12. APTA PR-M-S-012-99, Rev. 1 Standard for the Manufacture of Wrought Steel Wheels for Passenger Cars and Locomotives

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Abstract: This standard covers the minimum properties of wrought steel wheels for rail passenger vehicles with class of wheels based on intended service. The standard includes requirements for wrought steel wheel manufacture, heat treatment, machining, surface treatment, quality control, and finish. Also included are recommendations for marking and stamping wheels.

Manufacturing of wheels is a craft requiring specialized equipment. The Association of American Railroads (AAR) investigates, approves and tracks performance of wheel manufacturers. Duplication of this process for passenger wheels by APTA is not presently a viable option. Therefore, this safety standard recommends purchase of wheels only from AAR approved wheel manufacturers.

Keywords: brinell hardness, magnetic particle inspection testing, wheels, wheel stamping, wrought steel, rim heat treatment, shot peening, ultrasonic inspection

Introduction

(This introduction is not a part of APTA PR-M-S-012-99, Rev. 1 Standard for the Manufacture of Wrought Steel Wheels for Passenger Cars and Locomotives)

This standard describes the minimum-acceptable properties of wrought steel wheels to be applied to passenger railroad equipment including rail passenger vehicles and locomotives. The described properties and processes include:

- Chemical composition,
- Manufacturing processes,
- Rim heat treatment,
- Machining,
- Shot peening,

Quality control inspections, Brinell Hardness testing, Ultrasonic inspection, Magnetic particle inspection and Wheel stamping for identification.

This draft standard is based on Association of American Railroads (AAR) Specification M-107 Standard for Wheels, Wrought Carbon Steel *and refers to the 1994 edition for the latest technical information*. The last AAR M-107 edition that covered rail passenger vehicle wheels was issued in 1984. Class U wheels were included in the 1984 M-107 Edition, but have been omitted from this APTA PRESS standard because they are considered unsuitable for passenger service.

All aspects of wheel manufacture are covered in this draft standard except wheel tread-flange contour and boring for mounting. The purchaser shall designate the Class of wheel required and state any chemical or mechanical restrictions. The purchaser shall also furnish a drawing of the wheel that includes the wheel size and tread-flange contour. This drawing shall include the hub rough bore diameter and restrictions or requirements for plate design, special considerations for disc brake mounting, and/ or other necessary details of the wheel design.

All of the above information shall be included with the contract documents.

Participants

The American Public Transit Association greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Standard for the Manufacture of Wrought Steel Wheels for Railroad Passenger Cars and Locomotives*

John Pearson
Tom Rusin

At the time that this standard was completed, the PRESS Mechanical Committee included the following members:

Dave Carter, *Chair*

Asuman Alp
Gordon Bachinsky
Gilbert Bailey
R. Bailey
Walter Beard
George Binns
B.A. Black
Chris Brockhoff
Dave Brooks
Mark Campbell
Gary Carr
David Carter
John Casale
Al Cheren
George A. Chipko
Roger Collen
Richard Conway
Jack Coughlin
Tim Cumbie
Richard Curtis
Greg Dvorchak
Ed Deitt
Terry Duffy
James D. Dwyer
Magdy El-Sibaie
John Elkins
Rod Engelbrecht
Ronald L. Farrell
Andrew F. Farilla
Benoit Filion
Chuck Florian
Matt Franc
Greg Gagarin
John Goliber
Jeff Gordon
Thomas Grant
Harry Haber
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Chris Holliday
Cornelius Jackson
Paul Jamieson
James Jewell
Joe Kalousek
Bob Kells
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Sunil Kondapalli
John Kopke
Frank Lami
Bob Lauby
Rick Laue
John Leary
H. B. Lewin
Jason Lipscomb
Ben Lue
William Lydon
Frank Maldari
George Manessis
Valerie Marchi
James Martin
Tom McCabe
Thomas McDermott
Lloyd McSparran
Corneilius Mullaney
Ed Murphy
Dak Murthy
Larry Niemond
Frank Orioles
James Parry
George Payne
Tom Peacock
John Pearson, Jr.
Ian Pirie
Richard Polley
John Posterino
Chuck Prehm
Alfred Pucci
John Punwani
Jim Rees
Jack Reidy
Al Roman
John Rutkowski
Tom Rusin
Radovan Sarunac
Fred Schaerr
Dave Schanoes
Pete Schumacher
Kevin Simms
Tom Simpson
Mark Stewart
James Stoetzel
Philip M. Strong
Chris Studcart
Ali Tajaddini
Joe Talafous
Richard Trail
Mike Trosino
Ron Truitt
Tom Tsai
Richard Vadnal
David H. VanHise
John Wagner
Rich Walz
David Warner
Douglas Warner
Herbert Weinstock
Charles Whalen
Brian Whitten
James Wilson
Bruce Wigod
Werner Wodtke
Steve Zuiderveen
Clifford Woodbury, 3rd
Eric Wolf
Alan Zarembski
John Zolock

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Standard for the Manufacture of Wrought Steel Wheels for Passenger Cars and Locomotives

1. Overview

1.1 Scope

These specifications cover multiple-wear wrought carbon-steel heat-treated wheel manufacturing requirements for rail passenger cars and locomotives. Design requirements are outside the scope of this standard.

The passenger rail industry phased this standard into practice over the six-month period from July 1 to December 31, 1999. The standard took effect January 1, 2000.

Wheel classes are defined as L, A, B, and C and are described by their nominal hardness and carbon content range. The service for which the various classes are intended generally is as follows:

Class L - (241-277 BHN, 0.47% max. Carbon.) Service with more severe tread braking conditions than other classes and light wheel loads.

Class A - (255-321 BHN, 0.47-0.57% Carbon.) Service with severe tread braking conditions and light to moderate wheel loads.

