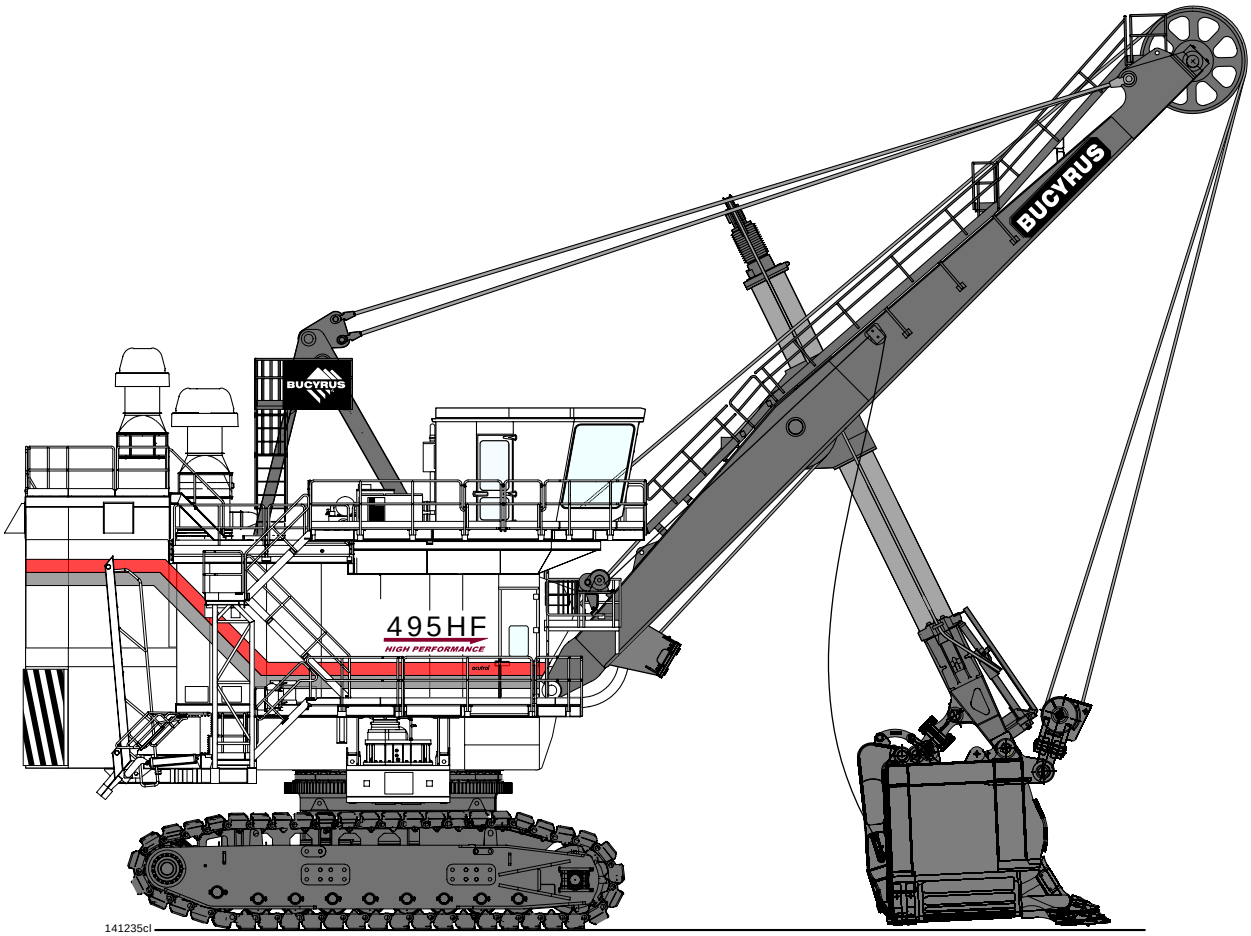
BUCYRUS®

495HF
MINING SHOVEL
MAINTENANCE and OPERATION MANUAL

SN: 141235

Manual No. *10545*



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Bucyrus International, Inc.

1100 Milwaukee Ave. • P.O.Box 500 • South Milwaukee, Wisconsin 53172-0500 USA

SAFETY - SWINGING RESTRAINT & BALLAST BOX SUPPORT

BALLAST BOX SUPPORT

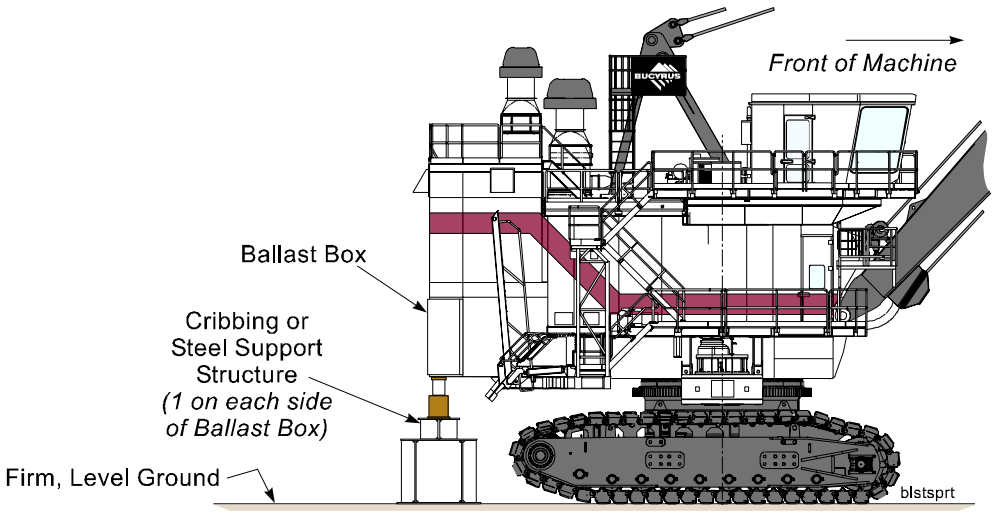
Before performing any maintenance on the mining shovel, it should be resting on a firm, level surface.

Any mining shovel field work that requires the removal or lowering of the boom must incorporate additional support of the ballast box. The supports may be wooden cribbing or steel structures. Two supports positioned side-by-side on level ground are recommended. These supports are intended to accept vertical loads only. To prevent machine rotation use the swing brakes, cable stays, welded ties, etc. Refer to “SWING RESTRAINT” below.

When electric-powered, cable-style mining shovels are properly ballasted and operational, the center of gravity for the machine's upper works lies within the roller circle area. This assumes that the boom is attached to the machine and in its elevated, working position. As such, the machine should not be prone to tipping.

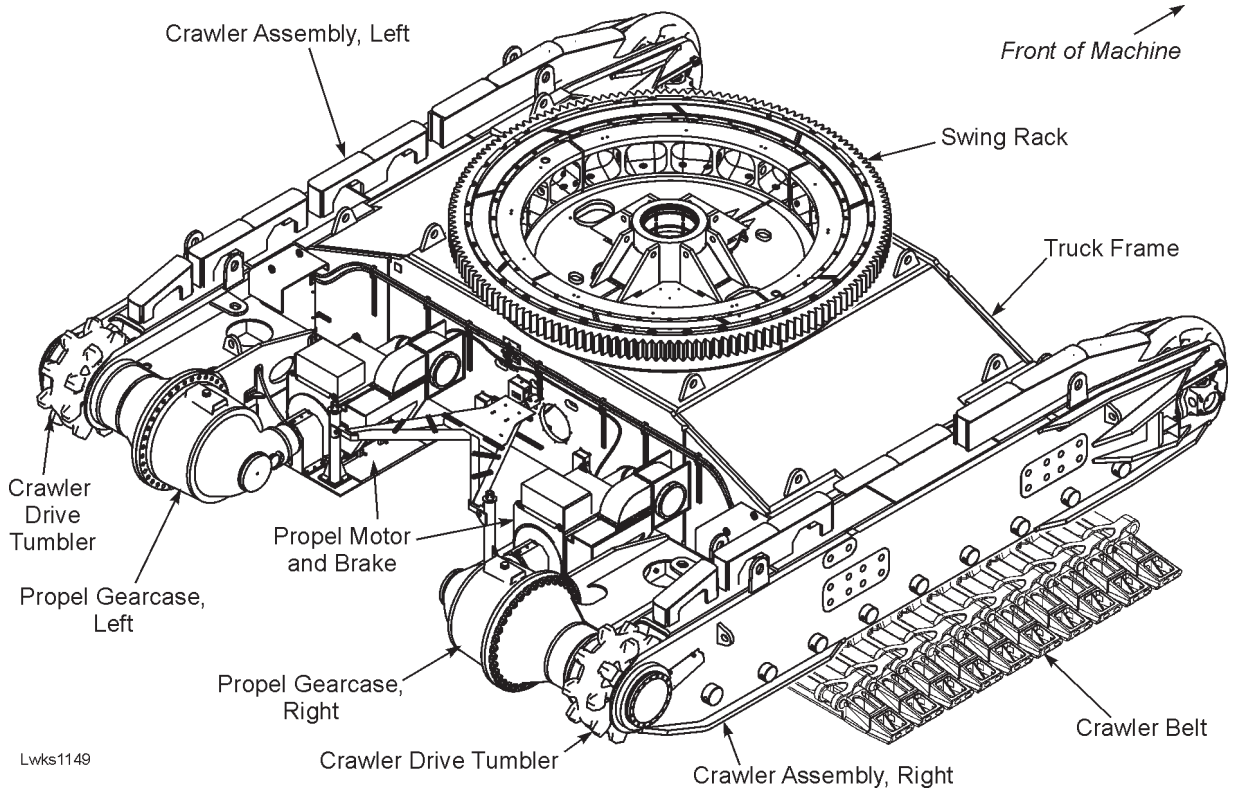
Boom removal or lowering will cause the center of gravity to shift toward the ballast box, decreasing machine stability. Stability is further dependent on the orientation of the upper works relative to the undercarriage. The machine may tip more easily over one of the four quadrants of the crawler mounting than it may over others.

Normally the machine is more likely to tip over the rear-most lower-roller than over the side of a crawler. Therefore, with the boom removed and the ballast box sitting over the rear of the crawlers, the machine may be unstable. Because ballast quantities differ from machine to machine and model to model, it is recommended that the ballast box be supported *before* beginning any procedure to lower and/or remove the boom.



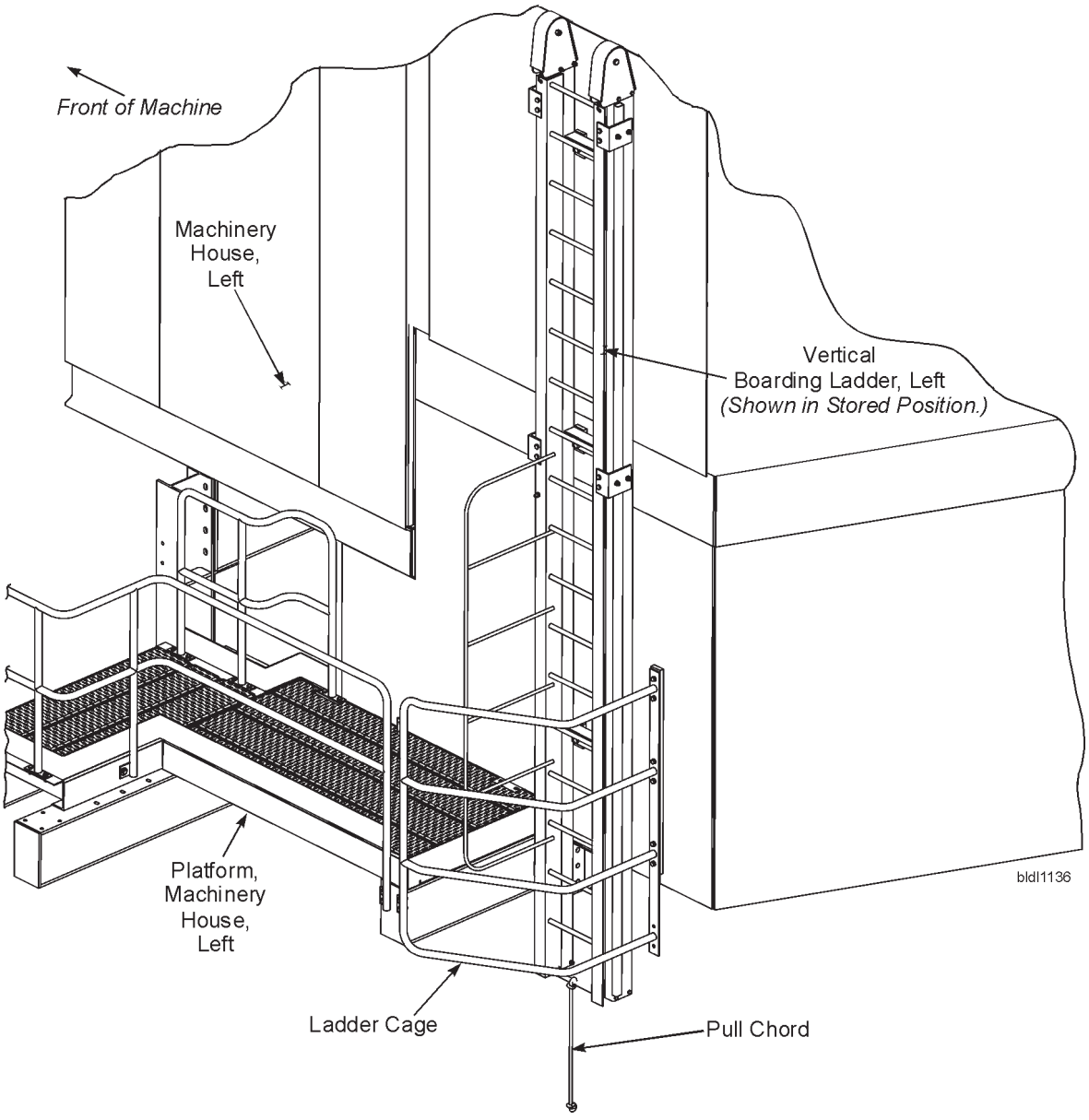
LOWER WORKS

The lower works is comprised of the truck frame, right and left crawler frames, crawler belts, propel machinery, swing rack and roller circle.



Truck Frame and Crawlers

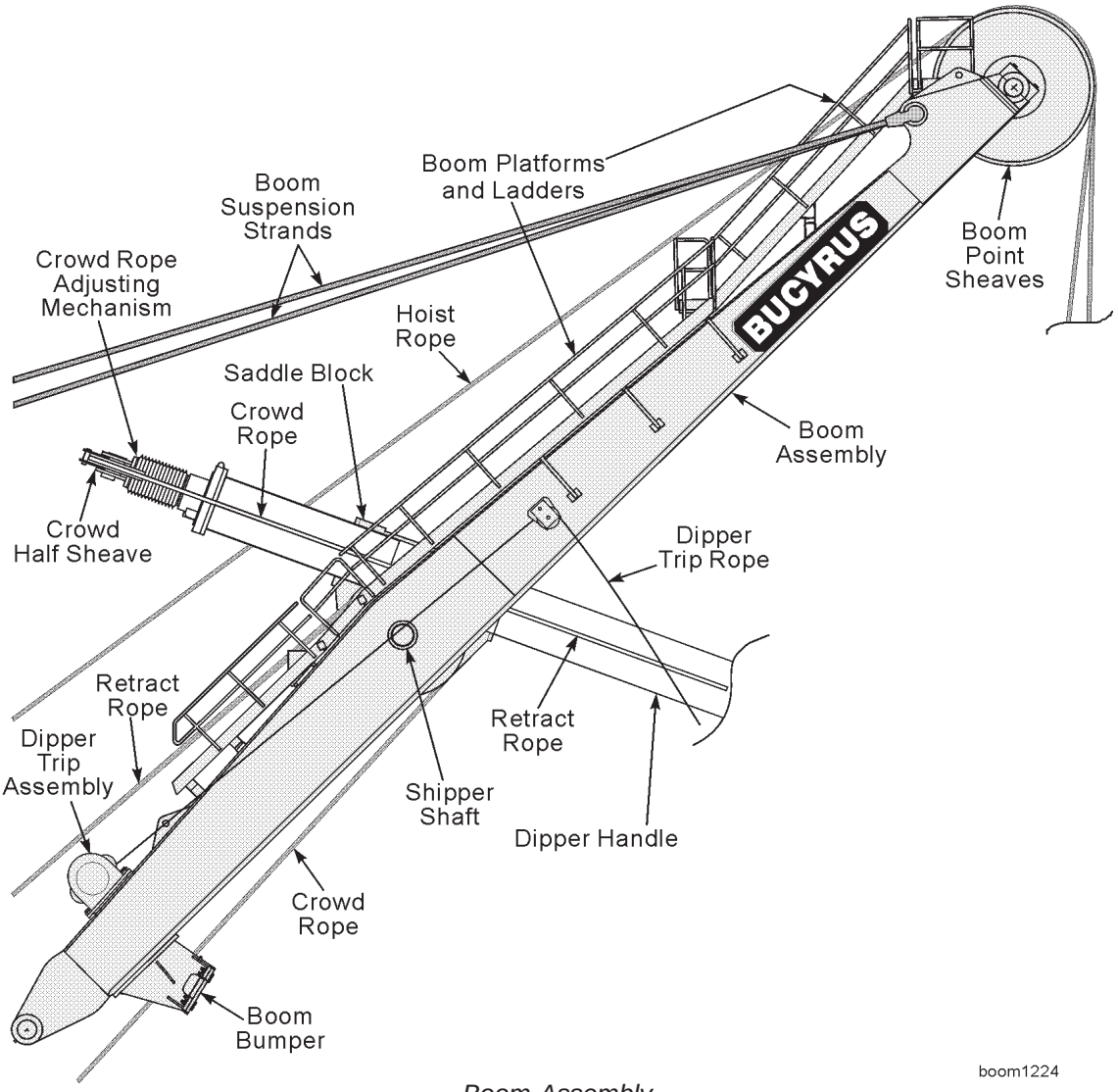
VERTICAL BOARDING LADDER



The vertical boarding ladder is one of the means for boarding the machine and is located on the left side of the machine, at the rear of the machinery house. Use the pull chord from ground level to lower the ladder. This ladder must be in their raised and latched position to enable the operator's controls.

