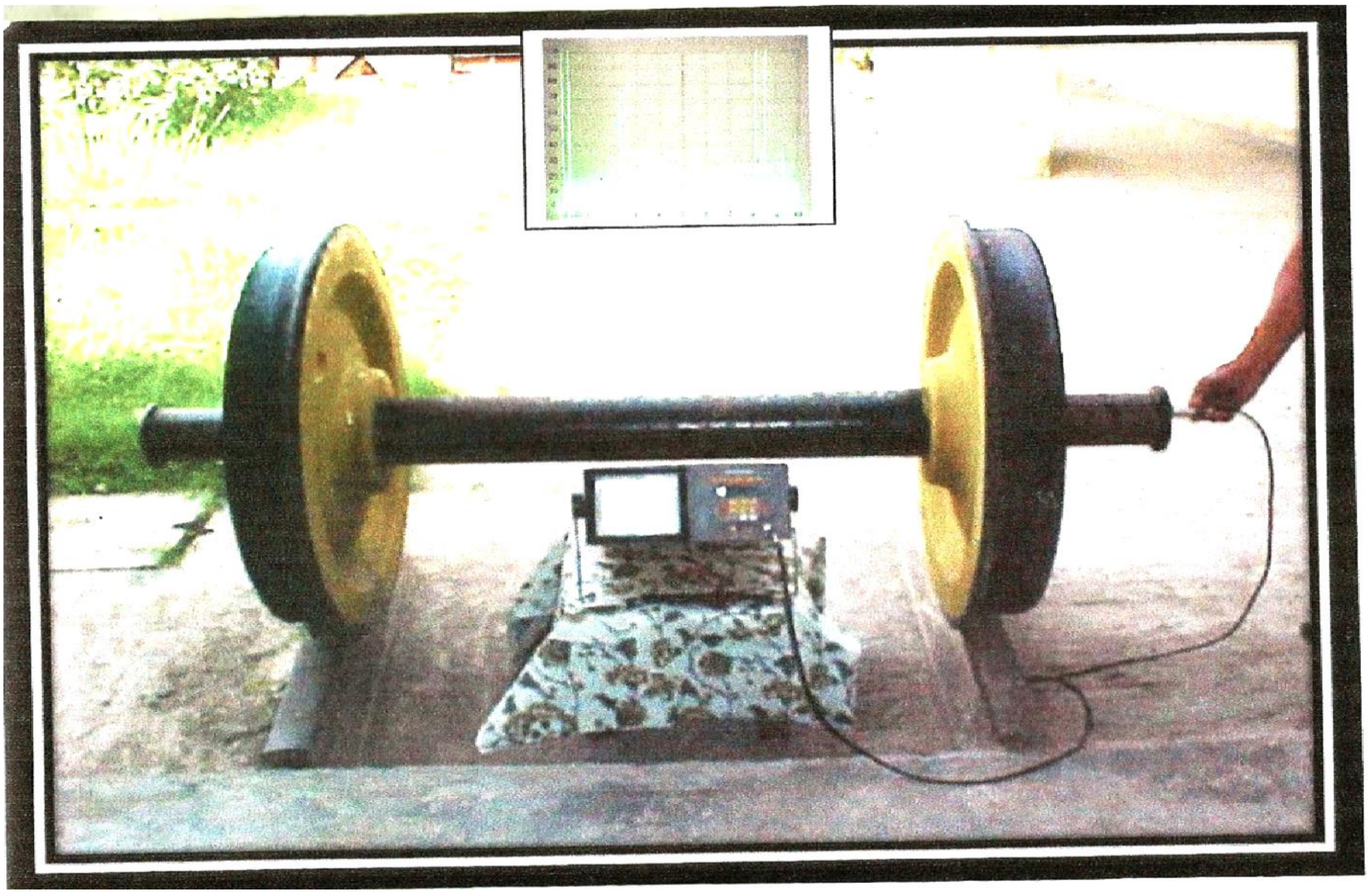


CODE OF PROCEDURES FOR ULTRASONIC TESTING OF AXLES OF TRACK MACHINES
MAY-2025

REFERENCES

<table>
<tr><th>S. No.</th><th>Machine Model</th><th>Type of axle</th><th>Report / Drawing Referred</th><th>RDSO Letter No.</th><th>Date of Issue</th></tr>
<tr><td>1.</td><td rowspan="2">RBMV
(Phooltas
Model No. RBMV.04.B)</td><td>Powered Axle</td><td>8B0304050200</td><td>TM/HM/8/USFD</td><td>May 2025 (Tentative)</td></tr>
<tr><td>2.</td><td>Non Powered Axle</td><td>8B0304050300</td><td>TM/HM/8/USFD</td><td>May 2025 (Tentative)</td></tr>
<tr><td>3.</td><td rowspan="2">RBMV
(SAN
Model No.
SAN-8W RBMV)</td><td>Powered Axle</td><td>SNSK4165</td><td>TM/HM/8/USFD</td><td>May 2025 (Tentative)</td></tr>
<tr><td>4.</td><td>Non Powered Axle</td><td>AC/DC EMU/D2-0-2-205</td><td>TM/HM/8/USFD [Metallurgical & Chemical Report No.: MC-180 (First Issue June – 2023)]</td><td>May 2025</td></tr>
</table>

CONTENTS

धातु एवं रसायन निदेशालय

एन॰ डी॰ टी॰अनुभाग

फ़ाइल सं.: RDSO-MC0NDT(TEST)/14/2020 दिनांक: As Signed

विषय: Code of Procedure for Ultrasonic Testing of Axles of Track Machines.

संदर्भ: Your letter no. TM/HM /8/USFD दिनांक 22.01.2025.

Reference above, tentative codes of procedure for Ultrasonic Testing of Powered Axle and Non-Powered Axles of Track Machine Model No. RBMV 04 B, Make: Phooltas, DRG. No 8B0304050200 and 8B0304050300 have been prepared on the basis of drawing provided and enclosed for your reference please. The detailed Code of Procedures (COP) will be prepared as per the availability of axles (place and date) in loose (fitted with wheel sets) and in fitted condition.

Necessary feedback regarding ultrasonic testing of axle using tentative code of procedure and availability of axles may be intimated to this office for further action please

संलग्नक : उपरोक्तानुसार

सुनीता
01.05.25

(श्रीमती सुनीता)
निदेशक / धातु एवं रसायन-।।

निदेशक/ट्रैक मशीन-।

Research Designs and Standards Organization
Ministry of Railways, Lucknow-226011

M&C Directorate

April 2025

Theoretical calculation and relative positions of signals during UST of Powered Axle of Track Machine Model No RBMV 04 B, Make: Phooltas, DRG. No 8B0304050200 (Tentative)

(A) FAR END SCANNING: Calibration: 1 Main Scale Div.= 150 mm (Compression wave)
Probe: 20/25 mm Dia., 2.5 MHz freq., Normal Probe, S/C

(i) Scanning From X End

S.No	Details	Distance	Division
1	Direct Reflection from Axle end	2362	9.4
2	Delayed-1 Reflection from Wheel Seat outer Fillet	2290	9.2
3	Direct Reflection from Journal Fillet	2201	8.8
4	Direct Reflection from Wheel Seat outer Fillet	2113	8.5
5	Delayed-2 Reflection from Fillet (A)	1922	7.7
6	Delayed-1 Reflection from Fillet (A)	1765	7.1
7	Delayed-2 Reflection from Fillet (B)	1751	7.0
8	Delayed-1 Reflection from Fillet (B)	1578	6.3
9	Direct Reflection from Fillet (A)	1572	6.3
10	Direct Reflection from Fillet (B)	1366	5.5
11	Delayed-2 Reflection from Fillet (D)	1352	5.4
12	Delayed-1 Reflection from Fillet (D)	1185	4.7
13	Direct Reflection from Fillet (D)	981	3.9
14	Delayed-2 Reflection from Wheel Seat inner Fillet	775	3.1
15	Delayed-1 Reflection from Wheel Seat inner Fillet	620	2.5
16	Direct Reflection from Wheel seat inner fillet	431	1.7

