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About This Standard

This specification is based on the TRS 0139

Version History

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1 Scope

This Standard provides for the manufacture, supply and delivery of wrought carbon steel wheels for locomotives and rolling stock - L, A, B and C (heat treated) wheels

Wheels manufactured to this specification are substantially to Specification AAR M107.82.

2 Manufacture

2.1 Process

The steel shall be made by any of the following processes:-

- electric furnace or
- basic oxygen process

2.2 Discard

A sufficient discard shall be made from each ingot to insure freedom from piping and undue segregation.

3 Temperature Control

During the manufacture, necessary care in the regulation of temperature gradients shall be exercised to obtain the physical properties to be expected from the chemical composition and mechanical work and to prevent the development of faulty structure. All wheels, immediately after last hot fabricating operation (coning or dishing), shall be allowed to cool to a temperature below the critical range. The cooling shall be controlled to prevent injury by too rapid cooling below the critical range.

4 Heat Treatment

For all wheels the heat treatment shall consist of treatment of the rim only.

4.1 Rim Quenching Treatment

The wheels shall be uniformly reheated to the proper temperature to refine the grain and then the rims shall be quenched. Following quenching, the wheels shall be charged into a furnace for tempering to meet the requirements of Section 8 and subsequently cooled under controlled conditions.

5 Shot Peening

Fully machined wheels need not be shot peened. Wheels with unmachined plates shall be shot peened in accordance with the following Clauses of this Standard.

This section covers shot peening of steel wheels to provide improvement in plate fatigue strength.

5.1 Shot Requirements

The shot shall be SAE No S550 or larger hardened steel as specified in SAE J827.

5.2 Shot Size Control.

The peening machines shall be equipped with a separator for continuously removing broken shot. Sufficient new shot shall be added to insure that a minimum of 85% of No S550 or larger shot is maintained in the machines at all times.

5.3 Peening Intensity.

The peening intensity shall be sufficient to produce an average arc height of not less than 0.20mm (0.19+) Almen C-2 on the front plate near the hub fillet and on the back plate near the rim fillet of wheels of the standard design and at back plate hub fillet and front plate rim fillet of the reverse plate design. The area to be peened is defined as the plate area extended approximately one-half of the way into the hub and rim fillet radii on the front and on the back of the wheel.

5.4 Arc Height Measurement

Measurements of arc height shall be made in accordance with SAE Standard J442 or SAE Recommended Practice J443.

5.5 Coverage

The minimum peening time shall be sufficient to insure full coverage is attained on the Almen C strip as defined in SAE Recommended Practices J443, or alternate procedure, *paragraph 6.11. of MIL-S-13165B*.

5.6 Sequence

Shot peening shall be performed on all wheels after any corrective surface preparation in the plates area. Plate area is defined in Section 5.3. Peening may be performed prior to inspection.

5.7 Portable Peeners

A portable peening device may be used to re-peen small reconditioned areas (no larger than about 50mm by 75mm) on wheel plate surfaces excluding the critical fillet areas (front hub and back rim). The portable equipment must be capable of peening an Almen C Strip to develop the required average arc height of not less than 0.2 mm with a reasonable time of peening. Peening time of wheel plates must be at least as long as the time required to develop the 0.2 mm arc height. The equipment must be tested on an Almen C Strip each 8 hour shift that the portable peener is used. A record of the Almen C test results shall be maintained.

5.8 Wheel Surface Condition

The peened appearance of rim and hub shall not be cause for rejection.

5.9 Frequency of Test

Arc height determination shall be made on Almen strips attached to a test wheel as often as required to insure proper adherence of specification.

5.10 Retest

If a test fails to meet the arc height requirements of 0.2 mm Almen C-2, two retests will be made. These retests shall be averaged with the first determination. The average shall not be less than 0.2 mm and no more than one value of the three shall be less than 0.2 mm.

5.10.1 Repeening

When test values fail to meet the provisions of Section 0, corrective action shall be initiated and satisfactory test value secured before proceeding with production peening. If the average Almen value of the unsatisfactory test is 0.15 to 0.18, the last half of the wheels peened prior to the unsatisfactory test, but subsequent to a satisfactory test, shall be repeened with at least 1/2 exposure time. If the average Almen value is less than 0.15, all the wheels peened since the last satisfactory test shall be repeened with full exposure.

