6. Our obligations hereunder shall remain in full force and effect and shall not in any way be affected, reduced or discharged by:

6.1 any alteration to the terms of the Contract made by agreement between you and the Supplier; and/or

6.2 any defence, counterclaim, set-off or other deduction available to the Supplier under the Contract; and/or

6.3 any alteration in the extent or nature or sequence or method or timing of the works/services to be carried out under the Contract; and/or

6.4 any time being given to the Supplier or any other indulgence or concession to the Supplier or any forbearance, forgiveness or any other thing done, omitted or neglected to be done under the Contract; and/or

6.5 any other bond, security or guarantee now or hereafter held by you for all or any part of the obligations of the Supplier under the Contract; and/or

6.6 the release or waiver of any such other bond, security or guarantee; and/or

6.7 any amalgamation or reconstruction or dissolution including liquidation or change in control or constitution of the Supplier; and/or

6.8 the termination of the Contract; and/or

6.9 any other event which might operate to discharge a guarantor at law or in equity.

7. Terms defined in the Contract and not otherwise defined herein shall have the same meaning in this Bond unless inconsistent with the context.

8. This Bond shall be governed by, and interpreted according to, the laws of England and the Courts of England shall have exclusive jurisdiction in relation to any claim, dispute or difference concerning this Bond and any matter arising from it save that you shall have the right to bring proceedings in the Courts of any other jurisdiction in which any of our assets may be situated.

9. This Bond may be assigned or transferred without our prior consent to any member of the TfL Group. Any other assignment or transfer of this Bond by either party shall require the consent of the other party, such consent not to be unreasonably withheld or delayed.

10. This bond may not be amended, varied or supplemented in any manner whatsoever without your prior written consent, other than in accordance with its express terms.

11. Each of the provisions of this bond is severable and distinct from the others, and if at any time any such provision is or becomes ineffective, inoperable, invalid or unenforceable it shall be severed and deemed to be deleted from this bond, and in such event the remaining provisions of this bond shall continue to have full force and effect.

12. All bank charges and other fees payable in relation to or in connection with this bond are for the account of the Manufacturer and you shall have no liability or responsibility therefor.

13. Except to the extent it is inconsistent with the express terms of this bond, this bond is subject to the ICC Uniform Rules for Demand Guarantees, 2010 revision, ICC Publication No. 758.

Executed as a deed by the parties and delivered on the date of this Bond.

Executed as a Deed by [GUARANTOR])

acting by)

.....

) Authorised Signatory

and) .....

) Authorised Signatory

Executed as a deed by affixing the Common Seal of)

[COMPANY])

in the presence of: -)

.....

[Authorised Signatory]

ANNEX 1

Form of Demand from the Company to the Guarantor

Dear Sirs

[Contract Title]

Contract No: [•] (the "Contract")

We refer to the Bond given by you to us dated [•].

An event has occurred of the type described in Clause [•] of the Contract.

We hereby demand payment from you of the sum of £[•] under the Bond. Please make payment by CHAPS made payable to [Company name / bank account details].

Yours faithfully

.....

[Company name]
5 Endeavour Square, Stratford
London
E20 1JN

Schedule 8

Form of Collateral Warranty

THIS AGREEMENT is made the day of 20[ ]

BETWEEN : -

(1) **London Underground Limited** registered in England and Wales under number: 01900907 and having its registered office at 5 Endeavour Square, Stratford, London E20 1JN (the "**Company**");

(2) [ ] a company registered in England and Wales under number: [.....]and having its registered office at [.....] (the "**Sub-Contractor**"); and

(3) [ ] a company registered in England and Wales under number: [.....]and having its registered office at [.....] (the "**Supplier**").

WHEREAS :-

(A) The Company has entered into a framework agreement, pursuant to which contracts may be made, with the Supplier (together the "**Main Contract**") pursuant to which the Supplier is to undertake and complete the following supply: [ ] (the "**Supply**").

(B) The Sub-Contractor has submitted a tender to the Supplier for the carrying out and completion of certain parts (the "**Sub-Contract Supply**") of the Supply referred to above as more particularly described in the tender.

NOW IN CONSIDERATION of the payment of £1 (one pound) by the Company to the Sub-Contractor (receipt of which the Sub-Contractor hereby acknowledges) IT IS HEREBY AGREED as follows:

1. The Sub-Contractor warrants to the Company that:

   1.1 the Sub-Contract Supply have been and will be carried out with the skill and care to be expected of appropriately qualified and experienced professional contractors with experience in carrying out works or services of a similar type, nature and complexity to the Sub-Contract Supply;

   1.2 reasonable skill and care has been and will continue to be exercised in connection with:

      (a) the design of any goods, works or services to the extent that the Sub-Contractor has or will be responsible for such design;

      (b) the selection of all goods and materials comprised in the Sub-Contract Supply (in so far as such goods and materials have been or will be selected by the Sub-Contractor);

(c) the satisfaction of any performance specification or requirement in so far as the same are included or referred to in the contract between the Supplier and the Sub-Contractor in relation to the Sub-Contract Supply (the **"Sub-Contract"**);

(d) the execution and completion of the Sub-Contract Supply;

(e) the Sub-Contract Supply will, on completion of the Main Contract, comply with all Applicable Laws and Standards (as such capitalised terms are defined in the Main Contract);

1.3 the Sub-Contract Supply will be reasonably fit for the purposes for which they are intended (awareness of which purposes the Sub-Contractor hereby acknowledges) and in particular but without limitation will be so fit for the period and with a rate of deterioration reasonably to be expected of high quality, reliable, well designed and engineered goods, materials and construction; and

1.4 it has the right to grant to the Company all licences (including without limitation all rights to sub-licence) of all intellectual property rights as contemplated in this Agreement.

For the purposes of construing the warranties in this Clause 1 references to the Sub-Contract Supply shall include any part of the Sub-Contract Supply. Each warranty shall be construed as a separate warranty and shall not be limited by reference to, or reference from, the terms of any other warranty or any other term of the Sub-Contract.

2. The Sub-Contractor shall, save in so far as he is delayed by any event in respect of which the Supplier is granted an extension of time under the Main Contract for completion of the Supply:

2.1 Execute and complete the Sub-Contract Supply in accordance with the provisions of the Sub-Contract; and

2.2 ensure that the Supplier shall not become entitled to any extension of time for completion of the Supply or to claim any additional payment under the Main Contract due to any failure or delay by the Sub-Contractor.

3. The Sub-Contractor shall from time to time supply the Company and the Supplier with such information as either may reasonably require.

4. To the extent that the intellectual property rights in any and all Documents have not already vested in the Company or the Supplier, the Sub-Contractor hereby grants to the Company an irrevocable, non-exclusive, non-terminable, royalty-free licence to copy and make full use of any and all Documents and all amendments and additions to them and any works, designs or inventions of the Sub-Contractor incorporated or referred to in them for the following purposes:

4.1 understanding the Supply;

4.2 operating, maintaining, repairing, modifying, altering, enhancing, re-figuring, correcting, replacing, re-procuring and re-tendering the Supply;

4.3 extending, interfacing with, integrating with, connecting into and adjusting the Supply;

4.4 enabling the Company to carry out the operation, maintenance repair, renewal and enhancement of the Underground Network (as such capitalised terms are defined in the Main Contract);

4.5 executing and completing the Supply; and

4.6 enabling the Company to perform its functions and duties as Infrastructure Manager and Operator of the Underground Network (as such capitalised terms are defined in the Main Contract)

provided always that the Supplier shall not be liable for the consequences of any use of the Documents as aforesaid for any other purpose. Such licence shall carry the right to grant sub-licences and shall be transferable to third parties without the prior consent of the Sub-Contractor.

For the purposes of this Clause, the term "**Documents**" shall mean documents, items of information, data, reports, drawings, specifications, plans, software, designs, inventions and any other materials provided by or on behalf of the Sub-Contractor in connection with the Sub-Contract (whether in existence or to be made).

5. The Sub-Contractor agrees:

5.1 on request at any time to give the Company or any persons authorised by the Company access to the material referred to in Clause 4 and at the Company's expense to provide copies of any such material; and

5.2 at the Sub-Contractor's expense to provide the Company with a set of all such material on completion of the Sub-Contract Supply.

6. The parties hereby agree that:

6.1 this Agreement shall be personal to the Sub-Contractor;

6.2 the Company may assign the benefit of this Agreement to any third party;

6.3 the rights and remedies contained in this Agreement are cumulative and shall not exclude any other right or remedy available to either party in law or equity.

7. **Not Used**

8. If any dispute of any kind whatsoever arises between the parties in connection with this Agreement or the Sub-Contract Supply which raises issues which are in opinion of the Company the same as or substantially the same as issues raised in a related dispute (the **"Related Dispute"**) between the Company and the Supplier and such Related Dispute has already been referred to a conciliator or arbitrator appointed under the provisions to that effect contained in the Main Contract, then the Sub-Contractor hereby agrees that the Company may at his discretion by giving notice in writing to the Sub-Contractor refer the dispute arising out of this Agreement or the Sub-Contract Supply to the adjudicator, conciliator, arbitrator or other party (the "**Appointed Party**") appointed to determine the Related Dispute. In this event the Appointed Party shall have power to give such directions for the determination of the dispute and the Related Dispute as he may think fit and to make such awards as may be necessary in the same way as if the procedure of the High Court as to joining one or more defendants or joint co-defendants or third parties was available to the parties and to him.

9.

9.1 Neither the Sub-Contractor nor the Supplier shall exercise or seek to exercise any right which may be or become available to it to terminate or treat as terminated the Sub-Contract or discontinue or suspend the performance of any of its duties or obligations thereunder or treat the Sub-Contract as determined without first giving to the Supplier or the Sub-Contractor (as applicable) not less than 35 days prior written notice of its intention to do so, with a copy to the Company, specifying the Sub-Contractor's or Supplier's grounds for terminating or treating as terminated the Sub-Contract or discontinuing or suspending its performance thereof or treating the Sub-Contract as determined.

9.2 If the Main Contract is terminated for any reason, within 35 days of such termination the Company may give written notice to the Sub-Contractor and to the Supplier (a **"Step-in Notice"**) that the Company or its appointee shall henceforth become the Supplier under the Sub-Contract in accordance with the terms of sub-clause 9.3 below.

9.3 With effect from the date of the service of any Step-in Notice:

(a) the Company or its appointee shall be substituted in the Sub-Contract as the Supplier thereunder in place of the Supplier and references in the Sub-Contract to the Supplier shall be construed as references to the Company or its appointee;

(b) the Sub-Contractor shall be bound to continue with the performance of its duties and obligations under the Sub-Contract and any exercise or purported exercise by the Sub-Contractor prior to the date of the Step-in Notice of any right to terminate or treat as terminated the Sub-Contract or to discontinue or suspend the performance of any of its duties or obligations thereunder or to treat the Sub-Contract as automatically determined shall be of no effect;

(c) the Company shall become bound by the terms and conditions of the Sub-Contract in respect of all obligations and duties of the Supplier thereunder which fall to be performed after the date of the Step-in Notice and shall promptly thereafter make payment of any amounts properly due to the Sub-Contractor as at the date of the Step-in Notice and still outstanding; and

(d) the Supplier shall be released from further performance of the duties and obligations of the Supplier under the Sub-Contract after the date of the Step-in Notice, but without prejudice to any rights and remedies of:

(i) the Sub-Contractor against the Supplier in respect of any matter or thing done or omitted to be done by the Supplier on or before the date of the Step-in Notice; and

(ii) the Supplier against the Sub-Contractor in respect of any matter or thing done or omitted to be done by the Sub-Contractor on or before the date of the Step-in Notice.

9.4 Notwithstanding anything contained in this Agreement and notwithstanding any payments which may be made by the Company to the Sub-Contractor, the Company shall not be under any obligation to the Sub-Contractor and the Sub-Contractor shall not be under any obligation to the Company unless the Company shall have served a Step-in Notice pursuant to Clause 9.2 above.

10. The Sub-Contractor's liabilities, duties and obligations hereunder shall be no greater and of no longer duration than the liabilities, duties and obligations which the Sub-Contractor owes to the Supplier under the Sub-Contract.

11. The Sub-Contractor further undertakes to indemnify the Company from and against the consequences of any breach by the Sub-Contractor of any of the warranties, covenants and undertakings contained in this Agreement.

12. The rights and benefits conferred upon the Company by this Agreement are in addition to any other rights and remedies that the Company may have against the Sub-Contractor including, without prejudice to the generality of the foregoing, any remedies in negligence.

13. Nothing contained in this Agreement shall in any way limit the obligations of the Supplier to the Company arising under the Main Contract or otherwise undertaken by the Supplier to the Company in relation to the Sub-Contract Supply.

14. No amendment to this Agreement shall be valid unless it is in writing and signed by all parties.

15. Any person who is not a party to this Agreement may not enforce any of its terms under the Contracts (Rights of Third Parties) Act 1999.

16. This Agreement shall be governed by and construed in accordance with English law and shall be subject to the exclusive jurisdiction of the Courts of England and Wales.

Schedule 9

Supplier Performance

1.1.1 KEY PERFORMANCE INDICATORS

(a) DELIVERY – The target is 100% on time delivery, to the agreed times included in the Contract Material & Pricing Data. Failure to meet delivery times will attract the following abatements against the full order value of all Goods due to be delivered in the measured period. This will be measured for each Accounting Period.