(ii) Scanning From Y End

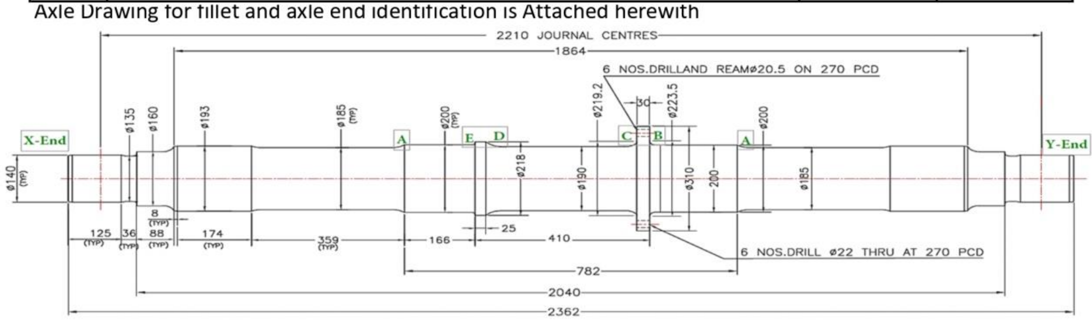
S.No	Details	Distance	Division
1	Direct Reflection from Axle end	2362	9.4
2	Delayed-1 Reflection from Wheel Seat outer Fillet	2290	9.2
3	Direct Reflection from Journal Fillet	2201	8.8
4	Direct Reflection from Wheel Seat outer Fillet	2113	8.5
5	Delayed-2 Reflection from Fillet (A)	1922	7.7
6	Delayed-2 Reflection from Fillet (E)	1786	7.1
7	Delayed-1 Reflection from Fillet (A)	1765	7.1
8	Delayed-1 Reflection from Fillet (E)	1615	6.5
9	Direct Reflection from Fillet (A)	1572	6.3
10	Direct Reflection from Fillet (E)	1406	5.6
11	Delayed-2 Reflection from Fillet (C)	1398	5.6
12	Delayed-1 Reflection from Fillet (C)	1231	4.9
13	Direct Reflection from Fillet (C)	1026	4.1
14	Delayed-2 Reflection from Wheel Seat inner Fillet	775	3.1
15	Delayed-1 Reflection from Wheel Seat inner Fillet	620	2.5
16	Direct Reflection from Wheel seat inner fillet	431	1.7

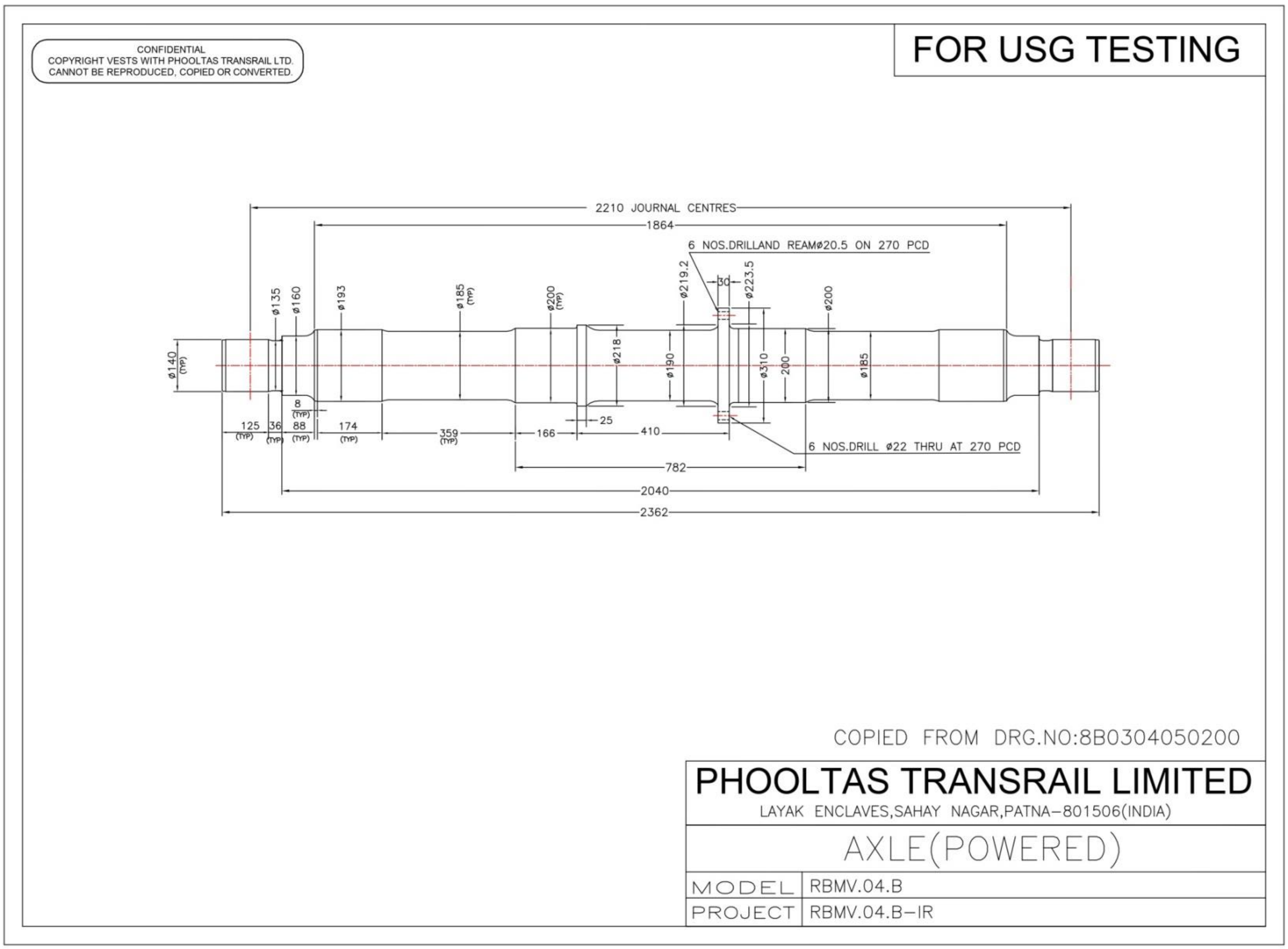
(B)Near End Low Angle Scanning: Calibration: 1 MSD. = 100 mm (Compression wave)
Probe: 20/25 mm Dia., 2.5 MHz, Normal Probe, Single Crystal

i) Wheel seats Inner Fillet / Wheel Boss (Both Ends):

S.No	Details	Distance	Division
1	Direct reflection from Wheel seat Inner Fillet / wheel boss, probe position on end face at a distance 39mm from center, angle 17.5°	452	4.5

Axle Drawing for fillet and axle end identification is Attached herewith

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COPYRIGHT VESTS WITH PHOOLTAS TRANSRAIL LTD.
CANNOT BE REPRODUCED, COPIED OR CONVERTED.
FOR USG TESTING
2210 JOURNAL CENTRES
1864
6 NOS.DRILLAND REAMø20.5 ON 270 PCD
6 NOS.DRILL ø22 THRU AT 270 PCD
782
2040
2362
COPIED FROM DRG.NO:8B0304050200
PHOOLTAS TRANSRAIL LIMITED
LAYAK ENCLAVES,SAHAY NAGAR,PATNA–801506(INDIA)
AXLE(POWERED)
MODEL RBMV.04.B
PROJECT RBMV.04.B–IR

Research Designs and Standards Organization
Ministry of Railways, Lucknow-226011

M&C Directorate

April 2025

Theoretical calculation and relative positions of signals during UST of
Non Power Axle of Track Machine Model no RBMV 04 B,
Make: Phooltas, DRG. No 8B0304050300 (Tentative)

(A) FAR END SCANNING: Calibration: 1 Main Scale Div.= 250 mm (Compression wave)
Probe: 20/25 mm Dia., 2.5 MHz freq., Normal Probe, S/C

