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ERL MAINTENANCE SUPPORT SDN BHD

(Company No. 498574-T)

E-MAS

Your Railway Operations & Maintenance Specialist

ROLLING STOCK DEPARTMENT

IN-HOUSE TECHNICAL INSTRUCTION

MANAGEMENT OF NON-DESTRUCTIVE TEST (NDT)

Doc. No. R00.OMR.M91121.QP.1001.A

Certified to ISO 9001 : 2008
Cert. No. AR 2874

Release

	Name	Dept./Position	Date	Signature
Released:	Ham Mow Wai	MTN Manager	20/4/10	
Checked:	Barry Gardner	BND	20/4/10	
Checked:	Mohamad	RST QMR	14.04.10	
Author:	Mohd Jamil	RST HoD	14.04.10	

Amendments or additions to this procedure must be indicated with a vertical black line in the adjacent left margin.

Change Record and Configuration Control

Revision	Date	Modification	Name
A	14.04.10	New – This document superceded the existing procedure, docs. ref. R00.OMR.M83300.QP.0001.B. Revision also has been done on 3.1.3 – Reassessment, 3.4 – Application of NDT, 3.5 – Records & Appendix 2 – Ultrasonic Test of Hollow Axle Procedure.	Mohd Jamil

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1 Purpose

Non-Destructive Test (NDT) operators, particularly the Ultrasonic (UT) Testers employed by E-MAS have a strict regime of rules to comply with to ensure that they retain the certification necessary under various National & International standards.

2 Scope

All staff in E-MAS who is responsible for the supervision or management of any person engaged in the NDT of any component/item. This procedure is accessible to all RST personnel via E-MAS Documentation Management System or RST Portal [http://express50/E-MAS_Portal/RST.html].

3 NDT Process

The NDT inspection is carried out in compliance with the requirement of Maintenance Manual for Power and Trailer Wheelsets Diameter 850 DESIRO ET 425 ET [R00_RSE_91121_XR_3011_D_MM_trailer wheelset (c.22_055_5iss_engl)].

3.1 Training & Certification

All operators shall be trained and certificated in accordance with European standard for certification of NDT personnel, EN 473.

3.1.1 Level 1

Level 1 personnel are qualified to carry out NDT operations according to written instructions under the supervision of Level 2 or Level 3 personnel.

3.1.2 Level 2

Level 2 personnel have demonstrated competence to perform & supervise NDT. The Level 2 personnel will be authorised to perform the following within the scope of their qualification.

a. Set up & verify equipment setting
b. Perform & supervise tests
c. Interpret & evaluate results
d. Prepare written NDT instructions
e. Manage the calibration of equipment

3.1.3 Reassessment

All operators shall be reassessed at every 5 years interval with a provision that the department has a certified and competent Level 2 UT inspector within the organization. The Level 2 UT inspector shall be someone that is familiar with EN473 and has been certified by DGZfP or any other recognized NDT institute that could demonstrate satisfactory familiarization with EN473.

3.1.4 Training Management

The NDT training management shall be carried out in accordance with RST Training Management Procedure, [R00.OMR.M12990.BT.0005.*].

3.2 Written NDT Procedures

NDT procedures can only be prepared by personnel who are qualified to at least Level 2 as defined in EN 473.

3.3 Work Experience

The UT trained personnel shall be required to have minimum work experience of 40 hours in each 4-week period. However if their work uses semi-automatic techniques where the operator is not required to interpret results the minimum is 10 hours in each 4-week period.

The UT trained personnel shall be required to maintain experience in the Magnetic Particle Inspection (MPI) and Liquid Dye Penetrant (LDP methods).

3.4 Application of NDT

The NDT inspection shall be carried out in accordance with the written NDT procedures as follows:

a. Ultrasonic Test Of Hollow Axles Procedure, [R00.SUP.M91121.PF.1001.B]. Refer to appendix 2.

b. NDT Inspection On Scratch Axle (55° ABP & MPI), [R00.SUP.M91121.PF.1002.A]. Refer to appendix 3.

The UT 55° and MPI will only apply whenever the scratched axle (inner ring seating) is machined to 118mm. Once the scratched axle is repaired and UT 55° and MPI were performed, the next NDT inspection would due in the next 300,000km and inspection with UT 45°.
In case of an indication of an intensity > +6dB above sound noise level, the indication shall be checked with the 70° angle probe.

3.4.1 NDT before wheel fitting

There is no NDT inspection is required before the wheel fitting take place. The NDT inspection interval mentioned in section 3.4 will apply.

* Refer to the most recent version.

3.5 Records

The NDT checklist is available in RST Scheduled Maintenance Checklist, [R00.OMR.M14100.PT.0002.*]. Refer to Appendix 2.a, 3.a and 3.b.

The NDT UT Level 2 personnel shall be responsible to keep auditable checklist records to demonstrate compliance with section 3. The responsible supervisor shall check and sign the checklist record after every work done in order to confirm that all the criteria has been satisfied.

3.5.1 Record Audit

All NDT checklist records shall be audited annually, or more often as determined by the RST HoD. The audit shall look at times spent testing, the records axles tested, the follow up actions as recommended by the tester.

3.5.2 NDT Test Results

The results of the tests of all axles shall be examined. Currently the periodicity of NDT inspection of axles is at 300,000 km as recommended by the manufacturer of the axles as per Manual ref no: R00_RSE_91121_XR_3011_D.
However, if a defect is found and could not be removed, the NDT inspection interval as Table 1 below will apply.

Defect echo	Action
≤19%	Next inspection 300,000km ±10%
20% ~ 29%	Next inspection 75,000km ±10%
30% ~ 39%	Next inspection 75,000km ±10%
≥40%	The wheelset shall be taken out of from service immediately

Table 1 – NDT Inspection Interval

The RST HoD shall determine whether the inspection frequency of all axles shall remain as recommended or shall be changed. This decision will be based on the analysis of all Ultrasonic Axle Tests performed in the previous 3 years.

Each decision to increase the interval between testing shall never be more than 100% of the original manufacturers recommendation, which was set at 150,000km#. Furthermore, advice from a level 3-testing organization (example SIRIM) shall be sought.

* Refer to the most recent version.
# Refer to Maintenance Manual for Power and Trailer Wheelsets Diameter 850 DESIRO ET 425 ET [R00_RSE_91121_XR_3011_D_MM_trailer wheelset (c.22_055_5iss_engl)].

4 Appendices

Appendix 1 - E-mail: Management of NDT from Mr. Holstein Ralf [mailto:ho@dgzfp.de] [R00.TRD.M90000.CZ.1001.A]

Appendix 2 - Ultrasonic Test Of Hollow Axles Procedure, [R00.SUP.M91121.PF.1001.B]

Appendix 2.a - Examination Report for Axle with Longitudinal Drillings 45°/70° ABP [R00.OMR.M14100.PT.0002.D]

Appendix 3 - NDT Inspection On Scratch Axle (55° ABP & MPI) [R00.SUP.M91121.PF.1002.A]

Appendix 3.a - Examination report for axle journals for longitudinal discontinuities [R00.OMR.M14100.PT.0002.D]

Appendix 3.b - Examination report for Magnetic Particle Testing (MPI) [R00.OMR.M14100.PT.0002.D]

MohamadJ@EMS

Subject: Management of NDT

-----Original Message-----
From: Holstein Ralf [mailto:ho@dgzfp.de]
Sent: Friday, April 24, 2009 8:47 PM
To: MdJamil@EMS
Cc: Baake@EMS
Subject: Management of NDT

Dear Sir,
during your stay in Berlin, we discussed your procedure "Management of Non-destructive Testing Operators" Rev A 6 Nov. 2002.

Under 3.4. "Reassessment" there is a period of 2 years defined. From our point of view, according to the practice of UIC and EN 473 a period of 5 years for reassessment would be sufficient.

with best regards
Ralf Holstein
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ERL Kuala Lumpur

MAINTENANCE SUPPORT

Rolling Stock Maintenance

NDT Recommendation by DGZfP, 2002
Fred Sondermann
Second Reading by Barry, 2006, E-MAS

ERL, Kuala Lumpur, Malaysia

Revision 3 / 2010
By W.S. Werkstoff Service GmbH on behalf of DGZfP
Dr. Martin Gumbiowski

ERL, Kuala Lumpur, Malaysia

Recommendation for the ultrasonic test of hollow bored axles (with longitudinal drilling)

General

This manual shall be used for the ultrasonic test for hollow bored axles as fitted to ERL/CRS and BTS trains during the maintenance of rolling stock. The aim is it to detect possible transversal defects (flaw or also transversal crack).
The possible reasons for these flaw / defects/ cracks are due to the operating load or external damage. The whole surface of the axle can contain defects, but special areas prone to defects are the transition radius of diameters, the press fits of the wheels, the press fits of the brake disks and the power train.

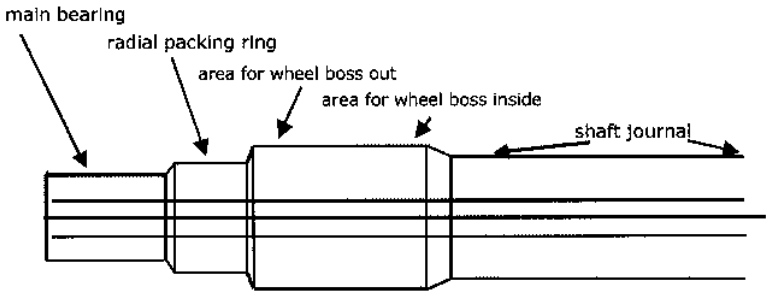


Fig. 1 terms of axle area (running axle)

Sections to be scanned
The ultrasonic test has to be carried out at the total length of the axle. The testing is carried out from the longitudinal drilling with purpose-made angle beam probes.

Qualification of the tester

Only employees who have passed an ultrasonic examination and a specific training are allowed to carry out this ultrasonic test.