BOOM

The boom is a welded steel structure consisting of twin box girders integrally connected at the boom point and in the lower section between the shipper shaft and boom feet. Impact resistant steel is utilized, coupled with 100% penetration and UT quality welds on all main splice joints. Design optimization has resulted in heavier outside skin plates, minimizing the need for internal diaphragms. This reduction in weld related stress concentrations further enhances structural life. Open manholes have been incorporated in the boom as a standard feature permitting periodic structural inspection. Integral “ladders” within the upper boom sections permit internal access without lowering the boom.



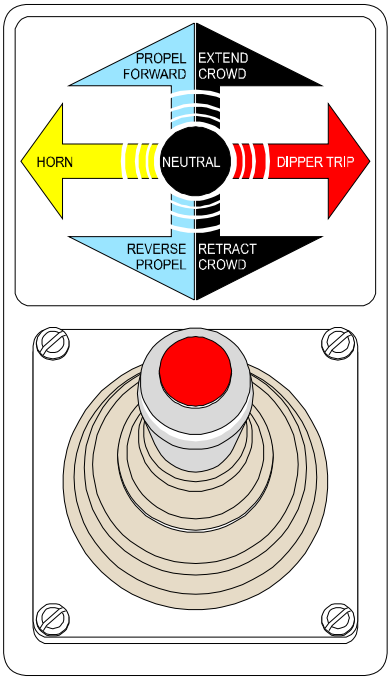
Boom Assembly

The boom is supported by four pre-stressed suspension (structural) strands attached to equalizer links on the A-frame. These inherent long life structural strands carry the working loads of the front end equipment. A boom limit switch with soft setdown prevents boom jacking shock loads.

	Quantity	Weight Each (U.S. Pounds)
Upper Works *(Cont.)*		
Hoist Machinery Guard - Lower Front	1	2,000
Hoist Machinery Guard - Upper Front	1	1,290
Hoist Machinery Guard - Rear	1	940
Hoist Bearing Housing	2	3,200
Hoist Drum	1	27,000
Hoist Spider	1	16,000
Hoist Drum Gear	1	11,000
Hoist Frame - R. H.	1	8,400
Hoist Oil Cooler	1	2650
Hoist Oil Cooler Support	2	850
Hoist Motor	1	15,000
Hoist Brake	1	1,350
Hoist Brake Adapter	1	500
Hoist Brake Hub	1	205
Hoist Motor Coupling Shaft Assembly	1	1,430
Coupling Shaft, Gearcase	1	940
Coupling, Motor	1	600
Hoist Motor Coupling Guard - Gearcase	1	130
Hoist Motor Coupling Guard - Motor	1	95
Boarding Stairs	1	4,650
Machinery House Filter Assembly	2	1,330
Control Room Filter Assembly	1	1,330
Revolving Frame	1	162,300
Front End		
Boom (Bare)	1	148,450
Boom Bumper Assembly	8	30
Boom Point Sheave Assembly	1	6,750
Boom Point Sheave	2	4,750
Saddle Block & Liner Assemby	1	25,000
Shipper Shaft Assembly	1	5,110
Crowd / Retract Rope	2	2,100
Hoist Rope	1 pair	10,750
Suspension Rope	4	2,750

CONTROLS ON THE LEFT CONSOLE

LEFT MASTER SWITCH



The Left Joystick functions as the crowd/horn/dipper trip/propel master switch. It is the vertical handle mounted on the left console of the operator's seat. The switch will spring return to neutral when released.

During normal operation, pushing the joystick forward will extend the dipper handle and dipper into the bank. Pulling the joystick rearward will retract the dipper handle and dipper toward the machine. The neutral position between the crowd and retract functions is defined by a detent that is easily felt. The rate of motion is controlled by varying the distance the joystick is moved from the neutral (center) position. Full forward or full rearward position provides maximum speed to the handle. Moving the joystick to neutral will cause a braking action slowing the crowding or retracting handle. Reversing the joystick will cause the motion to stop and if the joystick is held in this position, it will change the direction of the motion.

With the propel transfer switch in the PROPEL position, pushing the joystick forward will cause the left crawler to move forward. Pulling the joystick to the rear will cause the left crawler to move in the reverse direction. The crowd/retract motion is locked out electrically when the machine is in the propel mode.

DIPPER TRIP

The dipper trip is part of the crowd joystick function. Moving the joystick to the right will activate the dipper trip mechanism which releases the dipper door latch. The dipper trip is operational throughout the entire range of the crowd motion.

SIGNAL HORN

Moving the joystick to the left will activate the signal horn. The signal horn is operational throughout the entire movement range of the crowd motion.

DISPLAY AREA AND INDICATORS

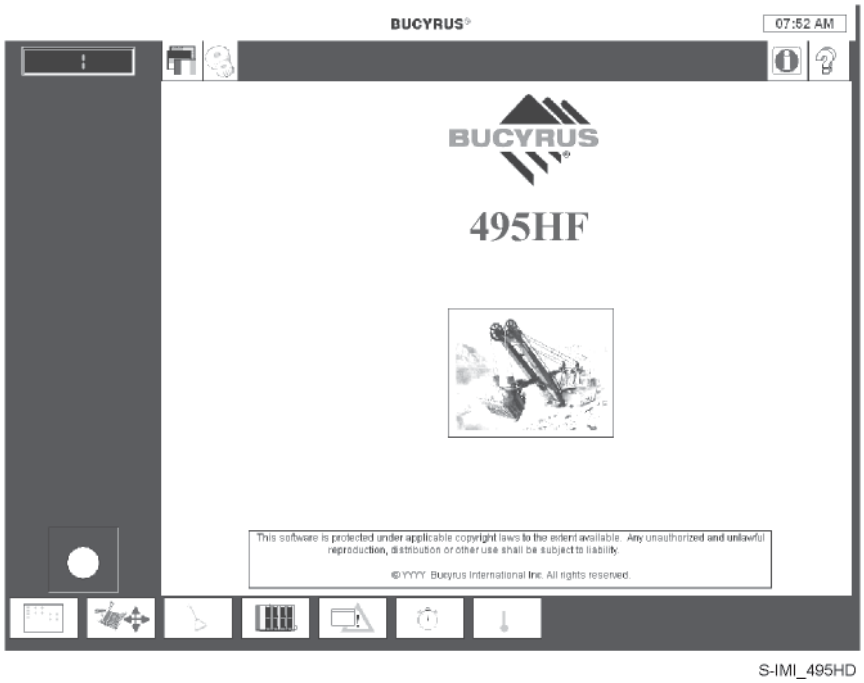
The display area of the monitor screen is the large area in the center of the screen. This area is “touch sensitive.” All information will be displayed on this area in either a text format or in the form of visual icons. The buttons and icons that appear on the screen will respond to touching the screen in the appropriate area of the icon. These icons and buttons will react by activating the screen, switch activation or display information relevant to the icon. The switches and buttons will be covered in the following pages under the screen topic in which they appear.

The indicators on the lower portion of the screen area are indicators and sensors which indicate functionality of the operator display and it’s interface with the machine’s PLC controller. They have no effect on machine operational use.

All the machine controls can be found on the Operator’s Display Panel touch sensitive screen or the left and right Control Consoles of the operator’s seat.

DISPLAY SCREENS

The Title Screen display appears when the machine is initially started.

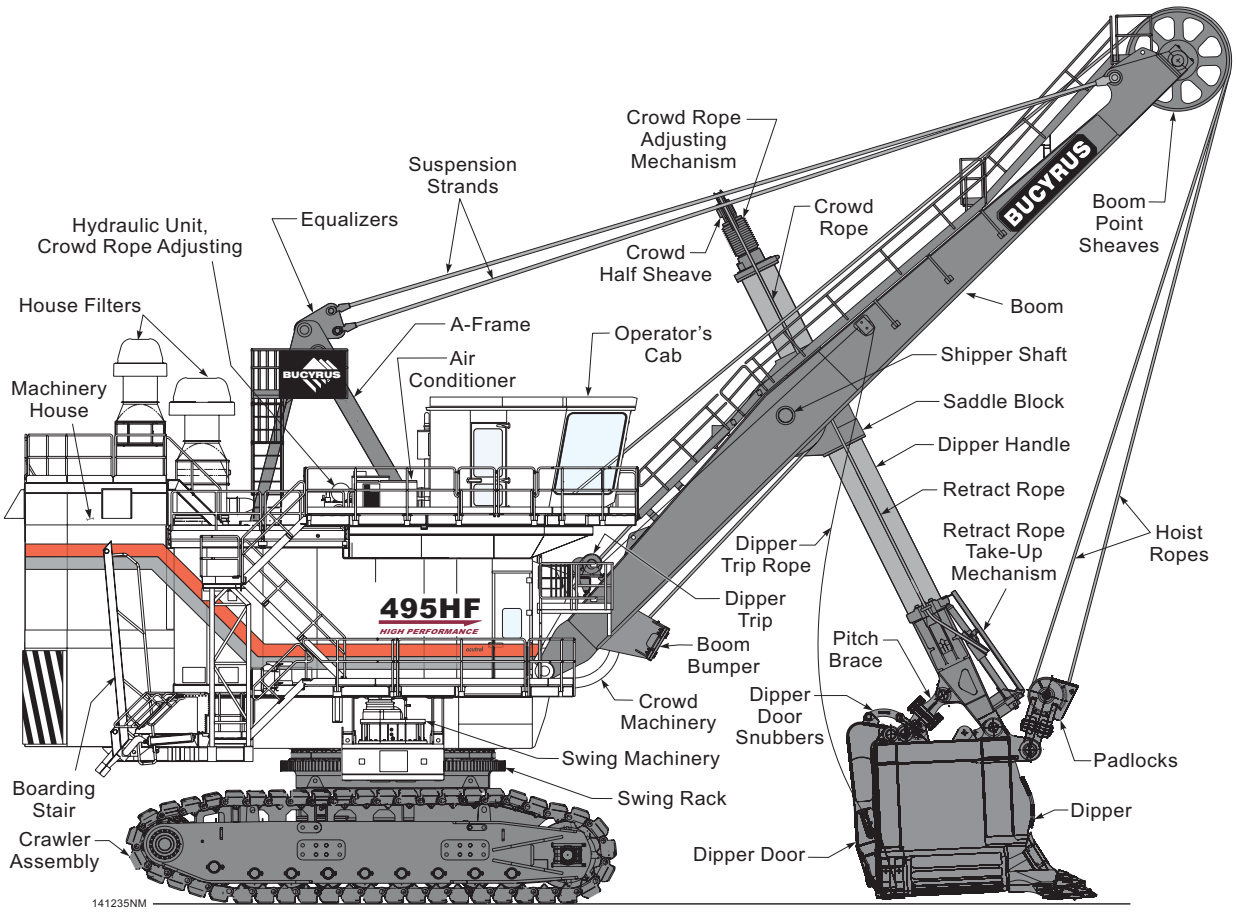


Title Screen

The information provided in the central area of the screen is machine specific.

PRE-START CHECKS

Before starting, inspect the machine to ensure it is ready to be put into operation. Failure to make such a routine check could result in unnecessary downtime. For example: an undetected oil leak could result in a dry gearcase, eventually leading to excessive gear wear or destruction, seized bearings or other mechanical problems. Broken strands in the hoist ropes, crowd rope, retract rope or structural strands could, if undetected, result in serious injury or damage to the machine or haulage unit. A few minutes spent inspecting the machine often results in considerable savings in time and machine efficiency. Section 4 of this manual contains reproducible checklists to assist in record keeping and ensure that adequate inspection standards are met.



WALK-AROUND GROUND LEVEL INSPECTION

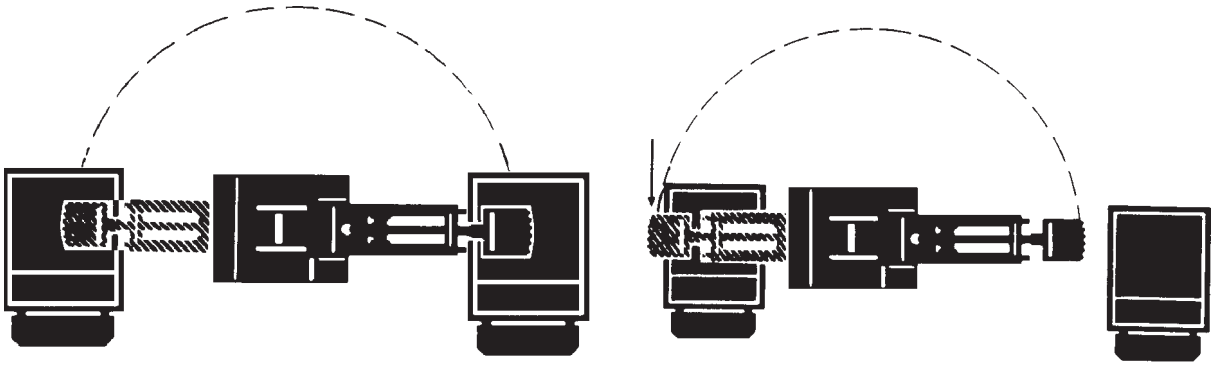
Check the following areas daily during a general walk-around inspection:

1. Check the areas under and around the crawlers for signs of oil leaks. If single droplets are noticed, leakage is minimal. Determine the point of leakage and make a note of it on the log sheet. If pooling of oil is noticed, determine the source and take corrective action immediately. Determine if loose hardware, a defective gasket, a combination of both, or a similar problem is responsible. Tighten hardware or replace defective gaskets.

PROPER SWING MOTION

Proper swing motion means smooth control and an efficient swing cycle. The swing motion is begun toward the haulage unit when the dipper is filled and is clear of the bank.

DANGER: Extensive damage to the dipper handle and dipper can occur if the machine is swung before the dipper clears the bank. The swing motion begins with acceleration to an optimum point at which the excavator is brought to a stop over the haulage unit. Maximum efficiency and minimum swing machinery wear are direct results of mastering the swing motion.



Proper spotting of trucks will result in more efficient load cycles.

Poor spotting of trucks will result in inefficient load cycles and reduced machine production.

trsp1101

NOTE: Improper swing motion results in erratic control, and an inefficient swing cycle.

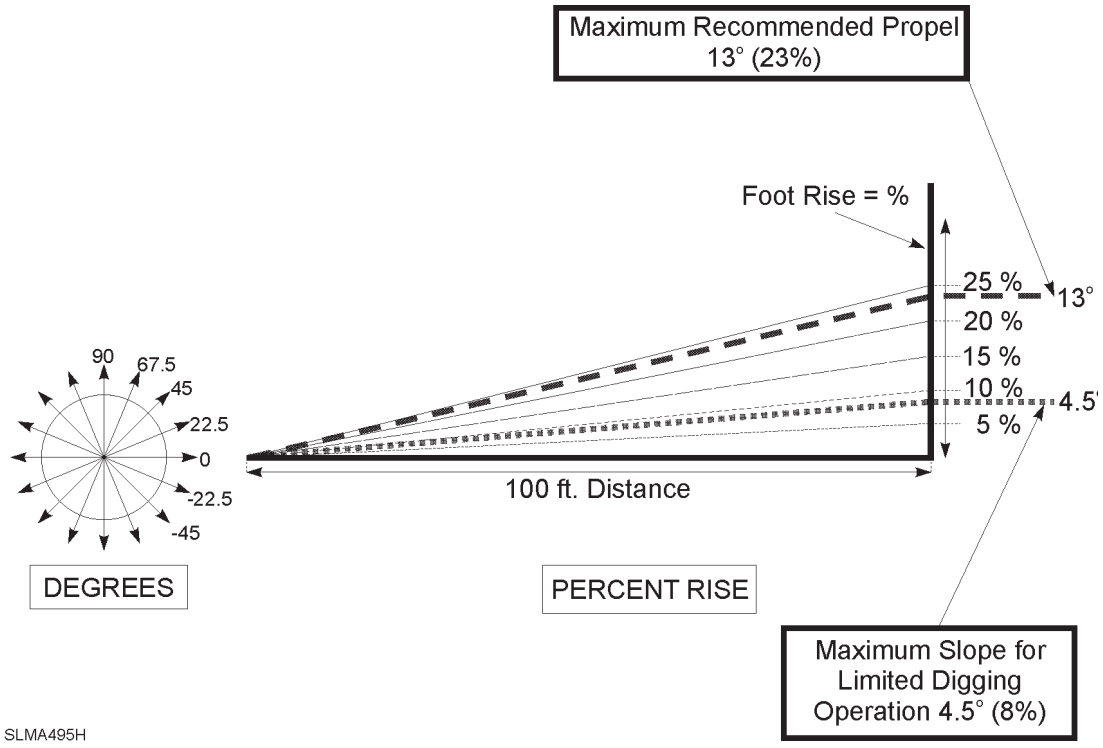
DANGER: The dipper should never be swung over personnel, trail cables, related electrical equipment or other equipment. When the dipper is loaded, accidental tripping of the dipper door could result in death or serious injury to personnel, and extensive damage to equipment. Empty dippers may contain small fragments of material that can be extremely dangerous when dropped from a considerable height. On long moves it's best to have the door open on an empty dipper and the dipper lowered to a point that permits moving without striking the ground.