(i) From Both Ends

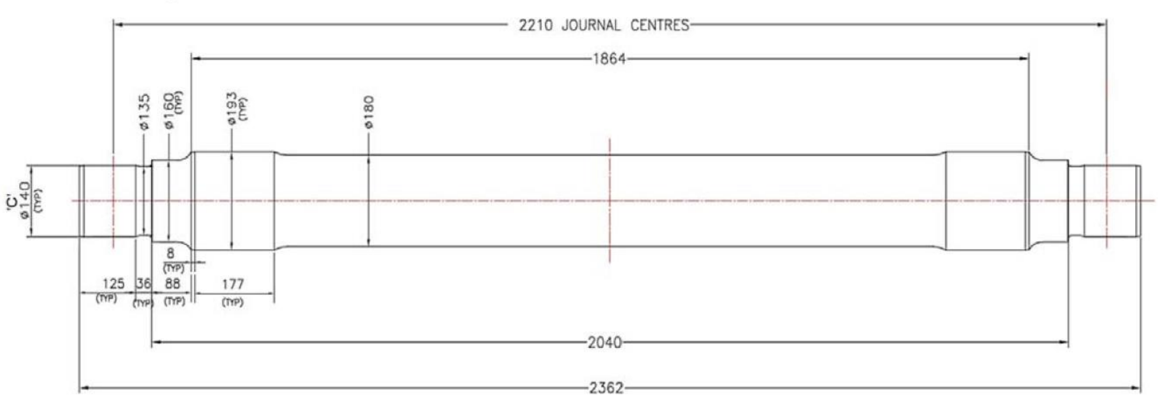
S.No	Details	Distance	Division
1	Direct Reflection from Axle end	2362	9.4
2	Delayed-1 Reflection from Wheel Seat outer Fillet	2290	9.2
3	Direct Reflection from Journal Fillet	2201	8.8
4	Direct Reflection from Wheel Seat outer Fillet	2113	8.5
5	Delayed-2 Reflection from Wheel Seat inner Fillet	773	3.1
6	Delayed-1 Reflection from Wheel Seat inner Fillet	621	2.5
7	Direct Reflection from Wheel seat inner fillet	434	1.7

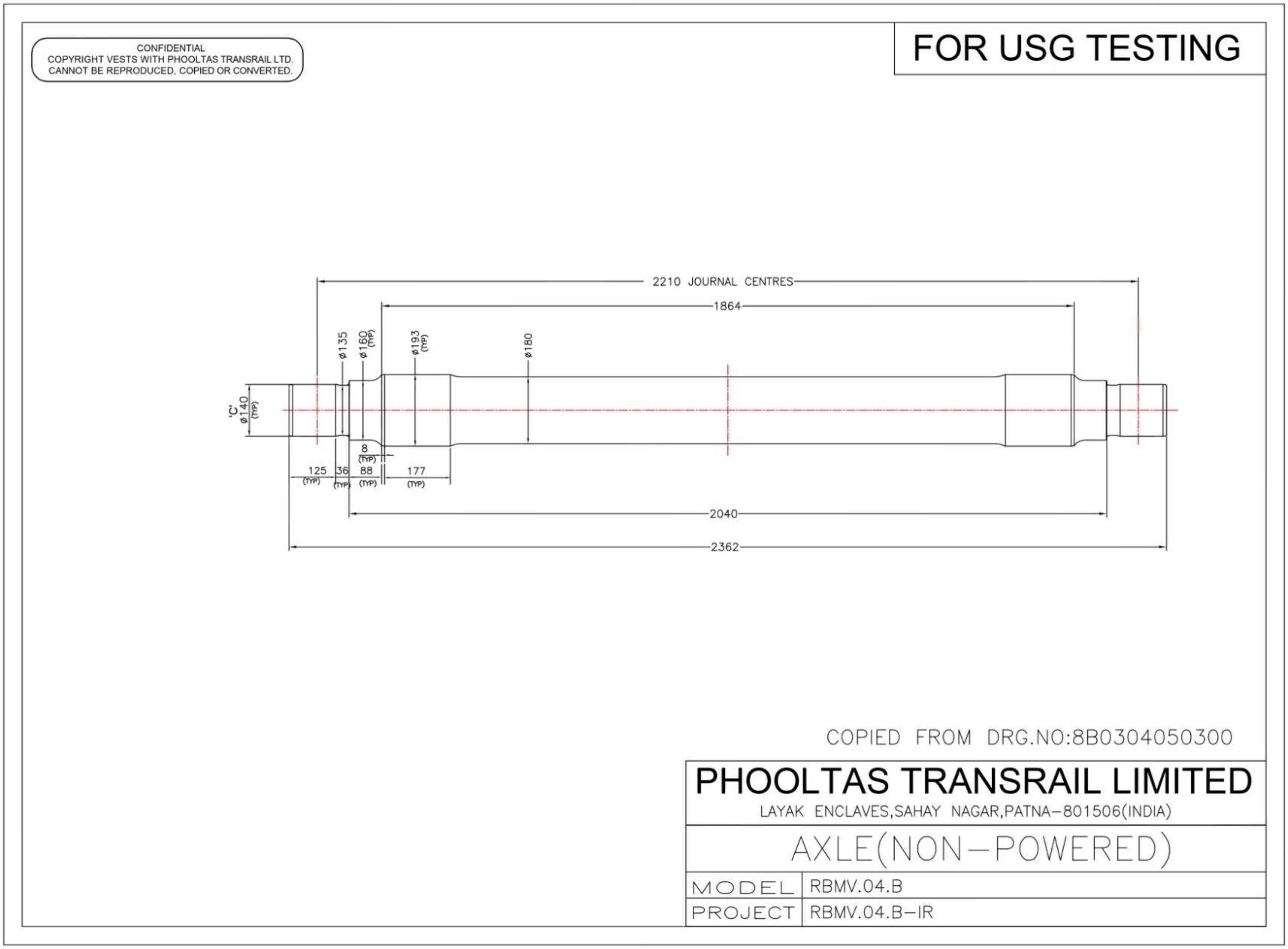
(B)Near End Low Angle Scanning: Calibration: 1 MSD. = 100 mm (Compression wave)
Probe: 20/25 mm Dia., 2.5 MHz, Normal Probe, Single Crystal

i) Wheel seats Inner Fillet / Wheel Boss (Both Ends):

S.No	Details	Distance	Division
1	Direct reflection from Wheel seats Inner Fillet / wheel boss, probe position on axle end face at a distance 40 mm from center, probe angle 17.5°	455	4.6

Axle Drawing for fillet and axle end identification is Attached herewith

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FOR USG TESTING
2210 JOURNAL CENTRES
1864
ø135
ø160 (TYP)
ø193 (TYP)
ø180
'C' ø140 (TYP)
8 (TYP)
125 (TYP)
36 (TYP)
88 (TYP)
177 (TYP)
2040
2362
COPIED FROM DRG.NO:8B0304050300
PHOOLTAS TRANSRAIL LIMITED
LAYAK ENCLAVES,SAHAY NAGAR,PATNA–801506(INDIA)
AXLE(NON–POWERED)
MODEL
RBMV.04.B
PROJECT
RBMV.04.B–IR

Research Designs and Standards Organization
Ministry of Railways
Lucknow-226011
M&C Directorate

Theoretical calculation and relative positions of signals for SPART Car axle to Drg No. SNSK 4165 (SAN Make) **(Tentative). March-2018**

(A) FAR END SCANNING:

Calibration: 1 Main Scale Div.=250 mm (compression wave)
Probe: 20/25 mm Dia., 2.5 MHz freq., Normal Probe, Single Crystal

From Axle End B

S. No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1.	Direct reflection from axle end.	2362	9.5
2.	Delayed reflection from journal fillet	2349	9.4
3.	Delayed reflection from wheel seat outer fillet	2288	9.2
4.	Direct reflection from journal fillet	2201	8.8
5.	Direct reflection from wheel seat outer fillet	2113	8.5
6.	Delayed reflection from fillet 4	1805	7.2
7.	Delayed reflection from fillet 3	1657	6.6
8.	Delayed reflection from fillet 4	1647	6.6
9.	Delayed reflection from fillet 3	1488	6.0
10.	Direct reflection from fillet 4	1455	5.8
11.	Direct reflection from fillet 3	1280	5.1
12.	Delayed reflection from wheel seat inner fillet	778	3.1
13.	Delayed reflection from wheel seat inner fillet	623	2.5
14.	Direct reflection from wheel seat inner fillet	434	1.7

From Axle End A

S. No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1.	Direct reflection from axle end.	2362	9.5
2.	Delayed reflection from journal fillet	2349	9.4
3.	Delayed reflection from wheel seat outer fillet	2288	9.2
4.	Direct reflection from journal fillet	2201	8.8
5.	Direct reflection from wheel seat outer fillet	2113	8.5
6.	Delayed reflection from fillet 1	1986	7.9
7.	Delayed reflection from fillet 2	1849	7.4
8.	Delayed reflection from fillet 1	1828	7.3
9.	Delayed reflection from fillet 2	1678	6.7
10.	Direct reflection from fillet 1	1636	6.5
11.	Direct reflection from fillet 2	1471	5.9
12.	Delayed reflection from wheel seat inner fillet	778	3.1
13.	Delayed reflection from wheel seat inner fillet	623	2.5
14.	Direct reflection from wheel seat inner fillet	434	1.7

26/3/18
(गंगा प्रसाद)
(GANGA PRASAD)
उप निदेशक/यां०रं०-I / Dy. Director/M&C-I
रेल मंत्रालय/Ministry of Railways
अ० अ० मा० सं०, लखनऊ/R.D.S.O., Lucknow

(B) Near End Low Angle for both end (Wheel seat inner fillet)

Calibration: 1 Main Scale Div. = 100 mm (Compression wave)
Probe: 20/25 mm Dia., 2.5 MHz freq., Normal Probe, Single Crystal, Perspex Wedge for 17.5^0 Probe.

