

Grove RT9130E-2

Operator Manual





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

Batteries, battery posts, terminals, and related accessories can expose you to chemicals, including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling. For more information, go to www.P65warnings.ca.gov

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.

The original language of this publication is English.

OPERATOR MANUAL

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

RT9130E-2

Crane Model Number

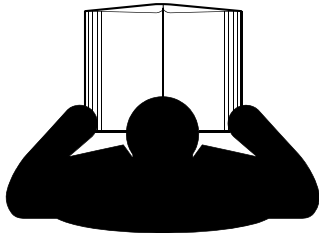

This Manual is divided into the following sections:

SECTION 1	INTRODUCTION
SECTION 2	SAFETY INFORMATION
SECTION 3	OPERATING CONTROLS AND PROCEDURES
SECTION 4	SET-UP AND INSTALLATION
SECTION 5	MAINTENANCE AND LUBRICATION

NOTICE

The crane serial number is the only method your distributor or the factory has of providing you with correct parts and service information.

The crane serial number is identified on the builder's decal attached to the operator's cab. **Always furnish crane serial number** when ordering parts or communicating service problems with your distributor or the factory.

	<h2> DANGER</h2> <p>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</p> <ul style="list-style-type: none">• You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.• You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.• The Operator Manual and Load Chart are in the holder provided on crane.
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*For
Reference
Only*

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GENERAL

NOTE: Throughout this manual, reference is made to left, right, front, and rear when describing locations. These reference locations are to be considered as those viewed from the Operator seat with the superstructure facing forward over the front of the carrier frame.

Basic nomenclature is shown in Figure 1-2.

This manual provides important information for the operator of the Model RT9130E Series Grove Crane.

The rough terrain crane incorporates an all welded steel frame, using planetary drive axles to provide four-wheel drive. Axle steering is accomplished utilizing hydraulic steer cylinders. The engine is mounted at the rear of the crane and provides motive power through a six speed forward and three speed reverse transmission. Hydraulic, double box, sliding beam outriggers are removable.

The carrier frame incorporates an integral fifth wheel, to which the rear axle is mounted, to provide axle oscillation. Axle oscillation lockout is automatic when the superstructure rotates from the travel position.

The superstructure is capable of 360° rotation in either direction. All crane functions are controlled from the fully-enclosed cab mounted on the superstructure. The crane is equipped with a five-section, full power, sequenced and synchronized boom. Additional reach is obtained by utilizing an optional swingaway jib. Lifting is provided by a main and auxiliary hoist.

Customer Support

Manitowoc and our Distributor Network want to ensure your satisfaction with our products and customer support. Your local distributor is the best equipped and most knowledgeable to assist you for parts, service and warranty issues. They have the facilities, parts, factory trained personnel, and the information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the distributor's service management to coordinate the contact on your behalf.

A compact disc or USB flash drive, which includes sections on Operation, Safety and Maintenance for crane operators and owners, is supplied when the crane is purchased new. Additional copies are available from your Grove distributor.

New Owners

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

Go to: https://www.manitowoccranes.com/en/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm and complete the form.

Safety Information

A Safety Compact Disc/USB flashdrive which includes sections on operation, safety and maintenance for crane operators and owners is supplied when the crane is purchased new. Additional copies are available from your local distributor.

NOISE/VIBRATION TEST RESULTS**Noise Level Test Results**

When equipped with the CE certification package, the guaranteed sound power level L_{WA} is 108 dB(A) (Tier 3) and 109 dB(A) (Tier 4) as measured by Directive 2000/14/EC and 80 dB(A) at the crane operator's position as measured by Annex G.1 of EN 13000:2010

Vibration Level Test Results

At the operator station with closed cab operation, vibration levels are less than 0.5 m/s/s for whole body vibration exposure and are less than 2.5 m/s/s for hand arm vibration exposure when measured according to Machinery Directive 2006/42/EC per standard ISO 2631-1:1997 - Evaluation of Human Exposure to Whole Body Vibration, EN ISO 5349-1:2001 - Measurement and Evaluation of Human Exposure to Hand Transmitted Vibrations, and ISO 8041:2005 - Human Response to Vibration Measuring Instrumentation.

For
Reference
Only

SERIAL NUMBER LOCATION

Refer to Figure 1-1 for the locations of the machine's serial number. Have the serial number available whenever contacting your local distributor or Manitowoc Crane Care.



Reference Only

Item	Description
1	Counterweight
2	Spotlight
3	Cab
4	Work Light
5	Outrigger Float
6	Valve Cover
7	Outrigger Jack Cylinder
8	Steps
9	Auxiliary Hoist
10	Main Hoist

Item	Description
11	Boom Pivot
12	Swingaway Nose
13	Lift Cylinder
14	Boom Nose Sheaves
15	Swingaway
16	Auxiliary Boom Nose
17	Front Axle
18	Rear Axle
19	Hydraulic Tank

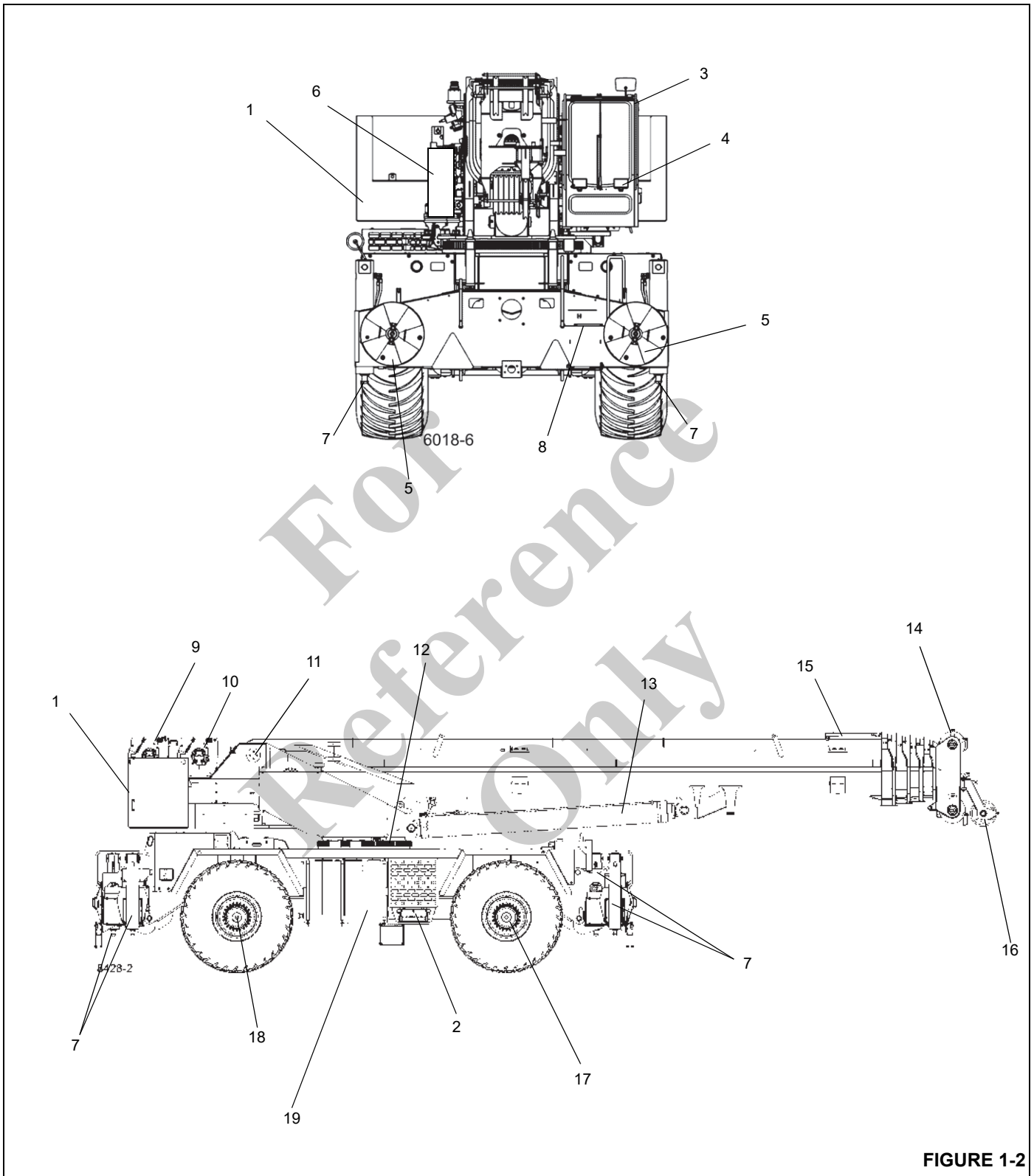


FIGURE 1-2

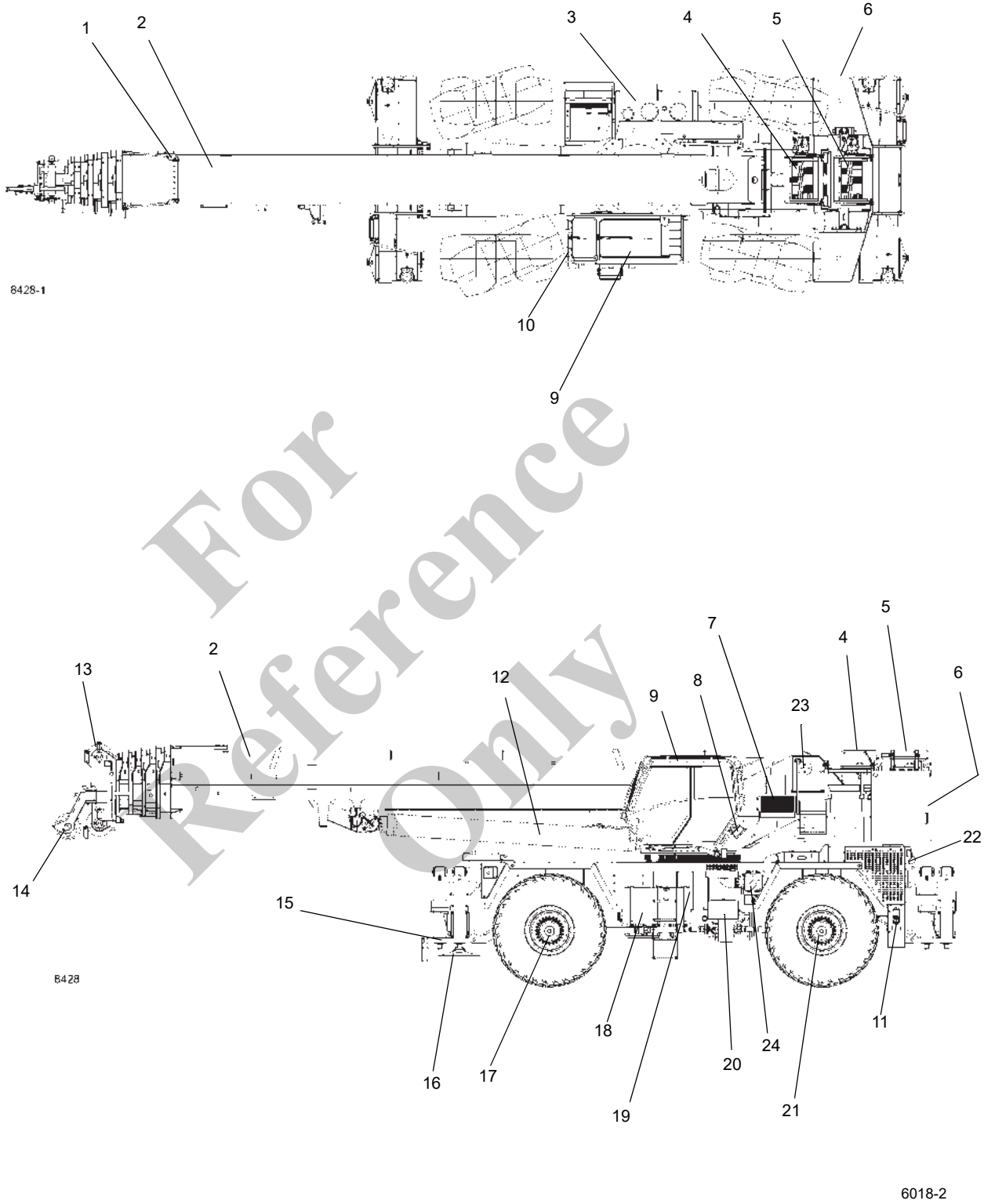


FIGURE 1-3

Item	Description
1	Rope Grab
2	Boom
3	Hydraulic Tank
4	Main Hoist
5	Auxiliary Hoist
6	Counterweight
7	Air Conditioning Components
8	Windshield Washer Fluid Container
9	Cab
10	Work Light
11	DEF Tank
12	Lift Cylinder

Item	Description
13	Boom Sheaves
14	Auxiliary Boom Nose
15	Outrigger Jack Cylinder
16	Outrigger Pad
17	Front Axle
18	Fuel Tank
19	Fuel Water Separator
20	Battery
21	Rear Axle
22	Exhaust System
23	Boom Pivot
24	Air Filter

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LIST OF SPECIFICATIONS

2nd 2.98
 3rd 0.95

General

Model RT9000E Series
 Rated Capacity See Load Chart in cab
 Drive 4 x 4 x 4
 Gross Weight . . . See Axle Weight Distribution Table

Dimensions

NOTE: Dimensions listed are for a crane with all components fully retracted in the travel mode with 33.25 x 29 tires.

Wheelbase 4940 mm (194.5 in)
 Overall Crane Length 16.48 m (54 ft 1 in)
 Overall Crane Width 3.80 m (12 ft 5 in)
 Overall Crane Height 4.172 m (13 ft 8.25 in) (Std)
 4089 mm (13 ft 5 in) (Opt)
 Tail-Swing 4.331 m (14 ft 2.5 in)
 Outrigger Spread
 Retracted 3.56 m (11 ft 8 in)
 Mid Extend 6.02 m (19 ft 9 in)
 Fully Extended 8.49 m (27 ft 10 in)

Capacities

Fuel Tank 378 l (100 gal)
 Coolant System See Engine Manual
 Engine Lubrication System . . . See Engine Manual
 Hydraulic Tank (Reservoir Capacity)
 Total 1363 l (360 gal)
 at Full Level 1226 l (324.1 gal)
 at Low Level 1176 l (310.6 gal)
 Expansion Space 51 l (13.5 gal)
 Hoists 21 l (22 qt)
 Swing Gearbox 5 l (5-1/4 qt)
 Axle Planetary Hubs 11 l (12 qt)
 Axle Differentials 27-1/2 l (29 qt)
 Transmission (Includes Torque Converter)
 32 l (34 qt)
 Diesel Exhaust Fluid (DEF) 37.9 l (10 gal)

Torque Converter

Stall Ratio 2.29:1
 Charge Pump Capacity 117.3 L/min (31 gpm)
 @ 2000 rpm

Transmission

Gear Ratios:
 Forward
 1st 7.87
 2nd 5.94
 3rd 2.98
 4th 2.25
 5th 0.95
 6th 0.73
 Reverse
 1st 7.87

Engine

Cummins QSL or (QSC)

HP Rating. 320 (300) hp [239 (224) kw @ 2200 rpm
 Peak Torque. 1020 (1000) lb-ft [1383 (1356) Nm @
 1500 rpm
 Lube Amount 22.7 l (18.9 l) [24 (20)qt]
 Coolant System 34.1 l (36 qt)

Axles

Total Ratio (w/differential lock) 33.43:1
 Total Ration (standard) 31.94:1
 Carrier Ratio (w/differential lock) 6.429:1
 Carrier Ratio (standard) 6.143:1
 Planetary Ratio 5.20:1

Brakes

Type . Hydraulic/Split system acting on all four wheels
 Size 470 x 40 mm (18.5 x 1.575 in)

Wheels and Tires

Lugs 24
 Torque 461 to 488 Nm (340 - 360 lb-ft)
 Tire Size
 Standard 33.25 x 29-38 ply rating
 Optional 29.5R29

NOTE: For roading and lifting pressures, refer to the Load Chart Book in the cab.

Swing Gearbox

Reduction Ratio 36:2
 Output Torque 5629 Nm (4152 lb-ft)

Boom

Length
 Retracted 12.8 m (42 ft)
 Extended 48.5 m (159 ft 3.6 in)
 Power 5 Section, Full Power
 Elevation -3 to +78 degrees
 Extensions
 Fixed* 11 m (36 ft 1.2 in)
 Folding* 11 m or 18 m
 (36 ft 1.2 in or 59 ft 1.2 in)
 *Extensions are offsettable at 0, 20, or 40 degrees.
 Extension Insert 8 m (26 ft 2.4 in)

Swivel Assembly

Electrical 20 Slip Rings
 Hydraulic 11 ports
 Water 2 ports

Hydraulic Pumps

NOTE: Pump output figures are theoretical.

Pump #1

Type Gear
 Sections 2
 Output @ 2486 rpm w/ load
 Section 1 194 l/min (51.2 gpm)
 Section 2 116 l/min (30.6 gpm)

Pump #2

Type Gear
 Sections 1
 Output @ 2486 rpm w/ load
 Section 1 115 l/min (30.3 gpm)

Pump #3

Type Gear
 Sections 2
 Output @ 2486 rpm w/ load
 Section 1 194 l/min (51.2 gpm)
 Section 2 58 l/min (15.3 gpm)

Pump #4

Type Gear
 Section 1
 Output @2486 rpm w/ load
 Section 1 41 l/min (10.7 gpm)

Hoists

Model HP35-26G
 Drum Dimensions
 Length 626 mm (26.65 in)
 Diameter 381 mm (15 in)
 Length (Standard) 676 mm (26.63 in)
 Cable
 Diameter 19 mm (0.75 in)
 Length-Main 290 m (951 ft)
 Length-Aux 214 m (702 ft)
 Max. Permissible Line Pull (6x36)
 7760 kg (17,070 lb)
 Max. Single Line Speed ... 171.3 m/min (562 fpm)
 Hoist Motor Displacement
 Low 80.3 cm³ (4.9 in³) per revolution
 High 46 cm³ (2.8 in³) per revolution
 Oil Capacity 21 l (22 qt)

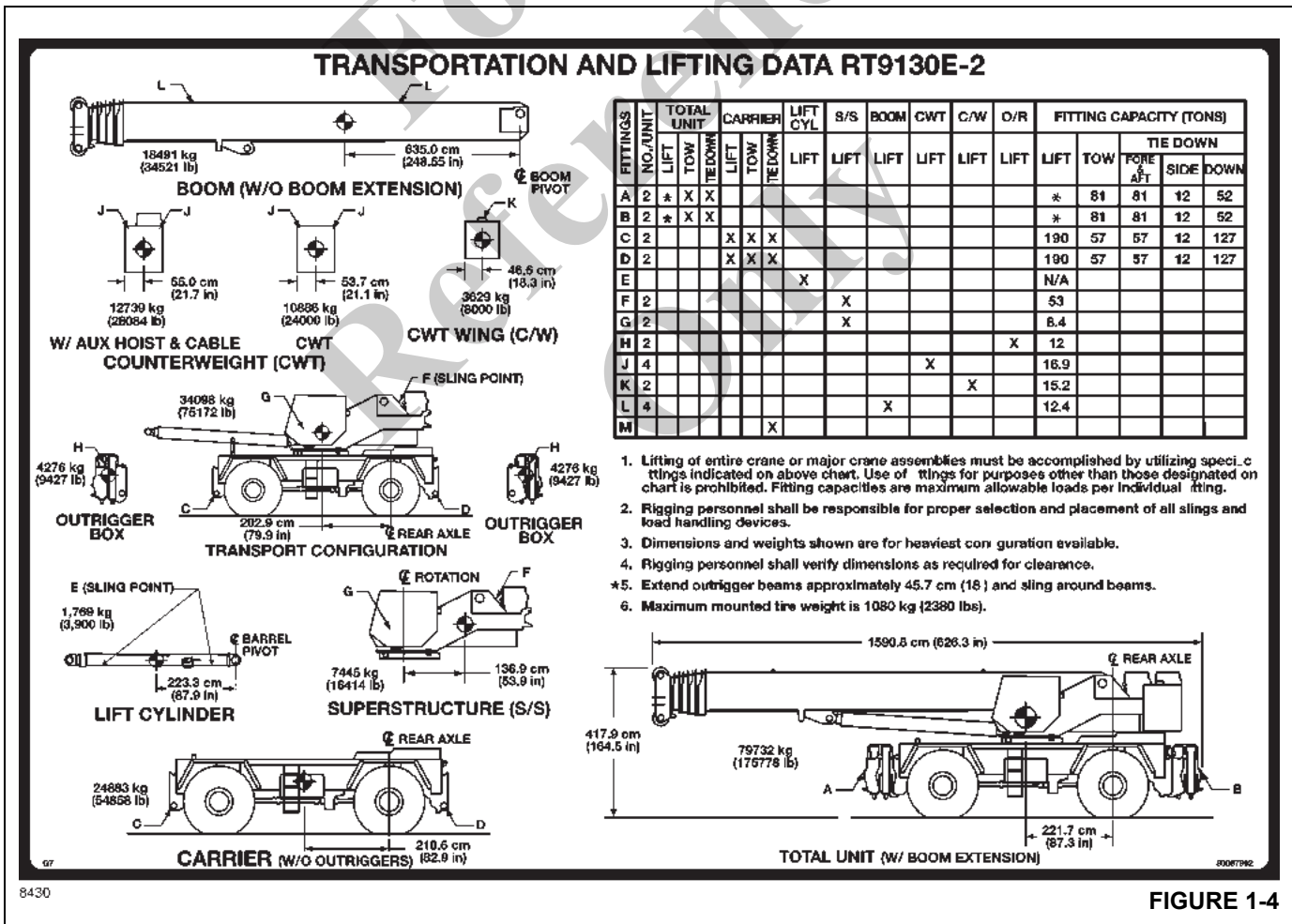


FIGURE 1-4

Table 1-1
Axle Weight Distribution Table

Description	CG to CL Bogie cm (in)	Weight kg (lb)	Front Axle kg (lb)	Rear Axle kg (lb)
Basic Unit				
Maximum Axle Loads Allowed at 24 km/h (15 mph)			40824 (90000)	40824 (90000)
Maximum Tire & Wheel Loads Allowed at 24 km/h (15 mph)			41223 (90880)	41223 (90880)
Maximum Axle Loads Allowed at 16 km/h (10 mph)			43092 (95000)	43092 (95000)
Maximum Tire & Wheel Loads Allowed at 16 km/h (10 mph)			44829 (98830)	44829 (98830)
Carrier 4 x 4; All Fluids	208.84 (82.22)	24492 (53996)	10353 (22825)	14139 (31171)
Front Outrigger Box and Beam Assembly	675.6 (266.00)	4276 (9427)	5848 (12892)	-1572 (-3465)
Rear Outrigger Box and Beam Assembly	-208.28 (-82.00)	4276 (9427)	-1803 (-3974)	6079 (13401)
Superstructure w/cab plus w/main hoist plus 950 ft cable; less counterweight plus lower lift pin	103.38 (40.70)	7070 (15587)	1480 (3262)	5591 (12325)
Removable Counterweight (includes cylinders, aux hoist and cables)	-141.17 (-55.58)	19996 (44084)	-5714 (-12597)	25710 (56681)
Boom Assembly; w/RCL, 2/7 Nose Sheaves, Lift Cyl Uptr Pin & Pivot Pins	661.19 (260.31)	15201 (33512)	20344 (44851)	-5143 (-11339)
Lift Cylinder	542.29 (213.50)	1769 (3900)	1942 (4281)	-173 (-381)
Complete Basic Machine: 12.8 - 48.8 m (42 - 160 ft) 5-Section Boom, Cummins QSL Tier 4 Final Engine, 33.25x29 (38 ply) Tires, Main Hoist w/290 m (951 ft) of 3/4 in 35x7 cable, Aux Hoist w/214 m (702 ft) of 3/4 in 35x7 cable, Full Fuel and Hydraulic Oil, A/C	207.98 (81.88)	77081 (169933)	32450 (71540)	44631 (98393)
Add to Basic Unit Weight				
10.97 to 17.98 m (36 to 59 ft) Bi-Fold Boom Extension	749.9 (295.25)	1411 (3110)	2141 (4721)	-731 (-1611)
10.97 meter (36 ft) Fixed Boom Extension	837.08 (329.56)	1043 (2300)	1768 (3897)	-724 (-1597)
10.97 to 17.98 m (36 to 59 ft) Bi-Fold Hydraulic Boom Extension	805.18 (317.00)	1595 (3516)	2599 (5730)	-1004 (-2214)
10.97m (36 ft) Fixed Hydraulic Boom Extension	893.65 (351.83)	1235 (2722)	2234 (4924)	-999 (-2202)
Components for Hydraulic Boom Extension	936.37 (368.65)	92 (202)	174 (383)	-82 (-181)
Boom Ext. Carrier Brackets (Bolt On)	606.09 (238.62)	100 (220)	122 (270)	-23 (-50)
Auxiliary Boom Nose - Installed	1346.20 (530.00)	60 (133)	164 (362)	-104 (-229)
8.0 m (26 ft) Boom Extension Insert (not included in weight)		652 (1437)		
72.5 mt (80 Ton), 5 Sheave Hookblock - Stowed in trough	469.90 (185.00)	730 (1610)	694 (1531)	36 (79)

Description	CG to CL Bogie cm (in)	Weight kg (lb)	Front Axle kg (lb)	Rear Axle kg (lb)
118 mt (130 Ton), 8 Sheave Hookblock - Stowed in trough	469.90 (185.00)	1148 (2530)	1091 (2406)	56 (124)
9.0 mt (10 Ton), Overhaul Ball (Swivel)- Attached to O/R Box	787.40 (310.00)	330 (727)	526 (1159)	-196 (-432)
Auxiliary Hydraulic Oil Cooler	335.28 (132.00)	93 (205)	63 (139)	30 (66)
Rubber Mat in Front Stowage Tray	449.58 (177.00)	27 (60)	25 (55)	2 (5)
Driver	233.68 (92.00)	113 (250)	54 (118)	60 (132)
Sound Package for CE - Carrier	-15.24 (-6.00)	136 (300)	-4 (-9)	140 (309)
Sound Package for CE	-27.94 (-11.00)	375 (827)	-21 (-47)	396 (874)
Substitutions, Additions and Removals				
Add: Boom Removal Kit	601.12 (236.66)	39 (85)	47 (103)	-8 (-18)
Rem: Counterweight 10886 kg (24,000 lb)	-142.5 (-56.10)	-10886 (-24000)	3140 (6922)	-14026 (-30922)
Rem: Titan 33.25 X 29 (38) Tires (for travel)	247.02 (97.25)	-4318 (-9520)	-2159 (-4760)	-2159 (-4760)
Sub: Tier 3 Engine	-109.22 (-43.00)	-287 (-633)	64 (140)	-351 (-773)
Rem: Counterweight 7256 kg (16,000 lb)	-137.24 (-54.03)	-7258 (-16000)	2016 (4445)	-9274 (-20445)
Rem: Counterweight 10886 kg (24,000 lb)	-142.49 (-56.10)	-10886 (-24000)	3140 (6922)	-14026 (- 30922)
Rem: Air Conditioning	93.42 (36.78)	-89 (-196)	-17 (-37)	-72 (-159)
Rem: Main Hoist Cable (290 m (951 ft) of 3/4 in 35x7 cable)	-69.09 (-27.20)	-526 (-1160)	73 (162)	-513 (-1132)
Rem: Aux Hoist Cable (214 m (702 ft) of 3/4 in 35x7 cable)	-159.41 (-62.76)	-388 (-856)	125 (276)	-72 (-159)
Add: Lift Cylinder Travel Support	570.87 (224.75)	57 (125)	65 (144)	-9 (-19)
Add: Counterweight Stand (pinned to carrier)	616.56 (242.74)	78 (172)	98 (215)	-20 (-43)
Tire Removal Tool (not included in unit weight)		247 (545)		

WIRE ROPE (HOIST CABLE)

General

The following information is a compendium of information from various wire rope manufacturers and includes inspection, replacement, and maintenance guidelines for wire rope as established by ASME B30.5, federal regulations, and Manitowoc. The inspection interval shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. Periodic inspections need not be at equal calendar intervals and should be performed at shorter time intervals as the wire rope approaches the end of its useful life. A periodic inspection shall be performed at least once a year. The following provides inspection and maintenance procedures for wire ropes used on Grove products (e.g. wire rope used as load lines [hoisting cables], jib and retraction cables, pendant cables, tow winch cables, and hook block tie down cables).

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the wire rope to abrasive material may shorten normal wire rope life. Frequent/periodic inspections and maintenance of your wire rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads beyond the endurance limit will shorten the wire ropes life expectancy. Examples of this type of loading are listed below.

- High velocity movement e.g.; hoisting or swinging of a load followed by abrupt stops.
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Moving a load that is beyond the rated capacity of the lifting mechanism, i.e.; overloading.

Lubrication

A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added throughout the life of a rope to replace factory lubricant which is used or lost. It is important that lubricant applied as part of a maintenance program shall be compatible with the original lubricant, and to this end, the rope manufacturer should be consulted. Lubricant applied

shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when lubricating rope. The object of rope lubrication is to reduce internal friction and to prevent corrosion.

During fabrication, ropes receive lubrication; the kind and amount depends on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

The following are important characteristics of a good wire rope lubricant:

- It should be free from acids and alkalis.
- It should have sufficient adhesive strength to remain on the ropes.
- It should be of a viscosity capable of penetrating the interstices between wires and strands.
- It should not be soluble in the medium surrounding it under the actual operating conditions (i.e. water).
- It should have a high film strength.
- It should resist oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Cleaning can be accomplished by using a stiff wire brush and solvent, compressed air, or live steam. Immediately after the wire rope is cleaned, it should be lubricated. Many techniques may be used; these include bath, dripping, pouring, swabbing, painting or pressure spray methods. Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. It should be noted, the service life of wire rope will be directly proportional to the effectiveness of the method used and amount of lubricant reaching the working parts of the rope.

Precautions and Recommendations During Inspection or Replacement

- Always lock out equipment power when removing or installing wire rope assemblies.
- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.

- When replacing fixed length cable assemblies (e.g. pendants) having permanently attached end fittings use only pre-assembled lengths of wire rope as supplied from Manitowoc. Do not build lengths from individual components.
- Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
- Never electroplate wire rope assemblies.
- Do not weld any wire rope assembly or component unless welding is recommended by the wire rope manufacturer. Welding spatter shall never be allowed to come in contact with the wire rope or wire rope ends. In addition, be sure that the wire rope is not an electrical path during other welding operations.
- Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly shall be discarded.
- On systems equipped with two or more wire rope assemblies operating as a matched set, they shall be replaced as an entire set.
- Do not paint or coat wire ropes with any substance except approved lubricants.
- Measure the rope's diameter across crowns (1) of the strands when determining if rope has become damaged (Figure 1-5).

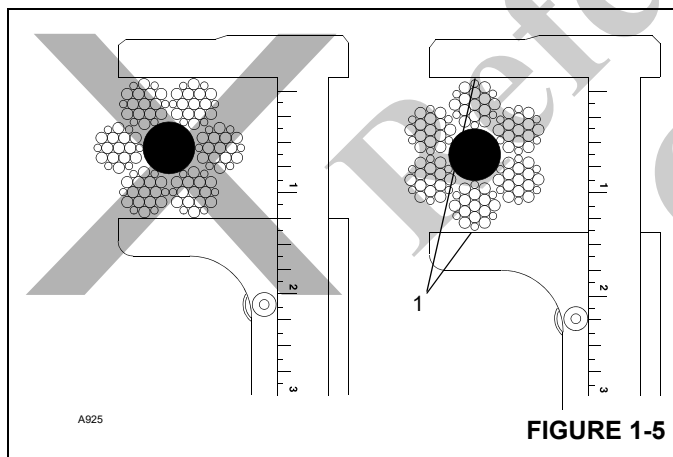


FIGURE 1-5

Wire Rope Inspection (Running Ropes and Pendant Cables)

Wire rope should be inspected frequently/daily and periodically/yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from crane to crane and may vary based on environmental conditions,

frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

NOTE: Wire rope may be purchased through Manitowoc Crane Care.

Any deterioration observed in the wire rope should be noted in the equipment inspection log and an assessment concerning wire rope replacement should be made by a qualified person.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Frequent Inspection

A frequent daily visual inspection is recommended for all running ropes in service. This inspection should be made on all wire rope which can be expected to be in use during the day's operation. This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement such as:

- Distortion, kinking, crushing, un-stranding, bird caging, reduction of diameter, etc.
- General corrosion.
- Broken or cut strands.
- Number, distribution and type of broken wires.
- Evidence of core failure.
- End fitting wear/abrasion.

Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-up Points: Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End Attachments: The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
- Abuse Points: The point where the wire rope is subjected to abnormal scuffing and scraping.

Periodic Inspection

Wire rope should be inspected periodically/annually or at a shorter time interval if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Only the outer surface of the wire rope need be inspected, and no attempt should be made to open the rope. Periodic inspection should include all items listed under frequent inspection plus the following:

- Inspect for reduction of rope diameter below nominal diameter.
- Inspect for severely corroded or broken wires at end connections.
- Inspect for severely corroded, cracked, bent, worn, or improperly applied end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
 - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
 - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
- Inspect boom nose sheaves, hook block sheaves, jib/jib sheaves, auxiliary boom nose sheaves, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Wire Rope Inspection/Replacement (All Wire Rope)

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgement of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by Manitowoc. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
- Evidence of any heat damage from any cause.
- Reductions from nominal diameter of more than 5%.

- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- Severe corrosion as evidenced by pitting.
- Manitowoc recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.
- Manitowoc recommends for cable extended booms, that jib cables be replaced every seven (7) years.

Seizing Wire Rope

It is important to seize the ends of rotation resistant wire ropes to prevent the displacement and unraveling of the individual wires and strands at the ends. All preformed and non-preformed styles of wire rope should be seized prior to cutting. Seizings must be placed on both sides of the point where the wire rope is to be cut.

The two preferred methods for seizing wire ropes are:

Method 1

Using a length of soft annealed wire (Figure 1-6), place one end in the groove between two strands of the wire rope. Turn the long end of the annealed wire at right angles to the wire and wrap it tightly over the portion in the groove.

The two ends of the annealed wire should be twisted together tightly. Cut off the excess wire and pound the twist flat against the wire rope.

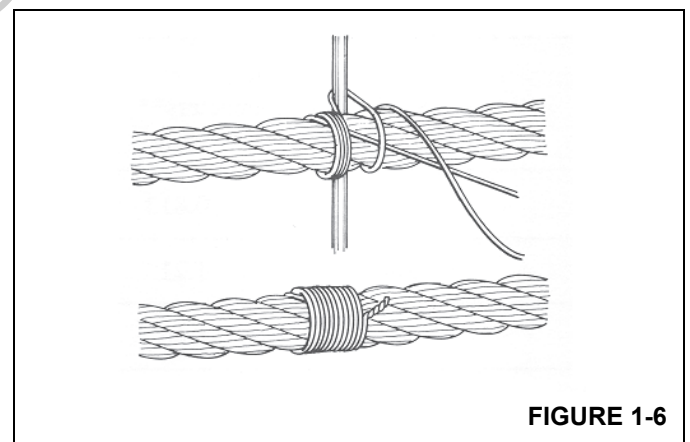


FIGURE 1-6

Method 2

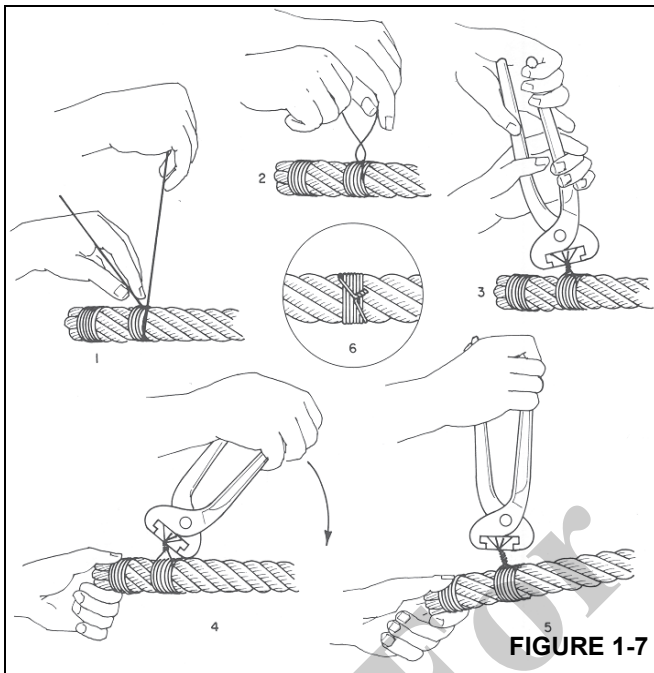
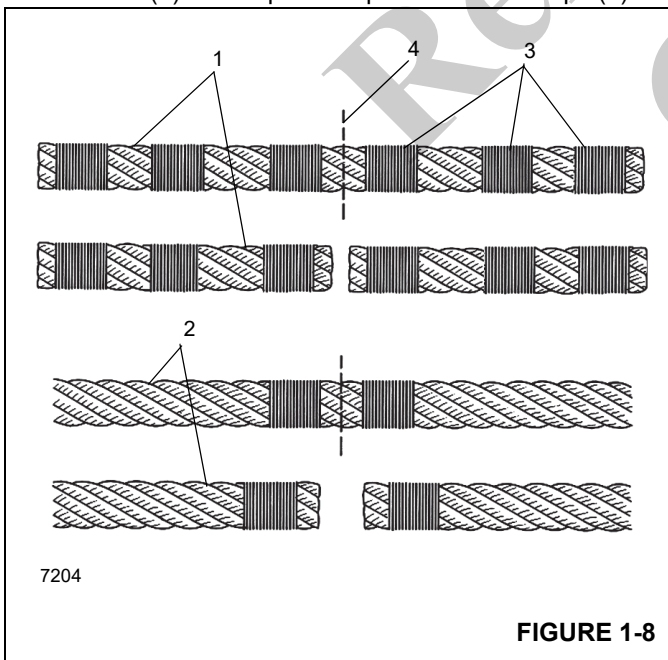


FIGURE 1-7

Wind a length of soft annealed wire (Figure 1-7) around the wire rope at least seven times. The two ends should be twisted together in the center of the seizing. Tighten the seizing by alternately prying and twisting. Cut off both ends of the wire and pound the twist flat against the rope.

NOTE: Non-preformed wire rope (1) (Figure 1-8) should have three seizings (3) located on each side of the cut (4) as compared to preformed wire rope (2).



7204

FIGURE 1-8

Installing 35x7 Class Wire Rope

CAUTION

Any cutting of this specific wire rope is not recommended. If 35x7 class wire rope must be cut for any reason, it is necessary to follow the following instructions. Also, unlike other types of wire rope, the ends on this wire rope must be welded to retain the rotation resistant characteristics.

1. Unload properly and relieve any twists. Pull the rope off the shipping reel or unroll it from a shipping coil. (If done improperly, you may kink the rope, which will result in permanent damage to the rope.) Then, lay the rope on the ground in direct line with the boom. This helps release any twist in the rope.
2. Pull the rope over the point sheave and attach the end to the hoist drum. Be sure not to remove the welded end.
3. Wind rope onto drum slowly and carefully. At this point, it isn't necessary to provide additional load other than the weight of the rope being pulled across the ground.
4. Spool first layer tightly. It is essential on smooth-faced drums that the first layer is spooled with wraps tight and close together since the first layer forms the foundation for succeeding layers. If need be, use a rubber, lead or brass mallet (but never a steel hammer) to tap the rope into place.
5. Spool multiple layers with sufficient tension. It's very important to apply a tensioning load to the ropes during the rope breaking-in process. (If not, the lower layers may be loose enough that the upper layers become wedged into the lower layers under load, which can seriously damage the rope.) The tensioning load should range from 1 to 2% of the rope's minimum breaking force.
6. For ropes in multi-part systems: Reeve the traveling block and boom tip sheaves so the rope spacing is maximized and the traveling (hook) block hangs straight and level to help assure block stability.
7. Breaking in new 35x7 class rope—After installation, properly break in the rope, which allows the rope's component parts to adjust themselves to the operating conditions:

With the boom fully raised and fully extended, attach a light load at the hook and raise it a few inches off the ground. Allow to stand for several minutes. Then cycle the load between the full "up" and "down" positions several times. Observe the drum winding and rope travel for any potential problems.

After making the lifts with a light load, increase the load and cycle it up and down a few times. This procedure will

train the rope and help assure smooth operation during its useful life.

Ideally, you should run these loads with reeving that lets you place the loads on the block with all wire rope off the

drum except the last three wraps. If this is not possible, alternate methods must be used to assure proper tensioning of the rope on the drum.

For
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Only

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SECTION 2 SAFETY INFORMATION

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SAFETY MESSAGES

General

The importance of safe operation and maintenance cannot be overemphasized. 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 safety alert symbol means **ATTENTION!** Become alert - **your safety is involved!** Obey all safety messages that follow this symbol to avoid possible death or injury.

Signal Words



DANGER

Identifies **hazards** that will result in death or serious injury if the message is ignored.



WARNING

Identifies **hazards** that may result in death or serious injury if the message is ignored.



CAUTION

Identifies **hazards** that could result in minor or moderate injury if the message is ignored.

CAUTION

Without the safety alert symbol, identifies **hazards** that could result in property damage if the message is ignored.

NOTE: Emphasizes operation or maintenance procedures.

GENERAL

It is impossible to compile a list of safety precautions covering all situations. However, there are basic principles that **must** be followed during your daily routine. Safety is **your primary responsibility**, since any piece of equipment is only as safe **as the person at the controls**.

Read and follow the information located in *Model Specific Information* near the end of this section.

This information has been provided to assist in promoting a safe working atmosphere for yourself and those around you. It is not meant to cover every conceivable circumstance which could arise. It is intended to present basic safety precautions that should be followed in daily operation.

Because you are the only part of the crane that can think and reason, your responsibility is not lessened by the addition of operational aids or warning devices. Indeed, you must guard against acquiring a false sense of security when using them. They are there to assist, not direct the operation. Operational aids or warning devices can be mechanical, electrical, electronic, or a combination thereof. They are subject to failure or misuse and should not be relied upon in place of good operating practices.

You are the only one who can be relied upon to assure the safety of yourself and those around you. Be **professional** and follow the **rules of safety**.

Remember, failure to follow just one safety precaution could cause an accident that results in death or serious injury to personnel or damage to equipment. You are responsible for the safety of yourself and those around you.

Safety Decals

Refer to the *Parts Manual* for a drawing indicating the location of safety decals on the crane.

ACCIDENTS

Following any accident or damage to equipment, the Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Should the distributor not be immediately available, contact should be made directly with Grove Product Safety at the address below. 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 your Grove distributor and/or Manitowoc Crane Care.

If this crane becomes involved in a property damage and/or personal injury accident, **immediately** contact your Grove distributor. If the distributor is unknown and/or cannot be reached, contact Product Safety at:

Grove U.S. L.L.C.

1565 East Buchanan Trail
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR.DEPT)
717-597-8121

Fax: 717-593-5152

E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

You must **read** and **understand** this *Operator Manual* and the *Load Chart* before operating your new crane. You must also **view** and **understand** the supplied safety video. This manual and *Load Chart* must be readily available to the operator at all times and must remain in the cab (if equipped) or operator's station while the crane is in use.

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.

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

Allow **No One** other than the operator to be on the crane while the crane is operating or moving, unless they are seated in a two-man cab.



Do not remove the *Load Chart*, this *Operator Manual*, or any decal from this crane.

Inspect the crane every day (before the start of each shift). Make sure that routine maintenance and lubrication are being dutifully performed. Don't operate a damaged or poorly maintained crane. You risk lives when operating faulty machinery—including your own.

If adjustments or repairs are necessary, the operator shall notify the next operator and personnel responsible for the maintenance and repair of the crane.

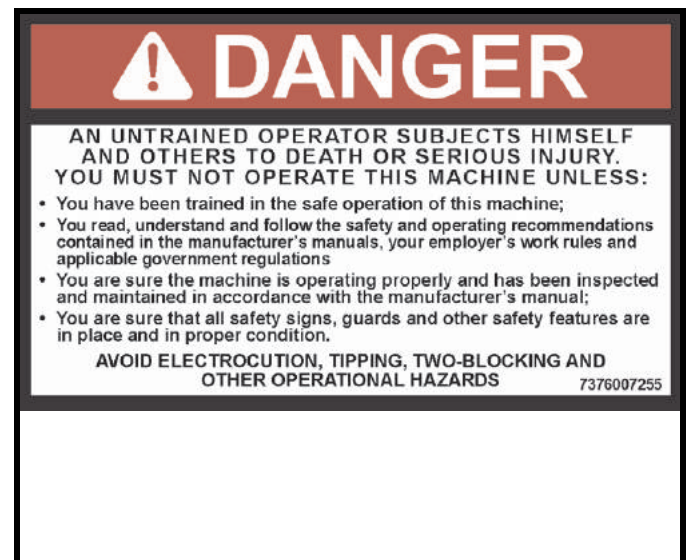
OPERATOR QUALIFICATIONS

Qualified person is defined as one who by reason of knowledge, 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.

Make sure that all personnel working around the crane are thoroughly familiar with safe operating practices. You must be thoroughly familiar with the location and content of all decals on the crane. Decals provide important instructions and warnings and must be read prior to any operational or maintenance function.

Refer to the *Parts Manual* for this crane for the locations of all safety decals.

You must be familiar with the regulations and standards governing this crane and its operation. Work practice requirements may vary slightly between government regulations, industry standards, and employer policies so a thorough knowledge of all such relevant work rules is necessary.



An untrained operator subjects himself and others to death or serious injury.

You must not operate this crane unless:

- You have been trained in the safe operation of this crane.
- You read, understand, and follow the safety and operating recommendations contained in the manufacturer's manuals, your employer's work rules, and applicable government regulations.
- You are sure the crane has been inspected and maintained in accordance with the manufacturer's manuals and is operating properly.
- You are sure that all safety decals, guards, and other safety features are in place and in proper condition.

Do not attempt to operate the crane unless you are trained and thoroughly familiar with all operational functions. Controls and design may vary from crane to crane; therefore, it is important that you have specific training on the particular crane you will be operating.

Training is ESSENTIAL for proper crane operation. Never jeopardize your own well-being or that of others by attempting to operate a crane on which you have not been trained.

You must be mentally and physically fit to operate a crane. Never attempt to operate a crane while under the influence of medication, narcotics, or alcohol. Any type of drug could impair physical, visual and mental reactions, and capabilities.

As operator of this crane, you are granted the authority to stop and refuse to lift loads until safety is assured.

OPERATIONAL AIDS

Operational aids are accessories that provide information to facilitate operation of a crane or that take control of particular functions without action of the operator when a limiting condition is sensed, as stated in the latest revision of the ASME B30.5, and ASME B30.8 standards. Examples of such devices include, but are not limited to, the following: anti-two-block device, rated capacity indicator, rated capacity limiter, boom angle or radius indicator, boom length indicator, crane level indicator, hoist drum rotation indicator, load indicator, and wind speed indicator.

Grove remains committed to providing reliable products that enable users and operators to safely lift and position loads. Grove has been an industry leader in the incorporation of operational aids into the design of its cranes. Federal law requires that cranes be properly maintained and kept in good working condition. The manuals that Grove provides that are specific for each crane and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the crane user or owner must

assure that repair or recalibration is accomplished as soon as is reasonably possible. If immediate repair or recalibration of an operational aid is not possible and there are exceptional circumstances which justify continued short-term use of the crane when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the crane:

- Steps shall be taken to schedule repairs and recalibration immediately. The operational aids shall be put back into service as soon as replacement parts, if required, are available and the repairs and recalibration can be carried out. Every reasonable effort must be made to expedite repairs and recalibration.
- When a *Load Indicator, Rated Capacity Indicator, or Rated Capacity Limiter* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures for determining load weights and shall ascertain that the weight of the load does not exceed the crane ratings at the radius where the load is to be handled.
- When a *Boom Angle or Radius Indicator* is inoperative or malfunctioning, the radius or boom angle shall be determined by measurement.
- When an *Anti-Two-Blocking Device, Two-Blocking Damage Prevention Device or Two-Block Warning Device* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures, such as assigning an additional signal person to furnish equivalent protection. This does not apply when lifting personnel in load-line supported personnel platforms. Personnel shall not be lifted when anti-two-block devices are not functioning properly.
- When a *Boom Length Indicator* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish the boom lengths at which the lift will be made by actual measurements or marking on the boom.
- When a *Level Indicator* is inoperative or malfunctioning, other means shall be used to level the crane.

Rated Capacity Limiter (RCL) Systems

Your crane is equipped with an RCL system which is intended to aid the operator. An RCL is a device that automatically monitors radius, load weight, and load rating and prevents movements of the crane, which would result in an overload condition

Test daily for proper operation. Never interfere with the proper functioning of operational aids or warning devices.

Under **no condition** should it be relied upon to replace the use of *Load Charts* and operating instructions. Sole reliance

upon these electronic aids in place of good operating practices can cause an accident.

Know the weight of all loads and always check the capacity of the crane as shown on the *Load Chart* before making any lifts.

NEVER exceed the rated capacity shown on the *Load Chart*. Always check the *Load Chart* to make sure that the load to be lifted at the desired radius is within the rated capacity of the crane.

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see the appropriate section later in this manual or the RCL manufacturer's manual supplied with the crane. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS), a safe load indicator (SLI), or an EKS5; Grove refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service manuals*.

Anti-Two-Blocking Device

This crane should have a functional Anti-Two-Block and Control Lock-Out System. Test daily for proper operation.

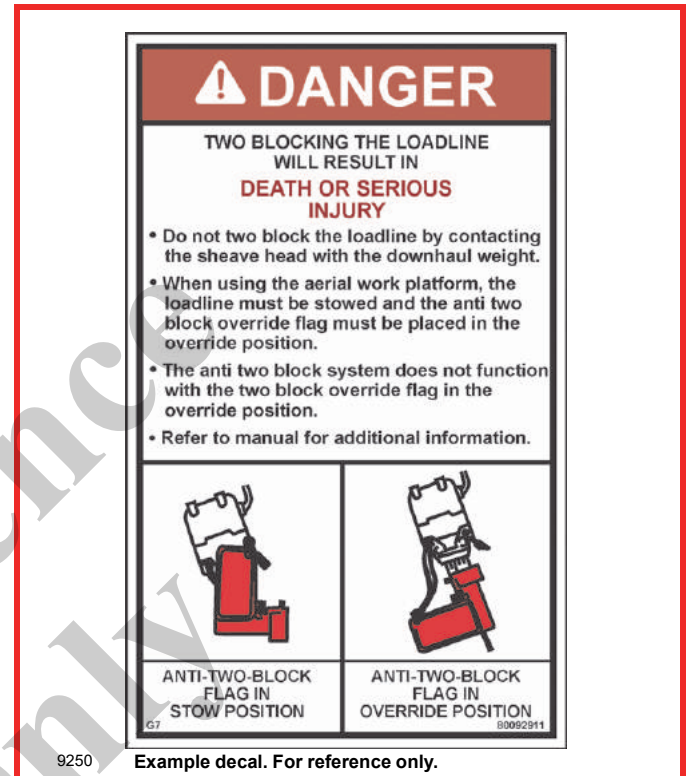
Two-blocking occurs when the load block (hook block, overhaul ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist rope (wire rope or synthetic rope), rigging, reeving, and other components to become highly stressed and overloaded in which case the hoist rope may fail allowing the load, block, etc. to fall.

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and boom extension nose respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or boom extension nose, thus causing damage to the sheaves, or causing the hoist rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

Caution must be used when lowering the boom, extending the boom or hoisting up. Let out load line(s) simultaneously to prevent two-blocking the boom tip(s) and the hook block, etc. The closer the load is carried to the boom nose the more important it becomes to simultaneously let out hoist rope as the boom is lowered. Keep load handling devices a minimum of 107 cm (42 in) below the boom nose at all times.

Two-blocking can be prevented. Operator awareness of the hazards of two-blocking is the most important factor in preventing this condition. An Anti-Two-Block System is intended to assist the operator in preventing dangerous two-block conditions. It is not a replacement for operator awareness and competence.

Never interfere with the proper functioning of operational aids or warning devices.

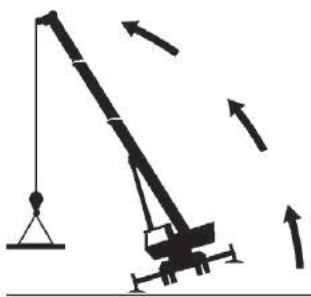


Working Area Limiter (If Equipped)

This crane may be equipped with a working area limiter as part of the RCL system, designated as either Work Area Definition System (WADS) or Working Range Limiter (WRL). You must read and understand the operator manual before operating the working area limiter system. Become familiar with all proper operating procedures and with the identification of symbol usage.

The working area limiter is intended to be used as an aid to the operator. It is not a substitute for safe crane operating practices, experience and good operator judgments.

! DANGER



TIPPING HAZARD

To avoid death or serious injury, ensure load and crane's configuration are within capacity as shown on crane's load rating chart and notes.

This crane should have a functional load moment indicator and control lock-out system. Test daily for proper operation.

POSITION CRANE ON FIRM SURFACE. EXTEND OUTRIGGERS AND LEVEL CRANE.

TO AVOID DEATH OR SERIOUS INJURY:


NEVER handle personnel with this machine unless the requirements of the applicable national, state and local regulations and safety codes are met.

NEVER use this crane for bungee jumping or any form of amusement or sport.

NEVER permit anyone to ride loads, hooks, slings or other rigging for any reason.

NEVER get on or off a moving crane.

NEVER allow anyone other than the operator to be on this crane while it is operating or traveling.



TWO-BLOCKING HAZARD

To avoid death or serious injury, keep load handling devices away from boom/jib tip when extending or lowering the boom and when hoisting up.

This crane should have a functional anti-two-block and control lock-out system. Test daily for proper operation.

DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.

ELECTRONIC EQUIPMENT on this crane is intended as an aid to the operator.

Under no condition should it be relied upon to replace the use of capacity charts and operating instructions. Sole reliance upon these electronic aids in place of good operating practices can cause an accident.

Do not remove any decal, the load chart, or the Operator's and Safety Handbook from this crane.

FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

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CRANE STABILITY/STRUCTURAL STRENGTH

To avoid death or serious injury, make sure that the crane is on a firm surface with load and crane's configuration within capacity as shown on the crane's *Load Chart* and notes.

Make sure that all pins and floats are properly installed and outrigger beams are properly extended before lifting on outriggers. On models equipped with outriggers that can be pinned at the mid-extend position (vertical stripe, if applicable), the outriggers must also be pinned when operating from the mid-extend position.

Use adequate cribbing under outrigger floats to distribute weight over a greater area. Check frequently for settling.

Carefully follow the procedures in this *Operator Manual* when extending or retracting the outriggers. Death or serious injury could result from improper crane setup on outriggers.

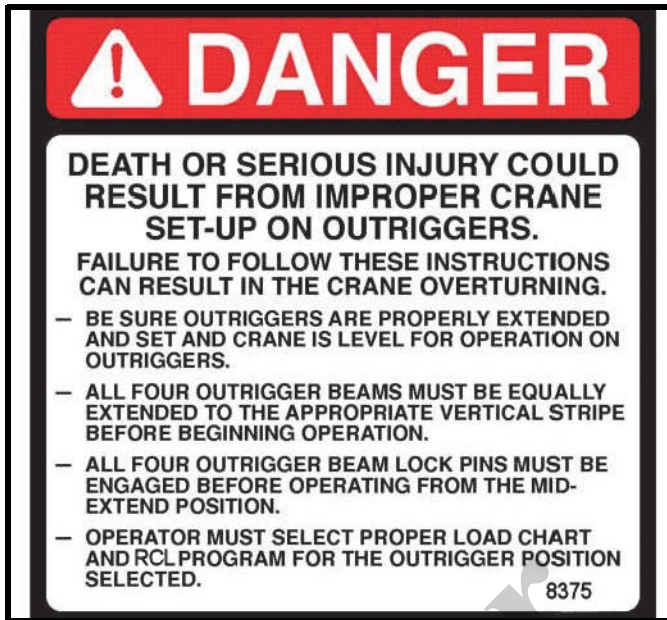
The operator must select the proper *Load Chart* and Rated Capacity Limiter (RCL) System program for the outrigger position selected.

Before swinging the superstructure over the side when the outriggers are retracted, check for backwards stability under the sub-section titled *Model Specific Information* later in this section.

Long cantilever booms can create a tipping condition when in an extended and lowered position. Retract the boom proportionally with reference to the capacity of the applicable *Load Chart*.

Check crane stability before lifting loads. Make sure that the outriggers (or tires if lifting on rubber) are firmly positioned on solid surfaces. Make sure that the crane is level, brakes are set, and the load is properly rigged and attached to the hook. Check the *Load Chart* against the weight of the load. Lift the load slightly off the ground and recheck the stability before proceeding with the lift. Determine the weight of the load before you attempt the lift.

Unless lifting within On Rubber capacities, outrigger beams and jack cylinders (plus center front stabilizer, if equipped) must be properly extended and set to provide precise leveling of the crane. Tires must be clear of the ground before lifting on outriggers.



KEEP THE BOOM SHORT. Swinging loads with a long line can create an unstable condition and possible structural failure of the boom.

Load Charts

Load Charts represent the absolute maximum allowable loads, which are based on either tipping or structural limitations of the crane under specific conditions. Knowing the precise load radius, boom length, and boom angle should be a part of your routine planning and operation. Actual loads, including necessary allowances, should be kept below the capacity shown on the applicable *Load Chart*.

Load Chart capacities are based on freely suspended loads.

You must use the appropriate *Load Chart* when determining the capability of the crane in the configuration required to perform the lift.

Maximum lifting capacity is available at the shortest radius, minimum boom length, and highest boom angle.

Do not remove the *Load Charts* from the crane.

Work Site

Prior to any operation, you must inspect the **entire** work site, including ground conditions, where the crane will travel and operate. Make sure that the surfaces will support a load greater than the crane's weight and maximum capacity.

Be aware of all conditions that could adversely effect the stability of the crane.

Be aware of the danger for people entering the working area. Do not allow unnecessary personnel in the vicinity of the crane while operating.

WIND FORCES

There are basic principles that must be followed while operating in windy conditions. This information has been provided to assist in determining safe operation in windy conditions.

Always use extreme caution when windy conditions exist. NEVER exceed the rated capacity shown on the *Load Chart*.

Always check the *Load Chart* to make sure that the load to be lifted is within the rated capacity of the crane.

Wind can have a significant effect on loads that may be lifted by a crane. Wind forces act differently on a crane depending upon the direction from which the wind is blowing (e.g., wind on the rear of the boom can result in decreased forward stability, wind on the underside of the boom can result in decreased backward stability, wind on the side of the boom can result in structural damages, etc.)

Wind forces can exert extreme dynamic loads. Grove recommends that a lift not be made if the wind can cause a loss of control in handling the load.

Wind forces can be determined by typical visible effects on the landscape. To assist you in determining prevailing wind conditions, refer to Table 2-1.

NOTE: The wind speed corresponding to the Beaufort scale in the table is mean wind speed at 10 m (33 ft) elevation over a period of 10 minutes.

Table 2-1 Beaufort Wind Scale

Beaufort Number	Description	Maximum Wind Speed			Visible Indicator Effects of wind as observed on land
		m/s	km/h	mph	
Zero (0)	Calm	0.3	1.1	0.7	Calm; smoke rises vertically
1	Light Air	1.5	5.4	3.4	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	Light Breeze	3.3	11.9	7.4	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	Gentle Breeze	5.4	19.4	12.1	Leaves and small twigs constantly moving. Light flags extended.
4	Moderate Breeze	7.9	28.4	17.7	Dust and loose paper raised. Small branches begin to move.
5	Fresh Breeze	10.7	38.5	23.9	Branches of a moderate size move. Small trees in leaf begin to sway.
6	Strong Breeze	13.8	49.7	30.9	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
7	High Wind	17.1	61.6	38.3	Whole trees in motion. Effort needed to walk against the wind.
8	Gale	20.7	74.5	46.3	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	Strong Gale	24.4	87.8	54.6	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	Storm	28.4	102.2	63.5	Trees are broken off or uprooted, structural damage likely.

Wind Speeds

The maximum permissible wind speed referred to in the load charts is the 3-second wind gust speed measured at the boom tip height and is designated as $V(z)$. This value is either recorded at boom tip or calculated based on mean wind speed recorded at crane operation site. For lift planning purposes only, the 3-second wind gust speed, $V(z)$, may be calculated based on mean wind speed reported at <http://www.windfinder.com> "Super Forecast".

This 3-second wind gust is assumed to act on the entire crane and the load. The wind effect on the load can be conservatively estimated as:

- If $V(z)$ is ≤ 13.4 m/s (30 mph), then the **allowable** load is the published rated capacity from the Load Chart.
- If $V(z)$ is > 13.4 m/s (30 mph) and is ≤ 20.1 m/s (45 mph), the **allowable** load is the published rated

capacity multiplied by the Capacity Reduction Factor from Table 2-4 (metric) or (non-metric).

NOTE: This condition is limited to operation with the main boom on fully extended outriggers only.

- If $V(z)$ is > 20.1 m/s (45 mph), then lifting is **NOT** permitted. Cease lifting operations and lower and retract the boom.

In both cases **a)** and **b)** above, the lift may also be limited by the projected wind area of the load A_p and by the wind drag coefficient C_d : This limit can be determined by comparing the **Actual** wind resistance area with the **Allowable** wind resistance area.

Refer to Figure 2-1 for a simplified calculation method to determine permissible wind speed.

