



Eaton Corporation

Vehicle Group-Valvetrain

19218 B Drive South

Marshall, Michigan 49068

269/781-0200

Background:

Materials and Basic Processes Report

Prepared By E. Vincent
Work Done By E. Vincent
Date 20 Sept. 2017
Pages 1 of 8

25 - 8620 specimens (P/N 329273 see appendix) were received at Eaton-Marshall from AISI for RBF testing at room temperature. The specimens were vacuum carburized and gas quenched by Dana with no finish grinding after heat treatment. The test machine is a Fatigue Dynamics RBF-200 operating at 4,500rpm in air. The beam load (in-lbs) was calculated using the bar diameter in the gage section. Specimens were tested until fracture or suspension at 10,000,000cycles.



Fatigue Dynamics RBF-200

Objective:

1. Perform metallurgical characterization on representative post-test RBF specimens.

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Findings:

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Date

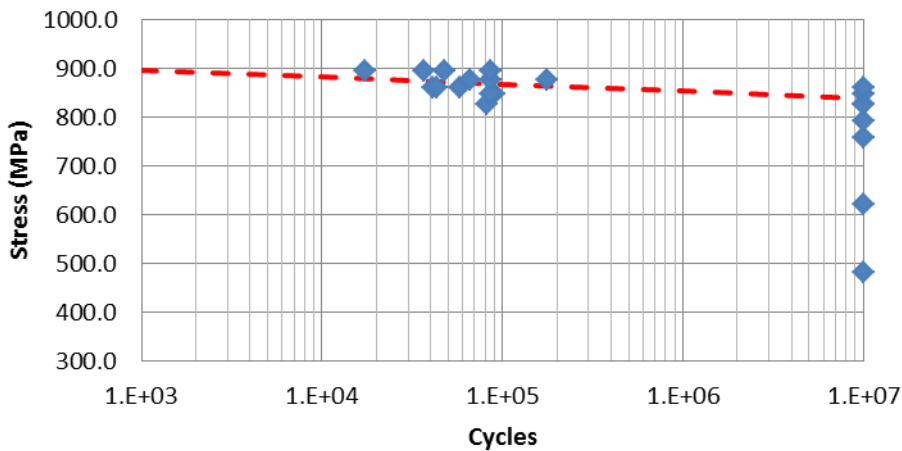
20 Sept. 2017

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1. Sample Red-19 tested at 123 KSI for 86,660 cycles was selected for metallurgical analysis.
2. The sub-surface hardness at 0.05 mm is 61.4 HRC converted from HV0.5.
3. The case depth is 0.366 mm.
4. Etched micrographs exhibit a typical carburized case and core microstructure.

RBF 8620 Room Temp



Stress Limit 10⁷ MPa		795
95% Confidence Interval		12

Figure 1: RBF test result summary.

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Table 1: RBF test data.

Specimen #	Material	Gage Diameter	Runout	cycles to failure on SN Curve	Stress	
					ksi	MPa
Red-1	8620	6.359	0.03302	10,000,000	70	482.7
Red-2	8620	6.418	0.04826	10,000,000	90	620.6
Red-4	8620	6.373	0.01016	10,000,000	110	758.5
Red-6	8620	6.36	0.0508	10,000,000	115	792.9
Red-5	8620	6.369	0.01778	82,320	120	827.4
Red-8	8620	6.367	0.10922	10,000,000	120	827.4
Red-11	8620	6.355	0.0254	10,000,000	120	827.4
Red-14	8620	6.37	0.04064	89,960	123	848.1
Red-18	8620	6.345	0.0254	10,000,000	123	848.1
Red-19	8620	6.336	0.03556	86,660	123	848.1
Red-9	8620	6.406	0.1143	41,210	125	861.9
Red-12	8620	6.372	0.02032	10,000,000	125	861.9
Red-13	8620	6.358	0.03302	43,330	125	861.9
Red-22	8620	6.367	0.10414	57,830	125	861.9
Red-25	8620	6.339	0.01524	175,980	127	875.7
Red-3	8620	6.381	0.06096	66,280	127	875.7
Red-10	8620	6.357	0.05842	85,880	127	875.7
Red-20	8620	6.353	0.03556	17,250	130	896.4
Red-21	8620	6.34	0.05334	36,900	130	896.4
Red-23	8620	6.337	0.03048	47,450	130	896.4
Red-24	8620	6.344	0.05334	86,410	130	896.4

Table 2: Representative sample test history.

Sample	Stress (KSI)	Test Temp.	Cycles
Red-19	123	R.T.	86,660



Figure 2: Red-19 representative test sample.