S.No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1.	Direct reflection from Wheel boss, probe position on axle end face at a distance 30 mm from axle end face outer periphery, probe angle 17.5°	455	4.6*

(C) HIGH ANGLE SCANNING: Wheel Seat inner fillet:

Calibration: 1Main Scale Div. =50 mm (Shear wave)
Probe: Normal Probe, 20/25 mm dia., 2.5 MHZ, Single Crystal, Perspex wedge for 37.5^0, dia of curvature 185 mm.

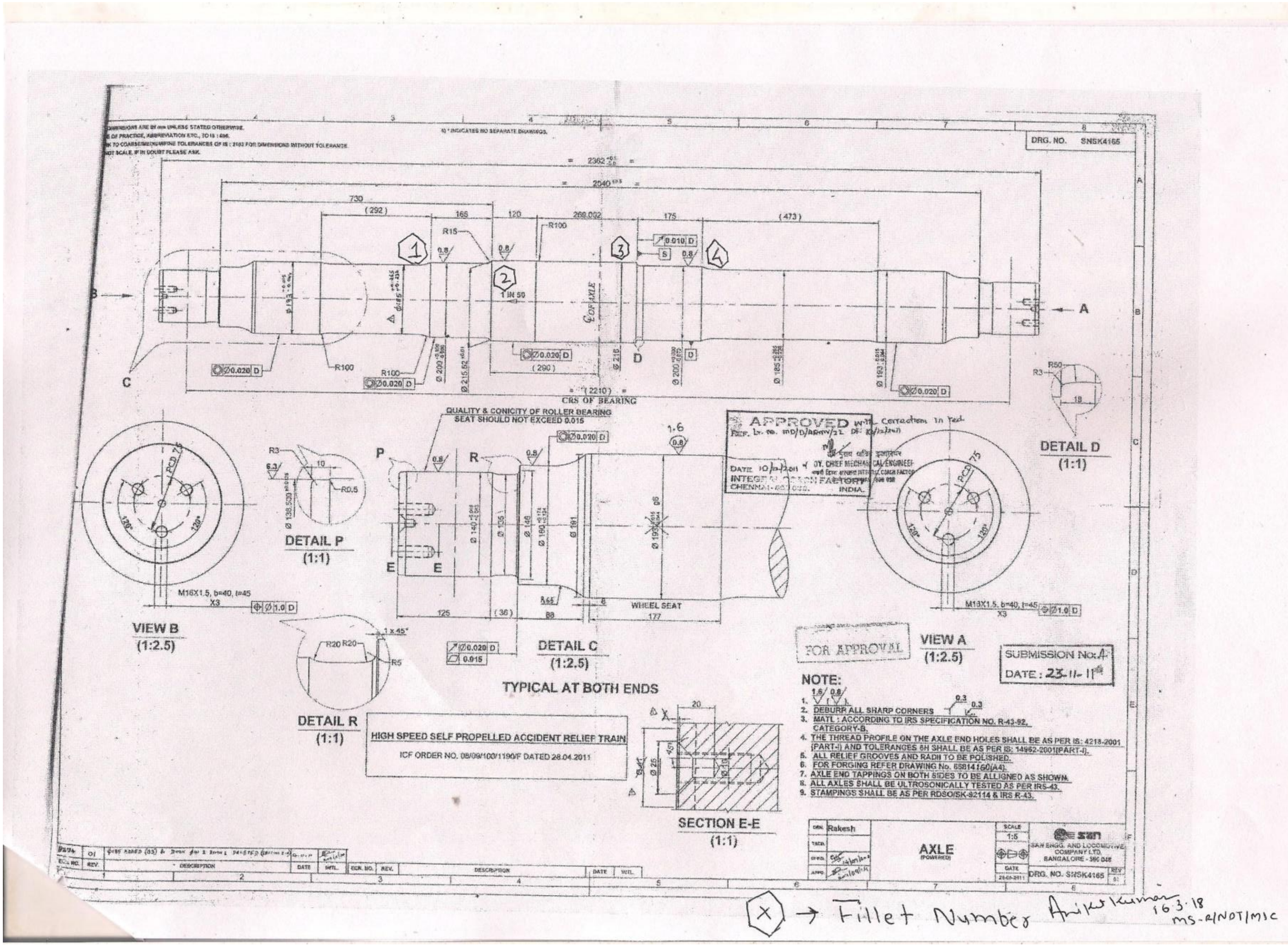
<u>**From Both End**</u>

S.No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1.	Direct reflection from wheel seat inner fillet. (Probe angle 37.5°, diameter of curvature 185 mm, standoff distance 145 mm from Wheel seat inner fillet).	238.2	4.8*

*** Signals may shift slightly from theoretical position due to Perspex Correction.**

GPrasad
16/3/18

(गंगा प्रसाद)
(GANGA PRASAD)
उप निदेशक/यांत्रिक-I / Dy. Director/M&C-I
रेल मंत्रालय/Ministry of Railways
अ.अ.मा.सं./R.D.S.O., Lucknow


DRG. NO. SNSK4165
VIEW B
(1:2.5)
DETAIL P
(1:1)
DETAIL C
(1:2.5)
DETAIL D
(1:1)
VIEW A
(1:2.5)
DETAIL R
(1:1)
SECTION E-E
(1:1)
TYPICAL AT BOTH ENDS
CRS OF BEARING
WHEEL SEAT
QUALITY & CONICITY OF ROLLER BEARING SEAT SHOULD NOT EXCEED 0.015
HIGH SPEED SELF PROPELLED ACCIDENT RELIEF TRAIN
APPROVED
FOR APPROVAL
SUBMISSION No.
NOTE:
2. DEBURR ALL SHARP CORNERS
3. MATL : ACCORDING TO IRS SPECIFICATION NO. R-43-92, CATEGORY-B.
5. ALL RELIEF GROOVES AND RADII TO BE POLISHED.
7. AXLE END TAPPINGS ON BOTH SIDES TO BE ALLIGNED AS SHOWN.
8. ALL AXLES SHALL BE ULTROSONICALLY TESTED AS PER IRS-43.
AXLE
(X) → Fillet Number

For Official use only

सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW

Code of Procedure (COP) for Ultrasonic Testing of Higher carrying capacity Trailer Coach Axle to Drawing no AC/DC EMU/D2-0-2-205 in Service.

METALLURGICAL AND CHEMICAL REPORT No.- MC -180

(First Issue June – 2023)

PREFACE

This report is based on Ultrasonic Tests conducted by the Metallurgical and Chemical Directorate of RDSO at Workshop, Kharagpur, South Eastern Railway. Every care has been taken in recording data accurately and in analyzing it objectively. The views expressed in this report are subject to modification from time to time in the light of fresh data.

This Report is based on the work carried out by:

Shri Prashant Kumar Tewari, Assistant Research Officer, NDT/M&C
Shri Om Prakash, Metallurgical Supervisor (Research), NDT/M&C

RAJESH SRIVASTAVA Digitally signed by RAJESH SRIVASTAVA Date: 2023.06.16 13:17:20 +05'30'

(Rajesh Srivastava)
Director/M&C

SUDHIR KUMAR SHRIVASTAVA Digitally signed by SUDHIR KUMAR SHRIVASTAVA Date: 2023.06.16 17:33:31 +05'30'

(Sudhir Kumar Srivastava)
Addl. Executive Director/M&C

CONTENT

M & C DIRECTORATE
RDSO/LUCKNOW

Standardisation of Ultrasonic Testing of Higher carrying capacity Trailer Coach Axle to Drawing no AC/DC EMU/D2-0-2-205 in Service.