Class B - (277-341 BHN, 0.57-0.67% Carbon.) Service with moderate tread braking conditions and heavier wheel loads, or where off-tread brakes are applied and/ or split duty brakes are applied.

Class C - (321-363 BHN, 0.67-0.77% Carbon.) (1) Service with light braking conditions and high wheel loads. (2) Service with heavier braking conditions where off-tread brakes are employed, or where split duty brakes are applied with reduced tread braking requirements.

2. References

2.1 Association of American Railroads (AAR)

AAR Specification M-107, “Standard for Wheels, Wrought Carbon Steel”, 1994 edition.

AAR Specification M-1003, “Specification for Quality Assurance”, Section J, 1998.

AAR Specification for Wheel Tape Gages, Recommended Practice RP-634, 1997

AAR Specification RP-66

2.2 American Society for Testing and Materials (ASTM)

ASTM Specification E 10, "Test Method for Brinell Hardness of Metallic Materials", 1993.

ASTM Specification E 350, "Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron", 1997.

ASTM Specification E 415, "Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low Alloy Steel", 1995.

ASTM Specification E 1019, "Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys," 1994.

ASTM Specification E 1806, "Practice for Sampling Steel and Iron for Determination of Chemical Composition", 1996.

2.3 Military Standards (MIL)

MIL-S-13165C, "Shot Peening of Metal Parts", 1991.

2.4 Society of Automotive Engineers (SAE)

SAE Standard J442, "Test Strip, Holder, and Gage for Shot Peening", 1995.

SAE Standard J443, "Procedures for Using Standard Shot Peening Test Strip", 1984.

SAE Standard J827, "High Carbon Cast Steel Shot", 1994.

2.5 American Society for Non-Destructive Testing

Recommended Practice No. SNT-TC-1A, 1996

3. Definitions

4. Design

Wheel information including tread contour, class of material, dimensions, tolerances, and balancing requirements shall be provided to the manufacturer by the purchaser.

5. Manufacture

5.1 Quality

The wheel manufacturer shall meet the requirements of the AAR Quality Assurance

Specification, M-1003, Section J.

5.2 Temperature control

During the manufacture, necessary care in the regulation of temperature gradients shall be exercised to obtain the mechanical properties to be expected from the chemical composition and mechanical work and to prevent the development of faulty structure. All wheels, immediately after the last thermal and/or-mechanical energy input, shall be control cooled.

6. Heat treatment

6.1 Wheel class

All wheels shall be heat treated. The wheels shall be uniformly austenitizied and then the rims shall be quenched. Following the quenching, the wheels shall be charged into a furnace for tempering to meet the requirements of Section 10, and subsequently cooled under controlled conditions defined by the manufacturer.

7. Shot peening

7.1 Scope

All wheels shall be shot peened to provide improvement in plate fatigue strength.

7.2 Requirements

7.2.1 Shot

The shot shall be SAE No. 550 or larger hardened steel as specified in SAE J827.

7.2.2 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. 550 or larger shot is maintained in the machines at all times.

7.2.3 Peening intensity

Measurements of arc height shall be made in accordance with SAE Standards J442 or SAE Recommended Practice J443. Peening intensity shall be sufficient to produce an average arc height of not less than 0.008 inch (0.20 mm) Almen C. For the straight plate design wheel, measurements shall be made on the front plate near the hub fillet and on the back plate near the rim fillet. For reverse plate design wheels, measurements shall be made at back plate hub fillet and front plate rim fillet. 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.

7.2.4 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, Alternate Procedure or MIL-S-13165B, paragraph 6.11.

7.2.5 Sequence

Shot peening shall be performed on all wheels and after any corrective surface preparation on the plate area. Plate area is defined in 7.2.3. Peening may be performed prior to inspection.

7.2.6 Portable peeners

A portable peening device may be used to re-peen small reconditioned areas (no larger than approximately 2- by 3-inches (5.1x7.6cm)) on wheel plate surfaces excluding the critical fillet areas (front hub and back rim). The portable equipment shall be capable of peening an Almen C Strip to develop the required average arc height of not less than 0.008 inch (0.20 mm) with a reasonable time of peening. Peening time of wheel plates shall be at least as long as the time required to develop the 0.008 inch (.20 mm) arc height. The equipment shall 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.

7.3 Quality assurance provisions

7.3.1 Wheel surface conditions

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

7.3.2 Frequency of test

Arc height determinations shall be made on Almen strips attached to a test wheel at the beginning and end of each production run but not less than once in each eight operating hours.

7.3.3 Retest

If a test fails to meet the arc height requirements of 0.008 inch (0.20 mm) Almen C, (2) two retests shall be made. These retests shall be averaged with the first determination. The average shall be not less than 0.008 inch (0.20 mm)and no more than one value of the three shall be less than 0.008 inch (0.20 mm).

7.3.4 Repeening

When test values fail to meet the provisions of paragraph 7.3.3, corrective action shall be initiated and satisfactory test values secured before proceeding with production peening. If the average Almen value of the unsatisfactory test is 0.006 inch (0.15 mm) or above, the last half of the wheels peened prior to the unsatisfactory test, but subsequent to a satisfactory test, shall be repeened with at least ½ exposure time. If the average Almen value is less than 0.006 inch (0.15 mm), all the wheels peened since the last satisfactory test shall be repeened with full exposure.

8. Chemical analysis

8.1 Ladle content

The steel shall conform to the following chemical requirements:

Weight Percent	
Carbon Class L, not over	0.47
Class A	0.47-0.57
Class B	0.57-0.67
Class C	0.67-0.77
Manganese	0.60-0.85
Phosphorous, not over	0.025
Sulfur, in the range	0.015-0.035
Silicon, not less than	0.15

Other elements may be as specified by the purchaser.

