






A Division of Transnet SOC Limited

ICTM (WHEELSET AND MATERIALS TECHNOLOGY) SPECIFICATION

MOTOR SUSPENSION TUBE STEEL CASTING

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- 1.0 Purpose:**
The purpose of this document is to specify the minimum standards of motor suspension unit materials used on Transnet Freight Rail traction and trailing stock.
- 2.0 Scope:**
This specification covers the chemical composition, minimum materials strength requirements, heat treatment, and quality requirements of new cast steel “U” type traction motor castings used on Transnet freight rail electric locomotives.
- 3.0 Definitions:**
- 3.1 Melt
The product of single furnace charge.
- 3.2 Cast
The product of a single ladle. If a melt is tapped into two or more ladles, the product of ladle shall be considered as a separate cast.
- 3.3 Heat Treatment Batch
The product of a single heat treatment cycle. To be kept in melt and cast lots as far as possible.
- 3.4 Cast Data
Data required on each casting to enable positive identification of the casting with the cast number and date of manufacture.
- 3.5 “U” type traction motor casting
“U” type traction motor castings will be referred to as U-tube hereafter on this specification.
- 4.0 Requirements**
- 4.1 The U-tube shall strictly conform to the relevant drawing supplied by the Transnet.
- 4.2 No deviations from the relevant drawings and contract are permitted without the Transnet written permission.
- 4.3 The approved concessions forms will be the only recognised manner of communication between the manufacture and Transnet to deviate from the specification or contract.

5.0 Manufacture

5.1 The steel shall be made in an electric furnace. Other processes will be considered provided full details of such processes are first submitted for approval.

6.0 Chemical composition

Table 1: Chemical requirements of the casting

ELEMENTS/ PROPERTIES	AAR, M-201. Grade C
% Carbon	0.32 max
%Silicon	1.50 max
%Manganese	1.85 max
%Sulphur	0.04 max
%Phosphorous	0.04 max

7.0 Mechanical Properties

7.1 A sufficient number of test coupons to meet the entire test and re-test requirements shall be provided for each cast and heat treatment batch.

- These test coupons, from which test specimens must be prepared, shall remain attached to the castings they represent and shall be heat treated together with the casting.
- The coupons shall be approximately 150 mm long and are to have a cross sectional area of approximately 3750mm² and shall not be less than 30 mm in thickness.
- Each test coupon and each casting shall reflect the cast data

7.2 Tensile test,

The steel shall conform to the minimum requirements detailed in in specification SANS 6892-1:2010. The test piece which shall not be smaller in diameter than 10mm shall be machined from the test coupon.