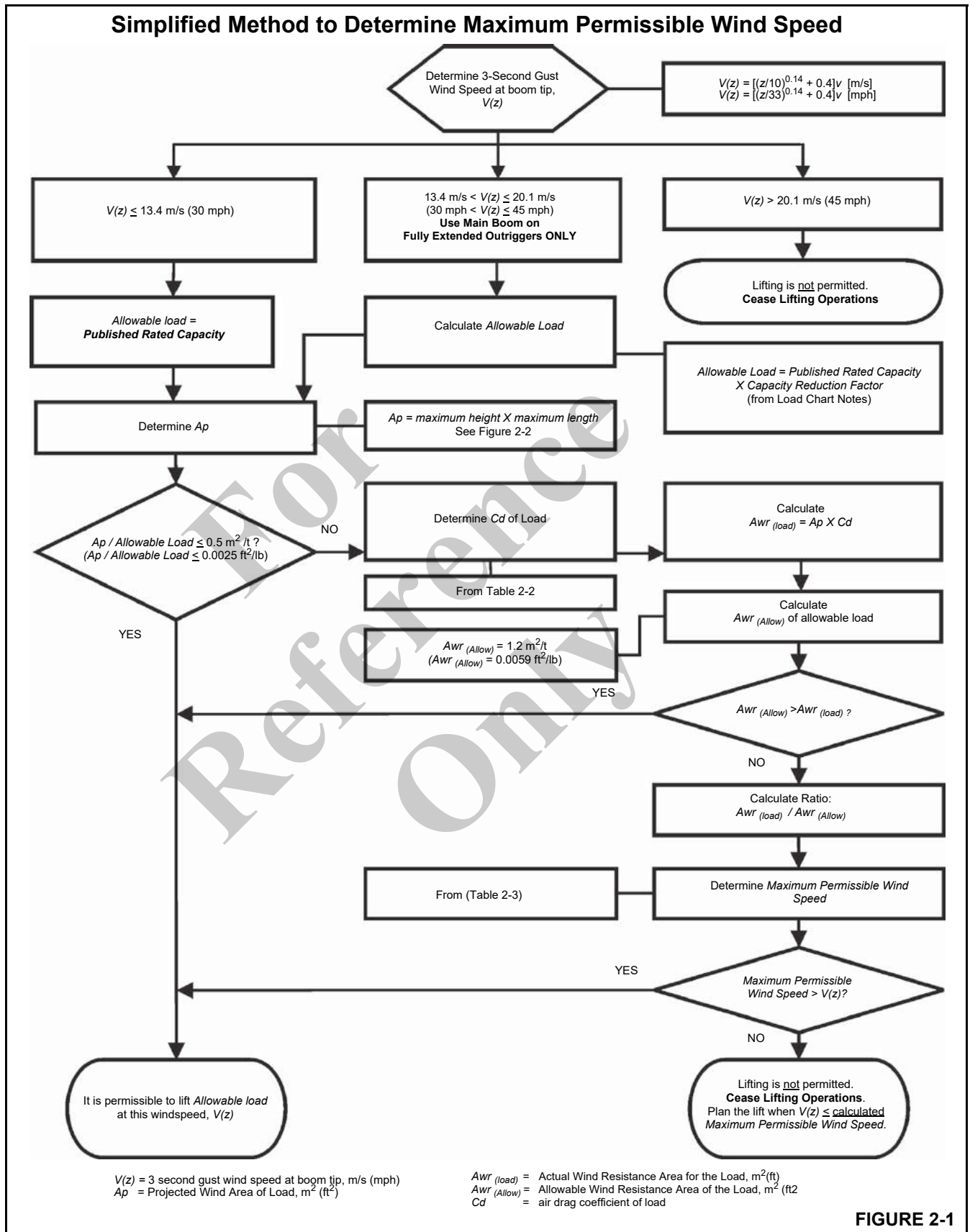


FIGURE 2-1

Determination of 3-second wind gust speed at boom tip height:

The following example illustrates how to calculate 3-second wind gust speed at boom tip height based on mean wind speed recorded by the device located at the crane operation site:

$V(z)$ is the 3-second wind gust speed at boom tip height Z then:

Metric, with Z [m] and V [m/s]

$$V(z) = [(Z/10)^{0.14} + 0.4] \times V \quad (2.1)$$

Non-metric, with Z [ft] and V [mph]

$$V(z) = [(Z/33)^{0.14} + 0.4] \times V \quad (2.2)$$

where:

V [m/s] [mph] - Mean wind speed at 10 m (22 ft) elevation (upper limit of Beaufort scale)

Example: Suppose you want to lift the load with the maximum boom tip height of 30 m (100 ft) and the recorded mean wind speed by the device located at the crane operation site is 5.5 m/s (13 mph). This mean wind speed of 5.5 m/s (13 mph) corresponds to Beaufort number 4 (see Table 2-1). The maximum wind velocity according to the Beaufort scale of 4 is 7.9 m/s (17.7 mph).

The mean wind speed (upper limit of Beaufort number) at 10 m (33 ft) height, to be used for calculation is:

$$V = 7.9 \text{ m/s (17.7 mph)}$$

Boom tip height for this lift is $Z = 30$ m (100 ft)

then:

Metric, with Z [m] and V [m/s]

$$V(z) = [(30/10)^{0.14} + 0.4] \times 7.9 = 12.4 \text{ m/s}$$

Non-metric, with Z [ft] and V [mph]

$$V(z) = [(100/33)^{0.14} + 0.4] \times 17.7 = 27.8 \text{ mph}$$

Since $V(z)$ is ≤ 13.4 m/s (30 mph), the allowable loads are the published rated capacities from the Load Chart and can be lifted at this condition.

Size and Shape of the load:

These rated capacities are also based on the assumption that the Wind Resistance Area of load, $Awr_{(load)}$ is not more than 0.0012 square meters per kilogram (0.0059 sq.ft per pound of load. (See below Formulas 2.4 and 2.5.)

The load capacities shall be reduced to account for the larger wind resistance area of load and 3-second wind gust speed at boom tip height. Use tag lines when the wind gust speed is above 13.4 m/s (30 mph) to help control the movement of the load. **Grove recommends that a lift not be made if the wind can cause a loss of control in handling the load.**

The lift may also be limited by the projected wind area of the load Ap and by the wind drag coefficient Cd . This limit can be determined by comparing the actual wind resistance area of the load with the allowable wind resistance area.

$$Awr_{(load)} = Ap \times Cd \quad (2.3)$$

where:

$Awr_{(load)}$ [m²] [ft²] - Wind resistant area of the load

Ap [m²] [ft²] - projected wind area,

Cd - wind drag coefficient.

Ap is determined by using the calculation of maximum height x maximum length (see Figure 2-2).

For Cd , refer to Table 2-2. If the Cd cannot be calculated or estimated, use a value of 2.4.

The allowable wind resistant area of the load $Awr_{(allow)}$ is equal to 0.0012 square meters per kilogram (0.0059 sq.ft per pound) of allowable load:

Metric, with $m_{(load)}$ [kg] - Mass of the allowable load

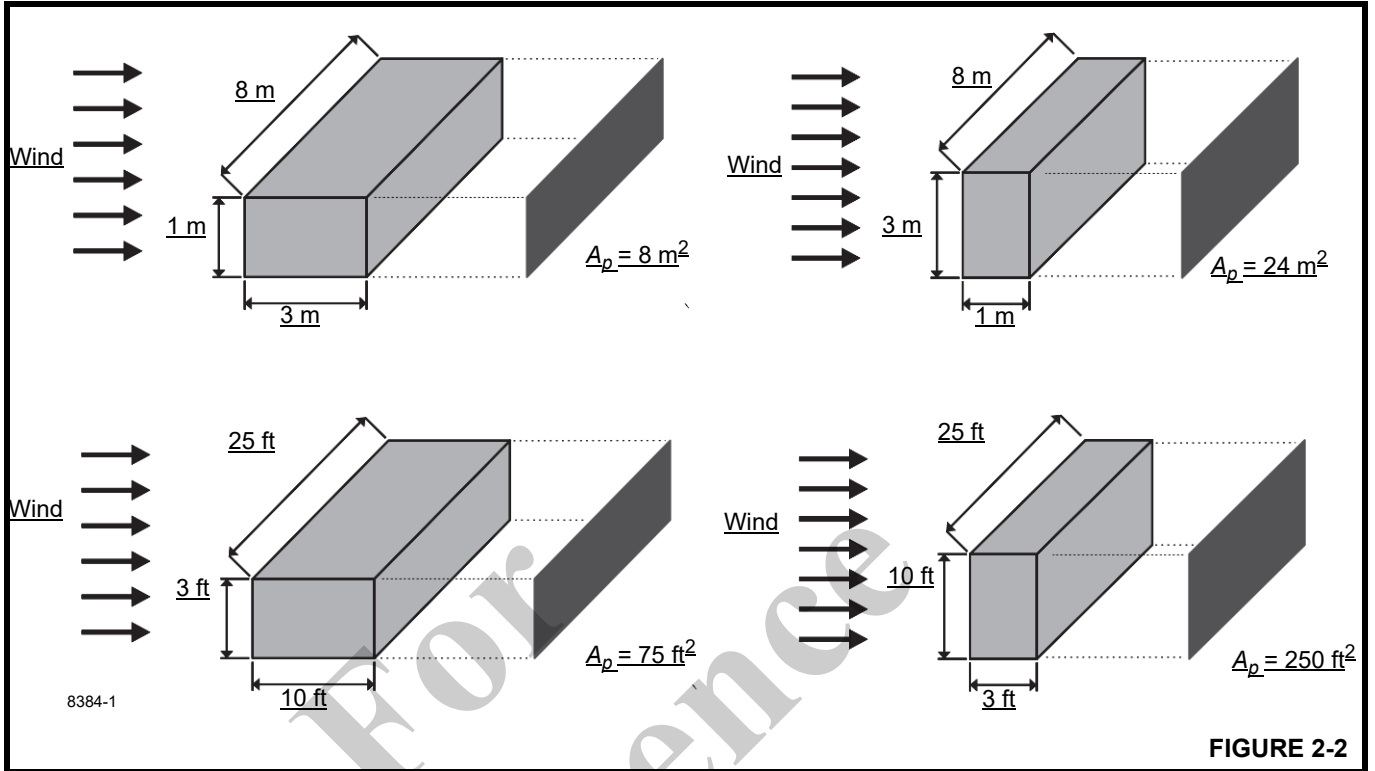
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

Non-metric, with $m_{(load)}$ [lb] - Mass of the allowable load

$$Awr_{(allow)} = 0.0059 \times m_{(load)} \quad (2.5)$$

If $Awr_{(load)}$ is greater than $Awr_{(allow)}$, then lifting this load at this wind speed $V(z)$ is NOT permitted.

Calculation of Projected Wind Area (A_p):



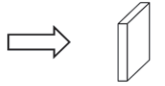
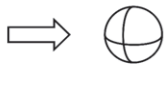
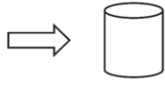
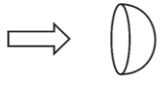



Determining Wind Drag Coefficient (C_d)

Table 2-2 shows the typical Shapes and corresponding Wind Drag Coefficient (C_d) values.

If the exact Wind Drag Coefficient of a shape is not known, use the maximum value of the shape's range (Table 2-2).

If the wind drag coefficient of the load cannot be estimated or determined, it shall be assumed that (C_d) = 2.4.

Table 2-2 Wind Drag Coefficient

Shape	C_d
	1.1 to 2.0
	0.3 to 0.4
	0.6 to 1.0
	0.8 to 1.2
	0.2 to 0.3
	0.05 to 0.1
	Approximately 1.6

Turbine Blade or Complete Rotor

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Maximum Permissible Wind Speed

If the wind resistant area of the load $A_{wr}(load)$ is greater than the allowable wind resistant area $A_{wr}(allow)$, the ratio can be used to determine a permissible wind speed $V(z)$ for the load using Table 2-3.

Table 2-3 A_{wr} Ratio and Permissible Wind Speed $V(z)$ - Imperial units

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.					
Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity at 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity at 45 mph	41.1	38.0	35.6	33.5	31.8

Rated Load Chart Example - Metric

RATED LIFTING CAPACITIES IN KILOGRAMS
10.9 m - 33.5 m BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Meters	#001									
	Main Boom Length in Meters									
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5	
3	+60,000 (69.5)	40,950 (72)	40,950 (76)							
3.5	53,000 (66.5)	40,950 (69.5)	40,950 (74)	28,350 (78)						
4	47,450 (63.5)	40,950 (66.5)	40,950 (72)	28,350 (75.5)	*18,225 (78)					
4.5	42,875 (60.5)	40,950 (64)	40,950 (70)	28,350 (73.5)	18,225 (76)					
5	39,050 (57.5)	39,025 (61.5)	38,300 (67.5)	28,350 (72)	18,225 (75)	*18,225 (78)				
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,225 (75)	*18,225 (78)			
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	18,225 (72)	18,225 (74.5)	*16,725 (78)	*11,400 (78)	
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 (61)	18,225 (69.5)	18,225 (72)	16,575 (74.5)	15,250 (74.5)	11,400 (76)	
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,250 (55)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)	
10		17,200 (20.5)	17,125 (41)	17,025 (54)	17,325 (60)	15,125 (66)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)	
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	12,125 (60)	11,600 (63)	10,725 (66.5)	10,050 (69)	
14				9,000 (35)	9,360 (46)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)	
16				6,750 (19)	7,110 (37.5)	7,470 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)	
18					5,960 (47)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)	
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)	
22							3,790 (16.5)	4,210 (33.5)	4,380 (42.5)	4,545 (48.5)
24								3,435 (23.5)	3,620 (36)	3,780 (43.5)
26									2,975 (28)	3,150 (37.5)
28									2,400 (16)	2,620 (31)
30										2,135 (22)
Minimum boom angle (°) for indicated length (no load)										0
Maximum boom length (m) at 0° boom angle (no load)										33.5

NOTE: () Boom angles are in degrees.
#RCL operating code. Refer to RCL manual for operating instructions.
*This capacity is based on maximum boom angle.
+ 9 parts line required to lift this capacity (using aux. boom nose) when using wire rope with a minimum breaking strength of 36,287 kg. Refer to Operator's & Safety Handbook for reeving diagram.
NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 13.4 m/s and up to 20.1 m/s, refer to Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 13.4m/s.

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
0°	13,775 (9.2)	11,675 (10.4)	8,145 (13.5)	5,930 (16.6)	4,565 (19.6)	3,535 (22.6)	2,860 (25.7)	2,220 (28.7)	1,770 (31.8)

NOTE: () Reference radii in meters.
** Boom length is with inner-mid fully extended and outer-mid & fly fully retracted.

FIGURE 2-3

Table 2-4 Example-Capacity Reduction Factors for Wind Speed V(z) Greater than 13.4 m/s - Metric

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)
 For wind speed V(z) (3-second gust speed at boom tip height) $V(z) > 13.4 \text{ m/s} \leq 20.1 \text{ m/s}$, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

	Main Boom Length in Meters								
Wind Speed $V(z) > 13.4 \text{ m/s}$ $\leq 20.1 \text{ m/s}$	10.9	12.2	15.2	18.4	21.0	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6

Wind resistance area of load, $Awr_{(load)}$ shall not exceed maximum allowable wind resistance area $Awr_{(allow)}$.
 Maximum allowable wind resistance area, $[m^2] Awr_{(allow)} = 0.0012 \times \text{calculated reduced capacity in kg}$.
 Wind resistance area of load, $Awr_{(load)}$ = projected wind area Ap x wind drag coefficient Cd for the load.
 For wind resistance Area of load, $Awr_{(load)} >$ maximum allowable wind resistance area, $Awr_{(allow)}$ refer to crane Operator Manual.

Table 2-5 Awr Ratio and Permissible Wind Speed V(z) - Metric

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.

Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (m/s)				
For Rated Capacity at 13.4 m/s	12.2	11.4	10.6	10.0	9.5
For Allowable Capacity at 20.1 m/s	18.3	17.0	15.9	15.0	14.2

Example and Sample Calculations (metric)

The following example illustrates how to calculate allowable load while operating in wind speed (3-second wind gust speed) above 13.4 m/s (30 mph) and maximum permissible wind speeds with various combinations of lifted load and wind resistance area.

NOTE: Permissible and calculated wind speeds in this example are the **3-second wind gust speeds at boom tip height V(z)**.

Example 1: Crane Configuration:

- boom length = 27.4 m,
- load radius = 9 m,
- wind speed is measured at $V(z) \leq 20.1 \text{ m/s}$.

From the **Rated Load Chart Example - Metric** (Figure 2-3), at maximum permissible wind speed, $V(z) = 13.4 \text{ m/s}$, the rated lifting capacity $m_{(allow)}$ for this configuration is 15,050 kg.

The maximum allowable wind resistance area of load is:

$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

$$Awr_{(allow)} = 0.0012 \times 15,050 = 18.06 \text{ m}^2$$

Lifting Limits at wind speed $V(z) \leq 13.4 \text{ m/s}$ at this configuration:

- Maximum load 15,050 kg
- Maximum wind resistance area of load 18.06 m²

For the allowable wind speed $> 13.4 \text{ m/s}$ and $\leq 20.1 \text{ m/s}$, reduce the allowable load. Per Table 2-4, the Factor for main boom length of 27.4 m is 0.8, the allowable load is:

$$m_{(allow)} = 0.8 \times 15,050 = 12,040 \text{ kg}$$

This reduced capacity load has an allowable wind resistance area of:

$$Awr_{(allow)} = 0.0012 \times 12,040 = 14.45 \text{ m}^2$$

Lifting Limits at wind speed $V(z) > 13.4 \text{ m/s}$ and $\leq 20.1 \text{ m/s}$, at this configuration:

- Maximum load 12,040 kg
- Maximum wind resistance area of load 14.45 m²

At wind speeds greater than 13.4 m/s, it is not permissible to lift a load greater than 12,040 kg, even if the wind resistance area of the load is less than 14.45 m².

Refer to the information from the above crane configuration, examine several load conditions.

Load example 1.1:

With known Wind Drag Coefficient of the load **Cd**, and

- load to be lifted of 11,200 kg,
- Projected Wind Area **Ap** = 9.20 m²,
- Wind Drag Coefficient **Cd** = 1.5

wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 9.2 \times 1.5 = 13.8 \text{ m}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 13.4 m/s and ≤ to 20.1 m/s**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
11,200 kg ≤ 12,040 kg YES
- Is **Awr_(load)** less than **Awr_(allow)** ?
13.8 m² ≤ 14.45 m² YES

Conclusion: This load is permissible to lift in wind speed up to 20.1 m/s.

Load example 1.2:

With unknown Wind Drag Coefficient of the load **Cd**,

- Load to be lifted of 10,000 kg,
- Projected Wind Area **Ap** = 5.45 m²,
- Wind Drag Coefficient **Cd** = unknown

NOTE: If exact Wind Drag Coefficient is not known, it shall be assumed as 2.4.

the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 5.45 \times 2.4 = 13.08 \text{ m}^2$$

Refer to the above **Lifting Limits at V(z) > 13.4 m/s and ≤ 20.1 m/s**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
10,000 kg ≤ 12,040 kg YES
- Is **Awr_(load)** less than **Awr_(allow)** ?
13.08 m² ≤ 14.45 m² YES

Conclusion: This load is permissible to lift in wind speed up to 20.1 m/s.

Load example 1.3a:

With large wind resistance area of the load **Awr_(load)**,

- Load to be lifted of 14,000 kg,
- Projected Wind Area **Ap** = 21.85 m²,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 21.85 \times 1.2 = 26.22 \text{ m}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 13.4 m/s and ≤ 20.1 m/s**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?
14,000 kg ≤ 12,040 kg NO

Conclusion: This load is NOT permissible to lift in wind speed up to 20.1 m/s.

Refer to the above **Lifting Limits at wind speed V(z) < 3.4 m/s**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?
14,000 kg ≤ 15,050 kg YES

The maximum permissible wind speed for this load is 13.4 m/s, depending on the wind resistance area of the load.

- Is **Awr_(load)** less than **Awr_(allow)** ?
26.22 m² ≤ 18.06 m² NO

Conclusion: This load is NOT permissible to lift in wind speed at 13.4 m/s, but is permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} = \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{26.22}{18.06} = 1.45$$

From Table 2-5, the maximum permissible wind speed at ratio of 1.45 (rounded to next higher table value of 1.6) is 10.6 m/s.

Conclusion: This load is permissible to lift in wind speed up to 10.6 m/s only.

Load example 1.3b:

With large wind resistance area of the load **Awr_(load)**,

- Load to be lifted of 8,000 kg,
- Projected Wind Area **Ap** = 15.25 m²,
- Wind Drag Coefficient **Cd** = 1.3

the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 15.25 \times 1.3 = 19.83 \text{ m}^2$$



Refer to the above **Lifting Limits at wind speed $V(z)$ > 13.4 m/s and ≤ 20.1 m/s**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
8,000 kg \leq 12,040 kg YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
19.83 m² \leq 14.45 m² NO

Conclusion: This load is NOT permissible to lift in wind speed up to 20.1 m/s, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} = \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{19.83}{14.45} = 1.37$$

From Table 2-5, the maximum permissible wind speed at ratio of 1.37 (rounded to next higher table value of 1.4) is 17.0 m/s.

Conclusion: This load is permissible to lift in wind speed up to 17.0 m/s only.

For
Reference
Only

Rated Load Chart Example - Non-metric

RATED LIFTING CAPACITIES IN POUNDS
36 FT. - 110 FT. BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Feet	#0001								
	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
10	130,000 (69.5)	90,300 (71.5)	90,300 (75.5)	*62,500 (78)					
12	112,500 (65.5)	90,300 (68.5)	90,300 (73)	62,500 (76.5)	*40,200 (78)				
15	93,250 (60)	90,300 (63.5)	90,250 (69.5)	62,500 (73.5)	40,200 (76)	*40,200 (78)			
20	71,550 (49.5)	71,500 (55)	71,300 (63)	62,500 (68)	40,200 (71.5)	40,200 (74.5)	40,200 (78)	*36,900 (78)	
25	56,650 (38.5)	56,600 (45)	56,350 (56)	53,650 (83)	40,200 (67)	40,200 (70.5)	37,950 (73)	34,900 (75)	*25,150 (78)
30	43,500 (11.5)	44,300 (32)	43,950 (48.5)	43,650 (57.5)	40,200 (62.5)	37,050 (66)	32,750 (69.5)	30,200 (72)	25,150 (74)
35			33,550 (40)	33,700 (51.5)	34,700 (58)	33,550 (62)	28,550 (66)	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	26,300 (52.5)	27,300 (58.5)	25,200 (62.5)	23,300 (66)	21,800 (68.5)
45				20,000 (36.5)	21,450 (47)	22,300 (54)	22,400 (59)	20,700 (62.5)	19,400 (65.5)
50				15,500 (25)	17,400 (41)	18,200 (49)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	15,000 (44)	16,000 (51)	16,400 (56)	15,800 (60)
60					11,000 (23.5)	12,700 (38)	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65					9,000 (31.5)	10,000 (41.5)	11,550 (48.5)	11,950 (53.5)	12,300 (58.5)
70						9,010 (22.5)	9,920 (36)	10,250 (44)	10,650 (50)
75							8,510 (29.5)	8,890 (39.5)	9,250 (46)
80							7,260 (21)	7,690 (34.5)	8,050 (42.5)
85								6,620 (28.5)	7,010 (38)
90								5,630 (20)	6,100 (33)
95									5,240 (27)
100									4,480 (19.5)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (ft.) at 0° boom angle (no load)									110

NOTE: () Boom angles are in degrees.
#RCL operating code. Refer to RCL manual for operating instructions.
*This capacity is based on maximum boom angle.
NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 30 mph and up to 45 mph, refer to Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 30 mph.

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
0°	30,350 (30.1)	25,700 (34.2)	17,950 (44.2)	13,050 (54.6)	10,050 (64.2)	7,790 (74.2)	6,300 (84.2)	4,900 (94.2)	3,900 (104.2)

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NOTE: () Reference radii in feet.
** Boom length is with inner-mid fully extended and outer-mid & fly fully retracted.

FIGURE 2-4

Table 2-6 Example-Capacity Reduction Factors for Wind Speed $V(z)$ Greater than 30 mph - Non-metric

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)

For wind speed Vz (3-second gust speed at boom tip height) is greater > 30 mph and ≤ 45 mph, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

Wind Speed $Vz > 30$ mph ≤ 45 mph	Main Boom Length in Feet								
	36	40	50	60	70	80	90	100	110
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.5

Wind resistance area of load, $Awr_{(load)}$, shall not exceed maximum allowable wind resistance area $Awr_{(allow)}$.

Maximum allowable wind resistance area of load, $Awr_{(allow)} = 0.0059 \times$ calculated reduced capacity in lb.

Wind resistance area of load, $Awr_{(load)} =$ projected wind area $Ap \times$ wind drag coefficient Cd for the load.

For wind resistance area of load, $Awr_{(load)} >$ maximum allowable wind resistance, $Awr_{(allow)}$, refer to crane Operator Manual.

Table 2-7 Awr Ratio and Permissible Wind Speed $V(z)$ - Non-Metric

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.

Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity@ 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity@ 45 mph	41.1	38.0	35.6	33.5	31.8

Example and Sample Calculations (Non-metric)

The following example illustrates how to calculate allowable load while operating in wind speed (3-second wind gust speed) above 13.4 m/s (30 mph) and maximum permissible wind speeds with various combinations of lifted load and wind resistance area.

NOTE: Permissible and calculated wind speeds in this example are the **3-second wind gust speeds at boom tip height $V(z)$** .

Example 2:

A crane is configured with:

- boom length = 90 ft,
- load radius = 40 ft, and
- wind speed is measured at $V(z) \leq 45$ mph.

The **Rated Load Chart Example - Non-metric** (Figure 2-4), at maximum permissible wind speed, $V(z) = 30$ mph, the rated lifting capacity $m_{(allow)}$ for this configuration is 25,200 lb.

The maximum allowable wind resistance area of load is:

$$Awr_{(allow)} = 0.0059 \times m_{(load)} \quad (2.5)$$

$$Awr_{(allow)} = 0.0059 \times 25,200 = 149 \text{ ft}^2$$

Lifting Limits at wind speed $V(z) < 30$ mph at this configuration:

- Maximum load 25,200 lb
- Maximum wind resistance area of load 149 ft²

For the allowable wind speed > 30 mph and ≤ 45 mph, reduce the allowable load. , the Factor for a main boom length of 90 ft is 0.8, thus the allowable load is:

$$m_{(allow)} = 0.8 \times 25,200 = 20,160 \text{ lb}$$

This reduced capacity load has an allowable wind resistance area of:

$$Awr_{(allow)} = 0.0059 \times 20,160 = 119 \text{ ft}^2$$

Lifting Limits at wind speed $V(z) > 30$ mph and ≤ 45 mph at this configuration:

- Maximum load 20,160 lb
- Maximum wind resistance area of load 119 ft²

Example, wind speeds greater than 13.4 m/s is **NOT** permissible to lift a load greater than 20,160 lb, even if the wind resistance area of the load is less than 119 ft².

Refer to the above crane configuration for the following load conditions:

Load example 2.1:

With known Wind Drag Coefficient of the load **Cd**,

- load to be lifted of 19,500 lb,
- Projected Wind Area **Ap** = 70 ft²,
- Wind Drag Coefficient **Cd** = 1.5

then the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 70 \times 1.5 = 105 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
19,500 lb ≤ 20,160 lb YES
- Is **Awr_(load)** less than **Awr_(allow)**?
105 ft² ≤ 119 ft² YES

Conclusion: This load is permissible to lift in wind speed up to 45 mph.

Load example 2.2:

With unknown Wind Drag Coefficient of the load **Cd**,

- Load to be lifted of 18,000 lb,
- Projected Wind Area **Ap** = 45 ft²,
- Wind Drag Coefficient **Cd** = unknown

NOTE: If exact Wind Drag Coefficient is not known, it shall be assumed as 2.4.

the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 45 \times 2.4 = 108 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
18,000 lb ≤ 20,160 lb YES
- Is **Awr_(load)** less than **Awr_(allow)**?
108 ft² ≤ 119 ft² YES

Conclusion: This load is permissible to lift in wind speed up to 45 mph.

Load example 2.3a:

With large wind resistance area of the load **Awr_(load)**,

- Load to be lifted of 22,000 lb,
- Projected Wind Area **Ap** = 180 ft²,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 180 \times 1.2 = 216 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?
22,000 lb ≤ 20,160 lb NO

Conclusion: This load is **NOT** permissible to lift in wind speed up to 45 mph.

Refer to the above **Lifting Limits at wind speed V(z) up to 30 mph**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?
22,000 lb ≤ 25,200 lb YES

The permissible wind speed for this load is 30 mph, depending on the wind resistance area of the load.

- Is **Awr_(load)** less than **Awr_(allow)**?
216 ft² ≤ 149 ft² NO

Conclusion: This load is **NOT** permissible to lift in wind speed at 30 mph, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio } \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{216}{149} = 1.45$$

From Table 2-7, the maximum permissible wind speed at ratio of 1.45 (rounded to next higher table value of 1.6) is 23.7 mph.

Conclusion: This load is permissible to lift in wind speed up to 23.7 mph only.

Load example 2.3b:

With large wind resistance area of the load **Awr_(load)**,

- Load to be lifted of 12,000 lb,
- Projected Wind Area **Ap** = 125 ft²,
- Wind Drag Coefficient **Cd** = 1.3

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 125 \times 1.3 = 162 \text{ ft}^2$$



Refer to the above **Lifting Limits at wind speed $V(z) > 30$ mph and ≤ 45 mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?
12,000 lb \leq 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
162 ft² \leq 119 ft² NO

Conclusion: This load is NOT permissible to lift in wind speed up to 45 mph, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{162}{119} = 1.37$$

From Table 2-7, the maximum permissible wind speed at ratio of 1.37 (rounded to next higher table value of 1.4) is 38.0 mph.

Conclusion: This load is permissible to lift in wind speed up to 38.0 mph only.

Lifting Operations

Before lifting, position the crane on a firm surface, properly extend and set the outriggers, and level the crane. Depending on the nature of the supporting surface, adequate cribbing may be required to obtain a larger bearing surface.

The crane is equipped with a bubble level that should be used to determine whether the crane is level. The load line can also be used to estimate the levelness of the crane by checking to make sure that it is in-line with the center of the boom at all points on the swing circle.

If the boom extension, or auxiliary boom nose is to be used, make sure that the electrical cable and the weight for the Anti-Two-Block Switch are properly installed and the Rated Capacity Limiter (RCL) is programmed for the crane configuration. Refer to the RCL operator manual supplied with the crane.

Verify the crane's capacity by checking the *Load Chart* against the weight of the load. Then, lift the load slightly at first to ensure stability before proceeding with the lift.

Make sure that the load is properly rigged and attached. Always determine the weight of the load before you attempt to lift it and remember that all rigging (slings, etc.) and lifting devices (hook block, boom extension, etc.) must be considered part of the load.

Measure the load radius before making a lift and stay within approved lifting areas based on the range diagrams and working area diagrams on the crane's *Load Chart*.

Always keep the load as near to the crane and as close to the ground as possible.

Do not overload the crane by exceeding the capacities shown on the appropriate *Load Chart*. Death or serious injury could result from the crane tipping over or failing structurally from overload.

The crane can tip over or fail structurally if:

- The load and crane's configuration is not within the capacity as shown on the applicable *Load Chart* and notes.
- The ground is soft and/or the surface conditions are poor.
- Outriggers are not properly extended and set. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.
- Cribbing under the outrigger pads is inadequate.
- The crane is improperly operated.

Do not rely on the crane's tipping to determine your lifting capacity.

Make sure that the hoist line is vertical before lifting. Do not subject the crane to side loading. A side load can tip the crane or cause it to fail structurally.

Load Chart capacities are based on freely suspended loads. Do not pull posts, pilings, or submerged articles. Make sure that the load is not frozen or otherwise attached to the ground before lifting.

If you should encounter a tipping condition, immediately lower the load with the hoist line and retract or elevate the boom to decrease the load radius. Never lower or extend the boom; this will aggravate the condition.

Use tag lines whenever possible to help control the movement of the load.

When lifting loads, the crane will lean toward the boom and the load will swing out, increasing the load radius. Make sure that the crane's capacity is not exceeded when this occurs.

Do not strike any obstruction with the boom. If the boom should accidentally contact an object, stop immediately. Inspect the boom. Remove the crane from service if the boom is damaged.

Never push or pull with the crane boom.

Avoid sudden starts and stops when moving the load. The inertia and an increased load radius could tip the crane over or cause it to fail structurally.

Using only one hoist at a time when lifting loads is recommended. See "Tilt-Up Panel Lifting" on page 2-21 for additional lifting instructions.

Always use enough parts-of-line to accommodate the load to be lifted. Lifting with too few parts-of-line can result in failure of the hoist rope.

Multiple Crane Lifts

Multiple crane lifts are not recommended.

Any lift that requires more than one crane must be precisely planned and coordinated by a qualified person. If it is necessary to perform a multi-crane lift, the operator shall be responsible for assuring that the following minimum safety precautions are taken:

- Secure the services of a qualified person to direct the operation.
- Make sure that all signals are coordinated through the lift director or person in charge of the lift.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.
- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on cranes so equipped.
- Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.
- Make sure that the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
- Do not travel. Lift only from a stationary position.

Lifting Multiple Loads

Grove recommends lifting only one load at a time.

Lifting two or more separately rigged loads at one time is only permitted during steel erection in accordance with 29CFR1926.753 when the following criteria are met:

1926.753(e)(1) A multiple lift shall only be performed if the following criteria are met:

- 1926.753(e)(1)(i) A multiple lift rigging assembly is used;
- 1926.753(e)(1)(ii) A maximum of five members are hoisted per lift;
- 1926.753(e)(1)(iii) Only beams and similar structural members are lifted; and
- 1926.753(e)(1)(iv) All employees engaged in the multiple lift have been trained in these procedures in accordance with § 1926.761(c)(1).
- 1926.753(e)(1)(v) No crane is permitted to be used for a multiple lift where such use is contrary to the manufacturer's specifications and limitations.

1926.753(e)(2) Components of the multiple lift rigging assembly shall be specifically designed and assembled with a maximum capacity for total assembly and for each individual attachment point. This capacity, certified by the manufacturer or a qualified rigger, shall be based on the manufacturer's specifications with a 5 to 1 safety factor for all components.

1926.753(e)(3) The total load shall not exceed:

- 1926.753(e)(3)(i) The rated capacity of the hoisting equipment specified in the hoisting equipment load charts;
- 1926.753(e)(3)(ii) The rigging capacity specified in the rigging rating chart.

1926.753(e)(4) The multiple lift rigging assembly shall be rigged with members:

- 1926.753(e)(4)(i) Attached at their center of gravity and maintained reasonably level;
- 1926.753(e)(4)(ii) Rigged from top down; and
- 1926.753(e)(4)(iii) Rigged at least 7 feet (2.1 m) apart.

1926.753(e)(5) The members on the multiple lift rigging assembly shall be set from the bottom up.

1926.753(e)(6) Controlled load lowering shall be used whenever the load is over the connectors.

Tilt-Up Panel Lifting

Requirements and recommendations regarding operation and use of Grove cranes are stated on decals and in the Operator Manual provided with each specific model machine. Using the subject crane to perform tilt-up panel lifting with two hoist lines poses new and different hazards than does normal lifting use.

Therefore, the following additional precautions must be taken if it is necessary for the crane to be used to perform tilt-up panel lifting using a crane equipped with two hoists:

- The crane must be set up and operated in accordance with Grove's instructions in the Operator Manual, Load Capacity Chart, and decals affixed to the crane.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part of line or up to two parts of line depending on the applicable load chart ratings.
- The load shall be connected with the main hoist line connected to the end closest to crane and the auxiliary hoist line connected to the end farthest from the crane.

- The anti-two-block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts of line.
- The wire rope and sheaves shall be inspected prior to and following the lifting operations for chaffing or scrubbing.
- The total gross load shall not exceed 80% of the standard load chart. The operator shall be responsible to control this as the RCL does not have a feature to set reduced lifting limits.
- The auxiliary hoist line shall be considered part of the deducts to determine net allowable load.
- The panel shall be lifted so that the hoist lines are in line with the crane.
- The load shall be controlled to prevent rotation of the load and to make sure that the load stays in line with the boom.
- The load must be balanced with the auxiliary: load line not taking more than half the load at any time during the lift. The RCL will not be providing coverage for the line pull of the auxiliary hoist line.
- The effect of wind loads on the crane and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

Make sure that all personnel working on and around the crane are properly trained and thoroughly familiar with operational functions of the crane and safe operating and work practices. Personnel should be thoroughly familiar with regulations and standards governing cranes and their operation. Work practices may vary slightly between government regulations, industry standards, local and job-site rules and employer policies so a thorough knowledge of and compliance with all relevant work rules is necessary.

Counterweight

On cranes equipped with removable counterweights, make sure that the appropriate counterweight sections are properly installed for the lift being considered.

Do not add material to the counterweight to increase capacity. United States Federal law prohibits modification or additions which affect the capacity or safe operation of the equipment without the manufacturer's written approval. [29CFR 1926.1434]

Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these cranes, as indicated on the crane's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and Grove criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

The occurrence of an outrigger lifting from the ground is often attributed to the natural flex in the crane's frame. This may happen when lifting a load in certain configurations within the capacity limits of the *Load Chart* and is not necessarily an indication of an unstable condition.

Provided the crane is properly set up, the crane is in good working condition, that all operator's aids are properly programmed, that the qualified crane operator adheres to the instructions found in the applicable *Load Chart*, *Operator Manual* and decals on the crane, the crane should not be unstable.

PILE DRIVING AND EXTRACTING

Pile driving and extracting are applications approved by Grove, provided all equipment is operated within factory guidelines. The following operating requirements must be used during pile driving and extracting with a Grove mobile hydraulic crane:

Pile driving and pile extraction using a mobile crane introduces many variable and unknown factors that must be considered when using a crane for this application. Because of these factors, discretion must be exercised when pile driving or pile extraction is being considered.

It is not the intention of Grove to recommend specific types or makes of pile driving and pile extraction equipment, but rather to advise of the operational requirements to help avoid the detrimental effects that pile driving and pile extraction can have on the crane.

In addition to the operating requirements that are detailed in the operating manuals and on the load capacity chart, pile driving and extracting operations are approved by Grove, provided all guidelines outlined below are followed:

- All pile driving and extracting operations shall be restricted to fully extended outriggers with all tires clear of the ground.

- The combined weight of the driver or extractor, piling, leads, attachments, etc., shall not exceed 80% of the published load chart values for on-outriggers operation.
- The pile driver or pile extractor and attachments shall be kept clear of the boom nose at all times.
- The pile driver and piling shall be suspended from a hoist cable with sufficient line speed to meet or exceed the rate of descent of the driver and piling to preclude impact loading or vibration from being induced into the boom and crane structure.
- Pile driving or extracting shall be restricted to over the main boom only and shall not be permitted over a boom extension.
- Pile extraction using only the crane's hoist line is unsafe and not permitted since load values cannot be accurately determined. Only pile extraction devices that do not transmit vibration or shock loading into the crane are permitted. All possible precautionary measures shall be taken to prevent shock loads or vibration from being imposed on crane components, either directly through the hoist cable or indirectly from ground borne vibration.
- The load lines shall be kept vertical at all times during pile driving and pile extraction operations.
- The operator and other personnel associated with the pile driving and pile extraction operation shall have read and understood all safety standards applicable to crane operations as well as being thoroughly trained in the safe operation of pile driving and extracting equipment.

Crane Equipment

- Hoists shall be equipped with a cable follower to aid in proper spooling of cable.
- All cable retainer pins and cable guides/retainers shall be in place.
- All boom extensions must be removed from the machine before pile driving or extraction begins.
- All hoist hooks shall be equipped with a positive locking latch.

Crane Inspection

- In addition to the crane's frequent and periodic inspections, dated daily records shall be maintained

showing inspections were performed on the crane during the time it was used for pile driving or extraction.

- All anti-two-block warning devices and RCL systems shall be inspected daily and verified to be functional.
- All areas of the crane subject to fatigue shall be inspected monthly, and before the crane is to return to lifting service.
- The boom shall be inspected daily to make sure that all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to make sure that the pinning mechanism operates properly and to check for undue wear at the pins and pinning plates.
- The hoist cable shall be inspected daily to make sure that no chafing or wear is occurring.

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 6 m (20 ft) to power sources up to 350 kV and greater distances for higher voltages unless the line's voltage is known [29CFR1910.180 and 29CFR1926, subpart CC].

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



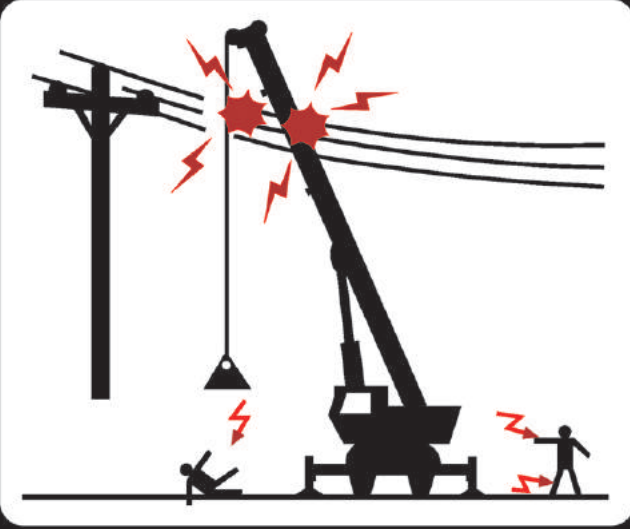
DANGER

Electrocution Hazard!

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

If operation within 3 m (10 ft) of any power lines cannot be avoided, the power utility **must** be notified and the power lines **must** be de-energized and grounded **before** performing any work.

Electrocution **can occur** even without direct contact with the crane.



! DANGER

**ELECTROCUTION HAZARD
TO AVOID DEATH OR SERIOUS INJURY**

Keep **ALL** parts of the crane, rigging and load at least 20 feet (6 meters) away from any energized power line. You **MUST** follow the OSHA requirements set forth in 29CFR 1926.1407 through 1926.1411.

This crane is not designed or equipped for use within 10 feet (3 meters) of energized power lines [Refer to 29CFR1926.1410 Table A]. If operation within 10 feet (3 meters) of any power lines cannot be avoided, the power utility **MUST** be notified and the power lines **MUST** be de-energized and grounded **BEFORE** performing any work.

If contact is ever accidentally made with a power line and any part of this crane, its rigging or load, **NEVER** touch the crane or even approach or come near the crane.

Electrocution **CAN OCCUR** even without direct contact with the crane.

80037260

THIS CRANE IS NOT INSULATED.

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Crane operation is dangerous when close to an energized electrical power source. Exercise extreme caution and prudent judgement. Operate slowly and cautiously when in the vicinity of power lines.

Before operating this 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.

This crane is **not insulated**. Always consider all parts of the load and the crane, including the hoist rope, wire rope, pendant cables, and tag lines, as conductors. You, the operator, are responsible for alerting all personnel of dangers associated with electrical power lines and equipment. 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, tag lines, or rigging gear.

If the load, hoist 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.

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 *Operator Manual* must be followed at all times, even if the electrical power lines or equipment have been de-energized.

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

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.

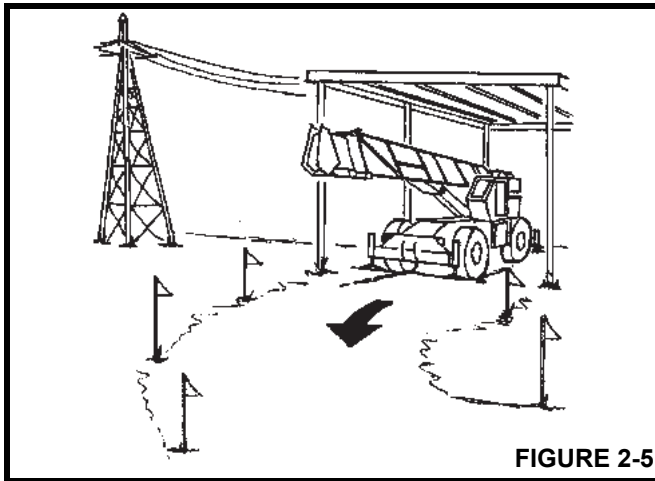
Set-Up and Operation

During crane use, assume that every line is energized ("hot" or "live") and take the necessary precautions.

Set up the crane in a position such that the load, boom, or any part of the crane and its attachments cannot be moved to within 6 m (20 ft) of electrical power lines or equipment. This includes the crane boom (fully extended to maximum height, radius, and length) and all attachments (boom extensions, rigging, loads, etc.). Overhead lines tend to blow in the wind so allow for lines' movement when determining safe operating distance.

A suitable barricade should be erected to physically restrain the crane and all attachments (including the load) from entering into an unsafe distance from electrical power lines or equipment.

Plan ahead and always plan a safe route before traveling under power lines. Rider poles should be erected on each side of a crossing to assure sufficient clearance is maintained.



United States OSHA regulations require a flagman when operating in close proximity to energized power lines.

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 shall have no other duties while the crane is working.

Tag lines should always be made of non-conductive materials. Any tag line that is wet or dirty can conduct electricity.

Do not store materials under power lines or close to electrical power sources.

Electrocution Hazard Devices

The use of insulated links, insulated boom cages/guards, or proximity warning devices does not assure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules listed here may result in serious injury or death. You should be aware that such devices have limitations and you should follow the rules and precautions outlined in this manual at all times even if the crane is equipped with these devices.

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.

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.

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 (e.g. dust, dirt, moisture, etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

Proximity sensing and warning devices are available in different types. Some use boom nose (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. Much reliance is placed upon you, the operator, in selecting and properly setting the sensitivity of these devices.

Never rely solely on a device to protect you and your fellow workers from danger.

Some variables you must know and understand are:

- Proximity devices are advertised to detect the existence of electricity and not its 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; 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.

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, the condition of the ground, the magnitude of the voltage and current present, and numerous other factors.

Electrical Contact

If the crane should come in contact with an energized power source, you must:

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 may have remained 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 operator's station, **jump completely clear of the crane. Do not step off.** Hop away with both feet together. **Do not** walk or run.

Following any contact with an energized electrical source, the Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the hoist rope and all points of contact on the crane. Should the distributor not be immediately available, contact Manitowoc Crane Care. 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 your Grove distributor or Manitowoc Crane Care.

Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

When operating near transmitter/communication towers where an electrical charge can be induced into the crane or load:

- The transmitter shall be deenergized OR,
- Tests shall 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 a qualified RF (radio frequency) Consultant. Also refer to local, state, and federal codes and regulations.

When operating cranes equipped with electromagnets, you must take additional precautions. Permit no one to touch the magnet or load. Alert personnel by sounding a warning signal when moving a load. Do not allow the cover of the electromagnet power supply to be open during operation or at any time the electrical system is activated. Shut down the crane completely and open the magnet controls switch prior to connecting or disconnecting magnet leads. Use only a non-conductive device when positioning a load. Lower the magnet to the stowing area and shut off power before leaving the operator's cab (if equipped) or operator's station.

Grounding the Crane

The crane may become charged with static electricity. This may occur especially when using outrigger pads made of

plastic or when the outrigger pads are cribbed with insulating material (e.g., wooden planks).



WARNING

Risk of accidents due to electric shock!

Ground the crane before you start to work with it

- Near strong transmitters (radio transmitters, radio stations, etc.)
- Near high-frequency switching stations
- If a thunder storm is forecast

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-6) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm² (0.025 in²) (AWG 5).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.

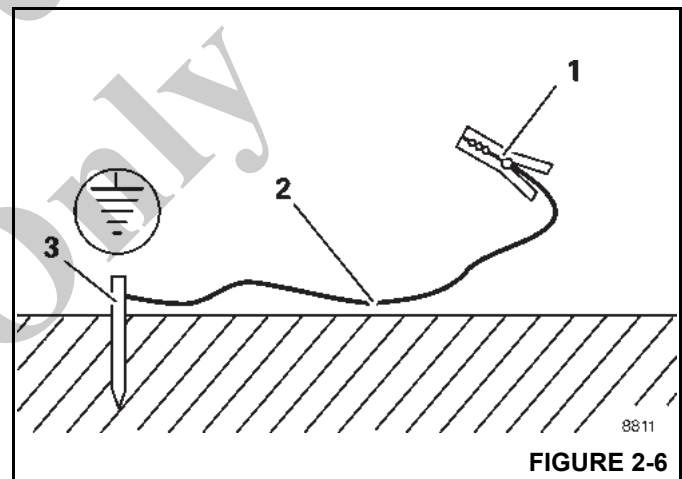


FIGURE 2-6



WARNING

Risk of accidents due to electric shock!

Make sure that the connections between the cable and the clamp are electrically conductive.

Do not attach the clamp to parts that are screwed on, such as valves, covers or similar parts.

PERSONNEL HANDLING

The American Society of Mechanical Engineers published the American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23:

This Volume establishes the design criteria, equipment characteristics, and operational procedures that are required when hoisting equipment within the scope of the ASME B30 Standard is used to lift personnel. Hoisting equipment defined by the ASME B30 Standard is intended for material handling. It is not designed, manufactured, or intended to meet the standards for personnel handling equipment, such as ANSI/SIA A92 (Aerial Platforms). The equipment and implementation requirements listed in this Volume are not the same as that established for using equipment specifically designed and manufactured for lifting personnel. Hoisting equipment complying with the applicable Volumes of the ASME B30 Standard shall not be used to lift or lower personnel unless there are no less hazardous alternatives to providing access to the, area where work is to be performed. The lifting or lowering of personnel using ASME B30-compliant hoisting equipment is prohibited unless all applicable requirements of this volume have been met.

This standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.1431:

General requirements. 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 worksite, 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 worksite conditions.

Additional requirements for crane operations are stated in ASME B30.5, *Mobile and Locomotive Cranes*, ASME B30.8, *Floating Cranes and Floating Derricks*, and in OSHA regulations 29CFR1910.180 for *General Industry* and 29CFR1926.1431 for *Construction*.

Use of a Grove crane to handle personnel is acceptable, provided:

- 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 must remain at the crane controls 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.
- The crane must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane's *Load Chart* is affixed at the operator's station and readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For hoist rope suspended platforms:
 - The crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
 - The crane is equipped with a functional anti-two-block device.
 - The platform is properly attached and secured to the load hook.
- For boom mounted platforms:
 - The platform is properly attached and secure.

To avoid death or serious injury:

- NEVER use this crane for bungee jumping or any form of amusement or sport.
- NEVER handle personnel on the loadline unless the requirements of applicable national, state and local regulations and safety codes are met.
- NEVER permit anyone to ride loads, hooks, slings or other rigging for any reason.
- NEVER get on or off a moving crane.
- NEVER allow anyone other than the operator to be on this crane while the machine is operating or traveling.
- NEVER allow anyone on the hoist access platform while traveling.

The following standards and regulations regarding personnel handling are available by mail at the following addresses:

- *ASME (formerly ANSI) B30 Series American National Safety Standards For Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings; ASME B30.5, Mobile And Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems*, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 07007-2900.

- or - check online at:

<https://www.asme.org/codes-standards/find-codes-standards>

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

ENVIRONMENTAL PROTECTION

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

Potentially harmful waste used in Grove 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, observe the following:

- 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 clean up any spills.

MAINTENANCE

The crane must be inspected prior to use on each work shift. The owner, user, and operator must make sure that routine maintenance and lubrication are being dutifully performed. **Never** operate a damaged or poorly maintained crane.

Grove continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Grove reminds crane owners to make sure that all safety decals are in place and legible. Grove continues to urge crane owners to upgrade their cranes with rated capacity limiter and control lever lockout systems for all lifting operations.

Shut down the crane while making repairs or adjustments.

Always perform a function check after repairs have been made to ensure proper operation. Load tests should be performed when structural or lifting members are involved.

Follow all applicable safety precautions in this manual when performing crane maintenance as well as crane operations.

Keep the crane free of mud, dirt, and grease at all times. Dirty equipment introduces hazards, wears-out faster, and makes proper maintenance difficult. Cleaning solutions used should be non-flammable, non-toxic and appropriate for the job.

Routine maintenance and inspection of this crane must be performed by a qualified person(s) according to the recommendations in the *Inspection and Lubrication Service Log*. Any questions regarding procedures and specifications should be directed to your Grove distributor.

Service and Repairs



WARNING

Fall Hazard!

Working at elevated heights without using proper fall protection can result in severe injury or death.

Always use proper fall protection as required by local, state or federal regulations.

Service and repairs to the crane must only be performed by a qualified person. All service and repairs must be performed in accordance with manufacturer's recommendations, this manual, and the service manual for this machine. If there is any question regarding maintenance procedures or specifications, contact your Grove distributor for assistance.

Qualified person is defined as one who by reason of knowledge, 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.

All replacement parts must be Grove approved.

Any modification, alteration, or change to a crane which affects its original design and is not authorized and approved by Grove is **strictly prohibited**. Such action invalidates all warranties and makes the owner/user liable for any resultant accidents.

Hydraulic Fluid

- Do not use your hand or any part of your body to check for hydraulic fluid leaks when the engine is running or the hydraulic system is under pressure. Fluid in the hydraulic system can be under enough pressure that it will penetrate the skin, causing serious injury or death. Use a piece of cardboard, or piece of paper, to search

for leaks. Wear gloves to protect your hands from spraying fluid.

- If any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Do not attempt to repair or tighten any hydraulic hose or fitting while the engine is running, or when the hydraulic system is under pressure.
- Never disconnect any hydraulic lines unless the boom is fully lowered, the engine is shut off, and the hydraulic pressure is relieved. To relieve hydraulic pressure, stop the engine, turn the ignition switch to RUN and move the hydraulic controls in both directions several times.



WARNING

Pressurized Fluid Hazard!

Hydraulic pressure may still be present in portions of the hydraulic system due to accumulators or trapped circuitry.

- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

Moving Parts

- Do not place limbs near moving parts. Amputation of a body part may result. Turn off the engine and wait until the fan and belts stop moving before servicing crane.
- Pinch points, which result from relative motion between mechanical parts, are areas of the machine that can cause personal injury or death. Do not place limbs or your body in contact with pinch points either on or around the machine. Care must be taken to prevent motion between pinch points when performing maintenance and to avoid such areas when movement is possible.
- Do not allow persons to stand near extending or lowering outriggers. Foot crushing could occur.

Before maintenance or repairs

Before performing any maintenance, service or repairs on the crane:

- The boom should be fully retracted and lowered and the load placed on the ground.
- Do not get under a raised boom unless the boom is blocked up safely. Always block up the boom before doing any servicing that requires the boom to be raised.

- Stop the engine and disconnect the battery.
- Controls should be properly tagged. Never operate the crane if it is **tagged-out** nor attempt to do so until it is restored to proper operating condition and all tags have been removed by the person(s) who installed them.

After maintenance or repairs

- Replace all guards and covers that have been removed.
- Remove all tags, connect the battery, and perform a function check of all operating controls.
- Consult with Manitowoc Crane Care to determine if load testing is required after a structural repair is performed.

Lubrication

The crane must be lubricated according to the manufacturer's recommendations for lubrication points, time intervals, and types. Lubricate at more frequent intervals when working under severe conditions.

Exercise care when servicing the hydraulic system of the crane, as pressurized hydraulic oil can cause serious injury. The following precautions must be taken when servicing the hydraulic system:

- Follow the manufacturer's recommendations when adding oil to the system. Mixing the wrong fluids could destroy seals, causing component failure.
- Be certain all lines, components, and fittings are tight before resuming operation.

Tires



WARNING

Possible equipment damage and/or personal injury!

Driving the crane with a tire and split-rim assembly under inflated at 80% or less of its recommended pressure can cause the wheel and/or tire to fail. Per *OSHA Standard 1910.177(f)(2)*, when a tire has been driven under inflated at 80% or less of its recommended pressure, it must first be completely deflated, removed from the axle, disassembled, and inspected before re-inflation.

Inspect the tires for nicks, cuts, embedded material, and abnormal wear.

Make sure that all lug nuts are properly torqued.

Make sure that pneumatic tires are inflated to the proper pressure (refer to the *Load Chart*). When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

HOIST ROPE

Synthetic Hoist Rope

For detailed information concerning synthetic hoist rope, refer to K100™ Synthetic Crane Hoist Line Manual P/N 9828100734 available by contacting Manitowoc Crane Care.

During installation and setup, care must be taken to avoid overlap and crossing of wire rope and synthetic hoist ropes.

Always make daily inspections of the hoist rope, keeping in mind that all hoist rope will eventually deteriorate to a point where it is no longer usable. Refuse to work with worn or damaged hoist rope.

During regular inspections, operator shall make sure that crane surfaces such as wear pads, sheaves, etc have not been damaged in a manner that can then damage the synthetic hoist rope.

NOTE: Example; if usage of a wire rope has cut grooves with sharp edges in a wear pad, they need to be addressed before the synthetic hoist rope is used in that same position.

Use **only** the hoist rope specified by Grove as indicated on the crane's *Load Chart*. Substitution of an alternate hoist rope may require the use of a different permissible line pull and, therefore, require different reeving.

NOTE: Hoist rope may be purchased by contacting Manitowoc Crane Care.

Wire Rope

Always make daily inspections of the rope, keeping in mind that all wire rope will eventually deteriorate to a point where it is no longer usable. Refuse to work with worn or damaged wire rope. Rope shall be taken out of service when any of the following conditions exist:

- For rotation-resistant running ropes: more than two (2) broken wires in a length of rope equal to six (6) times the rope diameter, or more than four (4) broken wires in a length of rope equal to thirty (30) times the rope diameter.
- For running ropes other than rotation resistant: six (6) broken wires in one rope lay or three (3) broken wires in one strand.
- One valley break where the wire fractures between strands in a running rope is cause for removal.
- Abrasion of the rope resulting in a 5% reduction in the original wire diameter.
- Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
- Rope that has been in contact with a live power line or has been used as a ground in an electric circuit (e.g., welding) may have wires that are fused or annealed and must be removed from service.
- In standing ropes, more than three (3) breaks in one rope lay in sections beyond the end connection or more than two (2) broken wires at an end connection.
- Core deterioration, usually observed as a rapid reduction in rope diameter, is cause for immediate removal of the rope.

The following is a brief outline of the basic information required to safely use wire rope.

- Wire ropes wear out. The strength of a rope begins to decrease when the rope is put to use and continues to decrease with each use. Rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a wire rope applies only to a new, unused rope.
- The nominal strength of a rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a rope should never be used as its working load.
- Each type of fitting attached to a rope has a specific efficiency rating which can reduce the working load of the rope assembly or rope system.
- If an operator hoists the hook block up or down too fast when reeved with multiple parts of line and no hook load, the wire rope can bird cage and damage the rope.
- Never overload a rope. This means never use the rope where the load applied to it is greater than the working load determined by the rope manufacturer.
- Never "shock load" a rope. A sudden application of force or load can cause both visible external and internal damage. There is no practical way to estimate the force applied by shock loading a rope. The sudden release of a load can also damage a rope.
- Lubricant is applied to the wires and strands of a wire rope when it is manufactured. The lubricant is depleted when the rope is in service and should be replaced periodically. Refer to the *Service Manual* for more information.
- In the U.S.A., regular inspections of the rope and keeping of permanent records signed by a qualified person are required by OSHA for almost every wire rope application. The purpose of the inspection is to determine whether or not a rope may continue to be safely used on the application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by OSHA, ANSI,

ASME and similar organizations. See the *Service Manual* for inspection procedures.

When inspecting ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves. Never handle the rope with bare hands.

Some conditions that lead to problems in wire rope systems include:

- Sheaves that are too small, worn or corrugated cause damage to a wire rope.
- Broken wires mean a loss in strength.
- Kinks permanently damage a rope and must be avoided.
- Ropes are damaged by knots. Rope with knots must never be used.
- Environmental factors such as corrosive conditions and heat can damage a wire rope.
- Lack of lubrication can significantly shorten the useful life of a wire rope.
- Contact with electrical wires and resulting arcing will damage a wire rope.
- An inspection should include verification that none of the specified removal criteria for this usage are met by checking for such things as:
 - Surface wear; nominal and unusual.

- Broken wires; number and location.
- Reduction in diameter.
- Rope stretch (elongation).
- Integrity of end attachments.
- Evidence of abuse or contact with another object.
- Heat damage.
- Corrosion.

NOTE: A more detailed rope inspection procedure is given in the *Service Manual*.

- ***When a rope has been removed from service because it is no longer suitable for use, it must not be reused on another application.***

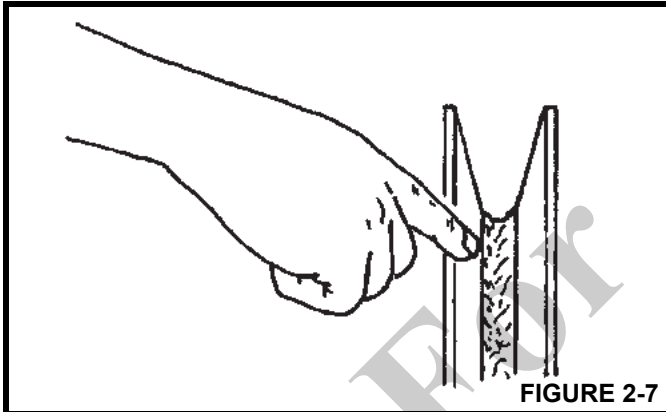
Installing a new rope

- Keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves.
- Never handle the wire rope with bare hands.
- Follow proper instructions for removing rope from a reel.
- Apply back tension to the storage/payoff reel of the new rope to ensure tight, even, spooling onto the hoist drum.
- Operate the new rope—first through several cycles at light load—then through several cycles at intermediate load, to allow the rope to adjust to operating conditions.

Reference Only

When using a wedge socket

- Always inspect socket, wedge, and pin for correct size and condition.
- Do not use parts that are damaged, cracked, or modified.
- Assemble the wedge socket with live end of rope aligned with the centerline of pin, and assure proper length of tail (dead end) protrudes beyond the socket.

Sheaves

Inspect the boom nose and hook block sheaves for proper operation, excessive wear, and damage every 50 hours or weekly. Inoperable, damaged and/or worn sheaves cause rapid deterioration of rope.

Make sure that sheaves carrying ropes, that can be momentarily unloaded, are equipped with close fitting guards or other devices to guide the rope back into the groove when the load is reapplied. Make sure that sheaves in the lower load block are equipped with close fitting guards that will prevent the ropes from becoming fouled when the block is lying on the ground with loose ropes.

To attain maximum hoist rope life and minimize hook block rotation, it is recommended that even numbers of parts-of-line be used in multiple-part reeving whenever possible.

The use of nylon (polyamide) sheaves, as compared with metallic sheaves, may change the replacement criteria of rotation-resistant hoist rope.

NOTE: The use of cast nylon (polyamide) sheaves will substantially increase the service life of rope. However, conventional rope retirement criteria based only upon visible wire breaks may prove inadequate in predicting rope failure. The user of cast nylon sheaves is therefore cautioned that a retirement criteria should be established based upon the user's experience and the demands of his application.

Batteries

Battery electrolyte must not be allowed to contact the skin or eyes. If this occurs, flush the contacted area with water and consult a doctor immediately.

When checking and maintaining batteries, exercise the following procedures and precautions:

- Wear safety glasses when servicing batteries.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
 - a. Make sure that the key switch has been off for 2 minutes.
 - b. Turn the battery disconnect switch to the OFF position.
 - c. Remove the ECM power fuse.
 - d. Remove negative battery cables.
- Do not break a live circuit at the battery terminal. Disconnect the ground battery cable first when removing a battery and connect it last when installing a battery.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- If applicable, maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your crane, check battery test indicator on maintenance-free batteries.
- Check battery condition only with proper test equipment. Batteries shall not be charged except in an open, well-ventilated area that is free of flame, smoking, sparks, and fire.

Super Capacitor (If Equipped)

Capacitor electrolyte must not be allowed to contact the skin or eyes. If this occurs, flush the contacted area with water and consult a doctor immediately.

When checking and maintaining capacitor, exercise the following procedures and precautions:

- Wear safety glasses when servicing.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
 1. Make sure that the key switch has been off for 2 minutes.
 2. Turn the battery disconnect switch to the OFF position.

3. Remove the ECM power fuse.
 4. Remove negative battery cables.
 5. Remove positive capacitor cable.
- Do not short across the capacitor posts to check charge. Short circuit will cause capacitor terminal damage. Spark or flame could cause capacitor explosion.
 - Check capacitor charge level with proper test equipment.

General Maintenance

Fuel the crane only with the engine turned off. Do not smoke while fueling the crane. Do not store flammable materials on the crane.

Be familiar with the location and use of the nearest fire extinguisher.

Be careful when checking the engine coolant level. The fluid may be hot and under pressure. Shut down the engine and allow the radiator time to cool before removing the radiator cap.

Shut down the engine and disconnect the battery before performing maintenance. If unable to do so for the task required, keep hands clear of the engine fan and other moving parts while performing maintenance.