Time is required to accelerate any motion from zero to working speed, and also to decelerate from working speed back to zero. The time expended for accelerating and decelerating the swing represents the major part of the entire dig cycle. Therefore, the swing arcs must be kept to a minimum to obtain maximum operating efficiency. As an example: assuming that a 90° swing results in 100 percent of the maximum output, increasing the swing arc to 180° reduces output to 70 percent, while decreasing the swing arc to 45° increased the output to 126 percent. Therefore, a swing arc of 90° or less should usually be used.

SLOPE LIMITATIONS

While it is strongly recommended that the machine dig on level ground for the greatest possible productivity and the longest component life, limited operation on slopes up to 8% is, however, acceptable with only minimal adverse effects.

NOTE: It is important to remember the difference between Slope Percent and Degrees!



Slope vs. Degrees

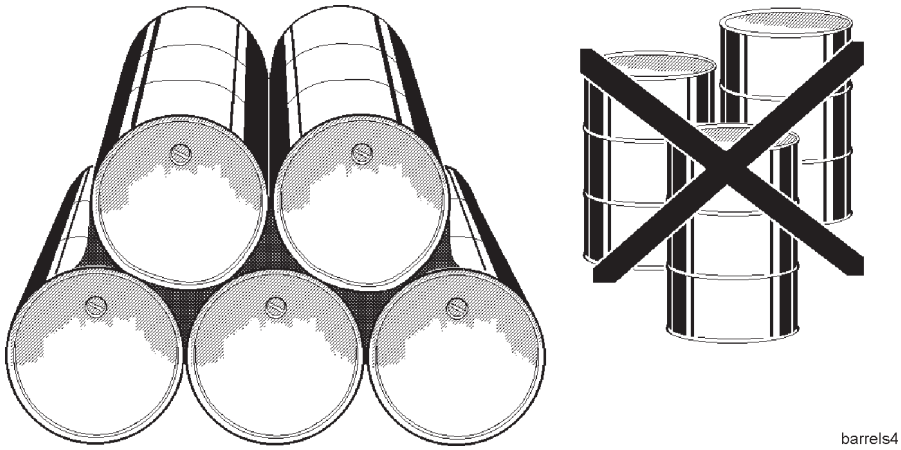
LUBRICANT SELECTION

The selection of the proper lubricants for use on this machine is critical to its reliability. Improperly lubricated bearings, gears, couplings and other precision parts quickly fail. For this reason, lubricants selected in accordance with the “American Standards Testing Material” (ASTM) standards are recommended. These standards were compiled in cooperation with major petroleum suppliers to ensure the consumer of an exact supply to specific requirements, regardless of source.

We recommend you advise the petroleum supplier of the following information to assist in selecting the proper product for each application of this machine.

Final acceptance of all lubricants supplied to this standard will be based upon their satisfactory performance in the intended application and does not relieve the supplier of performance responsibility for brand name products.

Operation of this machine in extreme temperatures (below -20°F/-29°C or above 110°F/44°C) requires special lubrication. Note the temperature ranges on the following lubricant specification sheets. Contact your local supplier, your Bucyrus representative, or the Service Department of you local Bucyrus International office for recommendations if you require additional information or advice.



barrels4

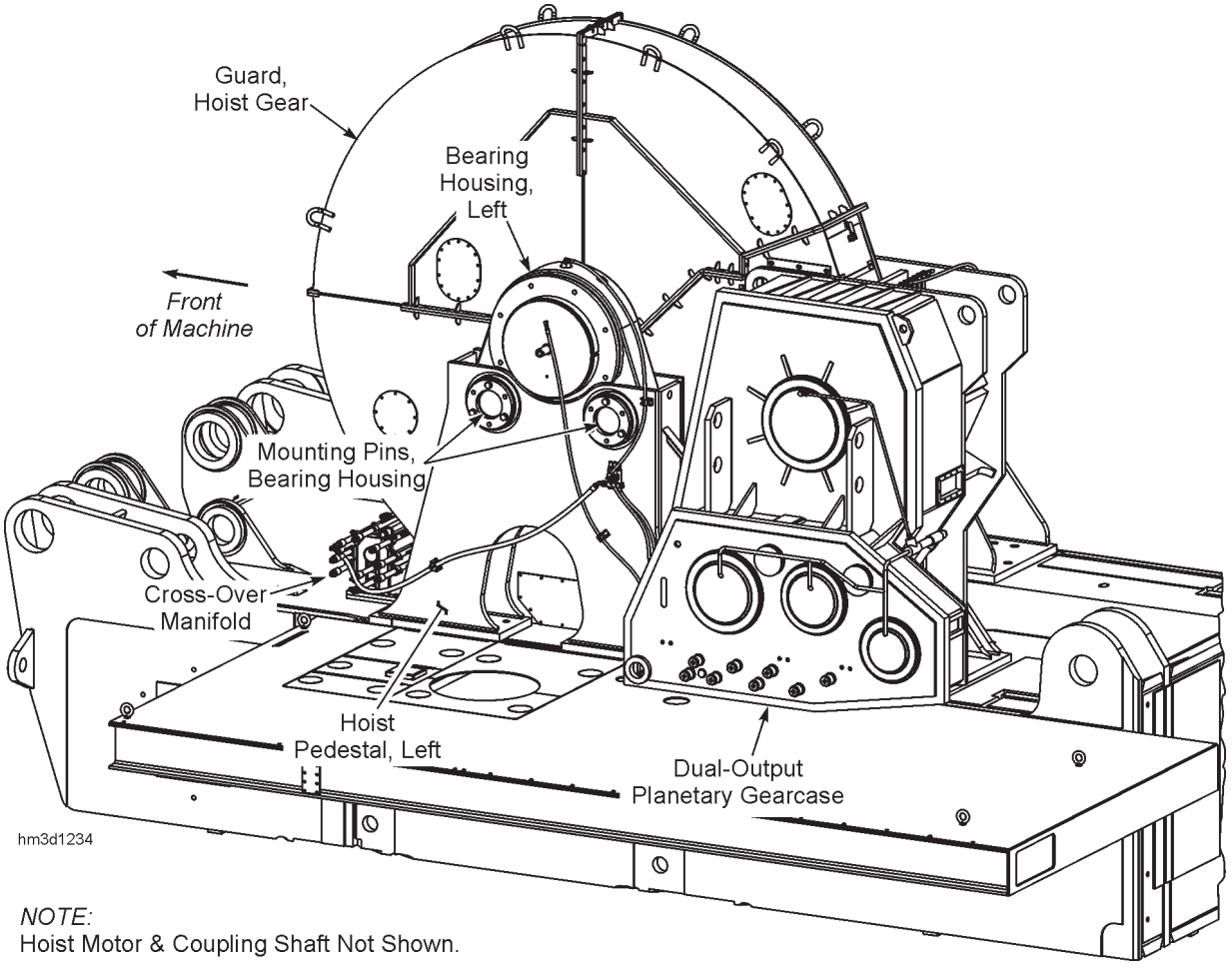
- STORE LUBRICATION DRUMS ON THEIR SIDE, WITH THE OPENING TOWARD THE TOP.
- STORE ALL LUBRICANTS IN TIGHTLY COVERED CONTAINERS!
- WIPE OFF COVERS AND SURROUNDING AREA BEFORE OPENING!
- FILTER ALL OIL BEFORE ADDING IT TO THE SYSTEM!
- USE ONLY CLEAN and PROPER LUBRICANTS!
- DO NOT MIX TYPES or BRANDS of LUBRICANTS!

Even the best lubricants are less useful in preventing wear if they become contaminated by dirt or water due to careless handling or storage.

HOIST MACHINERY LUBRICATION

The hoist machinery drive is comprised of 2 stages of gear reduction. The first stage gear reduction is an enclosed system running submersed in lubricant. The gearcase housing is equipped with lubricant level check plugs on the right side of the case. A filter breather is provided to allow for air entry to equalize pressure differentials created by the warming and cooling of the gearcase, allows moisture to escape and prevents contaminants from entering.

The second stage of gear reduction is operating as a semi-enclosed system lubricated by OGL. The drum shaft bearings are grease lubricated by System “C-1” along with the intermediate shaft of the hoist gearing. The motor pinion shaft bearings are splash lubricated from the 1st stage gearcase.



NOTE:
Hoist Motor & Coupling Shaft Not Shown.

FRONT END LUBRICATION

The front end equipment is exposed to the most extreme working environment of any part of the machine. The proper amount of lubrication and its quality is imperative to achieving a substantial service life from these components. Daily inspection and monitoring of the lubrication system will result in both parts durability and the reduction of machine downtime.

Boom Foot Pins: Although not under constant movement during the operation of the machine, the boom point feet are subjected to high loads and oscillations in a variety of directions. Virtually all movement of the front end equipment will exert a load on the pins. OGL is introduced from lube system “A-1” to reduce wear.

Saddle Block: The saddle block bears the brunt of movement from the dipper, dipper handle, attached equipment and any material being moved. The saddle block lube points need to be checked at least before each shift to avoid dry spots and accumulations of foreign material. The saddle block lube to the handle is received from lube system B-2. The crowd sheaves and shipper shaft bushings lube is received from lube system A-1.

Sheaves: Both fixed and rotating front end sheaves are subjected to loads introduced by the ropes as they move the larger components of the machine. The sheave bearings on the boom point, the crowd sheaves and the connection points of the structural strands are lubricated by lube system “A-1”.

Wire Ropes: Running and structural wire ropes have very specific requirements for lubrication in order to survive the difficult conditions they are forced to operate within. Without proper lubrication and maintenance the expected life from costly wire ropes will be seriously degraded. Refer to Section 9 - ENGINEERING DATA for general care and maintenance of wire ropes.

Suspension Ropes: The suspension ropes support the boom as well as the rest of the front end equipment. These ropes are under constant tension but also sustain additional loads during machine operation. Lubricate the suspension rope sockets approx. every 3 months or 1250 hours of machine operation.

Table 1

Ambient Temperature Range	ISO Viscosity Grade / Oil Type
14°F to 100°F (-10°C to 37°C)	ISO VG 320 / Mineral or Synthetic (poly-α-olefin) Oil
Less than 14°F to 120°F (Less than -10°C to 50°C)	ISO VG 320 / Synthetic (poly-α-olefin) Oil

Under normal circumstances, an ISO VG 320 oil viscosity is required for all Gearcases (Hoist, Swing, Crowd and Propel). For cold weather applications, an ISO VG 220 oil viscosity may be used for the Propel Gearcases to help ensure that the lubricant pour point remains below that of the ambient starting temperature. The pour point and flash point of individual brand name gear oils must be observed. Refer to the oil manufacturers technical data sheets for these properties.

Step #2

Select an approved lubricant for the Hoist, Swing, Crowd and Propel Gearcases from the Approved Lubricant Tables 2 & 3.

APPROVED LUBRICANTS:

Lubricants that have been approved for use by the Gearcase manufacturers are listed in the Approved Lubricant Tables 2 & 3. The use of non-approved lubricants may invalidate the Bucyrus International, Inc. product warranty obligation.

Specific product selection is the responsibility of the equipment operator/owner and is dependent on climate, application, performance and regional/regulatory requirements.

Bucyrus International, Inc.

SPECIFICATION FOR
OGL – OPEN GEAR LUBRICANT
SD4713 *(August 18, 2005)*

MINIMUM PERFORMANCE REQUIREMENTS:

PROPERTY	REFERENCE	REQUIREMENT
Flash point of product as applied, minimum (base product with diluent)	ASTM D92 / ISO 2592	
Ambient Temperature (See Note #1)		
-50°C(-58°F) to +10°C(50°F)		61°C (142°F)
Above +10°C(50°F)		80°C (176°F)
Flash point of base fluid(s), minimum	ASTM D92 / ISO 2592	140°C (284°F)
Rust protection	ASTM D 1743	Pass
Copper strip corrosion maximum rating 24hr. @ 100°C (212°F)	ASTM D 4048	2e
Four ball EP test weld point, minimum kgf (base product without diluent)	ASTM D 2596	800
Load wear index (LWI), minimum (base product without diluent)	ASTM D 2596	120
Four ball wear test 60 minutes @ 40 kgf. Maximum scar, mm (base product without diluent)	ASTM D 2266	0.7
Adhesive properties	Must adhere to surfaces at the lowest anticipated ambient temperature.	
Pumpability, Lincoln Ventmeter	To vent from 1800 psi (127 kgf/cm^2) to less than or equal to 600 psi (42 kgf/cm^2) within 30 seconds at the lowest anticipated ambient temperature (Testing temperature not less than -25°C/-13°F).	
Minimum Base Fluid Viscosity Ambient Temperature (See Note #1)	ASTM D 445	
°C (°F)		
-50 to +10 (-58 to +50)		680 cSt at 40°C
-20 to +40 (-4 to +104)		1860 cSt at 40°C
+10 to +50 (+50 to +122)		3600 cSt at 40°C
Lubricating Solids (Molybdenum Disulfide, Graphite, Etc.) Particle Size, (Microns, max.)		15 Microns

NOTE:
1. Ambient Temperature - The ambient temperature shall be the temperature at the point of lubricant application.

Section **4**

Preventive Maintenance

Always refer to the safety information in Section 1 of this manual before starting any maintenance procedure on this machine.

Table of Contents

MAINTENANCE INSPECTION CHECK POINTS

DAILY

1. Check the areas under and around the crawlers for signs of oil leaks. If single droplets are noticed, leakage is minimal. Determine the point of leakage and note it on the log sheet. If pooling of oil is noticed, determine the source and begin maintenance or repair activity immediately. Determine if loose hardware, a defective gasket, a combination of both, or a similar problem is responsible. Tighten hardware or replace defective gaskets.

2. Crawler Belts - Inspect for missing links or lock pins, excessive belt sag, cracked shoes or other deterioration.

3. Swing Rack - Check the pinions and pinion guards for rocks, dirt and other debris that will interfere with the operation of the machine. Inspect the swing rack gear and rollers for the proper lubricant film.

4. Propel Motor Couplings - Inspect for debris, adequate lubrication and evidence of damage. Apply MPG as required.

DANGER: HIGH VOLTAGE! The machine trail cable carries a lethal voltage. Handle the cable in an approved manner with appropriate rubber gloves and insulated hooks or tongs.

5. Machinery House Exterior - Visually inspect for damage or evidence of internal leakage.

Electric Mining Shovel

Preventive Maintenance

ITEM #	NOTED DISCREPANCY

pmc_1136

Date: _____

Shift: _____

Inspected By: _____

Supervisor: _____

MAINTENANCE INSPECTION CHECK POINTS

EVERY 1250 HOURS, OR QUARTERLY

(WHICHEVER OCCURS FIRST)

1. Crawler Links - Adjust the tension as required.

2. Take-Up Tumbler - Check the condition of the bushing.

3. Lower Rollers - Check for cracks, unusual wear, O.D. of the rollers, bushing wear, seal leakage and proper lubrication.

4. Crawler Links - Check the drive tumbler O.D. and the link pins for wear and/or an out of pitch condition.

5. Gearcases - Check all covers and plugs for leakage - seal as required.

6. Propel Brake Assembly - Verify proper brake operation. Replace worn friction linings as required. Check the air cylinder piston travel and the adjustment of the springs.

7. Roller Circle Rollers - Verify roller integrity, replace broken or cracked rollers.

8. Center Pintle - Verify the proper adjustment of the pintle locking nut and the security of the locking bars. Clean spent grease from under the lower nut.