Synopsis:

To ensure safety and reliability of rolling stocks, axles are required to be examined periodically for presence of cracks. This report describes the details of work carried out on standardization of Ultrasonic Testing Technique for above axle in service by far end, trace-delay, Near-end low-angle scanning & High-angel scanning using pulse echo reflection technique. This procedure is applicable for axles in service and intended to be used by ultrasonic personnel trained and certified by RDSO.

1. Scope:

To Standardize the Ultrasonic Testing of Higher carrying capacity Trailer Coach Axle to Drawing no AC/DC EMU/D2-0-2-205 in Service.

2. Normative References: The following RDSO/IS standards contain provisions, which through reference in this text constitute provisions of this code of procedure. At the time of Publication, the edition indicated were valid

Specification No.	**Title**
RDSO Specification no. M&C/NDT/125/2004, Rev-II, January 2017	Portable digital ultrasonic flaw detector with A-Scan Storage
RDSO Specification no. WD-17-Misc-92	Specification for Soft Grease
IS: 1628-1986 Reaffirmed in Feb 1996	Specification for Axle Oil
IS: 1875-1992	Carbon steel billets, blooms, slabs and bars for forgings
IS: 12666-2018/Latest	Methods for performance assessment of ultrasonic flaw detection equipment

3. Methodology:

The diagram of axle to the above drawing is shown in Fig. 1. The probe angles suitable for detecting cracks at vulnerable locations of the axle were calculated. Depending upon the direct reflections & trajectories, locations of the echoes likely to appear by Far End, Near End Low Angle scanning & High-angle scanning, were worked out. The theoretical calculations and relative positions of signal/echoes obtained are given in Appendix-1. Utilising these data as the basis, the axles free from any flaw were tested in the press-fit condition and bare condition to correlate the trace patterns as expected in the theoretical calculations with those obtained in actual testing.

4. Code of Procedure:

4.1 Equipment and accessories recommended:

4.1.1 Equipment: Ultrasonic Flaw Detector, approved by RDSO (Specification No. M&C/NDT/125/ 2004) or any other similar Ultrasonic Testing Equipment.

4.1.2 Accessories:

Far end Scanning: Normal probe, Single Crystal, Freq.- 2.5MHz, dia 20/25 mm, Lead-zirconate titanate or crystal of similar characteristics.

Near end low angle scanning: Normal probe, Single Crystal, Freq.- 2.5MHz, dia 20/25 mm, Lead zirconate titanate or crystal of similar characteristics with Perspex wedge capable of producing ultrasonic longitudinal wave at 17.5^0 angle.

High angle scanning: Normal probe, Single Crystal, Freq.- 2.5MHz, dia 20/25 mm Lead zirconate titanate or crystal of similar characteristics with:-

Perspex wedge capable of producing ultrasonic shear wave at 37.5^0 and having dia. of curvature 185 to 205 mm.

4.1.3 Couplant: Soft grease to RDSO specification No. WD-17-MISC-92 or Axle Oil (medium) as per IS: 1628 (1986) Reaffirmed in Feb. 1996.

4.1.4 Calibration Bar: 50 mm dia. x 500 mm long and 50 mm dia. x 182 mm long steel Bar designation 45C8 of IS: 1875 – 1992 or latest, rolled/forged and normalised having grain size No. 5 or finer to ASTM E-112.

4.**2 Personnel engaged in testing:** Testing of Axles shall be done only by trained and certified personnel having valid RDSO certificate. Under no circumstances testing shall be carried out by any other personnel not meeting this requirement.

4.3 Scanning techniques:

4.3.1 Far end scanning: *This technique shall be used for testing the full length of axle from both the ends***.** The time scale shall be calibrated to 250 mm per main scale division of compression wave. The normal probe of 2.5 MHz frequency having 20/25 mm dia shall be placed on the clean axle end face with the suitable couplant as shown in figure-1. The probe shall be given slight rotary movement for the proper acoustic coupling. The probe shall be moved to cover entire cross-section (except holes) of the end face. During scanning of the axle using the technique explained above, the sensitivity level of ultrasonic flaw detector shall be so adjusted that the signal amplitude of control echo is equal to that of trace pattern echo as shown in figure-2. Sensitivity setting is to be done separately for testing from both ends. The trace patterns which are obtained from flawless axle are shown in figure-2 (For both ends).

4.3.2 Examination by trace delay Technique: *This technique shall be employed to examine the axle in length part of 500 mm each. This technique may be employed for confirmation of findings during Far End Scanning.* The time scale shall be calibrated to 50 mm per main scale division of compression wave. Testing is carried out just like Far- End scanning by applying delay of 0 mm, 500 mm, 1000 mm, 1500 mm & 2000 mm respectively. The trace patterns as obtained from a flawless axle are shown in Fig 3A, 3B & 3C (For both ends).

4.3.3 Near end low angle scanning: *The technique is used for examination of fatigue cracks, if any, in the raised wheel seat inner fillet area, which remains un-scanned during far end scanning***.**

The time scale shall be calibrated to 100 mm per main scale division for compression wave. A normal probe (S/C) of 2.5 MHz frequency, having 20/25 mm dia fitted with a Perspex wedge capable of producing ultrasonic longitudinal wave at 17.5^0, shall be placed on the axle end face at a distance of 30 mm from the outer periphery. The probe shall be moved throughout periphery keeping probe index towards lathe centre, directing the central beam towards the wheel seat inner fillet as shown in figure 4. The same procedure shall be followed for both ends. During scanning the axle, using the technique explained above, the sensitivity level of ultrasonic flaw detector shall be so adjusted that the signal amplitude of control echo is equal to that of trace pattern echo as shown in Fig 4. The trace pattern obtained from a flawless axle is shown in fig 4 (For both ends).

4.3.4 High Angle scanning:

Wheel Seat Inner Fillet: *This technique may be employed for Confirmation of the findings during near end low angle scanning*.

High angle scanning is carried out from the body of the axle. The time scale shall be calibrated to 50 mm per main scale division for shear wave with the help of 50 mm dia x 182 mm long steel bar (Since 5 x 182 mm = 910 mm longitudinal wave is equivalent to 5 x 100 mm = 500 mm shear wave). A normal probe (S/C) of 2.5 MHz frequency, 20/25 mm dia, fitted with Perspex wedge for 37.5^0 and having dia of curvature 185 to 205 mm shall be placed on the body of the axle with probe index marking at a distance 143 mm from wheel seat inner fillet for both End Sides as shown in figure 5. The probe shall be moved forward and backward longitudinally from the mean position up to 20 mm and entire circumference on the body directing the central beam towards the wheel seat inner fillet as shown in figure 5. During Scanning of the axle using the technique explained above, the sensitivity level of the ultrasonic flaw detector shall be so adjusted that the signal amplitude of the control echo is equal to that of trace pattern echo as shown in Figure 5. The trace pattern obtained from a flawless axle is shown in figure 5 (for both ends).

4.3.5 Scale Expansion: The analysis of trace pattern having closely placed echoes may be simplified by expanding the relevant part of the pattern. This can be done with the scale expansion facility provided in the equipment.

5. Important Note

I. Prior to ultrasonic testing, it may be ensured that the axle end faces are smooth for achieving proper acoustic coupling. If required, the end faces of the axle should be properly smoothened by filing/ emery polishing for achieving proper acoustic coupling.

II. In low angle and high angle scanning the onset of the signal in relation to the initial pulse is a function of the thickness of the Perspex wedge at the probe index marking and the velocity of the ultrasonic wave in the Perspex. If the thickness of the Perspex wedge at the probe index marking is more/less than the one used for the preparation of this code, the onset of the signal is likely to shift slightly towards right/left side of the standard position of the signal.

III. It may be ensured that range calibration is checked weekly (Saved in memory) and sensitivity setting (Gain setting) shall be carried out for each axle during testing by setting height of control Signal.