Test equipment (for this manual ultrasound testing)

Ultrasound apparatus
angle beam probe for internal testing $\alpha = 45°$, f = 2 MHz or 4 MHz, hollow bore $\varnothing \geq 40$ mm
angle beam probe for internal testing $\alpha = 70°$, f = 4 MHz; hollow bore $\varnothing \geq 40$ mm
angle beam probe for internal testing $\alpha = 45°$, f = 4 MHz, hollow bore $\varnothing < 40$ mm
test cable

Test accessories

For the length calibration: calibration blocks K1; K2;
or one piece of steel with the shape of a half circle r = 50 mm
For the coupling either oil (e.g. gear oil SAE W80-90) or a mixture of oil and lubricating grease can be used

Important Notes

The correct mixture of oil and lubricating grease is important. If the mixture is too viscous, the sound pressure is damped. If the mixture is too fluid, then it can result in an irregular coupling.
The test surface is the surface of the drilling. This drilling has to be free of water, dirt and any other solid particles.

The visual testing is a good method to detect the quality of the drilling's surface before the ultrasound testing.
Clean the drilling before checking the axle.
The surface roughness should be less than $R_a < 12{,}5\mu m$, already checked by manufacturer before first UT-test
If the drilling is not cylindrical it can lead to an imprecise coupling. This could result that not all areas are being checked.

Distance adjustment

The time base range s_B = 0-150 mm, Tw, steel, valid to 45°beam probes.
The time base range s_B = 0-250 mm, Tw, steel, valid to 70°beam probes.

Calibration block K1; calibration length s_J = 100mm

s_J [mm]	T [div]	Echo designation
100	4,0	F
200	8,0	F_2

Calibration block K 2; calibration length s_J = 25mm

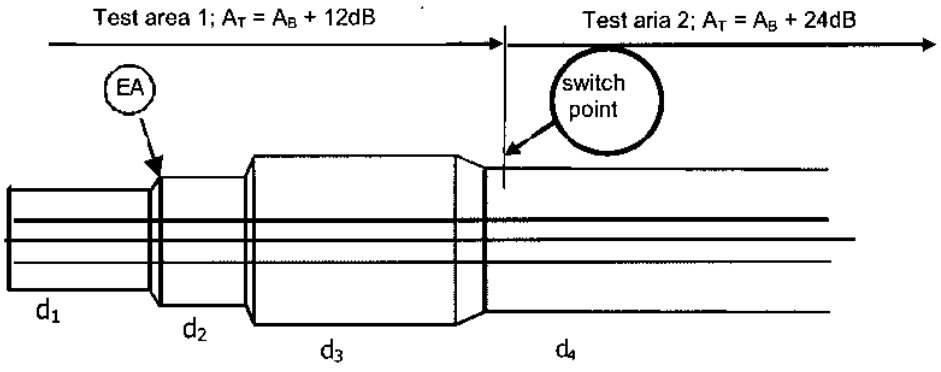
s_J [mm]	T [div]	Echo designation
25	1,0	F
100	4,0	F_2
175	7.0	F_3
250	10,0	F_4

Piece of steel with the shape of a half circle r = 50mm; calibration length s_J = 50mm

s_J [mm]	T [div]	Echo designation
50	2,0	F
150	6,0	F_2
250	10,0	F_3

The time base control has to be carried out at the point "EA". This sound path is dependent on the type of the axle. See the sketches in the appendix.

Sensitive calibration
The sensitive calibration has to be carried out on every single axle. The calibration reflector is marked with "EA" in the sketch (picture 2). There is a danger of mixing up the two radii (radius of diameter 1 with diameter 2.The reflector for sensitive calibration is the edge of
diameter 2 (look at picture 2).



Picture 2 the calibration reflector for the sensitive calibration

Adjustment of the test sensitivity

The echo of the edge has to be adjusted to 40% of the screen height. The indicated number of amplification has to be written down in the test report. This number is the basic of amplification A_B [dB], the amplification for testing has to be calculated like this: $A_T = A_B + \Delta A$. ΔA is a symbol for the additional amplification.

Test area 1
The main bearing, the radial packing ring and the area for wheel boss have to be tested with the following test sensitivity:
Formula for calculation: $A_T = A_B + 12dB$

Test area 2
The shaft has to be tested with the following test sensitivity:
The point where the area for wheel boss changes into the shaft journal is called the switch point (or change-over point).
Formula for calculation: $A_T = A_B + 24dB$

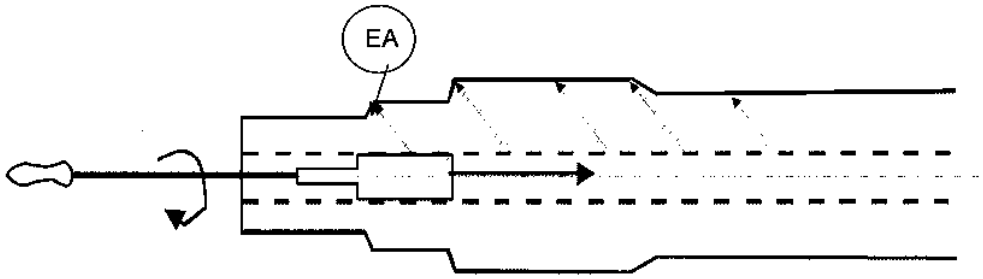
The instruction is valid for angle beam probes 45° (RT, ±0.6°per 10℃) and also 70°(RT, ±1.5°per 10 ℃)

Important Note
If you don't see a signal from the edge of adjustment then you have to search for the cause. In case of no signal, it is prohibited to use the axle. In case you cannot find a signal you have to scrap the axle.
The number of the signal-to-noise ratio should be to < 12 dB.

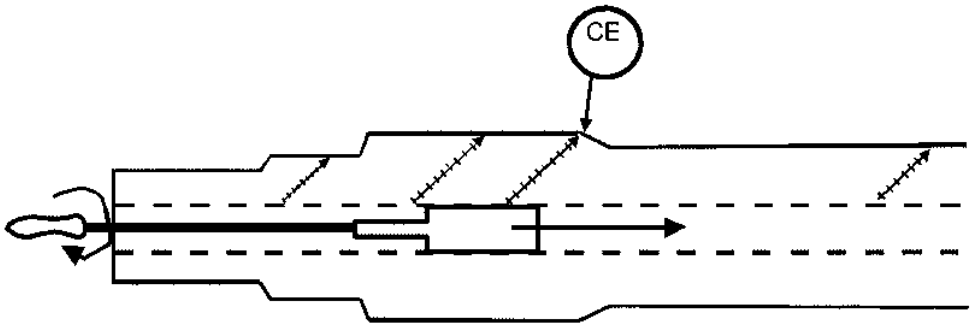
Carrying out of the ultrasonic test

Basics
The incidence has to be carried out into two directions from the surface of the drilling:
Incidence direction to the out side
Incidence direction to the middle of the axle
The incidence directions are to be carried out with all the beam probes.
The beam probes are coupled at the drilling surface. They have to be slowly rotated with a maximum rate of traverse of 5 mm per rotation.

Incidence direction to the outside (main bearing)



Incidence direction to the middle of the axle (shaft journal)



The contour echo (CE) has to be seen at the incidence direction to the middle of the axle. The data have to be written down in the test report. At different incidence angles it is likely to get different echo heights.
That is a normal phenomenon. It is important to see the contour echo signal at the whole circumference (= 360°).

Special feature of the incidence with angle probe 70°
In case of an indication of an intensity **> +6 dB** above sound noise level, the indication is to be re-checked with the angle beam 70°.
All echo signals which don't result from edges or contours, can be caused by a crack. In this case you must carry out a control testing with incidence angle 70°.
The data from the echo signal with greater amplitude **than 20%** have to be recorded on the test report.

Echo signals which do not result from flaws, contours or edges
(defects, cracks)
Any indication can have several causes. You should search for the cause of the indication before you scrap the axle.
Indications can have the following reasons:

- flaws within the material (pores or slag)
- flaws at the colour coat
- flaws resulting from the thermal spraying coating of molybdenum
- damages in the open surface of the shaft journal resulting from stones or other external objects
- water- and/or oil drops on the surface
- indications from the outer edge of the wheel boss
- sharp-edge of the oil injection groove of the wheel
- the high pressure between the wheel & the axle can result in increase of the density. This might result in unexpected echos.
- change of transversal waves into surface waves (phenomenon in the area of the wheel boss inside to the shaft journal)

The evaluation of the indications (inadmissible Indications)
The following indications are inadmissible:
Axle without wheel and with new thermal coating (Mo-layer on the wheel seat)
echo height >10%
Axle with wheel and with new thermal coating (Mo-layer on the wheel seat)
echo height >20%
Axle with wheel and old thermal coating
echo height >30%
Everywhere and in all conditions **except** those places where an echo of greater than 40% is by from edges or other known possible reflectors.
echo height >40%

