

Purchase Order No.: ORDPE/7732			Tag No.:		OSI Doc. No.: 21409C	
Rev. No.	Submittal Date	Revision	Prep By	OSI Checked	OSI Approved	Client Approval
A	23 Mar 2010	Official Release	T. Williams	E. Lutgring	S. Bergeron	







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Table of Contents

Foreword / Introduction

Symbols

Service Assistance and Ordering Information

#### Section 1.0 Crane Description

- 1.1 API Certificate
- 1.2 API 2C Placard
- 1.3 N2009SK4-025 Crane General Arrangement
- 1.4 N2009SK3-051 Lifting Load Capacity Chart
- 1.5 Crane Acceptance Test Procedure & Report
- 1.6 Crane Critical Component Log
- 1.7 Information Chart

#### Section 2.0 Installation Manual

- 2.1 Warning
- 2.2 Bolt Torquing Procedure
  - 2.2.1 Ballring To Pedestal
  - 2.2.2 Ballring To Turret
- 2.3 Torque For Plated Fasteners
- 2.4 Recommended Anchoring Of Wire Rope at Dead End
- 2.5 Anchoring Wire Rope
- 2.6 Wire Rope Break-In Procedure
- 2.7 Reeving Diagram
  - 2.7.1 4 Part Line
  - 2.7.2 1 Part Line
  - 2.7.3 8 Part Line
- 2.8 Spacer Kit



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.0 Operation Manual

- 3.1 Operation Guidelines
  - 3.1.1 About Load Charts
  - 3.1.2 Maintenance & Inspection Guidelines
- 3.2 General Operation of Crane
- 3.3 Operation Caution
- 3.4 Crane Operation
- 3.5 Crane Signals
- 3.6 Emergency Load Lowering Kit Instructions
  - 3.6.1 CH Series Hoist
  - 3.6.2 PD Series Hoist

### Section 4.0 Maintenance Manual

- 4.1 Maintenance Introduction
- 4.2 Maintenance Precaution
- 4.3 Routine Inspection & Service / Daily Function Test
- 4.4 Notes & Precautions
- 4.5 Maintenance Schedule
- 4.6 Lubrication Diagrams
  - 4.6.1 Load Block
  - 4.6.2 Boom Foot Pin / Lift Cylinder Pins
  - 4.6.3 Ballring
  - 4.6.4 Gearbox
  - 4.6.5 Sheave Case
  - 4.6.6 Floodlights
- 4.7 Recommended Fluids & Lubricants
  - 4.7.1 Hydraulic Oil
  - 4.7.2 Gear Oil



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

- 4.7.3 Oil Fill & Level Check For Geardrives
- 4.8 Miscellaneous Fluids
- 4.9 Maintenance Malfunction Diagnosis
- 4.10 Hoist Descriptive Literature, Catalogues
  - 4.10.1 Braden Gearmatic
  - 4.10.2 Hoist Installation, Maintenance and Service Manual
- 4.11 Manufacturer Ballring Data

### Section 5.0 Repair Manual

- 5.1 Hose Assembly List
- 5.2 Bill of Materials
- 5.3 Identified Parts - Pictures
- 5.4 N2009SK4-025 Crane General Arrangement
- 5.5 N2009SK4-024 Power Unit General Arrangement
- 5.6 N2009SK1-238 Hydraulic Schematic
- 5.7 N2009SK1-239 Electrical Schematic
- 5.8 N2009SK1-237 Wiring Diagram
- 5.9 N2009SK1-236 Air Schematic
- 5.10 Engine Operations & Maintenance Manual
- 5.11 Hydraulic System
- 5.12 Load Indicator System
- 5.13 Sentinel Engine Shutdown System



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 6.0

### Appendix

- 1.0 Material Certificates and NDE Reports
- 2.0 Pin Certificates
- 3.0 Ballring Certificates
- 4.0 Ballring Clearance Reports
- 5.0 Bolt Certificates
- 6.0 Wire Rope Certificates
- 7.0 Load Block Certificates
- 8.0 Overhaul Ball Certificates
- 9.0 Backlash Reports
- 10.0 Miscellaneous



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

## FOREWORD

Oil States Industries Houma, LA is pleased with the high quality of workmanship observed in the design, manufacture and testing of your Nautilus Crane. Maximum crane performance and utilization can be maintained only by PROPER OPERATION and equally as important, PROPER MAINTENANCE. In return, you will assure yourself a long lifespan of reliable operation and service.

Should, on the other hand, anything arise requiring service, Oil States Industries Service Department will provide you the assistance or quality maintenance you may require.

## INTRODUCTION

Specifications and information in this manual are current at the time of printing. Oil States Industries reserves the right to change and/or amend these specifications at any time without notice.

This manual has been prepared to assist you in the operation and maintenance of your Nautilus Crane. However, correct and prudent operation of a crane rests with the operator who must thoroughly understand the operation of the crane and the necessary maintenance requirements. The first scheduled maintenance of your Nautilus Crane starts from day one of operation.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### SYMBOLS



"Danger" symbol indicates a procedure, condition or statement that, if not properly observed, will absolutely result in serious equipment damage, physical injury and/or possible death.



"Warning" symbol indicates a procedure, condition or statement that, if not properly observed, could result in serious equipment damage, physical injury and/or possible death.



"Caution" symbol indicates a procedure, condition or statement that, if not properly observed, may result in possible equipment damage, physical injury and/or possible death.



"Safety Alert" symbol indicates a precautionary statement. Attention is required in order to avoid possible personal injury.



**NOTE:** THIS IS THE SYMBOL FOR SPECIAL OPERATING OR MAINTENANCE INSTRUCTIONS.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### SERVICE ASSISTANCE & ORDERING INFORMATION

24 Hours a Day

#### INTRODUCTION

This section contains information for ordering replacement parts for the equipment.



**NOTE:** CERTIFIED OEM REPLACEMENT PARTS CONTAIN NAUTILUS PART NUMBERS. INFORMATION ON PARTS NOT LISTED IN THIS MANUAL MUST BE RECEIVED FROM OSI NAUTILUS CRANE FOR PROPER VALIDATION AS NON-OEM PARTS MAY NOT MEET PERFORMANCE STANDARDS. ANY REPAIRS MADE WITH NON-OEM PARTS COULD EFFECT SAFE OPERATIONS OF THE CRANE AND CAUSE POSSIBLE PERSONNEL INJURY.

#### PARTS DELIVERY

To ensure prompt delivery of parts, be sure to give the correct name, address, town, state and country to which the parts are to be shipped. Include the Zip Code, if applicable, and specify the type of shipment. If the type of shipment is not specified, parts will be shipped by the best available means as determined by Oil States Industries.

#### PARTS AND SERVICE INQUIRIES

If difficulty is encountered with the repair of any assembly / component or if replacement parts are needed for any reason, contact the Oil States Industries Parts and Service Department for assistance at the following:

*Oil States Industries*  
1180 Mulberry Road  
Houma, LA 70363 USA

Telephone: (985) 868-0630  
Toll Free: (800) 247-5530  
Fax: (985) 851-0778

*Oil States Industries Thailand Ltd.*  
19 Watchaklukya Road  
Huaypong Sub-district, Muang District,  
Rayong 21150, Thailand

Telephone: + 66 (0) 38 691 643  
Fax: + 66 (0) 38 691 644



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 1.0 Crane Description



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 1.1 API Certificate



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









®

**American  
Petroleum  
Institute**



## **Certificate of Authority to use the Official API Monogram**

**License Number: 2C-0007**

**ORIGINAL**

The American Petroleum Institute hereby grants to

**OIL STATES INDUSTRIES**

**1180 Mulberry Rd.**

**Houma, Louisiana**

the right to use the Official API Monogram® on manufactured products under the conditions in the official publications of the American Petroleum Institute entitled API Spec Q1® and **API Spec 2C** and in accordance with the provisions of the License Agreement.

In all cases where the Official API Monogram is applied, the API Monogram should be used in conjunction with this certificate number: **2C-0007**

The American Petroleum Institute reserves the right to revoke this authorization to use the Official API Monogram for any reason satisfactory to the Board of Directors of the American Petroleum Institute.

The scope of this license includes the following product: Offshore Pedestal Mounted Cranes

QMS Exclusions: No Exclusions Identified as Applicable

**Effective Date: NOVEMBER 8, 2007**

**Expiration Date: NOVEMBER 8, 2010**

American Petroleum Institute

Director of Certification Programs

To verify the authenticity of this license, go to [www.api.org/compositelist](http://www.api.org/compositelist).

2007-005







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book



P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 1.2 API 2C Placard

<b>API SPEC 2C</b>		
SIXTH EDITION 2004		
		DATE MANUFACTURED FEBRUARY 2010
PRODUCED UNDER	2C-0007	QUALITY PROGRAM
MANUFACTURER'S MODEL NO.	180L4-50	
DESIGN SERVICE TEMPERATURE	MIN. 32	DEG. F.
	MAX. 115	
MANUFACTURER SERIAL NUMBER	21409C	
MANUFACTURED BY	 OIL STATES INDUSTRIES, INC. NAUTILUS MARINE CRANES	
ADDRESS	HOUMA, LOUISIANA 70363	



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

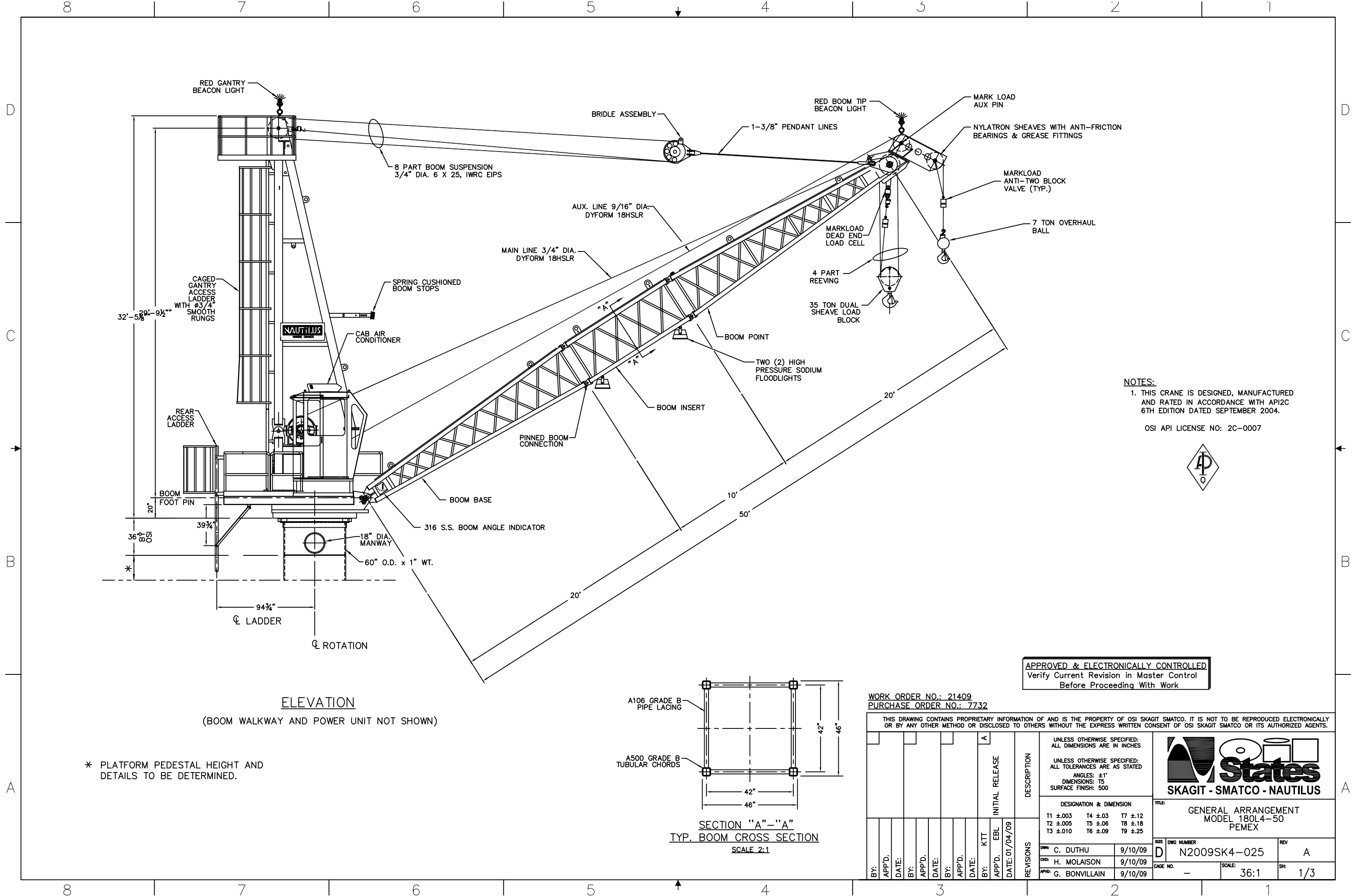
#### Section 1.3 Crane General Arrangement Drawing N2009SK4-025



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA








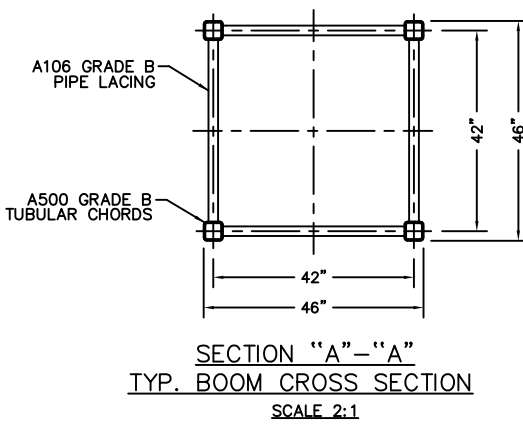
**NOTES:**  
1. THIS CRANE IS DESIGNED, MANUFACTURED AND RATED IN ACCORDANCE WITH API2C 6TH EDITION DATED SEPTEMBER 2004.  
OSI API LICENSE NO: 2C-0007



APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

WORK ORDER NO.: 21409  
PURCHASE ORDER NO.: 7732

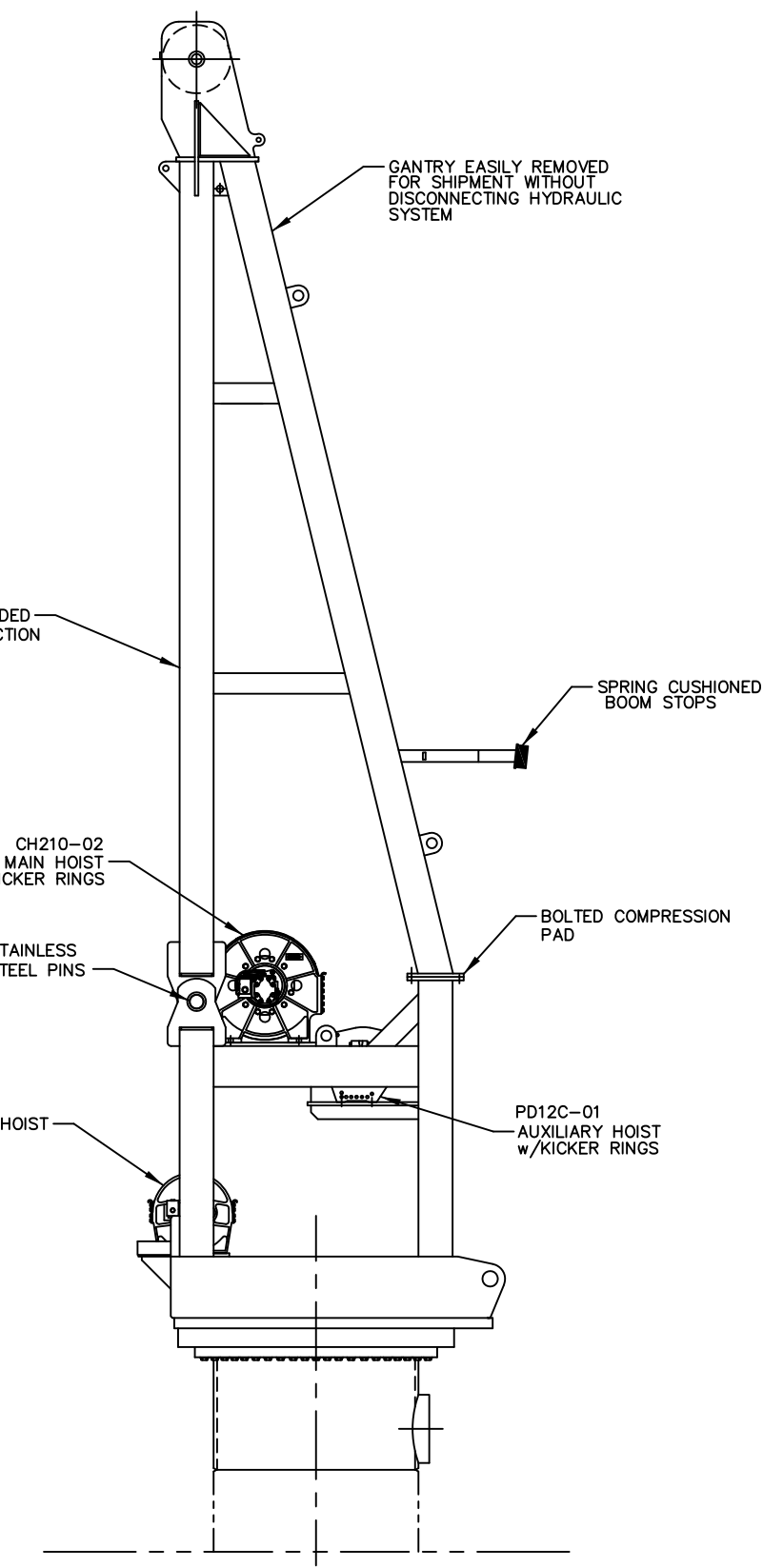
THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.												
											A	DESCRIPTION
											INITIAL RELEASE	
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	KT	EBL	REVISIONS
											DATE: 01/04/09	
UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES  UNLESS OTHERWISE SPECIFIED: ALL TOLERANCES ARE AS STATED  ANGLES: ±1° DIMENSIONS: T5 SURFACE FINISH: 500												 SKAGIT - SMATCO - NAUTILUS
DESIGNATION & DIMENSION												
T1 ±.003    T4 ±.03    T7 ±.12 T2 ±.005    T5 ±.06    T8 ±.18 T3 ±.010    T6 ±.09    T9 ±.25												
TITLE:  GENERAL ARRANGEMENT MODEL 180L4-50 PEMEX												
SIZE    DWG NUMBER												REV
D    N2009SK4-025												A
CAGE NO.										SCALE:		SH:
—										36:1		1/3



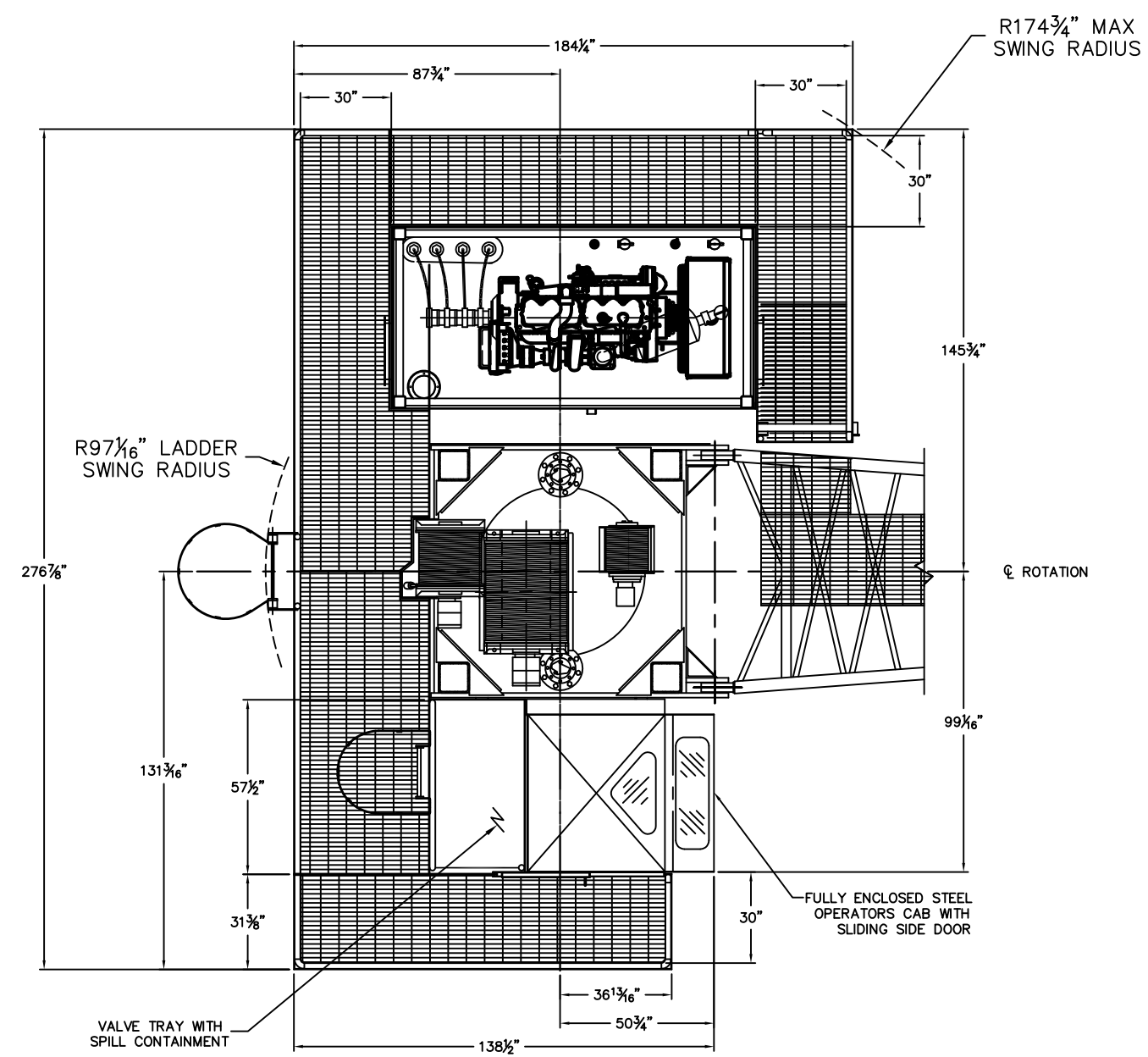
**ELEVATION**  
(BOOM WALKWAY AND POWER UNIT NOT SHOWN)

\* PLATFORM PEDESTAL HEIGHT AND DETAILS TO BE DETERMINED.

D  
C  
B  
A



SIDE VIEW OF  
GANTRY & UPPERSTRUCTURE  
(POWER UNIT, BOOM, CAB & WALKWAYS NOT SHOWN FOR CLARITY)



PLAN VIEW  
(GANTRY NOT SHOWN FOR CLARITY)

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.

UNLESS OTHERWISE SPECIFIED:  
ALL DIMENSIONS ARE IN INCHES

UNLESS OTHERWISE SPECIFIED:  
ALL TOLERANCES ARE AS STATED

ANGLES:  $\pm 1^\circ$   
DIMENSIONS: T5  
SURFACE FINISH: .500

DESIGNATION & DIMENSION		
T1 $\pm .003$	T4 $\pm .03$	T7 $\pm .12$
T2 $\pm .005$	T5 $\pm .06$	T8 $\pm .18$
T3 $\pm .010$	T6 $\pm .09$	T9 $\pm .25$

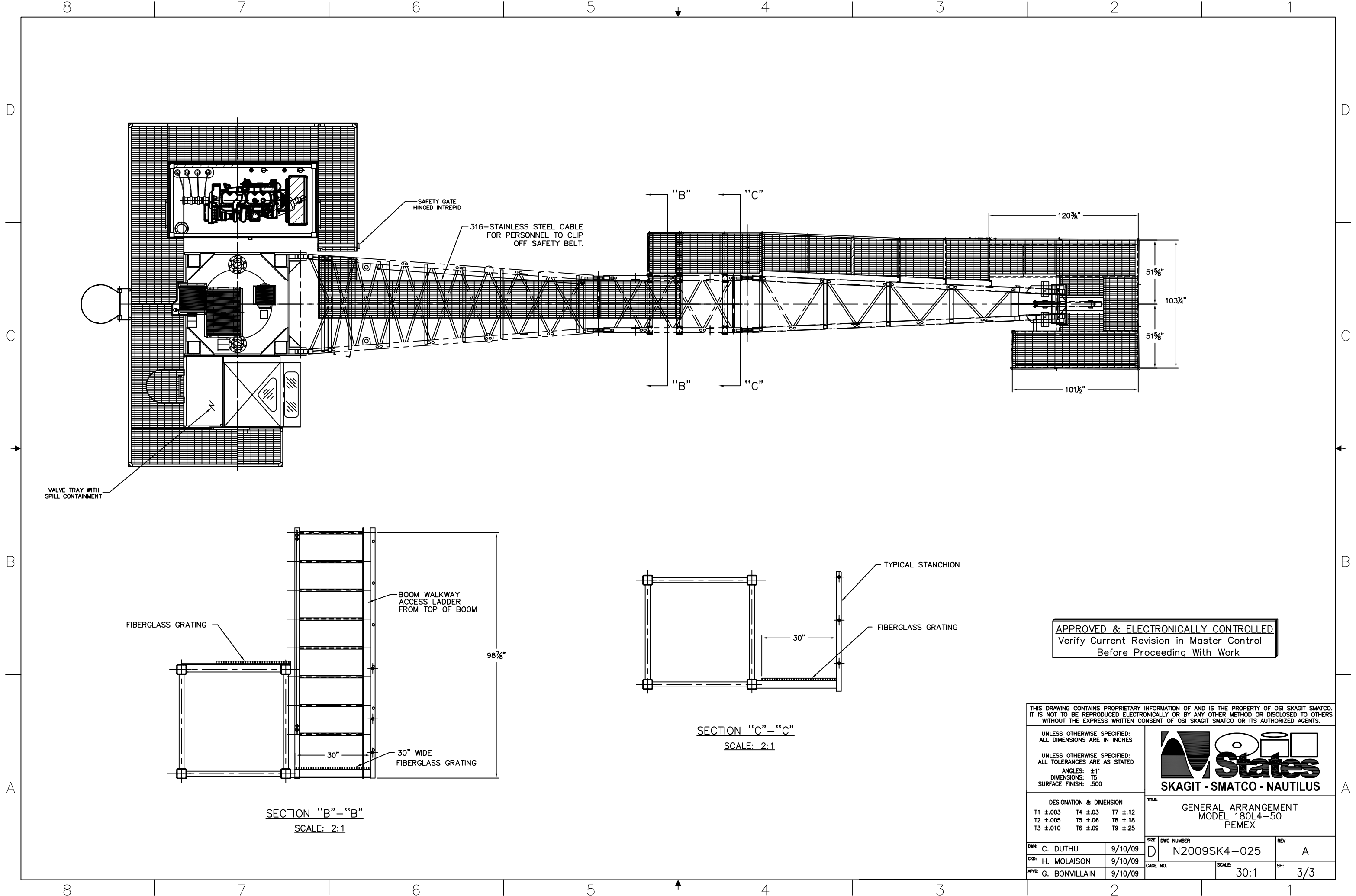
DWN: C. DUTHU 9/10/09  
CKD: H. MOLAISON 9/10/09  
APVD: G. BONVILLAIN 9/10/09

**States**  
SKAGIT - SMATCO - NAUTILUS

TITLE:  
GENERAL ARRANGEMENT  
MODEL 180L4-50  
PEMEX

SIZE	DWG NUMBER	REV
D	N2009SK4-025	A

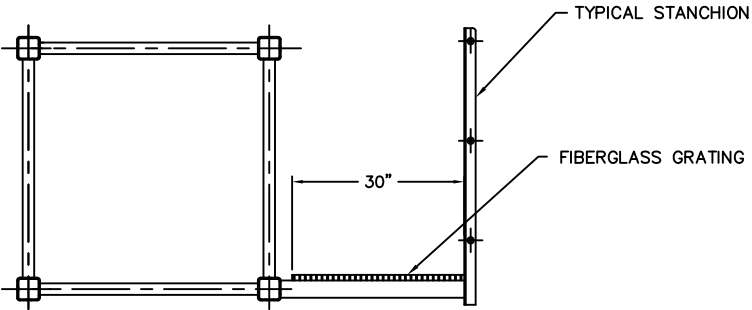
CAGE NO.	SCALE	SH
-	24:1	2/3



FIBERGLASS GRATING


BOOM WALKWAY  
ACCESS LADDER  
FROM TOP OF BOOM

SECTION "B"-"B"  
SCALE: 2:1



SECTION "C"-"C"  
SCALE: 2:1

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.			
UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES		 SKAGIT - SMATCO - NAUTILUS	
UNLESS OTHERWISE SPECIFIED: ALL TOLERANCES ARE AS STATED			
ANGLES: ±1°			
DIMENSIONS: T5			
SURFACE FINISH: .500			
DESIGNATION & DIMENSION		TITLE:	
T1 ±.003    T4 ±.03    T7 ±.12 T2 ±.005    T5 ±.06    T8 ±.18 T3 ±.010    T6 ±.09    T9 ±.25		GENERAL ARRANGEMENT MODEL 180L4-50 PEMEX	
OWN: C. DUTHU	9/10/09	SIZE	REV
CKD: H. MOLAISON	9/10/09	D N2009SK4-025	A
APVD: G. BONVILLAIN	9/10/09	CAGE NO. —	SH: 3/3
		SCALE: 30:1	





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 1.4 Lifting Load Capacity Chart N2009SK3-051



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







**NAUTILUS**

MARINE CRANES  
HOUMA, LOUISIANA 70363  
(985) 868-0630

MODELO 180L4-50  
NUMERO DE SERIE 21409C  
PEMEX



	MALACATE PRINCIPAL			MALACATE AUXILIAR		
	POLEA DE CUATRO PARTES			POLEA UNICA		
RADIO (MTS)	ANGULO DE LA PLUMA (GRADOS)	IZAJE DENTRO DE BORDA (KGS)	IZAJE FUERA DE BORDA (KGS)	IZAJE DENTRO DE BORDA (KGS)	IZAJE FUERA DE BORDA (KGS)	IZAJE DE PERSONAL (KGS)
3.8	81	20,001	20,001	3,003	3,003	1,741
4	80	20,001	20,001			
5	76	20,001	20,001			
6	72	20,001	20,001			
7	68	20,001	20,001			
8	64	20,001	20,001			
9	60	20,001	19,991			
10	55	20,001	17,839			
11	51	20,001	16,093			
12	45	20,001	14,648			
13	40	20,001	13,431			
14	34	18,760	12,393			
15	26	17,416	11,497			
16	15	16,243	10,715			
16.6	0	15,658	10,325			

CONDICIONES DE DISEÑO	
METODO USADO	DINAMICA PREDETERMINADA
DESCENSO DEL GANCHO	45.7 M
VEL. MIN. DEL GANCHO PRINCIPAL	19.2 MPM
VEL. MIN. DEL GANCHO (AUX.)	58.5 MPM

**NOTA:**

- 1) EL IZAJE A BORDO ESTA BASADO EN SWL (CARGA DE TRABAJO SEGURA)\*Cv (COEFICIENTE DINAMICO)
- 2) Cv ES EL COEFICIENTE DINAMICO VERTICAL DETERMINADO POR TRES METODOS:
  - \* METODO ESPECIFICO DE BUQUES-USADO PARA DETERMINAR LA CAPACIDAD DE FLOTACION DE LA PLATAFORMA/BUQUES
  - \* METODO GENERAL-USADO PARA DETERMINAR LA CAPACIDAD PARA UNA PLATAFORMA FLOTANTE/BUQUE O PLATAFORMA FIJA
  - \* METODO DINAMICO PREDETERMINADO-IZAJES FUERA DE BORDA DESDE UNA PLATAFORMA FIJA (Cv=2.0)
- 3) EFICIENCIA DE LA POLEA CONSIDERADO
- 4) LAS CAPACIDADES DEL CUADRO SON CAPACIDADES NETAS, PUES EL PESO DEL BLOQUE DE CARGA PRINCIPAL DE 340 Kg Y EL PESO DE LA ROTULA DE REVISION AUXILIAR DE 96 Kg HAN SIDO RESTADOS PARA DETERMINAR LA CAPACIDAD "NETA".
- 5) VEA EL MANUAL PARA LOS DIAGRAMAS DE POLEAS
- 6) TODAS LAS CLASIFICACIONES ESTAN DE ACUERDO A LA ESPECIFICACION API 2C (ESPECIFICACIONES 2C), SEXTA EDICION, SEPTIEMBRE DEL 2004.

REV: C  
P/N: N2009SK3-051





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 1.5 Crane Acceptance Test Procedure & Report



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







# FACTORY ACCEPTANCE TEST REPORT


Nautilus Model 180L4-50 Marine Crane  
*for*



Constructora Subacuatica Diavaz, S.A. de C.V.  
Pemex – A-V00415

Serial Number: 21409  
PO Number: ORDPE/7732

Date: March 1, 2010

  3/1/10  
(Oil States Industries, Inc. Representative)

 3/1/10  
(Constructora Subacuatica Diavaz, S.A. de C.V. Representative)

 J. BRIAN SHEPARDS   
(ABS Representative)



Crane Serial Number: 21409



API SPEC 2C  
LIC. NO., 2C-0007

## SECTION 0 – Crane Data:

Equipment	Model Number	Manufacture / Type	Serial / Reel Number
Power Unit (Engine)	3ER11557	Caterpillar	3406DITA
Boom Hoist	CH230B-35090-01P-1	Braden	0902143
Boom Wire Rope	6X25 – 3/4"	Bridon	BE081895A00
Main Hoist	CH210A-36120-02-1	Braden	0901218
Main Wire Rope	DYF 18 HSLR – 3/4"	Bridon	BE082182D00
Main Load Block	MO35D16H	Crosby	0862977
Auxiliary Hoist	PD12C-29051-01-1	Braden	0656188
Auxiliary Wire Rope	DYF 18 HSLR – 9/16"	Bridon	BE081186A00
Auxiliary Overhaul Ball	MB07T200E	Crosby	0984938

## SECTION 1 – Pre-start Verification:

Accept	Not Accept	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Oil Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Diesel Fuel Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Oil Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Coolant Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Boom Hoist Gear Oil Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Hoist Gear Oil Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux Hoist Gear Oil Level*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Lubrication (All grease points)

\*Verify fluid levels are within operating range prior to engine start up.

## SECTION 2 – Gauges:

Accept	Not Accept				
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Pressure (Main Hoist)	(Refer to load & no load test sections for hydraulic working pressures)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Pressure (Aux Hoist)	(Refer to load & no load test sections for hydraulic working pressures)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Pressure (Boom Hoist)	(Refer to load & no load test sections for hydraulic working pressures)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Pressure (Swing)	(Refer to load & no load test sections for hydraulic working pressures)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Pressure (Return)		10 PSI (engine idle)	20 PSI (full throttle)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Pilot (Control) Pressure		400 PSI (relief pressure)	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Pilot (Control) Return Pressure		5 PSI (engine idle)	10 PSI (full throttle)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Air Pressure		105 PSI	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Oil Temperature*		130 °F (Gauge Reading)	125 °F (Actual Reading)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Oil Pressure		45 PSI (engine idle)	60 PSI (full throttle)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Coolant Temperature*		170 °F (Gauge Reading)	165 °F (Actual Reading)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Tachometer		957 RPM (engine idle)	2240 RPM (full throttle)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hydraulic Oil Level		3/4 Tank	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Diesel Fuel Level		1/8 Tank	

\*Readings to be recorded at the end of FAT

### SECTION 3 – Verify and/or Function Test the Following:

Accept	Not Accept			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Primary Engine Start (Electric)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Secondary Engine Start (Pneumatic)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Throttle		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Fuel Shutdown		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Emergency Engine Air Intake Shutdown		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Low Oil Pressure/ High Water temperature Shutdown**		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Line Anti-Two Block		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux Line Anti-Two Block		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	High Boom Angle Kick Out		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Low Boom Angle Kick Out		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main hoist Brake	<u>2,800</u>	PSI (relief pressure)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux hoist Brake	<u>2,800</u>	PSI (relief pressure)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Boom hoist Brake	<u>2,800</u>	PSI (relief pressure)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Swing Park Brake	<u>1,200</u>	PSI (relief pressure)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Dynamic Swing Brake		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Free Swing Capability		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Windshield Wiper (Pneumatic)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Attention Horn (Pneumatic)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Fire Extinguisher (2)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Lightning Protection System (Faraday)		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Emergency Load Lowering	(Verify kit only, provided as a kit and is not permanently installed)	

\*Readings to be recorded at the end of FAT.

\*\*Tested by simulated condition.

### SECTION 4 – Baseline Pressure Readings with No Load:

Function	Boom Angle (Degrees)	Cracking Pressure No Load (PSI)	Full Speed Pressure No Load (PSI)
Boom Up:	60	400	700
Boom Down:	60	900	1400
Main Hoist Up:	60	100	500
Main Hoist Down:	60	800	1500
Aux Hoist Up:	60	100	500
Aux Hoist Down:	60	500	1200
Swing CW:	60	300	800
Swing CCW:	60	400	900



## SECTION 5: Load Test

### Main Hoist: 4 - Part Reeving

Lift No.	Radius (ft)	Onboard Rated Load (kg)	Test Load (kg)	Percent of Rated Load	Main Hoist Cracking Pressure		Main Hoist Full Speed Pressure		Engine RPM w/ Load (RPM)	Swing Cracking Pressure		Boom Cracking Pressure		Load Indicator (Kg)	3 M Speed Chain (sec)	Speed Chain Average (sec)	Hook Speed (Mpm)
					Up (PSI)	Down (PSI)	Up (PSI)	Down (PSI)		CW (PSI)	CCW (PSI)	Up (PSI)	Down (PSI)				
1	7	20,001	20,040	100%	2,200	800	2,500	1,400	2,175	700	800	900	20,000	1.846	8.74		20.92
2	13	20,001	25,032	125%	2,200	900	2,500	1,100	2,175	700	1,900	900	20,000	2.846			
3	13	20,001	20,040	100%	2,200	900	2,500	1,100	2,175	700	1,600	900	20,000	3.931			

### Aux. Hoist: 1 - Part Reeving

Lift No.	Radius (ft)	Onboard Rated Load (kg)	Test Load (kg)	Percent of Rated Load	Aux. Hoist Cracking Pressure		Aux. Hoist Full Speed Pressure		Engine RPM w/ Load (RPM)	Swing Cracking Pressure		Boom Cracking Pressure		Load Indicator (kg)	3 M Speed Chain (sec)	Speed Chain Average (sec)	Hook Speed (fpm)
					Up (psi)	Down (psi)	Up (psi)	Down (psi)		CW (psi)	CCW (psi)	Up (psi)	Down (psi)				
4	10	3,003	3,053	102%	2,400	900	2,600	1,100	2,150	500	500	800	900	2,500	1.226	2.47	73.94
5	10	3,003	3,788	126%	2,400	900	2,600	1,100	2,150	500	500	900	800	2,500	2.29		
															2.87		

## CERTIFIED TEST WEIGHTS (Kg)

Lift No.	Slings	A	1,025	+	H	6,509	+	I	12,270
1	20,040	=	236	+	1,025	+	6,509	+	12,270
2	25,032	=	236	+	1,025	+	6,509	+	17,078
3	20,040	=	236	+	1,025	+	6,509	+	12,270
4	3,053	=	64	+	1,025	+	603	+	1,361
5	3,788	=	64	+	1,025	+	603	+	1,361



## SECTION 6 – Speeds:

### Hoist Speeds (with 100% Onboard Rated Load)

Accept	Not Accept	(Refer to load test section for speed test load)			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Hoist	<u>7.19</u>	MPM	(Refer to load test section for speed test details)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux Hoist	<u>25.45</u>	MPM	(Refer to load test section for speed test details)

### Swing Speeds (with 100% Onboard Rated Load)

Accept	Not Accept	(Refer to load test section for speed test load)			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	360° Clockwise	<u>45.07</u>	Seconds =	<u>1.33</u> RPM
<input checked="" type="checkbox"/>	<input type="checkbox"/>	360° Counter-Clockwise	<u>44.95</u>	Seconds =	<u>1.33</u> RPM

### Luffing Speeds (with No Load)

Accept	Not Accept			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	0° to Max. High Angle (No Load)	<u>77.46</u>	Seconds

## SECTION 7 – Boom Radius Verification (Main Load Block)

Accept	Not Accept				
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Max/ High Angle	<u>3.8</u>	M = Radius (Stated on load chart)	
			<u>81</u>	° = Angle (Stated on load chart)	
			<u>3.7</u>	M = Actual Radius (Measured from center of rotation - center of load block)	
			<u>81</u>	° = Angle (Recorded from angle indicator in boom)	
			<u>3.8</u>	M = Radius (Recorded from electronic radius indicator)	
			<u>0</u>	° = Angle (Recorded from electronic angle indicator)	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Midrange Angle	<u>9</u>	M = Radius (Stated on load chart)	
			<u>60</u>	° = Angle (Stated on load chart)	
			<u>9</u>	M = Actual Radius (Measured from center of rotation - center of load block)	
			<u>59.8</u>	° = Angle (Recorded from angle indicator in boom)	
			<u>9</u>	M = Radius (Recorded from electronic radius indicator)	
			<u>60</u>	° = Angle (Recorded from electronic angle indicator)	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Minimum/ Low Angle	<u>16.6</u>	M = Radius (Stated on load chart)	
			<u>0</u>	° = Angle (Stated on load chart)	
			<u>16.5</u>	M = Actual Radius (Measured from center of rotation - center of load block)	
			<u>0</u>	° = Angle (Recorded from angle indicator in boom)	
			<u>16.6</u>	M = Radius (Recorded from electronic radius indicator)	
			<u>0</u>	° = Angle (Recorded from electronic angle indicator)	



## SECTION 8 – Electrical:

### 120 VAC, 1 Phase, 60 Hz System

Accept	Not Accept	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Boom Floodlights (4) <i>(Ensure floodlights cannot be damaged by normal operations)</i>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Boom Tip Beacon (1 Red)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Gantry Beacon (1 Red)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Interior Cab Light (Fluorescent)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Instrument Light (Red)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Hoist Light (1)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Light (1)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Power On Light (1 Green)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Circuit Breaker
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Air Conditioner

*Note: Tested by actuating the applicable switch in the operator's cabin.*

### 12 VDC System

Accept	Not Accept	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Engine Start Motor
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Alternator
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Batteries

### Anunicator System:

Accept	Not Accept	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	High Hydraulic Oil Temperature
<input checked="" type="checkbox"/>	<input type="checkbox"/>	High Engine Coolant Temperature
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Low Engine Oil Pressure

*Note: The alarms will have the switches manually tripped to simulate an alarm situation.*

### Electronic Load Indicator System:

Accept	Not Accept	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Load Indicator System (Reference Section 5 for Details)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux Load Indicator System (Reference Section 5 for Details)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Gross Overload Protection (Alarm and Trip)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Aux Gross Overload Protection (Alarm and Trip)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Main Hoist Anti-Two Block (Alarm and Trip)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Auxiliary Hoist Anti-Two Block (Alarm and Trip)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Angle Indicator
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Slew limit System (Alarm and Trip)

## SECTION 9 – Noise Level

BACKGROUND NOISE LEVELS:			Actual Test dB (A)
In Front of Power Unit at a distance of 1 meter			56.3
On Side of Power Unit at a distance of 1 meter			58.2
In Rear of Power Unit at a distance of 1 meter			57.5
In Enclosed Cab at Operator's Ear Level			41.6
POWER UNIT ENGINE AT IDLE:			Actual Test dB (A)
Engine RPM:	957	In Front of Power Unit at a distance of 1 meter	95.9
		On Side of Power Unit at a distance of 1 meter	93.4
		In Rear of Power Unit at a distance of 1 meter	98.4
POWER UNIT ENGINE AT FULL THROTTLE:			Actual Test dB (A)
Engine RPM:	1140	In Front of Power Unit at a distance of 1 meter	111.2
		On Side of Power Unit at a distance of 1 meter	97.2
		In Rear of Power Unit at a distance of 1 meter	107.1
CAB ENGINE AT IDLE:			Actual Test dB (A)
Engine RPM:	957	Operator's Ear Level (Door and Windows Open)	73.3
		Operator's Ear Level (Door and Windows Closed)	83.4
CAB ENGINE AT FULL THROTTLE:			Actual Test dB (A)
Engine RPM:	2240	Operator's Ear Level (Door and Windows Open)	83.6
		Operator's Ear Level (Door and Windows Closed)	76.6
POWER UNIT OPERATING MAIN HOIST AT FULL SPEED WITH LOAD:			Actual Test dB (A)
Engine RPM:	2240	In Front of Power Unit at a distance of 1 meter	108.2
		On Side of Power Unit at a distance of 1 meter	105.3
		In Rear of Power Unit at a distance of 1 meter	110.0
CAB OPERATING MAIN HOIST AT FULL SPEED WITH LOAD:			Actual Test dB (A)
Engine RPM:	2240	Operator's Ear Level (Door and Windows Open)	90.2
		Operator's Ear Level (Door and Windows Closed)	75.1







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume: 1

## Nautilus Crane Model 180L4-50

### Section 1.6 Crane Critical Component Log

Crane Model ..... 180L4-50  
Serial Number ..... 21409C  
Manufacture Date.....February 2010

Engine ..... N46669-037  
Serial Number ..... 3ER11557  
Model Number ..... 3406DITA  
Arrangement Number ..... 124-7563

Main Hoist ..... N47643-001  
Serial Number ..... 0901218  
Auxiliary Hoist ..... N45446-026  
Serial Number ..... 0953231  
Boom Hoist ..... N47922-009  
Serial Number ..... 0902143

Main Load Block ..... N46831-071  
Serial Number ..... 0862977  
Overhaul Ball ..... N46832-012  
Serial Number ..... 0984938

Main Wire Rope ..... N00031-012  
Serial Number ..... BE084226B00  
Aux Wire Rope ..... N00031-009  
Serial Number ..... BE081186A00  
Boom Hoist Wire Rope ..... N00034-012  
Serial Number ..... BE081895A00  
Pendent Line ..... N30603-014  
Serial Number ..... H25019

Ballring..... N45872-001  
Serial Number ..... 14005-1

Swing Drive Assembly:  
Gearbox No. 1 ..... N47103-003  
Gearbox No. 2..... N47103-003  
Pinion No. 2 ..... N60920-001



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 1.7 Information Chart

**NAUTILUS**  
MARINE CRANES  
HOUMA, LOUISIANA 70363  
(985) 868-0630

MODELO 180L4-50  
NUMERO DE SERIE 21409C  
PEMEX

**States**  
OIL STATES INDUSTRIES, INC.

RADIO (MTS)	MALACATE PRINCIPAL			MALACATE AUXILIAR		
	POLEA DE CUATRO PARTES			POLEA UNICA		
	ANGULO DE LA PLUMA (GRADOS)	IZAJE DENTRO DE BORDA (KGS)	IZAJE FUERA DE BORDA (KGS)	IZAJE DENTRO DE BORDA (KGS)	IZAJE FUERA DE BORDA (KGS)	IZAJE DE PERSONAL (KGS)
3.8	81	20,001	20,001	3,003	3,003	1,741
4	80	20,001	20,001			
5	76	20,001	20,001			
6	72	20,001	20,001			
7	68	20,001	20,001			
8	64	20,001	20,001			
9	60	20,001	19,991			
10	55	20,001	17,839			
11	51	20,001	16,093			
12	45	20,001	14,648			
13	40	20,001	13,431			
14	34	18,760	12,393			
15	26	17,416	11,497			
16	15	16,243	10,715			
16.6	0	15,658	10,325			

CONDICIONES DE DISEÑO	
METODO USADO	DINAMICA PREDETERMINADA
DESCENSO DEL GANCHO	45.7 M
VEL. MIN. DEL GANCHO PRINCIPAL	19.2 MPM
VEL. MIN. DEL GANCHO (AUX.)	58.5 MPM

NOTA:

- 1) EL IZAJE A BORDO ESTA BASADO EN SWL (CARGA DE TRABAJO SEGURA)\*Cv (COEFICIENTE DINAMICO)
- 2) Cv ES EL COEFICIENTE DINAMICO VERTICAL DETERMINADO POR TRES METODOS:
  - \* METODO ESPECIFICO DE BUQUES-USADO PARA DETERMINAR LA CAPACIDAD DE FLOTACION DE LA PLATAFORMA/BUQUES
  - \* METODO GENERAL-USADO PARA DETERMINAR LA CAPACIDAD PARA UNA PLATAFORMA FLOTANTE/BUQUE O PLATAFORMA FIJA
  - \* METODO DINAMICO PREDETERMINADO-IZAJES FUERA DE BORDA DESDE UNA PLATAFORMA FIJA (Cv=2.0)
- 3) EFICIENCIA DE LA POLEA CONSIDERADO
- 4) LAS CAPACIDADES DEL CUADRO SON CAPACIDADES NETAS, PUES EL PESO DEL BLOQUE DE CARGA PRINCIPAL DE 340 Kg Y EL PESO DE LA ROTULA DE REVISION AUXILIAR DE 96 Kg HAN SIDO RESTADOS PARA DETERMINAR LA CAPACIDAD "NETA".
- 5) VEA EL MANUAL PARA LOS DIAGRAMAS DE POLEAS
- 6) TODAS LAS CLASIFICACIONES ESTAN DE ACUERDO A LA ESPECIFICACION API 2C (ESPECIFICACIONES 2C), SEXTA EDICION, SEPTIEMBRE DEL 2004.

REV: C  
P/N: N2009SK3-051



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.0 Installation Manual



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.1 Warning



Failure to use proper ballring fasteners could result in property damage, severe personal injury or death.

Replacement fasteners must meet the specific requirements of API Specification 2C, Section 14.5, Sixth Edition.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.2 Bolt Torquing Procedure



**NOTE: Ballring to Pedestal** use 1 1/4"-7UNC Grade 8 Bolts.

**Ballring to Turret** use 1 1/4"-7UNC Grade 8 Bolts

**ALL BOLTS TO MEET API 2C REQUIREMENTS**



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

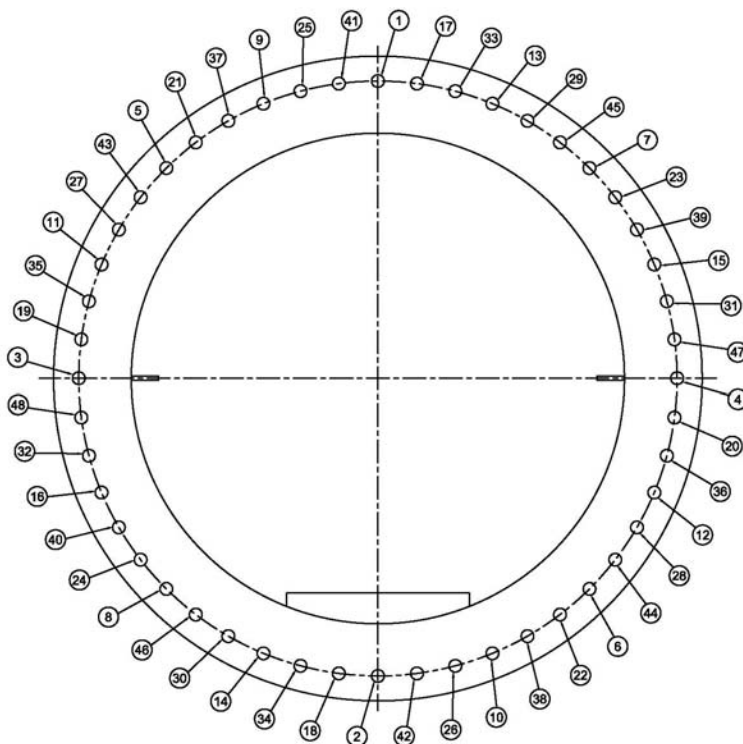
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.2.1 Ballring to Pedestal



1. Do not use oil or grease (Hydraulic oil only).
2. Diagram shows the sequence bolts are to be tightened.
3. Bolts are to be torqued in increments of 50, 80 and 100% of the maximum torque value of 1,236 ft-lbs.
  - a.) First iteration torque to 618 ft-lbs.
  - b.) Second iteration torque to 989 ft-lbs.
  - c.) Final iteration torque to 1,236 ft-lbs.

180L4-P



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

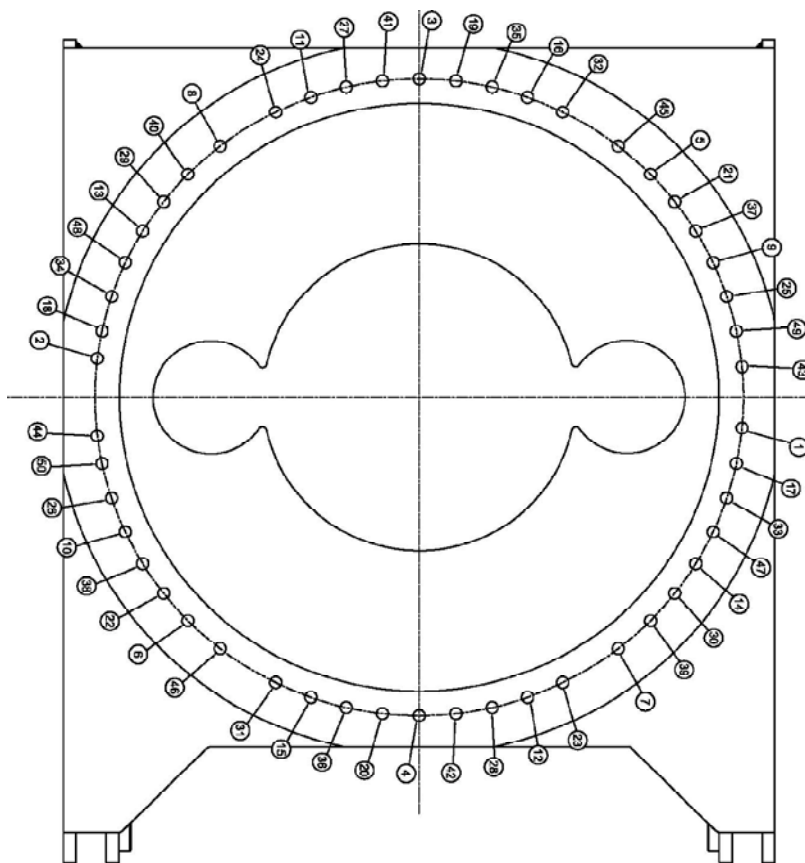
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.2.2 Ballring to Turret



1. Do not use oil or grease (Hydraulic oil only).
2. Diagram shows the sequence bolts are to be tightened.
3. Bolts are to be torqued in increments of 50, 80 and 100% of the maximum torque value of 1,236 ft-lbs.
  - a.) First iteration torque to 618 ft-lbs.
  - b.) Second iteration torque to 989 ft-lbs.
  - c.) Final iteration torque to 1,236 ft-lbs.

180L4-US



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.3 Torque for Plated Fasteners



**WARNING**

DO NOT APPLY to Crane Mounting Bearing Bolts

Threads must be free of debris, damage and coated with hydraulic oil or a light machine oil. The torque values are not valid for threads coated with grease or anti-seizing compound.

GRADE 8			
NOMINAL BOLT SIZE (IN)	MINIMUM (FT/LBS)	MID-RANGE (FT/LBS)	MAXIMUM (FT/LBS)
3/8 - 16	33	35	37
1/2 - 13	76	80	84
9/16 - 12	104	110	115
5/8 - 11	161	170	178
3/4 - 10	266	280	294
7/8 - 9	437	460	483
1 - 8	646	680	714
1-1/4 - 7	1,292	1,360	1,428
1-3/8 - 6	1,691	1,780	1,869
1-1/2 - 6	2,242	2,360	2,478

GRADE 5			
NOMINAL BOLT SIZE (IN)	MINIMUM (FT/LBS)	MID-RANGE (FT/LBS)	MAXIMUM (FT/LBS)
3/8 - 16	21	23	24
1/2 - 13	62	65	68
9/16 - 12	76	80	84
5/8 - 11	104	110	115
3/4 - 10	190	200	210
7/8 - 9	285	300	315
1 - 8	418	440	462
1-1/4 - 7	798	840	882
1-3/8 - 6	1,045	1,100	1,155
1-1/2 - 6	1,387	1,460	1,533

FASTENER MARKINGS		
	GRADE 5	GRADE 8
BOLT SAE J429		
NUT SAE J995	OR	OR



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

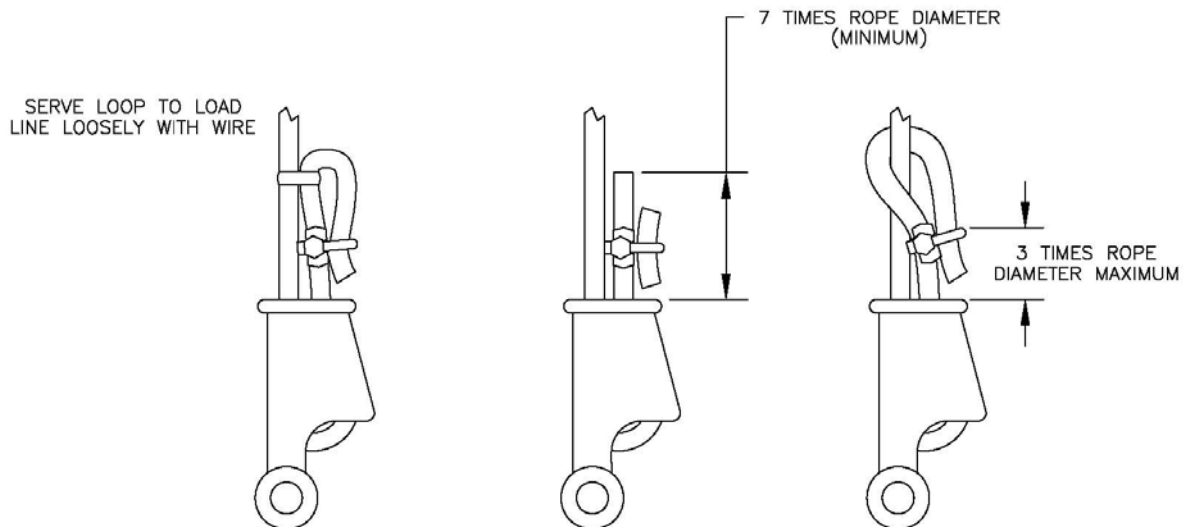
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.4 Recommended Anchoring of Wire Rope at Dead End



**Allowable methods for securing Dead Ends of Wedge Socket attachments**



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

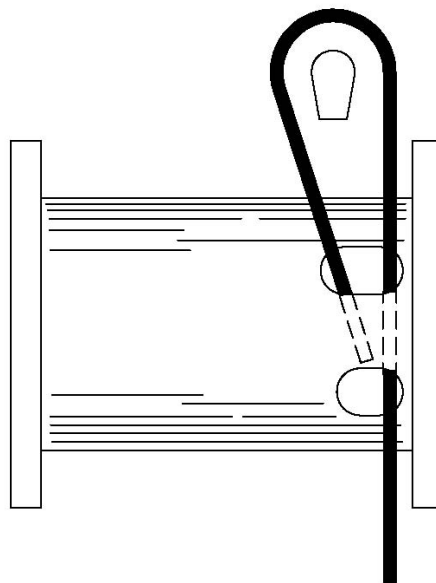
Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.5 Anchoring Wire Rope

Main Hoist CH210A – 3/4" Wire Rope  
Auxiliary Hoist PD12C – 9/16" Wire Rope  
Boom Hoist CH230B – 3/4" Wire Rope



Insert Cable Anchor Small End First

Anchoring wire rope on the hoist is very easy. Take the free end of the wire rope and insert it through the small opening of the anchor pocket. Loop the wire rope and push the free end about  $\frac{3}{4}$  of the way back through the pocket. Install the wedge, then pull the slack out of the wire rope. The wedge will slip into the pocket and secure the wire rope into the drum.



The cable anchor alone on hoists are not designed to hold rated loads. Therefore, a minimum of 5 wraps of cable must be left on the drum barrel to achieve rated load.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.6 Wire Rope Break-In Procedure

After properly installing the new rope, run the new rope through the crane operating cycle several times under a light load at a reduced line speed.

Progressively increase the loads until reaching the entire range of expected lifts.

As you increase the loads, run each load weight from light to maximum expected load at least six times before proceeding, especially when the crane operator will make a series of heavy lifts with new ropes.

This allows the rope to adjust gradually to working conditions, enables the strands to become settled and allows for slight stretching and diameter reduction to occur.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.7 Reeving Diagrams



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

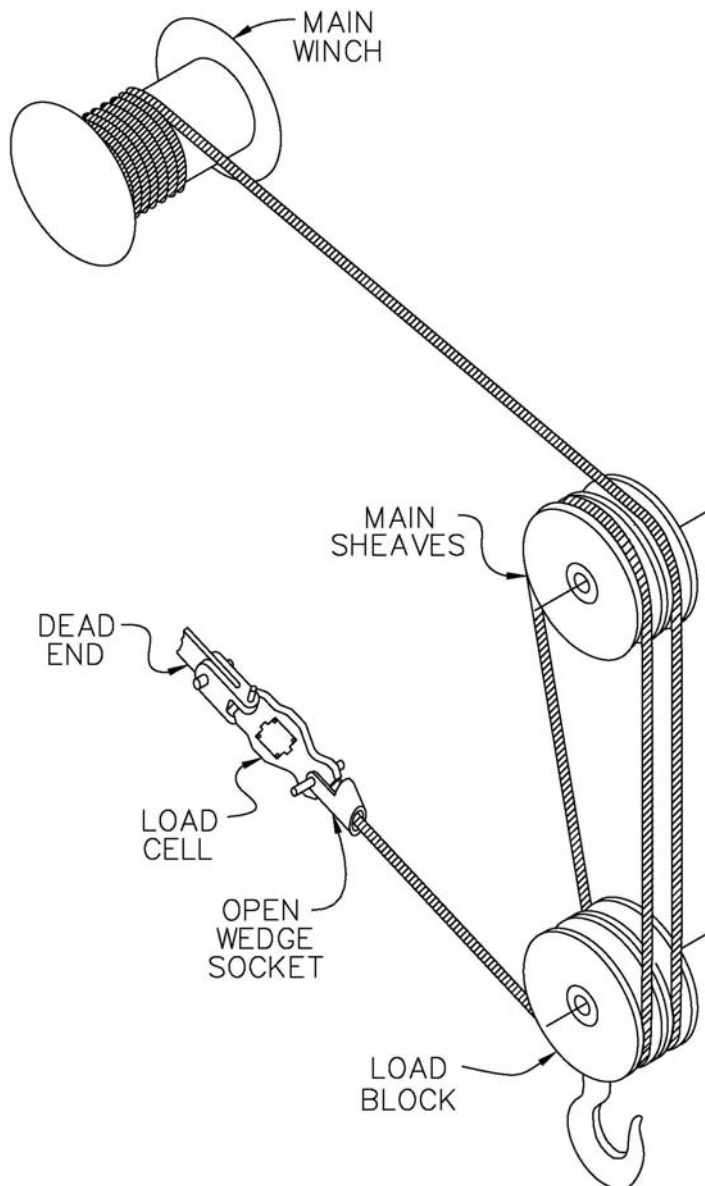
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.7.1 4 Part Line



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

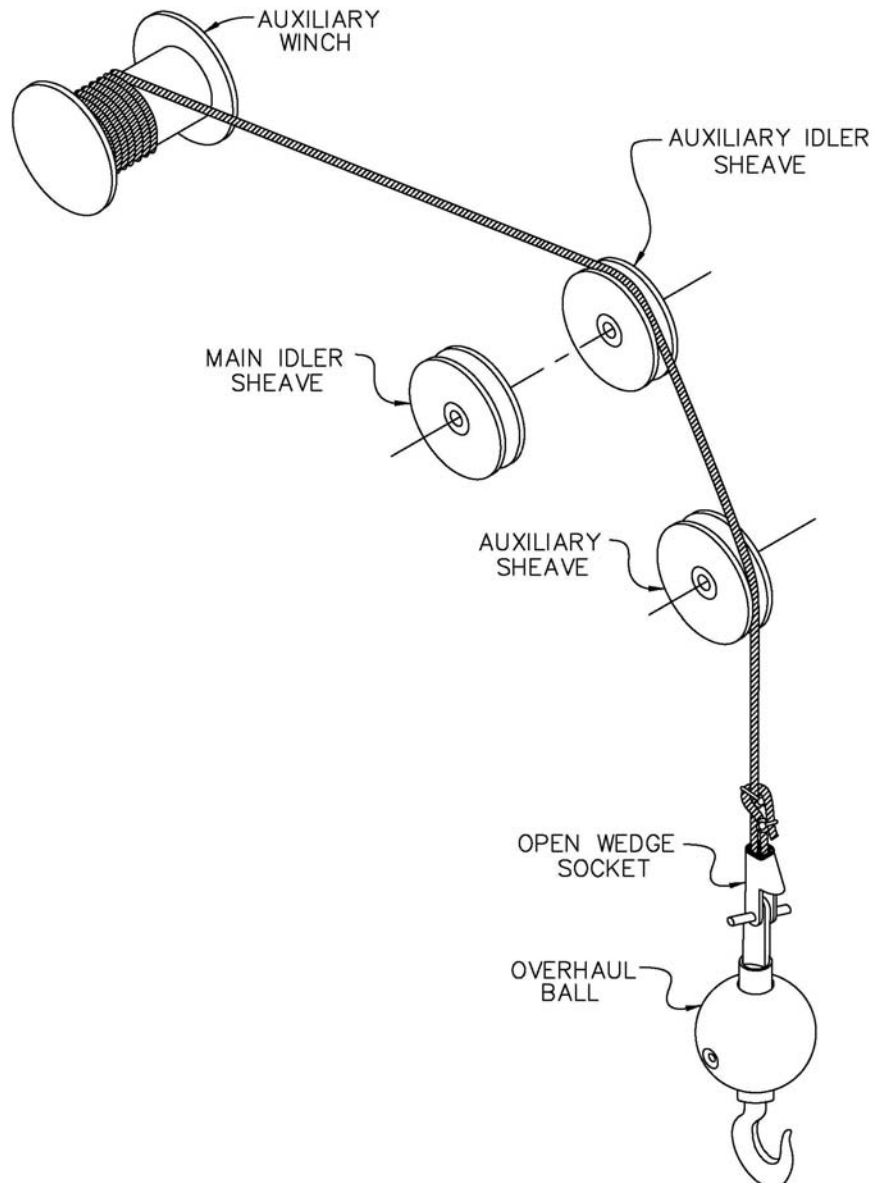
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.7.2 1 Part Line



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

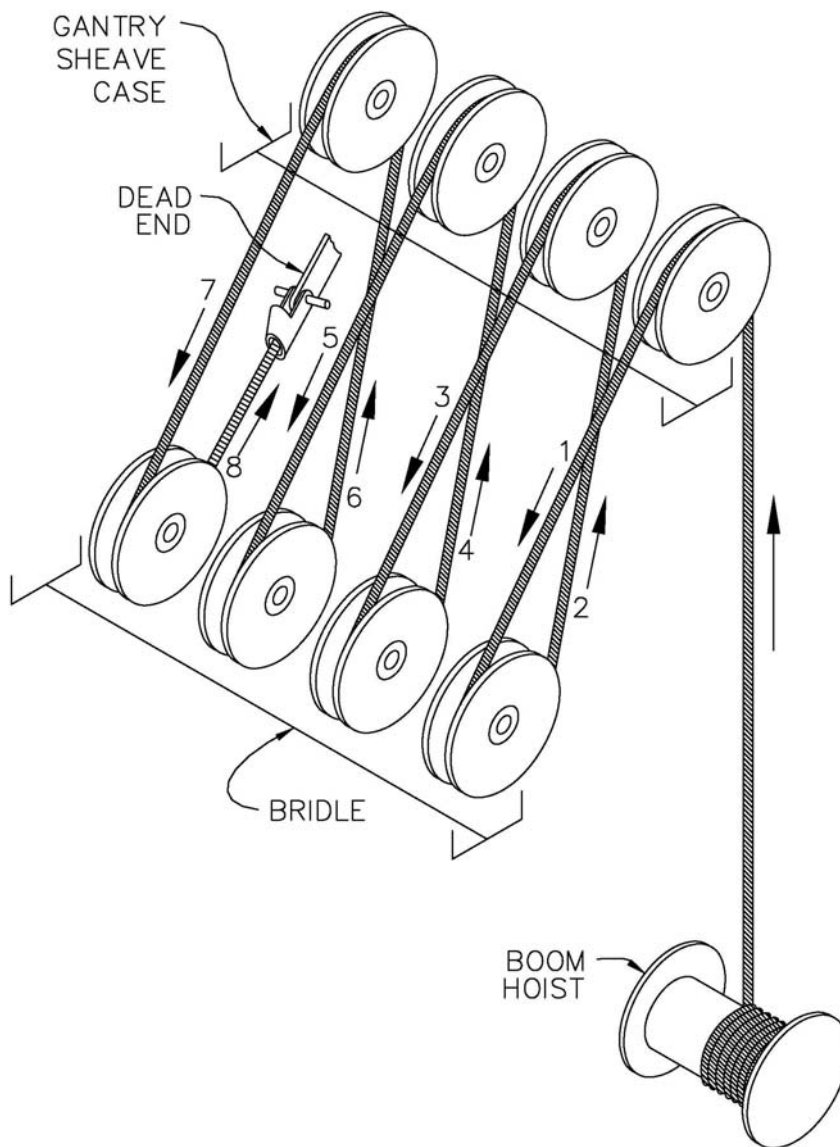
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 2.7.3 8 Part Line



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

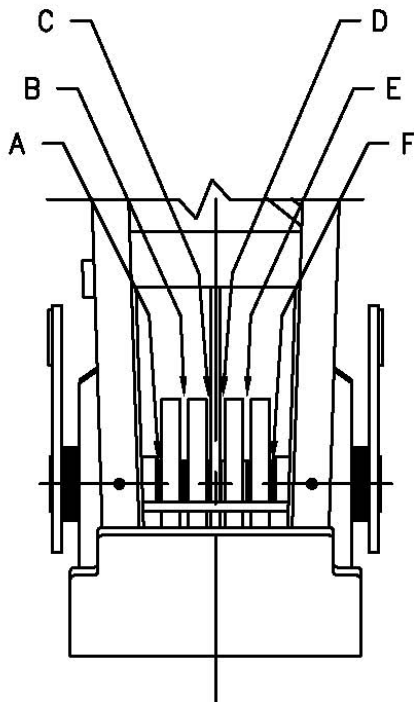
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 2.8 Spacer Kits



**Bearing Retainers**

Width	O.D.	I.D.	Material	Qty.
1/4"	5"	3-1/2"	NYL	6

Spacer	Thickness	O.D.	I.D.	Material
A	-	-	-	-
B	2-7/8"	5-1/2"	3-1/2"	NYL
C	3/16"	5-1/2"	3-1/2"	NYL
D	5/16"	5-1/2"	3-1/2"	NYL
E	3/8"	5-1/2"	3-1/2"	NYL
F	1/8"	5-1/2"	3-1/2"	NYL



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

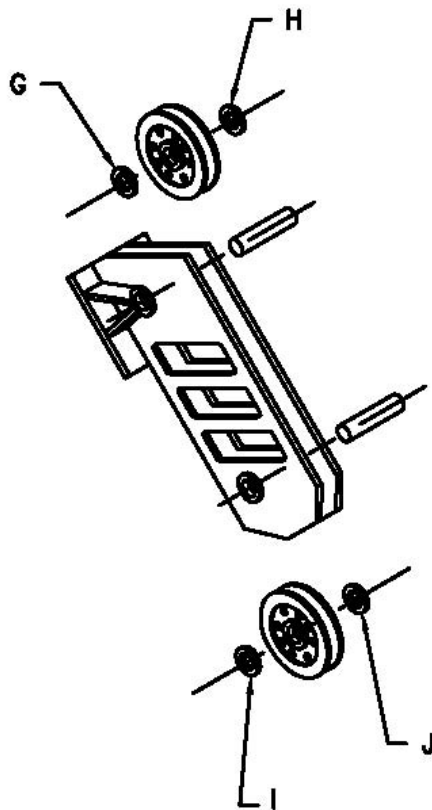
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



Bearing Retainers				
Width	O.D.	I.D.	Material	Qty.
1/8"	3-3/4"	2-1/2"	NYL	2
3/8"	2-5/16"	1-1/2"	NYL	2

Spacer	Thickness	O.D.	I.D.	Material
G	9/16"	5"	1-1/2"	NYL
H	5/8"	5"	1-1/2"	NYL
I	9/16"	4-1/2"	2-1/2"	NYL
J	9/16"	4-1/2"	2-1/2"	NYL



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

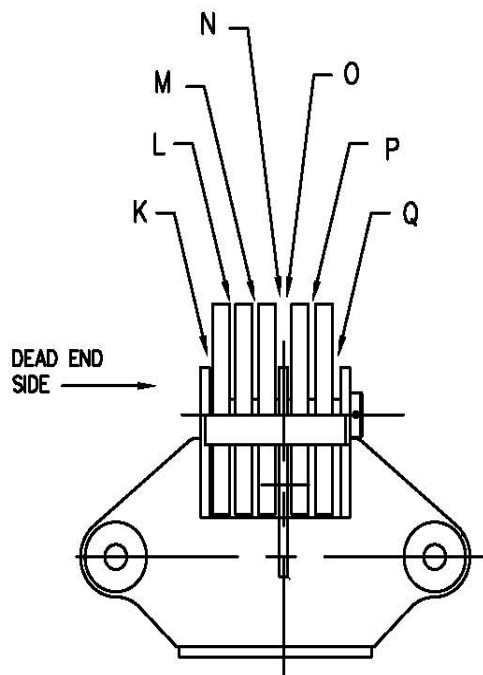
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



### Bearing Retainers

Width	O.D.	I.D.	Material	Qty.
1/4"	4-1/2"	3	NYL	8

Spacer	Thickness	O.D.	I.D.	Material
K	5/16"	5"	3"	NYL
L	1/4"	5"	3"	NYL
M	1/4"	5"	3"	NYL
N	-	-	-	-
O	3/8"	5"	3"	NYL
P	1/4"	5"	3"	NYL
Q	3/16"	5"	3"	NYL



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

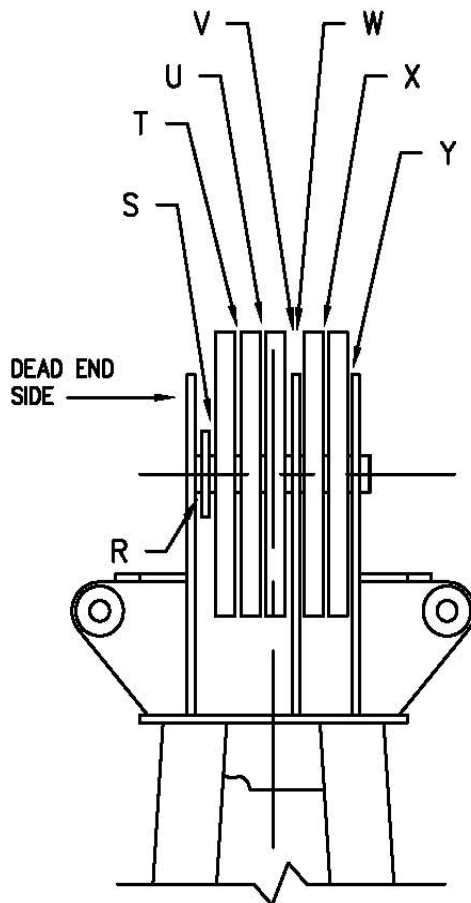
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



Bearing Retainers				
Width	O.D.	I.D.	Material	Qty.
1/4"	4-1/2"	3	NYL	8

Spacer	Thickness	O.D.	I.D.	Material
R	-	-	-	-
S	3/16"	5"	3"	NYL
T	3/8"	5"	3"	NYL
U	3/16"	5"	3"	NYL
V	-	-	-	-
W	3/16"	5"	3"	NYL
X	5/16"	5"	3"	NYL
Y	3/8"	5"	3"	NYL



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.0 Operation Manual



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 3.1 Operation Guidelines

As the crane operator you should be qualified in accordance with the latest edition of API RP2D, Recommended Practice for Operation and Maintenance of Offshore Cranes. You must insure that riggers, signalmen and other personnel associated with your lift are suitably trained and informed. You must be completely familiar with the individual crane operating characteristics and controls since they often vary from crane to crane. You must be familiar with the individual crane operation and maintenance manual. It may identify features which are critical to the safe operation of the individual machine.

By their nature, cranes are dangerous to operate and are sensitive to mishandling. You must consider any factors that could reduce crane capacity including:

Load swing, hoisting impacts, wind conditions, sea state, experience of personnel, condition of equipment, proper rigging technique, difficulty in centering boom tip over load, etc.

Observe extreme precaution when hazards are present such as:

Limited visibility, blind lifts, helicopter activities, electrical lines, hazardous surroundings, personnel lifts, high boom angles, heavy lifts, hook near boom tip, poor weather conditions, etc.

In such conditions you must judge to what degree operations or capacities are to be limited or if operations should cease.

Always perform a pre-use inspection to ensure that hazards are not present (rope fouled or damaged, pins unsecured, fuel leak, corrosion present, boom dented, cracked weld, etc.). You must determine that the equipment condition is suitable before resuming operations.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

Be familiar with and completely understand the load chart. Be able to determine the crane's actual net lifting capacity. Beware that the winch or boom capacity may be far greater than the weight that can be safely lifted. Recall the most fundamental lift rules:

**A**lways know the load before it is lifted.

**B**oom angle / load radius must be known.

**C**apacity of equipment must be ample at the lift radius.

Operate all functions smoothly, avoiding jerking or sudden stops and starts. This will prevent damage or failure from shock loading.

#### The swing function requires extra care:

- The speed of rotation is proportional to the engine RPM, hydraulic pump flow and the amount of control lever movement from the center position.
- Sudden motions with long booms or heavy lifts will cause the boom to bend sideways. This causes premature failure of the heel pin bearings and, if severe, could collapse the boom. Limit swing speed to prevent the load from swinging out beyond the intended radius (load swing) which may also endanger personnel. It is imperative that the starting and stopping of the crane be accomplished in a smooth manner.
- The operator shall be aware that the suspended load, once in motion, builds up inertia. Once a stopping point for the load is determined, the operator must plan his stopping method prior to reaching the final destination.
- When the crane is swinging with a load and the control lever is placed in the neutral position, the crane will continue to free-swing in the direction of motion. The crane is designed with a free-swing capability to assist the operator with alignment of the boom point and the load below in order to minimize side loading.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

- The operator has three choices to stop the swing motion of the crane:
  1. Allow the crane to coast to a stop.
  2. Gently depress or engage the dynamic swing brake pedal or lever (if the crane is equipped with this feature).



**This brake is capable of dynamic operation and has sufficient holding capability to cause major damage to the Boom and Swing Machinery in the event that it is applied suddenly. For this reason, caution is urged in the use of this brake for stopping the swing motion.**  
**The method described below using the swing control lever to control the swing is the preferred method of stopping the crane. However, do not abruptly engage the control lever in the opposite direction.**

3. Dynamic braking by “Back driving or Cross Controlling” the Left Hand swing control Joystick. This is accomplished by moving the swing lever into the neutral position and then slowly engaging the lever in the opposite direction of swing motion. This is considered the best method in which to stop the swing motion of the crane.

For example; if the crane is swinging to the left at high speed and the joystick is then centered, the crane will continue to “coast” to the left. Moving the joystick slowly away from the center to the right will apply a “braking torque” to the crane motion, hence stopping rotation more quickly.

The crane and its associated Swing System machinery are protected from damage during this operation by means of the hydraulic relief valve mounted in the swing directional control valve. This valve will limit the amount of swing torque available during acceleration and deceleration of the crane. However, it is strongly recommended that swing motion should start and stop as slowly and smoothly as possible to avoid possible damage to equipment or injury to personnel from an abruptly swinging load.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

- The crane and load can be held in position against the wind by means of the dynamic brake pedal (if the crane is equipped with this feature). Please refer to the Crane Operation section regarding the dynamic brake actuator.
- The parking brake should only be applied when the crane swing motion has completely stopped. This brake should be engaged when the crane is not in use or left unattended for short periods of time. It is recommended that the crane be returned to the cradle for parking when left for long periods of time.
- When a house lock is supplied, it shall only be engaged after the swing motion of the crane has been brought to a stop. It is intended as a functional item as described in API 2C. House locks are not designed nor intended to be used as a means of securing the crane for sea-fastening, for transit purposes or securing the crane during storm conditions.

Two-blocking, where the hook block contacts the boom tip, can cause the rope to break and the load to fall. This may result in equipment damage, injury or even death. It can occur when hoisting up, telescoping out, and sometimes, when booming down. Observe extreme precaution when the hook block is near the boom tip, when speeds are high or when two functions are operated simultaneously. Never rely on the anti-two-blocking as an operating tool, only a back-up safety device.

Observe extreme precaution at very high boom angles to prevent contact of the boom with the boom stop on rope supported booms. This can cause subsequent bending or collapse of the boom. Note that when unloaded the boom may "spring back" and contact the stop. Do not disable boom angle limiting devices. For cranes with hydraulic cylinder supported booms, do not stop the boom by fully extending the cylinder unless done very slowly. Impact forces of a fast moving boom could possibly break the cylinder and allow the boom to topple over backwards.

The boom angle is only an indication of operating radius and should be confirmed for critical lifts. Measure the load radius from the center of crane rotation.

Do not operate the crane when temperatures are less than the minimum service temperature stated on the crane monogram. Steels become brittle at low temperatures and the crane may fail at loads well below the normal capacity.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

Maintain the load directly below the boom tip. Side loads can cause the hoist rope to climb out of the sheave, resulting in damage to the rope, sheave, and pin, or even breaking of the rope. Side loading with long booms, heavy lifts, if severe, can cause the swing gear train to fracture (with loss of control) or even cause the boom to collapse. Off loads (the load is at a greater radius than the boom tip) tend to amplify the toppling effect of loads on the crane. This can overload the entire crane structure, notably the pedestal and swing bearing.

Take extra care to pay out rope in a smooth manner to prevent slack forming in the rope. Offshore hydraulic cranes, because of power lowering and high winch speeds, are particularly susceptible to rope fouling on the winch drum. Watch for trapped loops, bird nesting, etc. on the winch drum.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 3.1.1 About Load Charts

##### ONBOARD CONDITIONS

To be considered an onboard lift, the following conditions must be true:

The machine has a true vertical axis (a level machine with zero list, zero trim).

The load is directly below boom tip (zero offlead and zero sidelead). Note that a 2% design side lead accounts only for inertial affects of gently swinging the load - not for side loads.

The load is smoothly lifted from or landed upon a motionless surface (no hoisting impact such as jerking loads or suddenly stopping a falling load).

No wind, ice or other detrimental conditions are present.

##### OFFBOARD CONDITIONS

The offboard rated load can be lifted in specific conditions encountered when relative motion exists between the crane and the load to be lifted / landed. Such cases exist when the crane is on a stationary platform and the load is to be lifted / landed on a marine vessel. The specific conditions include significant wave height, offlead, sidelead and wind conditions.

In cases where sea conditions are not specified by the purchaser, wind, offlead and sidelead are taken as zero (see API SPECIFICATION 2C) and an offboard coefficient of 2 is used. Note that this condition is considered appropriate only when:

- Mild seas are encountered (example: maximum sea state of 4 in Gulf of Mexico).
- The vessel position is maintained to eliminate sidelead and offlead (due to drifting of the vessel away from the boom tip).



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

The offboard coefficient is basically an impact factor used to insure that crane strength limits are not exceeded. For fixed platform cranes, it is calculated based on crane flexibility, hook speed up and vessel deck speed down. It is affected by wave conditions, vessel size, height of boom tip above the vessel, reeving parts of line and other factors. Assumptions are made of vessel size and statistical determinations are made to estimate vessel deck speed down.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 3.1.2 Maintenance & Inspection Guidelines

The crane must be regularly maintained and inspected by qualified personnel in accordance with the latest edition of API RP 2D Recommended Practice for Operation and Maintenance of Offshore Cranes.

Since pedestal cranes do not tip over, they are particularly subject to accidental overloads. For this reason, it is important to check for damage periodically: before critical lifts, and after suspected overloads.

Some components possess stored energy which can be released in an uncontrolled manner. Improper handling can result in injury, damage or death. It is important to carefully de-energize these components prior to performing any work. Examples include:

- **Elevated boom** – lower boom into rest prior to working on boom hoist, boom ropes, boom cylinder, bridle, etc. Block or support boom as required prior to disassembling boom to prevent collapse of unsupported sections.
- **Pressurized vessels** – bleed pressure off before disconnecting lines, etc.
- **Rotating machinery** – arrest all motion prior to commencing work.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.2 General Operation of Crane



Failure to follow procedures below could result in property damage, severe personal injury or death!

1. Always operate crane within the capacity rating (see your lifting chart). Know the weight of the load you are lifting.
2. Never operate with anyone under the load or swing over personnel.
3. Know and follow recommended hand signals
4. Do not leave crane unattended while load is suspended or crane is operating.
5. Parking brake should always be set before leaving crane.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.3 Operation Caution



Do not operate crane unless you thoroughly understand its controls and operation and required maintenance has been performed.

1. Check all scheduled maintenance items including proper lubrication of ballring and hydraulic oil level.
2. Check all pin connections and inspect ballring bolts for looseness and corrosion.
3. Start prime mover and check crane operation without load.
4. Always be certain that wire rope reeving is in correct position before operating crane.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732



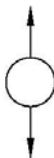
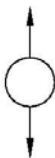
Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.4 Crane Operation

#### Pilot Controllers (Viewed from Operator's Station)

SWING	AUXILIARY HOIST	MAIN HOIST	BOOM
PUSH – LEFT  PULL – RIGHT	PUSH TO LOWER  PULL TO RAISE	PUSH TO LOWER  PULL TO RAISE	PUSH TO LOWER  PULL TO RAISE

1. Swing Control

Push lever to swing crane to the left. The center (neutral) is to stop. Pull lever to swing crane to the right.

2. Auxiliary Hoist Control

Push lever to lower load. The center (neutral) is to stop. Pull lever to hoist load.

3. Main Hoist Control

Push lever to lower load. The center (neutral) is to stop. Pull lever to hoist load.

4. Boom Hoist Control

Push lever to lower boom. The center (neutral) is to stop. Pull lever to raise boom.



During operation the control lever should be metered slowly when starting or stopping an operation to prevent harsh stresses on the hydraulic system and the equipment. All movements should be smooth; avoid jerking. Extra caution should be taken when boom is in a full horizontal position or when moving heavy loads.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

5. Engine Foot Throttle Actuator

Engine power and speed is controlled using the foot pedal located on the right side floor of the control cab. Depress the pedal to accelerate the engine. Release to idle the engine. Pedal is spring loaded to idle.

6. Engine Kill Cable

Located on the left side of the operator's seat. Pull lever to shut off fuel intake causing engine to shut down.

7. Emergency Engine Kill Cable

Located on the left side of the operator's seat. Pull lever to shut off air intake causing engine to shut down.

8. Engine Start Button

Located on the gauge panel to the left of the operator. Push button to start engine.

9. Foot Dynamic Swing Brake Actuator



Located on the front floor of the control cab. Gently depress the pedal to slowly stop swing of crane or to hold the crane in position against the wind. The preferred method to bring the crane to a slow smooth stop is described in the "Operation Guidelines". Please read and become familiar with these guidelines before operating the crane.

This brake is capable of dynamic operation and has sufficient holding capability to cause major damage to the Boom and Swing Machinery in the event that it is applied forcefully. For this reason, caution is urged in the use of this brake for stopping the swing motion. Refer to the "operation guidelines" in this manual.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### 10. Parking Brake Valve



Located on the left side of the operator's seat. Must be depressed to set the parking brake. Set the parking brake only when the crane has stopped swinging.

This crane is equipped with free swing capability. Crane must be completely stopped before engaging parking brake. Do not use parking brake to stop swing of crane.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732


Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50







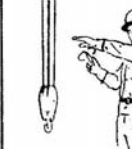






### Section 3.5 Crane Signals

**SEÑALES DE MANO PARA MANIOBRAS CON GRÚA**






**Oil States**  
OIL STATES INDUSTRIES, INC.

**Nautilus Marine Cranes**  
Houma, Louisiana (985) 868-0630

 <p><b>ELEVAR O SUBIR</b> Con el antebrazo en posición vertical, con el dedo índice hacia arriba, mover la mano en círculo horizontal pequeño.</p>	 <p><b>BAJAR</b> Con el brazo extendido hacia abajo, con el índice apuntando hacia abajo, mover la mano en un círculo horizontal pequeño.</p>
 <p><b>UTILIZAR MALACATE PRINCIPAL</b> Tocar la cabeza con el puño, luego utilizar los señales regulares.</p>	 <p><b>UTILIZAR LÍNEA AUXILIAR</b> "Malacate auxiliar". Tocar el codo con una mano, luego utilizar los señales regulares.</p>
 <p><b>SUBIR O ELEVAR PLUMA</b> Brazo extendido, dedos cerrados y pulgar apuntando hacia arriba.</p>	 <p><b>BAJAR O DESCENDER PLUMA</b> Brazo extendido, dedos cerrados y pulgar apuntando hacia abajo.</p>
 <p><b>MOVER LENTAMENTE</b> Usar una mano para dar cualquier señal de movimiento y colocar la otra mano en "off" (En el ejemplo se muestra "cabeza arriba").</p>	 <p><b>SUBIR LA PLUMA Y BAJAR LA CARGA</b> Con un brazo extendido, el pulgar apuntando hacia arriba, doblar los dedos dentro y fuera durante el tiempo que desee mover la carga.</p>
 <p><b>BAJAR LA PLUMA Y SUBIR LA CARGA</b> Con el brazo extendido, el pulgar apuntando hacia abajo, doblar los dedos adentro y afuera durante el tiempo que desee mover la carga.</p>	 <p><b>GIRO</b> Brazo extendido apuntando con el dedo en dirección al giro de la pluma.</p>
 <p><b>ALTO</b> Brazo extendido, palma hacia abajo, mantener rígida en posición.</p>	 <p><b>PARO DE EMERGENCIA</b> Brazo extendido, palma hacia abajo, mover la mano rápidamente a la derecha y a la izquierda.</p>
 <p><b>AVANCE</b> Brazo extendido al frente, mano abierta y ligeramente elevada, hacer movimiento como de empujar en dirección del desplazamiento deseado.</p>	 <p><b>ASEGURAR TODO</b> Unir ambas manos frente al cuerpo.</p>

**SEÑALES DE MANO PARA GRUAS CON PLUMA TELESCÓPICA**

 <p><b>EXTENDER LA PLUMA</b> Ambos puños en frente de su cuerpo con los dedos pulgares apuntando hacia fuera.</p>	 <p><b>RETRAER LA PLUMA</b> Ambos puños en frente de su cuerpo con los dedos pulgares apuntando entre ellos.</p>
 <p><b>EXTENDER LA PLUMA</b> Señal con una mano. Un puño en frente del pecho con el pulgar tocando al pecho.</p>	 <p><b>RETRAER LA PLUMA</b> Señal con una mano. Un puño en frente del pecho con el pulgar apuntando hacia fuera y el talón del puño tocando al pecho.</p>

P.N. 45376 De acuerdo con la Especificación API RP2D



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 3.6 Emergency Load Lowering Kit Instructions



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

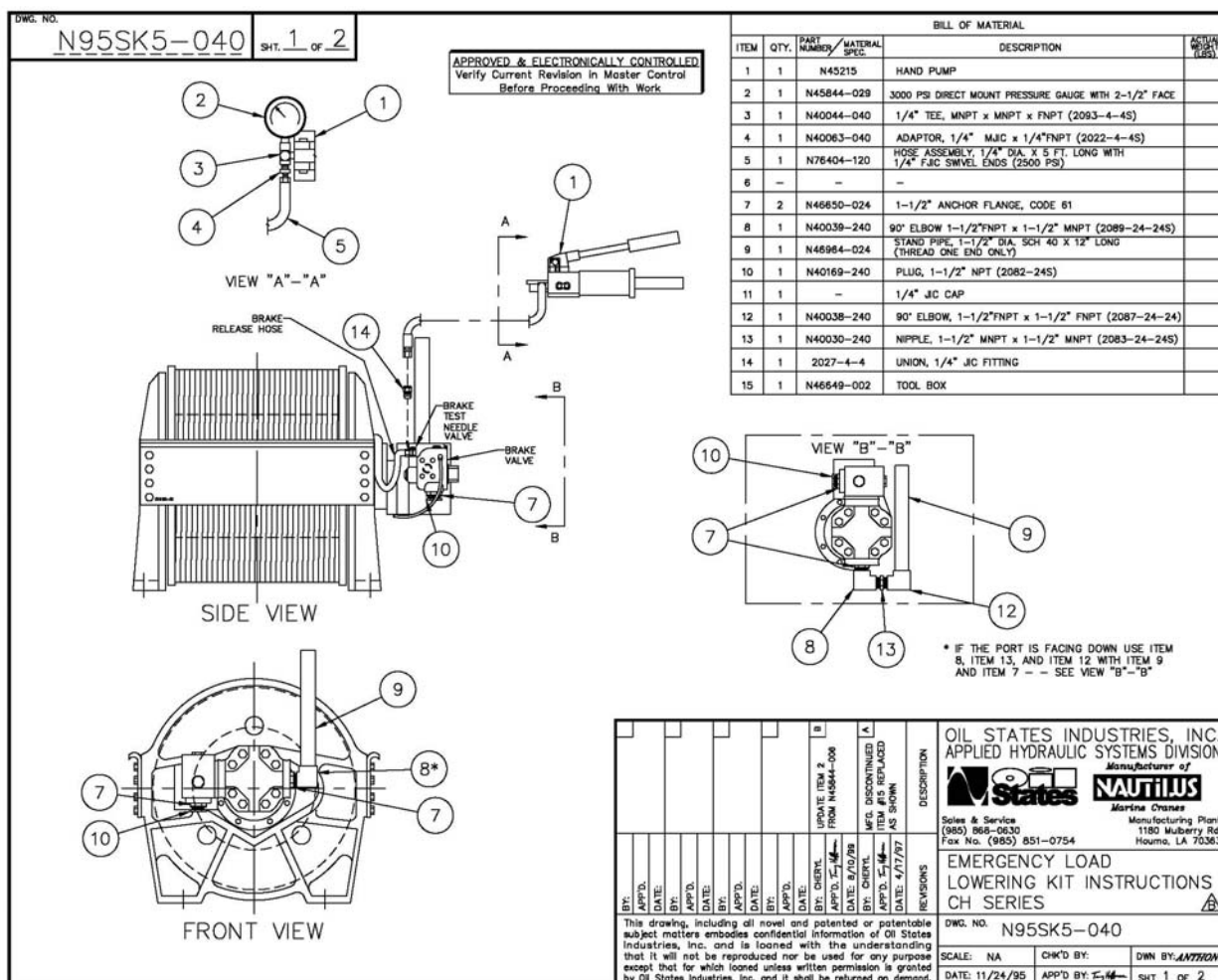
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.6.1 CH Series Hoist



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### EMERGENCY LOWERING PROCEDURE

#### CH SERIES HOIST ONLY

1. DISCONNECT THE BRAKE RELEASE HOSE FROM THE BRAKE TEST NEEDLE VALVE, PUT 1/4" JIC CAP (ITEM 11) ON OPEN FITTING, REMOVE LOCKWIRE ON BRAKE TEST NEEDLE VALVE AND CLOSE VALVE. (REF. SHEET 1)
2. INSTALL 1/4" UNION (ITEM 14) IN BRAKE RELEASE HOSE DISCONNECTED FROM NEEDLE VALVE.
3. INSTALL PRESSURE GAUGE (ITEM 2), HOSE (ITEM 5), 1/4" TEE (ITEM 3) AND 1/4" ADAPTER (ITEM 4) ON HAND PUMP (ITEM 1). (REF. SHEET 1)
4. ATTACH HAND PUMP HOSE (ITEM 5) TO 1/4" UNION (ITEM 14).
5. REMOVE BOTH MAIN HOSES FROM THE MOTOR AND ATTACH A STAND PIPE TO THE MOTOR PORT ON THE OPPOSITE SIDE OF THE MOTOR FROM THE BRAKE VALVE USING ITEMS 7, 8 & 9. THE STAND PIPE MUST BE INSTALLED VERTICALLY. (REF. SHEET 1)
6. INSTALL 1-1/2" ANCHOR FLANGE (ITEM 7) ON BRAKE VALVE WITH PLUG (ITEM 10).
7. FILL THE STAND PIPE (ITEM 9) WITH HYDRAULIC OIL.

### !CAUTION!

THIS EMERGENCY LOWERING PROCEDURE OPENS THE MULTIPLE-DISC BRAKE WHILE LEAVING THE BRAKE VALVE CLOSED. SINCE GEAR TYPE MOTORS ARE NOT ZERO LEAK DEVICES, INTERNAL MOTOR LEAKAGE PERMITS THE LOAD TO SLOWLY ROTATE THE MOTOR EVEN THOUGH THE OUTLET IS BLOCKED BY THE CLOSED BRAKE VALVE AND THE PLUG (ITEM 10). THIS PROCEDURE WILL NOT WORK IF THERE IS LITTLE OR NO OIL IN THE MOTOR. ATTEMPTING TO USE THIS PROCEDURE WITH NO OIL IN THE MOTOR WILL CAUSE THE LOAD TO FREE FALL. THE PURPOSE OF THE STAND PIPE IS TO INSURE THAT THE MOTOR IS FULL OF OIL. THE STAND PIPE IS SIMPLY A LENGTH OF PIPE ABOUT ONE (1) FOOT LONG (31 CM), ATTACHED TO A 90° ELBOW. THE OTHER END OF THE ELBOW IS ATTACHED TO A SHORT FITTING SUITABLE FOR MOUNTING ON THE MOTOR PORT OR MANIFOLD. THE STAND PIPE IS INSTALLED WITH THE PIPE POINTED IN A VERTICAL POSITION. WHILE LOWERING, OIL SHOULD BE ADDED TO THE STAND PIPE AS NECESSARY. THE PIPE DIAMETER SHOULD BE EQUAL TO OR LARGER THAN THE MOTOR PORT DIAMETER.

8. WITH THE HAND PUMP, SLOWLY APPLY 500-750 LBS. HYDRAULIC PRESSURE TO THE BRAKE RELEASE PORT WHILE CONSTANTLY MONITORING THE DESCENT OF THE LOAD. RELEASING THE PRESSURE ON THE HAND PUMP WILL CAUSE THE BRAKE TO RE-APPLY AND STOP THE LOAD. IF A CHATTERING NOISE IS HEARD WHILE THE LOAD IS COMING DOWN, PUMP THE HAND PUMP TO A HIGHER PRESSURE (DO NOT EXCEED 1000 PSI) UNTIL THE NOISE STOPS. DO NOT TOUCH THE MOTOR OR STAND PIPE WHILE USING THIS PROCEDURE; THESE ITEMS BECOME VERY HOT.
9. WHEN LOAD LOWERING IS COMPLETED, REVERSE THIS PROCEDURE AND SAFETY WIRE THE BRAKE TEST NEEDLE VALVE OPEN.

OIL STATES INDUSTRIES, INC. APPLIED HYDRAULIC SYSTEMS DIVISION Manufacturer of <b>NAUTILUS</b> States Crane States & Service (800) 866-0030 1180 Mulberry Road P.O. Box 1000 Houma, LA 70363 851-0754	
EMERGENCY LOWERING PROCEDURE CH HOIST ONLY	
DWE NO. N95SK5-040	
SCALE: NA	
DATE: 11/28/95	
DWG BY: PHBZ	
APP'D BY: JMD	
SHEET 2 OF 2	
DESCRIPTION	REVISIONS
	DATE: _____
	BY: _____
	DATE: _____
	BY: _____

This drawing, including all notes and specifications, is the property of Oil States Industries, Inc. and is loaned with the understanding that it is not to be reproduced or used in any way without the written permission of Oil States Industries, Inc. and it shall be returned on demand.

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

DATE: 11/28/95

N95SK5-040

SHEET 2 OF 2



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

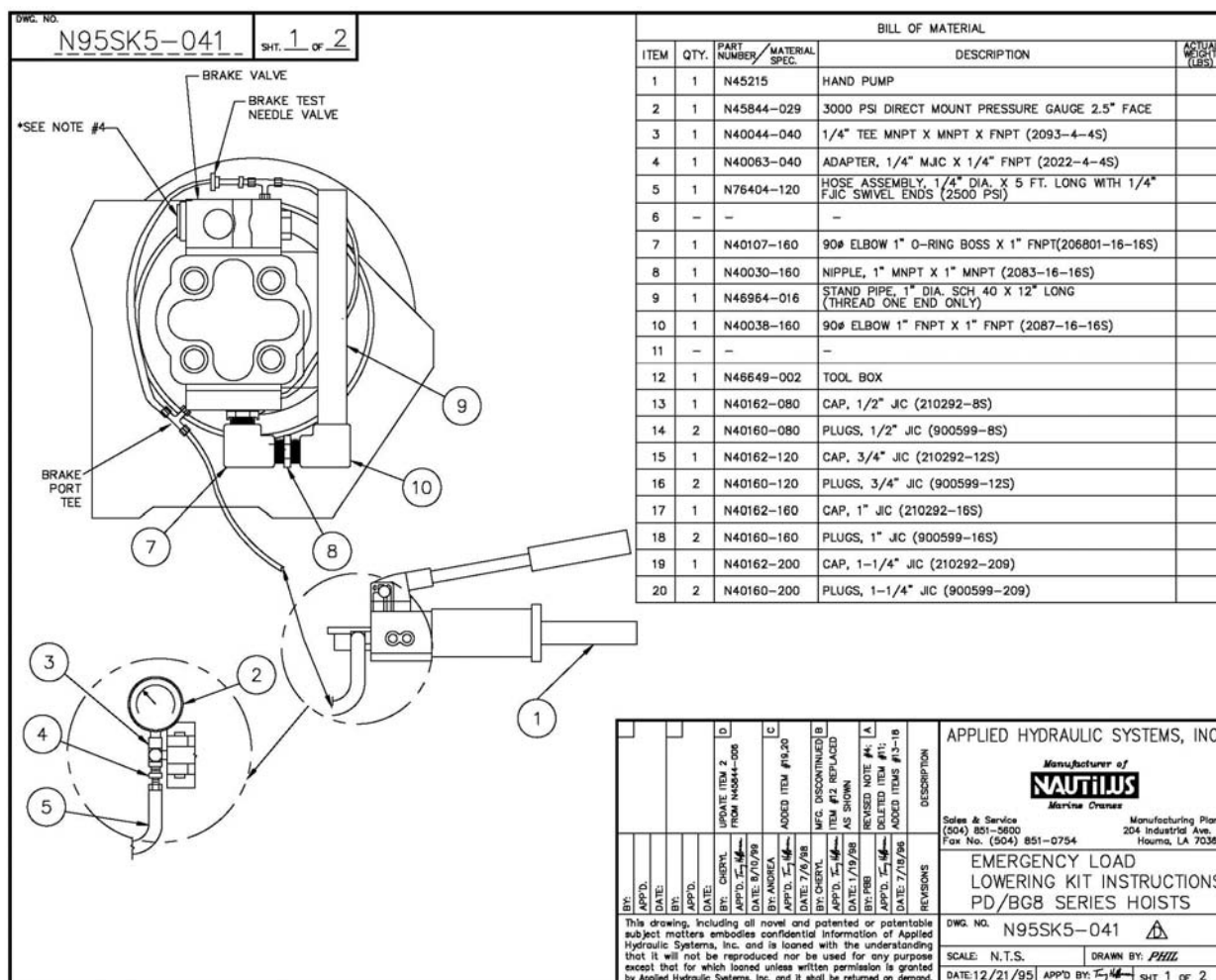
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 3.6.2 PD Series Hoist



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### EMERGENCY LOWERING PROCEDURE PD/BG8 SERIES HOISTS

1. REMOVE THE LOCKWIRE ON THE NEEDLE VALVE HANDLE AND CLOSE THE BRAKE TEST NEEDLE VALVE TIGHTLY. (REF. SHEET 1)
2. INSTALL PRESSURE GAUGE (ITEM 2), HOSE (ITEM 5), 1/4" TEE (ITEM 3) AND 1/4" ADAPTER (ITEM 4) ON HAND PUMP (ITEM 1) - (REF. SHEET 1)
3. REMOVE BOTH MAIN HOSES FROM THE WINCH MOTOR AND ATTACH A STAND PIPE TO THE MOTOR PORT ON THE OPPOSITE SIDE OF THE MOTOR FROM THE BRAKE VALVE USING ITEMS 7, 8, 9 & 19. THE STAND PIPE MUST BE INSTALLED VERTICALLY. (REF. SHEET 1)
4. INSTALL PLUG IN BRAKE VALVE ACCORDING TO HOSE SIZE AT HOIST. FOR 1/2" HOSE - SEE ITEMS 13 & 14; FOR 3/4" HOSE - SEE ITEMS 15 & 16; AND FOR 1" HOSE - SEE ITEMS 17 & 18.
5. FILL THE STAND PIPE (ITEM 9) WITH HYDRAULIC OIL.
6. REMOVE THE JIC CAP ON BRAKE PORT TEE. (REF. SHEET 1)
7. CONNECT HOSE (ITEM 5) FROM HAND PUMP TO THE OPENING ON THE BRAKE PORT TEE. (REF. SHEET 1)

### !CAUTION!

THIS EMERGENCY LOWERING PROCEDURE OPENS THE MULTIPLE-DISC BRAKE WHILE LEAVING THE BRAKE VALVE CLOSED. SINCE GEAR TYPE MOTORS ARE NOT ZERO LEAK DEVICES, INTERNAL MOTOR LEAKAGE PERMITS THE LOAD TO SLOWLY ROTATE THE MOTOR EVEN THOUGH ITS OUTLET IS BLOCKED BY THE CLOSED BRAKE VALVE AND THE PLUG (ITEM 11). THIS PROCEDURE WILL NOT WORK IF THERE IS LITTLE OR NO OIL IN THE MOTOR. ATTEMPTING TO USE THIS PROCEDURE WITH NO OIL IN THE MOTOR WILL CAUSE THE LOAD TO FREE FALL. THE PURPOSE OF THE STAND PIPE IS TO INSURE THAT THE MOTOR IS FULL OF OIL. THE STAND PIPE IS SIMPLY A LENGTH OF PIPE ABOUT ONE (1) FOOT LONG (31 CM), ATTACHED TO A 90° ELBOW. THE OTHER END OF THE ELBOW IS ATTACHED TO A SHORT FITTING SUITABLE FOR MOUNTING ON THE MOTOR PORT OR MANIFOLD. THAT STAND PIPE IS INSTALLED WITH THE PIPE POINTED IN A VERTICAL POSITION. WHILE LOWERING, OIL SHOULD BE ADDED TO THE STAND PIPE AS NECESSARY. THE PIPE DIAMETER SHOULD BE EQUAL TO OR LARGER THAN THE MOTOR PORT DIAMETER.

8. WITH THE HAND PUMP, SLOWLY APPLY 500-750 LBS. HYDRAULIC PRESSURE TO THE BRAKE RELEASE PORT WHILE CONSTANTLY MONITORING THE DESCENT OF THE LOAD. RELEASING THE PRESSURE ON THE HAND PUMP WILL CAUSE THE BRAKE TO RE-APPLY AND STOP THE LOAD. IF A CHATTERING NOISE IS HEARD WHILE THE LOAD IS COMING DOWN, PUMP THE HAND PUMP TO A HIGHER PRESSURE (DO NOT EXCEED 1000 PSI) UNTIL THE NOISE STOPS. DO NOT TOUCH THE MOTOR OR STAND PIPE WHILE USING THIS PROCEDURE; THESE ITEMS BECOME VERY HOT.
9. WHEN LOAD LOWERING IS COMPLETED, REVERSE THIS PROCEDURE AND SAFETY WIRE THE BRAKE TEST NEEDLE VALVE OPEN.

APPLIED HYDRAULIC SYSTEMS, INC.	
<b>NAUTILUS</b> Manufacture of Marine Cranes	
Sales & Service (504) 801-5000 For No. (504) 801-0754	
Manufacturing Plant 204 Industrial Ave. C Houma, LA 70363	
EMERGENCY LOWERING PROCEDURE PD/BG8 HOISTS SERIES	
DWG. NO. N95SK5-041	
SCALE: NTS	
DATE: 11/25/95	
DRAWN BY: PZZZ	
APPROVED BY: [Signature]	
BY: [Signature]	
REVISIONS	
DESCRIPTION	DATE
This drawing, including all notes and attachments, is the property of Applied Hydraulic Systems, Inc. and is loaned with the understanding that it will not be reproduced or used for any purpose other than that for which it was loaned. It is to be returned to Applied Hydraulic Systems, Inc. and it shall be returned as directed.	

DWG. NO. N95SK5-041  
SMT. 2 of 2



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.0 Maintenance Manual



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.1 Maintenance Introduction

**Maximum crane performance is maintained by proper upkeep and maintenance.**

This maintenance section provides guidelines for proper upkeep of the crane. The maintenance of your crane falls into two areas:

1. Routine inspection and service
2. Scheduled maintenance

Routine inspection and service should be performed each day the crane is operated or each 8 hours of operation. The routine inspection and scheduled maintenance of your engine, generator\*, winch, hydraulic pump, load and moment indicator system\* are specified in the manufacturer's maintenance operation manuals. See "Index" for the location of these manuals.

\* These manuals are included only when these options are installed on crane.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.2 Maintenance Precaution



Before maintenance, adjustment or repair is started on a crane, take the following precautions:

1. Place crane where it will cause the least interference with other equipment or operations in the area.
2. Shut power off and put control in neutral
3. Set the mechanical swing lock if your crane has a swing lock.
4. Set swing parking if your crane is equipped with a manually operated parking brake.
5. Lower boom, if possible, onto boom rest.
6. Lower load block and overhaul ball if needed.
7. Prior to hydraulic system maintenance, bleed off all pressure in each hydraulic circuit. Operate each control lever in a back and forth motion to bleed off the hydraulic circuit pressure.
8. Prior to electrical system maintenance, insure power is off and disconnects are open. Physically disconnect the power supply to the electrical system.



After adjustments and repairs have been made, the crane shall not be returned to service until all guards have been re-installed, trapped air removed from hydraulic system if required, safety devices reactivated and maintenance equipment removed.

When crane is not in operation for extended periods of time, lubrication of ballring should still be performed at least every three months and thorough inspection of the wire rope(s) made.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.3

### Routine Inspection & Service / Daily Function Test

#### Routine Inspection and Service

Check each day crane is in operation (before operating)

Upperstructure/Gantry Connection Pins	
Upperstructure/Gantry Connection Bolts	
Sheave Pins (Main / Auxiliary/Bridle/Gantry)	
Boom Foot Pins	
Ballring / Ballring Bolts	
Wedge Socket Connections	
Hoists and Wire Ropes (Main/Auxiliary/Boom)	
Boom Pendant Lines	
Hydraulic Hoses	
Pin Keepers and Bolts	
Hydraulic Oil Level	
Engine Fuel Level	
Engine Coolant Level	
Engine Oil Level	
Electric Swivel	
Boom Sections (Connection Pins)	
Load Block (Safety Latch)	
Overhaul Ball (Safety Latch)	

#### Daily Functional Test

Perform functional tests each day crane is operated

Test Main Anti-Two Block function by Raising Load Block	
Test Aux. Anti-Two Block Function by Raising Overhaul Ball	
Test Parking Brake Valve	
Test Boom High/Low Angle Kickout Assembly	
Test Anti-Two Block/Boom Low Angle Kickout Override Valve Function	
Test Electrical Components	
Activate Engine Kill Cable	
Test Swing Lock Function	



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.4 Notes & Precautions

The following maintenance schedule outlines the minimum frequency for thorough inspection, lubrication and changing specific items.

The lubrication frequency is the maximum length of time between lubrications. The necessary lubrication frequency is dependent on the environmental conditions. Over lubrication of non-sealed fittings (sheave pins, valve spools, wheel bearings, etc.) will not harm the fittings or components but under lubrication will definitely lead to a shorter lifetime. Grease fittings that are worn and will not hold the grease gun or those that have a stuck ball must be replaced.

On plug-type check points, the oil levels are to be at the bottom edge of the fill point.

An extensive wire rope inspection should be made at least every 100 hours of operation or every three (3) months. A comprehensive explanation of the wire rope inspection is given in the API Recommended Practice 2D (RP2D). Inspect the wire rope for any types of deterioration: distortion, corrosion, broken strands, etc. The listed lubrication frequency is the maximum length of time between lubrications. The necessary lubrication frequency is dependent on the environmental conditions.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.5 Maintenance Schedule

INSPECTION / REPLACEMENT	BREAK IN 50 HRS.	BREAK IN 100 HRS.	EVERY 100 HRS.	3 MONTHS OR 150 HRS.	3 MONTHS OR 500 HRS.	6 MONTHS OR 1000 HRS.	ANNUALLY
WINCH OIL	-----	CHANGE	-----	-----	-----	-----	CHANGE
GEARBOX OIL	-----	CHANGE	-----	-----	-----	CHANGE	-----
*BALLRING & PEDESTAL BOLTS	RE-TORQUE	-----	INSPECT	-----	-----	-----	RE-TORQUE
HOSES	-----	-----	CHECK	-----	-----	-----	-----
HOIST BOLTS	-----	-----	INSPECT	-----	-----	-----	RE-TORQUE
PIN KEEPERS	-----	-----	INSPECT	-----	-----	-----	-----
WELDS	-----	-----	INSPECT	-----	-----	-----	-----
HYDRAULIC OIL	-----	-----	-----	-----	-----	-----	DRAIN & CLEAN
SUCTION STRAINERS	-----	-----	-----	-----	-----	-----	REPLACE
HYD. OIL RETURN FILTER ELEMENT	CHANGE	-----	-----	-----	CHANGE	-----	-----
FUEL FILTERS	CHANGE	-----	-----	-----	CHANGE	-----	-----
EXHAUST SYSTEM	-----	-----	-----	-----	DRAIN	-----	-----
OIL FILTER	-----	-----	-----	CHANGE	-----	-----	-----
FUEL / HYDRAULIC TANK	-----	-----	-----	-----	DRAIN	-----	-----
EMERGENCY ENGINE KILL CABLE	TEST/INSPECT	-----	-----	-----	-----	-----	-----
ENGINE FOOT THROTTLE ACTUATOR	TEST/INSPECT	-----	-----	-----	-----	-----	-----
DYNAMIC SWING BRAKE ACTUATOR	INSPECT	-----	-----	-----	-----	-----	-----
AIR FILTER	-----	-----	-----	-----	CHANGE	-----	-----
RADIATOR	-----	-----	-----	-----	-----	-----	-----
COOLANT	-----	-----	-----	-----	-----	-----	-----
NORMAL USE	-----	-----	-----	-----	-----	-----	ANNUALLY
HEAVY USE	-----	-----	-----	-----	-----	CHANGE	-----

WIRE ROPE

API RECOMMENDED PRACTICE 2D (RP 2D)



\*Ballring and Pedestal bolts must be retorqued at the intervals shown to prevent premature bearing wear and / or failure.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book


P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

LUBRICATION	1 MONTH OR 50 HRS.	3 MONTHS OR 100 HRS.	6 MONTHS OR 1000 HRS.
OVERRIDE VALVE SPOOLS	LUBRICATE	-----	-----
BOOM FOOT PINS	LUBRICATE	-----	-----
SHEAVE PINS (MAIN/AUX/IDLER)	LUBRICATE	-----	-----
SHEAVE PINS (GANTRY/BRIDLE)	LUBRICATE		
GANTRY/UPPERSTRUCTURE PINS	LUBRICATE	-----	-----
LOAD BLOCK/OVERHAUL BALL	LUBRICATE	-----	-----
PARKING BRAKE SPOOLS	LUBRICATE	-----	-----
GEARBOX	LUBRICATE	-----	-----
HOIST (MAIN/AUXILIARY/BOOM)	LUBRICATE	-----	-----
CONTROL VALVE SPOOLS	LUBRICATE	-----	-----
CONTROL LEVER LINKAGE & PIN	LUBRICATE	-----	-----
ENG. FOOT THROTTLE ACTUATOR	LUBRICATE	-----	-----
DYNAMIC SWING BRAKE ACTUATOR	LUBRICATE	-----	-----
BOOM STOPS	-----	-----	-----
SWING LOCK BEARCLAW	-----	-----	-----
WIRE ROPES (MAIN/AUX/BOOM)	-----	-----	LUBRICATE
PENDANT LINES (BOOM)		-----	LUBRICATE
BALLRING		LUBRICATE	
PINION GEARS		LUBRICATE	



\*Ballring must be lubricated at the intervals shown to prevent premature bearing wear and/or failure.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.6 Lubrication Diagrams



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

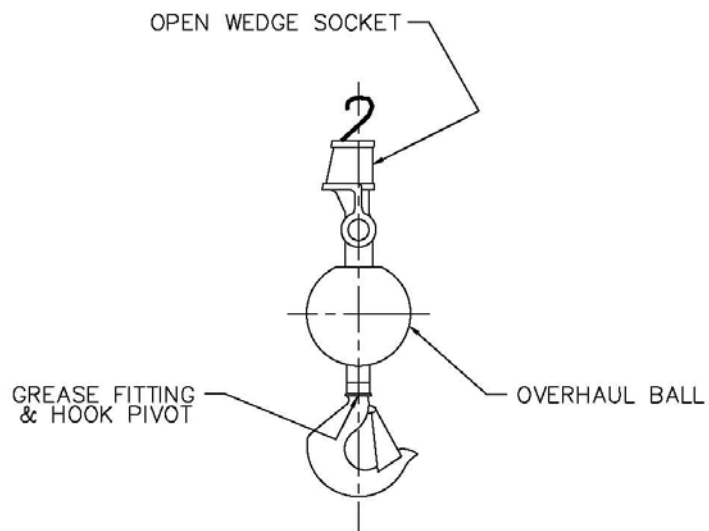
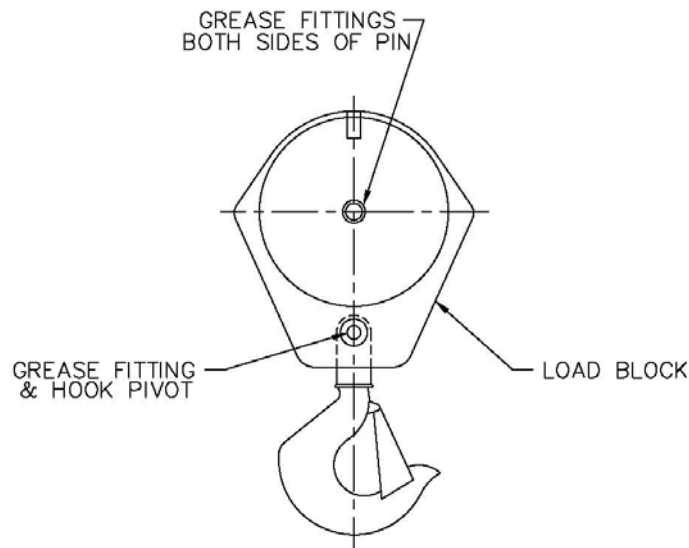
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.6.1 Load Block & Overhaul Ball





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

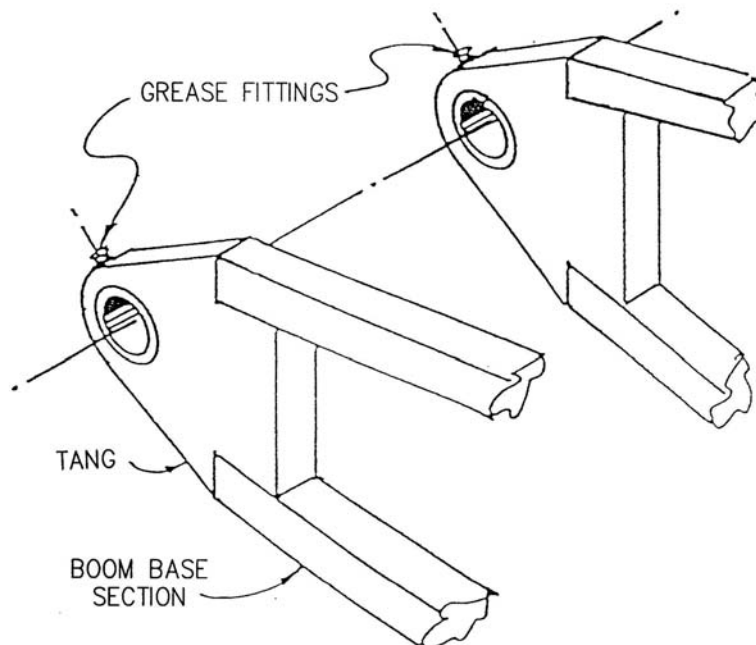
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.6.2 Boom Foot Pin / Lift Cylinder Pins



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

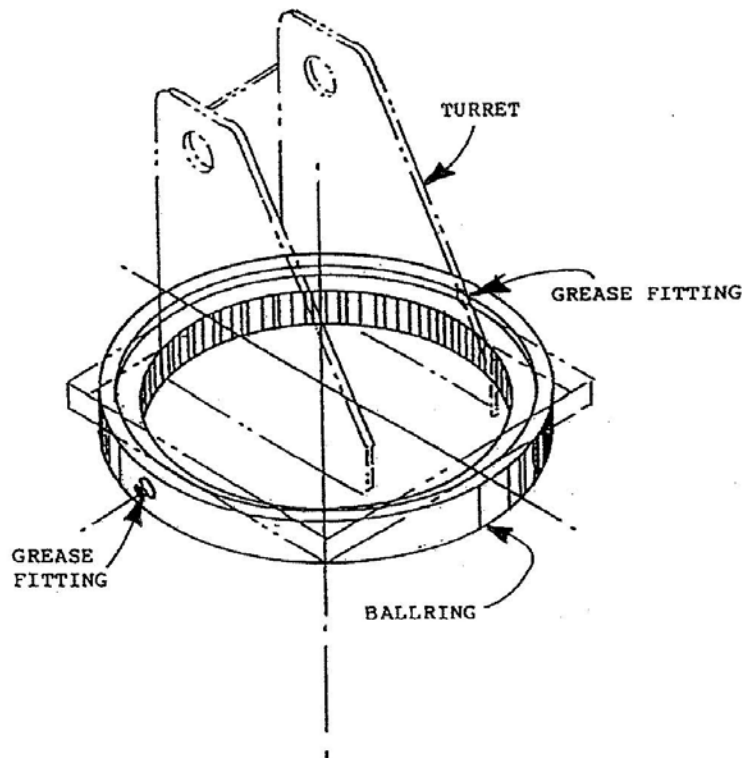
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.6.3 Ballring



Each bearing is equipped with one or more grease fittings. Models equipped with two or three rows of fittings should be greased on each row. To insure uniform distribution of grease throughout the bearing, the machine should be rotated at least two complete revolutions while greasing. When complete rotation is impractical, grease may be pumped into each fitting, rotating the device back and forth as possible as each fitting is greased. For bearings with integral gears, lubricate gear as necessary to prevent metal-to-metal contact.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

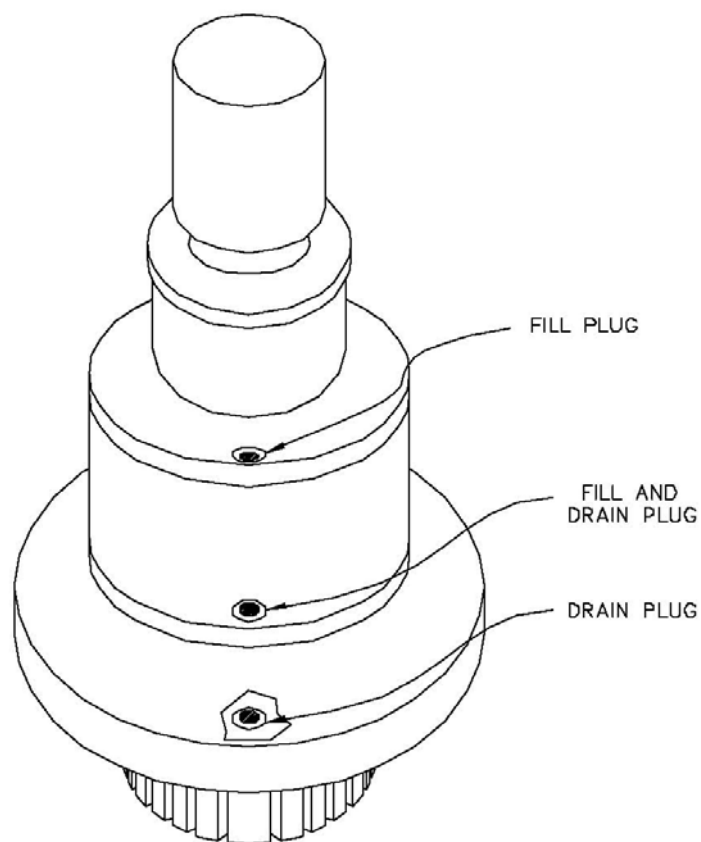
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.6.4 Gearbox





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

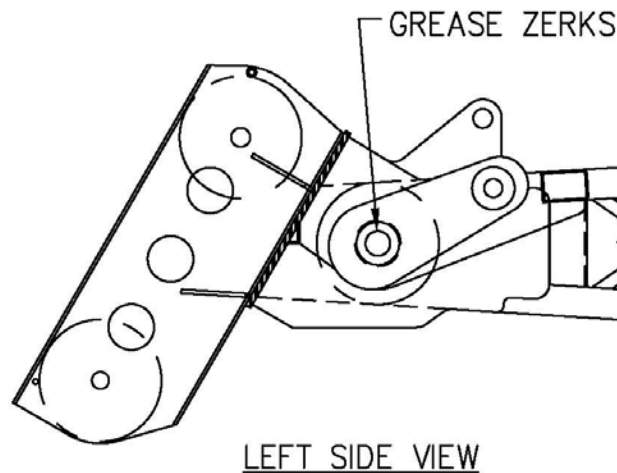
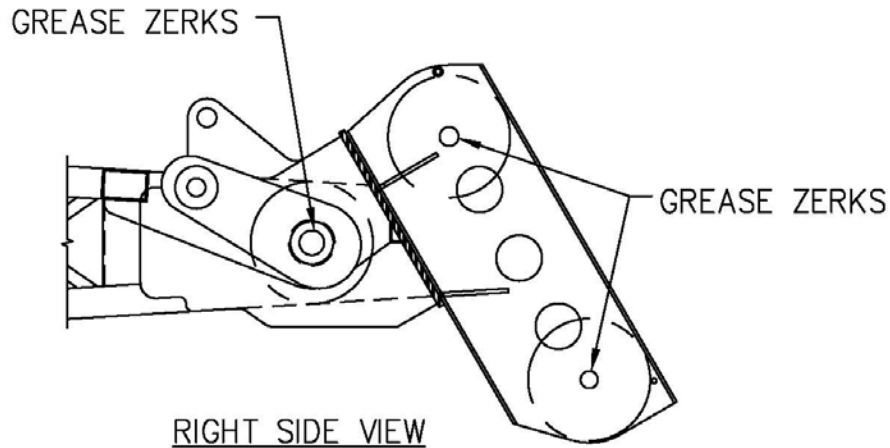
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.6.5 Sheave Case



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

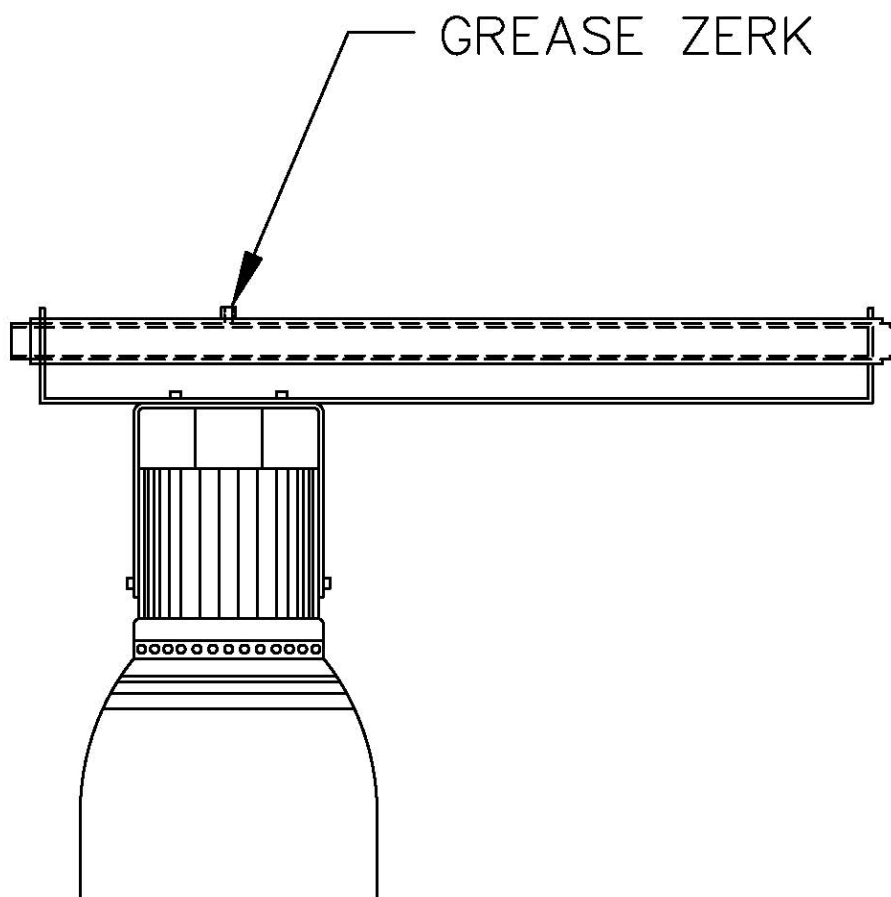
P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.6.6 Floodlights



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.7 Recommended Fluids & Lubricants



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.7.1 Hydraulic Oil

Viscosity	150-225 SSU @ 100°F
Viscosity Index	90 Minimum
Pour Point	No Higher than 20°F
Neutralization Point	0-05 Maximum
Compounds For	Wear
Compounds For	Anti-Foam
Compounds For	Anti-Rust

#### SUPPLIER

Arco  
Conoco  
CITGO  
Exxon  
Gulf  
Mobil  
Pennzoil  
Phillips  
Shell  
Sun  
Tenneco  
Chevron Texaco  
Union

#### DESIGNATION

Duro AW 46 Hydraulic Oil  
Super Hydraulic Oil 32  
AW Hydraulic 32  
NUTO 32  
Harmony 32 AW  
DTE 24  
Pennzoil AW 32  
Magnus A 32  
Tellus 32 (Winter) / 46 (Summer)  
Sunvis 816 WR  
EP 300  
Rando HD 46  
UNAS AW32



Do not use Phosphate Esters.  
Do not use Synthetic Fluids.

Seals are compatible with mineral base fluids only.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.7.2 Gear Oil

Recommended Hoist Lubricants

<u>SUPPLIER</u>	<u>DESIGNATOR</u>	<u>AMBIENT TEMPERATURE</u>
Texaco	Meropa 220 / Equivalent API GL-2/3	+ 50 to + 130°F
Texaco	Meropa 150 / Equivalent API GL-2/3	- 10 to + 50°F
Mobil	SCH630 Synthetic	- 40 to - 10°F

<u>SUPPLIER</u>	<u>DESIGNATION</u>
Conoco	Universal Gear 140w
CITGO	Premium Gear Oil 140w
Exxon	Gear Oil GX 140
Gulf	Multi-Purpose G.L. 140
Mobil	Mobilube HD 140w
Pennzoil	Pennzoil – 140w
Phillips	Philube SMP 140
Shell	Spirex HD 140w
Sun	Sunfleet GL 5 140w
Tenneco	
Texaco	Multigear EP 140w
Union	MP Gear Lube LS 140w



Failure to use the proper type and viscosity of planetary gear oil could result in property damage, severe personal injury or death.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

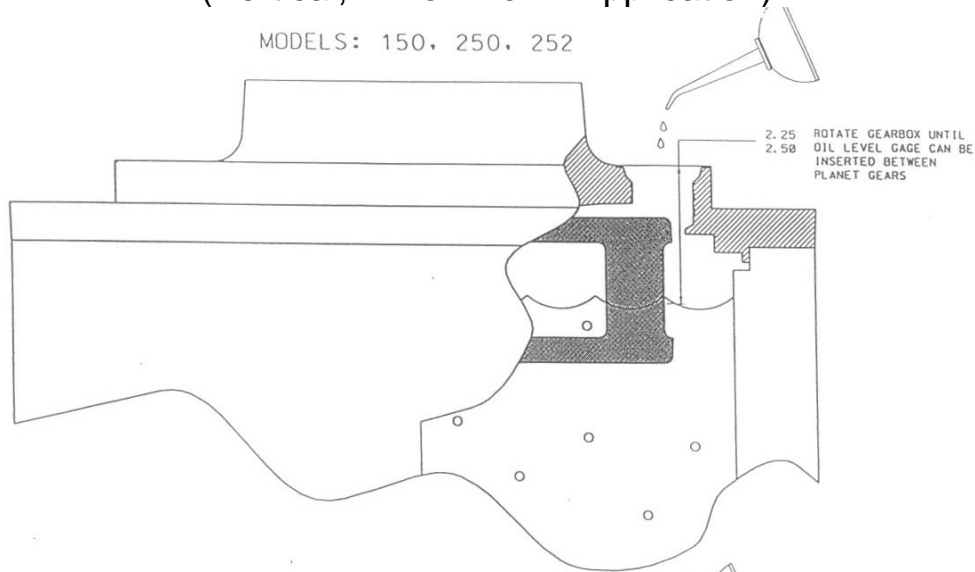
Serial # 21409C

Volume: 1

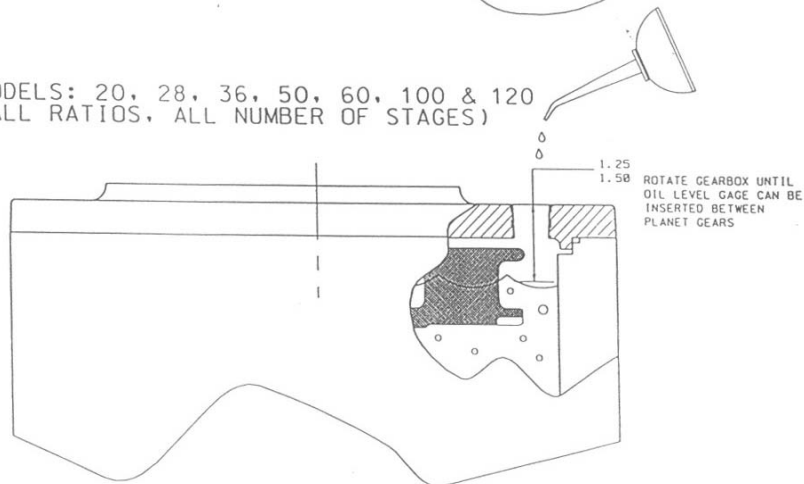
## Nautilus Crane Model 180L4-50

### Section 4.7.3 Oil Fill & Level Check for Geardrives (Vertical, Pinion Down Application)

MODELS: 150, 250, 252



MODELS: 20, 28, 36, 50, 60, 100 & 120  
(ALL RATIOS, ALL NUMBER OF STAGES)



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.8 Miscellaneous Fluids

##### Ballring, Pins, Bushings, Swivel:

Grease

General Purpose: Lithium based grease with "EP" additives and rust inhibitors (use Grade #2 for temperatures about 32°F and Grade #1 for temperatures under 32°F.)

##### Engine:

Fuel

See Engine Operators Guide

Lube Oil

See Engine Operators Guide

##### Coolant:

Depends on environmental requirements. Complete analysis provided in engine service manual (50% anti-freeze, 50% water normal mix). See also engine manual

##### For Personnel Handling:

Check oil level in winches every 2 weeks and brake test every quarter. Disassemble and inspect all wear parts annually.

##### Hydraulic Luffing Cylinders:

Wax

Car Wax (Turtle Wax is recommended)

Wax cylinder rods once a month to get longer life out of your cylinders

##### Wire Rope:

Esgard

##### Hydraulic Throttle Actuator:

HYDRAULIC OIL – Use quality oil as prescribed for the hydraulic system.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.9 Maintenance Malfunction Diagnosis

The following chart list malfunctions which may occur during equipment operation, followed immediately by the possible cause and solution. These are not all inclusive but are designed to help isolate the problem.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
<i>No response to control</i>	Load too heavy	Check Capacity Chart
	Low hydraulic fluid supply pressure	Check and fill as required
	Broken hydraulic pressure line	Replace as required
	Incorrect relief valve setting	Call OSI* Service
	Relief valve sticking	Call OSI* Service
<i>Poor hydraulic system performance</i>	Low hydraulic supply flow	Call OSI* Service
	Relief valve sticking	Call OSI* Service
	Relief setting too low	Call OSI* Service
	Boom holding valves out of adjustment	Warm oil or use less viscous oil
	Lines restricted	Check lines; clean and repair as necessary
	Internal valve crack	Replace valve
	Load too heavy	Check Capacity Chart and reduce load
<i>Swing moves erratic or loosely</i>	Loose turntable bearing	Torque bearing mounting and call OSI* Service
	Loose swing gearbox mounting bolts	Tighten bolts
	Worn gears or bearing	Replace worn parts or adjust gearbox spacing
	Operator control of lever too erratic	Operate controls smoothly
	Brake not releasing	Check pressure in brake release line



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

The following chart list malfunctions which may occur during equipment operation, followed immediately by the possible cause and solution. These are not all inclusive but are designed to help isolate the problem.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
<i>Swing will not turn</i>	Attempting to swing up too much on incline	Level machine
	Turn circuit relief valves sticking	Clean and check circuit pressure
	Turntable bearing drag	Lubricate thoroughly as rotating boom
	Brake not releasing	Use bleed screw on brake to remove air
<i>Excessive noise during operation</i>	Low oil temperature	Allow unit to warm up
	Low hydraulic oil supply	Check and fill
	Suction line kinked, collapsed or blocked	Clear blockage
	Hydraulic oil too thick	Warm oil use oil more applicable to environment
	Plugged suction strainers	Remove from tank and clean
	Relief valve chatting	Dirt in relief valve or damaged relief
	Swing brake dragging	Use bleed screw on brake to remove air
	Hydraulic tubing vibration	Check for loose tubing
	Tank breather plugged	Clean breather
<i>Cylinders drift loosely</i>	Not getting oil to cylinders	Clean and replace as required
	Worn or damaged piston seals	Replace as required
	Air in hydraulic oil	Cylinder operate crane cylinder to remove air
	Loose holding valve	Tighten valve
	Dirt in holding or check valve	Clean valve



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

The following chart list malfunctions which may occur during equipment operation, followed immediately by the possible cause and solution. These are not all inclusive but are designed to help isolate the problem.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
<i>Winch will not lift or hold load</i>	Load too heavy.	Check load and change to applicable multipart reeving
	Relief valve setting too low	Check and adjust if required
	Motor worn excessive.	Replace motor
	Counterbalance valve defective or leaking	Clean and replace as necessary
	Brake worn out	Repair or replace brake
** Boom chatters during extension or retraction or does not sequence	Boom section needs lubrication.	Grease boom
	Worn wear pads	Replace pads
	Locks inoperative	Clean and grease dirty locks or replace worn/broken parts
	Worn locks	Remove burrs or slightly worn areas with a file. Replace if major wear is evident
*** Boom winch chatters	Ratchet and pawl not releasing	Adjust

\* OSI Service (985)851-5600

\*\* If Telescopic Crane Only

\*\*\* If Lattice Boom Crane Only



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.10 Hoist Descriptive Literature, Catalog



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.10.1

#### Braden Gearmatic

Inspection, Testing, Preventive Maintenance and Special Operating Instructions



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







# BRADEN Gearmatic

## Inspection, Testing, Preventive Maintenance and Special Operating Instructions For Planetary Hoists

### **WARNING**

Read and understand these entire instructions BEFORE operating or servicing your BRADEN/Gearmatic hoist. Retain these instructions for future reference. Failure to properly operate, maintain and service a hoist may lead to loss of load control and result in property damage, serious injury or death.

→ **NOTE:** This publication replaces PB-308 Rev. 5, Bulletin PA125A and Braden Part No. 25672. ←

Inspection Records & Retention .....	1	Brake Test Procedure .....	6-7
Periodic Inspections .....	2-4	Emergency Lowering Procedure .....	8
Oil Sampling & Analysis .....	5	Personnel Handling .....	9

These instructions apply to the following planetary hoists:

PD5/GH5/BG6 (any design series)	CH150A, CH165A, CH175A, CH175B, CH185A
PD7/BG8 (any design series, Equal Speed only)	CH210A, CH230A, CH230B, CH240A, CH280A
PD12 (any design series)	CH330A, CH400A, CH400B, CH500A, CH600A
PD15B ("B" design series only)	CH640A, CH22B ("B" design series only)
PD17A	GH30, GH30B (with external motor & brake valve)
PD21A	GH50 (with external motor & brake valve)

The user of Braden products is responsible for hoist inspection, testing and maintenance with frequency dependent upon the severity of the hoist duty cycle and thoroughness of the preventive maintenance program in effect.

### **WARNING**

Any time a hoist exhibits erratic operation and/or unusual noise, the hoist must be taken out of service until it is inspected and serviced by a qualified technician. Continued operation of a hoist with a defect in a critical component may lead to loss of load control, property damage, serious injury or death.

### Record Retention:

A log of written, dated and signed records of ALL inspections, load tests, maintenance, repairs or modifications must be kept readily available in an appropriate location for a minimum of four (4) years.

To provide customers with qualified outlets for hoist service and repairs, BRADEN has established authorized Service Centers. These Service Centers have factory trained service technicians, up-to-date

service information, extensive parts inventories, complete testing facilities and are audited by BRADEN on a regular basis for compliance. BRADEN strongly recommends the use of BRADEN authorized Service for maintenance, repair and inspection of BRADEN/Gearmatic products. Contact the Braden Technical Support Department at 918-251-8511 for the names of current authorized Service Centers.

## Usage and Inspection:

Inspection procedures for hoists are divided into five general categories based upon their usage or duty cycle, which in turn determines appropriate intervals for inspections. The usage categories must be assigned by the crane user on a consistent crane-by-crane basis. The five crane/hoist usage categories are as follows:

**Idled** - The crane/hoist has not been used for three months.

**Infrequent Usage** - The crane/hoist is used less than ten hours per month based on a three month average.

**Moderate Usage** - Crane/hoist used 10 - 50 hours per month based on a three month average.

**Heavy Usage** - Crane/hoist used 50 - 200 hours per month.

**Severe Duty** - Crane/hoist is operated more than 200 hours per month-OR where 50% of the lifts exceed 75% of the Braden rated capacity for the hoist.

The following chart lists the inspections that are required for each type of usage category.

INSPECTION USAGE CATEGORY	PRE-USE DAILY INSPECTION	QUARTERLY INSPECTION	SEMI-ANNUAL INSPECTION	ANNUAL INSPECTION	TEAR-DOWN INSPECTION
<b>IDLED</b> Not used for 3 months or longer	REQUIRED BEFORE PLACED IN SERVICE QO / QI	REQUIRED BEFORE PLACED IN SERVICE QO / QI	REQUIRED BEFORE PLACED IN SERVICE QO / QI	---	REFER TO NOTE 1
<b>INFREQUENT USAGE</b> less than ten hours per month	REQUIRED QO / QI	REQUIRED QO / QI	REQUIRED QO / QI	REQUIRED QI	5 YEARS 3 YEARS IF NOT SUBJECT TO FULL INSPECTION PROGRAM
<b>MODERATE USAGE</b> 10-50 hours per month	REQUIRED QO / QI	REQUIRED QI	REQUIRED QI	REQUIRED QI	4 YEARS 2 YEARS IF NOT SUBJECT TO FULL INSPECTION PROGRAM
<b>HEAVY USAGE</b> 50-200 hours per month	REQUIRED QO / QI	REQUIRED MONTHLY QO / QI	REQUIRED QUARTERLY (3 months) QI	REQUIRED SEMI-ANNUALLY (6 months) QI	3 YEARS 1.5 YEARS IF NOT SUBJECT TO FULL INSPECTION PROGRAM
<b>SEVERE USAGE</b> 200+ hours per month or 50% of lifts exceed 75% rated capacity	REQUIRED QO / QI	REQUIRED QI	REQUIRED QUARTERLY (3 months) QI	REQUIRED SEMI-ANNUALLY (6 months) QI	1 YEAR

QO = Qualified Operator

QI = Qualified Inspector

**NOTE 1:** For idled units with unknown maintenance and repair history, it is highly recommended that the hoist undergo a tear down inspection prior to being placed into service. If personnel lifting is expected with such a hoist, a tear down inspection is required before use.

### Pre-Use or Daily Inspection:

Must include but is not limited to the following inspections that will be performed prior to placing the crane into service and then as necessary during extended operation. This inspection must be performed by a qualified crane operator or qualified crane inspector.

1. Check for external oil leaks and repair as necessary. **This is extremely important due to the accelerated wear that will result from insufficient lubricating oil in the hoist.** Hoists with a sight glass; check oil level daily. Hoists without a sight glass; check oil level monthly if no external oil leaks are detected. Lubricant level must be maintained between the minimum and maximum levels; midway up sight glass or at bottom of level plug port as equipped. Use only the recommended type of lubricant. Refer to the specific hoist service manual and/or the latest Braden Service Bulletin 503.
2. Check the ratchet and pawl mechanism (if equipped) for proper operation and full, spring-force engagement of the pawl with the ratchet wheel. Adjust or repair as necessary.
3. Check hydraulic fittings and hoses for chaffing, deterioration or corrosion and repair as necessary.
4. Visually inspect for corroded, loose or missing bolts, pins or other fasteners and replace or tighten as necessary.
5. Visually inspect rotation indicator transmitters, anti-two-blocking switches and other safety equipment and repair as necessary.

### Quarterly Inspection (every three months):

Must include but is not limited to the following inspections that must be performed by a qualified crane operator or qualified crane inspector. A qualified crane inspector shall perform inspections on cranes assigned a moderate, heavy or severe usage category.

1. Perform the pre-use inspection.
2. On hoists used for personnel handling, the internal spring-applied brake shall be tested in accordance with the procedure on page 6 of these instructions.
3. Inspect for corrosion of fasteners, hoist base, drum, etc. and repair/replace as required to maintain the structural integrity of the hoist.

### Semi-Annual Inspection (every six months):

Must include but is not limited to the following inspections that must be performed by a qualified crane operator or qualified crane inspector. A qualified crane inspector shall perform inspections on cranes assigned a moderate, heavy or severe usage category.

1. Perform the Pre-Use and Quarterly inspections.
2. Take a sample of the lubricant from the hoist gear cavity as described on page 5 and analyze it for wear metals content, correct viscosity, lubricant deterioration, moisture and other contaminants. If the oil sample contains an high amount of metallic particles, the hoist must be taken out of service to undergo a tear down inspection.

**NOTE: Oil analysis cannot detect nor warn against a fatigue failure.**

### Annual Inspection:

This inspection must be carried out by a qualified crane inspector. The annual inspection **MUST** include, but not be limited, to the following:

1. Perform the Pre-Use/Daily Inspection, Quarterly inspection and Semi-Annual Inspection.
2. Change the lubricating oil in the hoist gear cavity after an oil sample has been taken as described on page 5. Refill the hoist to the proper level with recommended lubricant. Refer to the latest Braden Service Bulletin 503.

### WARNING

Failure to use the proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in property damage, severe personal injury or death. Some gear lubricants contain large amounts of EP (extreme pressure) and anti-friction additives which may contribute to brake clutch slippage or damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake clutch operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake clutch slippage. Make certain that the gear oil viscosity used in your hoist is correct for your prevailing ambient temperature.

## Tear-down Inspection:

Tear down inspections of BRADEN hoists should be completed per the usage schedule defined below. Magnetic Particle Inspection (MPI) of the internal ring gear and reduction gears must be performed during tear down inspections to aid in the detection of cracks in the ring gears due to fatigue. The preferred inspection method is the Fluorescent Wet Magnetic Particle Inspection using ultraviolet light consistent with ASTM E709. For further information related to this inspection, and for testing of the older CH150 ring gears, P/N 24446, refer to BRADEN Service Bulletin LIT2162.

**Severe Duty** - Perform tear down inspection / MPI annually

**Heavy Usage** - Perform tear down inspection / MPI at least every (3) years

**Moderate Usage** - Perform tear down inspection / MPI at least every (4) years

**Infrequent Usage** - Perform tear down inspection / MPI at least every (5) years

It is strongly recommended that any moderate or infrequent usage hoist that is also used for personnel lifting undergo tear down inspections on a maximum basis of once every (3) years.

**Any hoist that has NOT been subject to regular oil sample analysis must undergo a tear down inspection on an annual (12 month) basis.** Also, if a hoist has an unknown history of repair and/or maintenance, it is highly recommended that the hoist undergo a tear down inspection prior to being placed into service.

**NOTE: Oil analysis alone cannot detect nor warn against component fatigue failure.**

A tear down inspection includes the hoist being completely disassembled, cleaned, inspected and repaired as required. Replacement of all worn, cracked, corroded or distorted parts, such as pins, bearings, shafts, gears, brake rotors, brake plates, drum and base should occur as required. All seals and O-rings should be replaced at this time.

**Any deficiencies, including but not limited to those above, shall be corrected immediately.**

All of the following operations **MUST** be performed **BEFORE** the hoist is placed back into service.

1. The rebuilt hoist **MUST** be line pull tested to the rated load of the hoist (hoist rating will vary with motor, gear ratio and drum options) with a dynamometer or equivalent load measuring device. This test load shall be the maximum rating of the hoist for the specific application (at the normal relief valve setting for the hoist) - **NOT** the reduced rating used for personnel lifts.
2. The hoist must be dynamically tested by rotating the drum several times, in both the hoisting and lowering directions, while under a load of at least 30% of the hoist lifting capacity. Check for smooth operation during this procedure.
3. The hoist internal friction brake shall be tested per the procedures on page 6 of this manual.
4. After inspection or rebuild and testing, a new certificate for personnel handling shall be issued by the inspector / service technician, effective on the date the hoist is placed back in service. A sample certificate is shown below, and shall include, at a minimum, all of the information depicted here.

### Name of Service Company

Approved by BRADEN for handling personnel  
if used and maintained in accordance with BRADEN  
Recommendations For Personnel Handling Hoists

Hoist Model No.: \_\_\_\_\_

Hoist Serial No.: \_\_\_\_\_

Date of Inspection: \_\_\_\_\_

Work Order/Job No: \_\_\_\_\_

Inspector's Name: \_\_\_\_\_

For a copy of recommendations call or write: BRADEN  
PO Box 547, Broken Arrow, OK, 74012, USA (918) 251-8511

## PREVENTIVE MAINTENANCE AND OIL SAMPLING

### Oil Change

The hoist gear oil must be changed after the first 100 operating hours then on an annual basis, at a minimum thereafter. In severe duty applications, the gear oil should be changed every six months. Use the recommended lubricants. Refer to the applicable hoist service manual or the latest Braden Service Bulletin 503 for the recommended lubricants.

### Gear Oil Sampling and Analysis

Proper gear oil sampling and analysis is a vital part of a comprehensive preventive maintenance program. Information obtained from the oil analysis allows the maintenance technician to substitute preventive maintenance for more costly unscheduled down time or a far more dangerous failure. Early detection of accelerated component wear allows the scheduling of corrective maintenance.

Prepare the hoist by cleaning the drain plug area and drain extension tube in order to obtain an uncontaminated sample. Operate the hoist in both directions for one or two minutes to thoroughly mix the gear oil then take the sample from the "mid-stream" flow of the oil to obtain an accurate representation of the oil condition. After taking the oil sample continue with the oil change or refill the hoist gear cavity to the proper level with recommended lubricant.

### **WARNING**

Hot oil may cause personal injury and/or burns to unprotected skin. Make certain the oil has cooled to a safe temperature (typically less than 110°F or 43°C) before taking an oil sample, changing oil or servicing the hoist.

General guidelines for iron contaminant level:

100-500 ppm	Normal
500-800 ppm	Caution - Abnormal Sample. Change oil and retake sample after 50 hours of operation. If second sample is above 500 ppm, remove hoist from service and perform tear-down inspection to determine source of contamination.
800+ ppm	Unacceptable. Remove hoist from service and perform tear-down inspection to determine source of contamination.

Iron contaminant levels will be on the high side of "Normal" during break-in.

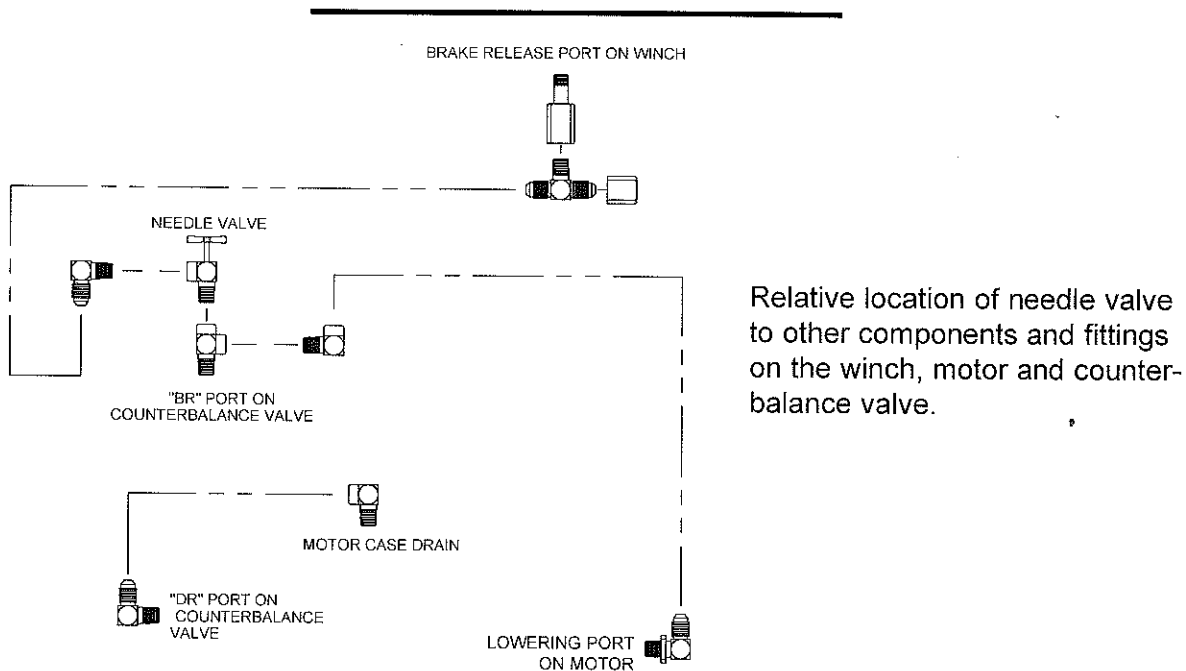
Equally important as the level of contamination is the change in level of contamination. An effective oil analysis program should provide the technician with a view of the progression of wear or a trend. If a sample shows a sudden rise in contaminant level action should be taken to determine "what has changed".

**NOTE:** *Oil analysis cannot detect nor warn against a fatigue failure.*

## BRAKE TEST PROCEDURE FOR BRADEN/Gearmatic HOISTS

All BRADEN planetary hoists have a spring applied, hydraulically released, multiple disc brake inside the hoist housing (Gearmatic hoists have a large single brake disc). This brake holds a suspended load when the directional control valve is in neutral, or when hydraulic power is lost. A brake clutch assembly permits the power train and drum to rotate in the direction to lift a load, while the brake remains fully applied. A load cannot be lowered, however, without applying hydraulic pressure to the release port and releasing the brake.

Hoists ordered for personnel handling cranes will have a needle valve in the brake release line. They will also have a tee in the brake release line between the needle valve and the brake release port on the hoist. One opening in the tee is capped. With the valve closed and the cap removed from the tee, the brake is isolated from system pressure and vented to atmosphere. The brake cannot be released under these conditions by actuating the directional control valve.



One purpose of the valve/tee combination is to provide a means to test the brake; the other is to provide a means to lower a load when hydraulic power is lost.

### **Brake Test Procedure (Hoists Equipped With Brake Valves)**

(Test to be performed with no load on the hoist.)

Remove the lockwire on the needle valve handle and close the valve tightly.

Remove the plug or cap in the tee (in the brake release circuit).

With the hydraulic power unit running, move the directional control valve handle slowly to the full open, lowering position.

Increase the engine speed, if necessary, to bring

system pressure up to the relief valve setting. The hoist drum should remain stationary.

If the drum rotates, the hoist should be disassembled and the brake components should be examined for wear. In addition, the brake springs should be measured for correct free length in those hoists using helical compression springs.

Replace any parts showing excessive wear and any spring whose length is shorter than the minimum shown in the applicable hoist Service Manual.

Reassemble the brake and hoist and repeat the above steps.

When testing is complete, be sure to reinstall the plug or cap in the tee, fully open the needle valve and install lockwire to secure the valve in position.

The above procedure utilizes the hoist hydraulic motor to test the brake's ability to resist approximately 115% of the rated hoist load.

**Brake Test Procedure (For Standard Hoists Not Equipped With The Needle Valve)**

(Test to be performed with no load on the hoist)

Remove and cap or plug the brake release line from fitting in the hoist brake release port.

With the hydraulic power unit running, move the directional control valve handle slowly to the full open, lowering position.

Increase the engine speed, if necessary, to bring system pressure up to the relief valve setting. The hoist drum should remain stationary.

If the hoist drum rotates, the hoist should be disassembled and the brake components should be

examined for wear. In addition, the brake springs should be measured for the correct free length in those hoists using helical compression springs.

Replace any parts showing excessive wear, and any spring whose free length is shorter than the minimum shown in the applicable hoist Service Manual.

Reassemble the brake and hoist and repeat the above steps.

When testing is complete, reattach the brake release line to the brake release port fitting.

The above procedure utilizes the hoist hydraulic motor to test the brake's ability to resist approximately 115% of the rated hoist load.

## EMERGENCY LOWERING PROCEDURES FOR HOISTS WITH GEAR MOTORS

The following procedure releases the multiple disc brake while leaving the brake valve closed. Since gear type motors are not zero leakage devices, internal motor leakage permits the load to slowly rotate the motor although its outlet is blocked by the closed brake valve. This procedure will **NOT** work if there is little or no oil in the motor. Using properly rated pipe and fittings, the standpipe described below may be permanently installed in the hydraulic system to avoid installing one in an emergency.

### CAUTION

The following procedure is specifically for use on hoists equipped with gear-type hydraulic motors. For hoists equipped with other hydraulic motors (piston, vane, etc) contact PACCAR Winch for assistance **BEFORE** attempting this procedure.

1. Remove the lockwire on the needle valve handle and close the valve tightly.

### WARNING

The standpipe referred to in step (3) below **MUST** be used. Attempting this procedure with no oil in the motor or with the brake valve stuck in the open position will cause the load to free fall, which could result in property damage, personal injury or death.

2. Remove the plug in the tee.
3. Remove both main hoses from the motor. Attach a standpipe to the lowering motor port (opposite side of the motor from the brake valve). Install a plug into the hoisting port in the brake valve.

The standpipe is simply a length of pipe (approximately 12 inches (305 mm) long) attached to a 90° elbow. The other end of the elbow is attached to the lowering motor port or manifold. The standpipe is installed with the long, open end pointing up in a vertical position to serve as a small reservoir. While the load is being lowered, hydraulic oil **MUST** be added to the standpipe as necessary to prevent the motor from running dry.

4. Fill the standpipe with hydraulic oil, making certain that oil is not running out of the brake valve.

If oil is running out of the brake valve, stop the emergency lowering procedure. Remove the spring retainer and tap the main spool of the brake valve to the closed position. Replace the spring retainer. After completing the emergency lowering procedure, the brake valve **MUST** be serviced and repaired if the spool was stuck.

5. Connect a hand pump to the open port in the tee.

### WARNING

Do not touch the motor, brake valve, or standpipe while lowering a load. They may become hot enough to cause burns.

6. Slowly operate the hand pump up to no more than 1,000 psi (6,900 kPa). A suspended load will slowly come down when the static brake is released. Releasing the pressure on the hand pump will cause the load to stop. If a chattering noise is heard while the load is coming down, pump the hand pump to a slightly higher pressure until the noise stops. Do not exceed 1,500 psi (10,350kPa) to the brake release port.
7. **Always** remove the hoist from service to inspect the brake components for signs of overheating and replace following this procedure. Refer to the applicable Braden or Gearmatic service manual for details.

### WARNING

Performing this procedure will create heat and may cause accelerated wear of hoist brake system and hydraulic components. Inspection and replacement of damaged brake assembly, hydraulic motor or brake valve components is critical to the safe operation of the hoist braking system. Failure to replace damaged components may result in loss of load control, property damage, personal injury, or death.

8. If this procedure was performed due to a malfunction of the hoist, remove the hoist from service and perform a complete teardown and inspection to correct the cause of the malfunction before returning the hoist to service.



## PERSONNEL HANDLING

BRADEN recognizes that most hoists and cranes are designed and intended for handling materials and not personnel. **The crane or hoist is only to be used to handle personnel if it can be shown there is no less hazardous way of carrying out the job.** In these situations, all safety precautions must be strictly adhered to. BRADEN recommends adherence to the latest revision of API 2C (RP 2D) and/or ANSI/ASME standard B30.5 and/or OSHA and/or other applicable standards for your application. It is important that you obtain a copy of all applicable safety standards, and that you read and understand them prior to using the hoist. **In addition to, or in conjunction with, the applicable standards, BRADEN requires \*:**

- The hoist must be maintained in accordance with the recommendations in this document and the service procedures in the Installation, Maintenance and Service Manual for your specific hoist.
- When handling personnel, the allowable line pull will be limited to 30% of the hoist rated line pull for the respective layer of wire rope on the drum. This reduction increases the hoist design factor from 3:1 to 10:1, approximately. Example: a hoist rated at 15,000 lbs. on the first layer will be rated at  $15,000 \times 0.3 = 4,500$  lbs. on the first layer when handling personnel.
- Personnel are only permitted to ride in an approved personnel platform as described in API, OSHA or ANSI/ASME standards.
- The crane must be in good working order and equipped with all required safety equipment, including an anti two-blocking device or warning signal and a boom angle and length indicator. Two-blocking occurs when the load block or hook assembly comes in contact with the upper block or point sheave assembly and often results in damage to the wire rope, rigging, crane and/or hoist.
- Personnel being lifted or supported shall wear safety belts with lanyards attached to designated points unless lifting over water. If lifting over water, provide approved personal flotation devices (PFD's).
- The lift shall be made under controlled conditions and under the direction of an appointed qualified signal person.
- The operator and signal person shall conduct a test lift, without personnel in the personnel platform, to verify adequacy of the crane footing or support. The crane outriggers, if so equipped, must be fully extended and properly set.
- Cranes shall not travel (move locations) while personnel are on the personnel platform.
- The platform must be landed or tied off, and all brakes set before personnel enter or exit.

\* If there are any questions, concerns, or conflicts with other safety standards, contact the BRADEN Product Support Department, PO Box 547, Broken Arrow, OK, 74013, USA, Telephone 1-(918) 251-8511, or via email at [winch.service@paccar.com](mailto:winch.service@paccar.com).

Additional information can be obtained from the following organizations:

- Booklet on "Hoisting Personnel", Crane Institute of America Inc., 1063 Maitland Center Commons, Suite 100, Maitland, Florida, 32751 USA (800) 832-2726
- OSHA Standard 29 CFR 1926.550 - Cranes, Derricks, Hoists, Elevators, and Conveyors, Occupational Safety and Health Administration (OSHA), 200 Constitution Ave. N.W., Washington D.C. 20210 USA (202) 219-4667
- ANSI/ASME Standard B30.5, American National Standards Institute (ANSI), 11 W. 42nd Street, New York, New York 10036 USA (212) 642-4900
- API Specification 2C and RP 2D, American Petroleum Institute (API) 1220 L Street, N.W., Washington, DC 20005 USA (202) 682-8375





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 4.10.2 Hoist Installation, Maintenance & Service Manuals



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### CH210A Series Hoist



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



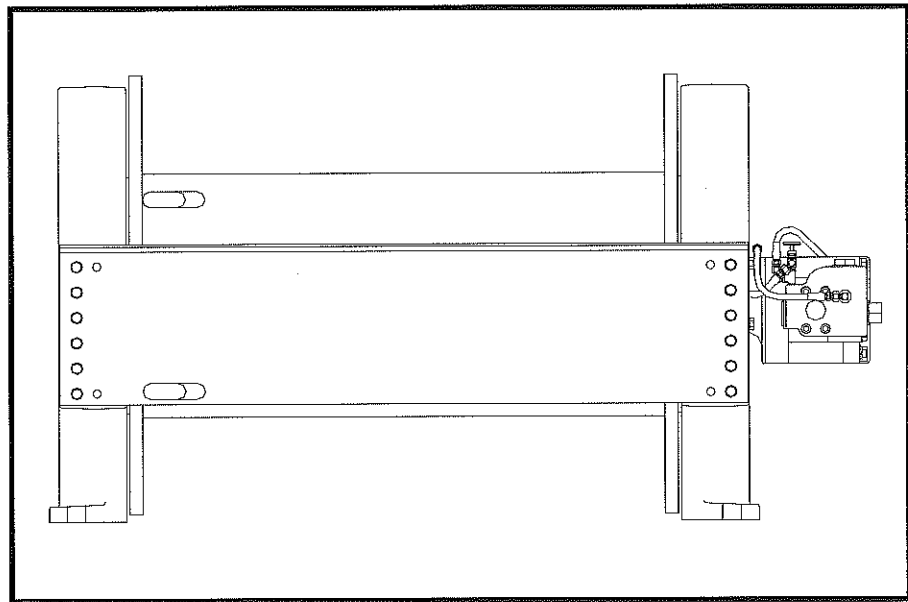


---

# BRADEN

---

## CH210 PLANETARY HOIST



### INSTALLATION, MAINTENANCE AND SERVICE MANUAL

---

# TABLE OF CONTENTS

FOREWORD .....	2
MODEL AND SERIAL NUMBER LOCATION .....	2
EXPLANATION OF MODEL NUMBER .....	2
GENERAL SAFETY RECOMMENDATIONS .....	3
BASIC OPERATION .....	4
INSTALLATION .....	6
WIRE ROPE INSTALLATION .....	6
HYDRAULIC CIRCUITS .....	8
RECOMMENDED BOLT TORQUE .....	8
PREVENTIVE MAINTENANCE .....	9
RECOMMENDED GEAR OIL .....	10
TROUBLE SHOOTING .....	14
EXPLODED VIEW DRAWINGS AND PARTS KEY .....	18
DISASSEMBLY PROCEDURE FOR HOIST .....	22
PLANET CARRIER SERVICE .....	24
OVER-RUNNING CLUTCH SERVICE .....	26
BRAKE CYLINDER SERVICE .....	27
HOIST ASSEMBLY .....	30
METRIC CONVERSION TABLE .....	32

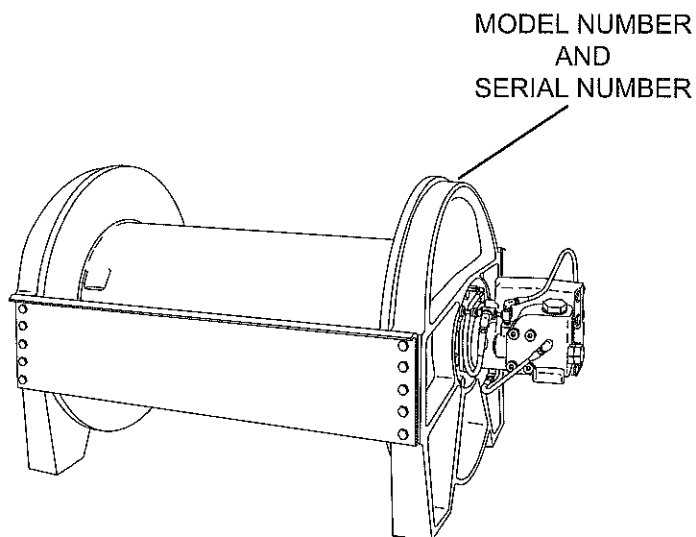


# FOREWORD

The following service instructions have been prepared to provide assembly, disassembly and maintenance information for the BRADEN Model CH series winch. It is suggested that before doing any work on these units, all assembly and disassembly instructions should be read and understood.

Some pictures in this manual may show details or attachments that are different from your winch. Also, some components have been removed for illustrative purposes.

Continuing product improvement may cause changes in your winch, which are not included in this manual. Whenever a question arises regarding your BRADEN Winch or this manual, please contact BRADEN Service Department for the latest available information.



## MODEL NUMBER AND SERIAL NUMBER

When information on a hoist is needed, always refer to the model number and serial number. Both are located on the top of the motor side end plate as indicated above.

## EXPLANATION OF MODEL NUMBER

<b>CH</b>	<b>210</b>	<b>A</b>	-	<b>36</b>	<b>110</b>	-	<b>01</b>	-	<b>1</b>
CONSTRUCTION HOIST	MAX RATING	DESIGN MODEL		GEAR RATIO	MOTOR SIZE		DRUM SIZE		OPTION

<b>CH</b>	DESIGNATES CONSTRUCTION HOIST
<b>210</b>	DESIGNATES 21,000 LB FIRST LAYER LINE PULL
<b>A</b>	DESIGNATES THE MODEL SERIES RELATING TO DESIGN CHANGES
<b>36</b>	DESIGNATES TOTAL GEAR REDUCTION
<b>110</b>	DESIGNATES HYDRAULIC MOTOR DISPLACEMENT IN CU IN/REV (DECIMAL POINT ELIMINATED EXAMPLE 110 – 11.0 CU IN/REV)
<b>01</b>	DESIGNATES THE DRUM OPTION
<b>1</b>	PERMITS TESTING AND INSPECTION PER API 2C FOR OFFSHORE CRANES

# GENERAL SAFETY RECOMMENDATIONS

Safety Informational callouts used in this manual include:

## **WARNING**

**WARNING** - This emblem is used to warn against hazards and unsafe practices which COULD result in severe personal injury or death if proper procedures are not followed.

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and winch must be operated with care and concern by the operator for the equipment, and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

## **WARNING**

Failure to obey the following safety recommendations may result in property damage, personal injury or death.

1. Read all warning tag information and become familiar with all controls before operating hoist.
2. Never attempt to clean, oil or perform any maintenance on a machine with the engine running, unless instructed to do so in the service manual.
3. Never operate hoist controls unless you are properly seated at the operators station on the prime mover and you are sure personnel are clear of the work area.
4. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
5. Ground personnel should stay in view of the prime mover operator and clear of hoist drum. Do not allow ground personnel near hoist line under tension. A safe distance of at least 1½ times the length of the cable should be maintained.
6. On machines having hydraulically, mechanically and/or cable controlled equipment, be certain the equipment is either lowered to the ground or blocked securely before servicing, adjusting and/or repairing the hoist. Always apply the prime mover parking brakes and lower equipment before dismounting the prime mover.
7. Inspect rigging, hoist and hydraulic hoses at the beginning of each work shift. Defects should be corrected immediately.

## **CAUTION**

**CAUTION**- This emblem is used to warn against potential or unsafe practices which COULD result in personal injury and property damage if proper procedures are not followed.

8. Keep equipment in good operating condition. Perform scheduled servicing and adjustments listed in the "Preventive Maintenance" section of this manual.
9. An equipment warm-up procedure is recommended for all start-ups and is essential at ambient temperatures below +40°F (4°C). Refer to "Warm-Up Procedure" listed in the "Preventive Maintenance" section of this manual.
10. Be sure of equipment stability before operating hoist.
11. The hoists described herein are neither designed nor intended for use or application to equipment used in the lifting or moving of persons.
12. Do not exceed the maximum pressure (PSI or kPa) or flow (GPM or LPM) stated in the hoist specifications.
13. Operate hoist line speeds to match job conditions.
14. Leather gloves should be used when handling hoist cable.
15. Never attempt to handle hoist cable when the hook end is not free.
16. When winding hoist cable on the hoist drum, never attempt to maintain tension by allowing hoist cable to slip through hands. Always use "hand-over-hand" technique.
17. Never use hoist cable with broken strands. Replace hoist cable.
18. Do not weld on any part of the hoist.
19. Do not use knots to secure or attach hoist cable.
20. Use recommended hydraulic oil and gear lubricant.
21. Keep hydraulic system clean and free from contamination at all times.
22. Use correct size cable anchor for cable and pocket in hoist drum.
23. The BRADEN wire rope anchors supplied with CH210 hoists are not designed to support the rated load of the hoist. ALWAYS maintain a minimum of five (5) wraps of wire rope on the drum.

# BASIC OPERATION

## DESCRIPTION OF HOIST

The hoist is made up of the following sub-assemblies:

1. Hydraulic motor and brake valve
2. Drum, drum closure, ball bearings and oil seals
3. Support end plate and bearing support
4. Motor end plate and motor adapter
5. Tie plates
6. Brake clutch assembly
7. Brake cylinder assembly and multiple-disc brake parts
8. Primary, second stage and output planetary reducer assemblies
9. Ring gear

## THEORY OF OPERATION

The primary sun gear is directly coupled to the hydraulic motor by the inner race of the brake clutch assembly. As the motor turns in the hoisting direction (normally clockwise), the three planetary assemblies reduce the input speed of the motor and rotate the ring gear and winch drum. Since the output reducer planet carrier is held from turning by the bearing support, the drum rotates in the opposite direction of the motor input shaft. In the hoisting direction, the static brake remains fully applied and the input shaft rotates freely through the sprag clutch. When the motor is stopped, the load tries to rotate the winch gear train in the opposite direction. The sprag clutch on the input shaft immediately locks up, allowing the fully applied static brake to hold the load from dropping. See Dual Brake System - Operation for a detailed description of the lowering sequence of operation.

### Dual Brake System – Description

The dual brake system consists of a dynamic brake system and a static brake system.