Be careful of hot surfaces and hot fluids when performing maintenance on or around the engine.

Do not use ether to start the engine on cranes equipped with intake manifold grid heaters.

The engine can enter into an engine exhaust cleaning mode where the exhaust temperature can be high, make sure that the exhaust is not pointed at materials that can melt, burn, or explode.

TRANSPORTING THE CRANE

Before transporting the crane, check the suitability of the proposed route with regard to the crane height, width, length, and weight.

Check load limits of bridges on the travel route, and make sure that they are greater than the combined weight of the crane and transporting vehicle.

When loading or unloading the crane on a trailer or railroad car, use a ramp capable of supporting the weight of the crane.

Make sure that the crane is adequately secured to the transporting vehicle.

Do not use the dead end lug (1, Figure 2-8) on the boom nose for tying down the boom during transport. Damage to the lug and boom can result from usage as a tie down point.

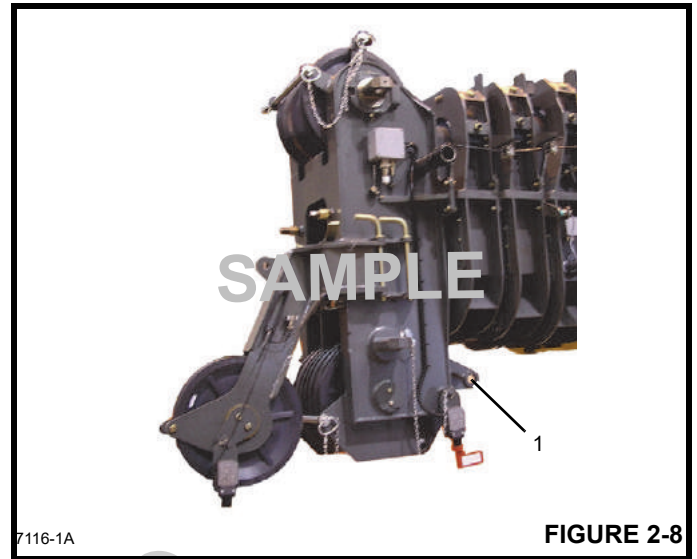


FIGURE 2-8

Before transporting the crane on a road or highway, first check state and local restrictions and regulations.

Either the hook block may be reeved over the main boom nose or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If the hook block or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.

When using hookblock tie downs, excessive loading can be applied by pulling the cable too tight, particularly when reeved with multiple part lines. When the cable is hooked into the hookblock tie down, the cable should be merely "snugged-up" with adequate slack provided at the center line of sheave to anchor point. Do not draw cable taut. Care must be exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down.

TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

When traveling, the boom should be completely retracted and lowered to the travel position and the turntable pin swing lock, if equipped, should be engaged. If equipped with boom rest, lower the boom into the boom rest and engage the turntable lock.

Strictly adhere to the guidelines and restrictions in the *Load Chart* for pick and carry operations.

RT cranes are manufactured without an axle suspension system. Traveling at high speeds, especially on rough ground, may create a bouncing effect that can result in loss of control. If bouncing occurs, reduce travel speed.

**WARNING**
Crushing Hazard!

Death or serious injury could result from being crushed by revolving tires.

Keep clear of revolving tires.

Stunt driving and horse-play are strictly prohibited. Never allow anyone to hitch a ride or get on or off a moving crane.

Follow the instructions in this manual when preparing the crane for travel.

If using a boom dolly/trailer, thoroughly read and understand all the steps and safety precautions in this manual for setup and travel.

When driving the crane make sure that the cab is down, if equipped with a tilting cab.

Secure the hook block and other items before moving the crane.

Watch clearances when traveling. Do not take a chance of running into overhead or side obstructions.

When moving in tight quarters, post a signal person to help guard against collisions or bumping structures.

Before traveling a crane, check suitability of proposed route with regard to crane height, width, and length.

Never back up without the aid of a signal person to verify the area behind the crane is clear of obstructions and/or personnel.

On cranes equipped with air-operated brakes, do not attempt to move the crane until brake system air pressure is at operating level.

Check load limit of bridges. Before traveling across bridges, make sure that they will carry a load greater than the crane's weight.

If it is necessary to take an RT crane on a road or highway, check state and local restrictions and regulations.

Keep lights on, use traffic warning flags and signs, and use front and rear flag vehicles when necessary. Check state and local restrictions and regulations.

Always drive the crane carefully, obeying speed limits and highway regulations.

Stay alert at the wheel.

If equipped, make sure that the hoist access platform hand rail and step are in the travel configuration.

For Reference Only

Slopes

- Pick and carry on level surfaces only.
- Refer to the *Operation Section* for more detailed information on traveling on slopes.
- Driving across a slope is dangerous, as unexpected changes in slope can cause tip over. Ascend or descend slopes slowly and with caution.
- When operating on a downhill slope, reduce travel speed and downshift to a low gear, to permit compression braking by the engine, and aid the application of the service brakes.

WORK PRACTICES

Personal Considerations

Always adjust the seat and lock it in position, and fasten the seat belt securely before you start the engine.

Do not wear loose clothing or jewelry that can get caught on controls or moving parts. Wear the protective clothing and personal safety gear issued or called for by the job conditions. Hard hat, safety shoes, ear protectors, reflective clothing, safety goggles, and heavy gloves may be required.

Crane Access



WARNING

Fall Hazard!

Working at elevated heights without using proper fall protection can result in severe injury or death.

Always use proper fall protection as required by local, state or federal regulations.

You must take every precaution to make sure that you do not slip and/or fall off the crane. Falling from any elevation could result in serious injury or death.

Never exit or enter the crane cab or deck by any other means than the access system(s) provided (i.e., steps and grab handles). Use the recommended handholds and steps to maintain a three-point contact when getting on or off the crane.

If necessary, use a ladder or aerial work platform to access the boom nose.

Do not make modifications or additions to the crane's access system that have not been evaluated and approved by Grove Crane.

Do not step on surfaces on the crane that are not approved or suitable for walking and working. All walking and working surfaces on the crane should be clean, dry, slip-resistant, and have adequate supporting capacity.

Do not walk on a surface if slip-resistant material is missing or excessively worn.

Do not use the top of the boom as a walkway.

Do not step on the outrigger beams or outrigger pads (floats) to enter or exit the crane.

Use the hoist access platform (if equipped) when working in the hoist area.

Wear shoes with a highly slip-resistant sole material. Clean any mud or debris from shoes before entering the crane cab/operator's station or climbing onto the crane superstructure. Excessive dirt and debris on the handholds, access steps, or walking/working surfaces could cause a slipping accident. A shoe that is not clean might slip off a control pedal during operation.

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.

Job Preparation

Before crane use

- Barricade the entire area where the crane is working and keep all unnecessary personnel out of the work area.
- Make sure that the crane is properly equipped, including access steps, covers, doors, guards, and controls.
- Conduct a visual inspection for cracked welds, damaged components, loose pins/bolts, and wire connections. Any item or component that is found to be loose or damaged (broken, chipped, cracked, worn-through, etc.) must be repaired or replaced. Inspect for evidence of improper maintenance (consult your *Service Manual*).
- Check for proper functioning of all controls and operator aids (for example, RCL).
- Check all braking (for example, wheel, hoist, and swing brakes) and holding devices before operation.

You must make sure that the outriggers and jack cylinders are properly extended and set before performing any lifting operations. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.

Clear all personnel from the outrigger area before extending or retracting the outriggers. Carefully follow the procedures in this *Operator Manual* when extending or retracting the outriggers. Death or serious injury could result from improper crane set up on outriggers.

Be familiar with surface conditions and the presence of overhead obstructions and power lines.

Working

Operator shall be responsible for all operations under his/her direct control. When safety of an operation is in doubt, operator shall stop the crane's functions in a controlled manner. Lift operations shall resume only after safety concerns have been addressed or the continuation of crane operations is directed by the lift supervisor.

Know the location and function of all crane controls.

Make sure that all persons are away from the crane and the Travel Select Lever is in the "N" (Neutral) position with the Parking Brake engaged before starting the engine.

Sparks from the crane's electrical system and/or engine exhaust can cause an explosion. **Do not** operate this crane in an area with flammable dust or vapors, unless good ventilation has removed the hazard.

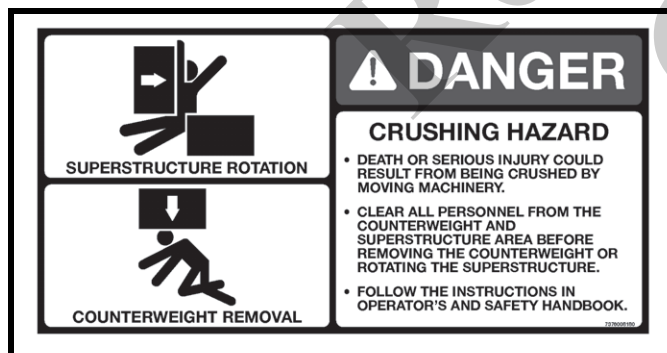
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

Before actuating swing or any other crane function, sound the horn and verify that all personnel are clear of rotating and moving parts.

Never operate the crane when darkness, fog, or other visibility restrictions make operation unsafe. Never operate a crane in thunderstorms or high winds.

Always be aware of your working environment during operation of the crane. Avoid contacting any part of the crane with external objects.

Clear all personnel from the counterweight and superstructure area before removing the counterweight.



Keep unauthorized personnel clear of the working area during operation.

Only the crane operator shall occupy the crane when in operation.

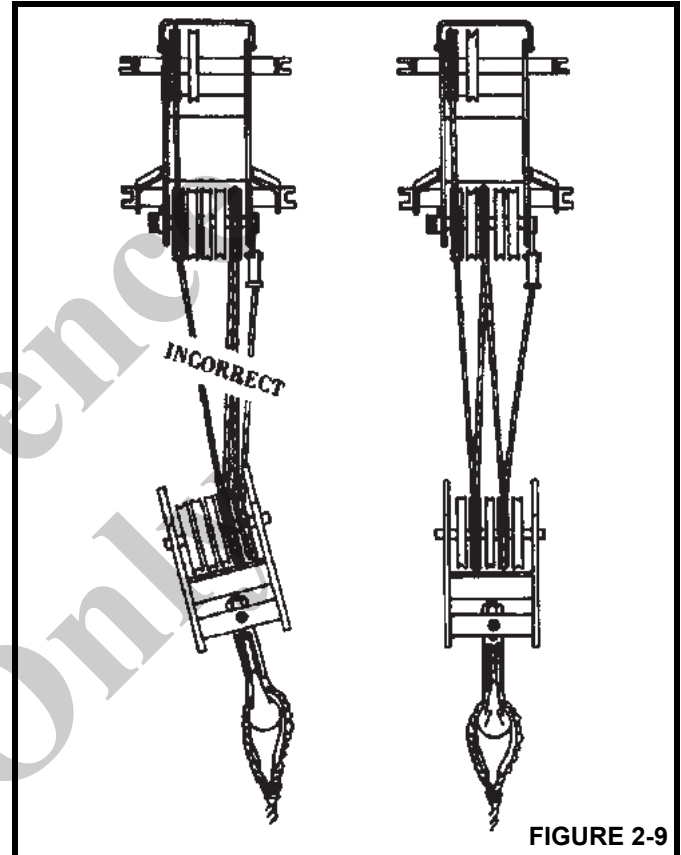
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

Operate the crane only from the operator's seat. Do not reach in a window or door to operate any controls.

Operate the crane slowly and cautiously, looking carefully in the direction of movement.

A good practice is to make a "dry run" without a load before making the first lift. Become familiar with all factors peculiar to the job site.

Make sure that the hoist rope is properly routed on the hook block and boom nose (Figure 2-9), and that all rope guards are in place.



Lifting

Grove Crane recommends lifting only one load at a time. See "Lifting Operations" on page 2-20.

Use enough parts of line for all lifts and check all lines, slings, and chains for correct attachment. To obtain maximum lifting capacities, the hook block must be set up with enough parts of line. Too few parts of line can result in failure of the hoist rope or hoist. **No less than three wraps of rope** should remain on the hoist drum. When slings, ties, hooks, etc., are used, make sure that they are correctly positioned and secured before raising or lowering the loads.

Make sure that the rigging is adequate before lifting. Use tag lines when possible to position and restrain loads. Personnel using tag lines should be on the ground.

Make sure good rigging practices are being used. Refuse to use any poorly maintained or damaged equipment. Never wrap the hoist cable around a load.

If using a clam bucket, do not exceed 80 percent of the crane's capacity.

Make certain the boom tip is centered directly over the load before lifting.

Make sure the load is well secured and attached to the hook with rigging of proper size and in good condition.

Check the hoist brake by raising the load a few inches, stopping the hoist and holding the load. Make sure that the hoist brake is working correctly before continuing the lift.

When lowering a load always slow down the load's descent before stopping the hoist. Do not attempt to change speeds on multiple-speed hoists while the hoist is in motion.

Watch the path of the boom and load when swinging. Avoid lowering or swinging the boom and load into ground personnel, equipment, or other objects. Never leave the crane with a load suspended. Should it become necessary to leave the crane, lower the load to the ground and stop the engine before leaving the operator's station.

Remember, all rigging equipment must be considered as part of the load. Lifting capacities vary with working areas. If applicable, permissible working areas are listed in the *Load Chart*. When swinging from one working area to another, make sure that *Load Chart* capacities are not exceeded. Know your crane!

Stop the hook block from swinging when unhooking a load.

Swinging rapidly can cause the load to swing out and increase the load radius. Swing the load slowly. Swing with caution and keep the load lines vertical.

Look before swinging your crane. Even though the original setup may have been checked, situations do change.

Never swing or lower the boom into the carrier cab (if applicable).

Never push or pull loads with the crane's boom. Never drag a load.

Do not subject crane to side loading. A side load can tip the crane or cause it to fail structurally.

If the boom should contact an object, stop immediately and inspect the boom. Remove the crane from service if the boom is damaged.

When lifting a load the boom may deflect causing the load radius to increase—this condition is made worse when the boom is extended. Make sure that the weight of load is within the crane's capacity on *Load Chart*.

Avoid sudden starts and stops when moving the load. The inertia and an increased load radius could tip the crane over or cause it to fail structurally.

Use tag lines (as appropriate) for positioning and restraining loads. Check the load slings before lifting.

Make sure that everyone is clear of the crane and work area before making any lifts.

Never swing over personnel, regardless of whether load is suspended from or attached to the boom.

Hand Signals

A single qualified signal person shall be used at all times when:

- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

At all times use standardized hand signals (Figure 2-10) that have been previously agreed upon and completely understood by the operator and signal person.

If communication with the signal person is lost, crane movement must be stopped until communications are restored.

Keep your attention focused on the crane's operation. If for some reason you must look in another direction, stop all crane movement first.

Obey a signal to stop from anyone.

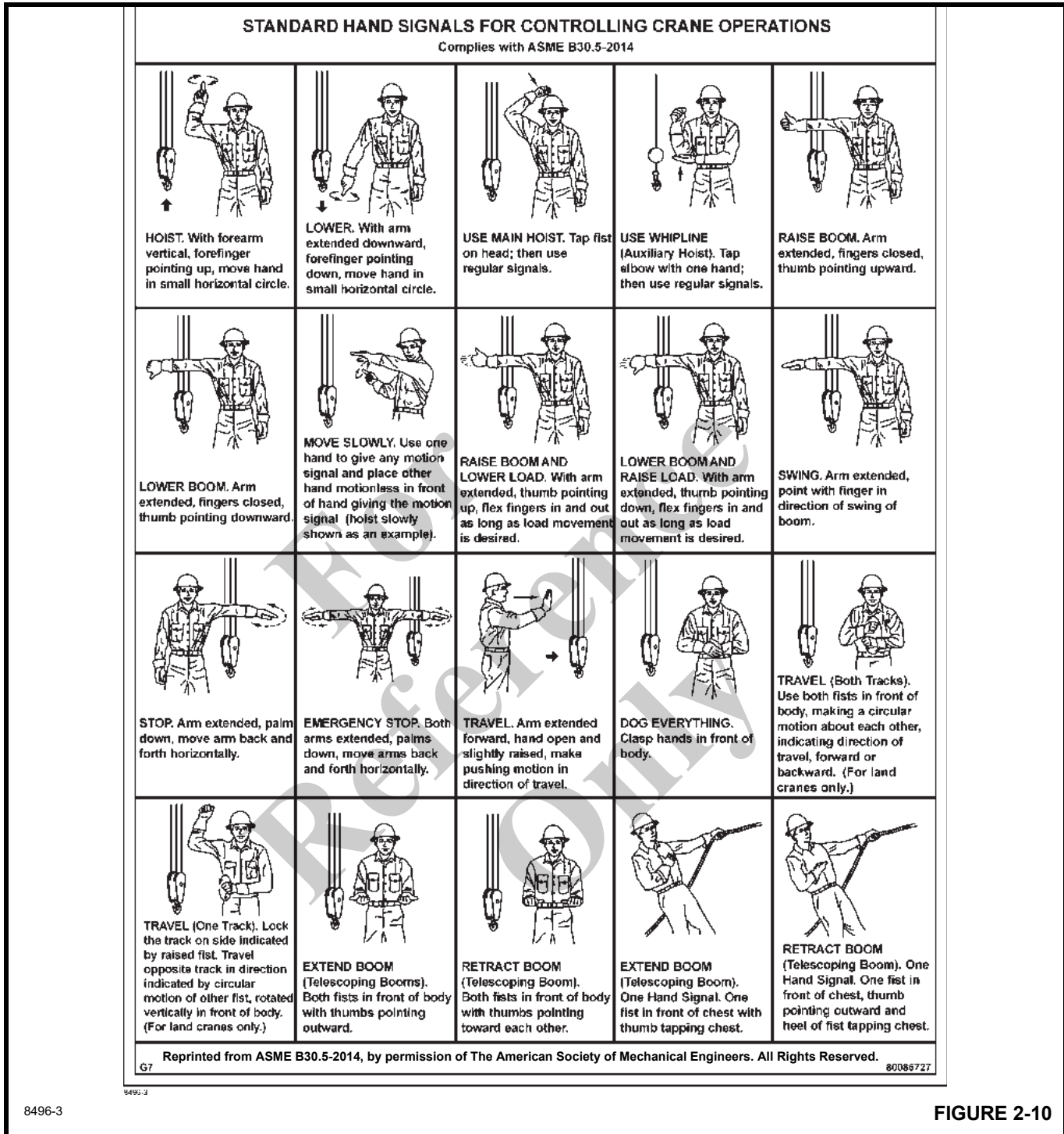


FIGURE 2-10

BOOM EXTENSION

To avoid death or serious injury, follow the procedures in this manual during erection, stowage, and use of the boom extension.

Install and secure all pins properly.

Control movement of the boom extension at all times.

Do not remove right side boom nose pins unless boom extension is properly pinned and secured on front and rear stowage brackets.



DANGER

Boom Extension Hazard!

To avoid death or serious injury, follow procedures in *Load Chart*, safety, and operation manuals during erection, stowage and use of boom extension. Install and secure all pins properly and control boom extension movement at all times.

Do not remove the pins from the front stowage bracket unless the boom extension is pinned to the right side of the boom nose.

Properly inspect, maintain, and adjust boom extension and mounting.

When assembling and disassembling boom extension sections, use blocking to adequately support each section and to provide proper alignment.

Stay outside of boom extension sections and lattice work.

Watch for falling or flying pins when they are being removed.

PARKING AND SECURING



DANGER

Tipping Hazard!

When parking the crane and leaving it unattended follow the instructions in Section 4 of this manual.

Failure to comply with these instructions may cause death or serious injury.

When parking on a grade, apply the parking brake and chock the wheels.

Section 4 of this manual provides instructions for parking and securing a crane when it is to be left unattended. These instructions are intended to allow the crane to be placed in the most stable and secure position. However, Grove recognizes that certain jobsite conditions may not permit the boom and boom extension of a crane to be fully lowered to the ground. When a qualified person at a jobsite determines

that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

- The crane should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The crane can not be left running, with a load on the hook, or with the jib deployed, or in wind conditions in excess of allowed values.
- The boom should be retracted as far as is practical, the crane configured in as stable a configuration as possible (boom angle, superstructure orientation, boom extension angle, etc.)
- In high winds the boom and boom extension should be lowered, or secured. Changing weather conditions including, but not limited to, wind, ice accumulation, precipitation, flooding, lightning, etc., should be considered when determining the location and configuration of a crane when it is to be left unattended.

SHUT-DOWN

Use the following steps when shutting down the crane:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin or 360 degree swing lock (if equipped).
- Disable all crane functions using the crane function Enable/Disable switch (if equipped).
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Wait a minimum of 2 minutes and then turn the battery disconnect switch to the OFF position.
- Chock the wheels, if not on outriggers.
- Lock the operator's cab (if applicable) and install vandal guards, if used.

COLD WEATHER OPERATION

Cold weather operation requires additional caution on the part of the operator.

Check operating procedures in this manual for cold weather starting.

Don't touch metal surfaces that could freeze you to them.

Clean the crane of all ice and snow.

Allow at least 30 minutes of engine run time for hydraulic oil to warm up.

Plastic components (battery casings, heater controls, dash controls, etc.) are extremely brittle in extreme cold. Use

caution handling and operating these components in sub-zero temperatures, avoiding shock loading.

In freezing weather, park the crane in an area where it cannot become frozen to the ground. The drive line can be damaged when attempting to free a frozen crane.

If applicable to your crane, frequently check all air tanks for water in freezing weather.

If applicable to your crane, always handle propane tanks according to the supplier's instructions.

Never store flammable materials on the crane.

If cold weather starting aids are provided on your crane, use them. The use of aerosol spray or other types of starting fluids containing ether/volatiles can cause explosions or fire.

TEMPERATURE EFFECTS ON HOOK BLOCKS

The Hook Block Working Load Limit (WLL) is valid between 60°C (140°F) and the low temperature limit given on the hook block identification plate with normal lifting precautions.

Lifting above 75% of the Working Load Limit, at temperatures between the service temperature given on the identification plate and -40°C (-40°F), must be done at a slow and steady rate to avoid stress spikes.

75% of the Working Load Limit must not be exceeded when lifting in temperatures below -40°C (-40°F).

For
Reference
Only

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00077 cm³ per cm³ of volume for 1°C of temperature change (0.00043 in³ per in³ of volume for 1°F of temperature change). **Thermal contraction will allow a cylinder to retract as the hydraulic fluid which is trapped in the cylinder cools.**

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-9 and Table 2-8]. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper lubrication or improper wear pad adjustments may, under certain conditions, cause a “stick-slip” condition in the boom. This “stick-slip” condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow

movement of the boom may be undetected by the operator unless a load is suspended for a long period of time. To minimize the effects of thermal contraction or “Stick-slip” it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of cooling oil.

If a load and the boom is allowed to remain stationary for a period of time and the ambient temperature is cooler than the trapped oil temperature, the trapped oil in the cylinders will cool. The load will lower as the telescope cylinder(s) retracts allowing the boom to come in. Also, the boom angle will decrease as the lift cylinder(s) retracts causing an increase in radius and a decrease in load height.

This situation will also occur in reverse. If a crane is set up in the morning with cool oil and the daytime ambient temperature heats the oil, the cylinders will extend in similar proportions.

Table 2-8 and Table 2-9 have been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder. The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

Reference Only

Table 2-8: Boom Drift Chart (Cylinder length change in inches)

Coeff. = 0.00043 (in ³ /in ³ / °F)											
STROKE	Temperature Change (°F)										
(FT.)	10	20	30	40	50	60	70	80	90	100	
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58	
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16	
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74	
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32	
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90	
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48	
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06	
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64	
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22	
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80	
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38	
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96	

Length change in inches = Stroke (Ft.) X Temperature Change (°F) X Coeff. (in³/in³/ °F) X 12 in/ft

Table 2-9 Boom Drift Chart (Cylinder length change in millimeters)

Coeff. = 0.000774 (1/ °C)		<i>Metric</i>									
STROKE	Temperature Change (°C)										
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	6	12	17	23	29	35	41	46	52	58	64
3	12	23	35	46	58	70	81	93	104	116	128
4.5	17	35	52	70	87	104	122	139	157	174	192
6	23	46	70	93	116	139	163	186	209	232	255
7.5	29	58	87	116	145	174	203	232	261	290	319
9	35	70	104	139	174	209	244	279	313	348	383
10.5	41	81	122	163	203	244	284	325	366	406	447
12	46	93	139	186	232	279	325	372	418	464	511
13.5	52	104	157	209	261	313	366	418	470	522	575
15	58	116	174	232	290	348	406	464	522	581	639
16.5	64	128	192	255	319	383	447	511	575	639	702
18	70	139	209	279	348	418	488	557	627	697	766

Length change in mm = Stroke (m) X Temperature Change (°C) X Coeff. (1/ °C) X 1000 mm/m

OVERLOAD INSPECTION

This information supplements the Rated Capacity Limiter (RCL) manual supplied with each Grove crane.

When the RCL system has acknowledged an overload on your crane, or the crane has been subjected to a collision with external obstacles, you must carry out specified inspections on the crane.

These inspections apply only to overloads up to 50%. For overloads of 50% or higher, crane operation must be stopped immediately and Crane Care must be contacted for corrective action.

Regular overload tests of mobile cranes are not recommended. Overload test may only be required after major overhaul or following the modification or repair of load bearing parts (e.g. repair of welded structural parts). In this case, the selection of configuration and test loads shall ensure the proof of competence of the repaired part only. Contact Manitowoc Crane Care for more information.

The following illustrations may not be an exact representation of your crane and are to be used for reference only.

**WARNING**
Overload Hazard!

To avoid an accident caused by overload damage to your crane:

- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the crane and contact Manitowoc Crane Care immediately for overloads of 50% and higher.

NOTE: If an overload condition is detected by the RCL, data are recorded by the event recorder. If your crane is equipped with CraneSTAR, an overload warning will be posted to the web site for review by the crane owner.

Overload warnings do NOT indicate real time events! Warnings could be sent 24 hours (or more) after the actual event.

For Reference Only

Boom Inspection

The following checklist includes all features that can be found on Manitowoc cranes. Your crane may not have some features.

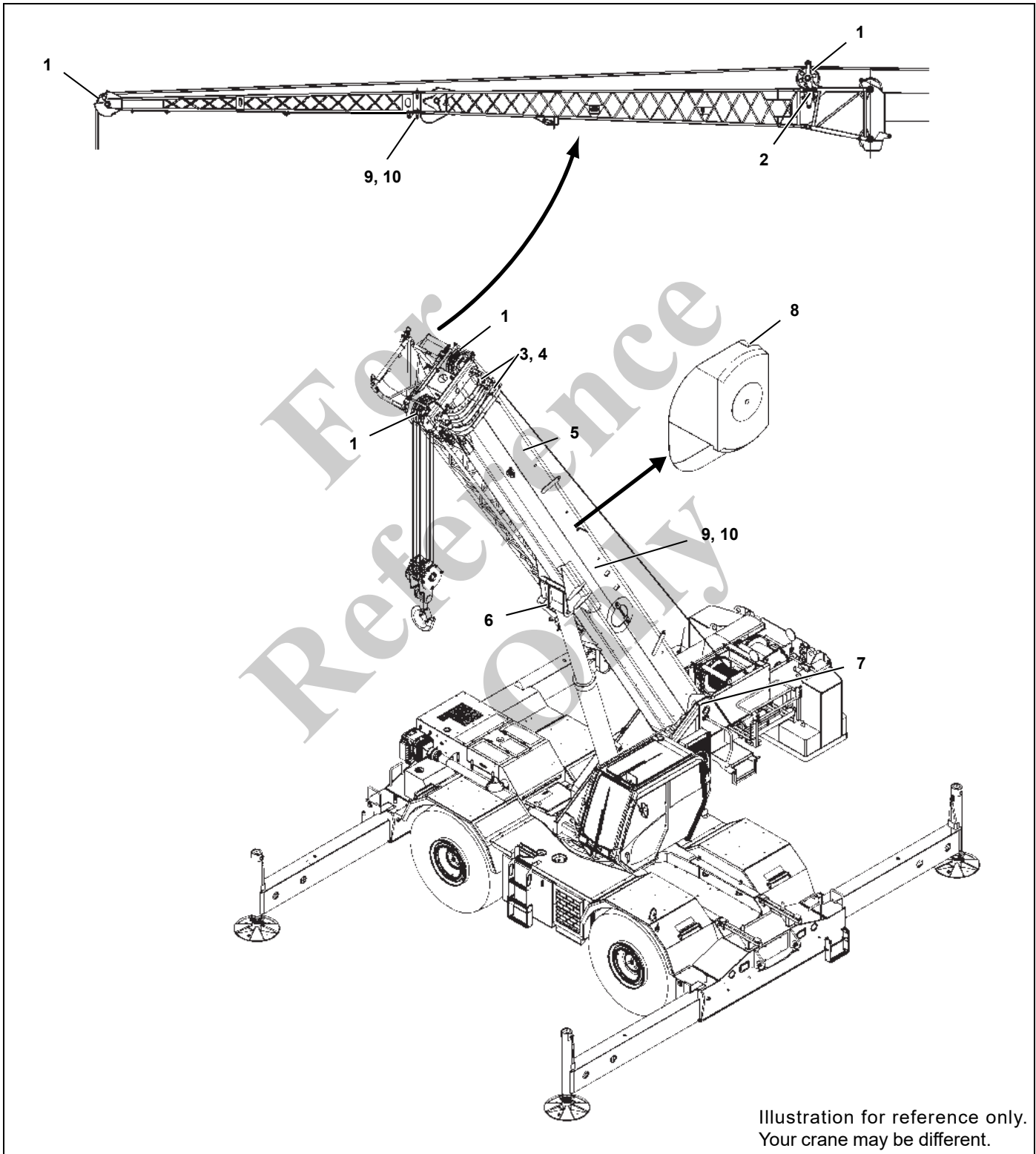
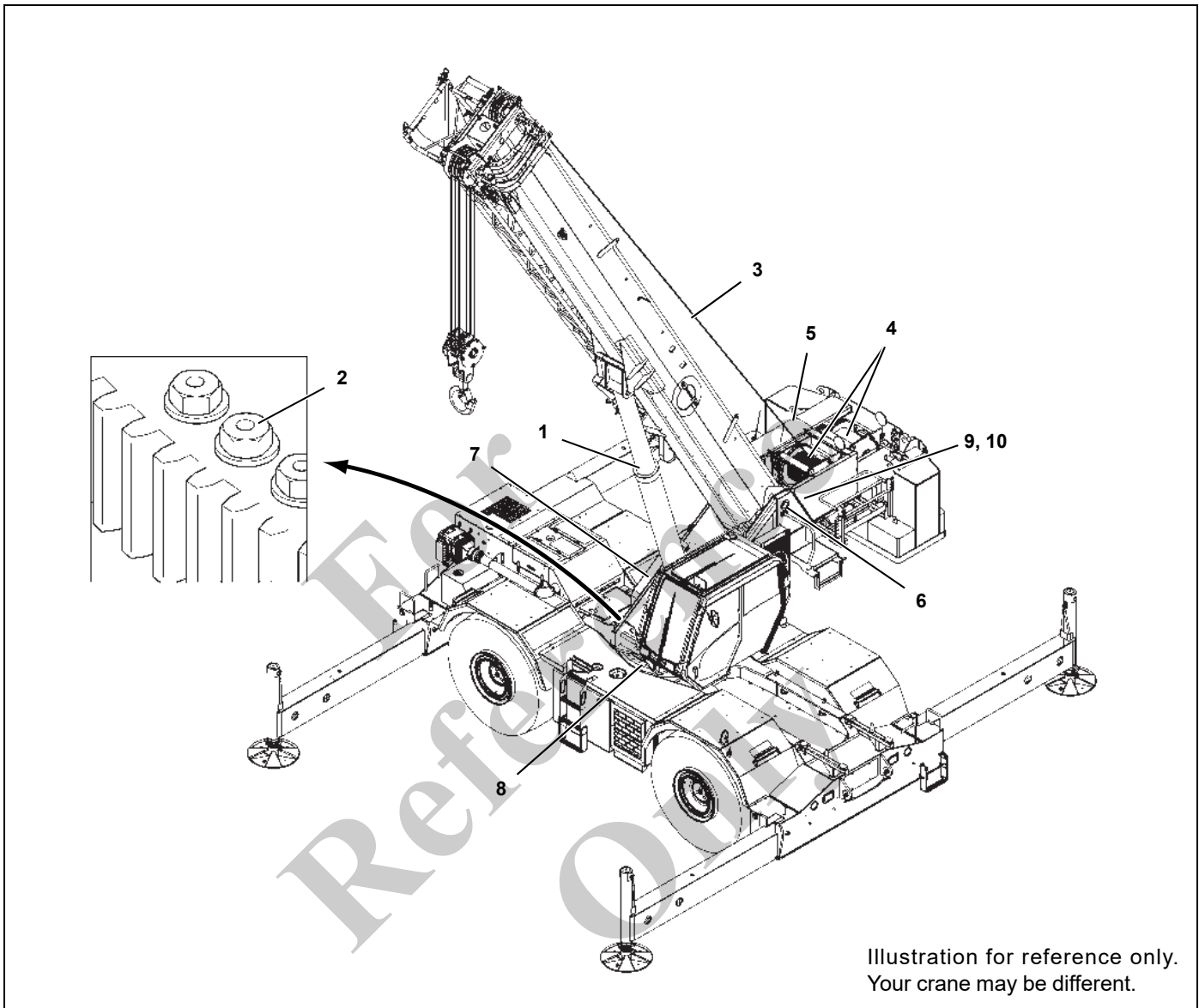


Illustration for reference only.
Your crane may be different.

Overload less than 25%			
1	Sheaves	Inspect all for damage.	
2	Luffing Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	Inspect all for damage.	
Overload from 25% to 49%			
1	Sheaves	Inspect all for damage.	
2	Luffing Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	Inspect all for damage.	
4	Collar-welds	Inspect all for cracks.	
5	Telescopic Sections	Inspect for bent or twisted sections. Check the boom for straightness.	
6	Lift Cylinder Head Area	Inspect for bends or cracked welds.	
7	Turret-Base Section	Inspect for cracked welds.	
8	Locking Area (Pin Booms)	Inspect for elongated holes.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

The following checklist includes all features that can be found on Manitowoc cranes. Your crane may not have some features.

Superstructure Inspection



The following checklist includes all features that can be found on Manitowoc cranes. Your crane may not have some features.

Overload less than 25%			
1	Lift Cylinder	Inspect for leaking.	
2	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
3	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
Overload from 25% to 49%			
1	Lift Cylinder	Inspect for leaking.	
2	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
3	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
4	Hoist/Drums	Inspect each for damage.	
5	Hoist Brakes	Brakes must hold rated line pull.	
6	Bearing Main Boom Pivot Pin	Inspect for deformation, cracked welds.	
7	Lift Cylinder-lower mount	Inspect pin and welds.	
8	Turntable	Inspect for deformation, cracked welds.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection

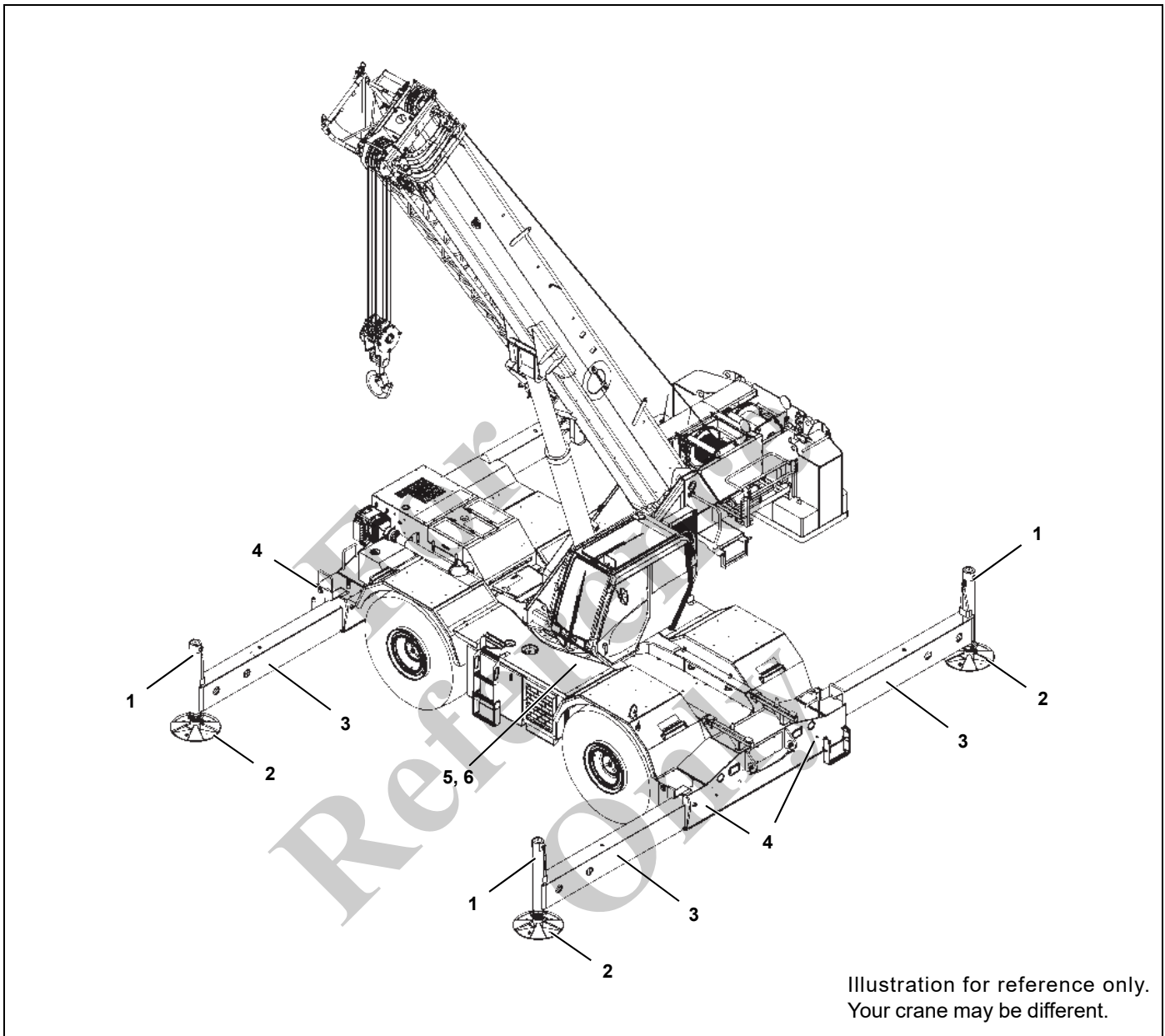


Illustration for reference only.
Your crane may be different.

The following checklist includes all features that can be found on Manitowoc cranes. Your crane may not have some features.

Overload less than 25%			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
Overload from 25% to 49%			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
3	Outrigger Beams	Inspect for deformation and cracked welds.	
4	Outrigger Boxes	Inspect for deformation and cracked welds.	
5	Welds	Inspect for cracks.	
6	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Reference Only

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CONTROLS AND INDICATORS

The engine is electronically controlled by the Electronic Control Module (ECM); it is the control center of the entire engine system. The ECM processes all of the inputs and sends commands to the fuel systems as well as vehicle and engine control devices. This Operator Manual does not include information on the engine ECM, however a separate manual as prepared in detail by the engine manufacturer is shipped with the crane from the factory.

All the controls and indicators to operate and monitor crane functions are found inside the crane cab (Figure 3-1) and include the following:

1. Foot Pedals
2. Outrigger Controller
3. Seat Joystick and Armrest Controls
4. Side Display Panel
5. Steering Column
6. Overhead Control Panel

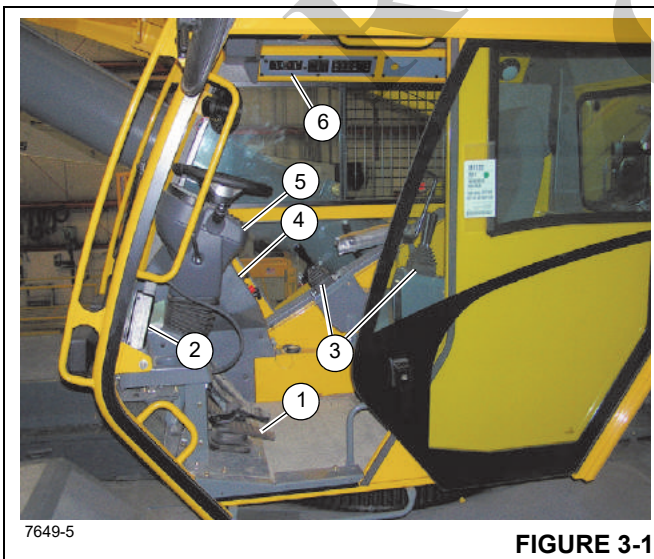


FIGURE 3-1

STEERING COLUMN

The steering column assembly in Figure 3-2 is a pedestal style tilt and telescoping steering column. It has the ability to tilt forward 30° or be raised vertically approximately 60 mm (2.5 in). It also includes the ignition switch and the CAN bus gauge display (11, Figure 3-2).

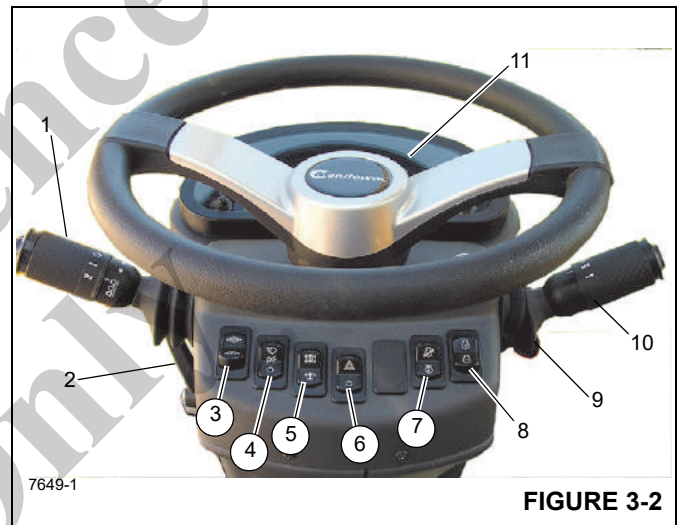


FIGURE 3-2

Figure 3-2 Item Numbers

Item	Description
1	Turn Signal Lever and Windshield Wiper/Washer/Headlight /Horn Controls
2	Steering Column Tilt/Telescope Lever
3	Park Brake Control Switch
4	Headlights Switch
5	Drive Axle Selector Switch
6	Hazard Lights Switch
7	Engine Diagnostic/Speed Control Switch
8	Increment/Decrement Switch
9	Ignition Switch
10	Transmission Shift Lever
11	Gauge Display

Turn Signal Lever and Windshield Wiper/Washer/Headlight /Horn Controls

The Turn Signal Lever and Windshield Wiper/Washer Controls (1, Figure 3-2) are located on the left side of the steering column. Pushing the turn signal lever down causes the left front and left rear turn signals to flash. Pushing the turn signal lever up causes the right front and right rear turn signals to flash.

The windshield wiper switch is incorporated in the turn signal lever. The knob of the lever has three positions: O, I, and II. Pushing the button in the end of the knob energizes the windshield washer pump to spray washer fluid on the windshield. Positioning the knob to I operates the wiper at low speed and positioning the knob to II operates the wiper at high speed. Positioning the knob to O turns the wiper motor off and automatically returns the wiper to the parked position.

Pushing the small button on the end of the lever sounds the horn.

Grasp the center section of the lever, push in and rotate to dim the headlights.

Steering Column Tilt/Telescope Lever

The steering control column can be rotated forward approximately 30° and raised approximately 2.5 inches. Move the control lever (2, Figure 3-2) down to lock the steering column in place; rotating the lever up releases the steering column for the desired adjustments.

Park Brake Control Switch

The Park Brake Control Switch (3, Figure 3-2) is located on the front of the steering column. This two-position rocker switch (ON/OFF) is used to apply and release the parking brake on the transmission. The red Park Brake Indicator light is illuminated when the pressure switch in the brake release system is activated and the brake is applied. The switch has a lock to prevent accidental activation.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

Headlights Switch

The Headlights Switch (4, Figure 3-2) is located on the front of the steering column. This three-position rocker switch (OFF/PARK/HEADLIGHT) controls operation of the

instrument lights, switch LED's, and the marker lights on the front, rear, and side of the crane. When the switch is in the ON position, the LED in the switch is illuminated.

Drive Axle Selector Switch

The Drive Axle Selector Switch (5, Figure 3-2) is located on the front of the steering column. This two-position rocker switch is used to select either Two-Wheel Drive (HIGH range) or Four-Wheel drive (LOW range). The switch controls a solenoid valve (energized for two-wheel drive) that operates the speed range and axle disconnect cylinders on the transmission. When the switch is in the four-wheel drive position, the Drive Axle Indicator light on the steering column is illuminated.

Hazard Lights Switch

The Hazard Lights Switch (6, Figure 3-2) is located on the front of the steering column. The switch is a two-position rocker switch (ON/OFF) that causes the four turn signal lights to flash at the same time when the switch is positioned to ON. When the switch is positioned to ON, the LED in the switch is also illuminated.

Engine Diagnostic and Engine Speed Control Switches

Two engine diagnostic and speed control switches (Engine Diagnostic/Speed Control and Increment/Decrement) are located on the front of the steering column.

Engine Diagnostic/Speed Control Switch

The Engine Diagnostic/Speed Control Switch (7, Figure 3-2) is a two position maintained ON/OFF rocker switch used to access the engine fault codes or enable the control of the low engine idle and engine RPM functions.

Diagnostic function — With the Ignition Switch in the RUN position and the engine off, press the top of the Engine Diagnostic/Speed Control Switch to view the engine fault codes on the steering column display. If there is more than one active engine fault code, use the Increment/Decrement Switch (8, Figure 3-2) to toggle forward and backward through the fault codes. If there are no engine fault codes, zeroes will be shown in the steering column display.

Engine low idle function — With the engine running and the top of the Engine Diagnostic/Speed Control Switch pressed, the engine low idle is adjusted using the Increment/Decrement Switch (8, Figure 3-2).

Engine RPM function — With the engine running and the bottom of the Engine Diagnostic/Speed Control Switch pressed, the engine RPM is adjusted using the Increment/Decrement Switch (8, Figure 3-2).

Increment/Decrement Switch

The Increment/Decrement Switch (8, Figure 3-2) is a three position momentary rocker switch with center maintained position being off. Use this switch to toggle backward and forward through active engine fault codes or adjust engine speed.

Diagnostic function — With the Ignition Switch in the RUN position, the engine off, and the top of the Engine Diagnostic/Speed Control Switch (7, Figure 3-2) pressed, press the top or bottom of the Increment/Decrement Switch to toggle forward and backward through the engine fault codes shown on the steering column display. If there are no engine fault codes, zeroes will be shown in the steering column display.

Engine low idle function — With the engine running and the top of the Engine Diagnostic/Speed Control Switch (7, Figure 3-2) pressed, press the top or bottom of the Increment/Decrement Switch to increase or decrease the low engine idle.

Engine RPM function — With the engine running and the bottom of the Engine Diagnostic/Speed Control Switch (7, Figure 3-2) pressed, the Increment/Decrement Switch is used to adjust engine RPM. Quickly press the top of the switch once to go to full engine RPM; quickly press the bottom of the switch once to return to low engine idle. If the engine speed is below the maximum RPM setting, pressing and holding the top of the switch will cause the engine RPM to slowly increase; release the switch when the desired RPM is attained. If the engine speed is above the minimum RPM setting, pressing and holding the bottom of the switch will cause the engine RPM to slowly decrease; release the switch when the desired RPM is attained.

Ignition Switch

The Ignition Switch (9) is located on the right side of the steering column and under the transmission shift lever(10).

The switch is key-operated and has four positions: ACC [3], OFF [0], RUN [1], and START [2]. In the OFF position, all electrical power is off except for the lights controlled by the Headlights Switch, turn/hazard/stop lights, dome light and work light. Positioning the switch to ACC energizes all electrical components except for the start solenoid. Positioning the switch to RUN is the same as ACC, but the ignition circuit is also energized. Positioning the switch to START energizes the start relay, which in turn energizes the cranking motor solenoid and cranks the engine for starting. The switch is spring returned from START to RUN. To shut down the engine, position the switch to OFF.

The Ignition switch has a mechanical anti-restart built into it. If the engine does not start after the first attempt, the key switch must go to the OFF position and then back to START in order to try and start the engine another time.

Transmission Shift Lever

CAUTION

Transmission Damage!

To prevent transmission damage: shift between two-wheel and four-wheel drive only with the crane stopped with the transmission in neutral or park.

The Transmission Shift Lever (10, Figure 3-2) is located on the right side of the steering column. The control lever operates the transmission selector valve electrically. Positioning the lever up actuates forward and positioning the lever rearward actuates reverse. When the lever is in neutral, it rests in a detent. To move the lever up or down, pull up on the lever first. To shift the transmission through the gears select 1 through 6 for forward or 1 through 3 for reverse gears.

The transmission has six forward gears and three reverse gears. To use the three low gears, put the Drive Axle switch at four-wheel drive. To use the three high gears, put the Drive Axle switch at two-wheel drive.

CAB OVERHEAD CONTROLS

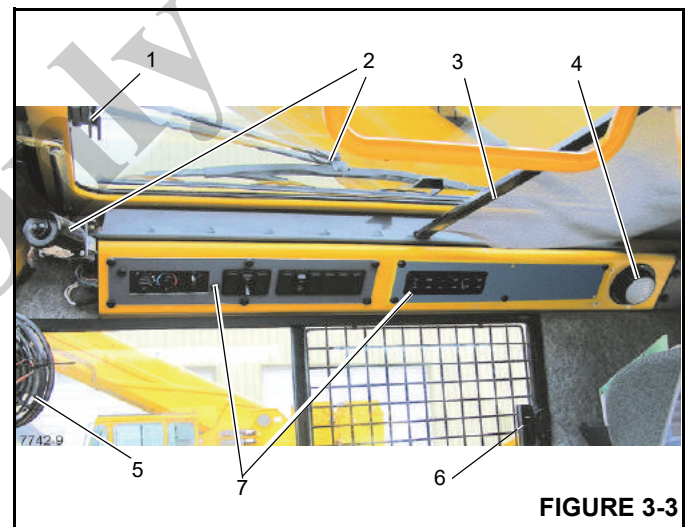


FIGURE 3-3

Item	Description
1	Skylight Window Latch
2	Skylight Wiper & Motor
3	Skylight Sunscreen
4	Overhead Light
5	Cab Circulating Fan
6	Window Latch
7	Overhead Control Panel

Skylight Window Latch

The skylight window latch (1, Figure 3-3) is at the front of the window. Squeeze the latch and slide the window to the rear to open. To close, slide the window forward until the latch engages.

Skylight Wiper and Wiper Motor

The skylight wiper (2, Figure 3-3) is controlled by the wiper switch (4, Figure 3-4) and operated by the wiper motor (2, Figure 3-3).

Skylight Sunscreen

The Skylight Sunscreen (3, Figure 3-3) is used to diminish direct sunlight. The sunscreen is self retracting and can be set to screen all the light or adjusted rearward by moving it into the notches provided.

Overhead Light

The cab Overhead Light (4, Figure 3-3) is on the right rear corner of the cab overhead console and provides illumination in the cab. The Overhead Light is controlled by a switch on the light.

Cab Circulating Fan

The Cab Circulating Fan (5, Figure 3-3) is located on the left front side of the cab, above the window frame. A swivel allows the fan to be rotated and a switch on the fan base controls the fan. The switch has a High, Low and Off position.

Right Side Window Latch

The window on the right side of the cab can be opened. Squeeze latch (6) to release the window and slide forward. To close slide the window rearward until the latch engages.

OVERHEAD CONTROL PANEL

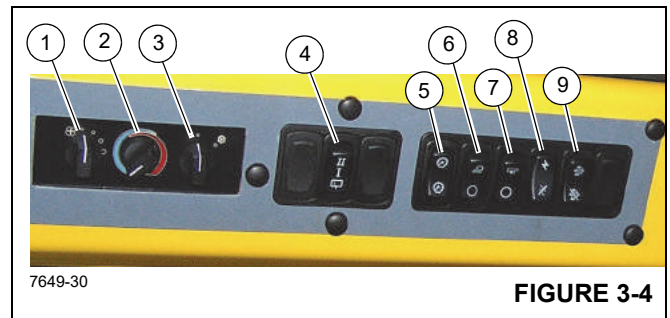


FIGURE 3-4

Figure 3-4 Item Numbers

Item	Description
1	Heater/Air Conditioner Fan Switch
2	Heater Control Switch
3	Air Conditioning Switch
4	Skylight Wiper Switch
5	Dimmer Light
6	Work Lights Switch
7	Boom Light Switch (Optional)
8	Crane Function Power Switch
9	Exhaust System Cleaning Switch

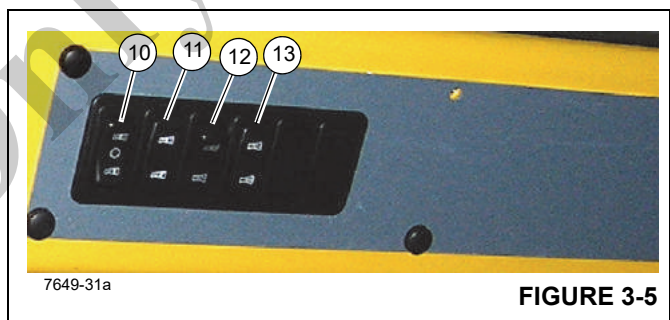


FIGURE 3-5

Figure 3-5 Item Numbers

Item	Description
10	Boom Tele-1 / Tele-2 Select Switch
11	Boom Tele-1 / Tele-2 Indicator
12	Boom Manual/Auto Switch
13	Boom Manual/Auto Indicator

Heater/Air Conditioner Fan Switch

The Heater/Air Conditioner Fan Switch (1, Figure 3-4) controls the cab fan's speed. Fan speed controls the volume of heated (or cooled) air output of the fan. Settings are Off, Low Speed, Medium Speed, and High Speed.

Heater Control Switch

The Heater Control Switch (2, Figure 3-4) controls intensity of heating temperature. Turn the switch to the right (clockwise) to open the valve for heat. (Heat comes from heated fluid going through the heater coil.) Turn the switch to the left (counterclockwise) to close the valve to stop fluid flow and minimize heat.

Air Conditioner Switch

The Air Conditioner Switch (3, Figure 3-4) controls the operation of the optional air conditioning system. Settings are Off (O) and On (I).

Skylight Wiper Switch

The electrically-operated skylight wiper is used to remove moisture from the skylight. The skylight wiper is controlled by the Skylight Wiper Switch (4, Figure 3-4). This is a 3 position switch Off/Low Speed/High Speed.

Dimmer Switch

The Dimmer Switch (5, Figure 3-4) controls the lighting for the overhead panel display (7, Figure 3-3), push the switch to increase or decrease the panel lighting.

Work Lights Switch

The Work Lights Switch (6, Figure 3-4) controls the crane's work lights mounted on the bottom front of the superstructure cab. Press the top of the switch to turn on the work lights. Press the bottom of the switch to turn off the work lights.

Boom Lights Switch (Optional)

The Boom Lights Switch (7, Figure 3-4) is located on the side display panel. This two-position rocker switch (ON/OFF) controls operation of the boom flood lights. Press the top of the switch to turn on the boom lights, press the bottom of the switch to turn the lights off.

Crane Function Power Switch

The Crane Function Power Switch (8, Figure 3-4) is located on the side display panel. This two-position (ON/OFF) rocker switch permits the operator to disconnect power from the crane functions controlled by the hydraulic remote controllers on the armrests. Positioning the switch to OFF prevents inadvertent operation of functions due to bumping the controllers while roading or any other operation. With the

switch in the OFF position, operation of hydraulic boost and high speed hoist is also prevented.

Hoist Rotation Indicator Display

The display is located in the front overhead panel Figure 3-10.

Refer to *Hoist Rotation Indicators (HRI)*, page 3-16 for more information.

Exhaust System Cleaning Switch (Tier 4 Engines Only)





WARNING Fire or Burn Hazard!

During the cleaning process the exhaust becomes very hot. Do not park the vehicle near flammable objects.

Use caution near the exhaust tailpipe during cleaning as it will become very hot.

The Engine Exhaust System Cleaning Switch (9, Figure 3-4) is located on the right side of the overhead control panel. This switch is a three position switch, Inhibit Cleaning/Permit Active Cleaning/Initiate Manual Cleaning. Center position enables clean to occur when required, or press this switch to force manual cleaning to begin immediately or to disable cleaning indefinitely:

- Manual Cleaning  (7649-10)
- Inhibit Cleaning  (7649-11)

To manually clean, set the crane parking brake, the crane transmission must be in neutral and have the brake and throttle pedals released.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

Refer to *Exhaust System Cleaning (Tier 4 Engines Only)*, page 3-11 for cleaning mode definitions and a description of when manual cleaning is needed.

Set up a safe area around the crane's exhaust; remove tools, rags, grease or any debris from the engine exhaust area.

With the engine idling push the Cleaning Switch (9) to the Manual Clean position to initiate manual cleaning.

Within 5 seconds the engine should rev up to 1000 to 1400 rpm. The engine will continue to run at this speed for up to 45 minutes.

As a warning, the light (1, Figure 3-6) below the exhaust pipe (2, Figure 3-6) will blink during cleaning.

Pressing the brake or throttle pedal during cleaning or activating the Inhibit Cleaning Switch will interrupt the manual cleaning process.

Make sure the crane and surrounding area are monitored during manual cleaning. If any unsafe condition occurs, shut off the engine immediately.

During this period the sound of the engine may change. When manual cleaning is complete the engine will return to its normal idle speed.



FIGURE 3-6

Boom Tele-1 / Tele-2 Select Switch & Indicator

The Tele-1 / Tele-2 boom section select switch (10, Figure 3-5) and indicator (11) are located on the overhead control panel. This switch is a three position rocker switch that is used in conjunction with the Boom Auto/Manual Telescope Mode Switch (12, Figure 3-5).

When the boom mode switch (12) is positioned to manual, the boom telescope section select switch is positioned to either of the two positions. When placed in the upper position, the Tele-2 can be extended. When the Tele-2 is fully extended, the Tele-3 and Tele-4 can be controlled.

The Tele-1 / Tele-2 indicator (11) will illuminate when the switch is positioned in either Tele-1 or Tele-2 position.

Boom Manual/Auto Switch

The Boom Manual/Auto Telescope Mode Switch (12, Figure 3-5) and indicator (13) are located on the overhead control panel. The switch is a two-position rocker switch, Auto or Manual. This switch has a lock to prevent accidental activation.

When the switch is in the auto mode, the boom sections extend in a predetermined sequence when telescoping the boom. The sections retract in the same manner in reverse order.

When in the manual mode the switch indicator (13) will illuminate and the boom telescope section select switch is positioned to either the Tele-1 or Tele-2 position in order to extend or retract the selected section until it is returned to the proper position for normal boom synchronization to occur.

STEERING COLUMN INDICATOR AND GAUGE DISPLAY

As a system check, the indicators will come on for two seconds when the ignition switch is turned to the RUN position.

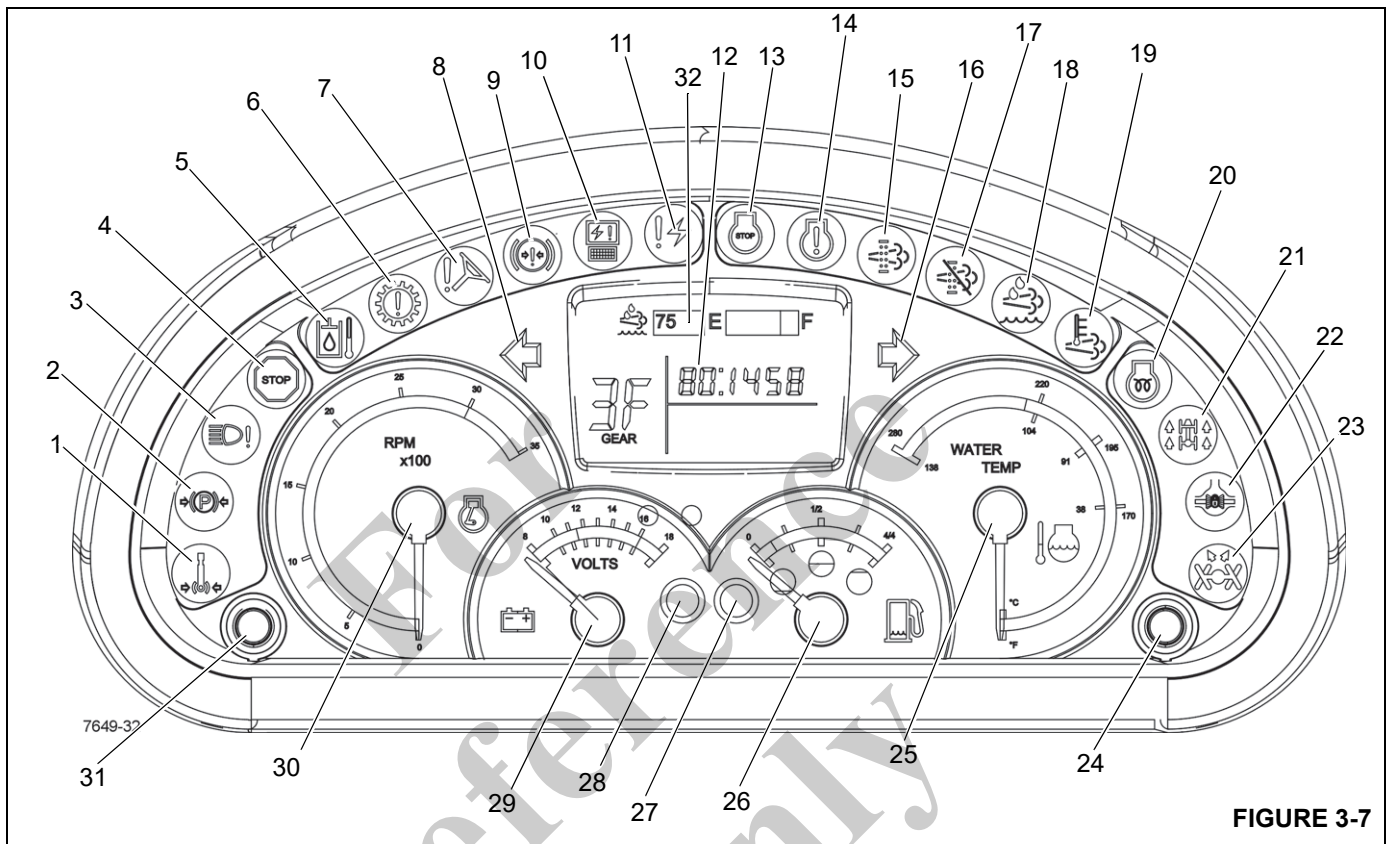


FIGURE 3-7

Figure 3-7 Item Numbers

Item	Description
1	Swing Brake Engaged
2	Parking Brake Engaged
3	Light Malfunction
4	Emergency Stop
5	Hydraulic Oil High Temperature
6	Transmission Warning
7	Low Steer Pressure
8	Left Turn Signal
9	Low Brake Pressure
10	Electronic Module Control
11	Electrical System Diagnostics
12	LCD Display
13	Engine Stop
14	Engine Warning
15	Exhaust System Cleaning Required

Item	Description
16	Right Turn Signal
17	Inhibit Cleaning Activated
18	Low Diesel Exhaust Fluid (DEF) Level
19	High Exhaust System Temperature (HEST)
20	Engine Wait to Start
21	Four Wheel Drive Engaged
22	Interaxle Locked
23	Rear Wheels Not Centered
24	Push Button Switch (no usage)
25	Engine Coolant Temperature Gauge
26	Fuel Gauge
27	Low Fuel Level Indicator
28	Battery Charge Indicator
29	Voltmeter
30	Tachometer

Item	Description
31	Push Button Switch (no usage)
32	DEF Level/Gauge

Swing Brake Engaged

The Swing Brake Engaged Indicator (1, Figure 3-7) is located in the steering column gauge display. It illuminates red when the Turntable Pin Lock Control (6, Figure 3-11) is engaged preventing the rotation of the crane superstructure.