Delivery Performance by Value	**Abatement Attracted on Full Value of orders**
>= 99.00%	0%
97.00% - 98.99%	1%
95.00% - 96.99%	2%
90.00% - 94.99%	3%
80.00% - 89.99%	4%
<80.00%	5%

1.1.2 SDI PERFORMANCE CRITERIA / SERVICE DELIVERY INDICATORS (SDI's)

(a) QUALITY – The Supplier will supply Goods with 0% Defects. When Defects are found the escalation process will begin in the following circumstances:

1.1.3 Non-Safety Critical Goods

- Defects found in 3 or more Accounting Periods over a rolling six Accounting Periods; or
- Defects found in over 2% of Goods Delivered in an Accounting Period.

1.1.4 Safety Critical Goods

- Any single Defect

(a) ETHICAL SOURCING & MODERN SLAVERY

Key Deliverables	KPIs	Year 1	Year 2	Year 3	Year 4
Percentage of supplier's buying staff attended ethical sourcing training	KPI 1	50%	75%	100 %	100 %

Key Deliverables	KPIs	Year 1	Year 2	Year 3	Year 4
Production sites audited less than 12 months ago	KPI 2	100%	100 %	100 %	100 %
Corrective actions completed within agreed timescales	KPI 3	100%	100 %	100 %	100 %

1.1.5 STOCK HOLDING

Stock holding to be measured by review of the agreed delivery schedules, Order Programme and in line with London Underground's Material Team.

1.1.6 ESCALATION PROCESS

(a) In the event of unsatisfactory performance standards, including (but not limited to) failure to reach the targets set by the Service Delivery Indicators, failure to reach the targets set by the key performance indicators (in paragraph 1.1.1(a) above), faults open beyond the rectification time and any other deficiencies in performance, the escalation process shall be invoked by the Company in their absolute discretion.

The purpose of the escalation process is to provide a structured framework within which the Parties can address unsatisfactory performance standards against timescales and deliverable targets. For the purposes of this process notified levels of poor performance will be termed **"Non-Conformances"**.

This procedure operates with four levels; the lowest level Non-Conformance being Level 1. Should Non-Conformances escalate they will receive an appropriate level of management intervention from the Company and the Supplier. Level 3 gives final review and opportunity for remedial actions to resolve issues before the Non-Conformance reaches Level 4, which will entitle the Company to terminate in accordance with Clause 24.1 of this Agreement.

In the event that a performance issue is not resolved between the Company and the Supplier then the Non-Conformance may be raised formally to a Level 1 or Level 2 Non-Conformance, depending upon the severity of the performance failure. It is possible for a number of Level 1 and/or Level 2 issues to be in hand at any one time.

(b) Summary of Escalation Process

TRIGGER	LEVEL	ACTION	BY	RESULT
Failure to rectify identified non- conformance issued as part of KPIs and/ or SDIs	LEVEL 1	Improvement plan with precise end date required. On going review dates specified.	Supplier	Satisfactory - Stop Unsatisfactory - Level 2
Level 1 re-occurrence Consistent failure to meet required requirement Safety Condition infringements.	LEVEL 2	Improvement plan with precise end date required. Ongoing review dates specified.	Supplier	Satisfactory - Stop Unsatisfactory - Level 3
Level 2 re-occurrence	LEVEL 3	Final review. Final opportunity for remedial action. Precise end date required.	Supplier	Satisfactory - Stop Unsatisfactory - Level 4
Level 3 re-occurrence	LEVEL 4	POSSIBLE TERMINATION		

Issues shall be resolved locally on a day-to-day basis to the mutual satisfaction of all Parties and shall not be raised to Level 1 without prior endeavours to resolve. At this stage of the process, the Supplier may be required to supply a Root Cause Analysis and a Recovery Plan.

(c) Escalation Process

Level 1

The Level 1 Non-Conformance will be recorded by the Company and a notice submitted to the Supplier. The Supplier shall in response (such response to be within 10 Working Days of service of the notice by the Company) prepare and submit to the Company a Level 1 Non-Conformance Report. Such report will contain:

- Confirmation of the date and details of the Level 1 Non-Conformance

- The steps to be taken by the Supplier to ensure there is no repetition of such Level 1 Non-Conformance (the "**Level 1 Required Action**")

- The time within which such Level 1 Required Action is to be completed (which shall be a reasonable period and no longer than the "**Level 1 Rectification Period**").

The Supplier and the Company will use all reasonable endeavours to agree the Level 1 Rectification Period and the Level 1 Required Action. If the agreed Level 1 Required Action is carried out within the agreed Level 1 Rectification Period, then the Non-Conformance will be classed as closed.

Level 2

If the Company determines, that a Non-Conformance should be treated as a Level 2 Non-Conformance; or the Supplier fails to provide the Company with a Level 1 Non-Conformance Report within 10 Working Days; or the Supplier fails to rectify the Level 1 Non-Conformance within the Level 1 Rectification Period, then this shall be a "**Level 2 Non-Conformance**" and the Company will submit a notice to the Supplier.

The Supplier shall in response (such response to be within 10 Working Days of service of the notice by the Company) prepare and submit to the Company a Level 2 Non-Conformance Report. Such report will contain:

- Confirmation of the date and details of the Level 2 Non-Conformance

- The steps to be taken by the Supplier to ensure there is no repetition of such Level 2 Non-Conformance (the "**Level 2 Required Action**")

- The time within which such Level 2 Required Action is to be completed (which shall be a reasonable period and no longer than the "**Level 2 Rectification Period**").

The Supplier and the Company will use all reasonable endeavours to agree the Level 2 Rectification Period and the Level 2 Required Action.

If the Level 2 Required Action is taken within the agreed Level 2 Rectification Period, then the Non-Conformance will be considered resolved. However, a record of the Non-Conformance will be made, and Level 2 trends monitored.

Level 3

If the Company determines, that a Non-Conformance should be treated as a Level 3 Non-Conformance; or the Supplier fails to provide the Company with a Level 2 Non-Conformance Report within 10 Working Days; or the Supplier fails to rectify the Level 2 Non-Conformance within the Level 2 Rectification Period, then this shall be a "**Level 3 Non-Conformance**" and the Company will submit a notice to the Supplier.

The Supplier will provide the Company a report (a "**Level 3 Non-Conformance Report**"), setting out the steps which the Supplier has taken, or will take, to ensure that no further Non-Conformances of this type shall arise (the "**Level 3 Required Action**"); and the period (being no greater than 2 months from the time of occurrence of the Level 3 Non-Conformance for the Supplier to put in place steps to ensure that no further Non-Conformances of the same type occur (the "**Level 3 Rectification Period**").

Level 4

The Supplier fails to provide the Company by the agreed deadline, a Level 3 Non-Conformance Report; or the Supplier fails to undertake the Level 3 Required Action within the Level 3 Rectification Period; or the Supplier fails to rectify the Level 3 Non-Conformance within the Level 3 Rectification Period.

Schedule 10

Framework Specification

Specification AOS-E-RS-Int-MU-SP_14-No-836-A2

December 2020

Supply of Monobloc Wheel Pans, Axles and Associated Components for 72TS, 73TS, 92TS and 96TS

Author

[redacted]

Reviewed by

[redacted] [redacted]

[redacted]

Approved by

_____ _____

[redacted] [redacted]

[redacted]

Contents

1. Introduction

1.1. This document details the technical requirements to supply Monobloc wheel pans, axles and associated components, for the following London Underground train fleets.

Bakerloo	72TS
Piccadilly	73TS
Central / W&C	92TS
Jubilee	96TS

Note: This specification is intended for use on multiple tenders, the scope of any single tender may or may not cover all components within this specification, and therefore TfL/LU will direct prospective tenderers to bid on those sections relevant at the time of any proposed tender.

1.2. This specification aims to bring together in one place the technical requirements for wheelset components from diverse technical documentation (including drawings and other supporting information) to enable easy competitive tendering of wheelsets for the fleets listed. The specification covers the following components: wheel pans, axles, gear wheels, pinions and suspension tubes.

1.3. The Supplier shall be responsible for but not limited to:

- production of the components;
- testing, inspection and assurance of the components;
- delivery of the components.

2. References and Standards

2.1. The text of this document cites other documents that provide information or guidance. These are listed under Standard Compliance.

2.2. References to British Standards, International Standards or standards in other standard systems (e.g. London Underground) shall be taken to include the words 'or equivalent with the agreement of LU'.

2.3. In the event of conflicts between this specification, any document to which it refers and between different standards, the Supplier shall bring these to the attention of the Procurement Manager. TfL Engineering will make a decision on which standard takes precedence.

3. General Requirements

3.1. Any supporting documentation or information referred to in this specification is provided for the Supplier's information and guidance only. TfL/LU shall not accept any liability including, without limitation, delays or costs resulting from any ambiguities or inaccuracies this information may contain.

3.2. The Supplier shall be responsible for checking the validity of documentation or information referred to in this specification on which it relies.

3.3. The Supplier shall be responsible for making all necessary enquiries and for obtaining all information required to enable it to meet the requirements of this specification. A request for information process shall be used for making any enquiries to TfL/LU.

3.4. TfL/LU does not offer any guarantees as to the degree of drawing compliance or accuracy which has been achieved. Experience indicates that whilst most information on the drawings appears to be accurate, certain aspects of the rolling stock may differ slightly from that presented in the drawings. The Supplier shall be responsible for ensuring any inconsistencies are highlighted and any changes jointly agreed with TfL/LU.

3.5. The Supplier shall provide assurance that the requirements defined in this specification have been complied with.

3.6. All steel is to be produced in accordance to the CARES SCS, BES 6001 or an equivalent certification'. Assurance of conformance is to be provided through the appropriate certification and an Environmental Product Declaration (EPD), which is part of the producer requirements of SCS.

4. Abbreviations

The following abbreviations are used within this specification:

72TS	1972 Tube Stock (Bakerloo line Stock)
73TS	1973 Tube Stock (Piccadilly line Stock)
92TS	1992 Tube Stock (Central / Waterloo & City line Stock)
96TS	1996 Tube Stock (Jubilee line Stock)
AC	Alternating Current
ATO	Automatic Train Operation
BS	British Standard
CARES	UK Certification Authority for Reinforcing Steels
CofC	Certificate of Conformance
DC	Direct Current
EN	Euronorm
EPD	Environmental Product Declaration
FAI	First Article Inspection
LU	London Underground
NDT	Non Destructive Testing
SCS	Sustainable Constructional Steel scheme
TfL	Transport for London

Note: A glossary of terms used in LU/TfL engineering documents can be found in E1006.

5. Background

5.1. Historically, the technical information concerning wheelsets design and manufacture has been spread across multiple documents. Transport for London established this document to bring together in one place all the

technical requirements, to enable easy competitive tendering of wheelsets for the fleets listed.

5.2. The fleets are a mixture of 4-car, 6-car, 7-car and 8-car formations.

5.3. Some of the fleets have power and trailer vehicles. Many of the newer fleets have all axles powered. Propulsion on the earlier fleets (72TS, 73TS and 92TS) is via DC motors, with wheel-tread-acting friction brakes. The 92TS fleet has rheostatic braking. Propulsion on the 96TS fleet is via AC electric traction motors with rheostatic and regenerative braking supplemented by wheel-tread-acting friction brakes.

5.4. Earlier fleets are driven manually; however, the newer fleets are all fitted with one or other of the ATO systems employed on London Underground. 73TS and 92TS trains often turn around during the course of operating the train service as opposed to running one way, then in reverse.

5.5. The wheelset quantities for the fleets are built up as listed in table 1. This is not a forecast of requirements.

Fleet	Trains	Cars		Wheelset		
		power	trailer	per car	per train	per fleet
72TS (Bakerloo)	36	4	-	4	16	576
		-	3	4	12	432
73TS (Piccadilly)	86.5	4	-	4	16	1384
		-	2	4	8	692
92TS (Central)	85	8	-	4	32	2720
		-	0	0	0	0
92TS (W&C)	5	4	-	4	16	80
		-	0	0	0	0
96TS (Jubilee)	63	4	-	4	16	1008
		-	3	4	12	756
TOTAL	-	-	-	-	-	7648

Table 1: Wheelset quantities - breakdown by fleet

6. Scope of Supply

6.1. 72TS

6.1.1. 72TS Wheelsets

NOTE: The information in Section 6.1.1 is provided for information only, as assembled wheelsets are not in the scope of supply.

6.1.1.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheelset	00142/0518
Trailer Wheelset	00142/0526

Drawing No	Drawing Title
81612	Motor Wheelset Assembly
81621	Trailer Wheelset Assembly

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.1.2

6.1.1.2. Standards

New Wheelsets shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
E6340	Engineering of rolling stock wheelsets	N/A
E6341	Rolling Stock General Requirements for New Wheelsets	RME 714
E6344	Non-destructive testing of rolling stock wheelsets	RSE/STD/017 Pt 4
BS 5892-6	Railway rolling stock materials. Part 6: Specification for Wheelsets for traction and trailing stock	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.1.1.3. Dimensions

All dimensions shall be as per LUL drawings 81612 (for Motor Wheelsets) and 81621 (for Trailer Wheelsets).