IV. Various characteristics of the equipment and probes shall be checked as per IS-12666 at least once a month.

V. Sensitivity of the equipment & probe shall be checked on reference axle (with 5 mm saw cut) at least once a month.

6. Important Points

i. In the code of procedure for UST of any axle, only those standards signals are shown which are practically observed during preparation of Code of Procedure. Due to some change in any fillet radius during machining, some additional standard signals may appear or some signals may disappear.

ii. If a signal is appearing while scanning throughout the periphery and in most of the axles that may be a standard signal or coming from press fit. This may be confirmed from theoretical calculation sheet or testing after removing of press fit in case of press fit.

iii. If any signal shows sudden increase in height during movement of the probe through the periphery, the detailed analysis of the signal shall be carried out by using scale expansion of that particular area to confirm merging of flaw signal with standard signal.

iv. During Far End testing some Delayed signals may appear beyond back peak, which are considered non-relevant.

v. It may also be noted that NELA & HA scanning are targeted to scan near end wheel seat / Gear seat inner fillet area and any flaw signal will appear near inner fillet area. Some delayed signals may appear at greater distance from fillet, which are considered non-relevant.

vi. Magnetic Particle Test shall be carried out to confirm the presence of the crack at the defect location.

7. Criteria for acceptance:

(a) Axle found to produce flaw signal other than those standard signals as shown in the relevant trace patterns during scanning by Far End and Near End Low Angle Scanning techniques shall be withdrawn from the service. Further confirmation of the defect may be carried out by Trace Delay or High Angle Scanning Technique as the case may be.

(b) Axle found to produce signals as per the standard signals as given in the Figure No. 2 to 5, should be declared satisfactory.

(c) During service, few standard signals may disappear due to change in the geometrical configuration of the axle. This aspect may be kept in view.

8. Magnetic Particle Testing: Axle found defective during ultrasonic examination described above should be subjected to magnetic particle examination (as per IS:3703 -2004 or latest) after removal of the wheels, bearing etc., as the case may be. Record of magnetic particle examination and observation made shall be maintained in the register.

9. Recording of test details: Ultrasonic personnel conducting the test shall maintained a register indicating the complete details of axle identification, technique employed, observation made, code of procedure followed and his remarks. He should also record his observations on visual examination of the axles. A-scan pattern of the axle obtained during testing shall be saved to memory of the equipment and the same shall be transferred to a computer once the memory of the equipment is exhausted. Considering three holes (CSK holes) are available on probing face, it may be noted that the 12 nos. A- Scan patterns (06 nos. A scan patterns during Far end scanning, 03 nos. from each side and 06 nos. A scan patterns during NELA scanning, 03 nos. from each side) per axle are required to be saved as per the RDSO letter no. M&C/NDT/1/8, dtd. 28.10.2016.

Appendix 1

Theoretical Calculation and relative position of signals for Ultrasonic Testing of Higher carrying capacity Trailer Coach Axle to Drawing no AC/DC EMU/D2-0-2-205 in Service.

(A) FAR END SCANNING:

Calibration: 1 Main Scale Div.= 250 mm (compression wave)

Probe: Normal probe, 20 / 25 mm Dia., frequency 2 / 2.5 MHz, Single Crystal

From both ends:

S. No.	DETAILS	DISTANCE (mm)	SIGNAL(div.)
1.	Direct Reflection from axle end	2362	9.5
2.	Delayed Reflection from Journal fillet	2342	9.4
3.	Delayed Reflection from Wheel seat outer fillet	2289	9.2
4.	Direct Reflection from Journal fillet	2201	8.8
5.	Direct Reflection from Wheel seat outer fillet	2113	8.5
6.	Delayed Reflection from Wheel seat inner fillet	766	3.1
7.	Delayed Reflection from Wheel seat inner fillet	617	2.5
8.	Direct Reflection from Wheel seat inner fillet	434	1.7
9.	Delayed reflection from grooved fillet at Journal	375	1.5
10.	Delayed reflection from grooved fillet at Journal	263	1.1
11.	Direct Reflection from groove at journal	125	0.5

Note: - *The above Signals are theoretical calculations only; some of these signals may not appear during UST.*

(B) NEAR END LOW ANGLE SCANNING (Wheel Seat inner fillet):

Calibration: 1 Main Scale Div. = 100 mm (Compression wave)

Probe: Normal Probe, Single Crystal, 20/25 mm. dia, frequency 2.5 MHz, Perspex wedge for angle 17.5°

For both ends:

S.No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1.	Direct reflection from Wheel seat inner fillet, probe position on axle end face at a distance of 30 mm from axle end face, probe angle 17.5°	455	4.6*

(C) HIGH ANGLE SCANNING: (Wheel Seat inner fillet & Journal fillet):

Calibration: 1 Main Scale Div. =50 mm (Shear wave)

Probe: Normal Probe, Single Crystal, 20/25 mm. Dia, frequency 2.5 MHz, Perspex wedge for angle 37.5° with dia. of curvature 185 mm to 205 mm (inner fillet).

For both ends:

S.No.	DETAILS	DISTANCE (mm)	SIGNAL (div.)
1	Direct reflection from wheel seat inner fillet.(Probe angle 37.5°, diameter of curvature 185 to 205 mm, standoff distance 143 mm from Wheel seat inner fillet on axle body).	234	4.7*

** Signals may shift slightly from theoretical position due to Perspex Correction.*

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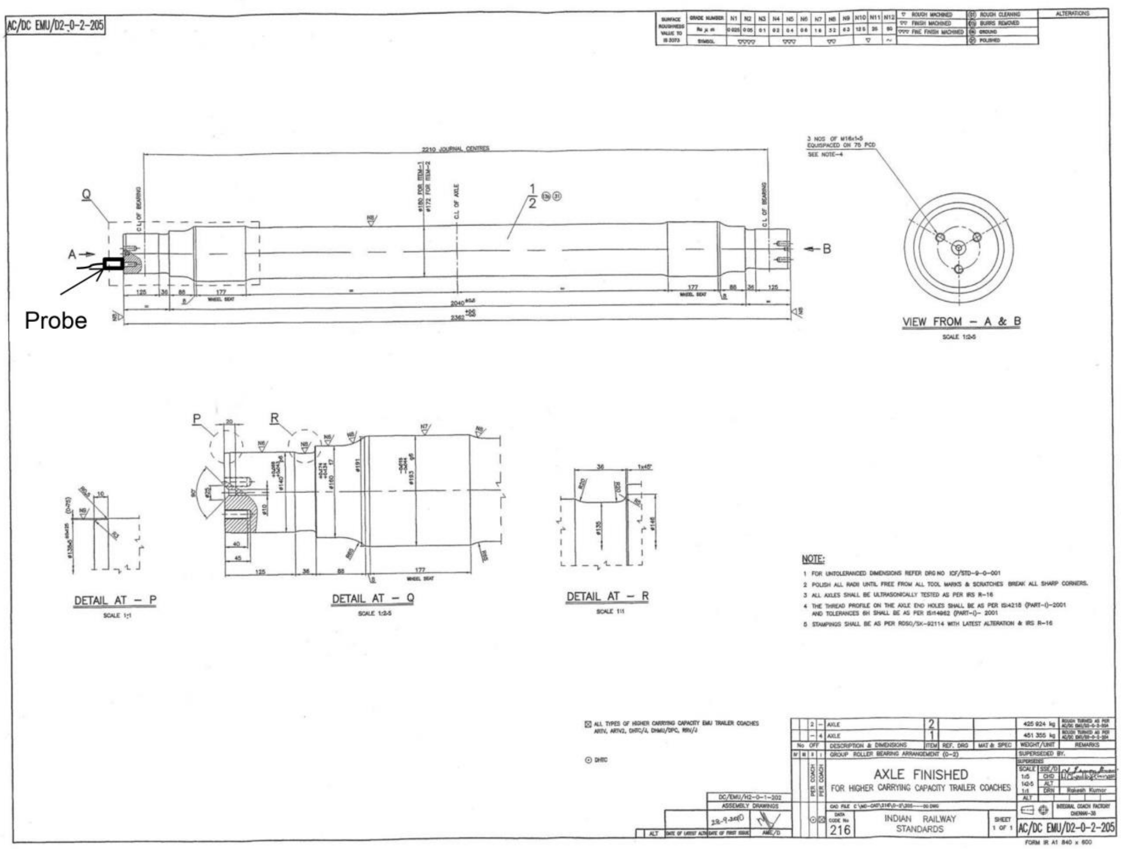
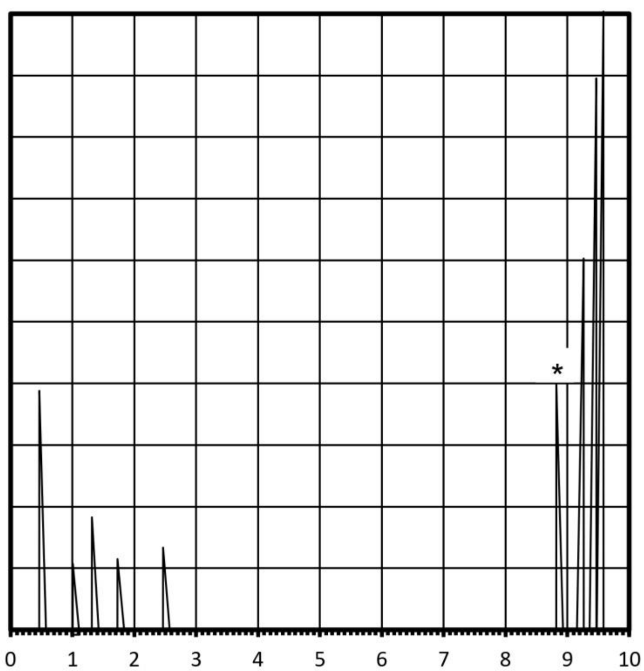


