

PE05-067
HEIL TRAILER
12/19/2005
EXHIBIT 7, 8, & 9
PART 3 OF 3

PE05-067
HEIL TRAILER
12/19/2005
EXHIBIT 7
SEE INRD-PE05067-23782

PE05-067
HEIL TRAILER
12/19/2005
EXHIBIT 8

Figure 10.a.1.



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FAILURE ANALYSIS OF TANK TRAILER FRAME COMPONENTS

ATS JOB #D 75275

PURCHASE ORDER # 025370

Prepared for

MR. JOE ROBINSON
HEIL TRAILER INTERNATIONAL
1125 CONGRESS PARKWAY
ATHENS, TN 37303

Prepared by

Venu Krishnardula, Metallurgist

Approved by

Joseph Maciejewski, P.E., Supervisor

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This report represents interpretation of the results obtained from the test specimen and is not to be
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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 1

of 14

Purchase Order: 025370

Mr. Joe Robinson
Heil Trailer International
1125 Congress Parkway
Athens, TN 37303

Subject

Failure Analysis of Tank Trailer Frame Components

Material

Carbon Steel

Objective and Background

The purpose of this evaluation was to determine the cause for failure of the tank trailer frame box beams submitted to our laboratory.

Test Procedure and Results

The as-received failed trailer frames are shown in Figures 1 and 2. The fracture surfaces were cleaned with detergent solution and inhibited hydrochloric acid (HCl). No macroscopic plastic deformation and a flat fracture surface with no wall thinning were observed.

The fracture surfaces of Frame A were observed at low magnification (3X to 50X) using a stereomicroscope. Multiple crack initiation sites were observed on the fracture surface (Figure 3). Corrosion and mechanical damage destroyed much of the fracture surface detail allowing limited area for failure analysis. Beach marks, typical of fatigue, were observed on the fracture surface (Figures 4 and 5). Box Beam B exhibited fracture features similar to Frame A.

Scanning electron microscope (SEM) examination (50X to 5,000X) revealed striations (Figure 6) on the fracture surface indicative of fatigue.

Transverse sections through the fracture surface, as shown in Figures 3 and 4, were cut, and prepared in accordance with ASTM E3-01, *Standard Practice for Preparation of Metallographic Specimens*. Excessive fit-up gap and multiple cracks were observed in the box/gusset weld section (Figure 7). The section through the fatigue fracture origin revealed features such as porosity, lack of fusion during welding and cracks at the weld fusion line (Figures 8 and 9). The Box beam base metal exhibited small



CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 2

of

14

volumes of pearlite in a ferritic matrix (Figure 10), consistent with a low carbon steel, and the weld metal exhibited a ferritic/bainitic structure (Figure 11).

Tensile samples were prepared in accordance with ASTM A370-03a, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*. The tensile test results are shown in Table I, which were normal for a low carbon steel.

Discussion and Conclusions

The box beams failed due to fatigue (i.e., cyclic loading). Cracks initiated at the box/gusset weld and propagated along the rest of box beam wall leading to complete separation of the beam. The extent of fatigue zone indicated low overall stress.

Poor weld quality which resulted in defects such as porosity, lack of fusion and/or cracks at the fusion line, likely contributed to the fatigue initiation. Excessive fit-up gap between the box beam and the gusset increased flexural stresses in the joint.

The weld procedures and process control during manufacturing should be investigated in order to reduce the weld defects. Non-destructive testing of the components of the as-manufactured components may be helpful in detecting the defects and decreasing the likelihood of fracture.



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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 3

of 14

Table I: Tensile Properties of the Box Beam Base Metal

Specimen Identification	Tensile Strength, psi	Yield Strength, psi	Elongation % in 2 in.
A	66,000	60,000	23
B	65,500	59,500	25



