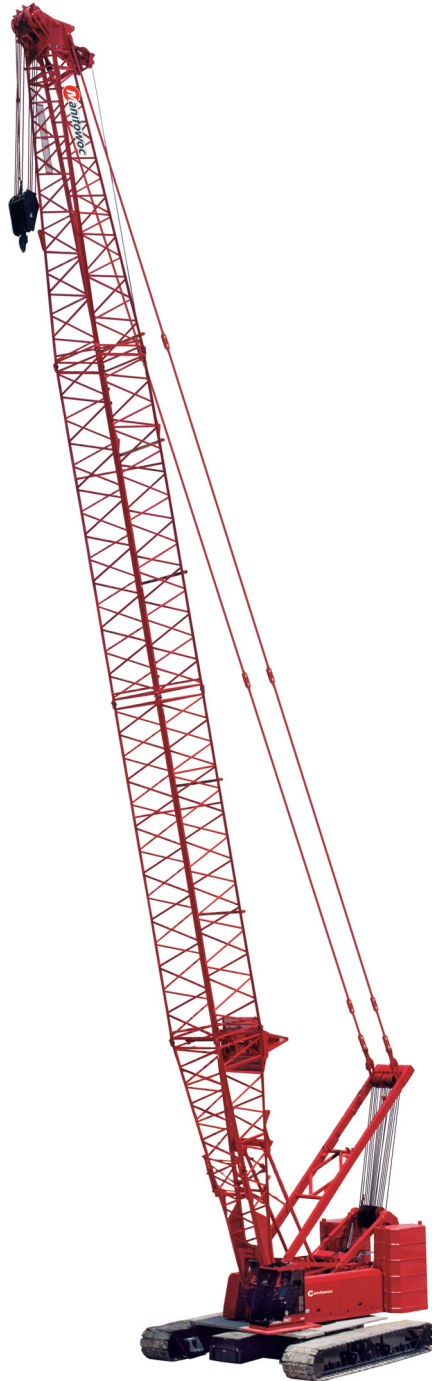


Manitowoc 999

Operator Manual





OPERATOR MANUAL

This manual has been prepared for and is considered part of -

999

Crane Model Number

XXXXXRef

Crane Serial Number

This Manual is divided into the following sections:


SECTION 1	INTRODUCTION
SECTION 2	SAFETY INFORMATION
SECTION 3	OPERATING CONTROLS AND PROCEDURES
SECTION 4	SETUP AND INSTALLATION
SECTION 5	LUBRICATION
SECTION 6	MAINTENANCE CHECKLIST

NOTICE

The serial number of the crane and applicable attachments (i.e. luffing jib, MAX-ER[®]) is the only method your Manitowoc dealer or the Manitowoc Crane Care Lattice Team has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator's cab and each attachment. Refer to the Nameplate and Decal Assembly Drawing in Section 2 of this manual for the exact location of the crane identification plate.

Always furnish serial number of crane and its attachments when ordering parts or discussing service problems with your Manitowoc dealer or the Manitowoc Crane Care Lattice Team.

	! WARNING
	<p>To prevent death or serious injury:</p> <ul style="list-style-type: none">• Avoid unsafe operation and maintenance. Crane and attachments must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.• Do not operate or work on crane or attachments without first reading and understanding instructions contained in Operator Information Manual and Service Manual supplied with crane and applicable attachments.• Store Operator Information Manual and Service Manual in operator's cab. <p>If Operator Information Manual or Service Manual is missing from cab, contact your Manitowoc dealer for a new one.</p>

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

SECTION 1. Introduction

Crane Data 1-1
 Crane/Attachment Identification 1-1
 Change of Ownership Registration 1-1
 Manitowoc Dealer 1-1
 Crane Orientation 1-1
 Identification and Location of Components 1-2
 Boom Rigging 1-2
 Tier 3 Engine Components 1-4
 Tier 4 Engine Components 1-5
 Rotating Structure and Mast 1-8
 Lowerworks 1-15
 Operator’s Cab/Controls 1-16
 Right Side with Free Fall 1-17
 Outline Dimensions — From Side 1-18
 Outline Dimensions — From Front 1-19
 Crane Weights 1-20
 English and Metric Conversions 1-27
 Direct Conversion 1-27
 Inverse Conversion 1-27

SECTION 2. Safety Information

Continuous Innovation 2-1
 Nameplates and Decals 2-1
 Safety Messages 2-1
 General 2-1
 Safety Alert Symbol 2-1
 Signal Words 2-1
 Symbol Identification 2-1
 Safety and Information Signs 2-3
 Maintaining Signs 2-3
 Ordering Signs 2-3
 Crane Access Points 2-5
 General 2-5
 Getting On or Off Crane 2-5
 Operator Manual/Capacity Chart Storage 2-6
 General 2-6
 Storing Manuals 2-6
 Safe Operating Practices 2-7
 General 2-7
 Read Operator Manual 2-7
 Operator Qualifications 2-7
 Operator Conduct 2-7
 Handling Load 2-9
 Signals 2-12
 Safety Devices 2-13
 Operational Aids 2-13
 Category 1 Operational Aids 2-13
 Category 2 Operational Aids 2-14
 Assembling, Disassembling, or Operating Crane Near Electric Power and Transmission Lines 2-15
 Electrocution Hazard 2-15
 Set-Up and Operation 2-15
 Electrocution Hazard Devices 2-16
 Electrical Contact 2-16
 Refueling 2-17

Fire Extinguishers	2-17
Accidents	2-17
Safe Maintenance	2-17
Maintenance Instructions	2-17
Safe Maintenance Practices	2-17
Environmental Protection	2-19
Boom Disassembly Safety	2-20
General	2-20
Location	2-20
Pin Removal	2-20
Disassembly Precaution — #82 Boom	2-20
Disassembly Precaution — #22E/22EL Boom	2-22
Personnel Handling Policy	2-23
Pedestal/Barge Mounted Cranes	2-26
Pedestal Mounted Crane	2-26
Barge Mounted Crane	2-27
Capacity Charts	2-28
Shock Loading	2-28
Operation On Barge	2-28
Crane Inspection	2-29
Transporting Crane on Barge	2-29

SECTION 3 Operating Controls And Procedures

Standard Hand Signals for Controlling Crane Operations	3-2
Symbol Identification	3-4
Front Window Operation	3-11
Closing Window	3-11
Opening Window for Ventilation	3-11
Opening Window for Emergency Exit	3-11
Operating Controls	3-11
Controls Identification and Function	3-14
Seat Controls	3-30
Preparing Crane for Operation	3-31
Operation	3-31
Stopping Engine/ Leaving Crane Unattended	3-44
Calibration Procedures	3-44
Remote Controls	3-47
Controls Identification and Operation	3-47
Display Readings	3-48
Operating Conditions	3-48
Operating Limits	3-48
System Faults	3-49
Selecting Display Language	3-49
Crane Diagnostics	3-54
Drum 1 and 2 (Front and Rear Drum)	3-54
Drum 4 (Boom Hoist)	3-54
Drum 8 (Auxiliary)	3-54
FFall	3-54
Swing (Crane)	3-55
Swing Speed/Torque	3-55
Drum Slip	3-55
Track	3-55
RIN	3-55
Accessory System	3-56
Engine Throttle	3-56
A1 (Handles)	3-56

D1, D2, and D3 (Digital Outputs and Inputs) 3-57

Wind Conditions 3-62

Preparation for Cold Weather 3-64

 Crane Limitations 3-64

 Wire Rope 3-64

 Cold Weather Starting Aid 3-64

 Cooling System 3-64

 Battery 3-64

 Engine Oil 3-65

 Fuel Oil 3-65

 Gear Oil 3-65

 Hydraulic Oil 3-65

Cold Weather Heater Package 3-65

 Heaters – Past Production 3-65

 Heaters – Current Production Tier 3 3-67

 Heaters – Tier 4 Production 3-69

 Fuses – Past Production 3-71

 Fuses – Current Production 3-72

SECTION 4. Setup And Installation

Rigging Drawings 4-1

Optional Attachments 4-1

General Safety 4-1

Crane Orientation 4-1

Self-erecting Equipment 4-1

Assembly and Disassembly Notes 4-2

Assembly and Disassembly Area 4-2

Accessing Parts 4-2

Crane Weights 4-2

Retaining Connecting Pins 4-2

Pin and Connecting Hole Cleanliness 4-2

Hose and Cable Cleanliness 4-2

Connecting/Disconnecting Hydraulic Hoses, Air Lines, and Electric Cables 4-2

Cold Weather Mast Operation 4-3

Shipping Crane Components 4-4

Engine Exhaust Pipe 4-7

 Connecting Exhaust Pipe 4-7

 Disconnecting Exhaust Pipe 4-7

Crane Assembly 4-9

 General 4-9

 Operating Controls 4-9

 Pre-Start Checks 4-9

 Remove Crane from Trailer 4-10

 Raise Mast To Operating Position 4-12

 Install Assembly Block 4-14

 Install Crawlers 4-17

 Install Counterweight 4-20

 Assemble Boom and Jib 4-24

 Remove Boom Butt From Trailer 4-24

 Remove Assembly Block 4-24

 Install Boom Butt 4-26

 Connect #22E or #22EL Boom Butt To Boom 4-30

 Connect #82 Boom Butt To Boom 4-32

Pre-Raising Checks 4-34

Crane Disassembly 4-34

 General 4-34

Disconnect #22E or #22EL Boom Butt To Boom	4-36
Disconnect #82 Boom Butt From Boom	4-38
Remove Boom Butt	4-40
Install Assembly Block	4-44
Install Boom Butt On Trailer	4-44
Disassemble Boom	4-44
Remove Counterweight	4-44
Remove Crawlers	4-46
Remove Assembly Block	4-50
Lower Mast To Transport Position	4-50
Install Crane On Trailer	4-51
Auxiliary Load Drum Installation	4-52
Crane Modifications	4-52
Drum Installation	4-52
Hydraulic, Air, and Electric Connections	4-54
Wire Rope Installation	4-54
Butt Removal	4-54
Boom Ladder Assembly	4-54
General	4-54
Removal From Boom Butt	4-54
Installation On Boom Inserts	4-54
Storage In Boom Butt	4-54
Boom and Jib Rigging	4-56
Assist Crane Requirements	4-56
Blocked Crawlers	4-57
Handling Components	4-57
Rigging Assembly Drawings	4-57
Identifying Boom and Jib Components	4-58
Removable Diagonal Lacings (optional)	4-60
Boom Installation – #82HL	4-61
Boom Removal – #82HL	4-65
Removable Diagonal Lacings (optional)	4-69
Boom Installation – #82LR	4-70
Boom Removal	4-75
Lower Boom Point Installation – #22EL or #82HL Boom	4-80
Jib Installation – #134	4-83
Jib Removal – #134	4-89
Wire Rope Installation	4-90
Wire Rope Storage	4-90
Removing Wire Rope from Shipping Reel	4-90
Seizing and Cutting Wire Rope	4-90
Anchoring Wire Rope to Drum	4-91
Winding Wire Rope onto Drum	4-91
Anchoring Wire Rope to Wedge Socket	4-92
Anchoring Wire Rope to Button Socket	4-95
Breaking in Wire Rope	4-95
Pad Eye Usage for Wire Rope Reeving	4-95
General	4-95
Safety	4-95
Load Line Reeving	4-97
Wire Rope Specifications	4-97
Wire Rope Installation	4-97
Liftcrane – #22EL or #82HL Boom	4-97
Clamshell – #22EL or #82HL Boom	4-103
Liftcrane – #82 LR Boom	4-105
Liftcrane – #22E Boom with Light Tapered Top	4-107
Universal Anchor Joint	4-109

Load Block Tieback4-110
 Specifications4-110
 Boom Hoist Reeving4-111
 Wire Rope Installation4-111

SECTION 5..... Lubrication

Lubrication5-1
 Lube and Coolant Product Guide5-1

SECTION 6.....Maintenance Checklist

Inspection and Maintenance Checklist6-1
 Fiberglass Maintenance6-1

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 1 INTRODUCTION

TABLE OF CONTENTS

Crane Data	1-1
Crane/Attachment Identification	1-1
Change of Ownership Registration	1-1
Manitowoc Dealer	1-1
Crane Orientation	1-1
Identification and Location of Components	1-2
Boom Rigging	1-2
Tier 3 Engine Components	1-4
Tier 4 Engine Components	1-5
Rotating Structure and Mast	1-8
Lowerworks	1-15
Operator's Cab/Controls	1-16
Right Side with Free Fall	1-17
Outline Dimensions — From Side	1-18
Outline Dimensions — From Front	1-19
Crane Weights	1-20
English and Metric Conversions	1-27
Direct Conversion	1-27
Inverse Conversion	1-27

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 1 INTRODUCTION

CRANE DATA

See the end of this section for crane data specific to your crane:

- Basic Specifications
- EC Declaration (if applicable)

CRANE/ATTACHMENT IDENTIFICATION

An identification plate is attached to the outside of the operator's cab (**Figure 1-1**) and to the attachments (luffing jibs, MAX-ER's, and Ringers) available for this crane.

The crane or attachment model, application, and serial number are provided on the plate.

For the exact location of the identification plates on your crane and attachments, see the Nameplates and Decals Drawing in Section 2.

CHANGE OF OWNERSHIP REGISTRATION

If you are the new owner of a Manitowoc crane, please register it with Manitowoc Crane Care so we can contact you if the need arises.

1. Go to www.manitowoccranes.com
2. Go to Service > Manitowoc Crane Care > Service Information > Change of Ownership Form.
3. Complete the form.

MANITOWOC DEALER

For questions about this manual or the 999 crane, contact your Manitowoc dealer. If you do not know the contact information for your dealer, locate the Manitowoc dealer nearest you, as follows:

1. Go to www.manitowoccranes.com
2. Go to Dealer Locator.
3. Follow the on-screen prompts to locate your Manitowoc dealer.

CRANE ORIENTATION

The terms RIGHT, LEFT, FRONT, REAR used in this manual refer to operator's right, left, front, and rear sides when seated in the operator's cab looking forward.

- The boom is on the front of the rotating bed.
- The carbody and crawler controls are on the front of the carbody.

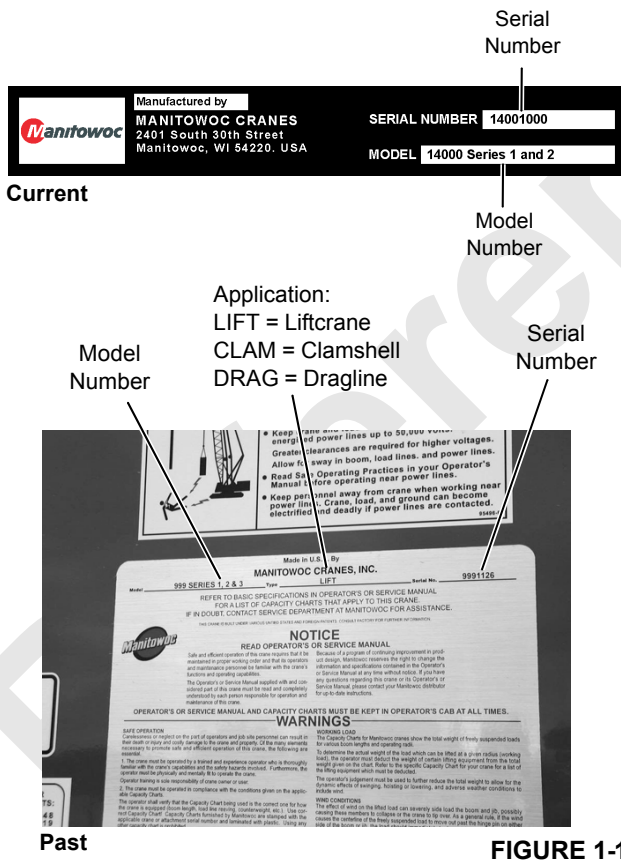


FIGURE 1-1

IDENTIFICATION AND LOCATION OF COMPONENTS

Boom Rigging

Item	Description
1	Rotating Bed
2	Undercarriage
3	Cab, Operator's
4	Counterweight, Carbody
5	Enclosure (both sides)
6	Crawler
7	Counterweight, Crane
8	Gantry
9	Wire Rope, Boom Hoist
10	Mast
11	Telescopic Boom Stop
12	Wire Rope Guide (Butt)
13	Straps (or Pendants)
14	Load Line
15	Wire Rope Guide (Top)
16	Boom Point, Lower
17	Block, Load
18	Top, Boom
19	Insert, Boom
20	Butt, Boom

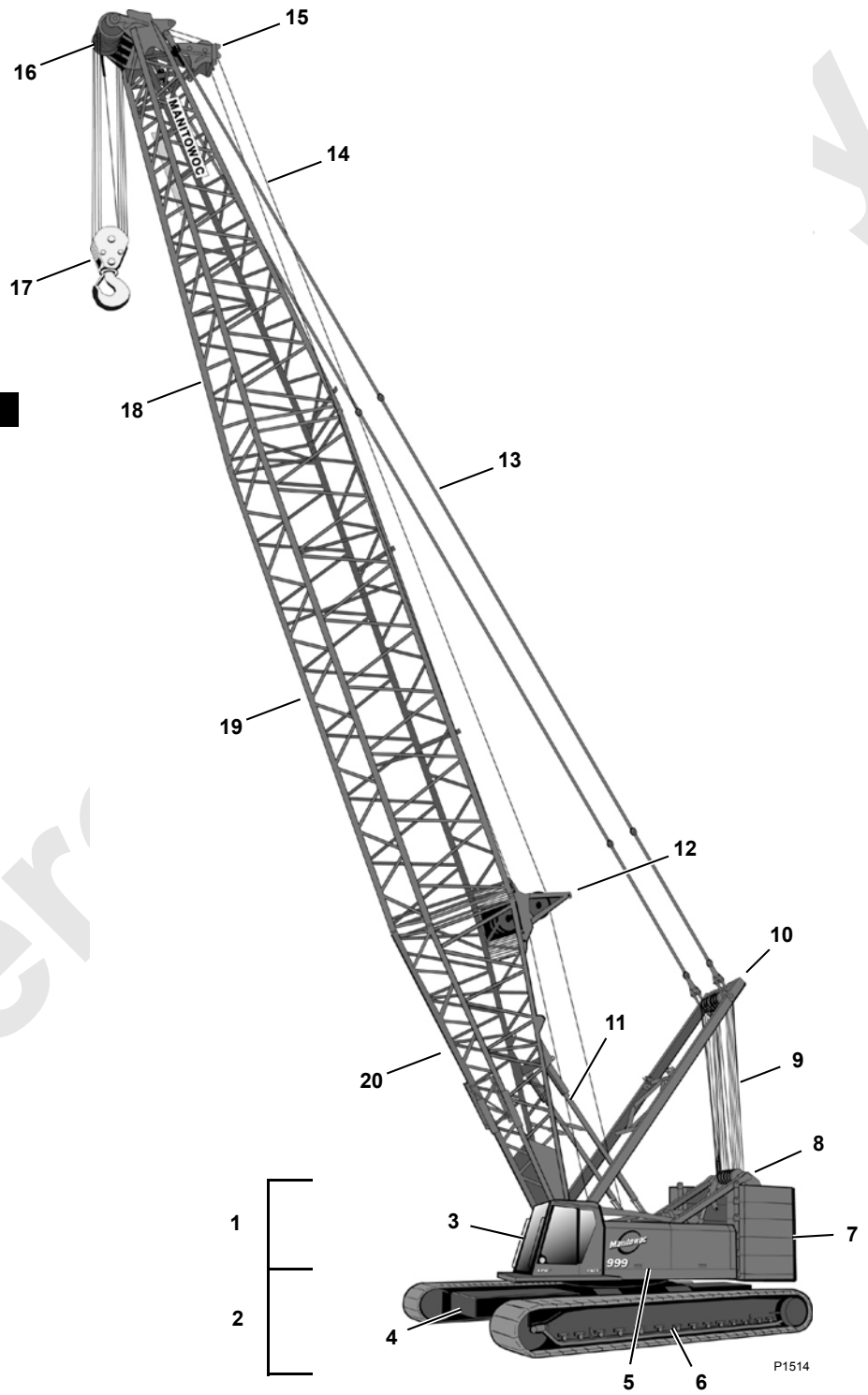


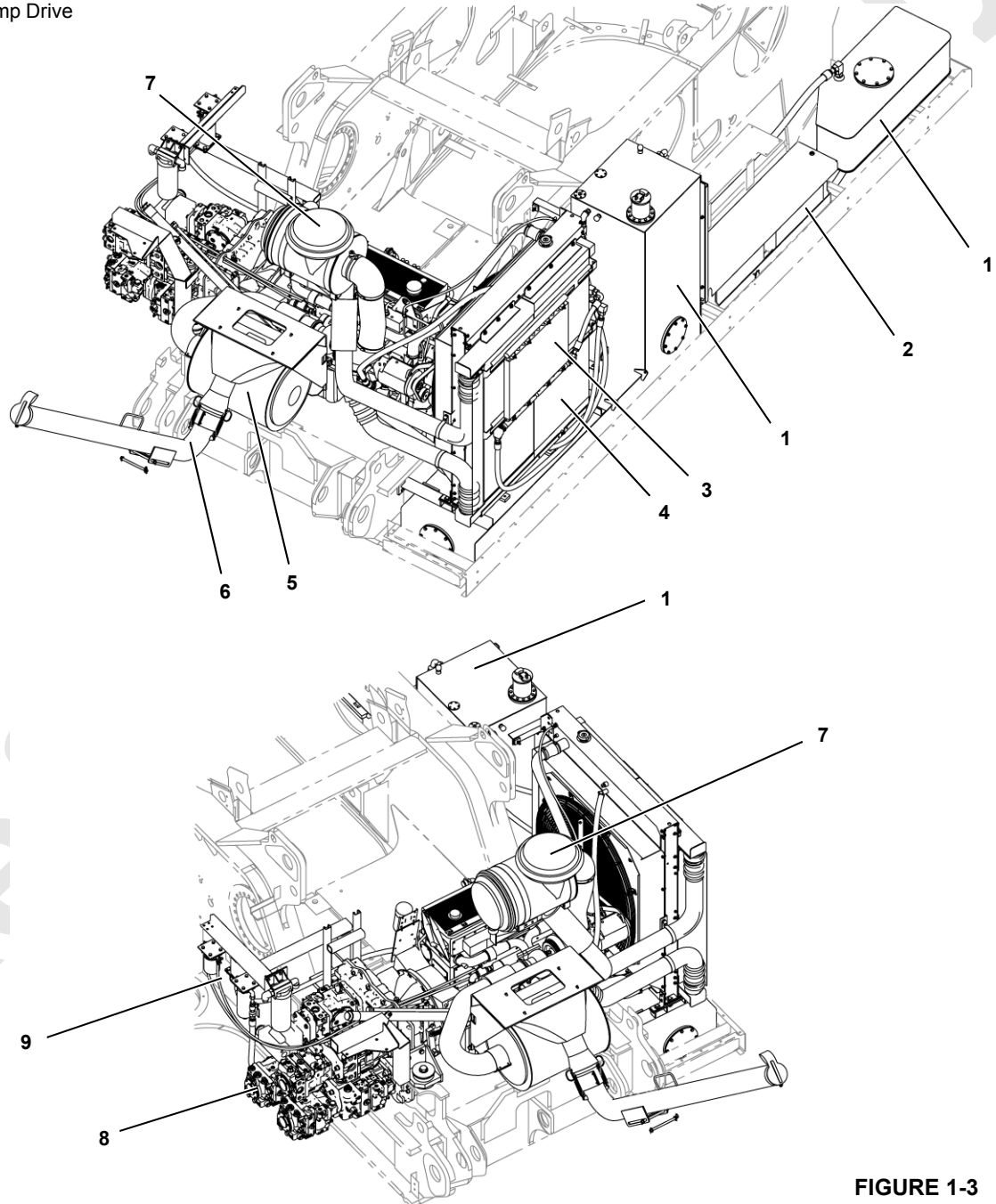
FIGURE 1-2

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Tier 3 Engine Components

Item	Description
1	Fuel Tanks (2)
2	Batteries
3	Engine Cooler
4	Air Conditioner and Heater
5	Muffler
6	Exhaust
7	Engine Air Pre-cleaner and Cleaner
8	Pumps and Pump Drive
9	Oil Filters



A16812

FIGURE 1-3

Tier 4 Engine Components

Item	Description
1	Fuel Tanks (2)
2	Batteries
3	Engine Cooler
4	Air Conditioner and Heater
5	Diesel Particulate Filter
6	Exhaust
7	Engine Air Pre-cleaner and Cleaner
8	Pumps and Pump Drive
9	Oil Filters

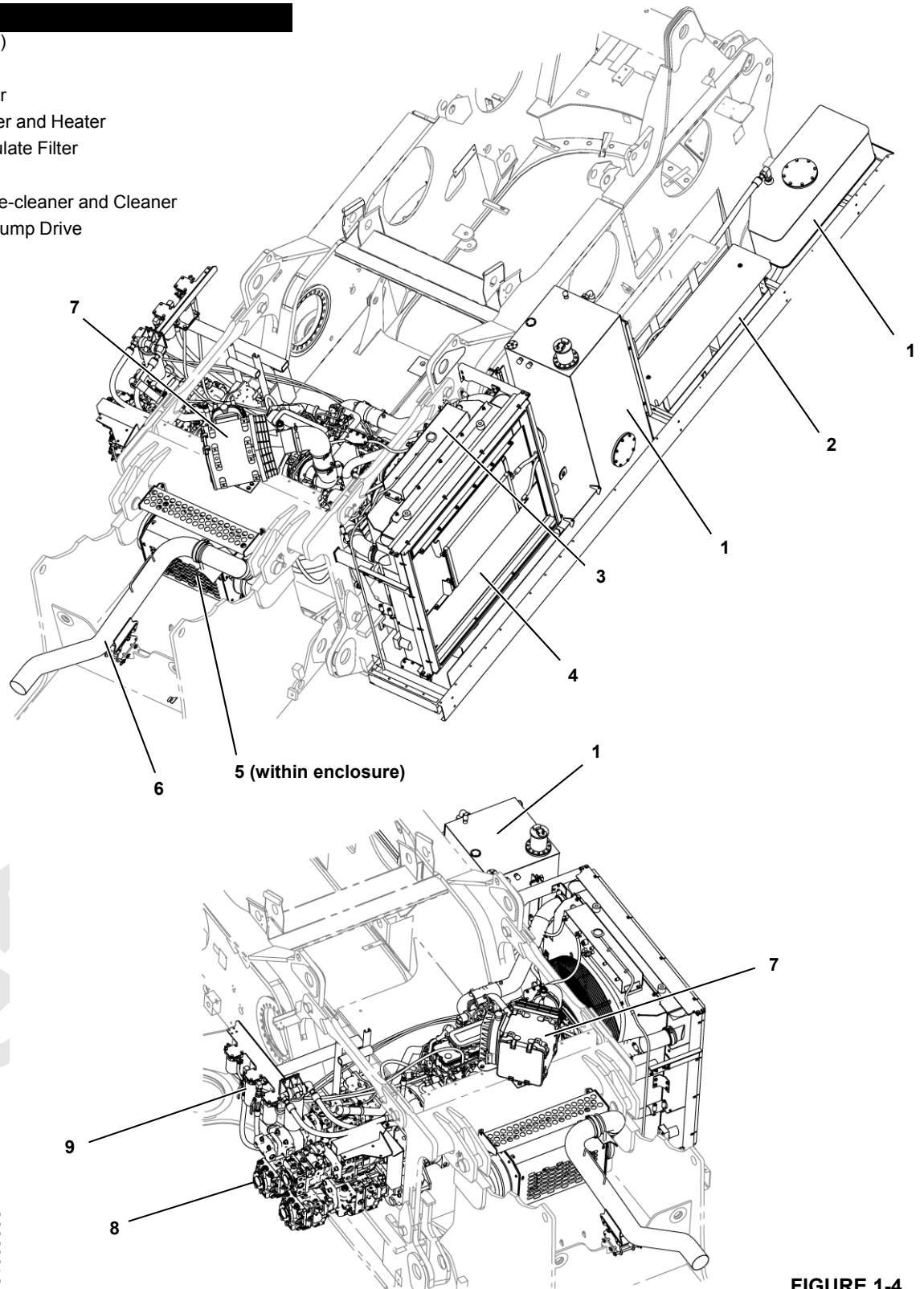
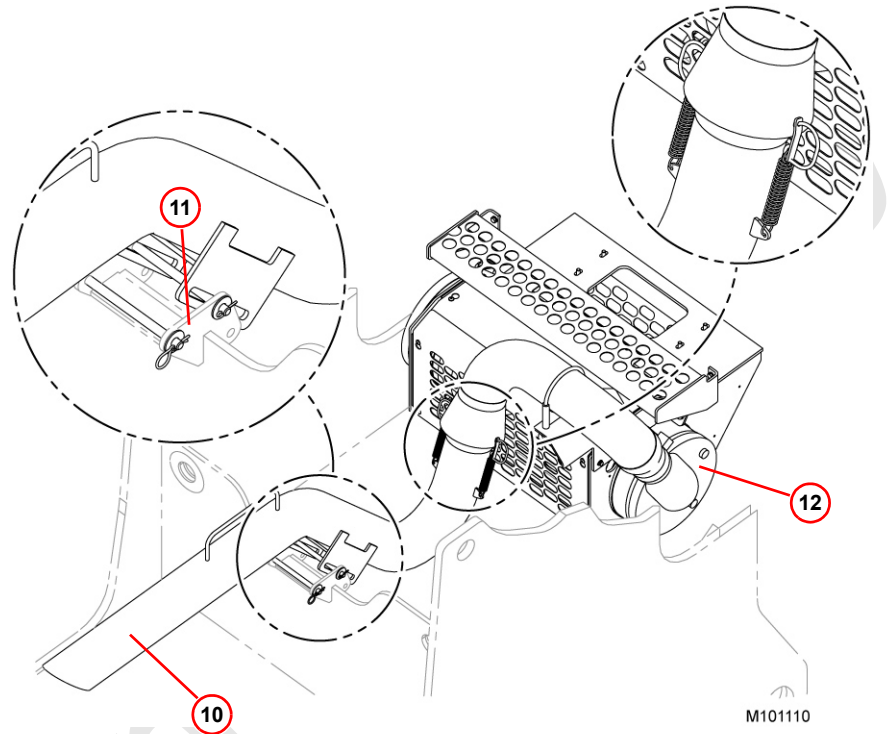


FIGURE 1-4

81009393

Item	Description
10	Engine Exhaust Pipe
11	Exhaust Bracket
12	Diesel Particulate Filter
13	Engine Alternator
14	Coolant Level Sensor
15	Engine Cooler
16	Hydraulic Fluid Level Switch
17	Fuel Level Sensor
18	Fuel Tank
19	Engine Grid Heater Junction Box



M101110

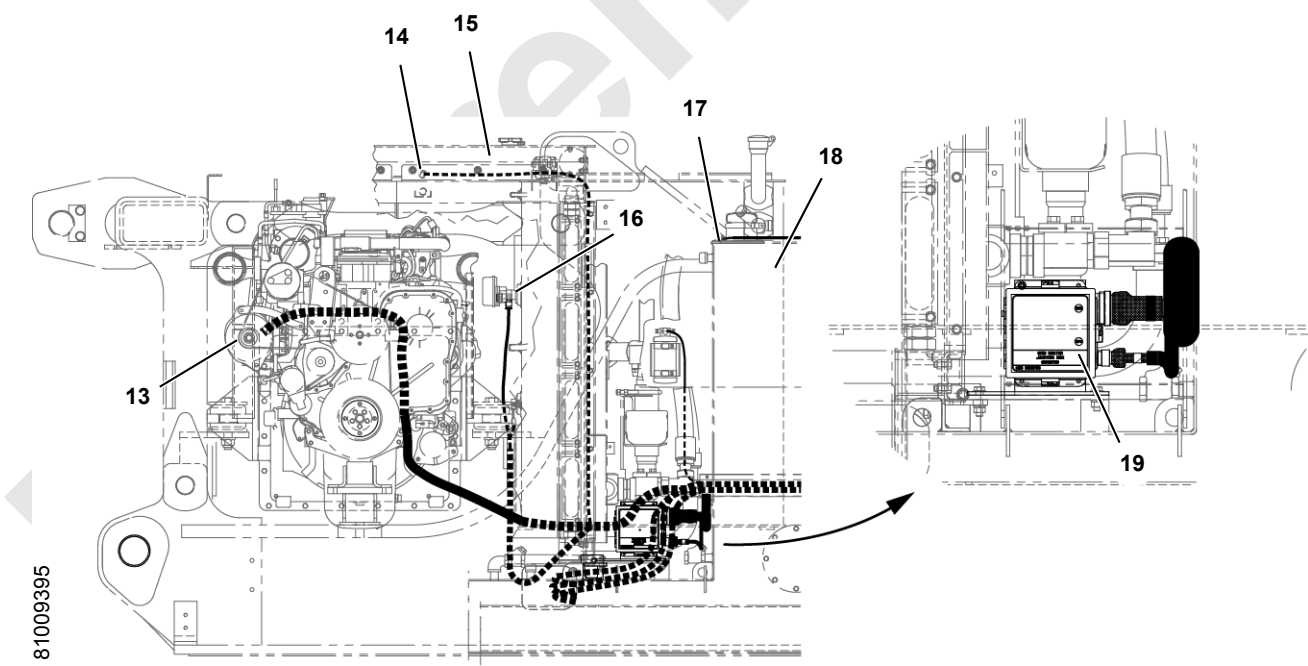
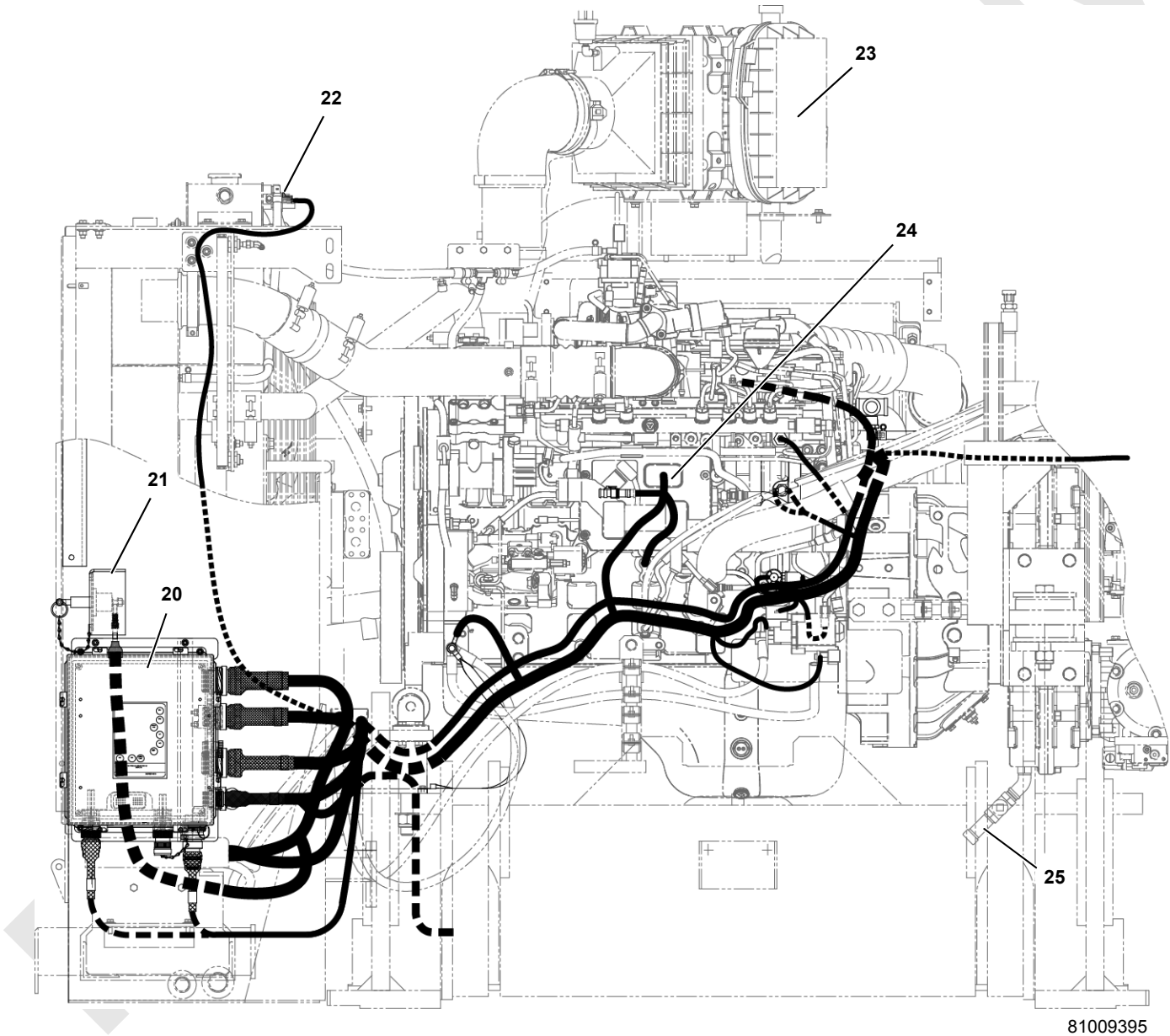


FIGURE 1-5

Item	Description
20	Engine Node
21	Battery Disconnect
22	Coolant Level Sensor
23	Air Filter Assembly
24	Engine ECM
25	Pump Drive Drain



81009395

FIGURE 1-6

Rotating Structure and Mast

Item	Description
1	Mast
2	Arm, Mast
3	Cylinder, Mast
4	Gantry
5	Counterweight, Crane
6	Crawler
7	Enclosure, Left Side
8	Cab, Operator's
9	Cylinder, Gantry
10	Cylinder, Counterweight Pin
11	Valve, Gantry Cylinders Equalizing (retract)
12	Valve, Gantry Cylinders Equalizing (extend)
13	Valve, Gantry Counterbalance (extend)
14	Valve, Gantry Counterbalance (retract)
15	Gear, Swing (Turntable Bearing)
16	Pawl, Drum
17	Sender, Drum Speed
18	Platform (typical on all sides of crane)
19	Drum, Auxiliary
20	Brake, Auxiliary Drum
21	Motor, Auxiliary Drum
22	Sender, Hydraulic Temperature
23	Valve, Hydraulic Shut-off
24	Tank, Hydraulic (bottom)

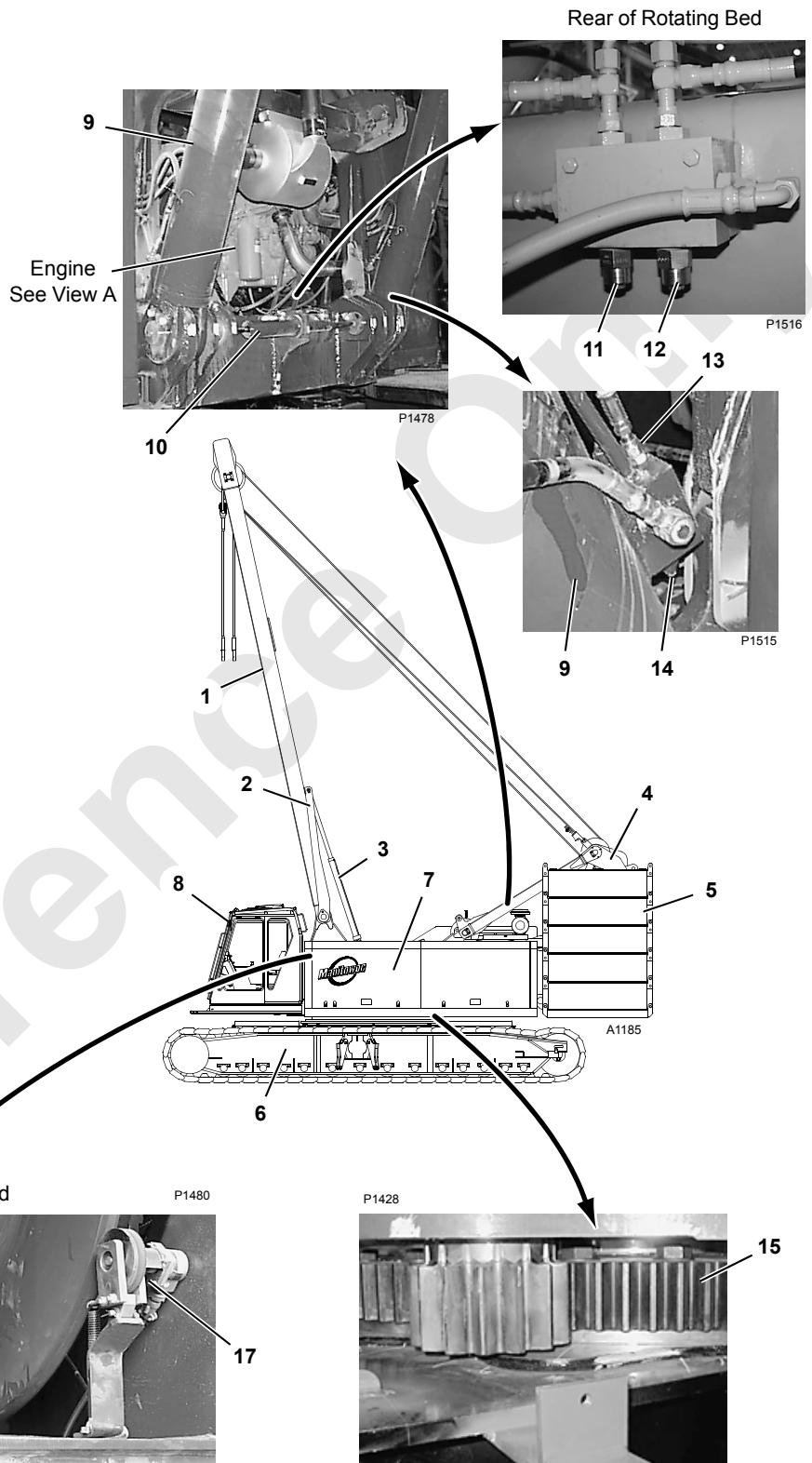
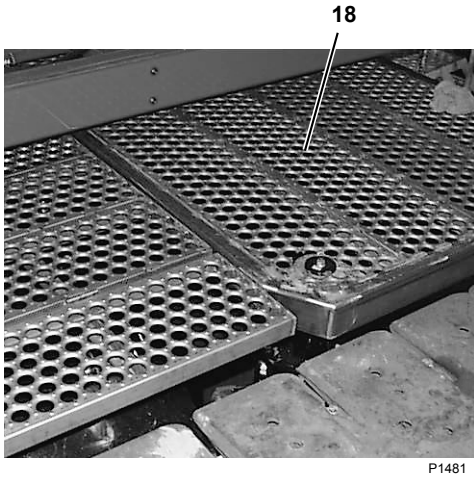
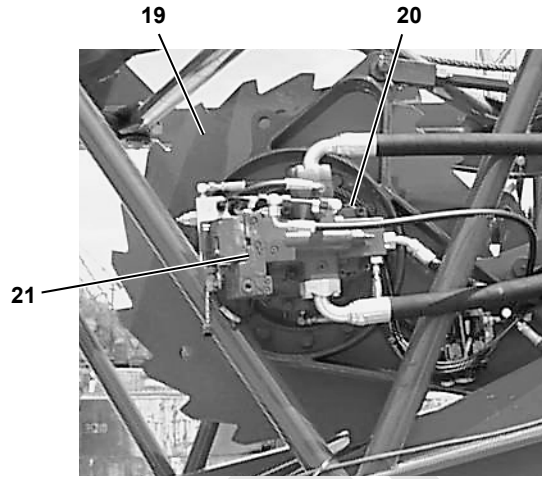


FIGURE 1-7



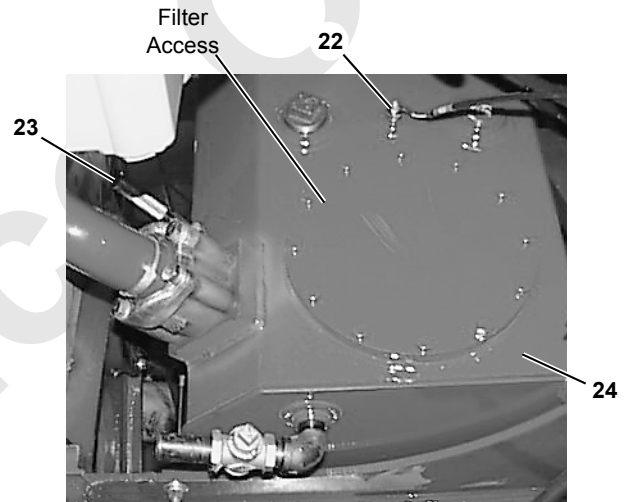
P1481



P1482

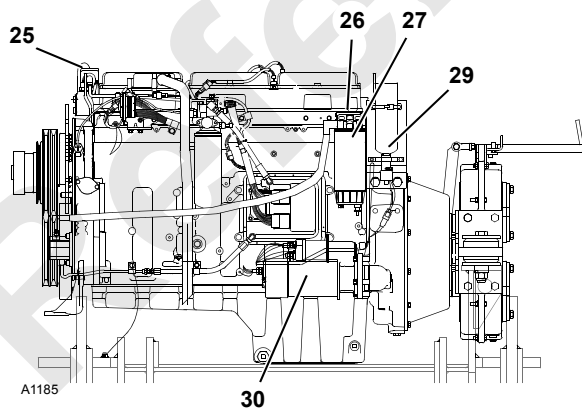
View in Boom Butt

Item	Description
25	Switch, Air Conditioner Pressure
26	Separator, Fuel/Water
27	Filter, Fuel
28	Sender, Engine Speed (top of flywheel housing)
29	Solenoid, Ether Start
30	Motor, Starter
31	Sender, Coolant Temperature
32	Switch, Coolant Temperature
33	Alternator
34	Switch, Oil Pressure
35	Sender, Oil Pressure
36	Drive, Pump
37	Clutch, Pump Drive



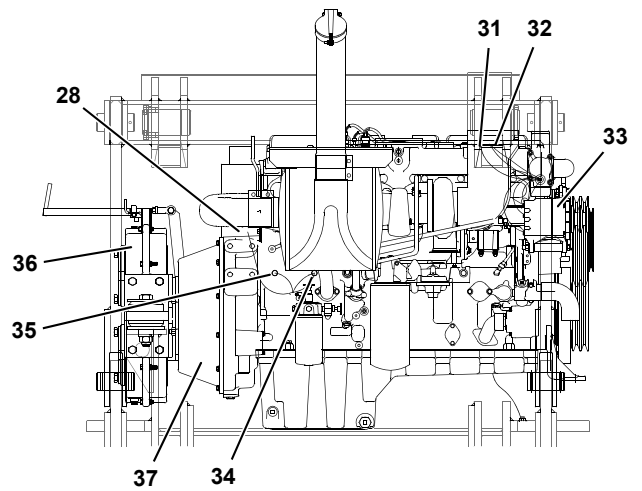
P1419

Under Rear of Rotating Bed



A1185

Engine Left Side (typical)
(Caterpillar 3276C shown)

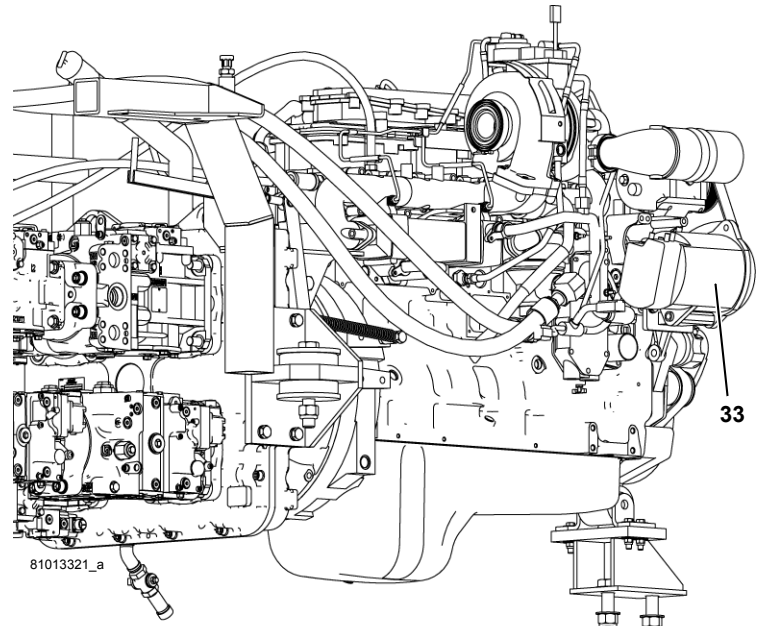


View A

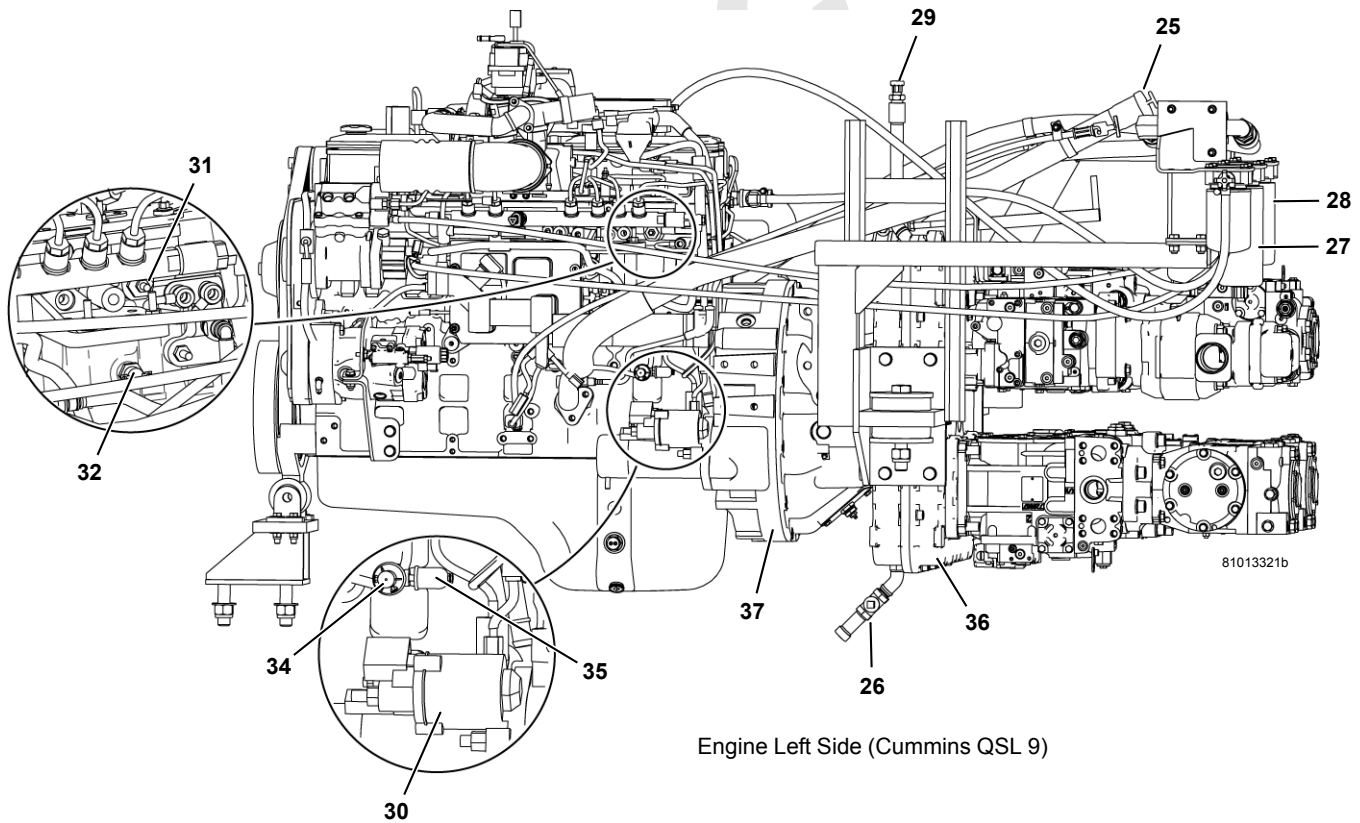
Engine Right Side (typical)
(Caterpillar 3276C shown)

FIGURE 1-8

Item	Description
25	Engine Oil Fill
26	Drain, Pump Drive
27	Filter, Fuel
28	Filter, Engine Oil
29	Pump Drive Oil Fill
30	Motor, Starter
31	Sender, Coolant / Oil Temperature
32	Switch, Coolant Temperature
33	Alternator
34	Switch, Oil Pressure
35	Sender, Oil Pressure
36	Drive, Pump
37	Clutch, Pump Drive

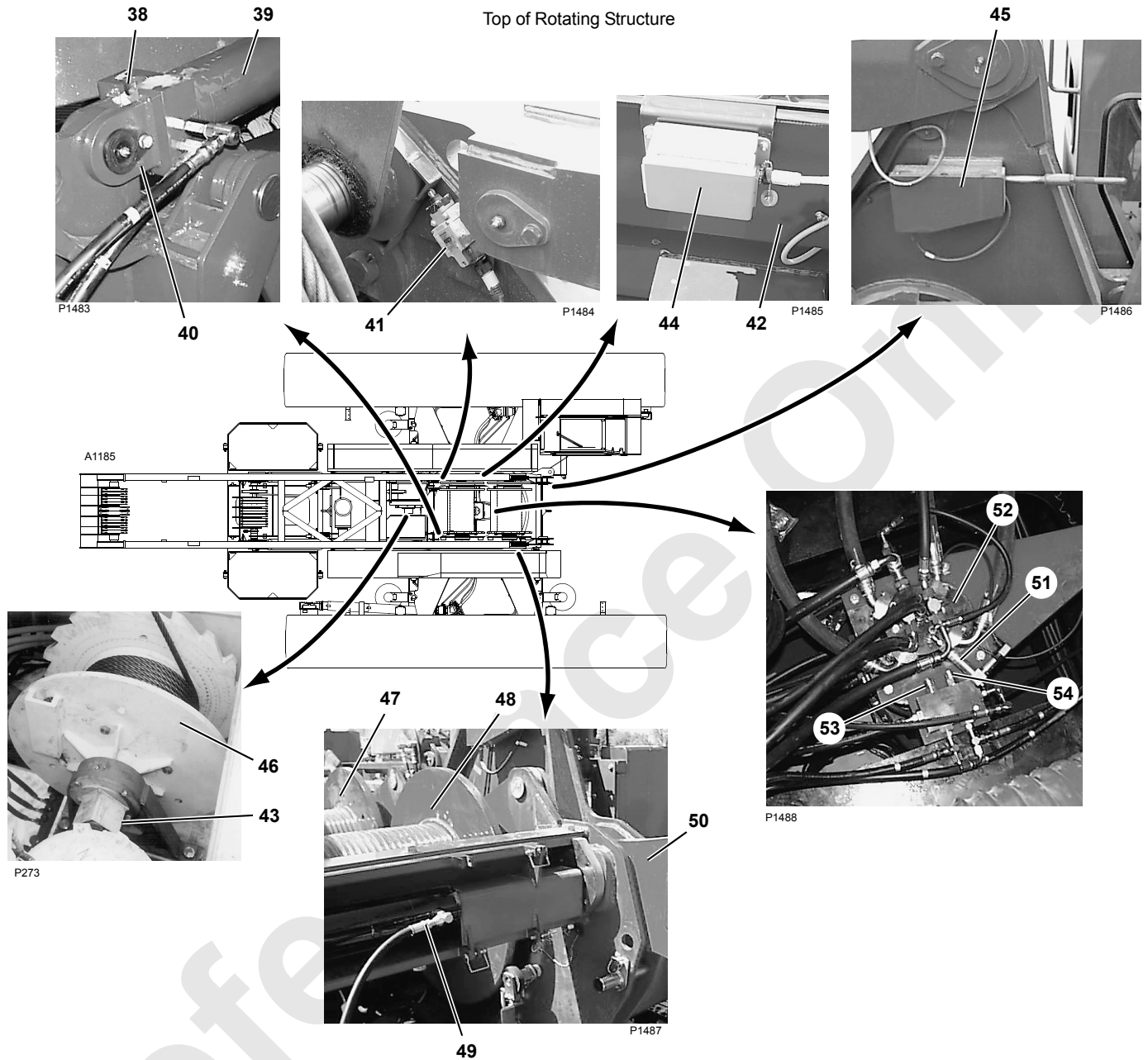


Engine Right Side (Cummins QSL 9)



Engine Left Side (Cummins QSL 9)

FIGURE 1-9

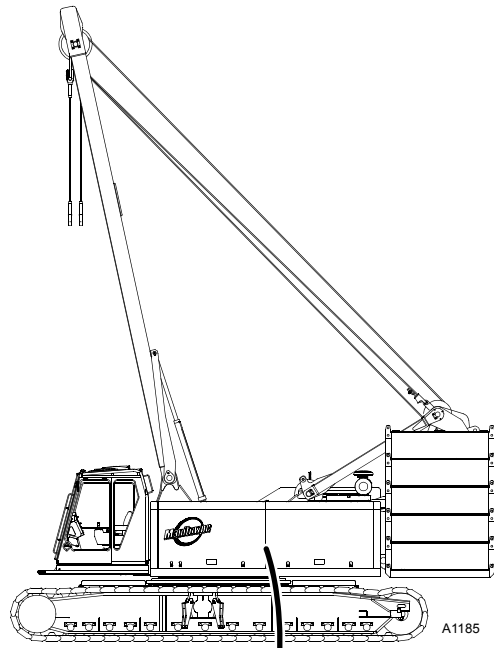


Item	Description	Item	Description
38	Valve, Mast Retract Counterbalance (see NOTE)	47	Drum, Rear
39	Cylinder, Mast Arm (left side)	48	Drum, Front
40	Valve, Mast Extend Counterbalance (see NOTE)	49	Cylinder, Boom Hinge Pins
41	Switch, Mast Up Limit	50	Boom
42	Mast	51	Switch, Accessory System Pressure
43	Sender, Drum Speed	52	Swivel, Hydraulic
44	Indicator, Mast Angle	53	Valve, Mast Cylinders Equalizing (retract)
45	Switch, Boom Stop Max Limit	54	Valve, Mast Cylinders Equalizing (extend)
46	Drum, Boom Hoist		

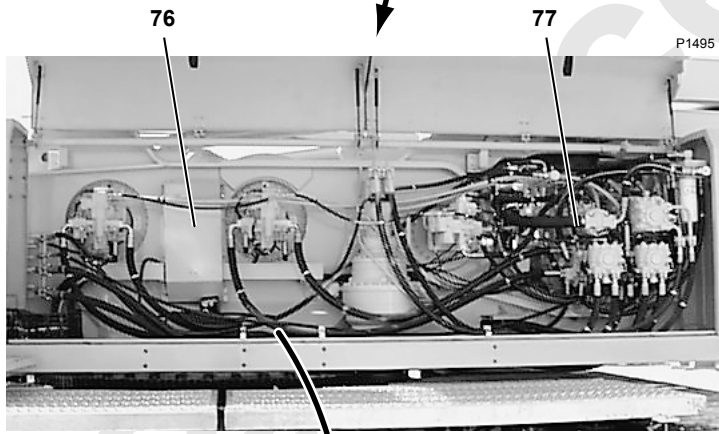
NOTE: Right side cylinder shown. For left side cylinder, retract valve is on bottom and extend valve is on top.

FIGURE 1-10

Left Side of Rotating Structure



Item	Description
76	Enclosure, Left-Front Side
77	Enclosure, Left-Rear Side
78	Motor, Front Drum
79	Brake, Front Drum
80	Sender, Front Drum Pressure
81	Junction Box, Left Side Electrical
82	Motor, Rear Drum
83	Brake, Rear Drum
84	Sender, Rear Drum Pressure
85	Sender, Accessory System Pressure
86	Controls, Remote Setup
87	Motor, Boom Hoist
88	Brake, Boom Hoist
89	Sender, Boom Hoist Pressure
90	Manifold, Hydraulic Return
91	Switch, Hydraulic Suction
92	Valve, Supercharge Shut
93	Line, Main Suction
94	Filter, Auxiliary Drum
95	Manifold, Supercharge Filter
96	Pump, Auxiliary Drum
97	Pump, Swing
98	Pump, Front Drum
99	Pump, Right Travel
100	Pump, Rear Drum
101	Pump, Left Travel
102	Pump, Supercharge
103	Boom Hoist
104	Motor, Swing
105	Brake, Swing
106	Sender, Swing Left Pressure
107	Sender, Swing Right Pressure
108	Sender, Auxiliary Drum Pressure
109	Valve, Right Travel Shuttle
110	Sender, Right Travel Pressure
111	Valve, Left Travel Shuttle
112	Sender, Left Travel Pressure



see View A on next page

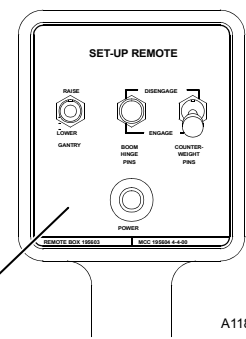
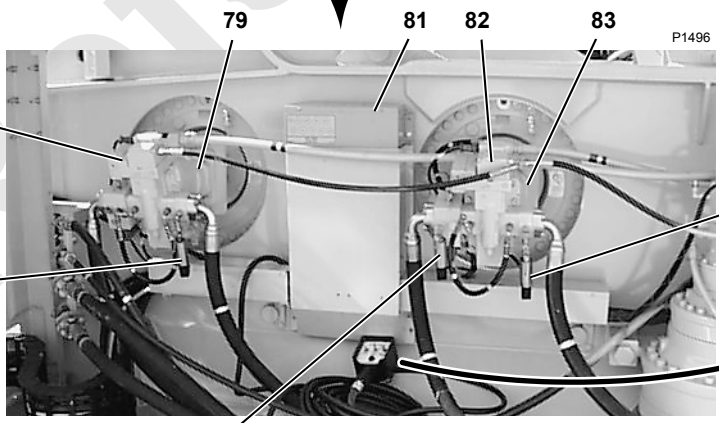
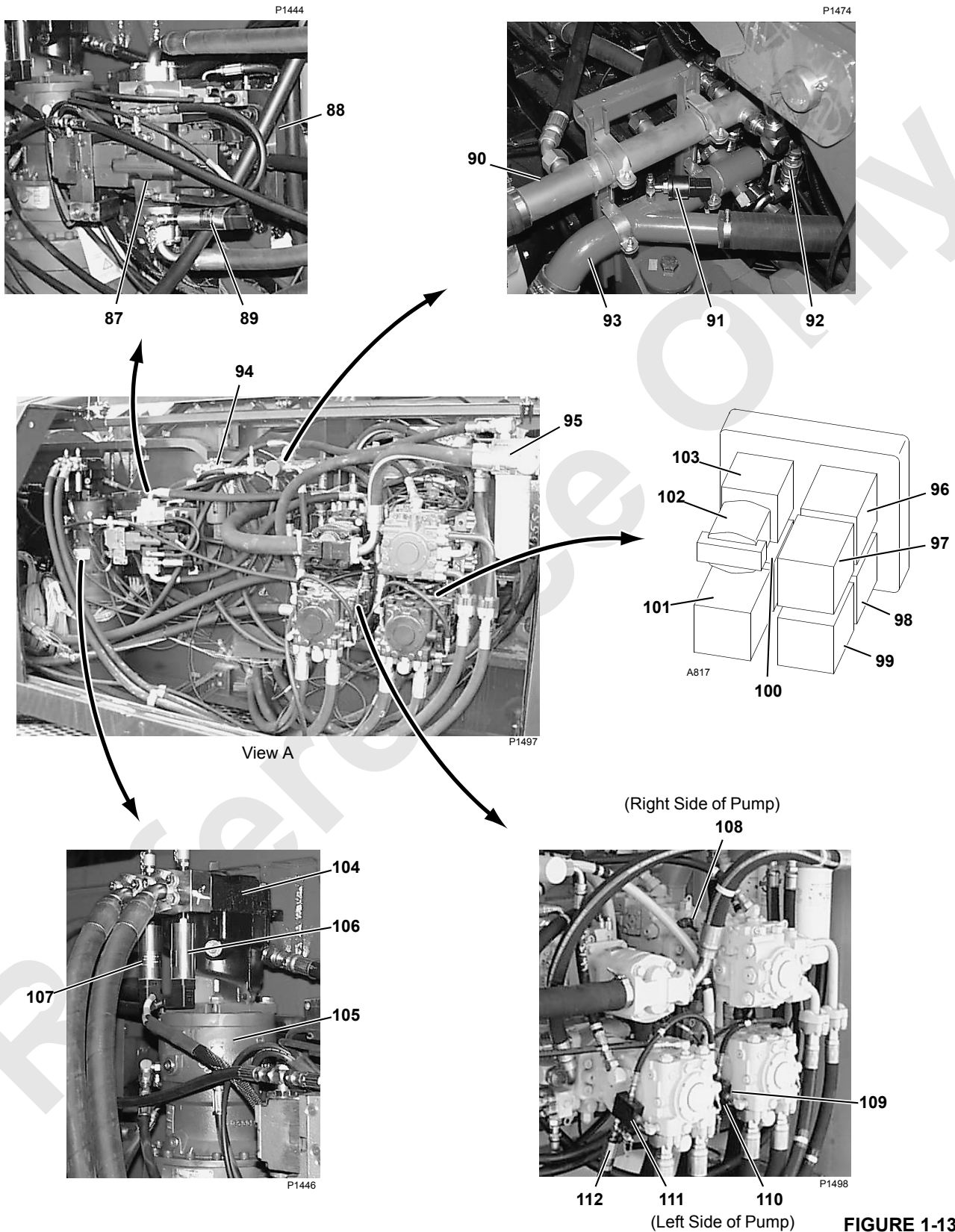


FIGURE 1-12

Left Side of Rotating Structure Continued



Lowerworks

Item	Description	Item	Description
1	Valve, Carbody Jack Extend Counterbalance	10	Pins Crawler (left crawler)
2	Valve, Carbody Jack Retract Counterbalance	11	Jack, Carbody (left rear)
3	Jack, Carbody	12	Jack, Carbody (left front)
4	Pad, Jack (stored on carbody)	13	Gearbox, Crawler Output (both crawlers)
5	Brake, Crawler Disc (both crawlers)	14	Planetary, Crawler Input (both crawlers)
6	Motor, Crawler (both crawlers)	15	Shaft, Drive (both crawlers)
7	Jack, Carbody (right front)	16	Roller, Intermediate Crawler (14 each crawler)
8	Jack, Carbody (right rear)	17	Roller, Crawler (1 each crawler)
9	Pins, Crawler (right crawler)		

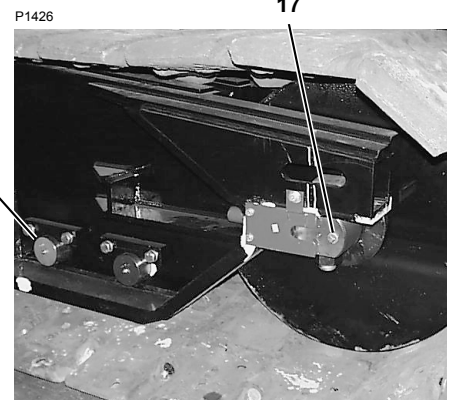
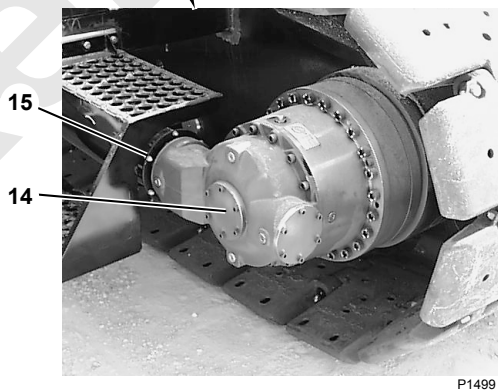
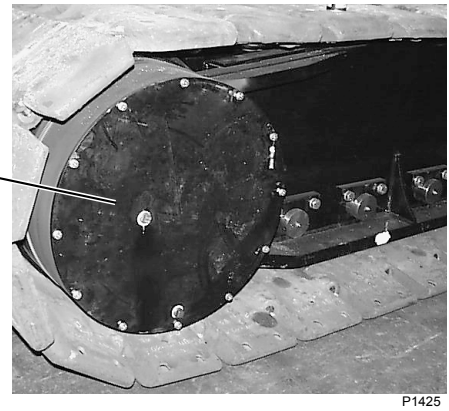
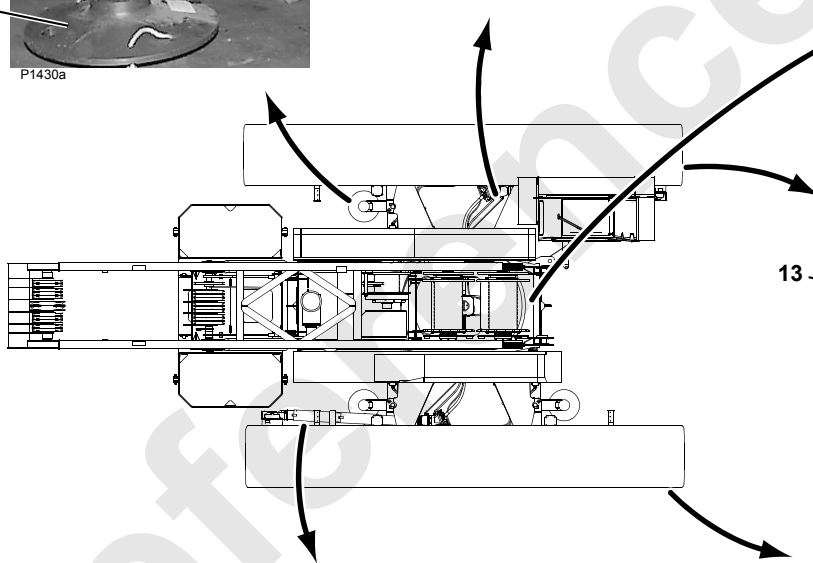
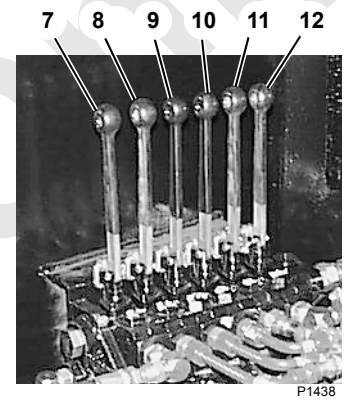
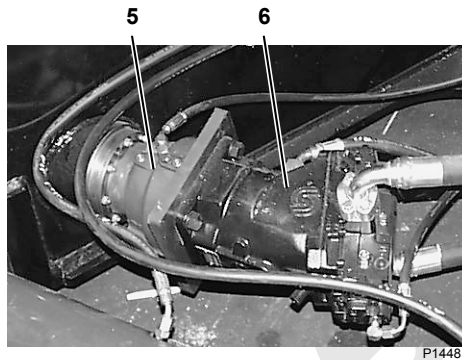
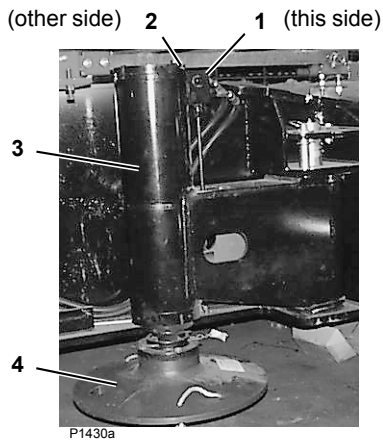


FIGURE 1-14

Operator's Cab/Controls

Item	Description
1	Gauges, Overhead Panel
2	Controls, Overhead Panel Accessory
3	Console, Rated Capacity Indicator/Limiter (optional)
4	Console, Front
5	Pedals, Travel Foot (optional)
6	Pedals, Free-Fall Working Brake (optional)
7	Throttle, Engine Foot
8	Handle, Front Drum
9	Handle, Rear Drum
10	Handle, Auxiliary Drum
11	Panel, Right Side Control
12	Seat
13	Throttle, Engine Hand
14	Handle, Right Crawler
15	Handle, Left Crawler
16	Handle, Boom/Swing
17	Controller, Programmable
18	Fuse Box
19	Junction Box, Main
20	Horn
21	Alarm, Swing/Travel
22	Grounding Strap, Cap

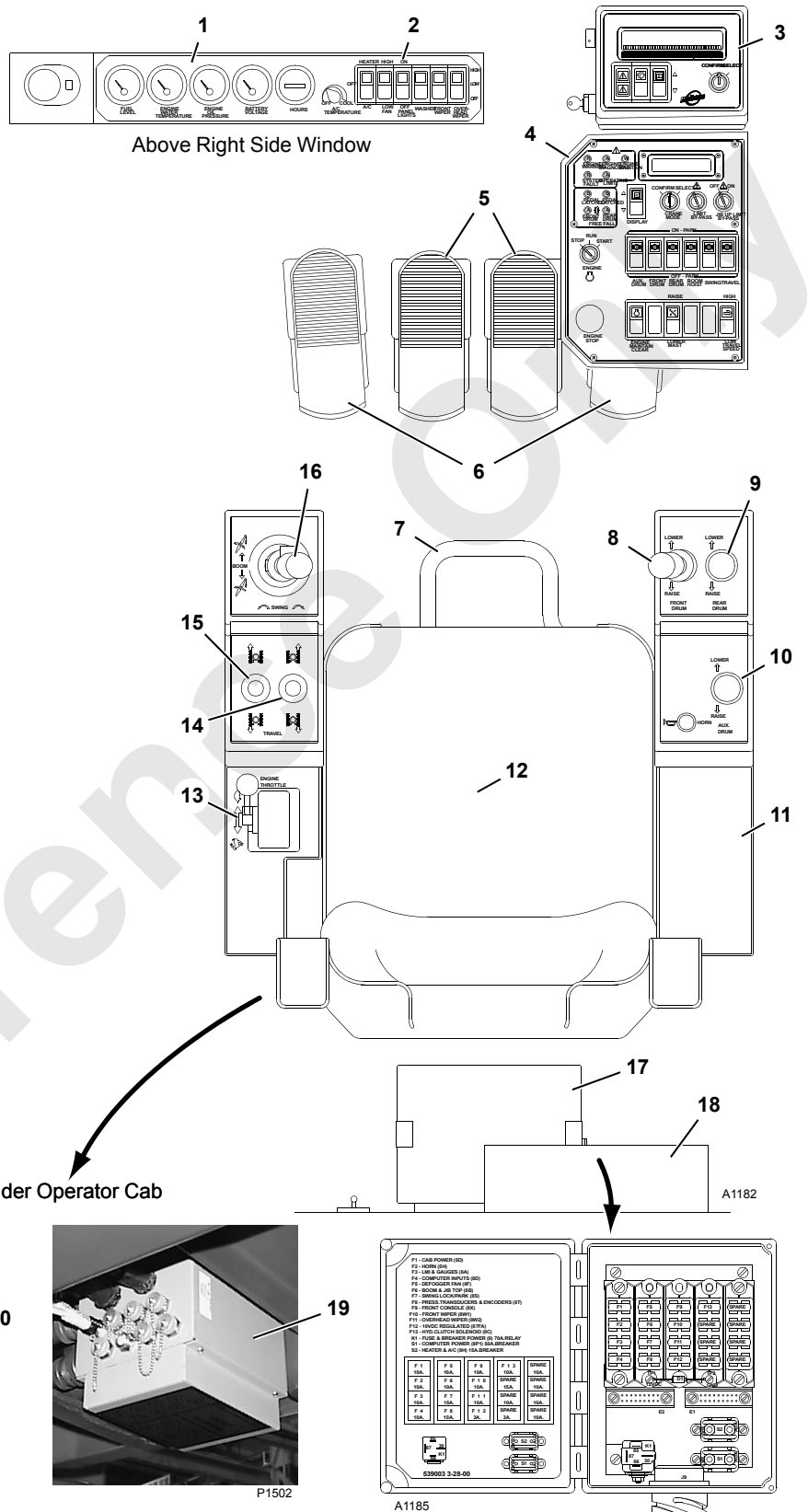
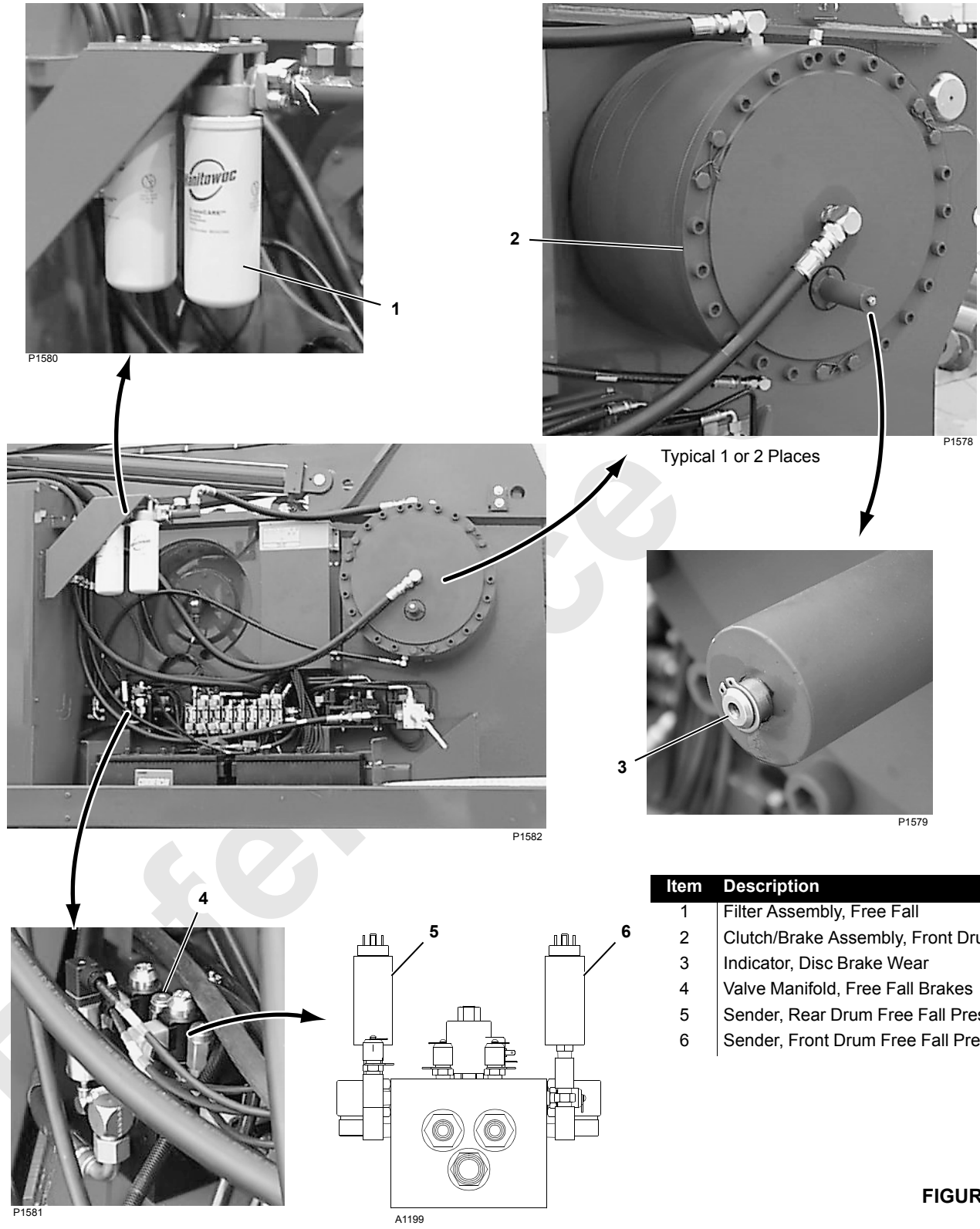


FIGURE 1-15

Right Side with Free Fall



Item	Description
1	Filter Assembly, Free Fall
2	Clutch/Brake Assembly, Front Drum
3	Indicator, Disc Brake Wear
4	Valve Manifold, Free Fall Brakes
5	Sender, Rear Drum Free Fall Pressure
6	Sender, Front Drum Free Fall Pressure

FIGURE 1-16

OUTLINE DIMENSIONS — FROM SIDE

196102

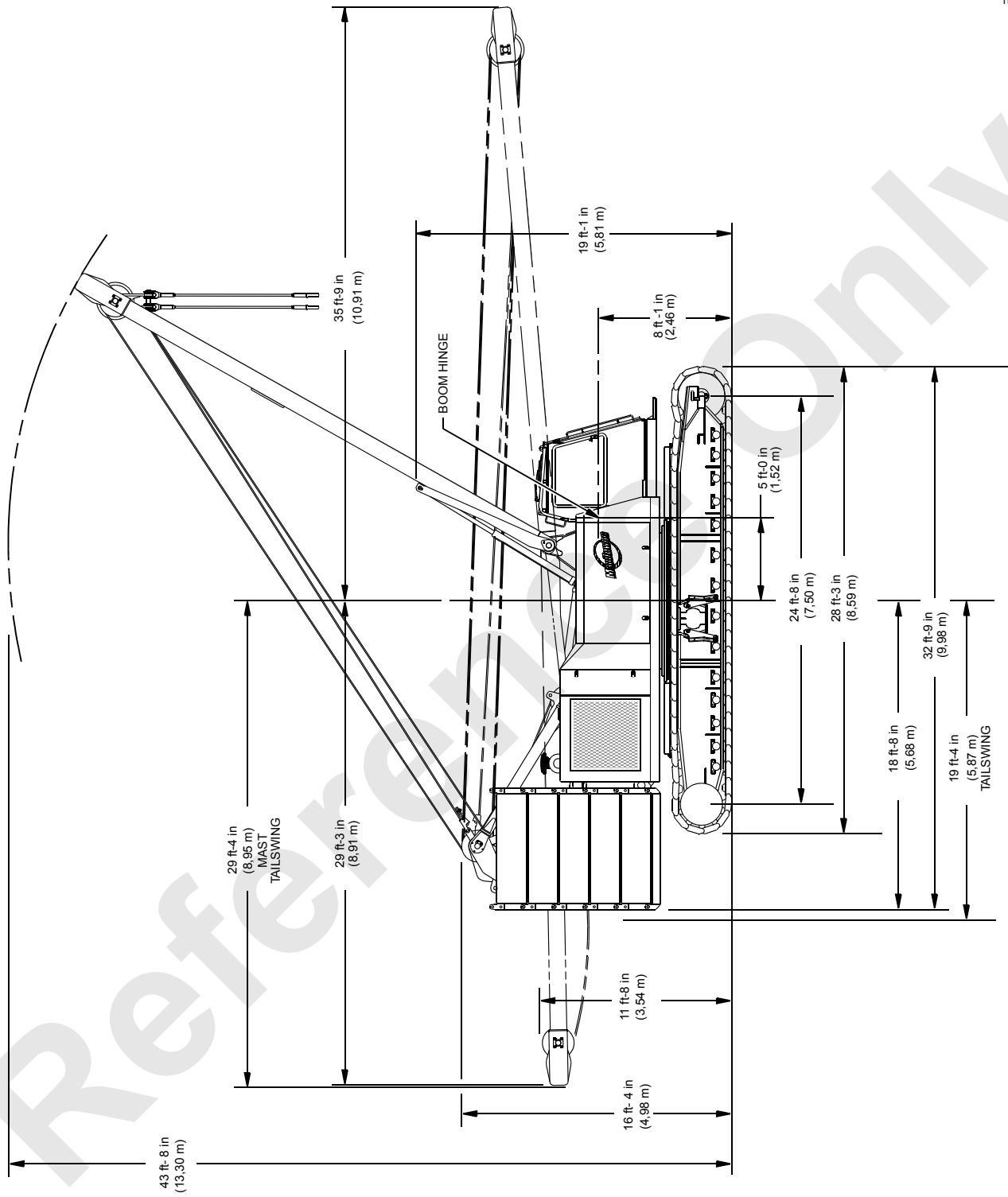


FIGURE 1-17

OUTLINE DIMENSIONS — FROM FRONT

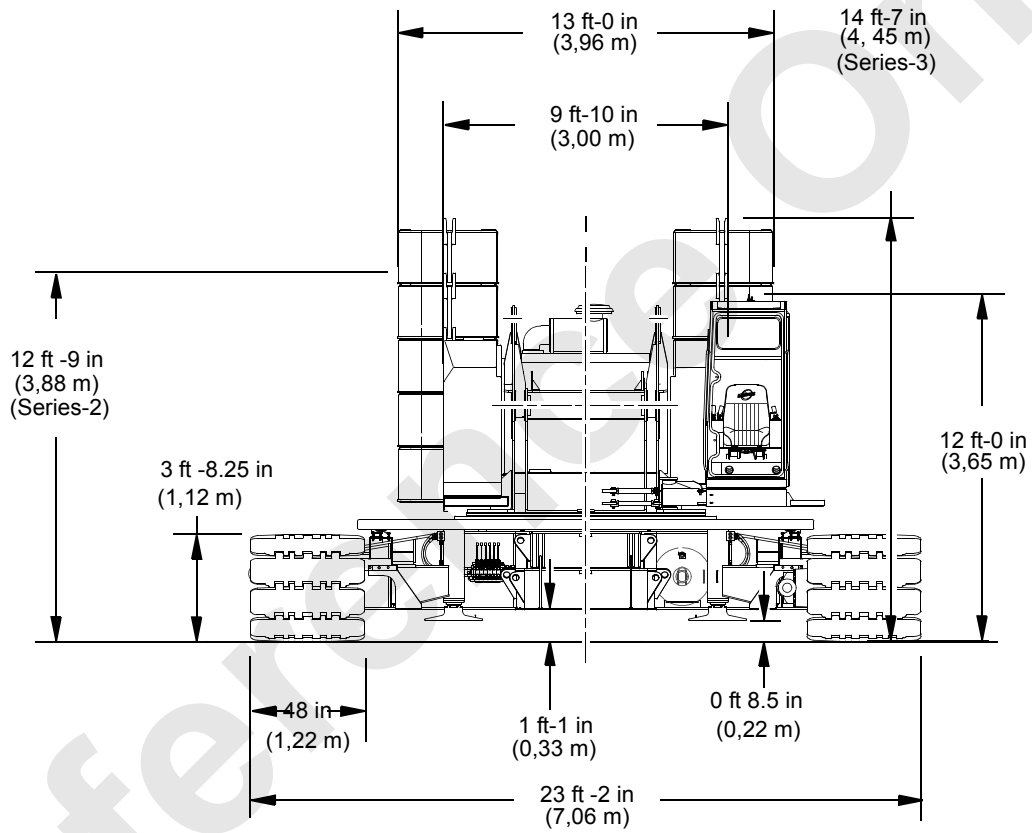


FIGURE 1-18

CRANE WEIGHTS

NOTE: Weights may fluctuate $\pm 3\%$ due to manufacturing tolerances.

