Ops LU - Engineering - Rolling Stock

Palestra

TITLE: Specification for Auto-coupler (T90), semi-permanent (Drawbar) overhaul and associated typical Drawgear

Ref: AOS-E-RS-Int-CT724-SP_15-No-979-A2

Prepared By: Mark Fox – RS Project Engineer

Reviewed/Consulted: Srinivas Pathakota – Senior Engineer Rail Vehicles

Approved By: Elias Haddouche – Principal Mechanical Engineer (Team Leader)

Date Issued and Version:

Version	Date	Comments
A1	02-11-2021	Draft
A2		

Contents

1. Purpose

The purpose of this specification is to outline the scope of overhaul for the 92TS Auto-coupler (T90), semi-permanent (Drawbar) overhaul and associated typical Drawgear in relation to the upcoming Programme Lift (PL) project starting in 2022, whereby the Contractor shall return the components to a condition capable of reliable operation for a nominal further 6 years before next PL in 2028/2029.

2. References

The text of this document cites other documents that provide information or guidance. These are listed in table 1.

References to British Standards or other standards shall be taken to include the words 'or equivalent'. Where equivalent standards are proposed, these shall be accepted by LU prior to their use.

In the event of any conflicts between this specification and any documents to which it refers the Contractor shall request clarification from the Company.

Description	Document number
LU CRS Assurance Process	S1538
LU assurance standard	S2180
First Article Inspection	BS EN 9102
Declaration of Conformity	BS EN ISO/IEC 17050-2
Quality management system	BS ISO 10005:2018

3. Abbreviation

The following abbreviations are used within this specification:

Abbreviation	Meaning
92TS	1992 Tube Stock (Central and Waterloo & City (W&C) line)
LU	London Underground
DM	Driving Motor
CAD	Computer Aided Design
FAI	First Article Inspection
TfL	Transport for London
OEM	Original Equipment Manufacturer
EN	European Norm
CRS	Change to Rolling Stock
COSHH	Control of Substances Hazard to Health

BS	British Standard
FEA	Finite Element Analysis
BoM	Bill of Materials

4. Definitions

Term	Definition
Approval	The written authority obtained from The Engineer in respect of methods, modifications, materials, activities and suppliers, for which documentation has been supplied by the Contractor.
Approved	The status of methods, modifications, materials, activities and suppliers for which documentation has been supplied by the Contractor and for which approval has been granted.
Cleaning	Removal of any foreign object or particles with or without the aid of a solvent.
Contract Manager	TfL's Head of Procurement or a nominated representative
Contractor	Supplier to TfL, the primary organisation or individual that is selected to deliver a product, service or facility to Transport for London and contracting directly to Transport for London.
Engineer	The Rolling Stock Asset Engineer working for London Underground / TfL, or their nominated representative. For contract use, this shall mean "The Engineer" via "The Contract Manager"
Inspection	Careful examination of parts for scratches, scuffs, dents, discolouration, extrusion marks and non-uniform machine marks.
Mandatory Replacement	Parts defined or agreed as 100% new replacements, irrespective of condition.
On Condition Replacement	Replacement of parts based on agreed condition assessment criteria.

5. Introduction

The Central and W&C lines are served by the 92TS fleet, which has a planned programme lift to ensure the continued safe and reliable running of the network. The last heavy overhaul HOPL occurred between 2015 and 2018 with the next one, known as the Programme Lift, scheduled to start in 2022. The Central Line 92TS has a total of 85 x 8 car trains and W&C 92TS has further 5 x 4 car trains.The Auto-couplers, Drawbars and associated drawgear require an essential overhaul as a part of the upcoming 2022 92TS Programme Lift.

6. General requirements

6.1. This specification is the property of Transport for London (TfL). The contents of the specification are confidential and shall not be disclosed to third parties without prior written consent of TfL.

6.2. The equipment covered by this specification may contain or be contaminated with materials considered hazardous to health.

6.3. The Contractor shall be aware of and work with the latest COSHH and Environmental Regulations.

6.4. The Contractor shall be responsible for identifying all hazards associated with this specification and adopting safe working methods/procedures to deal with them.

6.5. The Contractor shall dispose of materials, required as part of this specification, in accordance with industry best practice.

6.6. The Contractor shall consider all consumables (nuts, bolts, gaskets, seals, O-rings, washers/tab washers, grease, assembly and protection materials such as lagging and tags) as requiring mandatory replacement and within the contract cost.

6.7. The Contractor shall check all fixings have been torque marked (one continuous painted line from the top of the screw/bolt head down the side of the head and onto the bolted face) before delivery back to TfL.

6.8. Changes to this technical specification shall be managed through contract review meetings held with the TfL Contract Manager.

6.9. The Contractor shall not deviate from the requirements in this specification without the approval from TfL Engineering. Approval shall be obtained via the TfL Contract Manager.

6.10. If the Contractor is/becomes aware of errors, omissions or anomalies in this specification they shall contact the TfL Contract Manager to raise the concern and stop works whilst awaiting an answer to the issue.

6.11. Furthermore, if during a contract there is evidence of a failure or design weakness that is not covered in this specification the Contractor shall bring this to the attention of the TfL Contract Manager. Detailed options for the remedy of the failure or the design weakness shall be presented in writing to the TfL Contract Manager and shall be approved by TfL prior to implementation. The Contractor shall stop work whilst awaiting

an answer from TfL regarding the option(s) for design remedy that are being considered.

6.12. The Contractor shall ensure that the people carrying out this work have appropriate competencies to fulfil the requirements of this specification and shall define these in a competence matrix. The Contractor shall provide evidence of how they will maintain the required competencies within their organisation, and this must be provided to TfL on request.

6.13. The Contractor shall ensure that the equipment necessary to complete the contents of this specification is fit for purpose and where necessary is calibrated. In the case of Arising Work (should it occur), the proposed method (at that time) shall ensure that appropriate equipment is used and calibrated. The Contractor shall provide evidence at tender return detailing their supply chain and have an auditable trail of compliance for materials used, including for any Arising Work, during the lifetime of the project overhaul.

6.14. The Contractor shall have an effective process for the management and control of all documents relevant to its products/services. This shall include traceability of all customer requirements throughout the supply chain and the identification of all personnel who produce, review and authorise such documents both internal and external.

6.15. Records shall be kept of the production, review and authorisation of all issued documents (both internal and external).

6.16. The Contractor shall provide, maintain and update all deliverable documentation for the period up to the delivery of the last rolling stock / vehicle plus its warranty period or as described in the Supply Contract where this is a longer period.

6.17. The Contractor shall have suitable storage and transport facilities for the materials supplied and required before and during the contract period. Components shall be stored in a suitable storage location that shall ensure no damage to materials throughout the overhaul process.

6.18. The Contractor shall clearly label all defective components and they shall be quarantined until disposal instructions are received from TfL.

6.19. Arising work

Work that cannot be anticipated as being included in each, or any component overhaul, and is therefore an unknown at tender stage, shall upon discovery be designated Arising Work and shall be costed separately from the tender works.

All occurrences of Arising Work shall not proceed unless written authorisation has been received from the TfL Contract Manager following a technical and costed application by the Contractor.

Achieving approval to Arising Work may involve supporting a Change to Rolling Stock (CRS) Process.

6.20. Change to rolling stock process

The Contractor shall provide support, information and evidence to assist LU in achieving approval via the CRS process detailed in LU assurance standard S1538 (1). This may include, but not be limited to, the provision of drawings, specifications, reports, safety case work and FEA. Any deviation from the original components which

may change the original specification of the component being overhauled will constitute a change process. This also applies to any improvement of the component. The Contractor shall be requested to demonstrate that the performance, reliability, availability, maintainability and safety of the component will not be affected by the proposed change. Proposed components shall comply with all relevant British Standards and EN standards.

7. Documents and Deliverables

7.1. The Contractor shall develop overhaul and test processes, work instructions, quality plan, recording sheets and competency matrix. These documents shall be provided to TfL at the tender review stage and must be approved by TfL prior to use.

7.2. The Contractor shall be responsible for the design, manufacture or procurement of any test equipment and rigs, as well as ensuring that they are fit for purpose. The requirements for such test equipment shall be reviewed and agreed by TfL Engineering prior to design, manufacture or procurement. TfL will not provide equipment or designs.

7.3. The Contractor shall compile a detailed bill-of-materials (BoM) based upon the components assessed in preparation for the overhaul. The BoM will list all parts and components fitted including supplier details, OEM part numbers and specification sheet references. The BoM shall be issued to TfL for acceptance immediately once compiled; the overhaul programme shall not be interrupted whilst TfL consider the BoM. The Contractor shall make any amendments required by TfL, which will include the generation of a further (revised) issue of the BoM; and shall incorporate any further or additional information discovered, e.g. due to Arising Work.