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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 4

of

14

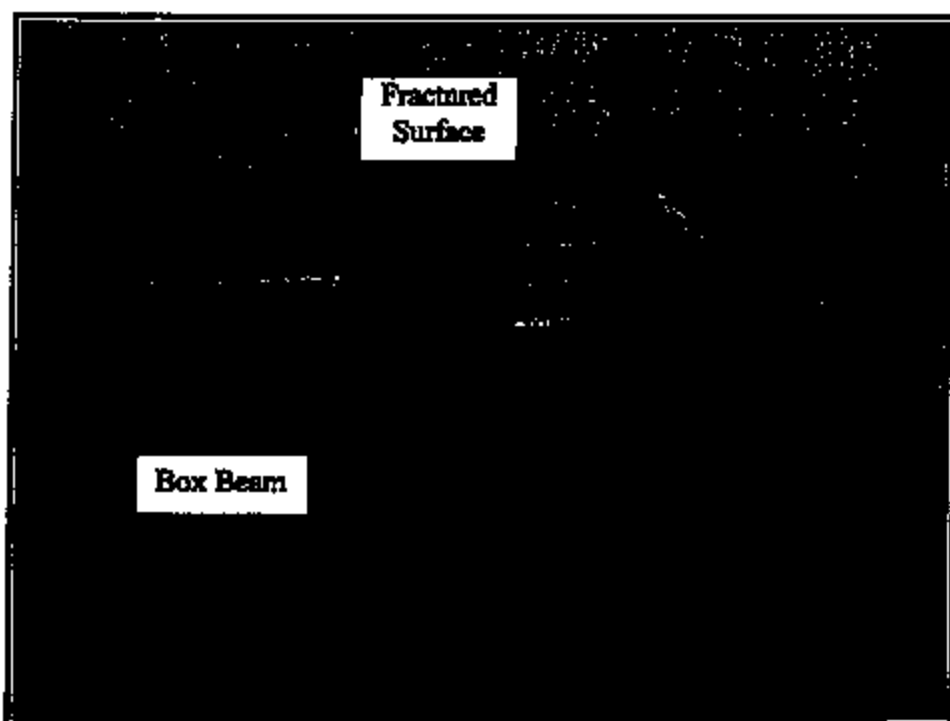


Figure 1: As-received Trailer Frame A components indicating the fractured surfaces (black arrows) and the box beam (red arrow)



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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 5

of 14

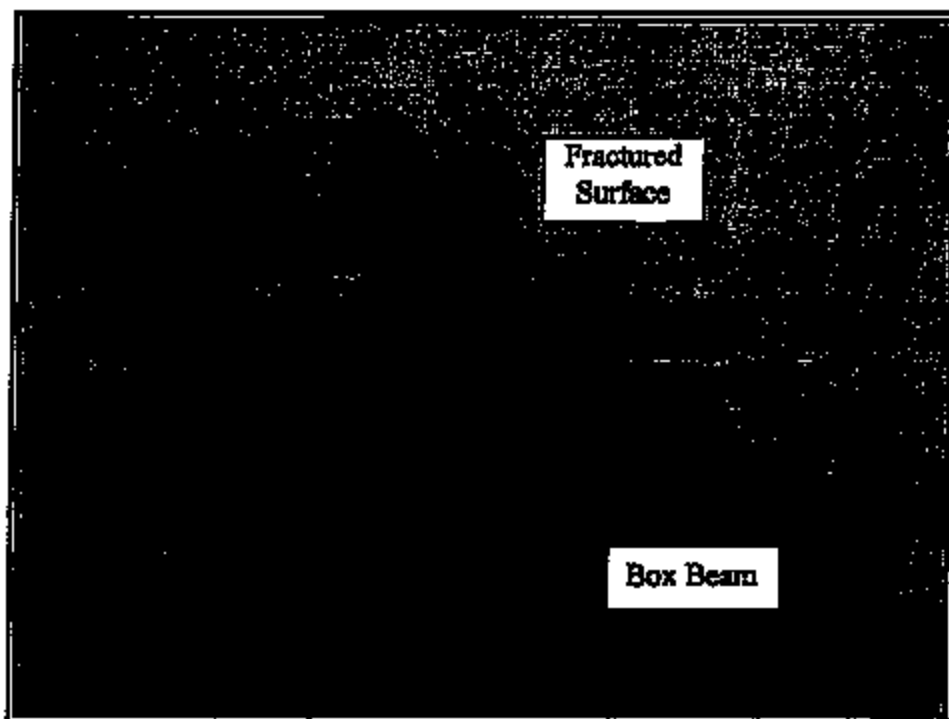


Figure 2: As-received Trailer Frame B components indicating the fractured surfaces (black arrows) and the box beam (red arrow)