Parking Brake Engaged

The Parking Brake Engaged Indicator (2, Figure 3-7) is located in the steering column gauge display. It illuminates red when the crane parking brake is engaged.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

Light Malfunction

The Light Malfunction Indicator (3, Figure 3-7) is located in the steering column gauge display. It illuminates amber when the crane headlights are malfunctioning.

Emergency Stop

The Emergency Stop Indicator (4, Figure 3-7) is located in the steering column gauge display. It illuminates red when the Emergency Stop Switch is pushed in (refer to *Emergency Stop Switch*, page 3-18) and a warning buzzer will sound.

Hydraulic Oil High Temperature

The Hydraulic Oil High Temperature Indicator (5, Figure 3-7) is located in the steering column gauge display. It illuminates red when the hydraulic oil temperature exceeds 93°C (200°F); a warning buzzer will also sound.

The hydraulic oil cooler is designed to provide adequate cooling of the hydraulic oil in ambient temperatures up to 49°C (120°F) when the machine is loaded continuously up to 30 percent of engine power (90HP) or functioning up to a 30 percent duty cycle. If the work exceeds these limits the high hydraulic oil temperature light will indicate when the oil

temperature has reached 93°C (200°F); at that time the machine should be idled for five minutes.

NOTE: If the crane is frequently operated at these loads and/or duty cycles an auxiliary oil cooler is available which will prolong the duration of operability.

Transmission Warning

The Transmission Warning Indicator (6, Figure 3-7) is located in the steering column gauge display. It illuminates red during low transmission oil pressure or high transmission oil temperature conditions. A warning buzzer will also sound.

Low Steer Pressure

The Low Steer Pressure Indicator (7, Figure 3-7) is located in the steering column gauge display. It illuminates red when the hydraulic pressure is low. A warning buzzer will also sound.

Left Turn Signal Indicator

The Left Turn Signal Indicator (8, Figure 3-7) is located in the steering column gauge display. It is a green arrow light that flashes when the turn signal lever is pushed down or the Hazard Light Switch is positioned to ON.

Low Brake Pressure

The Low Brake Pressure Indicator (9, Figure 3-7) is located in the steering column gauge display. It illuminates red when the pressure in the dual accumulator charge valve falls below normal operating requirements. A warning buzzer will also sound.

Electronic Module Control

The Electronic Module Control Indicator (10, Figure 3-7) is located in the steering column gauge display. If any of the control modules are off line and not communicating with the system the indicator illuminates amber.

Electronic System Diagnostic

The Electronic System Diagnostic Indicator (11, Figure 3-7) is located in the steering column gauge display. The indicator is a red light that is used for troubleshooting the CANbus system.

A laptop computer with appropriate cable and engine or electrical system software are required. Contact your local Grove distributor or Manitowoc Crane Care.

LCD Display

The LCD Display(12, Figure 3-7 and Figure 3-8) is located in the steering column gauge display. The display shows the transmission gear being used, fault codes, DEF level and master software version.

If an active engine fault code is present, the display will show the code when the Ignition Switch is in the RUN position and the engine is off. The display will show the master software version when the Ignition Switch is in the ACC position.

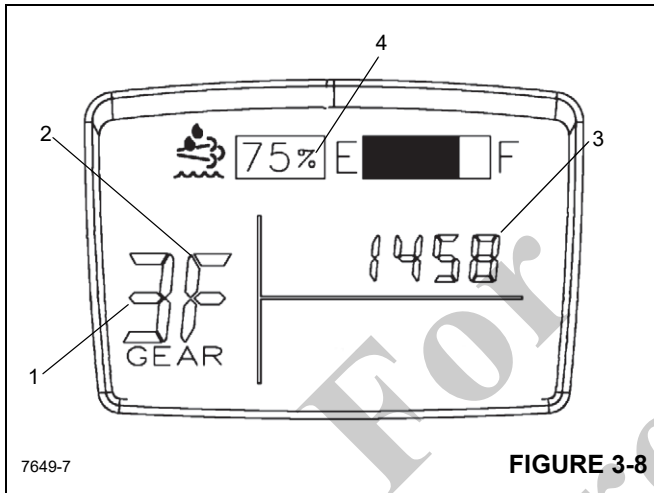


Figure 3-8 Item Numbers

Item	Description
1	Transmission Gear
2	Forward or Reverse, Transmission
3	Engine Fault Code, Master Software Version
4	DEF Level/Gauge

Engine Stop

The Engine Stop Indicator (13, Figure 3-7) is located in the steering column gauge display. It illuminates red when energized by a signal from the engine ECM. In addition, a warning buzzer will also sound.

If this indicator light illuminates note the fault code and shut off the engine and refer to the *Engine Operator Manual*.

Engine Warning

The Engine Warning Indicator (14, Figure 3-7) is located in the steering column gauge display. It illuminates amber when energized by a signal from the engine ECM.

If this indicator light illuminates note the fault code and refer to the *Engine Operator Manual*.

NOTE: This lamp may also illuminate along with the Exhaust System Cleaning Required lamp or Low DEF Level lamp (18).

Exhaust System Cleaning (Tier 4 Engines Only)

The Exhaust System Cleaning Required Indicator (15, Figure 3-7) is located in the steering column gauge display. This indicator illuminates amber when the exhaust system is in need of cleaning.

The indicator will be lit continuously during the early stages of required cleaning. If this condition continues, the lamp will begin to flash and a slight engine derate will occur.

If this condition continues further, the Engine Warning light (14) will illuminate in addition to the Cleaning indicator (15) and a severe engine derate will occur.

! WARNING
Extreme Heat Hazard!

During the cleaning process the exhaust becomes very hot. Do not park the vehicle near objects that are flammable.

Use caution near the exhaust tailpipe as it will also become very hot.

The only way in which either of these conditions can occur is if cleaning has been inhibited or a manual cleaning was interrupted. Refer to *Exhaust System Cleaning Switch (Tier 4 Engines Only)*, page 3-7, for more detail on these.

The cleaning process can take place in three different modes:

Passive: the exhaust is hot enough during normal working operation to burn off any hydrocarbon (soot) accumulation.

Active: Active cleaning occurs when there is not sufficient heat in the exhaust to perform the cleaning operation when it is required. Exhaust temperatures are raised by the system sufficiently high to enable a cleaning to occur. This is all done without any operator intervention. When the Cleaning Switch (9, Figure 3-4) is in the active cleaning (center) position, active cleaning is enabled. This is recommended.

Manual: Manual or stationary, cleaning is the same as active cleaning but takes place while the equipment is not being operated. It offers the equipment operator the option, if needed, of performing cleaning outside the normal duty cycle. When the Cleaning Switch (9, Figure 3-4) is momentarily placed in the manual cleaning position, manual cleaning is initiated. Often this is preceded by the Cleaning Switch (9, Figure 3-4) being placed in the inhibit cleaning position, which can lead to the engine operational implications discussed above.

Right Turn Signal Indicator

The Right Turn Signal Indicator (16, Figure 3-7) is located in the steering column gauge display. It is a green arrow light that flashes when the turn signal lever is pushed up or the Hazard Light Switch is positioned to On.

Inhibit Cleaning

The Inhibit Cleaning Indicator (17, Figure 3-7) is located in the steering column gauge display. When the Cleaning Switch (9, Figure 3-4) is in the inhibit cleaning position, this amber indicator is illuminated and both manual and active cleaning will be inhibited.

Diesel Exhaust Fluid (Tier 4F Engines Only)

The Diesel Exhaust Fluid (DEF) Level Indicator (18, Figure 3-7) is located in the steering column gauge display. The indicator has four different stages which will be triggered by the fluid level sensor in the DEF tank.

Low Tank: First warning to the operator is that the reducing agent in the tank is low. The Low DEF Indicator (18) will be lit continuously.

Derate: The Low DEF Indicator (18) will start to flash as a warning to the operator that a derate will be activated if the reducing agent in the DEF tank is not refilled.

Low Level Inducement: The Low DEF Indicator (18) will flash and the Engine Warning Indicator (14) will be lit continuously. Derate will be activated at this stage.

Severe Inducement: Once the DEF tank is empty, the crane operation will be restricted. The Low DEF Indicator (18) will flash and the Stop Engine Indicator (13) will be solid red.

High Exhaust System Temperature

The High Exhaust System Temperature (HEST) Indicator (19, Figure 3-7) is located in the steering column gauge display.

During cleaning it is possible for the engine exhaust to reach temperatures exceeding 1200°F. The HEST indicator will illuminate red to warn the operator of when temperatures reach 640°C (1184°F) and will stay on until the temperature falls below 625°C (1157°F).

A warning light near the tailpipe will flash during cleaning when high exhaust temperatures exist.

For more information on the cleaning process, refer to *Exhaust System Cleaning (Tier 4 Engines Only)*, page 3-11

Engine Wait to Start

The Engine Wait To Start Indicator (20, Figure 3-7) is located in the steering column gauge display. It illuminates amber for a period of time when the ignition switch is in the ON position. The engine should not be cranked until the Wait to

Start light turns OFF. This light is controlled by the engine ECM.

Four-Wheel Drive Engaged

The Four-Wheel Drive Indicator (21, Figure 3-7) is located in the steering column gauge display. It illuminates amber when the Drive Axle Selector Switch (5, Figure 3-2) is in the four-wheel low position. When in four-wheel drive only first and second gears are enabled. This lamp will blink when the two-wheel drive/four-wheel drive is selected without the brake pedal depressed and the transmission in neutral.

Interaxle Locked

The Interaxle Locked Indicator (22, Figure 3-7) is located in the steering column gauge display. This indicator illuminates when the Differential Lock Switch (10, Figure 3-9) is pressed to the Lock position, when in the Lock position there is no differential action between the wheels.

Rear Wheels Not Centered Indicator

The Rear Wheels Not Centered Indicator (23, Figure 3-7) is located in the steering column gauge display. The indicator is an amber light that will illuminate any time the rear wheels are not centered.

Engine Coolant Temperature Gauge

The Engine Coolant Temperature (water temp) Gauge (25, Figure 3-7) is located in the steering column gauge display. The gauge indicates the engine coolant temperature on a dual scale calibrated from 38 to 138°C and 100 to 280°F. The gauge receives a signal from the engine ECM and a temperature sending unit in the engine cooling system.

Fuel Gauge

The Fuel Gauge (26, Figure 3-7) is located in the steering column gauge display. The gauge indicates the quantity of fuel in the fuel tank and has a scale calibrated from 0 (zero) to 4/4 (full). The fuel gauge receives a signal from a sending unit in the fuel tank.

CAUTION

Engine Damage Hazard!

Ultra low sulfur diesel fuel required in Tier 4 engines.

If "Ultra Low Sulfur" fuel is not used in engines that require it, the Cummins warranty will be void and the engine performance will quickly deteriorate and may stop running.

Low Fuel Level

The Low Fuel Level Indicator (27, Figure 3-7) illuminates when the fuel level in the tank is nearing empty (15%) and

the crane is in danger of running out of fuel. When this indicator comes on, fuel should be added to the fuel tank immediately. The light will go out when the fuel tank level reaches 20% of capacity.

Battery Charge Indicator

With the engine running, the Battery Charge Indicator (28, Figure 3-7) illuminates red if battery system voltage is below 9 volts, engine ECM voltage is below 9 volts, or there is no alternator charge signal present.

If the engine is running and the Battery Charge Indicator illuminates, investigate possible alternator, alternator fuse, drive belt, or alternator wiring problems.

When the engine is not running and the Ignition Switch is in the ACC or RUN position, the Battery Charge Indicator turns on to indicate the batteries are being drained and not being charged.

Voltmeter

The Voltmeter (battery gauge) (29, Figure 3-7) is located in the steering column gauge display. The Voltmeter indicates the voltage being supplied to or from the batteries and has a scale of 8 to 18 volts.

If the Ignition Switch is in the ACC or RUN position and the Voltmeter indicator is in the red, the batteries may need to be recharged or possibly replaced.

Tachometer

The Tachometer (30, Figure 3-7) is located in the steering column gauge display. The tachometer registers engine RPM and is calibrated in RPM x 100 with a range of 0 (zero) to 35. The tachometer receives a signal from the engine ECM.

For
Reference
Only

CONTROL SEAT ASSEMBLY - SINGLE AXIS

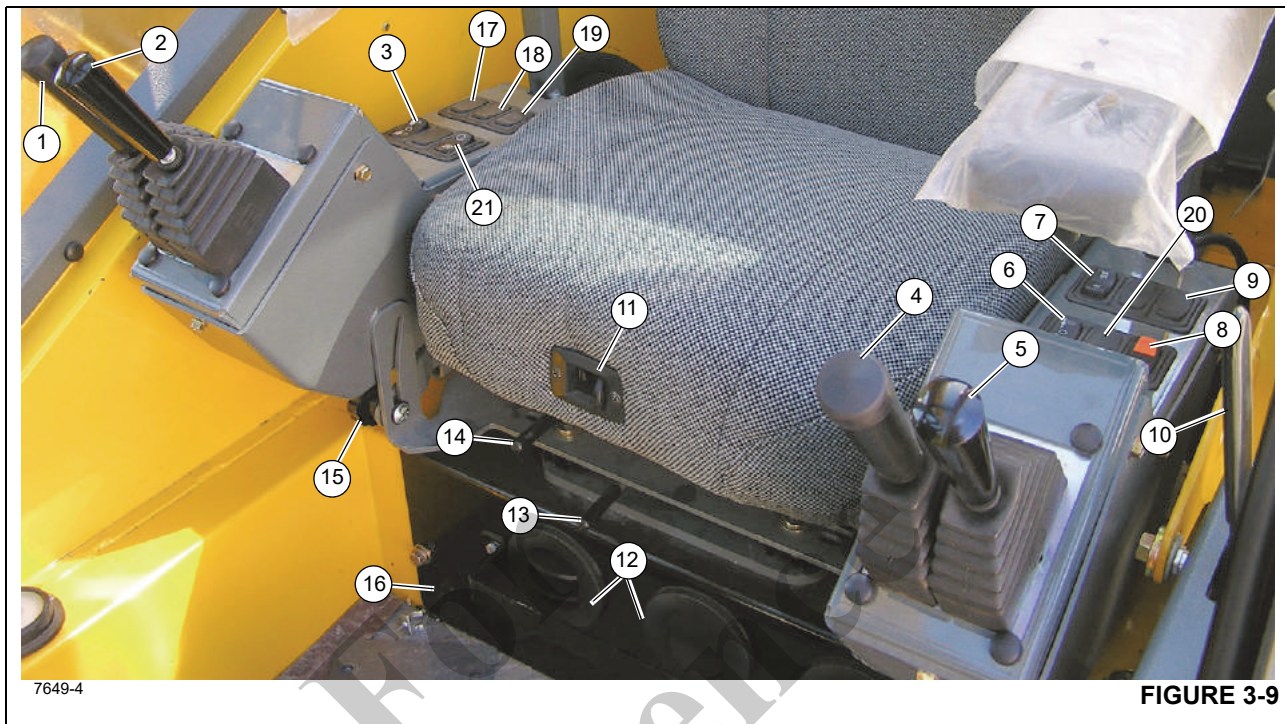


Figure 3-9 Item Numbers

Item	Description
1	Main Hoist Control, Raise/ Lower
2	Boom Lift Control
3	Main Hoist Speed Switch
4	Auxiliary Hoist Raise/Lower
5	Swing Control, Left/Right
6	Auxiliary Hoist Speed Switch
7	Rear Steer Switch
8	Swing Brake Control Switch
9	Axle Differential Lock Control Switch
10	Cab Door Release
11	Seat Back Adjustment
12	AC/Heater Vents
13	Seat Slide Lever
14	Whole Seat Slide Lever
15	Right Arm Rest Adjustment
16	AC/Heater Climate Control Unit
17	Cab Tilt Switch
18	Luffing Jib Raise/Lower Switch
19	Luffing Jib On/Off Switch

Item	Description
20	Swing Speed Switch
21	Hydraulic Boost Switch

Main Hoist Control (Single Axis Option)

The Main Hoist Control (1, Figure 3-9) is located on the right armrest. The joystick, when pushed forward, lowers the cable. When pulled back, it raises the cable.

Boom Lift Control (Single Axis Option)

The Boom Lift Control (2, Figure 3-9) is located on the right armrest. The joystick, when pushed forward lowers the boom or pulled back raises the boom.

Boom Lift and Main Hoist Control Lever (Dual Axis Option — Not Shown)

The Boom Lift/Main Hoist Control Lever is located on the right armrest. The controller, when pushed to the right lowers the boom or pushed left raises the boom.

When used for main hoist, the controller, when pushed forward lowers the cable or pulled back raises the cable.

Main Hoist Speed Selector Switch

The Main Hoist Speed Selector Switch (3, Figure 3-9) is a three positioned maintained switch (High/Off/Low) that is

located on the right armrest. Positioning the switch to High position allows main hoist functions and energizes the Main Hoist High Speed Solenoid, resulting in high line speeds. Positioning the switch to the center Off position will prevent hoisting. Positioning the switch to the Low position allows main hoist functions and de-energizes the Main Hoist High Speed Solenoid, resulting in low line speeds.

Auxiliary Hoist Control (Single Axis Option)

The Auxiliary Hoist Control (4, Figure 3-9) is located on the left armrest. The joystick controls auxiliary hoist functions, push the joystick forward to let out the hoist cable or pull the lever back to reel the cable in.

Swing Control (Single Axis Option)



DANGER Crushing Hazard!

Death or serious injury could result from being crushed by moving machinery.

Before actuating swing or any other function, sound horn and verify that all personnel are clear of rotating and moving parts.

The Swing Control Joystick (5, Figure 3-9) located on the left armrest, controls the swing function. The joystick, when pushed forward rotates the turntable clockwise or pulled back rotates the turntable counterclockwise, actuates a control valve through hydraulic pilot pressure to provide 360 degree continuous rotation in the desired direction.

Swing and Telescope or Swing and Auxiliary Hoist Control Lever (Dual Axis Option—Not Shown)



DANGER Crushing Hazard!

Death or serious injury could result from being crushed by moving machinery.

Before actuating swing or any other function, sound horn and verify that all personnel are clear of rotating and moving parts.

The Swing and Telescope or Auxiliary Hoist (Swing/Tele or Swing/Aux) control lever is located on the end of the left armrest. The lever controls the swing and telescope functions when the crane is not equipped with an auxiliary hoist. When equipped with an auxiliary hoist, the lever controls swing and auxiliary hoist functions and telescope functions are controlled through a foot pedal.

If not equipped with an auxiliary hoist, positioning the lever forward actuates the control valve to telescope the boom out and pulling the lever back actuates the boom to telescope in.

If equipped with an auxiliary hoist, positioning the lever forward actuates the control valve to let out hoist cable and pulling the lever back reels the cable in. Moving the lever in a diagonal direction actuates the two functions simultaneously.

Auxiliary Hoist Speed Selector Switch (Optional)

The Auxiliary Hoist Speed Selector Switch (6, Figure 3-9) is a three positioned maintained switch (High/Off/Low) that is located on the left armrest. Positioning the switch to High position allows auxiliary hoist functions and energizes the Auxiliary Hoist High Speed Solenoid, resulting in high line speeds. Positioning the switch to the center Off position will prevent hoisting. Positioning the switch to the Low position allows auxiliary hoist functions and de-energizes the Auxiliary Hoist High Speed Solenoid, resulting in low line speeds.

Rear Steer Switch

The Rear Steer Control Switch (7, Figure 3-9) is a three-position, spring centered to off, rocker switch, located on the left armrest. Press the bottom of the switch to actuate a control valve to turn the rear wheels to the left, causing the crane to turn to the right. Press the top of the switch actuates a control valve to turn the rear wheels to the right, causing the crane to turn to the left. When the wheels are not centered the Rear Wheels Not Centered light on the steering column illuminates. Releasing the switch causes it to return to the center off position.

To straighten the rear wheels press the switch until the Rear Wheels Not Centered indicator light goes off.

Swing Brake Control Switch

The Swing Brake Control Switch (8, Figure 3-9) is located on the left arm rest. This two-position rocker switch (On/Off) is used to control a hydraulic valve that directs a regulated flow of pressure to and from the swing brake. Positioning the switch to On will apply the swing brake and positioning the switch to Off will release the swing brake. When the switch is in the On position, the red indicator light on the steering column is illuminated. The switch has a lock to prevent accidental activation.

Axle Differential Lock Control Switch (Optional)

NOTE: The differential lock will only work when the crane is in the 4WD mode.

The Differential Lock Control Switch (9, Figure 3-9) is located on the left arm rest. It is a two position, momentary rocker switch. When positioned to Lock, the splines on the shift

collar are engaged with the splines on the differential case and the axle shafts and the differential assembly are locked together and there is no differential action between the wheels. When positioned to Unlock, there is normal differential action between the wheels all the time. The amber indicator on the steering column is illuminated when the proximity switches in each axle are activated.

CAUTION
Axle Damage!

Operating the machine with the differentials in the locked position while maneuvering on improved surfaces may result in damage to the axles.

CAB DOOR RELEASE

Use the Cab Door Release Lever (10, Figure 3-9) to open and close the cab door from inside the cab.

SEAT BACK ADJUSTMENT

To adjust the back of the seat press the adjustment knob (11, Figure 3-9) and then adjust the seat as needed.

A/C HEATER, CLIMATE CONTROL

The crane cab Air Conditioner/Heater Climate Control unit (16, Figure 3-9) is located in the cab under the driver's seat. The vents (12) are part of the climate control unit and can be adjusted to direct the flow of air.

SEAT SLIDE LEVER

Moving the Seat Slide Lever (13, Figure 3-9) will slide the seat only, either forward or backward.

SEAT FRAME SLIDE LEVER

Moving the Seat Frame Slide Lever (14, Figure 3-9) will slide the seat and the seat frame, with armrest controls, either forward or backward.

ARMREST ADJUSTMENT

The Armrest and armrest controls can be adjusted using the adjustment knobs (15, Figure 3-9). Loosen the knob and rotate the entire armrest to the desired position, retighten the knob when finished making the adjustment.

HOIST ROTATION INDICATORS (HRI)

The Hoist Rotation Indicators for the auxiliary and main hoist is located on top of each hoist control lever (1,4, Figure 3-9). Each indicator is electronically driven by an input signal from a sensor attached to its related hoist and an output signal from a control module. Each hoist control lever (1,4) pulses when its hoist is running so the operator's thumb can sense it.

HRI Display

The display is located in the front overhead panel Figure 3-10. The LED display illuminates to indicate the current hoist in operation and which direction the hoist is rotating.

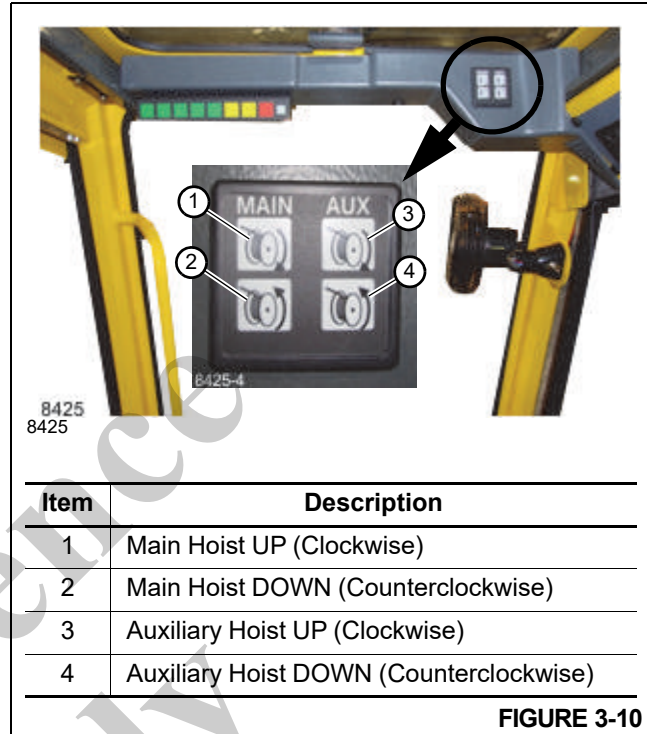


FIGURE 3-10

CAB TILT SWITCH

The Cab Tilt Switch (17, Figure 3-9) is located in the right arm rest. It is a three position, momentary spring centered to off rocker switch. It has two positions, Up and Down, allowing the cab to be tilted either up or down.

NOTE: The Parking Brake must be engaged to operate the Cab Tilt feature and the cab must be completely down for the drive functions to be enabled.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

LUFFING JIB RAISE/LOWER SWITCH (OPTIONAL)

The Luffing Jib Raise/Lower Switch (18) is located on the right armrest. It is a three position, momentary switch (Lower/Off/Raise) that energizes a solenoid to actuate the luffing jib

cylinder, it raises or lowers the jib when the Luffing Jib On/Off switch is On.

LUFFING JIB ON/OFF SWITCH (OPTIONAL)

The Luffing Jib On/Off Switch (19) is a two position switch located on the right armrest. When in the On position it energizes the Luffing Jib Raise/Lower Switch to operate the luffing jib.

TWO-SPEED SWING SWITCH

The Two-Speed Swing Switch (20) is located on the left armrest. This two-position (fast/slow) switch determines the swing motor speed. When in the fast position, the swing high speed solenoid is energized.

ARMREST SWITCH (NOT SHOWN)

The Armrest Switch is a proximity switch located in the left-hand armrest. The left-hand armrest must be in the down position before crane functions can be activated.

SEAT SWITCH (NOT SHOWN)

This switch is located in the seat. An operator must be sitting in the seat before the crane functions can be activated.

SIDE CONTROL PANEL

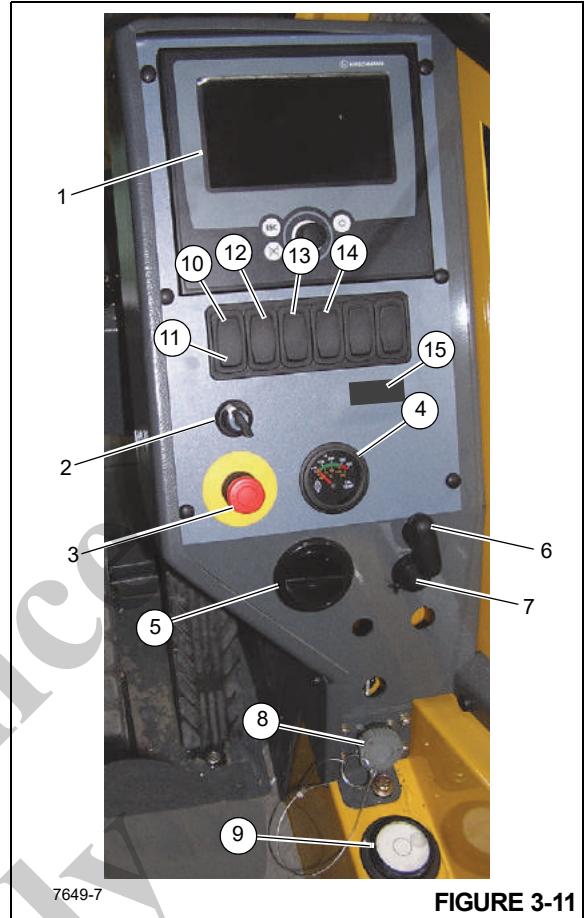


FIGURE 3-11

Figure 3-11 Item Numbers

Item	Description
1	Rated Capacity Limiter (RCL) Display
2	Rated Capacity Limiter (RCL) Bypass Switch
3	Emergency Stop Switch
4	Transmission Oil Temp Gauge
5	AC/Heater Vent
6	Turntable Pin Swing Lock Control
7	12 Volt Receptacle
8	Diagnostic Connector
9	Bubble Level Indicator
10	Boom Not Sync Indicator
11	Hose Reel Brake
12	3rd Wrap Indicator (optional)
13	Cold Weather Indicator (optional)
14	Telescope Cylinder Charge Indicator (If Equipped)
15	Ambient Temp. LED Indicator (optional)

Rated Capacity Limiter (RCL) and Work Area Definition System Control Panel

The Rated Capacity Limiter (RCL) and Work Area Definition System Control Panel (1, Figure 3-11) is located on the right side of the cab. It maintains the controls and indicators for the crane's RCL System and Work Area Definition System. Refer to the RCL Operator manual for detailed information.

Rated Capacity Limiter (RCL) Bypass Switch

The Rated Capacity Limiter (RCL) Bypass (Override) Switch (2, Figure 3-11) is a momentary type switch, turn the key to the On position (right) to disengage the RCL controls. Releasing the key allows the RCL controls to re-engage.

The RCL will be bypassed only as long as the switch is in the On position.

Turning the key switch to the On position re-engages the boom down, telescope out and hoist up controls. These functions were disabled when an overload condition was sensed by the RCL. It is important to read and understand the RCL override warning information in the *RCL Operator Manual* before using the RCL Bypass Switch (2) or the RCL On/Off Switch.

Emergency Stop Switch

The crane Emergency Stop Switch (3, Figure 3-11) is located on the right front console and is used to shut down the crane's engine. Push the red button in to shut down the engine, which illuminates the Emergency Stop indicator on the steering column. Rotate the knob and pull out to resume normal operation.

Transmission Oil Temperature Gauge

The Transmission Oil Temperature (Trans Temp) Gauge (4, Figure 3-11) is located in the center of the right front console. The gauge indicates the transmission oil temperature on a dual scale calibrated from 60 to 160°C and 140 to 320°F. The gauge receives a signal from a temperature sending unit in the oil line at the torque converter.

Turntable Pin Swing Lock Control

The Turntable Pin Swing Lock Control handle (6, Figure 3-11) is located on the side control panel. The purpose of the pin swing lock is to lock the superstructure in position directly over the front for pick and carry loads.

When the control handle is pushed in and the superstructure is directly over the front, the swing lock pin drops into the socket on the carrier frame, locking the superstructure in place.

When the control handle is pulled out, the pin is pulled out of the socket, unlocking the superstructure.

CAUTION

Swing Lock Damage!

Do not engage the Pin Swing Lock while superstructure is in motion. Center boom over the front and engage Pin Swing Lock to prevent superstructure rotation during travel.

12V Receptacle

This 12 volt accessory outlet (7, Figure 3-11) is located on the lower part of the control panel and is designed to mate with most 12 volt adapter plugs.

Diagnostic Connector

The Diagnostic Connector (8, Figure 3-11) is located on the lower part of the front control panel. It is used for servicing the crane's electrical system.

A laptop computer with a nine pin cable connector and the appropriate service software are required. Contact your local Grove distributor or Manitowoc Crane Care for assistance.

Bubble Level Indicator

The Bubble Level Indicator (9, Figure 3-11) is located below the front control panel. The indicator provides the operator with a visual aid in determining the levelness of the crane. Refer to *Proper Leveling of the Crane*, page 3-40 for more information.

NOTE: To ensure a true reading always make sure the cab tilt is completely lowered.

Hose Reel Brake Indicator

The Hose Reel Brake On Indicator (10, Figure 3-11) is located on the right side console. It illuminates red when the Hose Reel Brake is applied and the telescope control foot pedal is in neutral.

NOTE: Do not telescope the boom in or out when the indicator light is on and the telescope control foot pedal is depressed.

Boom Not Sync Indicator

The Boom Not Sync Indicator (11, Figure 3-11) is located on the right side console. It illuminates red when the boom sections are no longer telescoping in the correct synchronization. The Boom Mode and Boom Telescope Section Select switches must then be used to correct the synchronization. This indicator light is controlled by the rated capacity limiter (RCL).

Hoist 3rd Wrap Indicator (Optional, Standard w/CE)

The Hoist 3rd Wrap Indicator (12, Figure 3-11) is located on the right side console. The indicator will illuminate red when three wraps or less of cable remains on either hoist.

Cold Weather Indicator (Optional)

The optional Cold Weather Indicator (13, Figure 3-11) is located on the right side console. The indicator comes on when ambient temperature is at or below -29°C (-20°F). It serves as a warning for the operator to stop operation in extreme cold.

Telescope Cylinder Charge Indicator (If Equipped)

The Telescope Cylinder Charge Indicator (14, Figure 3-11) is located on the right side control panel and is part of the telescope cylinder charge system. The telescope cylinder charge system is designed to prevent boom retraction due to thermal contraction under the following operating conditions: If the crane is operated with a long boom length and low boom angle, and the hydraulic oil in the telescope cylinders cools and contracts, the friction forces in the extended boom will prevent the boom from retracting. Then, if the operator begins to elevate the boom without telescoping out slightly, the crane may reach a boom elevation angle where the weight of the boom sections and load overcomes the friction forces in the boom sections, causing the boom to retract until the column of oil inside the cylinders once again supports the boom sections. The telescope cylinder charge system will prevent the boom from retracting under these conditions by automatically replenishing the volume of hydraulic oil lost in the telescope cylinders due to thermal contraction.

The telescope cylinder charge system operates automatically and does not require any operator input. The indicator illuminates amber and the buzzer sounds (2, Figure 3-14) when the boom is elevated above 35° and the telescope cylinder charge system is not functioning properly. If the buzzer sounds and the indicator illuminates, the operator should immediately telescope out slightly to manually charge the telescope cylinders, stop operation, then have the system repaired as necessary.

NOTE: The telescope cylinder charge system does not prevent thermal contraction of hydraulic oil due to a drop in temperature and will only prevent boom retraction when the crane's engine is running and the boom angle is greater than 35° . The system is designed only to prevent boom retraction that may occur due to thermal contraction under the operating conditions previously described.

Ambient Temperature Indicator (Optional)

The Ambient Temperature Indicator (15, Figure 3-11) is located on the right side console. When the ambient temperature outside the crane reaches below -29°C (-20°F) the indicator will illuminate and send a signal to the rated capacity limiter (RCL) system. This temperature control is to prevent operation of crane lifting functions in temperatures below -29°C (-20°F). The system will initiate lockout of the following crane functions: hoist up, boom down, and boom telescope-extend. Hoist lowering, boom up and boom telescope-retract along with lockout override, will still be operational to lower the load.

OUTRIGGER CONTROL

Cab Outrigger Control

The Cab Hand-held Outrigger Control (1, Figure 3-12) is stowed in the cab (Figure 3-1) and is used to control the outriggers from inside the cab.

Extend/Retract Switch

The Extend/Retract Switch (6, 7 Figure 3-12) is located on the side of the Outrigger Control Box and is used in conjunction with the Outrigger Selector Switches (2,3,4,5 Figure 3-12) to control the outrigger functions.

Outrigger Selector Switches

There are four Outrigger Selector Switches (2,3,4,5, Figure 3-12) on the Outrigger Control Box. To extend or retract an outrigger component, first select the component with the Outrigger Selector Switch (2,3,4,5), then select extend or retract with the Extend/Retract Switch (6,7, Figure 3-12).

NOTE: The park brake must be engaged for the outriggers to operate.

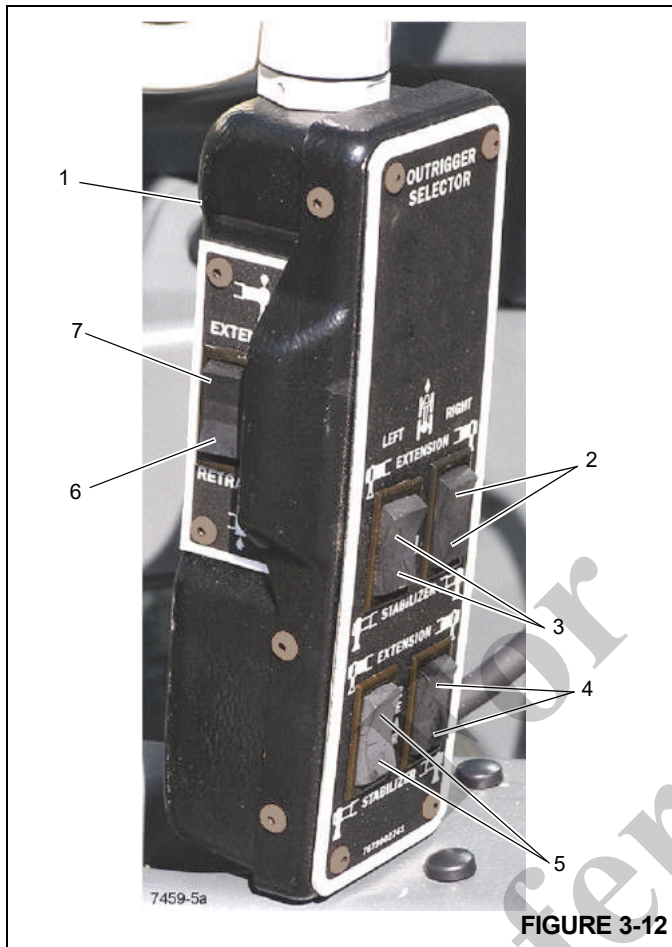


FIGURE 3-12

Item	Description
1	Hand Held Control
2	Right Front Extension/Right Front Jack
3	Left Front Extension/Left Front Jack
4	Right Rear Extension/Right Rear Jack
5	Left Rear Extension/Left Rear Jack
6	Retract O/R
7	Extend O/R

FOOT PEDAL CONTROLS

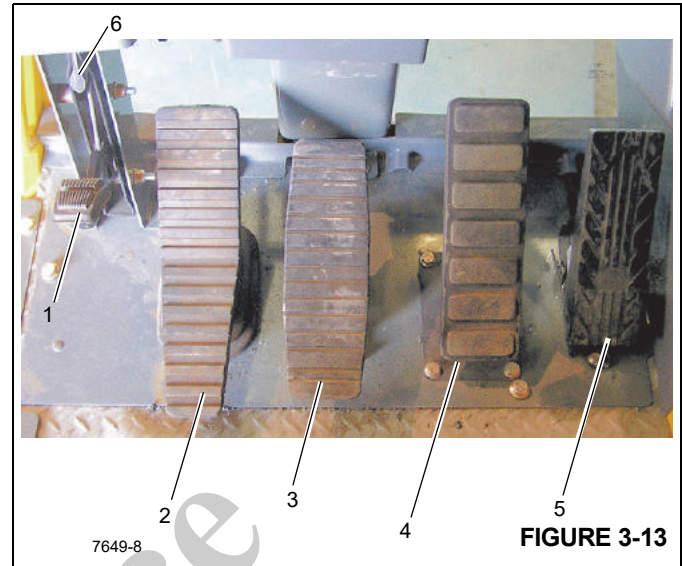


FIGURE 3-13

Figure 3-13 Item Numbers

Item	Description
1	Swing Lock Pedal
2	Swing Brake Pedal
3	Telescope Control Foot Pedal
4	Service Brake Foot Pedal
5	Foot Throttle Pedal
6	Swing Lock Release Lever

Swing Lock Pedal

The Swing Lock Pedal (1, Figure 3-13) is located on the left side of the crane cab floor. The brake pedal is used to activate the swing lock and hold the turntable in position. To release the swing lock, pull up on the Swing Lock Release Lever (6).

Swing Brake Pedal

The Swing Brake Pedal (2, Figure 3-13) is located on the left side of the cab floor. The Swing Brake Pedal is used to actuate the swing brake to slow or stop swing motion. Braking is proportional to pedal depression. With the pedal not depressed and the swing brake control valve disengaged, hydraulic pressure is applied to the brake, overcoming spring pressure and releasing the brake. Depressing the pedal actuates a swing power brake valve to apply pressure to the brake assembly. This pressure aids the spring pressure to overcome the hydraulic pressure being applied to the brake release circuit and applies the spring brake according to the pressure from the swing power brake valve.

Telescope Control Foot Pedal

The Telescope Control Foot Pedal, equipped on cranes with an auxiliary hoist, (3, Figure 3-13) is located on the left side of the cab floor. Pushing forward on the top of the pedal will extend the boom and pushing down on the bottom of the pedal will retract the boom.

Service Brake Foot Pedal

The Service Brake Foot Pedal (4, Figure 3-13) is the second pedal from the right on the cab floor. Depressing the pedal controls the application of the service brakes.

Foot Throttle Pedal

The Foot Throttle Pedal (5, Figure 3-13) is located under the Rated capacity limiter (RCL) display module, on the floor. It is used to control engine speed which increases or decreases proportionately with the amount of foot pressure applied to the pedal. The pedal is electrically connected to the superstructure control module which sends the signal to the engine ECM via the J1939 data link.

For
Reference
Only

MISCELLANEOUS CONTROLS AND INDICATORS

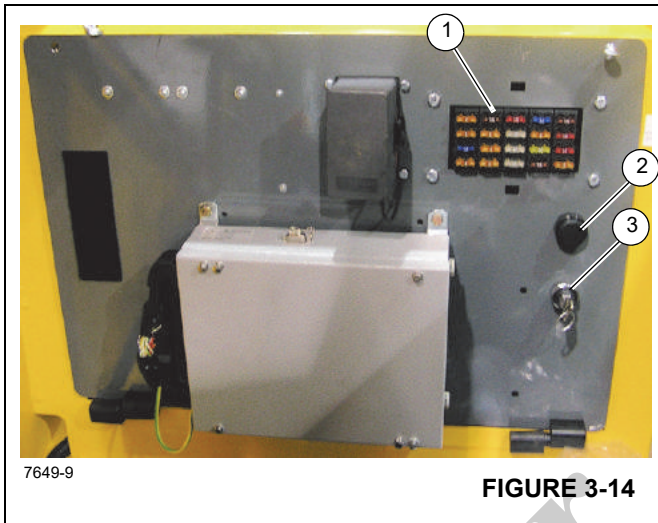


FIGURE 3-14

S/S CAB FUSES				
F1 5A	F5 7.5A	F9 10A	F13 15A	F17 7.5A
F2 5A	F6 5A	F10 25A	F14 5A	F18 10A
F3 15A	F7 5A	F11 25A	F15 20A	F19 10A
F4 7.5A	F8 5A	F12 25A	F16 7.5A	F20 5A

F1	Ignition, Start
F2	Steering Column Power
F3	Dome Light, Work Lights
F4	Spare (5A Max)
F5	ACC Power Outlet
F6	Ignition Power Out
F7	Engine ECM Ignition Signal
F8	Key Switch Accessory Power
F9	Cab Control Modules
F10	T/T I/O Module
F11	T/T Power Module (Horn, Fan Motor)
F12	T/TPower Module (AC Condenser Motor, Boom Lights, Cwt Removal-Opt)
F13	LMI CPU
F14	Luffing Jib (Option)
F15	Jib Stowage Power (Option)
F16	Spare (5A Max)
F17	Spare (5A Max)
F18	Windshield Wiper
F19	Skylight Wiper
F20	Circulating Fan

FIGURE 3-15

Fuse Panel

The Fuse Panel (1, Figure 3-14 and Figure 3-15) is located behind the cab seat, on the cab fuse and relay panel

assembly. It contains up to 20 fuses that protect the various electrical components of the crane.

Buzzer

The buzzer (2), located behind the cab seat, sounds when the following conditions exist:

- the Ignition Switch is turned to RUN
- after the engine is started until the proper hydraulic pressure is reached
- engine stop
- Emergency Stop Switch activated
- transmission service
- low brake pressure
- high hydraulic oil temperature
- high transmission oil temperature
- boom not synchronized
- low steer pressure condition (for CE units)
- hoist 3rd wrap condition (for CE units).

Rated Capacity Limiter (RCL) Emergency Override Switch (Non-CE Certified Cranes)



WARNING

Loss of RCL Monitoring Hazard!

The RCL Emergency Override switch is to be used in emergency situations only.

Do not operate the crane with the RCL overridden during normal operations.

The RCL system, when programmed accurately, will lockout the three craning functions—boom down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity or when a two-block condition exists. Locking out these three functions prevents the overload or two-block condition from worsening.

The RCL emergency override switch (3, Figure 3-14) is a key operated switch that is located inside the operator cab on the panel assembly behind the seat. When actuated (turned clockwise), the switch will override and prevent the RCL from locking out the three craning functions (boom down, telescope extend, and hoist up) should an overload or two-block condition occur.

Overriding the RCL with this switch should only be done in the case of an emergency or when servicing the boom.

A flashing light on the RCL display indicates the switch has been activated.

NOTE: Data is recorded automatically whenever the RCL is triggered or the override switch is used.

Refer to the *RCL Operator's Manual* for more information.

Rated Capacity Limiter (RCL) Emergency Override Switch and Indicator (CE Certified Cranes)



WARNING

Loss of RCL Monitoring Hazard!

The RCL Emergency Override Switch is to be used in emergency situations only.

Do not operate the crane with the RCL overridden during normal operations.

The RCL system, when programmed accurately, will lockout the three craning functions—boom down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity or when a two-block condition exists. Locking out these three functions prevents the overload or two-block condition from worsening.

The RCL emergency override switch is located inside a key-locked single-door enclosure (1, Figure 3-16) that is attached to the outside rear of the operator's cab. The switch is a two-position momentary rocker switch with integral indicator that, when actuated, will override and prevent the RCL, for a period of 30 minutes, from locking out the three craning functions (boom down, telescope extend, and hoist up) should an overload or two-block condition occur.

Overriding the RCL with this switch should only be done in the case of an emergency or when servicing the boom.

The indicator in the override switch will illuminate red and the RCL and A2B override indicators on the RCL display will flash to indicate the switch has been activated. Upon activation, all craning function movements are reduced to 15% of their normal maximum speeds.

The RCL override function is automatically cancelled after 30 minutes. The RCL override function can also be cancelled by the operator by either pressing the RCL emergency override switch a second time, by turning off the engine, or by turning the crane function power switch off.

Refer to the *RCL Operator's Manual* for more information.

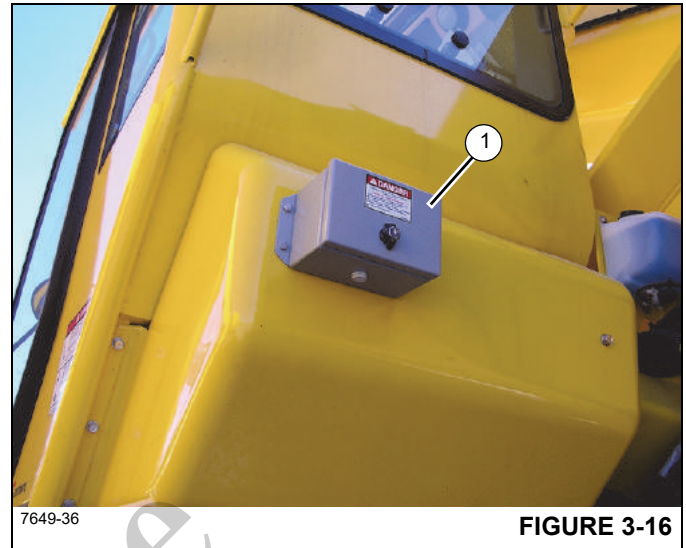


FIGURE 3-16

Rated Capacity Limiter (RCL) Internal Light Bar (Optional—Not Shown)

The Rated Capacity Limiter (RCL) Internal Light Bar is located on the upper left hand corner of the crane cab. The RCL is an operational aid that warns a crane operator of approaching overload conditions and over hoist conditions that could cause damage to equipment and personnel.

Strobe Light or Beacon (Optional—Not Shown)

The Strobe Light or Beacon is on the roof of the cab. It is on when the ignition switch is on.

Backup Alarm (Not Shown)

The Backup Alarm is an audio system used to warn personnel outside the crane when the crane is backing up. The alarm system is electrical and consists of the backup alarm and its associated wiring. The alarm is connected to the electrical wiring for the transmission reverse solenoids. It is activated when the transmission shifter is in the reverse position. The backup alarm is installed in the rear outrigger box behind the grill plate.

Emergency Exit

The windshield is considered the Emergency Exit. In an emergency, push out on the windshield and escape through the opening.

OPERATING PROCEDURES

Pre-Starting Checks

A complete walk-around visual inspection of the crane should always be made with special attention to structural damage, loose equipment, leaks, or other conditions that would require immediate correction for safety of operation. The following checklist items are suggested specifically for the operator's benefit to make certain the crane is prepared for starting the day's work.

Fuel Supply

Check the fuel level and make sure the cap is on tight. Drain any water from the fuel filter.

Engine Oil

Check the oil level in the crankcase and fill to the FULL mark on the dipstick. Do not overfill.

Engine Coolant

Check the coolant level in the radiator and fill to the proper level. Do not overfill and check to make sure the cap is secure.

Batteries

Check that the battery cables and clamps are tight and not corroded.

Signal and Running Lights

Check all signal and running lights for proper operation. Replace burned out lamps with those of the same number or equivalent.

Foot and Parking Brakes

Check the foot and parking brakes for proper operation.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

Daily Lubrication

Make certain that all components requiring daily lubrication have been serviced. (Refer to *Maintenance and Lubrication*, Section 5.)

Hydraulic Reservoir and Filter

Check hydraulic fluid quantity level and filter condition indicator. Check breather for cleanliness and ensure it is secure.

Tires

Check for severe cuts, foreign objects embedded in treads, and for correct inflation pressures. A tire inflation chart, providing the correct air pressures, is located in the *Load Chart Book* in the crane cab.

Wire Rope

Inspect wire rope in accordance with applicable Federal Regulations.

Inspect sheaves, guards, guides, drums, flanges, and any other surfaces that may come in contact with the rope for any condition that could cause possible damage to the rope.

Hook Block

Visually inspect for nicks, gouges, cracks, and evidence of any other damage. Replace any hook that contains cracks or shows evidence of excessive deformation of the hook opening, including twist. Be sure the safety latch is free and aligned.

Air Cleaner

Check the filter restriction indicator (Tier 3 models only). Check filter and tubing for security.

Air Intake Restriction Monitoring (AIRM) Communications System - Tier 4 Only

The Tier 4 engine includes the Cummins AIRM Communications System. This calculates real-time air filter restriction at operational flow rate using the temperature and pressure input from the TBAP sensor, which is included on the Direct Flow air cleaner.

A maintenance fault (Fault Code (FC) 5576) is initiated at the dirty filter restriction level, generating a blinking "Check Engine" light for 30 seconds at every key on until the intake air restriction drops below the dirty filter restriction threshold. A severe warning fault (FC 3341) is initiated if the maintenance fault condition degrades to a severe restriction level for a given time period, generating a solid amber "Check Engine" light and initiating a progressive engine derate in order to protect the engine from damage until the intake restriction drops below the dirty filter restriction threshold.

Cold Weather Operation

The following recommendations are for operating Grove cranes in regions with ambient temperatures below -9°C (15°F) which are considered arctic.

NOTE: Additional information regarding cold weather operation is available through your Cummins dealer/service center under Service Bulletin 3379009.

Use particular care to ensure that cranes being operated in very cold temperatures are operated and maintained in accordance with the procedures as provided by Grove. Therefore, always ensure adequate lubrication during system warm-up and proper operation of all crane functions when operating in cold weather and regardless of the oil viscosity of the crane's lubricants, always follow the cold weather start-up and operating procedures described in the *Operator Manual*. To ensure adequate lubrication during system warm-up and proper operation of all crane functions, (Refer to *Arctic Lubricants and Conditions*, page 5-5.) If in doubt of the suitability of a specific fluid or lubricant, check with an authorized Grove distributor or Manitowoc Crane Care. Cranes should have appropriate hydraulic oil, lubricants, and other auxiliary items required for operation in arctic temperatures.

Grove recommends the crane is equipped with the following cold weather accessories:

Down to -29°C (-20°F) Package

- Battery heater
- Fuel line heater
- Engine hood insulation
- Fan clutch
- Radiator air shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Fluids suitable to -29°C (-20°F)
 - Arctic windshield washer fluid
 - Arctic fuel

Down to -40°C (-40°F) Package

- Coolant heater (to circulate warm coolant through heaters and engine)
- Transmission heater
- Swivel heater
- Battery heater
- Fuel line heater
- Engine hood insulation
- Fan clutch
- Radiator shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator

- Super-capacitor starting system
- Fluids suitable to -40°C (-40°F):
 - Arctic windshield washer fluid
 - Arctic fuel

Individual crane functions should be operated to ensure they are sufficiently warmed prior to performing a lift.

Operation of cranes at full rated capacities in ambient temperatures between -9°C and -40°C (15°F and -40°F) or lower should be accomplished only by competent operators who possess the skill, experience, and dexterity to ensure smooth operation. Shock loading shall be avoided. See Section 5 of this manual for more detailed information on operation of cranes down to -40°C (-40°F).

Component Coolant Heater

A diesel fueled coolant heater circulates warm coolant through engine and crane components when operating during arctic temperatures. The coolant heater should be activated 2 hours before starting the crane to allow sufficient time to preheat fluids and assist with easy start-up conditions at maximum altitudes rating of 1,500 m (4,921 ft).

WARNING Explosion Hazard!

Before switching on, check if the heater can be operated at the current site of the crane. There is a danger of explosion when using the heater around combustible objects! Do not park the vehicle near objects that are flammable.

Use caution near the exhaust tailpipe as it will also become very hot.

NOTE: If a -40°C cold weather package is present (optional) start the diesel fired coolant heater (max altitude rating of 1500m) two hours before attempting to start the crane in temperatures below -29°C (-20°F).

NOTE: Operation of the heater is not permissible:

- At locations where flammable gas or vapors are found or can be formed (example: at fuel stations and chemical factories)
- At locations where explosive dust is found or can be formed (example: coal, wood or grain dust).
- There is a risk of suffocation when using the heater!
- Do not operate the heater in enclosed spaces (example: garages).

To activate the heater, ensure the fuel supply valve from the heater fuel reservoir is turned to the ON position. Ensure the battery disconnect switch is turned to the ON position and push the activation button at the heater control panel. A green light will illuminate indicating the system is activated. The start-up and shutdown cycles may take approximately 2 minutes for initialization. Ensure the coolant, transmission heater, swivel, battery heater, in-line fuel pump, in-line fuel heater, and hydraulic reservoir heater are heating properly.

To de-activate the heater, push the button at the heater control panel. The green light will turn off indicating the system is de-activated. The shutdown cycle may take approximately 2 minutes.

NOTE: Accelerated discharging of battery will occur when the crane engine is switched off. If you run the heater while the crane engine is stopped, the batteries voltage will need to be recharged after short periods of time.

Radiator Shutters

When starting the engine the shutters on the radiator will close and will open when the coolant temperature reaches 71°C (160°F).

Auxiliary Cab Heater

The superstructure crane cab is heated with an auxiliary air heating system that runs independently of the engine. The heat is generated by burning fuel taken from the heater fuel reservoir.

To heat the operator's cab, activate the auxiliary diesel heater and adjust the temperature control switch mounted in the overhead panel. The fan for the heating system delivers warm air into an air distribution box. The air is circulated according to the setting of the controls and then delivered into the crane cab by a fan through the various air extraction and air delivery vents. Do not cover the vents with bags, articles of clothing or any other objects. Keep the hot air inlet and hot air outlet free of dirt and foreign bodies. Soiled or blocked hot air lines may cause overheating, and result in damage. The crane auxiliary cab heater can be operated while the diesel engine is running or is stopped as part of the programmable auxiliary heating system. The standard hot water crane cab heater can also be turned on after the engine has started and is warmed to operating temperature.

NOTE: When using the heater at high altitudes, the factory heater setting will need to be re-calibrated for proper heater operation.

- Heating at altitudes up to 1,500 m (4,921 ft)
Unlimited heating is possible
- Heating at altitudes over 1,500 m - 3,000 m (4,921 ft - 9,842 ft):

Heating is possible for short periods at this altitude (example: driving over a mountain pass or taking a break while traveling between job sites).

During longer stays, (example: construction job project), the fuel supply must be adjusted to the altitude or the heater will malfunction. This can be done by installing an air pressure sensor kit (Grove part number 90037674). Contact an authorized Grove distributor or Manitowoc Crane Care for additional assistance.

NOTE: Accelerated discharging of battery will occur when the crane engine is switched off. If you run the heater while the crane engine is stopped, the batteries' voltage will need to be recharged after short periods of time.

Battery Heater

An in-line battery coolant heater circulates warm coolant under the battery when the temperature is below -9°C (15°F). The battery coolant heater should be activated 2 hours before starting the crane to allow sufficient time to preheat batteries and assist with easy start-up conditions.

Ensure battery heater coolant valve is turned to off position in ambient temperatures above -9°C (15°F).

Air Diverter

An air diverter directs warmed air collected from under the engine hood when the temperature is below -9°C (15°F) to preheat the air intake going to the engine.

Ensure air diverter is switched to outside air intake in ambient temperatures above -9°C (15°F).

Super Capacitor

The super capacitor provides additional cranking during cold weather startup. The super capacitor is connected to the standard batteries with an isolation relay. The positive relay feed is activated when the key is in the crank and run positions. The super capacitor allows the starter to be cranked for 30 seconds then cycled off for 60 seconds before cranking again until the engine starts.

If crane has been left with battery disconnected for an extended period of time, super capacitor will need up to 30 minutes to charge before having full cranking capacity.

Charge of capacitor can be measured by the following:

- Turn battery disconnect to on position.
- Press black button located on top of capacitor:
- If light flashes green, capacitor is charging and may not successfully start machine.
- If light is solid green, capacitor is charged and ready for starting.

Any other color or flash pattern may indicate an error, reference decal located on capacitor.

Diesel Fuel

Diesel fuel with low temperature characteristics is required to operate the engine down to an ambient temperature range from -40°C (-40°F) to 49°C (120°F). Refer to the applicable engine manual for proper specifications.

Use the correct grade of fuel for the prevailing temperature. Diesel fuel should have a cloud point of 6°C (10°F) less than the lowest expected temperature. In case of emergency, kerosene may be added to the fuel to bring the cloud point down to the required temperature. This will minimize clogging of filters and small passages by wax crystals. The addition of kerosene is NOT recommended for general use. Refer to the *Arctic Lubricants and Conditions*, page 5-5 of this operator manual.

CAUTION

Engine Damage Hazard!

If "Ultra Low Sulfur" fuel is not used in engines that require it, the engine warranty will be void and the engine performance will quickly deteriorate and may stop running.

Operation Below -40°C (-40°F)

For crane operation below -40°C (-40°F), derate load chart capacities by 6.60% for each degree Celsius or by 3.67% for each degree Fahrenheit below -40°C (-40°F).

CRANE WARM-UP PROCEDURES

The following procedures detail the actions that must be taken to properly warm the different crane components before operating the crane.

NOTE: For temperatures below -9°C (15°F) refer to arctic lubricants and conditions in the Operator and Service Manuals.

Before starting the crane, ensure the appropriate lubricants are used for the prevailing ambient temperatures in which the crane will operate in (a list of lubricants and their temperature ranges can be found in the Lubrication section of your crane's *Operator Manual*, by contacting your local Grove distributor, or by contacting Manitowoc Crane Care directly).

CAUTION

Crane Damage Hazard!

Operating the crane with the incorrect lubricants and fluids for the prevailing ambient temperature and/or failing to adequately warm the crane prior to cold weather operation can lead to a failure of a crane component or system.

Always use Grove recommended lubricants and fluids for the prevailing ambient temperature and properly start and warm the crane using the cold weather procedures found in this Operator Manual and supplement before operating the crane at full load.

Engine

Warm-up Procedures for All Temperature Ranges:

1. Upon startup, allow the engine to idle for 3 to 5 minutes before operating with a load.
2. Cold Engine Startup: After allowing the engine to warm by idling it for 3 to 5 minutes, slowly increase the engine speed to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

Transmission

Operating the transmission with a sump temperature below normal operating temperature is limited to:

- operating in the neutral gear or
- driving with an unloaded crane while not exceeding 1500 engine RPM and not exceeding half throttle.

Warm-up Procedures for Rough Terrain (RT) Cranes:

1. Engage the parking brake and apply the service brake.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

2. Shift the transmission into the highest gear and increase the engine RPM to 1500 for 15 seconds, then allow the engine RPM to return to idle.
3. Repeat Step 2 until the temperature of the transmission sump reaches normal operating temperature.

Alternate Warm-up Procedures for Rough Terrain (RT) Cranes:

1. Setup the crane on outriggers.
2. Engage the transmission with 4-wheel drive selected and allow crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

NOTE: Warm-up operation of 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

Hoist

Performing a warm-up procedure is recommended at every startup and is required at ambient temperatures below 4°C (40°F).

Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 3-28).
2. Once the hydraulic system is warm, operate the unloaded hoist, in both directions, at low speeds several times to prime all hydraulic lines with warm hydraulic oil and to circulate gear lubricant through the planetary gear sets.

Swing Drive and Turntable Bearing

Warm-up Procedures for Temperatures Above -7°C (20°F):

1. Setup the crane on fully extended outriggers, with the boom fully retracted and near maximum lift angle with no load applied.
2. Rotate the superstructure at a speed of less than one RPM for at least one complete revolution in one direction, then rotate the superstructure at a speed of less than one RPM for at least one complete revolution in the opposite direction.

Warm-up Procedures for Temperatures Below -7°C (20°F):

1. Setup the crane on fully extended outriggers, with the boom fully retracted and near maximum lift angle with no load applied.
2. Rotate the superstructure at a speed of less than one-half RPM for at least two complete revolutions in one

direction, then rotate the superstructure at a speed of less than one-half RPM for at least two complete revolutions in the opposite direction.

Axles

Warm-up Procedures for Temperatures Below -35°C (-30°F):

1. Setup the crane on outriggers.
2. Engage the transmission with 4-wheel drive selected and allow crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

NOTE: Warm-up operation of 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

Hydraulic Oil System

Operating Limits and Warm-up Procedures:

- **From 4°C to -10°C (40°F to 15°F):** Crane operation without a load is allowed with medium engine RPM and medium function speed (joystick position) until the fluid reaches at least 10°C (50°F). It is then recommended that all crane functions be cycled to remove cold fluid from all components and cylinders of the hydraulic system. If there is any unusual sound coming from the crane's hydraulic pumps or motors, stop the operation and engine immediately and contact a Grove distributor.
- **From 10°C to 4°C (50°F to 40°F):** Crane operation with a load is allowed with medium engine RPM and medium function speed (joystick position) until the fluid reaches at least 10°C (50°F).
- **From 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.

Above 95°C (200°F): No crane operation is allowed. Let the crane's hydraulic oil cool by running the engine at idle with no functions actuated.

ENGINE OPERATION

Starting and shutdown procedures for most diesel engines generally follow the same pattern. Therefore, the following procedures can be applied except where specific differences are noted. (Refer to the applicable engine manufacturers manual for detailed procedures.)

Jump Starting Hazard

Do not attempt to jump start the crane.

CAUTION

It is strongly recommended that the batteries not be “jumped” with a different vehicle, portable power pack, etc. The surge of power from these sources can irreparably damage the various electronic controls and computer systems. Jump starting the crane batteries with a different vehicle while the engine is running can damage the donor vehicle electronics as well if done improperly.

