THE BOEING COMPANY
AERO-SPACE DIVISION
LAUNCH SYSTEMS BRANCH

DOCUMENT NO. T5-6539-81

VOLUME ____ OF ____

TITLE METALLURGICAL ANALYSIS OF, HANDLING TOOL, FORWARD BOOSTER ASSEMBLEY LIFTING EYE, H.T. 370-7040-2-5.

MODEL NO. SAT V/S-IC CONTRACT NO. NAS8-5608

ISSUE NO. M-19 ISSUED TO Scientific & Technology, Inc.

PREPARED BY	R. R. Sands	11-29-66
SUPERVISED BY	E. L. Clark	11-29-66
APPROVED BY	T. J. Kornell	11/30/66
APPROVED BY		
APPROVED BY		
APPROVED BY		

REV. SYM. ____

S-406-10-3 REV. 7/64

Distribution

BOEING+

R. D. Strohl	5-7312	LC-99	
S. J. LeBlanc, Jr.	5-7474	LT-39	(2)
J. S. Hernandez	5-7474	LT-39	
J. J. Eckle	5-7470	LT-47	
W. J. Waugh	5-7400	LS-76	
R. A. Morehouse	5-7351	LT-46	
E. Tuseth	5-7350	LT-26	
R. R. Sands	5-7996	LS-81	(2)

NASA

R. McDaniel	R-P&VE-VNR
F. Uptagrafft	R-P&VE-ME

Scientific and Technical Information Facility
Marshall Space Flight Center
Huntsville, Alabama (Attn: MS-IP)

Scientific and Technical Information Facility
P. O. Box 33
College Park, Maryland 20740

CHANGE RECORD									
REV. SYM.	SECT.	PAGES			REV. SYM.	SECT.	PAGES		
		REVISED	ADDED	DELETED			REVISED	ADDED	DELETED

REV. SYM. _____

S-406-35-10 ORIG. 1/64

REVISIONS			
REV. SYM.	DESCRIPTION	DATE	APPROVED

REV. SYM. _____

ABSTRACT

The lifting eye weldment after proof load testing showed repeated presence of cracks. The metallurgical test revealed strength below drawing requirements and decarburization on top and bottom surfaces of the tool. It was recommended that, if the part is to be used in present conditions, magnaflux inspection should be performed after each loading and any cracks removed.

KEY WORDS

Decarburization

Hardenability

TABLE OF CONTENTS

LIST OF FIGURES

1.0 OBJECT

To determine metallurgical condition of lifting eye weldment and possible cause of numerous cracks.

2.0 BACKGROUND

The lifting eye weldment after proof load testing has been found to contain surface cracks. A recent magnaflux inspection of the part showed no cracks on the "D" and "F" vehicle tool but cracks were found on 501. These cracks were removed by grinding to a depth of less than .10 inch. As a result of the above findings and the repeated presence of cracks in other effectivity tools, it was determined to evaluate the material of the tool.

3.0 CONCLUSIONS

1) The general weakness of the 4130 plate due to surface laps and .010"depth of 100% decarburization is directly related to the surface cracking of the part.

2) The material was 90% below drawing strength requirements due to the inherant low hardenability of the 4130 steel plate.

4.0 RECOMMENDATIONS

1) If part is to be used in the present condition magnaflux inspection should be performed after each loading and any resultant cracks should be removed to preclude multiple loading propagation. Any rework done on the part should be reviewed to qualify the part for function.

2) If the part is to be scrapped all new parts should use the following material procurement and heat treatment processing drawing callouts.

   a) AISI 4335 Mod. Steel Plate per AMS 6434

   b) Heat treat assembly to 125-145 ksi per BAC 5617. maximum decarburization on any surface .003 inch.

5.0 PROCEDURES AND RESULTS

The lifting eye weldment was delivered to the M & P laboratory for Metallurgical Analysis. A 1" plug was removed from a webb area indicated by the stress unit: A 1½" hole was left in the webb.

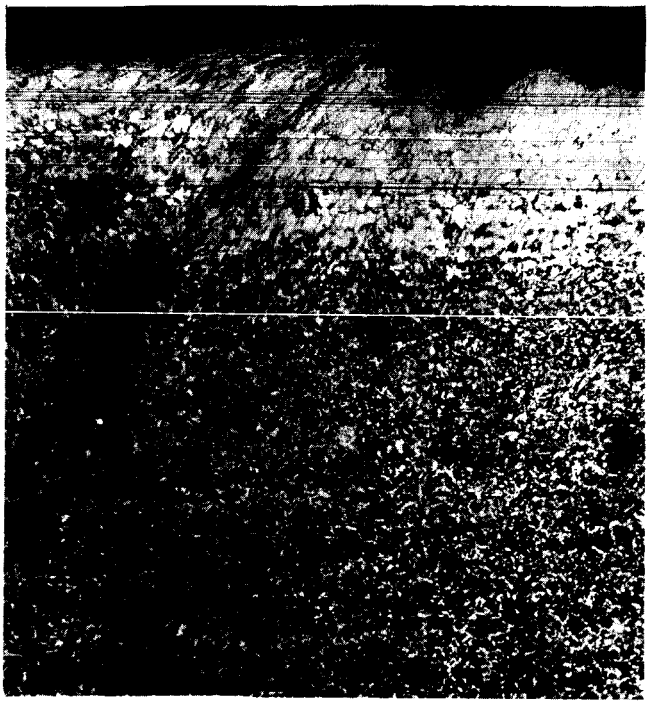
5.0 PROCEDURES AND RESULTS (Continued)

A spectrographic analysis and a carbon analysis run on part of the sample, identified the material as 4130 steel.