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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 6

of

14

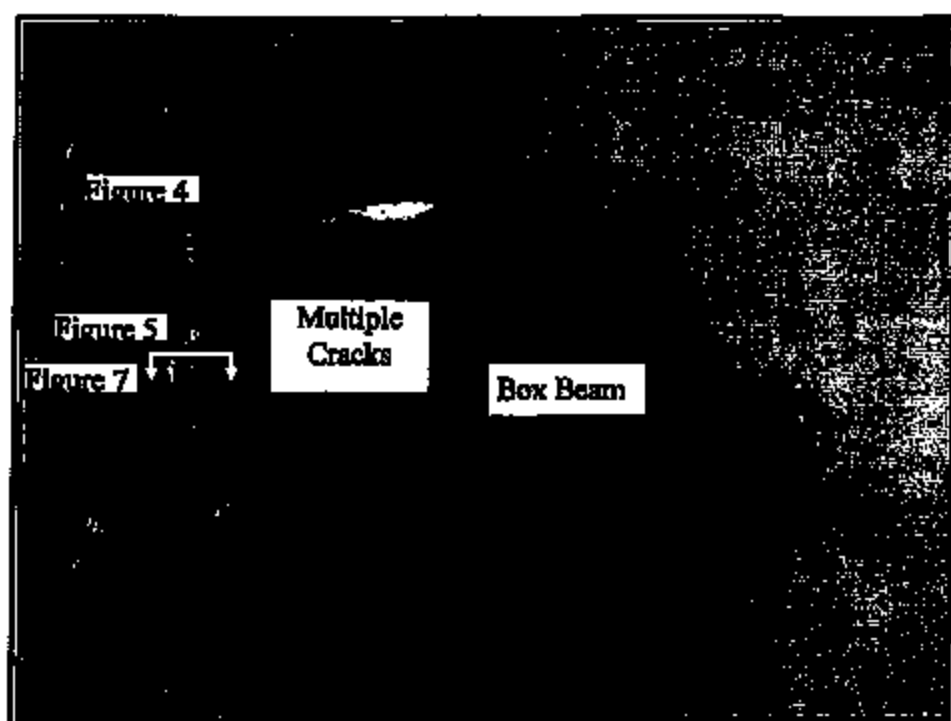


Figure 3: Failed trailer frame indicating multiple cracks on the fracture surface (black arrows) (also see Figures 4 - 6) (white line shows region sectioned for metallographic examination Figure 7)

CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 7

of 14

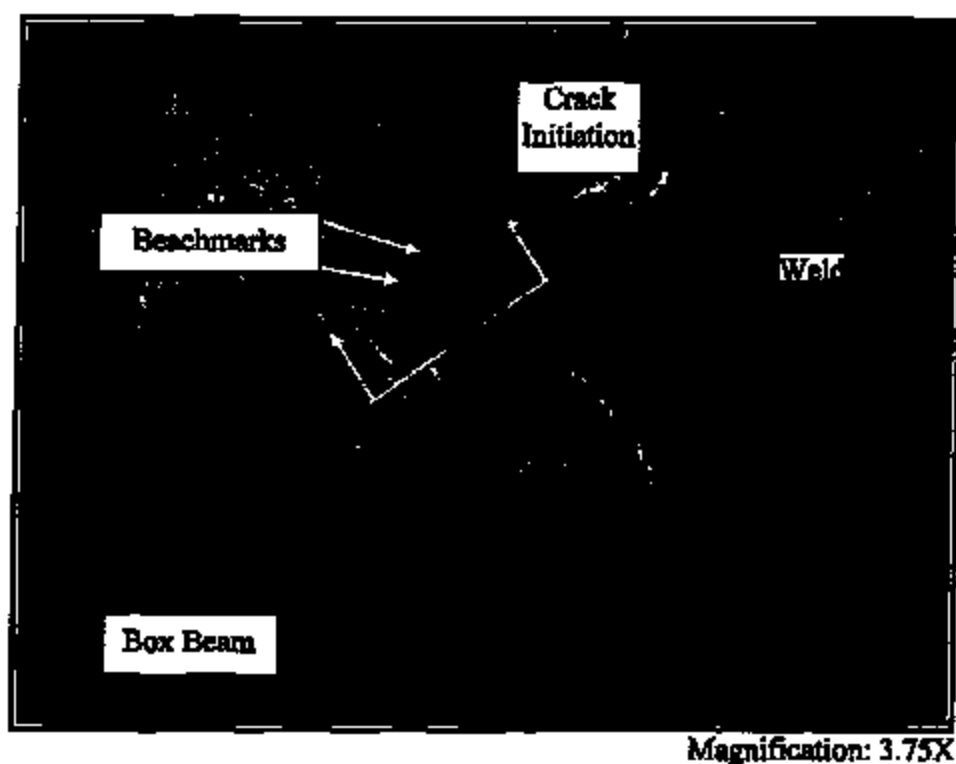


Figure 4: Frame fracture surface indicating crack initiation site (black arrow) and beach marks indicating fatigue failure (white arrows) (white dotted lines show region sectioned for metallographic examination Figures 8 - 11)