7.4. If for any reason an assembly is fitted with an alternative component in place of the part fitted to other assemblies, for example made by a different manufacturer or to a different specification to the equivalent components in other assemblies, the Contractor shall develop a method of clearly advising this difference within the BoM.

7.5. For on-condition replacements, the Contractor shall define the replacement criteria of component parts and provide justification. These are to be reviewed and agreed by TfL Engineering prior to use.

7.6. The Contractor shall also develop relevant repair procedures for remedial works as applicable. These are to be reviewed and agreed by TfL Engineering prior to use.

7.7. Any components or parts the Contractor deems they will have to reverse engineer to complete the overhauls shall be clearly indicated. Sufficient supporting information shall be provided to enable TfL Engineering to review and agree their use prior to the components being fitted. This includes, but is not limited to:

7.8. Proposing and agreeing with TfL Engineering the suitable sample size for components to be analysed.

7.9. Proposing and agreeing with TfL Engineering suitable types of testing, including associated costs and timescales

7.10. Arranging material analysis of component samples.

7.11. Reviewing material analysis reports.

7.12. Taking measurements from a sample or samples of components using tools which provide required accuracy for the application

7.13. Review of appropriate manufacturing processes, surface finishes and material treatments

7.14. The Contractor shall develop any diagrams and drawings from sample(s) to support the above as required.

7.15. Warranty documentation should clearly elaborate on what is covered during warranty against works carried out.

8. Equipment overview

8.1. Autocoupler

92TS cars are coupled together either by a wedgelock Auto-coupler between units or a drawbar between cars. (Refer to Figure 1, page 10)

The automatic coupling system is fully automatic and engages to link two units together when one car is driven onto the buffer of another. An electro-pneumatic coupling switch operated wedge then automatically locks the couplings together.

Uncoupling is achieved by reversing pressure to the wedge cylinder from uncoupling switches located in the cab and auto-coupler ends in the saloons.

The T90 Auto-coupler consists of the following significant parts:

- Front plate assembly
- Electrical Contact boxes
- Pneumatic connections and pipes
- Sector bar replaced with Radial support bar
- Coupler body with coupling tongue (hook) & centring arm
- Wedge engine
- Drawgear

8.2. Semi-permanent Coupler

The semi-permanent coupler (Drawbar) (refer to Figure 2, page 11) consists of the following significant parts:

- Drawbar body
- Drawbar connections including Main reservoir pipelines, Inter-car Jumper, Battery and Traction supply cables
- Drawgear (refer to Figure 4, page 12)

8.3. Drawgear

Attached to the auto-coupler/Drawbar is the drawgear which consists of an aluminium crossbeam and is supported by aluminium crossbeam supports bolted to the car body longitudinal members. The crossbeam is secured in position by two tie bars incorporating resilient rubber spring units and deformation tube assemblies. The drawgear assembly absorbs the car draw and buff forces and collision loads of up to 20 tonnes before starting to deform and collapse.

The pivot pin / Ampep bearing assembly provides a degree of flexibility in the coupling. This allows for differences in the relative movement of the cars on track vertical or horizontal curves. The drawgear tie bar assembly is located on all drawbar and auto-coupler assembly ends.