	Weight	
	Pounds	Kilograms
LIFTCRANE - BOOM NO. 82:		
Rotating bed and under carriage complete, 48 in (1 219 mm) crawler treads, counterweight, gantry, backhitch, mast, fully rigged 70 ft (21,3 m) Boom No. 82 [including single sheave upper boom point, 8 sheave lower point, 3 sheave wire rope guide, lower wire rope guide, 250 Ton (227t) block, and 15 Ton (14t) hook and weight ball], boom stops and maximum length hoist and whip lines		
----- 999 SERIES 1 -----	349,420	158 494
----- 999 SERIES 2 -----	428,445	194 339
----- 999 SERIES 3 -----	499,465	226 553
ROTATING BED MACHINERY MODULE WITH CARBODY:		
Carbody, rotating bed with two full power drums, operator's cab, gantry, backhitch, mast, boom hoist wire rope, carbody jacking arrangement (optional), and maximum length hoist and whip lines - - -		
	87,500	39 689
CRAWLERS:		
28 ft 2 in (8 585 mm) crawler assembly with platforms, steps and 48 in (1 219 mm) treads (each) -----		
	43,260	19 622
COUNTERWEIGHT - UPPER:		
Box - Side (6 on 999 SERIES 1; 8 on SERIES 2; 10 on SERIES 3) with pins (each)- - - - -		
	17,500	7 937
Box - Center -----		
	23,500	10 659
Tray - Lower counterweight -----		
	21,050	9 548
Total rotating bed counterweight ----- 999 SERIES 1 -----		
	149,600	67 857
----- 999 SERIES 2 -----		
	184,600	83 733
----- 999 SERIES 3 -----		
	219,600	99 608
COUNTERWEIGHT - UPPER — LOW-PROFILE:		
Box - Side (12 required) with pins (each) -----		
	14,485	6 570
Box - Center -----		
	23,500	10 659
Tray - Lower counterweight -----		
	21,050	9 548
Total rotating bed counterweight - 999 SERIES 3 only -----		
	219,600	99 608
COUNTERWEIGHT - LOWER:		
Carbody Counterweight (2 on SERIES 2, 4 on SERIES 3) (each)		
----- Upper Box -----	18,000	8 164
----- Lower Box -----	22,000	9 979
GANTRY:		
10 ft 2-3/4 in (3 118 mm) Gantry (with nylon sheaves) -----		
	4,430	2 009
Backhitch cylinders and pins (each) -----		
	1,030	467
Counterweight handling links and pins (each) -----		
	155	70
MAST FOR BOOM NO. 22EL:		
30 ft 0 in (9 144 mm) mast (with nylon sheaves) -----		
	5,190	2 354
Pendant link on mast (each) -----		
	165	74
2 ft 2 in (0,7 m) link (each) with pin -----		
	115	52
1 ft 2 in (0,4 m) link (each) with pin -----		
	75	34
6 in (152 mm) equalizer link (each) -----		
	50	22
8 ft 4 in (2,5 m) pendant (each) -----		
	100	45

	Weight	
	Pounds	Kilograms
MAST FOR BOOM NO. 82:		
30 ft 0 in (9 144 mm) mast (with nylon sheaves) - - - - -	5,100	2 313
Pendant link on mast (each) - - - - -	155	70
2 ft 2 in (0,7 m) link (each) with pin - - - - -	115	52
8-1/2 in (216 mm) link (each) with pin - - - - -	45	20
9 ft 1-1/4 in (2,8 m) strap (each) - - - - -	120	54
BOOM NO. 22EL:		
30 ft 0 in (9,1 m) butt - - - - -	6,290	2 853
40 ft 0 in (12,2 m) top (with 7 sheave lower point, 2 sheave wire rope guide and pendant links) - - - -	10,250	4 649
10 ft 0 in (3,0 m) insert with wire rope guide - - - - -	2,180	988
10 ft 0 in (3,0 m) insert - - - - -	1,495	678
20 ft 0 in (6,1 m) insert - - - - -	2,550	1 156
40 ft 0 in (12,2 m) insert - - - - -	4,460	2 023
40 ft 0 in (12,2 m) insert (with jib backstay lugs) - - - - -	4,560	2 068
36 ft 6 in (11,1 m) basic pendant (each) - - - - -	210	95
10 ft 0 in (3,0 m) pendant (each) - - - - -	110	49
20 ft 0 in (6,1 m) pendant (each) - - - - -	145	65
40 ft 0 in (12,2 m) pendant (each) - - - - -	210	95
Upper boom point - - - - -	905	410
Wire rope guide (top - 2 sheave) - - - - -	1,245	564
Wire rope anchor - - - - -	285	129
Wire rope roller assembly (each) - - - - -	55	24
Wire rope guide (butt) - - - - -	2,440	1 106
Boom stop assembly (each side) - - - - -	765	346
BOOM NO. 22E (Additional Components):		
40 ft 0 in (12,2 m) open throat top (with 6 sheave lower point and 2 sheave wire rope guide) - - - - -	9,225	4 184
40 ft 9-3/4 in (12,4 m) basic pendant (each) - - - - -	475	215
Pendant spreader - - - - -	395	179
Upper boom point (1 sheave) - - - - -	1,165	528
Upper boom point (2 sheave) - - - - -	1,505	682
Jib adaptor - - - - -	535	242
Wire rope guide - 2 sheave (top) - - - - -	510	231
BOOM NO. 82:		
30 ft 0 in (9,1 m) butt - - - - -	6,615	3 000
40 ft 0 in (12,2 m) top (with 8 sheave lower point and 3 sheave wire rope guide) - - - - -	11,230	5 093
10 ft 0 in (3,0 m) insert with wire rope guide - - - - -	2,270	1 029
10 ft 0 in (3,0 m) insert - - - - -	1,820	825
20 ft 0 in (6,1 m) insert (with jib backstay lugs) - - - - -	2,530	1 147
40 ft 0 in (12,2 m) insert - - - - -	4,400	1 995
40 ft 0 in (12,2 m) insert (with jib backstay lugs) - - - - -	4,430	2 009
37 ft 7-1/4 in (11,5 m) basic strap with link (each) - - - - -	445	201
10 ft 0 in (3,0 m) strap with link (each) - - - - -	160	72
20 ft 0 in (6,1 m) strap with link (each) - - - - -	275	124
40 ft 0 in (12,2 m) strap with link (each) - - - - -	480	217
Upper boom point (single sheave) - - - - -	920	417
Wire rope guide (top) - - - - -	1,845	836
Wire rope anchor - - - - -	285	129
Wire rope roller assembly (auxiliary drum) - - - - -	335	151
Wire rope guide (butt) - - - - -	2,490	1 129
Boom stop assembly (each side) - - - - -	765	346

	Weight	
	Pounds	Kilograms
BOOM NO. 82LR (Additional Components):		
50 ft 0 in (15,2 m) top (with 4 sheave lower point, 2 sheave wire rope guide) - - - - -	6,360	2 884
40 ft 0 in (12,2 m) long reach insert - - - - -	3,755	1 703
31 ft 4-1/2 in (9,6 m) basic strap (each) - - - - -	365	165
Wire rope intermediate suspension package - - - - -	400	181
Upper boom point (1 sheave) - - - - -	345	156
Wire rope guide (top) - - - - -	260	117
JIB NO. 123:		
15 ft 0 in (4,6 m) butt - - - - -	610	276
15 ft 0 in (4,6 m) top (with jib point, load sensor and limit control) - - - - -	680	308
10 ft 0 in (3,0 m) insert - - - - -	350	158
20 ft 0 in (6,1 m) insert - - - - -	580	263
33 ft 3-3/4 in (10,2 m) basic pendant (each) - - - - -	115	52
9 ft 6 in (2,9 m) pendant (each) - - - - -	65	29
19 ft 0 in (5,8 m) pendant (each) - - - - -	85	38
12 ft 6 in (3,8 m) strut with sheave - - - - -	405	183
10 in (0,3 m) jib backstay strap (each) - - - - -	15	6
48 ft 3 in (14,7 m) basic backstay pendant (each) - - - - -	90	40
2 ft 4 in (0,7 m) backstay link, pin (each) - - - - -	20	9
4 ft 8 in (1,4 m) backstay pendant (each) - - - - -	35	15
Jib stop assembly - - - - -	50	22
Wire rope anchor - - - - -	110	49
JIB NO. 134:		
15 ft 0 in (4,6 m) butt - - - - -	580	263
15 ft 0 in (4,6 m) top (with jib point) - - - - -	990	449
10 ft 0 in (3,0 m) insert - - - - -	350	158
20 ft 0 in (6,1 m) insert - - - - -	580	263
30 ft 9 in (9,4 m) basic pendant (each) - - - - -	115	52
9 ft 6 in (2,9 m) pendant (each) - - - - -	65	29
19 ft 0 in (5,8 m) pendant (each) - - - - -	85	38
12 ft 6 in (3,8 m) strut with sheave - - - - -	665	301
Backstay link (each) attached to strut - - - - -	25	11
Backstay tie link - - - - -	10	4
Backstay link (each) - - - - -	65	29
Backstay spreader - - - - -	50	22
44 ft 7 in (13,6 m) backstay pendant (each) - - - - -	150	68
4 ft 8 in (1,4 m) backstay pendant (each) - - - - -	50	22
Backstay link (each) attached to boom insert - - - - -	20	9
Jib stop assembly - - - - -	175	79
Wire rope anchor - - - - -	70	31
Winch - - - - -	35	15
Load sensor - - - - -	110	49
Jib adaptor (required for No. 82LR boom) - - - - -	400	181

	Weight	
	Pounds	Kilograms
JIB NO. 138:		
15 ft 0 in (4,6 m) butt - - - - -	335	151
15 ft 0 in (4,6 m) top (with jib point and wheel) - - - - -	685	310
10 ft 0 in (3,0 m) insert - - - - -	175	79
70 ft 6 in (21,5 m) basic pendant (each) - - - - -	90	40
9 ft 0 in (2,7 m) pendant (each) - - - - -	20	9
Pendant link (each) - - - - -	5	2
17 ft 9-7/16 in (5,4 m) strut with sheave - - - - -	440	199
Backstay link (each) - - - - -	5	2
56 ft 6-1/2 in (17,2 m) backstay pendant (each) - - - - -	75	34
Jib stop assembly - - - - -	95	43
LUFFING JIB NO. 135:		
27 ft 0 in (8,2 m) butt - - - - -	2,365	1 072
23 ft 0 in (7,0 m) top (with jib point, hand winches, and pendant links) - - - - -	3,005	1 363
10 ft 0 in (3,0 m) insert - - - - -	580	263
20 ft 0 in (6,1 m) insert - - - - -	980	444
40 ft 0 in (12,2 m) insert - - - - -	1,795	814
Offset link adaptor for fold-under arrangement - - - - -	320	145
20 ft 1-1/2 in (6,1 m) basic pendant (each) - - - - -	185	83
25 ft 11 in (7,9 m) basic pendant (each) - - - - -	200	90
10 ft 1 in (3,1 m) pendant (each) - - - - -	130	58
40 ft 3 in (12,3 m) pendant (each) - - - - -	260	117
26 ft 0 in (7,9 m) jib strut with guide sheaves, luffing sheaves and links - - - - -	4,395	1 993
22 ft 6 in (6,9 m) main strut with luffing sheaves and links - - - - -	3,110	1 410
Backstay beam link attached to main strut - - - - -	610	276
12 ft 3 in (3,7 m) basic backstay pendant (each) - - - - -	145	65
3 ft 3 in (1,0 m) backstay link (each) - - - - -	90	40
2 ft 0 in (0,6 m) backstay link (each) - - - - -	65	29
11 in (0,3 m) backstay link (each) attached to boom - - - - -	40	18
Rope guide on boom top for fold under arrangement - - - - -	440	199
Jib stop assembly - - - - -	870	394
Main strut stop assembly - - - - -	260	117
Wire rope guide on jib top - - - - -	600	272
Wire rope anchor - - - - -	225	102
Luffing jib hinge pin (each) - - - - -	25	11
LUFFING JIB NO. 149:		
25 ft 0 in (7,6 m) butt - - - - -	3,275	1 485
25 ft 0 in (7,6 m) top (with main and upper jib point, wire rope guide, hand winch, and strap links) - - - - -	5,875	2 664
10 ft 0 in (3,0 m) insert - - - - -	1,060	480
20 ft 0 in (6,1 m) insert - - - - -	1,710	775
20 ft 0 in (6,1 m) intermediate fall insert - - - - -	2,665	1 208
40 ft 0 in (12,2 m) insert - - - - -	2,995	1 358
Intermediate fall assembly including wire rope guide - - - - -	645	292
21 ft 9-1/2 in (6,6 m) basic strap (each) - - - - -	185	83
10 ft 0 in (3,0 m) strap with link (each) - - - - -	110	49
20 ft 0 in (6,1 m) strap with link (each) - - - - -	185	83
40 ft 0 in (12,2 m) strap with link (each) - - - - -	335	151
Intermediate suspension arrangement required without intermediate fall (complete) - - - - -	90	40
Intermediate suspension arrangement required with intermediate fall (complete) - - - - -	55	24
30 ft 6 in (9,3 m) jib strut with guide sheaves, luffing sheaves and links - - - - -	4,450	2 018
26 ft 6 in (8,1 m) main strut with luffing sheaves and links - - - - -	3,785	1 716

	Weight	
	Pounds	Kilograms
LUFFING JIB NO. 149:		
Backstay spreader link with pins	90	40
7 ft 1 in (2,2 m) backstay spreader strap (each) with pin	80	36
Backstay spreader beam	180	81
9 ft 5 in (1,0 m) backstay strap (each)	95	43
Adjustable link (each) with pin	85	38
20 ft 0 in (0,6 m) basic backstay strap (each)	160	72
10 ft 0 in (3,0 m) strap with link (each)	110	49
20 ft 0 in (6,1 m) strap with link (each)	185	83
40 ft 0 in (12,2 m) strap with link (each)	335	151
15-1/2 in (0,4 m) backstay link (each) attached to boom (with pin)	50	22
Rope guide on boom top	1,245	564
Jib stop assembly	730	331
Main strut stop assembly	325	147
Wire rope guide on jib top	405	183
Luffing jib hinge pin (each)	25	11
MACHINE OPTIONS:		
Carbody jacking (each)	720	326
BOOM NO. 22EL OR NO. 22E OPTIONS:		
Wire rope guide (top - 3 sheave - No. 22EL boom)	1,845	836
Wire rope guide (top - 3 sheave - No. 22E boom)	655	297
Boom butt support assembly	310	140
Auxiliary drum assembly in boom butt	3,670	1 664
Wire rope guide (10 ft (3,0 m) insert - required with auxiliary drum)	335	151
BOOM NO. 82 OPTIONS:		
Upper boom point assembly	920	417
Auxiliary drum assembly in boom butt	3,670	1 664
Wire rope guide (10 ft (3,0 m) insert - required with auxiliary drum)	450	204
Boom assembly ladder storage	30	13
Wire rope guide assembly (boom top)	625	283
Wire rope guide support assembly	505	229
Boom butt support assembly	265	120
LOAD BLOCK AND HOOK AND WEIGHT BALL OPTIONS:		
15 ton (14t) hook and weight ball	1,310	594
30 ton (27t) load block with 500 lb (227 kg) of weight plates	2,000	907
45 ton (41t) load block	2,600	1 179
60 ton (54t) load block	2,825	1 281
100 ton (91t) load block	3,900	1 769
155 ton (141t) load block	4,660	2 113
200 ton (181t) load block	5,600	2 540
220 ton (200t) load block	5,500	2 472
230 ton (209t) load block (Boom No. 22EL)	5,660	2 567
250 ton (227t) load block (Boom No. 82)	6,050	2 744
WIRE ROPE:		
Boom Hoist		
1060 ft (323 m) of 7/8 in (22 mm) wire rope - 1.50 lb per ft (2,23 kg/ m)	1,590	721
Luffing Jib Hoist - No. 135 Luffing Jib		
850 ft (259 m) of 1 in (25,4 mm) wire rope - 2.00 lb per ft (2,98 kg/ m)	1,700	771

	Weight	
	Pounds	Kilograms
WIRE ROPE:		
Luffing Jib Hoist - No. 149 Luffing Jib		
900 ft (274 m) of 1 in (25,4 mm) wire rope - 2.00 lb per ft (2,98 kg/m)- - - - -	1,800	816
Load Lines - Rotation resistant wire rope		
26 mm - 2.13 lb per ft (3,17 kg/ m)		
- - - - - 1625 ft (495 m) No. 82, 82LR or 22EL Boom - - - - -	3,460	1 569
- - - - - 1600 ft (488 m) No. 22E Boom - - - - -	3,410	1 546
- - - - - 1250 ft (381 m) No. 135 Luffing Jib - - - - -	2,665	1 208
- - - - - 1450 ft (442 m) No. 149 Luffing Jib - - - - -	3,090	1 401
26 mm - 2.39 lb per ft (3,56 kg/ m)		
- - - - - 1625 ft (495 m) No. 82, 82LR or 22EL Boom - - - - -	3,885	1 762
- - - - - 1600 ft (488 m) No. 22E Boom - - - - -	3,825	1 734
- - - - - 1250 ft (381 m) No. 135 Luffing Jib - - - - -	2,990	1 356
- - - - - 1450 ft (442 m) No. 149 Luffing Jib - - - - -	3,465	1 571
Alternate Load Lines - Conventional wire rope		
26 mm - 1.94 lb per ft (2,89 kg/m)		
- - - - - 1625 ft (495 m) No. 82, 82LR or 22EL Boom - - - - -	3,155	1 431
- - - - - 1600 ft (488 m) No. 22E Boom - - - - -	3,105	1 408
- - - - - 1250 ft (381 m) No. 135 Luffing Jib - - - - -	2,425	1 099
- - - - - 1450 ft (442 m) No. 149 Luffing Jib - - - - -	2,815	1 276
Whip Lines		
26 mm - 2.13 lb per ft (3,17 kg/m)		
- - - - - 1010 ft (308 m) No. 82 or No. 22EL Boom - - - - -	2,150	975
- - - - - 950 ft (290 m) No. 22E Boom - - - - -	2,025	918
- - - - - 1130 ft (344 m) No. 82LR Boom - - - - -	2,410	1 093
- - - - - 890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing		
Jib - - - - -	1,895	859
- - - - - 1400 ft (427 m) No. 149 Luffing Jib - - - - -	2,980	1 351
26 mm - 2.39 lb per ft (3,56 kg/m)		
- - - - - 1010 ft (308 m) No. 82 or No. 22EL Boom - - - - -	2,415	1 095
- - - - - 950 ft (290 m) No. 22E Boom - - - - -	2,270	1 029
- - - - - 1130 ft (344 m) No. 82LR Boom - - - - -	2,700	1 224
- - - - - 890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing		
Jib - - - - -	2,125	963
- - - - - 1400 ft (427 m) No. 149 Luffing Jib - - - - -	3,345	1 517
Alternate Whip Lines - Conventional wire rope		
26 mm - 1.94 lb per ft (2,89 kg/m)		
- - - - - 1010 ft (308 m) No. 82 or No. 22EL Boom - - - - -	1,960	889
- - - - - 950 ft (290 m) No. 22E Boom - - - - -	1,845	836
- - - - - 1130 ft (344 m) No. 82LR Boom - - - - -	2,190	993
- - - - - 890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing		
Jib - - - - -	1,725	782
- - - - - 1400 ft (427 m) No. 149 Luffing Jib - - - - -	2,715	1 231
Auxiliary Lines		
26 mm - 2.13 lb per ft (3,17 kg/m)		
- - - - - 1010 ft (308 m) No. 82 or 22EL Boom - - - - -	2,150	975
- - - - - 1130 ft (344 m) No. 82LR Boom - - - - -	2,410	1 093
- - - - - 1600 ft (488 m) No. 82E Boom - - - - -	3,410	1 546
- - - - - 1500 ft (457 m) No. 135 Luffing Jib - - - - -	3,195	1 449
- - - - - 2025 ft (617 m) No. 82 or No. 22EL Boom with No. 135 or		
149 Luffing Jib attached - - - - -	4,315	1 957
- - - - - 890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing		
Jib - - - - -	1,895	859
- - - - - 1050 ft (320 m) No. 149 Luffing Jib Intermediate Fall -	2,235	1 013

		Weight	
		Pounds	Kilograms
WIRE ROPE:			
26 mm - 2.28 lb per ft (3,39 kg/m)			
-----	1010 ft (308 m) No. 82 or 22EL Boom -----	2,305	1 045
-----	1130 ft (344 m) No. 82LR Boom -----	2,575	1 168
-----	1600 ft (488 m) No. 82E Boom -----	3,650	1 655
-----	1500 ft (457 m) No. 135 Luffing Jib -----	3,420	1 551
-----	2025 ft (617 m) No. 82 or No. 22EL Boom with No. 135 or 149 Luffing Jib attached -----	4,615	2 093
-----	890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing Jib -----	2,030	920
-----	1050 ft (320 m) No. 149 Luffing Jib Intermediate Fall	2,395	1 086
1 in. - 2.03 lb per ft (3,02 kg/m)			
-----	1010 ft (308 m) No. 82 or 22EL Boom -----	2,050	929
-----	1130 ft (344 m) No. 82LR Boom -----	2,295	1 040
-----	1600 ft (488 m) No. 82E Boom -----	3,250	1 474
-----	1500 ft (457 m) No. 135 Luffing Jib -----	3,045	1 381
-----	2025 ft (617 m) No. 82 or No. 22EL Boom with No. 135 or 149 Luffing Jib attached -----	4,110	1 864
-----	890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing Jib -----	1,805	818
-----	1050 ft (320 m) No. 149 Luffing Jib Intermediate Fall	2,130	966
Alternate Auxiliary Lines - Conventional wire rope			
26 mm - 1.94 lb per ft (2,89 kg/m)			
-----	1010 ft (308 m) No. 82 or 22EL Boom -----	1,960	889
-----	1130 ft (344 m) No. 82LR Boom -----	2,190	993
-----	1600 ft (488 m) No. 82E Boom -----	3,105	1 408
-----	1500 ft (457 m) No. 135 Luffing Jib -----	2,910	1 319
-----	2025 ft (617 m) No. 82 or No. 22EL Boom with No. 135 or 149 Luffing Jib attached -----	3,930	1 782
-----	890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing Jib -----	1,725	782
-----	1050 ft (320 m) No. 149 Luffing Jib Intermediate Fall	2,035	923
1 in - 1.85 lb per ft (2,75 kg/m)			
-----	1010 ft (308 m) No. 82 or 22EL Boom -----	1,870	848
-----	1130 ft (344 m) No. 82LR Boom -----	2,090	948
-----	1600 ft (488 m) No. 82E Boom -----	2,960	1 342
-----	1500 ft (457 m) No. 135 Luffing Jib -----	2,775	1 258
-----	2025 ft (617 m) No. 82 or No. 22EL Boom with No. 135 or 149 Luffing Jib attached -----	3,745	1 698
-----	890 ft (271 m) No. 138 Fixed Jib on No. 135 Luffing Jib -----	1,645	746
-----	1050 ft (320 m) No. 149 Luffing Jib Intermediate Fall	1,945	882

ENGLISH AND METRIC CONVERSIONS

Inverse Conversion

Direct Conversion

MULTIPLY (x) known value by conversion factor to obtain equivalent value in desired units. For example, 12 ft is converted to meters (m), as follows:

$$12 \text{ ft} \times 0.3048 = 3,6576 \text{ m}$$

DIVIDE (÷) known value by conversion factor to obtain equivalent value in desired units. For example, 3,6576 m is converted to feet, as follows:

$$3,6576 \text{ m} \div 0.3048 = 12$$

To Convert	Symbol	Application	To	Symbol	Multiply By
AREA					
Square Inch	in ²	Filter Area Clutch Contact	Square Centimeter	cm ²	6.4516
Square Foot	ft ²	Ground Contact	Square Meter	m ²	0.0929
FORCE					
Pound Force	lb	Pedal Effort	KiloNewton Newton	kN N	0.00445 4.4482
Pound Force	lb	Line Pull	KiloNewton	kN	0.00445
Pound Force Per Inch	lb/in.	Spring Force	Newton per millimeter	Nmm	0.1751
Pound Force Per Foot	lb/ft		Newton per meter	Nm	14.5939
LENGTH					
Inch	in.	Adjustments	Millimeter	mm	25.4000
Foot	ft	Outline Dimensions	Meter	m	0.3048
Mile	miles	Travel Distance	Kilometer	km	1.6093
POWER					
Horsepower	hp	Engine	Kilowatt	kW	0.7457
PRESSURE					
Pound/Sq. In.	psi	Hydraulic & Air	Bar		0.0689
TEMPERATURE					
Degrees Fahrenheit	°F	Oil, Air, Etc.	Degrees Centigrade	°C	°F - 32 ÷ 1.8
Degrees Centigrade	°C		Degrees Fahrenheit	°F	°C x 1.8 + 32
TORQUE					
Inch Pound	in lb	Bolt Torque	Newton Meter	Nm	0.1129
Foot Pound	ft lb		Newton Meter	Nm	1.3558
VELOCITY					
Miles Per Hour	mph	Vehicle Speed	Kilometers Per Hour	km/h	1.6093
Miles Per Hour	mph	Wind Speed	Meters Per Second	m/s	0.4470
Feet Per Minute	fpm	Line Speed	Meters Per Minute	m/min	0.3048
VOLUME					
Cubic Yard	yd ³	Bucket Capacity	Cubic Meter	m ³	0.7646
Cubic Foot	ft ³		Cubic Meter	m ³	0.0283
Cubic Inch	in ³	Pump Displacement	Cubic Centimeter	cm ³	16.3871

To Convert	Symbol	Application	To	Symbol	Multiply By
VOLUME (LIQUID)					
Ounce	oz	Fluid Capacities	Milliliter	mL	29.5735
Pint	pt		Liter	L	0.4732
Quart	qt		Liter	L	0.9464
Gallon	gal		Liter	L	3.7854
Gallon Per Minute	gpm	Pump Flow	Liters Per Minute	L/min	3.7854
WEIGHT					
Pound	lb	Unit/Component	Kilogram	kg	0.4536
Ton (2000 lb)	USt	Load Ratings	Metric Ton	t	0.9072
Ton (2000 lb)	USt		Kilogram	kg	907.1847

SECTION 2

SAFETY INFORMATION

TABLE OF CONTENTS

Continuous Innovation	2-1
Nameplates and Decals	2-1
Safety Messages	2-1
General	2-1
Safety Alert Symbol	2-1
Signal Words	2-1
Symbol Identification	2-1
Safety and Information Signs	2-3
Maintaining Signs	2-3
Ordering Signs	2-3
Crane Access Points	2-5
General	2-5
Getting On or Off Crane	2-5
Operator Manual/Capacity Chart Storage	2-6
General	2-6
Storing Manuals	2-6
Safe Operating Practices	2-7
General	2-7
Read Operator Manual	2-7
Operator Qualifications	2-7
Operator Conduct	2-7
Handling Load	2-9
Size of Load	2-9
Attaching Load	2-9
Lifting/Moving Load	2-10
Multiple Load Line Operation	2-11
Holding Load	2-12
Signals	2-12
Safety Devices	2-13
Operational Aids	2-13
Category 1 Operational Aids	2-13
Category 2 Operational Aids	2-14
Assembling, Disassembling, or Operating Crane Near Electric Power and Transmission Lines	2-15
Electrocution Hazard	2-15
Set-Up and Operation	2-15
Electrocution Hazard Devices	2-16
Electrical Contact	2-16
Refueling	2-17
Fire Extinguishers	2-17
Accidents	2-17
Safe Maintenance	2-17
Maintenance Instructions	2-17
Safe Maintenance Practices	2-17
Environmental Protection	2-19
Boom Disassembly Safety	2-20
General	2-20
Location	2-20
Pin Removal	2-20
Disassembly Precaution — #82 Boom	2-20
Disassembly Precaution — #22E/22EL Boom	2-22
Personnel Handling Policy	2-23

Pedestal/Barge Mounted Cranes	2-26
Pedestal Mounted Crane	2-26
Definition	2-26
Examples	2-26
Barge Mounted Crane	2-27
Definition	2-27
Examples	2-27
Capacity Charts	2-28
Shock Loading	2-28
Definition	2-28
Operation On Barge	2-28
General	2-28
Definitions	2-28
Crane Inspection	2-29
Transporting Crane on Barge	2-29

SECTION 2

SAFETY INFORMATION



WARNING

California Proposition 65

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel.

Battery posts, terminals, and related accessories contain chemical lead and lead compounds, chemicals known to the State of California to cause cancer, birth defects, and other reproductive harm. Wash hands after handling.

California Spark Arrestor

Operation of this equipment may create sparks that can start fires around dry vegetation. A spark arrestor may be required. The owner/operator should contact local fire agencies for laws or regulations relating to fire prevention requirements.

CONTINUOUS INNOVATION

Due to continuing product innovation, the information in this manual is subject to change without notice. If you are in doubt about any procedure, contact your Manitowoc dealer or the Manitowoc Crane Care Lattice Team.

NAMEPLATES AND DECALS

See drawing at the end of this section.

SAFETY MESSAGES

General

The importance of safe operation and maintenance cannot be over emphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or injury and costly damage to the crane and property.

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a safety alert symbol and a signal word to identify the hazard's degree of seriousness.

Safety Alert Symbol



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. **Obey all safety messages that follow this symbol to avoid possible death or injury.**

Signal Words



DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION

Used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

Without the safety alert symbol, identifies potential hazards that could result in property damage.

NOTE: Highlights operation or maintenance procedures.

Symbol Identification

Many of the symbols used in the safety and information signs and nameplates on this crane are identified in [Table 2-1](#) and [Table 2-2](#).

Table 2-1 Common Safety Symbols





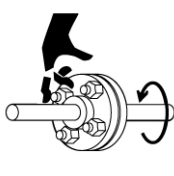


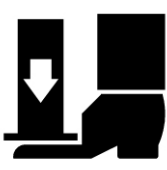












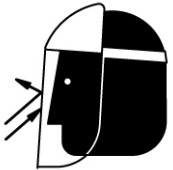




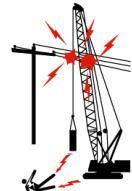


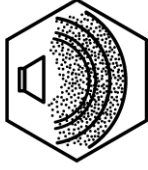









Cut or Crush Hazards					Cut Hazard
 M100090	 M100091	 M100066	 M100065	 M100069	 M100067
Crush Hazards					Fire Extinguisher
 M100070	 M100071	 M100072	 M100073	 M100074	 M100082
Fall Hazards			Falling Boom (Crush) Hazards		Explosion Hazard
 M100083	 M100084	 M100085	 M100068	 M100075	 M100080
Falling Load Hazards		Flying Objects Hazards		Overhead Obstruction Hazard	Pressure Release Hazard
 M100076	 M100077	 M100086	 M100088	 M100089	 M100081
Electrocution Hazards		Personal Fall Protection	Pressure Cleaning	Sound Power Level	Read Manual
 M100078	 M100079	 M100095	 M100087	 M100096	 M100093

Table 2-2 Miscellaneous Symbols

Diesel Fuel	Engine Coolant	Engine Coolant Vent	Engine Oil Level	Hydraulic Filter	Hydraulic Oil
 M100271	 M100267	 M100268	 M100269	 M100272	 M100273
Pump Drive Oil Level	Tire Pressure (if equipped)				
 M100270	 M100266				

2

SAFETY AND INFORMATION SIGNS



Maintaining Signs

The crane owner/user shall make sure that all safety and information signs are legible and installed at the proper locations on the crane. If a sign has been defaced or removed, it must be replaced immediately. See the Nameplate and Decal Drawing at the end of this section for the installation locations of signs.

Ordering Signs

Order replacement safety and information signs from your Manitowoc dealer.

When ordering a sign, give the crane model number, the crane serial number, and the name and part number of the sign.

Item	Description
1	Steps
2	Platforms (front and rear)
3	Platforms (side)
4	Catwalk (operator's cab)
5	Ladder (behind door)
6	Enclosure Doors
7	Platform (between drums)
8	Tool Storage Compartment (front corner of right enclosure)
	Non-Skid Surfaces
	Platforms and Steps

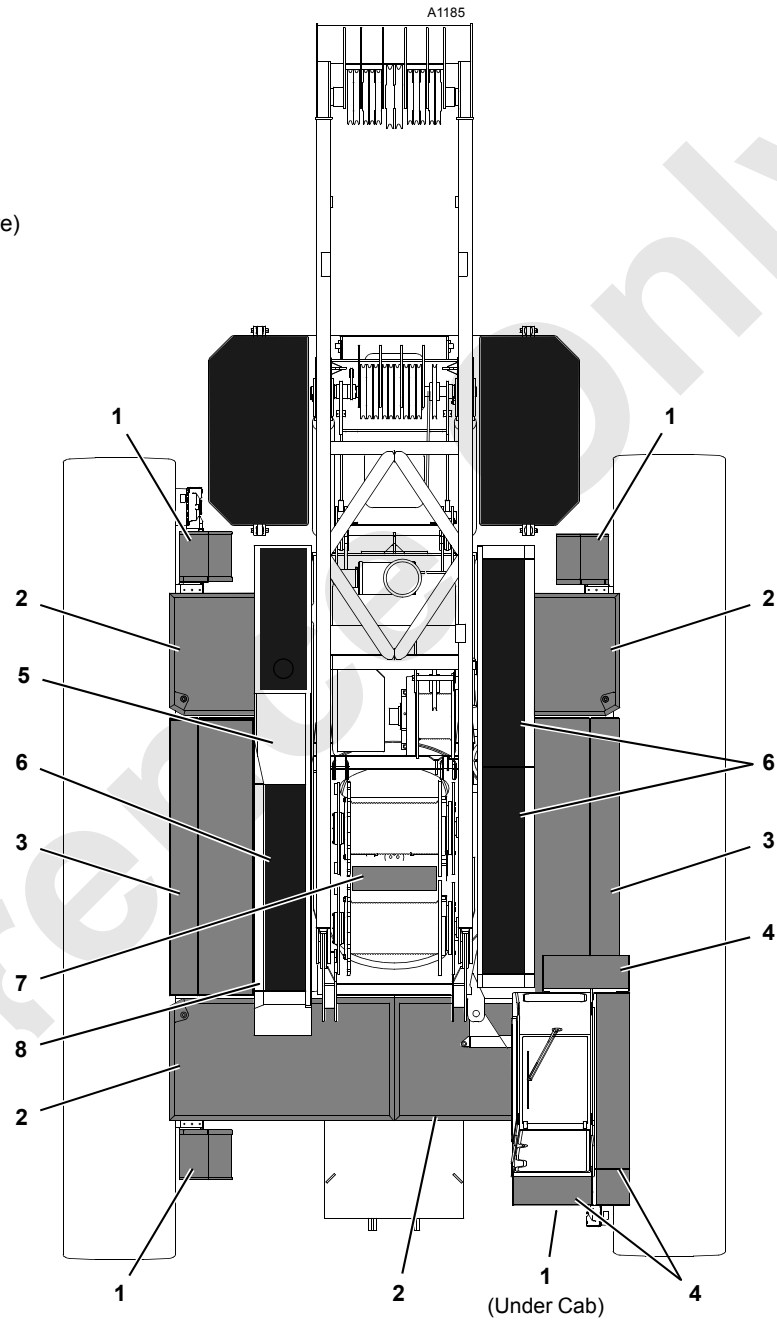


FIGURE 2-1

CRANE ACCESS POINTS



WARNING

Crush Hazard!

Upperworks can swing into and crush personnel climbing on or off crane.

Moving crawlers can crush personnel climbing on or off crane.

To prevent death or serious injury:

- Barricade all accessible areas to crane so personnel cannot be struck or crushed when upperworks is swung.
- Do not climb onto or off crane while upperworks is being swung or crane is being traveled.
- Signal operator for permission to climb onto/off crane.
- Operator: do not swing or travel while personnel are climbing onto or off crane. Stop swing and travel motions. Apply swing brake and turn on travel park.
- Operator: Always sound horn to alert personnel before you swing or travel.
- If equipped, automatic alarms will sound to alert personnel when the crane is swung or traveled.

NOTE: If the swing and travel alarms are not operating properly, they must be repaired as soon as possible. Until they are repaired, the operator shall alert personnel to crane movement using the horn on the control console.

General

Take necessary precaution to prevent slipping and/or falling off the crane during assembly, disassembly, maintenance, or other work. **Falling from any height could result in serious injury or death.**

Manitowoc has provided stairways, ladders, and platforms at the locations shown in [Figure 2-1](#).

The owner/user shall provide workers with approved ladders or aerial work platforms to access those areas of the crane, mast, and boom that cannot be reached from the ground or from steps, ladders, catwalks, and platforms provided by Manitowoc.

Adhere to local, state, and federal regulations for handling personnel and for personnel fall protection.

- Access points must be kept clear to prevent personal injury and unsafe operation of crane. Store clothing and

other personal belongings so they do not interfere with controls in operator's cab or with operation of crane.

- Do not allow ground personnel to store their personal belongings (clothing, lunch boxes, water coolers, and the like) on the crane.

This practice will prevent ground personnel from being crushed or electrocuted when they attempt to access personal belongings stored on the crane.

- Tools, oil cans, spare parts, and other necessary equipment must be stored in tool boxes or other appropriate locations. Do not allow these items to lie around loose in operators cab or on steps, ladders, catwalks, and platforms.
- To reduce risk of slipping, non-skid material (sand in paint) has been applied to painted walkways and platforms.

Walkways and platforms can be slippery when wet and when oil or is grease is spilled on them. **Keep walkways and platforms clean and dry to prevent slipping on them.** When non-skid material wears out, reapply it.

- Wear shoes with a highly slip-resistant sole material. Clean any mud or debris from shoes before entering the crane cab or climbing onto the cab. A shoe that is not clean might slip off a control pedal during operation.
- Do not make modifications or additions to the crane's access system that have not been evaluated and approved by Manitowoc.
- Do not use top of mast, boom, or jib as walkways unless they have catwalks.

NOTE: Catwalks are available from Manitowoc for boom and jib sections.

Two optional ladders, stored in the boom butt, are available for boom assembly and disassembly. See Boom Ladder Assembly in Section 4 for instructions.

GETTING ON OR OFF CRANE

Personnel getting on and off crane shall do so only at steps or ladders provided and only **while crane is parked**.

Never climb onto or off a moving crane. **Climb onto and off crane only when it is parked and only with operator's permission.**

When personnel use ladders to get on or off the crane, their hands shall be free of any objects. Objects which cannot be carried in pockets or tool belts must be lifted into place with a hand line or hoist.

OPERATOR MANUAL/CAPACITY CHART STORAGE

General

Manitowoc provides the following manuals and other important literature with your crane and attachment (Luffing Jib, etc.):

- Operator Manual (Serial Numbered)
Contains safety information, crane specifications, assembly/erection procedures, operating instructions, lubrication and maintenance checks.
- Parts Manual (Serial Numbered)
Contains illustrations and part numbers of replaceable parts.
- Capacity Chart Manual (Serial Numbered)
Contains lifting capacities and related information (wire rope specifications, drum and lagging information, etc.)
- Maintenance Checks and Lube Guide
Contains lists of maintenance checks and lube services and their prescribed intervals.
- Rated Capacity Indicator/ Limiter Operation
Contains rated capacity indicator and/or rated capacity limiter operation, limits, and calibration procedures.
- Service Manual (Serial Numbered)
Contains theory of operation, maintenance procedures, crane and wire rope inspection procedures, troubleshooting information, and shop procedures.

The manuals which must be retained in the operator's cab (Operator Manual, Capacity Charts, Maintenance Checks and Lube Guide, and RCL Operation) are supplied in an OPERATOR INFORMATION binder. A separate binder is provided for the crane and each applicable attachment.

The Operator Manuals and Capacity Charts are stamped with the serial number of the crane or attachment. The serial number on the manuals and capacity charts must match the serial number of the crane and attachment in use. **Using any other manual or capacity chart is prohibited.**

- The crane model and serial number are located on the Crane Identification Plate on the crane cab.

- The model and serial number of the attachment (other than standard boom) is located on the Crane Identification Plate on the attachment.

If the serial numbers of your manuals and capacity charts do not match the serial numbers of the crane or attachment, contact your Manitowoc dealer for the proper manual or capacity charts.

Do not operate crane or attachment if proper Capacity Chart is not in cab.

Storing Manuals

Store a copy of the Operator Manual for the crane and each applicable attachment in the holder provided in the Operator's cab ([Figure 2-2](#)).

Attach the chain from the manual in use to the link behind the operator's seat.

Keep all other manuals provided with the crane in the crane owner's/user's office so they are readily available when needed.

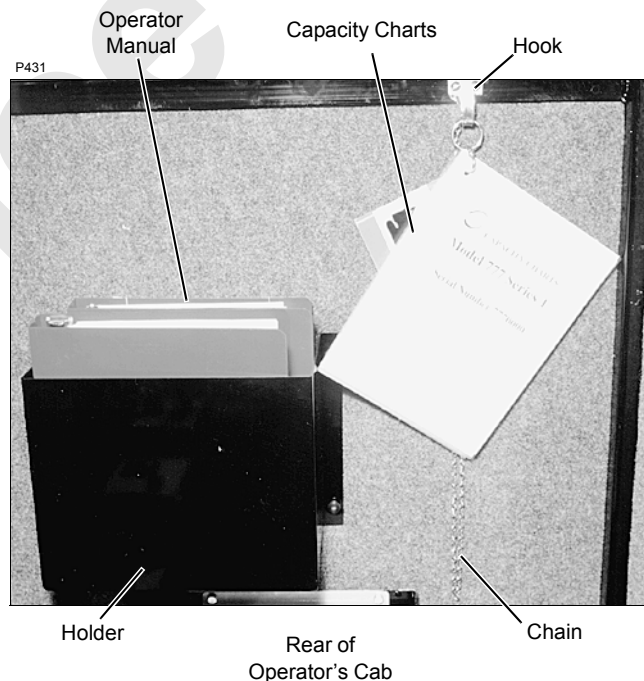


FIGURE 2-2

SAFE OPERATING PRACTICES

General

The importance of safe operation cannot be over emphasized. Carelessness and neglect on the part of operators, supervisors and planners, rigging personnel and job site personnel can result in their death or injury and costly damage to the crane or property.

The safety information in this publication is intended only as a guide to assist qualified operators, supervisors and planners, rigging personnel, and job site personnel in safe operation. Manitowoc cannot foresee all hazards that will arise in the field. Therefore, **safety remains the responsibility of crane operators and owner.**

Local, state, and other governmental agencies may require stricter operating practices. When a conflict in practices exists, follow the strictest practice.

Read Operator Manual

Safe and efficient assembly, disassembly, and operation of this crane requires that it be maintained in proper working order and that its operators and maintenance personnel be familiar with the crane's functions and capabilities.

The Operator Manual supplied with and considered part of your crane must be read and completely understood by each person responsible for assembly, disassembly, operation, and maintenance of the crane.

The Operator Manual must be read to personnel who cannot read or understand English or other language into which the manual is translated.

Because of a program of continuing improvement in product design, Manitowoc reserves the right to change the information and specifications contained in the Operator Manual at any time without notice. If you have any questions regarding the crane or its Operator Manual, please contact your Manitowoc dealer.

Operator Qualifications

The crane must be operated only by the following **qualified** personnel:

1. Designated operators
2. Trainees under direct supervision of a designated operator
3. Supervisors, inspectors, and maintenance or test personnel when necessary in performance of their duties. Operation of the crane by these personnel must be limited to the crane functions needed to perform the inspection or to verify the crane's performance after maintenance procedures.

No personnel shall be allowed to climb onto crane or enter crane cab unless performance of their duties requires them to do so, and then only with knowledge of operator or other qualified person.

Qualified person is defined as one who by reason of training and experience is thoroughly familiar with crane operations and the hazards involved. Such a person shall meet the operator qualifications specified in Occupational Safety and Health Administration (OSHA) Regulations (United States Federal Law), in ASME B30.5 American National Standard, or in any other applicable federal, state, or local laws.

Operator training and qualification is crane owner's responsibility.

NOTE: The regulations and standards mentioned above and later in this section can be obtained from:

US DOL/OSHA Rules and Regulations are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954 or by:

- Phone 202-512-1899
- Fax 202-512-2250
- Online at www.osha.gov.

ASME (formerly ANSI) B30 Series American National Standards are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 07004-2900 or by:

- Phone US & Canada 800-843-2763
- Phone Mexico 95-800-843-2763
- Phone Universal 973-882-1167
- Fax 973-882-1717 or 973-882-5155
- E-mail infocentral@asme.org.

Operator Conduct

1. The operator shall not engage in any practice which diverts his/her attention while operating the crane.
2. The operator shall not operate the crane when he/she is physically or mentally unfit.
3. The operator shall be responsible for all operations under his/her direct control. When safety of an operation is in doubt, the operator shall stop the crane's functions in a controlled manner. Lift operations must resume only after safety concerns have been addressed or the continuation of crane operations is directed by the lift supervisor.
4. The operator shall be thoroughly familiar with operation of crane and its proper care. If adjustments or repairs are necessary or if there are known defects that impair safe

operation, the crane must not be operated until unsafe conditions have been corrected.

5. If there is a warning sign at the start controls, the operator shall not start the engine until the warning sign has been removed by the person who installed it.
6. Before starting the engine, the operator shall make sure that:
 - a. All daily inspection and maintenance services have been performed.
 - b. All controls are in off the position and all brakes and locking devices are applied or engaged.
 - c. All personnel are clear of the crane. Deploy a swing radius barrier.



WARNING

Safety devices and operational aids such as rated capacity indicator or limiter, boom and jib angle indicator or limiter, anti-two-block device, level indicator, swing limiter, proximity device, etc., may be installed on your crane. Such devices are to be used only as **AIDS TO ASSIST OPERATOR**. Their presence on crane in no way substitutes for or lessens requirement that operator knowledge, experience, and judgment are required to ensure safe operation of crane.

Crane must not be loaded beyond applicable static or dynamic ratings given in Capacity Chart for crane.

- See Size of Load later in this section.
- For a description of each safety device and operational aid, see Safety Devices and Operational Aids in this section and Section 3.

7. The operator shall test all controls, limits, and communication systems at the start of each shift. Any defects found must be corrected before operation is begun.
8. The operator shall not start crane movement if the load or designated signal person is not within his/her range of vision or communication.
9. The operator shall understand and respond to signals from the person directing the lift or from the designated signal person. When a signal person or crane follower is not required, the operator is responsible for the lift. **Operator shall obey a stop signal at all times, no matter who gives it.**
10. The operator shall verify that the Capacity Chart being used is the correct one for the cranes configuration (boom length, load line reeving, counterweight, etc.).
11. The operator shall verify that:

- a. All attachments are properly assembled and attached to the crane according to the rigging drawings called for in the Capacity Chart.
- b. The counterweight — to include applicable auxiliary counterweight — is in place and of proper weight. **Maximum required counterweight must not be exceeded.**



WARNING

Moving Load/Tipping Crane Hazard!

Changing weather conditions including but not limited to: wind, ice or snow accumulation, precipitation, flooding, lightning, etc. should be considered when determining the location and configuration of a crane when it will be left unattended.

12. The operator shall perform the following operations before leaving the operator's cab for any reason:
 - a. Park crane and position upperworks so crane does not interfere with operation of other equipment.
 - b. Apply travel and swing brakes or locking devices.
 - c. Land any attached load.
 - d. Lower the boom onto blocking at ground level or onto a boom rest if possible.

If the boom cannot be lowered, as determined by a qualified designated person, it must be securely fastened from movement by wind or other outside forces (see Wind Conditions in Capacity Chart Manual).

NOTE: The designated person shall be familiar with the job site limitations, the crane configuration, and the expected weather conditions.

- e. Move all controls to off.
- f. Apply all drum brakes and pawls.
- g. Disengage the master clutch, if equipped.
- h. Stop the engine.

NOTE: Also read Unattended Crane instructions in Section 3.

13. The operator shall perform the following operations if power or a control function fails during operation:
 - a. Land all suspended loads, if possible, under brake or power control.
 - b. Apply all brakes and locking devices.
 - c. Move all controls to off.

14. If the crane will be operated at night, the operator shall make sure that there is sufficient lighting for safe operation. The load and landing area must be illuminated.

15. The operator shall not operate the crane during periods of bad weather if his/her ability to see the load or the signal person is impaired by darkness, fog, rain, snow, and the like.

Do not operate the crane with a snow or ice covered boom. The extra weight may cause overload, tipping, or structural damage.

Never operate the crane during an electrical thunderstorm.

When a local weather storm warning exists (including electrical thunderstorm), stop operation and secure the crane. See step 12 under Operator Conduct topic.

NOTE: DO NOT depend on grounding. Grounding of a crane affords little or no protection from electrical hazards. The effectiveness of grounding is limited by the size of the conductor (wire) used, condition of the ground, the magnitude of voltage and current present, and numerous other factors.

16. Wind can cause the crane to tip or the boom and other attachments to collapse. The operator or qualified person directing the lift shall compensate for the effect of wind on the load and boom by reducing ratings, reducing operating speeds, or a combination of both.

Unless otherwise specified in the Capacity Chart, or in Operator Manual, stop operation under the following wind conditions:

- a. If the wind causes the load to swing forward past the allowable operating radius or sideways past either boom hinge pin, land the load and apply the drum brakes.
- b. If the wind exceeds 35 mph, land all loads and apply the drum brakes, lower the boom onto blocking at ground level or otherwise restrain it, and apply the swing and travel brakes and/or locks.

NOTE: *“Land load”* means to set it down on a firm uniformly supporting surface.

17. Booms, jibs, or masts which are being assembled or disassembled on the ground (with or without support of boom rigging) must be securely blocked to prevent the boom, jib, or mast sections from dropping.

Workers shall not go under boom, jib, or mast sections when removing connecting pins or bolts.

18. Each outrigger must be visible to the operator or the signal person during extension and retraction.

Handling Load

Size of Load

1. The crane must not be loaded beyond the applicable static or dynamic ratings given in the Capacity Chart for the crane configuration.

NOTE: Capacity charts for Manitowoc cranes show the total weight of freely suspended loads for various boom and jib lengths and operating radii.

“Freely suspended load” is a load that is hanging free with no direct external force applied except by the crane’s load-line reeving.

To determine the actual weight of the load which can be lifted at a given radius (working load), the operator shall deduct the weight of certain lifting equipment from the total weight given in the chart. See the specific Capacity Chart for your crane for a list of lifting equipment which must be deducted.

The operator’s judgment must be used to further reduce total the load to allow for the dynamic effects of swinging, hoisting, or lowering, and adverse weather conditions to include wind.

2. The operator or other designated person directing the lift shall verify that the weight of load is within the static or dynamic rating for radius at which load will be lifted.

Verified weights and measured radii must take priority over RCI/RCL readings.

Attaching Load

1. Attach the hook to the load with slings, or other suitable rigging. Each hook must have a latch that is in proper working order. **Hook latches must not be wired open.**
 - a. Inspect each hook and latch before using.
 - b. Never use a hook or latch that is distorted or bent.
 - c. Make sure spring will force the latch against the tip of the hook.
 - d. Make sure the hook supports the load. The latch must never support the load. Latches are only intended to retain loose slings under slack conditions.
2. Only use slings and other rigging that are in safe operating condition and have a rating equal to or greater than the load to be lifted.
3. Do not wrap the load line around the load.
4. Use suitable protection between slings and any sharp edges on the load. When synthetic slings are used, the synthetic sling manufacturer’s instructions, limitations, specifications, and recommendations must be followed.

5. Secure unused legs of a multi-leg sling before handling a load with one leg of sling.

Lifting/Moving Load

1. Before lifting or moving a load, the operator or qualified person directing the lift shall make the following checks:

- a. Crane has a firm, uniformly supporting foundation under all crawlers. Unless otherwise specified in the Capacity Chart, the foundation must be level to within 1% — 1ft (0,3 m) rise or fall in 100 ft (30,5 m) distance.

When such a surface is not available, it must be provided with timbers, cribbing, or other structural members to distribute the load such that the allowable bearing capacity of the underlying member is not exceeded.

For ground bearing data go to:
www.manitowoccranes.com

- b. The load is secured and properly balanced in the slings or the lifting device before lifting the load more than 3 to 6 in (76 to 152 mm).
- c. The lift and swing paths are clear of personnel and obstructions.
- d. The load is free to be lifted.
- e. The load line is not kinked or otherwise damaged.
- f. Multiple part load lines are not twisted around each other in such a manner that the lines will not separate when the load is lifted.
- g. The hook is brought over the load in a manner that will minimize twisting or swinging.
- h. The load line and the boom hoist rope are properly spooled on the drums and seated in the sheaves.
- i. The load drum brakes are in proper working order.

The operator shall test the load drum brakes each time a load approaching the rated load is handled. Lift the load 3 to 6 in (76 to 152 mm) and fully apply the brakes — load must not lower through applied brakes.

- j. Unused load drums are parked (working and parking brakes applied if equipped, drum pawls engaged).
- k. All personnel are clear of the swing radius of the crane's counterweight.

2. While lifting or moving the load, the operator shall take the following precautions:

- a. Accelerate and decelerate the load smoothly to avoid excessive stress on the crane boom and machinery.

- b. Avoid sudden starts and stops while swinging. Keep the swing speed under control to prevent the load from swinging out beyond the radius at which the load can be handled and to minimize the pendulum action of the load.

- c. Sound the signal horn before swinging and intermittently while swinging, especially when approaching personnel.

If equipped, the automatic swing alarm will sound when the crane is swung.

- d. Use taglines or other restraints to control the load when necessary.
- e. Do not exceed any swing limitations (areas of operation) given in the Capacity Chart.
- f. Do not allow the load, the boom, or any other part of the crane to contact obstructions.
- g. Do not use the crane to drag a load.
- h. Do not hoist, lower, or swing the load while personnel are on the load or the hook. See Personnel Handling in this section.
- i. Avoid carrying the load over personnel. Loads which are suspended must be blocked or cribbed before personnel are allowed to work under or between them.

- j. Before lifting a load which requires the use of outriggers (or anytime outriggers are used), fully extend the outrigger beams and jacks so the truck tires do not bear any load.

Securely fasten the outrigger jack pads or floats to jacks and set them on a flat, firm surface that will support the load placed on the pads or floats. Do not set the jack pads or floats in holes, on rocky ground, or on extremely soft ground.

When dictated by ground conditions, install wood blocking or steel plates under the jack pads or floats to properly distribute the loading on the supporting surface.

Wood blocking or steel plates used under the jack pads or floats must be:

- Free of defects
- Strong enough to prevent crushing, bending, or shear failure
- Of sufficient thickness, width, and length to completely support the jack pad or float, transmit the load to the supporting surface, and prevent shifting, toppling, or excessive settlement under load

- k. Fully retract and lock the jacks and the outrigger beams so they cannot extend when not in use.

- I. Operate with extreme caution when using two or more cranes to lift the same load.

One designated person shall be responsible for operation when two or more cranes are used to lift same load. The designated person shall analyze the lift and instruct all personnel involved in proper rigging and positioning of the load and all movements to be made. Decisions such as the necessity to reduce crane ratings, load position, boom position, ground support, and speed of movements must be in accordance with the designated person's decision.

- m. Do not lower the load or the boom to a point where less than three full wraps of wire rope are remaining on the respective drum (or as otherwise indicated in local, state, or federal regulations).
 - n. Engage the boom hoist pawl when operating with the boom at a fixed radius.
 - o. Engage the luffing hoist pawl when operating with the luffing jib at a fixed radius.
3. While traveling, the operator shall take the following precautions:
- a. Sound the signal horn before traveling and intermittently while traveling, especially when approaching personnel.
If equipped, the automatic travel alarm will sound when the crane is traveled.
 - b. Carry the boom in-line with the lowerworks and facing the direction of travel.
 - c. Do not position the boom so high that it could bounce over backwards whether traveling with or without load.
 - d. Secure the rotating bed against rotation except:
 - When operating with a MAX-ER attachment
 - When it is necessary to negotiate a turn, and then only when the operator is seated at controls or the boom is supported on a dolly
 - e. Lash or otherwise restrain unused hooks so they cannot swing freely.
4. Before traveling with a load, the operator shall take the following additional precautions:
- a. A designated person shall be responsible for operation. Decisions such as the necessity to reduce crane ratings, load position, boom position, ground support, and speed of movements must be in accordance with the designated person's decision.
 - b. Maintain specified tire pressures (truck cranes).

- c. Avoid sudden starts and stops. Use taglines or other restraints to control the position of the load.

Multiple Load Line Operation



WARNING

Avoid Over Load and Side Load Damage to Crane

Manitowoc highly recommends that you contact your Maniowoc dealer for lift planning assistance and approval.

Multiple load line operation is becoming common practice for applications like panel tilt-up, pile tilt-up, pile driving, rolling fabricated sections, etc. The multiple lines may be on a common shaft (each with different parts of line) or on multiple shafts (lower boom point and upper point, boom point and fixed jib point, etc).

Manitowoc authorizes multiple load line operation for those applications requiring it, provided the following steps are performed:

1. The qualified lift planner and the crane operator shall read and become thoroughly familiar with the appropriate Capacity Charts and Wire Rope Specification Charts.
2. The lift planner and the crane operator shall make sure the total load does not exceed the rated capacity given in the Capacity Chart and Wire Rope Specification Chart for given boom point or jib point, whichever is less.
EXAMPLE: If one load line is lifting from the jib point, the proper jib chart applies.
3. The crane must be thoroughly inspected by a qualified person prior to setup.
4. The crane must be thoroughly inspected for load line interference caused by routing and reeving of multiple load lines. If interference is found, it must be eliminated.
5. For cranes produced before 2003, Rated Capacity Indicators/Limiters were not required by ASME B30.5 for non-personnel lifting.

To aid the operator in staying within the crane's Capacity Chart with the total applied load, Maniowoc recommends that its cranes be equipped with Rated Capacity Indicators/Limiters to monitor the load on each load line.

Operator is still responsible for knowing load and radius whether or not crane is equipped with load indicator(s).

6. Maniowoc recommends that each load line be equipped with an anti-two-block device.

7. Manitowoc's Capacity Charts are based on freely suspended loads. To prevent side load damage to the boom, the jib, and the sheaves:
 - The load lines must hang as close to vertical as possible to minimize side and forward loads.

The distance between the load points and the hook points must be a minimum of three times the horizontal distance between the hook point on the load being lifted.
 - The load must remain centered on the boom and jib point shafts unless special lift approval is granted by Manitowoc.
 - The load lines should be located over the load's center of gravity as it is supported on a trailer, a barge, or the ground.
8. The crane operator shall be familiar with the operational characteristic of the crane as it relates to multiple drum operation (simultaneous operation, same or opposite direction, or individual operation).
9. When using tandem drums, the maximum operating layers may be limited depending on whether the crane was initially designed for tandem drum operation or not.
10. Load shift when lifting with two hooks may be more unpredictable than typical one hook lifting.

Holding Load

When a load is suspended, the operator shall take the following precautions:

1. Not leave his/her position at the controls
2. Not allow personnel to stand or pass under the load
3. Move all controls to off, apply all drum brakes, engage the boom hoist pawl, and apply the swing and travel brakes or locks.

SIGNALS

1. Continuous communication must be maintained between the operator and the signal person during all crane movements. If communication is disrupted, **operator shall stop all crane movements.**
2. Signals to the operator must be in accordance with the standard signals shown in Section 3, unless communications equipment (telephone, radio, etc.) is used.
3. All signals must be easily understood by the operator at all times. The operator shall not respond to any signal which is not clearly understood.
4. For operations not covered in the standard signals, or for special situations or emergencies, additional signals may be required. In those cases, the signals used must be agreed upon in advance by the operator and the signal person. The signals used must not conflict with or have potential to be confused with the standard signals.
5. When it is necessary to give instructions to the operator (other than those established by the signal system), all crane motions must be stopped.
6. The signal person shall:
 - a. Be tested by a designated person and show that he or she has a basic understanding of crane operations and limitations, to include boom deflection.
 - b. Be thoroughly familiar with the standard hand signals and voice signals if used.
 - c. Be positioned in clear view of the operator. The signal person's position should give him or her a clear view of the load, the crane, and the operating area.
 - d. Direct the load so it does not pass over personnel.
 - e. Keep unnecessary personnel out of the crane's operating area.
7. When moving the crane, the following audible signals must be used:
 - a. STOP - one short audible signal
 - b. GO AHEAD - two short audible signals
 - c. BACK UP - three short audible signals

SAFETY DEVICES



WARNING

Do not operate crane unless all safety devices listed in this section are in proper working order.

- If a safety device stops working properly during operation, the operator shall safely stop operation.
- If any safety device listed in this section is not in proper working order, the safety device must be taken out of service and crane operation must not resume until the safety device is again working properly.
- Alternative measures are not permitted to be used for a faulty safety device.
- Always tag-out any faulty safety device and place a warning tag in the cab stating that the crane is out of service and must not be used.

Manitowoc provides the following safety devices on its cranes.

1. Horn activated by a switch on the control console in the operator's cab
If the horn is not working properly, it must be tagged-out or removed, if possible.
2. Crane level indicator: either electronic (viewable in crane's electronic display) or mechanical (viewable from operator's cab seat). If the crane level indicator is not working properly, it must be tagged-out or removed, if possible.
3. Cranes operating on a barge require: a trim indicator, a swing brake, and a wind direction indicator if the wind is a factor (supplied by crane owner or user).
4. Boom stops, both physical and automatic
If a boom stop is damaged or not working properly, it must be tagged-out or removed if possible.
5. Jib stops, both physical and automatic (for fixed jib and luffing jib)
If a jib stop is damaged or not working properly, it must be tagged-out or removed, if possible.
6. Pedal locks for all foot-operated brakes (if applicable)
If a pedal lock is damaged or not working properly, it must be tagged-out or removed if possible.
7. An integral holding device or check valve on each jacking cylinder

OPERATIONAL AIDS



WARNING

Do not operate crane unless all applicable operational aids listed in this section are in proper working order, except:

- Where an operational aid is being repaired
- The crane user implements a specified temporary alternative measure

If an operational aid stops working properly during operation, the operator shall safely stop operation until the temporary alternative measures are implemented or the device is again working properly.

Manitowoc provides the following operational aids on its cranes, either as standard equipment or optional equipment. The operational aids are designated as Category 1 or Category 2:

Category 1 Operational Aids

If a Category 1 operational aid is not working properly, it must be repaired no later than 7 calendar days after the deficiency occurs.

Exception: If the crane user documents that he/she has ordered the necessary parts within 7 calendar days of the occurrence of the deficiency, the repair must be completed within 7 calendar days of receiving the parts.

1. Boom or Luffing Jib Angle Limiter (automatic boom or jib stop)

Temporary alternative measures if inoperative or malfunctioning:

The qualified person directing the lift shall make sure the maximum boom or jib angle/radius specified in the Capacity Chart for the load being handled is not exceeded. One or more of the following methods must be used:

- a. Measure radius using a tape measure.
- b. Measure the boom angle with a protractor-level on the centerline of boom.
- c. Clearly mark the boom or luffing hoist cable (so it can easily be seen by the operator) at a point that gives the operator sufficient time to stop the boom or jib within the minimum allowable radius.

In addition, install mirrors or remote video cameras and displays if necessary for the operator to see the mark.

- d. Clearly mark the boom or luffing hoist cable (so it can easily be seen by a designated signal person) at a point that gives the signal person sufficient time to signal the operator and have the operator stop the boom or jib within the minimum allowable radius.

2. Anti-Two-Block Device

Temporary alternative measures if inoperative or malfunctioning:

The qualified person directing the lift shall establish procedures to furnish equivalent protection. One or more of the following methods must be used:

- a. Assign a signal person to signal the operator to stop hoisting when the load is a safe distance from the boom or jib point.
- b. Clearly mark the hoist cable (so it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the load a safe distance from the boom or jib point.

NOTE: The temporary alternative measures for the anti-two-block device do not apply when lifting personnel in load line supported baskets. ***Personnel shall not be lifted in load line supported baskets when anti-two-block devices are not functioning properly.***

Category 2 Operational Aids

If a Category 2 operational aid is not working properly, it must be repaired no later than 30 calendar days after the deficiency occurs.

Exception: If the employer documents that it has ordered the necessary parts within 7 calendar days of the occurrence of the deficiency, and the part is not received in time to complete the repair in 30 calendar days, the repair must be completed within 7 calendar days of receiving the parts.

1. Rated Capacity Indicator/Limiter

Temporary alternative measures if inoperative or malfunctioning:

The qualified person directing the lift shall establish procedures for determining load weights and shall make sure that the weight of the load does not exceed the crane's rating at the radius where the load is handled.

The weight of the load must be provided to the operator before the lift is made.

2. Boom Angle or Radius Indicator

Temporary alternative measures if inoperative or malfunctioning:

- a. Refer to the pendulum boom angle indicator on the boom butt (viewable from operator's cab).
- b. Measure the boom angle with a protractor-level on the centerline of boom.
- c. Measure radius using a tape measure.

3. Jib Angle or Radius Indicator

Temporary alternative measures if inoperative or malfunctioning. Use either or both:

- a. First, make sure you know the boom angle (see item 2 above).
- b. Then, measure radius using a tape measure.

4. Drum Rotation Indicator

Temporary alternative measures if inoperative or malfunctioning:

Mark the drum to indicate its rotation.

If the operator cannot see the drum, add mirrors or remote video cameras and displays so the operator can see the mark.

5. OPTIONAL Swing Limiter or Proximity Device

Temporary alternative measures if inoperative or malfunctioning:

The qualified person directing the lift shall establish procedures to furnish equivalent protection (for example, assign an additional signal person to observe the distance between the boom or load and job site obstructions to include power lines or to limit the swing sector specified in the Capacity Chart).

6. OPTIONAL Drum Spooling Limiter (maximum or minimum bail limit)

Temporary alternative measures if inoperative or malfunctioning:

The qualified person directing the lift, the operator, or a designated signal person shall watch the drum and signal the operator to stop it before it is over spooled (rope does not jump off drum) or before there are less than 3 full wraps of wire rope on the load drum or boom hoist.

7. OPTIONAL Closed-Circuit Television (CCTV)

Temporary alternative measures if inoperative or malfunctioning:

A designated signal person shall watch the load, the drums, and the counterweight and provide necessary hand or voice signals to the crane operator.

ASSEMBLING, DISASSEMBLING, OR OPERATING CRANE NEAR ELECTRIC POWER AND TRANSMISSION LINES

Electrocution Hazard

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations regarding operation of cranes near electric power lines or equipment.

United States federal law prohibits the use of cranes closer than 20 ft (6 m) to power sources up to 350 kV and greater distances for higher voltages unless the line's voltage is known [29CFR1910.180 and 29CFR1926.1400].

To avoid death or serious injury, Manitowoc recommends that all parts of crane, boom, and load be kept at least 20 ft (6 m) away from all electrical power lines and equipment less than 350 kV.

NOTE: For detailed guidelines on operating near power lines, refer to the current edition of OSHA 29CFR1926.1400 and ASME B30.5 American National Standard.



WARNING

Electrocution Hazard!

Manitowoc cranes are not equipped with all features required to operate within OSHA 29CFR1926.1408, Table A clearances when the power lines are energized.

1. Keep all personnel and their personal belongings (clothing, water coolers, lunch boxes, etc.) away from the crane if it is being operated near electrical power lines or equipment.
2. Before operating the crane in the vicinity of electrical power lines or equipment, notify the power utility company. Obtain positive and absolute assurance that the power has been turned off.

The crane is NOT INSULATED. Always consider all parts of the load and the crane as conductors, including the wire rope, pendants or straps, and taglines.

Most overhead power lines ARE NOT insulated. Treat all overhead power lines as being energized unless you have reliable information to the contrary from the utility company or owner.

The rules in this section must be followed at all times, even if the electrical power lines or equipment have been de-energized.

3. Crane operation is dangerous when close to an energized electrical power source. Exercise extreme caution and prudent judgment. Operate slowly and cautiously when in the vicinity of power lines.
4. If the load, wire rope, boom, or any portion of the crane contacts or comes too close to an electrical power source, everyone in, on, and around the crane can be seriously injured or killed.

The safest way to avoid electrocution is to stay away from electrical power lines and electrical power sources.

5. The operator is responsible for alerting all personnel to the dangers associated with electrical power lines and equipment. The crane is not insulated. Do not allow unnecessary personnel in the vicinity of the crane while operating. Permit no one to lean against or touch the crane. Permit no one, including riggers and load handlers, to hold the load, load lines, taglines, or rigging gear.
6. Even if the crane operator is not affected by an electrical contact, others in the area may become seriously injured or killed.
7. It is not always necessary to contact a power line or power source to become electrocuted. Electricity, depending on magnitude, can arc or jump to any part of the load, load line, or crane boom if it comes too close to an electrical power source. Low voltages can also be dangerous.

Set-Up and Operation

1. During crane use, assume that every line is energized ("hot" or "live") and take necessary precautions.
2. Position the crane such that the load, boom, or any part of the crane and its attachments cannot be moved to within 20 ft (6 m) of electrical power lines or equipment. This includes the crane boom and all attachments. Overhead lines tend to blow in the wind, so allow for movement of the overhead lines when determining a safe operating distance.
3. Erect a suitable barricade to physically restrain the crane, all attachments, and the load from entering into an unsafe distance from electrical power lines or equipment.
4. Plan ahead and always plan a safe route before traveling under power lines. A wooden clearance frame should be constructed to ensure sufficient clearance is maintained between crane and power lines.
5. Appoint a reliable and qualified signal person, equipped with a loud signal whistle or horn and voice communication equipment, to warn the operator when any part of the crane or load moves near a power

source. This person should have no other duties while the crane is working.

6. Taglines should always be made of non-conductive materials. Any tagline that is wet or dirty can conduct electricity.
7. DO NOT store materials under power lines or close to electrical power sources.
8. When operating near transmitter/communication towers where an electrical charge can be induced into the crane or load:
 - The transmitter must be deenergized OR,
 - Tests must be made to determine if an electrical charge will be induced into the crane or load.
 - The crane must be provided an electrical ground.
 - If taglines are used, they must be non-conductive.
 - Every precaution must be taken to dissipate induced voltages. Consult with a qualified RF (radio frequency) Consultant. Also refer to local, state, and federal codes and regulations.

Electrocution Hazard Devices

1. The use of insulated links, insulated boom cages/guards, proximity warning devices, or mechanical limit stops does not ensure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules in this section may result in serious injury or death.
2. Be aware that such devices have limitations and you should follow the rules and precautions outlined in this section at all times even if the crane is equipped with these devices.
3. Insulating links installed into the load line afford limited protection from electrocution hazards. Links are limited in their lifting abilities, insulating properties, and other properties that affect their performance. Moisture, dust, dirt, oils, and other contaminants can cause a link to conduct electricity. Due to their capacity ratings, some links are not effective for large cranes and/or high voltages/currents.
4. The only protection that may be afforded by an insulated link is below the link (electrically downstream), provided the link has been kept clean, free of contamination, has not been scratched or damaged, and is periodically tested (just before use) for its dielectric integrity.
5. Boom cages and boom guards afford limited protection from electrocution hazards. They are designed to cover only the boom nose and a small portion of the boom. Performance of boom cages and boom guards is limited by their physical size, insulating characteristics, and operating environment (for example dust, dirt, moisture,

etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

6. Proximity sensing and warning devices are available in different types. Some use boom point (localized) sensors and others use full boom length sensors. No warning may be given for components, cables, loads, and other attachments located outside of the sensing area. Reliance is placed upon the operator in selecting and properly setting the sensitivity of these devices.
7. Never rely solely on a device to protect you and your fellow workers from danger.

Some variables you shall know and understand are:

- Proximity devices are advertised to detect the existence of electricity and not its distance, quantity, or magnitude.
 - Some proximity devices may detect only alternating current (AC) and not direct current (DC).
 - Some proximity devices detect radio frequency (RF) energy and others do not.
 - Most proximity devices simply provide a signal (audible, visual, or both) for the operator and this signal must not be ignored.
 - Sometimes the sensing portion of the proximity devices becomes confused by complex or differing arrays of power lines and power sources.
8. DO NOT depend on grounding. Grounding of a crane affords little or no protection from electrical hazards. The effectiveness of grounding is limited by the size of the (wire) conductor used, the condition of the ground, the magnitude of the voltage and current present, and numerous other factors.

Electrical Contact

If the crane comes in contact with an energized power source, the operator shall:

1. Stay in the crane cab. DON'T PANIC.
2. Immediately warn PERSONNEL in the vicinity to STAY AWAY.
3. Attempt to move the crane away from the contacted power source using the crane's controls which are likely to remain functional.
4. Stay in the crane until the power company has been contacted and the power source has been de-energized. NO ONE must attempt to come close to the crane or load until the power has been turned off.

Only as a last resort should an operator attempt to leave the crane upon contacting a power source. If it is absolutely necessary to leave the cab, JUMP

COMPLETELY CLEAR OF CRANE. DO NOT STEP OFF. Hop away with both feet together. DO NOT walk or run.

- Following any contact with an energized electrical source, your Manitowoc dealer must be immediately advised of the incident and consulted on necessary inspections and repairs.

If the dealer is not immediately available, contact the Manitowoc Crane Care Lattice Team. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all damaged parts are repaired or replaced as authorized by Manitowoc or your Manitowoc dealer.

REFUELING

- When using a portable container to refuel the crane, the container must be a safety-type can equipped with an automatic closing cap and a flame arrester.
- The engine must be **stopped** before refueling crane.
- Smoking and open flames must be prohibited in refueling area.

FIRE EXTINGUISHERS

- A portable fire extinguisher with a minimum rating of 10 BC must be installed in operator's or machinery cab of crane.
- The operator and all maintenance personnel shall be thoroughly familiar with the location, use, and care of the fire extinguisher(s) provided.

ACCIDENTS

If this crane becomes involved in a property damage and/or personal injury accident, immediately contact your Manitowoc dealer or the Product Safety and Reliability Department at the following address:

Manitowoc Cranes
2401 So. 30th St.
Manitowoc, WI 54220
Phone: 920-684-6621

Provide a complete description of the accident, including the crane model and serial number.

The crane must not be returned to service until it is thoroughly inspected for any evidence of damage. All damaged parts must be repaired or replaced as authorized by Manitowoc.

SAFE MAINTENANCE



WARNING

Importance of safe maintenance cannot be over emphasized. Carelessness and neglect on part of maintenance personnel can result in their death or injury and costly damage to the crane or property.

Safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc cannot foresee all hazards that will arise in field. Therefore, **safety remains responsibility of maintenance personnel and crane owner.**

Maintenance Instructions

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to the instructions contained in this manual and in the Service Manual provided with the crane.

Crane maintenance and repair must be performed by qualified personnel. These personnel shall **read Operator Manual and Service Manual before attempting any maintenance procedure.** If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

Qualified person is defined as one who by reason of training and experience is thoroughly familiar with the crane's operation and required maintenance as well as the hazards involved in performing these tasks.

Training and qualification of maintenance and repair personnel are crane owner's responsibility.

Safe Maintenance Practices

- Perform the following steps (as applicable) before starting a maintenance procedure:
 - Park the crane where it will not interfere with other equipment or operations.
 - Lower all loads to the ground or otherwise secure them against movement.
 - Lower the boom onto blocking at ground level, if possible, or otherwise secure the boom against dropping.
 - Move all controls to off and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
 - Stop the engine and render the starting means inoperative.

- f. Place a warning sign at the start controls alerting other personnel that crane is being serviced and the engine must not be started. **Do not remove sign until it is safe to return crane to service.**
2. Do not attempt to maintain or repair any part of the crane while the engine is running, unless absolutely necessary.
If the engine must be run, keep your clothing and all parts of your body away from moving parts. **Maintain constant verbal communication between person at controls and person performing maintenance or repair procedure.**
 3. Wear clothing that is relatively tight and belted.
 4. Wear appropriate eye protection and approved hard hat.
 5. Never climb onto or off a moving crane. **Climb onto and off crane only when it is parked and only with operator's permission.**
Use *both hands* and handrails, steps and ladders provided to climb onto and off the crane.
Lift tools and other equipment which cannot be carried in pockets or tool belts onto and off the crane with hand lines or hoists.
 6. The boom and gantry are not intended as ladders. Do not attempt to climb lattice work of the boom or gantry to get to maintenance points. If the boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.
 7. Do not remove cylinders until the working unit has been securely restrained against movement.
 8. Pinch points are impossible to eliminate. Watch for them closely.
 9. Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.
Do not use your hands to check for air, coolant or hydraulic oil leaks:
 - Use a soap and water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
 - Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.
 10. Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.
 11. Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until the pressure drops and the coolant cools, then slowly remove the cap.
 12. Avoid battery explosion: do not smoke while performing battery maintenance or short across battery terminals to check its charge.
 13. Read the safety information in the battery manufacturer's instructions before attempting to charge a battery.
 14. Avoid battery acid contact with skin and eyes. If contact occurs, flush the area with water and immediately consult a doctor.
 15. Stop the engine before refueling crane.
 16. Do not smoke or allow open flames in refueling area.
 17. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.
 18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in the area when filling hydraulic tanks.
 19. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.
 20. Use extreme care when handling coiled pendants. Stored energy can cause the coiled pendants to uncoil quickly with considerable force.
 21. When inflating tires, use a tire cage, a clip-on inflater, and an extension hose which permits standing well away from the tire.
 22. Only use cleaning solvents which are non-volatile and non-flammable.
 23. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
 24. Use care while welding or burning on the crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.
 25. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform the following steps **before welding on crane:**
 - Disconnect all cables from batteries.
 - Disconnect output cables at engine junction box.
 - Attach the ground cable from the welder directly to the part being welded and as close to the weld as possible.

Do not weld on the engine or engine mounted parts (per engine manufacturer).
 26. Disconnect and lock the power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.
 27. When assembling and disassembling booms, jibs, or masts on the ground (with or without support of boom

rigging pendants or straps), securely block each section to provide adequate support and alignment.

Do not go under boom, jib, or mast sections while connecting bolts or pins are being removed.

28. Unless authorized in writing by Manitowoc, do not alter the crane in any way that affects the crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and Capacity Charts and make the crane owner/user liable for any resultant accidents.
29. **Keep crane clean.** Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.
30. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in the operator's cab or on walkways and stairs.
31. Do not store flammable materials on the crane.
32. Do not return the crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been

reactivated, and all maintenance equipment has been removed.

33. Perform a function check to ensure proper operation at the completion of maintenance or repair.

ENVIRONMENTAL PROTECTION

Dispose of waste properly! Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in Manitowoc cranes includes — but is not limited to — oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components: do not pour waste fluids onto the ground, down any drain, or into any source of water.

- Always drain waste fluids into leak proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately wipe up any spills.

BOOM DISASSEMBLY SAFETY

NOTE: The term **boom** used in the following instructions applies to all lattice attachments (fixed jib, luffing jib, mast, etc.).



DANGER!

Collapsing Boom Hazard!

Prevent death or serious injury when disassembling boom sections — read and adhere to the following instructions.

Safe handling of lattice booms during disassembly is a primary concern for preventing serious or fatal injuries. A boom can collapse during disassembly if workers fail to observe safe working practices.

Accidents during boom disassembly usually result from one of three primary causes:

- Workers are not familiar with equipment or are not properly trained.
- Disassembly area is not suitable.
- Safe procedures are overlooked because not enough time is allocated for task.

General

Safety decals ([Figure 2-3](#)) are placed near the connectors on the boom sections as shown on the Boom Disassembly Decal Drawing at the end of this section.

Workers involved with boom disassembly shall be trained and experienced in the operation and disassembly of construction cranes. Everyone shall read and understand these instructions, the information in the Boom Assembly Drawing, and the instructions in Section 4 before beginning disassembly. Anyone who has a question should ask for an explanation. **One worker who does not fully understand or fails to follow correct procedures can endanger other workers.**

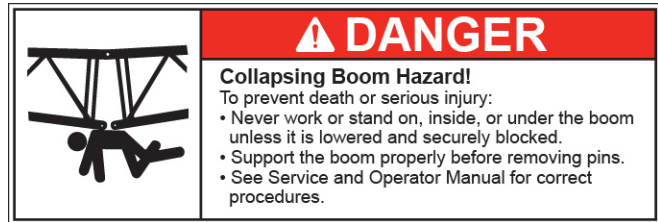
Location

Select a suitable location for boom disassembly. It must be firm, level, and be free of obstructions. It should have enough open space to accommodate the crane, the length of boom, and – if required – movement of an assist crane or other equipment. If possible, secure the area to keep unauthorized personnel and vehicles away.

Pin Removal

When removing pins from boom sections, stand clear of pins being removed. Even though the boom is resting on blocking, individual pin connections may still be under load.

Pins can be ejected forcefully if the boom has any pressure on it or if the boom is not supported properly.



M101904

FIGURE 2-3

Disassembly Precaution — #82 Boom

Always block boom sections so they are securely supported and cannot shift or move suddenly when pins are removed. If there is any doubt about a boom disassembly procedure, **block tightly under boom sections before removing any pin.**



DANGER

Collapsing Boom Hazard!

Boom can collapse or jerk when pins are removed. To avoid death or serious injury:

- Do not remove bottom connecting pins from any boom section when boom is supported by straps as shown in [Figure 2-4](#), View A.
- Do not remove strap connecting pins until straps are fully lowered into supports as shown in [Figure 2-4](#), View C.
- Do not remove bottom connecting pins from any boom section when boom point is resting on ground and handling pendants are slack as shown in [Figure 2-4](#), View B.
- Never work or stand inside boom unless it is lowered and securely blocked as shown in [Figure 2-4](#), View C.
- Do not stand or walk on top of boom unless it has walkways.



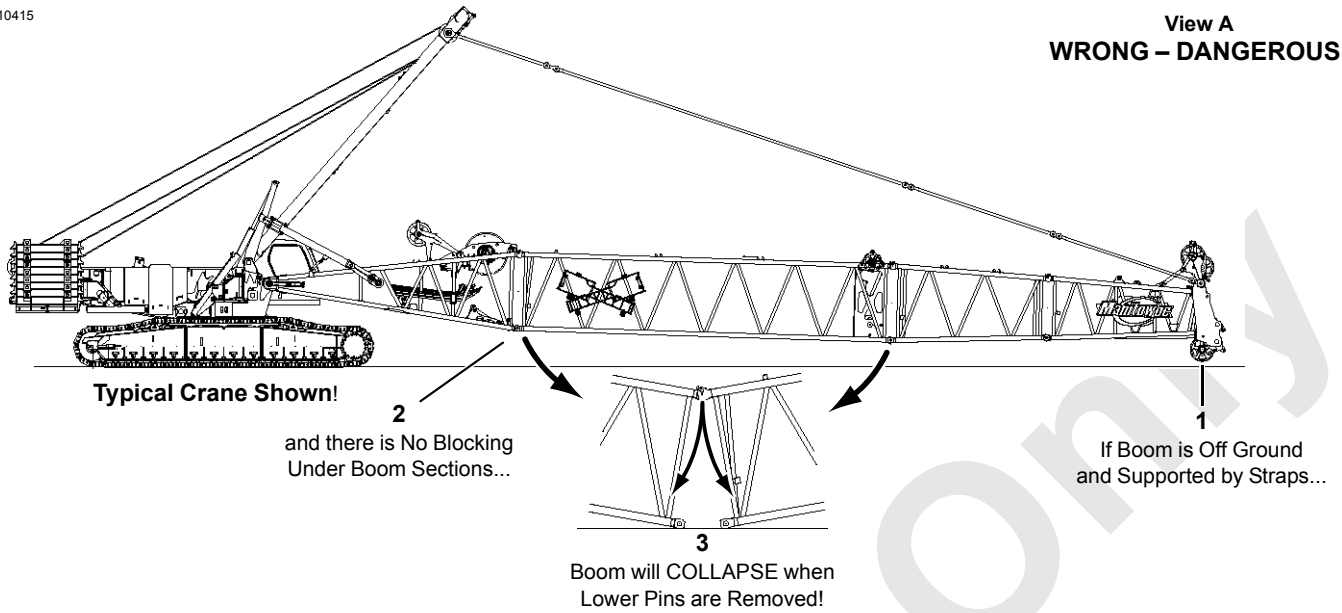
DANGER

Falling Boom Hazard!

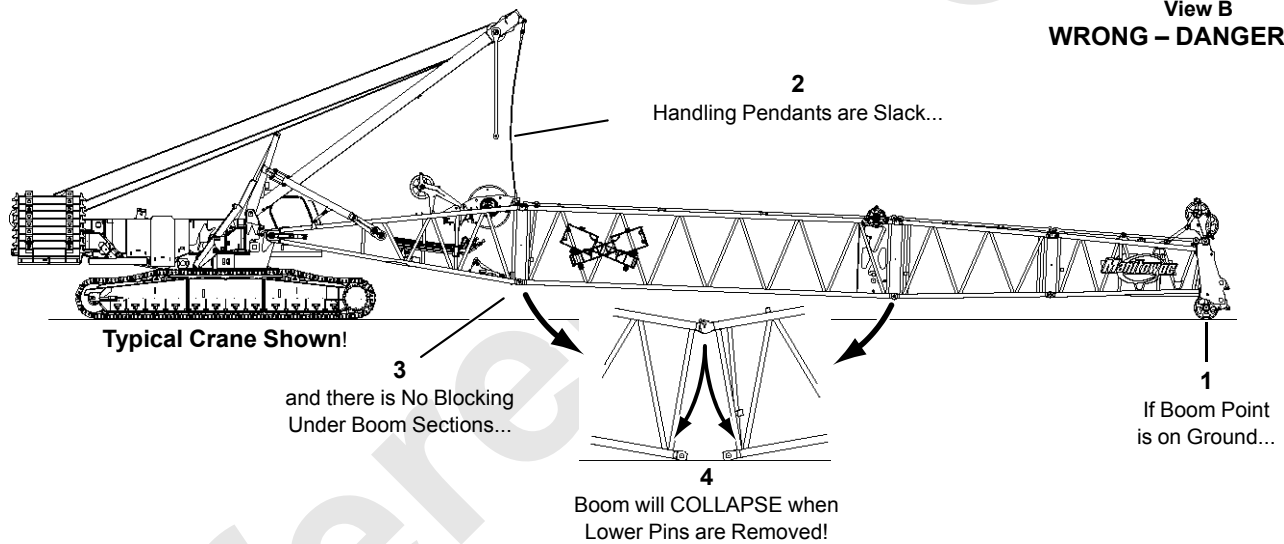
Crane can tip or boom can collapse if excess boom is cantilevered. Never cantilever more boom than allowed in rigging drawings or capacity charts.

A10415

**View A
WRONG – DANGEROUS!**



**View B
WRONG – DANGEROUS!**



**View C
RIGHT – SAFE**

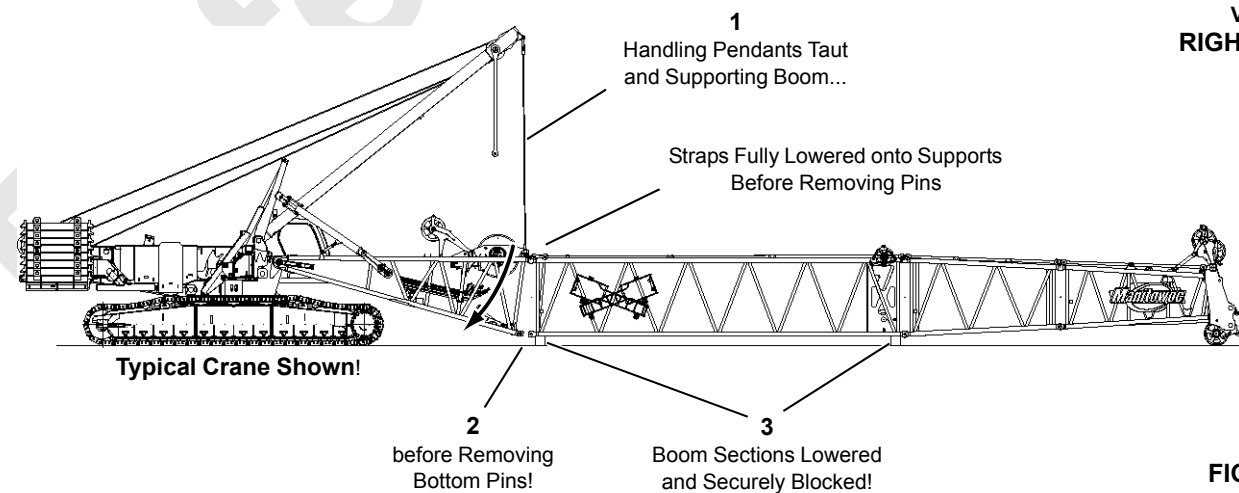


FIGURE 2-4

Disassembly Precaution — #22E/22EL Boom

See [Figure 2-5](#) for the following procedure.

Always block boom sections so they are securely supported and cannot shift or move suddenly when pins are removed. If there is any doubt about a boom disassembly procedure, **block tightly under boom sections before removing any pin.**



DANGER

Collapsing Boom Hazard!

Boom can collapse or jerk when pins are removed. To avoid death or serious injury:

- Never remove any pin until the boom is lowered and securely blocked.
- Never work or stand under or inside boom.
- Do not stand or walk on top of boom.
- Remove pins from outside of boom.



DANGER

Tipping Hazard!

Crane can tip if excess boom is cantilevered. Never cantilever more boom than allowed on rigging drawings and capacity charts.

If a cantilevered boom is disassembled, boom sections ahead of boom hoist connection must be blocked before removing pins. Boom will collapse if upper pins are removed and boom sections are not blocked. Boom will also collapse if lower pins behind boom hoist connection are removed and sections are not blocked.

A718

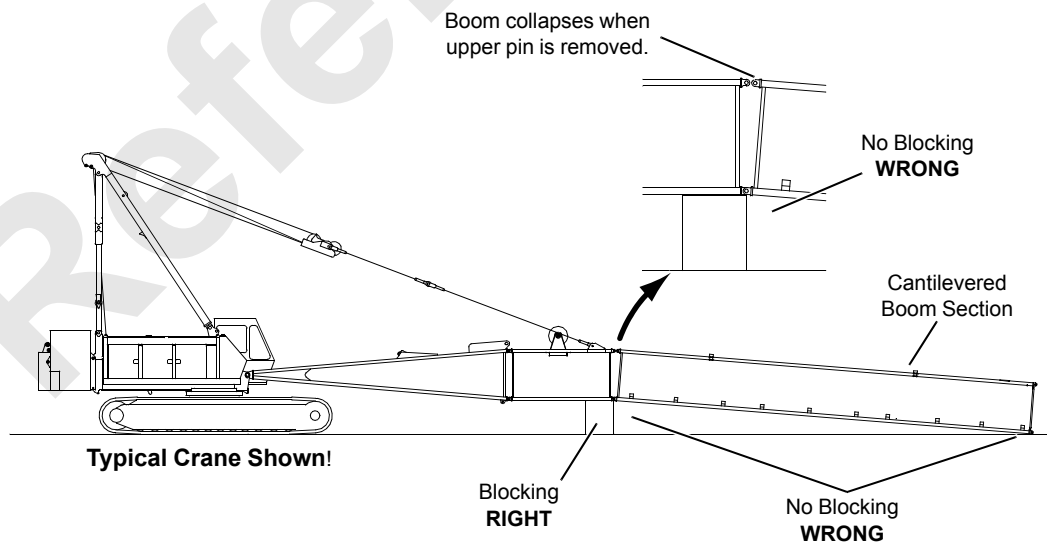
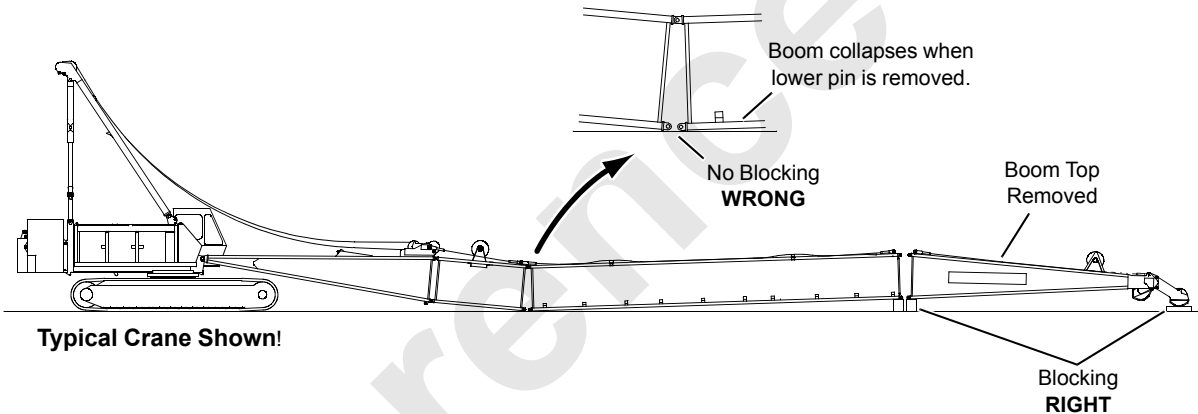


FIGURE 2-5

PERSONNEL HANDLING POLICY

In 1998, the American Society of Mechanical Engineers issued a new American National Standard entitled, Personnel Lifting Systems, ASME B30.23-1998. This standard provides, ***“lifting and lowering of personnel using ASME B30 Standard hoisting equipment shall be undertaken only in circumstances when it is not possible to accomplish the task by less hazardous means. Unless all of the applicable requirements of this volume are met, the lifting or lowering of personnel using ASME B30 Standard equipment is prohibited.”***

The ASME Standards recognize that mobile and locomotive cranes are primarily designed and intended for handling materials and not personnel. The ASME Standards have a retrofit statement that applies to existing cranes after the standards go into effect. It is not the intent of the standards to require retrofitting of existing equipment. If an item is being modified, the performance requirement must be reviewed relative to the current standard.

This new standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.1431(a): ***The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the work site, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or work site conditions.***

Use of a Manitowoc crane to handle personnel is acceptable provided:

- The crane user shall comply with the manufacturer’s specifications and limitations for lifting accessories (hooks, slings, personnel platforms, etc.).
- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator shall remain in the crane cab at all times when personnel are off the ground.
- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- Load and boom hoist drum brakes, swing brakes, and locking devices such as pawls and dogs must be

engaged when the occupied personnel platform is in a stationary position.

- The crane must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane must be equipped with boom hoist limiting device.
- If the luffing jib is used for hoisting personnel, the crane must be equipped with a luffing jib angle indicator that is visible to the crane operator.
- If the luffing jib is used for hoisting personnel, the crane must be equipped with a luffing hoist limiting device.
- The crane is equipped with a positive acting device which prevents contact between the load block or overhaul ball and the boom tip (anti-two-block device).

For friction cranes, this implies the addition of spring applied brakes activated by the anti-two-block device. The load line hoist drum must have a system or device on the power train, other than the load hoist brake, which regulates the lowering rate of speed of the hoist mechanism (controlled load lowering).

Free fall of the hoist line is prohibited.

- The crane’s Operator Manual is in the crane’s cab, readily accessible to the operator.
 - The crane’s load Capacity Chart is affixed inside the crane cab, readily accessible to the operator. The total weight of the loaded personnel platform and related rigging must not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
 - The crane is uniformly level within one percent of level grade and located on a firm footing. Some Capacity Charts require more stringent levelness criteria.
- Cranes with outriggers or stabilizers must have them all extended and locked. All outriggers or stabilizers must be extended equally in accordance with the Capacity Charts and operating procedures.
- Handling personnel from a platform suspended by wire rope from a luffing jib is acceptable, but only when it is not possible to accomplish the task using a less hazardous means. The crane user and operator shall take into account hazards that may be present when using a luffing jib.
 - Direct attachment of a personnel platform to a luffing jib is prohibited.
 - The platform meets the requirements as prescribed by applicable standards and regulations.
 - Applicable personal protection equipment is provided (for example personal fall-protection system, etc.)

- For wire rope suspended platforms, the crane is equipped with a hook latch that can be closed and locked, eliminating the throat opening.
- The platform is properly attached and secure.
- Personnel platforms must not be used in winds exceeding 20 mph (9 m/s) at the hoisted platform height or in electric storms, snow, ice, sleet, or other adverse weather conditions which could affect the safety of personnel.
- Hoisting personnel within 20 ft (6 m) of a power line that is up to 350 kV or within 50 ft (15 m) of a power line that is over 350 kV is PROHIBITED, except for work covered in OSHA 29CFR1926 subpart V.

For operation outside the United States, the requirements of the applicable national, state and local regulations and safety codes must be met. This may include, in addition to the above:

- Automatic brakes such that when the equipment operating controls are released, the motions are brought to rest.

- A holding device (such as a load hold check valve) must be provided in the hydraulic or pneumatic systems to prevent uncontrolled movement of the hoisting equipment in the case of a system failure.

Manitowoc offers upgrade packages for friction controlled models to install anti-two-block, dead man control, and automatic hoist system control requirements to satisfy other codes and standards.

Manitowoc recommends that cranes be properly maintained, regularly inspected, and repaired as necessary. All safety signs must be in place and legible. We also urge Manitowoc crane owners to upgrade their cranes with rated capacity indicator/limiter systems for all lifting operations.

If you have any questions about this subject or other product safety matters relating to the operation and use of a Manitowoc crane, please contact your Manitowoc dealer or the Product Safety and Reliability Department at the following address:

Manitowoc Cranes

2401 So. 30th St.
Manitowoc, WI 54220

Phone: 920-684-6621

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

PEDESTAL/BARGE MOUNTED CRANES

WARNING Overload Hazard!

A pedestal mounted crane will not tip to indicate to operator that crane's capacity has been exceeded. When capacity of a pedestal mounted crane is exceeded, hook rollers or other structural components may break, before load lines fail, causing crane to separate from pedestal.

For this reason, great care must be taken to operate a pedestal mounted crane within its rated capacity.

Careful planning is required before a crane can be operated on a barge. Crane user shall verify that barge is capable of limiting crane list and/or dynamics to maximum allowable specified in Capacity Charts. If specified crane list and/or dynamic conditions are exceeded, crane's capacity may be exceeded. Hook rollers or other structural components may break, causing crane to separate from pedestal.

WARNING

Crane owner/user shall verify that the method used to fasten or restrain crane to foundation, barge, ship or floating platform is strong enough, under all operating conditions, to prevent crane from breaking off foundation or moving on barge.

Manitowoc does not permit use of a truck crane on a barge, ship or floating platform.

Pedestal Mounted Crane

Also see ASME publication B30.8-2004, Floating Cranes and Derricks.

Definition

A pedestal mounted crane is a crane which is securely fastened to a foundation, barge, ship, or floating platform so the crane is restrained from tipping.

Examples

1. Crane rotating bed mounted on a turret (pedestal) which is securely fastened to the foundation ([Figure 2-6](#)).

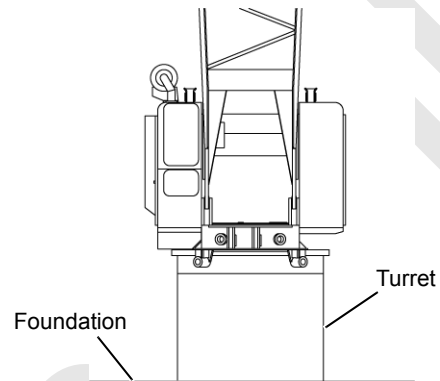
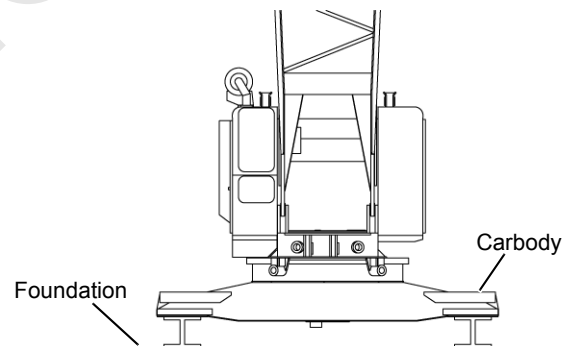


FIGURE 2-6

2. Crane rotating bed mounted on a carbody (crawlers removed) which is securely fastened to the foundation ([Figure 2-7](#)).



NOTE: If bolting carbody to foundation, contact your Manitowoc dealer for recommended bolt pattern and for type and quantity of bolts to be used.

FIGURE 2-7

Barge Mounted Crane

Definition

A barge mounted crane is a crane that is anchored or restrained in a work area of the barge, ship, or floating platform and is subjected to tipping forces.

Examples

NOTE: The foundation is the deck of the barge, ship, or floating platform.

1. Crawler-mounted crane with carbody anchored with tie-downs to the foundation (Figure 2-8).

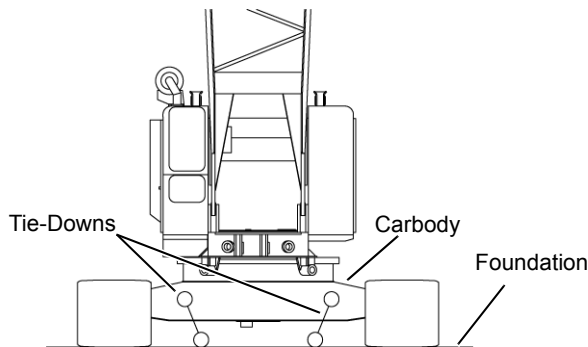


FIGURE 2-8

2. Crawler-mounted crane working on a timbered area of the barge, ship, or floating platform with the crawlers

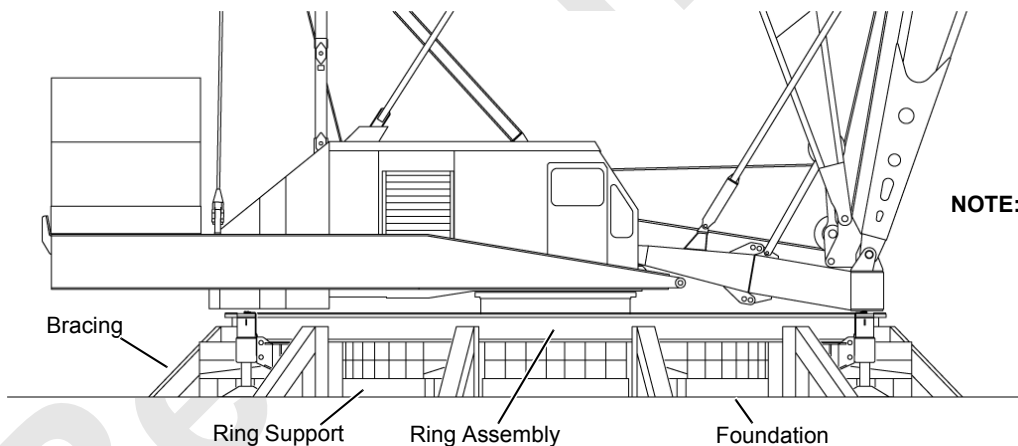
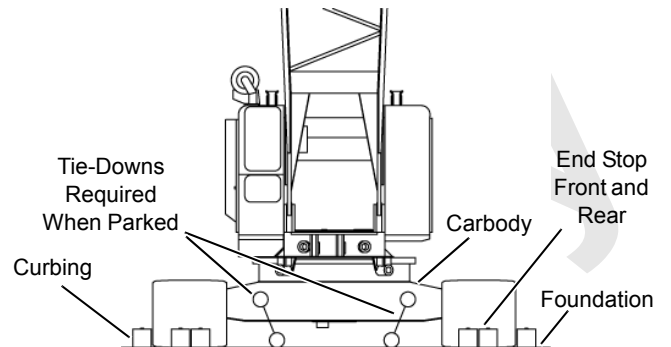


FIGURE 2-10

restrained by curbing and end stops (Figure 2-9). When not working, the crane carbody is anchored with tie-downs to the foundation. **Traveling with load is not permitted.**



NOTE: Manitowoc does not permit traveling with load.