9. Center Pintle Lube - Verify for correct spherical washer and truck frame pintle bushing lubrication.

Electric Mining Shovel

Preventive Maintenance

pmc_1136

ITEM #	NOTED DISCREPANCY

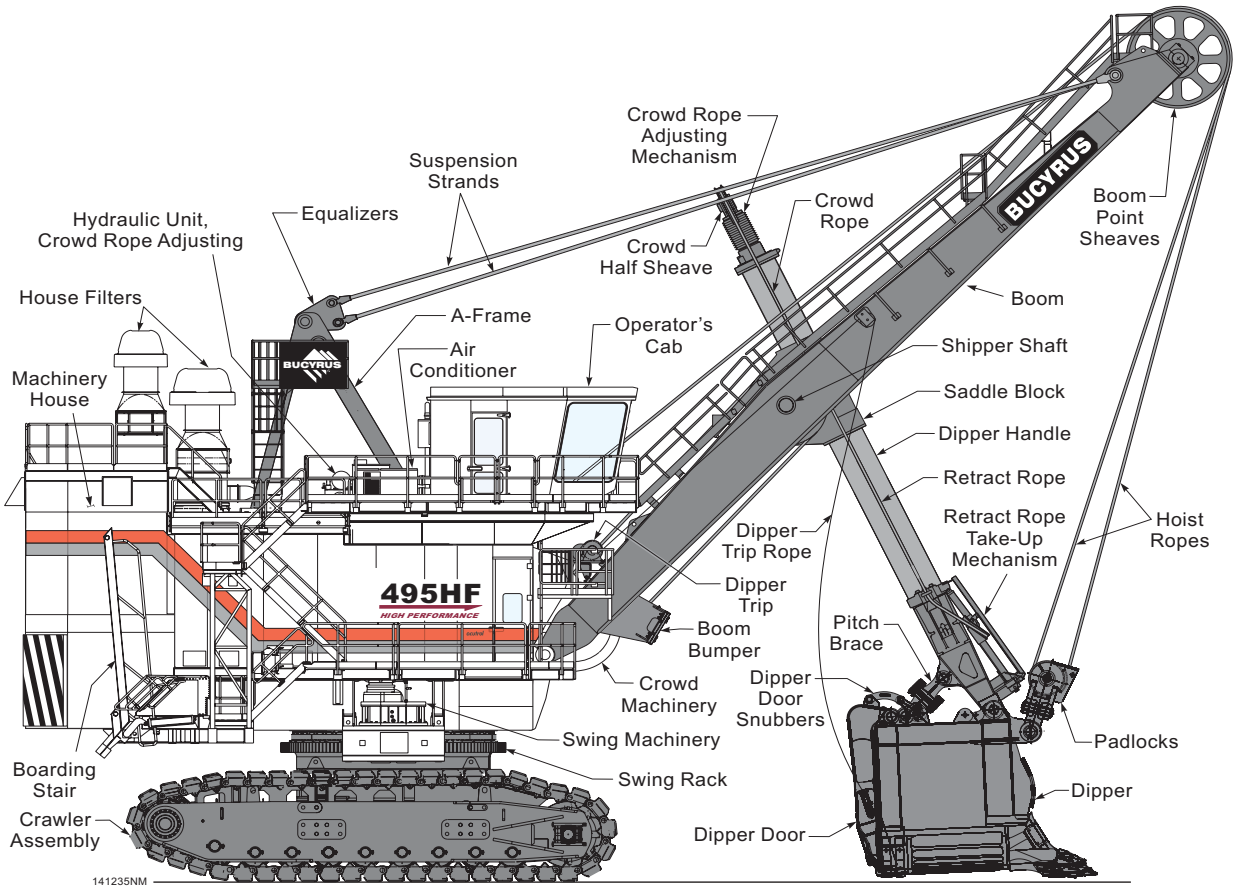
Date: _____

Shift: _____

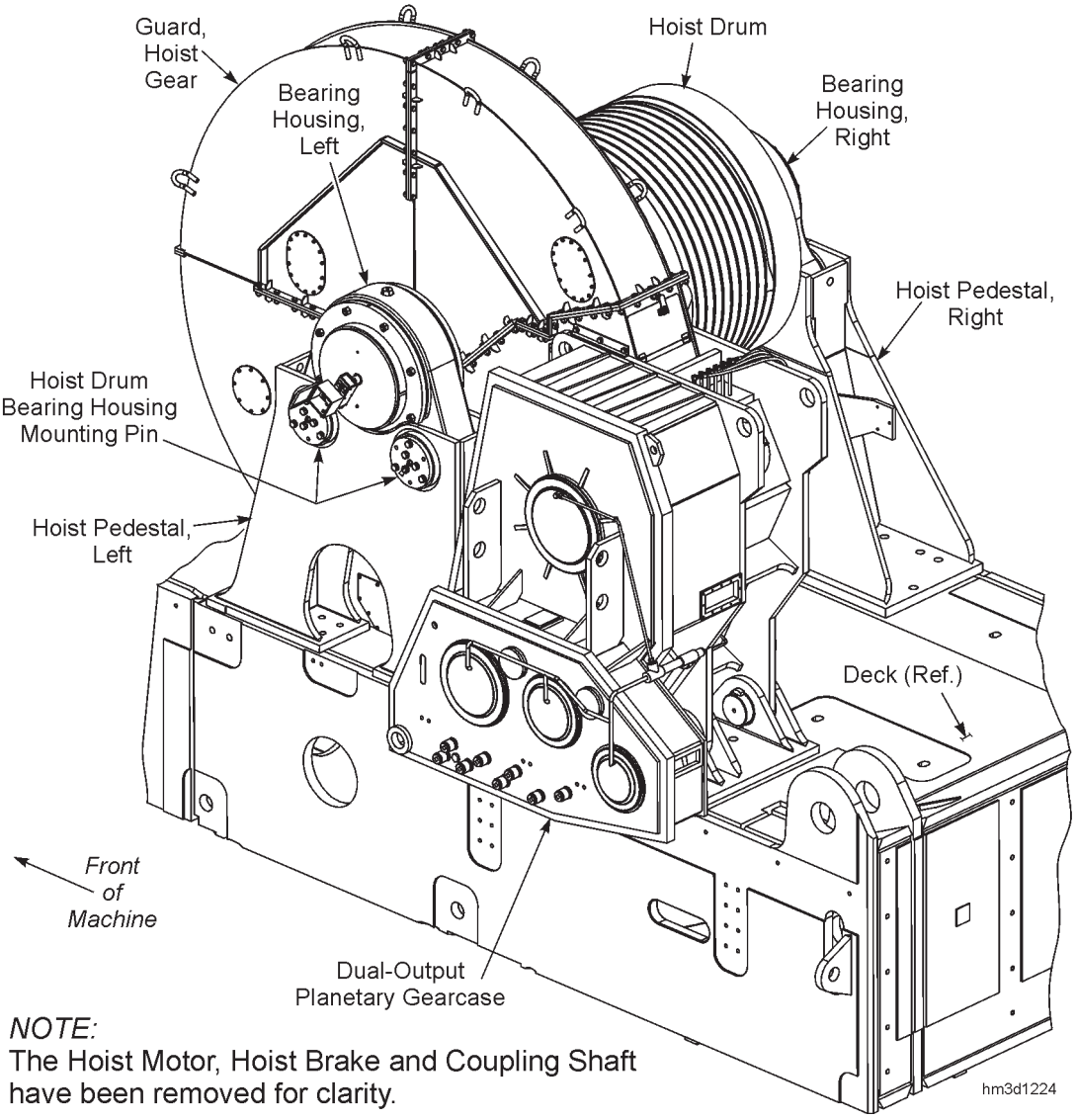
Inspected By: _____

Supervisor: _____

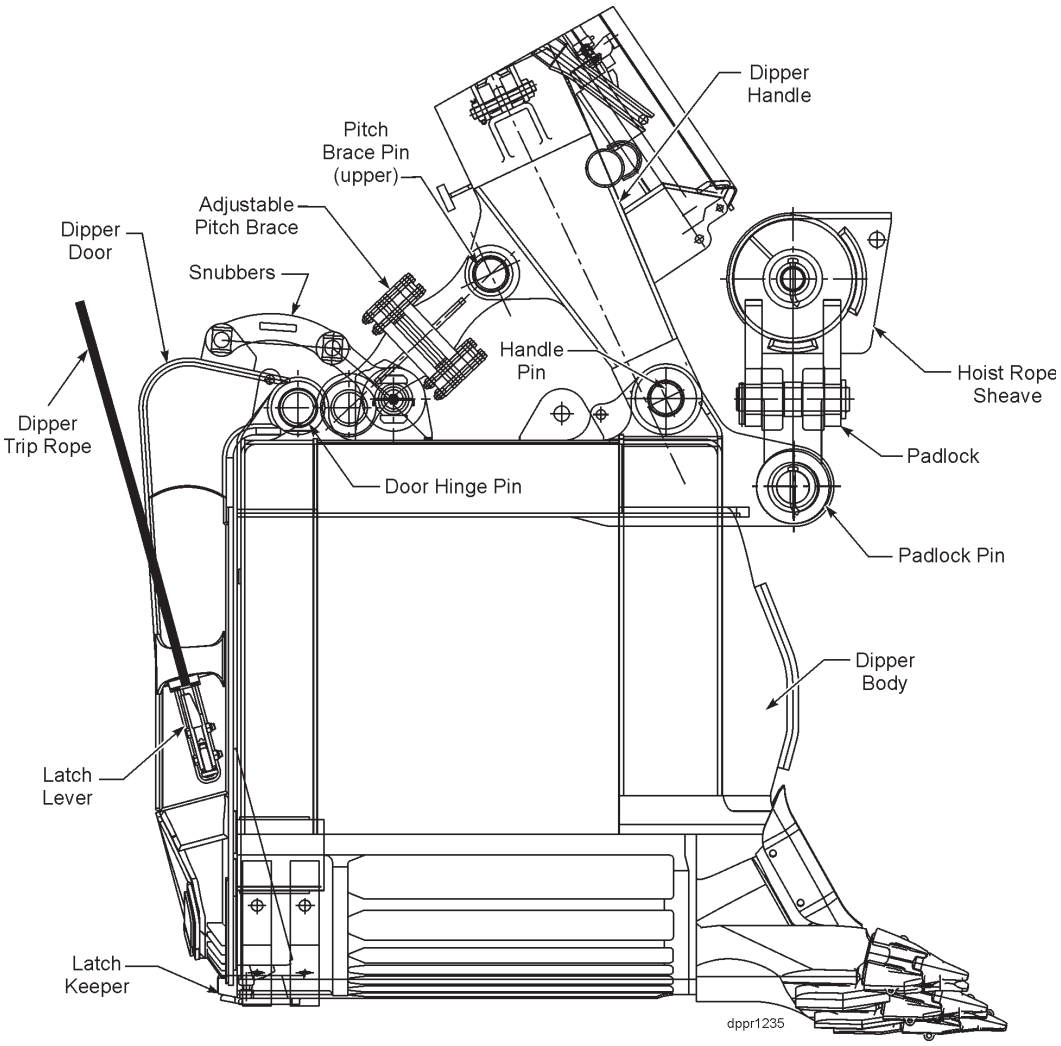
MAJOR COMPONENT LOCATIONS



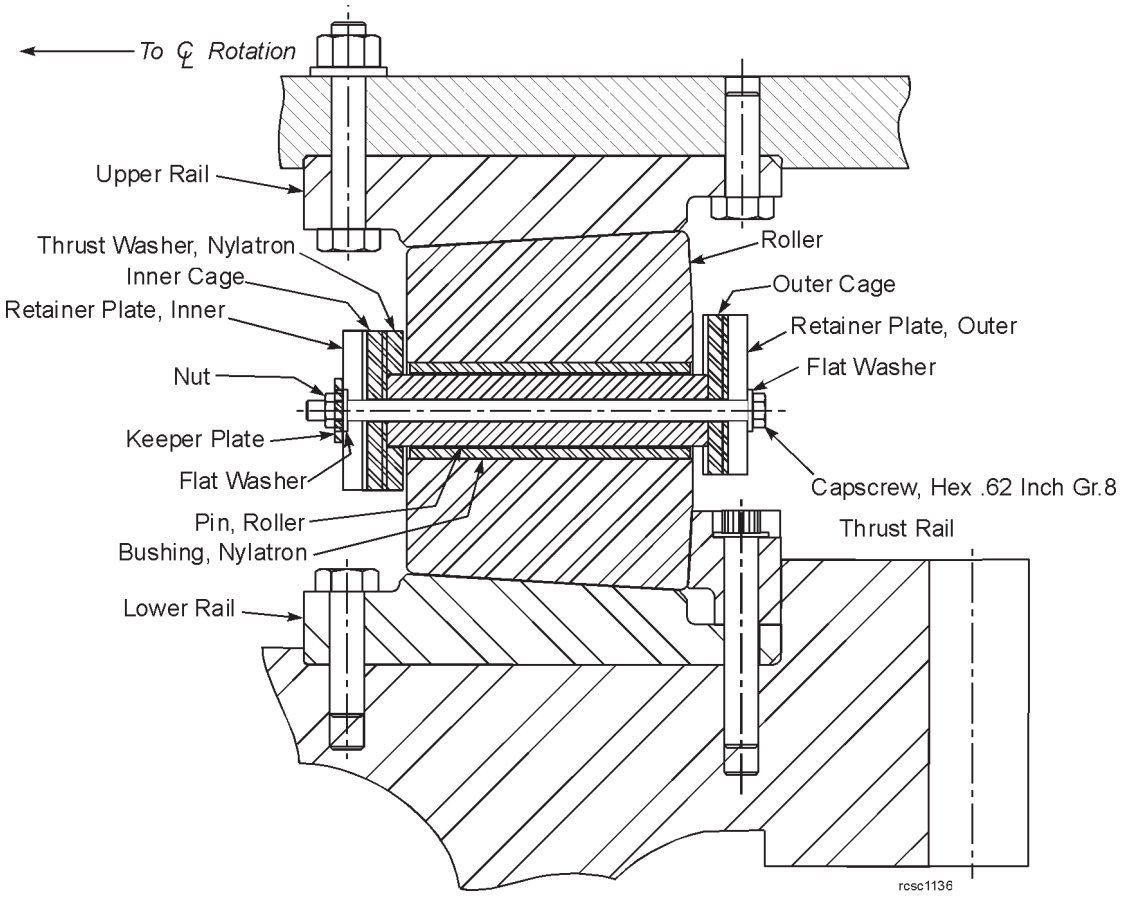
Machine Nomenclature



Hoist Machinery



Dipper Assembly



Section A-A

5. Slide the rail(s) along the roller circle to the nearest side of the revolving frame and lift the segment (approx. 500 Lbs.) clear of the machine.

6. Installation of new rails is the reverse of removal.

   - Clean and deburr all mating surfaces.
   - Be sure the rail flange is tight against the machined register on the revolving frame.
   - Check the rail height between adjacent rails. The variation in rail thickness is .005 inch maximum.
   - Tighten the mounting bolts to specification.

6. Align the other end of the shoe to the existing shoe to close the belt. Install the pins and locking hardware in 2 places to secure the shoe. Tighten the capscrews retaining all 4 pins removed to 1045 Ft.Lbs.

7. Remove the blocking and adjust the belt tension.

CRAWLER BELT REPLACEMENT

1. Park the machine in a level work area. Assemble the new belt forward of the machine, in line with the one to be replaced.

2. Add blocking between the top of the crawler frame and the shoes to remove any slack in the belt.

3. Remove any belt tension. To separate the belt, at the lowest point forward of the front idler, remove the locking hardware and pin from 2 places on the shoe.

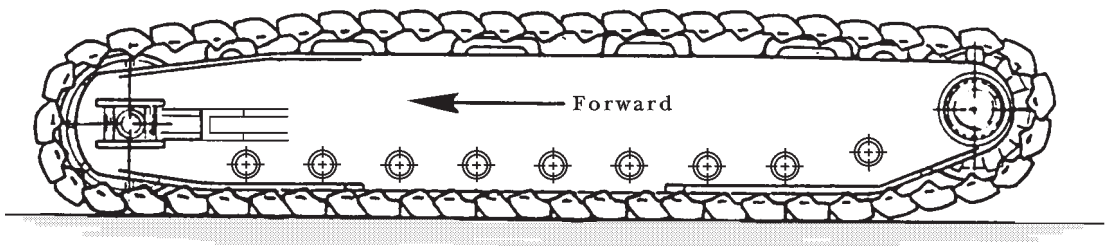
4. Connect the new belt to the front shoe under the front idler roller at the separation of the old belt. Install both pins and their locking hardware and tighten the capscrews to 1045 Ft.Lbs.

5. Attach a wire rope to the upper portion of the old belt at the separation point, then to a truck or dozer.

6. Pull on the top portion of the old belt to maintain engagement with the shoe lugs on the drive tumbler and *SLOWLY* propel the machine forward until the new belt has replaced the old on the crawler. Park the machine.