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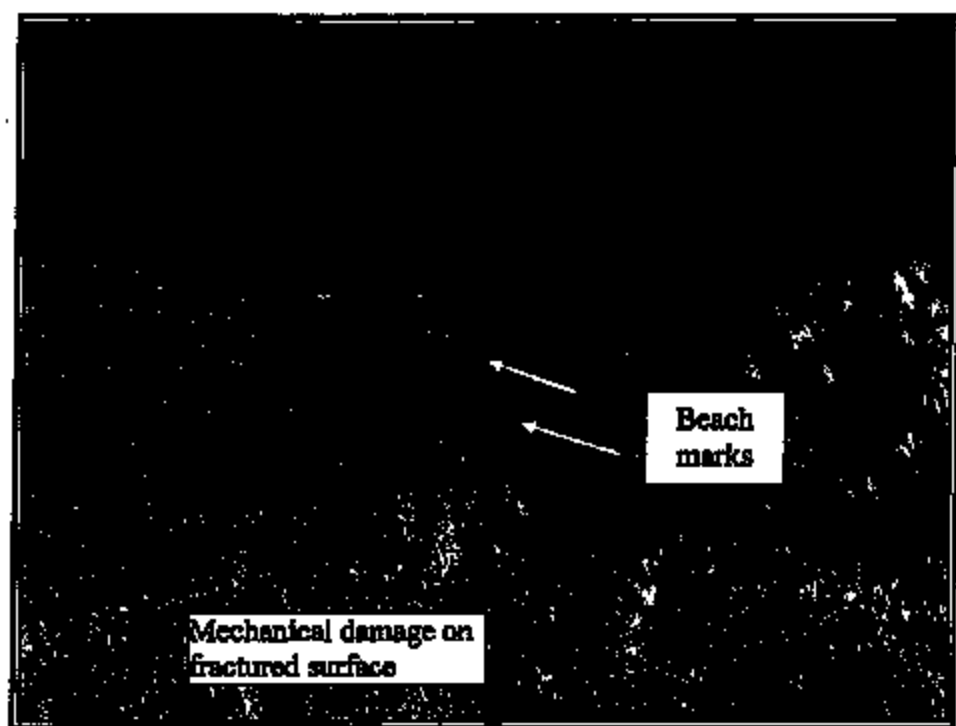
Ref. D 75275

Date: October 10, 2005

Page 8

of

14



Magnification: 3.75X

Figure 5: Frame fracture surface showing beach marks, typical of fatigue failure (white arrows) and mechanical damage (black arrows)



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CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 9

of

14



Magnification: 1500X

Figure 6: SEM picture of the fracture surface from the region shown in Figure 5 indicating striations (arrows)