6.1.2. 72TS Monobloc Wheels (extracted from LU standard MR-E6343)

6.1.2.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheel (00655/1875)	00201/3600
Trailer Wheel (00655/1875)	00201/3600

Drawing No	Drawing Title
81601	Monobloc Wheel, 790 Dia (31")
67620	LT3 Wheel Profile
57933	Wheel Tread Profile and Oil Injection Provision

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.2.2

6.1.2.2. Standards

New wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-3	Railway rolling stock materials. Part 3: Specification for Monobloc wheels for traction and trailing stock	N/A
BS 1134	Assessment of surface texture – Guidance and general information	N/A
BS 970-1	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of BS 970-1
MR-E6343	Rolling Stock Wheels	JNP-ENG-S6005, RME 256
E6347	Wheel Profiles	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 3 the following specific requirements shall apply:

6.1.2.3. Materials

Clause 4.1: Grade R9 Steel

Clause 4.2: Heat Treatment "T"

Noise deadening rings shall be made in accordance with BS 970 Part 1 grade 040A10.

6.1.2.4. Dimensions

Clause 5.7: The surface finish of the wheel bore shall be in the range of 1.6 to 0.8 micrometres (CLA).

The correct dimension for the single oil injection hole, on 72TS, is shown in drawing 81601 '790 Dia Monobloc wheel (31in)': 31 mm @ 40 degrees.

A limit of wear groove is not required.

The tread and flange profiles shall be in accordance with LUL drawing 67620.

All other dimensions to be as per LUL drawing 81601.

6.1.2.5. Imbalance

Clause 5.8: Elimination of imbalance shall not be applied

6.1.2.6. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard E6343 shall be applied in its place.

The following additional marks shall be applied:

The letter 'U' (to indicate that an ultrasonic test has been carried out).

The wheels are to be serialised, with the serialisation to be proposed by the Supplier and agreed with TfL/LU.

The stampings shall be 10 mm high.

The wheel serial number shall be stamped on the outside face of the wheel on the radius between the wheel boss and the web.

6.1.2.7. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.6.1: The uniformity of rim hardness test shall be carried out.

Clause 8.3.7: Wheel rims and bosses shall be ultrasonically inspected after heat treatment.

6.1.2.8. Test Methods

Clause 9.6: The assessment of residual stress shall not be carried out.

Clause 9.7: The ultrasonic test shall be carried out to written procedures defined by the Supplier.

The Supplier's procedures for ultrasonically inspecting wheels shall be submitted to TfL's NDT Engineer for acceptance.

The acceptance standard shall be as follows:

1) wheels possessing no more than 10 defect signals in the rim or the boss for which the ratio of the amplitude of the defect signal or supplementary echo to that of the back wall echo of an adjacent sound zone does not exceed 0.25 shall be accepted, provided that there is at least 15 mm between two adjacent defect signals;

2) In addition a visual inspection of the wheel including the rim, web and boss shall be performed to ensure that they are free from any surface markings indicative of rolled in laps or defects.

6.1.2.9. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied with every delivery including the results of the cast analyses and mechanical tests.

6.1.3. 72TS Axles (extracted from LU standard SSL-S-3279)

6.1.3.1. Part and Drawing Numbers

Type	SAP Number
Motor Axle (00024/1831)	00200/7004
Trailer Axle (00024/1848)	00200/6186

Drawing No	Drawing Title
81615	Motor Axle
81623	Trailer Axle
46083	Detail of Stress Relieving Groove in Rolling Stock Axles

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.3.2

6.1.3.2. Standards

New axles shall be manufactured as per with the following standards:

Document No	Document Title	Superseded Standard
BS 5892-1	Railway rolling stock materials. Part 1: Specification for axles for traction and trailing stock [Read for "Normal" Surface Speed]	N/A
SSL-S-3279	Rolling Stock Axles	RSE/STD/017 Pt 2, JNP-ENG-S6004, RME 7, E6342
MR-G6002	Cold Rolling of Rolling Stock Axles	RSE/STD/017 Pt 6, JNP-ENG-G6006, RME 715, E6346
MR-E6345	Engineering Standard – Protection of rolling stock Axles	JNP-ENG-S6008
E6344	Non Destructive testing for rolling stock wheelsets.	RSE/STD/017 Pt 4

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 1 the following specific requirements shall apply:

6.1.3.3. Materials

Clause 4.1: Grade A1 Steel

Clause 4.2: Heat Treatment "T"

6.1.3.4. Dimensions

Clause 5.7: The axle wheelseat in the "ready for assembly" condition shall have a surface roughness no greater than 0.8 micrometre R_a.

The Machining tolerances specified for fleets operating at 'Normal speeds' shall be used.

Dimensions for Axle Seats shall be such that the requirements of paragraph 6.1.3.9 are achieved.

Dimensions and geometry of Stress Relieving Grooves shall be as per LUL drawing 46083.

All other dimensions shall be as per LUL drawings 81615 (for Motor Axles) and 81623 (for Trailer Axles).

6.1.3.5. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard SSL-S-3279 shall be applied in its place.

The following additional marks shall be applied:

The cast number shall be stamped on one end of the axle (not the body) when hot.

The stampings shall be of such a depth as to be removed by the final machining process.

The brand marks shall be re-stamped cold at one end of the finished axle.

They shall be positioned on the end chamfer or spigot (not on the axle end face). The axle serial number shall be cold stamped in a similar position on the opposite end of the finished axle.

6.1.3.6. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.4: An impact test shall be carried out.

6.1.3.7. Test Methods

Clause 9.3.1: An ultrasonic test shall be carried out in accordance with E6344.

Clause 9.3.2: Magnetic particle tests test shall be carried out in accordance with E6344.

6.1.3.8. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests.

With regard to MR-G6002 the following specific requirements shall apply:

6.1.3.9. Cold Rolling of Axle Seats

Axles shall be manufactured with extended seats to enable them to be cold rolled as per LUL standard MR-G6002.

6.1.3.10. Cold Rolling of Stress Relieving Grooves

All Stress Relieving Grooves shall be cold rolled as per LUL standard MR-G6002.

6.1.3.11. Other Standards

Protection of axles shall be as per LUL Standard MR-E6345.

6.1.4. 72TS Suspension Tubes

6.1.4.1. Part and Drawing Numbers

Type	SAP Number
Suspension Tube (99999/9288)	00201/5277

Drawing No	Drawing Title
74514	Motor Suspension Bearing Unit (Casting) - for LT115 type Motors
74566	Dowel for Motor Suspension Unit
59675	Motor Suspension Bearing Unit (Fabricated) - for LT115 type Motors

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.4.2.

6.1.4.2. Standards

New Suspension Tubes shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS EN 1563	Founding – Spheroidal Graphite Cast Irons	BS EN 2789
BS EN ISO 8501-1	Preparation of steel substrates before application of paints and related products.	SIS 055900
E6241	Eng Standard – Rolling stock coating systems	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.1.4.3. Materials

Cast Suspension Tubes shall be made from Spheroidal Graphite Cast Iron in accordance with BS EN 1563 Grade/Symbol EN-GJS-450-10. **Note: BS EN 1563 Grade/Symbol EN-GJS-450-10 supersedes BS 2789 Grade 450/10 as this standard is now withdrawn.**

Fabricated Suspension Tubes shall be made from Steel to BS 970 150M19 (or equivalent). If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.1.4.4. Dimensions

Dimensions for Suspension Tubes shall be as per LUL drawings 74514, 74566 and 59675.

Note: At the time of ordering, LU will specify whether the Suspension Tubes should be cast or fabricated. This is likely to depend on the quantity to be ordered.

6.1.5. 72TS Gear Wheels

6.1.5.1. Part and Drawing Numbers

Type	SAP Number
Gear Wheel (00655/1852)	00201/4606

Drawing No	Drawing Title
47106	Gearwheel, 7½° Single Helical, 65 Teeth, 3.2618" DP (for LT115 Motor)

Note: Both internal and national/international Standards referenced in the above drawing are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.5.2.

6.1.5.2. Standards

New Gear Wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3

Note: For requirements and standards related to quality please see section 10 of this document.

Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 72TS stock.

Gear Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

6.1.5.3. Materials

Gear Wheels shall be made from Alloy Case Hardening Steel to BS 970-3 Grade 665M17, or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.1.5.4. Dimensions

Gear Wheels should be made in accordance with the requirements of LUL drawing 47106.

6.1.6. 72TS Pinions

6.1.6.1. Part and Drawing Numbers

Type	SAP Number
Pinion (00655/1853)	00201/4592

Drawing No	Drawing Title
47112	Pinion, 7½° Single Helical, 16 Teeth, 3.2618" DP (for LT115 Motor)

Note: Both internal and national/international Standards referenced in the above drawing are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.1.6.2.

6.1.6.2. Standards

New pinions shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3

Note: For requirements and standards related to quality please see section 10 of this document.

Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 72TS stock.

Gear Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

6.1.6.3. Materials

Pinions shall be made from Alloy Case Hardening Steel to BS 970-3 Grade 832M13, or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.1.6.4. Dimensions

Pinions should be made in accordance with the requirements of LUL drawing 47112.

6.2. 73TS

6.2.1. 73TS Wheelsets

NOTE: The information in Section 6.2.1 is provided for information only, as assembled wheelsets are not in the scope of supply.

1. Part and Drawing Numbers

Type	SAP Number
Motor Wheelset (00656/0825)	-
Trailer Wheelset (00656/0826)	-

Drawing No	Drawing Title
TL103009	Motor Wheelset Assembly
TL103010	Trailer Wheelset Assembly

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.1.1.

6.2.1.1. Standards

New Wheelsets shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
E6340	Engineering of rolling stock wheelsets	N/A
E6341	Rolling Stock General Requirements for New Wheelsets	RME 714
E6344	Non-destructive testing of rolling stock wheelsets	RSE/STD/017 Pt 4
BS 5892-6	Railway rolling stock materials. Part 6: Specification for Wheelsets for traction and trailing stock	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.2.1.2. Dimensions

All dimensions shall be as per LUL drawings TL103009 (for Motor Wheelsets) and TL103010 (for Trailer Wheelsets).

6.2.2. 73TS Monobloc Wheels (extracted from LU standard MR-E6343)

6.2.2.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheel (Non-Gear End) (00655/4068)	-
Motor Wheel (Gear End) (00655/4069)	-
Trailer Wheel (00655/4070)	-

Drawing No	Drawing Title
TL81601	Monobloc Wheel, 790 Dia (31")
67620	LT3 Wheel Profile
57933	Wheel tread profile and oil injection provision

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.2.2.

6.2.2.2. Standards

New wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-3	Railway rolling stock materials. Part 3: Specification for Monobloc wheels for traction and trailing stock	N/A
BS 970-1	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of BS 970-1
MR-E6343	Rolling Stock Wheels	JNP-ENG-S6005, RME 256
E6347	Wheel Profiles	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 3 the following specific requirements shall apply:

6.2.2.3. Materials

Clause 4.1: Grade R9 Steel

Clause 4.2: Heat Treatment "T"

The noise deadening rings shall be made in accordance with BS 970 Part 1 grade 040A10.

6.2.2.4. Dimensions

Clause 5.7: The surface finish of the wheel bore shall be in the range of 1.6 to 0.8 micrometres (CLA).

The correct dimensions for the oil injection holes, with the different positions and angles from the hub face, are as shown in drawing TL81601: 31 mm @ 40 degrees.

A limit of wear groove is not required.

The tread and flange profiles shall be in accordance with LUL drawing 67620.

All other dimensions to be as per LUL drawing TL81601.

6.2.2.5. Imbalance

Clause 5.8: Elimination of imbalance shall not be applied

6.2.2.6. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard E6343 shall be applied in its place.

The following additional marks shall be applied:

The letter 'U' (to indicate that an ultrasonic test has been carried out).

The wheels are to be serialised, with the serialisation to be proposed by the Supplier and agreed with TfL/LU.

The stampings shall be 10 mm high.

The wheel serial number shall be stamped on the outside face of the wheel on the radius between the wheel boss and the web.

6.2.2.7. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.6.1: The uniformity of rim hardness test shall be carried out.

Clause 8.3.7: Wheel rims and bosses shall be ultrasonically inspected after heat treatment.

6.2.2.8. Test Methods

Clause 9.6: The assessment of residual stress shall not be carried out.

Clause 9.7: The ultrasonic test shall be carried out to written procedures defined by the Supplier.

The Supplier's procedures for ultrasonically inspecting wheels shall be submitted to TfL's NDT Engineer for acceptance.

The acceptance standard shall be as follows:

1) wheels possessing no more than 10 defect signals in the rim or the boss for which the ratio of the amplitude of the defect signal or supplementary echo to that of the back wall echo of an adjacent sound zone does not exceed 0.25 shall be accepted, provided that there is at least 15 mm between two adjacent defect signals;

2) In addition a visual inspection of the wheel including the rim, web and boss shall be performed to ensure that they are free from any surface markings indicative of rolled in laps or defects.

6.2.2.9. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests with every delivery.

