



Test Certificate

Daido Steel Co.,Ltd.
Shinagawa Bldg., 6-35, 1-chome
Konan, Minato-ku
Tokyo, Japan
108-8478

REF No
Page
Ord No
Date Tested
Date Printed
Date Received

T 001136 : Issue 1
1 of 6
Wire Transferred - T915111
01/23/10
05/15/10
01/23/10

Attn: Dr. Kunio Namiki

Item - MATERIAL SUPPLIER QUALIFICATION: GRADE "DH31-EX"
HEAT #5C488F, 280mm Thick x 770mm Wide x 54mm Long

Specification - NADCA #207-2008

Chemical Analysis

	C [%]	Mn [%]	P [%]	S [%]	Si [%]	Ni [%]	Cr [%]	Mo [%]	Cu [%]	V [%]		Comments
001:	0.33	0.92	0.011	<0.002	0.34	0.14	5.43	2.36	0.06	0.53		Reference
Analysis by ICP, OES, Combustion and/or Gravimetric Methods. Details available upon request.												

Charpy Test - ASTM E23-07ae1

	Position	Dimensions [mm]	Denomination	Test Temp [°F]	Energy Absorbed [ft. lbf]	Average [ft. lbf]	Comments
002:Short Transverse	CVN = 43 HRC	10x10x2V	N/A	-110.0	9, 8, 11	9.3	Reference
003:Short Transverse	CVN = 43 HRC	10x10x2V	N/A	R/T	18, 17, 17	17.3	Reference
004:Short Transverse	CVN = 43 HRC	10x10x2V	N/A	212.0	28, 26, 28	27.3	Reference
005:Short Transverse	CVN = 43 HRC	10x10x2V	N/A	300.0	42, 39, 37	39.3	Reference
006:Short Transverse	CVN = 43 HRC	10x10x2V	N/A	450.0	55, 48, 54	52.3	Reference

Micro Examination - ASTM E3-01(07)e1

	Position	Details	Comments
007:Parent	Banding	NADCA #207-2008	Acceptable
008:Parent	Structure	NADCA Figure AS 3	Acceptable

Micro Examination - ASTM E112-96(04)Comn

	Position	Details	Comments
009:Grain Size	Austenitic	ASTM No. 9.0	Acceptable

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Micro Examination - ASTM E45-05e3: A			
	Position	Details	Comments
010:Inclusion Count	Plate 1-r	Type A: 0 T, 0 H	Acceptable
011:Inclusion Count	Plate 1-r	Type B: 0.5 T, 0 H	Acceptable
012:Inclusion Count	Plate 1-r	Type C: 0 T, 0 H	Acceptable
013:Inclusion Count	Plate 1-r	Type D: 1.0 T, 0 H	Acceptable

Hardness Test - ASTM E18-08b				
	Method	Load	Results	Comments
014:As Received Hardness	Rockwell A	60kgf	52, 53, 52	Eq(ASTM E140)= 165 HB
015:As Quenched Hardness	Rockwell A	60kgf	78, 78, 78	Eq(ASTM E140)= 54 HRC
Results obtained using carbide ball indenters (as applicable)				

Certificate Comments

CVN hardened @1885F, oil quenched, triple tempered 2hrs @1110F.

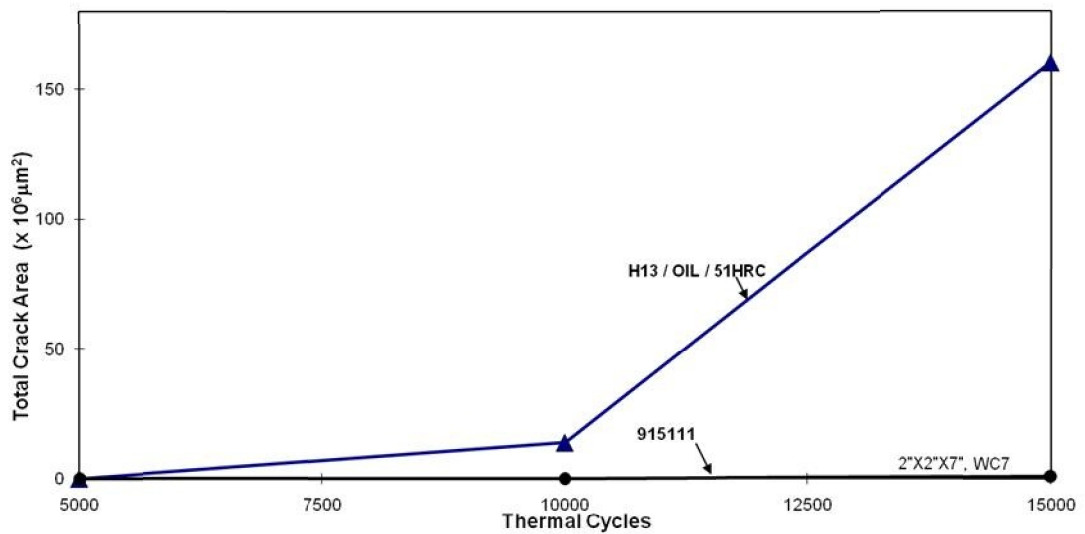
*Note: The fatigue dunk specimen was originally identified as 915111 for this DH31-EX material heat #5C488F. The report REF No has been modified to enable the inclusion of additional test data.