7. Disconnect the old belt from the new and remove it from the work area. Pin the new belt together at the front idler.

8. Adjust the belt tension.



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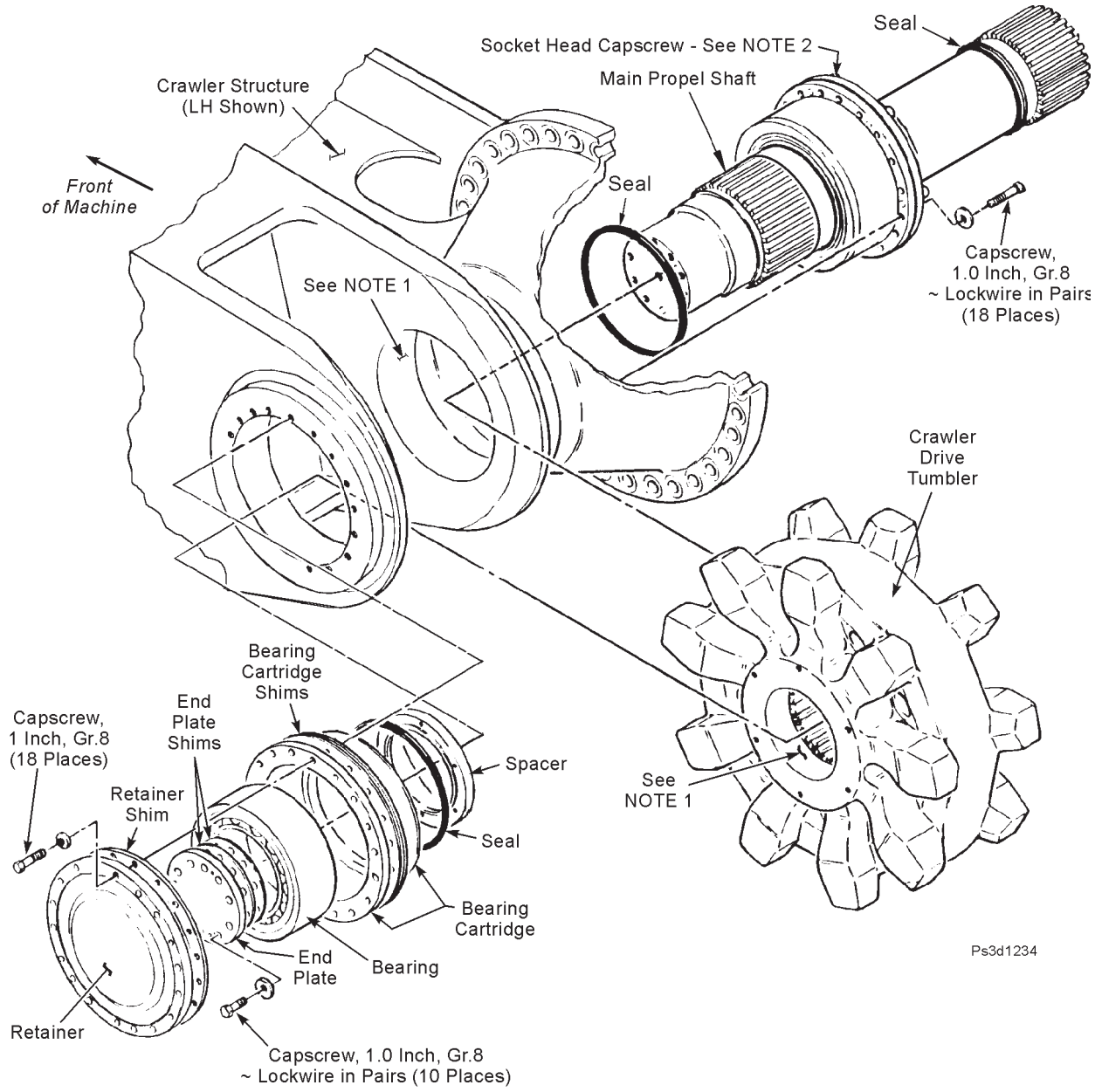
PROPEL ASSEMBLY

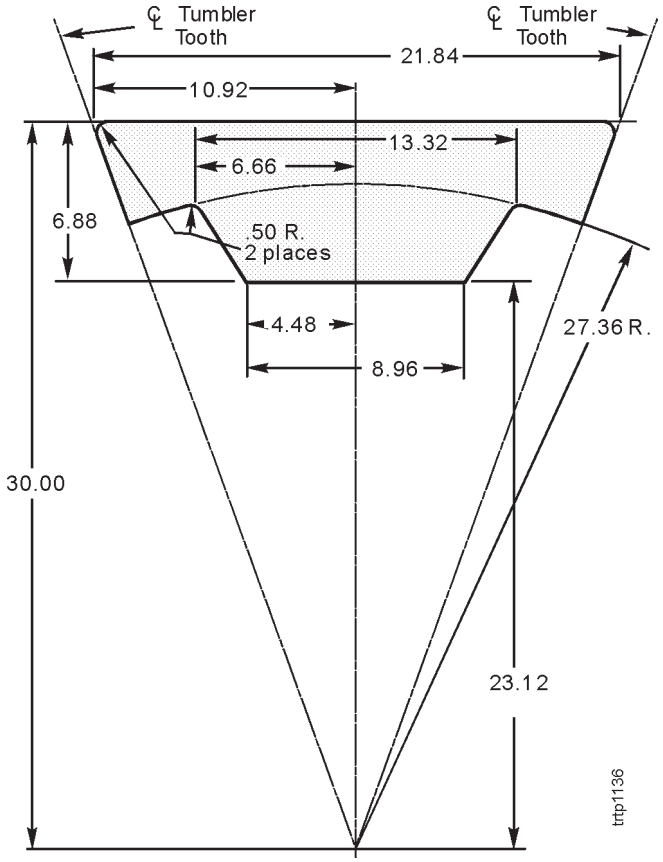


Propel Drive Shaft Assembly ~ Exploded View

NOTES:

1. After a thorough cleaning, coat both the internal and external splines and surfaces indicated with Optimoly grease paste (PN: 62042829).

2. The 6 socket head capscrews in the bearing cartridge of the Main Propel Shaft are present *only* to hold the subassembly of the cartridge and bearing to the shaft. They are not to be removed after installation, or during removal of the Main Propel Shaft.



Crawler Drive Tumbler Rebuild Template

1. To inspect for worn thrust washers, rails, or rollers proceed as follows:

   a. Every 3 months, check the amount of lift of the revolving frame at the rear of the machine. Engage the dipper in the bank at near maximum reach and apply hoist power.

   b. Measure the distance between the upper and lower roller rails at the rear of the machine.

   c. Subtract from this measurement the measured distance at the rear between the upper and the lower roller rails with the dipper on the ground.

   d. If the difference in measurement is greater than 1/2 inch, the pintle lower nut must be adjusted to limit the amount of lift to between 3/16 and 1/4 inch. Refer to the Adjustment procedure.

2. The thrust washer, rails, or rollers may be worn sufficiently to require replacement rather than adjustment. If necessary, replace a worn thrust washer per the center pintle repair procedure and replace a worn roller and/or rail per the applicable repair procedure.

3. Clearance for free rotation of the revolving frame must be provided between the truck frame bushing and the sleeve. Such clearance, however, cannot be excessive or premature wear of the truck frame bushing or sleeve will occur.

To determine this clearance, proceed as follows:

DANGER: HIGH VOLTAGE! EXTREME CARE MUST BE EXERCISED AT ALL TIMES WHEN PERFORMING MAINTENANCE IN THE CENTER PINTLE AREA OF ELECTRICAL ENERGY. High voltage can cause serious or fatal injury. Installation, operation and servicing of components should be performed only by qualified personnel. ALWAYS DISCONNECT the electrical power BEFORE ACCESSING the center pintle area.

   a. Disconnect the power to the machine. Enter the truck frame through the bottom access opening.

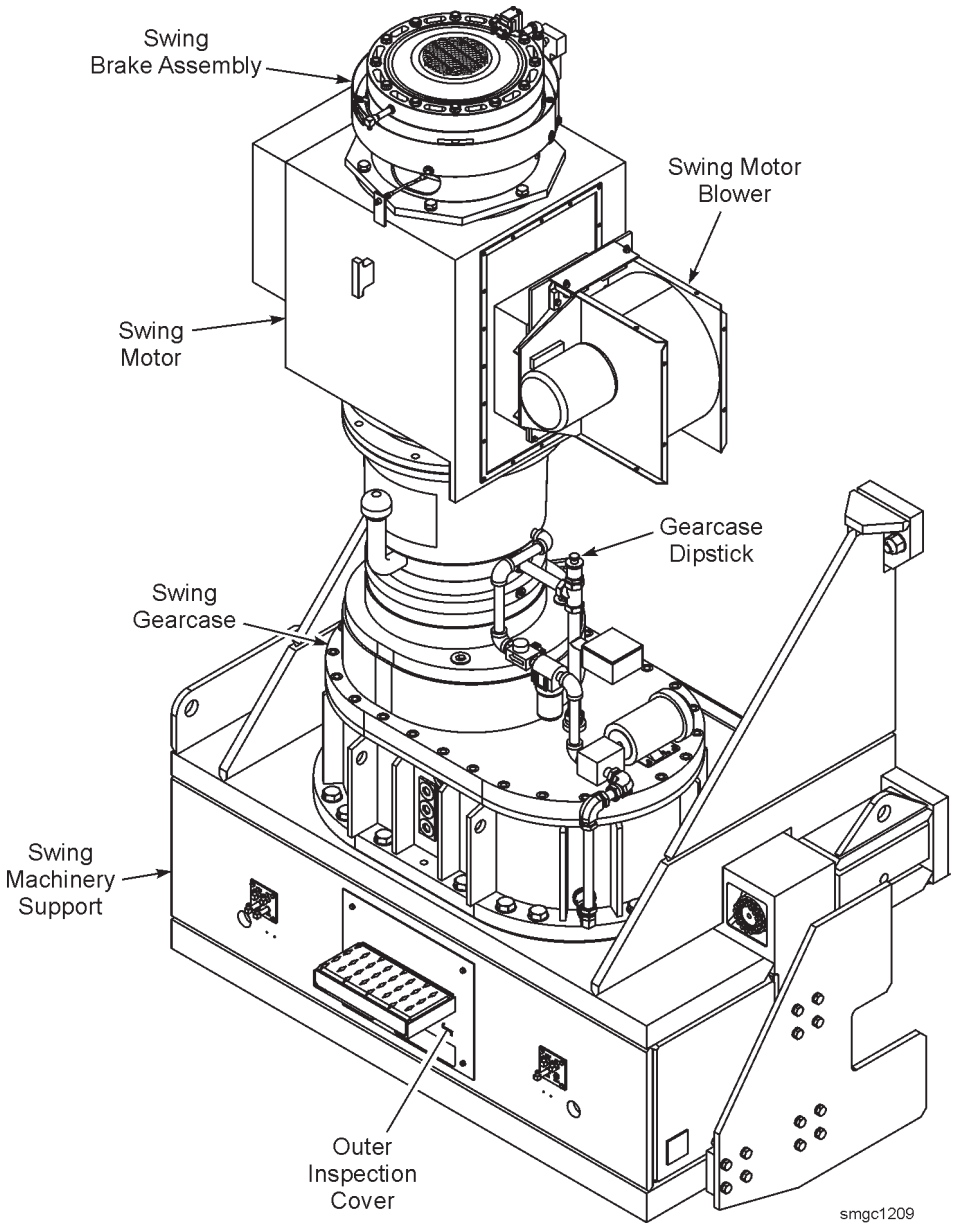
   b. Remove the cover from the top of the truck frame and gain access to the space between the pintle and the rollers. Insert a feeler gauge between the sleeve and the bushing of the truck frame. Any measurement over 0.250" diametral clearance is considered excessive and replacement of the bushing and/or sleeve is necessary.

SWING MOTOR INSTALLATION

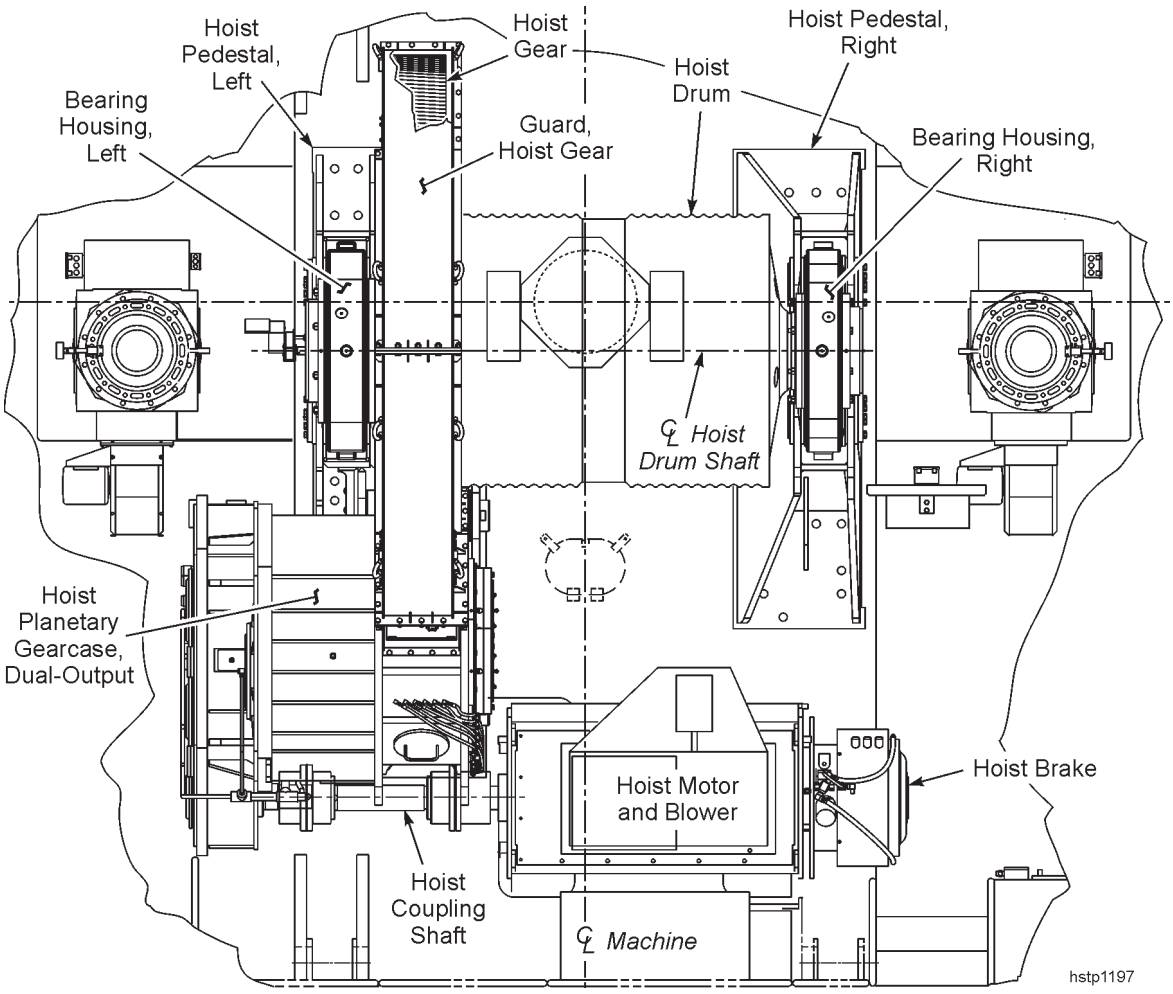
Installation of the swing motor is the reverse operation of the removal procedure covered above with the following exception:

IMPORTANT: Alignment of the motor coupling is critical to the longevity of the bearings within the motor and the planetary gearcase. Check and adjust the coupling alignment in accordance with the instructions found in Section 6 *~BRAKES AND COUPLINGS*, in this manual.

SWING PLANETARY GEARCASE



Frequently check the hoist machinery for loose or missing hardware. At least once a month, check the hardware on the hoist motor, shaft, couplings and right and left pedestals for tightness. Retighten or replace any missing hardware. Every 12 months remove the upper hoist gear guard inspection covers and the gearcase inspection covers and inspect the gear and pinions for pitting, abrasion, scratching, spalling, galling and/or other tooth wear. Check the gearcase for evidence of lubricant leakage. Replace any defective seals.



Hoist Machinery - Plan View

HOIST DRUM ASSEMBLY

The hoist drum shaft uses a single-helical hoist gear fastened to a large-diameter drum with the hoist spider and rotates on double-row, tapered roller bearings.

Removal of the hoist drum shaft will require lowering and supporting the boom. *To remove the hoist drum shaft:*

1. Position the machine so that the dipper lip and front are flat on the ground.

DANGER: BEFORE PERFORMING ANY MAJOR MAINTENANCE ON THE HOIST MACHINERY, PRESS AND TAG THE MAIN POWER OFF BUTTON. Failure to comply may result in injury or death.

2. Remove the hoist ropes.

3. Remove the A-Frame ladders and platforms.

4. Remove the two machinery house fan/filter assemblies.

5. Remove the A-Frame shrouds.

6. Remove the center front roof panel, the 6 center roof panels and the 3 left roof panels over the left deck extension. Save all indicated items for re-use.

NOTE: To remove the center roof panel, cut the welds between the channels on the front wall panels and the center roof panel ~ both sides. The rubber sheets can remain attached to the roof panel. All front wall panels can remain in place, however the upper left and upper center wall panels can be removed, with their hardware, and saved for later re-use.

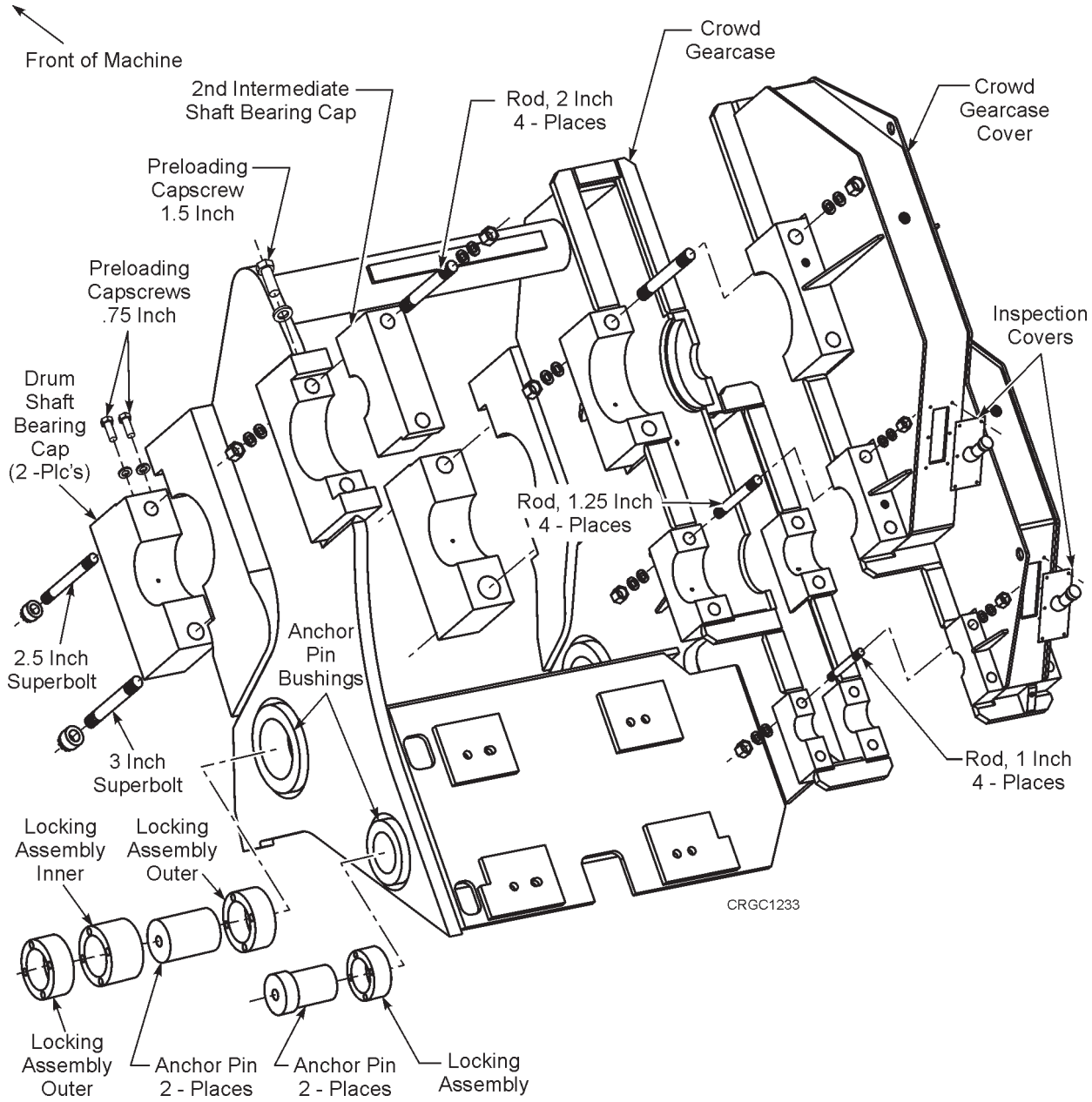
7. Remove 4 center roof cross-beams, 2 left roof cross-beams and 4 center roof fore/aft truss beams.

