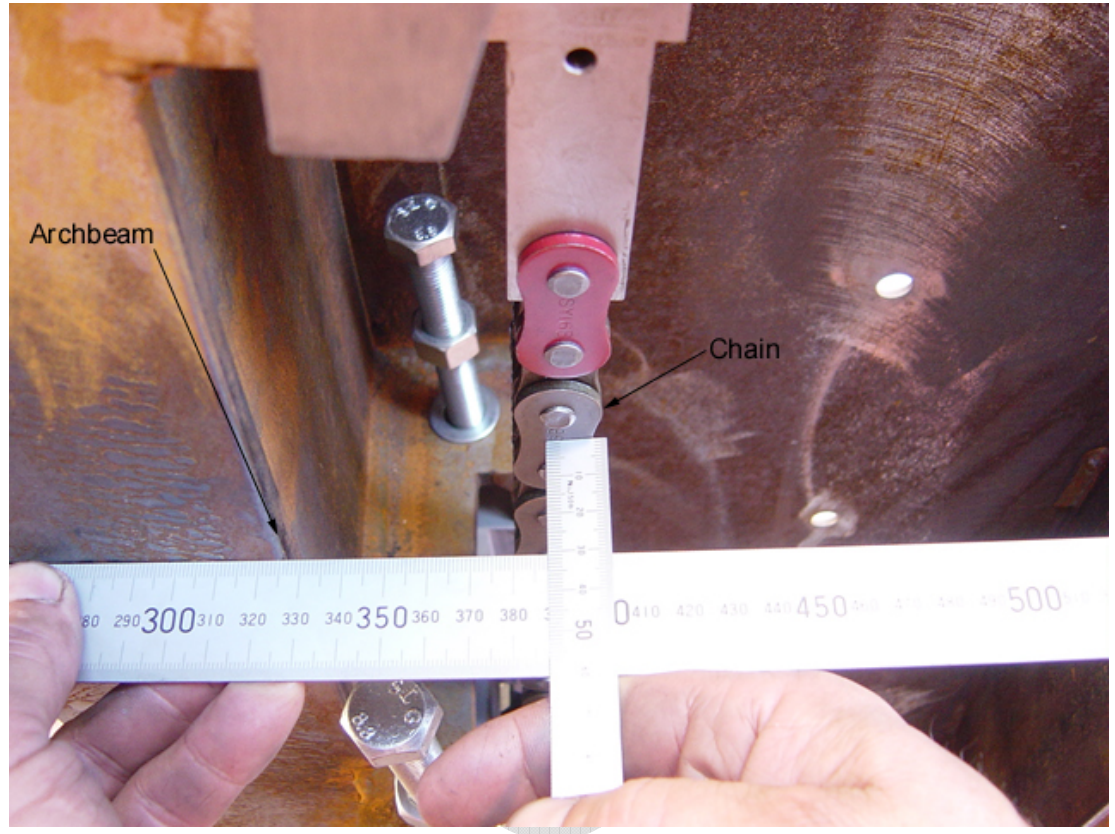


Figure 4.17

- d) Tighten transverse adjustment clamping screws on Load Cell Carrier Assy .
- e) Tighten transverse adjustment clamping screws on Shutter Drive Chain Pre-tensioner.

The procedure for tensioning and aligning the chain (below), needs to be repeated for each of the remaining Shutter Drive Pre-tensioners.

#### 4.1.4 Drive Chain Tension and Alignment Check

To be carried out once all necessary adjustments have been made to the shutter (end of limit travel stops etc).

- a) Both shutters should then be run to an approx position as shown in Figure 4.18, the exact position is not critical, but they should be at a position that is equal about centreline as shown in Figure 21.
- b) Run shutters back to position shown in Figure 4.3.

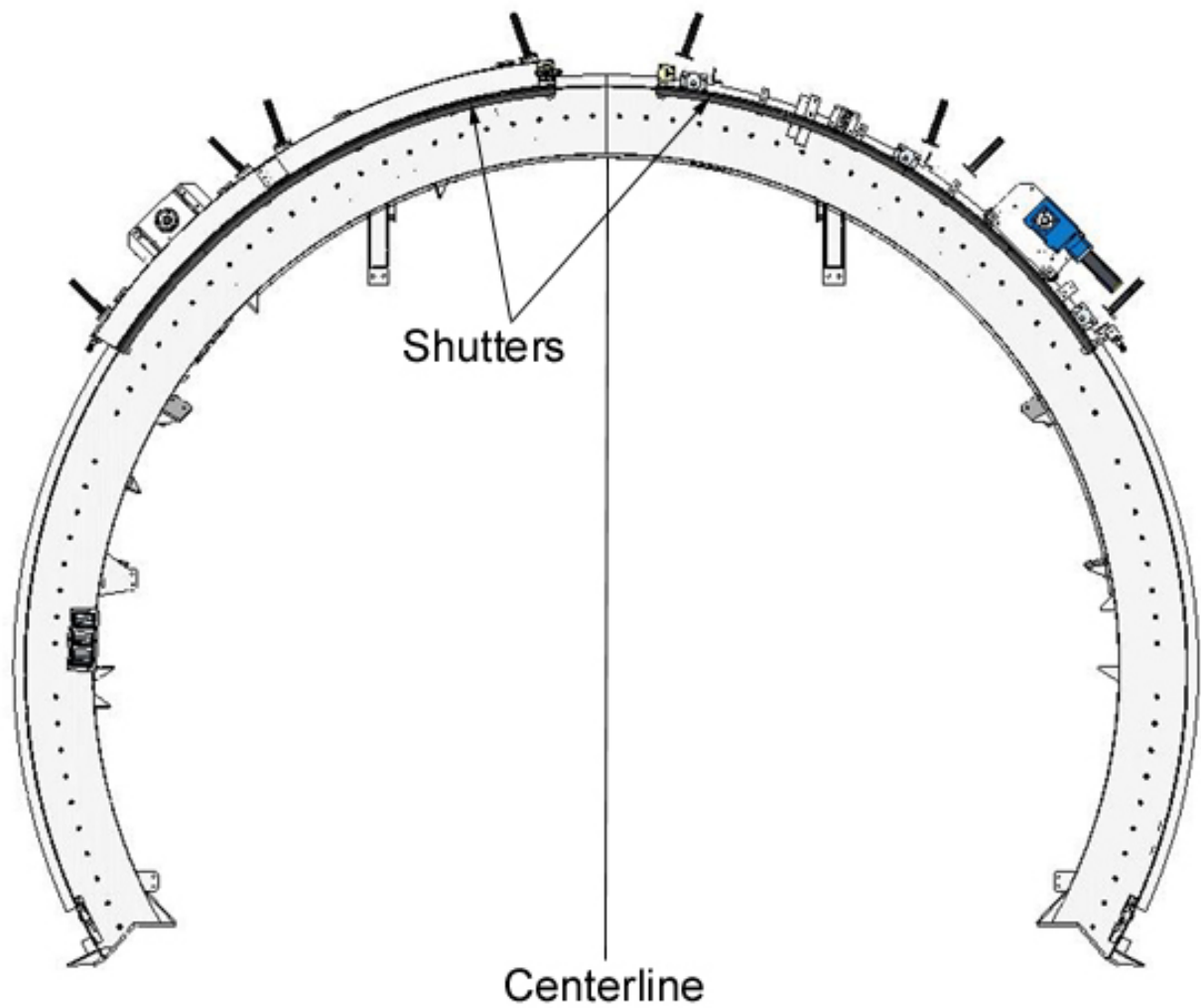


Figure 4.18

c) Starting on one corner of the Archbeam, follow the procedure detailed in **4.1.2h** through to **4.1.2k**, the only exception to this is the distance between the backing plate and nut should be **70mm** see Figure 4.19.

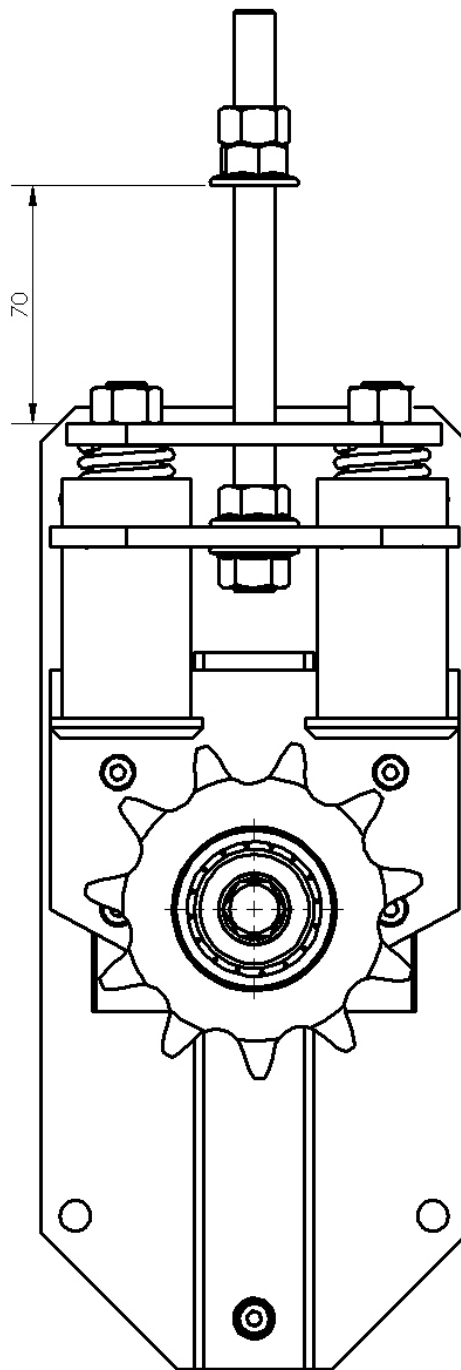


Figure 4.19

- c) Check the alignment of the chain as detailed in 4.1.3c if the chain is not parallel, then repeat the procedure detailed in 4.1.3 *Procedure for Alignment of Chain*.
- d) Repeat for remaining Shutter Drive Chain Tensioner Assemblies and Shutter Drive Chain Pre-tensioner assemblies.