CERTIFIED TEST REPORT

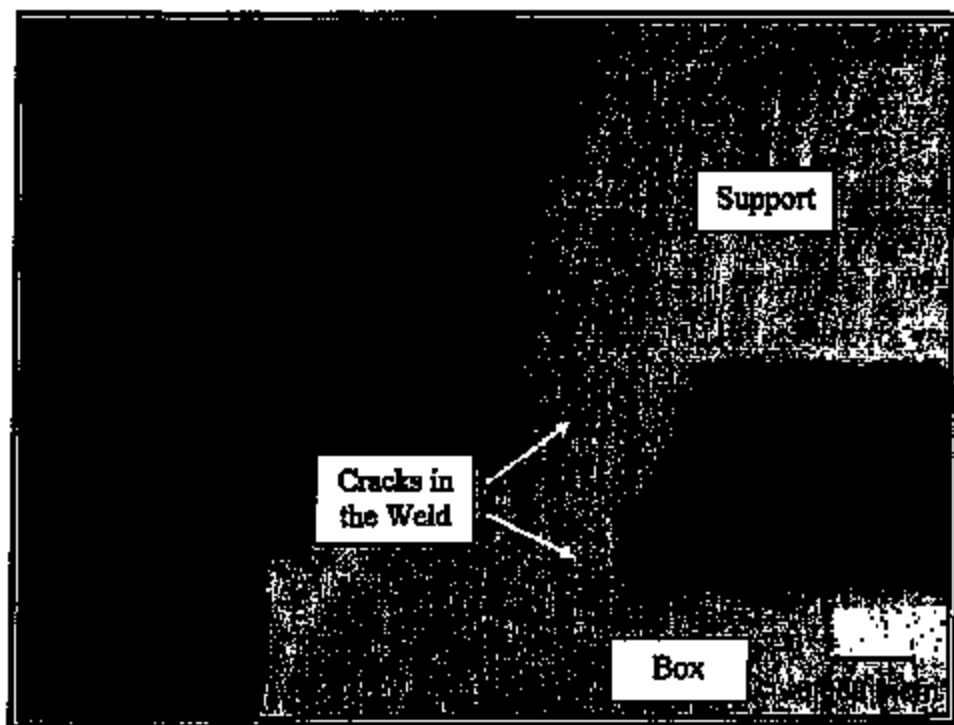
Ref. D 75275

Date: October 10, 2005

Page 10

of

14



Magnification: 7.5X

Figure 7: Cross-section of the box/frame weld indicating multiple cracks (arrows) from the section shown in Figure 3



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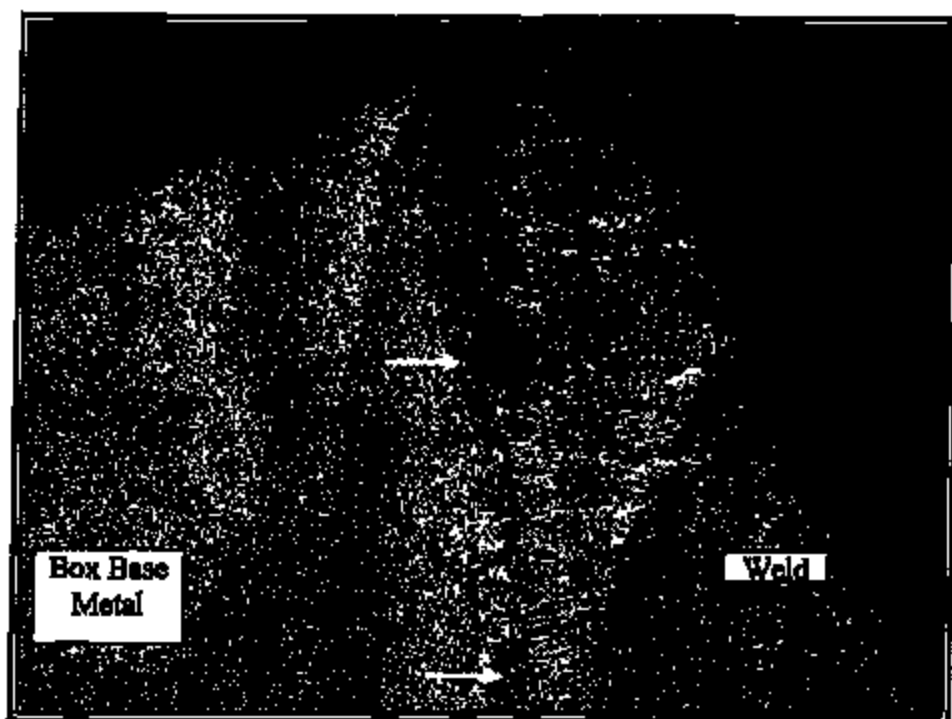
Ref. D 75275

Date: October 10, 2005

Page 11

of

14



Etchant: Nital

Magnification: 25X

Figure 8: Cross-section near the fracture origin showing lack of fusion (white arrows) and pores (black arrow)