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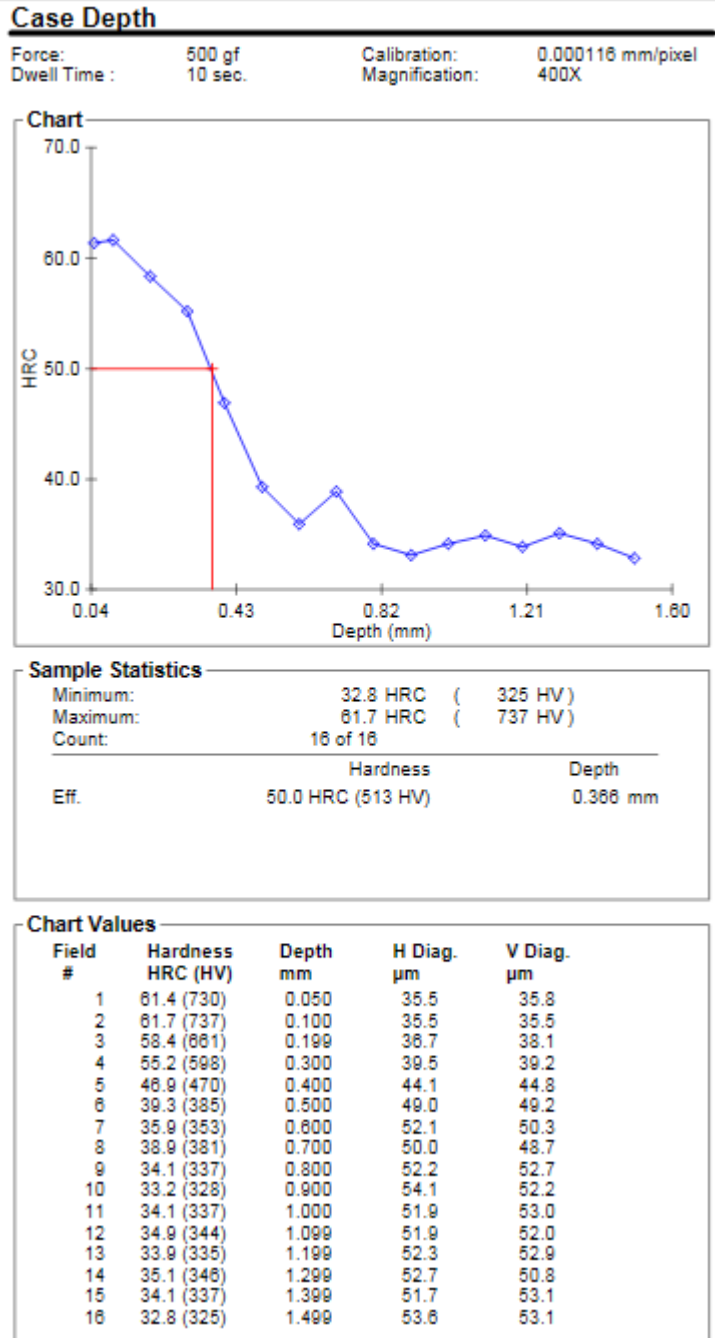


Figure 3: Case depth measurement, 0.366 mm measured HV0.5 converted to HRC. Sub-surface hardness at 0.05mm is 61.4 HRC.