This crane has multiple computer systems (crane control, RCL, engine and transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries. Refer to *Charging the Batteries*, page 3-29.

Charging the Batteries

When charging the batteries, do not turn on the battery charger until the charging leads have been connected to the battery(s). Also, if the battery(s) are found to be frozen, do not attempt to charge them. Remove the battery(s) from the crane, allow them to thaw, and then charge the battery(s) to full capacity.

“Slow charging” is preferred to “fast charging”. Fast charging saves time but risks overheating the battery(s). Slow charging at six (6) amps or less develops less heat inside the battery and breaks up the sulfate on the battery plates more efficiently to bring the battery up to full charge. The use of a “smart charger” that automatically adjusts the charging amperage rate should be used.

Starting Procedure

Make an under-the-hood inspection for fuel, oil, and coolant leaks, worn drive belts, and trash build-up.



CAUTION

Health Hazard!

Diesel engine exhaust can be harmful to your health. Only operate the engine in a well ventilated area or vent exhaust outside.

Unexpected Operation Hazard!

Before starting the engine, apply the parking brake and engage the swing lock.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

CAUTION

Machine Damage Hazard!

Never crank the engine for more than 30 seconds during an attempted start. If the engine fails to start after 30 seconds, stop and allow the starter motor to cool for approximately two minutes before attempting another start.

If the engine fails to start after four attempts, correct the malfunction before attempting further starts.

Use the correct grade of oil for the prevailing temperature in the crankcase to prevent hard cranking. Diesel fuel should have a cloud point of 6°C (10°F) less than the lowest expected temperature. In case of emergency, white kerosene may be added to the fuel to bring the cloud point down to the required temperature. This will minimize clogging

of filters and small passages by wax crystals. The addition of kerosene is NOT recommended for general use.

Battery Disconnect Switch

Ensure battery disconnect switch handle (1) (Figure 3-17) is in the ON position

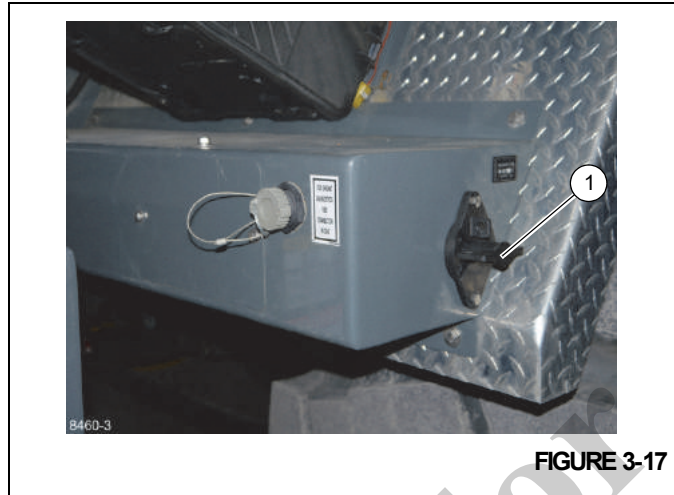


FIGURE 3-17

Cold Engine

WARNING
Risk of Explosion!

Do not spray starting fluid into the air inlet. The spray will contact the heater elements and could explode causing personal injury.

NOTE: The engine ECM monitors the engine and, under certain conditions, cycles the air heater on and off at start-up and during operation.

The engine is equipped with an electric grid heater at the air inlet elbow to aid in cold starting and reduce white smoke at start-up. In the preheat mode, the engine should not be cranked until the Wait-to-Start Lamp turns off.

1. Prior to starting a cold engine, ensure the Crane Function switch is positioned to OFF. Set the parking brake to On.

CAUTION
Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

2. Position the transmission to neutral, and depress the service brake foot pedal.

NOTE: The buzzer will sound upon turning the Ignition Switch to START and turn off after proper engine oil pressure is reached.

3. The Wait-to-Start Lamp is illuminated during the preheat time that takes place when the Ignition Switch is in the ON position during cold weather starting. To minimize cranking time during cold weather starting, the engine should not be cranked until the Wait-to-Start Lamp turns off.

CAUTION

Transmission Damage Hazard!

Apply the service brakes before starting the engine when the machine is on outriggers.

4. Turn the Ignition Switch to Start and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
5. Immediately check the engine instruments and warning lights for proper indication after starting.

CAUTION

Engine Damage Hazard!

If any warning light stays on or indicator(s) do not display proper readings, shut down the engine and correct the malfunction before resuming operation.

6. Allow the engine to warm up at least five minutes before applying a load. Do not race the engine for a faster warm up.

Detailed cold weather starting and operating procedures are covered in the engine manual.

Warm Engine

Set the parking brake to On.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

1. Position the transmission to neutral, and depress the service brake foot pedal.

NOTE: The engine will not crank unless the transmission shift lever is in neutral and the service brake foot pedal is depressed.

The buzzer will sound upon turning the Ignition Switch to START and turn off after proper engine oil pressure is reached.

CAUTION

Transmission Damage Hazard!

Apply the service brakes before starting the engine when the machine is on outriggers.

2. Turn the Ignition switch to Start and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
3. Immediately check the engine instruments and warning lights for proper indication after starting.

CAUTION

Engine Damage Hazard!

If any warning light stays on or indicator(s) do not display proper readings, shut down the engine and correct the malfunction before resuming operation.

Allow the engine to warm up at least five minutes before applying a load. Do not race the engine for a faster warm up.

Idling the Engine

Idling the engine unnecessarily for long periods of time wastes fuel and fouls injector nozzles. Unburned fuel causes carbon formation, oil dilution, formation of lacquer or gummy deposits on the valves, pistons, and rings, and rapid accumulation of sludge in the engine.

NOTE: When prolonged idling is necessary, maintain at least 900 rpm.

Racing the Engine

NEVER race the engine during the warm-up period. NEVER operate the engine beyond governed speed (as might occur in downhill operation or downshifting). Engine bearings, pistons, and valves may be damaged if these precautions are not taken.

Shutdown Procedure

1. Allow the engine to operate at idle for about five minutes to avoid high internal heat rise and allow for heat dissipation.
2. Turn the ignition switch to Off.

CRANE TRAVEL OPERATION

Traveling — General



WARNING

Inadvertent Operation Hazard!

Before traveling, ensure the Crane Function Switch is in the Off position. This will prevent inadvertent operation of craning functions due to bumping of the controllers while traveling.

RT machines are subject to the same road regulations as any truck, regarding gross weight, width, and length limitations.

Although RT machines are specifically designed for rough terrain, the operator should be extremely cautious and aware of the terrain in which he/she is operating.



WARNING

Tipping Hazard!

Avoid holes, rocks, extremely soft surfaces, and any other obstacles which might subject the crane to undue stresses or possible overturn.

Do not drive the crane with the boom off center because automatic oscillation lockout will occur, making the crane subject to tipping on uneven surfaces. Center the boom over the front, turn the Swing Brake Switch to On and engage the Turntable Lock Pin.

Fully retract the boom and ensure the swingaway jib is properly stowed and secured.

CAUTION

Machine Damage Hazard!

Do not travel with an empty hook in a position where it can swing freely (except where noted). Either remove the hook block and/or overhaul ball from the hoist cable(s) and stow securely or make sure the hook block or overhaul ball is properly secured to the tie down provided for that purpose.

Do not drive the crane with the lift cylinder bottomed. At a minimum, position the boom slightly above horizontal.

Fully retract the outrigger jacks and properly store the floats.

Disengage the pumps (if applicable) for extended traveling.

Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-37 for operating instructions.)

CAUTION

Machine Damage Hazard!

On open ground, tow or pull only on the tow/tie-down lugs or with the optional pintle hook.

Do not tow or pull in 1st gear with the Drive Axle Selector Switch in two-wheel drive position. Severe damage to the drive train will result. Always engage four-wheel drive.

Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the transmission or axles may occur if the operator attempts to free the crane unassisted.

There are two tow/tie-down lugs installed on each end of the crane. Use both lugs to tow or pull the crane.

- Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-37 for operating instructions.)
- Ensure the outrigger beams and jacks are fully retracted with the floats properly stowed.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

The owner/lessee must take appropriate measures to ensure that all persons operating or working with the affected models are in compliance with Grove recommendations. The operator of the crane assumes responsibility for determining the suitability of traveling conditions. Traveling under the controlled conditions specified in these guidelines, must be conducted with the utmost diligence and care to ensure the safety of all personnel performing the operation and/or working around the crane.

Traveling — Towing/Pulling

CAUTION

Machine Damage Hazard!

Grove recommends towing or pulling another vehicle with the optional pintle hook (if equipped) or by attaching at a point no higher than the pintle hook height, or severe damage may occur to the drivetrain.

Do not tow or pull by attaching to the tie-down lugs unless the attaching point is no higher than the pintle hook height.

Use four-wheel drive when greater traction is necessary to avoid severe damage to the drivetrain.

Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the drivetrain may occur if the operator attempts to free the crane unassisted.

To avoid severe damage to the drive train while using the crane to tow or pull another vehicle, follow these recommendations:

- Ensure the boom is in a horizontal position and not elevated above 0°.
- Ensure the outrigger beams and jacks are fully retracted with the floats properly stowed.
- Tow or pull on open ground when possible.
- Connect to the optional pintle hook (if equipped) or attach cables/straps to the crane at a point no higher than the pintle hook height.
- Use four-wheel drive when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-37 for operating instructions.)
- Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the drivetrain may occur if the operator attempts to free the crane unassisted.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

Traveling — Being Towed/Pulled

Grove recommends connecting to a pintle hook (if equipped) or evenly attaching to the tie-down lugs when being towed by another vehicle.

CAUTION

Machine Damage Hazard!

It is recommended to attach cables/straps to the optional pintle hook (if equipped) or evenly attach to the tie-down lugs if being towed by another vehicle.

Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the drivetrain may occur if the operator attempts to free the crane unassisted.

- Ensure the boom is in a horizontal position and not elevated above 0°.
- Ensure the outrigger beams and jacks are fully retracted with the floats properly stowed.

To avoid severe damage to the drive train while the crane engine is disabled:

- Disconnect drivelines.
- Disengage parking brake by manually turning parking brake adjustment until axle turns free.



DANGER

Run-away Crane Hazard!

Disabling the parking brake may result in the crane rolling away freely without the ability of the operator to stop the crane.

Ensure wheel chocks are properly placed when parking crane with the parking brake disabled.

Death or serious injury and damage to machinery could result from moving machinery.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

- Secure steering to prevent turning while towing.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

Travel on Slopes

Crane operators need to exercise caution whenever operating the crane on uneven surfaces. Travel on slopes is permitted as long as the following conditions are met.

- Do not exceed a 15% (8.5°) slope side-to-side or fore-and-aft.
- Travel must be on an improved surface or on hard-packed dry earth having a minimum 0.5 coefficient of adhesion.
- Limit travel to a forward direction only.
- Do not exceed a speed of 1.5 km/h (1 mph).
- Fully retract all boom sections.
- Stow or remove the jib from the crane.
- Lower the boom to horizontal and position over the front of the crane.
- Engage the swing brake and turntable lock pin.
- Either the hookblock may be reeved over the main boom nose or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose, the other must be removed. If the hookblock or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.
- Inflate tires to the recommended pressure for pick and carry operations.
- Ensure the hydraulic tank is filled to the specified level. Ensure the fuel tank is over half full
- Engine and transmission fluids must be filled to the specified levels.
- Axle differentials and planetary hub fluids must be filled to the specified levels.
- Do not support any loads by the boom (i.e., no pick and carry loads) while traversing a slope.
- Remove all cribbing or other non-standard accessories from the crane.
- Avoid holes, rocks, extremely soft surfaces, and any other obstacles that might subject the crane to undue stresses and possible overturn.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.
- "Slope limitations:
 - Side to side slope shall not exceed 15% (8.5 degrees) & travel speed shall not exceed 1 MPH on a side slope.
 - Fore-and-aft slope shall be less than or equal to 15% (8.5 degrees) for normal crane travel.

- For fore-and-aft slope greater than 15% (8.5 degrees) and less than 25% (14 degrees) the transmission shall be in 4-wheel-drive and travel speed shall not exceed 1 MPH. If the crane will be parked the transmission shall be in 4-wheel drive and the wheels shall be chocked.
- For fore-and-aft slope equal to or greater than 25% (14 degrees) an assist vehicle is required, the transmission shall be in 4-wheel drive, and the crane shall not be parked.
- Maximum fore-and-aft slope is 30% (16 degrees).
- For machine/application specific slope limitations (e.g. heavy counterweight) refer to the operators' manual.

Should the operator of an affected model need to traverse slopes outside of the criteria set forth in this publication, or traverse slopes with other crane models not addressed herein, please contact Grove U.S. L.L.C. for further guidance.

The owner/lessee must take appropriate measures to ensure that all persons operating or working with the affected models are in compliance with Grove U.S. L.L.C. recommendations. The operator of the crane assumes responsibility for determining the suitability of traveling on a slope. Traveling on a slope should only be attempted under the controlled conditions specified in these guidelines, and must be conducted with the utmost diligence and care to ensure the safety of all personnel performing the operation and/or working around the crane.

Should the operator need to traverse slopes outside the criteria defined in the above guidelines contact Grove U.S. L.L.C. for further guidance.

Traveling with Elevated Boom



WARNING

Overhead Objects Hazard!

Contacting overhead objects while driving the crane or driving the crane over rough terrain with the boom elevated may result in death, severe injury, and/or equipment damage. Traveling with the boom elevated should only be attempted under the controlled conditions specified in this section.

NOTE: Ensure that all personnel involved in the operation and those working around the crane are aware of any hazards that may be encountered and are trained about how to avoid the hazards.

Exercise caution whenever driving the crane with the boom elevated. Travel with the boom elevated is permitted as long as the following steps are followed:

- Limit travel to firm, level surfaces.
- Inspect the route of travel prior to moving the crane. Pay particular attention to any changing conditions in the terrain being traversed. Also, avoid any overhead obstructions.
- Travel must be performed in a controlled fashion.
- Do not exceed a speed of 24 km/h (15 mph) with the standard counterweight or 16 km/h (10 mph) with the heavy counterweight.
- Inflate tires to the recommended pressure for travel operations.
- When using the towing attachments, the boom must remain horizontal.
- Fully retract all boom sections.
- Refer to *Traveling with Jib and/or Inserts Erected*, page 3-34 if the jib is in the erected position.
- Position the boom over the front of the crane.
- Engage the swing brake and turntable lock pin.
- The hookblock may be reeved over the main boom nose. The overhaul ball may be reeved over the main boom nose or auxiliary boom nose. The block and ball may be suspended below the boom nose. It is also acceptable to secure the block or the ball to the tie down point on the carrier to prevent swinging, if necessary.
- Limit boom angle to a maximum of 30° with the standard counterweight or horizontal only with the heavy counterweight.
- Do not support any load from the boom (see Pick and Carry Load chart for limitations for this application).
- Remove all cribbing or other non-standard accessories from the crane.
- Avoid holes, rocks, extremely soft surfaces and any other obstacles that might subject the crane to undue stresses and possible overturn.
- Ensure adequate clearance to any overhead obstructions that the crane may be required to travel beneath.

Traveling with Jib and/or Inserts Erected

CAUTION

Traveling is not permitted with a jib reeved with two parts of line.

Damage to the jib may occur.

11 m (36 ft)/18 m (59 ft) Jib

Follow the steps below when traveling with the extension erected.

- Position the 11 m (36 ft) or 18 m (59 ft) jib at minimum offset. If traveling with just the 11 m (36 ft) jib, stow the stinger section on the boom base section, not on the jib base section.
 - Travel only on a firm, level surface.
 - Fully retract the main boom
3. Fold the deflection sheave in for transportation.

**CAUTION**

Make sure the deflection sheave is folded in the down position prior to transportation or damage to the crane may result.

- Limit main boom angle to a minimum of 0° and a maximum of 30°.
- Do not exceed a speed of 4 km/h (2.5 mph).
- Ensure main counterweight is installed.
- Position the boom over the front of the crane.
- Engage the swing brake and turntable lock pin.
- Remove hookblock from main boom nose.
- Overhaul ball may be reeved over jib, hanging 0.9 m (3 ft) below sheave.

18 m (59 ft) Jib Plus 8 m (26 ft) / 16 m (52 ft) Insert

Follow the steps below when traveling with the extension and insert erected.

- Position the 18 m (59 ft) jib plus insert(s) at minimum offset. If traveling with just the 11 m (36 ft) jib and insert(s), stow the stinger section on the boom base section, not on the jib base section.
- Travel only on a firm, level surface.

- Fully retract the main boom
4. Fold the deflection sheave in for transportation.

**CAUTION**

Make sure the deflection sheave is folded in the down position prior to transportation or damage to the crane may result.

- Limit main boom angle to a minimum of 0° and a maximum of 20°.
- Do not exceed a speed of 4 km/h (2.5 mph).
- Ensure main counterweight is installed.
- Position the boom over the front of the crane.
- Engage the swing brake and turntable lock pin.
- Remove hookblock from main boom nose.
- Overhaul ball may be reeved over jib, hanging 0.9 m (3 ft) below sheave.

Extended Travel

Depending upon the tire manufacturer, the higher inflation pressures normally specified for lifting on rubber are not recommended for site to site transfer over extended distances. The higher static/creep 8 km/h (5 mph) inflation pressures may remain in the tire while operating the crane on site within a distance of less than 6.4 km (4 mi).

CAUTION**Tire Damage Hazard!**

For extended travel, check the cold tire pressure prior to start. (Refer to tire inflation chart in the *Load Chart Book*.) After every one hour of travel time, regardless of ambient temperature, stop and allow the tires to cool off for at least 30 minutes. At the destination, the tires must be allowed to cool to ambient temperature before crane lifting on rubber.

Traveling — Forward

CAUTION

Machine Damage Hazard!

Engage the turntable lock pin for extended travel. Failure to engage the lock pin may allow the superstructure to swing uncontrolled, damaging the machine and/or property.

1. With the Transmission Shift Lever in the neutral (N) position, start the engine and allow it to adequately warm up.
2. Depress the Service Brake Foot Pedal.



WARNING

Run-away Crane Hazard!

Releasing the parking brake while the low service brake pressure indicator is illuminated and the buzzer is sounding, indicating the service brakes are inoperable, may result in the crane rolling away freely without the ability of the operator to stop the crane.

Never release the parking brake while the low service brake pressure indicator is illuminated and the buzzer is sounding.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

CAUTION

Use four-wheel drive only when more traction is required. Before shifting from two-wheel drive to four-wheel drive (or from four back to two), crane travel must be stopped, the transmission must be in neutral and the service brakes applied. Refer to *Four-Wheel Drive Operation*, page 3-37

3. Position the Drive Axle Switch to either two-wheel high or four-wheel low.
4. Lift the Transmission Shift Lever up out of its detent and push the lever to the forward (F) position, then rotate the Transmission Shift Lever Knob to the first (1) gear position. The gear selection "F1" will appear in the display to indicate that forward propulsion and first (1) gear have been selected; if the Service Brake Foot Pedal is not depressed prior to shifting to a gear, the gear selection will flash in the display until the Transmission Shift Lever is returned to the neutral (N) position and the transmission will not shift.
5. Release the Service Brake Foot Pedal and depress the Foot Throttle Pedal until maximum first gear speed is attained, then rotate the Transmission Shift Lever Knob to the second (2) gear position to continue to increase speed. For additional speed, continue shifting to a higher gear.

CAUTION

Possible Machine Damage!

Do not downshift to a lower gear if the road speed is greater than the maximum speed of the lower gear.

Traveling — Reverse

Traveling in reverse is accomplished the same way as traveling forward, except for shifting the Transmission Shift Lever to reverse (R). Refer to *Traveling — Forward*, page 3-36.

CAUTION

Possible Machine Damage!

Apply service brakes and bring crane to a complete stop before shifting transmission into reverse.

STEERING

Steering is accomplished by the steering wheel and the rear steer control. These controls, used singly or together, provide front wheel steering, rear wheel steering, four-wheel steering, and crabbing capabilities (Figure 3-18).

Front Wheel Steering

Conventional front wheel steering is accomplished with the steering wheel. This method of steering should always be used when traveling at higher speeds.

**WARNING****Unintentioned Operation Hazard!**

Operate the rear steer **ONLY** at slow speeds for added job site maneuverability.

Rear Wheel Steering

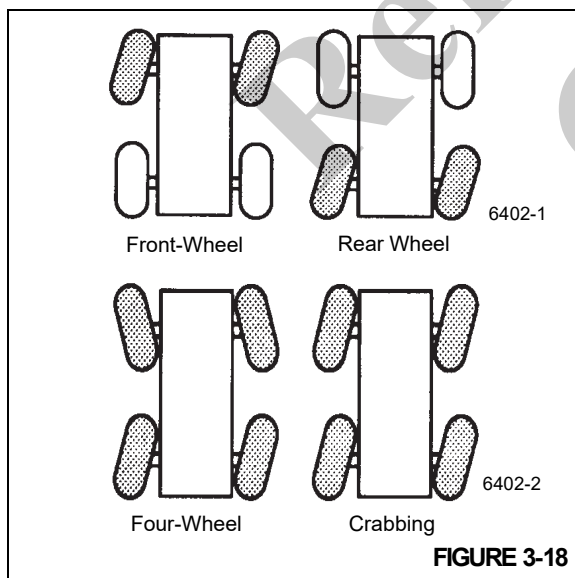
Rear wheel steering is controlled by the Rear Steer Control Switch. Moving the control switch to the desired position activates the rear steer cylinders, thereby steering the crane in the selected direction.

Four Wheel Steering

Four wheel steering is accomplished with the steering wheel and the Rear Steer Control Switch. Depending upon which direction the operator wishes to travel, the steering wheel is turned opposite direction of the Rear Steer control position. This allows the crane to turn or maneuver in close, restricted areas.

Crabbing

Crabbing is accomplished with the steering wheel and the Rear Steer Control Switch. Depending upon which direction the operator wishes to travel (crab), the steering wheel is turned in the same direction as the Rear Steer Control Switch. This permits driving the crane forward or backward in a crabbing manner.

**FIGURE 3-18****FOUR-WHEEL DRIVE OPERATION****CAUTION****Machine Damage Hazard!**

Do not tow or pull in 1st gear with the Drive Axle Selector Switch in two-wheel drive position. Severe damage to the drive train will result. Always engage four-wheel drive.

If more traction is required due to slipping or spinning wheels, engage the front axle drive as follows:

CAUTION**Possible Machine Damage!**

Before shifting from two-wheel drive to four-wheel drive (or from four back to two), crane travel must be stopped.

1. Stop the crane by depressing the Service Brake Foot Pedal.
2. Position the Transmission Shift Lever to the neutral (N) position.
3. Position the Drive Axle Selector Switch to four-wheel low.

NOTE: If the Drive Axle Selector Switch is positioned to four-wheel low and the Service Brake Foot Pedal is not depressed or the Transmission Shift Lever is not in neutral (N) position, the Four-Wheel Drive Indicator will flash and the four-wheel drive function will not engage.

4. Select gear speed and direction of travel using the Transmission Shift Lever and Knob.
5. Drive the crane as described under *Traveling — Forward*, page 3-36.
6. Return the Drive Axle Selector Switch to the two-wheel high position as soon as two-wheel traction will suffice and crane motion has stopped; again, the Service Brake Foot Pedal must be depressed and the Transmission Shift Lever must be in the neutral (N) position to shift from four-wheel low to two-wheel high.

DIFFERENTIAL LOCK OPERATION (OPTIONAL)



CAUTION

Unintended Operation!

When using the differential lock, steering characteristics may be affected with possible loss of control.

Try to use four-wheel drive to gain adequate traction before using the differential lock.

Do not operate the differential lock when traveling downhill; at speeds above 6 km/h (10 mph); on hard, dry surfaces; and/or during axle spin-out.

NOTE: The differential lock will not operate unless the Drive Selector Switch is in the four-wheel low position.

General

The purpose of the differential lock is to provide maximum traction and control on poor road or highway surfaces. When the differential locks are actuated, the clutch collar completely locks the differential case, gearing, and axle shafts together, thus maximizing traction to both wheels of each axle. The lock position will also protect against spinout. When normal driving conditions exist (during periods of good traction), the differential locks should not be actuated. The axles should be allowed to operate with differential action between both wheels.

Follow the steps below when engaging/disengaging the differential lock function.

1. Lock the differentials by pressing and holding the Axle Differential Control Switch in the lock position; disengage the function by releasing the switch.
2. Lock/unlock the differentials only when the vehicle is standing still or moving at a constant low speed with the wheels not slipping.

CAUTION

Possible Machine Damage!

When driving on hard, dry surfaces with the differentials locked, do not turn the wheels. Damage to the drive line components can result.

Do not lock the differentials when the wheels are slipping. Damage to the differentials can result.

3. Locked differentials cause the crane's turning radius to increase, creating an understeer condition; use caution, good judgment and drive at low speeds when operating the vehicle with locked differentials.

4. Lock the differentials only when maximum traction is needed on poor road or highway surfaces.

CAUTION

Possible Loss of Vehicle Stability!

Do not lock the differentials when the vehicle is traveling down steep grades and traction is minimal. Loss of stability may occur.

5. Always unlock the differentials when the need for maximum traction has passed or when traveling on good road or highway surfaces.

Operation

CAUTION

Axle Damage!

Operating the machine with the differentials in the locked position while maneuvering on improved surfaces may result in damage to the axles.

The differential lock function should preferably be engaged when the crane is stationary but may be engaged when moving, if the following conditions are met:

1. The crane is moving very slowly (creep speed).
2. The wheels are not spinning at the time of engagement.

When traveling with the differentials locked, do not deviate from a straight path more than is absolutely necessary. Engage the differential locks by doing the following:

1. Position the Axle Differential Lock Control Switch to the locked position with the crane stationary or moving at a slow speed.

If moving at a slow speed, let up momentarily on the Foot Throttle Pedal to relieve torque on the differential gearing. This will fully engage the differential locks.

NOTE: When the differentials are locked, the Interaxle Locked Indicator on the steering column display will illuminate.

2. Proceed over the poor road condition cautiously.

When the adverse condition has passed, disengage the differential locks by doing the following:

1. Release the Axle Differential Lock Control Switch, allowing it to return to the unlocked position while maintaining a slow speed.
2. Let up momentarily on the Foot Throttle Pedal to relieve torque on the differential gearing, allowing the differential to fully unlock.

NOTE: When the differentials are unlocked, the Interaxle Locked Indicator on the steering column display will go out.

- Resume driving at a normal speed using good driving judgment.

AXLE OSCILLATION LOCKOUTS OPERATION

The following procedure should be used to periodically check the axle oscillation system and ensure that it is in proper working condition.

- Ensure the tires are inflated to the recommended pressure. Refer to the *Load Chart Book* in the crane cab for proper inflation pressures.
- With the hook unloaded, the boom fully retracted and centered over the front at no more than a 10° to 15° boom angle, position the crane on a block or curb so that one rear tire is approximately 15 to 30 cm (6 to 12 in) above the level of the opposite tire.
- Slowly swing the superstructure to the left or right until the axle oscillation lockout valve is activated. This will lock the rear axle out of level. Do not swing beyond the tire track.
- After engaging the swing brake, slowly drive off of the block or curb and stop. The rear tires should both be touching the road surface and the opposite front tire should be light or slightly off the road surface.
- Release the swing brake and swing the superstructure until it is centered over the front.



DANGER

Tipping Hazard!

Do not operate the crane if the axle oscillation lockout system is not functioning properly.

Failure to comply with this warning may result in death or serious injury.

If the axle oscillation lockout valve is functioning properly, the crane will re-level itself; if the valve is not working properly, the crane will not re-level itself. If the rear axle does not lock or unlock properly, evaluate the lockout system and repair as necessary.

GENERAL CRANE OPERATION

Pump Drive

Pumps No. 1 and No. 2 are mounted on drive pads of the torque converter. Pump No. 3 is mounted off of the torque

converter via pump disconnect. Pump No. 4 is mounted on a drive pad of the engine.

The purpose of these pumps is to convert mechanical energy into fluid energy for the operation of the crane's hydraulic components. The pumps operate any time the engine is running.

Control Lever Operation

The control lever operation for all crane functions is standard, i.e. the closer the lever is to neutral (center), the slower the system responds. The control lever should be returned to neutral to hold the load. Never feather the hoist control lever to hold the load.

NOTE: Always operate the control levers with slow, even pressure.

Preload Check

After the crane has been readied for service, an operational check of all crane functions (with no load applied) should be performed. The Preload Check is as follows:

NOTE: Carefully read and become familiar with all crane operating instructions before attempting a preload check or operating the crane under load. Operate engine at or near governed RPM during preload check of crane functions.

- Engage the parking brake.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

- Extend and set outriggers, and level the crane.
- Raise, lower, and swing the boom a minimum of 45° right and left.
- Telescope the boom in and out.
- Raise and lower the cable a few times at various boom lengths. Ensure there is no kinking.

Using Your Load Chart

NOTE: One of the most important tools of every crane is the load chart found in the crane operator cab.

The load chart contains a large amount of information, which must be thoroughly understood by the operator.

The load chart contains outrigger capacity charts for fully extended and mid-extended outriggers for the main boom

and jib, and fully retracted outrigger beams for main boom only. In addition, the load chart contains two on-rubber capacity charts: 360° stationary, and pick and carry over front.

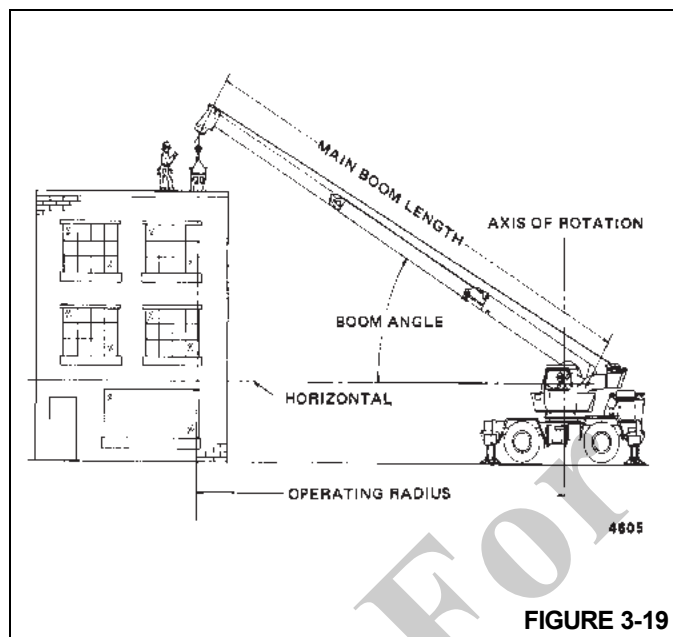


FIGURE 3-19

The capacity charts are divided into structural strength and stability limits. This is shown by the bold line across the chart. Capacities above the line are structural strength limits and capacities below the line are stability limits.

The left column is the load radius, which is the distance from the center of crane rotation to the load center of gravity. The top row lists various boom lengths ranging from fully retracted to fully extended or jib lengths and offsets. The number at the intersection of the left column and top row is the total load capacity for that load radius and boom length or jib lengths offset. The number in parentheses below the total load capacity is the required boom angle (in degrees) for that load. When the boom length or lift radius or both are between values listed, the smallest load shown at either the next larger radius or next longer or shorter boom length shall be used.

Another important section is the range diagram. The range diagram shows the operating radius and tip height that can be achieved at a given boom length and angle. If the operator knows the radius and tip height required for a specific lift, the angle and boom length can be quickly determined from the range diagram. Or, if the boom length and angle are known, the tip height and operating radius can be quickly determined.

A lifting diagram is included to describe over side, over rear, and over front lifting areas. The lifting area diagram shows that the locations of the outrigger jack cylinders in the fully extended position are used to mark the boundaries of the lifting areas.

A jib capacity chart and notes are included to list the capacities for the jib length, load radius, and boom angle.

Another section contains the notes for lifting capacities. Be sure to read and understand all the notes concerning lifting capacities.

The load chart also gives weight reductions for load handling devices such as hook blocks, overhaul balls, jibs, etc., which must be taken into consideration as part of the load. Remember, the weight of any other load handling devices such as chains, slings, or spreader bars must be added to the weight of the load.

Proper Leveling of the Crane

ASME B30.5 specifies that if a crane is not level within 1% of grade, the allowable capacities must be reduced. Therefore, whether lifting on rubber or outriggers, it is essential that the crane is level to within 1% of grade. The bubble level that is provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 3-41.

A working crane may settle during lifting operations. Frequently check the crane for level. When rechecking the crane for level, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). If necessary, relevel the crane using the procedures under *Setting the Outriggers*, page 3-41.

Bubble Level Adjustment

The bubble level adjustment should be checked periodically; if it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level as follows:

1. Engage the parking brake.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

2. Position the crane on a firm, level surface.
3. Extend and set the outriggers. Level the crane, as indicated by the bubble level indicator, using the outriggers.

4. Place a digital pointer level, inclinometer, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
5. Using the outriggers, level the crane as indicated on the leveling device used in step 4.
6. Using the bubble level indicator mounting screws, adjust the bubble level indicator to indicate level.

Setting the Outriggers

1. Engage the Parking Brake.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

NOTE: The Parking Brake must be engaged to enable outrigger functions.

2. Position the outrigger floats directly out from each outrigger to where the outriggers will be properly extended.

CAUTION

Possible Equipment Damage!

Always depress one of the Outrigger/Selector Switches before positioning the Outrigger Extension/Retraction Switch to extend or retract. Failure to do this may cause a hydraulic lock against the individual solenoid valves, preventing them from opening.



DANGER

Electrocution Hazard!

To avoid death or serious injury, keep all parts of this crane, the rigging, and materials being lifted at least 6.1 m (20 ft) away from electrical power lines and equipment.

3. If extending the outrigger to the mid-extend or fully extended position, depress the desired Extension Switch on the Outrigger Selector Panel and hold the Outrigger Extension/Retraction Switch to EXTEND. The appropriate outrigger beam begins to extend. Refer to *Engaging the Mid-Extend Lock Pin*, page 3-42, if the crane is to be operated with any outrigger at the mid-extend position.



DANGER

Tipping Hazard!

All four outrigger beams must be deployed to one of three positions before beginning operation, which include fully retracted, mid-extend, or fully extended; do not operate the crane with the outriggers in any other position.

NOTE: More than one outrigger beam can be extended at a time. However, to ensure that each outrigger is fully extended, repeat step 3 for each outrigger after a multi-outrigger extension.

4. After deploying the four outrigger beams to one of the three proper positions (fully retracted, mid-extend, fully extended), depress the desired Stabilizer Switch on the Outrigger Selector Panel and hold the Outrigger Extension/Retraction Switch to EXTEND. The appropriate jack begins to move.

Extend each jack, positioning the float as necessary, until the locking levers of the float engage the jack cylinder barrel.

NOTE: More than one jack can be extended at a time.

5. Extend the front jacks approximately 8 to 10 cm (3 to 4 in).
6. Extend the rear jacks approximately 8 to 10 cm (3 to 4 in).

NOTE: If crane is equipped with tilting cab, ensure cab is in the lowered position before leveling machine.

7. Repeat step 4 until all wheels are clear of the ground and the crane is level as indicated by the bubble level indicator located on the right side of the cab.

NOTE: If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under *Bubble Level Adjustment*, page 3-40.



DANGER

Tipping Hazard!

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend position.

The proper load chart and rated capacity limiter (RCL) program must be selected for the current outrigger configuration.

Outrigger Monitoring System (OMS) (Optional)

The Outrigger Monitoring System (OMS) aids the operator in accurately programming the Rated Capacity Limiter (RCL) by automatically identifying the horizontal position of each outrigger beam. The OMS uses four sensors, one per outrigger beam, to indicate when an outrigger beam is positioned to one of three pre-defined locations, including fully retracted, mid-extend, and fully extended.

Set up of the outriggers is the same for cranes equipped with OMS; refer to *Setting the Outriggers*, page 3-41.

If the crane is setup on outriggers and “On Outriggers” is chosen when programming the RCL (Figure 3-20), then the OMS indicates to the RCL the horizontal position of each of the four outrigger beams. Based on this information, the RCL will default to the most conservative outrigger beam configuration; that is, if three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration. A confirmation of this outrigger configuration is all that is needed (Figure 3-21). Refer to the *Rated Capacity Limiter Operator Handbook* for detailed instructions.

NOTE: Figure 3-21 depicts all four outrigger beams in the mid-extend position as indicated by the OMS and RCL.

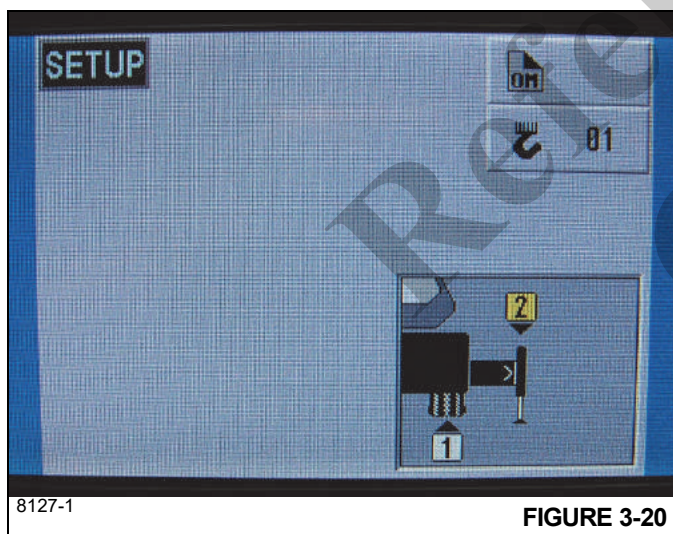


FIGURE 3-20

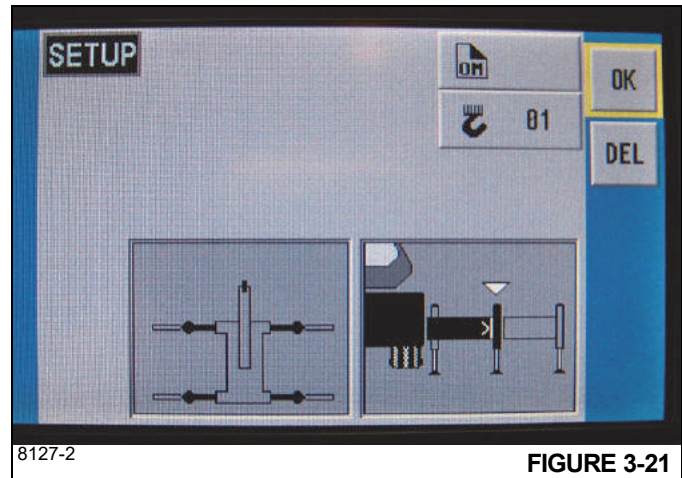


FIGURE 3-21

Engaging the Mid-Extend Lock Pin

! DANGER Tipping Hazard!

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend position.

The proper load chart and rated capacity limiter (RCL) program must be selected for the current outrigger configuration.

1. Turn the locking pin 90° from its stowed position and allow the pin to rest on top of the outrigger beam.

NOTE: It may be necessary to jog the outrigger extension/retraction switch slightly to ensure proper pin engagement.

2. Slowly extend or retract the outrigger beam, allowing the locking pin to drop into the hole in the top of the outrigger beam, engaging the outrigger beam at the desired length.

Stowing the Outriggers

1. Select the rear jacks with the Jack Selector Switches and hold the Extension/Retraction Switch to RETRACT until the rear jacks have retracted several inches.
2. Select the front jacks with the Jack Selector Switches and hold the Extension/Retraction switch to RETRACT until the front jacks have retracted several inches.
3. Repeat steps 1 and 2 until the crane is resting on all four wheels and the jack floats are several inches off the ground

**CAUTION**

Keep feet and hands clear of floats when unlocking the floats from the jacks.

NOTE: Jack floats weigh approximately 45 kg (99 lb).

4. Release the locking levers and allow the floats to drop to the ground.
5. Continue to retract the jacks until they are fully retracted.
6. Depress the desired rocker switch on the Outrigger Selector Controller and hold the outrigger Extension/Retraction rocker switch to RETRACT. The appropriate outrigger beam should begin to retract.

NOTE: More than one outrigger may be retracted at one time.

7. After all outriggers have been fully retracted, stow the outrigger floats.

Stowing the Mid-Extend Lock Pin

1. Lift the lock pin and turn it 90° to its stowed position.

NOTE: If the lock pin is wedged in the hole in the outrigger beam, it may be necessary to jog the outrigger Extension/Retraction Switch slightly while pulling upward on the pin.

2. Retract the outrigger extension/retraction cylinder.

Swinging the Boom**DANGER**
Crushing Hazard!

Death or serious injury could result from being crushed by moving machinery. Before activating swing, sound the horn and verify that all personnel are clear of rotating and moving parts.

Keep the area beneath the boom clear of all obstructions and personnel when lowering the boom.

**DANGER**

Incorrect load chart selection may lead to crane tipping or structural failure and may result in death or severe injury.

The operator must input the proper load chart and rated capacity limiter (RCL) program for the outrigger position selected.

CAUTION

Never push or pull the swing control lever through neutral to the opposite direction to stop swing motion. Use the swing brake foot pedal to stop swing rotation.

NOTE: Automatic rear axle oscillation lockout will activate when the boom swings right or left of the crane centerline.

To swing the boom, the Swing Control Lever is pushed forward, away from the operator, to swing clockwise, or pulled back, toward the operator, to swing counterclockwise. Always operate the control lever with a slow, even pressure. Use the swing brake foot pedal to stop rotation, then position the swing brake switch to On to prevent further rotation.

Elevating and Lowering the Boom**Elevating the Boom****WARNING**
Falling Load Hazard!

Keep the area above and below the boom clear of all obstructions and personnel when elevating the boom.

To elevate the boom, pull the Boom (lift) Control Lever back, toward the operator, and hold until the boom reaches the desired elevation level.

Lowering the Boom**DANGER**

Long cantilever booms can create a tipping condition, even when unloaded and in an extended, lowered position.

Keep the area beneath the boom clear of all obstructions and personnel when lowering the boom.

CAUTION

When lowering the boom, simultaneously let out the hoist cable to prevent two-blocking the boom nose and hook block.

The closer the load is carried to the boom nose, the more important it becomes to simultaneously let out the hoist cable as the boom is lowered.

To lower the boom, push the Boom Control Lever forward, away from the operator, and hold until the boom is lowered to the desired position.

Telescoping the Boom

Extending the Boom



DANGER

Tipping Hazard!

Check the load chart for the maximum load at a given radius, boom angle, and length before extending the boom with a load.



DANGER

Two-blocking Hazard!

When extending the boom, simultaneously let out the hoist cable to prevent two-blocking the boom nose and hook block.

CAUTION

Before extending the boom, ensure the large access cover on top of the boom base section is installed.

For a machine not equipped with an auxiliary hoist, push the Boom In/Out Control Lever forward to extend the boom.

If the crane is equipped with an auxiliary hoist, push on the top of the Telescope Control Foot Pedal.

Retracting the Boom



WARNING

Crushing Hazard!

When retracting the boom, the load will lower unless the hoist cable is taken in at the same time.

For a machine not equipped with an auxiliary hoist, pull the Boom In/Out Control Lever to the rear to retract the boom.

If the crane is equipped with an auxiliary hoist, push on the bottom of the Telescope Control Foot Pedal.

Lowering and Raising the Hoist Cable



DANGER

Keep the area beneath the load clear of all obstructions and personnel when lowering or raising the cable (load).

Do not jerk the control lever when starting or stopping the hoist. Jerking the lever causes the load to bounce, which could result in possible damage to the crane.

NOTE: When the load is stopped at the desired height, the automatic brake will engage and hold the load as long as the control lever remains in neutral.

Lowering the Cable

Push the Main or Auxiliary Hoist Control Lever forward, away from the operator, and hold until the hook or load is lowered to the desired height.

Raising the Cable

Pull the Main or Auxiliary Hoist Control Lever back, toward the operator, and hold until the hook or load is raised to the desired height.

Hoist Speed Range Selection

CAUTION

Do not change the hoist speed range with the hoist rotating.

To change the speed range of the hoist(s), position the applicable switch (Main Hoist Speed or optional Auxiliary Hoist Speed) to High or Low as applicable.

Raising and Lowering the Hydraulic Jib

The normal operating range for lifting loads with the hydraulic jib is an extension offset of 5 - 40 degrees. The jib must be retracted to 0 degree offset for stowage on the side of the boom.

The hydraulic luffing jib is controlled by two switches on the left hand seat armrest. The jib is controlled by an On/Off switch and a Raise/Lower Switch. See *Control Seat Assembly - Single Axis*, page 3-14 for location and description of these switches.

The jib may also be controlled by two remote stations on the jib (Figure 3-22). The first station is located on the jib adapter section, while the second station is located at the head of the jib base section.

Raising the Hydraulic Jib

The Luffing Jib On/Off Switch must be in the On position. Push the Luffing Jib Raise/Lower Switch to the Raise position and hold until the jib is raised to the desired position or a switch-off point is reached.

To raise the jib to 0 degree offset for stowage, the rated capacity limiter (RCL) system must be overridden. See the manufacturer's *RCL Operator manual* supplied with the crane for instructions.

To raise the jib at the remote stations, press the switch at the jib adapter or the switch at the head of the base section (Figure 3-22).

Lowering the Hydraulic Jib



WARNING

When lowering the jib, simultaneously let out the hoist cable to prevent two-blocking the jib sheave and the hook block or overhaul ball.

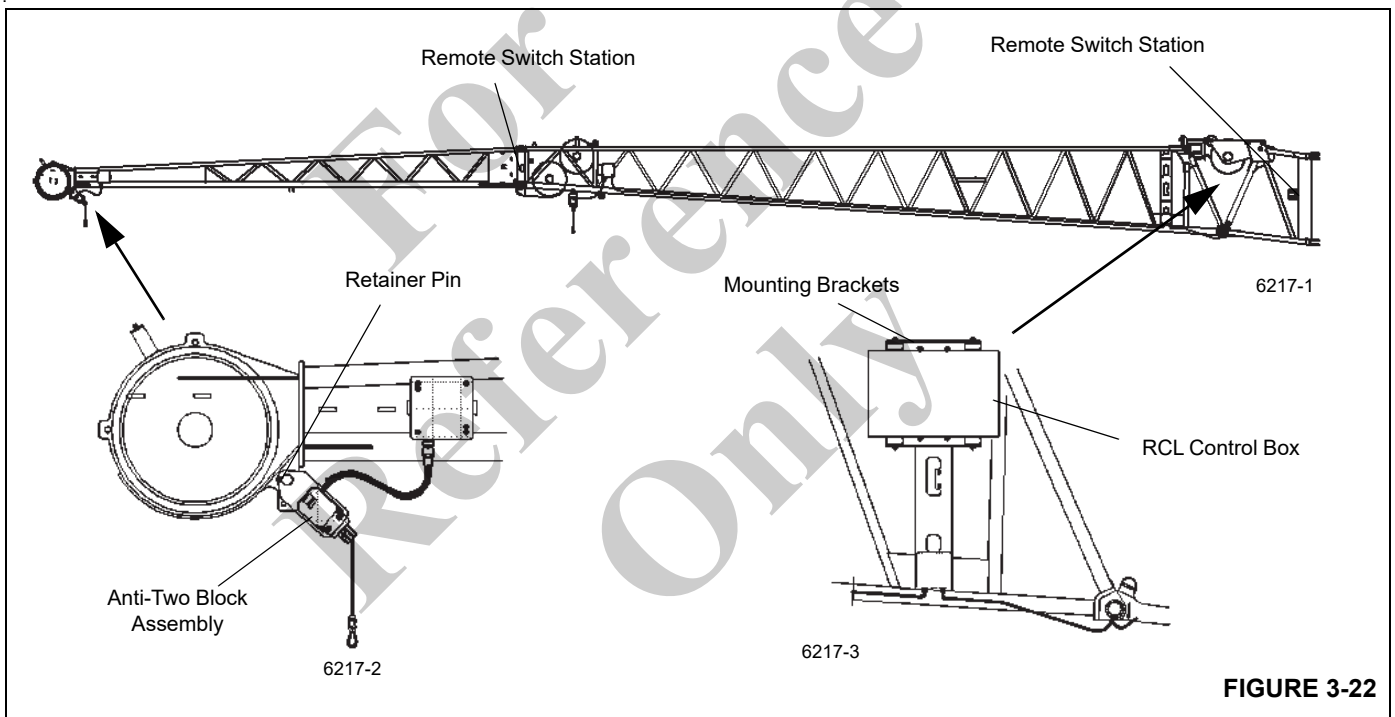


FIGURE 3-22

The Luffing Jib On/Off Switch must be in the On position. Push the Luffing Jib Raise/Lower Switch to the Lower position and hold until the jib is lowered to the desired position or a switch-off point is reached.

To lower the jib at the remote stations, press the switch at the jib adapter or the switch at the head of the base section.

OPERATIONAL AIDS



WARNING

Electronic equipment on this crane is intended as an aid to the operator. Under no condition should it be relied upon to replace the use of capacity charts and operating instructions. Sole reliance upon these electronic aids in place of good operating practices can cause an accident.

Rated Capacity Limiter (RCL) System

The Rated Capacity Limiter (RCL) is an electro-mechanical sensing system designed to prevent the crane from supporting a load outside the limits of the permitted configurations of the load capacity charts when the system has been properly preset by the operator. The control panel is mounted in the front console of the operator cab. When an overload condition is sensed, the system provides the operator with a visual and audible warning, and locks out the control levers to prevent lowering the boom, extending the boom, or raising the main or auxiliary hoist cables.

Three additional features are included within the RCL system:

- Swing Angle Set Limitation
- Work Area Definition
- Anti-two Block Device

Swing Angle Set Limitation allows left and right swing angle to be preset. When the preset angle is reached, the system will provide an audible warning.

Work Area Definition allows the crane operator to describe the crane's working area by setting up "virtual walls". They are referred to as virtual walls because they exist in the system and are not real walls. The virtual walls represent obstacles (i.e. buildings, towers, poles, etc.) in the crane's working range. They are set by defining points along the outer limits of the working area with the tip of the boom. Once the working area has been defined, the system will provide a visual and an audible warning if the boom approaches a virtual wall.



WARNING

Boom Collision Hazard!

There are no cutouts associated with the swing angle set limitation or the work area definition features.

CAUTION

When defining virtual wall(s), always allow a safe working distance to any obstacles. Never work outside a safe working area as defined by common practice, standards, and manuals.

An Anti-Two Block Device is also incorporated into the system to prevent the hook block or overhaul ball from coming into contact with the boom nose or jib. This condition will also cause a lockout of hoist up, boom down, and telescope out, and also provide a visual and an audible alarm.

Refer to the *rated capacity limiter (RCL) Operator Manual* for more detailed information on the function of the RCL system.

Control Lever Lockout System

The control lever lockout system consists of hydraulic solenoid valves (located in the directional control valves) which are in series between the hydraulic remote control valves (joysticks) in the cab and the pilot-operated directional control valves. When the valves are actuated, they prevent pilot flow between the hydraulic remote control valve in the cab and the appropriate directional control valve. The valves are activated in such a manner as to prevent worsening the condition, i.e. boom down, telescope out, or hoist up. The control lever lockout system is used with the anti-two-block system or the Rated Capacity Limiter (RCL) System.

STOWING AND PARKING



DANGER

Never park the crane near holes, or on rocky or extremely soft surfaces. This may cause the crane to overturn, resulting in injury to personnel.

When parking the crane, do the following:

1. Park the crane on a stable surface.
2. Remove the load from the hook.
3. Stow the swingaway jib, if erected.
4. Fully retract the boom and position it in the normal travel position.
5. Engage the swing brake and/or swing lock pin.
6. Retract all jack cylinders and outrigger beams.
7. Apply the parking brake.

CAUTION

Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

8. Put all operating controls in the neutral position.
9. Position the Crane Function Switch to OFF.

10. Shut down the engine following the proper procedures specified in this manual and the applicable engine manual.
11. Remove the keys.
12. Close and lock all windows, covers, and doors.

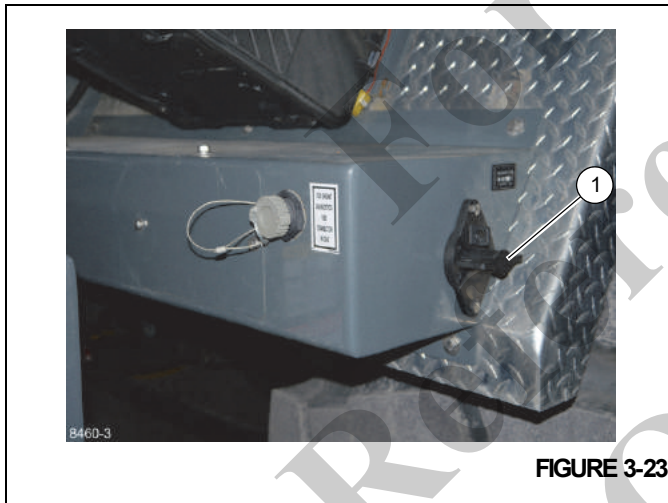
CAUTION

Risk of Undesirable Operation!

To avoid possible engine fault codes and undesirable operation, ensure the keyswitch has been off two minutes before disconnecting the batteries.

Disconnect batteries, if machine will be inactive for over 24 hours.

13. Turn Battery Disconnect (1, Figure 3-23) to Off position if machine will be inactive for over 24 hours.



UNATTENDED CRANE

WARNING **Tipping Hazard!**

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

Failure to comply with these instructions may cause death or serious injury.

The configuration in which the crane should be left while unattended shall be determined by a qualified, designated individual familiar with the job site, configuration, conditions, and limitations.

For
Reference
Only

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SECTION 4 SET-UP AND INSTALLATION

SECTION CONTENTS

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GENERAL

This section provides procedures for installing the hoist cable on the hoist drum, cable reeving, dead-end rigging, counterweight removal and installation, outrigger removal and installation, swingaway boom removal and installation, and hydraulic jib connecting and disconnecting.

INSTALLING CABLE ON THE HOIST

CAUTION

If cable is wound from the storage drum, the reel should be rotated in the same direction as the hoist.

NOTE: The cable should preferably be straightened before installation on the hoist drum.

Install cable on the hoist drum in accordance with the following procedure.

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.
3. Insert the cable through the slot and position around the anchor wedge (1) (Figure 4-1).

NOTE: The end of the cable should be even with the bottom of the slot for the anchor wedge.

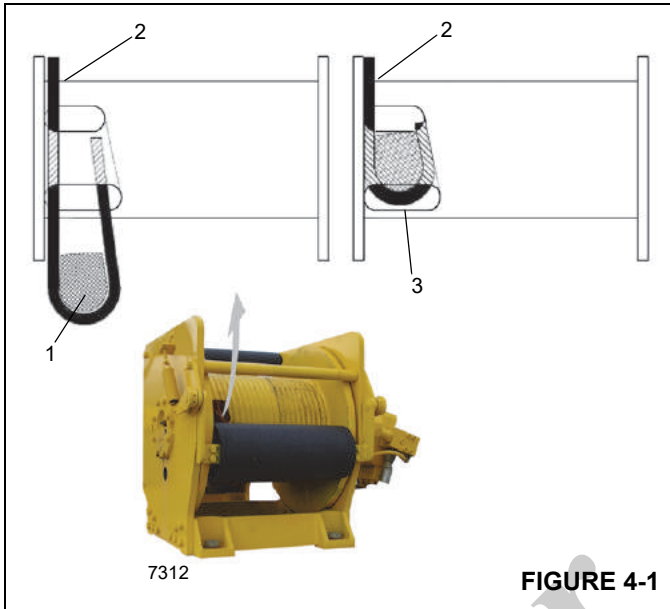


FIGURE 4-1

4. Position the anchor wedge in the drum slot; pull firmly on the free end (2) of the cable to secure the wedge.

NOTE: If the wedge does not seat securely in the slot, carefully tap (3) the top of the wedge with a mallet.



DANGER
Entanglement Hazard!

Death or serious injury may result should entanglement occur during hoist operation.

Keep all body parts and loose clothing clear while hoist is running.

5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
Install the remainder of the cable, as applicable.

CABLE REEVING

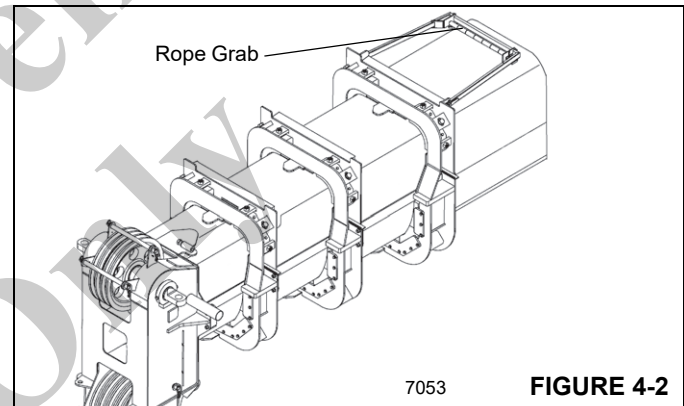
NOTE: There are two types of cable (wire rope) available on this crane; 6 x 36 WS and 35 x 7 (non-rotating).

Within the limits of the load and range charts and permissible line pull, multi-part lines allow the operator to raise a greater load than can be raised with a single part line. Various cable reeving (part line) is possible with the boom nose and hook block (Figure 4-7). This reeving should be accomplished by a qualified rigger using standard rigging procedures.

CAUTION

Do not reeve auxiliary hoist rope through the rope grab. Do reeve the main hoist rope through the rope grab. (Figure 4-2).

NOTE: Also use the rope grab when using the Main Hoist with lattice extensions



7053

FIGURE 4-2

In order to quick reeve the hookblock without removing the wedge socket on the end of the cable refer to Figure 4-3.

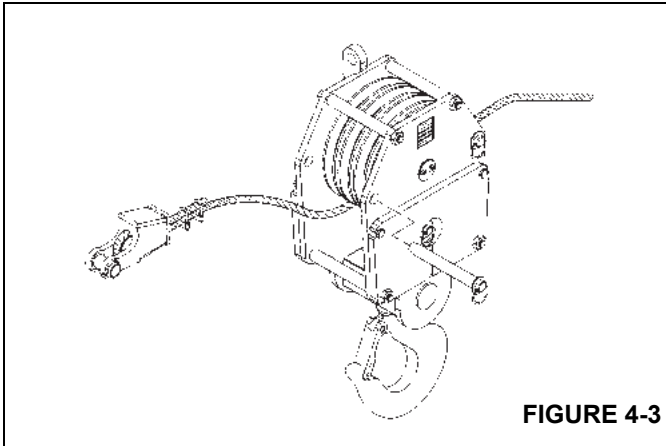


FIGURE 4-3

Boom Cable Reeving

When reeving the boom, always reeve the main hoist wire rope through the rope grab; if also reeving the auxiliary hoist rope, reeve the auxiliary hoist rope outside of the rope grab.

DEAD-END RIGGING/WEDGE SOCKETS

Wedge socket assemblies are popular rigging accessories and have been successfully used for decades to terminate wire ropes on mobile cranes. A wedge socket assembly is easily installed and dismantled but it must be installed and used correctly. It is essential to use only a wedge and socket of the correct size for the rope fitted. Failure to do so may result in the rope pulling through the fitting.

Since state and local laws may vary, alternate attachment methods may be necessary depending upon work conditions. If alternate methods are selected, the user is responsible and should proceed in compliance with the regulations in force. If there are any questions, contact your local Grove Distributor or Manitowoc Crane Care.

Do not mix components from different manufacturers. The selection, installation and use of a wedge socket assembly must be in accordance with the requirements of the wedge socket manufacturer and the wire rope manufacturer upon whose wire rope the wedge socket assembly will be used.

Grove specifies the size, type, class and line pulls for wire rope, predominately rotation resistant wire rope, and rigging accessories such as overhaul balls and hookblocks for use with each new crane that it manufactures. Other wire ropes and rigging accessories are available from various vendors. Different wire rope manufacturers have differing requirements for the construction, handling, cutting, seizing,

installation, termination, inspection and replacement of the wire ropes they produce. Their advice should be sought for each specific type of wire rope a crane user intends to install on a mobile crane.

When assembly is complete, raise the boom to a working position with a load suspended to firmly seat the wedge and rope into the socket before the crane is used operationally.

CAUTION

If the socket is not positioned with the flat face away from the boom sections, structural damage will occur.

When anchoring the socket to the boom, ensure the flat face of the socket is in position, as shown, away from the boom sections (Figure 4-4).

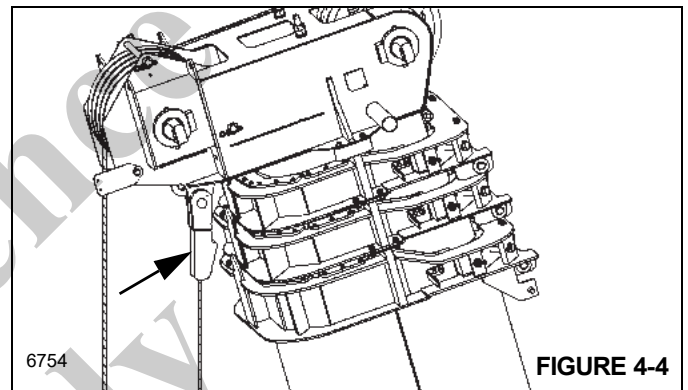
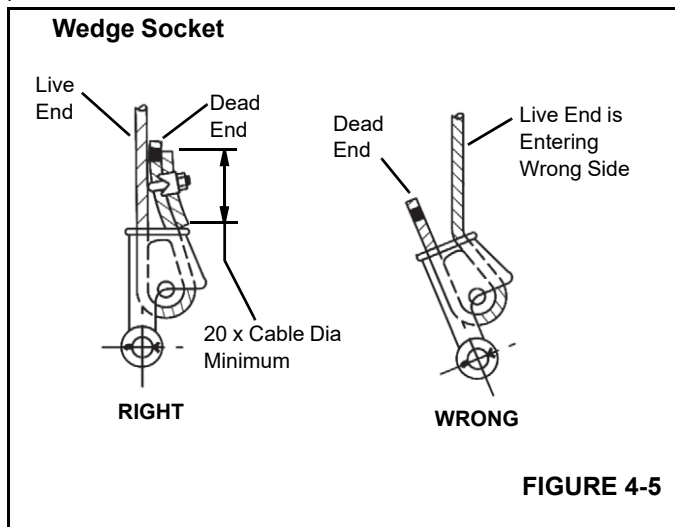


FIGURE 4-4

Installing Wedge and Socket

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6X37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to *Section 1 - Introduction* in the Service Manual for wire rope procedures.
3. Make sure the live-end (Figure 4-5) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 4-5) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the overhaul ball or hook block striking the ground, etc.

Sketches A through F (Figure 4-6) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

Of the methods shown below, Grove prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty clip or

wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less than 15.2 cm (6 in) for standard 6 to 8 strand ropes and 20 rope diameters but not less than 15.2 cm (6 in) for rotation resistant wire ropes.