FIGURE 2-9

3. RINGER® (crawler mounted, carbody mounted) supported on blocking, screw jacks, or steel pedestals which are braced and fastened to the foundation in such a manner as to prevent movement (Figure 2-10).
4. RINGER (platform mounted) which has the ring braced and fastened directly to the foundation in such a manner as to prevent movement.

NOTE: Ringers must be equipped with hook rollers on boom and counterweight carriers.

AXIS		TRANSITIONAL		ROTATIONAL	
SYMBOL	NAME	STATIC	DYNAMIC	STATIC	DYNAMIC
X	Longitudinal		Surge	Heel List	Roll
Y	Vertical		Heave		Yaw
Z	Lateral		Sway	Trim	Pitch

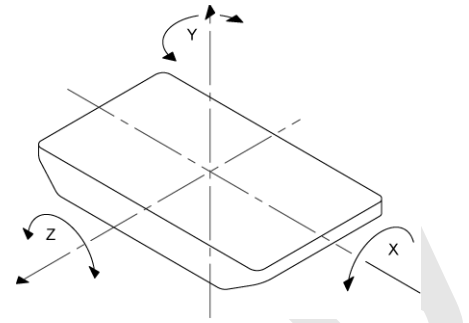


FIGURE 2-11

Capacity Charts

Manitowoc provides two types of Capacity Charts for a crane mounted on a barge or other supporting structure under static conditions.

1. A Capacity Chart based on tipping when the crane is anchored only to prevent shifting
2. A Capacity Chart based on structural competence when crane is securely fastened for use as a pedestal mounted crane

NOTE: Unless otherwise specified in a machine list Capacity Chart, a 0 degree machine list Capacity Chart rating applies to machine list **not to exceed 1/2 degree**. All other machine list ratings – 1°, 2°, and 3° – must NOT be exceeded.

Shock Loading

Definition

Shock loads to the crane can be experienced when the barge is subjected to up and down movement of wave action (referred to as DYNAMICS). [Figure 2-11](#) illustrates the dynamic conditions of the barge which influence crane capacity.

CAUTION

Structural Damage Hazard!

If crane boom or structure is shock loaded during operation, or there is any indication of shock loading, all structural components of crane must be inspected to detect cracks and other damage. Nondestructive test equipment, such as magnetic particle or ultrasonic procedures, is recommended for this inspection.

NOTE: Manitowoc does not recommend crane operation under dynamic conditions.

Operation On Barge

General

Machine list and/or dynamics will be experienced when a crane is operated on a barge, ship, or floating platform. Both of these conditions reduce the crane's capacity and each must be taken into account for safe operation on a barge, ship, or floating platform.



WARNING

Tipping Crane Hazard!

Tie-downs which only prevent crane from shifting as in barge, ship or floating platform mounting, may not provide adequate support when using a Capacity Chart for pedestal mounting. Before operating a crane on a barge, ship or floating platform, crane user shall verify that correct Capacity Chart is being used — pedestal mounted, barge mounted, 0°, 1°, 2° or 3° list or dynamic Capacity Chart.

Failing to use correct Capacity Chart can result in an accident.

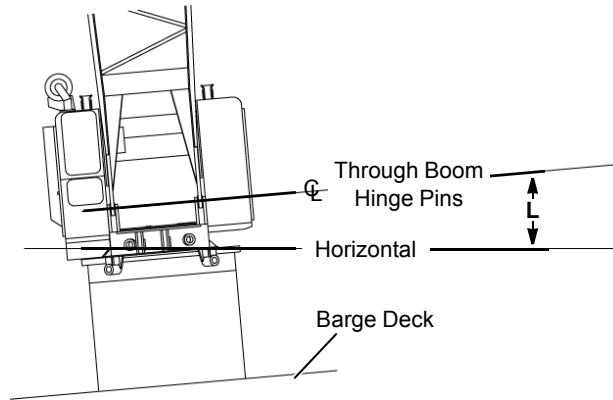
Definitions

1. Machine List, as defined by Manitowoc, is the crane's out-of-level condition — from side-to-side — as measured by the angle between horizontal and a line drawn through the centerline of the crane's boom hinge pins ([Figure 2-12](#)). This out-of-level condition creates side load and affects the crane's lifting capacity.
2. Barge List (also referred to as heel or trim) causes swing out of the load and may produce side load. When Manitowoc provides a Capacity Chart showing capacities for a 2 degree machine list for example, we are referring to the maximum allowable lifting capacity for the crane when experiencing an out-of-level condition (side-to-side) of 2 degrees as measured by

angle between horizontal and a line drawn through centerline of the crane's boom hinge pins.

Unless otherwise specified in the Capacity Chart, barge list (heel or trim) must not exceed the machine list degrees given in the Capacity Chart.

3. Barge List and Machine List are not the same. As the crane rotates on a barge, barge list (as defined above) will change. The worst machine list condition generally occurs when the crane swings over the corner of the barge, producing maximum side load.



L = Degrees of Machine List
(Maximum allowable is specified in Capacity Chart)

FIGURE 2-12

Crane Inspection

To aid in preventing harmful and damaging failure as previously indicated, regular inspection for signs of

overloading in the following load bearing components is required. Correct each defect found before placing the crane into service.

- Boom
- Counterweight
- Backhitch
- Rotating Bed
- Wire Rope
- Pendants and Straps
- Hook and House Rollers

When equipped with hook rollers, it is recommended that each hook roller assembly be inspected daily for any sign of overloading, to include:

- Deformation of roller path
- Proper hook roller adjustment
- Deformation or cracks in hook roller hanger
- Bent hook roller shaft
- Damaged bearings

Transporting Crane on Barge

If it is necessary to transport the crane on a barge, ship, or floating platform when dynamic conditions will be experienced, the boom must be lowered onto a cradle (or other support) and the crane's boom, rotating bed, and lowerworks must be secured against movement. If the crane is equipped with a mast, the mast must be securely tied down with guylines. Failing to take these steps can result in shock load or side load damage to the boom and mast.

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 3

OPERATING CONTROLS AND PROCEDURES

TABLE OF CONTENTS

Standard Hand Signals for Controlling Crane Operations	3-2
Symbol Identification	3-4
Front Window Operation	3-11
Closing Window	3-11
Opening Window for Ventilation	3-11
Opening Window for Emergency Exit	3-11
Operating Controls	3-11
Controls Identification and Function	3-14
A – Engine Controls	3-14
B – Accessory Controls	3-15
C – Indicators	3-16
D – Gauges	3-17
E – Special Controls	3-19
F – Boom Hoist Controls	3-24
G – Load Drum Controls	3-24
H – Swing Controls	3-25
J – Travel Controls	3-25
K – Setup Controls	3-26
L – Limit Devices	3-27
Seat Controls	3-30
Preparing Crane for Operation	3-31
Operation	3-31
Engine Start-Up	3-31
Engine Diagnostics — Cummins QSM11, QSL9 Tier 4, and Caterpillar 3176C	3-33
DPF Diagnostics — Cummins QSL9 Tier 4	3-34
Boom Hoist Operation	3-35
Luffing Hoist Operation	3-35
Swing Operation	3-37
Swing Speed/Torque Adjustment	3-37
Load Drum Operation – Liftcrane Full Power	3-38
Load Drum Operation – Liftcrane Free Fall	3-39
Free-Fall Drum Slip/Pedal Response	3-39
Load Drum Operation – Clamshell	3-40
Load Drum Operation – Dragline	3-40
Travel Operation	3-42
Stopping Engine/ Leaving Crane Unattended	3-44
Calibration Procedures	3-44
Remote Controls	3-47
Controls Identification and Operation	3-47
Carbody Jack Controls	3-47
Crawler Pin Controls	3-47
Carbody Level	3-47
Remote Throttle Controls	3-47
Remote Power Control	3-48
Gantry Control	3-48
Boom and Counterweight Pin Controls	3-48
Display Readings	3-48
Operating Conditions	3-48
Operating Limits	3-48
System Faults	3-49
Selecting Display Language	3-49

Crane Diagnostics	3-54
Drum 1 and 2 (Front and Rear Drum)	3-54
Drum 4 (Boom Hoist)	3-54
Drum 8 (Auxiliary)	3-54
FFall	3-54
Swing (Crane)	3-55
Swing Speed/Torque	3-55
Drum Slip	3-55
Track	3-55
RIN	3-55
Accessory System	3-56
Engine Throttle	3-56
A1 (Handles)	3-56
D1, D2, and D3 (Digital Outputs and Inputs)	3-57
Wind Conditions	3-62
Preparation for Cold Weather	3-64
Crane Limitations	3-64
Wire Rope	3-64
Cold Weather Starting Aid	3-64
Ether	3-64
Coolant and Oil Pan Heaters	3-64
Cooling System	3-64
Battery	3-64
Engine Oil	3-65
Fuel Oil	3-65
Gear Oil	3-65
Hydraulic Cranes	3-65
Hydraulic Oil	3-65
Cold Weather Heater Package	3-65
Heaters – Past Production	3-65
Thermostats	3-65
Turning Heaters On	3-66
Turning Heaters Off	3-66
Heaters – Current Production Tier 3	3-67
Thermostats	3-67
Turning Heaters On	3-67
Turning Heaters Off	3-67
Heaters – Tier 4 Production	3-69
Thermostats	3-69
Turning Heaters On	3-69
Turning Heaters Off	3-69
Fuses – Past Production	3-71
Fuses – Current Production	3-72

SECTION 3
OPERATING CONTROLS AND PROCEDURES


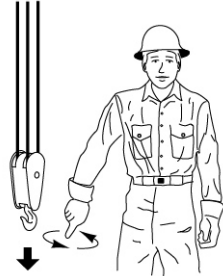
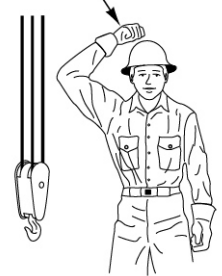
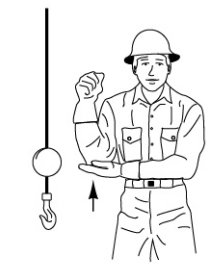


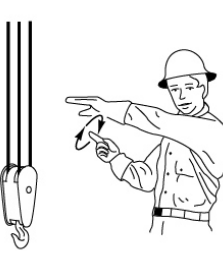

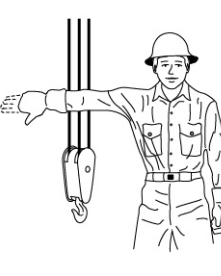
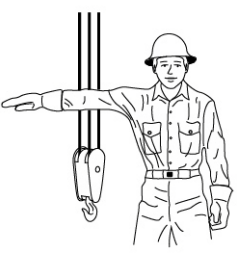

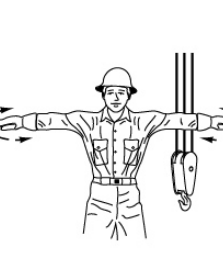
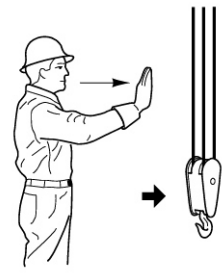
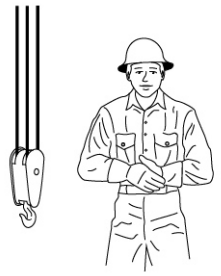
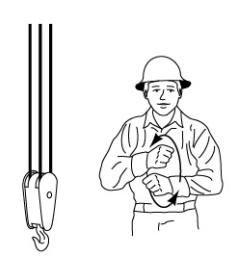

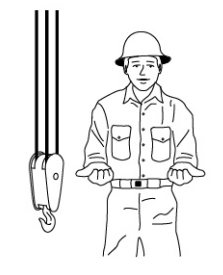
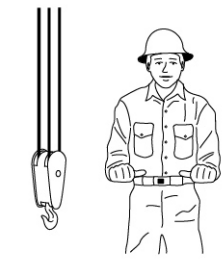
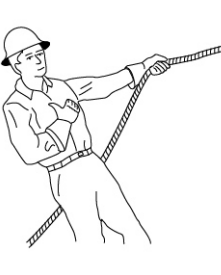

Reference Only

THIS SECTION STARTS ON THE NEXT PAGE

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS

The following standard hand signals comply with ASME B30.5-2014.

Table 3-1 Standard Hand Signals for Controlling Crane Operations

<p style="text-align: center;">1</p>  <p>M100118</p>	<p style="text-align: center;">2</p>  <p>M100119</p>	<p style="text-align: center;">3</p>  <p>M100120</p>	<p style="text-align: center;">4</p>  <p>M100121</p>	<p style="text-align: center;">5</p>  <p>M100122</p>
<p style="text-align: center;">6</p>  <p>M100123</p>	<p style="text-align: center;">7</p>  <p>M100124</p>	<p style="text-align: center;">8</p>  <p>M100125</p>	<p style="text-align: center;">9</p>  <p>M100126</p>	<p style="text-align: center;">10</p>  <p>M100127</p>
<p style="text-align: center;">11</p>  <p>M100128</p>	<p style="text-align: center;">12</p>  <p>M100129</p>	<p style="text-align: center;">13</p>  <p>M100130</p>	<p style="text-align: center;">14</p>  <p>M100131</p>	<p style="text-align: center;">15</p>  <p>M100132</p>
<p style="text-align: center;">16</p>  <p>M100133</p>	<p style="text-align: center;">17</p>  <p>M100134</p>	<p style="text-align: center;">18</p>  <p>M100135</p>	<p style="text-align: center;">19</p>  <p>M100136</p>	<p style="text-align: center;">20</p>  <p>M100137</p>

Reprinted from *ASME B30.5-2014*, by permission of the American Society of Mechanical Engineers. All Rights Reserved.

Item	Description
1	HOIST —With forearm vertical, forefinger pointing up, move hand in small horizontal circles.
2	LOWER —With arm extended downward, forefinger pointing down, move hand in small horizontal circles.
3	USE MAIN HOIST —Tap fist on head. Then use regular signals.
4	USE WHIPLINE (Auxiliary Hoist) —Tap elbow with one hand. Then use regular signals.
5	RAISE BOOM —Arm extended, fingers closed, thumb pointing upward.
6	LOWER BOOM —Arm extended, fingers closed, thumb pointing downward.
7	MOVE SLOWLY —Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as an example).
8	RAISE BOOM & LOWER LOAD —With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.
9	LOWER BOOM & RAISE LOAD —With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.
10	SWING —Arm extended, point with finger in direction of swing of boom.
11	STOP —Arm extended, palm down, move arm back and forth horizontally.
12	EMERGENCY STOP —Both arms extended, palms down, move arms back and forth horizontally.
13	TRAVEL —Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.
14	DOG EVERYTHING —Clasp hands in front of body.
15	TRAVEL (Both Tracks) —Use both fists in front of body, making a circular motion about each other, indicating direction of travel forward or backward. (For Land Cranes Only).
16	TRAVEL (One Track) —Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For Land Cranes Only).
17	EXTEND BOOM (Telescoping Booms) —Both fists in front of body with thumbs pointing outward.
18	RETRACT BOOM (Telescoping Boom) —Both fists in front of body with thumbs pointing toward each other.
19	EXTEND BOOM (Telescoping Boom) —One Hand Signal. One fist in front of chest with thumb tapping chest.
20	RETRACT BOOM (Telescoping Boom) —One hand signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

SYMBOL IDENTIFICATION

The following symbols identify controls on Manitowoc cranes. Some of the symbols shown may not apply to your crane.



















Safety Alert: Warning/Caution Operating Limit System Fault Engine Diagnostics		Boom - Lower	
Air Circulation - Cab	 	Boom - Raise	
Air Circulation - Outside	 	Brake Malfunction	
Air Conditioning		Cab Tilt	
Air Conditioning Temperature		Contrast (Light Background)	
Battery Voltage		Counterweights	
Blower (Fan)		Counterweights - Left Side	
Boom		Counterweights - Right Side	

FIGURE 3-1

Crawler Travel Forward (Left) <i>Arrow indicates which crawler is operating and direction of travel with drive motors to the rear.</i>	
Crawler Travel Forward (Right) <i>Arrow indicates which crawler is operating and direction of travel with drive motors to the rear.</i>	
Crawler Travel Reverse (Left) <i>Arrow indicates which crawler is operating and direction of travel with drive motors to the rear.</i>	
Crawler Travel Reverse (Right) <i>Arrow indicates which crawler is operating and direction of travel with drive motors to the rear.</i>	
Crawler (Travel)	
Crawler Travel Speed	
Crawler Travel Speed Control (Travel Cruise)	
Crawler Travel Speed - Low	

Cylinders – Gantry	
Cylinders - Mast	
Cylinders Extend — Retract	
Data - Enter	
Data - Save Entered	
Decrease/Increase	
Defroster/Defogger	

FIGURE 3-1 continued


















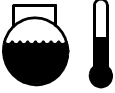






Drum		Engine	
Drum - Free Fall		Engine Brake	
Drum Lower - Load, Boom, Luffing Jib, or Mast (Depends on drum use.)		Engine - Ether Starting Aid	
Drum Number (Identifies which drum is in use.)		Engine - Failure/Malfunction	
Drum Raise - Load, Boom, Luffing Jib, or Mast (Depends on drum use.)		Engine - Maintain/Clear	
Emergency Stop		Engine Pressure	
Energize (turn on)		Engine Run	
Engine Maintenance Wait-to-Start (Tier 4)		Engine Start (Current and Past Production)	

FIGURE 3-1 continued

Engine Stop	
Engine Temperature	
Fast	
Fuel	
Hazard Warning	
Heater	
Horn	
Hour Meter (Engine Hours)	









Hydraulic Filter	
Hydraulic Oil	
Hydraulic Pump	
Light - Dome	
Light - Flood	
Light - Main	
Light - Panel (Current and Past Production)	
Lighter	

FIGURE 3-1 continued
















Limit Bypass		Mode - Setup	
Load - Lower		Mode - Standard	
Load - Raise		Monitor/Display	
Locked/Unlocked		Off/Stop	
Luffing Jib Limit Bypass		On/Start	
Maintenance		Park Off	
Mast - Raise/Lower		Park On	
Mode - Luffing Jib			

FIGURE 3-1 continued

Pins Engage — Disengage	
Pins - Boom Hinge	
Scroll - Up or Down	
Slow	
Swing	
Swing Left (Current and Past Production)	
Swing Lock	
Swing Right (Current and Past Production)	

Windshield Washer	
Windshield Wiper	
Windshield Wiper With Washer - Front	
Windshield Wiper With Washer - Overhead	
DPF High Temperature (Tier 4)	
DPF Condition (Tier 4)	
DPF Inhibit On (Tier 4)	

FIGURE 3-1 continued

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

FRONT WINDOW OPERATION

Closing Window

Rotate window latch handles to position shown in [Figure 3-2](#), View A.

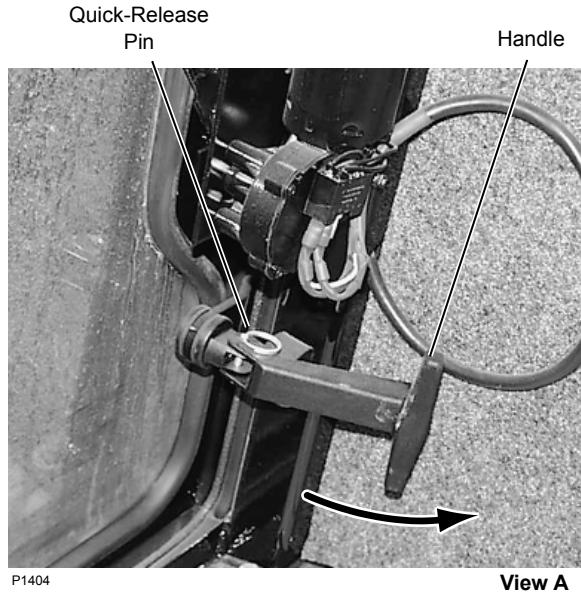


FIGURE 3-2

Opening Window for Ventilation

Rotate window latch handles to position shown in [Figure 3-2](#), View B. Window can be swung open 8 in (203 mm) for ventilation.

Opening Window for Emergency Exit

Pull out both quick-release pins [Figure 3-2](#), View B, Window can be swung open fully to allow emergency exit from cab.

OPERATING CONTROLS

The purpose of the following instructions is to familiarize qualified operators with the location and function of standard and optional operating controls for this crane. This section also contains safety information and a description of operation for each crane function.

Depending on the options your crane is equipped with, some controls identified in this section will not apply.

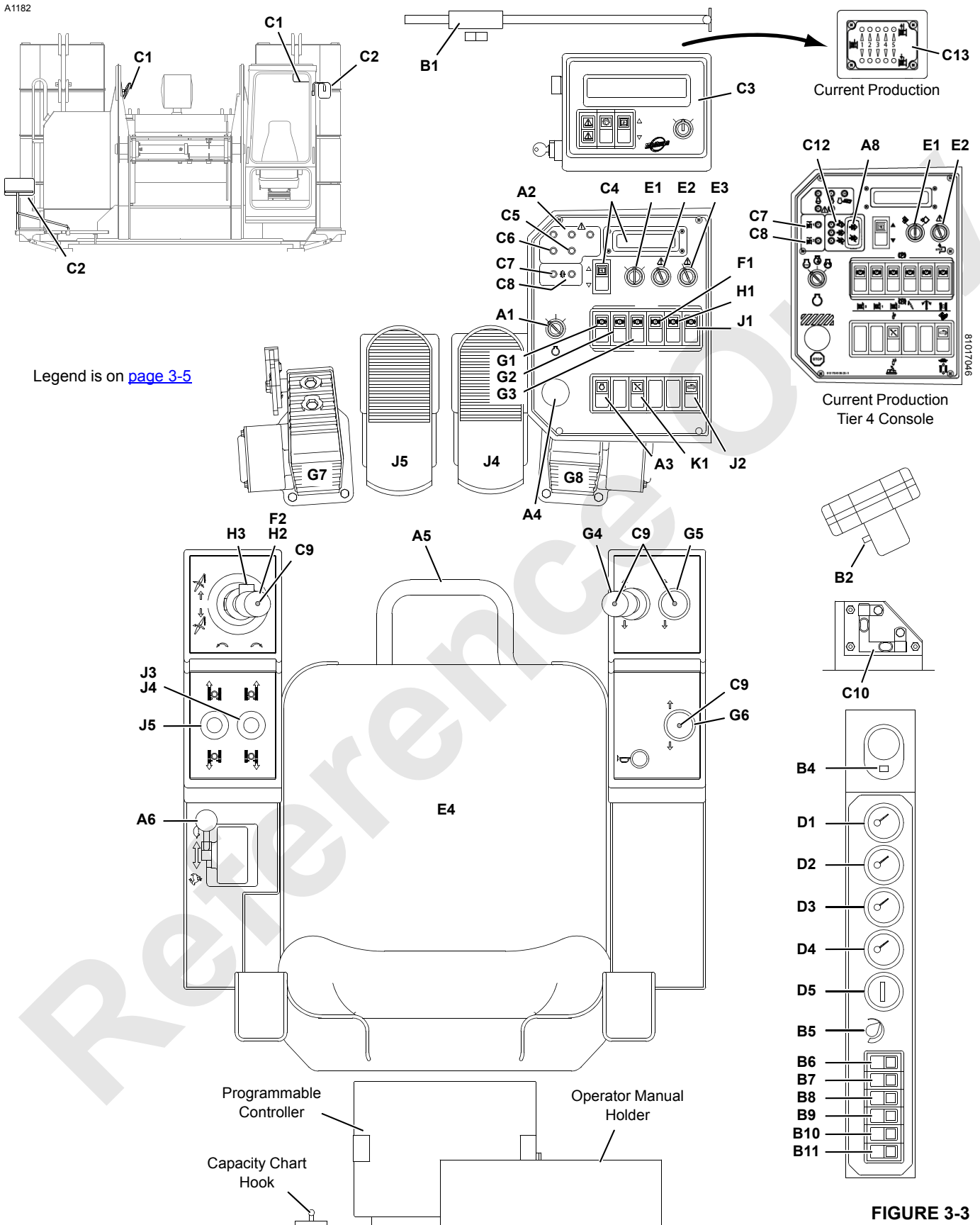


WARNING

Prevent death or serious injury to personnel!

Read and thoroughly understand instructions in this section, in Section 2, and in Capacity Chart Manual.

Contact the Manitowoc Crane Care Lattice Team for assistance if any operating procedure is not clearly understood.



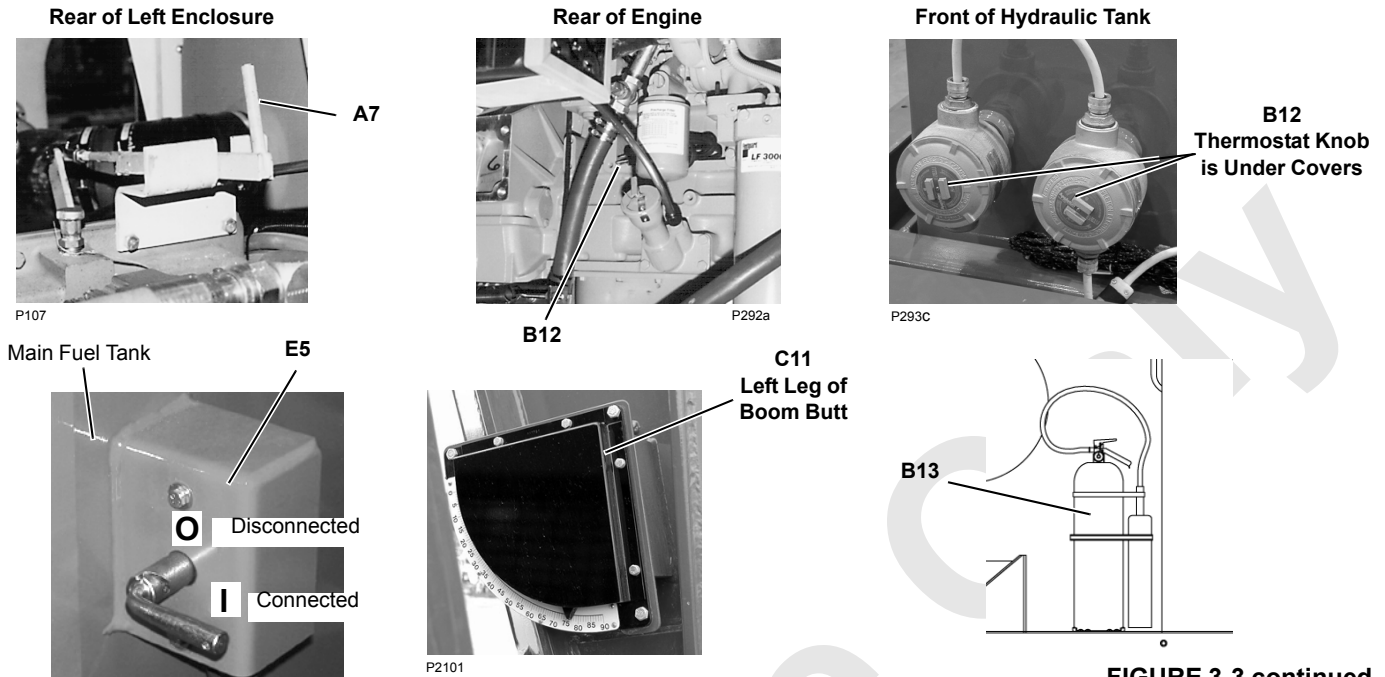


FIGURE 3-3 continued

Legend for [Figure 3-3](#)

A — Engine Controls

- A1 Engine Ignition Switch
- A2 Engine Warning/Diagnostic Lights
- A3 Engine Maintain/Clear Switch
- A4 Emergency Stop Switch
- A5 Engine Foot Throttle
- A6 Engine Hand Throttle
- A7 Engine Clutch Lever
- A8 DPF Switch

B — Accessory Controls

- B1 Tinted Visor
- B2 Overhead Fan Switch
- B3 Horn Switch
- B4 Dome Light Switch
- B5 Air Conditioner Temperature Selector
- B6 Heater/Air Conditioner Selector
- B7 Blower Fan Switch
- B8 Panel Lights Switch
- B9 Front Windshield Washer Switch
- B10 Front Windshield Wiper Switch
- B11 Overhead Windshield Wiper Switch
- B12 Machinery Heaters
- B13 Fire Extinguishers

C — Indicators

- C1 Drum Mirrors
- C2 Rear View Mirrors
- C3 Rated Capacity Indicator/Limiter

- C4 Display and Selector Switch
- C5 Operating Limit Alert
- C6 System Fault Alert
- C7 Front Drum Free-Fall Light
- C8 Rear Drum Free-Fall Light
- C9 Drum Rotation Indicators
- C10 Level
- C11 Boom Angle Indicator
- C12 DPF Status Indicator
- C13 Drum Direction Indicators

D — Gauges

- D1 Fuel Level Gauge
- D2 Engine Water Temperature Gauge
- D3 Engine Oil Pressure Gauge
- D4 Battery Voltage Gauge
- D5 Engine Hourmeter

E — Special Controls

- E1 Crane Mode Selector
- E2 Limit By-pass Switch *
- E3 Jib Up Limit By-pass Switch *
- E4 Seat Switch (not shown)
- E5 Battery Disconnect Switch

F — Boom Hoist Controls

- F1 Boom Hoist Park Switch
- F2 Boom Hoist Handle

G — Load Drum Controls

- G1 Auxiliary Drum Park Switch
- G2 Front Drum Park Switch
- G3 Rear Drum Park Switch
- G4 Front Drum Handle
- G5 Rear Drum or Luffing Jib Handle
- G6 Auxiliary Drum Handle
- G7 Front Drum Working Brake Pedal
- G8 Rear Drum Working Brake Pedal

H — Swing Controls

- H1 Swing Park Switch
- H2 Swing Handle
- H3 Swing Holding Brake Switch

J — Travel Controls

- J1 Travel Park Switch
- J2 Travel Speed Selector
- J3 Travel Detent Selector
- J4 Right Crawler Handle or Pedal
- J5 Left Crawler Handle or Pedal

K — Setup Controls

- K1 Mast Arms Switch

L — Limit Devices

Not Shown

* When bypassing a limit, carefully follow instructions in Limit Devices section.

Controls Identification and Function

See [Figure 3-3](#) for the following procedures.



WARNING

Unauthorized Start-Up!

Always STOP engine and remove key before leaving crane unattended. This practice will prevent unauthorized personnel from operating crane.

A – Engine Controls

A1. Engine Ignition Switch –

Insert key.

Rotate fully CLOCKWISE to START engine. RELEASE to RUN position as soon as engine starts.

Rotate COUNTERCLOCKWISE to STOP engine and to turn off crane's electric system.

NOTE: Stopping the engine in an emergency causes all brakes to apply and any functions being operated to stop — **beware that functions stop abruptly.**

Tier 3 engines, ether starting aid is controlled automatically by the engine's on-board computer. See engine manufacturer's manual for details.

Tier 4 engines, ether starting aid is not available. A computer controlled air intake grid heater is utilized and a wait to start procedure must be observed prior to engine start up. See engine manufacturer's manual for details.

A2. Engine Warning/Diagnostic Lights and A3. Engine Maintain/Clear Switch –

See engine manufacturer's manual for instructions.

When the red light comes ON, **stop the engine as soon as safely possible.**



WARNING

Engine Damage!

Lower lifted loads and then stop engine as soon as possible when red light is on. Do not run engine until fault is corrected.

The yellow light indicates the need to **repair engine fault at first available opportunity.**

The white light indicates the need to perform engine maintenance. **Tier 4 only**, the white indicator light remains lit during the wait to start period of initial start up. The ignition key will not start engine until the white indicator light turns off.

NOTE: Engine maintain/clear switch provided only on Caterpillar engine.

A4. Emergency Stop Switch –

Push knob DOWN to STOP engine only in an emergency — for example, if a crane function does not stop when control handle is released to off or any other uncontrolled motion of a crane function is observed.

Beware — when knob is pushed down, engine stops, brakes apply, and any **functions being operated come to an abrupt stop.**

NOTE: Knob must be pulled up before the engine can be restarted.

If the emergency stop switch has been activated, test all disk brakes for proper operation before putting the crane back into service. See Section 2 of Service Manual for procedure.

Use engine ignition switch (A1) to stop engine for normal operating conditions.

A5. Engine Foot Throttle –

PRESS pedal to INCREASE engine speed above the hand throttle setting.

RELEASE pedal to DECREASE engine speed to idle or to the hand throttle setting.

A6. Engine Hand Throttle –

Pull handle BACK to INCREASE engine speed.

Push handle FORWARD to DECREASE engine speed.

NOTE: The selected engine speed is maintained when the handle is released.

The speed of the crane functions depends on engine speed and on how far the control handles are moved in either direction from off.

Engine speed must be fast enough to provide sufficient power for the work being done. Engine can stall under load if engine speed is too slow.

A7. Engine Clutch Lever –

Pull lever OUT and push DOWN to DISENGAGE clutch.

Pull lever UP and push IN to ENGAGE clutch.

See Engine Start-Up in this section for precautions.

A8. DPF Switch (Tier 4 Equipped)

NOTE: DPF = Diesel particulate filter (cranes equipped with Tier 4 engine).

The DPF switch is a three position switch. Top position is momentary. Center and bottom position is maintained.

CENTER position is for NORMAL engine operation. Regeneration of the DPF will occur automatically.

Press TOP of rocker to START manual stationary regeneration. Release switch back to center position. Cummins ECM will control a DPF regeneration if necessary. It is normal for the DPF High Temperature lamp to illuminate.

Perform a manual stationary regeneration **only** if indicated by the DPF diagnostic in the Tier 4 Engine Diagnostics — Cummins QSL9 Tier 4, (see [DPF Condition \(Tier 4\)](#) for details).

NOTE: A guard over the top of the rocker prevents accidental manual regeneration of the DPF.

Press BOTTOM of rocker to INHIBIT active regeneration. The amber LED in the rocker will glow.

Use INHIBIT only for special circumstances where it is desirable to disable active regeneration. Prolonged engine operation with INHIBIT on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs it will be necessary to clean the DPF before the engine can be restarted.

See Engine Manufacturer's Manual for additional information regarding stationary regeneration and DPF inhibit operating instructions.

B – Accessory Controls

B1. Tinted Visor –

Position as desired to shade sun light.

B2. Overhead Fan Switch–

The fan has a 3-position switch: off, low, high. Adjust the fan's position to direct air flow as desired.

B3. Horn Switch –

PRESS and hold button to TURN ON the horn when necessary to warn or signal personnel while crane is being operated or serviced.

RELEASE button to TURN OFF the horn.

B4. Dome Light Switch –

The dome light has an on-off switch.

B5. Air Conditioner Temperature Selector –

Rotate knob CLOCKWISE for COOLER temperatures and COUNTERCLOCKWISE for WARMER temperatures.

B6. Heater/Air Conditioner Selector –

Press TOP of rocker to TURN ON the cab heater.

CENTER rocker to TURN OFF the heater or air conditioner.

Press BOTTOM of rocker to TURN ON the cab air conditioner.

NOTE: The shut-off valves in the heater hoses at the engine must be open for heater operation.

The shut-off valves can be closed to block hot water flow through the heater core during warm weather.

The shut-off valve in the supply line can be partially opened and closed to regulate heat.

B7. Blower Fan Switch –

NOTE: This fan operates only when the heater or air conditioner is on. Adjust the vents under the seat to direct air flow.

Press TOP of rocker to operate the fan in HIGH speed.

CENTER rocker to operate the fan in MEDIUM speed.

Press BOTTOM of rocker to operate the fan in LOW speed.

B8. Panel Lights Switch –

Press TOP of rocker to TURN ON the panel lights.

Press BOTTOM of rocker to TURN OFF the panel lights.

B9. Front Windshield Washer Switch –

PRESS and hold top of rocker to SPRAY washer fluid on the front windshield.

NOTE: The washer tank is mounted on right side of the cab support. Fill tank with a quality brand washing solution that will not freeze during cold weather.

B10. Front Windshield Wiper Switch, and B11. Overhead Windshield Wiper Switch –

Depress TOP of rocker to TURN ON the wiper and operate it in HIGH SPEED.

CENTER rocker to TURN ON the wiper and operate it in LOW SPEED.

Depress BOTTOM of rocker to TURN OFF the wiper.

B12. Machinery Heaters –

The engine is equipped with a 1500 W block heater (120 V) without a thermostat.

The hydraulic tank can be equipped with two thermostatically controlled heaters (120 V or 240 V), designed to keep the oil temperature 30°F (17°C) warmer than the ambient temperature.

To aid starting in cold weather, plug in heaters at shutdown; unplug heaters at start-up.

B13. Fire Extinguishers –

A fire extinguisher is located behind the seat in operator's cab and on the crane rotating bed (optional).

C – Indicators

C1. Drum Mirrors –

Adjustable to allow the operator to view operation of the load drums and the boom hoist.

One mirror is mounted inside the operator's cab. Another mirror is mounted near the front drum on the right side of the rotating bed.

C2. Rear View Mirrors –

Adjustable to give the operator a view to the rear of the crane. Both mirrors can be rotated inward for shipping.

NOTE: The boom hoist drum is not visible from either mirror. The operator can see the fleeting sheave above the boom hoist drum, however. The sheave moves back and forth on the shaft as the boom hoist drum turns.

C3. Rated Capacity Indicator/Limiter (RCL) –

See separate manual for RCL operating instructions.

C4. Display and Selector Switch –

Allows the operator to monitor three groups of crane information — operating conditions, operating limits, and system faults. See [Display Readings](#) for tables identifying the information which can be displayed.

Press top or bottom of selector to scroll up or down through the display readings. Release the selector when the desired information is displayed.

C5. Operating Limit Alert –

Glows YELLOW and a buzzer comes ON to alert the operator that an operating limit has been reached (limit automatically appears on digital display). See [Display Readings](#) for a list of operating limits, function responses, and corrective actions.

C6. System Fault Alert –

Glows RED and a beeper comes ON to alert the operator that a system fault exists (fault automatically appears on digital display). See [Display Readings](#) for a list of system faults, causes, function responses, and corrective actions.

C7. Front Drum Free-Fall Light, and

C8. Rear Drum Free-Fall Light –

NOTE: Free fall is optional.

Glows AMBER when FREE FALL is ON for corresponding drum.

C9. Drum Rotation Indicators –

Move UP and DOWN to signal the operator, by feel, that the corresponding drum is turning. Indicator movement corresponds to drum speed.

NOTE: Rotation indicators are pin-type actuators located under all drum handle covers.

C10. Level –

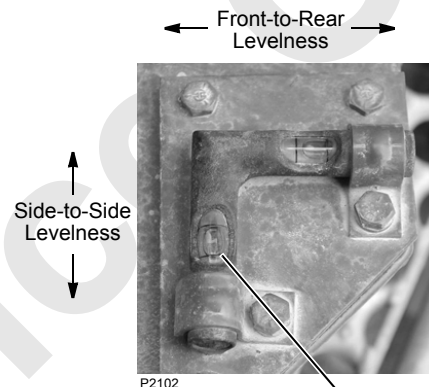
Indicates crane levelness from front to rear and from side to side as shown in [Figure 3-4](#). The level is mounted on the cab support and is visible through the right side window in the operator's cab.



WARNING

Tipping Hazard!

Unless otherwise specified on capacity chart, all crane operations must be performed with crane *level* to within one percent of grade in all directions – 1 ft in 100 ft (0,3 m in 30 m). Otherwise, crane could tip.



Centered bubble indicates level.

One half of bubble off center indicates approximately one percent of grade out of level.

FIGURE 3-4

C11. Boom Angle Indicator –

Shows the angle of the boom in degrees above horizontal. The boom, luffing jib, and mast angles can also be viewed under OPERATING CONDITIONS on the digital display.

See [Figure 3-5](#) for identification of the various boom and luffing jib angles.



WARNING

Overload Hazard!

Use boom angle indicator only as a guide to position boom near angle corresponding to radius for given load.

In all cases, radius must govern capacity. Exceeding radius given in capacity chart can result in tipping or structural damage.

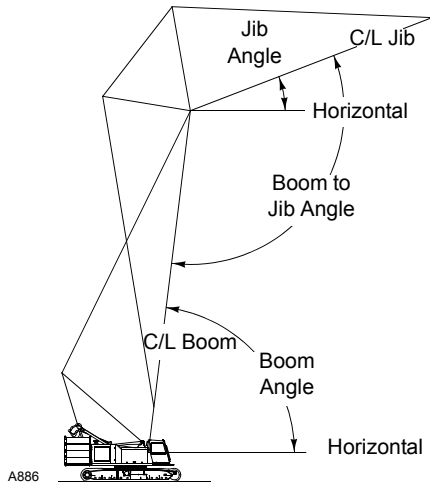


FIGURE 3-5

C12. DPF Status Indicator – Tier 4 equipped. See [Figure 3-13](#) for Tier 4 DPF diagnostics.

C13. Drum Direction Indicators

Glow green to indicate the direction in which a drum is being operated.

D – Gauges

D1. Fuel Level Gauge –

Shows how much fuel is left in the fuel tank.

D2. Engine Water Temperature Gauge –

See engine manufacturer's manual for operating specifications.

D3. Engine Oil Pressure Gauge –

See engine manufacturer's manual for operating specifications.

D4. Battery Voltage Gauge –

Shows the condition of the battery charging system. For a complete description of meter readings, See [Figure 3-6](#).

D5. Engine Hourmeter –

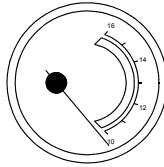
Shows the total number of hours the engine has been run.

Engine not running or running at idle.

Engine running fast enough to make alternator produce.

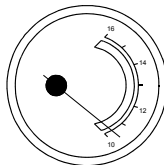
A915

1 Dead or disconnected battery. Disconnected or badly connected meter.



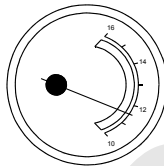
1 Disconnected meter. Engine could not run with dead or disconnected battery unless circuit was completed around battery.

2 Very low battery charge. Engine might not start.

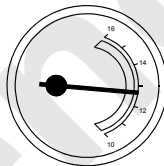


2 or 3 When pointer stays below 13.3 V with engine running fast enough to operate alternator, it shows that alternator is not operating, voltage regulator is out of adjustment, or current being drawn from battery by lights, heater, fan, or other load exceeds alternator output.

3 Low battery charge. Constant reading in this area indicates need to check alternator and voltage regulator.

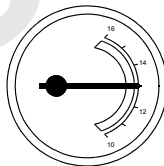


4 Well-charged battery. Indicates a good battery and that alternator and voltage regulator are operating properly.

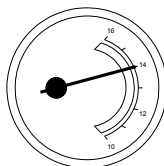


4 or 5 When engine is started, pointer might stay in this area temporarily, but it should gradually rise above 13.3 V as alternator reaches normal output.

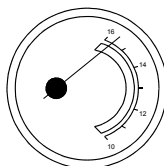
5 Pointer might remain in this position temporarily when engine has been stopped after considerable use, due to a "surface charge" in battery. To get a correct reading, turn on wipers or heater for a few minutes.



6 or 7 Under normal conditions, a 12 V battery is fully charged at 12.8 V. A slightly higher reading might occur under conditions outlined in No. 5. Generally speaking, however, any reading above 12.8 V when engine is stopped is not a true reading.



6 This is area where pointer should be when alternator, voltage regulator, and battery are all in good condition and working properly.



7 When pointer goes above 15.2 V, voltage regulator is set too high or jammed. Continued operation of engine will burn out battery.

FIGURE 3-6

E – Special Controls

E1. Crane Mode Selector –



WARNING

Moving Load Hazard!

Operator shall select proper operating mode prior to operating.

Unexpected drum motion or improper limit responses can result if wrong mode is selected.

Insert key. Turn CLOCKWISE and hold to SELECT the desired crane mode. CRANE MODE will appear on the first line of the digital display. The available crane modes will then scroll by (one to two seconds apart) on the second line of the display.

Turn key COUNTERCLOCKWISE to CONFIRM the desired crane mode when it appears on the digital display.

Release key to CENTER to LOCK the selector. Remove key to prevent unauthorized operation.

NOTE: To check the crane mode in effect at anytime, turn the key to the CONFIRM position. The current mode will appear on the digital display.

The crane mode in effect when the engine is stopped remains in memory. At each start-up, the crane mode in effect must be confirmed or another mode must be selected and confirmed. The load drums and boom hoist are not operable until this step is performed (the system fault alert will come on and CONFIRM MODE will appear on the digital display if operation is attempted.)

The following crane modes are available:

- STANDARD
Use this mode for all normal load handling operations. The load drums can be operated in full power or free fall.
- CLAMSHELL
Use clamshell mode to operate a clamshell bucket. In this mode, the front drum operates as the closing line and the rear drum as the holding line. Also the clamshell power down and closing features are turned on. The drums can be operated in full power or free fall.
- DRAGLINE
Use dragline mode for dragline operation. In this mode, the front drum operates as the dragline and the rear drum as the hoist line. The drums can be operated in full power or free fall.

- LUFFING JIB

Same as standard mode, except in this mode the rear drum operates as the luffing hoist and must be rigged accordingly. See Jib Rigging Guide in Luffing Jib Operator Manual for raising and lowering instructions when equipped with a luffing jib attachment.

For luffing jib operation, **free fall must be disabled for rear drum**. See [Luffing Hoist Operation](#) for procedure.

- FFALL (Free-Fall)

Allows the desired load drum (Drum 1 or 2) to be operated in free fall.

When selecting free fall, drum numbers appear on the digital display as follows:

DRUM 1 – Front Load Drum

DRUM 2 – Rear Load Drum



DANGER

Falling Boom Hazard!

For luffing jib operation, do not switch rear drum to free fall. Jib could fall uncontrolled.

To turn on free fall for the desired load drum, proceed as follows. The following example is for the front drum (Drum 1). The process is the same for the rear drum.

1. Bring front drum to complete stop.
2. Press down and latch drum working brake pedal. Free fall cannot be turned on until this step is performed.
3. Turn mode selector key CLOCKWISE and hold until DRUM 1 FFALL appears on digital display.
4. Turn mode selector key COUNTERCLOCKWISE to CONFIRM free fall.
5. DRUM 1 FFALL ON will appear on digital display and front drum free fall light will glow amber.

To turn off free fall for the desired load drum, proceed as follows. The following example is for the front drum (Drum 1). The process is the same for the rear drum.

1. Press down drum working brake pedal fully to bring front drum to complete stop.
2. Turn mode selector key CLOCKWISE and hold until DRUM 1 FFALL ON appears on digital display.
3. Turn mode selector key COUNTERCLOCKWISE to CONFIRM.
4. DRUM 1 FFALL will appear on digital display (word ON will disappear) and Drum 1 free fall light will turn off.

NOTE: When free fall is off, the corresponding load drum operates in full power. See [G – Load Drum Controls](#) for a description of full power operation.

- **SETUP**
Use this mode for crane assembly and disassembly. This mode allows the gantry, mast assist arms, and boom hinge pins to be operated.



WARNING

Falling Boom Hazard!

Setup mode is provided for crane assembly and disassembly purposes only.

Do not use this mode for normal load handling operations.

Read and follow Crane Assembly and Disassembly Instructions in Section 4.

- **LUFFING JIB SETUP**
Use this mode for luffing jib assembly and disassembly. This mode allows the limits identified in [Table 3-3](#) to be bypassed.



WARNING

Falling Boom Hazard!

Luffing Jib Setup mode is provided for luffing jib assembly and disassembly purposes only.

Do not use this mode for normal load handling operations.

Read and follow the Assembly and Disassembly instructions in Section 4 of the Luffing Jib Operator Manual.

E2. Limit Bypass Switch–



WARNING

When bypassing a limit, follow instructions under Limit Devices topic in this section carefully.

This switch bypasses the limits identified in [Table 3-2](#) and [Table 3-3](#).

Insert key. Turn CLOCKWISE to BYPASS (deactivate) reached operating limits. This position allows the functions to be operated beyond the limits.

RELEASE to ACTIVATE the limits. This position allows the limits to stop the functions in the normal manner.

Remove key to prevent unauthorized operation.

NOTE: To bypass the limits listed in [Table 3-3](#) for luffing jib setup on crane S/N 9991326 and newer, proceed as follows:

- Select and confirm luffing jib setup mode.
- Rotate limit bypass switch (E2) clockwise and release. The limits will remain bypassed for 10 seconds.
- Move the desired control handle (luffing hoist, boom hoist, load drum) — one control handle at a time — in the required direction. The limits will remain bypassed for as long as the handle is moved in either direction.
- The limits will remain bypassed for 10 seconds after the control handle(s) is returned to off.

E3. Luffing Jib Limit Bypass Switch –

If equipped, this switch bypasses the limits identified in [Table 3-2](#).

This switch is provided to allow the jib MAX Up 2 limit to be bypassed when the boom and luffing jib are lowered to the ground.

Insert Key. Turn CLOCKWISE to BYPASS the jib up limit. All other limits will be operational.

Turn key COUNTERCLOCKWISE to ACTIVATE the jib up limit and allow it to operate in the normal manner. **Key must be in this position for all normal operation. Otherwise, structural damage can occur.**

Remove key to prevent unauthorized operation.

E4. Seat Switch –

Prevents the crane from being operated until the operator is seated. When the operator is not seated, all control handles are inoperable, all parking brakes are applied, free fall is turned off, and the travel detent is turned off.

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Table 3-2 Bypassable Limit Identification (S/N 9991001 through 9991325)

Limit	Non-European Limit Bypass Switch (E2) (momentary rocker or key Switch)	European	
		Limit Bypass Switch (E2) (momentary key switch)	Luffing Jib Limit Bypass Switch ¹ (E3) (maintained key switch)
Boom Up Limit	Yes or No ²	Yes or No ²	No
Boom Down Limit	Yes	Yes	No
Block-Up Limit (each drum)	Yes	Yes	No
Bail Limits - Max & Min (each drum)	Yes	Yes	No
Rated Capacity Indicator/Limiter	Yes	Yes	No
Luffing Jib Maximum UP 1	Yes	No	Yes
Luffing Jib Maximum UP 2	Yes ³	No	Yes ³
Luffing Jib Maximum Down 2	Yes	No	Yes

¹ Use only for rigging.

² The boom up limit cannot be bypassed on current production cranes. To determine if the boom up limit can be bypassed on your crane, perform the test given on [page 3-27](#) in this section.

³ Only when boom is below 50°.

Table 3-3 Bypassable Limit Identification (S/N 9991326 and newer)

This Table Applies to Cranes Without Luffing Jib Limit Bypass Switch (E3)

Limit	Limit Bypass Switch (E2) (momentary key switch)		Limit Bypass Switch (E2) (momentary key switch) Luffing Jib Setup Mode On ¹		External Override Switch ²
	Non-CE	CE ³	Non-CE	CE ³	CE ³
Boom Up	No	No	No	No	No
Block Up (each drum)	Yes	Yes ⁶	Yes	Yes	No
Minimum Bail (each drum)	Yes	No	No	No	No
Luffing Jib Maximum Up 1	Yes	No	Yes	Yes	No
Luffing Jib Maximum Up 2	Yes	No	Yes ⁴	Yes ⁴	No
Luffing Jib Maximum Down 1	Yes	No	Yes	Yes	No
Luffing Jib Maximum Down 2	Yes ⁵	No	Yes ⁵	No	No
Mast Too Far Forward	No	No	No	No	No
Gantry Down	Yes	Yes	No	No	No
Boom Limiter	Yes	Yes	No	No	No
Swing Limiter	No	No	No	No	No
Rated Capacity Indicator/Limiter	Yes	Yes ⁶	Yes	Yes ⁶	Yes ⁷

¹ Use only for rigging. The luffing jib setup mode must be turned on (see [page 3-20](#)).

² Cranes meeting 2010 European requirements are equipped an RCI/RCL External Override Switch located outside the operator's cab (see Rated Capacity Indicator/Limiter Operation Manual).

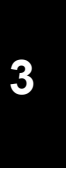
³ CE = Cranes that comply with 2010 European requirements (see NOTE below).

⁴ Only when boom is below 50°.

⁵ When this limit is contacted, operation will stop and you will not be able to continue lowering luffing jib. See Luffing Jib Max Down 2 on [page 3-28](#) for detailed instructions.

⁶ Only if boom or luffing jib is below allowable angle given in Capacity Chart (while raising or lowering boom and luffing jib from or to ground level).

⁷ When the external bypass is in override, the speed of the crane functions are limited to 15% of their maximum speed for movements that increase load.



Reference

E5. Battery Disconnect Switch–

Turn handle CLOCKWISE to CONNECT battery circuit.

Turn handle COUNTERCLOCKWISE to DISCONNECT battery circuit for the following reasons:

- When servicing crane's electrical control system
- If desired, to prevent batteries from discharging when the crane is stored for extended periods of time
- If desired, to prevent crane from being started by unauthorized personnel

CAUTION
Engine Damage!

To avoid possible engine fault codes and undesirable operation, make sure engine ignition switch has been off five minutes before disconnecting batteries.

Do not rely on this switch to protect crane's electronic systems when welding. Disconnect battery cables at batteries before welding.

Pull handle out when in the disconnect position to keep unauthorized personnel from connecting the battery and starting the crane.

F – Boom Hoist Controls

The boom hoist and swing are control by a dual-axis handle that allows both functions to be operated at the same time with one handle.

The boom hoist has a spring-applied, hydraulically-released disc brake on the motor end of the drum shaft.

- The parking brake is released automatically when the boom hoist handle is moved in either direction from off.
- The parking brake is applied automatically when the boom hoist handle is moved to off, the engine is stopped, applicable operating limits are reached or system faults occur, or boom hoist park is on.

F1. Boom Hoist Park Switch –

Press TOP of rocker to TURN ON boom hoist park. With park on, the boom hoist handle is inoperable, the brake is applied, and the drum pawl is engaged.

Press BOTTOM of rocker to TURN OFF boom hoist park. With park off, the boom hoist handle is operable, the brake is applied and released in conjunction with handle movement, and the drum pawl is disengaged.

F2. Boom Hoist Handle –

NOTE: The dual-axis handle allows the boom hoist and swing to be operated at the same time with one handle.

Pull handle BACK to RAISE boom. The brake releases and speed increases in relation to handle movement.

Release handle to CENTER to STOP the boom (brake applies).

Push handle FORWARD to LOWER. The brake releases and speed increases in relation to handle movement.

G – Load Drum Controls

The front and rear load drums are equipped with a spring-applied, hydraulically-released disc brake on the motor end of the drum shaft. When either drum is equipped with free fall, a spring-applied, hydraulically-released disc-type clutch/brake is mounted on the right end of the corresponding drum.

The parking brake for the butt mounted auxiliary load drum is a spring-applied, hydraulically-released disc brake on the motor end of the drum shaft.

For FULL POWER operation (free fall off):

- The corresponding parking brake is released automatically when the drum handle is moved in either direction from off.
- The corresponding parking brake is applied automatically when the drum handle is moved to off.

For FREE-FALL operation:

- The disc brake (on left end of drum) is applied at all times.
- The corresponding clutch/brake (on right end of drum) is spring applied when the drum handle is moved from off to hoist or lower the load with full power.
- *The corresponding clutch/brake is released when drum handle is moved to off. Use drum working brake to control lowering speed and to stop and hold load in position.*

NOTE: The drum parking brakes are applied automatically when the engine is stopped, applicable operating limits are reached or system faults occur, and drum park is on.

**G1. Auxiliary Drum Park Switch,
G2. Front Drum Park Switch, and
G3. Rear Drum Park Switch –**

Press TOP of rocker to TURN ON corresponding drum park. With park on, the drum handle is inoperable, the parking brake is applied, and (if equipped) the drum pawl is engaged.

Press BOTTOM of rocker to TURN OFF drum park. With park off, the drum handle is operable, the parking brake is applied and released in conjunction with handle movement, and (if equipped) the drum pawl is disengaged.

**G4. Front Drum Handle,
G5. Rear Drum Handle, and
G6. Auxiliary Drum Handle –**

NOTE: The following description is for full-power operation (free fall off if equipped). If free fall is on, **corresponding drum working brake must be applied to stop load when drum handle is released to off.**

Pull handle BACK to HOIST load. The parking brake releases and speed increases in relation to handle movement.

Release handle to CENTER to STOP the load (brake spring applies).

Push handle FORWARD to LOWER the load. The parking brake releases and speed increases in relation to handle movement.

**G7. Front Drum Working Brake Pedal and
G8. Rear Drum Working Brake Pedal –**

Each free fall equipped drum has a spring-applied, hydraulically-released working brake controlled by a brake pedal (Figure 3-7). When free falling a load, the working brake can be applied at any time to slow down and stop the load.

The brake pedals have no function and are inoperable when operating in full power.

DEPRESS pedal to APPLY the working brake in relation to pedal movement. Fully depress and latch the pedal to fully apply the brake.

DEPRESS heel of latch to unlatch the pedal and then RELEASE pedal (ease up) to RELEASE the working brake gradually as the pedal rises.

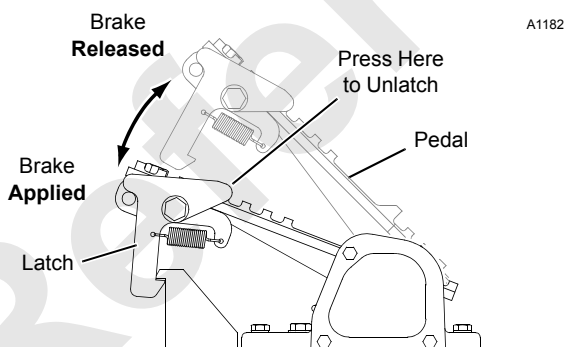


FIGURE 3-7

H – Swing Controls

H1. Swing Park Switch –

The swing drive is equipped with a spring-applied, hydraulically-released disc brake at the planetary.

Press TOP of rocker to TURN ON swing park. With park on, the swing handle is inoperable, the swing brake is applied, and the swing lock is engaged.

Press BOTTOM of rocker to TURN OFF swing park. With park off, the swing handle is operable, the swing brake is released, and the swing lock is disengaged.

H2. Swing Handle –

NOTE: The dual-axis handle allows the boom hoist and swing to be operated at the same time with one handle.

If equipped, the swing alarm will beep to warn personnel when the rotating bed is swung.

See instructions in this section for adjusting swing speed and torque.

Move handle to LEFT to SWING LEFT. Swing speed increases in relation to handle movement.

Release handle to CENTER to STOP. Swing speed decreases to off and the rotating bed slows to a stop. Move the handle in the opposite swing direction to stop the swing motion quicker.

Press the swing holding brake switch to hold the stopped rotating bed in position.

Move handle to RIGHT to SWING RIGHT. Swing speed increases in relation to handle movement.

H3. Swing Holding Brake Switch –

Use the swing holding brake switch (on side of handle) to hold the rotating bed in position for short periods of time during the operating cycle. The swing brake will apply and the swing handle will be inoperable while the switch is pressed.

PRESS button to APPLY the swing holding brake.

RELEASE button to RELEASE the swing holding brake.

CAUTION

Swing Drive/Boom Damage!

Do not apply swing holding brake or turn on swing park while swinging as the brake will bring rotating bed to an abrupt stop. This action could cause damage to boom from side loading or damage to swing drive from shock loading. Bring rotating bed to smooth stop with swing handle and then apply swing holding brake or turn on swing park.

J – Travel Controls

The crawlers are equipped with spring-applied, hydraulically-released disc brakes.

- Both crawler brakes release when either crawler handle is moved in either direction from off.

- Both crawler brakes apply when both crawler handles are moved to off.
- Both crawler brakes apply to hold the crane in position if power is lost for any reason.

J1. Travel Park Switch –

The travel park switch enables and disables travel operation. With travel park on, the crawler handles are inoperable and the travel brakes are applied.

Press TOP of rocker to TURN ON travel park.

Press BOTTOM of rocker to TURN OFF travel park (allow travel to be operated).

J2. Travel Speed Selector –

Press TOP of rocker to operate the travel motors in HIGH speed. High speed operation provides the maximum available travel speed for traveling long distances.

Press BOTTOM end of rocker to operate the travel motors in LOW speed. Low speed operation provides smoother starts and stops and more precise control of the travel motors than high speed.

In low speed, the travel motors operate at approximately 1/3 the speed of high speed.

NOTE: It is okay to change travel speed while traveling:

The travel motors will shift immediately from high to low when low speed is selected.

The travel motors will not shift from low to high when high speed is selected until:

- Engine speed is at high idle.
- Hydraulic pressure is low enough to allow the motors to shift from low to high speed.

J3. Travel Detent Selector –

NOTE: The travel detent selector allows the crawlers to be operated in either direction at a selected speed without the operator's hand on the crawler handles or feet on the pedals.

Move both crawler handles (or pedals) in either direction from off to select desired speed and direction of travel. PULL UP and release KNOB on right crawler handle to TURN ON the travel detent. Release handles (or pedals) to off. The crawlers will continue to travel at the selected speed and direction.

Slightly move either crawler handle (or pedal) in the opposite direction or pull up and release the knob on the right handle to TURN OFF the travel detent.

J4. Left Crawler Handle and J5. Right Crawler Handle –

NOTE: The following directions of travel are with **front of rotating bed and front of under carriage facing same direction**.

- Operator's cab is at front of rotating bed.
- Carbody and crawler control valve is at front of under carriage.

If the front of the rotating bed and the front of the under carriage face in opposite directions, the crane will travel in the direction opposite of handle movement.

Push handle FORWARD or depress front of pedal to travel FORWARD. Speed increases in relation to handle or pedal movement.

Release handle or pedal to CENTER to STOP traveling.

Pull handle BACK or depress rear of pedal to travel in REVERSE. Speed increases in relation to handle or pedal movement.

NOTE: If equipped, the travel alarm will beep to warn personnel when the crane is traveled.

K – Setup Controls



WARNING

Avoid Death or Serious Injury!

Read and understand Crane Assembly and Disassembly Instructions in Section 4 before selecting setup mode or using setup controls.

K1. Mast Arms Switch –

NOTE: The setup mode must be selected and confirmed before the mast arms or setup remote control can be operated.

The mast arms bypass valve ([Figure 3-8](#)) must be:

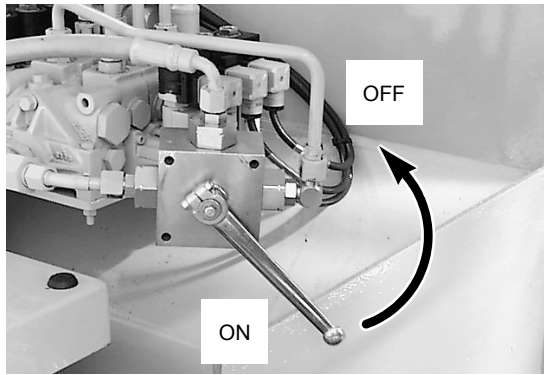
- Turned fully to stop in ON position to ensure proper operation of mast arms during crane assembly and disassembly (setup mode).
- Turned fully to stop in OFF position to prevent mast arms from rising accidentally during normal operation.

See Crane Assembly and Disassembly Instructions in Section 4 for mast raising and lowering procedure.

Depress and hold TOP of rocker to RAISE mast.

RELEASE rocker to center to STOP mast.

Depress and hold BOTTOM end of rocker to LOWER mast.



P1408
View in Right Side Enclosure

FIGURE 3-8

L – Limit Devices

See [Table 3-2](#) to determine which limit bypass switch bypasses a given limit.

L1. Boom Up Limit –

Automatically stops the boom when it is raised to a preset maximum angle:

- 81° — #82 Long Reach Boom
- 82° — #22E Open Throat Top
- 83° — #82 or 22EL Heavy Lift Boom
- 83° — #22E Open Throat Top Offset 4-1/2°.
- 88° — #82 or 22EL Heavy Lift Boom with #135 or 149 Luffing Jib when the boom up limit **can be bypassed**.
- 89° — #82 or 22EL Heavy Lift Boom with #135 or 149 Luffing Jib when the boom up limit **cannot be bypassed**.

The boom can be lowered after the limit is contacted.



WARNING

Falling Boom/Jib Hazard!

If you bypass boom up limit for any reason, DO NOT allow physical boom stops to bottom out. Boom butt could be damaged, causing boom and jib to fall over backwards.

Crush Hazard!

Maintain constant communication between operator and assistant during the following steps.

Stay clear of moving parts.

LIMIT BYPASS TEST: Perform the following test to determine if the boom up limit on your crane can be bypassed or not:

1. Lower the boom onto blocking at ground level.
2. Have an assistant push the boom stop rod in to trip the boom up limit switch open.
3. Rotate limit bypass key (D3) to the bypass position and hold.
4. Try to boom up SLOWLY — do not raise the boom any higher than necessary to perform the test:
 - a. If the boom rises, your boom up limit can be bypassed.
 - b. If the boom does not rise, your boom up limit cannot be bypassed.
5. The test is complete: release the limit bypass key and the boom stop rod to the normal operating positions.

L2. Boom Down Limit (if equipped) –

Automatically stops the boom when it is lowered to a preset minimum angle (usually 0°).

The boom can be raised after the limit is contacted. The limit bypass switch must be held down before the boom can be lowered below the limit.

The appropriate limit bypass switch must be turned to the bypass position before the boom can be lowered below the limit.



WARNING

Falling Boom Hazard!

When lowering boom below down limit, do so slowly with extreme caution. Do not lower boom to point where less than two full wraps of wire rope are on boom hoist drums. Wire rope could be pulled out of drums allowing boom to fall.

L3. Block-Up-Limit –

Automatically stops the boom or luffing hoist from lowering and the load drums from hoisting if the load contacts a block-up limit switch.

The load on the corresponding drum can be lowered and the boom or luffing jib can be raised after a block-up limit switch is contacted. The limit bypass switch must be held down before a load can be hoisted above the limit.

The appropriate limit bypass switch must be turned to the bypass position before a load can be hoisted above the limit.

**WARNING****Two-Blocking Hazard!**

If it is necessary to hoist a load above block-up limit, do so slowly with extreme caution to prevent two-blocking.

Do not hoist load above minimum block clearance given on Range Diagram in Capacity Chart Manual.

Do not use limit bypass switch to lower boom or luffing jib after block-up limit is contacted. Two-blocking could occur, causing load to fall.

L4. Luffing Jib Up Limit –

Two luffing jib up limits are provided:

- **LUFFING JIB MAX UP 1** limit which automatically stops the luffing hoist when the boom to luffing jib angle is 168°.

The luffing jib can be lowered after the limit is contacted.

The appropriate limit bypass switch must be turned to the bypass position to allow the luffing jib to be raised an additional 2° to LUFFING JIB MAX UP 2 limit.

**WARNING****Falling Boom/Jib Hazard!**

Proceed slowly when operating the luffing jib above the Max Up 1 limit.

Do not raise luffing jib above Max Up 2 limit. Structural damage will occur, possibly causing boom and luffing jib to be pulled over backwards.

- **LUFFING JIB MAX UP 2** limit which automatically stops the luffing hoist when the boom to luffing jib angle is 170°.

This limit can be bypassed with the jib up limit bypass switch only when the attachment is lowered to the ground (boom below 50°).

For crane S/N 9991326 and newer.

- For non-CE cranes, this limit can be bypassed only when the attachment is lowered to the ground (boom below 50°) and the handle is returned to neutral while holding the bypass switch in the bypass position.
- For CE cranes, the luffing jib cannot be lowered after the Jib Maximum Up 2 limit is contacted until the limit switch is reset. When the limit is contacted,

the following screen will appear on the digital display.

LUFFING JIB MAX UP 2
CONFIRM TO RESET

Once the screen appears, confirm it to reset the limit switch. The luffing jib can then be lowered.

L5. Luffing Jib Down Limit –**WARNING****Falling Boom/Jib Hazard!**

Do not lower luffing jib below down limit. Structural damage will result, possibly causing boom and luffing jib to collapse.

For crane S/N 9991001-9991325, this limit automatically stops the luffing jib when the boom to luffing jib angle is:

- 60° – #135 Luffing Jib
- 40° – Past Production #149 Luffing Jib

This limit cannot be bypassed.

The luffing jib can be raised after the limit is contacted.

For crane S/N 9991326 and newer, this limit automatically stops the luffing jib when the boom to luffing jib angle is:

- **LUFFING JIB MAX DOWN 1 Limit** is a programmed limit which automatically stops the luffing hoist when the boom to luffing jib angle is 58°.

The luffing jib can be raised after this limit is contacted.

- **LUFFING JIB MAX DOWN 2 Limit** is a limit switch which automatically stops the luffing hoist when the boom to luffing jib angle is 55°.

For non-CE cranes, the luffing jib can be raised after the luffing jib maximum down 2 limit is contacted.

For CE cranes, the luffing jib cannot be raised after the luffing jib maximum down 2 limit is contacted until the limit switch is reset. When the limit is contacted, the following screen will appear on the digital display.

LUFFING JIB MAX DN 2
CONFIRM TO RESET

Once the screen appears, confirm it to reset the limit switch. The luffing jib can then be raised.

L6. Maximum Bail Limit –

Automatically stops the corresponding drum from hoisting when there is a preset maximum number of wire rope layers on the drum.

The load can be lowered after the limit is contacted. The limit bypass switch must be held down before the load can be hoisted above the limit.

The appropriate limit bypass switch must be turned to the bypass position before the load can be hoisted above the limit.

**WARNING****Falling Load Hazard!**

Do not exceed maximum allowable spooling capacity given on Wire Rope Specifications Chart in Capacity Chart Manual. Wire rope could jump off drum allowing load to fall.

7. Minimum Bail Limit –

Automatically stops the corresponding drum from lowering when there are three wraps of wire rope remaining on the drum.

The load can be raised after the limit is contacted.

The appropriate limit bypass switch must be turned to the bypass position before the load can be lowered below the limit.

**WARNING****Falling Load Hazard!**

When lowering load below minimum bail limit, do so slowly with extreme caution. Do not lower load to point where less than three full wraps of wire rope are on drum. Wire rope could be pulled out of drum allowing load to fall.

L8. Rated Capacity Indicator/Limiter –

See separate manual for RCL operating instructions.

**WARNING****Overload Hazard!**

A rated capacity indicator/limiter has been installed on crane to aid operator.

Presence of rated capacity indicator/limiter on crane in no way substitutes for or lessens requirement that operator knowledge, experience, and judgment are required to ensure safe operation of crane.

Before using rated capacity indicator/limiter, operator shall:

- Read and thoroughly understand operating instructions.
- Make sure indicator is operating properly.
- Make sure indicator is calibrated properly.

NOTE: Limit devices L9 and L10 are active only in the setup mode.

L9. Gantry Down Limit –

Prevents boom hoist operation in either direction if gantry is down when mast angle is 120° or more.

**WARNING****Falling Mast hazard!**

Do not bypass this limit. Mast could fall unexpectedly.

L10. Mast Too Far Forward –

Automatically stops the boom hoist when the mast is lowered to 175°. The mast can be raised after the limit is contacted.

**WARNING****Falling Mast Hazard!**

Do not bypass this limit. Mast will fall suddenly.

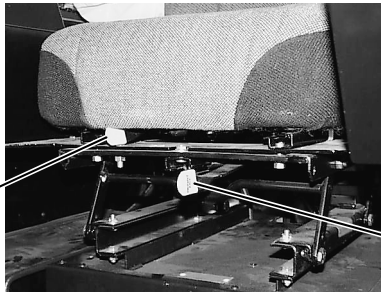
Seat Controls

Avoid Damage!

Disconnect electric cord from rear of left console before removing seat from operator's cab.

SEAT FORE-AFT

- Push lever to left to unlock.
- Use body weight to slide seat to desired position.
- Release lever and make sure it is latched to lock seat in position.

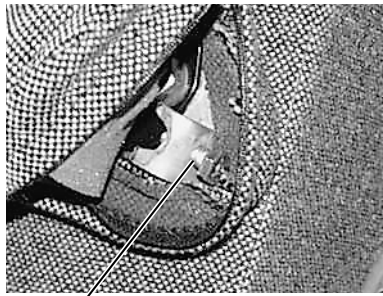


P1039

SEAT HEIGHT

- Push lever to left to unlock.
- Use body weight to raise and lower seat to desired position.
- Release lever and make sure it is latched to lock seat in position.

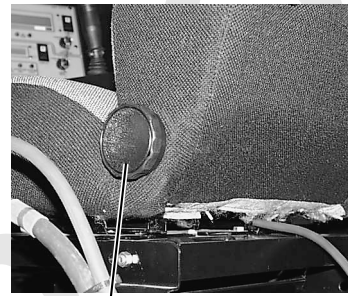
P1041a



ARMREST

- Open zipper at end of armrest.
- Turn bolt clockwise to raise arm rest or counterclockwise to lower armrest.
- Tighten jam nut and close zipper.

P1040



BACKREST

- Turn knob to raise and lower backrest to desired position.

FIGURE 3-9

Preparing Crane for Operation

WARNING

Read Capacity Charts!

Do not attempt to operate crane without first reading and understanding capacity charts.

Crane must be rigged and operated according to instructions given in capacity charts and rigging guides.

Unless otherwise specified in capacity charts, all crane operations must be performed with crane level to within one 1% of grade in all directions — 1 ft in 100 ft (0,3 m in 30 m). Otherwise, crane could tip.

Do not operate crane, to include raising boom from ground level, if wind exceeds limits given in Capacity Charts. Contact your local weather station for wind velocity.

Failing to comply with capacity charts can result in tipping or structural failure of boom/luffing jib.

Moving Load Hazard!

Operator shall select proper operating mode prior to operation.

Unexpected drum motion or improper limit responses can result if wrong mode is selected.

Limit bypass switch must be in activated position and all limits with which crane is equipped must be operational before operating crane.

Avoid injuring personnel in operating area!

Sound horn to alert personnel that operation is about to begin.

CAUTION

Avoid Machinery Damage!

Before operating crane at start of each shift, perform lubrication services in Section 5 and preventive maintenance checks in Section 6. Adjust operator's seat as shown in [Figure 3-9](#).

Operation

Engine Start-Up

WARNING

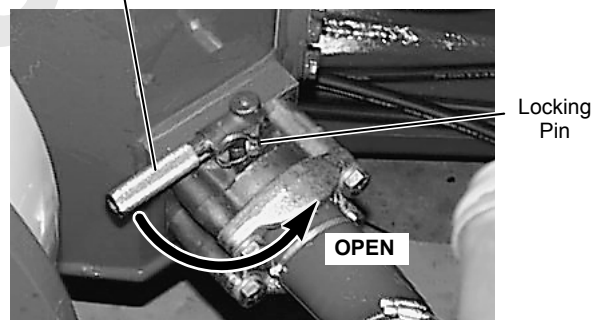
Avoid injuring personnel or damaging crane and property!

- Do not start engine if warning or out-of-order sign is present at start controls.
- Check that all controls are off so crane and load do not move when engine is started.
- Check that all personnel are clear of crane before starting engine. *Sound horn to alert personnel.*

Read and become thoroughly familiar with starting instructions in engine manufacturer's manual provided with crane.

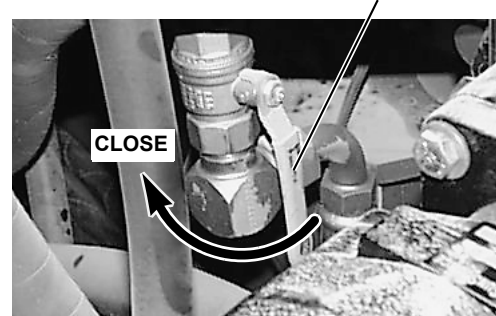
1. Unplug or turn off engine block heater and any other tank heaters crane is equipped with.
2. Open hydraulic tank and filter shut-off valves ([Figure 3-10](#)).

Hydraulic Tank Shut-Off Valve Shown **CLOSED**



Accessible from Under Rear of Rotating Bed

Filter Shut-Off Valve Shown **OPEN**



Left Enclosure Near Pumps

FIGURE 3-10

CAUTION**Pump Damage!**

Do not start engine until hydraulic tank and filter shut-off valves are open. Otherwise, pumps could cavitate and be damaged.

- Turn ignition switch to RUN.

NOTE: All of the indicator lights, the operating limit buzzer, and the system fault beeper should come on for one to two seconds when the ignition switch is in the RUN position. If not, replace defective parts.

Tier 4 engines only: Under cold conditions, the Wait-to-Start white indicator light will stay illuminated for a period of up to thirty seconds depending on the ambient temperature and engine ignition will be disabled.

CAUTION**Engine Damage!**

Tier 4 engines only: to avoid possible engine damage, do not use ether starting aids. See engine manufacturer's manual for details.

- If the ambient temperature is below 50°F (10°C), disengage engine clutch, as shown in [Figure 3-11](#). This step will disconnect the pumps from the engine and aid in cold weather start-up.

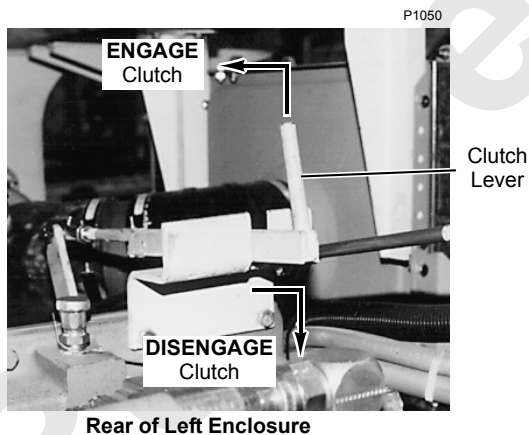


FIGURE 3-11

CAUTION**Pump Drive Damage!**

Observe the following precautions when equipped with an engine clutch:

- Decrease engine speed to idle** before engaging or disengaging clutch.
- Do not run engine longer than twenty minutes with clutch disengaged.
- Disengage and engage clutch several times monthly with engine running.

- Turn ignition switch to START.

CAUTION**Starter Motor Damage!**

If engine does not start after 30 seconds of cranking, wait a few minutes so starter motor cools before trying again.

- Increase engine speed as necessary to keep engine running after it starts.
- If engine clutch is disengaged, decrease engine speed to low idle and engage engine clutch within 20 minutes after starting engine.

NOTE: The engine clutch may be engaged when the temperature of the hydraulic oil is above 0°F (-18°C).

The hydraulic tank heaters are designed to keep the temperature of the oil in the tank at a minimum of 0°F (-18°C). If the heaters are being used, it is normal for the hydraulic oil temperature gauge to read low because it is mounted remotely to the tank. In this case, it is okay to engage the clutch. The gauge reading should rise to 0°F (-18°C) in less than one minute.

- Run engine at low idle until hydraulic oil temperature is at least 60°F (16°C).

NOTE: It is normal for the system fault alert and the engine warning/diagnostic lights to remain on after the engine is started. The alert and lights should go off as soon as engine oil pressure and hydraulic oil temperature rise to normal (if no other faults exist).

CAUTION

Machinery Damage!

Do not operate crane when system fault alert is on. If alert does not go off soon after engine is started or comes on during operation, immediately proceed as follows:

- Determine fault on digital display (or in engine manual)
- Land loads if possible. Otherwise apply drum brakes (if equipped with pedals) and park all functions
- Move all control handles to off
- Stop engine
- Correct cause of fault

9. Confirm crane mode in effect or select and confirm another crane mode. The drums and boom hoist are inoperable until this step is performed (operating limit alert will come on and CONFIRM MODE will appear on display if operation is attempted).

CAUTION

Mast Assist Damage!

Prevent damage to mast assist arms and cylinders during cold weather:

- Do not attempt to lower mast with boom hoist until temperature of hydraulic oil is 60°F (16°C).
- Once oil is at specified temperature, fully extend and retract mast assist cylinders twice to fill cylinders with warm oil.

Cylinders and arms will bend under weight of mast if this precaution is not taken.

CAUTION

Machinery Damage!

Continuous operation with hydraulic oil temperature above 180°F (82°C) can result in damage to hydraulic components. Troubleshoot hydraulic system if oil temperature exceeds 180°F (82°C).

Engine Diagnostics — Cummins QSM11, QSL9 Tier 4, and Caterpillar 3176C

See [Figure 3-12](#) and [Figure 3-13](#) for the following procedure.

The engines have two diagnostic modes:

- Offboard Diagnostics — requires special hardware/software from engine manufacturer.
- Onboard Diagnostics — has warning lights to alert the operator to engine problems during operation (engine running) and fault codes to identify specific engine problems.

To identify active faults, proceed as follows:

1. STOP engine.
2. Move engine ignition switch to RUN position.
3. On cranes with Cummins engine:
 - Move hand throttle from low speed to high speed and back to low speed three times within five seconds.
 - If no active faults exist, the engine yellow and red diagnostic lights come on but don't flash.
 - If there is an active fault the yellow diagnostic light flashes to indicate that a fault code is about to be flashed.
 - After a two second pause the red diagnostic light flashes the fault code.
 - After a two second pause the same fault code flashes a second time before advancing to next fault code.
4. On cranes with Caterpillar engine:
 - The engine yellow and red diagnostic lights come on for five seconds and turn off.
 - If there is an active fault, the diagnostic lights come on again and flash the fault codes.
 - The diagnostic lights turn off for five seconds and come on again to repeat all active fault codes until the problem is repaired.
5. See fault codes in operator's cab or see engine manufacturer's manual.

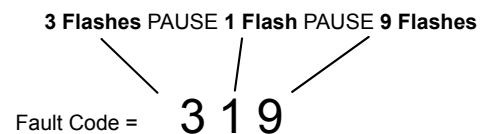


FIGURE 3-12

DPF Diagnostics — Cummins QSL9 Tier 4

See [Figure 3-13](#) for the following procedure.

DPF High Temperature

GLOWS YELLOW to alert operator that the exhaust system temperature is higher than normal due to DPF regeneration.

WARNING

High Exhaust Temperatures!

Active DPF Regeneration can occur at low engine idle as well as during crane operation. This may result in high exhaust temperature. Always keep personnel well away from the exhaust to prevent injury and possible death.

DPF Condition (Tier 4)

Displays one of three conditions if the Regeneration Inhibit switch is on (reference the Engine Manufacturer’s Manual for additional information):

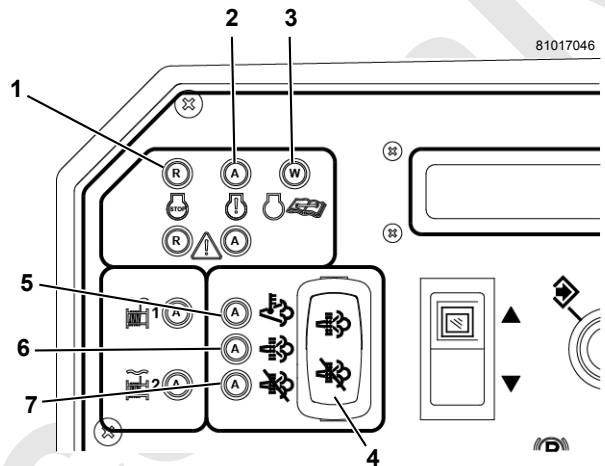
- GLOWS YELLOW when DPF is active and starting to fill. **Turn off regeneration inhibit switch.** No immediate action is required.
- FLASHING when DPF is nearly full. The operator may sense a reduction in power. **Turn off regeneration inhibit switch.** Perform a manual stationary regeneration of the DPF at earliest convenience.
- OFF when DPF is full and Red Engine Warning Light is ON. The soot level is critically high and past the point of a manual stationary regeneration. The operator will notice a significant reduction in engine power. **Turn off regeneration inhibit switch and shut down crane.** Do **NOT** perform a manual stationary regeneration. The DPF must be removed from the crane and physically cleaned and the Red Engine Warning Light can only be cleared by a Cummins Service Technician (see Engine Manufacturer’s Manual for details).

DPF Regeneration Inhibit (Tier 4)

GLOWS YELLOW when active regeneration has been stopped by pressing the Inhibit function (bottom) of the regeneration switch (B8). Excessive use of regeneration inhibit will result in the need to service or replace the DPF.

DPF Regen/Inhibit Switch

See [A8. DPF Switch \(Tier 4 Equipped\)](#) for operation procedure.



Tier 4 DPF Diagnostics

Item	Description
1	Engine Stop Light — Red
2	Engine Warning Light — Amber
3	Engine Maintenance Light — White
4	DPF Regen/Inhibit Switch
5	DPF High Temperature — Amber
6	DPF Regen On — Amber
7	DPF Inhibit On — Amber

FIGURE 3-13

Boom Hoist Operation**CAUTION**
Rigging Damage!

Avoid damage to boom rigging. Check that boom hoist wire is reeved through all sheaves and spooled properly onto boom hoist drum before raising boom from ground.

- See Boom Rigging Drawing in Section 4 for wire rope and reeving specifications.
- See Wire Rope Installation in Section 4 for instructions on attaching wire rope to boom hoist drum.

1. Select and confirm desired mode (STANDARD, CLAM, DRAG).
2. Turn off boom hoist park.

CAUTION
Boom or Luffing Damage!

Do not turn on boom hoist park while raising or lowering boom. Brake will bring boom to an abrupt stop. This action could cause shock load damage to boom and luffing jib. Bring boom to a smooth stop with boom hoist handle and then turn on boom hoist park.

3. Increase engine speed to desired RPM with hand throttle. Depress foot throttle to momentarily increase engine speed when more power is required.
4. See [Figure 3-15](#), View A or B (depending on mode selected).

Push boom hoist handle FORWARD from off to LOWER boom or pull handle BACK from off to RAISE boom.

 **WARNING****Two-Blocking Hazard!**

Pay out load lines while lowering boom. Load may contact boom point or jib point sheaves if this step is not taken. Wire rope or other parts could break allowing load to fall.

5. As boom nears desired angle, slowly move boom hoist handle toward off to decrease speed. Then move handle to off to stop boom and hold it in position (parking brake will spring apply).

NOTE: Besides being equipped with a boom up limit, a physical boom stop is provided. The physical boom stop cushions boom raising between approximately 78° and the up limit. The boom stop also provides a physical stop at 90°.

6. Turn on drum park if boom's angle will not be changed.

CAUTION
Fixed Jib Damage!

Avoid damage to fixed jib when lowering boom and jib to ground. Disconnect jib stop before jib point contacts ground.

Luffing Hoist Operation **WARNING****Avoid Death or Serious Injury!**

Read and understand rigging instructions in Luffing Jib Operator Manual before attempting to raise or lower luffing jib from or to ground.

Use extreme care when operating luffing hoist and boom hoist at same time. Maximum or minimum operating radius will be reached quickly when operating both hoists at same time

CAUTION
Rigging Damage!

Avoid damage to luffing jib rigging. Check that luffing hoist wire rope is reeved through all sheaves and spooled properly onto rear drum before raising boom and jib from ground.

- See Luffing Jib Rigging Drawing in Luffing Jib Operator Manual for wire rope and reeving specifications.
- See Wire Rope Installation in this manual for instructions on attaching wire rope to rear drum.

 **DANGER****Falling Jib Hazard!**

For luffing jib operation, do not operate rear drum in free fall mode. Disable free fall for rear drum before operating in luffing jib mode. Luffing jib will lower uncontrolled if this precaution is not taken.

1. Disable free fall for rear drum by moving valve handle to DISABLE (down) position as shown in [Figure 3-14](#). To enable free fall when luffing jib attachment is removed, move valve handle to ENABLE (up) position.
2. Select and confirm LUFFING JIB mode. Handle arrangement will switch to one of the versions shown in

[Figure 3-15](#), depending on how your crane was programmed.

3. Turn off rear drum park.

CAUTION

Boom or Luffing Damage!

Do not turn on rear drum park while raising or lower luffing jib. Brake will bring luffing jib to an abrupt stop. This action could cause shock load damage to boom and jib. Bring luffing jib to smooth stop with rear drum handle and then turn on rear drum park.

4. Increase engine speed to desired RPM with hand throttle. Depress foot throttle to momentarily increase engine speed when more power is required.

5. See [Figure 3-15](#).

Push luffing hoist handle FORWARD from off to LOWER luffing jib or pull handle BACK from off to RAISE luffing jib.



WARNING

Two-Blocking Hazard!

Pay out load lines while lowering luffing jib. Load may contact luffing jib point sheaves if this step is not taken. Wire rope or other parts could break allowing load to fall.

6. As luffing jib nears desired angle, slowly move luffing hoist handle toward off to decrease speed. Then move handle to off to stop luffing jib and hold it in position (parking brake will spring apply).

7. Turn on drum park if luffing jib's angle will not be changed.

CAUTION

Luffing Jib Damage!

Avoid damage to luffing jib when lowering boom and jib to ground. Disconnect jib stop pins before boom to luffing jib angle is 168° or jib stop pendants get tight, whichever occurs first.

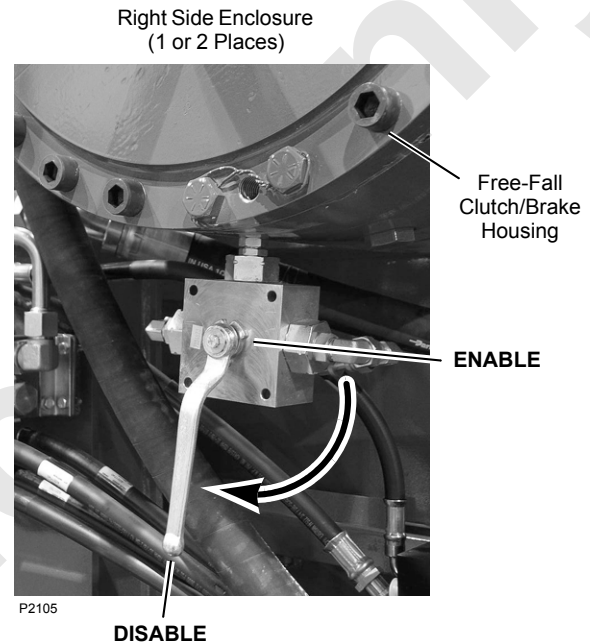


FIGURE 3-14

Swing Operation

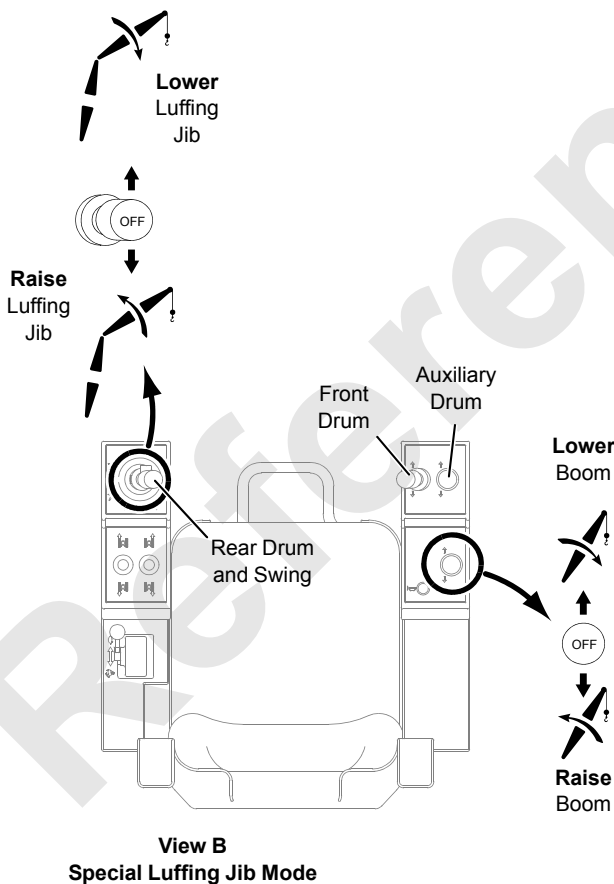
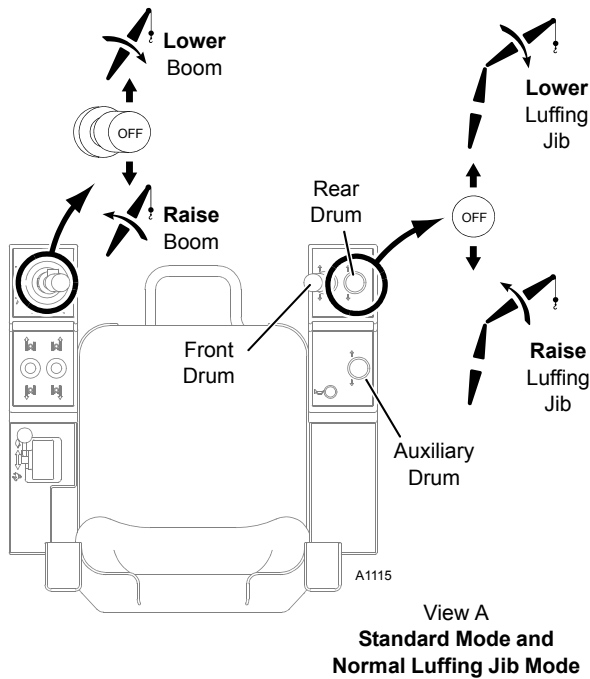


FIGURE 3-15

WARNING
Tipping Hazard!

To prevent crane from tipping, adhere to the swing limitations given in the capacity charts.

DANGER!
Moving Crane Hazard!

Counterweights can strike personnel in area of swing path! Warn personnel to stay clear of swing path. Sound horn prior to swinging.

1. Turn off swing park.

CAUTION

Boom/Swing Drive Damage!

Do not apply swing holding brake or turn on swing park while swinging. Brake will bring rotating bed to an abrupt stop. This action could cause damage to boom and luffing jib from side loading or damage to swing drive from shock loading. Bring rotating bed to smooth stop with swing handle and then apply swing holding brake or turn on park.