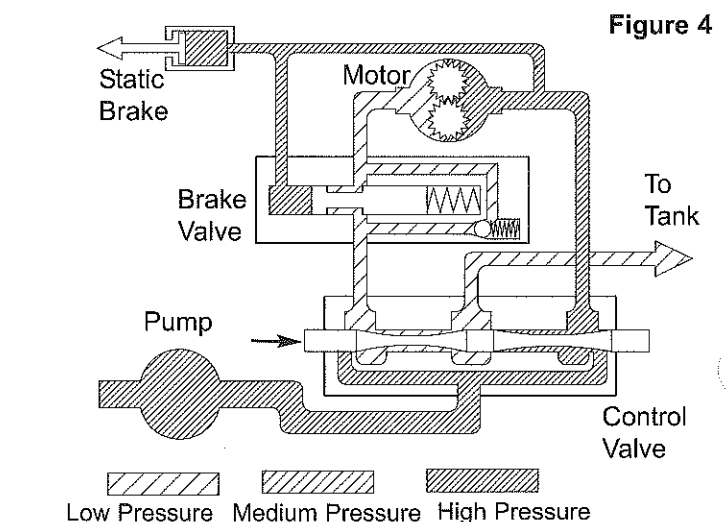
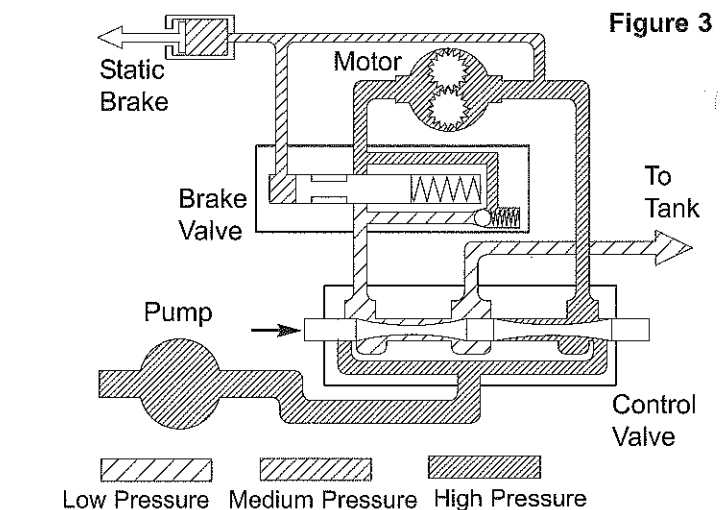
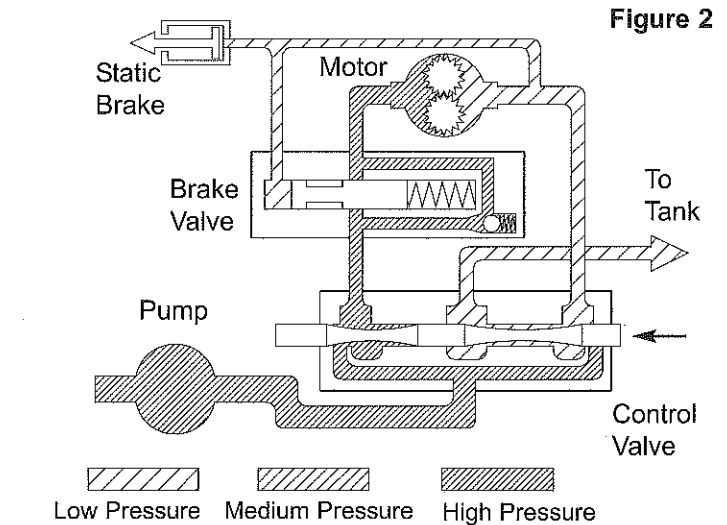
The dynamic brake system has two operating components:

1. Brake valve assembly
2. Hydraulic motor

The brake valve is basically a counterbalance valve. It contains a check valve to allow free flow of oil to the motor in the hoisting direction and a pilot operated, spring-loaded spool valve that blocks the flow of oil out of the motor when the control valve is placed in neutral. When the control valve is placed in the lowering position, the spool valve remains closed until sufficient pilot pressure is applied to the end of the spool to shift it against spring pressure and open a passage. After the spool valve cracks open, the pilot pressure becomes flow-dependent and modulates the spool valve opening which controls the lowering speed. See figures 2, 3 and 4

The static brake system has three operating components:

1. Spring Applied, Multiple Friction Disc Static Brake
2. Brake Clutch Assembly
3. Hydraulic Piston and Cylinder



The static brake is released by the brake valve pilot pressure at a pressure lower than that required to open the pilot operated spool valve. This sequence assures that dynamic braking takes place in the brake valve and that little, if any, heat is absorbed by the friction brake.

The friction brake is a load holding brake only and has nothing to do with dynamic braking or rate of descent of a load.

The brake clutch is splined to the primary sun gear shaft between the motor and the primary sun gear. It will allow this shaft to turn freely in the direction to raise a load and lock up to force the brake discs to turn with the shaft in the direction to lower a load. Figures 5 and 6.

The hydraulic cylinder, when pressurized, will release the spring pressure on the brake discs, allowing the brake discs to turn freely.

#### DUAL BRAKE SYSTEM – OPERATION

When hoisting a load, the brake clutch which connects the motor shaft to the primary sun gear, allows free rotation. The sprag cams lay over and permit the inner race to turn free of the outer race. Figure 5. The friction brake remains fully engaged. The winch, in raising a load, is not affected by any braking action. Figure 2.

When the lifting operation is stopped, the load attempts to turn the primary sun gear in the opposite direction. This reversed input causes the sprag cams to instantly roll upward and firmly lock the shaft to the fully engaged friction brake. Figure 6.

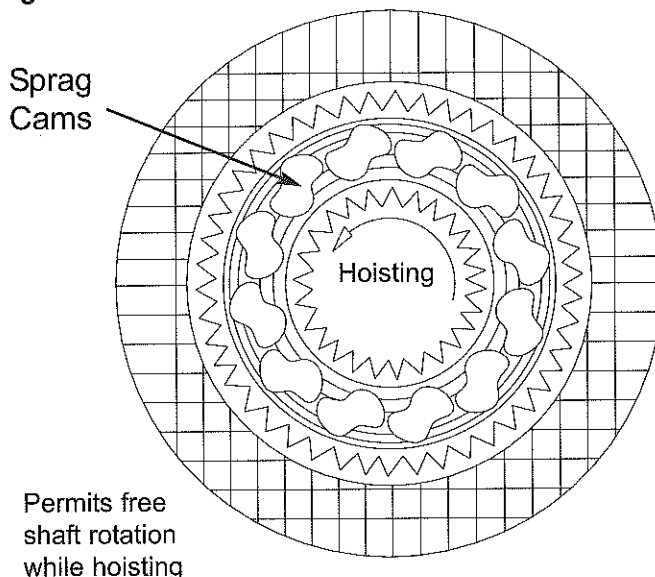
When the winch is powered in reverse, to lower the load, the motor cannot rotate until sufficient pilot pressure is present to open the brake valve. Figures 3 & 4. The friction brake within the winch will completely release at a pressure lower than that required to open the brake valve. The extent to which the brake valve opens will determine the amount of oil that can flow through it and the speed at which the load will be lowered. Increasing the flow of oil to the winch motor will cause the pressure to rise and the opening in the brake valve to enlarge, speeding up the descent of the load. Decreasing this flow causes the pressure to lower and the opening in the brake valve to decrease thus slowing the descent of the load.

When the control valve is shifted to neutral, the pressure will drop and the brake valve will close, stopping the load. The friction brake will engage and hold the load after the brake valve has closed.

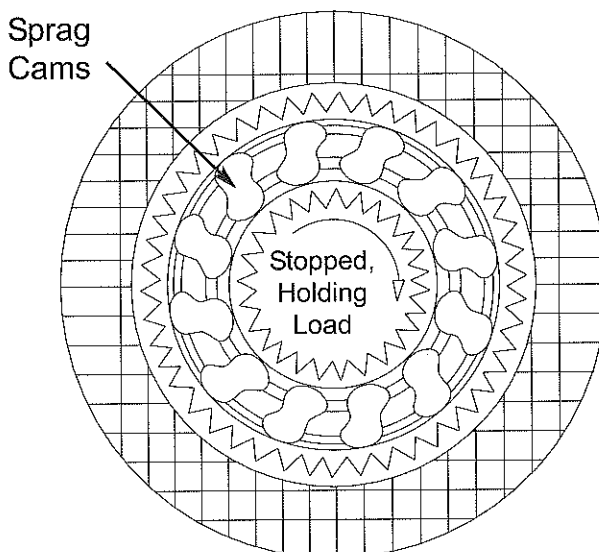
When lowering a load very slowly for precise positioning, no oil flow actually occurs through the winch motor. The pressure will build up to a point where the brake will release sufficiently to allow the load to rotate the motor through its own internal leakage. This feature results in a very slow speed and extremely accurate positioning.

The friction brake receives very little wear in the lowering operation. All of the heat generated by the lowering and stopping of a load is absorbed by the hydraulic oil where it can be readily dissipated.

**Figure 5** Static Friction Brake Applied



**Figure 6** Static Friction Brake Applied



# INSTALLATION

## GENERAL REQUIREMENTS

1. The hoist should be mounted with the centerline of the drum in a horizontal position. The mounting plane can be rotated to any position around this centerline.

### **WARNING**

DO NOT weld hoist to mounting surface. Welding may not provide adequate structural support for winch loads. This may cause loss of load control, which could result in property damage, injury or death. Welding may also damage bearings and seals, resulting in premature failure.

2. When mounting the hoist, Braden recommends using 4 one inch grade eight bolts and nuts, using both mounting holes in each end plate.
3. It is important that the hoist be mounted on a surface that will not flex when the hoist is in use, since this could bind the working parts of the hoist. Also, be sure the hoist is mounted on a flat surface. If necessary, use shim stock to insure proper mounting. The mounting surface should be flat within + or -0.020 in. (0.5 mm).
4. Hydraulic lines and components that operate the hoist should be of sufficient size to assure minimum back pressure at the hoist. The motor manufacturer recommends that the back pressure not exceed 100 psi for maximum motor seal life. 150 psi is the maximum allowable back pressure. The standard CH210A hoist is supplied with the motor internally drained. If high back pressures are encountered, the motor can be drained directly to tank to improve motor seal life. To insure adequate static brake load holding ability, back pressure on the hoist should not exceed 150 psi. For pressures exceeding 150 psi, consult Braden Engineering.
5. Make certain that the hoist drum is centered behind the first sheave and the fleet angle does not exceed 1 ½

degrees. The hoist should also be mounted perpendicular to an imaginary line from the center of the drum to the first sheave to insure even spooling.

6. The hoist directional control valve must be a three-position, four-way valve with a motor spool such that when the valve is in the center position both work ports are opened directly to tank.
7. The hydraulic oil filter should have a 10 micron nominal rating and be a full-flow type.
8. High quality hydraulic oil is essential for satisfactory performance and long hydraulic system component life.

Oil having 150 to 330 SUS viscosity at 100°F (38°C) and viscosity index of 100 or greater will give good results under normal temperature conditions. The use of an oil having a high viscosity index will minimize cold-start trouble and reduce the length of warm-up periods. A high viscosity index will minimize changes in viscosity with corresponding changes in temperature.

Maximum cold weather start-up viscosity should not exceed 5000 SUS with a pour point at least 20°F lower than the minimum temperature.

Under continuous operating conditions the temperature of the oil at any point in the system must not exceed 180°. 120-140°F is generally considered optimum.

In general terms; for continuous operation at ambient temperatures between 50 and 110°F, use SAE 20W; for continuous operation between 10 and 90°F, use SAE 10W; for applications colder than 10°F, contact the BRADEN Service Department. The use of multi-viscosity oils is generally not recommended.

## WIRE ROPE INSTALLATION

### **WARNING**

**THE CABLE ANCHORS ALONE ON HOISTS ARE NOT DESIGNED TO HOLD RATED LOADS.** Winch loads applied directly to the wire rope anchor may cause the wire rope to pull free and result in the sudden loss of load control and cause property damage, injury or death. A minimum of 5 wraps of wire rope must be left on the drum barrel to achieve rated load.

The wedge and anchor pocket must be clean and dry. The end of the wire rope being anchored to the drum must be clean and dry and not frayed. Anything on the end of the wire rope to keep it from fraying (i.e. tape or wire) must not be in contact with the wedge when the installation is complete. Consult the wire rope manufacturer on the proper

treatment of the dead end of the wire rope. Some rope manufacturers recommend when using rotation resistant wire rope, that the rope end be seized, welded or brazed before inserting the wire rope into the wedge socket to prevent core slippage or loss of rope lay.

Take the free end of the wire rope and insert it through the small opening on the cable drum. Loop the wire rope and push the free end about 3/4 of the way back through the pocket. Install the wedge as shown in figure 7, then pull the slack out of the wire rope. The "dead" end of the rope needs to extend slightly beyond the end of the wedge as shown in figure 8.

Using a hammer and brass drift, drive the wedge as deep into the pocket as possible to ensure it is fully seated and no further movement is detected. Applying a load on the wire rope will also help seat the wedge in the pocket.

Check to ensure the wedge does not protrude from either end of the pocket, causing it to interfere with proper spooling of wire rope onto the drum (see figures 9 & 10). If there is interference or the wedge does not seat firmly, contact the Braden Product Support Department at 918-251-8511 to determine the proper wedge size.

It is important that the wire rope have the proper tensioning when it is installed on the drum. When the wire rope is first installed, you should operate the hoist, with light to moderate loads, with reeving that let's you place these loads on the block and the drum with all the rope off the drum except for the last three wraps.

### Correct Installation

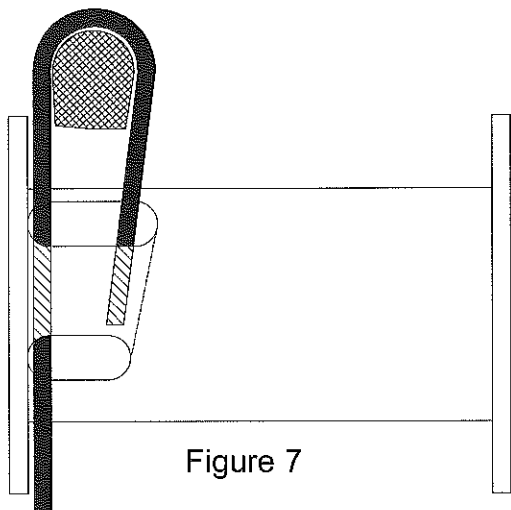


Figure 7

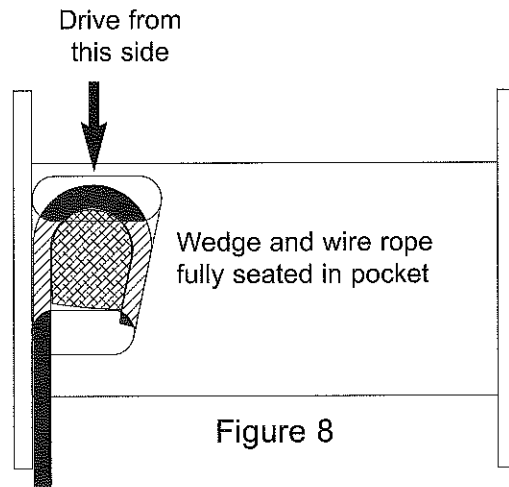
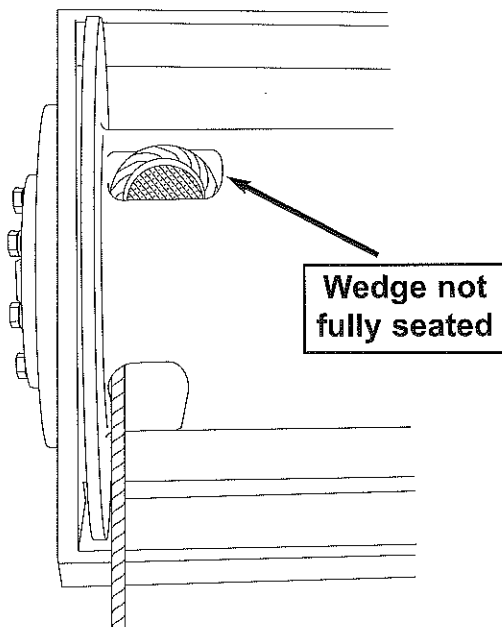


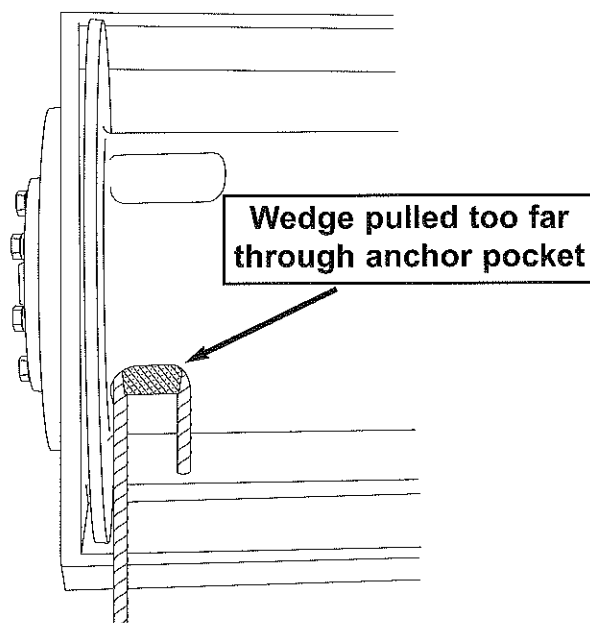
Figure 8

### Incorrect Installations



- Wire rope not tight against wedge
- Wedge may be too large

Figure 9



- "Dead" end of wire rope and/or wedge may interfere with proper spooling
- Wedge may be too small

Figure 10

### WIRE ROPE WEDGE PART NUMBERS

#### WINCH MODEL

CH210A .....

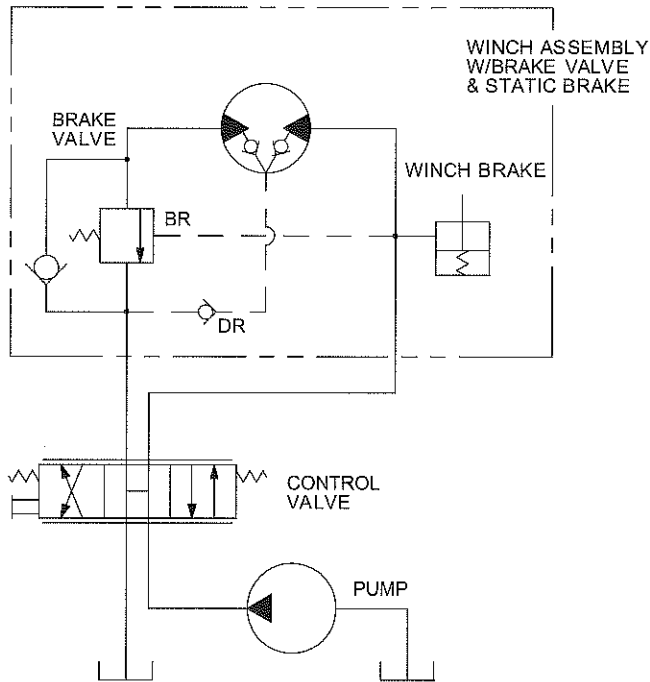
#### WEDGE PART NO.

24493\* for 1/2 thru 3/4 in. (13 - 19 mm)

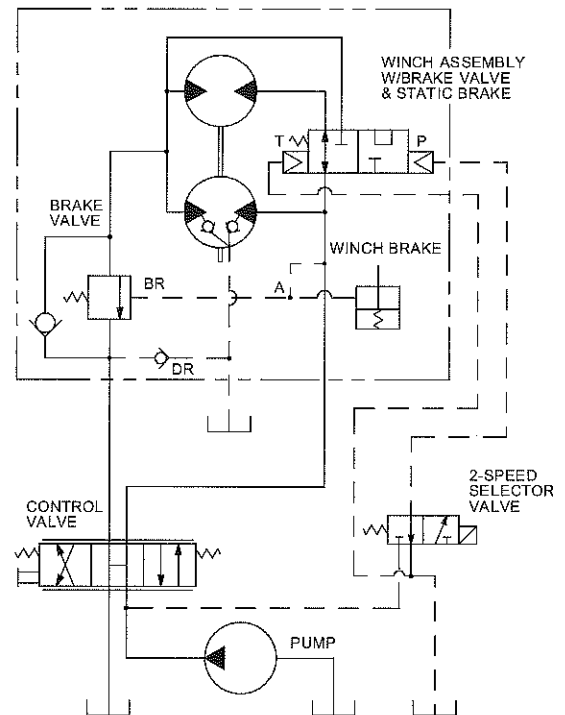
\* Standard Anchor

# HYDRAULIC CIRCUIT

## SINGLE SPEED MOTOR CIRCUIT



## TWO SPEED MOTOR CIRCUIT



## RECOMMENDED BOLT TORQUE

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30wt engine oil applied to threads and face of bolt or nut.

Avoid using thread lubricants as the applied torque may vary by 10 - 40%, depending upon the product used.

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
1/4	20 28	8	6	12	9
5/16	18 24	17	13	24	18
3/8	16 24	31	23	45	35
7/16	14 20	50	35	70	50
1/2	13 20	75	55	110	80
9/16	12 18	110	80	150	110
5/8	11 18	150	115	210	160

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
3/4	10 16	265	200	380	280
7/8	9 14	420	325	600	450
1	8 14	640	485	910	680
1 1/8	7 12	790	590	1290	970
1 1/4	7 12	1120	835	1820	1360
1 3/8	6 12	1460	1095	2385	1790
1 1/2	6 12	1940	1460	3160	2370

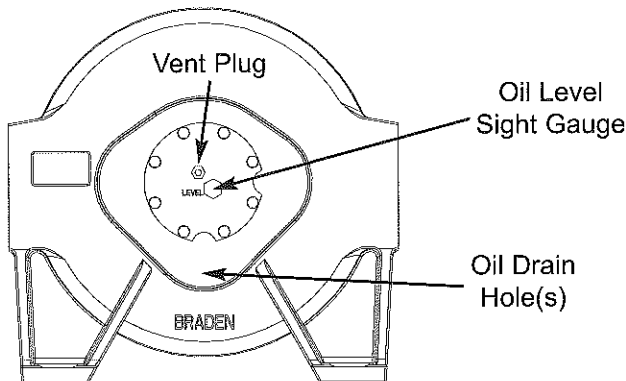
# PREVENTIVE MAINTENANCE

A regular program of preventive maintenance for your planetary hoist is strongly recommended to minimize the need for emergency servicing and promote safe, reliable hoist operation.

Initially, the gear oil should be changed after the first one hundred (100) hours of operation.

## 1. Vent Plug and Oil Level

The vent plug and oil level sight gauge are located in the bearing support on the end of the hoist opposite the motor. It is very important to keep the vent clean and unobstructed. Whenever gear oil is changed, remove the vent plug and sight gauge, clean in solvent and reinstall. Do not paint over the vent or replace with a solid plug.



## 2. Oil Change

Rotate the drum to align the drain plug with the lowest hole in the support bracket. Install a short piece of 1 inch pipe into the threads around the drain plug. Remove the drain plug (5/16 inch hex) and drain the oil into a suitable container. Always dispose of used oil in an environmentally responsible manner. Remove the 1 inch pipe and rotate the drum to align the hole in the drum with the highest hole in the support bracket. Re-install the pipe and fill the hoist drum with the recommended oil to the center of the sight gauge. Install the drain plug and remove the pipe.

## 3. Hydraulic System

The original filter element should be replaced after the first fifty (50) hours of operation, then every 500 operating hours or three (3) months, or in accordance with the equipment manufacturer's recommendations.

## 4. Wire Rope

Inspect entire length of wire rope according to wire rope manufacturer's recommendations.

## 5. Mounting Bolts

Tighten all winch base mounting bolts to recommended torque after the first one hundred (100) hours of operation, then every 1000 operating hours or six (6) months, whichever occurs first.

## 6. Warm-up Procedures

A warm-up procedure is recommended at each start-up and is essential at ambient temperatures below +40°F (4°C).

The prime mover should be run at its lowest recommended RPM with the hydraulic hoist control valve in neutral allowing sufficient time to warm up the system. The hoist should then be operated at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

## ! WARNING !

Failure to properly warm up the winch, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

## 7. Recommended Planetary Gear Oil

Field experience, supported by extensive engineering tests, indicates the use of the proper planetary gear oil is essential to reliable and safe operation of the brake and obtaining long gear train life. Refer to Recommended Gear Oil, later in this section.

## ! WARNING !

Failure to use the proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in property damage, severe personal injury or death. Some gear lubricants contain large amounts of EP (extreme pressure) and anti-friction additives which may contribute to brake slippage and damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake slippage. Make certain that the gear oil viscosity used in your winch is correct for your prevailing ambient temperature.

For simplicity, BRADEN has listed one (1) readily available product in each temperature range which has been tested and found to meet our specifications. This is not to say that other lubricant brands would not perform equally as well.

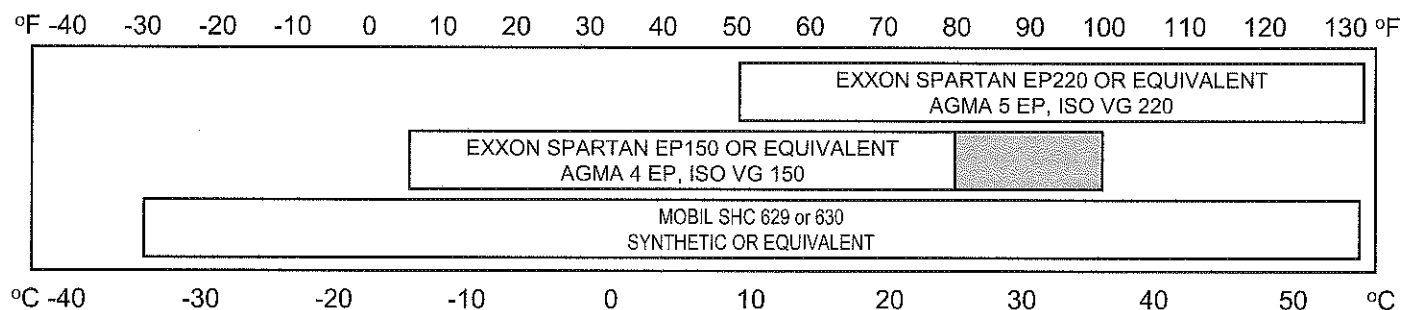
If the following lubricant brands are not available in your area, make certain your lubricant vendor supplies you with oil that is equivalent to those products listed below.



The gear oil should be changed whenever the ambient temperature changes significantly and an oil from a different temperature range would be more appropriate.

## RECOMMENDED PLANETARY GEAR OIL

### PREVAILING AMBIENT TEMPERATURE



**NOTE:** SHADED TEMPERATURE RANGE IN THE CHART ABOVE NOT RECOMMENDED FOR SEVERE APPLICATIONS SUCH AS: OFFSHORE CRANES, SUSTAINED FAST DUTY CYCLES OR FREQUENT LIFTING.

Texaco Meropa 150, previously used as factory fill, may no longer be widely available due to current market conditions. As of mid-year 2002, planetary hoists are factory filled with Exxon Spartan EP150, or equivalent. The chart below relates the Texaco products to 4 currently available oils. Consult your oil supplier for other equivalent oils if required.

Texaco	Exxon	Mobil	Shell	Chevron
Meropa 150	Spartan EP 150	Mobilgear 629	Omala 150	American Industrial Oils 150
Meropa 220	Spartan EP 220	Mobilgear 630	Omala 220	American Industrial Oils 220

9/2002

**Braden recommends the following Inspection, Testing and Preventive Maintenance procedures.**  
**For additional details, refer to Braden publication PB-308.**

Inspection, testing and preventive maintenance requirements are divided into several categories: Pre-use, Quarterly, Semiannual and Annual as outlined below. The Installation, Maintenance and Service Manual for each model provides specific instructions for maintenance and service.

Some inspection intervals make reference to hoists used in "Severe Duty Applications". Severe Duty Applications are where the hoist is operated more than 12 hours per day and/or for extended periods of time at or near the rated capacity of the hoist.

**Anytime that the hoist exhibits erratic operation and/or unusual noise(s), the hoist should be taken out of service until it is inspected and serviced by a qualified technician.**

**REGULAR INSPECTION, TESTING & PREVENTIVE MAINTENANCE** - Must include, but not be limited to the following:

**PRE-USE INSPECTION (each shift the hoist is used):** Will be performed prior to placing the crane into service and then as necessary during the day for extended operation.

1. Check for external oil leaks and repair as necessary. **This is extremely important due to the accelerated wear that can be caused by insufficient lubricating oil in the hoist.** Lubricant level must be maintained between the maximum and minimum levels. Use only the recommended type of lubricant; see service manual for details. On models without a sight glass, check oil level monthly.
2. Check the ratchet and pawl mechanism (if so equipped) for proper operation and for full engagement of the pawl with the ratchet wheel. Repair and/or adjust as necessary.
3. Check hydraulic plumbing for damage, such as chafed or deteriorated hoses, and repair as necessary.
4. Visually inspect for loose or missing bolts, pins, keepers or cotter pins and replace or tighten as necessary.

**QUARTERLY INSPECTION (every 3 months)** or monthly in Severe Duty Applications or prior to putting the machine into service if it has not been used for 3 months or more. Documentation of the inspections must be kept with the hoist/crane for a minimum of two (2) years from the date of the inspection (see page 3).

Perform the PRE-USE INSPECTION plus the following:

1. Check the lubricant level in the hoist(s) and maintain it between maximum and minimum levels. Use only recommended type of lubricant; see service manual for details.
2. On hoists used for personnel handling, the internal spring-applied brake shall be tested in accordance with the procedure on page 5 of publication PB-308.
3. Inspect for corrosion of fasteners, mounting base, drum, etc. and repair/replace as necessary.

**SEMI-ANNUAL INSPECTION (every 6 months)**, or quarterly in Severe Duty Applications. Documentation of the inspections must be kept with the hoist/crane for a minimum of two (2) years from the date of the inspection (see next page).

Perform the **PRE-USE INSPECTION** and **QUARTERLY INSPECTION** plus the following:

Take a sample of the lubricating oil from the hoist drum, following the oil sampling procedure on page 4 of publication PB-308, and analyze it for wear metals content, the correct viscosity, signs of overheating, water and other contaminants. If the oil sample contains an unusual amount of metallic particles, the hoist should be taken out of service and undergo a tear down inspection. The oil sample must be taken prior to changing the lubricating oil. The Semi-annual oil analysis can be omitted if the crane has been used less than 250 hours since the previous oil sample.

**ANNUAL INSPECTION, Testing & Preventive Maintenance** or Semi-annually in Severe Duty Applications. Documentation of the inspections must be kept with the hoist/crane for a minimum of two (2) years from the date of the inspection (see next page). The Annual Inspection must include, but not be limited to the following:

1. Perform the **PRE-USE INSPECTION, QUARTERLY** and **SEMIANNUAL INSPECTIONS**, plus the following:
2. Change lubricating oil in hoist drum or gearbox after oil sample is taken. Refer to Recommended Gear Oil, earlier in this section. Failure to follow these recommendations may result in brake failure.

**NOTE: If the oil sampling/analysis has not been performed as required, refer to the tear down inspection section below.**

The user of BRADEN products is responsible for hoist inspection, testing and maintenance noted above with frequency dependent upon the severity of the hoist duty cycle and the thoroughness of the preventive maintenance program in effect.

**Alternate inspection periods may be used if approved in writing by BRADEN.** Those that are interested in an alternate inspection period should submit a written proposal to BRADEN that includes typical duty cycle for the hoist along with a detailed description of the preventive maintenance program for these hoists.

#### **Inspection Records & Retention**

Crane inspection reports as well as records of preventive maintenance, repairs and modifications to hoists should be available and accessible for a minimum of two years. These records should include, but not be limited to, hoist model and serial number, name and employer of repair/inspection technician, date and description of preventive maintenance, functional test reports and repairs.

To provide customers with qualified outlets for hoist service and repairs, BRADEN has established authorized Service Centers. These Service Centers have factory trained service technicians, up-to-date service information, extensive parts inventories, complete testing facilities, and are audited by BRADEN on a regular basis for compliance. **BRADEN strongly recommends the use of BRADEN authorized Service Centers** for maintenance, repair and inspection of BRADEN/Gearmatic products. Contact the Braden Product Support Department at 918-251-8511 for the names of current authorized Service Centers.

**TEAR DOWN INSPECTION** – Any Hoist that has NOT been subject to regular oil sample analysis should undergo a tear down inspection on an annual (12 month) basis. Also, if a hoist has an unknown history of repair and/or maintenance, it is recommended that the hoist undergo a tear down inspection prior to it being placed into service.

A tear down inspection should include the hoist being completely disassembled, cleaned and inspected and replacement of all worn, cracked, corroded or distorted parts such as pins, bearings, shafts, gears, brake rotors, brake plates, drum and base. Refer to the applicable BRADEN or Gearmatic Service Manual for more details. All seals and o-rings should be replaced during a tear down inspection.

**Any deficiencies, such as those listed above shall be corrected immediately.**

All of the following operations must be performed before the hoist is placed back in service:

The rebuilt hoist must be line pull tested to the rated load of the hoist (hoist rating will vary with motor, gear ratio and drum options) with a dynamometer or equivalent measuring device. This test load should be the maximum rating for the hoist for the specific application (at the normal hydraulic relief valve setting for the hoist), not the reduced rating for personnel lifting.

The hoist must be dynamically tested by rotating the drum several times, in both the hoisting and lowering directions, while under a load of at least 30% of the hoist lifting capacity. Check for smooth operation during this procedure.

The brake should be tested per the brake test procedures on page 5 of Publication PB-308.

After inspection or rebuild and testing, a new certificate for personnel handling will be issued by the inspector/ service technician effective on the date the hoist is placed back in service.

**(See sample inspection certificate on next page)**

**Name of Service Company**

Approved by BRADEN for handling personnel  
if used and maintained in accordance with BRADEN  
Recommendations For Personnel Handling Hoists

Hoist Model No.: \_\_\_\_\_

Hoist Serial No.: \_\_\_\_\_

Date of Inspection: \_\_\_\_\_

Work Order/Job No.: \_\_\_\_\_

Inspector's Name: \_\_\_\_\_

For a copy of recommendations call or write: BRADEN  
PO Box 547, Broken Arrow, OK, 74012, USA (918) 251-8511

**Sample inspection certificate**

**PERSONNEL HANDLING**

BRADEN recognizes that most hoists and cranes are designed and intended for handling materials and not personnel. **The crane or hoist is only to be used to handle personnel if it can be shown there is no less hazardous way of carrying out the job.** In these situations, all safety precautions must be strictly adhered to. BRADEN recommends adherence to the latest revision of API 2D (RP 2D) and/or ANSI/ASME standard B30.5 and/or OSHA and/or other applicable standards for your application. It is important that you obtain a copy of all applicable safety standards, and that you read and understand them prior to using the hoist. **In addition to**, or in conjunction with, the applicable standards, BRADEN requires:

- The hoist must be maintained in accordance with the recommendations in this document and the service procedures in the Installation, Maintenance and Service Manual for your specific hoist.
- When handling personnel, the allowable line pull will be limited to 30% of the hoist rated line pull. This reduction increases the hoist design factor from 3:1 to 10:1, approximately. Example: a hoist rated at 15,000 lbs. on the first layer will be rated at  $15,000 \times 0.3 = 4,500$  lbs. on the first layer when handling personnel.
- Personnel are only permitted to ride in an approved personnel platform as described in API, OSHA or ANSI/ASME standards.
- The crane must be in good working order and equipped with all required safety equipment, including an anti two-blocking device or warning signal and a boom angle and length indicator. Two-blocking occurs when the load block or hook assembly comes in contact with the upper block or point sheave assembly and often results in damage to the wire rope, rigging and/or hoist.
- Personnel being lifted or supported shall wear safety belts with lanyards attached to designated points unless lifting over water. If lifting over water, provide approved personal flotation devices (PFD's).
- The lifting and supporting shall be made under controlled conditions and under the direction of an appointed signal person.
- The operator and signal person shall conduct a test lift, without personnel in the personnel platform, to verify adequacy of the crane footing or support. The crane outriggers, if so equipped, must be fully extended and properly set.
- Cranes shall not travel (move locations) while personnel are on the personnel platform.
- The platform must be landed or tied off, and all brakes set before personnel enters or exits.

# TROUBLE SHOOTING

## ⚠ WARNING ⚠

If a winch ever exhibits any sign of erratic operation, or load control difficulties (i.e. load creeping or chattering) appropriate troubleshooting tests and repairs should be performed immediately. Continued operation in this manner may result in property damage, serious personal injury or death.

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>A</b></p> <p>The winch will not lower the load or not lower the load smoothly.</p>	<p>1. The problem could be a plugged or loose pilot orifice. The pilot orifice is a small pipe plug with a hole drilled through it, located behind the pilot port fitting on the brake valve. If it becomes plugged, it will prevent the pilot pressure, from the manifold, from opening the brake valve. If it becomes loose, it will allow an unregulated amount of oil in to operate the brake valve which cause erratic brake valve operation.</p>	<p>Remove the pilot hose and fitting from the brake valve, then use a 5/32 inch Allen wrench to remove the pilot orifice. The diameter of the orifice is approximately .020 inches. Clean and install the pilot orifice tightly in the brake valve.</p>
	<p>2. The friction brake may not be releasing as a result of a defective brake cylinder seal.</p> <p>NOTE: If the brake cylinder seal is defective you will usually find oil leaking from the winch vent plug.</p>	<p>Check brake cylinder seal as follows:</p> <p>A. Disconnect the swivel tee from the brake release port. Connect a hand pump with accurate 0-2000 psi gauge and shut-off valve to the -4 J.I.C. fitting in the brake release port.</p> <p>B. Apply 1000 psi to the brake. Close shut-off valve and let stand for five (5) minutes.</p> <p>C. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and replacement of the seals. Refer to "Motor Support-Brake Cylinder Service".</p>
	<p>3. Friction brake will not release as a result of damaged brake discs.</p>	<p>Disassemble brake to inspect brake discs. Check stack-up height as described in "Motor Support-Brake Cylinder Service".</p>

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>B</b></p> <p>Oil leaks from vent plug.</p>	<ol style="list-style-type: none"> <li>1. Same as A2.</li> <li>2. Motor seal may be defective as a result of high system back pressure or contaminated oil.</li> </ol>	<p>Same as A2.</p> <p>System back pressure must not exceed 150 psi. Inspect hydraulic system for a restriction in the return line from the control valve to the reservoir. Be sure control valve and plumbing is properly sized to winch motor.</p> <p>Oil analysis may indicate contamination has worn motor shaft and seal. Thoroughly flush entire hydraulic system and install new filters and oil. Install new motor seal.</p>
<p><b>C</b></p> <p>The brake will not hold a load with the control lever in neutral.</p>	<ol style="list-style-type: none"> <li>1. Excessive system back pressure acting on the brake release port.</li> <li>2. Friction brake will not hold due to worn or damaged brake discs.</li> <li>3. Brake clutch is slipping.</li> </ol>	<p>The same as Remedy 2 of Trouble B2.</p> <p>Same as Remedy 3 of Trouble A3.</p> <p>Improper planetary gear oil may cause the brake clutch to slip. Drain old gear oil and flush winch with solvent. Thoroughly drain solvent and refill winch with recommended planetary gear oil listed in "Preventive Maintenance".</p> <p>Brake clutch may be damaged or worn. Disassemble and inspect brake clutch as described in "Brake Clutch Service".</p>
<p><b>D</b></p> <p>The winch will not hoist the rated load</p>	<ol style="list-style-type: none"> <li>1. The winch may be mounted on an uneven or flexible surface which causes distortion of the winch base and binding of the gear train. Binding in the gear train will absorb horsepower needed to hoist the rated load and cause heat.</li> <li>2. System relief valve may be set too low. Relief valve needs adjustment or repair.</li> </ol>	<p>Reinforce mounting surface.</p> <p>If necessary, use shim stock to level winch. Refer to "Winch Installation".</p> <p>First loosen, then evenly retighten all winch mounting bolts to recommended torque.</p> <p>Check relief pressure as follows:</p> <p>A. Install an accurate 0-4000 psi gauge into the inlet port of the brake valve.</p>

## TROUBLE

## PROBABLE CAUSE

## REMEDY

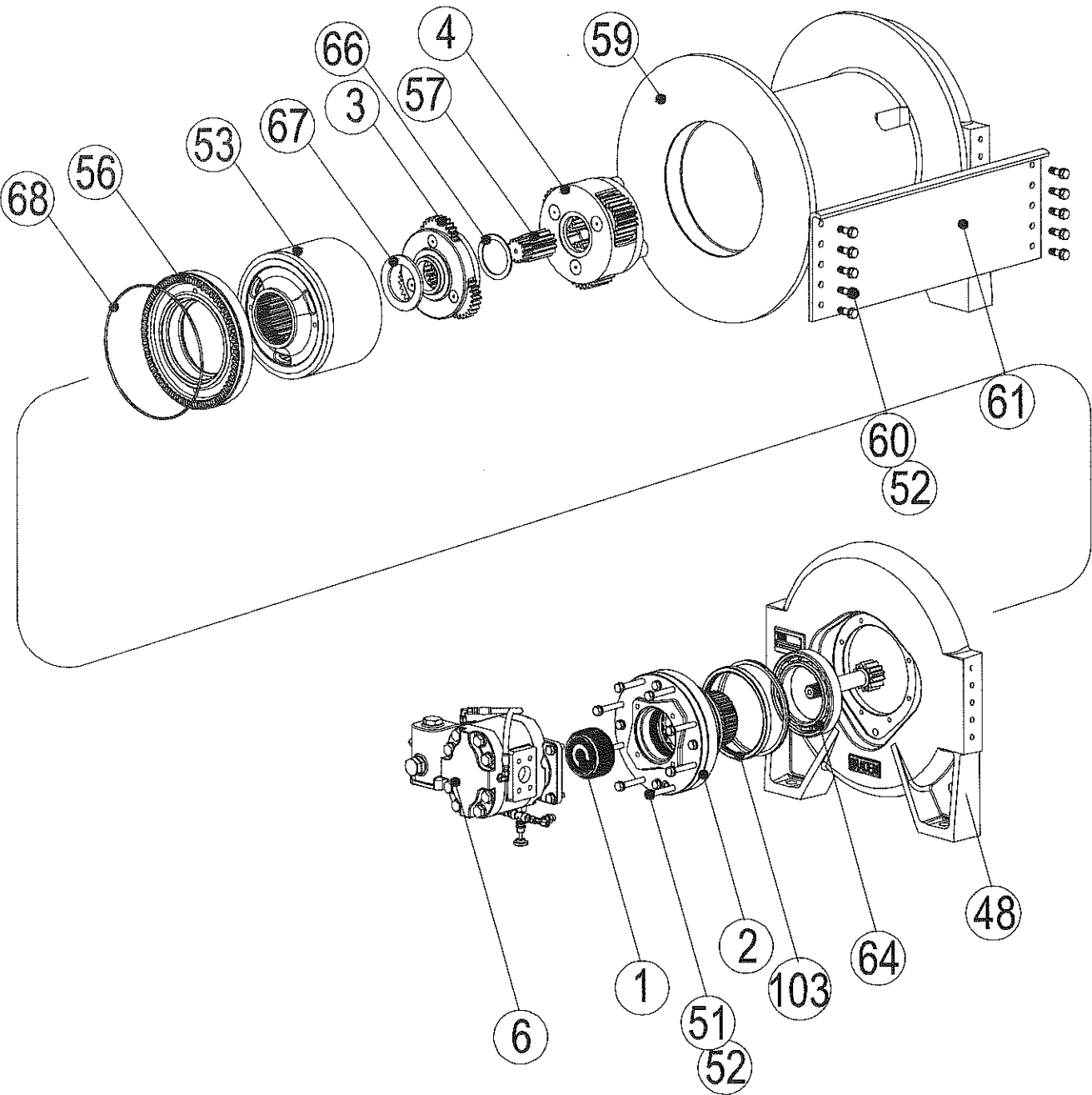
TROUBLE "D" CONTINUED FROM PREVIOUS PAGE	<p>3. Be certain hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures increase motor internal leakage and reduce motor performance.</p> <p>4. Winch line pull rating is based on 1<sup>st</sup> layer of wire rope.</p> <p>5. Rigging and sheaves not operating efficiently.</p>	<p>B. Apply a stall pull load on the winch while monitoring pressure.</p> <p>C. Compare gauge reading to winch specifications. Adjust relief valve as required.</p> <p>NOTE: If pressure does not increase in proportion to adjustment, relief valve may be contaminated or worn out. In either case, the relief valve may require disassembly or replacement.</p> <p>Same as remedies for Trouble D1 &amp; D2.</p> <p>Same as remedies for Trouble E2.</p> <p>Refer to winch performance charts for additional information.</p> <p>Perform rigging service as recommended by crane manufacturer.</p>
<p><b>E</b></p> <p>The winch runs hot.</p>	<p>1. Same as D1.</p> <p>2. Be certain that the hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures may be caused by:</p> <p>A. Plugged heat exchanger.</p> <p>B. Too low or too high oil level in hydraulic reservoir.</p> <p>C. Same as D2.</p> <p>D. Hydraulic pump not operating efficiently.</p> <p>3. Excessively worn or damaged internal winch parts.</p>	<p>Same as remedies for Trouble D1.</p> <p>Thoroughly clean exterior and flush interior.</p> <p>Fill/drain to proper level.</p> <p>Same as remedies for Trouble D2.</p> <p>Prime mover low on horsepower or R.P.M. Tune/adjust prime mover.</p> <p>Check suction line for damage.</p> <p>If pump is belt driven, belts are slipping. Replace/tighten belts.</p> <p>Pump worn. Replace pump.</p> <p>Disassemble winch to inspect/replace worn parts.</p>

TROUBLE	PROBABLE CAUSE	REMEDY
<p style="text-align: center;"><b>F</b></p> <p>Winch "chatters" while raising rated load.</p>	<ol style="list-style-type: none"> <li>1. Same as D2.</li> <li>2. Hydraulic oil flow to motor may be too low.</li> <li>3. Controls being operated too quickly.</li> </ol>	<p>Same as remedies for Trouble D2.</p> <p>Same as remedies for Trouble E2.</p> <p>Conduct operator training as required.</p>
<p style="text-align: center;"><b>G</b></p> <p>The wire rope does not spool smoothly on the drum.</p>	<ol style="list-style-type: none"> <li>1. The winch may be mounted too close to the main sheave, causing the fleet angle to be more than 1½ degrees.</li> <li>2. The winch may not be mounted perpendicular to an imaginary line between the center of the cable drum and the first sheave.</li> <li>3. Could possibly be using the wrong lay rope. There is a distinct advantage in applying rope of the proper direction of lay. When the load is slacked off, the several coils on the drum will stay closer together and maintain an even layer. If rope of improper lay is used, the coils will spread apart each time the load is removed. Then, when winding is resumed, the rope has a tendency to criss-cross and overlap on the drum. The result is apt to be a flattened and crushed rope.</li> <li>4. The winch may have been overloaded, causing permanent set in the wire rope.</li> </ol>	<p>Check mounting distance and fleet angle. Reposition winch as required.</p> <p>Refer to "Winch Installation".</p> <p>Consult wire rope manufacturer for recommendation of wire rope that best suits your application.</p> <p>Replace wire rope and conduct operator/rigger training as required.</p>



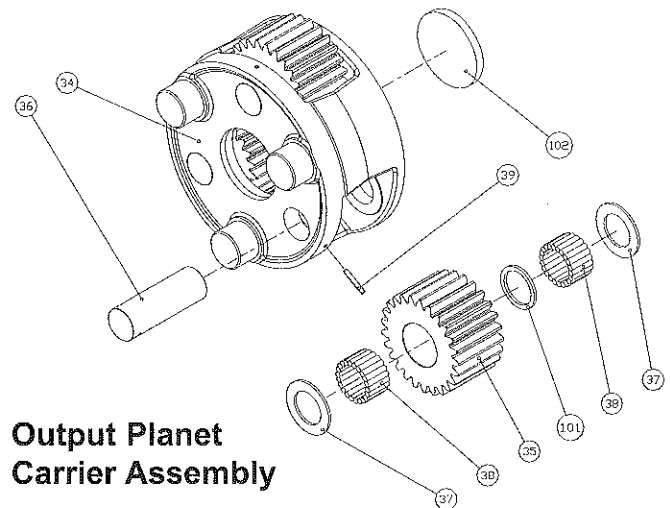
# BRADEN CH210 COMPONENTS

## Winch Assembly



## Winch Assembly

ITEM	DESCRIPTION	QTY.
1	Over-running Clutch Assembly	1
2	Brake Cylinder Assembly	1
3	Primary Planet Carrier Assembly	1
4	Output Planet Carrier Assembly	1
5	Drum Support Assembly	1
6	Motor Assembly	1
48	Motor Endplate	1
50	Retaining Ring	2
51	Capscrew	8
52	Lockwasher	28
53	Ring Gear	1
54	Ring Gear Adapter	1
55	Primary Sun Gear	1
56	Drum Closure	1
57	Output Sun Gear	1
59	Cable Drum	1
60	Capscrew	20
61	Tie Plate	2
64	Ball Bearing	1
65	Ball Bearing	1
66	Thrust Washer	1
67	Thrust Washer	1
68	O-Ring	1
69	Seal	1
70	Seal	1
71	Cable Wedge - Not Shown	1
72	Plug, O-Ring Flush	2
103	V-Ring Seal	1
105	Drive Screw	4
107	Nameplate	1
108	Closure	1



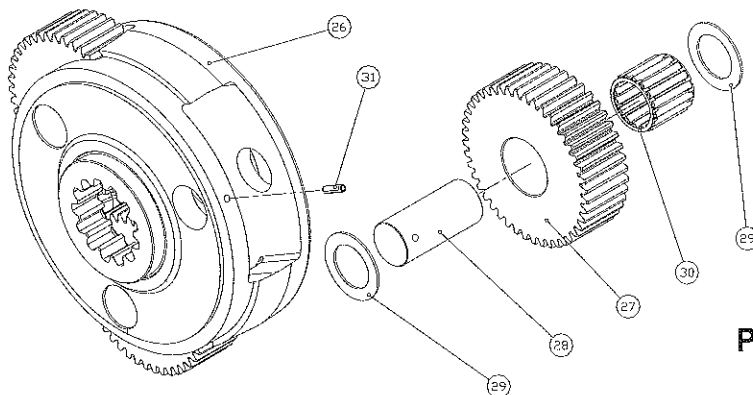
**Output Planet Carrier Assembly**

**Output Planet Carrier Assembly**

ITEM	DESCRIPTION	QTY.
34	Output Planet Carrier	1
35	Output Planet Gear	3
36	Output Planet Gear Shaft	3
37	Thrust Washer	6
38	Loose Rollers	132
39	Spirol Pin	3
101	Bearing Spacer	3
102	Thrust Plate	1

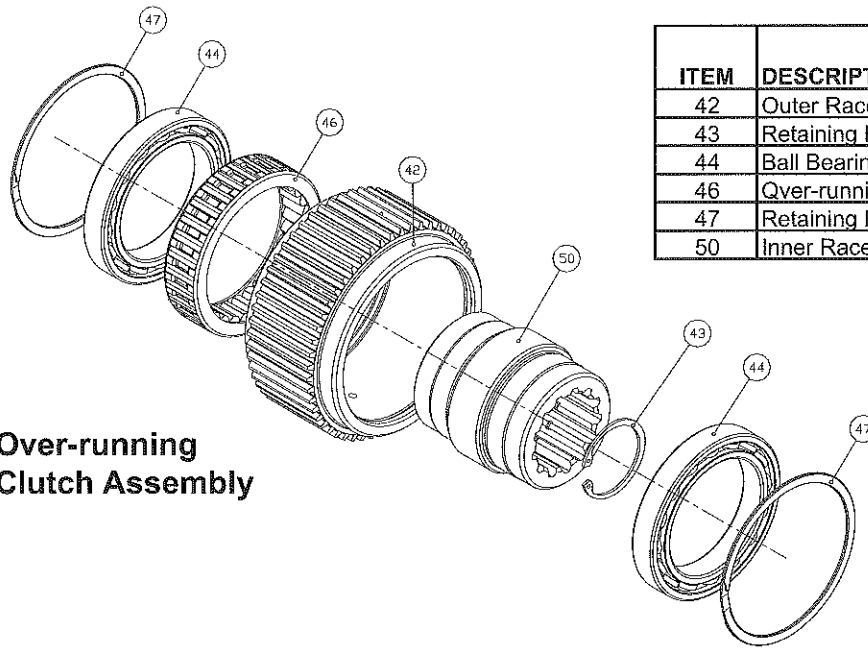
**Primary Planet Carrier Assembly**

ITEM	DESCRIPTION	QTY.
26	Primary Planet Carrier	1
27	Primary Planet Gear	3
28	Primary Planet Gear Shaft	3
29	Thrust Washer	6
30	Roller Bearing	3
31	Spirol Pin	3



**Primary Planet Carrier Assembly**

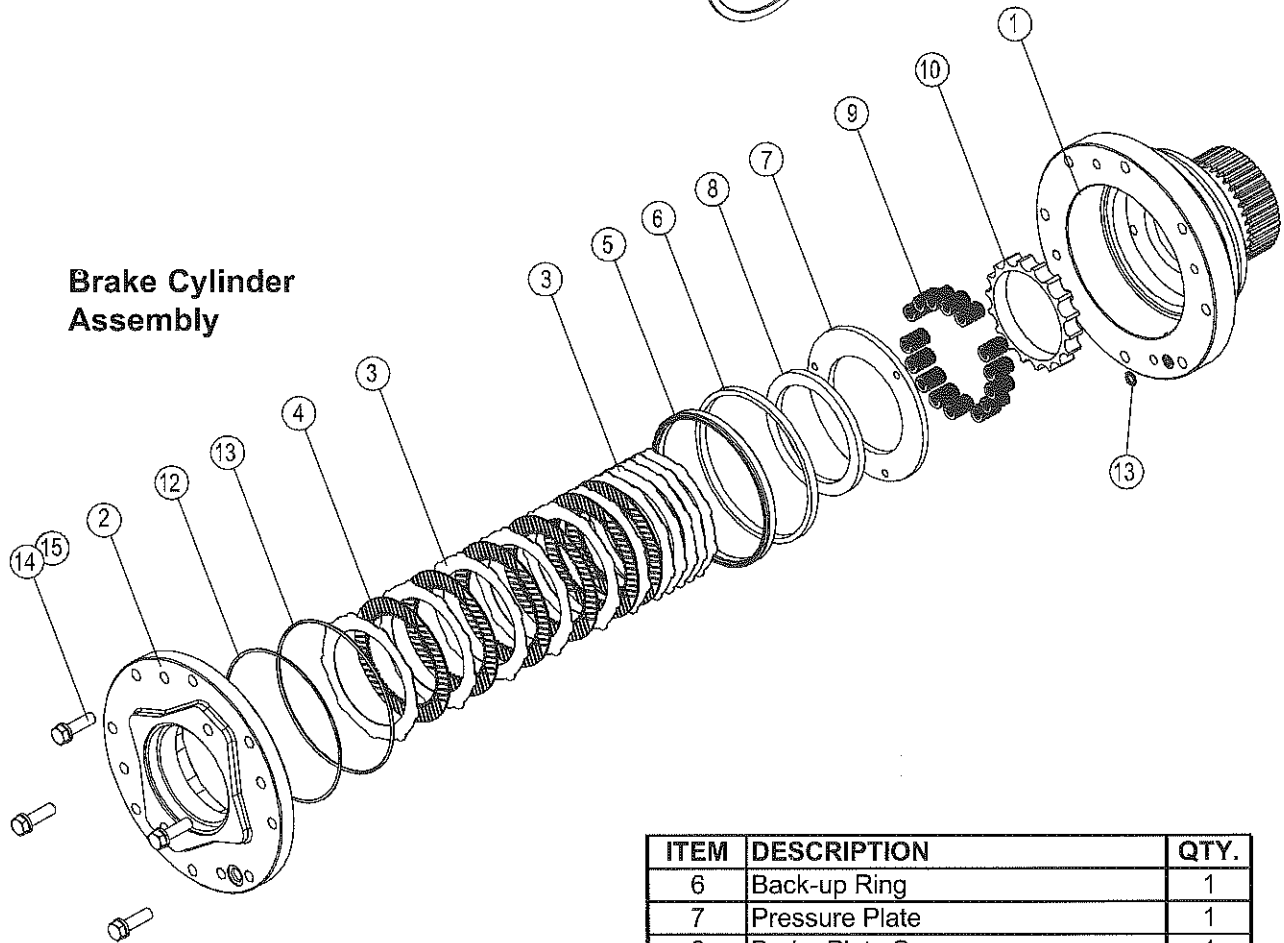
## Over-running Clutch Assembly



ITEM	DESCRIPTION	QTY.
42	Outer Race	1
43	Retaining Ring	2
44	Ball Bearing	1
46	Over-running Clutch	1
47	Retaining Ring	2
50	Inner Race	1

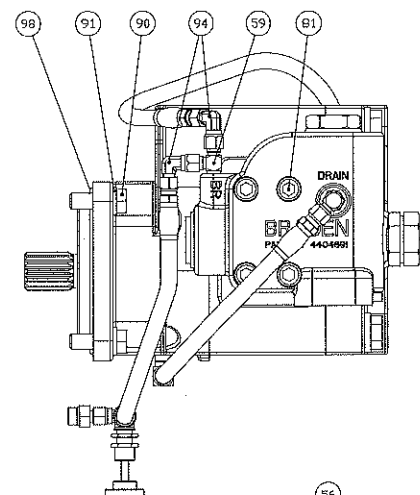
## Over-running Clutch Assembly

## Brake Cylinder Assembly

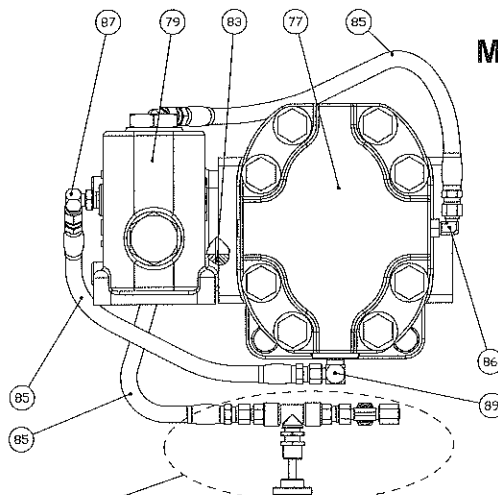


ITEM	DESCRIPTION	QTY.
1	Brake Cylinder	1
2	Motor Adapter	1
3	Brake Disc	8
4	Friction Disc	7
5	Seal	1

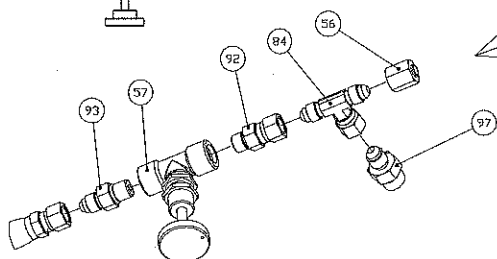
ITEM	DESCRIPTION	QTY.
6	Back-up Ring	1
7	Pressure Plate	1
8	Brake Plate Spacer	1
9	Spring	15
10	Spring Spacer	1
11	O-Ring	1
12	Backup Ring	1
13	O-Ring	1
14	Capscrew (1/2 - 13 X 1-3/4 G8 Z)	4
15	Lockwasher (1/2)	4



**Motor Group**



**Motor Group**

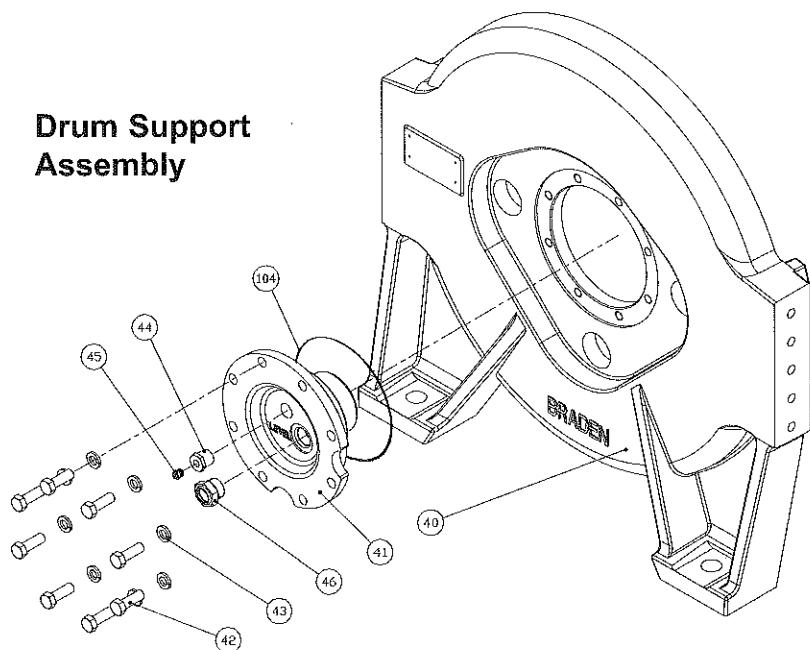


**Drum Support Assembly**

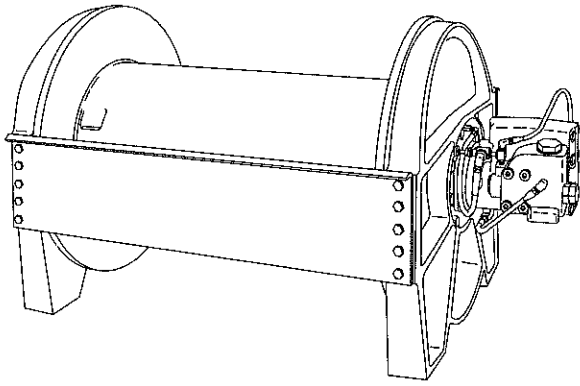
ITEM	DESCRIPTION	QTY.
40	Support Endplate	1
41	Bearing Support	1
42	Capscrew	8
43	Lockwasher	8
44	Reducer Bushing	1
45	Vent Plug	1
46	Sight Gauge	1
104	V-Ring Seal	1
105	Drive Screw (not shown)	4
106	Approval Plate (not shown)	1

ITEM	DESCRIPTION	PART NUMBER	QTY.
56	Cap Nut	70182	1
57	Needle Valve	103936	1
59	Male Run Tee	24526	1
77	Hydraulic Motor	25273	1
79	Brake Valve	81609	1
81	Capscrew (1/2 - 13 X 4-1/2 G8 Sock Hd)	23690	4
83	O-Ring	13542	1
84	Swivel Tee Fitting	25748	1
85	Hose Assembly	25935	3
86	Elbow Fitting	25302	1
87	Elbow Fitting	21163	1
89	Elbow Fitting	31341	1
90	Capscrew (1/2 - NC X 1-1/2 G5)	13413	4
91	Lockwasher (1/2)	11026	4
92	Adapter	103947	1
93	Adapter	25864	1
94	Swivel Nut Elbow, 90 degree	26140	2
97	Adapter	31284	1
98	O-Ring	10330	1
---	Warning Tag (not shown)	25257	1

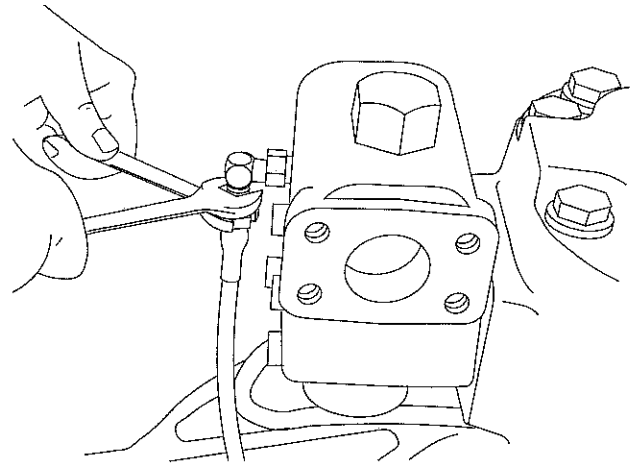
**Drum Support Assembly**



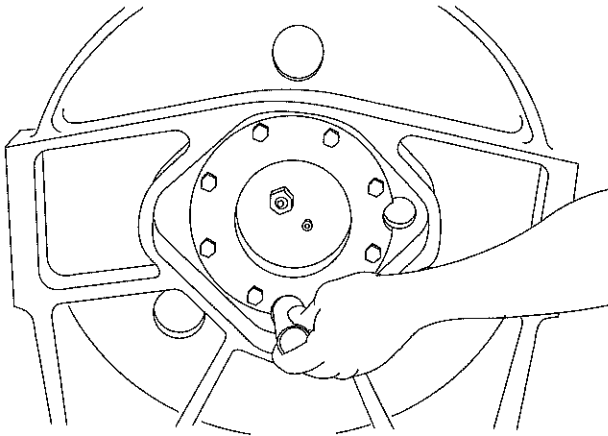
# DISASSEMBLY PROCEDURE FOR HOIST



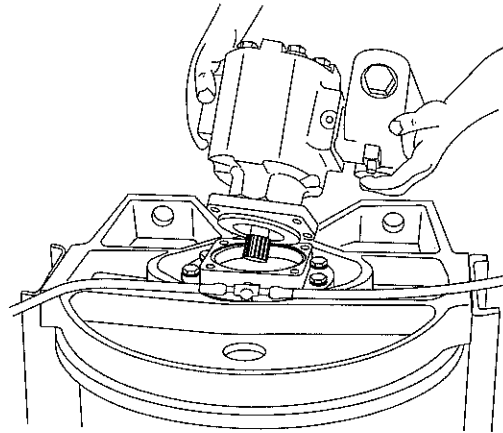
1. Remove the wire rope from the hoist drum and align the drain plug in the drum with the lowest hole in the support end plate before removing the hoses and mounting bolts. After the hoist is removed from its mounting, clean the outside surfaces.



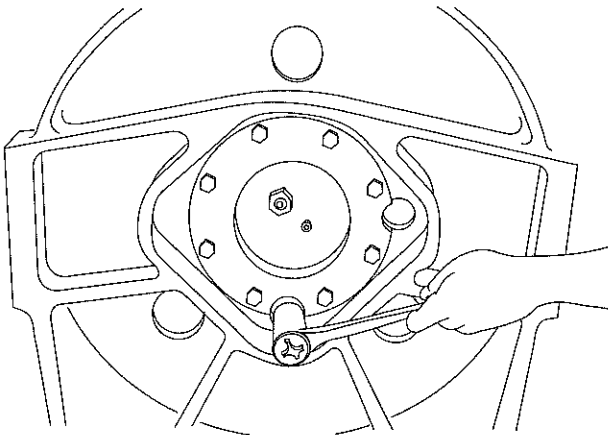
4. Begin the disassembly by standing the hoist on the end opposite the motor. Tag and remove the hydraulic hoses that connect the brake valve and the motor (manifold in the case of a two-speed motor) to the brake release port.



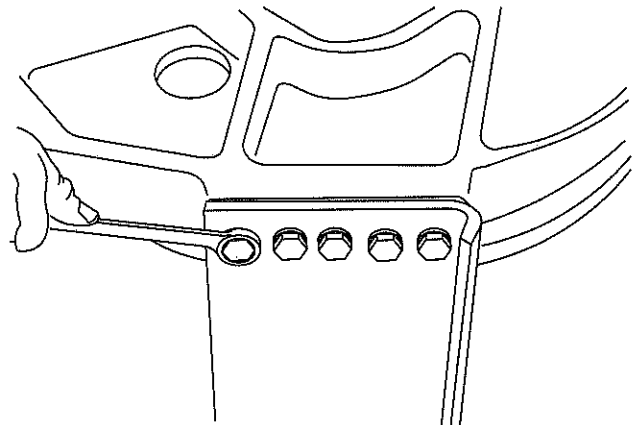
2. To drain the oil, screw a short piece of 1" pipe into the larger threads of the drain hole.



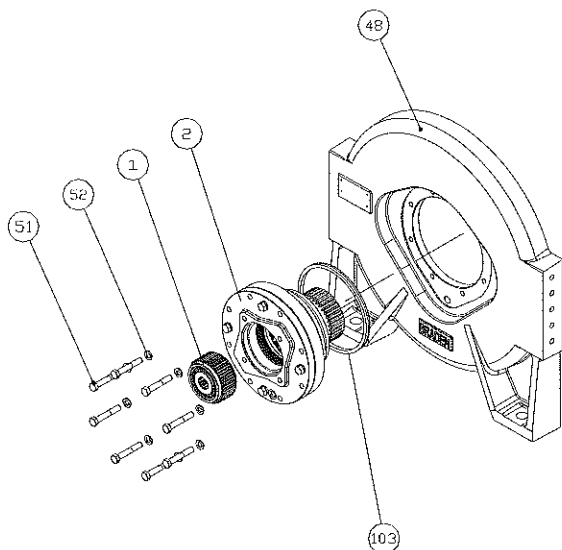
5. Remove the four (4) capscrews and lockwashers securing the motor and lift the motor off the hoist. Remove and discard the O-ring installed on the outside of the motor pilot.



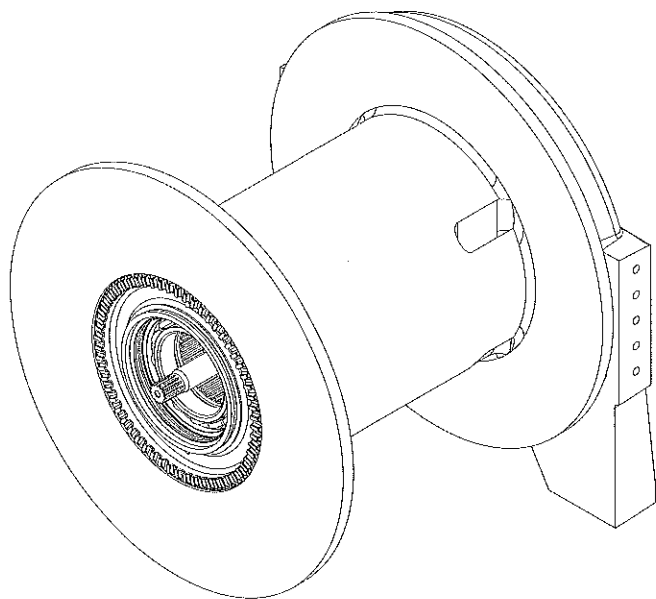
3. Use a 5/16" Allen hex to remove the drain plug through the pipe. If the drain holes were not aligned before the hoist was removed from its mounting, the oil can be drained by removing the vent plug and sight gauge in the bearing support and turning the hoist up on the bearing support end.



6. Remove the twenty (20) capscrews and lockwashers from the two (2) tie plates, and remove the plates.



8. Remove the over-running clutch assembly (item 1) from the center of the brake cylinder assembly. Refer to "Over-running Clutch Assembly Service" later in this manual for additional information. Remove the eight (8) capscrews (item 51) and lock-washers (item 52) from the motor adapter, and remove the brake cylinder assembly. Remove and discard the V-Ring seal (item 103) that was under the brake cylinder. Do not remove the four (4) cap-screws holding the motor adapter to the brake cylinder at this time. Refer to "Brake Cylinder Service" later in this manual.
9. Remove the motor end plate (item 48) from the drum.



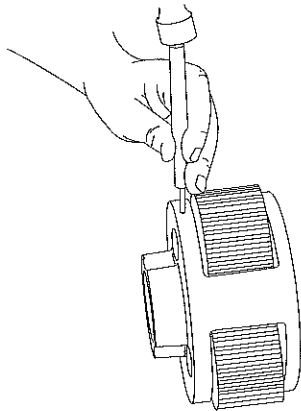
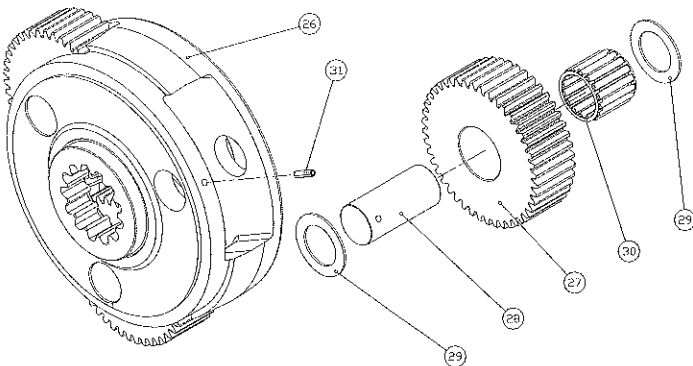
10. There are two 1/2 inch NC tapped holes in the drum closure (item 56). Install two capscrews or threaded eye-bolts to aid in removing the closure from the cable drum. Remove and discard the O-Ring (item 68) from the O.D. of the drum closure.

11. Install two eye-bolts into top end of ring gear. Lift ring gear out of drum. Remove planet gear sets from drum.
12. Lift the cable drum (item 59) off of the drum support assembly (item 5)
13. Thoroughly clean and inspect all disassembled components at this time. Inspect bearings in the drum closure and cable drum (items 64 & 65), and replace as required. Inspect sealing surfaces on the drum support and brake cylinder and repair any damaged areas if possible, or replace components as required. During a complete winch teardown, drum seals (items 69 and 70) and V-Ring seals (items 103 and 104) should always be replaced. Inspect thrust washers (items 66 and 67) for signs of excessive wear, heat damage or metal transfer and replace as necessary. Inspect the ring gear teeth for nicks, spalling or excessive wear. Replace if wear in contact areas is greater than 0.015 in. (0.4 mm) when compared to unworn area of teeth.

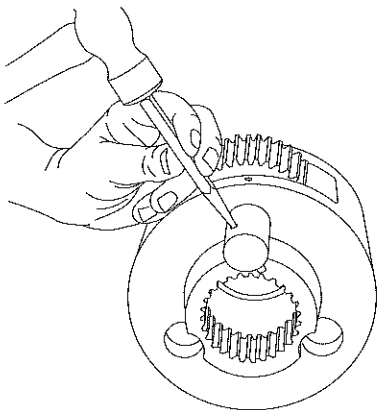
# PLANET CARRIER SERVICE

## PRIMARY PLANET CARRIER

### Disassembly



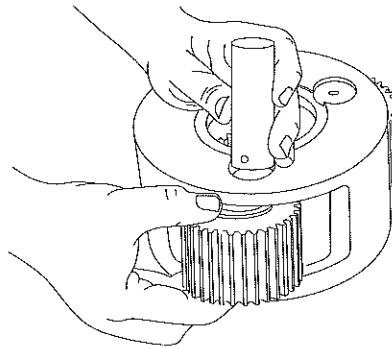
1. Remove the planet gears by first driving the roll pins (item 31) into the center of the planet gear shafts (item 28).



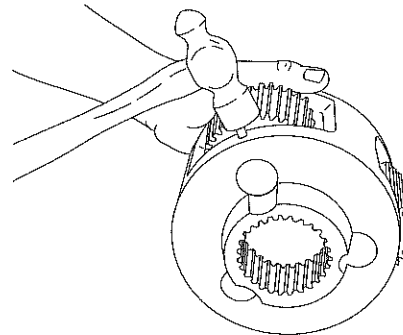
2. Use a punch to drive the roll pins from the planet gear shafts. DO NOT reuse the roll pins.

3. Now you can remove the planet shafts, bearings, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, the bearing should be replaced. Likewise, the cage should be inspected for unusual wear or deformation, particularly the cage bars. If there is any damage that will impair the cage's ability to separate, retain and guide the rollers properly, the bearing should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary

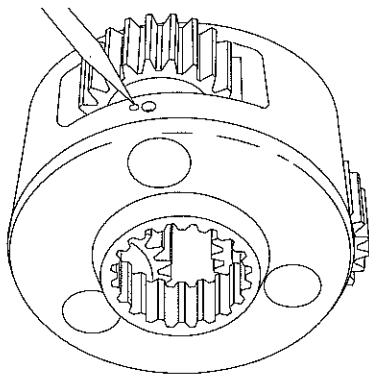
### Assembly



1. Install a bearing into a planet gear and place a thrust washer on each side of the gear. Position this assembly into an opening in the carrier. Slide a planet gear shaft through the carrier, thrust washer, bearing and remaining thrust washer.



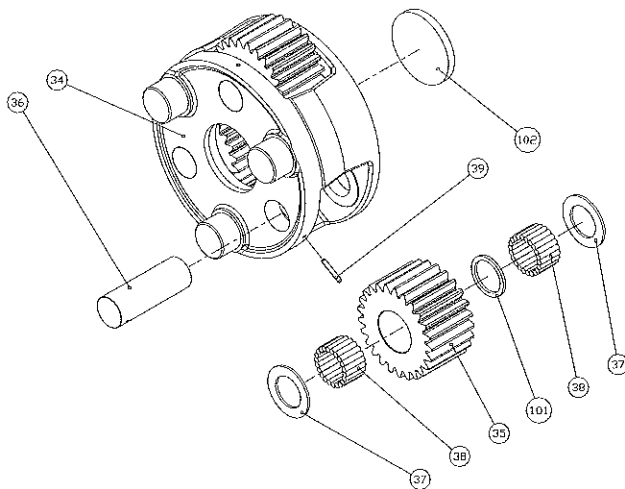
2. Carefully align the pin hole in the carrier with the hole in the shaft and drive a new roll pin into place. ALWAYS use NEW roll pins. When properly positioned, 50% of the roll pin will engage the planet gear shaft and 50% will remain in the carrier.



3. Note that the roll pin is slightly recessed into the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole and prevent the pin from backing out in operation. Repeat these steps for each of the three planet gears.

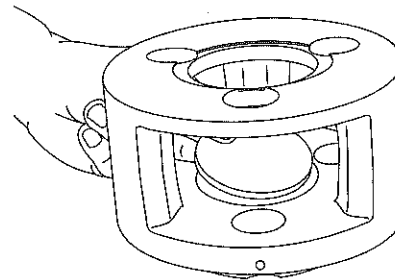
## OUTPUT PLANET CARRIER

### Disassembly



1. Follow steps 1 and 2 of the Primary Planet Carrier disassembly procedure to remove the roll pins from the planet gear shafts.
2. Now you can remove the planet shafts, bearings, spacers, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, they should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary.

### Assembly

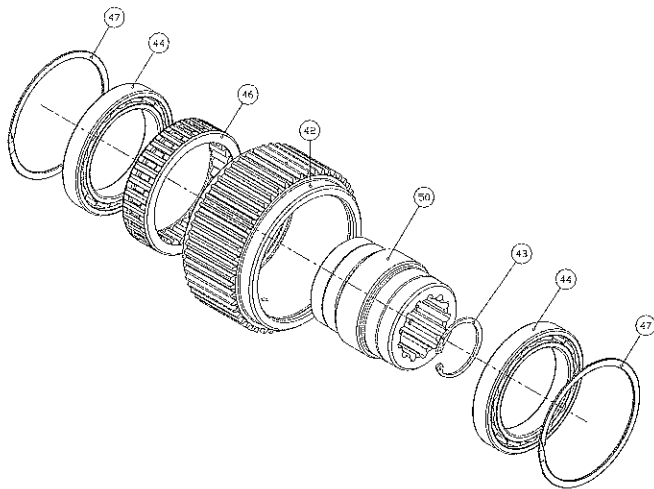


1. Place the output carrier on a clean work surface with the drive pins down. Install the output thrust plate (item 102) into the center of the carrier.
2. Apply a liberal coat of oil soluble grease to a thrust washer and center it on one side of a planet gear. Place the planet gear on a clean work surface with the thrust washer down. Apply a liberal coat of oil soluble grease to the bore of the gear. Stack a row of loose roller bearings into the planet gear, using the grease to hold them in position. There are 22 rollers in each row. Install a bearing spacer. Stack a second row of loose roller bearings on top of the bearing spacer. Place a second thrust washer on the planet gear. Carefully slide the planet gear, bearings and thrust washers into the carrier. Install a planet gear shaft into the carrier and through the planet gear bearings.
3. Follow steps 2 and 3 of the Primary Planet Carrier assembly procedure to install and stake a NEW roll pin in the carrier.

Repeat this procedure for each of the planet gears.



# OVER-RUNNING CLUTCH SERVICE



**NOTE:** Outer race (item 42), Inner race (item 50) and Over-running clutch (item 46) are NOT SOLD individually as replacement parts. If any of these parts require replacement, the entire over-running clutch assembly must be replaced. Carefully note the relative orientation between the inner and outer races, and the direction of free rotation of the inner race. The clutch **MUST** be re-assembled correctly for proper hoist operation.

## ! WARNING !

The polished surfaces of the inner and outer race and the over-running cams must be perfectly smooth to insure positive engagement of the clutch. The slightest defect may reduce clutch effectiveness, which may lead to loss of load control and result in property damage, injury or death. It is generally recommended to replace the entire clutch assembly if any component is defective. For these reasons, the over-running clutch assembly should be disassembled for inspection only if the hoist has exhibited any unusual operation that would point toward a clutch malfunction, or the over-running clutch assembly shows external signs of mechanical damage.

## Disassembly

1. Remove one of the retaining rings (item 47) from the outer race (item 42). Push the inner race (item 50), bearings (item 44) and over-running clutch (item 46) through the outer race.
2. Use a small punch and hammer to tap one of the bearings (item 44) off of the inner race. The over-running clutch can now be removed from the inner race. Closely inspect the over-running clutch and the polished surfaces of the inner and outer race for wear, cracks, pitting, corrosion or mechanical damage. Closely inspect the bearings for any signs of damage, wear, corrosion, pitting or heat discoloration.

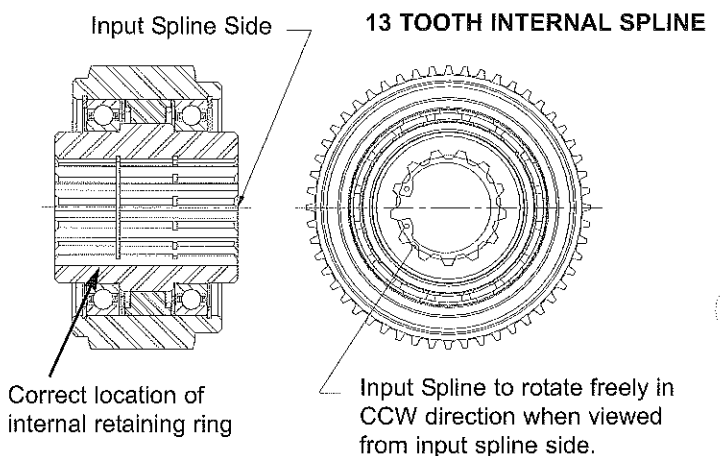
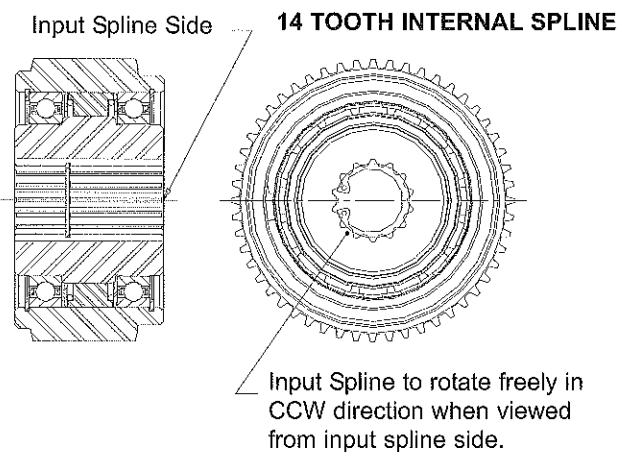
## Assembly

## ! WARNING !

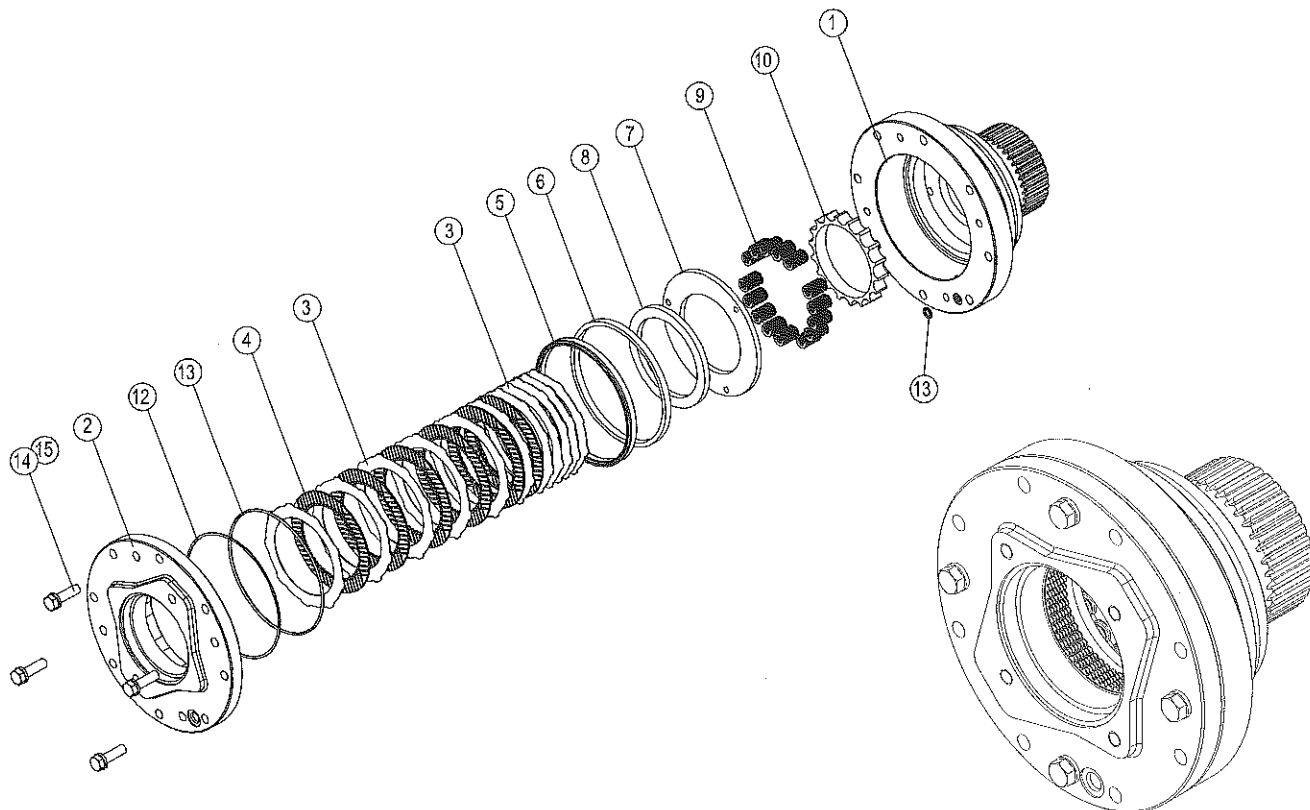
Failure to assemble the over-running clutch assembly with all parts oriented correctly may result in reduced brake effectiveness, which may lead to loss of load control and result in property damage, injury or death.

1. If both bearings (item 44) have been removed from the inner race, install one of them now.
2. Install the over-running clutch onto the inner race. Rotate the inner race slightly to get the clutch started onto the inner race.
3. Install the other bearing onto the inner race.
4. The outer race should have one retaining ring (item 47) installed in one end. Carefully slide the inner race, with bearings and clutch, into the outer race. Install the other retaining ring into the outer race.

Shown below are the two types of clutch assemblies used in CH210 hoists. The drawings show each type properly assembled.



# BRAKE CYLINDER SERVICE



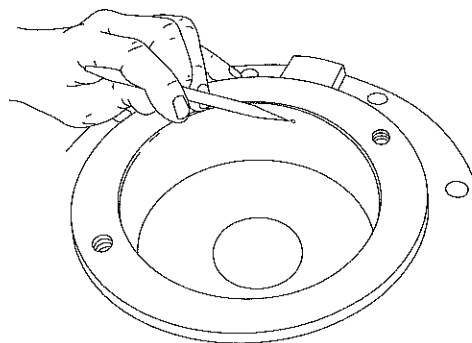
## Disassembly

### ⚠ CAUTION ⚠

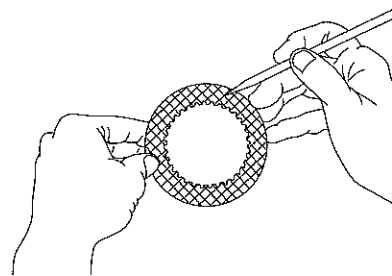
The motor adapter is under spring tension from the brake springs. Loosen each of the capscrews one turn at a time until spring tension is released.

1. Stand the brake assembly on the splined end, with the motor adapter up. Remove the four capscrews (item 14) and lockwashers (item 15). Use a criss-cross pattern and loosen each capscrew one turn at a time until spring tension is released.
2. Remove the motor adapter (item 2). Lift out all the brake discs (item 3), friction discs (item 40) and the spacer (item 8).
3. Remove and discard the O-Ring and backup ring (items 11 & 12) from the motor adapter. Remove and discard the seal (item 5) from the brake cylinder. Remove the steel backup ring (item 6).
4. Remove the pressure plate (item 7) and the springs and spacer (items 9 & 10) from the brake cylinder.

## Clean and Inspect



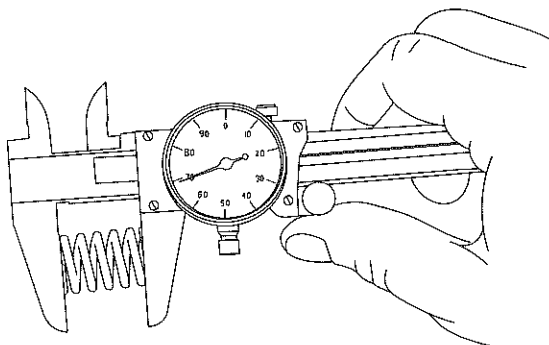
1. Thoroughly clean and inspect all parts at this time. Check sealing surfaces on both the motor adapter and brake cylinder. Be sure the brake release port is open and free of contamination.



2. Place friction brake disc on flat surface and check for distortion with a straight edge. Friction material should appear even across entire surface with groove pattern visible. Replace friction disc if

splines are worn to a point, disc is distorted, friction material is burned or worn unevenly, or groove depth is less than 0.003 in. (0.08 mm).

3. Place steel disc on flat surface and check for distortion with a straight edge. Check surface for signs of material transfer or excessive heat. Replace steel disc if distorted, heat discolored, or mechanically damaged.

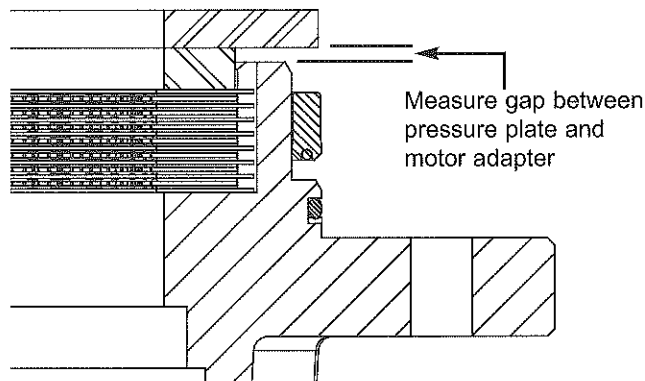
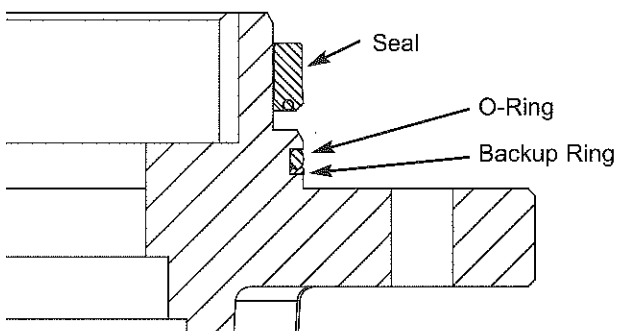


4. Check brake spring free length. Minimum free length is 1-7/16 in. (36.5 mm). Check springs for any signs of cracking or failure. If a brake spring must be replaced for any reason, then ALL brake springs must be replaced.

## ⚠ CAUTION ⚠

Failure to replace brake springs as a set may result in uneven brake application pressure and repeated brake spring failure.

### Assembly




1. Place the motor adapter on a clean work surface with the motor mounting surface down. Apply a light coat of oil to a new backup ring (item 12) and O-Ring (item 11) and install them into the groove on the motor adapter. Backup rings are always placed on the low pressure side of the O-Ring. In this case, the backup ring is toward the motor mounting surface. Lightly oil the brake cylinder seal (item 5) and install it onto the motor adapter with the seal lip down.
2. Install a steel brake disc (item 3) into the motor adapter, followed by a friction disc (item 4). Continue to alternately install steel and friction discs until there are 8 steel and 7 friction discs. A steel disc will be on top.
3. Install the brake plate spacer (item 8) on top of the last steel disc.
4. To check brake stack height, place pressure plate (item 7) on top of brake spacer. Hold pressure plate down firmly by hand and measure gap (in three places) between motor adapter and pressure plate. Average gap must measure between 0.160 in. (4 mm) maximum and 0.080 in. (2.0 mm) minimum. If the gap exceeds the maximum limit, there may be too many discs in the stack-up or the discs are distorted. If the gap is less than the minimum, there may be too few discs or the discs are worn beyond their serviceable limit and should be replaced. When the gap is within the minimum and maximum values, remove the pressure plate and all brake discs. Lubricate all friction discs with the same oil to be used in the hoist. Install all brake discs and brake plate spacer as described in steps 2 and 3.

5. Place the brake cylinder on a clean work surface with the splined end down. Install the spring spacer (item 10), then the 18 springs (item 9)

## **WARNING**

Always use the molded spring spacer to properly position the springs in the brake cylinder. Failure to install the spring spacer may allow the springs to contact each other and become damaged. This could result in loss of load control, property damage, injury or death.

6. Install the pressure plate (item 7) into the brake cylinder. Be careful that none of the springs fall over. Install the steel backup ring (item 6). Apply petroleum jelly or an oil soluble grease to a new O-Ring (item 13) and install it in the brake cylinder.

 **NOTE:** *The close fitting backup ring may be depressed slightly to one side to lodge it in the brake cylinder bore and temporarily hold the pressure plate and springs in place while the brake cylinder is inverted and lowered over the motor adapter.*

*As an alternate, the motor adapter and brake plates can be turned over and installed into the brake cylinder, holding the brake plates and spacer in place through the center opening. Be careful to not pinch your fingers between the spacer plate and the pressure plate.*

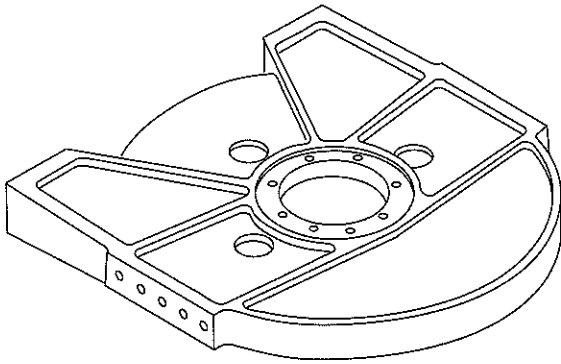
7. Apply petroleum jelly or an oil soluble grease to the sealing surface of the brake cylinder and the piston seal. Turn the brake cylinder over and lower it onto the motor adapter, being careful not to damage the piston seal or O-Ring on the adapter. Be careful the O-Ring (item 13) does not fall out of place, and the oil passages are aligned. The alternate assembly method above could also be used.

8. Turn the entire assembly over and install the four capscrews and lockwashers. After the capscrews make contact with the motor adapter, evenly tighten them one turn at a time until the motor adapter is drawn tight against the brake cylinder, then torque to the recommended value.

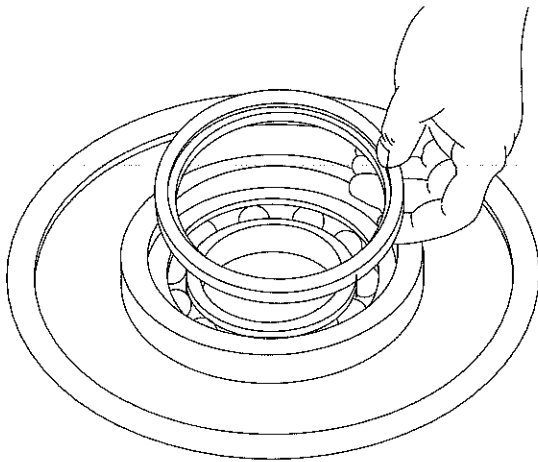
## **BRAKE CYLINDER PRESSURE TEST**

1. Install a -6 ORB fitting into the brake release port on the motor adapter. Connect a hand pump with an accurate 0-2,000 psi (0-13,800 kPa) gauge and shut-off valve to this fitting. Apply 1,000 psi (6,900 kPa) to the brake and close the shut-off valve. Let the unit stand for five minutes. If there is any loss of pressure, the brake cylinder should be disassembled for inspection of the sealing surfaces, seal and O-Ring. When the source of the pressure leak has been determined and corrected, re-assemble the brake cylinder and repeat the test.
2. **WHILE PRESSURE IS APPLIED AND THE BRAKE IS RELEASED,** install the over-running clutch assembly into the brake pack. Turn the clutch back and forth to align the splines on all the friction discs. Release the pressure on the brake cylinder and remove the clutch assembly. The brake cylinder is now complete and ready to be installed in the hoist.

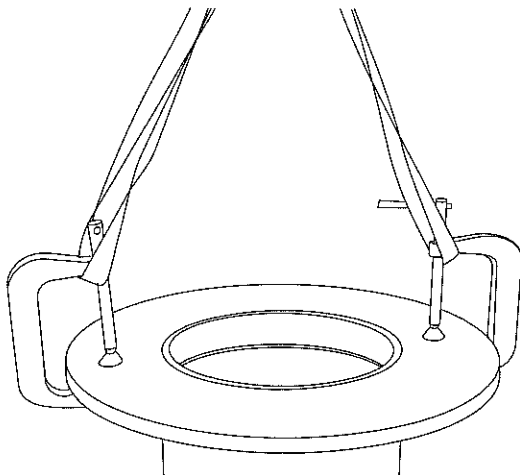
# HOIST ASSEMBLY



1. Place the drum support assembly on a clean work surface with the bearing support facing up. Lubricate the bearing and sealing surfaces on the bearing support. Install a new V-Ring seal onto the bearing support.

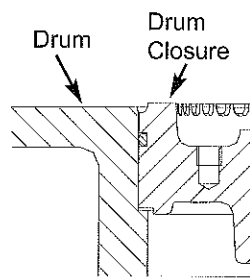


2. Install a new bearing in the drum if replacement is necessary, making certain to press it against the shoulder in the bottom of the bearing bore. Coat the outside diameter of a new seal with a good grade of sealant. Turn the spring side of the seal toward the bearing, and press the seal into the seal bore, leaving it flush with the surface of the drum bore.



3. Turn the drum over, and set it down on the bearing support. Be careful not to damage the seal when lowering the drum onto the bearing support.

4. Lower the output planet carrier assembly into the cable drum and engage the three lugs on the carrier into the three holes in the drum. Be sure the carrier is firmly seated against the web in the drum.
5. Install the thrust washer (item 66) into the recess in the output planet carrier, then install the output sun gear (item 57) into the center of the output planet gears.
6. Install the primary planet carrier assembly on top of the output planet carrier, engaging the splines in the primary carrier with the output sun gear. Install the thrust washer (item 67) onto the primary carrier.
7. Install the ring gear into the drum. Rotate the ring gear back and forth to engage the internal splines with the primary and output planet gears. When correctly installed, the bottom of the ring gear adapter will be resting on the thrust washer (item 67), which is on the primary planet carrier.
8. Install a new bearing in the drum closure if replacement is necessary, making certain to press it against the shoulder in the bottom of the bearing bore. Coat the outside diameter of a new seal with a good grade of sealant. Turn the spring side of the seal toward the bearing, and press the seal into the seal bore, leaving it flush with the surface of the drum closure. Lubricate a new O-Ring (item 68) and install it into the groove on the outside diameter of the closure. Lubricate the outside diameter of the closure and install it into the drum. When correctly installed, the drum closure will be approximately 0.034 in. (0.9 mm) above the drum flange. If the drum closure cannot be installed as shown, one or more components may be out of position or not properly seated. The most common causes of this problem are the thrust washers being out of position, or the output planet carrier not fully seated into the drum. DO NOT proceed with assembly until the source of the problem has been identified and corrected.



9. Place the motor endplate on the cable drum, aligning it approximately with the support endplate, and centering it on the drum. Lubricate and install a new V-Ring (item 103) onto the brake cylinder. Lubricate the sealing surface of the brake cylinder and carefully install the brake cylinder assembly through the endplate into the drum. Position the brake release port in the same location as removed. Rotate the brake cylinder back and forth to align the splines with those on the ring gear adapter. Install the input sun gear (item 55) through the center of the brake cylinder, engaging the teeth on the three input planet gears.

10. Install the eight (8) capscrews and lockwashers (items 51 & 52) through the brake cylinder into the motor endplate. Loosely tighten all capscrews until they are snug against the motor adapter. Continue to tighten the capscrews in a criss-cross pattern on turn at a time until the motor endplate is drawn tightly up against the brake cylinder. Torque capscrews to their correct value.
11. Install the two tie plates (item 61) between the two endplates of the hoist, using all twenty (20) capscrews and lockwashers (items 60 & 52). Be sure the curved sides of the tie plates are toward the top of the hoist. Torque all capscrews to their correct value.
12. Install the over-running clutch assembly into the center of the brake pack. Refer to page 26 for correct orientation. "Input Spline Side", shown on page 26, is the end of the clutch facing outward, toward the motor. It may be necessary to rotate the drum slightly in either direction to align the clutch splines with the input sun gear. The internal retaining ring in the clutch should be seated against the input sun gear when correctly installed.
13. Lubricate and install a new O-Ring onto the hydraulic motor pilot. Engage the motor shaft with the inner race of the over-running clutch and lower the motor into place. Install motor capscrews and lockwashers and torque to correct value.
14. Install all hydraulic lines disconnected during disassembly, then tighten all connections.
15. After the hoist assembly is complete, check all capscrews and fittings to make certain they have been properly installed and tightened correctly. Refill the hoist with the recommended oil listed in "Recommended Gear Oil".
16. Before returning the hoist to full service, a light load should be lifted and held a few feet off the ground to be sure the static brake is functioning properly. The hoist should also be able to slowly lower the load in a smooth and controlled manner. If the hoist does not perform either of these functions correctly, refer to "Trouble Shooting" for additional information.

# METRIC CONVERSION TABLE

English to Metric			Metric to English		
LINEAR					
inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.3937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)
AREA					
inches <sup>2</sup> (sq.in.)	X 645.15	= millimeters <sup>2</sup> (mm <sup>2</sup> )	millimeters <sup>2</sup> (mm <sup>2</sup> )	X 0.000155	= inches <sup>2</sup> (sq.in.)
feet <sup>2</sup> (sq.ft.)	X 0.0929	= meters <sup>2</sup> (m <sup>2</sup> )	meters <sup>2</sup> (m <sup>2</sup> )	X 10.764	= feet <sup>2</sup> (sq.ft.)
VOLUME					
inches <sup>3</sup> (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches <sup>3</sup> (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallon (gal.)
inches <sup>3</sup> (cu.in.)	X 16.39	= centimeters <sup>3</sup> (cc)	centimeters <sup>3</sup> (cc)	X 0.06102	= inches <sup>3</sup> (cu.in.)
feet <sup>3</sup> (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet <sup>3</sup> (cu.ft.)
feet <sup>3</sup> (cu.ft.)	X 0.02832	= meters <sup>3</sup> (m <sup>3</sup> )	meters <sup>3</sup> (m <sup>3</sup> )	X 35.315	= feet <sup>3</sup> (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= milliliters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)
MASS					
ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)
PRESSURE					
inches Hg (60°F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60°F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm <sup>2</sup> )	kilograms/sq.cm. (kg/cm <sup>2</sup> )	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H <sub>2</sub> O (60°F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H <sub>2</sub> O (60°F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars
POWER					
horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.
TORQUE					
pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.-lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)
VELOCITY					
miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)
TEMPERATURE					
°Celsius = 0.556 (°F - 32)			°Fahrenheit = (1.8°C) + 32		
COMMON METRIC PREFIXES					
mega	(M)	= 1,000,000 or 10 <sup>6</sup>	deci	(d)	= 0.1 or 10 <sup>-1</sup>
kilo	(k)	= 1,000 or 10 <sup>3</sup>	centi	(c)	= 0.01 or 10 <sup>-2</sup>
hecto	(h)	= 100 or 10 <sup>2</sup>	milli	(m)	= 0.001 or 10 <sup>-3</sup>
deka	(da)	= 10 or 10 <sup>1</sup>	micro	(μ)	= 0.000.001 or 10 <sup>-6</sup>







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### PD12C Series Hoist



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





# BRADEN

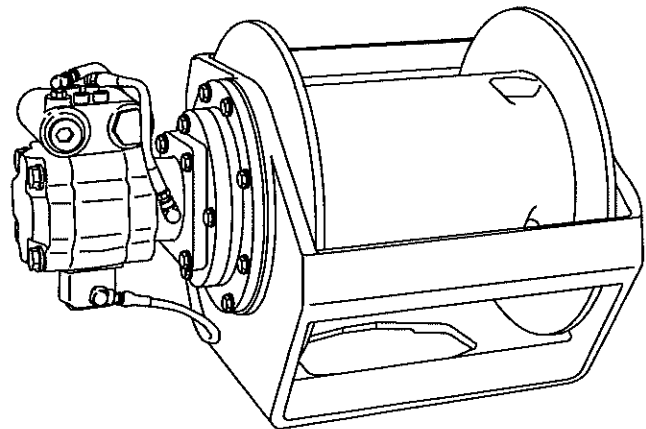
SERIES

**PD12C**

**PD15B**

**PD17A**

**HYDRAULIC WINCH**



**INSTALLATION, MAINTENANCE AND SERVICE MANUAL**

---

LIT2103 R3  
07/2007  
PRINTED IN U.S.A.

**PACCAR** WINCH DIVISION  
P.O. BOX 547 BROKEN ARROW, OK U.S.A. 74013  
PHONE (918) 251-8511 FAX (918) 259-1575  
[www.paccarwinch.com](http://www.paccarwinch.com)

# FOREWORD

Read this entire publication and retain it for future reference.

If you have any questions regarding your Braden Planetary Winch or this publication, call the Braden Service Department at 1-918-251-8511, 08:00-1630 hours, CT, Monday through Friday.

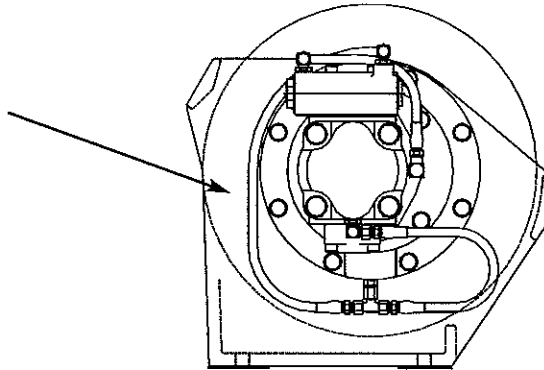
The minimum service intervals specified are for operating hours of the prime mover.

The following service instructions have been prepared to provide assembly, disassembly and maintenance information for the BRADEN Model PD12C, PD15B and PD17A series winch. It is suggested that before doing any work on these units, all assembly and disassembly instructions should be read and understood.

Some pictures in this manual may show details or attachments that are different from your winch. Also, some components have been removed for illustrative purposes. Illustrations and pictures in this manual are of a "typical" unit sold through our distribution channels. Some winches, particularly those sold directly to original equipment manufacturers, may differ slightly in appearance.

Whenever a question arises regarding your BRADEN winch, please contact BRADEN Service Department for the latest available information.

Serial Numbers and Model Numbers are located to the left hand side of the hydraulic motor, stamped into the base. Always refer to the Serial Number and Model Number when requesting information or service parts.



## EXPLANATION OF MODEL NUMBER

<b>PD</b>	<b>12</b>	<b>C</b>	<b>-</b>	<b>29</b>	<b>064</b>	<b>-</b>	<b>02</b>	<b>-</b>	<b>U</b>	<b>L</b>	<b>-</b>	<b>1</b>
POWER DRUM	MAX. RATING	DESIGN MODEL		GEAR RATIO	MOTOR SIZE		DRUM OPTION		ROTATION	BASE		OPTION

PD	DESIGNATES POWER DRUM
12	DESIGNATES 12,000 LB. APPROXIMATE FIRST LAYER LINE PULL
C	DESIGNATES THE MODEL SERIES RELATING TO DESIGN CHANGES
29	DESIGNATES TOTAL GEAR REDUCTION
064	DESIGNATES HYDRAULIC MOTOR DISPLACEMENT IN CU IN/REV (DECIMAL POINT ELIMINATED. EXAMPLE 064 = 6.4 CU IN/REV)
02	DESIGNATES THE DRUM OPTION
U	DESIGNATES UNDERWOUND CABLE DRUM – OPTIONAL
L	DESIGNATES LEFT HAND BASE – OPTIONAL
1	PERMITS TESTING AND INSPECTION PER API 2C FOR OFFSHORE CRANES

# TABLE OF CONTENTS

GENERAL SAFETY RECOMMENDATIONS .....	PAGE 3
THEORY OF OPERATION.....	4
WINCH INSTALLATION .....	6
RECOMMENDED FASTENER TORQUE .....	7
WIRE AND BRAIDED ROPE INSTALLATION .....	8
TWO SPEED MOTOR CASE DRAIN PLUMBING .....	8
PREVENTIVE MAINTENANCE –	
RECOMMENDED OIL CHANGE INFORMATION .....	9
TROUBLE SHOOTING .....	11
WINCH DISASSEMBLY .....	15
EXPLODED VIEW DRAWING AND PARTS KEY .....	18-19
PLANET CARRIER SERVICE .....	20
MOTOR SUPPORT – BRAKE CYLINDER SERVICE .....	22
BRAKE CLUTCH SERVICE .....	26
WINCH ASSEMBLY .....	28
BRAKE VALVE SERVICE .....	32
REVERSING DIRECTION OF DRUM ROTATION .....	34
PD17A ROTATION INDICATOR PROXIMITY SENSOR .....	36

# GENERAL SAFETY RECOMMENDATIONS

Safety and informational callouts used in this manual include:

## **WARNING**

**WARNING** – This emblem is used to warn against hazards and unsafe practice which **COULD** result in severe personal injury or death if proper procedures are not followed.

## **CAUTION**

**CAUTION** – This emblem is used to warn against potential or unsafe practices which **COULD** result in personal injury and product or property damage if proper procedures are not followed.

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and winch must be operated with care and concern by the operator for the equipment and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

1. Be certain equipment (boom, sheave blocks, pendants, etc.) is either lowered to the ground or blocked securely before servicing, adjusting, or repairing winch.
2. Be sure personnel are clear of work area **BEFORE** operating winch.
3. Read all warning and caution tag information provided for safe operation and service of winch.
4. Inspect rigging and winch at the beginning of each work shift. Defects should be corrected immediately.
5. Keep equipment in good operating condition. Perform scheduled servicing and adjustments listed in the "Preventive Maintenance" section of this manual.
6. An equipment warm-up procedure is recommended for all start-ups and essential at ambient temperatures below +40°F (4°C). Refer to "Warm-up Procedure" listed in the "Preventive Maintenance" section of this manual.
7. Operate winch line speeds to match job conditions.
8. Leather gloves should be used when handling wire rope.
9. Never attempt to handle wire rope when the hook end is not free. Keep all parts of body and clothing clear of cable rollers, cable entry area of fairleads and winch drum.
10. When winding wire rope on the winch drum, never attempt to maintain tension by allowing wire rope to slip through hands. Always use "Hand-Over-Hand" technique.
11. Never use wire rope with broken strands. Replace wire rope.
12. Do not weld on any part of the winch.
13. Use recommended hydraulic oil and gear lubricant.
14. Keep hydraulic system clean and free from contamination at all times.
15. Use correct anchor for wire rope and pocket in drum.
16. Do not use knots to secure or attach wire rope.
17. The BRADEN designed wire rope anchors are capable of supporting the rated load when installed properly. For additional safety, **ALWAYS** maintain a minimum of five (5) wraps of wire rope on the drum.
18. Never attempt to clean, oil or perform any maintenance on a machine with the engine or prime mover running, unless instructed to do so in this manual.
19. Never operate winch controls unless you are properly positioned at the operators station and you are sure personnel are clear of the work area.
20. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
21. Ground personnel should stay in view of the operator and clear of winch drum. Do not allow ground personnel near winch line under tension. A safe distance of at least 1 \_ times the length of the cable should be maintained.
22. Do not exceed the maximum pressure, PSI (kPa), or flow, GPM (LPM), stated in the winch specifications for hydraulically driven winches.
23. Install guarding to prevent personnel from getting any part of body or clothing caught at a point where the cable is wrapped onto the drum or drawn through guide rollers.
24. "Deadman" controls, which automatically shut off power to the winch whenever the operator leaves his station, should be installed whenever practicable.
25. Never allow anyone to stand under a suspended load.
26. Avoid sudden "shock" loads or attempting to "jerk" load free. This type of operation may cause heavy loads, in excess of rated capacity, which may result in failure of cable and winch.

# THEORY OF OPERATION

## DESCRIPTION OF WINCH

The winch has four basic component parts:

1. Winch base
2. Hydraulic motor and brake valve
3. Brake cylinder and motor support
4. Drum assembly

The drum assembly consists of three basic assemblies:

1. Drum with integral ring gear
2. Output planetary gear set
3. Primary planetary gear set

The hydraulic motor is bolted to the motor support which in turn is bolted to the brake cylinder and the base. The motor end of the drum, running on a ball bearing, is supported by the brake cylinder. The other end of the drum runs on a ball bearing on the support bolted to the base. The ring gear for both planetary sets is machined into the drum's inside surface.

## WINCH OPERATION

The hydraulic motor drives the sun gear of the primary planetary gear set through the splined inner race of the brake clutch. When driven by the sun gear, the primary planet gears walk around the ring gear in the drum and drive the primary planet carrier.

The primary planet carrier drives the output planet sun gear which, in turn drives the output planet gears. The output planet carrier is splined to the bearing support and cannot rotate. Therefore, as the output planet gears are driven by the sun gear, they will drive the ring gear/drum.

## Dual Brake System – Description

The dual brake system consists of a dynamic brake system and a static brake system.

The dynamic brake system has two operating components:

1. Brake valve assembly
2. Hydraulic motor

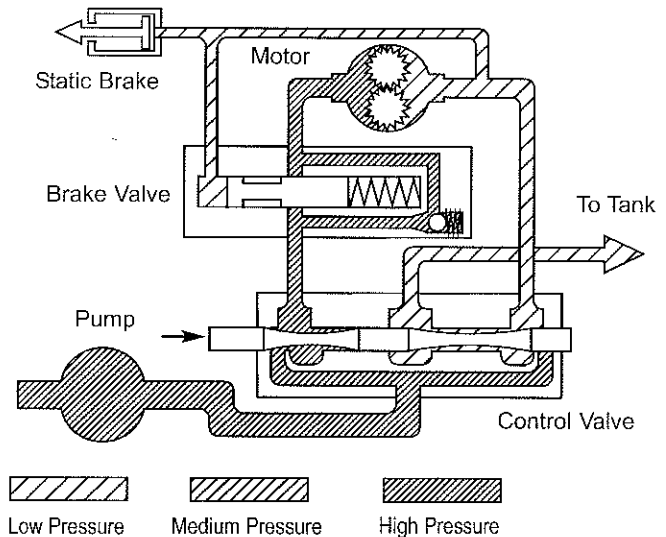
The brake valve is basically a counterbalance valve. It contains a check valve to allow free flow of oil to the motor in the hoisting direction and a pilot operated, spring-loaded spool valve that blocks the flow of oil out of the motor when the control valve is placed in neutral. When the control valve is placed in the lowering position, the spool valve remains closed until sufficient pilot pressure is applied to the end of the spool to shift it against spring pressure and open a passage. After the spool valve cracks open, the pilot pressure becomes flow-dependent and modulates the spool valve opening which controls the lowering speed.

Figures 2, 3 and 4.

The static brake system has three operating components:

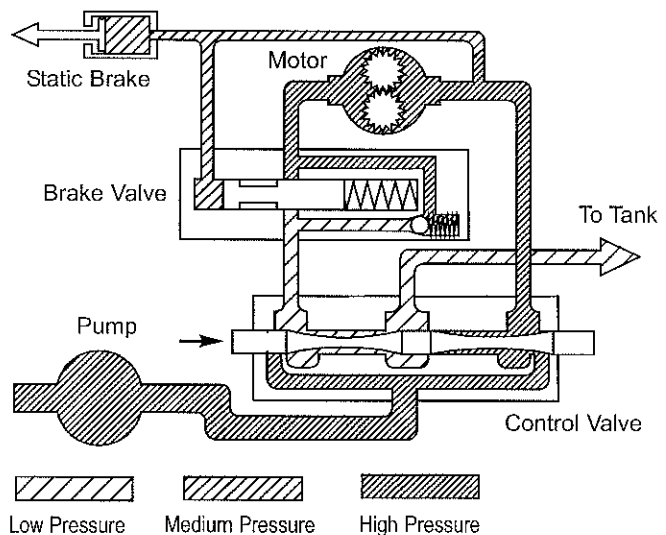
1. Spring Applied, Multiple Friction Disc Static Brake
2. Brake Clutch Assembly
3. Hydraulic Piston and Cylinder

Figure 2



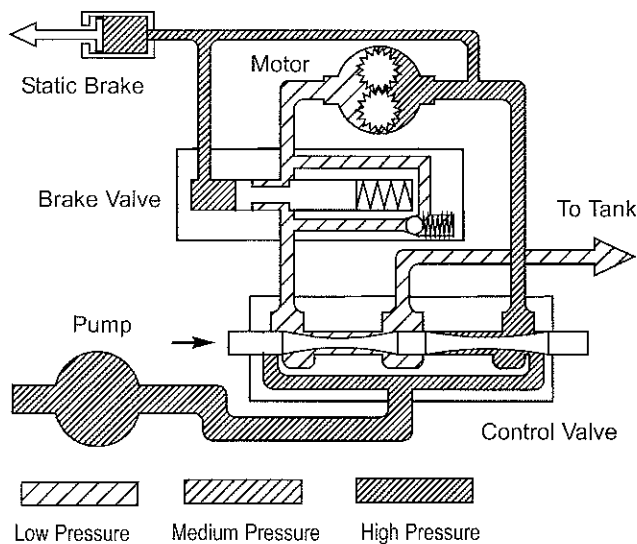
## HOISTING

Figure 3



## LOWERING 1

**Figure 4**



## LOWERING 2

The static brake is released by the brake valve pilot pressure at a pressure lower than that required to open the pilot operated spool valve. This sequence assures that dynamic braking takes place in the brake valve and that little, if any, heat is absorbed by the friction brake.

The friction brake is a load holding brake only and has nothing to do with dynamic braking or rate of descent of a load.

The brake clutch is splined to the primary sun gear shaft between the motor and the primary sun gear. It will allow this shaft to turn freely in the direction to raise a load and lock up to force the brake discs to turn with the shaft in the direction to lower a load. Figures 5 and 6.

The hydraulic cylinder, when pressurized, will release the spring pressure on the brake discs, allowing the brake discs to turn freely.

## Dual Brake System – Operation

When hoisting a load, the brake clutch which connects the motor shaft to the primary sun gear, allows free rotation. The sprag cams lay over and permit the inner race to turn free of the outer race. Figure 5. The friction brake remains fully engaged. The winch, in raising a load, is not affected by any braking action. Figure 2.

When the lifting operation is stopped, the load attempts to turn the primary sun gear in the opposite direction. This reversed input causes the sprag cams to instantly roll upward and firmly lock the shaft to the fully engaged friction brake. Figure 6.

When the winch is powered in reverse, to lower the load, the motor cannot rotate until sufficient pilot pressure is present to open the brake valve. Figures 3

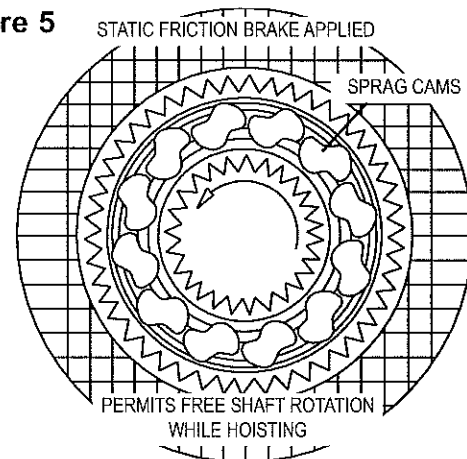
& 4. The friction brake within the winch will completely release at a pressure lower than that required to open the brake valve. The extent to which the brake valve opens will determine the amount of oil that can flow through it and the speed at which the load will be lowered. Increasing the flow of oil to the winch motor will cause the pressure to rise and the opening in the brake valve to enlarge, speeding up the descent of the load. Decreasing this flow causes the pressure to lower and the opening in the brake valve to decrease thus slowing the descent of the load.

When the control valve is shifted to neutral, the pressure will drop and the brake valve will close, stopping the load. The friction brake will engage and hold the load after the brake valve has closed.

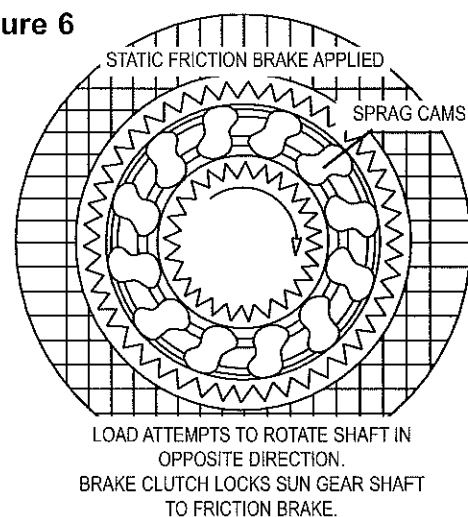
When lowering a load very slowly for precise positioning, no oil flow actually occurs through the winch motor. The pressure will build up to a point where the brake will release sufficiently to allow the load to rotate the motor through its own internal leakage. This feature results in a very slow speed and extremely accurate positioning.

The friction brake receives very little wear in the lowering operation. All of the heat generated by the lowering and stopping of a load is absorbed by the hydraulic oil where it can be readily dissipated.

**Figure 5**



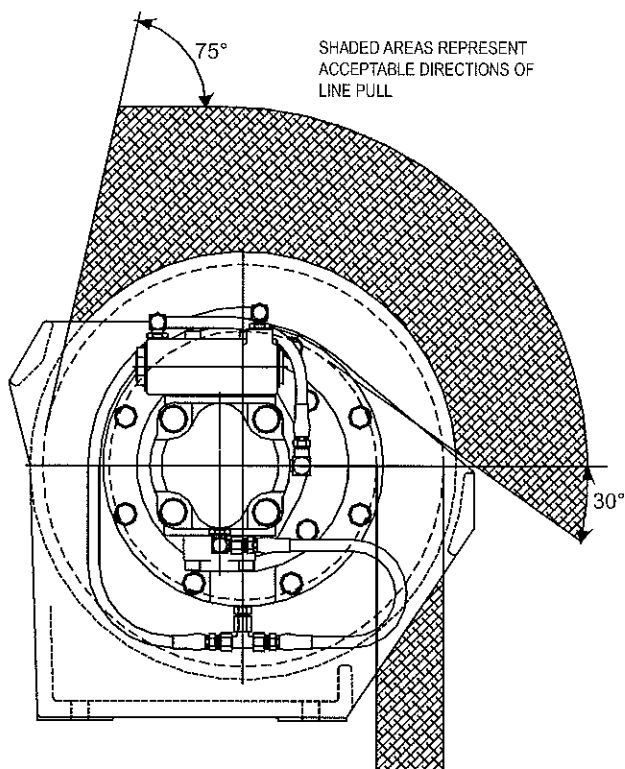
**Figure 6**





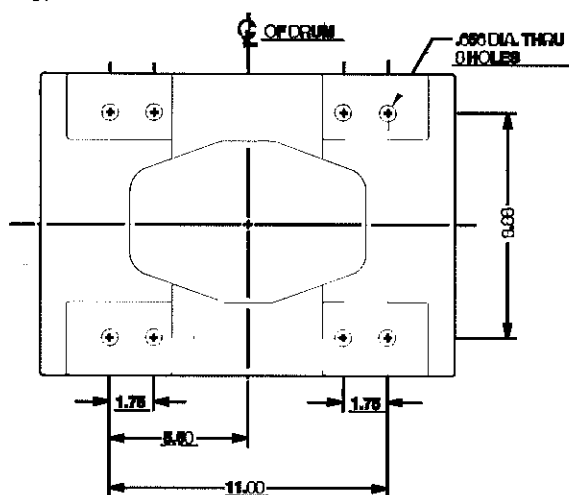
# WINCH INSTALLATION

1. The winch should be mounted with the centerline of the drum in a horizontal position. The mounting plane of the base may be rotated in any position around this centerline.



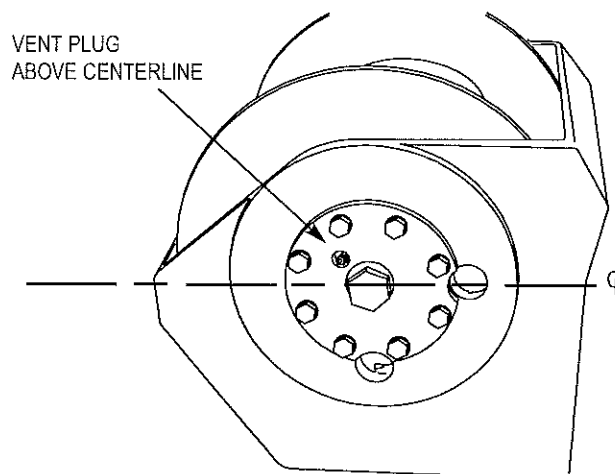
2. Because of the design of the mounting base, the direction of line pull should only be as shown in the above illustration. Line pulls in any other direction must be approved by BRADEN Engineering.

3.



When mounting the winch, use all eight (8) mounting holes and grade 5 or better bolts and nuts. Tighten to recommended torque.

It is important that the winch is mounted on a surface that will not flex when the winch is in use, and cause binding of the gear train. Binding in the gear train will result in accelerated wear and heat. Also, be sure the winch is mounted on a flat surface. If necessary, use shim stock to insure the mounting surface is flat within 0.020 in. (0.5 mm).

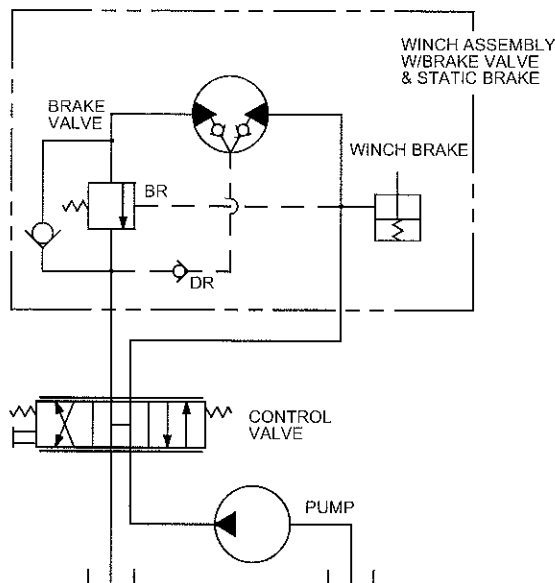


4. The vent plug must always be located above the horizontal centerline. If the winch is mounted on a pivoting surface, be sure vent plug remains above the centerline in all positions. If necessary, reposition bearing support and vent plug as follows:

- A. Remove bearing support bolts.
- B. Rotate bearing support until vent plug is positioned correctly and bolt holes are aligned.
- C. Evenly tighten bolts to recommended torque.

5. Hydraulic lines and components that operate the winch should be of sufficient size to assure minimum back pressure at the winch. The motor manufacturer recommends that the back pressure not to exceed 100 psi (690 kPa) for optimum motor seal life. 150 psi (1,030 kPa) is the maximum allowable back pressure. The standard winch is supplied with the motor internally drained. If high back pressures are encountered, the motor may be externally drained directly to tank to improve motor seal life. For back pressures exceeding 150 psi (1,030 kPa) consult BRADEN Service Department.

6. The winch should be mounted perpendicular to an imaginary line from the center of the drum to the first sheave to insure even spooling. Make certain the fleet angle does not exceed 1-1/2 degrees.



7. The winch directional control valve must be a three position four way valve with a motor spool such that when the valve is in the center position both work ports are open to tank (open center, open port).
8. High quality hydraulic oil is essential for satisfactory performance and long hydraulic system component life.

Oil having 150 to 330 SUS viscosity at 100°F (38°C) and viscosity index of 100 or greater will give good results under normal temperature conditions. The use of an oil having a high viscosity index will minimize cold-start trouble and reduce the length of warm-up periods. A high viscosity index will minimize changes in viscosity with corresponding changes in temperature.

Maximum cold weather start-up viscosity should not exceed 5000 SUS with a pour point at least 20°F (11°C) lower than the minimum temperature.

Under continuous operating conditions the temperature of the oil at any point in the system must not exceed 180° (82°C). Optimum oil temperature is generally considered to be 120-140°F (49-60°C).

In general terms; for continuous operation at ambient temperatures between 50 and 110°F (10 to 43°C) use SAE 20W; for continuous operation between 10 and 90°F (-12 to 32°C) use SAE 10W; for applications colder than 10°F (-12°C), contact the BRADEN Service Department. The use of multi-viscosity oils is generally not recommended.

9. The hydraulic oil filter should have a 10 micron nominal rating and be full flow type.

## RECOMMENDED FASTENER TORQUE

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30wt engine oil applied to threads and face of bolt or nut.

Avoid using thread lubricants as the applied torque may vary by 10-40% depending upon product used.

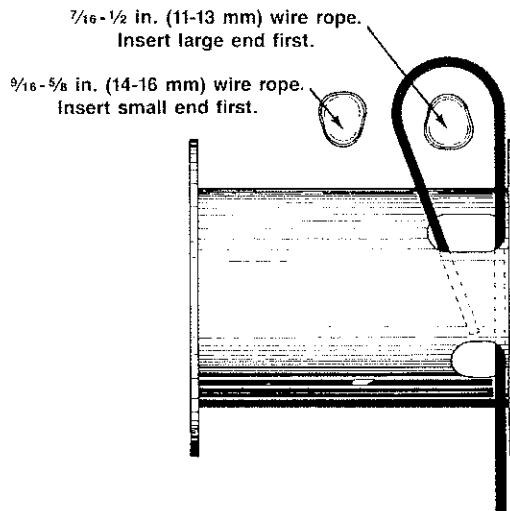
Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
1/4	20 28	8	6	12	9
5/16	18 24	17	13	24	18
3/8	16 24	31	23	45	35
7/16	14 20	50	35	70	50
1/2	13 20	75	55	110	80
9/16	12 18	110	80	150	110
5/8	11 18	150	115	210	160

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
3/4	10 16	265	200	380	280
7/8	9 14	420	325	600	450
1	8 14	640	485	910	680
1 1/8	7 12	790	590	1290	970
1 1/4	7 12	1120	835	1820	1360
1 3/8	6 12	1460	1095	2385	1790
1 1/2	6 12	1940	1460	3160	2370

To convert lb. ft. to kg·m, multiply lb. ft. value by 0.1383.

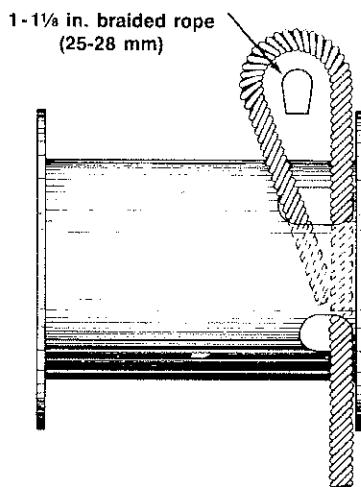
# WIRE AND BRAIDED ROPE INSTALLATION

## ANCHORING WIRE ROPE



Take the free end of the wire rope and insert it through the small opening of the anchor pocket. Loop the wire rope and push the free end about  $\frac{1}{2}$  of the way back through the pocket. Install the wedge, then pull the slack out of the wire rope. The wedge will slip into the pocket and secure the wire rope into the drum. The anchor is designed to accommodate several different sizes of wire rope. You may anchor 7/16 and 1/2 in. (11 & 13 mm) wire rope by inserting the wedge, large end first. Anchor 9/16 and 5/8 in. (14 & 16 mm) wire rope by inserting the wedge, small end first.

## ANCHORING BRAIDED ROPE



A special wedge is used to anchor 1 and 1 1/8 in. (25 & 28 mm) braided rope. The installation procedure is the same as for anchoring wire rope.

## Correct Installation

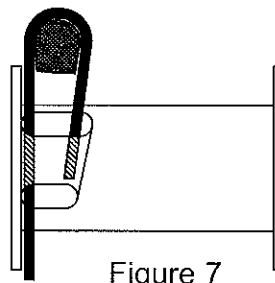


Figure 7

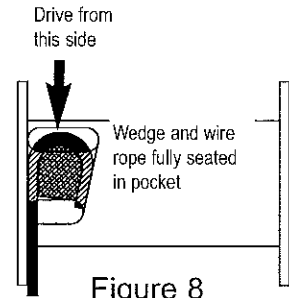


Figure 8

## Incorrect Installation

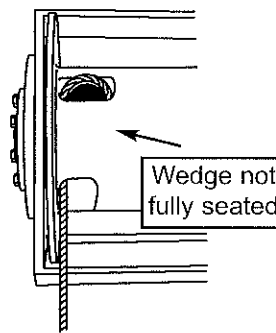


Figure 9

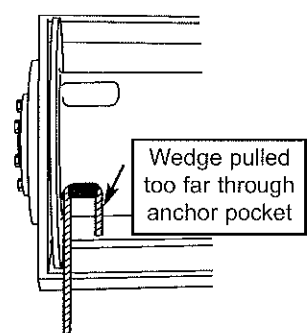


Figure 10

## TWO SPEED MOTOR CASE DRAIN PLUMBING

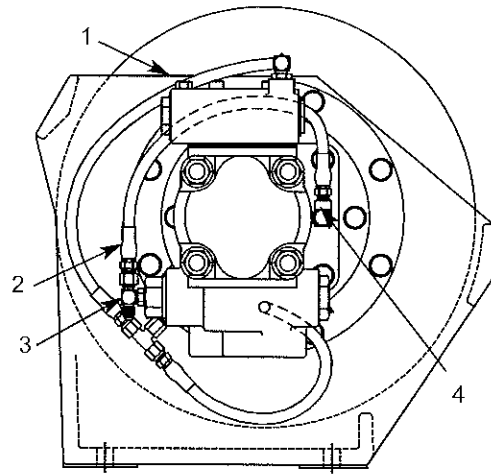
Winches built prior to 1991 with two speed motor, Part No. 26182, have the motor case drain connected to the drain port of the brake valve. This may result in accelerated motor shaft wear and leakage. The following modification should be made to the motor hydraulic piping to prevent this type of seal damage.

1. Remove the motor case drain hose from the brake valve drain port and install plug, Item 1, into the valve port. Remove the hose from the case drain port elbow, Item 4.
2. Install a new case drain hose, Item 2, onto the motor case drain elbow, Item 4.
3. Install the tee adapter, Item 3, into the two-speed motor shift valve drain port (identified by long end cap).
4. Install the new motor case drain hose, Item 2, onto the tee adapter.

5. Install a case drain hose for the tee directly to the reservoir. Minimum hose size is -6, 3/8 in. (9.5 mm). Maximum drain line back pressure is 100 PSI (7 Kg/cm<sup>2</sup>) measured at the motor case drain port.

Parts needed for modification:

Item	Qty	P/N	Description
1	1	25663	Plug -4 (Aeroquip 900598-4S)
2	1	13707	Hose 17 in. OAL (-4 JIC Fml Svl/-4 Hose / 1/8 NPT ml)
3	1	29078	Tee -4 (Aeroquip 203003-4-4S)



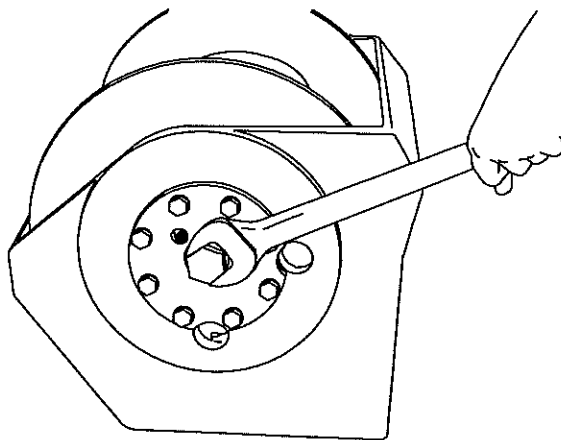
## PREVENTIVE MAINTENANCE

A regular program of preventive maintenance for your planetary winch is strongly recommended to minimize the need for emergency servicing and promote safe, reliable winch operation.

Field experience, supported by engineering tests, indicate the three (3) service procedures listed below are the **MOST** critical to safe, reliable winch operation and must be observed.

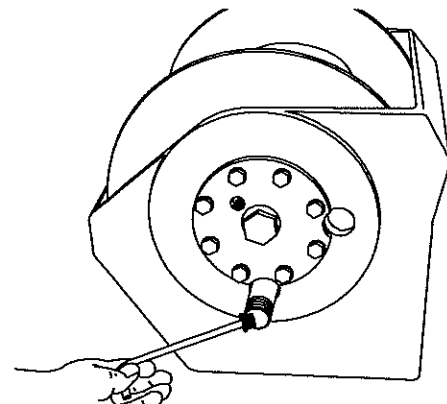
- **Regular Gear Oil Changes** – every 1000 hours or six (6) months
- **Use of Proper Gear Oil** – recommended type for prevailing ambient temperature
- **Annual Disassembly and Inspection of All Wear Items** – in compliance with American National Standards Institute (ANSI) specification B30.5c 1987 and American Petroleum Institute (API) recommended practice RP 2D section 3.

The following minimum service intervals are specified for operating hours of the prime mover.



### 1. Oil Level

The gear oil level should be checked every 500 operating hours or three (3) months, whichever occurs first. To check the oil level, remove the large plug located in the center of the drum support. The oil should be level with the bottom of this opening. If additional oil is needed, refer to "Recommended Planetary Gear Oil".



### 2. Oil Change

The gear oil should be changed after the first one hundred (100) hours of operation, then every 1,000 operating hours or six (6) months, whichever occurs first. The gear oil must be changed to remove wear particles that impede the reliable and safe operation of the brake clutch and erode bearings, gears and seals. Failure to change gear oil at these suggested minimum intervals may contribute to intermittent brake slippage which could result in property damage, severe personal injury or death.

The gear oil should also be changed whenever the ambient temperature changes significantly and an oil from a different temperature range would be more appropriate. Oil viscosity with regard to ambient temperature is critical to reliable brake

clutch operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake clutch slippage. Make certain that the gear oil viscosity used in your winch is correct for your prevailing ambient temperature. Failure to use the proper type and viscosity of planetary gear oil may contribute to brake clutch slippage which could result in property damage, severe personal injury or death. Refer to "Recommended Planetary Gear Oil" for additional information.

### 3. Vent Plug

The vent plug is located in the drum support as shown. It is very important to keep this vent clean and unobstructed. Whenever gear oil is changed, remove vent plug, clean in solvent and reinstall.

Do not paint over the vent or replace with a solid plug.

### 4. Hydraulic System

The original filter element should be replaced after the first fifty (50) hours of operation, then every 500 operating hours or three (3) months, or in accordance with the equipment manufacturer's recommendations.

### 5. Wire Rope

Inspect entire length of wire rope according to wire rope manufacturers recommendations.

### 6. Mounting Bolts

Tighten all winch base mounting bolts to recommended torque after the first one hundred (100) hours of operation, then every 1000 operating hours or six (6) months, whichever occurs first.

### 7. Warm-up Procedures

A warm-up procedure is recommended at each start-up and is essential at ambient temperatures below +40°F (4°C).

The prime mover should be run at its lowest recommended RPM with the hydraulic winch control valve in neutral allowing sufficient time to warm up the system. The winch should then be operated at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

#### **⚠ WARNING ⚠**

Failure to properly warm up the winch, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

### 8. Recommended Planetary Gear Oil

Field experience, supported by extensive engineering tests, indicates the use of the proper planetary gear oil is essential to reliable and safe operation of the brake clutch and obtaining long gear train life.

#### **⚠ WARNING ⚠**

Failure to use the proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in property damage, severe personal injury or death. Some gear lubricants contain large amounts of EP (extreme pressure) and anti-friction additives which may contribute to brake clutch slippage and damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake clutch operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake clutch slippage. Make certain that the gear oil viscosity used in your winch is correct for your prevailing ambient temperature.

For simplicity, BRADEN has listed one (1) readily available product in each temperature range which has been tested and found to meet our specifications. This is not to say that other lubricant brands would not perform equally as well.

If the following lubricant brands are not available in your area, make certain your lubricant vendor supplies you with oil that is equivalent to those products listed below.

BRADEN planetary winches are factory filled with Texaco Meropa 150 or equivalent AGMA No. 4EP gear oil.

### 9. Inspection

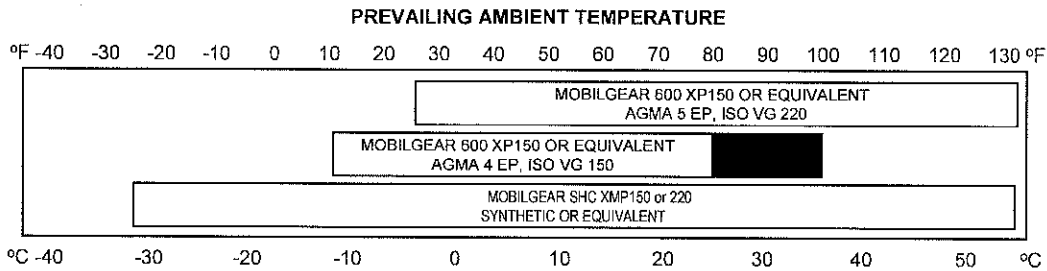
In compliance with ANSI specification number B30.5c1987 and API Recommended Practice RP 2D section 3, we recommend that the winch be disassembled for a thorough inspection of all wear items every 2,000 hours of operation or twelve (12) months, whichever occurs first.

**A. Bearings and Gears** – Refer to DISASSEMBLY OF WINCH, page 15; and PLANET CARRIER SERVICE, page 20.

**B. Brake Cylinder** – Refer to MOTOR SUPPORT – BRAKE CYLINDER SERVICE, pages 22 and 23.

**C. Brake Clutch** – Refer to BRAKE CLUTCH SERVICE, page 26.

## RECOMMENDED PLANETARY GEAR OIL



**NOTE:** SHADED TEMPERATURE RANGE IN THE CHART ABOVE NOT RECOMMENDED FOR SEVERE APPLICATIONS SUCH AS: OFFSHORE CRANES, SUSTAINED FAST DUTY CYCLES OR FREQUENT LIFTING.

Planetary hoists are factory filled with Mobilgear 600 XP 150, or equivalent. Consult your oil supplier for other equivalent oils if required.

Mobil	Shell	Chevron	Texaco
Mobilgear 600 XP 150	Omala 150	Gear Compounds EP 150	Meropa 150
Mobilgear 600 XP 220	Omala 220	Gear Compounds EP 220	Meropa 220

**OIL CAPACITIES:** (PD12C/PD15B) 01, 02 & 22 DRUM - 6 PINTS 04, 05 & 23G DRUM - 7 PINTS (PD17A) - 14 PINTS

**NOTE:** Capacities are approximate. Refer to "Oil Level" earlier in this section

## TROUBLESHOOTING

### ⚠ WARNING ⚠

If a winch ever exhibits any sign of erratic operation, or load control difficulties (i.e. load creeping or chattering) appropriate troubleshooting tests and repairs should be performed immediately. Continued operation in this manner may result in property damage, serious personal injury or death.

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>A</b></p> <p>The winch will not lower the load or not lower the load smoothly.</p>	<ol style="list-style-type: none"> <li>1. The problem could be a plugged or loose pilot orifice. The pilot orifice is a small pipe plug with a hole drilled through it, located behind the pilot port fitting on the brake valve. If it becomes plugged, it will prevent the pilot pressure, from the manifold, from opening the brake valve. If it becomes loose, it will allow an unregulated amount of oil in to operate the brake valve which cause erratic brake valve operation.</li> <li>2. The friction brake may not be releasing as a result of a defective brake cylinder seal.</li> </ol> <p><b>NOTE:</b> If the brake cylinder seal is defective you will usually find oil leaking from the winch vent plug.</p> <ol style="list-style-type: none"> <li>3. Friction brake will not release as a result of damaged brake discs.</li> </ol>	<p>Remove the pilot hose and fitting from the brake valve, then use a 5/32 inch Allen wrench to remove the pilot orifice. The diameter of the orifice is approximately .020 inches. Clean and install the pilot orifice tightly in the brake valve.</p> <p>Check brake cylinder seal as follows:</p> <ol style="list-style-type: none"> <li>A. Disconnect the swivel tee from the brake release port. Connect a hand pump with accurate 0-2000 psi gauge and shut-off valve to the -4 J.I.C. fitting in the brake release port.</li> <li>B. Apply 1000 psi to the brake. Close shut-off valve and let stand for five (5) minutes.</li> <li>C. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and replacement of the seals. Refer to "Motor Support-Brake Cylinder Service".</li> </ol> <p>Disassemble brake to inspect brake discs. Check stack-up height as described in "Motor Support-Brake Cylinder Service".</p>

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>B</b></p> <p>Oil leaks from vent plug.</p>	<p>1. Same as A2.</p> <p>2. Motor seal may be defective as a result of high system back pressure or contaminated oil.</p>	<p>Same as A2.</p> <p>System back pressure must not exceed 150 psi. Inspect hydraulic system for a restriction in the return line from the control valve to the reservoir. Be sure control valve and plumbing is properly sized to winch motor.</p> <p>Oil analysis may indicate contamination has worn motor shaft and seal. Thoroughly flush entire hydraulic system and install new filters and oil. Install new motor seal.</p>
<p><b>C</b></p> <p>The brake will not hold a load with the control lever in neutral.</p>	<p>1. Excessive system back pressure acting on the brake release port.</p> <p>2. Friction brake will not hold due to worn or damaged brake discs.</p> <p>3. Brake clutch is slipping.</p>	<p>The same as Remedy 2 of Trouble B2.</p> <p>Same as Remedy 3 of Trouble A3.</p> <p>Improper planetary gear oil may cause the brake clutch to slip. Drain old gear oil and flush winch with solvent. Thoroughly drain solvent and refill winch with recommended planetary gear oil listed in "Preventive Maintenance".</p> <p>Brake clutch may be damaged or worn. Disassemble and inspect brake clutch as described in "Brake Clutch Service".</p>
<p><b>D</b></p> <p>The winch will not hoist the rated load.</p>	<p>1. The winch may be mounted on an uneven or flexible surface which causes distortion of the winch base and binding of the gear train. Binding in the gear train will absorb horsepower needed to hoist the rated load and cause heat.</p> <p>2. System relief valve may be set too low. Relief valve needs adjustment or repair.</p>	<p>Reinforce mounting surface.</p> <p>If necessary, use shim stock to level winch. Refer to "Winch Installation".</p> <p>First loosen, then evenly retighten all winch mounting bolts to recommended torque.</p> <p>Check relief pressure as follows:</p> <p>A. Install an accurate 0-4000 psi (27,580 kPa) gauge into the inlet port of the brake valve.</p>

TROUBLE	PROBABLE CAUSE	REMEDY
TROUBLE "D" CONTINUED FROM PREVIOUS PAGE	<p>3. Be certain hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures increase motor internal leakage and reduce motor performance.</p> <p>4. Winch line pull rating is based on 1st layer of wire rope.</p> <p>5. Rigging and sheaves not operating efficiently.</p>	<p>B. Apply a stall pull load on the winch while monitoring pressure.</p> <p>C. Compare gauge reading to winch specifications. Adjust relief valve as required.</p> <p>NOTE: If pressure does not increase in proportion to adjustment, relief valve may be contaminated or worn out. In either case, the relief valve may require disassembly or replacement.</p> <p>Same as remedies for Trouble D1 &amp; D2.</p> <p>Same as remedies for Trouble E2.</p> <p>Refer to winch performance charts for additional information.</p> <p>Perform rigging service as recommended by crane manufacturer.</p>
<p><b>E</b></p> <p>The winch runs hot.</p>	<p>1. Same as D1.</p> <p>2. Be certain that the hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures may be caused by:</p> <p>A. Plugged heat exchanger.</p> <p>B. Too low or too high oil level in hydraulic reservoir.</p> <p>C. Same as D2.</p> <p>D. Hydraulic pump not operating efficiently.</p> <p>3. Excessively worn or damaged internal winch parts.</p>	<p>Same as remedies for Trouble D1.</p> <p>Thoroughly clean exterior and flush interior.</p> <p>Fill/drain to proper level.</p> <p>Same as remedies for Trouble D2.</p> <p>Prime mover low on horsepower or R.P.M. Tune/adjust prime mover.</p> <p>Check suction line for damage.</p> <p>If pump is belt driven, belts are slipping. Replace/tighten belts.</p> <p>Pump worn. Replace pump.</p> <p>Disassemble winch to inspect/replace worn parts.</p>



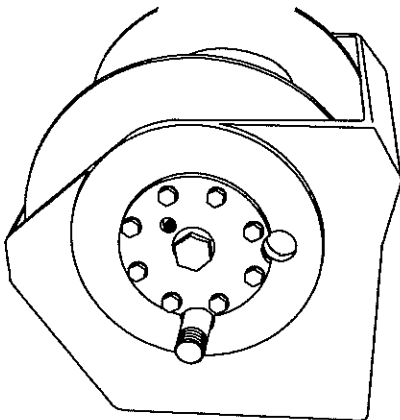
TROUBLE	PROBABLE CAUSE	REMEDY
<p style="text-align: center;"><b>F</b></p> <p>Winch "chatters" while raising rated load.</p>	<ol style="list-style-type: none"> <li>1. Same as D2.</li> <li>2. Hydraulic oil flow to motor may be too low.</li> <li>3. Controls being operated too quickly.</li> </ol>	<p>Same as remedies for Trouble D2.</p> <p>Same as remedies for Trouble E2.</p> <p>Conduct operator training as required.</p>
<p style="text-align: center;"><b>G</b></p> <p>The wire rope does not spool smoothly on the drum.</p>	<ol style="list-style-type: none"> <li>1. The winch may be mounted too close to the main sheave, causing the fleet angle to be more than 1-1/2 degrees.</li> <li>2. The winch may not be mounted perpendicular to an imaginary line between the center of the cable drum and the first sheave.</li> <li>3. Could possibly be using the wrong lay rope. There is a distinct advantage in applying rope of the proper direction of lay. When the load is slacked off, the several coils on the drum will stay closer together and maintain an even layer. If rope of improper lay is used, the coils will spread apart each time the load is removed. Then, when winding is resumed, the rope has a tendency to criss-cross and overlap on the drum. The result is apt to be a flattened and crushed rope.</li> <li>4. The winch may have been overloaded, causing permanent set in the wire rope.</li> </ol>	<p>Check mounting distance and fleet angle. Reposition winch as required.</p> <p>Refer to "Winch Installation".</p> <p>Consult wire rope manufacturer for recommendation of wire rope that best suits your application.</p> <p>Replace wire rope and conduct operator/rigger training as required.</p>

# DISASSEMBLY OF WINCH

## SERVICE PRECAUTIONS

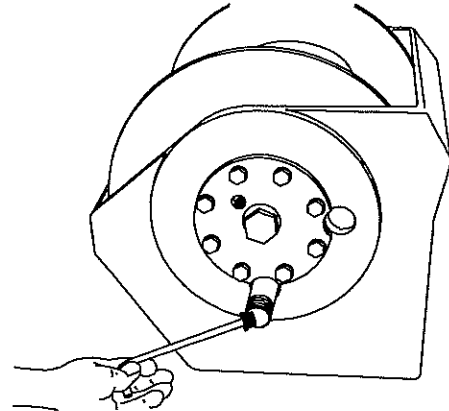
- Before any part is removed from the winch, all service instructions should be read and understood.
- Work in a clean, dust free area as cleanliness is of utmost importance when servicing hydraulic equipment.
- Inspect all replacement parts, prior to installation, to detect any damage which might have occurred in shipment.
- Use only genuine BRADEN replacement parts for optimum results. Never reuse expendable parts such as oil seals and O-rings.
- Inspect all machined surfaces for excessive wear or damage . . . before reassembly operations are begun.
- Lubricate all O-rings and oil seals with gear oil prior to installation.
- Use a sealing compound on the outside surface of oil seals and a light coat of thread sealing compound on pipe threads. Avoid getting thread compound inside parts or passages which conduct oil.
- Thoroughly clean all parts in a good grade of non-flammable safety solvent. Wear protective clothing as required.

After troubleshooting the winch and its hydraulic system as covered in the "Troubleshooting" section, and the problem is determined to be in the winch, use the following procedure to disassemble the winch.

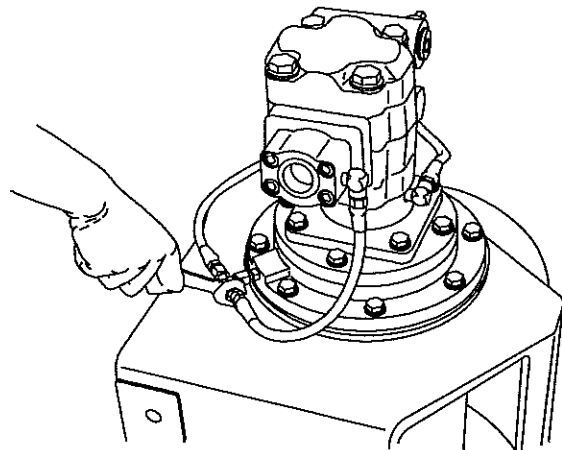


1. Remove the wire rope from the winch drum and align the drain hole in the drum with a hole in the support side plate before removing the hoses and mounting bolts. After the winch is removed from its mounting, thoroughly clean the outside surfaces. To drain the oil, install a short piece of

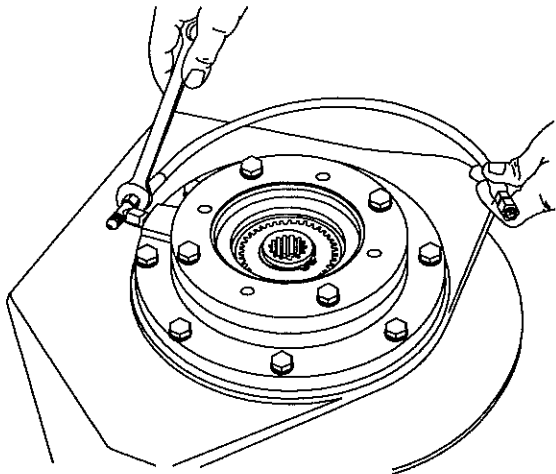
1 inch pipe in the larger threads of the drain hole. If necessary, insert a bar into the anchor pocket and manually rotate the drum in the direction to hoist a load until the drain holes are aligned.



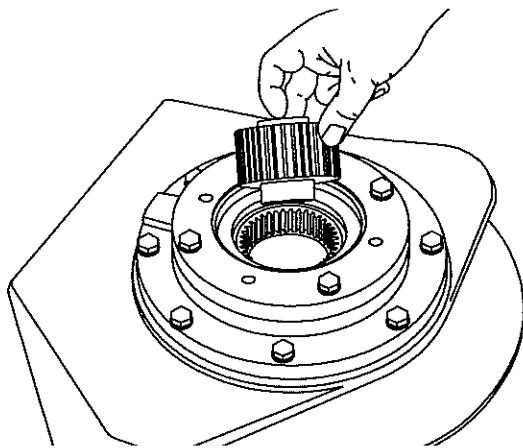
2. Use a 5/16 inch Allen wrench to remove the drain plug through the pipe.



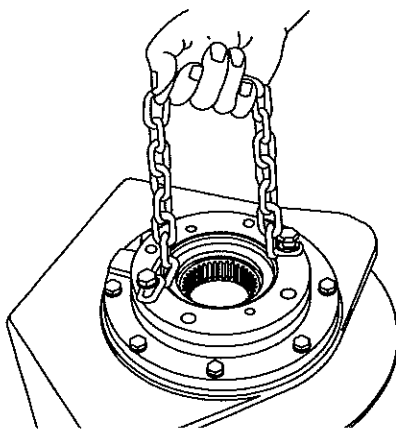
3. Begin disassembly by removing the oil level plug and standing the winch on the bearing support end. Tag and remove the hydraulic hoses that connect the brake valve and manifold to the brake cylinder.
4. Remove the capscrews securing the motor, and lift the motor off the winch. Remove and discard the O-ring installed on the pilot of the motor.



5. Tag and remove the hoses and fittings from the brake cylinder release port.



6. Remove the brake clutch assembly from the motor support. Refer to "Brake Clutch Service" for additional information.

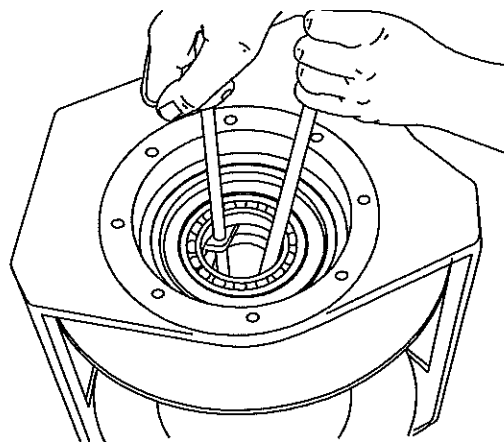


7. Remove the motor support capscrews and install two (2) capscrews and a short piece of chain into the motor mounting bolt holes. Using the chain as a handle, lift the motor support out of the brake cylinder being careful to avoid damaging the sealing surfaces. Remove and discard the O-

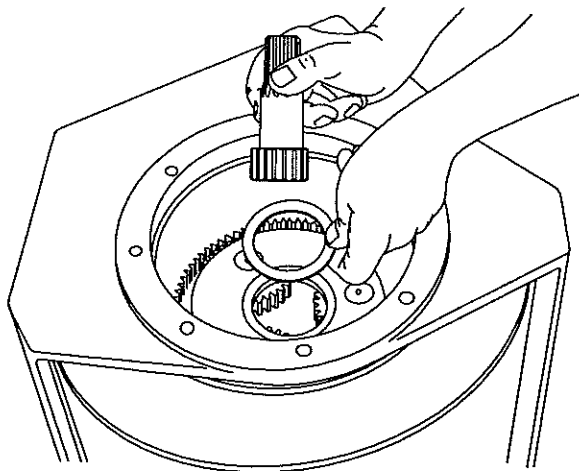
ring and back-up ring from the motor support. Refer to "Motor Support-Brake Cylinder Service" for additional information.

8. Remove the brake cylinder capscrews and install two (2) capscrews and a short piece of chain into the motor support mounting bolt holes. Using the chain as a handle, lift the brake cylinder out of the drum and base, being careful to avoid damaging the sealing or bearing surfaces. Refer to "Motor Support-Brake Cylinder Service" for additional information.

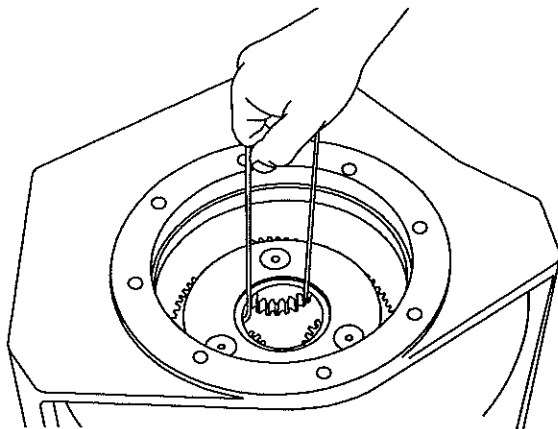
**For PD15B winches**, the drum closure cannot be removed through the opening in the base. If your winch has a cast base, remove the bearing support, as described in step 15, and remove the drum from the base. Then proceed with steps 9 thru 14. If your winch has a three piece base, remove the motor end side plate and continue with step 9.



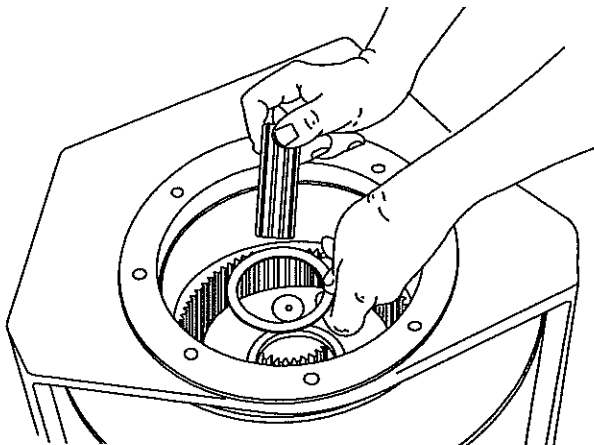
9. Using two heel type pry bars placed between the primary planet carrier and the drum closure, pry upward to remove the drum closure. Remove and discard the O-ring from the outside of the drum closure.
10. Remove the seal and bearing from inside of closure.



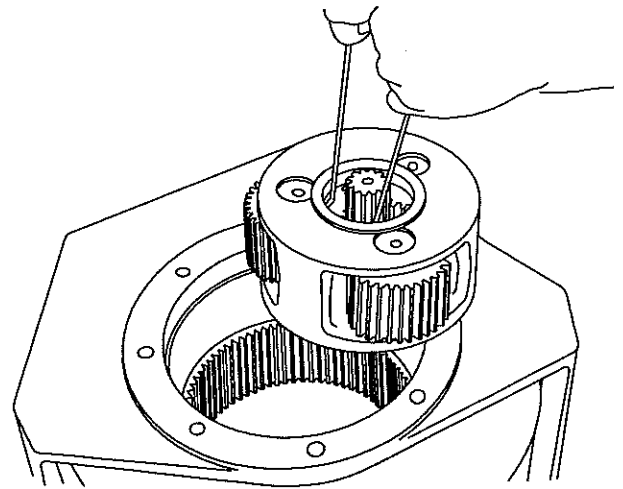
11. Remove the primary sun gear and thrust washer from the primary planet carrier.



12. Remove the primary planet carrier from the drum. Refer to "Planet Carrier Service" for additional information.



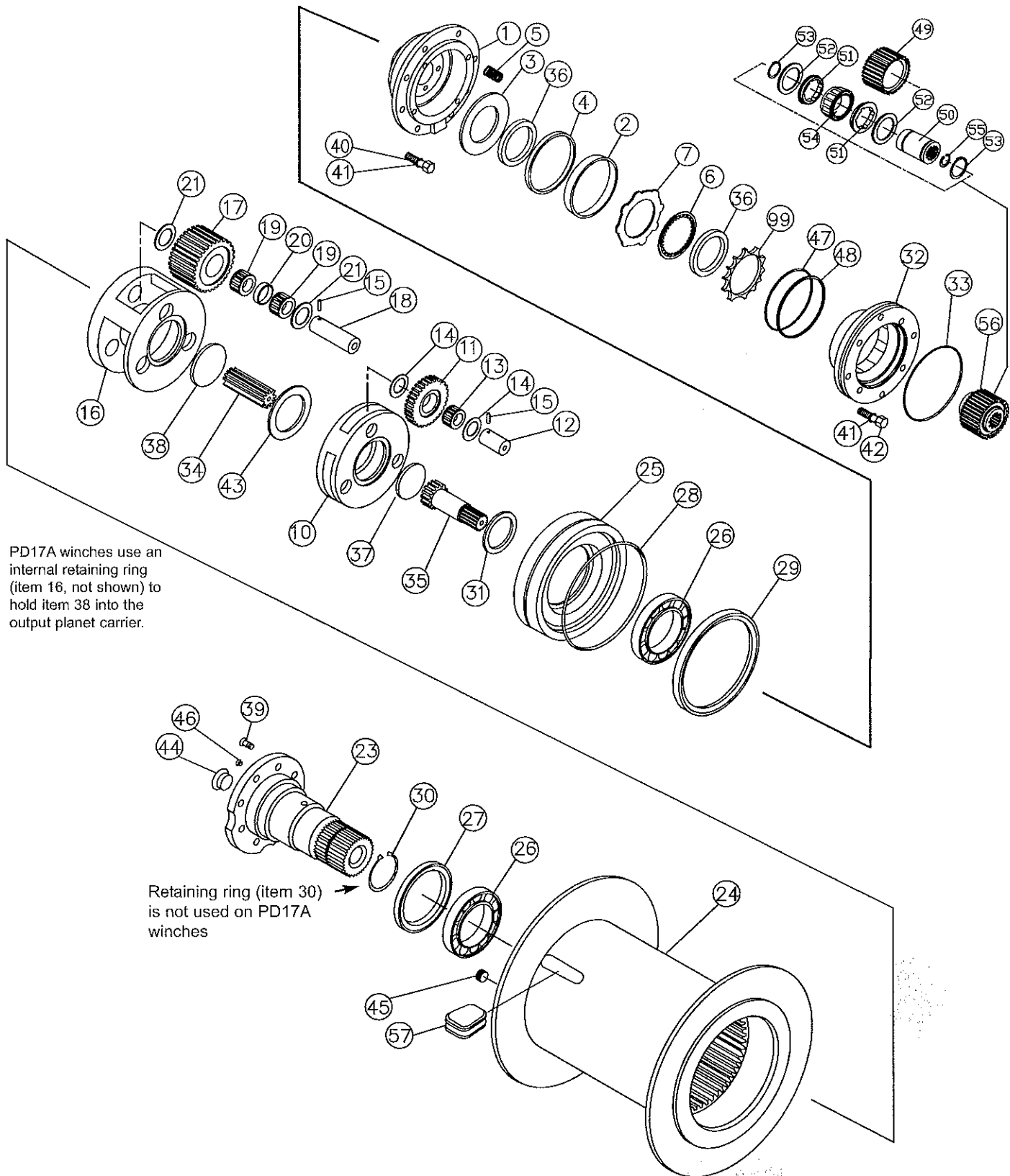
13. Remove the output sun gear and thrust washer from the output planet carrier.

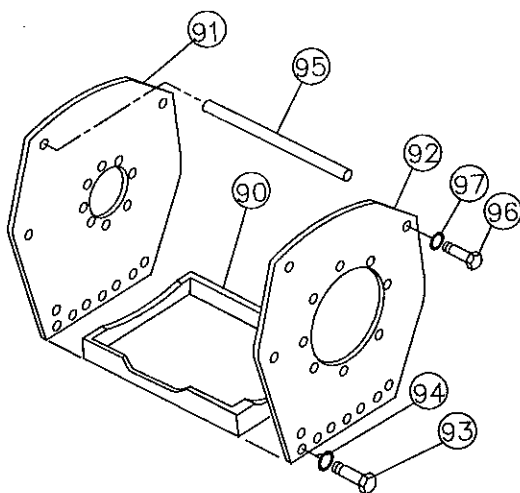
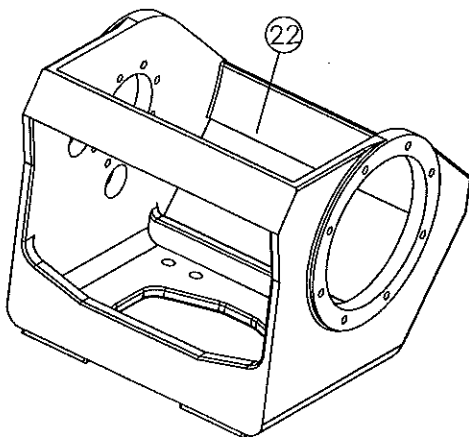
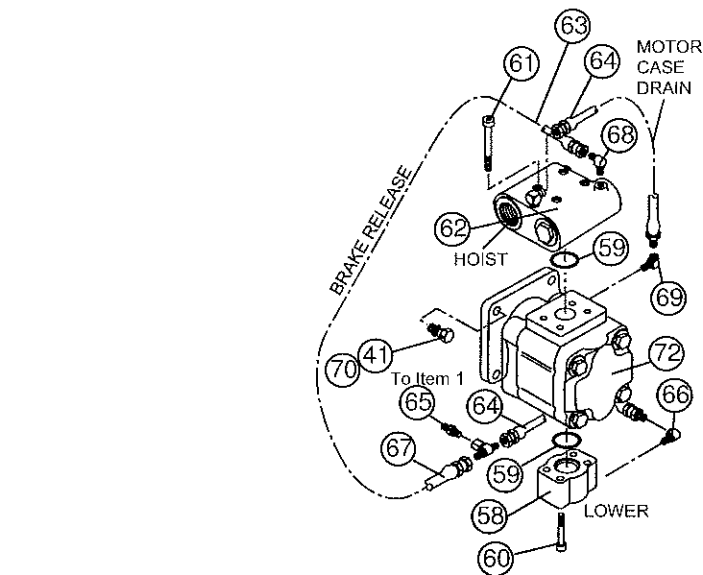


14. Remove the output planet carrier from the drum. Refer to "Planet Carrier Service" for additional information.
15. Stand winch on motor end with bearing support up; then remove eight (8) bearing support capscrews and bearing support being careful to avoid damaging the sealing or bearing surfaces.
16. Slide drum out of base onto a work bench and remove seal and bearing from support end.
17. Thoroughly clean and inspect drum and base. Check ring gear (machined into inside surface of drum) teeth for nicks, spalling or excessive wear. Replace if wear is greater than 0.015 in. (0.4 mm) when compared to unworn area of teeth.

# BRADEN PD12C/PD15B/PD17A COMPONENTS

PD17A winches use only 1  
each of items 52 and 53 due  
to the shoulder on item 50.  
(shoulder is toward motor)





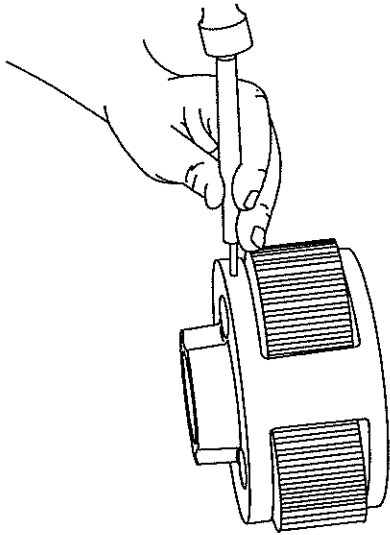
For actual part numbers, refer to:  
 PD12C Material List PB-109  
 PD15B Material List PB-229  
 PD17A Material List LIT2099

## PD12C/PD15B/PD17A PARTS KEY

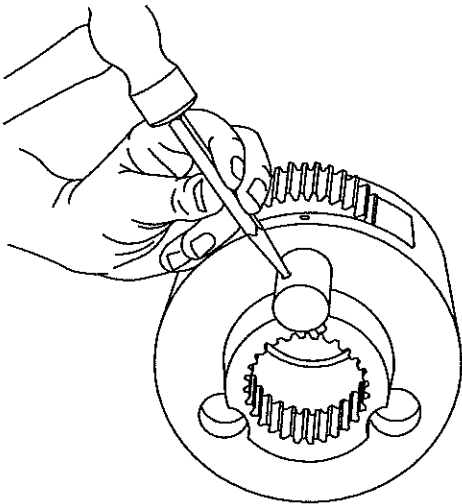
ITEM	QUANTITY	DESCRIPTION
1	1	Brake Cylinder
2	1	Piston Seal
3	1	Pressure Plate
4	1	Piston Back-up Ring
5	12	Spring
6	7	Disc-friction
7	8	Disc-brake
10	1	Primary Planet Carrier
11	3	Primary Planet Gear
12	3	Primary Planet Gear Shaft
13	3	Roller Bearing
14	6	Thrust Washer
15	6	Sprocket Pin
16	1	Output Planet Carrier
17	3	Output Planet Gear
18	3	Output Planet Gear Shaft
19	6	Roller Bearing
20	3	Bearing Spacer
21	6	Thrust Washer
22	1	Base
23	1	Bearing Support
24	1	Cable Drum
25	1	Cable Drum Closure
26	2	Ball Bearing
27	1	Oil Seal
28	1	O-Ring
29	1	Oil Seal
30	1	Retaining Ring
31	1	Thrust Washer
32	1	Motor Support
33	1	O-ring
34	1	Output Sun Gear
35	1	Primary Sun Gear
36	2	Spacer
37	1	Primary Thrust Plate
38	1	Output Thrust Plate
40	16	Capscrew
41	24	Lockwasher
42	4	Capscrew
43	1	Thrust Washer
44	1	Plug — Hex. Head
45	1	Plug — Flush
46	1	Vent Plug
47	1	O-ring
48	1	Back-up Ring
49	1	Brake Race — Outer
50	1	Brake Race — Inner
51	2	Sprag Bushing
52	2	Sprag Bushing Retainer
53	2	Retaining Ring
54	1	Sprag Clutch
55	1	Retaining Ring
57	1	Cable Clamp
58	1	Manifold
59	2	O-ring
60	4	Capscrew — Socket Head
61	4	Capscrew — Socket Head
62	1	Brake Valve
63	1	Hose Assembly
64	2	Hose Assembly — 12 In.
65	1	Adapter — Straight
66	1	Elbow
67	1	Swivel Tee
68	1	Elbow
69	1	Reducer Elbow
70	4	Capscrew
72	1	Hydraulic Motor
90	1	Base Plate
91	1	Side Plate (bearing support end)
92	1	Side Plate (motor end)
93	16	Capscrew (special)
94	16	Washer
95	1/2	Tie Bar
96	2/4	Capscrew
97	2/4	Lockwasher
99	1	Spring Spacer

# PLANET CARRIER SERVICE

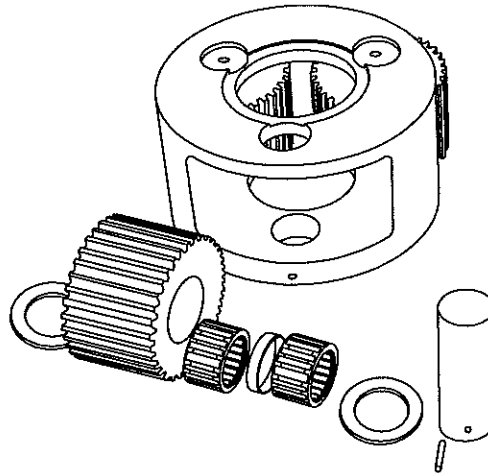
## OUTPUT PLANET CARRIER DISASSEMBLY



1. Remove the planet gears by driving the roll pins into the center of the planet shafts.

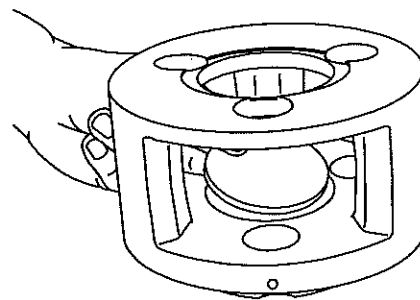


2. Use a punch to drive the roll pins from the planet shafts. Do not reuse the roll pins.



3. Now you can remove the planet shafts, bearings, spacer, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, the bearing should be replaced. Likewise, the cage should be inspected for unusual wear or deformation, particularly the cage bars. If there is any damage that will impair the cage's ability to separate, retain and guide the rollers properly, the bearing should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary.