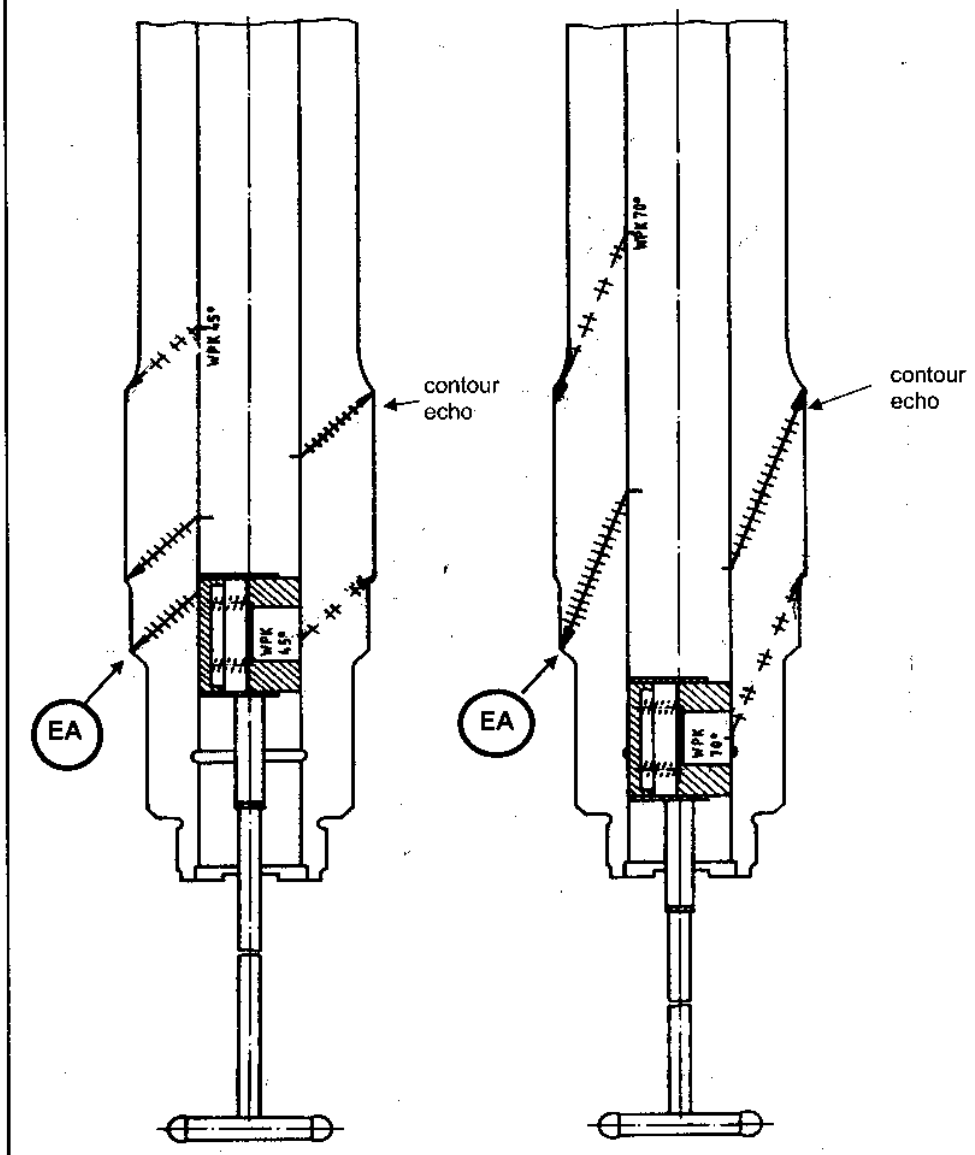
Undefined roots of indications
If the indication of the echo signals is not clear or cannot be explained or is in excess of the 40%, the wheel set has to be removed from the rolling stock.
Visual test, magnetic particle testing are methods that can help to clarify possible reasons.

The test report

The form "Ultrasonic test report", given on page No. 7 of this procedure is to be used for each test of each axle.
The contents of the test report are the

- data of adjustment,
- the data of the contour echo (form echo)
- all data from indications that are not from edges or other known possible reflectors. **All indications with an echo height ≥ 20% SCH and < 40% have to be recorded on this Ultrasonic test report..**

1.1.1.1 Principle of the Ultrasonic test of axles with longitudinal drilling



Ultrasonic test report			Number of the test report:								
Tester name. Department:	**Staff no.**	**Date of the test:**	**Number of the rolling stock:** Gearbox number **Number of the axle:**				**Position of installation of the axle:**				**axle side A** ☐ **axle side B** ☐
Day of the last ultrasonic test: Number of this test report:	Test during regular Routine maintenance ☐ Other causes for a test ☐		Train kilometres: Notes:				**Test equipment:** Type of the ultrasound apparatus: number: Number of the beam probes: 1. (for 45°) 2. (for 70°) calibration block:				
Incidence angle 45 ° s_B = 0-150 mm, Tw, steel	**incidence towards outside**						**incidence towards the middle of the axle**				
	adjust-ment echo	**description of the reflector** ↖					**Contour-echo**	**description of the reflector** ↗			
echo position T [div]											
sound path s [mm]											
Echo height [%]	**40**										
amplification basic A_B [dB]											
amplification addition ΔA [dB]	**12/24**						**12/24**				
test amplification A_T [dB]											
projection distance p_D [mm]											
length measurement L_M [mm]											
reflector position $R_P = L_M \pm p_D$ [mm]											
dimension of circumference [°]											
Notes to the test:											
Incidence angle 70° s_B = 0-250 mm, Tw, steel	**incidence towards outside**						**Incidence towards middle of the axle**				
	adjust-ment echo	**description of the reflector**					**contour-echo**	**description of the reflector**			
echo position T [div]											
Sound path s [mm]											
echo height [%]	**40**										
amplification basic A_B [dB]											
amplification addition ΔA [dB]	**12/24**						**12/24**				
test amplification A_T [dB]											
projection distance p_D [mm]											
length measurement L_M [mm]											
reflector position $R_P = L_M \pm p_D$ [mm]											
dimension of circumference [°]											
Final Assessment	**Axle is**	**ready for use**		**not ready for use**			**Note:**				
Signature of the tester:											

NDT Recommendation by DGZfP, Revision 3, 2010

Note

This recommendation was written by

Level 3 instructor Dipl. Ing. Fred Sondermann,
Deutsche Gesellschaft für Zerstörungsfreie Prüfung e.V. certificate No. K-002-24347,

at the end of the NDT training session in 2002.
The text amendments were done by myself for the purpose of English Correction or clarification.
The technical content was unchanged

This recommendation was incorporated into the
Management of Non-destructive Testing (NDT) Operators
R00.OMR.M83300.QP.0001.A
Docs #14969

Barry Gardner
26th July 2006

This recommendation was revised
Rev. 1, March 2009
Rev. 2, Aug. 2009
Rev. 3, March 2010
Level 3 instructor Dr. Martin Gumbiowski
W.S. Werkstoff Service GmbH, Essen
Certificate No. R-104-29259

Rolling Stock Maintenance Department

Examination Report for Axle with Longitudinal Drilling 45°/70° ABP

2nd T4

E-MAS
Your Railway Operations & Maintenance Specialist

Train no.: _____ **Axle No.:** _____ **Train Mileage :** _____ **KM** **Date of Test :** _____

Work Order No. : _____ **Axle S/N :** _____ **Gearbox S/N :** _____

UT Test Equipment : Flaw Detector, USM 25 **Calibration Block :** _____ **Bogie S/N :** _____

Reason for Test : ☐ **Scheduled Maintenance** ☐ **Others (Please specify):**.....

Reference Procedure : Management of Non-Destructive Testing (NDT) Operators, R00.OMR.M83300.QP.0001*

☐ **Incidence 45°** (s_B = 0-150 mm, Tw, steel) ☐ **Incidence 70°** (s_B = 0-250 mm, Tw, steel)	**Current Report No. :**					**Previous Report No. :**				
	Adjustment	**Description of the Reflector**				**Contour-Echo**	**Description of the Reflector**			
Echo position T [div]										
Sound path s [mm]										
Echo height [%]	40									
Amplification basic A_B [dB]										
Amplification addition ΔA [dB]	12					12				
Test amplification A_T [dB]										
Projection distance p_D [mm]										
length measurement L_M [mm]										
Reflector position $R_P = L_M \pm p_D$ [mm]										
Dimension of circumference [°]										

☐ **Incidence 45°** (s_B = 0-150 mm, Tw, steel) ☐ **Incidence 70°** (s_B = 0-250 mm, Tw, steel)	**Current Report No. :**					**Previous Report No. :**				
	Adjustment	**Description of the Reflector**				**Contour-Echo**	**Description of the Reflector**			
Echo position T [div]										
Sound path s [mm]										
Echo height [%]	40									
Amplification basic A_B [dB]										
amplification addition ΔA [dB]	12					12				
Test amplification A_T [dB]										
projection distance p_D [mm]										
Length measurement L_M [mm]										
reflector position $R_P = L_M \pm p_D$ [mm]										
Dimension of circumference [°]										

Final Assessment on the Axle : ☐ **Axle is serviceable for use.** ☐ **Axle is not serviceable for use.**

Other Remarks: .....

Tester:

Stamp

Signature:.....

Note:
All the parts removed/dismantle for carry out this inspection have been refitted/installed in accordance with the relevant manual and fit for service.

☐ **Yes** ☐ **No** ☐ **Not Applicable**

Stamp Stamp

Aknowledged Supervisor:

Stamp :.....

Date :.....

DGZfP
AUSBILDUNG UND
TRAINING GMBH

NDT Inspection Procedure

NDT Inspection On Scratch Axle (55° ABP & MPI)

DOC No. R00.SUP.M91121.PF.1002.A

Prepared by:

Wolf-Dieter Janke
Level 3 Instructor Dipl. Ing.
Lecturer of German Society of Non-Destructive Testing,
Certificate No. 22165

1 Introduction

NDT inspection is carried out on all train axles in order to ensure a safe train operation. NDT inspection on scratch axle is an additional inspection carried out in order to check the crack growth on every scratched axle.

There are two methods NDT inspection on scratch axle are implemented, they are:

a. **Testing of axle journals for longitudinal discontinuities (55° ABP)**
Initially, all trains shall receive this inspection to determine the scratches. The scratch axle will remain in service, unless the next scheduled inspection reveals crack growth from the scratches.

b. **Magnetic Particle Inspection (MPI)**
This inspection is carried out always after renewal (machined) of wheel seat surface and/or journal end of the axle.

2 Testing of axle journals for longitudinal discontinuities (55° ABP) Procedure

This procedure is written by Level 3 instructor, Wolf-Dieter Janke, Dipl. Ing. lecturer of German Society of Non-Destructive Testing, certificate No. 22165.
The inspection is using Angle Beam Probe 55° and should carry out the testing on the end of axle journals.

