1. **PERFORMER**: Romanian Railway Notified Body – Laboratories Department

2. **CLIENT**: Romanian Railway Investigating Body – OIFR

3. **TESTING OBJECT**: broken axle journal, end B, in the connection point of stress relief with the obstructing area, with the order number 14, charge 311561, series CFR 3836632, belonging to the wagon no. 31535494306-2, involved in the railway incident from Zavideni, occurred on the 13th of March 2008.

4. **DATE OF THE OBJECT RECEIVE FOR TESTING:** the 13th of August 2008

5. **DATE OF TESTING BEGINING:** te 25th of August 2008
   5.1 Testing was performed: in the laboratories of the Laboratories Department – Rolling Stock Laboratory
   5.2 During the testing performance: there were no interruptions

6. **TESTING WAS REQUESTED BY** : Romanian Railway Investigating Body, according to the Note no.7010/182/2008
   6.1 Requested tests:
   6.1.1 Microscopic checking
   6.1.2 Checking with ultrasonic control (CUS);
   6.1.3 Control with penetrating liquids;
   6.1.4 Control with eddy currents;
   6.1.5 Determination of the Brinell hardness on the cross section;
   6.1.6 Macro and microscopic metallographic analysis.
   6.2 Purpose of the tests was: technical examination

7. **TESTING PRESENTATION**:
   7.1 The testing methods used were: the tests from the points from 6.1.1 to 6.1.6 were performed in accordance with the provisions of the UIC Leaflet 811-1/87 „Technical specification for axles furniture for the motorised and houled rolling stock" (canceled from the 1st of July 2006) and : Instructions for the ultrasonic control, in operation, of the wagons wheel sets" – REFER, 1993.
   7.2 The object tested was: supplied by AFER – OIFR
   7.3 During the storrage, the object for testing: was kept in the laboratory

7.4. During the keeping of the object and tests performance, the environment conditions were: none

7.5. The measuring means used in order to perform the tests are presented in the following table:

No.	**Name of the measuring equipment**	**Series or stock number**	Date of the last metrological checking	**Measuring accuracy**	Tests according to the point
1	Measuring tape 5m	22	02.2006	-	6.1.1
2	Sliding callipers	1030	08.2004	± 0,05 mm	6.1.1
3	Equipment for the static test of the hardness, CV 998	S4 -1-1054-1945/2005	10.2006	cl. 1	6.1.4
4	Metallo graphic microscope AXIOVERT 200 MAT	89	Calibration from Dec 2006	± 0,5 μm	6.1.5

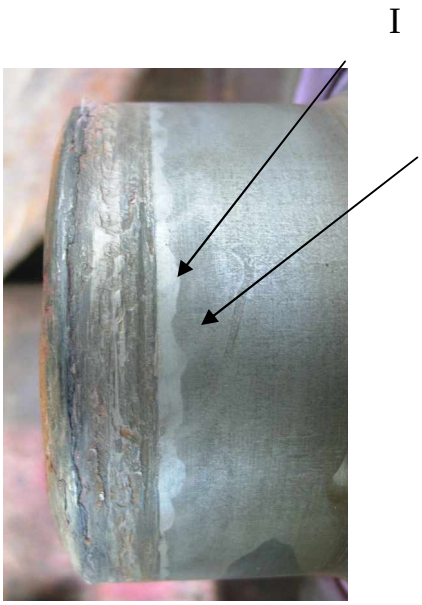
8. TESTING RESULTS:

8.1. Microscopic checking

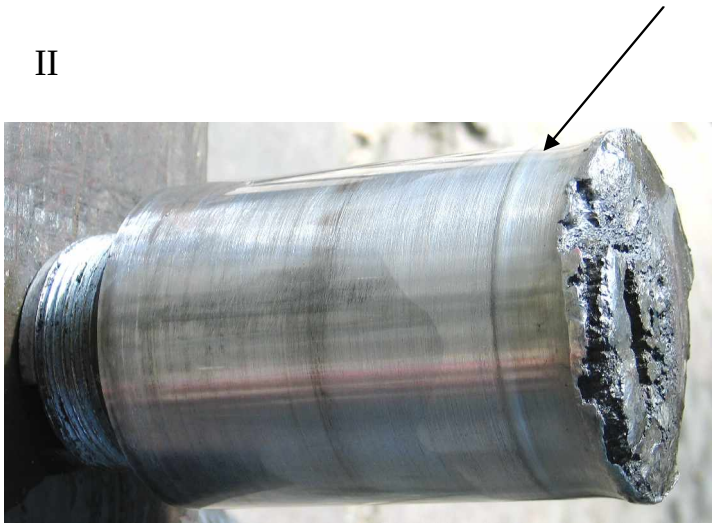
Axle breaking happend in normal plane on its logitudinal axis, by stress relief, under the roller bearing WJ, in the connection point with the cobstructing area – picture 1.