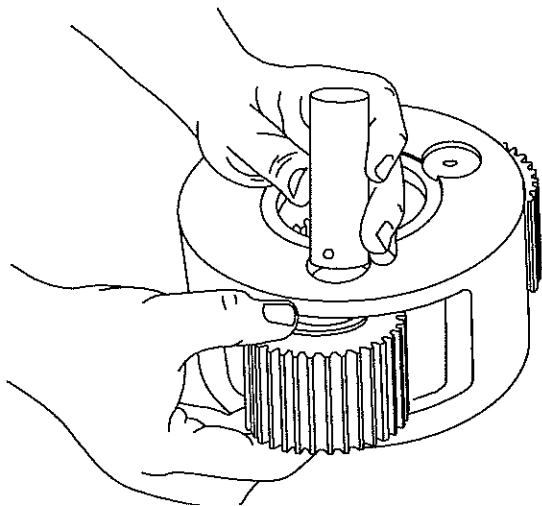
## ASSEMBLY



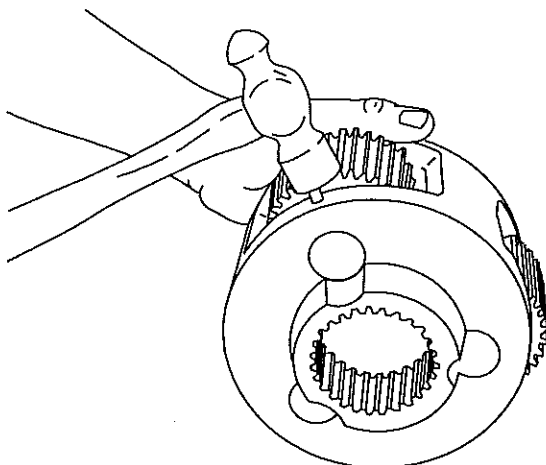
1. Place the output planet carrier on workbench with splined coupling side down. Install output thrust plate in center of carrier.

### ⚠ CAUTION ⚠

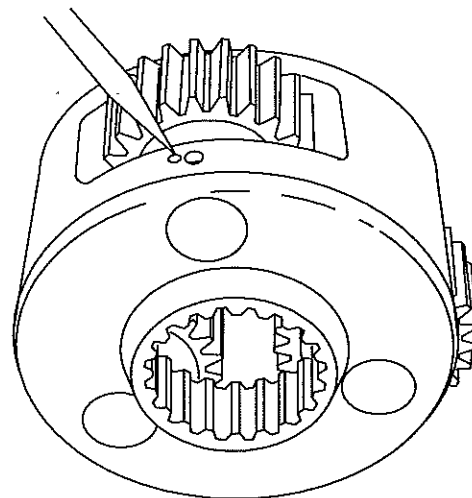
PD17A winches have an internal retaining ring to hold the thrust plate into the carrier. This retaining ring **MUST** be properly installed and fully seated before the planet gears are installed.



2. Insert two (2) bearings and a bearing spacer into a gear with the spacer between the bearings. Place a thrust washer on each side of the gear and position in a carrier opening. Slide the shaft through the carrier, thrust washer, bearing-gear sub-assembly and remaining thrust washer.



3. Carefully align the pin hole in the carrier with the hole in the planet gear shaft and drive the roll pin into place. Always use NEW roll pins. When properly positioned, 50% of the roll pin will engage the planet gear shaft and 50% will remain in the planet carrier.



4. Note that the roll pin is slightly recessed in the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole so the pin will not back out... Repeat these steps for each of the three planet gears.

### PRIMARY PLANET CARRIER

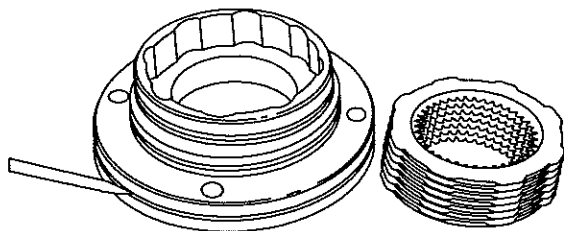
1. To service the primary planet carrier, the steps are the same as for the output carrier except there is only one bearing for each gear and no bearing spacer.

**i** **NOTE:** PD17A winches DO NOT have a thrust plate in the primary planet assembly.



# MOTOR SUPPORT-BRAKE CYLINDER SERVICE

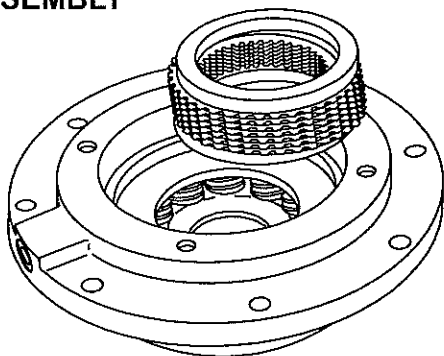
NOTE: Starting mid-year 1996, Braden changed the steel brake separator discs from a splined tooth design to a lobed design. This required a change to the motor support and brake cylinder and the addition of a spring spacer. A winch with the lobed discs can be identified by a machined groove on the outside diameter of the motor support. When replacing steel brake discs, the motor support or brake cylinder, care must be taken to properly identify the correct parts. Splined discs, and their mating motor support and brake cylinder will remain available as spare parts.



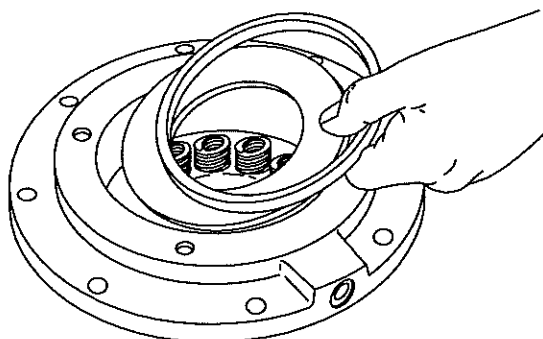
New lobed steel brake separator plates and motor support. Note groove on outside diameter of motor support.

Although most photos in this section show splined discs, all procedures are the same except where specifically noted.

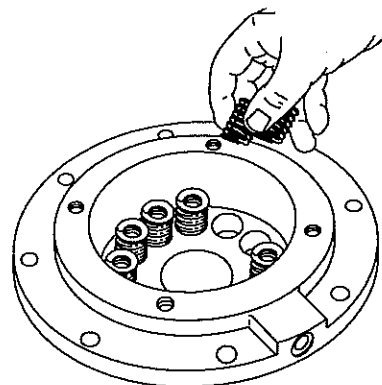
## DISASSEMBLY



1. After removing the motor support and brake clutch assembly, continue brake cylinder disassembly by removing the spacers, friction brake discs and steel brake discs.

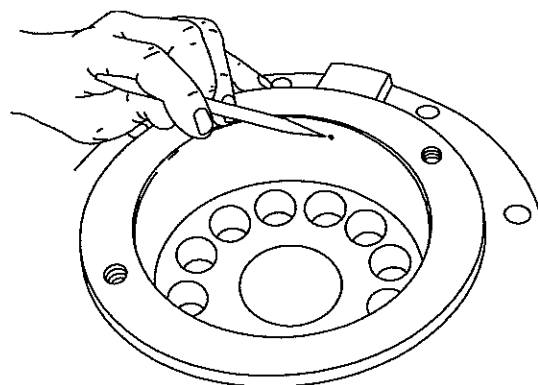


2. Remove the piston back-up ring and pressure plate.

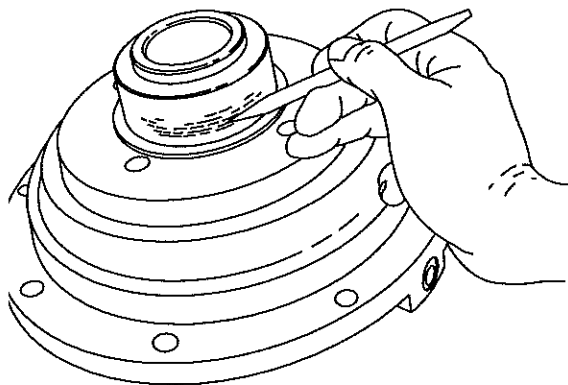


3. Remove the brake springs.

## CLEAN AND INSPECT

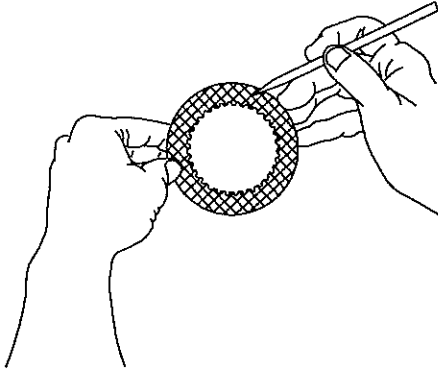


1. Thoroughly clean and inspect all parts at this time. Check brake piston sealing surfaces on brake cylinder and motor support. Be sure brake release port is free of contamination.

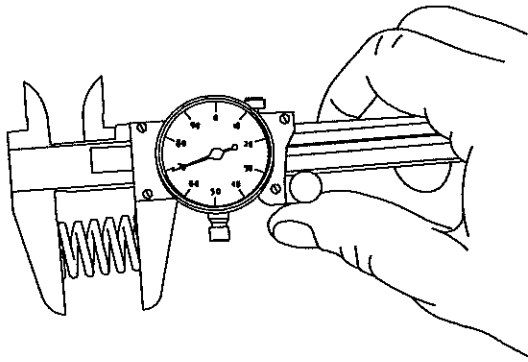


2. Check oil seal and bearing surfaces on brake cylinder for damage or wear.

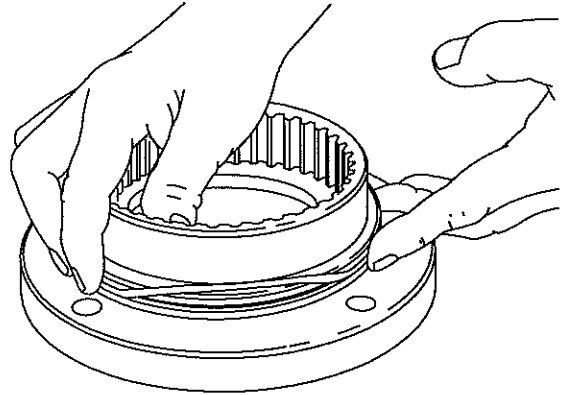
## ASSEMBLY



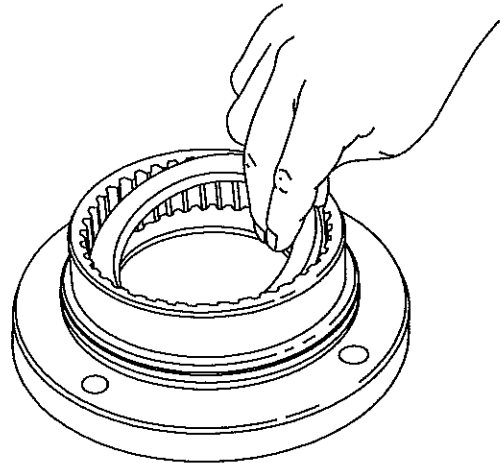
3. Place friction brake disc on flat surface and check for distortion with a straight edge. Friction material should appear even across entire surface with groove pattern visible. Replace friction disc if splines are worn to a point, disc is distorted, friction material is worn unevenly, or groove pattern is worn away.
4. Place steel brake disc on flat surface and check for distortion with a straight edge. Check surface for signs of material transfer or heat. Replace steel disc if splines are worn to a point, disc is distorted or heat discolored.



5. Check brake spring free length; minimum free length is 1 3/16 in. (30.2 mm). Check springs for any sign of cracking or failure. If a brake spring must be replaced for any reason, then ALL brake springs must be replaced.



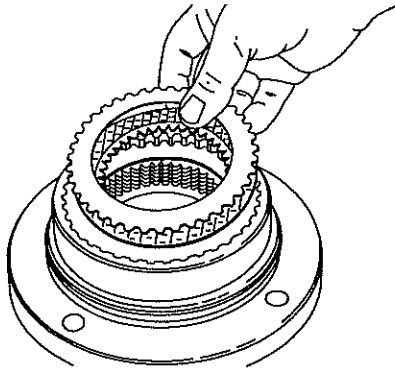
1. Begin assembly by placing motor support on workbench with motor mounting surface down. Install new O-ring and back-up ring as shown.



2. Install a brake spacer into the motor support. (Not required with lobed discs.)

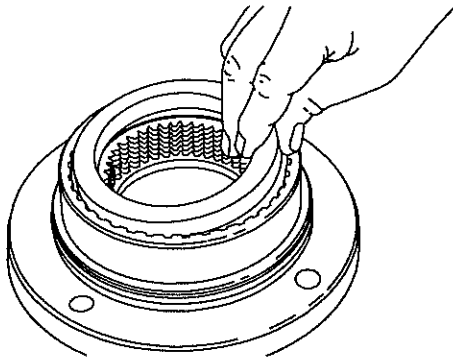
### **CAUTION**

Failure to replace brake springs as a set may result in uneven brake application pressure and repeated brake spring failure.

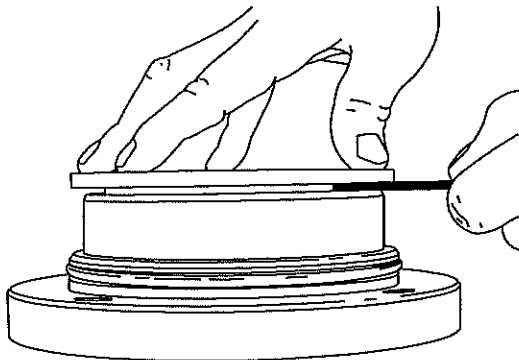


3. Insert first, a steel brake disc against the spacer followed by a friction brake disc then alternate steel and friction discs until seven (7) friction and eight (8) steel discs have been installed. Finish with a steel brake disc on top.

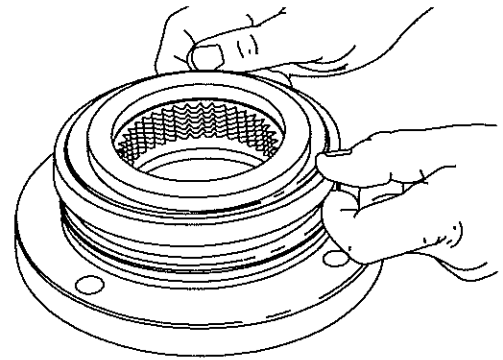
NOTE: It is a good practice to pre-lubricate the discs in light motor oil prior to assembly.



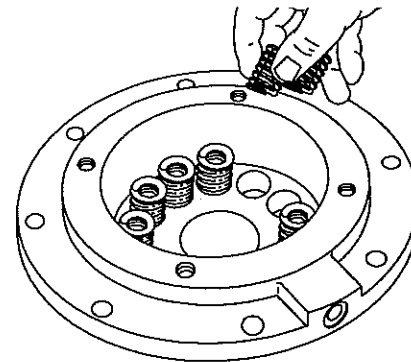
4. Install the remaining brake spacer on top of the last steel brake disc. (This is the only spacer used with lobed discs.)



5. To check brake stack height, place pressure plate on top of brake spacer. Hold pressure plate down firmly by hand and measure clearance in three places between motor support and pressure plate. Average gap must measure between .153 in. (4 mm) maximum and .080 in. (2 mm) minimum. If the gap exceeds the maximum limit, there are too many brake discs in stack-up or the discs are distorted. If the gap is less than the minimum, there are too few discs in stack-up or the discs are worn out. When stack height is correct, remove pressure plate and continue assembly.

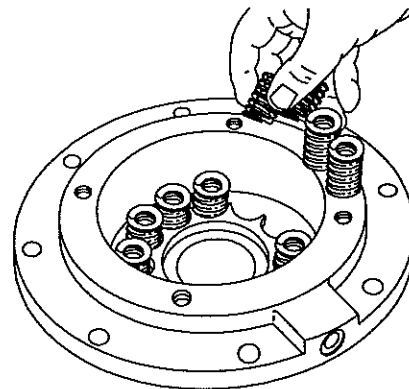


6. Lubricate the brake piston seal and motor support sealing surface with petroleum jelly or hydraulic oil. Install new piston seal to motor support, seal lip down.



#### OLDER STYLE BRAKE CYLINDER

7. Install brake springs into brake cylinder

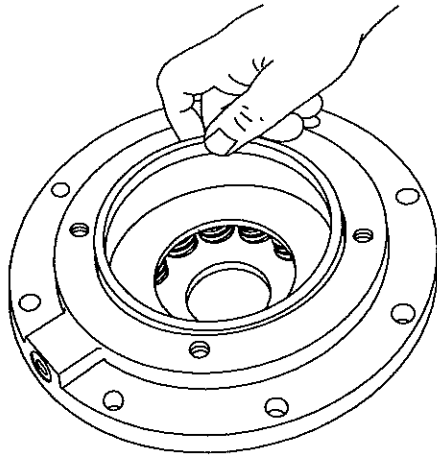


#### NEW STYLE BRAKE CYLINDER

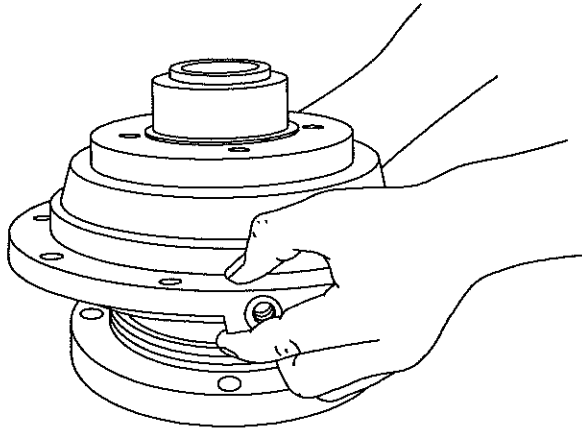
- 7A. When using the new style brake cylinder without milled spring pockets, install the spring spacer, then the brake springs.

#### ⚠ WARNING ⚠

Always use the molded spring spacer with the new brake cylinder. The brake springs must be properly positioned by the spring spacer. Failure to install the spring spacer may allow the springs to contact each other and become damaged. This could result in loss of load control, property damage, injury or death.

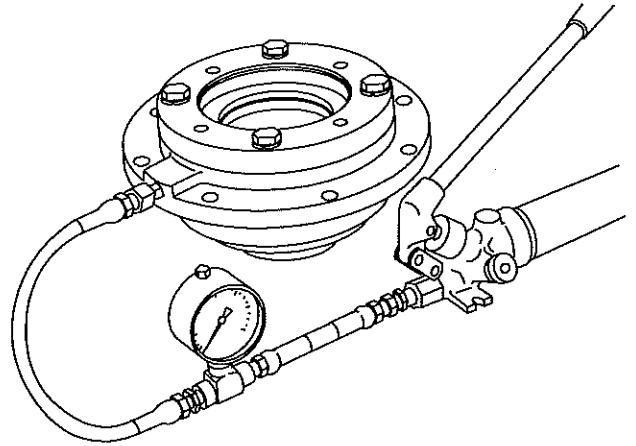


8. Install pressure plate into brake cylinder followed by the piston back-up ring. The close-fitting piston back-up ring may be depressed slightly to one side to lodge the back-up ring in the brake cylinder bore and temporarily hold the pressure plate and springs in place while you lower the brake cylinder over the motor support.



9. Apply petroleum jelly to the entire sealing surface of the brake cylinder and to the piston seal. Install the brake cylinder over the motor support being careful to avoid damaging the piston seal or motor support O-ring. (A press may be necessary to avoid cocking the brake cylinder during installation.)
10. Install motor support capscrews and evenly tighten to recommended torque.

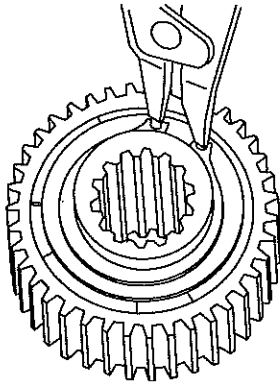
## BRAKE CYLINDER PRESSURE TEST



1. Install the -4 J.I.C. fitting into the brake release port. Connect a hand pump with accurate 0-2000 psi (0-13,800 kPa) gauge and shut-off valve to this fitting. Apply 1000 psi (6,900 kPa) to the brake. Close shut-off valve and let stand for five (5) minutes. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and brake piston.
2. WHILE PRESSURE IS APPLIED AND THE BRAKE RELEASED, install the brake clutch assembly in the brake pack, short end of the inner race toward motor. Turn the clutch back and forth as you align the outer race splines with the brake disc splines.
3. Release the pressure on the brake cylinder then remove the brake clutch assembly. The brake cylinder assembly is now complete and ready to be installed in the winch.

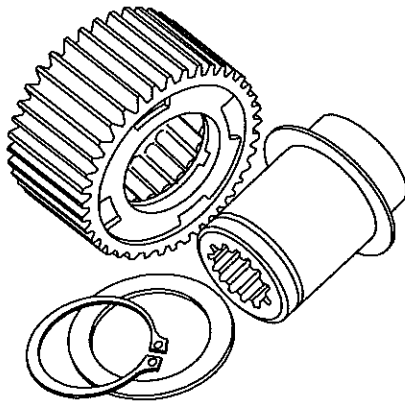
# BRAKE CLUTCH SERVICE

## DISASSEMBLY

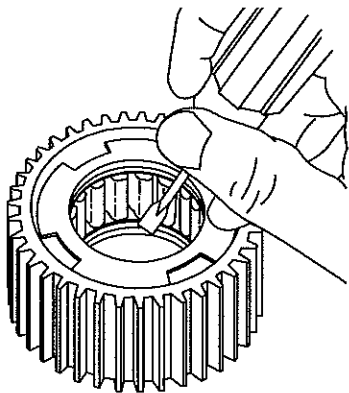


1. Remove the snap ring and sprag bushing retainer from one end only.

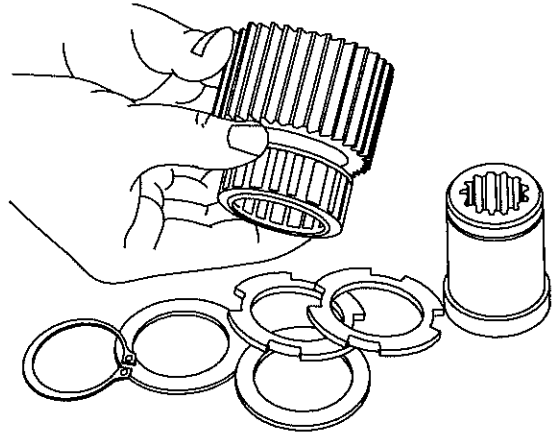
**i NOTE:** The brake clutch on PD17A winches uses a stepped inner race, which eliminates one retaining ring and bushing retainer. The larger end of the inner race is toward the motor.



2. Pull the inner race out. Examine the race for scoring, wear or indentations caused by the sprag cams.



3. Use a screwdriver and mallet to remove the sprag bushing from one end of the outer race. There are four special cut-outs in the bushing for this purpose. Be careful not to damage the bushing inside surface. If a bushing's inside surface is damaged or shows wear, replace it.

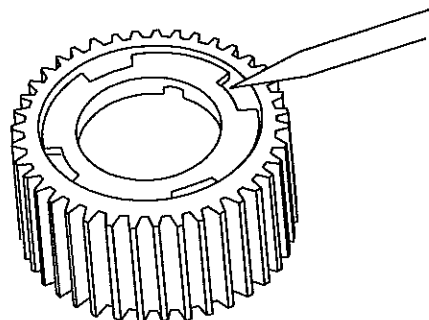


4. Next, slide the sprag clutch out, inspect the sprag clutch closely for abnormal wear, cracks, pitting or corrosion. Check small clips for breakage or bright spots; the signs of excessive wear. Unless the outer race or remaining sprag bushing is damaged or shows excessive wear, there is no need for further disassembly. If disassembly is necessary, remove the bushing according to the procedure covered in Step No. three (3). All brake clutch assembly parts should be thoroughly cleaned and inspected before assembly.

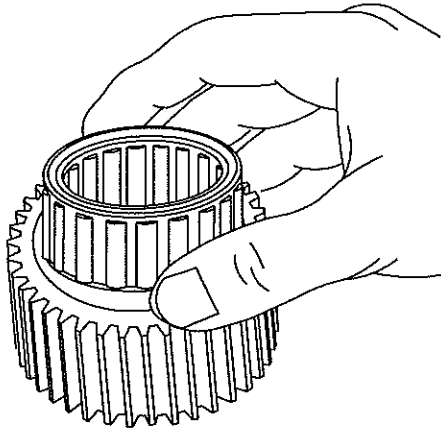
## ⚠ WARNING ⚠

The polished surfaces of the races and sprag cams must be perfectly smooth to insure positive engagement of the clutch. The slightest defect may reduce brake clutch effectiveness, which may lead to loss of load control and result in property damage, personal injury or death. It is generally recommended to replace the entire brake clutch assembly if any component is defective.

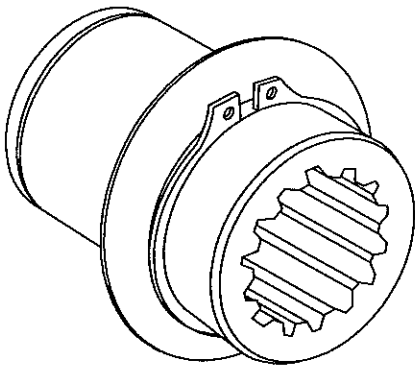
## ASSEMBLY



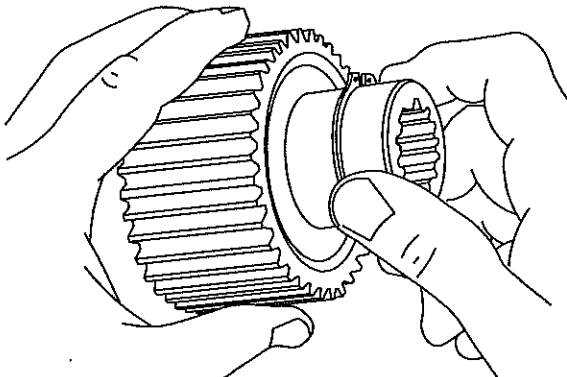
1. Press a sprag bushing into the outer race, using a mechanical or hydraulic press. A flat plate of approximately the same diameter as the bushing flange outside diameter should be placed between the press and bushing during assembly to protect the bushing. Be certain the bushing flange is against the shoulder in the outer race.



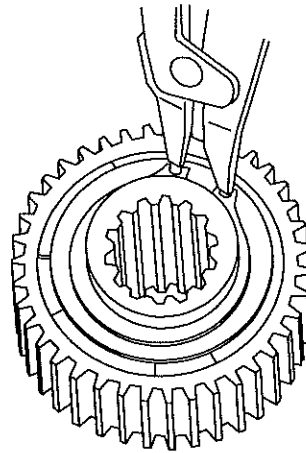
2. Turn the assembly over and install the sprag clutch in the bore of the outer race.
3. Press the remaining bushing into the race. Again, make sure the bushing is against the shoulder.



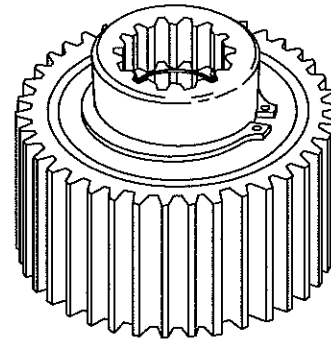
4. Next, install a sprag bushing retainer, then a snap ring on the inner race. Be sure the snap ring is seated in the snap ring groove. NOT necessary on PD17A due to stepped design.



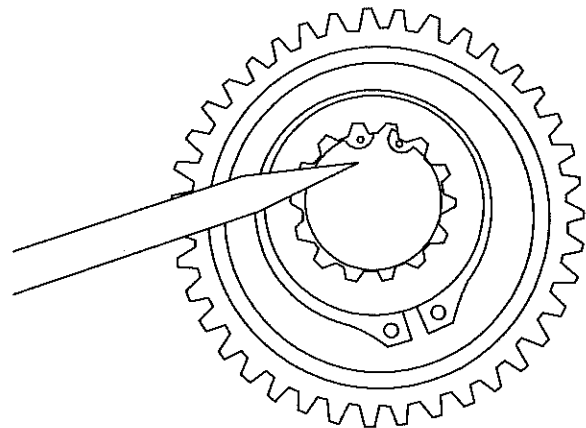
5. Slide the inner race through the bushings and sprag clutch (the race will have to be rotated in the free-wheeling direction to start it through the sprag clutch). If the inner race will not go through the bushings, the bushings have probably been damaged and should be replaced.



6. Turn the assembly over with the snap ring down. Install the second retainer and snap ring. Make certain the snap ring is seated in the groove properly.



7. This is a completed brake clutch assembly.



### ⚠ WARNING ⚠

Be certain the snap ring is seated in the groove in the splined bore of the inner race. This snap ring will keep the brake clutch assembly correctly positioned in the center of the friction brake pack. Binding of the brake or brake failure may occur if this snap ring is omitted.

# WINCH ASSEMBLY

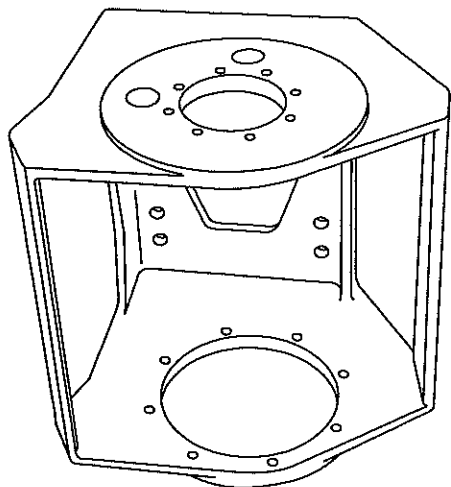
## NOTE: PD15B winches ONLY

The drum closure will not fit through the opening in the base. For winches with a three piece base, first assemble the bearing support side plate (91) to the base plate (90). Go to step 1 and follow the assembly procedure. Install the motor end side plate and tie bar(s) after installing the drum closure in step 10.

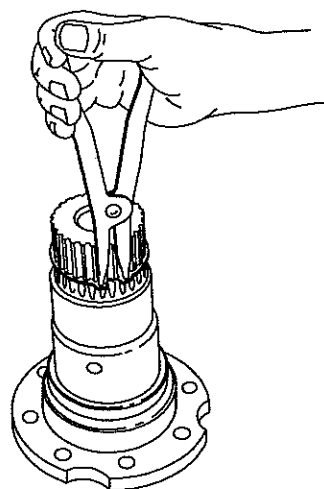
For winches with a one piece cast base, use the following assembly procedure. With the drum horizontal, install the output planet carrier assembly, output sun gear (34), thrust washer (43), primary planet carrier assembly, thrust washer (31) and drum closure. (Apply a light coat of grease to the thrust washer to hold them in position.) Position the drum in the base and install the bearing support. (Refer to step 3 for two caution statements.) You may have to rotate the bearing support or planet gears to engage the bearing support with the output planet carrier. Install and hand tighten the bearing support capscrews. Stand winch on bearing support end and visually check to verify the primary thrust plate is properly positioned. (Refer to caution and drawings in step 16.) Install the primary sun gear and proceed to step 11 to complete winch assembly. Tighten bearing support capscrews to recommended torque after motor is installed.

### ⚠ CAUTION ⚠

Winches with a three piece fabricated base use special shoulder capscrews to fasten side plates to the base plate. DO NOT use standard capscrews in their place.

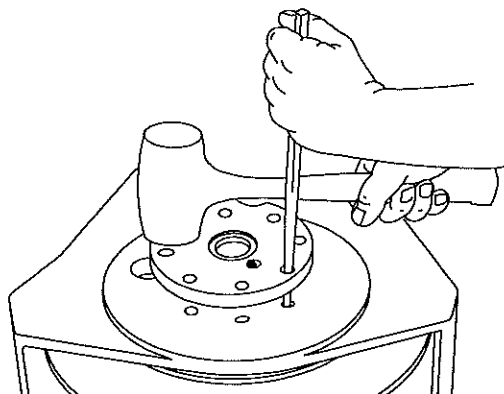


1. Place winch base on side with bearing support end up.
2. Install a new bearing in the drum if replacement is necessary. Apply a non-hardening sealant on the outside diameter of the new seal. Install the spring side of the seal next to the bearing, then press into the drum, using a flat plate to avoid distortion. Be sure drain plug is installed securely.



### ⚠ CAUTION ⚠

Make certain the snap ring is installed on the bearing support. This snap ring will keep the output planet carrier correctly positioned in the winch. Gear train damage may occur if this snap ring is omitted.

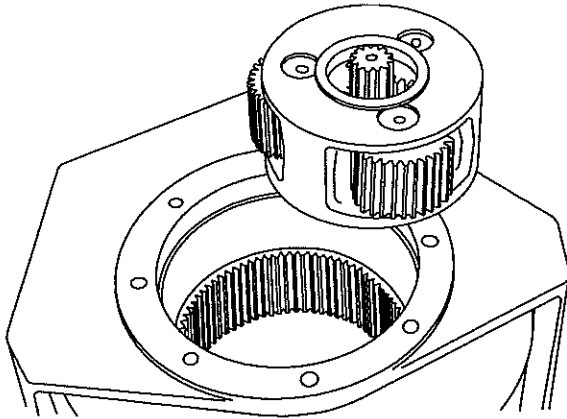


3. Center the drum in the opening of the base. Lubricate the bearing support with petroleum jelly or gear oil and install in base and drum.

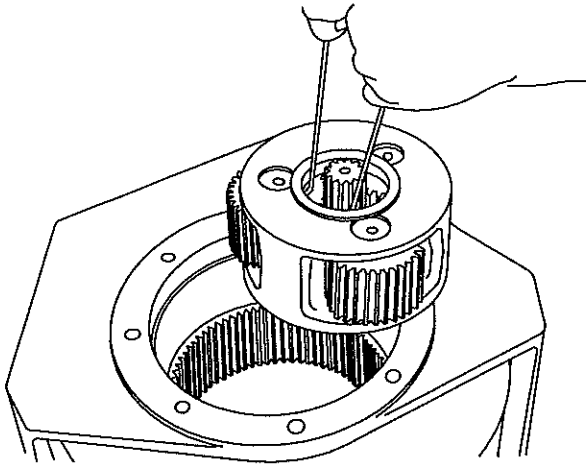
## ⚠ CAUTION ⚠

Be sure the vent plug is located above the horizontal centerline for the intended application. Oil leakage may occur if vent is positioned incorrectly.

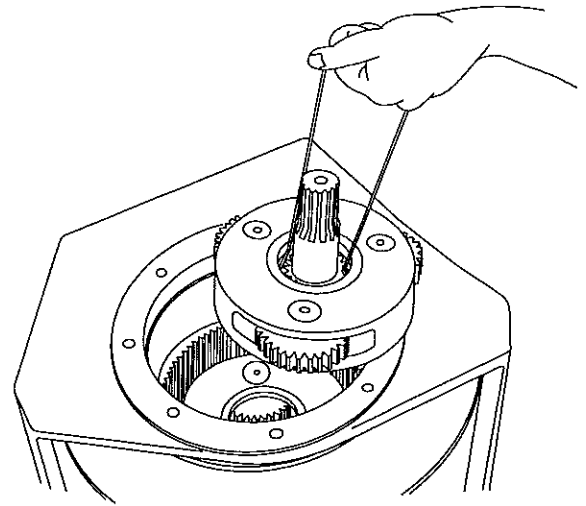
4. Tighten the bearing support capscrews to the recommended torque.



5. Stand with one foot on bearing support end. Install the output sun gear and thrust washer into output planet carrier.



6. Install the output planet carrier into the drum while meshing the planet gears with the ring gear and the planet housing with the bearing support.
7. Install the primary sun gear and thrust washer into the primary planet carrier.



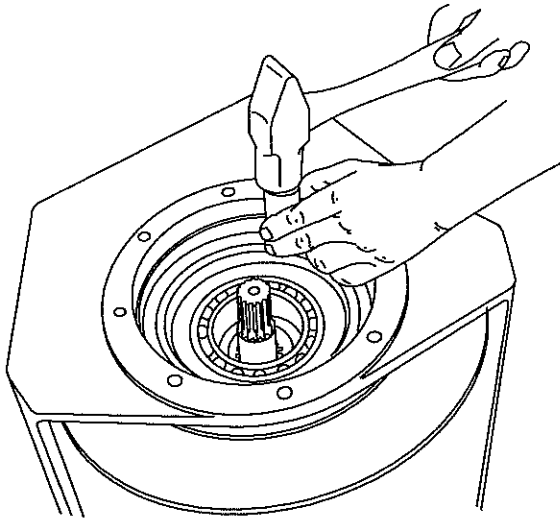
8. Install the primary planet carrier, meshing the planet gears with the ring gear and the planet housing with the output sun gear.



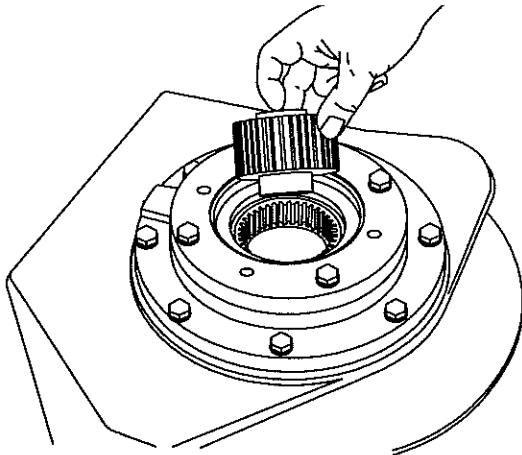
9. Install a new bearing in the drum closure as required. Use sealant on the outside surface of the oil seal. Install with spring side of the seal toward bearing, using a flat plate to avoid distortion.

Install a new O-ring in the groove on the O.D. of the drum closure.





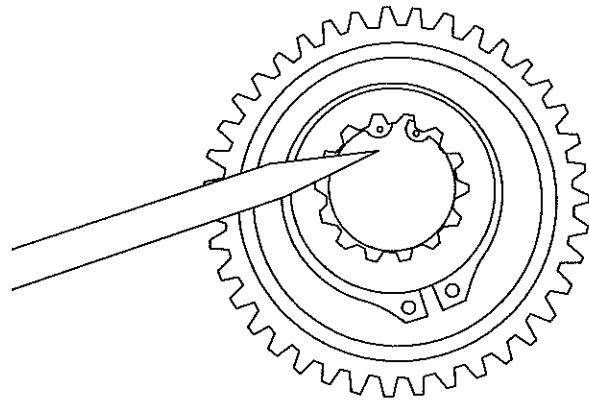
10. Lubricate the O-ring and drum opening with petroleum jelly or gear oil and install the drum closure into the drum.
11. Lubricate the pilot, oil seal and bearing surfaces of the brake cylinder and carefully install brake cylinder into base and drum. Locate the brake release port toward the lower rear corner of the base. Tighten brake cylinder capscrews to recommended torque.



12. Install the brake clutch assembly with the short end of the inner race toward motor.

When installed correctly, the inner race should turn freely in the opposite direction the drum turns to pull wire rope in. An easy way to check the rotation is to hold the outer race in one hand, and rotate the inner race.

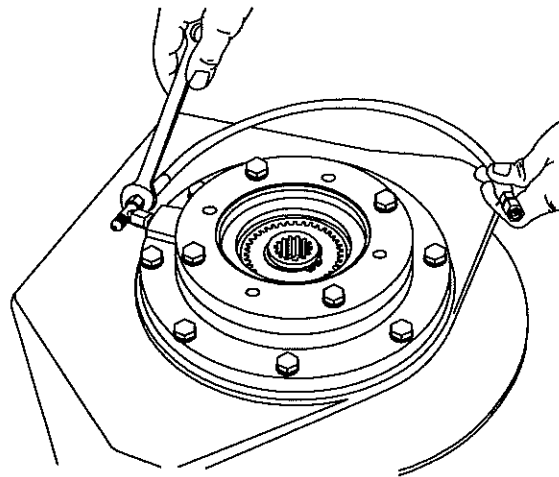
If the clutch free wheels in the wrong direction, disassemble the clutch and reverse the inner race. Refer to "Brake Clutch Service" for additional information.



### ⚠ WARNING ⚠

Be certain the snap ring is seated in the groove in the splined bore of the inner race. This snap ring will keep the brake clutch assembly correctly positioned in the center of the friction brake pack. Binding of the brake or brake failure may occur if this snap ring is omitted.

13. If the brake discs are misaligned, preventing the installation of the clutch, then with a hand pump, apply 750-1000 psi to the brake release port. The brake discs will move freely with the brake released, permitting alignment of the discs, brake clutch and input sun gear.



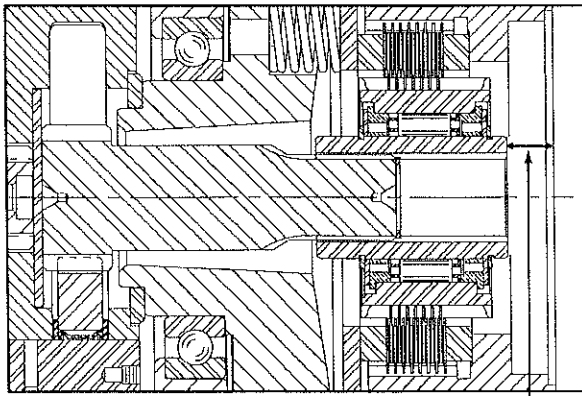
14. Install the hoses and fittings to the brake cylinder release port.

15. Install a new O-ring on the motor pilot then lubricate with petroleum jelly or gear oil.

**i** **NOTE:** The following caution DOES NOT apply to PD17A winches. Proceed to step 16.

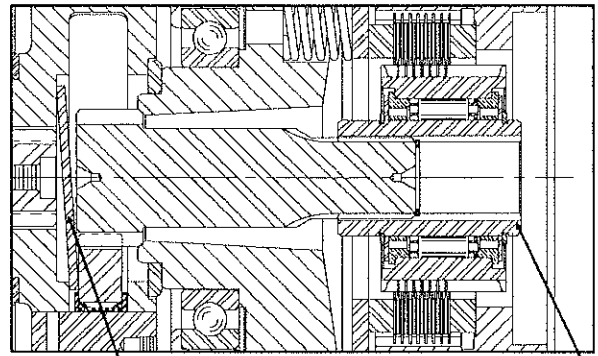
### △ CAUTION △

Care must be taken to assure the primary thrust plate remains properly located in its counterbore when the motor is installed for the first time, or is being reinstalled on the winch. It is possible for the primary thrust plate to drop out of its counterbore and become wedged between the planet gears and the planet carrier. If the winch is operated with the primary thrust plate wedged between primary gears and the planet carrier, or with a thrust washer out of position, severe damage to internal winch components could result.



MEASURE THIS  
DISTANCE

Measure the distance from the motor mounting surface to the inner brake race. With all components properly installed, this distance should be 11/16 in. (17.5 mm) to 3/4 in. (19.1 mm). If this distance is less than 9/16 in. (14.3 mm), the primary spacer may be positioned as shown below and should be checked.

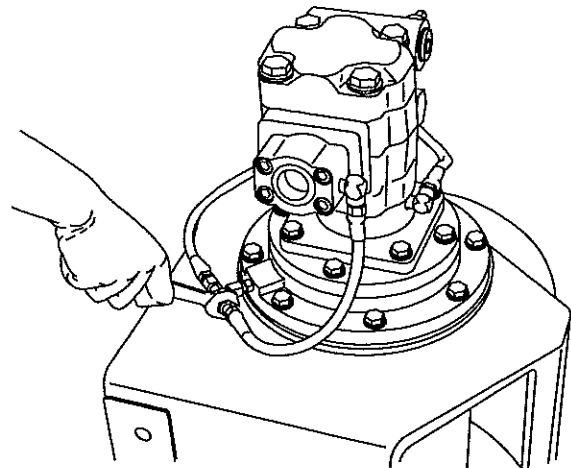


PRIMARY THRUST PLATE

BRAKE CLUTCH  
INNER BRAKE RACE

The Primary Thrust Plate is shown wedged between the planet gears and the planet carrier. Note that the Primary Sun Gear and the entire Brake Clutch Assembly have moved to the right (toward the hydraulic motor).

16. Engage the motor shaft with the brake clutch inner race and lower motor into place. Tighten capscrews to recommended torque.



17. Install the hoses that connect the manifold and brake valve to the brake cylinder.
18. After the winch assembly is complete, check all capscrews and fittings to make certain they have been tightened correctly.

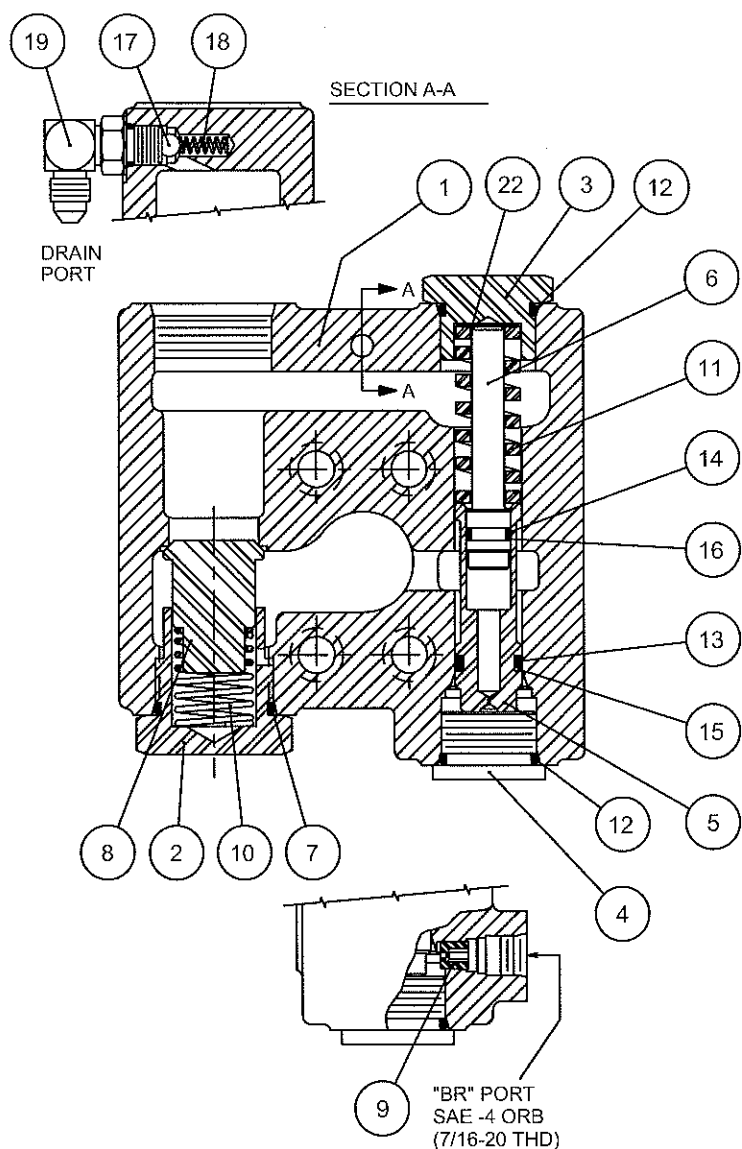
Refill the winch with the recommended oil listed under "Preventive Maintenance", and install the oil level plug.

# BRAKE VALVE SERVICE

The BRADEN brake valve is a reliable hydraulic valve with internal components manufactured to close tolerances. Due to the close tolerances and mating of components, the valve housing, spool, piston and check poppet are not available as replacement parts.

Before disassembling the brake valve, be sure you have conducted all applicable troubleshooting operations and are certain the brake valve is causing the malfunction.

Thoroughly clean the outside surfaces of the valve and work in a clean dust free area, as cleanliness is of utmost importance when servicing hydraulic components.

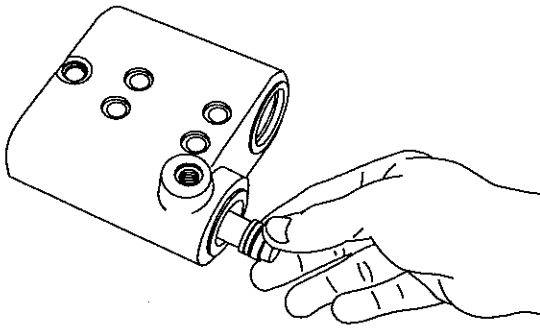


BRAKE VALVE ASSEMBLY		
ITEM	DESCRIPTION	QTY.
1	Valve Housing (NSS)	1
2	Check Valve Retainer (NSS)	1
3	Spring Retainer (NSS)	1
4	Plug (NSS)	1
5	Spool (NSS)	1
6	Damper Piston (NSS)	1
7	O-Ring	1
8	Check Valve Poppet (NSS)	1
9	Pilot Orifice	1
10	Check Valve Spring	1
11	Spool Spring	1
12	O-Ring	2
13	O-Ring	1
14	O-Ring	1
15	Back-up Ring	1
16	Back-up Ring	1
17	Check Ball (1/4 in.)	1
18	Check Ball Spring	1
19	Elbow Fitting	1
22	Shim	A.R.

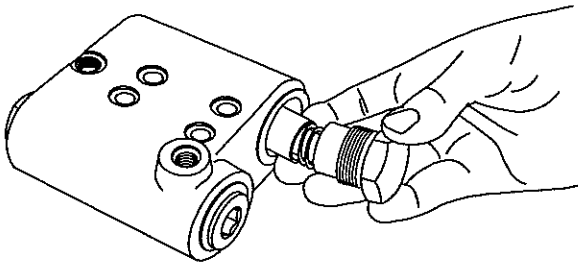
NSS - NOT SERVICED SEPARATELY. REPLACE COMPLETE VALVE ASSEMBLY

## DISASSEMBLY

1. Remove the pilot orifice from the brake release (BR) port using a 5/32 in. Allen wrench.
2. Remove the elbow fitting, motor drain check ball and spring.
3. Remove the spool spring retainer and spool spring. Check spring free length. Replace spring if less than 1 15/16 in. (49.2 mm) long.



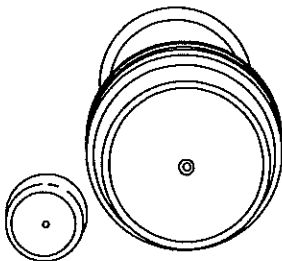
4. Remove spool plug and carefully remove spool assembly.
5. Remove the damper piston from the spool. The piston will come out slowly, because of a partial vacuum formed as it is removed. Use extreme care to avoid damaging the polished surfaces of the piston or spool.



6. Remove the check valve spring retainer, spring and check valve poppet. Check spring free length. Replace spring if less than 1-1/2 in. (38.1 mm) long.

## CLEAN AND INSPECT

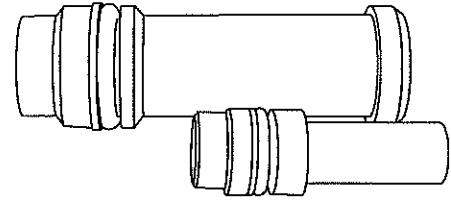
1. Discard all O-rings and back-up rings. Clean all parts in solvent and blow dry. Inspect polished surfaces of spool and damper piston for damage that may cause binding or leakage. Inspect spool bore in valve housing for damage or scoring. Inspect check valve seat in valve housing and check valve poppet. If the spools, bores or valves are damaged, the entire valve must be replaced as these parts are not serviced separately.



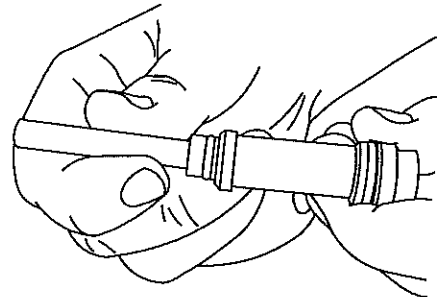
2. Inspect the .020 inch orifice in the end of the spool and the pilot orifice to be certain they are open.

## ASSEMBLY

1. Install new O-rings on the plug and spring retainers.



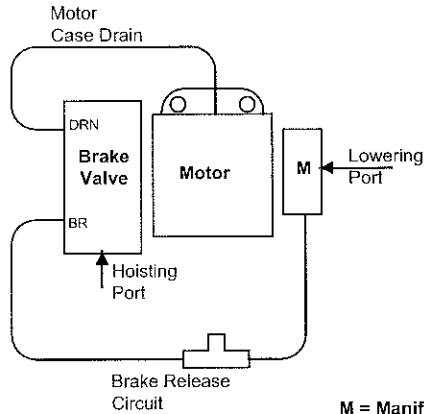
2. Install new O-rings and back-up rings on the spool and damper piston as shown. It is important that each back-up ring is on the correct side of its O-ring. Take care not to cut the O-rings during assembly. Let the spool and damper piston set for ten minutes before installing them in their respective bores. This will allow the O-rings to return to their original size after being stretched.
3. Lubricate the spool and damper piston O-rings with hydraulic oil. Carefully install the damper piston into the spool.



4. Lubricate the spool bore and spool O-rings with hydraulic oil. Carefully install the spool into the valve housing. Always install the spool from the plug end as shown to minimize the possibility of damaging the O-ring. Install the plug, spool spring and spring retainer.
5. Install the check valve poppet, spring and check valve spring retainer.
6. Install the motor drain check ball, spring and elbow fitting.
7. Install the pilot orifice into the valve housing.
8. The brake valve is complete and ready to be installed on winch motor.

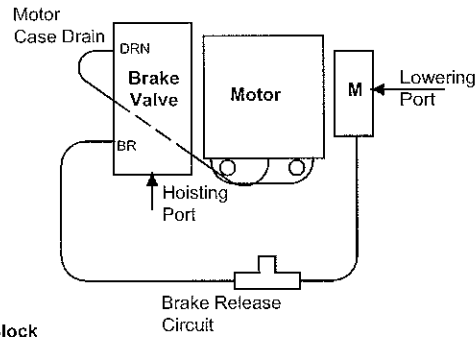
# REVERSING DIRECTION OF DRUM ROTATION

(029, 034, 039, 051, 064 & 049/024 motors ONLY)



"A"

M = Manifold Block



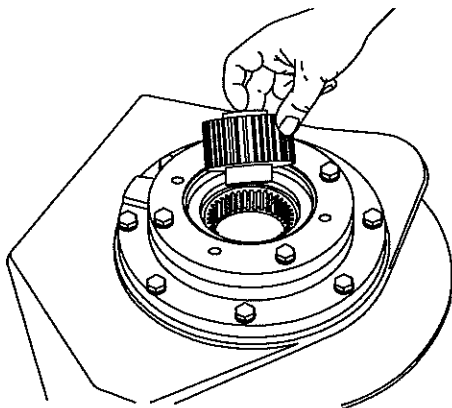
"B"

In order to change the direction of rotation, 2 things must be changed on the winch. First, the motor must be made to rotate in the opposite direction. This is done by exchanging positions of the brake valve and manifold block on the motor. Secondly, the brake clutch assembly must be made effective for the opposite direction of rotation. This is done by reversing the inner race of the brake clutch assembly.

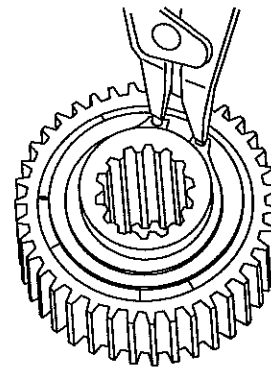
Figures "A" and "B" above show typical PD12C motor installations. Note that the only difference between the two drawings is the motor is rotated 180° (the "belly" of the motor moves to the opposite side). If the motor shaft rotates clockwise in figure "A" when the hoisting port is pressurized, it will rotate counterclockwise in figure "B".

1. Remove the four capscrews securing the brake valve to the motor. Remove the four capscrews securing the manifold block to the motor. Disconnect the motor case drain hose at the motor. NOTE: Some installations have the brake release hose connected directly to the motor, instead of to the manifold block. In this case, disconnect the brake release hose at the motor port. Stand winch up on drum support with the motor end up and secure in this position.

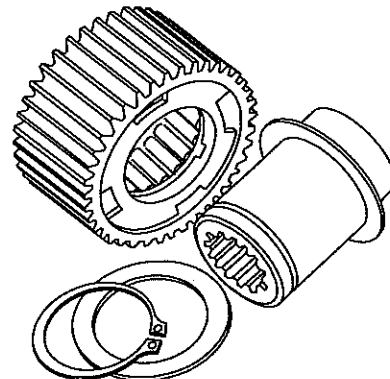
2. Before removing the motor, it is a good idea to note or mark the position of the motor in relation to the winch, since it will be rotated 180° when reinstalled. Remove the capscrews securing the motor to the winch and carefully remove the motor.



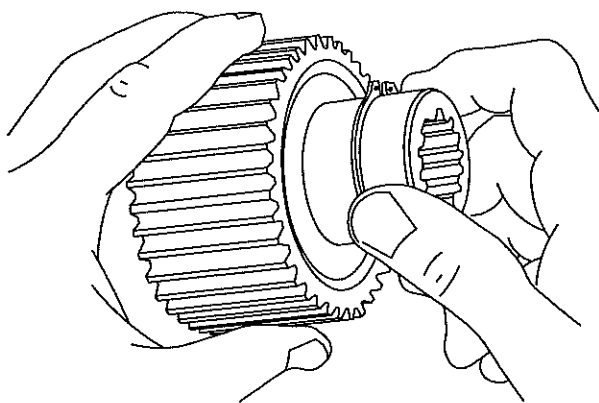
3. Remove the brake clutch assembly from the motor support.



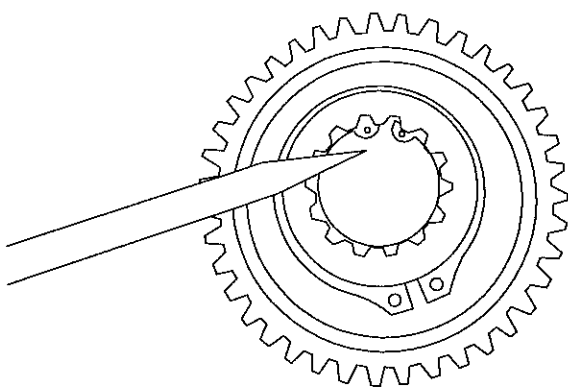
4. Remove the snap ring and sprag bushing retainer from one end only of the brake clutch assembly.



5. Pull the inner race out. Examine the race for scoring, wear or indentations caused by the sprag cams. If the inner race is not completely smooth, the assembly should be replaced.



6. Turn the sprag assembly around and slide the inner race (with 1 snap ring and bushing retainer) through the bushings and sprag clutch (the race will have to be rotated in the free-wheeling direction to start it through the sprag clutch). Install the remaining bushing retainer and snap ring. Make certain the snap ring is properly seated in the groove.



### **⚠ WARNING ⚠**

Be certain the snap ring is seated in the groove in the splined bore of the inner race. This snap ring will keep the brake clutch assembly correctly positioned in the center of the friction brake pack. Binding of the brake or brake failure may occur if this snap ring is omitted.

7. Before installing the brake clutch, be sure the inner race turns free in the opposite direction the drum will turn to haul-in wire rope. An easy way to check the rotation is to hold the outer race in one hand and rotate the inner race. Install the brake clutch with the short end of the inner race toward the motor.
8. Install a new O-ring on the motor pilot. Rotate the motor 180° from its original position and install it onto the winch. Install and tighten motor capscrews to recommended torque.
9. Install new O-rings in the brake valve and manifold block. Attach the brake valve and manifold block to the motor using the original capscrews and tighten to recommended torque.
10. Connect the motor case drain hose to the motor case drain port. **NOTE:** On two speed motors, the case drain and shift drain should be connected directly to tank. **DO NOT** use the drain connection on the brake valve. See "TWO SPEED MOTOR CASE DRAIN PLUMBING" for additional information.
11. If your winch had the brake release hose connected directly to the motor, the original motor port must be plugged and the hose connected to the motor pressure port near the manifold block (lowering port).
12. Operate the winch slowly in both directions and check for oil leaks and/or unusual sounds from the winch. The winch should operate smoothly in both directions. Refer to "WIRE AND BRAIDED ROPE INSTALLATION" and properly install rope onto the winch drum.
13. Before returning the winch to full service, a light load should be lifted and held a few feet off the ground to be sure the static brake is functioning properly. The winch should also be able to slowly lower the load in a smooth and controlled manner. If the winch does not perform either of these functions, refer to "TROUBLESHOOTING" for additional information.

## PD17A Rotation Indicator Proximity Sensor

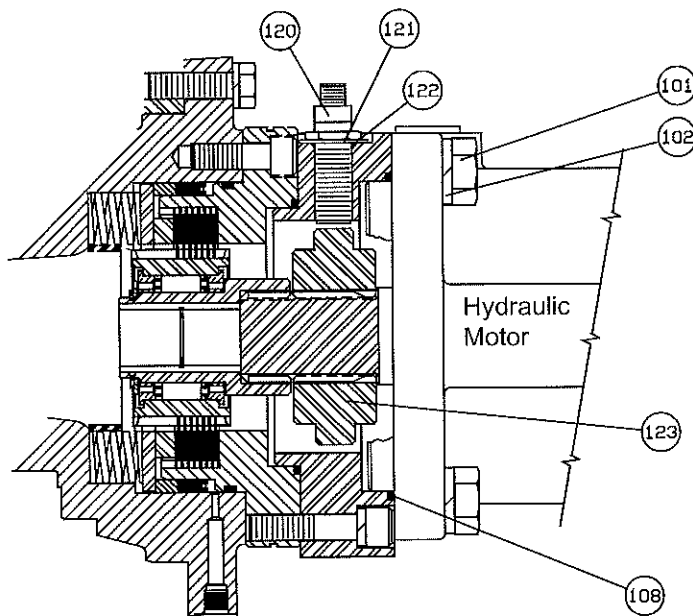
Some PD17A models have a rotation indicator proximity sensor and hub between the motor and the winch. If the sensor is removed or replaced, use the following procedure for adjustment and testing. Refer to the drawing below for item numbers.

Install a new O-ring (item 108) onto motor pilot. Install sensor hub (item 123) onto motor shaft, positioning the sensor hub so that one of the lobes will be directly under the sensor port. Install the motor onto the winch. Install capscrews and lockwashers (items 101 & 102) securing the motor to motor adapter.

### ⚠ CAUTION ⚠

If sensor hub is not correctly positioned with a lobe directly under the sensor port, proper adjustment may not be possible and severe damage to the sensor and internal winch components may result.

Install flatwasher (item 121) and O-ring (item 122) onto new sensor (item 120). Apply a small amount of silicone sealant to the threads just below the washer and O-ring. DO NOT apply sealant to the end of the sensor or to the threads of the sensor port where it could be pushed into the winch. Install the sensor into the motor adapter until it contacts the sensor hub. Back sensor out of the port 2 complete turns. Attach wire harness to sensor to verify proper sensor operation. IT IS NOT necessary to operate the winch motor. If sensor light is on, hold sensor from turning and tighten jam nut against motor adapter. If light is off or blinks intermittently, adjust sensor inward toward sensor hub until light remains on, then tighten jam nut.



# METRIC CONVERSION TABLE

## English to Metric

## Metric to English

### LINEAR

inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.3937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)

### AREA

inches <sup>2</sup> (sq.in.)	X 645.15	= millimeters <sup>2</sup> (mm <sup>2</sup> )	millimeters <sup>2</sup> (mm <sup>2</sup> )	X 0.000155	= inches <sup>2</sup> (sq.in.)
feet <sup>2</sup> (sq.ft.)	X 0.0929	= meters <sup>2</sup> (m <sup>2</sup> )	meters <sup>2</sup> (m <sup>2</sup> )	X 10.764	= feet <sup>2</sup> (sq.ft.)

### VOLUME

inches <sup>3</sup> (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches <sup>3</sup> (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallons (gal.)
inches <sup>3</sup> (cu.in.)	X 16.39	= centimeters <sup>3</sup> (cc)	centimeters <sup>3</sup> (cc)	X 0.06102	= inches <sup>3</sup> (cu.in.)
feet <sup>3</sup> (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet <sup>3</sup> (cu.ft.)
feet <sup>3</sup> (cu.ft.)	X 0.02832	= meters <sup>3</sup> (m <sup>3</sup> )	meters <sup>3</sup> (m <sup>3</sup> )	X 35.315	= feet <sup>3</sup> (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= milliliters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)

### MASS

ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)

### PRESSURE

inches Hg (60°F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60°F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm <sup>2</sup> )	kilograms/sq.cm. (kg/cm <sup>2</sup> )	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H <sub>2</sub> O (60°F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H <sub>2</sub> O (60°F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars

### POWER

horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.

### TORQUE

pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.-lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)

### VELOCITY

miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)

### TEMPERATURE

$$^{\circ}\text{Celsius} = 0.556 (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{Fahrenheit} = (1.8^{\circ}\text{C}) + 32$$

### COMMON METRIC PREFIXES

mega	(M)	= 1,000,000 or 10 <sup>6</sup>	deci	(d)	= 0.1 or 10 <sup>-1</sup>
kilo	(k)	= 1,000 or 10 <sup>3</sup>	centi	(c)	= 0.01 or 10 <sup>-2</sup>
hecto	(h)	= 100 or 10 <sup>2</sup>	milli	(m)	= 0.001 or 10 <sup>-3</sup>
deka	(da)	= 10 or 10 <sup>1</sup>	micro	(μ)	= 0.000.001 or 10 <sup>-6</sup>





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### CH230B Series Hoist



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



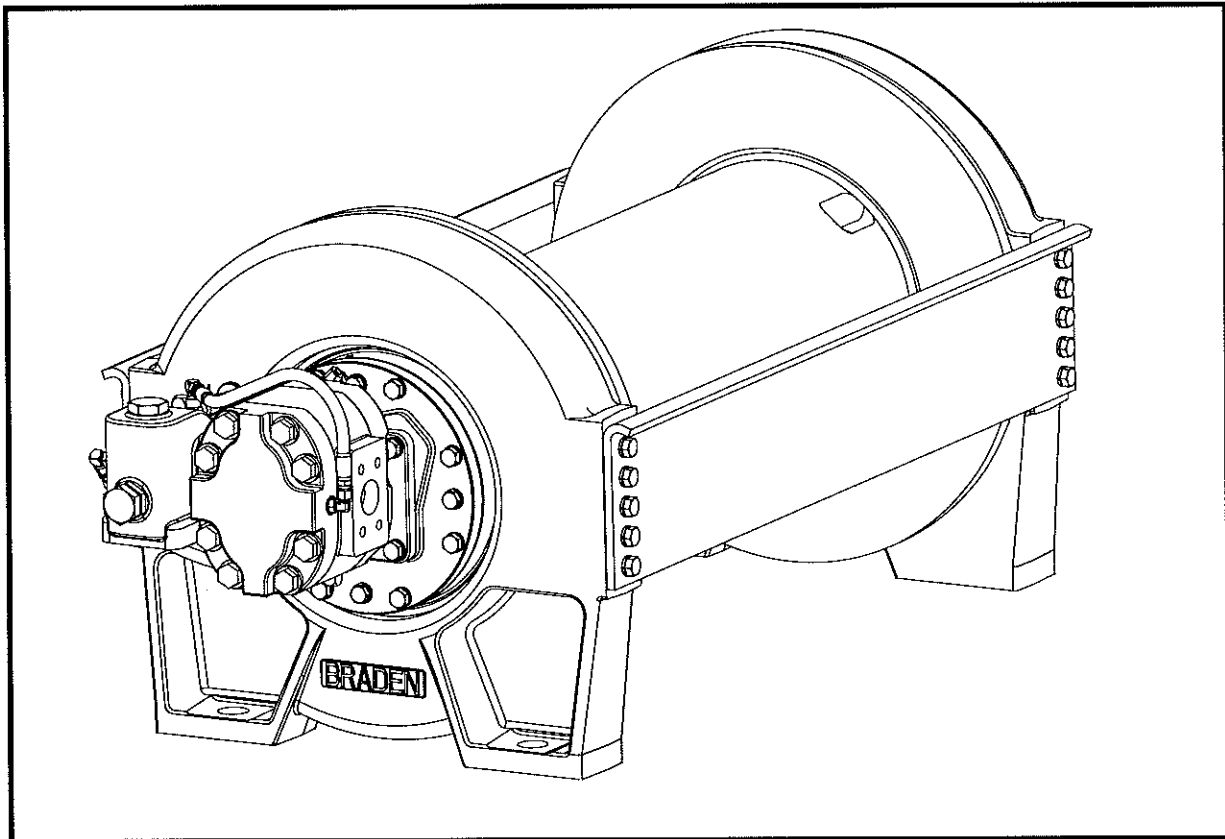


---

# BRADEN

---

## CH165A/ CH175B/ CH230B PLANETARY HOIST



### INSTALLATION, MAINTENANCE AND SERVICE MANUAL

## TABLE OF CONTENTS

FOREWORD.....	3
MODEL & SERIAL NUMBER LOCATION.....	3
EXPLANATION OF MODEL NUMBER.....	3
GLOSSARY OF TERMS.....	4
GENERAL SAFETY RECOMMENDATIONS.....	5
BASIC OPERATION.....	7
INSTALLATION.....	9
WIRE ROPE INSTALLATION.....	10
HOIST OPERATION.....	11
HYDRAULIC CIRCUIT.....	12
RECOMMENDED FASTENER TORQUE.....	12
PREVENTIVE MAINTENANCE.....	13
RECOMMENDED GEAR OIL.....	14
OIL SAMPLING AND ANALYSIS.....	15
TROUBLESHOOTING.....	16
DISASSEMBLY PROCEDURE.....	20
EXPLODED VIEW OF MAJOR COMPONENTS.....	22
PLANETARY CARRIER SERVICE.....	23
OVER-RUNNING CLUTCH SERVICE.....	25
BRAKE CYLINDER SERVICE.....	27
REVERSING DRUM ROTATION DIRECTION.....	30
HOIST ASSEMBLY.....	32
BRAKE VALVE SERVICE.....	34
BRAKE VALVE OPENING PRESSURE TEST.....	36
METRIC CONVERSION CHART.....	40

## FOREWORD

### CH165A, CH175B, & CH230B

The following service instructions have been prepared to provide assembly, disassembly and maintenance information for the BRADEN Model CH165A, CH175B, & CH230B series hoist. It is suggested that before doing any work on these units, all assembly and disassembly instructions should be read and understood.

Some illustrations in this manual may show details or attachments that are different from your hoist. Also, some components have been removed for illustrative purposes.

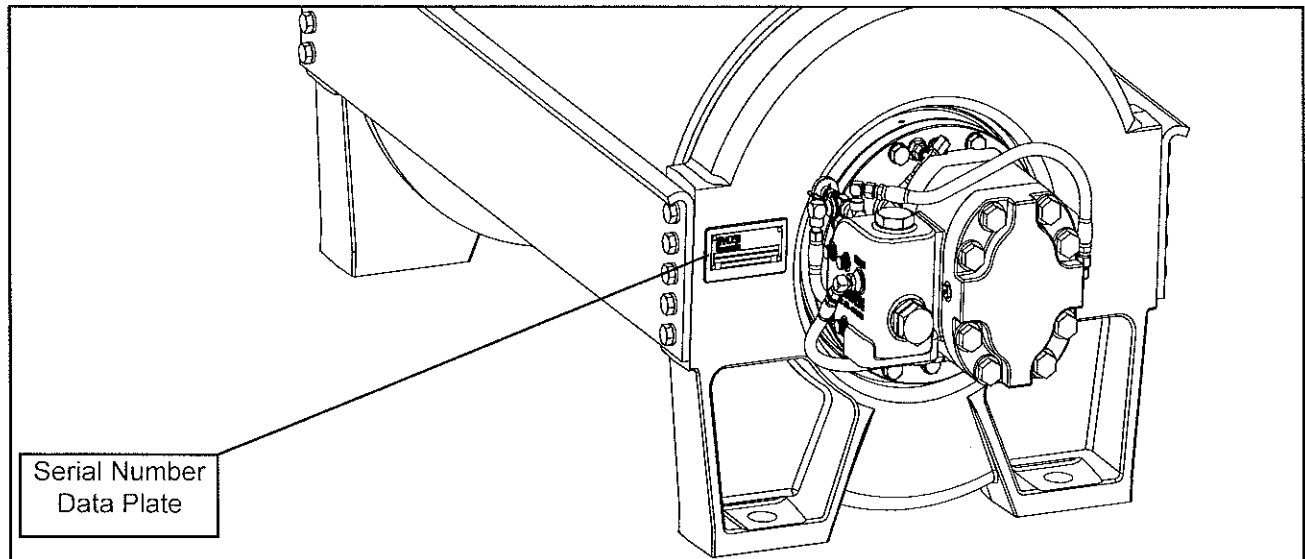
Continuing product improvement may cause changes in your hoist, which are not included in this manual. Whenever a question arises regarding your BRADEN hoist or this manual, please contact BRADEN Product Support Department for the latest available information.

Telephone- 1-918-251-8511

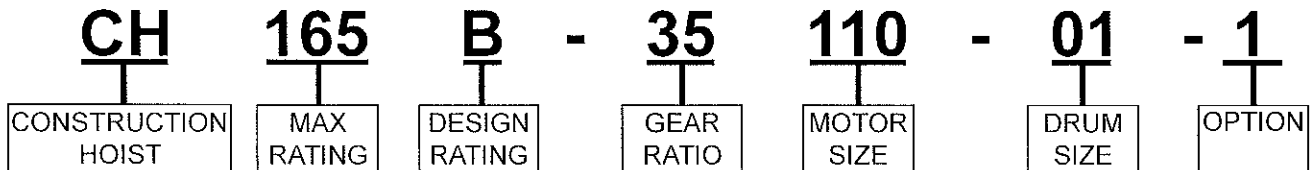
08:00-16:30 Central Time Zone, Monday thru Friday

FAX- 1-918-259-1575

[www.paccarwinch.com](http://www.paccarwinch.com)



### EXPLANATION OF SERIAL NUMBER



**CH** DESIGNATES CONSTRUCTION HOIST

**165** DESIGNATES 16,500 (CH165), 17,500 (CH175) OR 23,000 (CH230) LB DESIGN FIRST LAYER LINE PULL

**B** DESIGNATES THE MODEL SERIES RELATING TO DESIGN CHANGES

**35** DESIGNATES TOTAL GEAR REDUCTION (CH165= 25, 26; CH175= 22; CH230= 35, 36)

**110** DESIGNATES HYDRAULIC MOTOR DISPLACEMENT IN CU IN/REV (110 = 11.0 CU IN REV)

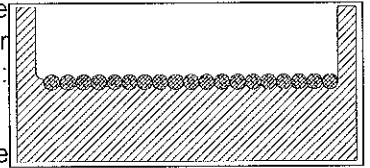
**01** DESIGNATES THE DRUM OPTION

**1** PERMITS TESTING AND INSPECTION PER API 2C FOR OFFSHORE CRANES

# GLOSSARY OF TERMS

**Brake Valve** - A hydraulic counterbalance valve is usually bolted to the hoist port of the hydraulic motor. It allows oil to flow freely through the motor in the hoisting direction. When oil pressure tries to rotate the motor in the lowering direction, the brake valve blocks the flow of oil out of the motor until the internal static brake is released. It then controls lowering speed based on the load and flow of oil to the motor. All the heat generated by controlling the speed of the load is dissipated by the hydraulic system, not by the internal static brake.

**Grooved Drum** - A cable drum with grooves on the barrel to ensure the first layer of cable spools properly onto the drum. The grooves can be cast or machined into the drum, or cast or machined into separate pieces that are mechanically fastened to the drum. NOTE: Only one size cable can be used on a grooved drum.



**Sprag or Over-Running Clutch** - A mechanical one-way clutch on the input shaft of the hoist, between the input shaft and the static mechanical brake. The clutch allows the input shaft to turn freely in the direction required to spool cable onto the drum (i.e. lift a load), then immediately locks the hoist gear train to the mechanical brake when the hoist is stopped, holding the load in place.

**Static, Mechanical, or Load-Holding Brake** - A multi-disc, spring applied, hydraulically released brake that works together with the sprag clutch to hold a suspended load. This brake is not designed to stop a load being lowered, but holds the load in place when the hoist is not being operated.

**First Layer Line Pull Rating** - The maximum rated line pull (in pounds or kilograms) on the first layer of cable. The maximum rating for any particular hoist is based on maintaining an acceptable structural design factor and service life. Certain combinations of drum, gear ratio, motor and hydraulic pressure, may reduce this rating.

**First Layer Line Speed Rating** - The maximum rated line speed (in feet or meters per minute) on the first layer of cable. Certain combinations of drum, gear ratio, motor and hydraulic flow may reduce or increase this rating.

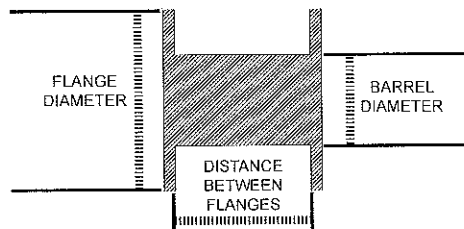
**D/d Ratio** - The ratio of cable drum barrel diameter (D) to wire rope diameter (d). Current ANSI standards require a minimum of 17:1.

## EXAMPLES:

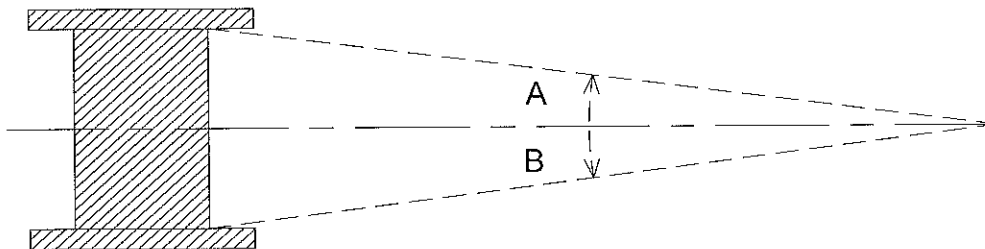
If you know the cable diameter you want to use, multiply it by 17 to get the MINIMUM cable drum barrel diameter. (i.e. ½ inch wire rope X 17 = 8.5 inches - this is the minimum hoist barrel diameter)

If you know the barrel diameter, divide it by 17 to get the MAXIMUM wire rope diameter. (i.e. 10 inch barrel diameter / 17 = 0.588, or 9/16 inch - this is the maximum wire rope diameter)

## Cable Drum Dimensions -



**Fleet Angle** - The angle between the wire rope's position at the extreme end wrap on a drum, and a line drawn perpendicular to the axis of the drum, through the center of the nearest fixed sheave or load attachment point.



First sheave or load should be centered between the drum flanges, so that angle "a" and angle "b" are equal.

Angles "a" and "b" should be a minimum of ½ degree and a maximum of 1½ degrees.

**Wrap** - A single coil of wire rope wound on a drum.

**Layer** - All wraps of wire rope on the same level between drum flanges.

**Freeboard** - The amount of drum flange that is exposed radially past the last layer of wire rope. Minimum freeboard varies with the regulatory organization. ASME B30.5 requires ½ in. minimum freeboard.

# GENERAL SAFETY RECOMMENDATIONS

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and hoist must be operated with care and concern for the equipment and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

1. Be certain equipment (boom, sheave blocks, pendants, etc.) is either lowered to the ground or blocked securely before servicing, adjusting, or repairing hoist.
2. Be sure personnel are clear of work area **BEFORE** operating hoist.
3. Read all warning and caution tags provided for safe operation and service of the hoist and become familiar with the operation and function of all controls before operating the hoist.
4. Inspect rigging and hoist at the beginning of each work shift. Defects should be corrected immediately. **DO NOT** operate a hoist with defects.
5. Keep equipment in good operating condition. Perform scheduled servicing and adjustments listed in the "Preventive Maintenance" section of this manual.
6. An equipment warm-up procedure is recommended for all start-ups and essential at ambient temperatures below +40°F (+4°C). Refer to "Warm-up Procedure" listed in the "Preventive Maintenance" section of this manual.
7. **DO NOT** exceed the maximum pressure (PSI, kPa) or flow (GPM, lpm) stated in the hoist specifications found in the specific sales brochure.
8. Operate hoist line speeds to match job conditions.
9. Protective gloves should be used when handling wire rope.
10. **NEVER** attempt to handle wire rope when the hook end is not free. Keep all parts of body and clothing clear of cable rollers, cable entry area of fairleads, sheaves and hoist drum.
11. When winding wire rope on the hoist drum, never attempt to maintain tension by allowing wire rope to slip through hands. Always use "Hand-Over-Hand" technique.
12. Never use wire rope with broken strands. Replace wire rope that is damaged. Refer to wire rope supplier manual.
13. **DO NOT** weld on any part of the hoist without approval from PACCAR Winch Engineering.
14. Use recommended hydraulic oil and gear lubricant.
15. Keep hydraulic system clean and free from contamination at all times.
16. Use correct anchor for wire rope and pocket in drum.
17. **DO NOT** use knots to secure or attach wire rope.
18. The BRADEN designed wire rope anchors are **NOT** intended to support the rated load. **ALWAYS** maintain a minimum of five (5) wraps of wire rope on the drum. It is recommended that the last five (5) wraps of wire rope be painted bright red to serve as a visual reminder.
19. Never attempt to clean, oil or perform any maintenance on a machine with the engine or prime mover running, unless instructed to do so in this manual.
20. Never operate hoist controls unless you are properly positioned at the operators station and you are sure personnel are clear of the work area.
21. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
22. Ground personnel should stay in view of the operator and clear of the hoist drum. **DO NOT** allow ground personnel near wire rope under tension. A safe distance of 1½ times the working length of the wire rope should be maintained.
23. Install guarding to prevent personnel from getting any part of body or clothing caught at a point where the cable is wrapped onto the drum or drawn through guide rollers or potential "pinch points".
24. Install switches or valves that will shut off power to the hoist, in locations where they can be reached by anyone entangled in the wire rope before being drawn into the hoist or any "pinch point".
25. "Deadman" controls, which automatically shut off power to the hoist whenever the operator leaves his station or releases the hoist control lever, should be installed whenever practical.
26. **NEVER** allow anyone to position any part of body under a suspended load.
27. Avoid sudden "shock" loads or attempting to "jerk" a load free. This type of operation may cause heavy loads, in excess of rated capacity, which may result in failure of wire rope, hoist or crane structure.
28. Whenever possible, install the hoist in a location that is not immediately adjacent to a "normal" operator's station.
29. All hoist controls shall be located within easy reach of the operator. The controls shall be installed in such a location that the operator is removed from the electrical path to ground if the load, rigging, or wire rope come in contact with or within proximity to an electrically energized conductor.

30. Before operating the hoist, be sure ALL safety procedures for the equipment or vehicle the hoist is mounted on are properly followed and/or in place.

If there is any question regarding the preceding safety recommendations, or the safe operation of your hoist, please contact the Braden Product Support Department at 1-918-251-8511, Monday through Friday from 0800 to 1630 hours, CST, by fax at 1-918-259-1575, or via the internet at [www.paccarwinch.com](http://www.paccarwinch.com) for the latest available information.

**Safety and informational callouts used in this manual include:**

**⚠ WARNING ⚠**

**WARNING** – This emblem is used to warn against hazards and unsafe practice which **COULD** result in severe personal injury or death if proper procedures are not followed.

**⚠ CAUTION ⚠**

**CAUTION** – This emblem is used to warn against potential or unsafe practices which **COULD** result in personal injury and product or property damage if proper procedures are not followed.



# BASIC OPERATION

## DESCRIPTION OF HOIST

The CH165A, CH175B & CH230B hoists are made up of the following sub-assemblies:

1. Hydraulic motor and brake valve
2. Brake cylinder and brake clutch assembly
3. Hoist base components
4. Hoist drum and gear train

(Refer to illustration on page 9)

## THEORY OF OPERATION

The primary sun gear is directly coupled to the hydraulic motor by the inner race of the brake clutch assembly. As the motor turns in the hoisting direction (clockwise for -01 drums) the planetary assemblies reduce the input speed of the motor and rotate the ring gear and winch drum. Since the output planet carrier is held from turning by the drum bearing support on -01 drums, the drum rotates in the opposite direction of the motor input shaft. On -02 and -21 drums the output carrier is splined to the drum, and the drum rotates in the same direction as the input shaft. In the hoisting direction, the static brake remains fully applied and the input shaft rotates freely through the sprag clutch. When the motor is stopped, the load tries to rotate the hoist gear train in the opposite direction. The sprag clutch on the input shaft immediately locks up, allowing the fully applied static brake to hold the load from dropping. See Dual Brake System - Operation for a detailed description of the lowering sequence of operation.

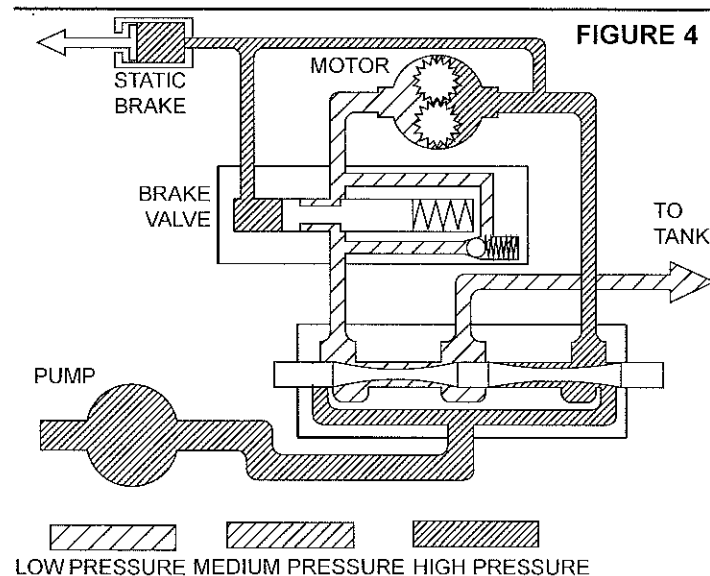
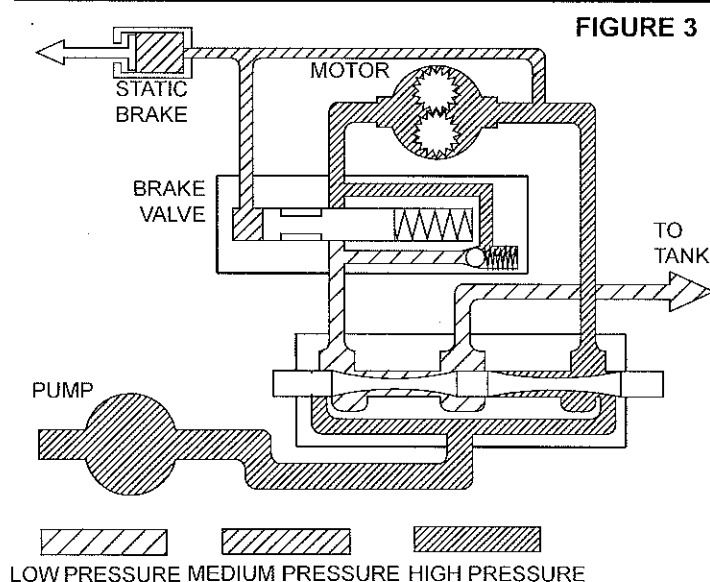
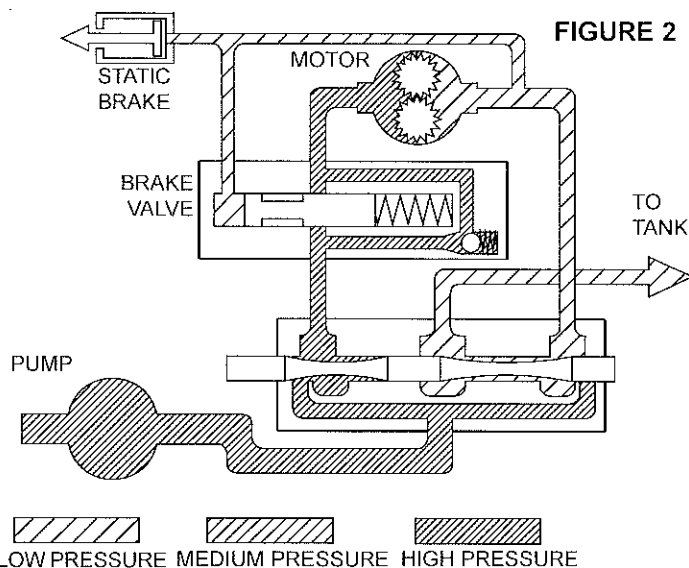
## Dual Brake System – Description

The dual brake system consists of a dynamic brake system and a static brake system.

The dynamic brake system has two operating components:

1. Brake valve assembly
2. Hydraulic motor

The brake valve is basically a counterbalance valve with improved metering. It contains a check valve to allow free flow of oil.



The static brake is released by the brake valve pilot pressure at a pressure lower than that required to open the pilot operated spool valve. This sequence assures that dynamic braking takes place in the brake valve and that little, if any, heat is absorbed by the friction brake.

The static friction brake is a load holding brake only and has nothing to do with dynamic braking or rate of descent of a load.

The brake clutch is splined to the primary sun gear shaft between the motor and the primary sun gear. It will allow this shaft to turn freely in the direction to raise a load and lock up to force the brake discs to turn with the shaft in the direction to lower a load. Figures 5 and 6.

The hydraulic cylinder, when pressurized, will release the spring pressure on the brake discs, allowing the brake discs to turn freely.

### Dual Brake System – Operation

When hoisting a load, the brake clutch which connects the motor shaft to the primary sun gear, allows free rotation. The sprag cams lay over and permit the inner race to turn free of the outer race. Figure 5. The static friction brake remains fully engaged. The hoist, in raising a load, is not affected by any braking action. Figure 2.

When the lifting operation is stopped, the load attempts to turn the primary sun gear in the opposite direction. This reversed input causes the sprag cams to instantly roll upward and firmly lock the shaft to the fully engaged friction brake. Figure 6.

When the hoist is powered in reverse, to lower the load, the motor cannot rotate until sufficient pilot pressure is present to open the brake valve. Figures 3 & 4. The friction brake within the hoist will completely release at a pressure lower than that required to open the brake valve. The extent to which the brake valve opens will determine the amount of oil that can flow through it and the speed at which the load will be lowered. Increasing the flow of oil to the hoist motor will cause the pressure to rise and the opening in the brake valve to enlarge, speeding up the descent of the load. Decreasing this flow causes the pressure to lower and the opening in the brake valve to decrease thus slowing the descent of the load.

When the control valve is shifted to neutral, the pressure will drop and the brake valve will close, stopping the load. The friction brake will engage and hold the load after the brake valve has closed.

When lowering a load very slowly for precise positioning, very little oil flow actually occurs through the hoist motor. The pressure will build up to a point where the static brake will release sufficiently to allow the load to rotate the motor through its own internal leakage. This feature results in a very slow speed and extremely accurate positioning.

The friction brake receives very little wear in the lowering operation. All of the heat generated by the lowering and stopping of a load is absorbed by the hydraulic oil where it can be readily dissipated.

### Static Friction Brake Applied

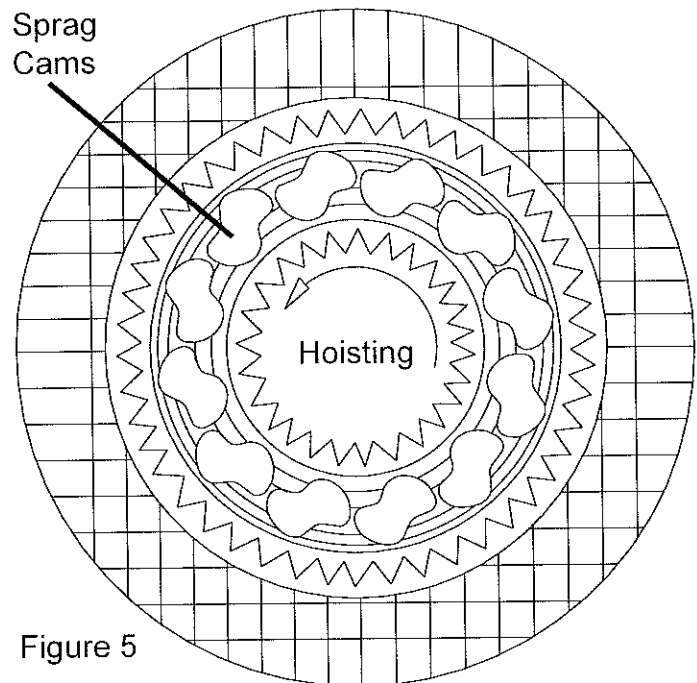


Figure 5

### Static Friction Brake Applied

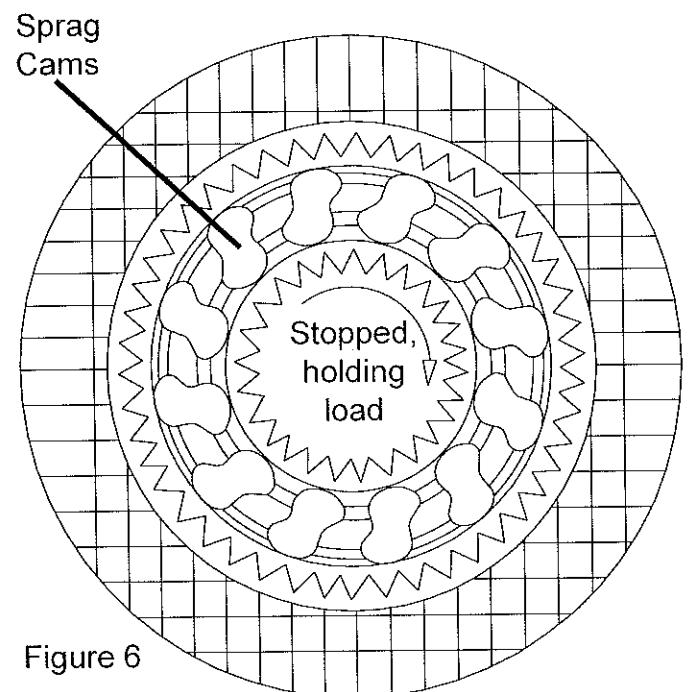


Figure 6

# INSTALLATION

## GENERAL REQUIREMENTS

1. The hoist must be mounted with the centerline of the drum in a horizontal position. The mounting plane can be rotated to any position around this centerline, providing the vent plug is positioned above the oil level.
2. When mounting the hoist, use four 1¼ in. grade 8 capscrews or bolts and nuts using both mounting holes in each end plate. Use narrow, hardened washers under the bolt heads and nuts

### ⚠ WARNING ⚠

**DO NOT** weld hoist to mounting surface. Welding may not provide adequate structural support for winch loads. This may cause loss of load control, which could result in property damage, injury or death. Welding may also damage bearings and seals, resulting in premature failure.

3. The vent plug must always be located above the horizontal centerline of the hoist drum. If the hoist is mounted on a pivoting surface, be sure the vent remains above the centerline at all times. If necessary, reposition the bearing support.
4. It is important that the hoist be mounted on a surface that will not flex when the hoist is in use, since this could bind the working parts of the hoist. Also, be sure the hoist is mounted on a flat surface. If necessary, use shim stock to insure proper mounting. The mounting surface must be flat within 0.020 inches (.5 mm).
5. Hydraulic lines and components that operate the hoist should be of sufficient size to assure minimum back pressure at the hoist motor ports. To insure adequate static brake load holding ability, back pressure on the hoist should not exceed 100 psi (690 kPa).
6. Make certain that the hoist drum is centered behind the first sheave and the fleet angle does not exceed 1½ degrees.

The hoist should also be mounted perpendicular to an imaginary line from the center of the drum to the first sheave to ensure even spooling. (ref. drawing on page 4)

### ⚠ WARNING ⚠

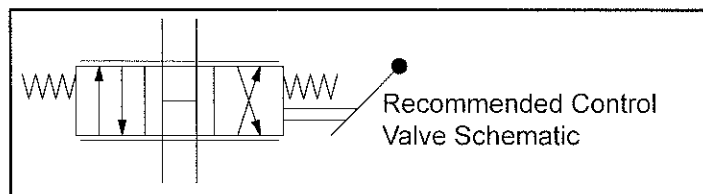
**DO NOT** use a control valve with any detents or latching mechanism that would hold the control valve in an actuated or running position when the operator releases the control handle. Use of the wrong type of control valve could lead to unintentional operation of the hoist, which could result in property damage, personal injury or death.

7. The hoist directional control valve must be a three-position, four-way valve without detents and with a spring centered motor spool such that the valve returns to the centered position whenever the handle is released, and both work ports are opened to tank (open center, open port, see schematic below).
8. The hydraulic oil filter should have a 10 micron nominal rating and be a full-flow type.
9. High quality hydraulic oil is essential for satisfactory performance and long hydraulic system component life.

Oil having 150 to 330 SUS viscosity at 100°F (38°C) and viscosity index of 100 or greater will give good results under normal temperature conditions. The use of an oil having a high viscosity index will minimize cold-start trouble and reduce the length of warm-up periods. A high viscosity index will minimize changes in viscosity with corresponding changes in temperature.

Maximum cold weather start-up viscosity should not exceed 5000 SUS with a pour point at least 20°F (11°C) lower than the minimum temperature.

In general terms; for continuous operation at ambient temperatures between 50 and 110°F (10-43°C) use ISO VG 46 – 68 (SAE20); for continuous operation between 10 and 90°F (-12 and 32°C) use ISO VG 32 (SAE10W).



# WIRE ROPE INSTALLATION

## (ONE PIECE CABLE WEDGE)

### ⚠ WARNING ⚠

#### THE CABLE ANCHORS ALONE ON HOISTS ARE NOT INTENDED TO HOLD RATED LOADS.

Hoist loads applied directly to the wire rope anchor may cause the wire rope to pull free and result in the sudden loss of load control and cause property damage, personal injury or death. A minimum of 5 wraps of wire rope must be left on the drum barrel to achieve rated load.

The wedge and anchor pocket must be clean and dry. The end of the wire rope being anchored to the drum must be clean and dry and not frayed. Anything on the end of the wire rope to keep it from fraying (i.e. tape or wire) must not be in contact with the wedge when the installation is complete. Consult the wire rope manufacturer on the proper treatment of the dead end of the wire rope. Some rope manufacturers recommend when using rotation resistant wire rope, that the rope end be seized, welded or brazed before inserting the wire rope into the wedge socket to prevent core slippage or loss of rope lay.

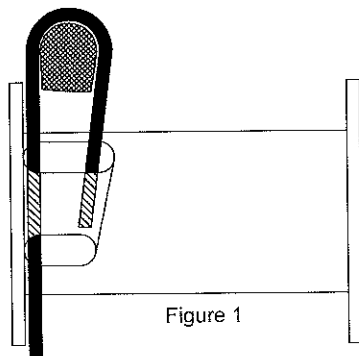
Take the free end of the wire rope and insert it through the small opening on the cable drum. Loop the wire rope and push the free end about 3/4 of the way back through the pocket. Install the wedge as shown in figure 1, then pull the slack out of the wire rope. The "dead" end of the rope needs to extend slightly beyond the end of the wedge as shown in figure 2.

Using a hammer and brass drift, drive the wedge as deep into the pocket as possible to ensure it is fully seated and no further movement is detected. Applying a load on the wire rope will also help seat the wedge in the pocket. Check to ensure the wedge does not protrude from either end of the pocket, causing it to interfere with proper spooling of wire rope onto the drum (see figures 1 & 2).

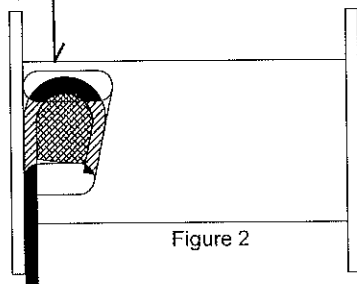
If there is interference or the wedge does not seat firmly, contact the Braden Product Support Department at 1-918-251-8511 to determine the proper wedge size.

It is important that the wire rope have the proper tensioning when it is installed on the drum. When the wire rope is first installed, you should operate the hoist, with light to moderate loads, with reeving that let's you place these loads on the block and the drum with all the rope off the drum except for the last five wraps.

### Correct Installations

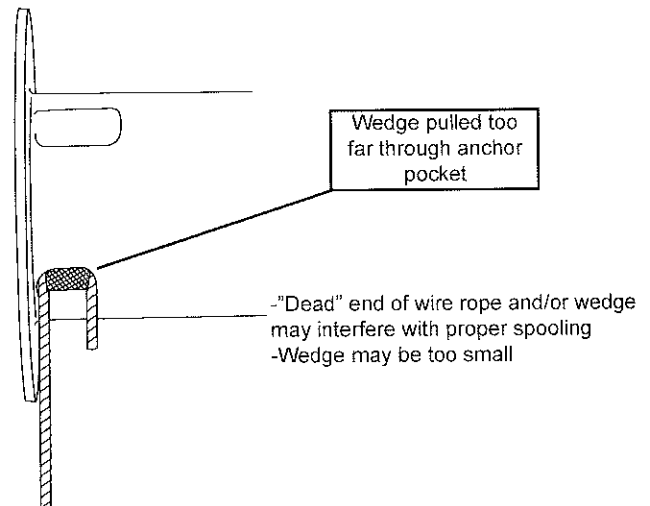
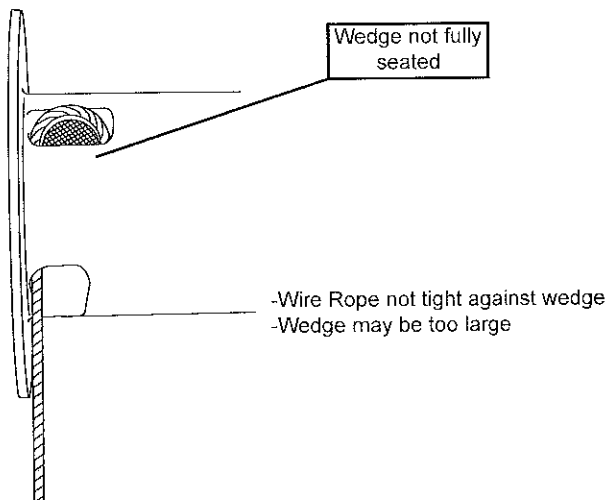


Drive down from this side



Wedge and wire rope fully seated in pocket

### Incorrect Installations



# HOIST OPERATION

The following warnings and instructions are basic to safe hoist operation. Please read them carefully and follow them each time your hoist is operated. These instructions are provided in addition to any information furnished by the Original Equipment Manufacturer. Equipment operators should be completely familiar with the overall operation of the piece of equipment on which the hoist is mounted (i.e. crane, truck crane, etc.). If you have any questions concerning the safe operation of this hoist or the equipment it is mounted on, contact the equipment manufacturer that installed the hoist, or the Braden Product Support Department at 1-918-251-8511, Monday through Friday, 0800 to 1630 hours CST, by fax at 1-918- 259-1575, or via the internet at [www.paccarwinch.com](http://www.paccarwinch.com).

## **WARNING**

Ground personnel must stay in view of the operator and clear of the load and hoist drum at all times. **DO NOT** allow personnel near the hoist line under tension. **DO NOT** allow personnel near the hoist drum while the hoist is in operation. **DO NOT** allow personnel to be in line with the load. **DO NOT** allow personnel to stand under a suspended load. A safe distance of at least 1½ times the working length of the cable should be maintained by ground personnel. A broken cable and/or lost load may cause property damage, personal injury or death.

## **WARNING**

Failure to properly warm up the hoist, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

### Warm-up Procedures

A warm-up procedure is recommended at each start-up and is essential at ambient temperatures below +40°F (4°C).

The engine should be run at its lowest recommended RPM with the hydraulic hoist control valve in neutral allowing sufficient time to warm up the system. The hoist should then be operated at low speeds, raise and lower with no load on the hook, several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

## **CAUTION**

If the hoist is mounted on a crane that has an extendable boom, care must be taken to pay-out cable as the boom is extended. Failure to pay-out sufficient cable could result in a "two-blocking" condition that could result in damage to and/or failure of the hoist, cable, sheaves and/or boom.

## **WARNING**

Failure to use the proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in property damage, severe personal injury or death. Some gear lubricants contain large amounts of EP (extreme pressure) and anti-friction additives which may contribute to brake slippage and damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake slippage. Make certain that the gear oil viscosity used in your hoist is correct for your prevailing ambient temperature.

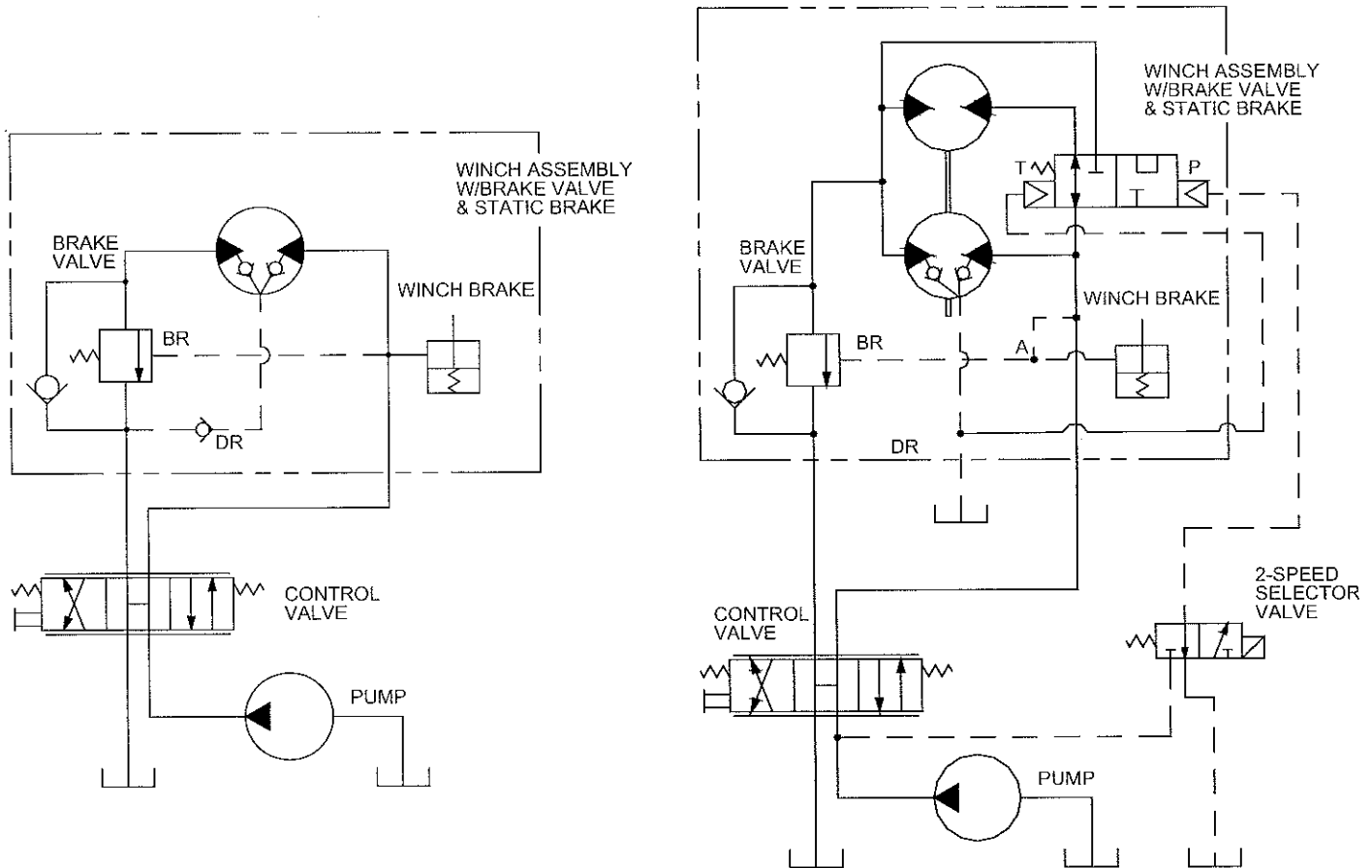
After the hoist/boom is properly positioned, we recommend the operator slowly pay-out, then haul-in a short length of cable. The hoist should perform these operations in a smooth and controlled manner. If the hoist does not operate smoothly or makes any unusual sounds, the source of the problem should be identified and corrected before any attempt is made to lift a load.

Slowly pay-out wire rope from the hoist drum until it reaches the load. Securely fasten the hoist cable to the load and be sure all ground personnel are a safe distance from the load. Slowly lift the load a short distance and stop. A small amount of "bounce" may be observed, depending on the weight of the load, size and type of wire rope, reaving and the amount of boom extension. Allow the load to stabilize and then watch for any sign of downward movement or cable drum rotation. The hoist static brake should hold the load in place without allowing any downward movement at all. If the load creeps down, it should be lowered to the ground immediately and the source of the problem identified and corrected.

If the hoist is holding the load securely, proceed with normal operations in accordance with the equipment manufacturer's operating procedures and load charts.

# TYPICAL HYDRAULIC CIRCUIT

**NOTE:** The hydraulic circuit shown below is representative of typical Braden hoists. Options and accessory equipment may result in changes to the circuit shown. If there are any questions regarding the hydraulic circuit, refer to information supplied by the original equipment manufacturer, or contact the Braden Product Support Department at the number given in the Foreword of this manual. (ALWAYS have the hoist model and serial number when contacting the factory)



## RECOMMENDED BOLT TORQUE

The general purpose torque shown in the chart applies to SAE Grade 5 & Grade 8 bolts, studs and standard steel full, thick and high nuts.

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30 engine oil applied to threads and face of bolt or nut.

### RECOMMENDED FASTENER TORQUE

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
1/4	20 28	8	6	12	9
5/16	18 24	17	13	24	18
3/8	16 24	31	23	45	35
7/16	14 20	50	35	70	50
1/2	13 20	75	55	110	80
9/16	12 18	110	80	150	110
5/8	11 18	150	115	210	160

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
3/4	10 16	265	200	380	280
7/8	9 14	420	325	600	450
1	8 14	640	485	910	680
1 1/8	7 12	790	590	1290	970
1 1/4	7 12	1120	835	1820	1360
1 3/8	6 12	1460	1095	2385	1790
1 1/2	6 12	1940	1460	3160	2370

# PREVENTATIVE MAINTENANCE

A regular program of preventive maintenance for your planetary hoist is required to minimize the need for emergency servicing and promote safe, reliable hoist operation.

The user of Braden hoist products is responsible for hoist inspection, testing, operator training and maintenance noted below with frequency dependent upon the severity of the hoist duty cycle and the thoroughness of the preventive maintenance program. Field experience, supported by engineering tests, indicate the three service procedures listed below are the most critical to safe, reliable hoist operation and **MUST** be observed.

- Regular Gear Oil Changes -
- Use of Proper Gear Oil – recommended type for prevailing ambient temperatures and additives.
- Periodic Disassembly and Inspection of All Wear Components – in compliance with ANSI specification B30.5c, 1987 and API RP 2D.

Crane inspection records as well as records of preventive maintenance, repairs and modifications must be available for a minimum of five (5) years. These records should include but not limited to, hoist model and serial number, name and employer of repair technician, date and description of work performed.

**Pre-use Inspection** (each shift the hoist is used): This inspection must be performed prior to placing the crane into service and then as necessary during the day for extended operation.

1. Check for external oil leaks and repair as necessary.  
**This is extremely important due to the accelerated wear that can be caused by insufficient lubricating oil in the hoist.** Lubricant level must be visible in the lower half of the sight glass. Use only recommended lubricants. See Recommended Lubricants chart in this manual.
2. Check hydraulic plumbing for damage, such as chafed or deteriorating hoses and repair as necessary.
3. Visually inspect for loose or missing bolts, pins, keepers or cotter pins and replace or tighten as necessary.
4. The gear oil should be changed after the first 100 hours of operation or 30 days. The regular gear oil change intervals may be adopted after the first oil change.
5. Inspect the full length of wire rope, rigging and all sheaves according to the wire rope and crane manufacturer's recommendations.
6. A warm-up procedure is recommended at each start-up and is mandatory at ambient temperatures below +40°F (4°C). The engine should be run at its lowest RPM with the hydraulic hoist control in neutral allowing sufficient time to warm up the system. The hoist should

then be operated at low speeds, hoisting and lowering with no load, several times to prime all hydraulic lines with warm oil and to circulate lubricant through the planetary gear sets.

## **WARNING**

Failure to properly warm up the hoist, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

**Quarterly Inspection** (every 3 months) or monthly in Severe Duty Applications or prior to placing the machine in service if it has not been used for three months or more.

1. Perform the Pre-use Inspection.
2. Inspect all hoist fasteners for tightness and corrosion. Replace all corroded fasteners and tighten per the torque specifications on page 13.
3. The hydraulic system filters should be changed after the first 50 hours of operation then every 500 hours or quarterly or in accordance with the crane manufacturer's recommendations.
4. Take a sample of the gear oil from the hoist drum following the oil sampling procedure on page 16. The oil sample must be taken prior to changing the gear oil. Analyze the sample for wear metals, viscosity, signs of overheating, oxidation, water and other contaminants. If the oil sample contains an unusual amount of metallic particles, the hoist should be removed from service and undergo a tear-down inspection.

**Annual Inspection, Testing & Preventive Maintenance** or semi-annually in Severe Duty Applications.

1. Perform the Pre-Use and Quarterly Inspections.
2. Change the lubricating oil in the hoist drum after an oil sample is taken.

## **WARNING**

The gear oil must be changed to remove wear particles that impede reliable and safe operation of the brake clutch and erode bearings and seals. Failure to change gear oil at recommended intervals may contribute to intermittent brake slippage, loss of load control, injury or death.

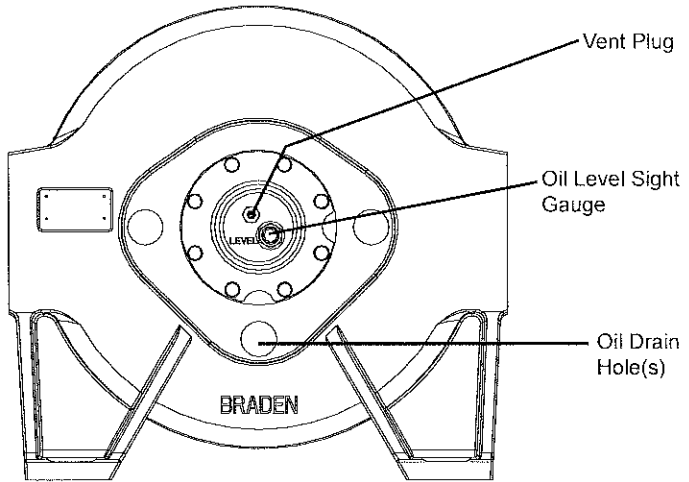
The gear oil should be changed whenever the ambient temperature changes significantly and an oil from a different viscosity range would be more appropriate. Oil viscosity is critical to reliable brake clutch operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake clutch slippage. Make certain the gear oil viscosity used in your hoist is correct for your prevailing ambient temperature.

⚠

WARNING

⚠

Failure to use the proper type and viscosity gear oil may result in loss of load control, property damage, injury or death.



**NOTE:** If the oil sampling/analysis has not been performed as required, tear-down inspections will be required. Refer to Hoist Disassembly section of this manual.

To change the gear oil, slowly rotate the drum until the oil drain plug is aligned with the lower oil port access hole. Install a short length of pipe threaded for 1 in. NPT into the threaded drain port in the cable drum. Reach through the pipe with a long hex-key and remove the drain plug. The oil will drain out the length of pipe and not between the drum and base. When the oil has drained, install the plug and remove the drain pipe. Removing the vent plug will hasten the oil drain. Rotate the drum until the drain port is aligned with the fill/level port in the end bracket. Refill the hoist with recommended lubricant. Install the plug securely.

3. The vent plug is located in the drum bearing support. It is important to keep the vent plug clean and unobstructed. Whenever the gear oil is changed, the vent plug should be removed, cleaned in solvent and reinstalled. Do not paint over the vent plug or replace with a solid plug or grease fitting.

⚠

WARNING

⚠

**DO NOT** insert fingers through oil drain hole to determine drain hole alignment. Movement of the drum could result in sever injury should appendages be present in the drain hole.

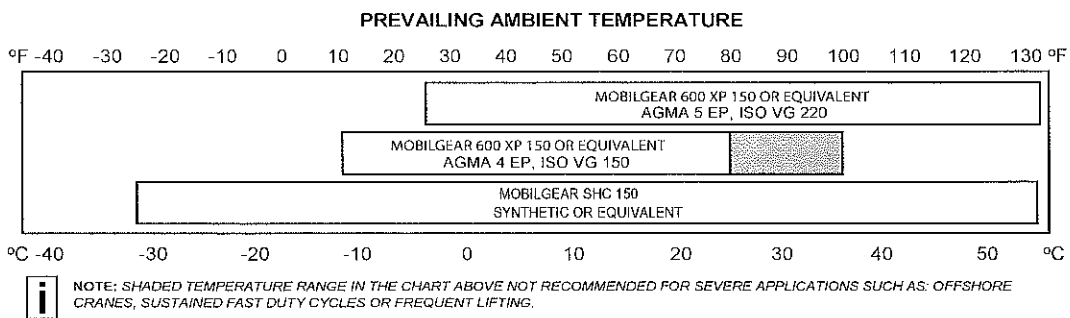
# Recommended Planetary Gear Oil

⚠

WARNING

⚠

Failure to use the proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in property damage, severe personal injury or death. Some gear lubricants contain large amounts of EP (extreme pressure) and anti-friction additives which may contribute to brake slippage and damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake operation. Our tests indicate that excessively heavy or thick gear oil may contribute to intermittent brake slippage. Make certain that the gear oil viscosity used in your hoist is correct for your prevailing ambient temperature.



Planetary hoists are factory filled with Mobilgear 600 XP 150, or equivalent. Consult your oil supplier for other equivalent oils if required.

Mobil	Shell	Chevron	Texaco
Mobilgear 600 XP 150	Omala 150	Gear Compounds EP 150	Meropa 150
Mobilgear 600 XP 220	Omala 220	Gear Compounds EP 220	Meropa 220



## Tear-down Inspection

Any hoist that has not been subjected to regular oil sample analysis should undergo a tear-down inspection every 24 months. Also, if a hoist has an unknown history of repair and/or maintenance, the hoist should undergo a tear-down inspection prior to being placed into service.

A tear-down inspection of the hoist should include the complete disassembly, cleaning, inspection and replacement of all worn, cracked, corroded or distorted parts such as pins, bearings, shafts and brake components. All seals and o-rings should be replaced during a tear-down inspection. Always use new Spirol pins in the planet gear shafts.

**Any deficiency must be corrected immediately.**

Before placing the hoist back in service, the rebuilt hoist must be pull tested to the rated load of the hoist with a dynamometer or equivalent measuring device. The hoist should be dynamically tested by rotating the drum several times, in both raising and lowering directions, while under load of at least 30 % of the hoist rated lifting capacity. Check for smooth, quiet operation during this procedure.

---

# OIL SAMPLING AND ANALYSIS

Proper oil sampling and analysis of the sample, is a vital part of a comprehensive preventive maintenance program. Information obtained from the oil analysis is best utilized in conjunction with a regular program of preventive maintenance. The early warning of abnormal wear provided by an analysis program allows the user to substitute preventive maintenance for a far more costly and dangerous failure that may lead to loss of load control that could result in property damage, personal injury or death. Early detection of accelerated component wear allows the scheduling of corrective maintenance and can reduce in-operation failures and costly down time.

### Taking a Valid Oil Sample

Prepare the hoist by cleaning the drain area and drain extension tube in order to obtain an uncontaminated sample. Operate the hoist in both directions for one to two minutes and then take the oil sample from the drain port as soon as possible. Do not take the sample from the first oil out of the drain port. Take a sample from the mid-stream flow of the oil to obtain an accurate representation of the oil condition. After taking an oil sample, refill hoist with recommended lubricant.

### Analysis

General Guide Lines

(After approximately 250 hours of operation)

**Note:** The first oil change usually contains more "wear metals". Following the initial break-in period, the wear metal levels should stabilize at a lower number.

### Iron Contaminates

100 to 400 ppm    Normal

400 to 700 ppm    Caution – Abnormal Sample (monitor more frequently), tear-down inspection may be required.

701 ppm & up    Unacceptable – Abnormal Sample (tear down inspection required)

In all contaminate monitoring, equally important as the level of contamination, is the change in the amount of contamination compared to previous samples.

Moisture contamination will lead to the formation of acids that damage all internal components. Silica found in the oil typically indicates "dirt" and contaminated lubricant supply or poor maintenance practices.

## ⚠ WARNING ⚠

Hot oil may cause personal injury and/or burns to unprotected skin. Make certain the oil has cooled to a safe temperature (less than 110°F or 43°C) before taking an oil sample, changing oil or servicing the hoist.

# TROUBLESHOOTING

The following troubleshooting section is provided as a general guide. You may also need to contact the Original Equipment Manufacturer (OEM) for additional information.

## ⚠ WARNING ⚠

If a hoist exhibits any sign of:

- Erratic operation such as poor load control, load creeping down or chattering.
- Unusual noise.
- Gear oil leaks
- A sudden rise in wear particles from oil analysis

The hoist **MUST** be removed from service until the problem has been corrected. If a hoist has been subjected to a sudden heavy load (shock-load) or overload, the hoist must be removed from service, disassembled and all internal components thoroughly inspected for damage. Continued operation with a defect may result in loss of load control, property damage, injury or death.

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>A</b></p> <p>The hoist will not lower the load or not lower the load smoothly.</p>	<p>1. The problem could be a plugged or loose pilot orifice. The pilot orifice is a small pipe plug with a hole drilled through it, located behind the pilot port fitting on the brake valve. If the orifice becomes plugged, it will prevent the pilot pressure, from the manifold, from opening the brake valve. If the plug becomes loose, it will allow an unregulated amount of oil in to operate the brake valve causing erratic brake valve operation.</p> <p><b>NOTE:</b> Some brake valves do not use a separate pilot orifice plug.</p> <p>2. The friction brake may not be releasing as a result of a defective brake cylinder seal.</p> <p><b>NOTE:</b> If the brake cylinder seal is defective you will usually find oil leaking from the hoist vent plug.</p> <p>3. Friction brake will not release as a result of damaged brake discs.</p>	<p>Remove the pilot hose and fitting from the brake valve, then use a 5/32 inch Allen wrench to remove the pilot orifice. The diameter of the orifice is approximately .020 inches (.5 mm). Clean and install the pilot orifice tightly in the brake valve.</p> <p>Check brake cylinder seal as follows:</p> <p>A. Disconnect the swivel tee from the brake release port. Connect a hand pump with accurate 0-2000 psi (13,800 kPa) gauge and shut-off valve to the fitting in the brake release port.</p> <p>B. Apply 1000 psi (6,900 kPa) to the brake. Close shut-off valve and let stand for five (5) minutes.</p> <p>C. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and replacement of the seals. Refer to "Brake Cylinder Service" section of this manual.</p> <p>Disassemble brake to inspect brake discs. Check stack-up height as described in "Brake Cylinder Service" section of this manual.</p>

TROUBLE	PROBABLE CAUSE	REMEDY
<p><b>B</b></p> <p>Oil leaks from vent plug</p>	<p>1. Same as A2.</p> <p>2. Motor seal may be defective as a result of high back pressure in the motor case drain circuit or contaminated oil. Contamination will usually cause the seal to wear a groove in the motor shaft.</p>	<p>Same as A2.</p> <p>Case drain back pressure must not exceed 100 psi (690 kPa) for gear motors and 44 psi (304 kPa) for piston motors. Inspect hydraulic system for a restriction in the return line to the reservoir.</p> <p>Oil analysis may indicate contamination has worn motor shaft and seal. Thoroughly flush entire hydraulic system and install new filters and oil. Install new motor shaft seal.</p>
<p><b>C</b></p> <p>The brake will not hold a load with the control lever in neutral</p>	<p>1. Excessive system back pressure acting on the brake release port.</p> <p>2. Friction brake will not hold due to worn or damaged brake discs.</p> <p>3. Brake clutch is slipping.</p>	<p>The pressure at the motor lowering port is also transmitted to the brake release pilot circuit. Inspect hydraulic circuit for restrictions, plugged filters or control valves not centering.</p> <p>Same as Remedy of Trouble A3.</p> <p>Improper planetary gear oil may cause the brake clutch to slip. Drain old gear oil and flush winch with solvent. Thoroughly drain solvent and refill hoist with recommended planetary gear oil listed in "Preventive Maintenance".</p> <p>Brake clutch may be damaged or worn. Disassemble and inspect brake clutch as described in "Over-running Clutch Service".</p>
<p><b>D</b></p> <p>The hoist will not hoist the rated load</p>	<p>1. The hoist may be mounted on an uneven or flexible surface which causes distortion of the hoist base and binding of the gear train. Binding in the gear train will absorb horsepower needed to hoist the rated load and cause heat.</p> <p>2. System relief valve may be set too low. Relief valve needs adjustment or repair.</p>	<p>Reinforce mounting surface.</p> <p>If necessary, use shim stock to level hoist. Refer to "Hoist Installation".</p> <p>First loosen, then evenly retighten all hoist mounting bolts to recommended torque.</p> <p>Check relief pressure as follows:</p> <p>A. Install an accurate 0-5000 psi (34,500 kPa) gauge into the inlet port of the brake valve.</p>

TROUBLE	PROBABLE CAUSE	REMEDY
Trouble "D" Continued From Previous Page		<p>B. Apply a stall pull load on the hoist while monitoring pressure.</p> <p>C. Compare gauge reading to hoist specifications. Adjust relief valve as required.</p> <p><b>NOTE:</b> <i>If pressure does not increase in proportion to adjustment, relief valve may be contaminated or worn out. In either case, the relief valve may require disassembly or replacement.</i></p>
	<p>3. Be certain hydraulic system temperature is not more than 180°F (82°C). Excessive hydraulic oil temperatures increase motor internal leakage and reduces motor performance.</p>	<p>Same as remedies for Trouble D1 &amp; D2.</p> <p>Same as remedies for Trouble E2.</p>
	<p>4. Hoist line pull rating is based on 1st layer of wire rope.</p>	<p>Refer to hoist performance charts for additional information.</p>
	<p>5. Rigging and sheaves not operating efficiently.</p>	<p>Perform rigging service as recommended by crane manufacturer.</p>
<p><b>E</b></p> <p>The winch runs hot</p>	<p>1. Same as D1.</p> <p>2. Be certain that the hydraulic system temperature is not more than 180°F (82°C). Excessive hydraulic oil temperatures may be caused by:</p> <p>A. Plugged heat exchanger.</p> <p>B. Too low or too high oil level in hydraulic reservoir.</p> <p>C. Same as D2</p> <p>D. Hydraulic pump not operating efficiently.</p> <p>E. Hydraulic oil is wrong viscosity for operating conditions.</p> <p>3. Excessively worn or damaged internal winch parts.</p>	<p>Same as remedies for Trouble D1.</p> <p>Thoroughly clean exterior and flush interior.</p> <p>Fill/drain to proper level.</p> <p>Same as remedies for Trouble D2.</p> <p>Engine low on horsepower or R.P.M. Tune/adjust engine.</p> <p>Check suction line for damage.</p> <p>Pump worn. Replace pump.</p> <p>Use correct hydraulic oil.</p> <p>Disassemble hoist to inspect/ replace worn parts.</p>

TROUBLE	PROBABLE CAUSE	REMEDY
<p style="text-align: center;"><b>F</b></p> <p>Hoist "chatters" or surges while raising rated load.</p>	<p>2. Same as D1</p> <p>1. Same as D2.</p> <p>2. Hydraulic oil flow to motor may be too low.</p> <p>3. Controls being operated too quickly.</p> <p>4. Hydraulic motor 2-speed control not shifting correctly.</p>	<p>Same as remedies for Trouble D1</p> <p>Same as remedies for Trouble D2.</p> <p>Same as remedies for Trouble E2.</p> <p>Conduct operator training as required.</p> <p>Inspect and repair motor displacement control.</p>
<p style="text-align: center;"><b>G</b></p> <p>The wire rope does not spool smoothly on the drum.</p>	<p>1. The hoist may be mounted too close to the main sheave, causing the fleet angle to be more than 1½ degrees.</p> <p>2. The hoist may not be mounted perpendicular to an imaginary line between the center of the cable drum and the first sheave.</p> <p>3. Could possibly be using the wrong lay rope. There is a distinct advantage in applying rope of the proper direction of lay. When the load is slacked off, the several wraps on the drum will stay closer together and maintain an even layer. If rope of improper lay is used, the coils will spread apart each time the load is removed. Then, when hoisting is resumed, the rope has a tendency to criss-cross and overlap on the drum. The result is apt to be a flattened and crushed rope.</p> <p>4. The hoist may have been overloaded, causing permanent set in the wire rope.</p>	<p>Check mounting distance and fleet angle. Reposition hoist as required to achieve ½ to 1½ degree fleet angle.</p> <p>Refer to "Hoist Installation".</p> <p>Consult wire rope manufacturer for recommendation of wire rope that best suits your application.</p> <p>Replace wire rope and conduct operator/rigger training as required.</p>

# DISASSEMBLY PROCEDURE

1. Remove the wire rope from the hoist drum and wind onto a cable reel as recommended by the wire rope manufacturer. Power-wash the hoist and all motor piping to remove contamination that might enter open hose and motor ports. Align the drain plug in the cable drum with the lowest access hole in the bearing support end plate before removing the hoses and piping. Drain the gear oil from the hoist as described in the Preventive Maintenance section of this manual.

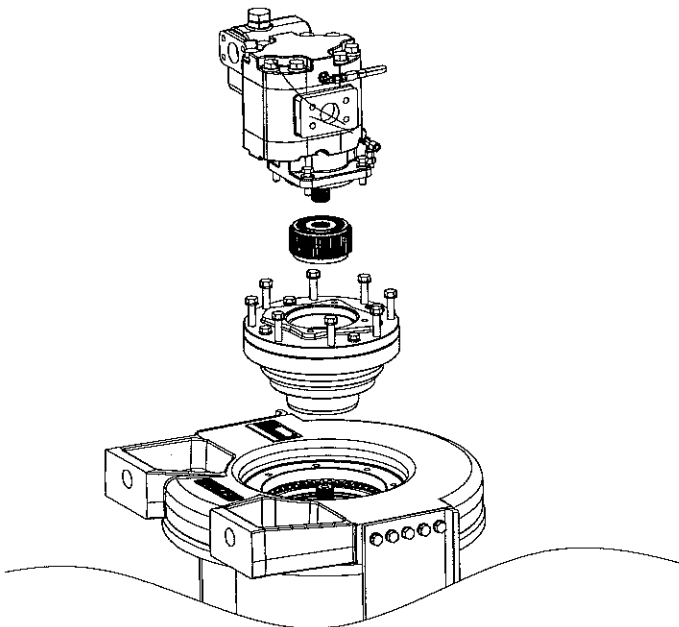
## ⚠ CAUTION ⚠

The CH Series hoist with the standard 01 drum weighs up to approximately 1100 lb (500 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

## ⚠ CAUTION ⚠

**DO NOT** attempt to disassemble/assemble the hoist in the horizontal position as thrust washers may become dislodged and the gear train out of alignment that may cause severe gear train damage that may result in loss of load control, property damage, injury or death.

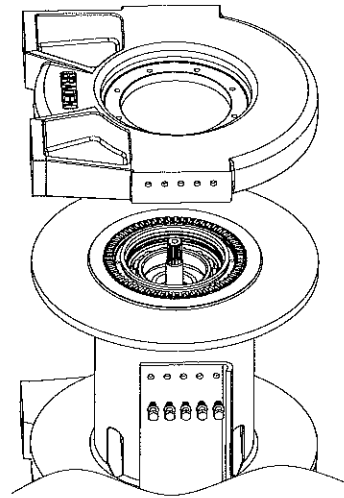
2. Stand the winch up on the drum bearing support end with the motor end up. Secure the hoist in this position so that it does not fall over and cause property damage or personal injury.
3. Tag and remove the hydraulic hoses that connect the brake valve and motor to the brake release port.



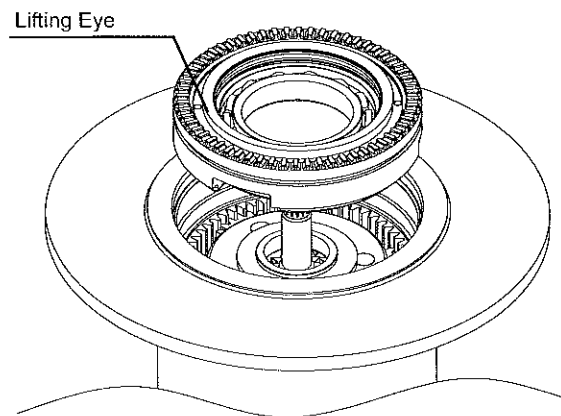
4. Remove the four capscrews and lockwashers securing the motor and lift the motor off the hoist. Cover the motor ports to prevent contamination. Remove the brake clutch assembly from the brake

cylinder. Disassembly of the brake clutch assembly will be discussed in the "Brake Clutch Service" section of this manual.

5. Remove the eight capscrews that secure the brake cylinder to the motor side plate. Lift the brake cylinder out of the hoist and place on a clean work surface. Disassembly of the brake cylinder will be discussed in the "Brake Cylinder Service" section of this manual. Remove and discard the V-Ring seal (Item 20) that was under the brake cylinder (CH165 & CH230 Only). Do not remove the four (4) capscrews holding the motor adapter to the brake cylinder at this time. Refer to "Brake Cylinder Service" later in this manual.



6. Remove the twenty (20) capscrews and lockwashers from the two (2) tie plates, and remove the plates.
7. Remove the motor end plate from the drum.



8. There are two (CH165 & CH230) 1/2 inch NC tapped holes in the drum closure (item 33). Install two capscrews or threaded eye-bolts to aid in removing the closure from the cable drum. Remove and discard the O-Ring (item 17) from the O.D. of the drum closure.

9. For -01 and -02 drums, the primary sun gear (item 22), primary planet carrier assembly (item 300), and output planet carrier assembly (item 400) can now be lifted out of the cable drum.

For -02 drums only, there are also two 1/2 inch NC tapped holes in the ring gear adapter (item 33). Install two capscrews or threaded eye-bolts into these holes and lift the ring gear adapter and ring gear out of the cable drum.

10. Lift the cable drum (item 10) off of the drum support assembly (item 3)
11. Remove the 8 capscrews securing the bearing support (Item 3) to the support side plate (Item 8) and remove the bearing support. Remove and discard the V-ring seal (CH165/ CH230 only.) Remove and discard the lip seal from the support end of the cable drum (item 6.)

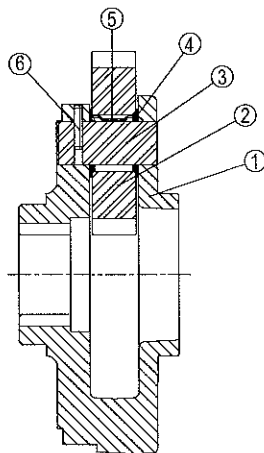
12. Thoroughly clean and inspect all disassembled components at this time. Inspect bearings in the drum closure and cable drum (items 9 & 16), and replace as required. Inspect sealing surfaces on the drum support and brake cylinder and repair any damaged areas if possible, or replace components as required. During a complete winch teardown, drum seals (items 18 and 70) and V-Ring seals (items 6 and 20) should always be replaced. Inspect thrust washers (items 13 and 15) for signs of excessive wear, heat damage or metal transfer and replace as necessary. Inspect the ring gear teeth for nicks, spalling or excessive wear. Replace if wear in contact areas is greater than 0.015 in. (0.4 mm) when compared to unworn area of teeth.

[illegible]

This exploded view diagram illustrates the assembly of a mechanical component, likely a pump or motor. The main body is a large cylindrical housing (1) with a flange (2) and a mounting bracket (3). A central shaft (4) is shown with a pulley (5) and a bearing (6). A motor unit (7) is shown with a shaft (8) and a pulley (9). A large flywheel (10) is shown with a shaft (11) and a pulley (12). A large gear (13) is shown with a shaft (14) and a pulley (15). A large gear (16) is shown with a shaft (17) and a pulley (18). A large gear (19) is shown with a shaft (20) and a pulley (21). A large gear (22) is shown with a shaft (23) and a pulley (24). A large gear (25) is shown with a shaft (26) and a pulley (27). A large gear (28) is shown with a shaft (29) and a pulley (30). A large gear (31) is shown with a shaft (32) and a pulley (33). A large gear (34) is shown with a shaft (35) and a pulley (36).

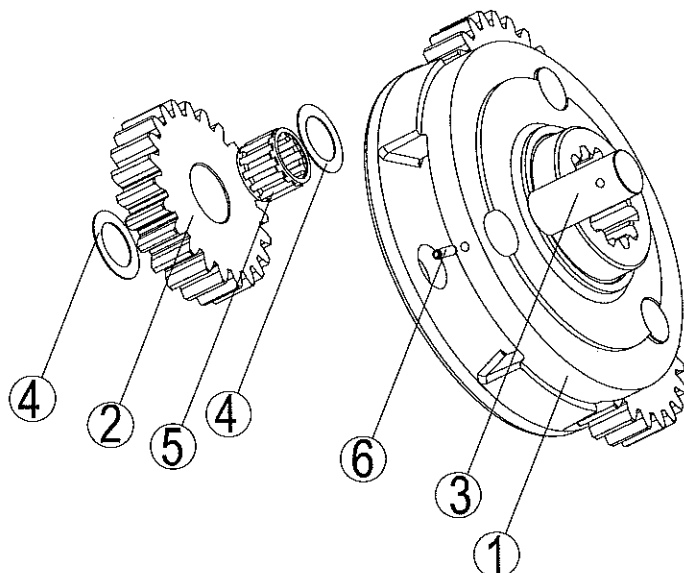


# PLANET CARRIER SERVICE



## Assembly

1. Install a bearing (5) into a planet gear (2) and place a thrust washer (4) on each side of the gear. Position this sub-assembly into an opening in the carrier. Slide a planet gear shaft (3) through the carrier (1), thrust washer (4), bearing (5) and remaining thrust washer (4). **DO NOT** drive shafts into carrier with a hammer. Shafts should move freely when properly aligned.



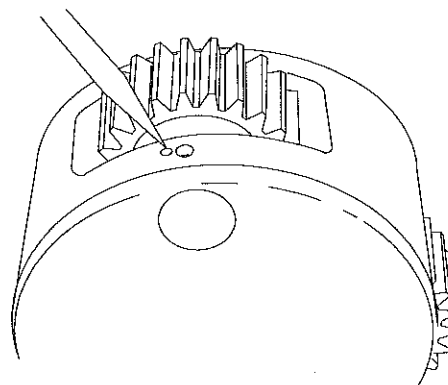
## PRIMARY PLANET CARRIER Disassembly

1. Remove the planet gears by first driving the roll pins (6) into the center of the planet gear shafts (3). Push the planet gear shafts far enough out of the planet carrier to expose the roll pin hole. Use a pin punch to drive the roll pins from the shafts. **DO NOT** reuse roll pins
2. Now you can remove the planet shafts, bearings, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, the bearing should be replaced. Likewise, the cage should be inspected for unusual wear or deformation, particularly the cage bars. If there is any damage that will impair the cage's ability to separate, retain and guide the rollers properly, the bearing should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary

## CAUTION

Driving planet shafts with a hammer may cause damage to the hardened thrust washers which could lead to catastrophic gear train failure which could result in loss of load control, property damage, injury or death

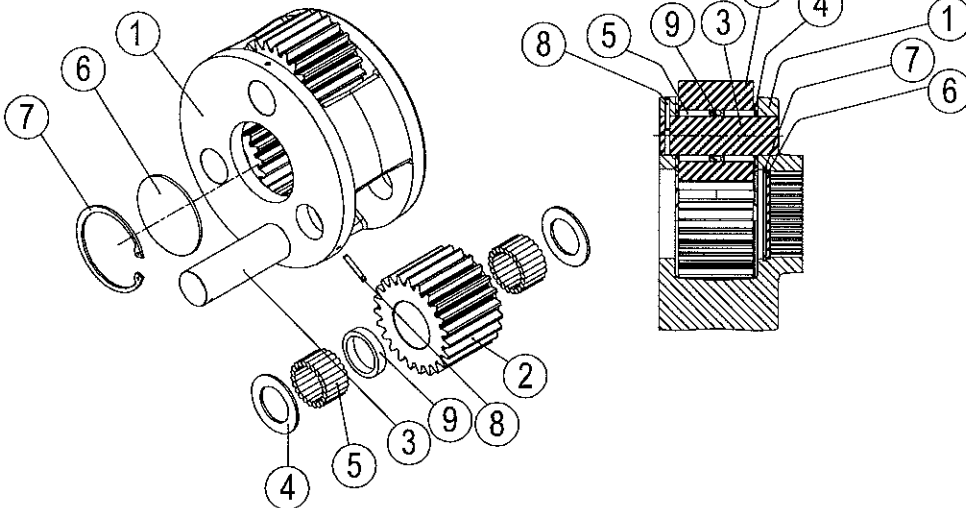
2. Carefully align the pin hole in the carrier with the hole in the shaft and drive a new roll pin into place. **ALWAYS** use **NEW** roll pins. When properly positioned, 50% of the roll pin will engage the planet gear shaft and 50% will remain in the carrier.



3. Note that the roll pin is slightly recessed into the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole and prevent the pin from backing out in operation. Repeat these steps for each of the three planet gears.

## Assembly

### -01 Drum



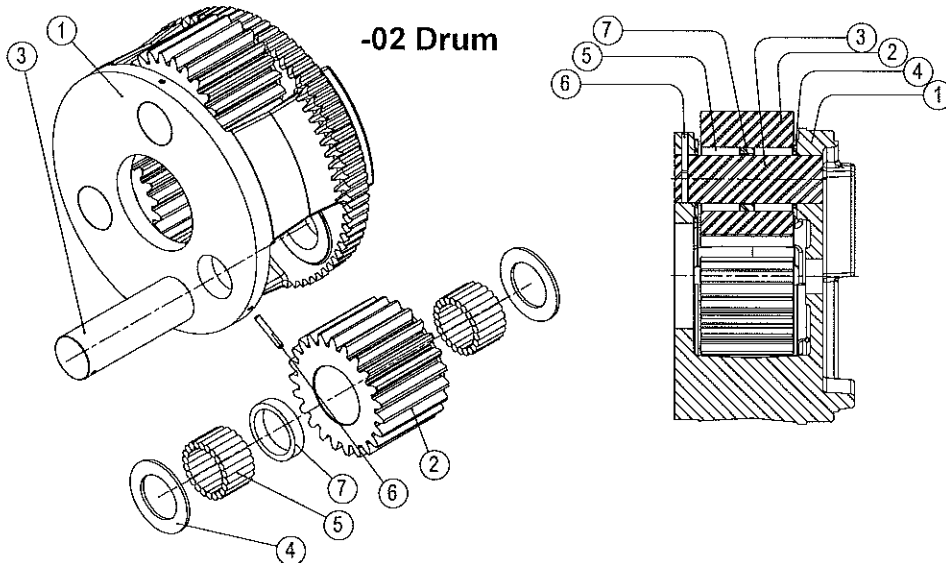
1. Place the output planet carrier on a clean work surface with the splined end of the housing down.

#### -01 Drums only-

Install the thrust plate (6) into the center bore of the housing and secure in place with retaining ring (7).

2. Apply oil soluble grease to a thrust washer (4) and install it on one side of a planet gear (2). Place the planet gear on a clean work surface with the thrust washer down. Apply oil soluble grease to the bore of the gear and stack a row of loose bearing rollers (5) into the planet gear using the grease to hold the rollers in position. There are 22 rollers (18 count in CH175B) in each row. Install a bearing spacer (9) into the gear. Install a second row of bearing rollers on top of the bearing spacer. Place the remaining thrust washer on top of the planet gear. Carefully slide the planet gear sub-assembly into the planet carrier. Install a planet gear shaft into the planet carrier and through the planet gear bearings. **DO NOT** drive shafts into carrier with a hammer. Shafts should move freely when properly aligned.

### -02 Drum



## OUTPUT PLANET CARRIER Disassembly

1. Remove the planet gears by first driving the roll pins (8) into the center of the planet gear shafts (3). Push the planet gear shafts far enough out of the planet carrier to expose the roll pin hole. Use a pin punch to drive the roll pins from the shafts. **DO NOT** reuse roll pins.
2. Remove the planet shafts, bearing rollers, spacers, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, they should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary.

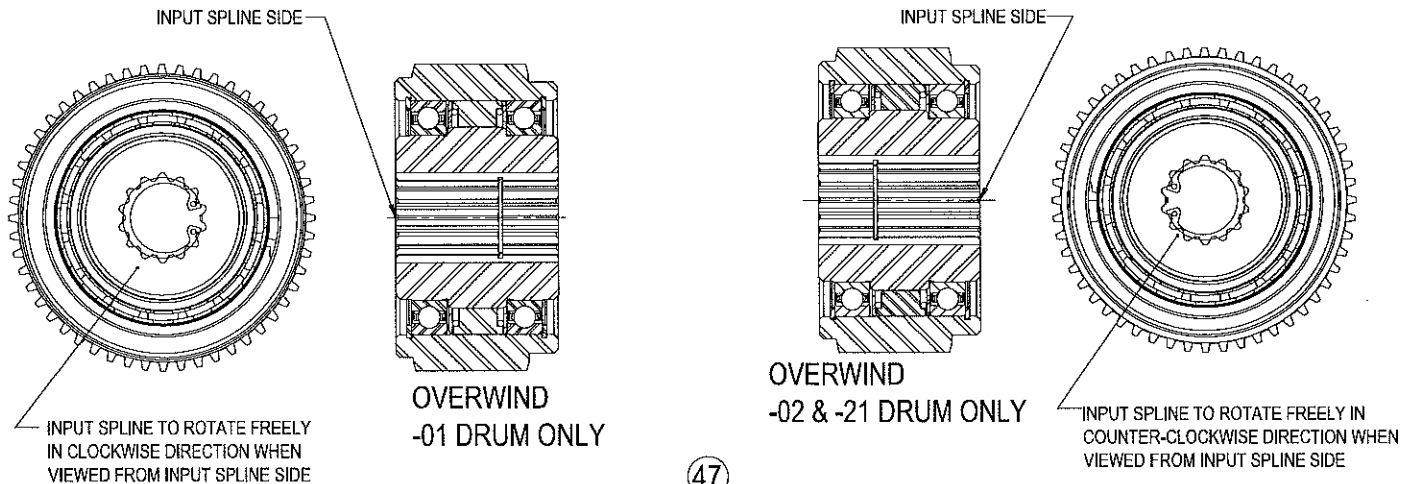
3. Follow steps 2 and 3 of the Primary Planet Carrier assembly procedure to install and stake a NEW roll pin in the carrier.

Repeat this procedure for each of the planet gears.

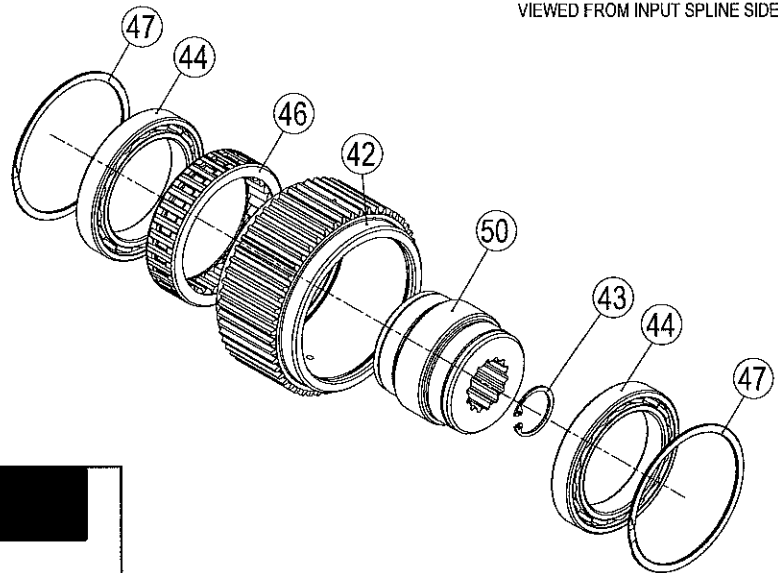
## CAUTION

Driving planet shafts with a hammer may cause damage to the hardened thrust washers which could lead to catastrophic gear train failure which could result in loss of load control, property damage, injury or death.

# OVER-RUNNING CLUTCH SERVICE



**NOTE:** Early production CH165A/ CH230B hoists (built prior to November 2006) with -01 drums included over-running clutch assemblies with the inner race (item 50) rotated 180° relative to the outer race (item 42) from the drawing defined above. When installing an over-running clutch into an early unit, assemble as shown above to ensure the inner race rotates freely in the correct direction for the proper drum rotation direction required



## ⚠ WARNING ⚠

The polished surfaces of the inner and outer race and the over-running cams must be perfectly smooth to insure positive engagement of the clutch. The slightest defect may reduce clutch effectiveness, which may lead to loss of load control and result in property damage, injury or death. It is generally recommended to replace the entire clutch assembly if any component is defective. For these reasons, the over-running clutch assembly should be disassembled for inspection only if the hoist has exhibited any unusual operation that would point toward a clutch malfunction, or the over-running clutch assembly shows external signs of mechanical damage.

## Disassembly

1. Remove one of the retaining rings (item 47) from the outer race (item 42). Push the inner race (item 50), bearings (item 44) and over-running clutch (item 46) through the outer race.
2. Use a small punch and hammer to tap one of the bearings (item 44) off of the inner race. The over-running clutch can now be removed from the inner race. Closely inspect the over-running clutch and the polished surfaces of the inner and outer race for wear, cracks, pitting, corrosion or mechanical damage. Closely inspect the bearings for any signs of damage, wear, corrosion, pitting or heat discoloration.

**NOTE:** Outer race (item 42), Inner race (item 50) and Over-running clutch (item 46) are NOT SOLD individually as replacement parts. If any of these parts require replacement, the entire over-running clutch assembly must be replaced. Carefully note the relative orientation between the inner and outer races, and the direction of free rotation of the inner race. The clutch MUST be re-assembled correctly for proper hoist operation.

## Assembly

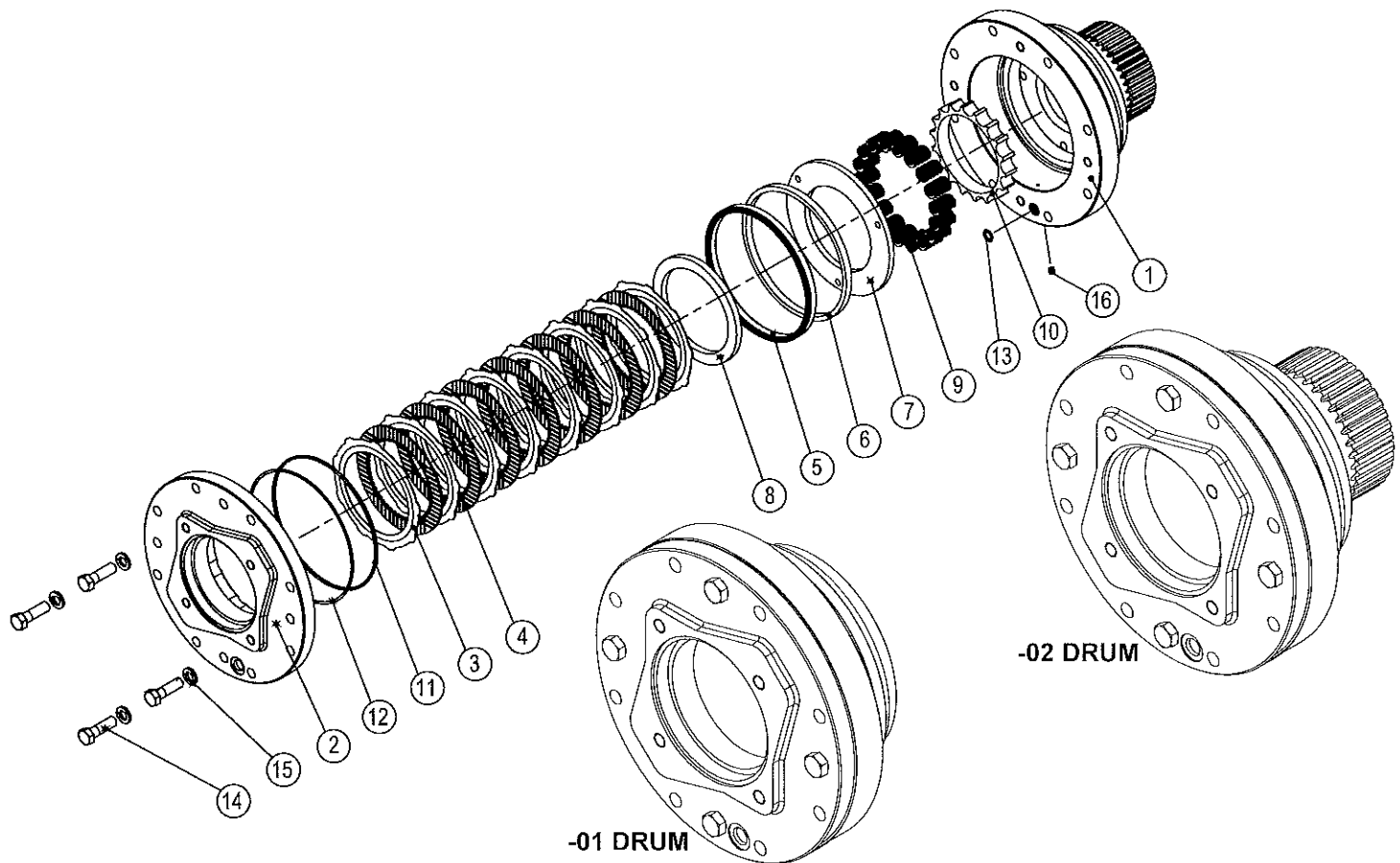
1. If both bearings (item 44) have been removed from the inner race, install one of them now.
2. Install the over-running clutch onto the inner race. Rotate the inner race slightly to get the clutch started onto the inner race.
3. Install the other bearing onto the inner race.
4. The outer race should have one retaining ring (item 47) installed in one end. Carefully slide the inner race, with bearings and clutch, into the outer race. Install the other retaining ring into the outer race.

Shown above are the two types of clutch assemblies used in CH165 and CH210 hoists. The drawings show each type properly assembled.

## WARNING

Failure to assemble the over-running clutch assembly with all parts oriented correctly may result in reduced brake effectiveness, which may lead to loss of load control and result in property damage, injury or death.

# BRAKE CYLINDER SERVICE



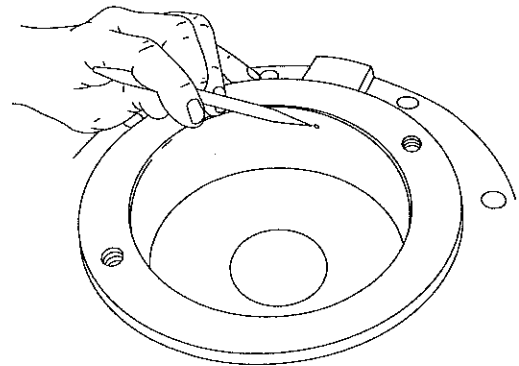
## Disassembly

### ⚠ CAUTION ⚠

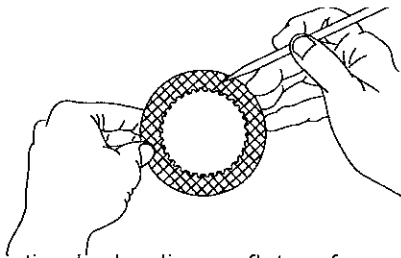
The motor adapter is under spring tension from the brake springs. Loosen each of the capscrews one turn at a time until spring tension is released.

1. Stand the brake assembly on the splined end, with the motor adapter up. Remove the four capscrews (item 14) and lockwashers (item 15). Use a criss-cross pattern and loosen each capscrew one turn at a time until spring tension is released.
2. Remove the motor adapter (item 2). Lift out all the brake discs (item 3), friction discs (item 40) and the spacer (item 8).
3. Remove and discard the O-Ring and backup ring (items 11 & 12) from the motor adapter. Remove and discard the seal (item 5) from the brake cylinder. Remove the steel piston backup ring (item 6).
4. Remove the pressure plate (item 7) and the springs and separator (items 9 & 10) from the brake cylinder.

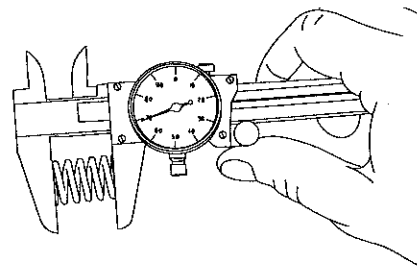
## Clean and Inspect



1. Thoroughly clean and inspect all parts at this time. Check sealing surfaces on both the motor adapter and brake cylinder. Be sure the brake release port is open and free of contamination.



2. Place friction brake disc on flat surface and check for distortion with a straight edge. Friction material should appear even across entire surface with groove pattern visible. Replace friction disc if splines are worn to a point, disc is distorted, friction material is burned or worn unevenly, or groove depth is less than 0.003 in. (0.08 mm).



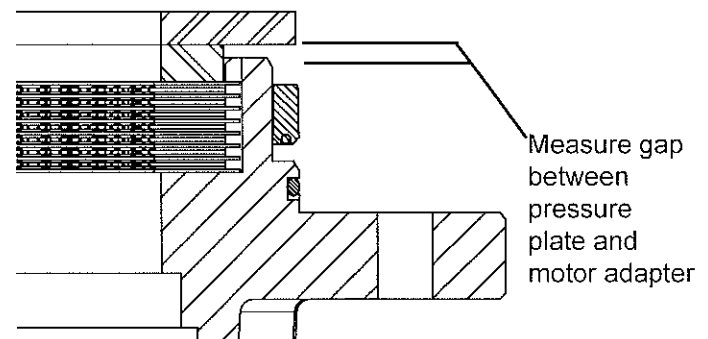
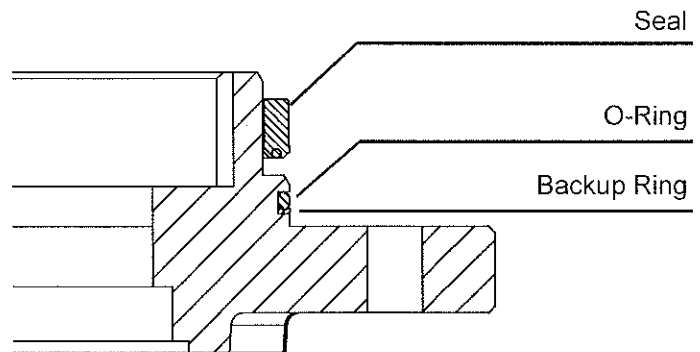
3. Place steel disc on flat surface and check for distortion with a straight edge. Check surface for signs of material transfer or excessive heat. Replace steel disc if distorted, heat discolored, or mechanically damaged.
4. Check brake spring free length. Minimum free length is 1-7/16 in. (36.5 mm). Check springs for any signs of cracking or failure. If a brake spring must be replaced for any reason, then **ALL** brake springs must be replaced.

### ⚠ CAUTION ⚠

Failure to replace brake springs as a set may result in uneven brake application pressure and repeated brake spring failure.

## Assembly

1. Place the motor adapter on a clean work surface with the motor mounting surface down. Apply a light coat of oil to a new backup ring (item 12) and O-Ring (item 11) and install them into the groove on the motor adapter. Backup rings are always placed on the low pressure side of the O-Ring. In this case, the backup ring is toward the motor mounting surface. Lightly oil the brake cylinder seal (item 5) and install it onto the motor adapter with the seal lip down.
2. Install a steel brake disc (item 3) into the motor adapter, followed by a friction disc (item 4). Continue to alternately install steel and friction discs until there are 8 steel and 7 friction discs. A steel disc will be on top.
3. Install the brake plate spacer (item 8) on top of the last steel disc.
4. To check brake stack height, place pressure plate (item 7) on top of brake spacer. Hold pressure plate down firmly by hand and measure gap (in three places) between motor adapter and pressure plate. Average gap must measure between 0.160 in. (4 mm) maximum and 0.080 in. (2.0 mm) minimum. If the gap exceeds the maximum limit, there may be too many discs in the stack-up or the discs are distorted. If the gap is less than the minimum, there may be too few discs or the discs are worn beyond their serviceable limit and should be replaced. When the gap is within the minimum and maximum values, remove the pressure plate and all brake discs. Lubricate all friction discs with the same oil to be used in the hoist. Install all brake discs and brake plate spacer as described in steps 2 and 3.



5. Place the brake cylinder on a clean work surface with the drum end down. Install the spring spacer (item 10), then the 18 springs (item 9.)

## **⚠ WARNING ⚠**

Always use the molded spring spacer to properly position the springs in the brake cylinder. Failure to install the spring spacer may allow the springs to contact each other and become damaged. This could result in loss of load control, property damage, injury or death.

6. Install the pressure plate (item 7) into the brake cylinder. Be careful that none of the springs fall over. Install the steel backup ring (item 6). Apply an oil soluble grease to a new O-Ring (item 13) and install it in the brake housing.
7. Apply an oil soluble grease to the sealing surface of the brake cylinder and the piston seal. Turn the brake cylinder over and lower it onto the motor adapter, being careful not to damage the piston seal or O-Ring on the adapter. Be careful the O-Ring (item 13) does not fall out of place, and the oil passages are aligned. The alternate assembly method below could also be used.
8. Turn the entire assembly over and install the four capscrews and lockwashers. After the capscrews make contact with the motor adapter, evenly tighten them one turn at a time until the motor adapter is drawn tight against the brake cylinder, then torque to the recommended value.

**NOTE:** The close fitting backup ring may be depressed slightly to one side to lodge it in the brake cylinder bore and temporarily hold the pressure plate and springs in place while the brake cylinder is inverted and lowered over the motor adapter.

*As an alternate, the motor adapter and brake plates can be turned over and installed into the brake cylinder, holding the brake plates and spacer in place through the center opening. Be careful to not pinch your fingers between the spacer plate and the pressure plate.*

## **BRAKE CYLINDER PRESSURE TEST**

1. Install a -6 ORB fitting into the brake release port on the motor adapter. Connect a hand pump with an accurate 0-2,000 psi (0-13,800 kPa) gauge and shut-off valve to this fitting. Apply 1,000 psi (6,900 kPa) to the brake and close the shut-off valve. Let the unit stand for five minutes. If there is any loss of pressure, the brake cylinder should be disassembled for inspection of the sealing surfaces, seal and O-Ring. When the source of the pressure leak has been determined and corrected, re-assemble the brake cylinder and repeat the test.
2. **WHILE PRESSURE IS APPLIED AND THE BRAKE IS RELEASED**, install the over-running clutch assembly into the brake pack. Turn the clutch back and forth to align the splines on all the friction discs. Release the pressure on the brake cylinder and remove the clutch assembly. The brake cylinder is now complete and ready to be installed in the hoist.

# REVERSING DIRECTION OF DRUM ROTATION (090, 110, & 120 MOTORS ONLY)

Figure A

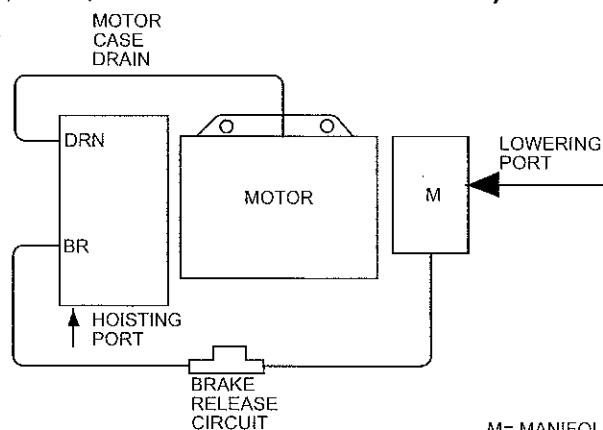
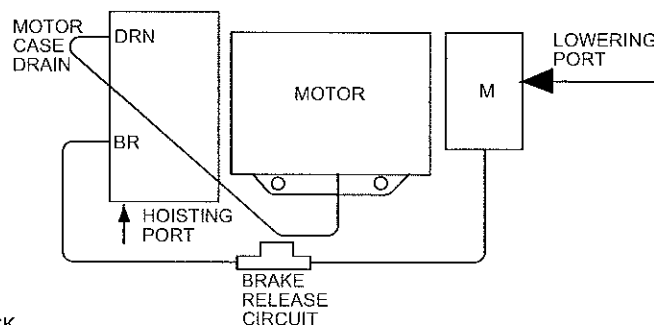


Figure B



M= MANIFOLD BLOCK

The procedure below applies to single speed gear motors. For two speed gear motors, the motor must be disassembled and the center section with the shift spool turned 180 degrees.

In order to change the direction of rotation, 2 things must be changed on the hoist. First, the motor hoist and lower directions of rotation must be changed to the opposite direction. This is done by exchanging positions of the brake valve and manifold block on the motor. Secondly, the brake clutch assembly must be made effective for the opposite direction of rotation. This is done by reversing the inner race of the brake clutch assembly.

Figures "A" and "B" above show typical CH165A/230B motor installations. Note that the only difference between the two drawings is the motor is rotated 180° (the "belly" of the motor moves to the opposite side). If the motor shaft rotates clockwise in figure 'A' when the hoisting port is pressurized, it will rotate counterclockwise in figure "B".

1. Remove the four capscrews if equipped securing the brake valve to the motor. Remove the four capscrews securing the manifold block to the motor. Disconnect the motor case drain hose at the motor.

**NOTE:** Some installations have the brake release hose connected directly to the motor, instead of to the manifold block. In this case, disconnect the brake release hose at the motor port. Stand winch up on drum support with the motor end up and secure in this position.

2. Before removing the motor, it is a good idea to note or mark the position of the motor in relation to the winch, since it will be rotated 180° when reinstalled. Rotating the motor allows the hoist and lowering hoses to connect on the same side of the hydraulic motor as in the previous setup. Remove the capscrews securing the motor to the winch and carefully remove the motor.
3. Remove the brake clutch assembly from the brake cylinder.
4. Remove the snap ring (47) from one-end of the brake clutch assembly and push the inner race out of the assembly. Refer to Over-Running Clutch Service section of this manual for drawings.
5. Use a punch to remove the bearing on one side of the inner race so the sprag assembly can be removed. Remove the sprag assembly and flip over so that the direction of free rotation is reversed. **Note:** The sprag assembly is etched with arrows indicating both the free turn and lock direction.
6. Using a press or punch reinstall the bearing on the inner race.
7. Slide the inner race into the outer race while ensuring the sprag cams do not catch on the outer race. Install the snap ring and ensure it is fully seated in the groove.



### For - 01 Drums

Before installing the brake clutch, be sure the inner race turns free in the opposite direction the drum will turn to haul-in wire rope. An easy way to check the rotation is to hold the outer race in one hand and rotate the inner race. Install the brake clutch with as shown in drawing above.

### For -02 or -21 Drums

## ⚠ WARNING ⚠

Be certain the snap ring is seated in the groove in the splined bore of the inner race. This snap ring will keep the brake clutch assembly correctly positioned in the center of the friction brake pack. Binding of the brake or brake failure may occur if snap ring is omitted, which may cause winch failure resulting in property damage, injury or death.

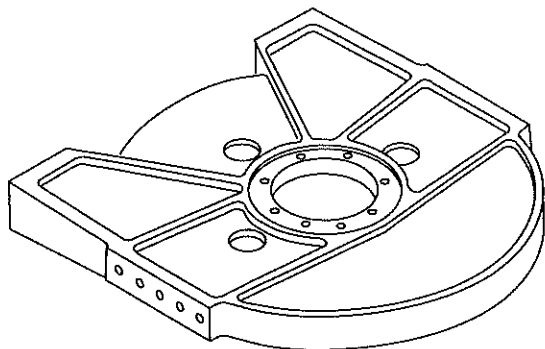
Before installing the brake clutch, be sure the inner race turns free in the same direction the drum will turn to haul-in wire rope. An easy way to check the rotation is to hold the outer race in one hand and rotate the inner race. Install the brake clutch as shown in drawing above.

8. Install a new O-ring on the motor pilot. Rotate the motor 180° from its original position and install it onto the brake cylinder. Install and tighten motor capscrews to recommended torque.
9. Install new O-rings in the brake valve and manifold block. Attach the brake valve and manifold block to the motor using the original capscrews and tighten to recommended torque.
10. Connect the motor case drain hose to the motor case drain port. **NOTE:** *On two speed motors, the case drain and shift drain should be connected directly to tank. DO NOT use the drain connection on the brake valve.*
11. If your winch had the brake release hose connected directly to the motor, the original motor port must be plugged and the hose connected to the motor pressure port near the manifold block (lowering port).
12. Operate the winch slowly in both directions and check for oil leaks and/or unusual sounds from the hoist. The winch should operate smoothly in both directions. Refer to "WIRE ROPE INSTALLATION" and properly install rope onto the hoist drum.
13. Before returning the hoist to full service, a light load should be lifted and held a few feet off the ground to be sure the static brake is functioning properly. The hoist should also be able to slowly lower the load in a smooth and controlled manner. If the hoist does not perform either of these functions, refer to "TROUBLESHOOTING" for additional information.

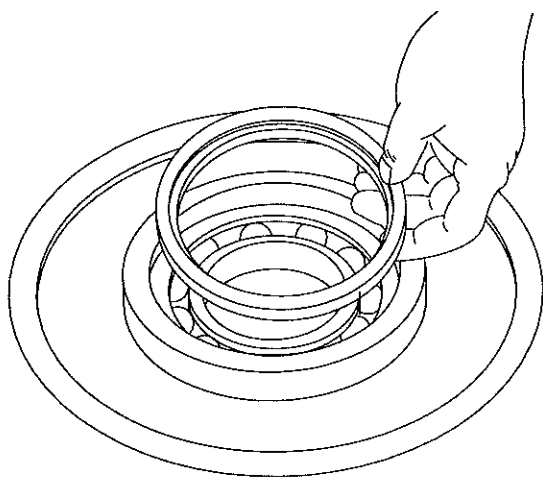
# HOIST ASSEMBLY

1. Install the bearing support (item 3) into the outboard endplate (Item 8.) Rotate the bearing support so that the vent port will be located at the highest position based on the hoist installation to the machine. Install the eight capscrews and lockwashers (item 1 & 2) and tighten to 160 lb-ft (217 N-m) torque.

**NOTE:** It may be easier to torque the fasteners after assembly has been completed



2. Place the drum support assembly on a clean work surface with the bearing support facing up. Lubricate the bearing and sealing surfaces on the bearing support. Install a new V-Ring seal onto the bearing support.



3. Install a new bearing in the drum if replacement is necessary, making certain to press it against the shoulder in the bottom of the bearing bore. Coat the outside diameter of a new seal (18) with a sealant. Turn the spring side of the seal toward the bearing, and press the seal into the seal bore, leaving it EVEN with the outer surface of the drum bore.
4. Turn the drum over, and set it down on the bearing support. Be careful not to damage the seal when lowering the drum onto the bearing support.
5. **-01 Drums:** Install the output planet carrier (400) into the drum while meshing the planet gears with the

ring gear and the planet carrier with the drum bearing support.

- 02 Drums: Lower the output planet carrier (400) into the drum, making certain the splines on the carrier mesh with the splines in the drum.

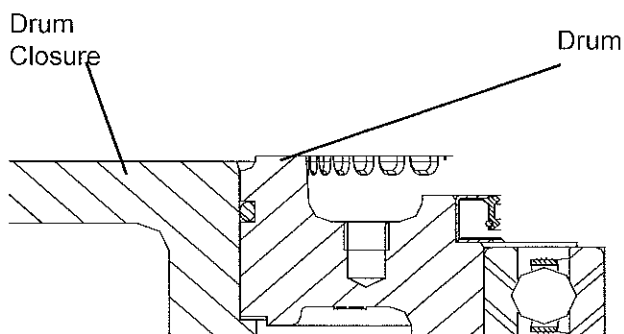
6. Install the output sun gear (12) in to the output planet carrier.

- 02 Drums: Lower the ring gear into the drum while meshing the ring gear teeth with the planet gear teeth.

7. Apply general purpose grease to thrust washer (13) and install it onto the pilot of the primary planet carrier (300). Turn the primary planet carrier over and install it into the ring gear while meshing the planet gears with the ring gear and the splines of the carrier with the output sun gear.

8. Install the primary sun gear (22) into the primary planet carrier. Apply general purpose grease to thrust washer (15) and place it on top of the primary planet carrier. Center the thrust washer on the primary planet carrier

- 02 Drums: Install the ring gear adapter (33) into the ring gear.



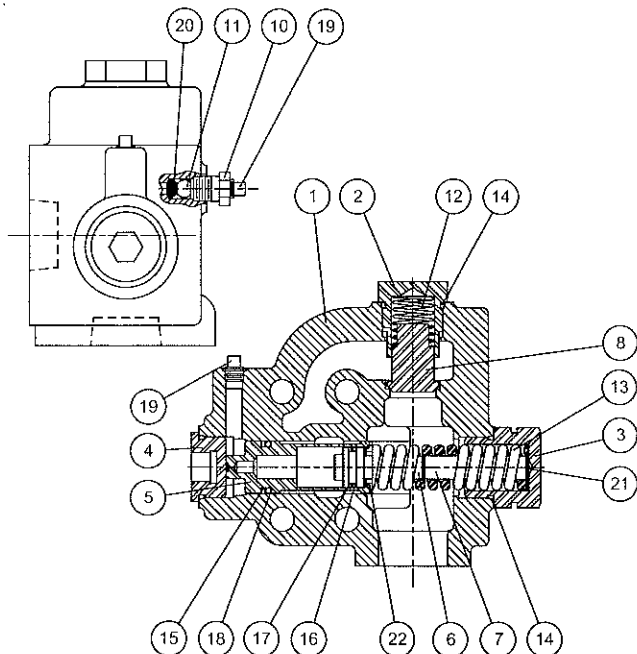
9. Install a new bearing (16) into the drum closure (23) if replacement is necessary. Make certain to press the bearing against the shoulder in the bearing bore. Coat the outside diameter of a new seal (18) with non-hardening sealant. With the spring side toward the bearing, press the seal into the drum closure until the seal is even with the outer edge of the closure. Install a new o-ring (17) into the drum closure. Apply general purpose grease to the outside diameter of the drum closure and install it into the drum. When properly installed, the outer edge of the drum closure will extend beyond the drum by approximately .034 in. (0.9 mm). If the drum closure can not be installed as shown, one or more components may be out of position. The most common cause is the thrust washers are out of position or the output planet carrier is not seated. DO NOT proceed with assembly until the source of the problem has been identified and corrected.