2. Increase engine speed to desired RPM with hand throttle. Press foot throttle to momentarily increase engine speed when more power is required.
3. See [Figure 3-16](#).
Push swing handle to LEFT from off to SWING LEFT or pull handle to RIGHT from off to SWING RIGHT
4. Start swing motion with a smooth acceleration. Continue handle motion to swing at desired speed.
5. Stop swinging by releasing swing handle to off. Swing speed will decrease to off and rotating bed will coast to a stop. If a faster stop is desired, move swing handle slightly past off to opposite swing direction.
6. Once rotating bed stops, apply swing holding brake to hold rotating bed in position for short periods during operating cycle.
7. To hold rotating bed in position for long periods, turn on swing park.

Swing Speed/Torque Adjustment

Swing speed and torque can be adjusted to suit operator need, as follows:

1. Stop swinging and apply swing parking brake.
2. Access diagnostic screens:
 - a. Turn limit bypass key clockwise and scroll up.
 - b. Scroll up at least one screen, release key, and scroll up or down through diagnostic screens until swing speed/swing torque screen appears (Figure 3-17).
3. Rotate crane mode selector back-and-forth from center position to SELECT position until cursor (*) appears next to SWING SPEED.
4. Scroll up and down to change swing speed to desired percentage between 25% and 100%.
5. Repeat steps 3 and 4 for SWING TORQUE.
6. Rotate crane mode selector back-and-forth from center position to SELECT position until cursor (*) disappears.
7. Adjustment is complete. The selected swing speed and torque will remain in computer memory, even after engine is stopped.

A1115

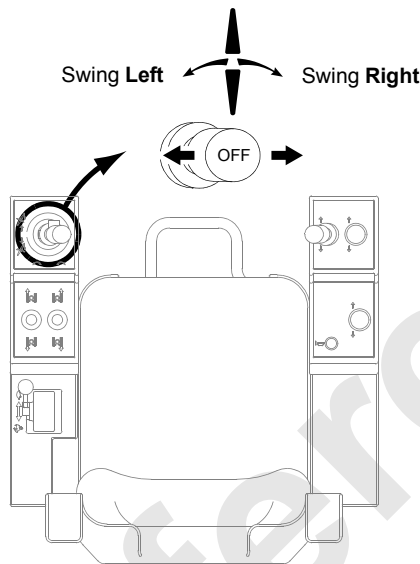


FIGURE 3-16

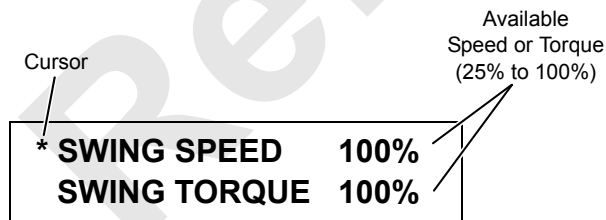


FIGURE 3-17

NOTE: See Drum and Lagging Chart in Capacity Chart Manual for load drum identification.

! WARNING
Falling Load Hazard!

Prevent load on unused drum from falling. Turn on drum park for drum not in use.

Load Drum Operation – Liftcrane Full Power

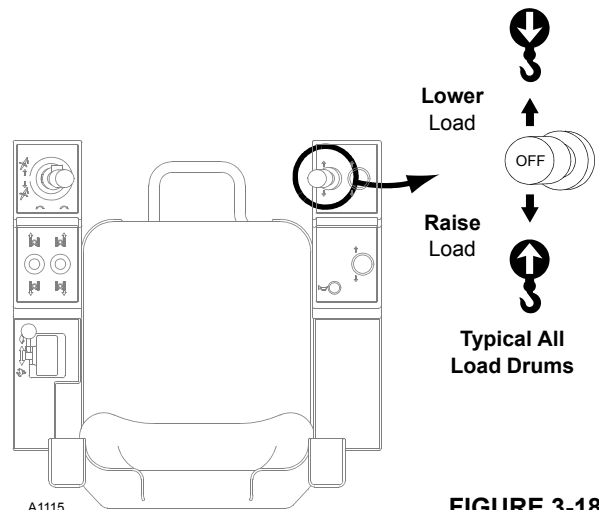
1. Turn off free fall for drum to be operated (see procedure in this section).
 2. Select and confirm desired crane mode.
- NOTE:** On free fall equipped cranes, the drum working brake pedals have no function and are inoperable while operating the drums in full power.
3. Turn off drum park for drum to be operated.

CAUTION
Boom or Luffing Damage!

Do not turn on drum park while raising or lowering load; brake will bring load to an abrupt stop. This action could cause shock load damage to boom, luffing jib, and load line. Bring load to smooth stop with drum handle and then turn on drum park.

4. Increase engine speed to desired RPM with hand throttle. Depress foot throttle to momentarily increase engine speed when more power is required.
5. See Figure 3-18.

Pull drum handle BACK from off to RAISE load or push handle FORWARD from off to LOWER load.



A1115

FIGURE 3-18

6. As load nears desired position, slowly move drum handle toward off to slow down load. Then release handle to off to stop load and hold it in position (drum parking brake will apply).

Load Drum Operation – Liftcrane Free Fall

1. If equipped with free fall disable valves, handles must be in ENABLE position (see [Figure 3-14](#)), **EXCEPT when the rear drum is configured for operation with luffing jib.**
2. Select and confirm FREE FALL mode for drum to be operated (see procedure in this section).
3. Turn off drum park for drum to be operated.

CAUTION

Boom or Luffing Damage!

Do not turn on drum park while raising or lowering load; brake will bring load to an abrupt stop. This action could cause shock load damage to boom, luffing jib, and load line. Bring load to smooth stop with drum handle and then turn on drum park.

4. Increase engine speed to desired RPM with the hand throttle. Depress foot throttle to momentarily increase engine speed when more power is required.
5. See [Figure 3-18](#).
Pull drum handle BACK from off (release working brake) to RAISE load or push handle FORWARD from off to LOWER load.
6. As load nears desired position, slowly move drum handle toward off to slow down load. Then fully apply drum working brake to stop load and release drum handle to off.



WARNING

Falling Load Hazard!

When operating in free fall, load will lower uncontrolled if drum working brake is not applied when drum handle is released to off.

Be ready to apply drum working brake so lowering speed can be controlled and load can be stopped immediately when necessary.

7. Load can be lowered in one of two ways — with drum working brake or with hydraulic power:
 - a. To lower load with DRUM WORKING BRAKE, leave drum handle in off and release drum working brake to lower load at desired speed.

As load nears desired position, slowly apply drum working brake to slow down load. Then fully apply brake to stop load and to hold it in position.

- b. To lower load with HYDRAULIC POWER, push drum handle forward from off and release drum working brake. Lowering speed is controlled by handle movement.

As load nears desired position, slowly move drum handle toward off to slow down load. Then fully apply drum working brake to stop load and to hold it in position.

CAUTION

Clutch/Motor Damage!

Do not move drum handle in either direction from off while free falling a load. Serious damage to drum clutch and motor could result. Stop load with drum working brake and then move drum handle in desired direction.

8. If load will be suspended for any length of time, latch working brake pedal in applied position and turn on drum park.

Free-Fall Drum Slip/Pedal Response

Two free fall adjustments can be made for each drum — drum slip and pedal response.

Drum Slip can be adjusted to meet the type of operation being performed:

- For most operations (such as liftcrane), 100% slip should be selected so that the load line pays out freely when a load is lowered with the brake pedal.
- For applications like pile driving, adjust slip so the hammer follows the pile at the desired rate of speed (load line pays out automatically without having to use brake pedal).

The corresponding brake pedal can be applied to stop the drum regardless of the slip adjustment. Likewise, the corresponding control handle can be pulled back or pushed forward to hoist or lower the load with full power.

Pedal Response can be adjusted to suit operator feel. A high setting increases the pedal movement required to control a small load and decreases the pedal movement required to control a heavy load.

To adjust drum slip and pedal response, proceed as follows:

1. Stop operating and turn on drum park for desired drum.
2. Turn on free fall for desired drum.
3. Access free fall adjustment screen as follows:
 - a. Turn limit bypass key clockwise (and hold) and scroll up with selector next to display screen.

- b. Scroll up or down through diagnostic screens until free fall adjustment screen appears (Figure 3-19).

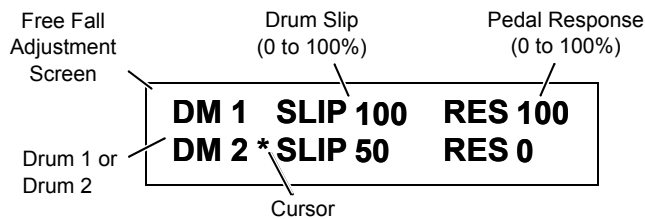


FIGURE 3-19

4. Rotate crane mode selector back-and-forth from center position to SELECT position until cursor (*), appears next to SLIP or RES for desired drum.
5. Scroll up or down to change SLIP or RES to desired percentage between 0 and 100%.
6. Rotate crane mode selector back-and-forth from center position to SELECT position until cursor (*), disappears.
7. Repeat steps 4-6 for each adjustment.

The selected adjustments will remain in computer memory, even after engine is stopped.

Load Drum Operation – Clamshell

Preparing For Clam Operation:

1. Switch both load drums to FULL-POWER mode.
2. Select and confirm CLAMSHELL mode.
3. Turn off drum park for both drums.
4. Set engine speed at desired rpm.
5. Clam closing pressure is set automatically.

Clamshell Operation In Full-Power Mode

Perform Preparing for Clam Operation steps. Then proceed as follows:

- CLOSING BUCKET (Digging)
 1. Lower bucket into digging area.
 2. Pull back closing line handle to close bucket. The holding line will pay out automatically allowing the bucket to dig in as it closes.
 3. Release closing line handle to off when bucket is closed fully.

NOTE: Watch the closing line when digging in a blind area. The bucket is closed when the closing line stops moving.

- RAISING BUCKET
 1. Pull holding line handle back to raise bucket at desired speed.
 2. Swing to dumping area as bucket rises.
 3. Release holding line handle to off when bucket is at desired height.

- DUMPING BUCKET

1. Push closing line handle forward to dump bucket at desired speed.
2. Release closing line handle to off as soon as bucket is empty and fully open.

Use care not to slacken closing line while dumping. Any slack in closing line will have to be taken out while digging. This action will slow down clam cycle.

- LOWERING BUCKET

1. Push holding line handle forward to lower bucket at desired speed.
2. Control lowering speed by slowly moving holding line handle toward off.

NOTE: Lowering speed is controlled by handle movement. It is not necessary to apply the working brakes to slow down the bucket in full-power clamshell operation.

3. Swing back to digging area as bucket lowers.
4. Stop swinging when bucket lands in digging area.
5. Bucket will stop lowering automatically when it contacts ground.
6. Release holding line handle to off.
7. Repeat clam cycle.

NOTE: Clamshell operation can also be performed with the load drums in the FREE-FALL mode. Use the working brakes to control the bucket when the handles are in the off position. If the holding line is operated in free fall, the closing line must also be operated in free fall. Otherwise, the closing line will not keep up with the holding line and the bucket will close while lowering.

Load Drum Operation – Dragline

Preparing for Dragline Operation

1. Select and confirm DRAGLINE mode with crane mode selector on front console.
 - In this mode, the FRONT DRUM operates the DRAG LINE and the REAR DRUM operates the HOIST LINE.

- The drum control handles switch from the standard arrangement to the drag line arrangement shown in [Figure 3-20](#).
- Increase engine speed to the desired RPM with the hand throttle. Depress the foot throttle to momentarily increase engine speed when more power is required.

Dragline Operation in Full-Power Mode

See [Figure 3-20](#) for the following procedures.

- Turn off free fall for both drums.

By operating the drums with free fall off, the drum working brakes are not used during the operating cycle — **the brakes remain released at all times**. The hydraulic pumps power the drums in response to control handle movement (drag, hoist, dump, lower), and pressurize the system sufficiently to stop the bucket and hold it in position when the control handles are returned to off.

The drums can be operated in free fall if a faster dumping or lowering speed is required. If free fall is used for either drum, the corresponding drum working brake must be applied, as required, to control dumping and lowering when the control handle is moved to off.
 - Turn off drum park for both drums.
 - Pull front drum handle BACK to DRAG bucket in.
 - Control digging depth with rear drum handle:

Push handle FORWARD slightly to LOWER bucket (dig deeper) or pull handle BACK slightly to HOIST bucket (dig shallower).
- NOTE:** If free fall is on, maintain tension in hoist line with rear drum brake pedal to control digging depth.
- As soon as the bucket is full and in close enough to be hoisted without dumping, pull rear drum handle BACK to HOIST bucket at desired speed.
 - Swing to dumping area as soon as bucket has been hoisted clear of digging area.
 - Stop swinging when bucket is over dumping area.
 - When bucket has been hoisted to desired height, release rear drum handle to off (stop hoisting) and hold front drum handle FORWARD to DUMP bucket.
- If desired, move rear drum handle forward the desired amount to dump and hoist at same time.

NOTE: If rear drum is in free fall, rear drum working brake must be applied to stop bucket and hold it in position when handle is released to off.

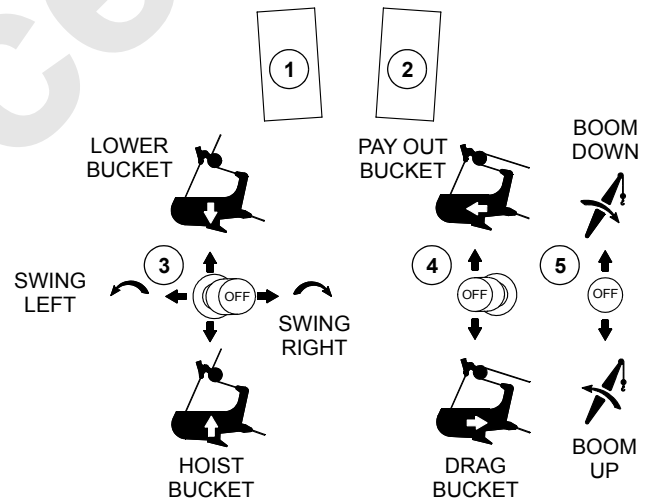
If front drum is in free fall, control dumping speed with front drum working brake.

- As soon as bucket is empty, push both drum handles FORWARD to LOWER bucket.

NOTE: If rear drum is in free fall, lower bucket with rear drum working brake.

- Swing back to digging area as bucket lowers.
- Stop swinging when bucket is over the digging area.
- Repeat dragline cycle as soon as bucket lands in digging area.

Item	Description
1	Front Drum Working Brake Pedal
2	Rear Drum Working Brake Pedal
3	Swing and Rear Drum Handle
4	Front Drum Handle
5	Boom Hoist Handle



A1113

FIGURE 3-20

Travel Operation



WARNING

Tipping Hazard!

Travel surface must be firm and uniformly supporting.

For traveling with load, grade must not exceed 1% in any direction.

For traveling without load, grade in direction of travel must not exceed 30%; grade from side to side must not exceed 2%, measured at boom hinge pins. For all travel on grades, see Maximum Allowable Travel Specifications Chart in Capacity Chart Manual.

Failing to comply with above specifications can result in tipping.

Moving Crane Hazard!

Know position of rotating bed with relation to under carriage before traveling. An accident can result if crane travels opposite of intended direction.

Flying Object Hazard!

Excessive dirt build-up at tumbler and front roller ends of crawlers can result in excessive tension in tread connectors. Tread connectors can break if over tensioned, causing treads to fly apart unexpectedly with dangerous force.

CAUTION

Crawler Damage!

Avoid damage to crawler components (treads, rollers, frames)!

Use care to prevent dirt from piling up at tumbler and front roller ends of crawlers when turning on soft surfaces:

- Bring crawlers to a complete stop before changing travel direction.
- Turn a few degrees. Then slowly travel forward or reverse so dirt falls away from crawlers. Continue this procedure until desired turn has been made.
- Avoid sharp turns ([Figure 3-22](#)) if possible.
- Make gradual turns ([Figure 3-23](#)) or counter-rotate ([Figure 3-24](#)) whenever possible so both crawlers are always powered.
- Clean crawlers often.
- Keep crawler treads properly adjusted.

CAUTION

Boom Damage!

Avoid shock loading boom and rigging!

- Perform all travel functions — starting, turning, stopping — slowly and smoothly.

1. Before traveling:

- a. Plan travel route. It must be free of ground and overhead constructions.
- b. Check crawlers for proper adjustment.
- c. Warn personnel to stand clear of travel area. Do not travel without a signal person.

2. Position boom at or above boom angle given on capacity chart when traveling with load.

3. Travel with boom in-line with crawlers except when swinging is necessary while traveling. Travel with boom facing direction of travel.

4. For traveling with load, carry load as close to ground as possible. Stabilize load with taglines.

For traveling without load, carry load block and weight ball low enough that they cannot swing into boom or jib. If desired, tie off load block at front of rotating bed.

5. Increase engine speed to desired RPM with hand throttle. Depress foot throttle to momentarily increase engine speed when more power is required.

6. Select desired travel speed, low or high.

NOTE: The following directions of travel are with **front of rotating bed and front of under carriage facing same direction.**

- Operator's cab is at front of rotating bed.
- Carbody/crawler control valve is at front of under carriage.

If the front of the rotating bed and the front of the under carriage face in opposite directions, the crane will travel in the direction opposite of handle movement.

- To TRAVEL STRAIGHT (Figure 3-21), move both crawler handles/pedals same amount in desired direction from off.

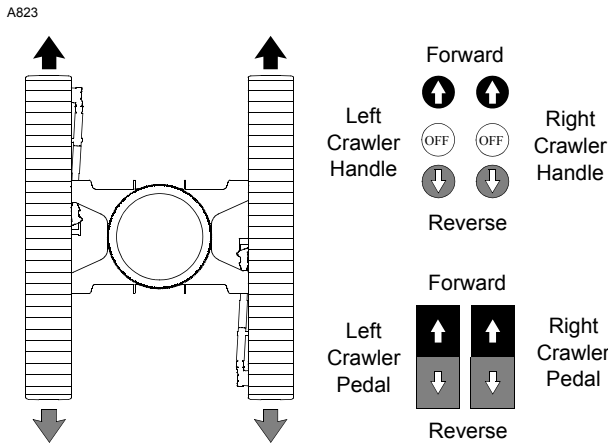


FIGURE 3-21

- To make a SHARP LEFT TURN (Figure 3-22), move right crawler handle/pedal to front from off and leave left crawler handle/pedal in off. Crane will pivot about left crawler.
- To make a SHARP RIGHT TURN, reverse step 8.

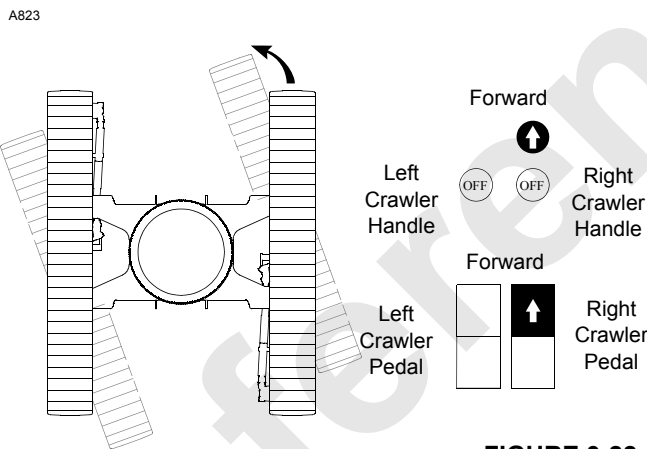


FIGURE 3-22

- To make a GRADUAL LEFT TURN (Figure 3-23), move both crawler handles/pedals to front from off, but move right crawler handle/pedal farther to front than left

crawler handle/pedal. Right crawler will turn faster than left crawler.

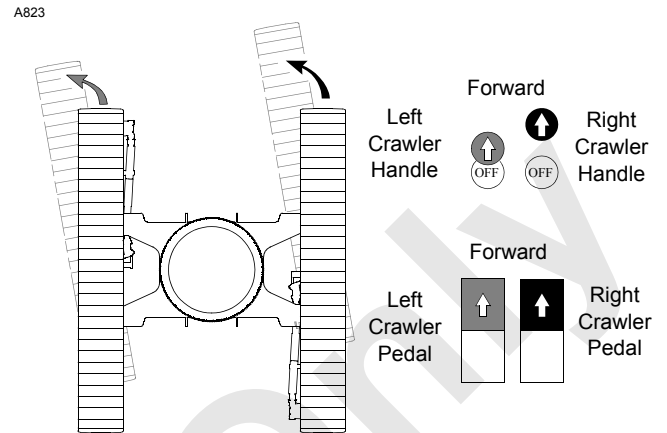


FIGURE 3-23

- To make a GRADUAL RIGHT TURN, reverse step 10.
- To COUNTER-ROTATE LEFT (Figure 3-24), move right crawler handle/pedal to front from off and move left crawler handle/pedal to rear from off.

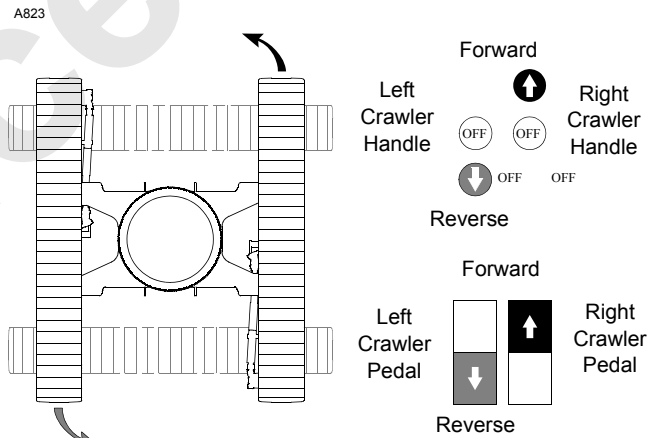


FIGURE 3-24

- To COUNTER-ROTATE RIGHT, reverse step 12.
- Slowly move both crawler handles/pedals to off to stop traveling and to hold crane in position.
- Turn on travel park.

Stopping Engine/ Leaving Crane Unattended



WARNING

Moving Load/Tipping Crane Hazard!

Operator shall not leave operator's cab until crane, loads and boom have been secured against movement.

Changing weather conditions including but not limited to wind, ice or snow accumulation, precipitation, flooding, lightning, etc. should be considered when determining the location and configuration of a crane when it will be left unattended.

1. Travel crane onto a level surface. **Do not leave crane unattended on a grade.**
2. Turn on travel park.
3. Swing rotating bed to desired position. Then turn on swing park.
4. Lower all loads to ground and fully apply drum working brakes (if equipped with brake pedals).
5. Turn on drum park for each load drum.

6. If possible, lower boom and luffing jib onto blocking at ground level.

If the boom and luffing jib cannot be lowered, as determined by a qualified designated person, they must be securely fastened from movement by wind or other outside forces (see Wind Conditions in Capacity Chart Manual).

NOTE: The designated person shall be familiar with the job site limitations, the crane configuration, and the expected weather conditions.

7. Check that all control handles are off.
8. Decrease engine speed to idle.
Allow engine to idle for three to five minutes so it cools evenly.
9. Stop engine.
10. Remove all keys from cab to prevent unauthorized operation.
11. Lock operator's cab windows and door to prevent unauthorized entry.

Calibration Procedures

To ensure proper operation of the crane functions, the hydraulic system must be properly calibrated. For instructions, see Hydraulic System Calibration Procedures in Section 2 of the Service Manual.

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Numbers correspond to [Controls Identification and Operation](#)

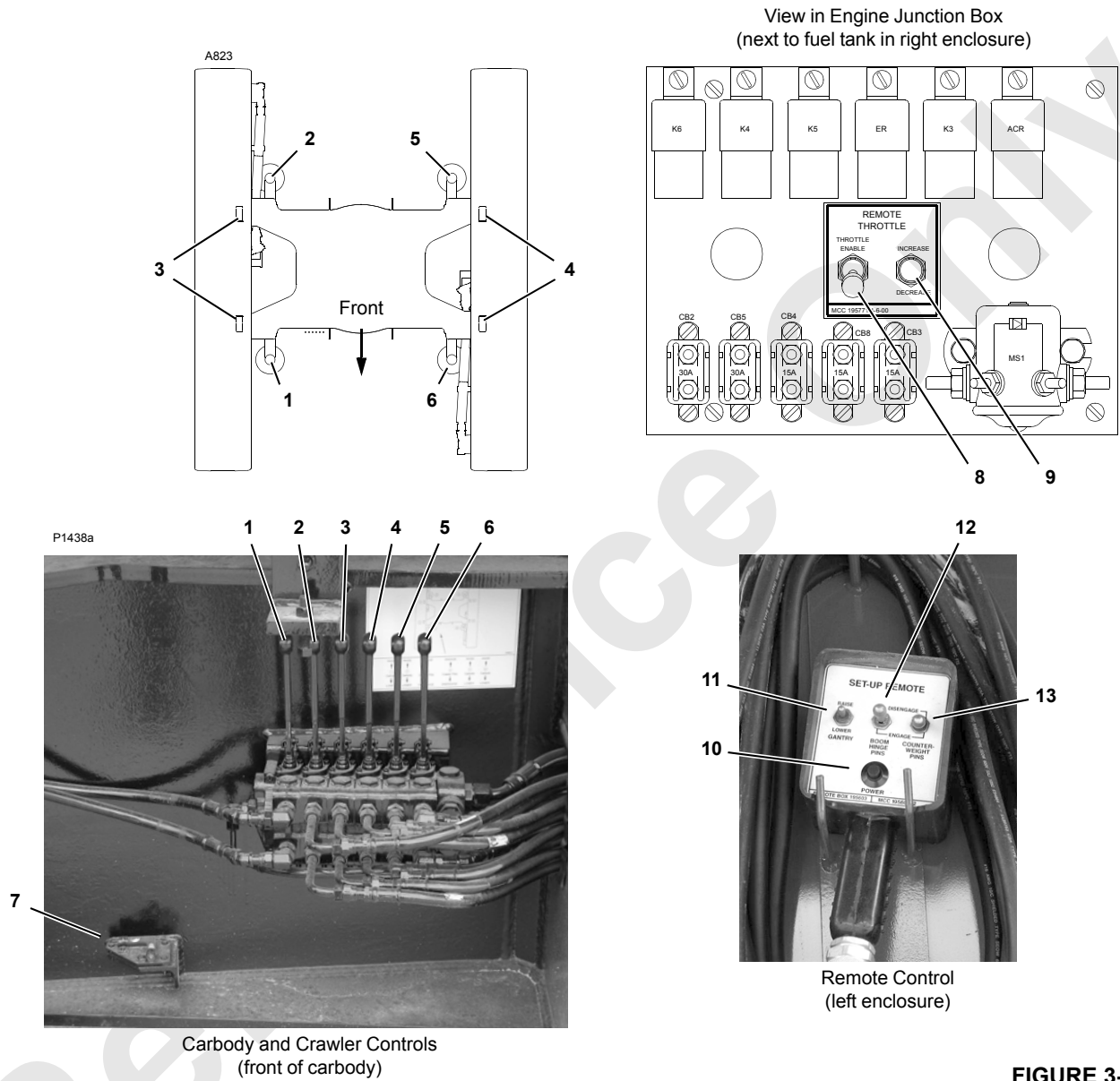


FIGURE 3-25

REMOTE CONTROLS



WARNING

Read Instructions!

Avoid death or serious injury to personnel and damage to crane:

- Read Crane Assembly and Disassembly Instructions in Section 4 before operating remote controls.

The following instructions identify and describe operation of the remote controls used for crane setup.

NOTE: The speed at which the jacks and pins operate depends on control handle movement and/or engine speed. To provide adequate speed, the engine must be operated at mid to high idle.

All control handles are spring returned to off.

Controls Identification and Operation

Carbody Jack Controls

- 1 – Right Front Handle,
- 2 – Right Rear Handle,
- 5 – Left Rear Handle, and
- 6 – Left Front Handle –

Push handle TOWARD carbody to RAISE carbody (extend jack).

Release handle to CENTER to stop jack. Valves on the jack lock it in position.

Pull handle AWAY from carbody to LOWER carbody (retract jack).



WARNING

Moving Part Hazard!

Avoid serious injury:

- Keep feet clear of moving jacks.
- Warn all personnel to stay clear of jacks while they are being extended.

CAUTION

Machinery Damage!

Avoid damage to carbody jacks:

- Fully retract jacks before traveling.

Crawler Pin Controls

3 – Right Crawler Handle and

4 – Left Crawler Handle –

Push handle TOWARD carbody to ENGAGE crawler connecting pins. Crawler locking pins must be installed to lock connecting pins in engaged position (read Crane Assembly and Disassembly Instructions in Section 4).

Release handle to CENTER to stop pins.

Pull handle AWAY from carbody to DISENGAGE crawler connecting pins. Crawler locking pins must be removed before pins can be disengaged (read Crane Assembly/Disassembly and Disassembly Instructions in Section 4).

Carbody Level

7 – Level –

Indicates crane levelness from front to rear and from side to side while jacking carbody (see [Figure 3-25](#)).



WARNING

Tipping Hazard!

Prevent crane from tipping over:

- Keep crane level while jacking.

NOTE: The following remote engine controls are for emergency use only if the throttle controls in the crane cab fail to operate.

Remote Throttle Controls

8 – Throttle Enable Switch

The toggle knob must be pulled out before the toggle can be moved in either direction.

Move toggle UP to ENABLE remote operation of the engine throttle. When the remote throttle is enabled, it has priority over the throttle controls in the crane cab.

Move toggle DOWN to DISABLE remote operation of the engine throttle. The engine throttle must be operated with the controls in the crane cab.

9 – Throttle Speed Switch

Toggle knob must be pulled out before toggle can be moved in either direction from center.

Move toggle UP to INCREASE engine speed. Release the toggle to center when the desired speed is reached. The selected speed will be maintained.

Move toggle DOWN to DECREASE engine speed. Release the toggle to center when the desired speed is reached. The selected speed will be maintained.

NOTE: The crane SETUP mode must be selected and confirmed to operate the remaining remote controls.

Remote Power Control

10 – Power Switch

DEPRESS button to TURN ON electric power to remote controls (controls can be operated).

RELEASE button to TURN OFF electric power to remote controls (controls cannot be operated).

Gantry Control

11 – Gantry Switch

Move toggle UP and hold to RAISE gantry (extend cylinders).

Release toggle to CENTER to STOP gantry. Valves on the cylinders lock the gantry in position.

Move toggle DOWN and hold to LOWER gantry (retract cylinders).

Read Crane Assembly and Disassembly Instructions in Section 4 for gantry/mast raising and lowering instructions.

Boom and Counterweight Pin Controls

12 – Boom Hinge Pins Switch

Toggle knob must be pulled out before toggle can be moved in either direction from center.

Move toggle UP and hold to DISENGAGE boom hinge pins.

Release toggle to CENTER to STOP pins.

Move toggle DOWN and hold to ENGAGE boom hinge pins.

WARNING Falling Load Hazard!

To prevent boom or boom butt from falling off crane:

- Do not disengage boom hinge pins until boom is disassembled and boom butt is properly supported on stands at ground level. Read Crane Assembly and Disassembly Instructions in this Section 4.

13 – Counterweight Pins Switch

Toggle knob must be pulled out before toggle can be moved.

Move toggle UP and hold to DISENGAGE counterweight pins.

RELEASE toggle to ENGAGE counterweight pins (pins are spring engaged).

WARNING Falling Load Hazard!

To prevent counterweights from falling off crane and crane from tipping over:

- Do not disengage counterweight pins until handling links on gantry have been connected to counterweights. Read Crane Assembly and Disassembly Instructions in Section 4.

DISPLAY READINGS

The display allows the operator to monitor three groups of crane information: operating conditions (normal and diagnostic), operating limits, and system faults.

Depress top or bottom of digital display selector to scroll up or down through the display readings. Release the selector when the desired information is displayed.

To access the diagnostic screens:

- Turn limit bypass key clockwise and hold.
- Scroll up at least one screen, release key, and scroll up or down until desired screen appears.

To turn off diagnostic screens:

- Turn limit bypass key clockwise and hold.
- Scroll down at least one screen and release key.

Stopping engine will also turn off diagnostic screens.

See [Table 3-7](#) for a list of abbreviations used in the tables. See [Table 3-8](#) for drum and pump identification.

Operating Conditions

[Table 3-4](#) lists operating conditions which can be displayed and the normal operating range of each.

When an operating condition is selected (such as ENGINE SPEED), the current status of the condition displays (see [Figure 3-26](#)).

ENGINE SPEED 900 RPM

FIGURE 3-26

Operating Limits

[Table 3-5](#) lists operating limits which can be displayed.

When one or more operating limits is reached, the operating limit alert (yellow light and buzzer in cab) turns on to warn the operator. At the same time, the operating limit display immediately appears (see [Figure 3-27](#)) and automatically

scrolls through the names of the limits, stopping at each for approximately three seconds.



FIGURE 3-27

The operating limit alert turns off when the cause of each limit is corrected. The name of each limit reached during operation is retained in memory, however, *until two things happen*:

1. Name of limit appears on display at least once.
2. Cause of limit is corrected.

For this reason, it is normal for the names of limits to appear when you scroll to the operating limit group, even when the operating limit alert is off.

To erase the names of inactive limits, scroll to the operating limit group. Wait until the display scrolls through the name of each limit. The names of inactive limits will be erased automatically. If the alert is on, only the names of active limits will remain.

NO FAULT appears on the display (see [Figure 3-28](#)) when no limits have been reached.



FIGURE 3-28

System Faults

[Table 3-6](#) lists system faults which can be displayed.

When one or more system faults occur, the system fault alert (red light and beeper in cab) turns on to warn the operator. At the same time, the system fault display immediately appears (see [Figure 3-29](#)) and automatically scrolls through the names of the faults, stopping at each for approximately three seconds.



FIGURE 3-29

The system fault alert turns off when the cause of each fault is corrected. The name of each fault that has occurred during operation is retained in memory, however, *until two things happen*:

1. Name of fault appears on display at least once.
2. Cause of fault is corrected.

For this reason, it is normal for the names of faults to appear when you scroll to the system fault group, even when the system fault alert is off.

To erase the names of inactive faults, scroll to the system fault group. Wait until the display scrolls through the name of each fault. The names of inactive faults will be erased automatically. If the alert is on, only the names of active faults will remain.

NO FAULT appears on the display (see [Figure 3-30](#)) when there are no faults.



FIGURE 3-30

Selecting Display Language

Current software for the Model 999 contains English and several foreign-language display readings. When a new computer chip is installed, any one of the languages could appear on the screen when the system is powered up the first time. Once the desired language is selected, it will remain in memory until another language is selected.

To select a different display language, perform both of the following steps at the same time:

1. Depress limit bypass switch.
2. Turn digital display confirm/select key switch to “confirm” position.
3. Repeat the steps until the screen displays the desired language.

Table 3-4 Operating Conditions

Listed below are the operating conditions that can be viewed on the display.

Display Reading	Unit of Measure	Operating Range
NORMAL OPERATING CONDITIONS		
ENGINE SPEED	RPM	1,000 rpm low idle; 1,800 rpm high idle (current production). 950 rpm low idle; 2,160 rpm high idle, 2,100 rpm full load governed (past production).
BOOM ANGLE	DEG	Degrees boom is positioned above horizontal.
JIB ANGLE [1]	DEG	Degrees luffing jib is positioned above horizontal.
BOOM TO LUFF JIB ANG [1]	DEG	Degrees between centerline of boom and centerline of luffing jib.
BOOM ANGLE JIB ANGLE [1]	DEG	Combination screen that displays both angles at same time.
MAST ANGLE	DEG	Degrees mast is positioned above transport position [2].
CRANE MODE (name of mode)	—	See Crane Mode Selector instructions in this section for procedure to select and confirm desired crane mode.
DIAGNOSTIC SCREENS		
HYD TANK FLUID TEMP	DEG F	Indicates temperature of oil in hydraulic tank.
HYD TANK FLUID LEVEL	%	0-100% of oil remaining in tank.
A1, A2, A3	2 Rows of numbers	These numbers are used to monitor and troubleshoot controls and hydraulic systems.
D1, D2, D3		
DRUM 1, 2, 4, 8		
FFALL		
SWING		
TRACKS		
ACC		
RIN	—	See RIN Display Readings in Service Manual for instructions.
SWING SPEED	%	See Swing Speed Adjustment instructions in this section.
SWING TORQUE	%	See Swing Torque Adjustment instructions in this section.
DRUM _ SLIP	%	See Free fall Drum Slip Adjustment instructions in this section.
HYD SYSTEM CHECK	—	See Hydraulic System Calibration in Service Manual for instructions.
PROGRAM M000001.0JP CON 000000000000	—	Computer Program Version and Crane Configuration Code. <i>The Manitowoc Crane Care Lattice Team will request these numbers when troubleshooting crane problems.</i>

[1] Optional Item.

[2] Mast angles are measured from transport position, which is 0°.

[3] Angles at which boom stops vary with attachment. See Limit Devices in this section for specifications.

Table 3-5 Operating Limits

Listed below are the limits which turn on the operating limit alert (yellow light and continuous buzzer). When the alert comes on, the OPERATING LIMIT group of the display will indicate which limit has been reached. Take corrective action.

Display Reading	Function Response	Corrective Action
BLOCK UP	Stops load drums from hoisting and boom/luffing jib from lowering.	Lower corresponding load or raise boom or jib.
MAX DOWN	Stops boom from lowering (limit usually set at 0°). Stops luffing jib from lowering when boom to luffing jib angle is: <ul style="list-style-type: none"> • 60° – #135 Luffing Jib. • 40° – Past #149 Luffing Jib • 55° – Current #149 Luffing Jib. 	Raise boom or luffing jib.
MAX UP 1	Stops boom from rising when maximum up limit is reached. Stops luffing jib from rising when boom to jib angle is 168°. This angle can be bypassed to raise jib to MAXIMUM UP 2 angle of 170°.	Lower boom/luffing jib.
MAX UP 2 [1]	Stops luffing jib from rising when boom to jib angle is 170°. This limit can be bypassed only when boom is below 50°.	Lower luffing jib.
CONFIRM MODE	Load drums and boom hoist inoperable until an operating mode is selected and confirmed.	Select and confirm the desired operating mode (see instruction in this section).
MAX BAIL	Drum stops hoisting.	Operate drum in lowering direction.
MIN BAIL	Drum stops lowering.	Operate drum in hoisting direction.
GANTRY DOWN [2]	Boom hoist inoperable in both directions if gantry is down when mast angle is 120° or more.	Raise gantry with switch on remote control.
JIB BELOW HORIZONTAL [1]	Luffing jib operable. See capacity chart for luffing jib minimum operating angles.	Raise luffing jib above horizontal.
LOAD MOMENT [1]	Stops all load drums from hoisting and boom/luffing jib from lowering.	Land load on load drum or raise boom or jib.
MAST TOO FAR FWD [2]	Boom hoist inoperable in lowering direction (occurs if mast is lowered below 175°).	Raise mast. Further lowering is not intended – mast will fall.
MAST SYSTEM	Boom hoist inoperable in both directions.	Stop operating immediately. Determine cause of fault – faulty boom hoist and/or accessory system pressure sender – and correct.
FUNCTION IS PARKED	Function inoperable because it is parked.	Turn corresponding park switch off and sit down in operator's seat.

[1] Optional item.

[2] Mast angles are measured from transport position, which is 0°.

Table 3-6 System Faults

Listed below are the faults which turn on the system fault alert (red light and beeper). When the alert comes on, the SYSTEM FAULT group of the digital display will indicate which fault has occurred. Take corrective action. The beeper sounds intermittently.

Display Reading	Function Response	Cause of Fault
BOOM ANGLE SENDER	All functions operable, but BOOM ANGLE and BOOM TO LUFF JIB ANG display will be faulty; correct cause of angle sender fault as soon as possible.	Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode.
ENGINE OIL PRESSURE	Does not affect operation. Correct cause of low oil pressure as soon as possible to prevent engine damage.	Oil pressure below 15 psi (1.0 bar).
ENGINE TEMPERATURE	Does not affect operation. Correct cause of overheating as soon as possible to prevent engine damage.	Engine coolant temperature above 205°F (96°C).
HYD TANK FLUID TEMP	Does not affect operation. Reduce loads and/or speeds to allow oil to cool.	Oil temperature in hydraulic tank above 180°F (82°C).
HYD TANK FLUID LEVEL	Does not affect operation. Fill tank as soon as possible.	Hydraulic oil at CAUTION LOW LEVEL indicated on tank gauge.
MAIN CHARGE FILTER	All functions operable. Replace filters as soon as possible.	Filters are dirty.
AUX DRUM CHRNG FILTER	All functions operable. Replace filter as soon as possible.	Filter is dirty.
FFALL FILTER	Replace filter(s) as soon as possible. ²	Filter(s) is dirty.
HYD SUCTION FILTER	Oil flow through suction screen inside hydraulic tank blocked.	Remove blockage immediately or hydraulic pumps will be damaged from cavitation.
LUFF JIB ANGLE SEND [1]	All functions operable, but JIB ANGLE and BOOM TO LUFF JIB ANG display will be faulty; correct cause of angle sender fault as soon as possible.	Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode.
MAST SYSTEM	Mast is disabled.	Stop operating. Find causes of fault and correct.

[1] Optional item.

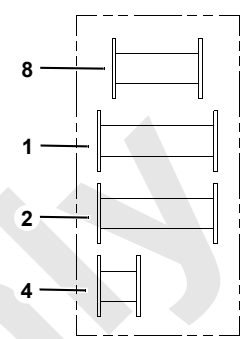
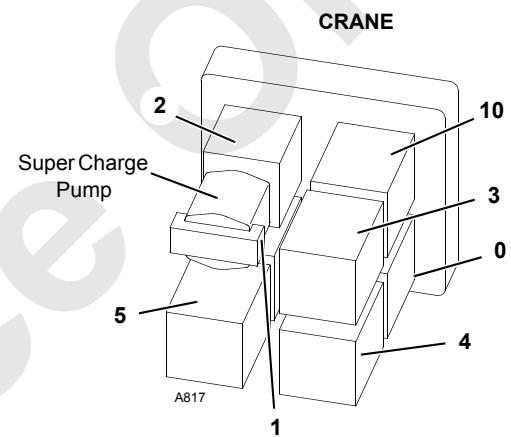
[2] Currently, there is no response to this fault. Earlier program versions did shut down operation of Free fall. This was canceled in program M0000K.

Table 3-7 Display Abbreviations

Abbreviation	Definition
+	Plus
-	Minus
%	Percent
A1	Handle Inputs
A2	Pump Control Outputs
A3	Programmer's Screen
ANG	Angle
AUX	Auxiliary
CALIB	Calibration
CHRG	Charge
CON	Configuration
D1	Digital On-Off Inputs
D2	Digital Inputs
D3	Digital Inputs or Outputs
DEG	Degrees (angle)
DEG F	Degrees Fahrenheit
FWD	Forward
FFall	Free Fall
HYD	Hydraulic
LUFF	Luffing
MIN	Minimum
MAX	Maximum
PRESS	Pressure
PSI	Pounds Per Square Inch
PSIA	Pounds Per Square Inch Absolute
RPM	Revolution Per Minute
RIN	Remote Input Node
SEND	Sender
SYS	System
TEMP	Temperature

Table 3-8 Drum and Pump Identification

Drum Number	Drum
1	Front Load Drum
2	Rear Load Drum
4	Boom Hoist
8	Auxiliary Load Drum (in boom butt)

Pump Identification

Pump Number	Crane
0	Front Load Drum
1	Rear Load Drum or Luffing Hoist
2	Boom Hoist
3	Swing
4	Right Crawler
5	Left Crawler
10	Auxiliary Load Drum (in butt)

CRANE DIAGNOSTICS

To activate the diagnostic display screens, turn the limit bypass key clockwise and scroll up at least one screen. Once this step is performed, you can scroll up and down through the diagnostic screens in addition to the normal operating screens. To deactivate the diagnostic screens, turn the limit bypass key clockwise and scroll down at least one screen. The normal operating screens will remain active.

The diagnostic display provides information about the status of all main crane components as well as the controller inputs and outputs during operation. The screen types are:

- Screens that display information about particular crane functions — DRUMS 1, 2, 4, and 8, SWING, TRACK, RIN, and ACCESSORY SYSTEM.
- Screens that display digital input and output information — A1 (analog handle inputs to crane controller), D1 (digital outputs from crane controller), and D2 (digital inputs to crane controller).
- Screens that display controller programming information — A2, A3, and D3. These screens are for factory use only, and are not shown.
- Screens that display hydraulic system calibration information — HYD SYSTEM CHECK. Check includes pressure sender, charge pressure, control calibration, and pump pressure.
- Program screens, SWING SPEED/TORQUE, and DRUM SLIP.

See [Table 3-8](#) for Drum and Pump Identification.

Drum 1 and 2 (Front and Rear Drum)

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
<u>6</u>	<u>7</u>	DRUM X		

1. The handle command in percent from neutral (+ raise and - lower). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
2. The pump command in percent from neutral (+ raise and - lower).
3. The motor command is in percent (0% is maximum displacement, 100% is minimum displacement).
4. Parking brake command (1 release, 0 engage).
5. Clutch command (1 release, 0 engage) (applies only to drums with free fall, otherwise has no meaning).
6. Measured pump pressure (port A) in psi.
7. Measured drum speed in rpm (+ raise and - lower).

X is where the corresponding drum number appears.

Drum 4 (Boom Hoist)

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
<u>5</u>	<u>6</u>	DRUM 4	

1. The handle command is in percent from neutral (+ raise and - lower). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
2. The pump command is in percent from neutral (+ raise and - lower).
3. The motor command is in percent (0% is maximum displacement, 100% is minimum displacement).
4. Park brake command (1 release, 0 engage).
5. Measured pump pressure (raise) in psi.
6. Measured drum speed in RPM (+ raise and - lower).

Drum 8 (Auxiliary)

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
<u>5</u>	<u>6</u>	DRUM 8	

1. The handle command in percent from neutral (+ raise and - lower). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
2. The pump command is in percent from neutral (+ raise and - lower).
3. The motor command is in percent (0% is maximum displacement, 100% is minimum displacement).
4. Park brake command (1 release, 0 engage).
5. Measured pump pressure (raise) in psi.
6. Measured drum speed in RPM (+ raise and - lower).

FFall

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	
<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	FFALL

1. The drum 1 pedal command is in percent (0% applied, 100% fully released).
2. Drum 1 PC output to proportional valve in percent of pressure (0% to 100%).
3. Drum 1 measured pressure to clutch/brake piston in psi.
4. Drum 1 clutch/brake command is (0 disengaged, 1 engaged).

5. Drum 2 pedal command is in percent (0% applied, 100% fully released).
6. Drum 2 PC output to proportional valve in percent of pressure (0% to 100%).
7. Drum 2 measured pressure to clutch/brake piston in psi.
8. Drum 2 clutch/brake command is (0 disengaged, 1 engaged).

Swing (Crane)

_ 1 _	_ 2 _	SWING
_ 3 _	_ 4 _	

1. The handle command is in percent from neutral (+ right and - left). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
2. The pump command is in percent from neutral (+ right and - left).
3. Measured pump pressure swing right (port A) in psi.
4. Measured pump pressure swing left (port B) in psi.

Swing Speed/Torque

See Swing Speed/Torque Adjustment instructions in Operator Manual.

Drum Slip

See Free Fall Drum Slip Adjustment instructions in Operator Manual.

Track

_ 1 _	_ 2 _	_ 3 _	_ 4 _	TRACK
_ 5 _	_ 6 _	_ 7 _		

1. The right handle/pedal command is in percent from neutral (+ forward, - backward). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
2. The right pump command is in percent from neutral (+ forward, - backward).
3. The left handle/pedal command is in percent from neutral (+ forward, - backward). For certain operating conditions the handle command can be set to neutral by the controller even if the handle is not in neutral.
4. Left pump command in percent from neutral (+ forward, - backward).
5. Measured system pressure right track in psi.

6. Measured system pressure left track in psi.
7. Parking brake command (1 release, 0 engage).

RIN

Depending on the crane configuration, RIN computers are mounted in the universal boom top junction box, luffing jib top junction box, or fixed jib top junction box (Figure 3-31). The junction boxes are interconnected in series with electrical cords that run up the boom to the last attachment component. The RIN computer in universal boom top junction box receives inputs from load sensors, limit switches, angle sensors, and other RIN computers in series. The RIN computer in universal boom top junction box transmits output information to crane EPIC computer in operator's cab.

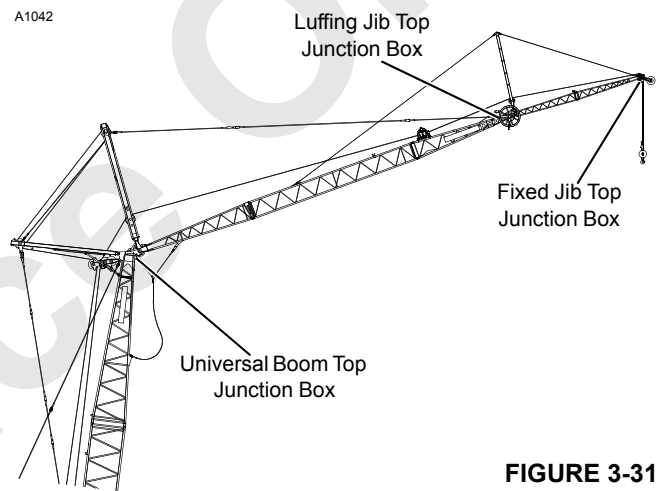


FIGURE 3-31

The RIN diagnostic screen is to assist in troubleshooting the boom top, luffing jib or fixed jib electrical system.

_ 1 _	_ 2 _	_ 3 _	_ 4 _	RIN
_ 5 _	_ 6 _	_ 7 _	_ 8 _	

The following voltages can be displayed on the first six banks of the RIN diagnostic screen. These voltage values can be compared with the voltages shown on the LMI (Rated Capacity Indicator/Limiter) diagnostic screen.

If the voltages do not match, the EPIC computer and the LMI are not communicating properly.

Bank 1	—	Boom Angle
Bank 2	—	Luffing Jib Angle
Bank 3	—	Lower Boom Point
Bank 4	—	Upper Boom Point
Bank 5	—	Lower Luffing Jib Point
Bank 6	—	Upper Luffing Jib Point or Fixed Jib Point

Bank 7 indicates the RIN digital inputs. For example, if Bank 7 displays the number 72, see [Table 3-11](#) and the shaded boxes in row 72. This indicates that Jib Maximum Up Working Limit (8) and Block-Up Limit – Luffing Jib Point (64) inputs (8 + 64 = 72) are active.

1	—	Block-Up Limit (Boom Point)
2	—	Block-Up Limit (Boom Point)
4	—	Jib Max Down Limit
8	—	Jib Max Up 1 Limit
16	—	Jib Max Up 2 Limit
32	—	Block-Up Limit (Luffing Jib/Fixed Jib Point)
64	—	Block-Up Limit (Luffing Jib Point)
128	—	Block-Up Limit (Fixed Jib on Luffing Jib Point)

To end the RIN circuit at the last used junction box, a **shorting plug** must be plugged into junction box jib cable receptacle. If shorting plug is not installed, the RIN computer sees an open circuit and assumes the electrical cable to next junction box is open. The RIN circuit turns off one or more block-up limit identifiers (switches) depending on where the open circuit exists. With an open RIN circuit at boom top junction box jib cable receptacle, Bank 7 numbers 32, 64, and 128 are off. With an open RIN circuit at luffing jib top junction box jib cable receptacle, Bank 7 number 128 is off.

Bank 8 indicates the status of each RIN computer as shown below.

0	—	EPIC computer is communicating with boom top RIN computer.
1	—	EPIC computer is communicating with boom top RIN computer, but there is a communication fault internal to universal boom top junction box RIN computer.
2	—	EPIC computer is communicating properly with boom top RIN computer and boom top RIN computer is communicating properly with at least one other RIN computer in series.
4	—	Shorting plug is installed to cable connector end at boom limit junction box or at cable reel to bypass operating limit fault(s).
8	—	No communication, all boom top operating limits are activated when a drum control handle is moved from neutral.

Accessory System

1	2	3	4
5	6	7	ACC

1. Rear drum/accessory system pump command in percent from neutral (+ retract mast cylinders;– extend mast cylinders).
2. Desired accessory system pressure in psi.
3. Actual accessory system pressure in psi.
4. Rear drum measured pump pressure (hoist) in psi.
5. The boom hoist pump command in percent from neutral (+ lower mast; – raise mast).
6. Boom hoist measured pump pressure (hoist) in psi.
7. Accessory system switches:
 - 1 - Raise Gantry Remote Switch
 - 2 - Lower Gantry Remote Switch
 - 4 - Mast Raise Switch
 - 8 - Mast Lower Switch
 - 16 - Boom Hinge Pins In Switch
 - 32 - Boom Hinge Pins Out Switch
 - 64 - Accessory System Enable Switch
 - 128 - Spare

Engine Throttle

1	2
3	ENG THROTTLE

1. Throttle pedal - is expressed in *counts* 0 to 25 = low idle and up to 230 to 255 = high idle.
2. Throttle Lever - is expressed in *counts* 0 to 25 = low idle and up to 230 to 255 = high idle.
3. Throttle Command - is expressed in *Hertz* with Cummins engines — 100 Hz = low idle and 305 Hz = high idle.
 Throttle Command - is expressed in *percent* with Caterpillar engines — <20% = high idle and 70% = low idle.

A1 (Handles)

The variable control handle output voltage is represented in the controller by a number between 0 (0 Volts) and 255 (10 Volts). Diagnostic screen A1 displays this number for each of the control handles/pedals. The normal operating outputs of the handles range from:

- Approximately 38 (1.5 Volts) to 120 (4.7 Volts) for lower/reverse/right.
- Approximately 136 (5.3 Volts) to 215 (8.5 Volts) for raise/forward/left.

NOTE: Some dual-axis handles (joysticks) are internally limited and will not put out the full range stated.

A switch opens when the handle is in the neutral range of (4.7 – 5.3 volts). In the neutral range, the screen reads 0 volts.

1	_2_	_3_	_4_	_5_
6	_7_	_8_	_9_	A1

- Handle 1 – Front Drum
- Handle 2 – Rear Drum
- Handle 3 – Boom Hoist
- Handle 4 – Swing
- Handle 5 – Right Track
- Handle 6 – Left Track
- Handle 7 – Auxiliary Drum
- Pedal 1 – Right Track
- Pedal 2 – Left Track

D1, D2, and D3 (Digital Outputs and Inputs)

The status of the digital outputs from the controller and the inputs to the controller is displayed in several banks in screens D1, D2, and D3. Each bank can indicate the state of up to nine individual digital inputs or outputs.

1	_2_	_3_	_4_	_5_
6	_7_	_8_	_9_	D X

1 – 9 is the bank number.

X corresponds to digital screen number (1, 2, or 3).

Each individual input/output is assigned a number (identifier) in the binary system (powers of two). The identifiers of all inputs/outputs that are ON (active), are added to a total in each bank. Thus, the number displayed for each bank is the sum of all identifiers of the inputs/outputs that are ON (0 – 255). With this system, each possible ON/OFF combination per bank has a unique total.

For identification of the digital outputs and inputs (and the crane components connected to them) see Tables 3-9 and 3-10.

To determine the state of the individual inputs/outputs in a bank, find the number displayed for the bank in the first column in Table 3-11. In the corresponding row the identifier numbers that are ON (active) in the bank are shaded. Use Tables 3-9 and 3-10 to identify the crane components associated with the identifiers for the corresponding bank.

If number displayed for short bank is more than the total of all bank identifiers, add missing identifier numbers (64 + 128 = 192) and subtract from displayed number to obtain remaining identifier number(s).

Example 1: The number displayed in Bank 4 of screen D2 of the digital display is 41. Go to row number 41 in Table 3-11. The boxes for identifiers 1, 8 and 32 are shaded in this row, indicating that the corresponding inputs are active. Find the component description for the identifiers in Table 3-10, Bank 4. In this example, the inputs for Front Drum Brake Switch (1), Display Scroll Up (8) and Gantry Lower Switch (32) are active.

Example 2: You want to know if the controller output for the rear drum clutch is ON. In Table 3-9 you will find Rear Drum Clutch in Bank 1 (identifier 64). Look up the current number for Bank 1 in screen D1 on the digital display (e.g. 152). Then go to the corresponding row number (152) in Table 3-11. Identifier 64 box is not shaded in this row, indicating that the controller output to the rear drum clutch is OFF.

NOTE: All numbers in screen D1, and the pump/motor command values in screens DRUM, SWING and TRACK represent controller commands to the corresponding output devices only. The state of a certain output port on the controller may not necessarily correspond to the actual state of the associated crane component (brake valve, clutch valve, etc.), since the connection between the controller and the component may be faulty due to loose connections, corroded terminals, broken wiring, or improperly operating components.

Table 3-9 D1 (Crane Digital Outputs)

Identifier*	Component
Bank 1	
1	Auxiliary Drum Pawl Enabled
2	Auxiliary Drum Pawl Disabled
4	Boom Hoist Park Brake
8	Travel Park Brake
16	Remote Output Node Communication
32	Front Drum Proportional Valve
64	Rear Drum Proportional Valve
128	Front Drum Brake
Bank 2	
1	Rear Drum Brake
2	Engine Throttle Output
Bank 3	
1	Auxiliary Drum Park Brake
2	Boom Hinge Pins Retract
4	Motion Alarm
8	Front Drum Enable Valve
16	Rear Drum Enable Valve
32	Gantry Cylinders Extend
64	Gantry Cylinders Retract
128	Mast Cylinders Extend
Bank 4	
1	Mast Cylinders Retract
2	Boom Hinge Pins Extend
Bank 5	
1	Counterweight Pins Retract
2	Front Drum Rotation Indicator
4	Rear Drum Rotation Indicator
8	Boom Drum Rotation Indicator
16	Auxiliary Drum Rotation Indicator
32	High Speed Travel
64	Front Drum Pawl Enabled
128	Front Drum Pawl Disabled
Bank 6	
1	Rear Drum Pawl Enabled
2	Rear Drum Pawl Disabled
Bank 7	
1	Boom Drum Pawl Enabled
2	Boom Drum Pawl Disabled
4	Rotating Bed Auto-Lube
8	Swing Auto-Lube
16	Travel Auto-Lube
32	Auxiliary Drum Pump Control Up **
64	Auxiliary Drum Pump Control Down **
128	Not Used
Bank 8	
Not used	
* Binary	
** These digital ports are pulsed for auxiliary pump control. For both ports a digital ON is displayed when pulsing, to prevent a flickering number for the corresponding bank.	
*** Bank 9 inputs are from RIN computer, not system computer.	

Table 3-10 D2 (Crane Digital Inputs)

Identifier*	Component
Bank 1	
1	Travel Detent Set/Cancel
2	Front Drum Maximum Bail Limit
4	Front Drum Minimum Bail Limit
8	Spare
16	Boom/Jib Maximum Angle Bypass
32	Mast Raise Switch
64	Rear Drum Maximum Bail Limit
128	Rear Drum Minimum Bail Limit
Bank 2	
1	Crane Mode Select
2	Crane Mode Confirm
4	Mast Lower Switch
8	Boom Maximum Up Limit
16	Remote Output Node Feedback
32	Spare
Bank 3	
1	Spare
2	Hydraulic Fluid Level
4	Spare
8	Spare
16	Spare
32	Spare
64	Rear Drum Brake Switch
128	Gantry Up Limit
Bank 4	
1	Front Drum Brake Switch
2	Rated Capacity Indicator/Limiter
4	Limit Bypass
8	Display Scroll Up
16	Gantry Raise Switch
32	Gantry Lower Switch
Bank 5	
1	Counterweight Pins Extend Switch
2	Counterweight Pins Retract Switch
4	Boom Hinge Pins Extend Switch
8	Boom Hinge Pins Retract Switch
16	Display Scroll Down
32	Seat Safety Switch
64	High Speed Travel Switch
128	Accessory Pressure Switch
Bank 6	
1	Front Drum Park Switch
2	Rear Drum Park Switch
4	Boom Hoist Drum Park Switch
8	Travel Park Brake Switch
16	Auxiliary Drum Park Switch
32	Auxiliary Drum Minimum Bail Limit
Bank 7	
1	Spare
2	Swing Park Brake Switch
4	Spare
8	Main Charge Filters Switch
16	Auxiliary Drum Charge Filter Switch
32	Free-Fall Filters Switch
64	Spare
128	Engine Oil Pressure Switch
Bank 8	
1	Engine Temperature Switch
2	Not Used
4	Not Used
8	Not Used
16	Not Used
32	Not Used

Table 3-10 D2 (Crane Digital Inputs)

Identifier*	Component
Bank 9***	
1	Block Up Limit (Boom Top)
2	Block Up Limit (Boom Top)
4	Jib Minimum Down Working Limit
8	Jib Maximum Up Working Limit
16	Jib Maximum Up Stop
32	Block Up Limit (Luffing Jib/Fixed Jib Top)
64	Block Up Limit (Luffing Jib Top)
128	Block Up Limit (Fixed Jib on Luffing Jib Top)
* Binary	
**	These digital ports are pulsed for auxiliary pump control. For both ports a digital ON is displayed when pulsing, to prevent a flickering number for the corresponding bank.
***	Bank 9 inputs are from RIN computer, not system computer.

Table 3-11 8-Bit Binary System

	1	2	4	8	16	32	64	128
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								

	1	2	4	8	16	32	64	128
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								
61								
62								
63								
64								
65								
66								
67								
68								
69								
70								
71								
72								
73								
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								

	1	2	4	8	16	32	64	128
87								
88								
89								
90								
91								
92								
93								
94								
95								
96								
97								
98								
99								
100								
101								
102								
103								
104								
105								
106								
107								
108								
109								
110								
111								
112								
113								
114								
115								
116								
117								
118								
119								
120								
121								
122								
123								
124								
125								
126								
127								
128								
129								

Dark shaded boxes indicate ON; white boxes OFF.

Table 3-11 8-Bit Binary System (continued)

	1	2	4	8	16	32	64	128
130								
131								
132								
133								
134								
135								
136								
137								
138								
139								
140								
141								
142								
143								
144								
145								
146								
147								
148								
149								
150								
151								
152								
153								
154								
155								
156								
157								
158								
159								
160								
161								
162								
163								
164								
165								
166								
167								
168								
169								
170								
171								
172								

	1	2	4	8	16	32	64	128
173								
174								
175								
176								
177								
178								
179								
180								
181								
182								
183								
184								
185								
186								
187								
188								
189								
190								
191								
192								
193								
194								
195								
196								
197								
198								
199								
200								
201								
202								
203								
204								
205								
206								
207								
208								
209								
210								
211								
212								
213								
214								
215								

	1	2	4	8	16	32	64	128
216								
217								
218								
219								
220								
221								
222								
223								
224								
225								
226								
227								
228								
229								
230								
231								
232								
233								
234								
235								
236								
237								
238								
239								
240								
241								
242								
243								
244								
245								
246								
247								
248								
249								
250								
251								
252								
253								
254								
255								

Dark shaded boxes indicate ON; white boxes OFF.

WIND CONDITIONS

Wind adversely affects lifting capacity and stability as shown in [Figure 3-32](#). The result could be loss of control over the load and crane, even if the load is within the crane's capacity.



WARNING

Tipping Crane Hazard!

Judgment and experience of qualified operators, job planners, and supervisors must be used to compensate for affect of wind on lifted load and boom by reducing ratings, reducing operating speeds, or a combination of both.

Failing to observe this precaution can cause crane to tip or boom and/or jib to collapse. Death or serious injury to personnel can result.

Wind speed (to include wind gusts) must be monitored by job planners and supervisors.

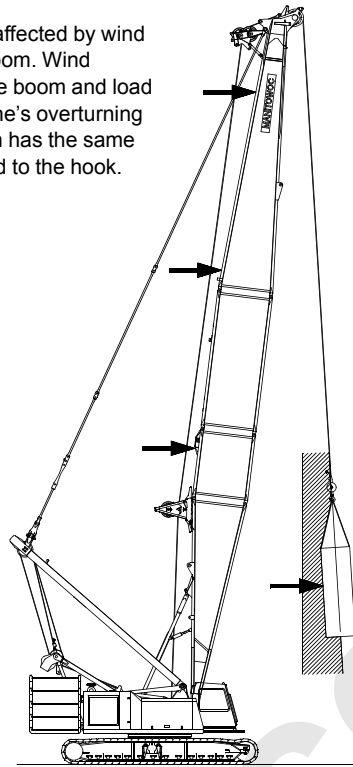
Be aware that wind speed at boom or jib point can be greater than wind speed at ground level. Also be aware that the larger the sail area of the load, the greater the wind's affect on the load.

As a general rule, ratings and operating speeds must be reduced when:

Wind causes load to swing forward past allowable operating radius or sideways past either boom hinge pin.

For wind conditions specific to this crane and its attachments, see the Wind Conditions publication at the end of this section or, if applicable, the Capacity Charts provided with this crane and its attachments.

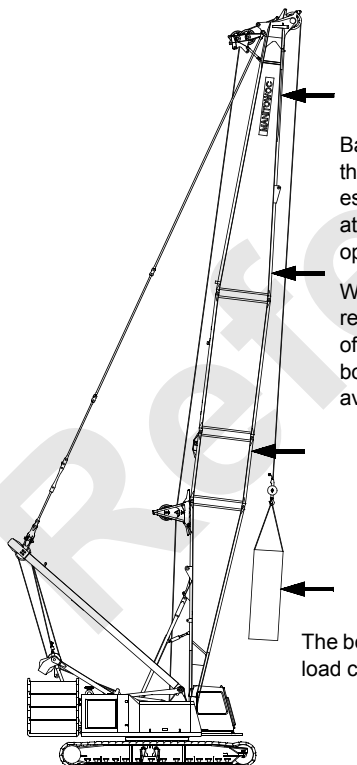
Forward stability is affected by wind on the rear of the boom. Wind applies a force to the boom and load that adds to the crane's overturning moment. This action has the same effect as adding load to the hook.



A910

The wind's affect on the rear of the load increases load radius. This condition can result in an overload hazard, possibly causing the crane to tip or the boom to collapse.

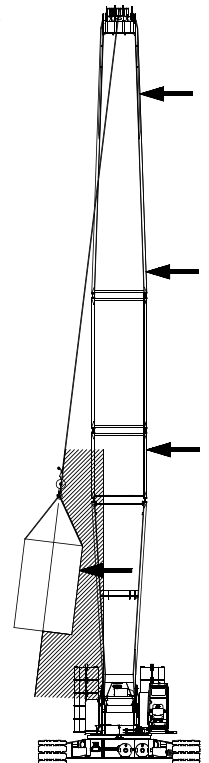
To avoid this hazard, reduce operating speeds and load (see Wind Conditions Chart at end of this section or see wind conditions in Capacity Charts if applicable).



Backward stability is affected by wind on the front of the boom. This condition is especially dangerous when the boom is at or near the maximum angle when operating without load.

Wind forces on the front of the boom reduce the normal forward tipping effect of the boom. The crane can tip or the boom can collapse if this condition is not avoided.

The boom can buckle and collapse if the load contacts the boom.



Boom strength is affected the most when the wind acts on the side of the boom.

The wind's affect on the side of the load can cause the load to swing out past the boom hinge pin. This condition can result in excessive side load forces on the boom, possibly causing the crane to tip or the boom to collapse.

To avoid this hazard, reduce operating speeds and load (see Wind Conditions Chart at end of this section or see wind conditions in Capacity Charts if applicable).

FIGURE 3-32

PREPARATION FOR COLD WEATHER

Crane Limitations

The static load carrying limitations of the steels used in Manitowoc cranes is not affected by cold weather. Therefore, Manitowoc's standard capacity charts are acceptable for use in cold weather.

Dynamic loads (impact and shock) can affect the steels used in Manitowoc cranes when operating in cold weather. Dynamic loads are created by traveling, sudden application and release of load, and duty-cycle operations (dragline, clamshell, magnet, container handling, concrete bucket placement).

To prevent possible damage to the crane and its attachment when operating during cold weather Manitowoc recommends:

-5F° (-21°C) to -22°F (-30°C)

Avoid impact or shock loading of crane and attachment. Operations involving hydraulic cranes should be conducted with due regard to potential failure of hydraulic components.

-23F° (-30°C) to -40°F (-40°C)

Derate crane by 40% for all lift operations. Halting all lifts should be considered. Duty-cycle operation is prohibited.

Below -40F° (-40°C)

All operation (lift and duty-cycle) is prohibited except in extreme emergencies, and then only with approval from a competent engineer who has derated the crane accordingly.

Wire Rope

The wire rope manufacturers indicate that wire rope will not become brittle in temperatures down to -30°F (-34°C). Lubrication may be a problem, however. During extreme cold weather, normal wire rope lubricants may harden and chip off leaving the rope un-lubricated.

Consult your wire rope supplier for recommended cold weather lubricants.

Cold Weather Starting Aid

Engine startup at temperatures below 40°F (4°C) requires the use of a cold weather starting aid.

Ether

Follow the engine manufacturer's recommendations and precautions for use of ether when starting the engine.



DANGER

Engine Explosion Hazard!

Some engines are equipped with an air intake pre-heater. If engine on your crane has an air intake pre-heater, do not spray any combustible starting aid (ether) into air intake. Pre-heater will ignite ether resulting in a severe explosion and/or burns.

Coolant and Oil Pan Heaters

120 V coolant and oil pan heaters can be installed in the engine. The heaters utilize an electric heating element to heat the coolant and oil inside the engine when the crane is idle. Each heater is equipped with an extension cord for connection to an owner furnished electric power supply. The coolant heater must be capable of maintaining the engine's coolant and oil temperatures between 40°F to 50°F (4°C to 10°C). Contact the nearest engine dealer for availability and installation of the heaters.

Engine heaters must be unplugged when engine is running to prevent cooling system from overheating.

Cooling System

The cooling system must be kept full and be protected from freezing at the lowest expected ambient temperature. See the engine manual for antifreeze recommendations.

Be aware that a mixture of 40% antifreeze and 60% water will provide freeze protection to -35°F (-37°C). A mixture of 60% antifreeze and 40% water will provide freeze protection to approximately -60°F (-51°C). 100% antifreeze will freeze at -10°F (-23°C).

Battery

To provide maximum cranking power and to prevent the battery from freezing, it must be kept fully charged (1.26 to 1.28 specific gravity) and warm when the crane is idle during cold weather.

It is recommended that the battery be stored indoors or heated with a battery heater when the crane is idle.

Be aware that:

- A battery with a 50% charge freezes at -16°F (- 27°C); on the other hand, a battery with a 100% charge freezes at -70°F (-57°C).
- A battery with a 100% charge retains only 40% of its cranking power at 0°F (-18). At -20°F (-29°C), the same battery retains only 18% of its cranking power.

Engine Oil

See engine manufacturer's manual for recommendations.

Fuel Oil

See engine manufacturer's manual for recommendations.

Gear Oil

Hydraulic Cranes

Use a gear oil which meets MIL-L-2105C specification or API-GL-5 classification. Change to one of the following viscosities when the corresponding temperature range will be encountered:

- 75W-90 below -10°F (-23°C)
- 80W-90 above -10 to 100°F (-23 to 38°C)
- 85W-140 above 100°F (38°C)

Hydraulic Oil

Optional thermostatically controlled heaters (120 V or 240 V) can be installed in the hydraulic tank to aid in cold-weather startup. The heaters are designed to keep the oil temperature 30°F (17°C) warmer than ambient air temperature. Each heater is equipped with an extension cord for connection to an owner furnished electric power supply.

Hydraulic tank heaters must be unplugged when engine is running to prevent hydraulic system from overheating.

Change the oil in the hydraulic system to ISO Grade 15 when the expected ambient temperature will remain at 32°F (0°C) or below.

Change the oil in the hydraulic system to ISO Grade 46 when the expected ambient temperature will remain above 32°F (0°C).

COLD WEATHER HEATER PACKAGE

The optional cold weather heater package preheats critical machinery and lubricant sumps during cold weather shutdown. See [Figure 3-33](#) (Past Production), [Figure 3-24](#) (Current Tier 3 Production) or [Figure 3-25](#) (Tier 4 Production) for heater components.

When operated in an arctic climate — outside temperature continuously between 0°F (-18°C) and -30°F (-34°C) — the crane should be equipped with the heaters identified in this section and lubricated with the lubricants listed in Section 5.

CAUTION

Machinery Damage!

Operating in an arctic climate without heaters can damage machinery during cold weather start-up due to lack of lubrication.

Heater package described in this section may not provide adequate protection when operating below -30°F (-34°C). Contact the Manitowoc Crane Care Lattice Team for recommendations.

CAUTION

Hydraulic Pump Damage!

To prevent damage to pumps, warm hydraulic oil to 60°F (16°C) minimum before operating crane in an arctic climate.

Heaters – Past Production

The heaters operate on 120 VAC (single phase) electrical power supplied through an external power supply. The heater package includes the following:

- Engine Oil Sump (300 watts)
- Hydraulic Oil Tank (two, 500 watts each)
- Control Console (30 watts)

Two heater packages were supplied on past production:

1. Serial numbers starting with "9991" (i.e. first serial number is 9991037): 037, 038, 087, 093, 098, 134, 165, 168:

A 1,250 watt engine coolant heater was supplied as standard equipment with the engine. This heater has its own cord. The total power requirement for the heater package plus the coolant heater is 2,580 watts. this heater package.

2. Serial numbers starting with "9991" (i.e. first serial number is 9991176): 176, 177, 179, 184, 195, 196, 198, 202, 204, 205, 218, 225, 235, 240, 245, 249, 254, 258, 266, 274, 276, 280, 299:

A 1,500 watt engine coolant heater was supplied as standard equipment with the engine. This heater has its own cord. The total power requirement for the heater package plus the coolant heater is 2,830 watts.

Thermostats

Thermostats turn the heaters on and off at the temperatures listed below:

Heater	Heater On	Heater Off
Hydraulic Oil Reservoir	60°F (16°C)	80°F (27°C)
Engine Oil Sump	60°F (16°C)	80°F (27°C)
Control Console	50°F (10°C)	60°F (16°C)

Turning Heaters On

1. Check that external power supply is off.



WARNING

Electrocution Hazard!

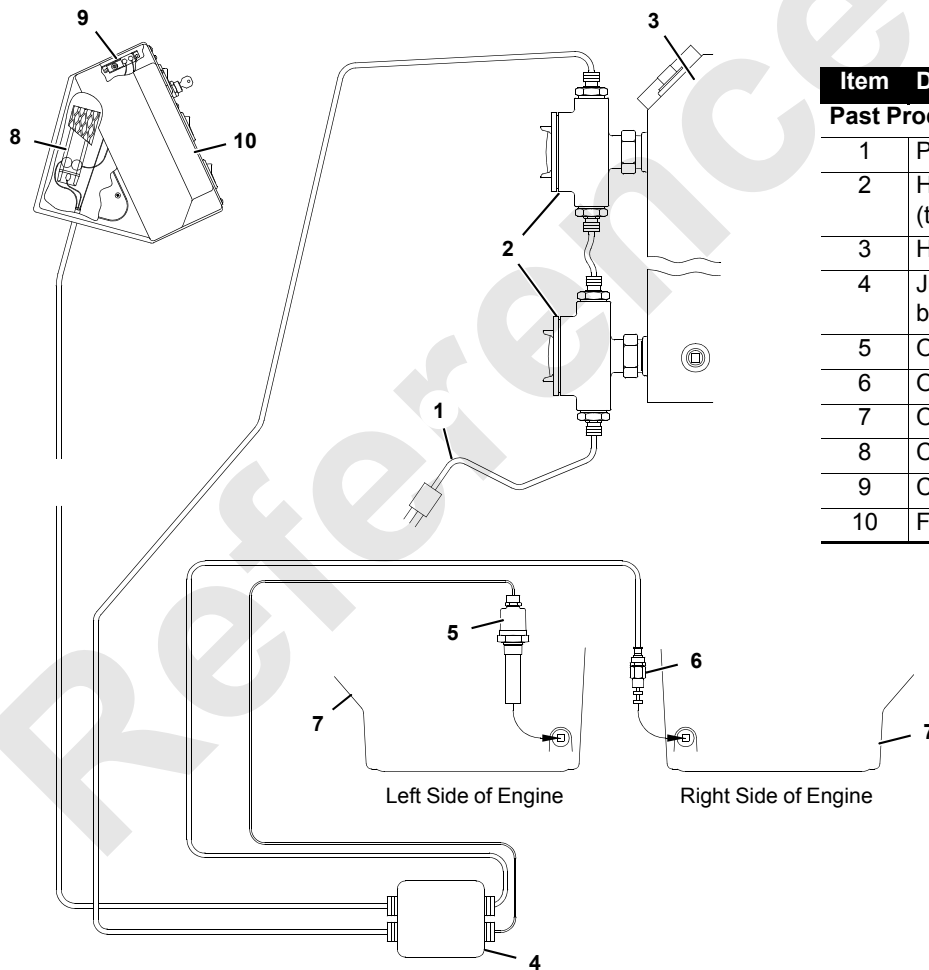
Severe electric shock can cause death or serious injury. Crane owner/user shall make provisions for turning off electrical power supply before connecting and disconnecting power supply cords.

2. Plug-in power supply cords from crane at external power supply.
3. Turn on external power supply.

Turning Heaters Off

1. Turn off external power supply.
2. Unplug power supply cords from crane at external power supply.

A1089



Item	Description
Past Production	
1	Power Supply Cord
2	Hydraulic Reservoir Heaters (two, 1,000 W total)
3	Hydraulic Reservoir
4	Junction Box (front of rotating bed beam under engine)
5	Oil Pan Heater (300 W)
6	Oil Pan Thermostat
7	Oil Pan
8	Control Console Heater (30 W)
9	Control Console Thermostat
10	Front Control Console

FIGURE 3-33

Heaters – Current Production Tier 3

The heaters operate on 240 VAC (single phase) electrical power supplied internally. The heater package includes the following:

:

Qty	Description
1	Engine Coolant, 1500 watt
1	Engine Oil Sump, 300 watt
2	Hydraulic Oil Tank, 500 watt
2	Battery Pads, 75 watt
1	Control Console, 150 watt

Thermostats

Thermostats turn the heaters on and off at the temperatures listed below:

Heater	Heater On	Heater Off
Hydraulic Oil Reservoir	60°F (16°C)	80°F (27°C)
Engine Oil Sump	60°F (16°C)	80°F (27°C)
Control Console	59°F (15°C)	77°F (25°C)

Turning Heaters On

1. Check that external power supply is off.



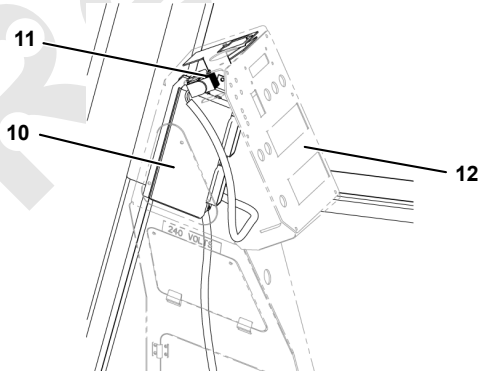
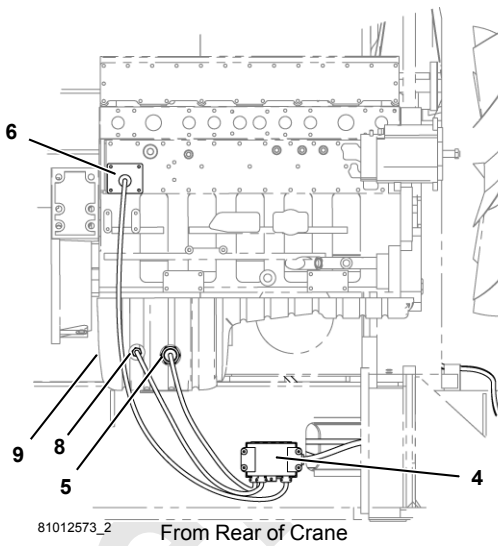
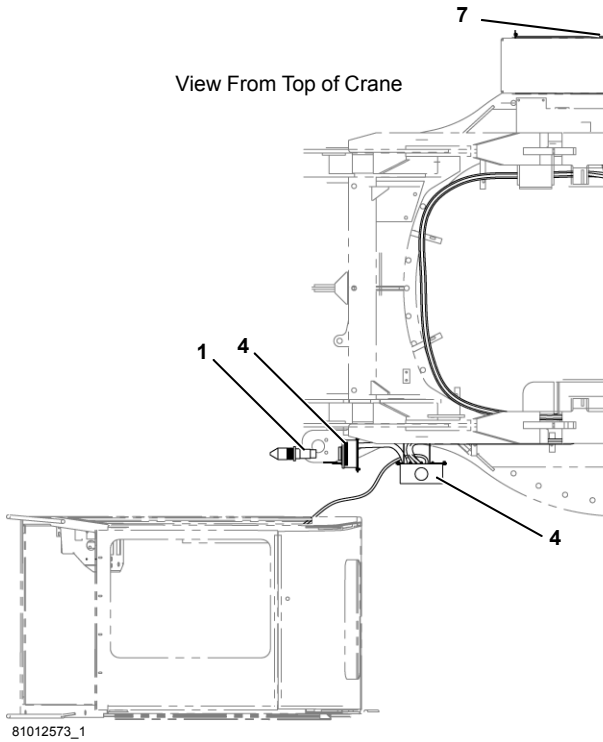
WARNING Electrocution Hazard!

Severe electric shock can cause death or serious injury. Crane owner/user shall make provisions for turning off electrical power supply before connecting and disconnecting power supply cords.

2. Plug-in power supply cords from crane at external power supply.
3. Turn on external power supply.

Turning Heaters Off

1. Turn off external power supply.
2. Unplug power supply cords from crane at external power supply.



Item	Description
Current Production	
1	Electrical Plug
2	Hydraulic Reservoir Heaters (two, 500 W each)
3	Hydraulic Reservoir
4	Junction Box (4)
5	Engine Oil Heater (300 W)
6	Engine Coolant Heater (1500 W)
7	Battery Pad Heaters (two, 75 W each)
8	Oil Pan Thermostat
9	Oil Pan
10	Cab Console Heater (150 W)
11	Cab Console Thermostat
12	Cab Front Control Console
13a	Main Breaker (50 amp)
13b	Hydraulic Reservoir Heaters and Cab Console Heater Breaker (15 amp)
13c	Engine Coolant Heater and Engine Oil Heater Breaker (15 amp)
13d	Battery Pad Heaters Breaker (15 amp)

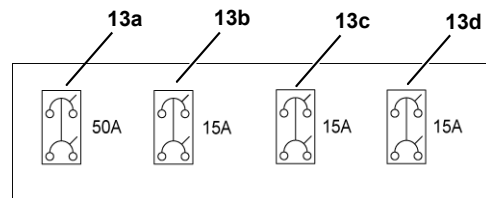


FIGURE 3-34

Heaters – Tier 4 Production

The heaters operate on 240 VAC (single phase) electrical power supplied internally. The heater package includes the following:

:

Qty	Description
1	Engine Coolant, 1000 watt
1	Engine Oil Sump, 300 watt
2	Hydraulic Oil Tank, 500 watt
2	Battery Pads, 75 watt
1	Control Console, 150 watt

Thermostats

Thermostats turn the heaters on and off at the temperatures listed below:

Heater	Heater On	Heater Off
Hydraulic Oil Reservoir	60°F (16°C)	80°F (27°C)
Control Console	59°F (15°C)	77°F (25°C)

Turning Heaters On

1. Check that external power supply is off.



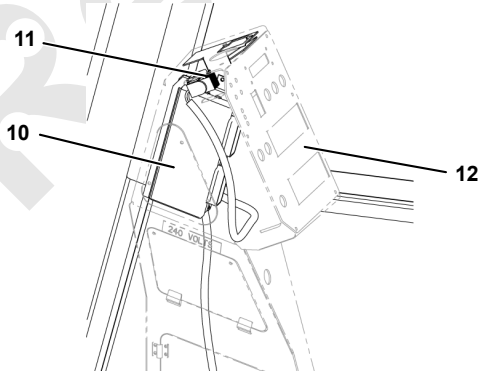
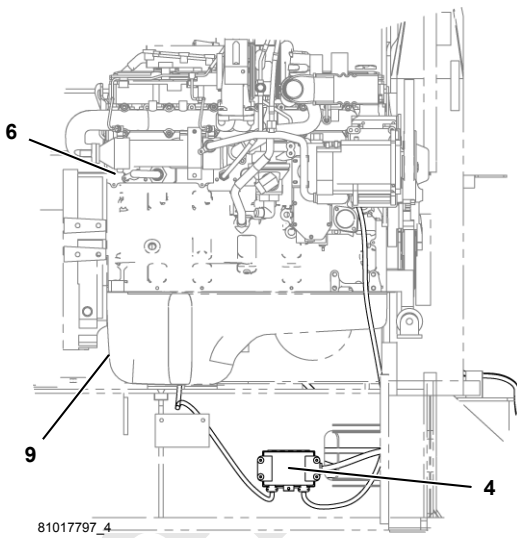
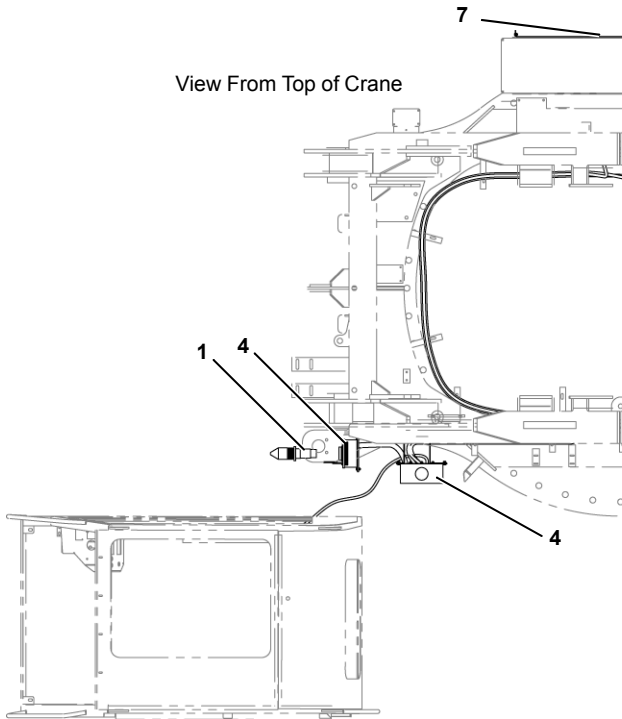
WARNING Electrocution Hazard!

Severe electric shock can cause death or serious injury. Crane owner/user shall make provisions for turning off electrical power supply before connecting and disconnecting power supply cords.

2. Plug-in power supply cords from crane at external power supply.
3. Turn on external power supply.

Turning Heaters Off

1. Turn off external power supply.
2. Unplug power supply cords from crane at external power supply.



Item	Description
Current Production	
1	Electrical Plug
2	Hydraulic Reservoir Heaters (optional, two, 500 W each)
3	Hydraulic Reservoir
4	Junction Box (4)
5	Engine Oil Heater
6	Engine Coolant Heater
7	Battery Pad Heaters (optional, two, 75 W each)
8	Oil Pan Thermostat (not supplied)
9	Oil Pan
10	Cab Console Heater (150 W)
11	Cab Console Thermostat
12	Cab Front Control Console
13a	Main Breaker (50 amp)
13b	Hydraulic Reservoir Heaters and Cab Console Heater Breaker (15 amp)
13c	Engine Coolant Heater and Engine Oil Heater Breaker (15 amp)
13d	Battery Pad Heaters Breaker (15 amp)

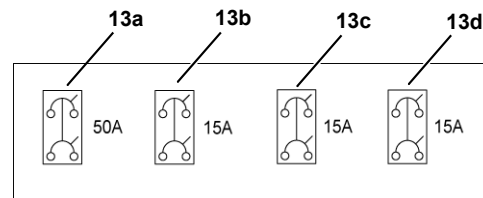
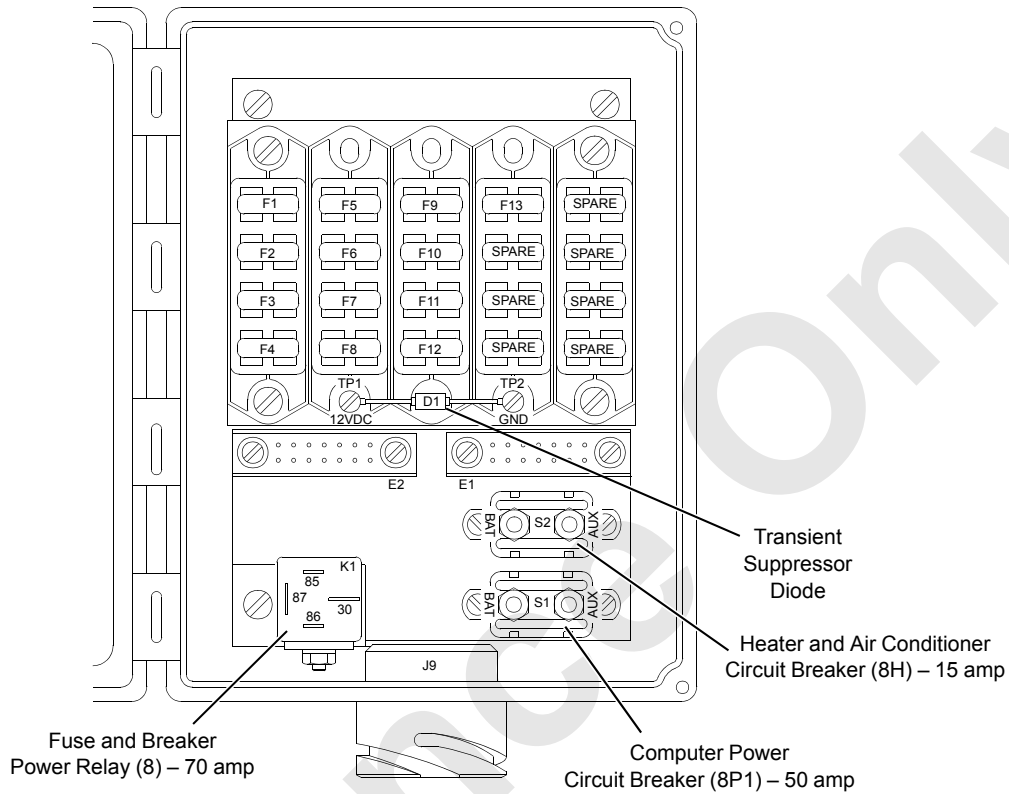


FIGURE 3-35

Fuses – Past Production

The fuse box is located in the right rear corner of the operator’s cab ([Figure 3-36](#)).

A1060



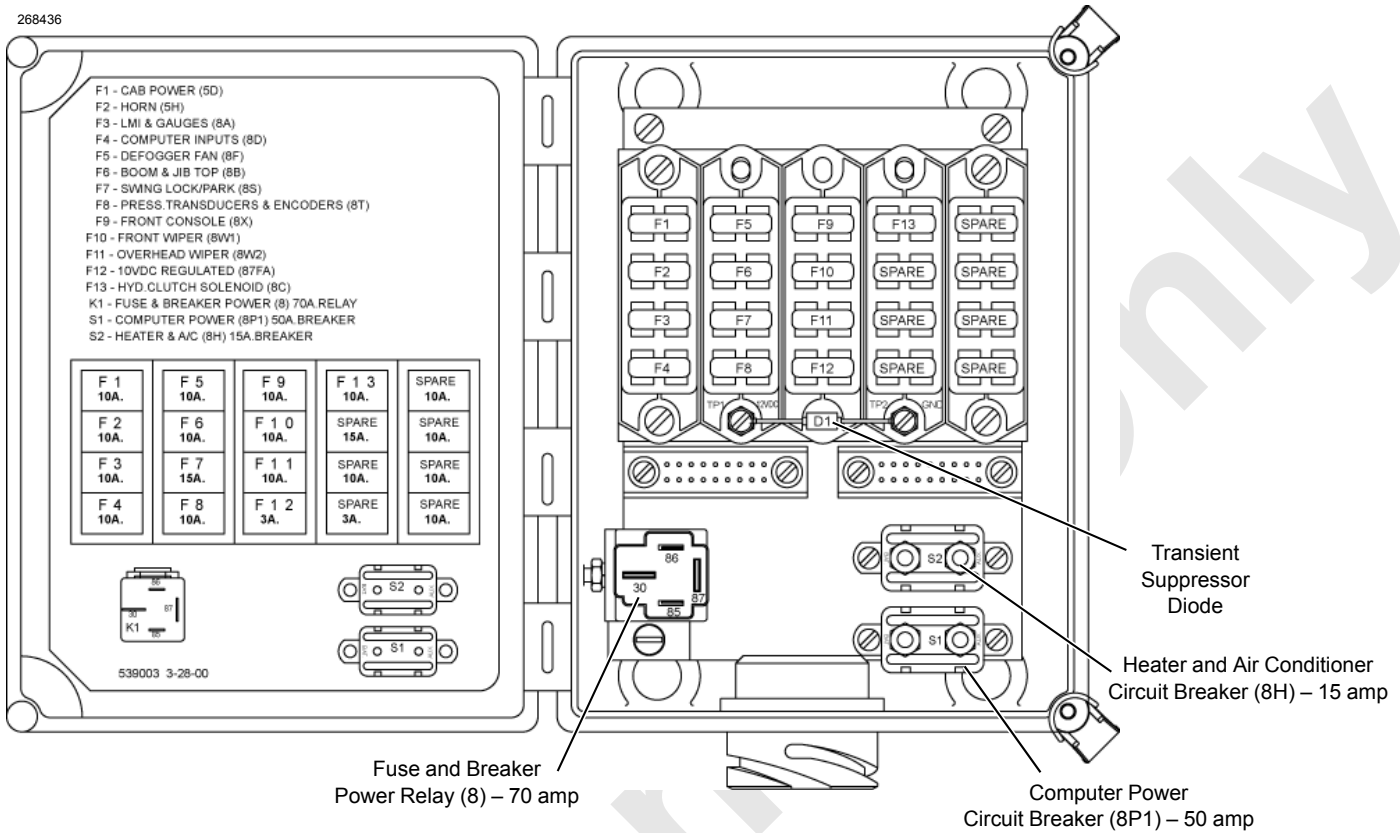
Fuse Identification

Item	Description	Item	Description
F1	Cab Power (5D) – 10 amp	F11	Overhead Wiper (8W2) – 10 amp
F2	Horn (5H) – 10 amp	F12	10 VDC Regulated (87FA) – 3 amp
F3	LMI and Gauges (8A) – 10 amp	F13	Hyd. Clutch Solenoid (8C) – 10 amp
F4	Computer Inputs (8D) – 10 amp	F14	Spare – 15 amp
F5	Defogger Fan (8F) – 10 amp	F15	Spare – 10 amp
F6	Boom and Jib Top (8B) – 10 amp	F16	Spare – 3 amp
F7	Swing Lock/Park (8S) – 15 amp	F17	Spare – 10 amp
F8	Press. Transducers and Encoders (8T) – 10 amp	F18	Spare – 10 amp
F9	Front Console (8X) – 10 amp	F19	Spare – 10 amp
F10	Front Wiper (8W1) – 10 amp	F20	Spare – 10 amp

FIGURE 3-36

Fuses – Current Production

The fuse box is located in the right rear corner of the operator's cab ([Figure 3-37](#)).