Picture 1

In the picture 2 one can notice a detail of the breaking area, where can be noticed an area with material deposited circular of silver colour, of irregular shape (I), with a breadth between 2 and 6 mm and an adjoining dark grey band (II), of thermo influence (II), with the breadth between 8 and 10 mm.



Picture 2



Picture 3

The broken axle journal of 220 mm length has the end threaded, and at about 35 mm from the breaking point is emphasized a circular area, with an increased height of about 0,15 mm, picture 3. The visible marks on the end of the broken axle journal are: IOB SNTFM 07 04 M90 070453 CFR 38366 32 – picture 4.

Picture 4

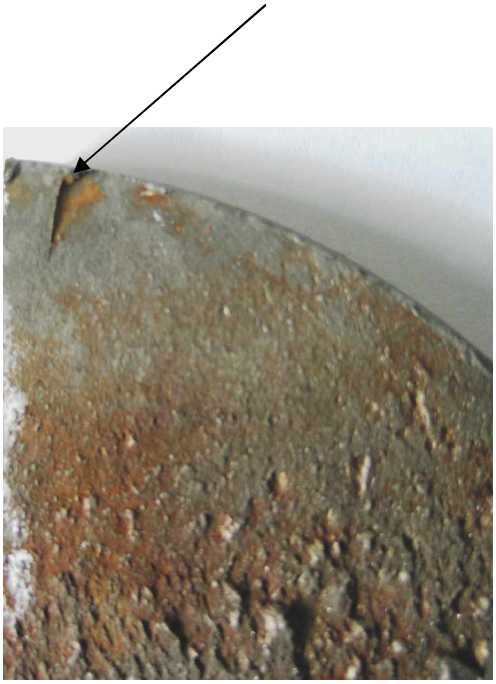
Picture 5

On the opposite end (whole axle journal) are visible the following marks: 1311561 IOB A1N M90 07 04 T 14 – picture 5.
The aspect of one of these two breaking surfaces (breaking) is presented in the picture 6, where can be noticed on about 60% fatigue breaking area (gradual) and on over 40% sudden breaking (with material plucking).

On the section edge can be noticed gradual tendency to break, areas with material deformed and printed form, following the repeated hits of the opened breaking surfaces until the axle journal breaking.

Foto 6

Two details of the edge tendencies to brake of the breaking section (marked with arrows are presented in the pictures 7 and 8).



Picture 7

Picture 8

8.2 Tests with ultrasonic control (CUS):

1. The ultrasonic transparency can not be performed, because both the breaking and the part from the non-broken end do not offer two cross sections, both parallel.

2. The control from the end with the conic special feeler ASW 29^0 – 90 (series 567) of the axle with the bearing tracks fit up on the axle journal. It can not be performed because the axle had the axle boxes taken off.

3. The control performed on the axle journal surface with the feeler WB 45^0 – 2 (series 1039) does not show failures.

4. The control performed on the axle journal surface with the feeler WB 35^0 – 2 (series 5019) does not show failures.

5. The control performed on the axle journal surface with surface wave, with the feeler WB 90^0 – 2 (series 1039) does not show failures.

Equipments used: Failures detector type USM 35-XS (series 1212a). Feelers used: WB 45^0 – 2, WB 90^0 – 2 and ASW 29^0 – 90.

Callibration bodies:

- Semi-cylindrical body with the radius of 50±0,1 mm and the breadth of 25 mm for CUS with cross waves, with gradient incidence of the axles and of the cast wheels
- An axle end type AI (OR1), (axle journal + obstructing area + pressing-on area), with artificial failures (cuts of some deepths at some distances for CUS of the axle journals A I, A II, A III).

8.3 Control with penetrating liquids

The control with penetrating liquids is used in order to confirm the failures found out during the ultrasonic control (cracks or pores over 1 mm) and shows pores over 1 mm.