8.2 Specimens

An analysis of each heat of steel shall be made by the manufacturer to determine the percentage of the elements specified in Paragraph 8.1. 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 specified by the purchaser, shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 8.1.

8.3 Chemical analysis procedures

Chemical analysis of each heat of steel shall be made by one of the following test methods listed below. All analyses shall report which method is used for the carbon analysis and how the other elements are determined.

8.3.1 Test method for carbon

Total carbon determinations shall be by one of the following test methods:

a. Total carbon by the combustion Gravimetric Method, ASTM E-350 "Standard Method for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron."

b. Total carbon by the Combustion Thermal Conductivity Method, ASTM E-1019 "Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steel and in Iron, Nickel, and Cobalt Alloys."

c. Total carbon by combustion, followed by a quantitative infrared analysis, ASTM E-1019 "Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steel and in Iron, Nickel, and Cobalt Alloys."

d. ASTM E-415 "Standard Method for Spectrochemical Analysis of Carbon and Low Alloy Steel Using a Vacuum Spectrometer."

9. Check analysis

An analysis may be made by the purchaser from a wheel block or from a finished wheel selected from each heat by the purchaser's representative. The chemical composition thus determined shall conform to the requirements specified in Section 8, 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 center and outside. When a finished wheel is used, the sample shall be obtained from the rim face or the hub in a manner that 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.

When wheel blocks or when whole wheels are not available for chemical analysis the laboratory conducting the chemical analysis shall follow a standard sampling method. This standard method of sampling shall be ASTM E-59 "Sampling Steel, Cast Iron, Open-Hearth Iron and Wrought Iron for Determination of Chemical Composition." Then use either ASTM E-350 or E-1019, or E-415, as specified in Section 8.3 for chemical analysis of the sample.

10. Brinell hardness

10.1 Hardness requirement

The hardness of the rim, when measured in accordance with the requirements of Section 10.2 shall show the following values:

Class	Minimum Hardness	Maximum Hardness
L	241 BHN	277 BHN
A	255 BHN	321 BHN
B	277 BHN	341 BHN
C	321 BHN	363 BHN

10.2 Method of measurement

Measurement shall be made in accordance to ASTM E-10 on the front face of the rim with the edge of the impression not less than 3/16 inch (.47 cm) from the radius joining face and tread. Before making the impression, any decarburized metal shall be removed from the front face of the rim at the point chosen for measurement.

11. Number of tests

Where continuous heat treating furnaces are used, Brinell hardness measurements shall be made on 10 per cent of the wheels from each heat. Where batch type heat treating furnaces are used, Brinell hardness measurements shall be made on 10 per cent of the wheels from each heat treatment lot, provided that at least one (1) wheel is selected for test from each heat represented in the heat treatment lot. For either process, where there are less than twenty (20) wheels from a heat, a minimum of two (2) wheels shall be checked for hardness except when there is only one (1) wheel from a heat, in which case a Brinell hardness measurement shall be made on the one wheel.

If all the wheels tested meet the requirements of Section 10, all of the wheels represented shall be accepted. If any wheel tested fails to meet the requirements of Section 10, it shall be checked by making two (2) additional hardness measurements, one on each side of the point first measured and each approximately 1.0 inch (2.54 cm) from that point. If both of these check measurements meet the requirements of Section 10, the wheel shall be considered to have met the requirements of Section 10.

When continuous heat treating furnaces are used, should any of the wheels tested fail on check test to meet the requirements of Section 10, the manufacturer may test for individual hardness measurements all of the wheels of that heat in the lot submitted for inspection. Wheels meeting the requirements of Section 10, shall be accepted.

Where batch heat treating furnaces are used, should any of the wheels tested fail on check test to meet the requirements of Section 10, the manufacturer may test all of the wheels in the heat treatment lot for individual hardness measurement. Wheels meeting the requirements of Section 10 shall be accepted.

12. Retreatment

Any wheel failing to meet the requirements of Section 10 may be re-heat treated and tested in accordance with Section 11.

13. Mating

Wheels shall be measured and marked to the lower tape number until the next graduation is reached. Wheels shall be shipped in pairs of the same measured tape size.

14. Gages

Wheel tape gages shall conform to Association of American Railroads Recommended Practice

RP-634. Alternate tape gaging shall meet the AAR measurement standard for taping wheels. Repeatability and reproducibility of all alternate gages shall be demonstrated. Other wheel gages shall be as approved by the Purchaser.

15. Permissible variations in dimensions

The wheels shall conform to the dimensions with tolerances as specified by the purchaser.

16. Finishing

Wheels shall be rough bored and shall not have “black spots” , that is, un-machined areas indicating oxidized surfaces, exposed internal discontinuity, etc in the rough bore. Front hub face of the wheels shall be parallel to the plane of the vertical reference line and shall be machined. The back hub face shall be machined. Wheels shall not be covered with any substance to such an extent as to inhibit the detection of defects.

The contour of tread and flange shall be as shown in the purchaser’s drawing, or as otherwise specified, and shall be machined and finished to drawing tolerances.

Spot grinding or machining to remove surface defects shall not exceed a depth of 1/8 inch, (0.125”, 3.2mm). Sectional properties shall meet all dimensional requirements following repair of surface defects. Repaired surfaces shall have a maximum surface roughness of 500 micro-inches prior to final shot peening. Repaired surfaces shall provide a uniform transition to the as-produced surfaces.

17. Marking

Identification markings shall be legibly stamped as shown in Figure 1. If any stamped characters are missing or illegible, these shall be replaced by cold stamping in the proper place in the marking sequence. Passenger car wheels may be hot stamped or cold stamped on front or back of the hub face as specified by the purchaser.