6.2.3. 73TS Axles (extracted from LU standard SSL-S-3279)

6.2.3.1. Part and Drawing Numbers

Type	SAP Number
Motor Axle (00024/1849)	00200/6098
Trailer Axle (00024/1850)	00200/7758

Drawing No	Drawing Title
TL81628	Motor Axle
TL81629	Trailer Axle
46083	Detail of Stress Relieving Groove in Rolling Stock Axles

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.3.2.

6.2.3.2. Standards

New axles shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-1	Railway rolling stock materials. Part 1: Specification for axles for traction and trailing stock [Read for "Normal" surface speed]	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3
SSL-S-3279	Rolling Stock Axles	JNP-ENG-S6004, RSE/STD/017 Pt 2, RME 7, E6342
MR-G6002	Cold Rolling of Rolling Stock Axles	JNP-ENG-G6006, RSE/STD/017 Pt 6, RME 715, E6346

MR-E6345	Engineering Standard – Protection of rolling stock Axles	JNP-ENG-S6008
E6344	Non Destructive testing of rolling stock axles	RSE/STD/017 Pt 4

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 1 the following specific requirements shall apply:

6.2.3.3. Materials

Clause 4.1: Grade A1 Steel

Clause 4.2: Heat Treatment "T"

6.2.3.4. Dimensions

Clause 5.7: The axle wheelseat in the "ready for assembly" condition shall have a surface roughness no greater than 0.8 micrometre R_a.

The Machining tolerances specified for fleets operating at 'Normal speeds' shall be used.

Dimensions for Axle Seats shall be such that the requirements of paragraph 6.2.3.9 are achieved.

Dimensions of Stress Relieving Grooves shall be as per LUL drawing 46083.

All other dimensions shall be as per LUL drawings / technical specifications TL81628 (for Motor Axles) and TL81629 (for Trailer Axles).

6.2.3.5. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard SSL-S-3279 shall be applied in its place.

The following additional marks shall be applied:

The cast number shall be stamped on one end of the axle (not the body) when hot.

The stampings shall be of such a depth as to be removed by the final machining process.

The brand marks shall be re-stamped cold at one end of the finished axle.

They shall be positioned on the end chamfer or spigot (not on the axle end face). The axle serial number shall be cold stamped in a similar position on the opposite end of the finished axle.

6.2.3.6. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.4: An impact test shall be carried out.

6.2.3.7. Test Methods

Clause 9.3.1: An ultrasonic test shall be carried out in accordance with E6344.

Clause 9.3.2: Magnetic particle tests test shall be carried out in accordance with E6344.

6.2.3.8. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests with every delivery.

With regard to MR-G6002 the following specific requirements shall apply:

6.2.3.9. Cold Rolling of Axle Seats

Axles shall be manufactured with extended seats to enable them to be cold rolled as per LUL standard MR-G6002.

6.2.3.10. Cold Rolling of Stress Relieving Grooves

All Stress Relieving Grooves shall be cold rolled as per LUL standard MR-G6002.

6.2.3.11. Other Standards

Protection of axles shall be as per LUL Standard MR-E6345.

6.2.4. 73TS Suspension Tubes

6.2.4.1. Part and Drawing Numbers

Type	SAP Number
Suspension Tube	00201/4504

Drawing No	Drawing Title
TL104941	Cast SG Iron Motor Suspension Tube (3 Sheets)
TL103004	Motor Suspension Unit (Steel) Detail

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.4.2.

6.2.4.2. Standards

New Suspension Tubes shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS EN 1563	Founding – Spheroidal Graphite Cast Irons	BS 2789
BS 970-1	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of BS 970-1
TUB/RSE/SP/027	Machining & Fitting Procedure for Replacement Pads and Bushes in 73TS Aluminium Suspension Tubes	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.2.4.3. Materials

Suspension Tubes shall be made from Spheroidal Graphite Cast Iron in accordance with BS EN 1563 Grade/Symbol EN-GJS-450-10.

Note: BS EN 1563 Grade/Symbol EN-GJS-450-10 supersedes BS 2789 Grade 450/10 as this standard is now withdrawn.

6.2.4.4. Dimensions

Dimensions for Suspension Tubes shall be as per LUL drawing TL104941 and TL103004 and associated sub-assembly drawings (see section 6.7) and as per specification TUB/RSE/SP/027.

6.2.5. 73TS Gear Wheels

6.2.5.1. Part and Drawing Numbers

Type	SAP Number
Gear Wheel (00655/4062)	-

Drawing No	Drawing Title
TL100445	75 Teeth Gearwheel, for LT118 Traction Motor
54128	Gearwheel Detail for LT118, LT118A, B and C

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.5.2.

6.2.5.2. Standards

New Gear Wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3
RSE-ST-00104	Standard – Gearwheels and Pinions	RME 246

Note: For requirements and standards related to quality please see section 10 of this document.

Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 73TS stock.

Gear Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

6.2.5.3. Materials

Gear Wheels shall be made from Alloy Case Hardening Steel to BS 970-3 Grade 665M17, or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.2.5.4. Dimensions

Gear Wheels should be made in accordance with the requirements of LUL drawings TL100445 and 54128.

6.2.6. 73TS Pinions

6.2.6.1. Part and Drawing Numbers

Type	SAP Number
Pinion (00655/4067)	00201/0826

Drawing No	Drawing Title
TL103116	Pinion, 17 Teeth, LT118 C/E

Note: Both internal and national/international Standards referenced in the above drawing are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.2.6.2.

6.2.6.2. Standards

New Pinions shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3
RSE-ST-00104	Standard – Gearwheels and Pinions	RME 246

Note: For requirements and standards related to quality please see section 10 of this document.

Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 73TS stock.

Gear Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

6.2.6.3. Materials

Pinions shall be made from Alloy Case Hardening Steel to BS 970-3 Grade 832M13, or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original

and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.2.6.4. Dimensions

Pinions should be made in accordance with the requirements of LUL drawing TL103116.

6.3. **92TS**

6.3.1. 92TS Wheelsets

NOTE: The information in Section 6.3.1 is provided for information only, as assembled wheelsets are not in the scope of supply.

6.3.1.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheelset with Bearing Seats for Half Tube (Style 1)	00142/0492
Motor Wheelset without Bearing Seats for Half Tube (Style 2)	00142/0500

Drawing No	Drawing Title
1P106587 – 3021	Motor Wheelset (Wheels and Axle)

Note: Both internal and national/international Standards referenced in the above drawing are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.3.1.2.

6.3.1.2. Standards

General Requirements for the manufacture of new Wheelsets shall be as per the following standards:

Document No	Document Title	Superseded Standard
E6340	Engineering of rolling stock wheelsets	N/A
E6341	Rolling Stock General Requirements for New Wheelsets	RME 714
E6344	Non-destructive testing of rolling stock wheelsets	RSE/STD/017 Pt 4
BS 5892-6	Railway rolling stock materials. Part 6: Specification for Wheelsets for traction and trailing stock	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.3.1.3. Dimensions

All dimensions shall be as per LUL Wheelset drawing 1P106587 – 3021 (all wheelsets are Motor).

6.3.2. 92TS Monobloc Wheels (extracted from LU standard MR-E6343)

6.3.2.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheel, LT5 (00655/8002)	00141/9176

Drawing No	Drawing Title
1P106588 A 3031 (marked-up)	Ring Damped Monobloc Wheel, 28"
57933	Wheel Tread Profile and Oil Injection Provision
92667	LT5 Wheel Profile Note: LT3 Profile (Drawing 67620) was applicable at build but this has, since, been superseded for 92TS.

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.3.2.2.

6.3.2.2. Standards

New wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-3	Railway rolling stock materials. Part 3: Specification for Monobloc wheels for traction and trailing stock	N/A
BS 970-1	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of BS 970-1
MR-E6343	Rolling Stock Wheels	RME 256, JNP-ENG-S6005
E6347	Wheel Profiles	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 3 the following specific requirements shall apply:

6.3.2.3. Materials

Clause 4.1: Grade R9 Steel

Clause 4.2: Heat Treatment "T"

The noise deadening rings shall be made in accordance with BS 970 Part 1 grade 040A10.

Note: Drawing 1P106588 refers indicates that the noise deadening ring should be manufactured from Japanese grade JIS G 4303 steel, BS 970 Part 1 Grade 040A10 is an LUL accepted British Standard equivalent grade.

6.3.2.4. Dimensions

Clause 5.7: The surface finish of the wheel bore shall be in the range of 1.6 to 0.8 micrometres (CLA).

The correct dimensions for the oil injection holes are as shown in LUL drawings 1P106588 A 3031 (marked-up) and 57933.

A limit of wear groove is not required.

The tread and flange profiles shall be in accordance with LUL drawing 92667.

Note: LUL drawing 1P106588 A 3031 (iss.f) states LT3 profile but the 92TS fleet has since been modified to use the LT5 profile and the drawing has been marked up to reflect this.

All other dimensions to be as per the marked-up version of LUL drawing 1P106588 A 3031.

6.3.2.5. Imbalance

Clause 5.8: Elimination of imbalance shall not be applied

6.3.2.6. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard E6343 shall be applied in its place.

The following additional marks shall be applied:

The letter 'U' (to indicate that an ultrasonic test has been carried out).

The wheels are to be serialised, with the serialisation to be proposed by the Supplier and agreed with TfL/LU.

The stampings shall be 10 mm high.

The wheel serial number shall be stamped on the outside face of the wheel on the radius between the wheel boss and the web.

6.3.2.7. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.6.1: The uniformity of rim hardness test shall be carried out.

Clause 8.3.7: Wheel rims and bosses shall be ultrasonically inspected after heat treatment.

6.3.2.8. Test Methods

Clause 9.6: The assessment of residual stress shall not be carried out.

Clause 9.7: The ultrasonic test shall be carried out to written procedures defined by the Supplier.

The Supplier's procedures for ultrasonically inspecting wheels shall be submitted to TfL's NDT Engineer for acceptance.

The acceptance standard shall be as follows:

1) wheels possessing no more than 10 defect signals in the rim or the boss for which the ratio of the amplitude of the defect signal or supplementary echo to that of the back wall echo of an adjacent sound zone does not exceed 0.25 shall be accepted, provided that there is at least 15 mm between two adjacent defect signals;
2) In addition a visual inspection of the wheel including the rim, web and boss shall be performed to ensure that they are free from any surface markings indicative of rolled in laps or defects.

6.3.2.9. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests with every delivery.

6.3.3. 92TS Axles (extracted from LU standard SSL-S-3279)

6.3.3.1. Part and Drawing Numbers

Type	SAP Number
Motor Axle with Bearing Seats for Half Tube (Style 1)	00201/4685
Motor Axle without Bearing Seats for Half Tube (Style 2)	00201/4639

Drawing No	Drawing Title
1P106589 – 3051	Axle
46083	Detail of Stress Relieving Groove in Rolling Stock Axles

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.3.3.2.

6.3.3.2. Standards

New axles shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-1	Railway rolling stock materials. Part 1: Specification for axles for traction and trailing stock [Read for "Normal" surface speed]	N/A
SSL-S-3279	Rolling Stock Axles	RME 7, E6342, JNP-ENG-S6004, RSE/STD/017 Pt 2
MR-G6002	Cold Rolling of Rolling Stock Axles	RME 715, E6346, RSE/STD/017 Pt 6, JNP-ENG-G6006
MR-E6345	Engineering Standard – Protection of rolling stock Axles	JNP-ENG-S6008
E6344	No destructive testing for rolling stock wheelsets	RES/STD/017 Pt 4

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 1 the following specific requirements shall apply:

6.3.3.3. Materials

Clause 4.1: Grade A1 Steel

Clause 4.2: Heat Treatment "T"

6.3.3.4. Dimensions

Clause 5.7: The axle wheelseat in the "ready for assembly" condition shall have a surface roughness no greater than 0.8 micrometre R_a.

The Machining tolerances specified for fleets operating at 'Normal speeds' shall be used.

Dimensions for Axle Seats shall be such that the requirements of paragraph 6.3.3.9 are achieved.

Dimensions & Geometry of Stress Relieving Grooves shall be as per LUL drawing 46083.

All other dimensions shall be as per LUL drawing 1P106589 – 3051.

6.3.3.5. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard SSL-S-3279 shall be applied in its place.

The following additional marks shall be applied:

The cast number shall be stamped on one end of the axle (not the body) when hot.

The stampings shall be of such a depth as to be removed by the final machining process.

The brand marks shall be re-stamped cold at one end of the finished axle.

They shall be positioned on the end chamfer or spigot (not on the axle end face). The axle serial number shall be cold stamped in a similar position on the opposite end of the finished axle.

6.3.3.6. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.4: An impact test shall be carried out.

6.3.3.7. Test Methods

Clause 9.3.1: An ultrasonic test shall be carried out in accordance with E6344.

Clause 9.3.2: Magnetic particle tests test shall be carried out in accordance with E6344.

6.3.3.8. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests with every delivery.

With regard to MR-G6002 the following specific requirements shall apply:

6.3.3.9. Cold Rolling of Axle Seats

Axles shall be manufactured with extended seats to enable them to be cold rolled as per LUL standard MR-G6002.

6.3.3.10. Cold Rolling of Stress Relieving Grooves

All Stress Relieving Grooves shall be cold rolled as per LUL standard MR-G6002.