Penetrating liquids used: One used a checking system with penetrating liquids type IICd-2 according to the SREN 571-1 from 1999. For this purpose one used: degreasing substance type MR 85, penetrating liquid MR 68C fluorescent red and eluent MR 70, all made by MR Chemie GmbH.

Following the control performance, there were no failures found out, but was noticed the unaccountable presence of a circular ring, as an increased height at the begining of the stress relief, both on the broken axle journal and on the non-broken one.

Picture 9

Picture 10

Picture 11

Picture 12

Following the increased height finding out, one proceeds to a wash with solvent, followed by an attack with a Nital substance 5%, at the visual examination were found out dark areas in the stress relief point, as can be seen in the next picture:

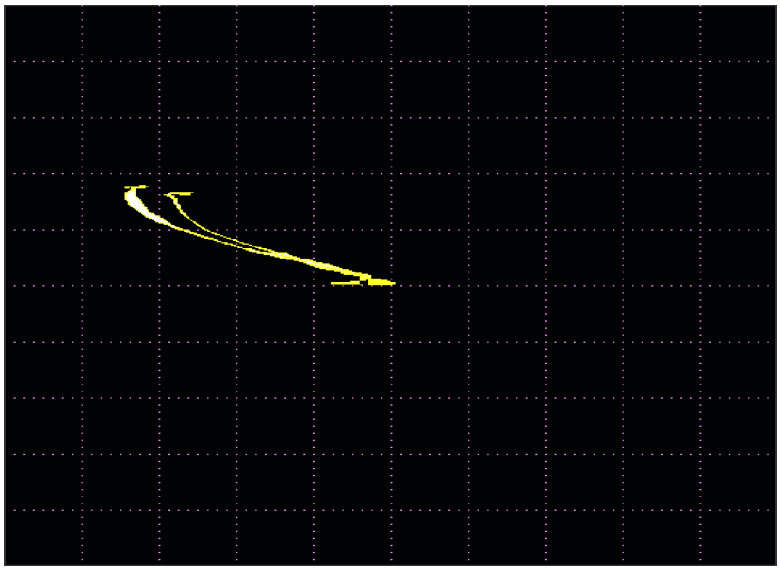
Picture 13

The same situation on the broken side.

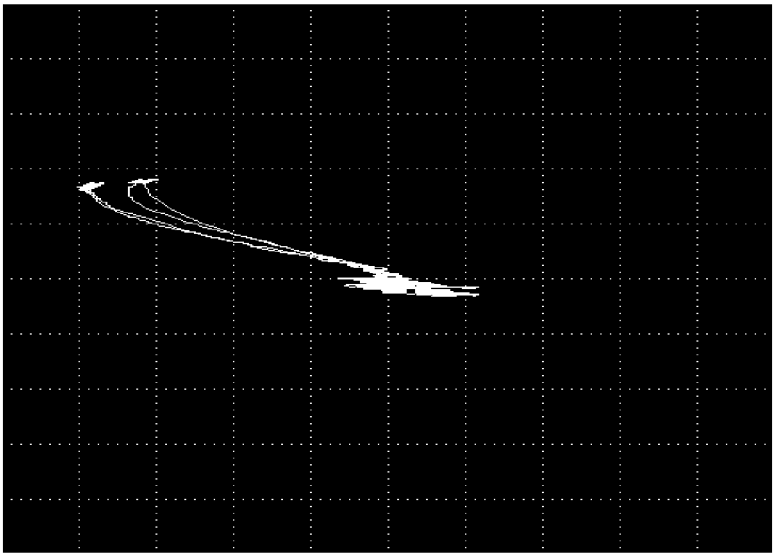
8.4. Control with eddy currents

On the basis of the above mentions, was performed a control with eddy currents in order to point out, if case, electrical conductibility differences on the axle journal surface, between the blakened areas and the rest of surfaces. In this respect was used a failures detector type NORTEC 500C (series N500X1693PO080577), made by OLYMPUS company, using as detection device a proof stick PENCIL of 500 kHz.

Following the control with the equipments above presented, was found out that there was an electrical conductibility difference between the rest of the axle and the stress relief area at the both ends of the wheel set, as results from the next diagram.



Aspect with conductibility difference on the stress relief area against the rest of the axle on the broken part.



Aspect with conductibility difference on the stress relief against the rest of the axle on the non-broken part

8.5. Determination of the Brinell hardness

In order to point out the hardness difference on radial direction, on a cross section of the axle, was determined Brinell hardness, starting from the outside surface to the central surface of the section.