Locomotive wheels shall only be hot or cold stamped on the front hub face or hot or cold stamped on the back hub face providing finish machining will completely remove the markings on the back hub face. Locomotive wheels that are to receive final hub machining by the purchaser may be ordered with markings paint stenciled on the wheel plate. After final machining, the purchaser shall cold stamp the markings on the front hub face.

The tape size of all wheels shall be paint stenciled on back plates in characters at least one-inch high. Stencil paint shall have a minimum service life of one year.

18. Inspection

The inspector representing the purchaser shall have free entry, at all times while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of wheels ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities and necessary assistance to satisfy him that the wheels are being

furnished in accordance with these specifications. Tests and inspection shall be made at place of manufacture prior to shipment, unless otherwise agreed.

The purchaser may make tests to govern the acceptance or rejection of the wheels in his own laboratory or elsewhere. Such tests shall be made at the expense of the purchaser.

All tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

18.1 Ultrasonic inspection

For detecting internal discontinuities in the rims of all steel wheels ultrasonic inspection shall be made by following either the procedures shown below or a purchaser approved equivalent. Equipment used in these procedures shall comply with the following requirements.

Each manufacturer shall maintain a documented test method and procedures for the ultrasonic inspection of all wheels manufactured under the provisions of this specification.

18.1.1 Equipment

The instrument shall have a pulse echo receiver and shall operate at frequencies of 2 to 5 MHz 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.

The ultrasonic inspection shall be performed with an automated scanning system. 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. The couplant shall be free of air bubbles. Rust inhibitors, softeners, and wetting agents may be added to the couplant.

Personnel responsible for set up and verification of the performance of the ultrasonic inspection of wheel system shall have ASNT level II certification to SNT-TC-1A in the ultrasonic inspection method.

18.1.2 Time of inspection

Inspection shall be performed after final thermal processing.

18.1.3 Calibration

Calibration shall be conducted using a reference standard of a wheel or portion of a wheel rim containing simulated defects or other purchaser approved procedure. The instrument sensitivity level should be adjusted to produce an approximate ½ full scale reflection from the reference standards of 18.4.3.2, 18.4.3.3, 18.4.3.4 and 18.4.4.2.

For axial testing of all wheels the reference standard shall be a 1/8 inch (3.2 mm) diameter flat

bottom hole drilled perpendicular to the rim face and to a depth of 1.5 inch (+/- 1/16 inch) (38 +/- 1.6 mm) at the mid-thickness of the rim. See Figure 2.

For radial testing the reference standard shall be a 1/8 inch (3.2 mm) diameter flat bottom hole drilled from the inside diameter of the rim perpendicular to the tread surface, and shall be a minimum of 1.25 inch (32 mm). below the tread surface. See Figure 3.

A distance amplitude correction (DAC) shall be used for axial and radial testing of wheels. The DAC shall be generated for each testing direction in the following manner.

Holes shall not be drilled close to each other so as to impede the response.

Axial As a minimum, two additional holes shall be drilled at whatever depth the manufacturer chooses. The creation of the DAC shall be accomplished using the reference standard and the response (s) from additional holes. Typical depth for the 3 holes could be 1.5, 2.5, and 3.5 inches (38, 64, and 89 mm). All holes shall be drilled from the front rim face to facilitate back rim testing. See Figure 2. Individual depth standards shall be permitted.

Radial To facilitate creation of a DAC, as a minimum, one (1) additional 1/8 inch (3.2 mm) diameter flat bottom hole shall be drilled in 1 W and 2 W wheels and, as a minimum, two (2) additional holes of the same size shall be drilled in MW wheels. Calibration shall be accomplished using the reference standard and the response (s) from the additional holes shall be used to create the DAC. Table 1 shows the depth of reference standard holes for the different wheel types. See Figure 3. Individual depth standards shall be permitted.

Note that 1 W, 2 W, and MW refer to thickness of allowable tread wear.

Alternate calibration standards may be used when authorized by the purchaser. The manufacturer shall demonstrate and document the correlation between the 1/8 inch (3.2 mm) diameter flat bottom hole and the proposed alternate standard.

Reference standards for the inspection of heat treated wheels shall be fabricated from heat treated steel made by the same process as the wheels being inspected. Reference standards need not be the same design as the wheels being inspected.

18.1.3.1 Recalibration

Conduct ultrasonic calibration to ensure system conformance to required specifications. Check the ultrasonic system and calibration of the instrument per documented procedures using calibration standard when any of the following occur:

Damage to any part of the ultrasonic system.

Change in transducers, cables, and other accessories.

Loss of power or equipment malfunction.

Whenever ultrasonic instrumentation is first turned on.

18.1.3.2 System verification and test results validation

Conduct ultrasonic calibration checks to ensure system conformance to required specifications.

System calibration to be verified per documented procedures using calibration standard at least every eight (8) hours of operation. If the results from system verification are outside of system tolerance, assessment must be made and appropriate action taken. Action taken to be supported by wheel reinspection data.

Records shall be maintained of system calibration and system verification.

18.1.4 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.

Each manufacturer shall ensure optimum volumetric coverage for the test method and manufacturing process. Optimization of coverage is verified by using supplemental reference standard holes located in different areas of the wheel rim, as shown in Figures 4A and 4 B.

Scanning speed shall permit detection of reference standards at calibration levels.

18.1.5 Rejection

Any wheel with a flaw indication equal to or larger than 50 % of the reference standard at the estimated discontinuity depth shall be cause for rejection.

Any indication from a discontinuity giving a loss of back reflection equal to or greater than the reference standard (covered in 18.4.3.4) during axial scanning shall be cause for rejection.

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

Final disposition of rejectable wheels may be determined by manual testing of questioned areas. Acceptance of wheels using hand scanning shall be to the same criteria as automated testing. Wheel records and test results shall be maintained for wheels found to be conforming under this paragraph.