7.2.1 Mechanical Properties

Tensile specimens to specification SANS 6892-1:2010

Charpy impact specimens to specification SANS 148-1:2007

Yield or 0.2% proof stress 410 Mpa minimum

UTS 620 MPa minimum

Elongation

$L_o = 5.65\sqrt{S_o}$ 17% minimum

Reduction in area 40% minimum

Charpy V notch impact @25°C 27.5J minimum

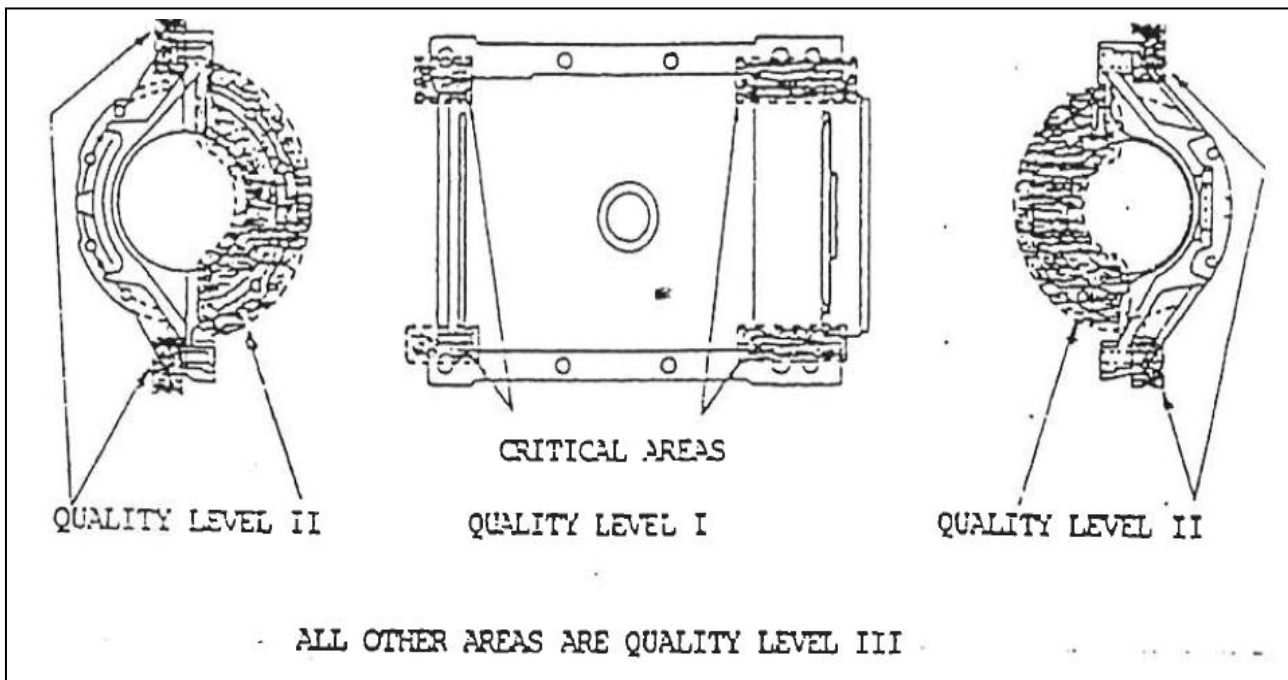
Izod V notch impact @ 25°C 33J minimum

Brinell hardness (HB 10/3000) 179 to 217

- 7.2.2 One tensile test shall be conducted on the test coupon for each cast included in each heat treatment batch. If tensile test specimen exhibits flaws before or after testing, it shall be discarded and another specimen substituted.
- 7.3 Each casting shall be hardness tested in accordance with specification SANS 6506-1:2009 and shall be within the Brinell hardness range specified.
- 8.0 Heat treatment**
- 8.1 The U-tubes shall be suitably heat treated to provide a uniform fine grained structure and to remove injurious stresses.
- 8.2 All the U-tubes of a cast shall be heat treated in batches or consecutively in the case of continuous heat treatment furnace. Uniform temperatures shall be maintained at each stage of the heat treatment cycle.
- 8.3 The temperatures shall be recorded on continuous recording pyrometers. The cast numbers and quality of U-tubes in each cast undergoing heat treatment shall be recorded on the relevant chart. The charts shall be retained by the manufacturer for a minimum of period of one year. They shall be made available to the clients' Quality Assurance representative on request.
- 8.4 Re-heat treatment
Casting may not be re-heat treated more than twice. All applicable tests, as specified, shall be conducted on castings which have been re-heat treated.
- 9.0 Defect classification**
- 9.1 There are two defect classifications:
- 9.1.1 Minor defect
A minor defect allows for a maximum area of 500mm^2 that may be excavated to a maximum depth of 30% of the casting thickness.
- 9.1.2 Major defect
A major defect is a defect with an area greater than 500mm^2 and one which is excavated to a depth exceeding 30% of the casting thickness.

10.0 Quality levels

The drawing below defines the three quality levels.



WELDING REPAIR PROCEDURE

Minor defects	
Condition	
Quality level	Before final heat treatment
I	Record details on report form
II	Weld allowed without authorisation. Record details on report form
III	Weld without authorisation

Major defects	
Condition	
Quality level	Before final heat treatment
I	Not permitted
II	Weld allowed without authorisation. Record details on report form
III	Weld without authorisation. Record details on report form

10.1 Quality level I (Critical)

This area of the casting is highly stressed in service. Defects in this area are likely to initiate fatigue or brittle fractures.

10.2 Quality level II (Major)

This area of the casting is less highly stressed in service. Certain types of defects may initiate failure.

10.3 Quality level III (Minor)

This area of the casting has low stress in service and defects should not have an adverse effect.

11.0 INSPECTION METHOD AND TESTS

The four methods of inspection and testing are listed below:

Application of inspection method to quality level:

Inspection method	Quality level		
	I	II	III
Radiographic	1 casting/ cast	1 casting/ cast	1 casting/ cast
Magnetic particle/ dye penetrant	100%	100%	Not required
visual	100%	100%	100%
dimensional	100%	100%	100%

NOTE: Before inspection the casting shall be dressed and shot blast or rough machined.