10. Place the motor end plate onto the drum, aligning it approximately with the support end plate and centered on the drum. Install a new v-ring seal (20) onto the brake cylinder. Lubricate the seal and bearing surfaces of the brake cylinder, seal and bearing. Install the brake cylinder assembly into the drum and motor end plate in the same orientation as it was removed.
11. Install the eight capscrews and lockwashers (214 & 215) through the brake cylinder into the end plate. Loosely tighten all capscrews until just snug against the brake cylinder. Continue to tighten the capscrews in a criss-cross pattern one turn at a time until the motor end plate is drawn tightly up against the brake cylinder.
12. Install the two tie plates (28) onto the end plates using all 20 capscrews and lock washers (25 & 26). Be sure the curved sides of the tie plates are toward the top of the hoist. Evenly tighten all tie plate and brake cylinder/end plate capscrews to 80 lb.-ft (109 N-m) torque.
13. Install the over-running brake clutch into the center of the brake pack. Refer to page 25 & 26 for correct orientation of the clutch. The input (motor) side of the clutch is the end facing the motor with the longest spline engagement. It may be necessary to rotate the drum and hoist gear train slightly to align the splines of the shaft with the splines of the brake clutch. If the clutch does not align with the brake discs and input sun gear, install a hand-pump onto the brake release port and apply approximately 1000 PSI (6900 kPa) to fully release the spring applied brake and permit easy alignment of the brake components. The internal retaining ring in the clutch bore should be seated against the input sun gear when correctly installed.
14. Lubricate and install a new O-Ring onto the hydraulic motor pilot. Engage the motor shaft with the inner race of the over-running clutch and lower the motor into place. Install motor capscrews and lockwashers and torque to correct value.
15. Install all hydraulic lines disconnected during disassembly and route hoses to avoid chafing. Be careful to clean lines and fittings if there is a chance that paint chips or other contamination has entered the ports. Tighten all connections.
16. After the hoist assembly is complete, check all capscrews and hydraulic lines to make certain they have been properly installed and tightened correctly. Fill the hoist gear cavity to the center of the sight gauge or level plug. Refer to the "Recommended Lubricant" section of this manual.
17. Before returning the hoist to service, it should be tested on a hydraulic test stand that can operate the hoist to at least 35% of the rated flow, pressure and load. A moderate load should be lifted and held 3 ft. (1m) off the ground to be sure the static brake is functioning properly. The hoist should be able to slowly lower the load in a smooth and controlled manner. If the hoist does not perform these functions correctly, refer to the "Trouble Shooting" section of this manual.

**NOTE:** For CH175B hoists only-

*Prior to reassembly, inspect and replace the "Speedi-Sleeve" on the bearing support and brake cylinder. Speedi-Sleeves should only require replacement if damaged and no longer smooth in sealing area.*

# BRAKE VALVE SERVICE



ITEM	DESCRIPTION	QTY.	PART NO.
1	Valve Housing	1	NSS
2	Check Valve Retainer	1	24424
3	Spring Retainer	1	101016
4	Plug	1	24420
5	Main Piston	1	NSS
6	Damper Piston	1	NSS
7	Damper Piston Extension	1	101017
8	Check Valve Poppet	1	24423
10	Reducer	1	24436
11	Check Ball	1	24428
12	Check Valve Spring	1	24190
13	Main Piston Spring	1	24434
14	O-Ring	1	24186
15	Back-up Ring	1	24778
16	O-Ring	1	24776
17	Back-up Ring	1	24777
18	O-Ring	1	21123
19	Pipe Plug	1	18009
20	Check Spring	1	25373
21	Shim	1	25662
22	Spring Seat	1	101015

Most CH Series hoists are supplied with our Braden 1-1/2" brake valve. It is a reliable hydraulic valve with internal components manufactured to close tolerances. Due to these close tolerances, several individual parts are not available as replacement parts and are noted in the following parts lists as NSS (Not Serviced Separately).

Before disassembling the brake valve, be sure you have conducted all applicable troubleshooting operations and are certain the brake valve is causing the malfunction.

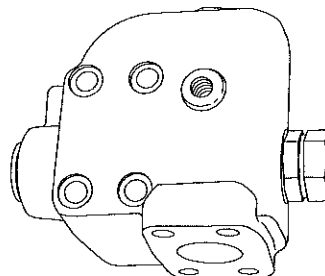
Thoroughly clean the outside surfaces of the valve and work in a clean dust-free area, as cleanliness is of utmost importance when servicing hydraulic components.

1 1/2 inch brake valves built after mid-March 1997 contain a spring seat (item 22) between the spool spring and the spool. This provides a slightly larger, more uniform area for the spring to seat against the spool. The result is increased spring service life and improved repeatability of pressure/flow modulation over the full compression range of the spring.

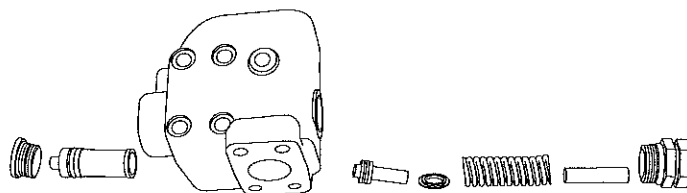
The spring retainer has been modified to allow for the additional thickness of the spring seat and a groove machined into the hex end cap serves as a visual indication that the valve contains the new spring seat. The spring seat improvement may be added to earlier brake valves by installing kit, Part Number 62805. Items 3, 7, 13, 14 and 22 are included in the kit. We recommend that this kit be installed whenever the brake valve is removed for inspection or service.

It is always a good practice to check the initial opening or "cracking" pressure of the brake valve whenever the hoist is serviced or inspected. Refer to Braden Service Bulletin 527 for complete brake valve test and adjustment procedures.

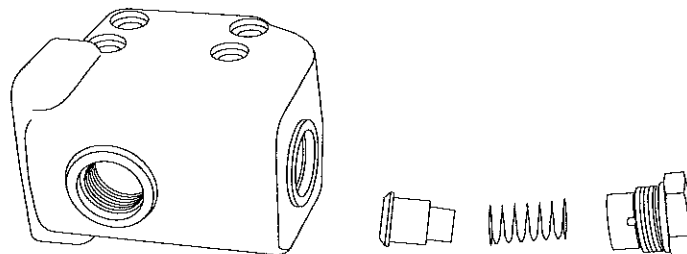
## DISASSEMBLY



1. Remove the fitting, motor drain check ball and spring.



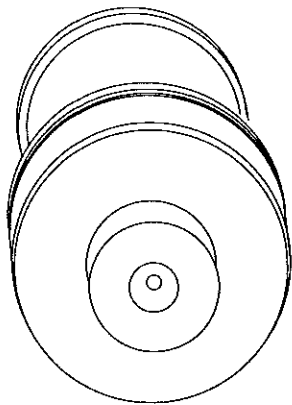
2. Remove the spool spring retainer and spool spring. Remove the spool plug and carefully remove the spool assembly. Remove the damper piston from the spool. The piston will come out of the spool slowly, because of a partial vacuum formed between the two. Use extreme care to avoid damaging the polished surfaces of either piece.



3. Remove the check valve spring retainer, spring and check valve poppet.

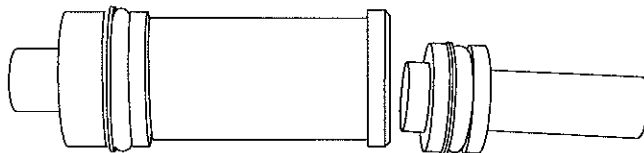
## CLEAN AND INSPECT

1. Discard all O-rings and back-up rings. Clean all parts in solvent and blow dry. Inspect polished surfaces of spool and damper piston for damage that may cause binding or leakage. Inspect spool bore in valve housing for damage or scoring. Inspect check valve seat in valve housing and check valve poppet. If the spools, bores or valves are damaged, the entire brake valve must be replaced. Check the free length of main piston spring. Replace if less than 3 7/16 in. (87.3 mm) long. Check the free length of the check valve spring. Replace if less than 1 1/2 in. (38.1 mm) long.



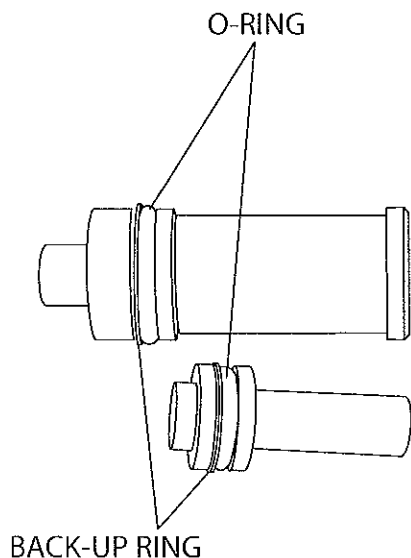
2. Inspect the 0.020 inch (0.5 mm) orifice in the end of the spool to be certain it is open.

2. Install new O-rings on the plug and spool retainers.
3. Lubricate the spool and damper piston O-rings with hydraulic oil. Carefully install the damper piston into the spool. Carefully install the spool into the valve housing. Always install the spool into the valve body from the plug end, so the O-ring enters the bore first. Install the spring seat, spool spring, damper piston extension and spring retainer.



4. Install the check valve poppet, spring and check valve retainer.
5. Install the motor drain check ball, spring and fitting.
6. The brake valve is now completely assembled and ready to be installed on the hoist motor.

## ASSEMBLY



1. Install new O-rings and back-up rings on the spool and damper pistons as shown. It is important that each back-up ring is on the correct side of its O-ring. Take care not to cut the O-rings during assembly. Let the spool and piston set for ten (10) minutes before installing them into the brake valve housing. This will allow the O-rings to return to their original size after being stretched.

## BRAKE VALVE OPENING PRESSURE TEST

Whenever brake components are replaced or a brake component malfunctions or fails, the entire brake system should be inspected and tested. Your testing must include checking the brake valve opening pressure in addition to a thorough inspection of the failed components.

### Preparation:

Begin the inspection by verifying that the brake valve and motor piping is correct for this application. If you are not certain, contact your nearest Braden distributor, the crane OEM, or the Braden factory Product Support Department before proceeding. Do not attempt repairs on equipment you are not familiar with. Fully remove the load from the hoist and block or secure any moveable parts of the crane or hoist before proceeding with brake valve test. It will be necessary to lower the hook block or ball to the ground (deck) since the brake will be completely released. Make certain the test area is clear of all unauthorized personnel as the hoist will be operated in raise and lower functions.

### Brake Valve Pressure Test

1. Shut off the engine or motor driving the hydraulic system and vent residual pressure as recommended by the crane OEM.
2. Install an accurate 0-2000 psi (0-13,800 kPa) pressure gauge teed into the brake release line, located at the lowering (non-brake valve) side of the hydraulic motor. This is typically a -4 JIC connection.
3. To eliminate the slight drag effect of the internal multi-disc brake, remove the brake release line from the hoist brake port and install a plug in the line or close to the needle valve if so equipped.
4. To the internal brake port, install a hand pump with an accurate 0-2000 psi (0-13,800 kPa) gauge. Operate the hand pump and apply approximately 1000 psi (6,900 kPa) to the brake port to fully release the brake. Close the hand pump valve to hold the brake released during the remainder of the test.
5. Operate the crane power source at full throttle and VERY slowly move the winch control lever toward the lowering direction while monitoring the brake valve opening pressure. Record the pressure when the cable drum begins to turn in the lowering direction.
6. The initial lowering pressure should be no lower than 575 psi for the 1.5-inch Braden brake valve, P/N 81609 which is used on most single speed motors on CH165A & CH230B planetary hoists.

If the initial lowering pressure is less than the specification listed the brake valve should be adjusted.

### ADJUSTMENT OF BRAKE VALVE

1. Inspect the main spool spring to make certain it is not damaged. If the spring is in good condition, the brake valve opening pressure should be adjusted by installing shims between the spring retainer, item 3, and the main piston spring. A maximum of .062 in. (1.6 mm) shims are allowed in the 1.5 in. valves. Additional shims may result in accelerated spring failure due to over-compensation.
2. If the spring requires more than the maximum number of shims listed above to achieve the recommended opening pressure, the spring should be replaced.
3. Inspect the brake valve piston and damper piston for scoring and seal ring condition. The seal rings should be replaced following disassembly and inspection. If there is any scoring of the pistons and/or the brake valve housing, the entire brake valve must be replaced.
4. Inspect the check valve poppet and seat for irregular wear or damage. If the poppet set is damaged the entire brake valve must be replaced. Tighten the spring retainers to 40 lb-ft torque.

**NOTE:** Always recheck the brake operation following inspection or adjustment, prior to placing the hoist back in service.

# METRIC CONVERSION TABLE

## English to Metric

## Metric to English

### LINEAR

inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.3937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)

### AREA

inches <sup>2</sup> (sq.in.)	X 645.15	= millimeters <sup>2</sup> (mm <sup>2</sup> )	millimeters <sup>2</sup> (mm <sup>2</sup> )	X 0.000155	= inches <sup>2</sup> (sq.in.)
feet <sup>2</sup> (sq.ft.)	X 0.0929	= meters <sup>2</sup> (m <sup>2</sup> )	meters <sup>2</sup> (m <sup>2</sup> )	X 10.764	= feet <sup>2</sup> (sq.ft.)

### VOLUME

inches <sup>3</sup> (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches <sup>3</sup> (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallon (gal.)
inches <sup>3</sup> (cu.in.)	X 16.39	= centimeters <sup>3</sup> (cc)	centimeters <sup>3</sup> (cc)	X 0.06102	= inches <sup>3</sup> (cu.in.)
feet <sup>3</sup> (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet <sup>3</sup> (cu.ft.)
feet <sup>3</sup> (cu.ft.)	X 0.02832	= meters <sup>3</sup> (m <sup>3</sup> )	meters <sup>3</sup> (m <sup>3</sup> )	X 35.315	= feet <sup>3</sup> (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= milliliters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)

### MASS

ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)

### PRESSURE

inches Hg (60°F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60°F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm <sup>2</sup> )	kilograms/sq.cm. (kg/cm <sup>2</sup> )	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H <sub>2</sub> O (60°F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H <sub>2</sub> O (60°F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars

### POWER

horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.

### TORQUE

pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.-lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)

### VELOCITY

miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)

### TEMPERATURE

$$^{\circ}\text{Celsius} = 0.556 (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{Fahrenheit} = (1.8^{\circ}\text{C}) + 32$$

### COMMON METRIC PREFIXES

mega	(M)	= 1,000,000 or 10 <sup>6</sup>	deci	(d)	= 0.1 or 10 <sup>-1</sup>
kilo	(k)	= 1,000 or 10 <sup>3</sup>	centi	(c)	= 0.01 or 10 <sup>-2</sup>
hecto	(h)	= 100 or 10 <sup>2</sup>	milli	(m)	= 0.001 or 10 <sup>-3</sup>
deka	(da)	= 10 or 10 <sup>1</sup>	micro	(μ)	= 0.000.001 or 10 <sup>-6</sup>







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 4.11 Manufacturer Ballring Data

#### LUBRICATION

Periodic lubrication is necessary to insure long life and proper performance. The required frequency of lubrication varies with the type of equipment and amount of usage. Some recommendations for lubricants are given below.

Typical recommendations for greasing intervals vary according to operating conditions. Generally the following lubrication intervals are recommended:

Ball bearings under light service	Every 100 operating hours
Ball bearings under heavy service or for a production type of application (e.g., excavators, grab cranes, magnet cranes, etc.) or where a high degree of reliability is required.	Every 40 operating hours
Roller bearings	Every 40 operating hours

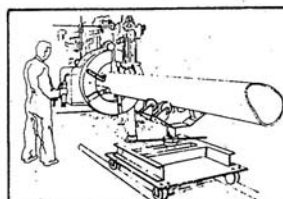
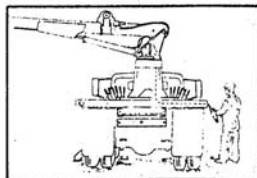
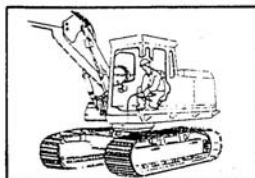
Use shorter intervals between greasings in tropical areas or where there is high humidity, dust, or wide ranges in temperature, or when there is continuous rotation.

Each Rotek bearing is equipped with one or more grease fittings. Models equipped with two or three rows of fittings should be greased in each row. To insure uniform distribution of grease throughout the bearing, the machine should be rotated at least two complete revolutions while greasing. When complete rotation is impractical, more grease fittings are required. Contact the Rotek engineering department for a recommendation. For bearings with integral gears, lubricate gear as recommended above and as necessary to prevent metal-to-metal contact.



#### CAUTION:

Extreme care must be taken when greasing and rotating any unit. Be sure that all personnel are clear of all parts of the machine during the rotating-greasing procedure. We recommend installation of an extension line from the grease fitting location to an area where the oiler will be safely clear of moving parts. Following are three examples of suggested extension arrangement.



Extension fittings and lines are widely available from local distributors of lubrication equipment such as Alemite.

ALL EQUIPMENT SHOULD BE GREASED AT LEAST TWICE YEARLY REGARDLESS OF AMOUNT OF USAGE.

The bearing should be lubricated immediately after installation. Before storing a machine, new or used, thoroughly lubricate so that clean grease can be seen venting at the seals. This procedure should be repeated periodically at least twice a year or in line with climatic conditions. Uninstalled bearings stored inside, outside or in humid environments must be properly wrapped according to Rotek specifications. They must also be stored in the horizontal position. The bearing must also be uniformly supported to prevent ring distortion. Relubrication and inspection are required at periodic intervals. Contact Rotek for instructions.

Some recommended lubricants are shown below:

	SHELL	EXXON	TEXACO	MOBIL	UNION	SUN
RACE	ALVANIA EP #2	RONEX MP	MULTIFAK EP #2	MOBILITH AW2	UNOBA EP #2	PRESTIGE 742 EP
GEAR		SURRETT Fluid 30	CRATER 2x Fluid 5x Fluid	GEAR Lube 275	GEARITE Hvy	

Under extremely dusty or dirty conditions, sufficient grease should be added to flush out contaminated grease. Under less severe conditions, add grease until it appears at the seal. The metal nameplate illustrated below, which is affixed to many styles of bearings, provides lubrication instructions suitable to most applications. Extra plates are available on request for installation on equipment.

LUBRICATION INSTRUCTIONS—Lubricate bearing through fitting every one hundred operating hours for per machine manufacturer's recommendation. Below 10 F use No. 2 Extreme Pressure Grease such as Texaco Multifak EP 2. Below 10 F use No. 1 Grease. Reduce grease amount until clean grease extrudes at seal. Lubricate gear with Texaco Crown Fluid or equivalent as required by direct machine manufacturer. Check mounting seal condition periodically per machine manufacturer's recommendation.

SERIAL NO.

# Rotek



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.0 Repair Manual



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.1 Hose Assembly List

ITEM	QTY.	HOSE ID	HOSE LOCATION	
			TO	FROM
1	1	1-1/2"	Boom control valve (inlet)	Pump #1 (flow divider "B")
2	1	1/4"	Boom pressure gauge	Boom control valve (inlet)
3	1	1-1/2"	Return manifold	Boom control valve (outlet)
4	1	1-1/2"	Boom hoist motor (down)	Boom control valve (down)
5	1	1-1/2"	Boom hoist motor (up)	Boom control valve (up)
6	1	1-1/2"	Main / Aux. control valve (inlet)	Pump #2
7	1	1/4"	Main / Aux. pressure gauge	Main / Aux. control valve (inlet)
8	1	1-1/2"	Return manifold	Main / Aux. control valve (outlet)
9	1	1-1/4"	Aux. hoist motor (down)	Main / Aux. control valve (down)
10	1	1-1/4"	Aux. hoist motor (up)	Main / Aux. control valve (up)
11	1	1-1/2"	Main hoist motor (down tee)	Main / Aux. control valve (down)
12	1	1-1/2"	Main hoist motor (up tee)	Main / Aux. control valve (up)
13	1	1-1/4"	Main control valve (inlet)	Pump #3
14	1	1/4"	Main pressure gauge	Main control valve (inlet)
15	1	1-1/2"	Return manifold	Main control valve (outlet)
16	1	1-1/2"	Main hoist motor (down tee)	Main control valve (down)
17	1	1-1/2"	Main hoist motor (up tee)	Main control valve (up)
18	1	1"	Swing control valve (inlet)	Pump #4
19	1	1/4"	Swing pressure gauge	Swing control valve (inlet)



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY.	HOSE ID	HOSE LOCATION	
			TO	FROM
20	1	1-1/4"	Return manifold	Swing control valve (outlet)
21	2	3/4"	Vent able relief valves (outlet)	Swing control valve (working tee)
22	2	3/4"	Swing drive #1 (tee)	Vent able relief valves (inlet)
23	2	3/4"	Swing drive #2	Swing drive #1 (tee)
24	1	1/4"	Park brake #1 (tee)	Swing control valve (inlet check tee)
25	1	1/4"	Park brake #2	Park brake #1 (tee)
26	1	1/4"	Park brake valve (in)	Swing control valve (inlet check tee)
27	1	1/4"	Hydraulic tank	Park brake valve (out)
28	1	1/4"	Hydraulic tank	Swing motor #1 case drain
29	1	1/4"	Hydraulic tank	Swing motor #2 case drain
30	1	1/4"	Return pressure gauge	Return manifold
31	1	4"	Return filter	Return manifold
32	1	1/4"	Hydraulic tank	Aux. hoist case drain
33	1	1/4"	Hydraulic tank	Main hoist case drain
34	1	1/4"	Hydraulic tank	Boom hoist case drain
35	3	1/4"	Ratchet & pawl	Boom hoist
36	1	1/2"	Hydraulic tank	Pump #1 (flow divider "R" relief)
37	1	1/2"	Swing / Aux. pilot controller - cab bulkhead (outside tee)	Pump #4 (flow divider "R" high pressure filter)
38	1	1/2"	Swing / Aux. pilot controller (pilot pressure)	Swing / Aux. pilot controller - cab bulkhead (inside)



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY	HOSE ID	TO	HOSE LOCATION	FROM
39	1	1/2"	Main / Boom pilot controller - cab bulkhead (outside tee)	Swing / Aux. pilot controller - cab bulkhead (outside tee)	
40	1	1/2"	Main / Boom pilot controller (pilot pressure)	Main / Boom pilot controller - cab bulkhead (inside)	
41	1	1/4"	Pilot pressure gauge	Main / Boom pilot controller - cab bulkhead (outside tee)	
42	1	1/4"	Swing / Aux. pilot controller - cab bulkhead (outside tee)	Pilot return pressure gauge	
43	1	1/2"	Swing / Aux. pilot controller (pilot return pressure)	Swing / Aux. pilot controller - cab bulkhead (inside)	
44	1	1/2"	Main / Boom pilot controller - cab bulkhead (outside tee)	Swing / Aux. pilot controller - cab bulkhead (outside tee)	
45	1	1/2"	Main / Boom pilot controller (pilot return pressure)	Main / Boom pilot controller - cab bulkhead (inside)	
46	1	1/2"	Hydraulic tank	Main / Boom pilot controller - cab bulkhead (outside tee check)	
47	1	1/4"	Swing / Aux. pilot controller - cab bulkhead (inside)	Swing pilot controller (left)	
48	1	1/4"	Swing control valve (pilot left)	Swing / Aux. pilot controller - cab bulkhead (outside)	
49	1	1/4"	Swing / Aux. pilot controller - cab bulkhead (inside)	Swing pilot controller (right)	
50	1	1/4"	Swing control valve (pilot right)	Swing / Aux. pilot controller - cab bulkhead (outside)	
51	1	1/4"	Swing / Aux. pilot controller - cab bulkhead (inside)	Aux. pilot controller (down)	
52	1	1/4"	Aux. control valve (pilot down)	Swing / Aux. pilot controller - cab bulkhead (outside)	



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY.	HOSE ID	HOSE LOCATION TO	ITEM FROM
53	1	1/4"	Swing / Aux. pilot controller - cab bulkhead (inside)	Aux. pilot controller (up)
54	1	1/4"	Aux. up solenoid valve ("A")	Swing / Aux. pilot controller - cab bulkhead (outside)
55	1	1/4"	Aux. control valve (pilot up)	Aux. up solenoid valve ("P")
56	1	1/4"	Main / Boom pilot controller - cab bulkhead (inside)	Main pilot controller (down)
57	1	1/4"	Main control valve #1 (pilot down tee)	Main / Boom pilot controller - cab bulkhead (outside)
58	1	1/4"	Main control valve #2 (pilot down)	Main control valve #1 (pilot down tee)
59	1	1/4"	Main / Boom pilot controller - cab bulkhead (inside)	Main pilot controller (up)
60	1	1/4"	Main up solenoid valve ("A")	Main / Boom pilot controller - cab bulkhead (outside)
61	1	1/4"	Main control valve #1 (pilot up tee)	Main up solenoid valve ("P")
62	1	1/4"	Main control valve #2 (pilot up)	Main control valve #1 (pilot up tee)
63	1	1/4"	Main / Boom pilot controller - cab bulkhead (inside)	Boom pilot controller (down)
64	1	1/4"	Low boom angle limit valve ("T")	Main / Boom pilot controller - cab bulkhead (outside)
65	1	1/4"	Boom down solenoid valve ("A")	Low boom angle limit valve ("A")
66	1	1/4"	Boom control valve (pilot down)	Boom down solenoid valve ("P")
67	4	1/4"	<del>Low angle override valve ("P")</del>	Low boom angle limit valve ("P")
68	4	1/4"	Low boom angle limit valve ("T" tee)	<del>Low angle override valve ("A")</del>



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY.	HOSE ID	HOSE LOCATION TO	ITEM FROM
69	1	1/4"	Main / Boom pilot controller - cab bulkhead (inside)	Boom pilot controller (up)
70	1	1/4"	High angle limit valve ("P")	Main / Boom pilot controller - cab bulkhead (outside)
71	1	1/4"	Boom control valve (pilot up)	High angle limit valve ("B")
72	1	1/4"	High angle limit valve ("T" tee)	Low boom angle limit valve ("P")
73	1	1/4"	Hydraulic tank	High angle limit valve ("T" tee)
74	1	1/4"	Main down solenoid valve ("B" tee)	Boom down solenoid valve ("B")
75	1	1/4"	Aux. down solenoid valve ("B" tee)	Main down solenoid valve ("B" tee)
76	1	1/4"	Hydraulic tank	Aux. down solenoid valve ("B" tee)
77	1	2-1/2"	Pump #1	Hydraulic tank
78	1	2-1/2"	Pump #2	Hydraulic tank
79	1	2"	Pump #3	Hydraulic tank
80	1	1-1/2"	Pump #4	Hydraulic tank
81	1	1/4"	Engine oil pressure gauge	Engine block (pressure)
82	1	1/4"	Throttle cylinder	Throttle actuator
83	1	3/8"	Fuel filter (in)	Fuel tank
84	1	3/8"	Fuel tank (return)	Fuel rack (out)
85	1	1"	Air tank	Air swivel (1" check)
86	1	1"	Air relay valve (in)	Air tank
87	1	1"	Air starter	Air relay valve (out)



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY.	HOSE ID	HOSE LOCATION TO	ITEM FROM
88	1	1/4"	Air start valve (in tee)	Air relay valve ("AUX")
89	1	1/4"	Air bendix (in)	Air start valve (out)
90	1	1/4"	Air relay valve ("APP")	Air bendix (out)
91	1	1/4"	Air pressure gauge (tee)	Air start valve (in tee)
92	1	1/4"	Air wiper valve #1 (in tee)	Air pressure gauge (tee)
93	1	1/4"	Air wiper valve #2 (in tee)	Air wiper valve #1 (in tee)
94	1	1/4"	Air wiper valve #3 (in)	Air wiper valve #2 (in tee)
95	1	1/4"	Engine oil pressure switch #1 (tee)	Engine block (pressure)
96	1	1/4"	Engine oil pressure switch #1	Engine oil pressure switch #1 (tee)
97	1	1/4"	Over speed valve (in tee)	Engine block (pressure orifice)
98	1	1/4"	Water temperature valve (in tee)	Over speed valve (in tee)
99	1	1/4"	Amot reset valve	Water temperature valve (in tee)
100	1	1/4"	Over speed valve (out tee)	Water temperature probe (out)
101	1	1/4"	Engine block (vent)	Over speed valve (out tee)
102	1	1/4"	Swing brake cooler #1 (in tee)	Return manifold (flow control)
103	1	1/4"	Swing brake cooler #2 (in)	Swing brake cooler #1 (in tee)
104	1	1/4"	Swing brake cooler #2 (out tee)	Swing brake cooler #1 (out)
105	1	1/4"	Hydraulic tank	Swing brake cooler #2 (out tee)
106	1	1/4"	Dynamic brake actuator (in)	Hydraulic reservoir
107	1	1/4"	Dynamic brake #1 (tee)	Dynamic brake actuator
108	1	1/4"	Dynamic brake #2	Dynamic brake #1 (tee)



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

ITEM	QTY.	HOSE ID	HOSE LOCATION TO	ITEM FROM
109	2	1/4"	Swing limit solenoid valves ("P")	Vent able relief valves (pilot)
110	1	1/4"	Swing limit solenoid valve "CW" ("B" tee)	Swing limit solenoid valve "CWW" ("B")
111	1	1/4"	Hydraulic tank	Swing limit solenoid valve "CW" ("B" tee)
112	1	1/4"	Engine oil pressure switch	Engine block (pressure)
113	1	1/4"	Fuel pressure switch	Fuel pressure
114	1	1/2"	Air compressor (inlet)	Engine cover (manifold)
115	1	1/2"	Air tank	Air compressor (out check)
116	1	1/4"	Air unloading valve (in)	Air compressor
117	1	1/4"	Air check valve (1/4" port)	Air unloading valve (out)
118	-	-	-	-
119	-	-	-	-



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.2 Bill of Materials

#### UPPERSTRUCTURE ASSEMBLY, N80794-501

<u>ITEM</u>	<u>QTY.</u>	<u>NUMBER</u>	<u>DESCRIPTION</u>
120	1.00	N45872-001	BALLRING
121	2.00	N47103-003	GEARBOX, SWING DRIVE
*122	1.00	N47255-017	BOLT KIT, UPPERSTRUCTURE
*123	1.00	N47255-018	BOLT KIT, PEDESTAL
*124	2.00	N47959-004	BOLT KIT, SWING DRIVE
125	2.00	N60920-001	PINION
126	1.00	N80389	SWING LOCK ASSY.
127	1.00	N2009SK1-235	PEDESTAL WELDMENT
128	1.00	N60908	UPPERSTRUCTURE BASE

#### BOOM ASSEMBLY, N80794-502

129	530.000	N00034-012	WIRE ROPE
130	1.00	N15969-001	SPRING, BOOM STOP
131	1.00	N15969-001	SPRING, BOOM STOP
132	1.00	N30602-007	SOCKET, OPEN WEDGE
133	2.00	N30603-014	PENDANT LINE

**\*Warning:** These are special bolts meeting SAE Grade 8 requirements and must be purchased from Oil States Industries. Standard off-the-shelf Grade 8 bolts **MUST NOT BE USED** as they do not meet the requirements of API Spec 2C.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### BOOM ASSEMBLY, N80794-502(cont'd)

134	1.00	N30606-012	CLAMP, CABLE
135	8.00	N45422-007	BEARING, SHEAVE
136	8.00	N45931-012	SHEAVE, NYLON
137	1.00	N46419-001	BOLK KIT, HOIST
138	2.00	N60982	BOOM STOP
139	2.00	N47008-001	BUMPER, BOOM STOP
140	1.00	N47140	RATCHET & PAWL INSTALLATION, CH SERIES
141	1.00	N47922-009	HOIST, CH230B-35090-01P-1
142	1.00	N60909	UPPERSTRUCTURE LEGS
143	1.00	N60910-001	GANTRY WELDMENT
144	1.00	N60964-005	GANTRY PLATFORM
145	1.00	N93SK1-326	GANTRY LADDER SUPPORTS
146	1.00	N60911	BRIDLE

### BOOM BASE ASSEMBLY, N80794-503

147	1.00	N45916-001	INDICATOR, BOOM ANGLE, RIGHT HAND
148	1.00	N60255-005	NEEDLE, INDICATOR BOOM ANGLE
149	1.00	N60888-001	BOOM BASE
150	1.00	N61865-007	BOOM BASE ROLLER
151	-	-	-



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### BOOM INSERT ASSEMBLY, N80794-504

152	1.00	N60884-010	BOOM MID 10 FT.
153	2.00	N61865-004	BOOM MID ROLLERS
154	-	-	-

### BOOM POINT ASSEMBLY, N80794-505

155	1.00	N61886-001	BOOM POINT
156	1.00	N61865-005	BOOM POINT ROLLER – FRONT
157	1.00	N61865-006	BOOM POINT ROLLER – REAR
158	-	-	-

### POWER UNIT ASSEMBLY, N80794-506

159	1.00	N00174-004	COATING, EPOXY
160	4.00	N13581-005	PAD, FABREEKA
161	1.00	N45031-016	PUMP, DRIVE, ASSY
162	1.00	N45101-024	DECAL, DIESEL FUEL
163	1.00	N45101-025	DECAL, HYD OIL
164	1.00	N45247-007	GAUGE, FUEL
165	1.00	N45414-009	VALVE, ENGINE, SHUTDOWN
166	2.00	N45690-024	GAUGE, LEVEL
167	2.00	N45722-012	VALVE, BALL
168	1.00	N45820-001	VALVE, ENGINE SHUTDOWN TEMP
169	1.00	N45846-003	VALVE, ENGINE SHUTDOWN, AIR



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### POWER UNIT ASSEMBLY, N80794-506(cont'd)

170	1.00	N45923-003	TACHOMETER, MAG.
171	2.00	N46181-001	MAGNET, SUMP
172	1.00	N46669-037	ENGINE
173	1.00	N46669-592	BELT, ALTERNATOR
174	1.00	N46669-669	ASSEMBLY, AIR COMPRESSOR
175	1.00	N46669-671	ASSEMBLY, AIR COMPRESSOR DRIVE
176	1.00	N46669-672	ASSEMBLY, AIR COMPRESSOR GOVERNOR
177	1.00	N46669-855	KIT , LINES, AIR COMPRESSOR
178	1.00	N46744-001	GUARD, RADIATOR
179	1.00	N46882-596	PULLEY, ALTERNATOR
180	1.00	N46952-001	VALVE, CHECK, AIR
181	1.00	N47233-002	VALVE, ENGINE SHUTDOWN
182	1.00	N47243-001	INSULATION , EXHAUST, BLANKET
183	1.00	N61590-031	POWER UNIT
184	-	-	-
185	-	-	-

### CONTROL STATION ASSEMBLY, N80794-507

186	1.00	N2007SK1-384	PLACARD, EMERGENCY LOAD LOWERING
187	1.00	N45358-001	THROTTLE, KIT HYDRAULIC FOOT
188	1.00	N45376-001	CHART, HAND SIGNAL, SPANISH



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### CONTROL STATION ASSEMBLY, N80794-507 (cont'd)

189	1.00	N45384-001	PEDAL, BRAKE, HYDRAULIC
190	2.00	N45880-013	FIRE EXSTINGUISHER
191	2.00	N45880-513	BRACKET, FIRE EXSTINGUISHER, ABC DRY CHEM.
192	1.00	N46017-004	TACHOMETER, DIGITAL
193	1.00	N46621-008	WINDOW, CAB
194	1.00	N46638-001	SEAT, TRIMLINE
195	1.00	N46638-501	PEDESTAL, SEAT
196	1.00	N46673-515	WINDOW, HINGED, GREEN TENT
197	2.00	N46748-030	GUAGE, TEMPERATURE
198	2.00	N47445-016	GUAGE, PRESSURE 0-100PSI
199	1.00	N47445-018	GUAGE, PRESSURE 0-200PSI
200	1.00	N47445-019	GUAGE, PRESSURE 0-300PSI
201	1.00	N47445-020	GUAGE, PRESSURE 0-600PSI
202	1.00	N47445-021	GUAGE, PRESSURE 0-100PSI
203	1.00	N47445-024	GUAGE, PRESSURE 0-3000PSI
204	3.00	N47445-026	GAUGE, PRESSURE, 0-5000PSI
205	1.00	N47646-029	PLACARD, CAUTION PARK BRAKE
206	1.00	N47646-030	PLACARD, SWING, PUSH-PULL
207	1.00	N47646-031	PLACARD, AUX WINCH, PUSH-PULL



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### CONTROL STATION ASSEMBLY, N80794-507 (cont'd)

208	1.00	N47646-032	PLACARD, BOOM, PUSH-PULL
209	1.00	N47646-032	PLACARD, BOOM, PUSH-PULL
210	1.00	N47646-033	PLACARD, WINCH, PUSH-PULL
211	1.00	N47643-034	PLACARD, PARKING BRAKE
212	3.00	N47646-035	PLACARD, WINDSHIELD WIPER
213	1.00	N47646-036	PLACARD, ANTI 2 BLOCK
214	1.00	N47646-037	PLACARD, ENGINE THROTTLE
215	1.00	N47646-038	PLACARD, WATER TEMP
216	1.00	N47646-039	PLACARD, TACHOMETER
217	1.00	N47646-039	PLACARD, TACHOMETER
218	1.00	N47646-040	PLACARD, AUX PRESSURE
219	1.00	N47646-042	PLACARD, DYN SWING BRAKE
220	1.00	N47646-043	PLACARD, ENGINE KILL
221	1.00	N47646-044	PLACARD, RETRUN PRESSURE
222	1.00	N47646-045	PLACARD, HYD OIL
223	1.00	N47646-046	PLACARD, AIR PRESSURE
224	1.00	N47646-047	PLACARD, ATTENTION HORN
225	1.00	N47646-048	PLACARD, MAIN PRESSURE
226	1.00	N47646-049	PLACARD, ENGINE KILL
227	1.00	N47646-050	PLACARD, BOOM PRESSURE



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### CONTROL STATION ASSEMBLY, N80794-507 (cont'd)

228	1.00	N47646-051	PLACARD, ENGINE START
229	1.00	N47646-052	PLACARD, SWING PRESSURE
230	1.00	N47646-053	PLACARD, EINGINE OIL PRESSURE
231	1.00	N47646-054	PLACARD, CAB LIGHT SWITCH
232	1.00	N47646-055	PLACARD, BEACON LIGHT
233	1.00	N47646-056	PLACARD, POWER ON PILOT
234	1.00	N47646-057	PLACARD, WARNING BOOM LOW
235	1.00	N47646-060	PLACARD, FLOODLIGHT SWITCH
236	1.00	N47646-061	PLACARD, SAFELOAD INDICATOR
237	1.00	N47646-062	PLACARD, RED INST LIGHT
238	1.00	N46746-063	PLACARD, GAI-TRONICS SWITCH
239	1.00	N47646-064	PLACARD, POWER SUPPLY
240	1.00	N47646-065	PLACARD, HOIST LIGHT SWITCH
241	1.00	N47646-066	PLACARD, WALKWAY LIGHT
242	1.00	N47646-067	PLACARD, POWER UNIT LIGHT
243	1.00	N47646-068	PLACARD, ENGINE LOW OIL
244	1.00	N47646-069	PLACARD, ENGINE, HIGH ALARM
245	1.00	N47646-070	PLACARD, HIGH HYD OIL TEMP
246	1.00	N47646-071	PLACARD, SWING LOCK PUSH
247	1.00	N47646-072	PLACARD, LOW BOOM ANGLE



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### CONTROL STATION ASSEMBLY, N80794-507 (cont'd)

248	1.00	N47646-074	PLACARD, MAIN HOIST LOAD
249	1.00	N47646-075	PLACARD, AUX HOIST LOAD
250	1.00	N47646-076	PLACARD, AUX/MAIN VALVE
251	1.00	N47646-081	PLACARD, SAFE AREA RADIO
252	1.00	N47646-082	PLACARD, A/C UNIT
253	1.00	N47646-083	PLACARD, 12V POWER SUPPLY
254	1.00	N47646-090	PLACARD, PILOT PRESSURE
255	1.00	N47646-092	PLACARD, GAI-TRONICS SYSTEM
256	1.00	N47646-093	PLACARD, OIL PRESSURE
257	1.00	N47646-094	PLACARD, WATER TEMP
258	1.00	N47646-095	PLACARD, FUEL PRESSURE
259	1.00	N47646-096	PLACARD, HYDRAULIC OIL
260	1.00	N47646-097	PLACARD, DIESEL FUEL
261	1.00	N47646-105	PLACARD, CIRCUIT BREAKER
262	1.00	N47646-133	PLACARD, A/C UNIT
263	1.00	N47646-137	PLACARD, CAUTION PARKING BRAKE
264	1.00	N47646-141	PLACARD, EMERG. STOP PROCEDURE
265	1.00	N47646-169	PLACARD, ELECTRIC
266	1.00	N47646-170	PLACARD, PNEUMATIC
267	1.00	N80278-059	GLASS, GREEN TINT



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### CONTROL STATION ASSEMBLY, N80794-507 (cont'd)

268	20.000	N80278-220	GASKET, DOOR END SEAL
269	1.00	N80278-659	INSULATION, CAB
270	1.00	N80278-059	CAB WELDMENT W/SLIDING DOOR
271	1.00	N62663	CAB TRAY
272	1.00	N89SK1-403	DYNAMIC SWING BRAKE
273	-	-	-
274	-	-	-

### PIN KIT, N80794-508

275	2.00	N61577	BOOM FOOT PIN
276	2.00	N60006-046	GANTRY/UPPERSTRUCTURE
277	1.00	N60952-001	MAIN IDLER
278	1.00	N60986-001	LOWER AUX EXTENSION
279	8.00	N60986-003	BOOM CONNECTION
280	1.00	N60955-001	UPPER AUX EXTENSION
281	2.00	N60954-001	BRIDLE/GANTRY
282	1.00	N60645-001	EXTENDED WEDGE SOCKET PIN /MAIN
283	2.00	N60646-004	LOAD CELL PIN

### BRACKETS, N80794-511

284	2.00	N60690	PINION KEEPER
285	2.00	N60064-003	SHEAVE PIN KEEPER



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### BRACKETS, N80794-511(cont'd)

286	2.00	N60944	PENDANT LINK
287	2.00	N60992-001	PENDANT SPACERS
288	2.00	N60995	ANCHOR SPACERS
289	2.00	N60993-001	ANCHOR SPACERS
290	2.00	N60484-003	PENDANT KEEPER
291	1.00	N60987-001	GANTRY LADDER
292	1.00	N62147-005	PILOT CONTROLLER BRACKETS
293	1.00	N61322-026	UPPER GAUGE PANEL
294	1.00	N61322-027	LOWER GAUGE PANEL
295	1.00	N60756-012	BOOM HI/LO KICKOUT
296	1.00	N60863-011	RETURN FILTER BRACKET
297	1.00	N60613-284	RETURN MANIFOLD
298	2.00	N60989-001	ANTI TWO BLOCK HANGERS
299	2.00	N96SK1-145	BOOM FLOODLIGHT BRACKET
300	1.00	N60242-022	MAIN HOIST KICKER RINGS CH210-02
301	1.00	N2010SK1-017	ACCESS LADDER
302	1.00	N97SK1-059	HOIST LIGHT BRACKET
303	1.00	N61109-114	BOOM TIP FLOODLIGHT BRACKET
304	1.00	N61738-029	BRACKET, ELECTRICAL SWIVEL
305	1.00	N80491-001	AMOT SPACER



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### BRACKETS, N80794-511 (cont'd)

306	1.00	N91SK1-344	STARTER BRACKET
307	1.00	N2009SK1-337	BOOM HOIST GUARD
308	1.00	N60924-008	SPACER, SHEAVE
309	1.00	N61981-002	BRACKET/AMOT
310	2.00	N92SK1-269	DR VALVE BRACKET
311	1.00	N95SK1-395	BRACKET, THROTTLE , CAT
312	1.00	N61628-042	RETURN PIPING
313	2.00	N60064-003	PENDANT PIN KEEPER
314	1.00	N63033	CONTORL PANEL MACHINING
315	1.00	N63035	BRIDLE REST
316	2.00	N91SK2-001	BRACKET, BEACON LIGHT
317	1.00	N63187	SWING LIMIT BRACKET
318	-	-	-
319	-	-	-

### WALKWAYS, N80794-509

320	1.00	N62991	WALKWAYS AND SUPPORTS
321	1.00	N61968-035	BOOM WALKWAY
322	-	-	-



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### RIGGING ASSEMBLY, N80794-512

323	274.000	N00031-009	WIRE ROPE
324	866.000	N00031-012	WIRE ROPE
325	8.00	N30601-006	SHACKLE, ANCHOR
326	1.00	N30602-004	SOCKET, OPEN WEDGE
327	1.00	N30602-007	SOCKET, OPEN WEDGE
328	1.00	N30606-009	CLAMP, CABLE
329	1.00	N30606-012	CLAMP, CABLE
330	4.00	N45315-048	CABLES, ANTI-TWO BLOCK SUSP
331	2.00	N45421-006	SHEAVE, NYLON
332	2.00	N45422-006	SHEAVE, BEARING
333	1.00	N45422-012	SHEAVE, BEARING
334	3.00	N45422-013	BEARING
335	1.00	N45446-026	HOIST, PD12C-29051-04-1
336	3.00	N45931-012	SHEAVE, NYLON
337	1.00	N46419-003	BOLT KIT, HOIST
338	1.00	N46419-007	BOLT, HOIST
339	1.00	N46831-071	LOAD BLOCK
340	1.00	N46832-012	OVERHAUL BALL
341	1.00	N47643-001	HOIST, CH210A-36120-02-1
342	1.00	N80196-004	KIT, EMERGENCY LOAD



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### RIGGING ASSEMBLY, N80794-512(cont'd)

343	1.00	N80541-025	CLEVIS, UNIVERSAL
344	-	-	-

### HYDRAULIC SYSTEM, N80794-513

345	400.00	N11488-820-S	TIEWRAP
346	1.00	N45025-001	VALVE DIRECTIONAL, HYD
347	1.00	N45025-501	SPRING KIT, DIRECTIONAL VALVE
348	1.00	N45025-502	KIT, HANDLE, DIRECTIONAL VALVE
349	2.00	N45401-001	VALVE, HYD
350	1.00	N45408-073	VA35-AA980-MA8-TR99
351	1.00	N45408-528	VALVE, CONTROL, HYD VA35, WORKING
352	1.00	N45410-004	VALVE, RELIEF, HYD, ASSY
353	1.00	N45674-015	VALVE, CHECK, HYD, INLINE
354	1.00	N45674-019	VALVE, CHECK, HYD, INLINE
355	2.00	N45686-005	MOTOR, SWING, HYDRAULIC
356	1.00	N45813-002	RESERVOIR, SWING BRAKE
357	2.00	N45813-003	SWING, BRAKE, CYLINDER
358	1.00	N45921-028	STRAINER, SUCTION
359	3.00	N45921-032	STRAINER, SUCTION
360	1.00	N46119-001	FILTER, HYDRAULIC HIGH PRESSURE ELEMENT
361	1.00	N46488-001	VALVE FLOW DIVIDER



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### HYDRAULIC SYSTEM, N80794-513 (cont'd)

362	1.00	N46632-012	CONTROLLER, HYD, SECTION 2
363	1.00	N46632-019	CONTROLLER, PILOT, SINGLE AXIS
364	1.00	N46785-545	PUMP, HYDGEAR, P365
365	2.00	N46896-001	VALVE, RELIEF
366	2.00	N47010-002	VALVE, CONTROL, HYD V90
367	1.00	N47010-007	VALVE, CONTROL, ASSY
368	2.00	N47199-001	BRAKE, SWING DRIVE
369	1.00	N47204-001	FILTER, RETURN, HYDRAULIC
370	1.00	N47204-501	FILTER, HYDRAULIC RETURN ELEMENT
371	1.00	N83SK1-043	FILTER, HIGH PRESSURE
372	-	-	-
373	-	-	-

### ELECTRICAL SYSTEM, N80794-514

374	1.00	N45039-001	BOX, ELECTRIC SERVICE
375	65.000	N45044-013	CABLE, ELEC
376	500.000	N45044-017	CABLE, ELEC
377	50.000	N45044-093	CABLE, ELEC
378	51.000	N45044-114	CABLE, 3 COND
379	1.00	N45425-009	SWITCH, PRESSURE, DIAPHRAM, NEO0DYN
380	2.00	N45425-009	SWITCH PRESSURE, DIAPHRAM, NEO-DYN



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### ELECTRICAL SYSTEM, N80794-514(cont'd)

381	2.00	N46140-012	BATTERY, LEAD ACID
382	1.00	N46140-524	BOX, BATTERY
383	2.00	N46184-011	SWITCH, TEMP
384	2.00	N46521-001	SWITCH, SELECTOR
385	6.00	N46521-002	SWITCH, SELECTOR
386	1.00	N46525-012	POWER SUPPLY
387	7.00	N46547-003	BOX, OUTLET
388	5.00	N46781-001	FLOODLIGHT
389	5.00	N46781-501	FLOODLIGHT BULB
390	5.00	N46813-501	FLOODLIGHT REFLECTOR
391	2.00	N46814-003	RED BEACON STROBE LIGHT
392	1.00	N46878-001	PAGING SYSTEM ASSEMBLY
393	1.00	N46878-504	HEADSET W/MIC ASSEMBLY
394	1.00	N46878-505	CABLE, 30FT
395	1.00	N46878-506	HORN/SPEAKER
396	1.00	N46878-507	SPEAKER DRIVER
397	3.00	N46930-003	RED PILOT LIGHT
398	1.00	N46930-004	GREEN PILOT LIGHT
399	1.00	N47021-113	ELECTRIC SWIVEL
400	1.00	N47024-002	ELECTRIC CAT STARTER



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### ELECTRICAL SYSTEM, N80794-514(cont'd)

401	1.00	N47025-001	SOLENOID, STARTER
402	1.00	N47043-001	SWITCH, PUSH BUTTON
403	2.00	N47047-034	POWER SUPPLY
404	1.00	N47062-002	CIRCUIT BREAKER
405	4.00	N47093-014	LAMP, COMPACT FLUORESCENT
406	2.00	N47093-515	MOUNT, CEILING, CLEAR COVER
407	2.00	N47093-516	MOUNT, CEILING, RED COVER
408	5.00	N47402-503	VALVE, SOLENOID
409	60.000	N47481-002	GLAND, CABLE
410	4.00	N47481-016	GLAND, CABLE
411	1.00	N47514-006	ROOF, AIR CONDITIONER
412	5.00	N47534-502	SUBPLATE, FOR VALVE, SOLENOID
413	5.00	N47534-503	BOLT KIT, FOR VALVE, SOLENOID
414	1.00	N47664-003	KIT, HINGE FOR JUNCTION BOX
415	1.00	N47664-004	BOX, JUNCTION
416	1.00	N47751-002	BOX, JUNCTION, CROUSE HINDS
417	20.000	N47927-025	CABLE, ELECTRIC
418	1.00	N47949-016	MARKLOAD SYSTEM DX
419	1.00	N48079-120	SYSTEM, LIGHTNING PROTECTION
420	2.00	N48079-121	CONDUIT BOX, "T" STYLE



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### ELECTRICAL SYSTEM, N80794-514(cont'd)

421	-	-	-
422	-	-	-

### PNEUMATIC SCHEMATIC, N80794-515

423	1.00	N45386-001	VALVE, PUSH BUTTON, MANUAL START
424	1.00	N45445-008	VALVE, POPOFF, AIR
425	1.00	N45457-005	MOTOR, START
426	1.00	N45457-501	VALVE, RELAY STARTER
427	1.00	N45674-017	VALVE, CHECK, HYD, INLINE
428	1.00	N45678-003	HORN, AIR, NYLON
429	1.00	N45844-002	GAUGE, WIKA 300 PSI
430	1.00	N46003-001	VALVE, PUSH BUTTON, AIR
431	3.00	N46051-002	WIPER, WINDSHIELD
432	3.00	N46051-503	ARM, WINDSHIELD WIPER
433	3.00	N46051-504	BLADE, WINDSHIELD WIPER
434	1.00	N46178-008	VALVE, BALL
435	1.00	N47164-004	RECEIVER, AIR, 200 GAL.
436	1.00	N48064-001	REGULATOR, AIR
437	1.00	N48064-002	BRACKET, AIR REGULATOR
438	-	-	-



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### LOAD CHART, API TAG, INFO CHART, N80794-522

439	1.00	21409 INFO	CHART, INFORMATION
440	1.00	21409 API	TEMPLATE, API TAG PLACARD

441

-

-

-

### MANUFACTURER ENGINE SPARE PARTS

442	1.00	N46669-862	AFTERCOOLER KIT
443	1.00	N46669-863	COOLER/LINES KIT
444	1.00	N46669-864	TURBO MTG. KIT
445	1.00	N46669-865	CYLINDER HEAD KIT
446	1.00	N46882-510	AIR FILTER
447	1.00	N46669-866	CART. GP.
448	1.00	N46669-867	HEAD AS-CYLINDER
449	1.00	N46669-584	VEE BELT SET
450	1.00	N46669-868	BEARING-ROD
451	1.00	N46669-869	CYLINDER PAC
452	1.00	N46669-870	GASKET
453	1.00	N46669-871	CORE AS-OIL
454	1.00	N46669-872	REGULATOR-TE
455	1.00	N46669-873	SEAL
456	1.00	N46669-874	GASKET
457	1.00	N46669-875	PUMP GP WTR



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### MANUFACTURER ENGINE SPARE PARTS

458	6..00	N46669-876	NOZZLE, FUEL
459	1.00	N46669-877	GASKET
460	1.00	N46669-582	PUMP ASSEMBLY
461	1.00	N46669-878	SEAL O RING
462	1.00	N46669-879	PUMP GASKET
463	1.00	N46669-879	FILTER ASSEMBLY, FUEL
464	1.00	N46669-880	BREATHER ASSEMBLY
465	1.00	N46669-881	CLAMP
466	1.00	N46669-882	RING
467	1.00	N46669-526	FILTER ASSEMBLY
468	1.00	N46669-883	PUMP GP OIL
469	1.00	N46669-884	SEAL GP-CSHF
470	1.00	N46669-885	SEAL GP-CSHF
471	1.00	N46669-886	BEARING-MA
472	1.00	N46669-509	FILTER, FUEL
473	-	-	-
474	-	-	-
475	-	-	-



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.3 Identified Parts – Pictures



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

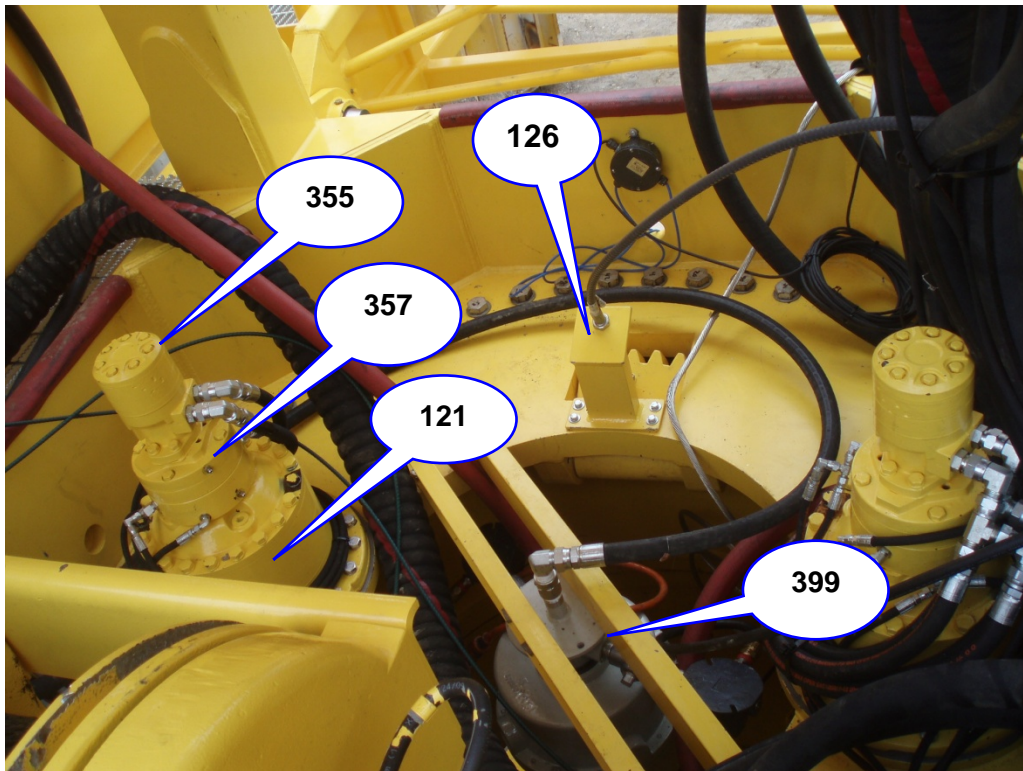
## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

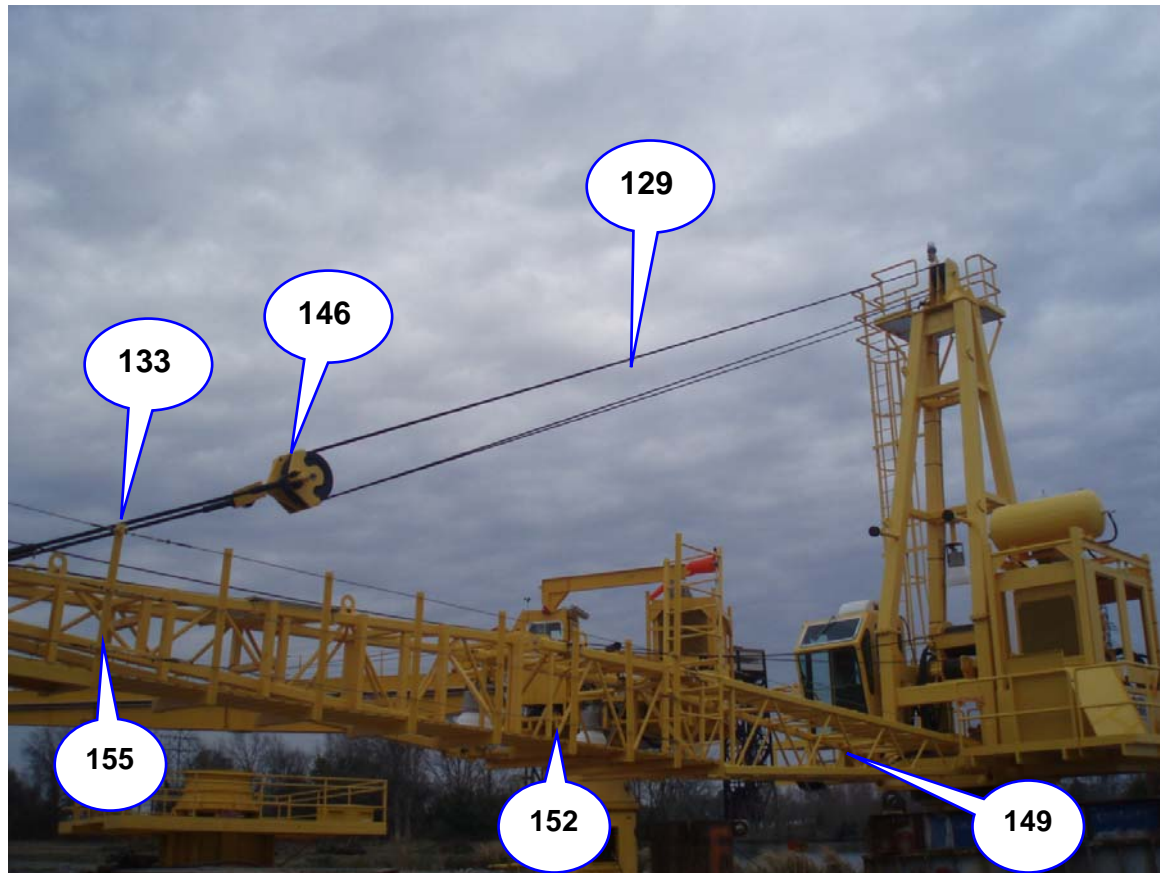
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

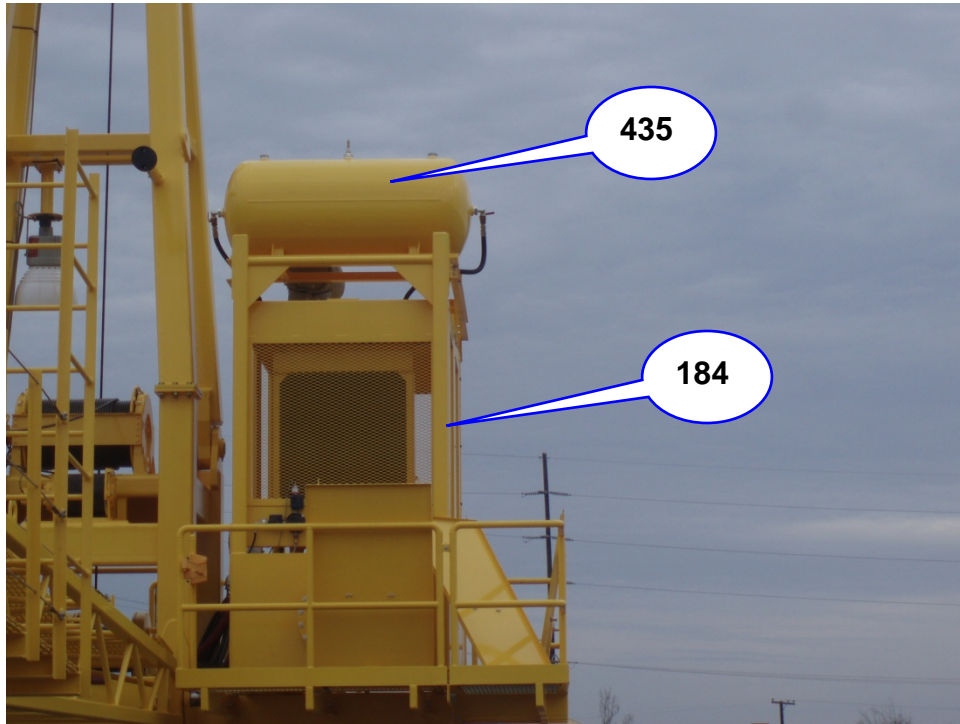
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

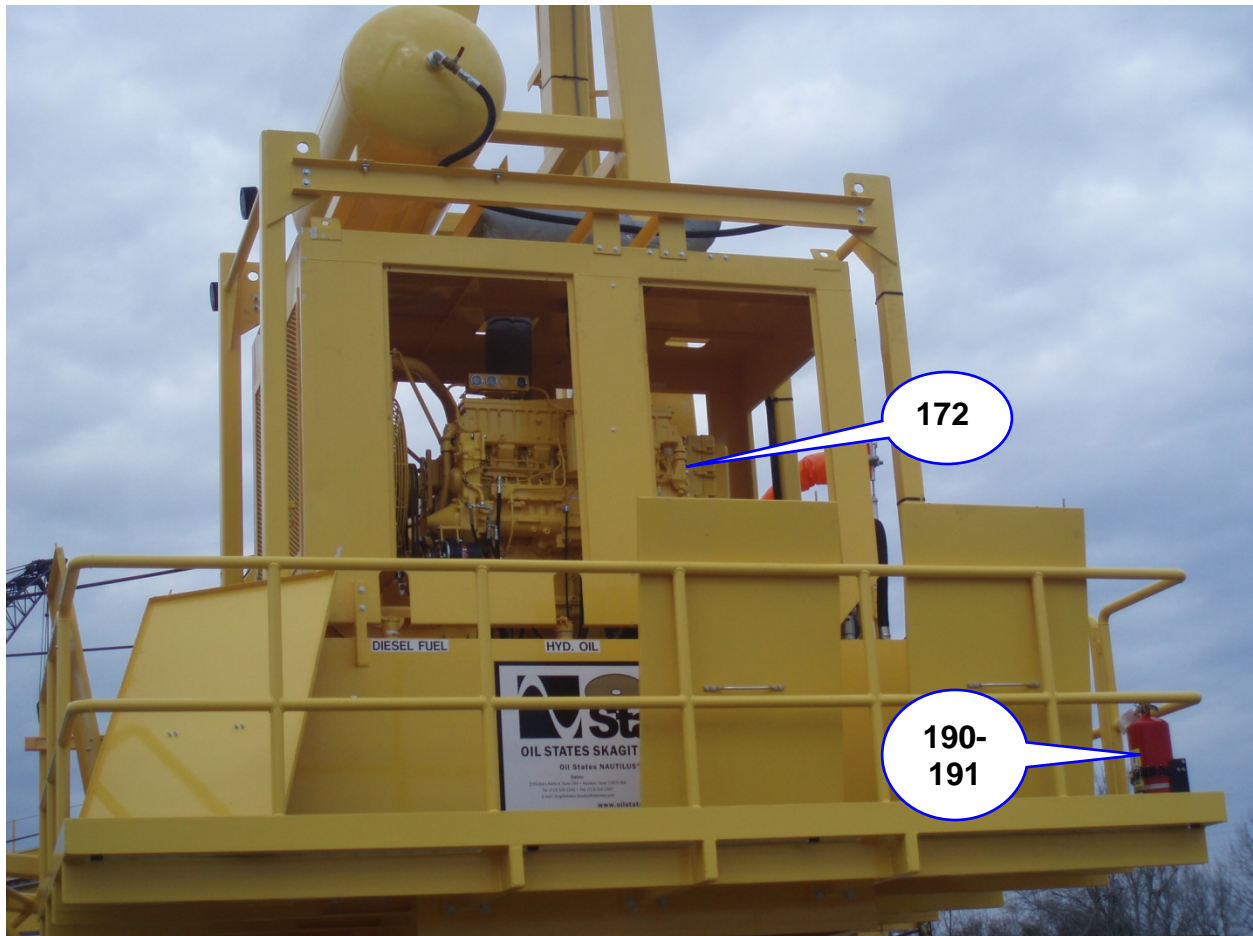
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

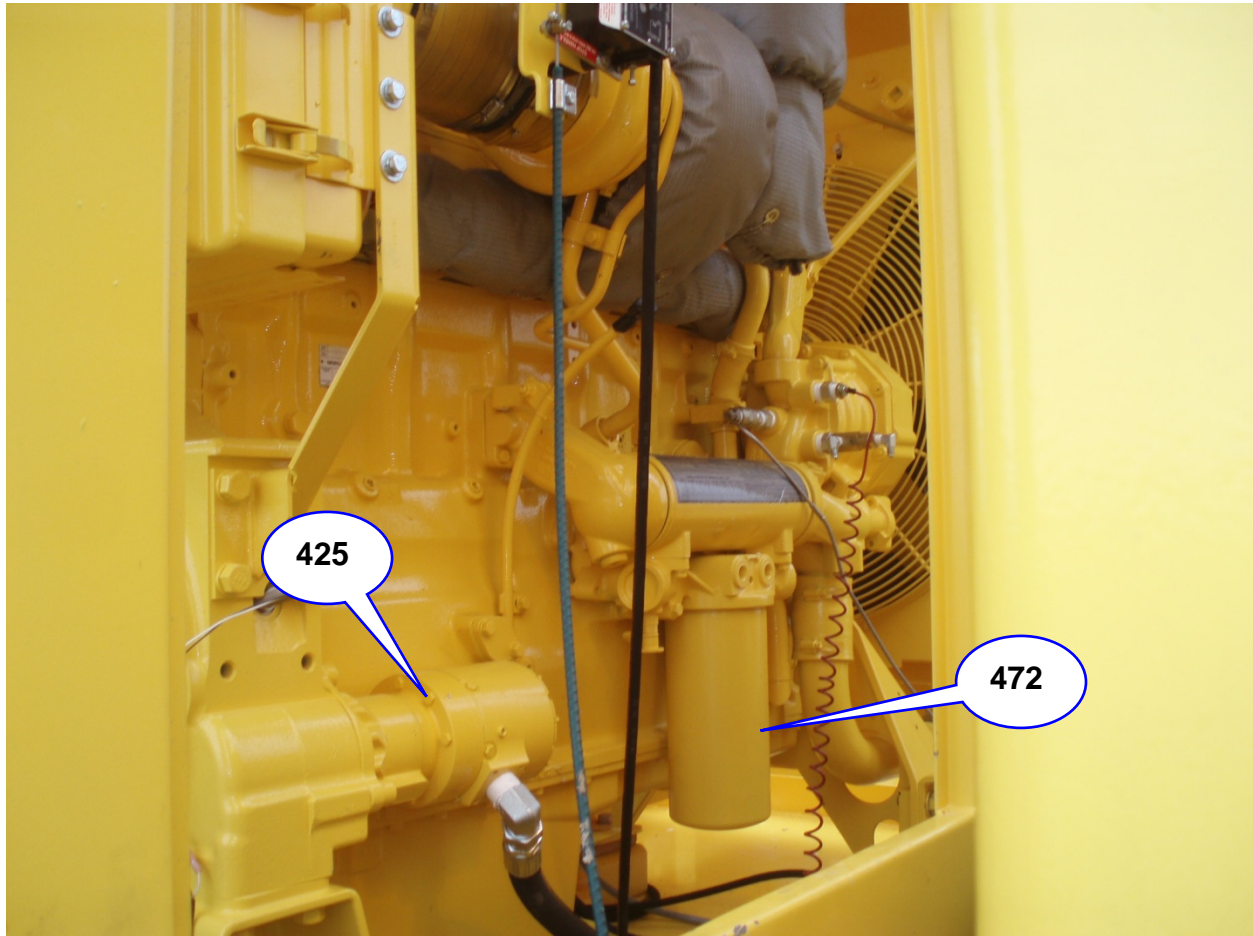
## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

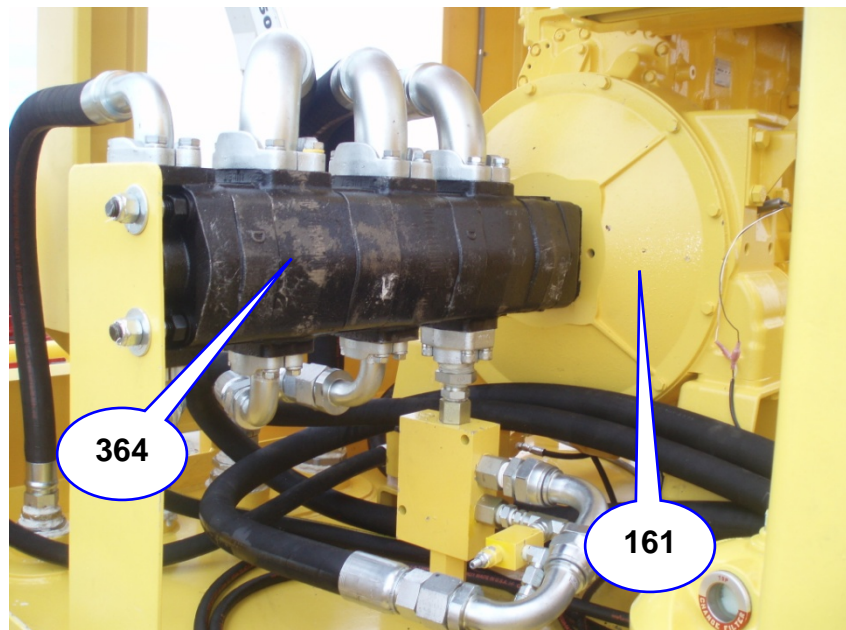
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

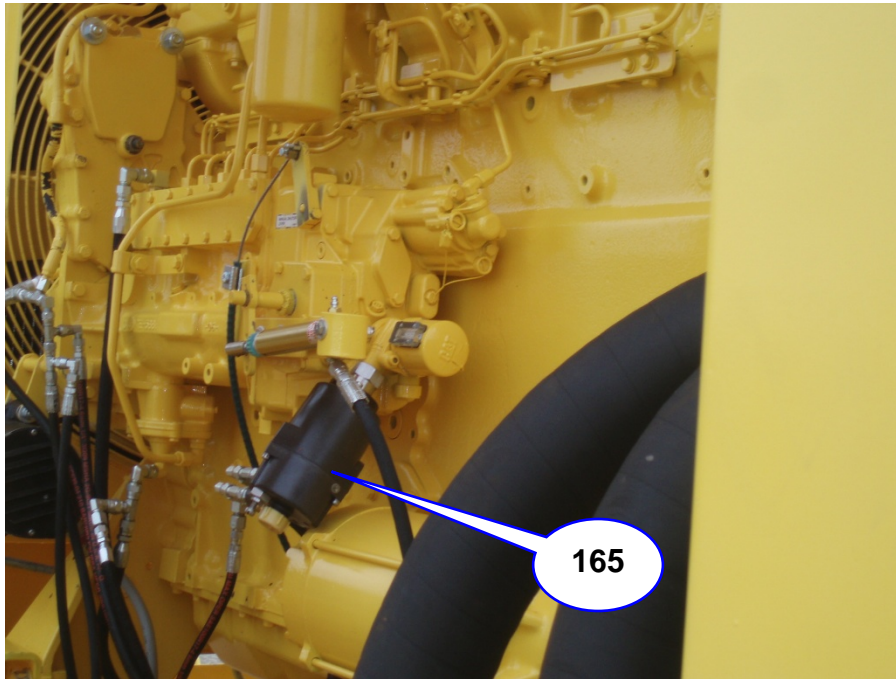
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

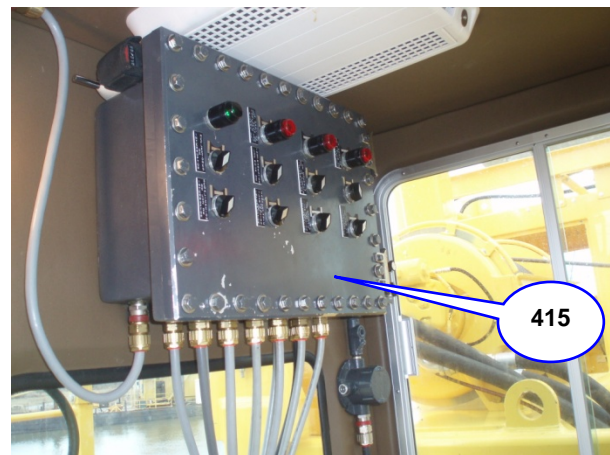
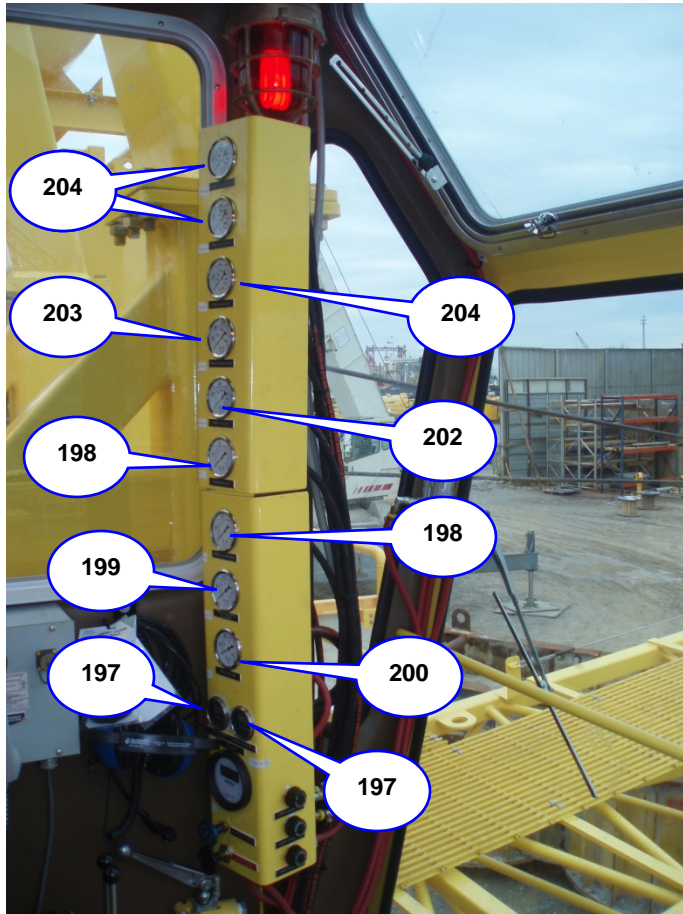
# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 5.4 Crane General Arrangement N2009SK4-025

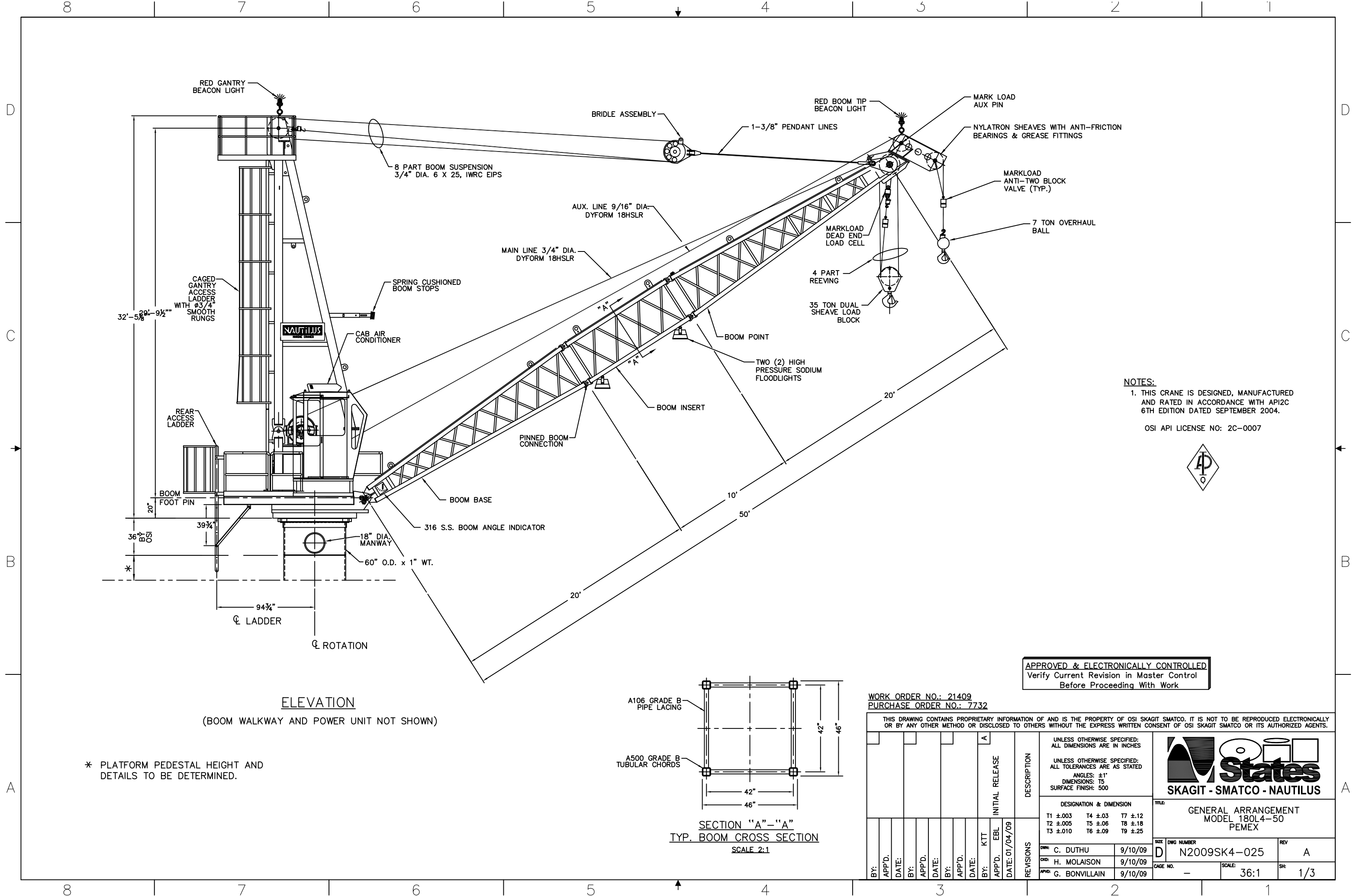


SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



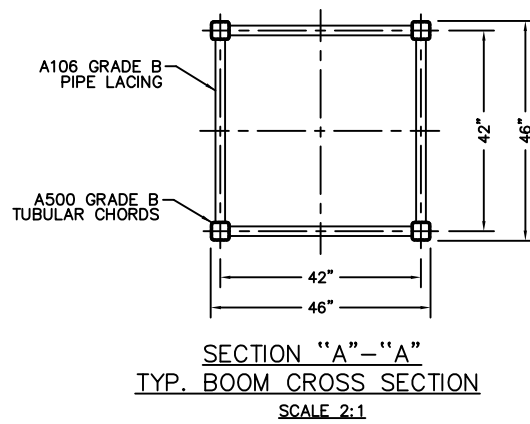






ELEVATION  
(BOOM WALKWAY AND POWER UNIT NOT SHOWN)

\* PLATFORM PEDESTAL HEIGHT AND  
DETAILS TO BE DETERMINED.



WORK ORDER NO.: 21409  
PURCHASE ORDER NO.: 7732

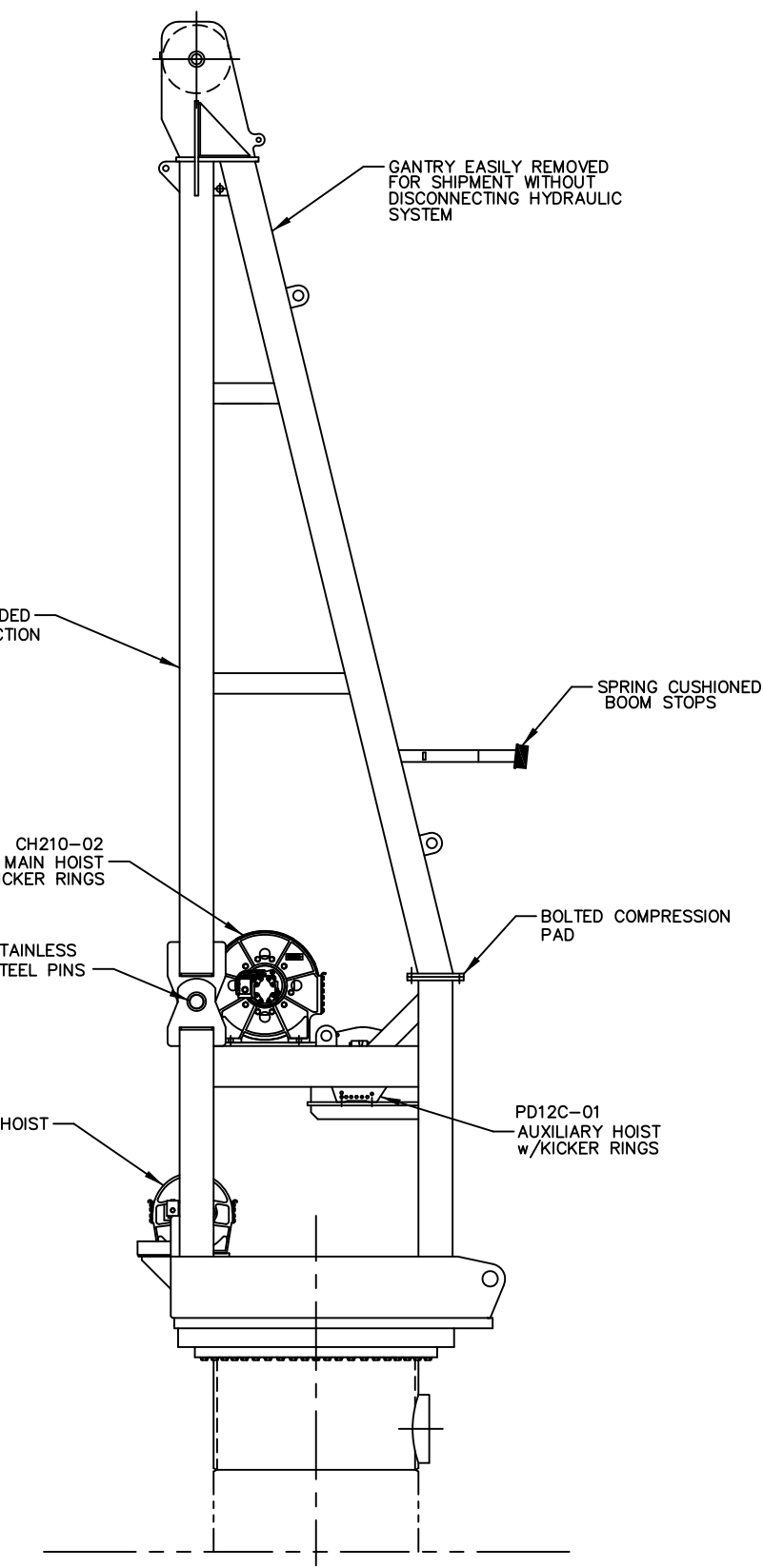
THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.												
<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:

NOTES:  
1. THIS CRANE IS DESIGNED, MANUFACTURED  
AND RATED IN ACCORDANCE WITH API2C  
6TH EDITION DATED SEPTEMBER 2004.  
OSI API LICENSE NO: 2C-0007

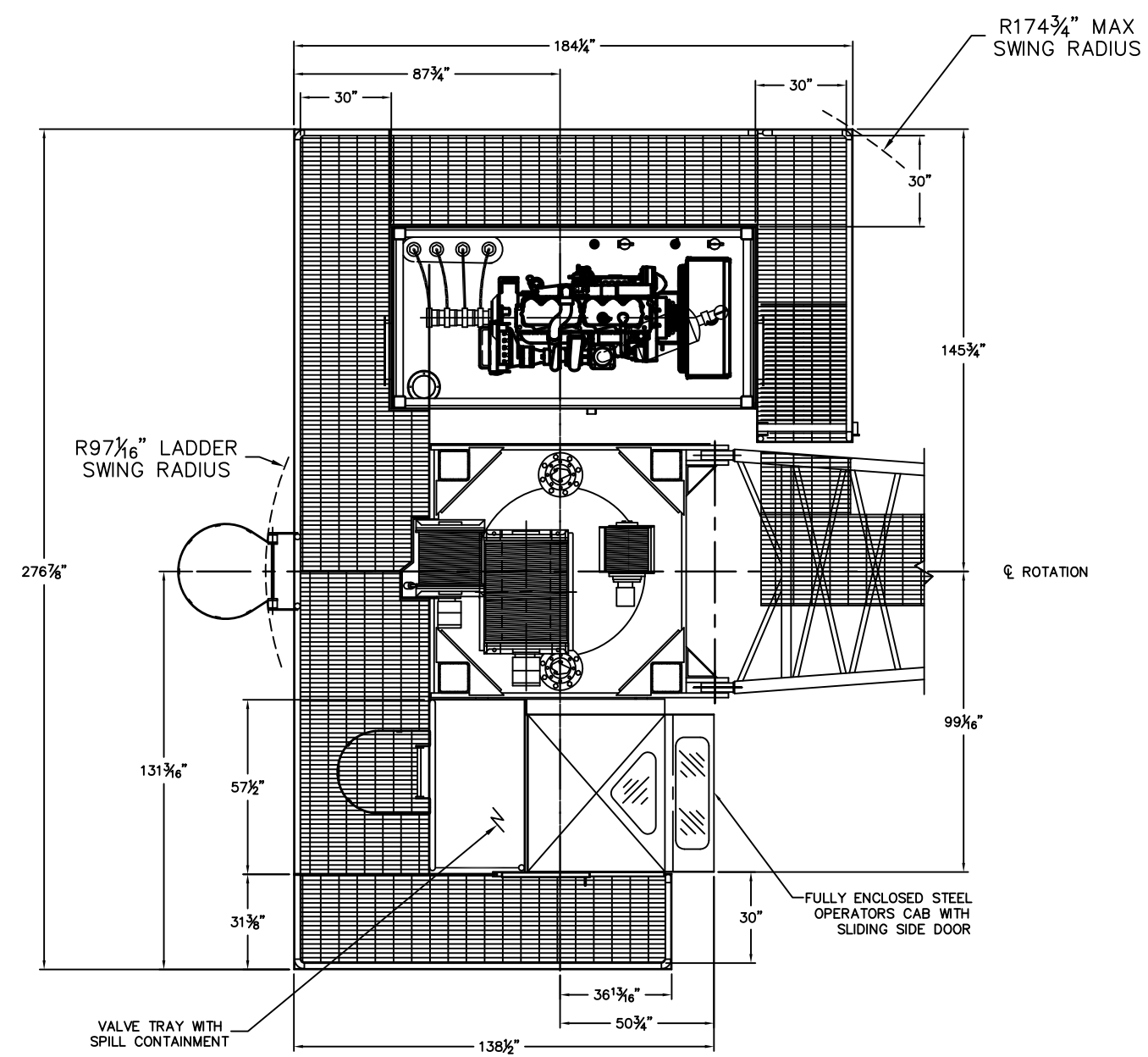


APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

D  
C  
B  
A



SIDE VIEW OF  
GANTRY & UPPERSTRUCTURE  
(POWER UNIT, BOOM, CAB & WALKWAYS NOT SHOWN FOR CLARITY)



PLAN VIEW  
(GANTRY NOT SHOWN FOR CLARITY)

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.

UNLESS OTHERWISE SPECIFIED:  
ALL DIMENSIONS ARE IN INCHES

UNLESS OTHERWISE SPECIFIED:  
ALL TOLERANCES ARE AS STATED

ANGLES:  $\pm 1^\circ$   
DIMENSIONS: T5  
SURFACE FINISH: .500

DESIGNATION & DIMENSION		
T1 $\pm .003$	T4 $\pm .03$	T7 $\pm .12$
T2 $\pm .005$	T5 $\pm .06$	T8 $\pm .18$
T3 $\pm .010$	T6 $\pm .09$	T9 $\pm .25$

DWN: C. DUTHU 9/10/09  
CKD: H. MOLAISSON 9/10/09  
APVD: G. BONVILLAIN 9/10/09

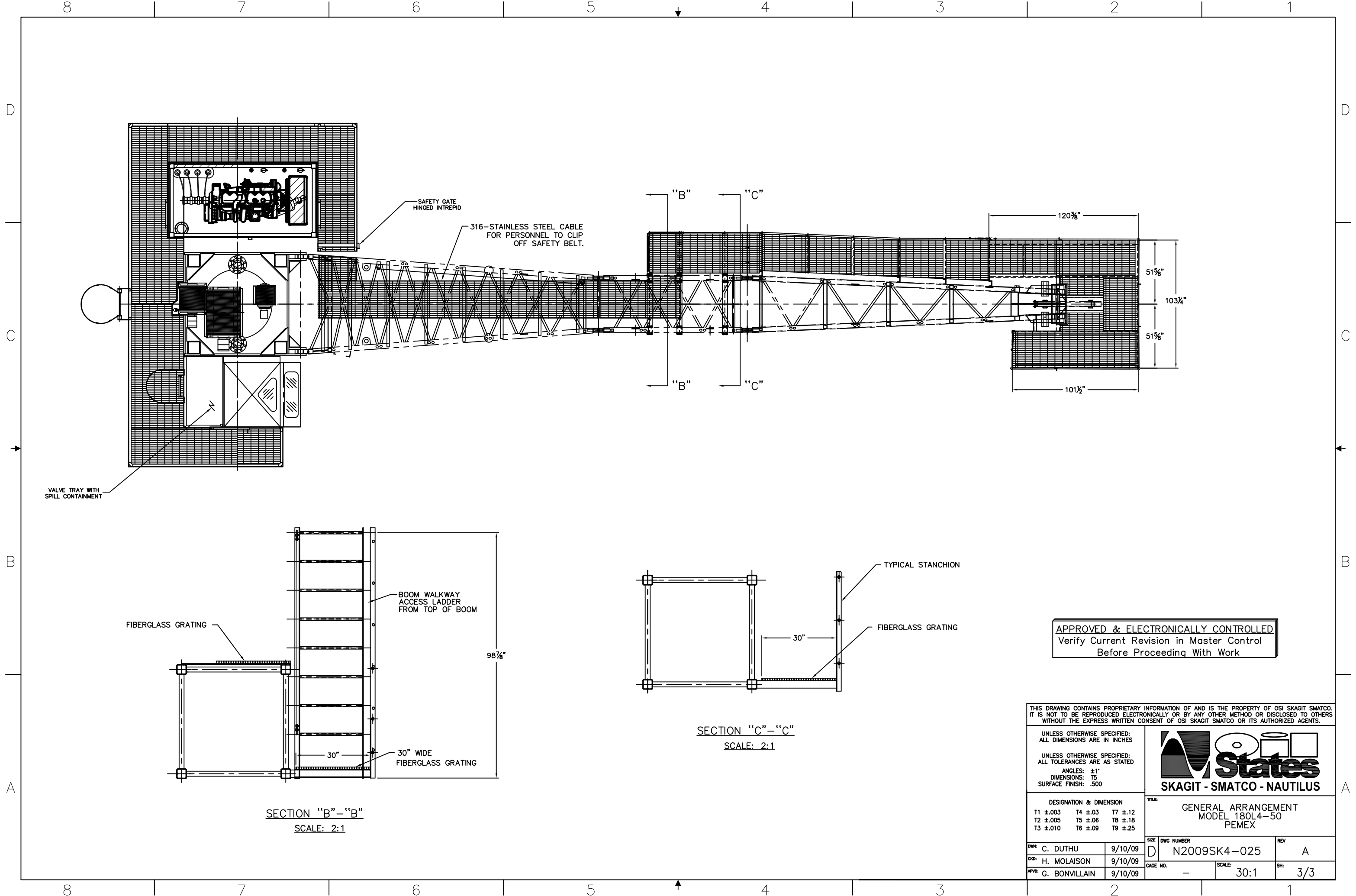
**States**  
SKAGIT - SMATCO - NAUTILUS

TITLE:  
GENERAL ARRANGEMENT  
MODEL 180L4-50  
PEMEX

SIZE	DWG NUMBER	REV
D	N2009SK4-025	A

CAGE NO.	SCALE	SH
-	24:1	2/3

D  
C  
B  
A



VALVE TRAY WITH  
SPILL CONTAINMENT

SAFETY GATE  
HINGED INTREPID

316-STAINLESS STEEL CABLE  
FOR PERSONNEL TO CLIP  
OFF SAFETY BELT.

FIBERGLASS GRATING

BOOM WALKWAY  
ACCESS LADDER  
FROM TOP OF BOOM

98 7/8"

SECTION "B"-"B"  
SCALE: 2:1

30" WIDE  
FIBERGLASS GRATING

30"

TYPICAL STANCHION

FIBERGLASS GRATING

30"

SECTION "C"-"C"  
SCALE: 2:1

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO.  
IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS  
WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.

UNLESS OTHERWISE SPECIFIED:  
ALL DIMENSIONS ARE IN INCHES  
  
UNLESS OTHERWISE SPECIFIED:  
ALL TOLERANCES ARE AS STATED  
ANGLES:  $\pm 1^\circ$   
DIMENSIONS: T5  
SURFACE FINISH: .500



DESIGNATION & DIMENSION  
T1  $\pm .003$  T4  $\pm .03$  T7  $\pm .12$   
T2  $\pm .005$  T5  $\pm .06$  T8  $\pm .18$   
T3  $\pm .010$  T6  $\pm .09$  T9  $\pm .25$

TITLE:  
GENERAL ARRANGEMENT  
MODEL 180L4-50  
PEMEX

DWG: C. DUTHU 9/10/09  
CHKD: H. MOLAISON 9/10/09  
APVD: G. BONVILLAIN 9/10/09

SIZE DWG NUMBER  
D N2009SK4-025  
CAGE NO. - SCALE: 30:1 SH: 3/3





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.5 Power Unit General Arrangement N2009SK4-024



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



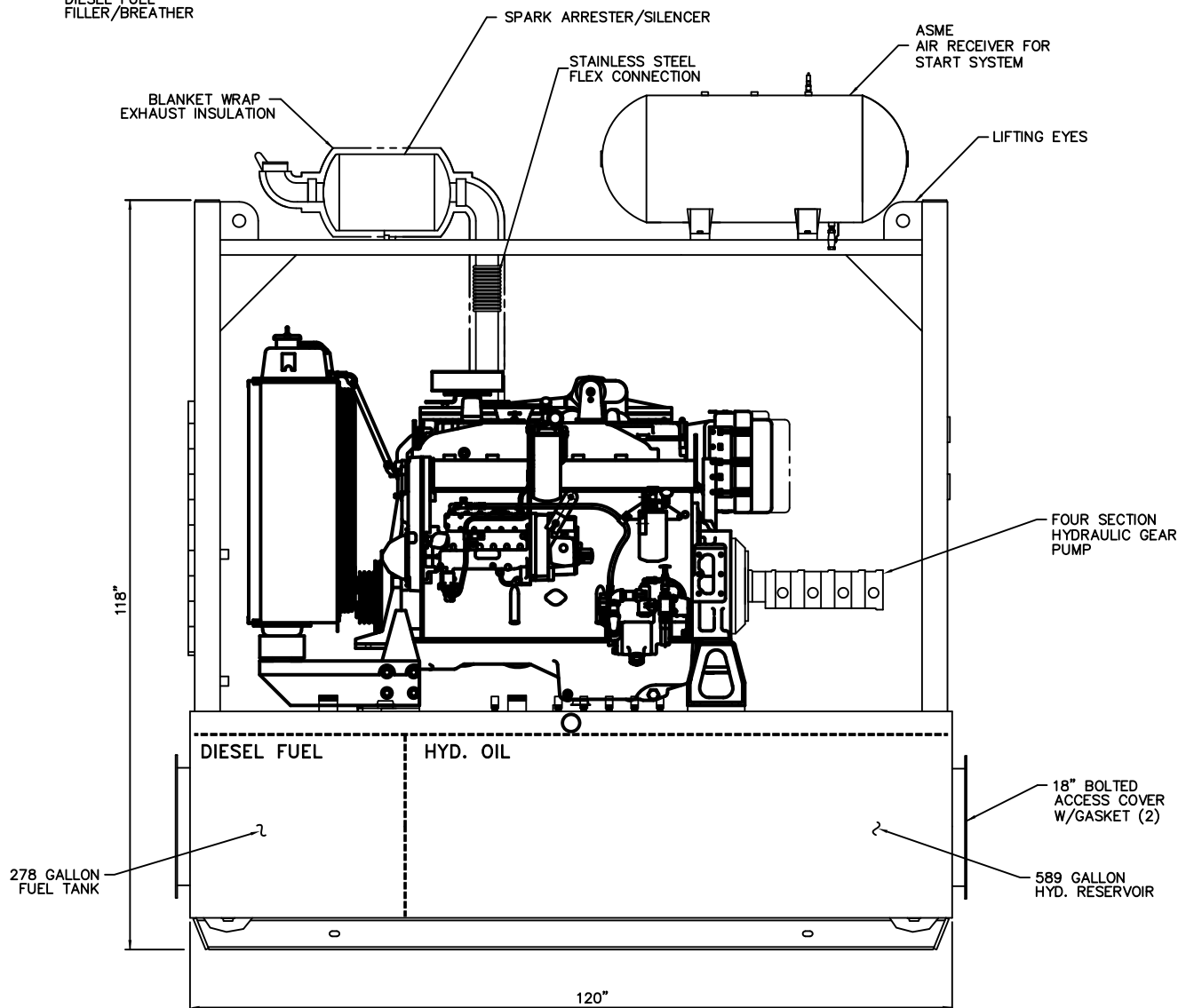
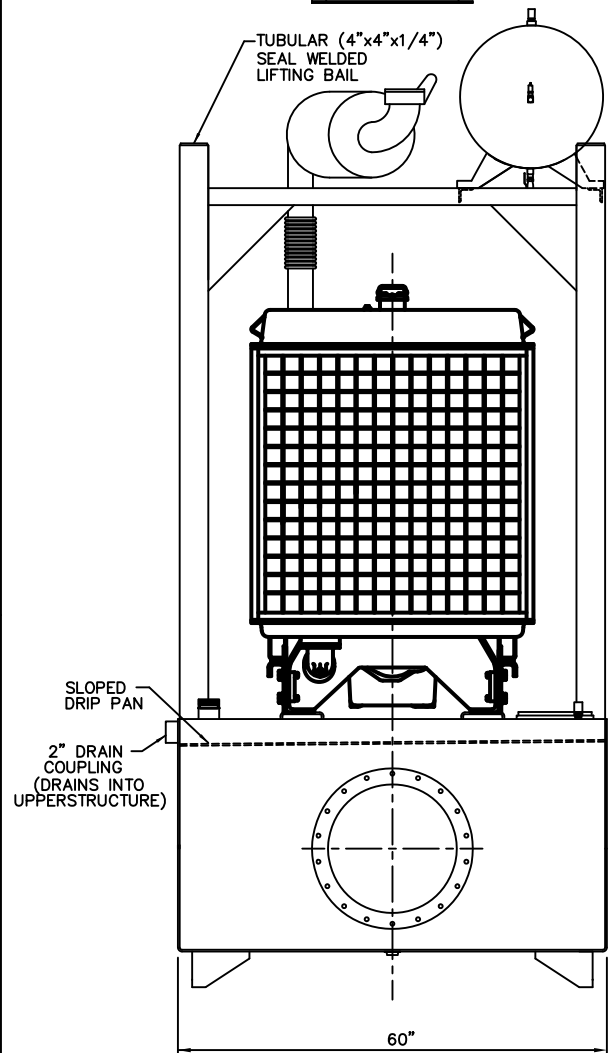
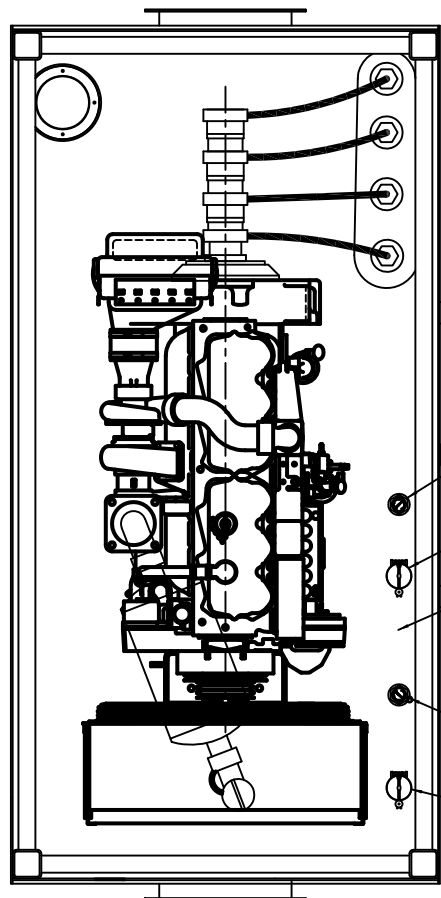


D

C

B

A



NOTE:

1. ENGINE EQUIPPED WITH PRIMARY ELECTRIC START SYSTEM AND SECONDARY AIR START SYSTEM.
2. ENGINE EQUIPPED WITH MANUAL EMERGENCY AIR INTAKE SHUTDOWN SYSTEM AS WELL AS A HIGH WATER TEMPERATURE, LOW OIL PRESSURE, AND OVERSPEED SHUTDOWN SYSTEM.
3. ENGINE GAUGE AND CONTROL PANEL IS LOCATED IN THE OPERATORS CAB.
4. HYDRAULIC RESERVOIR AND FUEL TANK TO BE SHIPPED FULL.
5. ENGINE EQUIPPED WITH HOOD & SIDE PANELS (NOT SHOWN FOR CLARITY.)

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

WORK ORDER NO.: 21409  
PURCHASE ORDER NO.: 7732

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.											
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:			







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

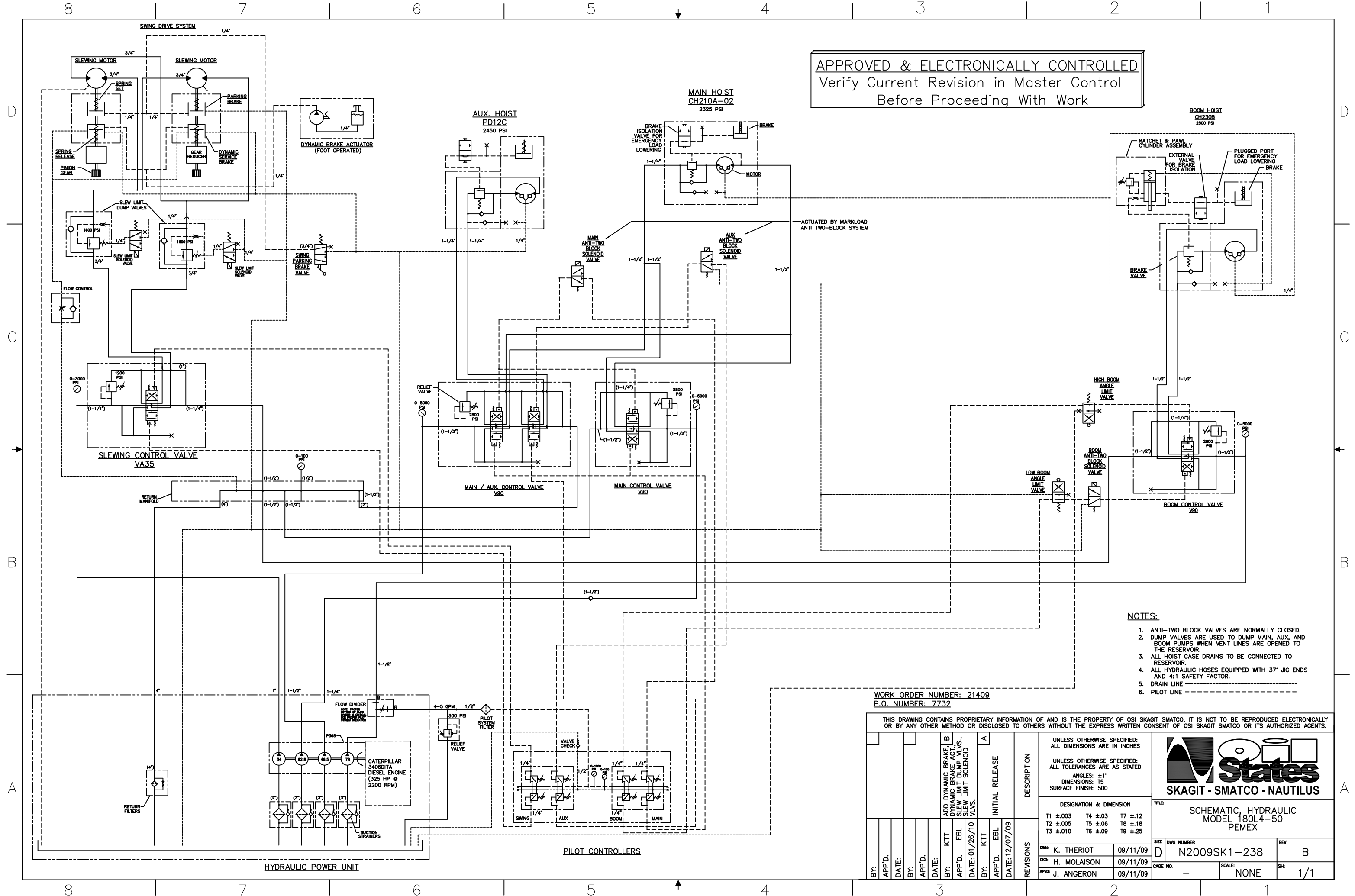
### Section 5.6 Hydraulic Schematic N2009SK1-238



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







APPROVED & ELECTRONICALLY CONTROLLED Verify Current Revision in Master Control Before Proceeding With Work
--

- ### NOTES:
1. ANTI-TWO BLOCK VALVES ARE NORMALLY CLOSED.
  2. DUMP VALVES ARE USED TO DUMP MAIN, AUX, AND BOOM PUMPS WHEN VENT LINES ARE OPENED TO THE RESERVOIR.
  3. ALL HOIST CASE DRAINS TO BE CONNECTED TO RESERVOIR.
  4. ALL HYDRAULIC HOSES EQUIPPED WITH 37" JIC ENDS AND 4:1 SAFETY FACTOR.
  5. DRAIN LINE -----
  6. PILOT LINE -----

WORK ORDER NUMBER: 21409

P.O. NUMBER: 7732

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.											
						B		A		DESCRIPTION	
						ADD DYNAMIC BRAKE, DUAL BREAKER, SLEW LIMIT PUMP VLV'S, SLEW LIMIT SOLENOID VLVS.		INITIAL RELEASE		REVISIONS	
BY: APP'D.		DATE:		BY: APP'D.		DATE:		BY: APP'D.		DATE:	
BY: KTT		APP'D. EBL		DATE: 01/26/10		BY: KTT		APP'D. EBL		DATE: 12/07/09	





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 5.7 Electrical Schematic N2009SK1-239



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





D

C

B

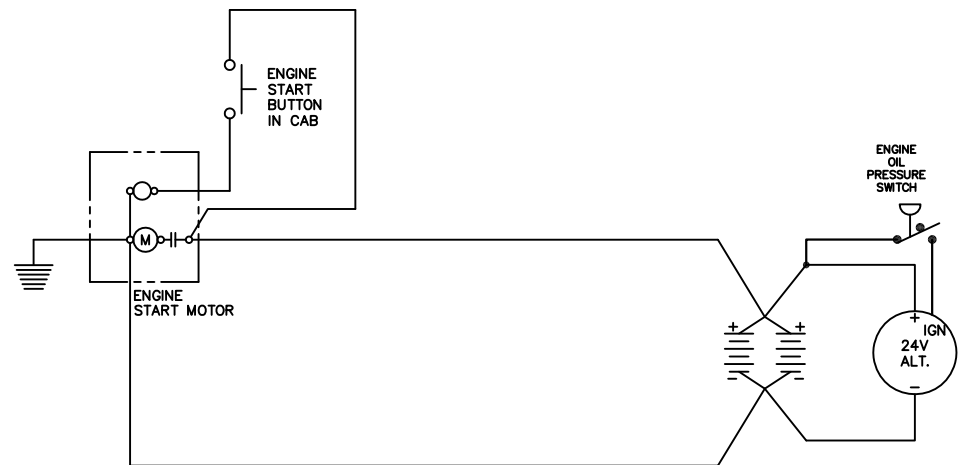
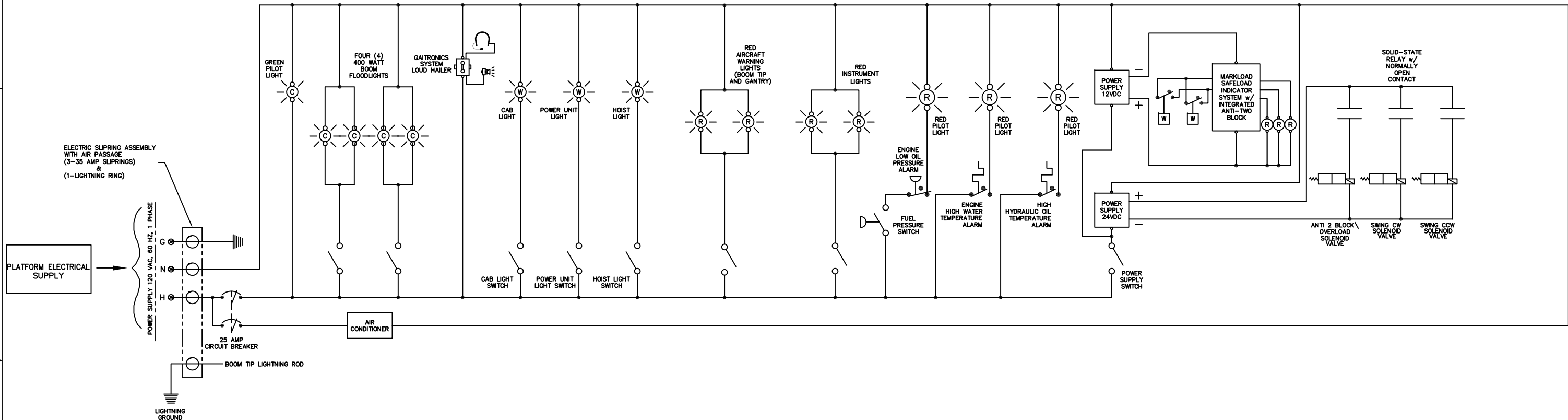
A

D

C

B

A



- NOTES:
- 1. POWER SUPPLY 120 VAC, 60 HZ, 1 PHASE.
  - 2. THE ELECTRICAL SYSTEM IS DESIGNED FOR A MARINE DUTY CLASS 1, DIVISION 1, GROUP D AREA EXCEPT A/C AND START SYSTEM WHICH WILL BE CLASS 1, DIVISION 2, GROUP D. THE RADIOS WILL BE SAFE AREA.
  - 3. ARMORED MARINE SHIPBOARD CABLE UTILIZED.

APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

WORK ORDER: 21409  
P.O. NUMBER: 7732

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.											
BY: APP'D. DATE: BY: APP'D. DATE: BY: KTT APP'D. EBL DATE: 03/04/10			ADDED 24VDC PWR SUPPLY			INITIAL RELEASE			DESCRIPTION		
BY: KTT APP'D. EBL DATE: 12/07/09			REVISIONS			UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED: ALL TOLERANCES ARE AS STATED ANGLES: ±1° DIMENSIONS: T5 SURFACE FINISH: 500			 TITLE: SCHEMATIC, AC ELECTRICAL, MODEL 180L4-50 PEMEX		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			DESIGNATION & DIMENSION T1 ±.003 T4 ±.03 T7 ±.12 T2 ±.005 T5 ±.06 T8 ±.18 T3 ±.010 T6 ±.09 T9 ±.25					
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09		
BY: KTT APP'D. EBL DATE: 12/07/09			BY: KTT APP'D. EBL DATE: 12/07/09								







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50


### Section 5.8 Wiring Diagram N2009SK1-237



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.																
					B	A										
					REMOVED EXTRA SWITCH BOXES, ADDED SWITCHES & LIGHTS TO SUPPLY JUNCTION BOX.		INITIAL RELEASE		DESCRIPTION		UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES  UNLESS OTHERWISE SPECIFIED: ALL TOLERANCES ARE AS STATED  ANGLES: ±1° DIMENSIONS: T5 SURFACE FINISH: 500			 SKAGIT - SMATCO - NAUTILUS		
									DESIGNATION & DIMENSION			TITLE:				
									T1 ±.003    T4 ±.03    T7 ±.12 T2 ±.005    T5 ±.06    T8 ±.18 T3 ±.010    T6 ±.09    T9 ±.25			DIAGRAM, WIRING MODEL 180L4-50 PEMEX				
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	KTT	APP'D.	EBL	DATE: 01/27/10	BY:	KTT	APP'D.	EBL	DATE: 12/07/09	
									REVISIONS		SIZE    DWG NUMBER    REV					
									DWN: C. DUTHU    9/11/09 CRD: H. MOLAISON    9/11/09 APVD: J. ANGERON    9/11/09			D    N2009SK1-237    B				
												CASE NO.    SCALE:    SH:				
												-    N.T.S.    1/1				





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

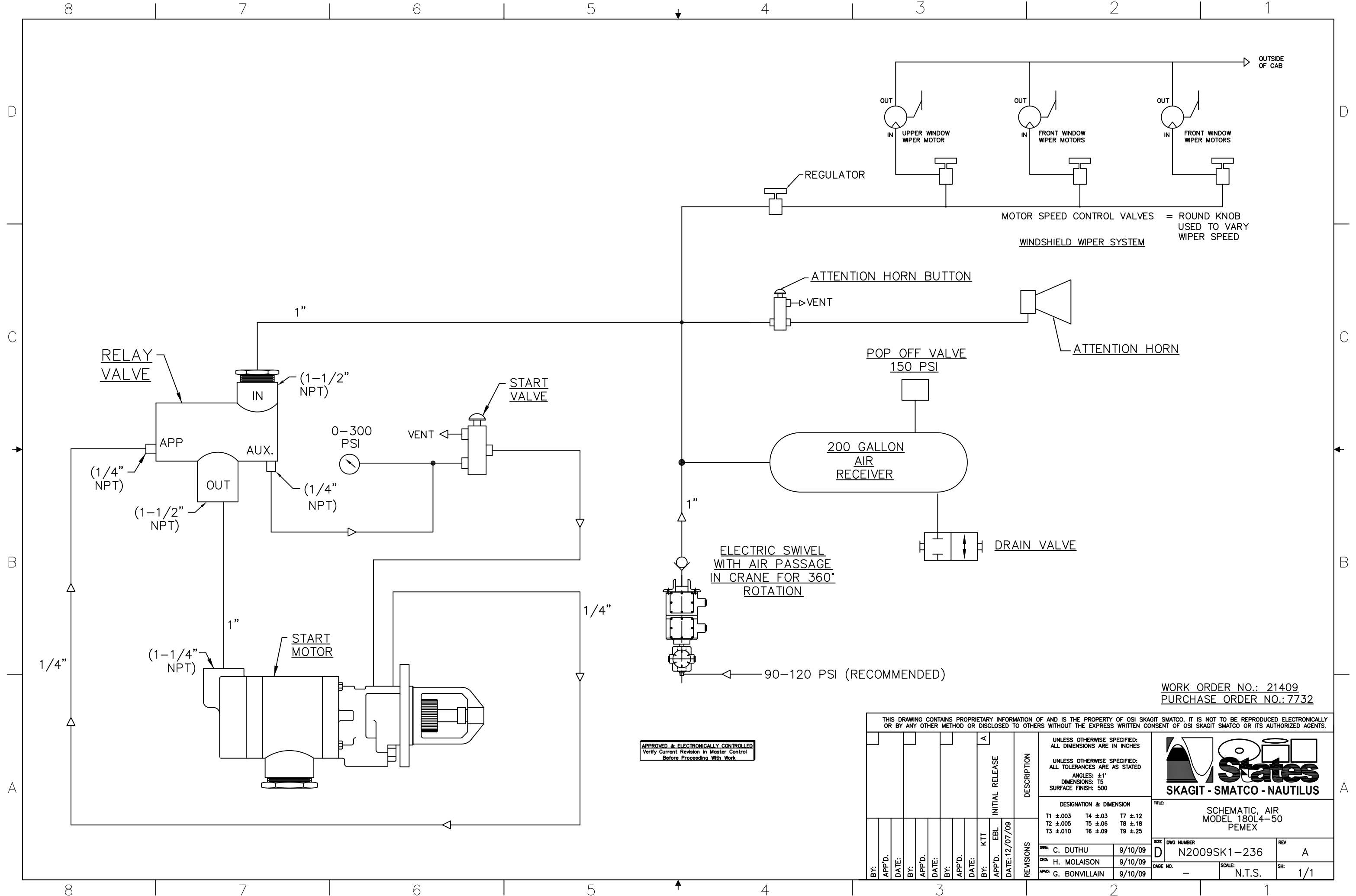
#### Section 5.9 Air Schematic N2009SK1-236



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







APPROVED & ELECTRONICALLY CONTROLLED  
Verify Current Revision in Master Control  
Before Proceeding With Work

THIS DRAWING CONTAINS PROPRIETARY INFORMATION OF AND IS THE PROPERTY OF OSI SKAGIT SMATCO. IT IS NOT TO BE REPRODUCED ELECTRONICALLY OR BY ANY OTHER METHOD OR DISCLOSED TO OTHERS WITHOUT THE EXPRESS WRITTEN CONSENT OF OSI SKAGIT SMATCO OR ITS AUTHORIZED AGENTS.														
BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	APP'D.	DATE:	BY:	KTT	APP'D.	EBL	DATE: 12/07/09	A
														INITIAL RELEASE
														DESCRIPTION
														UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES  UNLESS OTHERWISE SPECIFIED: ALL TOLERANCES ARE AS STATED ANGLES: ±1° DIMENSIONS: T5 SURFACE FINISH: 500
														DESIGNATION & DIMENSION
														T1 ±.003    T4 ±.03    T7 ±.12 T2 ±.005    T5 ±.06    T8 ±.18 T3 ±.010    T6 ±.09    T9 ±.25
														REVIEWS
														DRAWN: C. DUTHU 9/10/09 CHECKED: H. MOLAISON 9/10/09 APPROVED: G. BONVILLAIN 9/10/09
														TITLE: SCHEMATIC, AIR MODEL 180L4-50 PEMEX
														SIZE: D    DWG NUMBER: N2009SK1-236    REV: A
														CAGE NO.: -    SCALE: N.T.S.    SH: 1/1

WORK ORDER NO.: 21409  
PURCHASE ORDER NO.: 7732









Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 5.10 Engine Operations & Maintenance Manual



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





# Operation and Maintenance Manual

---

## **3406C Industrial Engines**

---

3ER1-Up (Engine)

**This Manual Must be Accessible at the Point of Operation**

---

## Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.



**When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

## Table of Contents

Foreword .....	4
----------------	---

### Safety Section

Safety Signs and Labels .....	6
General Hazard Information .....	7
Burn Prevention .....	10
Fire Prevention and Explosion Prevention .....	10
Crushing Prevention and Cutting Prevention .....	12
Mounting and Dismounting .....	12
Before Starting Engine .....	12
Engine Starting .....	13
Engine Stopping .....	13

### Product Information Section

Model Views .....	14
Product Identification Information .....	17

### Operation Section

Engine Lifting and Storage .....	19
Gauges and Indicators .....	20
Engine Features and Controls .....	21
Engine Starting .....	24
Engine Operation .....	28
Engine Stopping .....	30
Cold Weather Operation .....	32

### Maintenance Section

Torque Specifications .....	34
Lubricant Specifications .....	37
Fuel Specifications .....	44
Cooling System Specifications .....	46
Refill Capacities .....	58
Maintenance Interval Schedule .....	59

### Reference Information Section

Customer Service .....	90
Reference Materials .....	92

### Index Section

Index .....	96
-------------	----

## Foreword

### Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Caterpillar publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Caterpillar dealer for the latest available information.

### Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

### Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

### Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

### Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Caterpillar dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

### Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.



## California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds. **Wash hands after handling.**

## Safety Section

### Safety Signs and Labels

i01368857

**SMCS Code:** 1000; 7405

There may be several specific safety signs on an engine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiar with all safety signs.

Ensure that all of the safety signs are legible. Clean the safety signs or replace the safety signs if the words cannot be read or if the pictures are not visible. When the safety signs are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety signs. The safety signs that are loosened could drop off of the engine.

Replace any damaged safety signs or missing safety signs. If a safety sign is attached to a part of the engine that is replaced, install a new safety sign on the replacement part. Any Caterpillar dealer can provide new safety signs.

#### **WARNING**

**Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.**

The safety signs that may be found on the engine are illustrated and described below.

## Battery

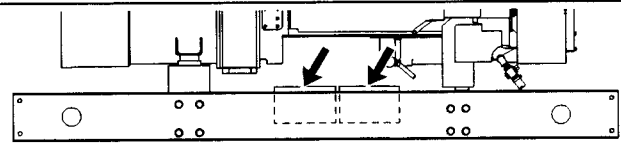
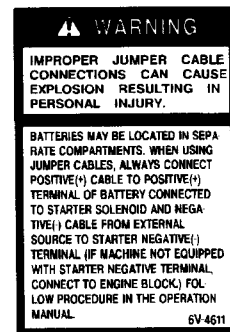


Illustration 1

g00524010

Typical location of the batteries in the battery compartment

The warning label for the battery is installed on the side of the engine or in a visible location near the battery. If batteries are located on both sides of the package, the warning label is located on both sides of the package.



g00455028

#### **WARNING**

**Improper jumper cable connections can cause an explosion resulting in personal injury.**

Batteries may be located in separate compartments. When you are using jump start cables, always connect the positive "+" cable to the positive "+" terminal of the battery that is connected to the starting motor solenoid. Connect the negative "-" cable from the external source to the negative "-" terminal of the starting motor. If the starting motor does not have a negative "-" terminal, connect the negative "-" cable from the external source to the engine block. Follow the procedure in this Operation and Maintenance Manual, "Engine Starting" topic (Operation Section).



## Clutch

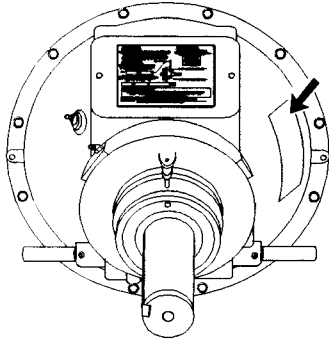
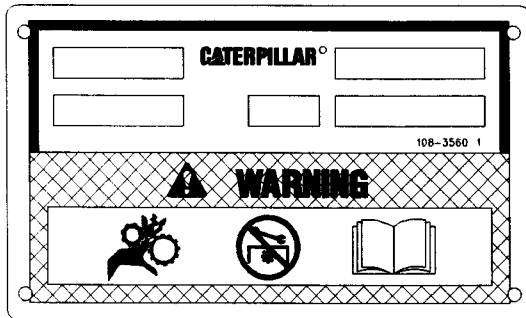


Illustration 2

g00107406

The warning label for the clutch is located on the clutch housing (if equipped).



g00107407

Rotating gears can cause finger entanglement or hand entanglement. Do not service this component without first reading the operator manual.

## Engine Lifting

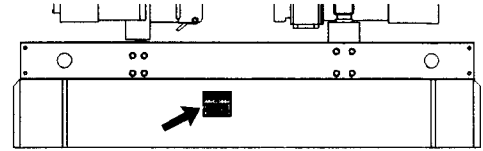
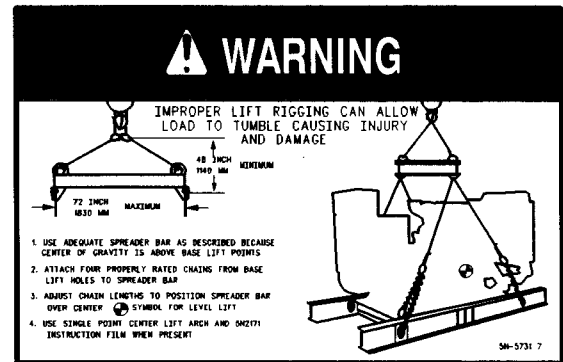


Illustration 3

g00367054

The warning label for lifting the engine with a fuel tank is located on the fuel tank (if equipped).



g00524148



Lift eyes or tank can fail when lifting tank containing fluids resulting in possible personal injury. Drain tank of all fluids before lifting.

i01359759

## General Hazard Information

SMCS Code: 1000; 7405

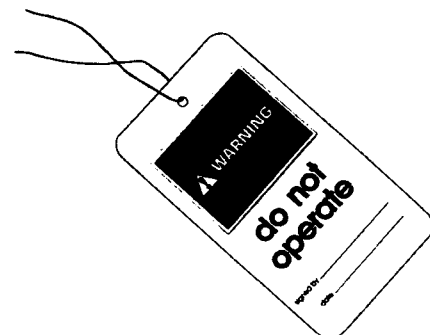


Illustration 4

g00104545

Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.



Illustration 5

g00702020

- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

**Unless other instructions are provided, perform the maintenance under the following conditions:**

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

**California Proposition 65 Warning**

Some engine exhaust constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

**Pressure Air and Water**

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressure air and/or pressure water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.

## Fluid Penetration

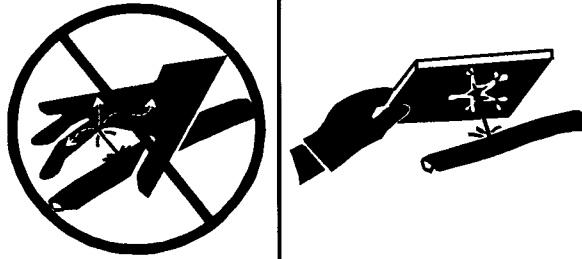


Illustration 6

g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

## Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Tools and Shop Products Guide" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

## Asbestos Information

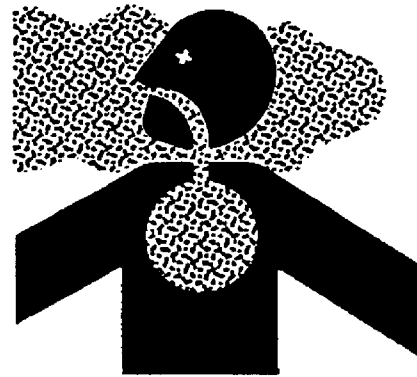


Illustration 7

g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.

- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

## Dispose of Waste Properly

---

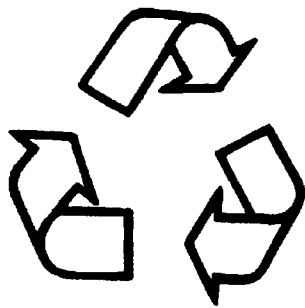


Illustration 8

g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i01329129

## Burn Prevention

**SMCS Code:** 1000; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

### Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level only after the engine has been stopped.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

### Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

### Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

i01359892

## Fire Prevention and Explosion Prevention

**SMCS Code:** 1000; 7405

---



Illustration 9

g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 10

g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.



Illustration 11

g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

## Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

## Ether

Ether is flammable and poisonous.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the engine is equipped with a thermal starting aid for cold weather starting.

i01359666

## Crushing Prevention and Cutting Prevention

**SMCS Code:** 1000; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i01359622

## Mounting and Dismounting

**SMCS Code:** 1000; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the machine or when you dismount the machine. Use a hand line to raise and lower tools or supplies.

i01072501

## Before Starting Engine

**SMCS Code:** 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

For the initial start-up of a new engine and for start-up of an engine that has been serviced, prepare to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel and the air supply to the engine.

See the Service Manual for repairs and for adjustments.

i01103904

## Engine Starting

**SMCS Code:** 1000

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in this Operation and Maintenance Manual, "Engine Starting" topic (Operation Section). Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion that can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

## Ether

Ether is poisonous and flammable.

Do not inhale ether, and do not allow ether to contact the skin. Personal injury could result.

Do not smoke while ether cylinders are changed.

Use ether in well ventilated areas.

Use ether with care in order to avoid fires.

Keep ether cylinders out of the reach of unauthorized persons.

Store ether cylinders in authorized storage areas only.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard the ether cylinders in a safe place. Do not puncture the ether cylinders. Do not burn the ether cylinders.

i00062369

## Engine Stopping

**SMCS Code:** 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been overhauled, be prepared to stop the engine if an overspeed condition occurs. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

# Product Information Section

## Model Views

i01369271

## Model View Illustrations

**SMCS Code:** 1000

The following model views show typical 3406C Industrial Engine features. Due to individual applications, your engine may appear different from the illustrations.



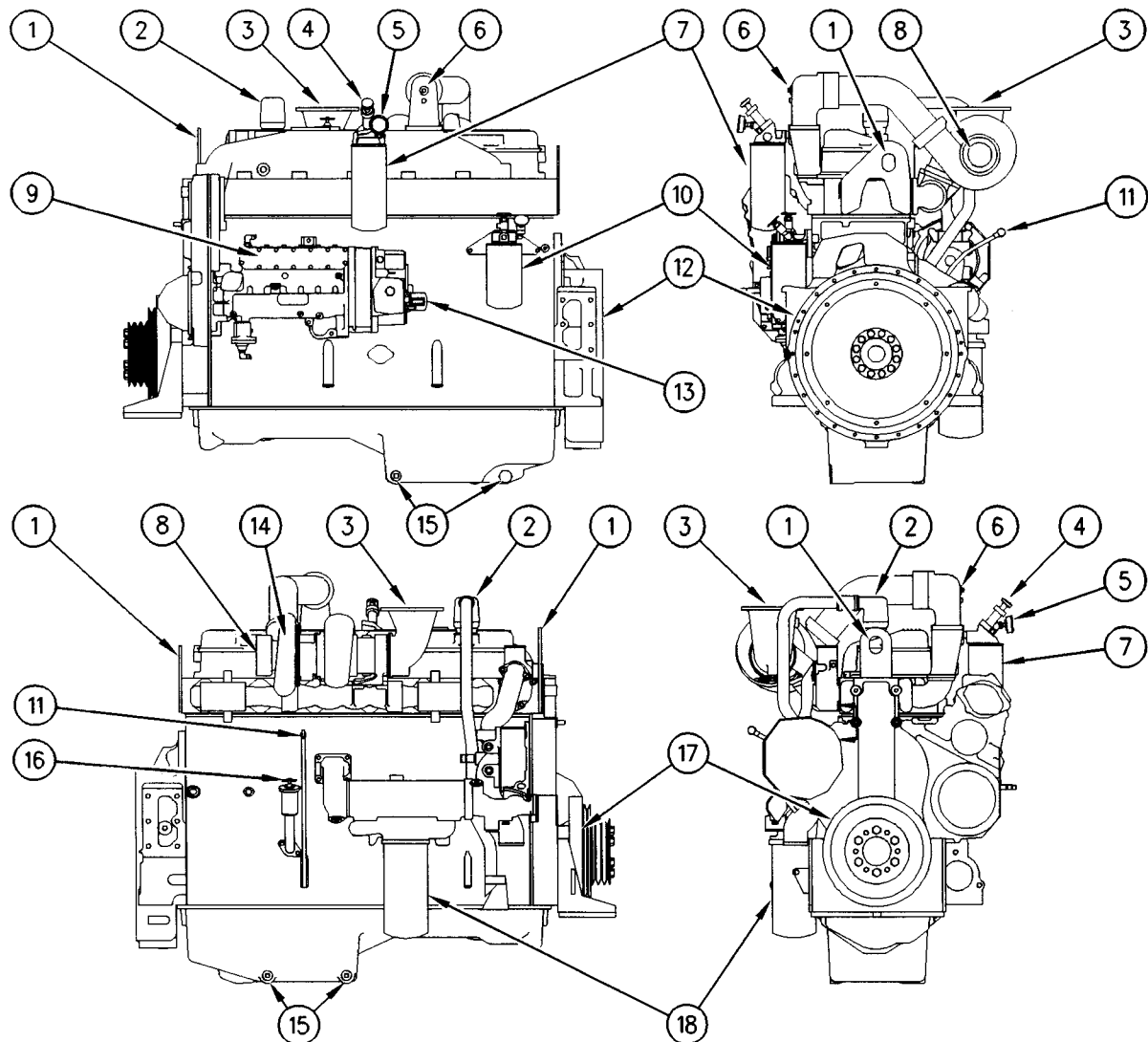


Illustration 12

g00722253

- (1) Lifting eye
- (2) Crankcase breather
- (3) Exhaust
- (4) Fuel priming pump
- (5) Fuel pressure gauge
- (6) Either starting aid (if equipped)

- (7) Fuel filter
- (8) Air inlet
- (9) Fuel pump
- (10) SCA element (if equipped)
- (11) Oil level gauge
- (12) Flywheel housing

- (13) Service hour meter
- (14) Turbocharger
- (15) Oil drain plugs
- (16) Oil filler cap
- (17) Crankshaft vibration damper
- (18) Oil filter

i01369284

## Engine Description

**SMCS Code:** 1000

## Engine Information

The 3406C Industrial Engine is designed primarily for agricultural, petroleum, and auxiliary applications.

A mechanical governor controls the fuel injection pump output. The output maintains the desired engine speed. An automatic timing advance provides the best fuel injection timing over the full range of engine speeds.

The fuel ratio control is located on the governor. The fuel ratio control restricts the fuel rack movement. Only the proper amount of fuel is allowed to be injected into the cylinders during acceleration. This minimizes exhaust smoke.

Inlet air is filtered by an air cleaner. The air is compressed by a turbocharger before the air enters the engine cylinders. The turbocharger is driven by engine exhaust. The engines can be turbocharged. The engines can also be turbocharged with jacket water aftercooling.

The engine is a four cycle engine. Each cylinder head has two inlet valves and two exhaust valves. The rocker arms and the valves are actuated by the camshaft. The action is performed by mechanical lifters and push rods.

## Engine Cooling and Lubrication

The cooling system consists of the following components:

- Centrifugal pump that is driven by gears
- Thermostats which regulate the engine coolant temperature
- Oil cooler
- A radiator or expansion tank (incorporating a shunt system)

The engine lubricating oil, that is supplied by a gear type pump, is cooled. The engine lubricating oil is also filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter elements (paper cartridge)

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the following items:

- Use of recommended coolant/antifreeze
- Use of recommended fuels
- Use of recommended lubrication oils

Refer to the recommended Maintenance Interval Schedule found within this publication in order to maintain the following emission related components:

- Air cleaner
- Engine oil
- Oil filter

- Fuel
- Fuel filter

## Engine Specifications

**Note:** The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

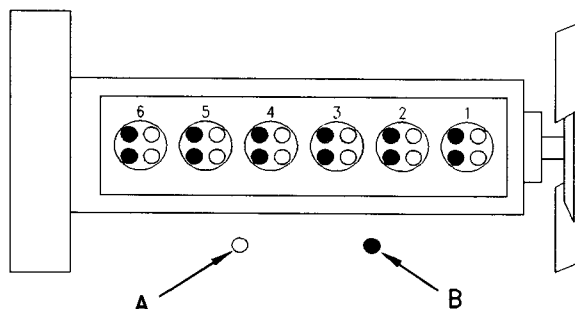


Illustration 13

g00284836

Cylinder and valve locations

(A) Inlet valves  
(B) Exhaust valves

Table 1

3406C Industrial Engine Specifications	
Cylinders and Arrangement	6 cylinder in-line block
Bore	137 mm (5.4 inch)
Stroke	165 mm (6.5 inch)
Compression Ratio	16:25:1
Aspiration	T or TA <sup>(1)</sup>
Displacement	14.6 L (893 in <sup>3</sup> )
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Valve Lash (inlet)	0.38 mm (.015 inch)
Valve Lash (exhaust)	0.76 mm (.030 inch)

<sup>(1)</sup> Turbocharged or Turbocharged and Aftercooled

## Product Identification Information

i00061495

### Engine Identification

i00826199

**SMCS Code:** 1000

Caterpillar engines are identified with serial numbers, with performance specification numbers, and with arrangement numbers. In some of the cases, modification numbers are used. These numbers are shown on the serial number plate that is mounted on the engine.

The numbers for fuel setting information for electronic engines are stored within the personality module. These numbers can be read by using Caterpillar electronic service tools.

Caterpillar dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

i01369380

### Serial Number Plate

**SMCS Code:** 1000

CATERPILLAR		CAT	
SERIAL NUMBER		ARRANGEMENT NUMBER	
ENGINE MODEL			

(ALWAYS GIVE ALL NUMBERS)

Illustration 14

g00722314

Typical serial number plate

The Serial Number Plate is located on the left side of the cylinder block near the rear of the engine.

The following information is stamped on the Serial Number Plate: engine serial number, model, and arrangement number.

## Information Plate

**SMCS Code:** 1000

CAT®	
SER. NO.	CORE AR.
MODIFICATION NO.	DATE DELIVERED
AR NO.	DNR CODE
OEM NO.	PERF SPEC
FULL LOAD STATIC FUEL POWER	MAX ALT
HP	FULL TORQ. STATIC FUEL
BARE ENG. HI IDLE RPM	kw A/F RATIO DYNAMIC
FULL LOAD RPM	FUEL TIMING

9L-6531 17

Illustration 15

g00102789

The Information Plate is on the valve cover. The following information is stamped on the Information Plate: engine's maximum altitude, horsepower, high idle, full load rpm, fuel settings, and other information.

i00610276

## Reference Numbers

**SMCS Code:** 1000

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information on the appropriate space. Make a copy of this list for a record. Retain the information for future reference.

### Record for Reference

Engine Model \_\_\_\_\_

Engine Serial No. \_\_\_\_\_

Engine Arrangement No. \_\_\_\_\_

Modification No. \_\_\_\_\_

Engine Low Idle rpm \_\_\_\_\_

Engine Full Load rpm \_\_\_\_\_

Performance Specification No. \_\_\_\_\_

Primary Fuel Filter No. \_\_\_\_\_

Water Separator Element No. \_\_\_\_\_

Secondary Fuel Filter Element No. \_\_\_\_\_

Lubrication Oil Filter Element No. \_\_\_\_\_

Auxiliary Oil Filter Element No. \_\_\_\_\_

Supplemental Coolant Additive Maintenance  
Element No. (Optional) \_\_\_\_\_

Total Lubrication System Capacity \_\_\_\_\_

Total Cooling System Capacity \_\_\_\_\_

Air Cleaner Element No. \_\_\_\_\_

Fan Drive Belt No. \_\_\_\_\_

Alternator Belt No. \_\_\_\_\_

101193826

## Emissions Certification Film

SMCS Code: 1000

<b>CAT</b>		CATERPILLAR INC.		IMPORTANT ENGINE INFORMATION		2000	JDM00001
ENGINE MODEL : 3116 - DISPLACEMENT : 6.6L - VALVE LASH : 0.38mm INTAKE 0.64mm EXHAUST							
ENGINE FAMILY XCPXL06.6MRB	MAXIMUM ADVERTISED KW (HP) 164 (220)	MAXIMUM RATED SPEED (RPM) 2600	MAXIMUM LOW IDLE SPEED (RPM) 875	MAX. FUEL RATE @ MAXIMUM (mm <sup>3</sup> /STROKE) 104	MAXIMUM INITIAL TIMING DEGREES BTDC 11.5	EXHAUST EMISSION CONTROL SYSTEM EM.D,TC,SPL,CAC	
THIS 3116 ENGINE CONFORMS TO DIRECTIVE 97/68/EC FOR NON-ROAD ENGINES.				EC TYPE APPROVAL NO. eURL*97/68AA*0001*00			
THIS 3116 ENGINE CONFORMS TO 2000 U.S. EPA AND CALIFORNIA REGULATIONS LARGE NON-ROAD COMPRESSION-IGNITION ENGINES.							
THIS ENGINE IS CERTIFIED TO OPERATE ON COMMERCIALLY AVAILABLE DIESEL FUEL.							
DATE OF MANUFACTURE MONTH : 08				7E-8050 01			

FMT:3500

Illustration 16

g00638668

EPA/EU Emissions Certification Film (typical example)

<b>CAT</b>		CATERPILLAR INC.		INFORMATION IMPORTANTE SUR LE MOTEUR			
MODÈLE MOTEUR : 3116 - DÉBIT : 6,6 l - JEU SOUPAPES : 0,38 mm ADMISSION : 0,64 mm ÉCHAPPEMENT							
FAMILLE DE MOTEURS : XCPXL06.6MRB	Kw (HP) MAXI PUBLES : 164 (220)	MAXI RÉGIME NOMINAL (tr/mn) : 2000	MAXI RÉGIME RALENTI (tr/mn) : 875	MAXI DÉBIT D'INJ. A PUIS MAXI (mm <sup>3</sup> /STROKE) (PISTON) : 104	MAXI CALAGE INITIAL D'INJ. (DEGRÉS) (AVANT PMH) : 11,5	DISPOSITIF ANTI-POLLUANT : FM,D,TC,SPL,CAC	
CE MOTEUR 3116 EST CONFORME AUX DIRECTIVES 97/68/EC POUR LES MOTEURS NON ROUTIERS.				NO APPROBATION TYPE EC eURL*97/68AA*0001*00			
CE MOTEUR 3116 EST CONFORME AUX RÉGLEMENTATIONS 2000 DE L'AGENCE AMÉRICAINE DE PROTECTION DE L'ENVIRONNEMENT (EPA) ET DE LA CALIFORNIE POUR LES GROS MOTEURS NON ROUTIERS À COMPRESSION-CONTACT.							
CE MOTEUR EST HOMOLOGUÉ POUR FONCTIONNER AVEC LE CARBURANT DIESEL DU COMMERCE.							
DATE DE FABRICATION (MOIS) : 08							

Étiquette d'homologation anti-pollution

Illustration 17

g00638373

EPA/EU Emissions Certification Film (French-typical example)

The EPA/EU Emissions Certification Film (if applicable) is located either on the side, the top, or the front of the engine.

## Operation Section

### Engine Lifting and Storage

i01028339

#### Engine Lifting

**SMCS Code:** 1000; 1122

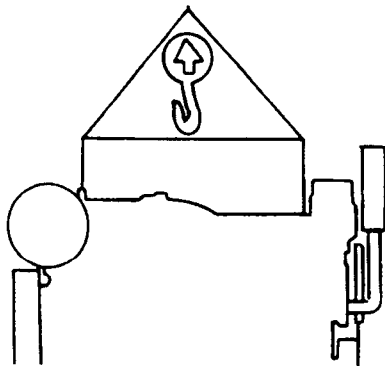


Illustration 18

g00103219

#### NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

### Engine Lifting with a Fuel Tank

#### ⚠ WARNING

**Lift eyes or tank can fail when lifting tank containing fluids resulting in possible personal injury. Drain tank of all fluids before lifting.**

Lifting the engine with a fuel tank that is mounted to the engine requires special equipment and procedures. Do not lift the unit with fuel in the fuel tank. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

i00777190

### Engine Storage

**SMCS Code:** 1000

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, "General Coolant Information" (Maintenance Section).

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

For more detailed information on engine storage, see Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products".

Your Caterpillar dealer can assist in preparing the engine for extended storage periods.

## Gauges and Indicators

i01369505

### Gauges and Indicators

**SMCS Code:** 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate a potential problem with a gauge or with the engine. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine the cause of any significant change in the readings, and/or correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

#### NOTICE

Be ready to activate the engine shutoff manually, if there is no oil pressure. Damage to the engine will result if the engine continues to run without the correct oil pressure.



**Engine Oil Pressure** – Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 275 to 606 kPa (40 to 88 psi).

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check and maintain the oil level.

The minimum recommended oil pressure at 600 rpm is 103 kPa (15 psi). If low oil pressure or no oil pressure is indicated, stop the engine and determine the cause of the problem. Refer to Troubleshooting for further information or consult with your Caterpillar dealer.



**Jacket Water Coolant Temperature** –

Typical temperature range is 87 to 98°C (189 to 208°F). The maximum allowable temperature with the pressurized cooling system is 104 °C (219 °F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine speed (rpm).
2. Inspect the cooling system for leaks.
3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



**Tachometer** – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position

without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

#### NOTICE

Engine overspeed may cause serious damage.

Keep the tachometer indicator in the green operating range.

**Note:** The high idle speed (rpm) and the full load speed (rpm) are stamped on the Information Plate.



**Ammeter** – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of "0"(zero).



**Service Hour Meter** – This gauge indicates the total number of clock hours that the engine has operated.



**Fuel Pressure** – This gauge indicates fuel pressure to the injection pump. The indicator should indicate the "NORMAL" range. If the indicator moves to the "OUT" position or registers below 160 kPa (23 psi) when equipped with a numerical gauge, the engine will not operate properly. A decrease in fuel pressure usually indicates a plugged fuel filter.

# Engine Features and Controls

## Engine Shutoffs and Engine Alarms

i01369587

**SMCS Code:** 1900; 7400; 7418

### Shutoffs

Shutoffs and alarms are electrically operated or mechanically operated. The operation of all electric shutoffs and alarms utilize components which actuate switches in a sensing unit.

Shutoffs are set at critical levels for the following items: operating temperature, operating pressure, operating coolant level, and operating speed (rpm). The particular shutoff may need to be reset before the engine will start.

#### NOTICE

**Always determine the cause of the engine shutdown. Make necessary repairs before attempting to restart the engine.**

Be familiar with the following items:

- Types and locations of shutoff
- Conditions which cause each shutoff to function
- The resetting procedure that is required to restart the engine

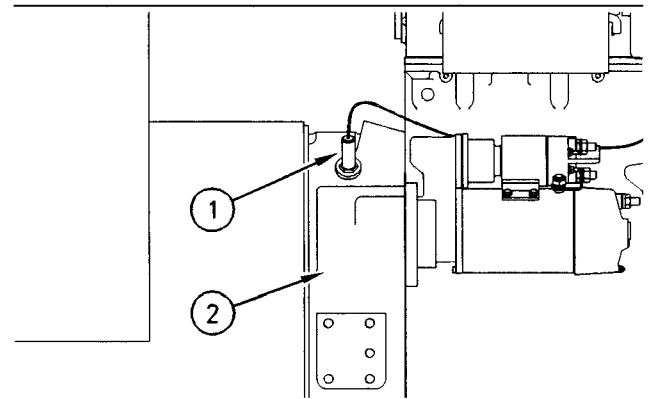
### Air Shutoff Solenoid (If Equipped)

This optional solenoid is located on top of the engine. The air shutoff is part of the air inlet system. When the solenoid is activated, the solenoid mechanically shuts off the inlet air to the engine. The solenoid can be activated only by the overspeed switch or by the emergency stop push button (ESPB). The cause of the shutoff should be determined before the engine is restarted.

### Fuel Shutoff Solenoid

The fuel shutoff solenoid is located on the governor or the fuel shutoff solenoid is located on the fuel injection pump. When the fuel shutoff solenoid is activated, the solenoid moves the fuel rack "OFF". The fuel shutoff solenoid moves the fuel rack directly or the fuel shutoff solenoid moves the fuel rack through the governor.

### Overspeed Shutoffs



**Illustration 19**

g00293335

- (1) Magnetic pickup  
(2) Flywheel housing

The magnetic pickup senses the passage of the teeth that are on the flywheel ring gear. The Electronic Overspeed Switch is set at 118 percent of the rated engine speed. If the engine speed increases above the overspeed setting, the magnetic pickup will sense the overspeed. A signal is sent to the Electronic Overspeed Switch. The Electronic Overspeed Switch activates both the air shutoff solenoid (if equipped) and the fuel shutoff solenoid.

The shutoffs must be reset before the engine will restart. The air shutoff lever that is located at the top of the air inlet housing must be manually reset. The cause of the overspeed must be determined before the engine is restarted.

### Alarms

Alarms consist of a switch and a contactor. The switches are wired to the contactors. The contactors activate alarm circuits in an annunciator panel. Your engine may be equipped with the following switches:

**Engine oil pressure** – The engine oil pressure switch indicates when oil pressure drops below rated system pressure.

**Coolant level** – The low coolant level switch indicates when the coolant level is low.

**Coolant temperature** – The coolant temperature switch indicates high jacket water coolant temperature.

**Note:** The sensing element of the coolant temperature switch must be submerged in coolant in order to operate.

Engines may be equipped with alarms in order to alert the operator when undesirable operating conditions occur.

---

**NOTICE**

**When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage.**

---

If corrective measures are not taken within a reasonable time, engine damage could result. The alarm will continue until the condition is corrected. The alarm may need to be reset.

A switch may be installed in the alarm while the engine is stopped for repairs. Before the engine is started, ensure that the switch is moved to the ON position and that the warning lights are flashing. The engine will not be protected if the switch is left in the OFF position.

## Testing the Shutoff and Alarm System

Most control panels are equipped with a lamp test switch. Turn the switch to the ON position in order to check the indicator lights for proper operation. Replace worn bulbs immediately.

---

**NOTICE**

**During testing, abnormal operating conditions must be simulated. Perform the tests correctly in order to help prevent possible engine damage.**

---

Refer to the Service Manual for more information on testing procedures or consult your Caterpillar dealer.

## Testing of the Overspeed Switch

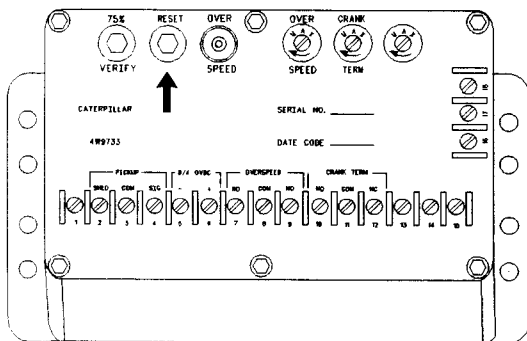


Illustration 20

g00291056

Electronic Overspeed Switch

The overspeed shutoff switch is located in the junction box. The overspeed shutoff switch must be reset before you can restart the engine. To reset the switch, push the "RESET" button. The button will remain in this position unless an overspeed condition occurs.

The Electronic Overspeed Switch with Cranking Termination has a 75 percent "VERIFY" button, a "RESET" button, and an "OVERSPEED" indicator lamp.

The Electronic Overspeed Shutoff Switch with Cranking Termination has a sensing circuit which prevents the starter pinion from remaining engaged in the flywheel at excessive rpm. Crank Termination has an adjustable engine speed setting. This signals the starter motor when the engine is firing. Cranking must be terminated. Once the speed setting is reached, a switch opens. This will start the engine hour meter.

Once the starting motor cranks the engine, the pinion gear can remain engaged with the flywheel as the engine speed increases. The magnetic pickup opens the circuit to the starting motor at 400 rpm. This will allow the pinion gear to disengage.

The circuit will remain open until the flywheel stops. This prevents energizing the starting motor circuit again while the flywheel is turning.

The engine may be equipped with either an Overspeed Shutoff Switch or an Electronic Overspeed Switch with Cranking Termination. Both switches can be checked for proper operation at 75 percent of overspeed condition. Use the following procedure:

1. Determine full load speed (rpm) from the Engine Information Plate.
2. Operate the engine at or slightly above the corresponding speed (rpm) shown for the engine. Refer to table 2.
3. Maintain the test speed (rpm). Push and hold the "VERIFY" button. The engine should stop. If the engine does not stop at the specified test speed (rpm), contact your Caterpillar dealer.



Table 2

<b>INDUSTRIAL ENGINE OVERSPEED TEST RPM</b>		
<b>Full Load RPM</b>	<b>Test RPM For Overspeed<sup>(1)</sup></b>	<b>Actual RPM Of Overspeed<sup>(2)</sup></b>
1500	1328	1770
1800	1593	2124
2000	1770	2360
2100	1859	2478

<sup>(1)</sup> The Test RPM for Overspeed is slower than the Full Load RPM. Multiply the Full Load RPM by 0.885. The product is the Test RPM.

<sup>(2)</sup> Multiply the Full Load RPM by 1.18. The product is the Actual RPM of Overspeed

**Note:** The "OVERSPEED" lamp will illuminate as the engine stops. Push the "RESET" button before you restart the engine.

# Engine Starting

i01197471

## Before Starting Engine

**SMCS Code:** 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.

---

### NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

---

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system.

### WARNING

**Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.**

---

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level gauge.
- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the "FULL" mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Remove any electrical loads.

i00970006

## Starting the Engine

**SMCS Code:** 1000; 1450

Refer to the Service Manual for your type of controls. Use the following procedure to start the engine.

1. Place the manual stop control (if equipped) in the RUN position. Turn the ignition switch to the RUN position. Advance the throttle in order to supply fuel to the engine.
2. Turn the ignition switch to the START position in order to crank the engine.

Allow the ignition switch to return to the RUN position as soon as the engine starts.

### NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

3. Move the throttle to approximately one quarter of the engine rpm.
4. Allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. The engine should run at low idle smoothly until speed is gradually increased to high idle. Allow the white smoke to disperse before proceeding with normal operation.

To minimize white smoke for cold weather starting, start the engine and allow the engine to idle for 30 seconds. Increase the rpm until the engine speed reaches 1200 rpm. Return the engine to low idle rpm.

5. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

i00998863

## Cold Weather Starting

**SMCS Code:** 1000; 1250; 1450; 1453; 1456; 1900

Refer to the Operation and Maintenance Manual that is for the control panels for detailed information on the control panels.

### WARNING

**When using starting fluid (ether), follow the manufacturer's instructions carefully. Use the starting fluid sparingly and spray only while cranking the engine. Failure to do so could result in an explosion and/or fire and personal injury.**

### NOTICE

The optional ether starting aid is the only starting fluid system that is recommended on the engine.

Startability will be improved at temperatures below  $-18^{\circ}\text{C}$  ( $0^{\circ}\text{F}$ ) from the use of a jacket water heater or extra battery capacity.

When No. 2 diesel fuel is used, the following items provide a means of minimizing starting problems and fuel problems in cold weather: starting aids, engine oil pan heaters, jacket water heaters, fuel heaters, and fuel line insulation.

For temperatures below  $-23^{\circ}\text{C}$  ( $-10^{\circ}\text{F}$ ), consult your Caterpillar dealer.

Use the procedure that follows for cold weather starting.

**Note:** If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to the Operation and Maintenance Manual for more information on priming the fuel system.

### NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

1. Turn the ignition switch to the RUN position. Advance the throttle in order to supply fuel to the engine.

### NOTICE

Excessive ether can cause piston and piston ring damage. Use ether for cold starting purposes only. Do not use excessive starting fluid while starting the engine. Do not use starting fluid after the engine is running.

2. If equipped, press the "Starting Aid" switch in order to improve cold weather starting. Release the "Starting Aid" switch when the engine starts. Use the starting fluid sparingly. Carefully follow the instructions of the OEM.

---

**NOTICE**

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

---

3. Increase the engine rpm to approximately 1/4 of the full load rpm.
4. Allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. The engine should run at low idle smoothly until speed is gradually increased to high idle. Allow the white smoke to disperse before proceeding with normal operation.
5. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

i01037941

## Starting with Jump Start Cables

**SMCS Code:** 1000; 1401; 1402; 1900

### **WARNING**

**Improper jump start cable connections can cause an explosion resulting in personal injury.**

**Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.**

---

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

First, determine the reason that it is necessary to start with power from an external source. Refer to Special Instruction, SEHS7768, "Use of the 6V-2150 Starting/Charging Analyzer".

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

---

**NOTICE**

Using a battery source with the same voltage as the electric starting motor. Use **ONLY** equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the engine control switch to the "OFF" position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

---

1. Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.
2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.
3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.
4. Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
5. Start the engine.
6. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

i01043333

i00830307

## After Starting Engine

**SMCS Code:** 1000

**Note:** In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately five minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

**Note:** Ensure that the self-test for the monitoring system (if equipped) is completed before operating the engine under load.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

**Note:** Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

## Air Starting

**SMCS Code:** 1451

For good life of the air starting motor, the air supply must be free from dirt and water.

1. Open the drain valve and close the drain valve in order to drain condensation and oil carryover. This drain valve is located on the bottom of the air tank.
2. Check the air supply pressure. The air starting motor requires a minimum of 690 kPa (100 psi) air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal operating air pressure will be 758 to 965 kPa (110 to 140 psi).

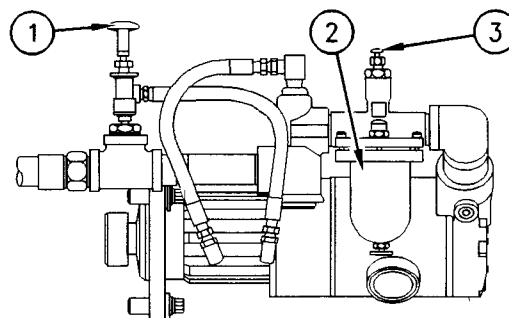


Illustration 21

g00381232

- (1) Air valve  
(2) Lubricator bowl  
(3) Adjustment knob

3. Check the oil level in lubricator bowl (2). Keep the bowl at least half full and add lubricant, if necessary.
4. Press air valve (1) or press the start button for the engine in order to crank the engine. After the engine starts, release the air valve or release the start button.

# Engine Operation

i00808595

i00718869

## Engine Operation

**SMCS Code:** 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time needed for a walk-around inspection of the engine.

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at the rated rpm. The engine will reach normal operating temperature faster when the engine is at rated speed. The engine will reach normal operating temperature faster when the engine is at low power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

## Engine Warm-up

**SMCS Code:** 1000

1. Run the engine at low idle for three to five minutes, or run the engine at low idle until the jacket water temperature starts to rise.

More time may be necessary when the temperature is below  $-18^{\circ}\text{C}$  ( $0^{\circ}\text{F}$ ).

2. Check all of the gauges during the warm-up period.
3. Perform another walk-around inspection. Check the engine for fluid leaks and air leaks.
4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the engine oil temperature reaches  $60^{\circ}\text{C}$  ( $140^{\circ}\text{F}$ ).

i00162260

## Engaging the Driven Equipment

**SMCS Code:** 1000

1. Operate the engine at one-half of the rated rpm.
2. Engage the driven equipment without a load on the equipment.

Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.

3. Ensure that the engine gauges register in the normal ranges when the engine is operating at one-half of the rated rpm. Ensure that any gauges for the equipment register in the normal ranges.
4. Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.
5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load.

Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance. When the engine is operated at reduced load, the engine should be fully loaded in four hour increments. This procedure burns excess carbon from the cylinders. Check the gauges and equipment frequently when the engine is operated under load.

i00165110

## Fuel Conservation Practices

**SMCS Code:** 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Ensure that the turbochargers are operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

One defective battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.
- Settings for the fuel system and the limits for the operating altitude are stamped on the Engine Information Plate. If an engine is moved to a higher altitude, the settings must be changed by a Caterpillar dealer. Changing the settings will help prevent damage to the turbocharger. Changing the settings will help to provide the maximum efficiency for the engine. Engines can be operated safely at higher altitudes, but the engines will deliver less horsepower. The fuel settings should be changed by a Caterpillar dealer in order to obtain the rated horsepower.

## Engine Stopping

i01057253

### Emergency Stopping

**SMCS Code:** 1000; 7418

#### NOTICE

Emergency shutoff controls are for **EMERGENCY** use **ONLY**. **DO NOT** use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

### Emergency Stop Button

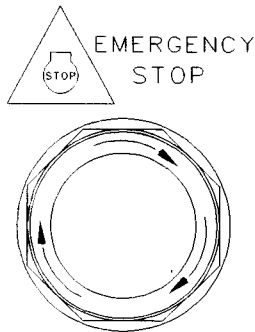


Illustration 22

g00104303

Typical emergency stop button

The emergency stop button is in the OUT position for normal engine operation. Push the emergency stop button. The engine will not start when the button is locked. Turn the button clockwise in order to reset.

i01370486

### Manual Stop Procedure

**SMCS Code:** 1000

A manual shutoff shaft will override the governor control. The shaft will move the fuel control linkage to the FUEL OFF position. Refer to the MODEL VIEWS for the engine location of the shaft. The engine may be stopped by using the shaft and either the Woodward Actuator (if equipped) or the Mechanical Governor (if equipped).

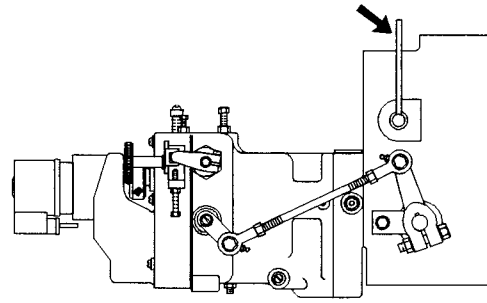


Illustration 23

g00723091

Typical Woodward actuator control lever

If the engine is equipped with a Woodward Actuator, move the control lever to the "FUEL OFF" position.

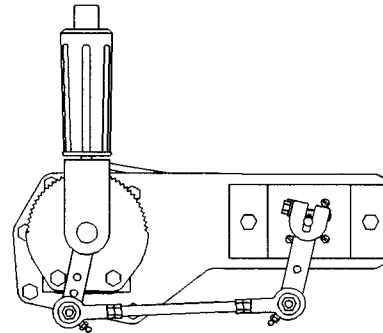


Illustration 24

g00723092

Typical mechanical governor control

If the engine is equipped with a Mechanical governor control, move the control lever to the FUEL OFF position.

Hold the lever at the FUEL OFF position until the engine stops.

Some engines are equipped with an air shutoff. The air shutoff is located between the aftercooler and the turbocharger. If the engine is equipped with an air shutoff lever, move the lever to the OFF position.

**Note:** Individual applications will have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.

1. Reduce the engine speed (rpm) to low idle. Remove the load.



2. Increase the engine speed (rpm) to no more than one-half of the rated speed (rpm). Perform this procedure for three to five minutes in order to cool the engine. Reduce the engine speed (rpm) to low idle.
3. After the cool down period, turn the start switch to the OFF position.

i01197515

## After Stopping Engine

**SMCS Code:** 1000

- Check the crankcase oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, "Maintenance Interval Schedule".
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

---

### NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

---

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

# Cold Weather Operation

i00169595

## Radiator Restrictions

**SMCS Code:** 1353; 1396

Caterpillar discourages the use of airflow restriction devices that are mounted in front of radiators. Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm<sup>2</sup> (120 in<sup>2</sup>).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

Caterpillar recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at 65°C (150°F). The inlet manifold air temperature should not exceed 65°C (150°F). Temperatures that exceed this limit can cause power loss and potential engine damage.

i01190421

## Fuel and the Effect from Cold Weather

**SMCS Code:** 1000; 1250

The following fuels are the grades that are available for Caterpillar engines:

- No. 1
- No. 2
- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold weather operation.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

There are three major differences between No. 1 and No. 2 diesel fuel. No. 1 diesel fuel has the following properties:

- Lower cloud point
- Lower pour point
- Lower rating of kJ (BTU) per unit volume of fuel

When No. 1 diesel fuel is used, a decrease in power and in fuel efficiency may be noticed. Other operating effects should not be experienced.

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through fuel lines.

Be aware of these values when diesel fuel is purchased. Anticipate the average ambient temperature within the area that the engine will be operated. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

When No. 2 diesel fuel is used the following components provide a means of minimizing problems in cold weather:

- Starting aids
- Engine oil pan heaters
- Engine coolant heaters
- Fuel heaters
- Fuel line insulation

For more information on cold weather operation, see Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations".

i01250450

## Fuel Related Components in Cold Weather

**SMCS Code:** 1000; 1250

### Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes, and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

### Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

---

#### NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a two micron absolute high efficiency fuel filter is required for all Caterpillar Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

---

## Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in the fuel system before the primary fuel filter.

The following fuel heaters are recommended for Caterpillar engines:

- 7C-3557 Fuel Heater Group
- 7C-3558 Heater Kit

For further information on fuel heaters, consult your Caterpillar dealer.

Disconnect the fuel heater in warm weather.

**Note:** Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65°C (149°F). A loss of engine power can occur if the fuel supply temperature exceeds 37°C (100°F).

**Note:** Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm weather operation.

## Maintenance Section

### Torque Specifications

i01252954

#### General Torque Information

SMCS Code: 7553

#### WARNING

**Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.**

**Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.**

Exceptions to these torques are given in the Service Manual, if necessary.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean the hardware with a noncorrosive cleaner. Do not lubricate the fastener threads except for the rust preventive. The rust preventive should be applied by the supplier of that component for purposes of shipping and storage. Other applications for lubricating components may also be specified in the Service Manual.

i00621349

### Standard Torque for Inch Fasteners

SMCS Code: 7553

Table 3

Inch Nuts and Bolts	
Thread Size Inch	Standard Torque
1/4	12 ± 3 N·m (9 ± 2 lb ft)
5/16	25 ± 6 N·m (18 ± 4 lb ft)
3/8	47 ± 9 N·m (35 ± 7 lb ft)
7/16	70 ± 15 N·m (50 ± 11 lb ft)
1/2	105 ± 20 N·m (75 ± 15 lb ft)
9/16	160 ± 30 N·m (120 ± 22 lb ft)
5/8	215 ± 40 N·m (160 ± 30 lb ft)
3/4	370 ± 50 N·m (275 ± 37 lb ft)
7/8	620 ± 80 N·m (460 ± 60 lb ft)
1	900 ± 100 N·m (660 ± 75 lb ft)
1 1/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/4	1800 ± 200 N·m (1320 ± 150 lb ft)
1 3/8	2400 ± 300 N·m (1780 ± 220 lb ft)
1 1/2	3100 ± 350 N·m (2280 ± 260 lb ft)

Table 4

Inch Taperlock Studs	
Thread Size Inch	Standard Torque
1/4	8 ± 3 N·m (6 ± 2 lb ft)
5/16	17 ± 5 N·m (13 ± 4 lb ft)
3/8	35 ± 5 N·m (26 ± 4 lb ft)
7/16	45 ± 10 N·m (33 ± 7 lb ft)
1/2	65 ± 10 N·m (48 ± 7 lb ft)
5/8	110 ± 20 N·m (80 ± 15 lb ft)
3/4	170 ± 30 N·m (125 ± 22 lb ft)
7/8	260 ± 40 N·m (190 ± 30 lb ft)
1	400 ± 60 N·m (300 ± 44 lb ft)
1 1/8	525 ± 60 N·m (390 ± 44 lb ft)
1 1/4	750 ± 80 N·m (550 ± 60 lb ft)
1 3/8	950 ± 125 N·m (700 ± 90 lb ft)
1 1/2	1200 ± 150 N·m (880 ± 110 lb ft)

i00621350

## Standard Torque for Metric Fasteners

SMCS Code: 7553

Table 5

Metric Nuts and Bolts	
Thread Size Metric	Standard Torque
M6	12 ± 3 N·m (9 ± 2 lb ft)
M8	28 ± 7 N·m (21 ± 5 lb ft)
M10	55 ± 10 N·m (41 ± 7 lb ft)
M12	100 ± 20 N·m (75 ± 15 lb ft)
M14	160 ± 30 N·m (120 ± 22 lb ft)
M16	240 ± 40 N·m (175 ± 30 lb ft)
M20	460 ± 60 N·m (340 ± 44 lb ft)
M24	800 ± 100 N·m (590 ± 75 lb ft)
M30	1600 ± 200 N·m (1180 ± 150 lb ft)
M36	2700 ± 300 N·m (2000 ± 220 lb ft)

Table 6

Metric Taperlock Studs	
Thread Size Metric	Standard Torque
M6	8 ± 3 N·m (6 ± 2 lb ft)
M8	17 ± 5 N·m (13 ± 4 lb ft)
M10	35 ± 5 N·m (26 ± 4 lb ft)
M12	65 ± 10 N·m (48 ± 7 lb ft)
M16	110 ± 20 N·m (80 ± 15 lb ft)
M20	170 ± 30 N·m (125 ± 22 lb ft)
M24	400 ± 60 N·m (300 ± 44 lb ft)
M30	750 ± 80 N·m (550 ± 60 lb ft)
M36	1200 ± 150 N·m (880 ± 110 lb ft)

i01206505

## Standard Torque for Worm Drive Band Hose Clamps

SMCS Code: 7553; 7554

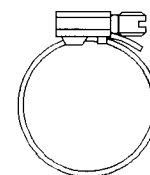


Illustration 25

g00280501

Table 7

Width of Clamp	Initial Installation Torque On New Hose
7.9 mm (0.31 inch)	0.9 ± 0.2 N·m (8 ± 2 lb in)
13.5 mm (0.53 inch)	4.5 ± 0.5 N·m (40 ± 4 lb in)
15.9 mm (0.63 inch)	7.5 ± 0.5 N·m (65 ± 4 lb in)
Width of Clamp	Reassembly or Retightening Torque
7.9 mm (0.31 inch)	0.7 ± 0.2 N·m (6 ± 2 lb in)
13.5 mm (0.53 inch)	3.0 ± 0.5 N·m (27 ± 4 lb in)
15.9 mm (0.63 inch)	4.5 ± 0.5 N·m (40 ± 4 lb in)

i01206414

## Standard Torque for Constant Torque Hose Clamps

SMCS Code: 7553; 7554

Use a constant torque hose clamp in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard hose clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause hose clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by hose clamps that have loosened. The constant torque hose clamp will help prevent these failures.

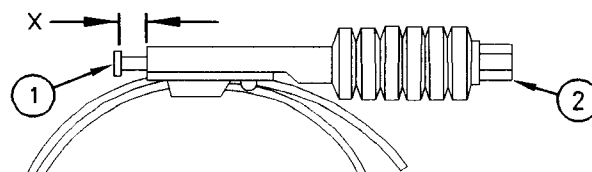


Illustration 26

g00279591

Use a torque wrench for proper installation of the constant torque hose clamps. The constant torque hose clamp is installed correctly under the following conditions:

- Screw tip (1) extends 6.35 mm (0.25 inch) (X) beyond the housing.
- The belleville washers are collapsed nearly flat after screw (2) is tightened to a torque of  $11 \pm 1 \text{ N}\cdot\text{m}$  ( $98 \pm 9 \text{ lb in}$ ).

# Lubricant Specifications

i01111306

## Lubricant Information

**SMCS Code:** 1000; 1300; 7581

## General Information

Because of government regulations regarding the certification of engine exhaust emissions, the lubricant recommendations must be followed.

## Engine Manufacturers Association (EMA) Oils

The "Engine Manufacturers Association Recommended Guideline on Diesel Engine Oil" is recognized by Caterpillar. For detailed information about this guideline, see the latest edition of EMA publication, "EMA LRG-1".

## API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API.

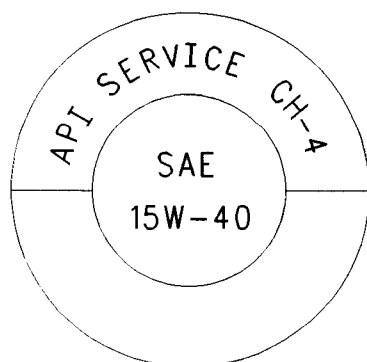


Illustration 27

Typical API symbol

g00546535

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 8 summarizes the status of the classifications.

Table 8

API Classifications	
Current	Obsolete
CF-4, CG-4, CH-4	CE
CF	CC, CD
CF-2 <sup>(1)</sup>	CD-2 <sup>(1)</sup>

<sup>(1)</sup> CD-2 and API CF-2 are classifications for two-cycle diesel engines. Caterpillar does not sell engines that utilize CD-2 and API CF-2 oils.

**Note:** API CF is not the same classification as API CF-4. API CF oils are only recommended for Caterpillar 3600 Series Diesel Engines and Caterpillar engines with precombustion chamber (PC) fuel systems.

## Grease

The classifications of grease are based on the "ASTM D217" worked penetration characteristics. These characteristics for grease are given a defined consistency number.

## Terminology

Certain abbreviations follow the nomenclature of "SAE J754". Some classifications follow "SAE J183" abbreviations, and some classifications follow the "EMA Recommended Guideline on Diesel Engine Oil". In addition to Caterpillar definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, "Engine Oil" topic (Maintenance Section).

i01261682

## Engine Oil

**SMCS Code:** 1300; 1348; 7581

## Caterpillar Diesel Engine Oil

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Caterpillar Diesel Engine Oil (10W30)**

### • Caterpillar Diesel Engine Oil (15W40)

Caterpillar multigrade Diesel Engine Oil is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar Diesel Engines.

Caterpillar multigrade Diesel Engine Oil is available in two viscosity grades (10W30 and 15W40). For direct injection engines, see Table 9 in order to choose the correct viscosity grade for the ambient temperature. Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade Diesel Engine Oil can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade Diesel Engine Oil. The current industry standards for Caterpillar Diesel Engine Oil are listed on the product label and on the data sheets for the product.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

## Commercial Oils

The performance of commercial diesel engine oils is based on American Petroleum Institute (API) classifications. These API classifications are developed in order to provide commercial lubricants for a broad range of diesel engines that operate at various conditions.

If Caterpillar multigrade Diesel Engine Oil is not used, only use commercial oils that meet the following classifications:

- EMA LRG-1 multigrade oil (preferred oil)
- API CH-4 multigrade oil (preferred oil)
- API CG-4 multigrade oil (preferred oil)
- API CF-4 multigrade oil (acceptable oil)

In order to make the proper choice of a commercial oil, refer to the following explanations:

**EMA LRG-1** – The Engine Manufacturers Association (EMA) has developed lubricant recommendations as an alternative to the API oil classification system. LRG-1 is a Recommended Guideline that defines a level of oil performance for these types of diesel engines: high speed, four stroke cycle, heavy-duty, and light duty. LRG-1 oils may be used in Caterpillar engines when the following oils are recommended: API CH-4, API CG-4, and API CF-4. LRG-1 oils are intended to provide superior performance in comparison to API CG-4 and API CF-4.