18.2 Magnetic particle inspection

18.2.1 Purpose

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

18.2.2 Scope

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

18.2.3 Equipment and personnel

18.2.3.1 Magnetizing apparatus

The magnetizing 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 magnetizing currents used shall be large enough to induce magnetic fields of sufficient intensity to disclose surface discontinuities exceeding 0.25 inch (6.3 mm) long. The use of prod type contacts is prohibited.

18.2.3.2 Personnel

Personnel performing magnetic particle inspection shall have an ASNT level I certification to SNT-TC-1A in the magnetic particle inspection method.

18.2.3.3 Lighting apparatus

The inspection shall be performed in a darkened booth with the area 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 the point of inspection.

18.2.3.4 Inspection medium

18.2.3.4.1

The bath or solution shall 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 bath container shall be cleaned out and the agitation and circulation system shall be flushed with one or two gallons of clean carrier. Filtering screens shall be removed and cleaned by blowing with air. In preparing the new bath only recommended materials shall be used. The amount of powder shall 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 shall be recorded on a regular form set up for this purpose, as outlined in paragraph 18.5.3.3.6.

18.2.3.4.2

Concentration and contamination of the bath solution shall be tested weekly as follows pump and agitation system shall be operated for 20 minutes and then solution shall be run through hose and nozzle for 30 seconds. Using a regular 100 ml centrifuge tube, fill the centrifuge tube with 100 ml 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 0.1 ml and correct reading in volume of particles shall 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.

18.2.3.4.3

The ultraviolet light shall 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 (365 nanometers). The latter type meters are calibrated in microwatts per square centimeter. The meter shall be held a fixed distance of 15" (38 cm) from the light source (from black light filter surface to meter sensing element) and shall have a minimum meter reading of 525 microwatts per square centimeter.

18.2.3.4.4

The conversion factor from foot candles (for sight meters) to microwatts per square centimeter is 5.7 times the foot-candle reading (at 15" (38 cm) distance).

18.2.3.4.5

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

18.2.3.4.6

A regular form shall be prepared embodying the information to be shown on monthly and weekly tests as outlined above and this form shall be on hand at the wheel shop.

18.2.4 Preparation for inspection

The surface shall be scale free before magnetic particle inspection.

18.2.5 Detection of discontinuities

This 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.

18.2.6 Time of inspection

The magnetic particle inspection shall be performed following final machining.

18.2.7 Rejection

Magnetic particle indications exceeding 0.25 inch (6.3 mm) shall be cause for rejection. Discontinuities may be removed by machining or grinding where sufficient stock remains. Such wheels shall be retested by magnetic particle inspection.

19. Certification

The certification shall be made a basis of acceptance of the material. This shall include a copy of the manufacturer's test results showing that materials have been sampled, tested and inspected in accordance with the provisions of the specification. Each certificate so furnished shall be signed by an authorized agent of the supplier or manufacturer.

20. Rejection

Wheels represented by samples that fail to conform to the requirements of these specifications shall be rejected.

21. Authorization to deliver wheels

At the time of delivery to the purchaser, each manufacturer shall have current AAR Certification for manufacture of wheels.

All hole dimensions have tolerance of ±1/16”, unless otherwise noted.

Table 1. Recommended Hole Depth for Radial Testing and DAC Generation

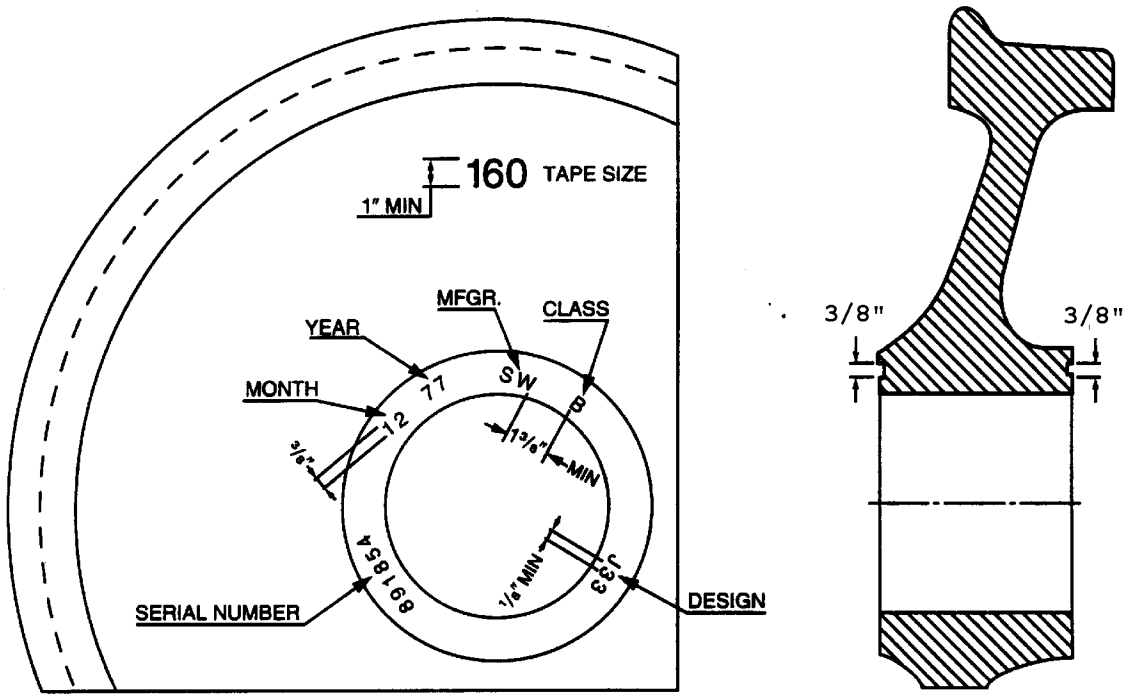
Wheel Type	Holes Required	Distance Below Tread Surface Inches		
		Reference Hole #1	Hole #2	Hole #3
1 W	2	1.25”	0.75”	--
2 W	2	1.25”	0.75”	--
MW	3	1.25”	0.75”	2.25”