Check: Visually check the chain separation from the archbeam flanges on both sides. The gap should be identical for the rear side and the front side, else the shutters will pull off line near their ends of travel, and will strain the lateral guide rollers out of alignment. If separations are not the same on each side, review 4.1.3 a, b and c above to fine tune the alignments. Check lateral guide roller brackets for correct setting near end of travel also.

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## 4.2 REMOVAL OF GEARBOX SUB-ASSEMBLY

- a) Lock shutter using shutter locking plates (scorpions).
- b) Electrically isolate motor & disconnect cables.
- c) Slacken off chain at pre-tensioner assembly & if required break chain by removing joining link at convenient location. Disengage chain from drive & idler sprockets.
- d) Remove electric motor. This step is not necessary but is recommended for ease of sub-assembly removal. Remove outrigger rail.

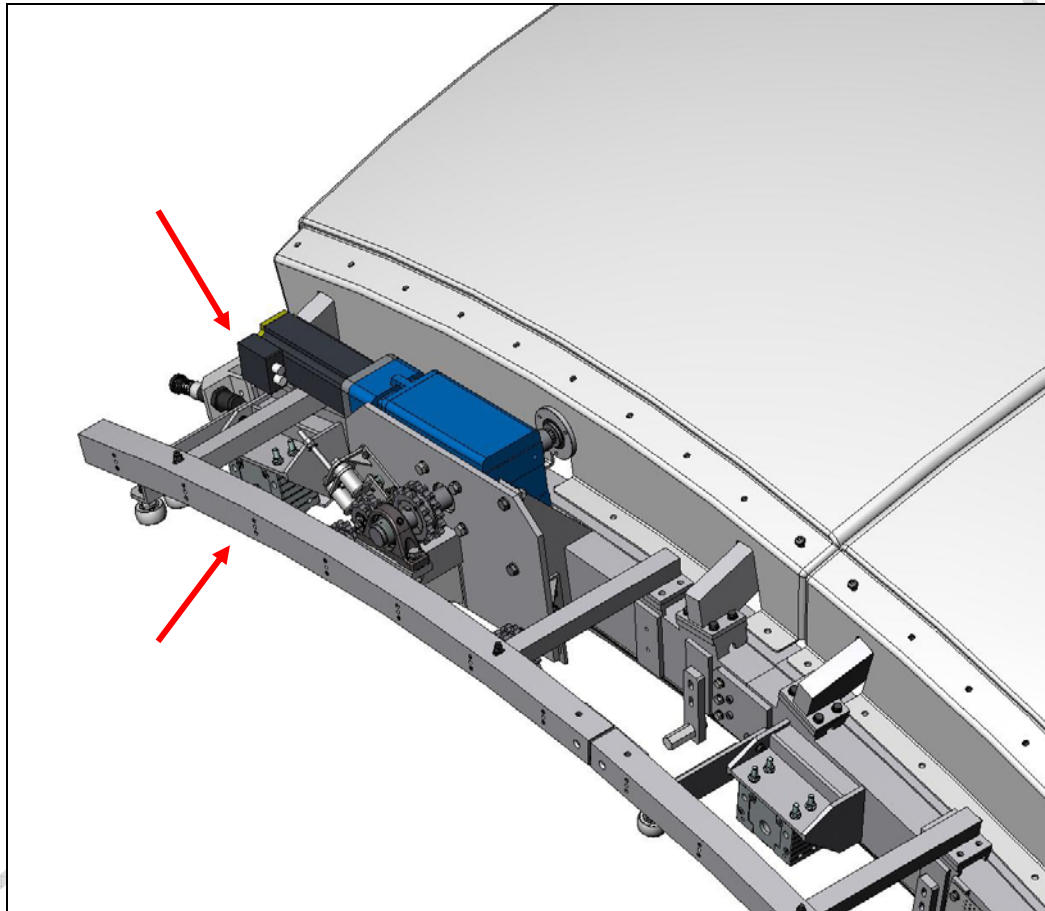


Figure 4.20

Remove M24 bolt & washers. Remove both idler assemblies.

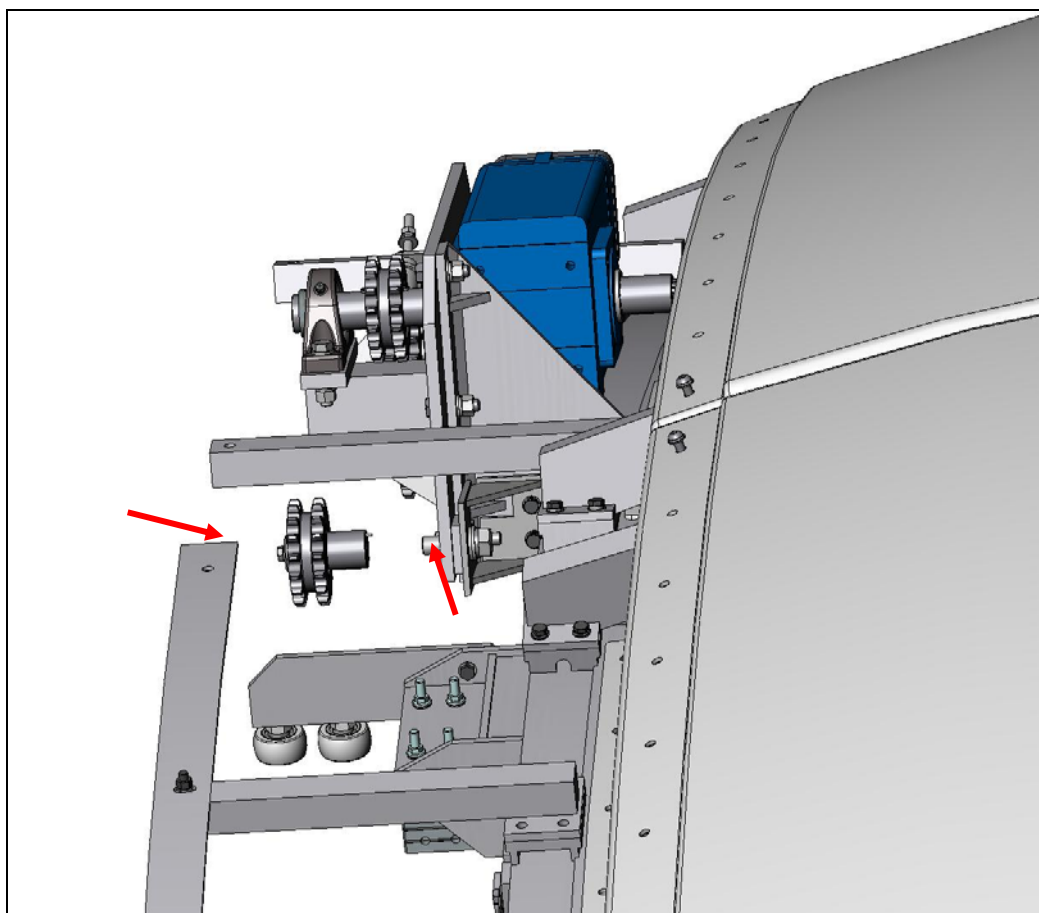


Figure 4.21

- e) Sling around gearbox & drive plate to support mass. Note mass of sub-assembly to be removed is approx 90kg.

- f) Support transfer shaft. Once the drive shaft has been removed, an alternate means of transfer shaft support **may** be required if the FRP is not sufficiently stiff enough around the seal housing. Note weight from the transfer shaft at this point is approx 5kg.

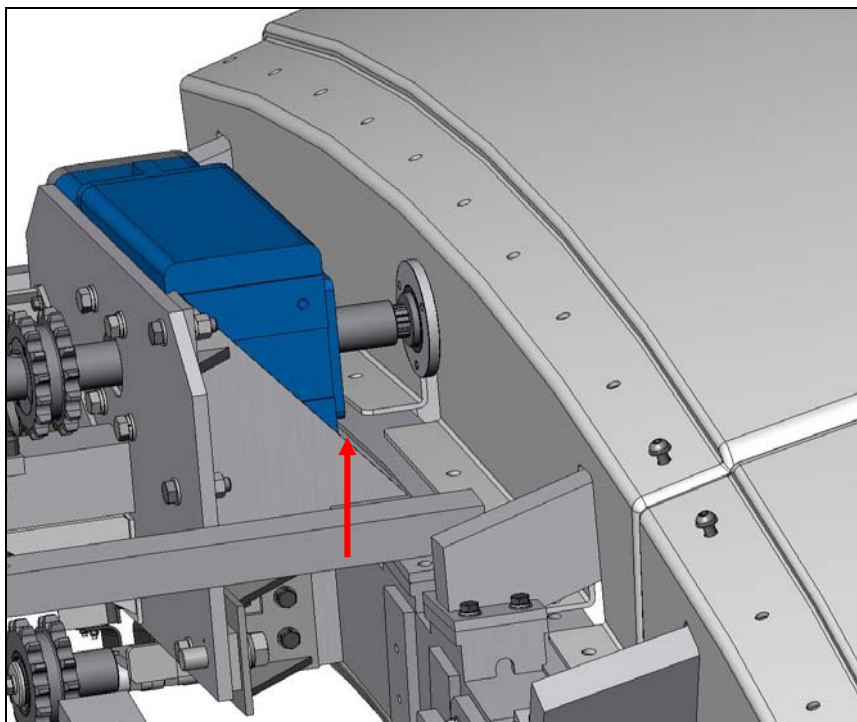


Figure 4.22

- g) Remove the M16 fasteners that hold the drive plate to the longitudinal beam. There are 3 fasteners on one side & 2 fasteners on the other side. Note that if installed, the drive plate gussets can remain fitted to the longitudinal beam.