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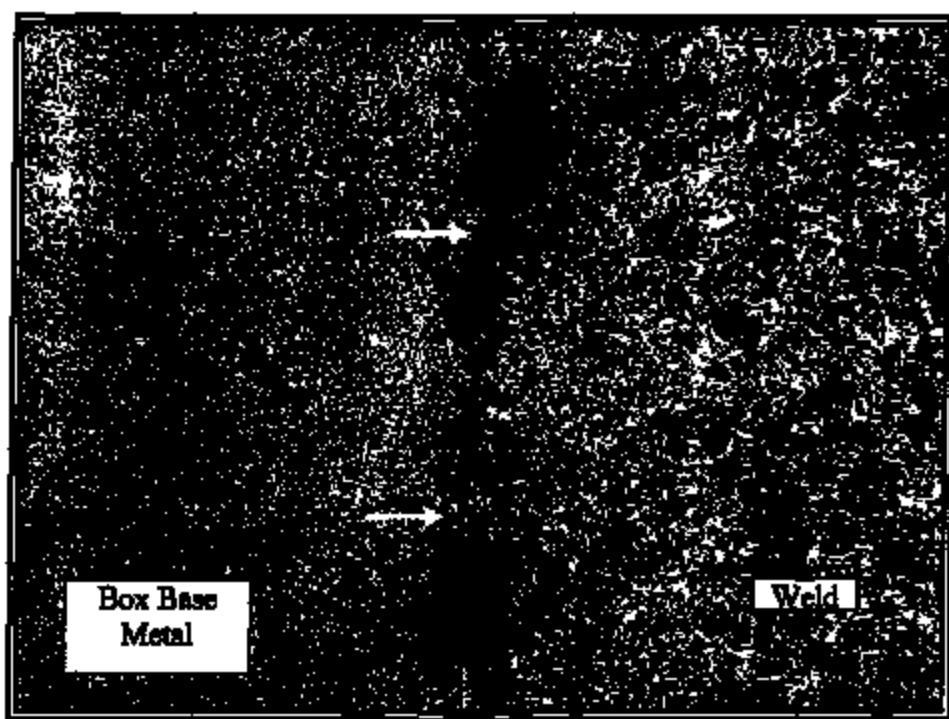
Ref. D 75275

Date: October 10, 2005

Page 12

of

14



Etchant: Nital

Magnification: 25X

Figure 9: Cross-section through the weld indicating cracks or lack of fusion (white arrows) and pores (black arrow)



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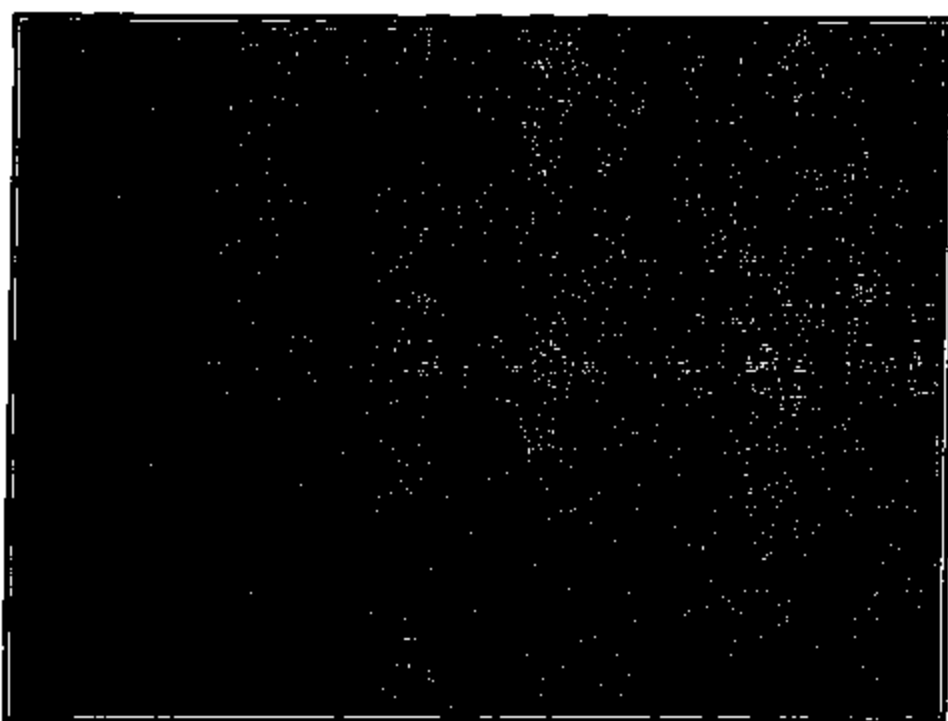
CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 13

of 14



Etchant: Nital

Magnification: 500X

Figure 10: Microstructure of the Box beam base metal, exhibiting small volumes of pearlite in a ferritic matrix