LRG-1 oils will meet the needs of high performance Caterpillar diesel engines that are operating in many applications. The tests and the test limits that are used to define LRG-1 are similar to the new API CH-4 classification. Therefore, these oils will also meet the requirements of the low emissions diesel engines. LRG-1 oils are designed to control the harmful effects of soot with improved wear resistance and improved resistance to oil filter plugging. These oils will also provide superior piston deposit control for engines with either two-piece steel pistons or aluminum pistons.

All LRG-1 oils must complete a full test program with the base stock and with the viscosity grade of the finished commercial oil. The use of "API Base Oil Interchange Guidelines" are not appropriate for LRG-1 oils. This feature reduces the variation in performance that can occur when base stocks are changed in commercial oil formulations.

LRG-1 oils are recommended for use in extended oil change interval programs that optimize oil life. These oil change interval programs are based on oil analysis. LRG-1 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has the specific guidelines for optimizing oil change intervals.

**API CH-4** – API CH-4 oils were developed in order to meet the requirements of the new high performance diesel engines. Also, the oil was designed to meet the requirements of the low emissions diesel engines. API CH-4 oils are also acceptable for use in older diesel engines and in diesel engines that use high sulfur diesel fuel. API CH-4 oils may be used in Caterpillar engines that use API CG-4 and API CF-4 oils. API CH-4 oils will generally exceed the performance of API CG-4 oils in the following criteria: deposits on pistons, control of oil consumption, wear of piston rings, valve train wear, viscosity control, and corrosion.



Three new engine tests were developed for the API CH-4 oil. The first test specifically evaluates deposits on pistons for engines with the two-piece steel piston. This test (piston deposit) also measures the control of oil consumption. A second test is conducted with moderate oil soot. The second test measures the following criteria: wear of piston rings, wear of cylinder liners, and resistance to corrosion. A third new test measures the following characteristics with high levels of soot in the oil: wear of the valve train, resistance of the oil in plugging the oil filter, and control of sludge.

In addition to the new tests, API CH-4 oils have tougher limits for viscosity control in applications that generate high soot. The oils also have improved oxidation resistance. API CH-4 oils must pass an additional test (piston deposit) for engines that use aluminum pistons (single piece). Oil performance is also established for engines that operate in areas with high sulfur diesel fuel.

All of these improvements allow the API CH-4 oil to achieve optimum oil change intervals. API CH-4 oils are recommended for use in extended oil change intervals. API CH-4 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has specific guidelines for optimizing oil change intervals.

**API CG-4** – API CG-4 oils were developed primarily for diesel engines that use a 0.05 percent level of fuel sulfur. However, API CG-4 oils can be used with higher sulfur fuels. The TBN of the new oil determines the maximum fuel sulfur level for API CG-4 and API CF-4 oils. See Illustration 28.

API CG-4 oils are the first oils that are required to pass industry standard tests for foam control and viscosity shear loss. API CG-4 oils must also pass tests that were developed for corrosion, wear and oxidation.

**API CF-4** – These oils service a wide variety of modern diesel engines. API CF-4 oils provide more stable oil control and reduced piston deposits in comparison to API CF and the obsolete CE and CD classifications of oil. API CF-4 oils provide improved soot dispersancy in comparison to API CF and obsolete CD oils. The API CF-4 classification was developed with a 0.40 percent sulfur diesel fuel. This represents the type of diesel fuels that are commonly available worldwide.

**Note:** Do not use single grade API CF oils or multigrade API CF oils in Caterpillar Direct Injection (DI) Commercial Diesel Engines.

Some commercial oils that meet the API classifications may require reduced oil change intervals. To determine the oil change interval, closely monitor the condition of the oil and perform a wear metal analysis. Caterpillar's S-O-S oil analysis program is the preferred method.

#### NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

### Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN of the new oil must be 10 times the fuel sulfur level. The TBN is defined by "ASTM D2896". The minimum TBN of the oil is 5 regardless of fuel sulfur level. Illustration 28 demonstrates the TBN.

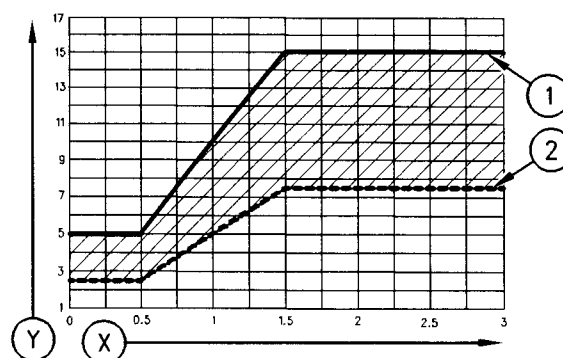


Illustration 28

g00104890

(Y) TBN by "ASTM D2896"

(X) Percentage of fuel sulfur by weight

(1) TBN of new oil

(2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

Use the following guidelines for fuel sulfur levels that exceed 1.5 percent:

- Choose an oil with the highest TBN that meets one of these classifications: EMA LRG-1, API CH-4, API CG-4, and API CF-4.
- Reduce the oil change interval. Base the oil change interval on the oil analysis. Ensure that the oil analysis includes the condition of the oil and a wear metal analysis.

Excessive piston deposits can be produced by an oil with a high TBN. These deposits can lead to a loss of control of the oil consumption and to the polishing of the cylinder bore.

#### NOTICE

Operating Direct Injection (DI) diesel engines with fuel sulfur levels over 1.0 percent may require shortened oil change intervals in order to help maintain adequate wear protection.

### Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 9 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 9 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

Table 9

Engine Oil Viscosity		
Caterpillar DEO Multigrade EMA LRG-1 API CH-4 API CG-4 and API CF-4 Viscosity Grade	Ambient Temperature	
	Minimum	Maximum
SAE 0W20	-40 °C (-40 °F)	10 °C (50 °F)
SAE 0W30	-40 °C (-40 °F)	30 °C (86 °F)
SAE 0W40	-40 °C (-40 °F)	40 °C (104 °F)
SAE 5W30	-30 °C (-22 °F)	30 °C (86 °F)
SAE 5W40	-30 °C (-22 °F)	40 °C (104 °F)
SAE 10W30	-20 °C (-4 °F)	40 °C (104 °F)
SAE 15W40	-15 °C (5 °F)	50 °C (122 °F)

i01111406

## Synthetic Base Stock Oils

**SMCS Code:** 1300; 1348; 7581

Synthetic base oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified for the engine compartment.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. However, Caterpillar does not recommend the automatic extension of oil change intervals for any type of oil. Oil change intervals for Caterpillar engines can only be adjusted after an oil analysis program that contains the following tests: oil condition and wear metal analysis (Caterpillar's S·O·S oil analysis), trend analysis, fuel consumption, and oil consumption.

i01111412

## Re-refined Base Stock Oils

**SMCS Code:** 1300; 7581

Re-refined base stock oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified by Caterpillar. Re-refined base stock oils can be used exclusively in finished oil or in a combination with new base stock oils. The US military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base stock oils that meet the same criteria.

The process that is used to make re-refined base stock oil should adequately remove all wear metals that are in the used oil and all additives that are in the used oil. The process that is used to make re-refined base stock oil generally involves the processes of vacuum distillation and hydrotreating the used oil. Filtering is inadequate for the production of high quality re-refined base stock oils from used oil.

i01113213

i01123104

## Cold Weather Lubricants

**SMCS Code:** 1300; 1348; 7581

When an engine is started and an engine is operated in ambient temperatures below  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ ), use multigrade oils that are capable of flowing in low temperatures.

These oils have lubricant viscosity grades of SAE 0W or SAE 5W.

When an engine is started and operated in ambient temperatures below  $-30^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$ ), use a synthetic base stock multigrade oil with a 0W viscosity grade or with a 5W viscosity grade. Use an oil with a pour point that is lower than  $-50^{\circ}\text{C}$  ( $-58^{\circ}\text{F}$ ).

The number of acceptable lubricants is limited in cold weather conditions. Caterpillar recommends the following lubricants for use in cold weather conditions:

**First Choice** – use an oil with an EMA LRG-1 Recommended Guideline or use a CH-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade. A CG-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used. A CF-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used.

**Second Choice** – use an oil that contains the CH-4, CG-4, or CF-4 additive package although the oil has not been tested for the requirements of the API license. The oil must have an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade.

### NOTICE

**Shortened engine service life could result if second choice oils are used.**

## Aftermarket Oil Additives

**SMCS Code:** 1300; 1348; 7581

Caterpillar does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the engine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge in the crankcase. Caterpillar discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Caterpillar engine, conform to the following guidelines:

- Select the proper Caterpillar oil or a commercial oil that meets the "EMA Recommended Guideline on Diesel Engine Oil" or the recommended API classification.
- See the appropriate "Lubricant Viscosities" table in order to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine compartment. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, "Maintenance Interval Schedule".

i01164576

## Lubricating Grease

**SMCS Code:** 7581

Caterpillar provides greases in order to cover a variety of applications and extreme temperature conditions. Consult your Caterpillar dealer for part numbers and for available sizes of containers.

**Note:** Some greases may not be used with other greases. When a commercial grease is used, ensure that the grease is compatible with the grease that is currently used in the system. If the commercial grease is not compatible, the system must be purged. If any questions arise concerning the compatibility of a grease, consult the supplier.

## Multipurpose Greases

### Multipurpose Lithium Complex Grease (MPGL)

Multipurpose Lithium Complex Grease (MPGL) is a general purpose lithium complex grease for medium-duty applications. This product has good characteristics at high temperatures such as a dropping point of 260 °C (500 °F). MPGL contains unleaded extreme pressure additives, antiwear inhibitors, and corrosion inhibitors that provide extra protection in the following applications:

- Construction
- Agricultural
- Automotive

MPGL meets the requirements for extended service intervals of automotive chassis points. MPGL also meets the requirements for extended service intervals of wheel bearings with disc brakes in automobiles, in vans and in light trucks. This product meets the NLGI certification of "GC-LB". MPGL is also available in a NLGI No. 2 grade. Normal operating temperatures for this product are -28 to 149 °C (-18 to 300 °F). This product is also available as a white lithium complex grease.

### Multipurpose Lithium Complex Grease with Molybdenum (MPGM)

Multipurpose Lithium Complex Grease with Molybdenum (MPGM) is a general purpose lithium complex grease that is used for light-duty applications and for medium-duty applications. The MPGM is available in the following grades: NLGI No. 2 and NLGI No. 0. The MPGM is strengthened with a molybdenum disulfide and a polymer for extra lubrication and protection. MPGM contains unleaded additives. MPGM also contains antiwear inhibitors, rust inhibitors, and corrosion inhibitors that are for protection and lubrication in many environments. The MPGM is formulated with a base fluid that has high viscosity.

The MPGM has the following features:

- Increased protection against water washout

- Increased retention
- Resistance to heavy loads

This product is recommended for heavily loaded pin joints and for journal bearings. This product meets the certification of "GC-LB". Normal operating temperatures for this product are -28 to 149 °C (-18 to 300 °F) for the NLGI No. 0. Normal operating temperatures for this product are -18 to 149 °C (0 to 300 °F) for the NLGI No. 2.

**Note:** If MPGM is not available, use a multipurpose type grease which contains three to five percent molybdenum.

## Special Purpose Grease (SPG)

### Bearing Lubrication (SPG)

Bearing Lubricant (SPG) is available in a NLGI No. 2 grade with a polyurea thickener. This grease is recommended for high temperature antifriction bearings in the following applications: electric starting motors, alternators, fan drives, and generators. The Bearing Lubricant (SPG) has an effective operating range of -29 to 177 °C (-20 to 350 °F).

### Water and Temperature Resistant Grease (WTR)

The Water and Temperature Resistant Grease is designed for use whenever the following conditions are a concern: water washout, severe corrosion, and high operating temperatures. The Water and Temperature Resistant Grease provides extreme pressure protection, antiwear protection, rust protection and corrosion protection. The Water and Temperature Resistant Grease is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, lead, and phosphorous materials. The Water and Temperature Resistant Grease has excellent shear stability. Water and Temperature Resistant Grease can also resist breakdown in the presence of water. The Water and Temperature Resistant Grease works well in the following applications:

- Construction
- Agricultural
- Automotive
- Industrial
- Marine

This product meets the NLGI certification of "GC-LB". Normal operating temperatures for this product are -40 to 204°C (-40 to 400°F).

i01065849

## Caterpillar Premium Grease (CPG)

### Desert Gold (CPG)

Desert Gold is a heavy-duty, premium synthetic grease that is developed for the most extreme operating environments. This grease is formulated with the following characteristics: high viscosity synthetic base fluid, polymers, molybdenum disulfide, high viscosity index, and high dropping point.

Desert Gold will protect equipment against heavy shock loads. Desert Gold protects against corrosion in extreme heat, in moist conditions, or in dusty conditions. This product has excellent characteristics of adhesion and of stability. Desert Gold provides longer protection than other greases. Desert Gold is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, lead, and phosphorous materials. Normal operating temperatures are -6 to 230 °C (21 to 450 °F). Desert Gold can operate at higher temperatures for short time periods. Desert Gold has additional extreme pressure protection for highly loaded pin joints.

### Arctic Platinum (CPG)

Arctic Platinum is a super-premium extreme pressure lubricating grease that is developed for lubrication in temperatures that are below zero to moderate operating temperatures. Arctic Platinum is available in grades 000, 00, 0, 1, and 2. These grades ensure pumpability in central lube systems in a variety of ambient temperatures from -60 to 18 °C (-76 to 65 °F). Arctic Platinum has a high dropping point. Arctic Platinum contains a five percent concentrate of molybdenum disulfide for protection against extra heavy loads. Arctic Platinum provides excellent corrosion protection and rust protection. Arctic Platinum is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, and phosphorous.

Arctic Platinum is designed for long life lubrication of the following components: horizontal pivot bearings, lower link bearings, steering cylinders, kingbolt bearings, upper hitch link bearings, and ejector carrier roller bearings. This grease is extra tacky for retention on excavator carbody bearings. Arctic Platinum has additional extreme pressure protection for highly loaded pin joints.

## S-O-S Oil Analysis

**SMCS Code:** 1348; 7542; 7581

Caterpillar recommends the use of the S-O-S oil analysis program in order to monitor the condition and the maintenance requirements of the equipment. The S-O-S oil analysis program will complement the preventive maintenance program.

The S-O-S oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured through the use of the S-O-S oil analysis. The S-O-S oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engine's metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil. For this reason, regular sampling at specified intervals is necessary in order to establish wear rates. Intermittent sampling does not allow wear rate trend lines to be established. Engine wear metals in the oil sample are compared to established Caterpillar norms in order to determine acceptability.
- Tests are conducted in order to detect contamination of the oil by water, glycol or fuel.
- The Oil Condition Analysis determines the loss of the oil's lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

The test results of the oil samples will then be used as a basis for determining the oil change interval for the engine. The results of the S-O-S oil analysis may allow the engine to operate longer between oil changes without the risk of engine damage.

Table 10

S-O-S Oil Analysis Interval	
Compartment	Interval
Engine crankcase	Every 250 Service Hours

For more information, see Special Publication, PEDP7036, "S-O-S Fluid Analysis". Consult your Caterpillar dealer for complete information and assistance about the program.

# Fuel Specifications

i01196007

## Fuel Recommendations

**SMCS Code:** 1250; 1280

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace fuel, gas oil, or kerosene.

The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life.

Diesel fuels that meet the specifications in Table 11 will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Table 11 is for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Table 11

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	Requirements	ASTM Test
Aromatics	35% maximum	"D1319"
Ash	0.02% maximum (weight)	"D482"
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	"D524"
Cetane Number	40 minimum (DI engines)	"D613"
	35 minimum (PC engines)	
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	-
Copper Strip Corrosion	No. 3 maximum	"D130"

(continued)

(Table 11, contd)

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	Requirements	ASTM Test
Distillation	10% at 282 °C (540 °F) maximum	"D86"
	90% at 360 °C (680 °F) maximum	
Flash Point	legal limit	"D93"
API Gravity	30 minimum	"D287"
	45 maximum	
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"
Sulfur <sup>(1)</sup>	3% maximum	"D3605" or "D1552"
Kinematic Viscosity <sup>(2)</sup>	1.4 cSt minimum and 20.0 cSt maximum at 40 °C (104 °F)	"D445"
Water and Sediment	0.1% maximum	"D1796"
Water	0.1% maximum	"D1744"
Sediment	0.05% maximum (weight)	"D473"
Gums and Resins <sup>(3)</sup>	10 mg per 100 mL maximum	"D381"
Lubricity <sup>(4)</sup>	3100 g minimum	"D6078"
	0.45 mm (0.018 inch) maximum at 60 °C (140 °F)	"D6079"
	0.38 mm (0.015 inch) maximum at 25 °C (77 °F)	

- (1) Caterpillar fuel systems and engine components can operate on high sulfur fuels. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. For additional information, see this publication, "Engine Oil" topic (Maintenance Section).
- (2) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain a 1.4 cSt viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to bring down the viscosity to a 20 cSt viscosity. For additional information, see Special Publication, SEBD0717, "Diesel Fuel and Your Engine".
- (3) Follow the test conditions and procedures for gasoline (motor).
- (4) The lubricity of a fuel is a concern with low sulfur fuel. To determine the lubricity of the fuel, use either the "ASTM D6078 Scuffing Load Wear Test (SBOCLE)" or the "ASTM D6079 High Frequency Reciprocating Rig (HFRR)" test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

# **NOTICE**

Operating with fuels that do not meet Caterpillar's recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

In the USA, 0.05 percent diesel fuels have been used in all on-highway truck engines since 1 January 1994. This low sulfur diesel fuel was mandated as a means of directly reducing particulate emissions from diesel truck engines. This low sulfur fuel will also be used in Caterpillar commercial diesel engines when low emissions are required or when the fuel supply sources provide this type of fuel. Caterpillar has not seen any detrimental effects with 0.05 percent sulfur fuel in Caterpillar diesel engines.

# **NOTICE**

Heavy Fuel Oil (HFO), Residual fuel, or Blended fuel must NOT be used in Caterpillar diesel engines (except in 3600 Series HFO engines). Severe component wear and component failures will result if HFO type fuels are used in engines that are configured to use distillate fuel.

In extreme cold ambient conditions, you may use the distillate fuels that are specified in Table 12. However, the fuel that is selected must meet the requirements that are specified in Table 11. These fuels are intended to be used in operating temperatures that are down to -54 °C (-65 °F).

Table 12

Distillate Fuels <sup>(1)</sup>	
Specification	Grade
"MIL-T-5624R"	JP-5
"ASTM D1655"	Jet-A-1
"MIL-T-83133D"	JP-8

<sup>(1)</sup> The fuels that are listed in this Table may not meet the requirements that are specified in the "Caterpillar Specifications for Distillate Diesel Fuel" Table. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 12 must be at least 40. If the viscosity is below 1.4 cSt at 38 °C (100 °F), use the fuel only in temperatures below 0 °C (32 °F). Do not use any fuels with a viscosity of less than 1.2 cSt at 38 °C (100 °F). Fuel cooling may be required in order to maintain the minimum viscosity of 1.4 cSt at the fuel injection pump.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in this specification. To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in Table 11.

# Cooling System Specifications

i01261719

## General Coolant Information

**SMCS Code:** 1350; 1395

---

### NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

---

---

### NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

---

---

### NOTICE

In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

---

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

**Note:** Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 20 L (5 US gal) per minute.

After you drain the cooling system and after you refill the cooling system, operate the engine. Operate the engine without the filler cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Ensure that the coolant is maintained to the proper level.

---

### NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

---

Refer to Special Instruction, SEBD0518, "Know Your Cooling System" and Special Instruction, SEBD0970, "Coolant and Your Engine" for more detailed information.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: overheating, leakage of the water pump, plugged radiators or heat exchangers, and pitting of the cylinder liners.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: water, additives, and glycol.

## Water

---

### NOTICE

All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

---

---

### NOTICE

Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

---

Water is used in the cooling system in order to transfer heat.

**Distilled water or deionized water is recommended for use in engine cooling systems.**

DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt, and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 13.



Table 13

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	"D512", "D4327"
Sulfate (SO <sub>4</sub> )	100 mg/L (5.9 grains/US gal)	"D516"
Total Hardness	170 mg/L (10 grains/US gal)	"D1126"
Total Solids	340 mg/L (20 grain/US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

For a water analysis, consult one of the following sources:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

## Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Pitting and erosion from cavitation of the cylinder liner
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

## Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and the cylinder liner

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

### NOTICE

All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

**Note:** Use a mixture that will provide protection against the lowest ambient temperature.

**Note:** 100 percent pure glycol will freeze at a temperature of  $-23^{\circ}\text{C}$  ( $-9^{\circ}\text{F}$ ).

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 14 and 15.

Table 14

Ethylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	$-36^{\circ}\text{C}$ ( $-33^{\circ}\text{F}$ )	$106^{\circ}\text{C}$ ( $223^{\circ}\text{F}$ )
60 Percent	$-51^{\circ}\text{C}$ ( $-60^{\circ}\text{F}$ )	$111^{\circ}\text{C}$ ( $232^{\circ}\text{F}$ )

### NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 15

Propylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	-29 °C (-20 °F)	106 °C (223 °F)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degree Celsius) or use the 1U-7297 Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

i01096597

## Coolant Recommendations

**SMCS Code:** 1350; 1395

The following two coolants are used in Caterpillar diesel engines:

**Preferred** – Caterpillar Extended Life Coolant (ELC) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

**Acceptable** – A Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications

### NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 or D4656 specification. This type of coolant/antifreeze is made for light duty automotive applications.

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

**Note:** Caterpillar DEAC DOES NOT require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications MAY require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

In stationary engine applications and marine engine applications that do not require anti-boil protection or freeze protection, a mixture of SCA and water is acceptable. Caterpillar recommends a six percent to eight percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

### NOTICE

All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

Table 16

Coolant Service Life	
Coolant Type	Service Life
Caterpillar ELC	6000 Service Hours or Six Years
Caterpillar DEAC	3000 Service Hours or Three Years
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D5345"	3000 Service Hours or Two Years
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D4985"	3000 Service Hours or One Year
Caterpillar SCA and Water	3000 Service Hours or Two Years
Commercial SCA and Water	3000 Service Hours or One Year

i01200209

## S·O·S Coolant Analysis

**SMCS Code:** 1352; 1395; 7542

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

### NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

## New Systems, Refilled Systems, and Converted Systems

Perform a coolant analysis (Level 2) at 500 service hours for new systems, for refilled systems, or for converted systems that use ELC or use DEAC. This 500 hour check will also check for any residual cleaner that may have contaminated the system.

## Recommended Interval for S-O-S Coolant Sample

Perform a coolant analysis (Level 1) at every 500 service hour interval. Perform a coolant analysis (Level 2) annually.

**Note:** Check the standard coolant's Supplemental Coolant Additive at every oil change.

## S-O-S Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol Concentration for freeze protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Water hardness
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

## S-O-S Coolant Analysis (Level 2)

Level 2 coolant analysis is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S-O-S Coolant Analysis has the following five features:

- Full analysis of Level 1
- Identification of the source of metal corrosion and of contaminants

- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of possible electrolysis within the engines' cooling system

The results are reported, and appropriate recommendations are made.

For more information on S-O-S Coolant Analysis, consult your Caterpillar dealer.

i01096605

## Extended Life Coolant (ELC)

**SMCS Code:** 1350; 1395

Caterpillar provides Extended Life Coolant (ELC) for use in the following applications:

- Heavy-duty spark ignited gas engines
- Heavy-duty diesel engines
- Automotive applications

The anti-corrosion package for Caterpillar ELC is different from the anti-corrosion package for other coolants. Caterpillar ELC is an ethylene glycol base coolant. However, Caterpillar ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Caterpillar ELC has been formulated with the correct amount of these additives in order to provide superior corrosion protection for all metals in engine cooling systems.

ELC extends the service life of the coolant to 6000 service hours or six years. ELC does not require a frequent addition of a Supplemental Coolant Additive (SCA). An Extender is the only additional maintenance that is needed at 3000 service hours or one half of the ELC service life.

ELC is available in a 1:1 premixed cooling solution with distilled water. The Premixed ELC provides freeze protection to  $-36^{\circ}\text{C}$  ( $-33^{\circ}\text{F}$ ). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

ELC Concentrate is also available. ELC Concentrate can be used to lower the freezing point to  $-51^{\circ}\text{C}$  ( $-60^{\circ}\text{F}$ ) for arctic conditions.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

**Note:** Caterpillar developed the EC-1 specification. The EC-1 specification is an industry standard. The EC-1 specification defines all of the performance requirements that are needed for an engine coolant to be sold as an extended life coolant for Caterpillar engines. ELC can be used in most OEM engines of the following types: diesel, gasoline, and natural gas. ELC meets the performance requirements of "ASTM D4985" and "ASTM D5345" for heavy-duty low silicate antifreeze/coolants. ELC also meets the performance requirements of "ASTM D3306" and "ASTM D4656" for automotive applications.

101111712

## Extended Life Coolant (ELC) Cooling System Maintenance

**SMCS Code:** 1350; 1352; 1395

### Proper additions to the Extended Life Coolant

#### NOTICE

Use only Caterpillar products or commercial products that have passed Caterpillar's EC-1 specification for pre-mixed or concentrated coolants.

Use only Caterpillar Extender with Extended Life Coolant.

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

In order to maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of Extended Life Coolant (ELC). Lowering the proportion of antifreeze lowers the proportion of additive. This will lower the ability of the coolant to protect the system from pitting, from cavitation, from erosion, and from deposits.

#### NOTICE

Do not use a conventional coolant to top-off a cooling system that is filled with Extended Life Coolant (ELC).

Do not use standard supplemental coolant additive (SCA). Only use ELC Extender in cooling systems that are filled with ELC.

## Caterpillar ELC Extender

Caterpillar ELC Extender is added to the cooling system halfway through the ELC service life. Treat the cooling system with ELC Extender at 3000 hours or one half of the coolant service life. Use Table 17 in order to determine the proper amount of ELC Extender that is required.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

Table 17

Caterpillar ELC Extender Additions by Cooling System Capacity	
Cooling System Capacity	Addition of ELC Extender
22 to 30 L (6 to 8 US gal)	0.57 L (20 fl oz)
31 to 38 L (9 to 10 US gal)	0.71 L (24 fl oz)
39 to 49 L (11 to 13 US gal)	0.95 L (32 fl oz)
50 to 64 L (14 to 17 US gal)	1.18 L (40 fl oz)
65 to 83 L (18 to 22 US gal)	1.60 L (54 fl oz)
84 to 114 L (23 to 30 US gal)	2.15 L (72 fl oz)
115 to 163 L (31 to 43 US gal)	3.00 L (100 fl oz)
164 to 242 L (44 to 64 US gal)	4.40 L (148 fl oz)

For cooling system capacities that exceed the capacities that are specified in Table 17, use the equation that is in Table 18 in order to determine the proper amount of ELC Extender that is required.

Table 18

Equation For Adding ELC Extender To ELC
$V \times 0.02 = X$
V is the total volume of the cooling system.
X is the amount of ELC Extender that is required.

Table 19 is an example for using the equation that is in Table 18.

Table 19

Example Of The Equation For Adding ELC Extender To ELC		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of ELC Extender that is Required (X)
946 L (250 US gal)	$\times 0.02$	19 L (5 US gal)

---

**NOTICE**

When using Caterpillar ELC, do not use standard SCA's or SCA filters. To avoid SCA contamination of an ELC system, remove the SCA filter base and plug off or by-pass the coolant lines.

---

## ELC Cooling System Cleaning

**Note:** If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when ELC is drained from the cooling system.

ELC can be recycled. The drained coolant mixture can be distilled in order to remove the ethylene glycol and the water. The ethylene glycol and the water can be reused. Consult your Caterpillar dealer for more information.

After the cooling system is drained and after the cooling system is refilled, operate the engine while the cooling system filler cap is removed. Operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

## Changing to Caterpillar ELC

To change from heavy-duty coolant/antifreeze to the Caterpillar ELC, perform the following steps:

---

**NOTICE**

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the coolant into a suitable container.
2. Dispose of the coolant according to local regulations.

---

**NOTICE**

Do not leave an empty SCA filter on an ELC system.

The filter housing may corrode and leak causing an engine failure.

Remove the SCA filter base and plug off or by-pass the coolant lines.

---

3. Remove the empty SCA filter and remove the filter base. Plug the coolant lines or bypass the coolant lines.
4. Flush the system with clean water in order to remove any debris.
5. Use Caterpillar cleaner to clean the system. Follow the instruction on the label.
6. Drain the cleaner into a suitable container. Flush the cooling system with clean water.
7. Fill the cooling system with clean water and operate the engine until the engine is warmed to 49° to 66°C (120° to 150°F).

---

**NOTICE**

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

---

8. Drain the cooling system into a suitable container and flush the cooling system with clean water.

**Note:** The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

9. Repeat Steps 7 and 8 until the system is completely clean.
10. Fill the cooling system with the Caterpillar premixed ELC.
11. Attach the Special Publication, PEEP5027, "Label" to the cooling system filler for the engine in order to indicate the use of Caterpillar ELC.

## ELC Cooling System Contamination

### NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for premixed or concentrate coolants. Use only Caterpillar ELC Extender with Caterpillar ELC. Failure to follow these recommendations can result in shortened cooling system component life.

---

ELC cooling systems can withstand contamination to a maximum of ten percent of conventional heavy-duty coolant/antifreeze or SCA. If the contamination exceeds ten percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with clean water. Fill the system with the Caterpillar ELC.
- Drain a portion of the cooling system into a suitable container according to local regulations. Then, fill the cooling system with premixed ELC. This should lower the contamination to less than 10 percent.
- Maintain the system as a conventional Diesel Engine Antifreeze/Coolant (DEAC). Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Diesel Engine Antifreeze/Coolant (DEAC).

## Commercial ELC

If Caterpillar ELC is not used, then select a commercial ELC that meets the Caterpillar specification of EC-1 and either the "ASTM D5345" specification or the "ASTM D4985" specification. Do not use an extended life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial ELC. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

i01111753

## Diesel Engine Antifreeze/Coolant (DEAC)

**SMCS Code:** 1350; 1395

Caterpillar recommends using Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) for cooling systems that require a heavy-duty coolant/antifreeze. Caterpillar DEAC is an alkaline single-phase ethylene glycol type antifreeze that contains corrosion inhibitors and antifoam agents.

Caterpillar DEAC is formulated with the correct amount of Caterpillar Supplemental Coolant Additive (SCA). Do not use SCA at the initial fill when DEAC is used.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

If concentrated DEAC is used, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water is not available or deionized water is not available, use water which has the required properties. For the water properties, see this publication, "General Coolant Information" topic (Maintenance Section).

i01069295

## Supplemental Coolant Additive (SCA)

**SMCS Code:** 1350; 1352; 1395

The use of SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liners
- Foaming of the coolant

Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) is formulated with the correct level of Caterpillar SCA. When the cooling system is initially filled with DEAC, adding more SCA is not necessary until the concentration of SCA has been depleted. To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Refer to the specific engine's Operation and Maintenance Manual, "Maintenance Interval Schedule".

Containers of SCA are available in several sizes.  
Consult your Caterpillar dealer for the part numbers.

i01164588

## Commercial Heavy-Duty Coolant/Antifreeze and SCA

**SMCS Code:** 1350; 1395

If Caterpillar DEAC is not used, select a coolant/antifreeze with low silicate content for heavy-duty applications that meets "ASTM D5345" or "ASTM D4985" specifications.

**Note:** When you are not using Caterpillar DEAC the cooling system must be drained one time during every year. The cooling system must be flushed at this time as well.

When a heavy-duty coolant/antifreeze is used, treat the cooling system with three to six percent Caterpillar SCA by volume. For more information, see this publication, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 1200 mg/L or 1200 ppm (70 grains/US gal) of nitrites in the final coolant mixture.

Coolant/antifreeze that meets "ASTM D5345" or "ASTM D4985" specifications MAY require treatment with SCA at the initial fill. These coolants WILL require treatment with SCA on a maintenance basis.

When concentrated coolant/antifreeze is mixed, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, water which has the required properties may be used. For the water properties, see this publication, "General Coolant Information" topic (Maintenance Section).

i01318169

## Water/Supplemental Coolant Additive (SCA)

**SMCS Code:** 1350; 1352; 1395

### NOTICE

All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

### NOTICE

Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

**Note:** Premix the coolant solution in order to provide protection to the lowest ambient temperature that is expected.

**Note:** Pure undiluted antifreeze freezes at  $-23^{\circ}\text{C}$  ( $-9^{\circ}\text{F}$ ).

In engine cooling systems that use water alone, Caterpillar recommends the use of SCA. SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liner
- Foaming of the coolant

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 2400 mg/L or 2400 ppm (140 grains/US gal) of nitrites in the final coolant mixture.

The quality of the water is a very important factor in this type of cooling system. Distilled water or deionized water is recommended for use in cooling systems. If distilled water or deionized water is not available, use water that meets the minimum requirements that are listed in the table for recommended water properties in this publication, "General Coolant Information" topic (Maintenance Section).

A cooling system that uses a mixture of SCA and water only needs more SCA than a cooling system that uses a mixture of glycol and water. The SCA concentration in a cooling system that uses SCA and water should be six to eight percent by volume. Refer to Table 20 for the amount of SCA that is required for various capacities of the cooling system.

Table 20

<b>Caterpillar SCA Requirements for SCA and Water Cooling Systems</b>		
<b>Cooling System Capacity</b>	<b>Caterpillar SCA at Initial Fill</b>	<b>Caterpillar SCA at 250 Hours</b>
22 to 30 L (6 to 8 US gal)	1.75 L (64 fl oz)	0.44 L (15 fl oz)
31 to 38 L (9 to 10 US gal)	2.30 L (80 fl oz)	0.57 L (20 fl oz)
39 to 49 L (11 to 13 US gal)	3.00 L (100 fl oz)	0.75 L (25 fl oz)
50 to 64 L (14 to 17 US gal)	3.90 L (128 fl oz)	0.95 L (32 fl oz)
65 to 83 L (18 to 22 US gal)	5.00 L (168 fl oz)	1.25 L (42 fl oz)
84 to 110 L (23 to 29 US gal)	6.60 L (224 fl oz)	1.65 L (56 fl oz)
111 to 145 L (30 to 38 US gal)	8.75 L (296 fl oz)	2.19 L (74 fl oz)
146 to 190 L (39 to 50 US gal)	11.50 L (392 fl oz)	2.88 L (98 fl oz)
191 to 250 L (51 to 66 US gal)	15.00 L (512 fl oz)	3.75 L (128 fl oz)

Refer to Table 21 for part numbers and for quantities of SCA.

Table 21

<b>Caterpillar Liquid SCA</b>	
<b>Part Number</b>	<b>Quantity</b>
6V-3542	0.24 L (8 oz)
111-2372	0.36 L (12 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
8C-3680	19 L (5 US gal)
5P-2907	208 L (55 US gal)

Maintain the SCA in the same way as you would maintain a cooling system that uses heavy-duty coolant/antifreeze. Adjust the maintenance for the amount of SCA additions. See Table 20 for the amount of SCA that is required.

## Cooling Systems with Larger Capacities

### Adding the SCA to Water at the Initial Fill

Use the equation that is in Table 22 to determine the amount of Caterpillar SCA that is required at the initial fill. This equation is for a mixture of only SCA and water.

Table 22

<b>Equation For Adding The SCA To Water At The Initial Fill</b>
<b><math>V \times 0.07 = X</math></b>
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 23 is an example for using the equation that is in Table 22.

Table 23

<b>Example Of The Equation For Adding The SCA To Water At The Initial Fill</b>		
<b>Total Volume of the Cooling System (V)</b>	<b>Multiplication Factor</b>	<b>Amount of SCA that is Required (X)</b>
946 L (250 US gal)	$\times 0.07$	66 L (18 US gal)

### Adding the SCA to Water for Maintenance

For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for your engine.

Use the 8T-5296 Coolant Conditioner Test Kit to test the concentration of SCA. Make the following modifications to Steps 3 and 5 of the 8T-5296 Coolant Conditioner Test Kit instructions:

**STEP 3** – Add tap water to the vial up to the "20 ml" mark.

**STEP 5** – When the defined procedure is used, a concentration of six to eight percent will yield between 20 drops and 27 drops. If the number of drops is below 20 drops, the concentration of SCA is low. If the number of drops is above 27 drops, the concentration of SCA is high. Make the appropriate adjustments to the concentration of SCA.

Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, "S-O-S Coolant Analysis" topic (Maintenance Section).



Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is required.

Use the equation that is in Table 22 to determine the amount of Caterpillar SCA that is required for maintenance, if necessary:

Table 24

SCA To Water Addition Equation For Maintenance	
$V \times 0.023 = X$	
V is the total volume of the cooling system.	
X is the amount of SCA that is required.	

Table 25 is an example for using the equation that is in Table 22.

Table 25

SCA To Water Addition Equation Example For Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
946 L (250 US gal)	$\times 0.023$	22 L (6 US gal)

**Note:** Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Table 21 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

Check the coolant/antifreeze (glycol concentration) in order to ensure adequate protection against boiling or freezing. Caterpillar recommends the use of a refractometer for checking the glycol concentration. Use the **1U-7298** Coolant/Battery Tester (Celsius) or use the **1U-7297** Coolant/Battery Tester (Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or with propylene glycol.

Caterpillar engine cooling systems should be tested at 250 hour intervals for the concentration of Supplemental Coolant Additive (SCA). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer at 250 hour intervals. Refer to S-O-S Coolant Analysis for more information on this topic.

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. An SCA that is liquid or a maintenance element for an SCA (if equipped) may be needed at 250 hour intervals.

Table 26 lists the amount of Caterpillar SCA that is needed at the initial fill in order to treat coolant/antifreeze. These amounts of SCA are for systems that use heavy-duty coolant/antifreeze.

Table 26 also lists additions of SCA for liquid and for maintenance elements at 250 hours. The additions are required for Caterpillar DEAC and for commercial coolant/antifreezes.

i01111872

## Conventional Coolant/ Antifreeze Cooling System Maintenance

**SMCS Code:** 1350; 1352; 1395

### NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Table 26

<b>Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze</b>			
<b>Cooling System Capacity</b>	<b>Initial Fill<sup>(1)</sup></b>	<b>250 Service Hour Maintenance<sup>(2)</sup></b>	<b>Spin-on Element at 250 Service Hour Maintenance<sup>(3)</sup></b>
22 to 30 L (6 to 8 US gal)	0.95 L (32 fl oz)	0.24 L (8 fl oz)	111-2370 (1)
31 to 38 L (9 to 10 US gal)	1.18 L (40 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
39 to 49 L (11 to 13 US gal)	1.42 L (48 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
50 to 64 L (14 to 17 US gal)	1.90 L (64 fl oz)	0.47 L (16 fl oz)	9N-3368 (1)
65 to 83 L (18 to 22 US gal)	2.37 L (80 fl oz)	0.60 L (20 fl oz)	111-2371 (1)
84 to 114 L (23 to 30 US gal)	3.32 L (112 fl oz)	0.95 L (32 fl oz)	9N-3718 (1)
115 to 163 L (31 to 43 US gal)	4.75 L (160 fl oz)	1.18 L (40 fl oz)	111-2371 (2)
164 to 242 L (44 to 64 US gal)	7.60 L (256 fl oz)	1.90 L (64 fl oz)	9N-3718 (2)

(1) When the coolant system is first filled, the SCA is not required to be used with Caterpillar DEAC.

(2) Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit.

(3) Do not use the maintenance element for the SCA and the liquid for the SCA at the same time.

**Note:** Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Refer to Table 27 for part numbers and for quantities of SCA.

Table 27

<b>Caterpillar Liquid SCA</b>	
<b>Part Number</b>	<b>Quantity</b>
6V-3542	0.24 L (8 oz)
111-2372	0.36 L (12 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
8C-3680	19 L (5 US gal)
5P-2907	208 L (55 US gal)

## Cooling Systems with Larger Capacities

### Adding the SCA to Conventional Coolant/Antifreeze at the Initial Fill

**Note:** Caterpillar DEAC DOES NOT require an addition of SCA when the cooling system is initially filled.

Commercial heavy duty coolant/antifreeze that meet "ASTM D4985" or "ASTM D5345" specifications MAY require an addition of SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

Use the equation that is in Table 28 to determine the amount of Caterpillar SCA that is required when the cooling system is initially filled with the following fluids:

- "ASTM D4985"
- "ASTM D5345"

Table 28

<b>Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill</b>
<b><math>V \times 0.045 = X</math></b>
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 29 is an example for using the equation that is in Table 28.

Table 29

<b>Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill</b>		
<b>Total Volume of the Cooling System (V)</b>	<b>Multiplication Factor</b>	<b>Amount of SCA that is Required (X)</b>
946 L (250 US gal)	$\times 0.045$	43 L (11 US gal)

## Adding the SCA to Conventional Coolant/Antifreeze For Maintenance

Heavy duty coolant/antifreeze of all types REQUIRE periodic additions of an SCA.

Test the coolant/antifreeze periodically for the concentration of SCA. For the interval, see the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, "S·O·S Coolant Analysis" topic (Maintenance Section).

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 30 to determine the amount of Caterpillar SCA that is required, if necessary:

Table 30

<b>Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance</b>
<b><math>V \times 0.014 = X</math></b>
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 31 is an example for using the equation that is in Table 30.

Table 31

<b>Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance</b>		
<b>Total Volume of the Cooling System (V)</b>	<b>Multiplication Factor</b>	<b>Amount of SCA that is Required (X)</b>
946 L (250 US gal)	$\times 0.014$	9 L (4 US gal)

**Note:** Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Table 27 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

## Cleaning the System of Heavy-Duty Coolant/Antifreeze

Caterpillar cooling system cleaners are designed to clean the cooling system of harmful scale and corrosion. Caterpillar cooling system cleaners dissolve mineral scale, corrosion products, light oil contamination and sludge.

- Clean the cooling system after used coolant is drained or before the cooling system is filled with new coolant.
- Clean the cooling system whenever the coolant is contaminated or whenever the coolant is foaming.
- For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for your engine.

## Refill Capacities

i01369854

## Refill Capacities

**SMCS Code:** 1348; 1395; 7560

## Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" (Maintenance Section) for more information.

Table 32

<b>3406C Industrial Engine Approximate Refill Capacities</b>		
<b>Compartment or System</b>	<b>Liters</b>	<b>Quarts</b>
Crankcase Oil Sump (Standard) <sup>(1)</sup>	34.1	36.0

<sup>(1)</sup> These values are the approximate capacities for the crankcase oil sump which include the standard oil filters that are installed at the factory. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

## Cooling System

To maintain the cooling system, the total cooling system capacity must be known. The approximate capacity for the engine only cooling system is listed. External system capacities will vary among applications. Refer to the OEM specifications for the external system capacity. This capacity information will be needed in order to determine the amount of coolant/antifreeze that is required for the total cooling system.

Table 33

<b>3406C Industrial Engine Approximate Refill Capacities</b>		
<b>Compartment or System</b>	<b>Liters</b>	<b>Quarts</b>
Engine Only	22.7	24.0
External System (OEM) <sup>(1)</sup>		
Total Cooling System <sup>(2)</sup>		

<sup>(1)</sup> The External System includes a radiator or an expansion tank with the following components: heat exchanger, aftercooler, and piping. Refer to Caterpillar specifications or to the OEM specifications and enter the capacity for the External System in this row.

<sup>(2)</sup> The Total Cooling System includes the capacity for the Engine Only cooling system plus the capacity for the External System. Enter the total in this row.

i01369886

## Maintenance Interval Schedule

**SMCS Code:** 1000; 7500

**Before performing any operation or maintenance procedures, ensure that the Safety Information, warnings, and instructions are read and understood.**

To determine the maintenance intervals, use fuel consumption, service hours, or calendar time, which ever occurs first.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed.

### When Required

Battery - Replace .....	63
Battery or Battery Cable - Disconnect .....	64
Engine - Clean .....	72
Engine Air Cleaner Element (Single Element) - Inspect/Replace .....	72
Fuel System - Prime .....	79

### Daily

Air Starting Motor Lubricator Oil Level - Check ....	61
Air Tank Moisture and Sediment - Drain .....	61
Cooling System Coolant Level - Check .....	68
Driven Equipment - Check .....	71
Engine Air Cleaner Service Indicator - Inspect ....	73
Engine Oil Level - Check .....	74
Power Take-Off Clutch - Check/Adjust/Lubricate ..	86
Walk-Around Inspection .....	88

### Every Week

Battery Charger - Check .....	64
-------------------------------	----

### Every 1000 Service Hours

Engine Protective Devices - Check .....	77
Fuel Control Linkage - Check/Lubricate .....	78

### Every 9500 L (2500 US gal) of Fuel or 250 Service Hours or Yearly

Aftercooler Core - Clean/Test .....	60
Alternator Belt - Inspect/Adjust/Replace .....	62
Battery Electrolyte Level - Check .....	63
Cooling System Supplemental Coolant Additive (SCA) - Test/Add .....	69
Engine Crankcase Breather - Clean .....	73
Engine Oil Sample - Obtain .....	74
Engine Oil and Filter - Change .....	75
Fan Drive Bearing - Lubricate .....	78
Fuel System Primary Filter - Clean/Replace .....	80
Fuel Tank Water and Sediment - Drain .....	81
Hoses and Clamps - Inspect/Replace .....	82

Radiator - Clean .....	86
------------------------	----

### Every 114 000 L (30 000 US gal) of Fuel or 3000 Service Hours or 2 Years

Cooling System Coolant (DEAC) - Change .....	65
Cooling System Coolant Extender (ELC) - Add ....	68
Cooling System Water Temperature Regulator - Replace .....	70
Crankshaft Vibration Damper - Inspect .....	71
Engine Mounts - Inspect .....	74
Engine Valve Lash - Inspect/Adjust .....	77
Engine Valve Rotators - Inspect .....	77
Fuel Ratio Control - Inspect/Adjust .....	79
Turbocharger - Inspect .....	87

### Every 190 000 L (50 000 US gal) of Fuel or 5000 Service Hours

Air Compressor - Inspect .....	60
Alternator - Inspect .....	62
Fuel Injection Nozzles - Test/Exchange .....	78
Starting Motor - Inspect .....	87
Water Pump - Inspect .....	89

### Every 228 000 L (60 000 US gal) of Fuel or 6000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change .....	67
---	----

### Every 380 000 L (100 000 US gal) of Fuel or 10 000 Service Hours

Overhaul Considerations .....	83
-------------------------------	----

i01371758

## Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

**SMCS Code:** 1064-070; 1064-081

**Note:** Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

### **WARNING**

**Personal injury can result from air pressure.**

**Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.**

**Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.**

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

**Note:** If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i01183385

## Air Compressor - Inspect

**SMCS Code:** 1803-040

### **WARNING**

**Do not disconnect the air line from the air compressor governor without purging the air brake and the auxiliary air systems. Failure to purge the air brake and the auxiliary air systems before removing the air compressor and/or the air lines could cause personal injury.**

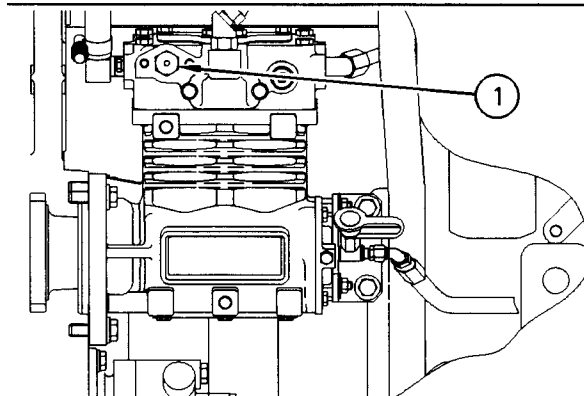


Illustration 29

g00633741

(1) Air compressor pressure relief valve

### **WARNING**

**If the air compressor pressure relief valve that is mounted in the air compressor cylinder head is bypassing compressed air, there is a malfunction in the air system, possibly ice blockage. Under these conditions, your engine may have insufficient air for normal brake operation.**

**Do not operate the engine until the reason for the air bypass is identified and corrected. Failure to heed this warning could lead to property damage, personal injury, or death to the operator or bystanders.**

The function of the air compressor pressure relief valve is to bypass air when there is a malfunction in the air compressor system.

The air compressor pressure relief valve releases air at 1723 kPa (250 psi). It is very important that all personnel stand clear of the air compressor pressure relief valve when compressed air is released. All personnel should also stay clear of the air compressor when the engine is operating and the air compressor is exposed.

Refer to the Service Manual or refer to the OEM specifications in order to find information concerning the air compressor. Consult your Caterpillar dealer for assistance.

i00805129

## Air Starting Motor Lubricator Oil Level - Check (If Equipped)

**SMCS Code:** 1451-535

### NOTICE

Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.

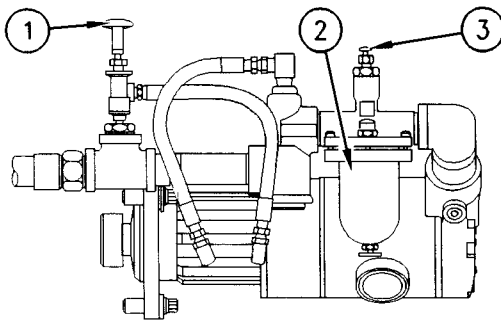


Illustration 30

g00381232

- (1) Air valve
- (2) Lubricator bowl
- (3) Adjustment knob

1. The vanes of the air starting motor are lubricated with a fine mist of oil from the air starting motor lubricator. Check the level of oil in lubricator bowl (2). If the oil level is less than 1/2, add oil to the lubricator bowl.
2. Ensure that the air supply to the lubricator is OFF.
3. Remove the plug. Pour oil into lubricator bowl (2). Use "10W" oil for temperatures that are greater than 0° C (32° F). Use air tool oil for temperatures that are below 0° C (32° F).
4. Install the plug.

## Oiler Feed Adjustment

If necessary, adjust the lubricator in order to release approximately two drops of fluid per 30 seconds into the starting motor air stream.

1. Ensure that the fuel supply to the engine is OFF.
2. Turn adjustment knob (3) clockwise until the adjustment knob locks.
3. Turn adjustment knob (3) counterclockwise for 1/4 turns.

### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Crank the starting motor for ten seconds and observe the exhaust air from the mufflers of the starting motor. Look for oil mist. A slight oil mist should be barely visible.

If no mist is observed, or if the mist is excessive, rotate adjustment knob (3) in increments of 1/16 in order to increase or decrease the oil mist. Repeat the starting motor cranking and observe until the mist is satisfactory.

**Note:** Drip rates should only be made under an average steady flow condition. Once a steady flow condition is established, the lubricator will automatically adjust the drip rate in proportion to the variations in air flow.

i00847451

## Air Tank Moisture and Sediment - Drain (If Equipped)

**SMCS Code:** 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

**! WARNING**

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
2. Close the drain valve.
3. Check the air supply pressure. The air starting motor requires a minimum of 620 kPa (90 psi) of air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal air pressure will be 758 to 965 kPa (110 to 140 psi).

i00072207

## Alternator - Inspect

**SMCS Code:** 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required. Refer to the Service Manual.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

i00165437

## Alternator Belt - Inspect/Adjust/Replace

**SMCS Code:** 1357-036; 1357-510

### Inspection

To maximize the engine performance, inspect the belt for wear and for cracking. Check the belt tension. Adjust the belt tension in order to minimize belt slippage. Belt slippage will decrease the life of the belt.

To check the belt tension, apply 110 N (25 lb) of force midway between the pulleys. A correctly adjusted belt will deflect 13 to 19 mm (0.50 to 0.75 inch).

### Adjustment

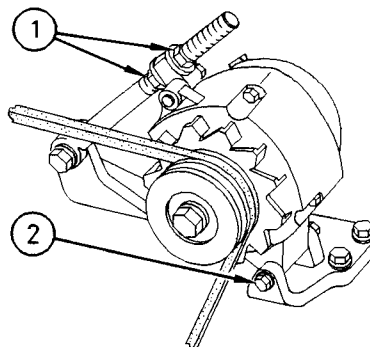


Illustration 31

g00122875

Typical Adjusting Nuts (1) and Mounting Bolt (2)

1. Remove the belt guard.
2. Loosen mounting bolt (2) and adjusting nuts (1).
3. Turn adjusting nuts (1) in order to increase or decrease the belt tension.
4. Tighten adjusting nuts (1). Tighten mounting bolt (2). Refer to the Operation and Maintenance Manual for the proper torques.
5. Reinstall the belt guard.

If new belts are installed, check the belt adjustment again after 30 minutes of engine operation at the rated rpm.



## Replacement

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belts are stretched. The additional load on the new belt could cause the new belt to break.

Refer to the Service Manual for more information on the procedures for the following topics: belt removal and belt installation.

i01179608

## Battery - Replace

**SMCS Code:** 1401-510

### WARNING

**Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.**

**Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.**

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE "-" cable connects the NEGATIVE "-" battery terminal to the ground plane. Disconnect the cable from the NEGATIVE "-" battery terminal.
4. The POSITIVE "+" cable connects the POSITIVE "+" battery terminal to the starting motor. Disconnect the cable from the POSITIVE "+" battery terminal.

**Note:** Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

**Note:** Before the cables are connected, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE "+" battery terminal.
8. Connect the cable from the ground plane to the NEGATIVE "-" battery terminal.

i01206348

## Battery Electrolyte Level - Check

**SMCS Code:** 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero.

### WARNING

**All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.**

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 1U-7298 Coolant/Battery Tester (°C) or the 1U-7297 Coolant/Battery Tester (°F).

3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 L (0.11 qt) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM grease.

i00095575

## Battery or Battery Cable - Disconnect

**SMCS Code:** 1402-029

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i01039758

## Battery Charger - Check

**SMCS Code:** 1401-535

### Checking Before Start-Up

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near "0" (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

## Charging the Battery

### WARNING

**Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.**

---

Perform the following procedure to charge the battery:

1. Ensure that the charger is turned OFF.
2. Adjust the voltage of the charger in order to match the voltage of the battery.
3. Connect the POSITIVE "+" lead of the charger to the POSITIVE "+" battery terminal. Connect the NEGATIVE "-" lead of the charger to the NEGATIVE "-" battery terminal.
4. Turn ON the battery charger.

### Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- Turn OFF the charger.

Table 34 describes the effects of overcharging on different types of batteries.

Table 34

Effects of Overcharging Batteries	
Type of Battery	Effect
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.
	The battery may not pass a load test.
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.
	The battery may not pass a load test.

## Checking After Stopping

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

i01206425

## Cooling System Coolant (DEAC) - Change

**SMCS Code:** 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

### NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

## Drain

### WARNING

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

Allow the coolant to drain.

### NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL  
Inside Illinois: 1-800-541-TOOL  
Canada: 1-800-523-TOOL

## Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

### NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

---

**NOTICE**

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

---

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

## Cooling Systems with Heavy Deposits or Plugging

**Note:** For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

---

**NOTICE**

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

---

**NOTICE**

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

---

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

## Fill

---

**NOTICE**

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i01206445

## Cooling System Coolant (ELC) - Change

**SMCS Code:** 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

**Note:** When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

**Note:** Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

### Drain



### WARNING

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

Allow the coolant to drain.

### NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL

Inside Illinois: 1-800-541-TOOL

Canada: 1-800-523-TOOL

### Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

### NOTICE

**Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.**

3. Fill the cooling system with clean water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

## Fill

---

### NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

---

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i00259474

## Cooling System Coolant Extender (ELC) - Add

**SMCS Code:** 1352-045; 1395-081

Caterpillar Extended Life Coolant (ELC) does not require the frequent Supplemental Coolant Additive (SCA) additions associated with the present conventional coolants. The Extender only needs to be added once.

Check the cooling system only when the engine is stopped and cool.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
2. It may be necessary to drain enough coolant from the cooling system in order to add the Extender.
3. Add Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section for the capacity of the cooling system for your engine. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" information for the Caterpillar ELC Extender additions.
4. Clean the cooling system filler cap. Inspect the cooling system filler cap gaskets. Replace the cooling system filler cap if the cooling system filler cap gaskets are damaged. Install the cooling system filler cap.

i01197583

## Cooling System Coolant Level - Check

**SMCS Code:** 1395-082

Check the coolant level when the engine is stopped and cool.

i00992487

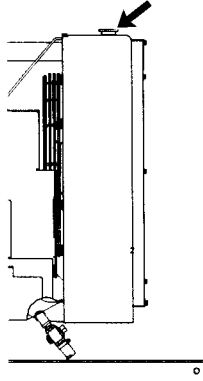


Illustration 32

g00285520

Cooling system filler cap

### **WARNING**

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

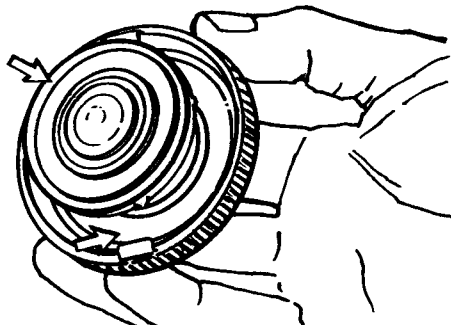


Illustration 33

g00103639

Typical filler cap gaskets

3. Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

## Cooling System Supplemental Coolant Additive (SCA) - Test/Add

**SMCS Code:** 1352-045; 1395-081

### **WARNING**

**Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.**

**Note:** Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

## Test for SCA Concentration

### Coolant/Antifreeze and SCA

#### **NOTICE**

Do not exceed the recommended six percent supplemental coolant additive concentration.

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to the Operation and Maintenance Manual for more information on conventional coolant/antifreeze cooling system maintenance.

### Water and SCA

#### **NOTICE**

Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Operation and Maintenance Manual, "Water/Supplemental Coolant Additive (SCA)" topic (Maintenance Section). Refer to the Operation and Maintenance Manual, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

## S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

## Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S-O-S Coolant Analysis.

## Add the SCA, If Necessary

---

### NOTICE

Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

---

### WARNING

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

---

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

**Note:** Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.

3. Add the proper amount of SCA. Refer to the Operation and Maintenance Manual for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i00912898

## Cooling System Water Temperature Regulator - Replace

**SMCS Code:** 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

---

### NOTICE

Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

---



Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

**Note:** If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i00894991

## Crankshaft Vibration Damper - Inspect

**SMCS Code:** 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

### Rubber Damper

Your engine may be equipped with a rubber damper. The rubber damper uses a ring which is mounted in rubber in order to reduce vibrations in the crankshaft.

Inspect the damper and repair or replace the damper for any of the following reasons:

- There is deterioration and cracking of the rubber.
- There is slippage of the outer ring from the original position.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

## Visconic Damper

Your engine may be equipped with a visconic damper. The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace the crankshaft seals.

Inspect the damper and repair or replace the damper for any of the following reasons:

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i00174798

## Driven Equipment - Check

**SMCS Code:** 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i01239442

## Engine - Clean

**SMCS Code:** 1000-070

### **WARNING**

**Personal injury or death can result from high voltage.**

**Moisture can create paths of electrical conductivity.**

**Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".**

### **NOTICE**

Water and/or condensation can cause damage to electrical components. Protect all electrical components from exposure to water.

### **NOTICE**

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

i01173387

## Engine Air Cleaner Element (Single Element) - Inspect/Replace

**SMCS Code:** 1054-040; 1054-510

Perform the Operation and Maintenance Manual, "Engine Air Cleaner Service Indicator-Inspect" procedure and perform the Operation and Maintenance Manual, "Engine Air Precleaner Check/Clean" procedure (if equipped) before performing the following procedure.

### **NOTICE**

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

### **NOTICE**

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

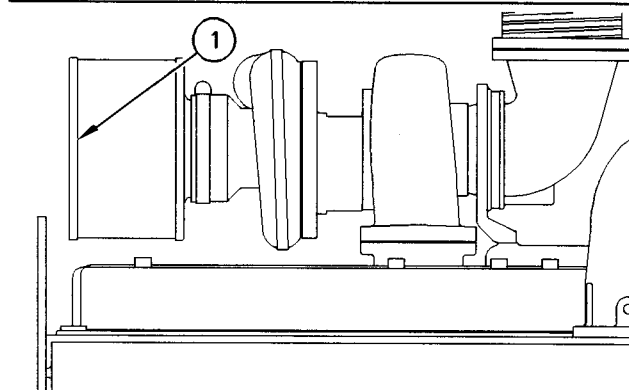


Illustration 34

g00310663

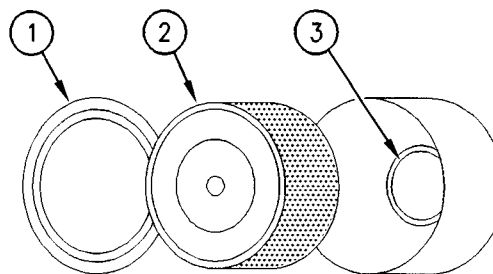


Illustration 35

g00310664

1. Remove the air cleaner cover (1) and remove the element (2).
2. Seal the air inlet (3) so that debris cannot enter the air inlet. Tape or a clean cloth can be used to cover the opening.
3. Clean the inside of the air cleaner cover. Clean the body that holds the air cleaner element.
4. Inspect the replacement element for the following items: damage, dirt, and debris.
5. Remove the seal from the opening of the air inlet.

6. Install a clean, undamaged element.
7. Install the air cleaner cover (1).
8. Reset the service indicator.

i01175055

## Engine Air Cleaner Service Indicator - Inspect

**SMCS Code:** 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

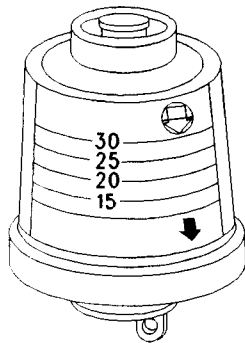


Illustration 36

g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

## Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be plugged.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

**Note:** When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i00906289

## Engine Crankcase Breather - Clean

**SMCS Code:** 1317-070

### NOTICE

Perform this maintenance with the engine stopped.

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

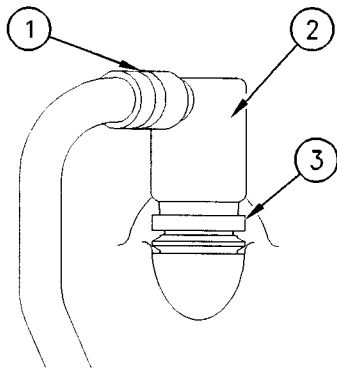


Illustration 37

g00463048

Typical example

- (1) Hose clamp
- (2) Breather assembly
- (3) Retaining clamp

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).
2. Loosen the retaining clamp (3). Remove breather assembly (2) and the seal.
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install breather assembly and seal (2) and install clamp (3). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.
5. Install the hose. Install hose clamp (1). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.

i00687861

## Engine Mounts - Inspect

**SMCS Code:** 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to the Service Manual for the recommended torques. Refer to your Caterpillar dealer for more information.

i00623423

## Engine Oil Level - Check

**SMCS Code:** 1348-535-FLV

### **WARNING**

**Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.**

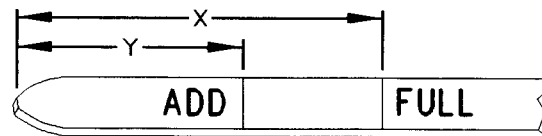


Illustration 38

g00110310

(Y) "ADD" mark. (X) "FULL" mark.

### **NOTICE**

**Perform this maintenance with the engine stopped.**

1. Maintain the oil level between "ADD" mark (Y) and "FULL" mark (X) on oil level gauge (1). Do not fill the crankcase above "FULL" mark (X).

### **NOTICE**

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i01070756

## Engine Oil Sample - Obtain

**SMCS Code:** 1000-008; 1348-554-SM;  
7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S-O-S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine.

## Obtain the Sample and the Analysis

### **WARNING**

**Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.**

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 8T-9190 Fluid Sampling Bottle Group is recommended for use with the sampling valve. The bottle group includes the parts that are needed for obtaining oil samples. Instructions are also provided.

### **NOTICE**

**Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.**

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S-O-S program for your engine.

100652130

## Engine Oil and Filter - Change

**SMCS Code:** 1318-510; 1348-044

### **WARNING**

**Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.**

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

## Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed.

## Replace the Oil Filter

### NOTICE

Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a **1U-8760 Chain Wrench**.
2. Cut the oil filter open with a **4C-5084 Oil Filter Cutter**. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

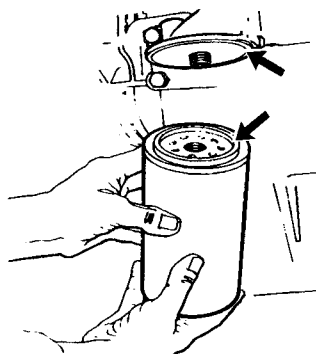


Illustration 39

g00103713

Typical filter mounting base and filter gasket

3. Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.
4. Apply clean engine oil to the new oil filter gasket.

### NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

## Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual for more information on lubricant specifications. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

### NOTICE

If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

### NOTICE

To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the oil level gauge.

i00626013

## Engine Protective Devices - Check

**SMCS Code:** 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

### NOTICE

During testing, abnormal operating conditions must be simulated.

**The tests must be performed correctly in order to prevent possible damage to the engine.**

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

## Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i00869628

## Engine Valve Lash - Inspect/Adjust

**SMCS Code:** 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

### NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

### WARNING

**Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.**

**Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.**

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i00937014

## Engine Valve Rotators - Inspect

**SMCS Code:** 1109-040

### WARNING

**When inspecting the valve rotators, protective glasses or face shield and protective clothing must be worn, to help prevent being burned by hot oil or spray.**

### NOTICE

A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Valve rotators cause the valves to rotate when the engine runs. This helps to prevent deposits from building up on the valves and the valve seats.

Perform the following steps after the valve lash is set, but before the valve covers are installed:

1. Start the engine according to this Operation and Maintenance Manual, "Engine Starting" procedure (Operation Section).

Operate the engine at low idle.

2. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

If a valve fails to rotate, consult your Caterpillar dealer.

i00175571

## Fan Drive Bearing - Lubricate

**SMCS Code:** 1359-086-BD

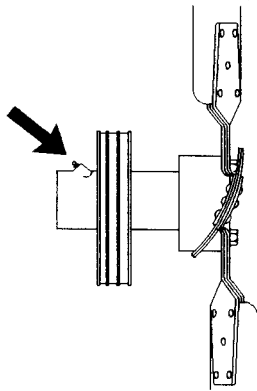


Illustration 40

g00123252

Typical Fan Drive Bearing Grease Fitting

Lubricate the fan drive bearing grease fitting with Bearing Lubricant Special Purpose Grease or the equivalent.

Inspect the fan drive pulley assembly. If the shaft is loose, an inspection of the internal components should be performed. Refer to the Service Manual.

i01370585

## Fuel Control Linkage - Check/Lubricate

**SMCS Code:** 1257-086; 1257-535

Check the fuel control linkage for proper operation. If necessary, adjust the fuel control linkage. Refer to the Service Manual for the adjustment procedures.

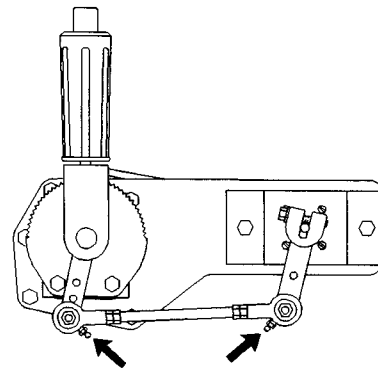


Illustration 41

g00723120

Typical grease fittings on the fuel control linkage

Some fuel control linkages require lubrication. Lubricate the grease fittings with 1P-0808 Multipurpose Grease or the equivalent.

i00626014

## Fuel Injection Nozzles - Test/Exchange

**SMCS Code:** 1254-013; 1254-081

### WARNING

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.**

### NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Fuel injection nozzles are subject to tip wear. Tip wear is a result of fuel contamination. Tip wear can cause the following problems:

- Increased fuel consumption
- Black smoke
- Misfire
- Rough running

Fuel Injection nozzles should be cleaned, inspected, tested, and replaced, if necessary. Refer to Special Instruction, SEHS7292 for using the 8S-2245 Injection Cleaning Tool Group. Consult your Caterpillar dealer about cleaning the fuel injection nozzle and testing the fuel injection nozzle.



i00908934

#### NOTICE

Never wire brush or scrape a fuel injection nozzle. Wire brushing or scraping a fuel injection nozzle will damage the finely machine orifice. Proper tools for cleaning and testing the fuel injection nozzles can be obtained from Caterpillar dealers.

The following items are symptoms of a malfunction of the fuel injection nozzle:

- Abnormal engine operation
- Smoke emission
- Engine knock

Each fuel injection nozzle must be isolated one at a time in order to determine the malfunctioning fuel injection nozzle.

1. Start the engine.
2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.
3. A defective fuel injection nozzle may be identified when a fuel line nut is loosened and the following conditions are present:
  - The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
  - Engine performance is not affected.

A fuel injection nozzle that is suspected of being defective should be removed. A new fuel injection nozzle should be installed in the cylinder in order to determine if the removed fuel injection nozzle is defective.

## Removal and Installation of the Fuel Injection Nozzles

For the removal and the installation of fuel injection nozzles, special tooling is required. Refer to the Service Manual for more information. Consult your Caterpillar dealer for assistance.

## Fuel Ratio Control - Inspect/Adjust

**SMCS Code:** 1278-025; 1278-040

Slow engine response and low power may indicate a need for adjustment or repair of the fuel ratio control. Refer to the Service Manual or your Caterpillar dealer for the complete adjustment procedure on the fuel ratio control.

i00891826

## Fuel System - Prime

**SMCS Code:** 1258-548



**Personal injury or death can result from a fire.**

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.**

**Clean up all leaked or spilled fuel. Do not smoke while working on the fuel system.**

**Turn the disconnect switch OFF or disconnect the battery when changing fuel filters.**

Prime the fuel system in order to fill dry fuel filters. You must also prime the fuel system after any one of the following conditions exist:

- The fuel system has run dry.
- The engine has been in prolonged storage.
- The fuel filter has been cleaned.
- The fuel filter has been replaced.

**Note:** If the engine does not have a fuel priming pump, refer to Step 4.

1. Unlock the priming pump, and operate the priming pump until a resistance is felt. This procedure will probably require a considerable amount of priming.
2. Push in the plunger, and hand tighten the plunger.

---

#### NOTICE

Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again. Turbocharger damage can result if the engine rpm is not kept low until the oil gauge display verifies that the oil pressure is sufficient.

---

#### 3. Crank the engine.

If the engine starts and the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

---

#### NOTICE

During periodic service, **DO NOT** remove the fuel filter plug that is in the fuel filter base in order to purge air from the fuel system. The periodic removal of the fuel filter plug will result in increased wear on the threads in the fuel filter base. This wear leads to fuel leakage.

---

4. Open the vent valve (if equipped) on the fuel injection pump's housing.
5. Operate the priming pump until the flow of fuel from the vent valve is continuous and the flow of fuel is free of air bubbles.

If the engine does not have a fuel priming pump, crank the engine. Crank the engine until the fuel flows freely and until the fuel is free of air bubbles.

6. Close the vent valve. Then, push in the plunger. Hand tighten the plunger.
7. Crank the engine. If the engine starts and if the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

**Note:** If the engine will not start, more priming is necessary. If the engine continues to run rough, more priming is necessary as well.

---

#### NOTICE

Do not let the tops of fuel nozzles turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the nozzle turns in the body.

The engine will be damaged if a defective fuel injection nozzle is used because the shape of fuel (spray pattern) that comes out of the nozzles will not be correct.

---

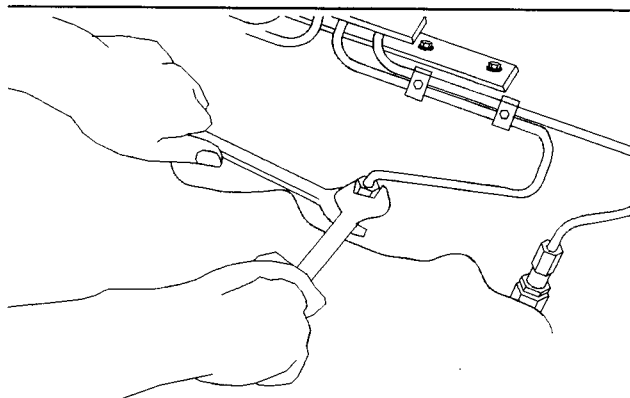


Illustration 42

g00290109

8. Loosen the fuel line nuts at the valve cover base. Loosen these line nuts one at a time.
9. Operate the priming pump until the flow of fuel from the fuel line is continuous and the flow of fuel is free of air bubbles.
10. Push in the plunger, and hand tighten the plunger. If the engine does not have a fuel priming pump, crank the engine.
11. Tighten each fuel line nut before you loosen the next fuel line nut. Tighten the fuel line nuts to a torque of  $40 \pm 7$  N·m ( $30 \pm 5$  lb ft).

Continue this procedure until all of the fuel lines have been cleared of any air. Before you start the engine, make sure that the fuel line nuts are properly tightened. Also make sure that the priming is locked.

i00951418

## Fuel System Primary Filter - Clean/Replace

**SMCS Code:** 1260-070; 1260-510

### **WARNING**

**Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.**

---

1. Stop the engine.
2. Turn the start switch to the "OFF" position. Disconnect the battery.
3. Shut off the fuel tank supply valve to the engine.

4. If the primary fuel filter is equipped with a drain valve, open the drain valve in order to drain any fuel from the filter case. Close the drain valve.

#### NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

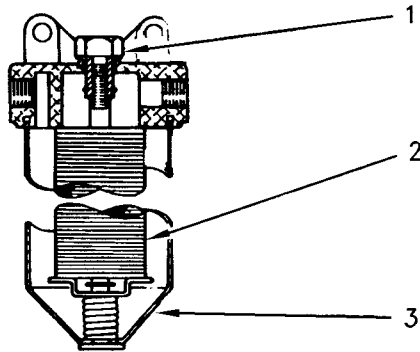


Illustration 43

g00485293

- (1) Bolt
- (2) Element
- (3) Case

5. Loosen the bolt (1) that is on the filter housing. Remove the filter case (3).
6. Remove the element (2) and wash the element in clean, nonflammable solvent.

#### NOTICE

Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

7. Install the element (2) and the filter case (3). Tighten the bolt (1) to a torque of  $24 \pm 4$  N·m ( $18 \pm 3$  lb ft).

## Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

### Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive fuel system wear. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

### Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

### Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i00907072

## Hoses and Clamps - Inspect/Replace

**SMCS Code:** 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

### NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

## Replace the Hoses and the Clamps

### WARNING

**Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.**

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
- Note:** Drain the coolant into a suitable, clean container. The coolant can be reused.
3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.

**Note:** For torques on hose clamps, see this Operation and Maintenance Manual, "Torque Specifications" (Maintenance Section).

7. Install the hose clamps with a torque wrench.

**Note:** For the proper coolant to use, see this Operation and Maintenance Manual, "Coolant Recommendations" (Maintenance Section).

8. Refill the cooling system.

9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i01037896

## Overhaul Considerations

**SMCS Code:** 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S-O-S analysis

### Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

## Overhaul Options

### Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

### After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

## Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

**Note:** Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

## Rebuild or Exchange

### Cylinder Head Assembly, Cylinder Packs, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

## Inspection and/or Replacement

### Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings

- Valve rotators
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Inspect the camshaft for damage to the journals and to the lobes.

**Note:** If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

### Oil Cooler Core

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

---

#### NOTICE

Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

---

**Note:** Use this cleaning procedure to clean the oil cooler core.

1. Remove the oil cooler core.
2. Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.
3. Flush the oil cooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core.

**Note:** Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 35 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 35

Hydrosolv Liquid Cleaners		
Part Number	Description	Size
1U-8812	Hydrosolv4165	4 L (1 US gallon)
1U-5490		19 L (5 US gallon)
8T-7570		208 L (55 US gallon)
1U-8804	Hydrosolv100	4 L (1 US gallon)
1U-5492		19 L (5 US gallon)
8T-5571		208 L (55 US gallon)

4. Use steam to clean the oil cooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.
5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler core thoroughly with clean water.



### WARNING

**Personal injury can result from air pressure.**

**Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.**

**Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.**

6. Dry the oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

## Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S-O-S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S-O-S Coolant Analysis (Level 2).

### S-O-S Coolant Analysis (Level 2)

An S-O-S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S-O-S Coolant Analysis (Level 2) provides the following information:

- Complete S-O-S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S-O-S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i00339617

## Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

### NOTICE

New power take-offs should have the clutch adjustment checked before being placed into service. The clutch adjustment should be checked again after the first ten hours of operation. New clutch plates have a "wear in" period, and the clutch may require several adjustments until the new plates are "worn in".

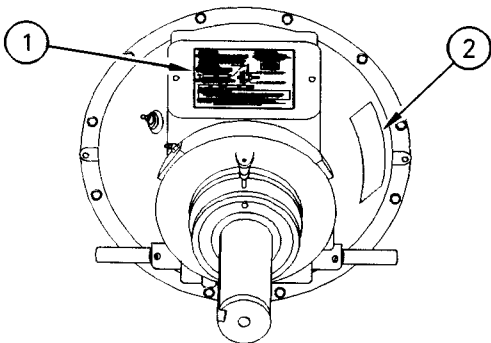


Illustration 44

g00108044

(1) Typical instruction plate for the clutch. (2) Typical serial number plate for the clutch.

The clutch adjustment should be checked regularly after "wear in". Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on the following items: lubrication, adjustment, and other service recommendations. Perform the maintenance that is specified on the instruction plate.



### WARNING

Do not operate the engine with the Instruction Plate cover removed from the clutch. Personal injury may result.

If the clutch is damaged to the point of burst failure, expelled pieces can cause personal injury to anyone in the immediate area. Proper safeguards must be followed to help prevent accidents.

i01206548

## Radiator - Clean

SMCS Code: 1353-070

**Note:** Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.



### WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.



After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i00651416

## Starting Motor - Inspect

**SMCS Code:** 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i00912946

## Turbocharger - Inspect

**SMCS Code:** 1052-040

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

### NOTICE

**Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.**

**Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.**

**When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.**

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

**Note:** Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

## Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

## Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.
2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.
5. Inspect the bore of the turbine housing for corrosion.
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i00632301

## Walk-Around Inspection

**SMCS Code:** 1000-040

### Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.

- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

---

#### NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

---

---

#### NOTICE

Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

---

- Ensure that cooling lines are properly clamped and tight. Check for leaks. Check the condition of all pipes.

- Inspect the water pump for coolant leaks.

**Note:** The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pump and the installation of water pump and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.

- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the engine-to-frame ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or can not be calibrated.

i01057943

## Water Pump - Inspect

**SMCS Code:** 1361-040; 1361

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump seal or the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

**Note:** Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

## Reference Information Section

### Customer Service

### Customer Assistance

i00790127

**SMCS Code:** 1000

### USA and Canada

When a problem arises concerning the operation of an engine or concerning the service of an engine, the problem will normally be managed by the dealer in your area.

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.
2. If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

1-800-447-4986

The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

Caterpillar Inc.  
Manager, Customer Service, Engine Division  
Mossville Bldg A  
P.O. Box 600  
Peoria, Illinois 61552-0600

Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

### Outside of the USA and of Canada

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Central America and Caribbean  
Caterpillar Americas Co.  
15550 NW 59th Avenue  
Miami Lakes, FL 33014  
USA  
Phone: 305-816-3306  
Fax: 305-816-3307

Mexico  
Grupo Financiero Caterpillar Mexico, S.A. de C.V.  
Primer piso del Arco Oriente de Arco Bosques Corporativa,  
Bosques del Alisos 45A  
Bosques de Las Lomas  
Mexico, D.F. 05120  
Phone (from within Mexico): 915-258-1515  
Fax (from within Mexico): 915-258-1530  
Phone (from within USA): 011-525-258-1515  
Fax (from within USA): 011-525-258-1530

Ecuador, Colombia, Venezuela, Guyana, and Suriname  
Caterpillar Americas Co.  
15550 NW 59th Avenue  
Miami Lakes, FL 33014  
USA  
Phone: 305-816-3316  
Fax: 305-816-3317

Peru, Chile, and Bolivia  
Caterpillar Americas Co.  
Edificio Centro Santa Maria  
Av. Los Conquistadores 1700  
Piso 14, Oficina A  
Santiago, Chile  
Phone: 011-562-366-5100  
Fax: 011-562-366-5125

Brazil, Argentina, Paraguay, and Uruguay  
Caterpillar Americas Co.  
Birmann II  
Rua Aleandre Dumas, 1.711-9.0  
Chac., Sto. Antonio  
04717-004-Sao Paulo, SP  
Phone: 55-11-5180-2000  
Fax: 55-11-5182-9694

Europe, Africa, and Middle East  
Caterpillar Overseas S.A.  
76 Route de Frontenex  
P.O. Box 6000  
1211 Geneva 6  
Switzerland  
Phone: 22-849-4444  
Fax: 22-849-4544

Far East  
Caterpillar Asia Pte. Ltd.  
7 Tractor Road  
Jurong, Singapore 627968  
Republic of Singapore  
Phone: 65-662-8333  
Fax: 65-662-8302

China  
Caterpillar China Ltd.  
37/F, The Lee Gardens  
33 Hysan Avenue  
Causeway Bay, Hong Kong  
China  
Phone: 852-2848-0333  
Fax: 852-2848-0440

Japan  
Shin Caterpillar Mitsubishi Ltd.  
Setagaya Business Square Tower  
10-1, Yoga 4-chome  
Setagaya, Tokyo  
Japan  
Phone: 81-3-5717-1121  
Fax: 81-3-5717-1177

Japan  
Caterpillar Power Systems, Inc.  
Japan Branch Sanno Grand Bldg.  
2-14-2 Nagatacho  
Chiyoda-ku, Tokyo, 100  
Japan  
Phone: 81-335-93-3237  
Fax: 81-335-93-3238

Australia and New Zealand  
Caterpillar of Australia Ltd.  
1 Caterpillar Drive  
Private Mail Bag 4  
Tullamarine, Victoria 3043  
Australia  
Phone: 03-9339-9333  
Fax: 03-9335-3366

## Ordering Replacement Parts

**SMCS Code:** 7567

### **WARNING**

**When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

## Reference Materials

i01370327

### Reference Material

**SMCS Code:** 1000

The following literature can be obtained through any Caterpillar dealer.

### Lubricants

- Special Publication, PEHP7041, "Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CG-4) (International only)"
- Special Publication, PEHP1026, "Data Sheet - Caterpillar Diesel Engine Oil (DEO) (CF-4) (International only)"
- Special Publication, PEHP1027, "Data Sheet - Caterpillar Diesel Engine Oil (CD)"
- Special Publication, PEHP8038, "Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CH-4) (North America and Australia)"
- Special Publication, PEWP9733, "Cat Fluids Selector Dial"
- Special Publication, PEWP3014, "Cat Fluids Selector Dial (International)"
- Special Publication, NEDG6022, "Data Sheet - Multipurpose Lithium Complex Grease (MPG)"
- Special Publication, PEHP0002, "Data Sheet - Multipurpose Lithium Complex Grease with Molybdenum (MPGM)"
- Special Publication, PEHP0017, "Data Sheet - Special Purpose Grease (SPG) Bearing Lubricant"
- Special Publication, NEHP5621, "How To Select The Right Grease For Any Job"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Special Publications, PEDP7036, "SOS Fluids Analysis Cornerstone"

### Fuels

- Special Publication, SEBD0717, "Diesel Fuels and Your Engine"

### Coolants

- Special Publication, SEBD0970, "Coolant and Your Engine"
- Special Publication, PEHP4036, "Data Sheet-Extended Life Coolant"
- Special Publication, SEBD0518, "Knowing Your Cooling System"
- Special Publication, PEEP5027, "Label ELC Radiator Label"
- Special Publication, PEHP7057, "S-O-S Coolant Analysis"

### Miscellaneous

- Service Manual, SENR1110, "3406C Industrial Engine"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Publication, PECP6026, "One Safe Source"
- Special Publication, SEHS7654, "Alignment - General Instructions"
- Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations"
- Special Instruction, SMHS7001, "Assembly of Fan Drive Pulley Assemblies"
- Special Instruction, SEHS7633, "Battery Test Procedure"
- Special Instruction, SEHS7332, "Do Not Operate Tag"
- Special Publication, SEBF8062, "Guideline for Reusable Parts - Cleaning and Inspection of Air Filters"
- Special Publication, SEBF8029, "Index of Publications for Reusable Parts and Salvage Operations"
- Special Publication, LEBH9324, "Industrial Application and Installation Guide"
- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"

- Special Instruction, NENG2500, "Tools and Shop Products Guide"
- Specifications, SENR3130, "Torque Specifications"
- Special Instruction, SEHS7292, "Using the 5P-4150 Nozzle Testing Group"
- Special Instruction, SEHS8024, "Governor Adjusting Tool Group"
- Special Instruction, SEHS8094, "Using the Nozzle Puller Group"
- Special Instruction, SEHS8622, "Using the FT-1984 Air-To-Air Aftercooler Leak Test Group"

## Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to Certified engines is found in Supplement, SEBU6981, "Federal Emissions Control Warranty Information". The Engine is Certified if the engine has a special label that states that the engine is certified. A Caterpillar dealer can also inform you if the engine is Certified.

i01109461

## Additional Reference Material

**SMCS Code:** 1000

The "EMA Lubricating Oils Data Book" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Association  
401 N. Michigan Ave.  
Chicago, IL, USA 60611  
Telephone: (312) 644-6610 ext. 3626

The "Society of Automotive Engineers (SAE) Specifications" can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International  
400 Commonwealth Drive  
Warrendale, PA, USA 15096-0001  
Telephone: (724) 776-4841

The "American Petroleum Institute Publication No. 1509" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute  
1220 L St. N.W.  
Washington, DC, USA 20005  
Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)  
1, rue de Varembe  
Case postale 56  
CH-1211 Genève 20  
Switzerland  
Telephone: +41 22 749 01 11  
Facsimile: +41 22 733 34 30  
E-mail: [central@iso.ch](mailto:central@iso.ch)  
Web site: <http://www.iso.ch>

European classifications are established by the Conseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat  
Lyoner Strasse 18  
60528 Frankfurt  
Germany  
Telephone: +49 69 6603 1567  
Facsimile: +49 69 6603 1566

i00912149

## Maintenance Records

**SMCS Code:** 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.

- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

**Fuel Consumption** – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

**Service Hours** – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

**Documents** – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner's repair costs
- Owner's receipts
- Maintenance log



i01176304

## Maintenance Log

**SMCS Code:** 1000

Table 36

[illegible]

# Index

## A

Additional Reference Material .....	93
After Starting Engine .....	27
After Stopping Engine.....	31
Aftercooler Core - Clean/Test (Air-To-Air Aftercooler) .....	60
Aftermarket Oil Additives .....	41
Air Compressor - Inspect.....	60
Air Starting.....	27
Air Starting Motor Lubricator Oil Level - Check (If Equipped) .....	61
Oil Feed Adjustment .....	61
Air Tank Moisture and Sediment - Drain (If Equipped) .....	61
Alternator - Inspect.....	62
Alternator Belt - Inspect/Adjust/Replace.....	62
Adjustment.....	62
Inspection.....	62
Replacement.....	63

## B

Battery - Replace.....	63
Battery Charger - Check.....	64
Checking After Stopping .....	65
Checking Before Start-Up.....	64
Battery Electrolyte Level - Check .....	63
Battery or Battery Cable - Disconnect.....	64
Before Starting Engine .....	12, 24
Burn Prevention .....	10
Batteries.....	10
Coolant.....	10
Oils.....	10

## C

Cold Weather Lubricants .....	41
Cold Weather Operation.....	32
Cold Weather Starting .....	25
Commercial Heavy-Duty Coolant/Antifreeze and SCA .....	53
Conventional Coolant/Antifreeze Cooling System Maintenance .....	55
Cleaning the System of Heavy-Duty Coolant/Antifreeze .....	57
Cooling Systems with Larger Capacities .....	56
Coolant Recommendations .....	48
Cooling System Coolant (DEAC) - Change.....	65
Cooling Systems with Heavy Deposits or Plugging .....	66
Drain .....	65
Fill .....	66
Flush .....	65

Cooling System Coolant (ELC) - Change.....	67
Drain .....	67
Fill .....	68
Flush .....	67
Cooling System Coolant Extender (ELC) - Add.....	68
Cooling System Coolant Level - Check .....	68
Cooling System Specifications .....	46
Cooling System Supplemental Coolant Additive (SCA) - Test/Add.....	69
Add the SCA, If Necessary .....	70
S.O.S Coolant Analysis.....	69
Test for SCA Concentration .....	69
Cooling System Water Temperature Regulator - Replace.....	70
Crankshaft Vibration Damper - Inspect .....	71
Rubber Damper .....	71
Visconic Damper.....	71
Crushing Prevention and Cutting Prevention.....	12
Customer Assistance.....	90
Outside of the USA and of Canada.....	90
USA and Canada .....	90
Customer Service.....	90

## D

Diesel Engine Antifreeze/Coolant (DEAC) .....	52
Driven Equipment - Check.....	71

## E

Emergency Stopping .....	30
Emergency Stop Button .....	30
Emissions Certification Film .....	18
Engaging the Driven Equipment.....	29
Engine - Clean.....	72
Engine Air Cleaner Element (Single Element) - Inspect/Replace.....	72
Engine Air Cleaner Service Indicator - Inspect.....	73
Test the Service Indicator .....	73
Engine Crankcase Breather - Clean.....	73
Engine Description .....	15
Engine Cooling and Lubrication .....	16
Engine Information.....	15
Engine Specifications.....	16
Engine Features and Controls .....	21
Engine Identification .....	17
Engine Lifting.....	19
Engine Lifting with a Fuel Tank .....	19
Engine Lifting and Storage .....	19
Engine Mounts - Inspect.....	74
Engine Oil .....	37
Caterpillar Diesel Engine Oil.....	37
Commercial Oils.....	38
Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines .....	39

Engine Oil and Filter - Change .....	75	Fuel Tank Water and Sediment - Drain.....	81
Drain the Engine Oil.....	75	Drain the Water and the Sediment.....	81
Fill the Engine Crankcase .....	76	Fuel Storage Tanks .....	81
Replace the Oil Filter .....	76	Fuel Tank .....	81
Engine Oil Level - Check .....	74		
Engine Oil Sample - Obtain .....	74	<b>G</b>	
Obtain the Sample and the Analysis.....	75	Gauges and Indicators .....	20
Engine Operation.....	28	General Coolant Information .....	46
Engine Protective Devices - Check .....	77	Additives .....	47
Visual Inspection.....	77	Glycol .....	47
Engine Shutoffs and Engine Alarms.....	21	Water .....	46
Alarms.....	21	General Hazard Information .....	7
Shutoffs.....	21	Asbestos Information .....	9
Testing the Shutoff and Alarm System.....	22	Containing Fluid Spillage .....	9
Engine Starting.....	13, 24	Dispose of Waste Properly .....	10
Ether .....	13	Fluid Penetration .....	9
Engine Stopping .....	13, 30	Pressure Air and Water.....	8
Engine Storage.....	19	General Torque Information.....	34
Engine Valve Lash - Inspect/Adjust.....	77		
Engine Valve Rotators - Inspect .....	77	<b>H</b>	
Engine Warm-up.....	28	Hoses and Clamps - Inspect/Replace .....	82
Extended Life Coolant (ELC).....	49	Replace the Hoses and the Clamps .....	82
Extended Life Coolant (ELC) Cooling System			
Maintenance .....	50	<b>I</b>	
Caterpillar ELC Extender .....	50	Important Safety Information .....	2
Changing to Caterpillar ELC .....	51	Information Plate .....	17
Commercial ELC.....	52		
ELC Cooling System Cleaning.....	51	<b>L</b>	
ELC Cooling System Contamination.....	52	Lubricant Information.....	37
Proper additions to the Extended Life Coolant ..	50	API Oils.....	37
		Engine Manufacturers Association (EMA) Oils ..	37
<b>F</b>		General Information .....	37
Fan Drive Bearing - Lubricate.....	78	Lubricant Specifications .....	37
Fire Prevention and Explosion Prevention.....	10	Lubricating Grease .....	41
Ether .....	12	Caterpillar Premium Grease (CPG) .....	43
Fire Extinguisher.....	12	Multipurpose Greases.....	42
Foreword.....	5	Special Purpose Grease (SPG).....	42
California Proposition 65 Warning .....	5		
Literature Information.....	4	<b>M</b>	
Maintenance .....	4	Maintenance Interval Schedule .....	59
Maintenance Intervals.....	4	Maintenance Log .....	95
Operation .....	4	Maintenance Records.....	93
Overhaul .....	4	Maintenance Section .....	34
Safety .....	4	Manual Stop Procedure.....	30
Fuel and the Effect from Cold Weather .....	32	Model View Illustrations.....	14
Fuel Conservation Practices.....	29	Model Views .....	14
Fuel Control Linkage - Check/Lubricate .....	78	Mounting and Dismounting.....	12
Fuel Injection Nozzles - Test/Exchange.....	78		
Removal and Installation of the Fuel Injection			
Nozzles .....	79		
Fuel Ratio Control - Inspect/Adjust.....	79		
Fuel Recommendations.....	44		
Fuel Related Components in Cold Weather .....	33		
Fuel Filters .....	33		
Fuel Heaters .....	33		
Fuel Tanks.....	33		
Fuel Specifications .....	44		
Fuel System - Prime.....	79		
Fuel System Primary Filter - Clean/Replace .....	80		

## O

Operation Section .....	19
Ordering Replacement Parts .....	91
Overhaul Considerations .....	83
Oil Consumption as an Overhaul Indicator .....	83
Overhaul Recommendation .....	83

## P

Power Take-Off Clutch - Check/Adjust/Lubricate...	86
Product Identification Information .....	17
Product Information Section .....	14

## R

Radiator - Clean .....	86
Radiator Restrictions .....	32
Re-refined Base Stock Oils .....	40
Reference Information Section .....	90
Reference Material .....	92
Coolants .....	92
Emissions Warranty .....	93
Fuels .....	92
Lubricants .....	92
Miscellaneous .....	92
Reference Materials .....	92
Reference Numbers .....	17
Record for Reference .....	17
Refill Capacities .....	58
Cooling System .....	58
Lubrication System .....	58

## S

S.O.S Coolant Analysis .....	48
New Systems, Refilled Systems, and Converted Systems .....	49
Recommended Interval for S.O.S Coolant Sample .....	49
S.O.S Coolant Analysis (Level 1) .....	49
S.O.S Coolant Analysis (Level 2) .....	49
S.O.S Oil Analysis .....	43
Safety Section .....	6
Safety Signs and Labels .....	6
Serial Number Plate .....	17
Standard Torque for Constant Torque Hose Clamps .....	35
Standard Torque for Inch Fasteners .....	34
Standard Torque for Metric Fasteners .....	35
Standard Torque for Worm Drive Band Hose Clamps .....	35
Starting Motor - Inspect .....	87
Starting the Engine .....	25
Starting with Jump Start Cables .....	26
Supplemental Coolant Additive (SCA) .....	52
Synthetic Base Stock Oils .....	40

## T

Table of Contents .....	3
Torque Specifications .....	34
Turbocharger - Inspect .....	87
Cleaning and Inspecting .....	87
Removal and Installation .....	87

## W

Walk-Around Inspection .....	88
Inspect the Engine for Leaks and for Loose Connections .....	88
Water Pump - Inspect .....	89
Water/Supplemental Coolant Additive (SCA) .....	53
Cooling Systems with Larger Capacities .....	54

## Product and Dealer Information

Note: For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual.

Delivery Date: \_\_\_\_\_

### Product Information

Model: \_\_\_\_\_

Product Identification Number: \_\_\_\_\_

Engine Serial Number: \_\_\_\_\_

Transmission Serial Number: \_\_\_\_\_

Generator Serial Number: \_\_\_\_\_

Attachment Serial Numbers: \_\_\_\_\_

Attachment Information: \_\_\_\_\_

Customer Equipment Number: \_\_\_\_\_

Dealer Equipment Number: \_\_\_\_\_

### Dealer Information

Name: \_\_\_\_\_ Branch: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

#### Dealer Contact

#### Phone Number

#### Hours

Sales: \_\_\_\_\_

Parts: \_\_\_\_\_

Service: \_\_\_\_\_





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.11 Hydraulic System



**SEE MAINTENANCE PRECAUTIONS  
PRIOR TO PERFORMING ANY WORK**

#### Part Repair or Replacement

Any repair of hydraulic parts, particularly pumps, motors and cylinders, requiring complete disassembly of the unit is not recommended to be performed in the field.

Major repairs should only be attempted by experienced, qualified and properly equipped personnel. Only minor repairs and adjustments as described in the manual should be performed in the field.

As always, the prime consideration when working on the hydraulic system is to insure that no contamination is introduced into the system. When replacing a hydraulic part, the following basic outline should be used:

1. Remove damaged part and install new part.
2. If any debris is present in the hoses or tubing, the lines should be flushed clean with a suitable solvent and blown dry before reconnecting.
3. If the hydraulic part is a pump or motor, power is off and disconnects are open, physically hand-fill ports with clean hydraulic oil (provides lubrication for initial start-up).
4. Reconnect all tubing and hoses.
5. If debris from damaged parts are in the system (such as motor which has "gone to pieces"), replace the return line filter element and check the suction strainers.
6. Check all mounting bolts, nuts and/or pins.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

7. Start prime mover and allow it to run at low idle (1000 rpm).
8. Operate system at least a few minutes at zero pressure.
9. Operate repaired system without a load on the hook observing operating pressure and general operational characteristics.
10. Operate system with a load observing operating pressures and general operational characteristics.
11. Inspect the system for hydraulic leaks and correct any abnormalities.



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA







Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

## Nautilus Crane Model 180L4-50

### Section 5.12 Load Indicator System



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





**Markload Systems Inc.®**  
**DX**  
**Manual de Operación, Servicio e Instalación**

# NOTAS IMPORTANTES

## INSTALACIÓN DEL SISTEMA

Las instalaciones deben ser hechas en clima seco, para asegurar que la humedad no penetre en alguna de las conexiones de los cables. Si se sospecha que hay humedad en alguna conexión, debe ser limpiada solamente con limpiador de contacto que esté etiquetado como "NO DEJA RESIDUOS".

## AJUSTE INICIAL DEL SISTEMA

A la instalación inicial o cuando alguno de los componentes del sistema es reemplazado, debe ser revisada y ajustada la calibración de todas las señales de entrada (cargas, ángulo, longitud...), si es necesario. Vea las páginas de calibración de este manual para los procedimientos detallados.

## PRECAUCIÓN CON LA ENERGÍA

En algunas grúas, cuando la energía de la grúa se conecta, o cuando el motor se arranca, hay fluctuaciones de energía de corta duración que son suficientemente severas para afectar la memoria del sistema Markload. Es aconsejable dejar **LA ENERGÍA DE MARKLOAD APAGADA HASTA DESPUÉS QUE EL MOTOR DE LA GRÚA SEA ARRANCADO**. También es mejor apagar el sistema Markload **antes** de apagar la grúa.

## PROBAR DIARIAMENTE EL ANTI DOBLE BLOQUEO (DISYUNTOR DE FIN DE CARRERA)

Si su sistema está equipado así, el anti doble bloqueo (disyuntor de fin de carrera), para cada gancho, debe ser probado diariamente para una operación apropiada.

## CALIBRACIÓN DE CARGA

La precisión de carga debe ser revisada una vez al año. Esto debe ser hecho usando pesas de prueba certificadas.

- Levantar una carga conocida.  
Una carga suficiente debe ser levantada para calibrar el sistema correctamente.  
La grúa debe ser ajustada para permitir que la siguiente carga sea recogida seguramente.  
(la  $\frac{1}{2}$  de la carga de trabajo máxima del cable único multiplicada por las partes reales de la línea)

(Ejemplo: Si la tracción máxima de trabajo de cable único para el cable es de 25,000 y cuatro partes de la línea están en uso, entonces

la  $\frac{1}{2}$  de 25,000 por 4 = 50,000 lb deben ser levantadas para una calibración apropiada)

# Manual de Operación para los Markload DX Systems

## Alertas y Alarmas

Las siguientes son condiciones típicas de alerta y alarma (alertas y alarmas especiales son programadas a solicitud del cliente):

Alerta a la presencia de una carga mayor del 85% de la capacidad - La luz de **ALERT** enciende intermitentemente y la alarma audible se escucha mientras que la pantalla muestra en forma intermitente el mensaje de alerta.

Alarma a la presencia de cargas mayores del 100% de capacidad - La luz de **ALARM** se enciende en forma constante y la alarma audible está funcionando constantemente mientras que la pantalla muestra en forma intermitente el mensaje de alarma.

Ángulos de la pluma mayores o menores a aquellos permitidos en las tablas de elevación (**NO LIFT ZONE** - ZONA DE NO ELEVACIÓN) - Las luces de **ALERT** y **ALARM** se iluminan en forma intermitente y una alarma audible se escucha mientras que en la pantalla destella el mensaje "**NO LIFT ZONE** (ZONA DE NO ELEVACIÓN).

Falla del equipo físico - La luz de **ALARM** está encendida constantemente y una alarma audible se escucha constantemente, mientras que la pantalla muestra intermitentemente el mensaje "**TRANSDUCER ERROR**" (ERROR DEL TRANSDUCTOR) en la línea superior de la pantalla.

Así como se han descrito las condiciones anteriores, la pantalla ofrece al operador la carga actual en ese gancho, la máxima capacidad permisible para ese gancho en la configuración actual y la geometría de la pluma (radio, ángulo, altura o longitud). La carga y la capacidad se muestran como un número digital y una representación de gráfica de barra de ese número.

### Uso de los menús

Las flechas para arriba (↑) y para abajo (↓) se usan para avanzar o mover la selección del menú hacia arriba o hacia abajo.

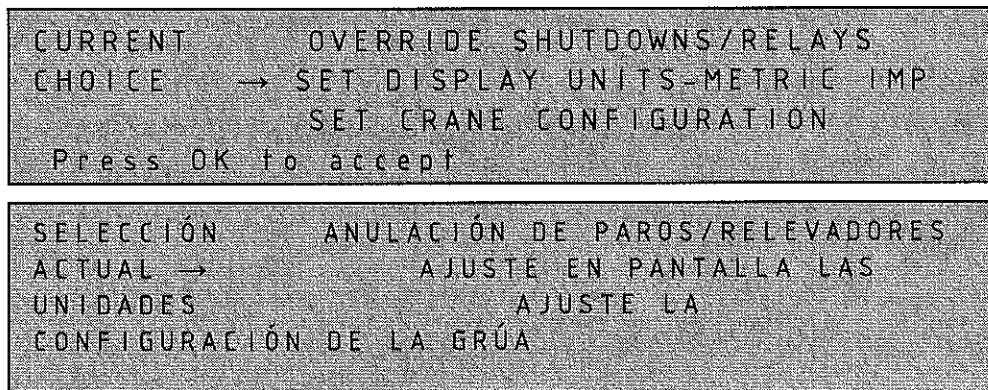
La selección actual aparece enfrente de la flecha (→).

Por ejemplo, en la ilustración de abajo la selección actual es "**SET DISPLAY UNITS-METRIC IMP**" (AJUSTE DE UNIDADES MÉTRICAS O INGLESAS EN PANTALLA).

Para ir a la selección actual, pulse el botón de **OK**.

### Ejemplo:

Para cambiar las unidades de la pantalla pulse ↓ varias veces hasta que aparezca la siguiente ilustración en la pantalla:



Pulse el botón **OK** para ir al menú de selección de unidades. A continuación pulse las flechas para arriba (↑) o para abajo (↓) hasta que las unidades de medida que desea se alineen con la flecha que apunta a la derecha (→) después pulse el botón **OK**. Las unidades de medida correctas aparecerán ahora en la pantalla.

## Pasos a seguir cuando se enciende el Sistema Markload

Arranque la grúa (La energía de Markload debe estar apagada mientras se arranca la grúa).

Encienda el Sistema Markload.

Verifique que toda la información en la línea superior de la pantalla coincide con la configuración actual de la grúa.

Ejemplo:

- 1) Gancho principal,
- 2) 8 Partes de línea,
- 3) Longitud de la pluma = 100,

```
MAIN PL 08 100' BOOM  
LOAD: 02.5 Klb  
CAP : 40.0 Klb  
RAD : 205 Ft
```

```
PLUMA PRINCIPAL PL 08 100 pies  
CARGA: 02.5 klb  
CAP: 40.0 klb  
RAD : 205 pies
```

### Para cambiar el gancho en uso:

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "CHANGE HOOK – MAIN/AUX" (CAMBIAR GANCHO - PRINCIPAL/AUX).
- Pulse OK para hacer esta selección.
- Esto cambiará el gancho que es monitoreado y guardará este ajuste. El gancho que es monitoreado será mostrado en el lado izquierdo de la línea superior de la pantalla.

### Para cambiar las partes de la línea en uso:

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "CHANGE PARTS OF LINE" (CAMBIAR PARTES DE LA LÍNEA).
- Pulse OK para hacer esta selección.
- Pulse ↑ tantas veces como se necesario, hasta que la pantalla muestre las partes de la línea correctas.
- Pulse OK para aceptar y guardar este ajuste.

### Para cambiar Línea en Pantalla de Capacidad:

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "SET CAPACITY/%CAPACITY DSPLY" (PANTALLA DE AJUSTE CAPACIDAD/% CAPACIDAD).
- Pulse OK para hacer esta selección.
- Esto cargará y guardará la pantalla de capacidad para o desde el ajuste de porcentaje.

### Para cambiar la pantalla de la geometría:

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "DISPLAY RAD-LEN-HGHT" (PANTALLA DE RAD-LONG-ALT)
- Pulse OK para hacer esta selección.
- Pulse ↑ tantas veces como se necesario hasta que la pantalla muestre el ajuste deseado.
- Pulse SET (AJUSTAR) para aceptar y guardar este ajuste.

"RAD" para radio,

"L G T H" (LONG) para longitud de la pluma,

"H G H T" (ALT) para altura de la pluma,

"A N G" para el ángulo principal de la pluma. Éste se muestra continuamente en la línea izquierda inferior de la pantalla

### Para cambiar la configuración de la grúa

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "SET CRANE CONFIGURATION" (AJUSTE DE CONFIGURACIÓN DE GRÚA).
- Pulse OK para hacer esta selección.
- A continuación pulse los botones (↑) o (↓) hasta que las unidades de medida que desea se alineen con la flecha que apunta a la derecha (→).
- Pulse OK para aceptar y guardar este ajuste.

## Para anular los relevadores (para los sistemas con esta opción)

Este menú permite al operador tomar control sobre los relevadores opcionales instalados. La descripción programada en el sistema para los relevadores depende de la aplicación específica del cliente.

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “OVERRIDE SHUTDOWNS/RELAYS” (ANULAR PAROS/RELEVADORES).
- Pulse OK para hacer esta selección.
- A continuación pulse los botones (↑) o (↓) hasta que las unidades de medida que desea se alineen con la flecha que apunta a la derecha (→).
- Pulse el botón SET (AJUSTAR) para cambiar el estado de anulación del relevador mostrado. La pantalla mostrará el estado actual.
- Pulse OK para aceptar y guardar este ajuste.

Este menú también puede actuar como una prueba para los relevadores. Si el relevador no fue activado cuando se entró en este menú, el operador puede activar el relevador, primero ANULANDO el relevador, después regresar a la operación normal (pulse el botón 'SET' (AJUSTAR) dos veces). El relevador regresará a la operación normal después de salir del menú o al terminar el intervalo de tiempo, si el operador no ANULA el relevador. El estado de anulación de los relevadores **no** será guardado cuando la energía del sistema se desconecta y será reajustado cuando la condición que activó al relevador se retira.

## Ajustar unidades de pantalla (Métricas o Inglesas)

Este menú permite al operador escoger las UNIDADES para la pantalla. Las unidades de la carga serán mostradas como Klb para miles de libras (1000 libras) o KKG para miles de kilogramos (1000 kilogramos toneladas métricas).

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “SET DISPLAY UNITS-METRIC/IMP” (AJUSTAR UNIDADES MÉTRICAS/INGLESAS EN PANTALLA).
- Pulse OK para hacer esta selección.
- A continuación pulse los botones (↑) o (↓) hasta que los ajustes que desea se alineen con la flecha que apunta a la derecha (→).
- Pulse OK para aceptar y guardar este ajuste.

## Otros menús

Están presentes menús adicionales cuando se requieren configuraciones de la grúa más complejos. Están presentes otros menús cuando opciones tales como cuando se ordena la grabadora de elevación u opciones de calibración especial.



## Función de la tara

La función de la tara permite al usuario tarar la carga actual, luego poner en ceros la carga mostrada. Esto permite al operador mostrar cualquier incremento por encima de la cantidad de la tara (útil para pesar el contenido de un recipiente).

**AVISO:** La revisión de Alerta y Alarma de sobrecarga no es afectada por la función de TARA.

Para usar la tara haga lo siguiente:

- Pulse el botón **SET** (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “**SET TARE-** (AJUSTAR TARA).
- Pulse **OK** para hacer esta selección.
- Pulse **SET** (AJUSTAR) para aceptar la carga actual como el valor de la tara. Esto guardará el valor y cambiará la pantalla de carga a la modalidad de tara. La pantalla mostrará ahora “**L D - T :**” para la pantalla de carga y el valor será la carga total menos la carga de la tara.
- Pulse **OK** para aceptar y guardar este ajuste.

El sistema retendrá la carga de la tara para usarse después (aun cuando la energía se desconecte).

Para cancelar la tara, haga lo siguiente:

- Pulse el botón **SET** (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “**SET TARE-** (AJUSTAR TARA).
- Pulse **OK** para hacer esta selección.
- Pulse el botón ↓. Esto cancelará la tara y guardará esta configuración.

## Función de prueba

Al pulsar y sostener el botón de **OK** se hace una prueba al sistema en todas las luces, dispositivos audibles y todos los canales de entrada usados. La prueba continúa mientras que el botón **OK** se mantenga pulsado. La última línea de la pantalla muestra los resultados de la prueba hecha en los canales de entrada. Una **FALLA** ocurre cuando la señal de entrada de ese canal cae por debajo de un nivel especificado o el preamplificador no está enviando una señal correcta que indique una línea abierta o falla de preamplificador. La función de prueba probará las luces y alertas audibles al encenderlas todas mientras el interruptor se encuentre pulsado. Si una de las luces no se enciende o si la alerta audible no se escucha durante la prueba, el sistema debe ser reparado. Mientras el botón **OK** esté pulsado, también se muestran el número de serie del sistema y otra información del sistema.

## Contraseñas

Contraseña del sistema = 7111

Para poder cambiar cualquiera de los ajustes de calibración del sistema se debe teclear una contraseña.

Siga los pasos de abajo para dar entrada a la contraseña:

- Cuando aparezca la pantalla de contraseña el dígito actual que se ha de cambiar se encenderá intermitentemente.
- El valor del dígito intermitente puede ser cambiado al pulsar las flechas ↓ o ↑.
- Para seleccionar otro dígito pulse el botón SET (AJUSTAR).
- Cuando la contraseña correcta se muestre en la pantalla , pulse el botón OK.

# **ACTIVAR / DESACTIVAR EL ANTI DOBLE BLOQUEO (DISYUNTOR DE FIN DE CARRERA) – ANTI-TWO-BLOCK**

(para sistemas con esta opción)

Si uno o ambos interruptores de anti doble bloqueo no son usados, pueden ser desactivados. Esto evita que el sistema monitoree el interruptor desactivado.

- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “ADVANCED MENU” (MENÚ AVANZADO).
- Pulse OK para hacer esta selección.
- Teclee la contraseña y después pulse OK. El valor del dígito intermitente puede ser cambiado al pulsar las flechas ↓ o ↑. Para seleccionar otro dígito pulse el botón SET(AJUSTAR).
- Pulse ↓ si es necesario, de tal modo que la flecha hacia la derecha apunte a “SETUP ANTI-TWO-BLOCK” (AJUSTE ANTI DOBLE BLOQUEO), después pulse OK.
- Pulse ↓ si es necesario, de tal manera que → ( flecha hacia la derecha) apunte al gancho principal o auxiliar para activar o desactivar esa función.
- Pulse el botón SET (AJUSTAR) para cambiar el estado. La pantalla mostrará el estado actual.
- Pulse OK para aceptar y guardar este ajuste.

## SENSORES DE ROTACIÓN

El sistema detecta la mató (rotación) de la grúa. Dos sensores se utilizan.

- **Zona-0:** El relé está cerrado. N alerta. No hay alarma.

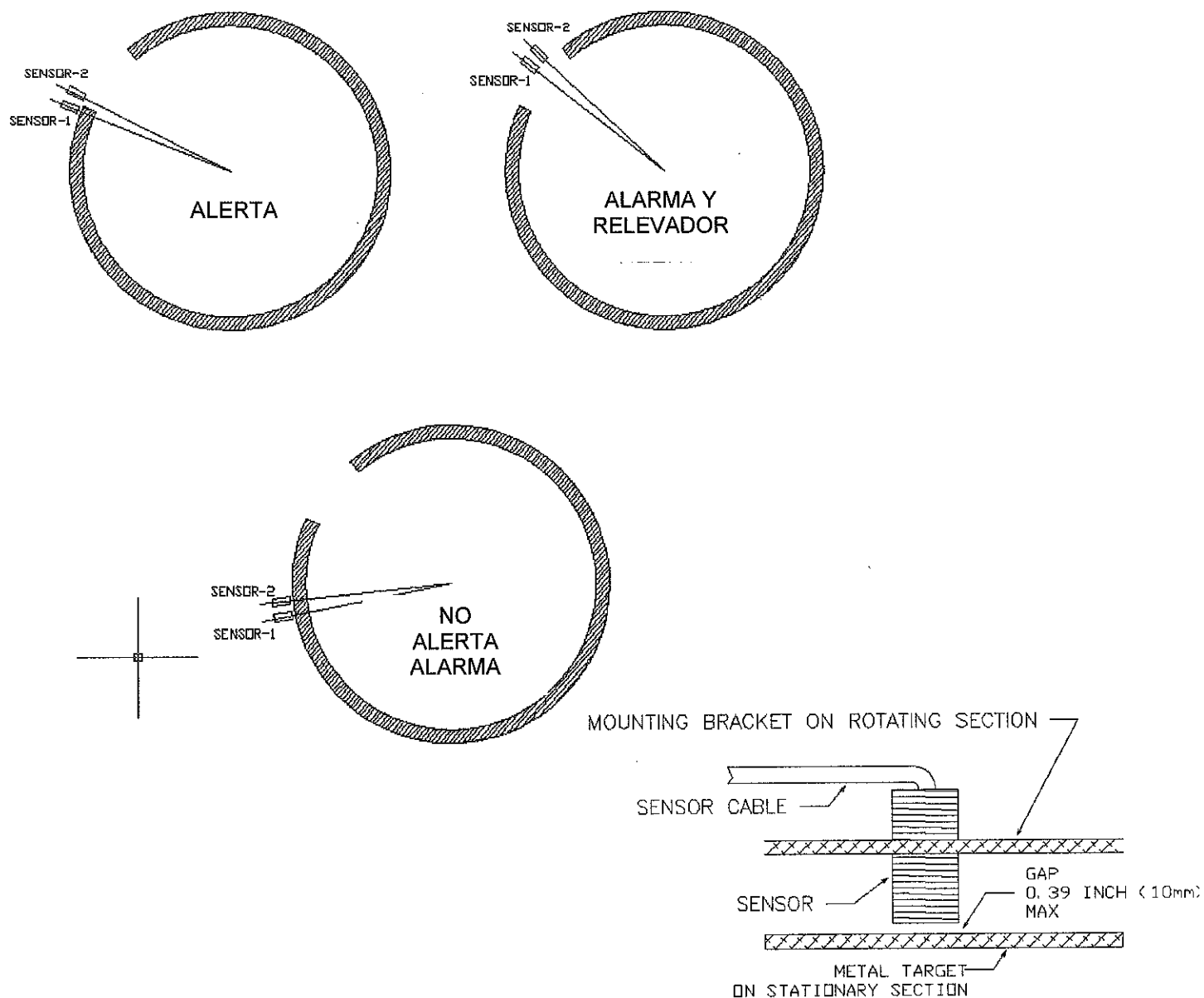
- **Zona restringida** (no hay ninguna zona ascensor):

El sistema abre relé y alerta al operador con alarmas audibles y visuales.

El sistema será también "la alerta de" operador con una luz intermitente amarilla y un mensaje de alerta ( " Alerta - LIMITE DE DAR UN GIRO ") bajo la siguiente condición:

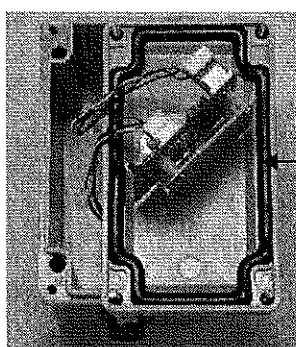
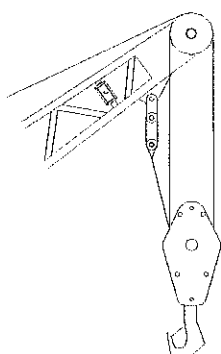
- Cuando uno de los dos sensores de proximidad se encuentra en la zona restringida

### INSTALACIÓN DEL SENSOR

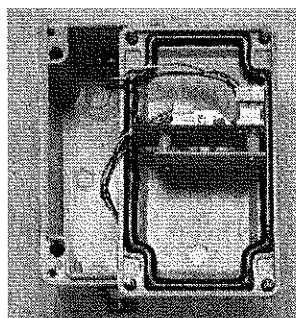
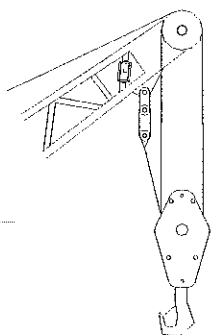


## INSTALACION DEL EMISOR GONIOMETRICO

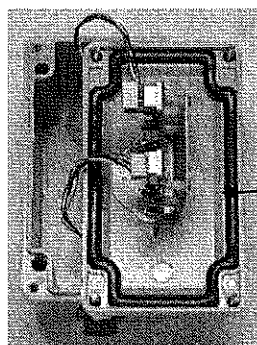
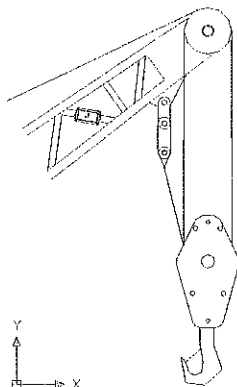
- La unidad del emisor goniométrico debe ser montada verticalmente (cuando la pluma está horizontal) si es posible en el interior de la pluma, para protección. La cubierta de la caja debe mirar hacia el lado derecho de la pluma cuando mire la parte de arriba de la pluma. El sensor que está dentro del transmisor de ángulo es embarcado de fábrica para montaje vertical. Si el transmisor de ángulo es montado verticalmente, no se necesita ningún ajuste a la tarjeta del sensor.
- Si el transmisor de ángulo es montado a una celosía diagonal de la pluma, la tarjeta del sensor que se encuentra dentro de la caja del ángulo debe ser reorientada.
- Los dibujos de abajo muestran la orientación de la tarjeta del sensor cuando la caja es montada en ángulos diferentes mientras la pluma está horizontal.
- Para ajustar la tarjeta del sensor, quite los cuatro tornillos que sostienen los soportes del tablero del sensor al soporte. Después quite los dos tornillos que retienen la brida de montaje a la cubierta. Oriente la tarjeta del sensor en la cubierta de la caja, como se muestra abajo. Reinstale el soporte de la cubierta de la caja usando los tornillos selladores. Finalmente, monte la tarjeta del sensor al soporte. Asegúrese en usar tornillos selladores instalados para sellar los agujeros no usados.
- Después de que la unidad del emisor goniométrico se instale, siga el procedimiento de 'ANGLE CALIBRATION' (CALIBRACIÓN DE ÁNGULO).



Orientación la  
tarjeta de circuito  
(Configuración)



Orientación de la  
tarjeta de circuito  
Para diagonal de -45



Orientación de la tarjeta  
de circuito  
Para diagonal de +45

## CALIBRACIÓN DEL ÁNGULO DE LA PLUMA

### Ajuste del ángulo de la pluma baja

- Mueva la pluma hasta los 0.0 grados, o tan bajo como sea posible.
- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección “ADVANCED MENU” (MENÚ AVANZADO).
- Pulse OK para seleccionar el menú avanzado.
- Teclee la contraseña y después pulse OK. El valor del dígito intermitente puede ser cambiado al pulsar las flechas ↓ o ↑. Para seleccionar otro dígito pulse botón SET (AJUSTAR).
- Pulse ↓ si es necesario, de tal modo que la flecha hacia la derecha apunte a “SET ANGLE ZERO” (AJUSTAR ÁNGULO CERO) después pulse OK.
- Teclee el ángulo de la pluma real. El valor del dígito intermitente puede ser cambiado al pulsar las flechas ↓ o ↑ Para seleccionar otro dígito pulse el botón SET (AJUSTAR).
- Pulse OK para aceptar y guardar el valor.

## CALIBRACION DE CARGA PRINCIPAL

Las siguientes instrucciones indican los pasos para ajustar el cero y ganar las líneas de carga.

### CALIBRACIÓN SIN CARGA

- Ponga el gancho en la condición sin carga con el bloque en tierra o con el bloque en el aire. La tabla de elevación del fabricante de la grúa identificará si el peso del bloque es considerado parte de la carga.
- Verifique que las 'partes de línea' para el gancho actual mostrado en la pantalla están ajustadas correctamente.
- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "ADVANCED MENU" (MENÚ AVANZADO).
- Pulse OK para seleccionar el ADVANCED MENU (MENÚ AVANZADO).
- Teclee la contraseña y después pulse OK.
- Pulse ↓ si es necesario, de tal modo que la flecha hacia la derecha → apunte a "MAIN LOAD ZERO WITH NO LOAD" (CARGA PRINCIPAL (o AUX) CERO SIN CARGA).
- Pulse OK para aceptar el nuevo valor 'sin carga'.

### CALIBRACIÓN DE CARGA CON CARGA DE PRUEBA

- Verifique que las 'partes de línea' para el gancho actual mostrado en la pantalla están ajustadas correctamente.
  - Levante una carga conocida.  
Una carga suficiente debe ser levantada para calibrar el sistema correctamente.  
La grúa debe ser ajustada para permitir que la siguiente carga sea recogida seguramente.  
(la  $\frac{1}{2}$  de la carga de trabajo máxima del cable único multiplicada por las partes reales de la línea)
- (Ejemplo: Si la tracción máxima de trabajo de cable único para el cable es de 25,000 y cuatro partes de la línea están en uso, entonces  
la  $\frac{1}{2}$  de 25,000 por 4 = 50,000 lb deben ser levantadas para una calibración apropiada)
- Pulse el botón SET (AJUSTAR).
  - Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "ADVANCED MENU" (MENÚ AVANZADO).
  - Pulse OK para seleccionar el ADVANCED MENU (MENÚ AVANZADO).
  - Teclee la contraseña y después pulse OK.
  - Pulse ↓ como sea necesario, de tal modo que la flecha hacia la derecha → apunte a "MAIN LOAD GAIN WITH LOAD" (GANANCIA DE CARGA PRINCIPAL (o AUX) CON CARGA) después pulse OK.
  - Teclee la carga real. El valor del dígito intermitente puede ser cambiado al pulsar las flechas ↓ o ↑. Para seleccionar otro dígito pulse el botón SET (AJUSTAR).
  - Pulse OK para aceptar el valor nuevo.

## CALIBRACION DE CARGA AUX

Este sistema incluye un sensor de carga PIN para controlar la carga sobre el gancho de la grúa auxiliar. El pasador está instalado en una desviación de la Asamblea polea. El ángulo de ajuste de la cuerda de alambre que se ejecuta sobre la polea no es constante. Esto hace que la carga en el sensor de carga PIN para cambiar dependiendo del ángulo de la pluma.

Este sistema DX Markload contiene un especial aux procedimiento de calibración en línea con el fin de compensar esta condición.

Nota: Este procedimiento especial, sólo es necesario para el gancho de Aux.

### AUX CARGA PROCEDIMIENTO DE CALIBRADO

- Ponga el gancho en la condición sin carga con el bloque en el aire. Verify that the 'parts of line' for the current hook shown on the display is set correctly.
- Verifique que las 'partes de línea' para el gancho actual mostrado en la pantalla están ajustadas correctamente.
- Pulse el botón SET (AJUSTAR) para entrar al menú de ajuste.
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "ADVANCED MENU" (MENÚ AVANZADO).
- Pulse OK para seleccionar el ADVANCED MENU (MENÚ AVANZADO).
- Teclee la contraseña y después pulse OK.
- Pulse ↓ si es necesario, de tal modo que la flecha hacia la derecha → apunte a "AUX LOAD ZERO WITH NO LOAD" (CARGA AUX CERO SIN CARGA).
- Pulse OK para aceptar el nuevo valor 'sin carga'.

#### CALIBRACIÓN DE CARGA CON CARGA DE PRUEBA

- Verifique que las 'partes de línea' para el gancho actual mostrado en la pantalla están ajustadas correctamente.
- Levante una carga conocida.

Una carga suficiente debe ser levantada para calibrar el sistema correctamente.

La grúa debe ser ajustada para permitir que la siguiente carga sea recogida seguramente.

(la  $\frac{1}{2}$  de la carga de trabajo máxima del cable único multiplicada por las partes reales de la línea)

(Ejemplo: Si la tracción máxima de trabajo de cable único para el cable es de 25,000 y cuatro partes de la línea están en uso, entonces

la  $\frac{1}{2}$  de 25,000 por 4 = 50,000 lb deben ser levantadas para una calibración apropiada)

- Pulse el botón SET (AJUSTAR).
- Pulse ↓ varias veces para avanzar hacia abajo, hasta la selección "ADVANCED MENU" (MENÚ AVANZADO).
- Pulse OK para seleccionar el ADVANCED MENU (MENÚ AVANZADO).
- Teclee la contraseña y después pulse OK.
- Pulse ↓ como sea necesario, de tal modo que la flecha hacia la derecha → apunte a "AUX LOAD GAIN WITH LOAD" (GANANCIA DE CARGA AUX CON CARGA) después pulse OK.
- Mover la pluma a 0 grados y esperar a que la carga para estabilizar
- Pulse el botón OK
- Teclee la carga real. El valor del dígito intermitente puede ser cambiado al pulsar las flechas □ o □. Para seleccionar otro dígito pulse el botón SET (AJUSTAR).
- Pulse el botón OK
- Mover la pluma a 20 grados y esperar a que la carga para estabilizar
- Pulse el botón OK
- Mover la pluma a 40 grados y esperar a que la carga para estabilizar
- Pulse el botón OK
- Mover la pluma a 60 grados y esperar a que la carga para estabilizar
- Pulse el botón OK
- Mover la pluma a 80 grados y esperar a que la carga para estabilizar
- Pulse OK para terminar y guardar la calibración.



# MENSAJES QUE INDICAN ERROR

## ÁNGULO DE LA PLUMA EN UNA ZONA DE NO ELEVACIÓN

El ángulo de pluma medido está más allá del ángulo permitido, de acuerdo con las tablas de elevación de la grúa para la configuración actual.

## ALERTA DE CARGA DENTRO DE LA ZONA DE ALERTA

La carga medida en el gancho especificada en la línea superior está más allá del límite 'Alerta', de acuerdo con las tablas de levantamiento de la grúa, para la configuración actual.

## CAPACIDAD QUE EXCEDE LA CARGA DE ALARMA

La carga medida en el gancho especificada en la línea superior de la pantalla está más allá de la capacidad permitida calculada de las tablas de levantamiento de la grúa, para la configuración actual.

## ERROR DEL TRANSDUCTOR DE ÁNGULO

El ángulo medido está más allá de las medidas normales para el sistema.

Los problemas posibles pueden ser:

El conjunto del emisor goniométrico puede estar dañado o instalado incorrectamente.

La lectura del ángulo puede necesitar ser recalibrada.

## ERROR DE CELDA DE CARGA PRINCIPAL (o AUX)

La señal medida de la celda de carga principal está fuera de alcance.

Los problemas posibles pueden ser:

El cable del preamplificador a la celda de carga puede estar dañado.

Las conexiones del preamplificador a la celda de carga pueden estar sueltas o dañadas.

El preamplificador puede estar dañado.

La celda de carga puede estar dañada.

## ERROR EN EL TRANSDUCTOR DE LONGITUD

El sensor de longitud (opcional) o la conexión, pueden estar dañados.

## ANTI DOBLE BLOQUEO (DISYUNTOR DE FIN DE CARRERA) PRINCIPAL (o AUX)

El sistema ha detectado una condición de error de anti doble bloqueo. Si no hay una condición de anti doble bloqueo: Revise el cable, todas las conexiones y el conjunto del interruptor en cuanto a daños. El preamplificador que monitorea los interruptores puede estar dañado también.

## ERROR EN LA SEÑAL DE ÁNGULO.

La unidad pantalla no es capaz de comunicarse con el conjunto del emisor goniométrico.

Los problemas posibles pueden ser:

El cable que va desde la pantalla hasta el emisor goniométrico puede estar dañado.

Siga el procedimiento anterior de 'Check Preamp Input Voltage' (Verifique el voltaje de entrada al preamplificador).

La caja de conectores del emisor goniométrico puede estar dañada.

La tarjeta de circuitos del emisor goniométrico puede estar dañada.

## ERROR EN LA SEÑAL DEL PREAMPLIFICADOR PRINCIPAL (o AUX)

La unidad de la pantalla no es capaz de comunicarse con el conjunto de preamplificador de carga.

Los problemas posibles pueden ser:

El cable que va desde la pantalla al preamplificador de carga puede estar dañado.

Siga el procedimiento anterior de 'Check Preamp Input Voltage' (Verifique el voltaje de entrada al preamplificador).

La caja o los conectores del preamplificador pueden estar dañados.

La tarjeta de circuitos del preamplificador puede estar dañada.

## PROBLEMAS DEL SISTEMA

## REVISIÓN - DETECCIÓN Y RESOLUCIÓN DE PROBLEMAS DEL SISTEMA COMPLETO

El primer paso deber ser inspeccionar todo el equipo visualmente:

Inspeccione todos los cables y conexiones en cuanto a lo apretado, daños y filtraciones de agua.

Abra la unidad de la pantalla y cualquiera otra caja y verifique en cuanto a malas conexiones, tornillos flojos y filtraciones de agua.

*Importante: Inspeccione todas las juntas y reemplácelas si es necesario.*

**Ponga el interruptor en la posición de ON (ENCENDIDO)**

Verifique las luces ('OK', 'ALERT', 'ALARM'), la pantalla y el avisador sonoro.

¿No funciona ninguno? ----- sí ----->      Vea la página 'CHECK INPUT VOLTAGES'  
(VERIFICAR VOLTAJES DE ENTRADA).

¿Alguno no funciona o se muestra débil? ----- sí -----> Vea la página 'CHECK SYSTEM VOLTAGES' (VERIFICAR VOLTAJES DEL SISTEMA).

¿Se muestran bien las cargas en pantalla? ----- no -----> Vea la página 'CHECK LOAD SENSORS'  
(REVISE LOS SENSORES DE CARGA).

## REVISE ALIMENTACION DE VOLTAJE DEL SISTEMA - DETECCION Y RESOLUCION DE PROBLEMAS

*Aviso: Si hay algún problema con el voltaje NO cambie el contraste de Display (Pantalla), los ajustes de Gain (Ganancia) o Zero (Cero), hasta que todos los voltajes estén en niveles normales.*

**IMPORTANTE:** Solamente personal calificado debe abrir la cubierta del sistema. Pueden existir voltajes peligrosos.

Ponga el interruptor en la posición de OFF (APAGADO).

Desconecte todos los cables del sensor de la pluma del tablero frontal. (PRINCIPAL, AUXILIAR, ÁNGULO, LONGITUD)

Ponga el interruptor en la posición de ON (ENCENDIDO)

Mida el 'System Supply Voltage' (Voltaje de alimentación al sistema), como se muestra en la ilustración.

¿Está bien la energía? ----- sí -----> Vea la página 'REVISE LOS VOLTAJES DEL SISTEMA'  
no

Ponga el interruptor en la posición de OFF (APAGADO).

Desconecte el conector del cable de ENERGÍA al frente de la caja de la pantalla.

Inspeccione dentro de los contactos del conector.

Revise los voltajes en el conector del cable.

Ajuste el voltímetro al voltaje apropiado.

+ mida del cable a la clavija A

(com) mida del cable a la clavija B

para sistema de 12 VCC, +10 a +14 VCC permitidos

para sistema de 24 VCC, +20 a +28 VCC permitidos

para un sistema de CA., 105 a 260 VCA 50/60Hz

La energía esta bien. ? ----- no ----->  
sí

Verificar la conexiones del cable de la fuente de energía.

Reconectar el conector del cable de ENERGÍA al frente de la unidad de pantalla.

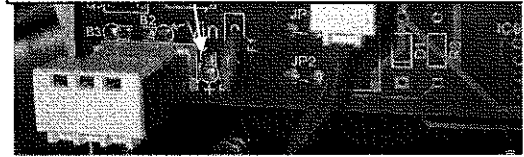
Ponga el interruptor en la posición de OFF (APAGADO).

Medir el voltaje en Vin (V de entrada), en la tarjeta princ

Entrada CA      Entrada CC

B1= Entrada CA B1 = CC +

B2 = Entrada CA B2 = Tierra CC



## REVISE LOS VOLTAJES DEL SISTEMA - DETECCION Y RESOLUCION DE PROBLEMAS

*Aviso: Si hay algún problema con el voltaje NO cambie el contraste de Display (Pantalla), los ajustes de Gain (Ganancia) o Zero (Cero), hasta que todos los voltajes estén en niveles normales.*

**IMPORTANTE:** Solamente personal calificado debe abrir la cubierta del sistema. Pueden existir voltajes peligrosos.

Ponga el interruptor en la posición de OFF (APAGADO).

Desconecte los cables del sensor de la pluma del frente de la caja.

Ponga el interruptor en la posición de ON (ENCENDIDO)

Mida el voltaje de entrada a través de B1 y B2, en la tarjeta principal. --- si existen malas lecturas-----> Revise las conexiones externas de energía

Mida +5 VCC en D5 en el tablero principal --- si hay lecturas erróneas-----> Revise si hay corto circuito en el tablero principal.

Ponga el interruptor en la posición de OFF (APAGADO).

Reconectar el cable del sensor de pluma al frente de la caja.

Ponga el interruptor en la posición de ON (ENCENDIDO)

Mida +5 voltios en el tablero principal --- si hay lecturas erróneas----->Vea la página de 'CHECK PREAMP' (REVISAR PREAMPLIFICADOR).

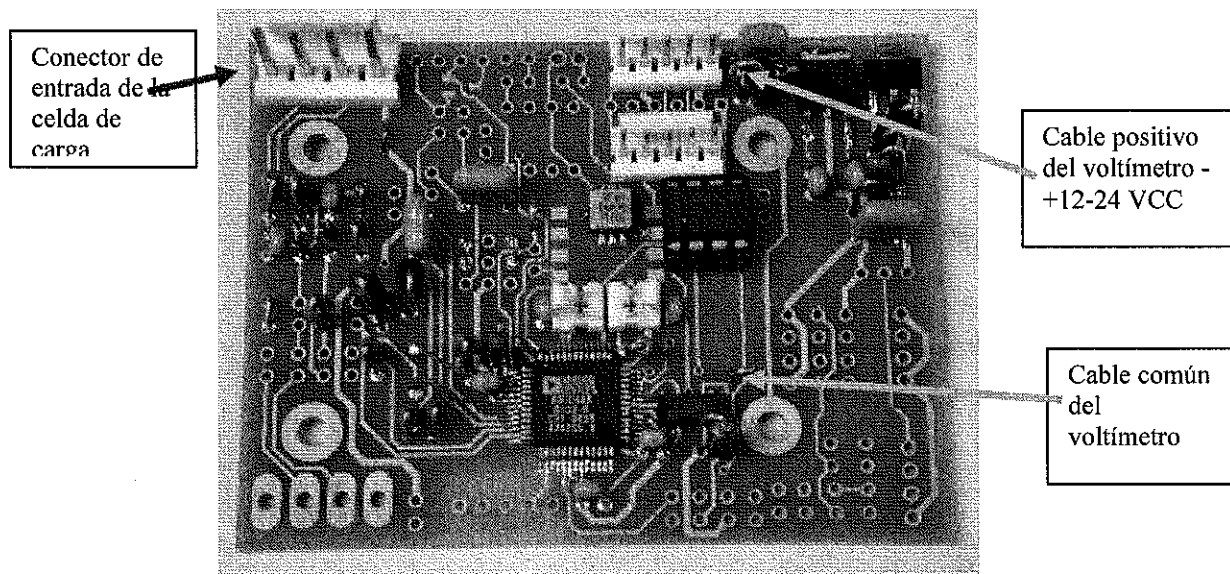
## REVISE EL VOLTAJE DE ENTRADA AL PREAMPLIFICADOR - DETECCION Y RESOLUCIÓN DE PROBLEMAS

Revise el voltaje de entrada al preamplificador (vea las ilustraciones de abajo).

El voltaje de entrada al preamplificador debe estar entre los 11 VCC y los 16 VCC.

Si el voltaje no está presente, haga lo siguiente:

1. Siga el procedimiento anterior de 'Check System Supply Voltage' (Revise el voltaje de alimentación del sistema).
2. Siga el procedimiento anterior de 'Check System Voltages' (Revise los voltajes del sistema).
3. Inspeccione el cable desde la pantalla hasta la caja del preamplificador.
4. Inspeccione los conectores en cada extremo del cable.
5. Verifique que todas las conexiones dentro de la caja del preamplificador estén bien apretadas.



## REVISE LOS SENSORES DE CARGA - DETECCIÓN Y RESOLUCION DE PROBLEMAS

Verifique los voltajes (vea la página de 'CHECK SYSTEM VOLTAGES' (REVISAR LOS VOLTAJES DEL SISTEMA).

Ponga el interruptor en la posición de OFF (APAGADO).

Desconecte el conector de 'Load Cell Input' (Entrada de la celda de carga) en la tarjeta del preamplificador.

Revise la resistencia entre cada uno de los cuatro cables en el conector que se conecta en la tarjeta del preamplificador y el metal de la caja de la celda de carga.

Debe haber un *mínimo* de resistencia de 1.0 Mega Ohm entre cada cable y la caja.

Aviso: Tenga cuidado de no tocar la parte metálica de los hilos metálicos cuando haga estas medidas, ya que puede afectar las lecturas.

O.K. ----- no -----> Reemplace la celda de carga.

| sí

Revise las resistencias de la celda de carga en el conector desconectado de la 'Entrada de la celda de carga'.

-- Para una celda de carga de extremo terminal solamente:

Revise la resistencia entre los siguientes pares de cables:

Cable VERDE a cable BLANCO resistencia 350 +/- 2 ohmios

Cable ROJO a cable NEGRO resistencia 430 +/- 40 ohmios

-- Para una celda de carga de compresión de polea triple solamente:

Revise la resistencia entre los siguientes pares de cables:

Cable VERDE a cable BLANCO resistencia 350 +/- 2 ohmios

Cable ROJO a cable NEGRO resistencia 365 +/- 20 ohmios

Mala resistencia -----> Reemplace la celda de carga

Inspeccione el conector en cuanto a corrosión o cables sueltos.

O.K. ----- no -----> Reemplace la caja del preamplificador o los conjuntos de cables/puentes conectores.

Conecte nuevamente *todos* los conectores en sus lugares correctos.  
(internos y externos).

Abra la unidad de la pantalla.

Inspeccione todas las conexiones.

Calibrar SIN CARGA

O.K. ----- no -----> Reemplace la tarjeta del sistema.

Calibrar CON CARGA.

O.K. ----- no -----> Reemplace la tarjeta del sistema.

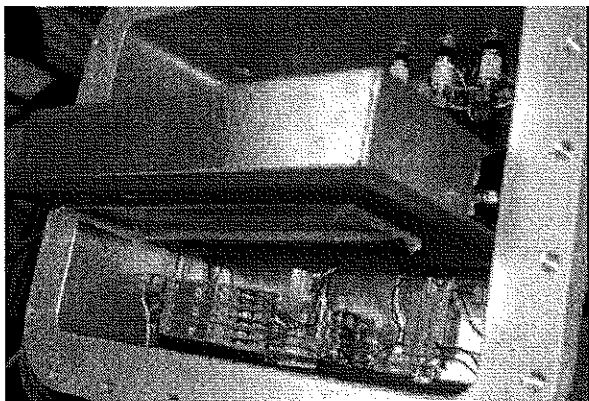
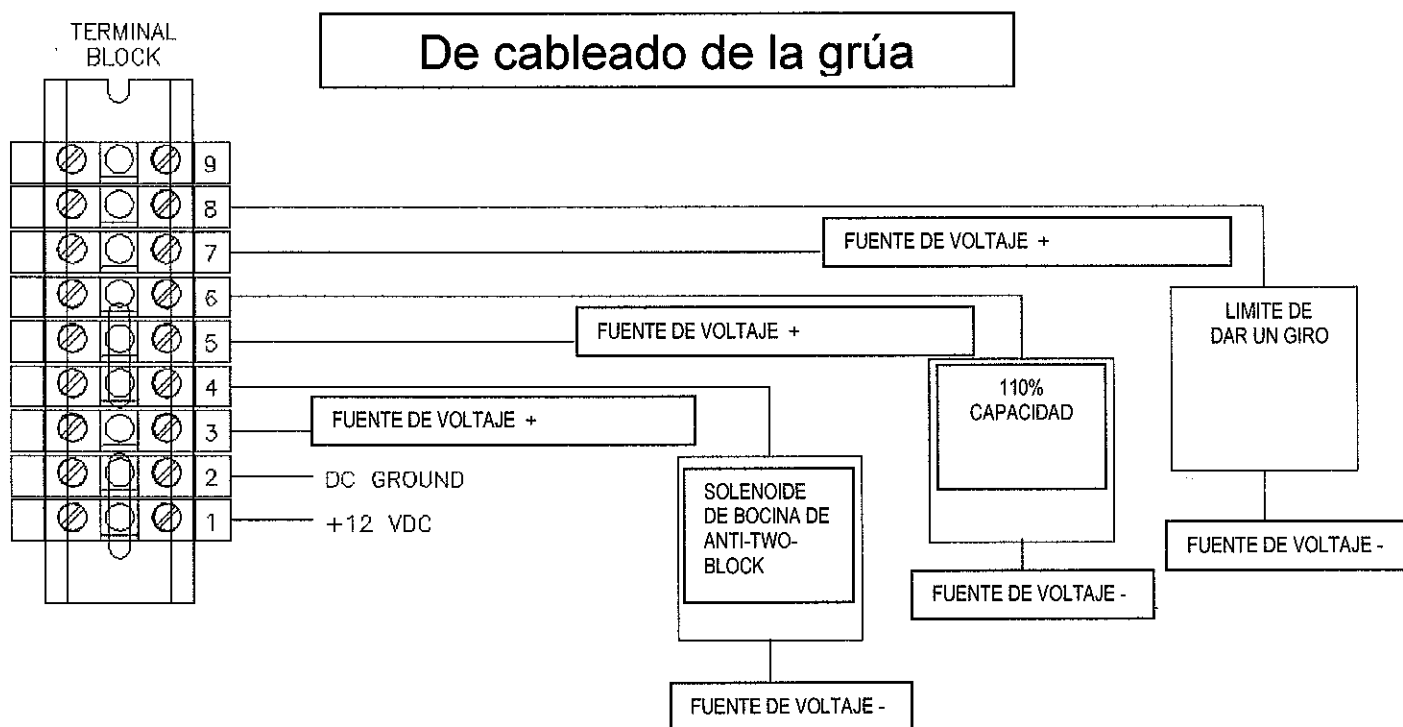
## NOTAS DEL RELEVADOR

El sistema debe contar con un marco estable y limpia de 12 voltios DC. El sistema se basará menos de 1 amperio.

### RELEVADOR

Tres internos de relés de estado sólido están instalados en la unidad de pantalla DX. Estos relés están cerradas durante el funcionamiento normal. Estos enlaces son los clasificados para 3 amperios máximo.

- El relevador 1 abre se abre al anti-dos-bloque.
- El relevador 2 abre cuando el límite cuando la capacidad límite es excedido. El sistema también dará una alarma audible y visual. Este relevador puede ser anulado al usar el procedimiento enlistado en el manual.
- Relé-3 se abre cuando el boom se gira en la zona restringida.



La pantalla puede inclinarse hacia delante para permitir un acceso más fácil al bloque de terminales de cableado.

Para inclinar la pantalla hacia adelante - Aflojar la tuercas a ambos lados de la caja de visualización.

### Power Relay Wiring through conduit to Crane Power and Solenoids

Signal Name	Terminal Block Location	Originating location
Relay-3 (-)	Terminal Block Pin-8	Crydom Relay Terminal-1
Relay-3 (+)	Terminal Block Pin-7	Crydom Relay Terminal-2
Relay-2 (-)	Terminal Block Pin-6	Main Board TB-2 C
Relay-2 (+)	Terminal Block Pin-5	Main Board TB-2 C
Relay-1 (-)	Terminal Block Pin-4	Main Board TB-1 C
Relay-1 (+)	Terminal Block Pin-3	Main Board TB-1 C
DC Ground	Terminal Block Pin-2	Bottom Barrier Terminal-7
+12 VDC	Terminal Block Pin-1	On/Off Switch

IS case ground wire should be connected to the large screw at the top tight of the inside of the Exp Proof housing.

### Barriers to Preamp Cable

Signal Name	Barrier Location	Wire Color
+12 (fused)	Top Barrier-Z765 Pin-4	Red
Ground	Top Barrier-Z765 Pin-2	Black
Data (+)	Top Barrier-Z765 Pin-1	Green
Data (-)	Middle Barrier-Z765 Pin-4	White
Shield	Mounting Plate screw	shield

### Barriers to Slew J-Box Cable

Signal Name	Preamp Board Main Location	Wire Color
Slew Sensor-1	Bottom Barrier-Z765 Pin-4	Green
Ground	Bottom Barrier-Z765 Pin-2	Black
Slew Sensor-2	Bottom Barrier-Z765 Pin-1	Red
Ground	Bottom Barrier-Z765 Pin-3	White

### Barriers to Sounder

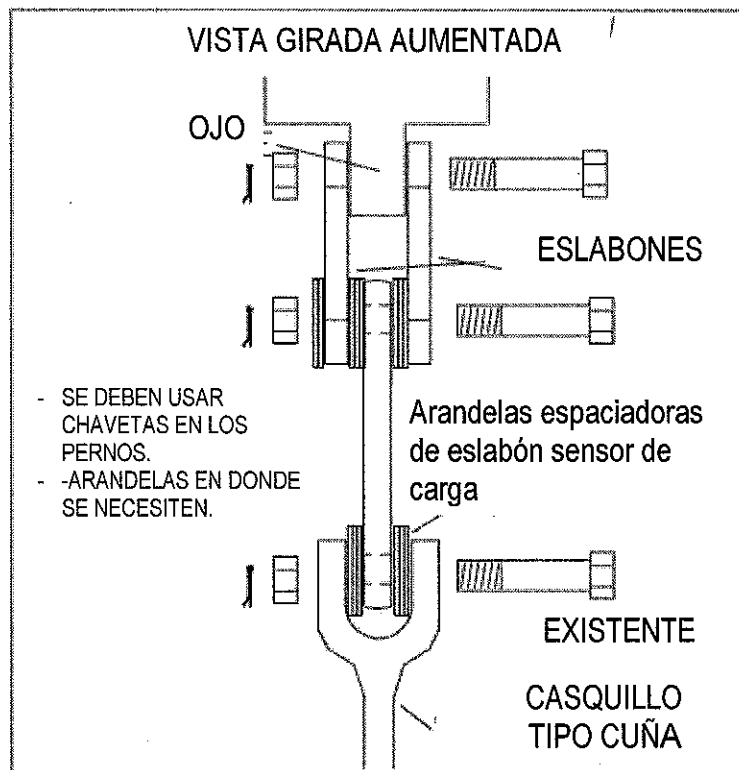
Signal Name	Preamp Board Main Location	Wire Color
Beeper signal	Middle Barrier-Z765 Pin-1	Brown-White
Ground	Middle Barrier-Z765 Pin-2	Black

### Main board Signals - Factory Installed Internal wiring

Signal Name	Main Board Location	Wire Color	Destination
+12	J11 Pin-1	Red	Top Barrier Terminal-5
Ground	J1 Pin-2	Black	Top Barrier Terminal-6
Data (+)	J11 Pin-2	Orange	Top Barrier Terminal-8
Data (-)	J11 Pin-3	Blue	Middle Barrier Terminal-5
Beep	J8 Pin-3	Yellow	Middle Barrier Terminal-8
Slew-1	J7 Pin-2	Violet	Bottom Barrier Terminal-5
Slew-2	J7 Pin3	Grey	Bottom Barrier Terminal-8
Up Arrow	SP1 Pin-19	White-Violet	Up button
Down Arrow	SP1 Pin-18	Orange-White	Down button
SET Button	SP1 Pin-17	Yellow-Black	SET button
OK Button	SP1 Pin-20	Blue-White	OK button
Buttons Ground		Black	Top Barrier Terminal-7
Chassis	J1 Pin-3	Green-White	Mounting plate screw
Slew relay control +	Beeper TB Pin-1	Yellow	Crydom Relay Terminal-3
Slew relay control -	Beeper TB Pin-2	Violet	Crydom Relay Terminal-4

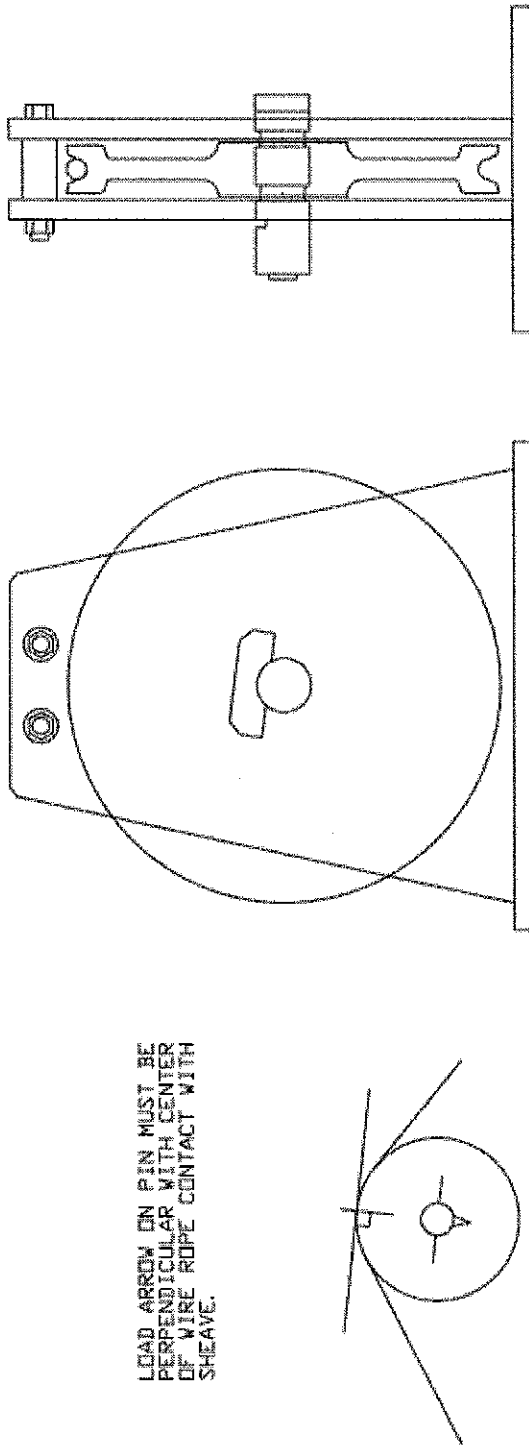


# DIAGRAMA DE MONTAJE DE CELDA DE CARGA EN EXTREMO MUERTO



LINKINS3C.DWG

LOAD ARROW ON PIN MUST BE  
PERPENDICULAR WITH CENTER  
OF WIRE ROPE CONTACT WITH  
SHEAVE.



DWN M.I. CK'D  
DATE DATE

UNLESS OTHERWISE NOTED  
BREAK SHARP EDGES  $45^\circ \times .005$   
MAX FILLET  $0.005$  RADIUS

#### TOLERANCES

FRAC.  $+ 1/64$  DEC.  $XX = +.010$   
ANGLES  $+ 30^\circ$   $XXX = +.005$   
 $X = \pm .015$

APPR  
DATE

ENG  
DATE

MATERIAL

FINISH OR TREATMENT

MARKLOAD SYSTEMS INC.

1118 N. MAIN  
PEARLAND, TEXAS  
77581 (713) 495-4900  
TELE (713) 495-5007

This document contains proprietary and confidential information of MARKLOAD SYSTEMS INC. It is loaned for  
limited purposes only and receiving the drawings of MARKLOAD SYSTEMS INC. is not to be reproduced in whole or  
in part without the written permission of MARKLOAD SYSTEMS INC. The drawings are to be returned to MARKLOAD SYSTEMS INC. upon  
request and to all levels upon completion of the use for which it was loaned.

TITLE:  
LOAD SENSING PIN  
INSTALLATION DETAILS

REVISION

REV.	DATE	BY	CHKD.
- /	- /	- /	- /
- /	- /	- /	- /
- /	- /	- /	- /

Cable  
1764-001

Preamp Box

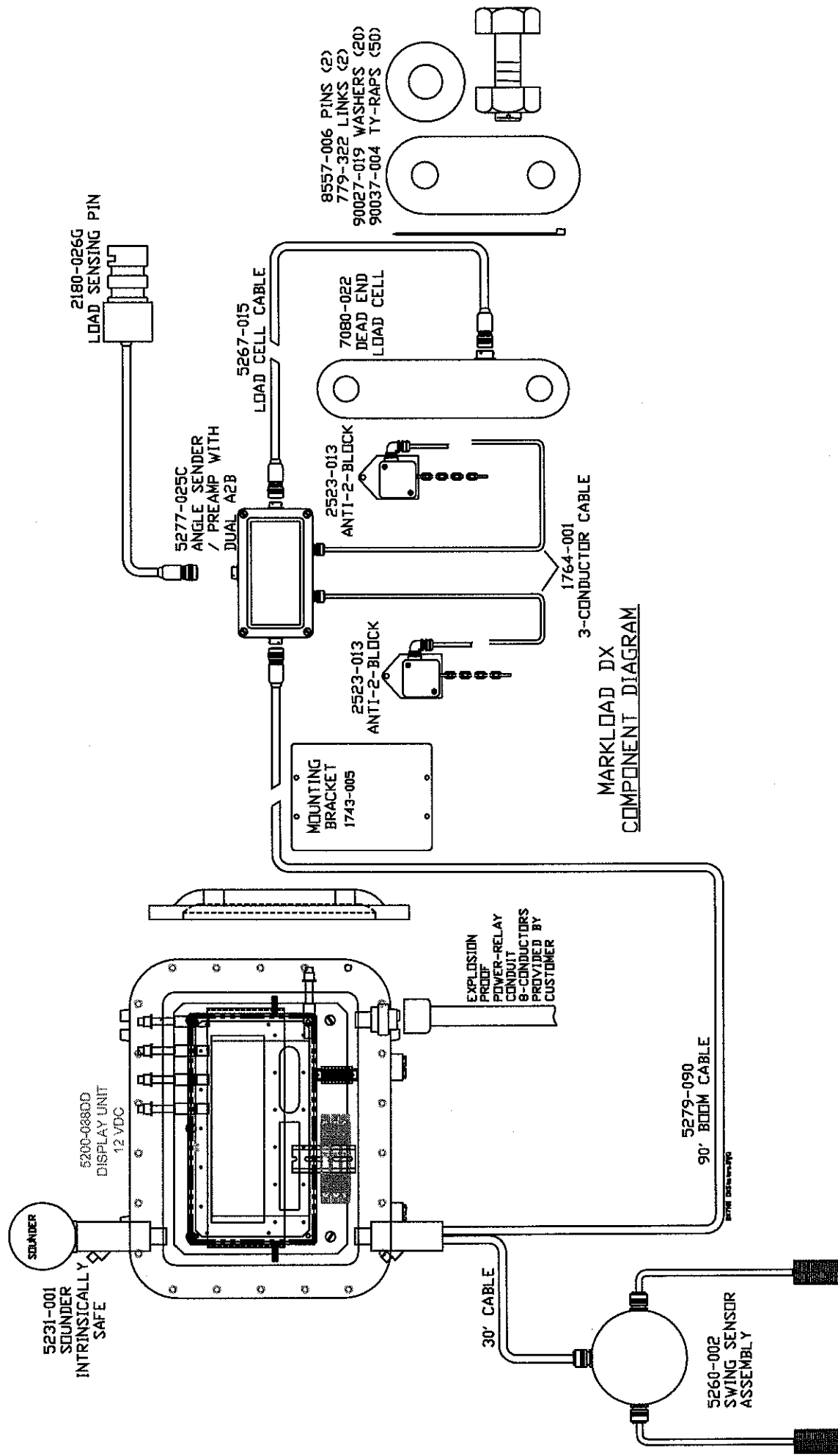
SECOND  
HOOK  
F2523-013

A2B Switch  
Assembly with  
Weight and Chain  
F2523-013

Side  
View

DWN M. R. I. CK'D DATE 9/30/93 DATE	ENG DATE	APPR DATE	MARKLOAD SYSTEMS INC. <small>THE AL MAIN PEBBLAND, TEXAS 77361-5733/MS-0600 FAX 1723-013-3017</small>	REVISION REV 1723-013-3017
UNLESS OTHERWISE NOTED BREAK SHARP EDGES .45° X .003 MAX FILLET .005 RADIUS	MATERIAL	FINISH OR TREATMENT	TITLE ANTI-TWO-BLOCK OPTION DUAL HOOK	
TOLERANCES FRAC. + 1/64 DEC. .XX = +.005 ANGLES + 30° .XX = +.010 X = ±.015				

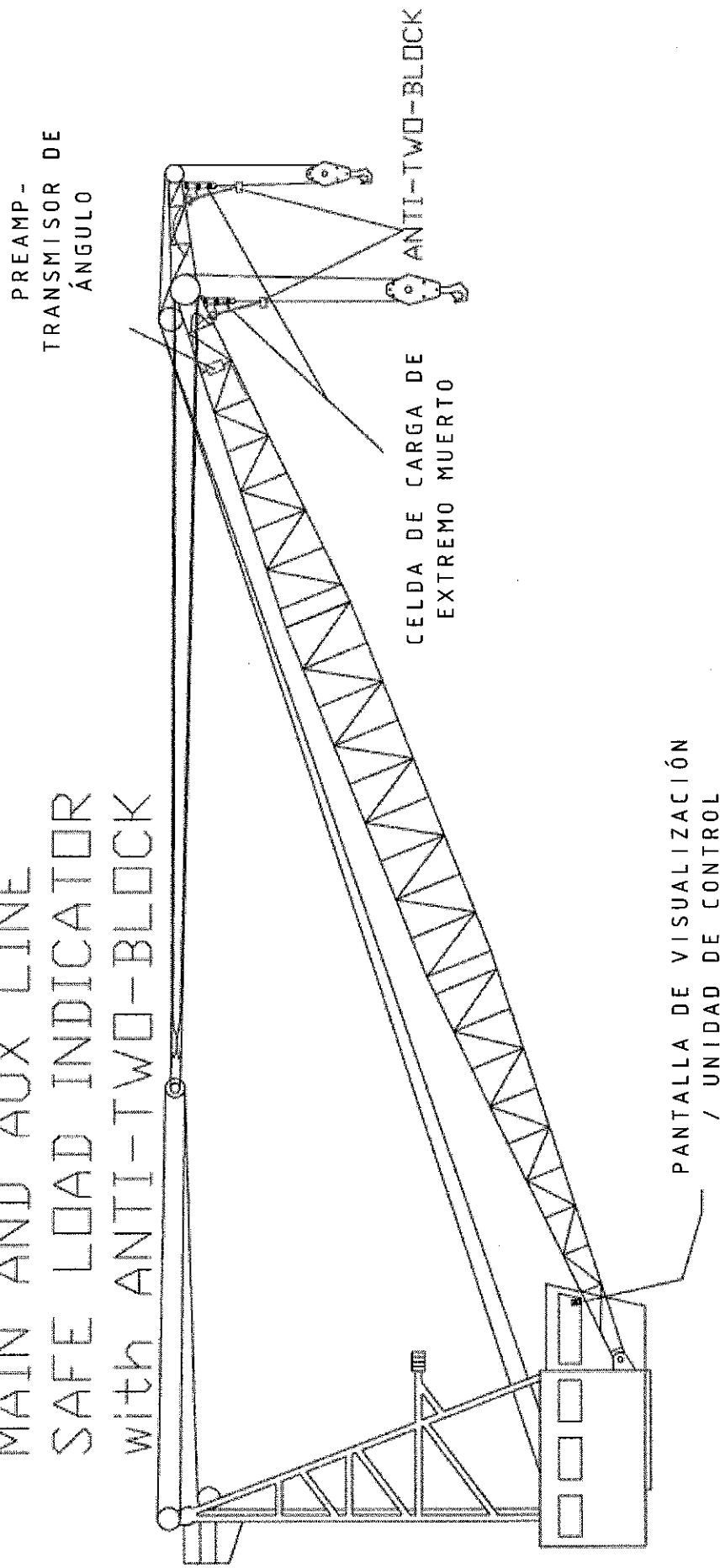
This document contains proprietary and confidential information of MARKLOAD SYSTEMS INC. It is loaned for your use only and is not to be distributed outside your organization. It is to be returned to MARKLOAD SYSTEMS INC. upon completion of your use. The document is not to be reproduced in whole or in part without the written consent of MARKLOAD SYSTEMS INC. Any reproduction or use of this document without the written consent of MARKLOAD SYSTEMS INC. is prohibited and may result in legal action.



MARKLOAD DX  
COMPONENT DIAGRAM

# UBICACIÓN DE COMPONENTES

MARKLOAD SYSTEMS, INC.  
MAIN AND AUX LINE  
SAFE LOAD INDICATOR  
with ANTI-TWO-BLOCK





# MARKLOAD SYSTEMS, INC.

1118 N. MAIN

PEARLAND, TX 77581

TEL.: 281-485-8600 FAX: 281-485-3007 sales@markload.com

## Packing Slip

Date	S.O. No.
1/28/2010	10012

Ship To
OIL STATES-SKAGIT-SMATCO 1180 MULBERRY RD. HOUMA, LA 70363

Name / Address
OIL STATES-SKAGIT-SMATCO 1180 MULBERRY RD. HOUMA, LA 70363

P.O. No.	Ship Via	FOB
4088824	UPS	PEARLAND, TX

Item	Description	Ordered	Shipped	Invoiced
DX SYSTEM	N47949-016 DUAL HOOK MONITORING MARKLOAD DX SYSTEM LOAD MOMENT COMPUTER FOR FIXED BOOM CRANES FEATURING THE DX MICRO-CONTROLLED DISPLAY/CONTROL MODULE PROVIDING LOAD - CAPACITY - RADIUS - BOOM ANGLE - BOOM LENGTH - BOOM HEAD HEIGHT. THE UNITIZED DISPLAY AND CONTROL MODULE, PROGRAMMED TO THE CRANE'S LIFT CHARTS AND CHARACTERISTICS, HOUSED IN A 316 STAINLESS STEEL ENCLOSURE, IS A BACKLIT LIQUID CRYSTAL UNIT FEATURING A COMBINATION OF DIGITAL NUMBERS AND ANALOG BAR GRAPH READOUTS. AUDIBLE AND VISUAL ALARMS ARE PRESET AT 90% AND 100% CAPACITY LEVELS. POWER INPUT TO BE 12 VDC. INFORMATION CONCERNING SELECTION OF BOOM CONFIGURATIONS AND PARTS OF LINE IS DISPLAYED ON THE SCREEN MENU IN EASY TO USE TABLED DATA FORMAT. THE LOAD SENSING TO BE TAKEN FROM A DEAD END LOAD SENSING LINK FOR THE MAIN HOIST LINE AND FROM A 1-1/2" DIAMETER INSTRUMENTED LOAD SENSING PIN FOR THE AUX LINE TO BE INSERTED IN THE CUSTOMER SUPPLIED DEFLECTION SHEAVE ASSEMBLY. A GREASE CHANNEL TO BE PROVIDED IN THE LOAD PIN FOR GREASING THE SHEAVE. THE SYSTEM TO HAVE DUAL LINE MONITORING INTEGRAL ANTI-TWO-BLOCK	1		0

# 10012

# Certificate of Conformance

For

Markload System DX Serial No. 7101-DX

For

OILSTATES SKAGIT SMATCO

1180 MULBERRY ROAD

HOUMA, LOUISIANA 70363

This instrument has been calibrated in terms of standards maintained at this factory, and was found to be within specifications.

THIS EQUIPMENT IS DESIGNED AND MANUFACTURED IN ACCORDANCE WITH UNITED STATES NEC CLASSIFICATION: CLASS 1, DIVISION 1, GROUP D.

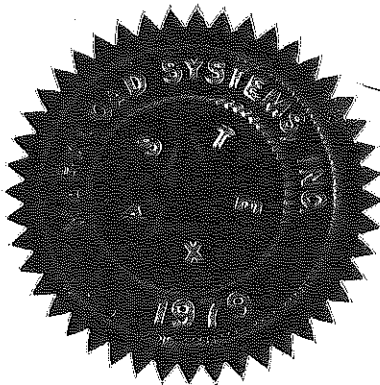
The following standards were used as references for this calibration. Their calibration is traceable to the National Reference Standards maintained by the National Bureau of Standards.

NBS TRACEABLE NUMBERS: SST01/10152; SAE J159, J375, J376

Calibration date: 2-16-2010

By

Approved



**MARKLOAD SYSTEMS, INC.**

1118 North Main  
Pearland, Texas 77581  
(281) 485-8600

**WARRANTY PROVISIONS SHOWN ON BACK.**

## MARKLOAD SYSTEMS, INC. WARRANTY

Markload components, of Markload Systems, Inc. manufacture, are warranted for one year against defects in material and workmanship. Purchased parts are covered only in accordance with Markload Systems, Inc. supplier's warranty. This warranty covers repair or replacement (at Markload's option) of all components in a system including labor, at Markload Systems, Inc. factory in Pearland, Texas. This does not include freight and forwarding charges on the returned components, and does not include a service technician's labor and travel expenses for field repairs. The above warranty does not extend to any product which has been subjected to misuse, neglect, accident, improper installation, or use in violation of Markload's instructions, or to any product repaired or altered by persons not expressly approved by Markload. Markload Crane Weight, Angle, and Load Moment Computer Systems are sold as an aid to proper crane operation. No further claim is made as to installed system accuracy nor will this equipment necessarily prevent crane damage due to overloading and related causes. No other warranty is expressed or implied, nor will Markload Systems, Inc. be responsible for damages or losses incidental to the use, installation, or removal of this equipment.





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732

Serial # 21409C

Volume: 1

### Nautilus Crane Model 180L4-50

#### Section 5.13 Sentinel Engine Shutdown System



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





# SENTINEL

## DIESEL ENGINE PROTECTION SYSTEMS



### INSTALLATION GUIDE

BE SURE the Master Control (Oil Sentinel) has the proper oil pressure setting for your application - this is determined by knowing engine oil pressure at hot-low idle. Use a setting under the hot-low idle oil pressure to avoid false shut-down at idle speed. The Master Control (Oil Sentinel) can be ordered with 5, 10, 15, 20 or 25 p.s.i. primary settings.

ALL MASTER CONTROLS HAVE EXCLUSIVE, BUILT-IN VARIABLE SHUT-OFF POINT. IT AUTOMATICALLY PROVIDES A HIGHER OIL PRESSURE SHUT-OFF POINT FOR ENGINE OPERATING UNDER LOAD AT HIGH SPEED. A unique advantage, particularly for engines that have low idling oil pressure. Engine fuel pressure is inherently used as a force to assist in automatically raising the oil pressure point at which the fuel valve closes. Fuel pressure values correspondingly increase and decrease with RPM, particularly on Detroit Diesel and Cummins Engine. The chart below shows the effect of fuel pressures on the oil pressure shut-off point:

APPROXIMATE CORRESPONDING OIL PRESSURE SHUT-OFF POINT OF SENTINEL

PRESSURE P.S.I	MODEL D-25 PRIMARY SETTING	MODEL D-20 PRIMARY SETTING	MODEL D-15 PRIMARY SETTING	MODEL D-10 PRIMARY SETTING	MODEL D5Y PRIMARY SETTING	MODEL D-5** PRIMARY SETTING
0	25	20	15	10	5	---
10	26	21	16	12	7	---
20	27	22	17	13	9	5
30	29	24	19	15	11	7
40	31	26	20	16	12	8
60	33	28	22	19	15	12
80	36	31	26	23	18	15
100	40	35	30	25	21	17
125	44	39	34	29	25	
150	49	44	39	33	29	
175	53	48	43	37	32	

\*\*FOR N SERIES OR OTHER DETROIT DIESELS WITH LOW IDLE OIL PRESSURE WITH 15 TO 20 P.S.I. FUEL PRESSURE AT IDLE.

By consulting chart, the approximate shut-off point can be determined, both at idle and accelerated speeds - i.e., a Sentinel Master Control with 10 p.s.i. primary oil pressure setting operating on an engine that is idling with 20 p.s.i. fuel pressure will actually shut-off at 13 p.s.i. oil pressure. When engine is accelerated and fuel pressure escalates to 80 p.s.i. the Sentinel will automatically compensate and produce a shut-off point at 23 p.s.i. oil pressure.

## RACOR®

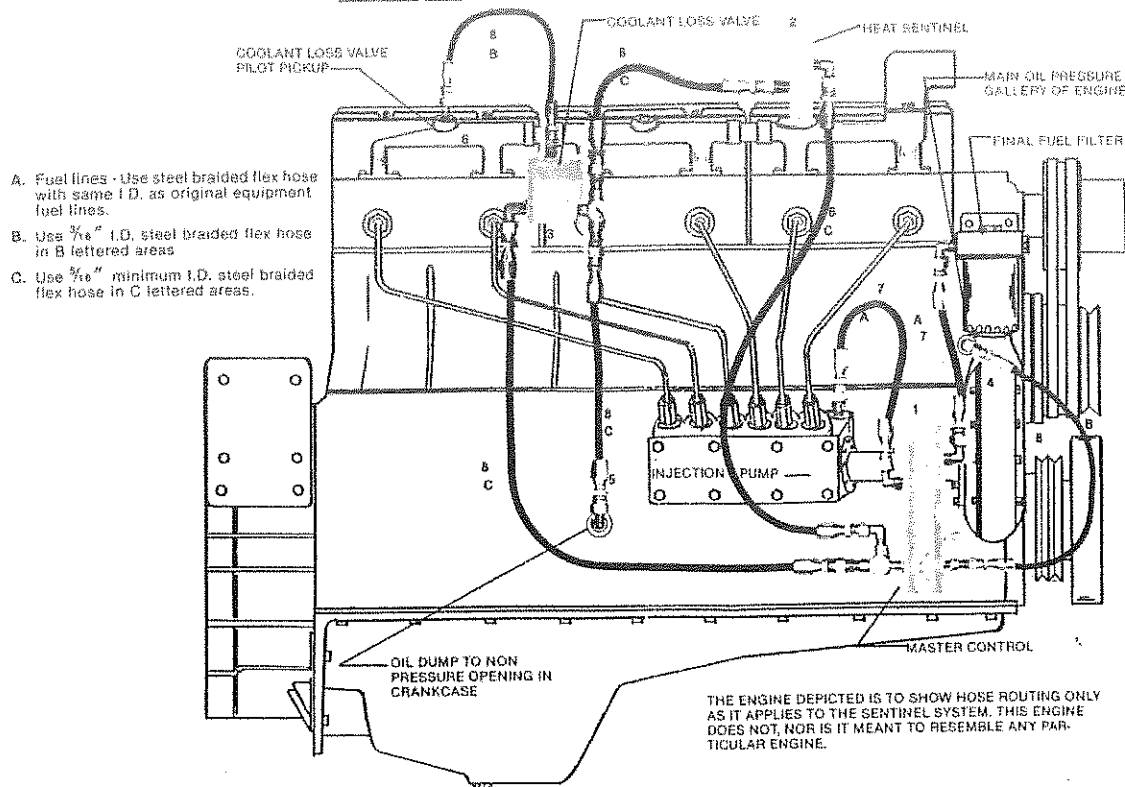
Parker Hannifin Corporation  
Racor Division  
P.O. Box 3208  
Modesto, CA 95353 USA  
800/344-3286, 209/521-7860  
Telex 359-408 RACOR MSTO

Parker Hannifin N.M.F. GmbH  
Racor Division Europe  
Geestemunder Strasse 42  
D5 Koln 60, West Germany  
(0021) 71720  
Telex 8885219



Filtration

# INJECTION FUEL SYSTEMS THAT HAVE HIGH PRESSURE LINES TO EACH INJECTOR



## GENERAL INSTALLATION INSTRUCTION GUIDE FOR ENGINES WITH INJECTION PUMPS THAT HAVE HIGH PRESSURE LINES TO EACH INJECTOR

Some of the pumps that fall into this category are Bosch, CAV, Caterpillar and Roosa Master. The engine shown in this illustration is for hose routing only and does not resemble any particular engine. It is drawn in this configuration to simplify drawing.

1. Mount the Master Control at a location near the injection pump and in a position to allow the fuel lines to be plumbed at the final fuel filter and injection pump as shown.  
**NOTE:** On some Caterpillar Engines the final fuel filter is mounted on the injection pump or so near it that a fuel adapter is required to break into fuel system. (See Caterpillar specification sheet for details.)
2. The Heat Sentinel should be installed in the hottest part of the coolant flow. This is usually the thermostat housing or water manifold just prior to the thermostat housing. On some older engines or on engines where no openings are available, it will be necessary to drill and tap the water manifold or a plate attached to the engine head to install the Heat Sentinel. Heat Sentinels are available with  $\frac{1}{2}$ " N.P.T.F. or  $\frac{3}{8}$ " N.P.T.F. installation threads. Thermowell Reducer Bushings are also available.
3. Using the MB-79 (Mounting Bracket for Coolant Loss Valve) or the four holes in the MB-1 Mounting Bracket, mount the Coolant Loss Valve at approximately the same height as the engine head.
4. Select an oil pressure opening from the main oil pressure gallery of the engine and install a suitable fitting that will accept a #4 Hose End. **DO NOT** tee into an oil supply line that feeds an engine accessory, such as an air compressor.
5. Locate a suitable opening in the non-pressure section of the oil crankcase. There are usually pipe plug openings in the engine block just above the oil pan. In some cases a gear plate or other plate on the engine may have to be removed and a hole be drilled and tapped  $\frac{1}{4}$ " N.P.T. for the oil dump. Install a fitting to accept the oil dump line.
6. Locate an opening in the coolant system between the discharge side of the water pump and the engine side of the thermostat. Most engines have numerous openings in the block, water manifold and thermostat housing. Install a suitable fitting in one of the openings that will accept a #4 Hose End. This is the Coolant Loss Valve pickup.  
**NOTE:** To make certain the opening that is selected is in the main coolant flow, it is recommended a pressure gage that reads in one pound increments be installed to monitor the coolant pressure at the opening. The engine should idle with at least one p.s.i. of coolant pressure and as the engine R.P.M. increases the coolant flow pressure should also increase to at least 5 p.s.i. over idle. If coolant pressure does not increase, select another opening for Coolant Loss Valve pilot pickup.
7. Locate the main fuel supply line that runs from the final fuel filter to the injection pump and remove it. Make up two new fuel lines and plumb Master Control into fuel system as shown. On Caterpillar engines that do not have fuel lines from the final fuel filter to the injection pump a fuel adaptor is required. (See Caterpillar specification sheet.)
8. Using the drawing as a plumbing guide, makeup the remaining hoses and install as shown. The plumbing does not have to be the exact configuration as shown, but the Heat Sentinel and Coolant Loss Valve must have an oil pressure line from the Master Control to the "IN" Port of each and a route from the "OUT" port of each back to the crankcase.
9. On some applications where the fuel tank is located higher than the injection pump it may be necessary to install a one-way Check Valve in the fuel return line to prevent fuel from being supplied by gravity to the injection pump when Master Control closes. During self-test if shutdown time is excessive and fuel tank is above injection pump, the check valve is necessary.