2.1 Preparation for examination of the axle end

2.1.1 Identification of the test piece

a. Checking or establishing of the Identification of the test piece, specific number.
b. Definition of the areas to be inspected and identification of the axle ends (N and NN side).
c. Establishing a reference system with reference points and details of the co-ordinate system.

2.1.2 General visual inspection

Inspection and recording of

a. The whole wheel set for general appearance and cleanliness and accessibility.
b. The outer surfaces of the axle end for noticeable features like scratches, cracks, etc.
c. The inner surface of the longitudinal drilling (scanning surface) must be free from foreign matter likely to interfere with the probe coupling or any other discontinuities.

2.2 Range and sensitivity setting

Setting of the Ultrasonic test unit for the 55° ABP (Angle of incidence: 55°)

2.2.1 Distance Setting

Range of setting: s_B: 70 mm (100 mm)

For setting and the control (check) of the setting should be performed each on different reflectors, e.g.:

a. One of the four boltholes Ø 18 mm placed in a circumference Ø 90 mm in the plain area (using surface without thread). The sonic distance is s= 18 mm
b. A rectangular notch on the outer surface of the journal test piece with a sonic distance of 42 mm (6 div)

2.2.2 Sensitivity Setting

For sensitivity setting the echo of the borehole Ø 18 mm (s= 18 mm) is set to 40% SH, the reference level is read as the amplification of the gain setting on the equipment (A_0)
Note: probe should be close to the end of the axle to generate the echo on the cylindrical hole and not on the thread (double echo)

For the evaluation and description of indications during testing the evaluation level A_E is applicable, it requires an additional amplification (ΔA= 18 dB).

$$A_E = A_o + \Delta A$$

Where;
A_E: evaluation level or evaluation gain
A_0: reference level
ΔA: additional amplification

2.3 Testing

2.3.1 Aids for location and interpretation of indications

Drawings with the probe positions and sound paths to scale prepared before testing are indispensable to understand and interpret the different patterns of ultrasonic response appearing during testing.

Marks on the screen indicating the expected position of the geometrical indications and those of defects should be used as well as aids for interpretation of the findings, see Figure 1.

The templates (Figure 1.1 and 1.2) showing the direction of the sound path in the axle for different probe positions indicating the locus of impingement on the outer surface can help to ease the interpretation of the indications.

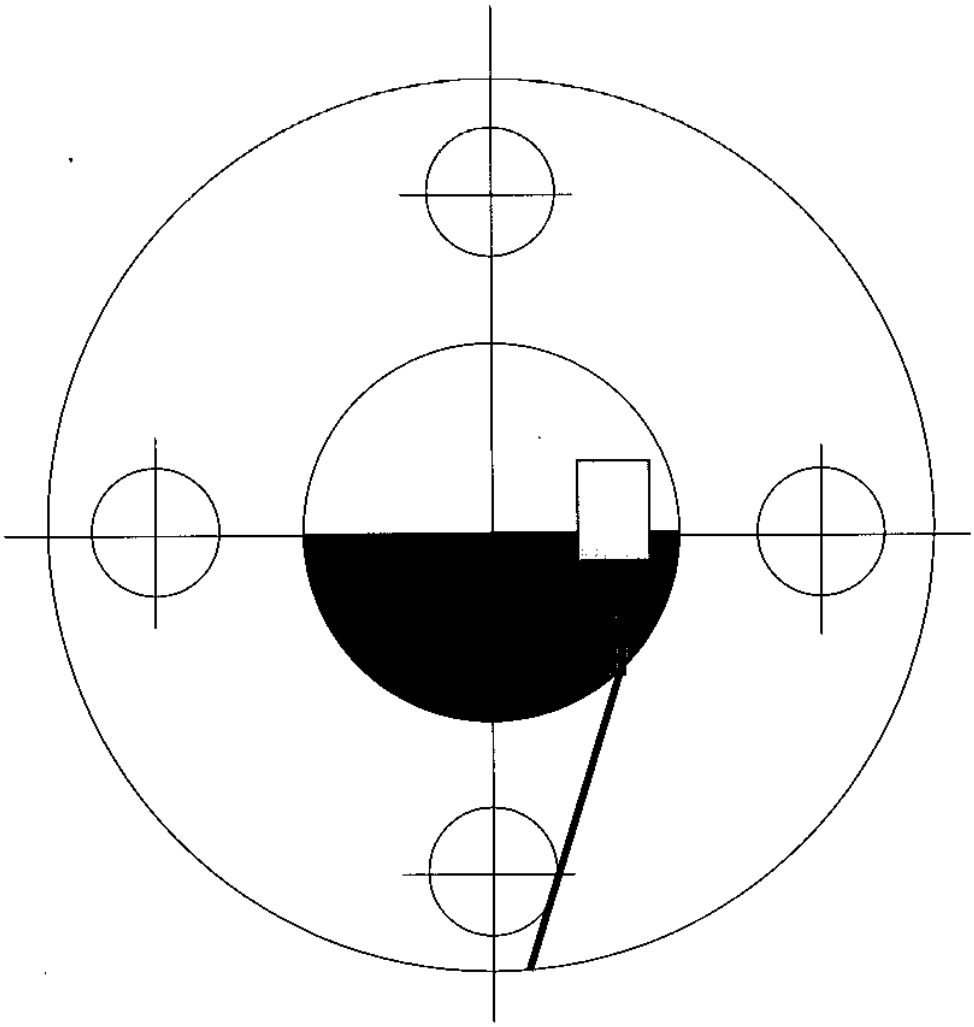


Figure 1: Example for entering the sound path in the axle journal for a particular probe position

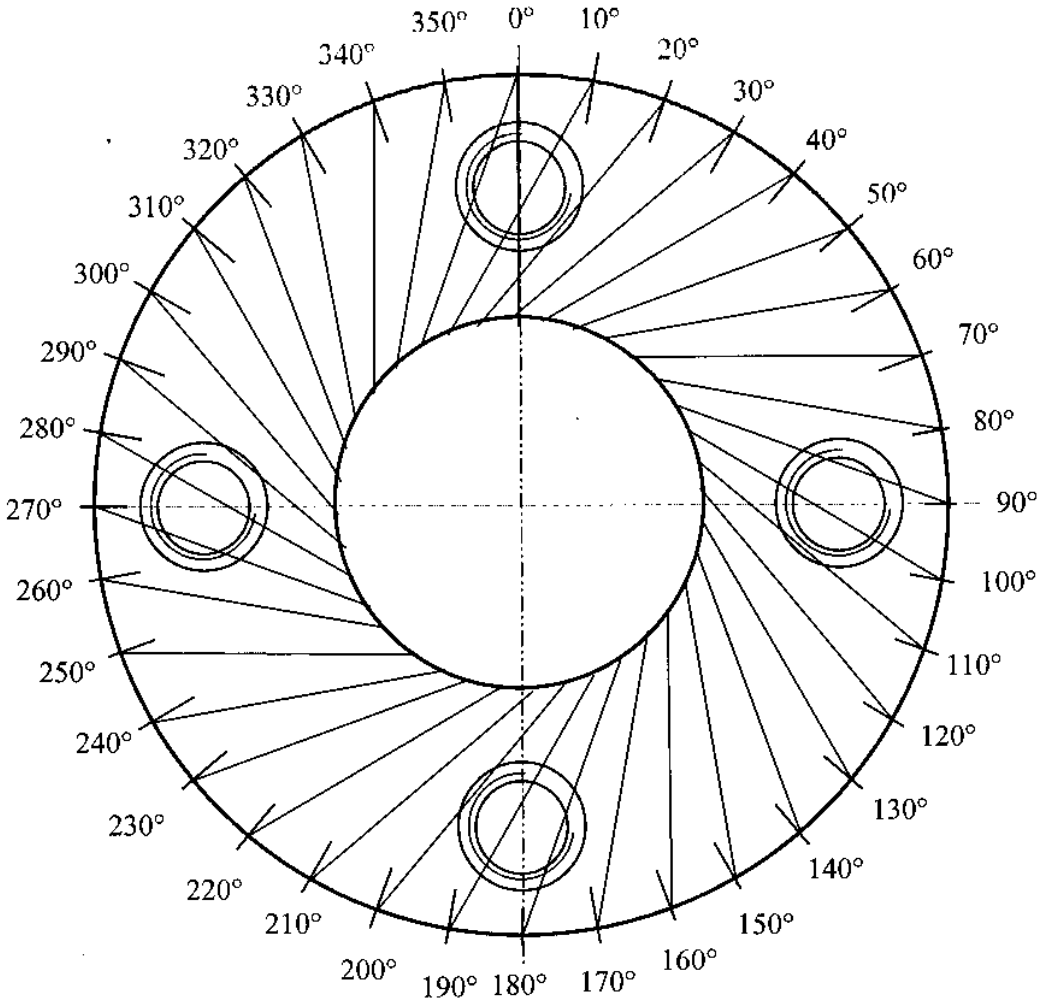


Figure 1.1: Scanning direction (clockwise)