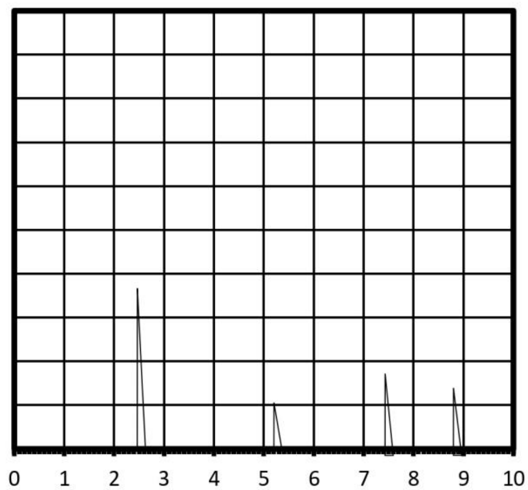
Fig 1 Sketch of Ultrasonic Testing of Higher carrying capacity Trailer Coach Axle to Drawing no. AC/DC EMU/D2-0- 2-205 in Service



9.5 Div: - Direct reflection from axle end.
9.4 Div: - Delayed reflection from Journal fillet.
9.2 Div: - Delayed reflection from wheel seat outer fillet.
*8.8 Div: - Direct reflection from Journal fillet.
2.5 Div: - Delayed Reflection from wheel seat inner fillet.
1.7 Div: - Direct reflection from wheel seat inner fillet.
1.5 Div:- Delayed reflection from grooved fillet at Journal.
1.1 Div: - Delayed reflection from grooved fillet at Journal.
0.5 Div: - Direct reflection from groove at Journal.

Fig. 2 – Far End Scan Trace Pattern for Both Ends.

* - Control Signal



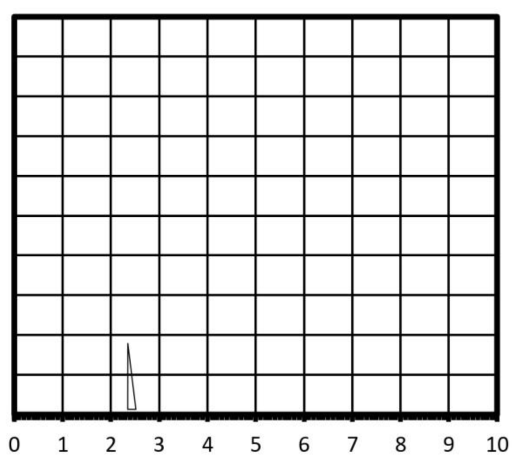
0 – 500 MM OF THE AXLE

8.7 Div: - Direct reflection from wheel seat inner fillet.

7.5 Div:- Delayed reflection from grooved fillet at Journal

5.3 Div: - Delayed reflection from grooved fillet at Journal

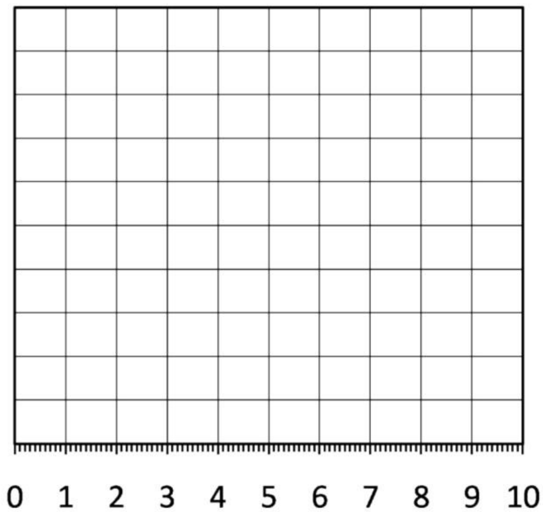
2.5 Div: - Direct reflection from groove at Journal.



500 -1000 MM OF THE AXLE

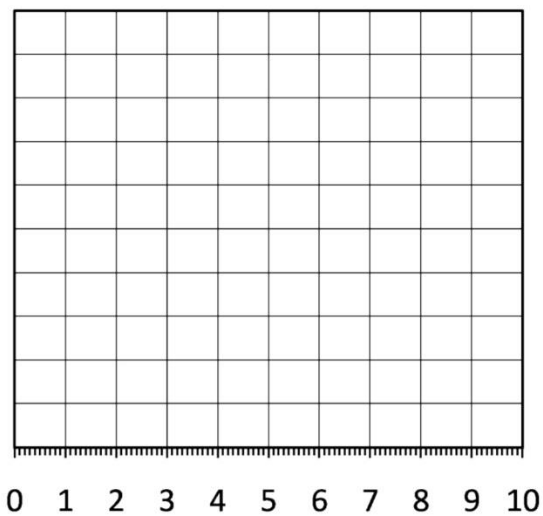
2.5 Div: - Delayed Reflection from wheel seat inner fillet

Fig. 3A Trace Delay Pattern for both ends for Range 0-500 and 500-1000 mm.



1000 -1500 MM OF THE AXLE

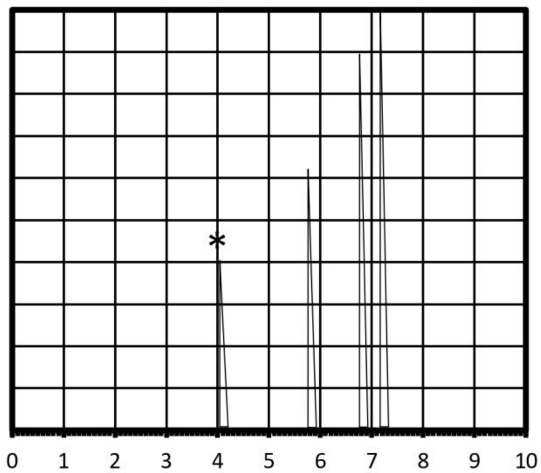
NIL



1500 -2000 MM OF THE AXLE

NIL

Fig. 3B Trace Delay Pattern for both ends for Range 1000 -1500 and 1500-2000 mm.



7.2 Div: - Direct reflection from axle end.

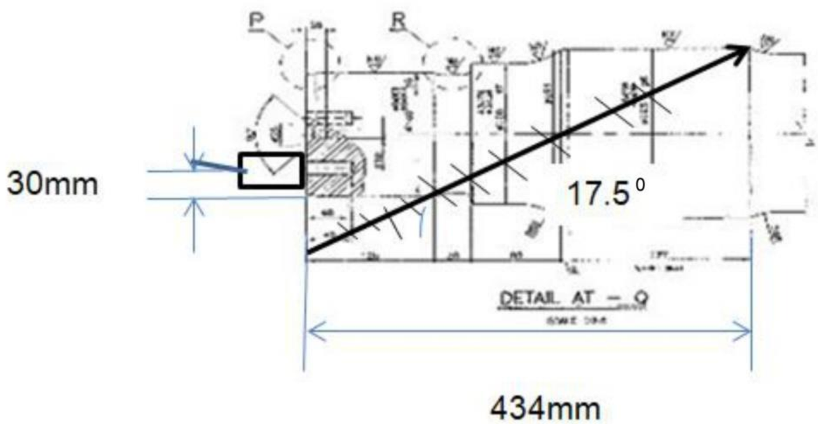
6.8 Div: - Delayed reflection from Journal fillet.