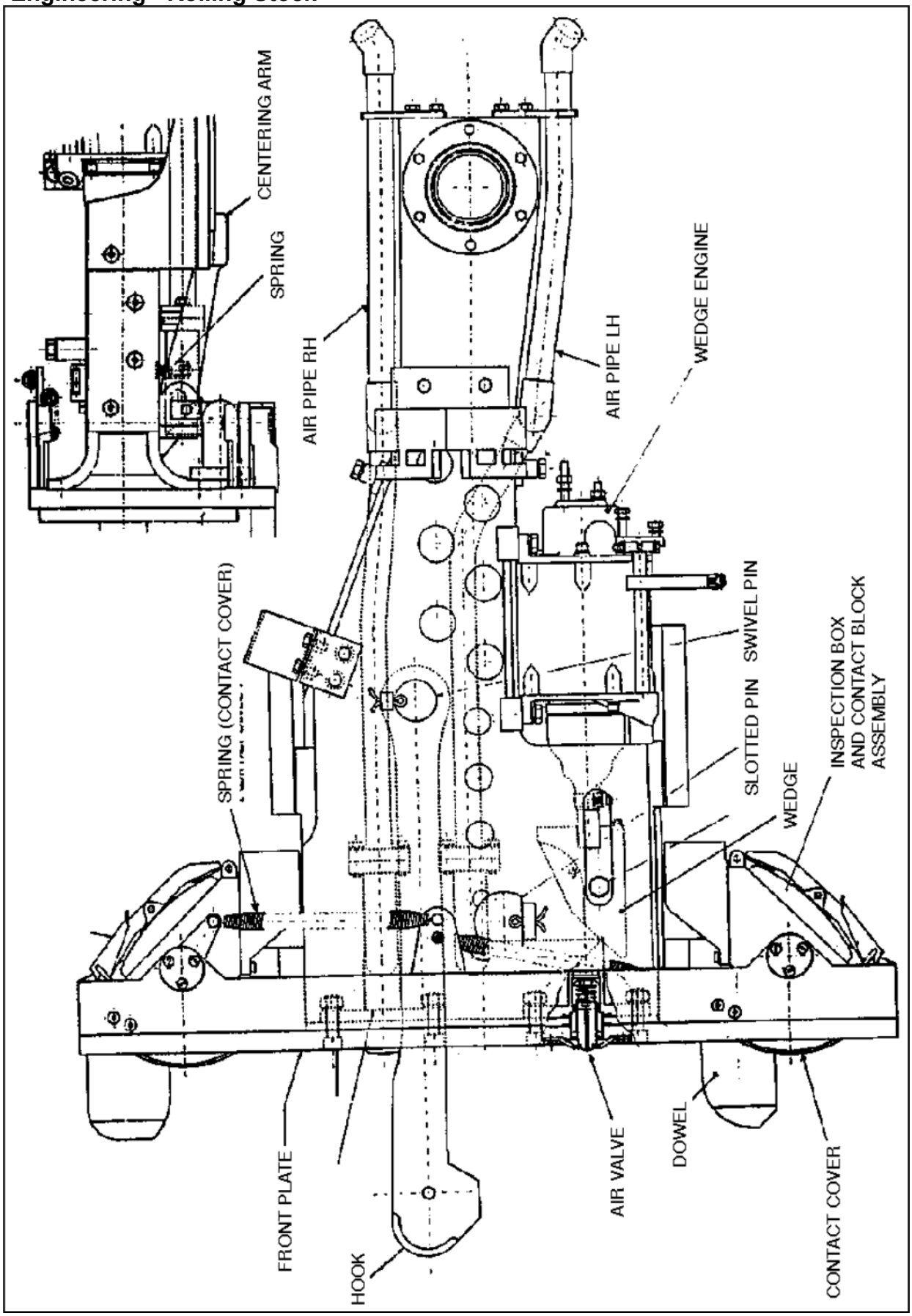


Figure 1 Auto-Coupler

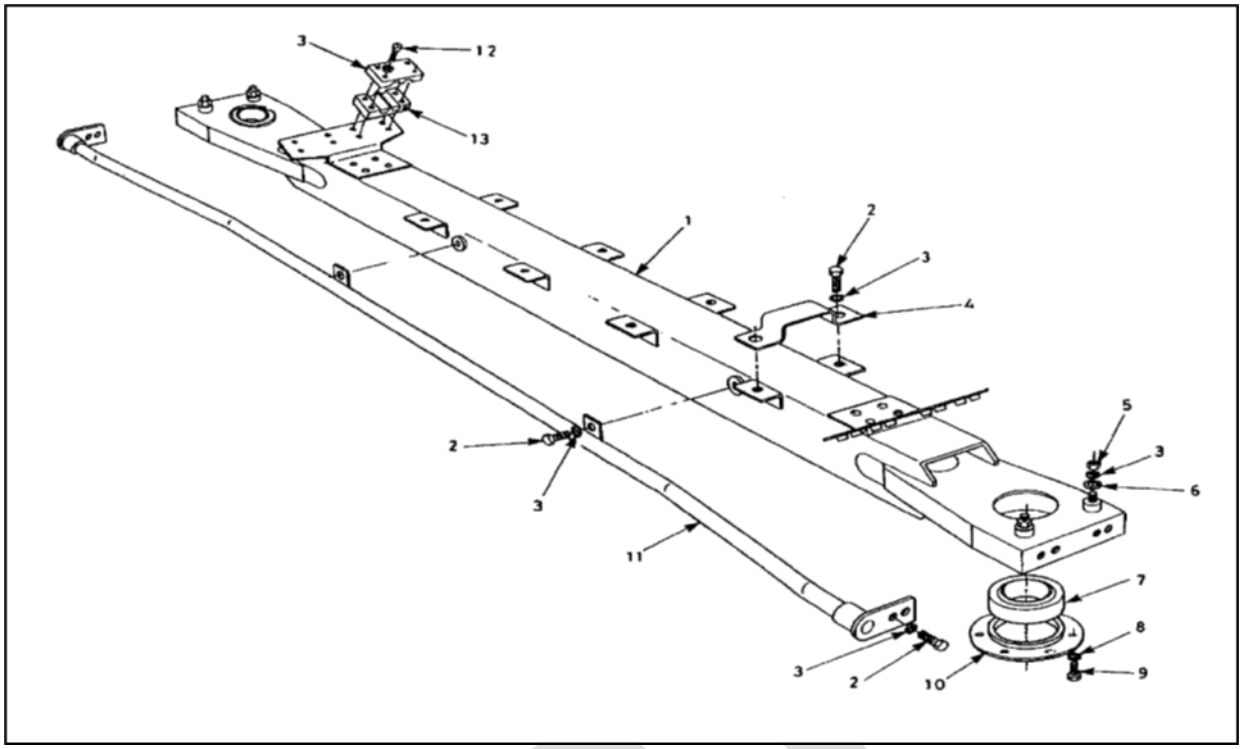


Figure 2 Drawbar

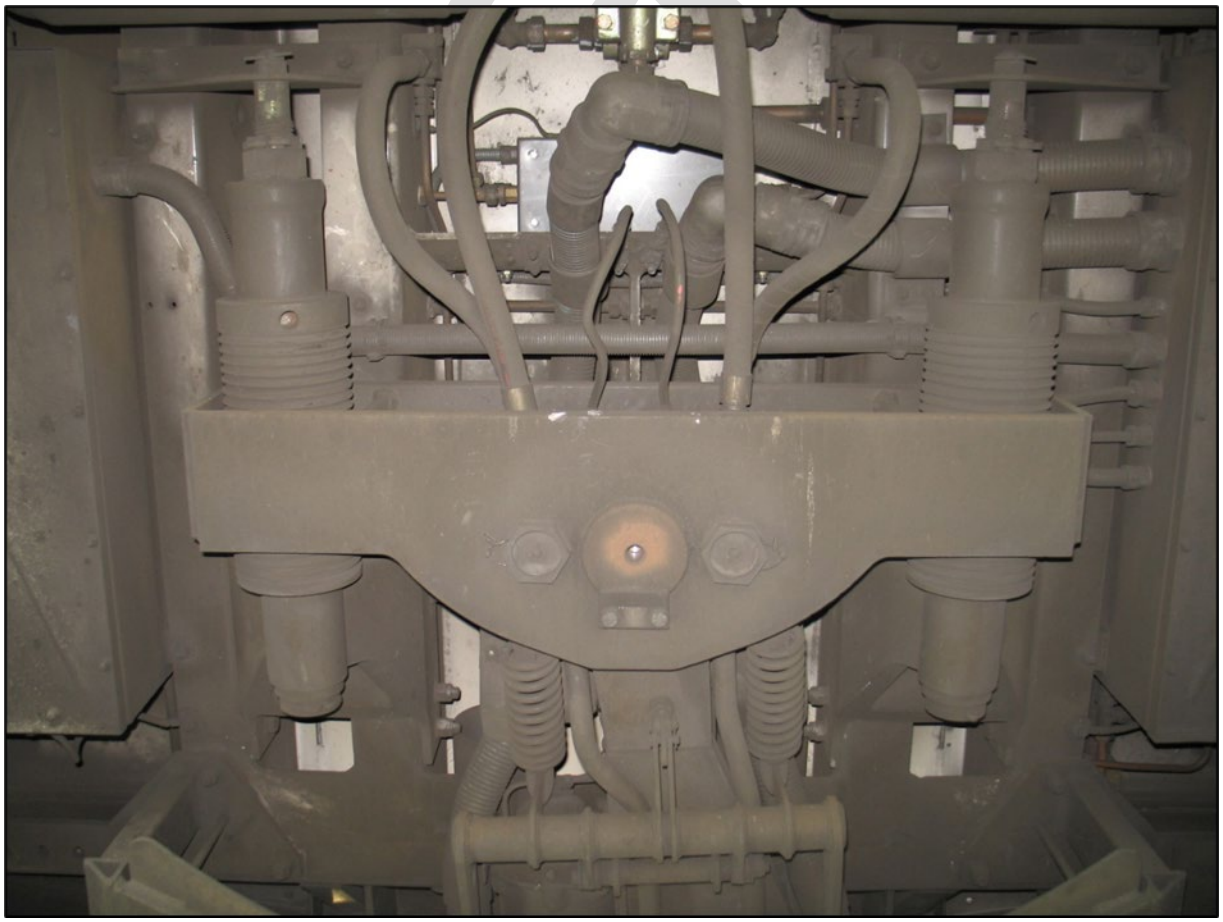


Figure 3 Drawgear assembly

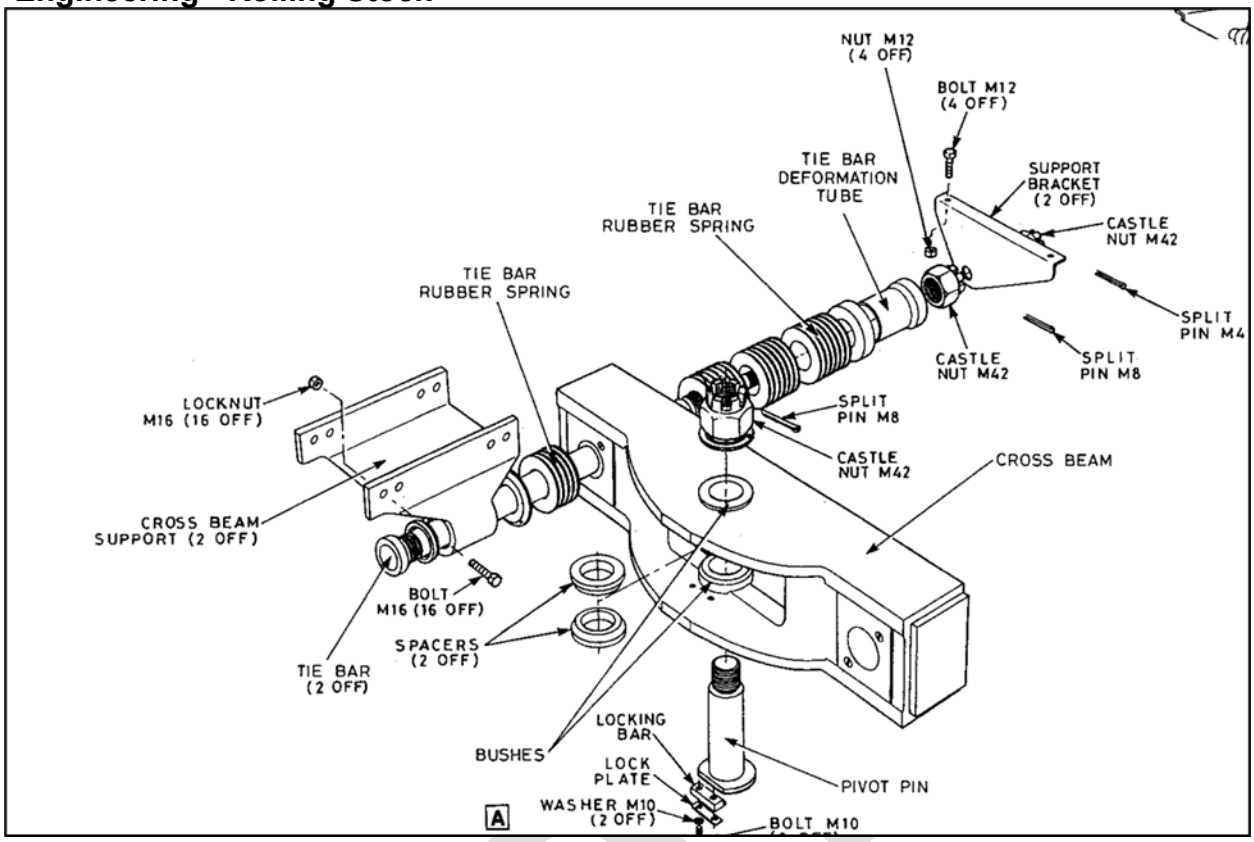


Figure 4 Drawgear assembly

9. Scope of Works

9.1. Overhaul and test as detailed below

- Review of core scope of works either a) in-situ (sample of fleet check) or b) sample(s) provided or c) combination of both and advise for any inclusions/exclusions
- Development of overhaul and test processes following review
- Development of replacement criteria of component parts and associated justification
- Design and manufacture of any test equipment required
- Development of any diagrams and drawings from sample(s) to support the above

Component	Qty (CL)	Qty (W & C)	OEM Part no.	SAP Part no.
Auto-couplers	680	20		00204/7363
Semi-permanent (Drawbar)	340	10		00129/0800
Drawgear – comprising LH & RH spring assembly	1360	40	111-3991, Issue G, 111-5257, Issue E	

The scope of this specification covers only the mechanical items of auto-coupler and semi-permanent (also known as drawbar), including typical drawgear assemblies, for both coupling systems. This includes stripping, cleaning, inspection, 100% replace, 100% overhaul, On-condition change and testing as applicable for individual components and sub-assemblies. Components to be replaced are categorised as follows:

- Replaced on conditional assessment – Engineering expertise and knowledge

required to determine the condition of components and if required replace based on pass/fail inspection criteria to check for damage or excessive wear.