Mark K Goodyear
 Mark K Goodyear
 Test Engineer
 For and on behalf of
 Exova Inc.

Attachment - Not Applicable

	Location	Position	Magnification	
016:Subcontract Report	DUNK TEST	Total Crack Area	xN/A	

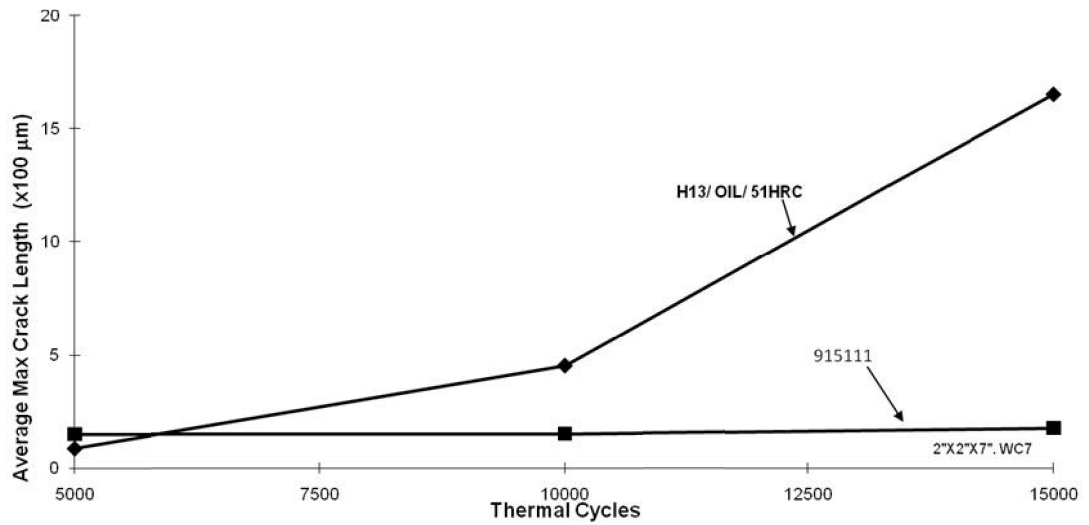
TOTAL CRACK AREA OF 915111 AND H13



Attachment - Not Applicable

	Location	Position	Magnification	
017:Subcontract Report	DUNK TEST	Average Crack Length	xN/A	