Table 1M. Recommended Hole Depth for Radial Testing and DAC Generation

Wheel Type	Holes Required	Distance Below Tread Surface MM		
1 W	2	32	19	--
2 W	2	32	19	--
MW	3	32	19	57

Note: Hole #1 is the reference hole and Holes #2 and #3 are used for Distance Amplitude Correction for both tables

Figure 1 Marking of Wrought Steel Wheels – Hub Stamping



Note 1--When ordered, wheels may be stamped on front or back hub face, as specified by the purchaser.

Note 2--Stamping to consist of manufacturer's serial number, date of manufacture, manufacturer's identification, class of heat treatment, and design designation in the order shown above. Hub stamping of wheels may be applied after final machining of the hub. Wheels that are to be marked by the purchaser after leaving the manufacturing facility shall be furnished with all markings stenciled on the front plate with paint using characters at least 1-inch (25 mm) in height.

Note 3--Manufacturer's identification shall be as provided by the Association of American Railroads.

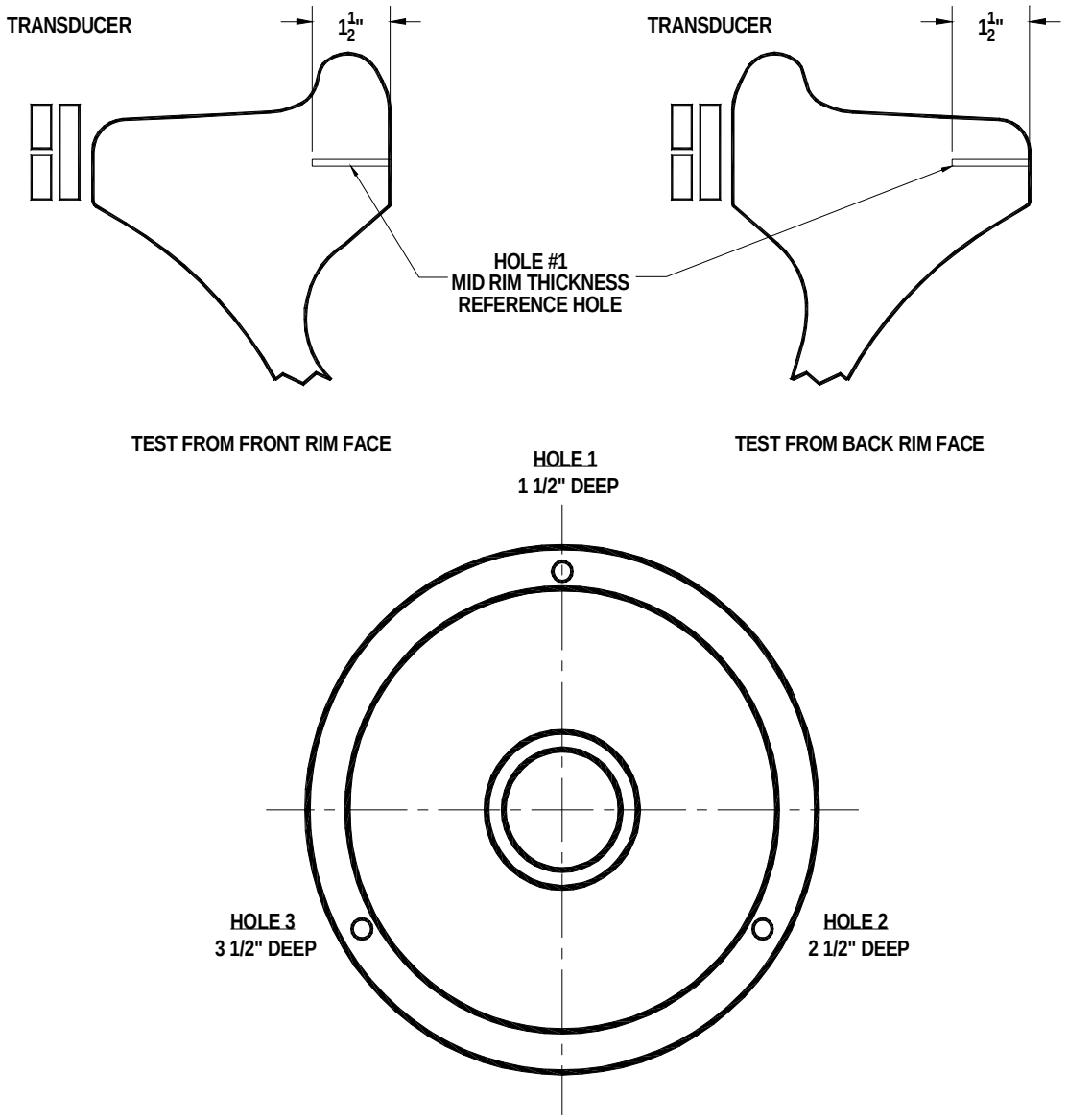
Note 4--Stamping to be spaced a minimum of 1/8-inch (3 mm) between characters and a minimum of 1-3/8-inches (35 mm) between groups and located approximately central of the hub face. Wheels for inboard bearing application that require stamping of the hub inboard face shall have the stamping located as directed by the engineer.

Note 5--Stamps used to produce characters shall not be less than 3/8-inch (10 mm) in height and shall not have sharp edges. Italicized characters sloped upward to the right shall be used.

Note 6--All wheels shall be marked for Class using letters L, A, B, or C, as appropriate.