Fuse Identification

Item	Description	Item	Description
F1	Cab Power (5D) – 10 amp	F11	Overhead Wiper (8W2) – 10 amp
F2	Horn (5H) – 10 amp	F12	10 VDC Regulated (87FA) – 3 amp
F3	LMI and Gauges (8A) – 10 amp	F13	Hyd. Clutch Solenoid (8C) – 10 amp
F4	Computer Inputs (8D) – 10 amp	F14	Spare – 15 amp
F5	Defogger Fan (8F) – 10 amp	F15	Spare – 10 amp
F6	Boom and Jib Top (8B) – 10 amp	F16	Spare – 3 amp
F7	Swing Lock/Park (8S) – 15 amp	F17	Spare – 10 amp
F8	Press. Transducers and Encoders (8T) – 10 amp	F18	Spare – 10 amp
F9	Front Console (8X) – 10 amp	F19	Spare – 10 amp
F10	Front Wiper (8W1) – 10 amp	F20	Spare – 10 amp

FIGURE 3-37

SECTION 4

SET-UP AND INSTALLATION

TABLE OF CONTENTS

Rigging Drawings	4-1
Optional Attachments	4-1
General Safety	4-1
Crane Orientation	4-1
Self-erecting Equipment	4-1
Assembly and Disassembly Notes	4-2
Assembly and Disassembly Area	4-2
Accessing Parts	4-2
Crane Weights	4-2
Retaining Connecting Pins	4-2
Pin and Connecting Hole Cleanliness	4-2
Hose and Cable Cleanliness	4-2
Connecting/Disconnecting Hydraulic Hoses, Air Lines, and Electric Cables	4-2
Cold Weather Mast Operation	4-3
Shipping Crane Components	4-4
Engine Exhaust Pipe	4-7
Connecting Exhaust Pipe	4-7
Disconnecting Exhaust Pipe	4-7
Crane Assembly	4-9
General	4-9
Operating Controls	4-9
Pre-Start Checks	4-9
Remove Crane from Trailer	4-10
Raise Mast To Operating Position	4-12
Raising Procedure	4-12
Install Assembly Block	4-14
Install Crawlers	4-17
Install Counterweight	4-20
Assemble Counterweight	4-20
Install Counterweight	4-22
Assemble Boom and Jib	4-24
Remove Boom Butt From Trailer	4-24
Remove Assembly Block	4-24
Install Boom Butt	4-26
Connect #22E or #22EL Boom Butt To Boom	4-30
Connect #82 Boom Butt To Boom	4-32
Pre-Raising Checks	4-34
Crane Disassembly	4-34
General	4-34
Disconnect #22E or #22EL Boom Butt To Boom	4-36
Disconnect #82 Boom Butt From Boom	4-38
Remove Boom Butt	4-40
Install Assembly Block	4-44
Install Boom Butt On Trailer	4-44
Disassemble Boom	4-44
Remove Counterweight	4-44
Remove Crawlers	4-46
Remove Assembly Block	4-50
Lower Mast To Transport Position	4-50
Lowering Procedure	4-50
Install Crane On Trailer	4-51

Auxiliary Load Drum Installation	4-52
Crane Modifications	4-52
Modifications	4-52
Equipment	4-52
Drum Installation	4-52
Hydraulic, Air, and Electric Connections	4-54
Wire Rope Installation	4-54
Butt Removal	4-54
Boom Ladder Assembly	4-54
General	4-54
Removal From Boom Butt	4-54
Installation On Boom Inserts	4-54
Storage In Boom Butt	4-54
Boom and Jib Rigging	4-56
Assist Crane Requirements	4-56
Blocked Crawlers	4-57
Handling Components	4-57
Rigging Assembly Drawings	4-57
Identifying Boom and Jib Components	4-58
Removable Diagonal Lacings (optional)	4-60
Boom Installation – #82HL	4-61
General	4-61
Assemble Boom Sections	4-61
Connect Boom Straps	4-61
Install Upper Boom Point	4-61
Raise Boom Top Wire Rope Guide	4-63
Remove Lower Boom Point Sheaves	4-63
Install Jib	4-63
Connect Boom Butt to Boom	4-63
Install Load Line	4-64
Install Block-Up Limit Control and Connect Boom Wiring	4-64
Boom Removal – #82HL	4-65
General	4-65
Disconnect Boom Butt From Boom	4-65
Disassemble Boom Sections	4-65
Removable Diagonal Lacings (optional)	4-69
Boom Installation – #82LR	4-70
General	4-70
Assemble Boom Sections	4-70
Install Intermediate Suspension	4-73
Connect Boom Straps	4-73
Raise Boom Top Wire Rope Guide	4-73
Install Upper Boom Point	4-74
Install Jib	4-74
Connect Boom Butt to Boom	4-74
Install Load Line	4-74
Install Block-Up Limit Control and Connect Boom Wiring	4-74
Boom Removal	4-75
General	4-75
Disconnect Boom Butt From Boom	4-75
Disassemble Boom Sections	4-75
Lower Boom Point Installation – #22EL or #82HL Boom	4-80
General	4-80
Removing and Installing Sheave Clusters	4-80
Greasing Sheave Bearings	4-80
Adjusting Bearing End Play	4-80
Jib Installation – #134	4-83
General	4-83

Prepare Boom	4-83
Install Butt	4-83
Install Inserts	4-83
Install Top	4-83
Install Jib Pendants	4-85
Install Backstay Pendants	4-85
Install Jib Offset Links or Pendants	4-85
Raise Jib Strut	4-85
Install Jib Stop	4-87
Install Load Line	4-87
Install Block-Up Limit Control and Connect Boom Wiring	4-87
Jib Removal – #134	4-89
Lower Boom and Jib	4-89
Store Jib Stop	4-89
Lower Strut	4-89
Remove Backstay Pendants	4-89
Remove Jib Pendants	4-89
Remove Sections	4-89
Wire Rope Installation	4-90
Wire Rope Storage	4-90
Removing Wire Rope from Shipping Reel	4-90
Seizing and Cutting Wire Rope	4-90
Anchoring Wire Rope to Drum	4-91
Winding Wire Rope onto Drum	4-91
Anchoring Wire Rope to Wedge Socket	4-92
Anchoring Wire Rope to Button Socket	4-95
Breaking in Wire Rope	4-95
Pad Eye Usage for Wire Rope Reeving	4-95
General	4-95
Safety	4-95
Load Line Reeving	4-97
Wire Rope Specifications	4-97
Wire Rope Installation	4-97
Liftcrane – #22EL or #82HL Boom	4-97
Reeving Diagrams	4-97
Dead-End Locations – Lower Boom Point	4-97
Guide Sheave Identification	4-97
Universal Anchor Joint	4-97
Load Blocks	4-97
Clamshell – #22EL or #82HL Boom	4-103
Guide Sheave Positions for Clamshell	4-103
Liftcrane – #82 LR Boom	4-105
Reeving Diagrams	4-105
Guide Sheave Identification	4-105
Universal Anchor Joint	4-105
Liftcrane – #22E Boom with Light Tapered Top	4-107
Reeving Diagrams	4-107
Guide Sheave Identification	4-107
Universal Anchor Joint	4-107
Universal Anchor Joint	4-109
Load Block Tieback	4-110
Specifications	4-110
Shackle	4-110
Sling Length	4-110
Sling Capacity	4-110
Boom Hoist Reeving	4-111
Wire Rope Installation	4-111

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 4

SETUP AND INSTALLATION

RIGGING DRAWINGS

For boom and jib rigging drawings that apply to your crane, see the end of this section.

OPTIONAL ATTACHMENTS

If applicable, instructions for optional attachments that apply to your crane are located at the end of this section.

GENERAL SAFETY

To prevent accidents that can result in death or injury during crane assembly and disassembly, comply with the following general safety information and with specific safety information contained in assembly and disassembly steps.



WARNING

Avoid Death or Serious injury!

Read and understand setup and installation instructions in this section before attempting to assemble or disassemble crane.



WARNING

Tipping/Overload Hazard!

Avoid tipping crane over or collapsing mast:

- Assemble and disassemble crane on a firm, level, uniformly supporting surface.
- Do not exceed swing limits and mast lifting capacities given in [Table 4-1](#).
- Keep crane level when operating carbody jacks.



WARNING

Avoid Falling Off Crane and Boom!

It is necessary to climb onto crane and boom during assembly and disassembly steps.

Use sturdy owner furnished ladders or an approved personnel hoist to gain access to areas which cannot be reached from ladders or steps provided with crane.



WARNING

Moving Parts/Pinch Points!

Avoid death or crushing injury during crane assembly and disassembly:

- Assembly personnel — take every precaution to prevent injury when working near moving parts.
- Maintain communication between operator and assemblers to avoid accidents.
- Do not raise or lower gantry and mast until all personnel are off crane.
Keep unauthorized personnel well clear of crane.



WARNING

Falling Load Hazard!

To prevent lifting equipment from failing and load from dropping, crane owner/user shall verify following prior to each lift:

- All lifting equipment (shackles, hooks, slings, blocks) has been properly maintained and are safe for use.
- All lifting equipment has a capacity equal to or greater than load to be lifted.

CRANE ORIENTATION

The terms RIGHT, LEFT, FRONT, REAR used in this section refer to the operator's right, left, front, and rear sides when seated in the operator's cab looking forward with the crawler motors to the rear.

SELF-ERECTING EQUIPMENT

The 999 is a self-erecting crane equipped with the following components for assembly and disassembly (see [Figure 4-1](#)):

- Carbody jacks with pads for lifting the crane onto and off the trailer. The jacks are also used to raise the crane during crawler repositioning.
- Hydraulically actuated pins for connecting and disconnecting the crawlers to and from the carbody
- Hydraulic cylinders for raising and lowering the gantry

- Hydraulically actuated mast arms for raising the mast to the operating position and lowering it to the transport position.
- Mast which can be used as a boom to handle the crane's crawlers and counterweights and to assemble and disassemble the boom and jib.
- Hydraulically actuated pins for connecting counterweight to rear of crane.
- 45 U.S. ton (41 metric ton) load block and 4-leg chain sling with hooks for handling components.

ASSEMBLY AND DISASSEMBLY NOTES

The crane, boom, and jib must be assembled and disassembled by experienced personnel trained in erection and operation of construction cranes.

Read and become thoroughly familiar with the instructions in the applicable capacity charts, in this section, and in the rigging drawings at the rear of this section before attempting to assemble or disassemble the crane, boom, or jib.

Contact your Manitowoc dealer for assistance if any procedure is not fully understood.

ASSEMBLY AND DISASSEMBLY AREA

Select an assembly/disassembly area that has a firm, level, uniformly supporting surface. Make sure the area is large enough to accommodate the crane, the selected boom and jib length, movement of trucks with trailers, and movement of the 999 (or assist crane).

Set the carbody jack pads on a flat, firm foundation that will support the load placed on them. The maximum load on each jack is 70,000 lb (31 752 kg).

Do not set the jack pads in holes, on rocky ground, or on extremely soft ground.

If necessary, use wood blocking or steel plates under the jack pads to properly distribute loading. Blocking or steel plates must be:

- Free of defects
- Strong enough to prevent being crushed or bent
- Of sufficient size to prevent settling under load

Contact the Manitowoc Crane Care Lattice Team for ground bearing information.

ACCESSING PARTS

Some parts of the crane, boom, and jib cannot be reached from the ground. Take the necessary precautions to prevent falling off the crane or boom during assembly and disassembly.

Owner/user shall provide approved ladders or personnel hoists so workers can safely access those areas of crane, boom, and jib that cannot be reached from ground. Adhere to local, state, and federal regulations for handling personnel.

Optional boom ladders (stored in boom butt) are available from Manitowoc. If your crane has ladders, see instructions later in this section.

CRANE WEIGHTS

See Crane Weights in Section 1 for overall weight of the crane and individual weights of components.

RETAINING CONNECTING PINS

Connecting pins are retained in various ways:

- Snap pins
- Quick-release pins
- Cotter pins
- Keeper plates with cap screws and lock washers.

Do not operate crane until all connecting pins are installed and properly retained.

PIN AND CONNECTING HOLE CLEANLINESS

To prevent dirt from damaging closely machined surfaces of pins and connecting holes:

- Thoroughly clean all pins and connecting holes.
- Apply a light coat of grease to all pins and connecting holes.

HOSE AND CABLE CLEANLINESS

To prevent dirt from entering the hydraulic and air systems or from damaging the electric connectors:

- Thoroughly clean the hydraulic or air fittings and the electric connectors before connecting them.
- Thoroughly clean the dust caps before attaching them to hoses, tubes, or cables.
- Do not drag the hydraulic or air hose fittings, the hydraulic or air hoses, the electric cable connectors, or the electric cables on the ground.

CONNECTING/DISCONNECTING HYDRAULIC HOSES, AIR LINES, AND ELECTRIC CABLES

Always STOP ENGINE before performing the following steps during crane assembly and disassembly:

- Connecting and disconnecting hydraulic or air lines. It will be easier to connect and disconnect the couplers when there is no pressure in the system.
- Connecting and disconnecting electric cables. The potential for operating faults or damage to the electric components exists if the engine is not stopped.

Do not attempt to lower the mast during cold weather until the following steps have been performed:

- Hydraulic oil warmed up to at least 60°F (16°C)
- Mast cylinders fully extended and retracted twice to fill cylinders with warm oil

COLD WEATHER MAST OPERATION

The mast, mast cylinders, and mast arms can be damaged when attempting to lower the mast during cold weather.

NOTE: To check hydraulic fluid temperature, observe HYD TANK FLUID TEMP on the digital display in the operator’s cab.

NOTE: Except for procedures specific to #82 boom, mast for #22E boom is shown throughout this section. Mast for #22EL and #82 booms is identical except that mast for #22EL boom has pendants and mast for #82 boom has straps.

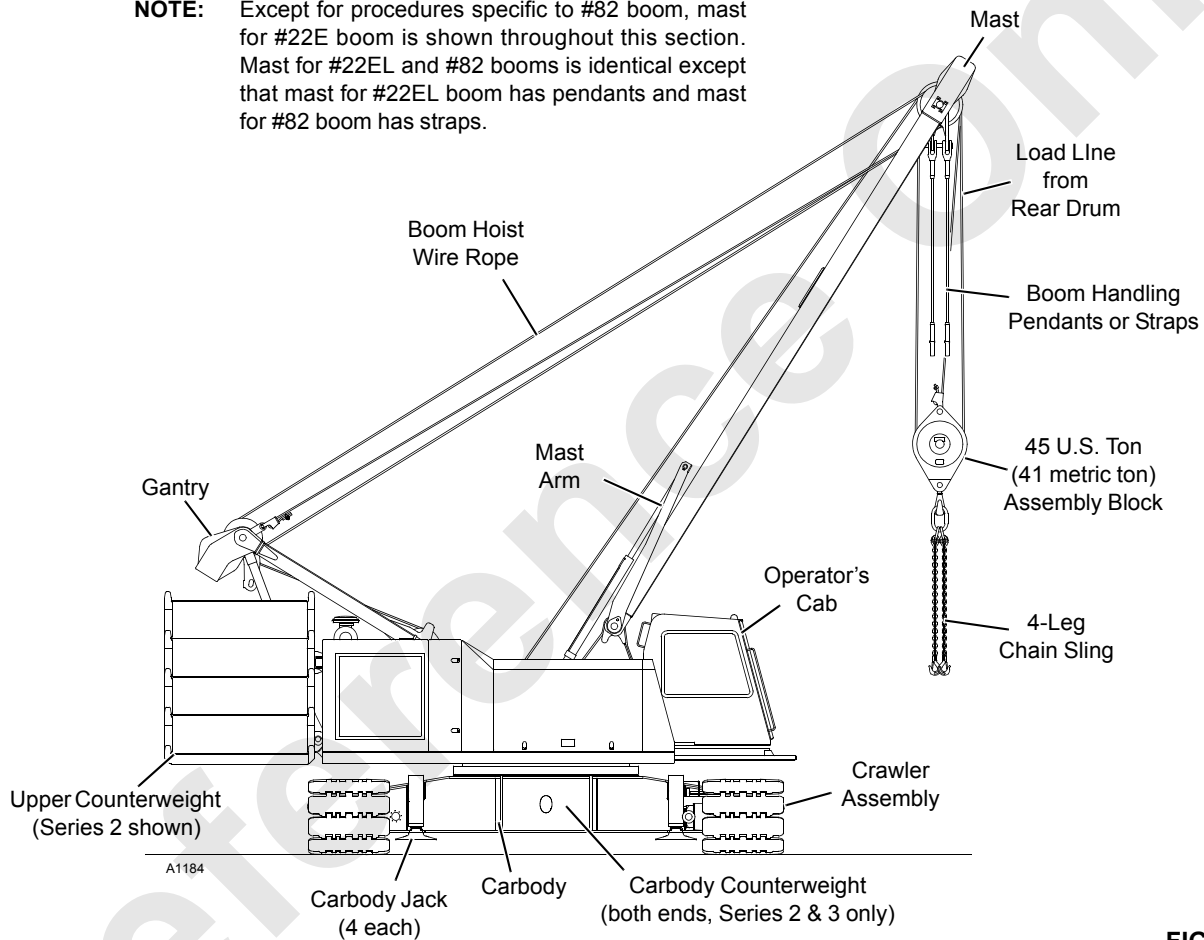


FIGURE 4-1

SHIPPING CRANE COMPONENTS

To ensure the crane's self-erecting system can load and unload the carbody and upperworks assembly, the trailer must meet the specifications given in [Figure 4-2](#).

It is the owner/user's responsibility to ensure the following:

- That all trailer loads comply with local, state, and federal transportation requirements
- ***That all crane components are properly blocked and secured so they cannot shift or fall off trailers***

- To avoid damage to components:

Use nylon tie-downs to secure components as shown in [Figure 4-2](#), View A.

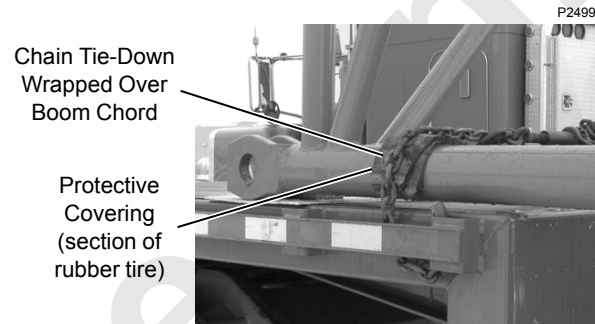
If chain tie-downs are used, install protective covering (such as sections of rubber tire) between the chain and component being secured as shown in [Figure 4-2](#), View B.

When securing boom sections, wrap tie-downs over chords — never over lacings. Keep tie-downs as close to blocking as possible (View A) to prevent bending the chords.



Nylon Tie-Down
Wrapped Over
Boom Chord

View A



Chain Tie-Down
Wrapped Over
Boom Chord

Protective
Covering
(section of
rubber tire)

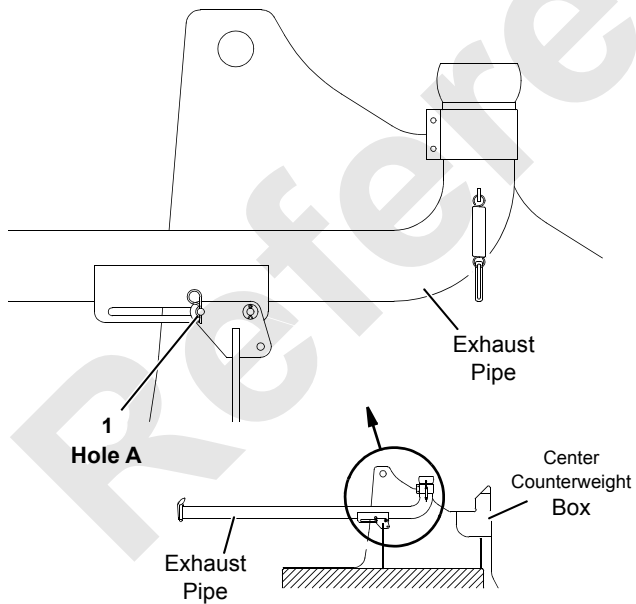
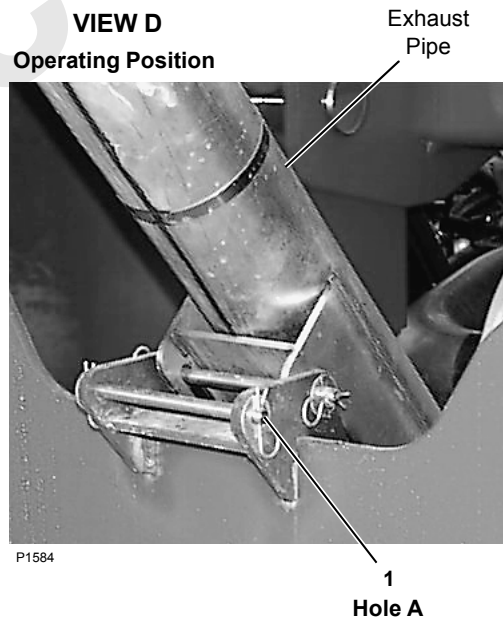
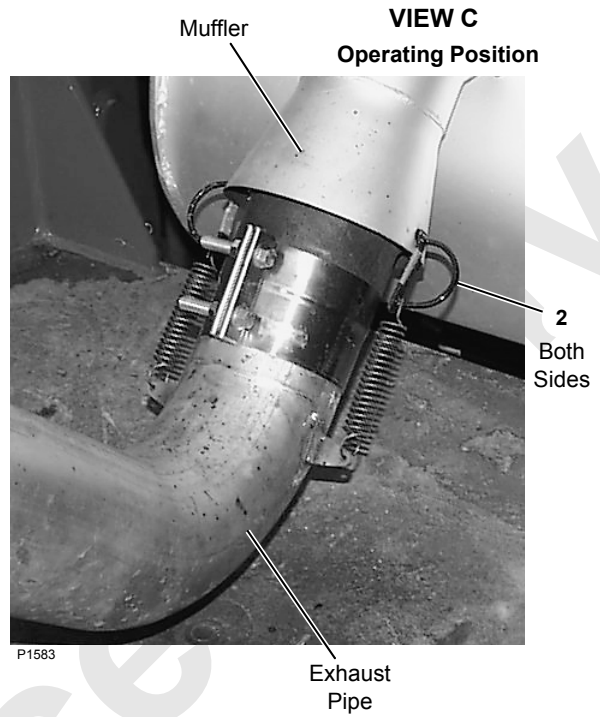
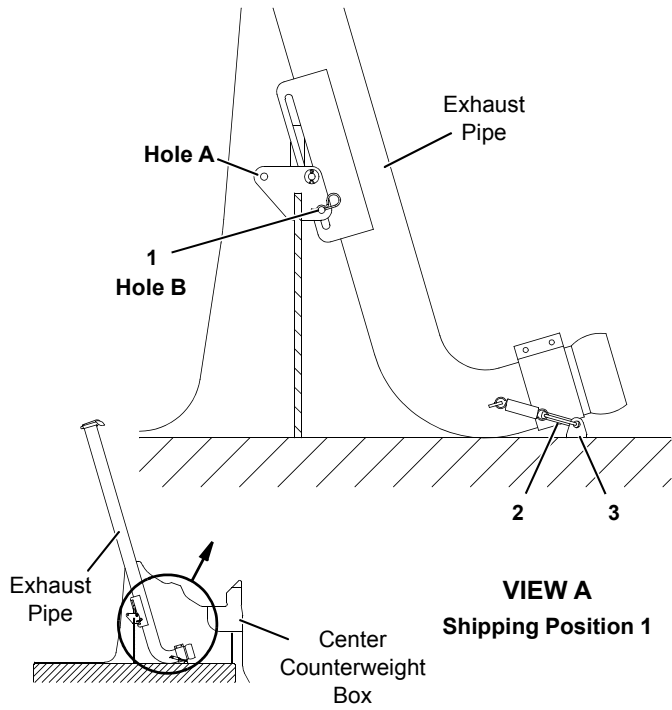
View B

FIGURE 4-2

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

A1201



Item	Description
1	Pin (with safety pins)
2	Hooks
3	Lug

FIGURE 4-3

ENGINE EXHAUST PIPE

CAUTION

Exhaust Pipe Damage!

Exhaust pipe must be stored before lowering counterweight.

Failing to comply with this caution will result in damage to the exhaust system.



WARNING

Burn Hazard!

Exhaust pipe gets extremely hot when engine is running. Stop engine and allow exhaust pipe to cool before disconnecting.

Connecting Exhaust Pipe

See [Figure 4-3](#) for the following procedure.

If exhaust pipe was shipped in POSITION 1, proceed as follows:

1. Remove pins (1, View A) from holes B and store in holes A (View D).
2. Disconnect hooks (2, View A) from lugs (3) on center counterweight box.
3. Rotate exhaust pipe to operating position with muffler. ***Make sure connector on end of exhaust pipe is snug inside muffler.***
4. Connect hooks (2) to holes in muffler (View C).

If exhaust pipe was shipped in POSITION 2, proceed as follows:

1. Remove pins (1, View B) from holes A.
2. Rotate exhaust pipe to operating position with muffler. ***Make sure connector on end of exhaust pipe is snug inside muffler.***
3. Connect hooks (2) to holes in muffler (View C).
4. Install pins (1, View D) in holes A for storage.

Disconnecting Exhaust Pipe

Reverse above steps to disconnect the exhaust pipe. Secure the exhaust pipe either in POSITION 1 or 2.

Table 4-1 Operating Limitations During Crane Assembly and Disassembly

Crane Configuration	Operating Limitations
Crane on Jacks Gantry and Mast in Transport Position No Counterweight Installed	360° Swing Permitted
Crane on Jacks Gantry UP Mast at Maximum Angle of 175° No Counterweight Installed	360° Swing Permitted
Crane on Jacks Gantry UP Mast at Maximum Angle of 150° Chain Sling and Assembly Block Installed No Counterweight Installed	360° Swing Permitted
Crane on Jacks Gantry UP Installing Crawlers with Mast No Counterweight Installed	15° Maximum Swing either Side of Center (see Figure 4-8) 16 ft (4,9 m) Maximum Radius
Crane on Crawlers Gantry UP Handling Loads with Mast Counterweight Installed	360° Swing Permitted 29 ft (8,8 m) Maximum Radius 50,000 lb (22 680 kg) Maximum Load
Crane on Crawlers Gantry DOWN Mast DOWN Counterweight (Series 3) Installed	360° Swing Permitted

CRANE ASSEMBLY

General

The following crane assembly instructions apply to cranes equipped with #22EL boom and #82 boom.

Operating Controls

All self-erecting cylinders and jacks are controlled from the operator's cab or the remote controller.

See Section 3 for identification and operation of all controls.

Pre-Start Checks

Make the following checks before starting the engine upon arrival at the assembly site. See Section 3 for starting instructions.

Engine

1. Check for leaks.
2. Check fuel, oil, and coolant levels.
3. Repair or refill as required.

Gear Boxes

1. Check for leaks.
2. Check levels.
3. Repair or refill as required.

Hydraulic System

1. Check for leaks.
2. Check level.
3. Repair or refill as required.

Remove Crane from Trailer

See [Figure 4-4](#) for the following procedure.

! WARNING
Moving Part Hazard!

Avoid serious crushing injury:

- Warn all personnel to stand clear of jacks.

Tipping Hazard!

Avoid tipping crane over:

- Keep crane level while jacking.

1. Untie crane from trailer.
2. Position each carbody jack as follows:
 - a. Remove connecting pin (View F).
 - b. Swing jack out (View E).
 - c. Install connecting pin (View E).
3. Remove jack pads from storage position (View D) and connect to jack rods with U-shaped pins.
4. Perform pre-start checks and start engine.

NOTE: It is normal for the system fault alert and the operating limit alert to come on when the engine is started.

The system fault alert should go off as engine oil pressure and hydraulic oil temperature rise to normal. **If alert does not go off soon after start-up, determine fault, stop engine, and correct cause of fault (see Display Readings in Section 3).**

5. Using controls on front of carbody, extend carbody jacks fully to raise crane off trailer.

NOTE: A 2-way level is provided near controls on front of carbody (View C).

6. Remove blocking from between crane and trailer and slowly pull trailer out from under crane.
7. Lower jacks (keep crane level) until carbody is approximately 3 ft (0,9 m) above ground.

OPERATING NOTE

360° swing is permitted when crane is on jacks with gantry and mast in transport position.

8. Rotate operator's cab to operating position:
 - a. Unpin strut from lug (A) on cab support (View A).
 - b. Rotate cab 90°.
 - c. Pin strut to lug (B) on cab support (View B).

A1184

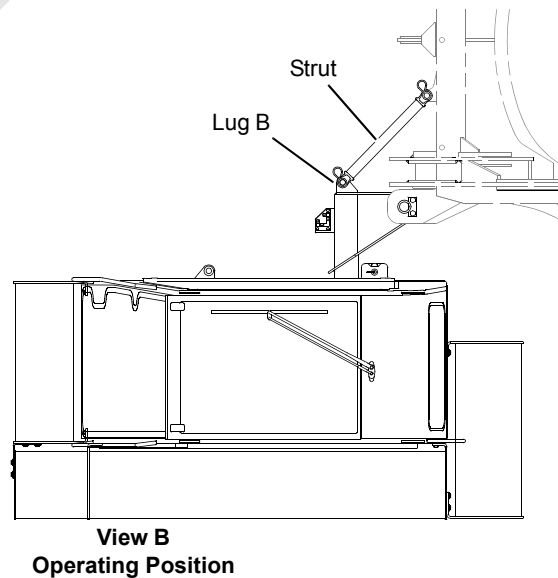
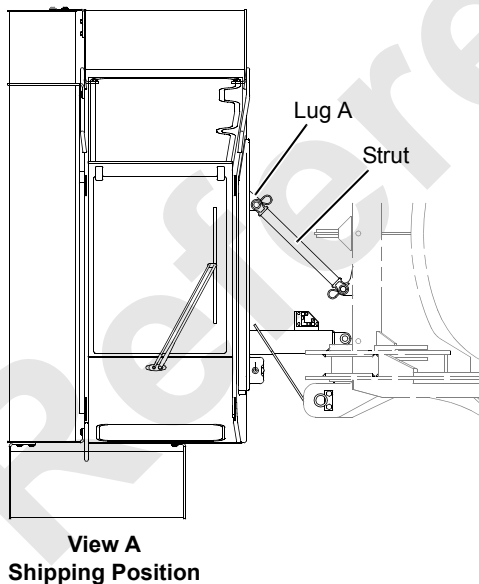


FIGURE 4-4

CIRCLED NUMBERS CORRESPOND TO REMOVE CRANE FROM TRAILER PROCEDURE

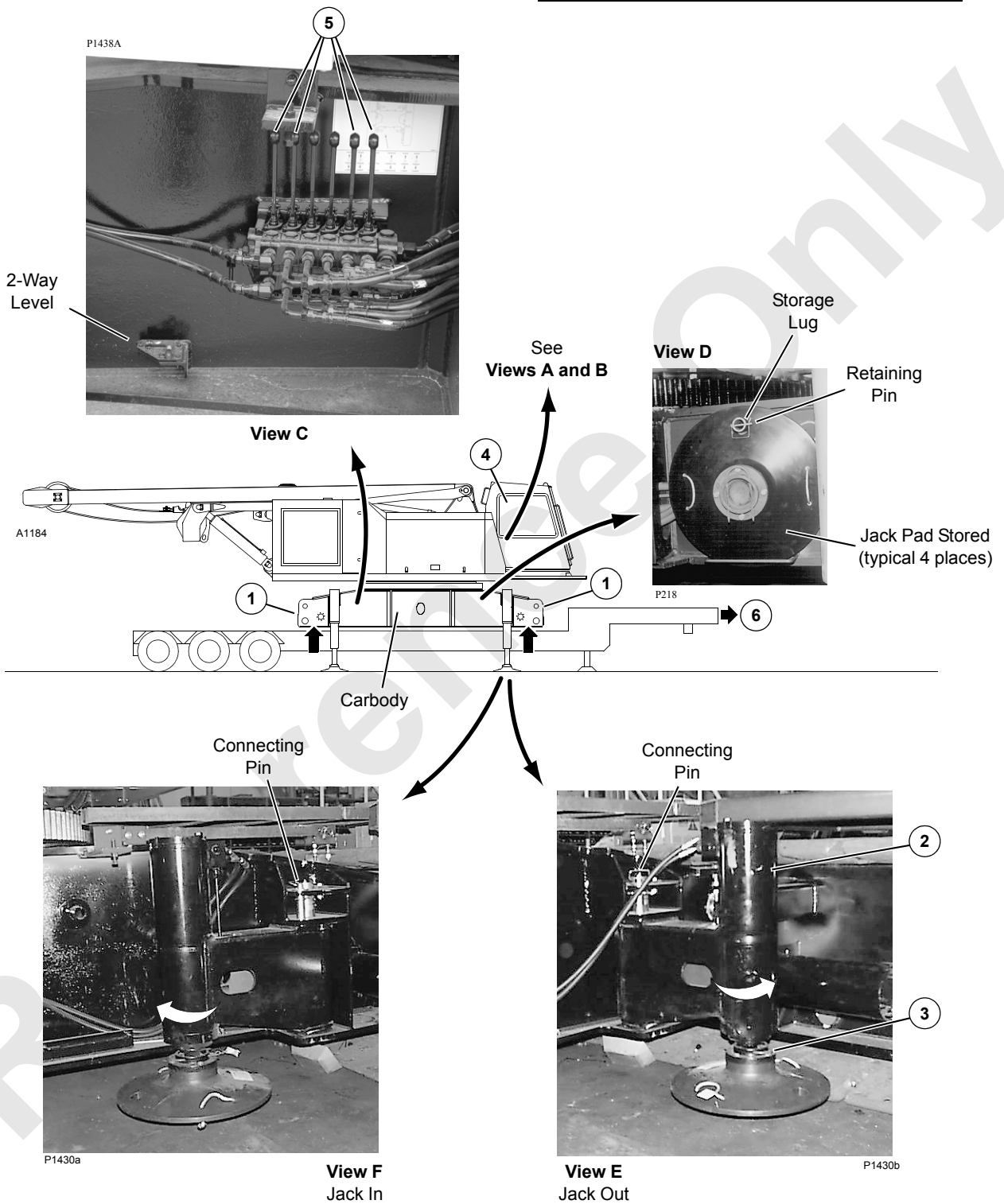


FIGURE 4-4 continued

Raise Mast To Operating Position

See [Figure 4-5](#) for the following procedure.

The following controls (located in operator's cab) are used to raise the mast and gantry. See Section 3 for identification and operation of these controls.

1. CRANE MODE SELECTOR to select setup mode.
 - Mast and gantry controls will not operate until setup mode is selected and confirmed.
 - Mast operating limits remain off until setup mode is selected and confirmed
2. MAST ARMS CONTROL to raise and lower the mast arms independently of the mast.
3. BOOM HOIST CONTROL to raise and lower the mast (and gantry) while using mast as a boom.
4. DIGITAL DISPLAY to monitor mast angles and operating limits.

See [Figure 4-5](#) for identification of mast operating limits.

 **DANGER**
Falling Mast Hazard!

Prevent mast from falling over backwards or forward:

- Read and thoroughly understand mast raising instructions.
- Select and confirm SETUP MODE before raising mast and using it as a boom. Mast operating limits remain off until this step is performed.

Raising Procedure

1. Move mast arms bypass handle in right enclosure to ON (fully down) (View B) and **leave in this position for remainder of assembly procedure.**
2. Select and confirm SETUP MODE.
3. Scroll to MAST ANGLE on digital display to monitor mast angles during raising procedure.

CAUTION
Mast Damage!

Make sure mast angle indicator is properly installed and calibrated prior to raising gantry and mast.

Mast will be damaged if this precaution is not observed.

-
4. Increase engine speed to desired RPM.

5. BOOM DOWN with boom hoist control to raise mast to operating position.
 - The gantry (with mast) will rise to its operating position and stop. Then, the mast cylinders will extend automatically to raise the mast with the mast arms.
6. Mast arms will stop automatically when cylinders are fully extended (at approximately 120°) (View D).

 **DANGER**

Falling Mast Hazard!

Do not lower mast arms until mast is connected to boom rigging. Mast will fall over backwards if raised to vertical when arms are down.

CAUTION

Mast Damage!

Stop operating immediately (release boom hoist handle to off) if MAST SYSTEM fault comes on during mast raising procedure.

Determine cause of fault and take corrective action before resuming operation.

Mast will be damaged if this precaution is not observed.

-
7. Proceed to use mast as a boom (View E) with boom hoist control for remainder of assembly procedure.

NOTE: The mast will stop lowering, the operating limit alert will come on, and MAST TOO FAR FWD will appear on the digital display if the mast is lowered to 175°.

 **DANGER**

Falling Mast Hazard!

Prevent mast from falling:

- Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.
- Do not lower mast arms until mast is connected to boom rigging. Mast will fall over backwards if raised to vertical when arms are down.

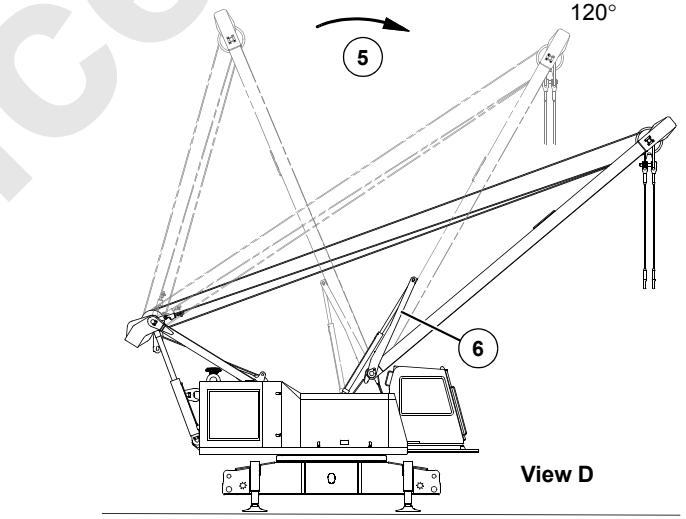
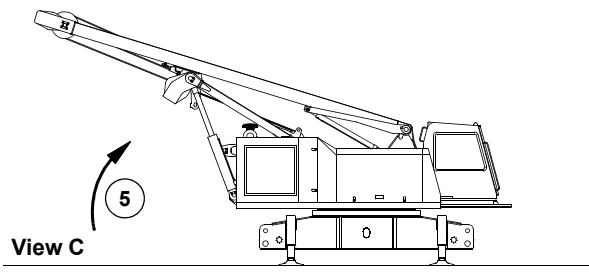
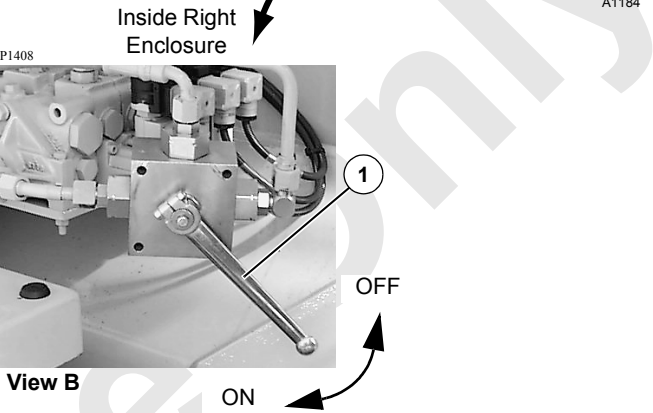
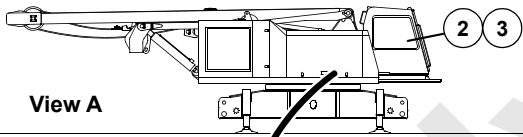
Operating Note

360° swing is permitted when crane is on jacks with gantry up and mast lowered to 175°.

Mast Operating Limits	
Operating Limits listed will appear on digital display when any limit is reached. See Display Readings in Section 3 for instructions.	
Limit/Display Reading ¹	
MAST SYSTEM	
GANTRY DOWN	
MAST TOO FAR FORWARD (occurs if mast is lowered to 175°)	

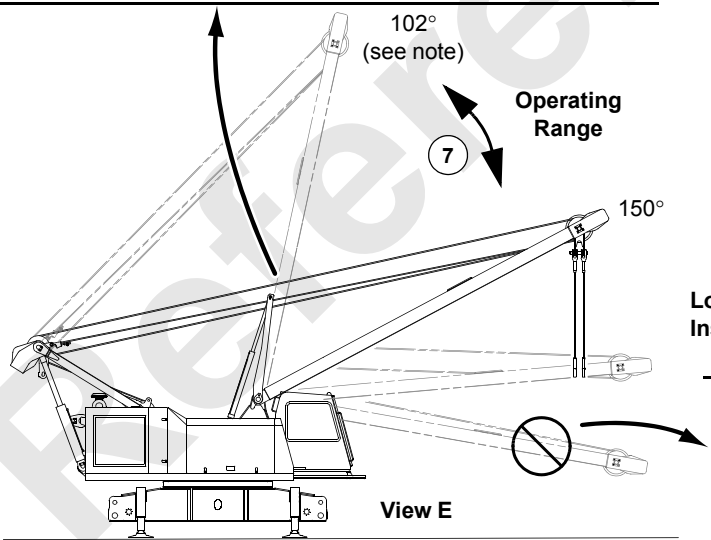
¹ Mast angles are measured from transport position which is 0°.

CIRCLED NUMBERS CORRESPOND TO RAISE MAST TO OPERATING POSITION PROCEDURE



! DANGER
Falling Mast Hazard!

Do not lower mast arms until mast is connected to boom rigging. Mast will fall over backwards if raised to vertical when arms are down.



NOTE: Mast must be raised to approximately 102° when installing crawlers and carbody counterweight. Mast arm cylinders will retract automatically as mast is raised and then extend when the mast is lowered.

Lower mast to 175° only for Installing Assembly Block

! DANGER
Falling Mast Hazard!

Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

4

FIGURE 4-5

Install Assembly Block

See [Figure 4-6](#) for the following procedure.

NOTE: Manitowoc suggests that the assembly block be shipped on the same trailer as one of the crawler assemblies. Assembly personnel can then stand on the deck of the trailer or the crawler when reeving the block.

1. Position crane and trailer as follows to provide access to mast point sheaves:
 - a. Fully retract jacks (keep crane as level as possible while jacking).
 - b. Raise jacks on side of carbody opposite mast not more than 8 in (203 mm). This step will tip mast down.
 - c. BOOM DOWN to lower mast to 175°.



DANGER

Falling Mast Hazard!

Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

2. Position trailer as shown in View A.

3. Reeve wire rope from rear drum through two center sheaves in mast point and sheave in assembly block (View B).
4. Anchor wire rope to socket and wedge on block (View C) (see [Wire Rope Installation](#) for instructions).
5. Extend jacks to level crane.
6. BOOM UP to raise assembly block off trailer and position mast in operating range (View D).

CAUTION

Wire Rope Damage!

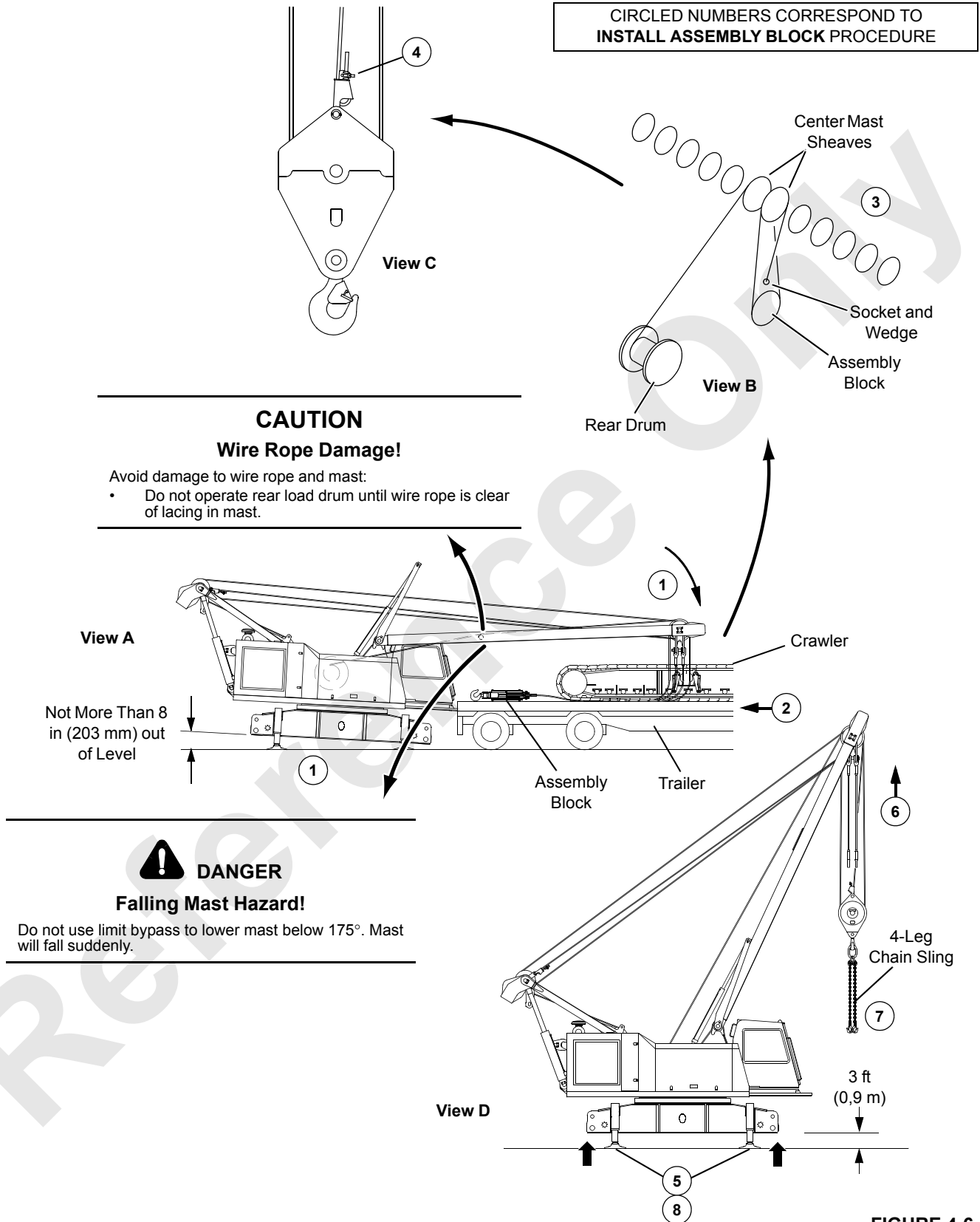
Avoid damage to wire rope and mast:

- Do not operate rear load drum until wire rope is clear of lacing in mast (View A).

7. Connect 4-leg chain sling to assembly block (View D).
8. Raise carbody (extend jacks) so it is level and at least 3 ft (0,9 m) off ground (View D).

Operating Note

360° swing is permitted when crane is on jacks with gantry up, mast above 150°, and assembly block and chain sling installed.



CIRCLED NUMBERS CORRESPOND TO
INSTALL ASSEMBLY BLOCK PROCEDURE

CAUTION
Wire Rope Damage!

- Avoid damage to wire rope and mast:
- Do not operate rear load drum until wire rope is clear of lacing in mast.

DANGER

Falling Mast Hazard!

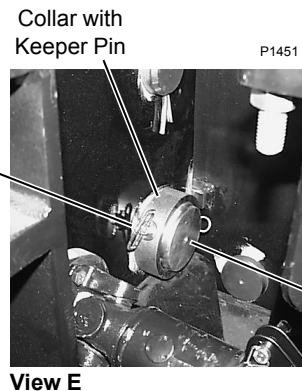
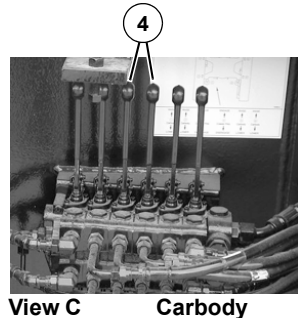
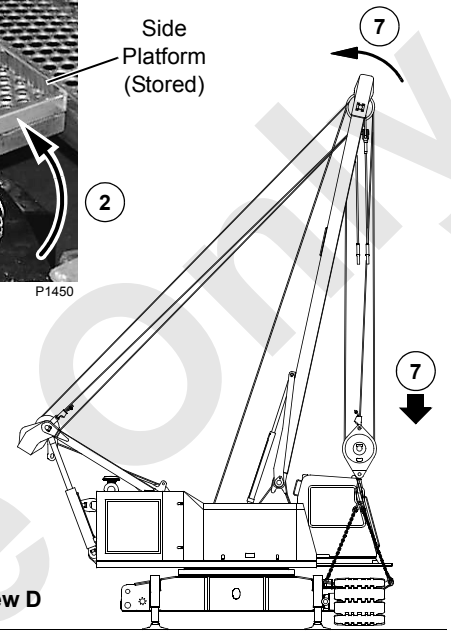
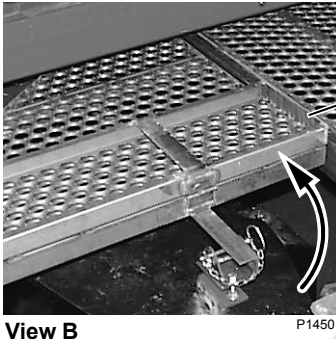
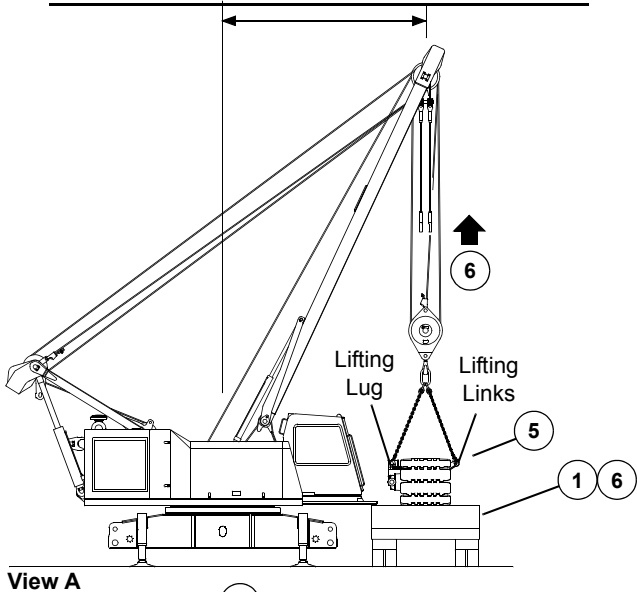
Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

FIGURE 4-6

! DANGER
Tipping Hazard!

Do not exceed 16 ft (4,9 m) radius while lifting either crawler. Crane will tip.

CIRCLED NUMBERS CORRESPOND TO
INSTALL CRAWLER PROCEDURE

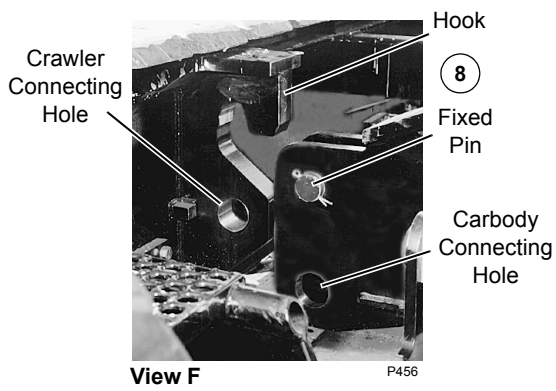


View H
Carbody

* Pin Holes

View G
Crawler

Areas marked * must be greased prior to assembly.



A1184

FIGURE 4-7

Install Crawlers

See [Figure 4-7](#) for the following procedure.



DANGER

Tipping Hazard!

Prevent crane from tipping over:

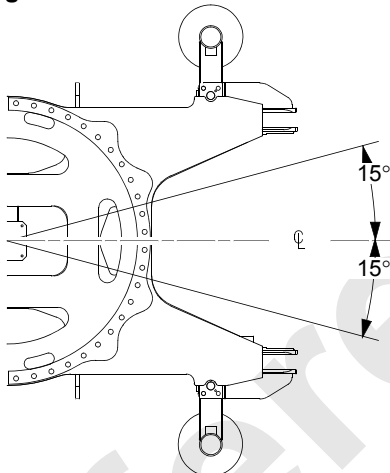
- Make sure crane is level. Check 2-way level on front of carbody. Adjust jacks as required.
- Do not swing 15° either side of center ([Figure 4-8](#)).
- Do not exceed 16 ft (4,9 m) radius while lifting either crawler (View A).

CAUTION

Parts Damage!

Avoid hitting carbody jacks with crawlers.

Swing Diagram



A1184

FIGURE 4-8

NOTE: Each time the crawlers are assembled to the carbody, thoroughly clean and grease all machined surfaces on the carbody and the crawlers (surfaces marked with asterisk * in Views G and H).

If this step is not performed, excessive friction will occur in the closely mating machined surfaces between the crawlers and the carbody. The result will be loud noises coming from under carriage when turning (cutting) the crawlers or swinging the rotating bed over the corner of the crawlers.

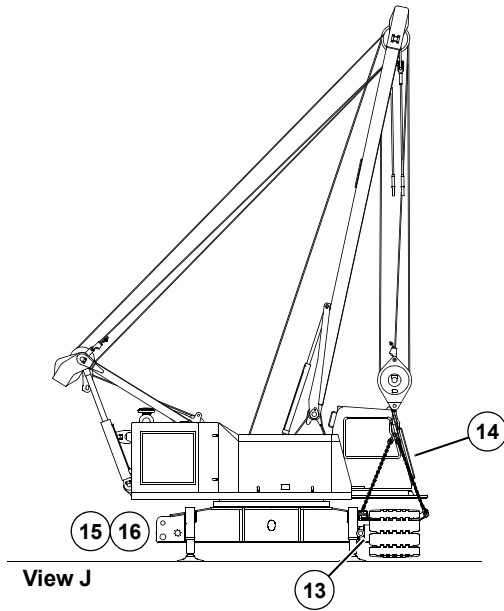
1. Position trailer with crawler along desired side of crane (View A).

NOTE: Make sure drive shafts are positioned at the appropriate end of carbody (left side to front; right side to rear).

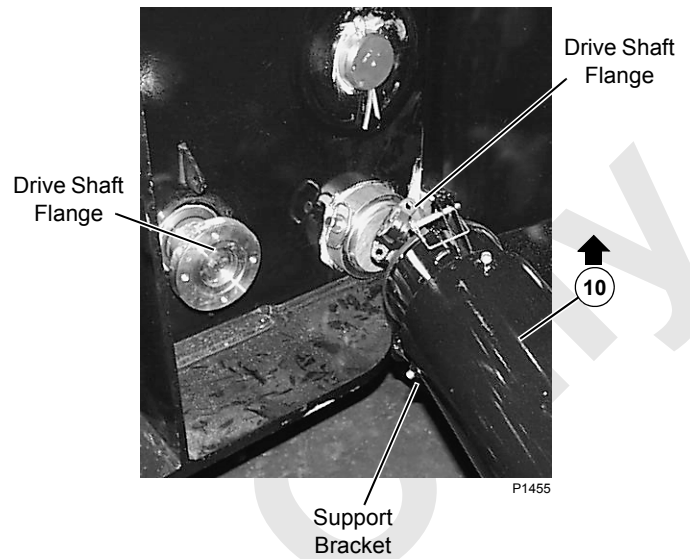
Carbody remote controls (View C) are at front of carbody.

2. Fold side platforms to stored position (View B). Platforms must be stored to provide clearance for crawler installation.
3. Remove keeper pins and collars from crawler connecting pins (View E).
4. Use handles on carbody remote control (View C) to retract connecting pins (View E).
5. Attach three hooks from chain sling to lifting lug on inboard side of crawler and lifting links on outboard side of crawler (View A).
6. Slowly hoist crawler clear of trailer and remove trailer.
7. Slowly lower crawler, boom up, and swing to engage hooks on crawler with fixed pins on carbody wings (View E and F).
8. STOP lowering and booming when crawler hooks are engaged with fixed pins and connecting holes are aligned (View F).
9. Engage crawler connecting pins and install collars and keeper pins (View E).

A1184

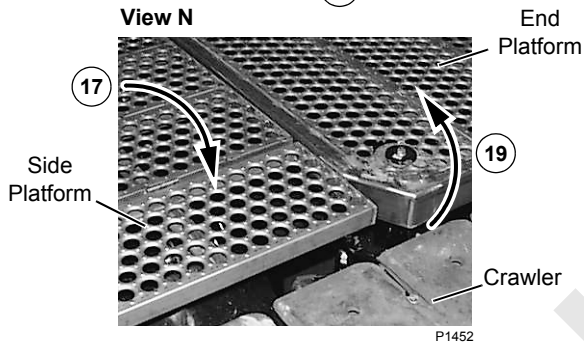


View K

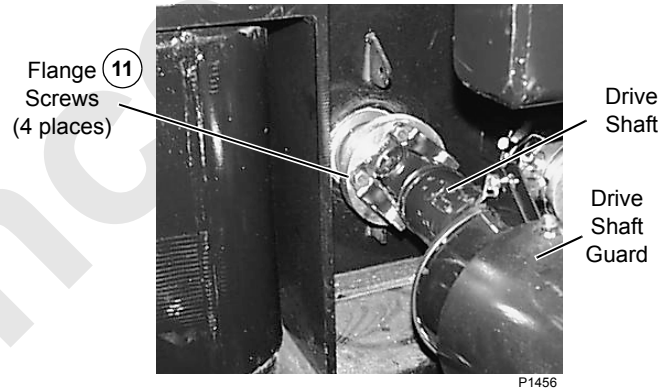


View J

View N



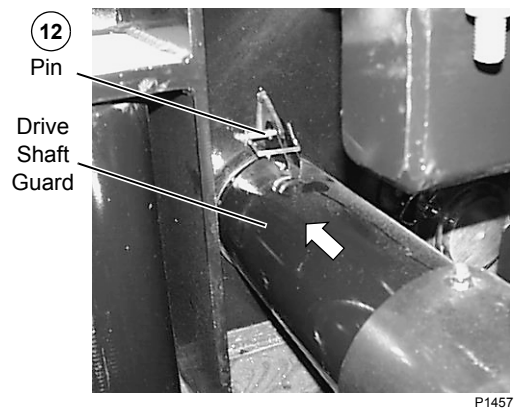
View L



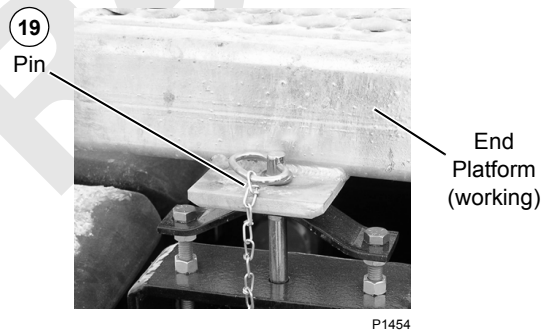
View P



View M



View Q



CIRCLED NUMBERS CORRESPOND TO
INSTALL CRAWLER PROCEDURE

FIGURE 4-6 continued

10. Lift crawler drive shaft off supporting bracket (View K), extend shaft, and align holes in drive shaft flanges (View L).



DANGER

Rotating Drive Shaft Hazard

Crawler drive shaft rotates at high speed. To prevent death or serious injury:

- Make sure drive shaft is securely attached at both ends.
- Make sure guards are in place and securely attached at both ends during operation.
- Do not attempt to service drive shaft until crane has been parked and engine stopped.

11. Insert flange screws (View L) and torque to 74 ft-lb (100 Nm).
12. Slide drive shaft guard over drive shaft and pin guard to carbody (View M).
13. If equipped with automatic crawler lube system, connect grease line from crawler to quick-disconnect coupling on carbody (Figure 4-9).

A1191

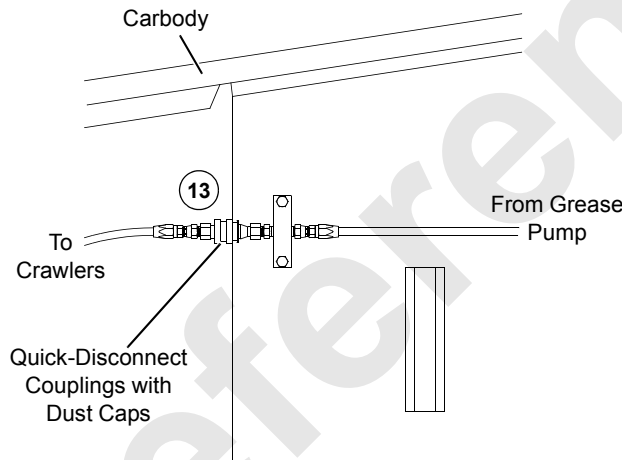


FIGURE 4-9

14. Unhook chain sling from crawler.
15. Swing over other side.
16. Repeat steps 1 through 14 for other crawler.



DANGER

Tipping Hazard!

Do not allow assembly block to swing past inside edges of carbody jacks while installing second crawler. Crane will tip.

17. Unfold side platforms to working position (View N).
18. Remove pins (four places) holding stored end platforms above crawlers (View P).
19. Swing end platforms to operating position (View N) and insert pins to secure (View Q).
20. Slowly rotate crawlers (travel forward and back) to center treads on rollers.
21. Lower carbody until crawlers are on ground. Then fully retract jacks.
22. Remove jack pads and store (Figure 4-4 continued, View D).
23. Position each carbody jack as follows:
 - a. Remove connecting pin (Figure 4-4 continued, View E).
 - b. Swing jack in (Figure 4-4 continued, View F).
 - c. Install connecting pin.

Install Counterweight

See [Figure 4-10](#) for the following procedure.



WARNING

Falling Load Hazard!

Prevent crane from tipping, wire rope from breaking, or mast from collapsing while lifting counterweights:

- Do not exceed 29 ft (8,8 m) radius. Wire rope will hit lacing in mast.
- Do not lift more than 50,000 lb (22 680 kg). Tipping or structural damage to mast may occur.

Tipping Hazard!

Avoid tipping crane over:

- Install counterweight in exact sequence given in this procedure and shown in View B.

Falling Load Hazard!

Avoid dropping counterweights:

- Do not lift lower tray and center box as a unit. Lifting lugs may break.
- Do not lift more than two side boxes at a time. Lifting lugs may break.
- Do not lift lower tray with side boxes installed.

The crane can be equipped with Series 1, Series 2, or Series 3 counterweight. The table [Figure 4-10](#) indicates the counterweight configuration for each series.

The 999 must be in the following configuration to assemble and install its own counterweight:

- Rotating bed in-line with under carriage while installing upper counterweight (360° swing is permitted while lifting counterweight and installing carbody counterweights).
- Mast arms fully raised.
- Crane setup mode selected and confirmed.
- Mast positioned at 150° while installing upper counterweight (mast will rise and lower approximately 20° as gantry is raised and lowered).
- Mast operated between fully extended mast arms and 150° (29 ft [8,8 m] radius) while lifting counterweight.
- Capacity limited to 50,000 lb (22 680 kg).

Assemble Counterweight

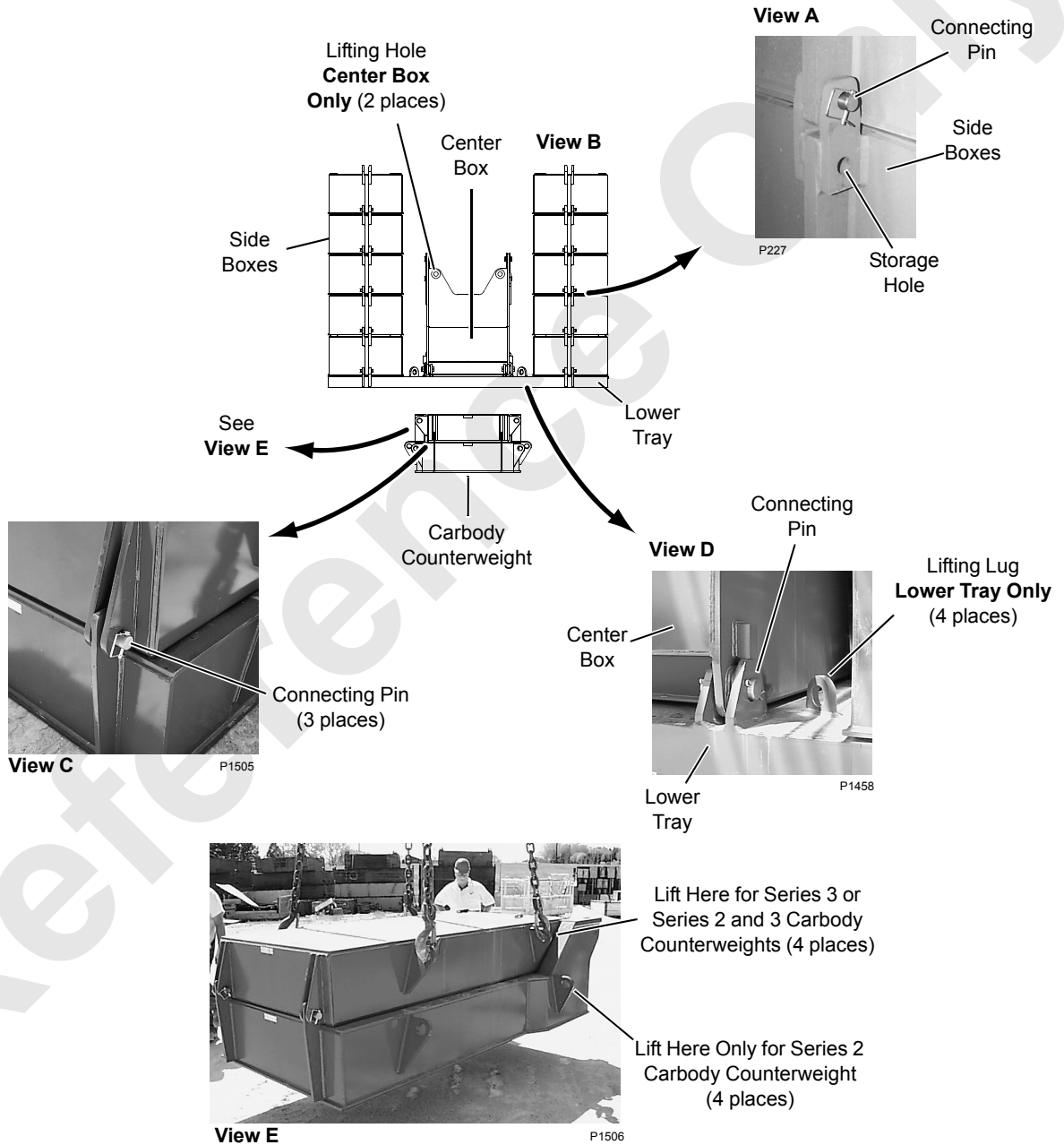
The 999 mast is used to assemble upper counterweights:

1. Lift lower tray onto ground and level it with blocking — lift at four lifting lugs (View D). Welded **F** on tray must face crane.
2. Lift center box into position and pin to lower tray (View D) — lift at two lifting holes (View B).
3. Lift one or two side boxes (angled corners facing out) into position and pin to lower tray — lift at connecting pins (View A).
4. Lift additional side boxes (as required for counterweight series) into position and pin to side box below (View A).
5. If equipped with Series 3 counterweight, pin carbody counterweights together (View C) — lift at lifting holes (View E).

A1184

Series	Center Box	Side Boxes	Carbody
1	1	3 each side	0
2	1	4 each side	1 each end
3	1	5 each side ¹	2 each end

¹ 6 boxes each side with optional low profile counterweight



4

FIGURE 4-10

Install Counterweight

6. If equipped with Series 2 or Series 3 counterweight, install 1st carbody counterweight as follows, before installing upper counterweight. For Series 1, go to step [7](#).

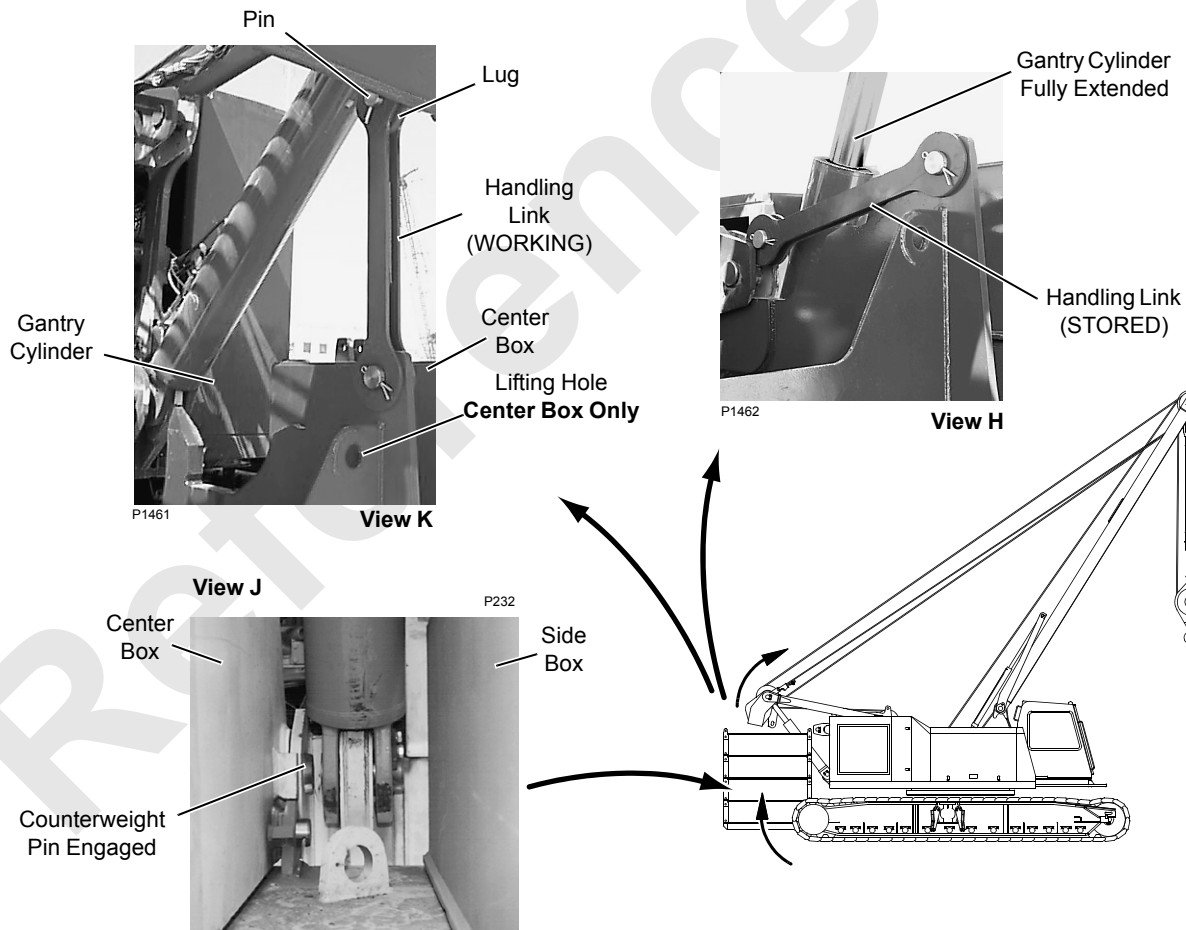
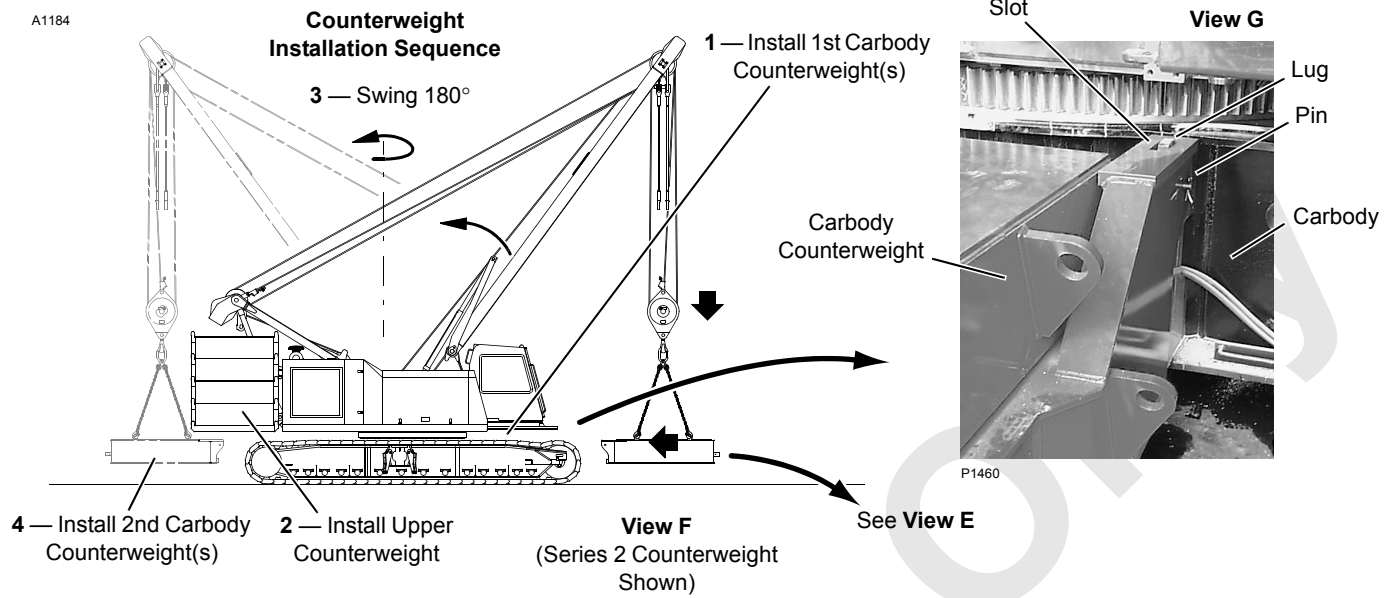
NOTE: Series 2 requires one carbody counterweight at both ends of carbody.

Series 3 requires two carbody counterweights at both ends of carbody.

Install carbody counterweight at only one end of carbody before you install upper counterweight.

- a. Hook onto carbody counterweight with chain sling and lift into position at desired end of carbody — lift at four lifting lugs (View E).
 - b. Boom, swing, and hoist as required to engage slots in counterweight with lugs on carbody (View F).
 - c. Lower counterweight and disconnect chain sling.
 - d. Install pins (View G) to connect carbody counterweight to carbody.
7. Position crane so it is in-line and centered with upper counterweights.
8. Position mast at 150°.
9. Lower gantry with control on remote control.
10. Travel crane in reverse until holes in handling links line up with lugs on gantry (View J).
11. Pin handling links to handling holes on gantry (View K).
Make sure links are hanging vertically before proceeding.
12. Slowly raise gantry and counterweight (View I) with control on remote control. Counterweight may swing in slightly.
13. Disengage counterweight pins using control on remote control.
14. Continue to raise gantry until lugs on center box engage cab rear pins and gantry cylinders are fully extended.
15. Release gantry control to off.
16. Engage counterweight pins with control on remote control.
17. Look between center and side boxes to check that both pins are fully engaged (View J).
18. Lower gantry only enough to loosen pins for handling links.
19. Disconnect handling links from gantry lugs (View K).
20. Rotate links to stored position (View H).
21. Raise gantry until cylinders are fully extended.
22. For Series 2 or Series 3, repeat steps [6a](#) – [6d](#) to install 2nd carbody counterweight.

A1184



4

FIGURE 4-10 continued

Assemble Boom and Jib

Assemble the desired boom and jib combination. See Boom and Jib Rigging instructions on [page 4-56](#).

The 999 must be in the following configuration to assemble its own boom and jib and install the boom butt:

- Counterweight installed
- Gantry fully raised
- Mast arms fully raised
- Crane setup mode selected and confirmed
- Mast operated between fully extended mast arms and 150° (29 ft [8,8 m] radius)
- Capacity limited to 50,000 lb (22 680 kg)



WARNING

Falling Load Hazard!

Prevent crane from tipping, wire rope from breaking, or mast from collapsing:

- Do not exceed 29 ft (8,8 m) radius. Wire rope will hit lacing in mast.
- Do not lift more than 50,000 lb (22 680 kg). Tipping or structural damage to mast may occur.

Remove Boom Butt From Trailer

See [Figure 4-11](#) for the following procedure.

1. Connect owner-furnished slings to top chords of boom butt (View A). Adjust position of slings so butt is balanced when lifted.
2. Lower boom butt until underside of butt is approximately 5 ft (1,5 m) off ground.
3. Lower boom butt support frame (View D) to assembly position:
 - a. Hold support frame in position and remove two pins retaining support frame to butt.
 - b. Lower support frame to vertical.
 - c. Pin struts to boom butt.

- d. Lower boom butt until it is supported on frame and bottom connectors (View C).

4. Disconnect assembly block from boom butt.
5. Lift wire rope guide to operating position and pin (View B).
6. Lower platforms on wire rope guide to working position and pin (View B).

Remove Assembly Block

See [Figure 4-12](#) for the following procedure.

NOTE: Manitowoc suggests that the assembly block be lowered onto a trailer. Assembly personnel can then stand on the deck of the trailer when removing the wire rope from the block and mast.

1. Lower assembly block and chain sling onto trailer (View A) or ground.
2. BOOM DOWN to lower mast to 175°.

CAUTION

Wire Rope and Mast Damage!

Wire rope will contact lacing in mast when mast is lowered. Take care not to damage wire rope or mast when removing wire rope.



DANGER

Falling Mast Hazard!

Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

3. Position trailer (if used) as required to provide workers with access to mast point.
4. Disconnect wire rope from socket and wedge on assembly block (View B).
5. Remove wire rope from assembly block and mast point and spool wire rope onto rear drum.
6. Raise mast to approximately 160°.
7. Remove trailer (if used) from assembly area.

A1184
A00970

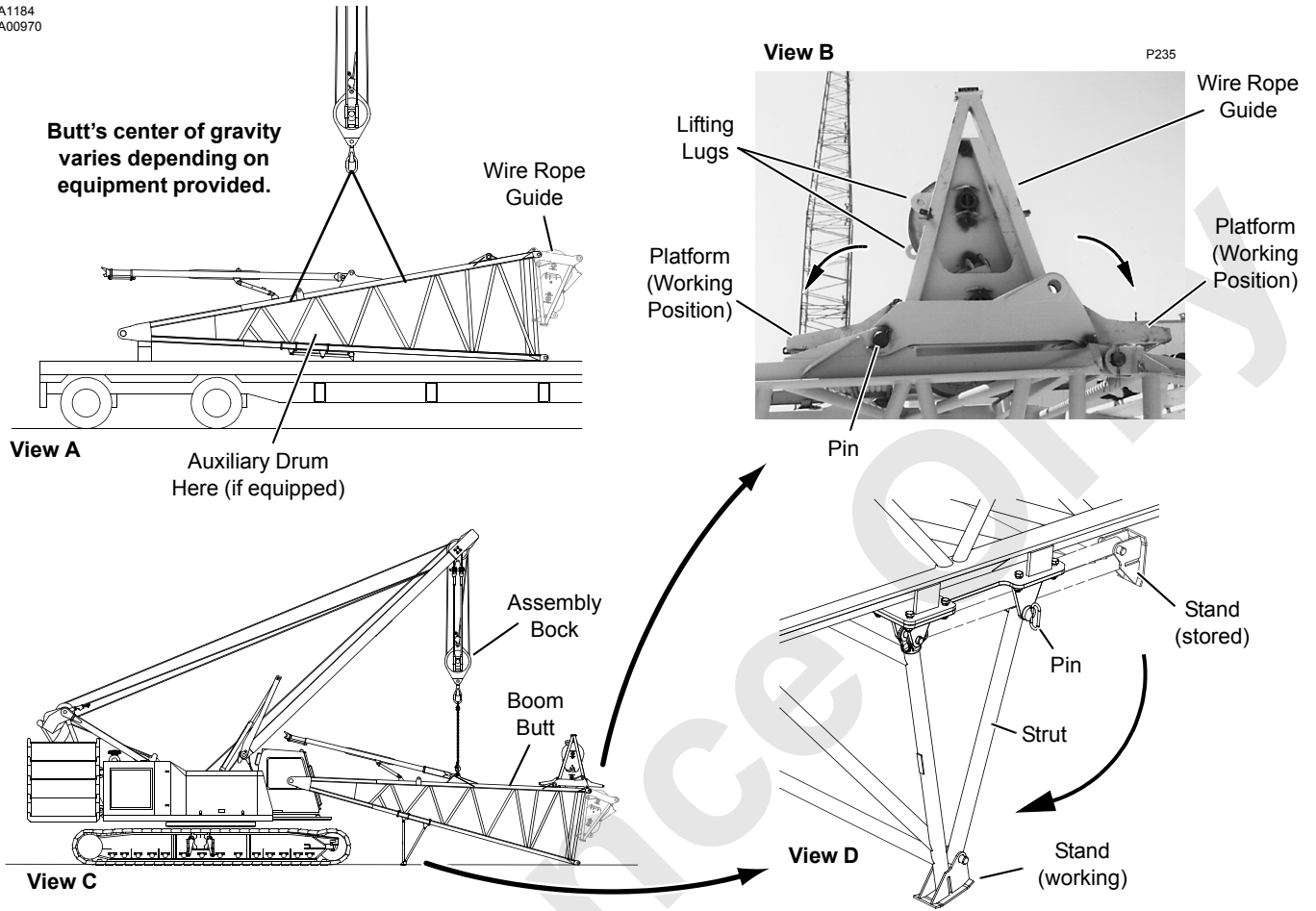


FIGURE 4-11

4

CAUTION

Wire Rope and Mast Damage!

Wire rope will contact lacing in mast when mast is lowered. Take care not to damage wire rope or mast when removing wire rope.



DANGER

Falling Mast Hazard!

Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

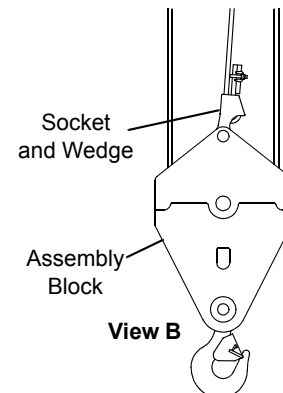
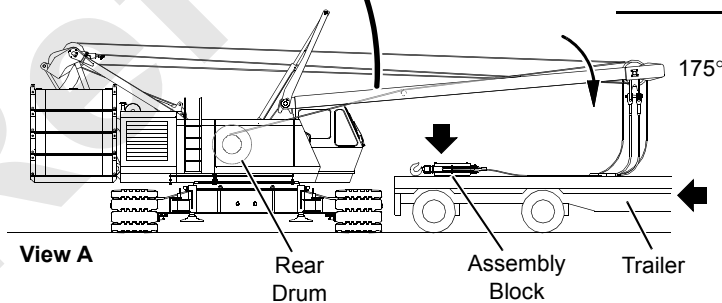


FIGURE 4-12

Install Boom Butt

See [Figure 4-13](#) for the following procedure.

1. Position crane in line with boom butt (View A).
2. Unpin and rotate locking cover down (View C) and fully disengage boom hinge pins with control on remote control.
3. Move guide pins from storage position to assembly position (View C).
4. Travel crane slowly forward until boom butt legs are aligned over guide pins (View C).
5. Apply a light coat of grease to underside of both boom butt legs (View C).
6. Raise boom stops (View A and B):
 - a. Unpin slings from storage position on mast and pin to lug on boom stops. Raise and lower mast as required to align connecting holes.
 - d. Lower mast until slings are slack (inner tubes resting on pins).
 - e. Unpin slings and store on mast.
7. For #22E or #22EL boom, proceed as follows (View D):
 - a. Lower mast until mast pendants are next to links in wire rope guide on boom butt.
 - b. Pin pendants to links in wire rope guide.
 - #22E Boom: Pin all four pendants to links.
 - #22EL Boom: Pin both *inboard* pendants to links.
8. For #82 boom, proceed as follows:
 - a. Lower mast until mast straps are near wire rope guide on boom butt.
 - b. Swing mast straps forward and install guide pins (View E).
 - c. Lower mast until connecting holes in mast straps line up with holes in links on wire rope guide (View F).
 - d. Install connecting pins, collars, and retaining pins (View F).
 - e. Remove and store guide pins (View F).

CAUTION

Boom Butt Damage!

Prevent damage to boom butt chords and lacings:

- For #82 boom, guide mast straps clear of chords and lacings as mast is lowered.
- b. Raise mast until hole in outer mast stop tubes are above ends of inner tubes.
- c. Install pins in outer tubes.

CAUTION

Wire Rope Guide Damage!

Prevent damage to wire rope guide and guide pins:

- Store guide pins before raising mast.
-

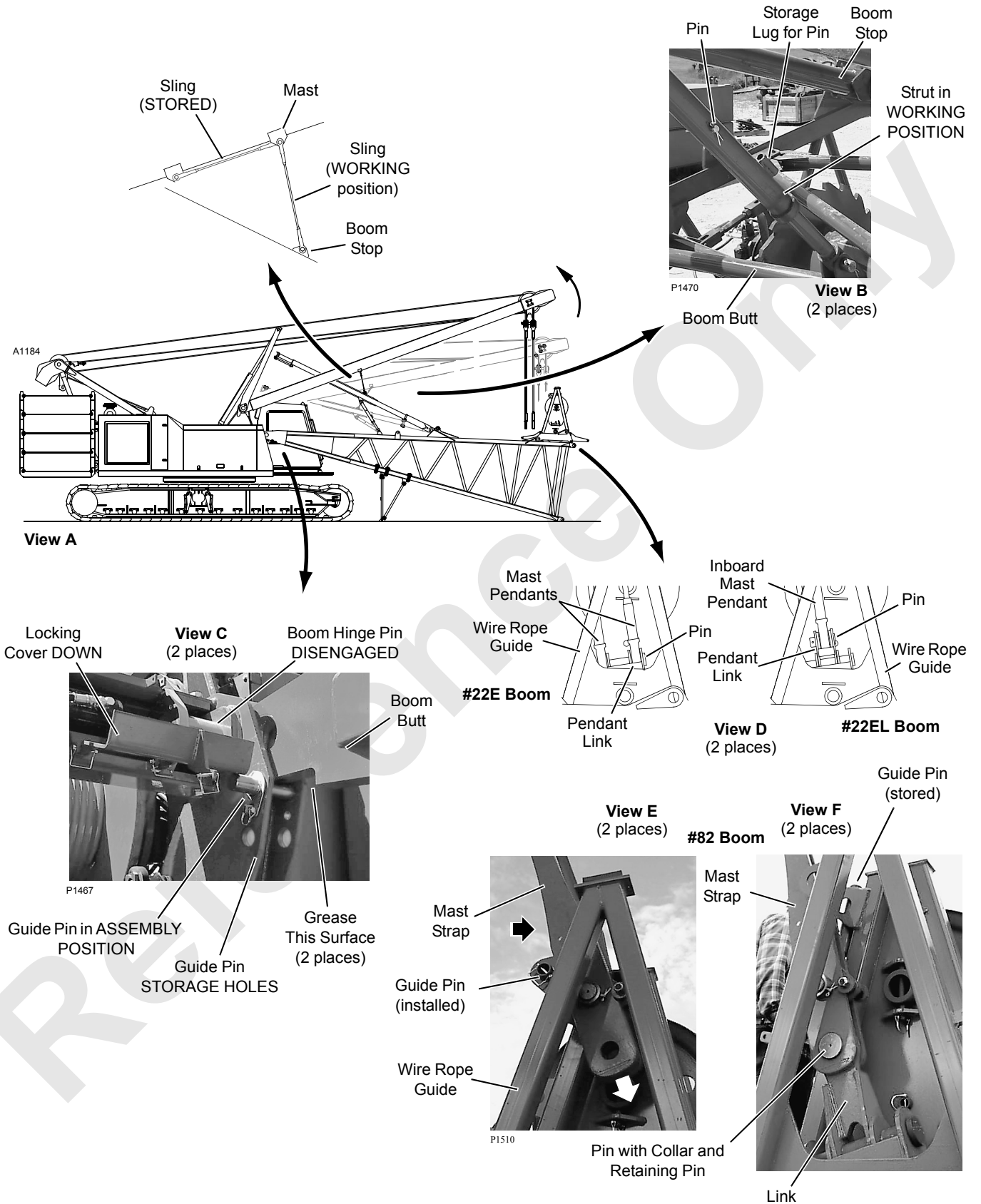


FIGURE 4-13

See [Figure 4-13](#) for the remaining steps.

9. Slowly raise boom butt (View G) until both stops on underside of boom hinge lugs are snug against guide pins (View H).
10. Slowly lower boom butt until hinge pin holes in boom butt are aligned with holes in rotating bed — bottom connectors will be approximately 18 in (0,46 m) off ground.
11. Fully engage boom hinge pins (View H) with control on remote control.
12. Raise butt slightly and move guide pins from assembly position to storage position (View J).

CAUTION

Boom Butt Damage!

Prevent damage to boom butt:

- Do not lower boom butt to ground until guide pins are stored.

-
13. Rotate locking cover up and pin (View J).



WARNING

Falling Boom Hazard!

Prevent boom from falling off crane:

- Pin locking cover UP after engaging hinge pins. Cover locks hinge pins in engaged position.
-
14. See [Figure 4-11](#), View D, and move boom butt support frame to storage position:
 - a. Lower boom butt until support frame legs are approximately 2 in (51 mm) off ground.
 - b. Unpin struts from butt.
 - c. Rotate support frame to storage position under boom butt.
 - d. Install two pins to connect support frame to boom butt.
 15. Lower boom butt until bottom connectors are on ground (View G).

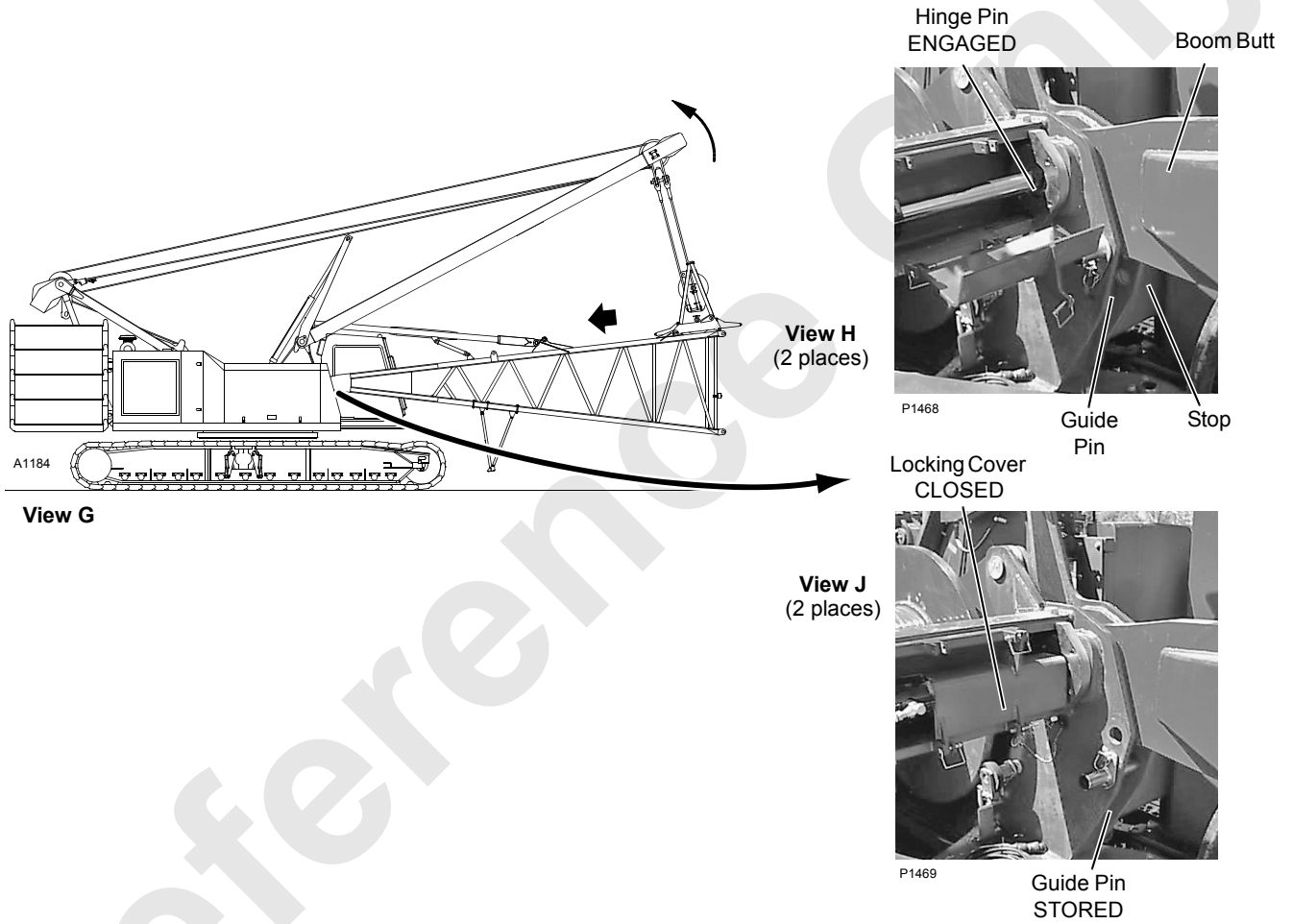


FIGURE 4-13 continued

Connect #22E or #22EL Boom Butt To Boom

See [Figure 4-14](#) for the following procedure.

1. Position crane so boom butt is in line with boom.
2. Travel forward slowly, swing, and boom up and down as needed to align top connector holes in butt with top connector holes in insert (View A).



WARNING Tipping Hazard!

Prevent crane from tipping:

- Block crawlers if required per capacity chart before attempting to raise boom.
3. Check appropriate capacity chart to see if crawlers must be blocked to raise boom. If so, proceed as follows:
 - a. Mark ground at center of front crawler roller and tumbler located under boom butt.
See Crawler Blocking Diagram in Capacity Chart Manual for blocking requirements.
 - b. Slowly travel in reverse several feet.
 - c. Place required blocking on ground at points marked in step 3a (View A).
 - d. Repeat step 2 while traveling onto blocking.
 4. Install top connector pins (View B).
 5. Slowly boom up only enough to align bottom connector holes in butt with bottom connector holes in insert (View C).

CAUTION

Boom Butt Damage!