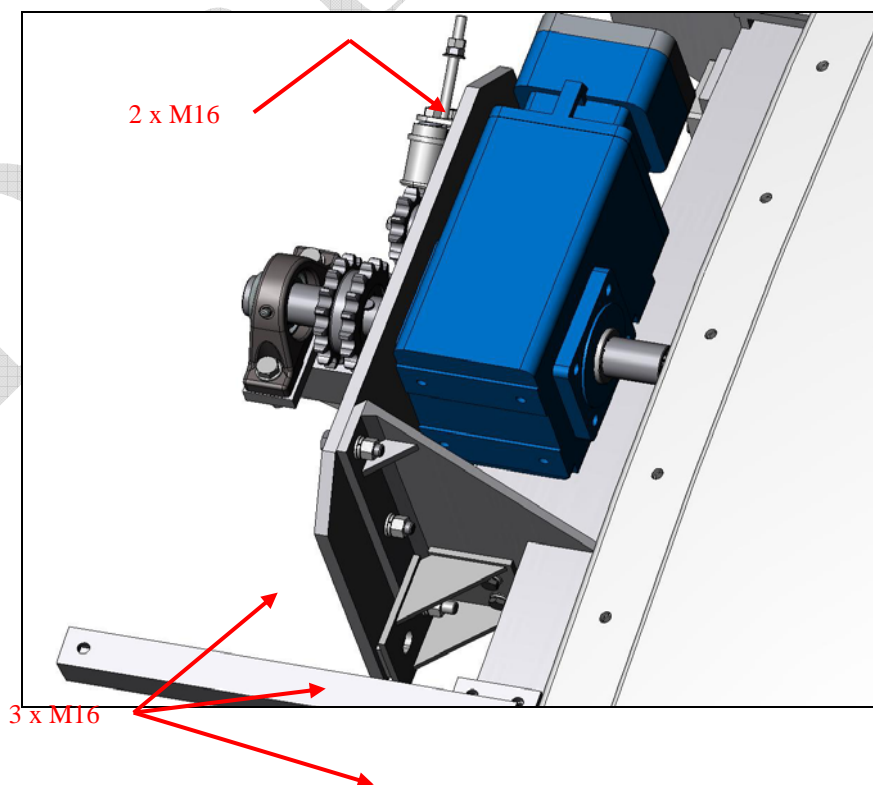
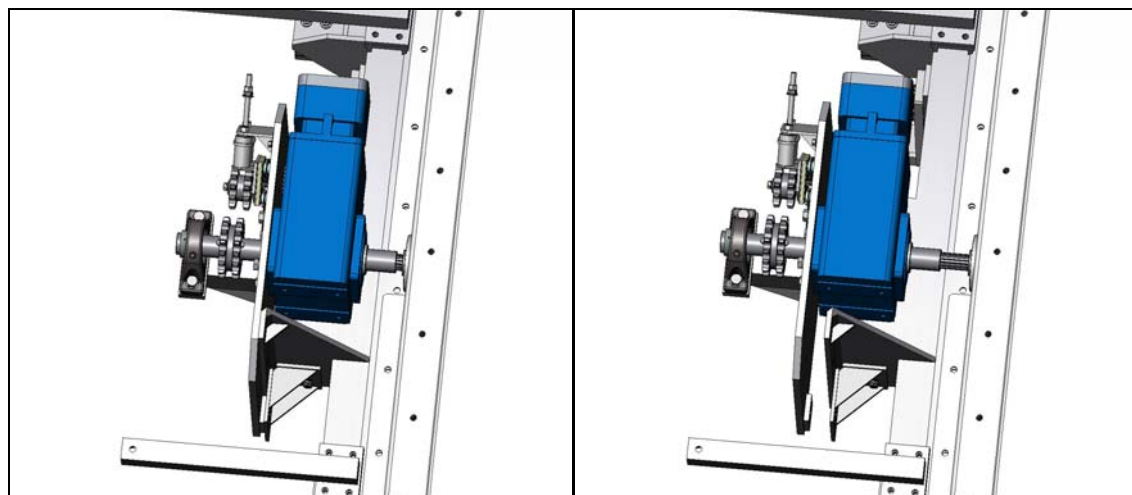


Figure 4.23

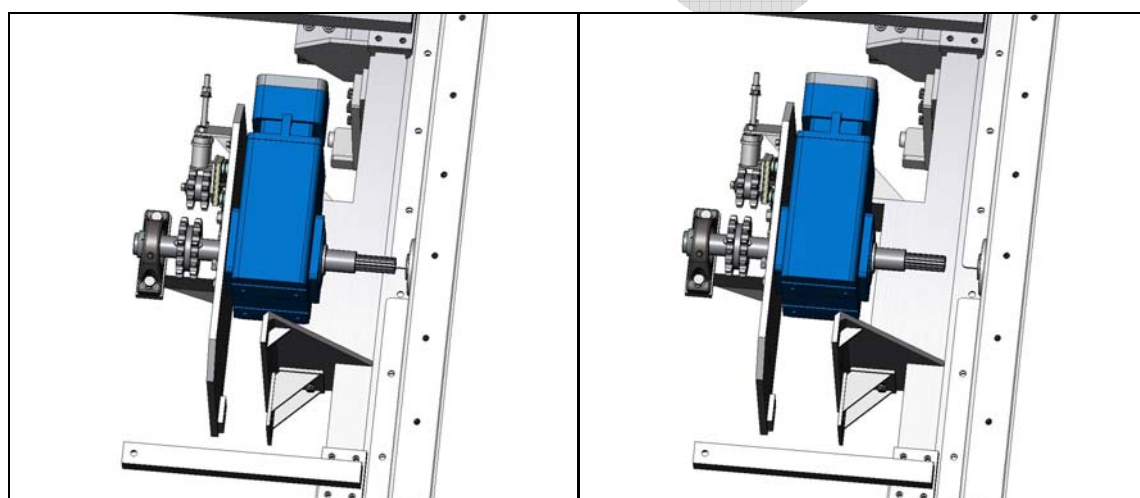
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h) Ensure that the sub-assembly is still supported via the sling. The sub-assembly, (including the gearbox, drive plate, drive shaft, sprocket, outboard bearing & chain tensioner), can now be carefully withdrawn from the transfer shaft splined coupling. Care is required as to not damage the transfer shaft seal housing & FRP, as well as the aluminium structure. The sub-assembly can now be lifted up & away.



Step 1

Step 2



Step 3

Step 4

Figure 4.24

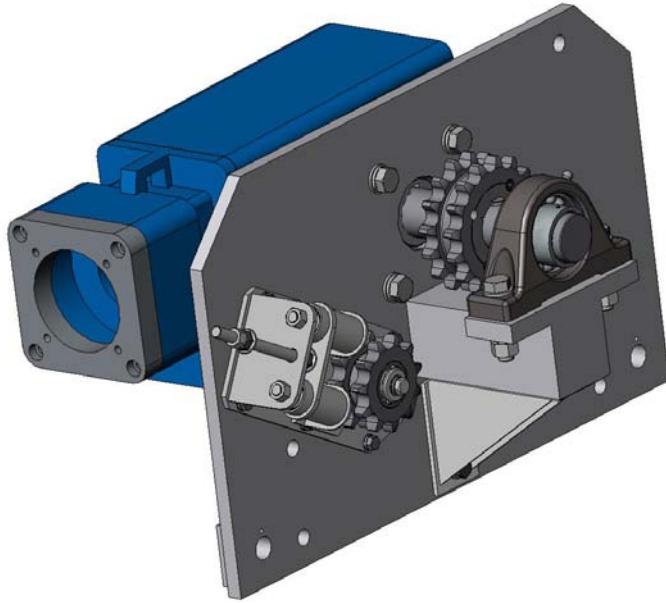


Figure 4.25 Sub-assembly to be removed (front view)

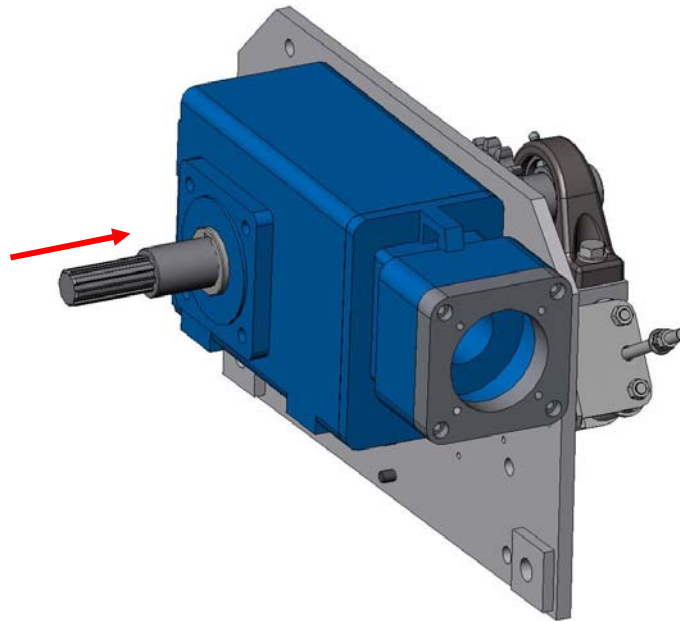


Figure 4.26 Sub-assembly to be removed (back view)

**Note: if persuasion is required to remove from splined coupling, it is preferred to tap gearbox journal or gearbox housing near journal.**

### 4.3 DISASSEMBLY OF GEARBOX SUB-ASSEMBLY

#### 4.3.1 Method No.1 – Gearbox

This is the preferred method for disassembly as it is the easiest & keeps the shimming of the outboard bearing intact. However it is only possible if the shaft is an easy fit in the gearbox journal. This is dependant on the original shaft fit & the condition of the shaft's surface finish due to environmental exposure.

a) Remove the 4 x M16 fasteners which hold the gearbox to the drive plate.