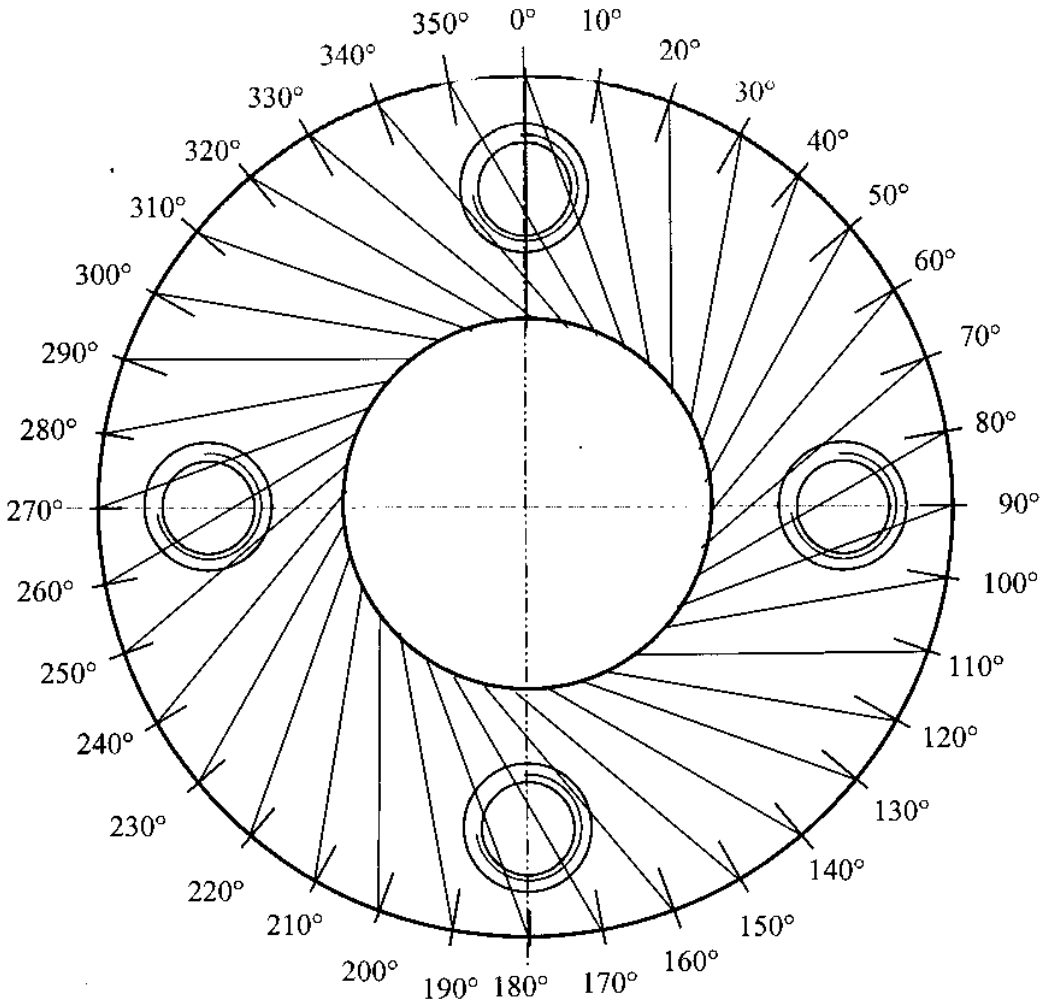


Figure 1.2: Scanning direction (anti-clockwise)

2.3.2 Coupling agent and coupling conditions

Special care is to be taken to ensure a uniform coupling. As couplant a mixture of oil and grease has proved to be adequate. However the proper composition has to be figured out in each case individually depending on the actual condition of the surface of the borehole.

The coupling also depends highly on a uniform and gentle manipulation of the probe.
However the coupling layer usually tears of after a few turns of the probe which can be noted from reduced amplitude of geometrical indications (echoes from Group 1 and 2), in such cases new couplant has to be applied. Sometimes it helps if the probe is rotated in the other direction.
Echoes from Group 1 and Group 2 are to be seen clearly and at amplitude and echo width comparable to the one during sensitivity setting.
When testing the axle, couplant should also be applied through the hole from the opposite side with a piston like device and cotton, pressing it gently against the probe. For this operation a second tester is required.

2.3.3 Preliminary inspection

In order to check proper coupling as well as the distance and sensitivity setting and for a rough orientation using the position of indications due to the geometrical configuration a pre-test pilot scanning should be performed.

With amplification about A_R the area is scanned rotating the probe while paying special attention to

a. A uniform scanning which can be assessed from the variations of the echo height of the 4 holes
b. The positions and the sequence of the previously calculated geometrical indications

Sequence of echo patterns: (e.g. for scanning direction A= anti clockwise)
See Figure 2 (TD-Presentation)

a. Group 1: Echo of the bolthole and related indications (direct: before half skip)
b. Echo A: Echo with a reflection at the hole and the outer surface of the journal (at half skip) with a sonic distance of around 42 mm
c. Group 2: Echo of the bolthole and related indications (after half skip)
d. Echo B: Echo of a reflexion between 2 boltholes with mode conversion TW to LW. This echo appears also at around an equivalent sound path of 42 mm and can lead to a wrong interpretation as an indication of a defect.

In addition the signal amplitude of the holes after a reflection on the interface to the wheel (press or shrink fit) related to the amplitude of the direct reflection should be evaluated to assess reflexion losses.

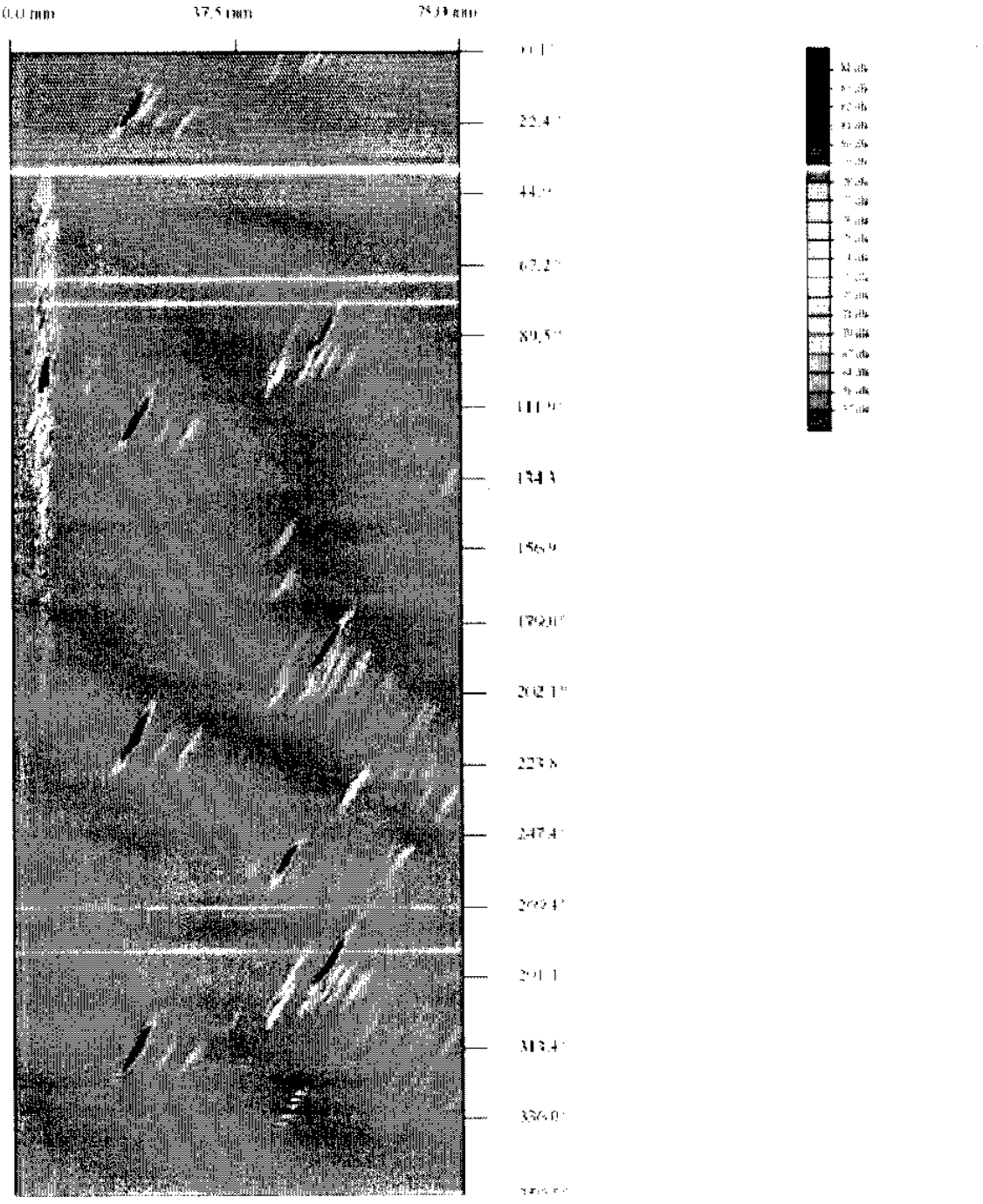


Figure 2: TD-Presentation

2.3.4 Test

Testing is performed with amplification slightly higher than A_E concentrating now on indications generated in the area of the surface. Indications due to irregularities are to be maximised and registered and evaluated when exceeding 40% SH at A_E in terms of:

a. Indication No.: consecutive number of indication.

b. Probe position: and Scanning direction (clock- or anti-clockwise).

c. Reflector position: on the shell circumference of the journal 0-360° (using template).

d. Echo dynamic pattern: (transverse) single or twin echoes, to asses the dynamic echo pattern, it might be necessary to increase the gain beyond AE paying special attention to the dynamic response pattern with twin echoes (see 1 and 2 in Figure 1 below).