Avoid overload damage to boom butt or wire rope guide:

- Do not allow bottom connectors in butt to bottom out against bottom connectors in insert while performing step 5.
- Do not continue to boom up after bottom connector pins are installed.



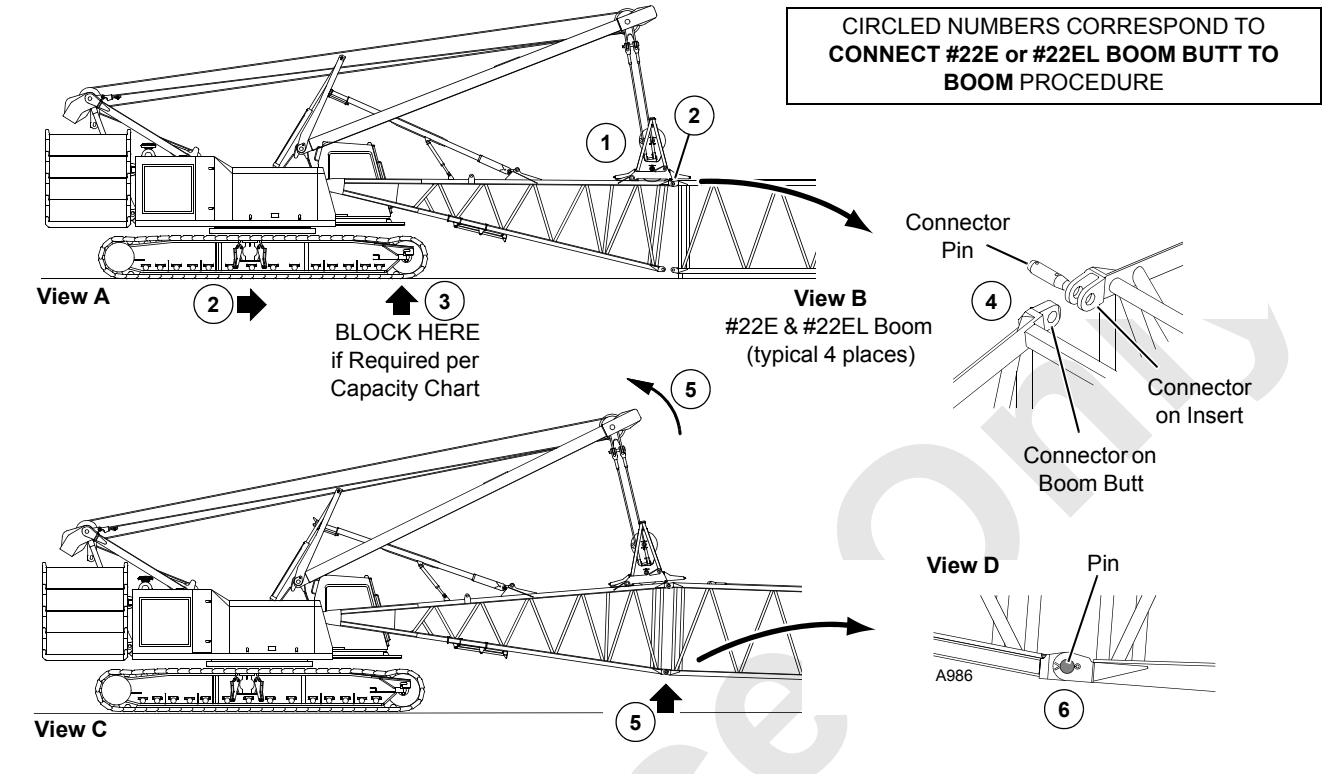
WARNING

Moving Part Hazard!

Prevent serious crushing injury:

- Do not stand inside boom while installing connector pins — STAND OUTSIDE BOOM.
6. Install bottom connector pins (View D)
 7. Boom down to slacken mast pendants (View E).
 8. Unpin pendants from links in wire rope guide.
 9. Pin mast pendants to boom pendants (View F).
 10. Fully lower mast arms (View E).
 11. Turn off setup mode by selecting and confirming desired operating mode.
 12. Move mast arms bypass handle in right enclosure to OFF position (View G).
 13. Install block-up limit components as shown in [Figure 4-31](#) and in Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at rear of this section.
See Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing and connect:
 - Electric cable from crane ([Figure 4-14](#), View K) to cable reel on boom butt.
 - Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junctions boxes.
 14. Install wind speed indicator assembly if removed for shipping. Use star washers to attach mounting bracket to boom or jib top to provide a good ground (see Wind Speed Assembly drawing at the end of this section).
Connect electrical cable at base of wind speed mounting bracket to cable on boom or jib.
 15. Boom can now be raised. **Perform pre-raising checks.**

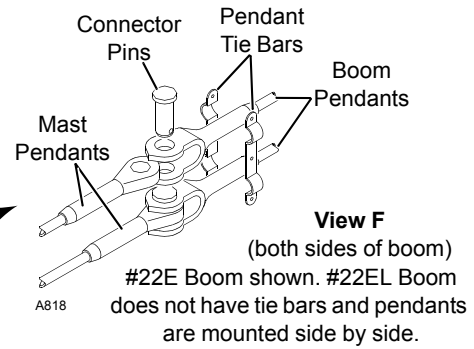
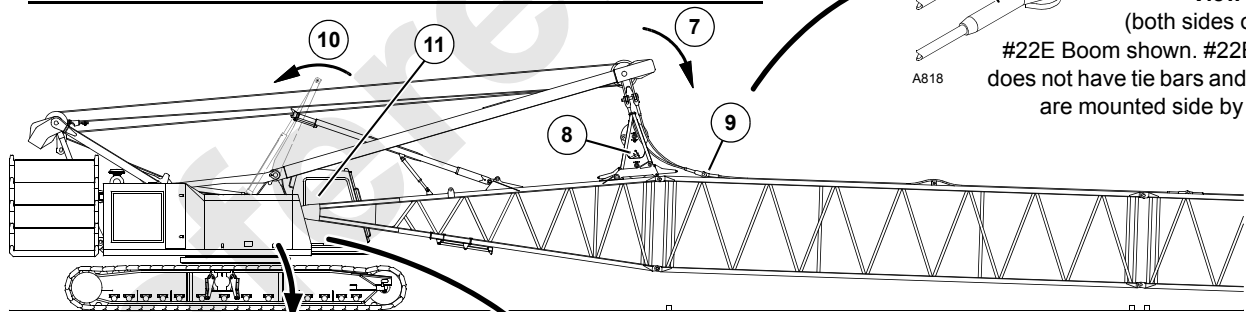
A1184



DANGER
Falling Mast/Boom Hazard!

Prevent mast and boom from collapsing:

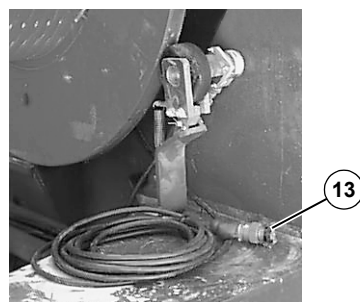
- Fully lower mast arms before raising boom. Mast will buckle and collapse if it contacts arms with a fully rigged boom attached.



View G Inside Right Enclosure P1408



P1471



View H

FIGURE 4-14

4

Connect #82 Boom Butt To Boom

See [Figure 4-15](#) for the following procedure.

1. Position crane so boom butt is in line with boom.
2. Travel forward slowly, swing, and boom up and down as needed to align vertical pins in butt with top connector holes in insert (View A and B).



WARNING

Tipping Hazard!

Prevent crane from tipping:

- Block crawlers if required per capacity chart before attempting to raise boom.
3. Check appropriate capacity chart to see if crawlers must be blocked to raise boom. If so, proceed as follows:
 - a. Mark ground at center of front crawler roller and tumbler located under boom butt.
See Crawler Blocking Diagram in Capacity Chart Manual for blocking requirements.
 - b. Slowly travel in reverse several feet.
 - c. Place required blocking on ground at points marked in step 3a (View A).
 - d. Repeat step 2 while traveling onto blocking.
 4. Boom up to engage fixed vertical pins (boom butt) with insert connector holes (View B).
 5. Slowly boom up only enough to align bottom connector holes in butt with bottom connector holes in insert (View D).

CAUTION

Boom Butt Damage!

Avoid overload damage to boom butt or wire rope guide:

- Do not allow bottom connectors in butt to bottom out against bottom connectors in insert while performing step 5.
- Do not continue to boom up after bottom connector pins are installed.



WARNING

Moving Part Hazard!

Prevent serious crushing injury:

- Do not stand inside boom while installing connector pins — STAND OUTSIDE BOOM.

6. Remove connector pins from stored position (View C) and pin butt to insert (View E).
7. Boom down, push mast straps forward, and install guide pins (View F).
8. Unpin mast straps from links in wire rope guide (View G).
9. Boom down to align connecting holes in mast straps with holes in boom straps (View H). Straps will slide down over guide pins (View F). Push straps forward as required.
10. Pin mast straps to boom straps (View H) – **pin heads facing outside**.
11. Relocate adjusting pin (View H) from Hole A to B (or vice versa) as specified on Boom Rigging Drawing. Boom up or down as needed to align holes and install pins in proper holes.

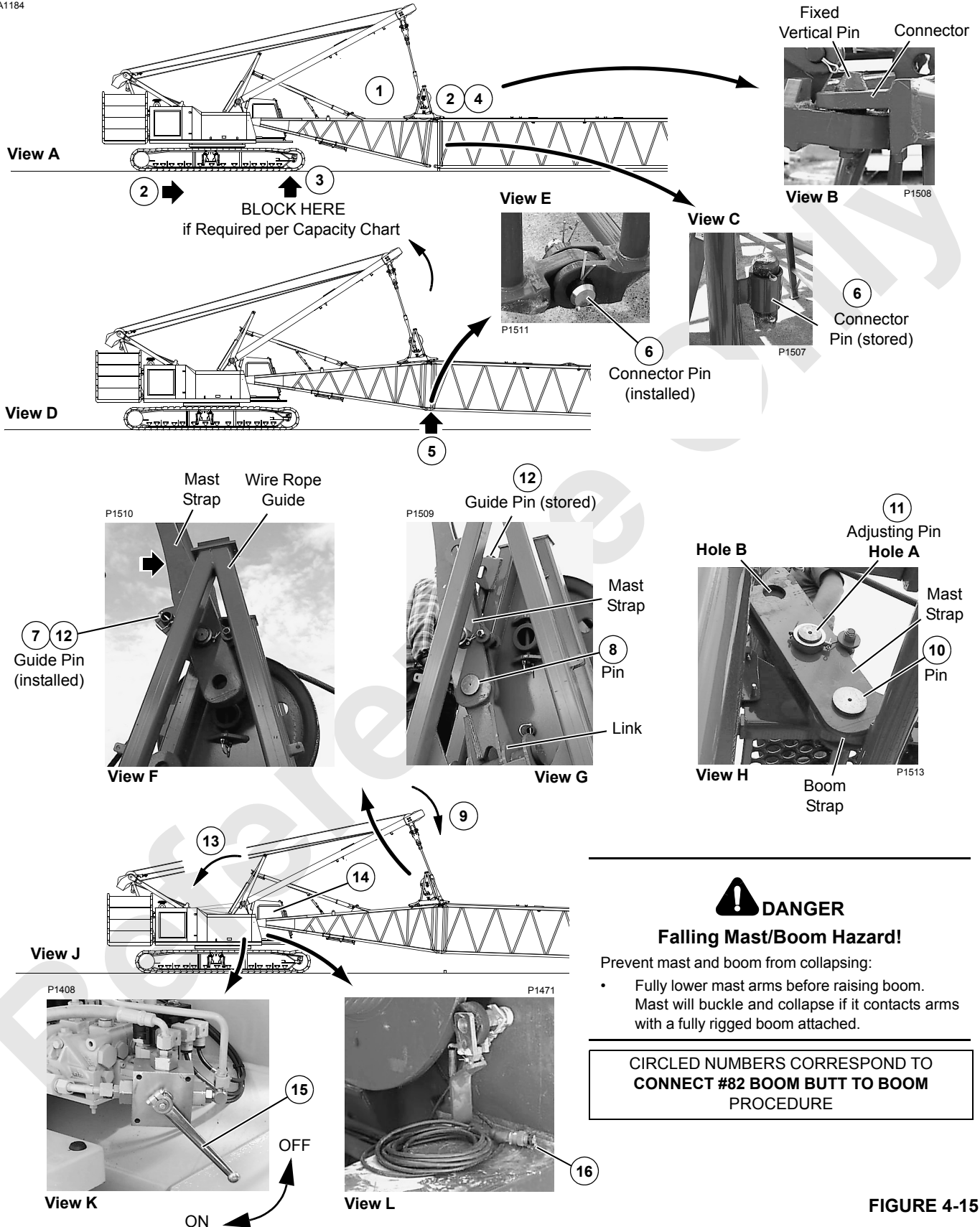
CAUTION

Wire Rope Guide Damage!

Prevent damage to wire rope guide and guide pins:

- Store guide pins before raising mast.
12. Remove guide pins (View F) and store (View G).
 13. Fully lower mast arms (View J).
 14. Turn off setup mode by selecting and confirming desired operating mode.
 15. Move mast bypass handle in right enclosure to OFF position (View K).
 16. Install block-up limit components as shown in [Figure 4-31](#) and in Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section.
See Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing and connect:
 - Electric cable from crane ([Figure 4-15](#), View L) to cable reel on boom butt.
 - Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junctions boxes.
 17. Boom can now be raised. **Perform pre-raising checks.**

A1184



4

FIGURE 4-15

PRE-RAISING CHECKS

Make the following checks and correct any defects before raising attachment:

- Crane on firm, level surface with crawlers blocked if required per capacity chart.
- Boom hinge pins fully engaged and locking cover pinned in up position.
- Crawler connecting pins engaged and locking pins installed.
- Carbody jack pads stored.
- Carbody jacks fully retracted and pinned in stored position.
- Boom and jib inserts installed in proper sequence per rigging drawing
- Spreader (22EL boom only) installed at proper location and spread to proper position.
- Intermediate suspension installed if required (#82 Long Reach boom only).
- Links properly connected between all straps.
- All insert and pendant connector pins installed. Cotter pins installed and spread.
- Gantry fully raised.
- Mast arms fully lowered.
- Mast arms bypass handle turned off.
- Setup mode turned off (desired operating mode is selected and confirmed).
- Boom hoist wire rope spooled tightly onto drum and engaged with proper sheaves. Wire rope securely anchored to wedge socket at gantry.
- Load lines spooled tightly onto drums and engaged with proper sheaves. Load lines securely anchored to wedge sockets at boom and jib point or at load block and weight ball.
- All blocking, tools, and other items removed from boom and jib.
- Automatic boom stop properly installed and operational.
- Electric cable from crane control system connected to cable reel on boom butt.
- Electric cables in boom and jib connected to proper receptacles on junction boxes.
- Block-up limit control properly installed and operational.

- LMI properly installed and operational.
- Crane and attachment properly lubricated.
- Wind within allowable limits for operation given on capacity chart.

CRANE DISASSEMBLY

General

1. Prepare crane and boom as follows:
 - a. Position crane in disassembly area.
 - b. If required per capacity chart, travel front crawler roller and tumbler at boom end of crane onto blocking.

See Crawler Blocking Diagram in Capacity Chart Manual for blocking requirements.



WARNING

Tipping Hazard!

Prevent crane from tipping. Block crawlers if required per capacity chart before lowering boom.

2. Lower boom to ground as follows:
 - a. Slowly lower boom to ground.

If equipped with a fixed jib, disconnect jib stops before jib point contacts ground. See Jib Rigging instructions.

If equipped with an upper point, remove lower connecting pins before upper point contacts ground. See Boom Rigging instructions.

CAUTION

Avoid Damage!

Jib or lower point will be damaged if the following steps are not performed.

- b. Install blocking approximately 6 in (152 mm) high between ground and bottom connectors at end of boom top.
- c. Continue to lower boom onto blocking until boom pendants (#22 or #22EL boom) or straps (#82 boom) are slack.
- d. Disconnect load lines from load block and weight ball and spool load lines onto load drums.

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Disconnect #22E or #22EL Boom Butt To Boom

See [Figure 4-16](#) for the following procedure.

1. Disconnect electric cord from cable reel on boom butt, connect terminating plug to electric cord, and coil cord on front of rotating bed (View H).
2. Move mast arms bypass handle in right enclosure to ON position (View G).
3. Turn on setup mode.
4. Fully raise mast arms (View E).
5. Boom down until boom pendants are resting on boom and mast pendants are slack (View E).
6. Unpin mast pendants from boom pendants (View F).
7. Pin mast pendants to links in wire rope guide (Figure 9, View D).
8. Boom up until mast pendants are taut.
9. Remove bottom connector pins (View D).
10. Boom down to lower boom inserts onto blocking at least 6 in (152 mm) high.

CAUTION

Boom Butt Damage!

Avoid overload damage to boom butt or wire rope guide:

- Do not attempt to raise entire boom when mast pendants are pinned to wire rope guide.

WARNING

Moving Part Hazard!

Prevent serious crushing injury:

- Do not stand inside boom while installing connector pins — STAND OUTSIDE BOOM.

11. Remove top connector pins (View B).
12. Travel in reverse to disengage boom butt from adjacent insert (View A).

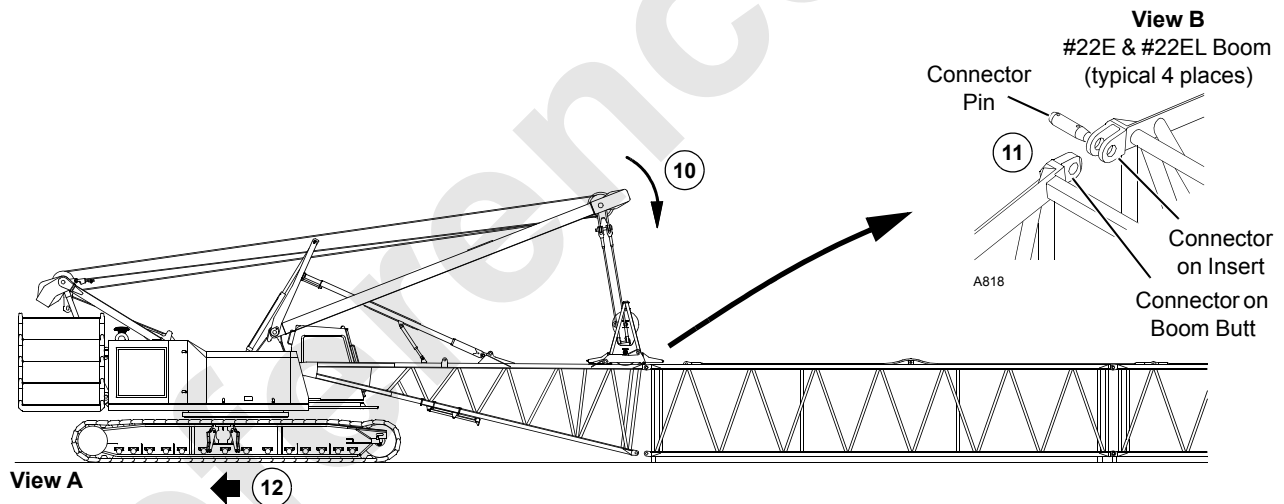
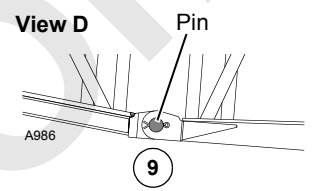
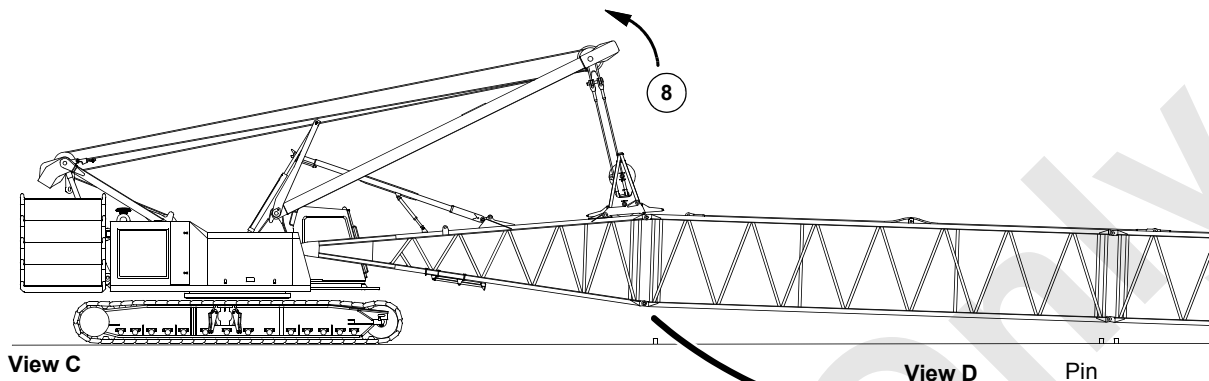


FIGURE 4-16

A1184

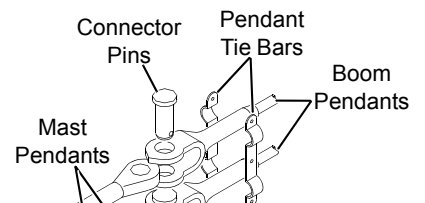
CIRCLED NUMBERS CORRESPOND TO DISCONNECT #22E or #22EL BOOM BUTT FROM BOOM PROCEDURE



DANGER
Falling Mast Hazard!

Prevent mast falling over backwards:

- Fully lower mast arms before raising mast to vertical.



View F
(both sides of boom)
#22E Boom shown. #22EL Boom does not have tie bars and pendants are mounted side by side.

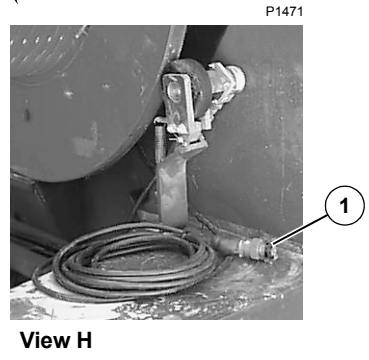
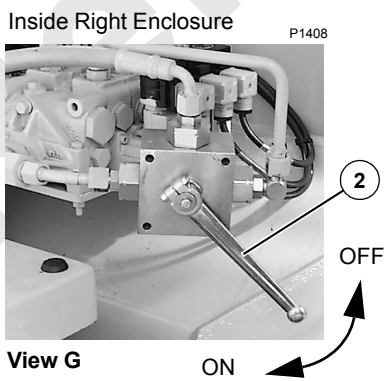
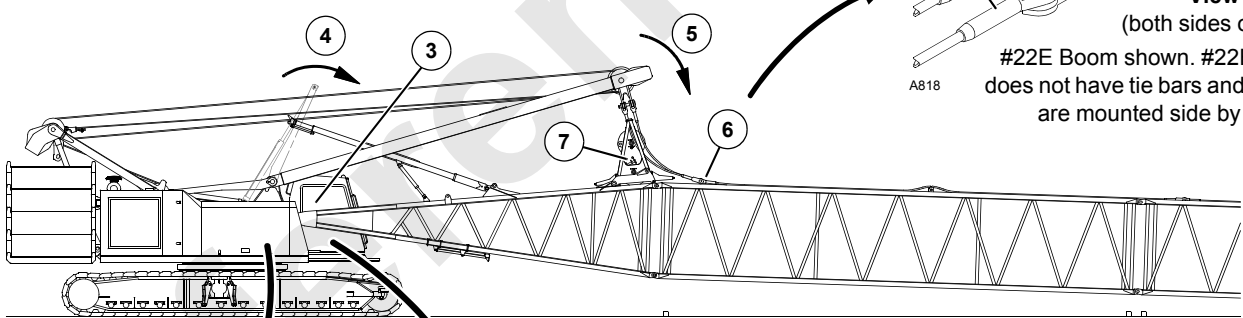


FIGURE 4-16 continued

Disconnect #82 Boom Butt From Boom

See [Figure 4-17](#) for the following procedure.

1. Disconnect electric cord from cable reel on boom butt, connect terminating plug to electric cord, and coil cord on front of rotating bed (View L).
2. Move mast arms bypass handle in right enclosure to ON position (View K).
3. Turn on setup mode.
4. Fully raise mast arms (View J).
5. Remove guide pins from storage lugs (View G) and install on wire rope guide (View F)
6. Boom down until boom straps are resting on boom and mast strap pins (View H) are loose.
7. Unpin mast straps from boom straps (View H).
8. Raise mast and pin mast straps to links in wire rope guide (View G).
9. Remove guide pins (View F) and store (View G)
10. Boom up until mast straps are taut.
11. Remove bottom connector pins (View E) and store on boom butt (View C).

12. Boom down to lower boom inserts onto blocking at least 6 in (152 mm) high.



CAUTION

Boom Butt Damage!

Avoid overload damage to boom butt or wire rope guide:

- Do not attempt to raise entire boom when mast straps are pinned to wire rope guide.



WARNING

Moving Part Hazard!

Prevent serious crushing injury:

- Do not stand inside boom while installing connector pins — STAND OUTSIDE BOOM.

13. Continue to boom down to disengage fixed vertical pins from connector holes in adjacent insert (View B).

14. Travel in reverse slowly to disengage boom butt from adjacent insert (View A).

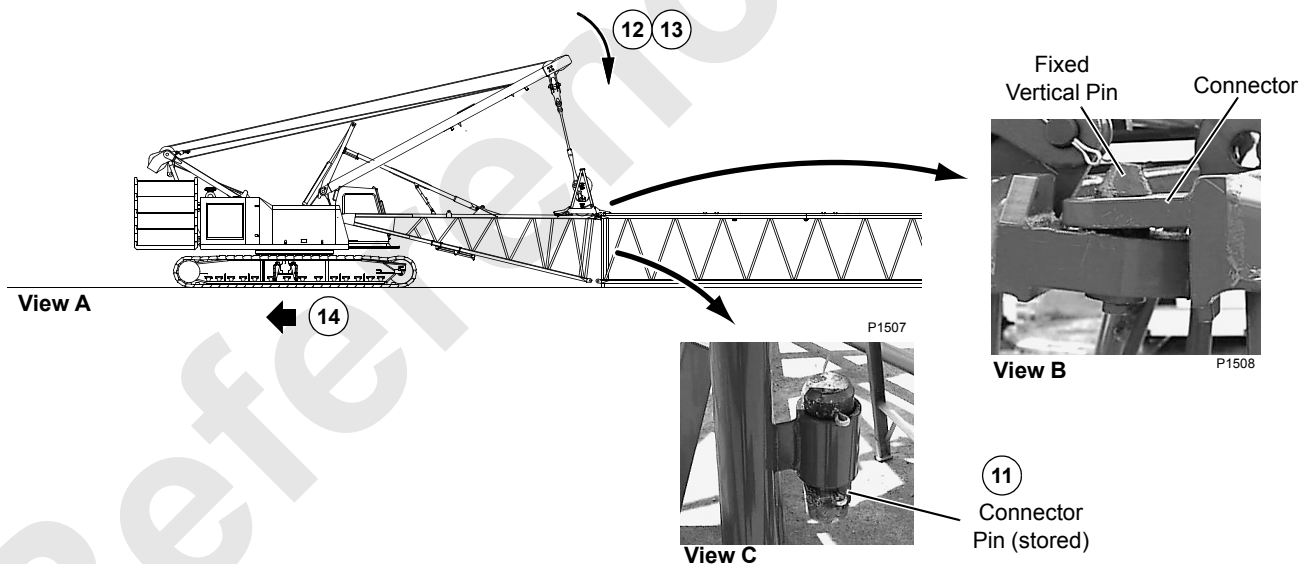
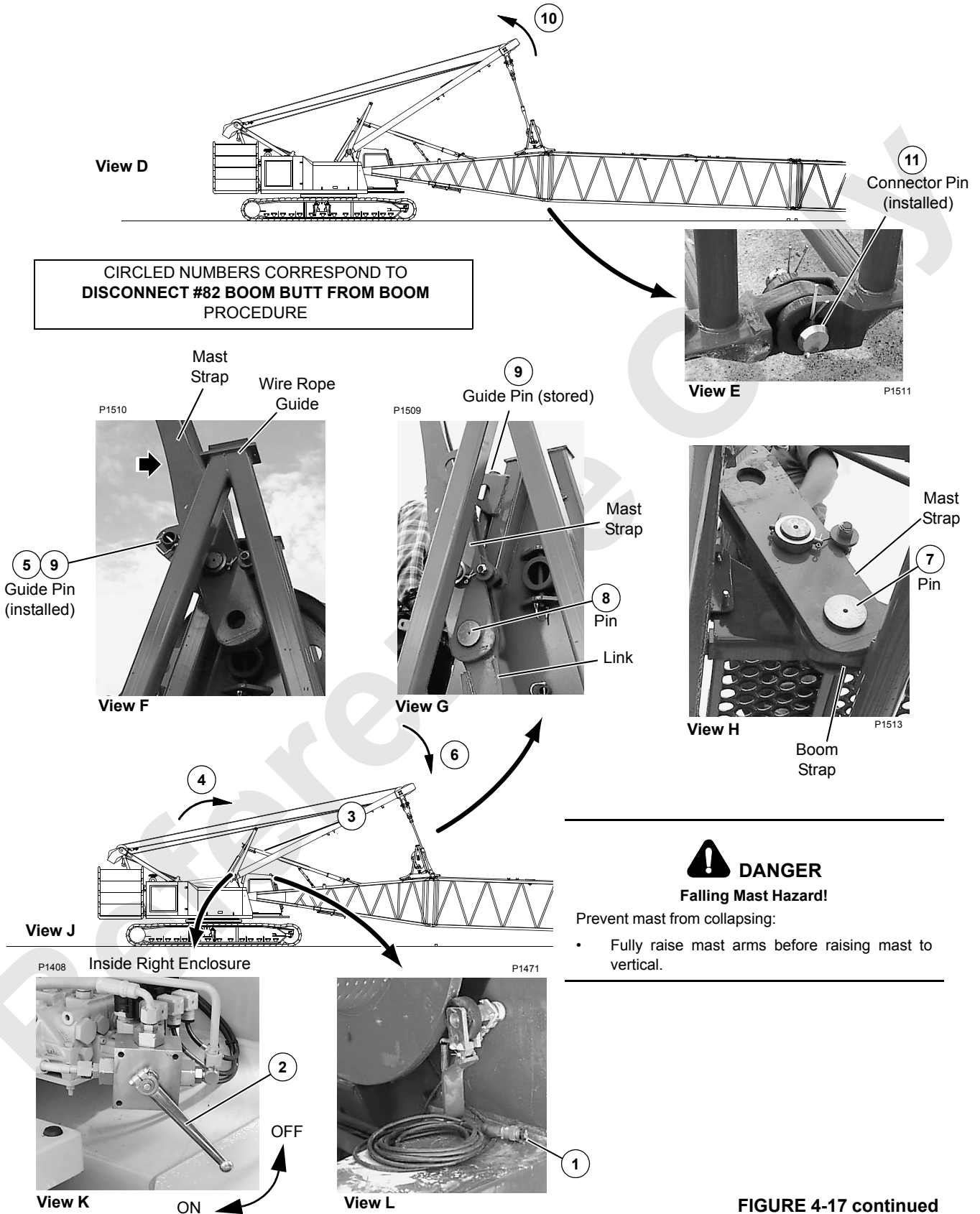


FIGURE 4-17

A1184



4

FIGURE 4-17 continued

Remove Boom Butt

See [Figure 4-18](#) for the following procedure.

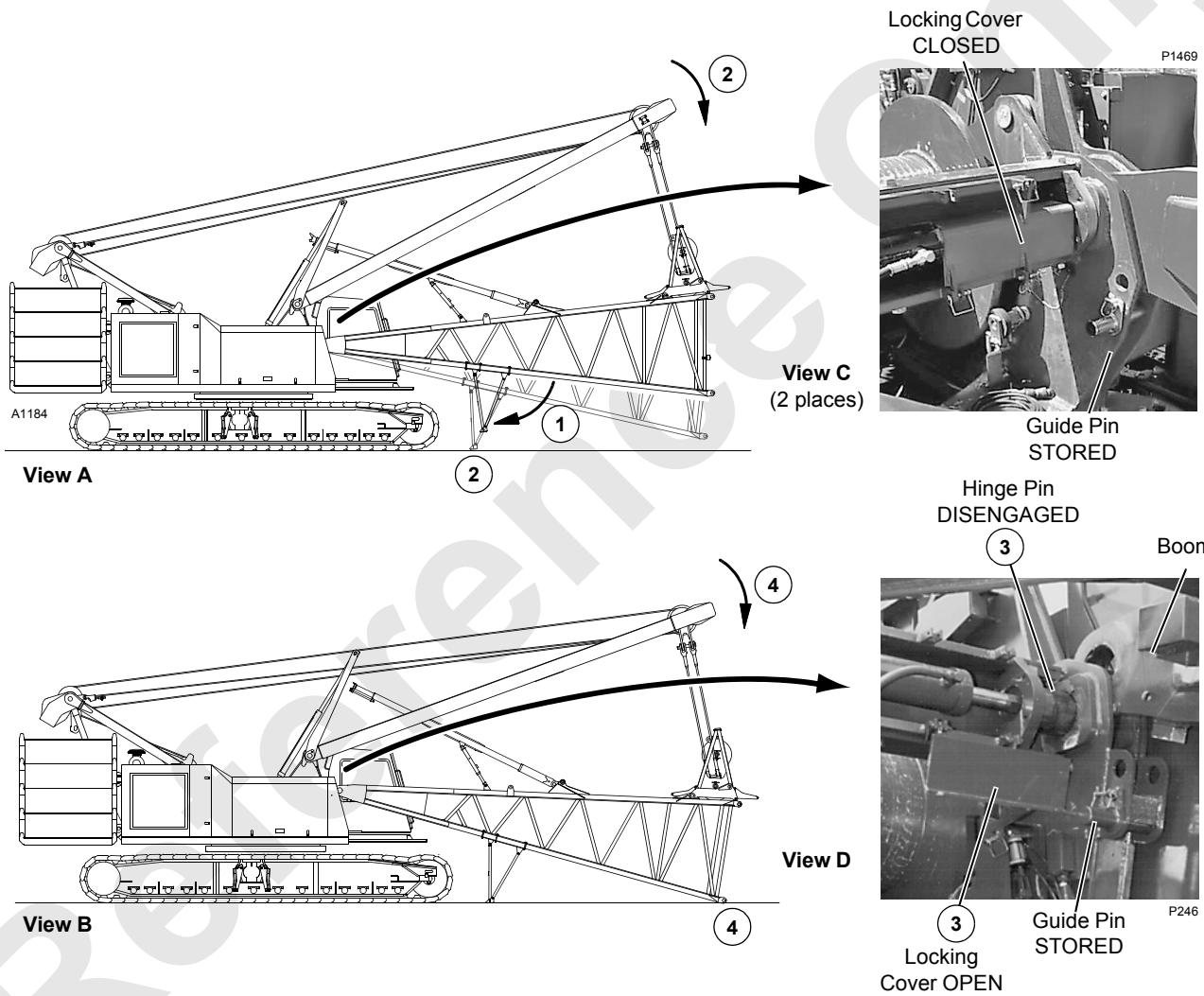
NOTE: Guide pins (View C) remain stored for the following procedure.

1. Lower boom butt until bottom connectors are approximately 18 in (0,5 m) off ground and move boom

butt support frame to assembly position (see Assembly Procedure G).

2. Slowly lower boom butt until support frame just contacts ground and stop (View A). Do not allow mast pendants or straps to slacken.
3. Unpin and rotate locking cover down (View D) and fully disengage boom hinge pins with control on remote control. Boom butt may rock forward slightly.
4. Slowly mast down to rock boom butt forward until bottom connectors are on ground (View B).

CIRCLED NUMBERS CORRESPOND TO REMOVE BOOM BUTT PROCEDURE



4

FIGURE 4-18

See [Figure 4-18](#) for the remaining steps.

5. For #22E or #22EL boom, proceed as follows (View G):
 - a. Lower mast until mast pendants are slack.
 - b. Unpin pendants from links in wire rope guide.
6. For #82 boom, proceed as follows:
 - a. Lower mast.
 - b. Unpin mast straps from links in wire rope guide (View G).
 - c. Push mast straps forward, and install guide pins (View H).
 - d. Raise mast until straps are clear of wire rope guide.
 - e. Remove and store guide pins (View J).
7. Lower boom stops (View E and F):
 - a. Unpin slings from storage position on mast and pin to lug on boom stops. Raise and lower mast as required to align connecting holes.

CAUTION

Boom Butt Damage!

Prevent damage to boom butt chords and lacings:

- For #82 boom, guide mast straps clear of chords and lacings as mast is lowered.
-
- b. Raise mast just enough to support boom stops.
 - c. Remove pins from outer tubes and store.
 - d. Lower mast until boom stops are fully retracted and slings are slack.
 - e. Unpin slings and store on mast.
8. Raise mast and travel crane away from boom butt.
 9. Engage boom hinge pins, rotate locking cover up and pin.

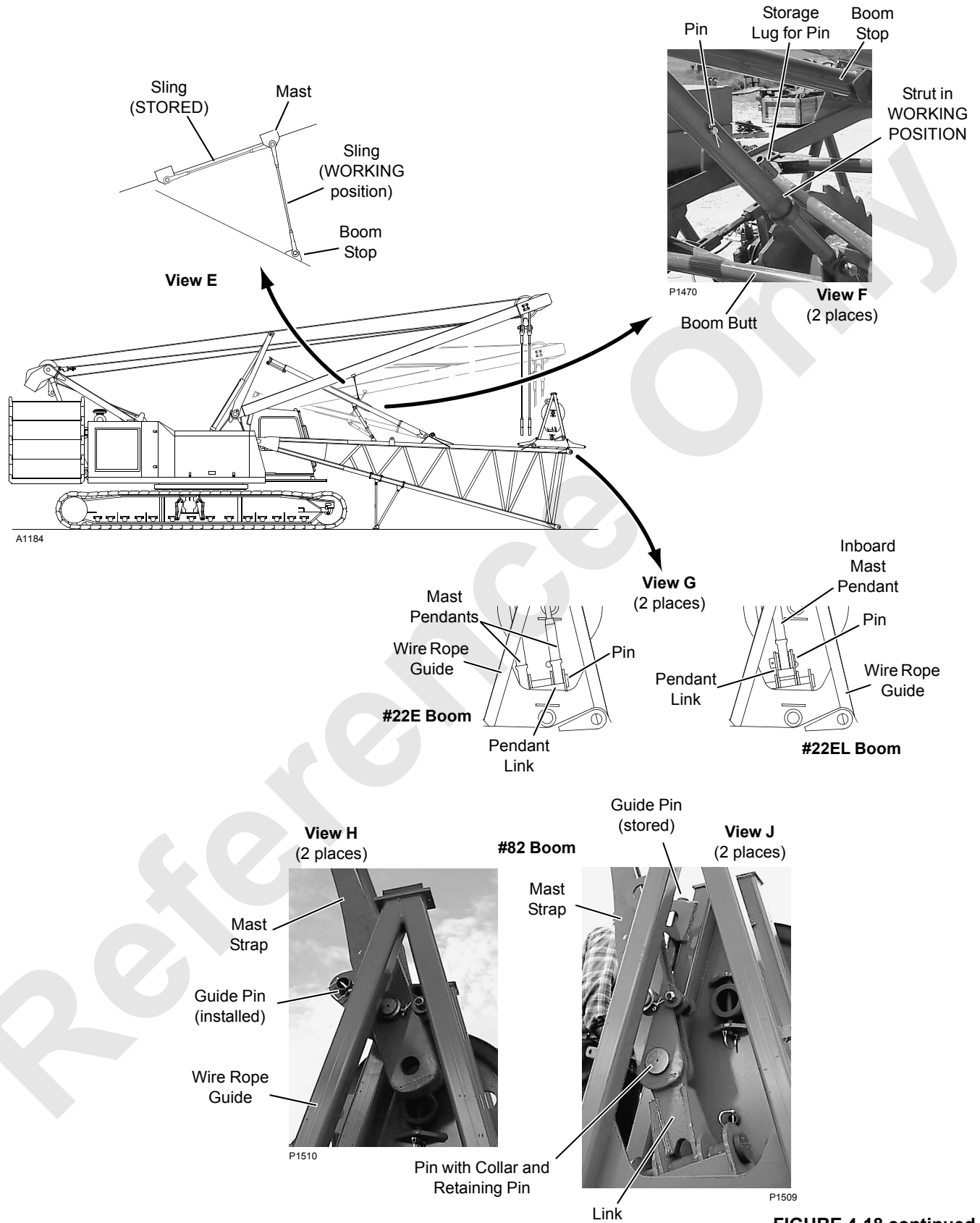


FIGURE 4-18 continued

Install Assembly Block

To install assembly block, see procedure on [page 4-14](#).

Install Boom Butt On Trailer

To install boom butt on trailer, reverse Remove Boom Butt from Trailer steps on [page 4-24](#).

Disassemble Boom

Disassemble the boom and jib as instructed in this section.

If the 999 will be used for this procedure, it must be in the configuration specified under Assist Crane Requirements on [page 4-56](#).



WARNING Falling Load Hazard!

Prevent crane from tipping, wire rope from breaking, or mast from collapsing while disassembling boom and handling counterweights:

- Do not exceed 29 ft (8,8 m) radius. Wire rope will hit lacing in mast.
- Do not lift more than 50,000 lb (22 680 kg). Tipping or structural damage to mast may occur.

Remove Counterweight

If the 999 will be used for this procedure, it must be in the configuration specified under Assist Crane Requirements earlier on [page 4-56](#).

See [Figure 4-19](#) for the following procedure.



WARNING Tipping Hazard!

To prevent tipping, Series 2 and Series 3 counterweight must be removed in sequence stated in this procedure and shown in View A.

1. If equipped with Series 2 or Series 3 counterweight, remove 1st carbody counterweight as follows, before removing upper counterweight. If not, go to step 3.
 - a. Position assembly block over 1st carbody counterweight.
 - b. Hook onto carbody counterweight with chain sling — lift at four lifting lugs as shown in View E.
 - c. Remove pins connecting counterweight to carbody (View B).

- d. Boom, swing, and hoist as required to disengage slots in counterweight with lugs on carbody (View B).
 - e. Lower counterweight and disconnect chain sling.
2. Swing 180° and position rotating bed in line with crawlers.
3. Position mast at 150°.
4. Disconnect and store exhaust pipe (see [page 4-7](#)).
5. Rotate handling links to working position (View H).
6. Lower gantry with control on remote control and pin links to lugs on gantry (View H).
7. Disengage counterweight pins with control on remote control. **Pins must be held out until counterweight is clear of crane.**
8. Slowly lower gantry and counterweight to ground (View D) with control on remote control.
9. Engage counterweight pins with control on remote control once counterweight is clear of crane.
10. Disconnect handling links from lugs on gantry and rotate to stored position (View C).
11. Travel crane away from counterweight.
12. Raise gantry fully and store remote control in enclosure.
13. For Series 2 or Series 3, repeat steps [1a](#) – [e](#) to remove 2nd carbody counterweight.



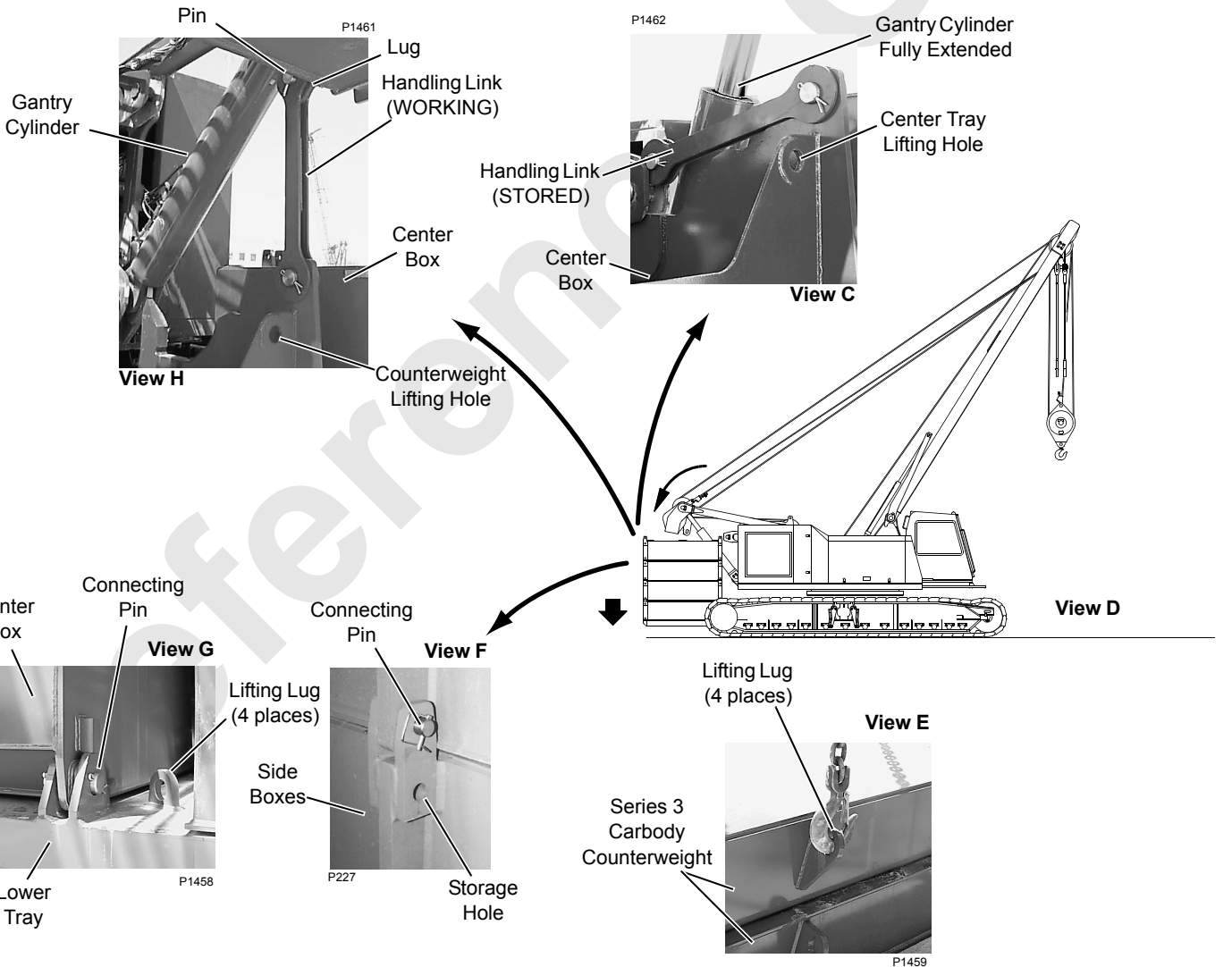
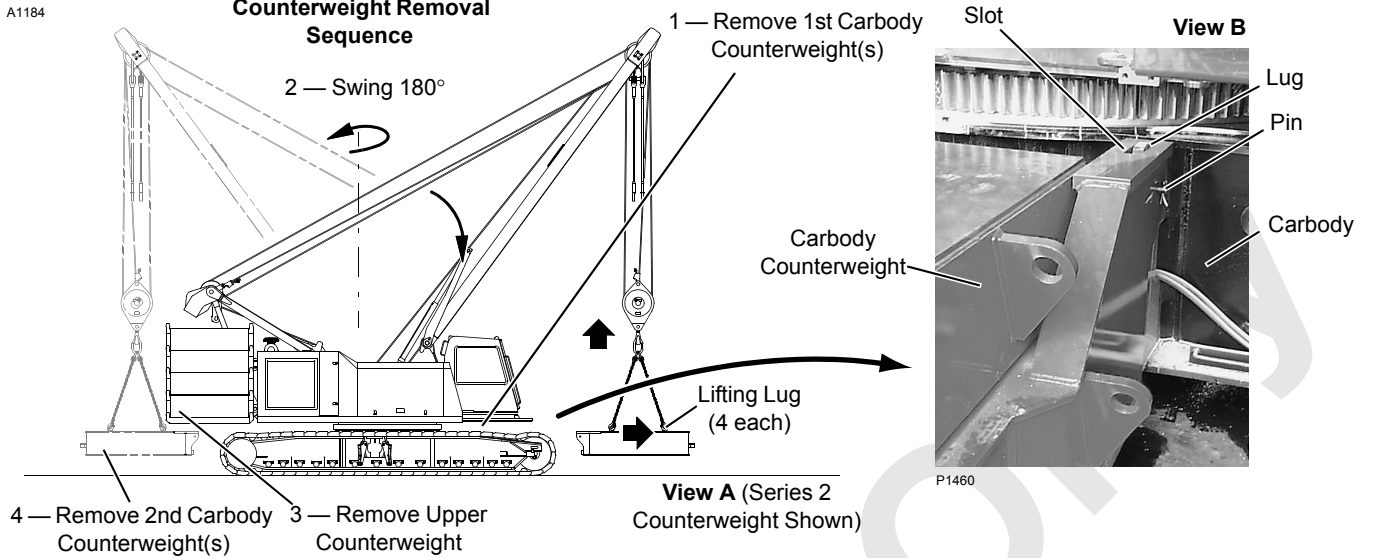
WARNING Falling Load Hazard!

Avoid dropping counterweights:

- Do not lift lower tray and center box as a unit. Lifting lugs may break.
 - Do not lift more than two side boxes at a time. Lifting lugs may break.
14. Disassemble upper counterweights (mast can be used for this purpose).
 - a. Unpin and lift side boxes off lower tray — lift at lugs.
 - b. Lift side boxes onto trailer.
 - c. Unpin and lift center box off lower tray — lift at two lifting holes.
 - d. Lift center box onto trailer.
 15. Lift lower tray onto trailer — lift at four lifting lugs (View G).

A1184

Counterweight Removal Sequence



4

FIGURE 4-19

Remove Crawlers

! DANGER
Tipping Hazard!

Prevent crane from tipping over:

- Make sure crane is level. Check 2-way level on front of carbody. Adjust jacks as required.
- Do not exceed 16 ft (4,9 m) radius while lifting either crawler.
- Do not swing 15° either side of center (see [Figure 4-20](#)).

Rotating Drive Shaft Hazard

Crawler drive shafts rotate at high speed. To prevent death or serious injury:

- Do not attempt to disconnect drive shafts until crane has been parked and engine stopped.

CAUTION
Parts Damage!

Avoid hitting carbody jacks with crawlers.

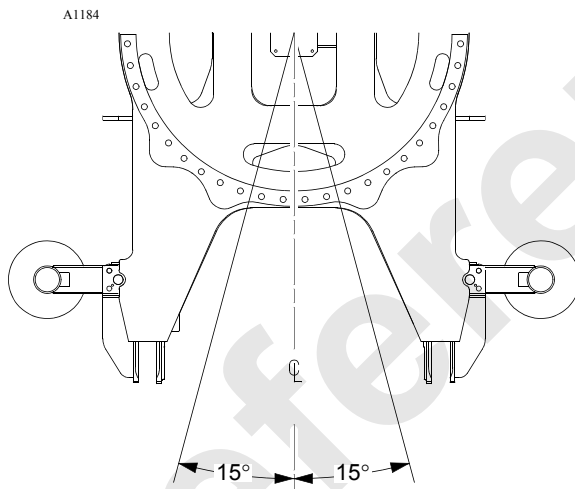


FIGURE 4-20

See [Figure 4-21](#) for the following procedure.

1. Fold side platforms to stored position (View H).
2. Perform the following steps at both drive shafts:
 - a. Unpin drive shaft guard (View G) and slide guard back.
 - b. Remove flange screws from drive shaft flange (View F). Store screws in flange on carbody.
 - c. Retract crawler drive shaft and place drive shaft on supporting bracket (View E).
 - d. If equipped, disconnect grease line from crawler at quick-disconnect coupling on carbody. Install dust caps.
3. Position each carbody jack as follows:
 - a. Remove connecting pin (View B).
 - b. Swing jack out (View C).
 - c. Install connecting pin (View C).
4. Remove jack pads from storage (View D) and connect to jacks with U-shaped pins.
5. Using controls on front of carbody, extend carbody jacks until crawler treads are just clear of ground.

! WARNING
Moving Part Hazard!

Avoid serious crushing injury:

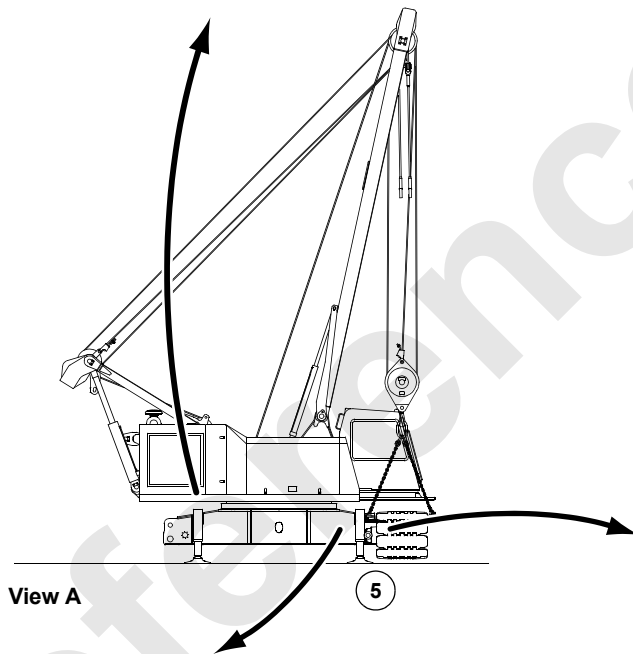
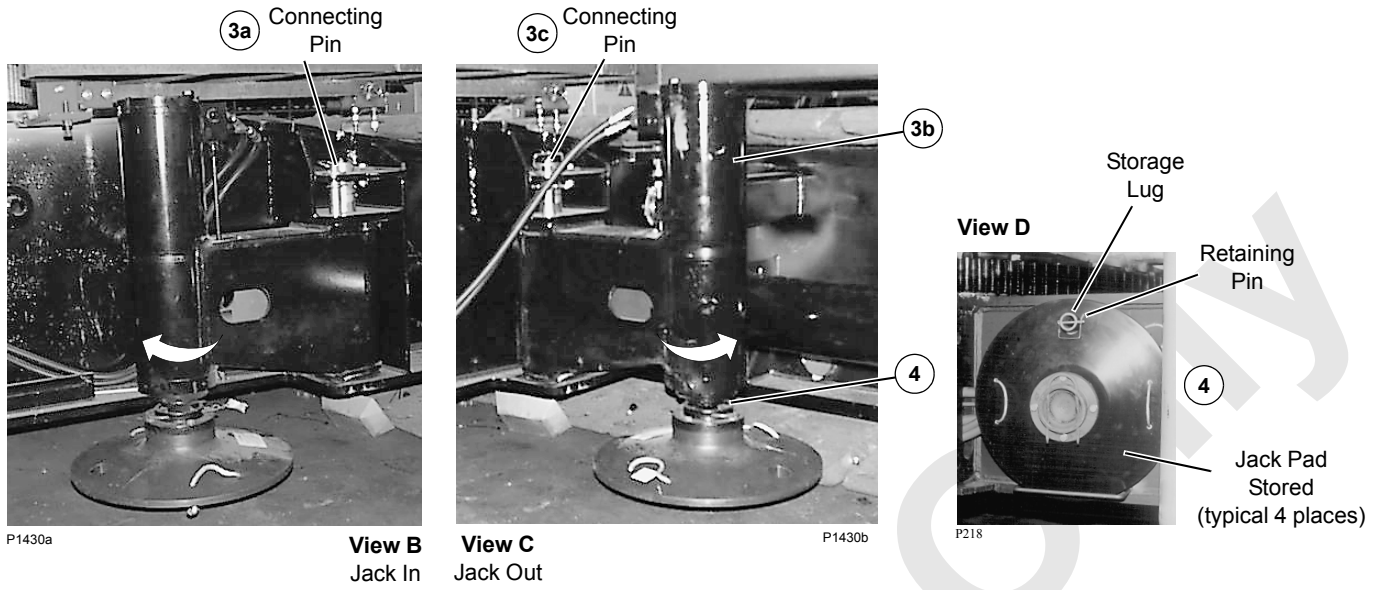
- Warn all personnel to stand clear of jacks.

Tipping Hazard!

Avoid tipping crane over:

- Keep crane level while jacking.

NOTE: A 2-way level is provided near controls on front of carbody ([Figure 4-4](#), View C).



CIRCLED NUMBERS CORRESPOND TO REMOVE CRAWLER PROCEDURE

4

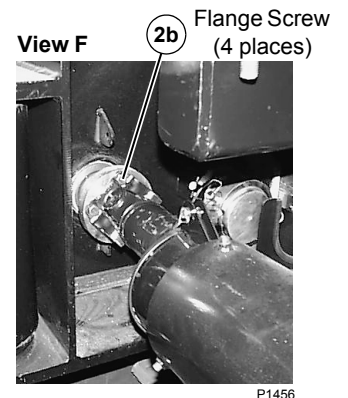
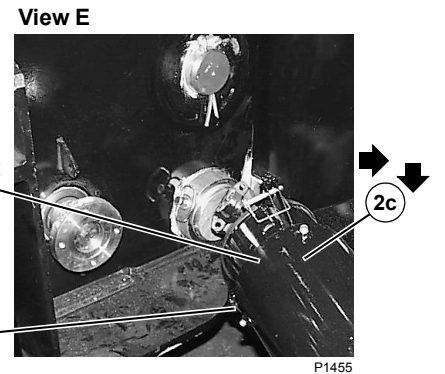
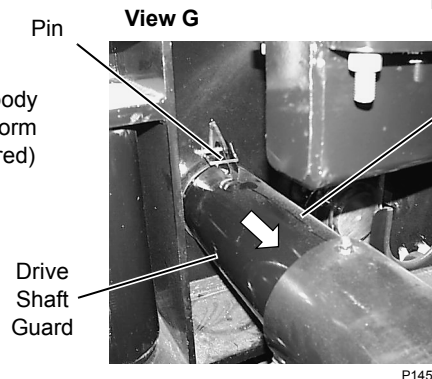
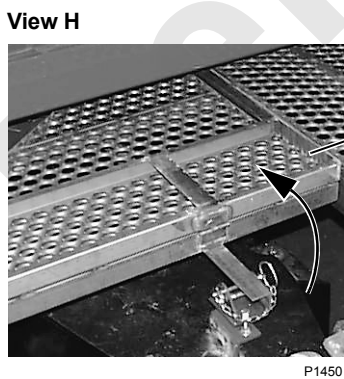


FIGURE 4-21

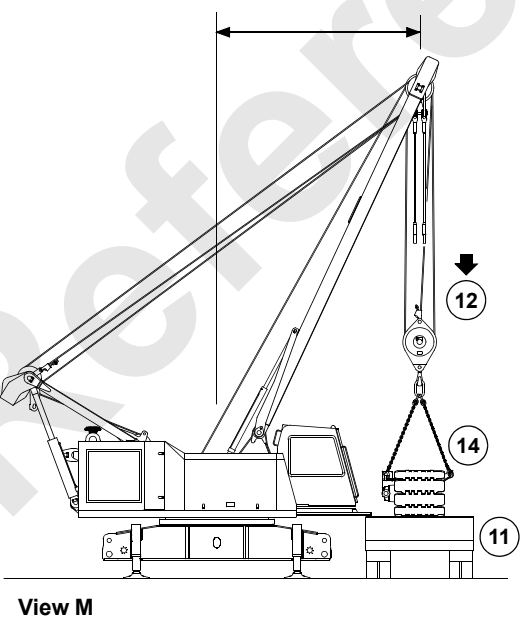
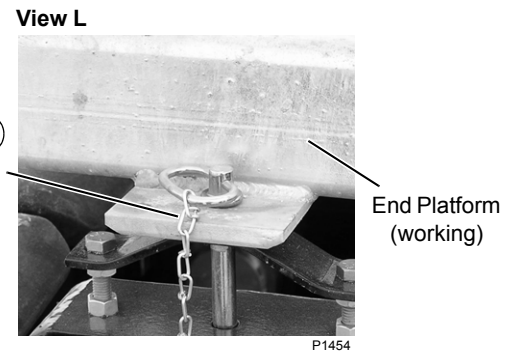
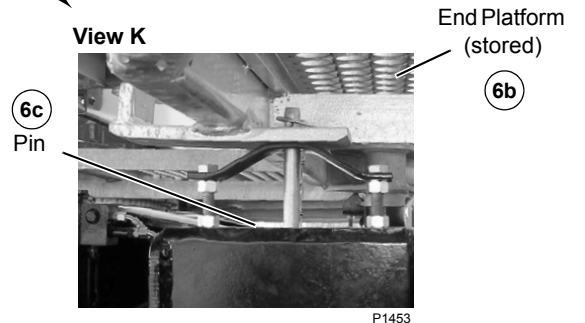
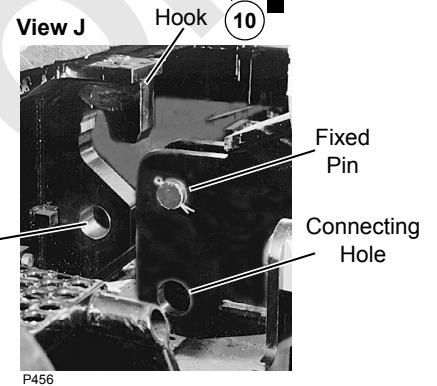
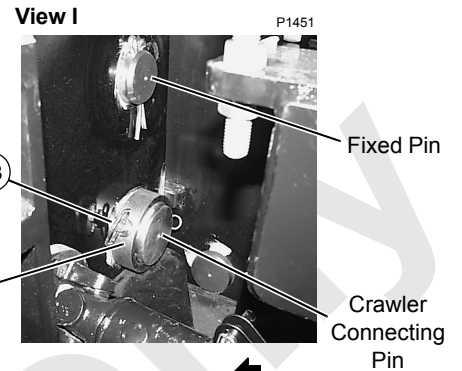
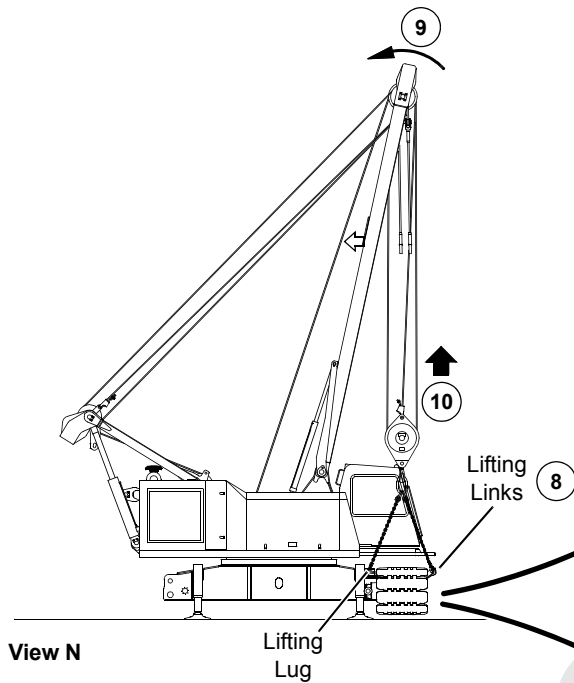
6. Store end platforms above crawlers (4 places):
 - a. Remove pins holding platforms in position between crawlers (View L).
 - b. Pivot platforms to stored position above crawlers.
 - c. Insert pins up-side-down to secure platforms in stored position (View K).
7. Remove keeper pins and collars from crawler connecting pins (View I). Use crawler controls on front of carbody to retract pins.
8. Attach three hooks from chain sling to lifting lug on inboard side of crawler and lifting links on outboard side of crawler (View N).
9. Position boom and rotating bed so assembly block is centered over crawler. Crawler can bind on carbody if crawler is not hoisted vertically.
10. Slowly hoist crawler to disengage hooks on crawler from fixed pins on carbody wings (View J).

**DANGER****Tipping Hazard!**

Do not allow assembly block to swing past inside edges of carbody jacks while removing first crawler. Crane will tip.

11. Position trailer under suspended crawler.
12. Lower crawler onto trailer (View M).
13. Engage crawler connecting pins and install collars and keeper pins (View I).
14. Unhook chain sling from crawler.
15. Swing over other side.
16. Repeat steps [7](#) through [14](#) for other crawler.

CIRCLED NUMBERS CORRESPOND TO REMOVE CRAWLER PROCEDURE



! DANGER
Tipping Hazard!
 Do not exceed 16 ft (4,9 m) radius while lifting either crawler. Crane will tip.

FIGURE 4-21 continued

Remove Assembly Block

To remove assembly block, reverse Install Assembly Block steps on [page 4-14](#).

Lower Mast To Transport Position

See [Figure 4-22](#) for the following procedure.

The following controls (located in operator's cab) are used to lower the mast and gantry to the transport position. See Section 3 for identification and operation of these controls.

1. CRANE MODE SELECTOR to select setup mode.
 - Mast and gantry controls will not operate until setup mode is selected and confirmed.
 - Mast operating limits remain off until setup mode is selected and confirmed
2. MAST ARMS CONTROL to raise mast arms independently of mast.
3. BOOM HOIST CONTROL to lower mast and gantry to transport position.
4. DIGITAL DISPLAY to monitor mast angles and operating limits.

See [Figure 4-22](#) for identification of mast operating limits.



DANGER

Falling Mast Hazard!

Prevent mast from falling over backwards or forward:

- Read and thoroughly understand mast lowering instructions.
- Select and confirm SETUP MODE before lowering mast and gantry to transport position. Mast operating limits remain off until this step is performed.
- Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

Lowering Procedure

1. Select and confirm SETUP mode.
2. Scroll to MAST ANGLE on digital display to view mast angles during lowering procedure.

CAUTION

Mast Damage!

Make sure mast angle indicator is properly installed and calibrated prior to lowering mast and gantry.

Mast will be damaged if this precaution is not observed

CAUTION

Mast Damage!

Prevent damage to mast arms and cylinders during cold weather:

- Do not attempt to lower mast until temperature of hydraulic oil is 60°F (16°C).
- Once hydraulic oil is at specified temperature, fully extend and retract mast cylinders twice to fill cylinders with warm oil.

Cylinders and arms will bend under weight of mast if this precaution is not taken.

3. Fully RAISE mast arms with mast arms control.



DANGER

Falling Mast Hazard!

Prevent mast from falling:

- Do not attempt to raise mast to vertical until assist arms are fully raised. Mast will fall over backwards if raised to vertical when arms are down.

4. Increase engine speed to desired RPM.
5. BOOM UP to raise mast against mast arms.
6. Continue to BOOM UP to lower mast past vertical to rear.

Do not use mast arms control to lower mast. The mast arms will lower automatically as mast is lowered with boom hoist control. The boom hoist wire rope will remain tight.

CAUTION

Mast Damage!

Stop operating immediately (release boom hoist handle to off) if MAST SYSTEM fault comes on during mast lowering procedure.

Determine cause of fault and take corrective action before resuming operation.

Mast will be damaged if this precaution is not observed.

7. Continue to BOOM UP to lower mast. The lowering speed will decrease automatically as the mast approaches the gantry.

Once the mast comes to rest on the gantry, the gantry and mast will lower simultaneously.

8. Release boom hoist control to off once gantry cylinders are fully retracted.

Install Crane On Trailer

To install crane on trailer, reverse Remove Crane from Trailer steps.

A1184

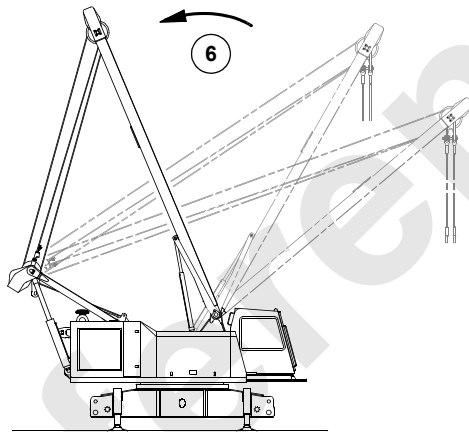
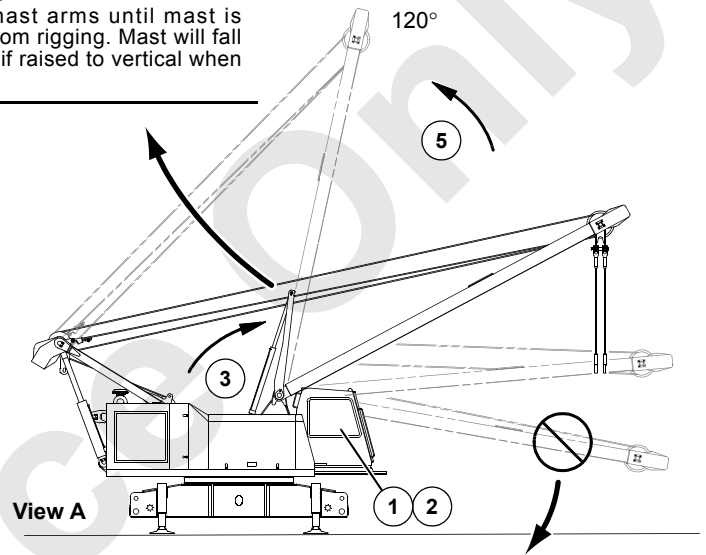
Mast Operating Limits	
Operating limits listed will appear on digital display when any limit is reached. See Display Readings in Section 3 for instructions.	
Limit/Display Reading ¹	
MAST SYSTEM	
GANTRY DOWN	
MAST TOO FAR FORWARD (occurs if mast is lowered to 175°)	
¹ Mast angles are measured from transport position which is 0°.	



DANGER

Falling Mast Hazard!

Do not lower mast arms until mast is connected to boom rigging. Mast will fall over backwards if raised to vertical when arms are down.

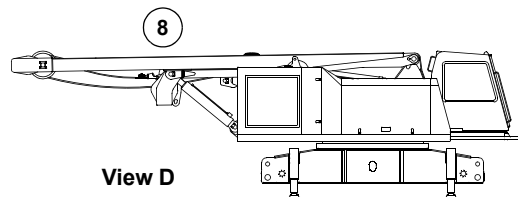
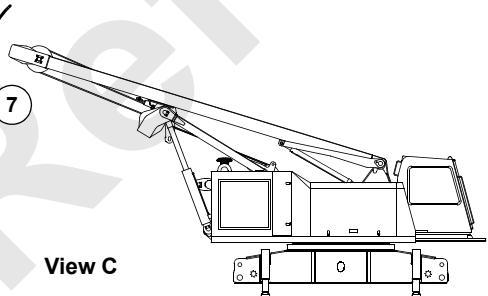


DANGER

Falling Mast Hazard!

Do not use limit bypass to lower mast below 175°. Mast will fall suddenly.

CIRCLED NUMBERS CORRESPOND TO LOWER MAST TO TRANSPORT POSITION PROCEDURE



4

FIGURE 4-22

AUXILIARY LOAD DRUM INSTALLATION

See [Figure 4-23](#) for the following procedure.

Crane Modifications

The auxiliary load drum can be installed only on cranes that have been modified and are equipped as indicated below. Contact the Manitowoc Crane Care Lattice Team to determine whether your crane meets these requirements.

Modifications

- Hydraulic, air, and electric components on crane
- Control handle and programmable controller in operator's cab
- Boom butt (drum mounting lugs and removable lacings).

Equipment

- 10 ft (3,05 m) special insert mounted next to boom butt
- Upper wire rope guide installed on boom top

Drum Installation

It is assumed that the hydraulic hoses, air lines, and electric cable are connected to the auxiliary load drum. If these parts are not installed, see the applicable assembly drawings in your crane Parts Manual for details.

1. Remove each lacing pinned to top chords of butt (Views D and G), as follows:
 - a. Support lacing so it cannot fall.
 - b. Remove keeper plates.
 - c. Remove nuts from tapered pins.
 - d. Carefully tap tapered pins up and out of tapered sleeves. **Be extremely careful to avoid damaging threads on pins.**
 - e. Remove tapered sleeves and remove lacing.

CAUTION!

Parts Damage!

To avoid damage to hydraulic motor and drum encoder during drum installation, remove both from drum assembly before lifting drum into place.

2. Support hydraulic motor with assist crane. The motor weighs approximately 150 lb (68 kg).
3. Remove hydraulic motor from studs on auxiliary load drum (View C). **Store motor in a clean, protected area free of dirt.**
4. Remove drum encoder from support on auxiliary load drum (View E). **Store encoder in a clean, protected area free of dirt.**

5. Hook assist crane to lifting lugs on auxiliary load drum (View C). The auxiliary drum weighs approximately 2,750 lb (1 247 kg).
6. Using assist crane, lift auxiliary load drum above boom butt, and lower it through opening. Motor side of drum must be on left side of butt.

CAUTION!

Parts Damage!

Use care not to damage chords or adjacent lacings while lowering drum into insert.

7. Pin auxiliary load drum to lugs on each side of boom butt (View E). Insert cotter pins.
8. Shift drum assembly as far to left as possible with assist crane.
9. Remove side play by tightening setscrew to jack drum frame to side (View E). Tighten jam nut to lock setscrew in place.
10. Pin link to lugs on right side of boom butt and auxiliary load drum (View F). Install cotter pins.
11. Pin turnbuckle rod ends to lugs on left side of boom butt and auxiliary load drum (View B).
Adjust turnbuckle as required so holes in rod ends line up with holes in lugs. Securely tighten jam nuts.
Install cotter pins.
12. Install hydraulic motor, as follows:
 - a. Be sure that O-ring is in place on hydraulic motor.
 - b. Lift motor into position with assist crane.
 - c. Slide hydraulic motor onto studs (View C) so motor is positioned as shown with Port A facing UP.
 - d. Install lock washers and nuts. Torque to 180 ft-lb (244 Nm).
13. Install each removable lacing, as follows (Views D and G):
 - a. Slide ends of lacing into lugs on boom butt and align holes.
 - b. Install tapered sleeves. Hole in sleeves must taper down.
 - c. Install tapered pins.
 - d. Carefully tap tapered pins down into sleeves and install nuts.
 - e. Alternate tapping pins down and tightening nuts until lacing is securely tightened to boom chord.
 - f. Install keeper plate.
14. Attach drum encoder to bracket on drum frame (View E).

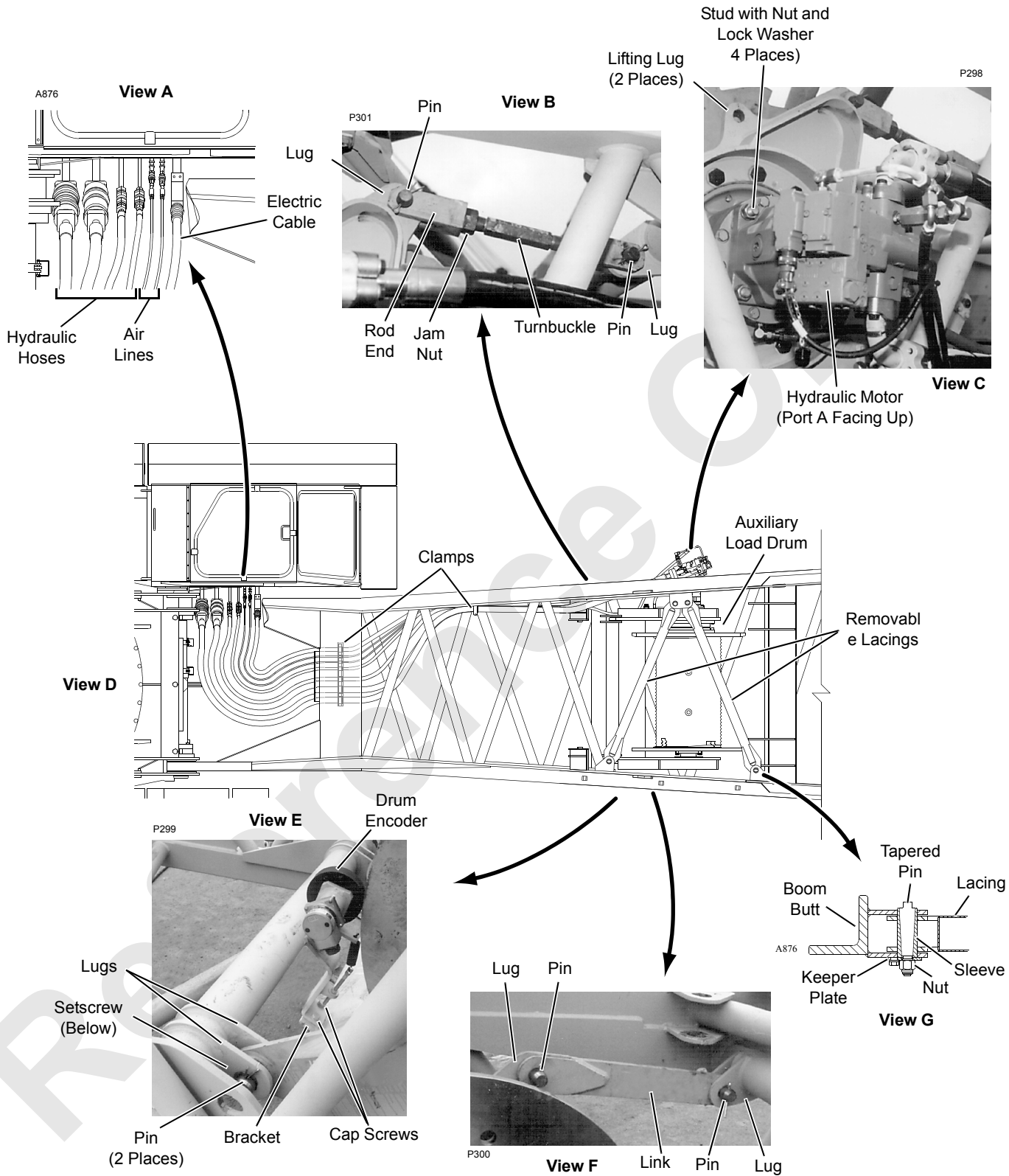


FIGURE 4-23

Hydraulic, Air, and Electric Connections

1. Install clamp assemblies ([Figure 4-23](#), View D) on boom butt (two places) for hydraulic hoses, air lines, and electric cable.
2. Fasten hydraulic hoses, air lines, and electric cable to clamps.
3. Connect hydraulic hoses and air lines to couplers at bottom right side of operator's cab ([Figure 4-23](#), View A). Size and configuration of couplers make it impossible to hook up hoses or lines incorrectly.
4. Connect electric cable to plug at bottom right side of operator's cab ([Figure 4-23](#), View A).

Wire Rope Installation

Install wire rope on auxiliary drum. See Wire Rope Installation instructions on [page 4-90](#).

Butt Removal

If butt is removed with auxiliary load drum installed, hydraulic hoses, air lines, and electric cable must be disconnected from couplers at bottom right side of operator's cab ([Figure 4-23](#), View A).

BOOM LADDER ASSEMBLY

See [Figure 4-24](#) for the following procedure.



WARNING

To Prevent Serious Injury or Death:

- Limit load on ladder to 300 lb (136 kg).
- Avoid improper use. This ladder is intended for use only on Manitowoc #22 and #82 boom inserts. Any other use is prohibited.
- Use ladder for boom assembly/disassembly and maintenance only when boom is horizontal.
- Make sure ladder is properly secured to insert.
- When climbing ladder, hands shall be free of any objects. Objects which cannot be carried in pockets or tool belts shall be lifted into place onto ladder platform prior to climbing ladder.
- Stand only on platform. Do not stand on cross braces.

General

Optional ladders are installed inside the boom butt, one on either side.

The ladders are designed for use in assembly/disassembly and maintenance of #22, #22A, #22E, and #82 boom sections and components. Each ladder weighs approximately 18 lb (8 kg).

Removal From Boom Butt

It is recommended that two people remove ladder from boom butt: one person inside butt to unlatch and lift ladder and another person outside of butt to help guide ladder out of butt. Use the following procedure:

1. Lower boom onto blocking at ground level. **Boom sections must be horizontal.**
2. Unhook rubber latches (View B).
3. Lift ladder up and out of hooks (View A).
4. Guide ladder through lacings to outside of boom butt.

Installation On Boom Inserts

Lift ladder to desired outside location on insert so that upper pads (View C) are securely hooked over backside of upper chord and lower pads (View D) rest firmly against lower chord.

Ladder must hang vertically against boom insert when in use.

Storage In Boom Butt

It is recommended that two people store ladder in boom butt: one person outside of butt to help guide ladder into butt, and another person inside butt to lift ladder and latch it in position. Use the following procedure:



WARNING

Falling Load Hazard!

Ladders must be properly stored to prevent them from falling out of butt when boom is raised.

1. Hang ladder rails over hooks inside butt (View A).
2. Pull rubber latches tightly over lower rail and latch in keepers (View B).
3. Make sure ladder cannot move once latched in place.

A913

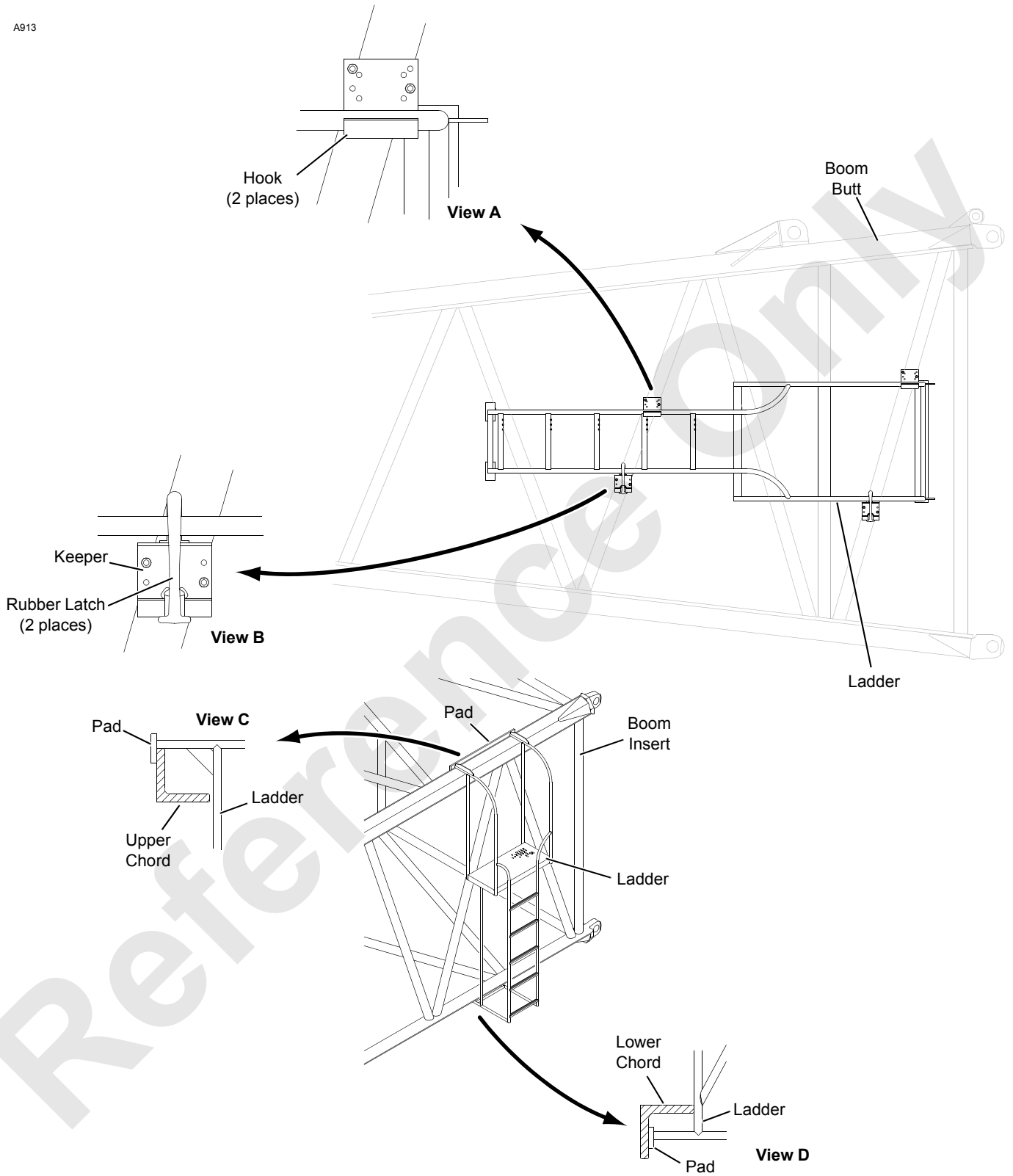


FIGURE 4-24

BOOM AND JIB RIGGING

In the following instructions, the #82 Heavy Lift Boom will be referred to as the #82HL Boom. The #82 Long Reach Boom will be referred to as the #82LR Boom.

Assist Crane Requirements

An assist crane is not required to assemble and disassemble boom and jib components. The 999 can be used to assemble and disassemble its own boom and jib. See Crane Weights in Section 1 for weights of boom and jib components.

The 999 must be in self-erect configuration shown in [Figure 4-25](#) to assemble its own boom and jib.

- Counterweight installed
- Gantry fully raised
- Mast arms fully raised
- Boom butt and assembly block installed

- Crane setup mode selected and confirmed
- Mast operated between fully extended mast arms and 150° (29 ft [8,8 m] radius). Mast angles are measured from transport position which is 0°.
- Capacity limited to 50,000 lb (22 680 kg)



WARNING

Falling Load Hazard!

Prevent crane from tipping, wire rope from breaking, or mast from collapsing:

- Do not exceed 29 ft (8,8 m) radius. Wire rope will hit lacing in mast.
- Do not lift more than 50,000 lb (22 680 kg). Tipping or structural damage may occur.

A1184

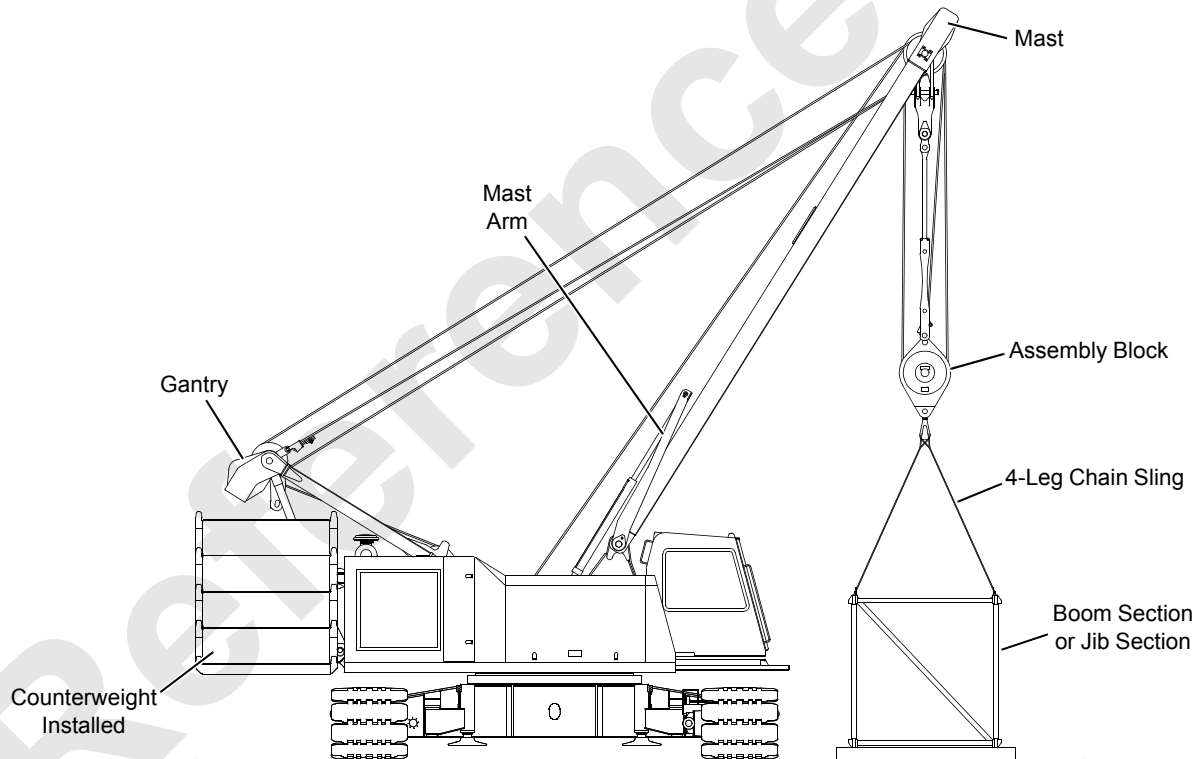


FIGURE 4-25

Blocked Crawlers

To prevent crane from tipping, some boom and jib lengths must be raised and lowered over blocked crawlers. See capacity charts for blocked crawler requirements and to Crawler Blocking Diagram in Capacity Chart Manual for instructions.

! DANGER
Tipping Hazard!

Do not attempt to raise or lower boom and jib from or to ground until crawlers are blocked, if required. Otherwise, crane will tip.

Handling Components

CAUTION
Lacing Damage!

Ensure straps for boom inserts and top remain pinned and secured in the shipping position during handling and transportation unloading.

CAUTION
Personal Injury or Property Damage!

Ensure the boom straps remain properly secured in the shipping position to the boom insert or boom top during transportation loading or unloading and assembly or disassembly of the boom. Straps could shift or fall resulting in personal injury or property damage if not properly secured.

Handle boom and jib sections with care to avoid damaging lacings and chords. All boom sections have lifting lugs (in top chords) designed to provide a balanced load and to prevent damage during lifting.

! WARNING
Falling Load Hazard!

Lifting lugs on each insert are designed only for lifting that insert. Do not attempt to lift two or more inserts with lifting lugs on one insert. Lifting lugs may break allowing inserts to fall.

When lifting lugs are not used (as in the case of jibs):

- Lift against chords only, never against lacings.
- Use nylon lifting slings. If wire rope or chain slings are used, install protective covering (such as sections of rubber tire) between slings and chords.

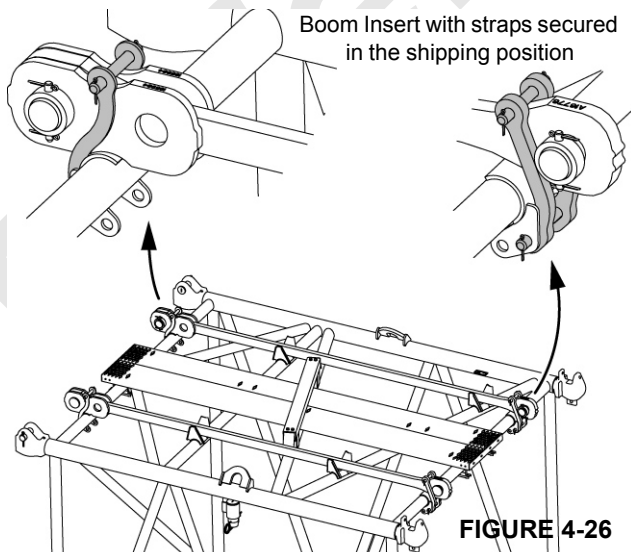
Boom handling with mast straps pinned to wire rope guide on boom butt is limited. See Boom Rigging Assembly Drawing for limitations.

! WARNING
Falling Boom Hazard!

Do not attempt to handle more boom with mast than specified on Boom Rigging Assembly Drawing. Structural failure of components can occur, possibly allowing boom to fall.

Rigging Assembly Drawings

Boom and jib components (top, inserts, butt, straps) must be assembled in proper sequence according to applicable Boom and Jib Rigging Drawings at the end of this section.



Identifying Boom and Jib Components

Boom and jib sections are marked for proper identification as shown in Views A and B, [Figure 4-27](#).

Boom and jib pendants are marked for proper identification as shown in View C, [Figure 4-27](#).

Boom straps and links are marked for proper identification as shown in View D, [Figure 4-27](#).

NOTE: The markings shown in [Figure 4-27](#) can vary depending on when your crane was produced and the original equipment manufacturer.

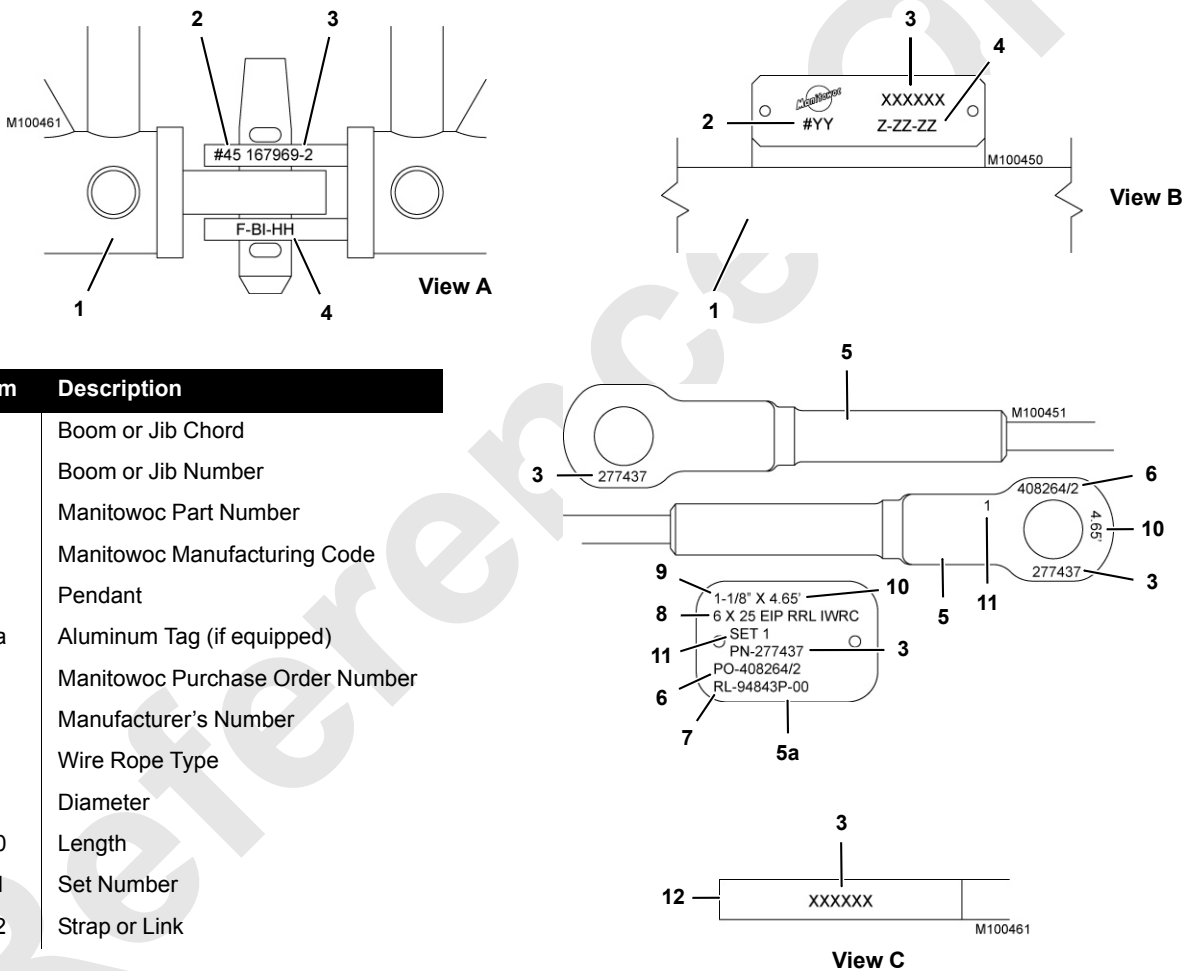


FIGURE 4-27

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Removable Diagonal Lacings (optional)

See [Figure 4-33](#) for the following procedure.