- Mandatory replacement – All fixings, fasteners, springs and seals.

Note: This overhaul does not include overhaul of the auto-coupler electrical contact boxes or the drawbar HV and LV cables.

Previously concluded Heavy Overhaul & Programme Lift program HOPL 2015-2018 mandated for extensive overhauls which would derive a service life of 12 years to last until next HOPL as set out in the requirements specification. To ensure this service life with continued safe and reliable operation is achieved, the following overhauls as a minimum (core-works) are recommended to be carried out during PL 2022-2025 on these coupling systems,

a) 100% Replacement of Ampep bearings to enhanced version ref: SKF 21-12868P

b) 100% Overhaul of Wedge engine/cylinder

c) 100% Overhaul of tie-bars - remove any corrosion built up on rubber spring interfaces

d) 100% Tie-bar rubber springs to be rotated 180deg for re-use, assuming these were 100% renewed during HOPL. If deemed unfit for re-use, the change has to be highlighted to TfL engineering and can be changed to 100% replace based on how prevalent this issue across fleet.

Condition assessment to be carried out on:

a. Components that were 100% Replaced (or) higher on-condition % change out during HOPL

b. Components that were categorised on-condition change but required no or very minimal change out during HOPL

f) Condition assessment of front plate mechanical & pneumatic interfaces for any undue wear or alignment issues

g) Key interfaces are appropriately aligned to avoid any untoward loadings onto the coupler

h) All items with damaged paintwork or corrosion should be cleaned and all corrosion removed before the area is repainted with RAL 7024 Graphite Grey colour paint. Specification to be reviewed and agreed by Principal Mechanical Engineer (AOS Engineering – Rolling Stock) – All of these components were shot-blasted and powder coated during HOPL and expect minimal patch repair works for PL 2021

9.1.1. Suppliers should state how long the overhaul of each Autocoupler, drawgear & drawbar will take, to meet the required throughput of each vehicle.

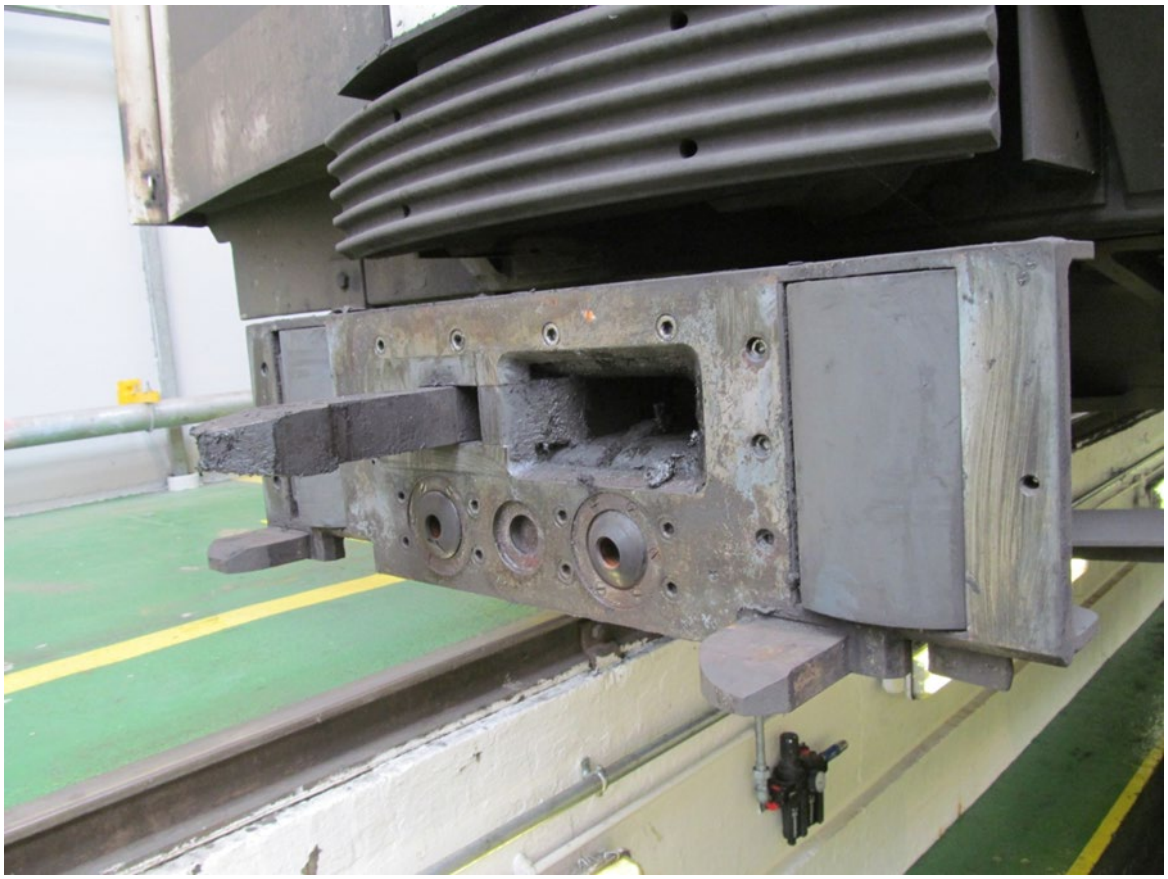
9.1.2. Development of overhaul instructions and test processes will be subject to review and agreement by the Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

- Components from the first 10 auto-coupler's, 5 drawbars and 20 drawgear assemblies returned for overhaul shall be subject to a detailed examination and a condition report is to be provided to LU by the supplier with photographic evidence. AOS Engineering – Rolling Stock to review findings and if required further detailed examination on subsequent units beyond this initial quantity maybe requested.

9.1.3. Any components or parts the supplier deems they will have to reverse engineer to complete the overhauls shall be clearly indicated with sufficient supporting information to enable AOS Engineering – Rolling Stock to obtain the necessary LU review and agreement by Principal Mechanical Engineer (AOS Engineering – Rolling Stock) prior to the components being fitted.

Note: All mainline air pipes fitted to the auto-coupler and drawbars are manufactured from stainless steel and any replacements that are supplied must be manufactured from stainless steel to an agreed grade