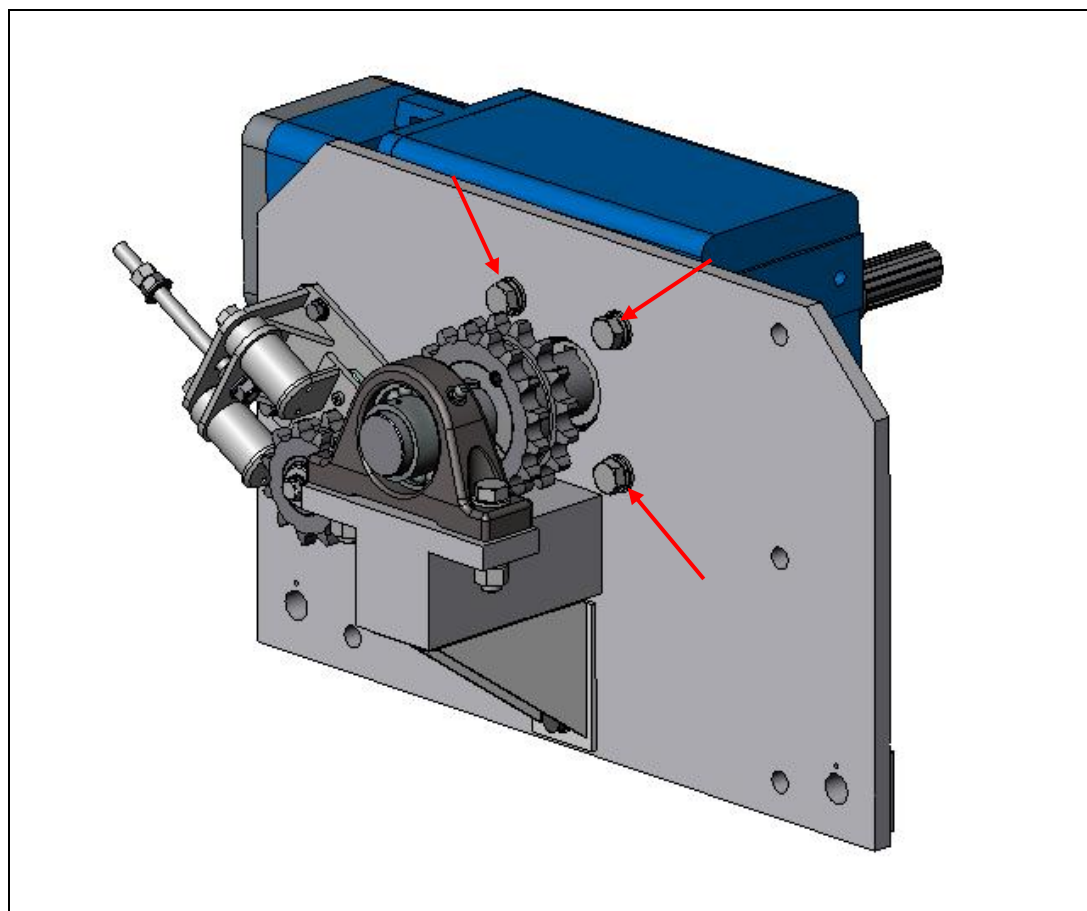


Figure 4.27

- b) Carefully withdraw the gearbox off the drive shaft. Note that if it not easily released then proceed to Method No 2.

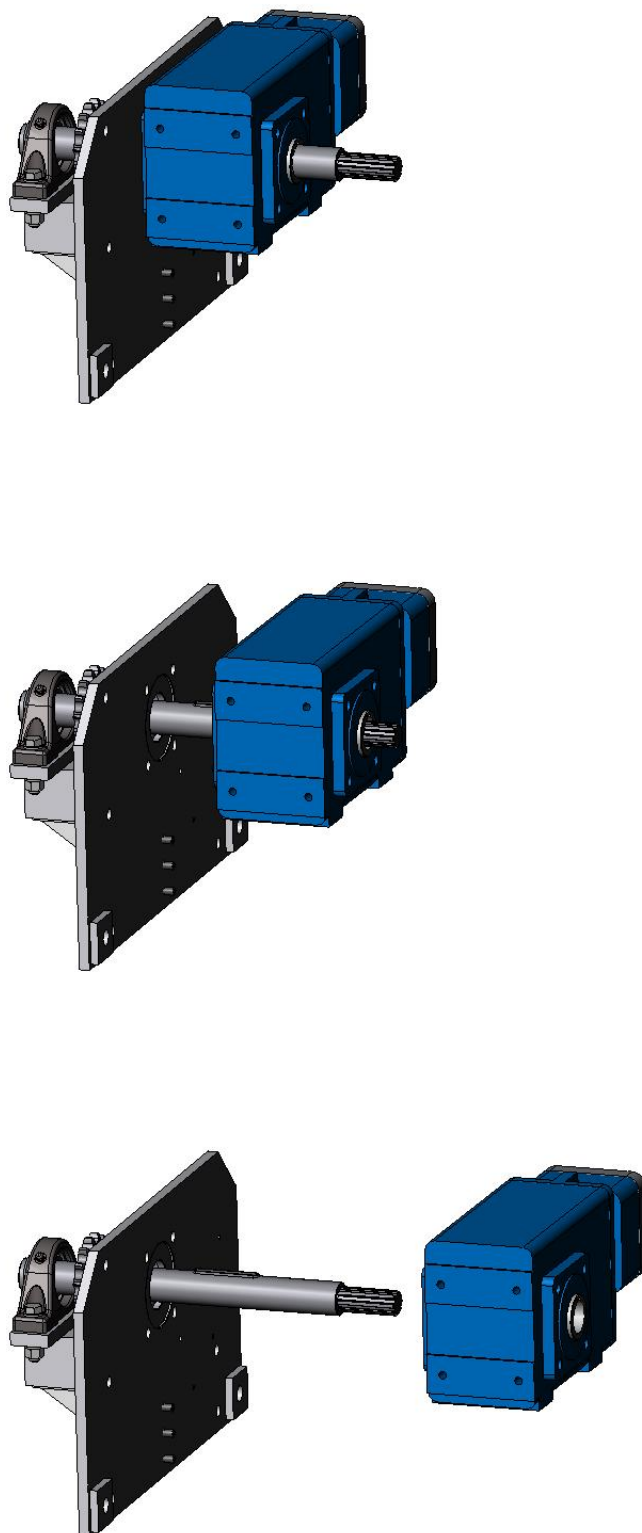


Figure 4.28



### 4.3.2 Method No.2 – Shaft

- a) Loosen & remove the 2 x M16 outboard bearing fasteners. Loosen the grub screw that locks the bearing inner race to the shaft.
- b) Remove outboard bearing from shaft. Keep shim material. Before removal of drive sprocket measure & record the distance between the sprocket face & the drive plate. It is important that on reassembly this distance is the same so that alignment between the idler, tensioner & drive sprockets is maintained.