6 Ladle Analysis

The steel shall conform to the following chemical requirements:-

Wheel Class	Carbon %
Class L	0.47 Max.
Class A	0.43 - 0.53
Class B	0.57 - 0.67
Class C	0.67 - 0.77

Table 1

Element s	%	Element s	%
Manganese	0.60 - 0.85	Chromium	0.25 Max.
Phosphorus	0.05 Max.	Nickel	0.25 Max.
Sulphur	0.05 Max.	Molybdenum	0.10 Max.
Silicon	0.15 Min.	Copper	0.35 Max.

Table 2

An analysis of each heat of steel shall be conducted by the manufacturer to determine the percentage of the elements specified in Table 2. This analysis shall be made on a test specimen taken during the pouring of the heat. The chemical composition thus determined together with such identifying records as may be desired, shall be reported to RIC and shall conform to the requirements specified in Table 2.

7 Check Analysis

An analysis may be made by RIC from a wheel block or from a finished wheel selected from each heat by RIC's representative. The chemical composition thus determined shall conform to the requirements specified in Section 6, with a permissible carbon variation of minus 0.02 or plus 0.03 percentage points. Samples from wheel blocks shall be drilled from the end of the block midway between the centre and outside. When a finished wheel is used, the sample shall be obtained from the rim face or the hub in a manner which will not impair the usefulness of the wheel. No drilling of the finished wheel plate shall be permitted. Each sample from any one block or wheel shall be thoroughly mixed together and shall be clean, and free from scale, oil and other foreign substances.

8 Brinell Hardness

The hardness of the rim, when measured in accordance with the requirements of Section 8.1, shall show the following values:-

Wheel Class	Minimum Hardness	Maximum Hardness
L	197 BHN	277 BHN
A	229 BHN	321 BHN
B	277 BHN	341 BHN
C	321 BHN	363 BHN

Table 3

8.1 Method of Measurement

Measurement shall be made on the front face of the rim with the edge of the impression not less than 5mm from the radius joining face and tread. Before making the impression, any decarburised metal shall be removed from the front face of the rim at the point chosen for measurement. The surface of the wheel rim shall be properly prepared to permit accurate determination of hardness

8.2 Number of Tests

Brinell hardness measurements shall be made on all wheels from each heat.

If any wheel tested fails to meet the requirements of Section 8., it shall be checked by making two (2) additional hardness measurements, one on each side of the point first measured and each approximately 25mm from that point. If both of these check measurements meet the requirements of Section 8, the wheel shall be considered to have met the requirements of Section 8.

9 Retreatment

Any wheel failing to meet the requirements of Section 8, may be retreated with the prior consent of RIC and tested in accordance with Section 8.

10 Finish

The wheels shall be rough bored. The faces of the hubs, the contour of the tread, flange and web shall be in accordance with related drawings and shall be machined and finished smoothly without excessive tool chatter marks.

Wheels shall not have black spots in the rough bore.

Wheels shall be given a thorough surface examination and gauging at the place of manufacture before they are offered for inspection. They shall be free from defects liable to develop in or cause removal from service and shall have a workmanlike finish and be free from burrs and fins at the junction of the inner edge of the inside of the rim and the radius of the web.

Wheels not machined all over shall be statically balanced as follows:-

- 125 gram metres for wheels operating at speeds up to 120km/hr.
- 75 gram metres for wheels operating at speeds above 120km/hr.

Wheels machined concentrically all over need not be statically balanced.

Wheels shall not be offered for inspection if covered with paint, rust or any other substance to such an extent as to conceal defects.

Mill-scale shall be removed from the entire wheel by the manufacturer.

11 Marking

When hot, each wheel shall be distinctly stamped on the outside of the rim with the data as shown on the related drawings. These markings shall be legibly stamped not less than 6mm from the inner diameter of the finished rim. The

height of the characters shall not be less than 12mm and shall be nominally 2.5mm deep. Characters on the stamps shall not have sharp edges. Cold stamping shall be used only when the original hot stamping is removed or rendered too shallow to be legible or when it is necessary for the manufacturer to add additional information not available at the time the wheel was originally hot stamped.

The contract number (ie. "W" number) to which the wheel has been manufactured, and the wheel tape size shall be stencilled on the inside of the web of each wheel with chrome yellow paint, using figures at least 50mm in height.

12 Ultrasonic Inspection

Defects not readily visible to the unaided eye are usually detected by ultrasonic testing. Such testing shall be used in the manufacture of all wheels as a part of mill quality control procedures. The method to be followed and the equipment to be used shall comply with the requirements as shown in the following paragraph. Tests and inspection shall be made at place of manufacture prior to shipment, unless otherwise specified.