Optional inserts with removable diagonal lacings are available for #82 booms.

This design feature allows lacings to be removed so that #123 or #134 fixed jib sections and #135 luffing jib sections can be stored inside the inserts, reducing shipping space and the number of shipping vehicles required.

Inserts with removable diagonal lacings are designated #22E as opposed to #22 inserts which do not have removable diagonal lacings.

Rollers are bolted to pads on bottom chords of inserts to make it easier to slide jib sections into and out of the boom inserts. See [Table 4-3](#) for lacing and roller requirements.

Table 4-2 Lacing and Roller Requirements

#22E Inserts	Diagonal Lacings Required	Rollers Provided	Rollers Provided for Shipping	Rollers Required for Shipping
10 ft (3,0 m)	2	0	2	2
20 ft (6,1 m)	2	1	1	2*
40 ft (12,2 m)	4	2	1	3*

* Remove required number of rollers from operating position and fasten in shipping position.

To store jib sections inside #22E inserts, proceed as follows:

1. Remove diagonal lacings from inserts (View A).
2. Remove rollers from operating position on top chords of inserts.
3. Fasten required number of rollers to bottom chords of inserts.
4. To prevent damage to rollers, do not exceed 1,500 lb. (680 kg) load on each roller.
5. Install jib sections inside inserts. **Take extreme care not to damage lacings or chords.**

6. Adjust position of jib sections so that diagonal lacings can be reinstalled.
7. Reinstall proper number of diagonal lacings with bolts and nuts provided (View A).
8. Securely attach jib sections to inserts so jib sections cannot shift during transport.

Fasten tie-downs to rollers or chords of inserts only, not to lacings. Take care not to bend rollers when tightening tie-downs. Use protective covering such as tire sections between tie-downs and chords or rollers.

To remove jib sections from inside the #22E inserts, proceed as follows:

1. Remove diagonal lacings from inserts (View A).
2. Carefully remove jib sections from inside inserts. **Take extreme care not to damage lacings or chords.**
3. Remove rollers from bottom chords inside inserts.
4. Fasten rollers in operating position on top chords of inserts.



WARNING

Tipping Crane Hazard!

Remove rollers from bottom cords inside inserts before attempting to raise boom. Added weight of rollers inside inserts may cause crane to tip when boom is raised.

5. Thoroughly clean all dirt from between lacings and mating mounting surfaces on inserts.
6. Reinstall proper number of diagonal lacings in inserts with bolts and nuts provided (View A).
7. Torque nuts dry to 300 ft-lb (407 N•m).



WARNING

Falling Boom Hazard!

Re-install diagonal lacings before attempting to raise boom. Boom may collapse if lacings are not re-installed.

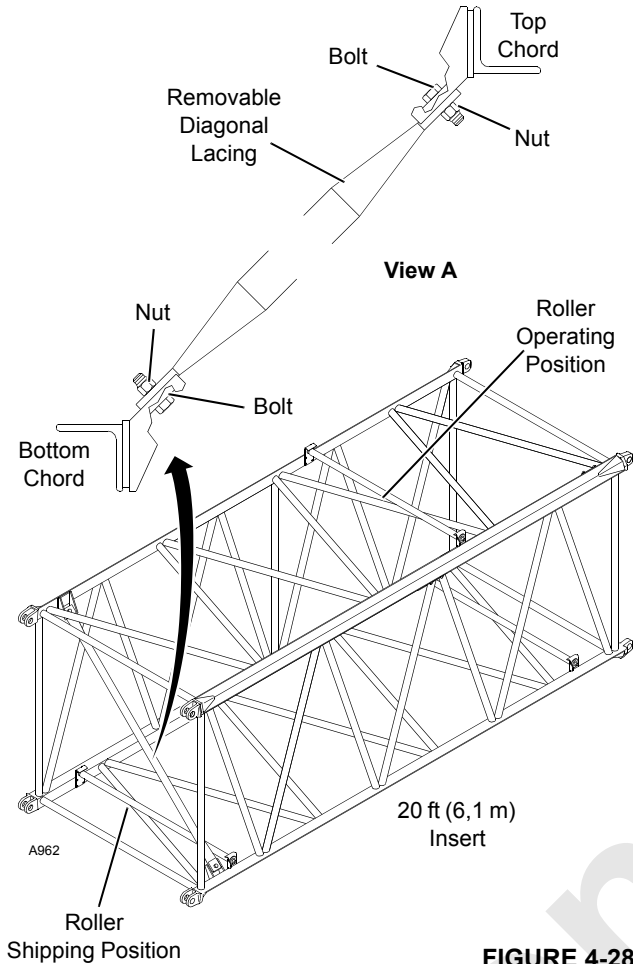


FIGURE 4-28

Boom Installation – #82HL

General

1. Before you start assembling boom, determine if a fixed jib will be installed. If so, install insert with backstay lugs (Figure 4-29, View D) next to boom top.
2. A minimum boom length of 90 ft (27,4 m) is required for fixed jib attachment (see Liftcrane Jib Capacity Chart for boom and jib length limitations).
3. Read all notes on Boom Rigging Drawing at the end of this section. See Figure 4-32 for assistance.



DANGER

Collapsing Boom Hazard!

To prevent death or serious injury, do not stand on, inside, or under boom sections during assembly. Always stand outside boom sections when installing connecting pins.

Assemble Boom Sections

See Figure 4-29 for the following procedure.

The boom sections have FACT™ connectors:

- The top connectors are joined by fixed vertical pins that hook into holes in the adjacent section (View A).
 - The bottom connectors are joined by removable connector pins (View G).
1. Assemble boom inserts in proper sequence (Figure 4-32), as follows, starting at butt end of boom:
 - a. Place first insert on blocking at least 6 in (152 mm) high.
 - b. Lift next insert into position and engage top connector holes with fixed vertical pins (View A).
 - c. Lower insert until bottom connector holes are aligned and install removable connector pins (View G). Removable connector pins are stored in pockets on adjacent insert (View F).
 - d. Block under bottom chords at top end of insert.
 2. Repeat steps 1b – 1d until all inserts and boom top are installed.

Connect Boom Straps

See Figure 4-29 for the following procedure.

The boom straps are shipped from the factory in the stored position on the inserts. Connect the straps, as follows:

1. Remove storage pins from top holes in strap brackets (View B).
2. Store storage pins in bottom holes in strap brackets (View C).
3. Rotate strap links forward and pin to adjacent straps (View C).

Install Upper Boom Point

See Figure 4-29 for the following procedure.

If required, install upper boom point as follows:

1. Lift upper boom point into position at end of boom top.
2. Align connecting holes and install pins (A, View E).
3. Install connecting pins (B, View E) after boom and lower boom point are raised clear of ground.

NOTE: Upper boom point must be removed prior to jib installation.

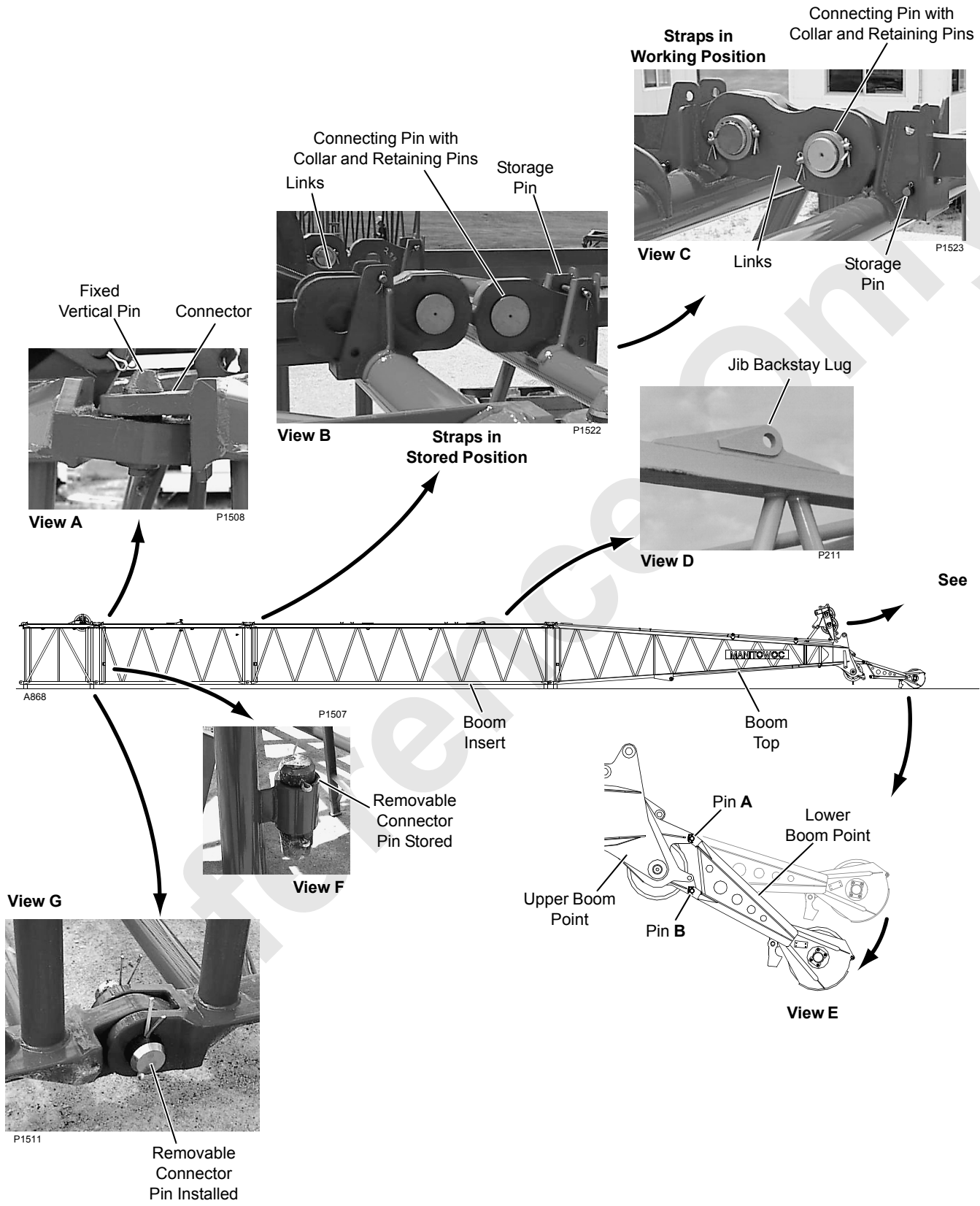


FIGURE 4-29

Raise Boom Top Wire Rope Guide

See [Figure 4-30](#) for the following procedure.

1. If equipped with three boom top sheaves, proceed as follows:
 - a. Support upper wire rope guide with a sling from assist crane and remove pins (1, View A).
 - b. Raise upper wire rope guide to operating position and install pins (1, View B).
2. Support lower wire rope guide with slings from assist crane and remove pins (2, View B).
3. Raise lower wire rope guide to operating position (View C) and store pins (2) in wire rope guide frame.
4. Remove pins (3) securing struts (4) in stored position and pin struts to lugs on boom top (View C).

Remove Lower Boom Point Sheaves

If a luffing jib will be installed, it may be necessary to remove sheaves from the lower boom point. See Raising Procedure in Luffing Jib Capacity Chart Manual to determine boom and

jib raising limitations. See Lower Boom Point on [page 4-80](#) for sheave removal instructions.

Install Jib

If required, install jib. See Jib Installation instructions on [page 4-83](#).

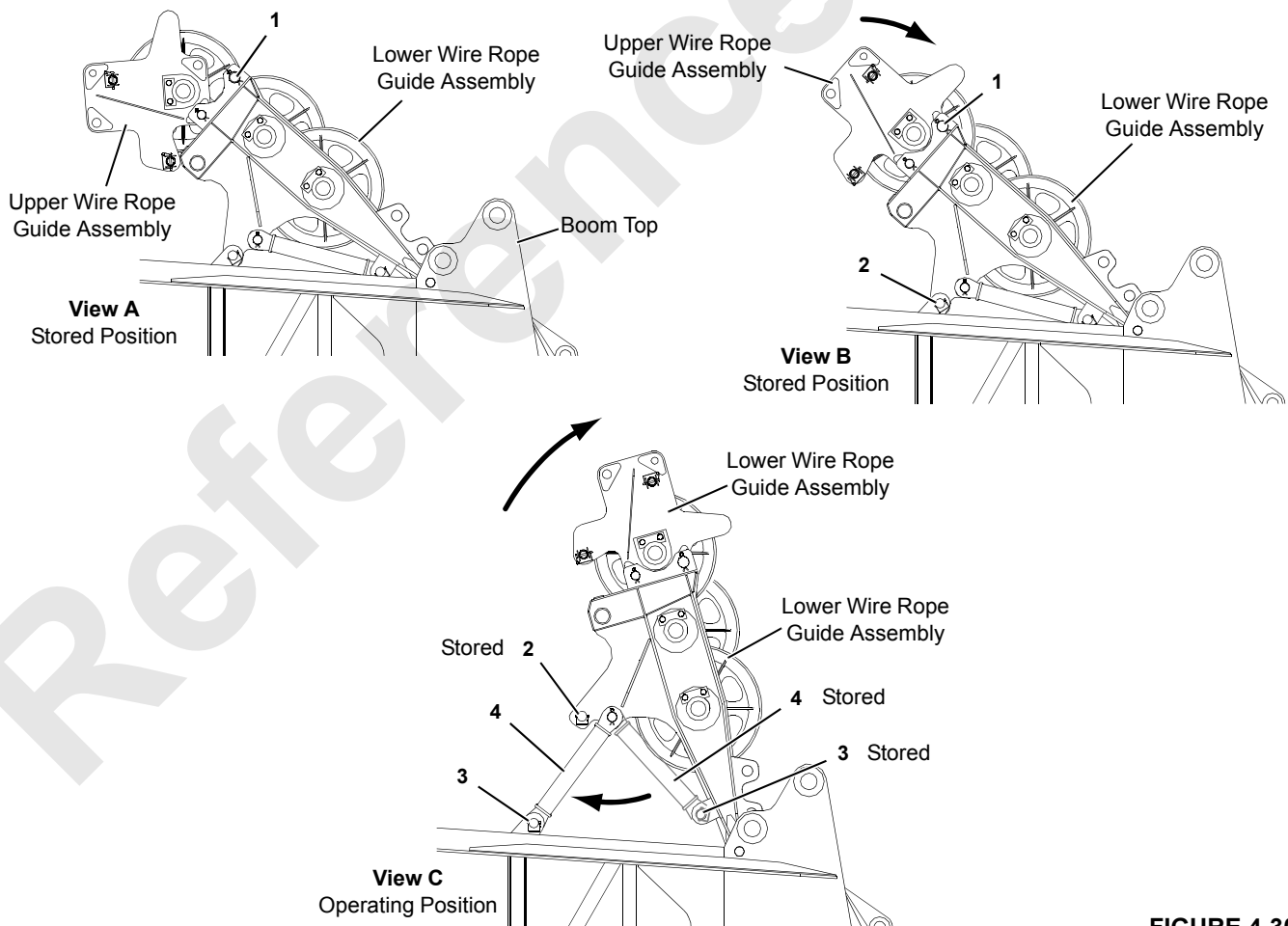
Connect Boom Butt to Boom

Remove assembly block, install boom butt, and connect boom butt to boom. See Crane Assembly instructions on [page 4-9](#).

Connect mast straps to boom straps See Crane Assembly instructions.

Make sure you perform the following steps. See Crane Assembly instructions on [page 4-9](#).

1. Lower mast arms.
2. Turn on desired crane mode (turn off setup mode) and turn mast bypass handle to off position ([Figure 4-17](#), View D).
3. Adjust mast straps to proper length.



A868

FIGURE 4-30

Install Load Line

See [Load Line Reeving](#) instructions for proper routing and reeving of load lines.

Install Block-Up Limit Control and Connect Boom Wiring

Install block-up limit components as shown in [Figure 4-31](#) and in Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section.

See Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at rear of this section and connect:

- Electric cable from crane to cable reel on boom butt
- Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junctions boxes
- Install wind speed indicator assembly if removed for shipping. Use star washers to attach mounting bracket to jib top to provide a good ground (see Wind Speed Assembly drawing at the end of this section).

Connect electrical cable at base of wind speed mounting bracket.

A873

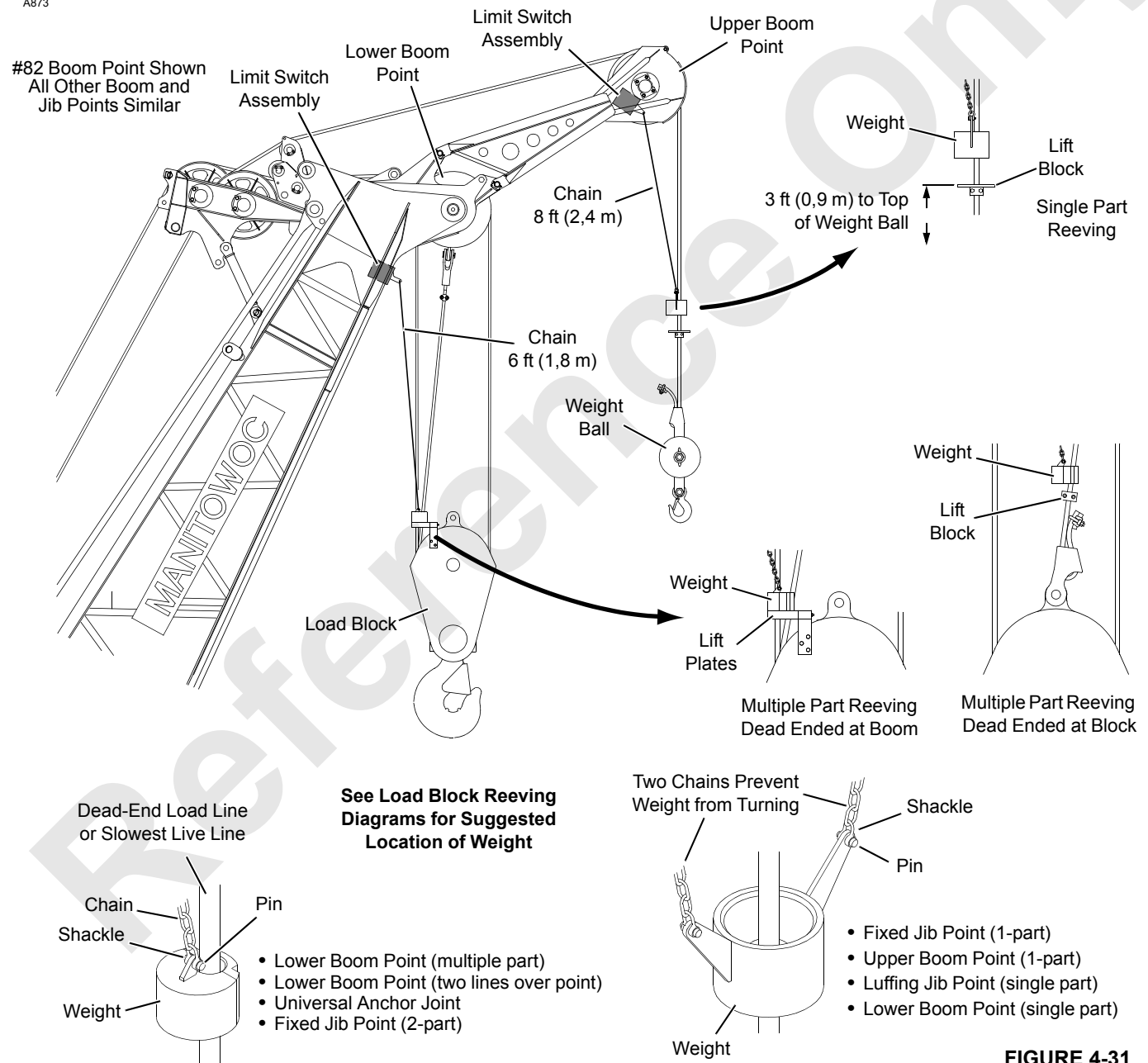


FIGURE 4-31

Boom Removal – #82HL

General

1. Prepare crane and boom as follows:
 - a. Position crane in disassembly area.
 - b. If required per capacity chart, travel front crawler roller and tumbler at boom end of crane onto blocking.

See Crawler Blocking Diagram in Capacity Chart Manual for blocking requirements.



WARNING

Tipping Hazard!

Prevent crane from tipping. Block crawlers if required per capacity chart before lowering boom.

2. Lower boom to ground as follows:
 - **If equipped with a fixed jib**, disconnect jib stops before jib point contacts ground. See Jib Rigging instructions on [page 4-89](#) for procedure.
 - **If equipped with a luffing jib**, disengage jib stop strut pins before maximum boom to luffing jib angle is reached. See Luffing Jib Rigging Guide in Luffing Jib Operator Manual for procedure.
 - **If equipped with an upper boom point**, remove lower connecting pins (B, [Figure 4-29](#), View E) before upper point contacts ground.

CAUTION

Avoid Damage!

Jib or boom point will be damaged if the preceding steps are not performed.

3. Install blocking approximately 6 in (152 mm) high between ground and bottom connectors at end of boom top.
4. Continue to lower boom (and mast) onto blocking until boom straps are resting in brackets on boom inserts.

5. Disconnect load lines from load block and weight ball and spool load lines onto load drums.
6. Disconnect electric cables as follows:
 - a. Electric cable from crane at cable reel on boom butt. Connect terminating plug to end of cable ([Figure 4-17](#), View C) or boom hoist and load hoists will not operate in up direction.
 - b. Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junctions boxes. Coil excess cable onto cable reel.
7. Remove wind speed indicator from boom or jib top to prevent damage during shipping (see Wind Speed Assembly drawing at the end of this section).
 - a. Disconnect electrical cable to wind speed indicator at base of mounting bracket.
 - b. Remove nuts, star washers, and bolts from base of wind speed mounting bracket.
 - c. Store wind speed assembly in a safe place on crane.

Disconnect Boom Butt From Boom

Disconnect boom butt from boom, remove boom butt, and install assembly block. See [Crane Disassembly](#) instructions.

Disassemble Boom Sections



DANGER

Collapsing Boom Hazard!

To prevent death or serious injury, do not stand on, inside, or under boom sections during disassembly. Always stand outside boom sections when removing connecting pins.

The crane must be in the self-erect configuration shown in [Figure 4-25](#) to disassemble its own boom. Disassembly is the reverse of assembly.

- Store boom top wire rope guide as shown in [Figure 4-30](#), View A.
- Store boom straps and links as shown in [Figure 4-29](#), View B.

Legend for [Figure 4-32](#) — #82HL Boom Components

Item	Description
1	Butt – 30 ft (9,1 m)
2	Top – 40 ft (12,2 m)
3	Insert – 10 ft (3,0 m) (see Note A and B)
4	Insert – 20 ft (6,1 m) with or without Jib Backstay Lugs (see Note A and C)
5	Insert – 40 ft (12,2 m) with or without Jib Backstay Lugs (see Note C)
6	Strap – 35 ft, 7 in (11,5 m)
7	Strap – 9 ft, 5 in (2,9 m) (see Note D)
8	Strap – 19 ft, 5 in (5,9 m) (see Note D)
9	Strap – 39 ft, 5 in (12,0 m) (see Note D)
Note A	<p>Maximum number of inserts (3) is two. Maximum number of inserts (4) is two. Combination of inserts (3 and 4) must not exceed:</p> <ul style="list-style-type: none"> • Two inserts (3) and one insert (4) or • One insert (3) and two inserts (4).
Note B	Must be equipped with wire guide if auxiliary drum is used.
Note C	Insert with jib backstay lug must be installed next to top, if jib will be used.
Note D	Each strap has a pair of links.
M	Connect to Mast Straps.

#82HL Boom

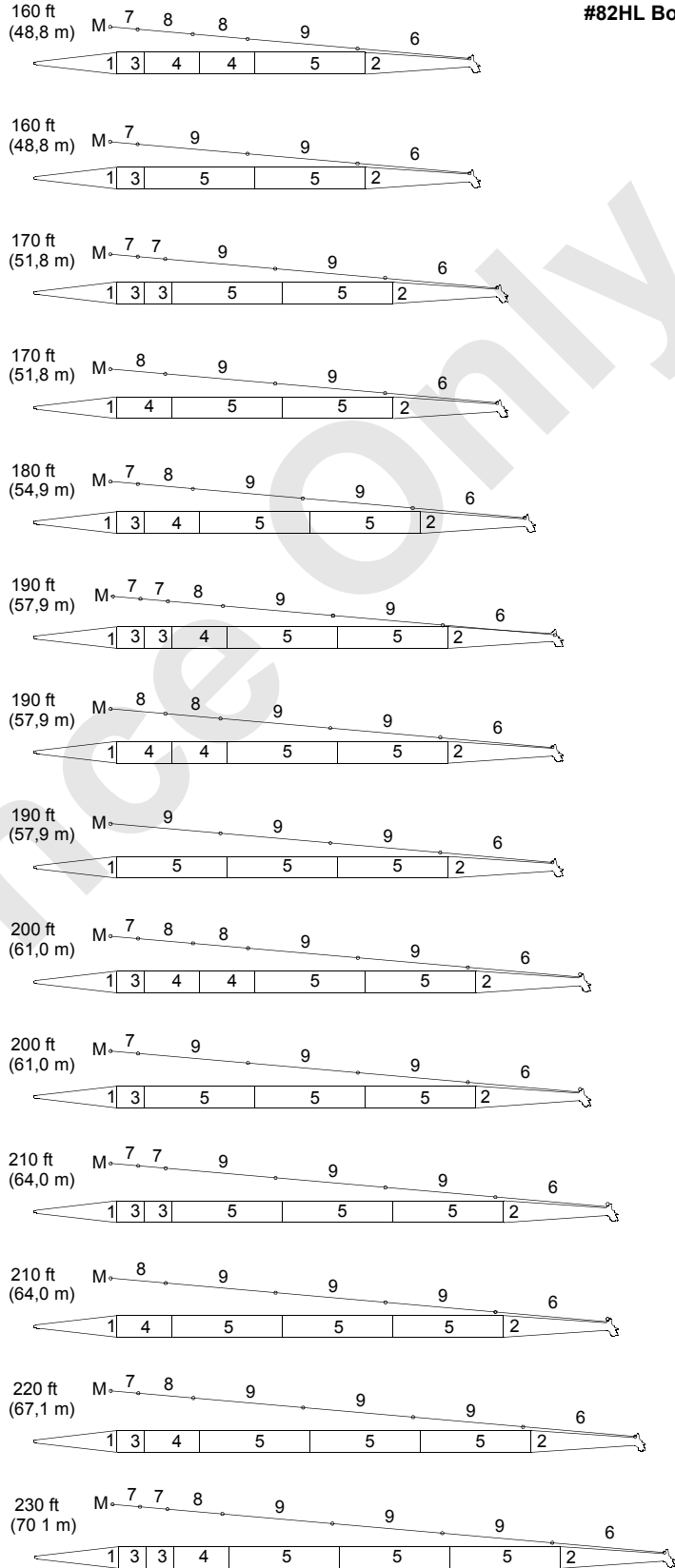
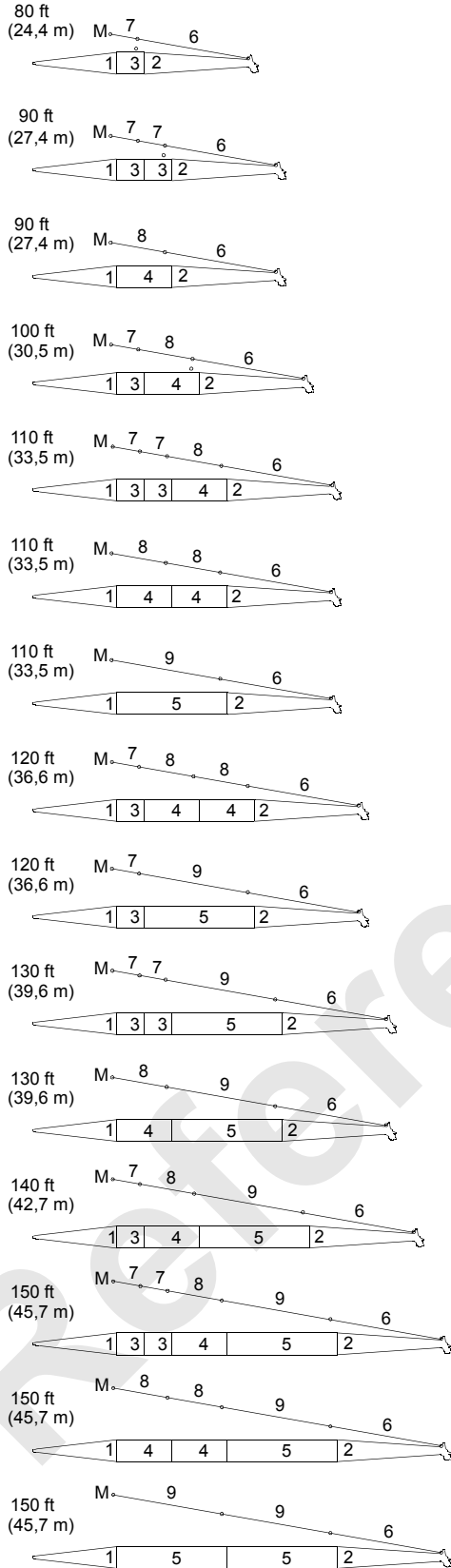


FIGURE 4-32

#82HL Boom

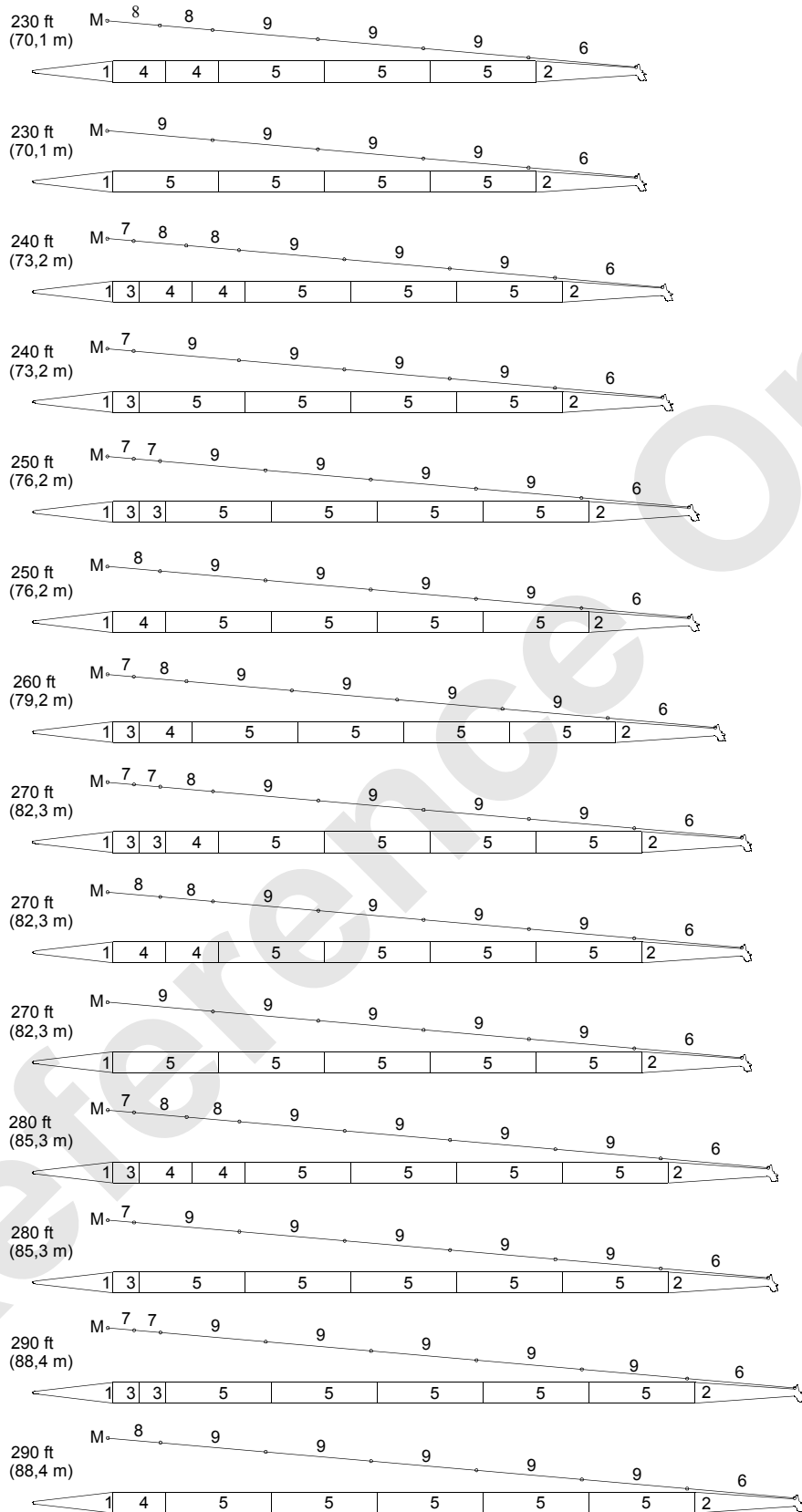


FIGURE 4-32 continued

Removable Diagonal Lacings (optional)

See [Figure 4-33](#) for the following procedure.

Optional inserts with removable diagonal lacings are available for #82 booms.

This design feature allows lacings to be removed so that #123 or #134 fixed jib sections and #135 luffing jib sections can be stored inside the inserts, reducing shipping space and the number of shipping vehicles required.

Inserts with removable diagonal lacings are designated #22E as opposed to #22 inserts which do not have removable diagonal lacings.

Rollers are bolted to pads on bottom chords of inserts to make it easier to slide jib sections into and out of the boom inserts. See [Table 4-3](#) for lacing and roller requirements.

Table 4-3 Lacing and Roller Requirements

#22E Inserts	Diagonal Lacings Required	Rollers Provided	Rollers Provided for Shipping	Rollers Required for Shipping
10 ft (3,0 m)	2	0	2	2
20 ft (6,1 m)	2	1	1	2*
40 ft (12,2 m)	4	2	1	3*

* Remove required number of rollers from operating position and fasten in shipping position.

To store jib sections inside #22E inserts, proceed as follows:

1. Remove diagonal lacings from inserts (View A).
2. Remove rollers from operating position on top chords of inserts.
3. Fasten required number of rollers to bottom chords of inserts.
4. To prevent damage to rollers, do not exceed 1,500 lb. (680 kg) load on each roller.
5. Install jib sections inside inserts. **Take extreme care not to damage lacings or chords.**

6. Adjust position of jib sections so that diagonal lacings can be reinstalled.
7. Reinstall proper number of diagonal lacings with bolts and nuts provided (View A).
8. Securely attach jib sections to inserts so jib sections cannot shift during transport.

Fasten tie-downs to rollers or chords of inserts only, not to lacings. Take care not to bend rollers when tightening tie-downs. Use protective covering such as tire sections between tie-downs and chords or rollers.

To remove jib sections from inside the #22E inserts, proceed as follows:

1. Remove diagonal lacings from inserts (View A).
2. Carefully remove jib sections from inside inserts. **Take extreme care not to damage lacings or chords.**
3. Remove rollers from bottom chords inside inserts.
4. Fasten rollers in operating position on top chords of inserts.



WARNING
Tipping Crane Hazard!

Remove rollers from bottom cords inside inserts before attempting to raise boom. Added weight of rollers inside inserts may cause crane to tip when boom is raised.

5. Thoroughly clean all dirt from between lacings and mating mounting surfaces on inserts.
6. Reinstall proper number of diagonal lacings in inserts with bolts and nuts provided (View A).
7. Torque nuts dry to 300 ft-lb (407 N•m).



WARNING
Falling Boom Hazard!

Re-install diagonal lacings before attempting to raise boom. Boom may collapse if lacings are not re-installed.

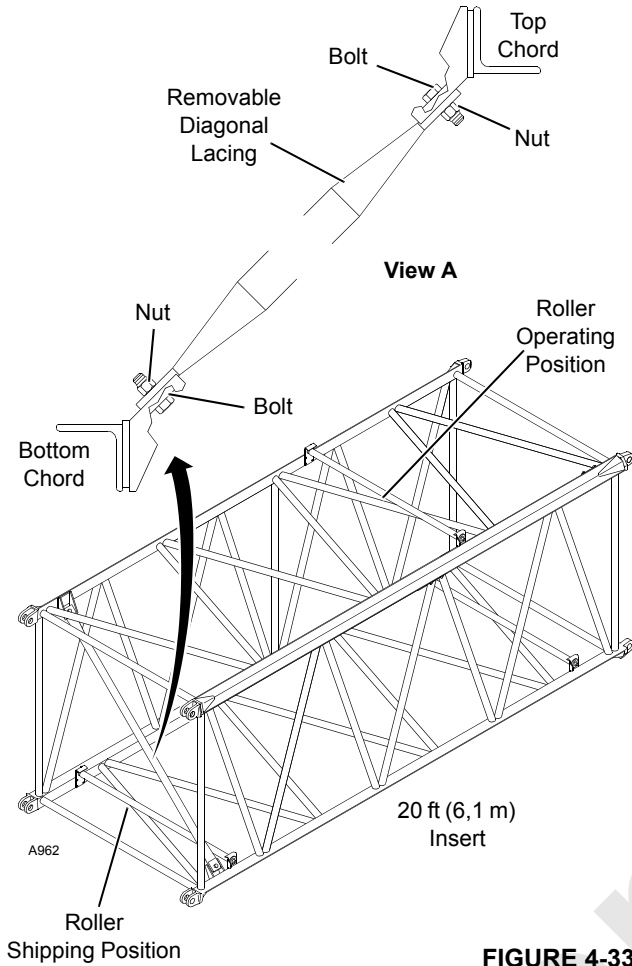


FIGURE 4-33

Boom Installation – #82LR

General

- Intermediate suspension and 40 ft (12,2 m) light insert are required for 310 ft (94,5 m) boom or longer.
- Jib can be used only with boom 120-300 ft (36,6-91,4 m) boom. Backstay lugs are on boom top.
- When jib is not used, remove all jib mounting hardware (adapters, spacers, shaft, and pins) from boom. See Jib Rigging on [page 4-89](#) for removal instructions.

- Upper boom point, if installed, must be removed before installing jib.
- Read all notes on Boom Rigging Assembly Drawing at rear of this section. See [Figure 4-38](#) for assistance.



DANGER

Collapsing Boom Hazard!

To prevent death or serious injury, do not stand on, inside, or under boom sections during assembly. Always stand outside boom sections when installing connecting pins.

Assemble Boom Sections

See [Figure 4-34](#) for the following procedure.

The boom sections have FACT™ connectors:

- The top connectors are joined by fixed vertical pins that hook into holes in the adjacent section (View A).
 - The bottom connectors are joined by removable connector pins (View G).
1. Assemble boom inserts in proper sequence ([Figure 4-38](#)), as follows, starting at butt end of boom:
 - a. Place first insert on blocking at least 6 in (152 mm) high.
 - b. Lift next insert into position and engage top connector holes with fixed vertical pins (View A).
 - c. Lower insert until bottom connector holes are aligned and install removable connector pins (View G). Removable connector pins are stored in pockets on adjacent insert (View F).
 - d. Block under bottom chords at top end of insert.
 2. For boom 310 – 340 ft (94,5 – 103,6 m), install 40 ft (12,2 m) light insert (View E) next to boom top.
 3. Repeat steps [1b](#) – [1d](#) until all inserts and boom top are installed.

NOTE: 40 ft (12,2 m) insert with jib backstay lug (View D) may be used as any 40 ft (12,2 m) insert except light insert.

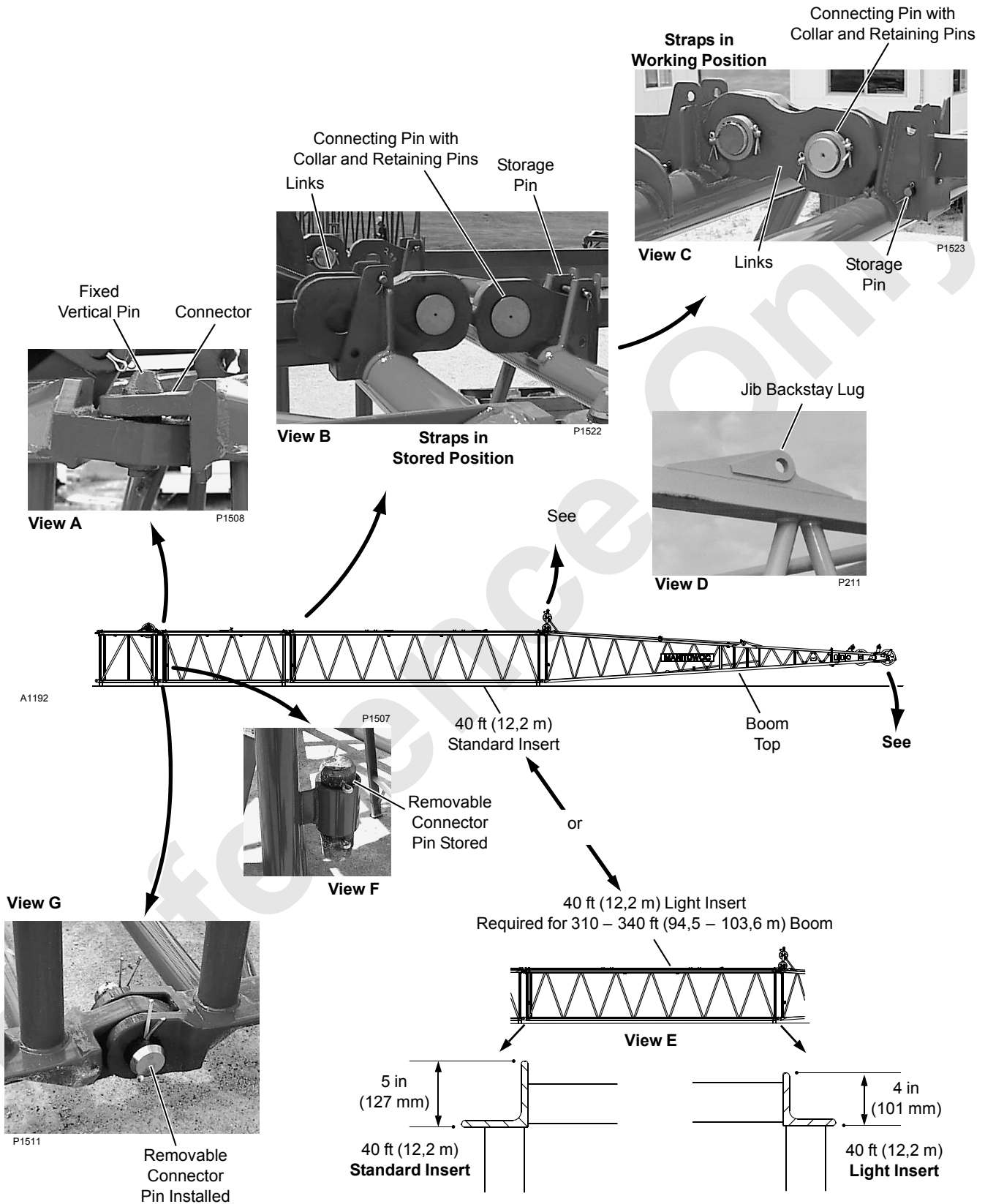
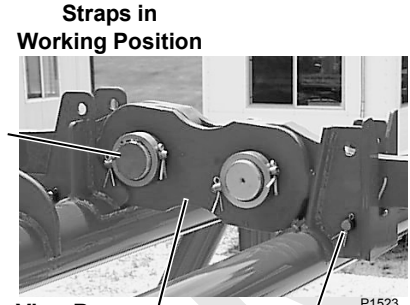
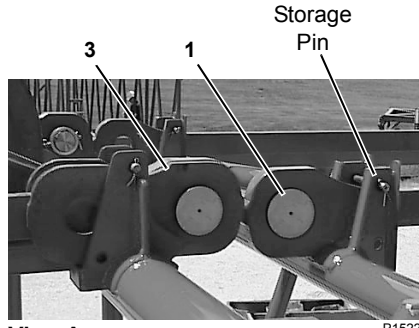


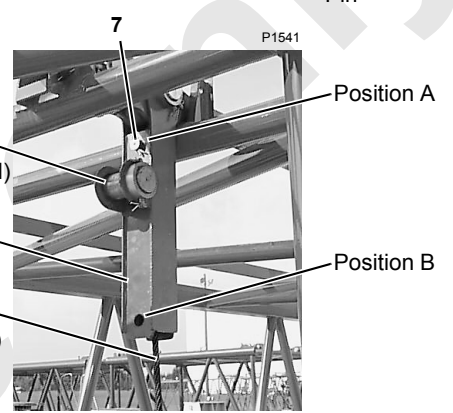
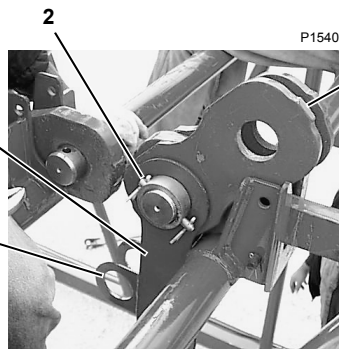
FIGURE 4-34

Item	Description
1	Standard Connecting Pin
2	5 in (127 mm) Pin
3	Links
4	Link
5	8-3/4 in (222 mm) Pin
6	Link
7	3-9/16 in (90 mm) Pin
8	6 ft (1,8 m) Pendant
9	Link



View A Straps in Stored Position

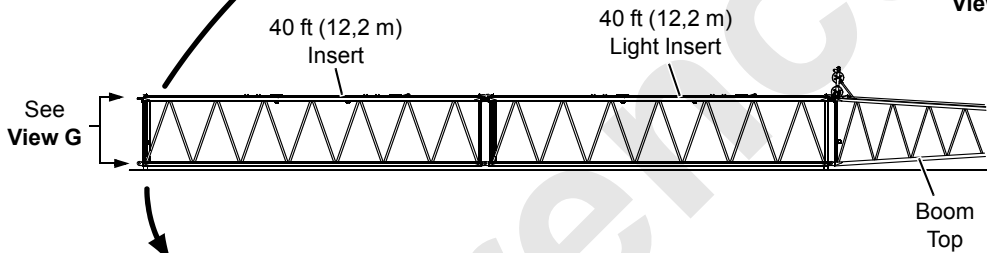
View B Straps in Working Position



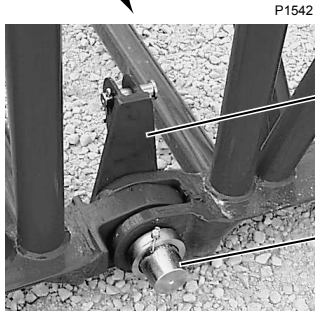
View C

View D

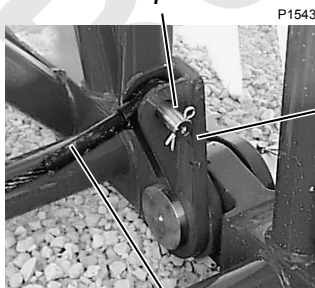
A1192



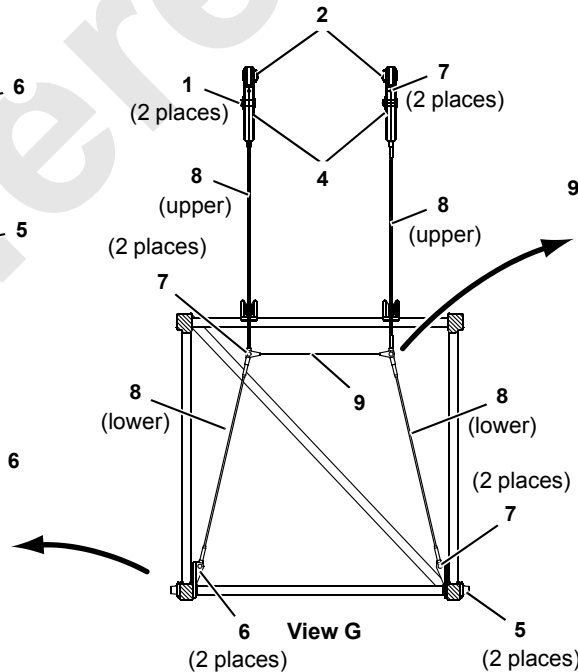
Position A	330 – 340 ft Boom (110,6 – 103,6 m)
Position B	310 – 320 ft Boom (94,5 – 97,5 m)



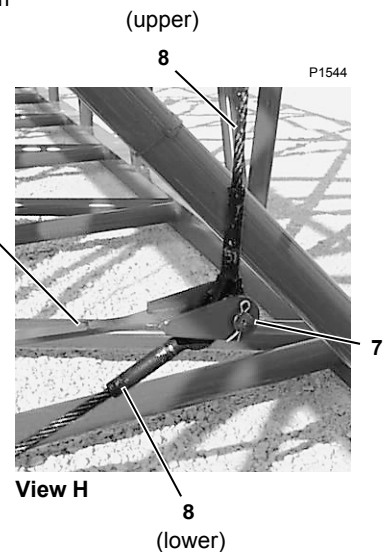
View E



View F



View G



View H

FIGURE 4-35

Install Intermediate Suspension

See [Figure 4-35](#) for the following procedure.

NOTE: Intermediate suspension is required only for 310-340 ft (94,5-97,5 m) boom. Intermediate suspension is always 130 ft (39,6 m) from boom top.

1. Remove standard connecting pin (1) securing links (3) to strap (View A).
2. Using pin (2), attach strap links (3) and intermediate suspension link (4) to strap (View C).
3. Store standard connecting pins (1) in lugs on links (4) (View D)
4. Remove standard insert connecting pin ([Figure 4-34](#), View G) and store in pocket on insert ([Figure 4-34](#), View F).
5. Using pin (5), install link (6) and reconnect inserts (View E).
6. Repeat steps [1-5](#) on other side of insert.
7. Using pins (7), attach lower pendants (8) to links (6) (View F).
8. Using pins (7), attach upper pendants (8) to links (4) in Position A or B, depending on boom length (View D).
9. Using pins (7), attach upper pendants and lower pendants (8) to link (9) (View H).

When boom is raised, booms straps will lift intermediate suspension into position (View G).

Connect Boom Straps

See [Figure 4-35](#) for the following procedure.

The boom straps are shipped from the factory in the stored position on the inserts (View A). Connect the straps, as follows:

1. Remove storage pins from top holes in strap brackets (View A).
2. Store storage pins in bottom holes in strap brackets (View B).

3. Rotate strap links forward and pin to adjacent straps (View B).

A1192

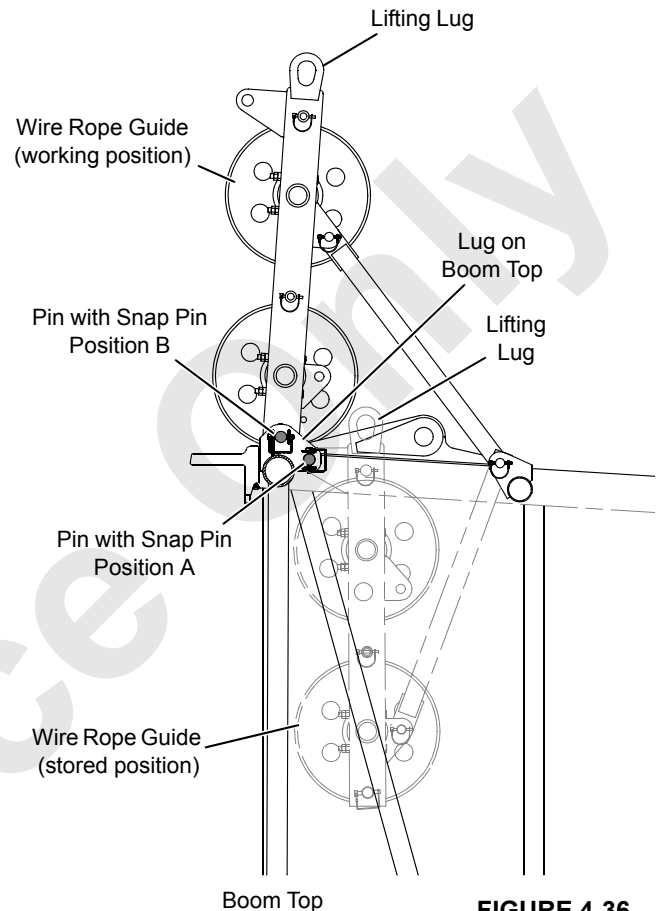


FIGURE 4-36

Raise Boom Top Wire Rope Guide

See [Figure 4-36](#) for the following procedure.

1. Connect outside assist to lifting lug on wire rope guide.
2. Remove pin holding wire rope guide in stored position (Position A).
3. Lift wire rope guide vertically into working position.
4. Pin wire rope guide to lugs on boom top (Position B).

A1192

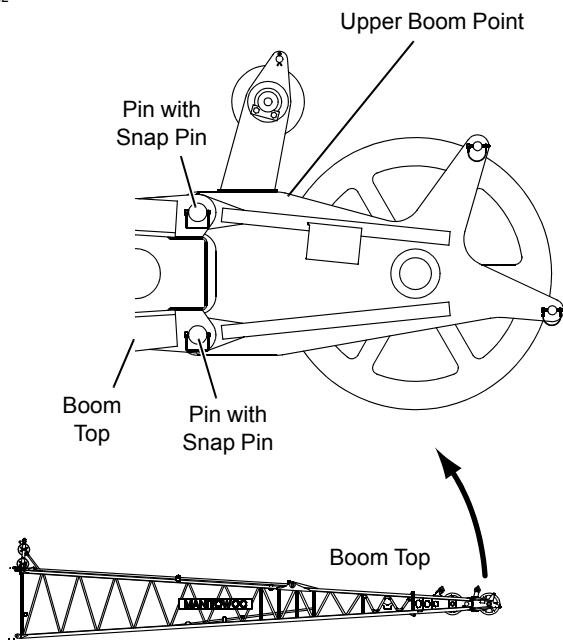


FIGURE 4-37

Install Upper Boom Point

NOTE: Optional upper boom point cannot be used on 340 ft (103,6 m) boom or with jib attachment.

See [Figure 4-37](#) for the following procedure.

If required, install upper boom point as follows:

1. Lift upper boom point into position at end of boom top.
2. Align connecting holes and install pins and snap pins.

Install Jib

If required, install jib. See Jib instructions on [page 4-83](#).

NOTE: Jib can be used only with boom 320 or 340 ft (97,5 or 103,6 m) boom.

Connect Boom Butt to Boom

Remove assembly block, install boom butt, and connect boom butt to boom as instructed in Crane Assembly instructions on [page 4-9](#).

Connect mast straps to boom straps as instructed in Crane Assembly instructions.

Make sure you perform following steps. See Crane Assembly instructions:

1. Lower mast arms.
2. Turn on desired crane mode (turn off setup mode) and turn mast bypass handle to off position ([Figure 4-17](#), View D).
3. Adjust mast straps to proper length.

Install Load Line

See [Load Line Reeving](#) instructions for the proper routing and reeving of load lines.

Install Block-Up Limit Control and Connect Boom Wiring

Install block-up limit components as shown in [Figure 4-31](#) and in Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section.

See Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section and connect:

- Electric cable from crane to cable reel on boom butt
- Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junctions boxes

Boom Removal

General

1. Prepare crane and boom as follows:
 - a. Position crane in disassembly area.
 - b. If required per capacity chart, travel front crawler roller and tumbler at boom end of crane onto blocking.
See Crawler Blocking Diagram in Capacity Chart Manual for blocking requirements.



WARNING

Tipping Hazard!

Prevent crane from tipping. Block crawlers if required per capacity chart before lowering boom.

2. Lower boom to ground.
If equipped with a fixed jib, disconnect jib stops before jib point contacts ground. See Jib Rigging instructions on [page 4-89](#) for procedure.

CAUTION

Avoid Damage!

Jib or boom point will be damaged if preceding steps are not performed.

3. Install blocking approximately 6 in (152 mm) high between ground and bottom connectors at end of boom top.

4. Continue to lower boom (and mast) onto blocking until boom straps are resting in brackets on boom inserts.
5. Disconnect load lines from load block and weight ball and spool load lines onto load drums.
6. Remove upper boom point ([Figure 4-37](#)).

Disconnect Boom Butt From Boom

Disconnect boom butt from boom, remove boom butt, and install assembly block as instructed in Crane Disassembly instructions on [page 4-34](#).

Disassemble Boom Sections



DANGER

Collapsing Boom Hazard!

To prevent death or serious injury, do not stand on, inside, or under boom sections during disassembly. Always stand outside boom sections when removing connecting pins.

The crane must be in the self-erect configuration shown in [Figure 4-25](#) to disassemble its own boom. Disassembly is the reverse of assembly.

- Store boom top wire rope guide as shown in [Figure 4-36](#).
- Remove and store intermediate suspension if equipped ([Figure 4-35](#)).
- Store boom straps and links as shown in [Figure 4-35](#), View B.

Legend for [Figure 4-38](#) — #82LR Boom Components

Item	Description
1	Butt – 30 ft (9,1 m)
2	Top – 50 ft (15,2 m)
3	Insert – 10 ft (3,0 m) (see Notes A, B, and E)
4	Insert – 20 ft (6,1 m) with or without jib backstay lugs (see Note A)
5	Insert – 40 ft (12,2 m) with or without jib backstay lugs
6	Insert – 40 ft (12,2 m) light insert (see Note C)
7	Strap – 31 ft, 4-1/2 in (9,6 m)
8	Strap – 9 ft, 5 in (2,9 m) (see Note D)
9	Strap – 19 ft, 5 in (5,9 m) (see Note D)
10	Strap – 39 ft, 5 in (12,0 m) (see Note D)
Note A	Maximum number of inserts (3) is two. Maximum number of inserts (4) is two. Combination of inserts (3 and 4) must not exceed: <ul style="list-style-type: none"> • Two inserts (3) and one insert (4) or • One insert (3) and two inserts (4).
Note B	Must be equipped with wire guide and positioned next to boom butt if auxiliary drum is used
Note C	Light insert must be installed next to top.
Note D	Each strap has a pair of links.
Note E	If auxiliary drum shaft assembly is used, 10 ft (3,0 m) insert with special wire rope guide must be installed next to boom butt.
M	Connect to mast straps
I	Intermediate suspension

A1191

#82LR Boom

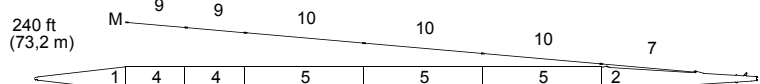
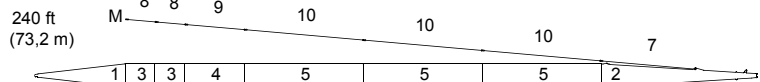
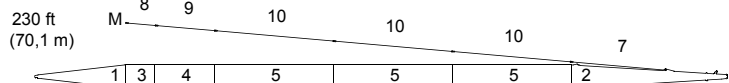
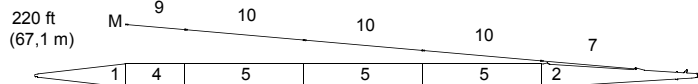
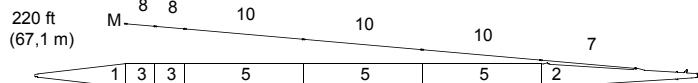
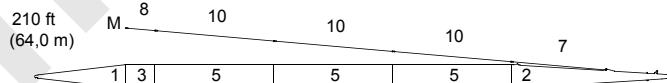
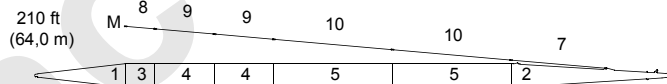
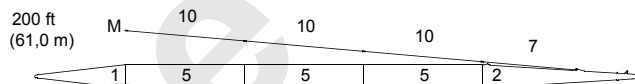
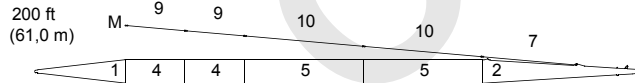
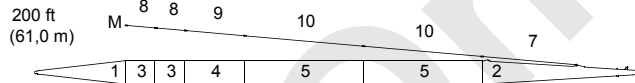
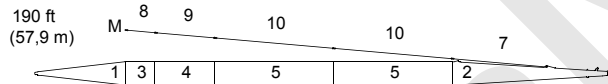
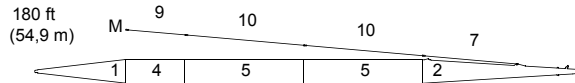
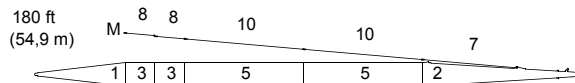
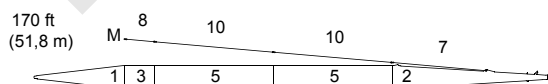
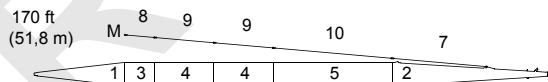
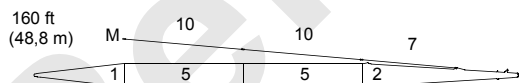
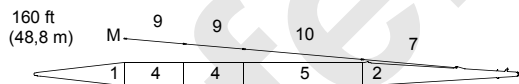
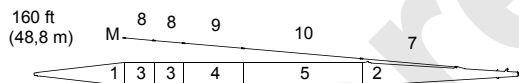
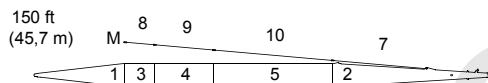
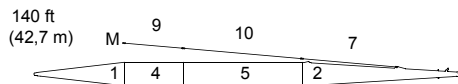
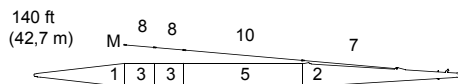
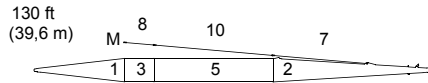
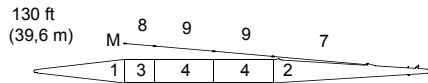
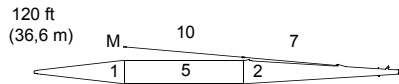
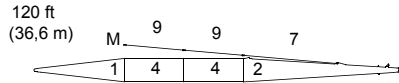
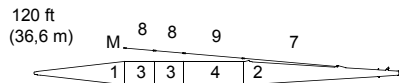


FIGURE 4-38



A1191

#82LR Boom

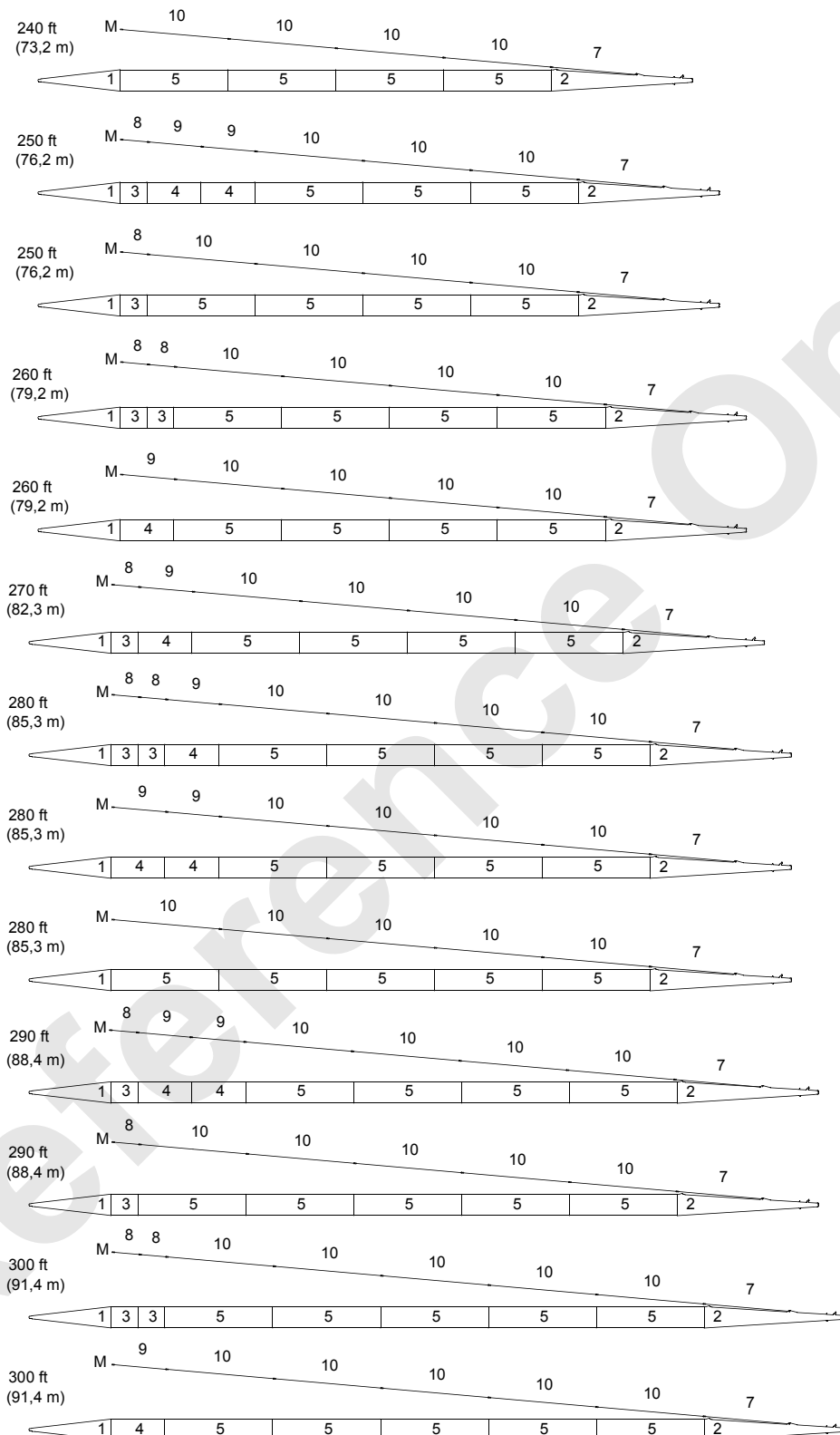


FIGURE 4-38 continued

A1191

#82LR Boom

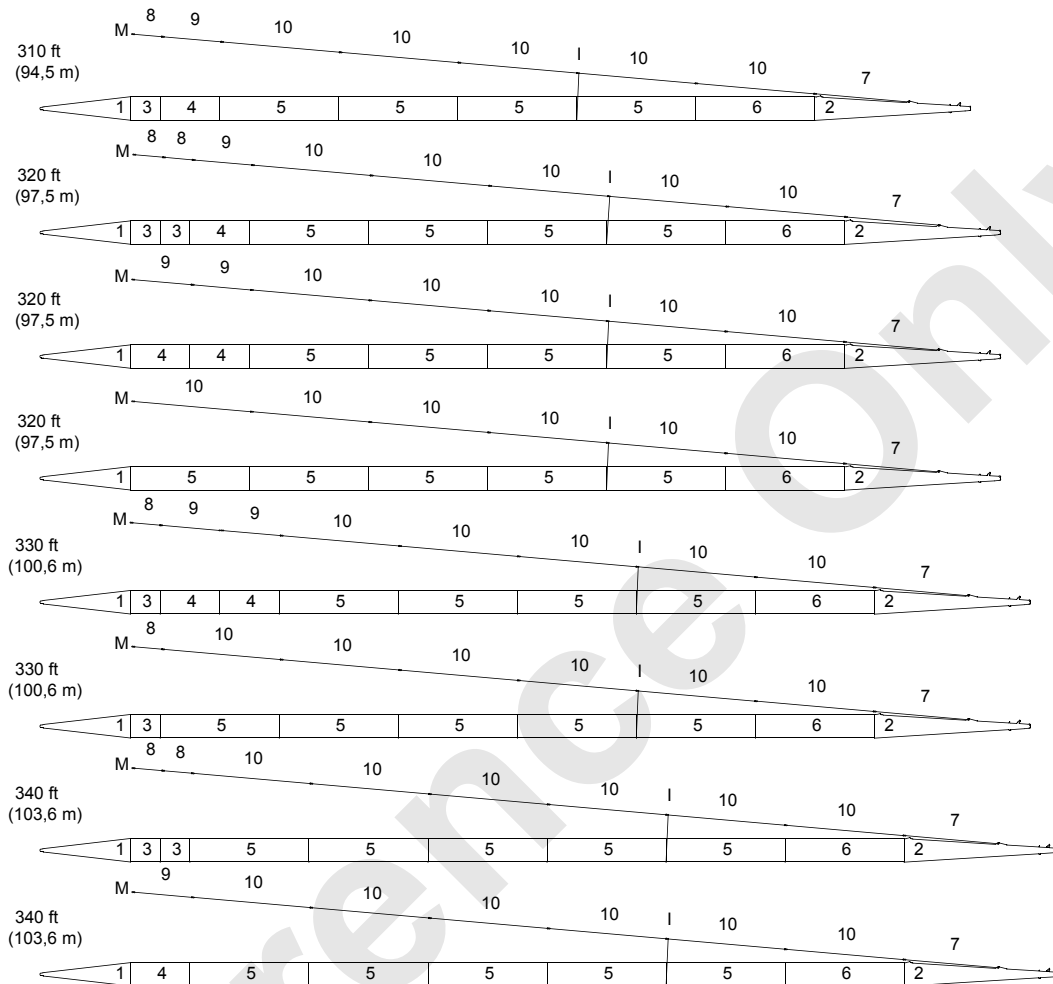


FIGURE 4-38 continued

Lower Boom Point Installation – #22EL or #82HL Boom

General

The lower boom point of the #22EL or #82 boom is equipped with seven or eight sheaves in three clusters as shown in [Figure 4-39](#).

Each sheave cluster is retained on a separate shaft with a spanner nut. The sheave clusters are supported by spacers and retained in the lower boom point with a bolt and elastic stop nut.

The outer two sheave clusters must be removed before the crane can be operated with some boom length or boom and luffing jib lengths. See Capacity Chart or Luffing Jib Raising Procedure Chart to determine which boom lengths require removal of sheave clusters.

The three sheave cluster weighs 500 lbs (227 kg).



WARNING

Tipping Crane Hazard!

Do not attempt to raise boom until outer two sheave clusters have been removed for boom lengths specified in Capacity Chart or Luffing Jib Raising Procedure Chart. Rear of crane will tip forward when boom or boom and jib is raised if this step is not performed.

Removing and Installing Sheave Clusters

When required, perform the following steps:

- When it is necessary to move the dead-end link, or
- Prior to lengthening the boom to a length that requires the outer two sheave clusters to be removed

See [Figure 4-39](#) for the following procedure.

1. Lower boom so that boom top is offset enough to allow sheave clusters to be removed by rolling them out of saddles onto ground or blocking.

NOTE: Centerline of saddles supporting sheaves is tilted 15° upwards when boom is horizontal to ground.

2. Remove cotter pins fastening rope guard to boom top and remove rope guard.
3. Lower boom so sheaves are contacting ground or blocking.
4. Remove elastic stop nut and bolt.

5. Push or pull sheave clusters from lower boom point.
6. If outer two sheave clusters are being removed, proceed as follows:
 - a. Store unused sheave clusters. Sheave cluster with dead-end link must be installed in middle of lower boom point.
 - b. Install a spacer on both sides of lower boom point in place of outer sheave clusters.
 - c. Install an equal thickness of shims on both ends of both spacers to limit side play to 0.030 in (0,76 mm).
7. Install required number of sheave clusters in saddles in lower boom point.

If only one cluster is used, install sheave cluster with dead-end link in middle of lower boom point.

If all three sheave clusters are used, install sheave cluster with dead-end link in proper position as shown in Load Line Reeving instructions on [page 4-97](#).
8. Install an equal thickness of shims on both ends of each sheave cluster to limit side play to 0.030 in (0,76 mm).
9. Install bolt with flat washers and securely tighten elastic stop nut.
10. Assemble rope guard over sheave clusters.
11. Securely fasten rope guard to boom top with cotter pins provided.

Greasing Sheave Bearings

Carefully hand pack each sheave bearing with MOBILUX EP #2 grease when a sheave assembly is overhauled.

Be sure to also fill cavities between bearing and seals with grease.

Adjusting Bearing End Play

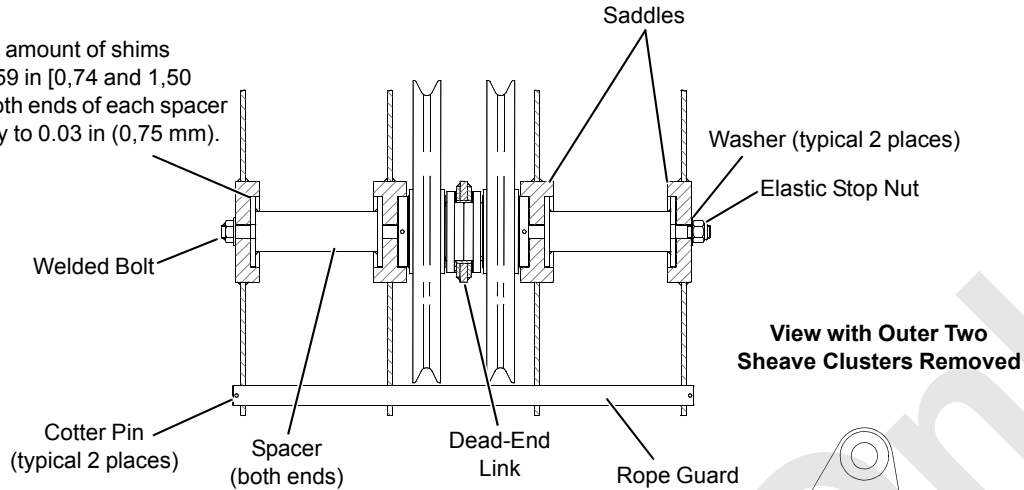
Perform the following steps when assembling a sheave cluster:

See [Figure 4-39](#) for the following procedure.

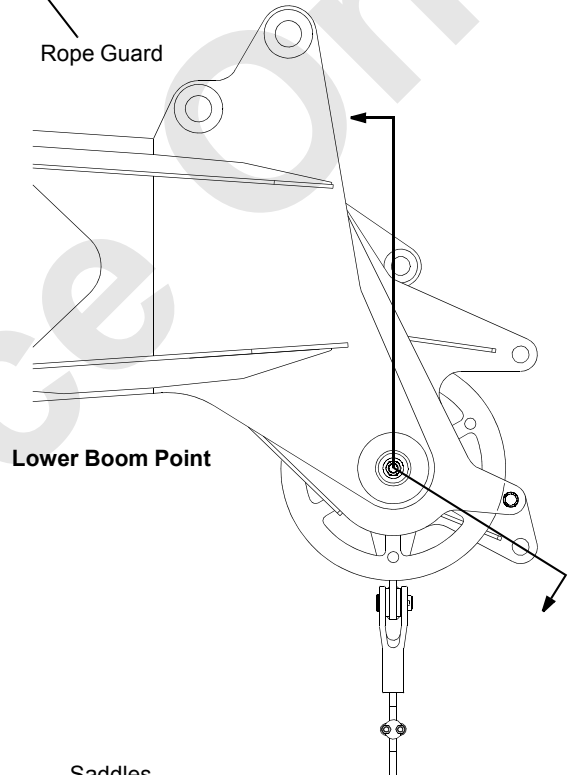
1. Assemble three sheaves on shaft.
2. Clean threads of shaft and spanner nut with solvent.
3. Apply LOCTITE #243 or equivalent thread locking adhesive to threads of shaft.
4. Install spanner nut and tighten to approximately 75 ft-lbs (102 Nm) to remove all bearing end play on shaft.

A868

Install an equal amount of shims (0.029 and 0.059 in [0,74 and 1,50 mm] thick on both ends of each spacer to limit side play to 0.03 in (0,75 mm).



View with Outer Two Sheave Clusters Removed



View with Outer Two Sheave Clusters Installed

Install an equal amount of shims (0.029 and 0.059 in [0,74 and 1,50 mm] thick on both ends of each shaft to limit side play to 0.03 in (0,75 mm).

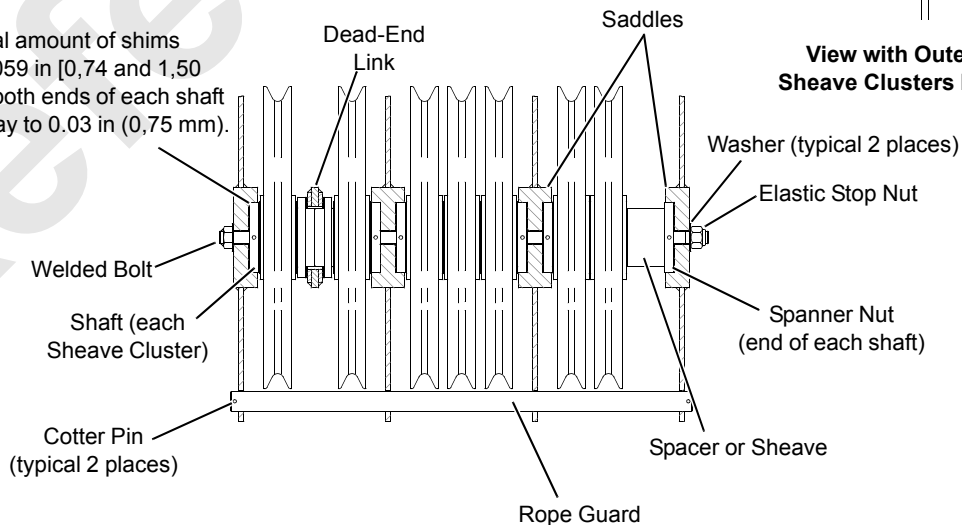
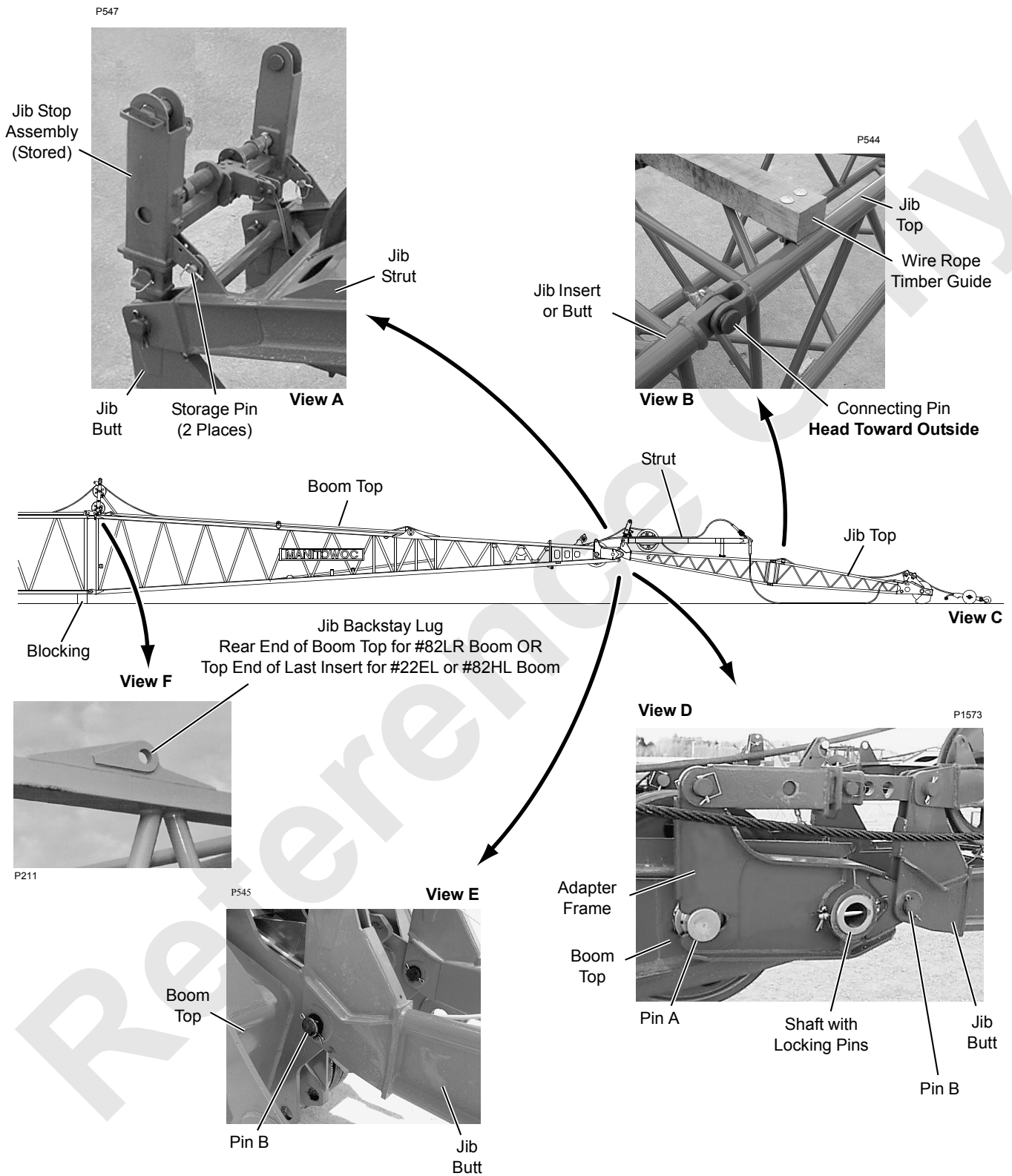


FIGURE 4-39



A1197

FIGURE 4-40

Jib Installation – #134

General

The following instructions apply to the #134 fixed jib used on the following booms:

- #22EL
- #82HL
- #82LR

The #134 jib consists of a 15 ft (4,6 m) jib butt and a 15 ft (4,6 m) jib top for a basic length of 30 ft (9,1 m). Inserts are available to make lengths of 40-80 ft (12,2-24,4 m).

Jib offsets (5°, 15°, 25°) are set by changing lengths of jib backstay straps, links, and pendants.

NOTE: The jib strut and jib stop assembly are shipped in the stored position on the jib butt as shown in [Figure 4-40](#), View A.

See [Figure 4-40](#) for the following procedure.

Prepare Boom

1. Lower boom onto blocking.
2. Remove load line from upper boom point, if equipped.
3. Remove and store upper boom point.
4. For #22EL and #82HL booms, make sure insert with jib backstay lugs (View F) is installed next to boom top.

Install Butt

1. For #82LR boom only, install adapter frames on boom top (View D):
 - a. Install shaft in boom top.
 - b. Slide shaft out of way.
 - c. Slide notch in adapter frame over Pin A.

- d. Slide shaft back into position to hold adapter frame in place.
 - e. Repeat steps [b-d](#) for other adapter frame.
 - f. Install locking pins to retain adapter frames on shaft.
2. Lift jib butt into position and align holes in jib butt with holes in adapter frames (View D) or boom top (View E).
 3. Install Pins B (2 places) to secure jib.

Install Inserts



WARNING!

Collapsing Jib Hazard!

To prevent death or serious injury, do not stand on, inside, or under jib during assembly. Always stand outside of jib when installing connecting pins.

NOTE: See Jib Rigging Drawing at the end of this section for required number of jib inserts and pendants for each jib length. See [Figure 4-44](#) for additional assistance.

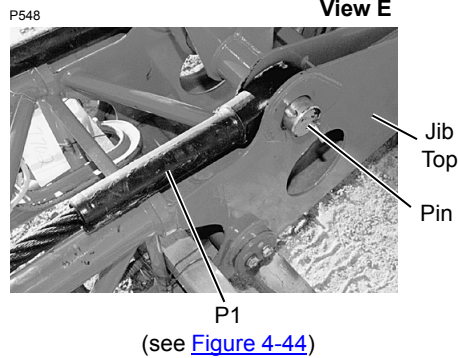
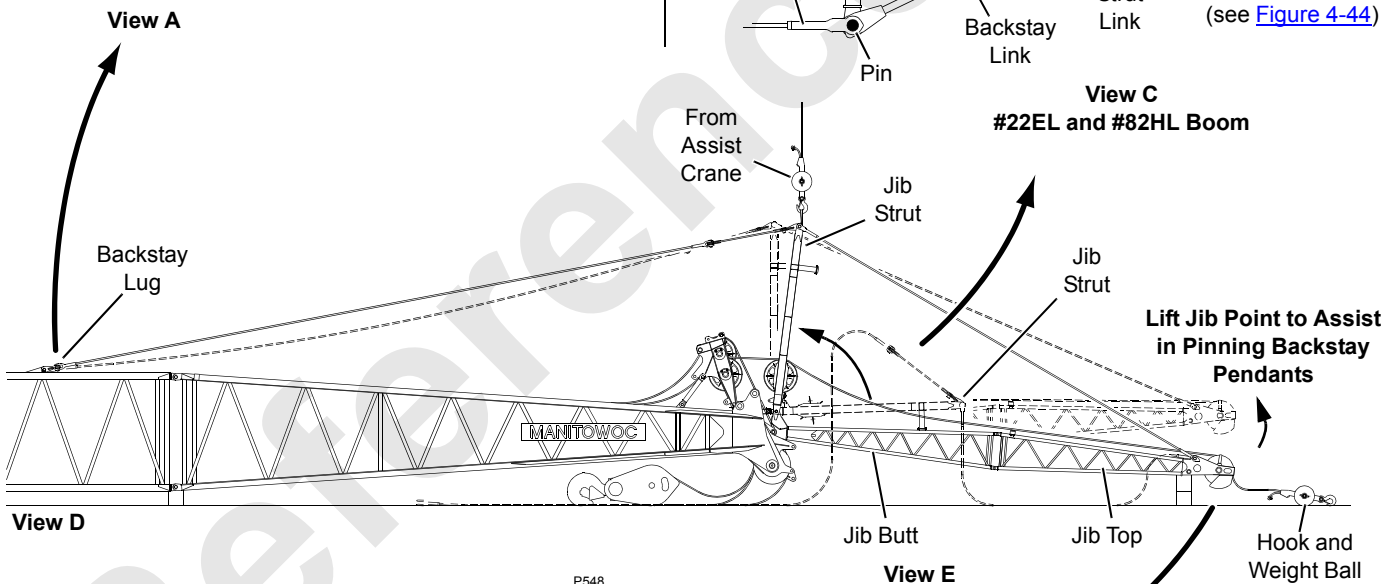
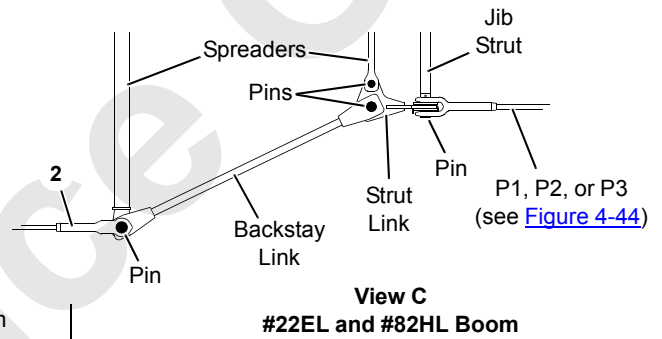
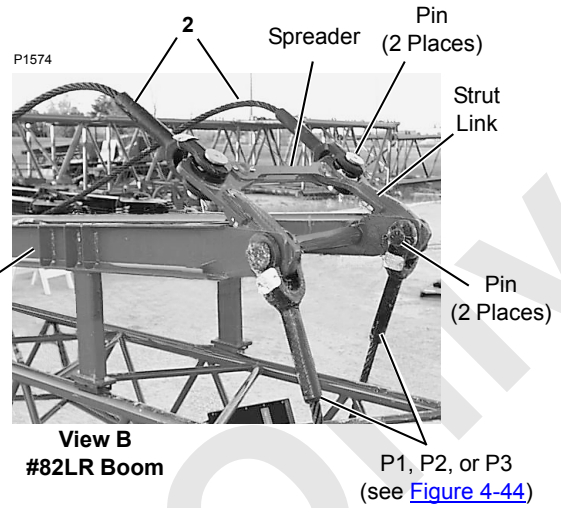
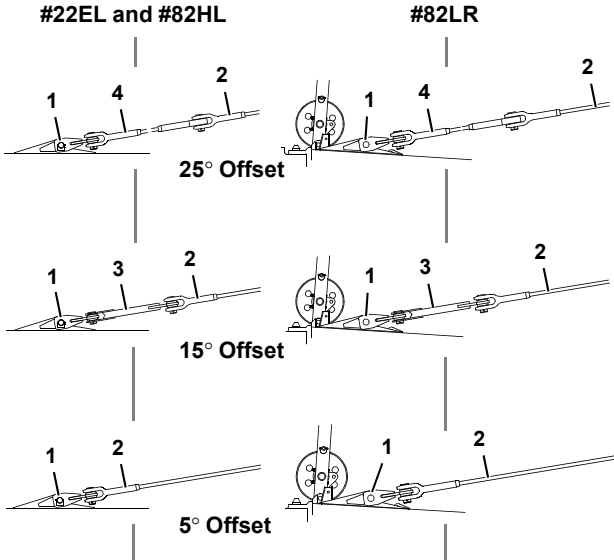
1. Pin desired length of jib inserts to butt:
 - Wire rope timber guards (View B) must face up
 - Shortest inserts must be closest to butt
 - Pin heads must be toward outside of jib (View B)
2. Block inserts as assembly progresses.

Install Top

Pin jib top to last insert or to butt, depending on jib length:

- Pendant lugs on jib top must face up
- Pin heads must be toward outside of jib (View B)
- If not already done, install wire rope timber guard (View B).

Item	Description
1	Backstay Links
2	Basic Backstay Pendants 44 ft, 7 in (13,6 m)
3	Offset Links 28 in (711 mm) and pins for 15° Offset
4	Offset Pendants 4ft, 8 in (1,4 m) and pins for 25° Offset



A874
A1197

FIGURE 4-41

See [Figure 4-41](#) for the following procedure.

Install Jib Pendants

NOTE: With the exception of the basic pendants, the jib pendants must be installed in the same sequence as the inserts.

The jib pendants (and backstay pendants) are furnished in matched sets of two and must be installed in matched sets — pendant on one side of insert must match pendant on other side of insert.

1. Pin basic jib pendants (P1) to lugs on jib top (View E).
2. Lay basic pendants on ground.
3. Assemble remaining jib pendants (P2 and P3) to basic pendants. Shortest pendants must be toward butt.
4. Pin other end of jib pendants and required links to jib strut (View B or C).

Install Backstay Pendants

1. For #22EL and #82HL boom (View C):
 - a. Install backstay links.
 - b. Pin backstay pendants (2) to backstay links and spreader.
 - c. Install spreader between strut links.

1. For #82LR boom (View B):
 - a. Pin backstay pendants (2) to strut links.
 - b. Install spreader between strut links.
2. Lay backstay pendants on ground alongside boom.

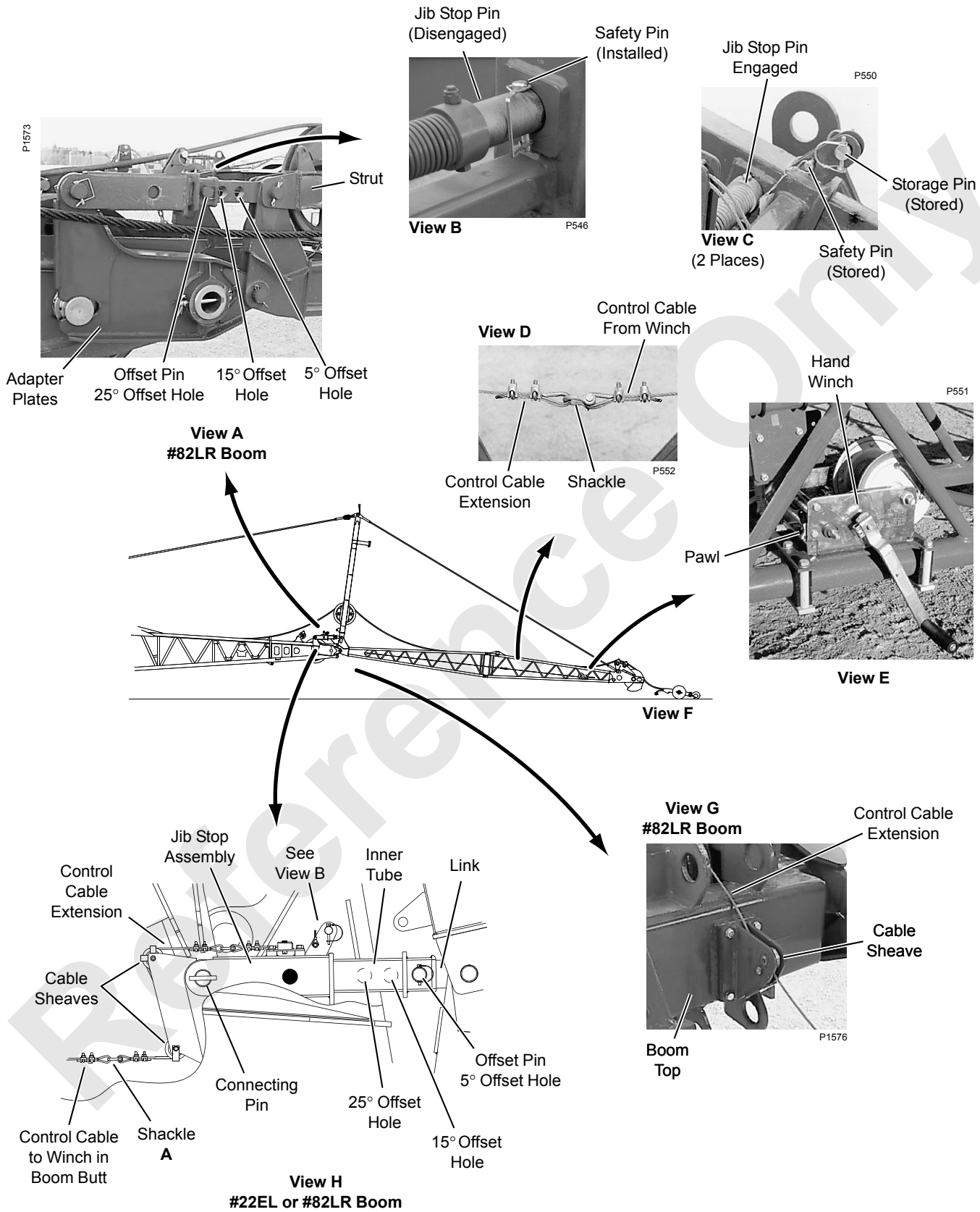
Install Jib Offset Links or Pendants

For the following procedure, see View A:

1. For 5° offset, pin link (1) to basic backstay pendants (2).
2. For 15° offset, pin links (3) and links (1) to basic backstay pendants (2).
3. For 25° offset, pin pendants (4) and links (1) to basic backstay pendants (2).