Applied Hydraulic Systems Inc.  
204 Industrial Ave. C  
Homa, LA 70363  
Attn: Mr. Gary Bondillain

Subject: Sentinel Heat Units

Dear Gary,

Our Sentinel heat unit bodies are made of leaded brass. The heat sensor unit is from Verna in France. It has a copper and wax fill and has been found to be extremely accurate over the past 35 years with great repeatability.

In manufacturing we test all units 100% before shipping. This is due to the fact that we use the same verna on two units. The travel of the pin caused by the expansion of the copper and wax fill in the verna lifts the ball in the heat unit and the travel of the pin determines the setting. All verna are put in the unit with sealer or lock-tite so that the settings can not change. All units are plus or minus 3 degree.

There is an unintentional safety built into the heat units. The internal spring in the heat unit can loose tension over the years from the constant heat. When this happens it allows the heat sentinel to open earlier than it's original setting. This has happened in a few cases over the years allowing the engine to shut down early rather than later.

When testing the units we use a mixture of 50-50 water and Prestone. We have a constant flow of the mixture across the heat element.

If you test the units in the field you need to have a moving or agitated mixture of water and Prestone. There can be a big difference in standing water nearest the heat source and in the middle of the water.

I hope that this answers some of your questions and feel free to contact me at any time.

Sincerely,  
Chub Burgess, Sentinel Product Manager  
Parker Hannifin Corporation  
Racor Division



## ACTUAL ENGINE OVERHEAT TEST

Although not recommended, the Heat Sentinel can be field tested by heating the engine up to the shutdown point. Care should be taken not to overheat and damage engine.

The Heat Sentinel is factory checked for defects prior to shipping. The unit is designed to give years of accurate maintenance-free service.

If testing becomes necessary, observe the following precautions.

## CHASSIS OR STATIONARY APPLICATION

1. Simulate a coolant loss or oil pressure loss as described earlier in this guide. This will ensure the system has been correctly installed.
2. Install an accurate mechanical heat gauge in the water manifold as close as possible to the Heat Sentinel.
3. Locate the #6 Dump Line that runs from the Heat Sentinel "OUT" port to the oil dump point on the engine.
4. Disconnect this line at the dump point on the engine. Place the end of this hose in the oil filler neck, or a five-gallon bucket or other suitable container. Position the hose end so as to be able to visually observe when oil is running out of the hose. Care must be taken to prevent oil from touching person.
5. Note the heat setting stamped on the Heat Sentinel (200° F, 212° F, etc.). This figure indicates the temperature at which the Heat Sentinel will open.
6. Restrict the air flow through the radiator by blocking about ¾" of the frontal area of the radiator with cardboard or some other material.
7. Start engine and ensure the manual override is turned to the run position (counterclockwise).
8. Run engine at a high idle and monitor the heat gauge.
9. When engine coolant temperature approaches figure stamped on Heat Sentinel, the valve will open and oil will be dumped out of the oil dump line. Engine shutdown will occur momentarily.

## DYNAMOMETER TEST

If an engine dynamometer is available, this test can be more easily performed due to closer control of coolant flow and power imposed upon the engine.



**Constructora Subacuatica Diavas,  
S.A. de C.V.**

# Pemex – A-V00415

# Appendix for the Nautilus Model Modes No. 180L4-50 Marine Crane

**Serial Number: 21409C**

Purchase Order No.: ORDPE/7732					OSI Doc. No.: 21409	
Rev. No.	Submittal Date	Revision	Prep By	OSI Checked	OSI Approved	Client Approval
A		Official Release	K. Blanchard	D. Bourgeois	R. Talbot	

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### INDEX

- 1.0 Material Certificates and NDE Reports
- 2.0 Pin Certificates
- 3.0 Ballring Certificates
- 4.0 Ballring Clearance Reports
- 5.0 Bolt Certificates
- 6.0 Wire Rope Certificates
- 7.0 Load Block Certificates
- 8.0 Overhaul Ball Certificates
- 9.0 Backlash Reports
- 10.0 Miscellaneous



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

### Nautilus Crane Model 180L4-50

#### Section 1.0

#### Material Certificates and NDE Reports

- Pedestal Weldment
- Upperstructure Weldment
- Upperstructure Leg Weldment
- Boom Base Weldment
- Boom Mid Weldment
- Boom Point Weldment
- Gantry Weldment
- Bridle Weldment



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



# Material Traceability Log

**CRANE WO. NO.:** 21409

**CUSTOMER:** Constructora Subacuatica Divar

**WELDMENT PART NO.:** N2009SK1-235

**WELDMENT S/N:** C09329-01

**DESCRIPTION:** Pedestal Weldment

**MODEL:** 180L4-50

**CHECKED BY:**

DATE:

[illegible]

07/02/2007 From: AMERICAN ALLOY STEEL

P.O.# : 4061700

S.O.# : 297040

To: OIL STATES-SKAGIT-SMATCO

AA PL#: 8032605

Item : 1 (2 PC) 1" X 144" X 96"

TAG: P/N N00149-003

## Mittal Steel USA Burns Harbor Plate

QUALITY ASSURANCE  
REPORT OF TEST AND ANALYSES

SHIPMENT NO. 804-31902		DATE SHIPPED 09-24-06		CAR OR VEHICLE NO. EJE-WCHGO-UP		BNSF 545163		PAGE 8				
AMERICAN ALLOY STEEL INC PO BOX 40469 HOUSTON TX 77040-0469				AMERICAN ALLOY STEEL INC C/O B&R MARINE SVS PORT OF GREATER BATON ROUGE TRACK #791 PORT ALLEN LA 70767								
S H I P T O	S E R I A L N O	P A T N O	H E A T N O	N O. P C S	THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG.	RED
					INCHES INCHES INCHES POUNDS PSI PSI IN %							

QUALITY STEEL MELTED &amp; MANUFACTURED IN THE U. S. A.

TEST PERFORMED AT A MITTAL APPROVE LABORATORY

PLATES - API -2H GR 50 INTEGRA 1999 EDITION

MOD C.15 MAX S1,S3,S4,S5,S12

CE=.43X PER IIW FORMULA, ASTM

A633-95 GR C, ABS GRD DH/EH36 REV 2001, ASME SA537-95 PVQ MOD CB

.04MAX CL 1, MIL-S-22698C GR DH36, CH-V A20S5 PLT T 30/25 FTLBS

AT -40F, THRU THK PER API-2H S4, NDT E208 HT NO BRK AT -30F THK

PER HEAT, UT A578 LEVEL 2 100%, PROD ANAL EA HEAT-PLT NORMALIZED

&amp; COOLED IN STILL AIR - TEST CERTS PREPARED IN ACCORDANCE WITH

PROCEDURE OUTLINED IN EN10204:2004 PARA 3.1

NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

----PLATE PASSED NDT E208 NO BREAK AT -30F THK PER HEAT----

CO# 67462-LA GH 361-5131

CH754163

PLATES HEAT TREATED - TEST SPECIMENS ATTACHED &amp; YIELD STRENGTH @ .5% EUL

PLATES ULTRASONICALLY TESTED PER ATTACHMENT

OUTSIDE INSPECTION BY AMERICAN BUREAU OF SHIPPING

S330599 601D20610 1 1 144 480 19602 56100 76800 8 25

66

68

N 1650 DEG F - 49 MIN

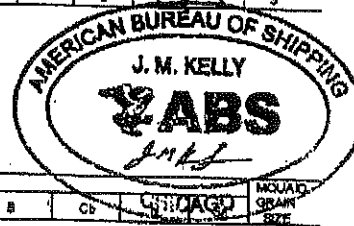
Q-QUENCH TEMPERATURE

T-TEMPERATURE

N-NORMALIZE TEMPERATURE

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY THE  
MITTAL BRN HRB PLT . TO THE APPLICABLE SPECIFICATION BY AN APPROVED PROCESS  
AND HAS BEEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN  
BUREAU OF SHIPPING RULES FOR THE INSPECTION AND TESTING OF MATERIALS TO THE  
SATISFACTION OF THE SURVEYORS.

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD	BEND	CHARPY IMPACT																		
					THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	ENERGY FT LBS			SHEAR(N)			LAT. EXP MILS							
										1	2	3	1	2	3	1	2	3					
8330599		601D20610			1.000	V	FULL T	-40		126	149	130											



HEAT NUMBER	CHEMICAL ANALYSIS															
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Co	INCHES	GRAIN SIZE
601D20610	.14	1.43	.010	.003	.280	.120	.05	.13	.010	.001	.003	.033	.0009	.030	.006	.006
	IIW	PCM														
	.42	.24														

Certified a true copy of the  
original, retained in our file.  
AMERICAN ALLOY STEEL, INC

Sept 11-19-07

I certify that the above results are a true and correct copy of actual results contained in records maintained by Mittal Steel Inc. and are in full compliance with the  
requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.  
PRODUCED UNDER A CERTIFIED QMS COMPLYING WITH ISO 9002 ABS-QE CERT. #30477

SHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

D. W. ELWOOD PER WNK

AMERICAN ALLOY  
PLATE # 8032605OST  
15  
INSPECTED

7-3-07

07/02/2007 From: AMERICAN ALLOY STEEL

To: OIL STATES-SKAGIT-SMATCO

P.O.# : 4061700

S.O.# : 297040

AA PL#: 8032605

Item : 1 (2 PC) 1" X 144" X 96"

:TAG: P/N N00149-003

# MITTAL

**MITTAL STEEL USA, INC.  
BURNS HARBOR PLATE  
250 WEST US HIGHWAY 12  
BURNS HARBOR, INDIANA 46304 - 1273**

September 25, 2006

American Alloy Steel Inc.  
P.O. Box 40469  
Houston, TX 77040-0469

GENTLEMEN:

The following plates have been 100 percent ultrasonically inspected and found acceptable to A578 Level 2.

Equipment: Epoch IV-0213, UTSYS1  
& USN50-0088CL  
Surface: As Rolled  
Test Method: Contact  
Couplant: Water  
Transducer: 2.25 MHz., 1" Diameter  
Manifest Number: 804-31902

Cust. Order #	Item No.	Serial Number	Heat Number	Plate Size	Recordable Indications
67372-LA	01	S 330395-01	821U00890	1.2500 x 120.000 x 480.0	None
66973-LA	01	P 332038-01	811T10430	1.2500 x 120.000 x 480.0	None
66973-LA	01	P 332039-01	811T10430	1.2500 x 120.000 x 480.0	None
66973-LA	01	P 332031-01	812T40510	1.2500 x 120.000 x 480.0	None
66973-LA	01	P 332028-01	821T10430	1.2500 x 120.000 x 480.0	None
67462-LA	01	S 330596-01	601D20410	1.0000 x 144.000 x 480.0	None
67462-LA	01	S 330597-01	601D20410	1.0000 x 144.000 x 480.0	None
67462-LA	01	S 330599-01	601D20610	1.0000 x 144.000 x 480.0	None

Very truly yours,  
MITTAL STEEL USA, INC.

*Daniel W. Elwood*

Daniel W. Elwood,  
Quality Manager  
Burns Harbor Plate



*JP* 7-3-07

**FRISA FORJADOS, S. A. DE C. V.**

Valentín G. Rivero No. 1227 Col. Los Treviño  
C.P. 66350 Tels. 52(8) 153-0321, 153-0302  
Fax: 52(8) 336-3560  
Sta. Catarina, N. L., México

CERTIFIED COMPANY

**ISO 9001 : 2000****Material Test Report No. 269389****Customer: OIL STATES SKAGIT SMATCO****Spec: ASTM A694 F50 R-03**

Pag. 1 / 2

Qty	Date	P.O. Number	Part No.	Job Order
6	29/12/2006	4053016	N47073-006	235977
Description ROLLED RING 71.000" X 54.000" X 3.000" MELTING PRACTICE: E. F. V. D.				

**HEAT: N1410 (6/6) PCS****CHEMICAL ANALYSIS**

Heat No.	Ladle	C %	Mn %	P %	S %	Si %	Ni %	Cr %	Mo %
N1410		0.2000	1.1400	0.0120	0.0030	0.2500	0.0800	0.0800	0.0200
Mill	Ladle	Cu %	V %	CE %					
		0.1900	0.0040	0.4300					

EQS

**MECHANICAL PROPERTIES**

Heat Treat Lot No.	Yield Strength (PSI)	Tensile Strength (PSI)	Elong. % (2")	A.R. (%)	Hardness HBW QTC	Hardness HBW PCS	CVN (ft/lb)	Lat. Exp. (IN)	Shear %	Test. Temp. (°F)
133126	56900	80800	36	73	159		178	0.085	100	0
					159		147	0.087	100	
							177	0.070	100	

**HEAT TREATMENT**

Quantity	Heat Treat Lot No.	Heat Treatment	Temperature (°F)	Time at Temp (Hrs)	Cooling Medium	Quench. M. Temp. (°F)
6 PCS	133125	AUSTENITIZED	1652	4.00	WATER	
6 PCS	133126	TEMPERED	1112	4.00	AIR	

**OBSERVATIONS**

Felix Arturo Villagomez Leal

WE HEREBY CERTIFY THAT ALL TEST RESULTS AND PROCESS  
INFORMATION CONTAINED HEREIN ARE CORRECT AND TRUE AS  
CONTAINED IN THE RECORDS OF THE COMPANY.

NO WELDING REPAIRS IS ALLOWED AND USED IN FRISA  
ALL MATERIALS ARE MERCURY FREE  
CER-F-01-A

QUALITY ASSURANCE

1.10.4

**FRISA FORJADOS, S. A. DE C. V.**

Valentin G. Rivero No. 127 Col. Los Treviño  
C.P. 66350 Tels. 52(8) 153-0321, 153-0302  
Fax: 52(8) 336-3560  
Sta. Catarina, N. L., México

CERTIFIED COMPANY

**ISO 9001 : 2000****Material Test Report No. 269389****Customer: OIL STATES SKAGIT SMATCO****Spec: ASTM A694 F50 R-03**

Pag. 2 / 2

Qty	Date	P.O. Number	Part No.	Job Order
6	29/12/2006	4053016	N47073-006	235977
<b>Description</b> ROLLED RING 71.000" X 54.000" X 3.000" MELTING PRACTICE:E. F. V. D.				

- . QTC SIZE (4" X 4" X 10")
- . IMPACT TEST: 0.39" X .39" X 2.16" CVN SPECIMEN
- . TENSILE TEST: 0.500" DIAMETER SPECIMEN
- . ULTRASONIC EXAMINATION PER:ASTM A388 / A578 L1
- . FURNACE CALIBRATED PER: API 6A APPENDIX H 19th EDITION
- . HARDNESS ON TEST SPECIMEN IS REPRESENTED BY TWO VALUES.
- . FURNACE TEMP. MONITORING METHOD: AIR THERMOCOUPLE
- . FULLY KILLED MATERIAL
- . TESTING ACCORDING TO ASTM A370
- . STEEL MELTED IN: UNITED STATES

Felix Arturo Villagomez Leal

WE HEREBY CERTIFY THAT ALL TEST RESULTS AND PROCESS  
INFORMATION CONTAINED HEREIN ARE CORRECT AND TRUE AS  
CONTAINED IN THE RECORDS OF THE COMPANY.

NO WELDING REPAIRS IS ALLOWED AND USED IN FRISA  
ALL MATERIALS ARE MERCURY FREE  
CER-F-01-A

QUALITY ASSURANCE



## ULTRASONIC TEST REPORT

Customer OIL STATES SKAGIT SMATCO

Certificate 12228

### IDENTIFICATION PART

Test Date DEC/29/2006

Job Order 235977

Purchase Order 4053016

Part Number N47073-006

Material ASTM A694 F50 R-03

Dimensions 71.000 " x 54.000 " x 3.000 "

Heat N1410 Qty 6 PCS

Specification ASTM A388 / A578 L1

Description ROLLED RING

### EQUIPMENT

Brand Krautkramer USM

Model

USM 35X

Serial No

2521a

Calibration Due

MAY/23/2007

### STRAIGHT BEAM (LONGITUDINAL WAVE)

Transducer				
Size	Frequency	Serial No	Model	Brand
7x18 mm	2 MHz	57467-00606	SEB 2E Dual	Krautkramer
Reference Gain dB		55		
Scanning Gain dB		+10		
Couplant		GEL		
Surface Condition		250 rms		
Calibration Technique		Back Reflection at 75% FSH		
Block Serial Number				

EVALUATION : ACCEPTED

REMARKS : NO DEFECTS FOUND

Evaluated by :

Odilon Quiroz

Level II SNT - TC-1A

FRISA FORJADOS S.A. DE C.V.  
OPEN DIE & ROLLED RING FORGINGS  
PO Box 1273 Monterrey, NL  
64000 Mexico Ph. (52 8) 153-0321 Fax (52 8) 336-3560  
e-mail: frisa@frisa.com



# ELLWOOD QUALITY STEELS COMPANY

A PENNSYLVANIA BUSINESS TRUST  
700 MORAVIA STREET, NEW CASTLE, PA 16101

(724) 658-6788  
Telefax (724) 658-6802

## CERTIFIED TEST REPORT

Date: October 10, 2006

Report of Tests of: (5), Dia. 21 x 197 - Grade A105 Ingots(s)

For:

Customer's Order: 6042

Company: Frisa Forjados S.A. DE C.

Date of Order: 08/01/06

Valentin G. Rivero #127

Our Shop Order: X001627

Mexico, 66350

Specification: ASTM A105

## CHEMICAL ANALYSIS

Heat #	C	MN	P	S	SI	NI	CR	MO	V	AL	CU	Hppm	TI	SN
N1410	.20	1.14	.012	.003	.25	.08	.08	.02	.004	.033	.19	1.2	.002	.009
	AS	CO	PB	B	SB	CB	CA	N	CE					
	.006	.006	.0001	.0003	.0010	.002	.0006	.0048	.43					

Jominy:

J-Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30	32
Rc Hardness																								

The material was melted using the electric arc furnace refined-vacuum degassed process and was subsequently bottom poured.

Cr + Mo = .10

Ni + Cr + Mo + Cu = .37

All work on this product was performed at Ellwood National Steel, Irvine, PA U.S.A.

STEVEN F. LUBINSKI  
Q.A. Manager

I certify that all items covered by this certificate are in full compliance with all purchase order/specifications requirements. The recording of false, fictitious or fraudulent statements or entries on this document may be punishable as a felony under Federal Statutes. During the manufacturing process, tests, and inspections, the material did not come in direct contact with mercury or any of its compounds nor with any mercury containing device employing a single boundary of containment. No welding or weld repair was performed on this material. The material was produced free of radioactive elements



CL STEEL CO.  
OIL STATES-SKAGIT-SMAICO  
ASTM A36 PER CUSTOMER SPEC "M 36-PL-C"  
2" X 96.000" X 120.000"  
PART NO.

PO/Rel 4076915 ROBERT HUDSON

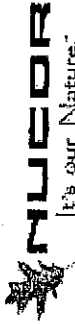
Certificate of Mill Test Results  
SO HOU-038108-001  
28Oct08  
Pg 1/1

**NUCOR**  
**PLATE MILL**

P.O. Box 279  
Winton, NC 27986  
(252) 356-3700

## Mill Test Report

Page 2



Issuing Date : 06/25/2008  
Vehicle No : PTIX 136542

Specification : 2.0000" x 96.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-07

B/L No. : 205842

Load No. : 207417

Our Order No. : 6172412

Cust. Order No. : HOU-3853

Sold To : CHAPEL STEEL CO  
P O Box 1000

FAX# 215-793-8415

SPRINGHOUSE, PA 19477

Ship To : CHAPEL STEEL  
6805 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

HOUSTON, TX 77061

Marking :

Heat No	C	Mn	P	S	Si	CU	NI	Cr	Mo	Alz	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
8105040	0.05	1.05	0.012	0.004	0.27	0.29	0.07	0.09	0.03	0.022	0.003	0.005	0.003	0.0010	0.0002	0.014	0.28	0.14	
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	(ksi) Yield	(ksi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	(ft-lb) 1 shear	(ft-lb) 2 shear	(ft-lb) 3 shear	(ft-lb) 4 shear	(ft-lb) 5 shear	Temp (°F)	Size	Min	Ave		
8105040-01	1	13.06	T	38,300	59,700	22.4	22.0	H-L	268.9	256.9	276.5	267.4	267.4	32	10mm	32	20		
8105040-02	1	13.06	T	38,300	59,700	22.4	22.0	H-L	268.9	256.9	276.5	267.4	267.4	32	10mm	32	20		

Manufactured to fully killed fine grain practice by Electric Arc Furnaces. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EL method unless otherwise specified.  $Ceq = C + (Mn/16) + ((Cr + Mo + V)/5) + (Cu + Ni)/15$

Pcm =  $C + HS/130 + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + S$

Melted and manufactured in the USA, ISO 9001:2000 certified (#12443-0) by SSI Quality System Registrar (#0985-09), PED 97723/EC 712 Annex 1, Para. 4.3 Compliant.

DIN 50449 3.1, EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMPQA-182

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

T. A. Dapretto

T. A. Dapretto, Metallurgist

07/07/2008 11:48:56 AM



Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metalltesters@msn.com

October 28, 2008

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/38108  
Report No. 08-2892-1

IDENTIFICATION: 2" x 4" x 6", HT# 8105040, SL# 02  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-38108

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
237.0	92	100
217.0	89	100
235.0	96	100

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	Temp	Size	Min Ave.	
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



8-10-09



化 学 成 分  
Chemical Composition  
BASE METAL

証明書番号

Certificate No. : UE-08-0677

頻 度

Sampling Frequency : 2/ 1HEAT

Page : 1

製造番号 Manufacture No.		87-04173	87-04182			
鋼 番 管理Code-Heat No.		9-5930	9-5930			
		Min.	Max.			
C	%	L	0.18	0.15	0.15	
		P	0.18	0.14	0.14	
Si	%	L	-	0.23	0.23	
		P	-	0.22	0.22	
Mn	%	L	1.20	1.08	1.08	
		P	1.20	1.08	1.07	
P	%	L	0.025	0.017	0.017	
		P	0.025	0.018	0.018	
S	%	L	0.015	0.005	0.005	
		P	0.015	0.005	0.004	
Cu	%	L	-	0.01	0.01	
		P	-	0.01	0.01	
Ni	%	L	1.00	0.01	0.01	
		P	1.00	0.01	0.01	
Cr	%	L	-	0.04	0.04	
		P	-	0.04	0.04	
Mo	%	L	-	0.00	0.00	
		P	-	0.00	0.00	
V	%	L	-	0.005	0.005	
		P	-	0.005	0.004	
Nb	%	L	-	0.000	0.000	
		P	-	0.000	0.000	
Ti	%	L	0.04	0.00	0.00	
		P	0.04	0.00	0.00	
B	%	L	-	0.0000	0.0000	
		P	-	0.0000	0.0000	
Nb+V	%	L	0.03	0.00	0.00	
		P	0.03	0.00	0.00	
Nb+V +Ti	%	L	0.15	0.00	0.00	
		P	0.15	0.00	0.00	
Ceq. 7B	%	L	0.43	0.34	0.34	
		P	0.43	0.33	0.33	
Pcm.	%	L	0.25	0.21	0.21	
		P	0.25	0.20	0.20	
		L				
		P				
		L				
		P				
		L				
		P				
		L				
		P				
		L				
		P				
		L				
		P				

Note 1: Ladle Analysis - とりべ分析

P: Product Analysis - 製品分析

Ceq. 7B =  $C + Mn/6 + (Cu + Ni)/15 + (Cr + Mo + V)/5$

Pcm. =  $C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$



Apr 12-3-08

## 引張試験 Tensile Test

証明書番号

Certificate No. : UE-08-0677

頻 度

Sampling Frequency : 1/ 100P/HEAT

Page : 2

单位

Unit : KSI

試片記号 Spec. Mark		耐 力 Yield Strength	引張強さ Tensile Strength	伸 び Elongation(%)	降伏比 Yield Ratio(%)
TS	Min.	42.0	60.0	30	
	Max.	72.0	110.0		93
TW	Min.		60.0		
	Max.		110.0		
	Min.				
	Max.				
	Min.				
	Max.				

[illegible]

Note Spec Mark: 叶片2号

TS: Transverse Stock 垂直方向 TS: Strip (W=38.1mm)

LS: Longitudinal Stock

Tw: Transverse in weld 縦横方向

LW: Longitudinal in weld 沿焊缝方向

15

15  
INSPECTED  
Jm 12-3-08

## 曲 げ 試 験 Bend Test

証明書番号

Certificate No. : UE-08-0677

頻 度

Sampling Frequency : 1/ 50P

Page : 3

--

[illegible]

Note A: JIG Dimension

\* REDUCED WALL SPECIMEN

OSI  
15  
INSPECTED

12-3-08



シャルピー衝撃試験 Charpy Impact Test

証明書番号

Certificate No. : UE-08-0677

頻度

Sampling Frequency : 1/ 100P/HEAT

Page

: 4

単位

Unit : FT-LBS

	Test Temperature	Energy		Fracture(%)		試片寸法 Specimen Size
		Min.	Ave.	Min.	Ave.	
TRANSVERSE BODY	32.0°F	15	20	-	-	(CENTER) 10 X 10 2mm V Notch
TRANSVERSE BODY	0.0°F	-	-	-	-	(CENTER) 10 X 10 2mm V Notch
WELD	0.0°F	-	-	-	-	(CENTER) 10 X 10 2mm V Notch

製造番号 Manufacture No.		87-04182									
鋼番 管理Code-Heat No.		9-5930									
TRANSVERSE BODY (CENTER) 32.0°F	1	90.0	80								
	2	87.0	70								
	3	86.0	70								
	Ave.	88.0	73								
TRANSVERSE BODY (CENTER) 0.0°F	1	52.0	25								
	2	67.0	30								
	3	35.0	20								
	Ave.	51.0	25								
WELD (CENTER) 0.0°F	1	88.0	50								
	2	46.0	35								
	3	86.0	50								
	Ave.	73.0	45								
	1										
	2										
	3										
	Ave.										
	1										
	2										
	3										
	Ave.										
	1										
	2										
	3										
	Ave.										

Note

E : Energy

F : Fracture



pp12-3-08

## 硬度試驗 Hardness Test

証明書番号

Certificate No. : UE-08-0677

頻度

Sampling Frequency : 1/ 100P/HEAT

Page : 5

## 試驗方法

荷 重

Test Method : VICKERS

Load : 10KG

	Spec.		RECORDED HARDNESS VALUES ARE MAXIMUM VALUES OBTAINED.
	Min.	Max.	
Body		248	
H. A. Z		248	
Weld		248	

[illegible]

**Note**

15  
INSPECTED

12-3-08

## MILL TEST CERTIFICATE

1700 HOLT RD N.E.  
Tuscaloosa, AL 35404-1000  
800-827-8872

Page #: 1  
klöckner & co  
multimetal distribution

Load Number	Tally	Mill Order Number	P.O. Number	Part Number	Certificate Number	Date
363265	00000000351733	N-097464-001	6221358		1768888-1	08/26/2009 17:23
Grade						
Order Description: A36, 0.2500 IN x 96.000 IN x 240.000 IN						
Quality Plan Description: A36/SA36/A70936: ASTM A36-08/ASME SA36-03/A709-36-08						
Customer: Sold TO: NAMASCO Roswell GA Ship TO: NAMASCO NEW ORLEANS LA						

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al	Ti	N2	B	Ca	Sn	Pb
9H0599B	A9U1324-02 ***	A9U1324	0.20	0.43	0.006	0.005	0.05	0.21	0.07	0.06	0.022	0.000	0.001	0.029	0.005	0.008	0.0002	0.0024	0.007	
9H0599B	A9U1324-03 ***	A9U1324	0.20	0.43	0.006	0.005	0.05	0.21	0.07	0.06	0.022	0.000	0.001	0.029	0.005	0.008	0.0002	0.0024	0.007	

Shipped Item	Certified By	Heat Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION %		Bend OK?	Hard HB	Charpy Impacts (ft-lbf)			Shear %			Test Temp	
						2"	8"			Size mm	1	2	3	Avg	1		2
9H0599B	S9H0592FTT	A9U1324 ***	46.1	67.9	67.9		29.4										
9H0599B	S9H0593FTT	A9U1324 ***	44.7	65.1	68.7		29.7										
9H0599B	S9H0592MTT	A9U1324 ***	40.9	60.0	68.2		26.6										
9H0599B	S9H0593MTT	A9U1324 ***	42.1	61.9	68.0		33.6										
9H0593BA	S9H0593FTT	A9U1324 ***	44.7	65.1	68.7		29.7										
9H0593BA	S9H0593MTT	A9U1324 ***	42.1	61.9	68.0		33.6										

Items: 2 PCS: 28 Weight: 45739 LBS

Mercury has not come in contact with this product during the manufacturing process and has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material.

Manufactured to a fully killed fine grain practice. \*\* Produced from Coil \*\*

ISO 9001:2008 Registered, PED Certified

\*\*\* Indicates Heats melted and Manufactured in the U.S.A

We hereby certify that the product described above passed all of the tests required by the specifications.

*Chun Yu*

Chun Yu - Rolling Mill Process Metallurgist



8-24-2009 17:15

Load - 718569

BL - 8566577

Cust. PO -4085127

BLR466

Namasco  
Oil States Skagit-Smatco, LLC

Order-Line - 4310000-1

Heat - JW0910400001

klöckner &amp; co multi metal distribution

## CERTIFIED MILL TEST REPORT

Page: 2

**NUCOR****BAR MILL GROUP  
JEWETT DIVISION**SOLD TO:  
NAMASCO CORP  
500 COLONIAL CENTER PKWY  
STE 500  
ROSWELL, GA 30076-SHIP TO:  
NAMASCO  
3837 SINGLETON BLVD  
DALLAS, TX 75212-

Ship from:

Nucor Steel - Texas  
8812 Hwy 79 W  
JEWETT, TX 75846  
903-626-4461Date: 17-Aug-2009  
B.L. Number: 521703  
Load Number: 141059Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

NBWG-08 March 24, 2009

HEAT NUM. *	DESCRIPTION	PHYSICAL TESTS				CHEMICAL TESTS														
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT%	DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Cb	Cu	Sn	C.E.
PO# => JW0910325702	6219833 Nucor Steel - Texas 1-1/2x1-1/2x3/16" Eq Ang 20' A36 ASTM A36/A36M-08 ASTM A709/A709M-08 GR 36 [250] ASME SA36-2007 EDITION	47,300 326MPa 47,500 328MPa	64,300 443MPa 65,200 450MPa	24.0% 24.0%				.11 .12	.67 .12	.016 .027	.050 .003	.22 .001	.29 .38							.28
PO# => JW0910400001	6219143 Nucor Steel - Texas 3/4 Round 20' A36/A529GR50 ASTM A36/A36M-08 A529/A529M-05 ASTM A529/A529M-05 GR 50 ASTM A36/A36M-08 Mn/C = 5.64	53,900 372MPa 54,300 374MPa	77,200 532MPa 77,100 532MPa	23.0% 22.0%				.14 .20 Mn/C 05.64	.79 .25	.023 .066	.039 .002	.22 .011	.38							

I HEREBY CERTIFY THAT THE ABOVE FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THIS CORPORATION

ALL MANUFACTURING PROCESSES OF THE STEEL MATERIALS IN THIS PRODUCT, INCLUDING  
WELDING, HAVE OCCURRED WITHIN THE UNITED STATES. ALL PRODUCTS PRODUCED ARE WELD PER-  
CENTAGE. IN ANY FORM, HAVE NOT BEEN USED IN THE PRODUCTION OR TESTING OF THIS MATERIAL.QUALITY  
ASSURANCE:

Ben Cave

087  
15  
IN REPLY

pp 8-27-09



Donny Carlos

Oceaneering International, Inc.

December 14, 2009

**Inspection Report: I109590**

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

**INSPECTION**  
**(985) 868 -5097**  
**DAILY WORK REPORT**

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer: Oil States

Contractor:

Job Location: Houma

Date/Time: 12/14/2009

S.S. Procedure #: AWS-RT-02-GEN  
Rev.2

P.O.#:

PKC/AFE #:

Oil Job #: 57348

Specifications: AWS D1.1

Job #: WO#21409.10

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: Gamma Ray Insp. of Crane Ped.

WELD NO	PIPE SIZE	DRAWING/LINE #	WELDER STENCIL	SFD:	UG:
1	L/S-1	60" X 1"	M1	15	.011

REMARKS:

Exposure	Status	Description	Photo
0-1-2	Reject	2" Slag	-
2-3-4	Accept		-

WELD NO	PIPE SIZE	DRAWING/LINE #	WELDER STENCIL	SFD:	UG:
2	L/S-1	60" X 1"	M1	15	.011

REMARKS:

Exposure	Status	Description	Photo
0-1-2	Accept		-
2-3-4	Accept		-



Technique A



Technique B



Technique C



Technique D

No. of Welds Checked: 2

Date: 12/14/2009

Material:

Source Type: Iridium 192

Curies: 122

Focal Size: 0.167

Screen Thickness: .010

Reference Standards: AWS D1.1,

Consumables: 4 Pcs. @ 4.5" X 17"

Penetrameter: ASTM B

Required Wire: .016

Achieved Wire: .013

Type: M. AGFA

Speed: 1. D7

Hours Worked: 3

Estimated cost: \$0.00

Travel Time:

Mileage: 0

Carlos, Donny (Level II - Technician)

Pennison, Brad (Level II - Technician)

Film Delivered to: Oil Manger:

Client:

Radiographer  
Signature:

(Carlos, Donny)

Customer Representative

(Please sign)

OCEANEERING®

INSPECTION

REPORT NO. 488646

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>12-29-09</b>
Billing Address	Project <b>21409.10.00</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>ASME B31.3 Rev-1</b>	Acceptance Criteria <b>ASME B31.3 Level B</b>

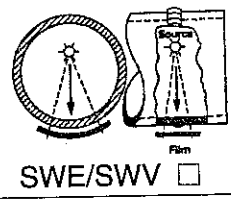
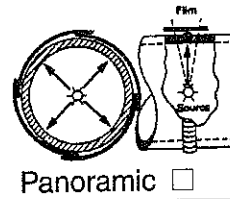
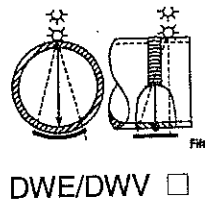
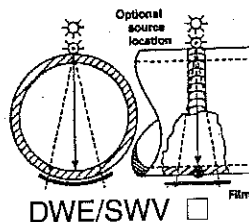
AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity  
ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion  
IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut  
LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: **ULTRASONIC Exam of:**

WELD NO.	PIPE SIZE	RECOMMENDATION		WELD NO.	PIPE SIZE	RECOMMENDATION	
		✓ X	ACCEPT REJECT			✓ X	ACCEPT REJECT
1				31			
2				32			
3	<b>PEDESTAL 180L-4, Pemex</b>			33			
4				34			
5	<b>2009 SKI-235</b>			35			
6				36			
7				37			
8				38			
9				39			
10				40			
11				41			
12	<b>100% LAM. scan of 5" Flange</b>			42			
13				43			
14				44			
15				45			
16				46			
17				47			
18				48			
19				49			
20	<b>After welding</b>			50			
21				51			
22				52			
23				53			
24				54			
25				55			
26				56			
27				57			
28				58			
29				59			
30				60			

Technique: check exposure setup

SFD \_\_\_\_\_ Thickness \_\_\_\_\_



Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **Mitch Darden**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **12-29-09** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **SITE-SCAN SIN 7000 510**

Penetrometer-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **0°**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_ Freq: **225** Cal Bloc: **ASC**

Hours Worked: **1** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: **celle**

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_ Consumables: \_\_\_\_\_ Specifications: \_\_\_\_\_

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance of clients specific codes and/or standard shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldment and their intended use by the client.

# OCEANEERING® INSPECTION

REPORT NO. 488645

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma LA</b>	Inspection Date / Time <b>12-29-09</b>
Billing Address	Project <b>21409.10.00</b>	Oil Job Number <b>52348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>MT-02 Rev-4</b>	Acceptance Criteria <b>API 11.6.1</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IPD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

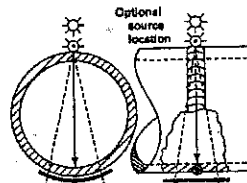
Job Description: **WET MAG EXAM OF:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓ X	ACCEPT REJECT	REMARKS			✓ X	ACCEPT REJECT	REMARKS
1					31				
2					32				
3	<b>PERIPHERAL 180L-4, PENEY</b>				33				
4					34				
5	<b>N0009511-235</b>				35				
6					36				
7					37				
8					38				
9					39				
10	<b>10090 WIT 105 All welds</b>				40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17				<b>WIS H, M-1</b>	47				
18				<b>H-1, E-1</b>	48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

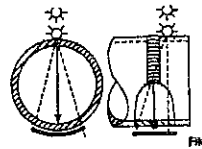
Technique: check exposure setup

SFD

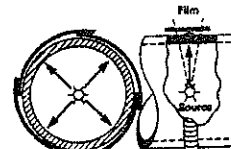
Thickness



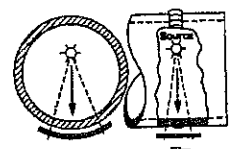
DWE/SWV ☐ Film



DWE/DWV ☐ Film



Panoramic ☐ Film



SWE/SWV ☐ Film

Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_

Customer Representative: **Match Dard**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_

Date: **12-29-09** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_

Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_

Instrument: **ESX115 SW 11001**

Penetrometer-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_

Angles Used: **3-6" SPAC**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: ☒

Freq: **110K** Cal Bloc: **1000**

Hours Worked: **3** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_

Consumables: **1 paint**

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_

Specifications: **2 LAK # 110502**

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability or the part of Oceaneering Inspection as to the fitness for service of such weldment and their intended use by the client.

# OCEANEERING® INSPECTION

REPORT NO. 488637

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
**DAILY WORK REPORT**  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7100  
Ingleside, TX  
(361) 776-7250

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>12-22-09</b>
Billing Address	Project <b>21409.10.00</b>	OII Job Number <b>52398</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>UT-02 Rev-1</b>	Acceptance Criteria <b>AWS D11 6.3 Class R</b>

AD = Accumulations of Discontinuities	ESI = Elongated Slag Inclusion	IFD = Incomplete Fusion Due to Cold Lap	LC = Low Crown
BT = Burn Through	EU = External Undercut	IP = Inadequate Penetration	NW = Narrow Weld
BTA = Burn Through Area	HB = Hollow Bead	IPD = Inadequate Penetration Due to High Low	P = Porosity
C = Crack/Cracks	IC = Internal Concavity	ISI = Isolated Slag Inclusions	
CP = Cluster Porosity	IF = Incomplete Fusion	IU = Internal Undercut	

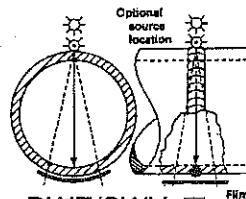
Job Description: **ULTRASONIC EXAM OF:**

RECOMMENDATION				RECOMMENDATION					
WELD NO.	PIPE SIZE	✓ X	ACCEPT REJECT	REMARKS	WELD NO.	PIPE SIZE	✓ X	ACCEPT REJECT	REMARKS
1					31				
2					32				
3	Pedi 180L-4, Penox				33				
4	N 20095KI-235				34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11	100% UT of welds				41				
12					42				
13				WIS	43				
14					44				
15	1"pg			Acc m-1, H-1E1	45				
16					46				
17					47				
18					48				
19	2"pg				49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

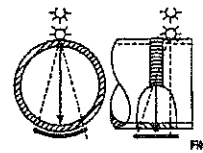
Technique: check exposure setup

SFD

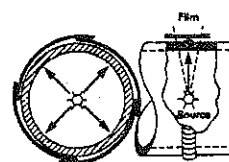
Thickness



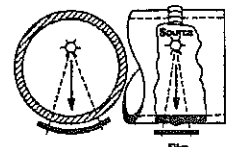
DWE/SWV ☐ Film



DWE/DWV ☐ Film



Panoramic ☐ Film



SWE/SWV ☐ Film

Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_

Penetrometer-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Achieved wire: \_\_\_\_\_

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_

Hours Worked: **2** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_

Sheet # **1 of 1** Subsistence (check if applicable): \_\_\_\_\_

Customer Representative: **match Oand**

Date: **12-22-09** Technician: **AL CARLOS**

Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_

Instrument: **Site-Son S/N I000570**

Angles Used: **0° 45° 60° 70°**

Freq: **2.25** Cal Bloc: **DSK**

Couplant: **celloy**

Consumables: \_\_\_\_\_

Specifications: \_\_\_\_\_

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.





Donny Carlos

Oceaneering International, Inc.

January 4, 2010

## Inspection Report: I109888

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

**INSPECTION**  
**(985) 868 -5097**  
**DAILY WORK REPORT**

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer: Oil States

Contractor:

Job Location: Houma

Date/Time: 12/29/2009

S.S. Procedure #: AWS-RT-02-GEN  
Rev.2

P.O.#:

PKC/AFE #:

Oil Job #: 57348

Specifications: AWS D1.1

Job #: WO#21409.10

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IPD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: Gamma Ray Insp. of Crane Ped. Repairs

WELD NO	PIPE SIZE	DRAWING/LINE #	WELDER STENCIL	SFD:	UG:
1 L/S 1 R1	60" X 1"		H1	15	.007

REMARKS:

Exposure  
0-1-2

Status  
Accept

Description

Photo



Technique A



Technique B



Technique C



Technique D

No. of Welds Checked: 1

Date: 12/29/2009

Material:

Source Type: Iridium 192

Curies: 122

Focal Size: 0.184

Screen Thickness: .010

Reference Standards: AWS D1.1,

Consumables: 1 Pc. @ 4.5" X 17"

Penetrameter: ASTM B

Required Wire: .016

Achieved Wire: .013

Type: .1. AGFA

Speed: 1. D7

Hours Worked: 2

Estimated cost: \$0.00

Travel Time:

Mileage: 0

Carlos, Donny (Level II - Technician)

Pennison, Brad (Level II - Technician)

Film Delivered to: Oil Manger:

Client:

Radiographer  
Signature:

(Carlos, Donny)

Customer Representative

(Please sign)



Donny Carlos

Oceaneering International, Inc.

January 4, 2010

## Inspection Report: I110060

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

**INSPECTION**  
**(985) 868 -5097**  
**DAILY WORK REPORT**

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer: Oil States

Contractor:

Job Location: Houma

Date/Time: 12/29/2009

S.S. Procedure #: AWS-RT-02-GEN  
Rev.2

P.O.#:

PKC/AFE #:

Oil Job #: 57348

Specifications: AWS D1.1

Job #: WO#21409.10

AD = Accumulations of Discontinuities

ESI = Elongated Slag Inclusion

IFD = Incomplete Fusion Due to Cold Lap

LC = Low Crown

BT = Burn Through

EU = External Undercut

IP = Inadequate Penetration

NW = Narrow Weld

BTA = Burn Through Area

HB = Hollow Bead

IPD = Inadequate Penetration Due to High Low

P = Porosity

C = Crack/Cracks

IC = Internal Concavity

ISI = Isolated Slag Inclusions

CP = Cluster Porosity

IF = Incomplete Fusion

IU = Internal Undercut

Job Description: Gamma Ray Insp. of Crane Ped.

WELD NO	PIPE SIZE	DRAWING/LINE #	WELDER STENCIL	SFD:	UG:
1	L/S 3	60 X 1 3/4"	E1	12	.015

REMARKS:

Exposure

Status

Description

Photo

0-1

Accept

WELD NO	PIPE SIZE	DRAWING/LINE #	WELDER STENCIL	SFD:	UG:
2	L/S 3	60 X 1 3/4"	E1	12	.015

REMARKS:

Exposure

Status

Description

Photo

0-1

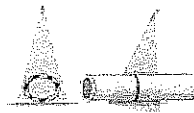
Accept



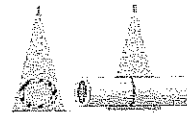
Technique A



Technique B



Technique C



Technique D

No. of Welds Checked: 2

Date: 12/29/2009

Material:

Source Type: Iridium 192

Curies: 78

Focal Size: 0.184

Screen Thickness: .010

Reference Standards: AWS D1.1,

Consumables: 2 Pcs . @ 4.5" X 10"

Penetrameter: ASTM B

Required Wire: .016

Achieved Wire: .013

Type: 1. AGFA

Speed: 1. D7

Hours Worked: 2

Estimated cost: \$0.00

Travel Time:

Mileage: 0

Carlos, Donny (Level II - Technician)

Pennison, Brad (Level II - Technician)

Film Delivered to: Oil Manger:

Client:

Radiographer  
Signature:



(Carlos, Donny)

Customer Representative  
(Please sign)



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

<b>CRANE WO. NO.:</b>	21409
<b>CUSTOMER:</b>	Constructora Subacuatica Divar
<b>WELDMENT PART NO.:</b>	N60908-001
<b>WELDMENT S/N:</b>	C09247-01
<b>DESCRIPTION:</b>	Upperstructure Weldment
<b>MODEL:</b>	180L4-50
<b>CHECKED BY:</b>	
<b>DATE:</b>	11-30-08 

[illegible]

# LUNGHORN STEEL

API 2H GR 80 INTEGRAL TO ABS 2005  
 3" X 120" X 240" X 240"  
 PART NO.

STEVE WILLIAM

## Certificate of Mill Test Results

SP HOU-041354-001 155  
 Pg 1/1

### Arceformittal Burns Harbor Plate

SHIPMENT NO. 801-09114	DATE SHIPPED 08-13-09	DATE OF TEST AND ANALYSIS 08-13-09	INSTRUMENT NO. LH-00000-0000	EMTC 036327	PAGE 3
---------------------------	--------------------------	---------------------------------------	---------------------------------	-------------	--------

Longhorn Steel & Flamecutting  
 Northwoods Industrial Park Centr  
 11921 FM 529  
 Houston, Texas 77041

Longhorn Steel & Flamecutting  
 Northwoods Industrial Park Centr  
 11921 FM 529  
 Houston, Texas 77041

CH1720281

SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO PCS	THICKNESS	WIDTH IN DIA	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG	RED
---------------	---------	-------------	--------	-----------	--------------	--------	--------	-------------	------------------	-------	-----

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.  
 PLATES - API 2H GR 80 INTEGRAL TO ABS 2005 NOTION

S1, S2, S4, S5, S12 MOD P.02 MAX N.01  
 MAX CE=.45X PER IIR & PCM FORMULA,  
 ASTM A633-01 GR C, ASME SA537 PVQ 2004 EDIT MOD CB.04 MAX CL 1.  
 ABS GR DE36 REV 2006, ABS GR EH36 REV 2006, MIL-S-22698C DE36,  
 EH36Z NOTICE 2 DTD 6/30/02 CL U, CH-V A2085 PLT T 30/25 FILBS AT  
 -40F, UT AS78 LEVEL A 100%, THUR THE PER API-2H S4, NOT API-2H  
 FLT NO BREAK AT -30F-GAS CUT 4 SIDES-PLT NORM & COOLED IN STILL AIR-TEST  
 CERTS PREPARED IN ACCORD WITH PROCEDURE OUTLINED IN EN 10204:2004 PARA 3.1  
 NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)  
 -----PLATE PASSED NOT API-2H NO BREAK AT -30F-----

ABS CERTIFICATION IS  
 LIMITED TO ONLY ABS GRADES

CON HOU-4373 CH 365-7004D

PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .8% XUL  
 PLATES ULTRASONICALLY TESTED PER ATTACHMENT  
 OUTSIDE INSPECTION BY AMERICAN BUREAU OF SHIPPING

→ C030018 812H38980 1 3 120 240 24503 52700 76200 2 35

TAB # 32612

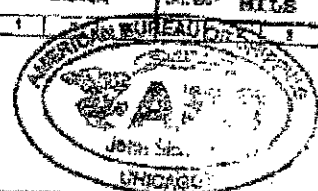
N 1650 DEG P - 152 MIN

71  
 70

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY THE  
 ARCELORMITTAL EN PLNT TO THE APPLICABLE SPECIFICATION BY AN APPROVED PROCESS  
 AND HAS BEEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN  
 BUREAU OF SHIPPING RULES FOR THE INSPECTION AND TESTING OF MATERIALS TO THE  
 SATISFACTION OF THE SURVEYORS.

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HEAT GRADE	TEST TYPE	THICKNESS INCHES	TYPE	SIZE	DR	TEST TEMP	SHARPENED LBS	SHEARIN	LAT. GR	MILL
---------------	---------	-------------	------------	-----------	------------------	------	------	----	-----------	---------------	---------	---------	------

C030018 812H38980 3.800 V FULL T -40 128 111 150



HEAT NUMBER	C	Mn	P	S	Si	Al	Ca	Ni	Cu	Mo	V	Nb	N	B	Co	N	Se	ANALYST
-------------	---	----	---	---	----	----	----	----	----	----	---	----	---	---	----	---	----	---------

812H38980 .25 1.40 .015 .003 .295.048 .13 .08.057.001.002.038.0002 .030.007.001  
 CM PCM  
 .42 .24

I hereby find the above results are a true and correct copy of actual results obtained in respects mentioned by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and shall be transmitted subject with any subsequent test results and reports, if required.

ANALYST: TP

DEPT. QUALITY ASSURANCE

D. W. ELWOOD FOR BHK



LONGHORN STEEL

OFFICE OF NON-DESTRUCTIVE TESTING

3701 ALBUQUERQUE

PART NO.

STEVE WILLIAM

Certificate of Mill Test Results

SO HOU 04154-001 155-00

Pg 1/2

## ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE  
REPORT OF TEST AND ANALYSES

SHIPPING NO.	DATE SHIPPED	SA OR VEHICLE	LMTC	PAGE
803-02134	08-13-02	INH-MCCOO-BNSF	026397	3

LONGHORN STEEL & FLAMECUTTING NORTHWOODS INDUSTRIAL PARK CENTR 11921 FM 529 HOUSTON, TEXAS 77041	LONGHORN STEEL & FLAMECUTTING NORTHWOODS INDUSTRIAL PARK CENTR 11921 FM 529 HOUSTON, TEXAS 77041
---	---

SERIAL NUMBER	SA NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY				YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
				THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT				
				INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	%

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.  
 PLATES - API - 2H GR 50 INTEGRA 2006 EDITION  
 S1, S3, S4, S5, S12MOD P.02 MAX N.01  
 MAX CE=.45X PER IIW & PCM FORMULA.  
 ASTM A633-01 GR C, ASME SA537 FVQ 2004 EDIT MOD CB-04 MAX CL 1,  
 ABS GR DH36 REV 2006, ABS GR DH36 REV 2006, MIL-S-22698C DH36,  
 EH36Z NOTICE 2 DTD 8/30/02 CL U, CH-V A2085 PLT T 30/25 FTLBS AT  
 -40F, UT A578 LEVEL A 100%, THUR THK PER API-2H S4, NDT API-2H  
 PLT NO BREAK AT -30F-GAS CUT & SIDING-PLT NORM & COOLED IN STILL AIR-TEST  
 CERTS PREPARED IN ACCORD WITH PROCEDURE OUTLINED IN EN 10204:2004 PARA 3.1  
 NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)  
 -----PLATE PASSED NDT API-2H NO BREAK AT -30F-----  
 CO# HOU-43773 GH 366-7004D  
 PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL  
 PLATES ULTRASONICALLY TESTED PER ATTACHMENT  
 OUTSIDE INSPECTION BY AMERICAN BUREAU OF SHIPPING

C030018 812H38980 1 3 120 240 24503 52700 78200 2 35

71  
70

N 1650 DEG F - 152 MIN

COOLING TEMPERATURE

TEMPERATURE

NORMALIZE TEMPERATURE

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY THE  
 ARCELORMITTAL BR PLNT TO THE APPLICABLE SPECIFICATION BY AN APPROVED PROCESS  
 AND HAS BEEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN  
 BUREAU OF SHIPPING RULES FOR THE INSPECTION AND TESTING OF MATERIALS TO THE  
 SATISFACTION OF THE SURVEYORS.

SERIAL NUMBER	PAT NO	HEAT NUMBER	HARD BHN	GEND	THICKNESS INCHES	VPS	SIZE	TEST TEMP F	CHEMICAL ANALYSIS												
									ANALYST LBS					ANALYST							
C030018		812H38980			3.000	V	FULL T	-40	128	111	150										

HEAT NUMBER	CHEMICAL ANALYSIS																MILLARD BRAND MARK
	C	Mn	P	S	Fe	Cr	Ni	Mo	V	Ti	Al	B	Co	H	Bn		
812H38980	.15	1.40	.015	.003	.298	.048	.13	.08	.057	.001	.002	.038	.0002	.030	.007	.001	
	CE	PCM															
	.42	.34															

I certify that the above results are a true and correct copy of actual results furnished to facilitate compliance with the requirements of the specification cited above. This test report cannot be altered and must be retained in the laboratory until the test results are submitted to the party test results are required.

B-01, TEST IF

QUALITY ASSURANCE

D. W. ALWOOD PER WNR



LONGHORN STEEL

ALL STEEL IS NORMALIZED TO A578 CL. 10

3" X 120.0000" X 240.0000"

PART NO.

STEVE WILLIAM

Certificate of Mill Test Results

80 HOU-041354-001-153-0

Pg. 2/2

  
ArcelorMittal

ArcelorMittal  
Burns Harbor Flat Carbon  
250 West US Highway 12  
Burns Harbor, Indiana 46304 - 1273  
August 14, 2009

Longhorn Steel & Flamecutting  
Northwoods Industrial Park Centr  
11921 FM 529  
Houston, Texas 77041

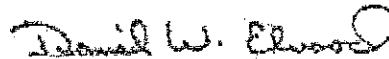
GENTLEMEN:

The following plates have been 100 percent ultrasonically inspected and found acceptable to A578 Level A.

Equipment: Epoch 081139806  
Surface: As Rolled & Normalized  
Test Method: Contact  
Couplant: Water  
Transducer: 2.25 MHz., 1" Diameter  
Manifest Number: 803-09134

Cust.	Item	Serial	Heat	Plate Size	Recordable	Technician
Order #	No.	Number	Number		Indications	Level II
HOU-4373	01	C030218-01	822J31550	1.250 x 120 x 480.00	None	C.L. Cleek
HOU-4373	02	C030038-01	812H38990	1.000 x 120 x 480.00	None	J.J. Janasiak
HOU-4373	01	C030018-01	812H38980	3.000 x 120 x 240.00	None	C.L. Cleek
HOU-4373	02	C030035-01	812H38980	2.250 x 120 x 348.00	None	C.L. Cleek

Very truly yours,  
ArcelorMittal



Daniel W. Elwood  
Quality Manager  
Burns Harbor Flat Carbon

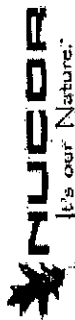


PART NO.

Alt:

**NUCOR**P.O. Box 279  
Winton, NC 27986  
(252) 356-3700**Mill Test Report**

Page 2



Issuing Date : 05/12/2009 Bill No. : 229727

Vehicle No: LW 62142

Specification: 1.5000" x 96.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09

ASTM A131-08 Grade A and B

Lead No.: 231420

Sold To: CHAPEL STEEL CO

P O Box 1000

FAX# 215-793-9415

SPRINGHOUSE, PA 19477

Cust. Order No.: HOU-4240

Ship To: CHAPEL STEEL

6605 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

NORTH HOUSTON, TX 77081

**Marking :**

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102152	0.08	1.15	0.012	0.003	0.30	0.37	0.11	0.06	0.03	0.028	0.004	0.002	0.003		0.0011	0.0004	0.016	0.32	0.17

**Tensile Test**

Plate Serial No	Places	Tons	Dir.	Yield (ksi)	Tensile (ksi)	Elongation % in 2"	Elongation % in 8"
9102152-05	2	19.60	T	37.600	59.500	28.4	24.6
		T		38.900	62.200		

**Charpy Impacts**

Dir.	(ft-lb) 1	(ft-lb) 2	(ft-lb) 3	(ft-lb) shear	(ft-lb) shear Ave.	(ft-lb) shear	Size	Temp (°F)	Min Ave.
H-L	254.2	253.5	265.7		261.1		10mm	32	20

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.002 inch method unless otherwise specified. Coq = C\*(1+0.0001\*(C-0.0001))

Pcm = C\*(S00-H\*120)/(C020+H\*120)+H\*120

Metal and manufactured in the USA. ISO 9001-2000 certified (#006461) by GRI Quality System Registrar (#0998-09). PED 9723IEC 712 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1, BEN 10204 3.1(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMP-QA-393

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Depretis*

T. A. Depretis, Metallurgist

05/20/2009 8:56:07 AM

05/15/09  
15  
9/16/09





Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metalltest@an-lab.com](mailto:metalltest@an-lab.com)

June 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40193  
Report No. 09-1150-2

IDENTIFICATION: 1-1/2" x 4" x 6", HT# 9102152, SL# 05  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-40193

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
218.0	91	100
210.0	93	100
213.0	93	100

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

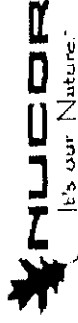
15  
JUN 15 2009  
Jp6-8-09

PART NO.

Attn:

**NUCOR**P.O. Box 279  
Winton, NC 27986  
(252) 356-3700**PLATE MILL****Mill Test Report**

Page 2



Issuing Date : 01/03/2009 B/L No. : 221830 Our Order No. : 683372 Cust. Order No. : HOU-4070  
 Vehicle No: NOKL 726177 Sold To: CHAPEL STEEL CO SHIP To: CHAPEL STEEL  
 Specification : 0.3750" x 120.000" x 480.000" P O Box 1000 8405 N. HOUSTON ROSSLYN ROAD  
 ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03/A709 36-07 FAX# 215-793-4415 RAIL SITE 720703  
 SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77061

## Marking :

Heat No	C	Min	P	S	Si	Cu	Ni	Cr	Mo	Al	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9100035	0.05	0.85	0.011	0.001	0.31	0.29	0.08	0.06	0.00	0.024	0.006	0.001	0.003		0.0020	0.0000	0.008	0.23	0.12

Plate Serial No	Tensile Test				Charpy Impacts						Min Temp Ave
	Places	Tons	Dia.	Yield	% Elongation in 2"	% Elongation in 8"	Dir.	(#) shear	(#) shear	(#) shear	

9100035-04	6	18.37	T	46,100	64,500	28.9							
			T	46,700	62,800	28.9							
9100035-07	2	6.12	T	46,100	64,500	28.9							
			T	46,700	62,800	28.9							

Manufactured to fully killed the grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Memory has not been used in the direct manufacturing of this material. Produced as continuous cast desphos plate as-rolled, unless otherwise noted in Specification.

Yield by 0.50% method unless otherwise specified. Ceq = C+(Mn/6)+(Cr+Mo+V)/5+(Cu+Ni)/15

Form = C+(Si/30)+(Mn/20)+(Cu/20)+(Nb/10)+(V/10)+(Ti/5)

Made and manufactured in the USA. ISO 9001-2000 certified (#0064611) by SRI Quality Systems Registrar (#0064611) PED 9772/EC 72 Annex 1, Para. 4.3 Compliant.

DIN 50048 3.1 (BEN 10204 3.1/2006), DIN EN 10204 3.1 (2006) compliant. For ABS grades only. Quality Assurance certificate 06-001/POA-383

T. A. Depretis

T. A. Depretis, Metallurgist

01/05/2009 8:28:19 AM

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 282265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[met@jastore.com](mailto:met@jastore.com)

Page 1 of 1

June 17, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/40375  
Report No. 09-1240-2

IDENTIFICATION: 3/8" x 4" x 6", HT# 9100035, SL# 04  
MATERIAL: A36, Mfg. NUC

IMPACT TEST

7.5mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
193.0	96	100
198.0	95	100
191.0	99	100



Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	Temp	Size	Min Ave.	
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



8-10-09

02/18/2009 From: MARMON/KEYSTONE

To: OIL STATES SKAGIT SMATCO

INIT. :BB

BR. OR:10-76191

CP.O. :4080113

## Steel Certificate of Test

1835 DUEBER AVE. S.W.

CANTON, OHIO 44706

ID #0199115-1

Page 1 of 2

# TIMKEN

Where You Turn

05/21/2008

S Marmon/Keystone Corporation  
O T PO Box 588  
L O  
D Bucyrus OH 44820 USA

S Marmon/Keystone Corporation  
H T 930 N. Sandusky Ave.  
I O  
P Bucyrus OH 44820 USA

Customer Order: 87-035738-005 Customer Part Number: 7.51.5130  
Timken Order: 53582-C (1510466) Heat Number(s): T8837

### Description of Material

OD: 7.500 in (190.500 mm) WALL: 1.500 in (38.100 mm) ID: 4.500 in (114.300 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-ULTRASONIC  
Condition: HOT ROLL

### Specification

- ASTM A 106 / A 106M Grades B and C Rev. 06a EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2004 EDITION GRADES B & C EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING
- ASTM A 519 Rev. 06
- NACE NACE MR0175/ISO 15156 Rev. 2005
- EUROPEAN STANDARD EN 10204 10/1/2004 Inspection certificate type 3.1

### Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025		.40	.40	.15	.40		.080
T8837 Ladle:	.26	.82	.011	.022	.25	.14	.15	.03	.24	.035	.001

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements. This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_

NOTARY PUBLIC

by

*Essie Dillard*

Essie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION



02/18/2009 From:MARMON/KEYSTONE

To: OIL STATES SKAGIT SMATCO

INIT. :BB

BR. OR:10-76191

CP.O. :4080113

## Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

**TIMKEN**  
Where You Turn

ID #0199115-1

Page 2 of 2

05/21/2008

Customer Order: 87-035738-005 Customer Part Number: 7.51.5130  
Timken Order: 53582-C (1510466) Heat Number(s): T8837

### Metallurgy Information

SPEC: Flattening

Material is capable of meeting flattening requirements of ASTM A106 and ASME SA106.

SPEC: Hardness MIDWALL 22 Max UOM ROCKWELL C

Heat	Piece#		UOM
T8837	A	MIDWALL 85 / 86	ROCKWELL B

SPEC: Tensile TENSILE 70,000.00 Min STRENGTH UOM PSI YIELD .2 40,000.00 Min  
MIN ELONGATION 22 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red Length	Gauge Length	Specimen	Direction
T8837	A	80,580	PSI	43,591	27.5	52.7	2 IN	0.505 in RD	LONG.

Heat T8837 Melt Source: USA  
Manufacturing: USA

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA



THE TIMKEN CORPORATION

**NUCOR**

P.O.Box 279  
Winton, NC 27986  
(252) 358-3700

## Mill Test Report

Page 3



Issuing Date : 08/15/2008

Vehicle No: NOKL 725044

Specification : 1.2500" x 96.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03/A709 36-07

Load No. : 212418

Sold To : CHAPEL STEEL CO

P O Box 1000

FAX# 215-793-9415

SPRINGHOUSE, PA 19477

Cust. Order No. : HOU-3936

Ship To : CHAPEL STEEL

6605 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

HOUSTON, TX 77091

### Marking :

Heat No	C	Min	P	S	SI	Cu	NI	Cr	Mn	AlZ	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
8106442	0.07	1.05	0.012	0.001	0.27	0.31	0.08	0.08	0.02	0.028	0.003	0.004	0.004	0.004	0.0001	0.0001	0.010	0.29	0.15

Plate Serial No	Pieces	Tens Dir.	Tensile Test		Charpy Impacts				Temp (F)	Min Ave.
			(psi) Yield	(psi) Tensile	Dir.	(ft-lb) 1 shear	(ft-lb) 2 shear	(ft-lb) 3 shear		
8106442-01	2	16.33 T	37,100	58,000	H-L	251.7	250.4	258.5	32	20
			36,400	58,100						

Manufactured to fully killed fine grain practice by Electric Arc Furnace, Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.002" method unless otherwise specified. Ceq = C+(Mn/6)+((Cu+Ni)/15)+((Cr+Mo+V)/5)+((Nb+Ti)/15)

Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/40)+(Cr/20)+(Nb/15)+(V/10)+B

Melted and manufactured in the USA, ISO 9001-2000 certified (#12443-0) by SRI Quality System Registrar (#6985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1 (EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMP-QA-152

T. A. Deprellis

T. A. Deprellis, Metallurgist

08/28/2008 4:06:41 PM

15  
03  
IN SPEC

11-1408





*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 282285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metallab@msn.com](mailto:metallab@msn.com)

November 11, 2008

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/38241  
Report No. 08-3011-5

IDENTIFICATION: 1-1/4" x 4" x 6", HT# 8106442, SL# 01  
MATERIAL: ASTM A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
222.0	91	100
222.0	89	100
239.0	86	100

*J. Pack*

Donald Derrick  
Mechanical Testing Supervisor

Sc

Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



*11-11-08*

# CERTIFIED MILL TEST REPORT

# NUCOR

## BAR MILL GROUP JEWETT DIVISION

**SOLD** DOLPHIN STEEL SALES INC  
PO BOX DS1  
TO: HOUMA, LA 70361-0000

**SHIP** DOLPHIN STEEL SALES INC  
583 THOMPSON RD  
TO: HOUMA, LA 00000-

Ship from:  
Nucor Steel - Texas  
8812 Hwy 79 W  
JEWETT, TX 75846  
903-626-4461

Date: 26-Jun-2009  
B.L. Number: 517548  
Load Number: 137229

Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

NBMG-08 March 24, 2009

Material Safety Data Sheets are available at [www.nucorcorp.com/en-us/](http://www.nucorcorp.com/en-us/)

HEAT NUM. *	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS													
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT%	DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Cb	Cu	Sn	C.E.
PO# => JW0910311301	974 Nucor Steel - Texas 2x2x1/4 Eq Ang 40' A36/A529GR50 ASTM A36/A36M-08 A529/A529M-05 ASTM A36/A36M-08	52,300 361MPa 52,700 363MPa	71,200 491MPa 71,700 494MPa	29.0% 29.0%				.12 .14	.73 .17	.019 .041	.044 .002	.20 .010	.30							.35

15  
8-31-09

I HEREBY CERTIFY THAT THE ABOVE FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION.

ALL MANUFACTURING PROCESSES OF THE STEEL MATERIALS IN THIS PRODUCT, INCLUDING MELTING, HAVE OCCURRED WITHIN THE UNITED STATES. ALL PRODUCTS PRODUCED ARE YIELD FREE.

QUALITY  
ASSURANCE:

Ben Cave

Ben R. Cave

# OCEANEERING<sup>®</sup> INSPECTION

REPORT NO. 472764

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma LA</b>	Inspection Date / Time <b>10-28-09</b>
Billing Address	Project <b>24409.7100</b>	Oil Job Number <b>52348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>MT-02 Rev-4</b>	Acceptance Criteria <b>AWS D11.6.1</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity  
ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion  
IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut  
LC = Low Crown  
NW = Narrow Weld  
P = Porosity

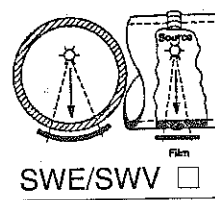
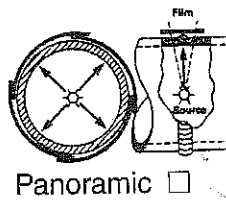
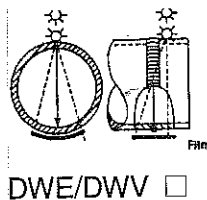
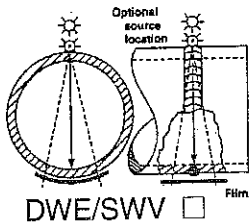
Job Description: **WIT Mark Exam of**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓	✗	REMARKS			✓	✗	REMARKS
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

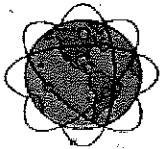
SFD

Thickness



Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: \_\_\_\_\_  
 X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: 10-28-09 Technician: AL CARLOS  
 No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_  
 Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: ES 115 SW 11021  
 Penetrator-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: 3-5° SOWE  
 Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_ Freq: 100K Cal Bloc: 1000  
 Hours Worked: 2 Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: \_\_\_\_\_  
 Sheet # 1 of 1 Subsistence (check if applicable): \_\_\_\_\_ Consumables: 1 paint  
 Specifications: 7C 06.16 Batch # 10097

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-445-6961

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## UT WORK REPORT

TERMS AND ABBREVIATIONS

HJR20090929-3

BTA--BURN THROUGH AREA  
C--CRACK

LP--LACK OF PENETRATION  
NF--NON FUSION

P--POROSITY  
SI--SLAG INCLUSIONS

CLIENT OILSTATES DATE 09/29/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
P.O. NO. 21409-01 AFE OTHER  
UT TECH Jeffrey Robichaux CLIENT'S REPRESENTATIVE LEV II

	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
			✓	✗				✓	✗	
1	100%	LAM			SCAN OF 3" UPPER	51				
2					STRUCTURE BASE	52				
3					PL. FOR 180L4	53				
4					BEFORE WELDING	54				
5						55				
6			✓		ACCEPT	56				
7						57				
8						58				
9						59				
10						60				
11						61				
12						62				
13						63				
14						64				
15						65				
16						66				
17						67				
18						68				
19						69				
20						70				
21						71				
22						72				
23						73				
24						74				
25						75				
26						76				
27						77				
28						78				GXT-UT-001-REV.
29						79				14
30						80				ASTM A578

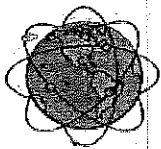
### EQUIPMENT

Model EPOCH 4B  
Serial # 31523704  
Transducer (MHz) 2.25 X .500 & 1"  
Angle Used 0-60-70  
Reference Standard AWS D1.1 SEC. 6  
CYCLICALLY LOADED CLASS R/IIW & DSC BLOCK

### CALIBRATION

db Gain 6 Sweep Delay 50  
Zero Delay          Reference Level         

Substances           
Auto Transport Miles           
Travel Time Hrs.           
Work Time Hrs.           
Standby Time Hrs.           
Total Time Hrs. 1 HR



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HMH 20091103-1

CLIENT Oilstates DATE 11/03/09  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.01.00 AFE OTHER  
MT TECH Mitchell Hebert Level II CLIENT'S REPRESENTATIVE Mitch Hebert

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.	of	Coverup areas on	51				
2	180L			Upperstructure	52				
3			✓	W5	53				
4				X93	54				
5					55				
6					56				
7					57				
8					58				
9	Total	Weld=	120"		59				
10					60				
11	Total	Repair=	0"		61				
12					62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH	006-09	
28					78	TEST	BLK.	10#	S/N#935
29					79				
30					80		Highlighter		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**

GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**

MAKE Electrospec MODEL E5-X S/N 13141

**CONTACTS**

PROD SPACING 3"-6" CONTINUOUS ☐

AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**

7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**

10# LIFT ☐ FLUX CHECK ☐ DATE: 11/03/09

**ACCEPTANCE CRITERIA**

AWS D1.1 SEC 6.10-06/ EXT-MPVWM-001-REV.17

**Statically Loaded**

Substances \_\_\_\_\_

Auto Transport Miles \_\_\_\_\_

Travel Time Hrs. \_\_\_\_\_

Work Time Hrs. \_\_\_\_\_

Standby Time Hrs. \_\_\_\_\_

Total Time Hrs. 2 Hr.



# GLOBAL X-RAY & TESTING CORPORATION

Post Office Box 1536  
Morgan City, Louisiana 70381

JOEL MOREAU, President  
Residence: 985-448-6861

Bus: 985-631-2426  
Fax: 985-631-0063

## MT WORK REPORT

HMH 20091102-2

CLIENT Oilstates DATE 11/02/09  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.01.00 AFE OTHER  
MT TECH Mitchell Hebert Level II CLIENT'S REPRESENTATIVE Mitch Oorden

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.	of	Coverup areas on	51				
2	180L			Upperstructure	52				
3		✓	WS	X96	53				
4					54				
5					55				
6					56				
7					57				
8					58				
9	Total	Weld=	120"		59				
10					60				
11	Total	Repair=	0"		61				
12					62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH	006-09	
28					78	TEST	BLK.	10#	S/N#935
29					79				
30					80	Highlighter			
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

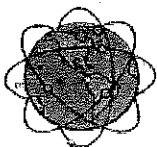
**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 11/02/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/ GXT-MPVWM-001-REV.17  
Statically Loaded

Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 Hr.

**GLOBAL X-RAY & TESTING CORPORATION**JOEL MOREAU, President  
Residence: 985-446-6861Post Office Box 1536  
Morgan City, Louisiana 70381Bus: 985-631-2426  
Fax: 985-631-0093**MT WORK REPORT**

HMH 20091030-3

CLIENT Oilstates DATE 10/30/09  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.01.00 AFE OTHER  
MT TECH Mitchell Hebert Level II CLIENT'S REPRESENTATIVE Mitchell Hebert

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.		of	Coverup areas on	51			
2	180L				Upperstructure	52			
3			✓	W5	AF	53			
4						54			
5						55			
6						56			
7						57			
8						58			
9	Total	Weld=		210"		59			
10						60			
11	Total	Repair=		0"		61			
12						62			
13						63			
14						64			
15						65			
16						66			
17						67			
18						68			
19						69			
20						70			
21						71			
22						72			
23						73			
24						74			
25						75			
26						76			
27						77	MEDIA	BATCH	006-09
28						78	TEST	BLK.	10# S/N#935
29						79			
30						80	ICAN	Highliter	
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 10/30/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/ GXT-MPVWM-001-REV.17

**Statically Loaded**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 Hrs.

# OCEANEERING<sup>®</sup> INSPECTION

REPORT NO.

488233

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>11-6-09</b>
Billing Address	Project <b>21409.07</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure <b>API 650 Rev 1</b>	Acceptance Criteria <b>ASME B7.1</b>

AD = Accumulations of Discontinuities  
 BT = Burn Through  
 BTA = Burn Through Area  
 C = Crack/Cracks  
 CP = Cluster Porosity  
 ESI = Elongated Slag Inclusion  
 EU = External Undercut  
 HB = Hollow Bead  
 IC = Internal Concavity  
 IF = Incomplete Fusion  
 IFD = Incomplete Fusion Due to Cold Lap  
 IP = Inadequate Penetration  
 IPD = Inadequate Penetration Due to High Low  
 ISI = Isolated Slag Inclusions  
 IU = Internal Undercut  
 LC = Low Crown  
 NW = Narrow Weld  
 P = Porosity

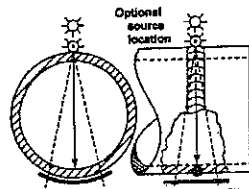
Job Description: **ULTRASONIC Exam of:**

WELD NO.	PIPE SIZE	RECOMMENDATION		REMARKS	WELD NO.	PIPE SIZE	RECOMMENDATION		REMARKS
		✓	✗				✓	✗	
1					31				
2	<b>UPPER STRUCTURE</b>				32				
3					33				
4	<b>BASE PLATE</b>				34				
5					35				
6	<b>N 60908</b>				36				
7					37				
8					38				
9					39				
10	<b>100% LAM-SCAN OF</b>				40				
11					41				
12	<b>3" BASE PLATE.</b>				42				
13					43				
14					44				
15	<b>(AFTER welding)</b>				45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

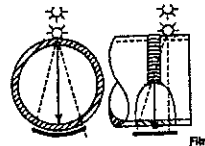
Technique: check exposure setup

SFD

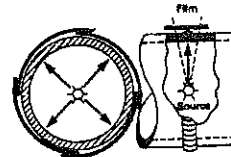
Thickness



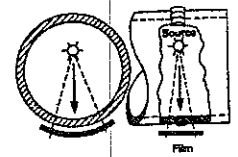
DWE/SWV ☐ Film



DWE/DWV ☐ Film



Panoramic ☐ Film



SWE/SWV ☐ Film

Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **AL CARLOS**  
 X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **11-6-09** Technician: **AL CARLOS**  
 No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_  
 Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **Site Scan SINT000510**  
 Penetrant-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **0**  
 Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_ Freq: **2.25** Cal Bloc: **ASC**  
 Hours Worked: \_\_\_\_\_ Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: **Colleg**  
 Sheet # \_\_\_\_\_ of \_\_\_\_\_ Subsistence (check if applicable): \_\_\_\_\_ Consumables: \_\_\_\_\_  
 Specifications: \_\_\_\_\_

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.



# OCEANEERING® INSPECTION

REPORT NO.

488232

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
**DAILY WORK REPORT**  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>11-6-09</b>
Billing Address	Project <b>21409.01.00</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>AUS MT-02 Rev-4</b>	Acceptance Criteria <b>AUS 31.1 6.1</b>

AD = Accumulations of Discontinuities

BT = Burn Through

BTA = Burn Through Area

C = Crack/Cracks

CP = Cluster Porosity

ESI = Elongated Slag Inclusion

EU = External Undercut

HB = Hollow Bead

IC = Internal Concavity

IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap

IP = Inadequate Penetration

IPD = Inadequate Penetration Due to High Low

ISI = Isolated Slag Inclusions

IU = Internal Undercut

LC = Low Crown

NW = Narrow Weld

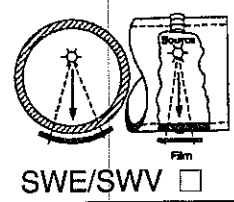
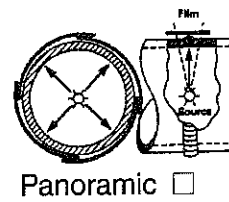
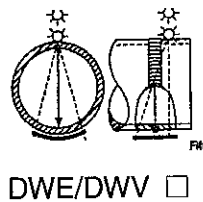
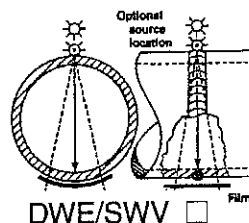
P = Porosity

Job Description: **WET MAG EXAM OF:**

RECOMMENDATION					RECOMMENDATION				
WELD NO.	PIPE SIZE	✓ X	ACCEPT REJECT	REMARKS	WELD NO.	PIPE SIZE	✓ X	ACCEPT REJECT	REMARKS
1					31				
2	Upper Structure				32				
3					33				
4	Base 180 L-4				34				
5					35				
6	N60908				36				
7					37				
8					38				
9					39				
10					40				
11					41				
12	100% MT OF ALL welds.				42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

SFD \_\_\_\_\_ Thickness \_\_\_\_\_



Film Delivered to: SS Manager: _____	Client: _____	Customer Representative: <u>AL Carlos</u>
X-Ray: _____ MAK V: _____	Gamma Ray: _____	Date: <b>11-6-09</b> Technician: <b>AL CARLOS</b>
No. of Welds Checked: _____	Focal Size: _____ Ug: _____	Assistant: _____ Assistant: _____
Linear Ft. Film: _____	Type: _____	Instrument: <b>ESX 115 SW 11021</b>
Penetrant-A _____ B _____ C _____	Required wire: _____	Angles Used: <b>3-6" SPAC</b>
Dye Penetrant: _____	Ultrasonic: _____	Mag Particle: <input checked="" type="checkbox"/>
Hours Worked: <b>2</b>	Travel Time: _____	Mileage: _____
Sheet # <b>1</b> of <b>1</b>	Subsistence (check if applicable): _____	Consumables: <b>1 Pa: AT</b>
		Specifications: <b>7C BK 10265</b>

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.

# OCEANEERING<sup>®</sup> INSPECTION

REPORT NO. 488602

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>12-12-09</b>
Billing Address	Project <b>21409.0400</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>MT02-Rev-4</b>	Acceptance Criteria <b>ASME B31.1 6.1</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

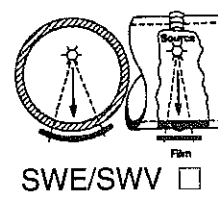
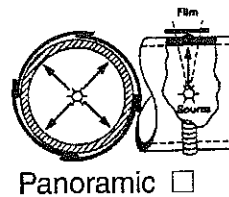
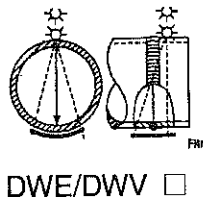
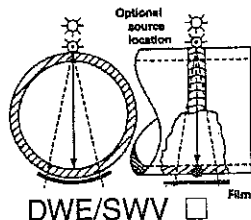
LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: **Net MAG Exam of:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓ X	ACCEPT REJECT	REMARKS			✓ X	ACCEPT REJECT	REMARKS
1					31				
2					32				
3	<b>Swing Lock</b>				33				
4					34				
5	<b>180°</b>			<b>N 2389</b>	35				
6					36				
7					37				
8					38				
9					39				
10					40				
11	<b>100% M.T. of All welds</b>				41				
12					42				
13					43				
14					44				
15					45				
16				<b>W/S</b>	46				
17				<b>103</b>	47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				<b>Level to</b>
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

SFD \_\_\_\_\_ Thickness \_\_\_\_\_



Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **Mitch Dad**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **12-12-09** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **ESX 115 SIN 11021**

Penetrameter-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **3-6" SPAC**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_ Freq: **100K** Cal Bloc: **100B**

Hours Worked: \_\_\_\_\_ Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: \_\_\_\_\_

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_ Consumables: **N/A**



Specifications: **70 Ark # 10267**

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

CRANE WO. NO.:	21409
CUSTOMER:	Constructora Subacuatica Divar
WELDMENT PART NO.:	N60909-001
WELDMENT S/N:	C09247-01
DESCRIPTION:	Upperstructure Leg Weldment
MODEL:	180L4-50
CHECKED BY:	
DATE:	11-14-09 

[illegible]



P.O. BOX 2750, Portland, Oregon 97208 • (503) 737-1200 • Fax (503) 737-1201

# REPORT OF CHEMICAL/PHYSICAL TESTS

CERTIFICATE NO.	DATE	PAGE
224795	Nov 20, 2006	2
MILL ORDER NO.	DATE	
23472		
CUSTOMER ORDER NO.		
4877		
ORDER NO.		
PT		
SHIPPING NO.	DATE	
224795	11/20/2006	
CARRIER		
UNION PACIFIC		
CARRIER NO.		
TPX80948		

TUBULAR STEEL  
1031 EXECUTIVE PARKWAY  
SAINT LOUIS, MO 63141-6351  
USA

TUBULAR STEEL  
1031 EXECUTIVE PARKWAY  
ATTN: ACCOUNTS PAYABLE  
SAINT LOUIS, MO 63141-6351  
US

**SOLD TO**

THIS MATERIAL HAS BEEN MANUFACTURED, TESTED AND FOUND TO MEET THE SPECIFICATIONS AND PURCHASE ORDER REQUIREMENTS  
CST ERW STRUCTURAL TUBING ASTM A500-03A GRADE B. CWN 25 FT/LBS AVG @ -4 F (H)  
17 FT/LBS MIN.

## PHYSICAL PROPERTIES

HEAT NO.	DESCRIPTION	HEAT NO.	SLAB	YIELD PSI X 100	TENSILE PSI X 100	% ELONG 8" 2"	% RA	HARDNESS BHN	IMPACTS
7	8.000 X 8.000 X 0.3750 X 40'	M06469							
8	10.000 X 10.000 X 0.3750 X 40'								
	Charpy Test								
	25/17 FT LBS @ -4F								
	4 PCS 7660 LBS	M05329		595	725				
9	10.000 X 10.000 X 0.5000 X 40'								
	Charpy Test								
	25/17 FT LBS @ -4F								
	8 PCS 19976 LBS	M05215		625	765				

## CHEMICAL ANALYSIS

HEAT NO.	C	Mn	P	S	Si	Cu	Ni	V	Co	Al	Cr	Mo	Ti	B	N	Cu	CE
M06469	.15	.69	.011	.005	.22	.01	.01	.000	.001	.038	.01	.01					
M05329	.14	.77	.009	.003	.23	.01	.01	.000	.002	.036	.01	.00					
M05215	.15	.73	.008	.002	.22	.02	.02	.001	.002	.037	.02	.01					
HEATS INDICATED WITH (+) WERE MELTED & MANUFACTURED IN THE USA. ALL OTHER HEATS WERE ROLLED IN THE USA.																	

I certify the above to be correct as contained in the records of COLUMBIA STRUCTURAL TUBING BY

15  
8-8-07

R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

1 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number

186012

510

Ship via

1318\_1420

4" SQ X 0.250 HR X 40'

101.6 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139530 Steel Grade 00

Heat # = 24590M08

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.760	.010	.006	.038	.011	.030	.030	.030	.010	.001	58710	70018	34

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 70 74 69 / 95 100 94

AVERAGE: ft-lbs/J 71 / 96

TEST: C TEMP: - 20.00 DEG: C

8" SQ X 0.375 HR X 40'

203.2 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139912 Steel Grade 00

Heat # = 26365M08

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.080	.740	.008	.007	.038	.013	.026	.030	.020	.010	.001	59540	69959	40

CHARPY TEST: SAMPLE SIZE: 7.5mmX10mmX55mm

RESULTS: ft-lbs/J 90 126 121 / 122 171 164

AVERAGE: ft-lbs/J 112 / 152

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



JP 5-21-09

R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

2 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number 186012

510

Ship via 1318\_1420

6" SQ X 0.500 HR X 40'

152.4 mm

Ladle Analysis and Physicals

Order # 281141

Purchase Order # 7617

A500-07 GRADE B

Item # 102370 Steel Grade 00

Heat # = 87614M09

P

BMT

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.750	.006	.005	.036	.016	.028	.010	.020	0.000	.001	52690	67125	39

3" SQ X 0.250 HR X 40'

76.2 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139533 Steel Grade 00

Heat # = 87743M09

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.770	.007	.011	.036	.011	.030	.020	.020	.010	.001	64070	74656	32

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 57 63 55 / 77 85 75

AVERAGE: ft-lbs/J 58 / 79

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



fp 5-21-09

R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

3 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number

186012

510

Ship via

1318\_1420

4" SQ X 0.250 HR X 40'

Order # 281141

101.6 mm

Ladle, Physicals, Charpy Test

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139530 Steel Grade 00

Heat # = K3703

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.080	.770	.010	.009	.022	.010	.032	.150	.070	.060	.001	68290	77194	30

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 47 50 50 / 64 68 68

AVERAGE: ft-lbs/J 49 / 66

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



5-21-09



**BULL MOOSE TUBE COMPANY**1819 Clarkson Road, Suite 100 • Chesterfield, Missouri 63017  
(636) 537-2600 • [www.bullmoosetube.com](http://www.bullmoosetube.com)

The following material supplied by Bull Moose Tube Company on BOL# 186012 meets the requirement set forth in DNV Standard for Certification No. 2.7-1; paragraph 3.1.1 Materials (steel).

4"sq x .250 x 40'  
BOL# 186012  
PO# 7617  
Heat# K3703  
Heat# 24590M08

3"sq x .250 x 40'  
BOL# 186012  
PO# 7617  
Heat# 87743M09

8"sq x .375 x 40'  
BOL# 186012  
PO# 7617  
Heat# 2636M08

Rick Cary  
Quality Assurance Manager  
ISO Coordinator  
Fax 636-530-5846  
e-mail [rcary@bullmoosetube.com](mailto:rcary@bullmoosetube.com)

Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4500  
Fax: 773-646-6128



Ref.B/L: 80304867  
Date: 07.03.2008  
Customer: 193

**Sold to**

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

**Shipped to**

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 4.0x3.0x188x40"0"0(5x4)VNMH

Material No: 40030188

Made in: USA

Melted & Manufactured in USA

Sales order: 396285

Purchase Order: 1893

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
Y65264	20	0.200	0.760	0.008	0.008	0.016	0.043	0.030	0.001	0.004	0.010	0.020	0.001

Bundle No	Yield	Tensile	Eln.2In
M800057115	069810 Psi	077750 Psi	35 %

Certification  
ASTM A500-07 GRADE B&C

Test	Sample	Absorbed	Absorbed	CHARPY Test Results	Avg	Shear	Shear	Shear	Avg
Ft_Lbs	Temp	Size	Energy1	Energy2	Absorbed	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	Energy3	%	%	%	%
					FT-LBS				
8	+14 F	10x3 mm	20	20	22	21	100	100	100

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x188x43"0"0(8x1)PBAY70

Material No: 60040188

Made in: USA

Melted & Manufactured in USA

Sales order: 382056

Purchase Order: 2261

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
C45849		0.040	1.140	0.010	0.008	0.030	0.035	0.110	0.031	0.020	0.040	0.050	0.069

Bundle No	Yield	Tensile	Eln.2In
M800055968	083530 Psi	090450 Psi	26 %

Certification  
ASTM A500-07 MOD 70Y

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x250x40"0"0(3x3)VNMH

Material No: 60040250

Made in: USA

Melted & Manufactured in USA

Sales order: 396285

Purchase Order: 1893

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2250	9	0.160	0.610	0.012	0.007	0.020	0.024	0.160	0.003	0.025	0.080	0.100	0.002

Bundle No	Yield	Tensile	Eln.2In
M800060594	065690 Psi	073260 Psi	38 %

Certification  
ASTM A500-07 GRADE B&C

Material Note:  
Sales Or.Note:

Authorized by Quality Assurance: *M. White*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



*12-1-2008*

Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4600  
Fax: 773-646-6128



Ref.B/L: 80304667  
Date: 07.03.2008  
Customer: 193

**Sold to**

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

**Shipped to**

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

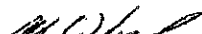
Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250				Made in: USA				
									Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893								
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2250	9	0.150	0.610	0.012	0.007	0.020	0.024	0.160	0.003	0.025	0.080	0.100	0.002
Bundle No	Yield	Tensile		Eln.2in		Certification							
MB00060593	065690 Psi	073260 Psi		38 %		ASTM A500-07 GRADE B&C							
Material Note:													
Sales Or.Note:													

Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250				Made in: USA				
									Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893								
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2251	9	0.140	0.630	0.010	0.007	0.020	0.028	0.160	0.003	0.026	0.080	0.090	0.001
Bundle No	Yield	Tensile		Eln.2in		Certification							
MB00060595	063480 Psi	069810 Psi		36 %		ASTM A500-07 GRADE B&C							
CHARPY Test Results													
Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg				
Ft_lbs	Temp	Size	Energy1	Energy2	Energy3	Area1	Area2	Area3	%				
			FT-LBS	FT-LBS	FT-LBS	%	%	%	%				
17	+14 F	10x4 mm	36	32	30	33	100	100	100	100			
Material Note:													
Sales Or.Note:													

**CHARPY Test Results**

Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg	
Ft lbs	Temp	Size	Energy1	Energy2	Energy3	FT-LBS	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	FT-LBS		%	%	%	%
17	+14 F	10x4 mm	36	32	30	33	100	100	100	100

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250					Made in: USA				
										Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893									
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	
L2251	9	0.140	0.630	0.010	0.007	0.020	0.028	0.160	0.003	0.026	0.080	0.090	0.001	
Bundle No	Yield	Tensile		Eln.2in		Certification								
MB00060596	063480 Psi	069810 Psi		36 %		ASTM A500-07 GRADE B&C								
CHАРY Test Results														
Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg					
Ft_lbs	Temp	Size	Energy1	Energy2	Energy3	Area1	Area2	Area3	%					
			FT-LBS	FT-LBS	FT-LBS	FT-LBS	%	%	%					
17	+ 14 F	10x4 mm	36	32	30	33	100	100	100	100				
Material Note:														
Sales Or.Note:														
Authorized by Quality Assurance: 														

**CHARPY Test Results**

Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg	
Ft lbs	Temp	Size	Energy1	Energy2	Energy3	FT-LBS	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	FT-LBS		%	%	%	%
17	+14 F	10x4 mm	36	32	30	33	100	100	100	100

Material Note:  
Sales Or.Note:  
Authorized by Quality Assurance: *M. Weber*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



*12-11-08*

07/14/2008 09:16 3148519338  
07/07/2008 14:09 281-371-5204

TUBULAR STEEL INC  
TUBULAR STEEL, TEXAS

PAGE 03  
PAGE 03

Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4500  
Fax: 773-646-6128

Ref.B/L: 80304667  
Date: 07.03.2008  
Customer: 193



## MATERIAL TEST REPORT

### Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

### Shipped to

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 16.0x12.0x500x40\*0\*0(1x2)NMH

Material No: 160120500

Made in: USA

Melted & Manufactured in USA

Sales order: 383649

Purchase Order: 884

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
Y65761	2	0.210	0.800	0.008	0.010	0.011	0.048	0.020	0.001	0.003	0.010	0.030	0.001

Bundle No

Yield

Tensile

Eln.2in

Certification

M900193442

058600 Psi

070880 Psi

42 %

ASTM A500-07 GRADE B&C

Material Note:

Sales Or.Note:

Material: 16.0x12.0x500x40\*0\*0(1x2)NMH

Material No: 160120500

Made in: USA

Melted & Manufactured in USA

Sales order: 383649

Purchase Order: 884

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
M85611	2	0.230	0.860	0.019	0.012	0.014	0.057	0.040	0.001	0.004	0.010	0.040	0.001

Bundle No

Yield

Tensile

Eln.2in

Certification

M900193633

061280 Psi

071450 Psi

40 %

ASTM A500-07 GRADE B&C

Material Note:

Sales Or.Note:

ALL INCLUDED ROUNDS MEET A500 GRADE B/C AND A53 NON-HYDRO-TESTED

Authorized by Quality Assurance: *M. White*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



Page : 3 Of 3



*12-10-08*

Atlas Tube (U.S.) Inc.  
13101 Eckles Road  
Plymouth, Michigan, USA  
48170  
Tel: 313-454-5600  
Fax: 313-454-1474



Ref.B/L: 80345702  
Data: 06.26.2009  
Customer: 193

Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

Shipped to

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 10.0x6.0x500x40'0"0(1x2)PB  
Sales order: 477455

Material No: 100080500  
Purchase Order: PO-008585

Made in: Canada

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
756613	0.060	0.570	0.010	0.007	0.018	0.039	0.043	0.035	0.004	0.015	0.034	0.000	0.002
Bundle No	Yield		Tensile		Elm.2in		Certification				CE: 0.17		
M200608037	063020 Psi		070730 Psi		31.6 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 12.0x4.0x500x40'0"0(1x1)PB  
Sales order: 478841

Material No: 120040500  
Purchase Order: PO-008695

Made in: Canada

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
801163	0.060	0.560	0.011	0.010	0.015	0.028	0.037	0.034	0.004	0.014	0.037	0.000	0.002
Bundle No	Yield		Tensile		Elm.2in		Certification				CE: 0.17		
M200603819	063350 Psi		077370 Psi		24.8 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 12.0x4.0x500x40'0"0(2x2).  
Sales order: 478841

Material No: 1200405004000  
Purchase Order: PO-008695

Made in: Canada

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
756198	0.060	0.600	0.014	0.006	0.016	0.027	0.035	0.032	0.005	0.013	0.048	0.000	0.002
Bundle No	Yield		Tensile		Elm.2in		Certification				CE: 0.18		
M200597957	060760 Psi		069330 Psi		31.1 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 12.0x4.0x500x40'0"0(2x2).  
Sales order: 478841

Material No: 1200405004000  
Purchase Order: PO-008695

Made in: Canada

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
801312	0.060	0.570	0.007	0.008	0.016	0.041	0.052	0.034	0.004	0.019	0.040	0.000	0.002
Bundle No	Yield		Tensile		Elm.2in		Certification				CE: 0.17		
M200605558	058030 Psi		065590 Psi		31.3 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Authorized by Quality Assurance:  
The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.

Conformity is based on the AWS D1.1 method.



15  
INSPECTED  
Jpg-16-09

Atlas Tube (U.S.) Inc.  
13101 Eckles Road  
Plymouth, Michigan, USA  
48170  
Tel: 313-454-6600  
Fax: 313-454-1474



Ref.B/L: 80345702  
Date: 06.26.2009  
Customer: 193

Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

Shipped to

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 12.0x4.0x500x48"0"0(2x2).  
Sales order: 481763

Material No: 1200405004800 Made in: Canada  
Purchase Order: PO-008695

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
758613	0.060	0.670	0.010	0.007	0.018	0.039	0.043	0.035	0.004	0.015	0.034	0.000	0.002
Bundle No	Yield		Tensile		Eln.2in		Certification				CE: 0.17		
M200608084	057880 Psi		067220 Psi		32.0 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 2.0x2.0x250x20"0"0(10x5).-D  
Sales order: 480813

Material No: 0200202502000-D Made in: USA  
Purchase Order: PO-008960

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
Y86554	0.170	0.780	0.012	0.007	0.014	0.046	0.010	0.001	0.001	0.010	0.030	0.001	0.001
Bundle No	Yield		Tensile		Eln.2in		Certification				CE: 0.31		
M300432317	071673 Psi		075399 Psi		26.0 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 2.0x2.0x250x40"0"0(10x3).-D

Material No: 0200202504000-D Made in: USA  
Melted & Manufactured in USA

Sales order: 477455

Purchase Order: PO-008586

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti
123164	0.200	0.530	0.017	0.003	0.020	0.020	0.110	0.000	0.010	0.040	0.040	0.000	0.001
Bundle No	Yield		Tensile		Eln.2in		Certification				CE: 0.31		
M300434743	070391 Psi		080148 Psi		23.0 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

ALL INCLUDED ROUNDS MEET A500 GRADE B/C AND A53 NON-HYDRO-TESTED

Authorized by Quality Assurance:  
The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.  
Conducted using the AWS D1.1 method.



OST  
15  
INSPECTED  
Jpa-16.09

**STORIK**

Materials Technology

Stork Testing &amp; Metallurgical Consulting

222 Cavalcade Street, 77009-3213  
 P.O. Box 8768, Houston, Texas 77249-8768  
 Tel: (713) 692-9151 Fax: (713) 696-6205

Attention: Accounts Payable**TUBULAR STEEL, INC.**

1031 Executive Parkway

Saint Louis, MO 63141

P: (314) 851-9200 / F: 314/851-9336

W/O. No.: TUB035-09-09-59837-1

P.O. No.: 010377-1

Report Date: 9/11/2009

Rev. 1 Re-Test

Heat No. / SO No.: 756613 / 098891

Description: 12" x 4" x 0.500"

Material: ASTM A500, B

**CHARPY TEST RESULTS**

Specification: Per Client  
 Procedure: ASTM A370 / ASTM E23  
 Direction: Longitudinal  
 Specimen Size: 10mm x 10mm x 2mm Notch

Test Temperature: +10°F  
 Specimen Type: ASTM Type A

Specimen	Location	Impact Value (Ft.Lbs.)				Lateral Expansion (Mils.)			Percent Shear Fracture		
		Individual		Avg.							
1, 2, 3		154	15	204	124	68	4	76	85	10	95
Requirements, minimum		10		15		---			---		

The samples tested conform to the specification requirements.

Respectfully Submitted:



Certificate Number 1480-05

Teent Hoagland, Mechanical Lab Supervisor

Our letters and reports are for the exclusive use of the client to whom they are addressed and shall not be reproduced except in full without the approval of the testing laboratory. The use of our name must receive our written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products. Material submitted to our metals department will be discarded after a period of 30 days unless otherwise directed.

Stork Testing & Metallurgical Consulting is an operating unit of Stork Materials Technology B.V., Amsterdam, The Netherlands, which is a member of the Stork Group.



BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

10/27/08  
Page 1 of 1

1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway Drive  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy TX 77493-1033

B/L Number 177865

Ship Via

22\_59271147

6" SQ X 0.500 HR X 40'

152.4 mm

Ladle, Physicals, Charpy Test

Order # 264490

Purchase Order # 4537

ASTM A500-03 Grade B Melted and Manufactured in the USA

Item # 137646 3840

Ticket # = 59271147

Heat # = 14235M08

C

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.080	.780	.007	.007	.033	.014	.026	.020	.020	.010	.001	59320	68364	39

CHARPY TEST: SAMPLE SIZE: 10mmX10mmX55mm

RESULTS: ft-lb/J 212 87 43 / 287 118 58

AVERAGE: ft-lb/J 114 / 155

TEST: C TEMP: - 20.00 DEG: C

Digitally signed by Robert Halsey  
DN: cn=Robert Halsey, o=Bull Moose Tube Co., ou=Elkhart, email=rhalsey@bullmoosetu.be.com, c=US  
Date: 2008.11.06 11:05:25 -05'00'

*Robert Halsey*

Quality Manager: *Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.





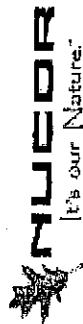
PO/Rel 4076915 ROBERT HUDSON

**NUCOR**  
 PLATE MILL

P.O. Box 279  
 Winton, NC 27986  
 (252) 356-3700

# Mill Test Report

Page 2



Issuing Date : 06/25/2008 B/L No. : 205842 Our Order No. : 6372412 Cust. Order No. : HOU-3853  
 Vehicle No. : PTIX 136542 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
 Specification : 2.0000" x 96.000" x 480.000" P O Box 1000 6805 N. HOUSTON ROSSLYN ROAD  
 ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-07 FAX# 215-793-8415 RAIL SITE 720703  
 SPRINGHOUSE, PA 19477 HOUSTON, TX 77061

Marking :

Heat No	C	Mn	P	S	Si	Cu	NI	Cr	Mo	Alz	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
8105040	0.05	1.05	0.012	0.004	0.27	0.29	0.07	0.09	0.03	0.022	0.003	0.005	0.003	0.0010	0.0002	0.014	0.28	0.14	
Plate Serial No	Tensile Test										Charpy Impacts								
	Pieces	Tons	Dir.	(ksi) Yield	(ksi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	(ft-lbs) 1 shear	(ft-lbs) 2 shear	(ft-lbs) 3 shear	(ft-lbs) 4 shear	(ft-lbs) 5 shear	Temp (°F)	Size	Min	Ave		
8105040-01	1	13.06	T	38,300	59,700	22.4	22.0	H-L	268.9	256.9	276.5	267.4	267.4	32	10mm	32	20		
8105040-02	1	13.06	T	38,300	59,700	22.4	22.0	H-L	268.9	256.9	276.5	267.4	267.4	32	10mm	32	20		



Manufactured to fully killed fine grain practice by Electric Arc Furnaces. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5EL method unless otherwise specified.  $Ceq = C + (Mn/16) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$   
 Pen = C-HS800-H(Mn/20)+H(Cu/20)+H(Ni/60)+H(Cr/20)+H(Mo/15)+H(V/10)+S8  
 Melted and manufactured in the USA, ISO 9001:2000 certified (#12443-0) by SSI Quality System Registrar (#0985-09), PED 97723/EC 712 Annex 1, Para. 4.3 Compliant.  
 DIN 50449 3.1, EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMPQA-182

T. A. Dapretto  
 T. A. Dapretto, Metallurgist

07/07/2008 11:48:56 AM



Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metalltesters@msn.com

October 28, 2008

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/38108  
Report No. 08-2892-1

IDENTIFICATION: 2" x 4" x 6", HT# 8105040, SL# 02  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-38108

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
237.0	92	100
217.0	89	100
235.0	96	100

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



PART NO.

Attn:

**NUCOR**

P.O.Box 279

Winton, NC 27986

**PLATE MILL** (252) 356-3700**Mill Test Report**

Page 2



Issuing Date : 07/15/2009

B/L No. : 234367

Vehicle No: ATW 116026

Specification : 1.0000" x 120.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS

ASTM A131-08 Grade A and B

Load No. : 236136

Sold To : CHAPEL STEEL CO

P O Box 1000

FAX# 215-793-9415

SPRINGHOUSE, PA 19477

Our Order No. : 73769/H1

Ship To: CHAPEL STEEL

6603 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

NORTH HOUSTON, TX 77081

Cust. Order No. : HOU-4302

**Marking :**

Heat No.	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(%)	V	Nb	Ti	N	Ca	B	Sh	CEQ	PCM
9103398	0.18	0.83	0.011	0.001	0.08	0.25	0.08	0.10	0.01	0.022	0.004	0.002	0.001	0.0005	0.0002	0.010	0.36	0.24	

Plate Serial No	Tensile Test			Elongation			Charpy Impacts			Min Ave.	
	Pieces	Tens	Dir.	(ksi) Yield	(ksi) Tensile	% in 2"	Dir.	1	2	3	Temp Ave.
9103398-06	2	16.33	T	44,200	70,700	24.9		(%) shear	(%) shear	(%) shear	
			T	40,900	70,000	22.3					
9103398-07	3	24.50	T	44,200	70,700	24.9					
			T	40,900	70,000	22.3					



8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.002" method unless otherwise specified.  $Eq = C + (Mn/6) + (Cr + Mo + V/5) + ((Cu + Ni)/15)$

$Pcm = C + (Si/20) + (Mn/20) + (Cu/20) + (Nb/10) + (V/10) + (B)$

Melted and manufactured in the USA, ISO 9001-2000 certified (R006461) by SRI Quality System Registrar (R0985-08). PED 9723/IEC 712 Annex 1, Para. 4.3 Compliant.

DIN 50048 3.1 (EN 10204 3.1 (2004)). DIN EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

07/16/2009 9:05:54 AM

T.A. Deparis, Metallurgist

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
mailto:info@an-tech.com

August 6, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40860  
Report No. 09-1555-2  
RETEST

IDENTIFICATION: 1" x 4" x 6", HT# 9103398, SL# 07  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40860

**IMPACT TEST**

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
15.0	22	10
71.0	70	40
18.0	31	10

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



28-10-09

# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	Temp	Size	Min Ave.	
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

A handwritten signature in black ink, appearing to read 'Donald Derrick', is written over a horizontal line.

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



8-10-09

**Steel Certificate of Test**1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

ID #0213396-1

Page 1 of 2

**TIMKEN**

Where You Turn

10/23/2008

S Tubular Steel Inc.  
O T 1031 EXECUTIVE PARKWAY DR  
L O  
D ST LOUIS MO 63141 USAS TUBULAR STEEL INCORPORATED  
H T 27700 KATY BROOKSHIRE RD  
I O  
P KATY TX 77494 USACustomer Order: 004061 LINE 4 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 52657-F (1541089) Heat Number(s): F1362**Description of Material**OD: 5.500 in (139.700 mm) WALL: 0.750 in (19.050 mm) ID: 4.000 in (101.600 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-VACUUM DEGAS-ULTRASONIC  
Condition: HOT ROLL**Specification**

- ASME SA-106 Rev. 2004 EDITION GRADES B & C EXCEPT TOLERANCES & EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM A 106 / A 106M Grades B and C Rev. 06a EXCEPT TOLERANCES & EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM A 105 / A 105M Rev. 05 FOR CHEMISTRY & PROPERTIES ONLY
- ASME SA-105/SA-105M Rev. 2004 EDITION FOR CHEMISTRY AND MECH PROPERTIES ONLY
- ASTM A 519 Rev. 06
- NACE NACE MR0175/ISO 15156 Rev. 2005
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING

**Chemistry Information**

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025	.35	.30	.40	.12	.40		.080
F1362 Ladle:	.26	.82	.008	.018	.26	.08	.13	.04	.28	.030	.001

**Metallurgy Information**

SPEC: Grain Size SIZE 5/FINER

5/FINER

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements including the purchase order, specification(s) and exception(s). This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_

NOTARY PUBLIC

by



Essie Dillard, CERTIFICATION PROCESSOR

**THE TIMKEN CORPORATION**


**Steel Certificate of Test**1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706**TIMKEN**  
Where You Turn

ID #0213396-1

Page 2 of 2

10/23/2008

Customer Order: 004061 LINE 4 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 52657-F (1541089) Heat Number(s): F1362Metallurgy Information (cont.)

SPEC: Hardness MIDWALL 187 Max UOM BRINELL

Heat	Piece#		UOM
F1362	A	MIDWALL 158 / 167	BRINELL

SPEC: Tensile TENSILE 70,000.00 Min STRENGTH UOM PSI YIELD .2 40,000.00 Min  
MIN ELONGATION 22 Min MIN REDUCTION IN AREA 30 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red	Gauge Length	Specimen	Direction
F1362	A	81,000	PSI	46,300	30.0	59.0	2 IN	.502" RD	LONG.

THIS TEST WAS PERFORMED AT STORK-HERRON TESTING LABORATORIES

Heat F1362 Melt Source: USA  
Manufacturing: USA

Flattening test - Satisfactory

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

No welding of this material has occurred.

THE TIMKEN CORPORATION



# OCEANEERING<sup>®</sup> INSPECTION

REPORT NO. 488231

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Customer <b>OIL / STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>11-6-09</b>
Billing Address	Project <b>21409.02.00</b>	OII Job Number <b>57398</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>AW 5 MTO2 Rev-4</b>	Acceptance Criteria <b>AW 5 D11 G1</b>

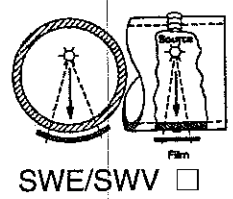
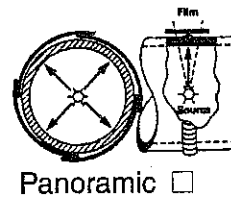
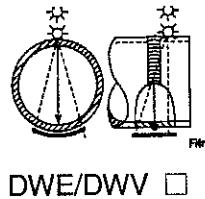
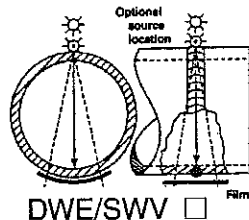
AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity  
ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion  
IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut  
LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: **WET MAG Exam AF:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓	ACCEPT	REMARKS			✓	ACCEPT	REMARKS
1					31				
2	<b>Upper structure</b>			<b>Leg</b>	32				
3					33				
4	<b>180 L4</b>			<b>N 60909</b>	34				
5					35				
6					36				
7					37				
8					38				
9					39				
10	<b>100% m.t. of ALL welds.</b>				40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17				<b>Acc w/s</b>	47				
18				<b>H, U-2, x96</b>	48				
19				<b>AF</b>	49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

SFD \_\_\_\_\_ Thickness \_\_\_\_\_



Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **Mac**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **11-6-09** Technician: **AL** **MR105**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **ESK115 SIM 11021**

Penetrameter-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **36" SPAC**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: ☒ Achieved wire: \_\_\_\_\_ Freq: **110K Cal Bloc: 103**

Hours Worked: **2** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: \_\_\_\_\_

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_ Consumables: **1 paint**

Specifications: **7C BK 10265**

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

**CRANE WO. NO.:** 21409

**CUSTOMER:** Constructora Subacuatica Divar

**WELDMENT PART NO.: N60888-001**

**WELDMENT S/N:** C09247-03

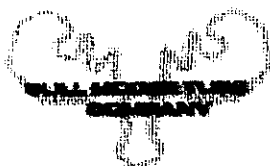
**DESCRIPTION:** Boom Base Weldment

**MODEL:** 180L4-50

**CHECKED BY:**

DATE:

[illegible]



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09

Page 1 of 2

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

2" SQ X 0.250 HR X 40'

50.8 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 54229336

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.670	.010	.007	.020	.040	.024	.140	.050	.040	.001	60280	70950	36

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 57 57 52 / 77 77 71

AVERAGE: ft-lb/J 55 / 75

TEST: C TEMP: - 20.00 DEG: C

4" SQ X 0.250 HR X 40'

101.6 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 59288105

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.670	.010	.007	.020	.040	.024	.140	.050	.040	.001	60280	70950	36

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 60 60 60 / 81 81 81

AVERAGE: ft-lb/J 60 / 81

TEST: C TEMP: - 20.00 DEG: C

5" SQ X 0.250 HR X 40'

127.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 399165

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.070	.760	.010	.006	.030	.060	.022	.180	.080	.080	.001	60550	72338	34

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 77 89 92 / 104 121 125

AVERAGE: ft-lb/J 86 / 117

TEST: C TEMP: - 50.00 DEG: C

Quality Manager:

Richard Lary

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



7-27-09



BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09

Page 2 of 2

1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

5" SQ X 0.187 HR X 40'

127.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 399168

C	MN	P	S
.060	.740	.011	.008

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = 76144M09

AL	SI	CB	CU
.032	.015	.030	.010

Order # 287944

Purchase Order # 8745

Item # 140610 3200

C

NI	VA	YLD psi	TSN psi	ELN
0.000	.001	58090	69843	30

CHARPY TEST: SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 40 40 48 / 54 54 65

AVERAGE: ft-lb/J 43 / 58

TEST: C TEMP: - 50.00 DEG: C

10" X 5" X 0.375 HR X 40'

127.0 X 254.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 59285056

C	MN	P	S
.060	.680	.010	.010

Ladle Analysis and Physicals

Structural-Dual Certified

Heat # = L3838

AL	SI	CB	CU
.033	.020	.020	.170

Order # 287946

Purchase Order # 8917

Item # 107668 3210

P

NI	VA	YLD psi	TSN psi	ELN
.090	.001	57600	71127	37

Quality Manager:

Richard Long

15  
INSPECTED  
JUL 27 2009

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

## REQUEST FOR COMPLIANCE

To: Tubular  
Attention:



Bull Moose Tube Company - Elkhart, Indiana has received your request for compliance or certification / MTR. Information supplied in your request is as follows:

<b>Requested Grade:</b>	<b>B&amp;C</b>	<b>Bill of lading number:</b>	
<b>Bill of lading date:</b>		<b>Size of tubing:</b>	<b>4 X 4 X 1/4</b>
<b>Gauge:</b>	<b>1/4</b>	<b>Length:</b>	<b>40"</b>
<b>Heat number:</b>	<b>M0689</b>	<b>Bundle tag numbers:</b>	<b>59288195</b>

Notification of Compliance

Based on the above submitted information, the tubing referenced does meet the chemical and physical properties of ASTM A500-01 Grade "C". Specific chemical and physical properties of respective tubing is as follows.

<b>C. .050</b>	<b>Mn. .670</b>	<b>P. .010</b>	<b>S. .007</b>
<b>AL. .020</b>	<b>Si. .040</b>		
<b>Yield Strength (psi)</b>	<b>60,280</b>	<b>Tensile Strength (psi)</b>	<b>70,950</b>
		<b>% Elongation</b>	<b>0.36</b>

Charpy Test

<b>Test Temp. -40d C</b>	<b>Ft/Lbs</b>	<b>Ft/Lbs</b>	<b>Ft/Lbs</b>	<b>Average</b>
<b>Specimen Size</b>	<b>Test 1</b>	<b>Test 2</b>	<b>Test 3</b>	
<b>5mmX10mmX55mm</b>	<b>58</b>	<b>58</b>	<b>53</b>	<b>56</b>

This welded steel tubing is manufactured in the USA and has been produced in accordance with the stated specification. Ladle chemistries are reported from documents provided by the supplying steel mill. Any physical and mechanical testing results shown on this notification are correct as contained in the records of the company.

Approved By: Rick Cary

Quality Assurance Manager

Date: 6/26/2009

Bull Moose Tube Company  
P.O. Box 1037  
Elkhart Indiana 46515

OST  
15  
INSPECTED  
JP 7-27-09



160 DAIN AVENUE, P.O. BOX 1010  
WELLAND, ONTARIO  
CANADA L3B 5Y6  
T. 905-735-7473  
F. 905-735-6215

**METALLURGICAL TEST  
CERTIFICATE  
CERTIFICAT D'ESSAIS  
METALLURGIQUE**

Certified Test Report Type 3.1.B  
in accordance with EN 10204

OUR ORDER NO.  
NOTRE N° DE COMMANDE  
111747

PAGE  
3

DATE  
MO. 05 29  
YEAR. 2009

CUSTOMER ORDER NO.  
N° DE COMMANDE DU CLIENT  
5372

DESCRIPTION & SPECIFICATION / DESCRIPTION & NORME

ASTMA106-06A/ASME SA106-07 B/C

05

WE HEREBY CERTIFY THAT THE MATERIAL SHIPPED ON THIS ORDER HAS BEEN TESTED AND/OR INSPECTED ON THE BASIS OF SAMPLES TAKEN FROM THE LOT OR QUANTITY DESCRIBED, FOUND TO BE IN ACCORDANCE WITH THE SPECIFICATION AND/OR DRAWING. THAT, SUBJECT TO THE COMPANY'S STANDARD PRACTICES OF RECORD KEEPING, THE RESULTS ARE CONTAINED IN ITS RECORDS.

DIXIE PIPE SALES, INC.  
2407 BROOKLIER  
HOUSTON, TX  
USA 77054

SMLS HSR PIPE ASTMA106-06A/ASME SA106-07 B/C R  
SEAMLESS  
1.660" OD X .191" WALL

Country of Manufacture: MAN Country of Melt: MELT  
LB/FT 3.00

MANAGER, METALLURGY & QUALITY ASSURANCE/  
DIRECTEUR, METALLURGIE ET ASSURANCE QUALITÉ  
Carmen Filice

CUSTOMER REPRESENTATIVE/REPRÉSENTANT DU CLIENT

PER/PAR  
SHN1

Country of Origin: USA

NACE MR0175/ISO 15156

HEAT OR LOT NO.  
N° DE COULÉE-N° DE LOT

**CHEMICAL ANALYSIS/COMPOSITION CHIMIQUE**

C	Mn	P	S	Si	Cu	Ni	Cr	V	Cb	C/E	TENSILE TEST RESULTS RÉSULTATS D'ESSAI DE TRACTION			WELD STRENGTH RESISTANCE DE LA SOUDURE
											YIELD LE	TENSILE L.T.	% ELONG. D'ALL.	A/B
.20	1.07	.011	.002	.240	.030	.030	.060	.001	.001	.41	KSI 49.9	KSI 74.4	46	.67

2X B68388  
MAN: USA / MELT: USA

PRESSURE TESTED AT  
PRESSION D'ESSAI  
2500 PSI

HEAT OR LOT NO.  
N° DE COULÉE-N° DE LOT

HARDNESS/DURETÉ  
ROCKWELL B  
BODY CORPS

PIPE NO.  
TUBE N°

PLATE OR COIL NO.  
TOLE OU BOBINE N°

CHARPY  
#1 #2 #3 AVG.

% S.A.

Lot No.

MECHANICAL TESTS/ESSAIS MÉCANIQUES

FLAT/APLATTISSEMENT  
DUCTILITY  
DUCTILITÉ

90° BEND/PLIAGE 90°  
PASSED

REV. FLAT  
APLATTISSEMENT RENV.

FLANGE/COLLET

FLARE/D'ÉVASAGE

79

147

2X B68388

**MILL TEST REPORTS  
FOR PO#  
DIXIE PIPE SALES, L.P.**



7-29-09

THIS CERTIFICATE MUST NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF LAKESIDE STEEL CORPORATION.  
LE PRÉSENT CERTIFICAT NE PEUT ÊTRE REPRODUIT QU'EN SA VERSION INTÉGRALE ET SANS L'AUTORISATION ÉCRITE DE LA CORPORATION D'ACIER LAKESIDE

GUIDED BANDING GUIDE

ROOT/SOURCE



# SRC MATERIALS TESTING, LLC

STEPHEN R. CALLEGARI, SR., P.E.

P.O. BOX 81903 LAFAYETTE, LA 70598-1903  
100 CARDINAL DRIVE LAFAYETTE, LA 70508-4449

(337) 837-3810 Fax (337) 837-5710  
srcengineers.com

## CERTIFICATE OF ANALYSIS

Date: July 23, 2009 P.O. No.: 10103  
Company: Dixie Pipe Sales, Inc.  
Test: Charpy V-Notch (Type B) Impact Test Per ASTM A-370, E-23  
Test Performed on: 1-1/4" Schedule 80 A106 Grade B SMLS Heat No. B68388  
Size of Specimens: Sub Size (10 mm x 4 mm x 55 mm)  
Test Temperature: +10°F Orientation of Specimens: Longitudinal

This Certificate may not be altered, deleted from, published and/or used except in full.

SPECIMEN NUMBER	SUB-SIZE RESULTS* Joules	ABSORBED ENERGY** Joules	SUB-SIZE RESULTS* ft-lbf	ABSORBED ENERGY** ft-lbf	PERCENT SHEAR FRACTURE	LATERAL EXPANSION (mils)
B68388-1	122	49	90	36	60	51
B68388-2	102	41	75	30	60	40
B68388-3	122	49	90	36	60	50
Average	115	46	85	34	60	47

\* THESE RESULTS ARE THE MODIFIED TEST RESULTS AS PER ASTM A-370 — ACTUAL TEST RESULTS ARE INCREASED BECAUSE SPECIMENS WERE MACHINED TO SUBSIZE DUE TO ACTUAL PIECE THICKNESS.

\*\* ACTUAL RECORDED TEST RESULTS.

SRC Job No. 09-0967

Tested By: *Ryan Jones*

Date: July 22, 2009

Reviewed By: *Barry Beirnat*

Date: July 23, 2009



*pp7-29-09*



No. 66432

Date 4/02/08

# MILL CERTIFICATE

Sales Order No.: 67346

Customer : TUBULAR STEEL INC

Specification : A500B

736-5 AL

Article :



8901 Arrow Route • P.O. Box 3059 • Rancho Cucamonga, CA 91730  
(909) 348-3060

THIS PRODUCT WAS MANUFACTURED IN THE U.S.A.

Article	S i z e	Quantity		Hydrostatic Test		Chemical Composition (Ladle Analysis)						Tensile Test			Rockwell (B) Hardness Test	(Heat No.)
		Number of Pieces	Calculated Weight Per lb	Test Pressure	Result	C (%) x 100	Mn (%) x 100	P (%) x 1000	S (%) x 1000	Si (%) x 100	Yield Strength ( - )	Tensile Strength ( - )	Elongation (%)			
2 SQ X .188 X HR 40'	50	4.310			16	76	10	13	5	61000	65000	25	E18718			
2 SQ X .250 X HR 20'	72	5.400			14	78	13	4	13	57000	65000	26	M83482			
2 SQ X .250 X HR 40'	50	5.400			18	86	16	2	16	67000	71000	23	JN7878			
2-1/2 SQ X .188 X HR 40'	30	5.590			15	75	14	10	5	58000	66000	26	E18741			

SEARING INDUSTRIES, INC.

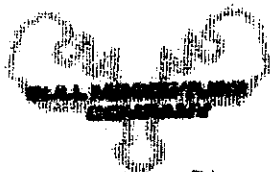
SEARING INDUSTRIES, INC.

We hereby certify that the material described herein  
conforms fully to the said specification.

*Robert King*  
(Chief - Laboratory Services)



pp8-18-09



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

09/24/09

Page 1 of 2

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 196076

Ship Via

08 216

3" SQ X 0.250 HR X 40'

76.2 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 290490

Purchase Order # 9505

Item # 139533 1920

Ticket # = 54232880

Heat # = M1484

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.690	.009	.010	.031	.030	.022	.150	.090	.070	.002	61720	71690	35

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 71 72 84 / 96 98 114

AVERAGE: ft-lb/J 76 / 103

TEST: C TEMP: -20.00 DEG: C

3" SQ X 0.250 HR X 48'

76.2 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 290490

Purchase Order # 9505

Item # 140950 1920

Ticket # = 54232879

Heat # = M1484

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.690	.009	.010	.031	.030	.022	.150	.090	.070	.002	61720	71690	35

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 71 72 84 / 96 98 114

AVERAGE: ft-lb/J 76 / 103

TEST: C TEMP: -20.00 DEG: C

4" X 2" X 0.187 HR X 40'

50.8 X 101.6 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 294736

Purchase Order # 10207

Item # 140304 1288

Ticket # = 405898

Heat # = 88493M09

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.770	.009	.007	.040	.013	.034	.010	.020	0.000	.001	60450	70306	31

CHARPY TEST: SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 25 35 34 / 34 47 46

AVERAGE: ft-lb/J 31 / 42

TEST: C TEMP: -20.00 DEG: C

Quality Manager:

Richard Long

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



10-7-09

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

09/24/09  
Page 2 of 2

1810 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 198076

Ship Via

08 216

4" X 2" X 0.187 HR X 40'

50.8 X 101.8 mm

ASTM A500-07 GRADE B & C

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 294736

Purchase Order # 10207

Item # 140304 1288

Ticket # = 405899

Heat # = L4485

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.710	.009	.004	.026	.030	.022	.200	.080	.080	.002	62320	70601	32

CHARPY TEST: SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 32 32 30 / 43 43 41

AVERAGE: ft-lb/J 31 / 42

TEST: C TEMP: - 20.00 DEG: C

6" SQ X 0.312 HR X 40'

152.4 mm

ASTM A500-07 GRADE B & C

Certified to DNV No. 2.7-1; paragraph 3.1.1

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Order # 294915

Purchase Order # 10164

Item # 141344 3840

Ticket # = 59299608

Heat # = M1120

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.860	.011	.007	.028	.030	.021	.160	.100	.090	.001	61260	71000	32

CHARPY TEST: SAMPLE SIZE: 6.7mmX10mmX55mm

RESULTS: ft-lb/J 90 102 102 / 122 138 138

AVERAGE: ft-lb/J 98 / 133

TEST: C TEMP: - 20.00 DEG: C

12" X 10" X 0.375 HR X 40'

254.0 X 304.8 mm

ASTM A500-07 B MELTED & MFG USA

Raw Material Is of Domestic Origin - Melted and Manufactured In the USA

Ladle Analysis and Physicals

Order # 295586

Purchase Order # 10085

Item # 141431 6405

Ticket # = 59299823

Heat # = 96203M09

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.064	.781	.007	.007	.045	.014	.028	.011	.017	.009	.001	58490	67590	38

Quality Manager:

*Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

15  
10-7-09

**NUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1



Issuing Date : 08/01/2009  
Vehicle No: LW 62017  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-06/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09  
ASTM A131-08 Grade A and B

Cust. Order No.: HOU-4302  
Ship To: CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77091

Our Order No.: 73769/3  
Sold To: CHAPEL STEEL CO  
P.O. Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

## Marking :

Heat No	C	Min	P	S	SI	Cu	Ni	Cr	Mo	Alt	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9103798	0.06	0.82	0.008	0.002	0.31	0.28	0.13	0.08	0.03	0.027	0.003	0.002	0.002	0.002	0.0034	0.0003	0.013	0.25	0.13

Plate Serial No	Tensile Test				Charpy Impacts								Min Temp Ave.	
	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1 shear	2 shear	3 shear	4 shear		Size
9103798-03	6	19.60	T	44,000	60,900	30.6	30.6							
			T	40,000	59,400	30.6	30.6							
9103798-04	6	19.60	T	44,000	60,900	30.6	30.6							
			T	40,000	59,400	30.6	30.6							

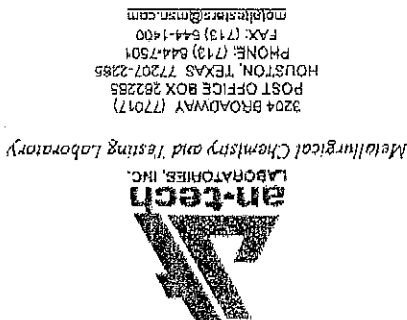
ASTM A283-03 GRADE C

OST 15 INSPECTED  
Jpa-14-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or field repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5%EL method unless otherwise specified. Def = C(44,000)+4(C(40,000)-44,000)<sup>0.5</sup>  
Pan = C(59,400)+4(40,000)<sup>0.5</sup>  
Met and manufactured in the USA. ISO 9001-2000 certified (#006481) by SRI Quality System Registrar (#0085-09). PED 9723/EC 712 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1 BEN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

T. A. Deprelis, Metallurgist  
08/07/2009 9:02:13 AM



3204 BROADWAY (77017)  
POST OFFICE BOX 282255  
HOUSTON, TEXAS 77207-2255  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metl@an-tech.com

September 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103798, SL# 03  
MATERIAL: A36, Mfg. NUC

IMPACT TEST		
10mm x 10mm CVN @ +10°F		
(Longitudinal)		
Foot/Pounds	220.0	100
	216.0	104
	218.0	103
Lateral Expansion (mils)		
%Shear	100	100

15  
09-14-09  
Donald Derrick  
Mechanical Testing Supervisor

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

Sc

# LUNGHORN STEEL

API 2H GR 80 INTEGRAL TO ABS 2005 EDITION  
 3" X 120" X 240" X 240"  
 PART NO.

STEVE WILLIAM

## Certificate of Mill Test Results

SP HOU-041354-001 155  
 Pg 1/1

### Arceformittal Burns Harbor Plate

SHIPMENT NO. 801-09114	DATE SHIPPED 08-13-09	DRAWING NO. IHP-MC000-BWSE	ENITC 036327	PAGE 3
---------------------------	--------------------------	-------------------------------	--------------	--------

Longhorn Steel & Flamecutting  
 Northwoods Industrial Park Centr  
 11921 FM 529  
 Houston, Texas 77041

Longhorn Steel & Flamecutting  
 Northwoods Industrial Park Centr  
 11921 FM 529  
 Houston, Texas 77041

CH1720281

SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO PCS	THICKNESS	WIDTH IN DIA	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG	RED
---------------	---------	-------------	--------	-----------	--------------	--------	--------	-------------	------------------	-------	-----

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A. POUNDS PSI PSI IN %

PLATES - API 2H GR 80 INTEGRAL 2005 EDITION

S1, S2, S4, S5, S12 MOD P.02 MAX N.01

MAX CE=.45% PER IIR & PCM FORMULA,

ASTM A633-01 GR C, ASME SA537 PVQ 2004 EDIT MOD CB.04 MAX CL 1.

ABS GR DE36 REV 2006, ABS GR EH36 REV 2006, MIL-S-22698C DE36,

EH36Z NOTICE 2 DTD 6/30/02 CL U, CH-V A2085 PLT T 30/25 FILBS AT

-40F, UT AS78 LEVEL A 100%, THUR THE PER API-2H S4, NOT API-2H

FLY NO BREAK AT -30F-GAS CUT 4 SIDES-PLT NORM & COOLED IN STILL AIR-TEST

CERTS PREPARED IN ACCORD WITH PROCEDURE OUTLINED IN EN 10204:2004 PARA 3.1

NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

-----PLATE PASSED NOT API-2H NO BREAK AT -30F-----

CON HOU-4373 CH 365-7004D

PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .8% YUL

PLATES ULTRASONICALLY TESTED PER ATTACHMENT

OUTSIDE INSPECTION BY AMERICAN BUREAU OF SHIPPING

ABS CERTIFICATION IS  
 LIMITED TO ONLY ABS GRADES

→ C030018 812H38980 1 3 120 240 24503 52700 76200 2 35

71  
 70

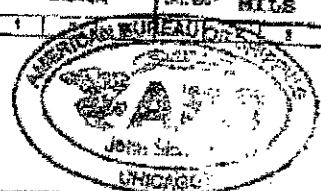
TAB # 32612

N 1650 DEG P - 152 MIN

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY THE  
 ARCELORMITTAL EN PLNT TO THE APPLICABLE SPECIFICATION BY AN APPROVED PROCESS  
 AND HAS BEEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN  
 BUREAU OF SHIPPING RULES FOR THE INSPECTION AND TESTING OF MATERIALS TO THE  
 SATISFACTION OF THE SURVEYORS.

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HEAT GRADE	END	THICKNESS INCHES	TYPE	SIZE	DR	TEST TEMP	SHOCK T LBS	SHEARIN	LAT. GR. MILS
---------------	---------	-------------	------------	-----	------------------	------	------	----	-----------	-------------	---------	---------------

C030018 812H38980 3.800 V FULL T -40 128 111 150



HEAT NUMBER	C	Mn	P	S	Si	Ca	Ni	Cr	Mo	V	Nb	N	B	Cu	N	Sn	MAKING GRADE
-------------	---	----	---	---	----	----	----	----	----	---	----	---	---	----	---	----	--------------

812H38980 .25 1.40 .015 .003 .295.048 .13 .08.057.001.002.038.0002 .030.007.001  
 CM PCM  
 .42 .24

I hereby find the above results are a true and correct copy of actual results obtained in respects mentioned by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and shall be transmitted subject with any subsequent test data and reports, if required.

AMPLIFY TO:

DO NOT QUALITY ASSURANCE

D. W. ELWOOD FOR BNS



LONGHORN STEEL

OFFICE OF NON-DESTRUCTIVE TESTING

3701 ALBUQUERQUE

PART NO.

STEVE WILLIAM

Certificate of Mill Test Results

SO HOU 04154-001 155-00

Pg 1/2

## ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE  
REPORT OF TEST AND ANALYSES

SHIPMENT NO.	DATE SHIPPED	SA OR VEHICLE	LMTC	PAGE
803-02134	08-13-02	INH-MCCOO-BNSF	026397	3

LONGHORN STEEL & FLAMECUTTING NORTHWOODS INDUSTRIAL PARK CENTR 11921 FM 529 HOUSTON, TEXAS 77041	LONGHORN STEEL & FLAMECUTTING NORTHWOODS INDUSTRIAL PARK CENTR 11921 FM 529 HOUSTON, TEXAS 77041
---	---

SERIAL NUMBER	SA NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY				YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
				THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT				
				INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	%

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.  
 PLATES - API - 2H GR 50 INTEGRA 2006 EDITION  
 S1, S3, S4, S5, S12MOD P.02 MAX N.01  
 MAX CE=.45X PER IIW & PCM FORMULA.  
 ASTM A633-01 GR C, ASME SA537 FVQ 2004 EDIT MOD CB-04 MAX CL 1,  
 ABS GR DH36 REV 2006, ABS GR DH36 REV 2006, MIL-S-22698C DH36,  
 EH36Z NOTICE 2 DTD 8/30/02 CL U, CH-V A2085 PLT T 30/25 PTLBS AT  
 -40F, UT A578 LEVEL A 100%, THUR THK PER API-2H S4, NDT API-2H  
 PLT NO BREAK AT -30F-GAS CUT & SIDING-PLT NORM & COOLED IN STILL AIR-TEST  
 CERTS PREPARED IN ACCORD WITH PROCEDURE OUTLINED IN EN 10204:2004 PARA 3.1  
 NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)  
 -----PLATE PASSED NDT API-2H NO BREAK AT -30F-----  
 CO# HOU-43773 GH 366-7004D  
 PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL  
 PLATES ULTRASONICALLY TESTED PER ATTACHMENT  
 OUTSIDE INSPECTION BY AMERICAN BUREAU OF SHIPPING

C030018 812H38980 1 3 120 240 24503 52700 78200 2 35

71  
70

N 1650 DEG F - 152 MIN

COOLING TEMPERATURE

TEMPERATURE

NORMALIZE TEMPERATURE

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY THE  
 ARCELORMITTAL BR PLNT TO THE APPLICABLE SPECIFICATION BY AN APPROVED PROCESS  
 AND HAS BEEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN  
 BUREAU OF SHIPPING RULES FOR THE INSPECTION AND TESTING OF MATERIALS TO THE  
 SATISFACTION OF THE SURVEYORS.

SERIAL NUMBER	PAT NO	HEAT NUMBER	HAND BHT.	GEND	CHEMIST ANALYST															
					THICKNESS INCHES	VPS	SIZE	TEST TEMP F	SWEET LBS			SWEET LBS			CAL. EXP. WTS					
									1	2	3	1	2	3	1	2	3			
C030018		812H38980			3.000	V	FULL T	-40	128	111	150									

HEAT NUMBER	CHEMICAL ANALYSIS																MILLARD BRAND MARK
	C	Mn	P	S	SE	CU	FE	CR	MO	V	TI	AL	B	CB	H	BN	
812H38980	.15	1.40	.015	.003	.298	.048	.13	.08	.057	.001	.002	.038	.0002	.030	.007	.001	
	CE	PCM															
	.42	.34															

I certify that the above results are a true and correct copy of actual results furnished to facilitate compliance with the requirements of the specification cited above. This test report cannot be altered and must be submitted in its original form with the subsequent third party test reports, if required.

B-01, TEST IF

QUALITY ASSURANCE

D. W. BLWOOD PER WNR

2

LONGHORN STEEL

ALL STEEL IS NORMALIZED TO A578 CL.100

3" X 120.0000" X 240.0000"

PART NO.

STEVE WILLIAM

Certificate of Mill Test Results

80 HOU-041354-001-153-0

Pg. 2/2

  
ArcelorMittal

ArcelorMittal  
Burns Harbor Flat Carbon  
250 West US Highway 12  
Burns Harbor, Indiana 46304 - 1273  
August 14, 2009

Longhorn Steel & Flamecutting  
Northwoods Industrial Park Centr  
11921 FM 529  
Houston, Texas 77041

GENTLEMEN:

The following plates have been 100 percent ultrasonically inspected and found acceptable to A578 Level A.

Equipment: Epoch 081139806  
Surface: As Rolled & Normalized  
Test Method: Contact  
Couplant: Water  
Transducer: 2.25 MHz., 1" Diameter  
Manifest Number: 803-09134

Cust.	Item	Serial	Heat	Plate Size	Recordable Indications	Technician Level II
Order #	No.	Number	Number			
HOU-4373	01	C030218-01	822J31550	1.250 x 120 x 480.00	None	C.L. Cleek
HOU-4373	02	C030038-01	812H38990	1.000 x 120 x 480.00	None	J.J. Janasiak
HOU-4373	01	C030018-01	812H38980	3.000 x 120 x 240.00	None	C.L. Cleek
HOU-4373	02	C030035-01	812H38980	2.250 x 120 x 348.00	None	C.L. Cleek

Very truly yours,  
ArcelorMittal



Daniel W. Elwood  
Quality Manager  
Burns Harbor Flat Carbon



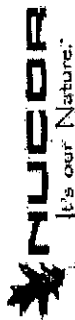


PART NO.

Alt:

**NUCOR**P.O. Box 279  
Winton, NC 27986  
(252) 356-3700**Mill Test Report**

Page 2



Issuing Date : 05/12/2009 Bill No. : 229727

Vehicle No: LW 62142

Specification: 1.5000" x 96.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-08

ASTM A131-08 Grade A and B

Lead No.: 231420

Sold To: CHAPEL STEEL CO

P O Box 1000

FAX# 215-793-9415

SPRINGHOUSE, PA 19477

Cust. Order No.: HOU-4240

Ship To: CHAPEL STEEL

6605 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

NORTH HOUSTON, TX 77081

**Marking :**

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102152	0.08	1.15	0.012	0.003	0.30	0.37	0.11	0.06	0.03	0.028	0.004	0.002	0.003		0.0011	0.0004	0.016	0.32	0.17

**Tensile Test**

Place	Serial No	Tons	Dir.	Yield (ksi)	Tensile (ksi)	Elongation % in 2"	Elongation % in 8"
2	19.60	T		37.600	59.500	28.4	24.6
		T		38.900	62.200		

**Charpy Impacts**

Dir.	(ft-lb) 1	(ft-lb) 2	(ft-lb) 3	(ft-lb) shear	(ft-lb) shear	(ft-lb) shear	Ave.	Size	Temp (°F)	Min Ave.
H-L	254.2	253.5	265.7				261.1	10mm	32	20

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.002 inch method unless otherwise specified. Coq = C\*(1+0.0001\*(C-0.0001))

Pcm = C\*(S00-H\*120)/(C020+H\*120)+H\*120

Metal and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0986-09). PED 9723IEC 712 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1, BEN 10204 3.1(2005), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMP-QA-393

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Depretis*  
T. A. Depretis, Metallurgist

05/20/2009 8:56:07 AM



Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
metalltest@an-tech.com

June 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40193  
Report No. 09-1150-2

IDENTIFICATION: 1-1/2" x 4" x 6", HT# 9102152, SL# 05  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-40193

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
218.0	91	100
210.0	93	100
213.0	93	100

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

15  
JUN 15 2009  
Jp6-8-09

PART NO.

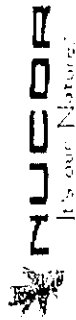
Attn:

**NUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 2



Issuing Date : 08/02/2009 B/L No. : 233081 Our Order No. : 731402 CusL Order No. : HOU-4286  
Vehicle No. : NOKL 725206 Sold To : CHAPEL STEEL CO Shp To : CHAPEL STEEL  
Specification : 0.5000" x 96.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 J6-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77061

Marking :

Heat No	C	Mn	P	S	Si	Cu	NI	Cr	Mo	Alloy	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9103035	0.06	0.84	0.008	0.001	0.29	0.27	0.11	0.08	0.22	0.027	0.009	0.002	0.002		0.0012	0.0003	0.011	0.25	0.14

Plate Serial No	Pieces	Tens	Dir.	Yield	Tensile		Elongation		Charpy Impacts		Min	
					U <sub>TS</sub>	T <sub>TS</sub>	% in 2"	% in 8"	Dir.	Temp	Temp	Ave
9103035-09	6	19.60	T	45,500	63,300	61,600	27.9	30.2	1	shear	2	shear
									3	shear	3	shear

ASTM A203-03 GRADE C

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5ELR method unless otherwise specified.  $Ceq = C + (Mn/6) + ((C + Mn + V)/5) + ((Cu + Nb)/15)$

Pcm =  $C + (S/30) + (Mn/20) + (Cu/20) + (Nb/10) + (V/10) + (W/10) + (B)$

Melted and manufactured in the USA, ISO 9001-2000 Certified (0006461), by SRI Quality System Registrar (0006461), by SRI Quality System Registrar (0006461), Para 4.3 Compliant.

ASTM A203-03 GRADE C, DIN EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 00-MMPDA-383

*T. A. Depina*

T. A. Depina, Metallurgist

07/08/2008 10:17:20 AM



*pp 7.29-09*



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 252255  
HOUSTON, TEXAS 77207-2255  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metlab@slcrs@man.com](mailto:metlab@slcrs@man.com)

Page 1 of 1

July 24, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/40768  
Report No. 09-1474-2

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103035, SL# 09  
MATERIAL: A36, Mfg. NUC

### IMPACT TEST


10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
215.0	98	100
235.0	95	100
214.0	100	100

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our reports apply only to the actual sample. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports are not necessarily indicative of the properties of other identical or similar materials.

  
JP 7-29-09



**BAYOU STEEL CORPORATION**  
(TENNESSEE)

2404 S. ROANE STREET  
HARRIMAN, TENNESSEE 37748  
Telephone (865) 982-5100

**MATERIAL CERTIFICATION REPORT**

NAMASCO CORPORATION  
500 COLONIAL CENTER PARKWAY  
SUITE 500  
ROSWELL, GA 30076

NAMASCO  
4501 N. MIRO @ THE INDUSTRIAL  
CANAL  
NEW ORLEANS, LA 70117  
PO: 6211982

INVOICE NO. BSHM09601750  
DATE 07/06/09  
Cust N-0112 -0003  
PRODUCT ANGLES  
GRADE A3644W  
HEAT NO. 68163 82 PCS  
SIZE L 1-1/2 X 1-1/2 X 1-1/2 X 2.340  
Length 20'0"

TESTED IN ASTM A6  
ACCORDANCE WITH

CHEMICAL ANALYSIS	
C	.12
Mn	.74
P	.011
S	.05
Si	.19
Cu	.32
Ni	.19
Cr	.14
Mo	.040
Cb	.000
V	.000
B	
Al	
Sn	
N	
Ti	

MECHANICAL PROPERTIES	TEST 1		TEST 2		TEST 3	
	IMPERIAL	METRIC	IMPERIAL	METRIC	IMPERIAL	METRIC
YIELD STRENGTH	49,200 PSI	339 MPa	48,600 PSI	335 MPa	PSI	MPa
TENSILE STRENGTH	70,400 PSI	485 MPa	70,400 PSI	485 MPa	PSI	MPa
ELONGATION	30.0 %	30.0 %	31.0 %	31.0 %	%	%
GAUGE LENGTH	8 in	203 mm	8 in	203 mm	in	mm
BEND TEST DIAMETER	d	d	d	d	d	d
BEND TEST RESULTS					sq in	sq mm
SPECIMEN AREA					%	%
REDUCTION OF AREA					ft-lbs	ft-lbs
IMPACT STRENGTH						J
IMPACT STRENGTH						
AVERAGE TEST TEMP						
ORIENTATION						
IMPACT STRENGTH						
AVERAGE TEST TEMP						
ORIENTATION						

Customer Grade & Specs: ASTM A36

CSA G40.20/G40.21-98 GR 44W

1. I HEREBY CERTIFY THAT THE MATERIAL TEST RESULTS PRESENTED HERE ARE FROM THE REPORTED HEAT AND ARE CORRECT. ALL TESTS WERE PERFORMED IN ACCORDANCE TO THE SPECIFICATIONS REPORTED ABOVE. ALL STEEL IS ELECTRIC FURNACE MELTED, MANUFACTURED, PROCESSED, AND TESTED IN THE U.S.A. WITH SATISFACTORY RESULTS, AND IS FREE OF MERCURY CONTAMINATION IN THE PROCESS.

*Robert L. Mowan*

SIGNED \_\_\_\_\_  
ROBERT L. MOWAN, QUALITY ASSURANCE MANAGER

NOT AUTHORIZED UPON REQUEST:

AND SUBSCRIBED BEFORE ME ON \_\_\_\_\_ DAY OF \_\_\_\_\_, 20\_\_\_\_

SWORN IN AND COUNTY, TENNESSEE BY \_\_\_\_\_

COMMISSIONER EXPIRATION: \_\_\_\_\_

15  
10-28-09

1-800-535-7692 (USA)

SOLD TO: Namasco Corp  
500 Colonial Center Pkwy  
STE 500  
Roswell, GA 30076-

SHIP TO: Namasco  
4501 N Miro &  
Industrial Canal  
New Orleans, LA 70117-4439

**NUCOR**  
**BAR MILL GROUP**  
**JEWETT DIVISION**

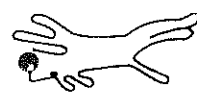
**CERTIFIED MILL TEST REPORT**

Page: 1

Ship from:

Nucor Steel - Texas  
8812 Hwy 79 W  
Jewett, TX 75846  
903-626-4461

Date: 21-May-2009  
B.L. Number: 514777  
Load Number: 134599



Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

NBMG-08 March 24, 2009

HEAT NUM. *	DESCRIPTION	PHYSICAL TESTS				CHEMICAL TESTS														
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT%	DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Cb	Cu	Sn	C.E.
in compliance with EN10204																				
PO# => 6202244																				
JW0910140502	Nucor Steel - Texas	55,100	73,500	23.0%					.10	.92	.19	.015	.039	.21	.003	.016		.38	.38	.38
	4x4x1/2 Eq Ang	380MPa	507MPa						.22			.071								
	40' A36/A529 GR50	54,200	75,200	22.0%																
	ASTM A36/A36M-08 A529/A529M-05	374MPa	518MPa																	
	ASTM A36/A36M-08																			
PO# => 6202973																				
JW0910150101	Nucor Steel - Texas	56,000	72,900	23.0%					.12	.85	.14	.024	.032	.20	.002	.011		.36	.36	.37
	2x2x1/4 Eq Ang	386MPa	503MPa						.16			.040								
	40' A36/A529GR50	55,100	73,600	24.0%																
	ASTM A36/A36M-08 A529/A529M-05	380MPa	507MPa																	
	ASTM A36/A36M-08																			
PO# => 6202973																				
JW0910181501	Nucor Steel - Texas	53,100	78,400	22.0%					.13	.83	.19	.022	.044	.20	.003	.013		.34	.34	.39
	5x3x1/4 Unequal Angle	366MPa	541MPa						.20			.068								
	40' A36/A529GR50	53,000	77,000	22.0%																
	ASTM A36/A36M-08 A529/A529M-05	365MPa	531MPa																	
	ASTM A36/A36M-08																			
PO# => 6202973																				
JW0910200302	Nucor Steel - Texas	47,700	66,900	25.0%					.12	.78	.24	.018	.020	.20	.003	.001		.31	.31	.34
	1/4x8" FL 20'	329MPa	461MPa						.15			.048								
	A36	47,600	68,700	25.0%																
	ASTM A36/A36M-08	328MPa	474MPa																	
metal data																				

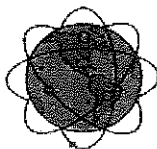


*Handwritten signature*  
7-2-09

*Handwritten signature*  
Ben R. C...

**Namasco**  
klöckner & co

ID 1013490 ID: 1013491



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-448-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HCA-20091215-02

CLIENT OILSTATES DATE 12/15/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
JOB NO. W.O. WO#21409.18.00 AFE OTHER  
MT TECH CLIFFORD ALLEN LEVIT CLIENT'S REPRESENTATIVE Mitch Darden

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT	OF	BOOM MAINTENANCE	51				
2		INSP.		WALKWAY	52				
3				180L4-50/PEMEX	53				
4					54				
5					55				
6				WS X98/ X84	56				
7					57				
8					58				
9					59				
10					60				
11					61				
12	TOTAL	WELD	✓ 100"		62				
13	TOTAL	REPAIR	0"		63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77				
28					78	MEDIA	BATCH	001-09	
29					79	TEST	BLK.	10#	S/N 1314
30					80				
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☒ FAIR ☐ PAINTED ☐ WELD ☒

**EQUIPMENT**  
MAKE PARKER MODEL B330 S/N 7193

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☒  
AC ☒ DC ☐ HALF WAVE ☒ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☒ 8A DRY ☐ WHT CONTRAST ☒

**CALIBRATION**  
10# LIFT ☒ FLUX CHECK ☒ DATE: 12/15/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/6XT MPVWM-001 REV.17

CYCLICALLY LOADED

Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 1 HR



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2425  
Fax: 985-631-0093

## MT WORK REPORT

HMH 20091208-1

CLIENT Oilstates DATE 12/08/09  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.18.00 AFE OTHER  
UT TECH Louie Cormier Level II CLIENT'S REPRESENTATIVE Michel Darden

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.		of	180L Lattice Boom	51			
2	Base					52			
3				WS	X98, X84, E1, H	53			
4					X79	54			
5						55			
6						56			
7	TOTAL	WELD=	1200"			57			
8	TOTAL	REPAIR=	0"			58			
9						59			
10						60			
11						61			
12						62			
13						63			
14						64			
15						65			
16						66			
17						67			
18						68			
19						69			
20						70			
21						71			
22						72			
23						73			
24						74			
25						75			
26						76			
27						77	MEDIA	BATCH#	09#7
28						78	CAL.	BLK.#	10# 935
29						79			
30						80	2CANS	Highlighter	
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 12/08/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6 / EXT-MPV-WM-001 REV 17  
Statically & Cyclically Loaded

Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 3 Hrs.





# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HMH 20100127-1

CLIENT Oilstates DATE 01/27/10  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.18.00 AFE OTHER  
UT TECH Louie Cormier Level II CLIENT'S REPRESENTATIVE [Signature]

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT Insp.	of	180L Lattice	51				
2	Boom	Maintenance		Walkways Item#9	52				
3					53				
4			✓	WS B2	54				
5					55				
6					56				
7					57				
8					58				
9					59				
10	TOTAL	WELD=		120"	60				
11					61				
12	TOTAL	REPAIR=		0"	62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH#	10#1	
28					78	CAL.	BLK.#	10#	935
29					79				
30					80		Highlighter		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 01/27/10


**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6 / EXT-MPV-WM-001 REV 17

**Statically Loaded**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 Hrs.



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

CRANE WO. NO.:	21409
CUSTOMER:	Constructora Subacuatica Divar
WELDMENT PART NO.:	N60884-010
WELDMENT S/N:	C09247-04
DESCRIPTION:	Boom Mid Weldment (10')
MODEL:	180L4-50
CHECKED BY:	
DATE:	11-04-09

[illegible]



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-8351

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09  
Page 1 of 2

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

2" SQ X 0.250 HR X 40'

50.8 mm

ASTM A500-07 GRADE B & C

Ticket # = 54229336

C	MN	P	S
.050	.670	.010	.007

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = M0689

AL	SI	CB	CU
.020	.040	.024	.140

Order # 284279

Purchase Order # 8148

Item # 139447 1280

C

CR	NI	VA	YLD psi	TSN psi	ELN
.050	.040	.001	60280	70950	36

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 57 57 52 / 77 77 71

AVERAGE: ft-lb/J 55 / 75

TEST:

C TEMP: - 20.00 DEG: C

Order # 284279

Purchase Order # 8148

Item # 139530 2560

C

Ticket # = 59288195

C	MN	P	S
.050	.670	.010	.007

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = M0689

AL	SI	CB	CU
.020	.040	.024	.140

CR	NI	VA	YLD psi	TSN psi	ELN
.050	.040	.001	60280	70950	36

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 60 60 60 / 81 81 81

AVERAGE: ft-lb/J 60 / 81

TEST:

C TEMP: - 20.00 DEG: C

Order # 287944

Purchase Order # 8745

Item # 140609 3200

C

Ticket # = 399165

C	MN	P	S
.070	.760	.010	.006

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = L4873

AL	SI	CB	CU
.030	.060	.022	.180

CR	NI	VA	YLD psi	TSN psi	ELN
.080	.080	.001	60550	72338	34

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 77 89 92 / 104 121 125

AVERAGE: ft-lb/J 86 / 117

TEST:

C TEMP: - 50.00 DEG: C

Quality Manager:

*Richard Lary*



*pp 9.30.09*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

06/25/2009 09:06

3148519338

TUBULAR STEEL INC

PAGE 02

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09

Page 2 of 2

1819 Clarkson Rd.  
Chesterfield, Missouri 63017BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

5" SQ X 0.187 HR X 40'

127.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 399168

C	MN	P	S
.060	.740	.011	.008

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = 76144M09

AL	SI	CB	CU
.032	.015	.030	.010

Order # 287944

Purchase Order # 8745

Item # 140610 3200

C

CR	NI	VA	YLD psi	TSN psi	FLN
.020	0.000	.001	58090	69843	30

CHARPY TEST:

SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 40 40 48 / 54 54 65

AVERAGE: ft-lb/J 43 / 58

TEST:

C TEMP: - 50.00 DEG: C

Order # 287946

Purchase Order # 8917

Item # 107668 3210

P

Ticket # = 59285058

C	MN	P	S
.060	.680	.010	.010

Ladle Analysis and Physicals

Structural-Dual Certified

Heat # = L3838

AL	SI	CB	CU
.033	.020	.020	.170

CR	NI	VA	YLD psi	TSN psi	ELN
.080	.090	.001	57600	71127	37

Quality Manager:

Richard Long



9.30.09

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

No. 66432

Date 4/02/08

THIS PRODUCT WAS MANUFACTURED IN THE U.S.A.



8901 Arrow Route • P.O. Box 3059 • Rancho Cucamonga, CA 91730  
(909) 348-3060

**MILL CERTIFICATE**

Sales Order No.: 67346

Customer : TUBULAR STEEL INC

Specification : A500B

736-5 AL

Article :

S i z e	Quantity		Hydrostatic test		Chemical Composition (Ladle Analysis)							Rockwell (B) Hardness Test	(Heat No.)	
	Number of Pieces	Calculated Weight Per lb	Test Pressure	Result	C (%) x 100	Mn (%) x 100	P (%) x 1000	S (%) x 1000	Si (%) x 100	Yield Strength ( - )	Tensile Strength ( - )			Elongation (%)
2 SQ X .188 X HR 40'	50	4.310			16	76	10	13	5	61000	65000	25	E18718	
2 SQ X .250 X HR 20'	72	5.400			14	78	13	4	13	57000	65000	26	M83482	
2 SQ X .250 X HR 40'	50	5.400			18	86	16	2	16	67000	71000	23	JN7878	
2-1/2 SQ X .188 X HR 40'	30	5.590			15	75	14	10	5	58000	66000	26	E18741	

SEARING INDUSTRIES, INC.

SEARING INDUSTRIES, INC.

We hereby certify that the material described herein  
conforms fully to the said specification.

*Robert King*  
(Chief - Laboratory Services)



pp8-18-09



# Sharon Tube Company

114 MIM Street  
PO Box 482  
Sharon, PA 16146  
(800) 248-8115  
(724) 983-1031 (fax)

## PRODUCT CERTIFICATION

HEAT NUMBER

536225

SALES ORDER

159026

SOLD TO

DIXIE PIPE SALES, INC.  
P.O. BOX 300650  
HOUSTON, TX 77230-0650  
USA

SHIP TO

DIXIE PIPE SALES, INC.  
HWY 92 EAST TO 1161 SMEDE  
HIGHWAY  
BROUSSARD, LA 70518  
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	BNDLS	LADING NO	SHIPMENT DATE					
3759		1,498 FT	2	00011695	05/04/2007					
SPECIFICATION SSP1660-080BdPe21R 1-1/4", Sch 80, Blue, PE, 21.0', R/L, ASTM A-106 Seamless Carbon Steel Pressure Pipe Grades A & B										
CERTIFICATION REQUIREMENTS										
Chemical, Ladle Analysis, %										
C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	V
.17	.81	.015	.005	.15	.	.21	.07	.10	.02	.001
Sn	SUM	CE								
.	.401	.348								
Pipe Mechanical Test Results										
	Yield, PSI	Tensile, PSI	Elong, %-2"	Y/T Ratio	Hard, HRB	Hydro, PSI	Bend	Flatten		
491160/007	48751	68127	49.8	.716	73	2500	Pass			
491160/008	48751	68127	49.8	.716	73	2500	Pass			
Certified Test Report Type 3.1B in accordance with EN 10204/ISO 10474/DIN 50049. Material has not come in direct contact with mercury, any of its compounds or any mercury bearing devices during the manufactured process, tests or inspections. Material does not contain any polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).										
Carbon Steel Seamless Pipe Meeting the Requirements of ASTM A106-06 Grades A & B, ASME SA-106 2004 Edition, A08 Revision Grades A & B, ASTM A53-06 Grades A & B, ASME SA-53 2004 Edition, and API 5L Grade B Seamless. Each length of pipe Hydrostatically Tested to 2500 P.S.I. No weld repairs made on any material. Material is acceptable to NACE Standard MR0175/ISO15156-2, 2003 Edition. Yield Strength determined @ 0.2% offset. Manufactured in the U.S.A.										
End of Certification										
MILL TEST REPORTS FOR PO# 4060515 DIXIE PIPE SALES, L.P.										

Steven M. Grabert, Manager, Technical Services, being duly sworn according to law, deposes and says that the figures set forth above are correct, as contained in the figures of Sharon Tube Company.

*Steven M. Grabert*  
18181

PART NO.

## After:

**DOUG**

**P.O. Box 279**

Winston, NC 27986

(252) 356-3700

Issuing Date : 05/12/2009  
Vehicle No: LW 62142

B/L No.: 229727

W 62142

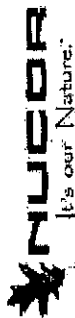
**Sacrifications: 1,500" x 96,000" x 480,000"**

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09

ASTM A131-08 Grade A and B

# Mill Test Report

Page 2



Cust. Order No.: HOU-4240

Ship To: CHAPEL STEEL

6605 N. HOUSTON ROSSLYN ROAD

RAW SITE 7207D3

**NORTH HOUSTON, TX 77091**

Our Order No.: 71911/8

CHAPEL STEEL CO

**0001 1000**

EA# 215-793-0415

SPRINGFIELD PA 19477

## Marketing

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(wt%)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
002	0.02	0.45	0.002	0.002	0.20	0.37	0.11	0.06	0.03	0.078	0.004	0.002	0.003	0.0011	0.0004	0.016	0.32	0.17	

[illegible]

We hereby certify that the contents of this report are accurate and correct. All test results were obtained from tests performed by personnel who are duly qualified.

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Produced as continuous cast discrete plate as-rolled, unless otherwise specified. Mercury has not been used in the direct manufacturing of this material. Auditable specifications, including customer specifications, are available upon request.

otherwise noted in Specification.

[illegible]

ISO 9001:2000 certified (#008461) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1, EN 10204 3.1, EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 05-MMP-QA-383

05/20/2009 8:56:07 AM

I. A. Desreñis, Metallurgist





Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
metalltest@an-tech.com

June 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40193  
Report No. 09-1150-2

IDENTIFICATION: 1-1/2" x 4" x 6", HT# 9102152, SL# 05  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-40193

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
218.0	91	100
210.0	93	100
213.0	93	100

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

15  
JUN 15 2009  
Jp6-8-09

# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24

Plate Serial No	Tensile Test							Charpy Impacts							Min Ave.				
	Places	Tons	Dir.	Yield (psi)	Tensile (psi)	Elongation % in 2"	Elongation % in 8"	Dir.	1	2	3	shear (%)	shear (%)	Temp		Size			
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



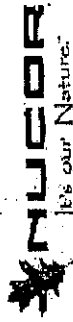
8-10-09

**NUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1



Issuing Date : 08/01/2009  
Vehicle No: LW 62017  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-06/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09  
ASTM A131-08 Grade A and B

Cust. Order No.: HOU-4302  
Ship To: CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77091

Our Order No.: 73769/3  
Sold To: CHAPEL STEEL CO  
P.O. Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

## Marking :

Heat No	C	Min	P	S	SI	Cu	Ni	Cr	Mo	Alt	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9103798	0.06	0.82	0.008	0.002	0.31	0.28	0.13	0.08	0.03	0.027	0.003	0.002	0.002	0.002	0.0034	0.0003	0.013	0.25	0.13

Tensile Test										Charpy Impacts					Min	
Plate Serial No	Pieces	Tons	Dir.	Yield	(ksi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1 shear	2 shear	3 shear	4 shear	Size	Temp	Ave.	
9103798-03	6	19.60	T	44,000	60,900	30.6	30.6									
			T	40,000	59,400	30.6	30.6									
9103798-04	6	19.60	T	44,000	60,900	30.6	30.6									
			T	40,000	59,400	30.6	30.6									

ASTM A283-03 GRADE C

OST 15 INSPECTED  
Jpa-14-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or field repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5% EL method unless otherwise specified. D<sub>01</sub> = C<sub>0.00010</sub> + (C<sub>0.00010</sub> - C<sub>0.00010</sub>) \* (C<sub>0.00010</sub> - C<sub>0.00010</sub>)<sup>1/5</sup>  
Pan = C<sub>0.00010</sub> + (C<sub>0.00010</sub> - C<sub>0.00010</sub>) \* (C<sub>0.00010</sub> - C<sub>0.00010</sub>)<sup>1/5</sup>  
Met and manufactured in the USA. ISO 9001-2000 certified (#006481) by SRI Quality System Registrar (#0085-09). PED 9723/EC 712 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1 BEN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

T. A. Deprelis, Metallurgist  
08/07/2009 9:02:13 AM

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
[metalltesters@an-tech.com](mailto:metalltesters@an-tech.com)

September 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. HOU-41202  
Report No. 09-1741

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103798, SL# 03  
MATERIAL: A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
220.0	100	100
216.0	104	100
218.0	103	100



JP 9-14-09

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70391

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HCA-20091023-03

CLIENT OILSTATES DATE 10/23/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
JOB NO. W.O. WO#21409 AFE OTHER  
MT TECH CLIFFORD ALLEN LEVIE CLIENT'S REPRESENTATIVE [Signature]

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT	OF	LATTICE BOOM	51				
2		INSP.		MID SEC.	52				
3				10'	53				
4					54				
5					55				
6				WS H	56				
7					57				
8	TOTAL	WELD	200"		58				
9	TOTAL	REPAIR	0"		59				
10					60				
11					61				
12					62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77				
28					78	MEDIA	BATCH	001-09	
29					79	TEST	BLK.	10#	S/N 1314
30					80				
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☒ FAIR ☐ PAINTED ☐ WELD ☒

**EQUIPMENT**  
MAKE PARKER MODEL B330 S/N 7193

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☒  
AC ☒ DC ☐ HALF WAVE ☒ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☒ 8A DRY ☐ WHT CONTRAST ☒

**CALIBRATION**  
10# LIFT ☒ FLUX CHECK ☒ DATE: 10/23/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/GXT MPVWM-001 REV.17

**STATICALLY**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 1 HRS



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

CRANE WO. NO.: 21409

**CUSTOMER:** Constructora Subacuatica Divar

**WELDMENT PART NO.:** N61886-001

WELDMENT S/N: C09247-05

**DESCRIPTION:** Boom Point Weldment

**MODEL:** 180L4-50

**CHECKED BY:**

DATE:

[illegible]





1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/29/09  
Page 1 of 2

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190569

Ship Via

93\_17

4" SQ X 0.250 HR X 40'

101.6 mm

ASTM A500-07 GRADE B & C

Ticket # = 59288451

C	MN	P	S
.050	.640	.011	.006

Ladle Analysis and Physicals

Structural-Dual Certified

Heat # = M0964

AL	SI	CB	CU
.026	.030	.023	.160

Order # 284279

Purchase Order # 8148

Item # 100247 2560

P

CR	NI	VA	YLD psi	TSN psi	ELN
.070	.080	.002	60540	70929	33

10" X 4" X 0.250 HR X 48'

101.6 X 254.0 mm

ASTM A500-07 GRADE B & C

Ticket # = 400075

C	MN	P	S
.070	.760	.010	.006

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = L4873

AL	SI	CB	CU
.030	.060	.022	.180

Order # 287640

Purchase Order # 8894

Item # 140637 2567

C

CR	NI	VA	YLD psi	TSN psi	ELN
.080	.080	.001	60550	72338	34

CHARPY TEST:

SAMPLE SIZE:

RESULTS: ft-lb/J 0 0 0 / 0 0

AVERAGE: ft-lb/J 0 / 0

TEST: C TEMP: 0.00 DEG:

Heat # = 95513M09

C	MN	P	S
.070	.825	.008	.007

AL	SI	CB	CU
.037	.019	.034	.008

CR	NI	VA	YLD psi	TSN psi	ELN
.021	.008	.001	59404	69832	36

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 55 63 51 / 75 85 69

AVERAGE: ft-lb/J 56 / 76

TEST: C TEMP: - 20.00 DEG: C

Quality Manager:

*Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.





1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6361

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/20/09  
Page 2 of 2

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190569

Ship Via

93.17

10" X 4" X 0.250 HR X 48'												Order #	287640
101.6 X 254.0 mm												Purchase Order #	8894
ASTM A500-07 GRADE B & C												Item #	140637 2567
Ticket # = 400076												C	
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.070	.825	.008	.007	.037	.019	.034	.008	.021	.008	.001	59404	69832	36
CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm												TEST: C TEMP: - 20.00 DEG: C	
RESULTS: ft-lb/J 55 63 51 / 75 85 69												Order # 287640	
AVERAGE: ft-lb/J 56 / 76												Purchase Order # 8894	
10" X 4" X 0.250 HR X 40'												Item # 140638 2567	
101.6 X 254.0 mm												C	
ASTM A500-07 GRADE B & C												VA YLD psi TSN psi ELN	
Ticket # = 400081												Heat # = 87981M09	
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.760	.009	.006	.039	.017	.031	.020	.020	.010	.002	64480	74350	31
CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm												TEST: C TEMP: - 20.00 DEG: C	
RESULTS: ft-lb/J 89 75 71 / 94 102 96												Order # 287946	
AVERAGE: ft-lb/J 72 / 97												Purchase Order # 8496	
8" X 4" X 0.375 HR X 40'												Item # 140558 2565	
101.6 X 203.2 mm												C	
ASTM A500-07 GRADE B & C												VA YLD psi TSN psi ELN	
Ticket # = 399163												Heat # = 88396M09	
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.760	.012	.007	.042	.022	.032	.010	.020	.010	.002	62170	72059	34
CHARPY TEST: SAMPLE SIZE: 7.5mmX10mmX55mm												TEST: C TEMP: - 40.00 DEG: C	
RESULTS: ft-lb/J 106 124 107 / 144 188 145													
AVERAGE: ft-lb/J 112 / 152													

Quality Manager:

*Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



**STORK®**  
 Materials Technology

## Stork Testing &amp; Metallurgical Consulting

 222 Cavalcade Street, 77009-3213  
 P.O. Box 8768, Houston, Texas 77249-8768  
 Tel: (713) 692-9151 Fax: (713) 696-6205

 Attention: Angel Hollins  
 TUBULAR STEEL, INC.  
 1031 Executive Parkway  
 Saint Louis, MO 63141  
 P: (314) 851-9200 / F: 314/851-9336

 W/O. No.: TUB035-07-09-57744-2  
 P.O. No.: PO-009343-1  
 Report Date: 7/10/2009

 Heat No. / SO No.: M0864 / 089140  
 Description: 4" x 4" x 0.250"  
 Material: ASTM A500, B

**CHARPY TEST RESULTS**

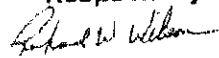
 Specification: Per Client  
 Procedure: ASTM A370 / ASTM E23  
 Direction: Longitudinal  
 Specimen Size: 10mm x 5.0mm x 2mm Notch

 Test Temperature: -45°C  
 Specimen Type: ASTM Type A

Specimen		Location		Impact Value (Ft.Lbs.)			Lateral Expansion (Mils.)			Percent Shear Fracture		
		Individual			Avg.							
1, 2, 3		92	75	75	81	75	80	56	100	100	100	
Requirements, minimum ( Full Size)		---			27	---			---			
Requirements, minimum (Sub Size)		---			14	---			---			

The sample tested conforms to the specification requirements.  
 Per ASTM A370 subsize charpies have reduced requirements as shown above.

Respectfully Submitted



 Richard W. Wilson  
 AWS CWI No. 97071771


Certificate Number 1480-05

Our letters and reports are for the exclusive use of the client to whom they are addressed and shall not be reproduced except in full without the approval of the testing laboratory. The use of our name must receive our written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products. Material submitted to our metals department will be discarded after a period of 30 days unless otherwise directed.

Stork Testing & Metallurgical Consulting is an operating unit of Stork Materials Technology B.V., Amsterdam, The Netherlands, which is a member of the Stork group



Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4500  
Fax: 773-646-6128



Ref.B/L: 80304867  
Date: 07.03.2008  
Customer: 193

**Sold to**

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

**Shipped to**

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 4.0x3.0x188x40"0"0(5x4)VNMH

Material No: 40030188

Made in: USA

Melted & Manufactured in USA

Sales order: 396285

Purchase Order: 1893

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
Y65264	20	0.200	0.760	0.008	0.008	0.016	0.043	0.030	0.001	0.004	0.010	0.020	0.001

Bundle No	Yield	Tensile	Eln.2In
M800057115	069810 Psi	077750 Psi	35 %

Certification  
ASTM A500-07 GRADE B&C

Test	Sample	Absorbed	Absorbed	CHARPY Test Results	Avg	Shear	Shear	Shear	Avg
Ft_Lbs	Temp	Size	Energy1	Energy2	Absorbed	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	Energy3	%	%	%	%
					FT-LBS				
8	+14 F	10x3 mm	20	20	22	21	100	100	100

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x188x43"0"0(8x1)PBAY70

Material No: 60040188

Made in: USA

Melted & Manufactured in USA

Sales order: 382056

Purchase Order: 2261

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
C45849		0.040	1.140	0.010	0.008	0.030	0.035	0.110	0.031	0.020	0.040	0.050	0.069

Bundle No	Yield	Tensile	Eln.2In
M800055968	083530 Psi	090450 Psi	26 %

Certification  
ASTM A500-07 MOD 70Y

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x250x40"0"0(3x3)VNMH

Material No: 60040250

Made in: USA

Melted & Manufactured in USA

Sales order: 396285

Purchase Order: 1893

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2250	9	0.160	0.610	0.012	0.007	0.020	0.024	0.160	0.003	0.025	0.080	0.100	0.002

Bundle No	Yield	Tensile	Eln.2In
M800060594	065690 Psi	073260 Psi	38 %

Certification  
ASTM A500-07 GRADE B&C

Material Note:  
Sales Or.Note:

Authorized by Quality Assurance: *M. White*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



*12-1-2008*

Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4600  
Fax: 773-646-6128



Ref.B/L: 80304667  
Date: 07.03.2008  
Customer: 193

**Sold to**

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

**Shipped to**

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250				Made in: USA				
									Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893								
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2250	9	0.150	0.610	0.012	0.007	0.020	0.024	0.160	0.003	0.025	0.080	0.100	0.002
Bundle No	Yield		Tensile		Eln.2in		Certification						
MB00060593	065690 Psi		073260 Psi		38 %		ASTM A500-07 GRADE B&C						

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250				Made in: USA				
									Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893								
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2251	9	0.140	0.630	0.010	0.007	0.020	0.028	0.160	0.003	0.026	0.080	0.090	0.001
Bundle No	Yield	Tensile		Eln.2in		Certification							
MB00060595	063480 Psi	069810 Psi		36 %		ASTM A500-07 GRADE B&C							

**CHARPY Test Results**

Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg
Ft lbs	Temp	Size	Energy1	Energy2	Energy3	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	FT-LBS	%	%	%	%
17	+14 F	10x4 mm	36	32	30	33	100	100	100

Material Note:  
Sales Or.Note:

Material: 6.0x4.0x250x40*0(3x3)VNMH					Material No: 60040250				Made In: USA				
									Melted & Manufactured in USA				
Sales order: 396285					Purchase Order: 1893								
Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
L2251	9	0.140	0.630	0.010	0.007	0.020	0.028	0.160	0.003	0.026	0.080	0.090	0.001
Bundle No	Yield	Tensile		Eln.2in		Certification							
MB00060596	063480 Psi	069810 Psi		36 %		ASTM A500-07 GRADE B&C							

**CHARPY Test Results**

Test	Sample	Absorbed	Absorbed	Absorbed	Avg	Shear	Shear	Shear	Avg
Ft lbs	Temp	Size	Energy1	Energy2	Energy3	Area1	Area2	Area3	%
			FT-LBS	FT-LBS	FT-LBS	%	%	%	%
17	+14 F	10x4 mm	36	32	30	33	100	100	100

Material Note:  
Sales Or.Note:

Authorized by Quality Assurance: *M. Weber*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



*12-11-08*

07/14/2008 09:16 3148519338  
07/07/2008 14:09 281-371-5204

TUBULAR STEEL INC  
TUBULAR STEEL, TEXAS

PAGE 03  
PAGE 03

Atlas ABC Corp (Atlas Tube Chicago)  
1855 East 122nd Street  
Chicago, Illinois, USA  
60633  
Tel: 773-646-4500  
Fax: 773-646-6128

Ref.B/L: 80304667  
Date: 07.03.2008  
Customer: 193



## MATERIAL TEST REPORT

### Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

### Shipped to

Tubular Steel  
27700 Highway Blvd.  
KATY TX 77493  
USA

Material: 16.0x12.0x500x40\*0\*0(1x2)NMH

Material No: 160120500

Made in: USA

Melted & Manufactured in USA

Sales order: 383649

Purchase Order: 884

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Co	Mo	Ni	Cr	V
Y65761	2	0.210	0.800	0.008	0.010	0.011	0.048	0.020	0.001	0.003	0.010	0.030	0.001

Bundle No

Yield

Tensile

Eln.2in

Certification

M900193442

058600 Psi

070880 Psi

42 %

ASTM A500-07 GRADE B&C

Material Note:

Sales Or.Note:

Material: 16.0x12.0x500x40\*0\*0(1x2)NMH

Material No: 160120500

Made in: USA

Melted & Manufactured in USA

Sales order: 383649

Purchase Order: 884

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Co	Mo	Ni	Cr	V
M85611	2	0.230	0.860	0.019	0.012	0.014	0.057	0.040	0.001	0.004	0.010	0.040	0.001

Bundle No

Yield

Tensile

Eln.2in

Certification

M900193633

061280 Psi

071450 Psi

40 %

ASTM A500-07 GRADE B&C

Material Note:

Sales Or.Note:

ALL INCLUDED ROUNDS MEET A500 GRADE B/C AND A53 NON-HYDRO-TESTED

Authorized by Quality Assurance: *M. White*

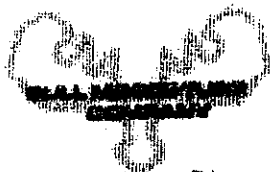
The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



Page : 3 Of 3



*12-10-08*



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

09/24/09

Page 1 of 2

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 196076

Ship Via

08 216

3" SQ X 0.250 HR X 40'

76.2 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 290490

Purchase Order # 9505

Item # 139533 1920

Ticket # = 54232880

Heat # = M1484

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.690	.009	.010	.031	.030	.022	.150	.090	.070	.002	61720	71690	35

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 71 72 84 / 96 98 114

AVERAGE: ft-lb/J 76 / 103

TEST: C TEMP: -20.00 DEG: C

3" SQ X 0.250 HR X 48'

76.2 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 290490

Purchase Order # 9505

Item # 140950 1920

Ticket # = 54232879

Heat # = M1484

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.050	.690	.009	.010	.031	.030	.022	.150	.090	.070	.002	61720	71690	35

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 71 72 84 / 96 98 114

AVERAGE: ft-lb/J 76 / 103

TEST: C TEMP: -20.00 DEG: C

4" X 2" X 0.187 HR X 40'

50.8 X 101.6 mm

Ladle, Physicals, Charpy Test

ASTM A500-07 GRADE B &amp; C

Structural-Dual Certified

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 294736

Purchase Order # 10207

Item # 140304 1288

Ticket # = 405898

Heat # = 88493M09

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.770	.009	.007	.040	.013	.034	.010	.020	0.000	.001	60450	70306	31

CHARPY TEST: SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 25 35 34 / 34 47 46

AVERAGE: ft-lb/J 31 / 42

TEST: C TEMP: -20.00 DEG: C

Quality Manager:

Richard Long

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



10-7-09

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

09/24/09  
Page 2 of 2

1810 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 198076

Ship Via

08 216

4" X 2" X 0.187 HR X 40'

50.8 X 101.8 mm

ASTM A500-07 GRADE B & C

Certified to DNV No. 2.7-1; paragraph 3.1.1

Order # 294736

Purchase Order # 10207

Item # 140304 1288

Ticket # = 405899

Heat # = L4485

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.710	.009	.004	.026	.030	.022	.200	.080	.080	.002	62320	70601	32

CHARPY TEST: SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 32 32 30 / 43 43 41

AVERAGE: ft-lb/J 31 / 42

TEST: C TEMP: - 20.00 DEG: C

6" SQ X 0.312 HR X 40'

152.4 mm

ASTM A500-07 GRADE B & C

Certified to DNV No. 2.7-1; paragraph 3.1.1

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Order # 294915

Purchase Order # 10164

Item # 141344 3840

Ticket # = 59299608

Heat # = M1120

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.860	.011	.007	.028	.030	.021	.160	.100	.090	.001	61260	71000	32

CHARPY TEST: SAMPLE SIZE: 6.7mmX10mmX55mm

RESULTS: ft-lb/J 90 102 102 / 122 138 138

AVERAGE: ft-lb/J 98 / 133

TEST: C TEMP: - 20.00 DEG: C

12" X 10" X 0.375 HR X 40'

254.0 X 304.8 mm

ASTM A500-07 B MELTED & MFG USA

Raw Material Is of Domestic Origin - Melted and Manufactured In the USA

Ladle Analysis and Physicals

Order # 295586

Purchase Order # 10085

Item # 141431 6405

Ticket # = 59299823

Heat # = 96203M09

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.064	.781	.007	.007	.045	.014	.028	.011	.017	.009	.001	58490	67590	38

Quality Manager:

*Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

15  
10-7-09





**SRC MATERIALS TESTING, LLC**

**STEPHEN R. CALLEGARI, SR., P.E.**

P.O. BOX 81903 LAFAYETTE, LA 70598-1903  
100 CARDINAL DRIVE LAFAYETTE, LA 70508-4449

(337) 837-3810 Fax (337) 837-5710  
srcengineers.com

# CERTIFICATE OF ANALYSIS

Date: September 9, 2009

P.O. No.: 10124

Company: Dixie Pipe Sales, Inc.