8. Using the crowd machinery (or a separate crane) support the weight of the boom to unload the A-Frame and main suspension strands.

9. Remove the upper A-Frame pins from the rear A-Frame legs. (Will require a cherry picker.)

10. Rotate the rear A-Frame legs back toward the rear of the machine and secure to the control room roof.

11. Using the crowd machinery (or a separate crane) lower the boom until the front A-Frame legs are pulled forward so that they are at an 80^{o} to 85^{o} angle to the top of the revolving frame. Set the crowd brake and block the boom in position. Install a safety cable to prevent the front A-Frame from being inadvertently over center.



Crowd Gearcase

Every six months remove the inspection covers of the gearcases and inspect the gears and pinions for pitting, abrasion, scratching, galling, spalling and other abnormal tooth wear.

Check the crowd machinery attachment pins for movement under load. Tight attachment pins minimizes wear on the pins and pin holes. Check every 100 hours.

Weekly, remove the pipe plugs in the first reduction gearcase and the second reduction gearcase and check the lubricant level. The first reduction gearcase lubricant level plug is located at the rear of the gearcase cover, to the rear of the first reduction pinion.

MACHINERY HOUSE

The machinery house has separate structural members consisting of a front and rear main truss and interconnecting beams. These form the permanent house structure.

Roof panels are individually fastened to the interconnecting beams. Any panel can be removed separately to provide access to a machinery house unit. All roof panels are secured with hold down bolts on retainer bands. Vinyl tape weather stripping is installed between the retainer band and roof panel.

Shroud covers around the A-frame legs have vinyl tape between the leg and shroud. Shroud support joints are sealed with rubber cement or silicone caulking.

All mating surfaces of the machinery house wall panels are sealed with rubber cement or silicone caulking to ensure weather tight seal.

Frequently inspect all house panels and structural members for cracking. Include a close examination of all roof structures. Examine all struts, beams and braces used to reinforce the machinery house.

Always restore defective structural members to their original state by repair welding.

Periodically observe the hinges and closure mechanisms on all doors and windows to ensure they will remain closed during machine operation. Verify the sealing of the leg closures of the A-frame. Tighten all loose bolts and replace all missing hardware. The absence or looseness of these fasteners can result in excessive vibration and wear of house components. Individually, these faults can be considered minor, but taken collectively, they represent a major exposure of the electrical and mechanical elements of the house to dust and water.

Check the condition of the house paint. Paint is not impervious to deterioration. A well-painted machine is less susceptible to rust, corrosion and progressive failure.

Be sure the pressurization system is functioning properly to keep the house well-ventilated at a pressure higher than atmospheric pressure.

BOOM POINT SHEAVE REMOVAL AND DISASSEMBLY

Use the following procedures to remove ONE Boom Point Sheave assembly:

1. Position the machine in a clear and level area.

2. It is not necessary to lower the boom when removing the boom point sheaves. However, lift the hoist ropes, with a suitable crane, and set them at the center of the boom away from the sheave assemblies.

CAUTION: THE HOIST ROPES MUST BE SECURED TO THE BOOM FOR SAFETY UNTIL THE REPAIR IS COMPLETED. USE BLOCKING BETWEEN THE ROPES AND THE BOOM STRUCTURE TO PREVENT DAMAGE TO THE ROPES.

CAUTION: ADEQUATE PRECAUTIONS MUST BE TAKEN TO ENSURE THE SAFETY OF PERSONNEL WHEN EQUIPMENT IS REMOVED AND REPLACED. USE EXTREME CAUTION AND PROPER SAFETY DEVICES WHEN WORKING AT THE BOOM POINT.

3. Disconnect and plug the lubrication lines to the sheave pins.

4. Use a suitable crane and provide just enough lift to the boom point sheave to be removed to carry its weight. The approximate weight is 7,000 Lbs. *DO NOT APPLY TOO MUCH FORCE WITH THE LIFTING DEVICE.*

5. Remove the sheave clamp collar from each end of the boom point shaft.

6. Ensure that the sheave assembly is supported with a sufficient sling or chain and loosen the four 1.5 inch capscrews that retain the bearing caps on the shaft to be removed.

7. With the shaft assembly secured, remove the capscrews and bearing caps.

8. Lift the sheave assembly away from the boom point and set on the ground.

NOTE: When lifting the sheave assembly, locate the key at the bottom of the outboard end of the shaft and retain for reinstallation.

CAUTION: THE SHAFT KEY MAY FALL WHEN THE SHAFT IS LIFTED!

To disassemble the boom point sheave:

1. Remove the spacer from the shaft.

2. Remove the bearing retainer, bearing clamp and associated hardware from both sides of the sheave.

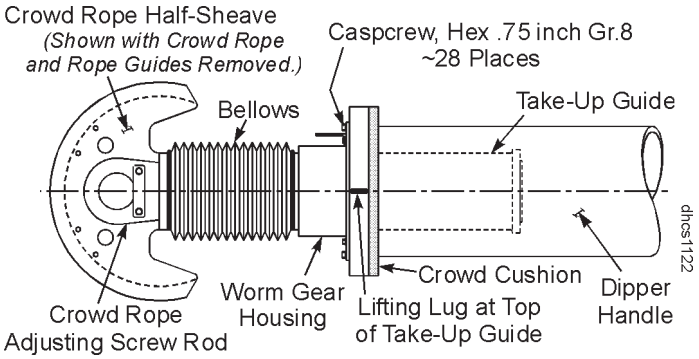
DIPPER HANDLE REMOVAL

1. Crowd the handle out until the saddle block is a slight distance from the crowd cushion. (This is to prevent undo tension on the worm gear housing capscrews.) Lower the dipper to the ground, resting it with the heel on the ground. Set all machine brakes, but do not lock out the power.

2. Remove the crowd and retract ropes. Refer to the proper instructions in the rope removal and replacement section of this manual.

3. Support the crowd screw half-sheave assembly with a crane, both at the half-sheave and at the take-up guide. (Weight is approx. 10,500 Lbs.) Be sure not to damage the bellows. Note the location of the lifting lug on the top of the take-up guide housing.

4. Remove the 28 - .75 inch capscrews, on the half-sheave end of the handle, that attach the worm gear housing and take-up guide to the handle. *Do not remove the 7 capscrews toward the inside of the worm gear housing, nor the 12 nuts and capscrews holding the cushion in place, at this time.*



NOTE: The 7 capscrews toward the inside of the worm gear housing attach the housing to the take-up guide. These screws must remain in place when removing the crowd rope take-up mechanism as a unit.

5. The crowd rope adjusting mechanism consists of the crowd half-sheave, screw rod, bellows, worm gear housing and crowd cushion. With the capscrews mentioned above removed, carefully slide the take-up mechanism out of the handle then lift it away from the handle and rest it on cribbing.

6. Secure a crane to the dipper handle, between the saddle block and the dipper. Insure that the crane will support the free end of the handle. Apply additional rigging to prevent the crane cable from sliding away from the dipper end of the handle. Support the saddle block to prevent it from rotating in either direction once the handle has been removed.

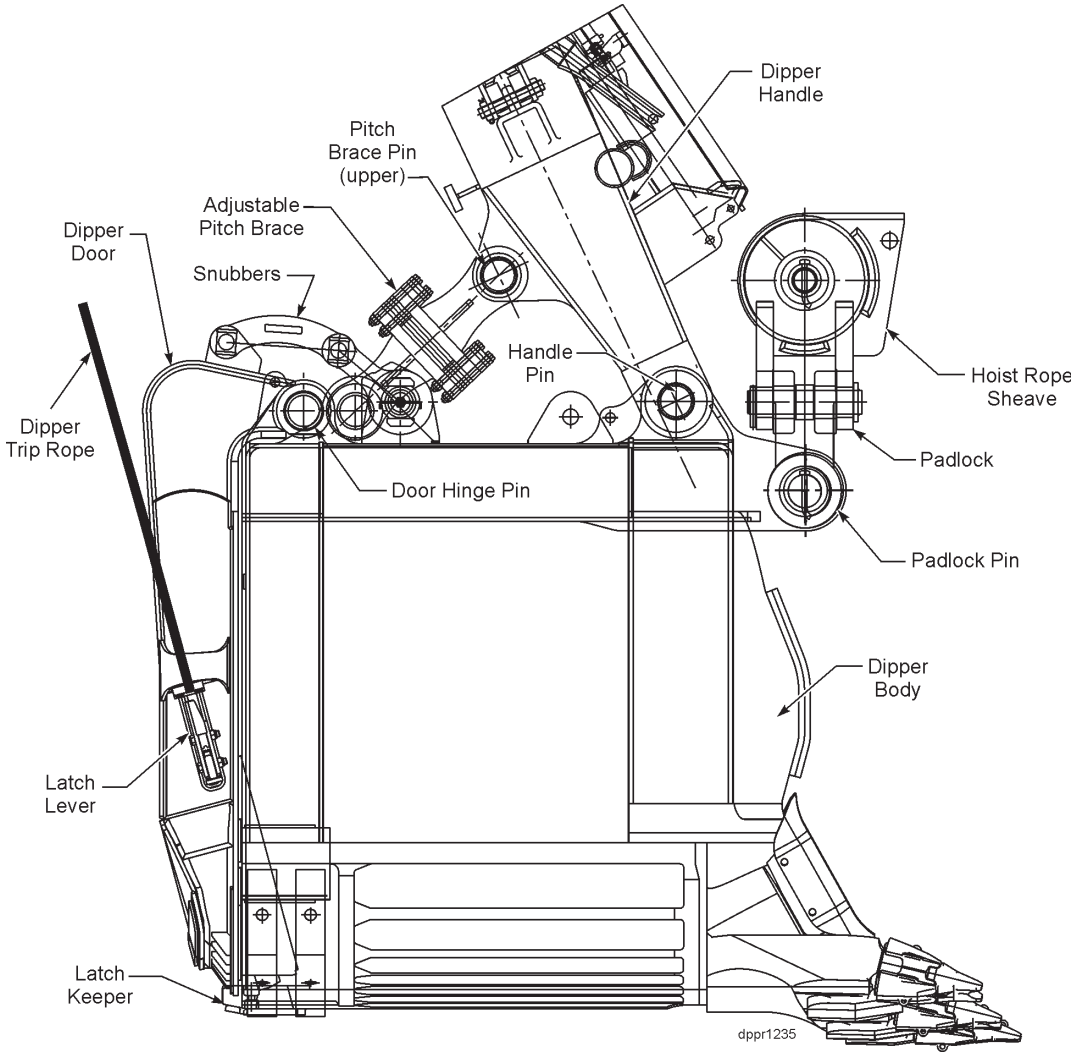
CAUTION: THE SADDLE BLOCK MAY ROTATE SUDDENLY ONCE THE HANDLE IS REMOVED. Be sure the saddle block is supported to prevent its rotation once the handle has been removed.

CAUTION: The rigging from the crane must be securely fastened with additional rigging to prevent the crane cable from sliding away from the dipper end of the handle, and also to support the free end of the handle once it is removed from the saddle block.

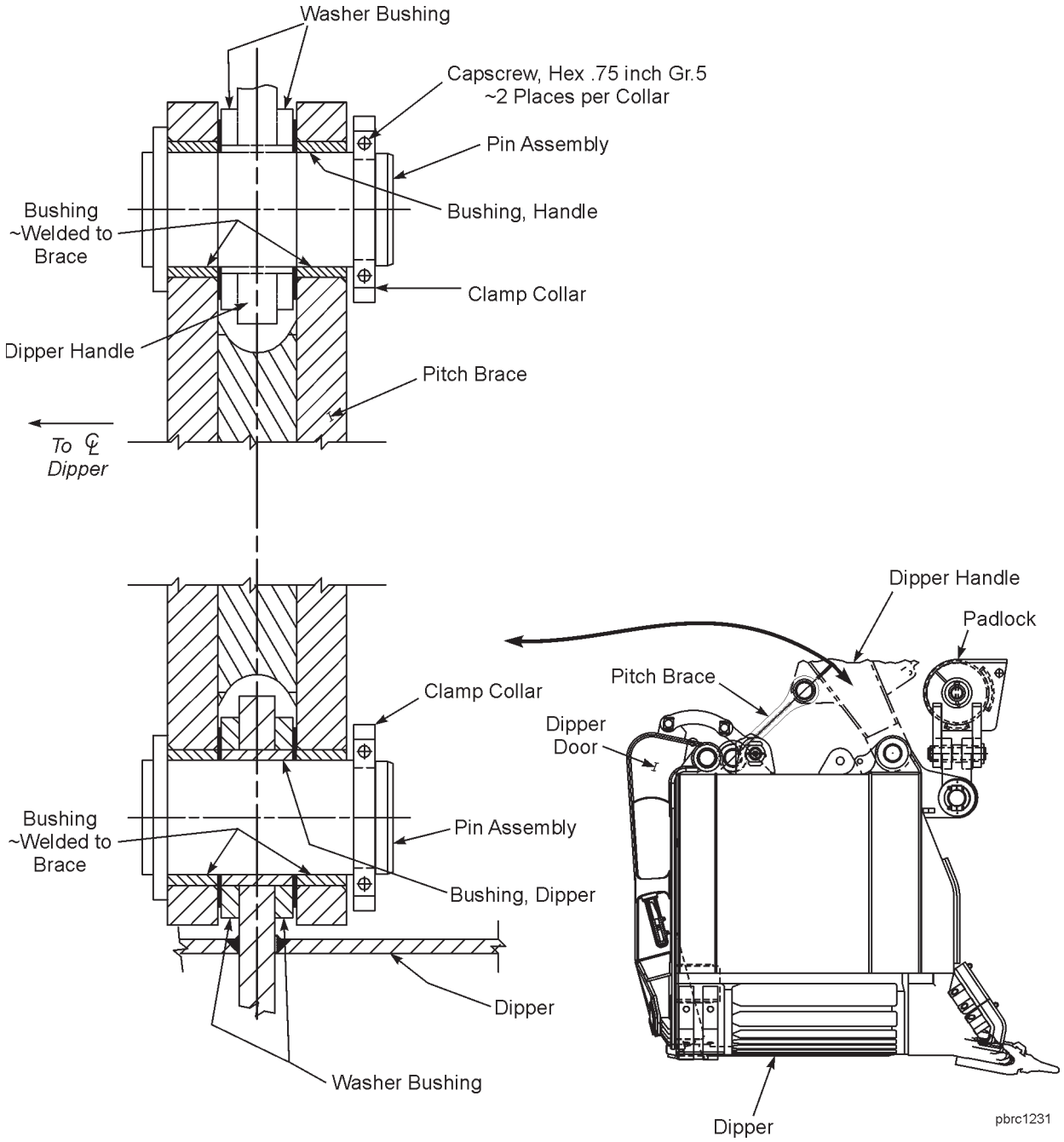
DIPPER ASSEMBLY

The dipper should be inspected before the start of each shift. The side and front surfaces provide critical reinforcement for the dipper. Consequently, they should be checked regularly for cracks and component wear. When wear spots develop in the side and front surfaces, the metal contour can be restored by building up the affected area. Contact the Bucyrus International Service Department for a specified welding repair solution.

DANGER: THE DIPPER HANDLE WILL FALL ONCE REMOVED FROM THE SADDLE BLOCK IF IT IS NOT FULLY SUPPORTED. Removal of bolts and pins requires the attached items to have proper support to release the load. Failure to comply could result in death, severe personal injury, or damage to the machine.