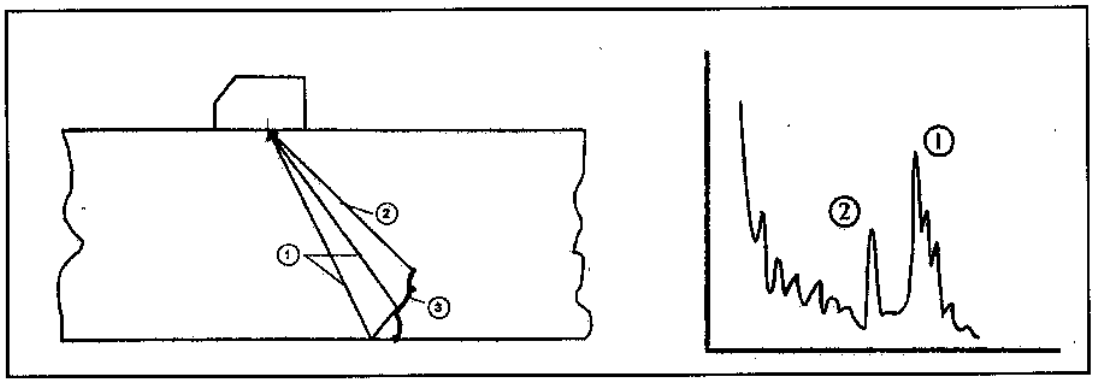


Figure 3:

Key: 1: crack root echo, 2: crack tip diffraction, 3; Crack (picture from EN 583-5)

The evaluation is based on the assessment of the sound paths of the crack root echo (corner reflector) s_1 and the tip diffraction indication s_2, each maximised individually. Since the tip indication is quite small it is necessary to increase the gain to evaluate it. Similar echo patterns can also be seen when scanning at notches.
The approximate depth of the reflector can under favourable circumstances be estimated from:

$$\Delta t = (s_1 - s_2) \cos \alpha$$

Where here α is 55°

e. Sonic distance: it should be around half skip sonic distance as measured at the notches in the reference block (s, s_1, s_2)

f. Amplification for the reflector A_R: Amplification gain when the echo of the reflector to be evaluated is set on 40% SH.

g. Echo height: the echo height is described by the excess of the amplitude of the reflector passing the evaluation level ($\Delta H_R = A_E - A_R$)

h. Length of the indication: Echo dynamic lateral (axial)

i. Reflector number: each reflector gets its own number for identification
(Note: there might be more than one indication of the same reflector when testing in two directions)

j. Evaluation: Indications have to be classified according to the table as shown in Figure 4.

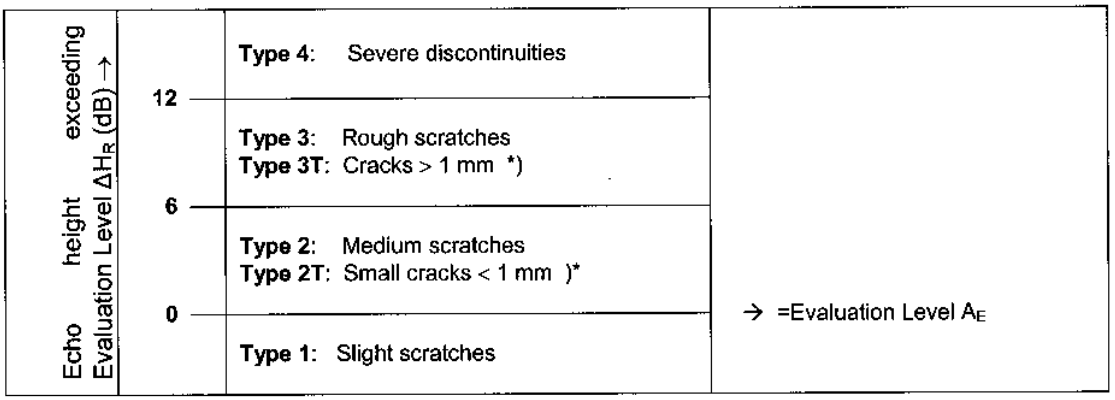


Figure 4 : Classification of indications

**): Twin indications*

2.4 Report

The report of test is written in standard report sheet. Refer to Examination report for axle journals for longitudinal discontinuities 55° ABP, in RST Scheduled Maintenance Checklist, DOCS reference no. R00.OMR.M14100.PT.0002*, refer to Appendix 3.a.

3 Magnetic Particle Inspection (MPI) Procedure

This procedure is written by Level 3 instructor Dipl. Ing. Fred Sondermann, Deutsche Gesellschaft fur Zerstorungsfreie Prufung e.V. Certificate No. K-002-24347.

3.1 Purpose

The aim is to detect cracks in longitudinal and across cracks in the surface of journal end of the axle after machining.

In the surface of journal end, scratches can develop during the machining. These cracks do not have a prefer direction (longitudinal or across). Refer to Figure 5, the typical of crack after machining.

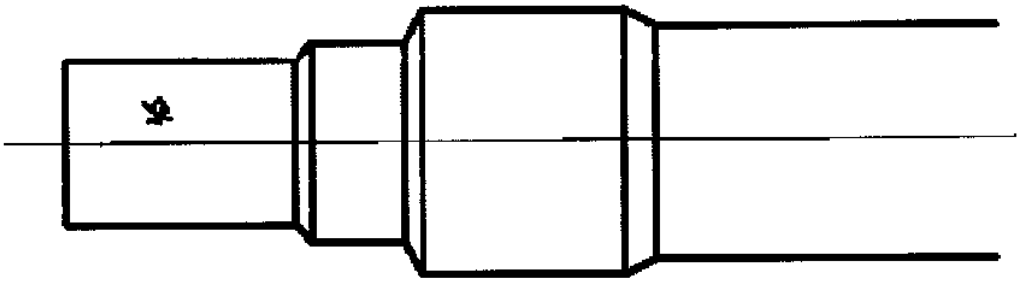


Figure 5: Typical crack after machining

3.2 Equipment

The following equipment is needed to carry out the test:

a. Electromagnet (normal Distance between the poles 140mm)
b. Magnetic fluorescent Suspension
c. UV-lamp with a minimal Intensity 15 W/m2 (1500µW/cm2)
d. Follow Control equipment
e. Magnetic field measurement to control the magnetic field strength
f. UV-Intensity measurement .to control UV-Intensity
g. Control-body (body of comparison) to control quality and sensitivity of suspension magnetic powder
h. Lighting strength measurement to control lighting strength

3.3 Preparation of test area

The test area surface must be clean and dry prior testing. There should be no grease, oil, dirt and shades.

3.3.1 Control UV lamp (control UV-intensity), Equipment UV- Intensity measurement and UV-Lamp

Switch on the UV-lamp and wait for 15 minutes, its important in order to get a correct measurement. Take the UV-lamp over the Intensity measurement and the distance should be 30cm and measure. The minimal Intensity has to be 15 W/m2 (1500µW/cm2). If the Intensity is less, change the UV-lamp.

3.3.2 Measurement the tangential magnetic field

The measurement should be carrying out on the test area. Set the magnet on the journal end and put the measurement sensor across between two poles.
The tangential magnet field strength has to be minimal HT = 25 A/cm (2,5 kA/m) and maximal HT = 60 A/cm (6 kA/m) HT.

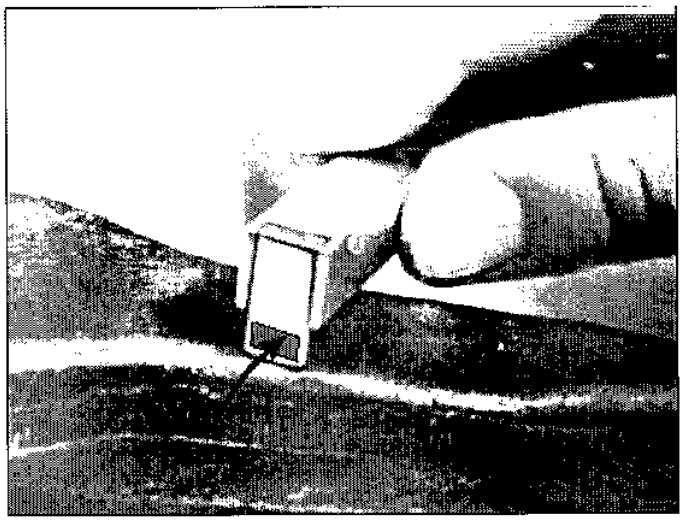


Figure 6: Example of tangential magnet field measurement

Important Note: The lighting strength, during the test, should higher then 70lux.

3.4 Test

The test area is the surface of journal end and the following test should be carried on each end journal:

a. Lengthwise direction to detect across cracks.
b. Circumference direction to detect longitudinal cracks.

3.5 Lengthwise direction to detect across cracks

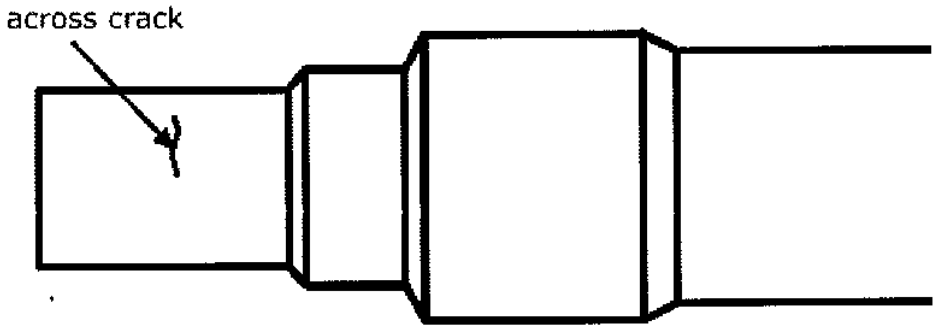


Figure 7: Example of across crack.

3.5.1 Test zones

There are four-test zone on each end journal and each test zone should be marked at 45° before a test as shown in figure 7.1.

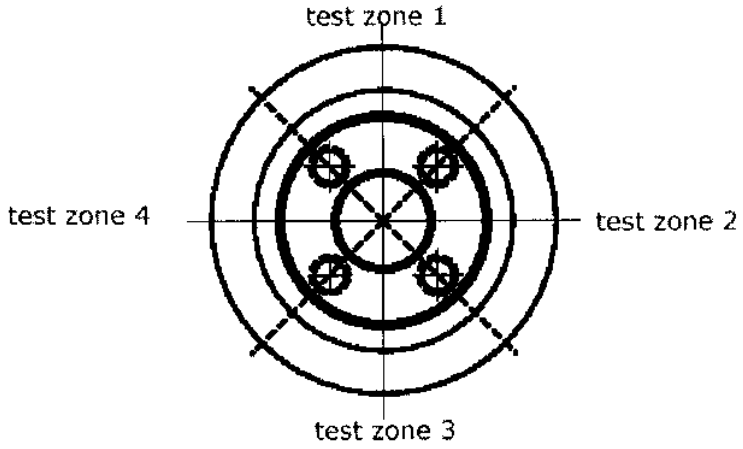


Figure 7.1: Four-test zones.