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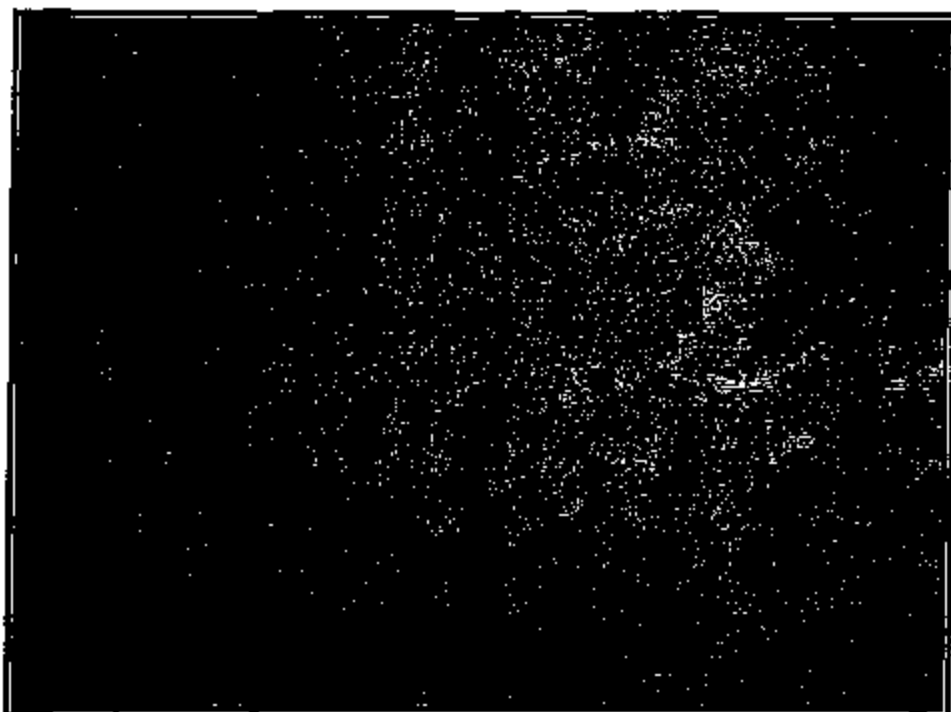
CERTIFIED TEST REPORT

Ref. D 75275

Date: October 10, 2005

Page 14

of 14



Etchant: Nital

Magnification: 500X

Figure 11: Microstructure of Box/Gusset weld metal exhibiting a ferritic/bainitic structure

Figure 10.e.1.

SAFETY MESSAGES

	DANGER	THESE SAFETY ALERT SYMBOLS INDICATE IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THESE SYMBOLS, CAREFULLY READ THE MESSAGES THAT FOLLOW AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH TO YOURSELF OR OTHERS.
	WARNING	
	CAUTION	

	CAUTION	
Inspection of equipment, safety devices and working areas must be performed before each trip to ensure personal and operational safety and to correct potential or actual hazards.		

	DANGER	
Do not alter or modify any of the equipment or components provided with this tank trailer. Use of non-HEIL parts or non-OEM component parts may cause serious personal injury, including death.		

	WARNING	
Before moving the tank trailer inside a building, the tank must be free of product and checked with an approved gas analyzer to ensure it is free of hazardous and/or flammable vapors.		

	DANGER	
Do not enter the tank trailer until each of the following conditions has been satisfied:		
+ The pressure in the vessel has been completely relieved. + The tank has been thoroughly purged and ventilated. + The tank has been degassed and cleaned by an authorized cleaning facility. + The MSDS for the last product(s) haled has been reviewed. + The OSHA 1910.126 Confined Space Entrance Requirements are strictly complied to.		
Failure to follow any one of these instructions may result in serious personal injury, including death.		

PE05-067
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12/19/2005
EXHIBIT 9

Beth Bennett

From: Bernie Rigglin
Sent: Friday, October 07, 2005 7:08 AM
To: David Morrow
Subject: FW: one piece tower plate-air bag plate

fyi

-----Original Message-----

From: Paul Katko
Sent: Friday, October 07, 2005 6:48 AM
To: Hunter Griffith; Tracy Harmon
Cc: Bernie Rigglin; Don Wilson; Ben Ubamadu; Joe Calonge
Subject: RE: one piece tower plate-air bag plate