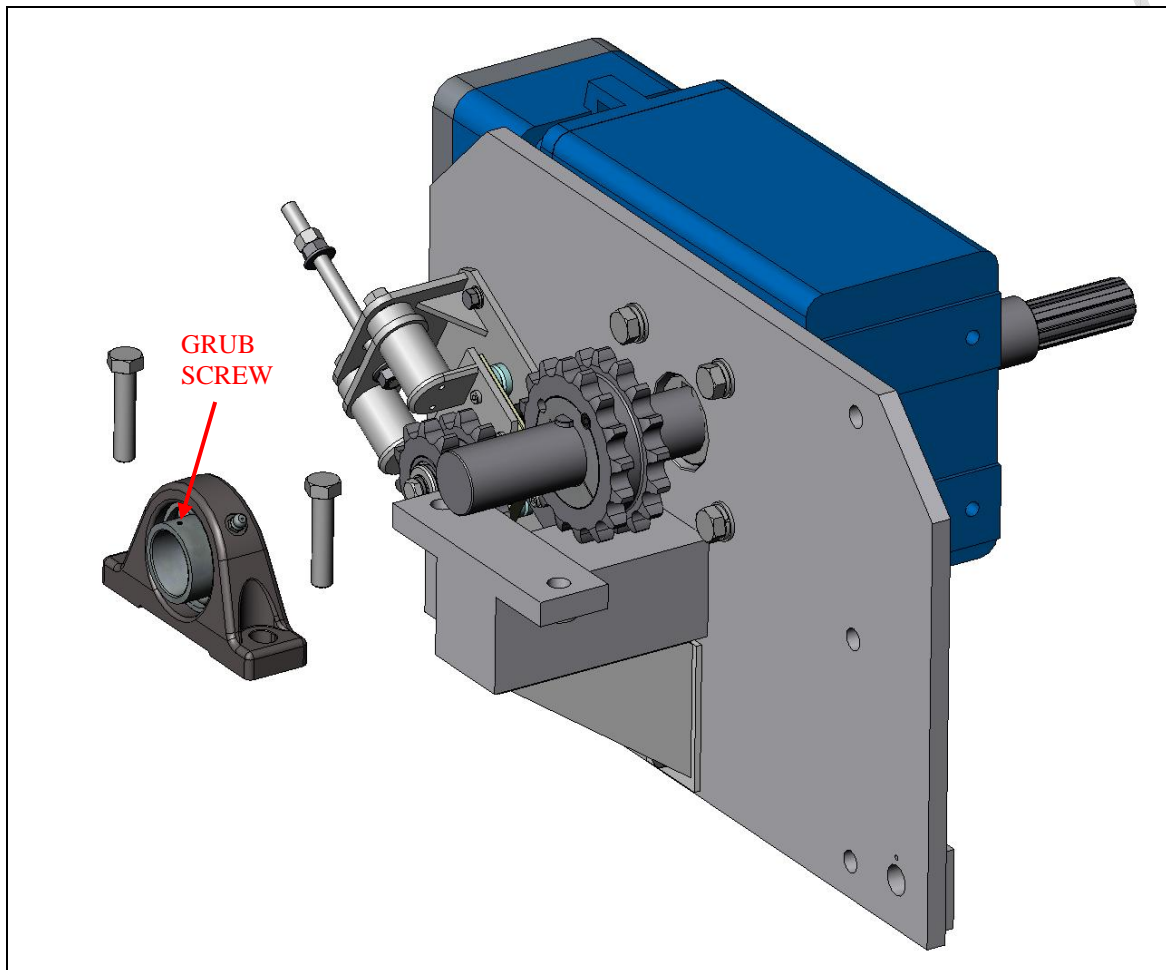


Figure 4.29

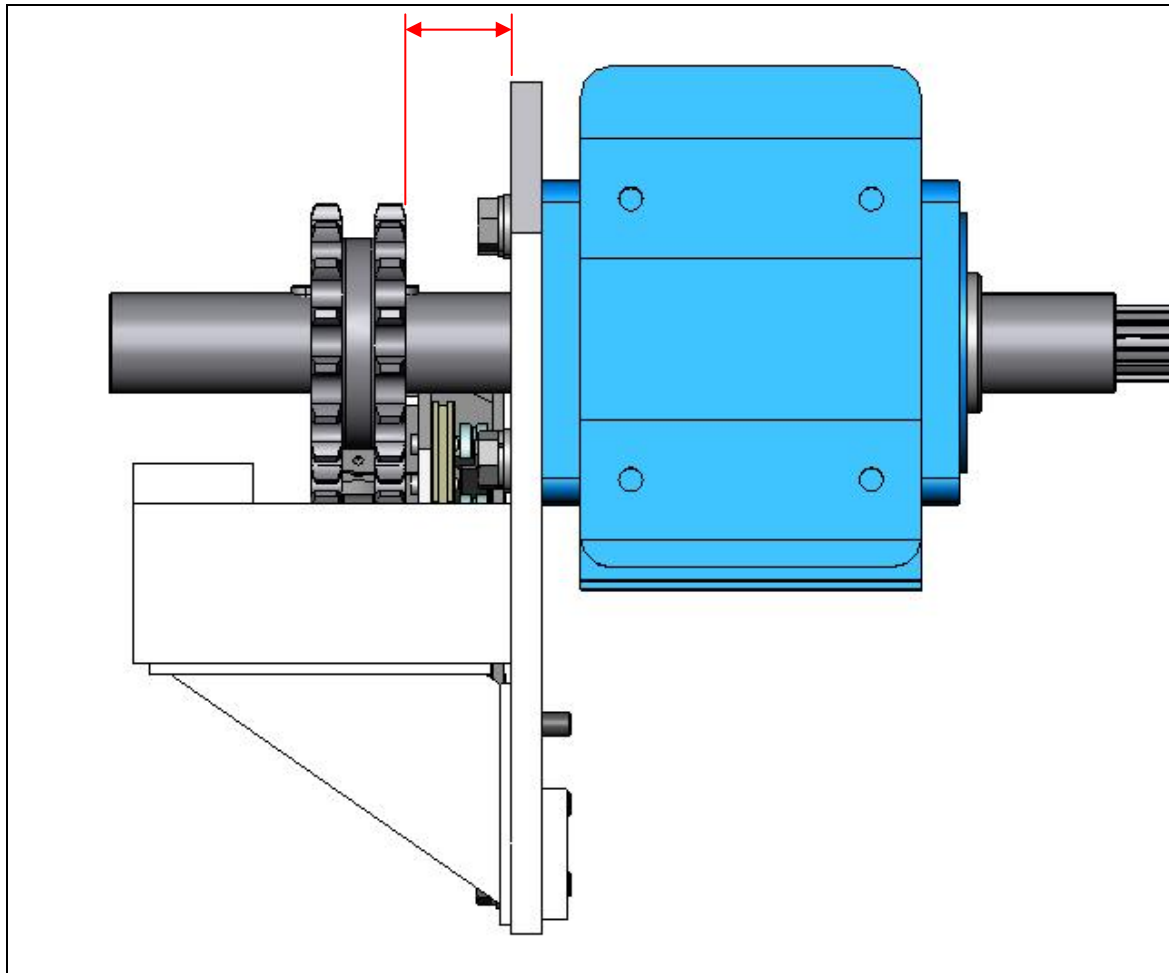


Figure 4.30

- c) Loosen the taper lock bush on the drive sprocket by following removal instructions (see appendix, note that bush size is 2517).
- d) Remove taper lock bush, drive sprocket & key from shaft.

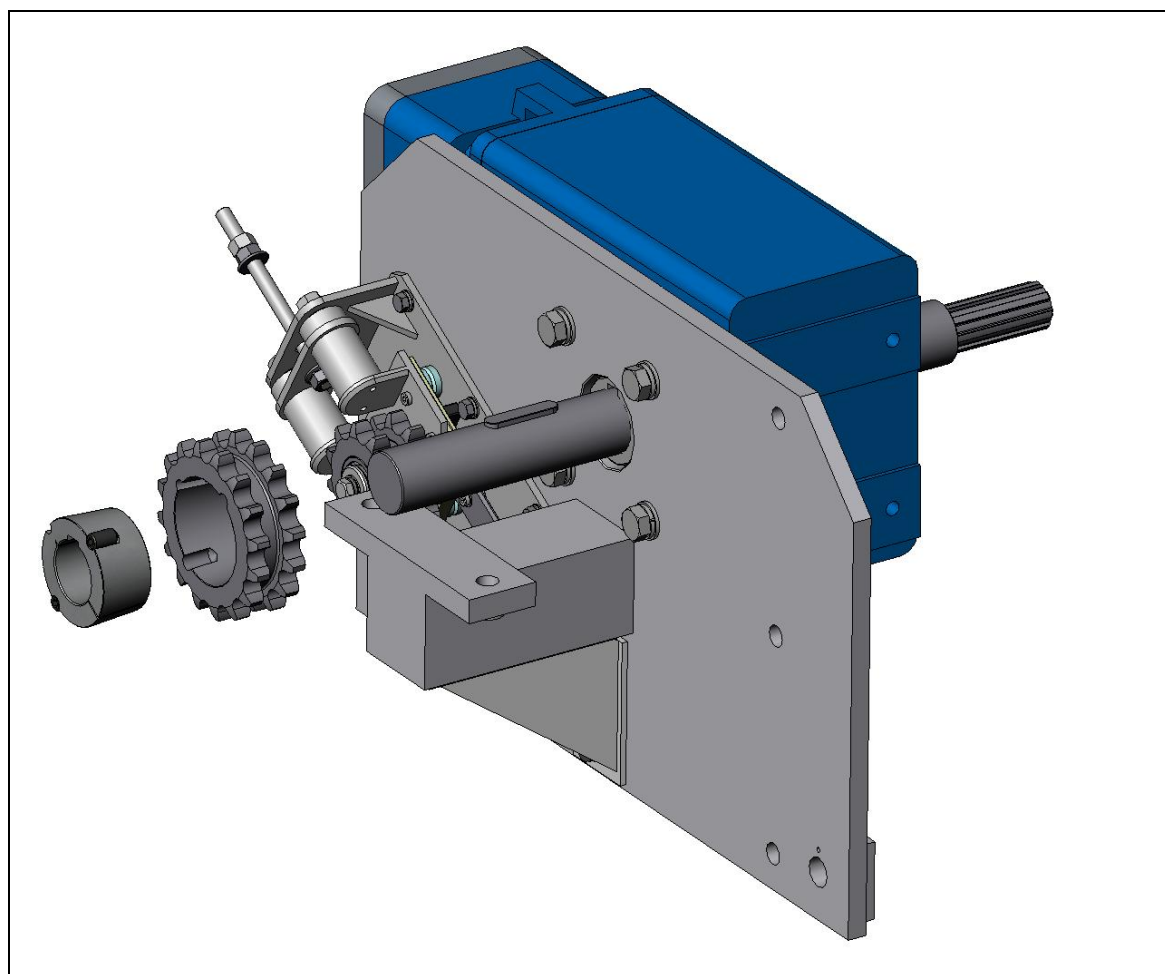


Figure 4.31

- e) Remove the 4 x M16 fasteners which hold the gearbox to the drive plate.