3.5.2 Test steps

Step 1: Place the magnet on the test surface i.e. test zone 1, as shown in 7.2.

Step 2: Magnetize for 3 to 5 seconds.

Step 3: Sprinkle on the magnetic suspension.

Step 4: Magnetize again for another 3 to 5 seconds.

Step 5: Inspect the test zone with UV –lamp.

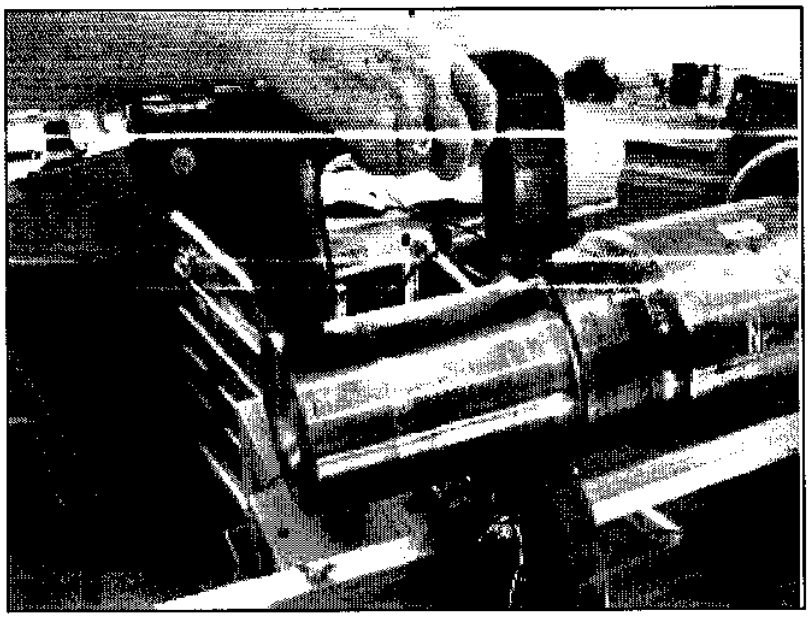


Figure 7.2: Placing magnet on a test zone

Note: Move to the next test zone (45° further) and repeat the test procedure again

3.6 Circumference direction to detect longitudinal cracks

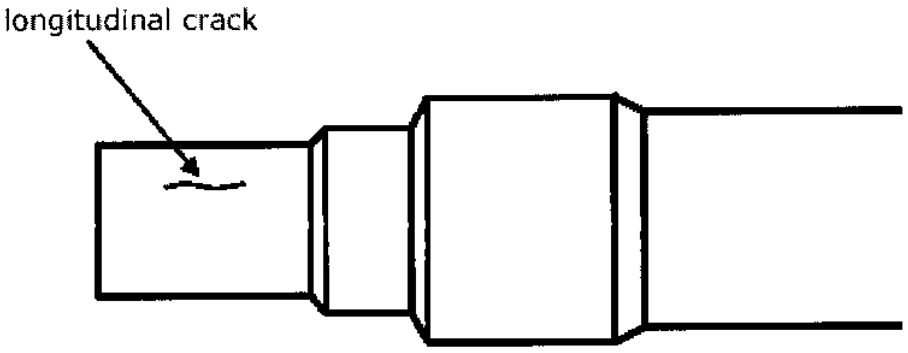


Figure 7.3: Example of a longitudinal crack

3.6.1 To check longitudinal cracks

The area is subdivided into to test zone as shown in figure 7.4.

a. Test zone 1 = 87mm
b. Test zone 2 = 83mm

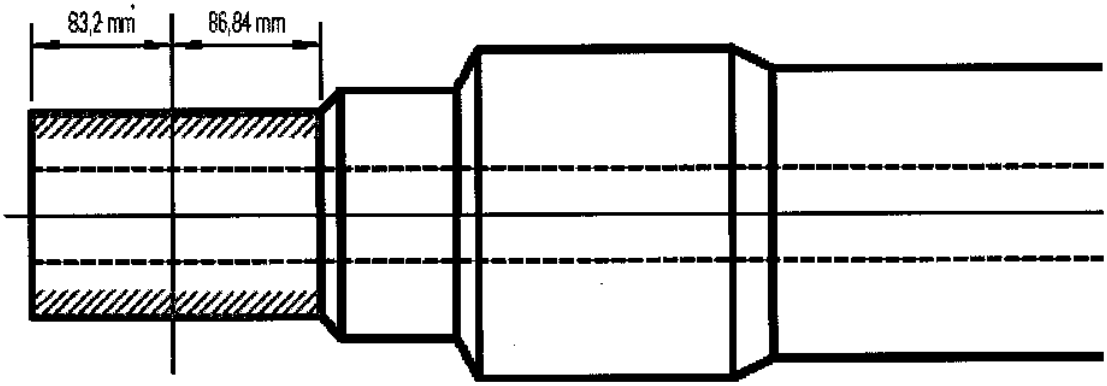


Figure 7.4: Test zone

3.6.2 Test steps for zone 87mm (lengthwise direction)

Step 1: Set a wide of 85mm between the poles as shown in figure 7.5.

Step 2: Place the magnet on the test surface i.e. test zone 1 as shown in figure 7.6.

Step 3: Magnetize for 3 to 5 seconds.

Step 4: Sprinkle on the magnetic suspension.

Step 5: Magnetize again for another 3 to 5 seconds.

Step 6: Inspect the test zone with UV –lamp.

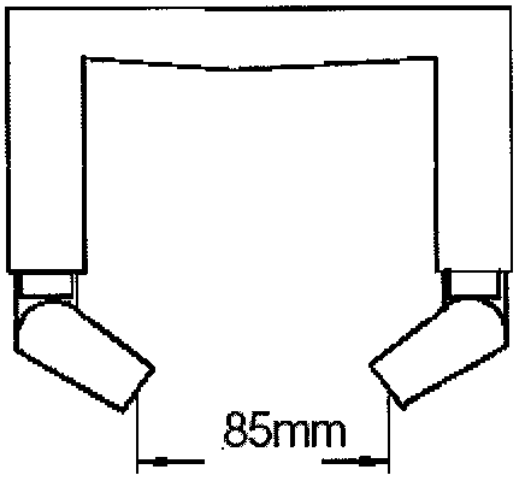


Figure 7.5: Set a wide of 85mm between the poles.

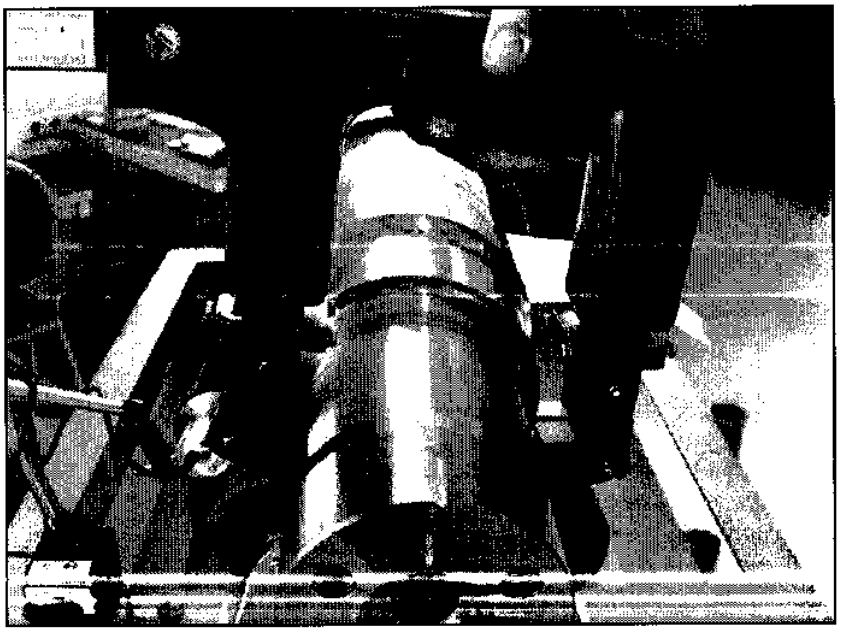


Figure 7.6: Placing the magnet on the test surface.

Note: Move to the next test zone (90° further) and repeat the test procedure again.

3.6.3 Test steps for zone 83mm (lengthwise direction)

For test zone 83mm, repeat the same test procedure as 5.6.2

3.6.4 Test report

The report of test is written in standard report sheet. Refer to Examination report for Magnetic Particle Testing (MPI), in RST Scheduled Maintenance Checklist, DOCS reference no. R00.OMR.M14100.PT.0002*, refer to Appendix 3.b.

5 Appendices

Appendix 3.a - Examination report for axle journals for longitudinal discontinuities [R00.OMR.M14100.PT.0002*]

Appendix 3.b - Examination report for Magnetic Particle Testing (MPI) [R00.OMR.M14100.PT.0002*]

Rolling Stock Maintenance Department

Examination report for axle journals for longitudinal discontinuities **2nd T4** E-MAS

Train No.: _____ Work Order No.: _____

Date Start: _____ Train Mileage (KM): _____

Reference Procedure : NDT Inspection on Scratch Axle Process Guide, R00.OMR.M12990.QP.0002*

1. General

a) Report No.:.....

b) Axle serial No.:.....