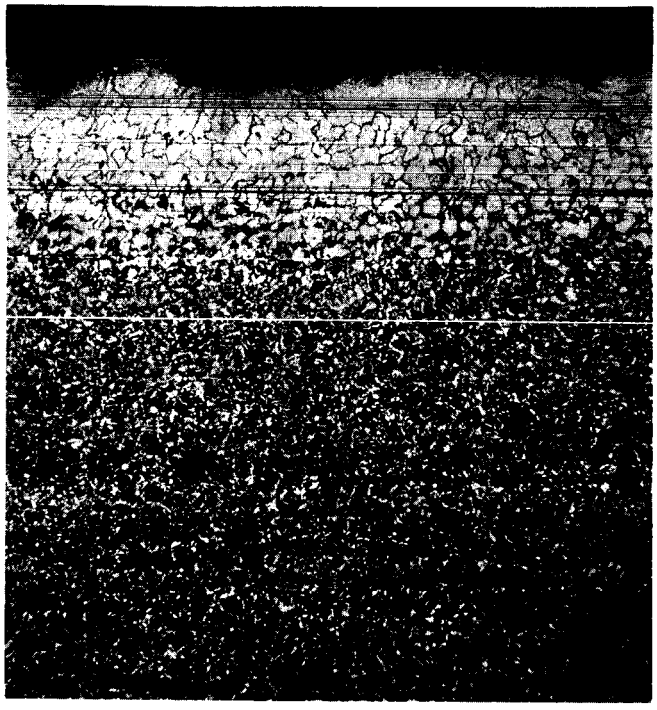
The metallographic structure and a 500g DPH hardness survey (Figure #2) showed 100% decarburization .010" deep (Figure #1) on the top and bottom surface while the top surface showed partial decarburization another .012 to .015" deeper.

Figure #1 shows a lap in the decarburized surface. This type of defect could be inherent in the as received plate or could be induced by surface impact.

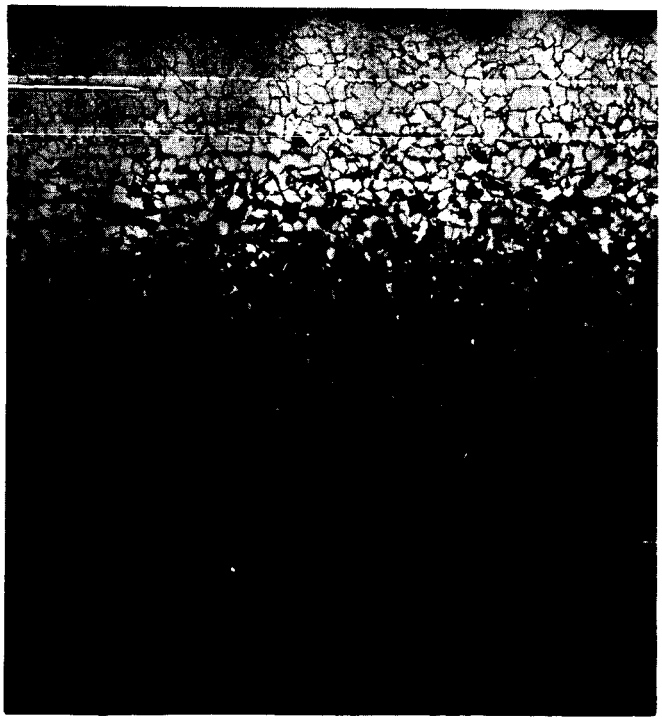
The crack as shown could propagate catastrophically or in a fatigue manner and therefore should be removed prior to loading of the part.



100X
Top Surface Cross Section
Note Seam In Decarburized Surface



100X
Top Surface Cross Section
Note Depth of 100% Decarburization
And Partial Decarburization



100X
Bottom Surface Cross Section
Figure #1

DIAMOND PYRAMID HARDNESS

LOAD 500G
OBJ. 50X

INCHES	L1	L2	FILAR	DPHN	Rc	Rb
			TOP OF SAMPLE			
.003	406	400	403	162	—	82
.006	359	360	360	203	—	92
.009	363	368	366	196	—	90
.012	334	332	333	237	—	98
.015	345	347	346	220	—	95
.018	330	328	329	243	21.5	99
.021	332	328	330	241	21.0	98
.200	328	327	327	245	22.0	99
.400	330	331	330	241	21.0	98
.600	332	338	335	232	19.0	97
.600	318	330	324	251	23.0	100
.400	334	338	336	231	19.0	97
.200	315	315	315	265	25.0	101
.021	318	314	316	264	25.0	101
.018	315	314	314	267	25.5	102
.015	327	332	329	243	21.5	98
.012	381	376	378	184	—	88
.009	420	412	416	152	—	79
.006	452	426	439	137	—	74
.003	414	413	413	154	—	80
			BOTTOM OF SAMPLE			

Figure #2