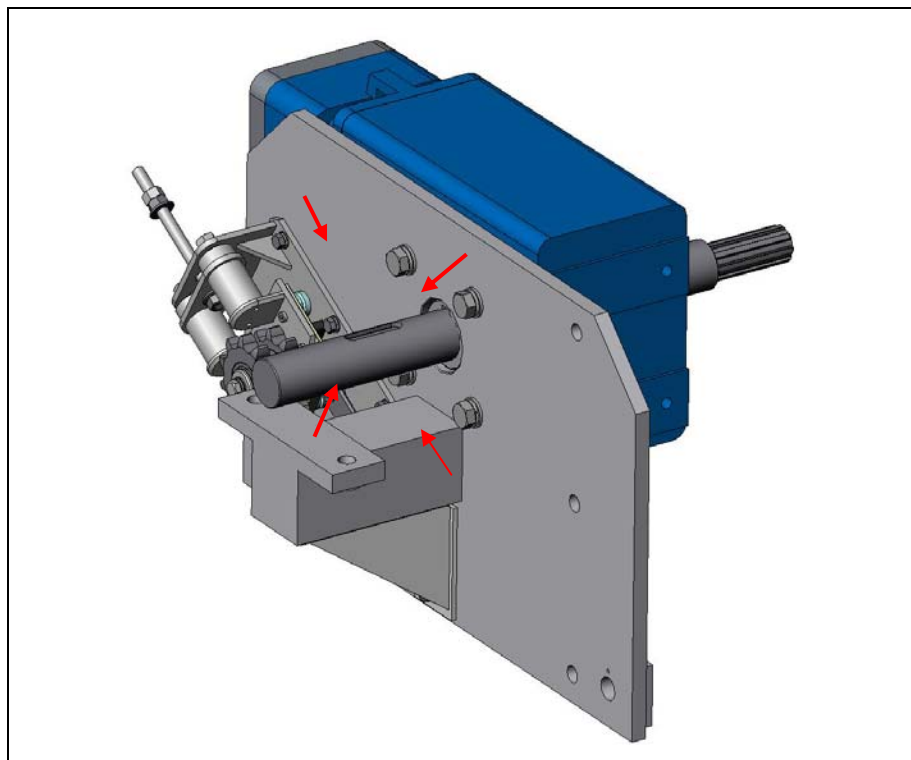


Figure 4.32

- f) The drive plate, along with the chain tensioner assembly intact, can now be separated from the gearbox.

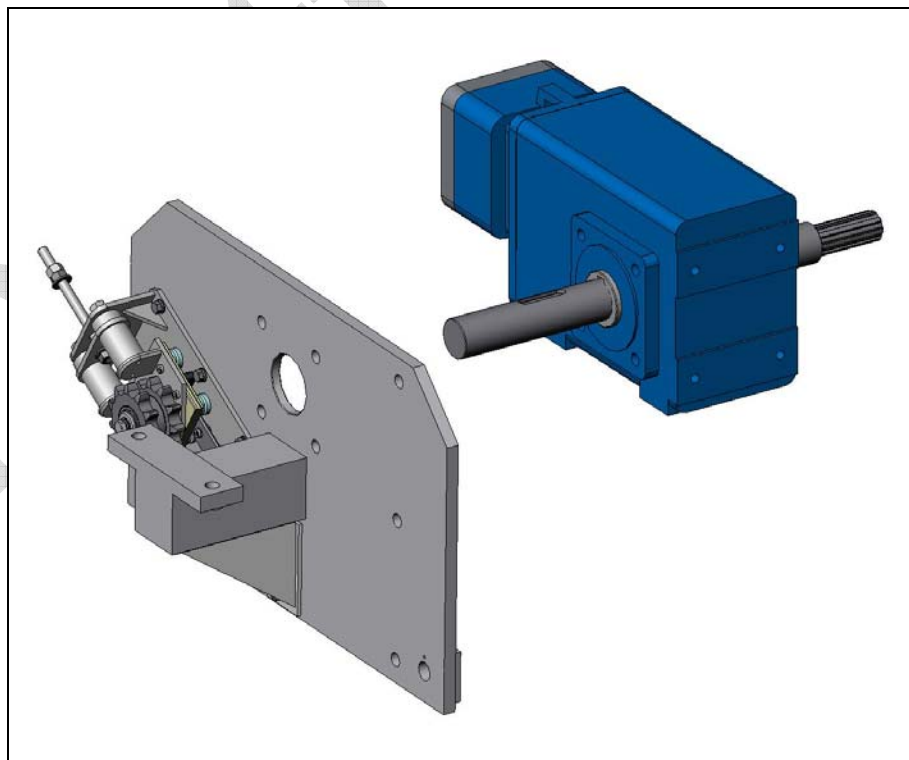


Figure 4.33

#### 4.4 ASSEMBLY OF GEARBOX SUB-ASSEMBLY

- a) Reassembly of the gearbox sub-assembly is the reverse of disassembly sequence, paying particular attention to the drive sprocket & outboard bearing.
- b) When securing the drive sprocket to the shaft ensure that the distance to drive plate is maintained to ensure correct sprocket alignment
- c) Before tightening the outboard bearing fasteners, ensure that the clearance between the bearing & mounting face is shimmed correctly. A clearance has been designed in to allow for manufacturing tolerances. It is essential that the clearance is filled so that when the M16 fasteners are fully torqued no bending stress is induced into the shaft. This will ensure correct alignment between the 2 gearbox bearings & the outboard bearing.

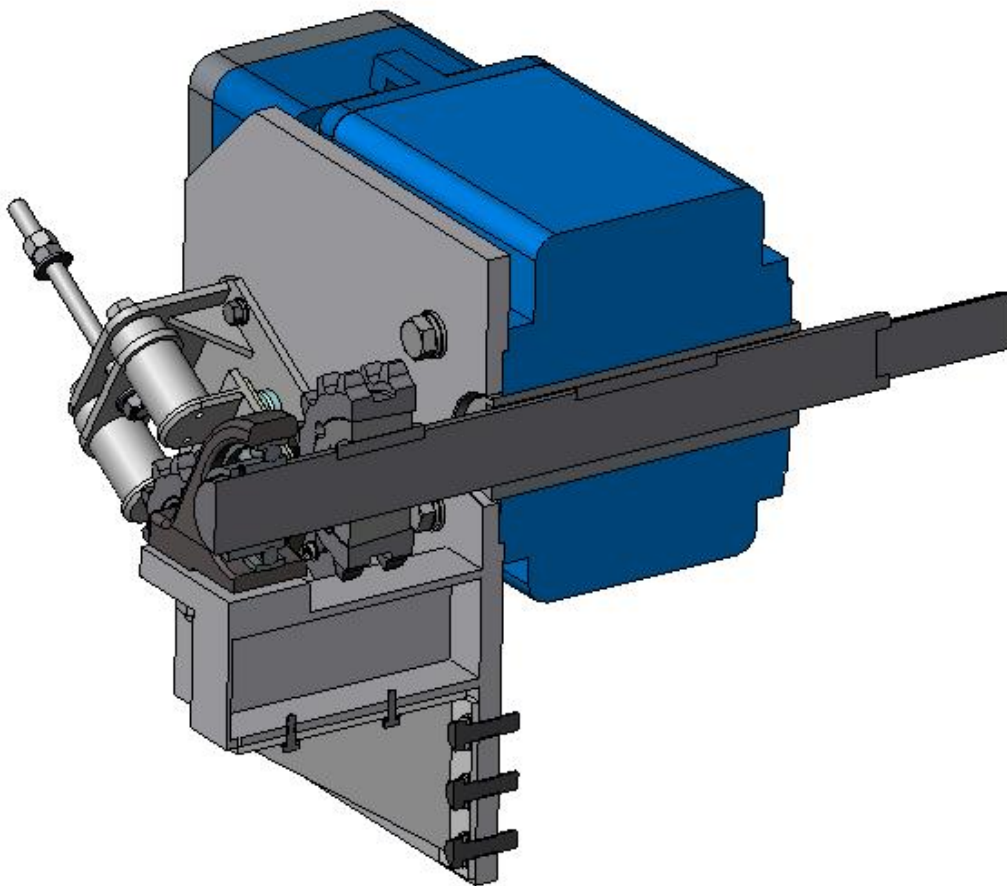


Figure 4.34 Perspective view of assembly showing cross section cutting plane through drive shaft