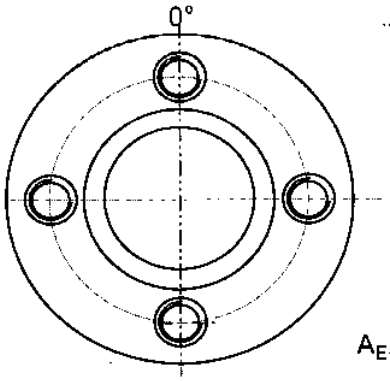
c) Side: N ( ) NN ( )

d) State of examination object: End Axle # .....

f) Bogie No.:.....

g) Gearbox S/N: .....

e) Identification of the axle, 0°-reference point.



.....

Type 4: Severe discontinuities

.....12dB

Type 3: Rough scratches

Type 3T: Cracks > 1mm*

.....6dB

Type 2: Medium scratches

Type 2T: Small cracks < 1mm*

A_E.....0dB

Type 1: Slight scratches

2. Specific data

a) Results of Visual inspection	
b) Apparatus Name, Probe. Name, Angle of	USM 25, Angle Beam Probe, 55°
c) Distance Calibration: - Calibration reflector,	Bolt hole dia. 18 mm
- Range s_B / P- Delay time µs	70 mm
d) Control of calibration. Reflector, sound path	Notch 42 mm
e) Sensitivity calibration. Reflector, s	Borehole 18 mm, s = 18
f) $A_E = A_0$ = ... + ΔA18dB	A_E = _____dB

3. Record of relevant indications

1	2	3	4	5	6	7	8	9	10	11
No.	Scan direction C or AC	Reflector position 0-360°	PatternTransverse Single / Twin	Sonic dist single: s twin: s1/s2	GainFor Echo on 40% AR dB)	Echo height Over AeΔHR (dB)	Length of indication from-to (mm)	Reflector No.	ClassifiCation TYPE	RemarksΔt (only for twin echoes)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

4. Result of examination: Type and number of detected discontinuities

Type→	1	2	2T	3	3T	4
Discontinuities Number →						

NDT-Personnel	Tester 1 (in charge)	Tester 2 (recording)	Supervisor
Name			
Signature			
Date			

5. Assessment

Axle is: ready for use / not ready for use

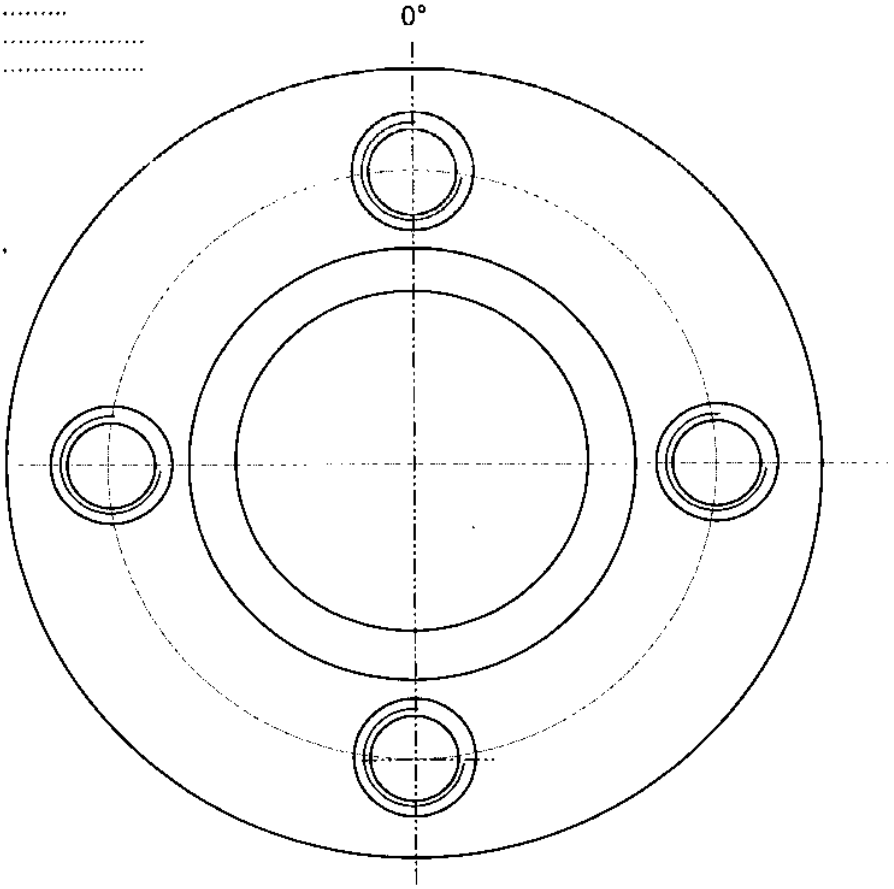
Rolling Stock Maintenance Department

Examination report for axle journals for longitudinal discontinuities

2nd T4

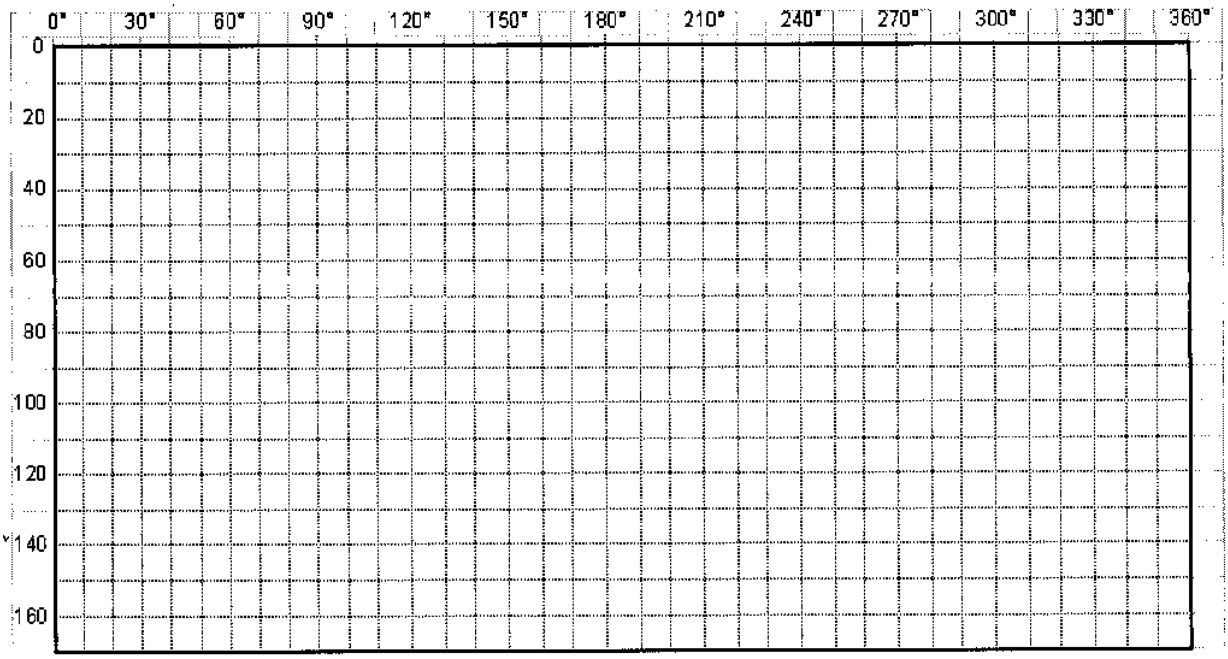
E-MAS

Date:.....
Report No.:.....
Train No:.....
Axle No:.....
Side (N) (NN)



Winding off of the journal

Results of the tests VT: - - - - - - - UT: ~~~~~~~~~~



Rolling Stock Maintenance Department

Examination report for Magnetic Particle Testing (MPI)

GEN E-MAS *Your Railway Operations & Maintenance Specialist*

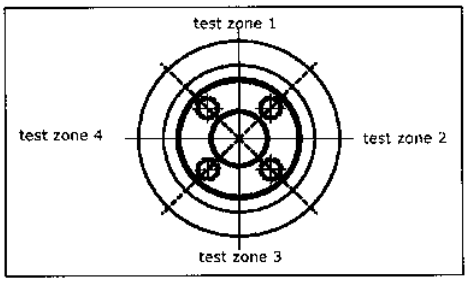
Axle No. : ..... **Work Order No. :** .....

Report No. : ..... **Date of test :** .....

Side : ☐ **N** ☐ **NN**

Reference Procedure : NDT Inspection on Scratch Axle Process Guide, R00.OMR.M12990.QP.0002*

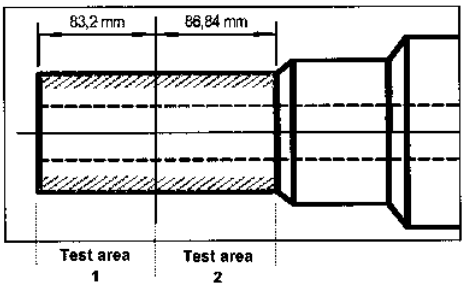
a) Length wise direction



Result of examination

	Lenghtwise Direction
Zone 1	
Zone 2	
Zone 3	
Zone 4	

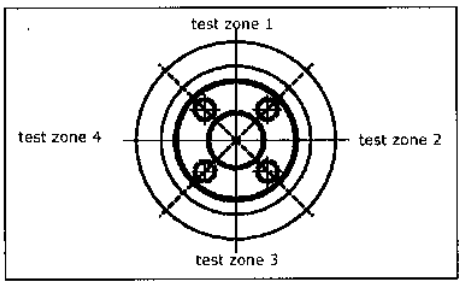
b) Longitudinal direction



Result of examination

Test area 1

83mm	Circumference Direction
Zone 1	
Zone 2	
Zone 3	
Zone 4	



Test Zone

Test area 2

87mm	Circumference Direction
Zone 1	
Zone 2	
Zone 3	
Zone 4	

c) Assesment:

☐ Axle is serviceable for use.

☐ Axle is not serviceable for use.

Done by:

Name:.....

Stamp

Acknowledged Supervisor:

Stamp:.....