9.2. Auto-coupler Overhaul



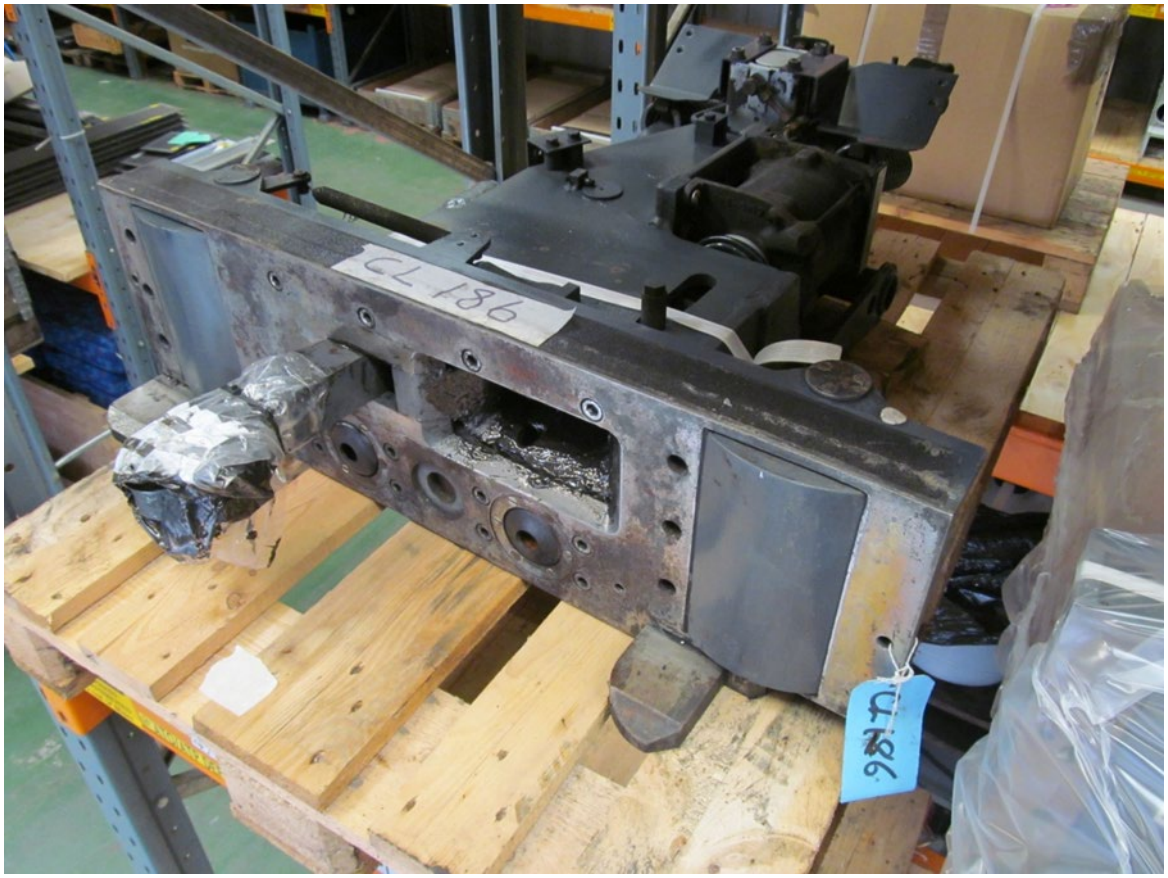


Figure 5 General Autocoupler Arrangement

9.2.1. Mandatory Work

- Document the condition of the auto-coupler on delivery including any abnormal damage.
- Upon the dismantling of the auto-coupler and component parts - The component parts of each auto-coupler, other than consumables or mandatory replacement items are to be kept together as a kit, if possible. However, it is mandatory to keep the dutch oven doors with the front plate and the mainline air pipes with the body that they were removed from.
- Cleaning and de-greasing of all components with a suitable cleaning agent approved for use on Rolling Stock by TfL.
- All items with damaged paintwork or corrosion should be cleaned before the area is repainted with RAL 7024 Graphite Grey colour paint. Specification to be reviewed and agreed by Principal Mechanical Engineer (AOS Engineering – Rolling Stock).
- Mandatory inspection and selected on condition tasks: (see pages 15,16 & 17)

92TS 2021 PL Maintenance description				
Component	**Maintenance description**	**Additional actions**	**Mandatory**	**On condition**
Autocoupler	Front plate to be de-greased/cleaned as required to remove all accumulated rust/dirt/debris Inspect front plate for flatness and corrosion especially around the main line air seal	Supplier to develop repair procedure to reclaim front plate if corrosion is found around the main air-line ports The supplier to specify the criteria and get agreement for the front plate flatness Check condition of air seal interfaces and stainless steel insert, that were fitted during HOPL.	Yes	
	Record damage to front plate and ensure damage is not detrimental to coupler operation	Supplier to report damage prior to rectification	Yes	
	Inspect ampep bearing housing bore	Inspect for damage and ensure interference fit tolerances for the bearings are maintained.	Yes	
	Ensure integrity of body to drawbar rivets	None	Yes	
	Inspect centring arm pivot bores		Yes	
	Inspect centring arm – especially wear from opposing hook and straightness	Supplier to develop repair procedure to enable reclaiming of the arm rather than replacement. Any replacement arms to the current fleet design fitted as per CEN CRS 2457 and CEN CRS 2571. Suppliers to state if they will need to reverse engineer this component If 100% repaired or replaced, PL expects minimum or no works except visual inspection for any anomalies.	Yes	
	Inspect wedge plate including welds on the body	None	Yes	
	Check crosstube assembly for straightness and damage	None	Yes	
	Inspect all pipework for damage	Replace if necessary	Yes	

	Inspect hook for damage and/or wear	See note below table	Yes	
Front plate assembly	Strip and repaint electrical contact cover doors	Patch paint repairs where applicable		Yes
	Replace contact cover door bearings and seals	None	Yes	
	Check condition of plating on door bearing covers	Strip and re-plate or replace as necessary		Yes
	Check condition of plating on front air seal retaining rings	Strip and re-plate as necessary		Yes
	Replace all fasteners	None	Yes	
	Clean and dimensionally check all components to drawing	None		Yes
	Replace contact cover springs (2 off)	None	Yes	
	Replace door cam lock tab washers (2 off)	None	Yes	
	Replace cam operating keys (2 off)	None	Yes	
	Replace main airline seals (2 off)	None	Yes	
	Replace door sealing strips (2 off)	None	Yes	
Coupler body assembly	Replace wear strip	None	Yes	
	Check condition of plating of anti-tilt bearing surface on pivot bearing retainer plate	Strip and re-plate if necessary. Patch paint repairs where applicable.	Yes	
	Replace centring arm pin and Oilite Bush	None	Yes	
	Clean and dimensionally check all components to drawing	Hook GO/NO-GO gauging. See note below table		Yes
	Replace hook bearing	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace ampep bearing with enhanced version		Yes	
	Replace centring arm bushes (2 off)	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace centring arm springs (2 off)	Supplier to advise if these are mandatory replace or		

		on condition replace every 6yr OH		
	Replace centring arm pin lock plate	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace air cylinder drawbar bush	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace air pipe sealing rings (4 off)	None	Yes	
	Clean and flush through stainless steel air pipes	Pressure test air pipes using air to 10 bar for 2 mins, no pressure drop allowed		Yes
	Clean and check condition of earth studs	Replace if necessary		yes
Foot mechanism	Overhaul or replace foot operating cylinder	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace all fasteners	None	Yes	
	Clean and dimensionally check all components to drawing	Replace if necessary		Yes
	Replace pivot lever bushes (2 off)	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace coupler support springs (2 off)	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
	Replace feet wear pads	Supplier to advise if these are mandatory replace or on condition replace every 6yr OH		
Wedge Engine	Replace rubber gaiter on wedge engine	None	Yes	
	Check condition of copper pipes	Replace if necessary		Yes
	Clean and dimensionally check all components to drawing	None	Yes	
	Replace wedge engine piston ring seals (2 off)	None	Yes	
	Replace end cover seals (2 off)	None	Yes	
	Replace piston rod seal	None	Yes	
	Replace wedge engine lock plate	None	Yes	
	Replace wedge engine spring	None	Yes	
Final assembly	Replace fibre washer	None	Yes	
	Final inspection to drawing	None	Yes	
	Coupling and function tests	None	Yes	
	Torque witness marks for all fasteners	Final check of witness marks. All fasteners to be torque tightened and witness marks applied (as required) during assembly	Yes	

	Reassembly with crossbeam including fitment of pivot pin assembly	None	Yes	

Note: Modified auto-coupler hooks (See Technical Bulletin TB0288 Issue 1) i.e. those that have a 10-degree chamfer at both the lower and upper leading edges. See details below:

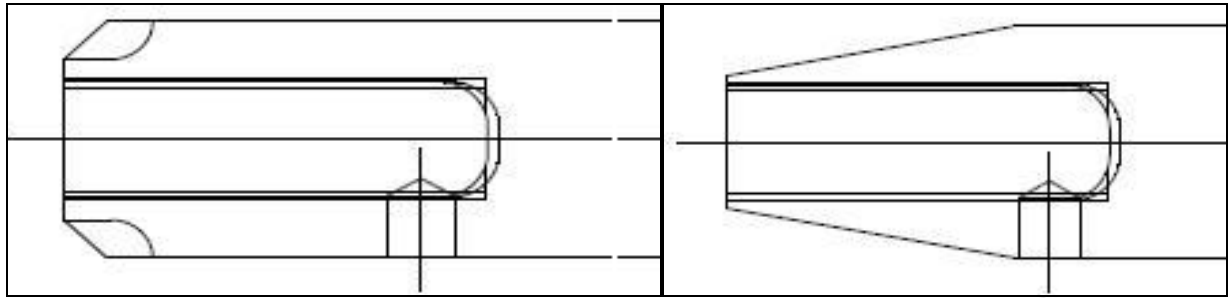


Figure 6 – Original Hook ***Modified Hook***

Suppliers should note that the original hook MUST be fitted to couplers fitted to ‘A’ cars and ‘E’ Cars. Both hook types can be fitted to couplers fitted to ‘B’, ‘C’, ‘C (D)’ and ‘F’ Cars. The preference however for these cars is for modified hooks to be fitted.