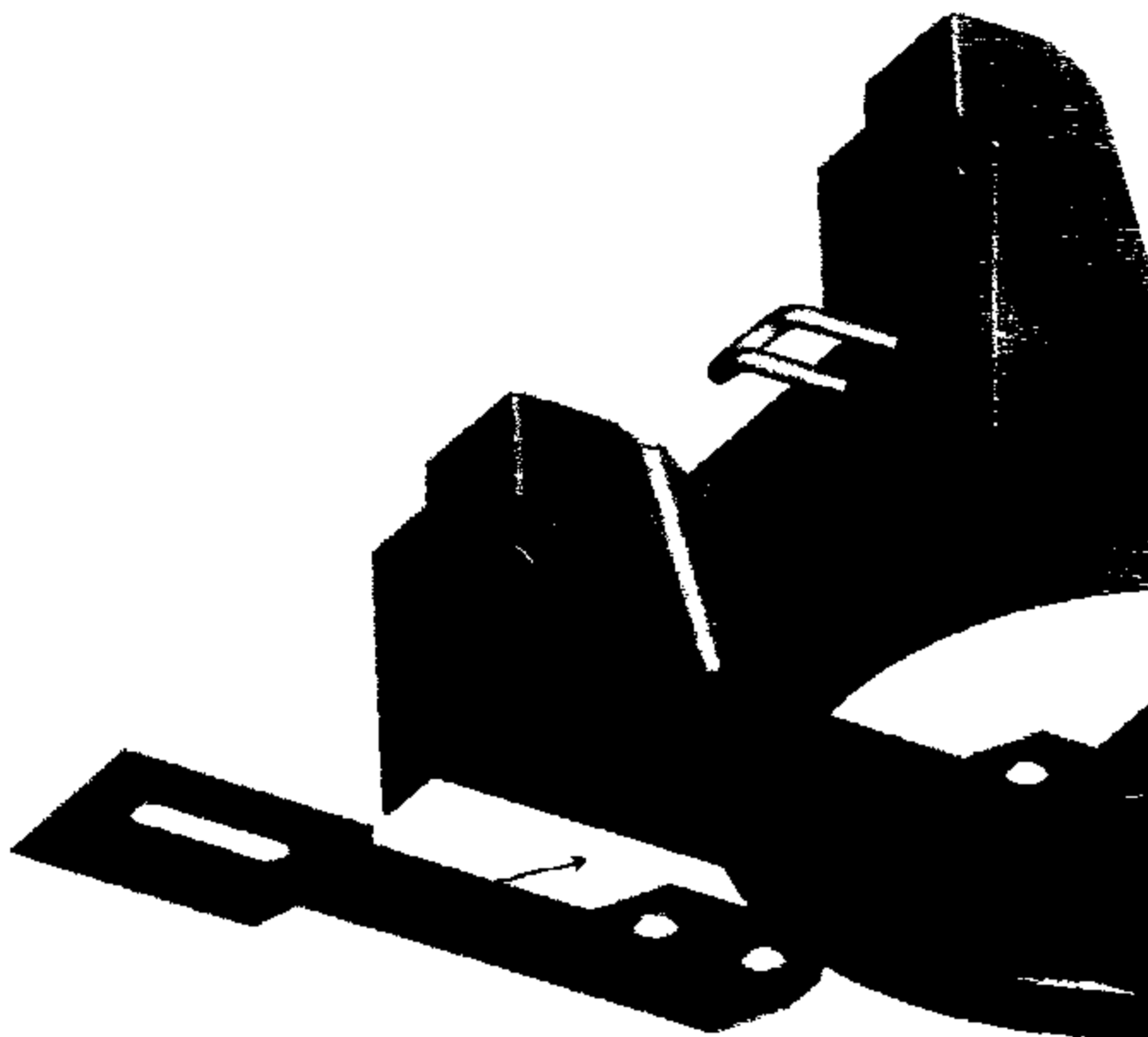
Hunter,

I like the concept; I think I would extend it past the end of the frame tube so there couldn't be a weld across the bottom of the tube to the rear of the bag plate.

From: Hunter Griffith
Sent: Thursday, October 06, 2005 8:59 AM
To: Tracy Harmon
Cc: Paul Katko; Bernie Rigglin; Don Wilson; Ben Ubamadu; Joe Calonge
Subject: one piece tower plate-air bag plate

Tracy,

Did you have any thoughts/concerns on using a one piece tower/air bag plate? Please see the attached image.



Best Regards,

Hunter Griffith
Design Engineer-Petroleum
Hell Trailer International
(423) 745-5830 x180

12/13/2005