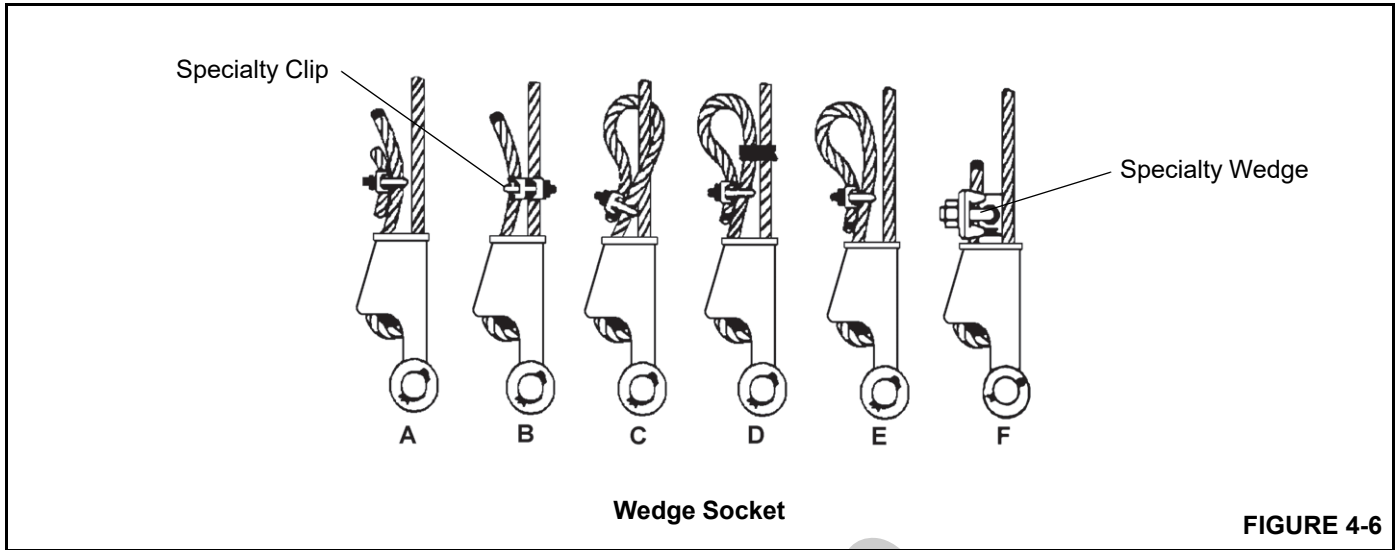
When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 4-1).

NOTE: The use of swivels is not allowed in conjunction with non-rotation resistant wire ropes

Other sources for information with which crane users should be familiar and follow is provided by the American Society of Mechanical Engineers, American National Standard, ASME B30.5, latest revised. ASME (formerly ANSI) B30.5 applies to cableways, cranes, derricks, hoists, hooks, jacks, and slings. It states, in section 5-1.7.3, "(c) Swaged, compressed, or wedge socket fittings shall be applied as recommended by the rope, crane or fitting manufacturer." Wire ropes are addressed in ASME B30.5, section 5-1.7.2, ROPES, it states, in pertinent part, "(a) The ropes shall be of a construction recommended by the rope or crane manufacturer, or person qualified for that service." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised edition.

Table 4-1

Wire Rope Clip Torque Values			
Clip Sizes		Torque	
Inches	mm	lb-ft	Nm
1/8	3.18	4.5	6
3/16	4.76	7.5	10
1/4	6.35	15	20
5/16	7.94	30	40
3/8	13.28	45	60
7/16	11.11	65	90
1/2	12.70	65	90
9/16	14.29	95	130
5/8	15.88	95	130
3/4	19.05	130	175
7/8	22.23	225	300
1	25.40	225	300
1-1/8	28.58	225	300
1-1/4	31.75	360	490
1-3/8	38.68	360	490
1-1/2	38.10	360	490



For Reference Only

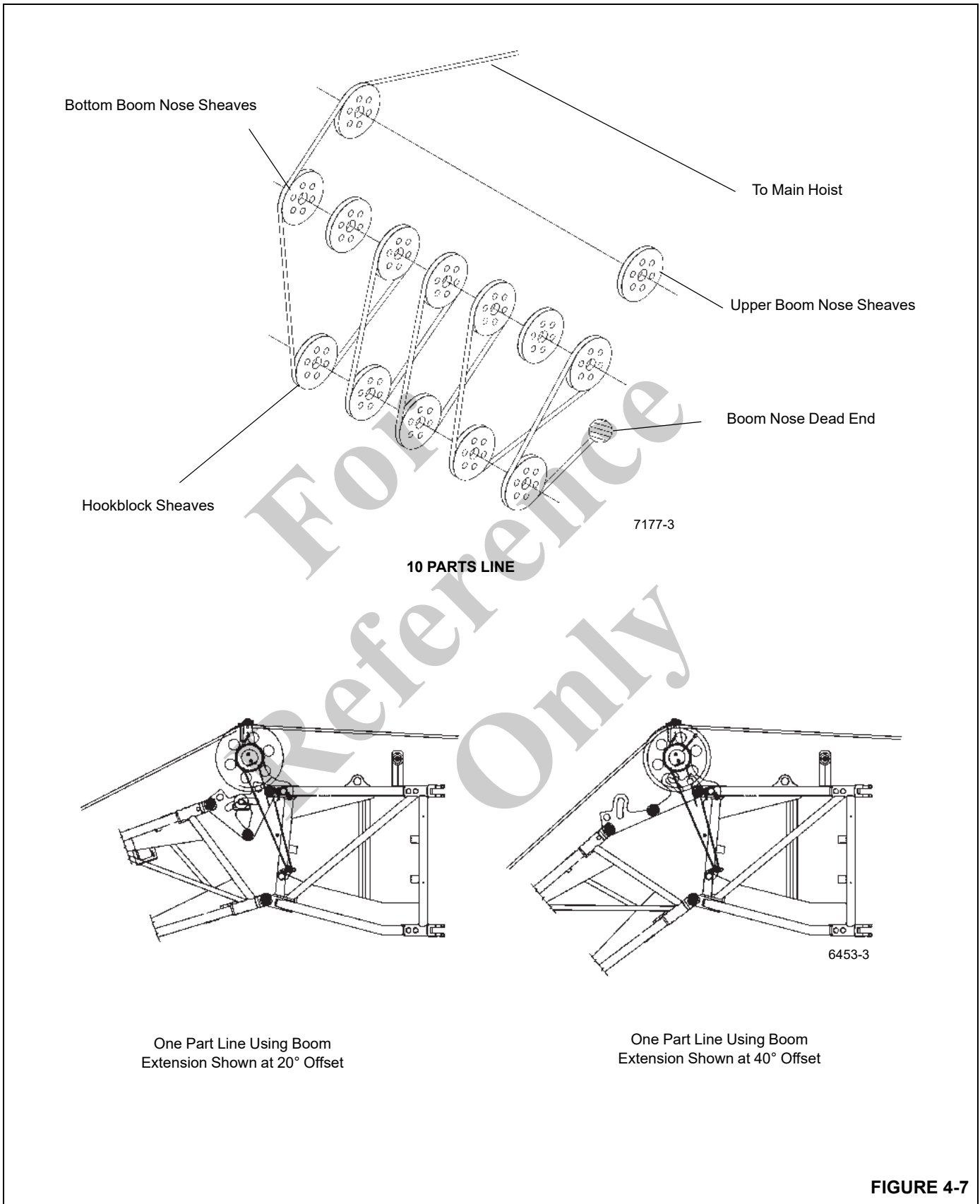


FIGURE 4-7

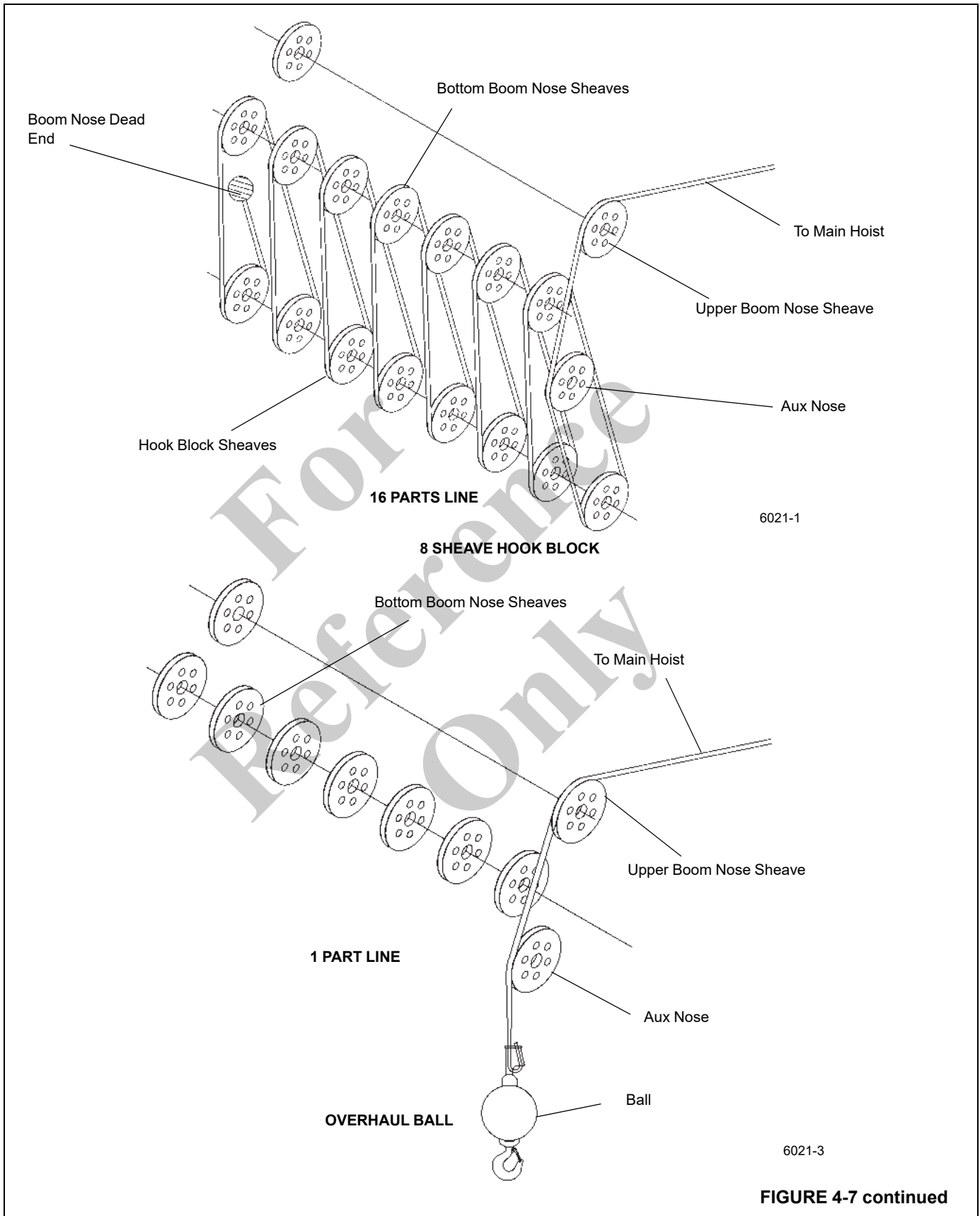
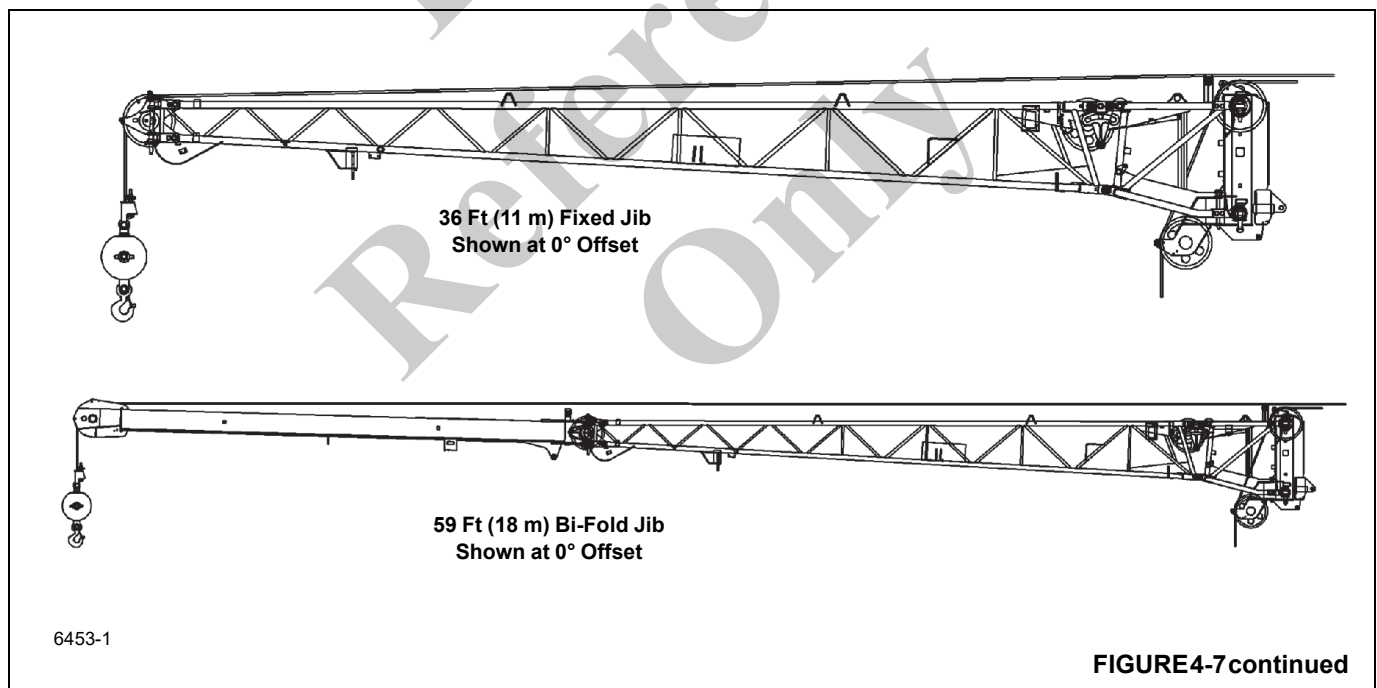
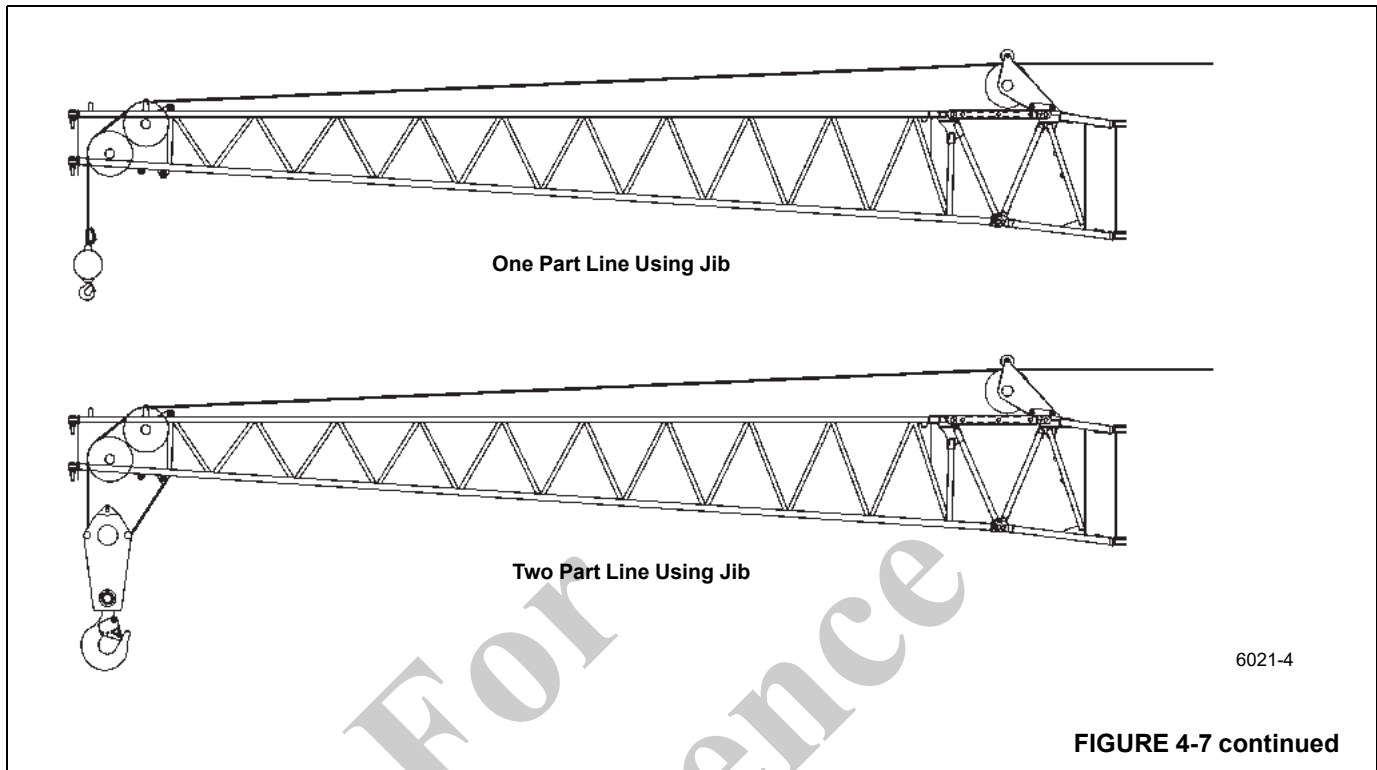


FIGURE 4-7 continued



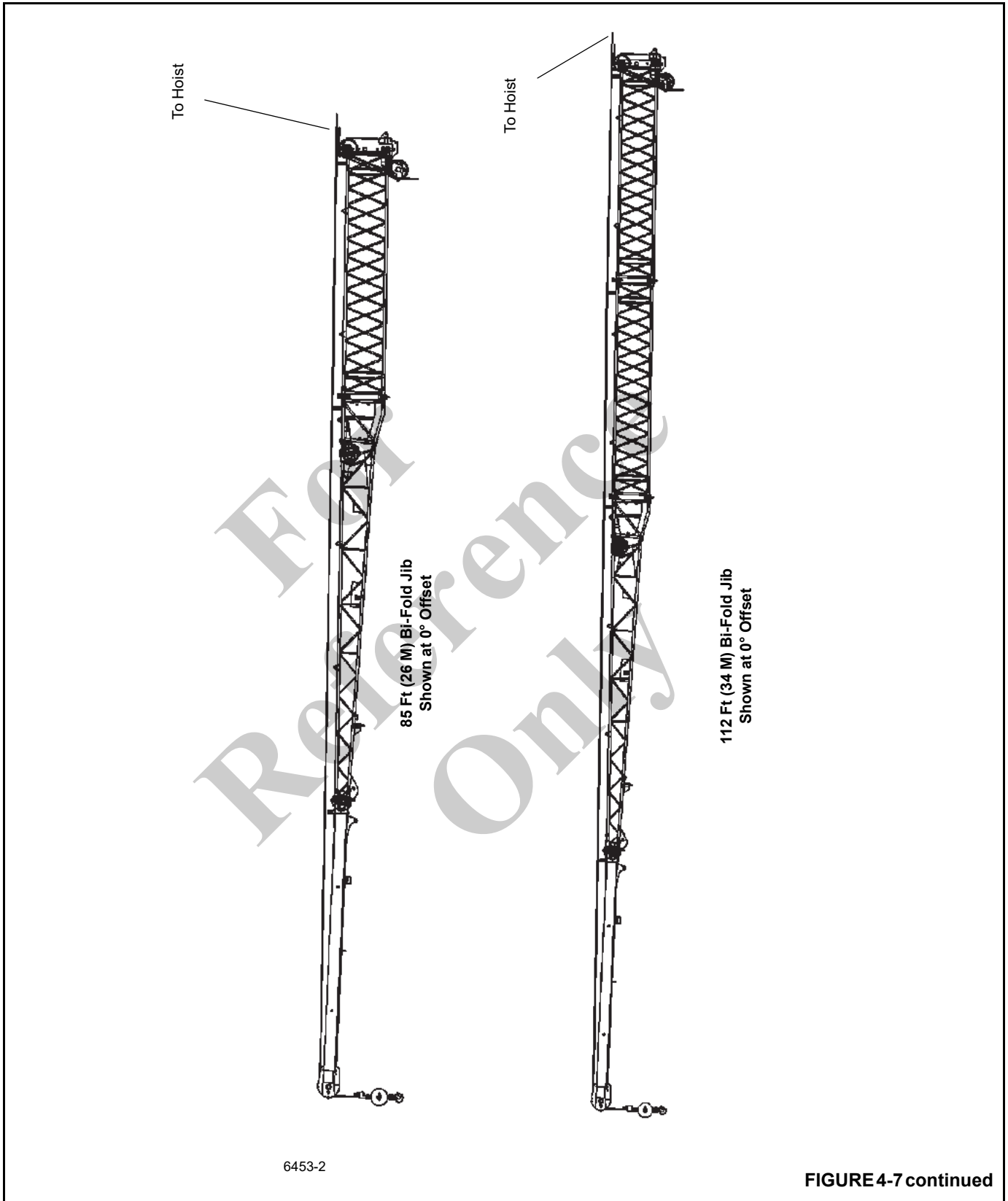


FIGURE 4-7 continued

ANTI TWO BLOCK (A2B) SWITCH

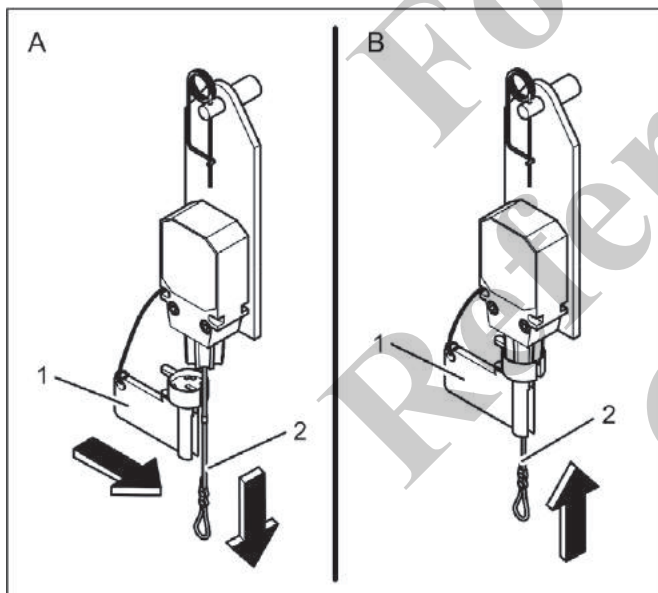
If a hoist rope has been reeved and two A2B switches are installed, the unused A2B switch must be locked (disabled) to allow all crane operations.

Lock

CAUTION

If the A2B switch is locked (disabled), the hook block could hit the main boom head or extension, resulting in damage to the hook block, main boom head or extension, and hoist rope. Never lock an A2B switch with a switch weight attached.

1. Remove A2B weight.
2. (A) Remove cap (1) from switch.
3. Pull lanyard (2) down.
4. (B) Secure lanyard (2) in this position using cap (1). A2B switch is locked (disabled).



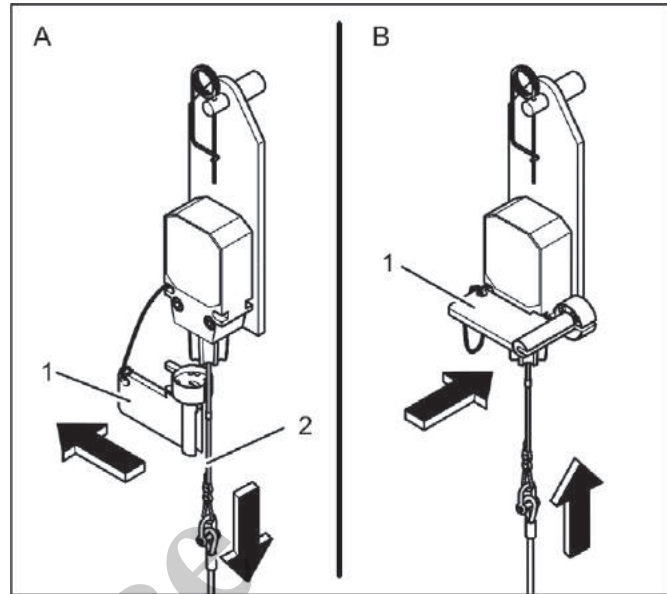
8684-1

FIGURE 4-8

Unlock

NOTE: Always remove the switch lock (enable) before installing an A2B weight around the hoist rope.

1. (A) Pull down lanyard (2) and remove cap (1). Switch is unlocked (enabled).
2. (B) Install cap (1) on A2B switch.



8684-2

FIGURE 4-9

Before Operation

Check the following electrical connections before operating the crane to ensure the RCL system is properly connected for the crane configuration.

Cranes with Main Hoist Only

If the crane is operated only with the boom and without boom extension or lattice extension, no additional connections are necessary. It must however be ensured that the A2B switch weight is correctly mounted on the main boom hoist rope. With even numbers of rope lines, the lifting limit switch weight shall be attached to the "dead end" of the hoist rope. With odd numbers of rope lines, the lifting limit switch weight shall be attached to the rope line with the lowest operating speed.

If the crane is operated with a main boom extension or top section, the connecting cable must be mounted between the distributor socket on the lattice extension and the distributor socket on the main boom. The main boom A2B switch weight must be disconnected and mounted on the extension or fly boom A2B switch.

WARNING

Failure to reposition the A2B weight will prevent the A2B system from functioning properly. No weight shall be mounted on the A2B switch of the main boom when working with the extension/top section.

Machines with Main and Auxiliary Hoists

If the main boom extension or fly section is not used, then the bridging plug must be plugged into the distributor socket on the main boom and the lifting limit switch weight must be mounted on the main boom.

If the crane is operated with a main boom extension and/or with a lattice extension, then the connecting cable must be mounted between the distributor socket on the extension or on the top section and the distributor socket on the main boom. In addition, weights must be fitted to both the A2B switch of the main boom and the extension or fly section.

If the boom extension or lattice extension are in working position and if the main boom is not equipped with a hoist rope, then the weight of the A2B switch on the main boom must be removed to prevent endangering personnel or damaging equipment.

After electrical connections have been checked to ensure the system is properly connected for the respective crane configuration, the following checks must be made:

1. Check electrical wiring connecting various parts of the system for physical damage.
2. Check A2B switches and weights for free movement.
3. Inspect spring cable drum for smooth running, initial drum tension, and correct cable winding.
4. Inspect mechanical and electrical installation of power measurement sockets on the lattice extension (if present).

WARNING

The following tests must be performed with care to prevent personnel injury or crane damage. Proper functioning of the CCS requires successful completion of these tests before starting work.

If the operator cannot see the hook block approaching the pulley head, this task must be assigned to an assistant (slinger).

The crane operator must be prepared to stop the crane immediately if the CCS is not working correctly, i.e. when warning indicators do not display, the acoustic alarm does not sound, and crane movements such as raising, extending and luffing are not disabled.

Check *Hoist limit switch warning light* and acoustic alarm as follows:

1. Manually raise weight fitted on the A2B switch. As soon as weight is raised, the acoustic alarm should sound and A2B switch warning should display.
2. Using the main hoist, pull hook block slowly against the A2B switch weight. As soon as the hook block raises the weight, the acoustic alarm should be triggered, the A2B switch warning should display, and the main hoist should switch off. Lower the hook block slightly to eliminate this condition.
3. Slowly lower the boom to bring about a potential hoist limit situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B switch warning should display, and the luffing gear should switch off. Lower the hook block slightly to eliminate this condition.
4. Slowly extend (telescope out) the boom to bring about a potential hoist limit situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B switch warning should display, and the telescoping function should switch off. Lower the hook block slightly to eliminate this condition.

WARNING

If warning indicators and audible alarm do not function as described and crane movements are not switched off, the system is not working properly. The malfunction must be corrected before starting work.

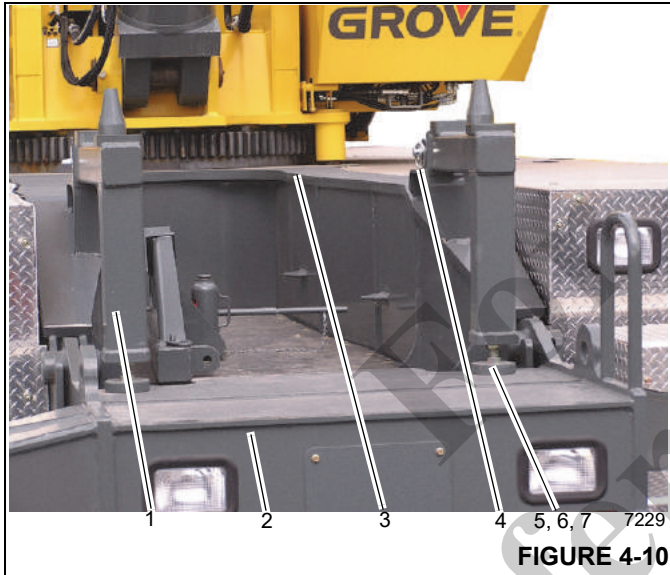
5. If crane is equipped with a main boom or lattice extension, the inspection procedure must be repeated for the A2B switch of the extension/top section.
6. Check display of main boom length agrees with actual boom length.
7. Check display of main boom angle agrees with actual boom angles.
8. Check display of the crane operating radius agrees with the actual radius.
9. Check load display by lifting a load of known weight. Load display accuracy must be within the tolerance range.

COUNTERWEIGHT REMOVAL AND INSTALLATION

Counterweight Stand Installation

NOTE: The counterweight stand must be installed on the front of the carrier before removing either the standard or heavy counterweight assembly.

1. Using an adequate lifting device, install the counterweight stands (1) (Figure 4-10) to the front of the carrier frame (3) and secure with the hitch pins (4).



2. Rotate the counterweight stands (1) until the foot plates (5) come to rest on top of the front outrigger box (2).

DANGER

Adjustment of the counterweight stand (1) (Figure 4-10) supports is prohibited when the counterweight (1) (Figure 4-11) is resting on them.

3. Adjust the foot plates (5) with the adjusting screws (6), into or out of the counterweight support, until the counterweight pads on top of the counterweight support are level. Do not exceed 5.72 cm (2.25 in).
4. Tighten jam nuts (7) against counterweight support.
5. Repeat for the other support.

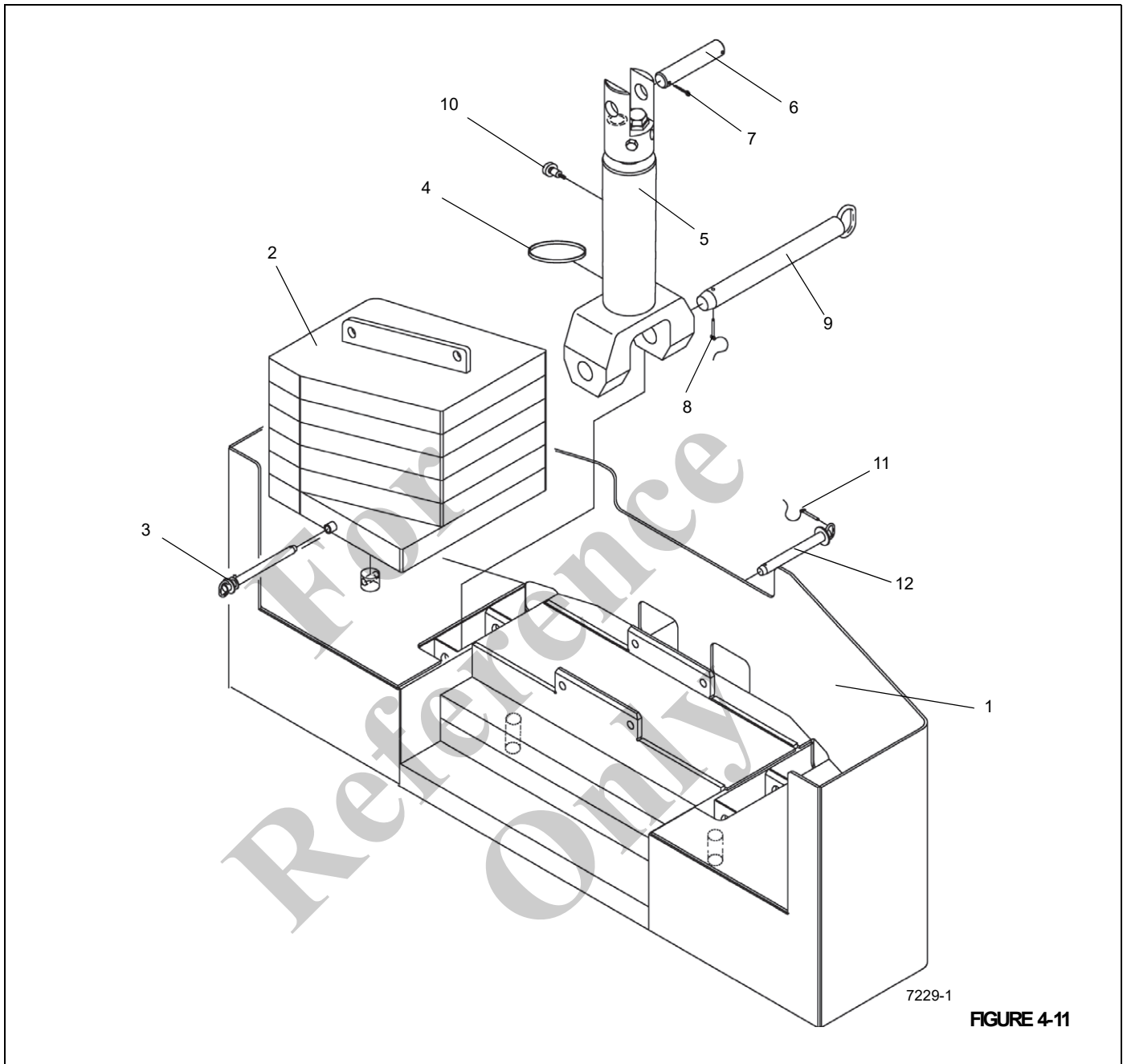
Standard and Heavy Counterweight and Auxiliary Hoist Structure

Removal

DANGER

Read and understand the following when removing and installing the counterweight, auxiliary hoist structure or counterweight stand, to avoid serious injury or death.

- Outriggers must be properly extended and set and crane level before installation or removal of counterweight or auxiliary hoist structure.
- Lifting operations are not permitted with any counterweight on the carrier deck except for the removal or installation of the counterweight and/or auxiliary hoist structure.
- Boom is not permitted over carrier deck when the boom angle is less than 30° and any counterweight is positioned on the deck.
- Hookblock is not permitted to come in contact with counterweight, auxiliary hoist or auxiliary hoist structure during removal or installation.
- When installing counterweight (1) (Figure 4-11), make sure that both auxiliary hoist structure (7) (Figure 4-12) hydraulic mounting pins are fully extended and retainer pins are in place before counterweight is lifted.
- Before unpinning auxiliary hoist structure (7), all counterweights must be fully lowered and firmly supported. Before lowering, make sure the auxiliary hoist structure (7) is properly supported by counterweight removal cylinders (5) (Figure 4-11) and both hydraulic mounting pins are completely retracted.
- Travel is not permitted with any counterweight on the carrier deck.



7229-1

FIGURE 4-11

Item	Description
1	Counterweight Weldment
2	Heavy Counterweight Weldment
3	Heavy Counterweight Weldment Pin
4	Wear Ring
5	Counterweight Removal Cylinder
6	Pin

Item	Description
7	Cotter Pin
8	Cotter Pin
9	Cylinder to Counterweight Pin
10	Shoulder Bolt
11	Hitch Pin
12	Counterweight to Hoist Structure Pin

1. Position the crane on a firm level surface.
2. Fully extend and set the outriggers and level the crane.
3. Position the superstructure over the rear with the counterweight positioned over the counterweight support on the front of the carrier frame.
4. Remove any load handling device from the auxiliary hoist cable and retract all cable onto the hoist drum. Secure the cable.
5. Tag and disconnect the auxiliary hoist hydraulic lines and electrical harnesses. Cap or plug all line openings. Secure lines so they will not be damaged during auxiliary hoist structure removal.
6. Do not disconnect the lines to the counterweight removal cylinders (5) (Figure 4-11) at this time.

NOTE: It may be necessary to retract the counterweight removal cylinders (5) (Figure 4-11) to relieve weight from the counterweight to auxiliary hoist structure pins (12) (Figure 4-11).

7. Remove the hitch pins (11) (Figure 4-11) and the counterweight to hoist structure pins (12) (Figure 4-11). These are accessible through the holes in the back of the counterweight (1) (Figure 4-11).

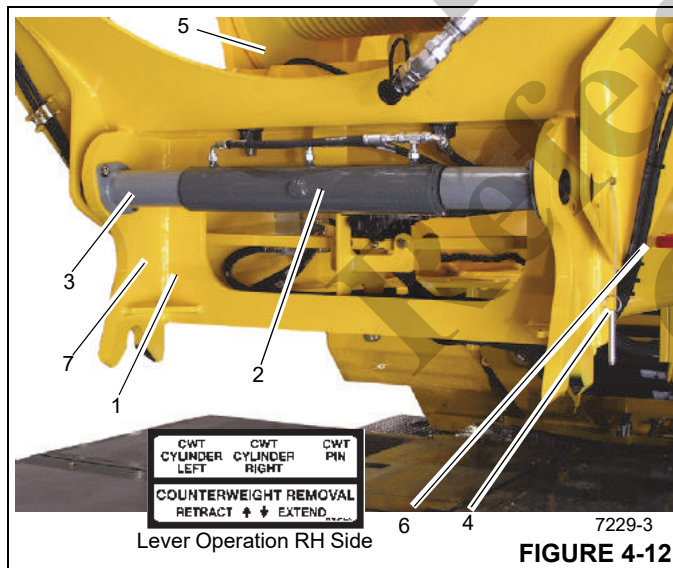


FIGURE 4-12

8. Using the counterweight removal levers (6) (Figure 4-12), extend the counterweight removal cylinders (5) (Figure 4-11) and carefully lower the counterweight (1) (Figure 4-11) onto the counterweight supports.

9. Remove the detent pins (4) (Figure 4-12) to allow the pin removal cylinder (2) (Figure 4-12) to retract the pins on its rod ends.
10. Use the counterweight removal levers (6) (Figure 4-12) to retract the pins on the rod ends of the pin removal cylinder (2) (Figure 4-12) and unpin the auxiliary hoist structure (7) (Figure 4-12) from the turntable.
11. Retract the counterweight removal cylinders (5) (Figure 4-11) and carefully lower the auxiliary hoist structure (7) (Figure 4-12) onto the counterweight.
12. Tag, disconnect and secure the counterweight removal cylinder hydraulic lines. Cap or plug all line openings.
13. Secure the counterweight (1) (Figure 4-11) to the auxiliary hoist structure (7) (Figure 4-12) with the counterweight to hoist structure pins (12) (Figure 4-11) and hitch pins (11) (Figure 4-11).

! DANGER

Do not attempt to separate the auxiliary hoist structure (7) (Figure 4-12) from the counterweight (1) (Figure 4-11) while on the counterweight stand (1) (Figure 4-10). The auxiliary hoist structure (7) (Figure 4-12) may hit the counterweight (1) (Figure 4-11) and knock it off the stand.

14. Disengage the swing lock pin and swing the superstructure over the front.

! DANGER

Death or serious injury may result with improper use. On the heavy removable counterweight option (2) (Figure 4-11), do not use the lifting lugs on the heavy counterweights to lift the entire heavy counterweight and auxiliary hoist structure. The heavy counterweight lifting lugs are designed to lift the heavy removable counterweight only.

15. Attach an adequate lifting device with slings to the auxiliary hoist structure (7) (Figure 4-12). Use the crane to carefully transfer the auxiliary hoist structure (7) (Figure 4-12) and counterweight (1) (Figure 4-11) to the ground or suitable transport vehicle.

NOTE: Step 16 applies to the heavy removable counterweight (2) (Figure 4-11).

16. If desired, lessen the weight on the counterweight by removing the two heavy counterweight weldments (2) (Figure 4-11). To remove the weldments, attach an adequate lifting device with slings attached to the lifting lugs. Free the weldments from the counterweight by removing the pins. Using the lifting device, remove the weldments.

Installation

1. Position the crane on a firm level surface.
2. Fully extend and set the outriggers. Level the crane.
3. Assemble the standard removable counterweight (1) (Figure 4-11) and auxiliary hoist structure (7) (Figure 4-12) on the ground or on a suitable transport vehicle.
OR
Assemble the heavy removable counterweight (2) (Figure 4-11) and auxiliary hoist structure (7) (Figure 4-12) on the ground or on a suitable transport vehicle.



DANGER

Crushing Hazard!

Do not attempt to assemble on the counterweight stand. The auxiliary hoist structure may hit the counterweight and knock it off the stand.

Tipping Hazard!

The heavy removable counterweight assembly (2) (Figure 4-11) must be installed with both heavy counterweights. Using only one heavy counterweight may cause the crane to become unstable.

NOTE: The following step applies to the heavy removable counterweight (2) (Figure 4-11).

4. Attach an adequate lifting device with slings to each heavy counterweight weldment's lift lugs. Using the lifting device, carefully install the two heavy counterweight weldments (2) (Figure 4-11) in place on the counterweight auxiliary hoist structure (7) (Figure 4-12). Pin the counterweight weldments in place with the pins.
5. Using an adequate lifting device, with slings attached to the auxiliary hoist structure (7) (Figure 4-12), carefully place the auxiliary hoist structure (7) (Figure 4-12) onto the counterweight (1) (Figure 4-11).
6. Secure the counterweight (1) (Figure 4-11) to the counterweight removal cylinders (5) (Figure 4-11) with the cylinder to counterweight pins (9) (Figure 4-11) and hitch pins (8) (Figure 4-11). Secure the counterweight

(1) (Figure 4-11) to the auxiliary hoist structure (7) (Figure 4-12) with the counterweight to hoist structure pins (12) (Figure 4-11) and hitch pins (11) (Figure 4-11).

CAUTION

The main boom must not be lowered below horizontal while swinging over the front while the counterweight supports are installed. Damage to the boom may result.

7. Install the counterweight stand (1) (Figure 4-10) on the front of the carrier. Refer to *Counterweight Stand Installation*, page 4-12.
8. Using an adequate lifting device with slings, carefully transfer the auxiliary hoist and counterweight to the counterweight stand.



DANGER

The main boom must not be elevated above horizontal while swinging into the auxiliary hoist mounting structure.

9. Swing the superstructure over the rear and engage the swing lock pin.
10. Connect the counterweight removal cylinder hydraulic lines disconnected and tagged earlier.
11. Remove the hitch pins (8) (Figure 4-11) and the counterweight to hoist structure pins (9) (Figure 4-11) to free the auxiliary hoist structure (7) (Figure 4-11) from the counterweight (1) (Figure 4-11).
12. Using the counterweight levers (6) (Figure 4-12), fully extend the counterweight removal cylinders (5) (Figure 4-11) and carefully raise the auxiliary hoist structure (7) (Figure 4-12) to meet the mating plates on the turntable.
13. Use the pin control lever (6) (Figure 4-12) to extend the pins on the rod ends of the pin removal cylinder (5) (Figure 4-12) and pin the auxiliary hoist structure (7) (Figure 4-12) to the turntable.
14. Install the detent pins (4) (Figure 4-12) to secure the pins on the rod ends of the pin removal cylinder (2) (Figure 4-12) to keep the auxiliary hoist structure (7) (Figure 4-12) secured.
15. Retract the counterweight removal cylinders (5) (Figure 4-11) and carefully raise the counterweight (1) (Figure 4-11) to its installed (working) position.
16. Secure the counterweight (1) (Figure 4-11) to the auxiliary hoist structure (7) (Figure 4-12) with the counterweight-to-hoist structure pins (12) (Figure 4-11).

CAUTION

Do not power the counterweight into the counterweight-to-hoist mounting pins.

17. Slowly extend the counterweight removal cylinders (5) (Figure 4-11) so the counterweight-to-hoist mounting pins (12) (Figure 4-11) take the weight of the counterweight (1) (Figure 4-11).
18. Connect the auxiliary hoist hydraulic lines and electrical wires as tagged and disconnected earlier.
19. Remove the counterweight support from the front of the carrier. Refer to *Counterweight Stand Removal*, page 4-16.

Counterweight Stand Removal

1. Attach an adequate lifting device with slings to the counterweight stand (1) (Figure 4-10).
2. Loosen jam nut (7) (Figure 4-10).
3. Rotate foot plates (5) (Figure 4-10) on the counterweight stand (1) (Figure 4-10) away from the outrigger box (2) (Figure 4-10).
4. Remove the counterweight stand (1) (Figure 4-10) to carrier frame hitch pins (4) (Figure 4-10).
5. Using the lifting device with slings, remove the counterweight stand (1) (Figure 4-10).
6. Repeat for the other counterweight stand.

For
Reference
Only

OUTRIGGER BOX REMOVAL AND INSTALLATION

Bleed Valve Operation

The manual bleed off pressure valve (Figure 4-13) is located on the back of the right rear fender. The purpose of the valve is to reduce the effort required to separate and connect the hydraulic quick disconnect couplers when removing or installing the front and rear outrigger boxes.

Procedure

1. Shut off the engine.
2. Turn the handle counterclockwise to open the bleed valve.
3. Wait approximately 30 seconds.
4. Disconnect or connect the quick couplings.
5. Close the bleed valve completely.
6. Restart the engine if necessary.

NOTE: Error codes related to the outriggers will appear as electrical connectors are disconnected during the outrigger removal process. If any unrelated error code appears, stop operation and determine the cause of that error code. Resolve this error code prior to resuming operation. When the outrigger box electrical connectors have all been connected, all related errors codes should clear once crane power has been cycled.

WARNING Tipping Hazard!

When lifting the outrigger box while on rubber, the boom must be fully retracted and limited to a 6 m (20 ft) maximum radius.

No counterweights are to be installed on the superstructure if swinging over the side on rubber.

With no load, the boom angle must not be less than 35° when over sides of the machine; loss of stability will occur causing a tipping condition. To lower boom below 35° boom angle, boom must be swung over front or rear and rated capacity limiter (RCL) bypass activated.

Once one outrigger box is installed, do not swing boom over that end of the machine while installing the other outrigger box.

Removal

DANGER Crushing Hazard!

Death or serious injury could result from being crushed by moving machinery or by improper set-up on outriggers. Stand clear while outriggers are being extended or retracted.

1. Remove the quick release pins from the ends of each of the pinning (power) cylinder rod ends.
2. Attach an adequate lifting device with lifting slings to the lifting lugs provided on each end of the outrigger box.

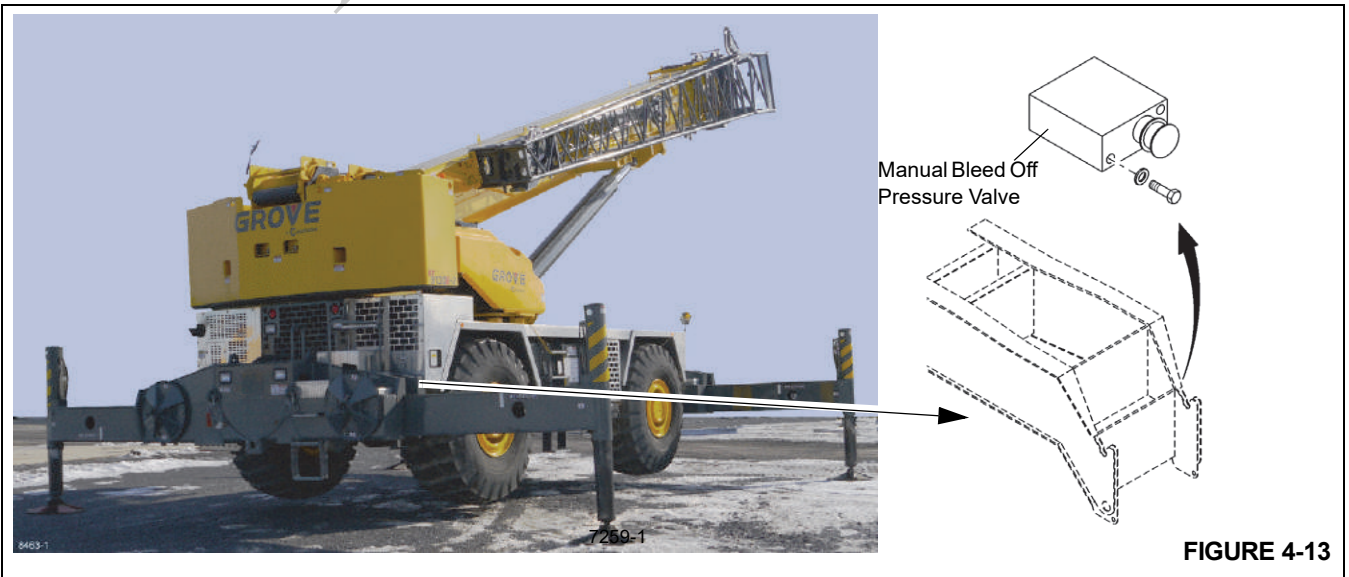


FIGURE 4-13

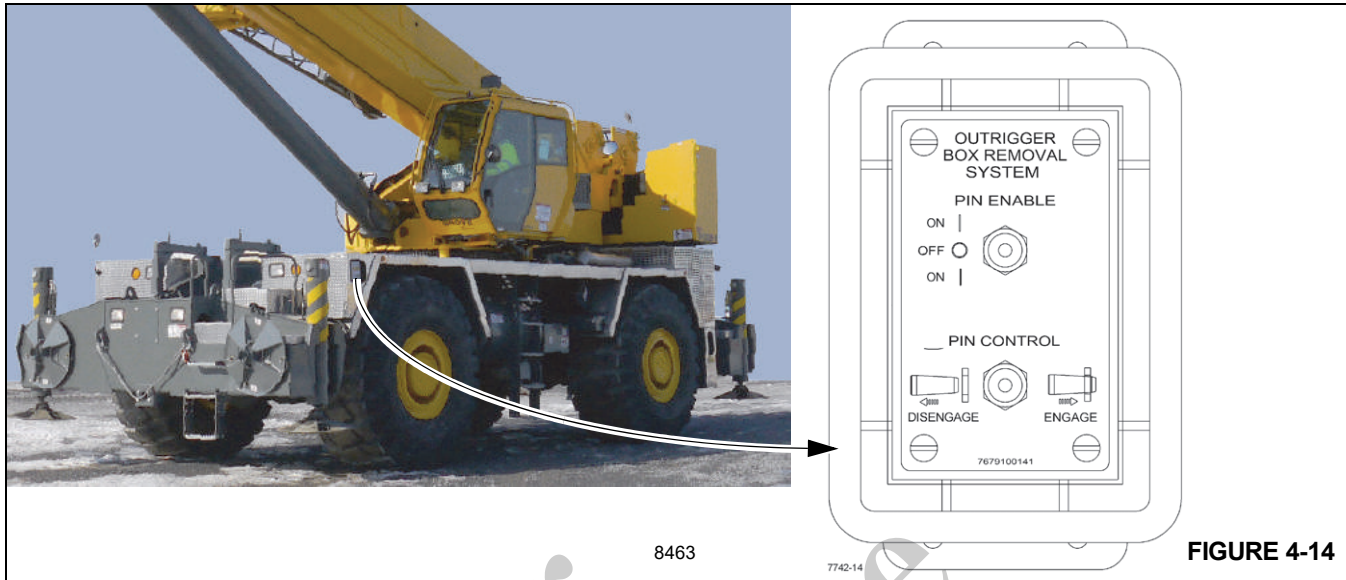


FIGURE 4-14

3. Use the remote mounted pinning cylinder control box (Figure 4-14) located on either the left front or the right rear side of the carrier and perform the following:
 - a. Position and hold the PIN ENABLE switch to the ON position.
 - b. Position and hold the PIN CONTROL switch to the DISENGAGE position until the pinning cylinder rods are fully retracted.
 4. Disconnect the carrier external electrical connector from the outrigger external connection.
 5. Disconnect the carrier hydraulic quick disconnects from the external connections of the outrigger. Stow the carrier lines inside the fender.
 6. Lift the outrigger box from the carrier.
 7. Stow the quick release pins in the stowage clamps on the outrigger box.
4. Install the carrier hydraulic quick disconnects to the external connections of the outrigger.
 5. Lower the outrigger box and align the pinning (power) pin cylinder pins with the attach points on the carrier frame.
 6. Use the remote mounted pin control box (Figure 4-14) located on either the left front or the right rear side of the carrier and perform the following:
 - a. Position and hold the PIN ENABLE switch to the ON position.
 - b. Position and hold the PIN CONTROL switch to the ENGAGE position (Figure 4-14).

**DANGER**

The retaining pins must be properly installed and secured in the power cylinder rod ends whenever the outrigger box is on the carrier

Installation

NOTE: The outrigger box assembly weighs approximately 4307 kg (9495 lb).

1. Attach an adequate lifting device with lifting slings to the lifting lugs provided on each end of the outrigger box.
2. Lift and position the outrigger box parallel with the rear or front of the carrier.
3. Connect the carrier external electrical connector to the outrigger external connection.

7. After the hydraulic cylinders have been activated, install a quick release pin in the end of each of the power cylinder rod ends.

CAUTION

If swinging the outrigger box over the side while on rubber, the boom must be fully retracted and limited to a 6 m (20 ft) maximum radius.

REMOVING AND INSTALLING THE BI-FOLD BOOM EXTENSION



DANGER

Crushing Hazard!

Before attempting to erect or stow the bi-fold boom extension, read and strictly adhere to all danger decals installed on the boom extension and stowage brackets.

Always secure the boom extension with a guide rope on the main boom before removing any connections to prevent uncontrolled swinging of the boom extension.

NOTE: The hydraulic boom extension must be at 0° offset for erecting and stowing the boom extension.

Removal

NOTE: If an adequate lifting device is available, the boom extension can be dismantled directly from the side of the boom.

1. Fully extend and set the outriggers.
2. Position the boom over the front.
3. If extended, fully retract all the boom sections and lower the boom to minimum elevation to permit ease of installation of pins and access to the boom nose.

NOTE: The auxiliary boom nose (rooster sheave) must be in stowed position or removed.



WARNING

Before starting the boom extension removal procedure, make sure that the stowage pin at the front stowage bracket is properly engaged and the retaining clip is installed, and the guide rail is in the out position.

4. Pull the eye bolt (3) downwards and fold out the guide rail (5) and release the eye bolt to lock the guide rail in the out position (Detail B) (Figure 4-16).

CAUTION

If the 7 m (23 ft) boom extension fly section is not to be removed, it should remain on the stowage brackets on the side of the boom.

NOTE: If removing the 7 m (23 ft) boom extension fly section with the 11 m (36 ft) boom extension base

section skip to step 10. If only removing the 11 m (36 ft) section, perform steps 5 thru 9 and skip steps 10 and 11.

5. Make sure the attach pins (16b) attaching the boom extension fly section to the boom base section rear support bracket (Detail C) (Figure 4-16) are in place.
6. Make sure the pin (9) and retaining pin (1) attaching the 7 m (23 ft) boom extension fly section to the guide rail bracket (Detail B) (Figure 4-16) is in place.
7. At the rear support bracket (Detail C) (Figure 4-16) remove the two retaining clips from the two attach pins (16a) and remove attach pins from the 11 m (36 ft) boom extension base section to the 7 m (23 ft) boom extension fly section attaching connection.
8. Stow the pins (16a) in the stowage lugs of the 7 m (23 ft) boom extension fly section.
9. At the 7 m (23 ft) boom extension fly section sheave end (Detail D) (Figure 4-16) swivel the catch hook (32) out to release the latch from the stirrup (26), allowing the 11 m (36 ft) boom extension base section to separate from the 7 m (23 ft) boom extension fly section at the sheave end.

NOTE: If only removing the boom extension base section, skip steps 10 and 11.

10. Remove the retaining pin (1) and pin (9) attaching the 7 m (23 ft) boom extension fly section to the guide rail bracket (Detail B) (Figure 4-16) and secure in the holding bracket.
11. Remove the retaining clips and attach pins (16b) connecting the 7 m (23 ft) boom extension fly section to the boom base section rear stowage bracket (Detail C) (Figure 4-16).
12. Attach a length of rope to the tip of the 11 m (36 ft) boom extension base section to aid in swinging it into place ahead of the boom nose. Attach the rope to the boom or other location to prevent the boom extension from rotating freely when the boom extension is released from the front stowage bracket (Detail A) (Figure 4-15).
13. Swing the 11 m (36 ft) boom extension base section, pivoting on the front stowage bracket (12) (Detail A) (Figure 4-15), until contact is made between the boom nose anchor lugs (11) and the 11 m (36 ft) boom extension anchor fittings (10). Align the boom nose anchor lugs with the 11 m (36 ft) boom extension anchor fittings. Remove the retaining pins from the front of the 11 m (36 ft) boom extension base section and install the two short attach pins into the anchor lug holes securing the boom extension to the right side of the boom nose. Install the retaining clips in the attach pins.

**DANGER****Crushing Hazard!**

To prevent serious injury or death, do not stand or sit on the crane deck when pulling the boom extension off the guide rail.

Once the stowage pin at the front stowage bracket is removed and the boom extension is free from the guide rail it may abruptly swing with enough force to severely injure or cause death to anyone standing or sitting on the crane deck.

DO NOT remove the retaining clip (19) (Detail A) (Figure 4-15) while standing on the crane deck. Remove the retaining clip after moving off the crane deck and onto the ground using the boom extension pole (tool p/n 7714100000) located in the cab.

14. Before removing the stowage pin from the front stowage bracket, make sure that the boom extension is properly connected to the right side of the boom nose.
15. On the front stowage bracket, use the boom extension pole to remove the retaining clip (19) and stowage pin (18) and place in pin holder (Detail A) (Figure 4-15).
16. Use the boom extension pole to lift the lever (15) and hold it, push the spring latch (24) out and let the lever rest on the spring latch (Figure 4-15).

**WARNING****Crushing Hazard!**

When erecting the boom extension, make sure that all personnel and equipment are kept clear of the swing path.

17. Slightly raise and/or lower the boom to help control the boom extension. Using the rope attached to the tip of the boom extension, swing the boom extension into place ahead of the boom nose, engaging the anchor fittings (10) with the anchor lugs (11) on the left side of the boom nose (Figure 4-15).

**WARNING**

Do not modify the attach points to permit the installation of the attach pins.

18. Install the short attach pin into the upper extension anchor fitting and boom anchor lug on the left side of the boom nose. Install the retaining clip in the attach pin.

19. Install the long attach pin in the lower extension anchor fitting and boom anchor lug on the left side of the boom nose. Install the retaining clip in the attach pin.
20. Extend and lower the boom until blocking can be placed under the boom extension to fully support the entire boom extension. Remove the rope from the tip of the boom extension base.
21. Lower the boom extension onto the cribbing. Remove and stow the attach pins securing the 11 m (36 ft) boom extension base section to the boom nose.
22. Retract the boom, freeing the boom extension from the boom nose.

Installation

1. Position the crane so the bi-fold boom extension lies in front of the crane with the boom extension base section facing the crane. Fully extend and set the outriggers.
2. Extend and lower the boom to engage the boom anchor lugs (11) and the extension anchor fittings (10) (Figure 4-15).
3. Use the four attach pins and retaining clips to secure the 11 m (36 ft) boom extension base section to the boom nose. Attach a length of rope to the boom extension tip. Raise the boom, lifting the boom extension from the cribbing on which it was resting. Retract the boom.
4. Swing and lock the guide rail in the out position (Detail B) (Figure 4-16).
5. If boom extension fly section is not erected, skip to step 6.

If erected, fold in the boom extension fly section and secure alongside the boom extension base section by doing the following.

- a. Remove and stow the left side attach pins that secure the boom extension fly section to the boom extension base section.
- b. While raising and/or lowering the boom to help control the boom extension fly section, use the rope attached to the tip of the boom extension fly section to swing the fly section to the side of the boom extension base section.
- c. At the sheave end of the boom extension fly section (Detail D) (Figure 4-16), swivel the catch hook (32) to engage the stirrup (26), securing the boom extension fly section to the boom extension base section.
6. Remove the retaining clips from the attach pins on the left side of the boom at the anchor fittings for the boom extension. Remove the attach pins out of the left side lower and upper anchor lugs and anchor fittings. Install

both attach pins into holders on the base of the boom extension and secure with retaining clips.

**DANGER****Crushing Hazard!**

Make sure that the guide rail is in the out position before swinging the boom extension for storage.

Make sure the connection between the 11 m (36 ft) boom extension base section and the front stowage bracket is engaged and secure before removing the attach pins on the right side boom nose. This will prevent the jib from falling.

When stowing the boom extension, make sure that all personnel and equipment are kept clear of the swing path.

Failure to comply with these warnings may cause death or serious injury.

CAUTION**Equipment Damage Hazard!**

Do not allow the boom extension to slam into the stowage brackets when swinging into the stowed position.

7. Raise and/or lower the boom to help control the boom extension, and using the rope attached to the tip of the boom extension, swing the boom extension to the side of the boom.

8. Swing the 11 m (36 ft) boom extension base section until it contacts the front stowage bracket. Use the boom extension pole to lift up on the lever (15), then push the boom extension until its mounting holes align with the extension hanger pivot mounting holes on the main boom (Detail A) (Figure 4-15). Use the boom extension pole to pull downward on the lever to insert the spring pin (16) into its mounting holes. Make sure the spring pin is secure and engaged properly between the boom extension and main boom.

9. Use the boom extension pole to secure the connection with stowage pin (18) and retaining clip (19).

**WARNING**

Before removing the right side attach pins, make sure that the stowage pin in the front stowage bracket is properly engaged to the boom extension and the retaining clip is installed.

10. Remove the retaining clips from the attach pins at the boom anchor lugs and extension anchor fittings on the right side of the boom nose. Remove the two attach pins out of the attaching points and insert them into the holders on the base of the boom extension base section, securing them with retaining clips.

11. With the guide rail in the out position, push the 11 m (36 ft) boom extension base section onto the guide rail until it comes into contact with all of the connections on the main boom.