Note 7--The three groups (1) design, (2) serial number, and (3) date of manufacture, manufacturer, and class shall be spaced approximately equidistantly around the hub face.

Figure 2 Typical Reference Standard for Rim Face Ultrasonic Test

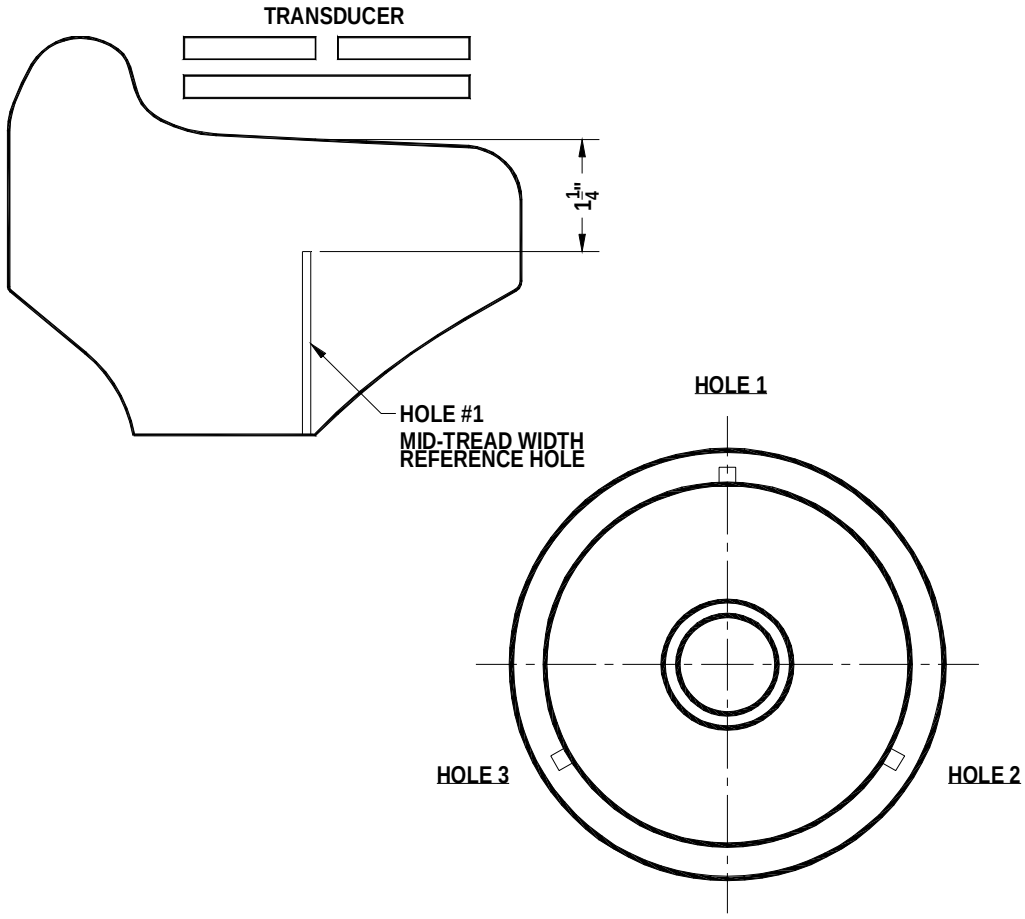


Axial Rim Test Paragraph 17.4.3.2 and 17.4.3.4

Hole # 1 Reference Hole

Hole # 2 and 3 used for Distance Amplitude Correction

Figure 3 Typical Reference Standard for Rim Tread Ultrasonic Test



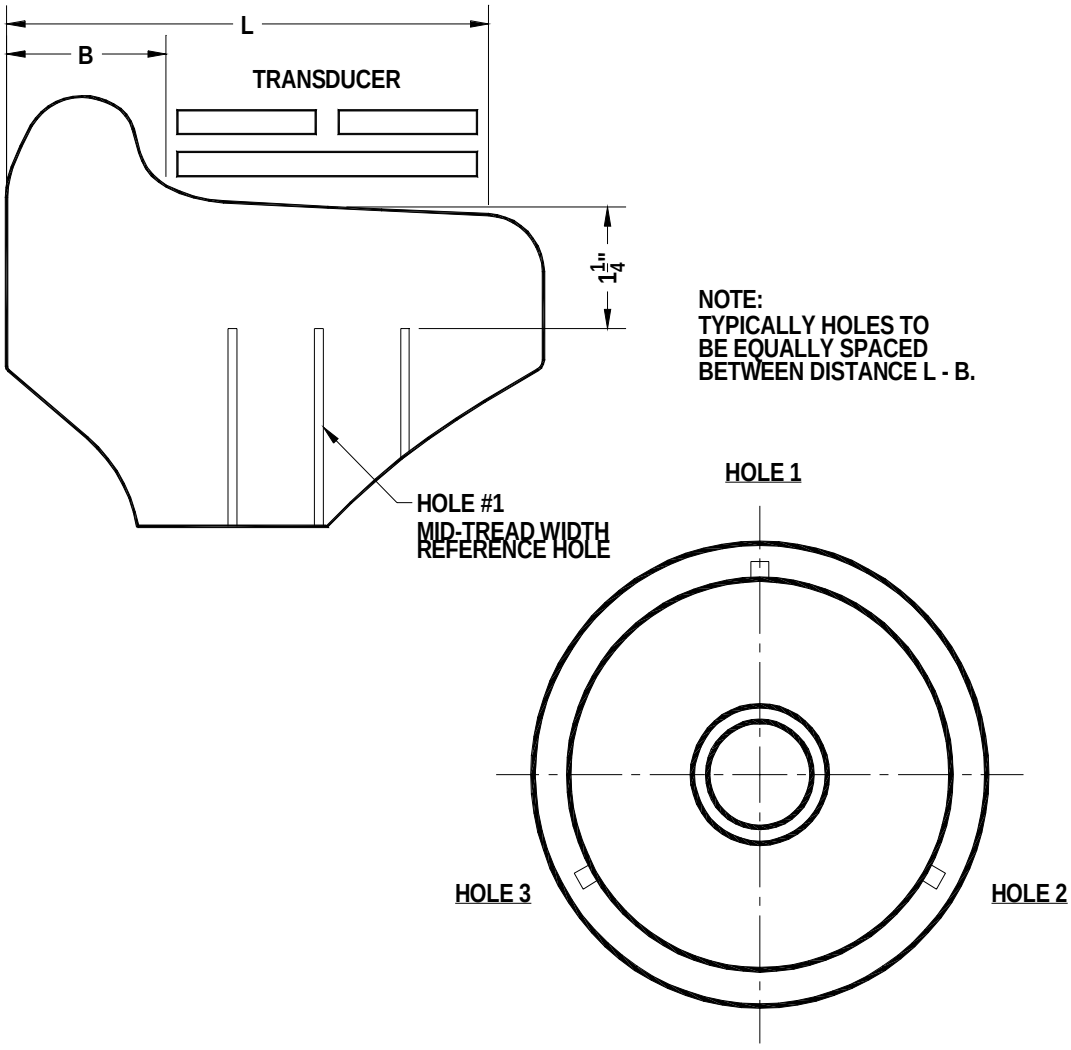
Radial Rim Test Paragraph 18.4.3.3 and 18.4.3.4