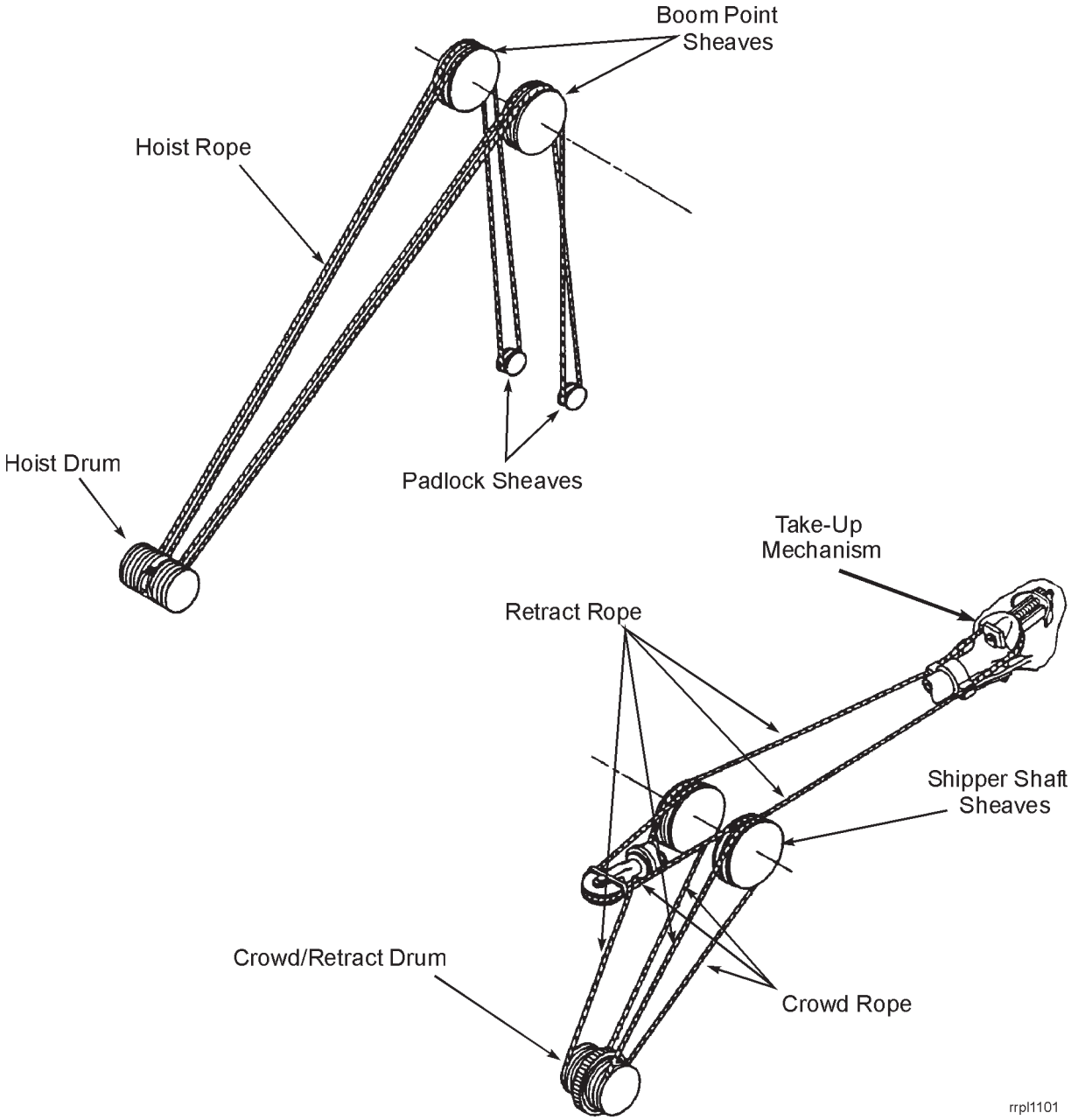
DIPPER PITCH BRACE - FIXED OR ADJUSTABLE



Fixed Length Pitch Brace

WIRE ROPES

In designing excavating machinery, careful study of the size and operating speed of all sheaves and drums is conducted to determine the proper wire rope for each application. Continual contact with many machines in the field and repeated consultation with leading rope manufacturers permits the selection of the most satisfactory rope for each machine. To maintain the machine at its highest level of efficiency, purchase new ropes which conform to Bucyrus International specifications, and thereby obtain the wire rope best suited for the particular application. Here are a few pointers relative to the proper inspection, lubrication and replacement of wire ropes on the machine.



If the old crowd rope IS NOT broken, attach the end of the new crowd rope to the end of the old crowd rope at the left side. Secure the end of the old crowd rope on the right side to a ground vehicle.

- OR -

If the old crowd rope IS broken and has to be removed in sections:

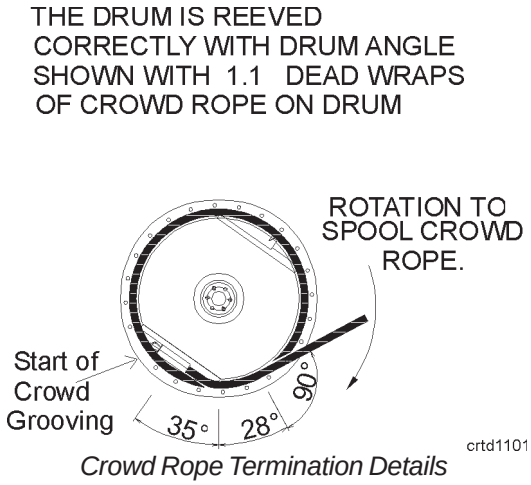
a. Inspect rope grooves and repair/weld as required.

b. Reeve an auxiliary line up to and over the inner groove of the right side saddle block sheave, around the crowd half-sheave, back over the inner groove of the left saddle block sheave, and down to the new reel of rope. Attach the auxiliary line to the becket loop of the new rope and the other end of the line to a ground vehicle as shown.

NOTE: The becketed ends of the crowd rope should pass through the rollers on the crowd half-sheave. If this becomes difficult, the rollers (2 places) can be removed during rope replacement. However, these rollers must be reinstalled before the machine is put into operation.

14. With the ground vehicle, pull the new crowd rope onto the machine until an equal amount of crowd rope hangs from each saddle block sheave. Secure the crowd rope and disconnect the auxiliary line.

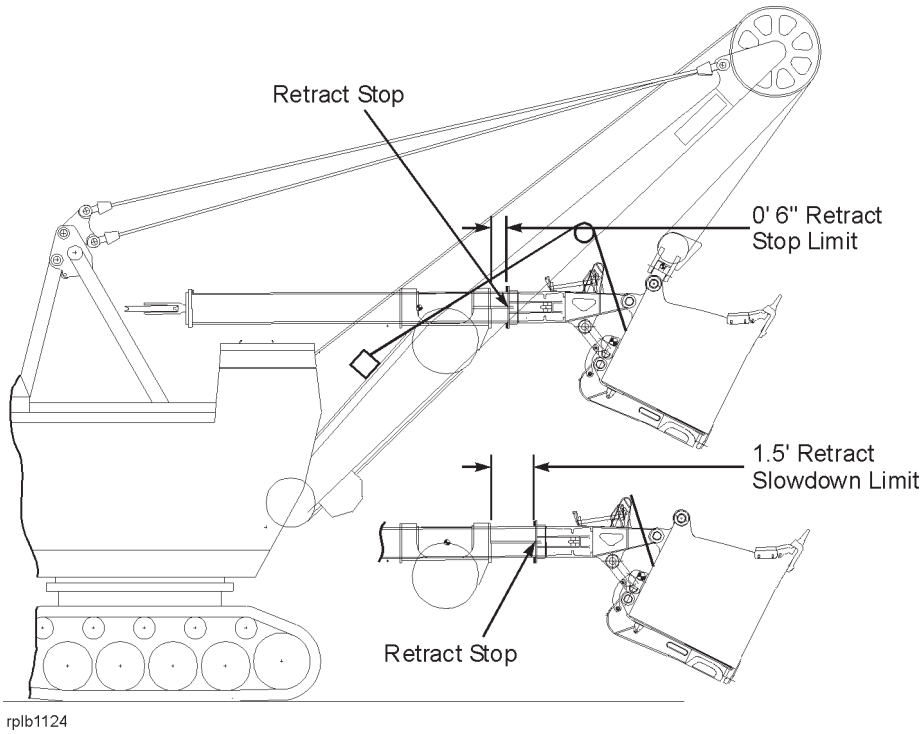
NOTE: Liberally lubricate the grooves of the crowd drum to help prevent damage to the new crowd rope as it is pulled into position on the crowd drum.



Crowd Rope Termination Details

15. Bring the auxiliary line over the top of the crowd drum, through the crowd rope socket, around the rear of the drum and forward from the bottom of the drum to the corresponding end of the new crowd rope. Connect the auxiliary line to the corresponding end of the crowd rope. Release the corresponding end of the crowd rope from (step 12) securing means, and with the ground vehicle still attached to the other end of the auxiliary line, pull the crowd rope onto the rope ferrule socket on the drum. Secure the crowd ferrule button into the drum ferrule socket. Release the auxiliary line from the crowd rope.

RETRACT SLOWDOWN/STOP LIMITS



1. Retract the handle until the retract stops are approximately 1.5 feet from the front end of the saddle block. Press “ACCEPT”.

2. Next, position the handle with the retract stops approximately 6 inches from the saddle block. Press “ACCEPT” to accept limit.

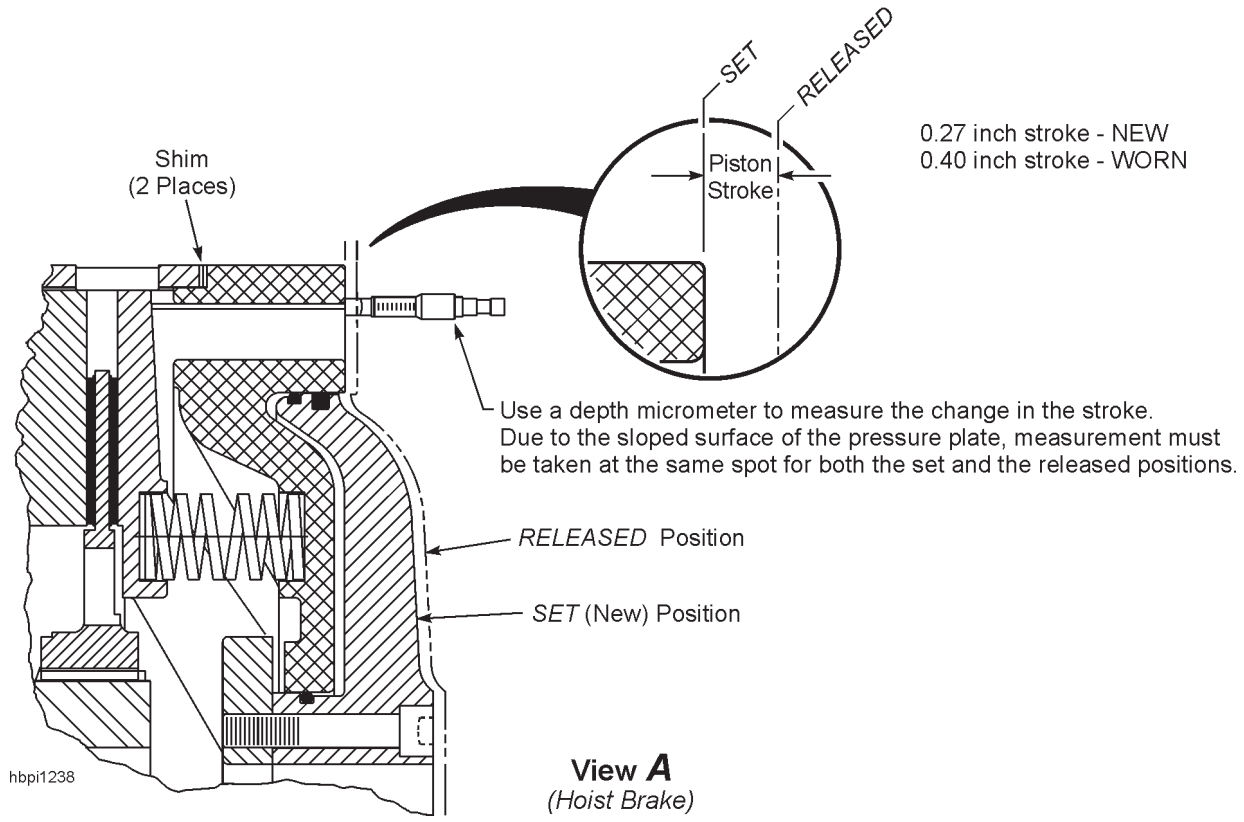
HOIST BRAKE ADJUSTMENT

The hoist brake is equipped with 2 adjustment shims to compensate for lining wear. This brake should be checked daily for lining wear and proper piston travel. If out of adjustment it will not be able to support a fully loaded dipper.

To inspect for excessive disc wear, use a depth micrometer as shown in View A. The reading must be taken from the same location with the brake engaged and released.

NOTE: The brake will be fully released once air pressure exceeds 60 PSI on a properly functioning brake. However, air pressure in excess of 125 PSI could damage the internal seals of the piston.

Due to the tapered surface of the pressure plate, care must be taken to duplicate the position and process as closely as possible. Friction disc adjustment must be performed when the total wear reaches .400 inch.



View *A*
(Hoist Brake)

NOTE: Adjustment shims are split for ease of removal and installation. DO NOT DISCARD shims after removal during brake adjustment. These shims will be required when reassembling the brake following a friction disc replacement.

4. When the piston stroke reaches 0.31 inch, one shim can be removed provided one shim remains in place. DO NOT remove the third shim!

5. To remove one shim, loosen the “X” stud nuts enough to slide the assembly back approximately 0.06 inch. Do not completely remove the stud nuts.

NOTE: Do not remove the heat treated “Y” socket head capscrews by the bore of the piston when removing shims.

6. Spread one shim at the split line and remove it from the brake, taking care not to bend or spring the shim. For ease of removal, the shims are split radially.

IMPORTANT: Store shims for later use. Shims will be needed when installing replacement friction discs.

7. Retighten the “X” stud nuts in a star tightening pattern to 90-100 Ft-Lbs and check piston stroke. Depressurize brake.

CAUTION: Do not overtighten the stud nuts as this will cause drive ring distortion and lead to excessive wear on brake disc and mating surfaces.

8. Reinstall the brake guard, tach supports and tachometer.

NOTE: If opposing plate surfaces (center, wear and pressure plates) show 0.03 inches per surface wear, they must be replaced.

8. Place new insulating washers, then new springs into the counterbores of the pressure plate. Reposition the cylinder with piston onto the springs taking care that each spring end properly seats into each counterbore of the brake cylinder.

9. Using piston bolts, assemble the cylinder with piston to the pressure plate and springs by reversing step 4 above. Tighten all piston bolts to 200-220 Ft-Lbs in a pattern 180° apart.

10. Close the temporary shut-off valve. Reconnect the auxiliary airline to the temporary shut-off valve and follow steps four and five of the Replacement of Friction Discs procedure.

11. Slide the pressurized piston with cylinder and pressure plate assembly onto the cylinder studs. (When applicable, make sure cylinder shimming is in place between the cylinder and drive ring.) Secure the assembly in place with the stud nuts. Tighten the nuts in a diametrical pattern to 90-100 Ft-Lbs.

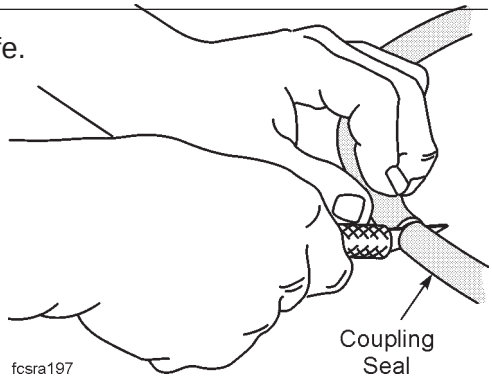
CAUTION: Do not overtighten the stud nuts as this will cause drive ring distortion leading to excessive wear on brake disc and mating surfaces.

NOTE: Observe the temporary regulator pressure gauge. If the pressure has dropped, the piston O-Rings may need replacement.

12. Open the temporary shut-off valve and release the brake pressure. Remove the temporary regulator with gauge and the shut-off valve from the brake inlet and reconnect the brake airline to the brake inlet.

13. Reinstall the brake guard, the tach supports, the tach and the tach cover.

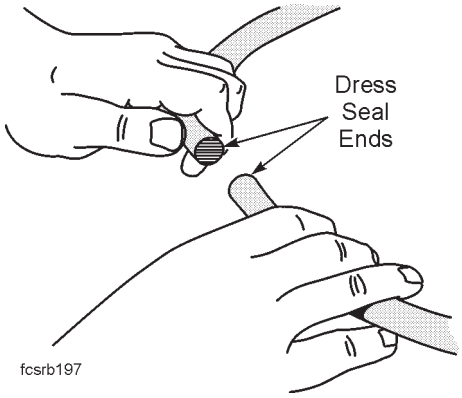
1. Cut the coupling seal using a clean, sharp utility knife.



NOTE: The following illustrations show O-Ring seals. The same procedures apply when replacing U-shaped or trapezoidal- shaped seals.

2. Lightly dress both cut surfaces on a grinding wheel. The resultant square evenly roughened seal ends provide excellent bonding surfaces. Thoroughly clean and degrease the cut ends.

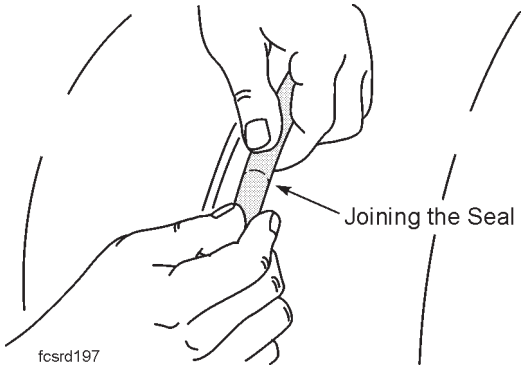
3. Apply adhesive to the seal ends as instructed by the adhesive manufacturer.
Use Masterbond EP21TDC-7, Loctite Superbond or Loctite 414 Superbond for Viton Seals.