Reference Only

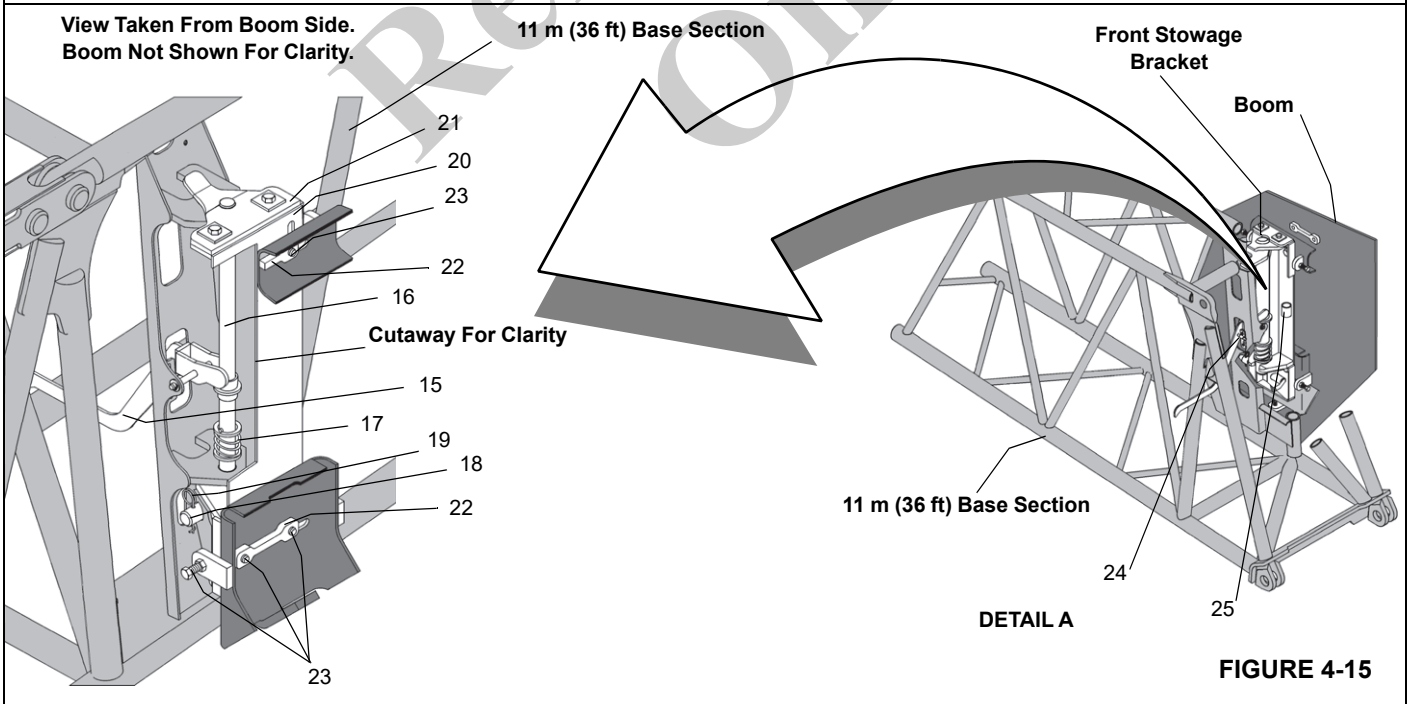
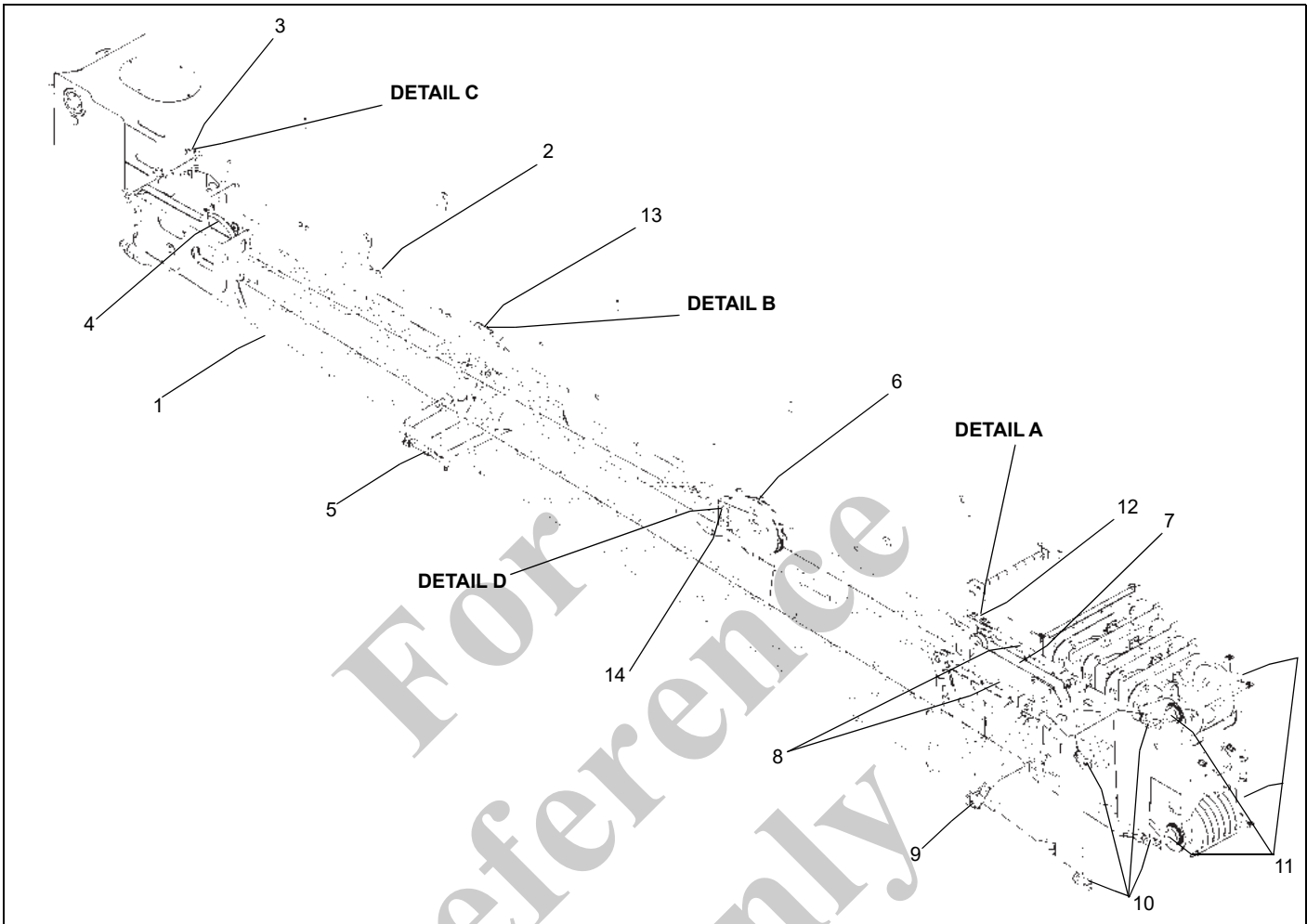


FIGURE 4-15

Item	Description
1	11 m (36 ft) Boom Extension Base Section
2	7 m (23 ft) Boom Extension Fly Section
3	Fly Rear Stowage Bracket
4	Base Extension Sheave
5	Guide Rail
6	Fly Sheave
7	Mast Assembly
8	Offset Lugs
9	Offset Pivot Pin
10	Boom Extension Anchor Fittings
11	Boom Nose Anchor Lugs
12	Front Stowage Bracket/Pivot Shaft
13	Middle Stowage Bracket

Item	Description
14	Fly Sheave Connection
15	Lever
16	Spring Pin
17	Pressure Spring
18	Stowage Pin
19	Retaining Clip
20	Support
21	Lifting Plate
22	Threaded Plate
23	Adjusting Bolt
24	Spring Latch
25	Holder Bracket

For
Reference
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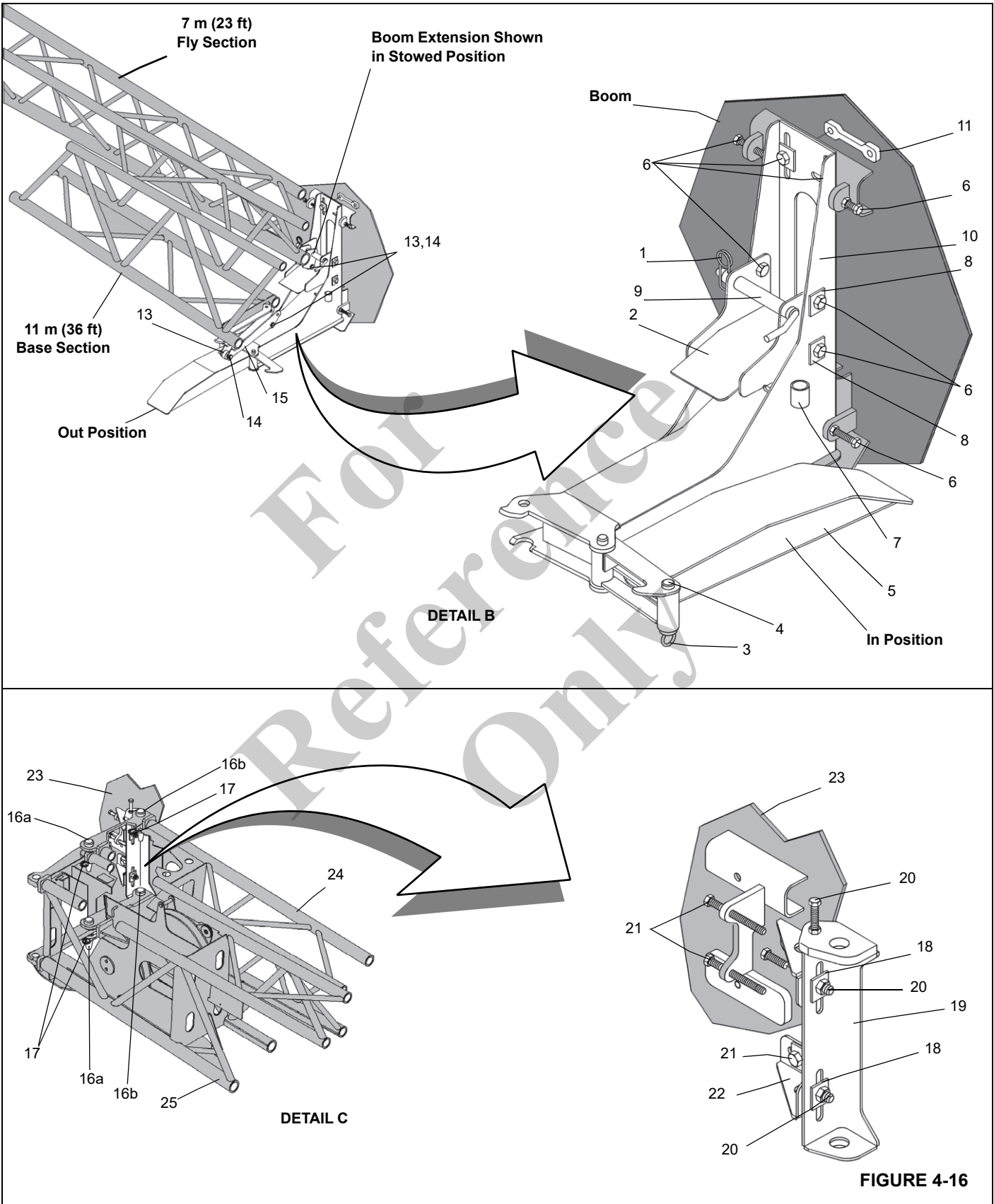
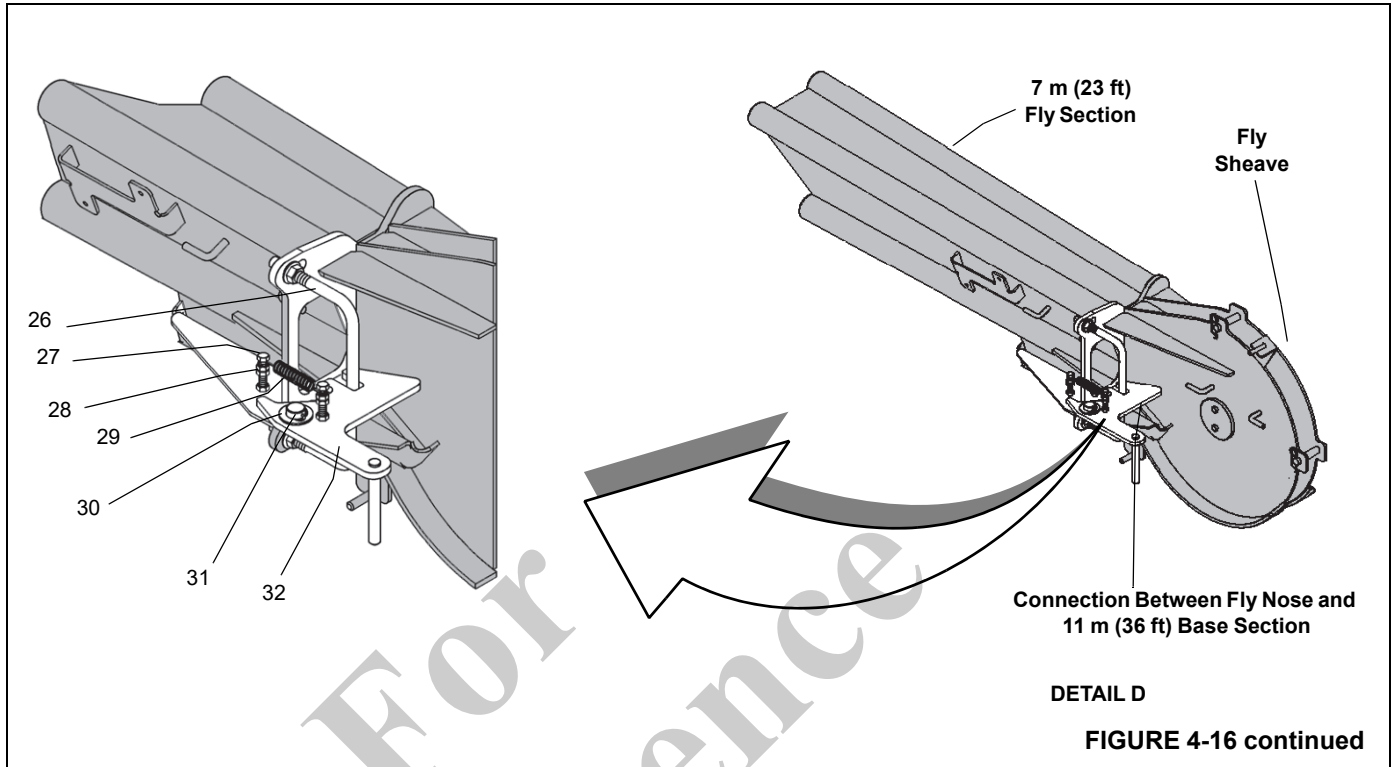


FIGURE 4-16



Item	Description
1	Retaining Pin
2	Mounting Plate
3	Eye Bolt
4	Pin
5	Guide Rail
6	Adjusting Bolt
7	Holding Bracket
8	Plate
9	Pin
10	Guide Rail Mounting Bracket
11	Threaded Plate
12	Grease Fitting
13	Supporting Roller
14	Pin
15	Roller Support
16	Attach Pins

Item	Description
17	Retaining Clips
18	Plate
19	Rear Extension Support Bracket
20	Vertical Adjusting Bolts
21	Horizontal Adjusting Bolts
22	Mounting Bracket
23	Boom
24	7 m (23 ft) Jib
25	11 m (36 ft) Jib
26	Stirrup
27	Bolts
28	Nuts
29	Tension Spring
30	Spacer Ring
31	Pin
32	Catch Hook

NOTE: If the 7 m (23 ft) section (fly) remained on the boom stowage brackets, perform steps 12 and 13, if not skip to step 14.

12. At the rear stowage support bracket, insert the attach pins (16a) stowed in the 7 m (23 ft) section stowage lugs and into the connection between the 11 m (36 ft) boom extension base section and 7 m (23 ft) boom extension fly section attaching fittings. Secure pins with retaining clips (17) (Detail C) (Figure 4-16).
13. At the sheave end of the boom extension fly section (Detail D) (Figure 4-16), swivel the catch hook (32) to engage the stirrup (26), securing the boom extension fly section to the boom extension base section.
14. Ensure the attach pin (9) and retaining clip (1) attaching the 7 m (23 ft) boom extension fly section to the guide rail bracket (Detail B) (Figure 4-16) are in place.
15. Ensure pins (16b) and retaining clips (17) attaching boom extension fly section to the rear support bracket on the boom base (Detail C) (Figure 4-16) are in place.
16. At the guide rail, pull downward on the eye bolt and fold in the guide rail and release the eye bolt to lock the guide rail in the stowed position (Detail B) (Figure 4-16).
17. Rig boom nose and hoist cable. Operate crane using normal operating procedures.

CONNECTING AND DISCONNECTING HYDRAULIC BOOM EXTENSION

Connecting



DANGER

If hose couplings are detached from boom after hose drum lock pin is released, do not release hose couplings until they have been re-attached to the boom. If hose couplings are released after being detached from the boom, hoses will spring back uncontrollably due to the spring force in the hose drum.

When working with just the main boom for longer periods of time, the hydraulic connection between the hose drum and the main boom should be disconnected. This prevents unnecessary reeling and unreeling of the hose.

Establish a Hydraulic Connection Between the Boom Extension and the Main Boom

If the hoses are stowed on the holder on the boom base section, release the hose drum (4) (Figure 4-17) lock pin and pull the hydraulic hoses toward the boom nose. Anchor the

hydraulic couplings (1) at the holder (2) on the boom nose. Guide the hydraulic hoses through the guide rollers (3).

1. Unwind the hoses on the lattice extension.
2. Remove the dust caps from the couplings on the lattice extension and the drum hoses.
3. Connect the lattice extension hoses to the hose drum hoses. Do not detach the drum hoses from the holder on the boom nose.

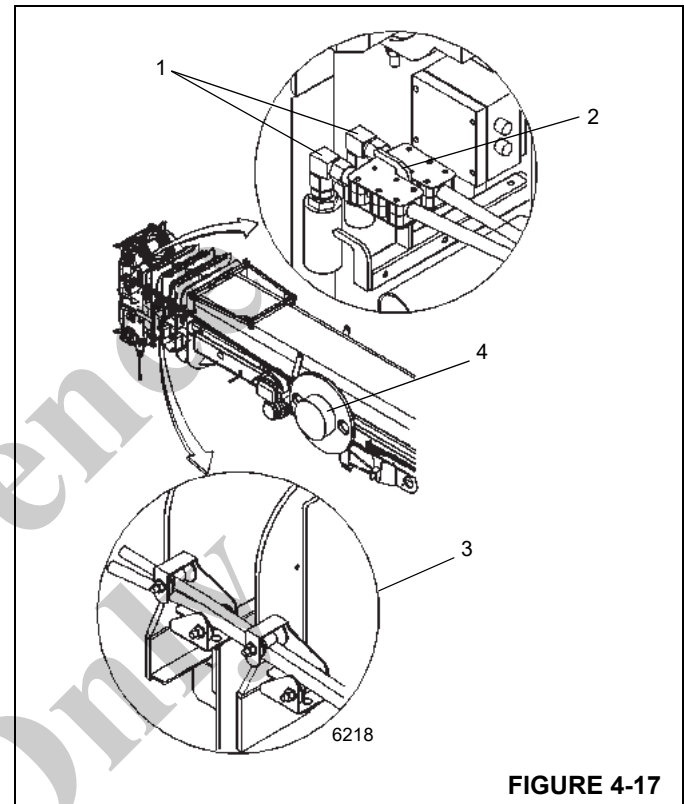


FIGURE 4-17

Item	Description
1	Hydraulic Couplers
2	Holder
3	Guide Rollers
4	Hose Drum

Establish an Electrical Connection Between the Lattice Extension and the Main Boom

1. Remove the bypass plug from the electrical junction box on the boom nose.
2. Unwind the electrical cable from the jib.
3. Disconnect the cable from the dummy plug on the jib.
4. Connect the jib cable to the boom nose junction box.

Establish Electrical Connection Between Boom Extension and Anti-Two Block Switch

NOTE: The anti-two block switch supplied with the jib is used for operation of the 11 m (36 ft) and 59 ft sections. The junction box connection for the section that is not in use must be overridden with a bypass plug.

1. Install the anti-two block switch on the appropriate pin near the nose sheave of the section being used. Secure the switch to the jib with a retaining clip.
2. Remove the bypass plug and connect the wire from the anti-two block switch to the junction box located near the nose sheave.

Disconnecting

Disconnect the Electrical Connection Between the Jib and the Main Boom

1. Disconnect the jib cable from the boom nose junction box.
2. Wind the cable onto the jib for storage.
3. Connect the cable to the dummy plug on the jib adapter.
4. Install the bypass plug into the open connector on the boom nose junction box.

Disconnect the Hydraulic Connection Between the Jib and the Main Boom



WARNING

If the hose couplings are detached from the boom after the hose drum lock pin has been released, do not release the hose couplings until they have been attached to the boom. If the hose couplings are released after being detached from the boom, the hoses will spring back uncontrollably due to the spring force in the hose drum.

1. Disconnect the jib hoses from the drum hoses. Do not detach the drum hoses from the boom nose.

When working with the main boom for longer periods of time, the hydraulic hoses should be disconnected from the boom nose and retracted to the hose drum. This prevents unnecessary reeling and unreeling of the hose.

2. Remove the hoses from the boom nose. Retract the hydraulic hoses to the holder on the boom base section.
3. Engage hose drum lock pin into hole on drum.
4. Wind the hoses onto the jib for storage.
5. Install dust caps attached to all couplings on the jib and the drum hoses.

Swingaway Mounting Adjustment

Refer to (Figure 4-15).

1. Set the 11 m (36 ft) section with the 7 m (23 ft) section stowed on the side, on cribbing. Use an adequate lifting device to place the jib at the side of the boom. Make the connection at the front stowage bracket and support with lifting device (Detail A).
2. Refer to Detail A (front stowage bracket). Pivot the jib on the front support bracket. Adjust the front support bracket adjustment bolts to maintain a loose condition when the jib anchor fittings (10) engage the boom anchor lugs (11).
3. Secure the guide rail on the middle jib stowage bracket in the out position.
4. Swing the jib until it contacts the guide rail at the middle jib stowage bracket (Detail B).

NOTE: When pushing the jib extension onto the guide rail, make sure contact does not occur at the rear jib mounting bracket and prevent proper alignment.

5. Adjust the middle stowage bracket so the roller supports on the 11 m (36 ft) section roll on the guide rail and aligns the roller support on the 7 m (23 ft) section. This should align the hole in the mounting lug on the 7 m (23 ft) (7m) section with the hole in the mounting piece on the stowage bracket. When adjusted properly, the pin (9) can be inserted to make the stowage connection.
6. Referring to Detail C (rear stowage bracket), adjust the adjustment bolts on the rear support bracket to support the jib and provide installation of attach pins (16b).
7. Remove the lifting device used for support after the jib is properly adjusted and secure.

Jib—with Inserts

Identification

The jib consists of the 18 m (59 ft) two-stage swingaway lattice extension and two jib inserts. The jib is designed for the crane it was delivered with. The parts belonging to the crane have the same serial number as the crane.

The following parts are labelled with the serial number:

- all parts of the 18 m (59 ft) two-stage swingaway lattice extension
- both sections of the jib 8 m (26 ft) inserts.

CAUTION

Operate the crane only with those sections of the jib which have the same serial number as the crane. This prevents malfunctions and damage.

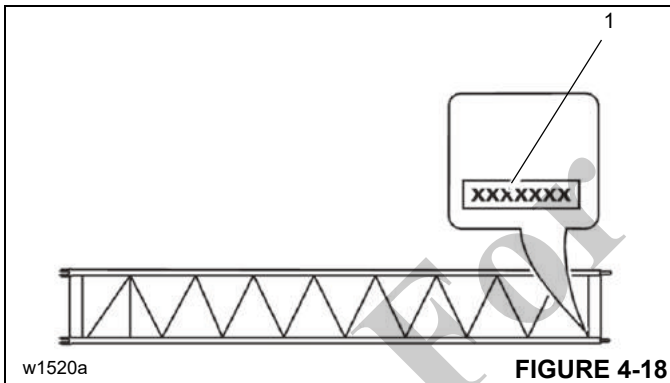
NOTE: For technical reasons a crane may only be set with one jib.

If you wish to use the jib on several Grove cranes, the parts of the jib must be adjusted for these cranes and labelled with all of the respective serial numbers.

CAUTION

Have the adjustment of the jib carried out only by your local Grove Distributor or Manitowoc Crane Care.

Serial Numbers On the 8 m (26 ft) Inserts



On the 8 m (26 ft) inserts the serial number (1) is at the front (Figure 4-18).

Slinging Points

! WARNING

This section shows the slinging points on the 8 m (26 ft) inserts. Attach the sling or chains to these slinging points only. They will then have the correct center of gravity. Use only lifting gear with sufficient load bearing capacity.

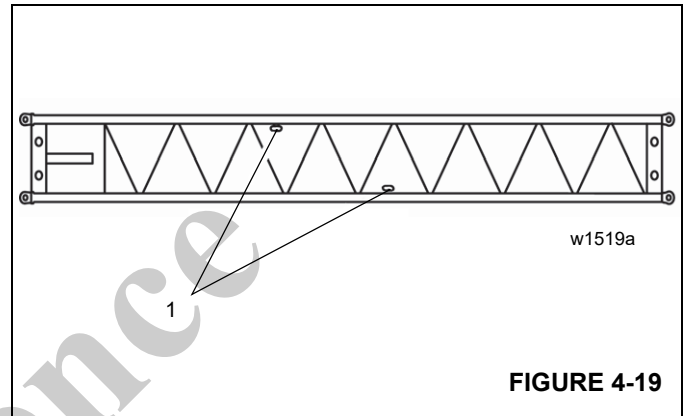


FIGURE 4-19

The 8 m (26 ft) inserts have two slinging points (1) (each slightly offset on each side) (Figure 4-19).

Reference Only

Assembly of Jibs

NOTE: The lengths of 26 m (85 ft) and 34 m (112 ft) respectively equal the distance between the center of the locking pin (on the main boom head) and the front edge of the head sheave.

The designations 11 m (36 ft) section, 7 m (23 ft) section and 8 m (26 ft) insert have been adapted to these lengths. The total lengths of the individual sections are greater (Figure 4-20).

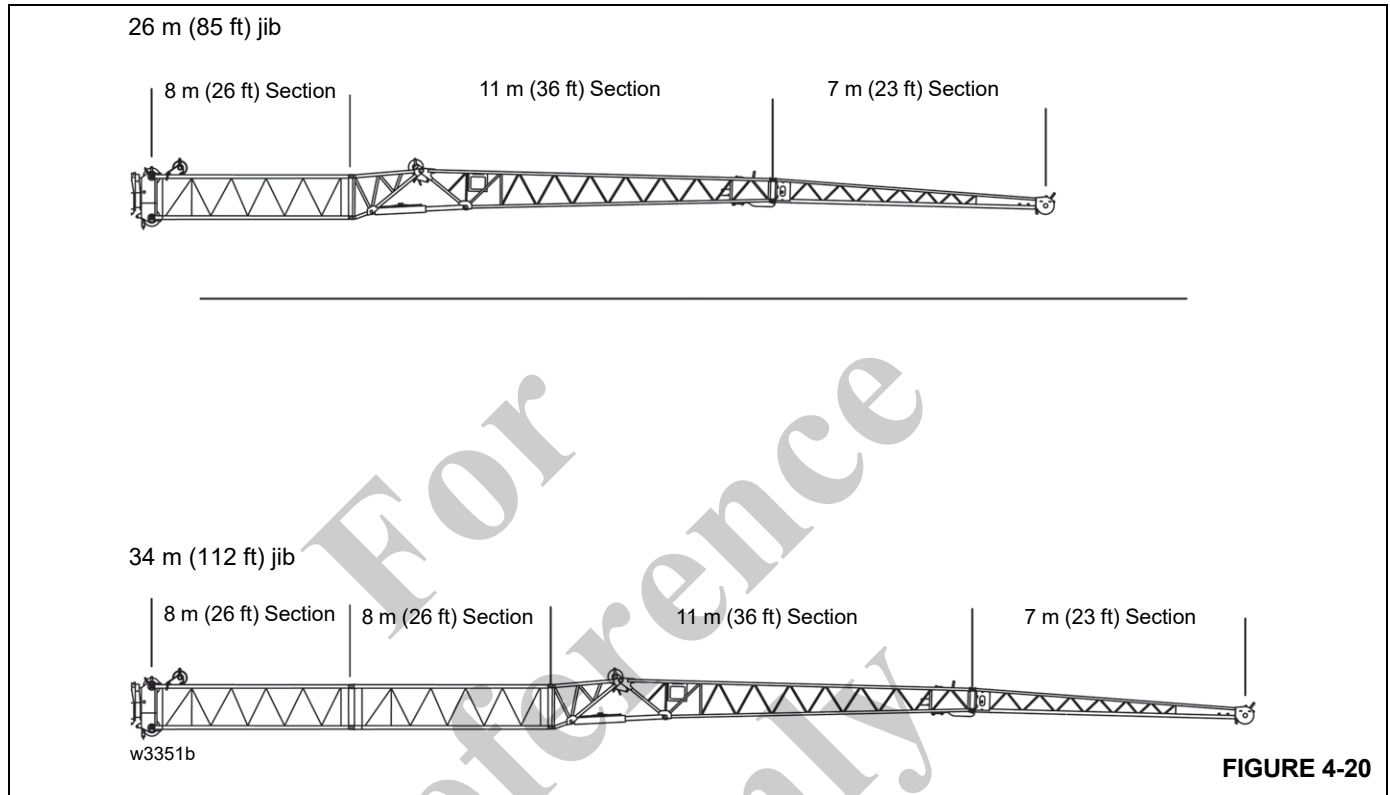


FIGURE 4-20

Installing the 26 m (85 ft)/34 m (112 ft) Jib

NOTE: An auxiliary crane must be used.

1. If the jib is folded at the side of the main boom, remove the jib, refer to *Removing and Installing the Bi-fold Boom Extension*, page 4-19.
2. Install the 8 m (26 ft) inserts in front of the main boom, refer to *Installing 8 m (26 ft) Inserts*, page 4-30:
 - For 26 m (85 ft) jib, one 8 m (26 ft) section
 - For 34 m (112 ft) jib both 8 m (26 ft) sections
3. Attach folded two-stage swingaway lattice extension in front of the inserts.
4. Attach guide rope to the head of the 7 m (23 ft) section.
5. Release connection between 7 m (23 ft) section and 11 m (36 ft) section.
6. Swivel the 7 m (23 ft) section in front of the 11 m (36 ft) section.
7. Fasten 7 m (23 ft) section with pins on left-hand side in front of 11 m (36 ft) section.
8. If unit is equipped with a hydraulic luffing jib, establish a hydraulic connection between lattice extension and main boom, refer to *Hydraulic Connection on the Boom Inserts*, page 4-32.
9. Establish electrical connections, refer to *Electrical Connection on the Boom Inserts*, page 4-32.

10. Fold out deflection sheaves on all sections, refer to *Folding Out/In the Deflection Sheaves on the 8 m (26 ft) Sections*, page 4-33.
11. Place hoist cable over all the deflection sheaves and the head sheave of the 7 m (23 ft) section.
12. Install the limit switch to the head of the 7 m (23 ft) section.
13. Reeve the hoist cable on the hook block.
14. Attach lifting limit switch weight and guide hoist cable through the weight.

Removing the 26 m (85 ft)/34 m (112 ft) Jib

NOTE: The crane must be on outriggers and level. An auxiliary crane must be used

1. Fully retract and set down main boom.
2. Remove lifting limit switch weight.
3. Reeve out hoist cable from the hook block.
4. Remove hoist cable and fold in deflection sheaves on all parts of the jib. Refer to *Folding Out/In the Deflection Sheaves on the 8 m (26 ft) Sections*, page 4-33
5. Reel hoist cable up to the main boom head.
6. If necessary, raise the lattice extension to the 0° position.
7. If equipped with hydraulic luffing jib, disconnect the hydraulic connections between lattice extension and main boom.
If necessary, also disconnect the hydraulic connection to the hose drum.
8. Disconnect electrical connections.
9. Remove the locking pins on the left-hand side between 7 m (23 ft) section and 11 m (36 ft) section.
10. Swing the 7 m (23 ft) section onto the 11 m (36 ft) section side until the connection between the two sections engages.
11. Establish connection between 7 m (23 ft) section and 11 m (36 ft) section.
12. Remove folded two-stage swingaway lattice extension from 8 m (26 ft) section.
13. Remove 8 m (26 ft) sections from the main boom, refer to *Removing 8 m (26 ft) Inserts*, page 4-31:

- For 85 ft jib one 8 m (26 ft) section
- For 112 ft jib both 8 m (26 ft) sections

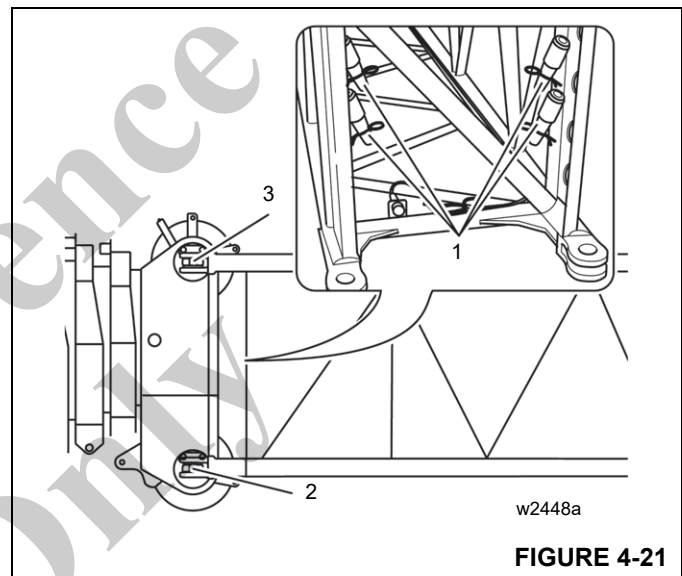
Installing/Removing 8 m (26 ft) Inserts

In order to rig the 85 ft jib you must install the 8 m (26 ft) insert with support roller in front of the main boom head.

To rig the 34 m (112 ft) jib you must also mount the 8 m (26 ft) insert without support roller in front of the 8 m (26 ft) insert with support roller.

NOTE: An auxiliary crane must be used to install and remove the 8 m (26 ft) inserts.

The securing pins (1) for the connection are in the holders on the foot of the 8 m (26 ft) sections and are secured with retaining clips (Figure 4-21).



Installing 8 m (26 ft) Inserts

1. Sling the 8 m (26 ft) insert with support roller on an auxiliary crane and lift it in front of the main boom head so that the bearing points (2) and (3) align with it on both sides (Figure 4-21).
2. Insert the securing pins on both sides into the bearing points.
3. Secure all pins with retaining clips.
4. For the 34 m (112 ft) jib, install the second 8 m (26 ft) insert in the same way as the first 8 m (26 ft) insert.

5. Fold out deflection sheaves on all sections, refer to *Folding Out/In the Deflection Sheaves on the 8 m (26 ft) Sections*, page 4-33.

Removing 8 m (26 ft) Inserts

1. Sling the 8 m (26 ft) insert on an auxiliary crane and lift it until the weight has been taken off the bearing points (2) and (3) (Figure 4-21).
2. Remove the retaining clips and pins from the bearing points (2) and (3) on both sides (Figure 4-21).
3. Insert the pins into the holders on the foot of the 8 m (26 ft) sections and secure them with retaining clips.

For
Reference
Only

Hydraulic Connection on the Boom Inserts

The hydraulic connection is required for raising and lowering the hydraulic jib. If the hydraulic connections for the hose drum were separated on the left side, they have to be re-established.

NOTE: The connections are made via quick couplings. Half couplings which belong together are color coded.

Connections on the 8 m (26 ft) Sections

At the rear of the 8 m (26 ft) inserts there are two hydraulic hoses (1) with quick couplings. These hydraulic hoses can be connected on the main boom head or on a second 8 m (26 ft) insert (Figure 4-22)

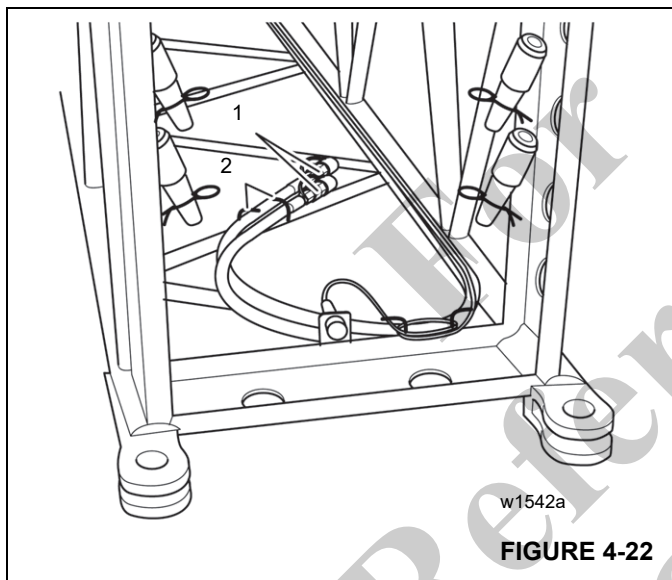


FIGURE 4-22

For transportation, hydraulic hoses are stored in holders (2) (Figure 4-22).

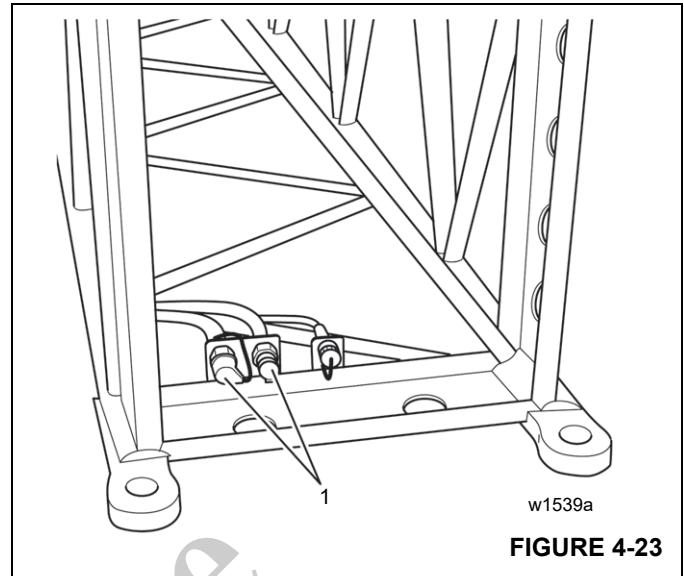


FIGURE 4-23

At the front of the 8 m (26 ft) inserts there are two quick couplings (1) (Figure 4-23).

Connect the hydraulic hoses of the 11 m (36 ft) section or a second 8 m (26 ft) insert here.

Electrical Connection on the Boom Inserts

This section describes the electrical connections on the 8 m (26 ft) inserts. For establishing electrical connection on the two-stage swingaway jib refer to *Establish an Electrical Connection Between the Lattice Extension and the Main Boom*, page 4-26.

Connections on the 8 m (26 ft) Sections

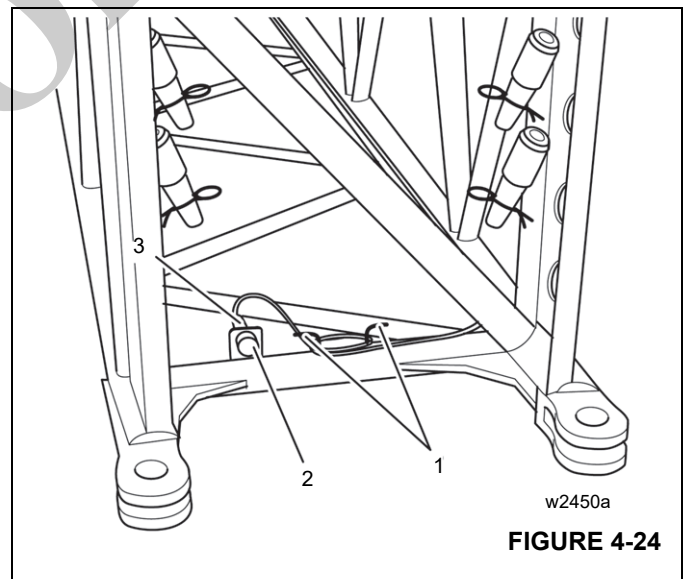
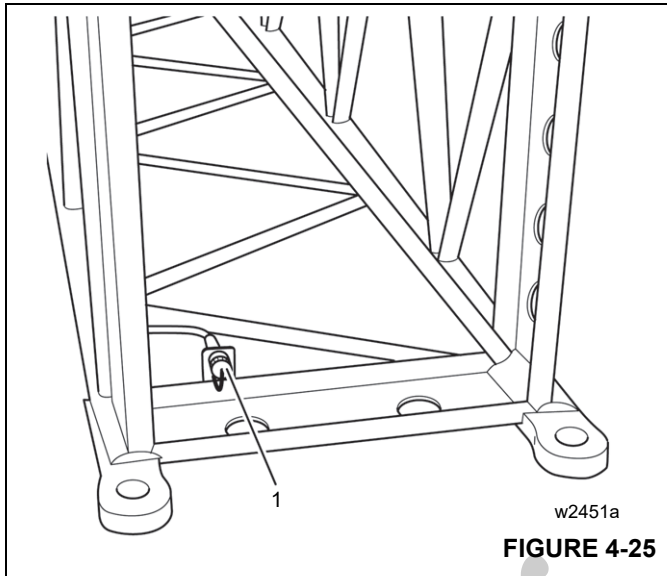


FIGURE 4-24

At the rear of the 8 m (26 ft) sections there is a cable with a plug (3) (Figure 4-24).



For transportation, the cable is wound around the holders (1) and plug is inserted in the dummy socket (2) (Figure 4-24).

At front of the 8 m (26 ft) insert there is a plug socket (1) (Figure 4-25).

Connect cable of the 11 m (36 ft) section or a second 8 m (26 ft) insert here.

Establishing Electrical Connections

For the 26 m (85 ft) Jib

1. Connect the cable from the 8 m (26 ft) section to the socket on the main boom head.
2. Connect the cable from the 11 m (36 ft) section to the socket at the front of the 8 m (26 ft) section.

For the 34 m (112 ft) Jib

1. Connect the cable from the first 8 m (26 ft) section to the socket on the main boom head.
2. Connect the cable from the second 8 m (26 ft) section to the socket at the front of the first 8 m (26 ft) section.
3. Connect the cable from the 11 m (36 ft) section to the socket at the front of the second 8 m (26 ft) section.

Folding Out/In the Deflection Sheaves on the 8 m (26 ft) Sections

This section describes only the folding in and out of the deflection sheave on the 8 m (26 ft) insert.

NOTE: Fold the deflection sheave in for transportation.

Folding Out Deflection Sheave

1. Hold the deflection sheave by the strut and remove the pin from the bore.
2. Fold the deflection sheave up and secure it by inserting the pin into the bore.
3. Secure the pin with a retaining clip.



CAUTION

Make sure the deflection sheave is in the raised position anytime the boom extension is erected.

Folding In Deflection Sheave

1. Hold the deflection sheave by the strut and remove the pin from the bore.
2. Fold the deflection sheave down and insert the pin in the bore.
3. Fold the deflection sheave in for transportation.



CAUTION

Make sure the deflection sheave is folded in the down position prior to transportation or damage to the crane may result.

4. Secure the pin with a retaining clip.

Positioning/Removing Hoist Cable



CAUTION

Always secure hoist cable holding rollers and rods with retaining clips. This prevents hardware from coming loose, falling down and injuring people.

Positioning the Hoist Cable

- Remove hoist cable holding rollers and rods (1) (Figure 4-26).
- Guide hoist cable via deflection sheaves (5), (4), (3) and head sheave (2) on the 7 m (23 ft) section for the boom insert(s) (Figure 4-26).
- Put all hoist cable holding rollers and rods back in place and secure these with retaining clips.
- Attach the hook tackle. The hoist rope can only be reeved once.

Removing the Hoist Cable

Reverse sequence of operations to remove hoist cable.

Setting Folding Swingaway Extension Offset



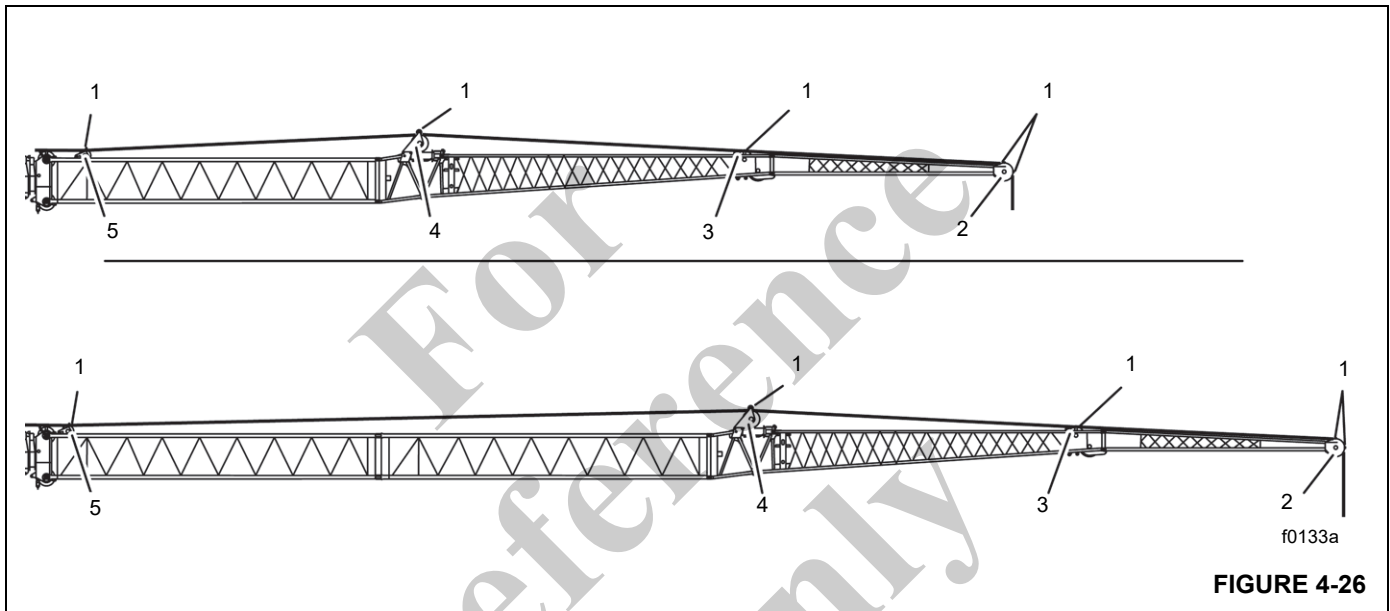
DANGER

Ensure any blocking material used is adequate to support the weight of the extension assembly without tipping or falling.

1. Extend and set outriggers. Swing boom over front and position above horizontal.
2. Block under tip of extension assembly section.
3. To set offset from a lesser to higher degree, perform the following procedures (Figure 4-27).

CAUTION

Do not overload extension anchor fittings or extension base section when lowering boom.



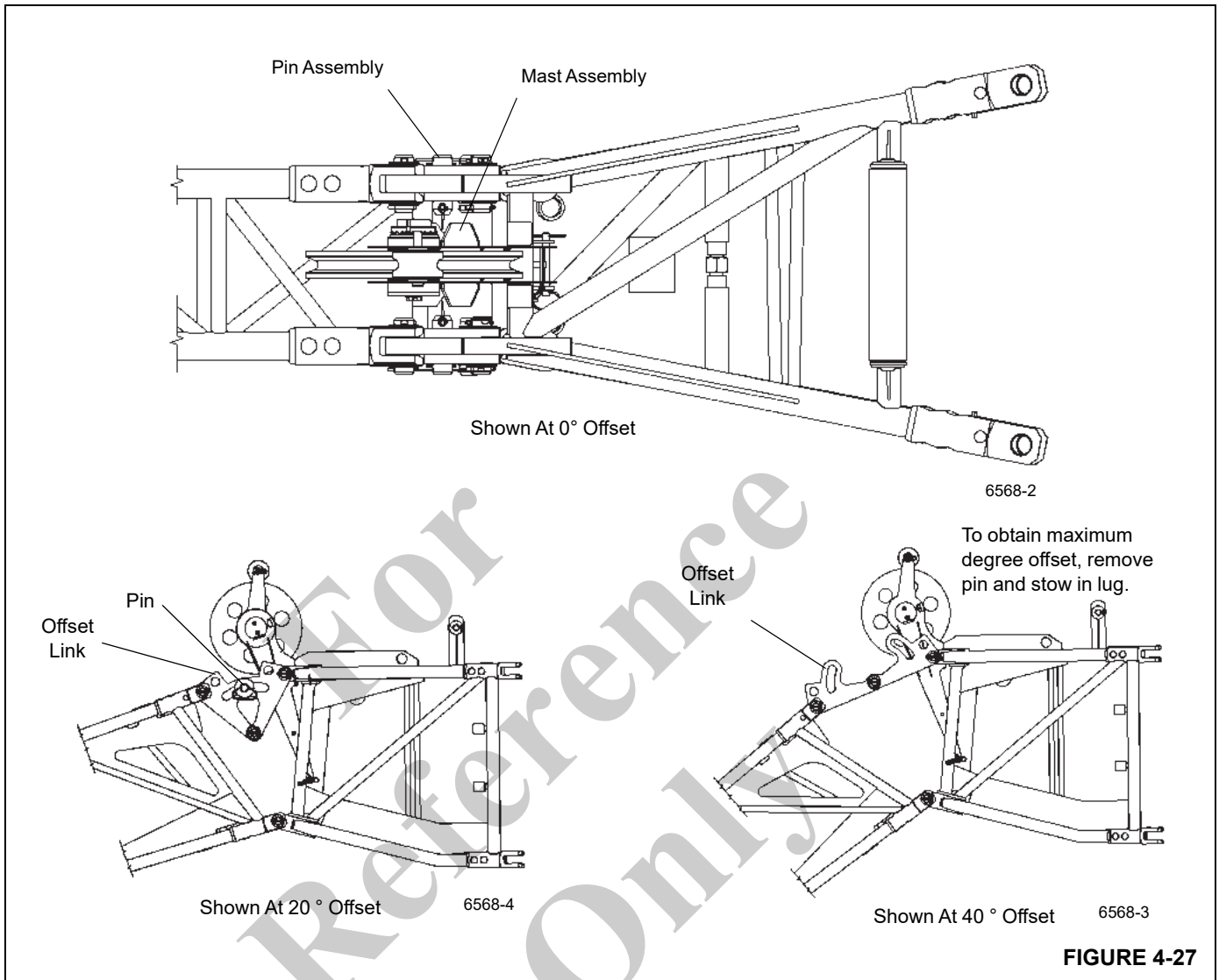


FIGURE 4-27



CAUTION

Make sure the mast is in the raised position anytime the boom extension is erected.

- a. Slowly lower the boom until the pressure is relieved on the offset link pins.
- b. Remove the offset link clip pins and attach pins securing the offset links in the lesser degree offset

position. If going to maximum offset, stow them in the stowage lugs. If going to the intermediate (20 degree) offset, install them in the offset links for that degree of offset.

- c. Slowly elevate and telescope the boom at the same time so that the extension does not move off of the blocking until the offset links take the full weight of the extension.
- d. Reeve the hoist cable as described under normal erecting procedures

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SECTION 5 MAINTENANCE AND LUBRICATION

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GENERAL

Following the designated lubrication procedures is important in ensuring maximum crane lifetime and utilization. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information.

Refer to your *Inspection and Lubrication Service Log* for routine checks which will help maintain the safety, dependability, and productivity designed into your crane. One copy of the *Inspection and Lubrication Service Log* is provided in the original package of manuals shipped with the crane. Additional copies are available through the Grove distributor network.

Refer to your Service Manual for specific maintenance and adjustment procedures.

ENVIRONMENTAL PROTECTION

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

Potentially harmful waste used in Grove 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, observe the following:

- 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 clean up any spills.

LUBRICANTS AND LUBRICATION INTERVALS

The service intervals specified are for normal operation where moderate ambient temperature, humidity, and atmospheric conditions prevail. In areas of extreme conditions, the service periods and lubrication specifications should be altered to meet existing conditions. For information on extreme condition lubrication, contact your local Grove Cranes distributor or Manitowoc Crane Care.

Lube intervals are to be used as a guideline only. Actual lube intervals should be formulated by the operator to correspond

according to conditions such as continuous duty cycles and/or hazardous environments.

NOTE: All fluids and lubricants may be purchased by contacting an authorized Grove distributor or Manitowoc Crane Care Parts Department.

CAUTION**Possible Equipment Damage!**

Chassis grease lubricants must not be applied with air pressure devices as this lubricant is used on sealed fittings.

The multipurpose grease applied during manufacturing is of a lithium base. Use of a non-compatible grease could result in damage to equipment.

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Standard Lubricants

Standard lubricants are used on all Grove cranes unless the crane is ordered with a cold weather package. These

standard lubricants are effective in ambient temperatures down to -9°C (15°F). Refer to TABLE 5-1: for a list of the recommended standard lubricants.

TABLE 5-1: Standard Lubricants/Fluids [Down to -9°C (15°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829012964	Century Unigear Semi-synthetic Texaco Multigear SS Chevron DELO	80W-90	
Tier 3 Engine Oil	6829003483	Exxon XD-3 Conoco Fleet Supreme	15W-40	CI-4
Tier 4 Engine Oil	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super	15W-40	CJ-4
Hydraulic/Transmission Oil	6829006444	Kendall Hyken 052 Exxon Torque Fluid 56 Esso Torque Fluid 56 BP-Eldoran UTH & Trak-Tran 9 BP- Blend- 7367	10W-20	Must Meet John Deere Std. JDM J20c
		Exxon Mobil 424 Phillip 66 PowerTran XP	ISO 46/68	
Hoist Gear/Swing Drive Oil	6829100213	Mobil: Mobilfluid 629 Texaco: Meropa 150		AGMA No. 4 EP
Grease, Multipurpose	6829015304	Citgo Lithoplex MP# 2 Texaco Starplex Moly # 2 Phillips 66 Philube M Mobil Mobilgrese XHP 222 Special Chemtool Inc, Lube-A-Boom	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Anti-Seize Compound (ASC)	6829003689	Jet Lube Kopr Kote Loctite C5-A Compound		
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Complete EG	Mix 50/50	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencoool 3000		

TABLE 5-1: Standard Lubricants/Fluids [Down to -9°C (15°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Diesel Fuel		Ultra Low Sulfur Diesel Fuel	Standard DF-2	
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		

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Arctic Lubricants and Conditions

Temperatures Below -9°C (15°F)

Regions with ambient temperatures below -9°C (15°F) are considered arctic. In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results in these temperatures. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, may not be compatible with hydraulic system seals and wear bands. Therefore, always check with an authorized Grove distributor or Manitowoc Crane Care if in doubt of the suitability of a specific fluid or lubricant.

When operating in cold weather and regardless of the oil viscosity of the crane's lubricants, always follow the cold weather start-up and operating procedures described in the *Operator Manual* to ensure adequate lubrication during system warm-up and proper operation of all crane functions.

Cold Weather Package and Lubricants

Grove recommends the following cold weather lubricants for use with ambient temperatures down to -29°C (-20°F) (TABLE 5-2) and -40°C (-40°F) (TABLE 5-3). But, these cold weather lubricants alone are not sufficient to operate the crane in extreme low temperatures. Therefore, it is also recommended that the crane be equipped with the following accessories:

Down to -29°C (-20°F) Package

- Battery heater
- Fuel line heater
- Engine hood insulation
- Fan clutch

- Radiator air shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Fluids suitable to -29°C (-20°F)
 - Arctic windshield washer fluid
 - Arctic fuel

Down to -40°C (-40°F) Package

- Coolant heater (to circulate warm coolant through heaters and engine)
- Transmission heater
- Swivel heater
- Battery heater
- Fuel line heater
- Hydraulic reservoir heater
- Engine hood insulation
- Fan clutch
- Radiator shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Super-capacitor starting system
- Fluids suitable to -40°C (-40°F):
 - Arctic windshield washer fluid
 - Arctic fuel

TABLE 5-2: Cold Weather Lubricants/Fluids [Down to -29°C (-20°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
Tier 3/Tier 4 Engine Oil	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Transmission Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
Hoist Gear/Swing Drive Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
Grease, Multipurpose	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Anti-Seize Compound (ASC)	6829003689	Jet Lube Kopr Kote Loctite C5-A Compound		
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Complete EG	Mix 50/50	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencoool 3000		
Hydraulic Oil	6829006993	Exxon Mobil Univis HVI	26	
Windshield Washer fluid	90037773	Splash De-icer		
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III Product #1	#1	NLOCK08
		NA1993, Fuel Oil (NO.1), 3, PG 111	111	8M
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		

TABLE 5-3: Cold Weather Lubricants/Fluids [Down to -40°C (-40°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
Tier 3/Tier 4 Engine Oil	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Transmission Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
Hoist Gear/Swing Drive Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
Grease, Multipurpose	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Anti-Seize Compound (ASC)	6829003689	Jet Lube Kopr Kote Loctite C5-A Compound		
Antifreeze Coolant	6829104212	Old World Industries, Inc. Fleet Charge SCA Pre-charged Fleetguard Compleat EG Petro-Canada	Mix 60/40	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencoool 3000		
Hydraulic Oil	6829006993	Exxon Mobil Univis HVI	26	
Windshield Washer fluid	90037773	Splash De-icer		
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III Product #1	#1	NLOCK08
		NA1993, Fuel Oil (NO.1), 3, PG 111	111	8M
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		

SURFACE PROTECTION FOR CYLINDER RODS

Steel cylinder rods include a thin layer of chrome plating on their surfaces to protect them from corroding. However, chrome plating inherently has cracks in its structure which can allow moisture to corrode the underlying steel. At typical ambient temperatures, hydraulic oil is too thick to penetrate these cracks. Normal machine operating temperatures will allow hydraulic oil to warm sufficiently to penetrate these cracks and if machines are operated daily, protect the rods. Machines that are stored, transported, or used in a corrosive environment (high moisture, rain, snow, or coastline conditions) need to have the exposed rods protected more frequently by applying a protectant. Unless the machine is operated daily, exposed rod surfaces will corrode. Some cylinders will have rods exposed even when completely retracted. Assume all cylinders have exposed rods, as corrosion on the end of the rod can ruin the cylinder.

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc Crane Care has Boeshield® T-9 Premium Metal Protectant available in 12 oz. aerosol cans by ordering part number 9999101803 through the Parts Department.

Cylinder operation and inclement weather will remove the Boeshield® protectant; therefore, inspect machines once a week and reapply Boeshield® to unprotected rods.

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacturing so that the strands, and individual wires in strands, may move as the rope moves and bends. A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added periodically throughout the life of a rope to replace factory lubricant which is used or lost. For more detailed information concerning the lubrication and inspection of wire rope, refer to Wire Rope in Section 1- Introduction in the Service Manual.

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LUBRICATION POINTS

A regular frequency of lubrication must be established for all lubrication points. Normally, this is based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log indicating crane usage. The log must use the engine hourmeter to ensure coverage of lube points that will receive attention based on their readings. Other lubrication requirements must be made on a time basis, i.e. weekly, monthly, etc.

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold, unless otherwise specified.

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

All grease fittings are SAE Standard unless otherwise indicated. Grease non-sealed fittings until grease is seen extruding from the fitting. One ounce (28 grams) of EP-MPG equals one pump on a standard one pound (0.45 kg) grease gun.

Over lubrication on non-sealed fittings will not harm the fittings or components, but under lubrication will definitely lead to a shorter lifetime.

On sealed U-joints, care must be exercised to prevent rupturing seals. Fill only until expansion of the seals first becomes visible.

Unless otherwise indicated, items not equipped with grease fittings, such as linkages, pins, levers, etc., should be lubricated with oil once a week. Motor oil, applied sparingly, will provide the necessary lubrication and help prevent the formation of rust. An Anti-Seize compound may be used if rust has not formed, otherwise the component must be cleaned first.

Grease fittings that are worn and will not hold the grease gun, or those that have a stuck check ball, must be replaced.

Where wear pads are used, cycle the components and relubricate to ensure complete lubrication of the entire wear area.

CraneLUBE

Grove highly recommends the use of CraneLUBE lubricants to increase your crane's reliability and performance. Contact your Grove Distributor for information about the Grove's CraneLUBE lubrication program.

Cummins Oil Registration List

Cummins has a program that lists engine oils that it has tested to meet its engineering specifications. Listing of recommended oils is on QuickServe® Online. Log on to quickserve.cummins.com and login with a current username and password or create a new account by selecting "Create an Account" under information, choose Limited Owners Plan and register. Once logged in, click on the "Service" Tab in the top red bar, "Service Tools" mini-tab and "Oil Registration Lists" link within the Service Tools list. This will load a list of the different Cummins Engineering Specification numbers. Select the one that applies to your engine to view the registered oils.

Safety

To lubricate many of the locations the engine will need to be started. After positioning areas of the unit for lubrication the engine must be turned off and the moved areas stable before approaching.



DANGER **Crushing Hazard!**

Movement of the superstructure and the boom may create a crushing and/or pinching hazard. Failure to observe this warning could result in death or serious injury if the message is ignored.