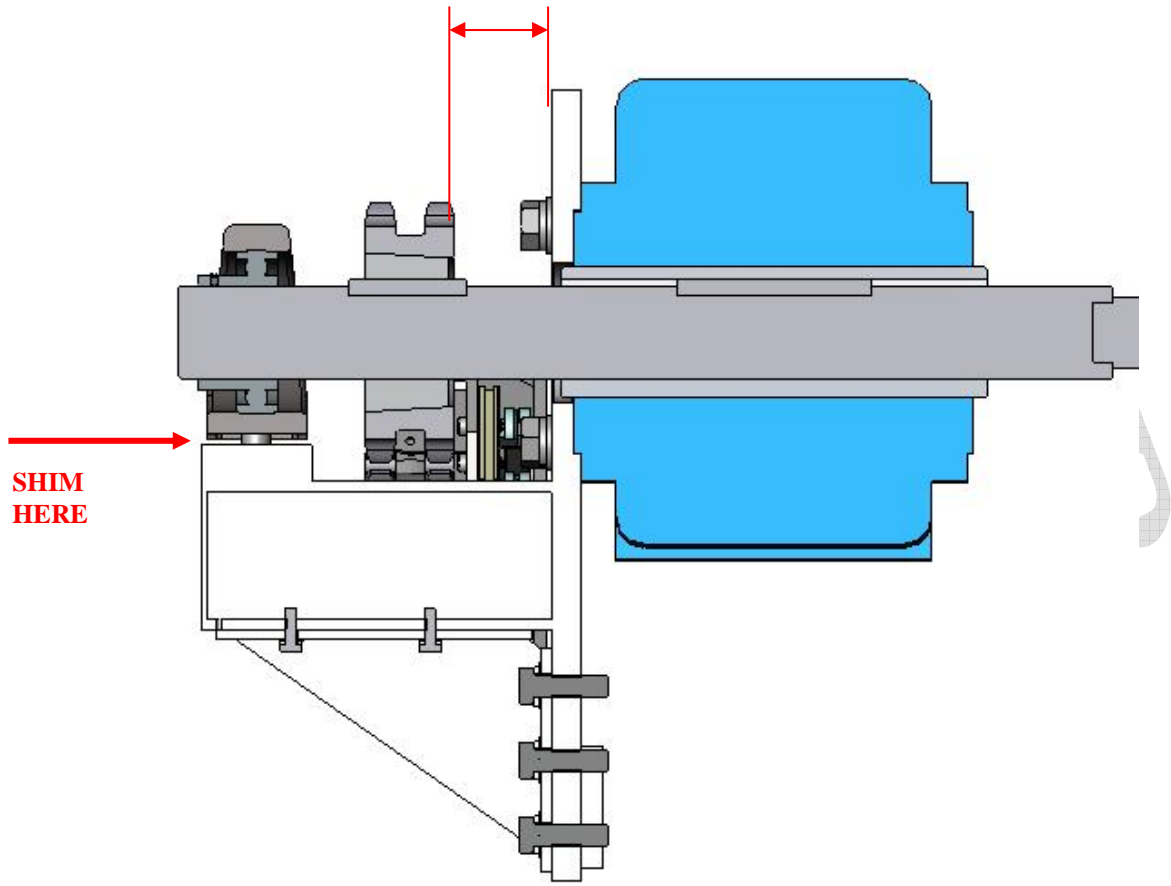




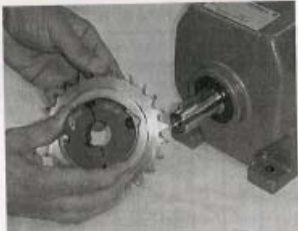
Figure 4.35 Orthogonal view of drive shaft cross section

## 4.5 APPENDIX – FENNER TAPER LOCK CATALOGUE




### INSTALLATION INSTRUCTIONS


- After ensuring that the mating tapered surfaces, bore and shaft are completely clean and free from oil or dirt, insert bush in hub so that holes line up.
- Sparingly oil thread and point of grub screws, or thread and under head of cap screws. Place screws loosely in holes threaded in hub, shown thus  in the diagram.
- If a key is to be fitted place it in the shaft keyway before fitting the bush. It is essential that it is a parallel key and side fitting only and has TOP CLEARANCE.
- Clean shaft and fit hub to shaft as one unit and locate in position desired, remembering that bush will nip the shaft first and then hub will be slightly drawn on to the bush.
- Using a hexagon wrench tighten screws gradually and alternately to torque shown in table below.
- Hammer against large-end of bush, using a block or sleeve to prevent damage. (This will ensure that the bush is seated squarely in the bore.) Screws will now turn a little more. Repeat this alternate hammering and screw tightening once or twice to achieve maximum grip on the shaft.
- After drive has been running under load for a short time stop and check tightness of screws.
- Fill empty holes with grease to exclude dirt.




**INSERT BUSH**




**INSERT SCREWS and LOCATE ON SHAFT**



**TIGHTEN SCREWS FINGER TIGHT**




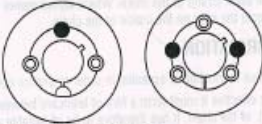
**TIGHTEN SCREWS ALTERNATIVELY**



**REMOVING A TAPER LOCK BUSH**

**TO REMOVE**

- Slacken all screws by several turns, remove one or two according to number of removal holes shown thus  in the diagram. Insert screws into removal holes after oiling thread and under head of cap screws.
- Tighten screws alternately until bush is loosened in hub and assembly is free on the shaft.
- Remove assembly from shaft.



**REMOVAL HOLES ●**

Bush size	1008	1108	1210	1610	1615	2012	2517	3020	3030	3525	3535	4030	4040	4535	4545	5040	5050
Screw tightening torque (Nm)	5,6	5,6	20	20	20	30	50	90	90	115	115	170	170	190	190	270	270
qty	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Screw details	size (BSW)	¼"	¼"	¾"	¾"	¾"	7/8"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"	1½"
	Hex, socket size (mm)	3	3	5	5	5	6	6	8	8	10	10	12	12	14	14	14
Large end dia. (mm)	35,0	38,0	47,5	57,0	57,0	70,0	85,5	108	108	127	127	146	146	162	162	178	178
Bush length (mm)	22,3	22,3	25,4	25,4	38,	31,8	44,5	50,8	76,2	63,5	89,0	76,2	102	89,0	114	102	127
Approx mass (kg)	0,1	0,1	0,2	0,3	0,5	0,7	1,5	2,7	3,6	3,8	5,0	5,6	7,7	7,5	10,0	11,1	14,0

34 [www.motionind.com.au](http://www.motionind.com.au)

Figure 4.36

## 5 VENT DOORS

The motors emit a high pitched rattling noise while the vent doors are being open or closed. Investigations revealed the noise was emanating from the braking mechanism on the lower part of motor. The brake is only engaged when the motor is not operational and was installed to prevent the door being opened from the outside.

The brake was a Keck requirement and not needed at Mount Stromlo. It should be noted that the Keck enclosures have a three-meter ring wall whereas the Stromlo enclosure has a 6-meter ring wall. The lower ring wall would allow easier access to vent doors and therefore enclosure security becomes an issue with the brakes removed. Keck would allow the removal of the brakes if the door could not be opened from the outside with the brake removed. The subsequent test proved the door could not be opened from the outside.

### 5.1 PROCEDURE FOR REMOVING THE BRAKES

- Isolate the vent doors prior to commencing work. The isolator is located adjacent to the vent door.

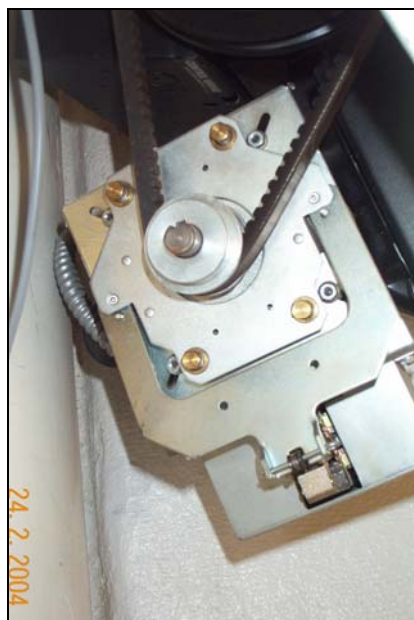
Remove the vent door guard (Fig. 1) to gain access to the motor.



Vent Door Guard



Brake Prior To Removal



Brake Prior To Removal



- Loosen the motor retaining screws (Fig. 4) this will enable the motor to be lowered so the pulley belt can be removed.



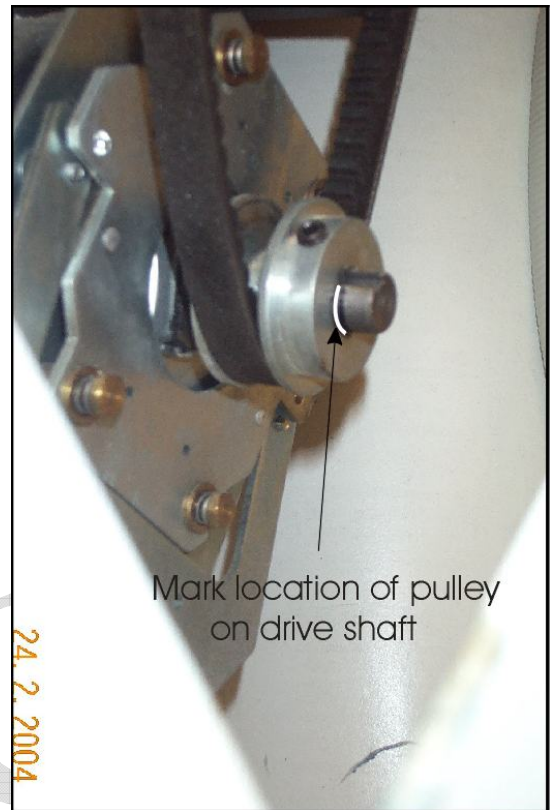
**Retaining Plate**

- Loosen the pulley wheel retaining (Grub) screw.



**Pulley Retaining Screw**

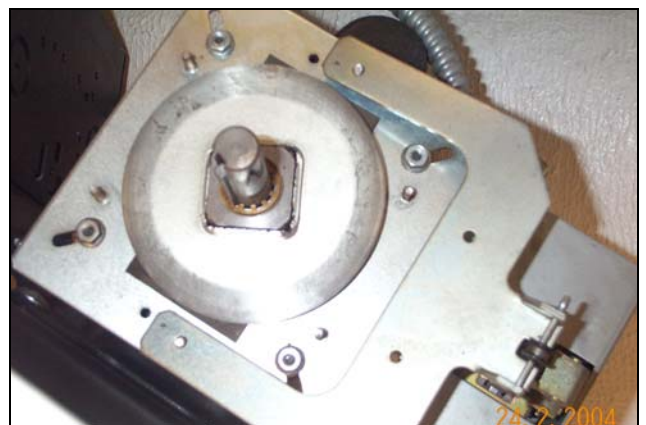
- Mark the location of the pulley wheel prior to removing wheel and pulley belt.



Mark location of pulley  
on drive shaft

**Mark Pulley Location Prior To Removal**

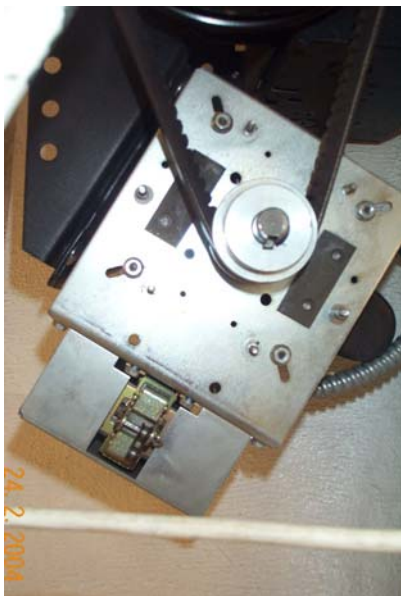
- Slide the pulley off the drive shaft and remove the belt. Undo the four retaining screws and remove the brake plate and large washer.