6.3.3.11. Other Standards

Protection of axles shall be as per LUL Standard MR-E6345.

6.3.4. 92TS Negative Shoegear Half Tubes

6.3.4.1. Part and Drawing Numbers

Type	SAP Number
Negative Shoegear Half Tube / Negative Bearing Support Body	00204/6412

Drawing No	Drawing Title
1119695	Assembly & Details Half Tube Negative Shoegear
1124534	Detail & Assembly of Liner to Negative Shoegear Half Tube

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.3.4.2

6.3.4.2. Standards

New Half Tubes shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS EN 1563	Founding – Spheroidal Graphite Cast Irons	BS 2789

Note: For requirements and standards related to quality please see section 10 of this document.

6.3.4.3. Materials

Negative Shoegear Half Tubes shall be made from Spheroidal Graphite Cast Iron to BS 2789 Grade 400/18 L20, or equivalent (e.g. grade EN-GJS-400-18-RT from BS EN 1563). If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.3.4.4. Dimensions

Dimensions for Negative Shoegear Half Tubes shall be as per LUL drawing 1119695 and 1124534.

6.3.5. 92TS Gear Wheels / Pinions

NOTE: The information in Section 6.4.5 is provided for information only, as 92TS Gear Wheels and pinions are to be purchased direct from current Supplier who owns the IPR for the design.

6.3.5.1. Part and Drawing Numbers

Type	SAP Number
Pinion (Input, Traction Gearbox) (00655/8001)	00141/9168
Gear Wheel (Axle) (00043/8005)	00200/8334

Drawing No	Drawing Title
N/A	N/A

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.3.5.2.

6.3.5.2. Standards

New Gear Wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
RSE-ST-00104	Standard – Gearwheels and Pinions	RME 246

Note: For requirements and standards related to quality please see section 10 of this document.

6.3.5.3. Materials

Gear Wheels shall be purchased direct from the current Supplier who owns the IPR for the design (including the material specification).

6.3.5.4. Dimensions

Gear Wheels shall be purchased direct from the current Supplier who owns the IPR for the design (including the drawings and dimensions).

6.4. 96TS

6.4.1. *96TS Wheelsets*

NOTE: The information in Section 6.4.1 is provided for information only, as assembled wheelsets are not in the scope of supply.

6.4.1.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheelset without Negative Support	00204/6278
Motor Wheelset with Negative Support	00204/6279
Trailer Wheelset	00204/6273

Drawing No	Drawing Title
11-232-111	Wheelset (Motor) with Negative Support
11-232-110	Wheelset (Motor) without Negative Support
11-233-110	Wheelset (Trailer)

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.4.1.2.

6.4.1.2. Standards

New Wheelsets shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
E6340	Engineering of rolling stock wheelsets	N/A
E6341	Rolling Stock General Requirements for New Wheelsets	RME 714
E6344	Non-destructive testing of rolling stock wheelsets	RSE/STD/0017 Pt 4
BS 5892-6	Railway rolling stock materials. Part 6: Specification for Wheelsets for traction and trailing stock	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

6.4.1.3. Dimensions

All dimensions shall be as per LUL Wheelset drawings:

11-232-111 and 11-232-110 (for Motor wheelsets).

11-233-110 (for Trailer wheelsets).

6.4.2. 96TS Monobloc Wheels (extracted from LU standard MR-E6343)

6.4.2.1. Part and Drawing Numbers

Type	SAP Number
Motor Wheel	00204/6050
Trailer Wheel	00204/6730

Drawing No	Drawing Title
11-232-121	Monobloc Wheel (Motor) 770-710 Dia
11-233-121	Monobloc Wheel (Trailer) 770-690 Dia
92667	LT5 Wheel Profile
57933	Wheel Tread Profile and Oil Injection Provision

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.4.2.2.

6.4.2.2. Standards

New wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-3	Railway rolling stock materials. Part 3: Specification for Monobloc wheels for traction and trailing stock	N/A
BS 970-1	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of BS 970-1
MR-E6343	Rolling Stock Wheels	RME 256, JNP-ENG-S6005
E6347	Wheel Profiles	N/A
EO.14.06.01 Part 4e	Overhaul of Wheelsets : Part 4e : Overhaul Requirements for Noise Rings	N/A

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 3 the following specific requirements shall apply:

6.4.2.3. Materials

Clause 4.1: Grade R9 Steel

Clause 4.2: Heat Treatment "T"

The noise deadening rings shall be made in accordance with BS 970 Part 1 grade 040A10.

6.4.2.4. Dimensions

Clause 5.7: The surface finish of the wheel bore shall be in the range of 1.6 to 0.8 micrometres (CLA).

The correct dimensions for the oil injection holes are as shown in LUL drawings 11-232-121 (for Motor wheels) and 11-233-121 (for Trailer wheels) and in LUL drawing 57933.

A limit of wear groove is not required.

The tread and flange profiles shall be in accordance with LUL drawing 92667 'LT5 Tread Profile'

All other dimensions to be as per the following LUL drawings:

11-232-121 (for Motor wheels);

11-233-121 (for Trailer wheels).

6.4.2.5. Imbalance

Clause 5.8: Elimination of imbalance shall not be applied

6.4.2.6. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard E6343 shall be applied in its place.

The following additional marks shall be applied:

The letter 'U' (to indicate that an ultrasonic test has been carried out).

The wheels are to be serialised, with the serialisation to be proposed by the Supplier and agreed with TfL/LU.

The stampings shall be 10 mm high.

The wheel serial number shall be stamped on the outside face of the wheel on the radius between the wheel boss and the web.

6.4.2.7. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.6.1: The uniformity of rim hardness test shall be carried out.

Clause 8.3.7: Wheel rims and bosses shall be ultrasonically inspected after heat treatment.

6.4.2.8. Test Methods

Clause 9.6: The assessment of residual stress shall not be carried out.

Clause 9.7: The ultrasonic test shall be carried out to written procedures defined by the Supplier.

The Supplier's procedures for ultrasonically inspecting wheels shall be submitted to TfL's NDT Engineer for acceptance.

The acceptance standard shall be as follows:

1) wheels possessing no more than 10 defect signals in the rim or the boss for which the ratio of the amplitude of the defect signal or supplementary echo to that of the back wall echo of an adjacent sound zone does not exceed 0.25 shall be accepted, provided that there is at least 15 mm between two adjacent defect signals;
2) In addition a visual inspection of the wheel including the rim, web and boss shall be performed to ensure that they are free from any surface markings indicative of rolled in laps or defects.

6.4.2.9. Certification

Clause 12: A Certificate of Conformance shall be supplied including the results of the cast analyses and mechanical tests.

6.4.3. 96TS Axles (extracted from LU standard SSL-S-3279)

6.4.3.1. Part and Drawing Numbers

Type	Sub-type	SAP Number
Motor Axle (with Negative Support)	Standard gear seat	00204/6313
	Oversize gear seat	00204/8832
Motor Axle (without Negative Support)	Standard gear seat	00204/6314
	Oversize gear seat	00204/8834
Trailer Axle		00204/6298

Drawing No	Drawing Title
11-232-120	Detail of Motor Axle *
11-232-122	Detail of Motor Axle with Negative Supt *
11-233-120	Detail of Axle (Trailer) *
46083	Detail of Stress relieving groove in rolling stock axles

* Cold Rolling of 96TS Axle Bearing Journals is not required (as per CRS JUB-2593). All other Cold Rolling remains

Item	Specification
Motor Axle (with Neg Support) Oversize gear seat	Axles to be manufactured to Drawing, with the exception of: 1) Drawing Coordinate 7B: Dimension 172 +0.160 / +0.135, Gear Seat diameter, which should be increased by 0.05 mm to 172 +0.210 / +0.185 targeting mid tolerance. 2) Drawing Coordinate 8F: Cold Rolling on Axle Bearing Journals is not required (as per CRS JUB-2593). All other Cold Rolling remains. Alstom Drawing No: 11-232-122 iss G.
Motor Axle (without Neg Support) Oversize gear seat	Axles to be manufactured to Drawing, with the exception of: 1) Drawing Coordinate 4B: Dimension 172 +0.160 / +0.135, Gear Seat diameter, which should be increased by 0.05 mm to 172 +0.210 / +0.185 targeting mid tolerance.

2) Drawing Coordinate 2G-3G: Cold Rolling on Axle Bearing Journals is not required (as per CRS JUB-2593). All other Cold Rolling remains.

Alstom Drawing No: 11-232-120 iss E.

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.4.3.2.

6.4.3.2. Standards

New axles shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 5892-1	Railway rolling stock materials. Part 1: Specification for axles for traction and trailing stock	N/A
SSL-S-3279	Rolling Stock Axles	RME 7, E6342, JNP-ENG-S6004, RSE/STD/017 Pt 2
MR-G6002	Cold Rolling of Rolling Stock Axles	RME 715, E6346, RSE/STD/017 Pt 6, JNP-ENG-G6006
MR-E6345	Engineering Standard – Protection of rolling stock Axles	JNP-ENG-S6008
E6344	Non Destructive testing for rolling stock Axles	RSE/STD/017 Pt 4

Note: For requirements and standards related to quality please see section 10 of this document.

With regard to BS 5892 Part 1 the following specific requirements shall apply:

6.4.3.3. Materials

Clause 4.1: Grade A1 Steel

Clause 4.2: Heat Treatment "T"

6.4.3.4. Dimensions

Clause 5.7: The axle wheelseat in the "ready for assembly" condition shall have a surface roughness no greater than 0.8 micrometre R_a.

The Machining tolerances specified for fleets operating at 'Normal speeds' shall be used.

Dimensions for Axle Seats shall be such that the requirements of paragraph 6.4.3.9 are achieved.

Dimensions of Stress Relieving Grooves shall be as per LUL drawing 46083.

All other dimensions shall be as per the following LUL drawings:

11-232-120 (for Motor axles);

11-232-122 (for Motor axles with Negative Support);

11-233-120 (for Trailer axles).

6.4.3.5. Manufacturer's Brand Marks

Clause 6: Item (a) shall not be applied. Standard SSL-S-3279 shall be applied in its place.

The following additional marks shall be applied:

The cast number shall be stamped on one end of the axle (not the body) when hot.

The stampings shall be of such a depth as to be removed by the final machining process.

The brand marks shall be re-stamped cold at one end of the finished axle.

They shall be positioned on the end chamfer or spigot (not on the axle end face). The axle serial number shall be cold stamped in a similar position on the opposite end of the finished axle.

6.4.3.6. Sampling and Test Pieces

Clause 8.3.2: A product check analysis shall be carried out.

Clause 8.3.4: An impact test shall be carried out.

6.4.3.7. Test Methods

Clause 9.3.1: An ultrasonic test shall be carried out in accordance with E6344.

Clause 9.3.2: Magnetic particle tests test shall be carried out in accordance with E6344.

6.4.3.8. Certification

Clause 12: A Certificate of Conformance (CofC) shall be supplied including the results of the cast analyses and mechanical tests with all deliveries

With regard to MR-G6002 the following specific requirements shall apply:

6.4.3.9. Cold Rolling of Axle Seats

Following the approval of CRS JUB-2593 the Cold Rolling of Axle Bearing Journals is not required: Reference drawing coordinate 8F on Alstom Drawing No. 11-232-122 iss G; drawing coordinate 2G-3G on Alstom Drawing No. 11-232-120 iss E; and drawing coordinate 4F on Alstom Drawing No. 11-233-120. All other Cold Rolling remains.

6.4.3.10. Cold Rolling of Stress Relieving Grooves

All Stress Relieving Grooves shall be cold rolled as per LUL standard MR-G6002.

6.4.3.11. Other Standards

Protection of axles shall be as per LUL Standard MR-E6345.

6.4.4. 96TS Gear Wheels

6.4.4.1. Part and Drawing Numbers

Type	SAP Number
Gear Wheel (First / Intermediate)	00204/5872
Gear Wheel (Second / Output)	00204/5874

Drawing No	Drawing Title
2034 L 0903	Gearwheel (First Gear train)
2034 L 0905	Gearwheel (Second Gear train)

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.4.4.2.

6.4.4.2. Standards

New Gear Wheels shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3
P.S. 99/027	Gearwheels and Pinions	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of document P.S. 99/027

Note: For requirements and standards related to quality please see section 10 of this document.

Gear Wheels should be made in accordance with the requirements of BS 235. Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 96TS stock.

Gear Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

Gear Wheels shall be Case Hardened by Carburizing as per BS EN ISO 683-3. The supplier shall submit details of their carburizing process to TfL Engineering for approval. Note: The process document referred to on the drawing (P.S. 99/027) is a proprietary document.

6.4.4.3. Materials

Gear Wheels for the G29AZ Gearbox shall be made from Steel to BS 970-3 Grade 832M13 or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

Dimensions

Gear Wheels should be made in accordance with the requirements of LUL drawings 2034 L 0903 and 2034 L 0905.

Details of the Gearbox are contained in LUL drawings 2002 X 2401, 2035 X 1597 and 2035 X 1598.