AVERAGE MAXIMUM CRACK LENGTH OF 915111AND H13



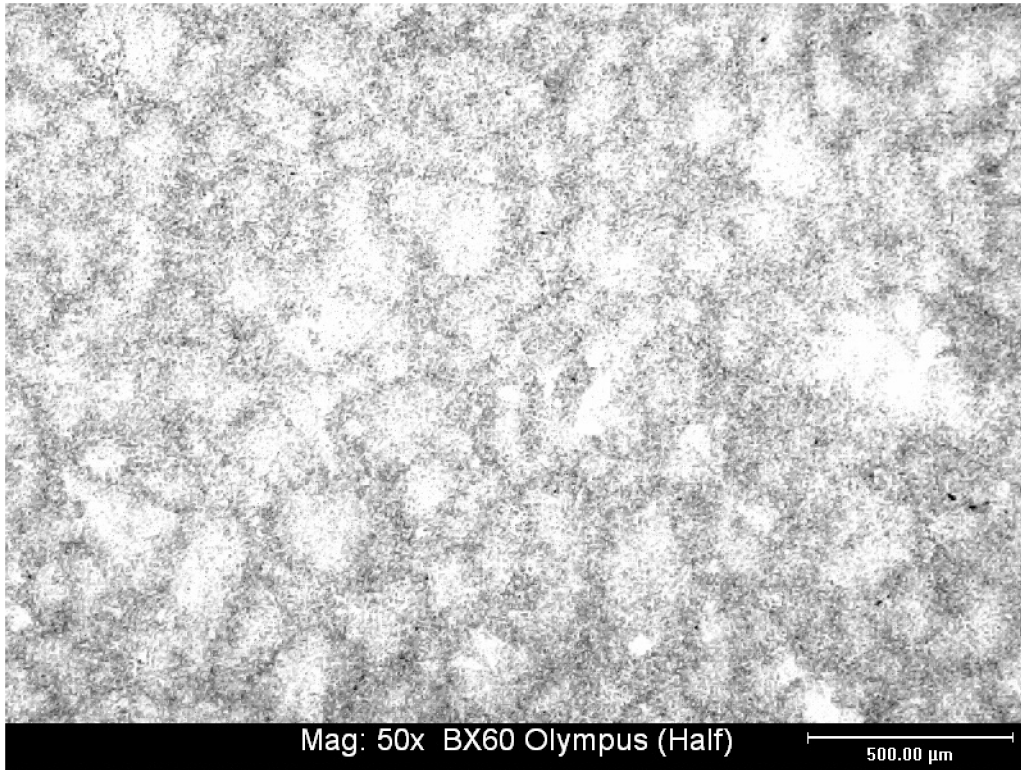
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Photographs - In House Procedure

	Location	Position	Magnification	
018:Micro Section	Etched	Banded Structure	x50	



Stated magnification refers to original capture condition.

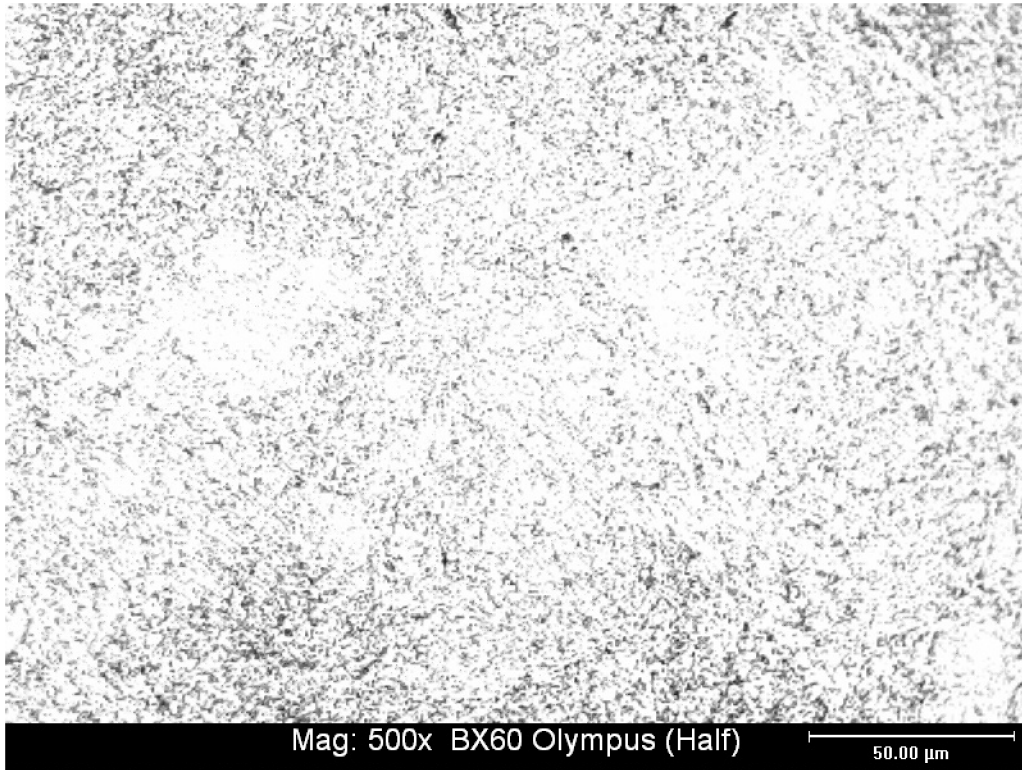
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Photographs - In House Procedure

	Location	Position	Magnification	
019:Micro Section	Etched	Annealed Structure	x500	



Stated magnification refers to original capture condition.