For detecting internal discontinuities in the rims of all steel wheels ultrasonic inspection shall be made by the following procedures shown below and by using equipment which complies with the following requirements.

12.1 Equipment

The instrument shall have pulse echo receiver and shall operate at frequencies of 2.25 to 5 MHz required for the test method and type of equipment being used.

The transducers shall be of the type whose composition and dimensions are appropriate for the test method used.

An automatic flaw alarm system shall be used in conjunction with the ultrasonic instrumentation.

A suitable couplant shall be used between the test surface and the transducer.

12.2 Time of Inspection

Inspection shall be performed after final thermal processing.

12.3 Calibration

Calibration shall be conducted using a reference standard of a wheel or portion of a wheel rim containing simulated defects. The instrument sensitivity level

should be adjusted to produce an approximate half full scale reflection from the reference standards in the following paragraphs.

For axial testing the reference standard shall be a 3mm diameter flat bottom hole drilled perpendicular to the rim face and to a depth of 25 to 38mm at the mid thickness of the rim. See Figure 1.

For radial testing the reference standard shall be 3mm diameter flat bottom hole drilled from the inside diameter of the rim essentially parallel to the rim face. It shall be a minimum of 32mm from the tread surface. See Figure.

The side of a small diameter hole on the order of 1.5 to 3mm in diameter may be used when it is drilled the same distance from the testing surface. The instrument shall be adjusted to give an equal test value to that of a 3mm diameter flat bottom hole. This practice is an alternate for the reference standards of Paragraphs 0 and 0. See the previous two paragraphs and Figures 1 and 2.

For axial testing when determining loss of back reflection, the reference standard shall be a 10mm diameter concave bottom hole drilled to a depth of 3mm at the front rim face and perpendicular to the back rim face. See Figure 3. This Clause is applicable, in certain cases, when agreed to between producer and purchaser.

Reference standards for the inspection of heat treated and untreated wheels shall be fabricated from heat treated and untreated steel respectively. Reference standards need not be the same design as the wheels being inspected.

12.4 Scanning

Wheels shall be inspected axially from either the front or the back rim face and radially from the tread surface.

One or more transducers shall be designed and located to give maximum coverage of the rim section - both radially and axially.

12.5 Rejection

Any wheel with a flaw indication equal to or larger than that from the reference discontinuity shall be cause for rejection.

Any indication from a discontinuity giving a loss of back reflection equal to or greater than the reference standard during axial scanning may be cause for rejection. This Clause is applicable, in certain cases, when agreed to between producer and purchaser.

Ultrasonic indications that result from wheel geometry or spurious electrical signals shall not be valid cause for rejection.

When automated equipment is used, the final disposition of rejectable wheels may be determined by manual testing of questioned areas.

13 Magnetic Particle Inspection

13.1 Purpose

To supplement visual inspection of the surface of new wheels by detecting discontinuities which may be harmful to wheel service.

13.2 Scope

This test covers the wet fluorescent magnetic particle inspection of the plates of wheels ordered to this specification.

13.3 Magnetising Apparatus

The magnetising apparatus shall be capable of inducing suitable magnetic fields within the entire plate area of the wheel to facilitate the disclosure of both circumferentially and radially oriented discontinuities. The magnetising currents used shall be large enough to induce fields of sufficient intensity to disclose surface discontinuities exceeding 0.4mm in depth and 6mm long. The use of prod type contacts is prohibited.

13.4 Lighting Apparatus

The inspection shall be performed in a darkened booth with the areas of the wheel to be inspected illuminated with properly filtered black light. The black light shall have a predominant wavelength of 4000 to 3400 angstrom units and the intensity of the black light, measured at the surface to be inspected, shall be a minimum of 75 foot candles at point of inspection.

13.5 Inspection Medium

The bath or solution should be prepared, using a suitable carrier fluid and fluorescent magnetic particles, and renewed monthly or more often if contamination is noted in weekly tests. Each time the bath is renewed the batch container should be cleaned out and the agitation and circulation system should be flushed with five to ten litres of clean carrier. Filtering screens should be removed and cleaned by blowing with air. In preparing the new bath only recommended materials should be used. The amount of powder should be carefully weighed out in accordance with the material manufacturer's recommendation and adding the powder directly to the bath containing the correct amount of carrier. It is recommended that powder be added directly over the sump so that it will be drawn quickly into the pump and circulated. The

amount of carrier and powder used and the date of preparation should be recorded on a regular form set up for this purpose, as outlined below.