6.4.5. 96TS Gear Pinions

6.4.5.1. Part and Drawing Numbers

Type	SAP Number
Pinion & Shaft (First Gear train)	00204/5871
Pinion & Shaft (Second Gear Train)	00204/5873

Drawing No	Drawing Title
2034 L 0902	Pinion & Shaft (First Gear train)
2034 L 0904	Pinion & Shaft (Second Gear train)

Note: Both internal and national/international Standards referenced in the above drawings are in some cases superseded, details of the currently applicable standards and those they supersede can be seen in the table in section 6.4.5.2.

6.4.5.2. Standards

New Pinions shall be manufactured as per the following standards:

Document No	Document Title	Superseded Standard
BS 235	Gears for Electric Traction	N/A
BS 436-2	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)	N/A
BS 970-3	Specification for wrought steels for mechanical and allied engineering purposes	N/A
BS EN 10277	Bright steel products. Technical delivery conditions	Parts of BS 970-3
P.S. 99/027	Gearwheels and Pinions	N/A
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels	Parts of document P.S. 99/027

Note: For requirements and standards related to quality please see section 10 of this document.

Pinions should be made in accordance with the requirements of BS 235. Although BS 235 and BS 436-2 have been withdrawn by BSI, the technical requirements contained within the specifications still apply to gears fitted to 96TS stock.

Pinion Teeth shall be finished to BS 436-2 Grade 5 limits of tolerance (or equivalent): i.e. $1.6\sqrt{l} + 4.0$

where l = any selected length of arc (in mm) less than $\pi d/2$

Pinions shall be Case Hardened by Carburizing as per BS EN ISO 683-3. The supplier shall submit details of their carburizing process to TfL Engineering for approval. Note: The process document referred to on the drawing (P.S. 99/027) is a proprietary document.

6.4.5.3. Materials

Pinions for the G29AZ Gearbox shall be made from Steel to BS 970-3 Grade 832M13 or equivalent. If an equivalent material is to be proposed by the Supplier, details must be supplied to TfL Engineering for approval, which should include mechanical and other relevant properties for both the original and proposed materials, together with a justification for both the change and the choice of the new material as a suitable alternative.

6.4.5.4. Dimensions

Pinions should be made in accordance with the requirements of LUL drawings 2034 L 0902 and 2034 L 0904.

Details of the Gearbox are contained in LUL drawings 2002 X 2401, 2035 X 1597 and 2035 X 1598.

6.5. Delivery Requirements

6.5.1. Wheels shall be delivered unpainted and coated with a corrosion protection oil, certified to provide a minimum of 12 months protection indoors.

6.5.2. Axles shall be delivered unpainted and protected as per the requirements of LUL Standard MR-E6345.

6.6. Handling and transportation conditions for new or maintained Wheels Axles & related components

6.6.1. The handling, transporting and storing shall not be the cause of damage to wheel, axles or other components and their protective covers. The handling, transportation and storage shall not damage the most stressed areas, such as the wheel seat transitions.

6.6.2. Exposed equipment shall be protected against corrosion and mechanical damage.

6.6.3. Written procedures specifying how these objectives will be reached shall be made available prior to award of contract for London Underground to review and agree.

6.6.4. All packaging must be in compliance with the following standards:

BS EN 15313:2016
RIS-2704-RST
ISO/TS 22163:2017 - Section 8.54

6.7. Standard Compliance

6.7.1. The wheels shall conform to the following standards (see Section 2 regarding Standards).

International & British Standards

Standard Number		Standard Title
General		
BES 6001		Framework for Responsible Sourcing
Wheelsets		
BS 5892-6		Railway rolling stock materials. Part 6: Specification for Wheelsets for traction and trailing stock
BS 1134		Assessment of surface texture – Guidance and general information
Monobloc Wheels		
BS 5892-3		Railway rolling stock materials. Part 3: Specification for Monobloc wheels for traction and trailing stock
Axles		
BS 5892-1		Railway rolling stock materials. Part 1: Specification for axles for traction and trailing stock
Gears		
BS 436-2	*Withdrawn. Still required*	Spur and Helical Gears. Part 2: Basic Rack Form, Modules and Accuracy (1 to 50 Metric Module)
BS 235	*Withdrawn. Still required*	Gears for Electric Traction
BS EN ISO 683-3		Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels
BS 970-1	*Superseded*	Wrought steels for mechanical and allied engineering purposes - Part 1: General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels
BS EN 10277		Bright steel products. Technical delivery conditions
BS 970-3	*Superseded*	Wrought steel for mechanical and allied engineering purposes – Part 3: Bright bars for general engineering purposes
Suspension Tubes		
BS EN 1563		Founding – Spheroidal Graphite Cast Irons
BS 2789	*Superseded*	Cast Iron – Spheroidal graphite or nodular graphite

6.7.2. LU Standards

Standard Number	Standard Title
Wheelsets	
E6340	Engineering Standard – Engineering of rolling stock wheelsets
E6341 *Supersedes RME 714*	Engineering Standard – Rolling stock general requirements for new wheelsets
E6344 *Supersedes RSE/STD/017 Part 4*	Engineering Standard – Non-destructive testing of rolling stock wheelsets
MR-E6343 *Supersedes RME 256*	Engineering Standard – Rolling Stock Wheels
RME 256 *Superseded by E6343*	Specification Maintenance of Rolling Stock Wheelsets
RME 714 *Superseded by E6343*	Specification Assembly of Rolling Stock Wheelsets
RSE/STD/017 Part 4 *Superseded by E6344*	Wheelset Standard : Pt 4 : Non-destructive testing
Monobloc Wheels	
E6347	Wheel Profiles
EO.14.06.01 Part 4e	Overhaul of Wheelsets : Part 4e : Overhaul Requirements for Noise Rings
JNP-ENG-S6009 *Superseded by E6343*	Engineering Standard – Rolling Stock Wheels
Axles	
SSL-S-3279 *Supersedes RME 7, JNP-ENG-S6004, E6342, RSE/STD/017 Part 2*	Rolling Stock Axles
MR-G6002 *Supersedes RME 715, JNP ENG G6006, E6346, RSE/STD/017 Part 6*	Cold Rolling of Rolling Stock Axles
MR-E6345 *Supersedes JNP-Eng-S6008*	Engineering Standard – Protection of rolling stock Axles
RME 7 (RCV) *Superseded by SSL-S-3279*	Engineering Standard – Rolling Stock Axles
JNP-ENG-S6006 *Superseded by SSL-S-3279*	Engineering Standard – Rolling Stock Axles
RSE/STD/017 *Superseded by E6345*	Engineering Standard – Protection of axles

Standard Number			Standard Title
RME 7N			Specification – Manufacture of Rolling Stock Axles
Superseded by SSL-S-3279			
RSE/STD/017 Part 2			Wheelset Standard - Part 2 - Rolling Stock Axles
Superseded by SSL-S-3279			
E6346			Engineering Standard – Cold Rolling of Axles
Superseded by MR-G6002			
INFENG-G6006			Cold Rolling of Rolling Stock Axles
Superseded by MR-G6002			
RML		715	Specification – Cold Rolling of Rolling Stock Axles
Superseded by MR-G6002			
RSE/STD/017	Part	6	Wheelset Standard : Part 6 - Cold Rolling of Axles
Superseded by MR-G6002			
Suspension Tubes			
-			
Negative Shoegear Half Tubes			
-			
Gears			
-			
Pinions			
RSE-ST-00104			Standard – Gearwheels and Pinions
RME 246L		Superseded	Specification – Gearwheels and Pinions
Material Grades			
E6241			Eng Standard – Rolling stock coating systems
BS EN ISO 8501-1			Preparation of steel substrates before application of paints and related products.

6.7.3. LU Drawings (72TS Bakerloo)

Drawing Number	Drawing Title
Wheelsets	
81612	Motor Wheelset Assembly (2 Sheets)
81621	Trailer Wheelset Assembly (2 Sheets)
Monobloc Wheels	
81601	Monobloc Wheel, 790 Dia (31")
67620	LT3 Wheel Profile
Axles	
81615	Motor Axle
81623	Trailer Axle
46083	Detail of Stress Relieving Groove in Rolling Stock Axles
Suspension Tubes	
74514	Motor Suspension Bearing Unit (Casting) – for LT115 type Motors
74566	Dowel for Motor Suspension Unit
59675	Motor Suspension Bearing Unit (Fabricated) – for LT115 type Motors
Gears	
47106	Gearwheel, 7½° Single Helical, 65 Teeth, 3.2618" DP (for LT115 Motor)
Pinions	
47112	Pinion, 7½° Single Helical, 16 Teeth, 3.2618" DP (for LT115 Motor)
Other	
-	

6.7.4. LU Drawings and Specifications (73TS Piccadilly)

Drawing/Spec Number	Drawing Title
Wheelsets	
TL103009	Motor Wheelset Assembly
TL103010	Trailer Wheelset Assembly
Monobloc Wheels	
TL81601	Monobloc Wheel, 790 Dia (31")
67620	LT3 Wheel Profile
Axles	
TL81628	Motor Axle
TL81628 (Specification)	Technical Specification – Motor Axle
TL81629	Trailer Axle
TL81629 (Specification)	Technical Specification – Trailer Axle
46083	Detail of Stress Relieving Groove in Rolling Stock Axles
Suspension Tubes	
TL104941	Cast SG Iron Motor Suspension Tube (3 Sheets)
TL103004	Motor Suspension Unit (Steel) Detail
TUB/RSE/SP/027	Machining & Fitting Procedure for Replacement Pads and Bushes in 73TS Aluminium Suspension Tubes
Gears	
54128	Gearwheel Detail for LT118, LT118A, B and C
TL100445	Gearwheel, 75 Teeth, for LT118 Traction Motor
Pinions	
TL103116	Pinion, 17 Teeth, LT118 C/E
Other	
-	

6.7.5. LU Drawings (92TS Central/W&C)

Drawing Number	Drawing Title
Wheelsets	
1P106587 – 3021	Motor Wheelset (Wheels and Axle)
Monobloc Wheels	
1P106588 A 3031 (marked-up)	Ring Damped Monobloc Wheel, 28"
57933	Wheel Tread Profile and Oil Injection Provision
92667	LT5 Wheel Profile
[illegible] Superseded for 92TS	LT3 Wheel Profile
Axles	
1P106589 – 3051	Axle (Sheet 1 & Supplementary Sheet 2)
46083	Detail of Stress Relieving Groove in Rolling Stock Axles
Negative Shoegear Half Tubes	
1119695	Assembly and Details Half Tube Negative Shoegear
1124534	Detail and Assembly of Liner to Negative Shoegear Half Tube
Gears	
#	#
Pinions	
#	#
Other	
-	-

6.7.6. LU Drawings and Specifications (96TS Jubilee)

Drawing Number	Drawing Title
Wheelsets	
11-232-111	Wheelset, Motor, with Negative Support
11-232-110	Wheelset, Motor, without Negative Support
11-233-110	Wheelset, Trailer
Monobloc Wheels	
11-232-121	Monobloc Wheel, Motor, 770-710 Dia
11-233-121	Monobloc Wheel, Trailer, 770-690 Dia
92667	LT5 Wheel Profile
57933	Wheel Tread Profile and Oil Injection Provision
Axles	
11-232-120	Detail of Axle without Negative Support (Motor)
11-232-122	Detail of Axle with Negative Support (Motor)
11-233-120	Detail of Axle (Trailer)
46083	Detail of Stress Relieving Groove in Rolling Stock Axles
Gears	
2034 L 0903	Gearwheel (First Gear train) G39AZ Gearbox
2034 L 0905	Gearwheel (Second Gear train) G39AZ Gearbox
BS EN ISO 683-3	Heat-treatable steels, alloy steels and free-cutting steels - Part 3: Case-hardening steels
P.S. 99/027 Part-superseded BS EN ISO 683-3	Gearwheels and Pinions (96TS)
Pinions	
2034 L 0902	Pinion & Shaft (First Gear train) G39AZ Gearbox
2034 L 0904	Pinion & Shaft (Second Gear train) G39AZ Gearbox

7. Verification

7.1. This engineering specification defines methods, measurable criteria and tests by which its requirements may be verified. Verification shall be conducted as described by the drawings and applicable standards and in accordance with the requirements of Section 10.

8. LU-supplied Information

8.1. LU will supply the following information:

a) All relevant LU drawings;

b) All relevant LU standards.

8.2. Detail of any additional information required from LU shall be detailed to LU by the Supplier.

9. Deliverables

9.1. Component Manufacture and Supply

9.1.1. The Supplier shall produce a sample batch (minimum of 2 axles in addition to the minimum FAI quantity) of Central line 92TS Style 1 axles, for destructive testing to prove that the cold rolling process has been effective as described in section 10.2.5 and Appendix A.

9.1.2. The first batch of components, of each type, shall be produced for the FAI; the quantity for which shall be a minimum of 10 for each component type unless otherwise agreed.

9.1.3. Full production test results to fulfil the requirements of component relevant standards, detailed in section 6 of this document, shall be provided to LU a minimum of 2 week prior to the FAI.

9.1.4. The Supplier will be expected to provide any further information and documentation as required to satisfy the LU assurance process.

9.1.5. Once the FAI and assurance processes have been completed the Supplier will be instructed to complete the remaining batch production runs.

10. Assurance Requirements and Approval Process

Note: The Supplier shall comply with the requirements documented below and only when these requirements are signed off by LUL Assurance and Engineering is the Supplier deemed competent to supply.