No. stamp	Area for the measurement of the Brinell hardness	Values of the measured Brinell Hardness**, [HBS]**
1	Material on the section edge, in the thermo influence area	177
2	Material on the section edge, on the limit thermo influence area– basis material (middle of the section)	169
3	Material on the section edge, in the thermo influence area	185
4	Material on the section edge, on the limit thermo influence area - basis material (middle of the section)	172
5	Material on the section edge, in the thermo influence area	181
6	Material in the middle of the section	159
7	Material in the middle of the section	157
8	Material in the middle of the section	154
9	Material in the middle of the section	154
10	Material in the middle of the section	154

8.6. Macro and microscopic metallo graphic analysis

The cross section, used to perform the macro graphic and microscopıc analaysis of the axle, was taken from the very close part of those broken.
On the cross section surface were performed:

- Baumann test – in order to point out the possible sulphur segregations;
- heat macro-attack in substance of 50% HCL – in order to find out the possible material failures (flakes, macro-blisters macro-segregations, sulphides, macro-inclusions, macro-pores, etc.), failures generated by the superficial thermic treatment or by the processing by plastic deformation (material overlaps , cracks).

After the macro-tests performance, both from the section that contained the breaking and from those close to it, were taken micro-stamps, on whose surfaces were followed :

- structural aspect of the material, by mentioning the type of the thermo treatment applied to the axle, starting from the outside surface to the its central section;
- the presence of the possible material failures or micro thermo treatment.