Concentration and contamination of the bath solution should be tested weekly as follows:-

- pump and agitation system should be operated for 20 minutes and then solution should be run through hose and nozzle for 30 seconds. Using a regular 100ml centrifuge tube, fill the centrifuge tube with 100ml of the solution. Allow bath solution to settle for the time recommended by the manufacturer of the type of powder used making sure that the tube is not subjected to excessive vibration during the settling period. Each horizontal division represents 0.1ml and correct reading in volume or particles must be as stipulated by the powder manufacturer. Check should also note contamination due to dirt, chips or other foreign matter settling with the powder. Contamination is also indicated when the carrier appears to acquire more than usual fluorescence or when the magnetic particles appear to have lost fluorescent qualities. This condition can be readily observed when the settling tube is exposed to ultraviolet light. The readings obtained are to be shown on the regular report form.

The ultraviolet light should be tested weekly using a sight meter, such as a type having 75 foot candle scale with 10X multiplying disc or equivalent or a meter that responds specifically to the ultraviolet range of 3650 angstrom units (36 nanometres). The latter type meters are calibrated in microwatts per square centimetres. The meter should be held a fixed distance of 380mm from the light source (from black light filter surface to meter sensing element) and should have a minimum meter reading of 525 microwatts per square centimetre.

The conversion factor from foot candles (for sight meters) to microwatts per square centimetre is 5.7 times the foot candle reading (at 380mm distance).

The maximum allowable foot candles will be left to the discretion of the user dependent on the degree of brilliance desired to obtain satisfactory inspection conditions. Before taking readings, it should be known that the glass black light filters are clean. Reports of this test are to be shown on regular form.

A regular form should be prepared embodying the information to be shown on monthly and weekly tests as outlined above and this form should be on hand at the wheel shop and a copy forwarded with the wheel on delivery.

13.6 Preparation for Inspection

The surface shall be scale free before magnetic particle inspection.

13.7 Detection of Discontinuities

The inspection shall be performed to detect discontinuities whose axes may be in any direction. Continuous or residual magnetization shall be used with adequate coverage by the inspection medium.

The magnetic particle inspection shall be performed following final machining.

13.8 Rejection

Interpretation of magnetic particle discontinuity indications is based upon their location, size, direction and shape. Experience with service performance and destructive testing shall be used for evaluation. Discontinuities may be removed by machining or grinding where sufficient stock remains. Such wheels shall be retested by magnetic particle inspection.

14 Protection

After inspection and approval, the wheel shall be painted uniformly with standard grey paint to AS.K185-671, AS.K126 type 1. The paint coating on the hub and rim surfaces shall be free of runs or droplets.

15 Certification

Certification shall be made the basis of acceptance of the material. This shall consist of a copy of the manufacturer's test report that the material has been sampled, tested and inspected in accordance with the provisions of the specification. Each certificate so furnished shall be signed by an authorised agent of the supplier or manufacturer.

16 Rejection

Wheels represented by samples which fail to conform to the requirements of these specifications will be rejected.

Wheels which show injurious defects subsequent to original inspection and acceptance at the manufacturer's works, or elsewhere will be rejected, and the manufacturer shall be notified and provided that it has been properly treated shall be replaced by the manufacturer at his own cost.

16.1 Rehearing

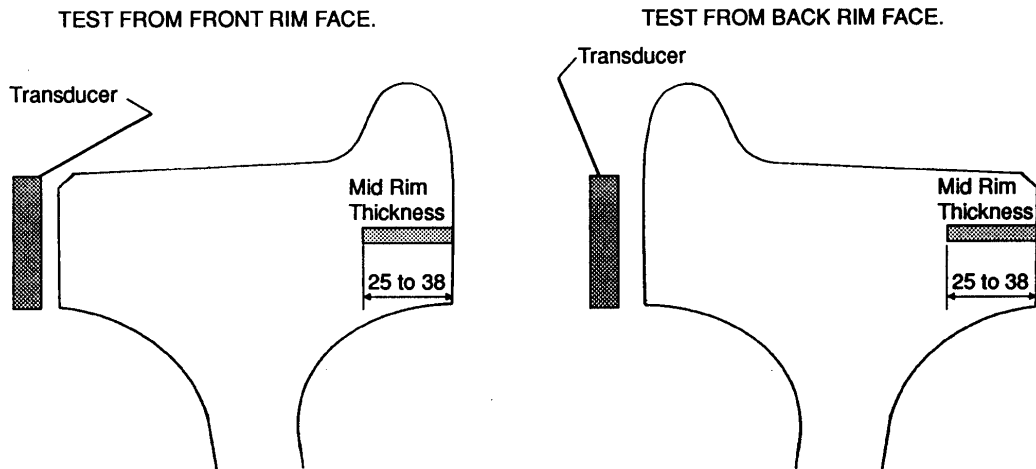
Samples tested in accordance with this specification, which represent rejected wheels, shall be held for a period of 14 days from date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