Raise Jib Strut

1. Using appropriate slings, attach hook from assist crane to front side of sheave in jib strut.
2. Slowly lift jib strut over center with assist crane. **Use extreme caution not to side load strut while lifting.**
3. If required, raise jib point with an outside assist (another crane or fork-lift truck) to gain enough slack to allow pinning backstay pendants.
4. Pin backstay links (1) to lugs on boom insert.



A1197

FIGURE 4-42

Install Jib Stop

See [Figure 4-42](#) for the following procedure.

! WARNING Crushing Injury!

Jib stop pins are spring engaged. Do not remove safety pins until jib stop assembly is pinned in working position and control cables are attached and tensioned.

1. Remove storage pins ([Figure 4-40](#), View A), and lower jib stop assembly to boom top.
2. Pin jib stop outer tubes to lugs on adapter frames (View A) or boom top (View H).
3. Store storage pins (View C).
4. Adjust jib stop length as follows (View A or H):
 - a. Remove offset pins.
 - b. Adjust position of inner tubes so holes in tubes are aligned with proper offset holes in links.
 - c. Reinstall offset pins.
5. Connect jib stop control cable as follows:
 - a. Route cable extension from jib stop through sheaves in boom top (View G or H).
 - b. For #22EL or #82HL boom, route control cable from winch through sheaves in boom butt.
 - c. Connect cable extension to control cable from winch with shackle (A).
6. Use winch on boom butt or jib top to take load off safety pins (pins loose) and remove safety pins (View B).
7. Pay out control cable to engage jib stop pins (View C). Then pay out an additional 2 ft (0,6 m) of control cable.
8. Store safety pins (View C).
9. Boom up until jib point just clears ground.

! WARNING Falling Jib Hazard!

Visually observe that jib stop pins fully engage holes in jib stop frame as boom and jib are raised from ground.

Jib can be pulled over backwards if jib stop pins do not engage.

Install Load Line

See [Load Line Reeving](#) instructions for proper routing and reeving of load lines.

On current production units, remove the rope guards ([Figure 4-43](#)) to pull the load line through the jib point and strut without removing the socket and wedge.

Install Block-Up Limit Control and Connect Boom Wiring

Install block-up limit components as shown in [Figure 4-31](#) and in Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section.

See Boom Wiring, Limits, and Load Indicator Electrical Assembly Drawing at the end of this section and connect:

- Electric cable from crane to cable reel on boom butt.
- Electric cables from block-up limit switches and all load sensing sheaves to proper receptacles on boom and jib junction boxes.

A00953

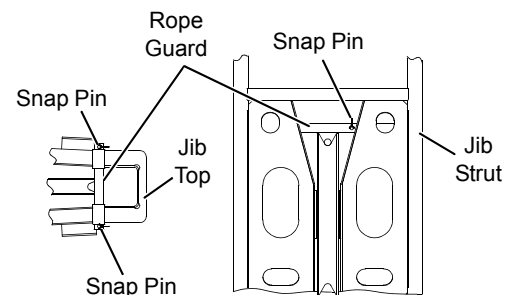


FIGURE 4-43

A875

#34 Fixed Jib

Section	Type	Length
J1	Jib Butt	15 ft (4,6 m)
J2	Jib Top	15 ft (4,6 m)
J3	Jib Insert	10 ft (3,1 m)
J4	Jib Insert	20 ft (6,1 m)

Pendant	Type	Length
P1	Basic Jib	30 ft, 9 in (9,4 m)
P2	Jib Insert	9 ft, 6 in (2,9 m)
P3	Jib Insert	19 ft (5,8 m)

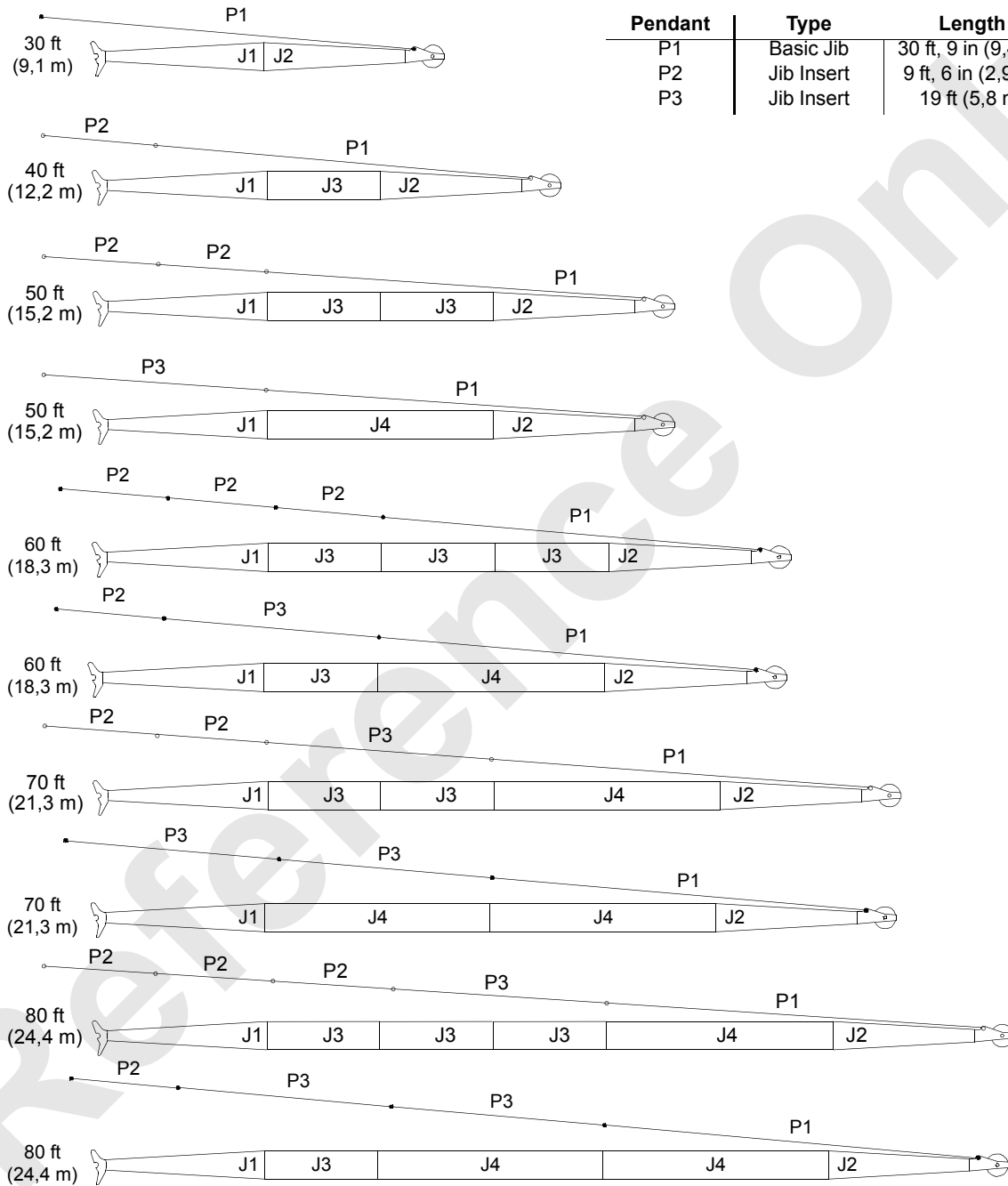


FIGURE 4-44

Jib Removal – #134



DANGER

Collapsing Jib Hazard!

To prevent death or serious injury, do not stand on, inside, or under jib during disassembly. Always stand on outside of jib when removing connecting pins.

Support jib properly before removing pins. Block sections at connection points.

Lower Boom and Jib

CAUTION

Jib Stop Damage!

Avoid jib stop damage. Do not allow jib point to contact ground until cable-actuated pins are disengaged.



WARNING

Crushing Injury!

Cable-actuated jib stop pins are spring engaged. Do not disengage control cables until safety pins are installed.

1. Lower boom until jib point is approximately 1 ft (305 mm) from contacting ground.
2. Disengage jib stop pins by hauling in cable on winch (turn handle until cable is tight and engage pawl). **Visually check that pins are disengaged.**
3. Install safety pins ([Figure 4-42](#), View B).
4. Lower boom onto blocking.
5. Remove weight ball or load block and wire rope from jib point.
6. Remove block-up limit parts from jib point and store.
7. Disconnect both ends of electric cable in jib and coil onto brackets on jib butt.

Store Jib Stop

See [Figure 4-42](#) for the following procedure.

1. Disconnect control cable from shackle (A) on cable extension (View D or H). Coil excess cable onto winch.
2. Remove cable extension from sheaves in boom point and coil cable extension onto jib stop assembly for storage.

3. Readjust length of jib stop by pinning it in 5° offset position (View A or H).
4. Remove storage pins from storage (View C).
5. Raise jib stop assembly and pin to strut with storage pins ([Figure 4-40](#), View A).

Lower Strut

See [Figure 4-41](#) for the following procedure.



WARNING!

Pendant Under Tension!

Do not disconnect pendants until pendants are slack.

1. Using appropriate slings, attach hook from assist crane to front side of sheave in jib strut. Avoid lifting jib butt/boom top in process. If required, raise jib point with an outside assist (another crane or a fork-lift truck) to gain enough slack to allow unpinning backstay pendants.
2. Disconnect backstay pendants and offset links from lugs on boom (View A).
3. Lay backstay pendants on ground alongside boom. Store offset links.
4. Lower jib strut onto jib butt.
5. Disconnect assist crane from jib strut.

Remove Backstay Pendants

See [Figure 4-41](#) for the following procedure.

1. Disconnect and remove backstay pendants (2) and spreader from strut links (View B or C).
2. Coil and store backstay pendants for future use.

Remove Jib Pendants

See [Figure 4-41](#) (View B, C, and E) for the following procedure.

1. Disconnect jib pendants from jib strut and basic jib pendants from jib top.
2. Disassemble and remove all jib pendants from jib.
3. Coil and store jib pendants for future use.
4. Store backstay spreader and links (View C).

Remove Sections

Reverse installation steps to remove jib sections.

WIRE ROPE INSTALLATION

NOTE: Wire rope manufacturer’s recommendations take precedence over information in this section.

Wire Rope Storage

Store wire rope in coils or on reels off the ground or floor in a clean and dry indoor location. If outdoor storage is necessary, the wire rope must be covered with a protective wrapper. Keep the wire rope away from acids, fumes, and other corrosives. Keep the wire rope away from heat that can dry out the lubricant. If the storage period will be long, lubricate the wire rope and perform periodic inspection given in this section at least monthly.

Removing Wire Rope from Shipping Reel

CAUTION!

Wire Rope Damage!

Shipping reel must rotate when wire rope is unwound. Attempting to remove wire rope from a stationary reel can result in a “kinked” wire rope, and wire rope will be ruined.

1. Mount wire rope shipping reel on a shaft supported at both ends by jacks or blocks as shown in [Figure 4-45](#).

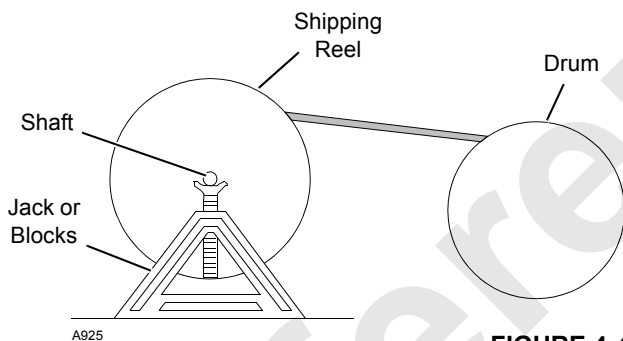
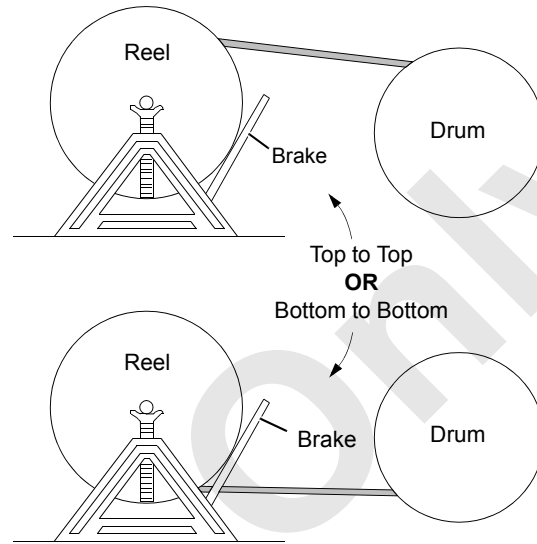


FIGURE 4-45

2. Provide a brake at shipping reel (see [Figure 4-46](#)) so wire rope can be wound tightly onto drum.



A925

FIGURE 4-46

3. **Avoid a reverse bend when winding wire rope onto drum:** wind from top of reel to top of drum or from bottom of reel to bottom of drum as shown in [Figure 4-46](#).
4. Avoid dragging wire rope in dirt or around objects that can scrape, nick, cut, or crush wire rope.

Seizing and Cutting Wire Rope

Apply tight seizings of annealed wire to the ends of all wire rope. If not done, the rope wires and strands may slacken. This action will result in overloading of some strands and underloading of others. Bird caging and breakage of the wire rope can occur.

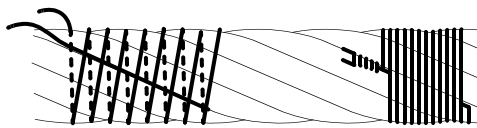
Before cutting wire rope, apply seizings on both sides of the point where the cut will be made. Then cut the wire rope with a torch, rope cutter, or abrasive cut-off wheel.

See [Figure 4-47](#) for:

- Number of seizings to be applied to the ends of wire rope and to both sides of the point where a cut will be made
- Proper application method: Each seizing should be one rope diameter long

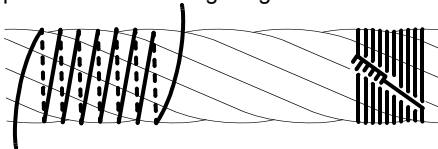
Wire Rope Type	Seizings Required
Preformed	1
Non-preformed	3

Place free end of seizing wire in valley between two stands. Then wind seizing wire over free end as shown. Finally, twist and pull two ends of seizing wire together until seizing is tight.



View A Rope Diameter 1 in (26 mm) and Larger

Wind seizing wire around wire rope as shown. Then twist two ends of seizing wire together at center of seizing. Alternately twist and pull ends until seizing is tight.



View B Rope Diameter Smaller than 1 in (26 mm)

A925

FIGURE 4-47

Anchoring Wire Rope to Drum

See [Figure 4-48](#) for the following procedure.

Use the correct wedge part number for the size of wire rope being used. See the parts drawing for the boom hoist drums or for the load drum shaft to obtain the correct part number.

1. Assemble wire rope and wedge to drum socket.
2. Tighten wedge, rapping back of wedge with a brass drift pin and hammer.

WARNING! Falling Load Hazard!

Wire rope can be pulled out of drum if the following steps are not taken.

- Install straight wedge so corrugated side is against wire rope.
- Install wedge so end of wire rope extends past end of wedge, but not out of drum socket.
- Make sure seizing is not under wedge. Remove seizing if it interferes with assembly.

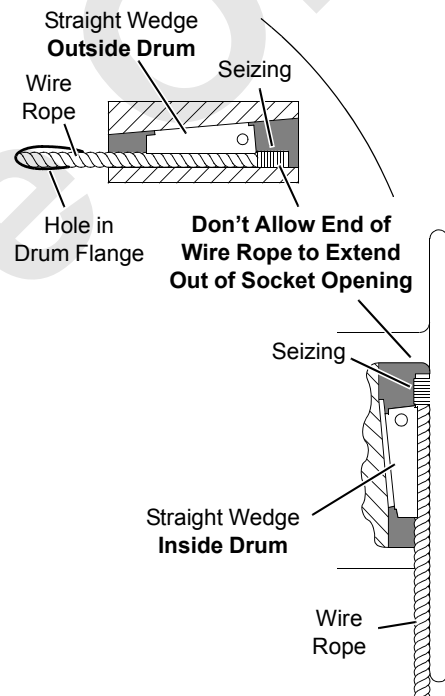


FIGURE 4-48

Winding Wire Rope onto Drum

See Drum and Lagging Chart in Capacity Chart Manual for correct size of drum laggings, if used.

See Wire Rope Specifications Chart in Capacity Chart Manual for correct type, size, and amount of wire rope to be installed on load drums.

See Boom Rigging Drawing at the end of this section for correct type, size, and amount of wire rope to be installed on boom hoist drums.

1. Carefully inspect drums and all rope guides, rollers, and sheaves for defects that can cause wire rope to wear or be cut. If defects cannot be fixed, replace faulty parts.

2. Apply tension to wire rope as it is wound slowly onto drum.

First wrap must be tight against drum flange for approximately three-fourths of drum diameter (see [Figure 4-49](#)).

3. Tap adjacent wraps against each other with a soft metal or wooden mallet.

Use extreme care not to put twists or turns in wire rope. Allow rope to assume its natural lay.

CAUTION!

Wire Rope Damage!

Voids or spaced wraps in first layer (see [Figure 4-49](#), View B) will permit movement and a wedging action with subsequent layers. Wedging action will cause crushing and abrasion of wire rope.

Never allow wire rope to “cross wind” on drums.

Anchoring Wire Rope to Wedge Socket



WARNING

Falling Load Hazard!

- Inspect all parts prior to use. Do not use parts that are cracked or otherwise defective.
- Remove minor nicks, burrs, or rough edges from socket, wedge, or pin by lightly grinding. Do not reduce original dimensions by more than 10%.
- Do not reinstall shipping material (bolt, plastic strap or wire) in hole of wedge or socket after assembling. Discard these materials because they can prevent wedge from tightening in socket.
- Only use a wedge and socket which are correct size for wire rope being used. Do not mix and match parts from one assembly with parts from another assembly.
- Terminator™ socket and wedge has “go” and “no-go” holes to check for proper rope size.
- Attach wire rope clip to dead end of wire rope after assembling wire rope to wedge and socket.
- If dead end of wire rope is welded, seize end of wire rope and cut off weld before assembling to wedge and socket. Weld will not allow strands of wire rope to adjust around bend of wedge, resulting in high strands and wavy rope. This condition can seriously weaken attachment.

See [Figure 4-50](#) for the following procedure.

1. Assemble wire rope and wedge to socket so live end of wire rope is in a straight line with socket pin hole. **Do not assemble WRONG as shown.**
2. Allow dead end of wire rope to extend past end of socket amount shown.
3. Allow wire rope to assume its natural lay.

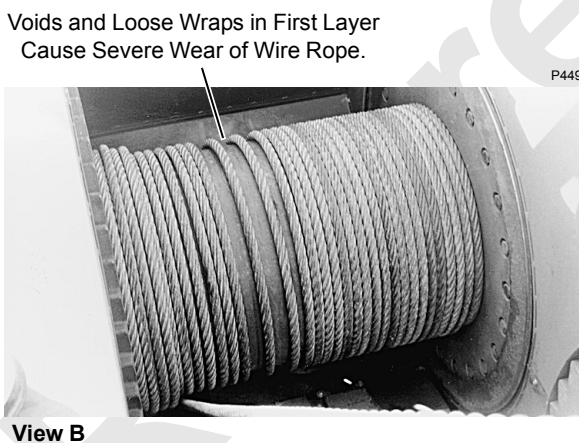
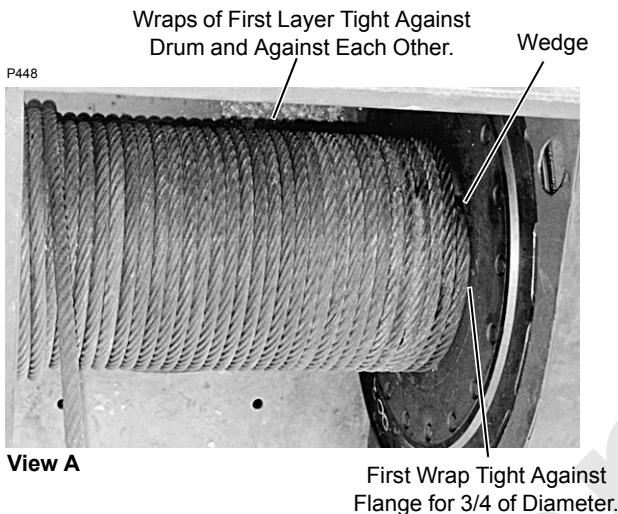


FIGURE 4-49

4. Pull against wedge and live end of wire rope enough to tighten wedge in socket.

Use a brass hammer to seat wedge and wire rope as deep into socket as possible.

5. Attach a wire rope clip to dead end of wire rope using one of the RIGHT methods shown. Rope clip will aid in preventing wire rope from being pulled out of socket.

NOTE: Use Right Method A only if wire rope clip is small enough to be securely tightened to dead end. Right Method C is only for a terminator wedge socket.

6. After socket is pinned in place, hoist load slowly so wedge seats tight. **Do not shock load socket and wedge.**



WARNING
Falling Load Hazard!

Wire rope can break if the following precaution is not observed:

- Do not attach dead end of wire rope to live end of wire rope with wire rope clip. Wire rope clip will transfer load from live side of wire rope to dead end, seriously weakening attachment.
-

Wire Rope/Clip Size inch (mm)	0.875 (22,23)	1.0 (25,4)	1.125 (28,58)	1.25 (31,75)
Torque * ft/lbs (kN/m)	225 (0,30)	225 (0,30)	225 (0,30)	360 (0,49)

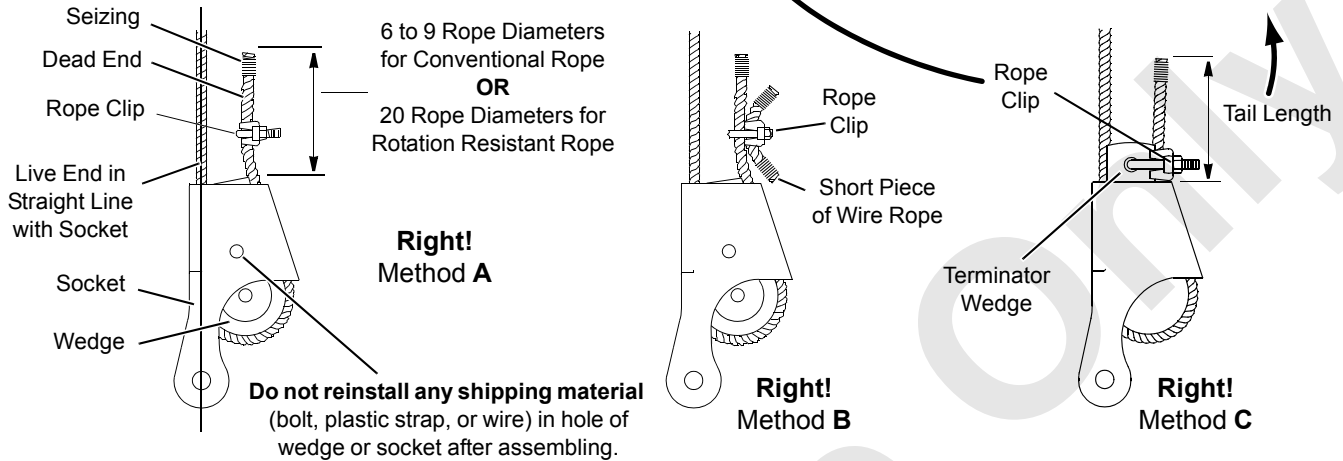
* Tightening torque values shown are based on threads being clean, dry and free of lubrication.

Standard 6 to 8 Strand Wire Rope

Minimum of 6 rope diameters, but not less than 6 in (152 mm).

Rotation Resistant Wire Rope

Minimum of 20 rope diameters, but not less than 6 in (152 mm).



ALL ARE DANGEROUS AND PROHIBITED!

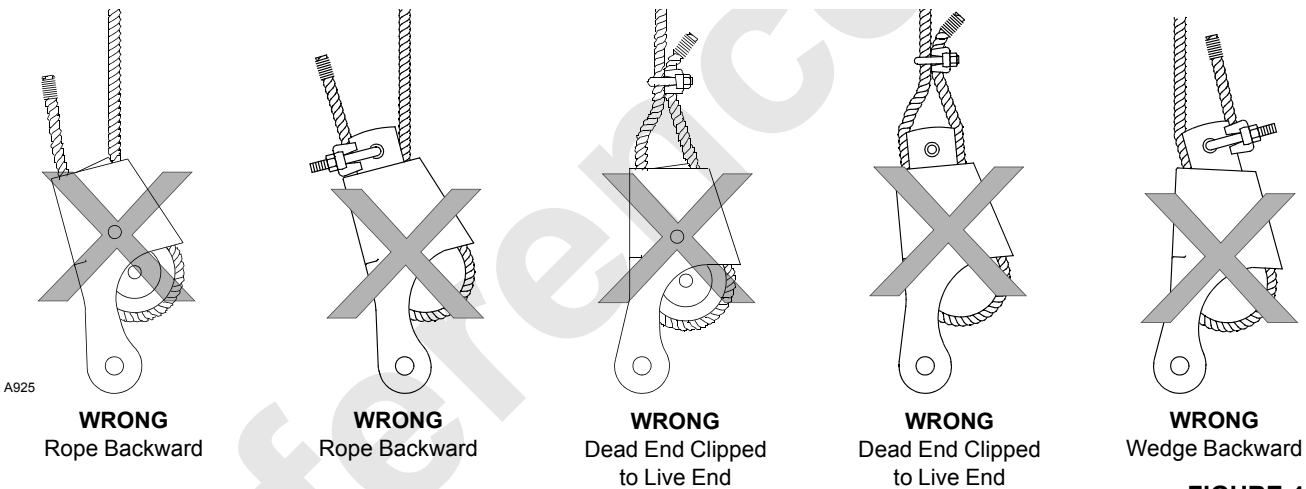


FIGURE 4-50

Anchoring Wire Rope to Button Socket

See [Figure 4-51](#) for the following procedure.

1. Remove pin from socket.
2. Install button end of load line in socket.
3. Pin socket to anchor point.
4. Securely tighten locking screw.

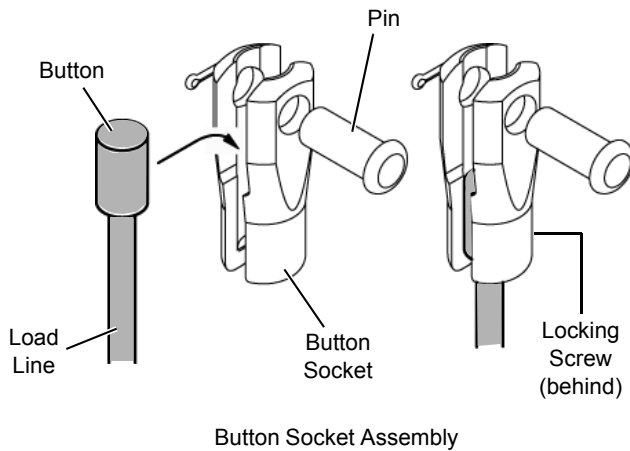


FIGURE 4-51

A1263

Breaking in Wire Rope

After installing a new wire rope, break it in by operating it several times under light load and at reduced speed. This practice allows the wire rope to form its natural lay and the strands to seat properly.

NOTE: Wire rope will stretch during the break-in period, reducing the wire rope's diameter as the strands compact around the core.

The dead wraps of wire rope on the drum can become slack during operation, even if the utmost care is used during installation of the wire rope. This slackening is caused by the normal stretch that occurs in a new wire rope under tension and periodically throughout the wire rope's life from release of the load.

When slackness is noted, tightly wind the dead wraps of wire rope onto the drum. If left uncorrected, a wedging action with subsequent layers will occur, and the resultant abrasion may cause broken wires in the dead wraps.

PAD EYE USAGE FOR WIRE ROPE REEVING

See [Figure 4-52](#) for the following procedure.

General

Some rotation-resistant wire rope supplied by Manitowoc is equipped with a No. 1.5 pad eye welded to the leading end of the wire rope.

A sucker-line can be attached to the pad eye to make it easier to reeve the load block.

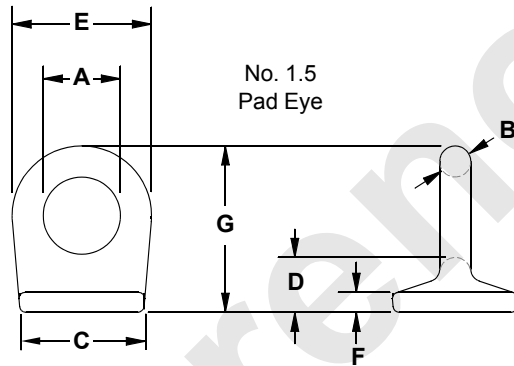
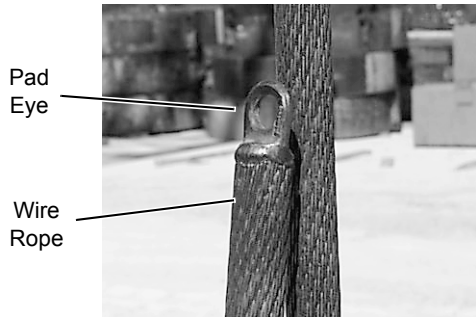
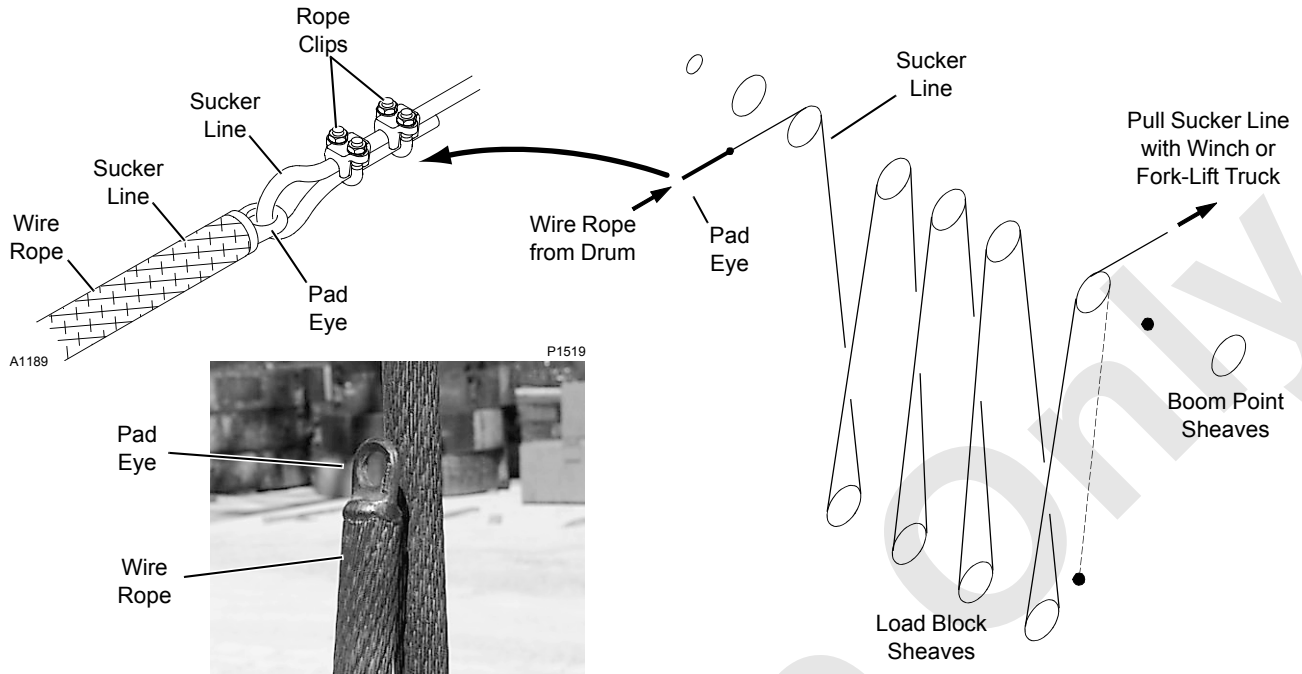
Safety

1. For No. 1.5 pad eye, do not exceed 1,000 lb (4,45 kN) single line pull.
2. Make sure sucker line and rope clips are rated for at least 1,000 lb (4,45 kN) line pull.
3. Inspect pad eye prior to each use. **Replace it if:**
 - Any original dimensions have changed ([Figure 4-52](#))
 - Cracks or breaks exist in metal or weld

! WARNING
Flying Part Hazard!

Pad eye on end of wire rope has been provided **for reeving purposes only**. Any other use is neither intended nor approved.

Pad eye can break and fly apart with considerable force if it is overloaded, not used properly, or not maintained properly.



Item	Inch	mm
A	0.63	16,00
B	0.25	6,35
C	1.00	25,40
D	0.44	11,18
E	1.13	28,70
F	0.16	4,06
G	1.31	33,27

FIGURE 4-52

LOAD LINE REEVING

Wire Rope Specifications

See Wire Rope Specifications Chart in Capacity Chart Manual for the following information:

- Parts of line required for various loads
- Wire rope lengths and notes about hoisting distance for various parts of line
- Maximum spooling capacity of load drums

CAUTION

Wire Rope Damage!

Avoid wire rope damage from improper fleet angle or contact with adjacent parts. Do not hoist load block or hook and weight ball any closer to boom or jib points than specified on Range Diagram in Capacity Chart Manual.

Wire Rope Installation

See [Wire Rope Installation](#) for the following instructions:

- Anchoring wire rope to drums
- Installing wire rope on drums
- Anchoring wire rope to wedge sockets

Liftcrane – #22EL or #82HL Boom

Reeving Diagrams

See [Figure 4-55](#) for suggested reeving diagrams.

See [Figure 4-53](#) for component identification and dead-end locations in boom and jib.

Dead-End Locations – Lower Boom Point

Depending on reeving requirements, it may be necessary to switch the middle and right sheave clusters ([Figure 4-53](#)) to properly position the dead-end link. See Lower Boom Point Installation on [page 4-80](#) for instructions.

Guide Sheave Identification

See [Figure 4-54](#) for identification of wire rope guide sheaves on boom.

The guide sheaves **must** be positioned at the specified dimensions to ensure proper fleet angles.

The wire rope must be routed through the load sensing sheaves as shown in [Figure 4-53](#).



WARNING

Falling Load Hazard!

Avoid damage to wire rope or wire rope guides. Route wire rope from load drums **over top** of proper sheaves in wire rope guides as shown in [Figure 4-53](#). Failing to route wire rope as shown can cause wire rope to break and load to fall.

Universal Anchor Joint

A universal anchor joint ([Figure 4-53](#)) is available on the #134 jib to provide a dead-end location for 2-part reeving from the jib point.

See Universal Anchor Joint on [page 4-109](#) for a complete description of the universal anchor joint and for safety information.

Load Blocks

The following load blocks are available from Manitowoc:

- 45 U.S. Ton (41 Metric Ton) with one sheave. This is same block used for self-erecting on Model 999. It can be used for 3-part reeving.
 - 60 U.S. Ton (54,4 Metric Ton) with two sheaves
 - 100 U.S. Ton (90,7 Metric Ton) with three sheaves
 - 200 U.S. Ton (181,4 Metric Ton) with six sheaves
 - 220 U.S. Ton (200 Metric Ton) with three sheaves
 - 220 U.S. Ton (200 Metric Ton) with seven sheaves
 - 250 U.S. Ton (227 Metric Ton) with eight sheaves
-



WARNING

Falling Load Hazard!

Load block capacity must be equal to or greater than weight of load to be handled. Load block can fail if overloaded, allowing load to fall.

A873
A920

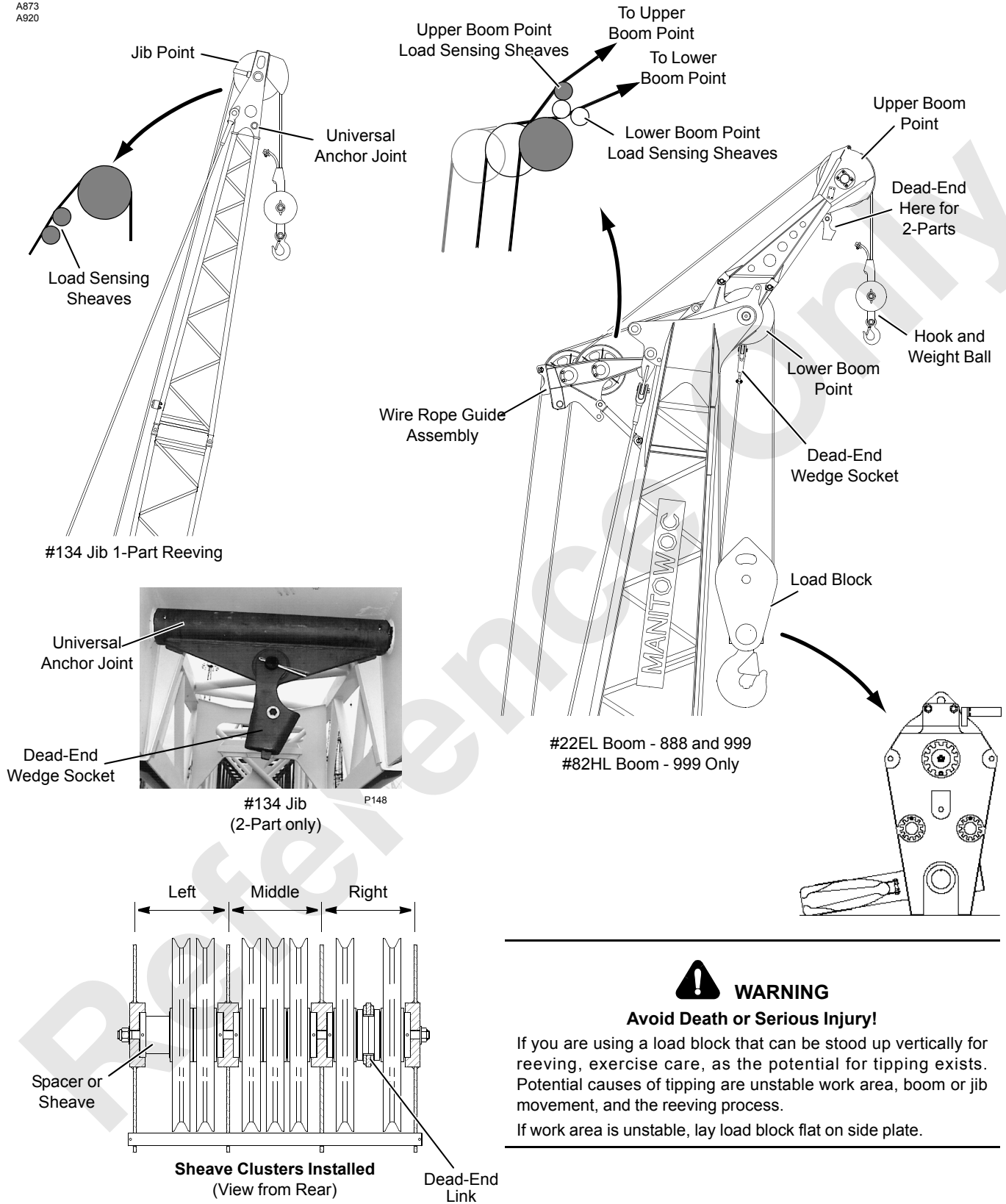
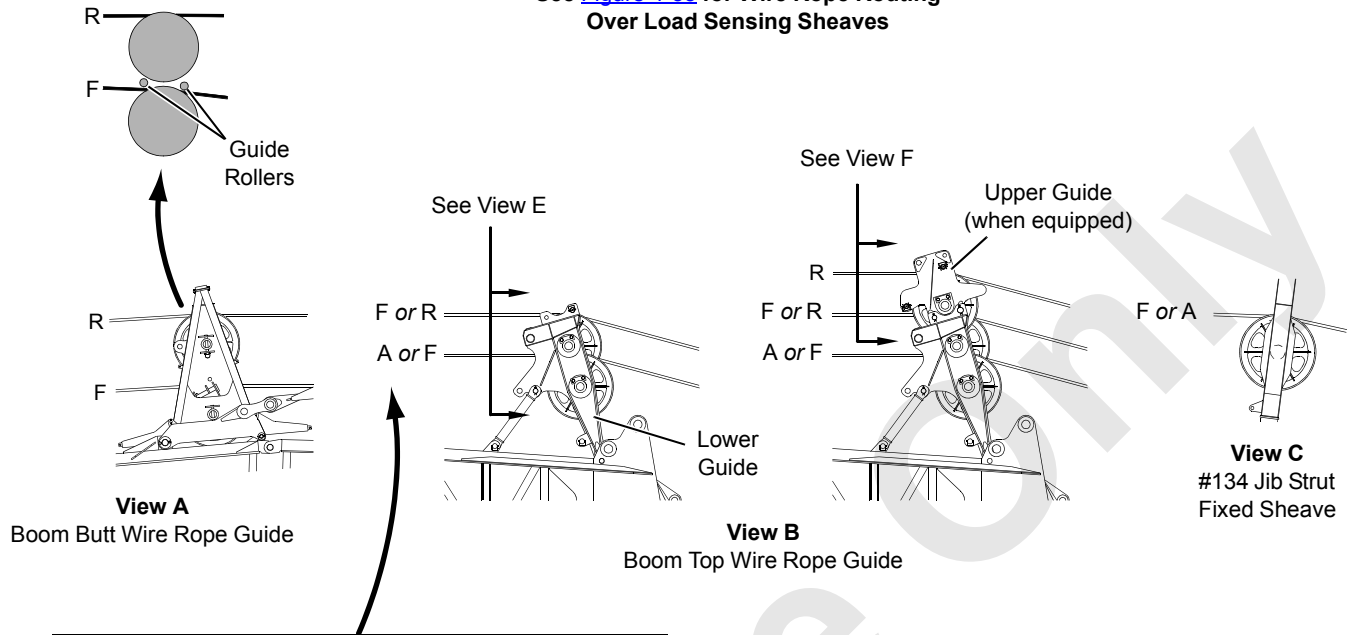


FIGURE 4-53

A920

See [Figure 4-53](#) for Wire Rope Routing Over Load Sensing Sheaves



CAUTION

Avoid Wire Rope Damage!

Do not allow load lines routed from boom butt wire rope guide to boom top wire rope guide to cross one another.



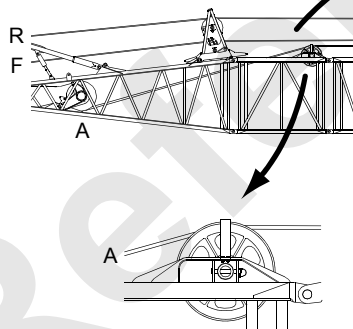
WARNING

Falling Load Hazard!

Route wire rope from auxiliary drum as shown. Rope must travel in a straight line from bottom of auxiliary drum over top of sheave on insert.

- Rope must travel through top of "X" formed by diagonal lacings in end of butt and insert.
- Rope must travel over rear of plate work on top of insert.

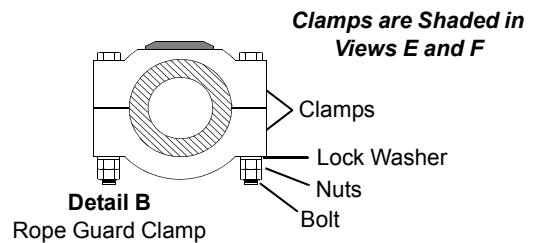
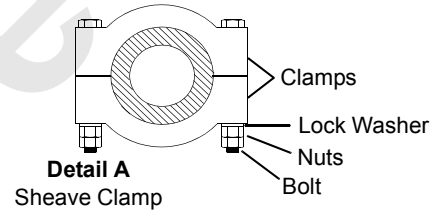
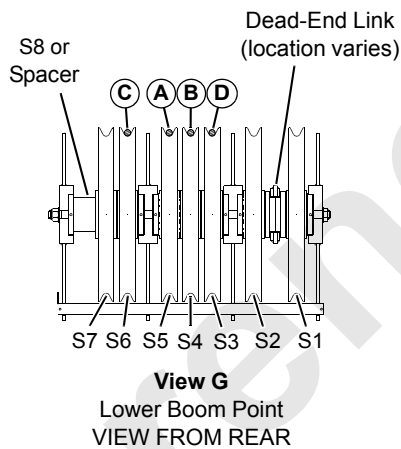
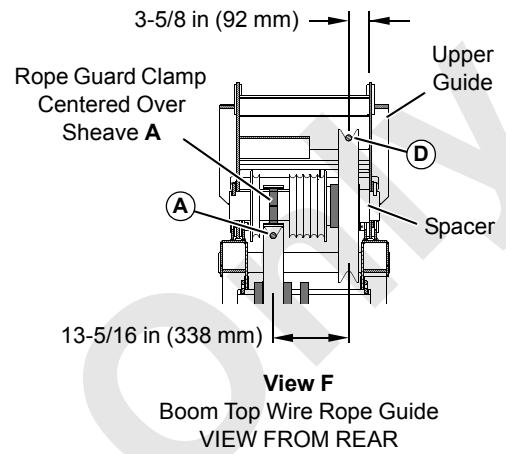
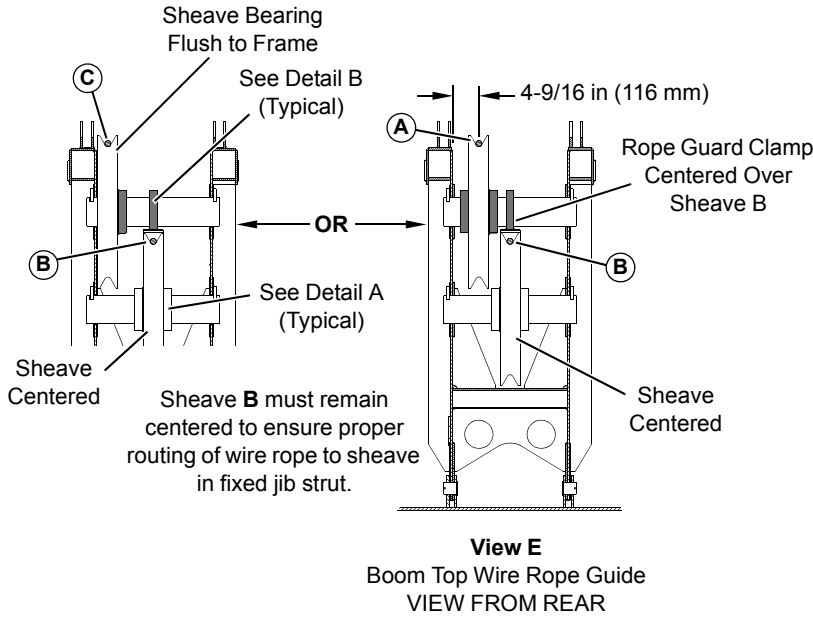
Wire rope could break allowing load to fall if these steps are not followed.



View D

Auxiliary Drum Wire Rope Guide on 10 ft (3,1 m) Insert

FIGURE 4-54

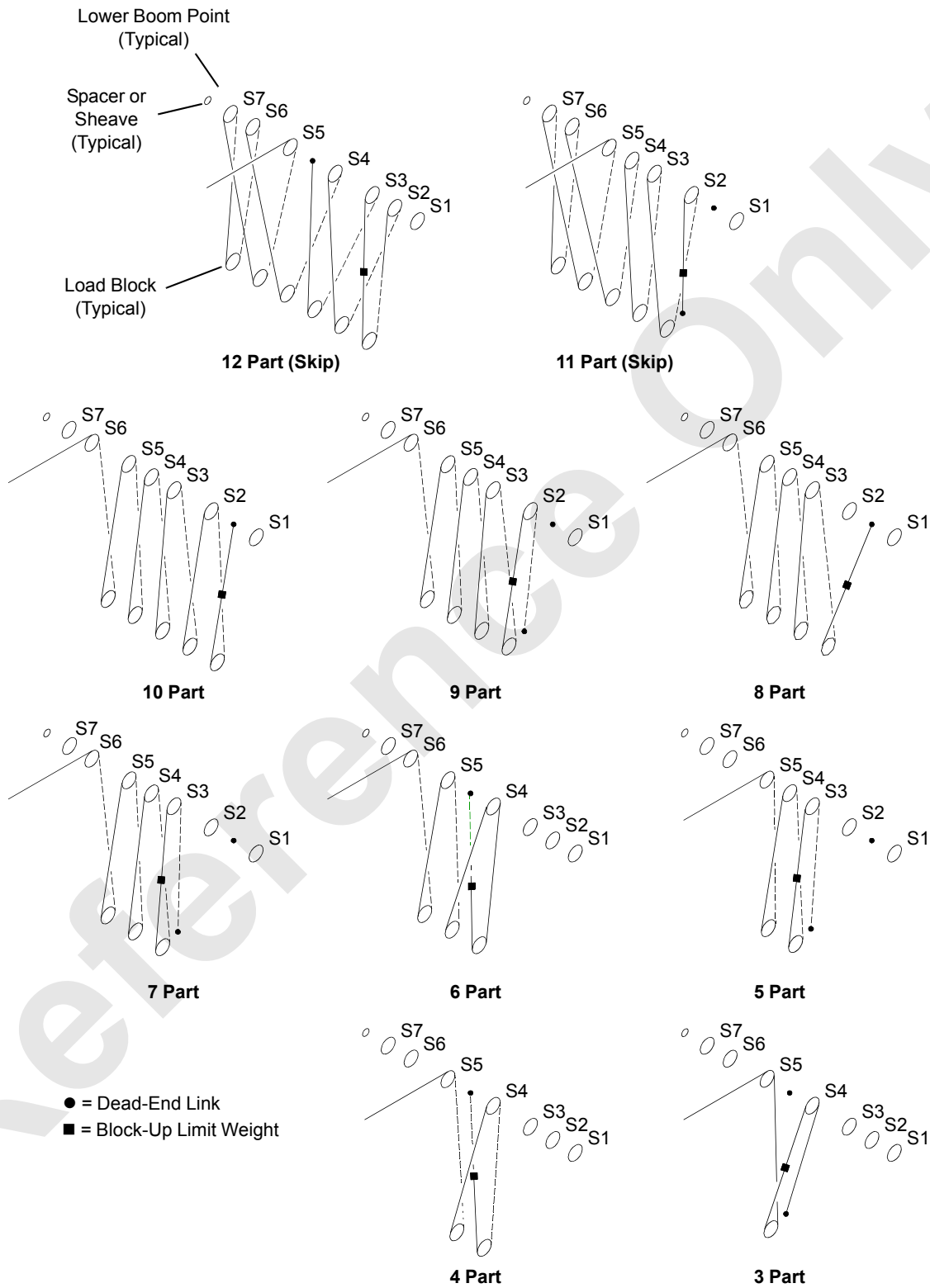


Boom Top Wire Rope Guide Sheaves — Lower Guide	
Item	Description
(A)	Sheave position for rope from F or R drum to lower boom point sheave S5.
(B)	Sheave position for rope from F or A drum to upper boom point, #134 jib point sheave, or lower boom point sheave S4.
(C)	Sheave position for rope from F or R drum to lower boom point sheave S6.
Boom Top Wire Rope Guide Sheaves — Upper Guide	
(D)	Sheave position used for rope from R drum to lower boom point sheave S3.

NOTES	
F =	Front Drum
A =	Auxiliary Drum
R =	Rear Drum
Route wire rope over top of all sheaves.	
Auxiliary drum is faster than front drum, but it has less line pull than front drum.	
Sheaves must be positioned at indicated dimensions with clamps (see Details A and B).	

FIGURE 4-54 continued

A881



4

FIGURE 4-55

A881

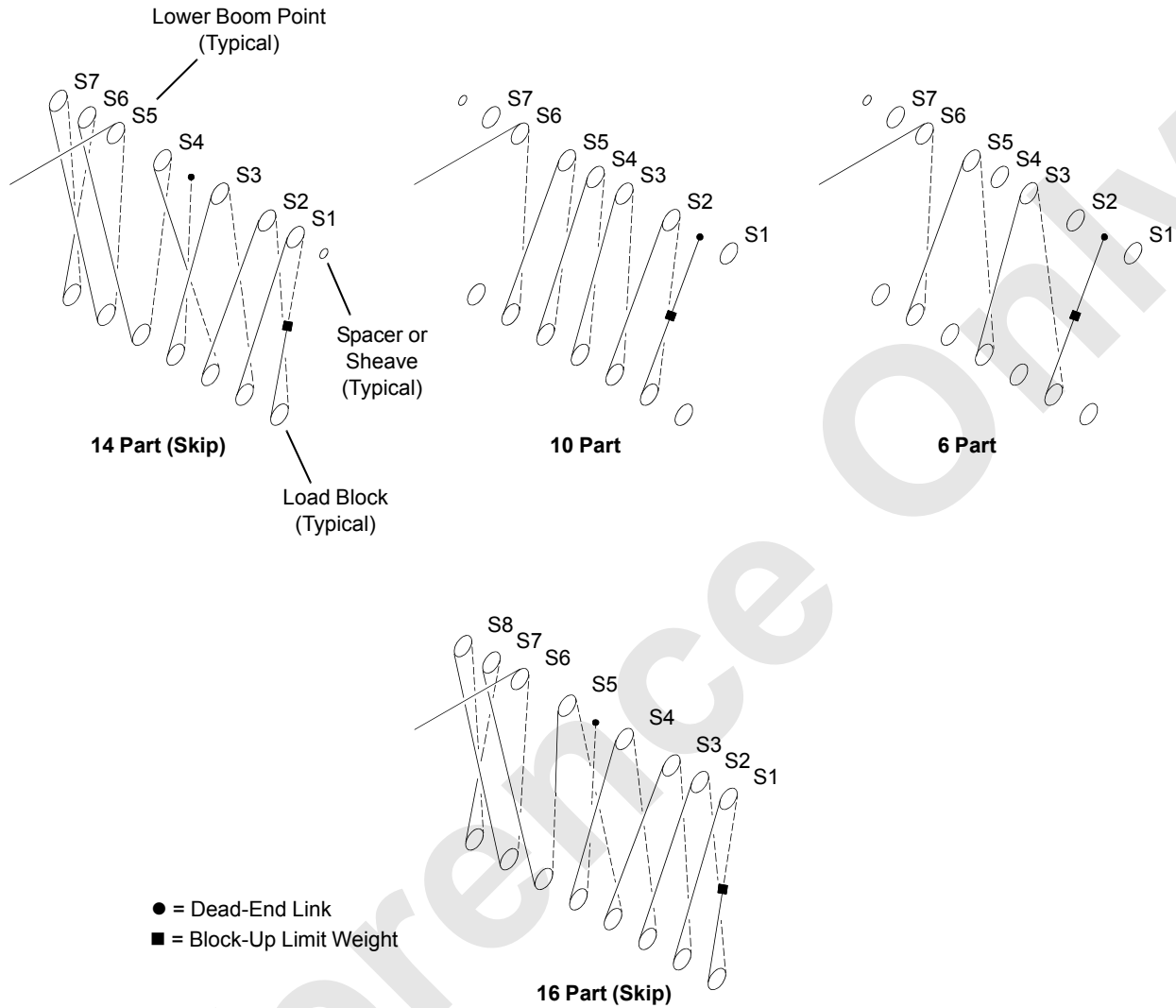


FIGURE 4-55 continued

Clamshell – #22EL or #82HL Boom

CAUTION Rope Wear!

Sheaves in boom top wire rope guide and lower boom point must be positioned as shown in [Figure 4-56](#), Views B and D to ensure proper fleet angles.

Wire rope life will be reduced if sheaves are not properly positioned.

See [Figure 4-56](#) for the following procedures.

Guide Sheave Positions for Clamshell

See [Figure 4-54](#) for routing of the load lines through the guide sheaves in the boom butt.

Boom Top Wire Rope Guide Sheaves

- Modify gusset in boom top wire rope guide as shown in Drawing A07895

- Move sheave on lower shaft (View A) to upper shaft (View B)
- Position sheaves on upper shaft as shown in View B

Boom Point Wire Rope Guide

- Remove both outer sheave clusters from lower boom point, and install wire rope guide as shown in Views C and D.

Center sheave cluster can have either three sheaves or two sheaves and a dead-end link (between sheaves).

If center sheave cluster has a dead-end link, link must be positioned as shown in View C.

- Center sheave cluster and wire rope guide frame must be centered in boom point. Add shims at locations indicated in View D to limit end play to 0.030 in. (0,762 mm).

A873
A920

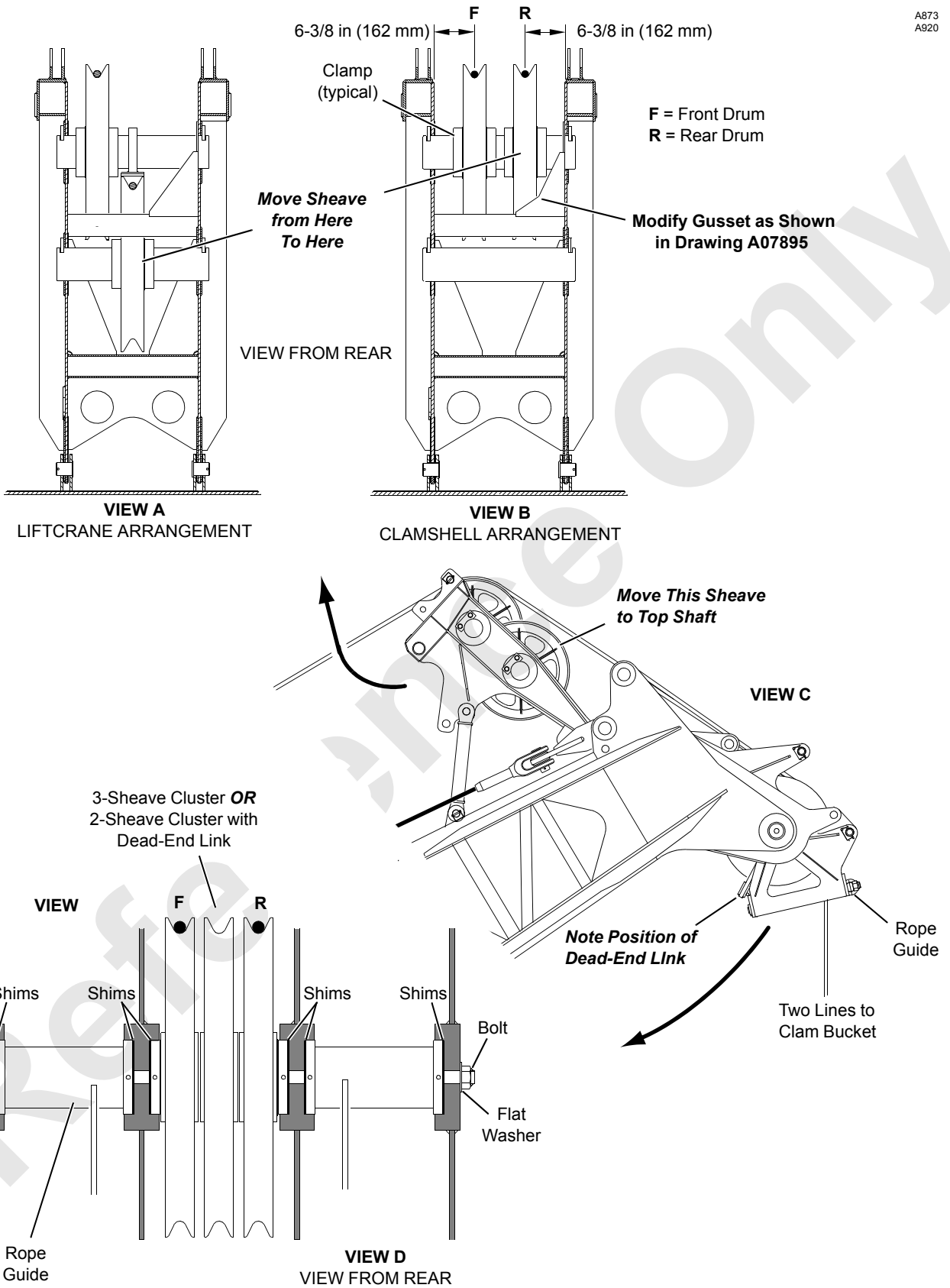


FIGURE 4-56

Liftcrane – #82 LR Boom

Reeving Diagrams

See [Figure 4-57](#) for suggested reeving diagrams. To obtain maximum lifting capacity from the lower boom point, 9-parts of line are required. To accommodate this reeving, the upper boom point must be used as shown.

Guide Sheave Identification

See [Figure 4-58](#) for identification of the wire rope guide sheaves on the boom and jib.

Universal Anchor Joint

A universal anchor joint is available to provide a dead-end location for 2-part reeving from the jib point.

See Universal Anchor Joint on [page 4-109](#) for a complete description of the universal anchor joint and for safety information.

! WARNING
Falling Load Hazard!

Avoid damage to wire rope or wire rope guides. Route wire rope from load drums **over top** of proper guide sheaves as shown in [Figure 4-58](#). Failing to route wire rope as shown can cause wire rope to break and load to fall.

Falling Load Hazard!

Load block capacity must be equal to or greater than weight of load to be handled. Load block can fail if overloaded, allowing load to fall.

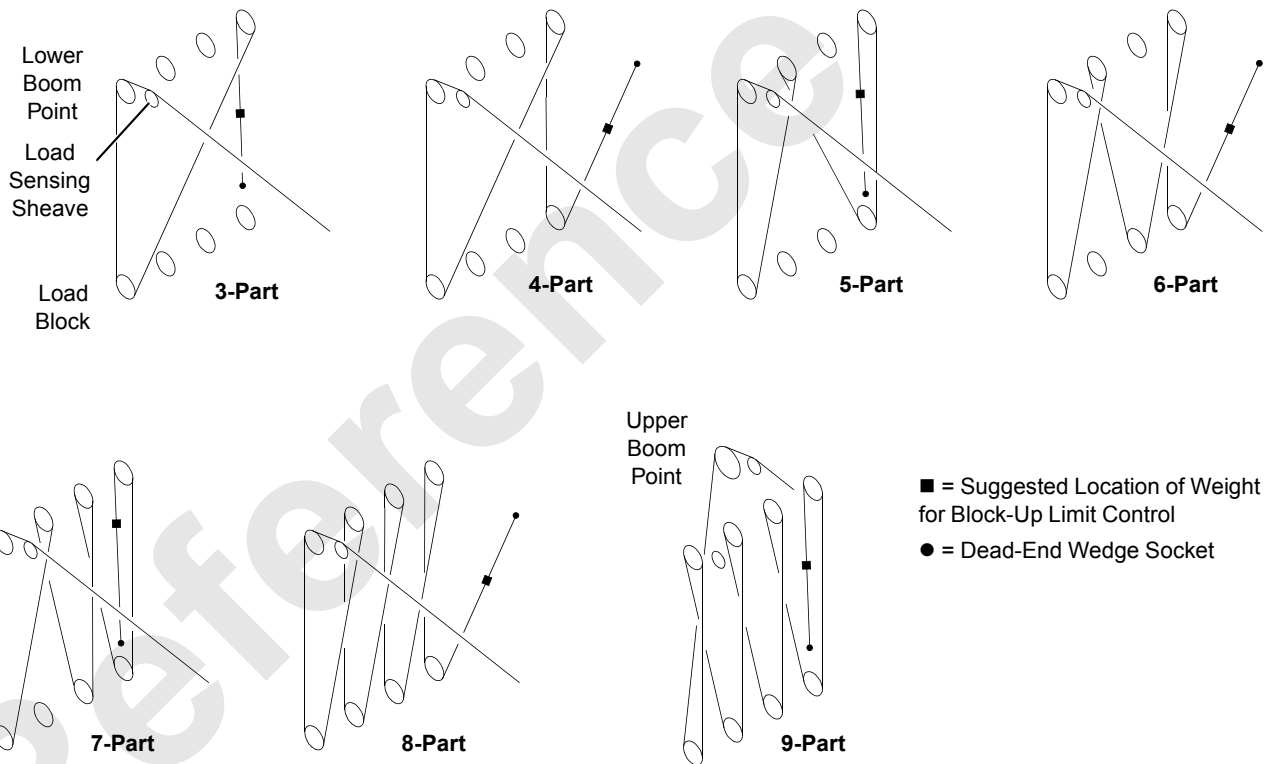
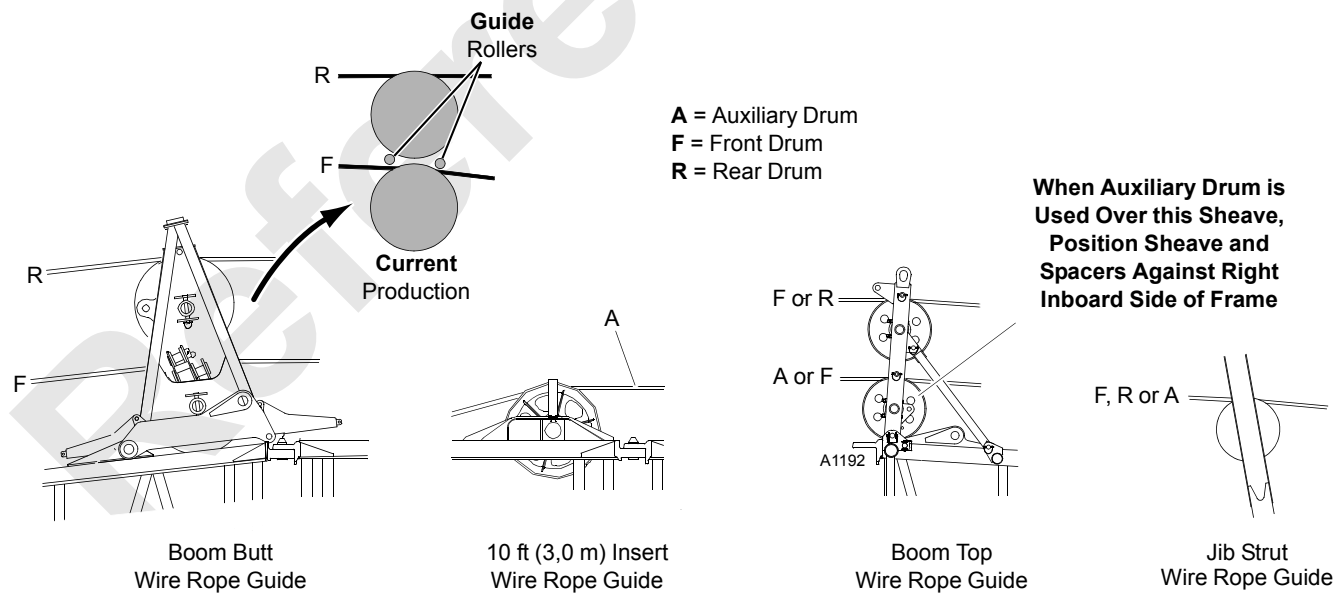
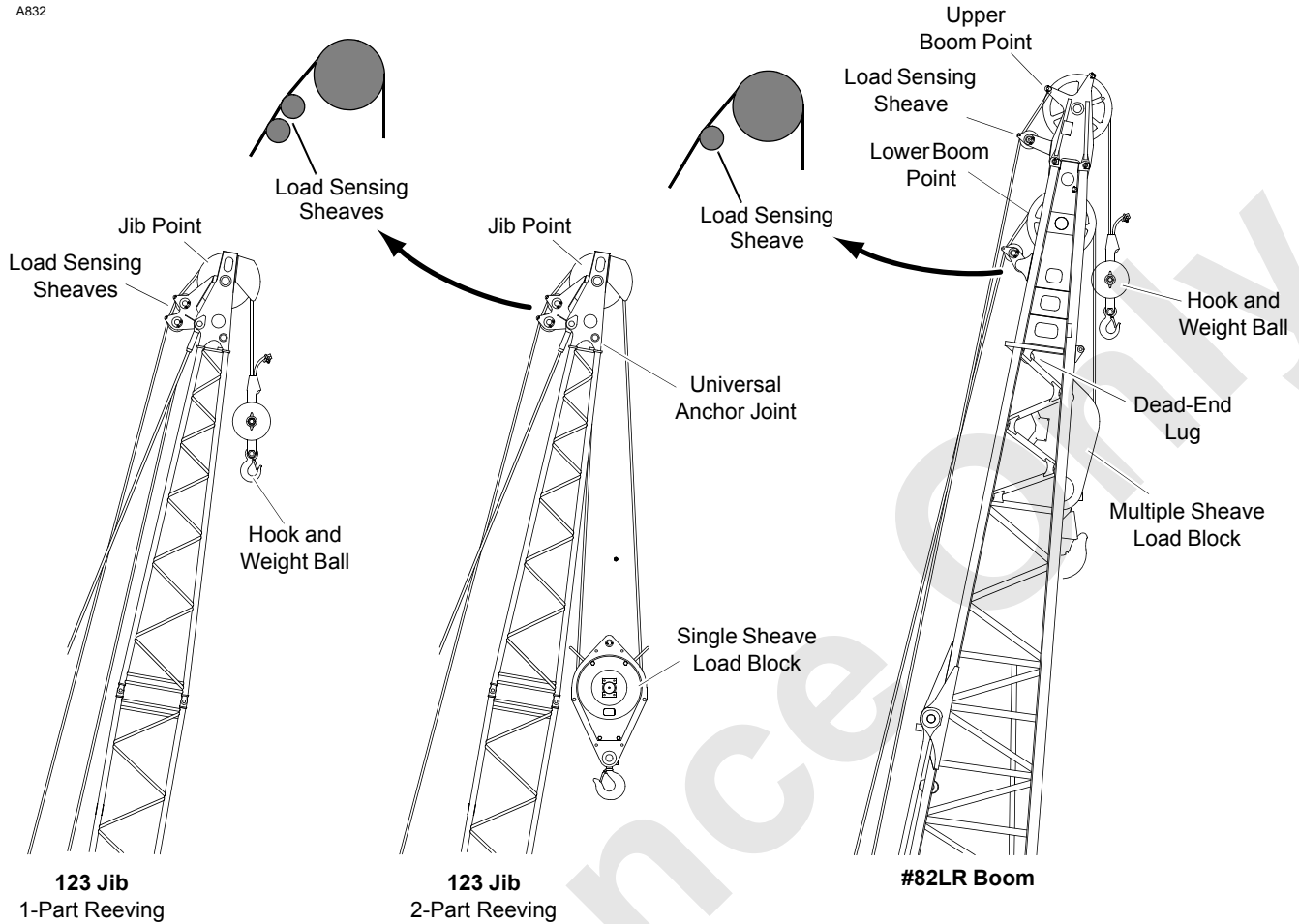


FIGURE 4-57

A832



Route Wire Rope Over Top of All Sheaves

FIGURE 4-58

Liftcrane – #22E Boom with Light Tapered Top

Reeving Diagrams

See [Figure 4-59](#) for suggested reeving diagrams. To obtain maximum lifting capacity from the lower boom point, 9-parts of line are required. To accommodate this reeving, the upper boom point must be used as shown.

Guide Sheave Identification

See [Figure 4-60](#) for identification of the wire rope guide sheaves on the boom and jib.

Universal Anchor Joint

A universal anchor joint is available to provide a dead-end location for 2-part reeving from the boom point.

See Universal Anchor Joint on [page 4-109](#) for a complete description of the universal anchor joint and for safety information.

! WARNING
Falling Load Hazard!

Avoid damage to wire rope or wire rope guides. Route wire rope from load drums **over top** of proper guide sheaves as shown in [Figure 4-60](#). Failing to route wire rope as shown can cause wire rope to break and load to fall.

Falling Load Hazard!

Load block capacity must be equal to or greater than weight of load to be handled. Load block can fail if overloaded, allowing load to fall.

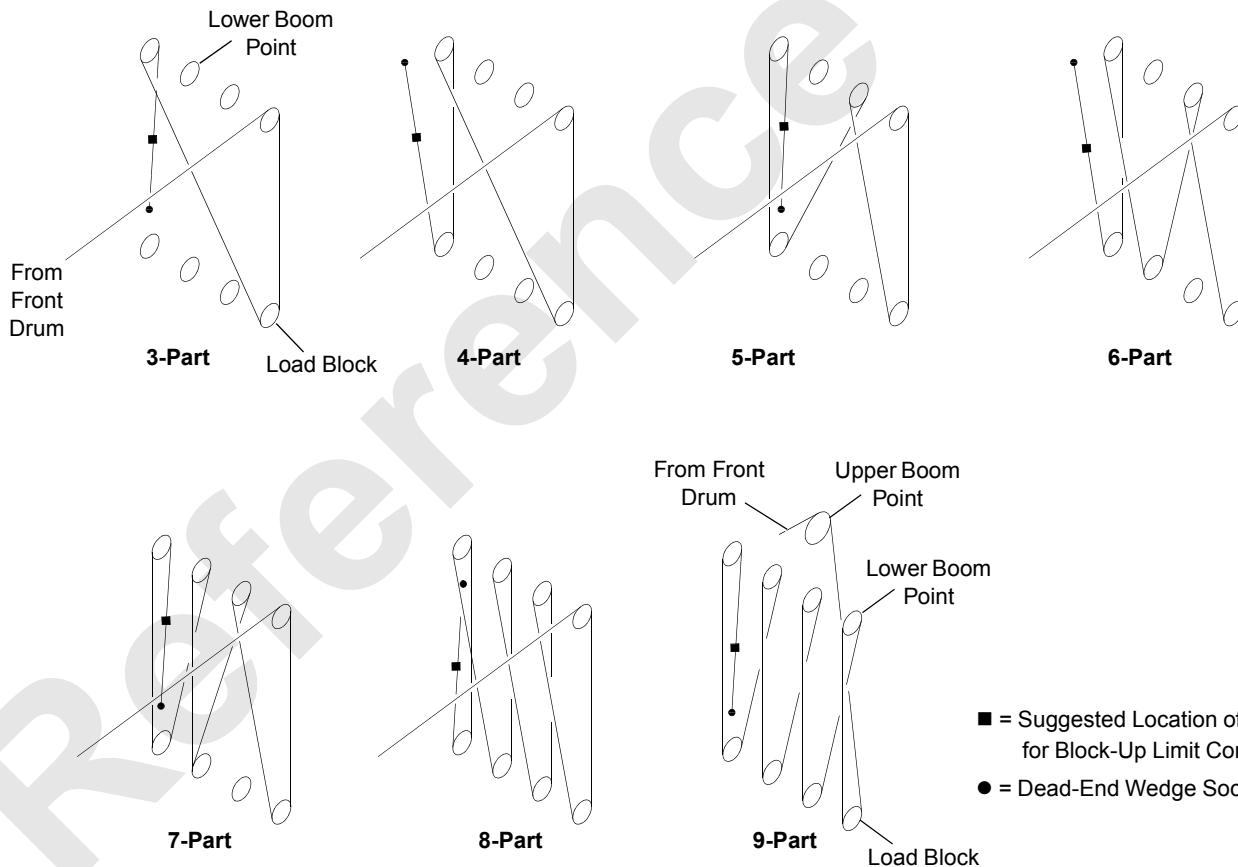


FIGURE 4-59

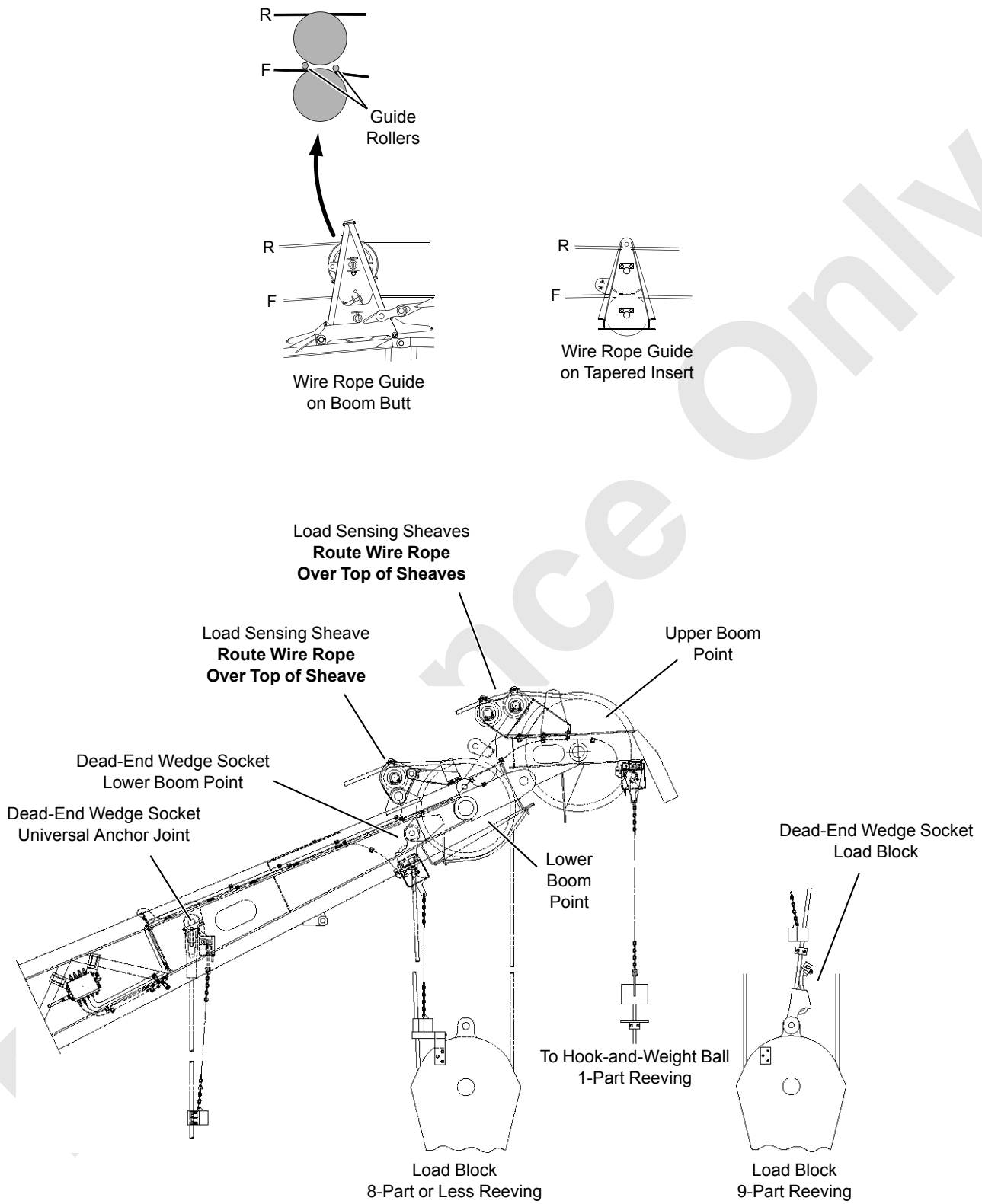


FIGURE 4-60

UNIVERSAL ANCHOR JOINT

The dead-end socket and wedge can be anchored to any of the following locations in the boom and jib point, depending on the type of operation (see [Figure 4-61](#)):

1. Link (if equipped) in boom or jib point for liftcrane operation.
2. Lug welded inside boom or jib point directly behind boom or jib point shaft for liftcrane operation.
3. Universal anchor joint located 30 in (0,8 m) to 72 in (1,8 m) behind boom or jib point. This location provides greater separation between the load lines which reduces twisting of the load. The universal anchor joint is used for magnet, clamshell, grapple and liftcrane operation requiring a 2-part load line. For container handling or rock tray operation, a double hanger universal anchor joint is used.

NOTE: Movement of the dead-end socket on the link or lug (1 and 2 above) is in two directions only – forward and back (see [Figure 4-61](#)). Movement of the dead-end socket on the universal anchor joint (3 above) is in four directions – forward, back and sideways (see [Figure 4-61](#)).

If the anchor link or lug in the boom or jib point has been used for any duty-cycle work with a 2-part load line, check for cracks due to side bending loads. Consult with factory for repair procedure.

If the boom or jib point is not prepared for the universal anchor joint, the boom or jib top is neither designed for nor intended for duty-cycle work.

For liftcrane operation requiring 3-parts of load line or greater, it is necessary to remove the universal anchor joint. This step will prevent interference of the universal anchor joint with the wire rope at high boom angles.

! WARNING
Falling Load Hazard!

Do not operate as liftcrane at high boom angle with universal anchor joint in place. Interference of wire rope with universal anchor joint can damage wire rope causing rope to break and load to fall.

For wire rope size and maximum load of universal anchor joint, see appropriate wire rope chart, capacity chart, or rigging drawing.

! WARNING
Falling Load Hazard!

Do not dead-end a 2-part load line to anchor link or lug in boom or jib point for magnet, clamshell, grapple or other operations requiring rapid swing cycles. Sideways motion may break link or lug causing load to fall.

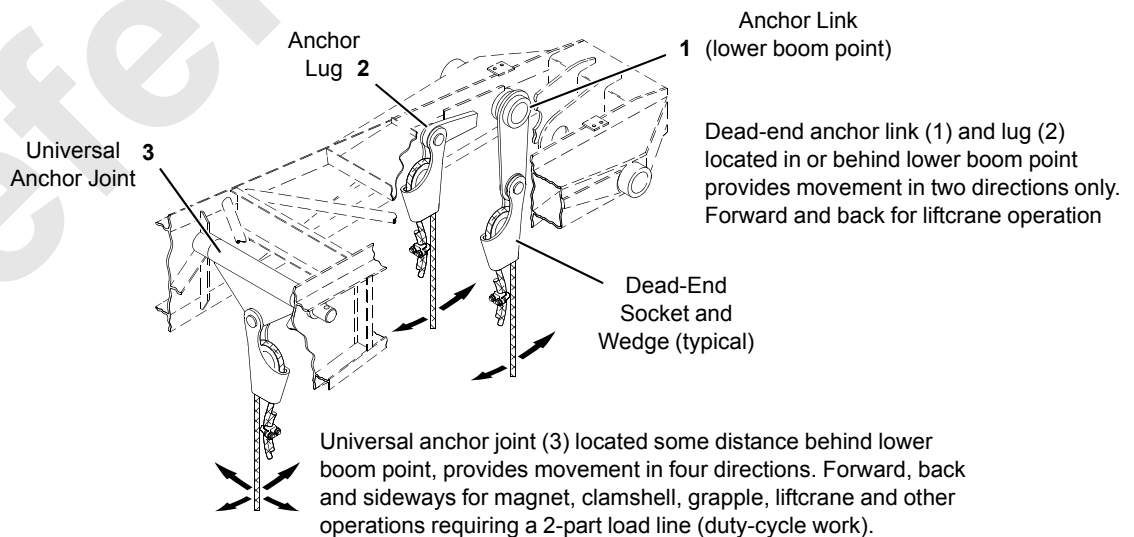


FIGURE 4-61

LOAD BLOCK TIEBACK

General

A lug is provided on the front of the rotating bed (Figure 4-62, View A) for tying back the load block when not in use.

Specifications

Shackle

See Figure 4-62 for identification of tieback hole diameter and shackle size.

Sling Length

The sling should be long enough to connect it to a shackle in the tieback hole and to the hook of the freely suspended load block. This will prevent personnel from having to swing the block in, toward crane, to make the connection.

Sling Capacity

The slings must be capable of supporting the weight of the load block and 1/2 the weight of the wire rope suspended

from the boom point. When sizing slings, take into account the dynamic affects of traveling and swinging the crane. ***It is the crane user's responsibility to calculate this load.***

CAUTION

Avoid damage to boom!

- Haul in load line only until tieback sling(s) is taut. Purpose of tieback is only to prevent load block from swinging when not in use.
- Do not tighten load line to point that load line rubs against lacings in boom sections or load block can bounce into lacings.

Operator, be aware that as you boom down load lines and tieback sling will tighten even more. Pay out load line while booming down so that you don't pull load block into boom. Damage to lacings or chords could result.

A630

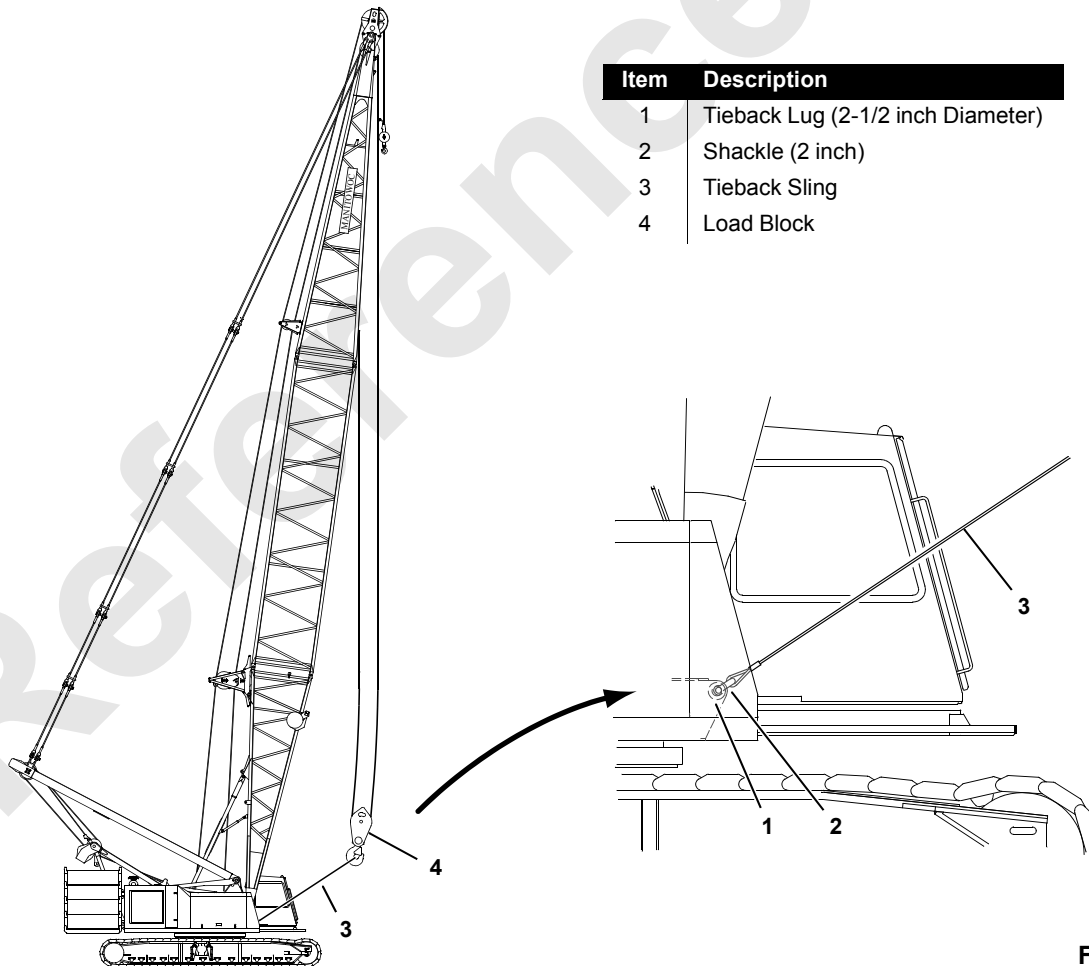


FIGURE 4-62

BOOM HOIST REEVING

See [Figure 4-63](#) for the following procedure.

The boom hoist wire rope must be reeved between the gantry and mast sheaves as shown in View A.

Manitowoc provides a 7/8 in (22 mm) terminator wedge socket for anchoring the wire rope to the dead-end link in the gantry, View B.

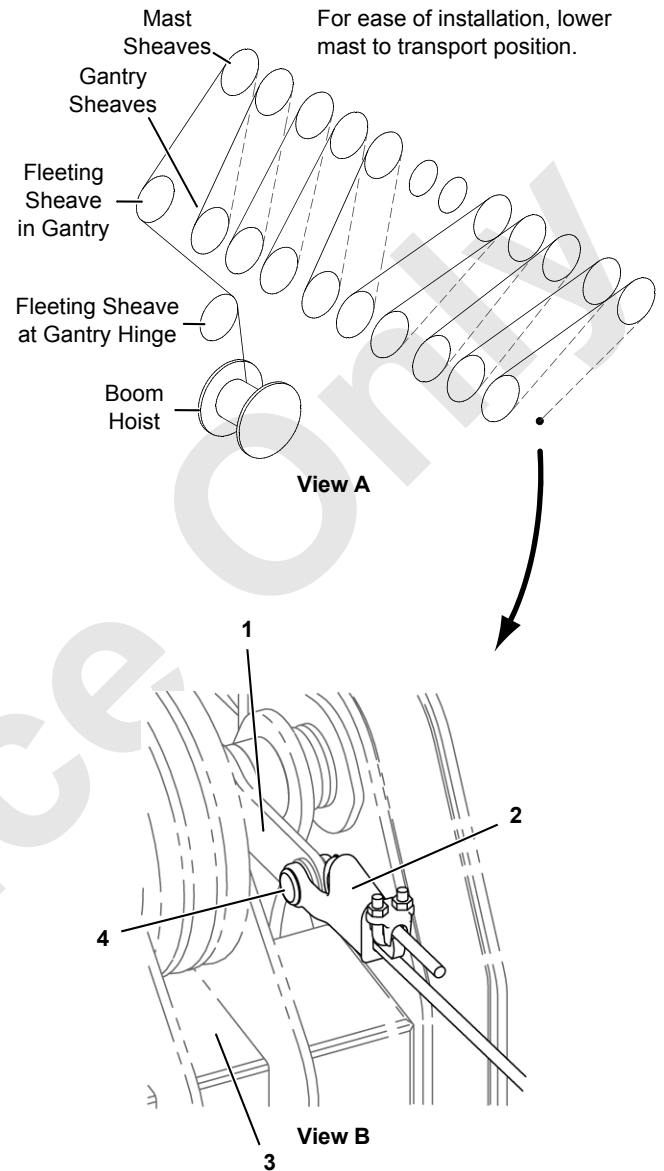
The wire rope tail length must be at least 6 in (152 mm).

NOTE: Wedge socket terminator pin position critical; pin head to face gantry sheave pack, View B.

Wire Rope Installation

See Wire Rope Installation and Maintenance on [page 4-90](#) for instructions on how to:

- Anchor wire rope to the drum
- Install wire rope on the drum
- Anchoring wire rope to wedge socket



Item	Description
1	Dead-End Link on Gantry
2	Wedge Socket - Terminator
3	Gantry
4	Wedge Socket - Pin

195449
81012634

FIGURE 4-63

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 5 LUBRICATION

TABLE OF CONTENTS

Lubrication	5-1
Lube and Coolant Product Guide	5-1

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 5 LUBRICATION

LUBRICATION

See F2080 at the end of this section.

LUBE AND COOLANT PRODUCT GUIDE

See the publication at the end of this section.

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 6 MAINTENANCE CHECKLIST

TABLE OF CONTENTS

Inspection and Maintenance Checklist	6-1
Fiberglass Maintenance	6-1

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

SECTION 6 MAINTENANCE CHECKLIST

INSPECTION AND MAINTENANCE CHECKLIST

See F2097 at the end of this section.

FIBERGLASS MAINTENANCE

See Bulletin W04-009 at the end of this section.

Reference Only

THIS PAGE INTENTIONALLY LEFT BLANK

Reference Only

ALPHABETICAL INDEX

Assembling, Disassembling, or Operating Crane Near Electric Power and Transmission Lines	2-15
Accessing Parts	4-2
Accidents	2-17
Assembly and Disassembly Area	4-2
Assembly and Disassembly Notes	4-2
Auxiliary Load Drum Installation	4-52
Boom and Jib Rigging	4-56
Boom Disassembly Safety	2-20
Boom Hoist Reeving	4-111
Boom Ladder Assembly	4-54
Change of Ownership Registration	1-1
Cold Weather Heater Package	3-65
Cold Weather Mast Operation	4-3
Connecting/Disconnecting Hydraulic Hoses, Air Lines, and Electric Cables	4-2
Continuous Innovation	2-1
Crane Access Points	2-5
Crane Assembly	4-9
Crane Data	1-1
Crane Diagnostics	3-54
Crane Disassembly	4-34
Crane Orientation	1-1
Crane Orientation	4-1
Crane Weights	1-20
Crane Weights	4-2
Crane/Attachment Identification	1-1
Display Readings	3-48
Engine Exhaust Pipe	4-7
English and Metric Conversions	1-27
Environmental Protection	2-19
Fiberglass Maintenance	6-1
Fire Extinguishers	2-17
Front Window Operation	3-11
General Safety	4-1
Getting On or Off Crane	2-5
Hose and Cable Cleanliness	4-2
Identification and Location of Components	1-2
Inspection and Maintenance Checklist	6-1
Introduction	1-1
Load Block Tieback	4-110
Load Line Reeving	4-97
Lube and Coolant Product Guide	5-1
Lubrication	5-1
Lubrication	5-1
Maintenance Checklist	6-1
Manitowoc Dealer	1-1
Nameplates and Decals	2-1
Operating Controls And Procedures	3-1
Operating Controls	3-11
Operational Aids	2-13
Operator Manual/Capacity Chart Storage	2-6
Optional Attachments	4-1
Outline Dimensions — From Front	1-19
Outline Dimensions — From Side	1-18
Pad Eye Usage for Wire Rope Reeving	4-95

Pedestal/Barge Mounted Cranes	2-26
Personnel Handling Policy	2-23
Pin and Connecting Hole Cleanliness	4-2
Preparation for Cold Weather	3-64
Pre-Raising Checks	4-34
Refueling	2-17
Remote Controls	3-47
Retaining Connecting Pins	4-2
Rigging Drawings	4-1
Safe Maintenance	2-17
Safe Operating Practices	2-7
Safety and Information Signs	2-3
Safety Devices	2-13
Safety Information	2-1
Safety Messages	2-1
Self-erecting Equipment	4-1
Setup And Installation	4-1
Shipping Crane Components	4-4
Signals	2-12
Standard Hand Signals for Controlling Crane Operations	3-2
Symbol Identification	3-4
Universal Anchor Joint	4-109
Wind Conditions	3-62
Wire Rope Installation	4-90