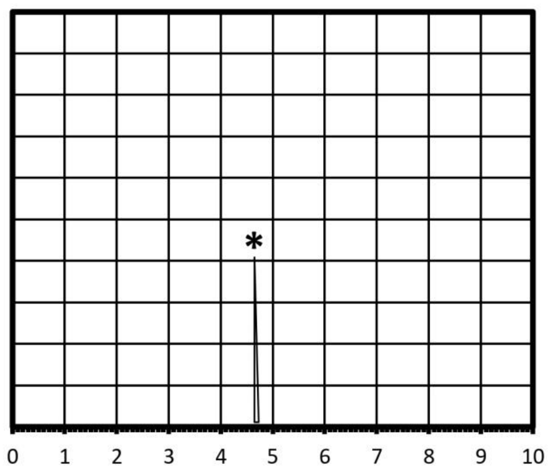
5.8 Div: - Delayed reflection from wheel seat outer fillet.

*4.0 Div: - Direct reflection from Journal fillet.

FIG.3C Trace Delay Pattern for both ends for Range 2000-2500 mm of the Axle

* - Control Signal

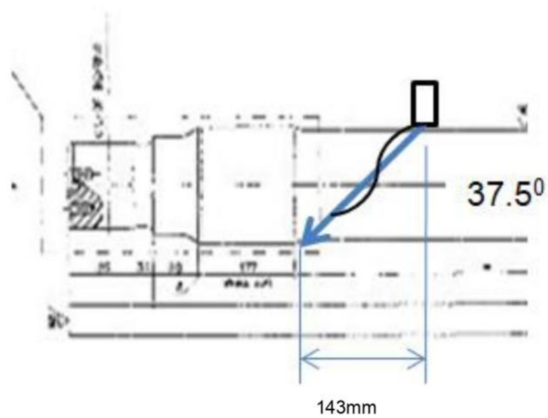


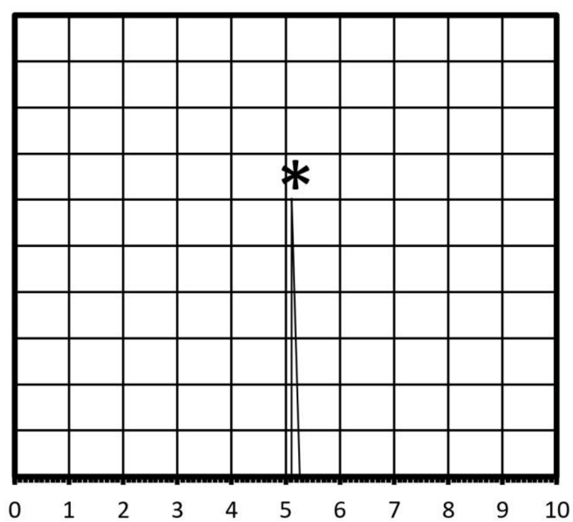


4.7 Div: - Direct reflection from Wheel seat inner fillet, probe position on axle end face at a distance of 30 mm from axle end face, probe angle 17.5°.

***Control Signal (May shift slightly due to Perspex correction)**

FIG. 4: Near End Low Angle Scan Trace Pattern of wheel seat inner fillet (For both ends)



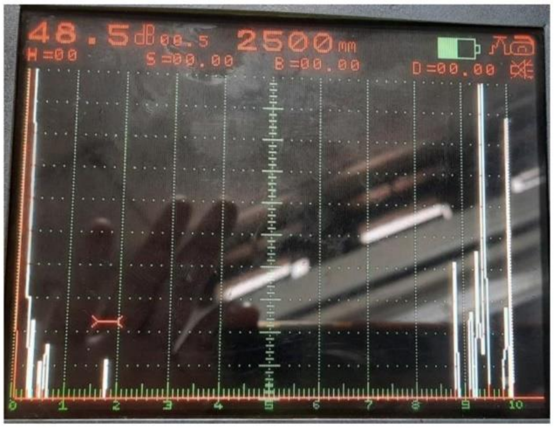


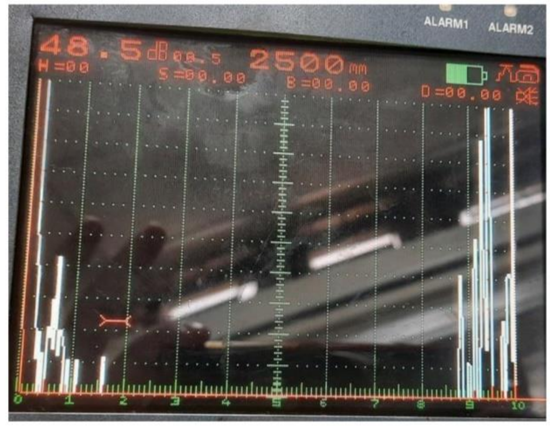
5.1 Div - Direct reflection from wheel seat inner fillet.(Probe angle 37.5°, diameter of curvature 185 to 205 mm, standoff distance 143 mm from Wheel seat inner fillet on axle body).

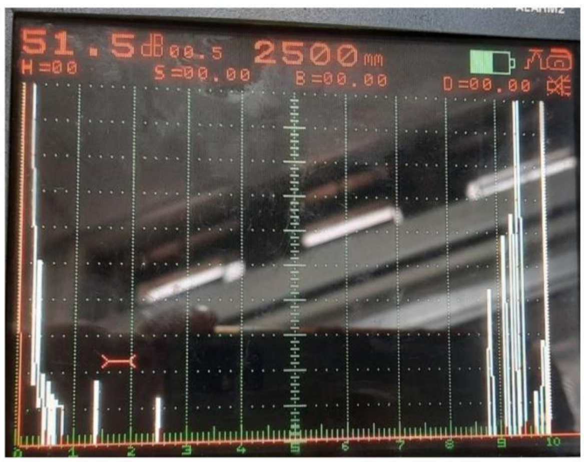
***Control Signal (May shift slightly due to Perspex correction)**

FIG. 5: High Angle Scan Trace Pattern of wheel seat inner fillet (For both ends)

Some Important A-Scan Images Taken during Data collection:



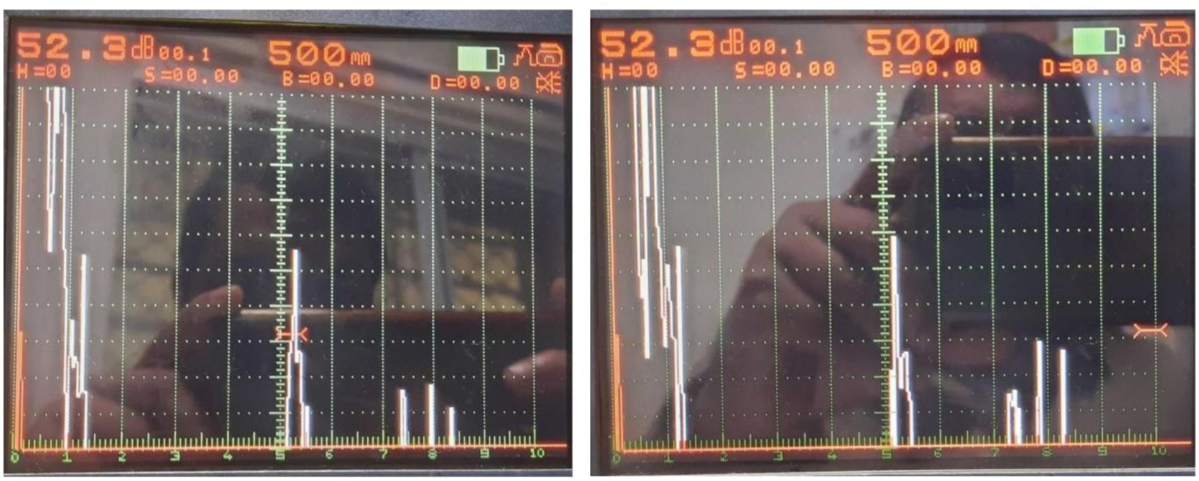




Far End Scanning for Both Ends

NELA 17.5^0 Wheel Seat (Both Ends)

In some Cases, Axle with cast wheel, bunch of signals observed before control signal (NELA Scanning)



High Angle Scanning (37.5^0) of wheel seat Inner fillet.