16.2 Delivery

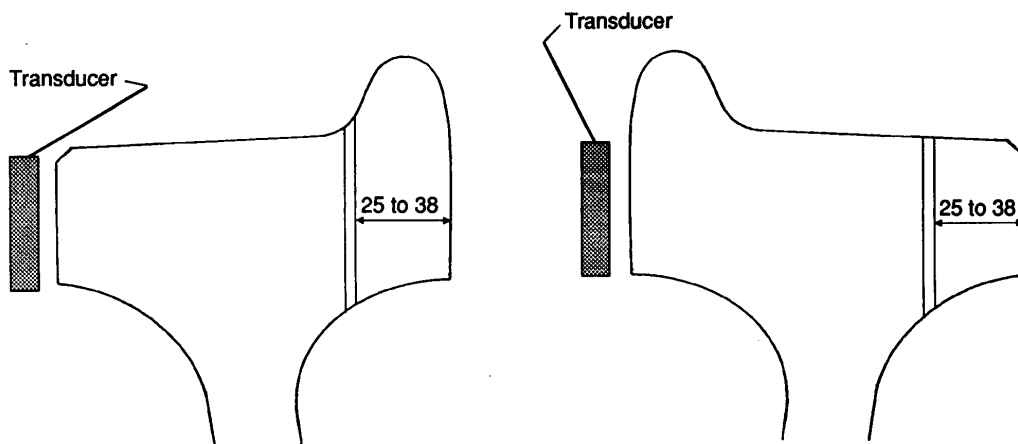
The manufacturer shall state in his tender, the time of delivery from the date of acceptance of the tender.

The manufacturer shall deliver the finished wheels, at his own expense to the railway siding nearest to the nominated delivery address.

TYPICAL REFERENCE STANDARDS FOR RIM FACE TEST.



1A. REFERENCE STANDARD.



1B. ALTERNATIVE REFERENCE STANDARD.

TYPICAL REFERENCE STANDARDS FOR RIM TREAD TEST.

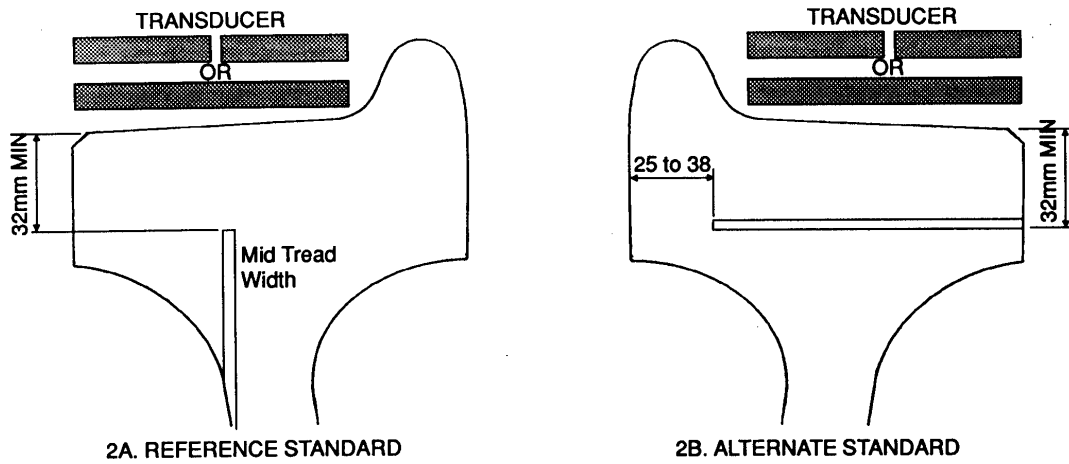


Figure 2

TYPICAL REFERENCE STANDARD TO DETERMINE LOSS OF BACK REFLECTION.