Hole # 1 Reference Hole

Hole # 2 and 3 used for Distance Amplitude Correction see Table 1

Figure 4A Typical Reference Standard for Rim Tread Ultrasonic Test

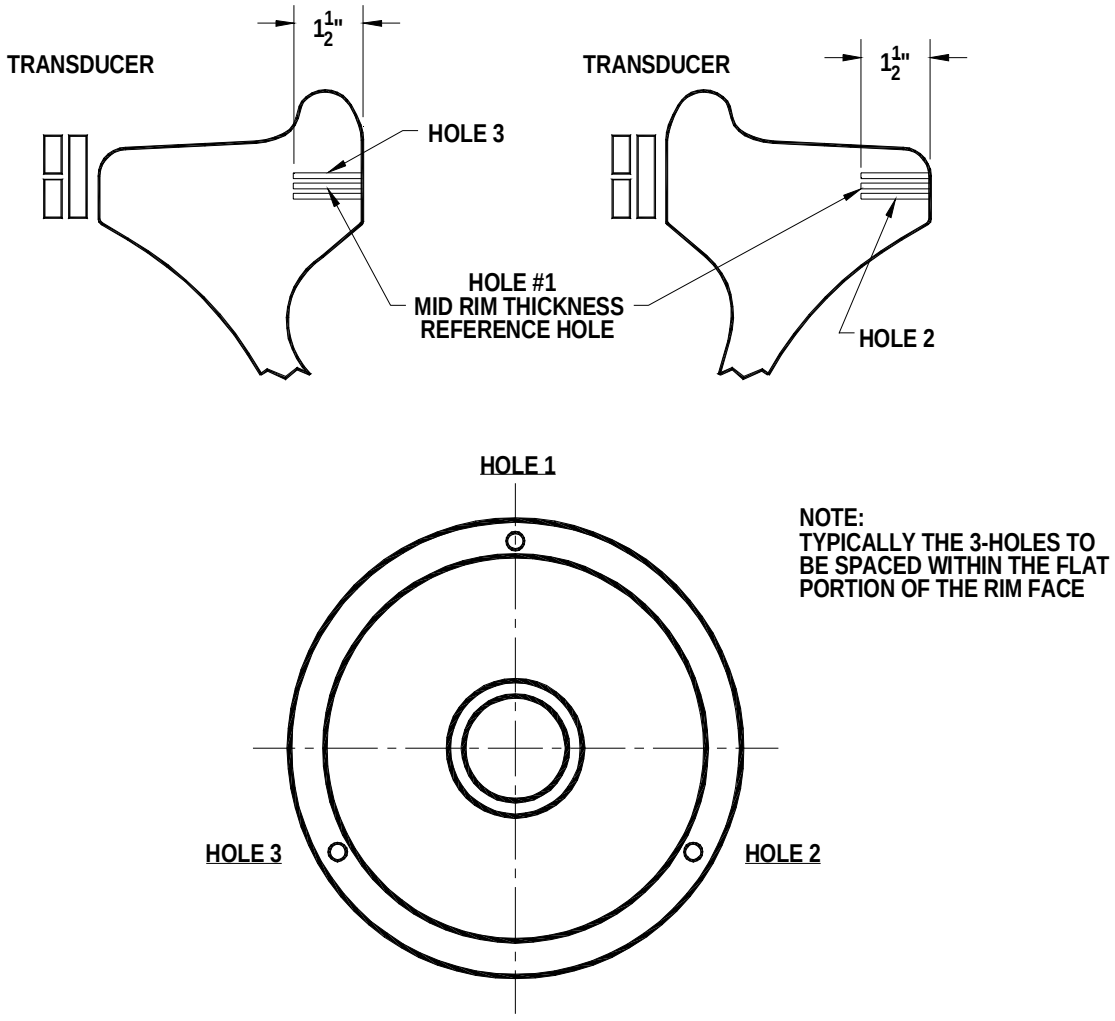
For Volumetric Coverage



Tread Rim Test Paragraph 17.4.4.2

Figure 4B Typical Reference Standard for Rim Face Ultrasonic Test

For Volumetric Coverage



Axial Rim Test Paragraph 17.4.4.2