**Pulley And Brake Cover Plate Fasteners Removed**

- Remove the split pin from solenoid and remove the clutch plate. Replace the pin after the plate is removed.

- Place the belt on the pulley and slide pulley onto the drive shaft. Ensure that the pulley is located in the same position on the drive shaft and tighten grub screw. Place a lever between the motor and the control cabinet and apply pressure so the belt is tight, tighten the four motor retaining screws.

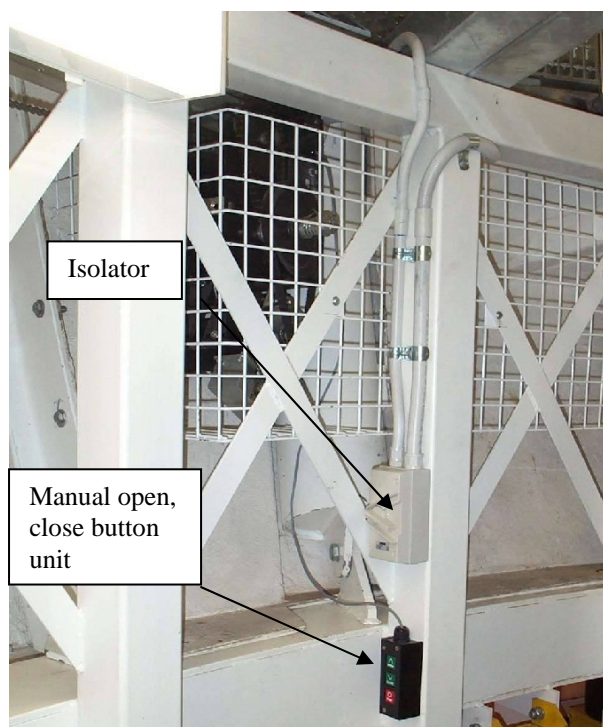


**Brake Plate And Washer Removed**

- Replace the vent door guard and activate vent door. Test to ensure correct operation.

## 5.2 TUNING OF THE OPEN AND CLOSE STATES

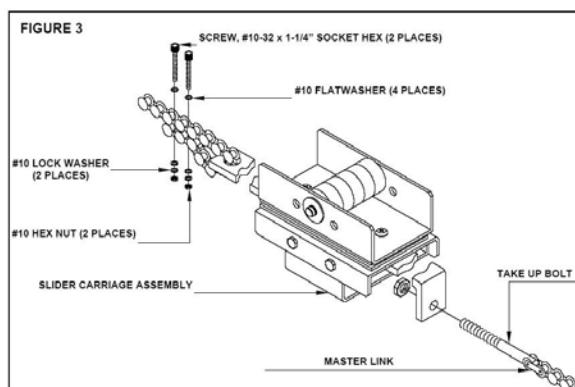
1. When the garage door opener style vent door operators are used, tuning of the drives via two cams is required. This prevents impact of the vent doors with the vent door, vertical seal assemblies, when opening and closing.
2. In the back of the vent door drives control-wiring area there are two ratable plastic cams on a threaded shaft, running horizontally across the drive enclosure. One cam will cur door power when opening and one cam will cut door power when closing.
3. Before attempting to adjust the cams, **disable the vent door drive at the surface mounted isolator located adjacent to the drive.** This will prevent accidental operation of the drive and possible injury to personnel when working around the vent doors.



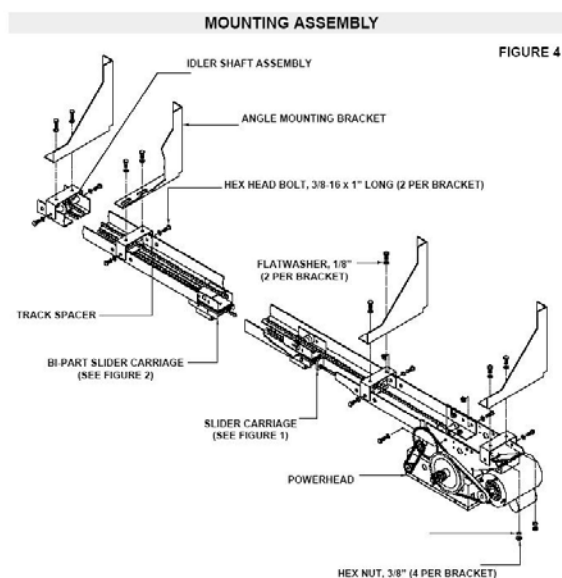
**A mounted and guarded VD drive unit. Note the position of the manual open and close buttons (small black box on post). The isolator for this each drive is typically mounted above the drives manual open, close button units (gray box on post).**

4. These cams can be moved by disengaging the locking bar and rotating the cams left or right. Once the cams have been adjusted, check that there are no obstructions, including people, in the vent door space and close the isolator. Operate the door via the manual buttons and check if further adjustment is required, i.e. if collisions are still in evidence. Do not forget to re-set the locking bar before operating the vent door drive. Repeat the above steps until the vent door is mechanically tuned. Complete for the four vent doors.
5. The vent door drive software input limits may have to be adjusted. These limits tell the controller what state the vent doors are currently in.
6. The operator can read the state of the doors via the Browser software supplied with the enclosure.
7. Check the status of the door with the door in each state. The door can be stopped in mid operation via the manual control buttons, allowing easy checking of the opening and closing states.
8. If the vent doors states do not match the software returns, adjust the limit switches under the cam bar by loosening their mounting fasteners and sliding them along the mounting bracket. The vent door “open” limit should be activated by the cams only when the door is fully open and the vent door “close” limit should be activated by the cams only when the door is fully closed.
9. Adjust the limit switches following the same safety procedure as if adjusting the cams.

## 5.3 OPERATING CHAIN TENSION

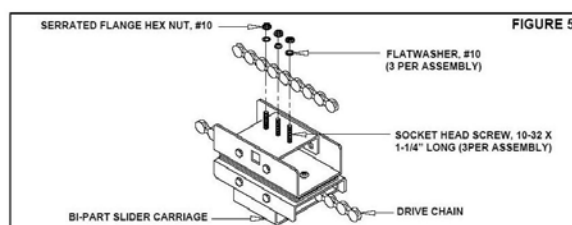


1. Attach the chain to the take up bolt on the slider carriage using the master link provided. Reel the chain around the drive sprocket, up to the idler shaft and then back to the hole on the front of the carriage.



2. Using the two 10-32 x 1-1/4" screws and hardware provided, attach the chain to the front end of the carriage (see Figure 3). It may be necessary to remove some links for proper tension. Tighten chain by adjusting chain take-up bolt. A properly adjusted chain will sag about 3" at the midpoint.

**NOTE:** Leave Bi-part slider carriage free at this time.



## 5.4 LINK ROD SETUP

Some installations have vertical offset blocks under the slide carriage, such that the adjustable link arm is in a horizontal plane. While this reduces the compressive load on the link arm during door closings, it has been known to affect the smoothness of opening and closing, due to the torquing of the slide carriage.

If smoothness becomes a problem, remove the offset blocks and redrill the slide carriage bottom plate for the link arm rose joint shank. Overdrill the nylon slide plate at the new hole location to expose both sides of the slide carriage steel plate where the link arm rose joint will now attach. Finally, bolt the rose joint shank through the hole with a split washer and nut. The link arm will now angle downwards to the pulling arm of the vent door, but the torque during opening and closing will be greatly reduced.



Note: this adjustment will slightly affect limit switch settings for ideal opening and closing positions, but the change will be very small, and is probably negligible in practice.

## 6 CRITICAL ENCLOSURE SPARES

### IS 2 Enclosures

#### Critical Spares List

Item	Qty (rec)	Lead (wks)
Azimuth Drive Wheel <sup>1,2</sup>	1	6
Azimuth Support Wheel (Bogey Wheel) <sup>1,2</sup>	1	6
Azimuth Drive (Motor / Gearbox Encoder set) <sup>3</sup>	0	8
Azimuth Drive Encoder set <sup>3</sup>	1	4
Shutter Chain Tensioner Assembly	0	4
Front Shutter (Windshield) Drive (Motor / Gearbox set) <sup>3</sup>	1	6
Rear Shutter (Windshield) Drive (Motor / Gearbox set) <sup>3</sup>	0	6
Azimuth Drive Control Panel <sup>5</sup>	1	12
Shutter Drive Control Panel <sup>5</sup>	1	10
I/O Panel <sup>5</sup>	1	8
Limit Switches	2	1
Telescope Interface Potentiometer	1	2
Telescope Interface Proximity Switch	1	1
UPS	0	6
Control PC <sup>6</sup>	1	8
Isolation Marshmallow (Azimuth Support)	0	2
Shutter Chain - 3m length (one box) <sup>1</sup>	1	16
75 mm Extruded Silicon Strip (3m) <sup>7</sup>	2	4
100 mm Extruded Silicon Strip (3m) <sup>7</sup>	4	4
UHMWPE Self Adhesive Tape (24m) <sup>7</sup>	1	2
Kit of assorted metric bolts, nuts, Nylock nuts and washers <sup>8</sup>	1	2

1. Long lead time
2. Wheel failure due to object left on track
3. Unlikely failure, but long lead time
4. Not required if complete sets held
5. Assembled and programmed for fast change out
6. Complete assembly, pre-wired in box
7. Not critical as enclosure functions without seals, but long lead time (ex UK)
8. Small fasteners used in the Seal Clamps and Banana Assemblies are easily lost.