The number of couplers required during the overhaul programme is dependent on the number and type of unit(s) overhauled each week. Therefore, LU will request certain numbers of auto-couplers to be delivered fitted with either the original or modified hooks during the overhaul programme.

9.2.2. On Condition Work

All other components not specifically mentioned in Section 9.1 to be checked for satisfactory condition and repaired/replaced as necessary.

Supplier to provide criteria for replacement and associated justification.

9.2.3. Functional Test Post Overhaul

To include as a minimum:

Auto-coupler gather, mechanical engagement and pneumatic tests including leakage test through mainline air seals (supplier to provide specification) and wedge engine leakage test.

The supplier to propose suitable tests post overhaul including any criteria and/or test values for review and agreement by Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

Note: The electrical tests (coupling and continuity), electrical insulation resistance test and dutch oven seal tests are not carried out as the electrical contact boxes and HV/LV cables are not supplied as part of the auto coupler and drawbar for overhaul.

9.2.4. Recording and Identification

The component serial number shall be referenced on all records and documentation.

A record sheet shall be provided for each overhauled component detailing:

- The initial condition on delivery including any abnormal damage.
- Description of repairs carried out and components changed including mandatory change items.
- Final test report and record sheet.

A warranty label (clearly showing the warranty end date) and a ‘test’ pass label (clearly stating the date when the test was passed) to be attached to the main coupler body.

9.3. Drawbar assembly

Figure 7 Drawbar assembly

9.3.1. Mandatory Work

1. Document the condition of the drawbar assembly on delivery including any abnormal damage.

2. Cleaning and de-greasing of all components with a suitable cleaning agent approved for use on Rolling Stock by TfL.

3. All items with damaged paintwork or corrosion should be cleaned and all corrosion removed before the area is repainted with RAL 7024 Graphite Grey colour paint. Specification to be reviewed and agreed by Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

4. All fixings, threaded fasteners and frictional locking devices to be replaced.

5. Mandatory inspection and selected on condition tasks: (see page 21)

92TS 2021 PL Maintenance description				
Component	Maintenance description	Additional actions	Mandatory	On condition
Drawbar	Inspect drawbar for damage including welds	None	Yes	
	Inspect ampep bearing housing bore	Inspect for damage and ensure interference fit tolerances for the bearing are maintained		Yes
	Inspect all pipework and fittings for damage	Replace if necessary	Yes	
	Clean and flush through stainless steel air pipes	Pressure test air pipes using air to 10 bar for 2 mins, no pressure drop allowed		Yes
	Replace ampep bearings with enhanced version (SKF 21-12868P)	None	Yes	
	Replace all fasteners	None	Yes	
	Clean and check condition of earth studs	Replace if necessary		Yes
	Check condition of plating of ampep bearing retainer plate	Strip and re-plate if necessary		Yes
	Check condition of cable brackets	Repaint or replace where necessary		Yes
	Final inspection to drawing	None	Yes	
	Torque witness marks for all fasteners	Final check of witness marks. All fasteners to be torque tightened and witness marks applied (as required) during assembly	Yes	
	Reassembly with crossbeam including fitment of pivot pin assembly and support brackets	None	Yes	

9.3.2. On Condition Work

All other components not specifically mentioned in Section 9.3 to be checked for satisfactory condition and repaired/replaced as necessary.
Supplier to provide criteria for replacement and associated justification.

9.3.3. Recording and identification

The component serial number shall be referenced on all records and documentation.

A record sheet shall be provided for each overhauled component detailing:

- The initial condition on delivery including any abnormal damage.
- Description of repairs carried out and components changed including mandatory change items.

A warranty label (clearly showing the warranty end date) and a 'test' pass label (clearly stating the date when the test was passed) to be attached to the main coupler body.

9.4. Drawgear Assembly (comprising of LH/RH tie-bar spring assembly and crossbeam)

9.4.1. Mandatory Work

1. Document the condition of the drawgear assembly on delivery including any abnormal damage.

2. Dismantle the component parts supplied (See Figure 6). The component parts of each assembly, other than consumables or mandatory replacement items, shall be kept together as a kit.

3. Cleaning and de-greasing of all components with a suitable cleaning agent.

4. All nuts, split pins and rubber spring units to be renewed on both LH and RH spring assemblies.

5. For all Central Line cars – check if the pivot pin and fastening assembly is as per drawing 204664 (as they are 100% replaced to this design during HOPL2015) and any anomalies to be recorded.

   For all W&C cars the current pivot pin and nut to be supplied. The pin is to the same design as currently fitted to Central Line cars with the exception that the threaded portion of the pin and hence overall pin length is 6mm shorter and has a different nut. SAP Part Nos. 00204/6286 (Pin) and 00204/6285 (M42 nut) applies.

   Anti-tilt mechanisms are to be fitted to the auto-coupler crossbeams following overhaul. The latest design of anti-tilt mechanism must be used. Refer to CEN CRS 3225 for details.

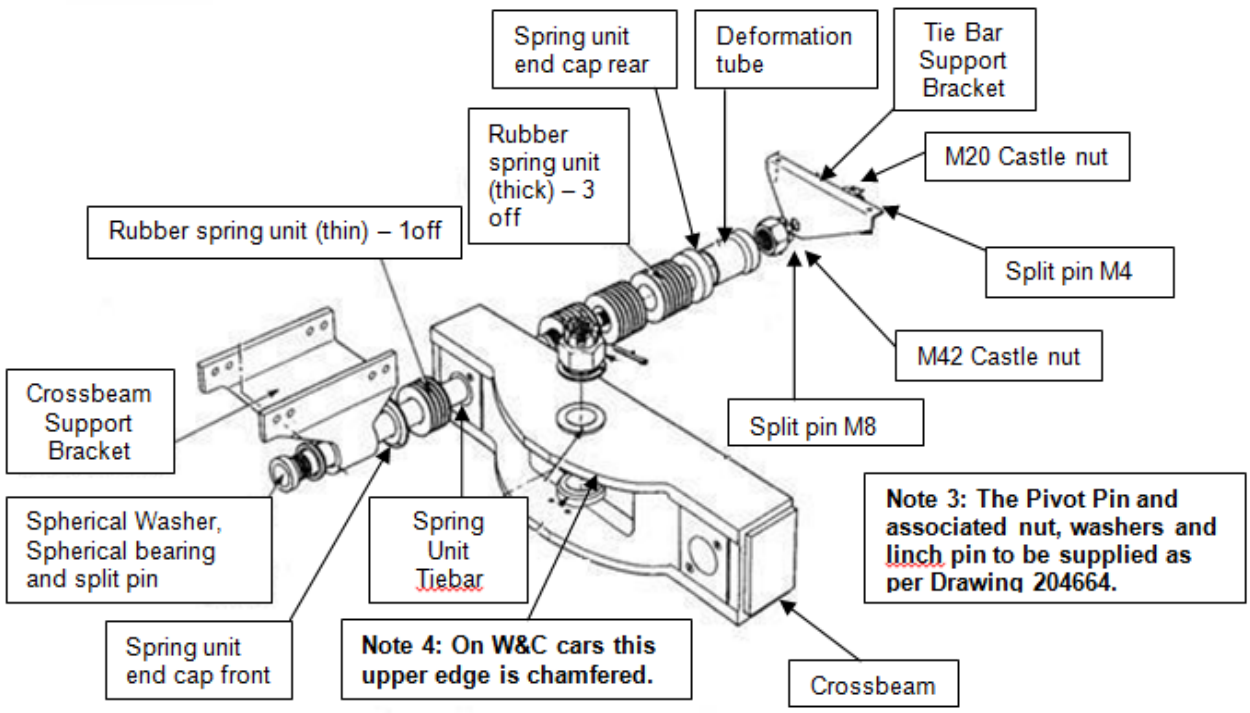


Figure 7 – Drawgear Assembly

9.4.2. On Condition Work

1. Inspect the crossbeam for defects or damage. All welds to be inspected for signs of cracking or other defects. Any damaged paintwork or corrosion should be cleaned before the area is repainted with RAL 7024 Graphite Grey colour paint. Specification to be reviewed and agreed by Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

   Supplier to propose a suitable repair method, where damage or defects are found, so that the Crossbeam can be re-claimed rather than replaced.

   Note: All crossbeams fitted to the outer (cab end) of W&C 'E' Cars (a total of 10 crossbeams) have a chamfer on the upper circular edge, See Note 4 on Figure 6. If this item is painted black then these should be returned following overhaul in the same colour. Any crossbeams found on the Central Line that have the chamfer present on the crossbeam shall be held back and another non-chamfered crossbeam used from the float. The chamfered crossbeams can then be used on the Waterloo and City line.