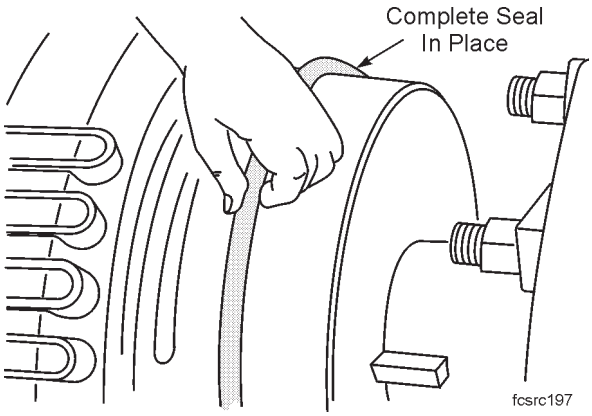


4. Place the split seal around the shaft and carefully align the two seal ends.

5. Carefully press and hold the joint together. Do not attempt to stretch the joint seal over the hub for several additional minutes. Refer to the adhesive manufacturer's instructions for procedure and drying time.

6. Carefully position the fused seal in place on the coupling hub.

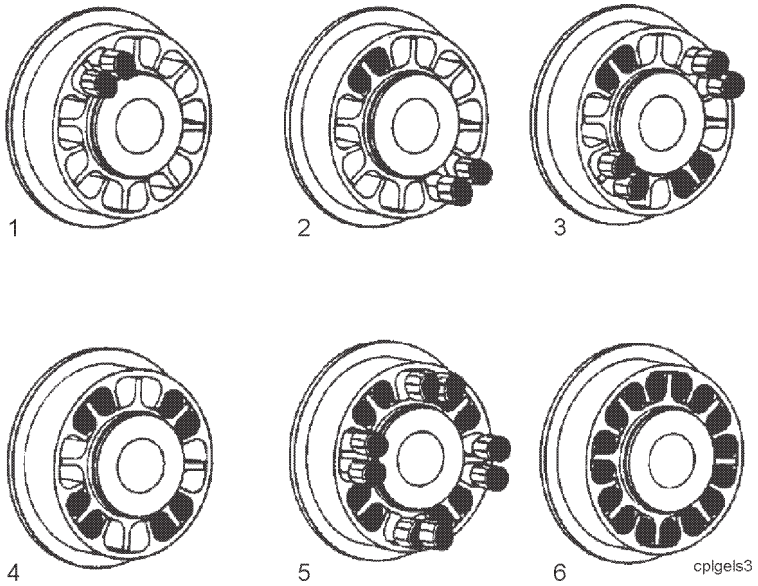




FITTING THE RUBBER ELEMENTS

The rubber elements may be fitted either before or after the coupling flange is bolted up. All PM couplings up through size PM 60 have 1 rubber element in each cavity. Size PM 90 up to PM 600 have 2 rubber elements in each cavity.

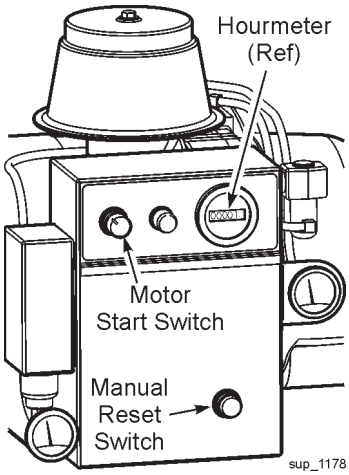
Refit the limited end float pads, if supplied (circular blue or white buttons). Place the outer member of the coupling over the inner member. Set the axial position of the outer member relative to the inner member. The outer member should be centered axially over the inner member. Fit the rubber elements in the sequence shown in the diagram below.



FITTING SEQUENCE

To ease installation of the rubber elements, silicone fluid should be used as a lubricant. Use a fluid that has a viscosity between 1000 and 3000 cs. Brush each rubber element and the cavities of the couplings with the fluid before inserting the rubber elements.

COMPRESSOR START-UP PROCEDURE



1. Prior to starting each compressor, check the fluid level in the sump. A sight glass is located on the bell housing. The fluid level in the sight glass should cover 1/4 to 1/2 of the sight glass during operation. DO NOT OVERFILL.

2. Open the shut-off valve to the service line.

3. Start the compressor motor by turning the selector switch to MANUAL START or AUTOMATIC START/STOP.

4. When the compressor is running, observe the instrumentation. Operating temperature should never exceed 200° F (93°C).

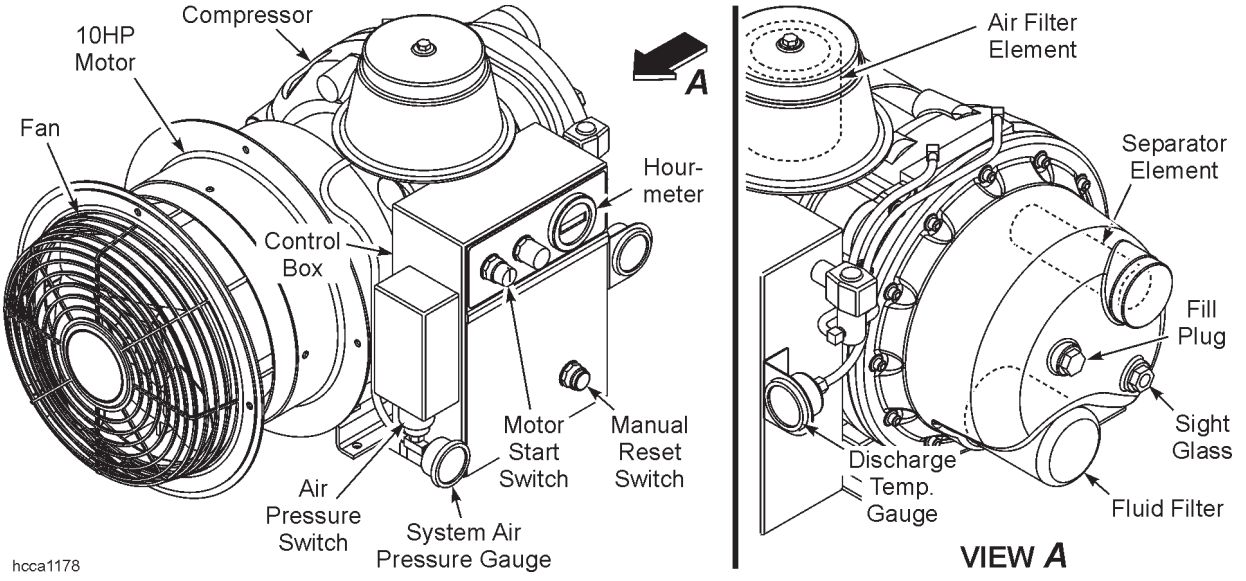
COMPRESSOR SHUTDOWN PROCEDURE

1. Turn the selector switch located on the control box to OFF/RESET position.

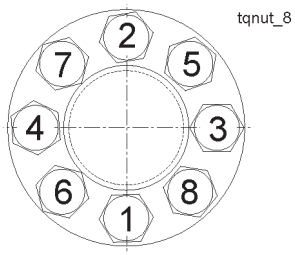
2. Close the shut-off valve to the service line.

COMPRESSOR FLUID LEVEL CHECK

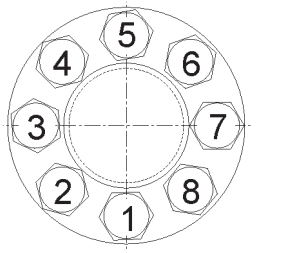
Prior to starting each compressor, check the fluid level in the sump. A sight glass is located on the bell housing. The fluid level in the sight glass should cover 1/4 to 1/2 of the sight glass during operation. DO NOT OVERFILL.



TIGHTENING PROCEDURE FOR ONE 2-INCH TORQUE NUT



STAR Tightening Pattern



CIRCULAR Tightening Pattern

Torque Nut with 8 Jackbolts

1. Ensure that a special steel washer, supplied with the torque nut, is placed beneath the torque nut. DO NOT USE STANDARD COMMERCIAL WASHERS.

2. The jackbolt threads and faces are prelubricated with graphite lube. Ensure that this lube is present. Apply additional lube (PN: MP390331) as needed.

3. Check the base of the torque nut to ensure that all jackbolts are flush with the bottom.

4. Spin the torque nut onto the rod or bolt by hand.

5. Tighten the jackbolts to **114** Ft-Lbs as follows:

   a. Snug all jackbolts to **10** Ft-Lbs each.

   b. Using the STAR pattern shown, tighten all jackbolts to **55** Ft-Lbs.

   c. Switch to the CIRCULAR pattern shown and tighten all jackbolts to **85** Ft-Lbs.

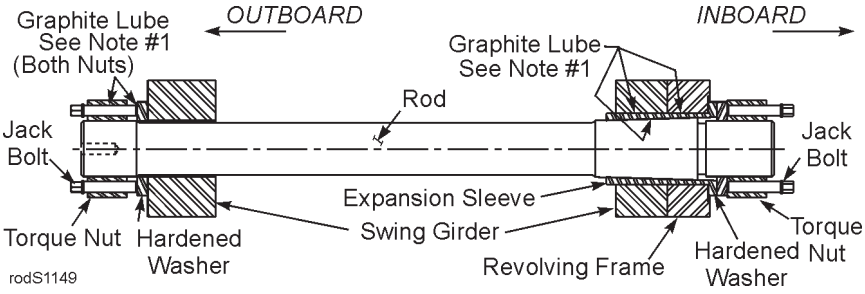
   d. Continue with the CIRCULAR pattern and tighten all jackbolts to **125** Ft-Lbs.

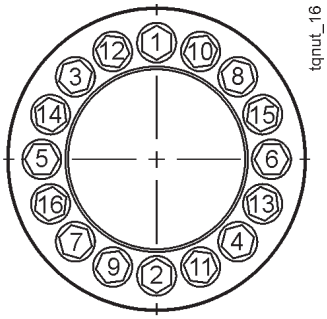
NOTES:

- With longer rods and bolts, stretch in the rod or bolt occurs during tightening of the jackbolts. Therefore, after tightening with the CIRCULAR pattern in step 5-d above, the first jackbolt may have loosened. The higher torque value is used in this step only to speed the tightening process. After performing the above steps, use a torque wrench for the final torque values and continue tightening the jackbolts in a CIRCULAR pattern until all jackbolts are tightened to a value of **114** Ft-Lbs.
- An impact wrench can be used for the initial tightening sequences, *however a torque wrench must be used to achieve the final torque values.*
- Repeat the above steps for all remaining torque nuts.

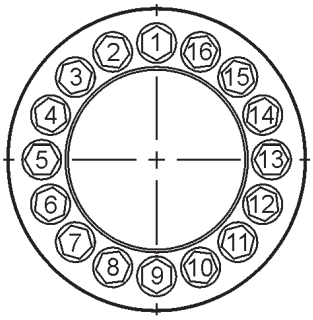
SWING TORQUE ROD & TAPERED SLEEVE

1. The jack bolt threads, tapered portion of the rod bolt and the expansion sleeve ID are prelubricated with graphite lube. Ensure that this lube is present. Apply additional lube (PN: MP390331) as needed. Also apply a thin film of lube to the OD of the expansion sleeve, the revolving frame and swing girder bores, and the jack bolt end faces and threads.





STAR Tightening Pattern



CIRCULAR Tightening Pattern

Torque Nut with 16 Jackbolts

2. Check the base of the torque nut to ensure that all jackbolts are flush with the bottom.

3. Insert the expansion sleeve from inside the frame structure.

4. Insert the tapered stud into the sleeve. Note the direction of the taper on the rod.

5. Slip the special washer (spacer) over the outer threaded end of the stud.

6. Spin the outer torque nut onto the stud by hand.

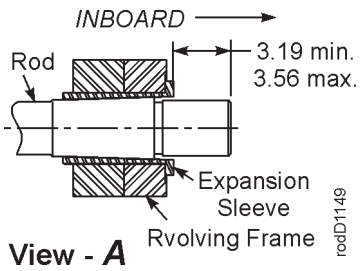
7. Tighten the outer nut jackbolts to **182** Ft-Lbs as follows:

   a. Using the STAR pattern shown, snug all jackbolts (one round only) to approx. **30** Ft-Lbs each.

   b. Continue using the STAR pattern shown, tighten all jackbolts (one round only) to approx. **90** Ft-Lbs.

   c. Switch to the CIRCULAR pattern shown and tighten all jackbolts (one round only) to **182** Ft-Lbs.

   d. Inside the revolving frame, measure the protrusion of the rod bolt beyond the face of the expansion sleeve flange. *Refer to View - A.* It must be within the acceptable range shown.



View - *A*

MAINTENANCE WELDING

These recommendations for repair welding apply to the major structural members of the machine. The high cyclic loading characteristics of the machine are considered in the design and material selected for the construction of the machine. However, due to unusual operational conditions that may be encountered and to the great number of cyclic loadings that may be applied to the machine, fatigue cracks or other abnormalities may occur. Early detection of these conditions through regular machine inspection helps to avoid problems or emergency breakdowns.

Maintenance welding is applied to the repair of cracked or broken structural components. Reconditioning of broken parts by the application of heating, cutting and welding processes requires attention to a number of details, careful adherence to the repair procedure and observance of federal, state and local safety regulations.

CAUTION: WELDING AND THERMAL-CUTTING OF METALS INVOLVE THE GENERATION OF TEMPERATURES UP TO THOUSANDS OF DEGREES AT WHICH METALS MELT AND VAPORIZE. When proper precautions are taken to protect personnel and property against the heat, evolved gases and fumes, electric shock and radiation, no harm will result either to personnel or property. In gas heating and cutting, the handling and storage of compressed gases present other hazards that also must be protected against to provide a safe working environment.

Safety precautions should conform to the latest edition of ANSI standard Z49.1, Safety in Welding and Cutting, published by the American Welding Society.

Reconditioning of failed members requires attention to a number of details and careful application of the repair procedure. Only in certain cases is it necessary to strengthen members by added reinforcement.

WARNING: REINFORCING STRUCTURAL MEMBERS SHOULD BE MADE ONLY UPON RECOMMENDATION BY BUCYRUS INTERNATIONAL, INC. IMPROPERLY APPLIED REINFORCEMENTS CAN HAVE AN ADVERSE EFFECT ON THE PERFORMANCE AND LIFE OF THE STRUCTURE.

A broken member is best repaired by making a complete penetration weld, preferably by welding from both sides, using the correct welding electrode and observing all precautions such as preheat, back-gouging, etc. The complete penetration groove weld should be ground flush with the base metal on both sides to remove all surface irregularities. An alternate procedure incorporates backup bars to ensure sound, complete penetration welds in the repair area. Be sure to follow all applicable safety measures and federal, state and local regulations.

A complete penetration weld repair conditioned by grinding instead of adding reinforcement is favored to maintain the original pattern of stress flow designed into the structural members. Addition of reinforcement which is not part of the design can reduce fatigue strength because of the change in geometry from the original structure.

DUPLEX WIRES - Chromel-Alumel - Type K - 16 AWG Stranded

LENGTH - Total External Resistance for both Wires including Thermocouple not to exceed 2500 Ohms or 410 Feet.

WIRE RESISTANCE - Nominal Resistance, Ohm per Foot at 20°C (66°F) - Chromel - Ohms - Alumel - .0683 Ohms.

WIRE INSULATION - each Conductor Enamel, Asbestos (Twisted Pair) Overall Asbestos Braid

WIRE CODE -Alumel, Negative Wire (Red); Chromel, Positive Wire (Yellow)

OVERALL COLOR - Yellow

CATALOG No. 16-59-17

POLARITY DISCONNECT

CHROMEL-ALUMEL COMPENSATED CONNECTION

JACK Color Code (Yellow) - Catalog No. 040419

PLUG Color Code (Yellow) - Catalog No. 040434

CABLE CLAMP - Catalog No. 072513

ADAPTER - Catalog No. 076794

THERMOCOUPLE ELEMENT

CHROMEL-ALUMEL - Type K - Swaged One (1) Inch Stripped

CHROMEL POSITIVE WIRE Color Code (None)

ALUMEL NEGATIVE WIRE Color Code (Red)

CATALOG No. 8784-K-1-3-12"-D

1. 588003 Kaopak Flex Heaters
2. 588004 Kaopak Collector Streamer Type
3. Kaopak Blankets 3, 5, or 6 Pocket Size as needed for Size Pipe being Stressed Relieved

Thermocouple Assembly, Complete

Catalog No. 8784-K-1-3-12"-Q

Temperature Indicating Pellets (Tempil° Pellets)

Indicating Temperature: 1050°F, 1100°F, 1200°F, and 1250°F.

(Several of each temperature)

INSPECTION DATA

It is essential to maintain a well-planned program of periodic inspection. Frequently, there are statutory and/or regulatory agencies that incur additional requirements that must be adhered to. Refer to the suggested procedures that follow.

Abrasion - Bending and crushing represent the ABC's of wire rope abuse. It is the primary goal of a good inspection practice to uncover such conditions early enough that corrections may be made, or ropes replaced safely with minimum effort. When any sudden degradation indicates a loss of original rope strength, a timely decision is required as to allowing the rope to remain in service. Such a decision can only be made by an experienced inspector. His/her determination should be based on:

1. Details of the equipment's operation.
2. Frequency of inspection.
3. Maintenance history.
4. Consequences of failure.
5. Historical records of similar equipment.

To ensure sufficient information can be obtained, the following pages contain guidelines that should be adhered to.