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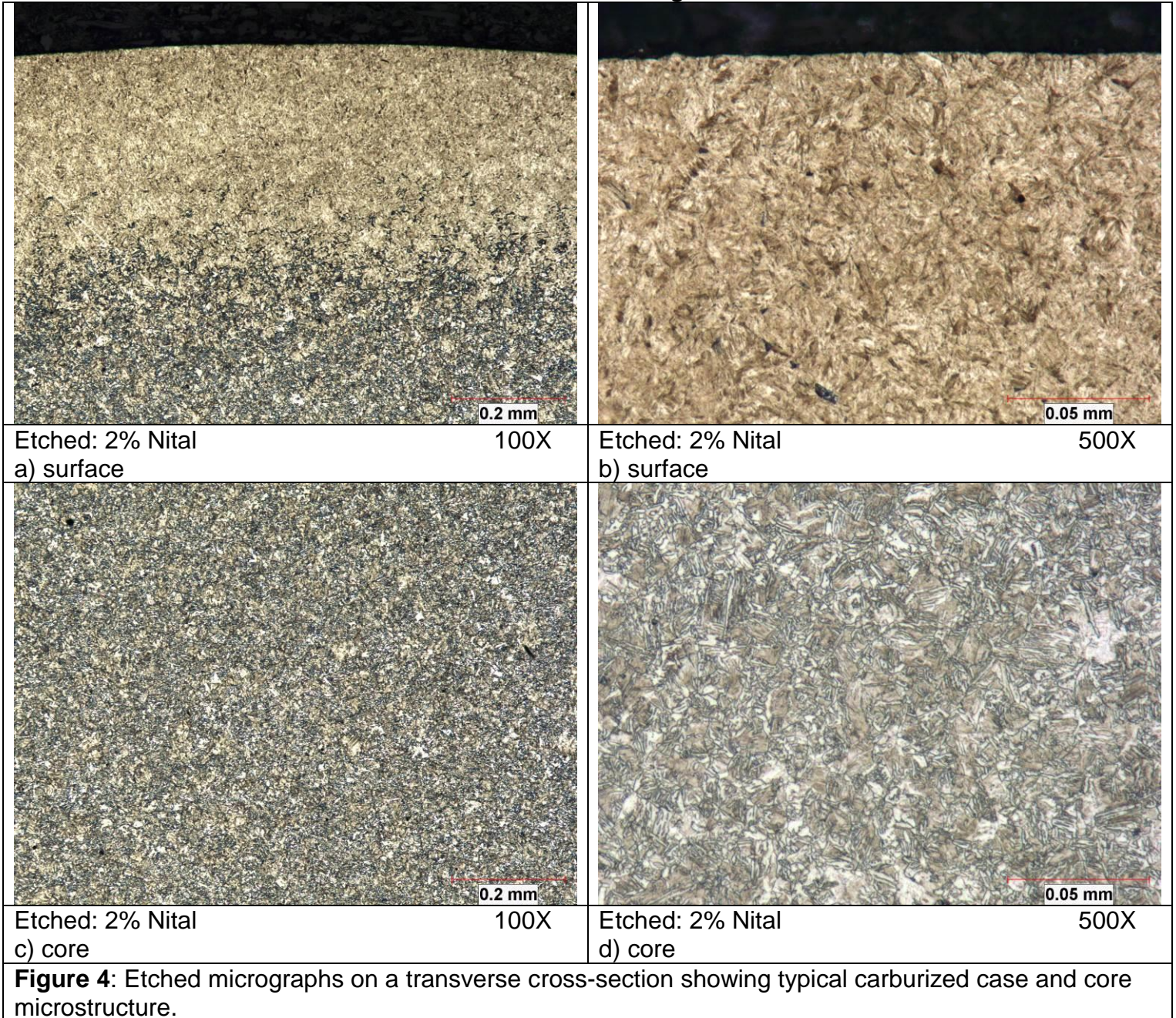
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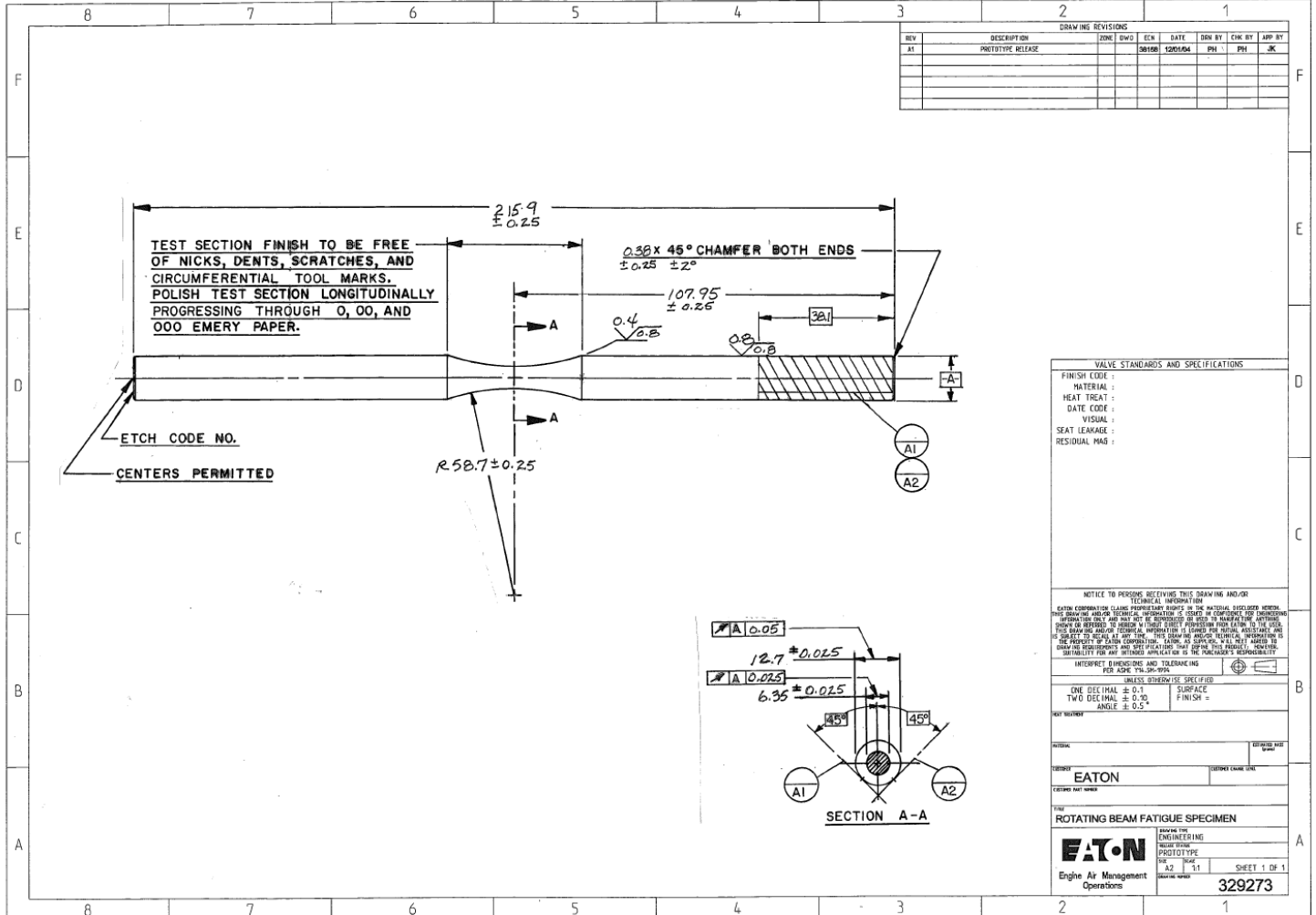