2. Inspect the crossbeam pivot pin bush and bores for damage or wear. Replace bushes or repair using a procedure reviewed and agreed by LU as required.

3. Inspect the crossbeam bores where the tie-bar assembly passes through the crossbeam for damage. Repair using a procedure reviewed and agreed by Principal Mechanical Engineer (AOS Engineering – Rolling Stock) as required.

4. Inspect condition of tie-bars for any corrosion built up at various interfaces and to be accordingly overhauled. *(Notes from HOPL: As the 92TS fleet is now at half-life and it is unknown how many of the tie-bars will require replacement on this overhaul. It has been agreed to replace 100% of the tie-bars for new at this programme lift, this*

will allow reclaim of the tie-bars on the next and final programme lift to take the train to the end of its life.)

5. Inspect Rubber springs for their stiffness/condition - these were 100% replaced during HOPL, hence retain and re-use by turning 180º.

   Any anomalies which require renewal must be fed back with findings for approval.

6. Inspect the condition of the deformation tube assembly, spherical washers, spherical bearing, spring unit end cap rear and spring unit end cap front for damage. Renew item if found damaged otherwise re-use. Check % change during HOPL and change requirement accordingly to either 100% Replace or On-condition change.

7. Supplier to provide criteria for replacement and associated justification of damaged and/or worn components.

9.4.3. Final Check post Overhaul

The drawgear crossbeam is to be assembled to the auto-coupler or drawbar with the new design coupler pivot pin fitted and secured with the Hardlock nut correctly torque tightened, see remove and refit document 0229 - RR – Pivot Pin Assembly – A1. All drawgear support brackets, tie-bars, rubber spring units and fasteners are to be supplied on a pallet in component form ready to reassemble onto the train with the auto-coupler/drawgear and crossbeam assembly with reference to 0225 – RR - Auto-coupler – A5.

The supplier to propose any further tests post overhaul deemed necessary including any criteria and/or test values for review and agreement by Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

9.4.4. Recording and identification

A record sheet shall be provided for each overhauled drawgear assembly detailing:-

- The initial condition on delivery including any abnormal damage.
- Description of repairs carried out and components changed including mandatory change items.

A warranty label (clearly showing the warranty end date) to be attached to the drawgear assembly.

Any components specific for Waterloo and City Line cars must be clearly labelled accordingly.

9.4.5. Air & Mechanical testing

Couplers once overhauled have to undergo bench testing on a test rig to prove

a) Mechanical couple test – gathering range

b) Check centring arm in the uncoupled position

c) Pressure test - correct pneumatic coupling and pipe integrity, leak testing, pressure drop check

d) Wedge engine pressure drop test, leak test, release bolt check

e) Contact covers functionality check

f) Pneumatic connections integrity

10. Quality, transport & Logistics

10.1. First Article Inspection (FAI)

10.1.1.1. Components from the first 10 auto-coupler's, 5 drawbars and 20 drawgear assemblies returned for overhaul shall be subject to a detailed examination and a condition report is to be provided to TfL by the Contractor with photographic evidence. TfL Engineering to review findings and if required further detailed examination on subsequent units beyond this initial quantity maybe requested.

10.1.1.2. A First Article Inspection (FAI) is to be completed by LU representatives on the first set of assemblies provided, before commencing with full production.

10.1.1.3. Test certificates shall be provided for builds and LU representatives shall be permitted to observe the testing and build process.

10.2. Additional Options

10.2.1.1. In addition to the scope of works required to be carried out in the section 6 above, the Contractor should propose priced modifications to improve the reliability of the component. The Contractor is to advise using their expertise on any modifications that will enhance the reliability of the component. These are to be quoted as standalone options and submitted to TfL on tender return.

10.3. Post-Overhaul Testing

10.3.1. Any post-overhaul tests proposed by the Contractor including usage of any specialist test equipment, any pass-fail criteria and/or test values shall be provided to TfL at the tender review stage and must be approved by TfL prior to use.

10.3.2. The Contractor shall carry out a final inspection ensuring that all relevant paperwork has been completed.

10.3.3. The Contractor shall despatch completed components with a delivery note clearly identifying the serial numbers to the nominated individual at TfL to record and receipt.

10.4. Assembly state to be delivered back to LU

The assembly detail below is to be finalised with LU prior to first delivery however this is not expected to change:

Auto-coupler and Drawgear:

The auto-coupler assembly is to be supplied back to LU assembled with the crossbeam and the new design coupler pivot pin fitted and secured with the Hardlock nut correctly torque tightened. All drawgear brackets, tiebars, rubber spring units and fasteners are to be supplied on a pallet in component form ready to reassemble onto the train with

the auto-coupler/drawgear and crossbeam assembly following remove and refit instruction 0225-RR-Auto-coupler-A5 and 0226-RR-Drawbar-A5.

Drawbar and Drawgear:

The drawbar assembly is to be supplied back to LU assembled with the crossbeam and the new design coupler pivot pin fitted and secured with the Hardlock nut correctly torque tightened. All drawgear brackets, tiebars, rubber spring units and fasteners are to be supplied on a pallet in component form ready to reassemble onto the train with the auto-coupler/drawgear and crossbeam assembly.

10.5. What LU Will Supply

The following is available on request during the bidding process:

- Reasonable access to a component sample(s) at the depot, with two to TfL required. Note: Inspection of a sample component is not compulsory, but it is recommended.
- Component maintenance documentation and OEM documentation where available. Note: This documentation has not been reviewed by LU who accept no responsibility for any omissions or inaccuracy.
- Failure data and Work Order history.
- Details of any known modifications made to the OEM components.
- Prior TfL investigation reports into known failure modes.
- Relevant sections of LU assurance standard S1538 (1) and LU assurance standard S2180 (2) can be provided upon request.

10.6. Control Process

10.6.1.1. The Contractor shall commit to TfL undertaking a First Article Inspection at the of BS EN 9102 prior to release of the first overhauled component. This shall include, as a minimum, the auditing of overhaul process, test process, inspection of first overhauled article and all relevant paperwork. All parts must be listed, with manufacturer and type, and with specification sheets provided where possible. The work shall be undertaken in a clean environment to ensure the quality of the final product. TfL shall be provided with evidence that the working environment is commensurate with producing a high-quality product and will undertake routine inspections to ensure that conditions are maintained throughout the life of the contract.

10.6.1.2. The Contractor shall gain approval of the proposed FAI process from the TfL Engineer no later than two weeks prior to its scheduled date and it will, as a minimum, verify that all dimensions, features and product attributes meet specified requirements. Documentation of first article inspection must be approved by The TfL Engineer prior to the first overhaul shipment. The Contractor shall produce FAI reports in accordance with B202-FAI Contents and B203 FAI Approval Form (4).

10.6.1.3. The Contractor must identify components that are not available or obsolete but not introduce any change or deviation from original components without approval from TfL.

10.6.1.4. For any agreed change, the Contractor shall provide support, information and evidence to assist TfL in achieving approval via the CRS Process detailed in LU assurance standard S2180 (2).

10.6.1.5. This may include the provision of drawings, specification and reports.

10.6.1.6. Any deviation from the original components which may change the specification of the components will constitute a change process. This also applies to any improvement of the component.

10.6.1.7. The Contractor shall procure materials and hold in stock sufficient level of spares to support the programme of repairs.

10.7. Recording, Identification and Transportation

10.7.1.1. The Contractor shall generate records for all components received for overhaul. These records shall be designed to enable TfL to extract statistical data about the condition and, where applicable, the failure mode of each component part. The records also form part of the overhaul history of the equipment. The records shall be available to TfL for analysis. The records shall be kept for a minimum of 7 years.

10.7.1.2. The Contractor shall issue a Certificate of Conformity for each component and the certificate shall verify that the work has been completed in full accordance with this specification and that all test criteria have been satisfied. Certificates shall record the individual serial numbers of the components in a template agreed with the TfL Contract Manager.

10.7.1.3. All supporting documentation necessary to substantiate a Declaration of Conformity shall be provided with that Declaration of Conformity and shall conform to BS EN ISO/IEC 17050-2. Supporting documentation for Declarations of Conformity of Goods made of metal shall include BS EN 10204 Type 2.2 inspection documents or better for the raw materials and semi-finished constituent products.

10.7.1.4. Supporting documentation for Declarations of Conformity of Goods created using external providers shall include declarations of conformity and supporting documentation for any externally provided process, product or service. For the avoidance of doubt, this applies to all tiers of the supply chain.