**Test:** Charpy V-Notch (Type B) Impact Test Per ASTM A-370, E-23

Test Performed on: 1-1/4" x Sch. 80 A106B pipe, H# B68388

**Size of Specimens:** Sub Size ( 10 mm x 4 mm x 55 mm)

Test Temperature: +10°F

Orientation of Specimens: Longitudinal

**This Certificate may not be altered, deleted from, published and/or used except in full.**

SPECIMEN NUMBER	SUB-SIZE RESULTS* Joules	ABSORBED ENERGY** Joules	SUB-SIZE RESULTS* ft-lbf	ABSORBED ENERGY** ft-lbf	PERCENT SHEAR FRACTURE	LATERAL EXPANSION (mils)
1	102	41	75	30	80	48
2	136	54	100	40	100	56
3	108	43	80	32	80	54
Average	115	46	85	34	87	53

\* THESE RESULTS ARE THE MODIFIED TEST RESULTS AS PER ASTM A-370 — ACTUAL TEST RESULTS ARE INCREASED BECAUSE SPECIMENS WERE MACHINED TO SUBSIZE DUE TO ACTUAL PIECE THICKNESS.

\* ACTUAL RECORDED TEST RESULTS.

SRC Job No.: 09-1208

Tested By:

Levon Ballard

Date: September 9, 2009

Reviewed By:

Billy Bidstrup

Date: September 9, 2009

**Note:** Unless notified in writing, samples will be discarded after 15 days.

OST  
15  
INSPECTED

# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24

Plate Serial No	Tensile Test							Charpy Impacts							Min Ave.				
	Places	Tons	Dir.	Yield (psi)	Tensile (psi)	Elongation % in 2"	Elongation % in 8"	Dir.	1	2	3	(%) shear	(%) shear	Temp		Size			
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



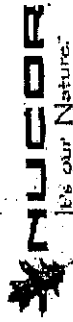
8-10-09

**NUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1



Issuing Date : 08/01/2009  
Vehicle No: LW 62017  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-06/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09  
ASTM A131-08 Grade A and B

Cust. Order No.: HOU-4302  
Ship To: CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77091

Our Order No.: 73769/3  
Sold To: CHAPEL STEEL CO  
P.O. Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

## Marking :

Heat No	C	Min	P	S	SI	Cu	Ni	Cr	Mo	Alt	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9103798	0.06	0.82	0.008	0.002	0.31	0.28	0.13	0.08	0.03	0.027	0.003	0.002	0.002	0.002	0.0034	0.0003	0.013	0.25	0.13

Plate Serial No	Tensile Test				Charpy Impacts								Min Temp Ave.	
	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1 shear	2 shear	3 shear	4 shear		Size
9103798-03	6	19.60	T	44,000	60,900	30.6	30.6							
			T	40,000	59,400	30.6	30.6							
9103798-04	6	19.60	T	44,000	60,900	30.6	30.6							
			T	40,000	59,400	30.6	30.6							

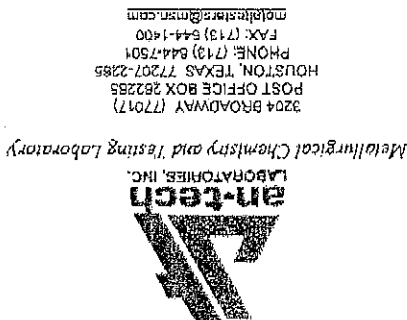
ASTM A283-03 GRADE C

OST 15 INSPECTED  
Jpa-14-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or field repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5% EL method unless otherwise specified. D<sub>01</sub> = C<sub>0.0010</sub> + 1.4(C<sub>0.0010</sub> - 0.0010) + 0.0010  
Pan = C<sub>0.0010</sub> + 1.4(C<sub>0.0010</sub> - 0.0010) + 0.0010  
Met and manufactured in the USA. ISO 9001-2000 certified (#006481) by SRI Quality System Registrar (#0085-09). PED 9723/EC 712 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1 BEN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

T. A. Deprelis, Metallurgist  
08/07/2009 9:02:13 AM



3204 BROADWAY (77017)  
POST OFFICE BOX 282255  
HOUSTON, TEXAS 77207-2255  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metl@an-tech.com

September 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103798, SL# 03  
MATERIAL: A36, Mfg. NUC

IMPACT TEST		
10mm x 10mm CVN @ +10°F		
(Longitudinal)		
Foot/Pounds	220.0	100
	216.0	104
	218.0	103
Lateral Expansion (mils)		
%Shear	100	100

15  
09-14-09

Donald Derrick  
Mechanical Testing Supervisor

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

Sc

PART NO.

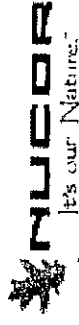
Attn:

**NUCOR**  
PLATE MILL

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

## Mill Test Report

Page 2



Issuing Date : 07/15/2009 B/L No. : 234367

Vehicle No: ATW 116026

Specification : 1.0000" x 120.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS

ASTM A131-08 Grade A and B

Load No. : 236136

Sold To : CHAPEL STEEL CO  
P O Box 1000

FAX# 215-793-9415

SPRINGHOUSE, PA 19477

Our Order No. : 73769/H1

Ship To: CHAPEL STEEL  
6603 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703

NORTH HOUSTON, TX 77061

Cust. Order No. : HOU-4302

## Marking :

Heat No.	C	Mn	P	S	SI	Cu	NI	Cr	Mo	A1001	V	Nb	Ti	N	Ca	B	Sh	CEQ	PCM
9103398	0.18	0.83	0.011	0.001	0.08	0.25	0.08	0.10	0.01	0.022	0.004	0.002	0.001	0.0005	0.0002	0.010	0.36	0.24	

Plate Serial No	Tensile Test			Elongation			Charpy Impacts			Min Ave.	
	Pieces	Tens	Dir.	Yield	Tensile	% in 2"	Dir.	1	2	3	Temp
9103398-06	2	16.33	T	44,200	70,700	24.9		(K) shear	(K) shear	(K) shear	
			T	40,900	70,000	22.3					
9103398-07	3	24.50	T	44,200	70,700	24.9					
			T	40,900	70,000	22.3					



8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Req = C+(Mn/6)+H+(Cr+Mo+V)/5+[(Cu+Ni)/15]

Yield by 0.002" method unless otherwise specified. Req = C+(Mn/6)+H+(Cr+Mo+V)/5+[(Cu+Ni)/15]

Req = C+(Mn/6)+H+(Cr+Mo+V)/5+[(Cu+Ni)/15]

Melted and manufactured in the USA. ISO 9001-2000 certified (R006461) by SRI Quality System Registrar (40985-08). PED 9723/IEC 712 Annex 1, Para. 4.3 Compliant.

DIN 50048 3.1 (EN 10204 3.1) (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

T.A. Deparis

07/16/2009 9:05:54 AM

T.A. Deparis, Metallurgist

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
mailto:info@an-tech.com

August 6, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40860  
Report No. 09-1555-2  
RETEST

IDENTIFICATION: 1" x 4" x 6", HT# 9103398, SL# 07  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40860

**IMPACT TEST**

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
15.0	22	10
71.0	70	40
18.0	31	10

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



28-10-09



# SSAB

13609 Industrial Road, Houston, TX 77015

## Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

07-30-2009 17:17 Load - 709391

BL - 8565325

Cust. PO -4084508

BLR466

Oil States Skagit-Smatco, LLC

Order-Line - 4223191-1

Heat - B8V8474

klöckner & co multi metal distribution

07/24/09 13:22 To:MTR DEPARTMENT

From:Mainframe MFAUT02

Page 2/3

Customer: NAMASCO - ATTN ACCOUNTS PAYABL 500 COLONIAL CENTER PKWY SUITE 500 ROSWELL GA 30076		Customer P.O. No.: 6213538		Mill Order No.: 41-247742-02		Shipping Manifest : HT057260	
Product Description: ASTM A36(05)/A709(06A)36/ASME SA36(04ED) AASHTO M270(01)36, 0.80-1.20 MN		Ship Date: 24 Jul 09		Cert No: 031095767 (Page 1 of 1)			
Size: 0.250 X 96.00 X 240.0 (IN)							
Tested Pieces				Tensiles			
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in 8in
B8V8474	811505	0.250 X 96.00 (T.L.C)	L57000	71000	29		
B8V8474	811510	0.313 X 96.00 (T.L.C)	C59000	71000	26		
			L50000	64000	33		
			C49000	64000	28		
Charpy Impact Tests				Chemical Analysis			
Heat Id	Tst Dir	Abs. Energy (FTLB)	% Shear	Avg	1	2	3
B8V8474	T	0.001	0.0004	0.1000	0.37		
				CEV			
				Ti B N			
				V Cb Mo Cr Ni Cu			
				Tot Al Si S P Mn C			
				.19 .89 .011 .009 .05 .032 .22 .06 .05 .02 .000 .002 .001 .0004 .0100 .37			
				USA			
<p>CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15</p> <p>MATERIAL MARKED WITH AN ASTERISK IS PRODUCED FROM COIL</p> <p>* B8V8474 811506 PCES: 13, WGT: 21236</p>							
Cust Part # :				<p>WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION</p> <p>Jason Thomas SENIOR METALLURGIST</p>			

08/15/09

83-09

**NUCOR**

P.O.Box 279  
Winton, NC 27986  
(252) 358-3700

# Mill Test Report

Page 3



Issuing Date : 08/15/2008

Load No. : 212418

Our Order No. : 65495/9

Cust. Order No. : HOU-3936

Vehicle No: NOKL 725044

Sold To: CHAPEL STEEL CO

Ship To: CHAPEL STEEL

Specification : 1.2500" x 96.000" x 480.000"

P O Box 1000

6605 N. HOUSTON ROSSLYN ROAD

ASTM A36-08/ABS Grade A/ABS Grade SA36-03a/A709 36-07

FAX# 215-793-9415

RAIL SITE 720703

SPRINGHOUSE, PA 19477

HOUSTON, TX 77091

## Marking :

Heat No	C	Min	P	S	SI	Cu	NI	Cr	Mn	AlZ	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
8106442	0.07	1.05	0.012	0.001	0.27	0.31	0.08	0.08	0.02	0.028	0.003	0.004	0.004	0.004	0.0001	0.0001	0.010	0.29	0.15

Plate Serial No	Pieces	Tens Dir.	Tensile Test		Charpy Impacts				Temp (F)	Size
			(psi) Yield	(psi) Tensile	Dir.	(ft-lb) 1 shear	(ft-lb) 2 shear	(ft-lb) 3 shear		
8106442-01	2	16.33 T	37,100	58,000	H-L	251.7	250.4	258.5	32	10mm
			36,400	58,100					20	

Manufactured to fully killed fine grain practice by Electric Arc Furnace, Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results  
Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless  
otherwise noted in Specification.

Test by 0.8ELJ method unless otherwise specified. Ceq = C+(Mn/16)+((Cu+Ni)/15)+((Cr+Mo+V)/5)+((Nb+Ti)/15)

Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/40)+(Cr/20)+(Mo/15)+(V/10)+(Nb/10)+(Ti/10)+B

Melted and manufactured in the USA, ISO 9001-2000 certified (#12443-0) by SRI Quality System Registrar (#6985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1 (EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMP-QA-182

T. A. Deprellis, Metallurgist  
08/28/2008 4:08:41 PM

15 OCT 15 2008

11-1408



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 282285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metallab@msn.com](mailto:metallab@msn.com)

November 11, 2008

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/38241  
Report No. 08-3011-5

IDENTIFICATION: 1-1/4" x 4" x 6", HT# 8106442, SL# 01  
MATERIAL: ASTM A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
222.0	91	100
222.0	89	100
239.0	86	100

*J. Pack*

Donald Derrick  
Mechanical Testing Supervisor

Sc

Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



*11-11-08*

9/28/09 14:50:19  
100% MILITED AND MANUFACTURED IN THE USA  
All beams produced by Nucor-Berkeley are cast and rolled to a fully killed and fine grain practice.

Customer H.: 405 - 19  
Customer PO: 6227169  
B.O.I. #: 774689

## CERTIFIED MILL TEST REPORT

NUCOR STEEL - BERKELEY  
P.O. Box 2259  
Mt. Pleasant, S.C. 29464  
Phone: (843) 336-6000

Sold To: NAMASCO CORPORATION  
500 COLONIAL CENTER PKWY.  
SUITE 500  
ROSWELL, GA 30076  
Ship To: NAMASCO-NEW ORLEANS  
4501 N MIRO  
NEW ORLEANS, LA 70117

SPECIFICATIONS: Tested in accordance with ASTM specification A6/A6M and A370.  
AASHTO: M270-50-05  
ASTM: A992-06a/A36-06/A529-05-50/A572-07-50/A709-09S05/A709-345M

Description	Heat#	Yield/ Tensile Ratio	Yield (PSI)	Tensile (PSI)	Elong %	C	Cr	Mn	P	S	Si	Cu	Ni	CE1	CE2	PCm
C10X25	1909752	.79	57700	72800	22.19	.06	.03	1.05	.009	.040	.25	.19	.05	.26	.3154	.1410
040' 00.00'	A992-06a		398	502		.03		.01	.0084	.0003	.0053	.030	4.53			
C250X37		.78	58100	74100	22.03											
012.1920m			401	511		8 Piece(s)							InvH:			0
C12X25	2908758	.81	57000	70800	22.36	.06	.03	.84	.009	.041	.17	.19	.05	.23	.2688	.1237
040' 00.00'	A992-06a		393	488		.03		.00	.0079	.0003	.003	.028	4.38			
C310X37		.81	57100	70800	25.00											
012.1920m			394	488		8 Piece(s)							InvH:			0
C12X30	2908690	.81	57400	71300	26.28	.06	.03	1.02	.009	.030	.26	.14	.04	.25	.3095	.1393
040' 00.00'	A992-06a		396	492		.03		.00	.0076	.0004	.003	.030	3.73			
C310X45		.78	55600	71300	27.51											
012.1920m			383	492		8 Piece(s)							InvH:			0
C8X11.5	1909601	.80	53700	67200	28.59	.06	.03	.80	.012	.025	.19	.16	.05	.22	.2580	.1250
040' 00.00'	A992-06a		370	463		.03		.00	.0076	.0002	.002	.013	4.09			
C200X17.1		.80	54200	67800	27.76											
012.1920m			374	467		47 Piece(s)							InvH:			0

Elongation based on 8" (20.32cm) gauge length. 'No Weld Repair' was performed.  
CI = 26.01Cu+3.88Ni+1.20Ca+1.49Si+17.28P-(7.29Cu+Ni)-(9.10Ni+P)-33.39(Cu+Cu)  
PCm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B  
CE1 = C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15)  
CE2 = C+((Mn+Si)/6)+((Cr+Mo+V+Cb)/5)+((Ni+Cu)/15)

I hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with material specifications, and when designated by the Purchaser, meet applicable specifications.

Bruce A. Work  
Metallurgist

(State of South Carolina  
County of Berkeley  
Sworn and subscribed before me  
day of

15  
10-9-09



BLR466

Cust. PO -4083674

BL - 8562994

Load - 697762

06-29-2009 17:05

Namascos

Oil States Skagit-Smatco, LLC

Klockner & co multi metal distribution

Heat - JW0910170601

Order-Line - 4127788-2

SOLD TO:

NAMASCO CORP  
500 COLONIAL CENTER PKWY  
STE 500  
ROSWELL, GA 30076-

SHIP TO:

NAMASCO  
4501 N MIRO &  
INDUSTRIAL CANAL  
NEW ORLEANS, LA 70117-4439

**NUCOR**

**BAR MILL GROUP  
JEWETT DIVISION**

**CERTIFIED MILL TEST REPORT**

Page: 2

Ship from:

Nucor Steel - Texas  
8812 Hwy 79 W  
JEWETT, TX 75846  
903-626-4461

Date: 19-May-2009  
B.L. Number: 514467  
Load Number: 134284



Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

NBMG-08 March 24 2009

HEAT NUM.	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS												C.E.
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Cb	Cu	Sn	
PO# => JW0910170601	6201411 Nucor Steel - Texas 3x3x1/4" Eq Ang 40' A36/A529Gr50 ASTM A36/A36M-08 A529/A529M-05 ASTM A36/A36M-08	55,300 381MPa 55,600 383MPa	77,100 532MPa 76,800 530MPa	22.0% 22.0%			.13 .16		.93 .06		.016 .055		.036 .002		.25 .012		.32	.38	

OST  
15  
INSPCT

17-2-09



17-2-009

Bar R Corp

# Steel Certificate of Test

# TIMKEN

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

Page 1 of 2

WORLDWIDE LEADER IN BEARINGS AND STEEL

11/19/2003

ID #0065430-1

S Tubular Steel Inc.  
O T 1031 EXECUTIVE PARKWAY DR  
L O  
D ST LOUIS MO 63141 USA  
ATTN: JANE KOPECKY

S TUBULAR STEEL INCORPORATED  
H T 7220 POLSON LANE  
I O  
P HAZELWOOD MO 63042 USA

Customer Order: 4450-103 HAZELWOOD Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 34096-A (1160823) Heat Number(s): Y1136

## Description of Material

OD: 6.500 in (165.100 mm) WALL: 2.000 in (50.800 mm) ID: 2.500 in (63.500 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-VACUUM DEGAS-ULTRASONIC  
Condition: HOT ROLL

## Specification

- ASTM A 106 Grades B and C Rev. 99 EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2001 EDITION GRADES B & C EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM A 105 / A 105M Rev. 01 FOR CHEMISTRY & PROPERTIES ONLY
- ASME SA-105/SA-105M Rev. 2001 EDITION FOR CHEMISTRY & P ROPERTIES ONLY
- ASTM A 519 Rev. 96 (Reapproved 2001)
- NACE MR0175 Rev. 97 01/01/1997
- ASME CODE CASE 2237 03/10/1997

## Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V	%Cb
SPEC Ladle Min:	.22	.60			.10							
SPEC Ladle Max:	.28	.90	.025	.025	.35	.20	.25	.06	.35		.050	.020
Y1136 Ladle:	.27	.86	.006	.020	.26	.06	.07	.03	.14	.032	.001	.001

## Metallurgy Information

SPEC: Grain Size SIZE FINE

Heat Y1136 SIZE: FINE

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements. This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_  
NOTARY PUBLIC

by

  
Essie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION



# Steel Certificate of Test

# TIMKEN

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

Page 2 of 2

WORLDWIDE LEADER IN BEARINGS AND STEEL

11/19/2003

ID #0065430-1

Customer Order: 4450-103 HAZELWOOD Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 34096-A (1160823) Heat Number(s): Y1136

## Metallurgy Information (cont.)

SPEC: Hardness MIDWALL 187 Max UOM BRINELL

Heat	Piece#		UOM
Y1136	A	MIDWALL 186 / 187	BRINELL

SPEC: Tensile MIN ELONGATION 22 Min MIN REDUCTION IN AREA 30 Min STRENGTH UOM PSI  
TENSILE 70,000.00 Min YIELD .2 40,000.00 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red	Gauge Length	Specimen	Direction
Y1136	A	79,980	PSI	53,457	27.2	56.3	2 IN	0.505 in RD	LONG.

Flattening test - Satisfactory

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

No welding of this material has occurred.

THE TIMKEN CORPORATION



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-8351

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09  
Page 1 of 2

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

2" SQ X 0.250 HR X 40'

50.8 mm

ASTM A500-07 GRADE B & C

Ticket # = 54229336

C	MN	P	S
.050	.670	.010	.007

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = M0689

AL	SI	CB	CU
.020	.040	.024	.140

Order # 284279

Purchase Order # 8148

Item # 139447 1280

C

CR	NI	VA	YLD psi	TSN psi	ELN
.050	.040	.001	60280	70950	36

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 57 57 52 / 77 77 71

AVERAGE: ft-lb/J 55 / 75

TEST:

C TEMP: - 20.00 DEG: C

Order # 284279

Purchase Order # 8148

Item # 139530 2560

C

Ticket # = 59288195

C	MN	P	S
.050	.670	.010	.007

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = M0689

AL	SI	CB	CU
.020	.040	.024	.140

CR	NI	VA	YLD psi	TSN psi	ELN
.050	.040	.001	60280	70950	36

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 60 60 60 / 81 81 81

AVERAGE: ft-lb/J 60 / 81

TEST:

C TEMP: - 20.00 DEG: C

Order # 287944

Purchase Order # 8745

Item # 140609 3200

C

Ticket # = 399165

C	MN	P	S
.070	.760	.010	.006

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = L4873

AL	SI	CB	CU
.030	.060	.022	.180

CR	NI	VA	YLD psi	TSN psi	ELN
.080	.080	.001	60550	72338	34

CHARPY TEST:

SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lb/J 77 89 92 / 104 121 125

AVERAGE: ft-lb/J 86 / 117

TEST:

C TEMP: - 50.00 DEG: C

Quality Manager:

Richard Lary



pp 9.30.09

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



06/25/2009 09:06

3148519338

TUBULAR STEEL INC

PAGE 02

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

06/23/09

Page 2 of 2

1819 Clarkson Rd.  
Chesterfield, Missouri 63017BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 190039

Ship Via

1\_A1

5" SQ X 0.187 HR X 40'

127.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 399168

C	MN	P	S
.060	.740	.011	.008

Ladle, Physicals, Charpy Test

Structural-Dual Certified

Heat # = 76144M09

AL	SI	CB	CU
.032	.015	.030	.010

Order # 287944

Purchase Order # 8745

Item # 140610 3200

C

CR	NI	VA	YLD psi	TSN psi	FLN
.020	0.000	.001	58090	69843	30

CHARPY TEST:

SAMPLE SIZE: 3.3mmX10mmX55mm

RESULTS: ft-lb/J 40 40 48 / 54 54 65

AVERAGE: ft-lb/J 43 / 58

TEST:

C TEMP: - 50.00 DEG: C

Order # 287946

Purchase Order # 8917

Item # 107668 3210

P

10" X 5" X 0.375 HR X 40'

127.0 X 254.0 mm

ASTM A500-07 GRADE B &amp; C

Ticket # = 59285058

C	MN	P	S
.060	.680	.010	.010

Ladle Analysis and Physicals

Structural-Dual Certified

Heat # = L3838

AL	SI	CB	CU
.033	.020	.020	.170

CR	NI	VA	YLD psi	TSN psi	ELN
.080	.090	.001	57600	71127	37

Quality Manager:

Richard Long



JP 9.30.09

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

# Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

Page 1 of 2

# TIMKEN

Where You Turn  
09/12/2005

ID #0116763-1

S Marmon/Keystone Corporation  
O T 4250 BLUE RIDGE INDUSTRIAL PARKWAY  
L O  
D NORCROSS GA 30071 USA

S LATER  
H T LATER  
I O LATER  
P

Customer Order: 25-010025-001 Customer Part Number: 3..5130  
Timken Order: 38763-C (1264150) Heat Number(s): 29003

## Description of Material

OD: 3.000 in (76.200 mm) WALL: 0.500 in (12.700 mm) ID: 2.000 in (50.800 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-ULTRASONIC  
Condition: HOT ROLL

## Specification

- ASTM A 106 Grades B and C Rev. 02a EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2001 EDITION GRADES B & C EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM E 213 Rev. 02 FOR NONDESTRUCTIVE ELECTRIC TESTING
- ASTM A 519 Rev. 03
- NACE MR0175 Rev. 97 01/01/1997
- BRITISH STANDARD BS EN 10204 01/01/1991 SECTION 3.1.B
- DIN EN 10204 01/01/1991 SECTION 3.1.B

## Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025		.40	.40	.15	.40		.080
29003 Ladle:	.24	.81	.006	.018	.26	.15	.13	.05	.22	.030	.002

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements. This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_  
NOTARY PUBLIC

by   
Essie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION

130 T  
3.5  
TI  
1-18-06

# Steel Certificate of Test

1235 DUEBER AVE. S.W.  
CANTON, OHIO 44706

Page 2 of 2

**TIMKEN**  
Where You Turn  
09/12/2005

ID #0116763-1

Customer Order: 25-010025-001 Customer Part Number: 3..5130  
Timken Order: 38763-C (1264150) Heat Number(s): 29003

## Metallurgy Information

SPEC: Hardness MIDWALL 22 Max UOM ROCKWELL C

Heat	Piece#				UOM
29003	A	MIDWALL	87	/	89 ROCKWELL B

SPEC: Tensile GAUGE LENGTH 2 IN MIN ELONGATION 26 Min SHAPE STRIP STRENGTH UOM PSI  
TENSILE 70,000.00 Min YIELD .2 40,000.00 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red	Gauge Length	Specimen	Direction
29003	A	83,867	PSI	56,312	32.5		2 IN	.750" STRIP	LONG.

Flattening test - Satisfactory

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

THE TIMKEN CORPORATION

*gpc*  
  
*1-18-06*

002176853

Atlas Tube Canada ULC  
200 Clark St.  
Harrow, Ontario, Canada  
NOR 1G0  
Tel: 519-738-3641  
Fax: 519-738-3537

Ref.B/L: 80281748  
Date: 02.27.2008  
Customer: 193



# MATERIAL TEST REPORT

## Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

## Shipped to

Tubular Steel  
7220 Polson Lane  
HAZELWOOD MO 63141  
USA

Material: 4.0x3.0x313x24'0"0(5x3)NMH  
Sales order: 368813

Material No: 40030313  
Purchase Order: 1582

Made in: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cr	Mo	Ni	Cr	V
752408	15	0.060	0.570	0.010	0.009	0.017	0.041	0.082	0.032	0.005	0.021	0.041	0.000
Bundle No	Yield	Tensile	Elon.2in	Certification									
M100723901	076290 Psi	078540 Psi	23.0 %	ASTM A500-03A GRADE B&C									

Material Note:  
Sales Or.Note:

Material: 20.0x4.0x375x44'0"0(1x2)NMH  
Sales order: 360709

Material No: 200040375  
Purchase Order: 1177

Made in: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cr	Mo	Ni	Cr	V
752539	2	0.060	0.570	0.010	0.007	0.013	0.029	0.039	0.032	0.005	0.017	0.034	0.000
Bundle No	Yield	Tensile	Elon.2in	Certification									
M200514786	063840 Psi	072550 Psi	34.8 %	ASTM A500-03A GRADE B&C									

Material Note:  
Sales Or.Note:

Material: 20.0x4.0x375x44'0"0(1x2)NMH  
Sales order: 360709

Material No: 200040375  
Purchase Order: 1177

Made in: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cr	Mo	Ni	Cr	V
752539	2	0.060	0.570	0.010	0.007	0.013	0.029	0.039	0.032	0.005	0.017	0.034	0.000
Bundle No	Yield	Tensile	Elon.2in	Certification									
M200514786	063640 Psi	072550 Psi	34.8 %	ASTM A500-03A GRADE B&C									

Material Note:  
Sales Or.Note:

Material: 20.0x4.0x375x40'0"0(1x4)NMH  
Sales order: 360709

Material No: 200040375  
Purchase Order: 1177

Made in: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cr	Mo	Ni	Cr	V
683271	4	0.070	0.650	0.009	0.007	0.015	0.039	0.041	0.034	0.003	0.017	0.027	0.000
Bundle No	Yield	Tensile	Elon.2in	Certification									
M200514792	060480 Psi	072450 Psi	39.2 %	ASTM A500-03A GRADE B&C									

Material Note:  
Sales Or.Note:

Authorized by Quality Assurance: *M. Weber*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



15  
INSPECTED  
pp9-27-09

Atlas Tube Canada ULC  
200 Clark St.  
Harrow, Ontario, Canada  
N0R 1G0  
Tel: 519-738-3541  
Fax: 519-738-3537



Ref.B/L: 80281748  
Date: 02.27.2008  
Customer: 193

002176853

Sold to

Tubular Steel  
1031 Executive Parkway  
ST. LOUIS MO 63141  
USA

**MATERIAL TEST REPORT**

Shipped to

Tubular Steel  
7220 Polson Lane  
HAZELWOOD MO 63141  
USA

Material: 4.5x4.5x313x40"0"0(3x3).  
Sales order: 360548

Material No: 450453134000  
Purchase Order: 1173

Made In: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
1940V	9	0.180	0.770	0.004	0.008	0.010	0.045	0.080	0.000	0.010	0.020	0.020	0.000

Bundle No	Yield	Tensile	Elm.2in	Certification
M100708909	060220 Psi	070050 Psi	32.5 %	ASTM A500-03A GRADE B&C

Material Note:  
Sales Or.Note:

Material: 4.5x4.5x375x40"0"0(3x3).  
Sales order: 360548

Material No: 450453754000  
Purchase Order: 1173

Made In: Canada

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
584852	9	0.200	0.810	0.011	0.005	0.170	0.034	0.044	0.005	0.003	0.015	0.039	0.000

Bundle No	Yield	Tensile	Elm.2in	Certification
M100706914	068200 Psi	078650 Psi	29.3 %	ASTM A500-03A GRADE B&C

Material Note:  
Sales Or.Note:

Material: 3.0x3.0x250x24"0"0(6x6)NMH-D  
Sales order: 360548

Material No: 0300302502400-DNMH  
Purchase Order: 1173

Made In: USA

Heat No	Pcs	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V
0138478		0.180	0.780	0.014	0.008	0.020	0.040	0.040	0.000	0.010	0.020	0.030	0.000

Bundle No	Yield	Tensile	Elm.2in	Certification
M300363917	059810 Psi	071888 Psi	29.7 %	ASTM A500-03A GRADE B&C

Material Note:  
Sales Or.Note:

ALL INCLUDED ROUNDS MEET A500 GRADE B/C AND A53 NON-HYDRO-TESTED

Authorized by Quality Assurance: *M. White*

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.



*ppg. 28-09*



2810 Clark Avenue • St. Louis, MO 63103-2574 • (314) 531-8080 • FAX (314) 531-8085  
Chemical, Metallurgical, Mechanical, Nondestructive, Environmental Testing, Analyses and Field Service.

**TUBULAR STEEL, INC.**  
1031 Executive Parkway Drive  
Creve Coeur, MO 63141

September 21, 2009  
Lab No.09P-3488  
P.O. No. 010550-1  
Page 1 of 1

Attention: Angel Hollins

**REPORT OF CHARPY IMPACT TEST**

**MATERIAL (SAMPLE ID):** HT# 752539; SO-100231; 20 X 4 X .375  
**SPECIFICATION:** ASTM A 370-07b  
**SPECIMEN TYPE:** "A" Vee Notch-Longitudinal  
**SPECIMEN SIZE:** 7.5 mm x 10 mm  
**TEMPERATURE OF TEST:** +10°F

**RESULTS:**

BASE METAL	FOOT LBS.	LATERAL EXPANSION	% SHEAR
752539-7	62	0.057	80
752539-8	30	0.010	30
752539-9	32	0.010	50
Average	41	0.026	53

Material meets specified requirements

*Identification of tested specimens provided by client.*

KS/art

  
Karl Schmitz, Director  
Materials Testing



Testing Cert. No. 0387-01  
Testing Cert. No. 0387-02

AN OFFICIAL COPY OF TEST REPORT WILL BE PROVIDED BY THIS LABORATORY ON REQUEST.  
NOT OFFICIAL WITHOUT THE RAISED SEAL OF ST. LOUIS TESTING LABORATORIES, INC.  
SEE REVERSE FOR CONDITIONS.



ppg-28-09





# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HLC 20100113-3

CLIENT Oilstates DATE 01/13/10  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.05.00 AFE OTHER  
UT TECH Louie Cormier Level II CLIENT'S REPRESENTATIVE mtl

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.		of	51				areas where Keepers
2	were	cut off		and	52				Inserts were
3	installed	on		180L4	53				Boom Tip
4					54				
5			✓	WS	55				M1
6					56				
7					57				
8					58				
9					59				
10	TOTAL	WELD=		120"	60				
11					61				
12	TOTAL	REPAIR=		0"	62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH#	10#1	
28					78	CAL.	BLK.#	10#	936
29					79				
30					80		Highlighter		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

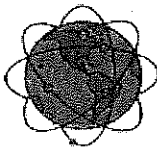
**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 01/13/10

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6 / EXT-MPV-WM-001 REV 17

**Statically Loaded**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 Hrs.



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2428  
Fax: 985-631-0093

## MT WORK REPORT

HCA-20091215-01

CLIENT OILSTATES DATE 12/15/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
JOB NO. W.O. WO#21409.05.00 AFE OTHER  
MT TECH CLIFFORD ALLEN LEVIE CLIENT'S REPRESENTATIVE Match Dadey

	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
			✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT		OF	BOOM POINT	51				
2		INSP.			ASSEMBLY	52				
3					180L4-50/PEMEX	53				
4						54				
5						55				
6					WS E1	56				
7						57				
8						58				
9						59				
10						60				
11						61				
12	TOTAL	WELD	✓	400"		62				
13	TOTAL	REPAIR		0"		63				
14						64				
15						65				2 CANS
16						66				HIGHLIGHTER
17						67				
18						68				
19						69				
20						70				
21						71				
22						72				
23						73				
24						74				
25						75				
26						76				
27						77				
28						78	MEDIA	BATCH	001-09	
29						79	TEST	BLK.	10#	S/N 1314
30						80				
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										

**SURFACE CONDITION**  
GOOD ☒ FAIR ☐ PAINTED ☐ WELD ☒

**EQUIPMENT**  
MAKE PARKER MODEL B330 S/N 7193

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☒  
AC ☒ DC ☐ HALF WAVE ☒ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☒ 8A DRY ☐ WHT CONTRAST ☒

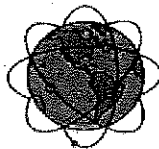
**CALIBRATION**  
10# LIFT ☒ FLUX CHECK ☒ DATE: 12/15/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/EXT MPVWM-001 REV.17

CYCLICALLY LOADED

Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 HRS





# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HCA-20091109-03

CLIENT OILSTATES DATE 11/09/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
JOB NO. W.O. WO#21409.05.00 AFE OTHER  
MT TECH CLIFFORD ALLEN LEVIT CLIENT'S REPRESENTATIVE MITCHELL DODD

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓	✗				✓	✗	
1	100%	MT	OF	BOOM POINT					
2		INSP.	✓	W/AUX 180L4	1				
3				COVER UP AREAS	2				
4					3				
5					4				
6				WS X 79	5				
7					6				
8	TOTAL	WELD	100"		7				
9	TOTAL	REPAIR	0"		8				
10					9				
11					10				
12					11				
13					12				
14					13				
15					14				
16					15				
17					16				
18					17				
19					18				
20					19				
21					20				
22					21				
23					22				
24					23				
25					24				
26					25				
27					26				
28					27	MEDIA	BATCH	001-09	
29					28	TEST	BLK.	10#	S/N 1314
30					29				
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☒ FAIR ☐ PAINTED ☐ WELD ☒

**EQUIPMENT**  
MAKE PARKER MODEL B330 S/N 7193

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☒  
AC ☒ DC ☐ HALF WAVE ☒ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☒ 8A DRY ☐ WHT CONTRAST ☒

**CALIBRATION**  
10# LIFT ☒ FLUX CHECK ☒ DATE: 11/09/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/EXT MPVWM-001 REV.17

**STATICALLY**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 1 HRS

# OCEANEERING® INSPECTION

REPORT NO. 488612

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma LA</b>	Inspection Date / Time <b>12-15-09</b>
Billing Address	Project <b>21409.78.00</b>	Oil Job Number <b>57398</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>ASMT-02 Rev 4</b>	Acceptance Criteria <b>ASME B31.1</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

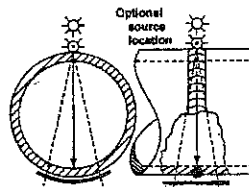
Job Description: **WET MAG EXAM OF:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓	✗	REMARKS			✓	✗	REMARKS
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

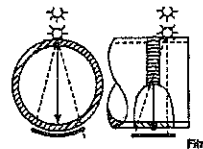
Technique: check exposure setup

SFD

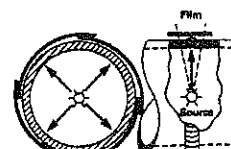
Thickness



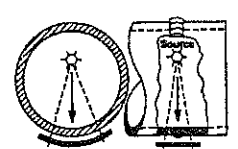
DWE/SWV ☐ Film



DWE/DWV ☐ Film



Panoramic ☐ Film



SWE/SWV ☐ Film

Film Delivered to: SS Manager: _____	Client: _____	Customer Representative: <b>Mitch D...</b>
X-Ray: _____ MAK V: _____	Gamma Ray: _____	Curies: _____
No. of Welds Checked: _____	Focal Size: _____	Ug: _____
Linear Ft. Film: _____	Type: _____	Instrument: <b>ESX 115 SW 11021</b>
Penetrameter-A _____ B _____ C _____	Required wire: _____	Achieved wire: _____
Dye Penetrant: _____	Ultrasonic: _____	Magnetic Particle: _____
Hours Worked: <b>2</b>	Travel Time: _____	Mileage: _____
Sheet # <b>1</b> of <b>1</b>	Subsistence (check if applicable): _____	
		Angles Used: <b>3-6" SPACE</b>
		Freq: <b>110K</b> Cal Bloc: <b>100B</b>
		Couplant: _____
		Consumables: <b>1 paint</b>
		Specifications: <b>7C AL# 10265</b>

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.

# OCEANEERING<sup>®</sup> INSPECTION

REPORT NO. 488627

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363

(985) 868-5097  
**DAILY WORK REPORT**  
ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>12-19-09</b>
Billing Address	Project <b>21409.09.00</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure <b>MT-02 Rev 4</b>	Acceptance Criteria <b>MT-02 Rev 4</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

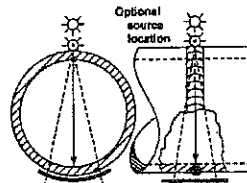
Job Description: **WET MAG EXAM OF**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓ X	ACCEPT REJECT	REMARKS			✓ X	ACCEPT REJECT	REMARKS
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

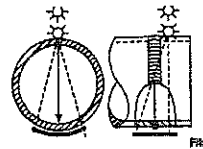
Technique: check exposure setup

SFD

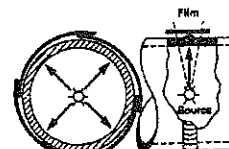
Thickness



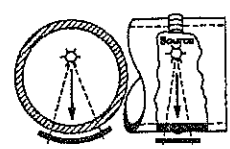
DWE/SWV ☐ Film



DWE/DWV ☐ Film



Panoramic ☐ Film



SWE/SWV ☐ Film

Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **Michael Darden**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **12-19-09** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_ Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **ESR115 SW 11021**

Penetrometer-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **3-6 1/2 SPAC**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: \_\_\_\_\_ Freq: **110KHZ** Cal Bloc: **105.6**

Hours Worked: **3** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: \_\_\_\_\_

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_ Consumables: **1 Paint**

Specifications: **5C 6K 111602**

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance of or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.



# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1636  
Morgan City, Louisiana 70381

Bus: 985-631-2426  
Fax: 985-631-0053

## MT WORK REPORT

HMH 20100128-3

CLIENT Oilstates DATE 01/28/10  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. 21409.05.99 AFE OTHER  
UT TECH Mitchell Hebert Level II CLIENT'S REPRESENTATIVE [Signature]

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.	of	Replaced Bushings on	51				
2	180L	Lattice	Boom	Point	52				
3					53				
4			WS	D3	54				
5					55				
6					56				
7					57				
8					58				
9					59				
10	TOTAL	WELD=	30"		60				
11					61				
12	TOTAL	REPAIR=	0"		62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH#	10#1	
28					78	CAL.	BLK. #	10#	935
29					79				
30					80		Highlighter		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electrospec MODEL ES-X S/N 13141

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 01/28/10

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6 / EXT-MPV-WM-001 REV 17



Statically Loaded

Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 1 Hr.



**THIS PAGE INTENTIONALLY LEFT BLANK**

# Material Traceability Log

CRANE WO. NO.:	21409
CUSTOMER:	Constructora Subacuatica Divar
WELDMENT PART NO.:	N60910
WELDMENT S/N:	C09247-02
DESCRIPTION:	Gantry Weldment
MODEL:	180L4-50
CHECKED BY:	
DATE:	12-3-05 

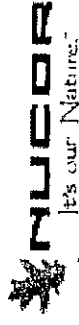
[illegible]

PART NO.

Attn:

**NUCOR**P.O.Box 279  
Winton, NC 27986  
(252) 356-3700**Mill Test Report**

Page 2



Issuing Date : 07/15/2009

Load No. : 234367

Our Order No. : 73769/H1

Cust. Order No. : HOU-4302

Vehicle No: ATW 116026

Sold To : CHAPEL STEEL CO  
P O Box 1000Ship To: CHAPEL STEEL  
6603 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77061

Specification : 1.0000" x 120.000" x 480.000"

ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03/A709 36-49  
ASTM A131-08 Grade A and B**Marking :**

Heat No.	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(%)	V	Nb	Ti	N	Ca	B	Sh	CEQ	PCM
9103398	0.18	0.83	0.011	0.001	0.08	0.25	0.08	0.10	0.01	0.022	0.004	0.002	0.001		0.0005	0.0002	0.010	0.36	0.24

**Tensile Test**

Pieces	Tens	Dir.	Yield	Tensile	Elongation % in 2"	Elongation % in 8"
2	16.33	T	44,200	70,700	24.9	24.9
3	24.50	T	40,900	70,000	22.3	22.3

**Charpy Impacts**

Dir.	1	2	3	(%) shear	(%) shear	(%) shear	Ave.	Size	Temp	Min Ave.

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Req = C+(Mn/6)+[(Cr+Mo+V)/5]+[(Cu+Ni)/15]

Yield by 0.002" method unless otherwise specified. Req = C+(Mn/6)+[(Cr+Mo+V)/5]+[(Cu+Ni)/15]

Req = C+(Mn/6)+[(Cr+Mo+V)/5]+[(Cu+Ni)/15]

Melted and manufactured in the USA. ISO 9001-2000 certified (R006461) by SRI Quality System Registrar (40985-08). PED 9723/IEC 712 Annex 1, Para. 4.3 Compliant.

DIN 50048 3.1 (EN 10204 3.1 (2004)). DIN EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383



8-10-09

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
mailto:info@an-tech.com

August 6, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40860  
Report No. 09-1555-2  
RETEST

IDENTIFICATION: 1" x 4" x 6", HT# 9103398, SL# 07  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40860

**IMPACT TEST**

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
15.0	22	10
71.0	70	40
18.0	31	10

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



28-10-09



PART NO.

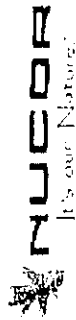
Attn:

**NUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 2



Issuing Date : 08/02/2009  
Vehicle No : NOKL 725206  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 J6-09  
ASTM A131-08 Grade A and B

Load No. : 234876  
Sold To : CHAPEL STEEL CO  
P O Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

Our Order No. : 731402  
Ship To : CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77061

CusL Order No. : HOU-4286

## Marking :

Heat No	C	Mn	P	S	Si	Cu	NI	Cr	Mo	Alloy	V	Nb	TI	N	Ca	B	Sn	CEQ	PCM
9103035	0.06	0.84	0.008	0.001	0.29	0.27	0.11	0.08	0.22	0.027	0.009	0.002	0.002	0.002	0.0012	0.0003	0.011	0.25	0.14

Plate Serial No	Tensile Test				Elongation				Charpy Impacts				Min Ave	
	Pieces	Tons	Dir.	Yield	100% Tensile	1/2 in 2"	% in 8"	% in 8"	Dir.	1	2	3	Temp	Ave
9103035-09	6	19.60	T	45,500	63,300	27.9	30.2	27.9	Dir.	1	2	3	Temp	Ave

ASTM A203-03 GRADE C

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5ELR method unless otherwise specified.  $Ceq = C + (Mn/6) + ((Cu + Ni + V)/5) + ((Cu + Ni + V)/15)$

Pcm =  $C + (S/30) + (Mn/20) + (Cu/20) + (Ni/20) + (Nb/10) + (V/10) + (B)$

Melted and manufactured in the USA, ISO 9001-2000 Certified (8006461), by SRI Quality System Registrar (80085-C9), FED 91723/EC /2 Annex 1, Para 4.3 Compliant.

ASTM A131-08 Grade A and B, DIN EN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 00-MMPDA-383

*T. A. Depotis*

T. A. Depotis, Metallurgist

07/08/2009 10:17:20 AM



*pp 7.29-09*



Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 252255  
HOUSTON, TEXAS 77207-2255  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
metlab@slcrs@man.com

Page 1 of 1

July 24, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/40768  
Report No. 09-1474-2

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103035, SL# 09  
MATERIAL: A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
215.0	98	100
235.0	95	100
214.0	100	100

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our reports apply only to the actual sample. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports are not to be used for any other material tested and are not necessarily indicative of the properties of other identical or similar materials.

15  
INSPECTED  
JP 7-29-09

PART NO.

**NUCOR**

**PLATE MILL**

P.O. Box 279  
Wilmington, NC 27986  
(252) 366-3700

**Mill Test Report**

Page 2



Insulating Date : 05/11/2009 B/L No. : 229617 Our Order No. : 7191115 Cust. Order No. : HOU-4240  
Vehicle No: NOKL 725129 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 1.0000" x 98.000" x 480.000" P O Box 1000 6805 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03/A709 36-09 FAX# 215-793-9415 RAIL SITE 720783  
ASTM A131-08 Grade A and B SPRINGHOUSE PA 19477 NORTH HOUSTON, TX 77091

**Marking :**

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Altot	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102114	0.17	0.85	0.009	0.004	0.16	0.31	0.11	0.06	0.02	0.024	0.004	0.002	0.002	0.002	0.0000	0.0002	0.012	0.36	0.24
9102115	0.18	0.83	0.007	0.001	0.12	0.33	0.18	0.07	0.02	0.027	0.004	0.002	0.002	0.002	0.0000	0.0002	0.012	0.37	0.25

**Tensile Test**

Plate Serial No	Place	Tons	Dir.	Yield	Tensile	Elongation % in 2"	Elongation % in 8"
9102114-01	3	19.60	T	48,800	71,100	27.4	27.0
			T	42,100	70,100	27.4	
9102115-01	2	13.06	T	43,000	70,700	26.6	
			T	42,900	71,300	27.9	

**Charpy Impacts**

Dir.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5% U.L. method or less otherwise specified.  $C_{eq} = C + (Mn/6) + (Si/24) + (Cu/12) + (Ni/6) + (Nb/6) + (V/6) + (Ti/6)$

Pcm =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/40) + (Cr/20) + (Mo/15) + (V/10) + (Nb/5) + (Ti/5)$

Milled and manufactured in the USA. ISO 9001:2000 certified (certificate # 1451451) by NSF Quality System Registrar (NSFQSR-09). PED 51723ED 12 Annex 1 Para. 4.3 Conforms

DIN 5049 3.1, EN 10204 3.1B(2004), DIN EN 10204 3.1(2004) compliant. For ABS grades only. Quality Assurance certificate (Q-MAT-04-392)

T. J. Dapretto  
T. J. Dapretto, Metallogist

05/18/2009 8:30:54 AM

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
[metallab@an-tech.com](mailto:metallab@an-tech.com)

Page 1 of 1

June 4, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40259  
Report No. 09-1155

IDENTIFICATION: 1" x 4" x 6", HT# 9102115-01  
MATERIAL: A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
60.0	48	40
82.0	65	60
50.0	38	40

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



106-8 09



1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

05/29/09

Page 1 of 2

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy

TX 77493-1033

B/L Number 188196

Ship Via

25 1025

10" SQ X 0.500 HR X 40'							Order #		282796				
254 mm							Purchase Order #		7798				
ASTM A500-07 GRADE B & C							Item #		140119 6400				
Ticket # = 394795							Heat # = 14445M08-MIT		C				
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.060	.750	.012	.009	.044	.013	.026	.040	.030	.020	.002	58140	66264	39
CHARPY TEST: SAMPLE SIZE: 10mmX10mmX55mm							TEST: C TEMP: - 20.00 DEG: C						
RESULTS: ft-lb/J 278 268 273 / 377 363 370							Order # 284279						
AVERAGE: ft-lb/J 273 / 370							Purchase Order # 8148						
3" SQ X 0.250 HR X 40'							Item #		139533 1920		C		
76.2 mm							Ladle, Physicals, Charpy Test		A500-07		C		
ASTM A500-07 GRADE B & C							A500-07 GRADE B & C		A500-07		C		
Ticket # = 396407							Heat # = L4872		C		C		
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.070	.720	.009	.007	.029	.020	.021	.180	.080	.070	.002	59670	71540	34
CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm							TEST: C TEMP: - 20.00 DEG: C						
RESULTS: ft-lb/J 64 64 63 / 87 87 85							Order # 284279						
AVERAGE: ft-lb/J 64 / 86							Purchase Order # 8148						
8" X 4" X 0.250 HR X 40'							Item #		139532 2565		C		
101.6 X 203.2 mm							Ladle, Physicals, Charpy Test		A500-07		C		
ASTM A500-07 GRADE B & C							A500-07 GRADE B & C		A500-07		C		
Ticket # = 396415							Heat # = M0731		C		C		
C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.070	.720	.012	.005	.020	.040	.020	.160	.080	.080	.001	59000	71216	35
CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm							TEST: C TEMP: - 20.00 DEG: C						
RESULTS: ft-lb/J 70 66 66 / 95 89 89							Order # 284279						
AVERAGE: ft-lb/J 67 / 91							Purchase Order # 8148						

Quality Manager:

Richard Long



JP 9-16-09

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.



P.O. BOX 2750, Portland, Oregon 97208 • (503) 737-1200 • Fax (503) 737-1201

**SOLD TO**

TUBULAR STEEL  
1031 EXECUTIVE PARKWAY  
ATTN: ACCOUNTS PAYABLE  
SAINT LOUIS, MO 63141-6351  
US

TUBULAR STEEL  
1031 EXECUTIVE PARKWAY  
SAINT LOUIS, MO 63141-6351  
USA

CERTIFICATE NO.	DATE	PAGE
224795	Nov 20, 2006	2
MILL ORDER NO.	DATE	
23472		
CUSTOMER ORDER NO.		
4877		
ORDER NO.		
PT		
SHIPPING NO.	DATE	
224795	11/20/2006	
CARRIER		
UNION PACIFIC		
CARRIER NO.		
TPX80948		

THIS MATERIAL HAS BEEN MANUFACTURED, TESTED AND FOUND TO MEET THE SPECIFICATIONS AND PURCHASE ORDER REQUIREMENTS  
CST ERW STRUCTURAL TUBING ASTM A500-03A GRADE B. CWN 25 FT/LBS AVG @ -4 F (H)  
17 FT/LBS MIN.

### PHYSICAL PROPERTIES

HEAT NO.	DESCRIPTION	HEAT NO.	SLAB	YIELD PSI X 100	TENSILE PSI X 100	% ELONG 8" 2"	% RA	HARDNESS BHN	IMPACTS
7	8.000 X 8.000 X 0.3750 X 40'	M06469							
8	10.000 X 10.000 X 0.3750 X 40'								
	Charpy Test								
	25/17 FT LBS @ -4F								
	4 PCS 7660 LBS								
9	10.000 X 10.000 X 0.5000 X 40'								
	Charpy Test								
	25/17 FT LBS @ -4F								
	8 PCS 19976 LBS								

### CHEMICAL ANALYSIS

HEAT NO.	C	Mn	P	S	Si	Cu	Ni	V	Co	Al	Cr	Mo	Ti	B	N	Cu	CE
M06469	.15	.69	.011	.005	.22	.01	.01	.000	.001	.038	.01	.01					
M06329	.14	.77	.009	.003	.23	.01	.01	.000	.002	.036	.01	.00					
M06215	.15	.73	.008	.002	.22	.02	.02	.001	.002	.037	.02	.01					
HEATS INDICATED WITH (+) WERE MELTED & MANUFACTURED IN THE USA. ALL OTHER HEATS WERE ROLLED IN THE USA.																	

I certify the above to be correct as contained in the records of COLUMBIA STRUCTURAL TUBING BY

15  
8-8-07

**Southland Tube, Inc.**  
**3525 Richard Arrington Jr. Blvd. N.**  
**Birmingham, AL 35234 Fax(205)421-4561**  
**TEST REPORT ASTM-E8**

Customer:  
Print Date: April 3, 2008  
Heat No.: U42901  
Description: CARBON STEEL TUBING  
Size: 10 X 10 X 1/2  
Spec/Grade: A500-07/B/C

Carbon: .220  
Manganese: .810  
Sulphur: .011  
Phosphorus: .009  
Silicon: .015

Sample Number	Date	Ultimate psi	OFS @ 0.2 psi	TE (Man) %
SL12480	01/03/08	69500	52300	30.5

We hereby certify that the above figures are correct as contained in the records of this company and that the tube/pipe were manufactured, tested, and inspected in compliance with applicable specifications.

Computer Generated Document

Quality Assurance

MELTED & MANUFACTURED IN THE U.S.A.



Page 1





CERTIFICATE NO. 39144  
SHEET NO. 1 of 1  
JOB NO. 65270-PT-002  
SAMPLE ID. HT# U42901  
DATE. 19 November, 2009

5 South Hollywood Road, Houma, LA 70360 Phone (985) 851-5310 1-800-445-4619

# Metallurgical Certificate

**Sample One (1) - 10" x 10" Square Tubing Section**

**from** OILSTATES

**for** Physical Testing

Physical Testing is certified and performed in accordance with customer requirements and applicable ASTM standard testing methods and procedures.

## IMPACT TEST DATA

Specimen Size : Full (10mmx10mm)

Specimen Orientation : Longitudinal

Test Temperature: 10°F

Specimen ID	Absorbed Energy (ft-lbs) <u>Actual</u>	% <u>Shear</u>	Lateral Expansion (inches)
B1	6	10	0.001
B2	6	10	0.001
B3	6	10	0.001
Average	6	10	0.001

NOTE: Refer to OSI PO# 4087767

CERTIFIED BY:

R.L. Sutton, P.E.  
Staff Metallurgist  
Reg. No. 24078

This Metallurgical Certificate may not be altered, deleted from, published and/or used except in full; shall not be used for advertising or in connection with advertising of any product unless permission for the publishing or advertising of an approved abstract has been obtained, in writing, from Partek Laboratories, Inc.





1618 Coteau Road Houma, LA 70364

OFFICE: 985-876-1243 / FAX: 985-876-4801

### CERTIFICATE OF ANALYSIS

Report No. **15792**

Page **1 of 1**

Date **11/25/2009**

Lab No. **15792-HL**

Material	N/A	Thickness	.500"	Dia. 10" X 10"	SQ TUBE	Ht/ID No.	U42901
Material	N/A	Thickness	N/A	Dia.	N/A	Ht/ID No.	N/A
Process	N/A	Filler Metal	N/A			Position	N/A
WPS	N/A	Welder				ID	436-57-4801
From	OILSTATES HOUMA, LA	PO	4087982			Other	----
Test For Charpy Impact						Test Date	11/25/2009
Machine Model & Serial No.	Satec Systems SI-1K3 / 1444					Date	2/18/2009
Calibration Certified By	INSTRON CORP.						
Specification Followed	ASTM E-23 Figure 1 Type A						
Orientation of Specimens					Size	10mm X 10mm X 55mm	

THIS CERTIFICATE MAY NOT BE ALTERED, DELETED FROM, PUBLISHED AND/OR USED EXCEPT IN FULL

#### CHARPY IMPACT TEST RESULTS

Specimen No.	Notch Location	Notch Type	Test Temperature	Impact Values (ft. lbs.)	% Shear	Mil Lateral Exp.	Joules
B1	BASE	V	20° F	8.0	10	0.013	11
B2		V	20° F	7.0	10	0.011	9
B3		V	20° F	10.0	10	0.006	14

We certify that the statements in this record are correct and that the test samples were prepared and testing accordance with the requirements of Techweld PMT Procedure No. 1, ASTM E-23 and ASME Section IX, 2004 Edition.

Test materials will be discarded after thirty (30) days unless prior written notification is received.

Certified By

Gerald. Schexnayder CWI 90020301

Date 11/25/2009



Techweld, Inc.  
GERALD J. SCHEXNAYDER

CWI 90030201

QC1 EXP. 03/01/11



BULL MOOSE TUBE ELKHART FACILITY  
CERTIFICATION OF TESTS

10/27/08  
Page 1 of 1

1819 Clarkson Rd.  
Chesterfield, Missouri 63017

BILL TO Tubular Steel, Inc.  
Attn: Accounts Payable  
1031 Executive Parkway Drive  
St. Louis MO 63141-6351

SHIP TO Tubular Steel, Inc.  
27700 Highway Boulevard  
Katy TX 77493-1033

B/L Number 177865

Ship Via

22\_59271147

6" SQ X 0.500 HR X 40'

152.4 mm

Ladle, Physicals, Charpy Test

Order # 264490

Purchase Order # 4537

ASTM A500-03 Grade B Melted and Manufactured in the USA

Item # 137646 3840

Ticket # = 59271147

Heat # = 14235M08

C

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN
.080	.780	.007	.007	.033	.014	.026	.020	.020	.010	.001	59320	68364	39

CHARPY TEST: SAMPLE SIZE: 10mmX10mmX55mm

RESULTS: ft-lb/J 212 87 43 / 287 118 58

AVERAGE: ft-lb/J 114 / 155

TEST: C TEMP: - 20.00 DEG: C

Digitally signed by Robert Halsey  
DN: cn=Robert Halsey, o=Bull Moose Tube Co., ou=Elkhart, email=rhalsey@bullmoosetu.be.com, c=US  
Date: 2008.11.06 11:05:25 -05'00'

Quality Manager: *Richard Long*

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION. LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.







**NUCOR**

P.O.Box 279  
Winton, NC 27986  
(252) 358-3700

# Mill Test Report

Page 3



Issuing Date : 08/15/2008

Load No. : 212418

Our Order No. : 65495/9

Cust. Order No. : HOU-3936

Vehicle No: NOKL 725044

Sold To: CHAPEL STEEL CO

Ship To: CHAPEL STEEL

Specification : 1.2500" x 96.000" x 480.000"

P O Box 1000

6605 N. HOUSTON ROSSLYN ROAD

ASTM A36-08/ABS Grade A/ABS Grade SA36-03a/A709 36-07

FAX# 215-793-9415

RAIL SITE 720703

SPRINGHOUSE, PA 19477

HOUSTON, TX 77091

## Marking :

Heat No	C	Min	P	S	SI	Cu	NI	Cr	Mn	AlZ	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
8106442	0.07	1.05	0.012	0.001	0.27	0.31	0.08	0.08	0.02	0.028	0.003	0.004	0.004	0.004	0.0001	0.0001	0.010	0.29	0.15

Plate Serial No	Pieces	Tons	Dir.	Tensile Test		Charpy Impacts				Temp (F)	Size
				(psi) Yield	(psi) Tensile	Dir.	(ft-lb) 1 shear	(ft-lb) 2 shear	(ft-lb) 3 shear		
8106442-01	2	16.33	T	37,100	58,000	H-L	251.7	250.4	258.5	32	10mm
			T	36,400	58,100					20	

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.002" method unless otherwise specified. Ceq = C+(Mn/6)+((Cu+Ni+V)/5)+((Cr+Mo+P)/5)

Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/40)+(Cr/20)+(Nb/10)+(V/10)+B

Melted and manufactured in the USA, ISO 9001-2000 certified (#12443-0) by SRI Quality System Registrar (#6985-09). PED 97723IEC 712 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1(B)EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMPQA-152

T. A. Deprellis, Metallurgist  
08/28/2008 4:06:41 PM

15 OCT 15 2008

11-1408



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 282285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metallab@msn.com](mailto:metallab@msn.com)

November 11, 2008

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/38241  
Report No. 08-3011-5

IDENTIFICATION: 1-1/4" x 4" x 6", HT# 8106442, SL# 01  
MATERIAL: ASTM A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
222.0	91	100
222.0	89	100
239.0	86	100

*J. Pack*

Donald Derrick  
Mechanical Testing Supervisor

Sc

Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



*11-11-08*

# Mill Test Report

Page 2



Issuing Date : 06/13/2009 B/L No. : 231795 Load No. : 233516 Our Order No. : 72741/5 Cust. Order No. : HOU-4268  
Vehicle No: NOKL 725093 Sold To : CHAPEL STEEL CO Ship To : CHAPEL STEEL  
Specification : 0.7500" x 120.000" x 480.000" P O Box 1000 6605 N. HOUSTON ROSSLYN ROAD  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09 FAX# 215-793-9415 RAIL SITE 720703  
ASTM A131-08 Grade A and B SPRINGHOUSE, PA 19477 NORTH HOUSTON, TX 77091

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9102711	0.18	0.83	0.010	0.002	0.18	0.28	0.10	0.12	0.03	0.024	0.004	0.001	0.002		0.0004	0.0003	0.013	0.37	0.25
9102713	0.17	0.85	0.013	0.006	0.14	0.25	0.09	0.11	0.02	0.030	0.004	0.001	0.001		0.0002	0.0003	0.011	0.36	0.24
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	Temp	Size	Min Ave.	
9102711-03	4	24.50	T	44,100	71,600		23.1												
			T	51,600	72,000		23.7												
9102713-03	1	6.12	T	42,700	70,400		23.9												
			T	39,700	70,200		22.0												

15  
INSPECTED  
8-10-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EU. method unless otherwise specified.  $CEQ = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15)$

PCM =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0885-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 B/EN 10204 3.1 B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

T. A. Depretis, Metallurgist

06/15/2009 8:05:10 AM

*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 844-7501  
FAX: (713) 844-1400  
[metall@anlabs.com](mailto:metall@anlabs.com)

August 4, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40871  
Report No. 09-1557

IDENTIFICATION: 3/4" x 4" x 6", PLT# H27233-1 HT# 9102711, SL# 03  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40871

**IMPACT TEST**

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
25.0	33	20
24.0	30	20
27.0	31	20

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.



8-10-09





**GERDAU AMERISTEEL**

CHARLOTTE STEEL MILL  
6601 LAKEVIEW ROAD  
CHARLOTTE NC 28269 USA  
(704) 596-0361

**Chemical and Physical Test Report**

MADE IN UNITED STATES

C-532360

<b>SHIP TO</b> NAMASCO CORP 8301 EAST 33RD STREET 317-897-7283 INDIANAPOLIS, IN 46226	<b>INVOICE TO</b> NAMASCO CORP (T FL) ***ACCTS PAYABLE** 500 COLONIAL CENTER PKWY S-500 ROSWELL, GA 30076	<b>SHIP DATE</b> 07/17/09  <b>CUST. ACCOUNT NO</b> 33119363
---	---	---

PRODUCED IN: CHARLOTTE														SALES ORDER		CUST P.O. NUMBER IND6214648-03	
SHAPE + SIZE		GRADE		SPECIFICATION													
A36		ASTM A36-05 & ASME SA36-08A															
HEAT I.D.	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Nb	Sn	C Eqv				
	.14	.53	.014	.027	.18	.39	.12	.16	.020	.001	<.008	.012	.32				
C902701																	

Mechanical Test: Yield 44552 PSI, 307.18 MPA Tensile: 65731 PSI, 453.2 MPA %EI: 30.0/8in, 30.0/200MM  
Customer Requirements: CASTING: STRAND CAST  
CUST ITEM NUMBER: MB122FLT20A36

PRODUCED IN: CHARLOTTE														SALES ORDER		CUST P.O. NUMBER IND6214733-01	
SHAPE + SIZE		GRADE		SPECIFICATION ASTM A36-05 & ASME SA36-08A										9630767-01			
F1/2 X 2		A36															
HEAT I.D.	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Nb	Sn	C Eqv				
	.14	.53	.014	.027	.18	.39	.12	.16	.020	.001	<.008	.012	.32				
C902701																	

Mechanical Test: Yield 44552 PSI, 307.18 MPA Tensile: 65731 PSI, 453.2 MPA %EI: 30.0/8in, 30.0/200MM  
Customer Requirements: CASTING: STRAND CAST  
CUST ITEM NUMBER: MB122FLT20A36

This material, including the billet, was produced and manufactured in the United States of America

*Shackley*  
Shackley Yalamanchili  
Quality Director  
Gerdau Ameristeel

*Angie Conner*  
Angie Conner  
Mgr. Metallurg. Svcs.  
CHARLOTTE STEEL MILL

Seller warrants that all material furnished shall comply with specifications subject to standard published manufacturing variations. NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, ARE MADE BY THE SELLER, AND SPECIFICALLY EXCLUDED ARE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. In no event shall seller be liable for indirect, consequential or punitive damages arising out of or related to the materials furnished by seller.

Any claim for damages for materials that do not conform to specifications must be made to the buyer to seller immediately after delivery of same in order to allow the seller the opportunity to inspect the material in question.



*ppa-24-09*

ID: #1217745 Page 9 of 11

Name: Mill Sales, Tampa, FL Ph: 1-800-237-0230

Klochner & Co multi metal distribution

07/17/2009 15:49

Heat - C902701

Order-Line - 4399816-1

BL - 8565500

Cust. PO -4085978

BLR466

Load - 729489

Namasco Oil States Energy Services, LLC

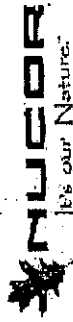
09-22-2009 17:48

**NLUCOR**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1



Issuing Date : 08/01/2009  
Vehicle No: LW 62017  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-06/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09  
ASTM A131-08 Grade A and B

Cust. Order No.: HOU-4302  
Ship To: CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77091

Our Order No.: 73769/3  
Sold To: CHAPEL STEEL CO  
P.O. Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

## Marking :

Heat No	C	Min	P	S	SI	Cu	Ni	Cr	Mo	Alt	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9103798	0.06	0.82	0.008	0.002	0.31	0.28	0.13	0.08	0.03	0.027	0.003	0.002	0.002	0.002	0.0034	0.0003	0.013	0.25	0.13

Tensile Test										Charpy Impacts					Min	
Plate Serial No	Pieces	Tons	Dir.	Yield	(ksi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1 shear	2 shear	3 shear	4 shear	Size	Temp	Ave.	
9103798-03	6	19.60	T	44,000	60,900	30.6	30.6									
			T	40,000	59,400	30.6	30.6									
9103798-04	6	19.60	T	44,000	60,900	30.6	30.6									
			T	40,000	59,400	30.6	30.6									

ASTM A283-03 GRADE C

OST 15 INSPECTED  
Jpa-14-09

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or field repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5% EL method unless otherwise specified. Doq = C44440141 (C44440141) (C44440141) (C44440141)

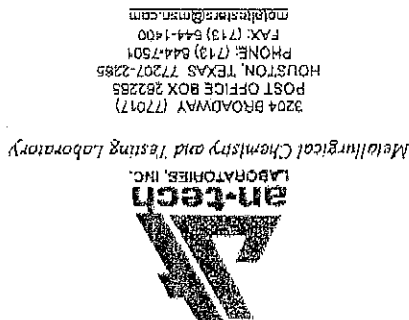
Pan = C44440141 (C44440141) (C44440141) (C44440141)

Melting and manufacturing in the USA. ISO 9001-2000 certified (#006481) by SRI Quality System Registrar (#0085-09). PED 9723/EC 712 Annex 1, Para. 4.3 Compliant.

DIN 50049 3.1 BEN 10204 3.1 (2005) compliant. For ABS grades only. Quality Assurance certificate 06-MMPQA-383

T. A. Deprelis, Metallurgist

08/07/2009 9:02:13 AM



3204 BROADWAY (77017)  
POST OFFICE BOX 282255  
HOUSTON, TEXAS 77207-2255  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
mailto:info@an-tech.com

September 3, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

IDENTIFICATION: 1/2" x 4" x 6", HT# 9103798, SL# 03  
MATERIAL: A36, Mfg. NUC

IMPACT TEST		
10mm x 10mm CVN @ +10°F		
(Longitudinal)		
Foot/Pounds	220.0	100
	216.0	104
	218.0	103
		100
Lateral Expansion (mils)		100
%Shear		100

15  
09-14-09

Donald Derrick  
Mechanical Testing Supervisor

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

Sc

# Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

ID #0222167-1

Page 1 of 2

**TIMKEN**  
Where You Turn

02/13/2009

S Tubular Steel Inc.  
O T 1031 EXECUTIVE PARKWAY DR  
L O  
D ST LOUIS MO 63141 USA

S TUBULAR STEEL INCORPORATED  
H T 27700 KATY BROOKSHIRE RD  
I O  
P KATY TX 77494 USA

Customer Order: 005060 LINE 3 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 56024-A (1550996) Heat Number(s): 26150

## Description of Material

OD: 4.500 in (114.300 mm) WALL: 0.750 in (19.050 mm) ID: 3.000 in (76.200 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-VACUUM DEGAS-ULTRASONIC  
Condition: HOT ROLL

## Specification

- ASTM A 106 / A 106M Grades B and C Rev. 06a EXCEPT AS NOTED; EXCEPT WEIGHTING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2004 EDITION GRADES B & C EXCEPT WEIGHTING OF INDIVIDUAL TUBES & EXCEPT TOLERANCES
- ASTM A 105 / A 105M Rev. 05 FOR CHEMISTRY & PROPERTIES ONLY
- ASME SA-105/SA-105M Rev. 2004 EDITION FOR CHEMISTRY & PROPERTIES ONLY
- ASTM A 519 Rev. 06
- NACE NACE MR0175/ISO 15156 Rev. 2005
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING

## Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025	.35	.30	.40	.12	.40		.080
26150 Ladle:	.28	.84	.009	.020	.26	.10	.08	.02	.20	.024	.001

## Metallurgy Information

SPEC: Grain Size SIZE 5/FINER

5/FINER

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements including the purchase order, specification(s) and exception(s). This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_

NOTARY PUBLIC

by

  
Essie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION



# Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

**TIMKEN**  
Where You Turn

ID #0222167-1

Page 2 of 2

02/13/2009

Customer Order: 005060 LINE 3 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 56024-A (1550996) Heat Number(s): 26150

---

**Metallurgy Information (cont.)**

SPEC: Flattening

Material is capable of meeting flattening requirements of ASTM A106 and ASME SA106.

SPEC: Hardness MIDWALL 187 Max UOM BRINELL

Heat	Piece#		1	UOM
26150	A	MIDWALL	170	BRINELL

SPEC: Tensile TENSILE 70,000.00 Min STRENGTH UOM PSI YIELD .2 40,000.00 Min  
MIN ELONGATION 22 Min MIN REDUCTION IN AREA 30 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red	Gauge Length	Specimen	Direction
26150	A	82,560	PSI	46,136	28.1	56.6	2 IN	0.505 in RD	LONG.

Heat 26150 Melt Source: USA

Manufacturing: USA

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

No welding of this material has occurred.



# MILL TEST CERTIFICATE

Order No. : J082300039  
 PO No. : LAP200801025  
 Commodity : STEEL PLATE  
 Specification : ASTM A36/A708-36/ASME SA36

Supplier : DONGKUK INTERNATIONAL INC.  
 Customer : JNK STEEL CORP.

Certificate No. : PP2-2-080328-158-02  
 Date of Issue : Mar. 28, 2008

Dimension Unit Inch: ", mm: Space	Product No	Quantity	Weight Kg	Heat No	Tensile Test			Chemical Composition										Remarks				
					Y P	T S	E L	C	S i	M n	P	S	C r	N i	C u	M o	N b		V			
																				Q	L	N/mm <sup>2</sup>
76.20x2438x4088 3"x96"x240"	Sub Total (20) 8828853-01	2	17,782 8,881	Q288031	T 5	300	476	32	L	15	28	122	14	8	30	2	2	4	2	1 B/R2	Tag: 31362	
*Specimen No : PP01651502-a	Sub Total (20) 8828852-01	1	8,891 8,891	Q288033	T 5	283	480	35	L	15	24	121	24	9	30	2	1	3	2	1 B/R2		
76.20x2438x4088 3"x96"x240"	Sub Total (20) 8830045-01	1	8,891 10,374	H488801	T 5	274	453	33	L	16	24	121	16	10	10	2	1	2	1	4 B/R2		
*Specimen No : PP01639708-a	Sub Total (30) 8830042-01 8830043-01	1	10,374 10,374	H488824	T 5	267	451	32	L	17	24	119	14	9	12	2	1	2	1	4 B/R2		
102.00x2438x5334 4"x96"x210"	Sub Total (30) 8830044-01	2	20,748 10,374	H488825	T 5	271	453	33	L	16	28	121	12	13	13	2	1	2	1	3 B/R2		
*Specimen No : PP02034201-a	Sub Total (30)	1	10,374																			
102.00x2438x5334 4"x96"x210"	<Grand Total>	16	146,198																			

We hereby certify that the material has been made by basic oxygen process (fully killed steel, fine grain practice) and satisfactorily tested in accordance with above specification requirement called for by the above order. If the amount of C, Ni, Cu, Mn, Ti or Si is blank, the heat analysis for that element is less than 0.02% and/or of Nb, V is blank, it is less than 0.008%.

\* Tensile Test Direction-Transverse  
 \* Supply Condition-As Rolled  
 \* Chemical Composition Unit(%): 2-x100, 3-x1000, 4-x10000

When using the ordered product for other uses, rather than the above specification use, product damage and safety accidents may be caused.

Surveyor to: \_\_\_\_\_ Surveyor to: \_\_\_\_\_

Chief of Quality Assurance Test: *[Signature]*

15  
 10.6.09

14610 Sheraton  
Houston, TX 77039

# Charpy Impact Test Report

15

REC'D  
JUN 16 5-09



JACKSON STEEL MILL  
801 AMERISTEEL ROAD  
JACKSON TN 38305 USA  
(731) 424-5600

Chemical and Physical Test Report  
MADE IN THE UNITED STATES

V-530229

PRODUCED IN: JACKSON TN

SHIP TO SABEL INDUSTRIES 1500 CHIPPEWA ST. 877-797-8335 BATON ROUGE, LA 70805		INVOICE TO SABEL INDUSTRIES INC PO DRAWER 4747 MONTGOMERY, AL 36103-4747		SHIP DATE 02/13/06	CUST. ACCOUNT NO 37835923
---	--	---	--	-----------------------	------------------------------

SHAPE * SIZE	GRADE	SPECIFICATION	SALES ORDER	CUST P.O. NUMBER
F3/4 X 2	A36	ASTM A36-05	6016242-02	45659
HEAT I.D.	C	Mn P S Si Cu Ni Cr Mo V Nb Sn C Eqv		
V6-0074	.14 .78 .010 .040 .20 .33 .08 .13 .030 <.008 .010 .329			

Mechanical Test: Yield 43860 PSI, 302.4 MPA Tensile: 68000 PSI, 468.84 MPA %El: 27.0/8in, 27.0/200MM  
Mechanical Test: Yield 43910 PSI, 302.75 MPA Tensile: 68410 PSI, 471.67 MPA %El: 26.0/8in, 26.0/200MM

SHAPE * SIZE	GRADE	SPECIFICATION	SALES ORDER	CUST P.O. NUMBER
R2	A36	ASTM A36-05/CSA G40.21-44W	6016242-03	45659
HEAT I.D.	C	Mn P S Si Cu Ni Cr Mo V Nb Sn C Eqv		
V6-0087	.14 .89 .020 .030 .26 .32 .10 .16 .040 .022 <.008 .010 .362			

Mechanical Test: Yield 49570 PSI, 341.77 MPA Tensile: 73300 PSI, 505.39 MPA %El: 21.0/8in, 21.0/200MM  
Mechanical Test: Yield 51070 PSI, 352.12 MPA Tensile: 73960 PSI, 509.94 MPA %El: 21.5/8in, 21.5/200MM

This material, including the billers, was produced and manufactured in the United States of America.

A.J. Turner  
Quality Assurance Manager  
MIL Group

THE ABOVE FIGURES ARE CERTIFIED EXTRACTS FROM THE ORIGINAL CHEMICAL AND PHYSICAL TEST RECORDS AS CONTAINED IN THE PERMANENT RECORDS OF COMPANY.

Mgr. Metallurg. Svcs.  
JACKSON STEEL MILL

3-17-06

05/14/06 From: THOMAS PIPE & STEEL  
FAX #  
ATTN:  
PO #



R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

1 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number

186012

510

Ship via

1318\_1420

4" SQ X 0.250 HR X 40'

101.6 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139530 Steel Grade 00

Heat # = 24590M08

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.760	.010	.006	.038	.011	.030	.030	.030	.010	.001	58710	70018	34

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 70 74 69 / 95 100 94

AVERAGE: ft-lbs/J 71 / 96

TEST: C TEMP: - 20.00 DEG: C

8" SQ X 0.375 HR X 40'

203.2 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139912 Steel Grade 00

Heat # = 26365M08

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.080	.740	.008	.007	.038	.013	.026	.030	.020	.010	.001	59540	69959	40

CHARPY TEST: SAMPLE SIZE: 7.5mmX10mmX55mm

RESULTS: ft-lbs/J 90 126 121 / 122 171 164

AVERAGE: ft-lbs/J 112 / 152

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL. ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



JP 5-21-09

R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

2 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number 186012

510

Ship via 1318\_1420

6" SQ X 0.500 HR X 40'

152.4 mm

Ladle Analysis and Physicals

Order # 281141

Purchase Order # 7617

A500-07 GRADE B

Item # 102370 Steel Grade 00

Heat # = 87614M09

P

BMT

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.750	.006	.005	.036	.016	.028	.010	.020	0.000	.001	52690	67125	39

3" SQ X 0.250 HR X 40'

76.2 mm

Ladle, Physicals, Charpy Test

Order # 281141

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139533 Steel Grade 00

Heat # = 87743M09

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.060	.770	.007	.011	.036	.011	.030	.020	.020	.010	.001	64070	74656	32

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 57 63 55 / 77 85 75

AVERAGE: ft-lbs/J 58 / 79

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



fp 5-21-09

R5641112

## CERTIFICATION OF TESTS

BULL MOOSE TUBE -

ELKHART FACILITY

04/29/09

Page -

3 of 3

BILL TO Tubular Steel, Inc.

SHIP TO Tubular Steel, Inc.

Attn: Accounts Payable

27700 Highway Boulevard

1031 Executive Parkway

St. Louis MO 63141-6351

CL

CL

Katy

TX 77493-1033

B/L Number

186012

510

Ship via

1318\_1420

4" SQ X 0.250 HR X 40'

Order # 281141

101.6 mm

Ladle, Physicals, Charpy Test

Purchase Order # 7617

A500-07 GRADE B &amp; C

Item # 139530 Steel Grade 00

Heat # = K3703

C

CSP

\*\*

C	MN	P	S	AL	SI	CB	CU	CR	NI	VA	YLD psi	TSN psi	ELN %
.080	.770	.010	.009	.022	.010	.032	.150	.070	.060	.001	68290	77194	30

CHARPY TEST: SAMPLE SIZE: 5mmX10mmX55mm

RESULTS: ft-lbs/J 47 50 50 / 64 68 68

AVERAGE: ft-lbs/J 49 / 66

TEST: C TEMP: - 20.00 DEG: C

THIS WELDED STEEL TUBING IS MANUFACTURED IN THE UNITED STATES OF AMERICA AND HAS BEEN PRODUCED IN ACCORDANCE WITH THE STATED SPECIFICATION LADLE CHEMISTRIES ARE REPORTED FROM DOCUMENTS PROVIDED BY THE SUPPLYING STEEL MILL ANY PHYSICAL AND MECHANICAL TESTING RESULTS SHOWN ON THIS CERTIFICATION ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY



5-21-09

**BULL MOOSE TUBE COMPANY**1819 Clarkson Road, Suite 100 • Chesterfield, Missouri 63017  
(636) 537-2600 • [www.bullmoosetube.com](http://www.bullmoosetube.com)

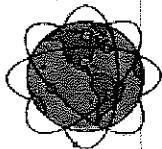
The following material supplied by Bull Moose Tube Company on BOL# 186012 meets the requirement set forth in DNV Standard for Certification No. 2.7-1; paragraph 3.1.1 Materials (steel).

4"sq x .250 x 40'  
BOL# 186012  
PO# 7617  
Heat# K3703  
Heat# 24590M08

3"sq x .250 x 40'  
BOL# 186012  
PO# 7617  
Heat# 87743M09

8"sq x .375 x 40'  
BOL# 186012  
PO# 7617  
Heat# 2636M08

Rick Cary  
Quality Assurance Manager  
ISO Coordinator  
Fax 636-530-5846  
e-mail [rcary@bullmoosetube.com](mailto:rcary@bullmoosetube.com)



# GLOBAL X-RAY & TESTING CORPORATION

Post Office Box 1536  
Morgan City, Louisiana 70381

JOEL MOREAU, President  
Residence: 985-446-6961

Bue: 985-631-2428  
Fax: 985-631-0093

## MT WORK REPORT

HCA-20091105-02

CLIENT OILSTATES DATE 11/05/09  
CONTRACTOR SAME JOB LOCATION MULBERRY ROAD  
JOB NO. W.O. 21409.02.00 AFE OTHER  
MT TECH CLIFFORD ALLEN LEVIT CLIENT'S REPRESENTATIVE [Signature]

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT	OF	180L4 GANTRY	51				
2		INSP.		COVER UP AREAS	52				
3			✓		53				
4					54				
5					55				
6				WS E1 /S98	56				
7					57				
8					58				
9					59				
10					60				
11					61				
12	TOTAL	WELD	100"		62				
13	TOTAL	REPAIR	0"		63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77				
28					78	MEDIA	BATCH	001-09	
29					79	TEST	BLK.	10#	S/N 1314
30					80				
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☒ FAIR ☐ PAINTED ☐ WELD ☒

**EQUIPMENT**  
MAKE PARKER MODEL B330 S/N 7193

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☒  
AC ☒ DC ☐ HALF WAVE ☒ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☒ 8A DRY ☐ WHT CONTRAST ☒

**CALIBRATION**  
10# LIFT ☒ FLUX CHECK ☒ DATE: 11/05/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/GXT MPVWM-001 REV.17

**STATICALLY**  
Substances \_\_\_\_\_  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 1 HR

**GLOBAL X-RAY & TESTING CORPORATION**

**JOEL MOREAU, President**  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381

**Bus: 985-631-2426**  
**Fax: 985-631-0093**

## MT WORK REPORT

HCA-20091113-01

CLIENT		OILSTATES		DATE 11/13/09			
CONTRACTOR		SAME		JOB LOCATION MULBERRY ROAD			
JOB NO.		W.O. 21409.02.00		AFE OTHER			
MT TECH CLIFFORD ALLEN LEVIE		CLIFFORD ALLEN		CLIENT'S REPRESENTATIVE			
WELD NO.	WALL THICKNESS	RECOMMENDATION	REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION	REMARKS
1	100%	MT	OF BOOM SUSPENION	51			
2		INSP.	180L4-50 GANTRY	52			
3				53			
4				54			
5			WS X98/E1	55			
6				56			
7				57			
8				58			
9				59			
10				60			
11				61			
12	TOTAL	WELD	700"	62			
13	TOTAL	REPAIR	0"	63			
14				64			
15				65			
16				66			
17				67			
18				68			
19				69			
20				70			
21				71			
22				72			
23				73			
24				74			
25				75			
26				76			
27				77			
28				78	MEDIA	BATCH	001-09
29				79	TEST	BLK.	10# S/N 1314
30				80			
31				SURFACE CONDITION			
32				GOOD <input checked="" type="checkbox"/>	FAIR <input type="checkbox"/>	PAINTED <input type="checkbox"/>	WELD <input checked="" type="checkbox"/>
33				EQUIPMENT			
34				MAKE	PARKER	MODEL B330	S/N 7193
35				CONTACTS			
36				PROD SPACING	3"-6"	CONTINUOUS <input checked="" type="checkbox"/>	
37				AC <input checked="" type="checkbox"/>	DC <input type="checkbox"/>	HALF WAVE <input checked="" type="checkbox"/>	FULL WAVE <input type="checkbox"/>
38				MEDIA			
39				7C BLACK WET <input checked="" type="checkbox"/>	8A DRY <input type="checkbox"/>	WHT CONTRAST <input checked="" type="checkbox"/>	
40				CALIBRATION			
41				10# LIFT <input checked="" type="checkbox"/>	FLUX CHECK <input checked="" type="checkbox"/>	DATE:	11/13/09
42				ACCEPTANCE CRITERIA			
43				AWS D1.1 SEC 6.10-06/GXT MPVWM-001 REV.17			
44				CYCLICALLY			
45				LOADED			
46				Substances			
47				Auto Transport Miles			
48				Travel Time Hrs.			
49				Work Time Hrs.			
50				Standby Time Hrs.			
				Total Time Hrs. 2 HRS			



**THIS PAGE INTENTIONALLY LEFT BLANK**

10

CRANE WO. NO.: 21409

**CUSTOMER:** Constructora Subacuatica Divar

**WELDMENT PART NO.:** N60911

WELDMENT S/N: C09247-06

**DESCRIPTION:** Bridle Weldment

**MODEL:** 180L4-50

CHECKED BY: 

DATE: 2-22-18

2-22-10





*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262285  
HOUSTON, TEXAS 77207-2285  
PHONE: (713) 644-7601  
FAX: (713) 644-1400  
[metalltesters@an-lab.com](mailto:metalltesters@an-lab.com)

Page 1 of 1

June 4, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091


P.O. No. 10647/40259  
Report No. 09-1155

IDENTIFICATION: 1" x 4" x 6", HT# 9102115-01  
MATERIAL: A36, Mfg. NUC

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
60.0	48	40
82.0	65	60
50.0	38	40

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

15  
JUN 10 2009

# MILCOR

---

## PLATE MILL

P.O.Box 279  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1



UNIVERSITÄT  
KÖLN

Issuing Date: 10/14/2009

Vehicle No: TTPX 811098

Specification: 1.0000" x 120.000" x 450.000"

ASTM A76-03/BS EN 573-4:1998

ASTM A30-08/ABS 61806 A/VB  
ASTM A121 08 C-4-1-1-10

સાચા જીવન માટે જીવનના દરેક ક્ષણને સચોટ બનાવો

E/L No.: 241956

255

Sold To: CHAPEL STEEL CO

P O Box 1000

36-09 FAX# 215-793-9415

SPRINGHOUSE PA 19477

Our Order No.: 75730/10

Ship To: CHAPEL STEEL

6605 N. HOUSTON ROSSLYN ROAD

RAIL SITE 720703

NORTH HOUSTON, TX 77091

**Marking :**

[illegible]

### Tensile Test

Plate Serial No	Pieces	Tons	Dfr.	Qd <sub>1</sub> Yield	Qd <sub>2</sub> Tensile	Elongation % in 2"	Elongation % in 8"
9105453-01	6	49.00	T	56,200	70,900	23.9	22.1
			T	45,500	73,600	22.1	22.1
9105453-02	1	8.16	T	56,200	70,900	23.9	22.1
			T	45,500	73,600	22.1	22.1

## Charpy Impacts

Dir.	1	2	3	Ave.	Min
	shear	shear	shear	shear	
	size	size	size	size	
	Temp	Temp	Temp	Temp	

Manufactured to fully listed line item practices by Electric Air Furnace. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast electric plate as listed, unless otherwise noted in Specification.

field of 0.5 Tesla, resulting in a 100% spin polarization. The spin polarization was measured by the EPR signal.

$\frac{1}{2} \log \frac{1}{2} = -0.153$

El producto 5002-1006 C57 "V57" es un producto, nuevo, que se produce

UN 50019 2, BEN 10778 3 13(2004), 014411-0204 3, 17005

We hereby certify that the contents of this report are accurate as stated. All test results and operations performed by the manufacturer are in compliance with the tested cable specifications, including customer specifications.

Field Notes

It is the people's money.



*Metallurgical Chemistry and Testing Laboratory*

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2205  
PHONE: (713) 844-7501  
FAX: (713) 644-1400  
[metallurgical@anbsp.com](mailto:metallurgical@anbsp.com)

Page 1 of 1

November 19, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/42188  
Report No. 09-2284

IDENTIFICATION: 1" x 4" x 6", PLT# 28030-1, HT# 9105453, SL# 02  
MATERIAL: ASTM A36, Mfg. NUC  
REFERENCE: HOU-42188

**IMPACT TEST**

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
50.0	49	30
66.0	64	40
20.0	27	20



Jp 11-30-09

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

# CHAPEL STEEL CO.

PO:Rel

## Certificate of Mill Test Results

HOUS-0000000000

Page 1 of 1

Attn:

PART NO.

**NUCOR**

**PLATE MILL**

P.O. Box 279  
Winston, NC 27986  
(252) 356-3700

### Mill Test Report

Page 2



Issuing Date : 08/30/2009 B/L No. : 233081  
Vehicle No. : NOKL 725206  
Specification : 0.5000" x 96.000" x 480.000"  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA36-03a/A709 36-09  
ASTM A131-08 Grade A and B

Sold To : CHAPEL STEEL CO  
P O Box 1000  
FAX# 215-793-9415  
SPRINGHOUSE, PA 19477

Ship To : CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77091

Cust. Order No. : HOU-4286

Marking :

Plate Serial No.	Tensile Test										Charpy Impacts					Min Temp Ave
	Pieces	Tons	Dir.	Yield	Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	2	3	Ave.	shear	shear	Size	
9103035-09	5	19.50	T	45,900	63,300	27.9	27.9									
			T	43,500	61,600	30.2	30.2									

ASTM A203-03 GRADE C

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

Yield by 0.5% EL method unless otherwise specified.  $C_{eq} = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Nb)/15$

Pcm =  $C + (Si/30) + (Mn/20) + (Cu/20) + (Nb/60) + (Cr/20) + (Mo/15) + (V/10) + 5B$

Melted and manufactured in the USA. ISO 9001:2000 certified (M008461) by SRI Quality System Registrar (M008461). T. A. Dapivela, Metallurgical

UNI 50049 3.1 EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 06-WMPDA-383

07/08/2009 10:37:20 AM

15  
RECEIVED  
JUL 29 2009



Metallurgical Chemistry and Testing Laboratory


5204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metlab@an-tech.com

Page 1 of 1

July 24, 2009

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091P.O. No. 10647/40768  
Report No. 09-1474-2IDENTIFICATION: 1/2" x 4" x 6", HT# 9103035, SL# 09  
MATERIAL: A36, Mfg. NUCIMPACT TEST10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
215.0	98	100
235.0	95	100
214.0	100	100

  
Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

15  
7-29-09

07-07-2008 17:13

Load - 540492

BL - 8542289

Cust. PO -4073724

BLR466

**Namasco**  
Oil States Skagit-Smatco, LLC

Order-Line - 3066423-2

Heat - 8102502

klackner &amp; co multi metal distribution

601

4/14/2008 11:46:48 PM PAGE 1/002 Fax Server

Page: 1

## CERTIFIED MILL TEST REPORT

**NUCOR****BAR MILL GROUP  
JEWETT DIVISION**

NAMASCO  
SOLD 500 COLONIAL CENTER PARKWAY  
TO: SUITE 500  
ROSWELL, GA 30076-

SHIP  
TO: NAMASCO  
4501 N MIRO &  
INDUSTRIAL CANAL  
NEW ORLEANS, LA 70117-4439

Ship from:

Nucor Steel - Texas  
8812 Hwy 79 W  
JEWETT, TX 75846  
903-626-4461

Date: 14-Apr-2008  
B.L. Number: 481753  
Load Number: 101971

NDMG-08 January 18, 2008

Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

Material Safety Data Sheets are available at [www.nucorbar.com](http://www.nucorbar.com) or by contacting your inside sales representative.

NUMC-08 JANUARY 19, 2008

HEAT NUM. *	DESCRIPTION	PHYSICAL TESTS				CHEMICAL TESTS														
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT%	DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Co	Cu	Sn	C.E.
PO# => 810240701 8102407	6137108 Nucor Steel - Texas 3/8x6" Flat 20' A529 Gr 55 ASTM A529/A529M-05 GR 55 Min/C = 3.81	64,900 447MPa 63,200 436MPa	72,100 497MPa 86,100 594MPa	21.0% 21.0%				.23 .14		.89 .12		.017 .030		.044 .002		.22 .018				.48
PO# => 810244901 8102449	6134851 Nucor Steel - Texas 1/2x6" FL 20' A36 ASTM A36/A36M-05 ASTM A709/A709M-07 GR 36 ASME SA36-2007 EDITION	51,300 354MPa 51,600 356MPa	78,200 539MPa 78,000 538MPa	23.0% 23.0%				.11 .13		.68 .17		.016 .033		.024 .002		.18 .001			.35	.30
PO# => 810246801 8102468	6139495 Nucor Steel - Texas 3/8x2" FL 20' A36 ASTM A36/A36M-05 ASTM A709/A709M-07 GR 36 ASME SA36-2007 EDITION	48,400 320MPa 45,900 316MPa	66,200 456MPa 66,200 456MPa	27.0% 26.0%				.11 .16		.76 .17		.015 .037		.033 .002		.18 .001			.40	.32
PO# => 810250201 8102502	6137690 Nucor Steel - Texas 3/4x3" FL 20' A36 ASTM A36/A36M-05 ASTM A709/A709M-07 GR 36 ASME SA36-2007 EDITION	49,400 341MPa 48,300 333MPa	65,900 454MPa 64,400 444MPa	27.0% 28.0%				.11 .16		.69 .16		.018 .039		.039 .002		.20 .001			.41	.30

I HEREBY CERTIFY THAT THE ABOVE FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION.

ALL MANUFACTURING PROCESSES OF THE STEEL MATERIALS IN THIS PRODUCT, INCLUDING  
MELTING, HAVE OCCURRED WITHIN THE UNITED STATES. ALL PRODUCTS PRODUCED ARE WELD FREE  
MERCURY, IN ANY FORM, HAS NOT BEEN USED IN THE PRODUCTION OR TESTING OF THIS MATERIAL.

QUALITY  
ASSURANCE:

Ben Cave

*Ben R. Cave*051  
15  
APR 2008

107-9-08



PO/Rel

HOU-000000-000

PART NO.

A444

**NUCOR**P.O. Box 279  
Winston, NC 27986  
(252) 356-3700**PLATE MILL****Mill Test Report**

Page 2

**NUCOR**  
It's our Nature.Issuing Date : 07/15/2009  
Vehicle No: ATW 116026  
Specification : 1.0000" x 120.000" x 480.000"  
ASTM A36-08/ABS Grade A/ABS Grade B/ASME SA335-03/A709 36-09  
ASTM A131-08 Grade A and B

Load No. : 238136

Our Order No. : 73769/11

Cust. Order No. : HOU-4302

Sold To : CHAPEL STEEL CO  
P O Box 1000Ship To : CHAPEL STEEL  
6605 N. HOUSTON ROSSLYN ROAD  
RAIL SITE 720703  
NORTH HOUSTON, TX 77081FAX# 215-793-8415  
SPRINGHOUSE, PA 19477

Marking :

Heat No	C	Mn	P	S	SI	Cu	NI	Gr	Mn	Al(%)	V	Nb	Ti	N	Ca	B	Sh	CEQ	PCM
9103398	0.18	0.83	0.011	0.001	0.08	0.25	0.08	0.10	0.01	0.022	0.004	0.002	0.001	0.0005	0.0002	0.010	0.010	0.36	0.24

**Tensile Test**

Plate Serial No	Pieces	Tens	Dir.	Yield	(psi)	Elongation % in 2"	Elongation % in 8"
9103398-06	2	16.33	T	44,200	70,700	24.9	22.3
9103398-07	3	24.50	T	44,200	70,700	24.9	22.3

**Charpy Impacts**

Dir.	1	shear	2	shear	3	shear	Ave.	(%)	Temp	Min
										Ave.

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material.

Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless

otherwise noted in Specification.

Yield by 0.5%EL method unless otherwise specified.  $Ceq = C + (Mn/6) + ((Cr+Mo+V)/5) + (Cu+Ni/15)$ Pcm =  $C + 16(Cu) + 16(Mn) + 16(Cr) + 16(Mo) + 16(V) + 16(Ni) + 16(Cu+Ni/15)$ 

Metall and manufactured in the USA. ISO 9001-2000 certified (#06461) by SRI Quality System Registry (#0985-09). PED 97/23/EC 712 Annex 1, Para. 4.3 Compliant.

DIN 50048 3.1, EN 10204 3.1(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 06-MMPQA-383

We hereby certify that the contents of this report are accurate and correct. All test results

and operations performed by the material manufacturer are in compliance with the

applicable specifications, including customer specifications.

T.A. Depetris

T.A. Depetris, Metallurgist

07/16/2009 8:05:54 AM

150  
8-10-09





Metallurgical Chemistry and Testing Laboratory

3204 BROADWAY (77017)  
POST OFFICE BOX 262265  
HOUSTON, TEXAS 77207-2265  
PHONE: (713) 644-7501  
FAX: (713) 644-1400  
metallab@an-tech.com

August 6, 2009

Page 1 of 1

Chapel Steel  
Attn: Jennifer Joiner  
6605 N. Houston Rosslyn Rd.,  
Houston, TX 77091

P.O. No. 10647/40860  
Report No. 09-1555-2  
RETEST

IDENTIFICATION: 1" x 4" x 6", HT# 9103398, SL# 07  
MATERIAL: ASTM A36, Mfg. Nucor  
REFERENCE: HOU-40860

IMPACT TEST

10mm x 10mm CVN @ +10°F  
(Longitudinal)

<u>Foot/Pounds</u>	<u>Lateral Expansion (mils)</u>	<u>%Shear</u>
15.0	22	10
71.0	70	40
18.0	31	10

Donald Derrick  
Mechanical Testing Supervisor

Sc

Tests were performed in accordance with the An-Tech Laboratories, Inc. Quality Assurance Manual, 2<sup>nd</sup> Edition, Revision 0 dated February 10, 2009. The contents for this report are correct and accurate and that all test results and operations performed by An-Tech are in accordance with the material specification and customer requirements. Our letters and reports are for the exclusive use of the client to whom they are addressed. Our reports apply only to the actual sample tested and are not necessarily indicative of the properties of other identical or similar materials.

09  
15  
RECEIVED  
J28-10-09

**Steel Certificate of Test**1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

ID #0222167-1

Page 1 of 2

**TIMKEN**  
Where You Turn

02/13/2009

S Tubular Steel Inc.  
O T 1031 EXECUTIVE PARKWAY DR  
L O  
D ST LOUIS MO 63141 USAS TUBULAR STEEL INCORPORATED  
H T 27700 KATY BROOKSHIRE RD  
I O  
P KATY TX 77494 USACustomer Order: 005060 LINE 3 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 56024-A (1550996) Heat Number(s): 26150**Description of Material**OD: 4.500 in (114.300 mm) WALL: 0.750 in (19.050 mm) ID: 3.000 in (76.200 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-VACUUM DEGAS-ULTRASONIC  
Condition: HOT ROLL**Specification**

- ASTM A 106 / A 106M Grades B and C Rev. 06a EXCEPT AS NOTED; EXCEPT WEIGHTING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2004 EDITION GRADES B & C EXCEPT WEIGHTING OF INDIVIDUAL TUBES & EXCEPT TOLERANCES
- ASTM A 105 / A 105M Rev. 05 FOR CHEMISTRY & PROPERTIES ONLY
- ASME SA-105/SA-105M Rev. 2004 EDITION FOR CHEMISTRY & PROPERTIES ONLY
- ASTM A 519 Rev. 06
- NACE MR0175/ISO 15156 Rev. 2005
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING

**Chemistry Information**

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025	.35	.30	.40	.12	.40		.080
26150 Ladle:	.28	.84	.009	.020	.26	.10	.08	.02	.20	.024	.001

**Metallurgy Information**

SPEC: Grain Size SIZE 5/FINER

5/FINER

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements including the purchase order, specification(s) and exception(s). This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_

NOTARY PUBLIC

by

  
Essie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION



# Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

**TIMKEN**  
Where You Turn

ID #0222167-1

Page 2 of 2

02/13/2009

Customer Order: 005060 LINE 3 KATY Customer Part Number: STEEL SERVICE CENTER  
Timken Order: 56024-A (1550996) Heat Number(s): 26150

## Metallurgy Information (cont.)

SPEC: Flattening

Material is capable of meeting flattening requirements of ASTM A106 and ASME SA106.

SPEC: Hardness MIDWALL 187 Max UOM BRINELL

Heat	Piece#	1	UOM
26150	A	MIDWALL 170	BRINELL

SPEC: Tensile TENSILE 70,000.00 Min STRENGTH UOM PSI YIELD .2 40,000.00 Min  
MIN ELONGATION 22 Min MIN REDUCTION IN AREA 30 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong %	%Red	Gauge Length	Specimen	Direction
26150	A	82,560	PSI	46,136	28.1	56.6	2 IN	0.505 in RD	LONG.

Heat 26150 Melt Source: USA

Manufacturing: USA

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

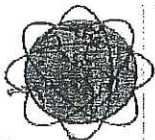
The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

No welding of this material has occurred.







# GLOBAL X-RAY & TESTING CORPORATION

JOEL MOREAU, President  
Residence: 985-446-6861

Post Office Box 1536  
Morgan City, Louisiana 70381  
Bus: 985-631-2426  
Fax: 985-631-0093

## MT WORK REPORT

HMH 20091102-3

CLIENT Oilstates DATE 11/02/09  
CONTRACTOR Same JOB LOCATION Mulberry Road  
JOB NO. W.O. 21409.02.00 AFE OTHER  
MT TECH Mitchell Hebert Level II CLIENT'S REPRESENTATIVE Mitch Dade

WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS	WELD NO.	WALL THICKNESS	RECOMMENDATION		REMARKS
		✓ X	ACCEPT REJECT				✓ X	ACCEPT REJECT	
1	100%	MT insp.	of	180L Briddle	51				
2					52				
3			✓	W5	53				
4				K2	54				
5					55				
6					56				
7					57				
8					58				
9	Total	Weld=		210"	59				
10					60				
11	Total	Repair=		0"	61				
12					62				
13					63				
14					64				
15					65				
16					66				
17					67				
18					68				
19					69				
20					70				
21					71				
22					72				
23					73				
24					74				
25					75				
26					76				
27					77	MEDIA	BATCH	006-09	
28					78	TEST	BLK.	10#	5/N#935
29					79				
30					80	ICAN	Highlighter		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

**SURFACE CONDITION**  
GOOD ☐ FAIR ☐ PAINTED ☐ WELD ☐

**EQUIPMENT**  
MAKE Electraspec MODEL ES-X S/N 13141

**CONTACTS**  
PROD SPACING 3"-6" CONTINUOUS ☐  
AC ☐ DC ☐ HALF WAVE ☐ FULL WAVE ☐

**MEDIA**  
7C BLACK WET ☐ 8A DRY ☐ WHT CONTRAST ☐

**CALIBRATION**  
10# LIFT ☐ FLUX CHECK ☐ DATE: 11/02/09

**ACCEPTANCE CRITERIA**  
AWS D1.1 SEC 6.10-06/ GXT-MPVWM-001-REV.17

Statically & Cyclically Loaded

Substances  
Auto Transport Miles \_\_\_\_\_  
Travel Time Hrs. \_\_\_\_\_  
Work Time Hrs. \_\_\_\_\_  
Standby Time Hrs. \_\_\_\_\_  
Total Time Hrs. 2 Hr.

# OCEANEERING<sup>®</sup>

## INSPECTION

REPORT NO. 489727

MAILING ADDRESS

1 Box 10267  
Houma, LA 70363

(985) 868-5097

### DAILY WORK REPORT

ISO 9002 Certified

Houma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>2-4-10</b>
Billing Address	Project <b>21409.02.99</b>	Oil Job Number <b>52348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>AWS MT-02 Rev-4</b>	Acceptance Criteria <b>AWS SM 6.1</b>

AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity

ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion

IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut

LC = Low Crown  
NW = Narrow Weld  
P = Porosity

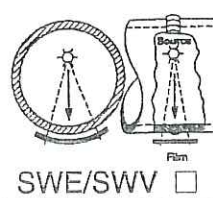
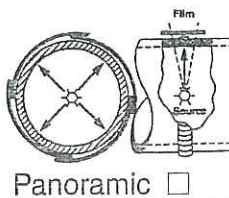
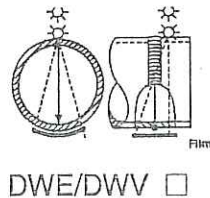
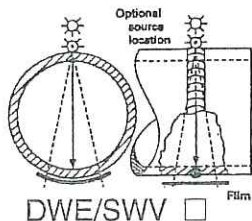
Job Description: **WCT MAG EXAM OF:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓ X	ACCEPT REJECT	REMARKS			✓ X	ACCEPT REJECT	REMARKS
1					31				
2	<b>BRIDLE</b>				32				
3					33				
4					34				
5	<b>N 6091</b>				35				
6					36				
7					37				
8					38				
9					39				
10	<b>10070 m.f. of All welds</b>				40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

SFD

Thickness



Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_ Customer Representative: **AL CARLOS**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_ Date: **2-4-10** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_ Assistant: \_\_\_\_\_

Lit: \_\_\_\_\_ Film: \_\_\_\_\_ Type: \_\_\_\_\_ Instrument: **ES 115 5m 11021**

Penetrameter-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_ Angles Used: **50° 50° 50°**

Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magneto Particle: \_\_\_\_\_ Freq: **100K** Cal Bloc: **100**

Hours Worked: **2** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_ Couplant: \_\_\_\_\_

Sheet # **1** of **1** Substistence (check if applicable): \_\_\_\_\_ Consumables: **Penetrant**

Specifications: **100° 100° 100°**

Oceaneering Inspection has furnished this Examination Report of weldments as a good faith interpretation. Acceptance of or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as to the fitness for service of such weldments and their intended use by the client.





REPORT NO. 489729

MAILING ADDRESS  
Sta. 1 Box 10267  
Houma, LA 70363(985) 868-5097  
DAILY WORK REPORT  
ISO 9002 CertifiedHouma, LA  
(985) 868-5097  
New Iberia, LA  
(337) 365-7102  
Ingleside, TX  
(361) 776-7251

Customer <b>OIL STATES</b>	Job Location <b>Houma, LA</b>	Inspection Date / Time <b>2-8-10</b>
Billing Address	Project <b>21409.02.99</b>	Oil Job Number <b>57348</b>
	P.O. #	PKC / AFE #
	S.S. Procedure # <b>AWS M-02 Rev-4</b>	Acceptance Criteria <b>AWS D-1.1 6.1</b>

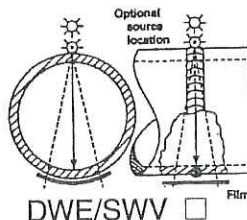
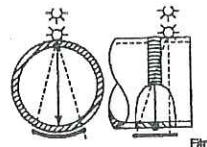
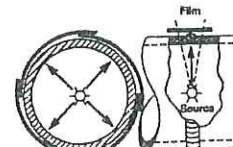
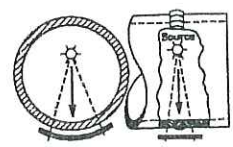
AD = Accumulations of Discontinuities  
BT = Burn Through  
BTA = Burn Through Area  
C = Crack/Cracks  
CP = Cluster Porosity  
ESI = Elongated Slag Inclusion  
EU = External Undercut  
HB = Hollow Bead  
IC = Internal Concavity  
IF = Incomplete Fusion  
IFD = Incomplete Fusion Due to Cold Lap  
IP = Inadequate Penetration  
IPD = Inadequate Penetration Due to High Low  
ISI = Isolated Slag Inclusions  
IU = Internal Undercut  
LC = Low Crown  
NW = Narrow Weld  
P = Porosity

Job Description: **WET MAG EXAM OF:**

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓	✗	REMARKS			✓	✗	REMARKS
1					31				
2					32				
3	<b>BRIDGE</b>				33				
4					34				
5	<b>N 60911</b>				35				
6					36				
7					37				
8					38				
9					39				
10					40				
11	<b>100% M.T. OF ALL REPAIRED</b>				41				
12					42				
13	<b>AREAS</b>				43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Technique: check exposure setup

SFD \_\_\_\_\_ Thickness \_\_\_\_\_

DWE/SWV ☐ FilmDWE/DWV ☐ FilmPanoramic ☐SWE/SWV ☐ Film

Film Delivered to: SS Manager: \_\_\_\_\_ Client: \_\_\_\_\_

Customer Representative: **Match Oarda**

X-Ray: \_\_\_\_\_ MAK V: \_\_\_\_\_ Gamma Ray: \_\_\_\_\_ Curies: \_\_\_\_\_

Date: **2-8-10** Technician: **AL CARLOS**

No. of Welds Checked: \_\_\_\_\_ Focal Size: \_\_\_\_\_ Ug: \_\_\_\_\_

Assistant: \_\_\_\_\_

Linear Ft. Film: \_\_\_\_\_ Type: \_\_\_\_\_

Instrument: **EX 115 SM 11021**

Penetrometer-A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_ Required wire: \_\_\_\_\_

Angles Used: **36" SPAC 10.04**Dye Penetrant: \_\_\_\_\_ Ultrasonic: \_\_\_\_\_ Magnetic Particle: ☒Freq: **110K** Cal Bloc: **101A**Hours Worked: **2** Travel Time: \_\_\_\_\_ Mileage: \_\_\_\_\_

Couplant: \_\_\_\_\_

Sheet # **1** of **1** Subsistence (check if applicable): \_\_\_\_\_Consumables: **WIC**Specifications: **706K 11059**

Oceaneering Inspection has furnished this Examination Report of weldments as good faith interpretation. Acceptance or rejection of welding discontinuities to the clients specific codes and/or standards shall not infer any warranty or liability on the part of Oceaneering Inspection as the fitness for service of such weldments and their intended use by the client.

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 2.0 Pin Certificates



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



# Lattice Boom Style

## PIN CERTIFICATE SHEET

DATE: 12/15/09  
CUSTOMER: DIAVAZ

REV: A

MODEL NO.: 180L4-50

WORK ORDER NO.: 21409

MATERIAL: SS = Stainless Steel with 100,000 PSI Minimum Yield										
4140 = 4140 with 100,000 PSI Minimum Yield										
COATING: U = Uncoated				F = Fluorocarbon Coated						
COMPONENTS				PART NUMBER/REV.	PIN NO.*	HEAT NO.	S = Special			COATING (4140 Only)
							SS	4140	U	
BOOM FOOT PIN				N61577-001 (2) REV B	P1 P2	332170	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GANTRY / UPPERSTRUCTURE				N60006-046 (2) REV R	P3 P4	332170	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MAIN IDLER				N60952-001 (1) REV E	P5	347260	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LOWER AUXILIARY EXTENSION				N60986-001 (1) REV D	P6	1C68S	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BOOM CONNECTIONS				N60986-003 (8) REV D	P7-P14	U1542-G13	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
UPPER AUXILIARY EXTENSION				N60955-001 (1) REV B	P15	330370	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BRIDLE / GANTRY				N60954-001 (2) REV C	P16 P17	211058	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EXTENDED WEDGE SOCKET PIN / MAIN				N60645-001 (1) REV B	P18	4KY8	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LOAD CELL PIN				N60646-004 (2) REV C	P19 P20	4KY8	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

NOTES: \* Pin number to be stamped on end of pin by machinist.  
 \*\* Heat Number to be recorded by machinist when material is pulled from inventory.  
 \*\*\* Please provide Document no.: SS1C-00-023 Rev A, "Machining Tolerances, Outsourced pins for Nautilus Cranes" when outsourcing or manufacturing pins.  
**SPECIAL COATING REQUIREMENTS:**

Revision: 1  
Date: 3/1/2007

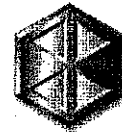
*Debra V. Veltrop*  
3-8-10  






# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 27.11.08

Seite/Page: 1 / 3

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97/23 EG
--------------------	--------------------	--

**Abnahmeprüfzeugnis nach** DIN EN 10204 3.1/01.05  
 Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.1B/08.95  
**Zeugnis-Nr./Certificate No./No.de Certificat** 1421380/953009/bit

**DEUTSCHE EDELSTAHLWERKE**  
 Schmolz + Bickenbach USA, Inc.  
 365 Village Drive

US- Carol Stream, Illinois 60188

**Warenempfänger**  
 Best Stainless & Alloys  
 11930 Proctor Rd

US-77038 Houston, Texas

<b>Herstellerzeichen/Supplier's Mark/Marque d'usine</b>	
<b>Prüfstempel/Inspector's stamp/Poinçon de l'expert</b>	

<b>Ihre Auftr.-Nr. vom</b> Your order No. date /No.de votre commande du	<b>Your material No.</b>
01D08-356 / 31.07.08	BEST STAINLESS 12797
<b>Unsere Auftr.-Nr.</b> Our order No./No.de notre Commande	<b>Unsere Material-Nr.</b> Our material No./No.de notre matériel
1109349 / 6	2252631
<b>Unsere Abteilung/Our department/Notre département</b>	<b>Telefon/Telephone/Téléphone</b>
VS-O	02302/294820

## Produkt/Product/Produit

STAINLESS STEEL BARS  
 TYPE 630 (17-4 PH)  
 HOT ROLLED, SOLUTION TREATED, DOUBLE AGE  
 HARDENED, PEELED  
 ASTM A 564-02A, UNS-S-17400, DH 1150,  
 NACE MR 01-75, ASTM A 484, AMS 5643P,  
 AMS 2303, ASTM A 370  
 UT per SA 388

**Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.** : 726608  
**Lieferschein-Nr./Delivery note/No. de Pavis de livraison** :  
**Schmelzen-Nr./Heat No./No.de coulée** : 332170  
**Stückzahl/Piece No./Nombre des pièces** :  
**Gewicht/Weight/Masse** :  
**Zeichnungs-Nr./Drawing No./No.de dessin** :  
**Format/Shape/Profil** : rund / round / rond  
**Durchm./Breite/Diameter/width/Diamètre/largeur** : 102.616 [mm] / 4.000 [in]  
 +0.510/-0.000 [mm] / +0.020/-0.000 [in]  
**Dicke/Thickness/Epaisseur** :  
**Länge/Length/Longueur** : 6095 - 6400 [mm]  
 239.961 - 251.969 [in]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.  
 Nombre des pièces et masse voir facture.

**Lieferzustand/Condition as supplied/Etat de livraison:**  
 1040 °C2H/Water + 620 °C4H/Air + 620 °C4H/Air  
 NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten  
 As for test results of your delivery see overleaf. / Vous trouverez les résultats d'essais de votre livraison aux pages suivantes.

**DEUTSCHE EDELSTAHLWERKE GMBH**  
 Abnahmetechnik/Inspection department/Département de Réception

**Abnahmebeauftragter/Der Werkssachverständige**  
 Test House Manager/Works' inspector/Responsible Reception/L'Agent Réceptionnaire de l'usine

*Krause*  
 11  
 2.10



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 27.11.08

Seite/Page: 2 / 3

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1421380/953009/bit	1109349 / 6	01D08-356	726608

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy/Metallurgie secondaire
332170	E	VOD

## Chemische Zusammensetzung / Chemical Composition / Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Ta	
Ist/Actual/Actuel	0.026	0.39	0.93	0.023	0.001	15.57	0.07	4.50	3.14	0.24	< 0.01	[%]

## Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette	HRC
14818	30.3

Pr-ent./Specimen location/Point d'prélèv.: Oberflaeche

## Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette	
14817	
Ist/Actual/Actuel	[HB]
306	

Pr-ent./Specimen location/Point d'prélèv.: Oberflaeche

## Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai				
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	23 [°C]				
Proben-Nr./Specimen-No./No.d'éprouvette	R <sub>p0.2</sub> [MPa (N/mm <sup>2</sup> )]	R <sub>p0.2</sub> [Ksi]	R <sub>m</sub> [MPa (N/mm <sup>2</sup> )]	R <sub>m</sub> [Ksi]	A <sub>2</sub> ' [%]	Z [%]
14817	868	126	990	144	20.5	63

## Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai	
[CHARPY V]	längs/longitudinal/longueur	23 [°C]	
Proben-Nr./Specimen-No./No.d'éprouvette	1.Prfl./Spec./Eprouvette	2.Prfl./Spec./Eprouvette	3.Prfl./Spec./Eprouvette
14817	119.5 [ft.lbs]	116.5 [ft.lbs]	116.5 [ft.lbs]

Laterale Breitung Pr.Nr.14817 = 1.29; 1.22; 1.24; mm  
Interkrist.Anteil Pr.Nr.14817 = 0; 0; 0; %

## Gefügeuntersuchung/ Examination of microstructure/ Examen de structure

MICRO- AND MACROSTRUCTURE NO OBJECTIONS

## Stufendrehprüfung/ step-down test/ essai de tournage en gradins

ACC. To AMS 2303C

## US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons

US-report see enclosure

Identity has been checked (Optical Emission Spectrometry)

Testing for surface cracks has been performed.

Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität./The Product is free from radioactive./Le matériel n'est pas radioactif.  
El material es libre de radioactividad.

## Erläuterung/ Explanations/ Explications

□ Erschmelzungsart/Steelmaking process/Procédé d'élaboration:

E = Elektrostahl / Electric-arc-furnace steel / Acier électrique

□ Sekundärmetallurgie/Secondary metallurgy/Metallurgie secondaire:

VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

11.09  
2.10



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 27.11.08

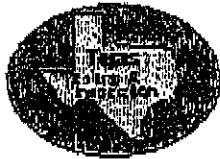
Seite/Page: 3 / 3

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1421380/953009/bit	1109349 / 6	01D08-356	726608

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme entspricht.  
We hereby certify that the material described above has been tested and complies with the terms of the order.  
Nous certifions que la livraison a été vérifiée et est conforme aux stipulations de l'acceptation de la commande.

Handwritten signature and circular stamp with text: 11, 10, 2008

# Tensile & Charpy Certification Report



Tejas Testing & Inspection, Inc.  
4601 South Pinemont, Suite 136  
Houston, TX 77041  
Phone: (713) 939-0440 • Fax: (713) 939-0430

Report: 1060204 -

Customer: Best Stainless & Alloys Inc.

PO Number 15161

Material: 17-4 HH150

HT No. 332170

No. Pieces: 1

Customer Info.: 4" DIA X 6.00" LG

Specification: TENSILE: LCVN @ -22°F PER OIL STATES SPEC A574

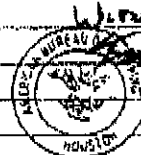
**Tensile Results** Unless otherwise stated, yield stress is 0.2% offset. Gauge length is 2" for a 0.5" specimen or 1" for a 0.25" specimen.

Number	1	2	3	4
Size (Inches):	<u>505</u>			
Yield (PSI):	<u>132,500</u>			
Tensile (PSI)	<u>149,500</u>			
Elongation (%)	<u>21</u>			
Reduction (%)	<u>62</u>			
Hardness				

**Charpy Results** Unless otherwise stated, specimens are full size, i. e. 10 mm x 10 mm

Number	1	2	3	4
Temperature:	<u>-22°F</u>			
Location:	<u>LCVN</u>			
Ft/Lbs	<u>36</u> <u>63</u> <u>42</u>			
% Shear	<u>30</u> <u>50</u> <u>50</u>			
MLE	<u>18</u> <u>27</u> <u>22</u>			

Comments: THIRD PARTY WITNESS BY: TODD GINAVAN



Submitted by:

Randall Tippit

Date: 5/12/2009

TTI Representative

*Randall Tippit*



# AMERICAN BUREAU OF SHIPPING

Customer Name	BEST STAINLESS & ALLOYS, L.P.	Purchase Order No.	15162
Attending Office	Houston, TX (Port)	Report Number	HS1668821.R1
First Visit Date	01-May-2009	Last Visit Date	14-May-2009

**Statement of Fact Of:** Stainless Steel

**Survey Location :** Houston, Texas

**Manufacturer :** BEST STAINLESS & ALLOYS, L.P.

**This is to Certify** that the undersigned surveyor(s) to this Bureau did, at the request of the customer, carry out the following survey and report as follows:

## Inspections

The scope of work was as agreed.

The survey of the items identified has been carried out in accordance with the applicable Process Instruction.

## Observations

The undersigned surveyor did attend Best Stainless and Tejas lab in Houston Texas on 1 May 2009 and subsequent dates in order to identify and witness the following:

The material was identified at Best Stainless and stamped with the Maltese Cross.

The Maltese cross was verified at Tejas lab and the following tests were witnessed:

Material Grade 17-4 HH150 - Heat Number - 332170

One (1) Tensile test:

Yield 132,500 PSI - Tensile 149,500 PSI - 21% Elongation - 62% Reduction in Area

Three (3) LCVN @ -22F -

36, 63, 42 Ft Lbs.

All testing was done with properly calibrated equipment.

## Surveyor(s) to The American Bureau of Shipping

### Attending Surveyors

Ginavan Todd A

Electronically Signed on 15-May-2009

### Reviewed By

Gardiakos, George N.

Electronically Signed on 15-May-2009, Houston Port

NOTE: This report evidences that the survey reported herein was carried out in compliance with one or more of the Rules, guides, standards or other criteria of the American Bureau of Shipping and is issued solely for the use of the Bureau, its committees, its clients or other authorized entities. This Report is a representation only that the vessel, structure, item or material equipment, machinery or any other item covered by this Report has been examined for compliance with, or has met one or more of the Rules, guides, standards or other criteria of American Bureau of Shipping. The validity, applicability and interpretation of this report is governed by the Rules and standards of American Bureau of Shipping who shall remain the sole judge thereof. Nothing contained in this Report or in any notation made in the contemplation of this Report shall be deemed to relieve any designer, builder, owner, manufacturer, seller, supplier, repairer, operator or other entity of any warranty express or implied.



ISO / TS 16949  
AS 9100  
ISO 14001



**DEUTSCHE EDELSTAHLWERKE**  
Providing special steel solutions



D-58452 Witten, D-57012 Siegen, http://www.dew-steel.com

Seite/Page: 1 / 3

Datum/Date: 18.06.09

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräterichtlinie 97 / 23 EG
--------------------	-----------------------	---

**Abnahmeprüfzeugnis nach** DIN EN 10204 3.1/01.05  
Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.1B/08.95  
**Zeugnis-Nr./Certificate No./No.de Certificat** 1456591/986959/bit

**DEUTSCHE EDELSTAHLWERKE**  
Schmolz + Bickenbach USA, Inc.  
365 Village Drive  
US- Carol Stream, Illinois 60188

<b>Herstellerzeichen/Supplier's Mark/Marque d'usine</b>	
<b>Prüfstempel/Inspector's stamp/Poinçon de l'expert</b>	

**Warenempfänger**  
Best Stainless & Alloys  
11930 Proctor Rd  
US-77038 Houston, Texas

<b>Ihre Auftr.-Nr. vom</b> Your order No. date /No.de votre commande du	<b>Your material No.</b>
01D09-056 / 17.03.09	14829
<b>Unsere Auftr.-Nr.</b> Our order No./No.de notre Commande	<b>Unsere Material-Nr.</b> Our material No./No.de notre matériel
1148937 / 6	2256262
<b>Unsere Abteilung/Our department/Notre département</b>	<b>Telefon/Telephone/Téléphone</b>
VS-O	02302/292221

**Produkt/Product/Produit**

STAINLESS STEEL BARS  
TYPE 630 (17-4 PH)  
HOT ROLLED, SOLUTION TREATED, DOUBLE AGE  
HARDENED, PEELED  
ASTM A 564-02A, UNS S-17400, DH 1150,  
NACE MR 01-75, ASTM A 484, AMS 5643P,  
AMS 2303, ASTM A 370, ASTM A388  
HIGH SULFUR

**Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.** : 756867  
**Lieferschein-Nr./Delivery note/No. de l'avis de livraison** :  
**Schmelzen-Nr./Heat No./No.de coulée** : 347260  
**Stückzahl/Piece No./Nombre des pièces** :  
**Gewicht/Weight/Masse** :  
**Zeichnungs-Nr./Drawing No./No.du dessin** :  
**Format/Shape/Profil** : rund / round / rond  
**Durchm./Brefte/Diameter/width/Diamètre/largeur** : 89.916 [mm] / 3.500 [in]  
+0.510/-0.000 [mm] / +0.020/-0.000 [in]  
**Dicke/Thickness/Épaisseur** :  
**Länge/Length/Longueur** : 6095 - 6395 [mm]  
239.961 - 251.772 [in]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.  
Nombre des pièces et masse voir facture.  
**Lieferzustand/Condition as supplied/État de livraison:**  
1040 °C 110 Min./Water + 620 °C 4 H/Air + 620 °C 4 H/Air  
**NO WELDING HAS BEEN PERFORMED**

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten.  
As for test results of your delivery see overleaf. / Vous trouverez les résultats d'essais de votre livraison aux pages suivantes.

**DEUTSCHE EDELSTAHLWERKE GMBH**  
Abnahme technik / Inspection department / Département de Réception

Krause

**Abnahmebeauftragter/Der Werkssachverständige**  
Test House Manager/Works' inspector/Responsable Réception/L'Agent Réceptionnaire de l'usine



pp11-23-09



ISO / TS 16949  
AS 9100  
ISO 14001



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, http://www.dew-steel.com

Seite/Page: 2 / 3

Datum/Date: 18.06.09

Zaun-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1456591/986959/bii	1148937 / 6	01D09-056	756867

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy/Metallurgie secondaire
347260	E	VOD

## Chemische Zusammensetzung / Chemical Composition / Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Ta	
Ist / Actual / Actuel	0.025	0.42	0.89	0.023	0.022	15.65	0.10	4.61	3.23	0.24	< 0.01	[%]

## Härte / Hardness / Dureté

Lieferzustand / Condition as supplied / Etat de livraison

Proben-Nr. / Specimen-No. / No.d'éprouvette	HRC
73017	30.6

Pr.-ent. / Specimen location / Point d'prélèv.: Oberfläche

## Härte / Hardness / Dureté

Lieferzustand / Condition as supplied / Etat de livraison

Proben-Nr. / Specimen-No. / No.d'éprouvette	73016
Ist / Actual / Actuel	311 [HB]

Pr.-ent. / Specimen location / Point d'prélèv.: Oberfläche

## Zugversuch / Tensile test / Essai de traction

Lieferzustand / Condition as supplied / Etat de livraison

Zugversuch / Tensile test / Essai Lieferzustand / Condition as supplied / Etat de livraison						
Probenabm. / Specimen dimension / Dimension d'éprouvette	Probenrichtung / Specimen direction / Sens de Prélèvement			Prüftemp. / Test temperature / Température d'essai		
Zugprobe; 12,5 mm rd	längs / longitudinal / longueur			23 [°C]		
Proben-Nr. / Specimen-No. / No.d'éprouvette	R <sub>p0.2</sub> [MPa (N/mm <sup>2</sup> )]	R <sub>p0.2</sub> [Ksi]	R <sub>m</sub> [MPa (N/mm <sup>2</sup> )]	R <sub>m</sub> [Ksi]	A <sub>2</sub> [%]	Z [%]
73016	879	128	991	144	21.5	65

## Schlagbiegeversuch / Impact test / Essai de résilience

Lieferzustand / Condition as supplied / Etat de livraison

Lieferzustand/Condition as supplied/Etat de livraison			
Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement		Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur		23 [°C]
Proben-Nr./Specimen-No./No.d'éprouvette	1.Prüf./Spec./Eprouvette	2.Prüf./Spec./Eprouvette	3.Prüf./Spec./Eprouvette
73016	109.2 [ft.lbs]	121.0 [ft.lbs]	118.0 [ft.lbs]
laterale Breitung/kristalliner-/duktiler Bruchanteil lateral expansion/crystalline fracture/shear fracture	1.40 [mm]/ 4 [%]/ 96 [%]	1.50 [mm]/ 3 [%]/ 97 [%]	1.40 [mm]/ 4 [%]/ 96 [%]

## Schlagbiegeversuch / Impact test / Essai de résilience

Lieferzustand / Condition as supplied / Etat de livraison

Schlagbiegeversuch / Impact test / Essai de choc / Essai de flexion			
Lieferzustand / Condition as supplied / Etat de livraison			
Probenform / Type of specimen / Type d'éprouvette	Probenrichtung / Specimen direction / Sens de Prélèvement		Prüftemp. / Test temperature / Température d'essai
[CHARPY V]	längs / longitudinal / longueur		-60 [°C]
Proben-Nr. / Specimen-No. / No. d'éprouvette	1. Prüfl. / Spec. / Eprouvette	2. Prüfl. / Spec. / Eprouvette	3. Prüfl. / Spec. / Eprouvette
73016	70 [J] / 51.6 [ft.-lb]	67 [J] / 49.4 [ft.-lb]	75 [J] / 55.3 [ft.-lb]
laterale Breitung / kristalliner - / duktiler Bruchanteil lateral expansion / crystalline fracture / shear fracture	0.57 [mm] / 36 [%] / 64 [%]	0.52 [mm] / 37 [%] / 63 [%]	0.62 [mm] / 32 [%] / 68 [%]

## Gefügeuntersuchung / Examination of microstructure / Examen de structure

MICRO- AND MACROSTRUCTURE NO OBJECTIONS

## Stufendrehprüfung / step-down test / essai de tournage en gradins

ACC. To AMS 2303C

## US-Prüfung / Ultrasonic testing / Contrôle par ultrasons

US-report see enclosure

Identity has been checked (Optical Emission Spectrometry)  
Testing for surface cracks has been performed.



11-23-09



ISO / TS 16949  
AS 9100  
ISO 14001



**DEUTSCHE EDELSTAHLWERKE**  
Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Seite/Page: 3 / 3

<b>Datum/Date:</b> 18.06.09	<b>Zeugnis-Nr.</b> Certificate No./No.de Certificat 1456591/986959/bit	<b>Unsere Auftr.-Nr.</b> Our order No./No.de notre Commande 1148937 / 6	<b>Ihre Auftr.-Nr. vom</b> Your order No. date /No.de votre commande du 01D09-056	<b>Fertigungsauftr.-Nr.</b> Production lot-No./Lot de fabrication No. 756867
-----------------------------	--	---	---	--

Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität./The Product is free from radioactive./Le matériel n'est pas radioactif.  
El material es libre de radioactividad.

**Erläuterung/ Explanations/ Explications**

■ **Erschmelzungsart**/Steelmaking process/Procédé d'élaboration:

E = Elektrostahl / Electric-arc-furnace steel / Acier électrique

■ **Sekundärmetallurgie**/Secondary metallurgy/Metallurgie secondaire:

VOO = Vakuum-Sauerstoff-Einkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellsannahme entspricht.  
We hereby certify that the material described above has been tested and complies with the terms of the order.  
Nous certifions que la livraison a été vérifiée et est conforme aux stipulations de l'acceptation de la commande.



pp 11-23-09





# 華新麗華股份有限公司檢驗證明書

SHANGHAI BAIHE WALSH LIHWA SPECIALTY STEEL PRODUCTS

MILL INSPECTION CERTIFICATE (ISO-9001)

地址: 上海青浦區白鶴鎮吳淞江大橋 郵編: 201711  
Add: Wu Song Jiang Bridge, Bai He QingPu, Shangti  
電話 Tel: (86-21) 59747027 傳真 Fax: (86-21) 59747027

## COMPRADOR INOXIDABLE INC.

日期 Date: 2008/2/22 編號 File: 2008022204  
訂單號碼 Order No: BWA080213319 P.O.NO.: 53183  
Workmanship (特殊要求)

1) U.T. ON ALL DIA OVER 1.5"  
2) Mid reduction: 6:1  
3) Solution treatment 1040°C, 1-2 hours, water quenched

客戶Customer		17-4PH		品名Commodity		STAINLESS STEEL ROUND BARS	
鋼種Steel Grade							
Item	BEST NO	Heat No.	Shape	Size(Inch)	Quantity(P'cs)	Weight(lbs)	Condition
1	10303	1C68S	R	1.750	23	3854	HRAPL
2	10303	1C67S	R	1.875	3	629	HRAPL
3	10303	1C68S	R	1.875	8	1700	HRAPL
4	10303	1C68S	R	2.750	14	6352	HRAPL
5	10303	1C68S	R	3.250	4	2517	HRAPL

### 化學成份 Chemical Composition (WT%)

Kind of Test	C	Si	Mn	P	S	Ni	Cr	Cu	Ta+Nb
Spec.	MAX 0.07	MAX 1.00	MAX 1.00	MAX 0.040	MAX 0.030	3.00 5.00	15.00 17.50	3.00 5.00	0.45 0.15
1	0.041	0.59	0.59	0.024	0.001	4.30	15.92	3.33	0.284
2	0.041	0.57	0.47	0.023	0.002	4.21	16.19	3.23	0.284
3	0.041	0.59	0.59	0.024	0.001	4.30	15.92	3.33	0.284
4	0.041	0.59	0.59	0.024	0.001	4.30	15.92	3.33	0.284
5	0.041	0.59	0.59	0.024	0.001	4.30	15.92	3.33	0.284

區分 Condition: FC: 爐冷 Furnace Cooled SPEC: Aqunox17  
S: 固溶化 Solution Treated AISI630(17-4) COND A HOT ROLLED ANNEALED SMOOTH TURNED  
HR: 熱軋 Hot Rolled A: 退火 Annealed  
CD: 冷抽 Cold Drawn R: 壓光 Reeled  
ST: 剥皮 Smooth Turned B: 黑皮 Black Bar  
CG: 研磨 Centerless Grinding  
RS: 矯直 Re Straight ness P: 拋光 Polished

Shape: R: Round  
H: Hexagonal  
S: Square  
SR: Square-Round  
E: Ellipse  
FB: Rectangular  
Here we certify that the material described herein has been manufactured and tested to satisfactory results in accordance with the requirement of the material specification.

MANAGER OF QUALITY ASSURANCE DEPARTMENT

2008/2/22



GLORIA MATERIAL TECHNOLOGY CORP.

# INSPECTION CERTIFICATE

MILL TEST CERTIFICATE

台南縣新營市新中路35號1樓

IFL NO.35 Hsin Chung Rd., Hsin Ying,

TAINAN, TAIWAN, R.O.C.

Tel: (06)6520000

Fax: (06)6520088

Messrs: BEST STAINLESS & ALLOYS INC

Order No: 2006007669

Grade: 630(H1150)

P.O.NO.: 52873/7724

FILE NO: 2007000271-A

Size: 2.375"

Date: 01/15/2007

HEAT-LOT No: U1542-G13

Weight: 287.0KG 632.73LB

P'es: 2

Condition: HR-Solution Annealed-Double Aged-Smooth Turned(-Stress Relief)

## Chemical Composition (wt%)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Nb+Ta
Min.						3.0	15.0		3.0	0.15
Max.	0.07	1.00	1.00	0.040	0.030	5.0	17.5	0.50	5.0	0.45
Result	0.03	0.36	0.61	0.022	0.005	4.6	15.6	0.10	3.3	0.29

	Nb	H	Ta
Min.	0.15		
Max.	0.45	0.0005	
Result	0.29	0.0002	0.00029

## Mechanical Properties Spec.

	Hardness	Hardness	Grain Size	$\delta$ -Ferrite	Impact(1)
Condition	1/2R	Surface			23°C
Spec.Min.	24HRC	24HRC			30Ft.Lbs
Spec.Max.	33HRC	33HRC		5%	
Result	32.8HRC	30.8HRC	7.5	0.3%	104Ft.Lbs

	Impact(2)	Impact(3)	Impact(Ave)	Impact(1)	Impact(2)
Condition	23°C	23°C	23°C	-60°C	-60°C
Spec.Min.	30Ft.Lbs	30Ft.Lbs	30Ft.Lbs	25Ft.Lbs	25Ft.Lbs
Spec.Max.					
Result	109Ft.Lbs	102Ft.Lbs	105Ft.Lbs	72Ft.Lbs	69Ft.Lbs

	Impact(3)	Impact(Ave)
Condition	-60°C	-60°C
Spec.Min.	25Ft.Lbs	25Ft.Lbs
Spec.Max.		
Result	75Ft.Lbs	72Ft.Lbs

## Tensile Test

	Elongation(A)	Tensile Strength(Rm)	Yield Strength(Rp)	Reduction of Area(Z)
Condition	(Ave)	(Ave)	(Ave)	(Ave)
Min.	16%	125KSI	105KSI	50%
Max.				
Result	23.6%	139KSI	119KSI	69%

## Heat Treatment Condition

Condition Temperature Time/hour Treatment

ISO 9001:2000

ISO 9001:2000+AS9100B

ISO 9001  
BSM

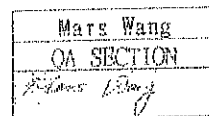


REGISTERED  
CERT. NO. 020095

Reg. No.: 020095

CERT. No. 92851

CERT. No. 020363:1054231



Our quality and environment management systems have been certified by AS9100, ISO9001 QMS and 14001 EMS.

We hereby certify that the material described herein has been manufactured and tested with satisfactory results in accordance with the requirement of the above material specification.

We hereby the Inspection Certificate comply with EN 10004 3.1



8/12/08



GLORIA MATERIAL TECHNOLOGY CORP.

# INSPECTION CERTIFICATE

## MILL TEST CERTIFICATE

台南縣新營市新中路35號1樓

IFL, NO.35, HSIN CHUNG RD., HSIN YING,

TAINAN, TAIWAN, R.O.C.

TEL: (06)6520000

FAX: (06)6520088

Messrs: BEST STAINLESS & ALLOYS INC

Order No: 2006007669

Grade: 630(HH1150)

P.O.NO.: 52873/7724

FILE NO: 2007000271-A

Size: 2.375"

Date: 01/15/2007

HEAT-Lot No: U1542-G13

Weight: 287.0KG 632.73LB

P'cs: 2

Condition: HR-Solution Annealed-Double Aged-Smooth Turned(-Stress Relief)

SOLUTION	1900°F	2.23	FAST AIR COOL TO BELOW 90°F
DOUBLE AGED	1150°F	5.24	COOL IN AIR

Non-Metallic Inclusions :(AMS 2303E)

Severity Frequency

Max. 0.85 0.9

Result 0 0

### Specification:

- 1.ASTM A564M-04.
- 2.ASTM A484M-03a.
- 2.ASME SA 564M.
- 3.AMS 5643Q.
- 5.AMS 2303B.
- 4.NACE MR0175..

### Remark:

- 1.MANUFACTURING PROCESS: EAF+LHF+VOD, FORGED OR HOT ROLLED.
- 2.MATERIAL FREE FROM KNOWN CONTACT WITH MERCURY & RADIUM.
- 3.MATERIAL IS FREE FROM WELDS OR WELD REPAIRS.
- 4.MACRO STRUCTURE OK.
- 5.MICRO STRUCTURE OK.
- 6.ULTRASONIC TEST GOOD.(SPEC. AS PER VICINENT CAMCO NDE-31 UT REQUIREMENT).
- 7.CHARPY IMPACT TESTED AT -75°F, 25 FT LB MIN(LONGITUDINAL DIRECTION)..



ISO 9001:2000



Reg. No.: 020095

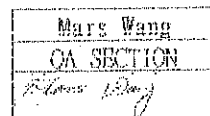


CERT. No. 92051

ISO 9001:2000+AS9100B



CERTF0020363:1054231



Our quality and environment management systems have been certified by AS9100, ISO9001 QMS and 14001 EMS.

We hereby certify that the material described herein has been manufactured and tested with satisfactory results in accordance with the requirement of the above material specification.

We hereby the Inspection Certificate comply with EN 10904 2.1

OSI  
13  
INSPECTED  
8/12/08



ISO / TS 16949  
AS 9100  
ISO 14001



**DEUTSCHE EDELSTAHLWERKE**  
Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 27.07.09

Seite/Page: 1/3

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräterichtlinie 97 / 23 EG
--------------------	--------------------	---

**Abnahmeprüfzeugnis nach** DIN EN 10204 3.1/01.05  
Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.1B/08.95  
Zeugnis-Nr./Certificate No./No.de Certificat 1462418/952699/gat

**DEUTSCHE EDELSTAHLWERKE**  
Schmolz + Bickenbach USA, Inc.  
365 Village Drive  
US- Carol Stream, Illinois 60188

Herstellerzeichen/Supplier's Mark/Marque d'usine	
Prüfstempel/Inspector's stamp/Poinçon de l'expert	

Warenempfänger  
Best Stainless & Alloys  
11930 Proctor Rd  
US-77038 Houston, Texas

Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Your material No.
01D08-356 / 31.07.08	BEST STAINLESS 12797
Unsere Auftr.-Nr. Our order No./No.de notre Commande	Unsere Material-Nr. Our material No./No.de notre matériel
1109349 / 3	2252629
Unsere Abteilung/Our department/Notre département	Telefon/Telephone/Téléphone
VS-O	02302/294820

**Produkt/Product/Produit**

STAINLESS STEEL BARS  
TYPE 304 (17-4 PH)  
HOT ROLLED, SOLUTION TREATED, DOUBLE AGE  
HARDENED, PEELED  
ASTM A 564-02A, UNS-S-17400, DH 1150,  
NACE MR 01-75, ASTM A 484, AMS 5643P,  
AMS 2303, ASTM A 370  
UT per SA 388

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No. : 722669  
Lieferschein-Nr./Delivery note/No. de l'avis de livraison :  
Schmelzen-Nr./Heat No./No.de coulée : 330370  
Stückzahl/Piece No./Nombre des pièces :  
Gewicht/Weight/Masse :  
Zeichnungs-Nr./Drawing No./No.du dessin :  
Format/Shape/Profil : rund / round / rond  
Durchm./Breite/Diameter/width/Diamètre/largeur : 64.516 [mm] / 2.500 [in]  
+0.510/-0.000 [mm] / +0.020/-0.000 [in]  
Dicke/Thickness/Epaisseur :  
Länge/Length/Longueur : 6095 - 6400 [mm]  
239.961 - 251.969 [in]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.  
Nombre des pièces et masse voir facture.  
Lieferzustand/Condition as supplied/Etat de livraison:  
1040 °C 80 Min./Water + 620 °C 4H/Air + 620 °C 4H/Air  
NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten.  
As for test results of your delivery see overleaf. / Vous trouverez les résultats d'essais de votre livraison aux pages suivantes.

**DEUTSCHE EDELSTAHLWERKE GMBH**  
Abnahmetechnik/Inspection department/Département de Réception

Abnahmebeauftragter/Die Werkssachverständige  
Test House Manager/Works' inspector/Responsable Réception/L'Agent Réceptionnaire de l'usine



10-29-09



ISO / TS 16949  
AS 9100  
ISO 14001



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 27.07.09

Seite/Page: 2 / 3

Zeugnis-Nr. Certificat No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1462418/952699/gat	1109349 / 3	01D08-356	722669

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy/Metallurgie secondaire
330370	E	VOD

## Chemische Zusammensetzung / Chemical Composition / Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Ti	
Ist/Actual/Actuel	0.028	0.30	0.90	0.021	0.002	15.66	0.07	4.75	3.21	0.24	< 0.01	[%]

## Härte / Hardness / Dureté

Lieferzustand / Condition as supplied / Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette	HRC
13962	31.3

Pr.-ent./Specimen location/Point d'prélèv.: Oberfläche

## Härte / Hardness / Dureté

Lieferzustand / Condition as supplied / Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette	13961	
Ist/Actual/Actuel	298	[HB]

Pr.-ent./Specimen location/Point d'prélèv.: Oberfläche

## Zugversuch / Tensile test / Essai de traction

Lieferzustand / Condition as supplied / Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
Zugprobe: 12,5 mm rd	längs/longitudinal/longueur	23 [°C]
Proben-Nr./Specimen-No./No.d'éprouvette	Rp0.2 [MPa (N/mm²)]	Rp0.2 [Ksi]
13961	864	125
	Rm [MPa (N/mm²)]	Rm [Ksi]
	1004	146
	A2 [%]	22.0
	Z [%]	65

## Schlagbiegeversuch / Impact test / Essai de résilience

Lieferzustand / Condition as supplied / Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	23 [°C]
Proben-Nr./Specimen-No./No.d'éprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette
13961	129.8 [ft.lbs]	123.2 [ft.lbs]
	3. Prfl./Spec./Eprouvette	118.7 [ft.lbs]
laterale Breitung/kristalliner-/duktiler Bruchanteil	laterale Breitung/kristalliner-/duktiler Bruchanteil	laterale Breitung/kristalliner-/duktiler Bruchanteil
[mm]/[%]/[%]	[mm]/[%]/[%]	[mm]/[%]/[%]

Laterale Breitung Pr.Nr.13961 = 1.53; 1.42; 1.36; mm

Krist.Bruchanteil Pr.Nr.13961 = 0; 0; 0; %

## Gefügeuntersuchung / Examination of microstructure / Examen de structure

MICRO- AND MACROSTRUCTURE NO OBJECTIONS

## Stufendrehprüfung / step-down test / essai de tournage en gradins

ACC. To AMS 2303C

## US-Prüfung / Ultrasonic testing / Contrôle par ultrasons

US-report see enclosure

Identity has been checked (Optical Emission Spectrometry)  
Testing for surface cracks has been performed.

Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität./The Product is free from radioactive./Le matériel n'est pas radioactif.  
El material es libre de radioactividad.



10-29-09



ISO / TS 16949  
AS 9100  
ISO 14001



**DEUTSCHE EDELSTAHLWERKE**  
Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Seite/Page: 3 / 3

Datum/Date: 27.07.09

Zeugnis-Nr. Certificate No./No. de Certificat	Unsere Auftr.-Nr. Our order No./No. de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No. de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1462418/952699/gat	1109349 / 3	01D08-356	722669

Probenabm./ Specimen dimension/ Dimension d'éprouvette : [ft-lbs]  
Probenrichtung/ Specimen direction/ Sens de Prélèvement: L  
Prüftemp./ Test temperature/ Température d'essai : -60 [°C]

Proben-Nr. / Specimen-No. / No. d'éprouvette : 13961

1.Prüf./ Spec./ Epreuve : 92

2.Prüf./ Spec./ Epreuve : 90

3.Prüf./ Spec./ Epreuve : 94

Dieses Zeugnis ersetzt Zeugnis-Nr./vom

This material test certificate substitutes certificate-no./date

Le certificat remplace le certificat no./du 1429030 13.01.09

#### Erläuterung/ Explanations/ Explications

□ **Erschmelzungsart/ Steelmaking process/ Procédé d'élaboration:**

E = Elektrostahl/ Electric-arc-furnace steel / Acier électrique

□ **Sekundärmetallurgie/ Secondary metallurgy/ Métallurgie secondaire:**

VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme entspricht.

We hereby certify that the material described above has been tested and complies with the terms of the order.

Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acceptation de la commande.



*10.29.09*



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 06.11.08

Seite/Page: 1 / 3

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräterichtlinie 97 / 23 EG
--------------------	--------------------	---

**Abnahmeprüfzeugnis nach** DIN EN 10204 3.1/01.05  
 Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.1B/08.95  
**Zeugnis-Nr./Certificate No./No.de Certificat** 1416011/949682/bit

**DEUTSCHE EDELSTAHLWERKE**  
 Schmolz + Bickenbach USA, Inc.  
 365 Village Drive

US- Carol Stream, Illinois 60188

**Warenempfänger:**  
 Best Stainless & Alloys  
 11930 Proctor Rd

US-77038 Houston, Texas

Herstellerzeichen/Supplier's Mark/Marque d'usine	
Prüfstempel/Inspector's stamp/Poinçon de l'expert	

<b>Ihre Auftr.-Nr. vom</b> Your order No. date /No.de votre commande du	<b>Your material No.</b>
01D08-356 / 31.07.08	BEST STAINLESS 12797
<b>Unsere Auftr.-Nr.</b> Our order No./No.de notre Commande	<b>Unsere Material-Nr.</b> Our material No./No.de notre matériel
1109349 / 5	2252626
<b>Unsere Abteilung/Our department/Notre département</b>	<b>Telefon/Telephone/Téléphone</b>
VS-O	02302/294820

## Produkt/Product/Produit

STAINLESS STEEL BARS  
 TYPE 630 (17-4 PH)  
 HOT ROLLED, SOLUTION TREATED, DOUBLE AGE  
 HARDENED, PEELED  
 ASTM A 564-02A, UNS-S-17400, DH 1150,  
 NACE MR 01-75, ASTM A 484, AMS 5643P,  
 AMS 2303, ASTM A 370  
 UT per SA 388

**Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.** : 713223  
**Lieferschein-Nr./Delivery note/No. de l'avis de livraison** :  
**Schmelzen-Nr./Heat No./No.de coulée** : 211058  
**Stückzahl/Piece No./Nombre des pièces** :  
**Gewicht/Weight/Masse** :  
**Zeichnungs-Nr./Drawing No./No.du dessin** :  
**Format/Shape/Profil** : rund / round / rond  
**Durchm./Breite/Diameter/width/Diamètre/largeur** : 77.216 [mm] + 0.510/-0.000 [mm]  
**Dicke/Thickness/Épaisseur** :  
**Länge/Length/Longueur** : 6095 - 6400 [mm]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.  
 Nombre des pièces et masse voir facture.

**Lieferzustand/Condition as supplied/Etat de livraison:**  
 1040 °C 90 Min. / Water + 620 °C 4 H / Air + 620 °C 4 H / Air  
 NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten  
 As for test results of your delivery see overleaf. / Vous trouverez les résultats d'essais de votre livraison aux pages suivantes.

**DEUTSCHE EDELSTAHLWERKE GMBH**  
 Abnahmetechnik/Inspection department/Département de Réception

**Abnahmebeauftragter/Der Werkssachverständige**  
 Test House Manager/Works' inspector/Responsible Reception/L'Agent Réceptionnaire de l'usine

1057  
 11  
 2.16.08



# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 06.11.08

Seite/Page: 2 / 3

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1416011/949682/bit	1109349 / 5	01D08-356	713223

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy/Metallurgie secondaire
211058	E	VOD

## Chemische Zusammensetzung/ Chemical Composition/ Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Ta	
Ist/Actual/Actuel	0.022	0.41	0.65	0.018	< 0.001	15.13	0.150	4.52	3.13	0.248	0	[%]

## Härte/ Hardness/ Dureté

Lieferzustand/ Condition as supplied/ Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette	HRC
93638	31.6

Pr.-ent./Specimen location/Point d'prélèv.: Oberfläche

## Härte/ Hardness/ Dureté

Lieferzustand/ Condition as supplied/ Etat de livraison

Proben-Nr./Specimen-No./No.d'éprouvette		
	93637	
Ist/Actual/Actuel	300	[HB]

Pr.-ent./Specimen location/Point d'prélèv.: Oberfläche

## Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/ Condition as supplied/ Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	23 [°C]
Proben-Nr./Specimen-No./No.d'éprouvette	Rp0.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]
93637	877	964
		A2" [%]
		Z [%]
		20.5
		70

## Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/ Condition as supplied/ Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	23 [°C]
Proben-Nr./Specimen-No./No.d'éprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette
93637	158.6 [ft.lbs]	149.7 [ft.lbs]
		3. Prfl./Spec./Eprouvette
		150.5 [ft.lbs]

Laterale Breitung Pr.Nr.93637 = 1.75; 1.63; 1.64; mm  
Interkrist.Anteil Pr.Nr.93637 = 0; 0; 0; %

## Gefügeuntersuchung/ Examination of microstructure/ Examen de structure

MICRO- AND MACROSTRUCTURE NO OBJECTIONS

## Stufendrehprüfung/ step-down test/ essai de tournage en gradins

ACC. To AMS 2303C

## US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons

US-report see enclosure

Identity has been checked (Optical Emission Spectrometry)

Testing for surface cracks has been performed.

Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität./The Product is free from radioactive./Le matériel n'est pas radioactif.  
El material es libre de radioactividad.

## Erläuterung/ Explanations/ Explications

□ Erschmelzungsart/Steelmaking process/Procédé d'élaboration:

E = Elektrostahl / Electric-arc-furnace steel / Acier électrique

□ Sekundärmetallurgie/Secondary metallurgy/Metallurgie secondaire:

VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

108  
Z-11  
2-10





# DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 06.11.08

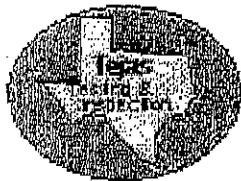
Seite/Page: 3 / 3

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
1416011/949682/bit	1109349 / 5	01D08-356	713223

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme entspricht.  
We hereby certify that the material described above has been tested and complies with the terms of the order.  
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

Handwritten signature and date: 2-10-08

# Tensile Certification Report

**Tejas Testing & Inspection, Inc.**

4601 South Pinemont, Suite 136

Houston, TX 77041

Phone: (713) 939-0440 • Fax: (713) 939-0430

OK

Report: T060273Customer: K & D HEAT TREAT, INC.PO Number 15199Material: 17-4PHHT No. 4KY8

No. Pieces:

1Customer Info.: 1 1/4" OD X 6" LGSpecification: TENSILE PER H1150

## Results

Unless otherwise stated, yield stress is 0.2% offset. Gauge length is 2" for a 0.5" specimen or 1" for a 0.25" specimen.

Number	1	2	3	4
Size (Inches):	<u>505</u>			
Yield (PSI):	<u>149,000</u>			
Tensile (PSI)	<u>153,500</u>			
Elongation (%)	<u>19</u>			
Reduction (%)	<u>57</u>			
Hardness				

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Submitted by:

Randall Tippit

TTI Representative

Date: 5/5/2009  
JPS-8-09

**CERTIFICATION OF  
HEAT TREATMENT**



2115 Humble Westfield  
Houston, Texas 77073  
(281) 821-0033 • 821-0066  
Fax: (281) 821-0072

Furnace calibration and surveys to AMS-H-6875A,  
AMS-2750 Rev. C, API 6A Annex P and API 16A Annex A  
Quality Assurance Program is registered to ISO 9001:2000

Date: 5/5/2009  
Certification Number : K&D-40436  
Customer's Order Number: 15199  
Heat Number: 4KY8  
Quantity: 4  
Part Numbers:

(3) 1 1/4" OD X 20' R/L

(1) TEST PIECE: 1 1/4" OD X 6" LG BHN 321-321

Material: 17-4PH

Spec: H1150

		Time at Heat	Coolant
Annealed	Deg. F		
Solution Annealed	Deg. F		
Preheat	Deg. F		
Normalized	Deg. F		
Quenched	Deg. F		
Temper	1150 Deg. F	4 hrs	Air
Temper	Deg. F		
Temper	Deg. F		
Stress Relieved	Deg. F		

Quench Media Temp Deg. F  
Hardness Test 321-341 50 % Pcs Tested

Times at temperature are determined by furnace atmosphere thermocouple.  
We further certify that heat treatment described above is true and correct and that  
temperatures and test results were obtained with standard approved methods.

K & D HEAT TREAT, INC

By Debbie Hoffart  
Debbie Hoffart



jos-8-09

# INSPECTION CERTIFICATE

2009 / 73577		DATE	1/02/2009
PACKING LIST #		443597	NUMBER
GRADE		700 P.O. #	:12850
AISI (		630)	Item Code:

CUSTOMER	TOLERANCE	PRODUCT
BEST STAINLESS & ALLOYS	ASTM-A-484-06B	Round Bar, Annealed, Smooth Turned, Cold Finished

ORDER NUMBER	MARK# / PROD ID	HEAT NUM	WEIGHT
INS 0470	70001/BC34104	4KX8	1890
"	70002/BC34106	4KX8	1854

REQUIREMENTS	LENGTH	SIZE	SURFACE AND DIMENSION CONTROL	INTERGRANULAR CORROSION
AISI	20.00 Ft	1.2750 Inches	Without Objections	

MECHANICAL PROPERTIES									
HEAT NUM	900 TMS KSI	906 YS KSI	900 EL %	900 RA %	900 HRC	EXP. NO.	ISV. NO.	PERIT. %	Req Values
4KX8	209	179	15	52	43	25	31		
Req Values	190	170	10	40	40	40	40		

CHEMICAL COMPOSITION %														
CM	HEAT	C	P	S	SI	Mn	Cr	Ni	Mo	Ti	N	Cu	Co	CB
US	4KX8	.0467	.0270	.0109	.5227	.4061	15.1889	4.2308	.3637	.0045	.0386	3.1637	.0776	.3158
Req Values														

## OBSERVATIONS/SPECIFICATIONS

UNS S17400, AMS 2303, ASTM A564-04, AMS 56430, AMS 2315E, ASME SA564-04

Product complies w/requirements of DEANS, EU directive 2002.95, EC, RoHS, and Free from Mercury contaminati  
No weld repair. NMS certifies the analysis on certification is correct & the material meets specs stated.

STEELMAKING PROCESS	QUALITY INSPECTOR
EAF+AOD+CC	Eric Hess

15  
0.87  
105-2-69

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 3.0 Ballring Certificates



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



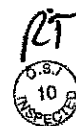
AVON BEARINGS CORPORATION  
1500 Nagle Rd.  
Avon, Ohio 44011  
(440) 871-2500

**CERTIFICATE OF CONFORMANCE**

Customer: Oil States Skagit Smatco  
P.O. No. 4054532  
Our Job No. 14005

THIS IS TO CERTIFY THAT THE MATERIALS, PARTS AND/OR ASSEMBLIES LISTED BELOW, FURNISHED FOR THE ABOVE ORDER, HAVE BEEN MANUFACTURED AND INSPECTED IN ACCORDANCE WITH ALL APPLICABLE CONTRACT REQUIREMENTS.

Material certifications listed below are included.



<u>Assy Ser. No.</u>	<u>Inner S/N</u>	<u>Inner Ht. No.</u>	<u>Outer S/N</u>	<u>Outer Ht. No.</u>
14005-1	14005-1	B570	14005-2	B570
14005-2	14005-5	B570	14005-3	B570
14005-3	14005-4	B570	14005-1	B570

SERIAL NO.  
See Above

PART NO.  
2571B2 Rev. n.a.

QUANTITY  
3 Pcs.

DESCRIPTION  
Bearing

  
Frank Bernat  
Quality Manager

8/23/07  
Date

## CERTIFICATION OF TEST

CERTIFICATION NO. 380966728312210



ThyssenKrupp

Customer  
Order no.

Rotek  
Order no.

Specification

Certification Date

79731

312210

AISI 4340 BES 2-1-055  
PER API-2C PARA 9.2.2, SEPT. 2004

5/23/2007  
1/11/2008 Revision Date

Customer Name AVON BEARINGS

Part No.

PCS

Rotek Heat Code

ROUGH RINGS

101560

70.69 X 58.26 X 5.25

5

B570

Heat No. 152969

Material Vendor LEHIGH SPECIALTY MELTING

### CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO	CU	V
.420	.680	.015	.012	.200	1.740	.860	.240	.120	.025

Per EPCRA section 313 chemical notice, this Rotek product contains the above chemical mixture by weight to facilitate your Form A and / or R reporting if so required

### MECHANICAL PROPERTIES OF TEST RING

BHN	TENSILE STRENGTH PSI	YIELD STRENGTH PSI	ELONG % IN 4D	%RED. OF AREA	GRAIN SIZE 5
302	149,000	136,000	17	53	SIZE = .503

### CLEANLINESS RATING PER E-45

A		B		C		D	
T	H	T	H	T	H	T	H
1.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00

### CHARPY IMPACT TEST RESULTS (FT. LBS)

TEM °	#1	#2	#3
-20C	056.0	056.0	054.0

ULTRASONIC INSPECTED

HEAT TREATMENT

NORMALIZED 1600 DEG.F. 4.75 HOURS AIR COOL, AUST. 1550 DEG.F. 4.75 HOURS  
TENAXOL QUENCHED, TEMPERED 1190 DEG.F. 4.75 HOURS AIR COOL

NOTES

REVISED CERTIFICATION

WE HEREBY CERTIFY THE ABOVE RESULTS ARE CORRECT AS  
REPORTED AND CONTAINED WITHIN COMPANY RECORDS. Testing,  
Inspection and documentation law EN10204-3.1 B

AUTHORIZED SIGNATURE

AVON BEARINGS CORPORATION  
1500 Nagle Rd.  
Avon, Ohio 44011  
(440) 871-2500

## CERTIFICATE OF CONFORMANCE

Customer: Oil States Skagit Smatco  
P.O. No. 4054532  
Our Job' No. 14005

THIS IS TO CERTIFY THAT THE MATERIALS, PARTS AND/OR ASSEMBLIES LISTED BELOW, FURNISHED FOR THE ABOVE ORDER, HAVE BEEN MANUFACTURED AND INSPECTED IN ACCORDANCE WITH ALL APPLICABLE CONTRACT REQUIREMENTS.

Material certifications listed below are included.

<u>Assy Ser. No.</u>	<u>Inner S/N</u>	<u>Inner Ht. No.</u>	<u>Outer S/N</u>	<u>Outer Ht. No.</u>
14005-4	14005-7	B660	14005-5	B570
14005-5	14005-6	B614	14005-4	B570

<u>SERIAL NO.</u>	<u>PART NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
See Above	2571B2 Rev. n.a.	2 Pcs.	Bearing



Dale Smith  
Chief Inspector

11-1-07  
Date





## CERTIFICATION OF TEST

CERTIFICATION NO. 380966727312200



Customer Order no.	Rotek Order no.	Specification	Certification Date
79731	312200	AISI 4340 BES 2-1-055 PER API-2C PARA 9.2.2. SEPT. 2004	5/23/2007 1/11/2008 Revision Date

Customer Name AVON BEARINGS

Part No.	PCS	Rotek Heat Code
ROUGH RINGS 101559 80.88 X 70.57 X 5.25	5	B570

Heat No. 152969 Material Vendor LEHIGH SPECIALTY MELTING

### CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO	CU	V
.420	.680	.015	.012	.200	1.740	.860	.240	.120	.025

Per EPCRA section 313 chemical notice, this Rotek product contains the above chemical mixture by weight to facilitate your Form A and / or R reporting if so required

### MECHANICAL PROPERTIES OF TEST RING

BHN	TENSILE STRENGTH PSI	YIELD STRENGTH PSI	ELONG % IN 4D	%RED. OF AREA	GRAIN SIZE
302	149,000	136,000	17	53	5 SIZE = .503

### CLEANLINESS RATING PER E-45

A		B		C		D	
T	H	T	H	T	H	T	H
1.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00

### CHARPY IMPACT TEST RESULTS (FT. LBS)

TEM °	#1	#2	#3
-20C	056.0	056.0	054.0

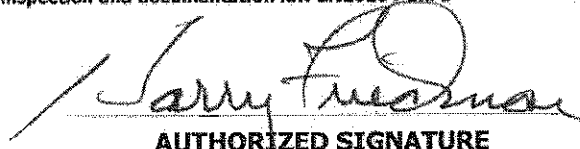
### ULTRASONIC INSPECTED

HEAT TREATMENT NORMALIZED 1600 DEG.F. 4.5 HOURS AIR COOL, AUST. 1550 DEG.F. 4.75 HOURS TENAXOL QUENCHED, TEMPERED 1190 DEG.F. 4.75 HOURS AIR COOL

### NOTES

REVISED CERTIFICATION

WE HEREBY CERTIFY THE ABOVE RESULTS ARE CORRECT AS REPORTED AND CONTAINED WITHIN COMPANY RECORDS. Testing, inspection and documentation iaw EN10204-3.1 B

  
AUTHORIZED SIGNATURE

## CERTIFICATION OF TEST

CERTIFICATION NO. 380968666324160



ThyssenKrupp

Customer  
Order no.

Rotek  
Order no.

Specification

Certification Date

80735

324160

AISI 4340 BES 2-1-055  
PER API-2C PARA 9.2.2., SEPT. 2004

9/20/2007  
1/11/2008 Revision Date

Customer Name AVON BEARINGS

Part No.

PCS

Rotek Heat Code

ROUGH RINGS

101560

70.69 X 58.26 X 5.25

1

B614

Heat No. 153360

Material Vendor

LEHIGH SPECIALTY MELTING

### CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO	CU	V	CB
.420	.730	.012	.009	.220	1.780	.820	.250	.090	.009	.001

Per EPCRA section 313 chemical notice, this Rotek product contains the above chemical mixture by weight to facilitate your Form A and / or R reporting if so required

### MECHANICAL PROPERTIES OF TEST RING

BHN	TENSILE STRENGTH PSI	YIELD STRENGTH PSI	ELONG % IN 4D	%RED. OF AREA	GRAIN SIZE
293	153,000	138,000	15	46	5 SIZE = .504

### CLEANLINESS RATING PER E-45

A		B		C		D	
T	H	T	H	T	H	T	H
1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00

### CHARPY IMPACT TEST RESULTS (FT. LBS)

TEM °	#1	#2	#3
-20C	052.0	048.0	048.0

ULTRASONIC INSPECTED


HEAT TREATMENT

NORMALIZED 1600 DEG.F. 4.75 HOURS AIR COOL, AUST. 1550 DEG.F. 4.75 HOURS  
TENAXOL QUENCHED, TEMPERED 1200 DEG.F. 4.75 HOURS AIR COOL

NOTES

REVISED CERTIFICATION

WE HEREBY CERTIFY THE ABOVE RESULTS ARE CORRECT AS  
REPORTED AND CONTAINED WITHIN COMPANY RECORDS. Testing,  
inspection and documentation law EN10204-3.1 B

  
AUTHORIZED SIGNATURE

## CERTIFICATION OF TEST

CERTIFICATION NO. 380968667324161



ThyssenKrupp

Customer Order no.	Rotek Order no.	Specification	Certification Date
80735	324161	AISI 4340 BES 2-1-055 PER API-2C PARA 9.2.2., SEPT. 2004	9/20/2007 1/11/2008 Revision Date

Customer Name AVON BEARINGS

Part No.	PCS	Rotek Heat Code
ROUGH RINGS 101560 70.69 X 58.26 X 5.25	1	B660

Heat No. 153760 Material Vendor LEHIGH SPECIALTY MELTING

### CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO	CU	V	CB
.410	.730	.013	.011	.260	1.730	.830	.250	.060	.067	.000

Per EPCRA section 313 chemical notice, this Rotek product contains the above chemical mixture by weight to facilitate your Form A and / or R reporting if so required

### MECHANICAL PROPERTIES OF TEST RING

BHN	TENSILE STRENGTH PSI	YIELD STRENGTH PSI	ELONG % IN 4D	%RED. OF AREA	GRAIN SIZE
293	144,000	127,000	15	48	SIZE = .503

### CLEANLINESS RATING PER E-45

A		B		C		D	
T	H	T	H	T	H	T	H
1.50	0.00	0.00	0.00	0.00	0.00	1.00	0.05

### CHARPY IMPACT TEST RESULTS (FT. LBS)

TEM °	#1	#2	#3
-20C	061.0	058.0	060.0


### ULTRASONIC INSPECTED

HEAT TREATMENT NORMALIZED 1600 DEG.F. 4.75 HOURS AIR COOL, AUST. 1550 DEG.F. 4.75 HOURS TENAXOL QUENCHED, TEMPERED 1200 DEG.F. 4.75 HOURS AIR COOL

### NOTES

REVISED CERTIFICATION

WE HEREBY CERTIFY THE ABOVE RESULTS ARE CORRECT AS REPORTED AND CONTAINED WITHIN COMPANY RECORDS. Testing, inspection and documentation iaw EN10204-3.1 B

  
AUTHORIZED SIGNATURE

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

### Nautilus Crane Model 180L4-50

#### Section 4.0 Ballring Clearance Reports

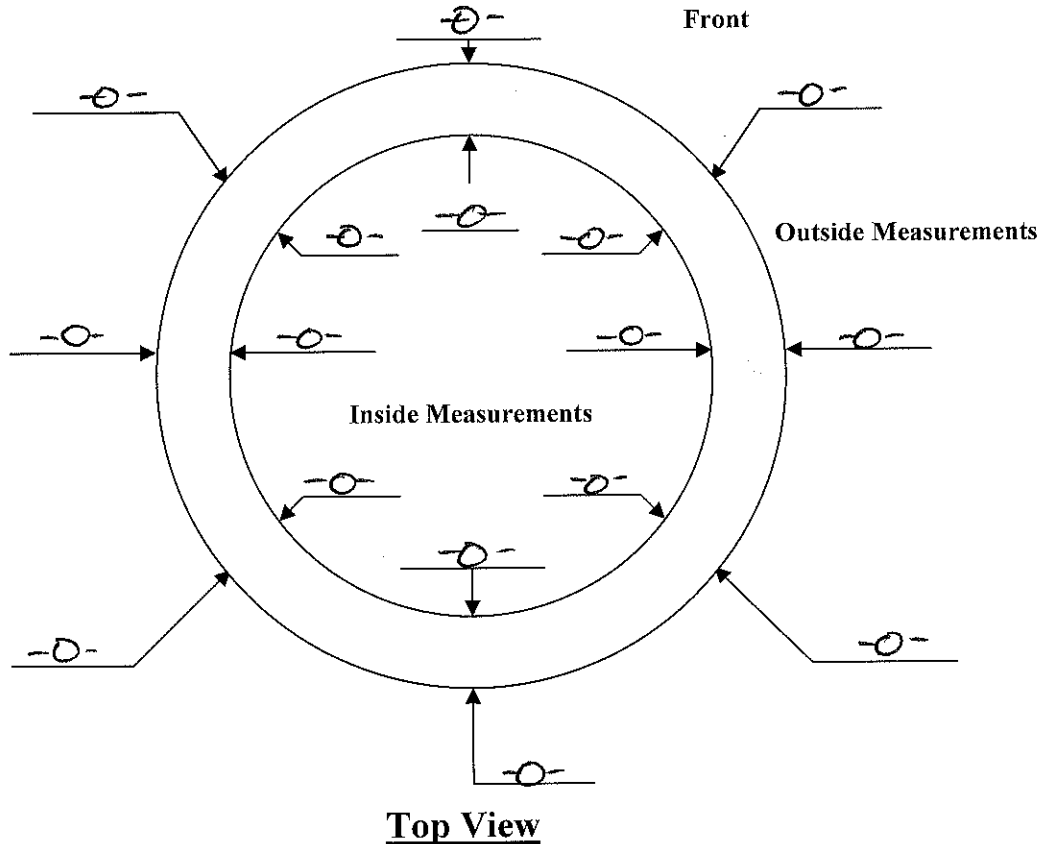


SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





## BALLRING TO TURRET/UPPER STRUCTURE CLEARANCE REPORT



Weldment Serial Number: C09247-01

Weldment Part Number: N60908

Crane Model Number: 180L4-50

Crane Serial Number: 21409

Customer: Pemex

Remarks: Flatness & Tilt are

within tolerance: Bores

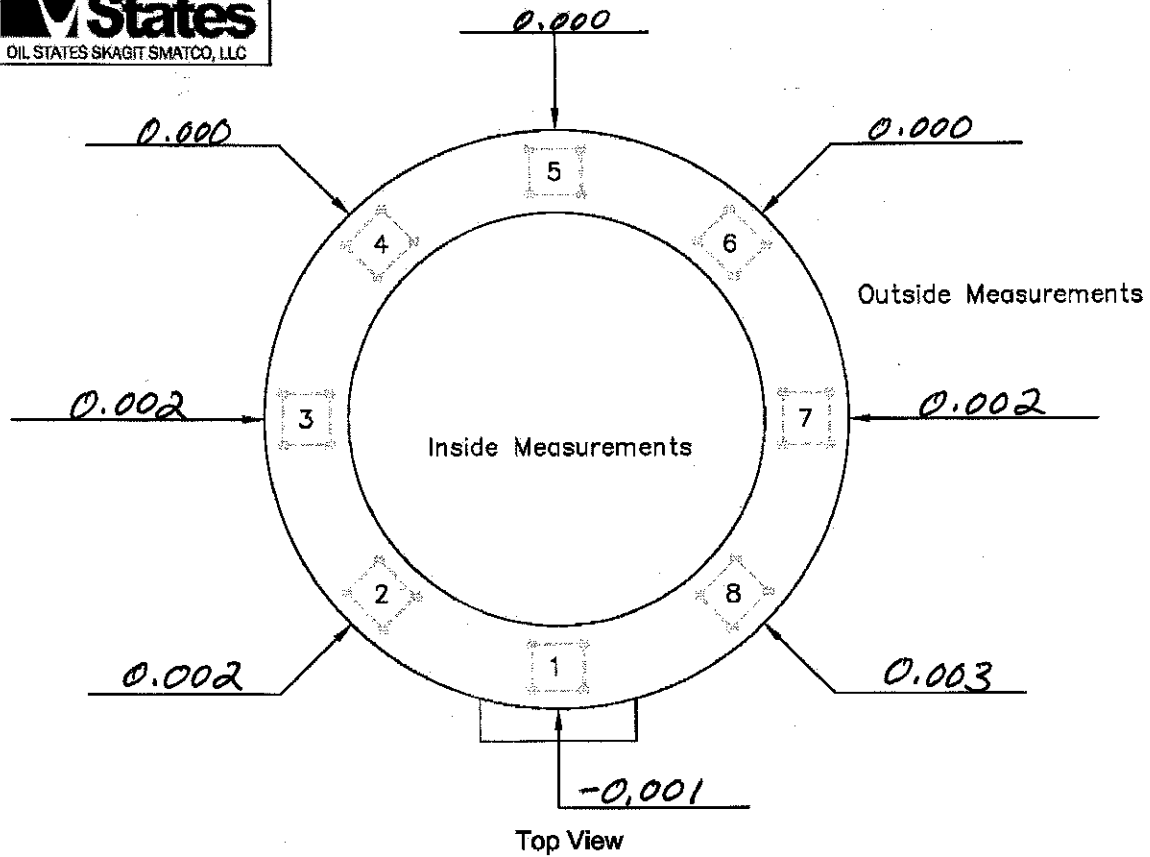
& Bolt Holes are Acceptable

Inspector: Cory Ford

Date Inspected: 12/1/09



# BALLRING TO PEDESTAL FLATNESS CLEARANCE REPORT



Weldment Serial Number : C09329-01

Weldment Part Number : N2009SK1-235

Crane Model Number : 180L4-50

Crane Serial Number : 21409.10.00

Customer : PEMEX

Remarks : FLATNESS IS  
WITHIN TOLERANCE

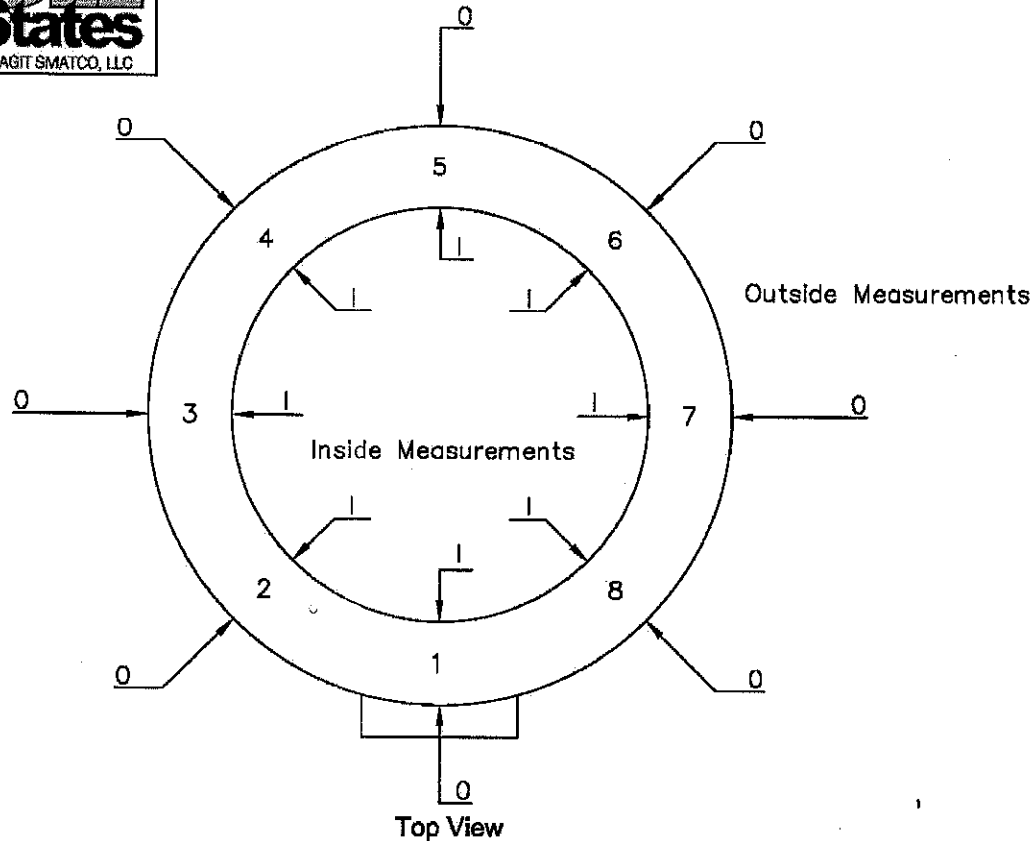
Inspector : JMR

Date Inspected : 1/13/10

Circumferential Flatness	
1 thru 3	<u>0.003</u>
3 thru 5	<u>0.002</u>
5 thru 7	<u>0.002</u>
7 thru 1	<u>0.004</u>



BALLRING TO PEDESTAL  
TILT CLEARANCE REPORT



Weldment Serial Number : C09329-01

Weldment Part Number : N2009SK1-235

Crane Model Number : 180L4-50

Crane Serial Number : 21409.10.00

Customer : PEMEX

Remarks : TILT IS  
WITHIN TOLERANCE

Inspector : [Signature]

Date Inspected : 1-13-10

Tilt Chart			
Pt.	Inside (I)	Outside (O)	Deviation
1	-0.0018	-0.0015	0.0003
2	0.0020	0.0033	0.0013
3	0.0049	0.0068	0.0019
4	-0.0006	0.0004	0.0010
5	-0.0028	-0.0020	0.0008
6	0.0003	0.0015	0.0012
7	0.0010	0.0014	0.0004
8	0.0030	0.0036	0.0006

Form No.: SS3R-0106

Rev.: B

Date: 1/16/08

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 5.0 Bolt Certificates



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA









1801 THEURER BLVD., WINONA, MN 55987

(P) 507.433.5374

(F) 507.453.8728



MECHANICAL 1046.01

**LABORATORY TEST REPORT**

CUSTOMER: Fastenal Manufacturing Division

CUSTOMER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

MANUFACTURER: Fastenal Manufacturing Division

MANUFACTURER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

JOB CONTROL NUMBER: rdh2009102601

DATE TESTED: 10/26/2009

DESCRIPTION: 1 1/4" x 10" Hex Bolt Blank

SPECIFICATION: Customer

GRADE: SAE J429 Grade 8

LOT SIZE: 937 pcs.