Note: If there is a substantive change to the manufacturing process or design the requirements below shall be revalidated.

10.1. Supplier - Wheels

Note: Points 10.1.1 to 10.1.4 occur prior to order placement, 10.1.5 occurs after.

10.1.1. Quality Plan & Inspection and Test Plan

The Supplier shall prior to manufacture submit for review a Contract Specific Quality Plan and Inspection and Test Plan (a combined plan will suffice). Generic plans are not acceptable.

These plans shall make reference to the drawings / standards / specifications stated within the Tender document.

The Quality Plan shall also make reference to the Quality Management Procedure which controls the activity being referenced.

The Inspection and Test Plan shall also make reference to the Quality Management Procedure which controls the activity, the frequency of test, the acceptance standard and the releasing authority.

10.1.2. Quality Audit

Upon acceptance of the plans referenced in section 10.1.1 the Supplier shall be audited against the requirements of BS EN 9000:2015 at the manufacturing site. The scope of audit will be the manufacture of Monobloc wheels.

10.1.3. Process Failure Mode and Effects Analysis (PFMEA)

The Supplier shall submit a PFMEA which details an analysis of potential failure risks in the manufacturing process of the Monobloc wheel. The whole process shall be analysed by means of FMEA techniques, to detect potential failure risks and weaknesses in the process. The risks must be quantified and classified so that adequate controls and safeguards are in place to prevent failure.

10.1.4. Delivery Paperwork

The Supplier shall submit an example of the Wheel delivery paperwork for review/approval. This shall conform to the applicable standard(s) requirements; as a minimum this shall include: Certificate of Conformance, chemical analysis, mechanical characteristic testing – tensile and impact tests, rim hardness – individual and batch, MPI (magnetic particle inspection), dimensional report.

10.1.5. First Article Inspection

A First Article Inspection shall be conducted at the manufacturing site by London Underground which will include a review of the manufacturing paperwork for compliance to the agreed Quality Plan and Inspection and Test Plan. In addition to this a Full Dimensional report will be required for critical dimensions/features to ascertain compliance to the specification. This measurement shall be conducted at the Supplier's premises with London Underground present.

10.2. Supplier - Axles

Note: Points 10.2.1 to 10.2.6 occur prior to order placement, 10.2.7 occurs after.

10.2.1. Quality Plan & Inspection and Test Plan

The supplier shall prior to manufacture submit for review a Contract Specific Quality Plan and inspection and Test Plan (a combined plan will suffice). Generic plans are not acceptable

These plans shall make reference to the drawings / standards / specifications stated within the Tender document.

The Quality Plan shall also make reference to the Quality Management Procedure which controls the activity being referenced.

The Inspection and Test Plan shall also make reference to the Quality Management Procedure which controls the activity, the frequency of test, the acceptance standard and the releasing authority.

10.2.2. Quality Audit

Upon acceptance of the plans referenced in section 10.2.1 the Supplier shall be audited against the requirements of BS EN 9000:2015 at the manufacturing site. The scope of audit will be the manufacture of Cold Rolled Axles.

10.2.3. Process Failure Mode and Effects Analysis (PFMEA)

The Supplier shall submit a PFMEA which details an analysis of potential failure risks in the manufacturing process of the Cold Rolled Axle. The whole process shall be analysed by means of FMEA techniques, to detect potential failure risks and weaknesses in the process. The risks must be quantified and classified so that adequate controls and safeguards are in place to prevent failure.

10.2.4. Delivery Paperwork

The Supplier shall submit an example of the axle delivery paperwork for review/approval. This shall conform to the applicable standard(s) requirements; as a minimum this shall include: Certificate of Conformance, chemical analysis, mechanical characteristic testing – tensile and impact tests, UAT (ultrasonic axle testing), MPI (magnetic particle inspection), cold rolling certification including

surface hardness measurement and hardness percentage increase, dimensional report.

10.2.5. Cold Rolling

Where the cold rolling method offered by the Supplier deviates from the referenced standards the Supplier shall be required to provide evidence that the method offered is at least as effective as that described in the aforementioned standards. To achieve this the Supplier shall produce a sample batch (minimum of 2 axles) of Central line 92TS Style 1 axles, for destructive testing. An independent UKAS approved and calibrated laboratory shall be selected with mutual agreement between the LU and the Supplier to validate the cold rolling as outlined in Appendix A. If there is disagreement over the effectiveness of the cold rolling the second axle will be tested. All such testing will be carried out at the Supplier's cost, and LUL shall not make any payment for the axles produced for such testing.

For all methods of cold rolling the Supplier shall provide evidence of how the consistency and continued effectiveness of the cold rolling shall be maintained for production batches across all axle types.

Evidence of the application of cold rolling to each cold rolled section, as shown on the drawing, shall be provided by the means of a minimally evasive hardness test, e.g. Leeb Rebound Hardness Test. The test shall be taken before and after cold rolling at different locations within the cold rolled section. A hardness increase of between 1.2 and 1.5 times from before to after cold rolling shall be achieved.

The Central line 92TS Style 1 axle was selected for this testing as it is considered to be the most complex of the variants. As such, if the testing of this axle(s) supports the effectiveness of the Supplier's cold rolling if will not be necessary to repeat this destructive assessment on the other axle variants unless there is a substantive change to the cold rolling process, the equipment used or the equipment location.

10.2.6. Cold Rolling contractual obligations

The Supplier acknowledges and agrees that that LUL shall not place any Orders nor have any obligation to enter into any Contract under the Agreement unless and until the testing described in section 10.2.5 has been successfully completed and the required results achieved.

If either (a) the Supplier has not produced sample batch of axles as described in section 10.2.5 within a timescale (not exceeding 6 months after contract award) to be agreed between LUL and the Supplier before contract award, or (b) the testing described in section 10.2.5 has not been successfully completed within a timescale (not exceeding 8 months after contract award) to be agreed between LUL and the Supplier before contract award , LUL shall be entitled to terminate the Agreement in accordance with the relevant Clause in the contract.

Note: It is expected that the Supplier will be able to agree to timescales shorter than the maximums outlined in this section 10.2.6.

10.2.7. First Article Inspection

Prior to the destructive testing in section 10.2.5 a First Article Inspection shall be conducted on the Axle at the manufacturing site by London Underground which will include a review of the manufacturing paperwork for compliance to the agreed Quality Plan and Inspection and Test Plan. In addition to this a Full Dimensional report will be required for critical dimensions/features to ascertain compliance to the specification. This measurement shall be conducted at the Supplier's premises with London Underground present.

10.3. Supplier - Suspension Tubes (Cast or Fabricated)

Note: Points 10.3.1 to 10.3.3 occur prior to order placement, 10.3.4 occurs after.

10.3.1. Quality Plan & Inspection and Test Plan

The supplier shall prior to manufacture submit for review a Contract Specific Quality Plan and inspection and Test Plan (a combined plan will suffice). Generic plans are not acceptable

These plans shall make reference to the drawings / standards / specifications stated within the Tender document.

The Quality Plan shall also make reference to the Quality Management Procedure which controls the activity being referenced

The Inspection and Test Plan shall also make reference to the Quality Management Procedure which controls the activity, the frequency of test, the acceptance standard and the releasing authority.

For Cast Suspension Tubes, the inspection and Test Plan shall make reference to:

- Ultrasonic examination
- Visual Inspection - All castings to be inspected for surface defects
- Magnetic Particle Inspection - Tests must be in accordance with BS EN 1369 1997 Level 1. If a casting fails this test the surface defect is to be examined and removed and the casting subject to retest
- Radiography - as per ASTM E446/186, Level 3
- Dimensional Inspection

Note: Different Inspection and Test Plan requirements will apply if Fabricated Suspension Tubes are ordered.

10.3.2. Quality Audit

Upon acceptance of the plans referenced in section 10.3.1 the Supplier shall be audited against the requirements of BS EN 9000:2015 at the manufacturing site. The scope of audit will be the manufacture of Suspension tubes (Cast or Fabricated).

10.3.3. Delivery Paperwork

The Supplier shall submit an example of the delivery paperwork for review/approval. This shall conform to the applicable standard(s) requirements; as a minimum this shall include: Certificate of Conformance, chemical analysis, mechanical properties, NDT (Non Destructive Testing) report, dimensional report.

10.3.4. First Article Inspection

A First Article Inspection shall be conducted at the manufacturing site by London Underground which will include a review of the manufacturing paperwork for compliance to the agreed Quality Plan and inspection and Test Plan. In addition to this a Full Dimensional report will be required for critical dimensions/features to ascertain compliance to the specification. This measurement shall be conducted at the Supplier's premises with London Underground present.

10.4. Supplier - Gearwheels and Pinions

10.4.1. Quality Plan & Inspection and Test Plan

The supplier shall prior to manufacture submit for review a Contract Specific Quality Plan and inspection and Test Plan (a combined plan will suffice). Generic plans are not acceptable

These plans shall make reference to the drawings / standards / specifications stated within the tender document including Standard RSE-ST-00104-A2 - Standard for Gearwheels and Pinions

The Quality Plan shall also make reference to the Quality Management Procedure which controls the activity being referenced

The Inspection and Test Plan shall also make reference to the Quality Management Procedure which controls the activity, the frequency of test, the acceptance standard and the releasing authority.

10.4.2. Quality Audit

Upon acceptance of the plans referenced in section 10.4.1 the Supplier shall be audited against the requirements of BS EN 9000:2015 at the manufacturing site.

10.4.3. Delivery Paperwork

The Supplier shall submit an example of the delivery paperwork and certification for review/approval, which shall comply with the requirements of Standard RSE-ST-00104-A2.

10.4.4. First Article Inspection

A First Article Inspection shall be conducted at the manufacturing site by London Underground which will include a review of the manufacturing paperwork for compliance to the agreed Quality Plan and inspection and Test Plan. In addition to this a Full Dimensional report will be required for critical dimensions / features to ascertain compliance to the specification. This measurement shall be conducted at the supplier's premises with London Underground present.

11. Review meetings

Stage	Purpose	Associated Documents	Required Delivery Date of Documents
Start-up Meeting *Location: London, UK or Supplier Location*	Confirm that all parties have an understanding of the requirements within the specification	Contract Documents Technical Drawings and Specifications	N/A
Intermediate reviews *Location: Remote*	Progress updates (as required)	TBC (as required)	TBC (if required)
FAI (First Article Inspection) *Location: Supplier*	Inspection of final parts, witnessed measurement, review of test and inspection documentation	*The following refers to BS EN 13262:* Production batch test and inspection documentation	2 weeks prior to FAI

Changes

Issue no.	Date	Changes	Author
A1	May 2020	First issue for ITT	G Turl
A2	December 2020	Post-ITT corrections: 6.4.3.1 Addition of new part numbers for 96TS motor axles with oversize gear seats. Note added against the axle drawings that Cold Rolling is not required for any 96TS Axle Bearing Journals (as per CRS JUB-2593). 6.4.3.9 Paragraph rewritten to state that Cold Rolling of 96TS Axle Bearing Journals is not required. All other Cold Rolling remains. 6.2.5.1 Correction of 73TS Gear wheel part number to 00655/4062. 6.3.1.3 and 6.4.1.3 Typo: 'Wheel' corrected to 'Wheelset' 6.4.1.1 Added drawing 11-232-110 for reference purposes. 6.4.1.3 Added a reference to newly added drawing 11-232-110. 6.7.6 Drawing list for 96TS updated to show drawing 11-232-110.	G Turl

12. Appendix A – Testing requirement to determine effectiveness of cold rolling

12.1. Introduction

The cold rolling standard for LU axles, MR-G6002, defines the method of cold rolling – roller dimensions and geometries, application loads, rotational speeds and feed rates – it does not define the change in or final properties of the axle material.

Changes in axle design and methods of cold rolling require concessions to this standard. Qualifying these changes is done by comparative hardness testing between the new axle and an axle produced using the original method to determine if the results of the cold rolling on the new axle are as good as or better than the original.

This requirement to equal or exceed the performance of the original method still remains; however, this appendix defines a minimum requirement and how this requirement is to be measured.

12.2. Testing Method

The Supplier shall produce a sample batch (minimum of 2 axles) of Central line 92TS Style 1 axles, deemed to be the most complex of the axles to cold roll, for destructive testing to prove that the cold rolling process has been effective.

An independent UKAS approved and calibrated laboratory familiar with testing for cold rolling shall be selected with mutual agreement between the LU and the Supplier. The laboratory shall take at least six cross-sections of one axle, at the locations defined in figure 1, and subject these to four sets of Vickers hardness tests, see figure 2, from the just below the surface to a depth of at least 10 mm, as defined in table 1, to evidence to what depth the cold rolling has been effective.

The test locations shall also be subject to micrographic analysis to provide further evidence of cold rolling.