10.7.1.5. A record sheet shall be provided for each overhauled component detailing (but not limited to):

- Dates received and despatched from the overhaul facility. Initial condition report on delivery including any abnormal damage.
- Description of repairs carried out including recording of on-condition and mandatory change components. (Casualty, warranty, overhaul etc)

- Production tasks performed.
- Final test report and sign off.
- A summary test result sheet and a signed statement of compliance with this specification (Certificate of Conformity).
- A warranty label (clearly stating the date when the test was passed) to be attached to the outer casing of the component.
- Full Bill-of-Materials
- Usage data of all IROC components shall be recorded electronically by the Contractor. This data shall be sent by the Contractor to TfL with each delivery and on completion, it should be consolidated on an Excel spreadsheet form.

10.7.1.6. The quote shall include the cost to securely package and transport the components between the relevant TfL Depot and the Contractor facility, and back again to the TfL depot. Packaging of the components at the TfL Depot and at the Contractor facility shall be the responsibility of the Contractor. The packaging shall be suitable for loading/unloading by forklift made available by TfL. The Contractor may assume that the returning of components shall be on the same vehicle that delivers the next batch of components.

10.7.1.7. The components will be removed from the train and will be set aside by Depot Staff ready for packaging and collection.

10.7.1.8. A Depot Staff-operated fork-lift shall be made available for loading and unloading the packaged components.

10.7.1.9. The collection and despatch dates shall be mutually agreed between TfL and the should there be any changes to this agreed schedule.

10.7.1.10. TfL shall endeavour to provide the number of components discussed in section 5.1.1 for overhaul each week.

10.7.1.11. The Contractor shall advise on their maximum capacity. The Contractor shall highlight to TfL if the float quantity is considered to be insufficient to support this turnaround rate, described in section 5.1.1

10.7.1.12. All overhauled components shall have all covers refitted. Any blanking plugs/protective plugs (where required) shall be fitted, and masking tape used where plugs are not available.

10.7.1.13. The Autocoupler serial number is to be referenced on all records and documentation. A record sheet shall be provided for each overhauled Autocoupler Assembly detailing:

- mandatory replaced components.
- Final test report with results.
- A warranty label (clearly stating the date when the test was carried out to be attached to the outer casing of each of the Autocoupler Assemblies.

- Overhauled assemblies to have blanking plugs/protective plugs (where required) and be suitably packaged for transportation to designated LU depots.

10.8. Quality Assurance

10.8.1.1. The Contractor shall have a quality management system which meets the minimum requirements of ISO9001:2015.

10.8.1.2. The Contractor shall establish, implement and maintain a quality plan for achieving conformity to the specification that meets the recommendations and follows the guidance of BS ISO 10005:2018 and applies PD ISO/TS 22163:2017. A draft guidance quality plan document has been provided for the Contractor. It is the responsibility of The Contractor to ensure that in complying with this specification, all work is carried out by personnel with suitable skills and qualifications, using appropriate equipment and controlled procedures which yield the standard desired. The quality of the work and the materials used are paramount to ensuring that the overhauled components perform satisfactorily.

10.8.1.3. As a minimum, the quality plan shall include the following information relevant to the overhaul of the component:

- Specific and measurable quality objectives (e.g. right first time %, rework %, scrap %).
- Details of the quality control procedures, criteria and certification to be undertaken for each activity, to ensure each component is delivered to specification.
- Evidence of achieving the quality objectives gained throughout the contracted works.
- The details of key personnel with information that all staff used to undertake the work are competent, experienced and have been trained to the requisite level commensurate to the task they are undertaking. TfL shall be provided with evidence of training and experience of staff used for this contract. An organisation chart showing the relationship between the various Details of all facilities, tooling and equipment used for the overhaul (e.g. manufacturing process flow including the facilities and equipment).
- A FAI report shall be provided with relevant information to ensure all requirements are met, documented and approved by TfL prior to volume manufacture.

10.9. Recording and Identification

The component serial number shall be referenced on all records and documentation.

A record sheet shall be provided for each overhauled component detailing

- The initial condition on delivery including any abnormal damage.
- Description of repairs carried out and components changed including

mandatory change items.

- Final test report and record sheet.

A warranty label (clearly showing the warranty end date) and a ‘test’ pass label (clearly stating the date when the test was passed) to be attached to the main coupler body.

11. Verification/Validation

11.1. Development of overhaul instructions and test processes will be subject to review and agreement by the Principal Mechanical Engineer (AOS Engineering – Rolling Stock).

11.2. Components from the first 10 10 auto-coupler's, 5 drawbars and 20 drawgear assemblies returned for overhaul shall be subject to a detailed examination with a condition report to be provided to LU by the supplier with photographic evidence. AOS Engineering – Rolling Stock to review findings and if required further detailed examination on subsequent units beyond this initial quantity maybe requested.

11.3. Any components or parts the supplier deems they will have to reverse engineer to complete the overhauls shall be clearly indicated with sufficient supporting information to enable AOS Engineering – Rolling Stock to obtain the necessary LU review and agreement by Principal Mechanical Engineer (AOS Engineering – Rolling Stock) prior to the components being fitted.

12. Documents and Deliverables

12.1. The Contractor shall develop overhaul and test processes, work instructions, quality plan, recording sheets and competency matrix. These documents shall be provided to TfL at the tender review stage and must be approved by TfL prior to use.

12.2. The Contractor shall be responsible for the design, manufacture or procurement of any test equipment and rigs, as well as ensuring that they are fit for purpose. The requirements for such test equipment shall be reviewed and agreed by TfL Engineering prior to design, manufacture or procurement. TfL will not provide equipment or designs.

12.3. The Contractor shall compile a detailed bill-of-materials (BoM) based upon the components assessed in preparation for the overhaul. The BoM will list all parts and components fitted including supplier details, OEM part numbers and specification sheet references. The BoM shall be issued to TfL for acceptance immediately once compiled; the overhaul programme shall not be interrupted whilst TfL consider the BoM. The Contractor shall make any amendments required by TfL, which will include the generation of a further (revised) issue of the BoM; and shall incorporate any further or additional information discovered, e.g. due to Arising Work.

12.4. If for any reason an assembly is fitted with an alternative component in place of the part fitted to other assemblies, for example made by a different manufacturer or to a different specification to the equivalent components in other assemblies, the Contractor shall develop a method of clearly advising this difference within the BoM.

12.5. For on-condition replacements, the Contractor shall define the replacement criteria of component parts and provide justification. These are to be reviewed and agreed by TfL Engineering prior to use.

12.6. The Contractor shall also develop relevant repair procedures for remedial works as applicable. These are to be reviewed and agreed by TfL Engineering prior to use.

12.7. Any components or parts the Contractor deems they will have to reverse engineer to complete the overhauls shall be clearly indicated. Sufficient supporting information shall be provided to enable TfL Engineering to review and agree their use prior to the components being fitted. This includes, but is not limited to:

12.8. Proposing and agreeing with TfL Engineering the suitable sample size for components to be analysed.

12.9. Proposing and agreeing with TfL Engineering suitable types of testing, including associated costs and timescales

12.10. Arranging material analysis of component samples.

12.11. Reviewing material analysis reports.

12.12. Taking measurements from a sample or samples of components using tools which provide required accuracy for the application

12.13. Review of appropriate manufacturing processes, surface finishes and material treatments

12.14. The Contractor shall develop any diagrams and drawings from sample(s) to support the above as required.

13. Depot Access and Visits

The Contractor shall be granted reasonable access to facilitate manufacture and testing of the instructor operator's seat.

Notice of at least a week shall be given by the Contractor for access to the depot and the need to provide trains for service shall always take priority over the Contractor's requirements.

Entry to LUL depots may require attendance by the Contractor's representatives to depot familiarisation courses. Advanced notice of four weeks is required to book places on the courses.

It is the responsibility of the Contractor to inform the project manager when access is required.

14. Available documents

Number	Description
CEN CRS 3812-1	This CRS covers the change of the semi-permanent coupler and auto-coupler bearing, from the Ampep No. 70 NZS (also known as SKF 21-4462P) to the upgraded bearing SKF 21-12868P.
CEN CRS 2457	1992 Tube Stock Replacement of Sector Bar with Radial Support Bar and Modifications to the Auto-coupler – Below Solebar Overhaul – Fleet Fit.
Note:	CEN CRS 2457 supersedes CEN CRS 2371, CEN CRS 2414 and CEN CRS 2438.
CEN CRS 2571	Completion of W&C 1992 Tube Stock, Replacement of Sector Bar with Radial Support Bar, and Modifications to the Auto-coupler – Below Solebar Overhaul.
CEN CRS 3195-1	Improved Coupler Pivot pin arrangement (M30)
Technical Bulletin TB0288 Issue 1	Modified auto-coupler hooks.
Drawing 204664	Coupler Pivot Pin Arrangement
CEN CRS 3225	Anti-Tilt Mechanism Design Change

0229 - RR – Pivot Pin Assembly – A1	Pivot Pin Assembly Remove and Re-fit instructions