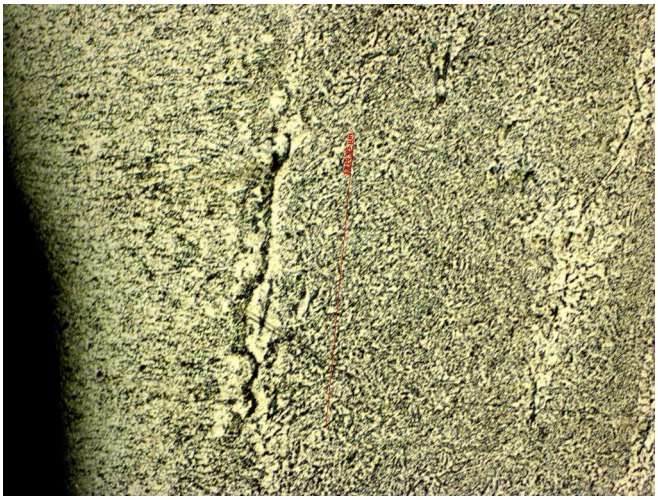
Picture 14

Picture 15

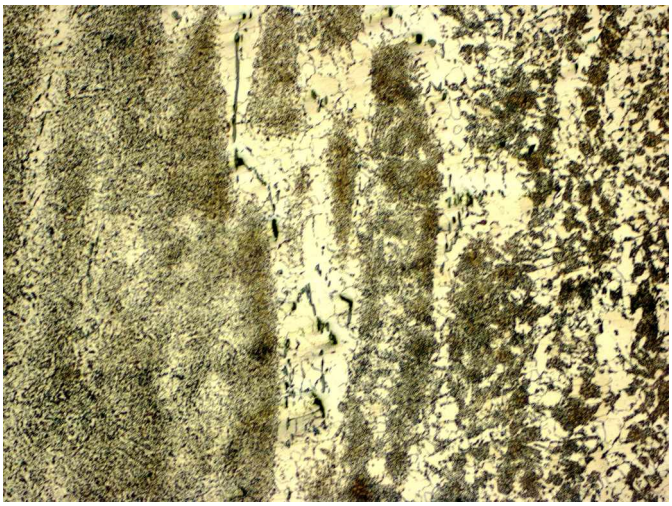
Picture 16

Picture 17

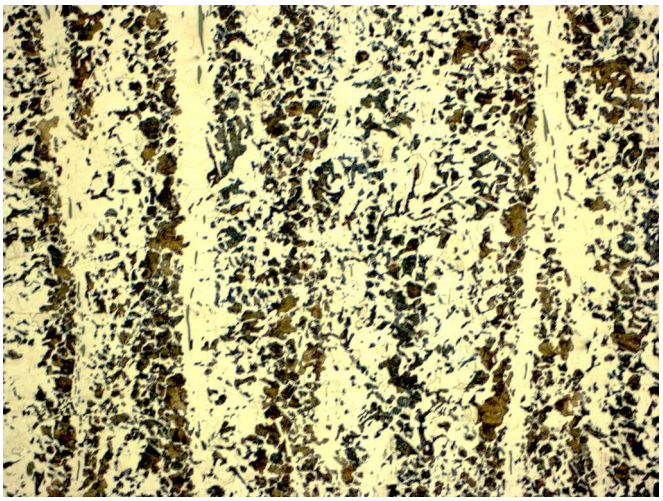
Characteristic type	Conclusions on the analised characteristic	Picture	Conditions established by the UIC Leaflet 811/1-87 for the analised characteristic
Macrographic and macroscopic analysis			
Baumann stamp	h Sulphur uniform ditribution on the cross section, without segregations. The image ranges among the limit images included in the enclosed album at the leaflet.	14	Point 6.2.2.4 – The image obtained has not to present failures more visible than those presented in the limit images included in the enclosed album at the leaflet
Macro aspect of the cross section after the heat attack in substance of 50% HCL	h Without macro-failures type flakes, material overlaps, segregations, macro-inclusions, cracks One can notice a central porosity with points= 1 On the section outline one can see, detailed, a thermic influence area, without interruptions, of dark colour, on a breadth of about 4 mm	15 16 17	Point 6.2.2.3 – After polishing, the examined surface has not to present any continuity solution
Microscopic analysis			
Characteristic type	Conclusions on the analised characteristic	Picture	Conditions established by the UIC Leaflet 811/1-87 for the analised characteristic
The structure at the outside cylindrical surface	h On the outline of the section was found out , at micro level, column pearlite- ferrite constituents, structure specific to a melted material (A). On the edge deposited material (A) – basis material (B), one found out a contraction micro-crack of about 1,22 mm length. h In the thermic influenced area, in the conditions of a ferrite structure, one pointed out the presence of some non-metallic inclusions series. Area (B) from the axle material has grain structure pearlite-ferrite fine recrystallised, being typical to a total recrystallization due to a thermo action.	18 19	Point 7.8.2.2 – Any welding, cutting/burning, heating, any re-building up by metallization, chemical or electrodepositions also any correction to hide a failures are strictly forbidden and lead to the whole lot refuse.
The structure of the axle material in the central section	h The pearlite-ferrite structure as rows, specific to a heat plastic deformed steel and submitted to a normalizing thermo treatment. The size of the structural composition corresponds to the grain value 7-8, so under the stipulated value 5.	19C 20	Point 6.2.2.2 – The normalized, axles structure has to be uniform and specific to the ordered thermo treatment. The size of the pearlite grain determined according to the SR ISO 643 has not to be over the value 5.

A  B

Picture 18 - (100:1), atac

B  C

Picture 19 – (100:1), atac



Picture 20 – (100:1), atac

9. SUB-CONTRACTORS IDENTIFICATION – none

10. OTHER INFORMATION:

a) **The report was drawn up in 4 copies, handed in as follows**:

- copies 1, 2 and 3 to Romanian Railway Investigating Body – OIFR
- copy 4 to Romanian Railway Notified Body – Laboratories Department

b) **Opinions, interpratations** : between 2004 – 2006, AFER performed technical examinations for the axles no. CFR 383112, charge 511969, railway event Campulung Moldovenesc – 2004; 3835154, charge 511970, railway event Zlatareni – 2004 and 3834212, charge 511973, railway event Basarabi – 2005, that broke in the thermo influenced points of the axle journal.

Attentions:

11.1 This report may be used only for the purpose stipulated at the point 6.2. The presented results at the point 8 concerned only the object presented by AFER and tested.

11.2 The extrapolation of the testing results to the characteristics of the lot, charge or to the manufacturing quantity from witch were taken the objects submitted to tests, is done only by the products supplier and the customer and only when it was asked to establish the quality of some lots, charges or manufacturing quantities.

11.3 The report may be completely and only upon the drawer agreement, Romanian Railway Notified Body – Laboratories Department

DRAWN UP

ing. Valeriu CRUCEANU

ing. Veronica NICOLAOS

VERIFIED

Chief of Laboratories Department

ing. Ion SIMION

APPROVAL
DIRECTOR
ROMANIAN RAILWAY NOTIFIED BODY
ing. Mircea Cristian ARNĂUTU