11.1 Radiography

Defect levels shall not exceed those laid down in ASTM E446-72 and ASTM E186 as shown below.

DEFECT TPYE	ASTM E446 FOR THICKNESS UP TO 50mm. Sources:250KV X-Rays Iridium: 192 GAMMA Rays Cobalt: 60 GAMMA rays			ASTM E186 FOR THICKNESS ABOVE 50mm TO 115mm. Sources:1-24MV X-Rays Cobalt: 60 GAMMA Rays		
	Quality level I	Quality level II	Quality level III	Quality level I	Quality level II	Quality level III
Gas holes and porosity	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5
Non-metallic inclusions	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5
Shrinkage						
CA	Class 3	Class 5	Class 5	Class 3	Class 4	Class 5
CB	Class 3	Class 5	Class 5	Class 3	Class 4	Class 5
CC	Class 3	Class 5	Class 5	Class 3	Class 4	Class 5
CD	Class 3	Class 5	Class 5	-	-	-
Surface defects, cracks, hot tears,etc, unfused chaplets, chill or inserts	Not acceptable	Not acceptable	Not acceptable	Not acceptable	Not acceptable	Not acceptable

11.2 MAGNETIC PARTICLES FLAW DETECTION/DYE PENETRANT

Hot tears, cracks, chills and fused chaplets are not acceptable and castings exhibiting such defects shall be repaired or rejected. The extent of other defects shall not exceed the discontinuities as laid down in ASTM E125-63 as follows:

- 11.2.1 The casting shall be subjected to wet magnetic particle inspection.
- 11.2.2 After final machining is complete the casting shall be dye penetrant inspected on machined critical area surfaces.

11.3 VISUAL EXAMINATION

Casting shall be free from the following defects:

- Cracks
 - Tears
 - Cold shuts
 - Short runs
- Surface scabs or obvious defects

11.4 DIMENSIONAL EXAMINATIONS.

The U-tube shall comply with the dimension and tolerances shown on the relevant drawings enumerated in the order\ contract. All dimensions must be measured. Measuring equipment must have required permission and be calibrated.

12.0 Weld repair

A weld repair procedure with the following information is requested from the manufacturer:

- a) Welding consumables:
Make and type
- b) Method of preparation
Carbon arc air gouging or grinding.
- c) Inspection of preparation before welding, dye penetrant or visual inspection etc
- d) Welding process
- e) Pre-heat
- f) Technique

- 12.1 The manufacturer may not deviate from the repair procedure given in clause 13.0 without written consent from the client.

Quality Level I	
Type I	Degree I
Type III	Degree I
Type IV	Degree I

Quality Level II and Level II	
Type I	Degree 2
Type II	Degree 2
Type IV	Degree 2

- 12.2 Weld repairs are to be carried out by welders who can maintain the standards specified in welding methods AAR M-201 clause 12 for casting repairs.
- 12.3 After weld repair the weld metal shall be ground flush with the parent metal and dye penetrant or magnetic particles inspected for sound repair in major and critical areas.

12.4 Castings must receive a final heat treatment after weld repairs.

13.0 **DEFECTIVE U-TUBES**

Any U-tube found to be defective after a delivery may be returned to the manufacturer at his expense, for replacement notwithstanding that representative U-tubes may have passed the tests prescribed in the specification and have been accepted by the client.

DEFECTIVE=Any U-tube which does not meet the requirements specified in accordance with this specification due to a manufacturer's defect.

14.0 **Annexure A (Welding procedure specification)**

Please refer to specification: **RW/TE/PRO/0068**

Revision History

Revision date	Version number	Details of changes	Remarks
February 20013	02	<p>Revision history added.</p> <p>Note:</p> <p>Material grade:</p> <p>The chemical composition of the casting is AAR, M201, grade C.</p> <p>Welding Procedure:</p> <p>The casting weld repairs will be done according to specification: RW/TE/PRO/0068</p> <p>Mechanical test SANAS specification:</p> <p>Tensile test: SANS 6892-1:2010</p> <p>Impact charpy: SANS 148-1:2007</p> <p>Hardness test: SANS 6506-1:2009</p>	