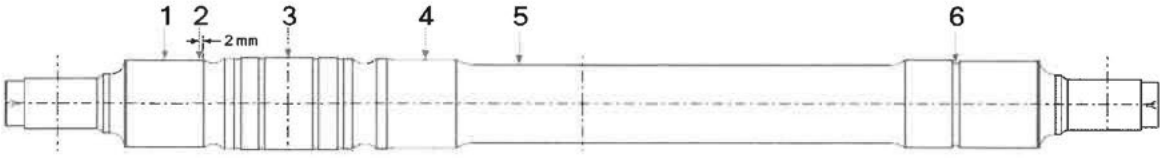

Figure 1: Central line 92TS Style 1 axle with minimum number and locations for cross-sections for Vickers hardness testing. All locations are to be at the centre of the seat or groove with the exception of location 2 which is taken 2 mm from the inboard edge of the wheel seat and location 5 which can be taken from any parallel portion of the main body of the axle unaffected by cold rolling.

Depth (mm)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10

Table 1: Minimum number and locations of Vickers hardness tests per set, with the depth measured from the surface of the axle towards the axle centre.

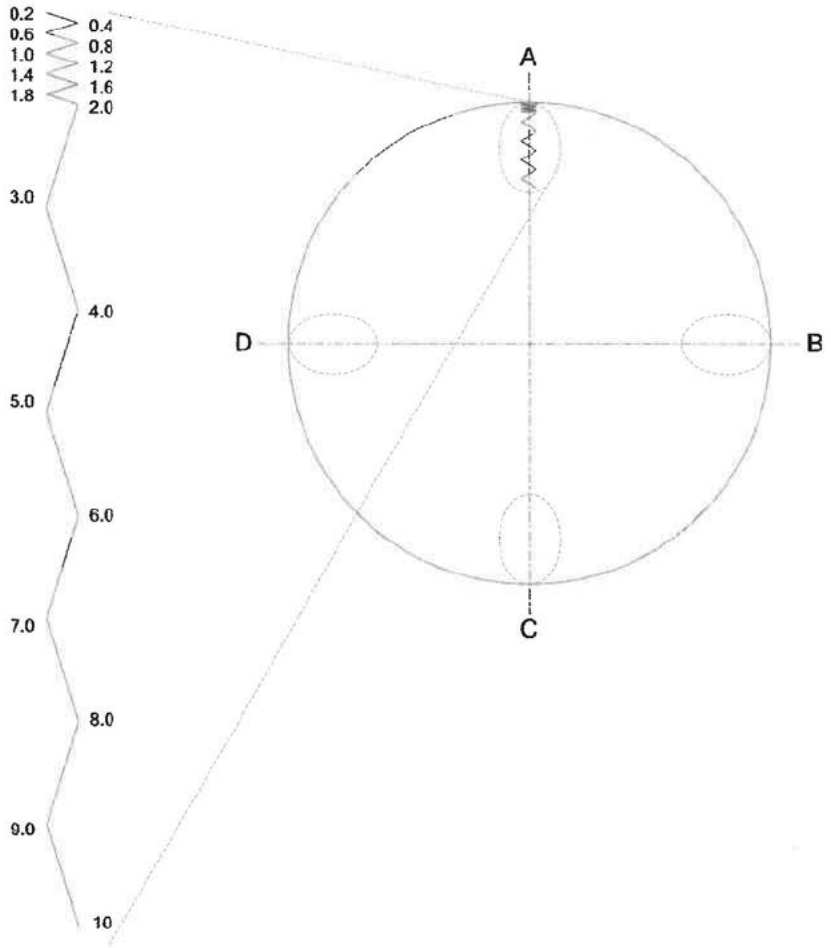

Figure 2: Location of Vickers hardness tests within a zig-zag set to prevent interference between locations (see left). Four sets, A to D, are located 90 degrees apart on each cross section (see right).

12.3. Results Analysis

The results will be reviewed by the laboratory, LU and the Supplier. There shall be a minimum 10% increase in hardness when compared to

a non-cold rolled portion of the axle at 0.5 mm below the surface with observable increases in hardness down to an effective depth of at least 2 mm.

This comparison must take into account the natural reduction in hardness of the axle material the further below the original surface of the pre-machined but forged and heat treated axle. To aid this the axle diameters at the defined hardness test locations shall be measured on the forged axle.

The results must show the characteristics of a cold rolled steel axle with a significant increased hardness at the surface that rapidly decreases within approximately the first 3 to 5 mm after which the decrease reduces to the almost level gradient of a plain forged and heat treated steel, see figure 3.

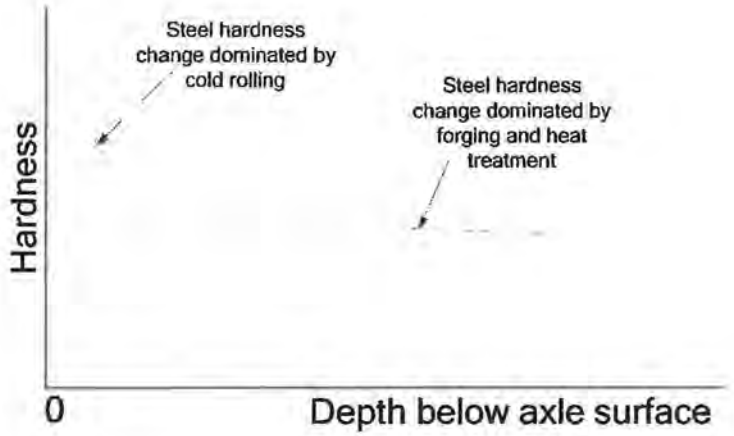

Figure 3: Characteristic change in hardness of a cold rolled steel axle as the dominate cause of the reduction in hardness changes with distance from the cold rolled surface.

The micrographic analysis can be further used to provide evidence for the effectiveness of the cold rolling, depicted by a compression of the crystalline structure of the steel at the surface, reducing as the effect of the cold rolling reduces.

If there is disagreement over the effectiveness of the cold rolling the second axle will be tested. All such testing will be carried out at the Supplier's cost, and LUL shall not make any payment for the axles produced for such testing.

Schedule 11Strategic Labour Needs and Training

1.1 In this Schedule 11, the following term shall have the corresponding meaning:

"Quarterly SLNT Monitoring Report"	means the report to be prepared by the Service Provider in the form set out at Appendix 1 (*Quarterly SLNT Monitoring Report Template*) to this Clause A2 and submitted to the Authority in accordance with Clause A2.3.

1.2 TfL is committed to the recommendations in the Department for Transport's Transport Infrastructure Skills Strategy (TISS) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/495900/transport-infrastructure-strategy-building-sustainable-skills.pdf. The strategy outlines the need to build sustainable skills in the transport and infrastructure sector, and commits to:

delivering 30,000 new apprenticeships by 2020, reflecting the government's overall apprenticeship target and funding from the apprenticeship levy;

ensuring the right mix of apprenticeships is on offer for the sector, including many at higher levels;

meeting the challenge of new technologies by upskilling the existing workforce;

promoting transport and engineering as a career of choice for the brightest and best;

encouraging greater diversity in the workforce, setting an ambition for 20% of new entrants to engineering and technical apprenticeships in the transport sector to be women by 2020, and to achieve parity with the working population at the latest by 2030;and

a 20% increase in the number of BAME candidates undertaking apprenticeships by 2020.

1.3 The Service Provider shall provide the Authority with a Quarterly SLNT Monitoring Report within ten (10) Business Days of the quarter end date in order to report any relevant skills and employment activity in connection with the Contract using the Quarterly SLNT Monitoring Report.

1.4 The Service Provider shall ensure at all times that it complies with the requirements of the Data Protection Act 2018 (as may be amended) in the collection and reporting of the information to the Authority pursuant to Clause A2.3 above.

Appendix 1 to Clause A2

Quarterly SLNT Monitoring Report Template

Sheet 1

SLNT Reporting Table

Organisation	
TfL Contract / Project	
Date	
SLNT Reporting Period (Quarter)	

SLNT Activity Area	Priority Output	Outputs this Period	Total Outputs to date	Cross Check		Additional Detail / Information
				SLNT Value	SLNT Totals	
Apprentices *(monitoring data to be provided on Sheet 3)*						
New Entrant - Level 2-3 (FTE)	Y			1	0	
New Entrant - Level 4+ (FTE)	Y			1.5	0	
Social Mobility - Level 2-3 (FTE)	Y			1	0	
Social Mobility - Level 4+ (FTE)	Y			1.5	0	
Exisiting Employee - Level 2-3 (FTE)	Y			1	0	
Exisiting Employee - Level 4+ (FTE)	Y			1.5	0	
Apprenticeship Success *(monitoring data to be provided on Sheet 2)*						
Completion (FTE)				1	0	
Job Creation *(monitoring data for placements to be provided on Sheet 2)*						
Social Mobility (FTE)				1	0	
Job Creation *(monitoring data to be provided on Sheet 2)*						
Targeted Placement Position (Days)				10	0	
Placement Positions (Days)				20	0	
Educational Engagement (Days)				20	0	
			Total SLNT Activity		0	
			Priority Activities		0	

Part 1 - SLNT Outputs (Excluding Apprentices)

Part 2 - SLNT Outputs – Apprentices

Schedule 12

Ethical Sourcing and Modern Slavery Action Plan

17. Where assessed by the Company to be a High Risk Contract, the Supplier shall implement an Ethical Sourcing and Modern Slavery Action Plan ("**Action Plan**") designed to protect workers from labour exploitations and human rights abuses and ensure compliance with the Modern Slavery Act 2015 and the Responsible Procurement Policy, in accordance with Appendix 1 to this Schedule 12.

18. The Supplier will, within 90 days of the Commencement Date, produce to the Company an Action Plan identifying the main risks of modern slavery, human trafficking, forced and bonded labour and human rights violations in its supply chain, highlighting the main products and countries involved and the steps to be taken by the Supplier to mitigate the risks in the short, medium and long term.

19. The costs of the creation and implementation of the Action Plan shall be borne by the Supplier.

20. The Supplier will update and provide to the Company the Action Plan annually (within 5 Working Days of the anniversary of the Commencement Date) for the duration of the Agreement. More regular updates will be provided when risks of modern slavery, human trafficking, forced and bonded labour and human rights violations in its supply chain are assessed as imminent by either the Supplier or the Company.

21. The Supplier shall, where relevant, train its employees and other personnel and subcontractors to ensure compliance with this Schedule 12. The Supplier shall keep a record of all training completed by its employees and other personnel and subcontractors and shall make a copy of the record available to the Company on request.

22. During the course of the Agreement, if the Company has reasonable cause to believe that the Supplier is not complying with any provision of this Schedule 12 or Clause 35 of the Contract:

    22.1 the Company shall notify the Supplier; and

    22.2 the parties shall agree a remediation plan ("**Remediation Plan**") with appropriate timeframes for compliance by the Supplier, such Remediation Plan to be agreed by the parties by no later than 30 days from the date of the Company's notification to the Supplier that remedial action is required or such other period as the parties may otherwise agree in writing (and where the parties fail to agree the plan within such time, the Company shall determine the Remediation Plan).

23. The costs of the creation and implementation of the Remediation Plan shall be borne by the Supplier.

24. Following the agreement or determination of the Remediation Plan, the Company reserves the right to conduct, or require to be conducted, one or more audits, (either itself or via a third party auditor approved by the Company) in relation to compliance by the Supplier with the Remediation Plan.

25. For the avoidance of doubt, the right of audit referred to in paragraph 8 above shall include, without limitation the right of the Company (or an auditor appointed by the Company) acting reasonably to:

    25.1 undertake physical inspections of relevant sites/factories;

    25.2 conduct interviews with relevant personnel; and

    25.3 inspect relevant documents.

26. The Supplier shall co-operate with the Company and/or the Company's auditor in relation to all aspects of any audit undertaken pursuant to paragraph 8 above.

27. The Supplier shall make the audit reports required pursuant to paragraph 9 available to the Company through the Supplier's Ethical Data Exchange ("**Sedex**"), or an equivalent process.

APPENDIX 1

The Supplier must prepare its Action Plan using the guidance information and template below. The Supplier's Action Plan should be no longer than ten (10) pages in length (excluding relevant policies or similar documents that may be included as appendices) and include:

(a) the Supplier's ethical sourcing policy, highlighting its key ethical sourcing objectives and the means by which the objectives will be achieved over the duration of the Contract;

(b) the Supplier's processes in place to comply with, and any additional processes to be put in place in order to adhere to the principles of the Ethical Trading Initiative (ETI) Base Code, or an equivalent code of conduct;

(c) identification of the main risks of modern slavery, human trafficking, forced and bonded labour and human rights violations in the Supplier's supply chain, highlighting the main products and source countries involved and the steps the Supplier is taking/will take to mitigate the risks in the short, medium and long term (including appropriate ethical sourcing training for the Supplier's buying staff and other relevant employees);

(d) the steps the Supplier will take to ensure that its subcontractors implement ethical sourcing policies similar to its own.

(e) the methods by which the Supplier proposes to monitor and report on the steps it has taken to mitigate risks and their effectiveness; and

(f) the Supplier's plan may include commissioning on social audit on sites of supply, which may be shared with the Company through Sedex.

ETI Base Code Item (Examples)	**Modern Slavery or Other Risk of Human Rights Abuse (Examples)**	**Mitigating or Capacity Building Action**	**When**	**Person Responsible**	**Resource Implications**	**Measure of Success**

EXECUTION PAGE:

Executed as a deed by the parties and delivered on the date of this Agreement

Executed as a deed by affixing the Common Seal of)

London Underground Limited)

in the presence of: -)

.....

Authorised Signatory

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]