Steering and Suspension						
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
1	Steer Cylinder Pivot Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	8 grease fittings
2	Upper and Lower King Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	8 grease fittings
3	Fifth Wheel Pivots	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	2 grease fittings
4	Lockout Cylinder Pivot Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	4 grease fittings
5	Tie Rod Pivot Pins	Figure 5-1	N/A	N/A	N/A	Non-Lubricating

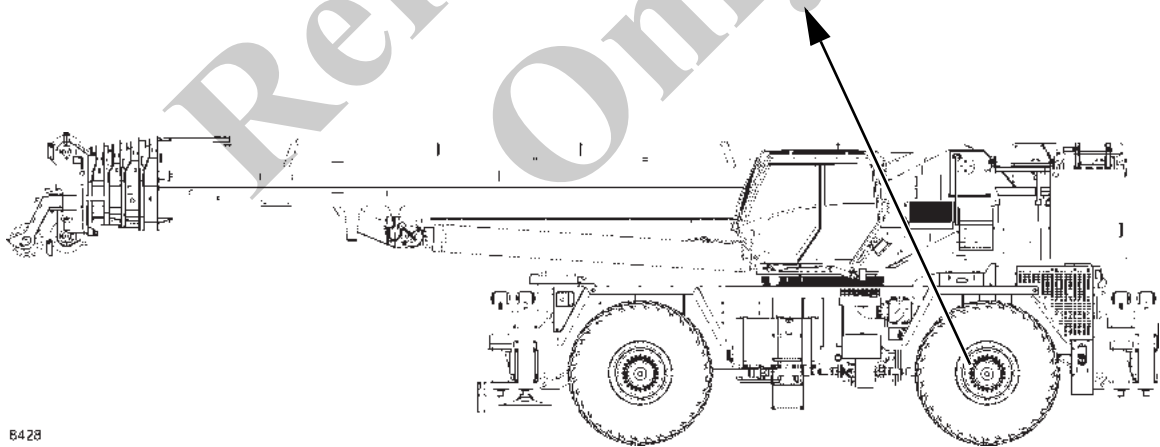
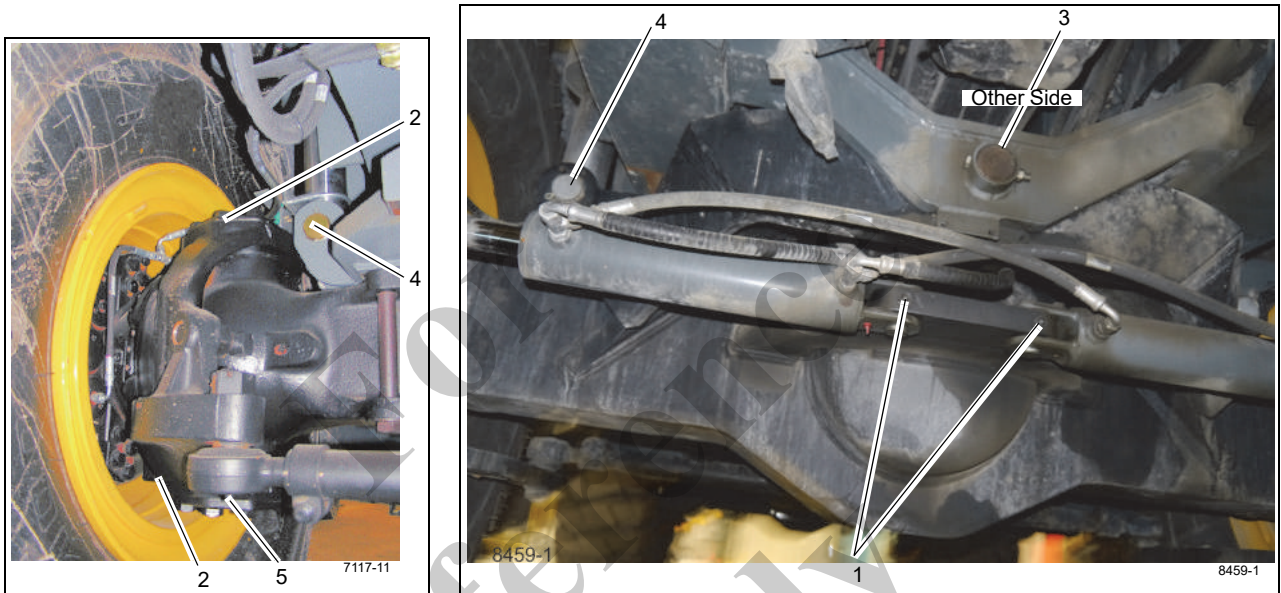


FIGURE 5-1

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Axles						
11	Differentials	Figure 5-2	GL-5 Extended Service Interval Gear Lubricant 6829012964	130.2 pints (62 l)	<ul style="list-style-type: none"> • Check level every 500 hours or 3 months • Drain and fill every 4000 hours or 2 years 	Fill to bottom of hole in housing on the steer cylinder side
<p>NOTE: Lube level close enough to the hole to be seen or touched is not sufficient. It must be level with the hole. When checking lube level, also check and clean housing breathers.</p> <p>CAUTION: Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p> <p>CAUTION: If the makeup amount is substantially more than 0.23 liter (0.5 pint), check for leaks.</p>						
12	Planetary Hubs and Wheel Bearings	Figure 5-2	GL-5 Extended Service Interval Gear Lubricant 6829012964	14.4 pints (7.0 l)	<ul style="list-style-type: none"> • Check level every 500 hours or 3 months • Drain and fill every 4000 hours or 2 years 	Fill to the bottom of the level hole in the housing with the fill plug and the oil level mark horizontal.
<p>CAUTION: Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p>						

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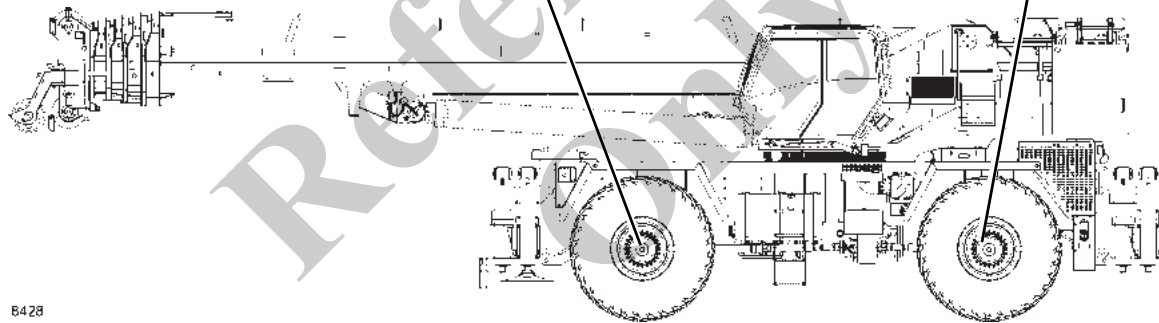
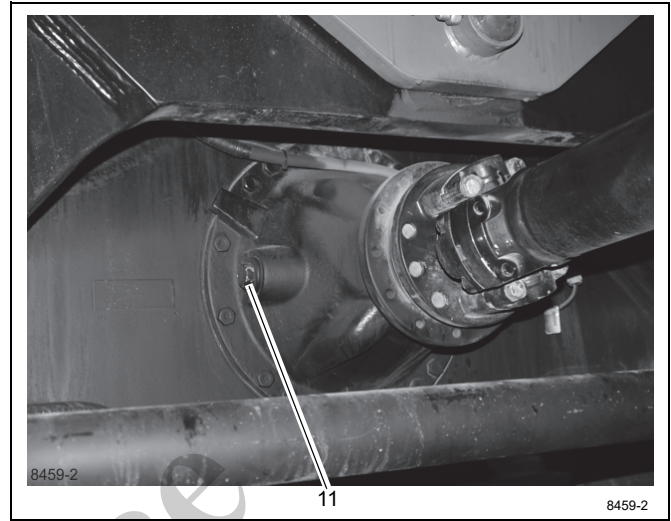


FIGURE 5-2

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Drive Train						
20a 20b	a. Engine Crankcase b. Filter	Figure 5-3	EO-15W/40 Engine Oil SAE 15W-40 T3 Engine: 6829003483 T4 Engine: 6829104182	21 qt (20 l) 23 qt (22 l)	<ul style="list-style-type: none"> • Check level every 10 hours or daily • Drain, fill and replace filter every 500 hours 	<ul style="list-style-type: none"> • Through fill pipe to FULL mark on dipstick • Filter located under radiator
21a 21b	a. Transmission, Torque Converter Dipstick b. Filter	Figure 5-3	HYDO Hydraulic Oil 6829006444	68 qt (64 l)	<ul style="list-style-type: none"> • Check level every 10 hours or daily • Drain and refill every 1000 hours or 6 months • Change transmission filter after first 50 and 100 hours of service, then every 500 hours thereafter 	Through fill pipe to FULL mark on dipstick
<p>NOTE:</p> <ul style="list-style-type: none"> • Check fluid level with engine running at 900 rpm idle and the oil at 82 to 93°C (180 to 200 °F). Do not attempt an oil level check with cold oil. To bring the oil temperature to this range, it is necessary to either work the crane or stall the converter. Converter stall should be accomplished by engaging shift lever in forward high range with the brakes applied and then accelerating the engine to half or three-quarter throttle. Hold the stall until the required converter temperature is reached and stabilized. Do not operate the converter at stall condition for longer than 30 seconds at one time. Shift to neutral for 15 seconds and repeat the procedure until the desired temperature is reached. Excessive temperature, i.e, 120°C (250°F) maximum will cause damage to transmission clutches, fluid, converter and seals. • Drain and fill with the oil at 65 to 93°C (150 to 200°F). • Transmission filters are located on the outside left hand frame in the area of the hydraulic oil cooler. • Do not operate the machine in two wheel drive while the machine is up on outriggers. Serious transmission damage could result. • To add fluid: <ol style="list-style-type: none"> a. Fill to FULL mark on dipstick b. Run engine at low idle to prime torque converter and lines c. Check oil level with engine running at low idle and oil at 82 to 93°C (180 to 200 °F). Add oil to bring oil level to FULL mark on dipstick. 						
22a 22b	a. Engine Cooling System and SCA Levels b. Coolant Filter	Figure 5-3	AFC 50/50 50/50 Blended Fully Formulated Antifreeze Coolant 6829101130 SCA 6829012858	42 qt (40 l)	<ul style="list-style-type: none"> • Check coolant level every 10 hours or daily • Change filter and check SCA levels every 500 hours • Check coolant for contamination every 1000 hour 	See <i>Service Manual</i>

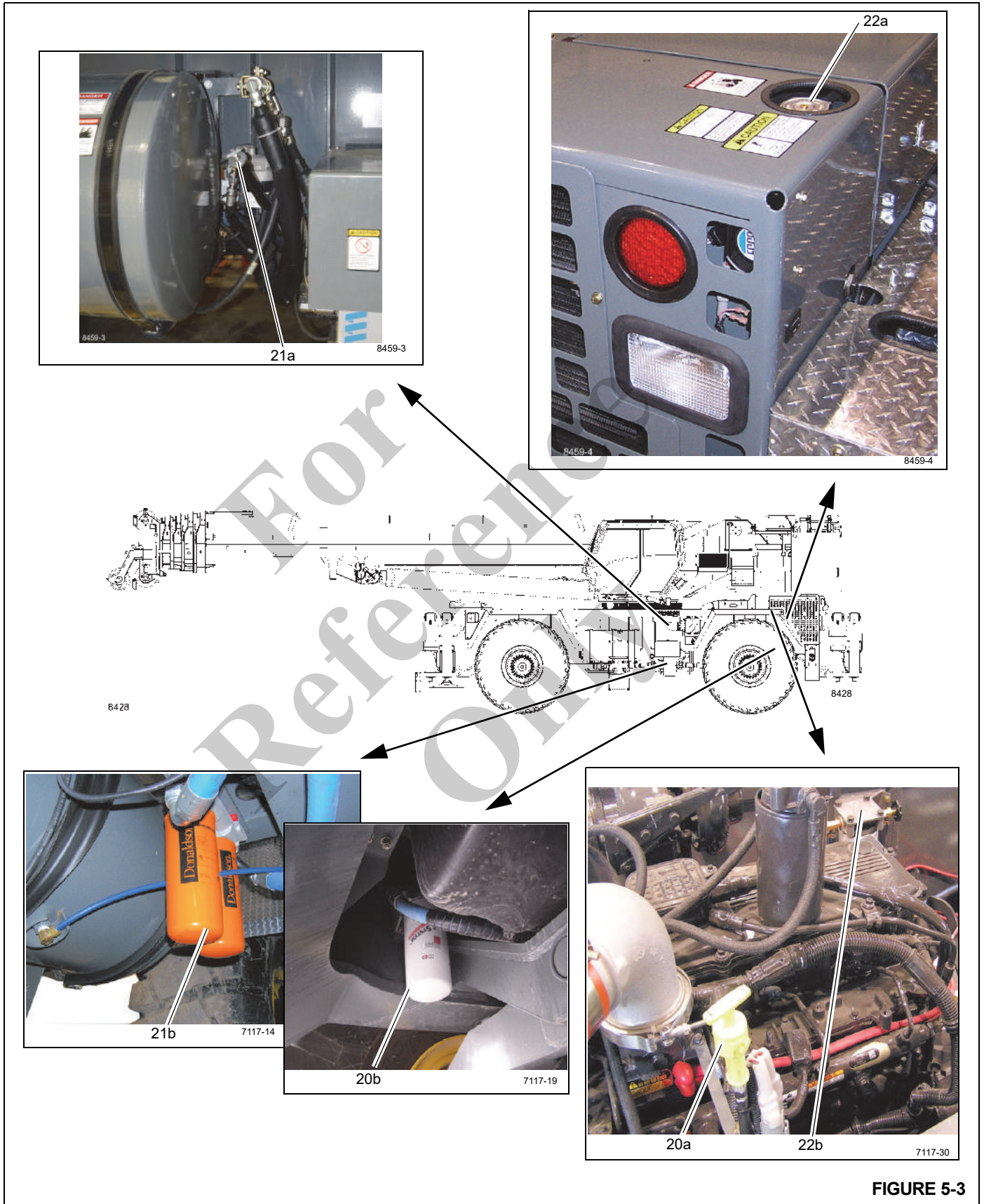


FIGURE 5-3

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Drive Train (continued)						
23	Coolant Strainer (Cab Heater)	Figure 5-4	---	---	Clean strainer screen after first 100 hours and every 2000 hours or 12 months thereafter.	Close shutoff valves. Unscrew hex plug to clean filter.
24a	Air Cleaner Filters	Figure 5-4	---	---	<ul style="list-style-type: none"> Replace primary filter element when either fault code 5576 or 3341 is displayed. Replace secondary filter every third time primary filter is replaced. In severe dust conditions the pre-cleaner may need to be serviced. 	Front of left rear fender.
24b	Pre-cleaner					
25a 25b	Water Separator Fuel Filter	Figure 5-4	---	---	<ul style="list-style-type: none"> Drain water trap every 10 hours or daily. Change filter every 500 hours or 6 months. 	Primary fuel/water separator is located beside the fuel tank
26a 26b	Driveline - Slip Joints	Figure 5-4	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	3 grease fittings
27	Retarder (Optional)	Figure 5-4	---	---	After 2000 hours	Grease using hand grease gun
<p>NOTE: Grease using hand grease gun until grease comes out of vent tube outlet located near grease nipple. CAUTION: DO NOT OVER GREASE.</p>						

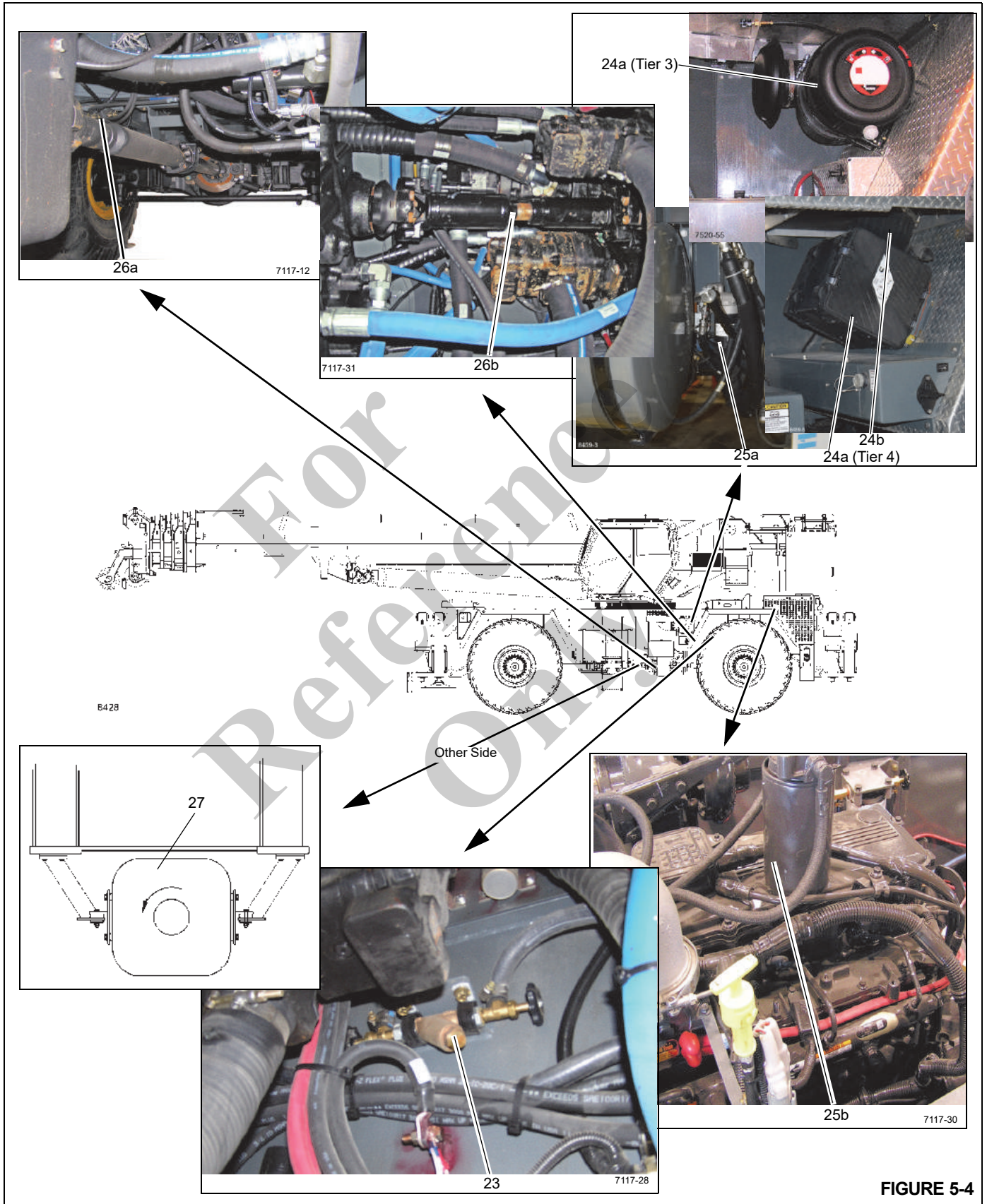


FIGURE 5-4

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Turntable						
30	Turntable Gear Box	Figure 5-5	GL-5 Extended Service Interval Gear Lubricant 6829012964	5.28 qt (4.9 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours • Drain and fill after first 250 hours and every 500 hours or 12 months thereafter. 	Fill until oil is at dipstick markings
31	Turntable Gear and Drive Pinion	Figure 5-5	EP-OGL Open Gear Lubricant 6829102971	Coat all teeth	500 hours or 6 months	Spray on
32	Turntable Bearing	Figure 5-5	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes the whole circumference of the bearing	500 hours or 6 months	2 grease fittings at the front of the turntable.
33	Turntable Swivel Lock Pin	Not shown	EP-OGL Open Gear Lubricant 6829102971	Coat pin	500 hours or 6 months	Spray on
NOTE: Rotate the turntable 90° and apply grease to fittings. Continue rotating 90° and grease the fittings until the whole bearing is greased.						
34	Hose Rollers	Figure 5-5	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3months	2 grease fittings

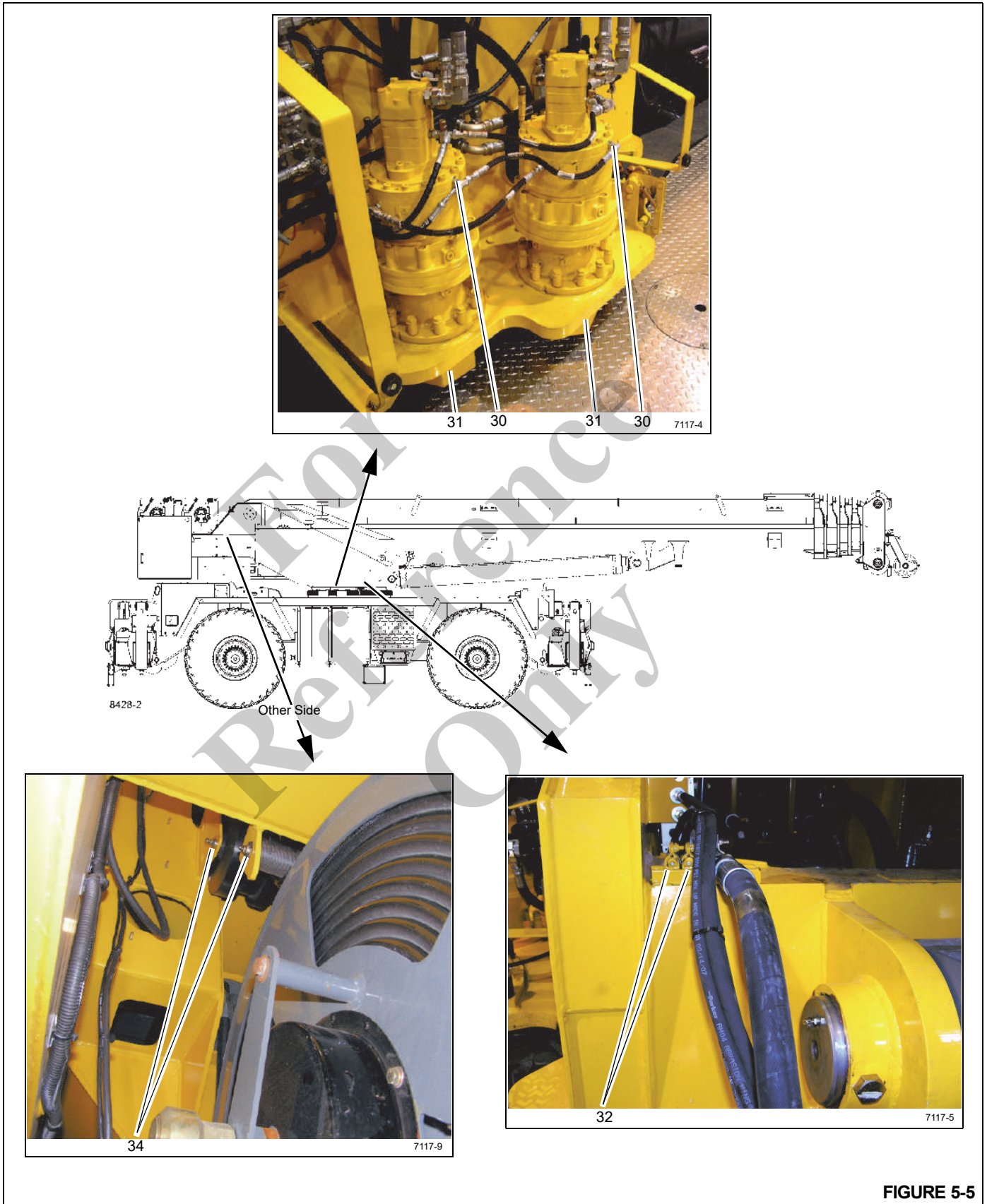
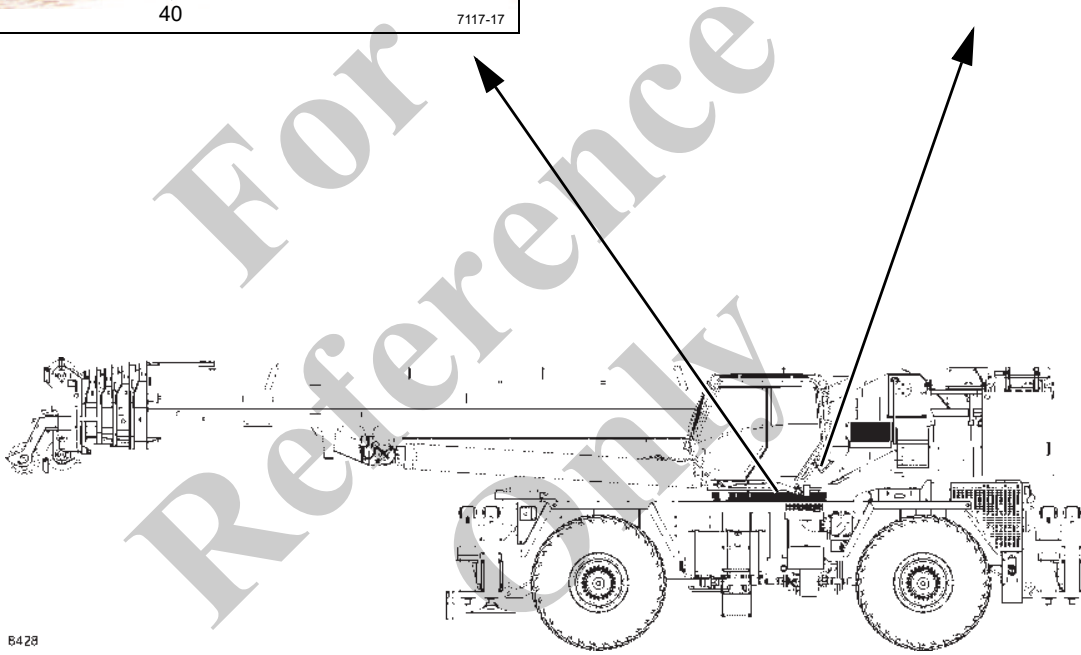
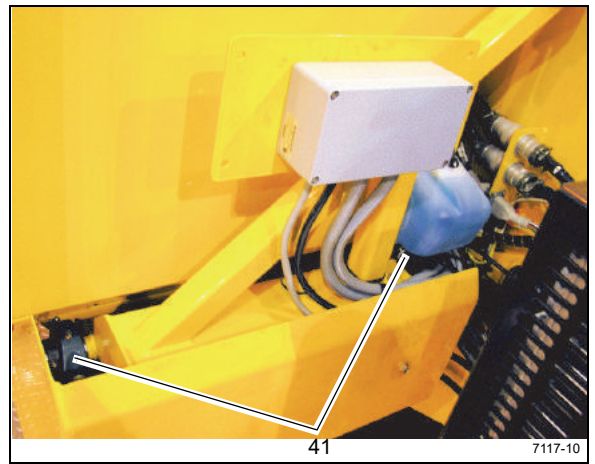
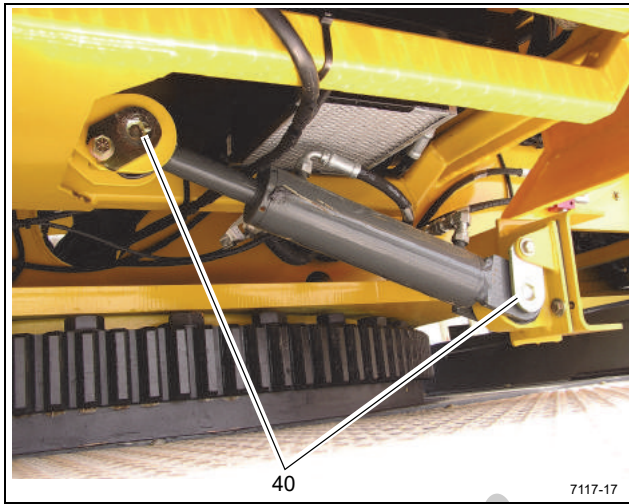


FIGURE 5-5

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Cab Tilt						
40	Cab Tilt Cylinder Pivot Pins	Figure 5-6	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	2 grease fittings
41	Pillow Block	Figure 5-6	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	2 grease fittings

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FIGURE 5-6

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Outriggers						
50	Outrigger Beams	Figure 5-7	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	---	50 hours or 1 week	Brush lubricant on bottom of outrigger beams
51	Jack Cylinder Support Tubes	Figure 5-7	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	---	50 hours or 1 week	Brush lubricant on inside diameter of jack cylinder support tubes, four places, before installing jack cylinders
52	Jack Cylinder Barrels	Figure 5-7	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	---	Apply during installation or any maintenance teardown and reassembly.	Brush lubricant on outside diameter of jack cylinder barrels at four places before installing jack cylinders
53	Removable Outrigger to Frame Attachment Areas	Figure 5-7	Anti-Seize Compound (ASC) 6829003689	---	Apply lubricant when attaching outrigger assembly to frame or if outrigger popping noise is encountered during heavy lift	Brush lubricant on all removable outrigger to frame attachment areas

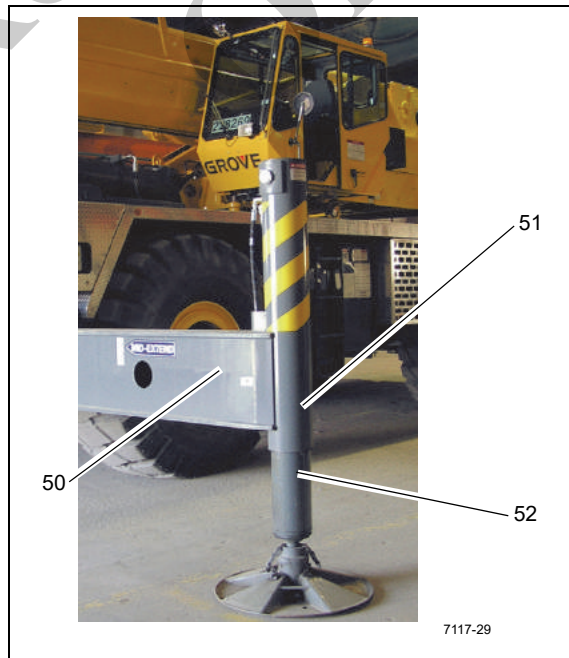
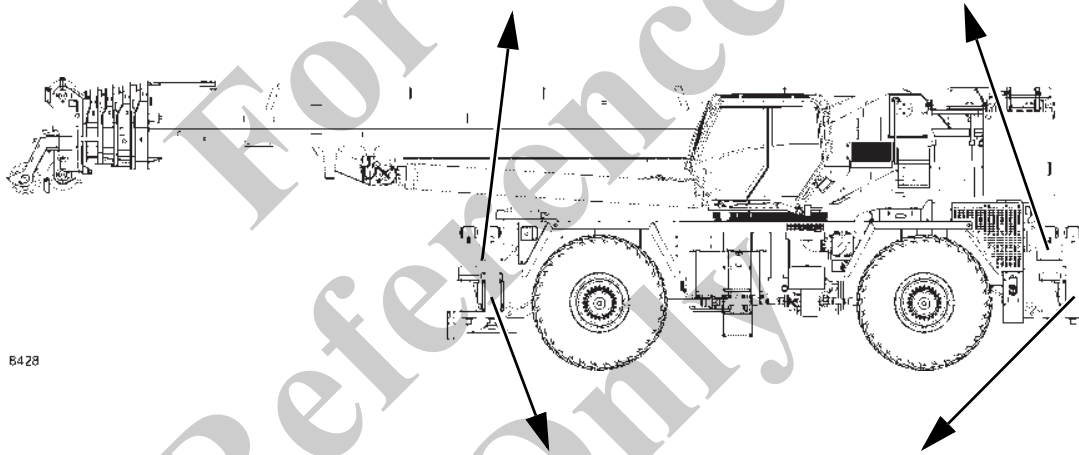


FIGURE 5-7

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom						
60	Upper Lift Cylinder Pin	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Until greases extrudes	500 hours or 3 months	1 grease fittings
61	Lower Lift Cylinder Pin	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Until greases extrudes	500 hours or 3 months	2 grease fittings
70	Hook Block Swivel Bearing	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting
71	Hook Block Sheaves	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting per sheave (80 Ton - 5 fittings total) (130 Ton - 8 fittings total)
72	Overhaul Ball	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting
73	Telescope Cylinder Wear Pads	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Thoroughly coat	Every boom teardown	5 places by brush

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
⚠ WARNING						
<p>Crane Setup for Items 74 & 75: Crane to be set up on firm level surface with fully extended outriggers and 40,000 lb counterweight installed. Ensure crane is level. Boom must be directly over the front and the house lock engaged. Set boom angle at zero degrees. No load is permitted on the boom. The weight of the hookblock, overhaul ball and rigging must not be supported by the boom. Do not extend the boom until the weight of these components is totally removed from the boom.</p>						
74	Internal Side and Bottom Wear Pads (Inner Sections)	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Thoroughly coat all areas the wear pad moves on	250 hours or 3 months	14 places by brush; through access holes with boom in extended position
<p>See Table 5-1, page 5-37 at the end of this sections for how to access lubrication points 74 & 75</p>						
75	Boom Section Upper Wear Pads	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Until grease extrudes	50 hours or 1 week	8 grease fittings; through access holes with boom in extended position

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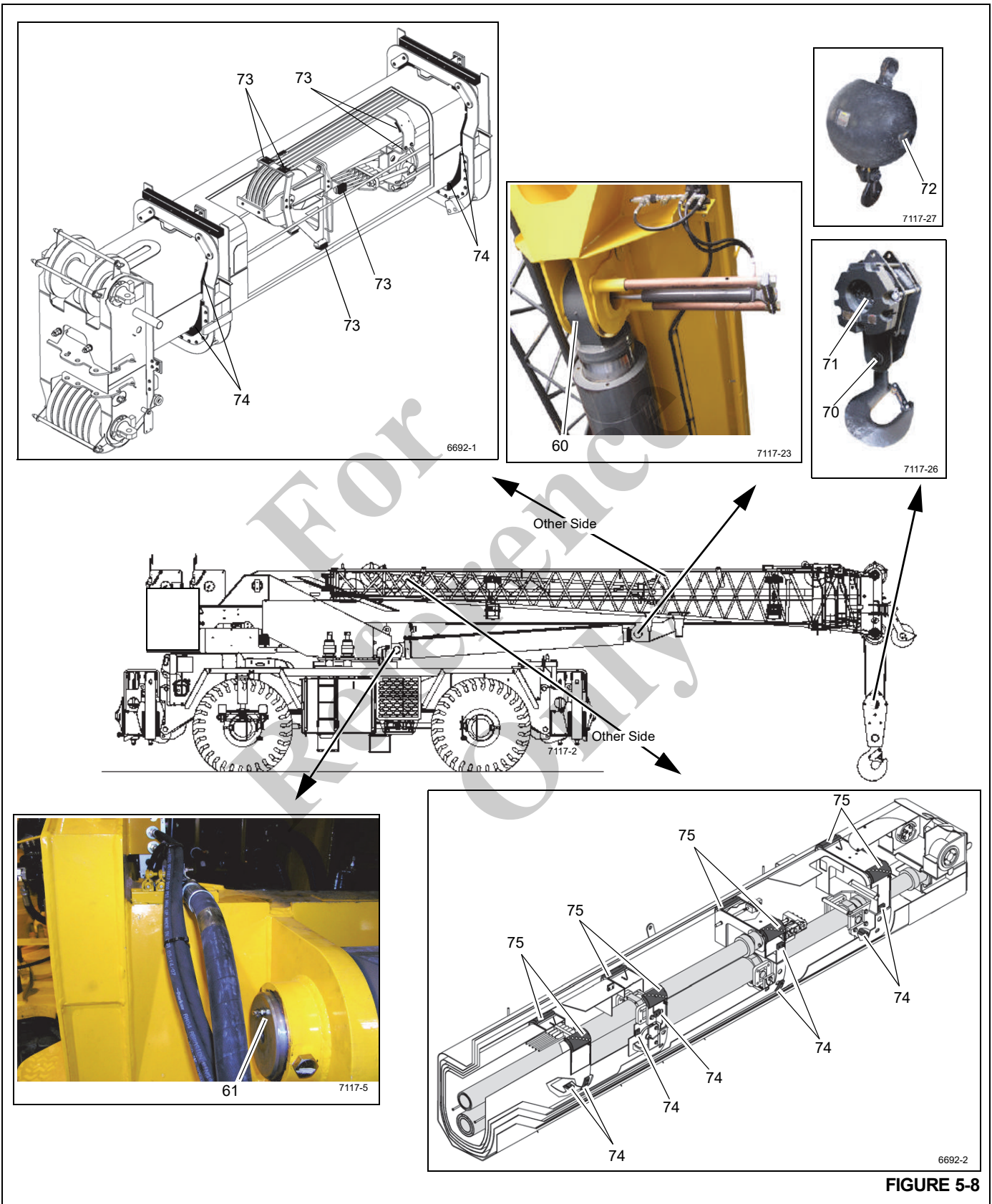


FIGURE 5-8

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom (continued)						
⚠ WARNING						
<p>Crane Setup for Items 76, 77, 78: Crane to be set up on firm level surface with fully extended outriggers and 40,000 lb counterweight installed. Ensure the crane is level. Boom must be directly over the front and the house lock engaged. Set boom angle at zero degrees. No load is permitted on the boom. The weight of the hookblock, overhaul ball and rigging must not be supported by the boom. Do not extend the boom until the weight of these components is totally removed from the boom.</p>						
76	Boom Section Upper and Lower Wear Pads	Figure 5-9	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Thoroughly coat all areas the wear pad moves on	50 hours or 1 week	12 places by brush
See Table 5-1, page 5-37 at the end of this sections for how to access lubrication points 76, 77, 78						
77	Extend Cable Sheaves	Figure 5-9	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting
78	Retract Cable Sheaves	Figure 5-9	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	2 grease fittings one on each side

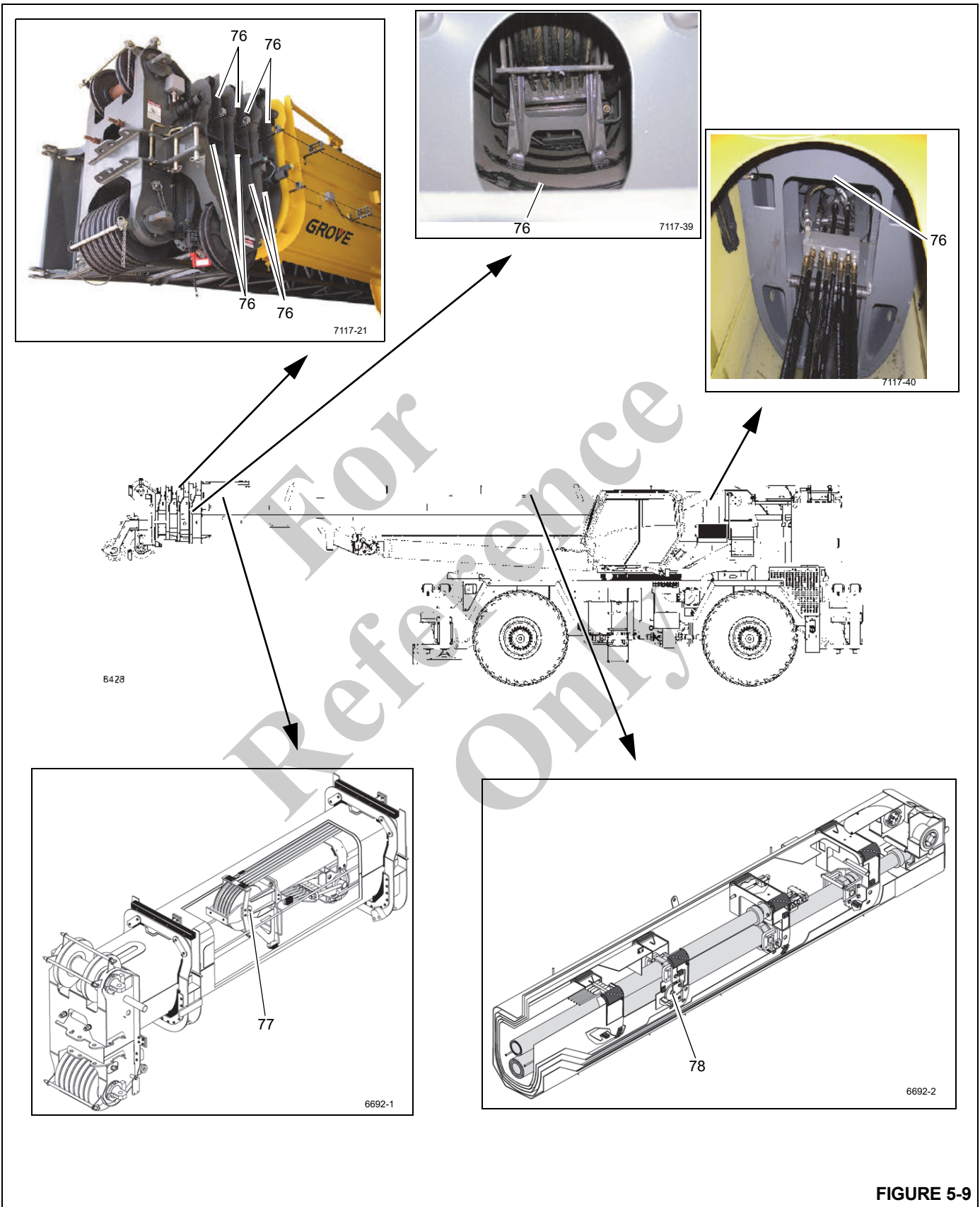


FIGURE 5-9

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom (continued)						
79	Boom Pivot Shaft	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease. Note: (Down to -9°C (15°F) use 6829015304). [Below -9°C (15°F) use 6829003477].	Until grease extrudes	250 hours or 3 months	4 grease fittings
80	Upper Boom Nose Sheave	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	2 grease fittings one per sheave
81	Lower Boom Nose Sheave	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting per sheave, 7 sheaves total
82	Hose Rollers	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	4 grease fittings
83	Auxiliary Boom Nose Sheave	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting

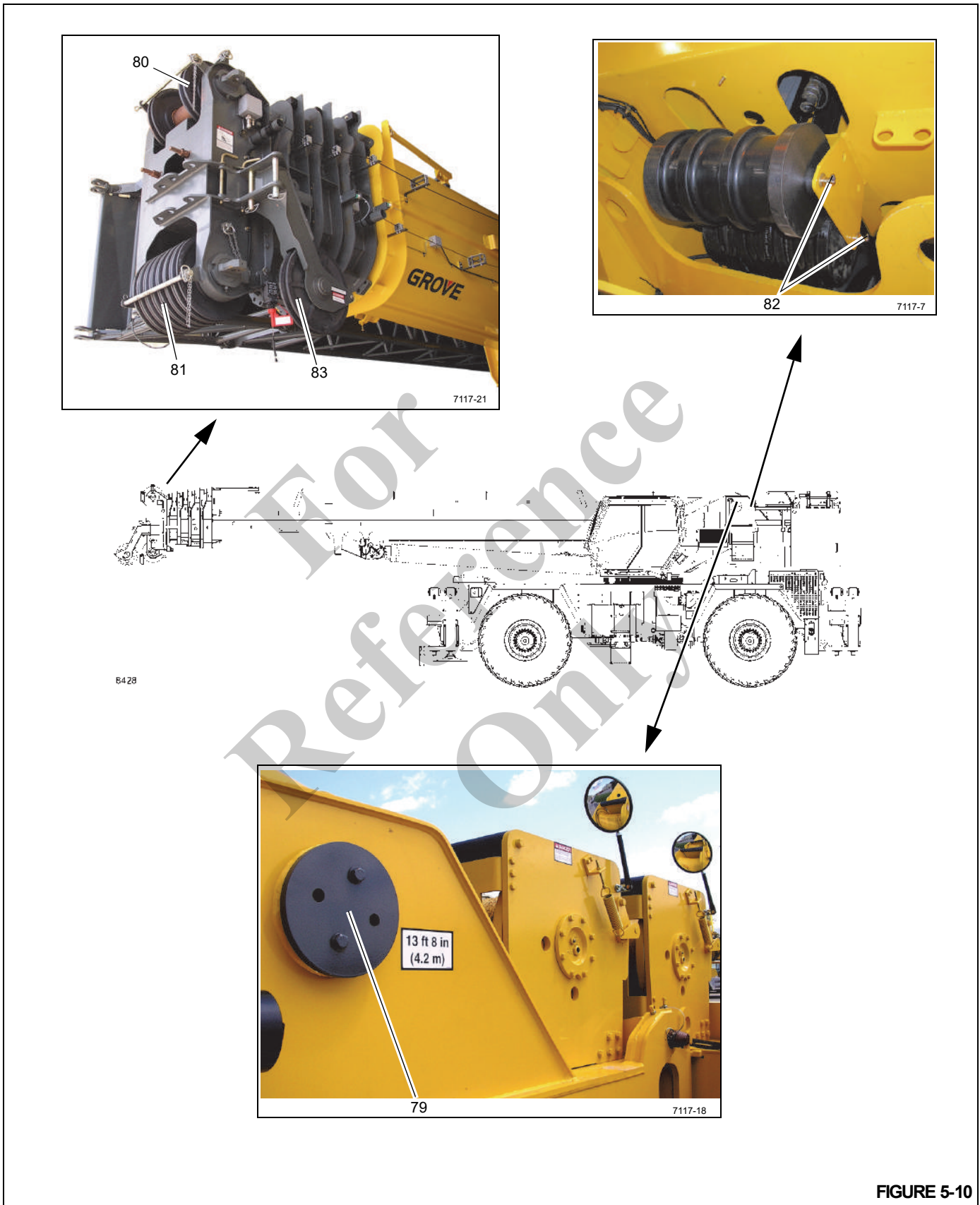
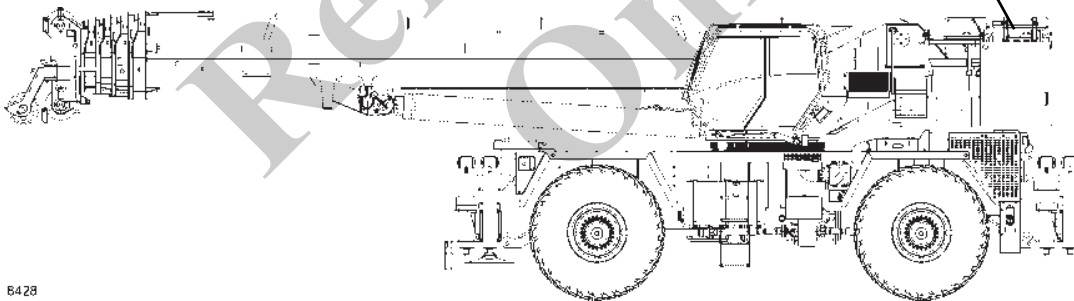


FIGURE 5-10

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Hoist						
90	Main Hoist	Figure 5-11	AGMA Extreme Pressure Gear Lubricant 6829100213	22 qt (20.8 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months 	Oil level must be visible in the sight glass. (See note)
91	Auxiliary Hoist	Figure 5-11	AGMA Extreme Pressure Gear Lubricant 6829100213	22 qt (20.8 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months 	Oil level must be visible in the sight glass. (See note)
<p>NOTE: To check hoist oil, ensure hoist is level and the fill plug is horizontal and centered in access hole at the 9:00 position. The oil must have settled for 20 minutes with the temperature in 21°C ± 7°C (70°F ± 20°F) range. Variations in oil temperature will cause oil level to fluctuate.</p> <p>If oil level is not visible in sight glass, the hoist may be under filled. Oil escaping from vent plug is an indication the hoist may be overfilled.</p>						
92	Cable Follower (Arms)	Figure 5-11	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Thoroughly coat	250 hours or 3 months	Spray on
<p>NOTE: Lubricate more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.</p>						

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FIGURE 5-11

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Hydraulic						
100	Hydraulic Tank	Figure 5-12	HYDO Hydraulic Oil 6829006444	324 gal (1226 l)	Check fluid level every 10 hours or daily.	<ul style="list-style-type: none"> • Use sight gauge on side of tank, with boom down and all outrigger cylinders retracted. • Drain and refill as necessary
NOTE:						
<ul style="list-style-type: none"> • Environmental and other conditions can dramatically affect the condition of hydraulic oil and filters. Therefore, specific intervals for servicing/changing hydraulic oil, filters and hydraulic tank breathers cannot be set. However, it is imperative for the continued satisfactory performance of Grove cranes that inspections be performed on the basis of how and where each crane is used. Air borne and ingested contaminants can significantly reduce the life of oil and the condition of hydraulic oil filters and tank breathers. • Under normal operating conditions, it is recommended that hydraulic oil, filters and breathers be inspected and oils sampled at least every 3 to 6 months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil (e.g., oil appears "milky" or no longer has a transparent clear to amber color). The return filter by-pass indicator should be observed daily to determine if the contaminants content may be high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir. • To inspect hydraulic oil, fill a small glass container with a sample of reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one to two hours and then compare the samples. If the reservoir oil is heavily contaminated with water the sample will appear "milky" with only a small layer of transparent oil on top. If the "milky" appearance was due to air foaming, it will dissipate and the oil should closely match the fresh oil. Should you have any questions, please contact your local authorized Grove distributor. • The hydraulic oil shall meet or exceed ISO #4406 class 19/17/14 cleanliness level. 						
101	Hydraulic Filter	Figure 5-12	HYDO Hydraulic Oil 6829006444	---	Change filter when the indicator is red	---
102	Hose Reel Swivel Joint	Figure 5-12	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 6 months	3 Grease fittings

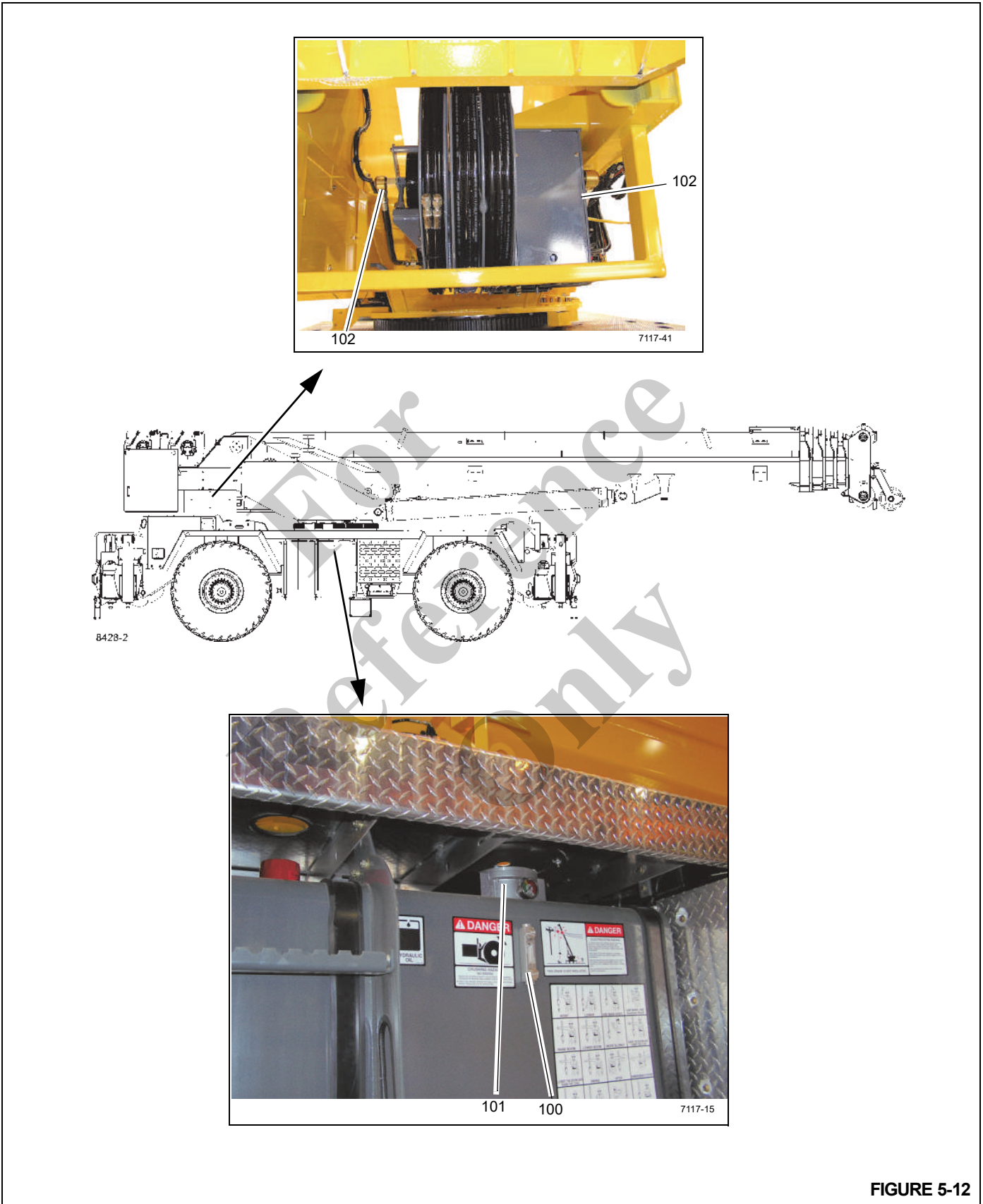
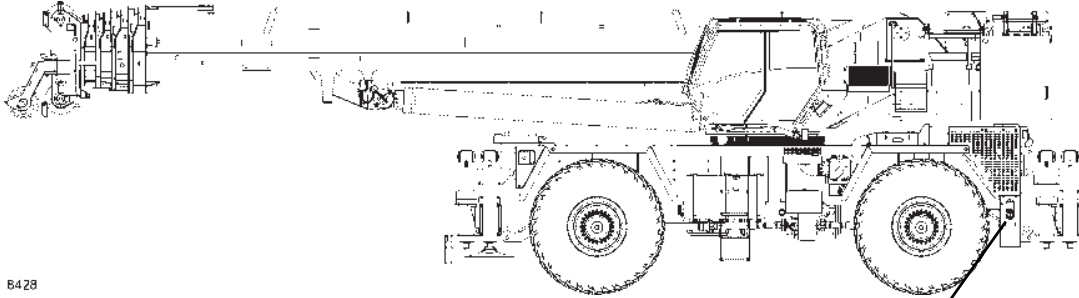


FIGURE 5-12

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Diesel Exhaust Fluid (DEF)						
110	DEF Tank	Figure 5-13	DEF 80019225	10 gal (38 l)	Fill when level is low per indicator.	---
<p>NOTE: Use caution when adding Diesel Exhaust Fluid (DEF) to avoid spills during vehicle fill-up.</p> <p>CAUTION: DEF is corrosive to certain metals and paint and should be washed off with mild soap and water if spilled.</p>						

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FIGURE 5-13

Table 5-1 Accessing Lubrication Points on Boom

Item	Boom Section	Access Location	Auto Mode	Manual Mode	Inner Mid%	Center Mid%	Outer Mid%
74	Inner	Large hole in center & outer mid	N/A	Yes	0	100	60
74	Inner	Large hole in inner mid	Yes	N/A	100	75	0
75	Outer mid & fly	Small holes on the sides	N/A	Yes	0	100	100
75	Inner mid	Small holes on the sides	Yes	N/A	100	75	0
75	Center mid	Small holes on the sides	Yes	N/A	100	100	0
76	Center, outer mid & fly	External on the boom	N/A	Yes	0	100	100
76	Inner mid	External on the boom	Yes	N/A	100	75	0
77	Extend cable sheaves	Small hole left side on the front of the outer mid	N/A	Yes	0	100	100
78	Retract cable sheaves	Oblong holes at the end of the center mid	N/A	Yes	0	100	100

Instructions for Accessing Lubrication Points on Boom

1. Set rated capacity limiter (RCL) operating code to 0001.
2. Set auto boom mode. Extend the boom sections to gain access to the Lubrication points as indicated in the table above for "Auto Mode". The rated capacity limiter (RCL) system will lockout at approximately 145 ft extension.
3. After performing the lubrication requirements accessible in one of the above, fully retract all boom sections.
4. Set boom configuration to manual boom mode and select the Tele-2 switch to fully extend the tele-2 section.
5. Fully extend the tele-2 section.

NOTE: During this extension you must override the rated capacity limiter (RCL) system.

6. Once tele-2 is fully extended, continue extending tele-3 and tele-4 section to reach the points indicated in the table above. The tele-2, tele-3, and tele-4 sections lube points may be fully extended during this step.



WARNING

Do **NOT** extend tele-1. The tele-1 section must remain fully retracted.

7. Once lubrication is complete, fully retract all boom sections and return boom to auto boom mode.

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

Grove cranes are manufactured to high quality standards, including the type of paint finish demanded by today's industry. In partnership with our paint supplier, we are also doing our part to help prevent premature corrosion of cranes.

Grove cranes will be treated with a rust inhibitor called Carwell® T32-CP-90. While a rust inhibitor cannot guarantee that a machine will never rust, this product will help protect against corrosion on Grove cranes that are treated with this product.

Carwell® is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29 CFR 19.10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

Once applied, treatment can appear to leave a slightly "oily" residue on painted surfaces and until the red tinting fades could initially be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

This treatment works in various ways: (1) it eliminates the moisture containing salt, dirt and other pollutants by lifting and removing them from the metal surface; (2) the film

creates a barrier to repel further moisture from coming in contact with the metal; and (3) it penetrates crevices.

In addition to the factory-applied treatment, Grove crane owners must provide proper maintenance and care to help ensure long-term protection of their crane against corrosion. This procedure provides information and guidelines to help maintain the paint finish on Grove cranes.

The most common causes of corrosion include the following:

- Road salts, chemicals, dirt, and moisture trapped in the hard-to-reach areas;
- Chipping or wear of paint, caused by minor incidents or moving components;
- Damage caused by personal abuse, such as using the decks to transport rigging gear, tools, or cribbing; and
- Exposure to harsh environmental hazards such as alkaline, acids, or other chemicals that can attack the crane's paint finish.

While the surfaces of the crane that are easily seen have the biggest impact on the appearance of the crane, particular attention should be given to the undercarriage of the crane to minimize the harmful effects of corrosion.

Exercise special care and increase the frequency of cleanings if the crane is operated:

- on roads where large quantities of salt or calcium are applied to treat icy and snowy road surfaces;
- in areas that use dust control chemicals;
- anywhere there are increased levels of wetness - especially near salt water;
- during prolonged periods of exposure to damp conditions (e.g., moisture held in mud), where certain crane parts may become corroded even though other parts remain dry; or
- in high humidity, or when temperatures are just above the freezing point.

Cleaning Procedures

To help protect against corrosion, Grove cranes recommends washing the crane at least monthly to remove all foreign matter. More frequent cleanings may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of

corrosion, but will also improve the ability to identify potential issues before they grow into larger problems.



CAUTION

High pressure water can be forced into spaces and infiltrate beyond seals. Avoid pressure washing in the vicinity of electrical controls, panels, wiring, sensors, hydraulic hoses and fittings, or anything that can be damaged by high pressure cleaning/spraying.

- Rinse the dirt and dust off before washing the crane. Dirt can scratch the crane's finish during washing/cleaning.
- Hard to clean spots caused by road tar or bugs should be treated and cleaned after rinsing and prior to washing. Do not use solvents or gasoline.
- Wash using only soaps and detergents recommended for automotive paint finishes.
- Rinse all surfaces thoroughly to prevent streaking caused by soap residue.
- Allow the crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

NOTE: Polishing and waxing (using an automotive-type wax) is recommended to maintain the original paint finish.

Inspection and Repair

- Immediately following cleaning, Manitowoc Crane Care recommends an inspection to detect areas that may have become damaged by stone chips or minor mishaps. A minor scratch (one that has not penetrated to the substrate surface) can be buffed with an automotive-type scratch remover. It is recommended that a good coat of automotive wax be applied to this area afterwards.
- All identified spots and/or areas that have been scratched through to the metal should be touched up and repaired as soon as possible to prevent flash rusting. To repair a major scratch (down to bare metal) or minor damage, follow these procedures:

NOTE: Manitowoc Crane Care recommends that a qualified body repairman prepare, prime and paint any major scratch(es) or minor damage.



CAUTION

To the extent any damage is structural in nature, Manitowoc Crane Care must be contacted and consulted as to what repairs may be required.

- For scratches and marks in highly visible areas:

- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat of paint using accepted blending techniques. Use of original paint colors is recommended to insure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard the effects of corrosion and enable you to do the repair at a later time during a normal maintenance interval.

Spots should be touched up with quality paint. Primers tend to be porous; using a single coat of primer only will allow air and water to penetrate the repair over time.

Application

Depending upon the environment in which a crane is used and/or stored, the initial factory application of Carwell T32-CP-90 should help inhibit corrosion for up to approximately 12 months.

It is recommended that the treatment be periodically reapplied by the crane owner after that time to help continue to protect against corrosion of the crane and its components.

However, if a crane is used and/or stored in harsh environments (such as islands, coastal regions, industrial areas, areas where winter road salt is regularly used, etc.), reapplication of treatment is recommended sooner than 12 months, e.g., repeat treatment in 6-9 months.

- Do not apply to recently primed and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying treatment.

NOTE: Unit must be completely dry before applying treatment.

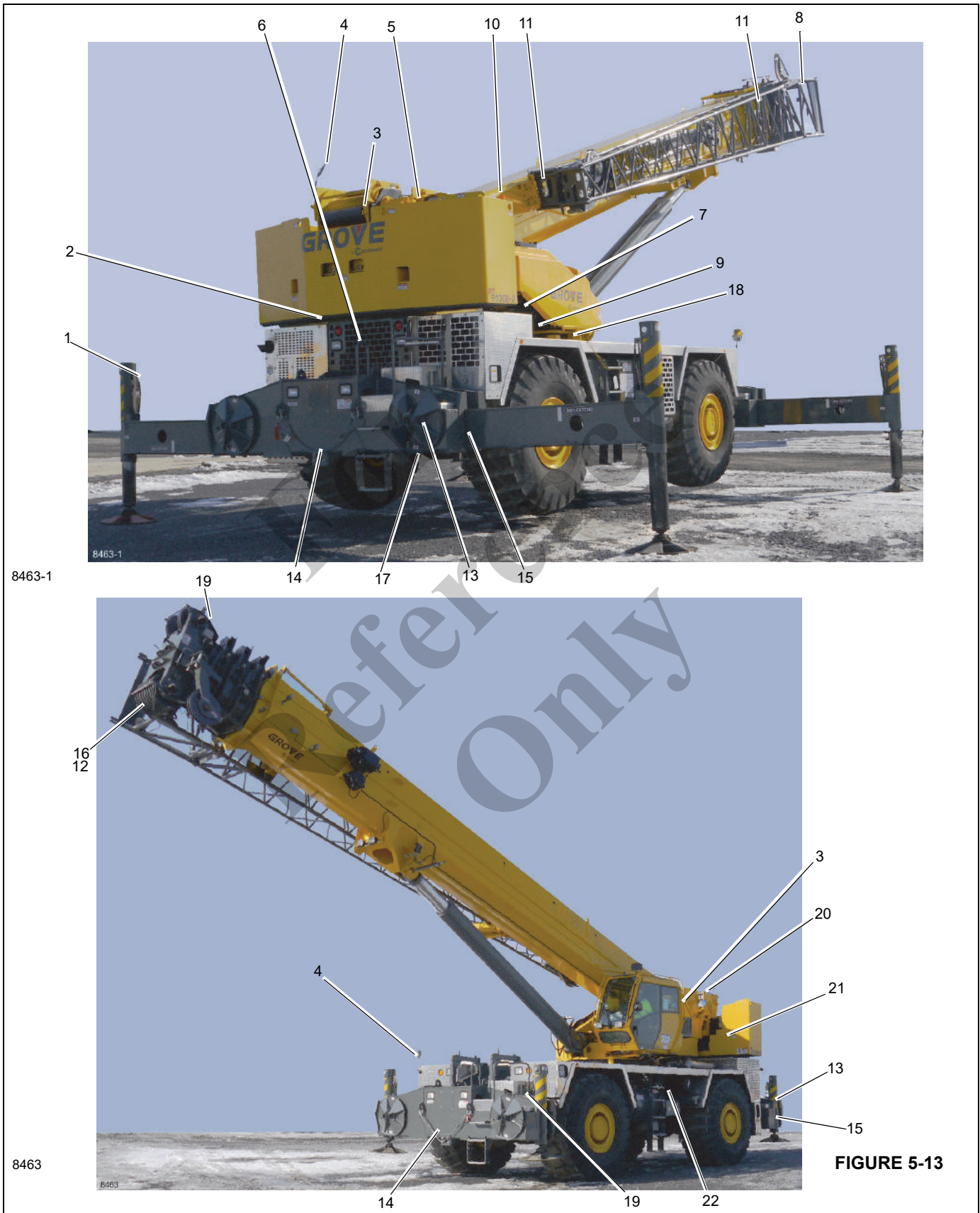
- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell treatment is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the treatment is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

Refer to Figure 5-13

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the painted surfaces. Areas include; Valves, hose ends and fittings, swivel, pumps, axles, drivelines, transmission, slew ring fasteners and all interior surfaces of the frame.
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarm hardware.
- Superstructure applications are; hose ends and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring fasteners and all bare metal surfaces.
- Boom applications areas are; pivot pins, hose ends and fittings, jib pins and shafts, all bare metal surfaces, overhaul ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.



Item	Description
1	O/R Hose Connections
2	Counterweight Removal Hoses
3	Hoist Tension Springs
4	Mirror Mounting Hardware
5	Hoist Hose Connections
6	Powertrain Hardware inside compartment
7	Valve Bank
8	Boom Extension Pins,Clips
9	Hose Connections inside turntable
10	Pivot Shaft
11	Boom Extension Hanger Hardware

Item	Description
12	Boom Nose Pins, Clips
13	O/R Pins, Clips
14	Hook block Tiedown Cable
15	O/R Beam Wear Pad Adjustment Hardware
16	Hook Block\Overhaul Ball
17	Entire underside of unit
18	Turntable Bearing Fasteners
19	All Hardware, Clips, Pins, Hose Connections not painted, O/R Pins,Clips
20	Wire Rope
21	Counterweight Mounting Hardware
22	Hose Connections

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