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APPENDIX



RBF Specimen

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GERDAU SPECIAL STEEL NORTH AMERICA
 5591 MORRILL ROAD
 JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
P019304	8620H01HR1.188	M54117	287727 101	4/21/14

Danieli Cast

ORDERED

GRADE	SIZE	LENGTH									
8620	1 3/16" RND	20'									
CUSTOMER SPECIFICATIONS											
8620H 01 HR 1.188 REV 11.01.12; DI 2.25/2.6; 190/230 BHN											
CHEMICAL ANALYSIS											
C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Sn	Al	
0.22	0.85	0.013	0.009	0.25	0.50	0.57	0.21	0.21	0.009	0.024	
V	Nb										
0.002	0.003										
GRAIN SIZE	SPECIFICATION ASTM E112		FINE GRAIN 5-8								
HARDNESS	SPECIFICATION ASTM E10		AFT STRAIGHTEN								
			SURFACE		197.0						
PAGE 1			We certify that these data are correct and in compliance with specified requirements.								
Gerdau Monroe 3000 East Front Street Monroe, MI 48161			 Wendy J. Craig <small>Quality Assurance Representative</small>								

CONTINUED ON PAGE 2

Material Certification

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Danieli Cast

REPORT TO
 DIANNE MINER
 IMPACT PRECISION FORGE
 P.O. BOX 919
 COLDWATER , MI 49036

SHIP TO
 IMPACT PRECISION FORGE
 551 JAY STREET
 COLDWATER , MI 49036

ORDERED

GRADE	SIZE	LENGTH
8620	1 3/16" RND	20'

CUSTOMER SPECIFICATIONS

8620H 01 HR 1.188 REV 11.01.12; DI 2.25/2.6; 190/230 BHN

HARDENABILITY SPECIFICATION ASTM A255/A304

THEORETICAL

J1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30	32	34
46	46	44	39	35	31	29	28	27	26	23	22	21	20	20										

DI CALCULATION SPECIFICATION CAT 1E0024

2.49

REDUCTION RATIO

RATIO= 32.5 TO 1.0

** MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION. GERDAU MONITORS ALL INCOMING SCRAP AND ALL HEATS OF STEEL TO ENSURE THAT PRODUCTS SHIPPED ARE FREE OF RADIOACTIVE MATERIAL.

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We certify that these data are correct and in compliance with specified requirements.

Gerdau Monroe
 3000 East Front Street
 Monroe, MI 48161

Wendy J. Craig
 Quality Assurance Representative

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