SHOP/LOT NUMBER: 0917286 / HT# 315358

**HEAT CHEMICAL ANALYSIS**

Tested According to

Heat Number:


Material Certificate from:

**IMPACT PROPERTIES**

Tested According to ASTM E-23

	SPECIFIED	Absorbed Energy	Test Temp	Type
	MIN:	30 ft/lb avg	-4° F	
SET #1	SAMPLE NO. 1	35.97 ft/lbs	-4° F	A
	SAMPLE NO. 2	39.17 ft/lbs	-4° F	A
	SAMPLE NO. 3	37.09 ft/lbs	-4° F	A
	AVERAGE:	37.41 ft/lbs		
SET #2	SAMPLE NO. 1	32.10 ft/lbs	-4° F	
	SAMPLE NO. 2	33.16 ft/lbs	-4° F	
	SAMPLE NO. 3	32.26 ft/lbs	-4° F	
	AVERAGE:	32.50 ft/lbs		

\* Minimum impact value permitted for (1) specimen only of a set is 22 ft/lbs.

COMMENTS: These samples conform to the standard specification(s) listed above.

Bradley James Partington  
Lab Manager

Page 1 of 1

FASTENAL COMPANY LABORATORY IS ACCREDITED BY THE AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION (A2LA) AND MEETS THE REQUIREMENTS OF ISO/IEC 17025:1999 IN THE FIELD OF MECHANICAL TESTING. THIS TEST REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF THE FASTENAL COMPANY LABORATORY. WE CERTIFY THIS DATA IS A TRUE REPRESENTATION OF THE INFORMATION PROVIDED BY THE MANUFACTURER/CUSTOMER AND OUR LABORATORY. THIS TEST REPORT APPLIES ONLY TO THE SAMPLES TESTED AND LISTED ON THIS REPORT. ANY DEVIATIONS OR DISCREPANCIES THAT ARE DETECTED, OR ANY DEPARTURES FROM DOCUMENTED POLICIES OR PROCEDURES WILL BE NOTED IN THE COMMENT SECTION.

QA7-11 Rev. 7, 4/09



# GEM-YEAR TESTING LABORATORY

## CERTIFICATE OF INSPECTION



TESTING CERT 1292-01  
MECHANICAL TESTING

MANUFACTURER GEM-YEAR INDUSTRIAL CO., LTD.  
ADDRESS : NO.8 GEM-YEAR  
ROAD, E.D.Z., JIASHAN, ZHEJIANG, P.R.CHINA

Tel: (0573)84185001(48Lines)  
Fax: (0573)84184488 84184567  
DATE : 2009/12/07

PURCHASER : FASTENAL COMPANY PURCHASING

PACKING NO : GEM090827009

PO. NUMBER : 110045728

INVOICE NO : GEM/FNL-090910 WI

COMMODITY : FINISHED HEX NUT GR-8

PART NO : 36423

SIZE : 1 1/4-7 NC

SAMPLING PLAN : ASME B18.18.2

LOT NO : N09070279

HEAT NO : 0309040819

SHIP QUANTITY : 1,300 PCS

MATERIAL : 45

HEADMARKS : GENIUS SYMBOL & 2 ARC LINES(60 DEGREE)

FINISH : H.T. PLAIN

### PERCENTAGE COMPOSITION OF CHEMISTRY :

Chemistry	C%	Mn%	Ni%	P%	S%	Si%
Spec. : MIN.	0.4200	0.5000				0.1700
MAX.	0.5000	0.8000	0.3000	0.0350	0.0350	0.3700
Test Value	0.4500	0.6100	0.0100	0.0130	0.0090	0.2200

### DIMENSIONAL INSPECTIONS : ACCORDING TO ASME/ANSI B18.2.2

TEST DATE : 2009/08/23

SAMPLED BY : YAN WANG

SAMPLING DATE : 2009/08/23

INSPECTIONS ITEM	SAMPLE	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
WIDTH ACROSS CORNERS	32 PCS	MIL-STD-120	52.490-54.970 MM	53.030-53.050 MM	32	0
HEIGHT	32 PCS	MIL-STD-120	26.180-27.760 MM	26.830-26.850 MM	32	0
WIDTH ACROSS FLATS	32 PCS	MIL-STD-120	46.040-47.600 MM	46.410-46.450 MM	32	0
SURFACE DISCONTINUITIES	100 PCS	ASTM F812		PASSED	100	0
THREAD	32 PCS	MIL-STD-120	2B	PASSED	32	0

### MECHANICAL PROPERTIES : ACCORDING TO SAE J 995-1999

TEST DATE : 2009/08/14

SAMPLED BY : ZHAO ZHENZHEN

SAMPLING DATE : 2009/08/14

INSPECTIONS ITEM	SAMPLE	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
CORE HARDNESS	8 PCS	ASTM F606/F606M	26-36 HRC	32-34 HRC	8	0
PROOF LOAD	4 PCS	ASTM F606/F606M	Min. 145,300 LBF	145,301-145,301 LBF	4	0

ALL TESTS ARE IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE APPLICABLE ASTM/SAE/ASME/MIL-STD-120 SPECIFICATION. WE CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIAL SUPPLIER AND OUR TESTING LABORATORY.

WE CERTIFY THE PARTS ARE ROHS COMPLIANT.

SIGNATURE : \_\_\_\_\_

**FASTENAL**

N46419-007

## CERTIFICATE OF COMPLIANCE

SOLD TO: LAHOU0103

PURCHASE ORDER NO: MN180 000049875  
/ HEAT/LOT: HT#72028

PART NUMBER: 10140852

JOB NO: 399832-1

DATE: 01/08/10

THIS IS TO CERTIFY THAT WE HAVE SUPPLIED YOU WITH THE FOLLOWING PARTS.  
THESE PARTS WERE PURCHASED TO THE FOLLOWING SPECIFICATIONS.

4 PCS. HHMB Length=4 " Diameter=1 " Material=(null) Thread Pitch=8 tpi Thread Length=Std Grade -

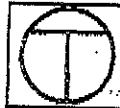
HHBT=Gr8 Test Type=Charpy Impact HMLA-55998

Additional info:

This is to certify that the above document is true  
and accurate to the best of my knowledge.

*Daniel Fritz*

Daniel Fritz  
Fastenal Company  
Quality Assurance Dept.

**Tormex S.A. DE C.V.****SINCE 1949****QUALITY ASSURANCE**

QUALITY CERTIFICATE# FAC - 10 / 427

DATE: 17/08/2007

CUSTOMER: FASTENAL COMPANY

INVOICE NUMBER: 50232

CUSTOMER'S ORDER: SHOP-49875

OUR ORDER: 7470

TRACEABILITY NUMBER: 8506

QUANTITY: 3127 PCS.

DESCRIPTION: HEX CAP SCREW, GRADE 8, BLANK, 1" x 10"

PRODUCT SPECIFICATIONS:

A.-MATERIAL: SAE J429 OKB.-DIMENSIONS: ASME B18.2.1 OKC.-PLATING: PLAIN OK

A 1.- MATERIAL SUPPLIER: SIMEC INTERNATIONAL S.A. DE C.V.

CHEMICAL COMPOSITION

HEAT NUMBER: 72028

CHEMICAL COMPOSITION

C	Mn	P	S	Si	Ni	Cr	Mo
0.39	0.78	0.014	0.007	0.20	0.07	0.82	0.16

A. ZMECHANICAL AND PHYSICAL TESTS: Ref: FAC-11/ 3019 &amp; 2815

CORE HARDNESS: 33.0 - 37.25 RC

PROOF LOAD: 120000PSI = PASSED

TENSILE STRENGTH: 153574 - 162340 PSI WEDGE 10°

VISUAL INSPECTION: OK

We certify that the results of test and process information are correct and true

  
RAUL TREJO MARTINEZ  
Quality assurance**CERTIFIED IN ISO 9001:2000**

Pellcano 248-B Col. Granjas Modernas Op. 07460 Mexico D.F. TEL 5577 9633, 35 44 35 35, Fax 5577 37 55 Ext.119 &amp; 125

raul@tormex.com, pedro@tormex.com, enrique@tormex.com, www.tormex.com

FAC-10\_PYC



# SUPER CHENG INDUSTRIAL CO.,LTD.

NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.  
TEL : 886-7-6225326-30(5 LINES) FAX : 886-7-6215377/6212335/6235829

## CERTIFICATE OF INSPECTION

CERT. # : S02-9808-04

ISSUED DATE : 2009/9/7

PAGE 1 OF 1

CLIENT : SUPER CHENG INDUSTRIAL CO., LTD.

ADDRESS : NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.

PURCHASER : FASTENAL COMPANY PURCHASING  
PART#36419

PO # : 180027838

QTY SHIPPED : 2,400 PCS

COMMODITY : GRADE 8 FIN HEX NUT

FINISH : PLN

SIZE : 1"-8

LOT# : S02-9808-04

SAMPLING PLAN : ANSI/ASME B18.18.2M-93

QTY : 71799 PCS

MATERIAL : 10B21

HEAT NO. : 1RE79


MANUFACTURER : SUPER CHENG IND. CO., LTD.

MANU. DATE : 2009/8/26

### DIMENSIONAL INSPECTION

SPEC. : ANSI/ASME B18.2.2-87

SAMPLED BY : HUI HUA YU

<u>ITEM</u>	<u>SAMPLE SIZE</u>	<u>SPECIFIED</u>		<u>ACTUAL RESULT</u>	<u>JUDGMENT</u>
APPEARANCE	100	ASTM F812-07		GOOD	OK
W.A.F.	32	1.500 ~ 1.450 in.		1.462 ~ 1.457 in.	OK
W.A.C.	8	1.732 ~ 1.653 in.		1.678 ~ 1.670 in.	OK
THICKNESS	8	0.887 ~ 0.831 in.		0.853 ~ 0.844 in.	OK
THREAD	32	ANSI/ASME B1.1		PASS	OK

### MECHANICAL PROPERTIES

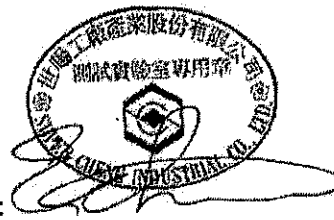
SPEC. : SAE J995-99

SAMPLED BY : HUI HUA YU

<u>ITEM</u>	<u>SAMPLE SIZE</u>	<u>TEST METHOD</u>	<u>SPECIFIED</u>	<u>ACTUAL RESULT</u>	<u>JUDGMENT</u>
HARDNESS	8	ASTM F606-07	34 ~ 26 HRC	30.0 ~ 28.0 HRC	PASS
PROOF LOAD	4	ASTM F606-07	MIN 90900LB	91161 ~ 91086 LB	PASS

- REMARK : 1、THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT WRITTEN APPROVAL OF THE LAB.  
2、THIS INSPECTION CERTIFICATE IS FOR RESPONSIBILITY UNDER SAMPLE ONLY  
3、ABOVE SAMPLES TESTED CONFORM TO THE FASTENER SPECIFICATION OR STANDARDS

LAB. DIRECTOR(SIGNATORY) :





中國鋼鐵

品質證明書  
TEST CERTIFICATE

中國鋼鐵股份有限公司

CHINA STEEL CORPORATION

中華民國高雄市小港區中鋼路1號

1 CHUNG KANG ROAD HSIAO KANG, KAOHSIUNG (812)

TAIWAN, REPUBLIC OF CHINA

TEL: (07) 802-1111 FAX: (07) 802-2511, (07) 801-9427

B0280-01 COMPANY REGISTRATION NUMBER: 30414175 1357

客戶名稱 SOLD TO	世場工廠產業股份有限公司 SUPER CHENG INDUSTRIAL CO., LTD.	產品名稱 PRODUCT	BAR-CARBON STEEL
規格名稱 SPEC.	CSC SPEC 10B21 (GCWQ-2)	發票號碼 INVOICE NO.	GW78719752
		客戶編號 CUSTOMER NO.	88700083
		交運日期 SHIPPING DATE	AUG. 03, 2009
		證明書日期 T/C ISSUE DATE	AUG. 04, 2009
檢 INSP	檢 T/C	客戶訂單編號 CUST ORDER NO.	

項 目 ITEM NO.	產品序號 SEQ. NO.	MATERIAL DESCRIPTION			爐號 HEAT NO.	化學成份 CHEMICAL ANALYSIS %										備 註 REMARKS
		直徑/厚 DIA/THICK	寬度 WIDTH	長度 LENGTH	數量 QTY	重量 GROSS kg	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	
001	BAG40 01	34.00		COIL	15	21,876	21	87	18	8	5					
	BAG40 02				25	36,992	20	82	10	7	6					
TOTAL:							40	58	868							

註釋 NOTES	茲證明本廠所列產品，均依材料規格製造及試驗，並符合規格之要求。 WE HEREBY CERTIFY THAT MATERIAL DESCRIBED HEREIN HAS BEEN MANUFACTURED AND TESTED WITH SATISFACTORY RESULTS IN ACCORDANCE WITH THE REQUIREMENT OF THE ABOVE MATERIAL SPECIFICATION
-------------	---

SURVEYOR TO	冶金技術處處長 GENERAL MANAGER METALLURGICAL DEPARTMENT
-------------	---

Lix Wei



# FASTENAL®

## CERTIFICATE OF COMPLIANCE

SOLD TO: LAHOU0103

PURCHASE ORDER NO: MN180 000049875  
/ HEAT/LOT: HT#72028

PART NUMBER: 10188406

JOB NO: 406457-1

DATE: 02/24/10

THIS IS TO CERTIFY THAT WE HAVE SUPPLIED YOU WITH THE FOLLOWING PARTS.  
THESE PARTS WERE PURCHASED TO THE FOLLOWING SPECIFICATIONS.

12 PCS. HHMB Length=3-3/4" Diameter=1" Material=(null) Thread Pitch=8 tpi Thread Length=Std Grade -

HHBT=Gr8 Test Type=Charpy Impact HMLA-36682

Additional info:

This is to certify that the above document is true  
and accurate to the best of my knowledge.



Daniel Fritz  
Fastenal Company  
Quality Assurance Dept.

**Tormex S.A. DE C.V.**

SINCE 1949

QUALITY ASSURANCE

QUALITY CERTIFICATE# FAC - 10 / 427

DATE: 17/08/2007

CUSTOMER: FASTENAL COMPANY

INVOICE NUMBER: 50232

CUSTOMER'S ORDER: SHOP-49875

OUR ORDER: 7470

TRACEABILITY NUMBER: 8506

QUANTITY: 3127 PCS.

DESCRIPTION: HEX CAP SCREW, GRADE 8, BLANK, 1" x 10"

PRODUCT SPECIFICATIONS:

A.-MATERIAL: SAE J429 OKB.-DIMENSIONS: ASME B18.2.1 OKC.-PLATING: PLAIN OK

A 1.- MATERIAL SUPPLIER: SIMEC INTERNATIONAL S.A. DE C.V.

CHEMICAL COMPOSITION

HEAT NUMBER: 72028

CHEMICAL COMPOSITION

C	Mn	P	S	Si	Ni	Cr	Mo
0.39	0.78	0.014	0.007	0.20	0.07	0.82	0.16

A. 2MECHANICAL AND PHYSICAL TESTS: Ref: FAC-11/ 3019 &amp; 2815

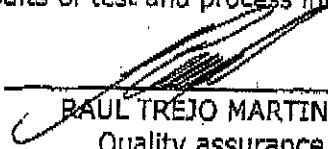
CORE HARDNESS: 33.0 - 37.25 RC

PROOF LOAD: 120000PSI = PASSED

TENSILE STRENGTH: 153574 - 162340 PSI WEDGE 10°

VISUAL INSPECTION: OK

We certify that the results of test and process information are correct and true

  
RAUL TREJO MARTINEZ  
Quality assurance

CERTIFIED IN ISO 9001:2000

Pellicano 248-B Col. Granjas Modernas Cp. 07460 México D.F. TEL 5577 9633, 35 44 35 35, Fax 5577 37 56 Ext.110 &amp; 125

raul@tormex.com, pedro@tormex.com, enrique@tormex.com, www.tormex.com

FAC-10\_PYC

# INSPECTION CERTIFICATE



Certificate No. : J420080616086

P/O No. : 120025970

L/C No. : CAD-FASTENAL

Date Issued : 2008/06/16

Date Shipped : 2008/06/14

Date Tested : 2008/06/02

Date Manufactured : 2008/05/28

Specifications : ASTM A194/A194M - 04a

Customer : FASTENAL COMPANY PURCHASING

Description : ASTM A194 GR.2H HEAVY HEX NUTS, PLAIN

Grade : GR.2H

Size : 1-BUNC

Marking : 2H,KPF LOGO

Surface Condition : PLAIN

Lot No. : F2K1439400

Q'ty Shipped : 12,000 PCS

FACTORY : 601 YONGTAN-DONG, CHUNGJU-CITY,  
CHUNGCHONGBUK-DO, KOREA 380-250  
TEL : (043) 849 - 1114  
FAX : (043) 849 - 1234

FIELD OF TESTING : MECHANICAL TESTING  
LAB. ID. : 111983  
CERT. NO. : 882-01

STANDARD  
OF CERTIFIED : ISO/TS 16949, ISO 9001, ISO 14001  
CERT. NO. : TS-01899, AC-01899, EAC-01899



## 1. Chemical Composition (%)

Heat No.	C	Si	Mn	P	S	Cr	Mo	Ni	B	Cu	Ti	V	Al
	x100	x100	x100	x1000	x1000	x100	x100	x100	x10000	x100	x100	x100	x1000
Min.	40												
Max.		40	100	40	50								
320148	44	21	68	9	14	11	2	7		16			

## 3. Mechanical Properties

Division	Hardness		Core		Yield Strength		Tensile Strength		Reduction of Area		Load		Elongation		Tensile Load		Sample Nut Hardness		Impact Test		Bending Test		Bolt Retaining Hardness		Tap Wrench Fit Test		Decarburization Test By Hardness	
	Surface	n = 5	Surface	n = 5	Strength	n = 5	Strength	n = 5	Reduction of Area	n = 5	Load	n = 5	Elongation	n = 5	Load	n = 5	540°C/24hr	n = 1	Individual	Average	Test	Test	Hardness	Hardness	Test	Test	Hardness	Hardness
Unit	Min.	HRC	Min.	HRC																								
Max.																												
Spec.	Min.	24	Min.	24							105,000						89											
Max.		35																										
1	HRC	31									6000						HRC	28										
2		31									GOOD						28											
3		31									GOOD																	
4		31									GOOD																	
5		31									GOOD																	
6		31									GOOD																	
7											***																	
8																												
9																												
10																												
Avg.																												
Tested By	G. Y. HWANG										G. Y. HWANG						G. Y. HWANG											
Spec. of Test Method	ASTM A370 -										ASTM A370 -						ASTM A370 -											

Reference : PART NO. : 38558  
ALL FASTENERS MEET THE REQUIREMENTS OF THE (FOA) AND RECORDS OF COMPLIANCE ARE ON FILE

This is to certify that the above results are true and correct in every details

*[Signature]*

IN-SUB CHOE

Chief of Quality Management Dept.

KPF

## 2. Macroetch Meet

Division	Surface Condition	Random Condition	Center Segregation	Spec. of Test Method
Spec.	S2	R2	C2	ASTM E381 -
Results	S2	R1	C2	
Tested By	K. R. LEE			

PAGE 1/2

Certificate No. : J420080616086

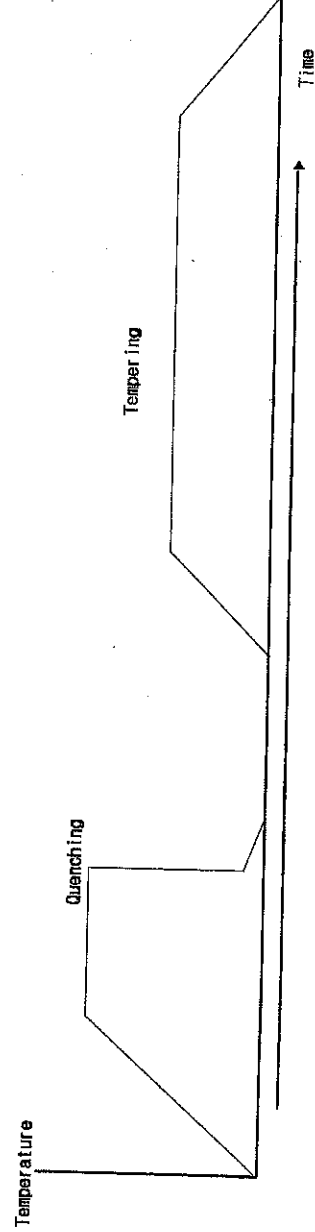
PAGE 2/2

4. Others

Division	Plate Thickness	Salt Spray Test	Decarburization Test By Microscope		Torque Tension Test		Prevailing Torque Test				Remark
			Partial Decarb. (Base Metal Height)	Gross Decarb. Depth.	Clamp Load	Tightening Torque	1st Install Prevailing Torque	Clamp Load	1st Rem. High Prevailing Torque	1st Rem. Low Prevailing Torque	
Unit	Min. Max.										
Spec.	Min. Max.										
Results	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
Avg.											
Tested By											
Spec. of Test Method											

5. Heat Treatment

Quenching	Min. Temp.	
	Max. Temp.	
	Working Temp.	870 °C
Tempering	Holding Time	30 min.
	Min. Temp.	455 °C
	Working Temp.	510 °C
	Holding Time	90 min.



This is to certify that the above results are true and correct in every details

KPF

# **FASTENAL<sup>®</sup>**

INDUSTRIAL & CONSTRUCTION SUPPLIES

## **TEST REPORT**



1801 Theurer Boulevard • Winona, MN 55987 • Phone (507)454-5374 • Fax (507)453-8728

CUSTOMER: Fastenal Manufacturing Division

CUSTOMER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

MANUFACTURER: Fastenal Manufacturing Division

MANUFACTURER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

JOB CONTROL NUMBER: rdh2008092401

DATE TESTED: 9/24/2007

DESCRIPTION: 1" x 10" Hex Cap Screw Blank

SPECIFICATION: Customer

GRADE: SAE J429 Grade 8

LOT SIZE: 3,127 pcs.

SHOP/LOT NUMBER: 0917281 / mn180-49875

HEAT LOT NUMBER: 72028

### **HEAT CHEMICAL ANALYSIS**

Heat Number:


Material Certificate from:

### **IMPACT PROPERTIES**

Tested According to ASTM E-23

	Absorbed Energy	Test Temp (F)	10mm x 10mm
SPECIFIED		0° F	Type
AVERAGE MIN:	30 ft/lbs		
SAMPLE NO. 1	31.90 ft/lbs	0° F	A
SAMPLE NO. 2	33.06 ft/lbs	0° F	A
SAMPLE NO. 3	31.53 ft/lbs	0° F	A
AVERAGE:	32.16 ft/lbs		

COMMENTS: These samples conform to the standard specification(s) listed above.

Bradley James Partington  
Lab Manager

**FASTENAL**

MANUFACTURING DIVISION

MANUFACTURING,  
MACHINING &  
ENGINEERING SERVICES

ISO 9001:2000 Certified  
QMS Registered by SGS ICS  
Certificate No.: 05012502  
Valid Through April 29, 2010  
1801 Thourer Blvd. Marietta, AL 35987

# CERTIFICATE OF CONFORMANCE

CUSTOMER: OIL STATES

DESCRIPTION: 5/8"-11X3" HEX BOLT  
SPECIFICATION: J-429  
GRADE: 8  
GRADE MARKING: Six Radial Lines  
MANUFACTURER'S I.D.: FNL  
THREAD FORM/CLASS: UNC 2A  
COATING: N/A  
COATING SPECIFICATION: N/A  
MATERIAL: GR 8

DATE: September 17, 2009

QUANTITY: 156

SHOP NUMBER: 385281-1

BRANCH CONTROL NUMBER: HMLA-54464

## HEAT CHEMICAL ANALYSIS

Heat/Lot Number: 0709-22362

C	Mn	P	S	Si	Cr	Mo	Ni	Cu	V	Co	Al	-	-
.36	.66	.005	.008	.23	.85	-	-	-	-	-	-	-	-

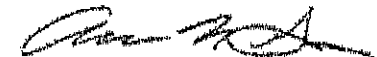
Material P.O. #: WW070504

## MECHANICAL PROPERTIES

	SPECIFIED MIN.	SPECIFIED MAX.	#1	#2	#3	#4	#5
TENSILE:	-	-	-	-	-	-	-
YIELD (.2% OFFSET):	-	-	-	-	-	-	-
% ELONG.:	-	-	-	-	-	-	-
% RED. OF AREA:	-	-	-	-	-	-	-
WEDGE TEN.: PSI	150,000	-	167,000	168,000	172,000	167,000	-
PROOF LOAD: PSI	120,000	-	120,000	-	-	-	-
CORE HARD.: HRC	33	39	37.7	38.5	37.3	37.4	38.3
SURFACE HARD.: 30 N	-	58.6	57.5	57.7	55.4	56.5	58.3
CARB/DECARB:	-	-	-	-	-	-	-

### COMMENTS/NOTES:

These samples conform to the standard specification(s) listed above.  
Test values provided by manufacturer/vendor.



SIGNATURE

This certificate of conformance shall not be reproduced except in full, without the written approval of the Fastenal Co. Manufacturing Division. We certify this data is a true representation of the information provided by the manufacturer, vendor, and/or the Fastenal Co. Laboratory. This test report applies only to the samples tested and listed on this report. Any deviations or discrepancies that are detected, or any departures from documented policies or procedures will be noted in the comment/notes section.



WW070504  
# 14325

LOT NO.: 0709-22362



# FASTENER TEST REPORT

(THIS DOCUMENT MAY BE REPRODUCED, BUT ONLY IN ITS ENTIRETY)

DATE 2007-10-03

DESCRIPTION AND MARKING			HEX HD CAP SCREW J429-8 FNA UNC N P SOLID TRIANGLE & 6 RADIAL LINES		
SIZE	5/8-11 X 6	GRADE	5135	QUANTITY	5,300

## HEAT CHEMICAL ANALYSIS

HEAT NO.	C %	Mn %	P %	S %	SI %	Cr %			
A87832	0.36	0.66	0.005	0.008	0.23	0.85			

METHOD	ASTM F606	ASTM F606		ASTM E18	ASTM F606		
SAMPLES SELECTED BY: 0099	PROOF LOAD (psi)	WEDGE TENSILE STRENGTH (psi)	SHEAR STRENGTH	SURFACE HARDNESS (HR 30N)	CORE HARDNESS (ROCKWELL)	MICRO HARDNESS	COATING THICKNESS
SPEC. MIN.	120,000	150,000			HRC 33.0		
SPEC. MAX:				58.6	HRC 39.0		
B NO.1	120,000	167,000		57.5	HRC 37.7		
A NO.2		168,000		57.7	38.5		
M NO.3		172,000		55.4	37.3		
P NO.4		167,000		56.5	37.4		
L NO.5				58.3	38.3		
E NO.6				56.5	37.2		
				57.6	35.5		
				57.0	38.3		

THE ABOVE TESTED SAMPLES HAVE BEEN INSPECTED FOR VISUAL DISCONTINUITIES AND FOUND ACCEPTABLE. THEY COMPLY IN ALL RESPECTS WITH THE FOLLOWING SPECS:  
SAE J-429, ASME B18.2.1, THREADS PER ASME B1.1 CLASS 2A UNLESS OTHERWISE SPECIFIED  
THESE FASTENERS WERE OIL QUENCHED AND TEMPERED AT A TEMP. ABOVE 900°F.

MANUFACTURED IN CANADA BY: INFASCO

Raw material used to manufacture fasteners is mercury and asbestos-free.

Fasteners were tested in the bare metal condition.

INFASCO

A Division of fastgroup LP 700 Ouellette, Mariville (Quebec) J3M 1P8  
A Helco Company Tel.: (450) 658-8741 Fax: (450) 460-5498

FQ-019-2 Rev. 03

*Abdelhaq El Ouadi*

Abdelhaq El Ouadi, eng.  
ISO Coordinator

Filed on 2007-10-05

Page 1 of 1

# FASTENAL®

1801 TIGLER BLVD., IVTONA, ALN 55087

(12) 507,453,5374

(P) 507.453.8738



MECHANICAL 1045.01

**LABORATORY TEST REPORT**

CUSTOMER: Fastenal Manufacturing Division

CUSTOMER ADDRESS: 1801 Theurer Blvd.  
Winona, MN 55987

MANUFACTURER: Fastenal Manufacturing Division

MANUFACTURER ADDRESS: 1801 Theurer Blvd.  
Winona, MN 55987

JOB CONTROL NUMBER: rdh2009091101

DATE TESTED: 9/11/2009

DESCRIPTION: 5/8"-11 x 3" Hex Bolt

SPECIFICATION: API 2C

GRADE: SAE J429 Grade 8

LOT SIZE: 156 pcs.

SHOP/LOT NUMBER: 10141758 / 385281-1

HEAT NUMBER: 0709-22362

## HEAT CHEMICAL ANALYSIS

Tested According to

Test Number:

[illegible]

Material Certificate from:

## IMPACT PROPERTIES

Tested According to ASTM E-23

SPECIFIED MIN:	Absorbed Energy	Test Temp 0° F	Type
	30 ft/lb avg		
SAMPLE NO. 1	31.21 ft/lbs	0° F	A
SAMPLE NO. 2	29.89 ft/lbs	0° F	A
SAMPLE NO. 3	39.54 ft/lbs	0° F	A
AVERAGE:	33.54 ft/lbs		

\* Minimum impact value permitted for (1) specimen only of a set is 22 ft/lbs.

COMMENTS: These samples conform to the standard specification(s) listed above.

Bradley James Pertington  
Lab Manager

*[Handwritten signature]*



# SUPER CHENG INDUSTRIAL CO.,LTD.

NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.  
TEL : 886-7-6225326-30(5 LINES) FAX : 886-7-6215377/6212335/6235829

## CERTIFICATE OF INSPECTION

CERT.# : S13-9711-01

ISSUED DATE : 2008/11/17

PAGE 1 OF 1

CLIENT : SUPER CHENG INDUSTRIAL CO., LTD.

ADDRESS : NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.

PURCHASER : FASTENAL COMPANY PURCHASING  
PART#36413

PO # : 180017406

QTY SHIPPED : 14,400 PCS

COMMODITY : GRADE 8 FIN HEX NUT

FINISH : PLN

SIZE : 5/8-11

LOT# : S13-9711-01

SAMPLING PLAN : ANSI/ASME B18.18.2M-93

QTY : 171481 PCS

MATERIAL : 10B21

HEAT NO. : 330806343


MANUFACTURER : SUPER CHENG IND. CO., LTD.

MANU. DATE : 2008/11/5

### DIMENSIONAL INSPECTION

SPEC. : ANSI/ASME B18.2.2-87

SAMPLED BY : HSIU SHING HUANG

<u>ITEM</u>	<u>SAMPLE SIZE</u>	<u>SPECIFIED</u>		<u>ACTUAL RESULT</u>	<u>JUDGMENT</u>
APPEARANCE	100	ASTM F812-07		GOOD	OK
W.A.F.	32	0.938 ~ 0.922 in.		0.930 ~ 0.926 in.	OK
W.A.C.	8	1.083 ~ 1.051 in.		1.060 ~ 1.057 in.	OK
THICKNESS	8	0.559 ~ 0.535 in.		0.547 ~ 0.544 in.	OK
THREAD	32	ANSI/ASME B1.1		PASS	OK

### MECHANICAL PROPERTIES

SPEC. : SAE J995-99

SAMPLED BY : HSIU SHING HUANG

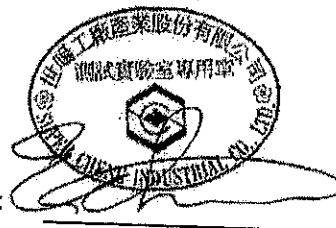
<u>ITEM</u>	<u>SAMPLE SIZE</u>	<u>TEST METHOD</u>	<u>SPECIFIED</u>	<u>ACTUAL RESULT</u>	<u>JUDGMENT</u>
HARDNESS	8	ASTM F606-07	32 ~ 24 HRC	28.0 ~ 27.0 HRC	PASS
PROOF LOAD	4	ASTM F606-07	MIN 33900LB	34046 ~ 34035 LB	PASS

REMARK : 1、THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT WRITTEN APPROVAL OF THE LAB.

2、THIS INSPECTION CERTIFICATE IS FOR RESPONSIBILITY UNDER SAMPLE ONLY

3、ABOVE SAMPLES TESTED CONFORM TO THE FASTENER SPECIFICATION OR STANDARDS

LAB. DIRECTOR(SIGNATORY) :







INDUSTRIAL & CONSTRUCTION SUPPLIES

## CERTIFICATE OF COMPLIANCE

CERTIFICATE NO: HMLA-56730-2010

SOLD TO: OIL STATES (APPLIE)

PURCHASE ORDER NO.: HT#20280407

JOB NO: 406663-1

DATE: 24 February 2010

THIS IS TO CERTIFY THAT WE HAVE SUPPLIED YOU WITH THE FOLLOWING PARTS.  
WHEN APPLICABLE, ALL FASTENERS SOLD BY FASTENAL COMPLY TO PUBLIC LAW 101-592.  
THESE PARTS WERE PURCHASED TO THE FOLLOWING SPECIFICATIONS.

50 PCS. HHMB 1-1/4" 7 tpi 10 " Gr8 Std Diameter = 1-1/4" Thread Pitch = 7 tpi Length = 10 " Grade - HHBT = Gr8 Material = (null)  
Thread Length = Std Test Type = Charpy Impact HMLA-56730

This is to certify that the above document is true  
and accurate to the best of my knowledge.

Joseph Bettencourt  
Fastenal Company



**JabaMet S.A. de C.V.**  
**JM Tor Par S.A. de C.V.**  
**TEST REPORT**

**SUSPENSION**

Customer: **FASTENAL COMPANY**  
Invoice: **Fact. 83711**  
Description: **BOLT GR 8 HXHD LTBLK - IMP**  
Size: **1 1/4" X 15"**  
Marking: **FNL, J, 8 RADIAL LINES**

Report No. **0907/045 EX**

Part Number **010917287**

Lot Quantity **1537-48/07**

Lot No. **Sep/18/07**

Date Manufac... **1006 PCS.**

Cantidad (Quantity) **1006 PCS.**

Factura (Invoice) **Fact. 83711** O. Compra (P. O.) **SHOP-52591**

**CHEMICAL ANALYSIS (%)**

HEAT No.	C	Mn	P	S	Si	Cr	Mo
20280407	0.28-0.55	---	0.030 Max	0.050 Max	---	0.82	0.15
	0.39	0.78	0.014	0.007	0.20		

**STEEL: SAE 4140**

**RAW MATERIAL USED TO MANUFACTURE C.S.C. REM: 25695**

Verification	100% Verimet	Wedge Angle:	5°		ASTM F606 CORE HARDNESS ROCKWELL HRC	ASTM F606 SURFACE HARDNESS HR30-N
METHOD SAMPLES SELECTED BY: ASTM A 1470 TEST CONDITION SPEC. MIN. SPEC. MAX.	ASTM F606 TENSILE STRENGTH PSI	ASTM F606 ELONGATION In 4D MIN, % Full-Size	ASTM F606 REDUCTION OF AREA MIN %	S A M P L E		
No. 1	150,000			No. 1	39	58.5
No. 2	153,500			No. 2	39	54.5
No. 3	153,700			No. 3	35.5	55.0
	171,500			No. 4	36.0	56.0
				No. 5	35.0	54.0
				No. 6	36.0	54.5
				No. 7	37.0	56.0
				No. 8	38.0	57.0
				No. 9	38.0	57.5
				No. 10	38.0	56.5
				No. 11	35.5	54.5
					36.0	55.0

WE HEREBY CERTIFY THAT ALL RESULTS AND / OR MATERIALS INCLUDED IN THIS SHIPMENT HAVE BEEN MANUFACTURED, INSPECTED, TESTED AND THEY COMPLY IN ALL RESPECTS WITH THE FOLLOWING SPECS:  
SAE J429 GR 8, DIMENSIONS: ASME B18.2.1, THREADS: BLANK, APPEARANCE: ASTM F788/F788M-02  
THE ABOVE TESTED SAMPLES HAVE BEEN INSPECTED FOR VISUAL DISCONTINUITIES AND FOUND ACCEPTABLE.  
SUPPORTIVE EVIDENCE IS ON FILE A MINIMUM OF (5) FIVE YEARS.

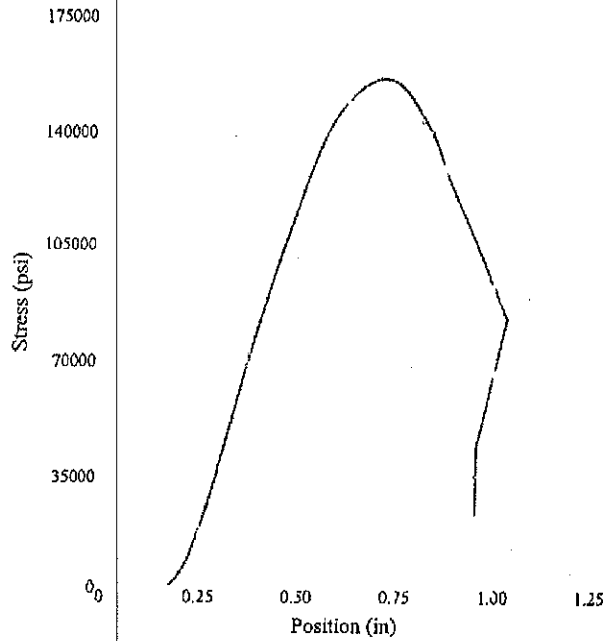
**P. HURTADO**  
SIGNATURE QUALITY ENG.

DATE

Aug/25/07



1-800-900-2000



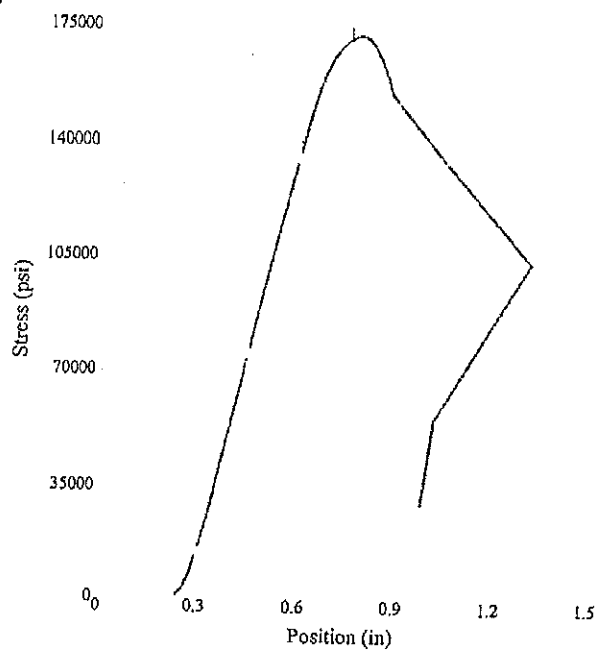
Area:  
Tensile Strength:  
Peak Load:

#### Test Results

0.9690 in<sup>2</sup>  
155975 psi  
151140 lbf

#### Test Summary

Counter: 16611  
Elapsed Time: 00:01:03  
Branch/Customer: SHOP  
Description: 1 1/4 x 16 Bolt Blanks  
Job Control Number: 010917287 shop52591  
Shop Number:  
Wedge Angle: 6 deg  
Procedure Name: Tensile Test (Stress Area)  
Start Date: 10/11/2007  
Start Time: 2:56:17 PM  
End Date: 10/11/2007  
End Time: 2:57:20 PM  
Workstation: FASTENAL  
Tested By: BRAD



Area:  
Tensile Strength:  
Peak Load:

#### Test Results

0.9690 in<sup>2</sup>  
171971 psi  
166640 lbf

#### Test Summary

Counter: 16612  
Elapsed Time: 00:00:57  
Branch/Customer: SHOP  
Description: 1 1/4 x 16 Bolt Blanks  
Job Control Number: 010917287 shop52591  
Shop Number:  
Wedge Angle: 6 deg  
Procedure Name: Tensile Test (Stress Area)  
Start Date: 10/11/2007  
Start Time: 2:59:27 PM  
End Date: 10/11/2007  
End Time: 3:00:24 PM  
Workstation: FASTENAL  
Tested By: BRAD



1801 THEURER BLVD., WINONA, MN 55987

(P) 507.453.5374

(F) 507.453.8728



MECHANICAL 1046.01

## LABORATORY TEST REPORT

CUSTOMER: Fastenal Manufacturing Division

CUSTOMER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

MANUFACTURER: Fastenal Manufacturing Division

MANUFACTURER ADDRESS: 1801 Theurer Blvd.

Winona, MN 55987

JOB CONTROL NUMBER: rdh2007122701

DATE TESTED: 12/27/2007

DESCRIPTION: 1 1/4" x 16" Hex Bolt Blank

SPECIFICATION: API 2C

GRADE: SAE J429 Grade 8

LOT SIZE: 1,000 pcs.

SHOP/LOT NUMBER: 0917287 / mn180-52891

HEAT NUMBER: 20280407

### HEAT CHEMICAL ANALYSIS

Tested According to

Heat Number:


Material Certificate from:

### IMPACT PROPERTIES

Tested According to ASTM E-23

SPECIFIED	Absorbed Energy	Test Temp	Type
MIN:	30 ft/lb avg	0° F	
SAMPLE NO. 1	45.1 ft/lbs	0° F	A
SAMPLE NO. 2	48.3 ft/lbs	0° F	A
SAMPLE NO. 3	44.1 ft/lbs	0° F	A
AVERAGE:	458 ft/lbs		

\* Minimum impact value permitted for (1) specimen only of a set is 22 ft/lbs.

COMMENTS: These samples conform to the standard specification(s) listed above.

Bradley James Partington  
Lab Manager

**Constructora  
Subacuatica Diavas,  
S.A. de C.V.**

# **Vendor Data Book**

**P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1**

## **Nautilus Crane Model 180L4-50**

### **Section 6.0 Wire Rope Certificates**



*SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA*





SD # 1215237

840 FT

**BRIDON**

AMERICAN

**CERTIFICATE OF EXAMINATION OR TEST OF WIRE ROPE**

WIRE ROPE DESCRIPTION: 3/4" 6X26 EIP IW RREG BRZ

CUSTOMER: CERTEX USA/HARAHAN, LA

CUSTOMER ORDER NO: 1202047

BRIDON AMERICAN ORDER NO.: 60291

DATE TESTED: 7/15/09

REEL NUMBER: 081895A00

MINIMUM BREAKING FORCE: 58,800 LBS. 26,671 KGS.

ACTUAL BREAKING FORCE: 63,900 LBS. 28,985 KGS.

DATE: 7/22/09 CO# 10 CHECK BY:

SIGNED: *David M. Sleight* TECHNICAL DIRECTOR

Bridon American Quality Program Certificates:  
American Petroleum Institute Spec Q1 and 9A, License #9A0058  
Lloyds Register Quality Assurance - ISO 9001:2000, License #101907  
Bridon American wire ropes are manufactured to the applicable requirements of API 9A and ASTM1023.

**WARNING:** Any warranties, expressed or implied, concerning the use of this product apply only to the nominal strength of new, unused wire rope. All equipment using this product must be properly used and maintained. Wire rope must be properly stored, handled, used and maintained. Most importantly, wire rope must be regularly inspected during use. Damage, abuse or improper maintenance can cause rope failure. Consult the AISI Wire Rope Users Manual, ASME or ANSI Standards, or Bridon American Corporation before usage. Wire rope removal criteria are based on the use of steel sheaves. If synthetic sheaves are used, consult the sheave equipment manufacturer. **WARNING!**

**BRIDON American Corporation**

280 New Commerce Boulevard Wilkes-Barre Pennsylvania 18706 570 822 3349 Fax 570 822 9180

SO # 1215208

1081 FT

**BRIDON**

AMERICAN

**CERTIFICATE OF EXAMINATION OR TEST OF WIRE ROPE**

WIRE ROPE DESCRIPTION: 9/16" , 18X7 DY18 RREG DFTP

CUSTOMER: CERTEX USA/HARAHAN, LA

CUSTOMER ORDER NO: 1201995-00

BRIDON AMERICAN ORDER NO.: 59470

DATE TESTED: 4/30/09

REEL NUMBER: 081186A00

MINIMUM BREAKING FORCE: 38,500 LBS. 17,463 KGS.

ACTUAL BREAKING FORCE: 38,700 LBS. 17,554 KGS.

DATE: 4/30/09 CO# 10 CHECK BY:

SIGNED: *David M. Sleight* TECHNICAL DIRECTOR

Bridon American Quality Program Certificates:

American Petroleum Institute Spec Q1 and 9A, License #9A0058

Lloyds Register Quality Assurance - ISO 9001:2000, License #101907

Bridon American wire ropes are manufactured to the applicable requirements of API 9A and ASTM1023.

**WARNING:** Any warranties, expressed or implied, concerning the use of this product apply only to the nominal strength of new, unused wire rope. All equipment using this product must be properly used and maintained. Wire rope must be properly stored, handled, used and maintained. Most importantly, wire rope must be regularly inspected during use. Damage, abuse or improper maintenance can cause rope failure. Consult the AISI Wire Rope Users Manual, ASME or ANSI Standards, or Bridon American Corporation before usage. Wire rope removal criteria are based on the use of steel sheaves. If synthetic sheaves are used, consult the sheave equipment manufacturer. **WARNING!**

**BRIDON American Corporation**

280 New Commerce Boulevard Wilkes-Barre Pennsylvania 18706 570 822 3349 Fax 570 822 9180

50 #1215636

N00031-012

866 FT

**BRIDON**

AMERICAN

**CERTIFICATE OF EXAMINATION OR TEST OF WIRE ROPE**

WIRE ROPE DESCRIPTION: 3/4" 18X19 DY18 RREG DFTP

CUSTOMER: CERTEX USA/HARAHAN, LA

CUSTOMER ORDER NO: 1202160

BRIDON AMERICAN ORDER NO.: 62144

DATE TESTED: 2/11/10

REEL NUMBER: 084226B00

MINIMUM BREAKING FORCE: 64,800 LBS. 29,393 KGS.

ACTUAL BREAKING FORCE: 66,700 LBS. 30,255 KGS.

DATE: 2/12/10 CO# 10 CHECK BY:

SIGNED: *David M. Sleight* TECHNICAL DIRECTOR

Bridon American Quality Program Certificates:

American Petroleum Institute Spec Q1 and 9A, License #9A0058

Lloyds Register Quality Assurance - ISO 9001:2000, License #101907

Bridon American wire ropes are manufactured to the applicable requirements of API 9A and ASTM1023.

**WARNING:** Any warranties, expressed or implied, concerning the use of this product apply only to the nominal strength of new, unused wire rope. All equipment using this product must be properly used and maintained. Wire rope must be properly stored, handled, used and maintained. Most importantly, wire rope must be regularly inspected during use. Damage, abuse or improper maintenance can cause rope failure. Consult the AISI Wire Rope Users Manual, ASME or ANSI Standards, or Bridon American Corporation before usage. Wire rope removal criteria are based on the use of steel sheaves. If synthetic sheaves are used, consult the sheave equipment manufacturer. **WARNING!**

**BRIDON American Corporation**

280 New Commerce Boulevard Wilkes-Barre Pennsylvania 18705 570 822 3349 Fax 570 822 9180



# HALO

HALOSUPPLY.NET

New Orleans Facility  
Port Fourchon Facility

701 South Alexander Street, New Orleans, LA 70119  
542 Dudley Bernard Road, Port Fourchon, LA 70357

Date: 12/01/09 Serial Number: H25019

WIRE ROPE SYNTHETICS CHAIN RIGGING

ph 504.738.2414  
ph 985.396.3050

fax 504.738.2440  
fax 985.396.3800

## CERTIFICATE OF TESTING

Customer: Oil States Industries

Order Number: 052595

Division:

Serial Number: H25019

Reference Number:

RFID Number: E00401000C2F0A1D

Purchase Order: 4086100

Product Type: Wire Rope Sling

Job / Location:

Product Description: 1 3/8" x 10 ft, Thimble - Thimble 1 Leg, WLL: V 18 ton, C, B, 30°, 45°, 60°

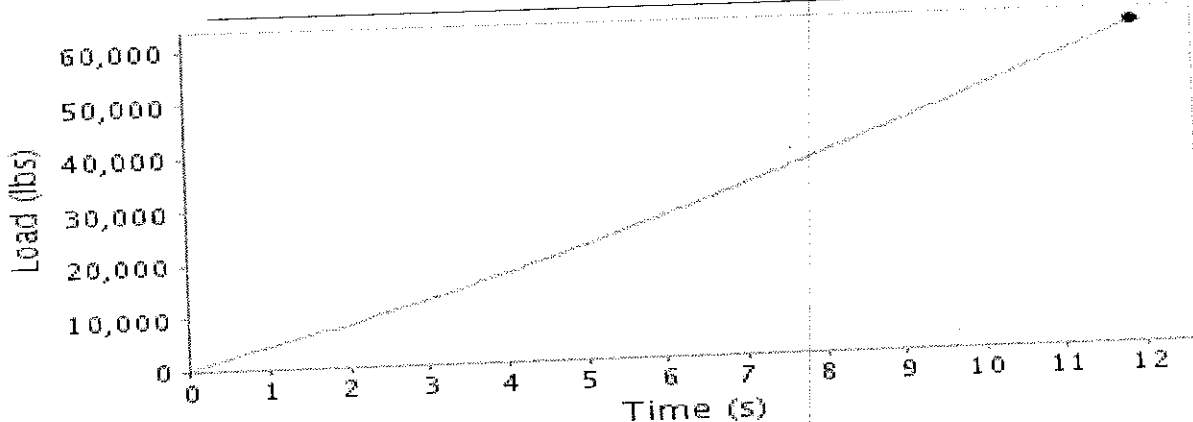
Item Comments: oss-oss

Test Type: Load Test

Peak Load: 60780.91 lbs.

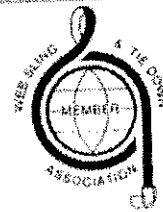
Duration: 12.0 sec.

Test Comments:



**NOTE:** Proof test equipment calibrated to ASTM E-4, +/- 1%, traceable to the National Institute of Standards and Technology. Tests are performed in accordance to the requirements of these applicable organizations: OSHA, AWRF, WSTDA, WRTB, ASME, ASTM, ANSI and API.

**WARRANTY:** These goods have had a load applied in conformance with the customer's design/specifications, if any, as supplied to us by the customer. There is no warranty actual or implied that these goods shall be fit for a particular purpose or merchantability. This is to certify that the product held at time of test only.



Conducted By:

Date: 12/01/09 8:46

Doyle Shumaker



# HALO

*Life Force*

HALOSUPPLY.NET

New Orleans Facility  
Port Fourchon Facility

701 South Alexander Street, New Orleans, LA 70119  
542 Dudley Bernard Road, Port Fourchon, LA 70357

Date: 12/01/09

Serial Number:

H25019

WIRE ROPE SYNTHETICS CHAIN RIGGING

ph 504.738.2414  
ph 985.396.3050

fax 504.738.2440  
fax 985.396.3800

## CERTIFICATE OF TESTING

Customer: <u>Oil States Industries</u>	Order Number: <u>052595</u>
Division: _____	Serial Number: <u>H25019</u>
Reference Number: _____	RFID Number: <u>E00401000C2F0A1D</u>
Purchase Order: <u>4086100</u>	Product Type: <u>Wire Rope Sling</u>
Job / Location: _____	
Product Description: <u>1 3/8" x 10 ft , Thimble - Thimble</u> <u>1 Leg, WLL: V 18 ton , C , B , 30° , 45° , 60°</u>	

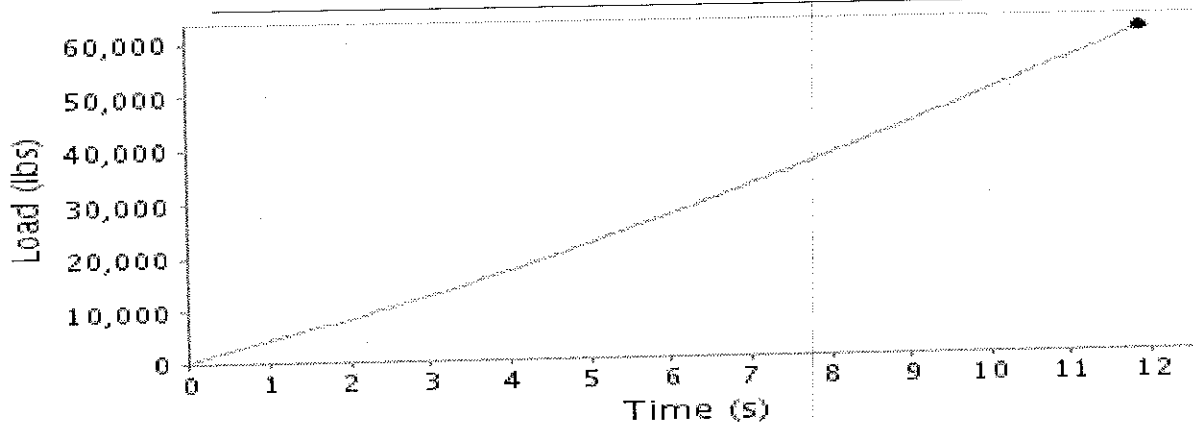
Item Comments: oss-oss

Test Type: Load Test

Peak Load: 60780.91 lbs.

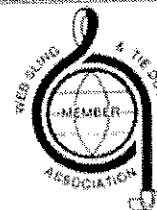
Duration: 12.0 sec.

Test Comments: \_\_\_\_\_



**NOTE:** Proof test equipment calibrated to ASTM E-4, +/- 1%, traceable to the National Institute of Standards and Technology. Tests are performed in accordance to the requirements of these applicable organizations: OSHA, AWRP, WSTDA, WRTB, ASME, ASTM, ANSI and API.

**WARRANTY:** These goods have had a load applied in conformance with the customer's design/specifications, if any, as supplied to us by the customer. There is no warranty actual or implied that these goods shall be fit for a particular purpose or merchantability. This is to certify that the product held at time of test only.



Conducted By: Doyle Shumaker

Date: 12/01/09 8:46

Doyle Shumaker

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 7.0 Load Block Certificates



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



OIL STATES SKAGIT-SMATCO LLC, AHSC  
1180 MULBERRY RD  
HOUMA, LA 70363

**the Crosby group inc.**

Certificate Form No. 763572 Ln 2

Customer Purchase Order No. 4067418

Work Order No. 697955

**CERTIFICATE OF CONFORMANCE OF CHAINS, RINGS, HOOKS, SHACKLES,  
SWIVELS AND PULLEY BLOCKS**

(1) Distinguishing number or mark (if any)	(2) Description of gear	(3) Number	(4) Date	(5) Working Load Limit
SERIAL NO. 08-629-73 Thru 08-629-77	M035D16H 16" 35 TON API 2C CRANE BLOCK W/.75" WIRE LINE  PART NO.: 8011980  PICS: HOOK - 5HD (08-629-73,75-77) HOOK - 5GI (08-629-74) TRUNION - HHCG (08-629-73-77) SIDE PLATES - HHCC (08-629-73-77) CENTER PIN - HDJK (08-629-73-77) DEAD END - HHBZ (08-629-73,74,76,77) DEAD END - HHCU (08-629-75) HUBS - HFEX (08-629-73,74) HUBS - IFBE (08-629-75-77) WEBS - HEEH (08-629-73,74) WEBS - IEBF (08-629-75-77)	5	02/23/08	70,000 Lbs

(7) Name and address of makers or suppliers The Crosby Group / McKissickProducts

2801 Dawson Road, Tulsa, Ok 74110-5040 U.S.A.

(8) Name and address of public service, association, company or firm making test and examination \_\_\_\_\_

SAME

(9) Position of signatory in public service, association, company or firm \_\_\_\_\_

QUALITY ASSURANCE INSPECTOR

We hereby certify that the above described material was manufactured and processed in a manner compatible to meeting the specified load ratings when used under normal and proper applications.

February 27, 2008  
(Date) \_\_\_\_\_ (Signature) MARK A. TAYLOR

MARK A. TAYLOR



Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1115

**SHERRY**Laboratories

Testing Today - Protecting Tomorrow\*

Tel: 918-258-6066  
800-982-8378  
Fax: 918-258-1154

**LABORATORY REPORT**

Attn: Bucky Weaver  
Crosby Group, Inc.  
P.O. Box 3128  
Tulsa, OK 74101

Report No.: 07100469-002-v1  
Date Received: 10/15/2007  
Date Reported: 10/18/2007  
P.O. No.: M-0715262

Sample Description: (1) Sample, 37 Ton Hook API 2c, Order No.: 352137, Part No.: 2009054, Plc Code: 5HD

**Tensile Test (Round) per ASTM E8-04**

Parameter	Result
Orientation	Longitudinal at 4/5 Radius
Diameter, inch	0.498
Tensile Strength, psi	105,000
Yield Strength, psi at 0.2% offset	79,000
Elongation in 2 inch, %	21
Reduction of Area, %	64

**Rockwell Hardness Test per ASTM E18-07**

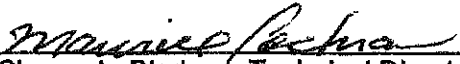
Parameter	Result
Location	Charpy
Reading 1	HRBW 97
Reading 2	HRBW 97
Reading 3	HRBW 97

**Impact Test per ASTM A370-07a/ASTM E23-07**

Testing Machine Capacity, lbs: 264  
Specimen Type: Charpy V Notch  
Specimen Location: ASTM A370-07a  
Notch Orientation: Perpendicular to Surface  
Specimen Orientation: Longitudinal at 4/5 Radius  
Specimen Size: 10mm X 10mm  
Test Temperature °F: -40

Notch Location	Impact Values (Ft.-Lbs)	Lateral Expansion (Mils)	Shear (%)
Base	65, 61, 55	46, 42, 36	75, 65, 65

Comments: Absorbed energy values above 80% of the scale range are approximate.

Approved by:   
Sharon L. Bledsoe, Technical Director  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmittal of a report on services provided by Sherry Laboratories is at the request of the client. The transmittal is NOT the official report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in information in the transmittal. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall control for all purposes.



NOV-10-2000 08:41AM FROM: CROSBY-LEBUS MFG

7803/391441

1-839 P 01.000

02Mar06 11: 7

TEST CERTIFICATE

No: 1



P/O No 56314

Rel

S/O No 1 141169-001

B/L No 1 118669-002

Inv No

Shp 027000  
Inv

Sold To: ( 376)  
CROSBY-LEBUS MFG.  
P.O. BOX 271  
LONGVIEW, TX 75606

Ship To: (001)  
CROSBY-LEBUS MFG.  
900 FISHER ROAD  
LONGVIEW, TX 75606

Tel: 903-759-4424 Fax: 903-759-4499

CERTIFICATE of ANALYSIS and TESTS

Cert. No: 1

027000

Part No  
HOT ROLLED ROUNDS 8630  
4.2500 X 20'

Heat Number  
A050531

\*\*\* Chemical Analysis \*\*\*

C=0.3200 Mn=0.8000 P=0.0110 S=0.0160 Si=0.2700 Ni=0.4800  
Cr=0.4800 Mo=0.1700 Al=<.029> Cu=<.24> Sn=<.011> N=<.0086>  
V=<.002> Nb=<.002> Ti=<.001> W=<.010> B=<.0005> Pb=<.001>  
Ca=<.0019> GR=<PINE>

\*\*\* Jominy Tests \*\*\*

1=52 2=52 3=51 4=47 5=43 6=39 7=37 8=36  
9=34 10=33 12=30 14=28 16=27 18=26 20=25 24=23  
28=22 32=21

C=0.3300 Mn=0.8200 P=0.0090 S=0.0150 Si=0.2600 Ni=0.4400  
Cr=0.5200 Mo=0.1900 Al=<.024> Cu=<.21> Sn=<.01> N=<.0090>  
V=<.002> Nb=<.002> W=<.010> Ti=<.003> B=<.0003> Ca=<.0018>  
Pb=<.003> GR=<7>

\*\*\* Jominy Tests \*\*\*

1=52 2=52 3=52 4=49 5=46 6=42 7=40 8=38  
9=37 10=35 12=32 14=31 16=29 18=28 20=27 24=25  
28=24 32=23

I hereby certify that this data is correct as  
contained in the records of this company.

Elin Hulse

319 -A 37 Ton Hook  
PIC: 5GI  
HEAT: A053371

**theCrosby® group,  
Inc.**

Date: 11/29/06

**Tensile Test Data Sheet  
QCP1400**

Lab Log Number: L-06-328

Description: 19-A-37-5GI

Die Number: 572

Specifications: ASTM Class AE (521-76(92)) Or K (668-93)

Specimen Size: 0.505 Inches Diameter

Specimen Area: 0.2 Square Inches

Elongation: 19 %

Reduction of Area: 57 %

Tensile Strength: 124.0 KSI

Tensile Load: 24,800 LBS.

Yield Strength: 96.5 KSI

Yield Load: 19,300 LBS.

Hardness: 269 BHN

Hardness @ Surface of Tensile Bar: 235 BHN

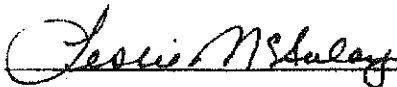
Exceptions: Elongation

Impact Results @ -40° F Per ASTM E23:

Ft/Lbs	31, 35, 40
Joules	42, 47, 54

Test performed by Sherry Laboratories, Inc.

Prepared By: Leslie McAulay



Approved By: James E. Fryar



FAX NO. : 281-494-6144  
Jul. 17 2006 03:25PM P1

Form 1041-1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

Customer:  
METALS USA PLATES & SHAPES SOU  
P.O. BOX 3528  
101 EAST ILLINOIS  
ENID  
OK 73702

Customer P.O. No.: MUS-224842  
Product Description: ASME S4516-70/S4516-65/S4516-60(04E.)  
ASTM A516-70/A516-65/A516-60(05)  
LCVN 15/12 FT. LRS @ 60F/A673-P  
NORMALIZED

Shipment Manifest: AR036803

Ship Date: 02 May 07  
Cert Date: 02 May 07  
Cert No: 081082255  
(Page 1 of 1)

0 750 X 96.00 X 480.0 (IN)

Tested Pieces		Tensiles					Charpy Impact Tests						
Heat Id	Piece Id	Piece Dimensions	YS (PSI)	UTS (PSI)	%RA Elong % 2in 8in	Average Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Temp Dir (F/C)	Tst Tst Temp Dir (F/C)	BDWTT Temp %Shr		
E7D109	C20	0.749 X 96.00 (DISCRD)	49000	72000	30		18 50 34 34.0		-60F L 10.				

Heat Id	Chemical Analysis															ORGN
	C	Mn	P	S	Si	Total	Al	Cr	Ni	Cr	Mo	Ch	V	Ti	CEV	
77D109	.18	1.03	.014	.003	.20	.028	.024	.33	.16	.15	.04	.003	.005	.021	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT  
CEV (IIV) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15  
103% MELTED AND MANUFACTURED IN THE USA. MTF DIN EN10204 TYPE 3.1 COMPLIANT.  
NORMALIZED PLATES. HEATED AT 1650F FOR 32 MINUTES.  
C20 6023068 PCS: 1, WGT: 9858 E7D109 C20 6023069 PCS:

WELL TEST REPORTS FURNISHED  
BY UNI-STEEL, INC.  
DATE 5-23-07  
CUSTOMER Mobissick  
CUSTOMER P.O. # M-0701430  
CUSTOMER PART # 2008023  
HEAT # 67ND9 2305 1  
MEAT # \_\_\_\_\_ PCS \_\_\_\_\_

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH THE APPROPRIATE SPECIFICATION

**Jason Thomas**  
**SENIOR METALLURGIST**



# CERTIFICATE OF TEST

Page 01 of 02

Certification Date  
27-OCT-2007

**CUSTOMER ORDER NUMBER**

M-0714940

EARLE M. JORGENSEN COMPANY  
7311 E. PINE STREET  
TULSA OK 74115

Invoice Number  
S819191

**CUSTOMER PART NUMBER**

92740

**SOLD TO:** MCKISSICK PRODUCTS CO

P O BOX 3128  
TULSA OK 741013128

**SHIP TO:**

MCKISSICK PRODUCTS CO

2801 DAWSON RD GATE 5  
TULSA OK 74110

Description: 8620/8620H HR BAR ASTM A322 ASTM A304  
3-3/4 RD X 20' R/L

Line Total: 1482 IN

HEAT: 7442240

ITEM: 507018

**Specifications:**

ASTM A322 06

ASTM A304 05

ASTM A 29 05

JDM AO QL-2 7/96

**CHEMICAL ANALYSIS**

C	MN	P	S	SI	CU	NI	CR
0.2	0.83	0.008	0.022	0.21	0.01	0.44	0.45
V	MO	SN	AL	CB	CA	N	H
0.004	0.17	0.003	0.03	0.001	0.0001	0.0036	0.0001

RCPT: R318590

MILL : MAGELLAN

COUNTRY OF ORIGIN : USA

**MECHANICAL PROPERTIES**

DESCRIPTION	YLD STR	ULT TEN	%ELONG	%RED IN AREA	HARDNESS BHN 174
-------------	---------	---------	--------	-----------------	------------------------

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on the certificate. All test results remain on file subject to examination.

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

Material did not come in contact with mercury while in our possession.

MARVIN FOSTER

Manager, Quality Assurance



PIN: HDJK  
PART NO: 92740

# CERTIFICATE OF TEST

Page 02 of 02

Certification Date  
27-OCT-2007

## CUSTOMER ORDER NUMBER

M-0714940

EARLE M. JORGENSEN COMPANY  
7311 E. PINE STREET  
TULSA OK 74115

Invoice Number  
S819191

## CUSTOMER PART NUMBER

92740

SOLD TO: MCKISSICK PRODUCTS CO

P O BOX 3128  
TULSA OK 741013128

SHIP TO:

MCKISSICK PRODUCTS CO

2801 DAWSON RD GATE 5  
TULSA OK 74110

Description: 8620/8620H HR BAR ASTM A322 ASTM A304  
3-3/4 RD X 20' R/L

Line Total: 1482 IN

HEAT: 7442240

ITEM: 507018

END-QUENCH HARDENABILITY (JOMINY - RC) IN

1	2	3	4	5	6	7	8
44	43	39	30	25	21	21	20

GRAIN SIZE : 5 -

## CLEANLINESS

	A		B		C		D	
	THIN MAX	THICK MAX	THIN MAX	THICK MAX	THIN MAX	THICK MAX	THIN MAX	THICK MAX
1	2.5	0.0	1.0	0.0	0.0	0.0	0.5	0.0

STRAND CAST REDUCTION RATIO 16.2 TO 1  
MATERIAL IS FREE FROM MERCURY CONTAMINATION  
NO WELD REPAIR PERFORMED ON MATERIAL  
MACRO: OK

## COMMENTS

MELT SOURCE LORAIN

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on the certificate. All test results remain on file subject to examination.

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

Material did not come in contact with mercury while in our possession.

MARVIN FOSTER

Manager, Quality Assurance



# Test Certificate

Form TCI: Revising 1: Date 31 Oct 2000

# Test Certificate

Customer: METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702		Customer P.O. No.: MUS-223839		Mill Order No.: 41-161716-09		Shipping Manifest: AR032118						
Product Description: ASME SA516-70/SA516-65/SA516-60(04ED.) ASTM A516-70/AS16-65/AS16-60(05) LCVN 15/12 FT. LBS @ -50F/A673-P NORMALIZED				Shp Date: 10 Jan 07		Cert No: 081067398						
				Cert Date: 10 Jan 07		(Page 1 of 1)						
Size: 1.250 X 96.00 X 480.0 (IN)												
Tensiles				Charpy Impact Tests								
Heat Id	Place Id	Place Dimensions	YS (PSI)	UTS (PSI)	%RA Elong 2in	%RA Elong 8in	Abs. Energy (FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Temp	Tst Dir	Tst Siz	BDWTT Temp %Shr
W7A580	C10	1.250 X 96.00 (DISCRD)	51000	73000	27	28	79 44 80 67.7		-50F	L	10	
W7A580	C11	1.250 X 96.00 (DISCRD)	50000	73000			77 56 52 61.7		-50F	L	10	
Chemical Analysis												
Heat Id	C	Mn	P	S	Si	Total Sol Al	Ca	Ni	Cr	Mo	Ch	CEV
W7A580	.17	1.18	.011	.003	.23	.025	.023	.30	.15	.13	.06	.004 .021 .44
<p>MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT</p> <p>CEV (IIW) = <math>C + Mn/6 + (Cr+Mo+V)/5 + (Ni-Cu)/15</math></p> <p>100% MELTED AND MANUFACTURED IN THE USA. MFR DIN EN10204 TYPE 3.1 COMPLIANT.</p> <p>NORMALIZED PLATES. HEATED AT 1650F FOR 50 MINUTES.</p> <p>W7A580 C10 6014362 PCES: 1, WGT: 16531</p> <p>W7A580 C11 6014363 PCES: 1, WGT: 16549</p>												
<p><b>ALL TEST REPORTS FURNISHED</b></p> <p>BY UNI-STEEL INC.</p> <p>DATE 5-25-07</p> <p>CUSTOMER Missick</p> <p>CUSTOMER P.O. # DD-07077</p> <p>CUSTOMER PART #</p> <p>HEAT # W7A580 C11</p> <p>WEAT # PCS</p>												

AM: TEST REPORTS: E11040504

RAYMOND STEEL INC.

DATE 5-25-01

CUSTOMER (Youssaf)

CUSTOMER PO. # 00-07021

CUSTOMER PARTIAL

WEST 17A58041

23

WE HEREBY CERTIFY THAT THIS MATERIAL  
WAS TESTED IN ACCORDANCE WITH THE  
APPROPRIATE SPECIFICATION

Cust Part #: ITEM 023

**Jason Thomas**  
**SENIOR METALLURGIST**

DEAD END: HHBZ  
PART NO: 2008032



12400 Highway 43 North, Axis, Alabama 36505

## Test Certificate

Form TCI Revision I: Date 31 Oct 2000

Customer: METALS USA PLATES & SHAPES CO P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702		Customer P.O. No.: MUS-224999		Mill Order No.: 41-176059-04		Shipping Manifest: AR037373											
Product Description: ASME SA516-70/SA516-65/SA516-60(04ED.) ASTM A516-70/A516-65/SA516-60(06) LCVN 15/12 FT. LRS @ -50F/A673-P NORMALIZED		Ship Date: 14 May 07 Cert Date: 14 May 07		Cert No: 081083658 (Page 1 of 1)													
Size: 1.250 X 96.00 X 480.0 (IN)																	
Tensile		Charpy Impact Tests															
Heat Id	Piece Id	YS (PSI)	UTS (PSI)	%RA	Elong % 2in 8in	Avg Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Temp Dir	Tst Dir	Tst Size (mm)	BDWTT Temp %Shr					
W7D663	A13	47000	71000	29			59 28 31 39.3		-50F	L	10						
W7D663	A14	48000	71000	31			24 23 31 26.0		-50F	L	10						
Chemical Analysis																	
Heat Id	C	Mn	P	S	Si	Ti	Al	SAI	Cu	Ni	Cr	Mo	Ch	V	Ti	CEV	ORON USA
W7D663	.19	1.08	.012	.003	.24	.027	.023	.24	.12	.09	.04	.003	.006	.021	.42		
<p>MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT</p> <p>CEV (IIT) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15</p> <p>100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN 10204 TYPE 3.1 COMPLIANT.</p> <p>NORMALIZED PLATES. HEATED AT 1650F FOR 50 MINUTES.</p> <p>W7D663 A13 PCS: 1, WGT: 16534</p> <p>W7D663 A13 PCS: 1, WGT: 16517</p>																	
<p>ALL TEST REPORTS FURNISHED BY UNI-STEEL INC.</p> <p>DATE 12-14-07</p> <p>CUSTOMER: J. J. JESSICK</p> <p>CUSTOMER P.O. # 0717934</p> <p>CUSTOMER PART # 2008032</p> <p>HEAT: W7D663 A13</p> <p>POS: 1</p>																	
Cust Part #		WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH THE APPROPRIATE SPECIFICATION										Jason Thomas SENIOR METALLURGIST					



04/27/2007 From: MARMON/KEYSTONE  
M/K OR:30-000867  
C P.O. M-0706088  
C PART:91243

INIT: BP

To: CROSBY GROUP/MC KISSICK PROD  
BR. OR:

HUB: HFEX  
PART NO: 91243

## Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706

ID #0147625-1

Page 1 of 2

**TIMKEN**  
Where You Turn

09/21/2006

S Marmon/Keystone Corporation  
O T 10700 MARMON DRIVE  
L O  
D BOLINGBROOK IL 60440 USA

S MARMON/KEYSTONE CORPORATION  
H T 10700 MARMON DRIVE  
I O  
P BOLINGBROOK IL 60440 USA

Customer Order: 60-000761-003 Customer Part Number: 5.51.5130  
Timken Order: 44700-D (1372034) Heat Number(s): X7669

### Description of Material

OD: 5.500 in (139.700 mm) WALL: 1.500 in (38.100 mm) ID: 2.500 in (63.500 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-ULTRASONIC  
Condition: HOT ROLL

### Specification

- ASTM A 106 / A 106M Grades B and C Rev. 06 EXCEPT AS NOTED; EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2004 EDITION GRADES B & C; EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING
- ASTM A 519 Rev. 03
- NACE MR0175 Rev. 97 1/1/1997
- BRITISH STANDARD BS EN 10204 1/1/1991 SECTION 3.1.B
- DIN EN 10204 1/1/1991 SECTION 3.1.B

### Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60		.025	.10	.40	.40	.15	.40		.080
SPEC Ladle MAX:	.28	.90	.025	.025							
X7669 Ladle:	.26	.70	.011	.018	.25	.18	.16	.06	.24	.032	.001

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements. This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved:

NOTARY PUBLIC

by

*Ernie Dillard*  
Ernie Dillard, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION

T 5.51.5 130

04/27/2007 From: MARMON/KEYSTONE  
M/K OR:30-000867  
C P.O. M-0706088  
C PART:91243

INIT: BP

To: CROSBY GROUP/MC KISSICK PROD

BR. OR:

HUB: HFEX  
PART NO: 91243

## Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44705

**TIMKEN**  
Where You Turn

ID #0147625-1

Page 2 of 2

09/21/2006

Customer Order: 60-000761-003 Customer Part Number: S.91.5130  
Timken Order: 44700-D (1372034) Heat Number(s): X7669

### Metallurgy Information

SPEC: Hardness MIDWALL 22 Max UOM ROCKWELL C

Heat	Piece#	UOM
X7669	A	ROCKWELL B

SPEC: Tensile TENSILE 70,000.00 Min STRENGTH UOM PSI YIELD .2 40,000.00 Min  
MIN ELONGATION 22 Min

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong	Red	Gauge Length	Specimen	Direction
X7669	A	81,280	PSI	59,422	24.6	55.5	2 IN	0.505 in RD	LONG.

Heat X7669 Melt Source: USA

Flattening test - Satisfactory

Ultrasonic in lieu of hydrostatic testing - Satisfactory.

The Timken Company certifies that there is no mercury or radio-active material used in the melting or processing.

Material melted and produced in the USA

C.C. REVIEWED

THE TIMKEN CORPORATION

01/04/2008 From: MARMON/KEYSTONE  
M/K OR:30-23661  
C P.O. #0800017  
C PART:91243

INIT: KO

To: CROSBY GROUP/MC KISSICK PROD.

BR. OR:

HUB: IFBE  
PART NO: 91243

## Steel Certificate of Test

1835 DUEBER AVE. S.W.  
CANTON, OHIO 44706  
ID #0174956-1

Page 1 of 2

# TIMKEN

Where You Turn

08/16/2007

S Marmon/Keystone Corporation  
O T PO Box 588  
L O  
D Bucyrus OH 44820 USA

S Marmon/Keystone Corporation  
H T 930 N. Sandusky Ave.  
I O  
P Bucyrus OH 44820 USA

Customer Order: 87-029645-004 Customer Part Number: 5.51.5130  
Timken Order: 51531-A (1447361) Heat Number(s): T4195

Q.C. REVIEWED

nc

### Description of Material

OD: 5.500 in (139.700 mm) WALL: 1.500 in (38.100 mm) ID: 2.500 in (63.500 mm)  
Shape: RD  
Sales Type: 1026  
Int Quality: ELECTRIC FURNACE-ULTRASONIC  
Condition: HOT ROLL

### Specification

- ASTM A 106 / A 106M Grades B and C Rev. 06a EXCEPT AS NOTED; EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASME SA-106 Rev. 2004 EDITION GRADES B & C; EXCEPT WEIGHING OF INDIVIDUAL TUBES
- ASTM E 213 Rev. 04 FOR NONDESTRUCTIVE ELECTRIC TESTING
- ASTM A 519 Rev. 06
- NACE MR0175/ISO 15156 Rev. 2005
- EUROPEAN STANDARD EN 10204 10/1/2004 Inspection certificate type 3.1

### Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.025	.025		.40	.40	.15	.40		.080
T4195 Ladle:	.25	.82	.006	.020	.26	.07	.10	.03	.22	.032	.001

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements. This certificate or report shall not be reproduced except in full, without the written approval of the Timken Corporation.

Approved: \_\_\_\_\_

NOTARY PUBLIC

by

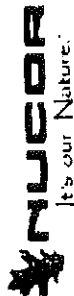
*Diana Chavers*

Diana Chavers, CERTIFICATION PROCESSOR

THE TIMKEN CORPORATION

**NUCOR**P.O. Box 279  
Winton, NC 27786  
(252) 356-3700**Mill Test Report**

Page 3



Issuing Date : 10/06/2007  
Vehicle No : NOKL 725013  
Specification : 0.5000" x 96.000" x 252.000"  
AISI 1035 ASTM A830-06 G1035

Load No. : 180273  
Our Order No. : 57533/1  
Sold To : METALS USA - SOUTH CENTRAL  
2800 N 43RD STREET EAST  
MUSKOGEE, OK 74403

Cust. Order No. : MUS-225876

Ship To : METALS USA - PLATES AND SHAPES  
TRACK 747  
MUSKOGEE, OK 74401

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Alz	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
7107095	0.35	0.70	0.017	0.003	0.19	0.21	0.06	0.11	0.01	0.006	0.005	0.001	0.001		0.0019	0.0005	0.008	0.51	0.42

Plate Serial No	Pieces	Tons	Dir.	Tensile Test		Elongation		Charpy Impacts			Min	
				(ksi)	(ksi)	% in 2"	% in 8"	Dir.	1	(ft) shear	(ft) shear	Temp
7107095-01	11	18.86	T	48,000	82,400	19.9	20.4					

ALL TEST REPORTS FURNISHED  
BY UNISURE INC.

DATE 12-18-07

CUSTOMER: MISSISSIPPI

CUSTOMER: 0011-0718105

CUSTOMER PART: 94062

HEAT: 1107095 PCS 3

HEAT: 1107095 PCS 3

Manufactured to fully killed practice by Electric Arc Furnace. Welding or weld repair was not performed on this material.  
Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast as-rolled discrete plate.  
Yield by 0.5%EL method unless otherwise specified. Coq = C+(Mn/6)+((C+Mn+V)/5)+((Cu+Ni)/15)

Pem = C+(S/20)+(Mn/20)+(Ni/20)+(Cu/20)+(Mo/15)+(V/10)+55

Melting and manufacturing in the USA. ISO 9001-2000 certified (H12443-0) by SRI Quality System Registrar (R0905-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1, B1EN 10204 3.1, B1(2004) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMPQA-182

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications.

T. A. Depretto

10/08/2007 9:17:15 AM

T. A. Depretto, Metallurgist

**NUCOR**  
**PLATE MILL**P.O. Box 279  
Winston, NC 27986  
(252) 356-3700**Mill Test Report**  
Page 3Issuing Date: 10/08/2007  
Vehicle No: NOKL 725013  
Specification: 0.5000" x 96.000" x 262.000"  
ASTM A36/A36M G1035Load No.: 180273  
Sold To: METALS USA - SOUTH CENTRAL  
2800 N 43RD STREET EAST  
MUSKOGEE, OK 74403Cust Order No.: MEUS-225876  
Ship To: METALS USA - PLATES AND SHAPES  
TRACK 747  
MUSKOGEE, OK 74401

Marking:

Heat No	C	Mn	P	S	Si	Cu	NI	Cr	Mo	Alz	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM	
7107095	0.35	0.70	0.017	0.003	0.19	0.21	0.06	0.11	0.01	0.006	0.005	0.001	0.001	0.0019	0.0005	0.008	0.51	0.42		
Plate Serial No	Tensile Test										Charpy Impacts									
	Places	Tons	Dir.	Yield	(ksi)	Tensile	(ksi)	Elongation % in 2"	Elongation % in 8"	Dir.	1	(ft)	shear	2	(ft)	shear	3	(ft)	shear	Min Temp Ave.
7107095-01	11	18.86	T	48,000	82,400	82,400	19.9													
			T	51,500	88,400	88,400	20.4													

ALL TEST REPORTS FURNISHED  
BY UNI-STEEL, INC.

DATE

1-16-07

CUSTOMER

McKissick

CUSTOMER P.O. #

M-0800888

CUSTOMER PART #

94062

HEAT #

7107095

PO#

PO#

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications.

T. A. Deparis

T. A. Deparis, Metallurgist

10/08/2007 9:17:15 AM

Manufactured to fully listed practices by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast as-rolled discrete plate. Yield by 0.5001, method unless otherwise specified. Ceq = C+(Mn/6)+(Cr+Mo)/5+(Cu+Ni)/15

Pan = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/20)+(Mo/15)+(Nb/10)+(B/5)  
Method and manufactured in the USA. ISO 9001:2000 certified (#12443-0) by SRI Quality System Registrar (#0385-09). PED 97723/EC 712 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1, BSEN 10204 3.1, B(2004) compliant. For ABS grades only. Quality Assurance certificate No. 03-MMP-QA-102



CROSBY-McKISSICK  
2857 DAWSON RD.  
TULSA, OK 74101

GENERAL OFFICES  
2801 DAWSON ROAD (74110-5040)

P.O. BOX 3128  
TULSA, OKLAHOMA 74101-3128

TELEPHONE 918-834-4611  
CROSBY FAX NO. 918-832-5388

## CERTIFICATE OF NONDESTRUCTIVE TESTING

\*\*\*\*\*

INSPECTION PERFORMED ON: 5 PC(S)- M035D16H 16" 35 TON API 2C CRANE BLOCK  
W/.75" WIRE LINE

TESTING SERIAL NO: 08-629-73 Thru 08-629-77

CUSTOMER PURCHASE ORDER NO: 4067418

CROSBY W/O ORDER NO: 702154

TEST PERFORMED:

✓✓✓ MAGNETIC PARTICLE INSPECTION PER ASTM E-709.

✓✓✓ WET METHOD            DRY METHOD.

           DYE PENETRANT INSPECTION PER ASTM E-165.  
ALTERNATE SPECIFICATION:

DEFECTS AND DISPOSITION: NO REJECTABLE INDICATIONS  
PART NO: 8011980

PICS:

HOOK - 5HD (08-629-73,75-77)  
TRUNION - HHCG (08-629-73-77)  
CENTER PIN - HDJK (08-629-73-77)  
DEAD END - HHCU (08-629-75)  
HUBS - IFBE (08-629-75-77)  
WEBS - IEBF (08-629-75-77)

HOOK: 5GI (08-629-74)  
SIDE PLATES - HHCC (08-629-73-77)  
DEAD END - HHBZ (08-629-73,74,76,77)  
HUBS - HFEX (08-629-73,74)  
WEBS - HEEH (08-629-73,74)

WE CERTIFY THAT THE INDICATED INSPECTIONS WERE PERFORMED ON THE  
DESCRIBED MATERIAL.

DATE: 02/22/08

BY: Monty Reed  
MONTY REED, SUPERVISOR

products of uncompromising quality . . .

CROSBY Clips & Fittings, LEBUS Load Binders, McKISSICK Blocks & Sheaves, CROSBY- WESTERN Blocks, NATIONAL Swaging Systems

Plants and facilities in: Jacksonville, Arkansas - Los Angeles, California - Atlanta, Georgia - Chicago, Illinois - Tulsa, Oklahoma - Harrisburg, Pennsylvania  
Dallas, Texas - Longview, Texas - Seattle, Washington - Toronto (Brampton), Ontario - Barnsley, England - Mechelen (Putte), Belgium - Cergy St. Christophe, France

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 8.0

### Overhaul Ball Certificates



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



OIL STATES SKAGIT-SMATCO LLC, AHSC  
1180 MULBERRY RD  
HOUMA, LA 70363

**the Crosby group**  
**inc.**

Certificate Form No. 825055 Ln 1

Customer Purchase Order No. 4075224

Work Order No. 730174

**CERTIFICATE OF CONFORMANCE OF CHAINS, RINGS, HOOKS, SHACKLES,  
SWIVELS AND PULLEY BLOCKS**

(1) Distinguishing number or mark (if any)	(2) Description of gear	(3) Number	(4) Date	(5) Working Load Limit
SERIAL NO. 09-849-20 Thru 09-849-38  PICS: SWIVEL BASE PLUG - 22 (09-849-20-31,36-38) SWIVEL BASE PLUG - 21 (09-849-32-35) HOOK - 5IK (09-849-20,21,32-34) HOOK - 5IJ (09-849-22-31,35-38) LARGE BOLT - IBHC (09-849-20-38)	API 2C MB07T200E UB500 7 TON OVERHAUL BALL  PART NO.: 8009632  PICS: SWIVEL UPPER EYE - 81J (09-849-20,23,32-36,38) SWIVEL UPPER EYE - 160 (09-849-21,22,24-26,28-31) SWIVEL UPPER EYE - 160 (09-849-37) SWIVEL UPPER EYE - 20J (09-849-27) SWIVEL LOWER EYE - 093 (09-849-20) SWIVEL LOWER EYE - 011 (09-849-21) SWIVEL LOWER EYE - E105 (09-849-22) SWIVEL LOWER EYE - 097 (09-849-23) SWIVEL LOWER EYE - 005 (09-849-24) SWIVEL LOWER EYE - 114 (09-849-25) SWIVEL LOWER EYE - 065 (09-849-26) SWIVEL LOWER EYE - 036 (09-849-27) SWIVEL LOWER EYE - 106 (09-849-28,30,31,34,37) SWIVEL LOWER EYE - 098 (09-849-29,36) SWIVEL LOWER EYE - 068 (09-849-32) SWIVEL LOWER EYE - 108 (09-849-33) SWIVEL LOWER EYE - 109 (09-849-35) SWIVEL LOWER EYE - 056 (09-849-38)	19	01/15/09	14,000 Lbs

(7) Name and address of makers or suppliers The Crosby Group / McKissick Products

2801 Dawson Road, Tulsa, Ok 74110-5040 U.S.A.

(8) Name and address of public service, association, company or firm making test and examination

SAME

(9) Position of signatory in public service, association, company or firm

QUALITY ASSURANCE SUPERVISOR

We hereby certify that the above described material was manufactured and processed in a manner compatible to meeting the specified load ratings when used under normal and proper applications.

(Date) January 15, 2009

(Signature) Bucky Weaver

BUCKY WEAVER



*Goltra Castings Company*

**Goltra Castings Company, Inc.**

501 McIntyre Street Golden, CO 80401-5022  
tel (303) 279-7818 fax (303) 279-3250  
Website: [www.goltracastings.com](http://www.goltracastings.com)  
Email: [castings.goltra@comcast.net](mailto:castings.goltra@comcast.net)

**Materials Certificate of Compliance**


**UPPER EYE  
81J**

June 7, 2007

We, the above named manufacturer, certify that ALL of the items presently manufactured and supplied by us to McKissick are in compliance with the requirements specified in your quote documents and purchase orders. See the table below for parts shipped on this date via YELLOW #:

PART NUMBER	PURCHASE ORDER	HEAT CODE	QUANTITY	INVOICE
20-S-4	M-0704980-1	81J	42 ✓	47036
7-S-4	M-0704979-1	81J	162 ✓	47037
1042286	M-0703976-4	27J, 28J, 29J, 30J	660	47038

All the information that is provided in this Certificate of Compliance is accurate to the best of my knowledge, as of the date of issuance.

  
Larry Draper  
General Manager



Email or fax this form to:

Pat Grant  
McKissick - The Crosby Group  
Quality Assurance  
E-Mail: [patgrant@THECROSBYGROUP.COM](mailto:patgrant@THECROSBYGROUP.COM)  
Fax: 918-834-9447

**UPPER EYE  
81J**

**GOLTRA CASTINGS COMPANY, INC.**

501 McIntyre STREET  
Golden, Colorado 80401  
PHONE 303-279-7818

DATE: 6/13/07

ASTM SPECIFICATION  
ASTM-A-487 4B

CUSTOMER DESCRIPTION  
MCKISSICK  
P/N: 7-S-4

**TENSILE TEST PER ASTM E 8**

HEAT CODE	YIELD PSI	TENSILE PSI	ELONGATION %	REDUCTION IN AREA %
81J	106,000	124,000	18	42.0

Brinell: 248

**QUENCH AND TEMPER**

**CHEMICAL COMPOSITION**

Element Units Average	Carbon %	Manganese %	Phosphorous %	Sulfur %
	0.2990	0.8300	0.0160	0.0091
	Silicon %	Copper %	Nickel %	Chromium %
	0.5200	0.1860	0.4990	0.4340
	Molybdenum %	Aluminum %	Vanadium %	Carbon Equiv. %
	0.1630	0.0098	0.0078	0.6000

**CHARPY IMPACT TEST PER ASTM A370 FIG. 1**

TYPE OF SPECIMEN: CHARPY V NOTCH

SPECIMEN	#1	#2	#3
----------	----	----	----

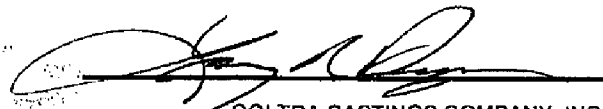
IMPACT VALUE

METHOD OF TEST ASTM E 23	23	29	31
--------------------------	----	----	----

TEST TEMPERATURE	-25.4 DEGREES F.
------------------	------------------

MADE AND MELTED IN THE USA

I HEREBY CERTIFY THAT THE ABOVE INFORMATION IS CORRECT.



GOLTRA CASTINGS COMPANY, INC.  
Larry Draper, General Manager

FROM :

FAX NO. :

Nov. 20 2008 08:55AM P1

**GOLTRA CASTINGS COMPANY, INC.**501 McIntyre STREET  
Golden, Colorado 80401  
PHONE 303-279-7818**UPPER EYE  
160**

DATE: 10/24/08

ASTM SPECIFICATION

ASTM-A-487 GRADE 4 CLASS B

CUSTOMER DESCRIPTION

MCKISSICK

P/N: 7-S-4

**TENSILE TEST PER ASTM E 8**

HEAT CODE	YIELD PSI	TENSILE PSI	ELONGATION %	REDUCTION IN AREA %
160	95,000	113,000	22	52.5

Brinell: 241

**QUENCH & TEMPER****CHEMICAL COMPOSITION**

Element Units	Carbon %	Manganese %	Phosphorous %	Sulfur %
Average	0.3500	0.9500	0.0210	0.0160
	Silicon %	Copper %	Nickel %	Chromium %
	0.4970	0.2160	0.4520	0.6000
	Molybdenum %	Aluminum %	Vanadium %	Carbon Equiv. %
	0.2800	0.0038	0.0170	0.7500

**CHARPY IMPACT TEST PER ASTM A370 FIG. 1**

TYPE OF SPECIMEN: CHARPY V NOTCH

SPECIMEN

#1

#2

#3

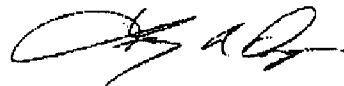
IMPACT VALUE

METHOD OF TEST ASTM E 23

TEST TEMPERATURE

MADE AND MELTED IN THE USA

I HEREBY CERTIFY THAT THE ABOVE INFORMATION IS CORRECT.

GOLTRA CASTINGS COMPANY, INC.  
Larry Draper, General Manager

**UPPER EYE  
20J**

**GOLTRA CASTINGS COMPANY, INC.**

501 McIntyre STREET  
Golden, Colorado 80401  
PHONE 303-279-7818

DATE: 5/17/07

ASTM SPECIFICATION

CUSTOMER DESCRIPTION

ASTM-A-487 4B

MCKISSICK

P/N: 7-S-4

**TENSILE TEST PER ASTM E 8**

HEAT CODE	YIELD PSI	TENSILE PSI	ELONGATION %	REDUCTION IN AREA %
20J	106,000	123,000	19	41.0

Brinell: 248

**QUENCH AND TEMPER**

**CHEMICAL COMPOSITION**

Element	Carbon	Manganese	Phosphorous	Sulfur
Units	%	%	%	%
Average	0.2940	0.9400	0.0150	0.0110
	Silicon	Copper	Nickel	Chromium
	%	%	%	%
	0.6100	0.1750	0.5100	0.5500
	Molybdenum	Aluminum	Vanadium	Carbon Equiv.
	%	%	%	%
	0.1780	0.0044	0.0120	0.8500

**CHARPY IMPACT TEST PER ASTM A370 FIG. 1**

TYPE OF SPECIMEN: CHARPY V NOTCH

SPECIMEN	#1	#2	#3
----------	----	----	----

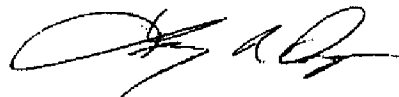
IMPACT VALUE

METHOD OF TEST ASTM E 23	45	46	42
--------------------------	----	----	----

TEST TEMPERATURE	-25.3 DEG F
------------------	-------------

MADE AND MELTED IN THE USA

I HEREBY CERTIFY THAT THE ABOVE INFORMATION IS CORRECT.



GOLTRA CASTINGS COMPANY, INC.  
Larry Draper, General Manager



**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

## LOWER EYE 093

DATE CERTIFIED: 05/05/2008

McKissick Products Company  
2857 Dawson Road  
  
Tulsa, OK 74101

PART NUMBER: 230379  
DESCRIPTION: 5 TON SWIVEL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0800310

HEAT#: B2453	Fe: 96.600	Cr: 0.55	P: 0.019	TENSILE STRENGTH: 132,342
QUANTITY: 9	C: 0.232	Mo: 0.19	Cu: 0.18	YIELD STRENGTH: 112,752
	Mn: 0.913	Al: 0.00	V: 0.00	ELONGATION: 18
	Si: 0.500	Ti: 0.02	Nb: 0.04	REDUCTION: 46
	Ni: 0.476	S: 0.013	W: 0.03	BHN:

**NOTES:** Lot code: 085

Charpy results @ -25F (ft\*lb): 15, 24, 18 Average: 19

HEAT#: B2570	Fe: 97.000	Cr: 0.62	P: 0.014	TENSILE STRENGTH: 114,538
QUANTITY: 29	C: 0.200	Mo: 0.18	Cu: 0.12	YIELD STRENGTH: 96,744
	Mn: 0.778	Al: 0.00	V: 0.00	ELONGATION: 17
	Si: 0.382	Ti: 0.01	Nb: 0.02	REDUCTION: 43
	Ni: 0.568	S: 0.005	W: 0.01	BHN:

**NOTES:** Lot code: 095

Charpy results @ -25F (ft\*lb): 33, 27, 28 Average: 29.3

HEAT#: B2571	Fe: 97.000	Cr: 0.59	P: 0.016	TENSILE STRENGTH: 115,500
QUANTITY: 26	C: 0.243	Mo: 0.24	Cu: 0.14	YIELD STRENGTH: 99,825
	Mn: 0.779	Al: 0.00	V: 0.00	ELONGATION: 19
	Si: 0.412	Ti: 0.01	Nb: 0.03	REDUCTION: 42
	Ni: 0.432	S: 0.003	W: 0.00	BHN:

**NOTES:** Lot code: 093

Charpy results @ -25F (ft\*lb): 28, 27, 29 Average: 28



AJ Menefee

05/05/2008



**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

**LOWER EYE  
011**

DATE CERTIFIED: 08/09/2006

**McKissick Products Company**  
2857 Dawson Road  
Tulsa, OK 74101

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0606134

HEAT#: A1038	Fe: 97.00	Mo: 0.22	Cu: 0.13	TENSILE STRENGTH: 103,078
QUANTITY: 87	C: 0.23	Al: 0.00	V: 0.00	YIELD STRENGTH: 86,640
	Mn: 0.90	Ti: 0.01	Nb: 0.04	ELONGATION: 25
	Si: 0.49	S: 0.02	Se: 0.00	REDUCTION: 50
	Ni: 0.43	P: 0.03	W: 0.03	BHN: 0
	Cr: 0.52			

**NOTES:** Lot codes: 008, 009, & 010

Charpy results: 18, 16, 18 ft-lbs. Average: 17.3 ft-lbs

HEAT#: A1039	Fe: 97.00	Mo: 0.22	Cu: 0.12	TENSILE STRENGTH: 109,450
QUANTITY: 77	C: 0.24	Al: 0.00	V: 0.00	YIELD STRENGTH: 92,793
	Mn: 0.86	Ti: 0.01	Nb: 0.03	ELONGATION: 24
	Si: 0.58	S: 0.02	Se: 0.00	REDUCTION: 49
	Ni: 0.44	P: 0.03	W: 0.02	BHN: 0
	Cr: 0.50			

**NOTES:** Lot Codes: 007, 011, 012

Charpy results: 16, 14, 17 ft-lbs. Average: 15.7 ft-lbs



*Bruce Gilbert*  
Bruce Gilbert / AJ Menefee 08/09/2006



**EAGLE**  
PRECISION CAST PARTS, INC.

# **MATERIAL CERTIFICATION**

**LOWER EYE  
E105**

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 01/05/2007

**McKissick Products Company**  
**2857 Dawson Road**  
**Tulsa, OK 74101**

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0610746

HEAT#: E105	Fe: 97.00	Cr: 0.47	P: 0.02	TENSILE STRENGTH: 107,045
QUANTITY: 74	C: 0.23	Mo: 0.18	Cu: 0.22	YIELD STRENGTH: 94,850
	Mn: 0.91	Al: 0.00	V: 0.00	ELONGATION: 20
	Si: 0.35	Ti: 0.00	Nb: 0.02	REDUCTION: 50
	Ni: 0.44	S: 0.02	W: 0.01	BHN:

**NOTES:** Lot code: 025

Charpy results @ -25F: 18, 18, 19 ft\*lbs, Average: 18.3 ft\*lbs

HEAT#: E106	Fe: 96.90	Cr: 0.47	P: 0.02	TENSILE STRENGTH: 103,632
QUANTITY: 78	C: 0.21	Mo: 0.17	Cu: 0.22	YIELD STRENGTH: 88,400
	Mn: 0.92	Al: 0.00	V: 0.00	ELONGATION: 22
	Si: 0.53	Ti: 0.01	Nb: 0.02	REDUCTION: 47
	Ni: 0.41	S: 0.02	W: 0.01	BHN:

**NOTES:** Lot code: 026

Charpy results @ -25F: 15, 18, 18 ft\*lbs, Average: 17 ft\*lbs

HEAT#: E107	Fe: 96.90	Cr: 0.47	P: 0.01	TENSILE STRENGTH: 106,524
QUANTITY: 78	C: 0.22	Mo: 0.16	Cu: 0.25	YIELD STRENGTH: 92,805
	Mn: 0.90	Al: 0.00	V: 0.00	ELONGATION: 18
	Si: 0.59	Ti: 0.01	Nb: 0.01	REDUCTION: 49
	Ni: 0.41	S: 0.02	W: 0.01	BHN:

**NOTES:** Lot code: 027

Charpy results @ -25F: 20, 21, 24 ft\*lbs, Average: 21.7 ft\*lbs



Page 1 of 1

P:\EPCP QUALITY RECORDS\QR 36 - MATERIAL CERTIFICATION.RPT

Bruce Gilbert/AJ Manefee 01/05/2007



**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

**LOWER EYE  
097**

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 05/05/2008

**McKissick Products Company**  
**2857 Dawson Road**  
**Tulsa, OK 74101**

PART NUMBER: **230379**  
DESCRIPTION: **5 TON TIMKEN SWIVEL**  
METAL: **8620**  
METAL SPEC: **ASTM A487 4D**  
P.O. NUMBER: **M-0800310**

HEAT#: <b>A1516</b>	Fe: <b>96.800</b>	Cr: <b>0.54</b>	P: <b>0.020</b>	TENSILE STRENGTH: <b>121,485</b>
QUANTITY: <b>1</b>	C: <b>0.226</b>	Mo: <b>0.19</b>	Cu: <b>0.20</b>	YIELD STRENGTH: <b>108,135</b>
	Mn: <b>0.880</b>	Al: <b>0.00</b>	V: <b>0.00</b>	ELONGATION: <b>18</b>
	Si: <b>0.454</b>	Ti: <b>0.02</b>	Nb: <b>0.05</b>	REDUCTION: <b>41</b>
	Ni: <b>0.461</b>	S: <b>0.014</b>	W: <b>0.01</b>	BHN: <b>235</b>

**NOTES:** Lot code: 082, 084

Charpy results @ -25F (ft-lbs): 23, 20, 19 Average: 20.7 ft-lbs

HEAT#: <b>A1602</b>	Fe: <b>97.000</b>	Cr: <b>0.60</b>	P: <b>0.017</b>	TENSILE STRENGTH: <b>119,436</b>
QUANTITY: <b>28</b>	C: <b>0.227</b>	Mo: <b>0.18</b>	Cu: <b>0.17</b>	YIELD STRENGTH: <b>108,138</b>
	Mn: <b>0.819</b>	Al: <b>0.00</b>	V: <b>0.00</b>	ELONGATION: <b>21</b>
	Si: <b>0.370</b>	Ti: <b>0.00</b>	Nb: <b>0.02</b>	REDUCTION: <b>48</b>
	Ni: <b>0.504</b>	S: <b>0.009</b>	W: <b>0.00</b>	BHN:

**NOTES:** Lot code: 089, 091

Charpy results @ -25F (ft\*lb): 31, 26, 28 Average: 28.3

HEAT#: <b>A1629</b>	Fe: <b>96.800</b>	Cr: <b>0.72</b>	P: <b>0.014</b>	TENSILE STRENGTH: <b>113,619</b>
QUANTITY: <b>25</b>	C: <b>0.233</b>	Mo: <b>0.21</b>	Cu: <b>0.15</b>	YIELD STRENGTH: <b>96,250</b>
	Mn: <b>0.710</b>	Al: <b>0.02</b>	V: <b>0.00</b>	ELONGATION: <b>19</b>
	Si: <b>0.463</b>	Ti: <b>0.04</b>	Nb: <b>0.02</b>	REDUCTION: <b>48</b>
	Ni: <b>0.514</b>	S: <b>0.002</b>	W: <b>0.02</b>	BHN:

**NOTES:** Lot code: 097

Charpy results @ -25F (ft\*lb): 29, 27, 27 Average: 27.7



A.J. Menefee

05/05/2008





**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

## LOWER EYE 005

DATE CERTIFIED: 07/10/2006

**McKissick Products Company**  
2857 Dawson Road  
Tulsa, OK 74101

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0606133

HEAT#: C1986	Fe: 97.50	Mo: 0.18	Cu: 0.13	TENSILE STRENGTH: 107,868
QUANTITY: 30	C: 0.25	Al: 0.00	V: 0.00	YIELD STRENGTH: 91,848
	Mn: 0.78	Ti: 0.00	Nb: 0.02	ELONGATION: 18
	Si: 0.34	S: 0.02	Se: 0.00	REDUCTION: 38
	Ni: 0.43	P: 0.02	W: 0.01	BHN: 235
	Cr: 0.48			

**NOTES:** Lot code: #003

Charpy results @ -25F: 18, 15, 16 ft-lbs. Average: 16.3 ft-lbs.

HEAT#: C1987	Fe: 97.40	Mo: 0.18	Cu: 0.14	TENSILE STRENGTH: 105,148
QUANTITY: 18	C: 0.21	Al: 0.00	V: 0.00	YIELD STRENGTH: 81,300
	Mn: 0.67	Ti: 0.01	Nb: 0.03	ELONGATION: 22
	Si: 0.41	S: 0.03	Se: 0.00	REDUCTION: 50
	Ni: 0.43	P: 0.02	W: 0.02	BHN: 235
	Cr: 0.53			

**NOTES:** Lot code: #005

Charpy results @ -25F: 19, 22, 24 ft-lbs. Average: 21.7 ft-lbs.

HEAT#: C1988	Fe: 97.30	Mo: 0.19	Cu: 0.14	TENSILE STRENGTH: 103,694
QUANTITY: 28	C: 0.20	Al: 0.00	V: 0.00	YIELD STRENGTH: 86,180
	Mn: 0.75	Ti: 0.01	Nb: 0.03	ELONGATION: 19
	Si: 0.38	S: 0.03	Se: 0.00	REDUCTION: 40
	Ni: 0.42	P: 0.02	W: 0.03	BHN: 229
	Cr: 0.52			

**NOTES:** Lot code: #006

Charpy results @ -25F: 24, 21, 26 ft-lbs. Average: 23.7 ft-lbs.



*Bruce Gilbert*  
Bruce Gilbert / AJ Menefee 08/04/2006

**CORPORATE OFFICE**

8181 Broadmoor SE, Caledonia, MI 49316

Phone: (800) 748-0208 • Fax: (616) 891-3565

Web: www.nondestructivetesting.com • Email: ndtg@iserv.net



Wednesday, August 02, 2006

**Magnetic Particle  
Examination Report****LOWER EYE  
005**

Page 1 of 1

**Client:** EAGLE PRECISION CAST PARTS,**Purchase Order:** 080106AJ**Address:** 5112 EVANSTON AVE.  
MUSKEGON, MI, 49442**Work Order:** B5346**NDTG Shipper No.:** 32261**Attention:** A.J. MENESEE**Description:** MCKISSICK (PN#230379)**Part Number:** 230379**Procedure:** NDTG-MT-1, ASTM E 709**Technique Number:** MT294**Acceptance:** ASTM E-125**Results:****No. Acceptable:** 157**No. Rejectable:** 5**Remarks:** THE REJECTED PARTS ARE TAGGED WITH A REJECT TAG. THIS REPORT APPLIES ONLY TO THESE PARTS EXAMINED.**Technician:** DAN VERBRUGGE**Certifications:** NDTG-CTP-1, MT LEVEL II**Signed:** **Lead Inspector:** Michael P. McDaniels**Signed:** 



**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

**LOWER EYE  
114**

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 09/22/2008

**McKissick Products Company**  
**2857 Dawson Road**  
  
**Tulsa, OK 74101**

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL BARREL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0806303

HEAT#: A1859	Fe: 96.400	Cr: 0.80	P: 0.014	TENSILE STRENGTH: 102,670
QUANTITY: 58	C: 0.248	Mo: 0.19	Cu: 0.21	YIELD STRENGTH: 85,212
	Mn: 0.752	Al: 0.04	V: 0.00	ELONGATION: 18
	Si: 0.409	Ti: 0.08	Nb: 0.01	REDUCTION: 38.1
	Ni: 0.572	S: 0.006	W: 0.04	BHN: 223

**NOTES:** Lot code: 112, 113

Charpy results @ -25F (ft\*lb): 27, 28, 29 Average: 28

HEAT#: A1860	Fe: 96.600	Cr: 0.55	P: 0.018	TENSILE STRENGTH: 107,353
QUANTITY: 34	C: 0.228	Mo: 0.18	Cu: 0.24	YIELD STRENGTH: 83,520
	Mn: 0.778	Al: 0.00	V: 0.00	ELONGATION: 25
	Si: 0.494	Ti: 0.05	Nb: 0.02	REDUCTION: 48.9
	Ni: 0.479	S: 0.009	W: 0.04	BHN: 217

**NOTES:** Lot code: 111, 114, 115

Charpy results @ -25F (ft\*lb): 33, 35, 35 Average: 34.3

HEAT#: B3060	Fe: 97.100	Cr: 0.54	P: 0.010	TENSILE STRENGTH: 104,154
QUANTITY: 26	C: 0.206	Mo: 0.17	Cu: 0.22	YIELD STRENGTH: 76,270
	Mn: 0.793	Al: 0.00	V: 0.00	ELONGATION: 24
	Si: 0.349	Ti: 0.01	Nb: 0.01	REDUCTION: 48.2
	Ni: 0.496	S: 0.002	W: 0.02	BHN: 229

**NOTES:** Lot code: 110

Charpy results @ -25F (ft\*lb): 23, 24, 23 Average: 23.3



REG 9001:2000  
P.1/10/01

Page 1 of 2

P:\EPCP QUALITY RECORDS\QR 36 - MATERIAL CERTIFICATION.RPT

A.J. Menefee

09/22/2008



Oklahoma Investment Casting Company

## CERTIFICATE OF CONFORMANCE

LOWER EYE

065

DATE: December 24, 2004

THIS IS TO CERTIFY THAT THE PARTS LISTED BELOW WERE MANUFACTURED TO THE SPECIFICATIONS AS INDICATED BELOW.

COMPANY:	McKissick
P.O. NUMBER:	M-0405381
PART NUMBER:	230379 5 Ton Eye Barrel
O.I.C.C NUMBER:	142-006
ALLOY:	ASTM A487 Grade 4 Class B
HEAT NUMBER(S):	11/08/04 #5 thru 12
PIC CODE:	065

NUMBER OF PARTS ON THIS ORDER: 184

### CHEMICAL ANALYSIS

ELEMENT TESTED	RESULTS (%)
C	0.29
Mn	0.65
P	0.01
S	0.01
Si	0.60
Cu	0.17
Ni	0.51
Cr	0.51
Mo	0.17
Fe	BASE

QUALITY ASSURANCE:

STUART K. DENSCH

708 N. 29th Street • P.O. Box 580 • Blackwell, OK 74631 • (580) 363-1412 • (580) 363-5712 FAX

**LOWER EYE  
065**

Materials Testing  
3100 N. Hemlock Circle  
Broken Arrow, OK 74012

**SHERRY**Laboratories  
Testing Today - Protecting Tomorrow®

Tel: (918) 258-6066  
(800) 324-8378  
Fax: (918) 258-1154

**LABORATORY REPORT**

Attn: Stuart Bensch  
Oklahoma Investment Castings Corp.  
708 N. 29th Street  
Blackwell, OK 74631

DEC 27 2004

Report No: 2004120563-1  
Date Received: 12/20/2004  
Date Reported: 12/22/2004  
P.O. No: 33557

Description S/N- 1: McKissick 5T Eye Barrel, ASTM A487 Grade 4 CL. D Material, TB=IZ7

**Impact Test, ASTM A370-03a/ASTM E23-02a**

230379  
5T Eye Barrel  
M-0485381  
PIC 065

Test Machine Capacity: 300 Ft-Lbs.  
Specimen Type: Charpy "V" Notch  
Specimen Location: ASTM A370 Longitudinal  
Notch Orientation: Perpendicular to Surface  
Specimen Size: 10mm X 10mm  
Test Temperature: -25 °F

SKB  
27 Dec 04

Notch Location:	Base
Impact Values (Ft-Lbs.):	41, 40, 39
Lateral Expansion(Mils):	30, 31, 31
Shear(%):	70, 65, 65

Absorbed energy values above 80% of the scale range are approximate.

Approved by:

Carol Judd, Manager of Material Testing  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmittal of a report on services provided by Sherry Laboratories is at the request of the client. The transmittal is NOT the official report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in information in the transmittal. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall control for all purposes.

Materials Testing  
3100 N. Hemlock Circle  
Broken Arrow, OK 74012



**LOWER EYE  
065**

Tel: (918) 258-6066  
(800) 324-8378  
Fax: (918) 258-1154

**LABORATORY REPORT**

Attn: Stuart Bensch  
Oklahoma Investment Castings Corp.  
708 N. 29th Street  
Blackwell, OK 74631

DEC 27 2004

Report No: 2004120563-2  
Date Received: 12/20/2004  
Date Reported: 12/22/2004  
P.O. No: 33557

Description S/N- 2: McKissick 5T Eye Barrel, ASTM A487 Grade 4 CL. D Material, TB=IZ7

Room Temperature Tensile Test (ASTM E 8-04), Longitudinal

230379  
5T Eye Barrel  
M-0405381  
PIC 065

Parameter	Result
Diameter, in.	0.502
Tensile Strength, psi	113,400
Yield Strength, psi by 0.2% offset	92,600
Elongation in 2", %	18
Reduction of Area, %	51

SKB  
27 Dec 04

Approved by:

Carol Judd, Manager of Material Testing  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmittal of a report on services provided by Sherry Laboratories is at the request of the client. The transmittal is NOT the official report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in information in the transmittal. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall control for all purposes.



**EAGLE**  
PRECISION CAST PARTS, INC.

## MATERIAL CERTIFICATION

**LOWER EYE  
036**

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 09/27/2007

**McKissick Products Company**  
2857 Dawson Road  
Tulsa, OK 74101

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0706872

HEAT#: A1289	Fe: 97.00	Cr: 0.57	P: 0.02	TENSILE STRENGTH: 110,019
QUANTITY: 1	C: 0.23	Mo: 0.15	Cu: 0.15	YIELD STRENGTH: 93,912
	Mn: 0.90	Al: 0.00	V: 0.00	ELONGATION: 17
	Si: 0.37	Ti: 0.01	Nb: 0.02	REDUCTION: 38
	Ni: 0.51	S: 0.03	W: 0.01	BHN: 221

**NOTES:** ✓ Lot code: 033

Charpy results at -25F: 24, 24, 25 ft-lbs Avg: 24.3 ft-lbs

HEAT#: A1326	Fe: 96.80	Cr: 0.45	P: 0.03	TENSILE STRENGTH: 109,344
QUANTITY: 5	C: 0.22	Mo: 0.25	Cu: 0.20	YIELD STRENGTH: 95,200
	Mn: 0.85	Al: 0.00	V: 0.00	ELONGATION: 19
	Si: 0.34	Ti: 0.02	Nb: 0.03	REDUCTION:
	Ni: 0.43	S: 0.03	W: 0.03	BHN:

**NOTES:** ✓ Lot code: 036

Charpy results @ -25F (ft\*lb): 15, 16, 16 Average: 15.7

HEAT#: A1327	Fe: 96.60	Cr: 0.46	P: 0.02	TENSILE STRENGTH: 114,124
QUANTITY: 2	C: 0.22	Mo: 0.25	Cu: 0.20	YIELD STRENGTH: 101,132
	Mn: 0.95	Al: 0.04	V: 0.00	ELONGATION: 18
	Si: 0.42	Ti: 0.09	Nb: 0.03	REDUCTION:
	Ni: 0.43	S: 0.03	W: 0.05	BHN:

**NOTES:** ✓ Lot code: 035

Charpy results @ -25F (ft\*lb): 15, 19, 16 Average: 16.7



*Bruce Gilbert*  
Bruce Gilbert/AJ Menefee 09/27/2007

Oklahoma  
Investment  
Casting  
Company

Oklahoma Investment Casting Company  
**CERTIFICATE OF CONFORMANCE**

**LOWER EYE  
068**

DATE: April 22, 2005

**THIS IS TO CERTIFY THAT THE PARTS LISTED BELOW WERE MANUFACTURED TO THE SPECIFICATIONS AS INDICATED BELOW.**

COMPANY:	McKissick
P.O. NUMBER:	M-0409988
PART NUMBER:	230379 5 Ton Eye Barrel
O.I.C.C NUMBER:	142-006
ALLOY:	ASTM A487 Grade 4 Class B
HEAT NUMBER(S):	3/10/05 #7 thru 12
PIC CODE:	068

NUMBER OF PARTS ON THIS ORDER: 168

**CHEMICAL ANALYSIS**

ELEMENT TESTED	RESULTS (%)
C	0.29
Mn	0.59
P	0.01
S	0.02
Si	0.68
Cu	0.16
Ni	0.49
Cr	0.50
Mo	0.20
Fe	BASE

QUALITY ASSURANCE:

  
STUART K. BENSCH

704 N. 29th Street \* P.O. Box 580 \* Blackwell, OK 74631 \* (580) 363-1412 \* (580) 363-5712 FAX



**LOWER EYE  
068**

Materials Testing  
3100 N. Hemlock Circle  
Broken Arrow, OK 74012

**SHERRY**Laboratories

Testing Today - Protecting Tomorrow

Tel: (918) 258-6066  
(800) 324-8378  
Fax: (918) 258-1154

**LABORATORY REPORT**

Attn: Stuart Bensch  
Oklahoma Investment Castings Corp.  
708 N. 29th Street  
Blackwell, OK 74831

Report No: 2005040410-1  
Date Received: 04/18/2005  
Date Reported: 04/21/2005  
P.O. No: 33878

Description S/N- 1: McKissick 5T Eye Barrel, ASTM A487 Grade 4 CL. D Material, TB=MD7

**Room Temperature Tensile Test (ASTM E 8-04), Longitudinal**

Parameter	Result
Diameter, in.	0.501
Tensile Strength, psi	108,400
Yield Strength, psi by 0.2% offset	86,900
Elongation in 2", %	16
Reduction of Area, %	33

→ Approved BRAD BEALL 4-15-05

→ Approved BRAD BEALL 4-15-05

230379  
5T Eye Barrel  
M-0409988  
PIC 068

S&B  
22 Apr 05

The elongation and reduction-of-area do not meet the minimum requirements of ASTM A487 Grade 4 Class D. The elongation is 1% short and the reduction-of-area is 2% short.

Approved by

Carol Judd, Manager of Material Testing  
Sherry Laboratories

Stuart Bensch  
OICC  
22 April 2005

Test results relate only to the item tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmittal of a report on services provided by Sherry Laboratories is at the request of the client. The transmittal is NOT the official report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in information in the transmittal. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall control for all purposes.

**LOWER EYE  
068**

Materials Testing  
3100 N. Hemlock Circle  
Broken Arrow, OK 74012

**SHERRY Laboratories**

Testing Today - Protecting Tomorrow®

Tel: (918) 258-6066  
(800) 324-8378  
Fax: (918) 258-1154

**LABORATORY REPORT**

Attn: Stuart Bensch  
Oklahoma Investment Castings Corp.  
708 N. 28th Street  
Blackwell, OK 74631

Report No: 2005040410-2  
Date Received: 04/18/2005  
Date Reported: 04/21/2005  
P.O. No: 33979

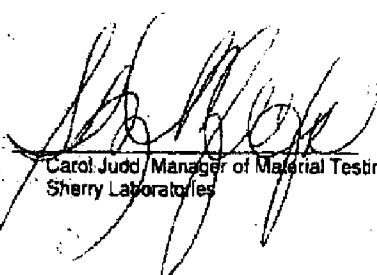
Description: SN- 2: McKissick ST Eye Barrel, ASTM A487 Grade 4 CL. D Material, TB=MD7

**Impact Test, ASTM A370-03a/ASTM E23-04**

Test Machine Capacity: 264 Ft-Lbs.  
Specimen Type: Charpy "V" Notch  
Specimen Location: ASTM A370 Longitudinal  
Notch Orientation: Perpendicular to Surface  
Specimen Size: 10mm X 10mm  
Test Temperature: -25 °F

Notch Location:	Base
Impact Values (Ft-Lbs.):	17, 18, 16
Lateral Expansion (Mils):	13, 14, 12
Shear(%):	40, 40, 40

Absorbed energy values above 80% of the scale range are approximate.

Approved by:   
Carol Judd / Manager of Material Testing  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmittal of a report on services provided by Sherry Laboratories is at the request of the client. The transmittal is NOT the official report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in information in the transmittal. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall control for all purposes.



**EAGLE**  
PRECISION CAST PARTS, INC.

# MATERIAL CERTIFICATION

## LOWER EYE 106, 108, 109, 098

5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 09/22/2008

**McKissick Products Company**  
**2857 Dawson Road**  
  
**Tulsa, OK 74101**

PART NUMBER: 230379  
DESCRIPTION: 5 TON TIMKEN SWIVEL EYE BARREL  
METAL: 8620  
METAL SPEC: ASTM A487 4D  
P.O. NUMBER: M-0806303

HEAT#: E532	Fe: 96.200	Cr: 0.80	P: 0.016	TENSILE STRENGTH: 107,460
QUANTITY: 5	C: 0.244	Mo: 0.24	Cu: 0.12	YIELD STRENGTH: 90,450
	Mn: 0.883	Al: 0.01	V: 0.00	ELONGATION: 19
	Si: 0.545	Ti: 0.07	Nb 0.01	REDUCTION: 43.7
	Ni: 0.612	S: 0.003	W: 0.03	BHN: 217

**NOTES:** Lot code: 098

Charpy results @ -25F (ft\*lb): 24, 21, 23 Average: 22.7

HEAT#: E533	Fe: 96.700	Cr: 0.83	P: 0.017	TENSILE STRENGTH: 113,670
QUANTITY: 16	C: 0.254	Mo: 0.22	Cu: 0.11	YIELD STRENGTH: 98,550
	Mn: 0.874	Al: 0.00	V: 0.00	ELONGATION: 20
	Si: 0.386	Ti: 0.04	Nb 0.01	REDUCTION: 38.9
	Ni: 0.546	S: 0.002	W: 0.02	BHN: 217

**NOTES:** Lot code: 106, 107

Charpy results @ -25F (ft\*lb): 28, 30, 28 Average: 28.7

HEAT#: E534	Fe: 97.000	Cr: 0.83	P: 0.014	TENSILE STRENGTH: 103,834
QUANTITY: 17	C: 0.238	Mo: 0.22	Cu: 0.10	YIELD STRENGTH: 87,156
	Mn: 0.754	Al: 0.00	V: 0.00	ELONGATION: 20
	Si: 0.374	Ti: 0.03	Nb 0.02	REDUCTION: 39.1
	Ni: 0.570	S: 0.000	W: 0.01	BHN: 211

**NOTES:** Lot code: 099, 108, 109

Charpy results @ -25F (ft\*lb): 25, 30, 25 Average: 26.7



ISO 9001:2000  
FAC 03001

Page 2 of 2

P:\EPOP QUALITY RECORDS\QCR 36 - MATERIAL CERTIFICATION.RPT

*A.J. Menefee*  
A.J. Menefee 09/22/2008



Oklahoma Investment Casting Company 056  
**CERTIFICATE OF CONFORMANCE**

LOWER EYE

DATE: October 23, 2003

THIS IS TO CERTIFY THAT THE PARTS LISTED BELOW WERE MANUFACTURED TO THE SPECIFICATIONS AS INDICATED BELOW.

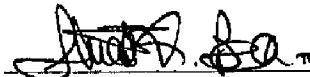
COMPANY:	McKissick
P.O. NUMBER:	M-0304603
PART NUMBER:	230379 5 Ton Eye Barrel
O.I.C.C NUMBER:	142-006
ALLOY:	ASTM A487 Grade 4 Class B
HEAT NUMBER(S):	9/17/03 #4 thru 9
PIC CODE:	056

NUMBER OF PARTS ON THIS ORDER: 141

**CHEMICAL ANALYSIS**

ELEMENT TESTED	RESULTS (%)
C	0.21
Mn	0.56
P	0.01
S	0.02
Si	0.57
Cu	0.23
Ni	0.55
Cr	0.46
Mo	0.19
Fe	BASE

QUALITY ASSURANCE:



STUART K. BENSCH

708 N. 29th Street \* P.O. Box 580 \* Blackwell, OK 74631 \* (580) 363-1412 \* (580) 363-5712 FAX

an  
10-24-03

Materials Testing  
1100 N. Hendrick Circle  
Broken Arrow, OK 74012

**SHERRY Laboratories**

(Being Today - Proving Tomorrow)

**LOWER EYE  
056**

Tel: (918) 258-0066  
(800) 924-8378  
Fax: (918) 258-1154

### LABORATORY REPORT

Attn: Paul Hays  
Central Machine & Tool  
P.O. BOX 3909  
Enid, OK 73702

Report No: 2003100446  
Date Received: 10/22/2003  
Date Reported: 10/24/2003  
P.O. No: 15762

Description: McKissick ST Eye Barrel, ASTM A487 Grade 4 CL, B Material, TB="CG7"

#### Room Temperature Tensile Test (ASTM E 8-01), Longitudinal

Parameter	Result
Diameter, in	0.5020
Tensile Strength, psi	109,100
Yield Strength, psi	86,800
by 0.2% offset	
Elongation in 2", %	18
Reduction of Area, %	40

#### Impact Test, ASTM A370-97a/ASTM E23-02

Test Machine Capacity	300 Ft-Lbs.
Specimen Type	Charpy "V" Notch
Specimen Location	ASTM A370 Longitudinal
Notch Orientation	Perpendicular to Surface
Specimen Size	10mm X 10mm
Test Temperature	-25 °F

Notch Location:	Base
Impact Values (Ft-Lbs.)	18, 18, 10
Lateral Expansion (Mils)	16, 16, 12
Shear (%)	20, 20, 20

Absorbed energy values above 60% of the scale range are approximate.

Approved by:

*Harry J. Oate*  
Harry Oate, Manager of Mechanical Testing  
Sherry Laboratories

Test results relate only to the items tested. These documents shall not be reproduced, except by written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. The electronic transmission of a report on services provided by Sherry Laboratories is at the request of the client. This is not a final report of Sherry Laboratories, but is provided for the convenience of the recipient. Sherry Laboratories is not liable for any degradation or changes in the information transmitted. The official report of Sherry Laboratories will be provided on Sherry Laboratories letterhead in hard copy form and shall remain the property of Sherry Laboratories.

Page 1 of 1

**EAGLE**

PRECISION CAST PARTS, INC.

**MATERIAL  
CERTIFICATION****SWIVEL BASE PLUG  
21,22**5112 EVANSTON AVE.  
MUSKEGON, MI 49442  
PHONE: (231) 788-3318  
FAX: (231) 788-5409

DATE CERTIFIED: 01/29/2008

**McKissick Products Company**  
**2857 Dawson Road**  
  
**Tulsa, OK 74101**

**PART NUMBER: 2001076**  
**DESCRIPTION: 5 TON TAPERED BEARING SWIVEL**  
**METAL: 8620**  
**METAL SPEC: ASTM A487 4D**  
**P.O. NUMBER: M-0714125**

<b>HEAT#: B1952</b>	<b>Fe: 96.80</b>	<b>Cr: 0.65</b>	<b>P: 0.02</b>	<b>TENSILE STRENGTH: 109,620</b>
<b>QUANTITY: 146</b>	<b>C: 0.26</b>	<b>Mo: 0.25</b>	<b>Cu: 0.14</b>	<b>YIELD STRENGTH: 91,800</b>
	<b>Mn: 0.91</b>	<b>Al: 0.00</b>	<b>V: 0.00</b>	<b>ELONGATION: 21</b>
	<b>Si: 0.39</b>	<b>Ti: 0.01</b>	<b>Nb 0.02</b>	<b>REDUCTION: 42</b>
	<b>Ni: 0.61</b>	<b>S: 0.00</b>	<b>W: 0.01</b>	<b>BHN: 211</b>

**NOTES:** Lot code: 022

<b>HEAT#: B1953</b>	<b>Fe: 96.60</b>	<b>Cr: 0.58</b>	<b>P: 0.02</b>	<b>TENSILE STRENGTH: 113,847</b>
<b>QUANTITY: 154</b>	<b>C: 0.26</b>	<b>Mo: 0.25</b>	<b>Cu: 0.15</b>	<b>YIELD STRENGTH: 96,396</b>
	<b>Mn: 0.80</b>	<b>Al: 0.00</b>	<b>V: 0.00</b>	<b>ELONGATION: 20</b>
	<b>Si: 0.41</b>	<b>Ti: 0.02</b>	<b>Nb 0.04</b>	<b>REDUCTION: 41</b>
	<b>Ni: 0.54</b>	<b>S: 0.01</b>	<b>W: 0.03</b>	<b>BHN: 217</b>

**NOTES:** Lot code: 021

<b>HEAT#: B1954</b>	<b>Fe: 97.00</b>	<b>Cr: 0.60</b>	<b>P: 0.01</b>	<b>TENSILE STRENGTH: 116,416</b>
<b>QUANTITY: 153</b>	<b>C: 0.25</b>	<b>Mo: 0.25</b>	<b>Cu: 0.15</b>	<b>YIELD STRENGTH: 100,640</b>
	<b>Mn: 0.79</b>	<b>Al: 0.00</b>	<b>V: 0.00</b>	<b>ELONGATION: 20</b>
	<b>Si: 0.37</b>	<b>Ti: 0.01</b>	<b>Nb 0.02</b>	<b>REDUCTION: 38</b>
	<b>Ni: 0.52</b>	<b>S: 0.00</b>	<b>W: 0.01</b>	<b>BHN: 211</b>

**NOTES:** Lot code: 023ISO 9001:2000  
FAB 82067

Page 1 of 1

P:\EPCP\QUALITY RECORDS\QR 36 - MATERIAL CERTIFICATION.RPT

A.J. Menefee

01/29/2008

**HOOK  
5IK**



**SHERRY Laboratories**

Testing Today - Protecting Tomorrow®

Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1116

Tel: 918-258-6068  
800-682-8378  
Fax: 918-258-1154

**LABORATORY REPORT**

Attn: Bucky Weaver  
Crosby Group, Inc.  
P.O. Box 3128  
Tulsa, OK 74101

Report No.: 09100433-003-v1  
Date Received: 10/9/2008  
Date Reported: 10/15/2008  
P.O. No.: M-0816310

Sample Description: (1) Test Sample, 7 Ton Eye Hook, Material: 8630, Work Order No.: 373809, Part No.: 8017836,  
Pic Code: 5IK

**Tensile Test (Round) per ASTM E8-08**

Parameter	Result
Orientation	Longitudinal at 4/5 Radius
Diameter, Inch	0.503
Tensile Strength, psi	150,000
Yield Strength, psi at 0.2% offset	134,000
Elongation in 2 inch, %	15
Reduction of Area, %	57

**Rockwell Hardness Test per ASTM E18-08**

Parameter	Result
Location	Charpy
Reading 1	HRC 33
Reading 2	HRC 33
Reading 3	HRC 35

**Impact Test per ASTM A370-08/ASTM E23-07**

Testing Machine Capacity, lbs: 300  
Specimen Type: Charpy V Notch  
Specimen Location: ASTM A370-08  
Notch Orientation: Perpendicular to Surface  
Specimen Orientation: Longitudinal at 4/5 Radius  
Specimen Size: 10mm X 10mm  
Test Temperature °F: -40

Notch Location	Impact Values (Ft.-Lbs)	Lateral Expansion (Mils)	Shear (%)
Base	36, 36, 36	19, 20, 21	75, 65, 75

Comments: Absorbed energy values above 80% of the scale range are approximate; absorbed energies below 6 Ft.-Lbs. (8 Joules) are outside of verified range.

Approved by: \_\_\_\_\_

Jeffrey Simmons, Laboratory Director  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. A2LA Accredited Laboratory Certificate No. 1089-01 (Mechanical) & 1089-02 (Chemical).

Hook of S1320 7t 5/8" Grade 100 Eye Hoist Hook (JA) with PIC: 5IK and Heat #: 11820220

THIS MATERIAL CERTIFICATE DOCUMENT MEETS THE REQUIREMENT OF INSPECTION CERTIFICATE "TYPE 3.1" PER EN 10204

**CERTIFIED MATERIAL TEST REPORT**  
**GERDAU AMERISTEEL**  
Midlothian Mill  
300 Ward Road  
Midlothian, TX 76065  
(972) 775-8241

Order Date: 01/09/2008  
PO No: 58819\*  
Mill Order No: 3415838  
Load No: 1202269  
Manifest No: 1909340

Ship To: 2  
LEBUS MANUFACTURING  
900 FISHER ROAD  
LONGVIEW  
75604  
TX  
US

Bill To:  
LEBUS MANUFACTURING  
SUB CROSBY GROUP  
P.O. BOX 271  
LONGVIEW  
75606

PRODUCT  
ROUNDS

LENGTH  
18 FT 9 IN / 5.715 M

GRADE  
8630

SIZE  
1 5/8 ROUNDS / N/A

**SPECIFICATIONS**

ASTM A29-05, A322-06

HEAT NO: 11820220

CHEMICAL ANALYSIS									
C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn
.30	.79	.009	.011	.26	.25	.43	.49	.196	.009
									.036
									.001
									2.88

**PHYSICAL PROPERTIES**

Grain Size Practice: FINE GRAIN

SOUNDNESS - E381 CLEANLINESS

S R C OXIDE SILICATE

1 1 1 0 0

REDUCTION RATIO 20.4:1

**Remarks**

**HOOK  
5IK**

All manufacturing processes of this product, including electric arc melting and continuous casting, occurred in the U.S.A. CMTR complies with DIN EN 10204 3.1.B

"I hereby certify that the contents of this report are correct and accurate. All tests and operations performed by this material manufacturer or its sub-contractors, when applicable, are in compliance with the requirements of the material specifications and applicable purchaser designated requirements."

Signed: Tom L. Harrington Date: Jun. 20, 2008  
Tom L. Harrington: Quality Assurance Manager

Signed: Notary Public (if applicable)

Date: \_\_\_\_\_  
Page: 1 of 1





Sherry Laboratories  
3100 North Homlock Circle  
Broken Arrow, OK 74012-1115

TESTING TODAY, PROTECTING TOMORROW

WWW.SHERRYLABS.COM

Tel: 918-258-6086  
800-682-6378  
Fax: 918-258-1154

### LABORATORY REPORT

Attn: Bucky Weaver  
Crosby Group, Inc.  
P.O. Box 3128  
Tulsa, OK 74101

Report No.: 08110409-001-v1  
Date Received: 11/11/2008  
Date Reported: 11/17/2008  
P.O. No.: M-0818893

Sample Description: (1) Sample, 7 Ton Eye Hook API 2C, Material: 8830, Order No.: 376369, Part No.: 8017836, Plc Code: 81J

#### Tensile Test (Round) per ASTM E8-08

Parameter	Result
Orientation	Longitudinal at 4/5 Radius
Diameter, Inch	0.350
Tensile Strength, psi	148,000
Yield Strength, psi at 0.2% offset	128,000
Elongation in 1.4 Inch, %	18
Reduction of Area, %	58

#### Rockwell Hardness Test per ASTM E18-08

Parameter	Result
Location	Charpy
Reading 1	HRC 32
Reading 2	HRC 32
Reading 3	HRC 32


#### Impact Test per ASTM A370-08/ASTM E23-07

Testing Machine Capacity, lbs: 300  
Specimen Type: Charpy V Notch  
Specimen Location: ASTM A370-08  
Notch Orientation: Perpendicular to Surface  
Specimen Orientation: Longitudinal at 4/5 Radius  
Specimen Size: 10mm X 10mm  
Test Temperature °F: -40

Notch Location	Impact Values (Ft.-Lbs)	Lateral Expansion (Mils)	Shear (%)
Base	26, 24, 34	14, 12, 19	50, 50, 60

Comments: Absorbed energy values above 80% of the scale range are approximate; absorbed energies below 6 Ft.-Lbs. (8 Joules) are outside of verified range.

Approved by:

  
Jeffrey Simmonds, Laboratory Director  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. A2LA Accredited Laboratory Certificate No. 1089-01 (Mechanical) & 1089-02 (Chemical).

Hook of S1320 7t 5/8" Grade 100 Eye Hoist Hook (JA) with PIC: 5IJ and Heat #: 11823680

THIS MATERIAL CERTIFICATE DOCUMENT MEETS THE REQUIREMENT OF INSPECTION CERTIFICATE "TYPE 3.1" PER EN 10204

**CERTIFIED MATERIAL TEST REPORT**  
GERDAU AMERISTEEL  
Midlothian Mill  
300 Ward Road  
Midlothian, TX 76065  
(972)775-8241

Order Date: 04/03/2008  
PO No: 58951\*  
Mill Order No: 3463908  
Load No: 1212449  
Manifest No: 1918619

Ship To: 2  
LEBUS MANUFACTURING  
900 FISHER ROAD  
LONGVIEW  
75604

Bill To:  
LEBUS MANUFACTURING  
SUB CROSBY GROUP  
P.O. BOX 271  
LONGVIEW  
75606

TX  
US

TX  
US

PRODUCT  
ROUNDS

LENGTH  
19 FT 7 IN / 5.969 M

GRADE  
8630

SIZE  
1 3/8 ROUNDS / N/A

SPECIFICATIONS

ASTM A29-05, A322-06

HEAT NO: 11823680

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Al	Nb	DI
.29	.75	.016	.008	.24	.30	.52	.53	.229	.009	.004	.037	.003	3.08

PHYSICAL PROPERTIES

Grain Size Practice: FINE GRAIN

SOUNDNESS - E381 CLEANLINESS

S R C OXIDE SILICATE

1 1 1 0 0

Remarks

REDUCTION RATIO 28.4:1

**HOOK  
5IJ**

All manufacturing processes of this product, including electric arc melting and continuous casting, occurred in the U.S.A. CMTR complies with DIN EN 10204 3.1.B

"I hereby certify that the contents of this report are correct and accurate. All tests and operations performed by this material manufacturer or its sub-contractors, when applicable, are in compliance with the requirements of the material specifications and applicable purchaser designated requirements."

Signed: *Tom L. Harrington* Date: Aug. 05, 2008  
Tom L. Harrington: Quality Assurance Manager

Signed: \_\_\_\_\_ Date: \_\_\_\_\_  
Notary Public (if applicable)

Date: \_\_\_\_\_  
Page: 1 of 1

LRG. BOLT  
IBHC



## SHERRY Laboratories

Testing Today - Protecting Tomorrow®

Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1115

Tel: 918-258-8088  
800-962-8378  
Fax: 918-258-1154

### LABORATORY REPORT

Attn: Bucky Weaver  
Crosby Group, Inc.  
P.O. Box 3128  
Tulsa, OK 74101

Report No.: 08101288-001-v1  
Date Received: 10/30/2008  
Date Reported: 11/5/2008  
P.O. No.: M-0816466

Sample Description: (1) Sample, 1.25" Bar API 2C, Material: 4140, Order No.: 374561, Part No.: 2015011, Pic Code: IBHC

#### Tensile Test (Round) per ASTM E8-08

Parameter	Result
Orientation	Longitudinal at 4/5 Radius
Diameter, inch	0.505
Tensile Strength, psi	144,000
Yield Strength, psi at 0.2% offset	129,000
Elongation in 2 inch, %	19
Reduction of Area, %	58

#### Rockwell Hardness Test per ASTM E18-08

Parameter	Result
Location	Charpy
Reading 1	HRC 30
Reading 2	HRC 29
Reading 3	HRC 30

#### Impact Test per ASTM A370-08/ASTM E23-07

Testing Machine Capacity, lbs: 254  
Specimen Type: Charpy V Notch  
Specimen Location: ASTM A370-08  
Notch Orientation: Perpendicular to Surface  
Specimen Orientation: Longitudinal at 4/5 Radius  
Specimen Size: 10mm X 10mm  
Test Temperature °F: -25

Notch Location	Impact Values (Ft.-Lbs)	Lateral Expansion (Mils)	Shear (%)
Base	71, 70, 64	42, 37, 39	100, 100, 100

Comments: Absorbed energy values above 80% of the scale range are approximate; absorbed energies below 5 Ft.-Lbs. (8 Joules) are outside of verified range.

Approved by:

  
Jeffrey Simmons, Laboratory Director  
Sherry Laboratories

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. AZLA Accredited Laboratory Certificate No. 1089-01 (Mechanical) & 1089-02 (Chemical).

# CERTIFICATE OF TEST



LRG-BOLT  
IBHC

Page 01 of 02

Certification Date  
26-SEP-2008

## CUSTOMER ORDER NUMBER

M-0813749

7311 E. PINE STREET  
TULSA OK 74115

Invoice Number  
T589753

## CUSTOMER PART NUMBER

2017970

Ship# T723245

SOLD TO: MCKISSICK PRODUCTS CO

SHIP TO:

MCKISSICK PRODUCTS CO

P O BOX 3128  
TULSA OK 741013128

2801 DAWSON RD GATE 5  
TULSA OK 74110

Description: 4142 CF HEAT TREATED S/R OR STRESS FREE BAR  
1-1/4 RD X 12' R/L !!!CUT ORDER!!! Line Total: 2880 IN  
HEAT: M28634 ITEM: 506040

## Specifications:

ASTM A434 CL BC 06  
ASTM E10  
ASTM E381

ASTM A193 GR B7 07  
ASTM A255  
ASTM E8

ASTM E112  
ASTM A304  
ASTM A370

## CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO
0.41	0.88	0.011	0.024	0.25	0.08	0.95	0.17
CU	SN	AL	V	NB			
0.22	0.007	0.024	0.006	0.002			

RCPT: R522626

MILL : MACSTEEL (CF ALLOY)

COUNTRY OF ORIGIN : USA

## MECHANICAL PROPERTIES

DESCRIPTION	YLD STR KSI	ULT TEN KSI	%ELONG IN 02 IN	%RED IN AREA	HARDNESS BHN
	131.0	141.0	41.0	55.0	311

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on the certificate. All test results remain on file subject to examination.

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

Material did not come in contact with mercury while in our possession.

MARVIN FOSTER

Manager, Quality Assurance

# CERTIFICATE OF TEST



LRG. BOLT  
IBHC

Page 02 of 02

Certification Date  
26-SEP-2008

## CUSTOMER ORDER NUMBER

M-0813749

7311 E. PINE STREET  
TULSA OK 74115

Invoice Number  
T589753

## CUSTOMER PART NUMBER

2017970

Ship# T723245

SOLD TO: MCKISSICK PRODUCTS CO

SHIP TO:

MCKISSICK PRODUCTS CO

P O BOX 3128  
TULSA OK 741013128

2801 DAWSON RD GATE 5  
TULSA OK 74110

Description: 4142 CF HEAT TREATED S/R OR STRESS FREE BAR  
1-1/4 RD X 12' R/L !!!CUT ORDER!!! Line Total: 2880 IN

HEAT: M28634 ITEM: 506040

END-QUENCH HARDENABILITY (JOMINY - RC)

1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
57	57	57	57	57	57	56	54	53	52	49	47	45	44	44
24	28	32												
42	39	37												

GRAIN SIZE :5 - 8

VACUUM DEGASSED MATERIAL IS FREE FROM MERCURY CONTAMINATION  
NO WELD REPAIR PERFORMED ON MATERIAL  
THERMAL TREATMENT: OK  
AUST. TEMP 1640 DEG F TIME (MIN.) 0.80  
TEMPER TEMP 1390 DEG F TIME (MIN.) 0.80  
MACRO: OK

## COMMENTS

RED. RATIO 27.2 TO 1.0  
100% MELTED & MFG IN USA

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on the certificate. All test results remain on file subject to examination.

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

Material did not come in contact with mercury while in our possession.

MARVIN FOSTER

*Marvin Foster*  
Manager, Quality Assurance

**McKISSICK** P.O. BOX 3128 TULSA, OK. 74101

**the Crosby group inc.**

TELEPHONE 918/834-4611  
TELEX 262569 CRSBY UR  
FAX 918/834-9447

CROSBY - MCKISSICK  
2857 DAWSON RD  
TULSA, OK 74110

**CERTIFICATE OF NONDESTRUCTIVE TESTING**

\*\*\*\*\*

INSPECTION PERFORMED ON: 19 PC(S)- API 2C MB07T200E UB500 7 TON OVERHAUL BALL

TESTING SERIAL NO: 09-849-20 Thru 09-849-38

CROSBY W/O ORDER NO: 730174

TEST PERFORMED:

\_\_\_\_\_ ULTRASONIC INSPECTION PER ASTM A-609.

✓✓✓ \_\_\_\_\_ MAGNETIC PARTICLE INSPECTION PER ASTM E-709.

✓✓✓ \_\_\_\_\_ WET METHOD \_\_\_\_\_ DRY METHOD

DEFECTS AND DISPOSITION: NO REJECTABLE INDICATIONS FOUND.

**PART NO: 8009632**

**PICS:**

SWIVEL UPPER EYE - 81J (09-849-20,23,32-36,38)	SWIVEL UPPER EYE - 160 (09-849-21,22)
SWIVEL UPPER EYE - 160 (09-849-24-26,28-31,37)	SWIVEL UPPER EYE - 20J (09-849-27)
SWIVEL LOWER EYE - 093 (09-849-20)	SWIVEL LOWER EYE - 011 (09-849-21)
SWIVEL LOWER EYE - E105 (09-849-22)	SWIVEL LOWER EYE - 097 (09-849-23)
SWIVEL LOWER EYE - 005 (09-849-24)	SWIVEL LOWER EYE - 114 (09-849-25)
SWIVEL LOWER EYE - 065 (09-849-26)	SWIVEL LOWER EYE - 036 (09-849-27)
SWIVEL LOWER EYE - 106 (09-849-28,30,31,34,37)	SWIVEL LOWER EYE - 098 (09-849-29,36)
SWIVEL LOWER EYE - 068 (09-849-32)	SWIVEL LOWER EYE - 108 (09-849-33)
SWIVEL LOWER EYE - 109 (09-849-35)	SWIVEL LOWER EYE - 056 (09-849-38)
SWIVEL BASE PLUG - 22 (09-849-20-31,36-38)	SWIVEL BASE PLUG - 21 (09-849-32-35)
HOOK - 5IK (09-849-20,21,32-34)	HOOK - 5IJ (09-849-22-31,35-38)
LARGE BOLT - IBHC (09-849-20-38)	

WE CERTIFY THAT THE INDICATED INSPECTIONS WERE PERFORMED ON THE DESCRIBED MATERIAL.

DATE: 01/13/09

BY:

Chris Ballance

CHRIS BALLANCE, INSPECTOR LEVEL II

*products of uncompromising quality . . .*

CROSBY Clips & fittings, LEBUS Load Binders, McKISSICK Blocks & Sheaves, CROSBY - WESTERN Blocks, NATIONAL Swaging System

Plants and facilities in : Jacksonville, Arkansas - Los Angeles, California - Atlanta, Georgia - Chicago, Illinois - Tulsa, Oklahoma - Harrisburg, Pennsylvania  
Dallas, Texas - Longview, Texas - Seattle, Washington - Toronto (Brampton), Ontario - Barnsley, England - Mechelen (Putte), Belgium - Cergy St. Christophe, France

Constructora  
Subacuatica Diavas,  
S.A. de C.V.

# Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

## Nautilus Crane Model 180L4-50

### Section 9.0

### Backlash Report



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA





## BACKLASH REPORT

### PINION/BALLRING

CRANE SERIAL NUMBER: 21409 RightSide


BACKLASH TOP: .026" BOTTOM: .026"

ALIGNMENT

X1	1 9/16"	, X2	1 9/16"	L	11 3/4"	SLOPE X=	$\frac{X2-X1}{L}$	=	0
Y1	1 9/16"	, Y2	1 9/16"	L	11 3/4"	SLOPE Y=	$\frac{Y2-Y1}{L}$	=	0

ARE BOLTS (TURRET OR UPPERSTRUCTURE/ BALLRING) IN PLACE? X YES      NO

DATE: 12/14/09

ACCEPTABLE: mitch  Derda

NOT ACCEPTABLE:





## BACKLASH REPORT

### PINION/BALLRING

CRANE SERIAL NUMBER: 21409 Rightside

BACKLASH TOP: .020" BOTTOM: .020"

#### ALIGNMENT

X1 1 29/32", X2 1 29/32" L 11 3/4" SLOPE X =  $\frac{X2-X1}{L} = \underline{0}$   
Y1 1 29/32", Y2 1 29/32" L 11 3/4" SLOPE Y =  $\frac{Y2-Y1}{L} = \underline{0}$

ARE BOLTS (TURRET OR UPPERSTRUCTURE/ BALLRING) IN PLACE? ☒ YES ☐ NO

DATE: 1/15/10

ACCEPTABLE:

Cory Ford

NOT ACCEPTABLE: \_\_\_\_\_



## BACKLASH REPORT

### PINION/BALLRING

CRANE SERIAL NUMBER: 21409 Left Side

BACKLASH TOP: .019" BOTTOM: .019"

ALIGNMENT

X1	<u>1 28/32"</u>	X2	<u>1 28/32"</u>	L	<u>11 3/4"</u>	SLOPE X =	$\frac{X2-X1}{L}$	=	<u>0</u>
Y1	<u>1 28/32"</u>	Y2	<u>1 28/32"</u>	L	<u>11 3/4"</u>	SLOPE Y =	$\frac{Y2-Y1}{L}$	=	<u>0</u>

ARE BOLTS (TURRET OR UPPERSTRUCTURE/ BALLRING) IN PLACE? ☒ YES ☐ NO

DATE: 1/15/10

ACCEPTABLE: 

NOT ACCEPTABLE: \_\_\_\_\_



Constructora  
Subacuatica Diavas,  
S.A. de C.V.

## Vendor Data Book

P.O. # ORDPE/7732  
Serial # 21409C  
Volume 1

### Nautilus Crane Model 180L4-50

#### Section 10.0

#### Miscellaneous

-Certificate of Leak Test

-Paint Logs

-Straightness Check



SKAGIT SMATCO  
1180 MULBERRY ROAD  
HOUMA, LA 70363  
USA



# Certificate of Leak Test

Vessel Description: Return Manifold

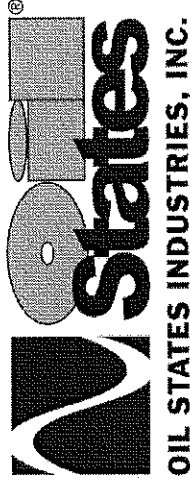
Oil States Industries, Inc. Work Order Number: 21409

Test Pressure (PSIG): 45 LBS

Test Date: 1/8/2010

It is hereby certified that:

- The referenced vessel has been pressure tested to the recorded value in accordance with NES184-051 Vessel Leak Test work instruction (bubble method).
- The test has proven the vessel to be free of leaks.
- The test was performed correctly and it is accurately recorded.



  
Quality Inspector

# Certificate of Leak Test

Vessel Description: Power Unit

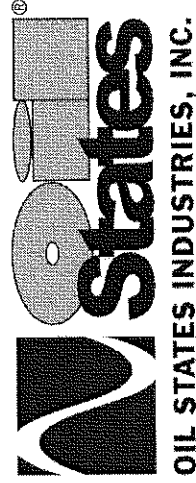
Oil States Industries, Inc. Work Order Number: 21409

Test Pressure (PSIG): 2 ½ lbs

Test Date: 12/23/09

It is hereby certified that:

- The referenced vessel has been pressure tested to the recorded value in accordance with NES184-051 Vessel Leak Test work instruction (bubble method).
- The test has proven the vessel to be free of leaks.
- The test was performed correctly and it is accurately recorded.



*Mitchell*  
Quality Inspector

# Certificate of Leak Test

Vessel Description: Suction Lines

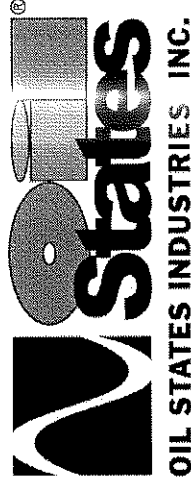
Oil States Industries, Inc. Work Order Number: 21409

Test Pressure (PSIG): 2 ½ lbs

Test Date: 12/9/09

It is hereby certified that:

- The referenced vessel has been pressure tested to the recorded value in accordance with NES184-051 Vessel Leak Test work instruction (bubble method).
- The test has proven the vessel to be free of leaks.
- The test was performed correctly and it is accurately recorded.



*Midgarden*  
Quality Inspector

# Certificate of Leak Test

Vessel Description: Return Filter Piping

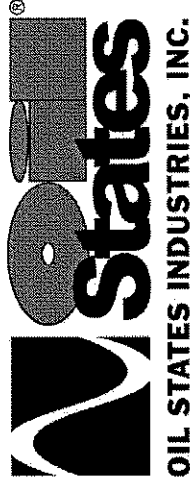
Oil States Industries, Inc. Work Order Number: 21409

Test Pressure (PSIG): 45 lbs

Test Date: 2/5/10

It is hereby certified that:

- The referenced vessel has been pressure tested to the recorded value in accordance with NES184-051 Vessel Leak Test work instruction (bubble method).
- The test has proven the vessel to be free of leaks.
- The test was performed correctly and it is accurately recorded.

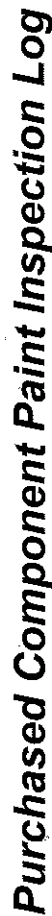


*Mitchell*  
Quality Inspector





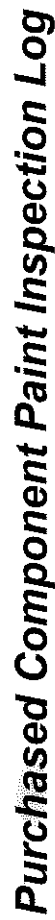
**THIS PAGE INTENTIONALLY LEFT BLANK**



11/4/09 13:17

<u>Coat 1</u> CarboGuard 890	<u>Coat 2</u> Carbothane 134 HG	<u>Coat 3</u> N/A	<u>Coat 4</u> N/A
<u>Color</u>	3694		
<u>DFT</u> 6 - 8 Mils	2 - 3 Mils		
<u>Surface Prep:</u> SP 1, 2, 3	<u>Profile:</u> A/R	<b>Total Millage:</b> 8 - 11 MILS	

**NOTE:** All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated



11/4/09 13:17

**NOTE: All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated**



**Statco**  
No. 22  
Reading 2.0  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

Work Order: 21409.20

**Statco**  
No. 2.9  
Reading 2.9  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.6  
Reading 2.6  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.7  
Reading 2.7  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.9  
Reading 2.9  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

## Structural Paint Inspection Log

**Statco**  
No. 2.9  
Reading 2.9  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.8  
Reading 2.8  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

Approved: CAT 11/4/09 13:17

Blast										First Coat				
Weldment	Date	Time	Air Temp	Surf. Temp	Dew Point	Hum	Profile	Date	Time	Air Temp	Surf. Temp	Dew Point	Hum	DFT
UPPER STRUCTURE	1-4	10:00am	64°	68°	58°	54%	2.8	1-5	10:30am	50°	52°	49°	46%	2.3
POWER PLANT	1-4	10:00am	64°	68°	58°	54%	3.1	1-5	10:30am	50°	52°	44°	46%	2.3
CAB	1-4	10:00am	64°	68°	58°	54%	2.7	1-5	10:30am	50°	52°	44°	46%	2.3
MID SECTION	1-4	10:00am	64°	68°	58°	54%	2.6	1-5	10:30am	50°	52°	44°	46%	2.3
GAUZE	1-4	10:00am	64°	68°	58°	54%	2.9	1-5	10:30am	50°	52°	44°	46%	2.3
WALKWAYS	1-6	3:00pm	68°	70°	32°	32%	2.9	1-7	11:00am	64°	66°	52°	50%	2.3
BRACKET PARTS	1-8	3:00pm	68°	64°	32°	44%	2.2	1-9	1:50pm	60°	62°	52°	48%	2.3
CONTACT STATION	1-6	3:00pm	68°	70°	32°	32%	2.7	1-7	11:00am	64°	66°	52°	50%	2.3
BOOM BASE	1-7	3:00pm	60°	66°	48°	52%	2.6	1-9	1:50pm	60°	62°	52°	48%	2.3
BOOM TIP	1-29	9:00am	62°	64°	52°	52%	2.9	1-26	11:50am	66°	68°	54°	54%	2.3
BRIDGE	1-2	3:00pm	68°	70°	32°	32%	2.8	1-7	11:00am	64°	66°	52°	50%	2.3
LAOBBE BARREL	1-7	3:00pm	60°	66°	48°	52%	2.5	1-9	1:50pm	60°	62°	52°	48%	2.3
PEDESTAL & B.P.	1-16	11:00am	58°	62°	50°	52%	2.7	1-18	9:00am	62°	64°	52°	50%	2.3

Coat 1 Carbozinc 859

Coat 2 Carboguard 893 Epc

Coat 3 Carbothane 134 HG

Coat 4 N/A

Color

DFT 2.5 - 3 Milis

Surface Prep: SP 10

4 - 6 Milis

1 - 2 Milis

2 - 3 Milis

Total Millage: 8.5 - 12 Milis

3694

**Statco**  
No. 2.8  
Reading 2.8  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.2  
Reading 2.2  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

All items which are chromed and/or stainless steel (other than diesel and hydraulic)

**Statco**  
No. 2.7  
Reading 2.7  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**Statco**  
No. 2.7  
Reading 2.7  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

Form No: SS3R-0032  
Date 3/1/05



# Structural Paint Inspection Log

Work Order:

21409.20

Approved: CAT 11/4/09 13:17

**3-0 PRESS-O-FILM™** Made in USA  
TESTEX NEWARK, DE 19715  
Reading: 2.5  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

**L-0 PRESS-O-FILM™** Made in USA  
TESTEX NEWARK, DE 19715  
Reading: 2.5  
Gage less 2.0 mils  
or 50 µm  
X COARSE (1.5 to 4.5 mils) or (40 to 115 µm)

Weldment	Second Coat							Third Coat						
	Date	Time	Air Temp	Surf. Temp	Dew Point	Hum	DFT	Date	Time	Air Temp	Surf. Temp	Dew Point	Hum	DFT
UPPER STRUCTURES	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	9-10
POWER UNIT	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	9-10
CAB	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	10-11
MID SECTION	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	10-11
GALLERY	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	11-12
WALKWAYS	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	10-11
BRACKET PANTS	1-10	8:30 AM	62°	64°	54°	46%	6-7	1-10	12:25 PM	62°	64°	54°	46%	9-10
CONTROL STATION	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	10-11
BOOM BASE	1-10	8:30 AM	62°	64°	54°	46%	6-7	1-10	12:25 PM	62°	64°	54°	46%	9-10
BOOM TIP	2-1	9:30 AM	58°	62°	52°	48%	6-7	2-2	11:35 AM	66°	68°	54°	46%	9-10
BARREL	1-7	8:15 PM	68°	70°	54°	56%	7-8	1-8	5:50 PM	62°	64°	52°	44%	10-11
UPPER BARREL	1-10	8:30 AM	62°	64°	54°	46%	6-7	1-10	12:25 PM	62°	64°	54°	46%	9-10
REDUCED BARREL	1-10	10:30 AM	58°	62°	50°	52%	6-7	1-10	12:25 PM	62°	64°	52°	44%	9-10
PEDESTAL	1-18	11:15 AM	62°	64°	52°	50%	6-8	1-19	8:00 AM	64°	66°	54°	50%	9-10

Coat 1 Carbozinc 859

Coat 2

Carboguard 893 Epoxy

Coat 3

Carbothane 134 HG

Coat 4 N/A

Color

DFT 2.5 - 3 Mil

4 - 6 Mil

2 - 3 Mil

0

Surface Prep: SP 10

Profile: 1 - 2 Mil

Total Millage: 8.5 - 12 Mil

NOTE: All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated



11/4/09 13:17

Coat 4 N/A

3694

4 - 6 Mils

2-3 Mils

**Profile:** 1 - 2 Mils

**Total Millage: 8.5 - 12 Mils**

**NOTE: All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated**



11/4/09 13:17

Coat 1 Thermaline 4700 Alu Coat 2 Thermaline 4700 Alu

**Total Millage: 2 - 3 Mils**

 $\frac{A}{N}$ 

**NOTE:** All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated

Form No: SS3R-0081  
Date 3/1/05



11/4/09 13:17

<u>Coat 1</u>	<u>Thermaline 4700 Alti</u>	<u>Coat 2</u>	<u>Thermaline 4700 Aluminum</u>	<u>Coat 3</u>	<u>N/A</u>	<u>Coat 4</u>	<u>N/A</u>
<u>Color</u>	0	0				0	0
<u>DFT</u>	1 - 1.5 Mils	1 - 1.5 Mils				0	N/A
<b>Surface Prep:</b> SP10		<b>Profile:</b> 1 - 1.5 Mils		<b>Total Millage:</b> 2 - 3 Mils			

**NOTE:** All items which are chromed and/or stainless steel (other than diesel and hydraulic reservoirs) will not be blasted or coated

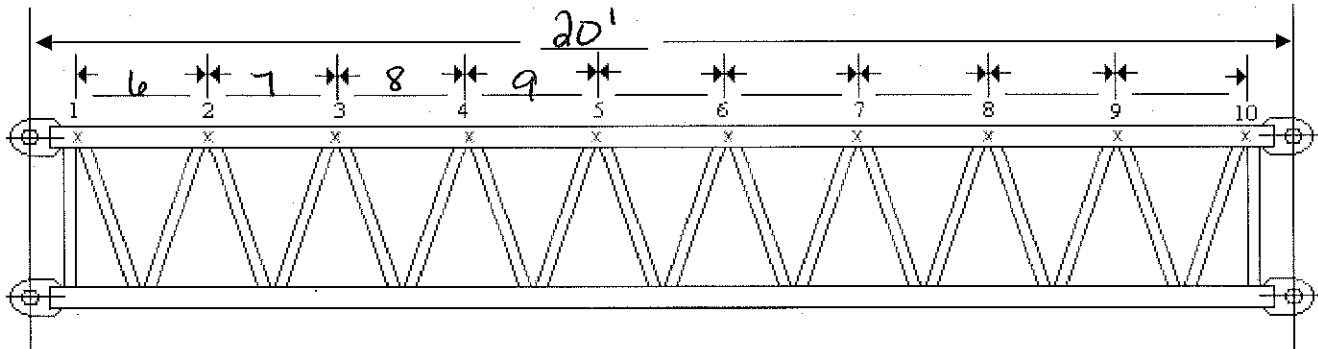




**THIS PAGE INTENTIONALLY LEFT BLANK**



## MAIN CHORD STRAIGHTNESS CHECK



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TOP RIGHT	A	0	1/32	0	0	0	0	3/64	1/32	3/32							
	B	0	0	1/32	0	0	1/64	1/64	3/64	3/64							
TOP LEFT	A	0	1/32	1/32	1/32	0	0	1/32	1/32	3/64							
	B	0	1/32	1/32	1/32	0	0	1/32	1/32	1/32							
BOTTOM RIGHT	A	0	1/32	1/16	3/64	0	0	1/16	1/16	1/32							
	B	0	1/32	3/64	1/64	0	0	1/32	1/32	0							
BOTTOM LEFT	A	0	3/32	3/32	1/32	0	3/64	1/16	1/32	0							
	B	0	0	1/64	1/32	0	0	1/32	3/64	1/32							

BOOM  
CONSTRUCTION

<p>1</p>	<p>2</p>
<p>3</p>	<p>4 OTHER:</p>

Weldment Type: 20' Boom Tip

Weldment Serial Number: C09247-05

Crane Serial Number: 21409

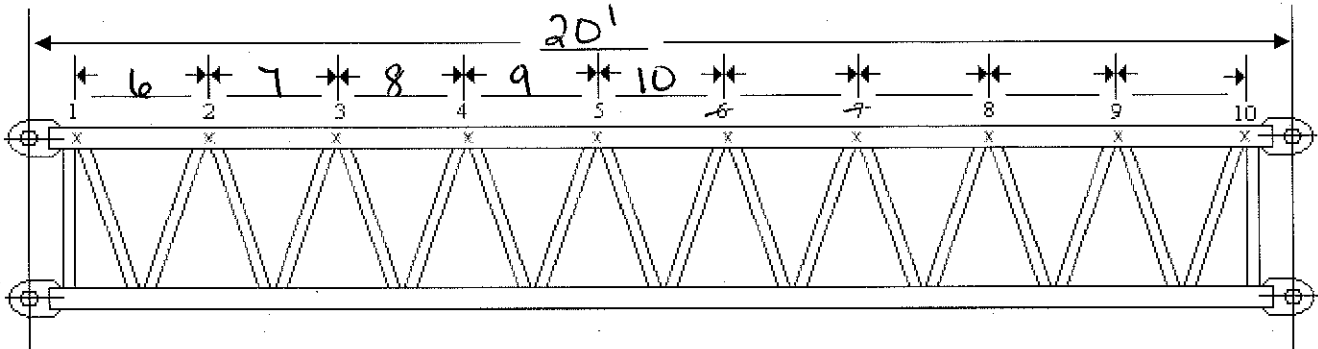
Crane Model Number: 180L4-50

Inspected by: mitch [signature]

Date Inspected: 11-20-09



## MAIN CHORD STRAIGHTNESS CHECK



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TOP RIGHT	A	0	$\frac{3}{164}$	$\frac{3}{164}$	$\frac{1}{116}$	$\frac{1}{32}$	0	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{32}$	0						
	B	0	$\frac{3}{164}$	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{3}{164}$	$\frac{3}{164}$	$\frac{1}{116}$	$\frac{1}{32}$	0						
TOP LEFT	A	0	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{32}$	0	$\frac{1}{164}$	0	0	$\frac{1}{32}$	0						
	B	0	$\frac{1}{164}$	0	0	0	0	$\frac{3}{164}$	$\frac{1}{164}$	0	0						
BOTTOM RIGHT	A	0	0	$\frac{1}{32}$	$\frac{1}{116}$	$\frac{3}{164}$	$\frac{1}{32}$	0	$\frac{1}{32}$	$\frac{3}{164}$	0						
	B	0	0	$\frac{1}{164}$	0	$\frac{1}{32}$	0	$\frac{1}{116}$	$\frac{1}{164}$	$\frac{3}{164}$	0						
BOTTOM LEFT	A	0	$\frac{1}{164}$	0	$\frac{1}{164}$	0	0	$\frac{1}{164}$	$\frac{3}{164}$	$\frac{1}{32}$	0						
	B	0	0	0	$\frac{3}{164}$	$\frac{1}{32}$	0	0	0	$\frac{1}{32}$	0						

BOOM  
CONSTRUCTION

<p>1</p>	<p>2</p>
<p>3</p>	<p>4 OTHER:</p>

Weldment Type: 20' Boom Base

Weldment Serial Number: C09247-03

Crane Serial Number: 21409

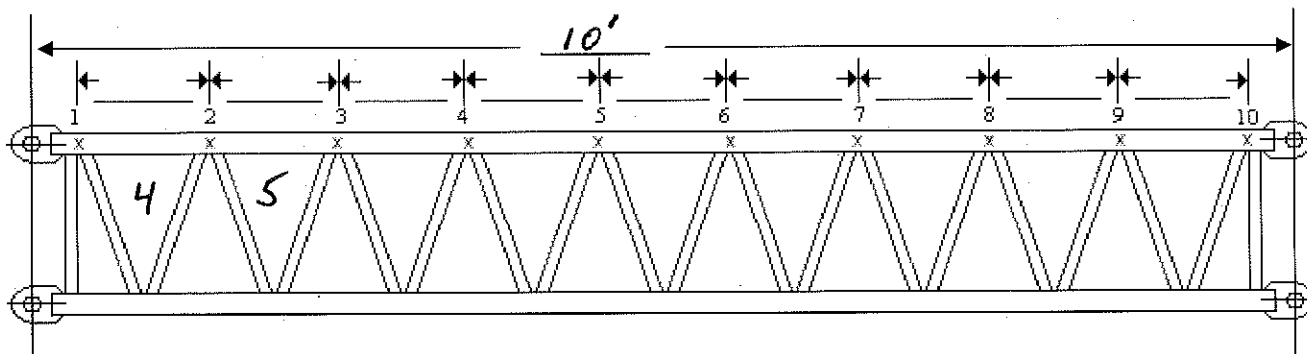
Crane Model Number: 18DL4-50

Inspected by: match Onda

Date Inspected: 11-21-09



## MAIN CHORD STRAIGHTNESS CHECK



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TOP RIGHT	A	0	0	0	0	0											
	B	0	0	0	0	0											
TOP LEFT	A	0	+3/64"	0	+1/64"	0											
	B	0	0	0	0	0											
BOTTOM RIGHT	A	0	0	0	-1/32"	0											
	B	0	0	0	0	0											
BOTTOM LEFT	A	0	0	0	0	0											
	B	0	0	0	0	0											

BOOM  
CONSTRUCTION

<p>1</p>	<p>2</p>
<p>3</p>	<p>4 OTHER:</p>

Weldment Type: 10' Lattice Boom mid

Weldment Serial Number: C09247-04

Crane Serial Number: 21409

Crane Model Number: 180L4

Inspected by: Karla S. [Signature]

Date Inspected: 10/23/09